Sales document

Deconstruction effort for wind turbines

For all wind turbines Nordex K08
Generation delta

K0801_041841_EN

Revision 10 / 2017-06-02

- Translation of the original instructions -

Document is published in electronic form.

Signed original at Nordex Energy GmbH, Engineering.

Technical modifications

This document was created with utmost care, taking into account the currently applicable standards.

However, due to continuous development, the figures, functional steps and technical data is subject to change without prior notice.

Contact details

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1. Introduction

Due to the necessity for reducing the greenhouse gas CO_2, the number of wind turbines has greatly increased during recent decades.

Every wind turbine (WT) has been designed for a limited service life. After expiry of this time it must be disassembled, disposed of and the site returned to its original condition – the condition prior to the erection of the wind turbine. The operator must save up provisions for this purpose. Nordex provides disassembly instructions for the wind turbine and this compilation of the deconstruction effort.

The calculated service life of a WT is 20 years. In reality, however, a turbine life can be longer or shorter (keyword repowering). The estimated costs for the deconstruction are already saved up and put aside for financial security while the WT is still operating.

However, it has become apparent that the old wind turbines above approx. 150 kW power capacity are not normally scrapped but disassembled and exported abroad. If the WT is sold, careful planning, execution and documentation of the following steps is important for deconstruction: disconnection through the grid operator, disassembly of the WT (backwards – in line with the erection), packing and transport. Selling the WT or parts of the WT is always more favorable than scrapping.

Individual components, especially motors or transformers, can be overhauled and reused. They will then no longer be classified as electronic scrap and can continue yielding revenue. Partial or complete reuse, however, cannot be considered here as the market for old turbines and spare parts always changes and any sales return is a matter of negotiation.

The deconstruction is completed with the deconstruction of the foundation, of all ancillary buildings, the cabling to the supply grid, and the access roads.

2. Factors affecting the costs of WT deconstruction

2.1 Site-specific factors

The costs for the deconstruction of wind turbines depend on the site-specific conditions, such as landscape, costs for access roads and crane costs. Therefore, the figures calculated here for access roads can only represent guide values for the actual costs in Germany. Another guide value are the originally incurred costs during the erection of the wind farm. These, however, are often not known to Nordex.

In interconnected wind farms there are additional costs, e.g., for a substation, separate met mast or buildings. On the other hand, fixed costs, such as planning and mobilization costs for the cranes, are allocated to the entire wind farm.

2.2 Regional factors

The disposal costs and sales returns depend on the individual disposal companies and the region. For a particular project, i.e., a specific location, the current regionally applicable costs and prices must in each case be obtained and applied afresh.

For the transport costs arising, a distance of max. 50 km has been applied.

2.3 Additional factors

The disposal costs and the sales returns for scrap metal and electronic scrap depend to a large extent on the economy. In addition, changed legal requirements might have an effect on disposal and its costs.

The costs for planning, documenting and monitoring the deconstruction may differ greatly and cannot be considered here. Legal concerns, e.g., lease agreements, can also not be considered. The economies of scale in the deconstruction of several wind turbines are also not considered.

3. Wind turbine data

The values refer to Nordex K08 generation delta wind turbines on a steel or hybrid tower and a standard shallow foundation. They should be considered only an example as all foundations are designed for the specific project.

