

The Imbalance Pricing System as at 01-01-2001, revised per 26-10-2005

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Version 3.4

Version	Date	Modification History
1.00	30-11-2000	Initial draft
1.1	07-12-2000	Revision of Incentive Component Table
2.0	21-12-2000	Decree by DTe 00127 dated 19-12-2000
2.1	01-02-2001	Explanation 5.2.3 adapted
3.1	01-08-2005	Complete overhaul of document, Decree by DTe 102055 dated 26-10-2005, bidirectional regulation redefined
3.2	01-12-2006	Revision in 3.3 upgraded functionality LFC
3.3	01-05-2009	Revision in 5 update decision tree
3.4	02-06-2010	Incentive Component removed to Implementation Guide

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Preliminary comment:

The *modus operandi* as outlined in this document is anchored in DTe Decree 00127 dated 19-12-2000 as amended by DTe Decree 102055 dated 26-10-2005.

1. Summary

This document describes TenneT's implementation of Decree by DTe 00127 dated 19-12-2000 as amended by Decree 102055 dated 26-10-2005.

These decrees relate to Chapter 3.9 of the Netherlands System Code.

Attention is first devoted to the notion of system balancing and the associated duties and roles bestowed upon:

- TenneT, in its capacity as administrator of the national high voltage grid,
- Programme Responsible Parties (PRPs) with their underlying market players.

The systematics as described contain the computation rules applied to derive the imbalance price per direction¹ from:

- the established regulation state,
- the price of measures having been taken on TenneT's behalf so as to preserve or restore system balance,
- the incentive component.

The financial consequences are explained relative to the system service tariff.

The document finally outlines the grounds on which as well as the ways in which the incentive component will be revised (art. 3.9.8, System Code).

2. Duties and roles of TenneT and Programme Responsible Parties in System Balancing

TenneT, in its capacity as grid administrator of the national high voltage grid, and pursuant to the Electricity Act 1998, is under the obligation to monitor and “preserve” the balance between electrical power injected into and taken from the Dutch electricity grid² including in relation to other countries. The main instruments which TenneT has at its disposal in acquitting itself of these duties are of a purely *administrative* nature, viz.:

- Programme Responsibility (PR),
- Single buyer sourcing³ of regulating and reserve as well as emergency power,
- Settlement.

The parties involved are the following:

- TenneT in its capacity as grid administrator of the national high voltage grid,
- Programme Responsible Party (PRP),
- Regulating and reserve power supplier (RRPS)³,
- Emergency power supplier (EPS).

¹ Surplus or shortfall.

² “Electricity grid” is defined in this context as the aggregate of all grids irrespective of voltage level or grid administrator.

³ Both up- and downward regulating!

2.1 Preparation (day ahead of operational day)

The PR system is aimed at ensuring a balanced intended supplying and sourcing energy use of the system by market players, across the programme time unit (PTU⁴).

This is communicated by having all Programme responsible Parties (PRPs) set out their proposed market transactions per PTU in the form of E Programmes.

These E Programmes are submitted to TenneT, which checks them and gives its approval provided they have been found to be consistent internally as well as externally.

Connected parties whose contracted and allotted transport capacity exceed 60 MW are moreover under the obligation⁵ to make available to TenneT, in the form of *bids*, such excess power as they are capable of generating more or less or as they can reduce their consumption by; other connected parties are allowed to do so⁶.

2.2 Implementation (operational day)

PRPs are required throughout implementation to act in accordance with the E Programmes they have submitted to TenneT and which have been approved by the latter, and are thus bound to preserve the balance per individual PTU.

TenneT continually monitors and adjusts the collective actions of the full complement of market players *within* the PTU in question, automatically compensating in the process the imbalance, if any, of the full complement of deviations from E Programmes *per* PTU.

To this end TenneT requests the RRPS/EPS that these deploy the power having been bid in, or otherwise made available:

- in so far as there is a (threatening) power shortfall in the system, TenneT suppletes by requesting power from the suppliers of upward regulating power,
- in so far as there is a (threatening) power surplus in the system, TenneT absorbs by requesting (negative) power to the suppliers of downward regulating power.

