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# International Collaboration on the Cost of Wind Energy Under IEA Wind Task 26

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iea wind

Cost of Wind Energy Task 26

## Abstract

Thirteen international wind energy experts are researching and analyzing the cost of onshore wind energy, under International Energy Agency (IEA) Wind Task 26 – Cost of Wind Energy. This collaboration examines country-specific cost variables and inter-country differences in the cost of electricity generation (capital costs, wind regimes, national support policies, operational expenditures, financing terms, etc.). Wind energy experts from each participating country provide precise data, and the working group has developed an Excel-based cost of energy model that will be released publicly.

## Objectives

- To establish an international forum for exchange of knowledge and information related to the cost of wind energy.
- To identify the major drivers of wind energy costs, such as capital investment, installation costs, operations and maintenance, replacement, and finance; and to quantify the elements of the cost of wind energy unique to each participating country.
- To develop an internationally accepted, transparent method for calculating the cost of wind energy that can be used by various energy agencies and other organizations.

## Methods

**1)** The first step of Task 26 was for each task member to compile wind energy cost and project features data representing an average onshore wind project in their country in 2007/2008. Data included capital and operating costs, financing terms, policy support mechanisms, and other critical cost of wind energy variables.

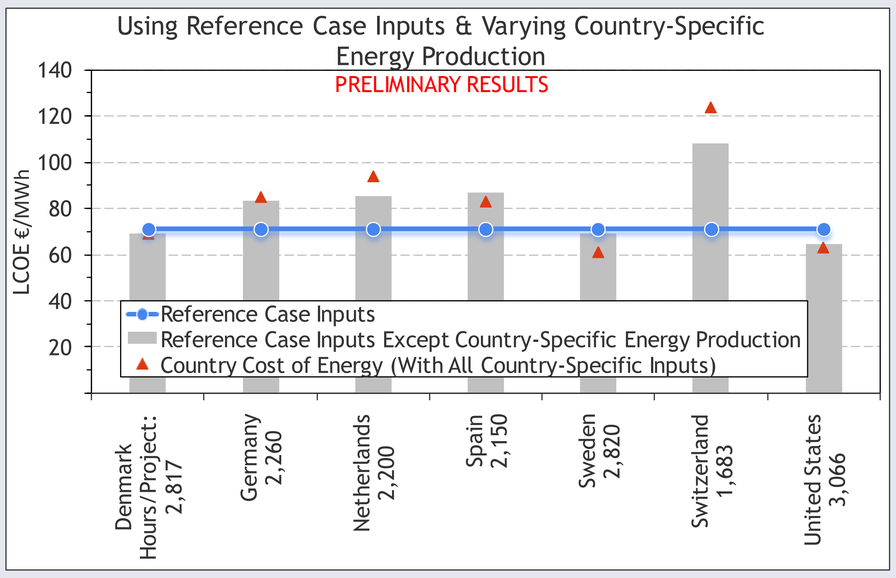
**2)** After collection and verification of data, each participant then estimated the cost of wind energy in their representative country. A detailed levelized cost of energy (LCOE) model was provided to all members. The model was developed by ECN researchers and was thoroughly examined by IEA Task 26 members. When the task is complete, the model will be available publicly for use as an independent cost of wind energy estimation tool.

**3)** Lastly, cross-country analysis on the cost of wind energy was performed to indentify interesting differences across countries and in comparison to a baseline wind energy project (the Reference Case).

### Data Collection: Wind Energy Cost Variables by Country

| | | Denmark | Germany | Netherlands | Spain | Sweden | Switzerland | United States | Reference Case |
|---|---|---|---|---|---|---|---|---|---|
| Technical Parameters | Unit size (MW) | 2.3 | 2.0 | 3.0 | 2.0 | 2.4 | 2.0 | 1.7 | 2.1 |
| | Number of Turbines | 7 | 3 | 5 | 15 | 41 | 6 | 50 | 34 |
| | Full load hours (h/yr) | 2,817 | 2,260 | 2,200 | 2,150 | 2,820 | 1,683 | 3,066 | 2,720 |
| | Capital costs (€/kW) | 1,404 | 1,373 | 1,325 | 1,250 | 1,591 | 1,790 | 1,377 | 1,460 |
| | Decommisioning costs (€/kW) | 0.0 | 1.5 | 0.0 | 0.0 | 1.6 | 0.0 | 0.0 | 0.6 |
| | Other costs (€/kWh) | 0.003 | 0.000 | 0.010 | 0.003 | 0.000 | 0.000 | 0.000 | 0.001 |
| | O&M costs fixed (€/kW) | 0.00 | 46.33 | 31.39 | 0.00 | 0.0056 | 0.00 | 5.00 | 4.51 |
| | O&M costs variable (€/kWh) | 0.013 | 0.000 | 0.013 | 0.020 | 0.011 | 0.031 | 0.006 | 0.011 |
| | *Total O&M Costs (€/kWh)* | *0.013* | *0.021* | *0.028* | *0.020* | *0.011* | *0.031* | *0.007* | *0.013* |
| Financial Parameters | Return on debt | 5.5% | 5.5% | 5.0% | 7.0% | 5.0% | 5.0% | 6.0% | 5.5% |
| | Return on equity | 9.5% | 9.5% | 15.0% | 10.0% | 12.0% | 7.0% | 7.5% | 9.5% |
| | Debt share | 60% | 70% | 80% | 80% | 87% | 70% | 0% | 70% |
| | Equity share | 40% | 30% | 20% | 20% | 13% | 30% | 100% | 30% |
| | Loan duration (yrs) | 12 | 13 | 15 | 15 | 20 | 20 | 15 | 15 |
| | National Tax Rate | 25.0% | 29.8% | 25.5% | 30.0% | 28.0% | 21.0% | 35.0% | 28.0% |

