AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Fast Start Inflexibility Profile

June 2021

NER 3.8.19(d)-(g)

Important notice

PURPOSE

AEMO has prepared this document to provide information on the fast start inflexibility profile and how AEMO's central dispatch system processes the profile, as at the date of publication.

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VERSION CONTROL

Version	Release date	Changes
1.0	09/02/2010	Initial release
1.1	10/10/2014	Apply new AEMO template and expand the range of information
1.2	30/06/2021	Apply new AEMO template. Include FSIP in 5MPD. Include guidance on scheduled loads and wholesale demand response units.

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1. Introduction

This document provides information on the dispatch inflexibility profile associated with fast start plant and explains how AEMO's central dispatch system uses these profiles in scheduling, pricing, and dispatching the National Electricity Market (NEM).

Section 2 discusses the characteristics of fast start generating units. It focuses on the dispatch inflexibility profile and the various operating modes that a fast start unit might occupy. The dispatch inflexibility profile is introduced in section 3.8.19 of the National Electricity Rules (NER). The dispatch inflexibility profile is commonly referred to as the fast start inflexibility profile (FSIP).

While the focus of this guide is on fast start generating units, the principles are equally applicable to scheduled loads and wholesale demand response units. NER 3.8.19(f) and – from 24 October 2021 – NER 3.8.19(f1) place similar but less prescriptive requirements on scheduled loads and wholesale demand response units to supply any MW capacity and time-related inflexibilities if they submit a dispatch inflexibility profile in their bids.

Section 3 discusses the use and pre-processing of fast start parameters in real-time dispatch (RTD). Pre-processing consists of passing the NEM Dispatch Engine (NEMDE) the necessary information in the appropriate format for committing and dispatching fast start units. This section focuses on some non-standard scenarios for fast start plant in which their operating mode and times might need to be reset before passing to NEMDE.

Section 4 discusses the use and pre-processing of fast start parameters in five-minute pre-dispatch (5MPD).

Section 5 discusses the commitment and dispatch of fast start plant in NEMDE. It describes the two-pass solution scheme designed to overcome the possible over-commitment of fast start units, and how dispatch inflexibility profiles and operating modes are used in this process.

