VGB-Standard

Basic Terms of the Electric Utility Industry

11th edition 2019
(Former VGB-RV 809)

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Phone: +49 201 8128-200
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E-Mail: mark@vgb.org

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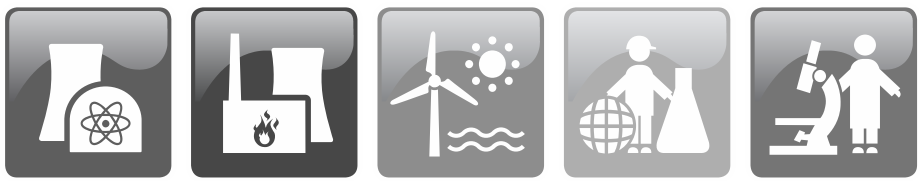

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The German-language version of this VGB-Standard is the reference edition for translations.

Treatment of proposing amendments

Amendments can be sent to the e-mail address ***vgb.standard@vgb.org****. The subject line should contain the exact specification of the relevant document in order to clearly assign the e-mail content to the appropriate VGB-Standard.*

Table of Revision

VGB-Standard	Date of Revision	Chapter	Description
2019 Edition	May 2016	3.4.10	New version
2019 Edition	August 2016	3.4.7.2	Updated
2019 Edition	April 2017	3.3	New version
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2019 Edition	November 2017	3.1.2.3	New version
2019 Edition	November 2017	4.1.36	New version
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2019 Edition	September 2018	4.1.13	Updated
2019 Edition	September 2018	4.1.15	Updated
2019 Edition	November 2018	4.3.4	Updated
2019 Edition	March 2019	2.58	New version
2019 Edition	March 2019	4.1.6	New version
2019 Edition	March 2019	4.1.35	New version

Preface

As a result of the now almost global energy transition and the associated requirements for the ever-increasing regulation of the markets while securing competition, the number of terms used and their definitions continues to increase. In addition to the influence of market and stock market concepts, network concepts are increasingly influencing the daily work of electricity producers, dealers, analysts and other market participants. At the same time, the processing of official and association-related inquiries requires a clear understanding of the contents of the terms used.

The project group “Definitions and Evaluations” in the VGB PowerTech e.V. has taken this fact into account in the present revision of the VGB Standards and has worked on the existing terms and definitions as required and added new ones. Apart from the familiar content relating to

- structural terms in the industry,
- power plant, grid and integrated supply system terms,
- energy and capacity terms and
- terms from the stock exchanges and trading markets

now also newer terms from the immigrant energy transition and the global initiative to phase out fossil energy sources.

The comprehensive definitions are intended to improve the general understanding of terms and to bring the provision of data to the public, as well as investigations, analyses and acquisitions to a common understanding. Suggestions for improvement for future editions are welcome and will be gladly accepted by the contact person of the VGB Technical Group “Performance Indicators”:

https://www.vgb.org/en/performanceindicators.html

Essen, May 2019

VGB PowerTech e.V.

Members of the editorial team

This VGB-Standard was produced by the “Definitions and Evaluations” project group. Members of the project group:

Cord Bredthauer	Uniper Kraftwerke GmbH
Uwe Dorn	Lausitz Energie Kraftwerke AG
Ralf Kirsch	Vattenfall Europe AOC
Dr. Klemens Kirstaedter	Vattenfall Europe Wärme AG
Frank-Peter Laube	PreussenElektra GmbH
Jean-François Lehougre	EDF-DPIT
Louwrens Luyt	Eskom
Henrik Møller Jørgensen	Fjernvarme Fyn A/S
Joao Proenca	EDP
Stefan Prost	VGB PowerTech e. V.
Dr. Jörn Rassow	EnBW Energie Baden-Württemberg AG
Heiko Scheel	STEAG GmbH
Dr. Ralf Uttich	RWE Generation SE

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General Preliminary Remarks

The terms of time, capacity, and energy relate to the generation of electrical energy. By analogy, they can also be used for the conversion, storage, transmission, and distribution of electrical energy.

Generally, capacity and energy should be understood as effective electric capacity and effective electric energy. If terms refer to reactive or apparent values, they are to be identified accordingly.

When units are used, the “Law on Units in Weights and Measurements” (last implementation ordinance: 2nd Ordinance to Amend the Law on Units in Weights and Measurements, German Federal Gazette, Part I, Page 2537) must be observed. Based on the International System of Units (SI = Système International d'Unités), watt is used as the unit of capacity and joule (watt second) as the unit of energy. The kilowatt hour (kWh) is derived from this as a unit in common use.

Units

The following units* are used

Term	Unit				
Capacity					
Effective capacity	W	kW	MW $=10^3$ kW	GW $=10^6$kW	TW $=10^9$ kW
Apparent capacity	VA	kVA	MVA	GVA	TVA
Reactive capacity	var	kvar	Mvar	Gvar	Tvar
Energy					
Effective energy	Ws = J	kWh = 3.6 MJ	MWh $=10^3$ kWh	GWh $=10^6$ kWh	TWh $=10^9$ kWh
Apparent energy	VAh	kVAh	MVAh	GVAh	TVAh
Reactive energy	varh	kvarh	Mvarh	Gvarh	Tvarh

Prefixes to describe decimal multiples of the units

Prefix	Abbreviation	Factor	Number value**
Kilo	k	10^3	Thousand
Mega	M	10^6	Million
Giga	G	10^9	Billion
Tera	T	10^{12}	Trillion
Peta	P	10^{15}	Quadrillion
Exa	E	10^{18}	Quintillion

* A comprehensive description of units in the energy industry can be found in:

- DIN 1301 International System of Units, Part 1, Part 2, Part 3.
- List of recommended units of measurement for the power plant industry.
- VGB Power Plant Technology, Booklet 6/1981, and special edition.
- Units in the gas and water industries. DVGW, leaflet GW 110.
- Thermodynamische Tabellen. K. Raznjevic, VDI-Verlag.

** In the USA, 10^9 is referred to as Billion and 10^{12} as Trillion

Alphabetical list of abbreviations

Symbol	Designation	Chapter
E	Energy content	4.6.10
g_{ben}	Degree of utilisation	4.4.13.1
g_g	Degree of concurrency	4.5.8
GG	Grade	4.6.3
H_o	Gross calorific value	4.6.10.2
H_u	Net calorific value	4.6.10.1
k_t	Time availability	4.5.3
k_W	Energy availability	4.5.4
m_o	Capacity ratio (load ratio)	4.5.7
n_t	Time utilisation	4.5.1
n_W	Energy utilisation	4.5.2
P	Capacity	4.3.1
P_b	Dispatchable capacity	4.3.14
P_B	Capacity generated	4.3.10
P_{br}	Gross capacity	4.3.2
P_{Bzg}	Reference capacity	4.3.21
P_C	Guaranteed capacity	4.3.27
P_E	Bottleneck capacity	4.3.7
P_{Eig}	Auxiliary capacity	4.3.4
$P_{Eig\ B}$	Operating auxiliary consumption capacity	4.3.4.1
$P_{Eig\ S}$	Standstill auxiliary consumption capacity	4.3.4.2
P_F	Free capacity	4.3.29
P_G	Basic capacity	4.3.19.3
PGÜ	Process quality monitoring	4.6.5
P_{KB}	Power plant and reference capacity	4.3.23
P_L	Capacity requirements	4.3.18
P_{LL}	Delivery capacity outside the system	4.3.22.1
P_M	Average capacity	4.3.19.5
P_{max} / P_{min}	Absolute maximum capacity / Minimum capacity	4.3.17
P_{max} / P_{min}	Maximum load / Minimum load	4.3.18.4

Symbol	Designation	Chapter
P_N	Nominal capacity	4.3.6
P_{Nsp}	Grid feed-in capacity	4.3.5
P_{nb}	Non-dispatchable capacity	4.3.15
P_{ne}	Net capacity	4.3.3
P_{ng}	Unused capacity	4.3.11
P_{ns}	Unusable capacity	4.3.24
P_{nv}	Unavailable capacity	4.3.13
$P_{nv\ p}$	Planned unavailable capacity	4.3.13.1
$P_{nv\ u}$	Unplanned unavailable capacity	4.3.13.2
P_R	Stand-by capacity	4.3.12
P_R	Reserve capacity	4.3.25.2
P_{re}	Required reserve capacity	4.3.26
$P_{re\ B}$	Required reserve capacity for demand side	4.3.26.1
$P_{re\ D}$	Required reserve capacity for supply side	4.3.26.2
P_S	Peak capacity	4.3.19.7
p_t	Time failure rate	4.5.5
P_U	Minimum capacity	4.3.16
$P_{Ü}$	Overcapacity	4.3.10.1
$P_{ÜV}$	Capacity losses in grid	4.3.28
P_v	Available capacity	4.3.9
p_W	Energy failure rate	4.5.6
T	Time	4.4.1
t_a	Usage time	4.4.14
t_{aE}	Usage time of maximum capacity	4.4.14.1
t_{aN}	Usage time of nominal capacity	4.4.14.2
t_B	Operating time	4.4.4
t_{ben}	Usage time	4.4.13
t_M	Measuring time	4.4.11
t_N	Reference period	4.4.2
t_{nb}	Non-usage time	4.4.10
t_{ng}	Available time not in operation	4.4.7
t_{ns}	Available non-dispatchable time	4.4.9

Symbol	Designation	Chapter
t_{nv}	Unavailable time	4.4.8
$t_{nv\ p}$	Planned unavailable time	4.4.8.1
$t_{nv\ u}$	Unplanned unavailable time	4.4.8.2
t_R	Stand-by time	4.4.5
t_v	Available time	4.4.3
t_z	Access time	4.4.12
W	Electrical energy	4.1.1
w	Specific heat consumption	4.6.8
W_A	Electricity output to customers	4.1.27
W_{Ab}	Electricity output	4.1.22
W_b	Dispatchable energy	4.1.11
W_B	Generated energy	4.1.4
$W_{B\ br}$	Gross electricity generation	4.1.5
$W_{B\ ne}$	Net electricity generation	4.1.6
$W_{B\ ne\ B}$	Net electricity generation operating time	4.1.6.1
W_{BS}	Electricity procurement	4.1.17
W_{BV}	Not operational auxiliary consumption	4.1.26
W_{Bzg}	Electricity purchase	4.1.13
$W_{Bzg\ NA}$	Electricity purchase in lieu of payment	4.1.13.3
$W_{Bzg\ V}$	Electricity purchase for supplies	4.1.13.1
W_E	Heat consumption	4.6.7
W_{Eig}	Auxiliary consumption	4.1.7
$W_{Eig\ B}$	Auxiliary consumption operating time	4.1.7.1
$W_{Eig\ S}$	Standstill auxiliary consumption	4.1.7.2
$W_{EÜ}$	Feed-in for transfer	4.1.14.1
$W_{EÜ}$	Extraction for transfer	4.1.14.2
W_N	Nominal energy	4.1.2
W_{NA}	Electricity supply in lieu of payment	4.1.24
W_{nAb}	Usable electricity output	4.1.25
W_{nb}	Non-dispatchable energy	4.1.12
W_{Nsp}	Grid feed-in	4.1.15
W_{ng}	Available energy not generated	4.1.8.2

Symbol	Designation	Chapter
W_{nv}	Unavailable energy	4.1.10
$W_{nv\ p}$	Planned unavailable energy	4.1.10.1
$W_{nv\ u}$	Unplanned unavailable energy	4.1.10.2
W_{P}	Pump energy (Pump electricity consumption)	4.1.20
W_{PV}	Pump storage losses	4.1.21
W_{R}	Stand-by energy	4.1.9
W_{S}	Electricity amount (Electricity sales)	4.1.18
W_{Sb}	Electricity requirements	4.1.19
$W_{Ü}$	Excess energy	4.1.8.1
$W_{ÜV}$	Energy losses in the grid	4.1.23
W_{v}	Available energy	4.1.8
W_{Vb}	Power consumption	4.1.31
$W_{Vb\ br}$	Gross electricity consumption of a country	4.1.32
$W_{Vb\ ne}$	Net electricity consumption of a country	4.1.33
W_{VG}	Total electricity consumption of a country	4.1.34
w_{z}	Increase in specific heat consumption	4.6.9
ζ	Utilisation ratio	4.6.6
η	Efficiency	4.6.1
η	Efficiency of a generation unit	4.6.1.1
η	Efficiency of a solar power plant	4.6.1.6
η	Efficiency of a thermal power plant	4.6.1.3
η	Efficiency of a wind turbine	4.6.1.5

1 Structural terms/Energy industry

Designation	Symbol	Definition
1.1 Electricity industry		As an industrial sector, the electricity industry is part of the national economy. As part of the energy industry: – from a functional aspect it includes the complete technical, economic, organisational and legal resources and objectives of generation, transmission, distribution, supply, and purchase of electrical energy; – from a structural aspect it includes all the companies that generate, transmit, distribute, supply, and purchase electrical energy and that advise others about the use of electrical energy. Note: The companies in the electricity industry are split into – power companies (see 1.3) for general (public) energy supplies – plant operators (see 1.8). As an industrial sector, in economic statistics (industrial sectors for the manufacturing industry) more specifically the “electricity industry” is understood to mean electricity generation and distribution for general (public) supply.

Designation	Symbol	Definition
1.2 General (public) electricity supply		General (public) electricity supply is the procurement (generation and purchase, see 4.1.17) and provision (transmission, distribution, and supply, see Chapter 3 and Part 4; Electricity transmission and distribution terms) of electrical energy for others by power companies via fixed cables. Note: In principle, opening up electricity supplies for the competition should allow consumers to choose their supplier. Within the scope of closed supply regions, the supply duty is replaced by a connection and supply duty for power companies that are responsible for general electricity supplies to end consumers for municipal areas (see 4.1.31.2).
1.3 Power companies		Power companies in terms of the German Energy Economy Law (Energiewirtschaftsgesetz) – without consideration of the legal structure or ownership situation – are companies or businesses that supply others with electricity. Brokers that bring interested parties together (electricity suppliers and customers) are not power companies (see 1.5). Power companies are distinguished by their functions, function holders, and ownership relationships (capital participation).
1.3.1 Functions of the power companies		Power companies fulfil at least one of the following functions:
1.3.1.1 Generation		Generation is the production of electrical energy or, in case of cogeneration, the production of electrical energy and heat.

Designation	Symbol	Definition
1.3.1.2 Transmission		Transmission is a form of transporting electricity (see 3.8, in connection with the energy balance, see 4.1.14). Transmission is usually carried out via the extra high-voltage network.
1.3.1.3 Distribution		Distribution is the transportation of electrical energy in physically/technically limited regions to feed in to the distribution stations and supply customers' systems. Distribution is usually implemented via the high, medium, and low voltage networks.
1.3.2 Power companies as function holders		Power companies as function holders are split into:
1.3.2.1 Interconnected companies		Interconnected companies carry out the interconnected operation. Interconnected companies are power companies – that, as owners or operators of generation and transmission systems (mainly high-voltage grids, interconnected grids) play a major role in maintaining the reliability of large-scale electricity supply (load-frequency control, see 3.19; supra-regional reserve capacity) and – that carry out supra-regional energy sharing with other domestic power companies and in neighbouring countries. Depending on the extent of the network (see 3.5) that a power company is responsible for, a distinction is made between:
1.3.2.2 Regional power companies		Regional power companies are power companies with a network covering several municipalities.

Designation	Symbol	Definition
1.3.2.3 Local power companies		Local power companies are power companies with a network covering one or less municipalities (e.g. municipal power companies, public utilities). Note: Apart from interconnected operation, interconnected companies can also handle the tasks of a regional or local power company.
1.3.2.4 Distributing power companies		Distributing power companies (resellers) are power companies that mainly buy electrical energy from others or themselves generate electricity and that sell this to customers as grid operators (4.1.31). Note: The term “distributor” describes the multiple layers of electricity supply from the aspect of the upstream to the downstream supply level. It includes regional and local power companies.
1.3.2.5 Vertically integrated power companies		Vertically integrated power companies are power companies with at least two of the functions of generation, transmission, or distribution.
1.3.2.6 Horizontally integrated power companies		Horizontally integrated power companies are power companies that, as well as supplying electricity, are active in at least one other business area (e.g. gas, water, district heating, disposal).

Designation	Symbol	Definition
1.3.2.7 Independent generators (pure generators)		Independent generators (pure generators) are power companies that do not have any transmission or distribution functions in the networks in which they deliver their energy.
1.4 Grid operators		Grid operators (operators of a transmission or distribution grid) are responsible for the safe and reliable operation of the respective grid in a specific area and its connection with other grids (grid system, see 3.5). It does not have to own the systems it operates. The system must be defined within its limits so that responsibility can be defined (see 1.9). Operators of a transmission grid are also responsible for transmission via the grid with consideration of sharing with other transmission grids. They ensure the provision of indispensable system services (see 3.15) and thus guarantee reliability of supply.
1.5 Grid end users		Grid end users are all natural persons or legal entities with a usage relationship to the grid (see 3.5) and, accordingly, make use of the grid operator's services on a contractual basis (see 1.4). Services in this sense include: – connection to the grid (grid connection) – transporting electrical energy (transport) – balancing feed and extraction – synchronous connection with the grid (system services)
1.5.1 Grid users		Grid users are natural persons or legal entities that feed energy into or extract it from an electricity or gas supply grid.

Designation	Symbol	Definition
1.5.2 Grid customers		Grid customers are power customers, power users, and grid users. Note: To distinguish between different grid end users, from the aspect of the grid operator one uses concepts such as transmission customer, transportation customer, and system service customer.
1.5.3 Connection users		Connection users are natural persons or legal entities that use a system in the distribution grid of the grid operator.
1.6 Unbundling		Unbundling in the electricity industry means on the one hand, separation of generation and purchase and, on the other hand, separation of the transmission and distribution of electrical energy from an accounting aspect and, in some cases, also from an organisational aspect. Note: This unbundling in combination with the liberalisation of electricity supply is aimed at creating more transparency and especially ensuring discrimination-free access of electricity providers to the grid (see 3.5).
1.7 Ownership of the power companies		– Public power companies are power companies where 95% or more of the capital is held by regional corporations (government, states, municipal associations, municipalities). – Public-private power companies are power companies where less than 95% of the capital is in public ownership and less than 75% is in private ownership. – Private power companies are power companies where 75% and more of the capital is in private ownership.

Designation	Symbol	Definition
1.8 Own systems		Own systems are systems for the generation of electrical energy, essentially for own use that are owned by companies and private persons whose main business is something other than a power company. Own systems can be used to cogenerate electrical energy and heat. Note: The official German statistics differentiate between: – Own systems in mining companies and in the manufacturing sector – Own systems used by railway companies – Own systems to utilise renewable energies
1.9 Electricity supply system		An electricity supply system is a functional unit within the electricity industry that can be defined according to technical, economic or other criteria. Note: To delimit electricity supply systems the particular technical-physical conditions (e.g. line dependence, inability to feed into the system, concurrency of consumption and generation), legal regulations (right of way, name of the grid operator), and organisational forms (see 1.3) are important.

2 Market/Stock Exchange

Designation	Symbol	Definition
2.1 ARA		ARA is the oil and coal trading area in the Amsterdam-Rotterdam-Antwerp triangle. It is also known by the synonym NWE (North West Europe) or simply “Rotterdam”.
2.2 Asset		In connection with energy supply this is used to describe valuable, tradable goods such as power plants and their maintenance, fuels (gas, coal, oil), products (electricity and its derivatives, heat, power plant by-products such as gypsum, fly ash, etc.) and CO_2 certificates.
2.3 Asset management		Optimum use of the available assets for the long-term maximisation of the financial result under the respective technical, economic, and political boundary conditions.
2.4 Default risk (also counterparty risk)		The risk that a party to the contract does not fulfil its contractual obligations (e.g. payment obligations, delivery obligations, etc.). Elements of counterparty risk include replacement risk and payment risk.
2.5 Back office		Organisational area of the trading floors that is responsible for market analyses and forecasts, portfolio management, risk management, and the structuring of transactions.
2.6 Bear market		A strong decline in share or market prices generally continuing for some time. The opposite is a bull market.

Designation	Symbol	Definition
2.7 Fixed quantity delivery		Energy delivery (e.g. electricity or natural gas) at a constant capacity for the entire agreed contractual period.
2.8 Base (base load)		Electricity supply within a standardised delivery time interval (month, quarter, year) over 24 hours every day at a constant capacity. Synonym: fixed-quantity delivery.
2.9 Bullish/ Bearish		Descriptions of the state of the market. On the stock market the bull is the symbol for optimists; i.e. rising prices. Bearish is the opposite, falling prices.
2.10 Balancing group		In a balancing group, traders aggregate all their feed-in and extraction points within a grid area (for electricity: a control zone). Note: Commercial transaction A commercial transaction is a defined exchange of electrical energy between different balancing groups based on a plan (e.g. a schedule). Wholesale commercial transactions with physical fulfilment are shown, for example, as scheduled deliveries between different balancing groups and are notified to the grid operators. The grid operators check the consistency of the plans (e.g. schedules) submitted from various traders (persons responsible for the balancing group) as regards their compliance with the plans for the actual energy flow.

Designation	Symbol	Definition
		Balancing groups are thus virtual balance sheets that enable commercial transactions and physical energy flows to be mapped against each other.
2.11 Balancing group agreement		Balancing group agreements are concluded between the persons responsible for (sub) balancing groups (supplier) and the transmission grid operator. The subject of the agreement is management and processing of the balancing group and recording the energy supplies for all registered participants.
2.12 Stock exchange		Organised, anonymous market in which certain exchangeable goods (shares and other securities, foreign currencies, precious metals, commodities, or other derivatives) are traded. Brokers or computer-based trading systems define prices based on buy or sell orders during the trading hours. Contracts traded on the exchange are standardised transactions in which the exchange acts as the trading partner and thus minimises the counterparty risk. Stock exchange trading is officially supervised.
2.13 Delivery balancing groups		Delivery balancing groups are the balancing groups that are allocated to the energy conversion systems of the respective power plant operator.
2.14 Redispatch balancing group		A redispatch balancing group is a balancing group (schedule) of the grid operator. It is the counterpart of the delivery balancing group.

Designation	Symbol	Definition
2.15 Broker		In general, brokers in Anglo-American stock exchanges differ from German stock exchange brokers in that they are also allowed to deal with private clients. Brokers act as intermediaries between different contractual parties. The broker is not the contractual party but is interested only in the transaction taking place for which they receive a volume-related brokerage fee. In the energy area there are, for example, brokers on the EEX. These certified brokers are accredited to work in the EEX where they offer third parties access to this market. Brokers also work off-market in energy product trading.
2.16 CAL		Abbreviation for a trading product with a delivery time interval of one calendar year.
2.17 Cap		An OTC instrument to ensure a highest price in a long-term delivery agreement, such as oil. A cap acts as an insurance against high prices. If the agreed top value is exceeded, the seller of the cap pays the buyer the difference between the actual price and the top value or, in case of physical deliveries, offsets this price. The buyer of a cap pays a premium to the seller, either as a one-off premium or in regular instalments.
2.18 Capacity options		Options to buy or sell additional capacities. The price for the corresponding energy delivery is determined only when the actual purchase or sale takes place.

