

vgbe Technical-Scientific Report

Availability of Power Plants 2014 – 2023

VGBE-TW-103Ve (2024)



vgbe
Technical-Scientific Report
Availability of
Power Plants 2014 – 2023

VGBE-TW-103Ve (2024)
(formerly VGB-TW 103Ve)

Publisher:

vgbe energy e.V.

Publishing house:

vgbe energy service GmbH

Verlag technisch-wissenschaftlicher Schriften

Deilbachtal 173, 45257 Essen, Germany

Tel.: +49 201 8128-200

E-mail: sales-media@vgbe.energy

ISBN 978-3-96284-375-5 (e-book, English)

ISBN 978-3-96284-374-8 (e-book, German)

All rights reserved, vgbe energy.

www.vgbe.energy | www.vgbe.services

Copyright

vgbe-publications, hereafter referred to as “work”, including all articles and images, are protected by international copyright. vgbe energy owns and controls the copyright.

The term “work” covers the publication at hand as printed hard copy and as digitalised version. The copyright covers the entire work and parts of it.

Any kind of use beyond the limits of copyright is prohibited without the prior written consent of vgbe energy. Any unauthorised reproduction, translation, digitalisation and modification will constitute an infringement of copyright.

Disclaimer

vgbe-publications are recommendations, the application of which is optional. vgbe-publications represent the state of the art at the time of publication. No claim regarding its completeness and correctness is made as a matter of principle.

Application of vgbe-publications is carried out at the user’s own responsibility and risk. vgbe energy accepts no legal liability in the event of any claim relating to or resulting from the application of vgbe-publications.

Treatment of proposing amendments

Amendments can be sent to the e-mail address vgbe-standard@vgbe.energy. The subject line should contain the exact specification of the relevant document in order to clearly assign the e-mail content to the appropriate vgbe-publication.

Reference to series

Verfügbarkeit von Kraftwerken 2014 – 2023

VGBE-TW-103V (2024) German Edition: ISBN 978-3-96284-374-8 (e-book)

Analysis of Availability of Power Plants 2014 – 2023

VGBE-TW-103Ve (2024) English Edition: ISBN 978-3-96284-375-5 (e-book)

Analyse der Nichtverfügbarkeit von Kraftwerken 2014 – 2023

VGBE-TW-103A (2024) German Edition: ISBN 978-3-96284-376-2 (e-book)

Analysis of Unavailability of Power Plants 2014 – 2023

VGBE-TW-103Ae (2024) English Edition: ISBN 978-3-96284-377-9 (e-book)

Contents

I.	Introductory remarks	8
II.	Definition of performance indicators.....	16
III.	Results.....	20
A.	Fossil fired units (without combined cycle units)	20
1.	Total.....	20
1.1	Capacity	21
1.2	Age.....	26
1.3	Operating time	30
2.	Trend	34
2.1	Capacity	34
2.2	Age.....	44
2.3	Operating time	50
3.	Fuel	56
3.1	Capacity	56
3.2	Age.....	69
3.3	Operating time	75
4.	Type of boiler.....	81
4.1	Single boilers	81
4.2	Duo-boiler	95
5.	Mode of operation	97
5.1	Subcritical	97
5.2	Supercritical	109
B.	Combined cycle units (combined gas-steam turbine units).....	119
1.	Total.....	121
1.1	Capacity	123
1.2	Age.....	125
1.3	Operating time	129
2.	Steam turbine, total	133
2.1	Capacity	133
2.2	Age.....	136
2.3	Operating time	140
3.	Gas turbine, total.....	144
3.1	Capacity	146
3.2	Age.....	148
3.3	Operating time	152

- C. Gas turbine units 156
 - 1. Open cycle units, total 156
 - 1.1 Age 157
 - 1.2 Operating time, total 160
 - 2. Jet engine units 164

- D. Nuclear light water power plants 166
 - 1. Single values 166
 - 2. Total 168
 - 2.1 Type 168
 - 2.2 Capacity 170
 - 2.3 Age 174
 - 2.4 Operating time 176
 - 3. Trend 180

