Leonardo ENERGY

Power Quality and Utilisation Guide

Distributed Generation and Renewables

8.5.1 Wind Farm Case Study

Copper Development Association
Institution of Engineering and Technology Endorsed Training Provider

European Copper Institute

Distribution Generation and Renewables

Wind Farm Case Study

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Wind Farm Case Study

Introduction

Nowadays, most European governments are well aware of the potential of wind energy. From 1980 to 2000, the awareness of wind energy was mainly concentrated in Denmark and Germany where a large number of wind turbines were manufactured and installed. Germany still leads in terms of annually installed capacity with Spain close behind. Over the last 5 to 10 years many European governments have developed policies to promote renewable energy sources, including wind energy. Prominent examples are the United Kingdom, France, Italy, the Netherlands and Eastern European countries where wind energy is already installed or incentives are defined to boost the increase of renewables.

During the last 20 to 25 years the implementation of wind energy has changed dramatically. In the early stages, standalone wind turbines with installed power between 100 and 500 kW were quite common while the development of wind farms was rare. Now, after the development of incentives and planning regimes, most installations are in farms of up to 25 or more turbines. Currently, the installed power per turbine ranges from 750 kW to 3 MW and farms totalling 50 MW are not uncommon. Wind turbines in the range of 4.5 to 6 MW are available as prototypes and test specimens but are not yet commercially exploited.

Offshore wind farms are more expensive that onshore wind farms, requiring about double the initial investment – due to the extra costs of construction, transport to site and interconnection – and double the operational costs. However, the installed power of offshore farms is greater, the wind resource is greater and there is less environmental impact, especially in respect of noise.

The costs of onshore wind energy ranges from 55 to 100 EUR/MWh mainly depending on the wind resource (Figure 1). For most locations, wind energy is not cost-effective and incentives are a prerequisite to make a wind farm profitable.

The time span from first initiative to final commissioning of a wind farm is subdivided into a development period and a construction period. The duration of the construction period is predictable at about 1 year for a small to medium farm (< 15 MW) and at 1 to 2 years for a large wind farm. The duration of the development period is less predictable, especially the time required to obtain planning consent which, depending on the mandatory procedures and the number and kind of objections raised, may vary from approximately 6 months to more than 5 years. The technical life span of a wind turbine is 20 years.

The financing of a wind farm is a crucial issue. Construction of a single turbine was often part of a company's normal capital expenditure and would have been assessed as such. Most wind farms are developed by a dedicated company with capital made up of a limited amount of equity supported by loans, for which guarantees are required. The sole objective is to make a profit, so the financial projections are vitally important.

Generally the development and operation of a wind farm can be subdivided into the following four phases:

- initiation and feasibility (concluded by go/no-go)
- prebuilding (concluded by go/no-go)
- building
- operation and maintenance.

The following case has been selected for this application note:

Installed power	10 MW
Wind turbines of	2 MW
Hub height	80 metres
Rotor diameter	80 metres, 3 bladed rotor
Octangular foundation, gross dimensions	18 x 18 metres
Nacelle weight	100 tonnes
Tower weight	200 tonnes
Life span	20 years

Wind farm initiation and feasibility phase

In this phase, the basic parameters of the project are determined (e.g. the number and type of turbines and total installed power) and potential sites are assessed and compared, taking into account the wind resource available, the proximity of suitable grid connections and the limitations of regional, national and local planning regulations.

At the end of this phase the least suitable sites will have been eliminated and a decision made whether to proceed with further study of the remaining sites or to abandon the project.

Site selection and wind assessment

Wind farms require large sites. Depending on the rotor diameter the required mutual separation is 300 to 500 metres with a further similar separation distance from dwellings and commercial buildings to limit noise nuisance and to provide a safety zone. Even for a medium size wind farm, such as the 5 wind turbines of 2 MW considered here, a substantial land area is required.

Generally speaking, potential wind farm sites are preferably open areas of flat land or on top of hilly areas. Obviously, the sites should be known to be windy, with high and recurrent wind resources. Having selected the site, the next step is to assess the local long-term wind climate by reference to existing data or by long term monitoring. The objective in this phase is to eliminate all sites that may be unsuitable (in other words, unprofitable) in the long term.

If the site screening process does not identify any prohibitive limitations the feasibility study may proceed.