2.3 Settlement (after operational day)

The settlement stage is where the energy which TenneT has *requested* is settled with RRPS-es/EPS-es:

- The requested energy from bids activated is settled with the RRPS per direction, per PTU against the ladder price for each direction that has been deployed⁷,
- The balance of the requested energy per RRPS/EPS per PTU in both directions is adjusted on the imbalance of the PRP of the relevant RRPS/EPS.

Settlement moreover involves deviations from approved E Programmes; these deviations are, per PRP and per PTU, established as *imbalance*, with TenneT effecting settlement with each PRP:

- PRPs eventually having supplied energy to the system per PTU (PRP surplus) are deemed to have sold such energy to TenneT,
- PRPs eventually having sourced energy from the system per PTU (PRP shortfall) are deemed to have bought such energy from TenneT.

⁴ Clock-quarter (15 mins).

⁵ Grid Code, art. 5.1.1.1.a.1

⁶ Grid Code, art. 5.1.1.1.a.2

⁷ See section 3.3 below.

2.4 Incentives

The premise underpinning the imbalance pricing system is the use of a market-led imbalance price by correlating it to the variable costs of the sourcing of regulating and reserve power³, and emergency power.

The mechanism of having suppliers tender their bids on a daily basis (open to adjustment 4 PTU's prior to the PTU of implementation) ensures that the current market price of regulating, reserve and emergency power can be established.

The deployment of these resources in accordance with the ladder system implies that the best-priced bids are activated first (if compliant with relevant preconditions), with the price of subsequent activated bids going up at the upward regulating side or down at the downward regulating side⁸. Significant discrepancies may occur between bid prices and the generally accepted market price for electricity when supplies are scarce⁹.

A supplier of downward regulating power will usually pay compensation to TenneT in return (having already sold the energy to some other party, and by not having to produce this energy, thus saving on fuel and other cost).

However, the (bid) price for downwards regulating power may as well be negative, i.e. with TenneT paying for the energy supplied to the provider.

Programme Responsibility and the sourcing of regulating and reserve power generate at the settlement stage the following (dis) incentives *vis-à-vis* the market:

- At the preparatory stage:
 - Imbalance Minimal,
 - Imbalance Inadvertent,
 - Risk of bidding less or equal to risk of not bidding¹⁰.
- At the implementation stage:
 - Balance disruptive actions: disincentive,
 - Balance restoring actions: incentive,
 - Risk of *requested* actions less or equal to risk of *unrequested* actions¹¹.

⁸ See section 3.3 below.

⁹ It is standard practice to wield the APX day-ahead price as representative of the market price.

¹⁰ See section 3.5 below.

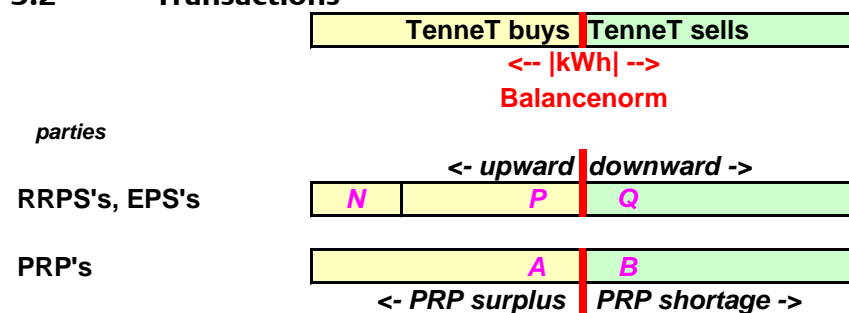
¹¹ See section 3.5 below.

3. Systematics

3.1 Premises

- An imbalance price is required to be set per PTU, both for imbalance surplus and shortfall.
- An upward and/or downward regulating price may or may not be established per PTU.
- The imbalance price includes an incentive component ≥ 0 €/MWh adjusted on a weekly basis¹².
- The annual financial balance from transactions between TenneT on the one hand and RRPS/EPs and PRPs on the other is settled in the system service tariff applied in respect of the next year (as per art. 3.9.9 of the System Code)¹³.