- E. Hydro power plants 186
 - 1. Pumped storage hydro power plants (PSP), total 186
 - 1.1/1.2 Capacity 186
 - 1.3 Quartile 190
 - 1.4 Indicators 192
 - 1.5 Mode of operation 198
 - 2. Storage hydro power plants (SP), total 200
 - 2.1/2.2 Capacity 200
 - 2.3 Quartile 204
 - 2.4 Indicators 206
 - 2.5 Mode of operation 210

- IV. List of Power Plants 212**

- V. References 226**

I. Introductory Remarks

Introduction

Since 1970 vgbe/VGB¹ has been collecting data according to standardised uniform definitions and recording procedures. With the liberalisation of the energy markets, the technical and economic assessment of power plants has gained more and more importance. On the basis of the cooperation between Eurelectric and the former VGB it was decided to merge data collection regarding the availability and unavailability of power plants. These data provide information about the availability and utilisation of thermal power plants in order to compare the performance of power plants and to assess plants' behaviour in daily operation. Reasons for unavailability of systems and main components also have been collected since 1988 in order to identify and assess direct cause.

However power generation in Europe has changed substantially over the last decade.

The development of renewables, the generation decrease of conventional power plants, the different European energy policies, and the electricity market development need more flexibility in operation and effective tools to help taking the right decisions.

According to the suggestions of the vgbe Technical Committee "Performance Indicators" (TCPI) the database system KISSY has been modified and upgraded in order to be able to provide technical benchmark reports in real time. The European utilities which provide data are able to analyse the data online. Currently the German, English, French, Italian, Dutch, and Portuguese languages are supported. In the future apart from the existing parameters, it will also be possible to evaluate the parameters that were newly defined by the TCPI with the new online analysis tool. Commercial background information (e.g. price data of the electricity stock exchange) are foreseen to be included in the KISSY system, too.

In addition to upgrade the KISSY database, the associated vgbe/VGB-Standards are already published in different languages. The former VGB Guidelines "Availability of Thermal Power Plants", "Unavailability of Thermal Power Plants" and "EMS Event Criterion Key Systems" had been merged into one, completely revised guideline and in the meanwhile has been updated by the newly defined parameters for several times on a regular update basis. The up-to-date English, French and German versions can be downloaded from the vgbe Homepage² for free.

1 * vgbe energy e.V. has been the new name of VGB PowerTech since April 2022.

2 www.vgbe.energy

III. Results

Fossil fired units

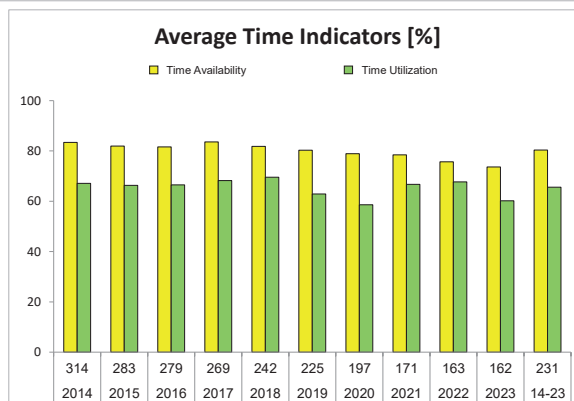
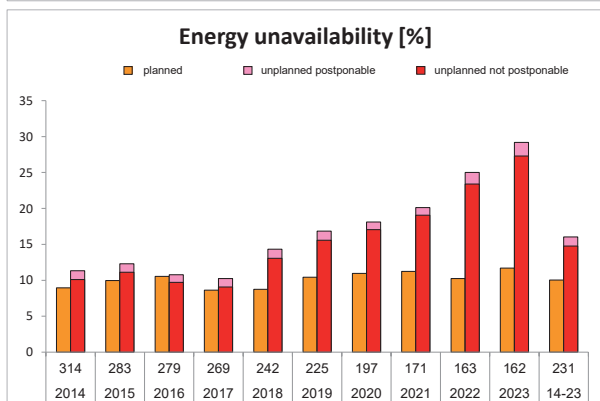
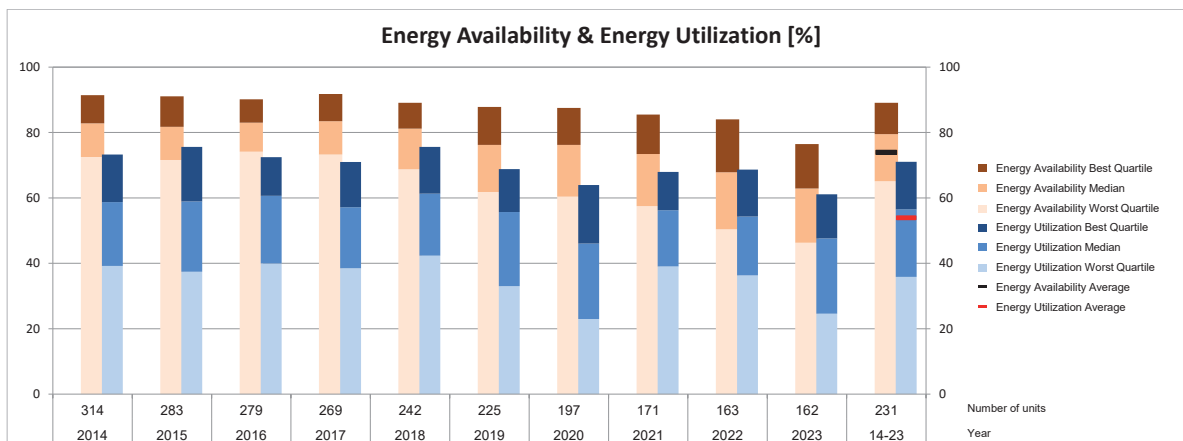
A. Fossil fired units (without combined cycle units)