Financial feasibility is obviously a prerequisite for the development of a wind energy project – a non-feasible project will not attract the required finance. The wind resource assessment and the consequent estimation of the yearly energy yield is of crucial importance since they determine the project yield. The energy available from the wind is proportional to the third power of the wind speed. Based on local wind speed data from meteorological stations a local wind atlas of the planned wind farm can be determined. It is necessary to use at least one full year of wind data to take into account variations in wind speed during the seasons.

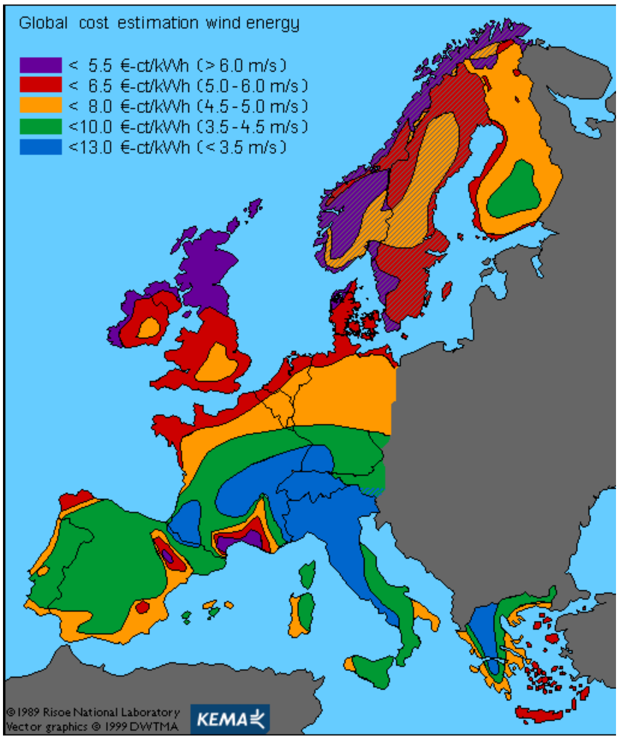

Figure 1 – Overview of European Wind Atlas
(No data is available for the Balkans and Eastern Europe)

Figure 2 – Photograph of 10 MW wind farm on flat land near the Atlantic coastline

The European Wind Atlas (Figure 1) shows that Scandinavia, UK, Ireland and the Atlantic coastline of the European continent have the best wind conditions for the development of wind energy. This wind atlas is combined with a contour map of the area to determine the wind speed at a specific site and height. The estimated wind distribution results in a yearly energy yield representing the gross income of the wind farm.

Figure 3 shows a power/wind speed curve (PV) of a 2 MW wind turbine with optimal efficiency, i.e. without noise reduction measures that usually result in reduced energy generation. Figure 4 shows a typical wind speed distribution based on the statistical Weibull function with shape factor of 2 and average wind speed of 7 m/s. This distribution indicates the number of hours per year that a particular wind speed may be expected. It is site dependent and must be determined.

The annual energy yield is calculated by multiplying the wind turbine power curve with the wind distribution function at site:

$$E_y = \left(\sum_{i=1}^{i=n} f_{w_i} \, P_{w_i} \right)$$

where:

E_y is annual energy yield in kWh

w is the wind speed in m/s

n is the number of data bins covering the wind speed range of the turbine (0.5 or 1 m/s intervals)

f_{wi} is the number of hours per year for which wind speed is w m/s (refer to Figure 4)

p_{wi} is the power resulting from a wind speed of w m/s

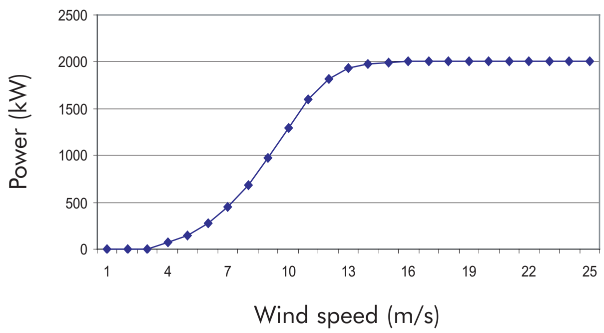

Figure 3 – Power/wind speed curve of a 2 MW wind turbine (without noise reduction measures)