Designation	Symbol	Definition
2.19 Clearing		Balancing mutual claims between two or more partners where the balance amounts are balanced by payment or credits. Clearing refers to stock exchange transactions and also forward transactions on OTC markets. In stock exchange transactions apart from processing, clearing also includes hedging transactions made on a future and options exchange.
2.20 Close-of-Day		Time of the day when trading on the stock exchange stops and when prices are determined. In OTC markets the time when activities routinely slow down.
2.21 Closing Price		The closing price is the price determined at the end of a trading day. It is often the same as the settlement price.
2.22 CO_2 tax		Price-influencing economic instrument used to lower energy consumption and to trigger substitution processes to achieve low or no-carbon fuels.
2.23 Commodity		Goods or raw materials standardised for trading purposes so that the quality and functions of products from different suppliers can be compared, exchanged, and traded.
2.24 Confirmation		Confirmation of a stock exchange transaction. The details of the transaction are registered and are thus made binding for both trading partners. So that a confirmation can be issued, the information from the trading partners must be compared. The transaction is confirmed only if the information matches.

Designation	Symbol	Definition
2.25 Compliance		Trading in compliance with applicable laws and regulations in accordance with the requirements of the supervisory authorities, of stock exchange customs, etc. The aim of compliance is to protect investors by ensuring legally compliant behaviour and by preventing conflicts of interest.
2.26 Day-Ahead		In day-ahead, trading transactions are made in which the delivery takes place the following day. The spot markets of many electricity and gas exchanges, such as the EEX in Germany, are organised as day-ahead markets. Trading is also often day-ahead in the OTC market.
2.27 Derivative		A derivative is a derived financial instrument based, for example, on a commodity traded on the spot market (like electricity or gas) as a basic value. Important derivatives are options, forwards, and futures. The value of a derivative depends on the price of the underlying basic value. Derivatives are traded off-market or on future and options exchanges.
2.28 End customer		End customers are feeders and ultimate consumers.
2.29 Energy trading		Procurement and marketing of electricity and, increasingly, also gas as well as coal and oil at market prices on the wholesale market. Various quantities are traded at different times and on the basis of different price expectations on and off market.

Designation	Symbol	Definition
2.30 ETS (Emissions Trading Scheme)		ETS is the EU system for emissions trading of CO_2 and other gases that affect the climate (according to the Kyoto Protocol: CH_4, N_2O, HCFCs, CFCs, SF_6). The trading system started on January 1, 2005, originally only for CO_2. Those responsible for CO_2 emissions that are obliged to trade emissions are mainly in the following sectors: combustion plants (especially power plants), oil refineries, coke ovens, iron and steel mills and plants in the cement, glass, lime, brick-making, ceramic, pulp, and paper industries. The first trading period was from 2005 to 2007, the second from 2008 to 2012. From 2013, the trading periods will be extended to 8 years and will also include other greenhouse gases and aviation.
2.31 Schedule		A schedule is an electricity supply with a pre-defined capacity sequence. The schedule states within the duration of a corresponding transmission – for each 15 minutes for example – how much capacity is exchanged between balancing groups or how much is fed in or extracted at entry and exit points.
2.32 Redispatch schedule		A redispatch schedule includes the transaction between the provider and the grid operator triggered by the redispatch measures . It defines the agreed exchange of energy (redispatch energy) between the delivery and the redispatch balancing groups.

Designation	Symbol	Definition
2.33 Forward		A forward is an individually structured forward transaction on the unofficial market (see OTC) in which the business partners agree on the price of the trading object, the delivery volume and the maturity date or delivery date. Collateral is also agreed individually, since as opposed to a future, the business partner and not the clearing house bears the risk.
2.34 Forward Curve/ Price Forward Curve (PFC)		A forward curve shows the current price of forward and future transactions for an underlying instrument with different maturities. An extension of the forward curve is the (hourly) price forward curve (HPFC) that shows the value of future energy purchases or deliveries in a high (up to hourly) timely resolution. The curve contains the market information that is currently available about future price developments. It does not show the future prices, but only the current expectations in the market. Traders create an individual (hourly) price forward curve based on their analyses, their expertise, and their assessment of market trends.
2.35 Front Office		Organisational area of the trading floor that is responsible for (wholesale) trading. This is where the trading partners actually carry out the transactions.
2.36 Front-year, Y1		Contract for next year.

Designation	Symbol	Definition
2.37 Front-month, M1		Contract for next month.
2.38 Front-quarter, Q1		Contract for the next quarter.
2.39 Future		Contractual obligation to buy or sell a defined quantity of electricity at a defined price in a future delivery period. Futures are standardised forward transactions, usually traded on the market in which a cash settlement is agreed between the trader and the exchange as a contractual partner.
2.40 Closed position		Closing an open position by entering a similar countertrade deal. Closed positions are no longer subject to a market price risk but only to a credit risk.
2.41 Gross exposure		Gross exposure is the replacement risk of the open positions if no hedging or netting has been agreed with the contractual party. The value is calculated as the sum of current market-to-market and the estimated development in the value over the time of the contract in relation to a transaction or a portfolio.

Designation	Symbol	Definition
2.42 Gross limit		Gross limit defines the permitted scope of open positions for a contractual party if no hedging is agreed. Limits for each calculation period and a maximum contract period are defined. Gross exposure is compared to this limit.
2.43 Base load		The load type for electricity supply or purchasing with a constant capacity over 24 hours of every day in the delivery period. See also base.
2.44 Trader		A market participant who can carry out transactions and report schedules. This assumes that the trader has a balancing group or a sub-balancing group contract with the Transmission System Operator (TSO). A trader can be, but does not have to be, a supplier.
2.45 Hedging		Reducing the risk of an underlying transaction with hedging transactions. A suitable hedging strategy is chosen for this purpose. The objective of the hedging strategy is to close transactions to hedge against the risk of unfavourable market developments (e.g. price, temperature). Different hedging strategies offer protection against price rises and price falls. The basic types of price increase protection include long hedges (future, forward, swap, call, cap and collar); strategies to protect against falling prices are short hedges (future, forward, swap and collar).

Designation	Symbol	Definition
2.46 In the money		Market price constellation when it is worth exercising an option. For a call option it is in the money when the option's strike price is below the market price of the underlying asset. For a put option it is in the money when the strike price is above the market price of the underlying asset. The opposite is out of the money.
2.47 Intra-day margin		Intra-day margin is the collateral that the buyer or seller has to deposit as cash or credit during the trading day. It guarantees that a forward transaction will be fulfilled.
2.48 Intra-day trading		Intra-day trading means that a product is traded and delivered within one day.
2.49 Load profile/load course		The time series that defines a power value for every hour or quarter hour billing period. The load profile is often used as a basis for the schedules.
2.50 Load forecast		Forecast for a future load profile or the process to create a load profile.
2.51 Liquidity		Market liquidity describes the extent to which products are traded on a market. The higher the market liquidity, the higher the confidence in market price information.

Designation	Symbol	Definition
2.52 Long/Long position		In trading markets, “long” generally means the position of a contract buyer. he seller is then “short”. A long position arises through the sale of one or more contracts if this is not balanced out by the purchase of corresponding contracts. A long position can be balanced out by buying corresponding contracts. Opposite: short position.
2.53 Make-or-buy		Decision by a company whether to make or buy a service or product.
2.54 Market coupling		The objective of market coupling is to optimise use of the available transmission capacities. From a trade aspect, market coupling is designed as an implicit auction. Electricity trading and allocation of transmission capacities are carried out in one process.
2.55 Market maker		A market maker is a trading participant who is obliged to provide buy and sell quotations for a specific product. The market maker strives to keep a balanced portfolio. The risk that a market maker takes is balanced out by the expectation of achieving profits from the difference between the buy and sell quotations.

Designation	Symbol	Definition
2.56 Market taker		The market taker is the trading participant who accepts the prices provided by the market maker. He can accept the price and then take up a position on associated markets as a procurer, hedger, or market maker.
2.57 MCP (Market Clearing Price)		The price at which there is market balance between supply and demand on an exchange, usually the highest execution price (highest order volumes with the lowest surplus demand). This price is also simply known as the market price.
2.58 MTU (Market Time Unit		“Market time unit” (MTU) means the period for which the market price is established or the shortest possible common time period for at least two bidding zones, if their market time units are different (Article 2(19) of the Regulation 543/2013 of 14 June 2013 on submission and publication of data in electricity markets).
2.59 Netting		Determination of the net positions from the offsetting of long and short positions or the mutual claims of two counterparties; corresponds to the balancing of long and short positions.
2.60 Open position		An open position is exposure in firm deals or options where the position holder expects that there will be some trading before maturity. If a trader has short sold a commodity, he must cover the open position by the delivery date at the latest by reselling the open position or by buying the commodity that he has to deliver. Long and short positions are open positions. Opposite: Closed position.
2.61 Off-peak		Is the time when there is the lowest load in the power grid that is not defined as peak. In Germany, for example, the following times are off-peak: Monday – Friday midnight to 8:00 a.m. and 8:00 p.m. to midnight as well as Saturday and Sunday midnight to midnight (see 4.4.15).

Designation	Symbol	Definition
2.62 Option		With an option the buyer acquires the right but not the obligation to buy (call option) or sell (put option) a certain quantity of a commodity (underlying) during the term of the contract or at the end of the period at the execution date at a defined price. The seller (writer) receives the purchase price of the option and, if it is executed, must buy (if he sold a put) or sell (call) the underlying at the pre-determined price. There is a difference between US and European options. The US options can be executed at any time within the term, while the European options may be executed only on the date the option expires.
2.63 OTC market (Over-the-counter market)		OTC is off-market trading with contracts. They can be adapted to suit individual requirements and are therefore not very standardised. An over-the-counter market is not localised and has no fixed trading times. Negotiations are national and international via computer or phone systems. The transactions are generally handled via brokers. The OTC market has spot and forward markets.
2.64 Out-of-the-money		Market price constellation where it is not worthwhile exercising an option. If the current market price of an underlying asset is below the strike price, the call option is described as out of the money. A put option is out of the money if the price of the underlying is below the strike price. Opposite: In the money.

Designation	Symbol	Definition
2.65 Peak/Peak load		Peak load describes the hours where there is a high demand for electricity during the day. In Germany, these are the 12 delivery hours between 8:00 a.m. and 8:00 p.m. Monday to Friday (see 4.4.15).
2.66 Physical electricity trading		In physical electricity trading, power is actually exchanged. A certain quantity of energy is traded and delivered for a defined price within a fixed time interval.
2.67 Portfolio/ portfolio management		A portfolio is a customer's or a trader's total inventory of goods or securities (e.g. also investment funds). Portfolio management in the energy industry is used to cover the needs of power companies or large industrial companies while spreading the risks. Purchases are optimised via various sub-quantities and sources with different terms and conditions, prices, and deadlines. A portfolio typically includes the different products of the wholesale market, possibly generation plants and also hedging instruments such as options.
2.68 Position		A position is an exposure on the trading market resulting from a transaction. An open position is created by opening (i.e. buy or sell) and is closed again by a closing trade. See also long and short positions.

Designation	Symbol	Definition
2.69 Settlement		Settlement includes the conclusion, processing, and fulfilment of a transaction on the stock exchange. A trading object and a cash value are exchanged.
2.70 Short/ Short position		In the trading markets, “short” generally means the position of a contract seller. The buyer is then “long”. In share markets this occurs as an open position through short selling of contracts if they are not covered by a corresponding purchase. The opposite is described as a long position.
2.71 Spot market		This is a sub-market of the wholesale market where short-term transactions (off and on-market) are concluded. With spot deals delivery, acceptance and payment must take place within a short time (in Germany: two stock exchange days). The spot market often closes 12 hours before the contract execution day – like the EEX. In this case, it is described as a day ahead market.

Designation	Symbol	Definition
2.72 Spread		Generally the difference between two prices. 1) A bid-ask spread describes the difference between the best buying and selling price for a product/security at a certain time. 2) A spread between different trading floors allows a trader to achieve arbitrage profits by simultaneously buying and selling contracts for a similarly valued underlying on different markets. 3) Generation margin for electricity; is created by the difference between the electricity price and the fuel costs for the production of electricity. A distinction is made between: – Spark spread: Margin in gas-fired power plants; – Dark spread: Margin in coal-fired power plants; – Clean spread: Margin with consideration of the costs for emission certificates.
2.73 Take-or-pay contract		Agreements in which the buyer must accept a traded product and pay the cash price or a specified amount, even if the product is not utilised. In relation to the energy market, it means that the obligation exists to pay for a certain quantity of gas or electricity regardless whether this quantity is accepted or not.

Designation	Symbol	Definition
2.74 Futures market		The on and off-market futures market is a sub-market of the wholesale market in which derivatives and forward deals are made and traded. Usually in the futures market the obligation and settlement transaction times differ. When a contract is concluded, the seller does not have to own the traded goods nor does the buyer have to possess the liquid resources. Futures products on energy are traded on most energy exchanges.
2.75 Trading floor		The place where a trading company carries out its business, split into three organisational areas: front office, middle office and back office.
2.76 Volatility		Volatility is a measure for the fluctuation intensity of the price of a security or an index above and below its average value within a specific time interval. Volatility does not specify the direction of the price fluctuations, but only the amplitude. The higher the volatility, the more the price moves up or down. A distinction is made between historic and implicit volatility. While historic volatility is calculated with the historical prices of the underlying for a specific time interval and is given as a percentage of the average price for the underlying, implicit volatility indicates the price fluctuations the market players expect in the future. Implicit volatility is a variable that is derived from the observed prices for options and represents the expectations of the market players as regards future volatility.

Designation	Symbol	Definition
2.77 Wholesale market		Goods markets are usually split into wholesale and retail markets. Normally, producers do not deliver directly to end customers, but to wholesalers and exchanges, as well as retailers and companies in the wholesale trade. On wholesale markets, the goods change ownership but generally remain in downstream markets. Retailers and end consumers, on the other hand, are the players in the retail market from which the ultimate consumers finally remove the good from the market.
2.78 Weather derivative		Weather derivatives are futures contracts that involve standardised trading with options or fixed contracts where the underlying is weather conditions (e.g. temperature, rainfall). Companies can thus hedge against weather-related risks. Weather derivatives are used by gas and electricity suppliers to hedge against lost income caused by quantity uncertainties, for example due to unforeseeable temperatures. Hydro or wind turbine generators hedge against unfavourable rain or wind conditions. For power companies the heating degree day (HDD), cooling degree day (CDD), and cumulative average temperature (CAT) are especially relevant.
2.79 Market players		Market players are all natural persons or legal entities in the market for electrical energy as generators, grid operators, ultimate consumers, or brokers between the above three. Apart from power companies with power plants or that operate grids and their customers, electricity dealers take part in the electricity market by buying and selling electrical energy as do brokers by mediating between electricity providers and electricity customers.

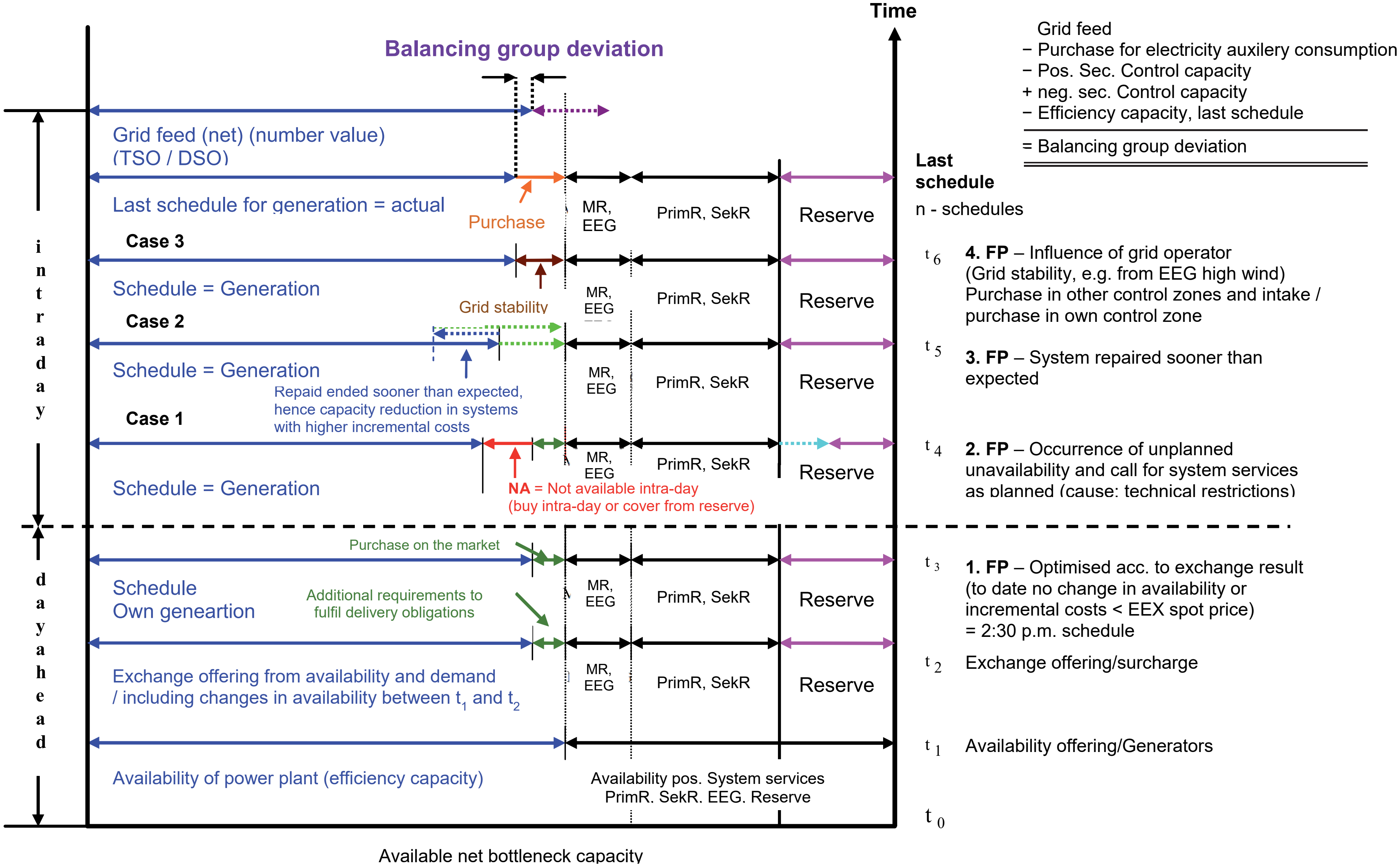


Figure 1: Energy conversion (electricity) under market aspects (schedule-managed power plants)

3 Power plant, grid, transmission and integrated system terms

Designation	Symbol	Definition
3.1 Power plant		A power plant is a plant designed to generate electrical energy and/or heat by converting energy. Note: Depending on the type of energy conversion in the power plant a distinction is made between hydro, wind turbine, solar, fuel cell and thermal power plants (including geothermal). In hydro power plants a distinction is made between impoundment, diversion, and pumped storage. In thermal power plants a distinction is made between fossil and nuclear fuels and then according to the specific fuel, such as hard coal, lignite, oil, gas, uranium/thorium, waste. Depending on the type of drive machine, a particular distinction is made between steam turbine, gas turbine and internal combustion power plants. A common combination is a gas turbine with a downstream steam turbine (combined cycle power plant). A power plant can consist of several generation units. Due to historical developments at a power plant location, there can be different ownership relationships and different energy conversion processes that can be allocated to existing generation units and also several power plants.
3.1.1 Generation unit		A generation unit for electrical energy is a system in a power plant that can be defined according to certain criteria. For example, it could be a power plant block, a range type power plant, a cogeneration system, the machine unit of a hydro power plant, a fuel cell stack, or a solar module.

Designation	Symbol	Definition
3.1.2 Power plant block		A power plant block is a generation unit with a direct switching technology allocation between the main parts of the plants (e.g. in thermal power plants between the steam generators, turbine, and generator).
3.1.2.1 Range-type power plant		A range-type power plant consists of several generation units (turbine, generator) that are supplied by steam from several steam generators via a shared pipeline. Note: For more information about thermal power plants and cogeneration, see Part B, Booklet 2, District Heating.
3.1.2.2 Combined heat and power (CHP) generation		Combined heat and power generation (cogeneration) is the simultaneous conversion of energy into mechanical or electrical energy and heat in a technical facility. Note: As far as the mechanical or electrical energy and the heat remain in the facility itself, this is not combined heat and power generation (e.g. for regenerative feedwater pre-heating).
3.1.2.3 CHP facility		The term CHP facility refers to energy conversion facilities that can simultaneously convert the energy used into mechanical or electrical energy and heat in a stationary technical facility; this includes among others: – Plants with backpressure, extraction or bleed steam condensation turbine – Combustion plants with steam engines including heat extraction – Gas turbine plants with waste heat boiler

Designation	Symbol	Definition
		– Steam turbine plant – Combustion engine installations including heat extraction – Stirling engines – Organic Rankine cycle plants – Fuel cell installations
3.1.2.4 Power plant operator		A power plant block is a generation unit with a direct switching technology allocation between the main parts of the plants (e.g. in thermal power plants between the steam generators, turbine, and generator).
3.2 Balancing power plant		A balancing power plant is a power plant in which individual or all generation units (occasionally or continuously) can be used to control the frequency or handover power within the scope of system services (e.g. primary and secondary control, minute reserve, etc., see 3.17 and 3.18.
3.3 Reserve power plant		Reserve power plants are plants that allocate a fraction or the entire electrical and/or thermal capacity solely based on legal or contractual obligations. They often don't participate for economic reasons in normal electricity and heat markets. Capacity provision can relate to e.g.: − Black start capacity, − Outage/maintenance reserve capacity, − Capacity to cover supply shortfalls in areas where the market is unable to provide considerable bottlenecks with endangering security of supply. Reserve power plants typically maintain their capacity in (mothballed) cold reserve. This means that their reactivation occurs only under special circumstances and with sufficient notice. Reserve capacity is not balancing energy but complements it.

Designation	Symbol	Definition
3.4 Start of operation		The start of operation of power plants is the culmination of the commissioning process. It is the point in time when closed-loop operation (commercial operation) commences for the first time. This is the point at which the risk is transferred from the manufacturer to the plant operator, and constitutes the true time of sale under European Law.
3.4.1 Test run		The test run is the temporary operation of a complete plant in order to test its operational function after installation and the commissioning of components, equipment and systems. This is concluded by the acceptance test. The acceptance test confirms technical readiness for commercial operation.
3.4.2 Commission-ing		The commissioning, or commissioning phase, covers the period between installation and start of operation (commercial operation) of a plant. This includes the commissioning of components, equipment and systems, as well as the commissioning of the overall plant (test run). This encompasses the commissioning, various functional tests, the cold and hot commissioning, the trial runs and the acceptance test (verification of the contractually guaranteed characteristics). Production facilities are not commercially available during the commissioning process, as the suitability of the respective plant for continuous operation needs to be verified before their commercial use, i.e. before closed-loop operation is commenced. These suitability tests correspond to technical and official tests. The capacity generated during the commissioning process is fed into the public electricity grid as an unsecured capacity. In the event of e.g. a subsequent significant alteration to the facility, a further commissioning process may be necessary.

