

Optimal routing of power lines for a sustainable energy future



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Abstract

The Norwegian Institute of Nature Research (www.nina.no) is leading a project (January 2011 to December 2013) where the main aim is to develop a Least Cost Path (LCP) toolbox for environmental friendly routing of high voltage power lines based on ecological, economical, social and technological perspectives. Thematic content and criterias will be defined by stakeholders, best practices and all legal requirements. Consensus about the relative importance of the thematic content will be achieved through the implementation of standardized dialogue seminars. The toolbox is ment to be a usefull planning tool in an early phase of a power line routing project in order to identify optimal routing macro corridors for scoping of EIA, to minimize potential stakeholder conflicts and to make the decision processes more transparent to the public.

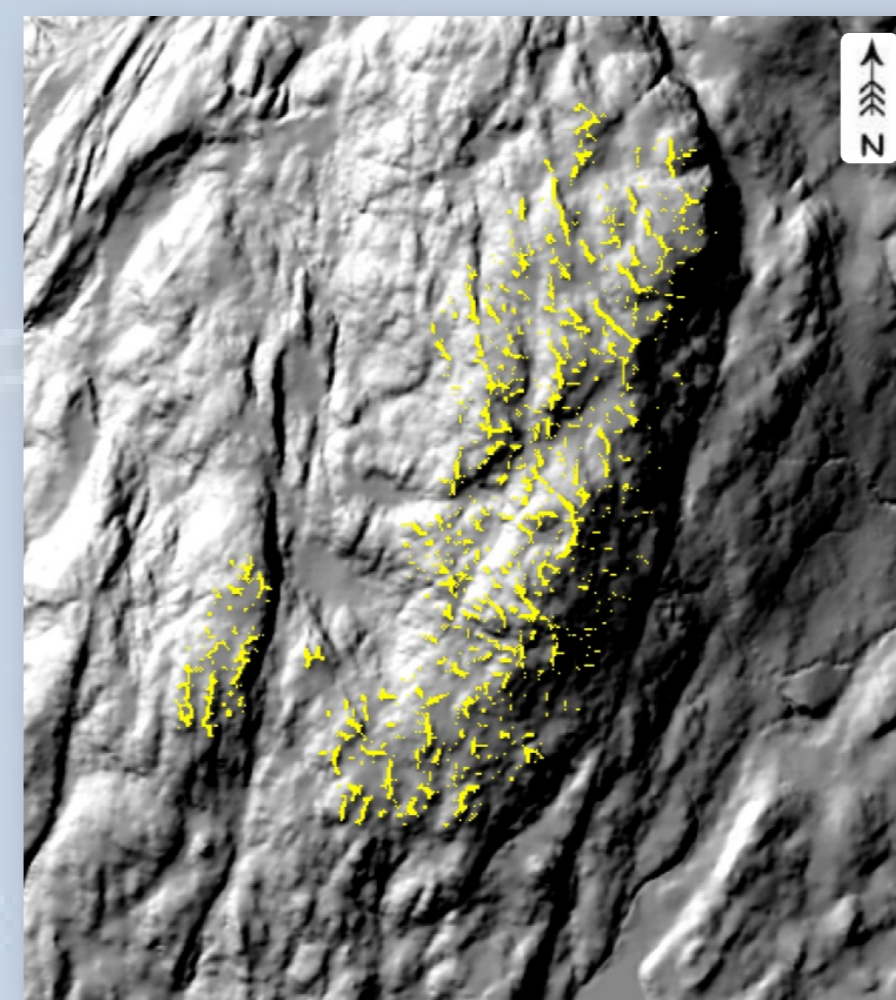
Background

Norway is facing a future with a great expansion of the central power transmission line network. As a direct response to this the Norwegian Government will emphasize EIA's more heavily in future power line routing projects.