Masses/volumes of the wind turbine components

WT type		N100		N117						
Performance class [kW]		3300		3000			3600			
Rotor masses										
Blade										
- GRP	[t]	Approx. 32		Approx. 31						
- Copper	[t]	0.9		0.9						
- Electrical components	[t]	Approx. 0.2		Approx. 0.2						
Hub										
- Steel	[t]	30.2		30.2						
- Electrical components	[t]	1.6		1.3						
- GRP (spinner)	[t]	0.5		0.5						
Nacelle masses										
- GRP	[t]	3.5								
- Steel	[t]	100.3*								
- Electrical components	[t]	12.5								
- Copper (from cables)	[t]	1.0								
Hub heights/ designation	[m]	75/ R75	100/ R100	91/ R91	120/ R120	141/ PH141	91/ TS91	106/ TS106	120/ TS120	141/ TCS141
Tower masses										
- Steel as per tower drawing	[t]	161	311	217	470	98.9	190.7	293	336.8	105.3
- Aluminum	[t]	0.4	0.5	0.4	0.5	0.9	0.4	0.5	0.5	0.9
- Volumes of concrete	[m³]					413				427
- Mass of reinforcement	[t]					40				70.0
- Mass of tendons	[t]					41				28.0
Foundation										
- Volumes of concrete	[m³]	519	630/ 806[3)]	515/ 623[3)]	616/ 726[3)]	611	500/ 650[3)]	476/ 535[3)]	554/ 672[3)]	554/ 633[4)]
- Mass of reinforcement (incl. anchor cage)	[t]	67	94/ 111[3)]	70/76[3)]	101/ 114[3)]	95	70/75[3)]	74/84[3)]	71/82[3)]	80/82[4)]
Cabling[1)]	[t]	2.7	3.2	2.7	3.2	4.2	2.7	3.2	3.2	4.2
Electrical components (transformer, MV switchgear, switch cabinet in the tower base etc.)	[t]	Approx. 13.5 external transformer substation: approx. 13								
Hazardous waste (oils, greases, transformer oil, coolant, etc.)[2)]	[t]	Approx. 2.8 Approx. 2.8								

WT type		**N131**			
Performance class [kW]		3000		3000 / 3300	3300
Rotor masses Blade - GRP and CRP - Copper* - Electrical components Hub - Steel - Electrical components - GRP (spinner)	[t]	 Approx. 42 0.9 Approx. 0.2 39.5 1.3 0.5			
Nacelle masses - GRP - Steel - Electrical components - Copper (from cables)	[t]	 3.5 106.2** 12.5 1.0			
Hub height/designation	[m]	99 / R99	114 / R114	134 / PH134	164 / PH164
Tower masses - Steel as per tower drawing - Aluminum - Volumes of concrete - Mass of reinforcement - Mass of tendons	 [t] [t] [m³] [t] [t]	 221.5 0.4	 291.9 0.5	 84.6 0.9 393 35 34	 106.1 0.9 518 47 53
Foundation - Volumes of concrete	[m³]	500-650[3)]	660-760[3)]	611	611 / 702[4)]
- Mass of reinforcement (incl. anchor cage)	[t]	70-78	78-86	72	72/99.1[3)]
Cabling[1)]	[t]	2.7	3.2	4.2	4.2
Electrical components (transformer, MV switchgear, switch cabinet in the tower base etc.)	[t]	Approx. 13.5 external transformer substation: 13			
Hazardous waste (oils, greases, transformer oil, coolant, etc.)[2)]	[kg]	Approx. 2800 (greases: 120; coolant: 200; oils: 750; transformer oil: 1300)			

WT type		N131						
Performance class [kW]		3600/3900	3600		3600 / 3900			
Rotor masses Blade - GRP and CRP - Copper* - Electrical components Hub - Steel - Electrical components - GRP (spinner)	t	 Approx. 42 0.9 Approx. 0.2 39.5 1.3 0.5						
Nacelle masses - GRP - Steel - Electrical components - Copper (from cables)	t	3.5 106.2** 12.5 1.0						
Hub height/designation	m	84 / TS84	106 / TS106	112 / TS112	114 / TS114	120 / TS120	134 / TS134	134/ TCS134
Tower masses - Steel as per tower drawing - Aluminum - Volumes of concrete - Mass of reinforcement - Mass of tendons	t t m³ t t	174.4 incl. damper 0.4 - - -	293.0 incl. damper 0.4 - - -	360.3 0.5 - - -	303.4*** 0.5 - - -	336.8 0.5 - - -	423.0 0.9 - - -	90.4 0.9 427 70.0 28.0
Foundation - Volumes of concrete - Mass of reinforcement (incl. anchor cage)	m³ t	380/450[3)] 60 / 70	476/535[3)] 79-89	Approx. 778[5)] 86.7-100.7[5)]	553/608[3)] 82-92[3)]	553/608[3)] 82-92[3)]	542/664[4)] 86-104[6)]	554/633[4)] 82-82[4)]
Cabling[1)]	t	2.7	2.7	3.2	3.2	3.2	4.2	4.2
Electrical components (transformer, MV switchgear, switch cabinet in the tower base etc.)	t	Approx. 13.5 external transformer substation: 13						
Hazardous waste (oils, greases, transformer oil, coolant, etc.)[2)]	kg	Approx. 2800 (greases: 120; coolant: 200; oils: 750; transformer oil: 1300)						