Designation	Symbol	Definition
3.4.3 Trial runs		Trial runs of a plant serve the purpose of testing its operational function after the initial synchronisation. Within the framework of the trial runs, extensive functional tests are performed, generating power until the commencement of the acceptance test of the plant.

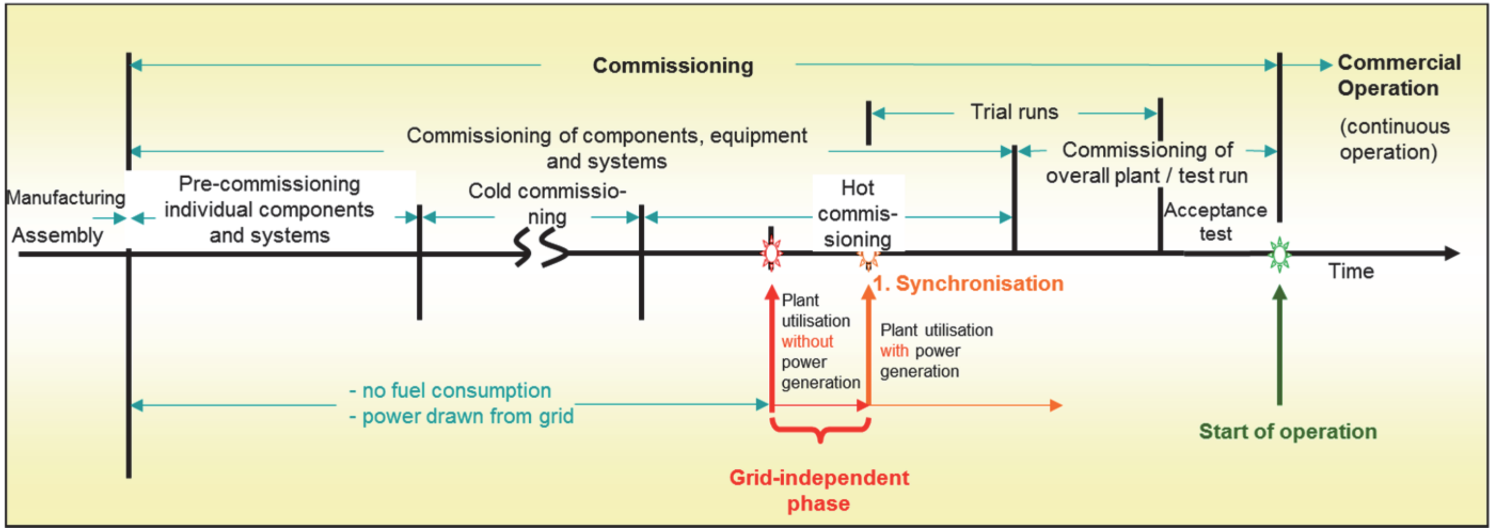


Figure 2: Start-up phase in general

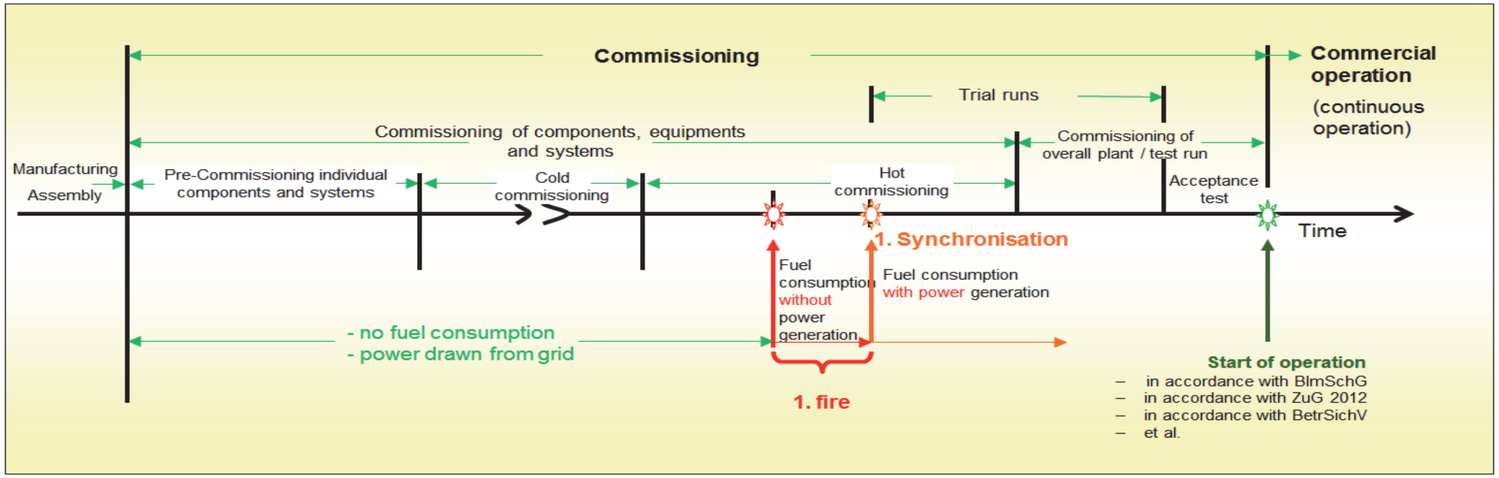


Figure 2a: Start-up phase of fossil fuel-fired power plants

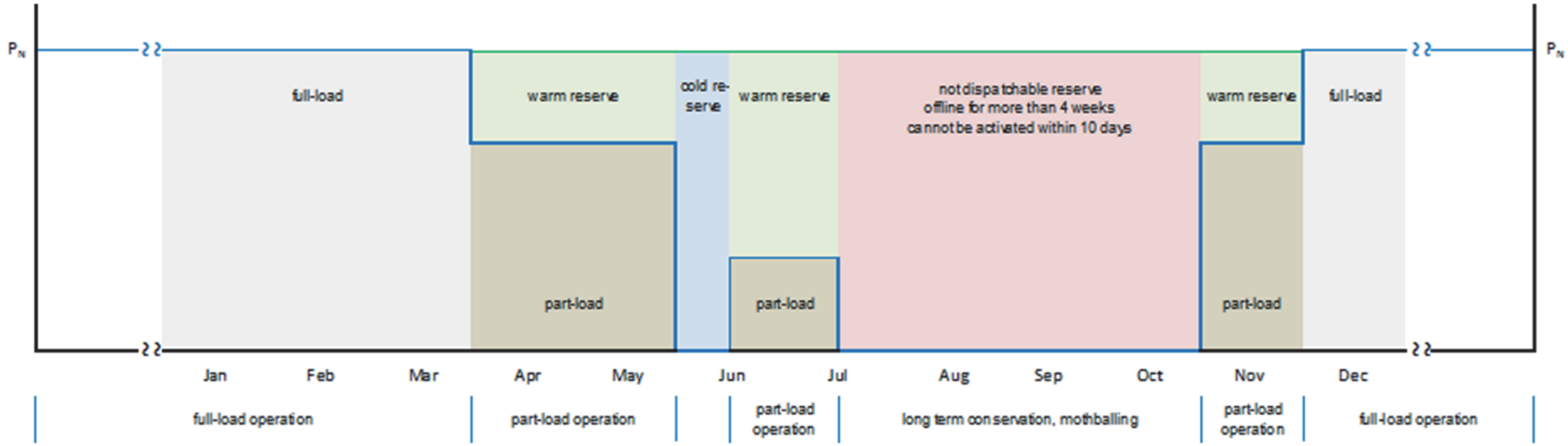


Figure 2b: Utilisation of a full available power generation unit (exemplary schedule for 1 calendar year)

Operational modes (unit is dispatchable)
- full-load operation
- part-load operation
- Stand-by (dispatchable reserve capacity)
  - warm reserve (spinning reserve)
  - cold reserve*, short-term conservation

Non-operational modes (unit is not dispatchable)
- long-term conservation (> 4 weeks)
- Decommissioning

*) Cold reserve in South Africa: can be activated within 24 h

Designation	Symbol	Definition
3.4.4 Decommissioning		Permanent decommissioning of a plant in connection with returning, termination or cancellation of operating licence.
3.4.5 Commercial operation/ closed-loop operation		The mostly scheduled commercial operation/closed-loop operation of a plant takes place in (intermittent) continuous operation. This takes place in compliance with the operating licence and in accordance with the grid safety specifications of the power grid operator. The responsibility for commercial operation/closed-loop operation lies with the plant operator or the owner of the facility.
3.4.6 Shutdown/ interruption of operation		Shutdown/interruption of operation; definition according to DIN 31 051, 4.5.2.2 (from DIN EN 13 306, 6.17): “An interruption of functional activity scheduled in advance for reasons of maintenance or other purposes” (note according to DIN 31 051: shutdown is used as a synonym for interruption of operation.)
3.4.7 Reserve		The reserve, as an operating state of available energy conversion plants, differentiates between hot reserve and cold reserve (in reference to IEV 602-03-17).
3.4.7.1 Hot reserve		The hot reserve is the reserve capacity that can be activated at short notice (see 4.3.24.2), which can be e.g. provided by the already rotating machinery.

Designation	Symbol	Definition
3.4.7.2 Mothballing		Mothballing is the condition of a plant (power plant block, plant components) for which operational reactivation is possible. In order to be capable of operation, the plant must be placed in this condition by having its functional properties restored through appropriate security measures, e.g. preservation, removal of media etc. This excludes the possibility of the plant being functional immediately. In order to restore function, the security/preservation measures must be suspended and a commissioning process must be started. If the security measures can be suspended at short notice, this is called mothballing. If the suspension of the security measures e.g. for preservation takes > 4 weeks, this is described as conserved mothballing. Note: The plant has a valid operating licence and all the necessary official approvals.
3.4.8 Temporary decommis-sioning		Temporary decommissioning; definition according to DIN 31 051, 4.5.3.3: “scheduled indefinite interruption of the functional operation of a unit for purposes of maintenance.” Temporary shutdown of a production plant for technical, operational or economic reasons.

Designation	Symbol	Definition
3.4.9 Deactivation		Deactivation; definition according to DIN 31 051: “scheduled limited interruption of the functional operation of a unit during use for purposes of maintenance.”
3.4.10 Revision		Revision is a maintenance measure of an energy conversion plant. This measure serves for restoration and improvement of the plant’s usability properties on the one hand and on the other there is a need to comply the legal demands for operational safety (for example the operating safety regulations). Revisions are distinguished depending on their duration or scope.
3.5 Grid		In electricity supply a grid is all the connected components for the transmission or distribution of electrical energy. To make a distinction it can be named according its tasks, mode of operation, voltages, and ownership. Often, uniform nominal voltages and current types (direct current (DC) or alternating current (AC)/3-phase current) are used as additional criteria to distinguish a grid.
3.5.1 Public electricity supply grid		As regards the task, a distinction is made between: integrated grid, transmission grid, distribution grid (see Part 4). Another distinction is made between the 3-phase current grid of the public electricity supply system, including industrial own supply, the single-phase power grid of the railroad company and individually isolated operated grids.
3.5.2 Grid operators		A grid operator (operator of a transmission or distribution grid) is responsible for the safe and reliable operation of the respective grid in a specific area and for connection with other grids. The operator of a transmission grid also controls transmission via the grid with consideration of exchanging with other transmission grids. They ensure the provision of indispensable system services and thus ensure supply reliability.

Designation	Symbol	Definition
3.5.3 Integrated grid		The integrated grid as a part of the transmission grid includes all the cables and systems for the transmission of electrical energy to carry out integrated operation (see 1.3.2) and especially includes the systems of the top voltage levels (extra-high voltage grid).
3.5.4 Transmission grid		Transmission grids are grids that are used to transmit electrical energy to subordinate distribution grids. The main feature of a transmission grid is that it is used mainly to transport the capacity of power plants over great distances (on average about 100 km) to consumers. German transmission grids usually have voltages of 220 kV and above. The power grids with lower voltages are usually distribution systems.
3.5.5 ENTSO-E (European Network of Transmission System Operators for Electricity)		ENTSO-E is an association of European transmission grid operators that was formed by the integration of ATSOI, BALTSO, ETSO, NORDEL, ENTSO-E, and UKTSOA. ENTSO-E is responsible for coordinating operation, trading, and supply across EU borders. It also deals with rules and development to ensure safe operation of the grids and of power plants, with coordinating extensions to the grids and with documentation and planning the exchange procedures.

Designation	Symbol	Definition
3.5.6 TSO (Transmission system operator)		The operator of an electricity transmission system who is responsible for safe and reliable operation of the respective system. They also provide the system services needed to ensure supply reliability.
3.5.7 Distribution system		Distribution systems are systems used to supply end consumers with electrical energy. The voltage is lower than in the transmission systems (between 230 V and 110 kV) and the transmitted capacities are also lower.
3.5.8 Grid characteristic curve		The characteristic curve of a grid is a description of the (mathematical) function of the grid frequency in relation to the grid load in a state of equilibrium with the secondary control deactivated. This function is determined by the feeding generation units and by the consumer units connected to the grid.
3.6 Grid access		Grid access is the basis for generators, customers, power companies, and other grid end users to conclude agreements with each other: it allows them to make use of the grids of all the operators concerned for their deliveries and purchases via a physical grid connection.
3.6.1 Negotiated grid access		Negotiated grid access is a system in which voluntary commercial grid utilisation agreements are implemented (see 3.9) on the basis of which the deliveries between generators, customers, power companies and others are enabled via the grids of all the operators concerned.

Designation	Symbol	Definition
3.6.2 Grid usage agreement		In grid usage agreements all the issues of grid usage, including fees, over and above the grid connection are regulated.
3.7 Single customer system		A single customer system is, instead of the grid utilisation system (see 3.9) of negotiated grid access, an alternative form of grid access with which a power company - in the usage of the European Union also called “single customer” - is permitted by the responsible authority to be the sole supplier of end customers in a specific area. This power company must take the electrical energy that an end consumer living in this area has bought from another power company and must pay this other power company a price that is at least the price paid by such a customer to the single customer reduced by the public tariff for using the grid.
3.8 Transmission		In electricity terms, transmission is the technical-physical process of simultaneously feeding in electrical capacity at one or more transfer points and a corresponding extraction of electrical capacity at one or more transfer points of a grid. For transmission as a measure of the energy balance, see 4.1.30.

Designation	Symbol	Definition
3.8.1 Feed and extraction points		Feed and extraction points are the contractually defined transfer points where energy is fed in or extracted. The feed point can be the transfer point of a generation system into the grid or it can be a defined technically suitable point of the feed-in grid for transmitting capacity.
3.9 Grid passthrough		Grid passthrough, as a special case of transmission, is the process of feeding electrical energy at one or more transfer points and the associated extraction at one or more other transfer points in the grid. Neither the supplier nor the recipient are the grid operator.
3.10 Transit		Transit is a special case of transmission in which the supplier and the recipient are interconnected companies with electricity control zones not next to each other. Transit is processed by interconnected companies between the two.

Designation	Symbol	Definition
3.11 Delivery and purchase		Delivery is the feeding in of electrical energy at one or more transfer points. Purchase is the extraction of electrical energy from one or more transfer points. Both are carried out on the basis of agreements for cash or exchange. Note: If the recipient is not connected directly to the supplier's grid, or if interconnected companies are not neighbouring companies (see 3.12), grid utilisation or transit agreements are necessary to process the delivery and purchasing.
3.12 Electricity industry neighbourhood		In the electricity industry, neighbourhood refers to the exchangeable capacity between two interconnected companies and exists if between them there is a suitable free cross section at the coupling point suitable for the capacity to be exchanged and the “principle of single failure” (3.14) is fulfilled in the entire grid.
3.12.1 Coupling point cross section		The coupling point cross section is the technically or contractually usable transmission capability of electrical energy of a coupling point defined between two neighbouring grid operators. The direct connection between the partners can consist of one or more lines (coupling lines or transformers) between the end nodes of the grid or of one node where the lines of several partners meet.
3.12.1.1 End node 3.12.1.2 Grid node 3.12.1.3 Coupling node		End and grid nodes are also described as coupling nodes or, if they belong to an integrated grid of two interconnected companies, as integrated coupling nodes.

Designation	Symbol	Definition
3.13 Supply reliability		Supply reliability (often expressed as a percentage of probability) is a quantitative measure of the extent to which a defined electricity supply system (see 1.9), consisting of transmission and distribution systems, power plants, and electricity purchases, is able to fulfil the respective supply tasks; in other words, to guarantee that it can cover the load geographically and in terms of time, even under unfavourable operating conditions. Note: International parameters of supply reliability include: − Deficit probability; that is, the probability that at a certain time, such as during maximum load, the capacity cannot be provided because of the failure of equipment − Deficit frequency; that is, the expected number, such as days per year, when a capacity shortfall is to be expected − Deficit duration; that is, the expected duration, such as hours per year, when a capacity shortfall is to be expected − Expectation value of the energy that cannot be delivered; that is, the consumption wish that cannot be fulfilled on time. These parameters can be determined as system parameters or as local parameters for a transfer point with consideration of the grid topology.

Designation	Symbol	Definition
3.14 Principle of single failure		The principle of single failure is a synonym for the terms used in literature “(n-1) criterion” and “single security”. A grid fulfils this criterion when in technically feasible and operationally practical situations it survives the fault-related outage of a piece of equipment without any restrictions in its transmission or distribution functions. The remaining equipment in the plant may not be stressed beyond the permitted limits so that the fault cannot spread.
3.14.1 Isolated operation capability		In the formation of asynchronous sub-grids the remaining load usually differs from the capacity provided by the generation unit. It is therefore necessary to design the control system of the generation unit so that it is able to cushion any partial load above the defined own requirements criterion in the same way as it can cushion for its own requirements. Timely restrictions are to be avoided. It must be possible for isolated operation to be maintained for several hours.
3.15 System services		In the electricity industry, system services are the services that are indispensable for the system to function properly, which the grid operators provide additionally for the transmission and distribution of electrical energy and thus determine the quality of the electricity supply.

Designation	Symbol	Definition
3.15.1 System services that must be provided		System services that must be provided are indispensable for the functioning of the supply system but cannot be determined individually by customers. Therefore, they must be coordinated and provided by the grid operators. These include: – Frequency stabilization – Voltage stabilization – Operational Management – Resumption of supply
3.16 Control zone		The control zone is a defined area in which variables agreed with external partners must be complied with (see also 3.18). Usually this concerns the effective electrical power – purchased or supplied – that must be maintained constantly within a certain bandwidth or at defined values within a defined time, if necessary, modified by a frequency-related share.
3.16.1 Control block		A control block includes one or more control zones that work together in the load-frequency control system vis-à-vis the other control blocks in the system. It must ensure implementation of the aggregated schedules of the control blocks vis-à-vis all other control blocks and must be able to reset the frequency to its set value after frequency deviations. A control block is not responsible for primary control; this task remains the responsibility of the individual control zones.

Designation	Symbol	Definition
3.17 Primary control		Primary control is the automatic, stabilising effective power control for the entire connected, synchronously operated 3-phase integrated grid in the secondary area. It arises from the active contribution of the power plants in changing the grid frequency and is supported by the passive contribution of the loads that are dependent on the grid frequency (self-regulating effect). Primary control should be seen as being closely connected with spinning reserve. It is an element of the system service “frequency maintenance” (see 3.18.5).
3.17.1 Primary controller (speed controller, turbine controller)		The primary controller (speed controller, turbine controller) is the self-contained control facility of a generation unit for frequency-related (speed-related) influencing of the delivered capacity. The characteristic curve of the controller has the effect that at the set frequency (set speed) the specified target capacity is fed to the grid, but in cases of higher or lower frequency (higher or lower speed), based on the characteristic of the turbine controllers (calculation), the generation unit automatically feeds more or less capacity into the grid.
3.17.2 Primary control band		The primary control band is the adjusting range of the primary control within which the primary controller can act automatically in both directions in case of a frequency deviation. The term “primary control band” can be used for any machine, for any control zone, and for the entire integrated grid.

Designation	Symbol	Definition
3.17.3 Primary control reserve		Primary control reserve is the positive part of the primary control range from the working point before the fault to the maximum primary control power (with consideration of the limitation). The term “primary control reserve” can be used for machines, for control zones, and for the integrated grid.
3.18 Secondary control		Secondary control is the regional influence of a generation unit belonging to a supply system. It is used to maintain the desired energy exchange of the region (control zone) with the other members of the integrated system (other control zones) while providing integral support for the frequency. It is an element of the system service “frequency maintenance” (see 3.18.5).
3.18.1 Secondary control (load-frequency control)		The secondary controller is the central automatic system in a control zone of the transmission system operator. It continuously issues adjusting commands to the system control power plants so that the energy exchange (balance of all actual values of delivery and reference capacities) and the actual value of the frequency are reset to their set value (balance of all schedule values for the exchange of capacity and the frequency setpoint).
3.18.2 Minute reserve/ Minute reserve capacity		The minute reserve/minute reserve capacity is used to balance longer capacity deviations that are called up shortly by the grid operator (e.g. typically within 5 to 15 minutes) and that can have an effect on the capacity. The power plant systems intended for this must be prequalified according to the currently valid transmission code.

Designation	Symbol	Definition
3.18.3 Secondary control band		The secondary control band is the adjustment range of the secondary control power within which the secondary controller can act automatically in both directions from the working point of the secondary control power (current value).
3.18.4 Secondary control reserve		Secondary control reserve is the positive part of the secondary control band from the working point to the maximum value of the secondary control band. The part of the secondary control band that is already set at the working point is called the secondary control capacity.
3.18.5 Frequency maintenance		Frequency maintenance is the correction of frequency deviations as a result of imbalances between feed-in and extraction (effective capacity control) and is carried out by primary and secondary control and by using minute reserves in the power plants.

Designation	Symbol	Definition
3.19 Load-frequency control		Load-frequency control is a control process with which operators of connected transmission systems of the entire connected, synchronously operated 3-phase integrated grid maintain the agreed electric parameters at grid connection points (see 3.13) during normal operation and especially during faults. Every transmission system operator, such as interconnected companies, tries to maintain the exchange capacity with the rest of the integrated system within the agreed framework and also the grid frequency close to the setpoint (50 Hertz in the European interconnected system). Note: Transmission system operators that are responsible for deviations from the agreed setpoints in the controlled parameters must balance out this deviation either internally or outside their transmission system (e.g. through agreed additional purchases of capacity from other systems). Maintaining the grid frequency and the agreed exchange capacities at the grid connection points may not be possible temporarily. Technical precautions ensure that the required priorities are maintained during transition periods.

Designation	Symbol	Definition
3.20 Hourly, daily reserve		The hourly or daily reserve (also known as cold reserve or standing reserve) is, in Germany for example, generally provided by thermal power plants. They have to be started up for this. Note: In the case of storage and pumped storage power plants, the potential duration of the use of reserve capacity must be stated.
3.21 Tertiary control		Tertiary control is shifting capacity between individual generation units; also activating and deactivating (start-up/shutdown) them with the following objectives: – to provide adequate secondary control in terms of time and quantity at all times, and – to split up generation on the whole between individual units in an optimum economical manner. Shifting is done subordinately to secondary control within the scope of the respective freedom and control gradients by influencing the power plants of the supply system (regions, control zone). Tertiary control should also be considered together with hourly and daily reserve (see 4.3.26).

