SUMMARY OF VATTENFALL AB GENERATION NORDIC CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION, EPD® OF ELECTRICITY AND HEAT FROM THE DANISH COAL-FUELLED COMBINED HEAT AND POWER PLANTS

EPD®

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PRODUCER

Vattenfall AB, Generation Nordic is responsible for the electricity and heat generation in the five Danish combined heat and power (CHP) units. All facilities are 100 % owned by Vattenfall AB, SE-162 87 Stockholm, Sweden, telephone + 46 8 739 50 00. All units have an environmental management system certified according to ISO 14001 and work environmental certificate according to OHSAS 1800.

PRODUCT AND DECLARED UNIT

Electricity and Heat belongs to the product category UNCPC Code 17, Group 171 – Electrical energy and Group 172 - Steam and hot/cold water.

Power Plant Unit	Short name	Max MW el	Max MW heat	Average yearly production (net) TWh el 2003-2007	Average yearly production (net) TWh heat 2003-2007
Amager 3	AMV3	250	331	1,5	1,1
Fyn 3	FYV3	255	354	0,33	0,43
Fyn 7	FYV7	388	450	1,6	1,8
Nordjylland 2	NJV2	275	42	0,52	0,0041
Nordjylland 3	NJV3	376	420	2,3	0,97
Total				**6,3**	**4,3**

The average total generation per year is 6,3 TWh of electricity (net) and 4,3 TWh of heat (net). All plants are tuned to the consumption of electricity and heat, running at full output in the cold season and at reduced output during summer. The declared unit is:

- 1 kWh electricity net generated and thereafter distributed to an industrial customer connected to the medium voltage network.
- 1 kWh heat net generated and thereafter distributed to a customer connected to the local district heating system.

THE EPD®SYSTEM

The EPD®system managed by the International EPD Consortium (IEC) is based on ISO 14025, Type III Environmental Declarations. The relevant governing documents in hierarchical order are: PCR-CPC17, General Programme Instructions for an international EPD®system for environmental product declaration, ISO 14025, ISO 14040, ISO 14044.

ENVIRONMENTAL PERFORMANCE – BASED ON LCA

See chapter 3 of the complete EPD® documentation.

System boundaries

The EPD® comprises the Core processes, i.e. generation of electricity and heat in the power units, Upstream processes, i.e. coal fuel production and production of auxiliary supplies, and Downstream processes, i.e. distribution of electricity and heat. Further, construction and dismantling of the power units, the facilities for local storage, for ash, and waste handling have been included. The use of electricity and heat at the consumer has been excluded. The assumed technical service lifetime varies dependent on power unit, between 27 and 44 years.

Environmental information

A short summary of compiled data is presented below per generated and distributed kWh electricity and heat. The results are presented for the following lifecycle modules:

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Upstream	Mining and transportation of coal to Ensted harbour and further to CHP units. Manufacturing and transport of inputs used in the opertaion of CHP units.
Core	Operation of CHP, transportation and deposition/incineration of operational waste, transportation of mineral products (ash etc).
Core - Infrastructure	Construction incl. necessary lifetime reinvestments and decommissioning of CHP.
Downstream	Specific emissions and transports during operation of the networks incl. the extra generation to compensate for losses in the networks.
Downstream - Infrastructure	Construction and decommissioning of the transmission grid and distribution networks.

Distribution of electricity and heat implies losses, which must be compensated by increased generation. The distribution losses to an average industrial customer connected to the Danish network amounts to 4,7 %. The losses are different for different types of customers and often higher in rural areas. The average loss to a district heating customer amounts to approximately 10 %.

