TENAGA

TENAGA GENERASI LIMITED

To,
The Registrar,
National Electric Power Regulatory Authority,
NEPRA Tower, Attaturk Avenue (East)
Sector G-5/1, Islamabad.

Telephone No.: 051 201 3200
Facsimile No.: 051 260 0021

Subject: **TENEGA GENERASI LIMITED ("TGL") - APPLICATION FOR LICENSEE PROPOSED MODIFICATION OF TGL'S GENERATION LICENCE No. WPGL/04/2006, DATED 23 FEBRUARY, 2012**

I, Inam ur Rahman, being the duly authorized representative of Tenaga Generasi Limited by virtue of the Board of Directors Resolution/Power of Attorney, dated 25 August 2011 (attached as Annex B to the Application), hereby apply to the National Electric Power Regulatory Authority ("Authority") for modification of TGL's Generation Licence No. WPGL/04/2006, dated 23 February, 2012, pursuant to Regulation 10 of the National Electric Power Regulatory Authority Licensing (Application & Modification Procedure) Regulations, 1999 ("Regulations").

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing(Application and Modification Procedure) Regulations, 1999, and undertake to abide by the terms and provisions of the above said regulations. I further undertake and confirm that the information provided in the attached documents-in-support is true and correct to the best of my knowledge and belief.

A Bank draft No. **BBB10040396,** dated: 27th August 2014, for the sum of Rupees Two Hundred and Seventy Four Thousand and Nine Hundred and Ninety Two Only (PKR 274,992/-), being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

Date: 28th August 2014

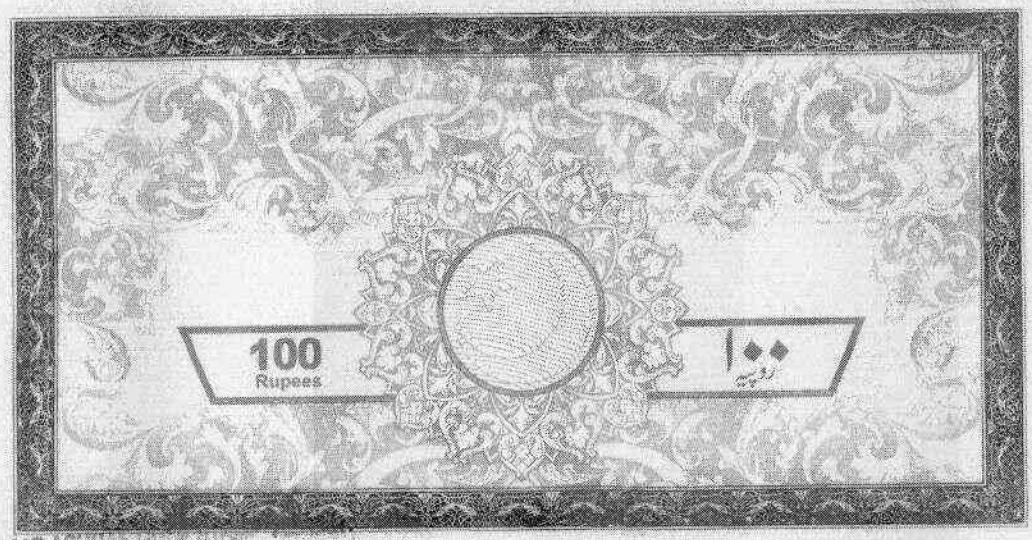
MR. INAM UR RAHMAN

CHIEF EXECUTIVE OFFICER AND AUTHORIZED REPRESENTATIVE

Tenaga Generasi Limited TENAGA

Dawood Centre, M.T. Khan Road, Karachi - 75530, Pakistan.
Tel : (92-21) 35632200-09 Lines Fax : (92-21) 35633970 UAN : 111-736-611 E-mail : info.reon@dawoodhercules.com

A685135



25 FEB 2014

BEFORE

THE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY

AFFIDAVIT

AFFIDAVIT of **MR. INAM UR RAHMAN**, Chief Executive Officer and authorized representative of M/s. TENAGA GENERASI LIMITED, Dawood Centre, M.T. Khan Road, Karachi-75530, Pakistan

I, the above named Deponent, do hereby solemnly affirm and declare that:-

1. I am the Chief Executive Officer of M/s TENAGA GENERASI LIMITED, Dawood Centre, M.T. Khan Road, Karachi-75530, Pakistan.

2. I am the authorized representative of M/s TENAGA GENERASI LIMITED, Dawood Centre, M.T. Khan Road, Karachi-75530, Pakistan.

3. The contents of the accompanying modification of generation license application dated August 28, 2014, including all supporting documents are true and correct to the best of my knowledge and belief, and nothing material or relevant thereto has been concealed or withheld therefrom,

4. I also affirm that all further documentation and information to be provided by me in connection with the aforesaid application shall be true and correct to the best of my knowledge and belief.

DEPONENT

VERIFICATION

It is hereby verified on solemn affirmation as Islamabad, Pakistan on the 28th day of August 2014, that the contents of the above Affidavit are true and correct to the best of my knowledge and belief, and that nothing material or relevant thereto has been concealed or withheld therefrom

DEPONENT

TENAGA

TENAGA GENERASI LTD.

Extract from the Minutes of the Board of Directors Meeting
Held on August 24, 2011

I, Hafsa Shamsie, Company Secretary of Tenaga Generasi Limited, hereby certify that the following Resolution was passed by the Board of Directors at the Meeting held on August 24, 2011.

"**RESOLVED** that the submission by Tenaga Generasi Limited (the **Company)** of an application for the modification of the generation licence granted by National Electric Power Regulatory Authority to the Company in respect of the 49.5 MW wind power generation facility to be located at Khuti Kun, Mirpursakro, District Thatta, Province of Sindh Pakistan (the **Project**) being set up by the Company be and is hereby approved and in relation thereto, entering into and execution of all required documents, making all filings and payment of all applicable fees, in each case, of any nature whatsoever, by the Company be and is hereby approved.

FURTHER RESOLVED that in respect of submitting an application for the modification of a generation licence to National Electric Power Regulatory Authority, the **CHIEF EXECUTIVE OFFICER** and any **DIRECTOR** be and are hereby singly and jointly authorized and empowered for and on behalf of the Company to:

(a) review, execute, submit, and deliver the generation license modification application and any related documentation required by National Electric Power Regulatory Authority for the modification of the generation licence, including any contracts, affidavits, statements, documents, powers of attorney, letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, letters, communications, notices, certificates, requests, statements and any other instruments of any nature whatsoever;

(b) represent the Company in all negotiations, representations, presentations, hearings, conferences and/or meetings of any nature whatsoever with any entity (including, but in no manner limited to National Electric Power Regulatory Authority, any private parties, companies, partnerships, individuals, governmental and/or semi governmental authorities and agencies, ministries, boards, departments, regulatory authorities and/or any other entity of any nature whatsoever);

(c) sign and execute the necessary documentation, pay the necessary fees, appear before the National Electric Power Regulatory Authority as needed, and do all acts necessary for completion and processing of the generation license modification application;

Dawood Centre, M.T. Khan Road, Karachi-75530 - Pakistan.
Tel: + 9221 35686001 - 16 Lines, Fax: +9221 35633970, Website: www.dawoodlawrencepur.com

(d) appoint or nominate any one or more officers of the Company or any other person or persons, singly or jointly, in their discretion to communicate with, make presentations to and attend the National Electric Power Regulatory Authority hearings; and

(e) do all such acts, matters and things as may be necessary for carrying out the purposes aforesaid and giving full effect to the above resolution."

