An environmentally friendly investment

Lifecycle Assessment of a V80-2.0 MW onshore wind turbine
Assessing a Wind Turbine’s Lifecycle

In 2006, Vestas conducted a Lifecycle Assessment (LCA) of a V80-2.0 MW onshore wind power plant. The LCA surveys and evaluates the environmental impact of the wind power plant throughout its lifecycle. The LCA proves that wind power offers a strong environmental performance over the lifecycle of a wind turbine.

The LCA assesses the entire lifecycle of a wind turbine: Extraction and manufacturing of raw materials and production of wind turbines, transportation, erection, operation, maintenance, dismantling and disposal of the wind turbines, their foundation and the transmission grid. The figure below illustrates the lifecycle.

A V80-2.0 MW ONSHORE WIND TURBINE ON AN AVERAGE LOCATION PRODUCES 31 TIMES MORE RENEWABLE ENERGY THAN IT CONSUMES DURING A 20 YEAR PERIOD.
THE ENERGY BALANCE OF A V80-2.0 MW ONSHORE WIND TURBINE IS ONLY 7.7 MONTHS

Outstanding energy balance

A wind turbine’s energy balance reflects the time the turbine needs to be in operation before it has produced as much energy as it consumes throughout its lifecycle. The figure below illustrates how much energy a V80-2.0 MW onshore wind turbine produces through its entire lifecycle. It will generate approximately 113,000 MWh during a 20 year period, which is 20 years. The average energy balance of a V80-2.0 MW is just 7.7 months.
VESTAS WIND TURBINES REDUCE CO₂ EMISSIONS BY MORE THAN 40 MILLION TONS PER YEAR

CO₂ emissions for 1 kWh electricity produced by:

Low CO₂ emissions

On an average location, A V80-2.0 MW onshore wind turbine will generate around 113,000 MWh during a 20 year period, sparing the environment approx. 93,000 tons of CO₂ compared to energy production at a coal-fired power plant. The figure above compares the CO₂ emissions per 1 kWh produced by a V80-2.0 MW onshore, wind turbine and a gas- and coal-fired power plant.

Energy consumption

The most energy-intensive part of a wind turbine’s lifetime involves metal extraction and processing, which account for about 50 per cent of the total energy consumption. This is illustrated in the figure below, which shows the CO₂ emission of the turbine in its expected life time divided into main categories.
ABOUT 80% OF A V80-2.0 MW
ONSHORE WIND TURBINE CAN BE RECYCLED
Lifecycle of a V80-2.0 MW onshore wind turbine

Most of the resources used by wind power plants are consumed during production – which is also the lifecycle phase where a turbine has the biggest impact on the environment. It is primarily the extraction of iron ore for the production of steel components and the casting of these that impacts the environment. 100% of the iron and steel is recycled when the turbine is dismantled.

The manufacturing phase covers the extraction of raw materials, sub-contractor manufacturing and Vestas’ own production of the foundation, tower, nacelle and blades.

The entire lifecycle is illustrated in the figure below.

Ressources used to produce, erect and commision a wind turbine

Input: Materials, chemicals and energy
- Steel, cast iron, copper, plastic, carbon fibers, glass fibers, epoxy, energy
- Concrete, gravel, machine work, oil, energy
- Oil, energy, components
- Machine work, oil, energy

Output: Bi-products, waste and emissions to air and water, energy
- Waste, CO\(_2\), NO\(_x\), SO\(_2\) etc.
- Waste, CO\(_2\), NO\(_x\), SO\(_2\) etc.
- Waste, Oil
- Renewable electricity
- Waste, CO\(_2\), NO\(_x\), SO\(_2\) etc.
Recycling reduces global warming

A wind turbine is designed to produce renewable energy for up to 20 years. During the phase of operation and maintenance, the turbine’s impact on the environment is minimal. When the turbine is dismantled, about 80% of a V80-2.0 MW onshore wind turbine on a 78-meter tower can be recycled, sparing the environment the impact of extracting new materials. Fiberglass elements are incinerated in a system that uses heat recovery, and the waste are carefully deposited.

Some types of steel, iron, copper, aluminum and lead are expected to be recycled 100%, which is an important target for Vestas. In the production of a V80-2.0 MW, a 10% increase in recycling of metal will reduce global warming by 8%.
IN THE PRODUCTION OF A V80-2.0 MW ONSHORE
A 10% INCREASE IN RECYCLING OF METAL WILL
REDUCE GLOBAL WARMING BY 8%

Ressources used to produce, erect and commission a wind turbine

<table>
<thead>
<tr>
<th>Materials</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>1 Rotor Blades and hub incl. spinner</td>
<td>37 tons</td>
</tr>
<tr>
<td>2 Blade Fiberglass, epoxy and carbon fiber</td>
<td>20 tons</td>
</tr>
<tr>
<td>3 Hub incl. spinner Cast iron, steel, fiberglass and polyester</td>
<td>17 tons</td>
</tr>
<tr>
<td>4 Gear Cast iron and steel</td>
<td></td>
</tr>
<tr>
<td>5 Generator Cast iron, steel and copper</td>
<td></td>
</tr>
<tr>
<td>6 Transformer Steel, copper, aluminum and epoxy</td>
<td></td>
</tr>
<tr>
<td>7 Nacelle</td>
<td>61 tons</td>
</tr>
<tr>
<td>8 Main foundation Cast iron</td>
<td></td>
</tr>
<tr>
<td>9 Electricity switchboard approx</td>
<td></td>
</tr>
<tr>
<td>10 Tower (78m) Steel with surface coating</td>
<td>165 tons</td>
</tr>
<tr>
<td>11 Cover Fiberglass, steel and plastic</td>
<td></td>
</tr>
<tr>
<td>12 Yaw system Cast iron, steel and plastic</td>
<td></td>
</tr>
<tr>
<td>A Foundation Steel, aluminum and concrete</td>
<td>832 tons</td>
</tr>
<tr>
<td>Various Electronic components, cables, plastic, oil, etc.</td>
<td></td>
</tr>
</tbody>
</table>

PVC plastic, which can be sorted, is deposited. The rest is incinerated. The rest of the plastic and rubber is incinerated with heat recovery.
Impact on local surroundings

The impact of a finished turbine on the local surroundings can largely be divided into:

- Emissions of noise
- The visual impact
- Impact on birds, bats, etc.

When planning a wind power plant, its impact on local surroundings must be taken into careful consideration. Vestas offers the means to reduce noise levels, and we keep the wind turbines’ visual impact and their impact on birds, animals and marine life at acceptable levels.

The impact on the local surroundings of a wind turbine is different at various sites, so we assess it separately at each project.

Information

The assessment is based on ISO 14040-43 and EDIP methods. This environmental product declaration is based on the LCA, which you will find at www.vestas.com. Lifecycle assessments for V90-3.0 MW, V82-1.65 MW and V80-2.0 MW wind turbines are available at www.vestas.com under “Sustainability” – where environmental product declarations for each wind turbine type will also be published as LCAs are prepared. General assumptions for the environmental product declaration: Verified structural design lifetime of a wind turbine: 20 years Average annual production: 5,634,000 KWh.

All the data in this environmental product declaration is calculated per KWh of electricity generated.