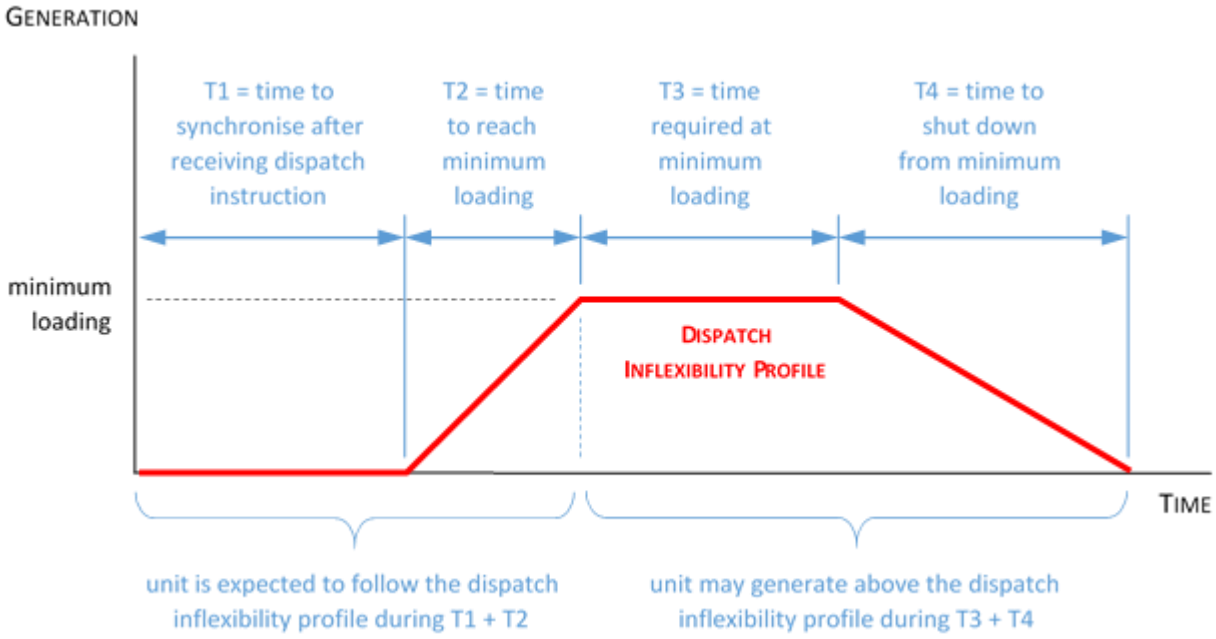
2. Fast start generating units

This section discusses the characteristics of fast start generating units. It focuses on the dispatch inflexibility profile, and the various operating modes that a fast start unit might occupy.

A fast start generating unit is a unit that can synchronise and reach its minimum loading within 30 minutes, and can synchronise, reach minimum loading, and shut down in less than 60 minutes. It must register with AEMO as a fast start unit to participate in the NEM as a fast start unit but can submit offers as a fast start or slow start unit.

A fast start generating unit must submit a dispatch inflexibility profile to be dispatched as a fast start unit. The format of the dispatch inflexibility profile is defined in section 3.8.19(e) of the Rules and consists of the parameters shown schematically in Figure 1. The dispatch inflexibility profiles for scheduled loads and wholesale demand response units are compared to this profile in Appendix 1.

Figure 1: Characteristics of a dispatch inflexibility profile for a fast start generating unit



where

T1, T2, T3, T4 ≥ 0

at least one of T1, T2, T3, T4 > 0

T1 + T2 ≤ 30 minutes

T1 + T2 + T3 + T4 < 60 minutes

T1, T2, T3, T4 are all measured in minutes

At the start of each dispatch run NEMDE must also be told which segment of the inflexibility profile the unit is sitting on, and how long the unit has been there, in order to commit and dispatch fast start units. The

position of a unit on the inflexibility profile is known as its mode. Fast start units can be assigned any one of the operating modes shown in Table 1.

Table 1: Fast start modes and descriptions

Mode	Mode Title	Mode Description
Mode 0	Offline Mode	The fast start unit is offline.
Mode 1	Synchronising Mode	The fast start unit has received a dispatch instruction to generate. This mode lasts for T1.
Mode 2	Start Up Mode	The fast start unit is generating but has not reached minimum loading. It is on fixed dispatch. This mode lasts for T2.
Mode 3	Minimum Loading	The fast start unit has reached minimum loading but has not operated at or above this level for the required time. This mode lasts for T3.
Mode 4	Normal Operation (Time in Mode < T4)	The fast start unit has been running at or above minimum loading for more than T3 but not longer than T3+T4. Energy dispatch is still lower bounded by the dispatch inflexibility profile.
Mode 4	Normal Operation (Time in mode ≥ T4)	The fast start unit is dispatched the same as any other scheduled unit until the dispatch target becomes ≤ 0.005 MW, in which case the fast start unit is placed into the Offline mode.

3. Pre-processing of fast start parameters for real-time dispatch

This section discusses the use and pre-processing of fast start parameters at the start of each RTD run. Pre-processing consists of passing NEMDE the necessary information in the appropriate format for committing and dispatching fast start units.

The previous section discussed the standard operation of fast start units from synchronisation to shutdown. In standard fast start operation NEMDE needs to know, at the start of each RTD run:

- the mode that a fast start unit is operating in; and
- how long it has been in that mode.

This section discusses three non-standard scenarios for fast start plant in which the operating mode and times might need to be reset before passing to NEMDE.

3.1 A fast start unit offers to run as slow-start

If a fast start unit offers in all fast start timing parameters (T1, T2, T3, and T4) as zero or null, then the unit will be dispatched by NEMDE as a slow-start unit i.e. without a dispatch inflexibility profile.

