Wind energy will displace fuel consumed in other power plants and thereby reduce emissions. The fact that wind energy will also increase balancing needs has raised concern about the less-efficient use of other power plants due to cycling up and down to balance the system. However, studies show that emissions due to increased cycling of power plants are small compared to the benefits of reducing their overall generation and fuel use.

How does wind power reduce emissions?

Wind power is a renewable electricity generation source that does not emit CO₂ in operation. It has very low life cycle CO₂ emissions when compared with fossil fuelled generation. When wind power is generated it will displace generation from power plants, reducing their fuel use and emissions of CO₂, NOₓ, SO₂, and particulates. What power plant generation and fuel will be displaced depends on the cost structure of operating power plants, as well as timing. During each hour, the generation that has most expensive operational costs will be reduced, usually fossil fuelled generation. If the fuel displaced is coal, the emission benefits are greater than when displacing natural gas. Examples of studies showing the emission reductions of wind power can be seen in Figure 1.

Does wind power variability cause extra emissions?

At high levels of wind generation, fuel-consuming generators will experience steeper ramps and will be starting up and shutting down more often. This is to respond to changing dispatch orders to compensate for total fluctuation in system - variation in wind generation and demand. When fossil fuel power plants start up, ramp output up or down, or operate at less than full load, they are less efficient in fuel use than when they run continuously at full load. This results in more CO₂ and other emissions.

Detailed studies have shown that even in power systems with large amounts of wind power, extra emissions from balancing needs are not much. The main impact of replacing coal and gas generated electricity and reducing fuel use and emissions is order of magnitude greater than increased emissions from cycling the power plants.
For example, providing 33% of annual electricity needs with wind and solar energy, balancing related emissions are less than 2% of the emission reductions from decreased fuel use. (Source: Lew et al., 2013) (Figure 2 and 3)

<table>
<thead>
<tr>
<th>Emission Reduction Due to Renewables</th>
<th>Cycling Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>260-300 billion lbs</td>
</tr>
<tr>
<td></td>
<td>29%–34%</td>
</tr>
<tr>
<td>NOₓ</td>
<td>170-230 million lbs</td>
</tr>
<tr>
<td></td>
<td>16%–22%</td>
</tr>
<tr>
<td>SO₂</td>
<td>80-140 million lbs</td>
</tr>
<tr>
<td></td>
<td>14%–24%</td>
</tr>
</tbody>
</table>

Figure 3. The increase in plant emissions from cycling to accommodate variable renewables is very low compared to the overall reduction in CO₂, NOₓ, and SO₂ due to adding renewables. (Source: WWSIS2, 2013) (1 million lbs = .45 million Kg)

Associated publications


More information

This Fact Sheet draws from the work of IEA Wind Task 25—a research collaboration among 18 countries. The vision is to provide information to facilitate the highest economically feasible wind energy share within electricity power systems worldwide. IEA Wind Task 25 works on analysing and further developing the methodology to assess the impact of wind power on power systems.

See our website at [https://community.ieawind.org/task25](https://community.ieawind.org/task25)

See also other fact sheets

Wind Integration Issues Fact Sheet
Storage Needs and Wind Power Fact Sheet
Balancing Power Systems with Wind Power