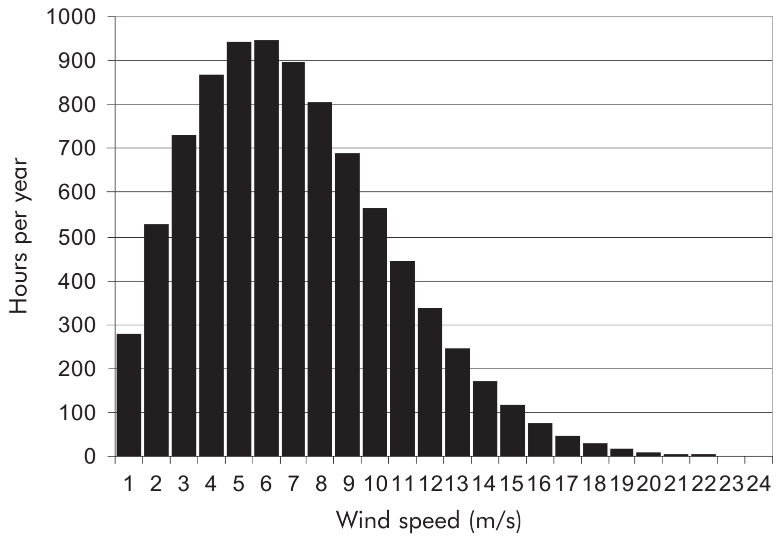

Figure 4 – Wind speed distribution, average wind speed 7 m/s and Weibull shape factor of 2

Based on the PV curve from Figure 3 and Weibull wind speed distribution with a shape factor of 2, the gross energy yield corresponding to 7 to 8.5 m/s is presented in Table 1.

Average wind speed	7.0 m/s	7.5 m/s	8.0 m/s	8.5 m/s
	Weibull shape factor = 2			
Wind farm power (MW)	10	10	10	10
Gross annual energy yield (MWh)	27 000	31 000	34 000	37 000
Equivalent full load hours	2 700	3 100	3 400	3 700

Table 1 – Gross yearly energy yield of a 10 MW wind farm as a function of average wind speed

The yearly gross energy yield of the 10 MW wind farm, assuming:

- 7 m/s average wind speed at hub height
- wind speed distribution according to Weibull distribution function, shape factor 2
- no noise reduction measures required

is 27 000 MWh, equivalent to 2700 full load hours (utilisation 31%).

Technical feasibility

Modern wind turbines are available in the power range from 0.75 to more than 3 MW, having rotor diameters varying from 55 to more than 100 metres. Although two-bladed rotors were also used in the past, nowadays only three-bladed rotors are commercially available. Generally, the hub height varies from 0.9 to 1.25 times the rotor diameter and most manufacturers offer wind turbines with two or three different rotor diameters corresponding to low (large rotor), medium (standard rotor) and high or offshore (small rotor) wind conditions.

At a first screening the outer dimensions of the available terrain are of importance. Wind turbines require a mutual spacing of at least four to five rotor diameters, corresponding to approximately 300 to 500 metres. A flat and undisturbed area is required because buildings, trees and other obstacles lead to a lowering of the wind speed.

It is also important to examine the local grid characteristics at an early stage. The main issue is the distance to the nearest medium or high voltage substation with an adequate feed-in capacity and the cost of installing this interconnection. Construction of this connection may require a lengthy planning cycle and involve a significant cost.

Main risk assessment

In most countries wind turbine rotors may not rotate above roads, railway tracks and waterways and a minimum clearance from public infrastructure must be observed. In northern countries and countries with a continental climate specific attention has to be paid to the possibility of icing. Ice developed on rotating rotor blades can be thrown long distances from the turbine, potentially causing injury and damage.

Planning authorities and regulatory bodies may require an additional risk analysis if the site is subject to icing or close to other infrastructure such as:

- facilities for transport, storage or processing of hazardous goods
- pipelines for transport of hazardous goods (including underground)
- residential, commercial or public buildings
- roads, railway tracks and waterways
- medium and high voltage conductors of transmission lines or cables.

Planning requirements of local authorities

The wind farm site has to meet planning and regulatory requirements. There may be a zoning plan that may prohibit wind turbines or limit the maximum height of structures. Under such circumstances the relevant authorities should be approached to investigate the possibility of obtaining permission at the earliest possible stage.

In most European countries wind turbines must be certified according to the relevant national or international safety standards. Manufacturers have to demonstrate conformance by the production of a valid ’type-certificate’.