3.2 A fast start unit previously running as slow start changes to fast start

A fast start unit is deemed to be making a transition from slow-start to fast start if the following conditions are met:

- The unit has offered a non-zero fast start timing parameter (T1, T2, T3, or T4)
- The unit was scheduled for energy in the previous dispatch run (TotalCleared > 0)
- The unit was not operating in a fast start dispatch mode in the previous dispatch run (DispatchMode = 0)
- The unit is available to produce energy in the current dispatch run (MaxAvail > 0)

In this case the unit is dispatched by NEMDE as a fast start unit with an operating mode and time determined by the following logic:

IF InitialMW < 1 MW

THEN Reset CurrentMode to 0 and CurrentModeTime to 0

ELSE Reset CurrentMode to 4 and CurrentModeTime to T4

During intervention pricing, the same logic should be applied to the What-If pricing run to reset the What-If CurrentMode and What-If CurrentModeTime.

If the conditions for making a transition from running as slow-start to fast start are not met, then the unit remains as slow-start, and no pre-processing is required to reset the operating mode and time.

3.3 A fast start unit operating in an inflexible mode re-offers unavailable

If a fast start unit operating in one of the fast start modes is re-offered as unavailable, then the unit should be decommitted. A fast start unit is deemed to be making this transition if:

- The unit has offered a non-zero fast start timing parameter (T1, T2, T3, or T4).
- The unit was operating in fast start dispatch mode 0, 1, 2, 3, or 4 in the previous dispatch run.
- The unit is offered unavailable (MaxAvail = 0).

In this case the unit is dispatched by NEMDE as a fast start unit with an operating mode and time determined by the following logic:

IF InitialMW < 1 MW and CurrentMode is 0

THEN Reset CurrentMode to 0 and CurrentModeTime to 0

ELSE Reset CurrentMode to 4 and CurrentModeTime to T4

During intervention pricing, the same logic should be applied to the What-If pricing run to reset the What-If CurrentMode and What-If CurrentMode ime.

If the conditions for the fast start unit to re-offer as unavailable are not met, then the unit remains as fast start, and no pre-processing is required to reset the operating mode and time.

4. Pre-processing of fast start parameters for five-minute pre-dispatch

This section discusses the use and pre-processing of fast start parameters in 5MPD.

Dispatch inflexibility profiles for the first period of 5MPD are treated the same way as in the current RTD run, described in sections 2 and 3.

For all subsequent periods of 5MPD, the TargetMode and TargetModeTime from the previous period is used as the CurrentMode and CurrentModeTime. (And for all other periods of 5MPD during intervention pricing, the What-If TargetMode and What-If TargetModeTime from the previous period is used as the What-If CurrentMode and What-If CurrentModeTime.)

Furthermore, the dispatch inflexibility profile used in the first period of 5MPD – which is the dispatch inflexibility profile used in the current RTD run – will be used for every period of 5MPD. This means:

- a fast start unit cannot rebid to run as slow start during a 5MPD run; and
- a fast start unit running as a slow start unit cannot rebid to run as fast start during a 5MPD run.

This section discusses the consequences of using the same dispatch inflexibility profile for each period of 5MPD in two other non-standard scenarios.

4.1 A fast start unit operating in an inflexible mode re-offers unavailable

Dispatch inflexibility profiles are applied to entire trading days, while maximum availabilities are applied to each trading interval within a trading day. It is therefore possible that a unit may change its MaxAvail to zero during the 5MPD forecast horizon at a time when it is on an inflexible segment of its profile.

In this case 5MPD will continue to schedule the unit, and price the market, by following the dispatch inflexibility profile. This is because the constraint violation penalty (CVP) factors associated with the dispatch inflexibility profile are higher than the CVP factor for MaxAvail. This is similar to the situation in 30-minute pre-dispatch (PD) in which a unit may change its MaxAvail to zero but be unable to reach that target due to ramp rate constraints, because the CVP factor for ramp rates is higher than the CVP factor for MaxAvail.

