MEGAVIND

Megavind LCOE Model
Guidelines and documentation

Content

1 Background

The model for levelized cost of energy (LCOE model) has been created by Megavind. Megavind is Denmark's national partnership for wind energy, and acts as catalyst and initiator for a stronger strategic agenda for research, development and demonstration (RD&D). Megavind is the Danish equivalent of the European Technology Platform for Wind Energy; TP Wind.
Established in 2006, the role of Megavind is to strengthen public-private cooperation between the state, private enterprises, knowledge institutions and venture capital to accelerate innovation processes within several areas of technology.

The Megavind steering committee is comprised of representatives from the following companies/institutions:

Aalborg University

COWI A/S

Danish Research Consortium for Wind Energy

DNV GL

DONG Energy

DTU Wind Energy

E.ON

Envision Energy

Fritz Schur Energy A/S

Global Lightning Protection Services A/S

MHI Vestas Offshore Wind A/S

Mita-Teknik A/S

Siemens Wind Power A/S

Vattenfall A/S

Vestas Wind Systems A/S

Øglænd System A/S

Energinet.dk (observer)

Offshoreenergy.dk (observer)

The Danish Energy Agency (observer)

The LCOE model has been developed in cooperation with ESP Consulting and has been tested by DONG Energy, E.ON, MHI Vestas Offshore Wind A/S, Siemens Wind Power A/S and Vattenfall A/S.

1.2 Objective

The objective of the LCOE model is for it to become the industry's common and most accurate tool for calculating cost of energy. Furthermore the LCOE model will encourage targeted and scientific innovation addressing the main cost drivers in offshore wind.

In particular, the LCOE model will:

- Develop into an agreed and commonly accepted method of calculating the cost of energy from offshore wind
- Be a common tool for dialogue throughout the wind industry
- Provide an opportunity to compare the cost of offshore wind farms
- In the long term make it possible to produce a benchmark for progress towards reducing LCOE in offshore wind
- In the long term make it possible to identify the main cost drivers and their relative potential for future LCOE reductions

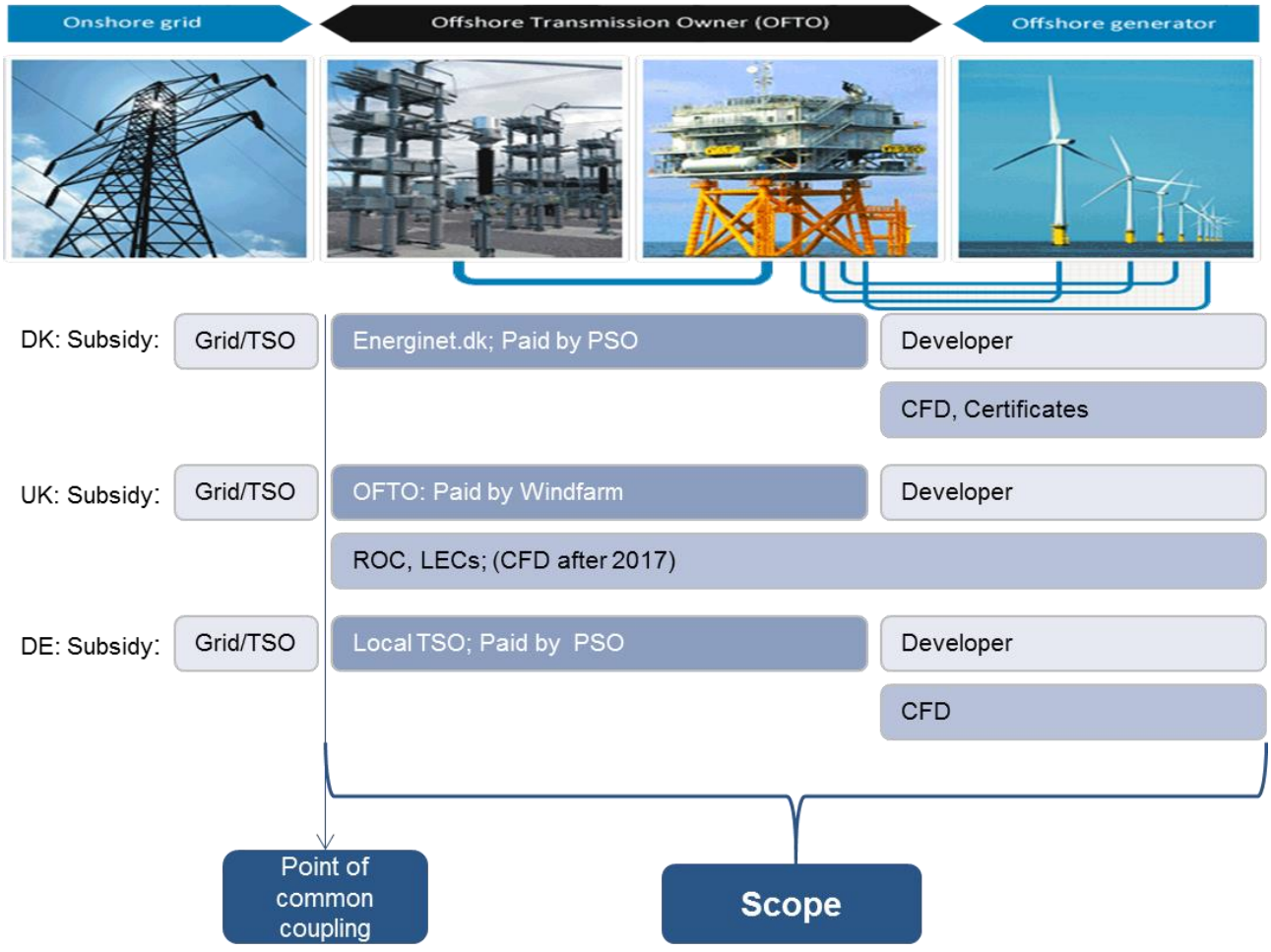
Work on the LCOE model was initiated in May 2014 and completed in March 2015.

2 Documentation

2.1 The LCOE model applies to all wind farms

The LCOE model applies to all offshore wind farms without geographical constraints without geographical constraints and calculates the cost of the wind farm from the point of common coupling, as shown in figure 1. This means that the LCOE model is applicable in many countries regardless of regulatory differences. This is exemplified by the cases of Denmark, UK and Germany in figure 1.

Figure 1



2.2 Levelized Cost of Energy (LCOE)

LCOE expresses the ”levelized” unit cost of 1 MWh over the lifetime of the wind farm by taking the sum of the discounted lifetime costs relative to the sum of discounted energy production at the time of the financial investment decision.
LCOE can therefore be expressed as:

$$\boldsymbol{LCoE} = \frac{\boldsymbol{Present\ value\ (Cost)}}{\boldsymbol{Present\ value\ (Production)}}$$

The sum of discounted energy production (the denominator) is the present value of the energy production. The sum of discounted energy production is independent of perspective.

$$\boldsymbol{Production} \sum_{t=k}^{T} \frac{E_t}{(1+W_r)^t} = \frac{E_{year\ 0}}{(1+W_r)^0} + \frac{E_{year\ 1}}{(1+W_r)^1} + \cdots + \frac{E_{year\ T}}{(1+W_r)^T}$$

The discounted lifetime costs (the numerator) is the present value of all expenditures associated with the wind farm. The sum of discounted lifetime costs can be formulated as:

$$\boldsymbol{Cost} \sum_{t=k}^{T} \frac{I_t + O_t + A_t}{(1+W_n)^t} = \frac{I_{year\ 0} + O_{year\ 0} + A_{year\ 0}}{(1+W_n)^{\ 0}} + \frac{I_{year\ 1} + O_{year\ 1} + A_{year\ 1}}{(1+W_n)^1} + \cdots + \frac{I_{year\ T} + O_{year\ T} + A_{year\ T}}{(1+W_n)^T}$$