1) Transformer in the tower means approx. 0.1 t less cable; HCV means approx. 0.1 t more

2) Transformer oil for external transformer substations; synthetic esters possible for internal transformers

3) Values depend on variant with or without buoyancy

4) Small or large foundation, selection depends on location

5) Values for exemplary foundation, foundation is not designed by Nordex

6) Project-specific selection (foundation size, certification specifications)

*) Only for variant with anti-icing

**) Additional 1.1 t of steel if a rolling mass damper is installed

***) Additional 5 t of steel if a damper is installed

Further explanations on the tables:

- GRP = glass-fiber reinforced plastics, material of the rotor blade and the nacelle enclosure
- CRP = carbon-fiber reinforced plastics, additional rotor blade material
- The quantities of plastics other than GRP are negligible
- Additional options are not taken into account
- The tower is a hybrid tower with approx. 80 m/100 m concrete tower and approx. 51 m/61 m tubular steel tower. No anchor cage is required in the foundation

4. Applied costs and returns

The most important cost factors are: rotor (with rotor hub), nacelle, tower (incl. cabling), switchgear, transformer with substation and the crane hard standing areas as well as the crane, transport and personnel costs. All disassembly costs are considered in chapter 4.9. The transport costs are considered in the respective prices/returns.

Only the materials steel, aluminum, copper and GRP are listed separately. The quantities of other materials are negligible. Electronic scrap and hazardous waste must be disposed of separately by law. Returns from cast iron are a little higher than those from steel. All prices stated in this document are net prices rounded to whole numbers. Since raw material costs may fluctuate greatly, the actual daily prices may differ significantly.

- Returns of steel: approx. € 260.00 per t
- Returns of copper with insulation: approx. €1,600.00 per t
- Returns of aluminum: approx. €900.00 per t
- Returns of electronic scrap: approx. €100.00 per t
- Costs for hazardous waste: approx. €360.00 per t*
- Costs for GRP material, crushing and disposal: approx. €268.00 per t*
- Costs for foundation break-up, transport, disposal and backfilling: from €50.00 per m^3*
- Costs for earth work, crane hard standing areas and access roads: from €15.00 per m^2
- Crane costs: €8,000.00 per day
  + one-time amount of €25,000.00 to €80,000.00
- Personnel costs: €4,000.00 per day

* Depends greatly on the region

The individual items are further explained in the following chapters.

4.1 Rotor and rotor hub

The rotor must be dismantled with the aid of a crane. The rotor blades are crushed on site, picked up and passed to thermal or material recycling. Metal parts, such as lightning protection, are neglected here. Already the crushing of waste places high demands due to the size of the rotor blades and for reasons of dust protection and may account for approx. 30 % of the costs.

4.2 Nacelle

The nacelle must be disassembled using a crane. The nacelle can be disassembled into the individual parts drive train (rotor shaft and gearbox), generator and the support frame construction, then transported away and recycled.

4.3 Tower

The tubular steel tower of the wind turbine must be disassembled using a crane. The aluminum installations and copper cables are removed. The tower is disassembled on site and transported away. A concrete tower is blown up. The concrete is broken up, the reinforcement scrapped.

4.4 Electronic scrap

The electrical components present in the wind turbine and in the compact transformer substation must be disposed of separately as they are subject to the regulations on electronic waste. This affects particularly switch cabinets, transformer and medium-voltage switchgear. The electronic scrap is sorted and recycled by specialist companies. Depending on the degree of sorting, the recycling company and the raw material prices, the returns or costs may differ greatly.

4.5 Foundation

The foundation in accordance with DIBt (Deutsches Institut für Bautechnik - German Institute of Construction Technology) is a round shallow foundation with steel reinforcement. The foundation must be broken up partially or completely in accordance with the specifications of the building permits or other regulations. Blowing up the foundation might be the most effective method. The concrete must be disposed of and the reinforcement scrapped. Depending on authority directives or the technology used it may be cheaper to break up and dispose of the entire foundation; this case was applied here.

4.6 Transformer substation/substation

The substation (1 per wind farm) and the transformer (1 per WT) must be disassembled and transported away. This results in transport and disposal costs and sale returns. There is no foundation.

4.7 Cabling/underground cable

During wind turbine disassembly a significant amount of copper and aluminum cables is recovered. These run from the generator through the tower via the switch cabinet to the transformer. The "transformer inside tower" version requires a lot less cabling than a transformer in a separate transformer substation. Here, the separate transformer substation is considered.