4.2 A fast start unit changes its dispatch inflexibility profile between adjacent trading days

A fast start unit might change its dispatch inflexibility profile between adjacent trading days. If the 5MPD forecast horizon spans the transition between trading days at 0400 hrs, 5MPD will continue to use the previous trading day's profile for the entire forecast horizon.

5. Two-pass solution for fast start commitment

This section focuses on the two-pass solution scheme designed to overcome the possible over-commitment of fast start units. This scheme applies in RTD and each period of 5MPD. The two-pass solution is summarised in Table 2.

Table 2: Summary of two-pass solution scheme for fast start commitment

Step	Description
Step 1	The dispatch inflexibility profiles for all fast start units are ignored in the first pass of NEMDE
Step 2	Fast start units are committed based on the results from Step 1 and their operating mode at the start of the dispatch run
Step 3	The dispatch inflexibility profiles for all fast start units committed in Step 2 are enforced in the second pass of NEMDE

5.1 Step 1

A fast start commitment solve is performed in the first pass. In this solve all fast start units are modelled with their dispatch inflexibility profile constraints ignored. Any bid and SCADA-metered energy ramp rate constraints and joint ramping constraints for fast start units that are in modes 0, 1, or 2 at the start of the current RTD run or 5MPD period are also ignored. The purpose of Step 1 is to estimate the amount of energy that would be dispatched from fully flexible fast start units.

5.2 Step 2

Step 2 determines the target operating mode for all fast start units at the end of the current RTD run or 5MPD period, based on their operating mode at the start of the RTD run or 5MPD period, and their MW target from Step 1.

5.2.1 Continuation

All fast start units that were committed at the start of the current RTD run or 5MPD period have their target operating modes set to follow their dispatch inflexibility profile (these are the profile constraints during T1 and T2, and a minimum loading – or "greater than or equal to" – constraint in T3 and T4). The exception is for decommitting fast start units that progress beyond T4 at the end of the current interval, as described below.

5.2.2 Decommitment

Once a fast start unit has operated at or above minimum loading for T3 the unit enters normal operation mode. The minimum loading constraint is removed and the unit becomes flexible, subject to a lower bound which is the most restrictive of the bid/telemetered down ramp rates and the T4 profile. The T4 lower bound is proportional to the time spent in the normal operating mode and reduces to zero after T4 minutes, leaving

the unit constrained by the bid/telemetered down ramp rates only. At the end of T4 units will be decommitted the first time their dispatch target is less than or equal to the fast start threshold of 0.005 MW. They will resume their fast start status at Mode 0 after they have ramped down to zero at the most restrictive of their bid/telemetered ramp down rates.

5.2.3 Commitment

Units in Mode 0 at the start of the current RTD run or 5MPD period are candidates for start-up (entering Mode 1). A unit will be started if its MW result from Step 1 is greater than the fast start threshold of 0.005 MW. The target mode for the end of current RTD run or 5MPD interval, which is used in Step 3, is calculated according to its start-up profile. For example, units having T1+T2 < 5 minutes will enter Mode 3. Step 3 may then determine non-zero MW generation targets for the end of the current RTD run or 5MPD period.

5.3 Step 3

A second-pass dispatch and pricing solve is performed with all the constraints of the fast start units set in accordance with their dispatch inflexibility profile and their target operating mode as determined in Step 2. This solve produces the final real-time MW targets and regional prices for the current RTD run and each period of 5MPD.