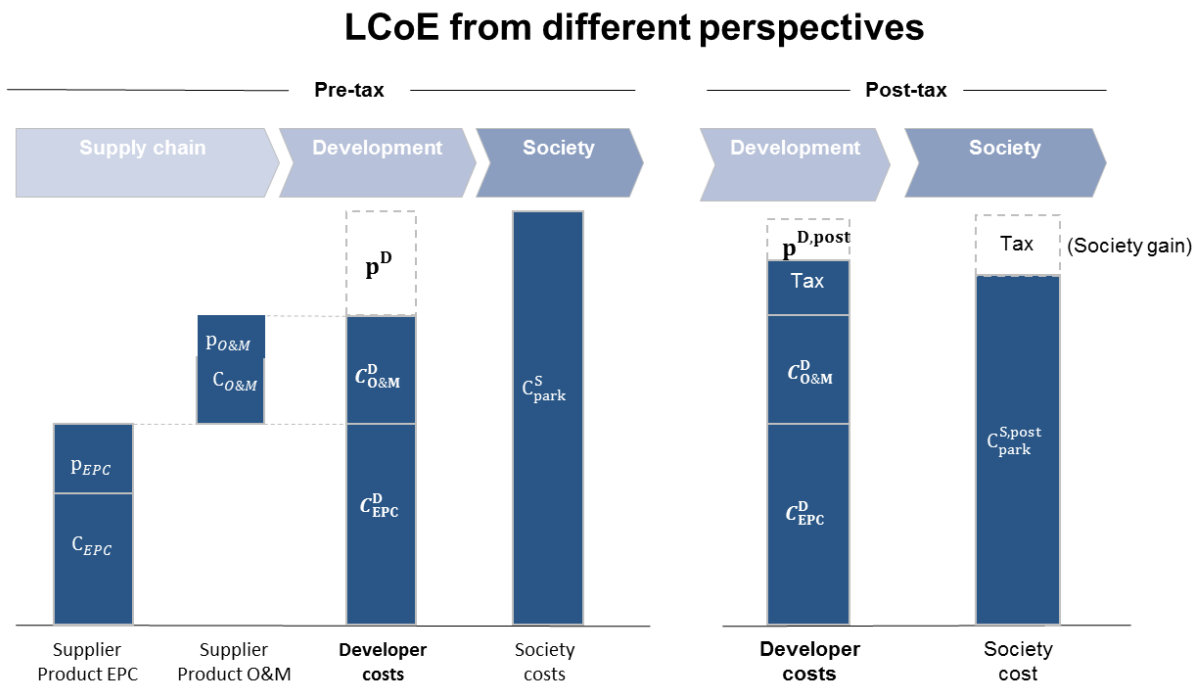
Definition of variables:

t	Is the time period
k	Is the earliest period with cash flows or energy production; discount is applied to period 0
T	Is the latest period with cash flow
I_t	Is the cash flow at time t from invest at time t including both nominal DEVEX (development expenditures) and CAPEX (capital expenditures)
O_t	Is the cash flow at time t from nominal OPEX (operational expenditures)
A_t	Is the cash flow at time t from nominal ABEX (abandonment cost)
E_t	Is the electricity production at time t
W_r	Is the real WACC (weighted average cost of capital)
W_n	Is the nominal WACC

2.3 LCOE from different perspectives

The LCOE model views the levelized cost of energy from two perspectives; the developer's and the society, and shows these both before and after tax. The discounted lifetime cost therefore depends on the cost perspective, which is illustrated in figure 2.

Figure 2



Where:
EPC is engineering, procurement and construction
C_{EPC} is the cost to supplier for EPC
p_{EPC} is premium (cost of capital) charged by supplier for EPC
$C_{O\&M}$ is the cost to supplier for O&M (operation and maintenance)
$p_{O\&M}$ is premium (cost of capital) charged by supplier for O&M
C^S_{park} is the total cost to society before tax

By definition:
$p^D = (r^D_{subsidy} + r^D_{market}) - (C^D_{EPC} + C^D_{O\&M})$
$p^{D,post} = p^D - tax$

Investor cost is interpreted as costs before cost of capital (debt service and dividends). The difference between pre- and post-tax is tax on the profit element

LCoE version	Included elements
Developer, pre-tax	C^D_{EPC}, $C^D_{O\&M}$
Developer, post-tax	C^D_{EPC}, $C^D_{O\&M}$, tax
Society, pre-tax	C^D_{EPC}, $C^D_{O\&M}$, p^D
Society, post-tax	C^D_{EPC}, $C^D_{O\&M}$, $p^{D,post}$

Pre-tax developer costs consist of EPC costs (C^D_{EPC}) and costs of operation & maintenance ($C^D_{O\&M}$). The cost to society is equal to the developer's costs plus the developer's profit (P^D). This is measured as (C^S_{farm}).
Taking tax into account, the developer is obliged to repay society some of the profit as tax. The developer therefore pays a higher LCOE post-tax than pre-tax. Tax paid by the developer is a gain for society – and therefore society has a lower LCOE figure post-tax than pre-tax.

The formulas for LCOE for both the developer and society before and after tax are shown in box 1.

Box 1: LCOE formulas from four perspectives

	Pre-tax	Post-tax
Developer	$\frac{\sum_{t=k}^{T} \frac{I_t + O_t + A_t}{(1+W_n)^t}}{\sum_{t=k}^{T} \frac{E_t}{(1+W_r)^t}}$	$\frac{\sum_{t=k}^{T} \frac{I_t + O_t + A_t + p_t \cdot ct}{(1+W_n)^t}}{\sum_{t=k}^{T} \frac{E_t}{(1+W_r)^t}}$
Society	$\frac{\sum_{t=k}^{T} \frac{I_t + O_t + A_t + p_t}{(1+W_n)^t}}{\sum_{t=k}^{T} \frac{E_t}{(1+W_r)^t}}$	$\frac{\sum_{t=k}^{T} \frac{I_t + O_t + A_t + p_t \cdot (1-ct)}{(1+W_n)^t}}{\sum_{t=k}^{T} \frac{E_t}{(1+W_r)^t}}$

Definition of variables:

t	Is the time period
k	Is the earliest period with cash flows or energy production; discount is applied to period 0
T	Is the latest period with cash flow
I_t	Is the cash flow at time t from invest at time t including both DEVEX and CAPEX (nominal)
p_t	Is the developer premium at time t (nominal)
ct	Is the corporate tax rate
O_t	Is the cash flow at time t form operations and maintenance cost (nominal)
A_t	Is the cash flow at time t from abandonment cost (nominal)
E_t	Is the electricity production at time t
W_r	Is the real WACC (weighted average cost of capital)
W_n	Is the nominal WACC (weighted average cost of capital)

The pre-tax developer costs are the sum of the discounted investment (in the form of DEVEX and CAPEX), O&M (OPEX) and abandonment expenditures (APEX):

$$\sum_{t=k}^{T} \frac{I_t + O_t + A_t}{(1+W_n)^t}$$

The post-tax developer cost is equal to the sum of the developer cost pre-tax plus the sum of the discounted corporate tax of the developer's premium.

$$\sum_{t=k}^{T} \frac{I_t + O_t + A_t}{(1+W_n)^t} + \sum_{t=k}^{T} \frac{p_t \cdot ct}{(1+W_n)^t} = \sum_{t=k}^{T} \frac{I_t + O_t + A_t + p_t \cdot ct}{(1+W_n)^t}$$

