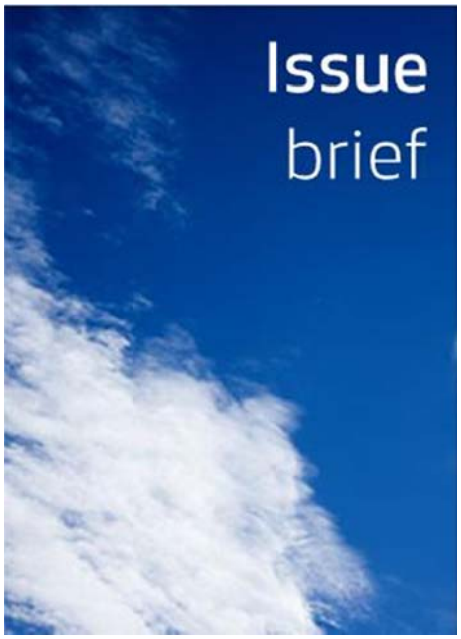
Vestas



Cost of Energy

This issue brief provides more information on the topics discussed in the five Vestas videos addressing Cost of Energy.

Contents

May 2011 By Group Government Relations

Cost of Energy (CoE), Global

Why focus on cost of energy

Everyone needs energy, and generating energy consumes limited resources and in many cases limited natural resources like fossil fuels. Everyone and everything requires energy. The cost of energy matters for the competitiveness of local business, for creating and maintaining local jobs, and for economic growth. If energy is too expensive, it limits growth and prosperity.

As a society, we run risks in planning our future energy supply because we don't know what the cost of energy or fuel is going to be in the future. We need to limit the risks associated with our energy choices compared to the current energy mix. We need to get the most power out of our investment both today and in the future. How do we ensure that the best energy choices are made? We focus on the cost of energy.

If we want to secure a more stable and sustainable energy supply in the future, we have to look into better long term alternatives – we need to include wind energy in our future energy mix.

What is cost of energy?

It is the total cost of generating 1 kWh of power from a power plant, and includes the cost of building, fueling and operating the power plant.

Building blocks of cost of energy

Cost of energy consists of many building blocks, both direct and indirect. When choosing our power sources, we should take both the direct and the indirect costs of energy into account.

Direct costs

CAPEX

The capital expenditure (CAPEX), or initial cost, covers all the costs associated with building a power plant. It also includes the cost of capital, that is, the interest rate you have to pay to get funding.

"*The influence of interest rates on the cost of wind power generation cannot be over-emphasized. […] A single percentage point change in the project interest rate has a significant effect on the end price of the electricity produced.*"

David Milborrow, Windpower Monthly article in 2010

OPEX

The operating costs (OPEX) cover operations and maintenance, and, for some energy forms, the cost of fuel (purchasing or drilling/mining and transporting the fuel used at the power plant), purchasing carbon permits for fossil fuel energy that emits greenhouse gases, and storing waste.

The potential price volatility of some fuel types can also have a cost to society, as the risk of large price fluctuations increases energy costs for all.

Costs are project specific

"Pinning a single figure to the cost of wind power is a meaningless exercise given the range of installed costs, the number of operating cost variables, the strong influence of wind speeds on wind power economics and the equally strong influence of interest rates on project financing."

"The precise cost competitiveness [of nuclear, coal, gas, hydro and wind] depends more than anything on the local characteristics of each particular market and their associated cost of financing as well as CO_2 and fossil fuel prices."

Sources: David Milborrow, Windpower Monthly article in 2010, IEA 2010 (respectively)

Indirect costs

The indirect costs are many and often hard to quantify. Indirect costs are often divided into social and environmental costs. Most of the indirect costs of energy are currently not carried by the owners of the power plants but by citizens and society.

Social costs

Among the social costs we can name the potential health costs – the cost of hospitals, doctor visits and medicine as a result of the emissions from a power plant, or as a result of an accident at a power plant.

Environmental costs

Among the environmental costs we can also name the costs of air pollution and waste – polluting drinking water, destroying nature areas, and also the cost of using fresh water for cooling in power plants, impacting both the environment and people.