## Preliminary Results




The relative impact of country-specific full load hours on LCOE was examined, using the Reference Case for comparison. In Figure 1, the Reference Case is the blue line where model input values are equivalent across countries. The gray bars show how the Reference Case LCOE changes when each country-specific, full load hours value is modeled instead of the Reference Case full load hours. **This process was repeated for all key wind energy cost variables (Figure 2) .**

**Figure 1: Analyzing Full-Load Hours' LCOE Impact Across Countries**

## Preliminary Results (Continued)

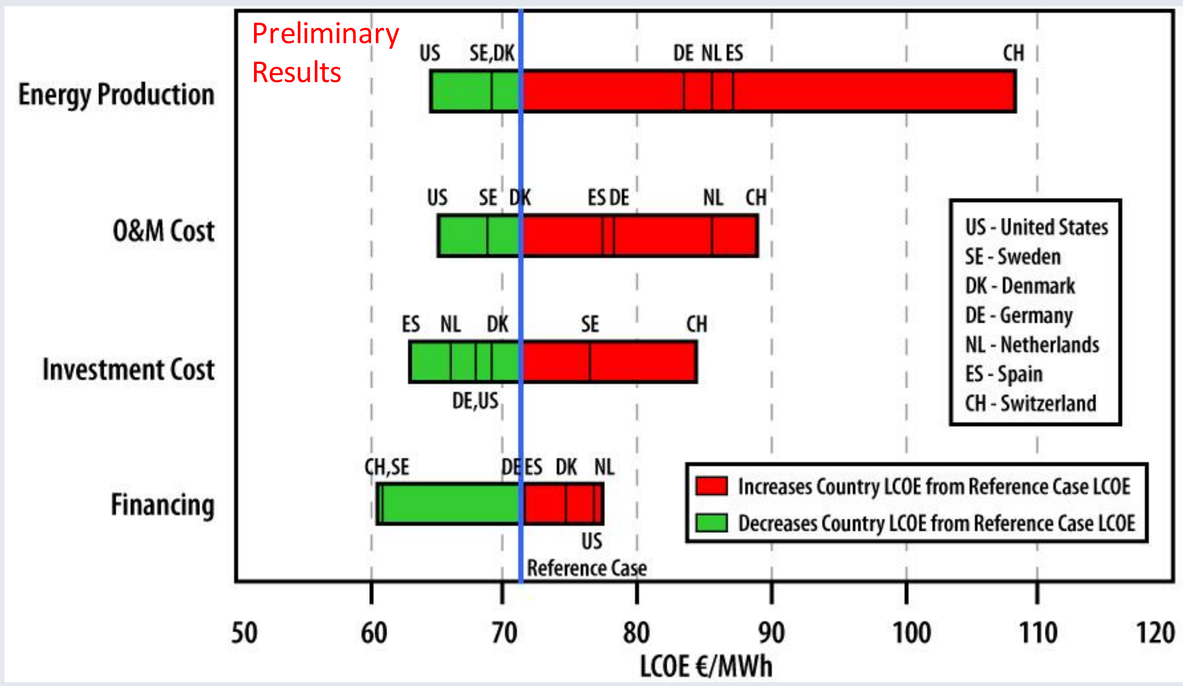



**Figure 2: Analyzing Four Key Cost Variables' LCOE Impact Across Countries**

Repeating the methodology described in Figure 1, each country's operations and maintenance cost (O&M), investment cost, and financing terms were set to their country- specific value one at a time, while all other model inputs were held to the Reference Case. By showing the results of the country-specific input variable analysis together, Figure 2 reveals several interesting comparisons.

Figure 2 shows the relative impact of each country-specific cost variable, and the magnitude of increase or decrease in the country's LCOE. For example, the highest reported O&M cost (CH) increased Switzerland's LCOE above the Reference Case, and did so by a greater amount than the highest reported financing cost (NL) increased the Netherland's LCOE.