For the proposed area for the 10 MW wind farm the following should be considered:

- check municipality zoning plan on competing activities and maximum building height
- mutual distance wind turbines 400 metres
- wind turbines in line, required length 1600 metres
- there are to be no dwellings or other buildings and as few obstacles as possible within 300 to 500 metres of the wind turbines
- authorities or concerned parties may request a risk analysis if other activities are to take place within 400 to 500 metres from the wind turbines.

Project financing

Tables 2 and 3 give examples of the investment and operational costs of a 10 MW wind farm consisting of five wind turbines of 2 MW each. The costs are fully proportional to the installed capacity: investment costs per MW installed are about 1.25 M EUR and annual operating cost somewhat more than 40 k EUR per MW.

	Costs per wind turbine [k EUR]	Wind farm costs [k EUR]
Preparatory costs	100	500
Wind turbines of 2 MW each	2 000	10 000
Wind farm civil and electrical infrastructure	200	1 000
Grid connection	200	1 000
Investment (year 1)	**2 500**	**12 500**
Refurbishment (at year 10)	250	1 250
TOTAL	**2 750**	**13 750**

Table 2 - Non-recurring investment costs (at 2006 levels)

Annual operating costs	Costs per wind turbine [k EUR]	Wind farm costs [k EUR]
Wind turbine service, maintenance and insurance	50	250
Local taxes and contribution to grid connection	10	50
Land lease	15	75
Daily management	5	25
Own electricity consumption	5	25
TOTAL	**85**	**425**

Table 3 - Annual operating and maintenance costs (at 2006 levels)

Investment and operational costs for a 10 MW wind farm (at 2006 levels):

- initial investment costs 12.5 M EUR (1.25 M EUR/MW)
- annual operational costs 0.425 M EUR (42.5 k EUR/MW)
- estimated refurbishment costs halfway through the life span 1.25 M EUR; i.e. 10% of the initial investment.

In most cases the wind farm is financed by a mix of capital (equity) and a bank loan. The amount of equity is usually limited to 20 to 40% of the total investment. It may be attractive for companies, investment groups and individuals to invest in wind energy for possible tax reduction benefits. A number of national governments in Europe have introduced incentives to promote electricity production by renewable sources, for example, by introducing tax allowances for investments in 'green' energy sources.

Pre-building phase

Having established the basic installation parameters, the predicted availability of wind, any planning constraints and connection possibilities, the task during this phase is to confirm the details and draw up detailed agreements so that project finance can be secured. To enable this to happen, a power purchase agreement (PPA) must be negotiated and suppliers of equipment and contractors selected. It is during this stage that any assumptions made during the start-up phase are re-examined and justified to avoid expenditure on a non-viable project.

Wind farm design including energy yield predictions

Based on the wind resource assessment the most promising wind farm locations are studied in more detail. 'WasP', 'Wind farmer' and 'WindPRO' are well known computer models to calculate energy yield. The modelling takes into account not only wind speed and direction distributions but also the geography and terrain; for instance, a steep slope in the terrain will cause higher winds at the hill top. Such details in the modelling ensure that wind turbines are optimally sited. Generally the layout is optimised for exposure to the prevailing wind direction.

The mutual distance between the wind turbines has to meet the requirements of the manufacturers. If the wind turbines are too close together output may be reduced. Another, more serious, consequence may be damage to primary structural parts caused by the wake of wind turbines sited upwind. The minimum distance depends on the siting with regard to the prevailing wind direction. For turbines sited perpendicular to the prevailing wind direction, the mutual separation distance has to be at least four and preferably five times the rotor diameter.

The gross energy yield of the wind farm is determined by the local wind distribution and the siting of the wind turbines. To calculate the net energy yield the anticipated losses must be determined. These losses include:

- wake losses
- grid losses
- availability.

Wake losses

Downstream of the turbine rotor, in the so-called wake, the wind speed is lower than the undisturbed wind speed, resulting in a somewhat reduced performance of other turbines sited in this area. The wake is characterised by extra turbulence that may lead to premature damage of main structural components.

It is common practice to estimate the wake losses as being in the range of 3 to 4% of the gross energy yield.

Grid losses

In this context, grid losses are defined as the electrical losses between wind turbine switchgear and public grid connection, i.e. the location of the metering position. Depending on the layout the electrical losses are in the range of 2 to 3% of the gross energy yield.