Certified True Copy

Hafsa Shamsie
Company Secretary

Dated: August 28, 2014

Dawood Centre, M.T. Khan Road, Karachi-75530 - Pakistan.
Tel: + 9221 35686001 - 16 Lines, Fax: +9221 35633970, Website: www.dawoodlawrencepur.com

TENAGA GENERASI LIMITED

BEFORE
THE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY (NEPRA)

APPLICATION FOR MODIFICATION IN GENERATION LICENSE NO. WPGL/04/2006 FOR WIND POWER GENERATION FACILITY

PURSUANT TO ENABLING PROVISIONS OF NEPRA ACT 1997 READ WITH ENABLING PROVISIONS OF RULES MADE THEREUNDER , LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATION 1999 AND LICENSING (GENERATION) RULES 2000 & THE FEDERAL GOVERNMENT'S 'POLICY OF RENEWABLE ENERGY FOR POWER GENERATION 2006'

ON BEHALF OF

TENAGA GENERASI LIMITED

FOR NEPRA'S APPROVAL OF MODIFICATIONS IN THE GENERATION LICENSE NO. WPGL/ 04/2006 FOR TENAGA GENERASI LIMITED

FOR A POWER PROJECT OF 49.5 MW

AT

KHUTTIKUN, MIRPURSAKRO TALUKA, DISTRICT THA[illegible]A, PROVINCE OF SINDH, PAKISTAN

DATED: August 28, 2014

TENAGA GENERASI LIMITED

ADDRESS : 3RD FLOOR, DAWOOD CENTRE, M.T. KHAN ROAD, KARACHI-75530
PHONE # : (+9221) 3568 6001- 16
FAX # : (+9221) 3563 3970
FAX # : 92-213-4541974

Tenaga Generasi Limited

1. BACKGROUND – GRANT OF GENERATION LICENSE

1.1 NEPRA'S GRANT OF GENERATION LICENSE

1.1.1 Under the Regulation of Generation, Transmission and Distribution of Electric Power Act (XL of) 1997 (the **NEPRA Act**) and the National Electric Power Regulatory Authority Licensing (Generation) Rules 2000, the National Electric Power Regulatory Authority (**NEPRA**) is responsible for and has the authority to, *inter alia*, grant licenses for the generation of electric power.

1.1.2 Pursuant to the Sections 7(2) (a) and 15 of the NEPRA Act read with the other enabling provisions of the NEPRA Act, the National Electric Power Regulatory Authority Licensing (Application & Modification Procedure) Regulations 1999 (the **Licensing Regulations 1999**), National Electric Power Regulatory Authority Licensing (Generation) Rules 2000, and in accordance with the Policy for Development of Renewable Energy for Power Generation 2006, **TENAGA GENERASI LIMITED** submitted its application (Ref: TGL/GH001-NEPRA/01-06) (the **Generation License Application**) on 27 March 2006 to NEPRA for grant of a generation license to Tenaga Generasi Limited for its power generation facility to be located at Khuttikun, Mirpursakro Taluka, District Thatta, Province of Sindh, Pakistan (the **Project**).

Later pursuant to the provisions of Regulation 10 of the Licensing Regulation 1999 of NEPRA, **TENAGA GENERASI LIMITED** submitted its application for the Modification Generation License on 27 October 2011

1.1.3 NEPRA in exercise of the powers conferred upon it under the laws of Pakistan granted a generation license (Ref: WPGL/04/2006) (the **Generation License**) to Tenaga Generasi Limited on 18 December 2006 and the Modification License (Ref: WPGL/04/2006) (the **Modification Generation License**) was granted by NEPRA on 23 February 2012.

TENAGA GENERASI LIMITED

2. APPLICATION FOR MODIFICATION IN THE GENERATION LICENSE

2.1 CHANGES RESULTING IN APPLICATION FOR MODIFICATION II

2.1.1 Tenaga Generasi Limited, being the licensee under the Generation License, (the **Licensee**), is desirous of modifying the Generation License, to the extent and in the form set out hereunder in Section 3 (*Proposed Modification in the Generation License*), due to certain changes relating to its Project – as set out in this Generation License Modification Application (the **Project Changes**):

Change in Wind Turbine Generator (WTG) Type

i. The Licensee previously applied for Modification in Generation License to change from Clipper Liberty C93, (50 MW capacity), to GE 1.5 xle (49.5MW capacity). This decision was pragmatically taken by the Licensee with the aim to achieve the highest standards in technology for its Project.

ii. The licensee is again applying for a Modification Generation License with the same aim in mind, to have the latest technology available for the project. The previous turbines GE 1.5 xle selected by the Licensee have now been upgraded for improved performance and output. The new upgraded version, which the licensee has now opted for is General Electric (GE) 1.6 - 82.5m turbines, is the latest and technically the best of its class available in the market. As a result of the new technology, the capacity of a single turbine has increased to 1.6MW. The new model turbine, in addition to increased capacity, has updated software and as result is more robust and well suited to any complex environments

iii. In order to keep the total installed capacity of the complex at the same level as in earlier generation license application we propose to use a configuration of 30 machines of 1.6MW capacity and one machine of 1.5MW capacity (30*1.6MWxle + 1*1.5MWxle) with the total complex capacity of 49.5 MW. It may still be pointed out that regardless of the machines used, they will be brand new equipment. The proposed configuration is attached as annex A and updated single line diagram is attached at annex B.

iv. The step to install higher generating capacity turbines was taken keeping in view the power crisis in the country. Though the installed capacity remains the same, these machines are more efficient and the extra generation produced by the new turbines would be added to our national grid, resulting in a reduced quantum of load shedding, combating the power crisis and giving a boost to our energy deficient economy.

Tenaga Generasi Limited TENAGA

2.2 AEDB APPROVAL OF PROJECT CHANGES

2.2.1 The Project Changes set out in Section 2.1.1 conform to the LOI issued to us by the AEDB, therefore no further review or approval by AEDB is required. Similarly there is no change required in the bank guarantees submitted to AEDB or for a modification of the LOS.

2.3 PROCESS FOR MODIFICATION

2.3.1 Subject to the provisions of sub-regulation (2) of the Regulation 10 of the Licensing Regulation 1999, a licensee may, at any time during the term of its generation license, communicate to NEPRA a licensee proposed modification setting out:

(a) the text of the proposed modification;

(b) a statement of the reasons in support of the modification; and

(c) a statement of the impact on the tariff, quality of service (QoS) and the performance by the Licensee of its obligations under the generation license.

2.4 APPLICATION FOR MODIFICATION OF LICENSE

2.4.1 PURSUANT TO Regulation 10 of the NEPRA Licensing (Application & Modification Procedure) Regulation 1999: TENAGA GENERASI LIMITED SUBMITS for NEPRA's kind consideration and approval, the application for modification in its Generation License together with supporting documents (the **Generation License Modification Application**) appended to the Generation License Modification Application at **Annexure A** (*Amended Schedule-I*) **and Annexure B** (*Amended Schedule-II*).

2.4.2 This Generation License Modification Application is submitted in triplicate, together with the Bank Draft No. BBB10040396 dated 27 August 2014 amounting to PKR 274,992/- as the requisite fee for the Generation License Modification Application, as communicated by NEPRA.