A.1 KPI overview of fossil fired units with different types of cluster

A.1.1 KPI overview by capacity cluster

A.1.1.1 Fossil-fired units, total

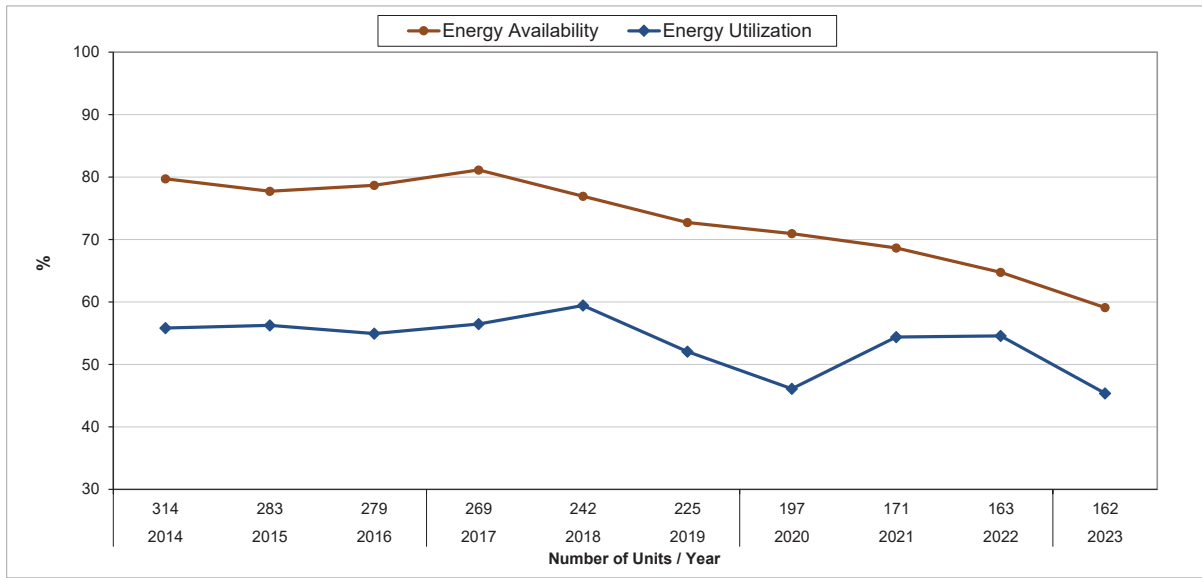
(351 units, AT, BE, CZ, DE, FR, IE, IT, NL, PL, PT, UK, ZA)