Availability

The availability of a wind turbine is defined as the percentage of time that the wind turbine is either in operation or available for operation should wind conditions permit and the grid connection be available. The technical availability of the turbine is 97% or higher, based on data from modern operational wind farms.

For this case study, we assume:

- 3% wake losses
- 3% grid losses
- 97% availability

The gross energy yield of 27 000 MWh becomes a net yield of 24 500 MWh.

Planning procedures

Environmental issues

The wind farm must comply with all relevant environmental regulations. This may require a number of studies of, for example, the effects on birds, animals and plant life during the construction and use phases.

Noise

Wind turbines produce noise, mostly caused by the rotor blades and drive train, and the noise impact of wind turbines on the environment is one of the major planning issues. The distance to nearby residential buildings has to be sufficient to ensure that the noise level at the house front is below the statutory limit.

Visual impact

Visual impact of a wind farm is an important planning consideration. Wind farms require open, often elevated, sites and are consequently highly visible from a distance. Many of the potentially most productive sites are in areas of great natural beauty where planning regulation is very restrictive.

Shadow flickering is due to the periodic – about once per second – interruption of the sunlight by the rotating blades. Both flickering and shadow casting on dwellings and offices can be very annoying for the occupants. Shadow flickering is not regulated by law.

Safety

Most planning authorities demand safety and risk assessment studies. Wind turbines are not permitted to rotate above roads or railway-tracks.

Where icing of the blades or nacelle is likely limitations may be placed on the operation of the turbines with the rotor being stopped during icing and only released for restart when the ice has dispersed.

Grid connection

Each of the turbines of the farm is connected to a farm grid, operating at medium voltage (10 to 20 kV) to minimise losses. Usually a ring connection is used to provide a degree of redundancy. Since the generators operate at, typically, less than 1 kV a transformer is required to step the voltage up to the grid voltage. The transformers may be housed in the nacelle or at the base of the tower.

The bulk connection equipment required depends on the operating voltage of the public grid at the connection point. A transformer may be required in addition to switching, metering and protection equipment.

In some locations there may be a suitable connection point or the available connection point may have insufficient capacity. The cost of work to extend or reinforce the grid specifically for the wind farm has to be borne fully by the wind farm developer.

Feed-in contract

In all cases a Power Purchase Agreement (PPA) or feed-in contract is necessary. The feed-in tariff is made up of a price for the production and delivery of electricity and, in most cases, an additional amount for generating renewable energy or corresponding carbon credits. Depending on the wind resources and the investment and operational costs, a feed-in tariff of at least 60 EUR/MWh is required to cover costs and, for an economically viable project, a tariff of 80 to 90 EUR/MWh is needed.

Selection of suppliers

Depending on the working practices of the wind farm developer, the tendering process may be public or restricted to a shortlist of pre-qualified or preferred suppliers. In either case, a 'Tender Enquiry Document' (TED) is required containing all the relevant information.

The TED should include at least the following information:

- basic information such as project time plan and planning status
- information required from bidders, e.g. financial, technical and operational information
- time schedule, e.g. tender closure date, consultation period, site visit opportunities
- contractual issues
- scope of supply
- technical specifications
- maintenance and repair conditions
- insurance and warrantee agreements.

With regard to the scope of supply it may be decided that a single contractor is responsible for delivering (by sub-contracting) a 'turnkey' wind farm including the wind turbines, foundations, access roads, wind farm grid and grid connection. Alternatively, the wind farm developer may manage the individual subcontracts. The latter may have cost advantages, however the project developer becomes the main contractor and is responsible for the integration commissioning, either internally or by appointing a contractor for this phase of the work. Turnkey delivery by one main contractor is usually the better option since responsibility is clearer.

It is important that the wind turbine is certified by a recognised body and possesses a type-certificate valid for the local wind climate and wind farm layout. In order to avoid any problems on warrantees the contractor should be required to state formally that the delivered wind turbines are 'fit for purpose' for the site as described by the developer.

Project financing

As noted earlier, for most sites in Europe wind energy is not yet cost-effective and incentives are essential to encourage investment in wind energy. The most common promotion measures are:

- subsidies (governmental or local) on investments in renewable energy sources
- tax benefits for investing in renewable energy sources
- reduced interest tariffs on loans for renewables
- subsidies on the production of renewable energy (i.e. increased feed-in tariff).