Tenaga Generasi Limited TENAGA

3. PROPOSED MODIFICATION IN THE GENERATION LICENSE

3.1 AMENDMENTS TO SCHEDULE I: PLANT DETAILS – Section entitled "General Information"

i. The proposed modification to section 1 entitled "GENERAL INFORMATION" of "SCHEDULE I – PLANT DETAILS" of the Modification Generation License is attached hereto at **Annexure A** (***Modified Schedule-I***)

3.2 AMENDMENTS TO SCHEDULE I: PLANT DETAILS – Sections entitled "Plant System Description", "Turbine Data", "Generator Data", "Power Performance Curve" and "Single Line Diagram"

i. The proposed modifications to sections entitled "Plant System Description", "Turbine Data", "Generator Data", "Power Performance Curve" and "Single Line Diagram" of "SCHEDULE I – PLANT DETAILS" of the Modification Generation License are attached hereto at **Annexure A** (***Modified Schedule-I***) with "Plant System Description", "Turbine Data", "Generator Data", and "Power Performance Curve" being modified.

ii. The sections entitled "Plant System Description", "Turbine Data", "Generator Data", "Power Performance Curve" and "Single Line Diagram" of "SCHEDULE I – PLANT DETAILS" of the Modification Generation License are submitted for modification due to the WTG Type Change (as submitted in Section 2.1.1 above). The mentioned sections reflect the information relating to GE 1.6 - 82.5m WTGs (as selected for the Project) in addition to the previously selected GE 1.5 xle WTGs (details of which are presently set out in the Modified Generation License of 23 February 2012).

iii. Considering that the Licensee has selected the GE 1.6 – 82.5m WTGs with an aim of achieving high standards in technology for its Project, the output and the performance by the Licensee of its obligations under the Generation License will improve as a result of this selection. And as stated above considering the power crisis of the economy, this shift will increase the power available for the national grid, in turn abating the quantum of load shedding and will ameliorate our energy deficient economy at minimal increased project cost.

3.3 AMENDMENTS TO SCHEDULE I: PLANT DETAILS – Section entitled "Project Commissioning Date (Anticipated)"

The proposed modification to the section entitled "Project Commissioning Date (Anticipated)" of "SCHEDULE I – PLANT DETAILS" of the Modification Generation License is attached hereto at **Annexure A** (***Modified Schedule-I***).

ii. The proposed modification to the section entitled "Project Commissioning Date (Anticipated)" of "Schedule I – Plant Details" is as follows: deletion of the anticipated date presently set out in the section (i.e. 31 March 2014) and replacement of this with 30 September 2016.

3.4 AMENDMENTS TO SCHEDULE II: NET CAPACITY OF THE LICENSEE'S GENERATION FACILITIES

i. The proposed modification to Schedule II – "Net CAPACITY OF THE LICENSEE'S GENERATION FACILITIES" of the Generation License is attached hereto at **Annexure B** (***Modified Schedule-II***).

ii. The proposed modifications to Schedule II – "Net CAPACITY OF THE LICENSEE'S GENERATION FACILITIES". of the Modification Generation License are submitted for modification due to the WTG Type Change (as submitted in Section 2.1.1 above). Schedule II reflects the information relating to GE 1.6 – 82.5 m WTGs (as selected for the Project) in addition to the previously selected GE 1.5 xle WTGs (details of which are presently set out in the Modification Generation License). In addition, the table set out the technical parameters for the wind power producers.

Dawood Centre, M.T. Khan Road, Karachi - 75530, Pakistan.
Tel : (92-21) 35632200-09 Lines Fax : (92-21) 35633970 UAN : 111-736-611 E-mail : info.reon@dawoodhercules.com

4. IMPACT ON THE TARIFF, QOS AND THE PERFORMANCE BY THE LICENSEE

i. The Modification Application submitted to NEPRA by the Licensee takes into account the modifications proposed by the Licensee and does not have any effect on the quality of service and the performance by the Licensee of its obligations under the Generation License. The Modification in fact increases the available generation and adds power to the national grid, abating load shedding and boosting the energy deficient economy in turn amelioration the power crisis for the nation.

ii. There will be no impact on the tariff by NEPRA's acceptance of this application. On the contrary, the requested modification would benefit consumers as it would ensure that generation capacity continues to be available due to improved technology.

iii. There will be no adverse impact on the quality of service provided by the Licensee by NEPRA's acceptance of this application.

iv. The new turbines use updated software enhancements that make the turbines better suited for complex activity and will benefit the power purchaser and the seller in the long run and provide a better QoS for the complex.

v. There will be no adverse impact on the performance by the Licensee of its obligations under the License and the energy purchase agreement (to be entered into between the Licensee and the power purchaser) by NEPRA's acceptance of this application. NEPRA.

vi. The requested modification does not cause NEPRA to act or acquiesce in any act or omission of the Licensee in a manner contrary to the provisions of the NEPRA Act or the rules or regulations made pursuant to the NEPRA Act.

vii. The requested modification would be beneficial to the consumers as it would ensure that generation capacity continues to be available. The new technology consists of a 'new generation' turbine which has better output and is more robust.

Tenaga Generasi Limited TENAGA

5. CONCLUSION

In light of the submissions set out herein and the information attached hereto (together with the Annexures), this Modification Generation License Application is submitted for NEPRA's approval of the proposed modifications in the Generation License granted to the Licensee. Given the advance stage of the Project, NEPRA is kindly requested to process the Modification Generation License Application at the earliest, thereby enabling the Licensee to proceed further with the development process.

Respectfully submitted for and on behalf of:
TENAGA GENERASI LIMITED

.....

MR. INAM UR RAHMAN
(CHIEF EXECUTIVE OFFICER AND AUTHORIZED REPRESENTATIVE)

Tenaga Generasi Limited TENAGA

Plant Details - Annexure A (Modified Schedule-I)

"Plant System Description", "Turbine Data", "Generator Data", "Power Performance Curve", "WTG Layout" and "Single Line Diagram"

1) General Information

1	Name of Applicant/Company	Tenaga Generasi Limited
2	Registered/Business Office	3rd Floor, Dawood Centre, M.T. Khan Road, Karachi
3	Plant Location	Deh Khuttikun, Taluka Mirpur Sakro, District Thatta Sindh
4	Type of Generation	Wind Power

2) "Plant System Description", "Turbine Data", "Generator Data"

Wind Farm Capacity & Configuration

1	**Wind Turbine type, Make & Model**	**General Electric (GE) 1.6xle -82.5m, General Electric (GE) 1.5xle -82.5m**
2	Installed Capacity of Wind Farm (MW)	49.5 MW
3	Number of Wind Units/ Size of each unit (kW)	30/1600KW, 01/1500KW

Wind Turbine Details - (a) General Electric 1.6MW xle

a)	**Rotor**	
1	Number of blades	3
2	Rotor speed	9.8 — 18.7 rpm
3	Rotor diameter	82.5 m
4	Swept area	5346 m2
5	Power regulation	Combination of blade pitch angle adjustment, and generator / converter torque control.
6	Cut-in wind speed	3 m/s
7	Cut-out wind speed	25 m/s
8	Survival wind speed	40 m/s, 3s average
9	Pitch regulation	Electric motor drives a ring gear mounted to the inner race of the blade pitch bearing.
b)	Blades	
1	Blade Length	40.3 m
2	Material	Fiberglass polyester resin
c)	Gearbox	
1	Type	Multi-stage planetary/helical gear design
2	Gear ratio	1:107.1
3	Main Shaft bearing	Roller bearing mounted in a pillow-block housing arrangement
d)	**Generator**	