Figure 2 also shows the LCOE impact of each country-specific input variable relative to other countries, and whether it is above or below the Reference Case value. For example, the United States (US) generally benefited (in terms of LCOE) from the highest energy production and lowest O&M cost compared to other countries. Yet high financing terms in the U.S. increased the U.S. LCOE more so than nearly all other countries (except the Netherlands).

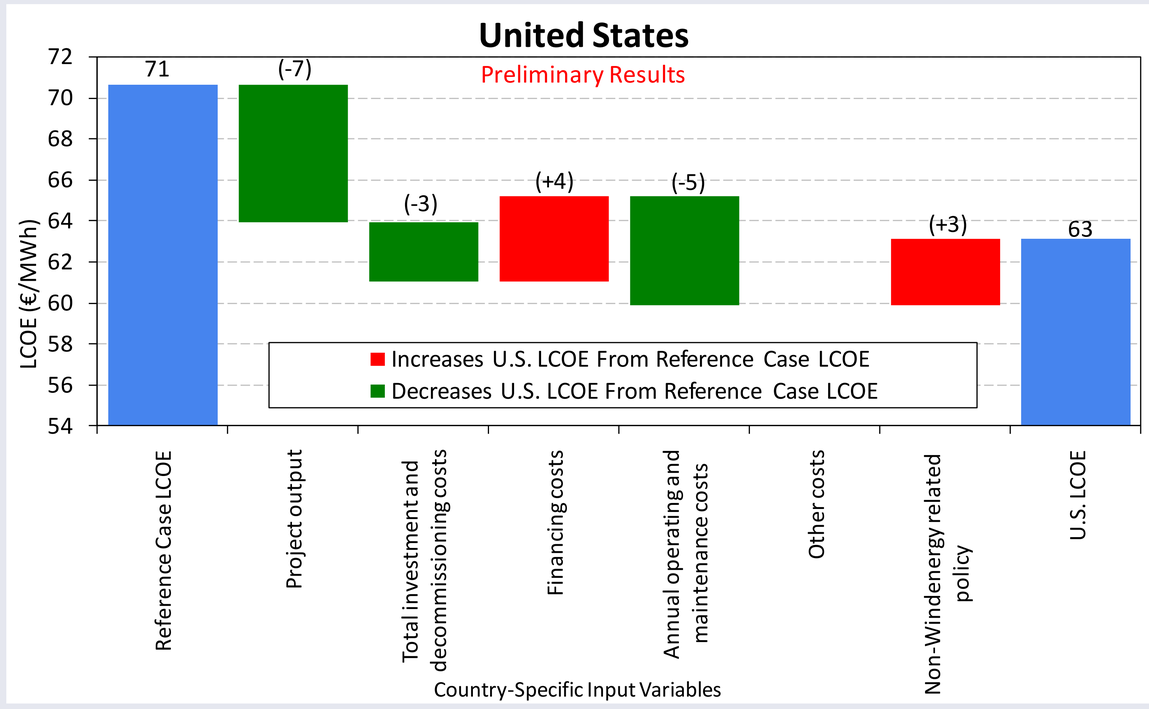



**Figure 3: Comparison of Country Specific Costs (U.S.) Against Reference Case**

Lastly, each task member examined the difference between their country's estimated LCOE and the Reference Case LCOE. The impact of each country-specific input variable (including some not shown in Figure 2) was quantitatively estimated and categorized as either increasing or decreasing the country LCOE from the Reference Case LCOE. Each country representative contributed a chapter to the report (in progress) that qualitatively described their country-specific cost components. For example, as shown in Figure 3, the U.S. LCOE is generally lower than the Reference Case LCOE primarily due to greater energy output, lower capital costs, and lower operations and maintenance expenditures.

## Conclusions

Preliminary results of IEA Wind Task 26 indicate that the LCOE varies considerably among countries. The magnitude of this variation has been attributed to energy production, investment cost, operations and maintenance cost, and financing cost. As expected, the largest LCOE impact among countries was the anticipated energy production that is principally due to the inherent wind regime (assuming similar technology). Market forces greatly impacted the overall cost of wind energy through large variations in both capital expenditures and financing terms for a wind project. Costs attributed to the operations and maintenance of a wind project ranged widely across countries and had a sizable LCOE impact. In summary, the continued and ongoing efforts of IEA Task 26 are leading to a better, more comprehensive, and collaborative understanding of the cost of wind energy internationally.

## References

Due to the multi-contribution nature of this project, data sources are many and diverse. Preference was given to publicly available sources whenever possible. A full listing of all data sources used in this task will be reported in the final report. For more information: http://www.ieawind.org/Summary_Page_26.html

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