Designation	Symbol	Definition
3.21.1 Emergency reserve		Emergency reserve is the replacement energy delivered by a TSO to a grid user as the result of an inadmissible purchase of capacity. This replacement energy can be – procured on the market at short notice, – taken as unguaranteed capacity from the system service "minute reserve", or – kept by a TSO in an emergency reserve pool.
3.21.2 Voltage stabilization		Voltage stabilization is used to maintain an acceptable voltage profile in the entire grid. This is achieved by an equalised reactive power balance in relation to the respective reactive power requirements of the grid and the customers.
3.21.3 Black start capability		Black start capability is the ability of a generation unit, when it is separated from the grid, to start on its own with grid-independent resources, to power up to idle running conditions and to take over a load. The start process, switching to the grid and taking over the load can be controlled locally or remotely. The grid can be a sub-grid that has no voltage or is under voltage before the switching process. The TSO must ensure for its control zone that a sufficient number of black start capable generation units are available.

Designation	Symbol	Definition
3.21.4 Grid bottleneck		A bottleneck in the distribution grid exists if the grid is not able to be operated in a reliable condition even after all the appropriate measures have been taken. Appropriate includes the use of all measures available to the DSO, such as load shedding and deployment of a power plant.
3.21.5 Bottleneck management		All the measures taken by the grid operator to prevent or rectify a bottleneck (e.g. auctions, redispatch, counter-trading, market splitting).
3.21.6 Critical operation		Critical operation is characterised by the following: – All customers are supplied. – Limit values are complied with. – The (n-1) criterion is not fulfilled.
3.21.7 Downtime planning		Downtime planning is planning temporary shutdown of a generation unit.
3.21.8 Decommis-sioning planning		Decommissioning planning is planning the final or temporary decommissioning of a generation unit.
3.22 Redispatch		Redispatch means the preventive (ex ante) or curative (ex post) influence on energy deliveries (e.g. effective power, voltage stabilization, etc.) by a grid operator. The aim is to prevent or remedy short-term bottlenecks.

Designation	Symbol	Definition
3.23 Redispatch measure		A redispatch measure is the request from a grid operator to the entity responsible for the balancing group to change the feed of energy from generation units in its balancing group based on system-related specifications.
3.24 Designation system		The designation system is used for uniform and systematic designation of power plant systems. It helps power plant construction companies and operators clearly name and identify systems, facilities, and equipment. Examples of designation systems include the KKS Power Plant Identification System and the Reference Designation System for Power Plants (RDS-PP®).
3.25 Cold, warm, hot starts		According to [VDE 1996], a hot start is the start-up process of a thermal power plant after downtime of less than eight hours. In practice, many of the auxiliary and secondary systems of the plant are not shut down for this time. If the downtime of a thermal power plant is between 8 and 50 hours, this is described as a warm start. General: Depending on the temperature of a thermal power plant at the beginning of a start-up process a distinction is made between the following: – Cold start (e.g. after servicing downtime) – Warm start (e.g. after weekend downtime) – Hot start (e.g. daily start-up process) Downtime-related start-up times depend on the power plant, such as the type of fuel, the size of the plant, and the duration of the downtime as follows:

Power plant type	Capacity	Downtime-related start-up times		
		Cold start	Warm start	Hot start
Hard coal-fired power plant	500 – 750 MW	6 – 8 h	4 h	1 h
Lignite-fired power plant	500 – 1,000 MW	9 – 15 h	5 h	–
Cogeneration power plant	200 – 500 MW	1 – 5 h	3 h	85 min 50 min
Gas turbine (also oil-fired)	250 – 400 MW	2 – 3 h	20 min	
Nuclear power plant	750 – 1,500 MW	24 – 50 h	–	–

Table 1: Downtime-related start-up times for thermal power plants

Designation	Symbol	Definition
3.26 Starting up		Process for establishing power generation with a power generation unit, which includes grid synchronisation and feed-in of the generated power into the power grid. The start-up begins with the first energy-related measure required based on the start-up request. For preserved plants, this is the start of the depreservation, and for non-preserved plants in idle, it is usually the moment of connection of the first unit or the commencement of measures for starting up necessary systems. The trigger of these measures is the direct request for start-up by the person responsible for operation or the corresponding operational planning with the scheduled time for starting the grid feed-in. Depending on the downtime duration between the shutdown and restart of a thermal generation plant, there are different types of start-up (cold, warm and hot start). The successful start-up of the power generation unit is complete when the grid has synchronised and the plant can be operated in a stable condition in one working point. Examples for this are: – For thermal plants, this is usually the equivalent to attaining the working point of the minimum load. – Note: The losses occurring during start-up of the thermal generation plants can be determined using the VGB PowerTech Guideline “Start-up and shutdown losses in block plants” (VGB-R 123 C/2.10).

Designation	Symbol	Definition
		– To start up wind turbines, the rotor blades of the braked rotor are driven into the wind and the mechanical rotor brake is released as soon as the attainment of the starting speed is confirmed through measurement of the wind speed. The rotor speed is increased from idle by adjusting the blade angle until the synchronisation speed of the generator is attained. If the synchronisation speed can be kept constant over a defined period, the generator is coupled onto the grid. – The start-up and grid synchronisation of photovoltaic plants are usually performed fully automatically via the the solar inverter.
3.27 Variant Start-up/ Black start		A black start refers to the start-up of a power generation unit when it occurs independently of the public power grid based on the status “Out of order”. This is particularly significant in the event of a widespread power failure in order to restart operation of the grid. The energy of black start-capable power generation units can then be used for the start-up of non-black start-capable power generation units. In the event of a black start, the start-up also begins with the first energy-related measure required based on the start-up request. This may be the start of a diesel unit or the connection of the power of a water turbine, for example. The start-up ends when the plant can be operated in a stable condition in one working point. In the event of a black start, this can be done independently of a grid synchronisation.

Designation	Symbol	Definition
3.28 Shutting down		Process for shutting down power generation with a power generation unit and feed-in of the generated power into the power grid. The shutdown process begins upon initiation of the operational shutdown program or after abandoning the minimum load. The end of the shutdown procedure is attained when the final large unit is switched off. Examples for this are: – In thermal power plants, the final large unit is, for example, the main cooling water pump. Measures for slowly cooling down the plant (e.g. turn operation of the propeller shaft or ventilation systems) are excluded from this. – In hydro power plants, the water is either retained after closing the water supply or guided past the turbine via a bypass. – Wind turbines and hydro power plants can additionally be shut down for plant and machine protection reasons when there is an extreme surplus of wind or water. – Solar plants have a safety shutdown for overfrequency when a current individual value of between 50.3 and 51.5 Hertz is to be fixed and for underfrequency when a current individual value below 47.5 Hertz is to be fixed for each plant. In order to prevent the plants from continuously switching on and off, they only switch back on 30 seconds after the switch-off frequency has been undercut. If a solar plant does not have this protection device, the inverter must be set in such a way that the plant automatically slows down gradually between 50.2 and 51.5 Hertz, and completely disconnects from the grid when falling below 51.5 Hertz.

Designation	Symbol	Definition
3.29 Variant – shutdown procedure with load rejection		– Load rejection refers to a special situation in a power plant whereby the generator suddenly runs without load (load rejection at zero) or only covers own requirements (load rejection at own requirements), for example. – Such a condition is, among other things, caused by • overloading of the generator and triggering of the protection devices (underfrequency), whereby the generator is disconnected from the power grid and only the own requirements of the generation plant continue to be supplied (load rejection at own requirements) • grid-side disturbance (load rejection at own requirements) • a failure of exciter or machine transformer (load rejection at zero) • damage to the turbine controller (turbine trip) or complete failure of the generation plant (load rejection at zero). In this case, shutdown begins directly with the event of the load rejection. The shutdown is complete when the final large unit is switched off, as described above. In the event of a fault-related load rejection, the shutdown can be ended by starting the start-up process.

4 Generation Plants

4.1 Energy Terms

In principle, electrical energy is understood to be the electrical energy provided by a voltage difference at the end of a conductor. The voltage difference can be created in various ways, especially by moving a conductor in an electromagnetic field, as a result of a chemical reaction, or through direct conversion from radiation. In general, electrical energy is the product of the voltage difference U, the current I and the time t. The fact that electrical energy is simply described as electricity is taken account of here (e.g. Electricity generation, see 4.1.4). See General preliminary remarks regarding the units.

When mentioning electrical energy, as a rule the time in which it applies should be stated. The flow diagram with an explanation of the energy terms of a supply system provides an overview, see Figure 4. Many energy terms have their equivalent in the capacity terms. Therefore, in some cases, analogies will occur in a shortened version. It is thus worthwhile to cross reference.

Designation	Symbol	Definition
4.1.1 Electrical energy	W	Electrical energy is the generated, transmitted, delivered, purchased, or converted electrical energy. With no particular addition, energy is to be understood as effective energy.
4.1.2 Nominal energy	W_N	The nominal energy is the product of nominal capacity (see 4.3.6) and reference period (see 4.4.2). $W_N = P_N \times t_N$ This variable is used as a reference variable (100% value) for availability considerations.
4.1.3 Redispatch energy		Redispatch energy is the additional or reduced generation of the generation unit concerned as a result of the redispatch measure that is settled between the entities responsible for the balancing group and the grid operators via the balancing group (redispatch).

Designation	Symbol	Definition
4.1.4 Generated energy	W_B	The electricity generation of a generation unit (e.g. a power plant block or a power plant) is the electrical energy generated in a time (operating time). Under special conditions (e.g. favourable fuel properties, low cooling water temperature, temporary useful excess capacity) electricity generation may also exceed nominal energy (excess energy $W_Ü$, see 4.1.8.1). Depending on the origin of the energy, a distinction is made between primary and secondary electricity generation.
4.1.4.1 Primary electricity generation		Primary electricity generation is the planned electrical energy generated from fossil fuels, nuclear fuels, biomass, waste, wind energy, photovoltaic systems, geothermal energy and natural flows in water, storage, and tidal power plants.
4.1.4.2 Secondary electricity generation		Secondary electricity generation (extraction, e.g. generation in pumped storage power plants) is the generation of electrical energy from stored energy (storage feed, e.g. pump energy minus pump storage losses) that was recovered from electrical energy at an earlier time.
4.1.4.3 Storage extraction		Note: Usually, storage extraction and storage feed do not take place in the same reporting period.
4.1.4.4 Storage feed		

Designation	Symbol	Definition
4.1.5 Gross electricity generation	$W_{B\ br}$	Gross electricity generation of a generation unit is the generated electrical energy measured at the generator terminals.
4.1.6 Net electricity generation	$W_{B\ ne}$	Net electricity generation of a generation unit is the gross electricity generation minus auxiliary consumption (see 4.3.4). $W_{B\ ne} = W_{B\ br} – W_{Eig}$ If nothing else is stated, net electricity generation refers to the reference period (see 4.4.2). The net electricity generation can also be negative.
4.1.6.1 Net electricity generation operating time	$W_{B\ ne\ B}$	The net electricity generation operating time of a generating unit is the gross electricity generation reduced by its auxiliary consumption operating time. $W_{Bne\ B} = W_{B\ br} – W_{Eig\ B}$
4.1.7 Auxiliary consumption	W_{Eig}	Auxiliary consumption is the electrical energy that is consumed in the secondary and auxiliary systems of a generation unit (e.g. a power plant block or a power plant) for water treatment, water storage for steam generation, supplying fresh air and fuel and flue gas treatment. It does not include plant consumption (see 4.1.26). The losses from the step-up transformers (machine transformers) in the power plant are counted as auxiliary consumption. Consumption by non-electrically operated secondary and auxiliary systems is included in the total heat consumption of the power plant and is not added to electrical auxiliary consumption (see also 4.6.6 = Utilisation ratio). Auxiliary consumption during the reference period consists of:

Designation	Symbol	Definition
4.1.7.1 Auxiliary consumption operating time	$W_{Eig\ B}$	Auxiliary consumption during the operating time t_B.
4.1.7.2 Standstill auxiliary consumption	$W_{Eig\ S}$	Standstill auxiliary consumption outside the operating time (during the time $t_N - t_B$ or $t_R + t_{nb}$). Standstill auxiliary consumption is not counted in the net calculation.
4.1.8 Available energy	W_v	The available energy is the energy which can be generated in the reference period due to the technical and operational condition of the plant. $W_V = W_N - W_{nv}$
4.1.8.1 Excess energy	$W_Ü$	Energy availability factors above 100% should be excluded as being impractical. Energy amounts generated from capacities above the nominal capacity (Excess energy $W_Ü$) should therefore be disregarded in availability calculations. If available energy is calculated from the plant energy and the available not generated energy (analogous to the unused capacity, see 4.3.11 and Figure 6), excess energy should be subtracted.
4.1.8.2 Available energy not generated	W_{ng}	$W_V = W_B + W_{ng} - W_Ü$

Designation	Symbol	Definition
4.1.9 Stand-by energy	W_R	The stand-by energy is the energy which may be generated in addition to the energy generated, but which is not generated.
4.1.10 Unavailable energy	W_{nv}	The unavailable energy is the energy which cannot be generated during the reference period for plant-internal reasons or for other reasons that cannot be influenced by management. It consists of planned and unplanned parts $W_{nv} = W_{nv\,p} + W_{nv\,u}$
4.1.10.1 Planned unavailable energy	$W_{nv\,p}$	The planned unavailable energy is the unavailable energy for which the beginning and duration have to be determined more than four weeks in advance (e.g. long-term planned work such as servicing or complete overhaul).
4.1.10.2 Unplanned unavailable energy	$W_{nv\,u}$	Unplanned unavailable energy is determined by lacks of availability caused by unforeseen events such as faults or damage whose start cannot be postponed or can be postponed only up to four weeks. It is split into a postponable (within certain deadlines) and a not postponable part.
4.1.11 Dispatchable energy	W_b	Dispatchable energy is the difference between available energy and externally influenced energy $W_b = W_V - W_{ns}$

Designation	Symbol	Definition
4.1.12 Non-dispatchable energy	W_{nb}	Non-dispatchable energy of a generation unit is the total unavailable energy and unusable energy. $W_{nb} = W_{nv} + W_{ns}$
4.1.13 Electricity purchase	W_{Bzg}	Electricity purchase in a system (e.g. by a power company) is the electrical energy that it purchases from other power companies or from third parties. It is split into:
4.1.13.1 Electricity purchase for supplies	$W_{Bzg\ V}$	1. Electricity purchase for supplies; that is, the amount of energy that the purchaser plans for delivery to its customers
4.1.13.2 Electricity purchase for account	$W_{Bzg\ SO}$	2. For account purposes also balanced values on the base of MTU (Market Time Unit) are used beside the physical values. On this occasion, the physical feed-in and the purchase are balanced in the MTU. A further index describes "SO" (System Operator) this context: $W_{Bzg\ SO}$

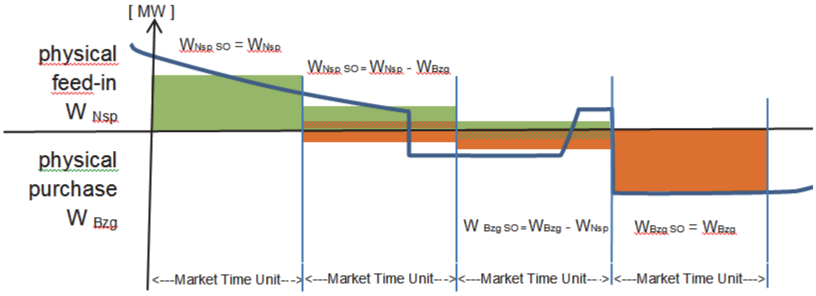


Figure 3: Electricity feed-in and purchase

Designation	Symbol	Definition
4.1.13.3 Electricity purchase in lieu of payment	$W_{Bzg\ NA}$	3. Electricity purchase in lieu of payment; that is, the amount of energy that a market player (e.g. a power company) obtains in lieu of payment for losses in its own grid due to transmission, for assisting to rectify faults, for zero balancing in synchronous operation of grids or for other services. $W_{Bzg} = W_{Bzg\ V} + W_{Bzg\ NA}$ Note: In statistics, electricity purchase by a system (e.g. a power company) from industrial power plants is often described as feeding from own systems. This also includes electricity purchase from market players whose generation units are installed outside the planning of the existing system (e.g. wind turbines or independent generators, see 3.8). These purchases must be broken down according to the individual situations.
4.1.14 Transmission		For a general explanation of transmission in terms of the electricity industry, see 3.8. In the energy balance of a system (e.g. a power company), transmission especially means the part (see 4.1.13) of the electricity (see 4.1.18) that the grid operator transports expressly for third parties (not for itself or for a customer), as opposed to other electricity purchasing that is included in electricity requirements (see 4.1.19). Note: To compile the capacity and energy balances and to ensure reliable operation, the responsible grid operator must have an itemised record of feeds and extractions for transmissions within and outside its system boundaries.

Designation	Symbol	Definition
4.1.14.1 Feed-in for transfer	$W_{EÜ}$	Feed-in for transfer and extraction for transfer are the same amount in terms of the definition. The losses caused by them in the transmission and distribution systems can be balanced out by deliveries in lieu of payment or by compensation to the transferring company (see also Note 4.1.23).
4.1.14.2 Extraction for transfer	$W_{EÜ}$	
4.1.15 Grid feed-in	W_{Nsp}	Grid feed-in of a system (e.g. a power company) is the electrical energy that is physically fed into its transmission and distribution grids. Grid feed-in is not an item in the energy balance (see Note on 4.1.17).
4.1.15.1 Grid feed-in for account	$W_{Nsp\ SO}$	For account purposes also balanced values on the base of MTU (Market Time Unit) are used beside the physical values. On this occasion, the physical feed-in and the purchase are balanced in the MTU. A further index “SO” (System Operator) describes this context: $W_{Nsp\ SO}$.
	$W_{Nsp\ Net}$ $W_{Bzg\ Net}$	If there is the need for a report to net either the physical values or the MTU related feed-in and purchase (e.g. netting on a monthly value), these netted values should have the index "Net".
4.1.16 Grid connection point		The grid connection point is the physical location agreed upon between the operator of an energy conversion plant and the grid operator. At the grid connection point, the energy conversion plant is connected to the technical plants of the power grid.

Designation	Symbol	Definition
4.1.17 Electricity procurement	W_{BS}	Electricity procurement is the total of electricity generation and electricity purchasing for supplies and in lieu of payment, in particular when there are differences between (own) electricity generation and (third-party) electricity purchasing and their respective sub-divisions. It is thus the equivalent of electricity requirements (see Figure 5). Electricity procurement can be recorded gross or net: $W_{BS} = W_B + W_{Bzg_V} + W_{Bzg_{NA}} = W_B + W_{Bzg}$ Note: Electricity procurement is different from grid feed-in. As an energy balance variable, it also includes generation and purchases that are outside the system grid but that are recorded in the balance sheet. Pure transmissions, on the other hand, do not count as electricity procurement.
4.1.18 Electricity amount (Electricity sales)	W_S	The electricity amount (formerly electricity sales) of a system (e.g. a power company) is recorded as the sum of generation and purchase (including transmission) of the highest number value in the energy balance. It can be recorded gross or net. $W_S = W_B + W_{Bzg} + W_{EÜ}$ Note: With the addition of new market players as a result of liberalisation of the electricity markets – such as independent generators (see 1.3.2.7) – to the previous categories of public electricity supply, industrial and private own supply, the term takes on a new meaning. In the electricity balance, the electricity amount marks the demarcation line between the supply and the demand sides.

Designation	Symbol	Definition
4.1.19 Electricity requirements	W_{Sb}	Electricity requirements of a system (e.g. a power company) are calculated from the electricity amount after deductions for transmission and are thus the same as electricity procurement (see 4.1.17). They can be recorded gross or net. $$W_{Sb} = W_S - W_{EÜ} = W_B + W_{Bzg}$$
4.1.20 Pump energy (Pump electricity consumption)	W_P	Pump energy (formerly pump electricity consumption) is the electrical energy used in pumps of pumped storage power plants to pump the stored water. This applies also to other storage media.
4.1.21 Pump storage losses	W_{PV}	Pump storage losses are the difference between the pump energy and the associated recoverable gross electricity generation of the pumped storage power plant, with consideration of storage feed and extraction (see 4.1.4).
4.1.22 Electricity output	W_{Ab}	The electricity output of a system (e.g. a power company) is calculated from the electricity requirements reduced by own consumption (see 4.1.7) and the pump energy. $$W_{Ab} = W_{Sb\,br} - W_{Eig} - W_P = W_{Sb\,ne} - W_{Eig_S} - W_P$$

Designation	Symbol	Definition
4.1.23 Energy losses in the grid	$W_{ÜV}$	Energy losses in transmission and distribution grids (grid losses) (e.g. by a power company) are the difference between the electrical energy physically fed into the grid within a certain time and the electrical energy extracted from it in the same time. Note: In practice certain amounts of energy, e.g. in cases where it is delivered in lieu of payment, are not classified as usable electricity output for accounting reasons; but they are also not energy losses. Official statistics use the terms “losses” and “not recorded” for the difference between electricity output and usable electricity output. $W_{ÜV} = W_{Ab} - W_{nAb} - W_{NA}$ Transmission, deliveries in lieu of payment, and pump energy also cause energy losses in the grid. Because of this, they were included in the diagram explaining the energy terms of the supply system (see Figure 4) behind the energy losses. The arrangement in the diagram takes account of the practical recording options for statistical balancing.

Designation	Symbol	Definition
4.1.24 Electricity supply in lieu of payment	W_{NA}	Electricity supply in lieu of payment is the equivalent for the corresponding item on the coverage side (see 4.1.13). Energy amounts that are delivered for losses in third-party grids outside the system (e.g. a power company), for fault assistance to be remunerated in lieu of payment, for zero balancing in synchronised operation of grids, etc. It is not counted as useable electricity output.
4.1.25 Usable electricity output	W_{nAb}	Usable electricity output of a system (e.g. a power company) is the total delivery to customers measured with contractually agreed measuring equipment. Usable electricity output also includes plant consumption. In principle, usable electricity output is also calculated from the electricity output minus the energy amounts that occur as losses in the transmission and distribution systems, amounts delivered in lieu of payment and amounts that were not recorded (see Note on 4.1.23). $W_{nAB} = W_{Ab} - W_{ÜV} - W_{NA}$
4.1.26 Not operational auxiliary consumption	W_{BV}	Not operational auxiliary consumption of a system (e.g. a power company) is the consumption in its own facilities, such as administration buildings, repair shops, switchgear and transformer systems for heating and lighting systems, electrical drives and cooling units. Not operational auxiliary consumption is counted as usable electricity output. Auxiliary consumption of the power plants is not counted as not operational auxiliary consumption.