Climate change

The costs of climate change as a result of fossil fueled power plant emissions affect both society and the environment. The effects of climate change range from local changes to weather and the environment to global changes and the associated costs of rebuilding, of lost economic activity, of crop failures and water and food shortages, of higher insurance premiums.

Estimating indirect costs

There are many uncertainties in estimates of the indirect costs or the avoided costs of fossil-fuel power generation, however, existing research suggests these costs can surpass the direct costs of energy, sometimes many times over.

The U.S. National Academy of Sciences concludes that *"the life cycle effects of coal and the waste stream generated are costing the U.S. public a third to over one-half of a trillion dollars annually. […] Accounting for the [cumulative] damages conservatively doubles to triples the price of electricity from coal per kWh generated, making wind […] economically competitive."* Their estimated value of coal externalities is $178.4/MWh, which does not represent the full burden of coal due to difficulty in monetizing all the impacts, and therefore they go on and state that "*the true ecological and health costs of coal are thus far greater than the numbers suggest.*"

Source: Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use, 2010

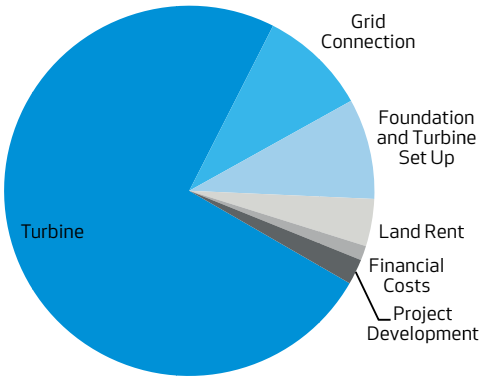
Costs of different power sources

Wind energy

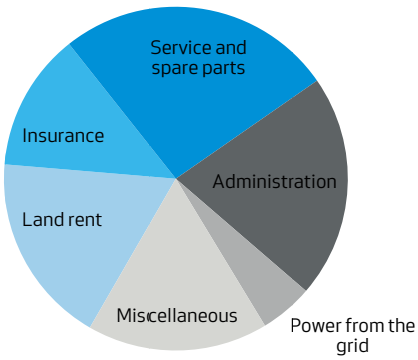
Wind power, like most renewables, has a high initial investment compared to operating costs, but the latter are low. The cost of wind energy is most impacted by variations in the load factor (how often the power plant runs, which reflects the energy resource among others). While the power output is variable it is stable and predictable over longer periods. There is no fuel cost, no carbon cost and virtually no environmental cost. Onshore wind energy is already competitive with conventional power sources in some cases, and further cost improvements are expected.

The pie charts show typical cost profiles for an onshore wind farm. Costs for offshore wind are higher than for onshore, but this is offset by higher energy production in most cases. The higher offshore costs are due primarily to higher foundation and grid costs; the turbines account for a smaller percentage of the total cost.

Average cost profile for onshore wind farm



Average operating cost profile for onshore wind farm



Source for both pie charts EWEA 2009, data from 2006

Cost of energy varies…

The cost of energy is not a fixed value for each power source but comprises a range of values dependent on source, location and time. These values are affected by local political and regulatory conditions, by macro-economic factors, by financing options available and by the structure of power markets and transmission systems.

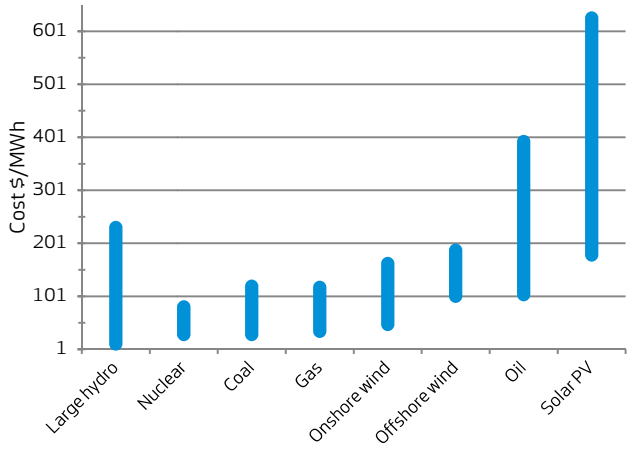
Comparing power sources

Due to the challenge of monetizing the indirect costs of energy, many comparisons include only the direct cost components.