When financing is based for the greater part on loans, the financiers may ask for additional securities to guarantee that the loan can be repaid. The following securities may be requested:

- power purchase agreement with fixed minimum feed-in tariff for the loan period
- guarantee that, even in years with moderate wind resources, the income is sufficient to meet interest and capital repayment
- warrantees on supplied components and wind farm performance (availability and power curve) for the loan period
- machine breakdown and business interruption insurance
- service and maintenance contract.

Annex A gives cash flow calculations for two different feed-in tariffs over an anticipated lifespan of 20 years; the results are summarised in Table 4. Financing costs are not taken into account and all expenses and incomes are based on 2006 price levels so the influence of inflation is implicitly included.

Feed-in tariff	60 EUR/MWh	85 EUR/MWh
Gross income	1.47 M EUR/yr	2.08 M EUR/yr
Break even period	> 15 years	> 9 years
Net present value over 20 years (NPV)	6.1 M EUR	17.7 M EUR
Internal rate of return (IRR)	4%	11%

Table 4 – Summary of cash flow calculations for a 10 MW wind farm (see Annex A)

The calculations show that, at a feed-in tariff of 60 EUR/MWh, the rate of return of 4% is just enough to cover the cost of financing the project (assuming the project is fully financed by a bank loan) and no profit is generated. At a tariff of 85 EUR/MWh the project generates an 11% return gross, or 7% after paying the costs of financing the project.

Building phase

The building phase includes all activities from commencement of the works up to handover of the operational wind farm to the operator.

Overview of the building process

Once all the previous stages have been concluded, and the status reviewed, the manufacturing and build stage can commence.

Wind turbines are large and heavy so suitable site access for transport is required. On-site storage and on-site assembly work will require space at the base of each tower of approximately 80 by 50 metres. In addition, heavy lifting equipment will be required on site – a 2 MW turbine will require a caterpillar crane with a capacity of 600 tonnes for hoisting of the tower parts, nacelle and rotor into position.

Manufacturing and assembly of the main components takes place in the factories of the wind turbine supplier and the following assembled main components are then shipped to site:

- foundation anchor or tube
- three or four tubular tower parts
- ground controller and switchgear
- fully assembled nacelle (including gearbox, generator, yaw mechanism, mechanical break, converter and transformer, if applicable)
- hub and rotor blades
- wind farm Supervisory Control and Data Acquisition system (SCADA)
- transformer (in case of ground based).

For a small and medium size wind farm the time between placing a purchase order and shipment from the factory is 6 to 9 months. In the meantime the civil engineering work, including access roads, turbine foundations and substation, and the electrical infrastructure, is built. The time required for rotor assembly and construction of the main structure takes 2 to 3 working days per wind turbine. Once the turbines are installed, about 7 to 10 working days are needed to complete the installation work, commission the system and make the connection to the grid.

From the time all the material is on site the construction time of a small and medium size wind farm takes only 2 to 3 months.

Quality control during production and construction

It is common practice that the contractor assigns a number of so-called ‘hold and witness’ points for the client. These hold and witness points are meant for the wind farm owner to audit the progress and quality of work including the verification that the components conform to the specifications. Hold and witness points are mostly planned immediately following a project milestone, for instance a main component ready for transport to site. Often, hold and witness points are linked to staged payments against the contract.

Typical hold and witness points are:

- start of component production including audit of contractors' quality system
- factory acceptance test (FAT) of components ready for shipment
- site acceptance test (SAT) of components delivered to site
- several inspections during building on site, connected to milestones.

Commissioning and handover

Following completion of the building and installation period, and before handover of the wind farm, an overall inspection and commissioning of the works is carried out. Commissioning inspections are performed by representatives of the contractor and the final owner, with participation from the local network operator. The commissioning may involve an elaborate testing and monitoring plan, but the main objective is to verify that the system is complete, correctly installed and functioning properly. Normally a commissioning procedure is formulated in co-operation with all the parties involved.

It is quite common that a number of defects are discovered during the first commissioning inspection, resulting in a defect or 'snag' list. Actions to clear this list are decided between the parties concerned and, if there are serious defects, may result in a second commissioning inspection being required.

Approved commissioning and handover is usually related to final project payment.

Operation and maintenance

Starting from date of handover, the owner is responsible for the daily operation of the wind farm. Also, from that date warranty and maintenance contracts become valid. The technical and economical life span of a wind farm is anticipated as 20 years.