ECOPROFILE - electricity	**Input**							
Resource	**Unit/ kWh**	**Upstream**	**Core**	**Core - infra-structure**	**Total - generated**	**Downstream[1]**	**Downstream - infra-structure**	**Total - distributed**
Copper in ore	g	$1{,}1 \cdot 10^{-3}$	$4{,}8 \cdot 10^{-3}$	$2{,}5 \cdot 10^{-3}$	**$8{,}4 \cdot 10^{-3}$**	$3{,}9 \cdot 10^{-4}$	$3{,}6 \cdot 10^{-3}$	**$1{,}2 \cdot 10^{-2}$**
Fossil energy resources	kWh	$2{,}2 \cdot 10^{-1}$	2,0	$2{,}4 \cdot 10^{-2}$	**2,3**	$1{,}1 \cdot 10^{-1}$	$6{,}9 \cdot 10^{-3}$	**2,4**
Gravel, stone and sand	g	$3{,}0 \cdot 10^{-1}$	$1{,}6 \cdot 10^{-5}$	2,5	**2,8**	$1{,}3 \cdot 10^{-1}$	$8{,}2 \cdot 10^{-2}$	**3,0**
Iron in ore	g	$4{,}4 \cdot 10^{-1}$	$4{,}4 \cdot 10^{-1}$	1,2	**2,0**	$9{,}6 \cdot 10^{-2}$	$8{,}9 \cdot 10^{-1}$	**3,0**
Limestone	g	4,5	2,3	$3{,}4 \cdot 10^{-1}$	**7,2**	$3{,}4 \cdot 10^{-1}$	$4{,}0 \cdot 10^{-1}$	**7,9**
Potential energy of water through hydro turbines	kWh			$9{,}0 \cdot 10^{-8}$	**$9{,}0 \cdot 10^{-8}$**	$4{,}2 \cdot 10^{-9}$		**$9{,}4 \cdot 10^{-8}$**
Renewable fuel	kWh			$1{,}1 \cdot 10^{-7}$	**$1{,}1 \cdot 10^{-7}$**	$5{,}2 \cdot 10^{-9}$	$4{,}3 \cdot 10^{-8}$	**$1{,}6 \cdot 10^{-7}$**
Soil	g	4,4		110	**120**	5,5		**120**
Electricity use in the power unit[2]	kWh		$7{,}3 \cdot 10^{-2}$		**$7{,}3 \cdot 10^{-2}$**	$3{,}4 \cdot 10^{-3}$		**$7{,}7 \cdot 10^{-2}$**
Water, different sources	g	11 213	40 947	192	**52 353**	2 461	24	**54 838**
Input of material from the technosphere (agglomeration of app. 40 substances)	g	$1{,}4 \cdot 10^{-3}$	$2{,}0 \cdot 10^{-4}$	$3{,}3 \cdot 10^{-5}$	**$1{,}7 \cdot 10^{-3}$**	$8{,}0 \cdot 10^{-5}$	$1{,}1 \cdot 10^{-3}$	**$2{,}9 \cdot 10^{-3}$**