The benefit of comparing power sources based on both the direct and indirect components is that it will provide the best basis for making long term energy decisions. However, the comparison should be on a common basis with the same assumptions for all technologies, based on the full lifetime costs. When you include all of the actual costs into the calculations, wind energy can be a competitive power source – and already is in some cases.

The graph below shows levelized cost of electricity from various power sources in 2009, based on data collected from OECD and BRICS countries. The graph highlights that large variability in costs and is based only on direct costs- the indirect costs of energy are not included.

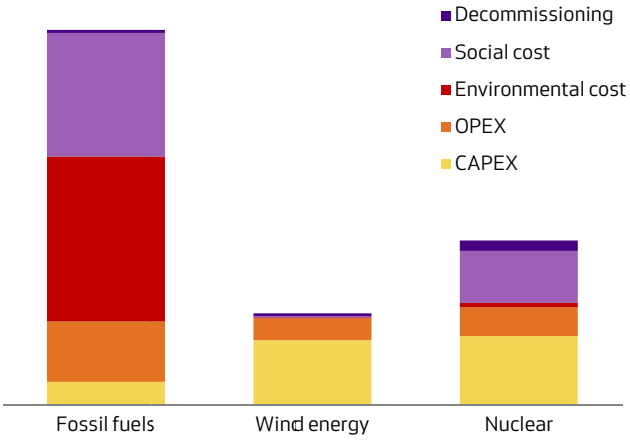
Cost ranges for selected energy technologies



Source IEA 2010

The graph below shows average direct and estimated indirect costs for fossil fuels, wind energy and nuclear power. There is a large variability hidden in the data, however there is little doubt that the indirect cost components play a significant role for fossil fuels and can play a potentially large role in the case of nuclear energy.

Average direct and indirect costs for selected energy types



Sources: Direct costs compiled from EER 2009 and 2010 and IEA 2010. Indirect costs compiled and/or calculated based on data from EPA 2011, World Bank 2011, and Stern Review 2006. Fossil fuel data based on supercritical coal and CCGT gas technologies. Wind energy data based on onshore wind plants. Nuclear data based on generation III technology.

Relative impact of different cost components

Variations in the direct cost components of energy impact different energy technologies in unique ways as a result of their cost structures.

For fossil fuel-based technologies variations in the fuel price have the largest effect on the levelized cost of energy. A 50% increase in the fuel price can cause the cost of electricity to increase by more than a third depending on the fuel. Fossil fuels or nuclear power-based power plants have a lasting - and most likely rising - fuel cost, and the fuel cost for wind is zero.

Fossil fuel-based power plants will - or potentially already do – have a price on their emissions of carbon and other pollutants, and that price is also zero for wind energy.

Reducing cost of energy

The cost of energy for various sources fluctuates over time and some trends can be seen for different sources. The cost of wind energy is still falling.

What Vestas is doing

Vestas works in a focused way to continue lowering the cost of energy through technological advances in turbine technology. This means that we make turbines that are finely tuned to each type of wind speed and each type of site. Another key focus area is to make the power production from our turbines as stable, predictable and efficient as possible. Vestas gives guarantees for availability and lost production thereby reducing risks further. In that way we get the most energy out of every blade and every turbine, lowering the cost of energy compared to the installed amount of MW.