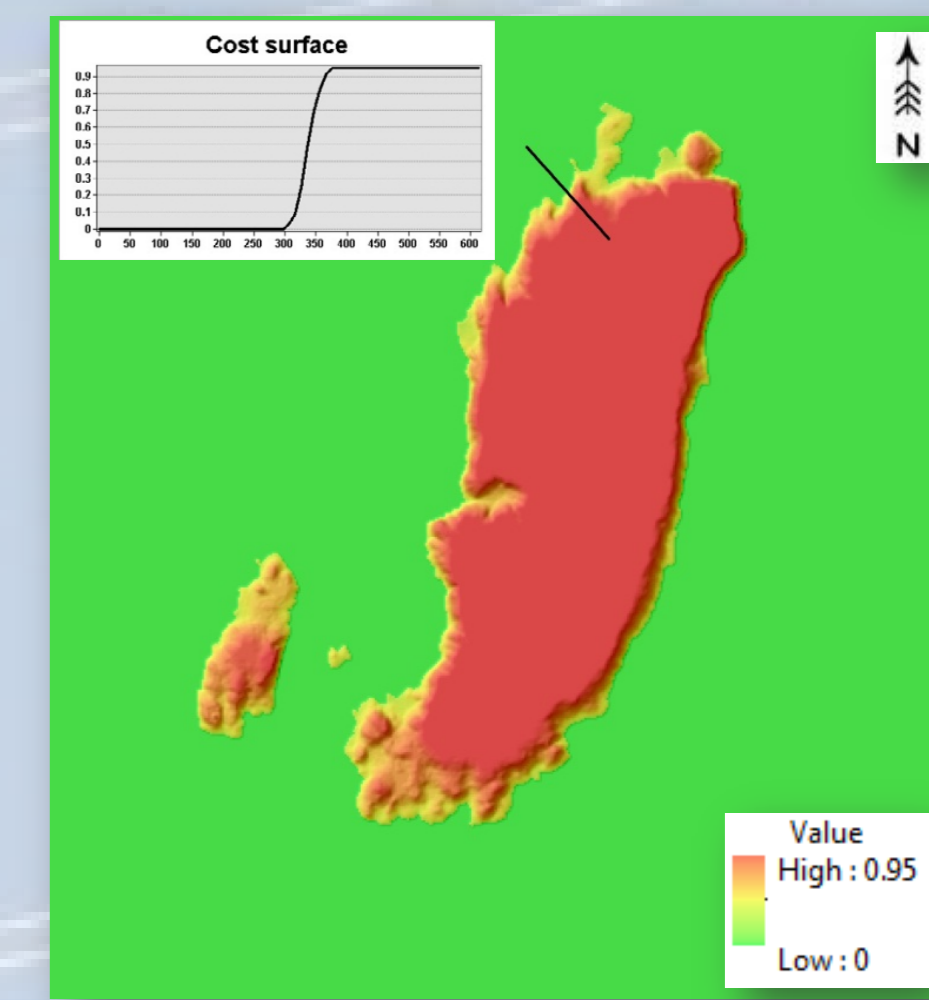


This work is a part of the research project on optimal design and routing of power lines (OPTIPOL) organized by the Centre for Environmental Design of Renewable Energy (CEDREN).

CEDREN initiates research and development of hydropower, wind power, power line rights-of-way and implementation of environment and energy policy. CEDREN is funded by The Research Council of Norway, the private energy industry, and involved research institutes and universities.