The cabling between the wind turbines within the wind farm is not considered here, because the number of wind turbines and distances differ between projects.

4.8 Crane hard standing areas and access roads

In accordance with the Nordex sales documentation crane hard standing areas and access roads are necessary for the wind turbine and exist since its erection. These areas must be deconstructed again after completion of the deconstruction work (excavation and backfill with soil). A minimized crane hard standing area is assumed.

The access roads between the wind turbines within the wind farm are not considered here, because the number of wind turbines and distances differ between projects.

4.9 Cranes and disassembly costs

An 800 t crane and a 120 t auxiliary crane are required for deconstruction work. So-called one-off mobilization costs of €25,000.00 to €80,000.00 arise for the crane delivery. The large margin can be explained by the unpredictable local conditions. Additional crane costs arise for each working day – in wind farms also for the additional logistics requirements for the cranes.

4 days were estimated for the dismantling of the wind turbine and transport of the turbine components.

The figures given here as an example assume a 100 m tower. The crane costs depend greatly on tower height and maximum required hook load (degree of disassembly of the WT).

4.10 Hazardous waste

The hazardous waste materials arising from a wind turbine must be collected separately and recycled or disposed of by special companies. This includes batteries, coolants and lubricants. A list of used coolants and lubricants including quantities will be provided by Nordex.

Batteries are present in the rotor hub, switch cabinet in the tower base and – where applicable – in switch cabinets for obstacle lights and any other installed options.

Sales document

Measures at the end of service life

For all wind turbines Nordex K08
Generation delta

K0801_042966_EN

Revision 08 / 2017-02-28

- Translation of the original instructions -

Document is published in electronic form.

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List of materials for a Nordex K08 delta wind turbine

After decommissioning the wind turbine, a complete deconstruction is required. The following table shows the main components and materials that have to be disassembled, including their masses.

WT type		N100		N117						
Performance class [kW]		3300		3000			3600			
Rotor masses Blade - GRP - Copper - Electrical components Hub - Steel - Electrical components - GRP (spinner)	[t]	Approx. 32 0.9 Approx. 0.2 30.2 1.6 0.5		Approx. 31 0.9 Approx. 0.2 30.2 1.3 0.5						
Nacelle masses - GRP - Steel - Electrical components - Copper (from cables)	[t]	3.5 100.3* 12.5 1.0								
Hub heights/ designation	[m]	75/ R75	100/ R100	91/ R91	120/ R120	141/ PH141	91/ TS91	106/ TS106	120/ TS120	141/ TCS141
Tower masses - Steel as per tower drawing - Aluminum - Volumes of concrete - Mass of reinforcement - Mass of tendons	[t] [t] [m³] [t] [t]	161 0.4	311 0.5	217 0.4	470 0.5	98.9 0.9 413 40 41	190.7 0.4	293 0.5	336.8 0.5	105.3 0.9 427 70.0 28.0
Foundation - Volumes of concrete	[m³]	519	630-806[3]	515-623[3]	616-726[3]	611	500-650[3]	600-760[3]	554-672[3]	554-633[4]
- Mass of reinforcement (incl. anchor cage)	[t]	67	94-111[3]	70-76[3]	101-114[3]	95	70-75[3]	89-103[3]	71-82[3]	80-82[4]
Cabling[1]	[t]	2.7	3.2	2.7	3.2	4.2	2.7	3.2	3.2	4.2
Electrical components (transformer, MV switchgear, switch cabinet in the tower base etc.)	[t]	Approx. 13.5 external transformer substation: approx. 13								
Hazardous waste (oils, greases, transformer oil, coolant, etc.)[2]	[t]	Approx. 2.8 Approx. 2.8								