How governments can help

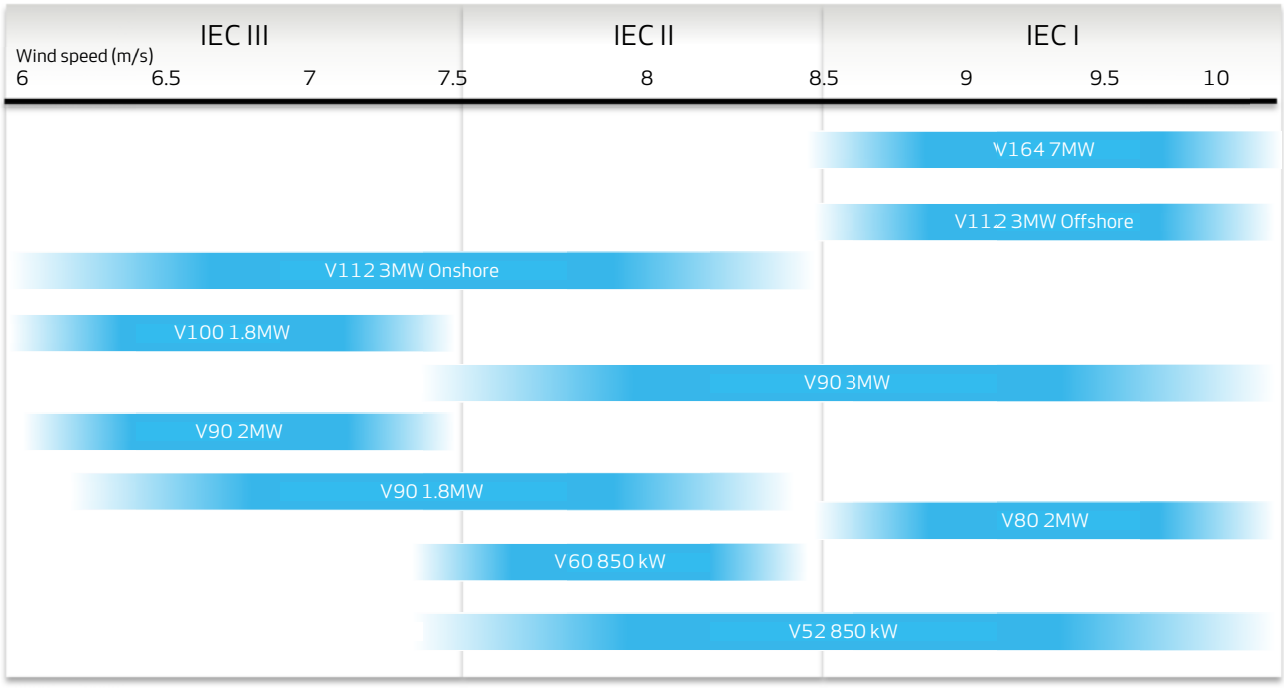
Governments play an important part in lowering the cost of energy by reducing risks and indirect costs for wind project developers and owners.

Many potential risks can impact energy investments, and every risk has a cost. Risks have an impact on the interest rates for getting funding, and they can be reduced by addressing political and regulatory uncertainties: the more political and regulatory uncertainties there are around wind energy, the higher the risk premium that an investor will require and the higher the interest rate that a bank will demand. This higher risk makes it more expensive to fund wind projects – increasing the direct cost of energy. The clearer and more transparent the rules are for planning and developing a project, for financial compensation, for grid connection, and for all the other factors that impact energy projects, the more certain the projected return on investment – and the lower the cost of project funding, which lowers the final cost of energy.

In addition, governments can lower the cost of energy through stable support schemes, further reducing the risk of investing in wind energy. Support schemes can make revenue from a wind project more predictable, which make the projected return on investment more certain. Again, this decreases the cost of borrowing money, which again decreases the cost of energy.

Vestas product portfolio

A range of turbines suited to specific wind speeds and conditions, customizable for various environments and requirements.