The pre-tax costs to society are the sum of the discounted investment (in the form of DEVEX and CAPEX), O&M (OPEX) and abandonment expenditures (APEX) plus the developer's premium:

$$\sum_{t=k}^{T} \frac{I_t + O_t + A_t}{(1+W_n)^t} + \sum_{t=k}^{T} \frac{p_t}{(1+W_n)^t} = \sum_{t=k}^{T} \frac{I_t + O_t + A_t + p_t}{(1+W_n)^t}$$

The post-tax costs to society are equal to the pre-tax costs to society minus society's gains on discounted corporate tax on the developer's premium. This means that society will gain from the tax paid by the developer:

$$\sum_{t=k}^{T} \frac{I_t + O_t + A_t + p_t}{(1+W_n)^t} - \sum_{t=k}^{T} \frac{p_t \cdot ct}{(1+W_n)^t} = \sum_{t=k}^{T} \frac{I_t + O_t + A_t + p_t \cdot (1-ct)}{(1+W_n)^t}$$

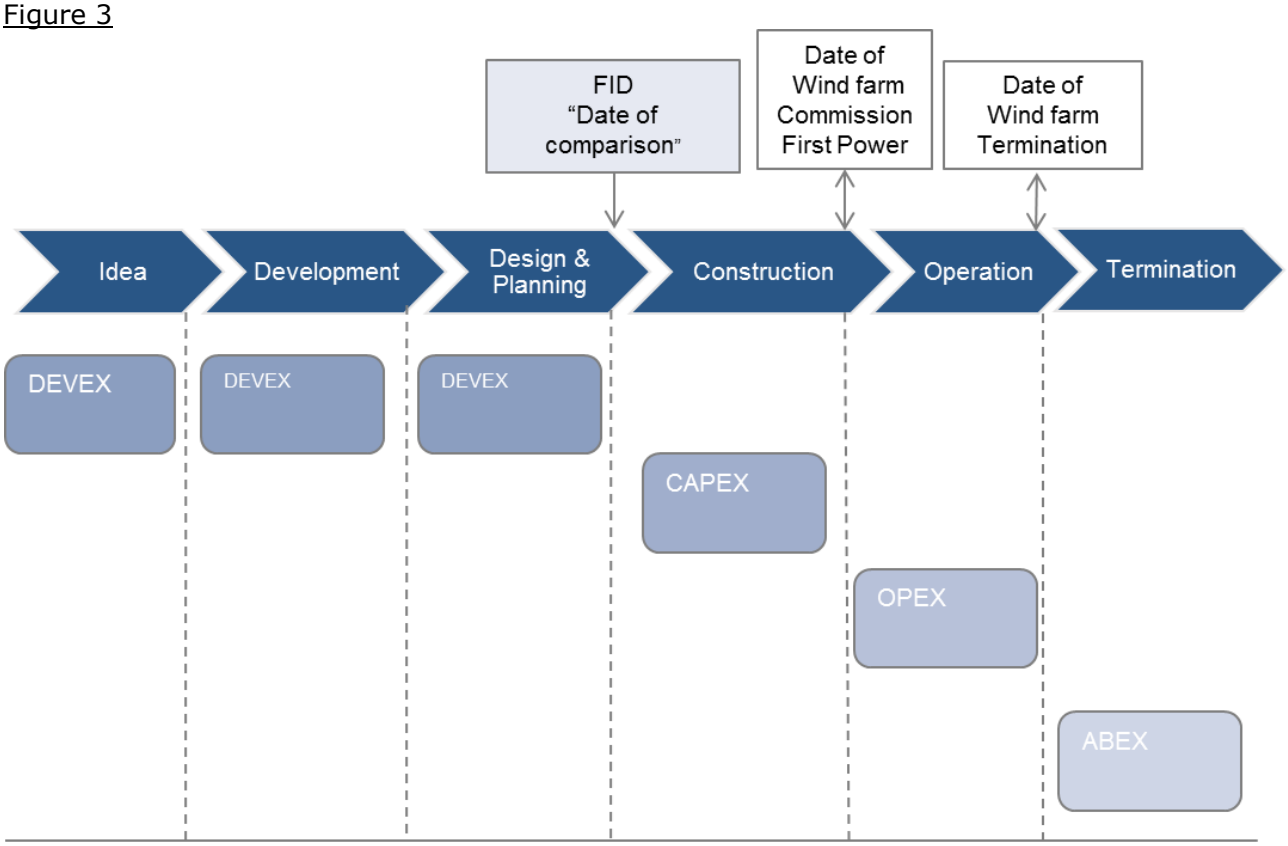
LCOE seen from the perspective of various parts of the supply chain. The discounted costs can also be found for components.

$$\sum_{t=k}^{T} \frac{A_t}{(1+W_n)^t}$$

2.4 Definition of costs

The total lifetime costs of an offshore wind farm are included in the LCOE model.
Costs are defined in four different overall categories. These are DEVEX, CAPEX, OPEX and ABEX.
As shown in figure 3, DEVEX is defined as all costs spent in the period from idea and development to design & planning. CAPEX is defined as all expenditure in the period of construction up to the date the wind farm is commissioned (first power). Costs in the operational period are defined as OPEX. Finally, ABEX is defined as all costs related to abandonment of the wind farm from the wind farm termination date.

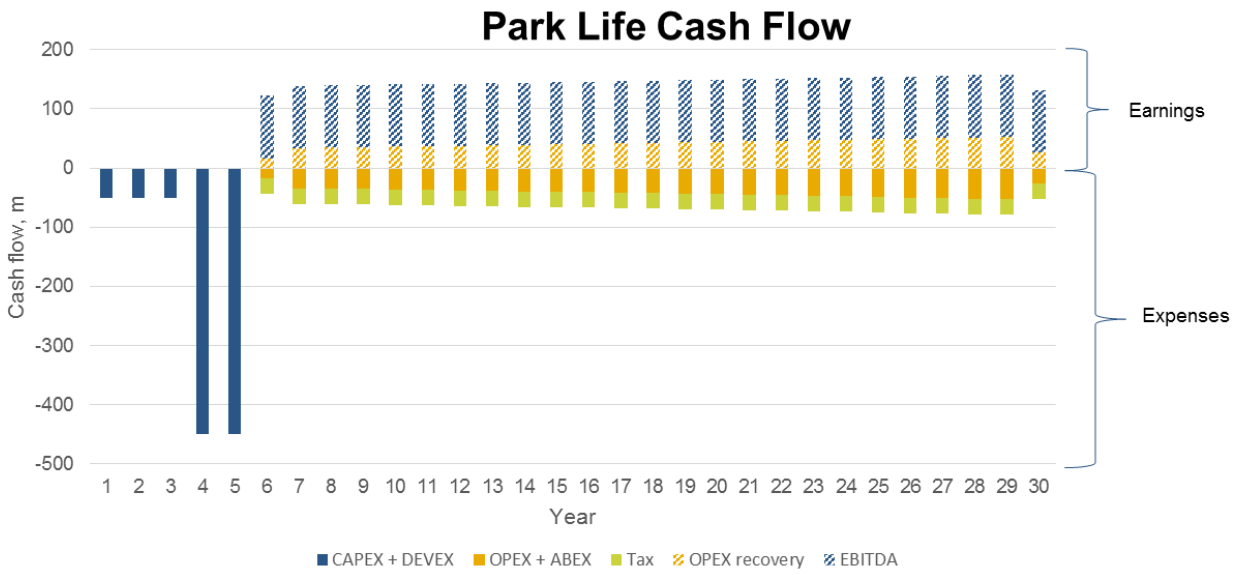
Figure 3



Any comparison between different wind farms requires the same starting point. Therefore FID (Final Investment Decision) is selected as the date of comparison.