WT type		N131			
Performance class [kW]		3000		3000/3300	3300
Rotor masses Blade - GRP and CRP - Copper - Electrical components Hub - Steel - Electrical components - GRP (spinner)	[t]	Approx. 42 0.9 Approx. 0.2 39.5 1.3 0.5			
Nacelle masses - GRP - Steel - Electrical components - Copper (from cables)	[t]	3.5 106.2* 12.5 1.0			
Hub height/designation	[m]	99 / R99	114 / R114	134 / PH134	164 / PH164
Tower masses - Steel as per tower drawing - Aluminum - Volumes of concrete - Mass of reinforcement - Mass of tendons	 [t] [t] [m³] [t] [t]	 221.5 0.4	 291.9 0.5	 84.6 0.9 393 35 34	 106.1 0.9 518 47 53
Foundation - Volumes of concrete - Mass of reinforcement (incl. anchor cage)	[m³] [t]	500-650 3) 70-78	660-760 3) 78-86	611 72	611 / 702 4) 72/99.1 3)
Cabling 1)	[t]	2.7	3.2	4.2	4.2
Electrical components (transformer, MV switchgear, switch cabinet in the tower base etc.)	[t]	Approx. 13.5 external transformer substation: 13			
Hazardous waste (oils, greases, transformer oil, coolant, etc.) 2)	[kg]	Approx. 2800 (greases: 120; coolant: 200; oils: 750; transformer oil: 1300)			

WT type		N131			
Performance class [kW]		3600			
		3900	-		3900
Rotor masses Blade - GRP and CRP - Copper - Electrical components Hub - Steel - Electrical components - GRP (spinner)	[t]	 Approx. 42 0.9 Approx. 0.2 39.5 1.3 0.5			
Nacelle masses - GRP - Steel - Electrical components - Copper (from cables)	[t]	3.5 106.2* 12.5 1.0			
Hub height/designation	[m]	84 / TS84	106 / TS106	112 / TS112	120 / TS120
Tower masses - Steel as per tower drawing - Aluminum	 [t] [t]	 174.4 0.4	 293.0 0.4	 360.3 0.5	 336.8 0.5
Foundation - Volumes of concrete - Mass of reinforcement (incl. anchor cage)	 [m³] [t]	 380-450[3)] 60-70	 650-760[3)] 79-89	 Approx. 778[5)] 86.7-100.7[5)]	 550-610[3)] 82-92[3)]
Cabling[1)]	[t]	2.7	2.7	3.2	3.2
Electrical components (transformer, MV switchgear, switch cabinet in the tower base etc.)	[t]	Approx. 13.5 external transformer substation: 13			
Hazardous waste (oils, greases, transformer oil, coolant, etc.)[2)]	[kg]	Approx. 2800 (greases: 120; coolant: 200; oils: 750; transformer oil: 1300)			

1) Transformer in the tower means approx. 0.1 t less cable; HCV means approx. 0.1 t more

2) Transformer oil only with external transformer substation

3) Values depend on variant with or without buoyancy

4) Small or large foundation (21.5 m or 23.0 m diameter), selection depends on location

5) Values for exemplary foundation, foundation is not designed by Nordex

*) Additional 1.1 t of steel if a rolling mass damper is installed

- GRP = glass-fiber reinforced plastics, material of the rotor blade and the nacelle and hub housing
- CRP = carbon-fiber reinforced plastics, additional rotor blade material
- The quantities of plastics other than GRP are negligible
- Additional options are not taken into account
- Hybrid tower with approx. 80 m/100 m concrete tower and approx. 51 m/61 m tubular steel tower.

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Fossoul, F (Frédérique)

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Envoyé:	mercredi 5 juin 2019 10:04
À:	Fossoul, F (Frédérique); Dôme, F (Fabrice)
Cc:	Wieczerzak, Laurent
Objet:	RE: contact Nordex - WP Perwez repowering
Pièces jointes:	01_2017-10-20 44 220 16117724-TC-IEC-b Rev.1 NORDEX N131-3300_3600 IEC S.pdf; 09_K0801_041837_EN_4_CC01_EN_Lubricants,-coolants,-transformer-oil-and-meas....pdf; 11_K0801_074779_EN_14_CC01_EN_Technical-description.pdf; 13_K0801_077241_EN_9_CC01_EN_Transport,-access-roads-and-crane-requirements.pdf; 15_K0815_051312_EN_2_CC01_EN_Shadow-flicker-module.pdf; 16_E0004283686_0_CC01_EN_Ice-detection-in-Nordex-wind-turbines.pdf; 17_K0801_055240_EN_R01_Rotor-blade-ice-detection.pdf; 18_K0815_051346_EN_01_Ice-sensor.pdf; K0801_041841_EN_10_CC01_EN_Deconstruction-effort-for-wind-turbines.pdf; K0801_042966_EN_8_CC01_EN_Measures-at-the-end-of-service-life.pdf; 02_20190412_Reference_List_N131.pdf; 04_E.3.5.07_E0004883169_0_DD01_DE_STE.pdf; 06_E0003806750_1_CC01_EN_Lightning-detection-system-in-the-tower-base.pdf; 19_K0818_078271_EN_9_CC01_EN_Noise-level,-Power-curves,-Thrust-curves-Nordex-N131_3600-IEC-S.pdf

Classification: Internal Purpose

Dear Frederique,

Thank you for your e-mail. One question, which hub height are you looking for?