1	Power	1600 kW
2	Voltage	690 V
3	Type	Doubly-fed induction type
4	Enclosure class	IP 54
5	Coupling	Flexible coupling
6	Power Factor	0.95 Lagging - 0.95 Leading
(e)	Yaw System	
1	Yaw bearing	Roller bearing
2	Brake	Planetary yaw drives (with brakes that engage when the drive is disabled)
3	Yaw drive	4 planetary yaw drives.
4	(iv). Speed	0.5 degree/s
(f)	**Control System**	
1	Type	Automatic or manually controlled.
2	Scope of Monitoring	Remote monitoring of different parameters, e.g. temperature sensors, pitch parameters, speed, generator torque, wind speed and direction, etc.
3	Recording	Production data, event list, long and short term trends
(g)	**Brake**	
1	Design	Three independent systems, fail safe (individual pitch)
2	Operational brake	Aerodynamic brake achieved by feathering blades.
3	Secondary brake	Mechanical brake on (high speed) shaft of gearbox.
(h)	**Tower**	
1	Type	Tubular steel tower
2	Hub heights	80

Wind Turbine Details - (b) General Electric 1.5MW xle

a)	**Rotor**	
1	Number of blades	3
2	Rotor speed	9.8 — 18.7 rpm
3	Rotor diameter	82.5 m
4	Swept area	5346 m2
5	Power regulation	Combination of blade pitch angle adjustment, and generator / converter torque control.
6	Cut-in wind speed	3 m/s
7	Cut-out wind speed	25 m/s
8	Survival wind speed	40 m/s, 3s average
9	Pitch regulation	Electric motor drives a ring gear mounted to the inner race of the blade pitch bearing.
b)	Blades	
1	Blade Length	40.3 m
2	Material	Fiberglass polyester resin
c)	Gearbox	
1	Type	Multi-stage planetary/helical gear design
2	Gear ratio	1:107.1
3	Main Shaft bearing	Roller bearing mounted in a pillow-block housing arrangement
d)	**Generator**	

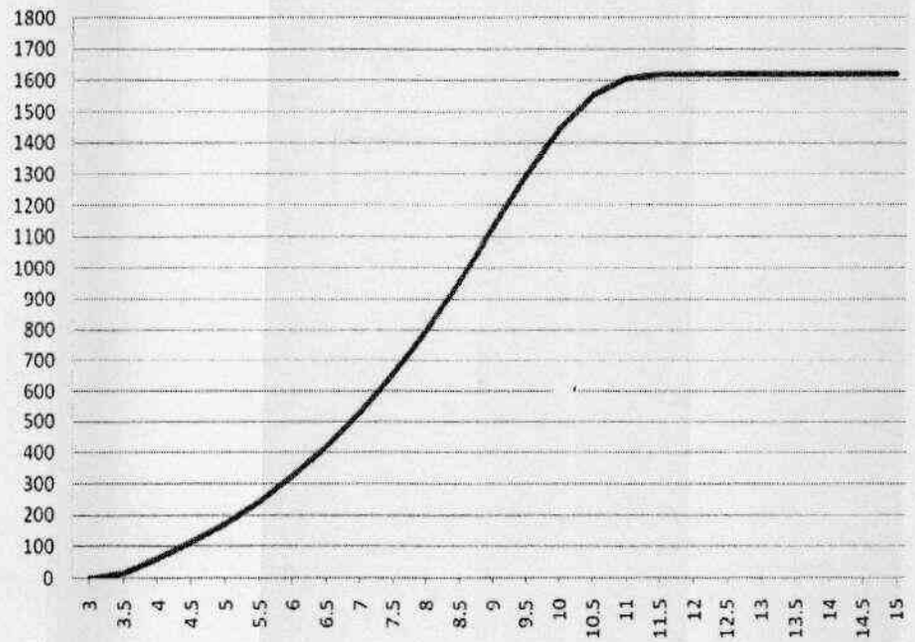
1	Power	1500 kW
2	Voltage	690 V
3	Type	Doubly-fed induction type
4	Enclosure class	IP 54
5	Coupling	Flexible coupling
6	Power Factor	0.95 Lagging - 0.95 Leading
(e)	Yaw System	
1	Yaw bearing	Roller bearing
2	Brake	Planetary yaw drives (with brakes that engage when the drive is disabled)
3	Yaw drive	4 planetary yaw drives.
4	(iv). Speed	0.5 degree/s
(f)	**Control System**	
1	Type	Automatic or manually controlled.
2	Scope of Monitoring	Remote monitoring of different parameters, e.g. temperature sensors, pitch parameters, speed, generator torque, wind speed and direction, etc.
3	Recording	Production data, event list, long and short term trends
(g)	**Brake**	
1	Design	Three independent systems, fail safe (individual pitch)
2	Operational brake	Aerodynamic brake achieved by feathering blades.
3	Secondary brake	Mechanical brake on (high speed) shaft of gearbox.
(h)	**Tower**	
1	Type	Tubular steel tower
2	Hub heights	80

Other Details

1	**Project Commissioning Date (Anticipated)**	30th September 2016
2	Expected Life of the Project from Commercial Operation Date (COD)	20 years

Tenaga Generasi Limited TENAGA

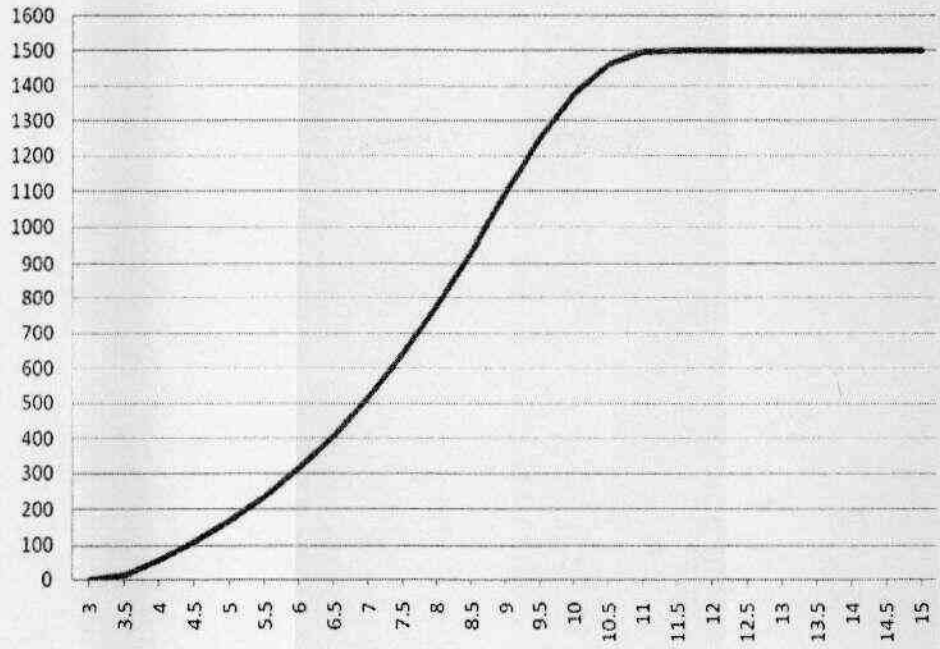
Power Performance Curve
Power Performance of GE 1.6 -82.5 (1.6MW)