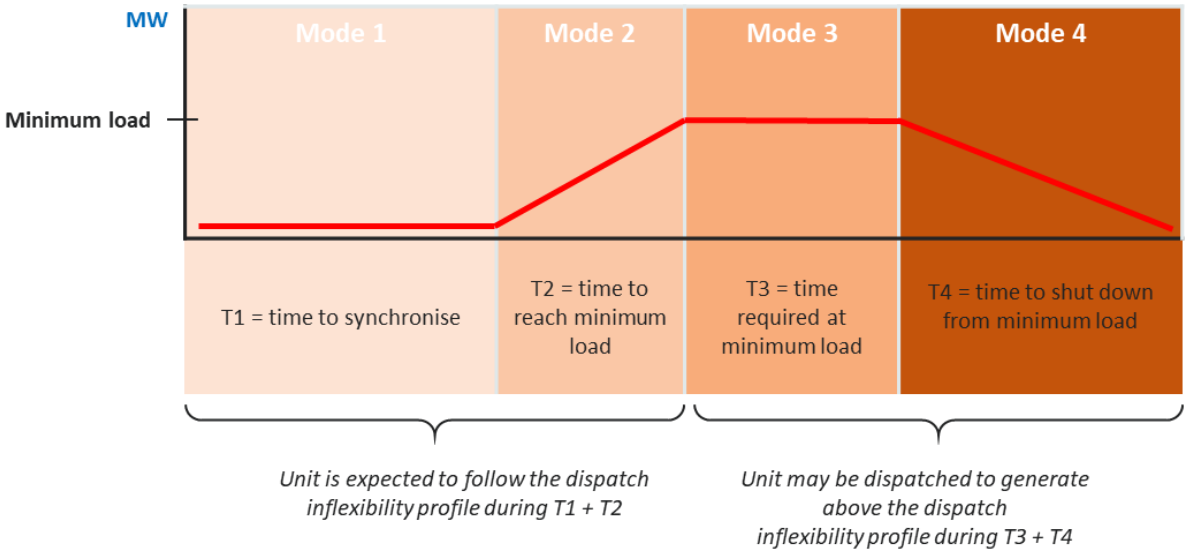
5.4 Basslink switch run and intervention constraints

NEMDE is required to perform a Basslink switch-run every time it runs RTD and in each period of 5MPD. In unusual circumstances NEMDE may also be required to perform intervention pricing runs. These requirements add to the potential number of NEMDE runs required each interval. However, they do not change the logic used in the two-pass solution scheme for committing and decommitting fast start plant.