Daily operation

During normal operation it is not necessary to man the site. SCADA equipment allows remote monitoring, via a modem and telephone line or via the internet, of the performance and condition of the turbines and the farm.

The main function of the daily operator is to verify regularly that the wind farm is in the optimum condition and performing according to expectation and to ensure that maintenance and repairs are carried out in accordance with the contract and within a reasonable time.

Warranties and insurance

The following warranties are common for the first five years following handover:

- on delivered goods, including repairs and modifications
- availability of individual wind turbines and wind farm, values of 95% or higher are not uncommon
- performance according to the power curve - warranties of 95% of the certified turbine PV-curve are common. No warranty on actual performance can be given because the exact wind supply cannot be predicted.

If the availability or performance is below the warranted value, the difference between actual and warranted values has to be settled by the supplier. Some suppliers offer warranties of up to 8 to 12 years, or at least for a period comparable to the financing period.

Insurance cover is required for:

- third party liability
- machine breakdown (e.g. material flaws, lightning strikes, fire, vandalism, actions of maintenance engineer and/or operator, etc.)
- business interruption (compensation for unproductive days following a machine breakdown event).

Maintenance and repair

Modern wind turbines require a preventive maintenance service twice a year. For a wind turbine in the MW-segment a planned preventive maintenance overhaul requires 2 to 3 working days for two engineers. The work includes inspection and testing of the control and safety devices, repair of small defects, replacement or replenishment of consumables such as bearing grease and gearbox lubrication. The gearbox is the most vulnerable component and therefore the subject of special interest during maintenance. Oil samples are taken at regular intervals and analysed for signs of degradation, filters are replaced and gears are inspected for damage.

The number of repairs required varies widely between different wind turbines and wind farms. On average, 3 to 4 corrective actions (i.e. those requiring a visit by a service engineer) are required for each turbine. The mean downtime per failure is 2 to 4 days and the causes are equally divided between mechanical and electrical problems.

Although not formally admitted by the manufacturers, it is common practice that a major overhaul is carried out on wind turbines after 10 to 12 years of operation. The overhaul includes cleaning of, and repair work to the rotor blades and refurbishment of the drive train, i.e. replacement of bearings and, if necessary, replacement of gearbox parts.