3.2 Transactions



The following transactions are deemed to be effected between TenneT and the RRPS/EPs through deployment of regulating and reserve bids and emergency power:

- upward regulation side:
 - RRPS supplies to TenneT the requested volume (P) at upward regulating price,
 - EPs supplies to TenneT the volume (N) at emergency power price,
 - TenneT pays RRPS/EPs.
- downward regulating side:
 - RRPS sources from TenneT the requested volume (Q) at downward regulating price,
 - RRPS pays TenneT (the downward regulating price may have a negative value, in which case it will be TenneT which pays the RRPS).

The following transactions are deemed to be effected between TenneT and PRP in imbalance:

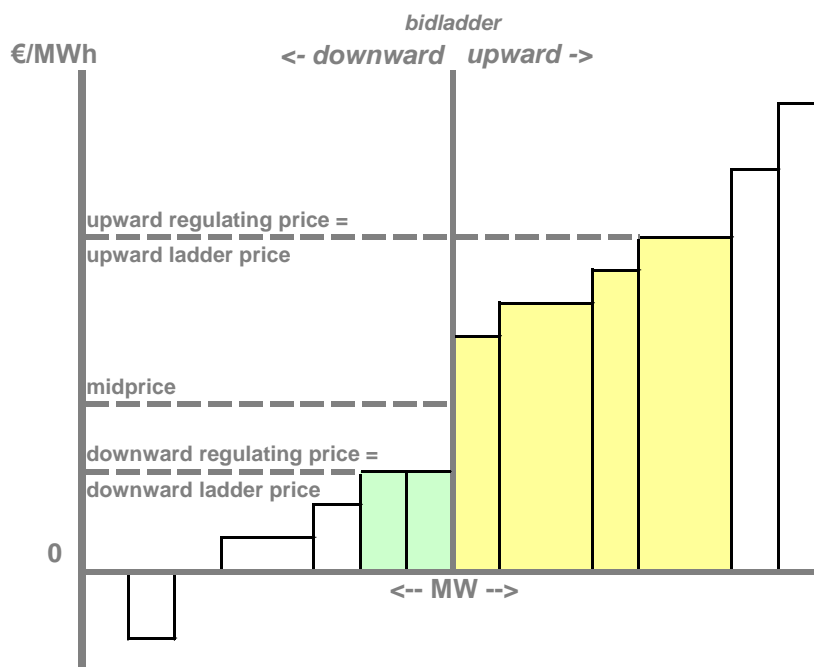
- Imbalance PRP surplus:
 - PRP supplies the energy in imbalance (A) to TenneT at imbalance price surplus,
 - TenneT pays PRP (the imbalance price may have a negative value, in which case it will be PRP which pays TenneT).
- Imbalance PRP shortfall:
 - PRP sources energy in imbalance (B) from TenneT at imbalance price shortfall,
 - PRP pays TenneT (the imbalance price may have a negative value, in which case it will be TenneT which pays PRP).

¹² Chapter **Fout! Verwijzingsbron niet gevonden..**

¹³ TenneT is disinterested in the financial results of system balancing.