Power Curve GE 1.6 MW xle		Power Curve GE 1.6 MW xle	
Wind Speed at Hub Height	Power Output [kW] Low Turbulence Intensities TI < 10%	Wind Speed at Hub Height [m/s]	Power Output [kW] Low Turbulence Intensities TI < 10%
[m/s]	[kW]	[m/s]	[kW]
3	0	9	1132
3.5	18	9.5	1296
4	61	10	1447
4.5	114	10.5	1553
5	175	11	1607
5.5	244	11.5	1620
6	326	12	1620
6.5	422	12.5	1620
7	532	13	1620
7.5	657	13.5	1620
8	801	14	1620
8.5	960	14.5	1620
9	1132	15	1620

Tenaga Generasi Limited TENAGA

Power Performance Curve
Power Performance of GE 1.5 - 82.5 (1.5MW)



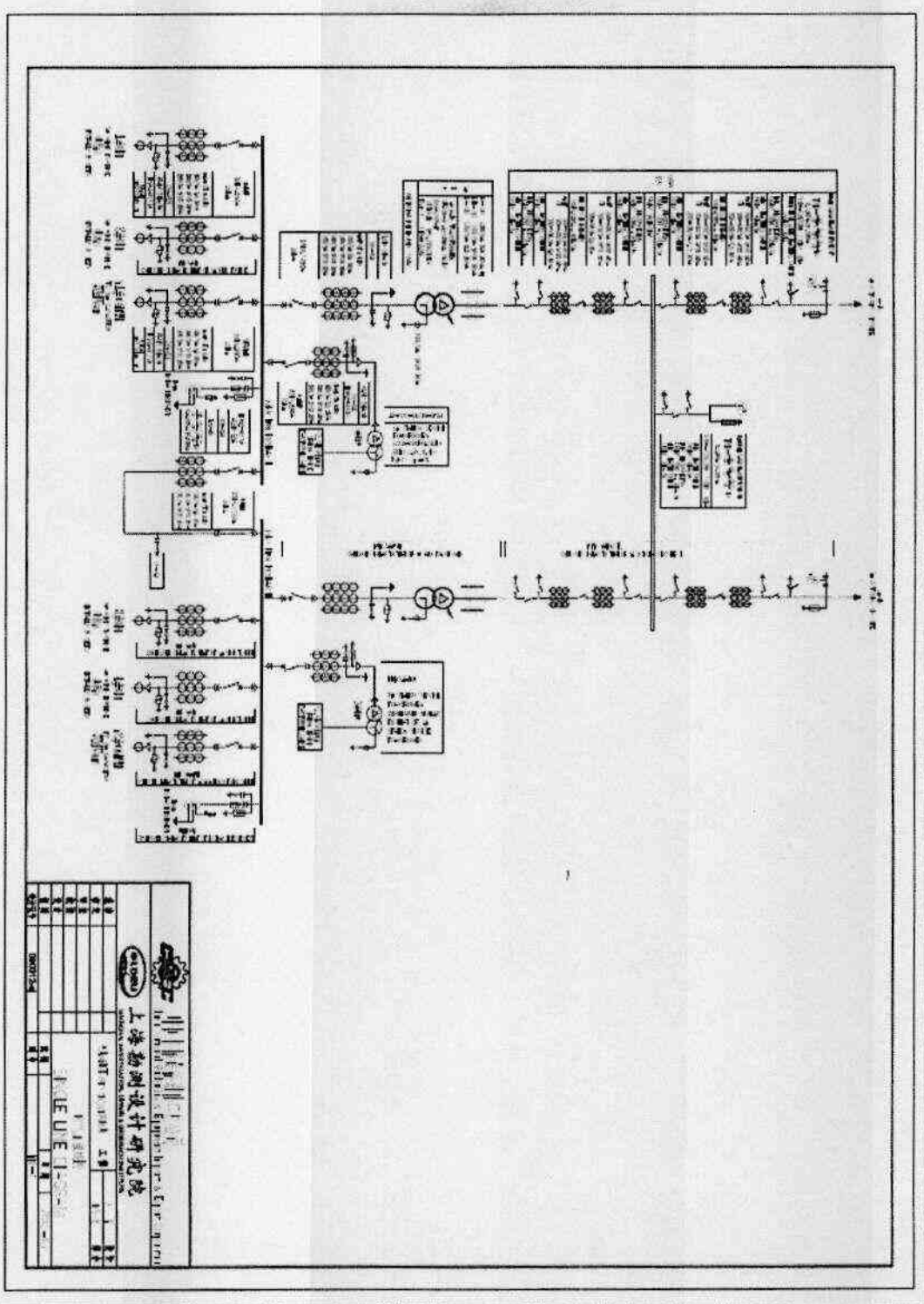
Power Curve GE 1.5 MW xle		Power Curve GE 1.5 MW xle	
Wind Speed at Hub Height	Power Output [kW] Low Turbulence Intensities TI < 10%	Wind Speed at Hub Height [m/s]	Power Output [kW] Low Turbulence Intensities TI < 10%
[m/s]	[kW]	[m/s]	[kW]
3	0	9.5	1250
3.5	18	10	1380
4	61	10.5	1463
4.5	114	11	1497
5	175	11.5	1500
5.5	244	12	1500
6	326	12.5	1500
6.5	422	13	1500
7	532	13.5	1500
7.5	657	14	1500
8	801	14.5	1500
8.5	960	15	1500
9	1132	15.5	1500

Tenaga Generasi Limited TENAGA

WTG Layout

Tenaga Generasi Limited			
WTGs Capacity & Location			
WTG No.	Capacity (kW)	Location	
		E	N
WTG 1	1600	342050	2720000
WTG 2	1600	340764	2724827
WTG 3	1600	340527	2724345
WTG 4	1600	340580	2723874
WTG 5	1600	340012	2723386
WTG 6	1600	341374	2723652
WTG 7	1600	341497	2723347
WTG 8	1600	341810	2721641
WTG 9	1600	341561	2723047
WTG 10	1600	341665	2722394
WTG 11	1600	339855	2725078
WTG 12	1600	339628	2724697
WTG 13	1600	339608	2724404
WTG 14	1600	339601	2724146
WTG 15	1600	339691	2723899
WTG 16	1600	340730	2722834
WTG 17	1600	341726	2722024
WTG 18	1600	342415	2720599
WTG 19	1600	341056	2721215
WTG 20	1600	341429	2724965
WTG 21	1600	341463	2724223
WTG 22	1600	339837	2723637
WTG 23	1500	341388	2724636
WTG 24	1600	340691	2721779
WTG 25	1600	341270	2720989
WTG 26	1600	341753	2720344
WTG 27	1600	341600	2722736
WTG 28	1600	340686	2723583
WTG 29	1600	340549	2722084
WTG 30	1600	340739	2723216
WTG 31	1600	341496	2720669

Single Line Drawing



Annexure B Modified SCHEDULE-II

Net Capacity of the Licensee's Generation Facilities

(1)	**Total Installed Gross ISO Capacity of the Generation Facility/Wind Farm (MW/GWh)**	**49.5 MW**
(2)	Total Annual Full Load Hours	2970 Hours
(3)	Auxiliary Consumption	Approximately 3%
(4)	Average WTG Availability	95.9%
(5)	Net Capacity Factor	Approximately 33.9%[1]
(6)	Annual Energy Generation (20 years Equivalent NET AEP)	154.38 GWh*