Designation	Symbol	Definition
4.1.27 Electricity output to customers	W_A	Electricity output to customers is the usable electricity output that a system (e.g. a power company) delivers to customers; that is, to end consumers (see 4.1.31.2), to power companies (see 1.3), and to other market players (see 2.79). It is split into direct and indirect electricity supply. $W_A = W_{nAB} - W_{BV}$ Note: To compile the capacity and energy balances and to guarantee reliable operation, the responsible grid operators need an itemised record of the deliveries and purchases across the boundaries of their systems. Required information are: – Within a balancing group: Delivery/Supply between customers from their own generation. – Outside a balancing group: External procurement across the boundaries for customers within the balancing group. – Delivery across the boundaries to customers outside of the balancing group.
4.1.28 Direct electricity supply		Direct electricity supply is the part of the electricity output to customers that a system (e.g. a power company, power plant operator) delivers directly to end consumers inside and outside its own system boundaries. This means that plant consumption is also counted here, although it is recorded separately (see Figure 8). In the case of customers outside the system (e.g. direct connection), these could be customers with no physical connection to the system's grid.

Designation	Symbol	Definition
4.1.29 Indirect electricity supply		Indirect electricity supply is the part of the electricity output to customers that a system (e.g. a power company, power plant operator) delivers to other power companies, e.g. resellers and other market players inside and outside its own system boundaries. In the case of customers outside the system, these could be customers with no physical connection to the system's grid.
4.1.30 Energy balance		In the electricity industry, the energy balance is the comparison of energy amounts in a supply system (e.g. in a power company grid or in a country) split into individual items on the supply and demand sides for a specific time interval. This can be with or without own consumption (usually without, i.e. net balance). See also Figure 4.

Designation	Symbol	Definition
4.1.31 Power consumption	W_{Vb}	Electricity consumption is the electrical energy moved in the direction of a consumer. This can be purchased or be generated in one's own system (see 1.8).
4.1.31.1 Consumer		Consumers include devices and systems as well as natural persons and legal entities that use electrical energy to convert it into other types of energy.
4.1.31.2 Final customer		An final customer is a natural person or a legal entity that uses electrical energy only for his/her/its own purposes; in other words, does not supply electrical energy to a third party.
4.1.31.3 Customer		In terms of the Regulation on General Conditions for the Supply of Energy to General Customers (AVBEltV), customers are natural persons or legal entities that are supplied with electrical energy by a power company on the basis of supply agreements.
4.1.31.4 Purchaser		Purchasers are natural persons or legal entities or organisational units that physically purchase electrical energy from a power company regardless whether they have a contractual relationship or not. Note: Usually customers and purchasers are identical. Counter-example: barracks as the purchaser, site administration as the contractual partner, and hence the customer.

Designation	Symbol	Definition
4.1.32 Gross electricity consumption of a country	$W_{Vb\ br}$	Gross electricity consumption of a country is the entire electrical energy sold in the entire territory. It is calculated as the sum of the gross electricity generation in the country and the balance of the exchange across the country's borders (import minus export), in which case imports are to be recorded as electricity purchases – W_{Bzg} – and pro rata transmission, exports are to be recorded as electricity supplies outside the system – W_{LL} – and pro rata transmission. $W_{Vb\,br} = W_{B\,br} + W_{Bzg} - W_{LL}$
4.1.33 Net electricity consumption of a country	$W_{Vb\ ne}$	Net electricity consumption of a country is the electrical energy used by consumers. It is calculated from the sum of direct electricity supplies to purchasers plus plant consumption and consumption by industry from own systems and other own generators from their own systems (see 1.8); it is the total electricity consumption of a country minus the energy losses in the grids (see 4.1.23). $W_{Vb\,ne} = W_{VG} - W_{ÜV}$ $= W_{Vb\,br} - W_{Eig} - W_{P} - W_{ÜV}$

Designation	Symbol	Definition
4.1.34 Total electricity consumption of a country	W_{VG}	Total electricity consumption of a country as a special case of electricity output (see 4.1.22) is the electrical energy that is needed to cover the requirements of the consumers and the energy losses in the grids. It is calculated from gross electricity consumption of a country minus own consumption and pump energy. $W_{VG} = W_{Vb\,br} - W_{Eig} - W_P$ Note: If total electricity consumption is calculated only for the public supply area, electricity purchasing from own systems (see 1.8) must be taken into account.
4.1.35 CHP electricity		CHP electricity is the calculated product of CHP heat extraction and the power of the CHP facility. In facilities without waste heat removal devices the total net electricity generation is considered as cogeneration.
4.1.36 Electricity indicator		The electricity indicator is the ratio of cogeneration of net electricity generation to cogeneration of heat extraction in a given period of time. CHP net electricity generation corresponds to that part of net electricity generation, which is physically directly linked to the generation of heat. $\sigma_{ne\ KWK} = \frac{W_{ne\ KWK}}{Q_{ne\ KWK}}$

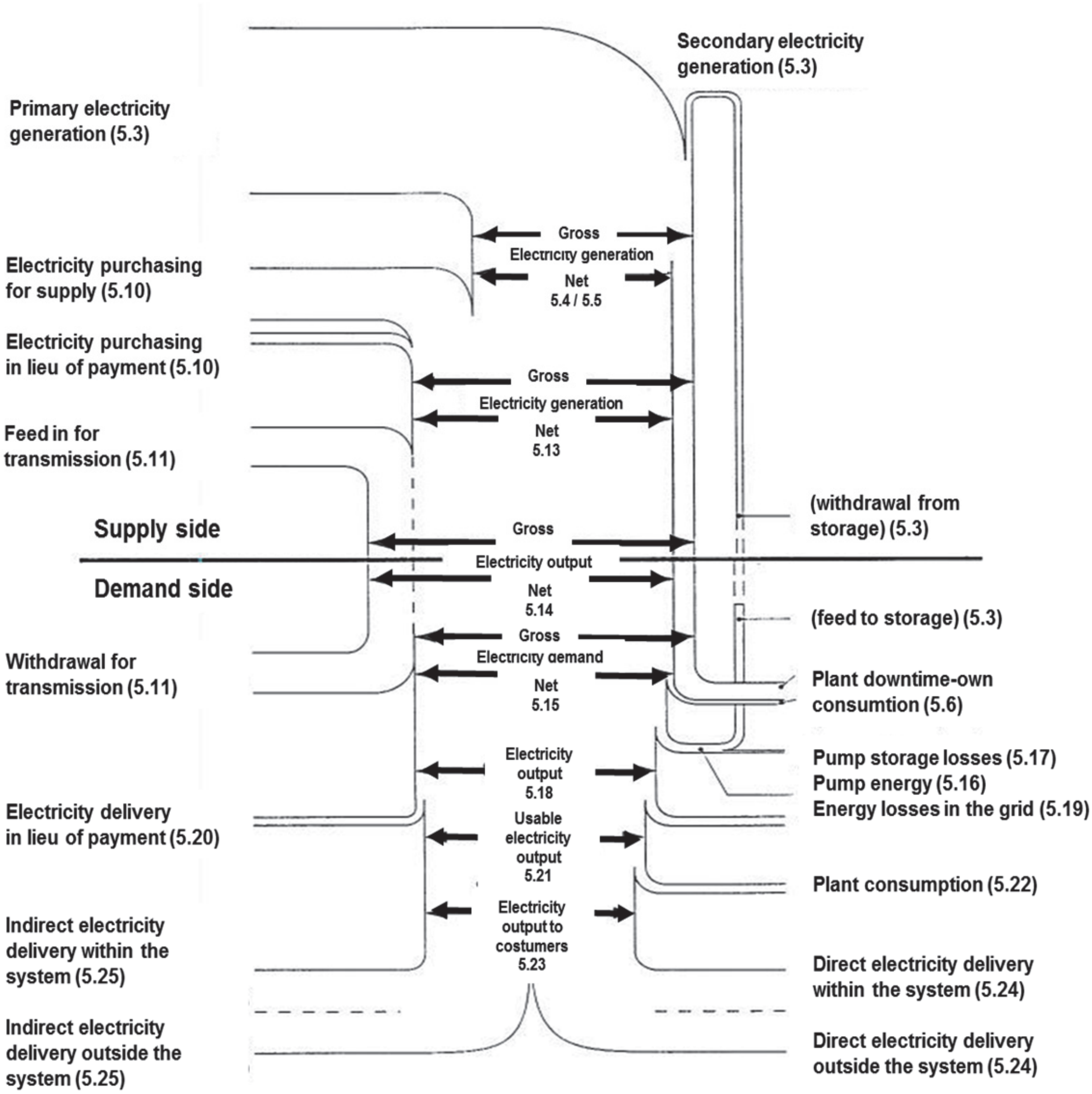


Figure 4: Diagram (flow diagram) to explain the energy terms of a supply system

4.2 Graphical presentations

Designation	Symbol	Definition
4.2.1 Load curve		The load curve is the graphical presentation of a variable over a certain time schedule. Note: The presentation can be analogue as a recording of the current values (measured values of an analogues measuring instrument) or digital as a sequence of averages in specific time intervals (measuring times of e.g. ¼ h, 1 h, measured value of an integrated measuring instrument). Figure 5 and Figure 7 for examples of this, such as a daily capacity load curve or a daily load curve.
4.2.2 Duration curve		The duration curve is the graphical presentation of a variable over a time interval, arranged according to the level of the values. Note: The duration curve shows how long a certain value of the presented variable occurs or is exceeded within the specific time interval. An example of a daily duration curve of hourly load averages can be seen in Figure 5. In the duration curve, the time relationship of the individual values is lost; but it allows an estimate to be made of the load ranges and their energy content.

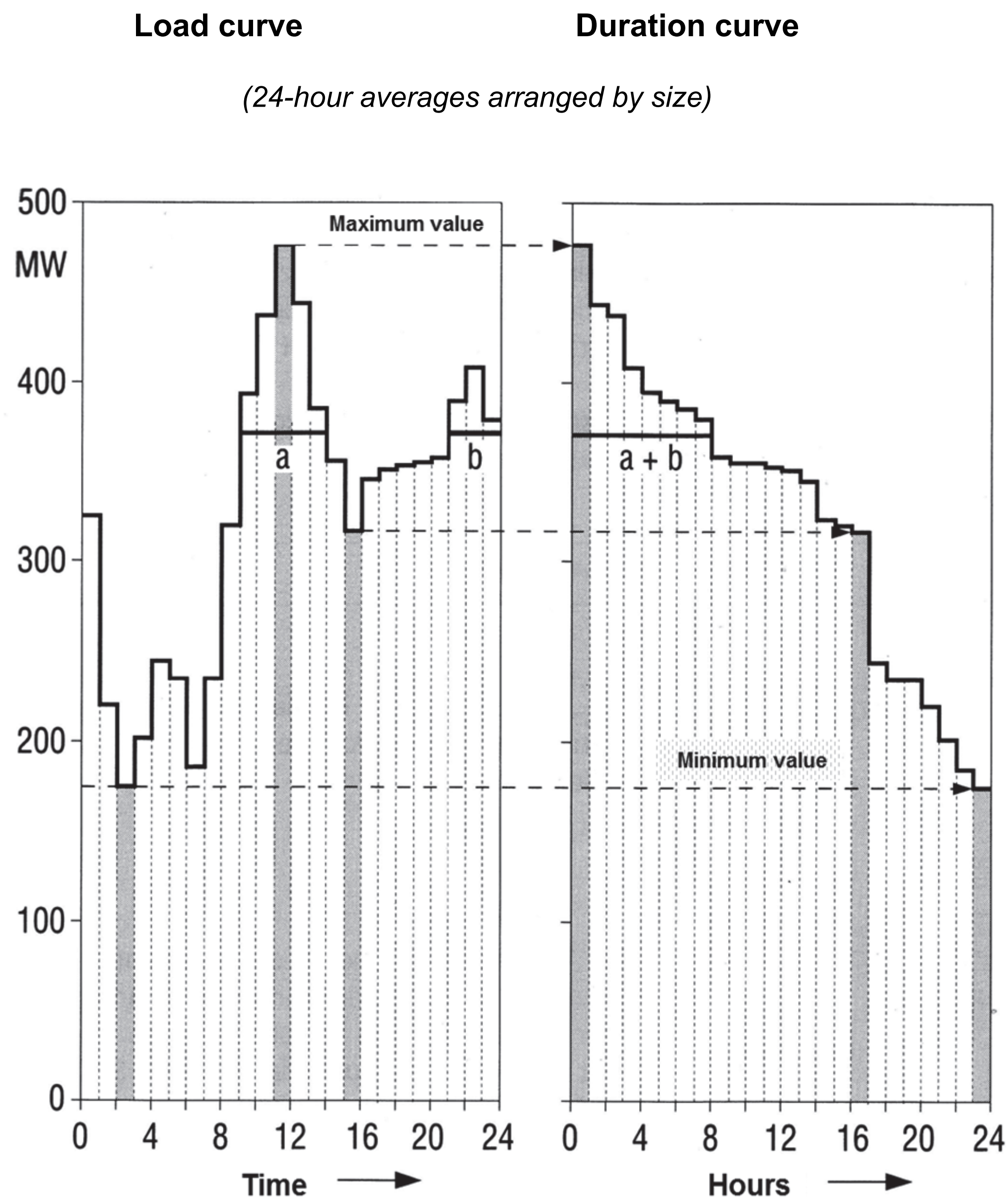


Figure 5: Connection between load curve and duration curve

4.3 Capacity terms

The diagram presenting the capacity terms of a generation units (see Figure 6), the diagram explaining the capacity terms of a supply system (see Figure 8), and the presentation of the capacity balance of a supply system (see Figure 9) give overviews of the connections.

Many capacity terms have their equivalent in the energy terms. Therefore, in some cases, analogies will occur in a shortened version. It is thus worthwhile to cross reference. See General preliminary remarks regarding the units.

Designation	Symbol	Definition
4.3.1 Capacity	P	In physical terms, as the product of current and voltage, electrical capacity is an instant value. When instant values are being given, the time must be stated (date and time). In the electricity industry, apart from instant values, average capacities for defined time intervals (measuring times, e.g. ¼ or 1 h) are also used. Capacity is then the quotient of the energy W output in a time interval and the same time interval t. $P = \frac{W}{t}$ If nothing else is stated, capacity means effective electrical capacity in the following definitions. Capacity values from generation systems can be given – with or without consideration of the operating auxiliary capacity (see 4.3.4) – as gross or (usually) a net value and should be marked accordingly.
4.3.1.1 Control capacity		The control capacity of a generation unit is the capacity range within which the capacity can be changed due to the effects of the primary or secondary control.
4.3.2 Gross capacity	P_{br}	The gross operating capacity of a generation unit (see 3.1.1) is the delivered capacity at the terminals of the generator.

Designation	Symbol	Definition
4.3.3 Net capacity	P_{ne}	The net capacity of a generation unit (see 3.1.1) is the capacity which is delivered to the supply system at the higher voltage side of the machine transformer (transmission and distribution system, consumer). It is calculated from the gross capacity minus the electric auxiliary capacity during operation (see 4.3.4) even if this is not provided from the generation unit, but from elsewhere. $P_{ne} = P_{br} - P_{Eig\,B}$ Note: To avoid negative net capacities, own consumption during downtime is not considered in the net calculation (considered on the requirements side).

Designation	Symbol	Definition
4.3.4 Auxiliary capacity	P_{Eig}	The auxiliary capacity of a generation unit (see 3.1.1) is the electrical capacity needed to operate its ancillary and secondary systems (e.g. water treatment, water storage for steam generation, supplying fresh air and fuel, flue gas treatment), plus the capacity losses of step-up transformers (machine transformers). A distinction is made between auxiliary capacity during operation and during downtime. $P_{Eig} = P_{Eig\ B} + P_{Eig\ S}$
4.3.4.1 Operating auxiliary consumption capacity	$P_{Eig\ B}$	The operating auxiliary consumption capacity is the electrical capacity needed for secondary and auxiliary plant units during the operation of a generation unit.
4.3.4.2 Standstill auxiliary consumption capacity	$P_{Eig\ S}$	Standstill auxiliary consumption capacity is the electrical capacity needed for the secondary and auxiliary systems of a generation unit outside the operating time (see 4.4.4).

Designation	Symbol	Definition
4.3.5 Grid feed-in capacity	P_{Nsp}	The grid feed-in capacity from an energy conversion plant is the electrical capacity measured at the grid connection point.
4.3.6 Nominal capacity	P_N	The nominal capacity (gross or net) of a plant is the maximum continuous output under nominal conditions that the plant is capable of achieving at the time of handover. Alteration of the capacity is only permitted in the case of significant alterations to the nominal conditions, or if structural changes are made to the plant. Until the precise calculation of this nominal capacity has taken place, the order value according to the supply agreement should be specified. If the order value does not clearly correspond to the real licence and operating conditions, a preliminary average capacity value should be calculated in advance until supported measurement results are available. It must be defined in such a way that the potential fluctuations in power generation balance out over one normal year (e.g. as a result of the cooling water temperature cycle). The conclusive definition of the nominal capacity of a power plant block takes place after the handover of the plant, generally after the results of the acceptance test measurements are available. It is of considerable importance here that the nominal conditions correspond to an annual average, i.e. that the seasonal effects (e.g. the temperature of the cooling water and inflowing air) and the plant's own electrical and steam requirements are balanced out, and that the conditions during the acceptance test measurements, e.g. special switching circuits, are recalculated to incorporate normal operating conditions. In contrast to the maximum capacity, the nominal capacity must not be adapted to temporary fluctuations in performance.

Designation	Symbol	Definition
		It is also not allowed to change the nominal capacity in the case of capacity decreases as a consequence of or to avoid damages. In the same way, a decrease in nominal capacity is not admissible due to ageing, wear or soiling. A change in nominal capacity may be made only if additional investments are made, such as: – Retrofitting measures that improve efficiency are carried out with the aim of increasing the capacity of the plant, – Plant parts are finally shut down or removed with the conscious acceptance of capacity losses, – Due to external influences, the plant is continuously, i.e. for the rest of its service life, operated outside the dimensioning range determined in the supply agreements, or – As a result of an official order or due to statutory regulations the plant is allowed to be operated until the end of its service life with only reduced capacity even if no technical defect exists. For cogeneration systems, the nominal electrical capacity is to be given for the nominal capacity.

Designation	Symbol	Definition
4.3.7 Bottleneck capacity	P_E	The bottleneck capacity (gross or net) of a generation unit (see 3.1.1) is the continuous capacity (see 4.3.8) that can be achieved under normal conditions. It is limited by the weakest parts of the system (bottleneck), is determined by measurements, and is adjusted to normal conditions.
		With longer-term changes (e.g. changes to individual units, ageing effects), the bottleneck capacity must be determined according to the new conditions. The bottleneck capacity may deviate from the nominal by an amount $\pm\Delta P$ (see Figure 10). Plant components that cannot be used for a short time do not reduce the bottleneck capacity. For cogeneration systems see 4.3.6, last sentence applies correspondingly.
4.3.7.1 Bottleneck		A bottleneck exists if the (n-1) criterion is not complied with or if the grid operator has the justified expectation that the (n-1) criterion cannot be complied with based on forecast schedule reports without it changing the way in which the power plant is deployed.

Designation	Symbol	Definition
4.3.7.2 Reactive capacity	Q	Is the electrical capacity needed to develop magnetic fields (e.g. in motors, transformers) or electric fields (e.g. in capacitors, cables, power lines) and that is not counted as usable energy. Reactive capacity reduces the effective usable capacity of the grid and causes losses.
4.3.7.3 Apparent capacity		Apparent capacity is the geometric total of effective and reactive power. It is important for dimensioning electrical systems.
4.3.8 Continuous capacity		The continuous capacity of a generation, transmission, or consumption system is the highest capacity provided during normal operation with no timely limitation and that does not affect the operating safety. Note: Continuous capacity may fluctuate depending on the season (e.g. due to cooling water conditions).
4.3.9 Available capacity	P_v	The available capacity is the achievable capacity based on the technical and operational condition of the system. Available capacity is the total of capacity generated (see 4.3.10) and available unproducible capacity (see 4.3.11) or the difference between nominal capacity (see 4.3.6) and unavailable capacity (see 4.3.13). $P_v = P_B + P_{ng}$ $= P_N - P_{nv}$

Designation	Symbol	Definition
4.3.10 Capacity generated	P_B	Capacity generated is the actual capacity at a specific time. The working point of an energy conversion plant is the performance variable of effective capacity including the system services that the generator creates, and moves between the technical minimum and maximum capacity.
4.3.10.1 Overcapacity	$P_Ü$	The operating capacity may be greater than the nominal capacity, e.g. overcapacity due to favourable cooling water conditions. $P_Ü = P_B - P_N$ for $P_B \geq P_N$
4.3.11 Unused capacity	P_{ng}	The unused capacity of a generating unit is that part of the available capacity (see 4.3.9) that is not in operation. $P_{ng} = P_v - P_B$
4.3.11.1 Unusable capacity		The unused capacity can be divided into the standby capacity (see 4.3.12) and the available unproducible capacity (see 4.3.24). $P_{ng} = P_R + P_{ns}$ (see Figure 7)
4.3.12 Stand-by capacity	P_R	The stand-by capacity is the capacity of a generating unit that is available, but which is not required by the load distributor to cover demand, and which is therefore not utilised.

Designation	Symbol	Definition
4.3.13 Unavailable capacity	P_{nv}	The unavailable capacity of a generation unit is the capacity not generated at a specific time due to the technical and operational condition of the system. $P_{nv} = P_N - P_v$ for $P_N \geq P_v$ Note: A distinction can be made between the planned and unplanned parts of unavailable capacity (see 4.3.13.1 and 4.3.13.2). $P_{nv} = P_{nv\,p} + P_{nv\,u}$
4.3.13.1 Planned unavailable capacity	$P_{nv\,p}$	Planned unavailable capacity is the unavailable capacity at a specific time due to planned measures.
4.3.13.2 Unplanned unavailable capacity	$P_{nv\,u}$	Unplanned unavailable capacity is the unavailable capacity at a specific time due to faults, damage, or other circumstances. It is split into postponable and not postponable parts like 4.4.8 and 4.1.10 (see VGB-S-002-03).
4.3.14 Dispatchable capacity	P_b	Dispatchable capacity of a generation unit is the sum of capacity generated and stand-by capacity. $P_b = P_B + P_R$

Designation	Symbol	Definition
4.3.15 Non-dispatchable capacity	P_{nb}	The non-dispatchable capacity of a generation unit is the sum of unavailable capacity and unproducible capacity. $P_{nb} = P_{nv} + P_{ns}$
4.3.16 Minimum capacity	P_U	The minimum capacity of a generation unit is the capacity that cannot be undercut during continuous operation for system-specific or equipment-specific reasons. If the minimum capacity is not to relate to continuous operation, but to a shorter time interval, this should be clearly identified.
4.3.17 Absolute maximum capacity / Minimum capacity	P_{max} P_{min}	The absolute maximum or minimum capacity is the highest or lowest generated and purchased capacity (e.g. of a power plant, power company or supply system) within a certain time interval. It is determined as an instant value or an average value over a short time interval, e.g. over ¼ hour (see also 4.3.18.4).