3.3 Bid ladder and regulating price (arts. 3.9.2 to 3.9.6, System Code, Implementation Regulations)

- Bids are deployed/dispatched by TenneT in accordance with the bid parameters and TenneT's requirements as derived from UCTE Policy 1.
- TenneT can deploy multiple regulating capacity bids in parallel in order to obtain the regulating speed in MW/min that it requires.
- Upward adjustment bids (+) are deployed/dispatched by TenneT in order of increasing bid price.
- Downward adjustment bids (-) are deployed/dispatched in order of decreasing bid price.
- Deployment of a regulating capacity bid in a PTU occurs when TenneT allocates a setpoint to a non-deployed bid in the regulating direction that is on offer.
- If a setpoint is allocated to a bid at the end of a PTUN, that bid will be deployed in the next PTU, unless:
 - the bid no longer exists in PTUN+1;
 - the sign (+/-) of the correction required by TenneT in PTUN+1 does not correspond with the sign of the bid's setpoint at the end of PTUN;
 - the correction required by TenneT at the beginning of PTUN+1 is allocated to other bids with lower prices (if it concerns upwards adjustment) or other bids with higher prices (if it concerns downwards adjustment).
- Setpoints that are allocated to regulating capacity bids that are no longer deployed in PTUN+1 are readjusted to 0 in PTUN+1, with due regard for the regulating speed of the bid deployed in PTUN.
- A bid is activated as reserve capacity when TenneT sends a dispatch notification to the supplier
- The volume to be allocated to suppliers is settled per PTU per direction. Positive bids are settled at the price of the highest activated bid in that PTU (i.e. the price for upward adjustment). Negative bids are settled at the price of the lowest activated bid deployed in that PTU (i.e. the price for downward adjustment).
- If no price for upward or downward adjustment is available, the volume to be allocated to suppliers per PTU per direction is settled at the upward or downward adjustment price of the previous PTU.



Where neither an upward or downward ladder price can be set¹⁴, the imbalance price (exclusive of the incentive component) will be fixed at the mid price, i.e. the midpoint between the lowest bid price at the upward and the highest bid price at the downward regulating side.

¹⁴ Where it has not been necessary or possible for TenneT to deploy regulating power.

3.4 Dependencies

party	EPS	RRP		PRP	
	<i>upward</i>	<i>upward</i>	<i>downward</i>	<i>surplus</i>	<i>shortage</i>
Volume [kWh]/PTE	<i>N</i>	<i>P</i>	<i>Q</i>	<i>A</i>	<i>B</i>
Price €/kWh	Pem	Pup	Pdo	Psurp	Pshort
reg. state: 0	Pnull	Pnull	Pnull	Pmid - ic	Pmid + ic
-1	Pnull	Pup, Pnull	Pdo	Pdo - ic	Pdo + ic
+1	Pnull	Pup	Pdo, Pnull	Pup - ic	Pup + ic
2	Pnull	Pup	Pdo	Pdo - ic	Pup + ic
-1, em	Pem	Pup	Pdo	Pdo - ic	Pdo + ic
+1, em	Pem	Pup	Pdo	max(Pem, Pup) - ic	max(Pem, Pup) + ic
2, em	Pem	Pup	Pdo	Pdo - ic	max(Pem, Pup) + ic

“Price” abbreviations used: Pem – emergency power, Pup – upscaling, Pdown – downscaling, Psurp – surplus, Pshort – shortfall, Pnull – undefined, Pmid – midpoint price, ic – incentive component.

The PRP’s imbalance price is determined by:

- The direction of the PRP’s imbalance:
 - Surplus, supplying in imbalance,
 - Shortfall, sourcing in imbalance.
- The regulation state, determined by TenneT as follows: where TenneT in any PTU regulates¹⁵:
 - Neither upward nor downward: **0**,
 - Exclusively upward: **+1**,
 - Exclusively downward: **-1**,
 - Both upward and downward, with the balance delta¹⁶ representing:
 - a continuous non-decremental sequence: **+1**,
 - a continuous non-incremental sequence: **-1**,
 - neither a continuous non-incremental nor a continuous non-decremental sequence: **2**,
 - both a continuous non-incremental and a continuous non-decremental sequence: **2**.
- The level of the incentive component.
- The regulating prices:
 - Regulation state **-1** of **2**: downward regulating price = downward ladder price ,
 - Regulation state **+1** of **2**:
 - upward regulating price without emergency power being deployed = upward ladder price,
 - upward regulating price with emergency power being deployed = upward ladder price or, if higher, emergency power price.
- The midprice, where the regulation state is **0**.

¹⁵ This expression is being used for the sake of brevity, even though TenneT deploys bids rather than dispatches power itself.

¹⁶ The actual contribution to system balancing which TenneT requests from RRPS(EPS), as published by TenneT on a per-minute basis, i.e. 15 values for each PTU. In a continuous non-decremental series each subsequent value is greater than or equal to the previous value within this PTU whereas in a continuous non-incremental series it is smaller than or equal to the previous value.