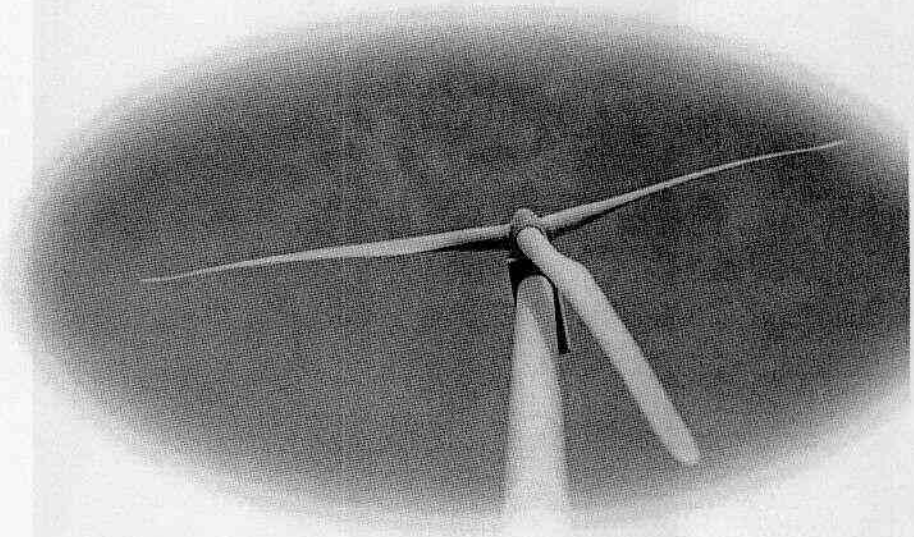
Note:

1. The original table was configured for capacity data which is not applicable to wind powered IPP's. The technical parameters as per the above table are relevant for wind power generation.
2. All the above figures are indicative as provided by the Licensee. The net capacity available to NTDC for dispatch and provision to purchasers will be determined through procedures contained in the agreements of the Grid code.

[1] As per Upfront Tariff document we are only allowed 31% as billable number

GE Energy

Technical Documentation
Wind Turbine Generator Systems
1.6-82.5 - 50 Hz and 60 Hz



Calculated Power Curve

GE imagination at work

GE Energy

Gepower.com

Visit us at
www.gewindenergy.com

All technical data is subject to change in line with ongoing technical development!

GE imagination at work

Table of Contents

1 Calculated Power Curve 1.6-82.5 – 50 Hz and 60 Hz

Standard Atmospheric Conditions (Air Density of 1.225 kg/m³)

Rotor Diameter: 82.5 m

(Cut-out wind speed based on 10 minute average)

Wind Speed at Hub Height [m/s]	Normal Turbulence Intensities 10% < TI < 15%	Low Turbulence Intensities TI < 10%	High Turbulence Intensities 15% < TI < 20%	Cp,e Normal Turbulence Intensities
3.0	0	0	0	-
3.5	20	18	24	0.14
4.0	63	61	69	0.30
4.5	116	114	123	0.39
5.0	178	175	186	0.43
5.5	248	244	259	0.46
6.0	331	326	344	0.47
6.5	428	422	446	0.48
7.0	540	532	562	0.48
7.5	667	657	692	0.48
8.0	812	801	840	0.48
8.5	971	960	990	0.48
9.0	1136	1132	1140	0.48
9.5	1289	1296	1274	0.46
10.0	1431	1447	1400	0.44
10.5	1530	1553	1488	0.40
11.0	1590	1607	1552	0.36
11.5	1615	1620	1593	0.32
12.0	1620	1620	1615	0.29
12.5 - cutout	1620	1620	1620	-

Table 1: Calculated power curve for the 1.6-82.5

2 Air Density Tables for Normal, Low and High Turbulence Intensities

Wind Speed at Hub Height [m/s]	Air Density [kg/m³]										
	ρ = 1.02	ρ = 1.04	ρ = 1.06	ρ = 1.08	ρ = 1.1	ρ = 1.12	ρ = 1.14	ρ = 1.16	ρ = 1.18	ρ = 1.2	ρ = 1.225
	Electrical Power [kW]										
3.0	0	0	0	0	0	0	0	0	0	0	0
3.5	11	12	13	14	14	15	16	17	18	19	20
4.0	47	49	50	52	53	55	57	58	60	61	63
4.5	91	94	96	99	101	104	106	108	111	113	116
5.0	143	146	149	153	156	160	163	166	170	173	178
5.5	202	206	211	215	220	224	229	234	238	243	248
6.0	271	277	282	288	294	300	306	312	318	324	331
6.5	352	360	367	374	382	389	397	404	412	419	428
7.0	446	455	464	473	483	492	501	510	519	529	540
7.5	552	564	575	586	597	609	620	631	642	653	667
8.0	674	688	701	715	728	742	755	768	782	795	812
8.5	810	826	842	858	874	889	905	921	936	952	971
9.0	958	976	994	1012	1030	1047	1064	1081	1098	1115	1136
9.5	1107	1126	1145	1163	1181	1199	1216	1234	1251	1268	1289
10.0	1253	1272	1291	1310	1328	1346	1363	1380	1396	1412	1431
10.5	1388	1406	1423	1439	1454	1468	1482	1494	1506	1517	1530
11.0	1491	1505	1517	1529	1540	1550	1560	1569	1576	1583	1590
11.5	1557	1564	1572	1578	1585	1592	1598	1604	1609	1613	1615
12.0	1594	1598	1602	1606	1609	1612	1615	1617	1619	1620	1620
12.5	1606	1608	1610	1612	1614	1616	1617	1619	1620	1620	1620
13.0	1616	1617	1618	1619	1620	1620	1620	1620	1620	1620	1620
13.5 - cutout	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620

Table 2: Calculated power curve for the 1.6-82.5 for normal turbulence intensities

Wind Speed at Hub Height [m/s]	Air Density [kg/m³]										
	ρ = 1.02	ρ = 1.04	ρ = 1.06	ρ = 1.08	ρ = 1.1	ρ = 1.12	ρ = 1.14	ρ = 1.16	ρ = 1.18	ρ = 1.2	ρ = 1.225
	Electrical Power [kW]										
3.0	0	0	0	0	0	0	0	0	0	0	0
3.5	10	10	11	12	13	14	15	15	16	17	18
4.0	46	47	49	50	52	53	55	56	58	59	61
4.5	89	92	94	97	99	101	104	106	108	111	114
5.0	140	144	147	150	154	157	160	164	167	170	175
5.5	198	203	207	212	216	221	225	230	234	239	244
6.0	266	272	278	284	290	295	301	307	313	318	326
6.5	346	354	361	368	376	383	390	398	405	412	422
7.0	439	448	457	466	475	484	493	502	511	520	532
7.5	544	555	566	577	589	600	611	622	633	644	657
8.0	664	678	691	704	718	731	744	757	771	784	801
8.5	799	815	831	847	862	878	894	909	925	940	960
9.0	948	966	985	1003	1021	1039	1057	1075	1092	1110	1132
9.5	1104	1124	1144	1164	1183	1202	1221	1240	1258	1275	1296
10.0	1259	1279	1299	1319	1338	1357	1375	1393	1410	1427	1447
10.5	1403	1422	1440	1457	1473	1488	1503	1516	1529	1540	1553
11.0	1512	1526	1539	1551	1562	1572	1581	1588	1595	1601	1607
11.5	1579	1586	1593	1598	1603	1607	1611	1613	1616	1618	1620
12.0	1610	1614	1617	1619	1620	1620	1620	1620	1620	1620	1620
12.5	1617	1619	1619	1620	1620	1620	1620	1620	1620	1620	1620
13 - cutout	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620