Attached are several documents, which do also provide you the technical information you are looking for.

Interesting is that the latest noise measurement shows a much low noise level than part of our warranty document.

The net costs for dismantling is about 175 kEuro.

Hope this information is of help. You can use all documents for the permit if needed except, noise measurement report.

Met vriendelijke groet / Kind regards

Erik de Graaf
Senior Sales Manager Benelux

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From: Fossoul, F (Frédérique) [mailto:Frederique.Fossoul@eneco.com]
Sent: Monday, June 03, 2019 4:11 PM
To: Aalto, Jukka <JAalto@nordex-online.com>; Dôme, F (Fabrice) <Fabrice.Dome@eneco.com>
Cc: Graaf, Erik de <EGraaf@nordex-online.com>
Subject: RE: contact Nordex

Dear Jukka,
Dear Erik ,

We will now applicate for the repowering permit in Perwez very soon.

The following technical info are still missing for the N131/3600 :

- The mass composition of the WT (or life cycle assessment)
- Estimated dismantling costs (WT, foundations, cables, gravel, waste etc)
- Technical features for shadow module and ice detection systems

The permit will be printed in 2 weeks'time and data above are mandatory.

Thanks a lot for your feedback.

Best regards,

Frédérique

Frédérique Fossoul
Senior Project Developer

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A titre informatif étant donné que la M122 est désormais disponible en 3.4 MW, mais cette fiche donne une bonne idée des coûts de démantèlement pour ce type de machine

SENVION wind energy solutions

	MM92	MM100	3,0M122	3,2M114	3,4M104
Estimation des coûts de démantellement					
Tip height 130m	**50 600 €**	**51 300 €**	**N/A**	**N/A**	**95 400 €**
Tip height 150m	**54 800 €**	**55 500 €**	**79 000 €**	**78 430 €**	**105 100 €**
Tip height 180m	**N/A**	**N/A**	**97 000 €**	**96 400 €**	**166 300 €**
Tip height 200m	**N/A**	**N/A**	**123 000 €**	**122 090 €**	**N/A**
Détails des principaux matériaux composant l'éolienne					
Rotor					
fibre de verre (en tonnes)	18	19,5	38	37	36
acier (en tonnes)	0,35	0,35	0,35	0,35	0,35
Nacelle					
fibre de verre (en tonnes)	3,4	3,4	4,7	4,7	4,7
acier (en tonnes)	52	52	114	114	114
cuivre (en tonnes)	3,5	3,5	3,5	3,5	3,5
Tour acier (tip height 150m)					
aluminium (en tonnes)	7	7	6	6	6
acier (en tonnes)	250	250	187	194	200
cuivre (en tonnes)	3,7	3,7	3	4	5
Tour hybride					
béton (en m^3)	N/A	N/A	274	274	274
matériau de renforcement (en tonnes)	N/A	N/A	30	30	30
acier (en tonnes)	N/A	N/A	25	25	25
Equipements					
transformateur interne (en tonnes)	12	12	10	10	10
composant électroniques (en tonnes)	3,2	3,2	5	5	5
TOTAL MACHINE SEULE TIP HEIGHT 150m	**353**	**355**	**372**	**379**	**385**
TOTAL MACHINE SEULE TIP HEIGHT 180m-200m	**N/A**	**N/A**	**701**	**708**	**714**
Pourcentage massique des principaux matériaux composant l'éolienne avec tour acier					
fibre de verre (en %)	**6,1%**	**6,5%**	**11,5%**	**11,0%**	**10,6%**
acier (en %)	**85,6%**	**85,3%**	**81,1%**	**81,5%**	**81,7%**
cuivre (en %)	**2,0%**	**2,0%**	**1,7%**	**2,0%**	**2,2%**
aluminium (en %)	**2,0%**	**2,0%**	**1,6%**	**1,6%**	**1,6%**
composant électroniques (en %)	**4,3%**	**4,3%**	**4,0%**	**4,0%**	**3,9%**
Pourcentage massique des principaux matériaux composant l'éolienne avec tour hybride					
fibre de verre (en %)	**N/A**	**N/A**	**6,1%**	**5,9%**	**5,7%**
béton (en %)	**N/A**	**N/A**	**39,1%**	**38,7%**	**38,4%**
acier (en %)	**N/A**	**N/A**	**50,9%**	**51,4%**	**51,8%**
cuivre (en %)	**N/A**	**N/A**	**0,9%**	**1,1%**	**1,2%**
aluminium (en %)			**0,9%**	**0,8%**	**0,8%**
Composant électroniques (en %)	**N/A**	**N/A**	**2,1%**	**2,1%**	**2,1%**
Détails des principaux matériaux composant le reste de la ferme éolienne (par éolienne sauf poste de livraison)					
Fondation tip height 130m					
Béton (en m^3)	200	220	N/A	N/A	230
acier (en tonnes)	24	24	N/A	N/A	24
Fondation tip height 150m					
Béton (en m^3)	340	350	400	380	370
acier (en tonnes)	34	35	40	38	37
Fondation tip height 180m					
Béton (en m3)	N/A	N/A	600	600	600
acier (en tonnes)	N/A	N/A	60	60	60
Fondation tip height 200m					
Béton (en m^3)	N/A	N/A	800	800	N/A
acier (en tonnes)	N/A	N/A	80	80	N/A
Poste de livraison (cabine de tête)					
Béton (en tonnes)	7	7	7	7	7
Plateforme et chemins d'accès					
Gravier (en m3)	562	562	562	562	562