3.5 Risks

The system entails the following risks related to bidding and operational behaviour.

A bid is an option, with the bidder putting out a minimum condition (bid price) for acceptance of the risks of a particular volume (up to the extent of the bid per PTU) in imbalance adjustment.

The TenneT-requested volume from a bid generates additional turnover for the bidder¹⁷.

Where the bidder comprehensively complies with the requested volume, TenneT's adjustment of the imbalance will not bring about any additional imbalance volume.

Where the bidder does not (comprehensively) comply with the requested volume, TenneT's adjustment of the imbalance will bring about an imbalance volume to be effectively offset in the amount of the "failed" portion, in the opposite direction to that of the requested volume.

The risk is the price difference between the two set-offs, and will usually be confined to the incentive component¹⁸.

Additional (positive and negative) price risks will occur for the "failed" portion for:

- Requested upward regulating power and regulation state -1: $P_{up} - P_{down}$ ¹⁹
- Requested downward regulating power and regulation state +1: $P_{down} - P_{up}$ ¹⁹
- Requested upward regulating power and deployment of emergency power: $P_{up} - P_{em}$ ¹⁸

Any imbalance on the part of a PRP in the same direction as that of the system will intensify the use being made of the bid ladder and thus, exacerbate the collective imbalance price risk.

Any imbalance on the part of a PRP in the opposite direction to that of the system will reduce the use being made of the bid ladder and thus, lessen the collective imbalance price risk, and will be offset – except for the incentive component – at the same price as the requested volume from bids.

The main risks are the incentive component¹⁸, regulation state 2 and, where emergency power is being deployed²⁰, the chance that the regulation state will cease being +1 at any given moment.

¹⁷ This is deemed profitable to the bidder as the bidder sets the minimum condition.

¹⁸ TenneT at the collecting end.

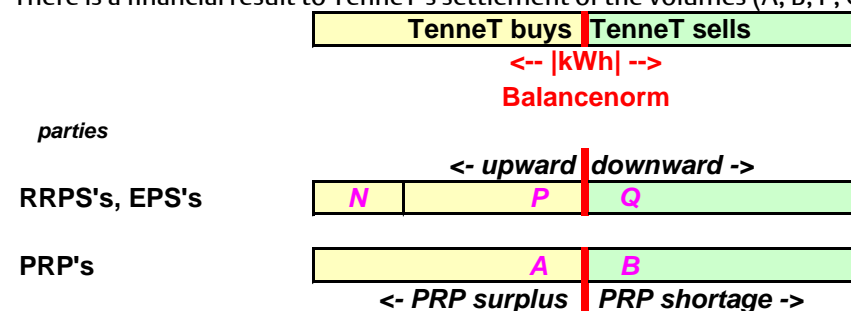
¹⁹ TenneT at the paying end.

²⁰ PRP surplus is offset at a higher price where the regulation state is +1 than the requested volume of bids at the upscaling end.

4. Financial results and system service tariff

4.1 Inherent

There is a financial result to TenneT's settlement of the volumes (A, B, P, Q, N) at the designated prices.



The basic formula that applies to the financial result is:

$$(Q * P_{do} + B * P_{short}) - (N * P_{em} + P * P_{up} + A * P_{surp})$$

Or:

$$B * P_{short} - A * P_{surp} + Q * P_{down} - P * P_{up} - N * P_{em}$$

Elaborated per regulation state, this becomes:

reg. state: 0	$B * (P_{mid} + ic)$	$- A * (P_{mid} - ic)$	
-1	$B * (P_{do} + ic)$	$- A * (P_{do} - ic)$	$+ Q * P_{do} - P * P_{up}$
+1	$B * (P_{up} + ic)$	$- A * (P_{up} - ic)$	$+ Q * P_{do} - P * P_{up}$
2	$B * (P_{up} + ic)$	$- A * (P_{do} - ic)$	$+ Q * P_{do} - P * P_{up}$
-1, em	$B * (P_{do} + ic)$	$- A * (P_{do} - ic)$	$+ Q * P_{do} - P * P_{up} - N * P_{em}$
+1, em	$B * (\max(P_{em}, P_{up}) + ic)$	$- A * (\max(P_{em}, P_{up}) - ic)$	$+ Q * P_{do} - P * P_{up} - N * P_{em}$
2, em	$B * (\max(P_{em}, P_{up}) + ic)$	$- A * (P_{do} - ic)$	$+ Q * P_{do} - P * P_{up} - N * P_{em}$

