ESTIMATING ABATEMENT COST CURVE - POWER FROM SHORE

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Overview

In the last decades, the concern for global warming caused by emissions of Greenhouse gases such as CO_2 has been steadily increasing. One branch of research has been on identifying and assessing possible projects for GHG-emission reductions. A method to reduce local emissions on the Norwegian continental shelf is to supply offshore petroleum facilities with power from shore. This abatement measure has many implications. This paper focuses on abatement cost calculations for power from shore.

Norwegian power mix is almost solely based on hydro-power. In national climate policy increased used of power from grid has been regarded as not increasing CO2-emissions. Norwegian grid is interconnected with continental Europe as well as the other Nordic countries. Norwegian petroleum industry is also a part of the ETS. Understandably, the effect of power from shore on reduction of climate gas emissions has been debated. See. e.g. Osmundsen (2012).

Power from shore replaces natural gas turbines. Since the scope includes not only building new installations but also modifications of existing facilities only turbines used to produce electricity have been replaced.. Replacing other turbines would be a much bigger project and on most existing installations, this would not be feasible. Based on a data set of engineering studies of power from shore and executed projects installing cables for supplying offshore installations with power from shore. Cost curves are derived. Three important cost drivers are identified. AC vs DC, power output and distance to shore. AC has generally lower investment needs compared toDC. Understanding when AC is the best solution and what the limits are for this choice has been an important work securing a good basis for estimation of costs.

Methods

How much power that needs to be transferred is the main variable when it comes to deciding equipment size and cost both offshore and onshore. Distance from shore is a vital variable when it comes to cable cost and transfer losses from onshore to offshore.

Curves showing cost per distance for both AC and DC-cables have been developed. These are used when estimating cost for cables.

The model consists of two cost functions for cable, one for AC and one for DC. Onshore equipment is included with one constant for AC and one for DC respectivally. For DC-technology, three different cost functions are calculated and for AC-technology four different cost factors are calculated. These functions and factors are corresponding to levels of complexity of the project.

For all projects only three factors need to be set exogenously. These are distance to shore, expected life span of project and effect. Given these three variables all other variables can be derived.

In order to capture the full complexity of modifications on existing installations a dummy variable corresponding to different cost levels is introduced into the model.

Based on the different outcomes from the dummy variable, we have performed a Monte Carlo simulation. The analysis is done with 2000 draws from cost function matrix. The results are then sorted and presented in a price range table as well as an abatement cost curve.

The Monte Carlo simulation has been done using the ‘data table’-function in the MS Excel combined with MS Excel’s random data generator.

Results

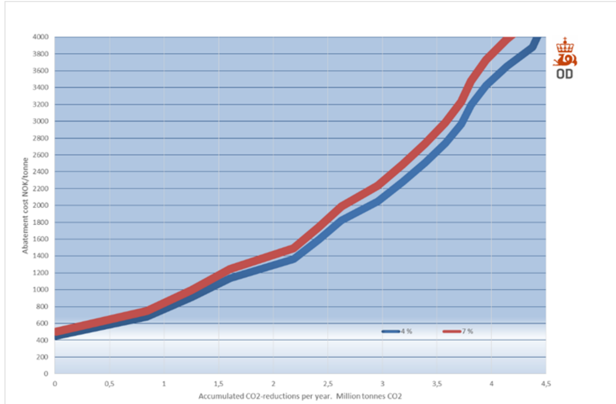

Figure 1 Abatement cost curves for power from shore from NCS. 4% and 7% real discount rate. (NOK/tonne)

Accumulated yearly CO2 reductions	0-1 million tonnes	1-2 million tonnes	2-3 million tonnes	3-4 million tonnes
Expected abatement cost (7%)	500-850	850-1450	1450-2300	2300-3800
Expected abatement cost (4%)	450-800	800-1400	1400-2050	2050-3450

Table ***1*** Expected abatement cost for different levels of CO2 reductions. Million tonnes CO2/year. NOK/tonne CO2 reduced on norwegian continental shelf.(NOK/tonne)

Conclusions

The analysis shows that understanding technological obstacles are of key importance before making decisions on specific projects. Earlier reports have mainly concluded on economy of scale and on green-field as the main parameters on which choosing among projects. The results of this work questions this conclusion and our recommendations are as follows:

- A statistical analysis on an aggregated cost function can be done, where the different possible outcomes can be incorporated through a Monte Carlo simulation
- Green-field projects are on average more cost efficient than brown-field
- Even so, there may be brown-field projects that will come in on quite cost-effective if no technical obstacles are present. A reason for this is that brown-field platforms typically have much higher CO2 emissions than new field developments.
- The impact of possible technological obstacles imply that no project decision can be made before a thorough engineering study has been made.
- The impact of such technological obstacles outweigh the effect of economy of scale
- Earlier recommendations on electrifying areas of multiple fields are therefore abandoned
- In an early planning situation with unclarified technological project understanding, the cost estimate of a specific project will be very high.

Abatement measures in the petroleum sector is in the overall picture very costly compared to other climate measures as well as carbon tax and ETS. Some projects have costs that are more reasonable. Understanding which projects have the lowest abatement cost, demands for a better understanding of the relevant cost factors offshore. Our research indicate that unknown factors leading to obstacles in offshore implementation of new technology, by far outweigh the general economy of scale that is present in power from shore-projects.