2.5 Cash flow

Figure 4



The LCOE model covers the full lifetime of the wind farm. Figure 4 (above) shows the wind farm lifetime cash flow.

The costs of the wind farm are given by DEVEX, CAPEX, OPEX, ABEX and taxes during operation. Expenses in the first years until date of commission to first power are given by DEVEX and CAPEX (as explained in figure 3).

After first power (when the wind farm is in operation), the wind farm will generate revenue from energy production. Deducting OPEX costs (OPEX recovery) every year from annual revenue, the result is the wind farm's EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization). EBITDA is an indicator of the wind farm's financial performance and is expressed as:

$$\mathbf{EBITDA} = \mathbf{Revenue} - \mathbf{Expenses}\ (\mathbf{excluding\ tax}, \mathbf{interest}, \mathbf{depreciation\ and\ amortization})$$

Tax is paid out of EBITDA, regardless of OPEX and ABEX.

2.6 Definition overview of input parameters

The following section presents an overview of relevant input parameters for the LCOE model, along with a description:

Parameter	Description
Perspective	• The model provides both the developer's and society perspective of the levelized cost of electricity and shows them both before and after tax.
Periods	• Periods are annual and based on calendar years • Fixed years 2008 to 2050
Price basis	• Inputs can be specified in either nominal or real prices at the user's discretion • The price basis of output numbers are stated in real prices for the selected output year
Discounting	• Discounting date is mid-year of the output year • WACC is to be specified in nominal terms and it is assumed not to be time-dependent • WACC is to include all systematic risks of the wind farm
Inflation	• The inflation input is static but can be specified in the model calculation sheet
Currency	• The default currency is EUR. However, the user can specify DKK or GBP as currency • The standard model will not convert between currencies, so all amounts have to be converted to the same currency before using the model • For realised costs, realised exchange rates should be used when converting amounts • For future costs, FX forward curves should be used for converting amounts
Asset lifetime	• The model is not restricted to a specific asset lifetime
Costs	• Cost inputs are specified from the developer's perspective, i.e. including premiums/margins/cost of capital from suppliers and sub-suppliers • The scope covers the wind farm to the common point of coupling to the grid • All types of costs relating to the wind farm should be included, i.e. DEVEX, CAPEX, OPEX and ABEX • Costs are to be dated based on cash flow effect (unlike accounting principles, which use the invoice date) • All project specific risks should be accounted for in cash flows
Production	• Production is the expected (P50) net annual energy production of the wind farm relative to the meter at the common point of coupling • Thus all deductions for availability and losses should be accounted for
Revenue	• The model generates EBITDA for the wind farm. Input can be typed into the model manually for each year or calculated based on input of the overall size of EBITDA (in real terms) relative to investment.
Tax rate	• Only relevant for post-tax calculations • The corporate tax rate input is static

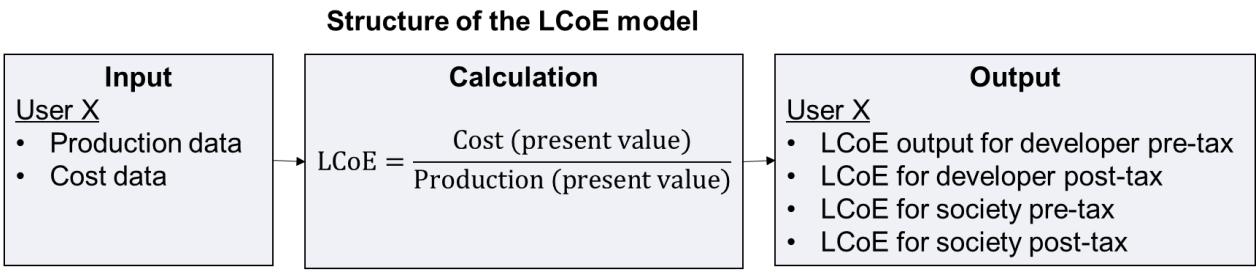
3 Operating instructions

For the LCOE model to succeed as a scientific collaborative benchmark tool and as a scientific tool by which to address the main cost drivers in offshore wind, users must apply the LCOE model uniformly. If inputs to the model are comparable, then output from it will also be comparable.
All users should therefore take note of the input specifications in the LCOE model. For this purpose we have prepared the following guidelines and operating instructions to the LCOE model.

3.1 Structure of the Megavind LCOE model

The user (e.g. an offshore developer) types in production data, and cost data for a given offshore wind farm. The data is calculated as a fraction of costs over production. The output consists of LCOE figures seen from both the developer's and society's respective perspectives, before and after tax. The output also creates detailed LCOE figures for subcategories of cost. The structure of the LCOE model is illustrated in figure 1.

Figure 5:



The Megavind LCOE model consists of eight sheets: Front page, Terminology, Changelog, Input, Calculation, Output, Lists and Appendix. The overall content of these eight sheets is outlined in the following section:

3.1.1 Front page

Presentation of the model

Version v2.1 04-03-2015

MEGAVIND

LCOE model

- Official Megavind open-source methodology for calculating LCOE for a wind project

- The model is developed in cooperation with ESP Consulting

Questions, comments and improvement suggestions can be sent to ek@windpower.org

All received suggestions will be logged. At least once per year all logged suggestions will be reviewed and it will be decided whether a new model version is to be made based on the approved suggestions.

3.1.2 Terminology

Describes abbreviations, format types, title conventions and cell types.

Terminology and definitions

Terminology	
Abbreviation	Description
LCOE	Levelized Cost of Energy
DEVEX	Development Expenditure
CAPEX	Capital Expenditure
OPEX	Operational Expenditure
ABEX	Abandonment Expenditure
WACC	Weighted Average Cost of Capital
AEP	Annual Energy Production
FID	Final Investment Decision
MW	Megawatt
kWh	Kilowatt hours
MWh	Megawatt hours
GWh	Gigawatt hours
TWh	Terawatt hours
DKK	Danish kroner
GBP	British pounds
EUR	Euro

Number formats	
Cell type	Format
Number (with one decimal point)	* #,##0.0;* -#,##0.0;* "-";@
Text	Text
Percent	Percent, 1-2 decimals
Date	dd-mm-yyyy

Title convention

Level 1 title:	White bold text with black background RGB(255,255,255)
Level 2 title:	White bold text with blue background RGB(31,73,125)
Level 3 title:	White bold text with light blue background RGB(184,204,228)
For column descriptions	Black text with grey background RBG(221,217,196)

Cell types

	Filled out	No value/input
Admin - hard coded/calculated:	Text black RGB(0,0,0)	n.a.
User - mandatory input:	Text light blue RGB(79,129,189)	
User - optional input:	Text light blue RGB(79,129,189)	