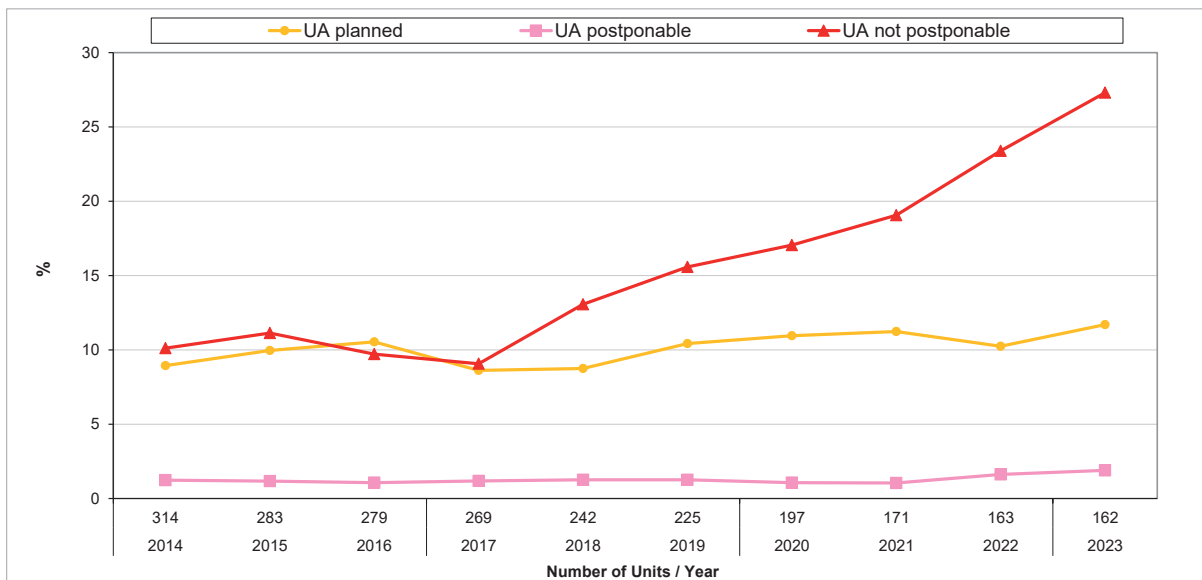
Average values/Quartile values		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	14-23
Number		314	283	279	269	242	225	197	171	163	162	231
Capacity	MW	113,064	104,194	102,773	97,463	89,682	86,156	81,034	74,258	71,884	72,834	89,334
Energy Availability	%	79.7	77.7	78.7	81.1	76.9	72.7	70.9	68.7	64.8	59.1	73.9
worst quartile	%	72.5	71.6	74.1	73.3	68.8	61.8	60.4	57.5	50.4	46.3	65.1
median	%	82.8	81.7	83.0	83.5	81.2	76.2	76.2	73.4	67.8	62.9	79.5
best quartile	%	91.4	91.0	90.1	91.8	89.1	87.8	87.5	85.5	84.0	76.5	89.1
Energy Unavailability	%	20.3	22.3	21.3	18.9	23.1	27.3	29.1	31.3	35.2	40.9	26.1
planned part	%	8.9	10.0	10.5	8.6	8.7	10.4	11.0	11.2	10.2	11.7	10.0
unplanned part	%	11.3	12.3	10.8	10.2	14.3	16.8	18.1	20.1	25.0	29.2	16.0
postponable	%	1.2	1.2	1.1	1.2	1.3	1.3	1.1	1.0	1.6	1.9	1.3
not postponable	%	10.1	11.1	9.7	9.1	13.1	15.6	17.0	19.1	23.4	27.3	14.8
Energy Utilization	%	55.8	56.3	55.0	56.5	59.4	52.1	46.1	54.4	54.6	45.4	53.9
worst quartile	%	39.2	37.4	40.0	38.5	42.3	33.0	23.0	39.0	36.3	24.6	35.9
median	%	58.7	58.9	60.7	57.1	61.3	55.7	46.1	56.2	54.3	47.6	56.5
best quartile	%	73.3	75.6	72.5	71.0	75.6	68.8	63.9	67.9	68.7	61.1	71.0
Time Availability	%	83.4	81.9	81.6	83.6	81.8	80.3	78.9	78.4	75.7	73.6	80.3
worst quartile	%	77.5	77.6	76.9	76.5	73.5	72.3	71.9	70.3	65.9	67.6	73.2
median	%	86.7	85.8	85.5	86.4	85.9	83.5	81.9	81.2	80.5	78.0	84.4
best quartile	%	92.8	93.3	91.6	93.3	91.6	91.5	90.3	90.8	87.6	88.4	91.7
Time Utilization	%	67.1	66.3	66.5	68.3	69.5	62.9	58.6	66.7	67.7	60.2	65.6
worst quartile	%	56.1	48.5	55.5	47.6	53.4	45.8	36.0	53.6	48.5	37.0	48.8
median	%	74.6	76.5	76.9	71.8	75.3	69.1	64.4	71.3	72.5	66.3	72.2
best quartile	%	87.2	88.6	86.7	85.8	87.8	83.9	80.0	84.2	85.9	80.0	85.8

