EXTERNALITY IMPLICATION ON BULK ENERGY TRANSPORT

Alexandre Oudalov, ABB Switzerland Ltd., Phone +41 58 586 80 31, E-mail: alexandre.oudalov@ch.abb.com
Muhamad Reza, ABB AB Sweden, Phone +46 21 324 274, E-mail: muhamad.reza@se.abb.com

Overview

International Energy Agency's projections indicate that coal and natural gas will be the world's fastest growing electric energy sources accounting for around 38% and 30% of the increase in world electric energy generation over the next 30 years. Since primary energy resources deposits are usually distant from load/population centers, a transfer of bulk quantities of primary resources or electric energy is required to meet the growing demand and becomes an important concern from an energy, economic, and environmental standpoint.
We define a bulk energy transport (BET) as a transfer of a large quantity of primary energy resources or electric energy (>500 MW) over a long distance (>100 km). The way primary energy resources are moved to power plants and then to load centers is determined by a complex decision making process and depends upon the amount of energy to be moved, haul distance, capital and operating costs of the transport system, a presence of existing infrastructure, etc. Additional factors affecting a selection are linked to externality cost which is related to the environmental and social consequences of energy transport. In this paper we consider air pollution emissions, safety hazard, noise, visual (aesthetic), and EMF impact as major "building blocks" of the externality cost.
The outline of the paper is as follows: after the introduction the second section gives a brief overview of the bulk energy transport model; a number of bulk energy transport scenarios are compared in section three; section four discusses the results of sensitivity analysis, and section five concludes the paper.

Methods

This paper presents a method to compare alternatives for bulk energy transport, and ultimately assesses the relative pros and cons of various related technologies used or proposed to meet evolving needs for electric energy consumption. In particular, it offers insight into the advantages of underground electric transmission technologies, when compared to overhead line electric transmission and various methods of primary energy source transport coupled with local generation.
A straightforward bulk energy transport model (BET model) is constructed to address all relevant combinations of problem scenarios and technologies, and embraces common practice techniques for life cycle cost analysis with monetization of externalities (e.g. environmental, safety, noise, visual and EMF impact) and supporting sensitivity analysis.
Restrictions on land use may stretch beyond the default right of way corridors due to increased limits on noise, visual, and EMF impacts imposed by transport infrastructure and power generation on society. In the BET model the extension is defined by a maximum of individual extensions required to fulfill noise, visual effect and EMF regulations. The individual extensions depend on how much the level of noise, visual effect and EMF has to be limited and obtained using annoyance characteristics. Annoyance characteristics are directly linked to psychological and stressed-induced effects of noise, visual and EMF impact on society. They are used for a conversion of a percentage of highly annoyed population from a total population at the border of default right of way corridor into the required extension in meters.

Results

The BET model was implemented as a spreadsheet simulation tool for a comparative analysis of different bulk energy transport scenarios. It can be used in the context of existing planning and decision making instruments, such as integrated resource planning, technology assessment, power plant sitting, etc.

First, a set of long distance energy transport scenarios according to state of the art technology and typical use on the mainland was examined.

Second, we analyzed a sensitivity of the results to a variation in the externality cost.

Conclusions

This paper presents the model for a technology assessment and comparative analysis of bulk energy transport systems and for an identification of the most important impact categories in the context of environmental policy. Taking into account stricter land-use, regulatory and environmental restrictions, modern electric transmission technologies paired with remote generation demonstrate a significant improvement over the conventional overland transport of primary energy sources. Thus, it is highly probable that in the future the long distance bulk energy transportation will shift from moving primary energy resources to electric energy transmission and from overland to underground transport systems.

References

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