ECOPROFILE - electricity	**Output**							
Pollutant emissions	**Unit/ kWh**	**Upstream**	**Core**	**Core - infra-structure**	**Total generated**	**Downstream[1]**	**Downstream - infra-structure**	**Total distributed**
Greenhouse gases	g CO_2 eq. (100 y)	49,0	724,6	7,2	**780,8**	36,9	1,6	**819,2**
Ozone-depletion potential	g R-11 eq. (20 y)	$7{,}6 \cdot 10^{-6}$	$7{,}2 \cdot 10^{-7}$	$2{,}9 \cdot 10^{-7}$	**$8{,}6 \cdot 10^{-6}$**	$4{,}2 \cdot 10^{-7}$	$4{,}8 \cdot 10^{-8}$	**$9{,}0 \cdot 10^{-6}$**
Acidifying potential	g SO_2 eq.	$7{,}7 \cdot 10^{-1}$	$7{,}4 \cdot 10^{-1}$	$1{,}6 \cdot 10^{-2}$	**1,5**	$7{,}2 \cdot 10^{-2}$	$5{,}7 \cdot 10^{-3}$	**1,6**
Photochem. ozone creation potential	g ethene eq.	$6{,}8 \cdot 10^{-2}$	$4{,}5 \cdot 10^{-2}$	$2{,}2 \cdot 10^{-3}$	**$1{,}2 \cdot 10^{-1}$**	$5{,}6 \cdot 10^{-3}$	$1{,}4 \cdot 10^{-3}$	**$1{,}2 \cdot 10^{-1}$**
Eutrophication potential	g phosphate eq.	$9{,}1 \cdot 10^{-2}$	$3{,}4 \cdot 10^{-1}$	$1{,}3 \cdot 10^{-3}$	**$4{,}3 \cdot 10^{-1}$**	$2{,}0 \cdot 10^{-2}$	$1{,}1 \cdot 10^{-3}$	**$4{,}5 \cdot 10^{-1}$**
Emissions of toxic and other substances to air, ground, and water								
Mercury to air	g	$5{,}41 \cdot 10^{-7}$	$1{,}00 \cdot 10^{-5}$	$1{,}29 \cdot 10^{-7}$	**$1{,}08 \cdot 10^{-5}$**	$5{,}05 \cdot 10^{-7}$	$8{,}87 \cdot 10^{-8}$	**1,13**
Particulate matter to air	g	$1{,}7 \cdot 10^{-1}$	$4{,}7 \cdot 10^{-2}$	$5{,}7 \cdot 10^{-3}$	**$2{,}2 \cdot 10^{-1}$**	$1{,}1 \cdot 10^{-2}$	$8{,}7 \cdot 10^{-3}$	**$2{,}4 \cdot 10^{-1}$**
Polyaromatic hydrocarbons to air and water	g	$6{,}9 \cdot 10^{-6}$	$8{,}2 \cdot 10^{-7}$	$2{,}6 \cdot 10^{-7}$	**$8{,}0 \cdot 10^{-6}$**	$3{,}9 \cdot 10^{-7}$	$2{,}1 \cdot 10^{-6}$	**$1{,}0 \cdot 10^{-5}$**
C-14 to air	kBq	$2{,}5 \cdot 10^{-4}$	$1{,}1 \cdot 10^{-4}$	$2{,}4 \cdot 10^{-6}$	**$3{,}6 \cdot 10^{-4}$**	$1{,}7 \cdot 10^{-5}$	$5{,}8 \cdot 10^{-6}$	**$3{,}8 \cdot 10^{-4}$**
Kr-85 to air	kBq	$2{,}1 \cdot 10^{-5}$	$3{,}3 \cdot 10^{-5}$	$9{,}6 \cdot 10^{-7}$	**$5{,}4 \cdot 10^{-5}$**	$2{,}6 \cdot 10^{-6}$	$1{,}7 \cdot 10^{-6}$	**$5{,}9 \cdot 10^{-5}$**
Rn-222 to air	kBq	4,8	1,9	$4{,}3 \cdot 10^{-2}$	**6,7**	$3{,}2 \cdot 10^{-1}$	$1{,}1 \cdot 10^{-1}$	**7,2**

[1] *Generation compensating for distribution losses is included in the Downstream column.*

[2] *This electricity is assumed to be generated by the CHP unit itself and environmental impact is accounted for since this electricity amount has been subtracted from the reference flow.*

ECOPROFILE – heat	Input							
Resource	**Unit/ kWh**	**Upstream**	**Core**	**Core - infra-structure**	**Total generated**	**Downstream[1]**	**Downstream - infra-structure**	**Total distributed**
Copper in ore	g	$5{,}1 \cdot 10^{-4}$	$3{,}3 \cdot 10^{-3}$	$1{,}3 \cdot 10^{-3}$	**$5{,}1 \cdot 10^{-3}$**	$6{,}0 \cdot 10^{-4}$	$7{,}9 \cdot 10^{-3}$	**$1{,}4 \cdot 10^{-2}$**
Fossil energy resources	kWh	$1{,}2 \cdot 10^{-1}$	$9{,}9 \cdot 10^{-1}$	$1{,}3 \cdot 10^{-2}$	**1,1**	$1{,}3 \cdot 10^{-1}$	$1{,}1 \cdot 10^{-2}$	**1,3**
Gravel, stone, and sand	g	$1{,}4 \cdot 10^{-1}$	$1{,}1 \cdot 10^{-5}$	1,3	**1,5**	$1{,}8 \cdot 10^{-1}$	20	**21**
Iron in ore	g	$2{,}2 \cdot 10^{-1}$	$3{,}0 \cdot 10^{-1}$	$6{,}1 \cdot 10^{-1}$	**1,1**	$1{,}3 \cdot 10^{-1}$	1,0	**2,3**
Limestone	g	2,4	1,6	$1{,}8 \cdot 10^{-1}$	**4,1**	$4{,}9 \cdot 10^{-1}$	1,1	**5,7**
Potential energy through hydro turbines	kWh			$4{,}8 \cdot 10^{-8}$	**$4{,}8 \cdot 10^{-8}$**	$5{,}7 \cdot 10^{-9}$	$3{,}4 \cdot 10^{-6}$	**$3{,}5 \cdot 10^{-6}$**
Renewable fuel	kWh			$5{,}9 \cdot 10^{-8}$	**$5{,}9 \cdot 10^{-8}$**	$7{,}0 \cdot 10^{-9}$	$1{,}3 \cdot 10^{-5}$	**$1{,}3 \cdot 10^{-5}$**
Soil	g	2,1		55	**57**	6,8	6,5	**71**
Electricity use in the power plant[2]	kWh		$3{,}5 \cdot 10^{-2}$		**$3{,}5 \cdot 10^{-2}$**	$4{,}1 \cdot 10^{-3}$		**$3{,}9 \cdot 10^{-2}$**
Water, different sources	g	5 325	34 446	102	**39 873**	4 737	44	**44 654**
Input of material from the technosphere (agglomeration of app. 40 substances)	g	$7{,}1 \cdot 10^{-4}$	$1{,}4 \cdot 10^{-4}$	$1{,}8 \cdot 10^{-5}$	**$8{,}6 \cdot 10^{-4}$**	$1{,}0 \cdot 10^{-4}$	$2{,}3 \cdot 10^{-1}$	**$2{,}3 \cdot 10^{-1}$**