A.2.1 KPI trend by capacity cluster
Fossil-fired units, total

Time range: 2014 - 2023



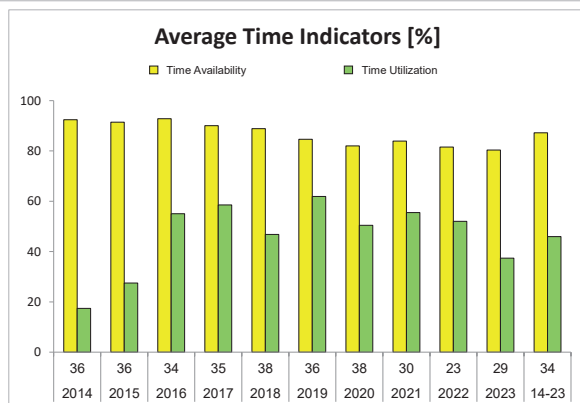
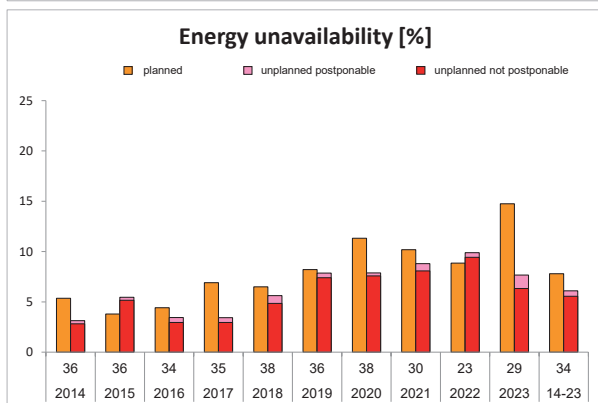
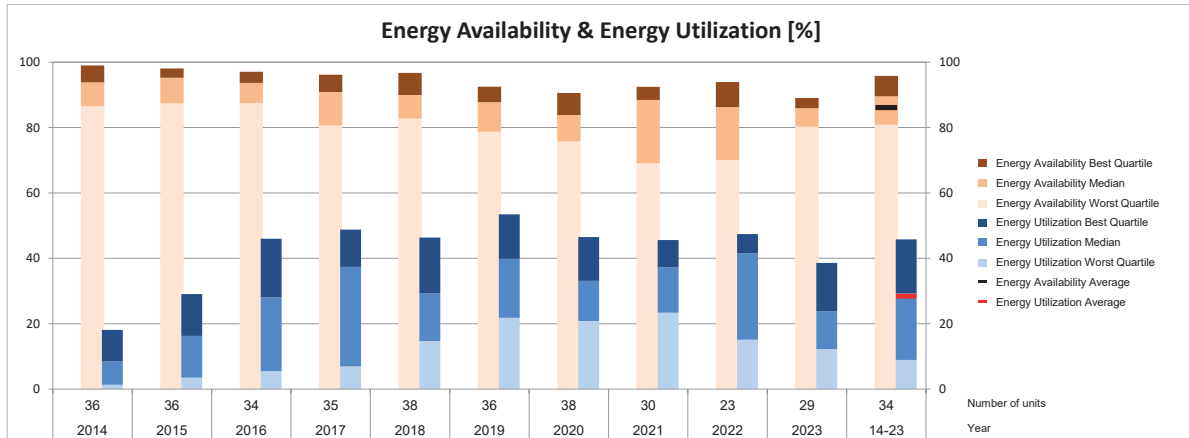
Time range: 2014 - 2023