Designation	Symbol	Definition
4.3.18 Capacity requirements	P_L	The capacity requirements of a supply system is the capacity needed to maintain the equilibrium between supply and demand in this system; in other words, the sum of its loads and the transmission losses and stand-by capacities (see 4.3.25, Figure 9). From the aspect of a partner purchasing electrical energy, its capacity requirements are the same as the required provision of capacity. This can be presented as a load curve over a certain time interval, such as one day (daily load curve) or also in a duration curve arranged by volume (see Figure 5 and Figure 7). Note: As the size and complexity of a supply system increase, this changes the importance of the terms of the capacity requirement sum. For a tariff customer, only its load is relevant because according to the purchase agreement the supplier is responsible for grid losses and stand-by capacity. For a power company the capacity requirements can consist of a large number of different load, loss and stand-by capacity components (see Figure 9). The capacity requirements of storage pumps in pumped storage power plants are a special case. Because of their size and, to a certain extent, free disposability, their capacity requirements are usually reported separately
4.3.18.1 Load		In the electricity industry, the capacity used is generally called the load.

Designation	Symbol	Definition
4.3.18.2 Load profile		The load profile describes the course of the purchased capacity over a certain time. The purchased capacity of large consumers is measured each quarter hour, for example. The other consumers have a standardised load profile according to their purchasing behaviour.
4.3.18.3 Residual load		The residual load is equal to the difference between the load and the non or partly controllable power supply that is available from renewable energies (e.g. wind and solar power). The positive residual load is currently covered predominantly by conventional power plants, e.g. through storage power plants and reserve power plants.

Designation	Symbol	Definition
4.3.18.4 Maximum load / Minimum load	P_{max} P_{min}	The maximum and minimum loads are the highest and lowest load values occurring within a certain time interval (see also 4.3.17). Forecasting in Germany takes into consideration not only the maximum load under normal requirement conditions, but also maximum load under exceptional conditions. The difference is the required reserve capacity for meeting demands (see 4.3.25.2). At the ENTSO-E, the difference between the (simultaneous) maximum load of each 3rd Wednesday in the month at 11:00 a.m., and the (non-simultaneous) monthly maximum load is described as the “margin to maximum load”. Note: In individual supply systems (e.g. power company), the maximum loads generally occur at different times. It is possible to calculate the time and extent of the simultaneous maximum load by adding up the load curves. Where non-simultaneous maximum loads occur, particular attention should be drawn to this.
4.3.19 Power plant capacity of a supply system		The power plant capacity of a supply system is the capacity of all the generation units (power plant fleet).

Designation	Symbol	Definition
4.3.19.1 Power plant fleet		The units of a power plant fleet are divided into basic, medium and peak capacity power plants based on their operational properties and cost structure. Depending on the timely structure of the energy offering or other circumstances there are also mixed forms (e.g. wind, tidal, solar, geothermal, fuel cell power plants and cogeneration systems).
		The investment and deployment planning (load balancing) of the power companies are faced with optimisation tasks based on the different loads in daily, weekly and annual cycles (load curve, see Figure 8, page 126). The capacity requirements are to be covered by the various generation units over time in such a way that the target function of electricity supply is fulfilled in the best possible manner – reliable, cost-effective, conserving the environment and resources, regionally balanced and sustainable. In practice, ideal planning is restricted due to historical circumstances, energy policy guidelines and market conditions in the competition.
4.3.19.2 Power plant types		The shares of total requirements to be covered most favourably by the individual generation units, corresponding to the short. medium, and long-term optimums in the system planning, are determined by their individual properties. In investment planning, ideally-typically a distinction is made between the following types of power plant (see 4.3.19.3 to 4.3.19.8):

Designation	Symbol	Definition
4.3.19.3 Basic capacity	P_G	Basic capacity is the part of the complete net maximum capacity of a power plant fleet, which on the basis of the energy offering, the technical design (investment planning) and as regards the ratios of the fuel-heat prices is given a high deployment priority because of its cost structure (especially low energy costs). This produces a high utilisation duration (see 4.4.14).
4.3.19.4 Basic capacity power plant		Basic capacity power plants include run-of-the-river hydro power plants, lignite plants and nuclear power plants.
4.3.19.5 Average capacity	P_M	Average capacity is the part of the complete net bottleneck capacity of a power plant fleet that is designed for operation with frequently changing generated capacity and for daily start-ups and shutdowns , the technical design (investment planning) and as regards the ratios of the fuel-heat prices is given a subordinate deployment priority because of its cost structure (average energy costs). This produces average utilisation duration.
4.3.19.6 Average capacity power plants		Average capacity power plants include hard coal, oil and gas-fired power plants.

Designation	Symbol	Definition
4.3.19.7 Peak capacity	P_S	Peak capacity is the part of the complete net bottleneck capacity of a power plant fleet, which from the technical design (investment planning) – several start-ups each day, short start-up times and high rates of capacity changes – can be used but is used only in special cases because of its usually limited energy and its cost structure (high energy costs) in which its particular operational properties are used to the best advantage. Hence low utilisation duration.
4.3.19.8 Peak capacity power plants		Peak capacity power plants are gas turbine and pumped storage power plants, in some cases also storage power plants.
4.3.19.9 Load range		The course of the load curves allows a differentiation between various load ranges, although there is no really clear distinction. Most of the load is described as the base load range. The peak load range is characterised by the fact that within a short time the load curve is so steep that it projects beyond the previous and subsequent load levels. This time can be less than an hour or can also be several hours. Several separate parts of the peak load range can occur within one day. The load range between the base and the peak load range is described as the medium load range. See Figure 7 for the connections.

Designation	Symbol	Definition
4.3.20 Capacity deployment		Capacity deployment is the deployment of power plant and reference capacity to cover the load. It is carried out by the load balancer in such a way that the minimum cost is striven for with consideration of boundary conditions and by taking advantage of the available scheduling options (see also 4.3.19).
4.3.21 Reference capacity	P_{Bzg}	The reference capacity of a supply system is the capacity that is provided for the system from outside the system boundaries (from domestic and foreign power companies, own systems (see 1.8) and others). A distinction is made between reference capacity for supplies and reference capacity in lieu of payment (see Figure 9).
4.3.21.1 Capacity utilisation		Capacity utilisation of the fluctuating feed of reference capacity into a system is the part of this capacity that can be put on a level with the corresponding capacity of the system's own power plant fleet in the planning terms of its contribution towards the reliability of covering demand. Note: The term “capacity utilisation” takes account of the not unusual circumstances that in an electricity supply grid or system feed-ins from own systems often fluctuate with cogeneration without the purchaser of this capacity being able to do anything about it. So as not to have an adverse effect on supply reliability, the purchaser can take this into account to a certain extent in its requirements planning.

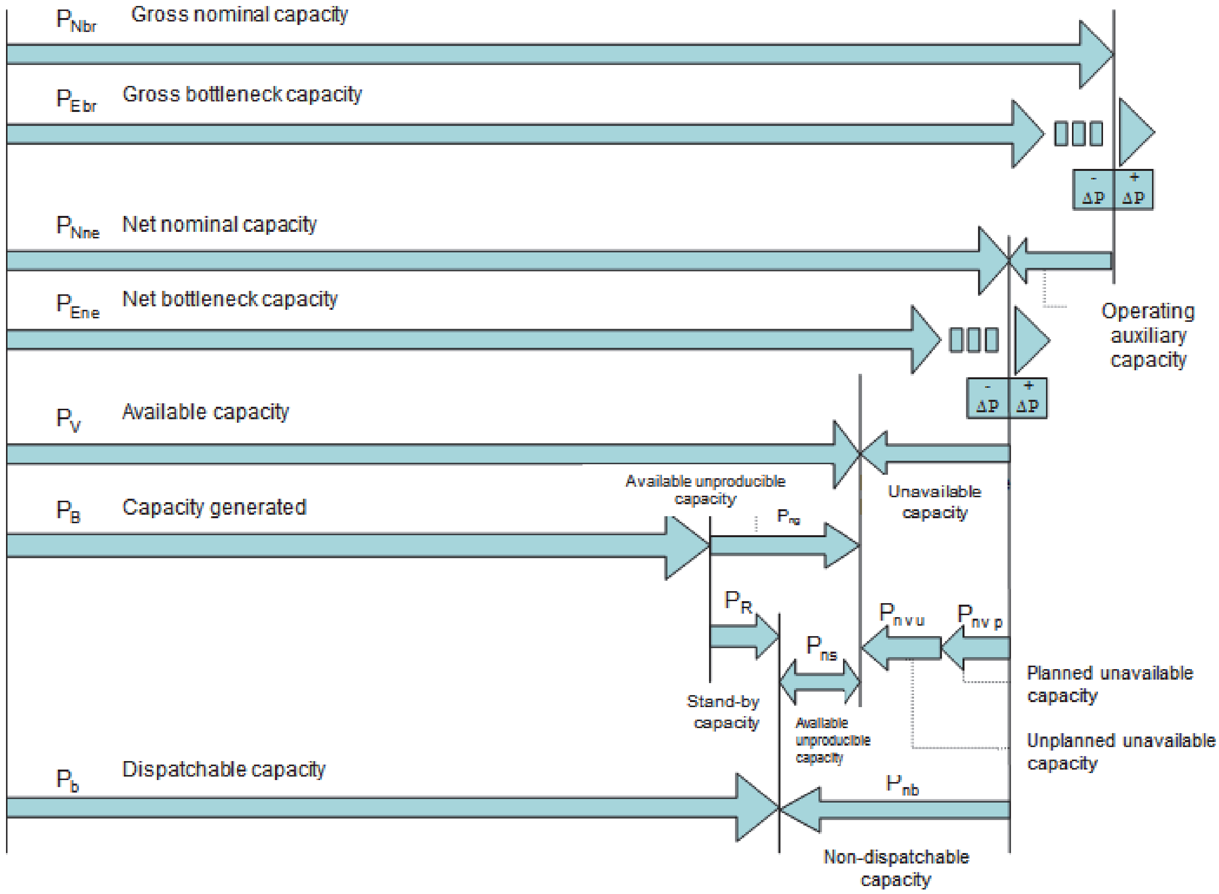
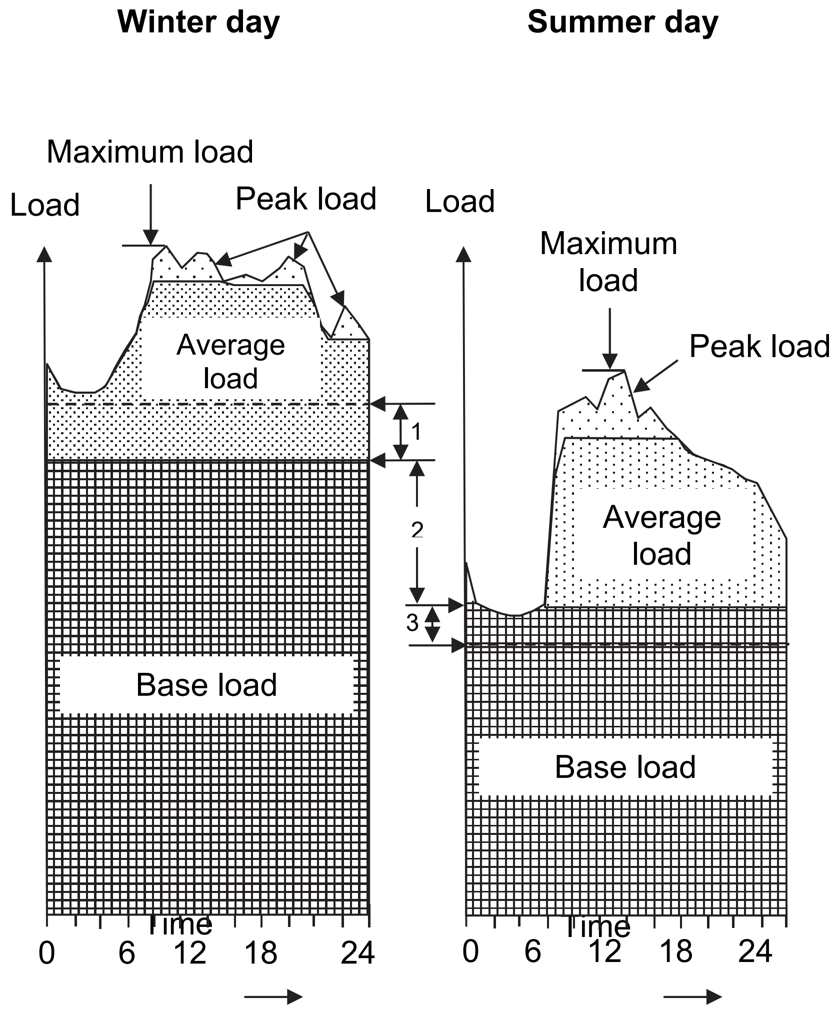


Figure 6: Diagram to explain capacity terms of a generation unit



1. In this range a constant load exists for 24 hours only on typical business days in winter. This load range is covered by average load power plants unless coverage by base load power plants would be more economical in spite of the lower utilisation throughout the year.

2. This load range is covered during the service time of the base load power plant – usually summer – by average load power plants.

3. In this load range the available base load power plants are operated at times with reduced capacity in excess of that which would be necessary for pure load reasons – especially during summer nights – to allow average load power plants to operate at minimum capacity.

Figure 7: Daily load curves of an electricity supply system with a basic presentation of the load ranges on a typical business day in winter and in summer

Designation	Symbol	Definition
4.3.22 Delivery capacity		In general, delivery capacity – like reference capacity – is a supply system's provision of capacity to cover a requirement.
4.3.22.1 Delivery capacity outside the system	P_{LL}	Delivery capacity outside the system is the capacity of a supply system that is provided for a requirement outside the system boundaries. When capacity balances are being compiled, reliability aspects of the delivery and reference capacity must be taken into account (guaranteed/ unguaranteed).
4.3.23 Power plant and reference capacity	P_{KB}	Power plant and reference capacity is the sum of all capacities available in a supply system. It includes net maximum capacities of all generation units, including the contractual shares from joint venture power plants and the reference capacities.
4.3.23.1 Power plant and reference capacity for the domestic market		Power plant and reference capacity for the domestic market (e.g. for Germany: public electricity supply; i.e. without own capacities of industry and the railroad), minus delivery capacity (see 4.3.22) for abroad, is described as power plant and reference capacity for the domestic market.
4.3.24 Unusable capacity	P_{ns}	Available unproducible capacity (external influences) of a generation unit is the part of available capacity (see 4.3.9) that cannot be used because of external influences, i.e. for reasons which are outside the control of the plant.

Designation	Symbol	Definition
		As an item in the capacity balance of a supply system, available unproducible capacity (external influences) describes the part of the entire power plant and reference capacity of the system that cannot be used at a specific reference time, e.g. the maximum load, to cover the load exclusively for the reasons below: – In a long-term average compared to the hydraulic data on which the maximum capacity is based, a lack of running water or losses in height of fall (e.g. flooding) – Lack of wind, analogous to running water – Lack of sun, analogous to running water – Meteorological influences on the thermodynamic process in thermal power plants, e.g. air pressure with gas turbines – Limited storage capacity, not sufficient for the deployment of the power plant at full capacity during the entire duration of high load – Stretch-out operation in nuclear power plants with higher fuel consumption – Fuel quality deviating from the specification (e.g. coal with a too low net calorific value) – Interruptibility in gas deliveries – Bottlenecks in the grid – Reduction in electrical capacities in multipurpose systems in favour of other purposes (e.g. thermal decoupling)

Designation	Symbol	Definition
		– Delays in the start-up of new generation systems – Start-up and testing of generation systems in which the capacity generated is specified in the test program – Officially imposed conditions or no operating license (e.g. for environmental protection reasons) Capacity reduction in generation systems because of a required change from flow cooling to cooling tower, no cooling water or water too warm – Preserving generation systems that can only be used again in the long term – Strikes and force majeure
4.3.25 Usable capacity		The usable capacity of a generation unit is the part of the available capacity (see 4.3.9) that can be used to cover the load. Note: In terms of figures, the same as dispatchable capacity (see 4.3.14)
4.3.25.1 Usable power plant and reference capacity		Usable power plant and reference capacity as an item in the capacity balance of the supply system describes the remaining part of the power plant and reference capacity that can be used to cover the capacity requirements after deduction of the delivery capacity outside the system (see 4.3.22) and the unusable capacity (see 4.3.25).

Designation	Symbol	Definition
4.3.25.2 Reserve capacity	P_r	Reserve capacity is the capacity intended to balance out deviations in the capacity balance (see 4.3.29) between the expected and the actual relationships or that is kept for specific planned situations. In detail, reserve requirements result from: On the demand side when the capacity requirements (see 4.3.18) are higher than expected because of the weather, the economic situation, special demand-synchronising influences or changes in the consumer structure. On the supply side, if the available power plant capacity is less than expected, e.g. as a result of the weather (lack of running water, less than the long-term average, see 4.3.24), outages and unplanned servicing of power plant blocks, environmental problems (e.g. smog) and outages of reference capacities for planned servicing. reserve capacity is required for this if the complete scope of the capacity reduction is greater than the latitude over the course of the year. Reserve requirements also exist for keeping control capacity (see 3.2) to guarantee reliable operation of an integrated grid (e.g. due to the sudden failure of large generation units), a capacity that cannot be used to cover normal loads.

Designation	Symbol	Definition
4.3.25.3 Clearance		Clearance is the relieving change in the capacity balance of a system at specific times compared to the planning-relevant (usually maximum load) time, e.g. because of a lower load and a higher occurrence of water, wind, and solar.
4.3.26 Required reserve capacity	P_{re}	The required reserve capacity is a planning value. It is the capacity of a supply system that must be available, which must be more than the expected load in order to maintain the required level of supply reliability (see 3.13). The composition of this reserve capacity according to power plant types (see 4.3.19) and the size and type of the supply system (load curves, power plant fleet, reference capacities) must also be taken into account. The required reserve capacity can be split into one part for the demand side and one part for the supply side (see Figure 8).
4.3.26.1 Required reserve capacity for demand side	$P_{re\,B}$	
4.3.26.2 Required reserve capacity for supply side	$P_{re\,D}$	
4.3.27 Guaranteed capacity	P_C	The guaranteed capacity of a supply system is the capacity remaining when the delivery capacity outside the system (see 4.3.23), the available unproducible capacity (external influences) (see 4.3.26) and the required stand-by capacity for the supply side (see 4.3.23) are deducted from the power plant and reference capacity of the system (see 4.3.22). See Figure 8. $P_C = P_{KB} - P_{LL} - P_{ns} - P_{re\,D}$ For guaranteed capacity in hydro power plants, see Part 3.

Designation	Symbol	Definition
4.3.28 Capacity losses in grid	$P_{ÜV}$	Capacity losses occur in the transmission and distribution systems. They are calculated from the capacity balance as a difference between the capacity requirements for the electricity output of a supply system and the simultaneous capacity requirements for the usable electricity and for the capacity in lieu of payment (see 4.1.24 and Figure 8). Note: The capacity losses in the grid are included in the maximum load of a supply system because this is usually recorded as the sum of the net capacity generated by the generation units and purchased quantities. Otherwise, it should be marked accordingly.
4.3.29 Free capacity 4.3.29.1 Capacity balance	P_F	Free capacity is the capacity (usually recorded at the time of the maximum yearly load) remaining if you deduct the delivery capacity outside the system (see 4.3.24), the available unproducible capacity (external influences) (see 4.3.18.4), the load (maximum load) during normal requirements (see 4.3.26) and the entire required stand-by capacity (see 4.3.23) from the power plant and reference capacity of a supply system (see 4.3.22) (capacity balance). A negative P_F is called a capacity deficit. $P_F = P_{KB} - P_{LL} - P_{ns} - P_{max} - P_{re}$
4.3.29.2 Capacity deficit		See Figure 9 and Figure 10.

Designation	Symbol	Definition
		Note: In ideal planning, the capacity balance would be balanced out; in other words, there would be no free capacity and the usable power plant and reference capacity would be equal to the total capacity requirements. In practice this is virtually impossible because free capacities occur due to planning forecasts and standardised sizes of power plants.
4.3.30 Capacity balance		The capacity balance (see Figure 9) is a comparison of the capacity requirements of a supply system and its coverage capabilities at a specific point in time. The power plant and reference capacity (see 4.3.23) on the one hand and all capacity requirements (maximum load, reserves, deployment restrictions) on the other produce a capacity balance (free capacity or capacity deficit, see 4.3.29) as an indication of the supply and demand situation.
4.3.31 Collateral capacity		The collateral capacity from an energy conversion plant is the capacity which the operator holds available in one of their energy conversion plants in order to compensate for fluctuations in the schedule capacity and provide system services securely. The collateral capacity is not a component of the “free capacity” of an energy conversion plant. It must be able to be performed at any time and is thus physically allocated to the energy conversion plant as a capacity provision.
4.3.32 Load change rate		The load change rate indicates the maximum capacity change per time unit in uninterrupted operation.
4.3.33 LI Quote		The quote of the ongoing maintenance (LI Quote) comprises parts of the entire energy conversion plant maintenance, e.g. servicing, troubleshooting and cleaning.

Designation	Symbol	Definition
4.3.34 Increased capacity area		The increased capacity area is the capacity area of an energy conversion plant from the bottleneck capacity or movable nominal capacity to the maximum capacity that is not continuously movable.
4.3.35 Increased capacity, short-term		The short-term increased capacity from an energy conversion plant is an approved capacity with which the energy conversion plant can be operated short-term above the nominal capacity. It results from suspension of the throttling in the energy conversion plant for the purpose of providing control energies from the storage capacity of the boiler, for example.
4.3.36 Increased capacity, continuous		The continuous increased capacity from an energy conversion plant is an approved capacity with which the energy conversion plant can be operated long-term above the nominal capacity. It results from the shutdown of preheaters while reducing the efficiency at the same time to increase the nominal capacity, for example.