Fossoul, F (Frédérique)

De:	Tasse, Aurelien <aurelien.tasse@senvion.com>
Envoyé:	jeudi 2 mai 2019 10:34
À:	Fossoul, F (Frédérique)
Cc:	Dôme, F (Fabrice)
Objet:	RE: Demande fiches techniques pour demande de permis

Bonjour Frédérique,

Je n'ai pas ce document pour ces 2 machines, mais j'en ai refait le tableau sur la base des informations dont je dispose.
Cela donne les valeurs suivantes :

Détails des principaux matériaux composant l'éolienne	3.4M122 119m	4.2M140 110m
Rotor		
fibre de verre (tonnes)	38,0	62,4
acier (tonnes)	0,4	5,0
Nacelle		
fibre de verre (tonnes)	4,7	4,7
acier (tonnes)	114,0	114,0
cuivre (tonnes)	3,5	3,5
Tour acier		
aluminium (tonnes)	6,0	6,0
acier (tonnes)	341,0	392,0
cuivre (tonnes)	5,2	5,2
TOTAL MACHINE SEULE	512,8	592,8
Pourcentage massique des principaux éléments		
fibre de verre (%)	8%	11%
acier (%)	89%	86%
aluminium (%)	1%	1%
cuivre (%)	2%	1%

J'espère que cela pourra t'être utile.
Bien cordialement,

Aurélien Tasse
Head of Engineering South Europe

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De : Fossoul, F (Frédérique) <Frederique.Fossoul@eneco.com>
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Cc : Dôme, F (Fabrice) <Fabrice.Dome@eneco.com>
Objet : RE: Demande fiches techniques pour demande de permis

Bonjour Aurélien,

Parfait, merci pour les détails et la réponse rapide.

Je me permets aussi de te relancer sur la question des coûts de démantèlement et de la composition de ces 2 machines.
Nous en aurons en effet besoin pour le dépôt du permis au début du mois de mai.
Il y a quelques années, vous m'aviez envoyé cette fiche (en PJ), qui contient toutes les infos nécessaires (inutile d'avoir plus).
Un document équivalent est-il disponible pour la 4.2M140 et la 3.4M122 ,

Merci d'avance et très bonne journée,

Bien à toi,

Frédérique

Frédérique Fossoul
Senior Project Developer

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Objet : RE: Demande fiches techniques pour demande de permis

Bonjour Frédérique,

Voici les vues générales de ces machines pour lesquelles j'ai ajouté les diamètres demandés.
En ce qui concerne les hauteurs, ces dernières dépendantes de la fondation qui est faite.

Pour la 4.2M140 110m, la hauteur de moyeu peut varier de 107 à 110m :