UA = unavailability

B.1.1 KPI overview of combined cycle units by capacity cluster

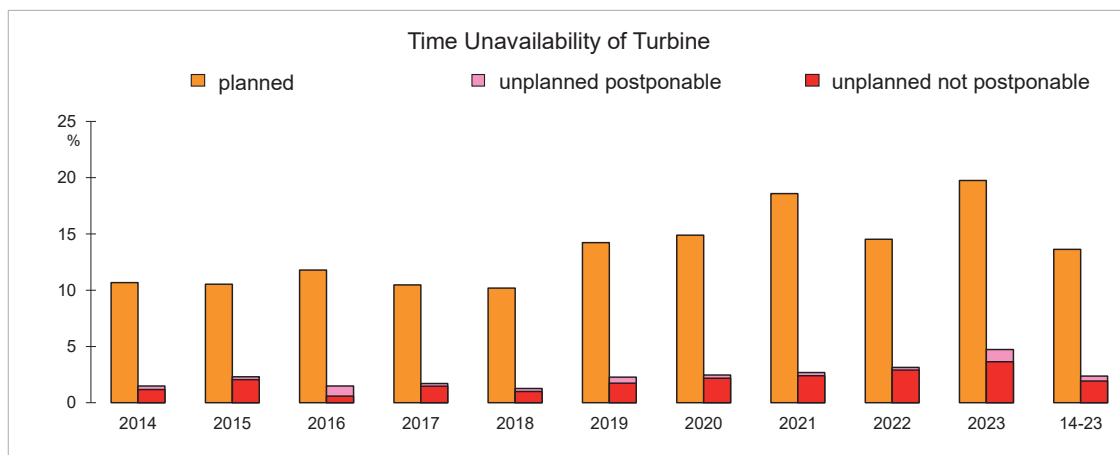
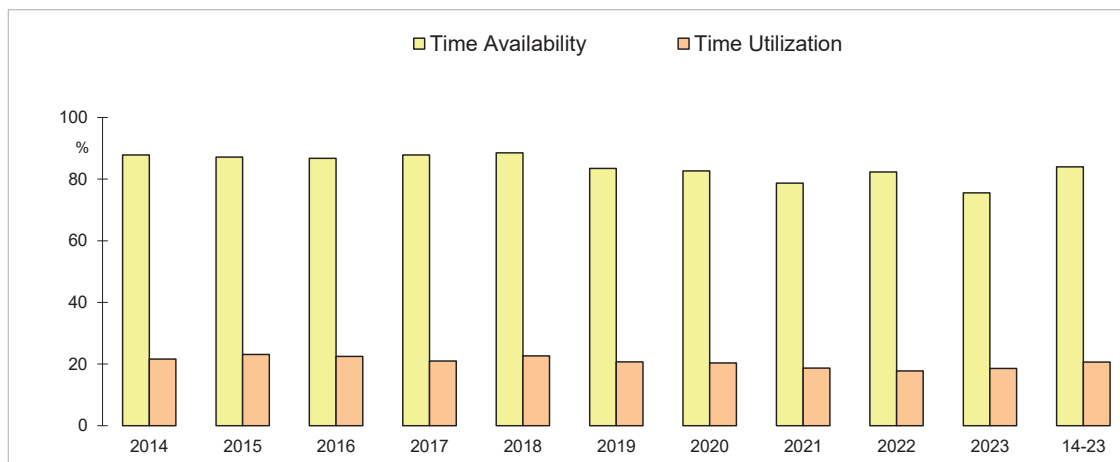
B.1.1.4 Combined cycle units, nominal capacity ≥ 400 MW
(48 units, AT, BE, CZ, DE, ES, FR, GR, IE, IT, LV, NL, PT, UK)