Where $P_{em} > P_{up}$, and after a bit of reshuffling this becomes:

reg. state: 0	$(B - A) * P_{mid}$		$+ (A + B) * ic$
-1	$(B - A + Q) * P_{do}$	$- P * P_{up}$	$+ (A + B) * ic$
+1	$(B - A - P) * P_{up}$	$+ Q * P_{do}$	$+ (A + B) * ic$
2	$((A + B) - (P + Q)) * (P_{up} - P_{do})/2$		$+ (A + B) * ic$
-1, em	$(B - A + Q) * P_{do}$	$- (P + N) * P_{em}$	$+ P * (P_{em} - P_{up}) + (A + B) * ic$
+1, em	$(B - A - P - N) * P_{em}$	$+ Q * P_{do}$	$+ P * (P_{em} - P_{up}) + (A + B) * ic$
2, em	$((A + B) - (P + N + Q)) * (P_{em} - P_{do})/2$		$+ P * (P_{em} - P_{up}) + (A + B) * ic$

A positive component in the financial result occurs where:

- $p_c > 0$,
- $P_{em} > P_{up}$.

Where implementation is perfect and $p_c = 0$, no financial result occurs in the other components for:

- Regulation state -1 where $P = 0$,
- Regulation state +1 where $Q = 0$.

The sign of the components' contribution is variable in other cases, depending as it will on volumes and prices, with a frequently positive contribution occurring for:

- Regulation state 0, where $B > A$ and $P_{mid} > 0$,
- Regulation state 2, where $(A + B) > (P + Q)$ and $P_{up} > P_{down}$.

4.2 Imperfections

Where implementation is perfect, $N + P + A - Q - B = 0$, or $N + P - Q = B - A$.

Imperfect implementation will physically result in inadvertent exchange, and is caused by:

- The reactive nature (UCTE policy: (linear) recovery of balance start within 30 seconds of disruption having occurred),
- The required inertia (UCTE policy: recovery of balance to be achieved *15 minutes* of disruption having occurred, zero overshoot),
- The indirect nature (uncertainty regarding compliance of RRPS and EPS with bids activated)²¹.

These imperfections affect the financial result even though TenneT has no immediate control of them.

There are certain scenarios in which both P and Q are greater than 0 within a PTU, viz.:

- Regulation state 2,
- Regulation state -1 with $P > 0$,
- Regulation state +1 with $Q > 0$.

This can occur sequentially or simultaneously as a result of:

- Actual power balance pattern: actions of connected players within and between PTUs,
- Reserve power bids inertia: once activated they may be decisive for at least 2 PTUs,
- Regulating power bids inertia: the regulation rate of bids activated is limited and activated bids have to be regulated back to 0. These imperfections affect the financial result even

though TenneT has no immediate control of them.

4.3 Correlation with system service tariff

The system provides PRPs with a level playing field, enabling them in competition with other PRPs to minimise their own contribution to the settlement process and thus to the financial result, through their behaviour in the areas of:

- Programming,
- Bidding,
- Implementation.

As *all* connected parties through their PRP contribute to the financial result and this (if any) is offset against the system service tariff based on kWh used, a *positive* balance essentially represents a transfer from generation to consumption whereas a *negative* balance represents a transfer in the opposite direction.

5. References

Electricity Act 1998

Systemcode

Gridcode

UCTE Handbook Operations

²¹ TenneT's (administrative) balance preservation system merely entails a market-led *incentive* rather than an *obligation* for the bidder to proceed with dispatch or deployment of a bid, see section 3.5.