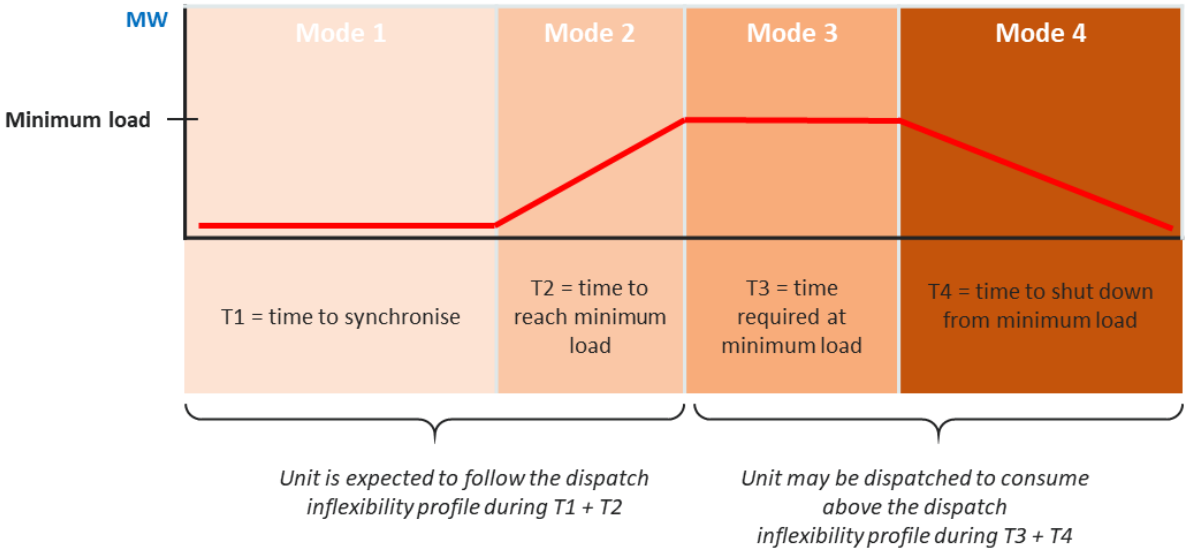
Appendix 1

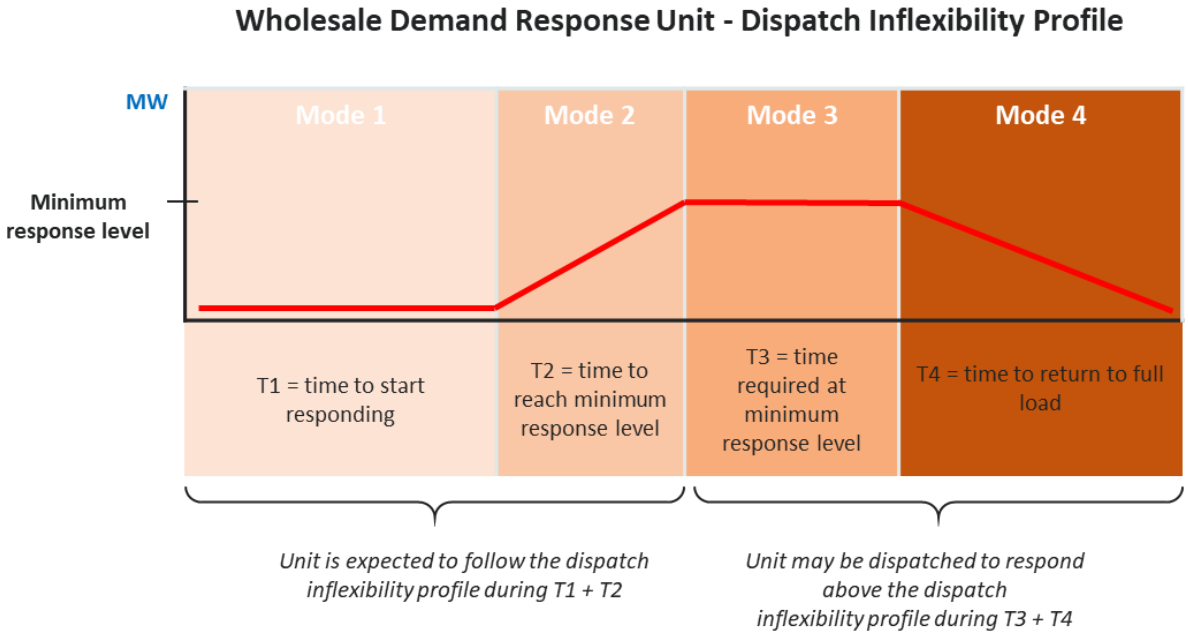
This appendix compares the dispatch inflexibility profiles for fast start generating units, scheduled loads, and wholesale demand response units.

Fast Start Generating Unit - Dispatch Inflexibility Profile



Scheduled Load - Dispatch Inflexibility Profile





In all cases:

T1, T2, T3, T4 ≥ 0

at least one of T1, T2, T3, T4 > 0

T1 + T2 ≤ 30 minutes

T1 + T2 + T3 + T4 < 60 minutes

T1, T2, T3, T4 are all measured in minutes

Glossary

This document uses many terms that have meanings defined in the NER. The NER meanings are adopted unless otherwise specified.

Term	Definition
5MPD	Five-minute pre-dispatch (also known as P5 or P5Min)
AEMO	Australian Energy Market Operator
CVP	Constraint violation penalty
FSIP	Fast start inflexibility profile (also known as dispatch inflexibility profile)
NEM	National Electricity Market
NEMDE	NEM Dispatch Engine
NER	National Electricity Rules
RTD	Real-time dispatch