Annex A – Examples of two cash flow calculations for a 10 MW wind farm

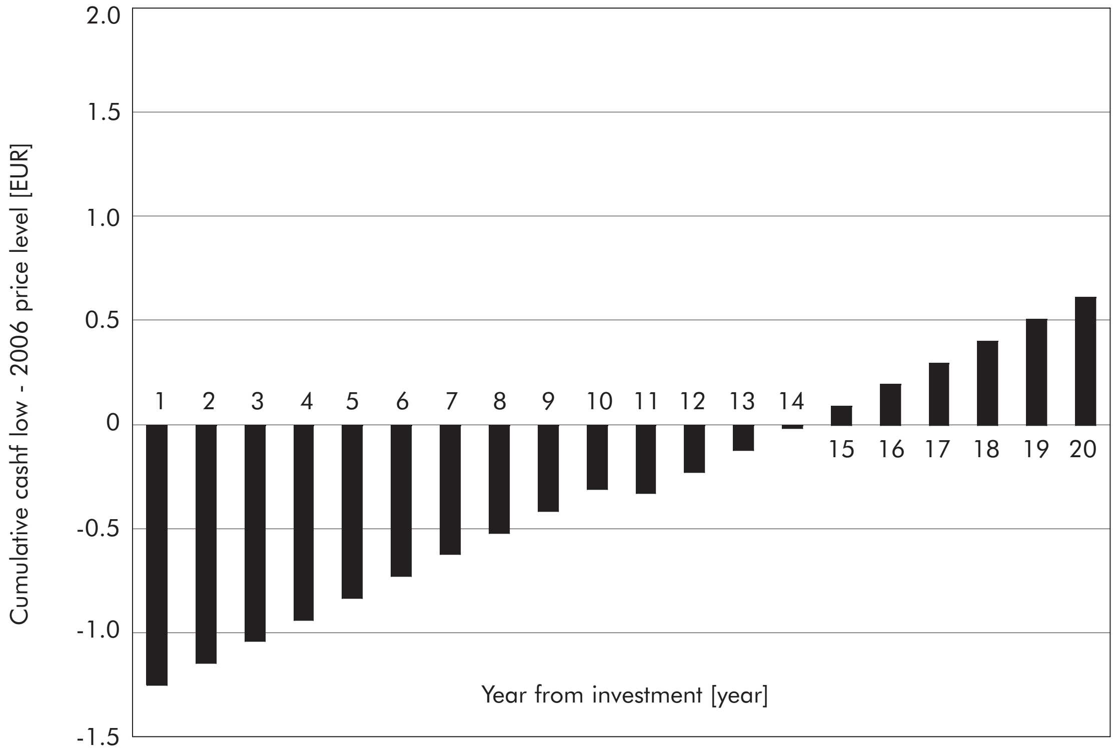

Figure A1 - Cash flow for 10 MW wind farm at 60 EUR/MWh

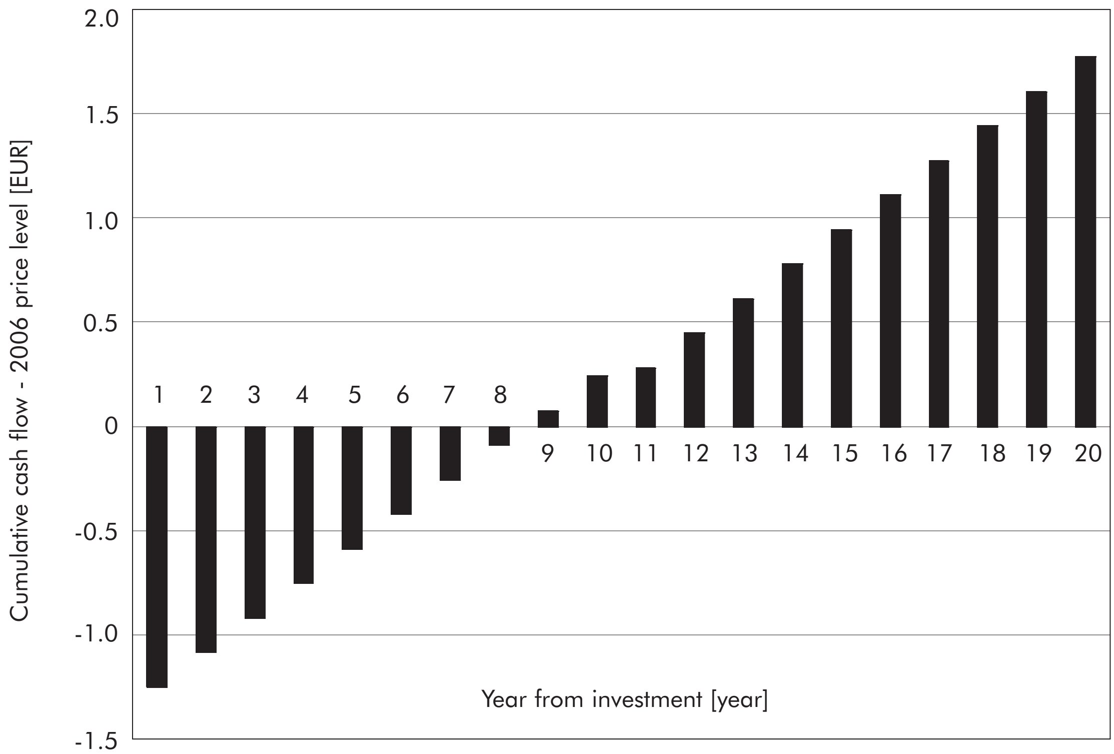

Figure A2 - Cash flow for 10 MW wind farm at 85 EUR/MWh

Feed in tariff	0.060	0.085	EUR/kWh
Investment costs (year 1)	12 500 000	12 500 000	EUR
Refurbishment costs (year 10)	1 250 000	1 250 000	EUR
Yearly wind farm production in kWh	24 500 000	24 500 000	kWh
Gross income from energy production	1 470 000	2 082 500	EUR
Yearly recurring costs	425 000	425 000	EUR
Break even period	15	9	years
Net Present Value (2006 price level, 20 year life)	6 100 000	17 750 000	EUR
Internal Rate of Return	4	11	%

Table A1 - Summary of cash flow for a 10 MW farm. No financing costs are included. 2006 prices levels

Notes

Notes

Reference & Founding* Partners

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