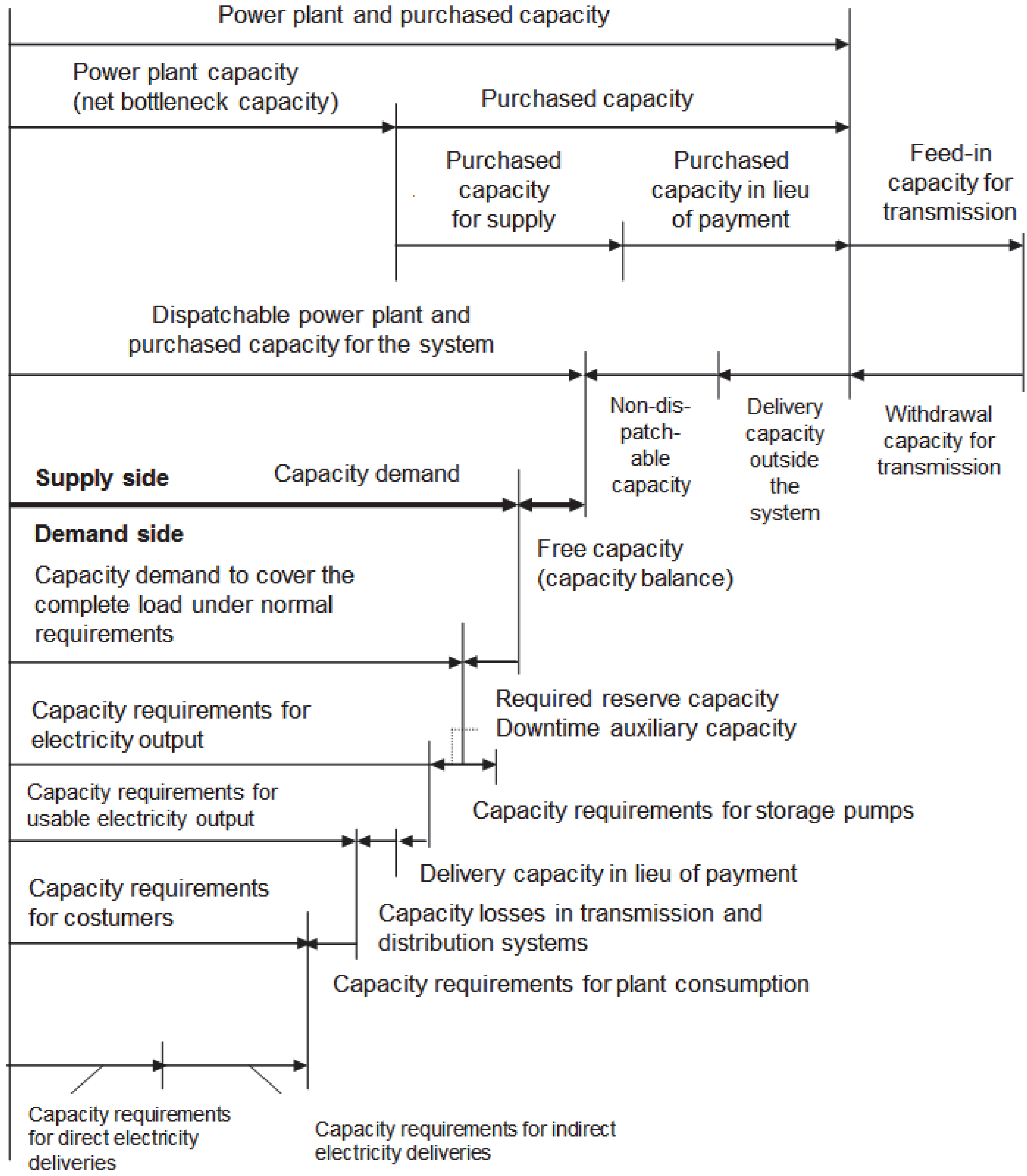


Figure 8: Diagram to explain the capacity terms of a supply system (e.g. of a power company)

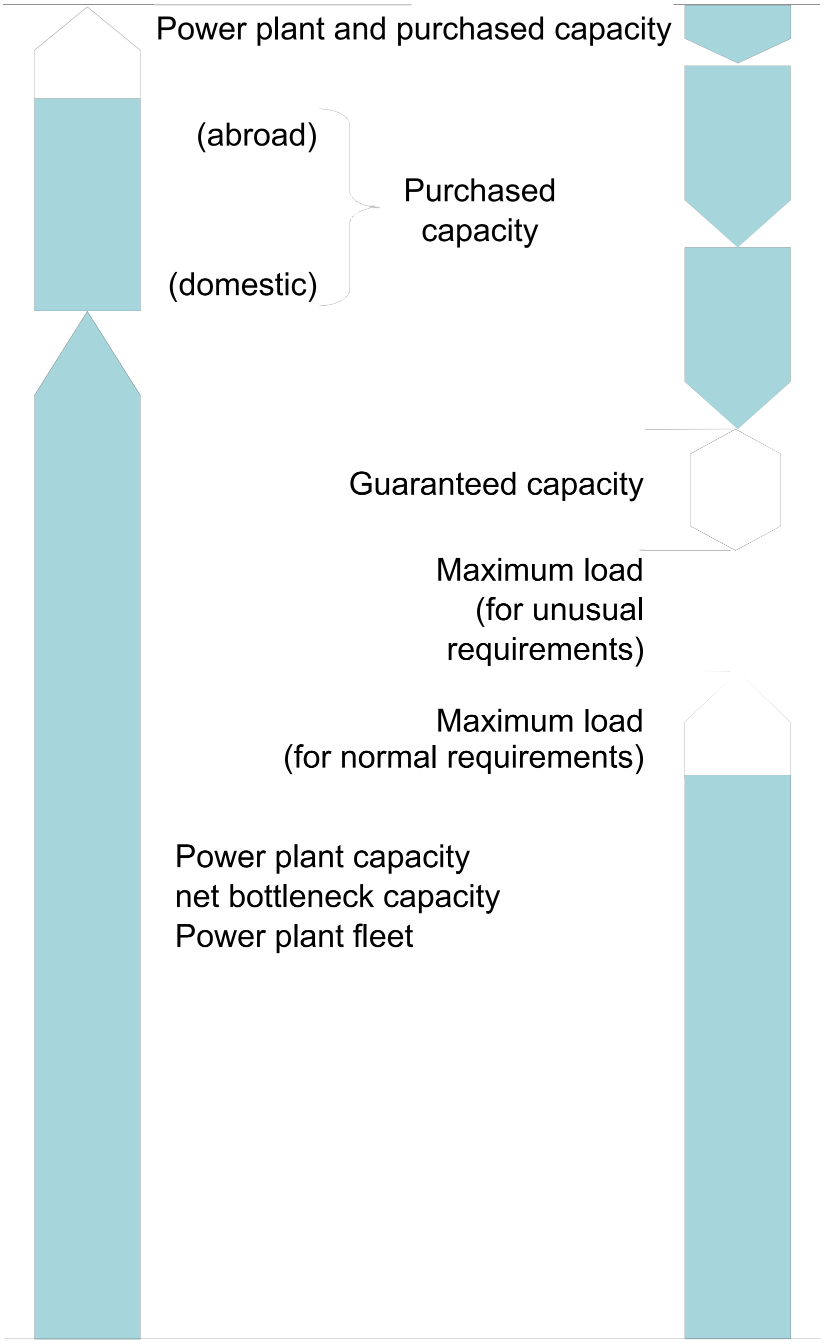


Figure 9: Capacity balance of a supply system using the forecast for Germany as an example (time of maximum load)

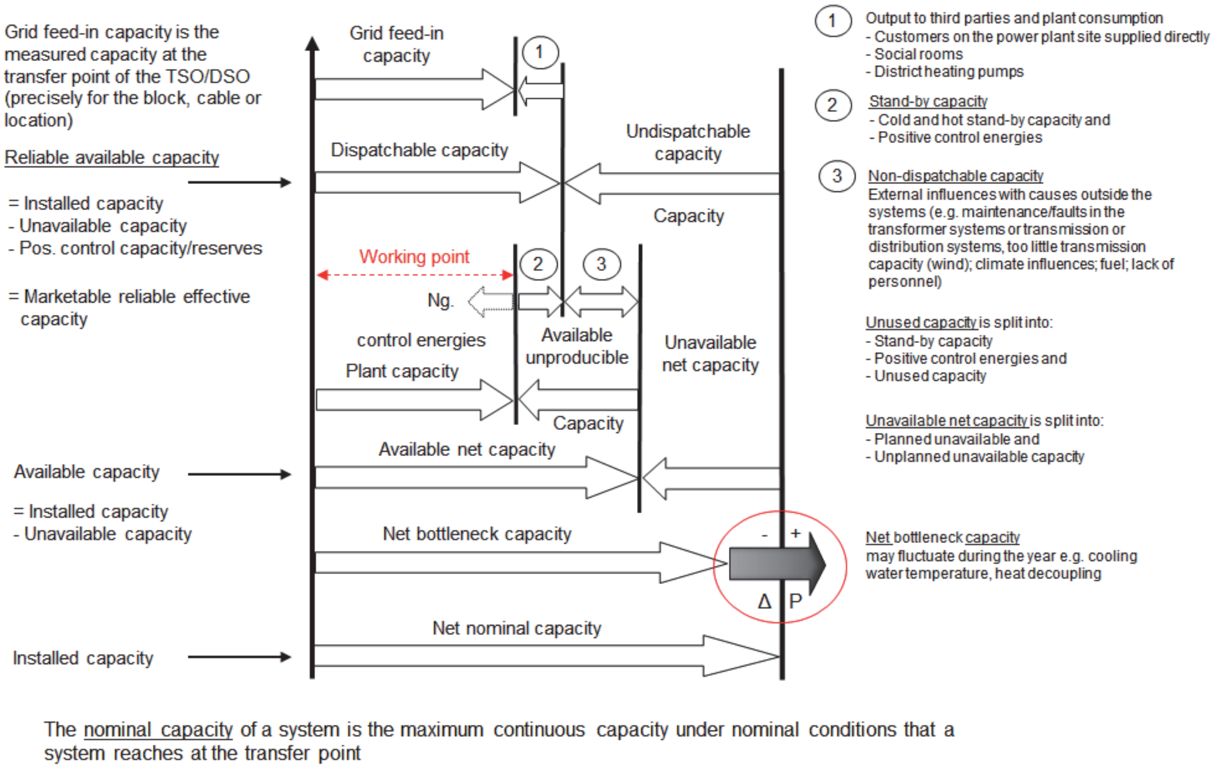


Figure 10: Capacity consideration from an electricity marketing aspect

4.4 Time terms

Time in terms of these definitions include points in time, such as date, usually factually connected time intervals that can be made up of several partial times that may not be consecutive. The time intervals should be clearly marked. The diagram explaining time terms provides an overview (see Figure 12).

Designation	Symbol	Definition
4.4.1 Time	t	Time is an interval describing how long a process takes.
4.4.2 Reference period	t_N	The reference period is the total recording period without any interruption (calendar time, e.g. day, month, quarter, year)
4.4.3 Available time	t_v	The available time is the period in which a plant converts or transmits energy or can convert or transmit it independently of the achievable capacity. It is the difference between reference period and unavailable time. $t_v = t_N - t_{nv}$
4.4.4 Operating time	t_B	The operating time is the period in which a plant converts or transmits energy. Operating time starts when the system is switched on and ends when it or a part of the system is separated from the grid. Start-up and shutdown times with no output of usable energy are not counted as operating time.
4.4.5 Stand-by time	t_R	The stand-by time is the period in which the plant can be operated, but will not be operated. Note: During stand-by time it must be possible to start up the system according to the specifications of the manufacturer or of the operator. Consequently, start-up and shutdown times are counted as stand-by times (see also 4.4.8).
4.4.6 Minimum time in operation		Minimum duration that the energy conversion plant should run for after start-up (often economically justified).

Designation	Symbol	Definition
4.4.7 Available time not in operation	t_{ng}	The available time not in operation is the period in which a plant is available but not in operation and/or cannot be operated due to external influences. $t_{ng} = t_v - t_B$ $t_{ng} = t_R + t_{ns}$
4.4.8 Unavailable time	t_{nv}	The unavailable time is the period in which the plant cannot be operated for reasons, which are inside the plant. The unavailable time is composed of a planned and an unplanned part. $t_{nv} = t_N - t_v$; $t_{nv} = t_{nv\,p} + t_{nv\,u}$
4.4.8.1 Planned unavailable time	$t_{nv\,p}$	Unavailable time consists of planned and unplanned times. The unplanned unavailable time is divided into a postponable and a not postponable part (analogous to 4.1.10 and 4.3.13).
4.4.8.2 Unplanned unavailable time	$t_{nv\,u}$	$t_{nv} = t_{nv\,p} + t_{nv\,u}$
4.4.9 Available non-dispatchable time (external influence time)	t_{ns}	The available non-dispatchable time is the period in which the plant cannot be operated due to external influences although the plant itself could function. (For causes of non-dispatchable time, see also 4.3.24.)

Designation	Symbol	Definition
4.4.10 Non-usage time	t_{nb}	Non-usage time is the sum of unavailable time (see 4.4.8) and available non-dispatchable time (see 4.4.9). $t_{nb} = t_{nv} - t_{ns}$
4.4.11 Measuring time	t_M	Measuring time is the time in which a divisor can be used to convert a unit of energy into an average capacity value. Measuring times of up to 1 hour are usual (see also 4.3.1).
4.4.12 Access time	t_Z	Access time is the time between the occurrence of a capacity requirement or a capacity request by the load balancer and achieving the full capacity (or stand-by capacity) amount (see 4.3.25.2).
4.4.13 Usage time	t_{ben}	In general, usage time is the quotient of the energy during a specific time and a capacity during the same time; usual capacities are maximum capacity and contractual capacity. $t_{ben} = \frac{W}{P}$

Designation	Symbol	Definition
4.4.13.1 Degree of utilisation	g_{ben}	The degree of utilisation is a variable associated with usage time. The degree of utilisation (the degree of load) is the quotient of usage time of a capacity and the associated time interval. $$g_{ben} = \frac{t_{ben}}{t}$$ Note: When this term is used, the type of capacity and the reference time must be stated exactly (e.g. electricity purchasing capacity; monthly high tariff time).
4.4.14 Usage time	t_a	The usage time of a generation unit or a system as a special case of usage time is the quotient of the plant energy of this generation unit or system in a specific time interval and a capacity that characterises the system. There are separate definitions for usage time
4.4.14.1 Usage time of maximum capacity	t_{aE}	of maximum capacity $$t_{aE} = \frac{W_B}{P_E}$$

Designation	Symbol	Definition
4.4.14.2 Usage time of nominal capacity	t_{aN}	and nominal capacity $t_{aN} = \frac{W_B}{P_N}$ Note: An associated variable to usage time is the percentage of energy utilisation (see 4.5.2). As opposed to the calculation of availabilities, usage time includes excess energy (see 4.1.8.1).
4.4.15 Exchange times		On the German electricity exchange EEX, distinctions are made between the following time intervals:

Block description	Delivery times	
EEX-Night	Hours 1 – 6	(00:00 – 06:00)
EEX-Morning	Hours 7 – 10	(06:00 – 10:00)
Business	Hours 9 – 16	(08:00 – 16:00)
EEX-High-Noon	Hours 11 – 14	(10:00 – 14:00)
EEX-Afternoon	Hours 15 – 18	(14:00 – 18:00)
EEX-Rush-Hour	Hours 17 – 20	(16:00 – 20:00)
EEX-Evening	Hours 19 – 24	(18:00 – 24:00)
Baseload	Hours 1 – 24	(00:00 – 24:00)
Peakload (Monday – Friday)	Hours 9 – 20	(08:00 – 20:00)
Off-Peak-Load	Hours 1 – 8 and 21 – 24	(00:00 – 08:00 and 20:00 – 24:00)

Figure 11: Diagram explaining time terms

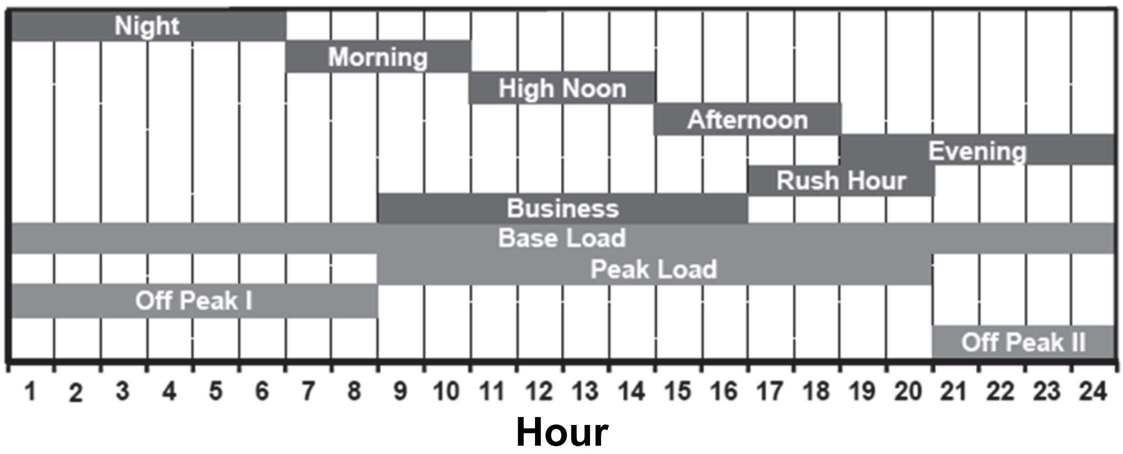


Figure 12: Diagram explaining time terms

4.5 Utilisation and availabilities

The parameters for utilisation and availability of electrical systems and system parts are relative, dimensionless variables. Therefore, it is important to state what they refer to, especially if for special reasons it is not calendar time or nominal capacity. In cases such as this, an explicit reference is advisable (e.g. “in relation to the high tariff time of 6:00 a.m. to 9:00 p.m. during business days”).

Additional information and practical tips can be found in the VGB-Standard “Basics and system of availability determination for thermal power plants”. By analogy, these can also be used for transmission and consumption systems.

Designation	Symbol	Definition
4.5.1 Time utilisation	n_t	Time utilisation is the quotient of operating time of a plant and the reference period (calendar time). $n_t = \frac{t_B}{t_N}$
4.5.2 Energy utilisation	n_W	Energy utilisation is the quotient of electricity generation (plant energy) of a plant and its nominal energy. It is also a quotient of usage time (see 4.4.14) and the reference period. $n_w = \frac{W_B}{W_N} = \frac{t_{aN}}{t_N}$ Note: Energy utilisation may include amounts of excess energy. Hence, energy utilisation can be in excess of 100% (opposite of energy availability factor, see 4.5.4).
4.5.3 Time availability	k_t	The time availability is the quotient of available time of a plant (see 4.4.3) and the reference period. $k_t = \frac{t_v}{t_N}$

Designation	Symbol	Definition
4.5.4 Energy availability	k_W	The energy availability is the quotient of available energy of a plant and the nominal energy. $$k_W = \frac{W_v}{W_N}$$ Note: Energy availability factors in excess of 100% are thus impossible, as opposed to energy utilisation.
4.5.5 Time failure rate	p_t	The time failure rate is the quotient of unplanned unavailable time (see 4.4.8.2) of a plant and the sum of operating time (see 4.4.4) and unplanned unavailable time. $$p_t = \frac{t_{nv\,u}}{t_B + t_{nv\,u}}$$
4.5.6 Energy failure rate	p_W	The energy failure rate is the quotient of unplanned unavailable energy (see 4.1.10.2) of a plant and the sum of plant energy (see 4.1.4) and unplanned unavailable energy. $$p_W = \frac{W_{nv\,u}}{W_B + W_{nv\,u}}$$

Designation	Symbol	Definition
4.5.7 Capacity ratio (load ratio)	m_0	The capacity ratio (load ratio) is the quotient of minimum capacity (minimum load) and maximum capacity (maximum load) in a specific time (e.g. power plant capacity, capacity used, load of a power company or supply system in one month). $m_o = \frac{P_{min}}{P_{max}}$
4.5.8 Degree of concurrency	g_g	The degree of concurrency is the quotient of a simultaneously recorded total maximum capacity (maximum load) from a number of generation or consumption systems and the sum of the (usually not simultaneous) individual maximum capacities (maximum loads) of these systems in the same time. $g_g = \frac{P_{min}}{\sum P_{i\,max}}$

4.6 Efficiency und Heat consumption

Designation	Symbol	Definition
4.6.1 Efficiency	η	The efficiency of an energy conversion process as an instant value is the quotient of the sum of the usable output energies (target energies) and the sum of the input energies. In practice, the efficiency is recorded in a stationary operating state during a (defined) measuring time (see 4.4.11). Efficiency can be recorded as gross or net.
4.6.1.1 Efficiency of a generation unit	η	The efficiency of a generation unit (see 3.1) is the quotient of electricity generation (plant energy) and the simultaneously technically input energy or energy taken from the natural yield. $\eta = \frac{W_B}{W_E}$
4.6.1.2 Total efficiency		Total efficiency is the efficiency of a complete system consisting of several sub-systems whose efficiencies can usually be determined individually. Total efficiency is then a product of the efficiencies of the individual sub-systems.
4.6.1.3 Efficiency of a thermal power plant	η	The efficiency of a power plant fired with fossil or renewable fuel (e.g. wood), geothermal heat, or nuclear fuel is the quotient of its electricity generation and the simultaneous input of energy content of fuels or geothermal heat (see also 4.6.10).

Designation	Symbol	Definition
4.6.1.4 Thermal efficiency/ Process efficiency		Thermal efficiency is the ratio of the recovered thermal capacity to the heat flow input to a thermal power plant: $\eta_{th} = \frac{P_{th}}{\dot{Q}}$ where η_{th} is the thermal efficiency, P_{th} the recovered thermal capacity, and $\dot{Q}$ the input heat flow. Thermal efficiency is used as a benchmark for the effectiveness of the process, which is the reason it is also called process efficiency.
4.6.1.5 Efficiency of a wind turbine	η	The efficiency of a wind turbine is the quotient of its electricity generation and the kinetic energy from the flowing air that is simultaneously fed to the power plant in relation to the entire coated rotor surface area. $\eta = \frac{3.6 \cdot 10^3 \cdot W_B}{1/2 \cdot \rho \cdot F \cdot v^3 \cdot t_M}$ Where: W_B Electricity generation in kWh; ρ Density of the air in t/m^3; F Rotor surface area in m^2; v Uninterrupted wind speed (in front of the rotor surface) in m/s; t_M Measuring time in s

Designation	Symbol	Definition
4.6.1.6 Efficiency of a solar power plant	η	The efficiency of a solar power plant is the quotient of its electricity generation and the radiation energy from the sun in relation to the entire collector surface area (global radiation, measured with a solarimeter) fed to the power plant simultaneously. $\eta = \frac{3.6 \cdot 10^3 \cdot W_B}{F \cdot G \cdot t_M}$ Where: W_B Electricity generation in kWh F Collector surface area in m^2 G Global radiation in kW/m^2 t_M Measuring time in s.
4.6.2 Process quality		The process quality describes the condition of a plant, a system, or components on the basis of technical parameters regardless of environmental or operating conditions.

Designation	Symbol	Definition
4.6.3 Grade	GG	The grade is a quotient of the actual value and the associated reference value of a technical plant variable. $GG = \frac{Wert_{Ist}}{Wert_{Referenz}}$ It assesses the ratio of an actual measured value/parameter (actual value of an energetic or technical plant variable) to a reference value as a percentage. It is an indicator for a loss or an improvement. Grades should be defined so that increasing number values reflect an improvement in the process. Grades can be defined for different actual values/ parameters, such as measured values, efficiencies, heat transfer coefficients, capacities. Notes: – The term “KPI” (Key Performance Indicator) is often used in place of grade. Grades can be higher than 100 % in certain cases; e.g. in case of efficiency.

Designation	Symbol	Definition
4.6.4 Reference value		The reference value is the theoretical or practically determined amount of a measured value/parameter when the plant has a status that is defined as a reference status. When the reference value is being determined, the environmental and operating conditions must be taken into account. Depending on the objective, the reference status (also called target or comparison status) can be defined in different ways. The following can be used as a basis. – The design status/planned status – The new status after commissioning (results of the acceptance measurements) – The status achieved after conversion, modernisation, or maintenance measures (results of subsequent control measurements) – The best achievable/achieved status. Note: – To determine the reference values for all grades to be calculated, it is necessary to define a standard reference status. – When grades are compared, the chosen reference status must be stated. This is practical only for the same reference status.
4.6.5 Process quality monitoring	PGÜ	Process quality monitoring is the continuous comparison of actual and reference values using grades of process improvement.

