

Manufacturing

Bill of materials for the V90-3.0MW

Component	Sub-component	Materials	Total mass (t)	[kg CO2-eq/t]	[MJ/kg]
Tower		Steel	108000	193320	2219400
Rotor	Blade (x3)	Fibre glass	11880	34570,8	607186,8
		Epoxy	7920	52747,2	936936
	Hub	Cast iron	7600	11149,2	65116,8
		Aluminium	400	3356	50324
Nacelle	Generator	Aluminium	3010	25253,9	378688,1
		Steel	5160	9236,4	106038
	Frame, machinery and	Copper	2184	5831,28	92601,6
		Steel	30940	55382,6	635817
		Aluminium	3276	27485,64	412153,56
	Gearbox	Copper	230	614,1	9752
		Steel	22540	40346,6	463197
Aluminium		230	1929,7	28936,3	
Foundation	Concrete	261900	31428	209520	
	Steel	8100	14499	166455	

Material	[kg CO2-eq/kg]	[MJ/kg]
Steel	1,8	20,6
Concrete	0,1	0,8
Glass fibre	2,9	51,1
Epoxy	6,3	118,3
Copper	2,7	42,4
Aluminium	8,4	47,0
Cast iron	1,5	8,6

Transportation and installation

Component	Location	Port	Truck (km)	Ship (km)
Nacelle	Ringkøbing, Denmark	Esbjerg, Denmark	80	615
Hub	Ringkøbing, Denmark	Esbjerg, Denmark	80	615
Blades	Lem, Denmark	Esbjerg, Denmark	70	615
Generator	Travemünde, Germany	Hamburg, Germany	95	1385
Tower	Travemünde, Germany	Hamburg, Germany	95	670
Foundation	Søborg	Copenhagen, Germany	45	1170
Gearbox	Travemünde, Germany	Hamburg, Germany	95	670

Transport of wind plant components from manufacturer to Felixstowe port

Component	Port	Truck (tkm)	Ship (tkm)	Energy [MJ]	Emissions [kg]
Nacelle	Esbjerg, Denmark	87360	671580	143122	12565
Hub	Esbjerg, Denmark	19200	147600	6913	2762

Blades	Esbjerg, Denmark	41580	365310	37055	6003
Generator	Hamburg, Germany	24510	357330	21365	3610
Tower	Hamburg, Germany	307800	2170800	1629992	44174
Foundation	Copenhagen, Denmark	364500	9477000	8426855	55778
Gearbox	Hamburg, Germany	462300	462300	521369	64942

Ecoinvent 3.0

Kolonne1	Energy [MJ/tkm]	Emissions [kg CO2/tkm]
Container shi	0,00027539	0,00050202
Lorry	0,00885837	0,13997369
	Energy [MJ/L]	Energy [kg CO2/MJ]
HFO	38,3	0,095
MGO	34,5	0,092

Lorry:

Products								
Outputs to technosphere: Products and co-products	Amount	Unit	Quantity	Allocation	Category	Comment		
Transport, freight, lorry 16-32 metric ton, euro3 (RER) market for transport	1	tkm	Transport	100 %	Road\Market			
Outputs to technosphere: Avoided products	Amount	Unit	Distribution	SD2 or 2SD	Min	Max	Comment	
Inputs								
Inputs from nature	Sub-compartment	Amount	Unit	Distribution	SD2 or 2SD	Min	Max	Comment
Potassium chloride	in ground	1,5362192E-6	kg	Undefined				
Carbon dioxide, in air	in air	7,8356103E-4	kg	Undefined				
Energy, gross calorific value, in biomass	biotic	8,8583706E-3	MJ	Undefined				
Occupation, construction site	land	1,0482086E-5	m2a	Undefined				
Occupation, dump site	land	1,6384308E-4	m2a	Undefined				
Occupation, forest, intensive	land	1,0386608E-3	m2a	Undefined				
Occupation, industrial area	land	1,8510313E-4	m2a	Undefined				
Occupation, mineral extraction site	land	1,1827504E-4	m2a	Undefined				
Occupation, shrub land, sclerophyllous	land	2,8905228E-5	m2a	Undefined				
Occupation, traffic area, rail network	land	1,1965152E-5	m2a	Undefined				
Occupation, traffic area, road network	land	7,0176586E-3	m2a	Undefined				
Occupation, urban, discontinuously built	land	2,3583654E-8	m2a	Undefined				
Occupation, water bodies, artificial	land	1,3916529E-4	m2a	Undefined				
Transformation, from dump site, inert material land	land	5,6613590E-6	m2	Undefined				
Transformation, from dump site, residual material li	land	1,0576358E-7	m2	Undefined				
Transformation, from dump site, sanitary landfill	land	8,3515790E-9	m2	Undefined				
Transformation, from dump site, slag compartment	land	5,4017826E-9	m2	Undefined				