Table 3: Calculated power curve for the 1.6-82.5 for low turbulence intensities

Wind Speed at Hub Height [m/s]	Air Density [kg/m³]										
	ρ = 1.02	ρ = 1.04	ρ = 1.06	ρ = 1.08	ρ = 1.1	ρ = 1.12	ρ = 1.14	ρ = 1.16	ρ = 1.18	ρ = 1.2	ρ = 1.225
	Electrical Power [kW]										
3.0	0	0	0	0	0	0	0	0	0	0	0
3.5	15	16	16	17	18	19	20	21	22	23	24
4.0	52	53	55	57	58	60	62	63	65	67	69
4.5	97	99	102	104	107	110	112	115	117	120	123
5.0	149	153	156	160	164	167	171	174	178	181	186
5.5	210	215	220	224	229	234	239	243	248	253	259
6.0	282	288	294	300	306	312	318	324	330	337	344
6.5	367	375	382	390	398	406	413	421	429	436	446
7.0	464	474	483	493	503	512	522	531	541	550	562
7.5	574	586	597	609	620	632	644	655	667	678	692
8.0	700	714	727	741	755	769	782	796	809	823	840
8.5	834	850	866	882	897	912	927	942	957	972	990
9.0	976	993	1010	1027	1043	1059	1075	1090	1106	1121	1140
9.5	1108	1125	1142	1159	1176	1193	1209	1225	1241	1256	1274
10.0	1240	1257	1274	1291	1307	1323	1339	1354	1369	1383	1400
10.5	1359	1375	1390	1404	1417	1430	1442	1453	1464	1475	1488
11.0	1451	1464	1476	1487	1498	1508	1518	1527	1535	1543	1552
11.5	1517	1527	1536	1545	1553	1561	1569	1576	1582	1587	1593
12.0	1561	1568	1575	1581	1587	1593	1599	1603	1608	1611	1615
12.5	1588	1593	1598	1602	1606	1610	1614	1617	1619	1620	1620
13.0	1604	1607	1610	1613	1615	1616	1618	1619	1620	1620	1620
13.5	1612	1614	1616	1617	1618	1619	1619	1620	1620	1620	1620
14.0	1618	1619	1619	1620	1620	1620	1620	1620	1620	1620	1620
14.5 - cutout	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620

Table 4: Calculated power curve for the 1.6-82.5 for high turbulence intensities

3 Applicability

The power curve information provided above applies to the following conditions:

- The stated range of mean horizontal wind turbulence intensity, defined as the mean value at 15 m/s average hub height wind speed.
- The specified value for mean air density.

Furthermore, also referencing the comprehensive requirements given in the Technical Specifications for Machine Power Performance Tests:

- The stated performance applies to:
  - clean, non-degraded, and uncontaminated blade surfaces without icing;
  - A wind turbine generator system decoupled from WindCONTROL. WindCONTROL controls and regulates the voltage and/or power of the entire wind farm. The stated performance of the power curve in this document assumes that the wind turbine generator system power output is not being regulated or controlled by WindCONTROL. The term "decoupled" implies that there are no voltage or power commands being assigned from the WindCONTROL system and the output of the wind turbine generator system is free to operate up to the maximum capability of the machine itself.
  - power values apply to the low-voltage side of the transformer.
- Wind-speed labels are mid-bin values; for example, the 5.0 m/s bin extends from 4.75 to 5.25 m/s.
- The wind inclination at the site should be within the turbine design conditions (typically +/- 8° for onshore machines per the IEC 61400-1).
- Information on the influences of the cold weather options is located in the document "Technical Description – Cold Weather Adaptations".

The turbine shall operate within its normal operating range.

4 Cut-Out and Re-Cut-In Wind Speeds 1.6-82.5 – 50 Hz and 60 Hz

If the average wind speed exceeds

- 25 m/s in a 600 s time interval
- 28 m/s in a 30 s time interval or
- 30 m/s in a 3 s time interval

the wind turbine generator system will shut down.

If the average wind speed remains below

- 22 m/s in a 300 s time interval

the wind turbine generator system will cut in again.

GE Energy

Technical Documentation
Wind Turbine Generator Systems
1.5-82.5 - 50 Hz & 60 Hz

Calculated Power Curve

GE imagination at work

GE Energy

Gepower.com

Visit us at
www.gewindenergy.com

All technical data is subject to change in line with ongoing technical development!

GE imagination at work

Table of Contents

1 Calculated Power Curve 1.5-82.5 - 50 Hz and 60 Hz

Standard Atmospheric Conditions (Air Density of 1.225 kg/m³)

Rotor Diameter: 82.5 m

(Cut-out wind speed based on 10 minutes average)

Wind Speed at HH (m/s)	Electrical Power (kW)			$C_{p,e}$ normal turbulence intensities
	Low turbulence intensitie TI < 10 %	Normal turbulence intensities 10 % < TI < 15 %	High turbulence intensities 15 % < TI < 20 %	
3.0	0	0	0	0.000
3.5	13	14	19	0.102
4.0	55	57	62	0.272
4.5	107	109	115	0.365
5.0	167	170	177	0.414
5.5	235	239	249	0.438
6.0	315	320	333	0.452
6.5	408	414	431	0.461
7.0	517	525	547	0.468
7.5	641	650	675	0.471
8.0	781	792	817	0.472
8.5	936	947	967	0.471
9.0	1098	1100	1096	0.461
9.5	1250	1239	1219	0.441
10.0	1380	1362	1330	0.416
10.5	1463	1443	1407	0.381
11.0	1497	1483	1451	0.340
11.5	1500	1495	1469	0.300
12.0	1500	1500	1485	0.265
12.5	1500	1500	1495	0.235
13.0	1500	1500	1500	0.209
13.5	1500	1500	1500	0.186
14.0	1500	1500	1500	0.167
14.5	1500	1500	1500	0.150
15.0	1500	1500	1500	0.136
15.5	1500	1500	1500	0.123
16.0	1500	1500	1500	0.112
16.5	1500	1500	1500	0.102
17.0	1500	1500	1500	0.093
17.5	1500	1500	1500	0.085
18.0	1500	1500	1500	0.079
18.5	1500	1500	1500	0.072
19.0	1500	1500	1500	0.067
19.5	1500	1500	1500	0.062
20.0	1500	1500	1500	0.057
20.5*	1500	1500	1500	0.053
21.0*	1500	1500	1500	0.049
21.5*	1500	1500	1500	0.046
22.0*	1500	1500	1500	0.043
22.5*	1500	1500	1500	0.040
23.0*	1500	1500	1500	0.038
23.5*	1500	1500	1500	0.035
24.0*	1500	1500	1500	0.033
24.5*	1500	1500	1500	0.031
25.0*	1500	1500	1500	0.029

Table 1: Calculated power curve for the 1.5-82.5 - *Applies only to turbines with windEXTEND enabled