Designation	Symbol	Definition
4.6.6 Utilisation ratio	ζ	The utilisation ratio of an energy conversion process is the quotient of the total usable output energy and the total input energy in the same time (e.g. calendar year). The utilisation ratio can be recorded as gross or net.
4.6.6.1 Efficiency method		In order to compare different energy conversion processes with each other as regards their usage efficiency, one refers to the primary energy needed to generate a certain amount of useful energy. Primary energy is calculated according to the efficiency method. The efficiency method is the method used internationally to determine primary energy consumption of electricity. In the case of electricity from energy sources whose net calorific value is known (fossil fuels), the net calorific value is multiplied by the amount used. In the case of electricity sources for which no net calorific value can be added, like the renewable energies water, wind, and solar, the primary energy is calculated from the end energy with an efficiency factor of 100 %.
4.6.6.2 Substitution method		When primary energy consumption is calculated using the substitution method, it is assumed that the electricity from water, wind, and solar replaces the same amount of electricity from conventional power plants and also that their fuels are substituted. In general, the amount of fuel used is calculated using a substitution factor that corresponds to the consumption of fossil fuels to generate electricity from these fuels.

Designation	Symbol	Definition
4.6.7 Heat consumption	W_E	Heat consumption is the energy input by fossil fuels, by biomass in renewable energies, by geothermal energy, or by nuclear energy from nuclear fission or nuclear fusion and their subsequent nuclear-physical processes into an energy conversion plant in a certain period of time.
4.6.8 Specific heat consumption	w	Specific heat consumption of an energy conversion plant is the heat consumption required per unit of generated usable energy (e.g. electricity generation, plant energy). Specific heat consumption is generally not recorded as an instant value but as an average for a period (e.g. a calendar year in the plant). $w = \frac{W_E}{W_B}$ Note: Specific heat consumption is the reciprocal value of efficiency or the utilisation ratio. However, it is not given as a dimensionless variable but as a quotient of two different energies. It is usually given in relation to net generation. If in special cases specific heat consumption is given for gross generation, as in the German official electricity statistics, this must be especially marked.

Designation	Symbol	Definition
		In cogeneration plants it is not a simple matter to split heat consumption and source-specific allocation between the generated energies electricity and heat. It cannot be determined by physical boundary conditions but must be determined according to the economic boundary conditions on a case-by-case basis. Gas is a special case (see comment on 4.6.10).
4.6.9 Increase in specific heat consumption	w_z	The increase in specific heat consumption of a generation unit, e.g. a power plant block, is the change in fuel capacity necessary for a change in the capacity generated (fuel-heat flow). $w_z = \frac{\delta W}{\delta P_B} = \frac{\Delta W}{\Delta P_B}$ Note: The fuel capacity is calculated as a quotient of fuel consumption in a (short) measuring time.
4.6.10 Energy content	E	The energy content (heat content) of a mass unit of a fuel is the energy that can be released when it is combusted under certain boundary conditions.

Designation	Symbol	Definition
		Note: During the conversion of chemically bound energy in fuels, different values are produced for the heat content depending on whether the water occurring during combustion is gaseous or liquid.
4.6.10.1 Net calorific value	H_u	The net calorific value of a substance is the enthalpy difference in relation to a mass unit between the starting materials fuel and air and the combustion products if the water forming during the combustion is gaseous (steam).
4.6.10.2 Gross calorific value	H_o	The gross calorific value of a substance is the enthalpy difference in relation to a mass unit between the starting materials fuel and air and the combustion products if the water forming during combustion is liquid. Accordingly, the gross calorific value is higher than the net calorific value by the (condensation or evaporation) enthalpy of the water contained in the combustion products. Net and gross calorific values are determined under standardised conditions (see DIN 5499). To calculate the fuel heat consumption for fossil fuels, usually the net calorific value H_u is used. However, in the gas industry, the roughly 10% higher value of the gross calorific value H_o is more common.

Annex 1: Hydro power terms

Designation	Symbol	Definition
Capacity	P	Electrical capacity in physical terms as a product of current and voltage is an instant value. When instant values are being given, the time must be stated (date and time). By analogy, the term can also be used for the conversion, storage and distribution of electrical energy. If nothing else is stated, capacity means effective electrical capacity.
Gross capacity	P_{br}	In turbine operation gross capacity is measured at the terminals of the generator. In pumped storage power plants, net capacity is measured at the terminals of the (motor) generators if the system is operated as a motor. The gross capacity is calculated from net capacity plus own requirements, including capacity losses of the machine transformers of the power plant without plant consumption and purchasing for power factor correction.
Net capacity	P_{ne}	The net capacity of a generation unit is the capacity output to the supply system (transmission and distribution systems, consumers) without consideration of transmission and transformation losses. It is calculated from the gross capacity minus the electric auxiliary capacity during operation, even if this is not provided from the generation unit, but from elsewhere. $P_{ne} = P_{br} - P_{EigB}$ It is calculated from gross capacity minus auxiliary electrical capacity during operation, even if this is not provided by the generation unit itself but from elsewhere.

Designation	Symbol	Definition
		Note: To avoid negative net capacities, own consumption during downtime is not considered in the net calculation (considered on the requirements side).
Average capacity	P_M	In the electricity industry, apart from instant values, average capacities for defined time intervals (measuring times, e.g. ¼ hour or 1h) are also used. Capacity is then the quotient of the energy W output in a time interval and the same time interval t. $P_M = \frac{W}{t}$ For planning tasks in connection with storage and pumped storage power plants, the average capacity is the largest capacity at an average height of fall.
Reactive capacity	Q	Reactive capacity is the electrical capacity needed to develop magnetic fields (e.g. in motors, transformers) or electrical fields (e.g. in capacitors, cables, lines) and that is not counted as usable energy. Reactive capacity reduces the effective usable capacity.

Designation	Symbol	Definition
Efficiency of a hydro power plant	η	The efficiency of a hydro power plant is the quotient of its electricity generation and the simultaneous feed of potential (or kinetic) energy of the driving water. $\eta = \frac{3.6 \cdot 10^3 \cdot W_B}{\rho \cdot g \cdot \dot{Q} \cdot h \cdot t_M}$ W_B Electricity generation in kWh ρ Density of the water in t/m^3 g Gravitational acceleration in m/s^2 $\dot{Q}$ Turbine flow in m³/s h Height of fall in m t_M Measuring time in s
Bottleneck capacity	P_E	The bottleneck capacity of a generation unit is the continuous capacity that can be achieved under normal conditions. It is limited by the weakest parts of the system (bottleneck), is determined by measurements, and is adjusted to normal conditions. The term “bottleneck capacity” should not be used for run-of-the-river hydro, storage, or pumped storage power plants, because on the one hand, no continuous capacity is possible because of fluctuations in the water supply and on the other hand, the stored volume is limited, which also prevents a continuous capacity. The bottleneck capacity would have the value “0”. For run-of-the-river hydro power plants the bottleneck capacity in this sense would be the minimum load of the machine at the lowest water level.

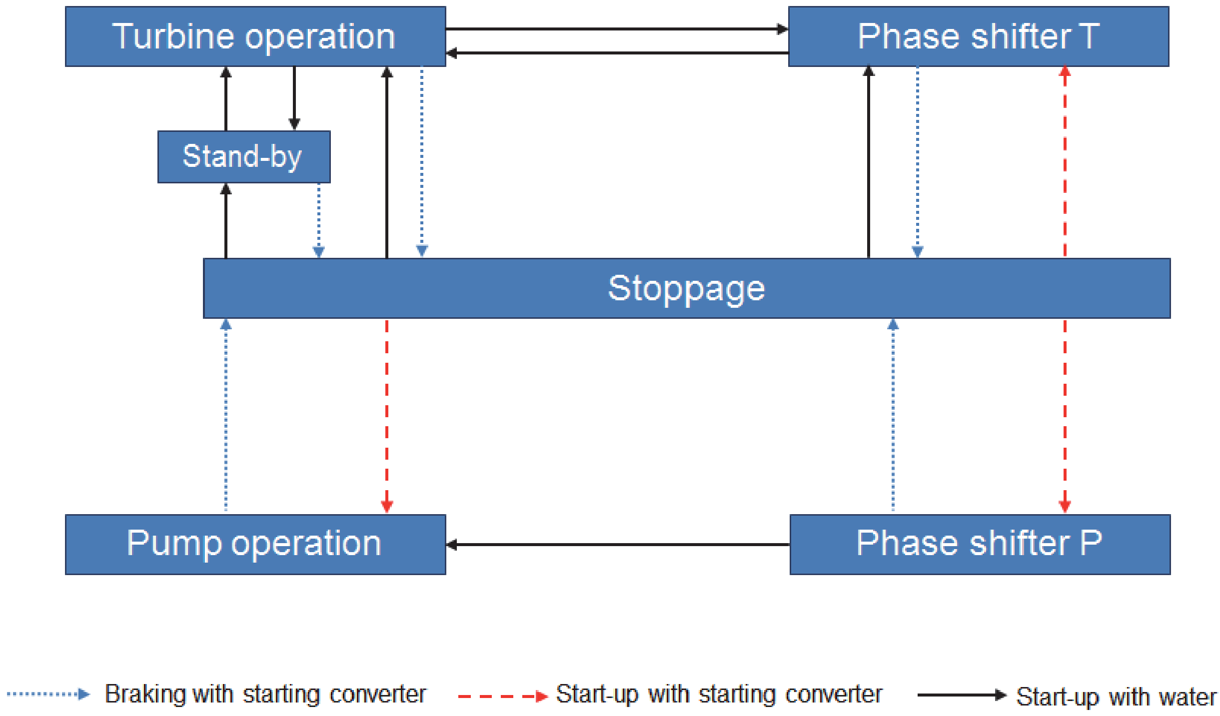
Designation	Symbol	Definition
		With longer-term changes (e.g. changes to individual units, ageing effects), the bottleneck capacity must be determined according to the new conditions. The bottleneck capacity may deviate from the nominal by an amount ±ΔP. Plant components that cannot be used for a short time do not reduce the bottleneck capacity. In cogeneration plants, the nominal capacity is the nominal electrical capacity. Regardless of the limited use of the above definition for hydro power plants, the term “bottleneck capacity” is still used as follows: the bottleneck capacity (internationally accepted: maximum capacity P_M) of a hydro power plant is the highest electrical capacity possible in the plant with the condition that the maximum value is defined by the flow in combination with the height of fall. In run-of-the-river hydro power plants, the bottleneck capacity is often the rated capacity. In storage power plants and pumped storage power plants the bottleneck capacity is the highest possible capacity at the maximum height of fall for turbine operation or (with pumped storage power plants) also at the minimum height of fall for pump operation. Note: Bottleneck capacity should be changed only if parts of the plant are completely shut down or removed with the conscious acceptance of lost capacity or if it has to be redefined due to other influences (e.g. official conditions, changed flows, changed damming level or minimum operating level, deepening). Plant components that cannot be used for a short time do not reduce the bottleneck capacity.

Designation	Symbol	Definition
Efficiency of a pumped storage power plant (circulation efficiency)	η_{PT}	The efficiency of a pumped storage power plant is the quotient of the circulation energy and the pump energy for the pumped storage with the same pumping and height of fall blade. $\eta = \frac{W_W}{W_P}$ W_W Circulation energy W_P Pump energy Note: Circulation and pump energy are measured at the generator terminal.
Average pumped storage efficiency	η_{PTm}	Average pumped storage efficiency of a pumped storage power plant is the quotient of plant energy in a time interval and the associated pump energy during this interval. It is usually determined for an operating year. It must be assumed that the water levels at the start and end of the interval are the same. η_{PTm} also takes account of the use of individual machine assemblies and the partial load range.

Designation	Symbol	Definition
Change of operating modes		Pumped reservoir power plants allow the following operating modes: – Turbine operation, – Pump operation, – Phase shifter operation, – Hydraulic short circuit (if technically available), – Standstill (= stand-by). Pumped reservoir power plants are characterised by the fact that a coordinating unit (load distributor) is capable of switching between the individual operating modes at will. This applies both to switching out of one of the end statuses and to switchovers made during running operations. The operating mode changeover takes place very fast, generally within just a few minutes. In connection with a pumped reservoir power plant, the operating state "standstill" generally means that the machinery is ready to start up at any time, and hence available for control tasks at short notice. This likewise means that even during the stoppage phase, it is not permissible to perform servicing and maintenance work (unless the machinery has first been registered as "unavailable"). As a result of their design, pumped and simple reservoir power plants are suitable for providing various system services. In particular, these include the following: – Frequency start where established grid frequency limit values are not met – Primary control – Secondary control

Designation	Symbol	Definition
		– Regulation capacity positive and negative (through staged use of the machinery); in the case of hydraulic short circuit, the negative regulation capacity can even be adjusted continuously based on nominal values – Black start capability. The flexibility of pumped and simple reservoir power plants allows many changes between operating modes. These place stresses on the machinery; for this reason, the number of operating mode changeovers is an important parameter. In contrast to other power plants, the number of switchover processes in the machinery output switch is not the critical factor in the loading of the machinery. There is a significant difference in terms of loading the machinery depending on which operating mode has been switched to which. For example, an operating changeover from stoppage or turbine operation to phase shifter operation is associated with low stress loading, while a changeover from pump operation to phase shifter operation constitutes a considerable load, and is therefore restricted or prohibited outright in many pumped reservoir power plants.

Operating changeovers



Operating modes
1. Stoppage
2. Turbine operation
3. Pump operation
4. Phase shifter operation in direction of turbine rotation
5. Phase shifter operation in direction of turbine rotation with starting converter

Operating changeovers

1. Stoppage after turbine operation
2. Turbine operation after stoppage
3. Turbine operation after phase shifter operation in direction of turbine rotation
4. Phase shifter operation in direction of turbine rotation after turbine operation
5. Stoppage after phase shifter operation in direction of turbine rotation
6. Stoppage after phase shifter operation in direction of turbine rotation with starting converter
7. Phase shifter operation in direction of turbine rotation after stoppage
8. Stoppage after phase shifter operation in direction of pump rotation
9. Phase shifter operation in direction of pump rotation after stoppage
10. Phase shifter operation in direction of pump rotation during pump operation
11. Stoppage after pump operation
12. Pump operation after stoppage
13. Stoppage after hydraulic short circuit
14. Hydraulic short circuit after stoppage

Designation	Symbol	Definition
Operating duration		The operating duration is the time in which a machine assembly is in one or more modes of operation.
Usage time	t_a	The usage time of a generation unit or a plant as a special case of usage time is the quotient of plant energy of this generation unit or plant in a certain time and a capacity that is characteristic for the plant. There are separate definitions for usage times a) of bottleneck capacity $t_{aE} = \frac{W_B}{P_E}$ b) of nominal capacity $t_{aN} = \frac{W_B}{P_N}$
Time availability factor in a machine	k_t	A quotient of the sum of the operating time t_B (*) and the stand-by time t_R and the reference period t_N of a machine in a reporting year. $k_t = \frac{t_v}{t_N} = \frac{t_B + t_R}{t_N}$ $(*): t_B = t_{TU} + t_{PU} + t_{PH} + t_{Hy}$ t_{TU} Operating time in turbine operation t_{PU} Operating time in pump operation t_{PH} Operating time in power factor correction t_{Hy} Operating time in hydraulic short circuit t_v Stand-by time Quotient of the time availability factor of the individual machine assemblies multiplied by the nominal capacity* of the machine(s) and the nominal capacity of the complete power plant P_N*:

Designation	Symbol	Definition
		When all machine assemblies are working together, the extendible capacity of a power plant is smaller than the total of all the individual nominal capacities. This is due to the hydraulic boundary conditions.
Time availability factor of a power plant	k_t	A quotient of the sum of the operating time t_B (*) and the stand-by time t_R and the reference period t_N of a machine in a reporting year. $k_t = \frac{t_v}{t_N} = \frac{\sum t_B + t_R}{\sum t_N}$ $(*):\ t_B = t_{TU} + t_{PU} + t_{PH} + t_{Hy}$ t_{TU} = Operating time in turbine operation t_{PU} = Operating time in pump operation t_{PH} = Operating time in power factor correction t_{Hy} = Operating time in hydraulic short circuit t_v = Stand-by time Quotient of the time availability factor of the individual machine assemblies multiplied by the nominal capacity* of the machine(s) and the nominal capacity of the complete power plant P_N. Note: When all machine assemblies are working together, the extendible capacity of a power plant is smaller than the total of all the individual nominal capacities. This is due to the hydraulic boundary conditions.

Designation	Symbol	Definition
Energy availability	n_w	In hydro power plants, like in thermal power plants, the energy availability factor comes from the specific capacity terms. The capacity is especially dependent on the height of fall and/or the inflow. The unusable stand-by energy resulting from the dependency on height of fall and/or inflow has no effect on the energy availability factor, as this is external influence-related reduced energy. Relevant for the unavailability of energy are exclusively technical unavailabilities. Like in thermal plants, a distinction is made between planned and unplanned (postponable and not postponable) unavailabilities. The energy availability factor is not used for pumped storage power plants.
Unavailability		In hydro power plants, unavailability is determined like in thermal power plants and is the inability to generate electricity or heat. Unavailability is split into planned and unplanned (postponable and not postponable) unavailability and is considered separately for each mode of operation (turbine, pump, etc.). The cause can be an internal problem in the plant that can be corrected by maintenance, repair, replacement, etc. Unavailability cannot be influenced by management but remains under the control of management. By definition, external influences are outside the control of management and are not counted as unavailability, but are part of non-usability.

Designation	Symbol	Definition
Available capacity of a hydro power plant in terms of water management	P_H	Available capacity of a hydro power plant in terms of water management: P_H at a specific time is the available capacity under the respective conditions of inflow and height of fall. These conditions can result from the natural inflow conditions or from the restrictions that are caused by the operations of upstream or downstream plants. This capacity corresponds to the available capacity of the plant under the condition that all parts of the plant are ready for operation. Note: P_H must be calculated as follows: – for a run-of-the-river hydro power plant as a function of the respective inflow – for a short-term storage power plant as a function of inflow and height of fall and the type of storage in the respective grid – for a long-term storage power plant as a function of height of fall and possibly the special regulations to limit generation.
Available capacity		Highest capacity of a technical energy facility that can be achieved at a specific time with consideration of all technical and operational conditions.
Available capacity for run-of-the-river power plants		Available capacity that can be achieved as a result of the technical condition of the plant and the water management conditions (usable inflow and height of fall).

Designation	Symbol	Definition
Available capacity for storage or pumped storage power plants		Available capacity that can be achieved as a result of the technical condition of the plant and the height of fall.
Hydraulic available capacity		Available capacity that can be achieved without consideration of technical unavailability.
Technical available capacity		Available capacity that is achievable at a specific time under the specific technical conditions. It is the bottleneck capacity or that minus the amount corresponding to the outage of plant components at a specific time. Outages of plant components can be split into: – forced outage – outage due to unscheduled maintenance – outage due to scheduled maintenance.
External influence		External influences are all external events that have an effect on a power plant system/block that affect the provision or availability of capacity. The plant operator has no influence on these events (e.g. climate, official conditions). Capacity restrictions due to external influences are restrictions that have an effect on the capacity capability of a plant due to external effects that management has no or little influence over, but they do not affect the availability.

Designation	Symbol	Definition
		Capacity restrictions due to external influences are defined as available unproducible capacity (external influences) if the cause of the capacity losses are due to the events listed below or to similar events and they do not cause any technical damage or faults (regardless whether postponable or not). If an external influence which the plant is designed to handle causes technical damage or a fault, this is classified as unavailability.
Hydraulic short circuit		In a hydraulic short circuit, one or more turbines and one or more pumps are operated simultaneously with the electrical capacity offered/agreed from the grid for pump operation in the same power plant. The participating hydraulic machines (turbine and pump) can belong to one machine assembly. The water that drives the turbines comes completely or partially directly from the pump operation. Note: As opposed to pump operation (constant capacity withdrawal from the grid), a hydraulic short circuit is operation with reduced and controllable capacity withdrawal. With the help of controllable turbines, the electrical capacity offered/agreed from the grid can be maintained for pump operation.

List of Abbreviations

ARA	Oil and coal trading area in the Amsterdam-Rotterdam-Antwerp triangle (Öl- und Kohle-Handelsraum im Städtedreieck Amsterdam-Rotterdam-Antwerpen)
ATSOI	Association of the Transmission System Operators of Ireland
AVBEltV	Regulation on General Conditions for the Supply of Energy to General Customers (Verordnung über Allgemeine Bedingungen für die Elektrizitätsversorgung von Tarifkunden)
BALTSO	Baltic Transmission System Operators
BetrSichV	Ordinance on Industrial Safety and Health (Betriebssicherheitsverordnung)
BImSchG	German Federal Emissions Protection Law (Bundes-Immissionsschutzgesetz)
CAT	Cumulative Average Temperature
CDD	Cooling Degree Day
CFC	Chlorofluorocarbons
DIN	German Institute for Standardisation (Deutsches Institut für Normung)
DIN EN	German Institute for Standardisation European Standardisation (Deutsches Institut für Normung Europäische Norm)
DSO	Distribution System Operator
DVGW	German Technical and Scientific Association for Gas and Water (Deutscher Verein des Gas- und Wasserfaches)
EEG	German renewable energy sources law (Erneuerbare-Energie-Gesetz)
EEX	European Energy Exchange
ENTSO-E	European Network of Transmission System Operators for Electricity
ETS	Emissions Trading Scheme
ETSO	European Transmission System Operators
EVU	Electrical supply company (Elektrizitätsversorgungsunternehmen)
FKW	Hydrocarbons (Kohlenwasserstoffe)
FP	Schedule (Fahrplan)
GuD	Gas and steam, cogeneration (Gas und Dampf)
HCFC	Halogenated fluorocarbons

HDD	Heating Degree Day
HPFC	(Hourly) Price Forward Curve
IBS	Commissioning (Inbetriebsetzung)
IEV	International Electrotechnical Vocabulary
KKS	Identification System for Power Stations (Kraftwerks-Kennzeichensystem)
MCP	Market Clearing Price
MR	Minute reserve
NORDEL	Transmission System Operators of Denmark, Finland, Iceland, Norway and Sweden
NWE	North West Europe
OTC	Over-the-counter
PFC	Price Forward Curve
PrimR	Primary control (Primärregelung)
RDS-PP®	Reference Designation System for Power Plants
SekR	Secondary control (Sekundärregelung)
TSO	Transmission System Operator
UKTSOA	United Kingdom Transmission System Operators Association
ÜNB	Transmission system operator (Übertragungsnetzbetreiber)
ZuG	German Emissions Allocation Law (Zuteilungsgesetz)

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VGB PowerTech e.V.
Deilbachtal 173
45257 Essen | Germany

Tel: +49 201 8128 – 200
Fax: +49 201 8128 – 302
www.vgb.org | mark@vgb.org