Average values/Quartile values		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	14-23
Number		36	36	34	35	38	36	38	30	23	29	34
Capacity	MW	19,833	19,847	19,075	19,234	20,003	19,607	20,473	15,755	12,024	14,728	18,058
Energy Availability	%	91.5	90.8	92.1	89.7	87.9	83.9	80.8	81.0	81.3	77.6	86.1
worst quartile	%	86.5	87.4	87.5	80.6	82.8	78.7	75.7	69.1	70.0	80.3	80.9
median	%	93.8	95.2	93.7	90.9	90.0	87.8	83.8	88.4	86.2	85.9	89.5
best quartile	%	99.0	98.1	97.1	96.2	96.7	92.5	90.6	92.4	93.9	89.0	95.8
Energy Unavailability	%	8.5	9.2	7.9	10.3	12.1	16.1	19.2	19.0	18.7	22.4	13.9
planned part	%	5.4	3.8	4.4	6.9	6.5	8.2	11.3	10.2	8.9	14.8	7.8
unplanned part	%	3.1	5.5	3.5	3.4	5.6	7.9	7.9	8.8	9.9	7.7	6.1
postponable	%	0.3	0.3	0.5	0.5	0.8	0.5	0.3	0.7	0.5	1.3	0.5
not postponable	%	2.8	5.2	3.0	3.0	4.8	7.4	7.6	8.1	9.4	6.3	5.6
Energy Utilization	%	16.9	19.6	28.0	31.6	29.4	34.5	31.2	34.6	35.9	26.0	28.4
worst quartile	%	1.3	3.5	5.5	7.0	14.7	21.8	20.9	23.4	15.1	12.2	8.9
median	%	8.5	16.3	28.0	37.4	29.2	39.9	33.1	37.2	41.5	23.8	29.3
best quartile	%	18.1	29.1	46.0	48.8	46.3	53.5	46.5	45.6	47.4	38.6	45.8
Time Availability	%	92.4	91.4	92.8	90.0	88.9	84.7	82.0	83.9	81.5	80.3	87.2
worst quartile	%	89.9	88.6	88.0	80.8	84.2	79.0	77.7	72.7	70.0	81.2	81.8
median	%	95.8	95.9	94.4	91.7	91.3	87.8	85.4	90.0	86.2	88.5	90.9
best quartile	%	99.8	98.7	97.5	97.7	97.3	93.0	91.4	94.8	93.9	97.0	96.9
Time Utilization	%	17.4	27.5	55.1	58.5	46.8	61.9	50.4	55.5	52.0	37.4	46.0
worst quartile	%	0.3	7.6	22.3	21.0	23.8	43.4	34.1	27.4	19.6	19.7	12.6
median	%	9.0	17.8	41.8	49.4	40.1	59.5	47.2	47.3	55.5	35.5	41.1
best quartile	%	23.1	39.7	63.1	70.3	69.6	70.6	63.6	69.6	66.5	57.0	64.5

E.1.4 PSP indicators by capacity clusters

E.1.4.1 Pumped storage power plants, total (96 machine sets, AT, CZ, DE, IE, LU, PT)



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	14-23
Number	91	91	91	92	96	96	96	95	92	96	94
Capacity MW	8,802	8,724	8,724	8,922	9,214	9,214	9,345	9,109	9,027	9,319	9,040
Time Availability %	87.8	87.2	86.7	87.8	88.6	83.5	82.7	78.7	82.3	75.5	84.0
Time Utilization %	21.6	23.1	22.5	21.0	22.7	20.7	20.4	18.7	17.8	18.6	20.7
Time Unavailability Total %	12.2	12.8	13.3	12.2	11.4	16.5	17.3	21.3	17.7	24.5	16.0
Time Unavailability Planned %	10.7	10.5	11.8	10.5	10.2	14.2	14.9	18.6	14.5	19.7	13.6
Time Unavailability Unplanned %	1.5	2.3	1.5	1.7	1.3	2.3	2.5	2.7	3.1	4.7	2.4
Unplanned Postponable %	0.3	0.2	0.9	0.2	0.3	0.5	0.3	0.3	0.2	1.1	0.4
Unplanned not Postponable %	1.2	2.1	0.6	1.5	1.0	1.7	2.2	2.4	2.9	3.6	1.9