Container ship:

Outputs to technosphere: Products and co-products	Amount	Unit	Quantity	Allocation %	Category	
Transport, freight, sea, container ship (GLO) transport, freight, sea, container ship Cut-off, 5	1	tkm	Transport	100 %	Water\Transformation	
Outputs to technosphere: Avoided products	Amount	Unit	Distribution	SD2 or 2SD	Min	Max
Inputs						
Inputs from nature	Sub-compartment	Amount	Unit	Distribution	SD2 or 2SD	Min
Potassium chloride	in ground	7,8040337E-8	kg	Undefined		
Carbon dioxide, in air	in air	2,2594853E-5	kg	Undefined		
Energy, gross calorific value, in biomass	biotic	2,7538688E-4	MJ	Undefined		
Occupation, construction site	land	2,5092348E-7	m2a	Undefined		
Occupation, dump site	land	4,3057012E-6	m2a	Undefined		
Carbon dioxide, biogenic			1,9886240E-6	kg	Undefined	
Carbon dioxide, biogenic	low. pop.		1,8225852E-6	kg	Undefined	
Carbon dioxide, biogenic	high. pop.		1,8440080E-5	kg	Undefined	
Carbon dioxide, fossil			5,0202076E-4	kg	Undefined	
Carbon dioxide, fossil	low. pop.		8,4681977E-3	kg	Undefined	
Carbon dioxide, fossil	low. pop., long-term		5,1325539E-8	kg	Undefined	
Carbon dioxide, fossil	high. pop.		1,1992025E-4	kg	Undefined	
Carbon dioxide, fossil	stratosphere + troposphere		1,3816314E-9	kg	Undefined	
Carbon disulfide			4,7703808E-18	kg	Undefined	

Number of vessels and workdays and the usage of fuels in the installation stage

Activity	No. of vessi	Fuel type	Fuel rat	Work hou	Liter fuel	Energy [MJ]
Foundation						
Vessel for transport o	1	HFO	360	120	43200	1654560
Vessel for transport o	1	HFO	210	120	25200	965160
Jack-up vessel for trar	1	HFO	87	120	10440	399852
Tugboats for transpor	2	MGO	320	240	76800	2649600
Wind turbine						
Crane vessel for instal	1	HFO	160	720	115200	4412160
Tugboats for transpor	2	MGO	320	1440	921600	31795200

Operation and maintenance

Number of vessels and workdays and the usage of fuels in the OM stage

Activity	Number of	Fuel type	Fuel rat	Work hou	Liters fuel	Energy [MJ]
Support vessel for ma	1	MGO	99	11300	1118700	38595150
Crane vessel for repla	1	HFO	160	416	66560	2549248
Replacement gearbox						7256385
Replacement of generator						3712620

End of life

Activity	Number of	Fuel type	Fuel rat	Work hou	Liters fuel	Energy [MJ]
Crane vessel for instal	1	HFO	160	720	115200	4412160
Tugboats for transpor	2	MGO	320	1440	921600	31795200

Kolonne1	Energy [MJ], Emissions	
Steel	7,50	0,8400
Copper	10,60	0,8800
Aluminium	44,60	3,5400
Landfill	0,04	0,0009

Material	Mass (kg)	Energy [M	Emissio
Steel	5227200	36067680	4E+06
Aluminium	207480	8513319	675721
Copper	72420	706239,8	58631

Landfill	Energy [MJ] Emissions	
Steel	16727,04	376,3584
Aluminium	663,936	14,93856
Copper	231,744	5,21424

Material	Treatment	Kolonne1
Steel	92% recycled + 8% landfilled	
Aluminium	92% recycled + 8% landfilled	
Copper	92% recycled + 8% landfilled	

Emissions [k

157845,024

92076,264

38145,8808

242888,832

420920,064

2914665,98

Emissions [k

3538017,4

243198,259

517354,5

643356,0

Emissions [k

420920,064

2914665,98