	Air Density [kg/m^3]										
	1.020	1.040	1.060	1.080	1.100	1.120	1.140	1.160	1.180	1.200	Standard Atmospheric Conditions 1.225
Wind Speed at HH [m/s]	Electrical Power [kW]										
3.0	0	0	0	0	0	0	0	0	0	0	0
3.5	6	7	8	8	9	10	11	12	12	13	14
4.0	41	43	44	46	47	49	50	52	54	55	57
4.5	85	87	89	92	94	96	99	101	103	106	109
5.0	135	138	142	145	149	152	155	159	162	165	170
5.5	193	198	202	206	211	215	220	224	228	233	239
6.0	260	266	272	278	284	289	295	301	307	313	320
6.5	339	347	354	361	369	376	383	391	398	405	414
7.0	432	441	450	460	469	478	487	496	505	514	525
7.5	537	548	559	570	581	592	603	614	625	636	650
8.0	656	670	683	696	710	723	736	749	762	775	792
8.5	789	805	820	836	852	867	882	898	913	928	947
9.0	929	947	964	982	999	1015	1032	1048	1064	1080	1100
9.5	1067	1085	1103	1121	1138	1155	1172	1188	1204	1220	1239
10.0	1200	1218	1236	1253	1270	1286	1302	1318	1332	1346	1362
10.5	1317	1333	1349	1364	1378	1391	1403	1414	1424	1433	1443
11.0	1404	1415	1426	1436	1445	1453	1461	1467	1473	1478	1483
11.5	1455	1462	1467	1473	1477	1481	1484	1487	1490	1492	1495
12.0	1483	1486	1489	1492	1494	1496	1498	1500	1500	1500	1500
12.5	1497	1499	1500	1500	1500	1500	1500	1500	1500	1500	1500
13.0	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
13.5	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
14.0	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
14.5	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
15.0 – 20.0	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
20.5 – 25.0*	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500

Table 2: Calculated power curve for the 1.5-82.5 for normal turbulence intensities - *Applies only to turbines with windEXTEND enabled

	Air Density [kg/m^3]										
	1.020	1.040	1.060	1.080	1.100	1.120	1.140	1.160	1.180	1.200	Standard Atmospheric Conditions 1.225
Wind Speed at HH [m/s]	Electrical Power [kW]										
3.0	0	0	0	0	0	0	0	0	0	0	0
3.5	5	5	6	7	8	9	9	10	11	12	13
4.0	40	41	43	44	46	47	49	50	52	53	55
4.5	83	85	87	90	92	94	97	99	101	104	107
5.0	133	136	139	143	146	149	153	156	159	163	167
5.5	190	194	199	203	208	212	216	221	225	230	235
6.0	256	262	268	273	279	285	291	296	302	308	315
6.5	334	341	349	356	363	370	377	385	392	399	408
7.0	425	434	443	452	461	470	479	488	497	506	517
7.5	529	540	551	562	573	583	594	605	616	627	641
8.0	647	660	673	686	699	712	726	739	752	765	781
8.5	779	795	810	826	841	856	872	887	902	917	936
9.0	922	940	957	975	993	1010	1028	1045	1062	1078	1098
9.5	1067	1086	1105	1124	1142	1160	1177	1195	1212	1229	1250
10.0	1209	1228	1247	1265	1283	1300	1316	1332	1347	1362	1380
10.5	1333	1350	1367	1382	1397	1410	1423	1434	1444	1453	1463
11.0	1424	1436	1447	1456	1465	1472	1479	1484	1489	1493	1497
11.5	1473	1479	1484	1488	1492	1495	1498	1500	1500	1500	1500
12.0	1496	1499	1500	1500	1500	1500	1500	1500	1500	1500	1500
12.5	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
13.0	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
13.5	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
14.0	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
14.5	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
15.0 - 20.0	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
20.5 - 25.0*	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500

Table 3: Calculated power curve for the 1.5-82.5 for low turbulence intensities - *Applies only to turbines with windEXTEND enabled

	Air Density [kg/m^3]										
	1.020	1.040	1.060	1.080	1.100	1.120	1.140	1.160	1.180	1.200	Standard Atmospheric Conditions 1.225
Wind Speed at HH [m/s]	Electrical Power [kW]										
3.0	0	0	0	0	0	0	0	0	0	0	0
3.5	9	10	11	12	13	14	15	16	17	17	19
4.0	46	47	49	51	52	54	55	57	59	60	62
4.5	90	92	95	97	100	102	105	107	110	112	115
5.0	142	145	149	152	156	159	163	166	169	173	177
5.5	201	206	211	215	220	224	229	234	238	243	249
6.0	271	277	283	289	295	301	307	313	319	325	333
6.5	353	361	368	376	384	391	399	406	414	421	431
7.0	450	460	469	478	488	497	507	516	525	535	547
7.5	558	569	581	592	604	615	626	638	649	661	675
8.0	680	694	707	721	734	748	761	774	788	801	817
8.5	812	828	843	859	874	889	904	919	934	949	967
9.0	941	958	974	990	1005	1020	1035	1049	1064	1078	1096
9.5	1063	1080	1096	1112	1128	1143	1159	1173	1188	1202	1219
10.0	1183	1199	1215	1231	1246	1261	1275	1289	1302	1315	1330
10.5	1287	1303	1317	1331	1344	1356	1367	1377	1387	1396	1407
11.0	1366	1377	1387	1397	1406	1414	1422	1429	1436	1443	1451
11.5	1416	1424	1431	1437	1443	1448	1453	1457	1461	1465	1469
12.0	1451	1456	1461	1465	1469	1472	1475	1477	1480	1482	1485
12.5	1473	1476	1479	1482	1484	1486	1488	1490	1491	1493	1495
13.0	1486	1489	1490	1492	1493	1494	1496	1497	1498	1499	1500
13.5	1495	1496	1497	1498	1499	1500	1500	1500	1500	1500	1500
14.0	1499	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
14.5	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
15.0 – 20.0	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
20.5 – 25.0*	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500

Table 4: Calculated power curve for the 1.5-82.5 for high turbulence intensities - *Applies only to turbines with windEXTEND enabled

2 Applicability

The here provided power curve information applies under the following conditions:

- The stated range of mean horizontal wind turbulence intensity, defined as the mean value at 15 m/s average hub height wind speed.
- The specified value for mean air density.

Furthermore, also referencing the comprehensive requirements given in the Technical Specifications for Machine Power Performance Tests:

- The stated performance applies to:
  - clean, non-degraded, and uncontaminated blade surfaces including possible icing;
  - a turbine that is decoupled from the wind farm management system;
  - for onshore machines, power values apply to the low-voltage side of the transformer and downstream of the transformer for offshore machines.
- The air density adjustment method of the most recent IEC 61400-12 has been used to determine power curves at air densities other than sea level.
- Wind-speed labels are mid-bin values; for example, the 5.0 m/s bin extends from 4.75 to 5.25 m/s.
- The wind inclination at the site should be within the turbine design conditions (typically +/- 8° for onshore machines per the IEC 61400-1).
- Information on the influences of the cold weather options is located in the document "Technical Description – Cold Weather Adaptations".

The turbine shall operate within its normal operating range.

3 Cut-Out and Re-Cut-In Wind Speeds 1.5-82.5 - 50Hz and 60 Hz

If the average wind speed exceeds

- 20 m/s in a 600 s time interval
- 23 m/s in a 30 s time interval or
- 25 m/s in a 3 s time interval

the wind turbine generator system will shut down.

If the average wind speed remains below

- 17 m/s in a 300 s time interval

the wind turbine generator system will cut in again.

4 Cut-Out and Re-Cut-In Wind Speeds 1.5-82.5 - 60 Hz with windEXTEND

If the average wind speed exceeds

- 25 m/s in a 600 s time interval
- 28 m/s in a 30 s time interval or
- 30 m/s in a 3 s time interval

the wind turbine generator system will shut down.

If the average wind speed remains below

- 22 m/s in a 300 s time interval

the wind turbine generator system will cut in again.