Our energy future

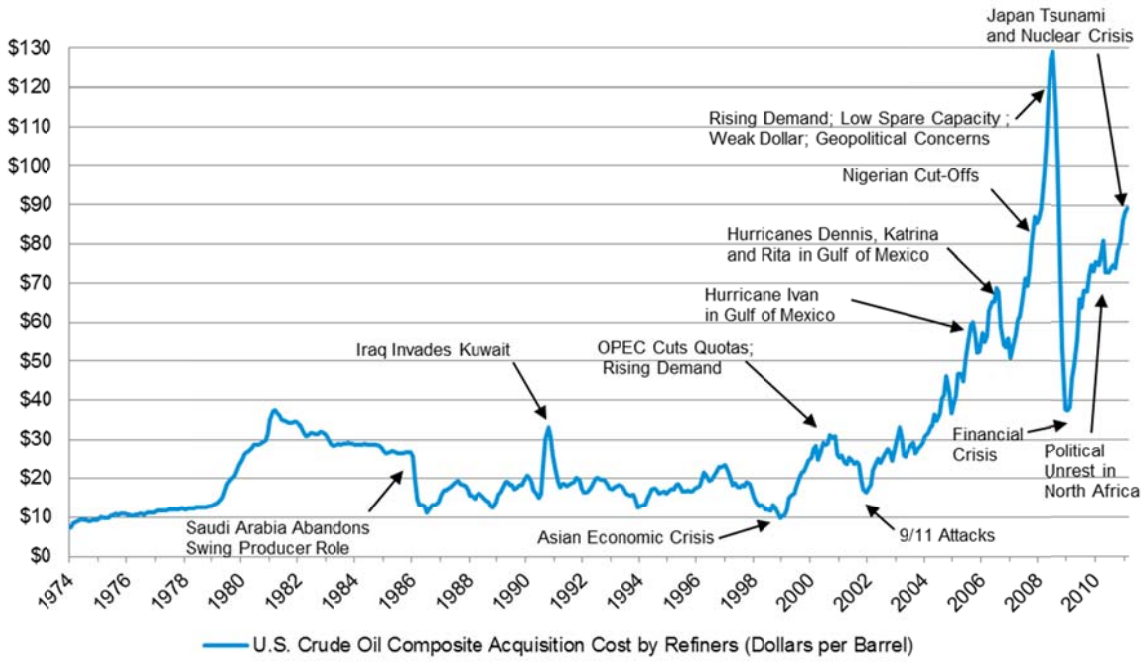
We keep the cost of energy low and stable in the future by making the right decisions now regarding what power technologies and what types of fuel to rely on. We need to focus on both the direct and indirect components of cost of energy. Reducing our dependency on limited resources such as non-renewable fuels is a way to secure a stable, predictable and affordable energy supply for the future.

Building a power plant today is a bet on future energy and fuel prices in terms of future cost of energy. Building a fossil fueled power plant is a bet on future fossil fuel prices and the price of carbon emissions. Fossil fuel costs have remained high despite the financial crisis and resulting deep recession in most of the world and energy experts including the IEA warn of a further rebound in fuel costs due to growth in developing economies.

Wind energy is a less risky future energy investment than fuel-based energy because wind energy has a stable and certain cost model imbedded – there are no fuel costs, no carbon costs and virtually no environmental costs. So all in all, wind energy is the safest bet for our energy future. Including wind energy in both short- and long-term energy planning will continue ensuring a local, stable, predictable, clean and affordable power supply for many countries.

Oil price chronology 1974-2011

Dollars per barrel



Source: EIA

FAQ

Question	Answer
What's the difference between cost of energy and price of energy?	The cost of energy is what it costs to actually generate power, whereas the price of energy refers to the rates paid for the use of energy. The price of energy may include fees, taxes, grid and transmission costs, among others, beyond simply the cost of energy. The price reflects supply and demand of power and the existing transmission infrastructure – it may not express the true cost of generating that electricity.
Why use levelized cost of energy and new-build power plants for comparing cost of energy for various energy sources?	When comparing power plants the comparison should always use the levelized cost of energy, which takes into account the full lifetime costs, rather than the energy price at any given time. Moreover a comparison should always be made between new-build power plants, since the costs for existing power plants represent the cost of resources at the time when they were built and over their operating time, which may have changed significantly compared to new-build power plants, even those of the same type.
Why are there differences in the cost of energy calculated by different institutions?	There are differences in the estimates for cost of energy published by different institutions for the same power sources because to calculate cost of energy, you need to express the full lifetime costs of a power plant as net present value – what those costs would be today. Different institutions may choose different costs and factors depending on the data they have and the accuracy thereof, where they are, the macro-economic situation, and their assessment of the risks for each technology and each situation.
How about the balancing and system integration costs for wind?	Levelized cost of energy can be used at the individual project level or at the electricity system-wide level; in order to compare technologies, using it at the individual project level makes more sense. Balancing and system integration costs are relevant when discussing the system-wide cost of energy. For more information on this please contact GR Operations in Group Government Relations at governmentrelations@vestas.com.

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