Note: All text is default font Calibri with font size 10

3.1.3 Changelog

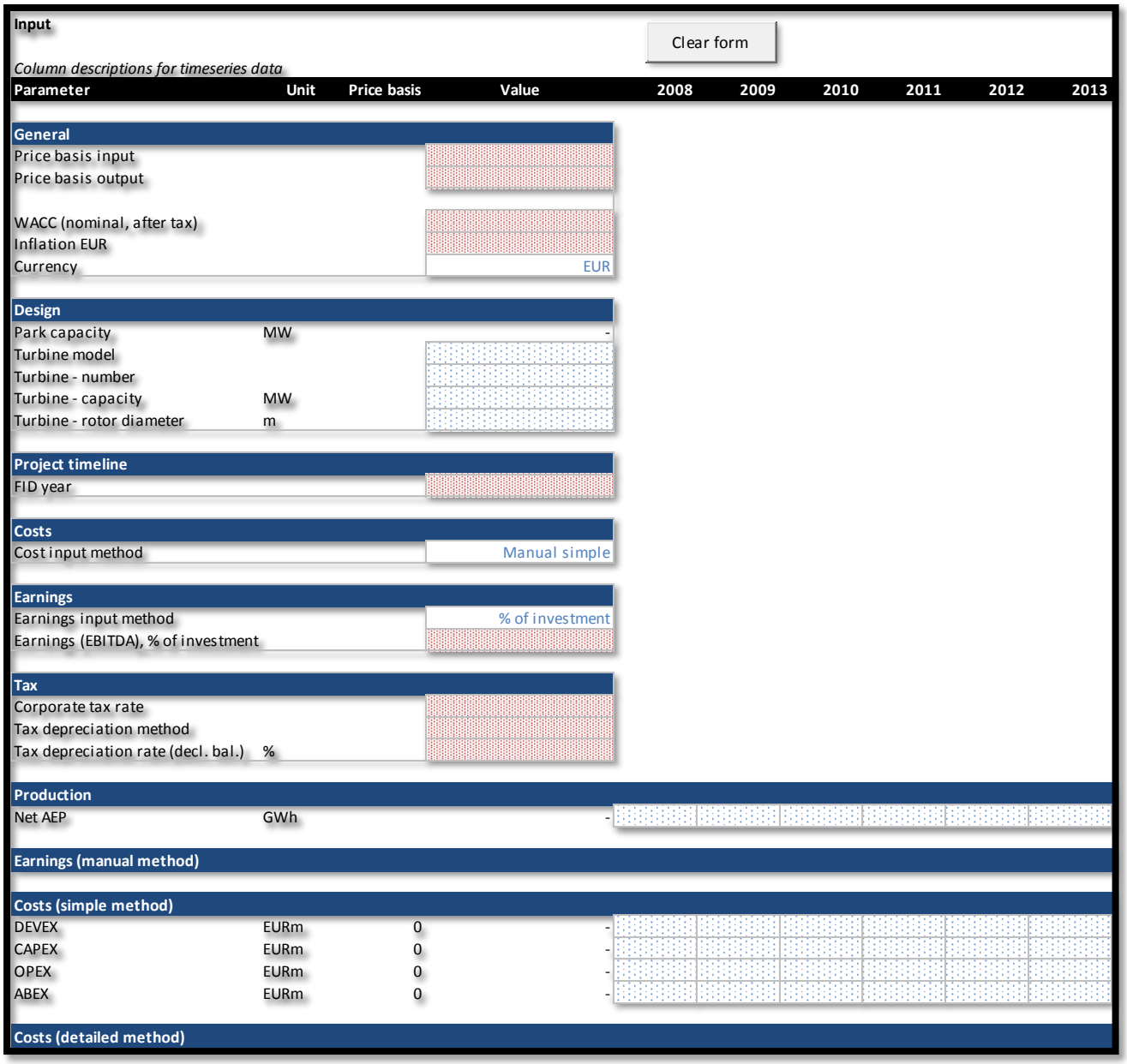
Lists changes to the model including version of the model, date of change and comments. The need for an update of the model will be evaluated once a year.

Changelog

ID	Version	Date	Responsible	Change	Comment
0	v2.0	05-12-2014	MSS	Version 2.0 released	
1	v2.1	04-03-2015	MSS	Standard cost category	Implemented for for cost input method manual detailed
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					

3.1.4 Input

In this sheet, the user enters input divided into the overall categories: General input, design, project timeline, option to count costs in either a simple or detailed version, earnings, tax, production, earnings by manual method, costs in simple version (total figures for development expenditures (DEVEX), capital expenditure (CAPEX), operational expenditure (OPEX) and abandonment expenditure (ABEX)) or costs in the detailed version with breakdowns for DEVEX, CAPEX, OPEX and ABEX.



3.1.5 Calculation

In this sheet, calculations based on the input are presented in the categories: multipliers, flags and counters, financial parameters, production and costs.
The sheet is locked for users. To unlock the sheet, click on the "Review tab"
in "Changes group", then click "Unprotect sheet". The user can then enter variations, e.g. in inflation or WACC during the lifetime of the farm, which would otherwise have been measured as an average value for the entire period.

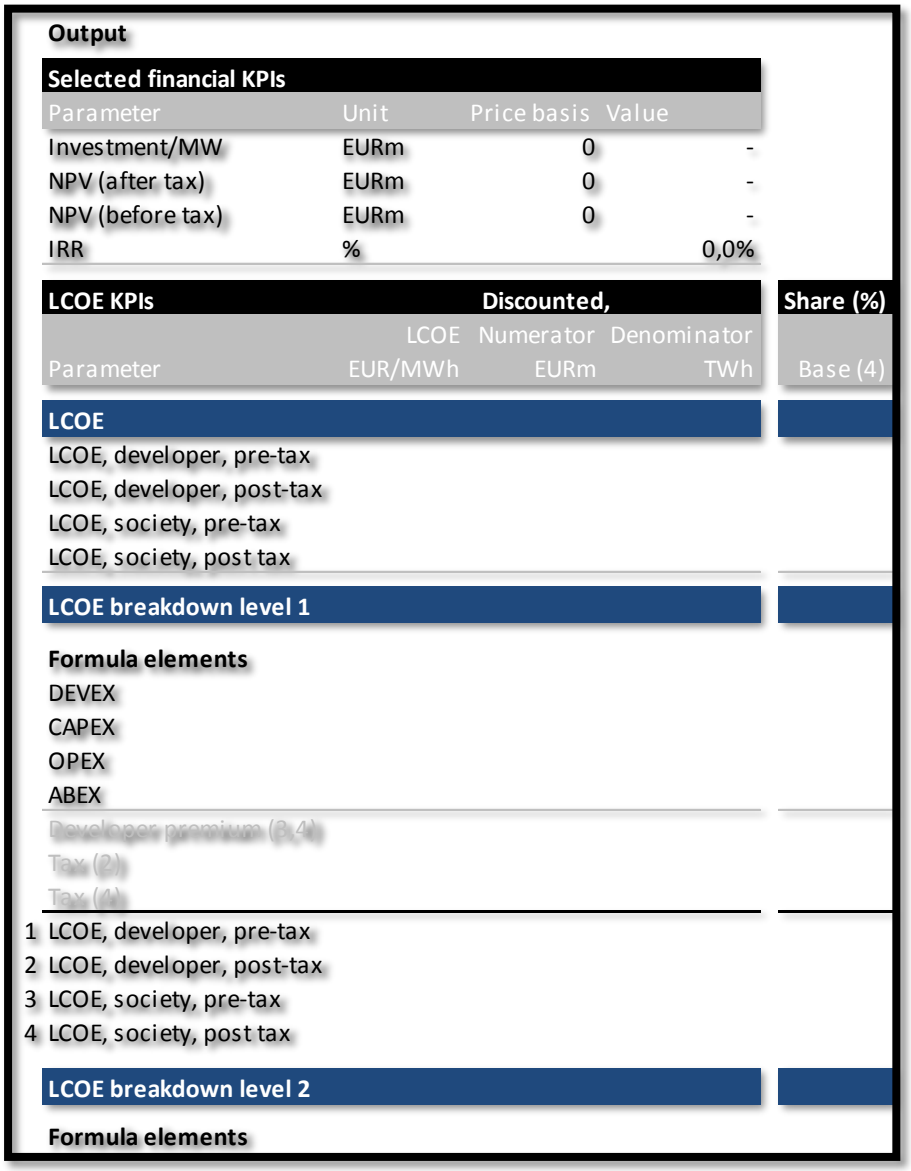
Calculations

Column descriptions for timeseries data

Parameter	Unit	Price basis	Value
Multipliers			
Discounting			
WACC annual factor, nominal			
WACC annual factor, real			
Discount factor, nominal			
Discount factor, real			
Price basis (PB)			
PB input			
PB output			
PB FID			R
Price basis conversion			
Price basis factor, PB Input --> N			N
Price basis factor, PB Input --> PB Output			
Price basis factor, PB Input --> PB FID			R
Price basis factor, N --> PB Input		N	
Price basis factor, N --> PB Output		N	
Price basis factor, N --> PB FID		N	R
Price basis factor, PB Output --> N			N
Price basis factor, PB FID --> N		R	N
Price basis factor, PB FID --> PB Output			
Flags and counters			
Flags			
Operational year			
Financial			
Inflation EUR	%		
WACC (nominal, after tax)	%		
WACC (real, after tax)	%		
Corporate tax rate	%		
Production			
Gross AEP	GWh		
Net AEP	GWh		
Discounted			
Net AEP, discounted	GWh		
Costs			
Cash flow			
Per cost item (level 1)			
DEVEX total	EURm		
CAPEX total	EURm		
OPEX total	EURm		
ABEX total	EURm		
Total	EURm		
Per cost item (level 2)			