ECOPROFILE – heat	Output							
Pollutant emissions	**Unit/ kWh**	**Upstream**	**Core**	**Core - infra-structure**	**Total generated**	**Downstream[1]**	**Downstream - infra-structure**	**Total distributed**
Greenhouse gases	g CO_2 eq. (100 y)	23	350	3,8	**370**	44	1,0	**420**
Ozone-depletion potential	g R-11- eq. (20 y)	$4{,}0 \cdot 10^{-6}$	$4{,}8 \cdot 10^{-7}$	$1{,}5 \cdot 10^{-7}$	**$4{,}7 \cdot 10^{-6}$**	$5{,}5 \cdot 10^{-7}$	$3{,}2 \cdot 10^{-8}$	**$5{,}2 \cdot 10^{-6}$**
Acidifying potential	g SO_2 eq.	$3{,}7 \cdot 10^{-1}$	$4{,}7 \cdot 10^{-1}$	$8{,}5 \cdot 10^{-3}$	**$8{,}5 \cdot 10^{-1}$**	$1{,}0 \cdot 10^{-1}$	$2{,}9 \cdot 10^{-3}$	**$9{,}5 \cdot 10^{-1}$**
Photochem. ozone creation potential	g ethene eq.	$3{,}3 \cdot 10^{-2}$	$2{,}9 \cdot 10^{-2}$	$1{,}2 \cdot 10^{-3}$	**$6{,}3 \cdot 10^{-2}$**	$7{,}4 \cdot 10^{-3}$	$5{,}7 \cdot 10^{-4}$	**$7{,}1 \cdot 10^{-2}$**
Eutrophication potential	g phosphate eq.	$4{,}3 \cdot 10^{-2}$	$2{,}2 \cdot 10^{-1}$	$6{,}8 \cdot 10^{-4}$	**$2{,}7 \cdot 10^{-1}$**	$3{,}2 \cdot 10^{-2}$	$4{,}7 \cdot 10^{-4}$	**$3{,}0 \cdot 10^{-1}$**
Emissions of toxic and other substances to air, ground, and water								
Mercury to air	g	$2{,}74 \cdot 10^{-7}$	$4{,}73 \cdot 10^{-6}$	$6{,}86 \cdot 10^{-8}$	**$5{,}08 \cdot 10^{-6}$**	$6{,}02 \cdot 10^{-7}$	$9{,}13 \cdot 10^{-8}$	**$5{,}77 \cdot 10^{-6}$**
Particulate matter to air	g	$8{,}1 \cdot 10^{-2}$	$3{,}0 \cdot 10^{-2}$	$3{,}0 \cdot 10^{-3}$	**$1{,}1 \cdot 10^{-1}$**	$1{,}4 \cdot 10^{-2}$	$3{,}9 \cdot 10^{-3}$	**$1{,}3 \cdot 10^{-1}$**
Polyaromatic hydrocarbons to air and water	g	$3{,}3 \cdot 10^{-6}$	$5{,}6 \cdot 10^{-7}$	$1{,}4 \cdot 10^{-7}$	**$4{,}0 \cdot 10^{-6}$**	$4{,}8 \cdot 10^{-7}$	$3{,}1 \cdot 10^{-7}$	**$4{,}8 \cdot 10^{-6}$**
C-14 to air	kBq	$1{,}2 \cdot 10^{-4}$	$7{,}6 \cdot 10^{-5}$	$1{,}3 \cdot 10^{-6}$	**$1{,}9 \cdot 10^{-4}$**	$2{,}3 \cdot 10^{-5}$	$8{,}4 \cdot 10^{-7}$	**$2{,}2 \cdot 10^{-4}$**
Kr-85 to air	kBq	$1{,}0 \cdot 10^{-5}$	$2{,}2 \cdot 10^{-5}$	$5{,}1 \cdot 10^{-7}$	**$3{,}3 \cdot 10^{-5}$**	$3{,}9 \cdot 10^{-6}$	$2{,}8 \cdot 10^{-7}$	**$3{,}7 \cdot 10^{-5}$**
Rn-222 to air	kBq	2,3	1,3	$2{,}3 \cdot 10^{-2}$	**3,6**	$4{,}3 \cdot 10^{-1}$	$1{,}5 \cdot 10^{-2}$	**4,0**