3.1.6 Output

Selected financial KPIs are shown first, then the overall LCOE figures and, finally, a breakdown of the LCOE figures into DEVEX, CAPEX, OPEX and APEX. The second level of the LCOE breakdown shows LCOE for categories within DEVEX, CAPEX, OPEX and APEX.



Output

Selected financial KPIs			
Parameter	Unit	Price basis	Value
Investment/MW	EURm	0	-
NPV (after tax)	EURm	0	-
NPV (before tax)	EURm	0	-
IRR	%		0,0%

LCOE KPIs		Discounted,		Share (%)
	LCOE	Numerator	Denominator	
Parameter	EUR/MWh	EURm	TWh	Base (4)
LCOE				
LCOE, developer, pre-tax				
LCOE, developer, post-tax				
LCOE, society, pre-tax				
LCOE, society, post tax				
LCOE breakdown level 1				
Formula elements				
DEVEX				
CAPEX				
OPEX				
ABEX				
Developer premium (3,4)				
Tax (2)				
Tax (4)				
1 LCOE, developer, pre-tax				
2 LCOE, developer, post-tax				
3 LCOE, society, pre-tax				
4 LCOE, society, post tax				
LCOE breakdown level 2				
Formula elements				

3.1.7 Lists

Lists

	Description	List of all possible price basis	List of possible output price basis	List of possible foreign exchange	List of possible tax depreciation profiles	List of possible cost input methods	List of possible earnings input methods
	Position start	L_PB_Start	L_PBO_Start	L_FX_Start	L_TDP_Start	L_CIM_Start	L_EIM_Start
	List name	L_PB	L_PBO	L_FX	L_TDP	L_CIM	L_EIM
ID	Title	Price basis	Price basis output	Currency	Tax depreciation pr	Cost input method	Earnings input method
1		N	R2008	EUR	Linear	Manual simple	% of investment
2		R2008	R2009	DKK	Declining balance	Manual detailed	Manual
3		R2009	R2010	GBP	Immediate		
4		R2010	R2011				
5		R2011	R2012				
6		R2012	R2013				
7		R2013	R2014				
8		R2014	R2015				
9		R2015	R2016				
10		R2016	R2017				
11		R2017	R2018				
12		R2018	R2019				
13		R2019	R2020				
14		R2020					

3.1.8 Appendix

Empty

3.2 Step by step

The LCOE model contains macros, which means that the user must accept macros when opening the model. This includes ignoring the warning for macros.

3.2.1 Sheet 1: Front page
No user input

3.2.2 Sheet 2: Terminology
No user input

3.2.3 Sheet 3: Changelog
No user input

3.2.4 Sheet 4: Input
All inputs typed into the model can be cleared by pressing "clear form**".**

Box 1: General

Price basis input: Select price period (year or years) for your cost input calculation. Mark the cell and scroll down to the preferred year in the drop down menu. To select nominal prices, scroll down to the letter N.

Price basis output Select price period (year or years) for your cost input calculation. Mark the cell and scroll down to the preferred year in the drop down menu. We recommend that you select the year of financial investment decision (FID year) as price basis output.

WACC (nominal, after tax): Type in the percentage rate expected to be paid on average to all security holders. The percentage rate must be in nominal terms, after tax.

Inflation EUR: Enter the average expected inflation rate over the lifetime of the wind farm in percent (normally around 2 %).

Currency: Choose the currency in which your costs are counted. We recommend that you select EUR, although you can also select GBP or DKK in the drop down menu. Note that all cost values in the LCOE model must be in the same currency and that the output will be in that currency.

Box 2: Design

Design		
Park capacity	MW	-
Turbine model		
Turbine - number		
Turbine - capacity	MW	
Turbine - rotor diameter	m	

Park capacity: The park capacity in MW is generated based on input regarding the number of turbines and turbine capacity.

Turbine model: Enter the turbine model – e.g. 4 MW offshore turbine

Number of turbines: Type in the total number of turbines in the farm.

Turbine capacity: Enter turbine capacity in MW – e.g. 4.

Turbine rotor diameter: Enter turbine rotor diameter – e.g. 120.

Box 3: Project timeline

Project timeline	
FID year	

FID year: Type in the year of financial investment decision for the farm (only relevant if the price basis output equals FID year).

Box 4: Costs

Costs	
Cost input method	Manual simple

Cost input: Select "Manual simple" or "Manual detailed" in the drop down menu. The simple version allows the user to enter one total figure each year for DEVEX, CAPEX, OPEX and ABEX, respectively. The detailed version allows the user to specify costs in DEVEX, CAPEX, OPEX and ABEX for each year into subcategories of the user's own choice – please see boxes 9 and 10 for further details.

Box 5: Earnings

Earnings	
Earnings input method	% of investment
Earnings (EBITDA), % of investment	

Earnings input method: Choose either to count earnings as a percentage of investment or to enter earnings manually.

Earnings (EBITDA), % of investment: Enter EBITDA (*earnings before interest, taxes, depreciation, and amortization).*

Box 6: Tax

Tax		
Corporate tax rate		
Tax depreciation method		
Tax depreciation rate (decl. bal.)	%	

Corporate tax rate: Enter the corporate tax rate for the country in which your company is registered for tax. In Denmark the corporate tax rate is 22%.

Tax depreciation method: Select linear, declining balance or immediate in the drop down menu.

Tax depreciation rate (decl. bal) %: Enter tax depreciation rate in per cent, if declining balance is selected as tax depreciation method.

Box 7: Production

Production		
Net AEP	GWh	-

Net AEP: Enter the expected net annual production in GWh for each year of the farm's lifetime between 2008 and 2050. When entering production figures, the user must take degradation into account, e.g. falling production towards the end of the wind farm's lifetime.

Box 8: Earnings

Earnings (manual method)			
Earnings (EBITDA)	EURm	0	-

Earnings (EBITDA): If the manual earnings input method is selected, enter EBITDA for each year of the farm's lifetime between 2008 and 2050.

Box 9: Costs (simple method)

Costs (simple method)			
DEVEX	EURm	0	-
CAPEX	EURm	0	-
OPEX	EURm	0	-
ABEX	EURm	0	-

Costs (simple method): Enter costs in millions of EUROs for each year between 2008 and 2050 for DEVEX, CAPEX, OPEX and ABEX, respectively. When entering cost figures, the user must take degradation into account e.g. increased OPEX towards the end of the wind farm's lifetime.

Box 10: Costs (detailed method)

Costs (detailed method)					
DEVEX			Unit	Price basis	Value
DEVEX category1			EURm	0	-
DEVEX category2			EURm	0	-
DEVEX category3			EURm	0	-
DEVEX category X			EURm	0	-
Total			EURm	0	-
CAPEX			Unit	Price basis	Value
CAPEX category1			EURm	0	-
CAPEX category2			EURm	0	-
CAPEX category3			EURm	0	-
CAPEX category X			EURm	0	-
Total			EURm	0	-
OPEX			Unit	Price basis	Value
OPEX category1			EURm	0	-
OPEX category2			EURm	0	-
OPEX category3			EURm	0	-
OPEX category X			EURm	0	-
Total			EURm	0	-
ABEX			Unit	Price basis	Value
ABEX category1			EURm	0	-
ABEX category2			EURm	0	-
ABEX category3			EURm	0	-
ABEX category X			EURm	0	-
Total			EURm	0	-

Costs (detailed method): Enter costs in millions of EUROs for each year between 2008 and 2050 for DEVEX, CAPEX, OPEX and ABEX, respectively, sub-divided into categories of your own choice. The categories could be e.g. onshore substation, export cables, offshore substation, array cables, substructure, WTG, etc.
When entering cost figures, the user must take degradation into account e.g. increased OPEX towards the end of the wind farm's lifetime.

3.2.5 Sheet 5: Calculation

Box 1: Multipliers

Calculations				
Column descriptions for timeseries data				
Parameter	**Unit**	**Price basis**	**Value**	
Multipliers				
Discounting				
WACC annual factor, nominal				
WACC annual factor, real				
Discount factor, nominal				
Discount factor, real				
Price basis (PB)				
PB input				0
PB output				0
PB FID			R	
Price basis conversion				
Price basis factor, PB Input --> N		0	N	
Price basis factor, PB Input --> PB Output		0		0
Price basis factor, PB Input --> PB FID		0	R	
Price basis factor, N --> PB Input	N			0
Price basis factor, N --> PB Output	N			0
Price basis factor, N --> PB FID	N		R	
Price basis factor, PB Output --> N		0	N	
Price basis factor, PB FID --> N	R		N	
Price basis factor, PB FID --> PB Output				

Discounting
WACC annual factor, nominal: Shows the annual factor of WACC in nominal terms throughout the lifetime of the wind farm.

WACC annual factor, real: Shows the annual factor of WACC in real terms throughout the lifetime of the wind farm.

Discount factor, nominal: Shows the annual discount factor in nominal terms

Discount factor, real: Shows the annual discount factor in real terms

Price basis (PB):
PB input: Shows the price basis in which the input is counted
PB output: Shows the price basis in which the output is counted
PB FID: Shows the price basis for the year of financial investment decision

Price basis conversion
Price basis factor, PB Input--> N: Shows the price basis factor for price basis input in relation to nominal input

Price basis factor, PB input--> PB Output: Shows the price basis factor for price basis input in relation to price basis output

Price basis factor, PB Input--> PB FID: Shows the price basis factor for price basis input in relation to price basis FID

Price basis factor, N --> PB Input: Shows the price basis factor for nominal input in relation to price basis input

Price basis factor, N --> PB Output: Shows the price basis for nominal input in relation to price basis output

Price basis factor, N--> PB FID: Shows the price basis factor for nominal input in relation to price basis FID

Price basis factor, PB Output --> N: Shows the price basis factor for price basis output in relation to nominal terms

Price basis factor, PB FID--> N: Shows the price basis factor for price basis FID in relation to nominal terms

Price basis factor, PB FID--> PB Output: Shows the price basis factor for price basis FID in relation to price basis output

Box 2: Flags and counters

Flags and counters	
Flags	
Operational year	-

The years in which the wind farm has operational costs are marked with a flag (1).
There are no predefined counters.

Box 3: Financial

Financial	
Inflation EUR	%
WACC (nominal, after tax)	%
WACC (real, after tax)	%
Corporate tax rate	%

Inflation: Shows the average annual percentage rate of inflation in each year of the lifetime of the wind farm. Inflation is measured between (mid-year) of last year and (mid-year) of this year. It is possible to specify inflation by unlocking the sheet and manually entering variable rates of inflation for each year.

WACC *(nominal, after tax):* Shows the average annual percentage of WACC in each year of the lifetime of the wind farm in nominal terms. WACC is measured between (mid-year) of last year and (mid-year) of this year. "After tax" refers to tax benefits of cost of capital (either equity, hybrids or debt). It is possible to specify the annual WACC factor for specific years by unlocking the sheet and manually entering the precise factor for each year.

WACC (real, after tax): Shows the average annual percentage of WACC in each year of the lifetime of the wind farm in real terms. WACC is measured between (mid-year) of last year and (mid-year) of this year. "After tax" refers to tax benefits of cost of capital (either equity, hybrids or debt). It is possible to specify the annual factor of WACC for specific years by

unlocking the sheet and manually entering the precise factor for each year.

Corporate tax rate: Shows the corporate tax rate

Box 4: Production

Production	
Gross AEP	GWh
Net AEP	GWh
Discounted	
Net AEP, discounted	GWh

Gross AEP: Shows the gross annual energy production in GWh

Net AEP: Shows the net annual energy production in GWh

Net AEP, discounted: Shows the net present value of annual energy production

Box 5: Costs

Costs		
Cash flow		
Per cost item (level 1)		
DEVEX total	EURm	0
CAPEX total	EURm	0
OPEX total	EURm	0
ABEX total	EURm	0
Total	EURm	0

DEVEX total: Shows the sum of DEVEX costs in the selected output price basis along with the costs for each year in the output price basis

CAPEX total: Shows the sum of CAPEX costs in the selected output price basis along with the costs for each year in the output price basis

OPEX total: Shows the sum of OPEX costs in the selected output price basis along with the costs for each year in the output price basis

ABEX total: Shows the sum of ABEX costs in the selected output price basis along with the costs for each year in the output price basis

Per cost item (level 2)

Per cost item (level 2): Shows the sum of costs in the selected output price basis for specific subcategories of DEVEX, CAPEX, OPEX and ABEX along with the costs for each year in the output price basis.

Box 6: Earnings

Earnings		
Earnings input method: % of investment		
Park lifetime earnings (EBITDA), % of investment		
Investment	EURm	
Earnings (EBITDA)	EURm	
Earnings (EBITDA), linear dist.	EURm	
Developer earnings (EBITDA)	EURm	N
Earnings input method: Manual		
Earnings (EBITDA)	EURm	
Earnings (EBITDA)	EURm	
Earnings (EBITDA)	EURm	N
CHOICE: Earnings input method		
Earnings (EBITDA)	EURm	N
Discounted		
Earnings (EBITDA), discounted	EURm	

Earnings input method: % of investment:
Shows earnings as a percentage of investment for: Investment in million euros, earnings (EBITDA), earnings (EBITDA) in a linear distribution, and developer earnings (EBITDA) in million euros.

Earnings input method: Manual
Shows earnings (EBIDTDA) in million euros, as defined manual

CHOICE: Earnings input method
Shows earnings (EBIDTDA) in million euros

Discounted:
Shows discounted earnings (EBIDTDA) in million euros

Box 7: Tax

Tax		
Tax depreciation		
Tax depreciation method: Linear		
Tax asset base	EURm	N
Investment	EURm	N
Depreciation	EURm	N
Tax asset value, BoP	EURm	N
Tax asset value, EoP	EURm	N
Tax depreciation method: Declining balance		
Tax depreciation rate (decl. bal.)	%	
Tax asset base	EURm	N
Investment	EURm	N
Depreciation	EURm	N
Tax asset value, BoP	EURm	N
Tax asset value, EoP	EURm	N
Tax depreciation method: Immediate		
Tax asset base	EURm	N
Investment	EURm	N
Depreciation	EURm	N
Tax asset value, BoP	EURm	N
Tax asset value, EoP	EURm	N
CHOICE: Tax depreciation method		
Depreciation	EURm	N
Tax payable		
Earnings (EBITDA)	EURm	N
Depreciation	EURm	N
Taxable income, gross	EURm	N
Losses caried forward	EURm	N
Taxable income, net	EURm	N
Tax payable	EURm	N
Discounted		
Tax payable	EURm	

Tax depreciation: Shows tax depreciation for the linear method, declining balance, immediate and CHOICE: Tax depreciation method.