[1] *Generation compensating for distribution losses is included in the* ***Downstream*** *column.*

[2] *This electricity is assumed to be generated by the CHPs themselves and environmental impact is accounted for since this electricity amount has been subtracted from the reference flow.*

Resource use and emissions related to handling and treatment of the lifecycle waste through incineration or deposition are included in the Ecoprofiles, i.e. no crediting has been performed.

Conclusions of the LCA

The major environmental impact is attributable to the activities in the Core processes, i.e. operation of the power plants.

ADDITIONAL ENVIRONMENTAL INFORMATION

Land use and impact on biodiversity

Vattenfall´s Biotope Method is used for quantifying impacts on biodiversity as a direct consequence of the utilisation of land and water for economic activities. Affected areas are categorised into Critical Biotope, Rare Biotope, General Biotope and Technotope.

In the table below the identified biotope changes are shown. See chapter 4.1 of the complete EPD® documentation.

Categories	Difference 2007 (ha)	Difference 2007 (ha) only electricity	Difference 2007 (ha) only heat	Change per kWh electricity (m^2/kWh heat)	Change per kWh heat (m^2/kWh heat)
Critical Biotopes	-24	-19	-5	$-1 \cdot 10^{-4}$	$-0{,}2 \cdot 10^{-4}$
Rare Biotopes	-24	-19	-5	$-1 \cdot 10^{-4}$	$-0{,}2 \cdot 10^{-4}$
General Biotopes	31	25	6	$1 \cdot 10^{-4}$	$0{,}2 \cdot 10^{-4}$
Technotopes	17	13	4	$1 \cdot 10^{-4}$	$0{,}2 \cdot 10^{-4}$

Environmental risk assessment

The conclusion is that over a longer period of time, the emissions due to undesired events are considerably smaller than those emanating from normal operation. See the complete EPD® documentation.

Radiation

Miners in uranium and other mines are exposed to external gamma and beta radiation gases, as well as to ore dusts containing radioactive materials such as radon. The information given by the coal-mining facilities is that in many of the mines the doses to personnel are not measured since the levels of radon in the mines are very low. The maximum measured and reported dose to an individual mine worker is 1,2 mSv during 2007.

Noise

Performed measurements at Amagerværket show that the noise levels are below the permitted levels. At Nordjyllandværket and especially Fynsværket actions to reduce noise levels and impulses are ongoing since noise levels are exceeding current permits at some measuring points.

INFORMATION

To be noted: EPDs from different EPD programmes may not be comparable.

The use stage of produced electricity and heat has been omitted in accordance with the PCR since the use of electricity covers various functions in different contexts.

EPD programme: The EPD®system managed by International EPD Consortium (IEC), *www. environdec.com*
Product Category Rules: PCR-CPC 17
PCR review was conducted by: Sven-Olof Ryding, International EPD Consortium (IEC), *www.environdec.com*
Independent verification of the declaration och data, according to ISO 14025: ☐ Internal ☒ External
Third party verifier: SP, Technical Research Institute of Sweden

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This is a very short summary of the material that has been certified. The complete documentation is presented at *www.environdec.com* (click the globe symbol).