Tax payable: Shows tax payable in million euros for earnings (EBITDA), depreciation, taxable income, losses carried forward, taxable income, tax payable and the discounted tax payable.

Box 8: Valuation

Valuation		
EBITDA	EURm	N
Depreciation	EURm	N
EBIT	EURm	N
Tax payable	EURm	N
NOPAT	EURm	N
Depreciation	EURm	N
DEVEX	EURm	N
CAPEX	EURm	N
ABEX	EURm	N
FCF (after tax)	EURm	N
FCF (before tax)	EURm	N
Discounted		
FCF (after tax)	EURm	
FCF (after tax)	EURm	
Financial KPIs		
Investment/MW	EURm	
NPV (after tax)	EURm	
NPV (before tax)	EURm	
IRR	%	

Valuation: Shows EBITDA, depreciation, EBIT, tax payable, NOPAT, depreciation, DEVEX, CAPEX, ABEX, FCF (before and after tax), discounted FCF (before and after tax), the financial KPI's (Investment, NPV before and after tax and IRR.

3.2.6 Sheet 6: Output

Box 1: Selected financial KPIs

Selected financial KPIs			
Parameter	Unit	Pric	Value
Investment/MW	EURm	0	
NPV (after tax)	EURm	0	
NPV (before tax)	EURm	0	
IRR	%		0,0%

This box gives an overview of the KPIs (key performance indicators), investment/MW, net present value (after tax), net present value (before tax) and internal rate of return.

Box 2: LCOE

LCOE KPIs	Discounted,			Share (%)
	LCOE	Numerator	inator	
Parameter	EUR/MWh	EURm	TWh	Base (4)
LCOE				
LCOE, developer, pre-tax				
LCOE, developer, post-tax				
LCOE, society, pre-tax				
LCOE, society, post tax				

LCOE, developer, pre-tax: The first column shows the LCOE figure, which is the discounted total sum of the development costs in connection with the total discounted energy production of the farm before tax is paid. The second column shows the numerator, which gives the discounted total sum of costs for the wind farm for developer *before* tax. The third column shows the nominator which is measured in total discounted energy production. Fourth column shows the percentage of LCOE, developer, pre-tax in proportion to LCOE to society, post-tax.

LCOE, developer, post-tax: The first column shows the LCOE figure, which is the discounted total sum of costs for developer in connection with the total discounted energy production of the wind farm, after tax is paid. The second column shows the numerator, which gives the discounted total sum of costs for the wind farm for developer *after* tax. The third column shows the nominator which is measured in total energy production. Fourth column shows the percentage of LCOE, developer, post-tax in proportion to LCOE to society, post-tax.

LCOE, society, pre-tax: The first column shows the LCOE figure, which is the discounted total sum of costs to society in connection with the annual energy production of the wind farm, before tax is paid by developer. The second column shows the numerator, which gives the discounted total sum of costs for the wind farm to society *before* tax. The third column shows the nominator which is measured in annual energy production. Fourth column shows the percentage of LCOE to society pre-tax in proportion to LCOE to society, post-tax.

LCOE, society, post-tax: The first column shows the LCOE figure, which is the discounted total sum of costs to society in connection with the annual energy production of the wind farm, after tax is paid by developer. The second column shows the numerator, which gives the discounted total sum of costs for the wind farm to society *after* tax. The third column shows the nominator which is measured in annual energy production. Fourth column shows the percentage of LCOE to society post-tax in proportion to LCOE to society, post-tax – hence 100%.

Box 2: LCOE breakdown level 1

LCOE breakdown level 1	
Formula elements	
DEVEX	
CAPEX	
OPEX	
ABEX	
Developer premium (3, 4)	
Tax (2)	
Tax (4)	
1 LCOE, developer, pre-tax	
2 LCOE, developer, post-tax	
3 LCOE, society, pre-tax	
4 LCOE, society, post tax	

DEVEX: The first column shows the LCOE figure for DEVEX, which is the discounted total sum of DEVEX over annual energy production of the wind farm. The second column shows the numerator, which gives the discounted total sum of DEVEX for the wind farm. The third column shows the denominator which is measured in annual energy production. Fourth column shows the percentage of DEVEX in proportion to LCOE to society, post-tax.

CAPEX: The first column shows the LCOE figure for CAPEX, which is the discounted total sum of CAPEX over annual energy production of the wind farm. The second column shows the numerator, which gives the discounted total sum of CAPEX for the wind farm. The third column shows the denominator which is measured in annual energy production. Fourth column shows the percentage of CAPEX in proportion to LCOE to society, post-tax.

OPEX: The first column shows the LCOE figure for OPEX, which is the discounted total sum of OPEX over annual energy production of the wind farm. The second column shows the numerator, which gives the discounted total sum of OPEX for the wind farm. The third column shows the denominator which is measured in annual energy production. Fourth column shows the percentage of OPEX in proportion to LCOE to society, post-tax.

ABEX: The first column shows the LCOE figure for ABEX, which is the discounted total sum of ABEX over annual energy production of the wind farm. The second column shows the numerator, which gives the discounted total sum of ABEX for the wind farm. The third column shows the denominator which is measured in annual energy production. Fourth column shows the percentage of ABEX in proportion to LCOE to society, post-tax.

Developer premium (3, 4): The first column shows the LCOE figure for developer premium, which is the discounted total sum of developer premium over annual energy production of the wind farm. The second column shows the numerator, which gives the discounted total sum of developer premium. The third column shows the denominator which is measured in annual energy production. Fourth column shows the percentage of developer premium in proportion to LCOE to society, post-tax.

Tax (2): The first column shows the LCOE figure tax, which is the discounted total sum of tax over annual energy production of the wind farm. The second column shows the numerator, which gives the discounted total sum of tax. The third column shows the denominator which is measured in annual energy production. Fourth column shows the percentage of developer premium in proportion to LCOE to society, post-tax.

Tax (4): The first column shows the negative LCOE figure for tax. The second column shows the negative discounted total sum of tax. The third column shows the denominator which is measured in annual energy production. Fourth column shows the percentage of tax in proportion to LCOE to society, post-tax in negative terms.

LCOE, developer, pre-tax: See explanation in box 1: LCOE

LCOE, developer, post-tax: See explanation in box 1: LCOE

LCOE, society, pre-tax: See explanation in box 1: LCOE

LCOE, society, post-tax: See explanation in box 1: LCOE

Box 3: LCOE breakdown level 2

Formula elements: The LCOE breakdown level 2 shows the LCOE figures divided into subcategories under DEVEX, CAPEX, OPEX and ABEX.

4 Abbreviations

Abbreviation	Description
ABEX	Abandonment Expenditure
AEP	Annual Energy Production
CAPEX	Capital Expenditure
DEVEX	Development Expenditure
DKK	Danish kroner
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
EPC	Engineering, procurement and construction
EUR	Euro
FCF	Free Cash Flow
FID	Final Investment Decision
GBP	British pounds
GWh	Gigawatt hours
KPI	Key Performance Indicators
kWh	Kilowatt hours
LCOE	Levelized Cost of Energy
MW	Megawatt
MWh	Megawatt hours
NOPAT	Net Operating Profit after Tax
OPEX	Operational Expenditure
TWh	Terawatt hours
WACC	Weighted Average Cost of Capital