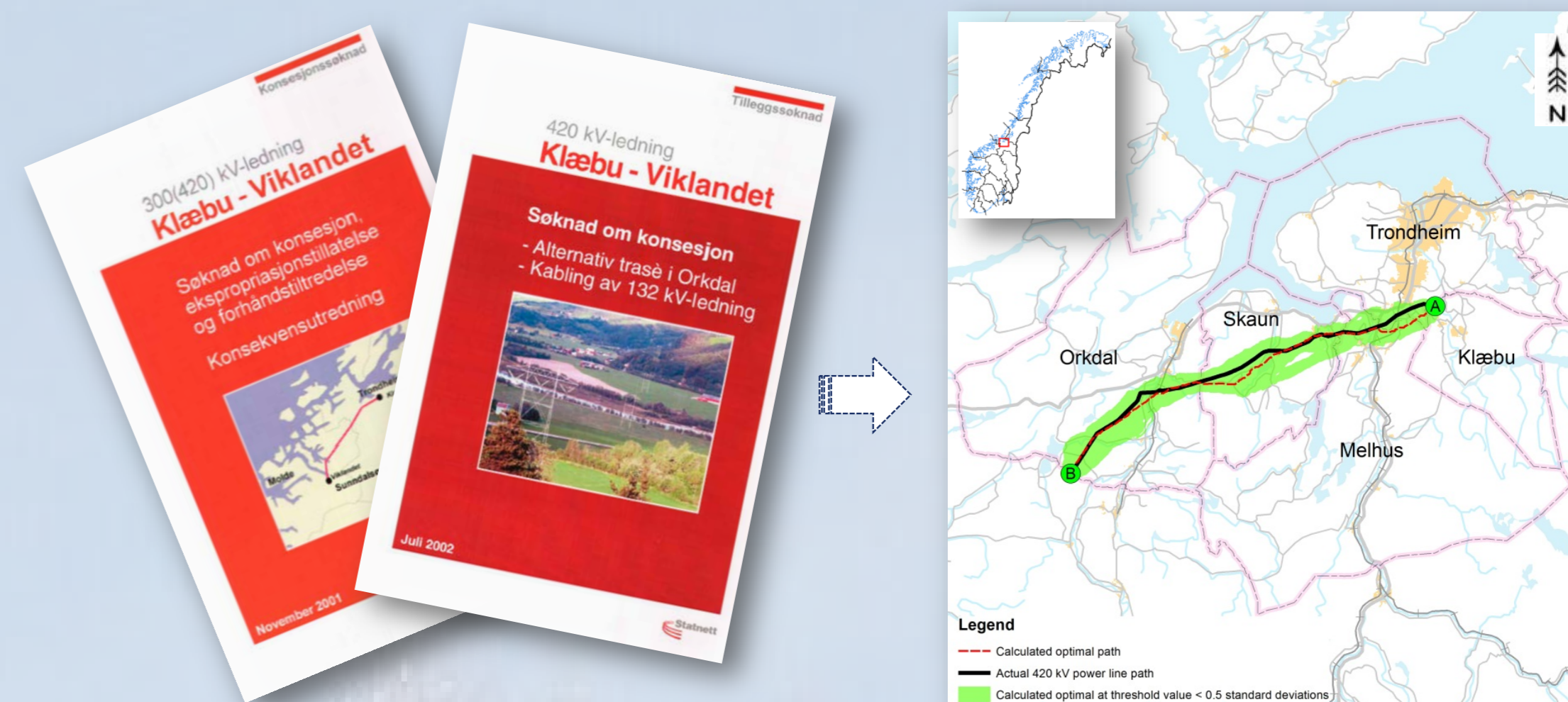
High altitude ridges



Cost surface (silhouette effects)

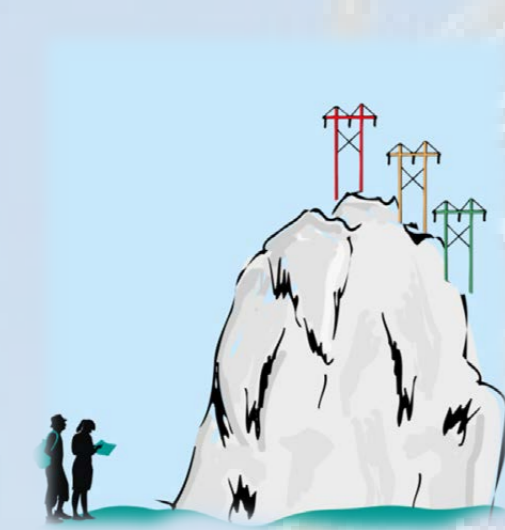
Toolbox validation (version 1.0)

The toolbox is validated with a 420 kV power line built from Klæbu to Viklandet in central Norway in 2005. EIA content made prior to the construction phase was implemented in the toolbox and the result correlates very well with the constructed power line path.



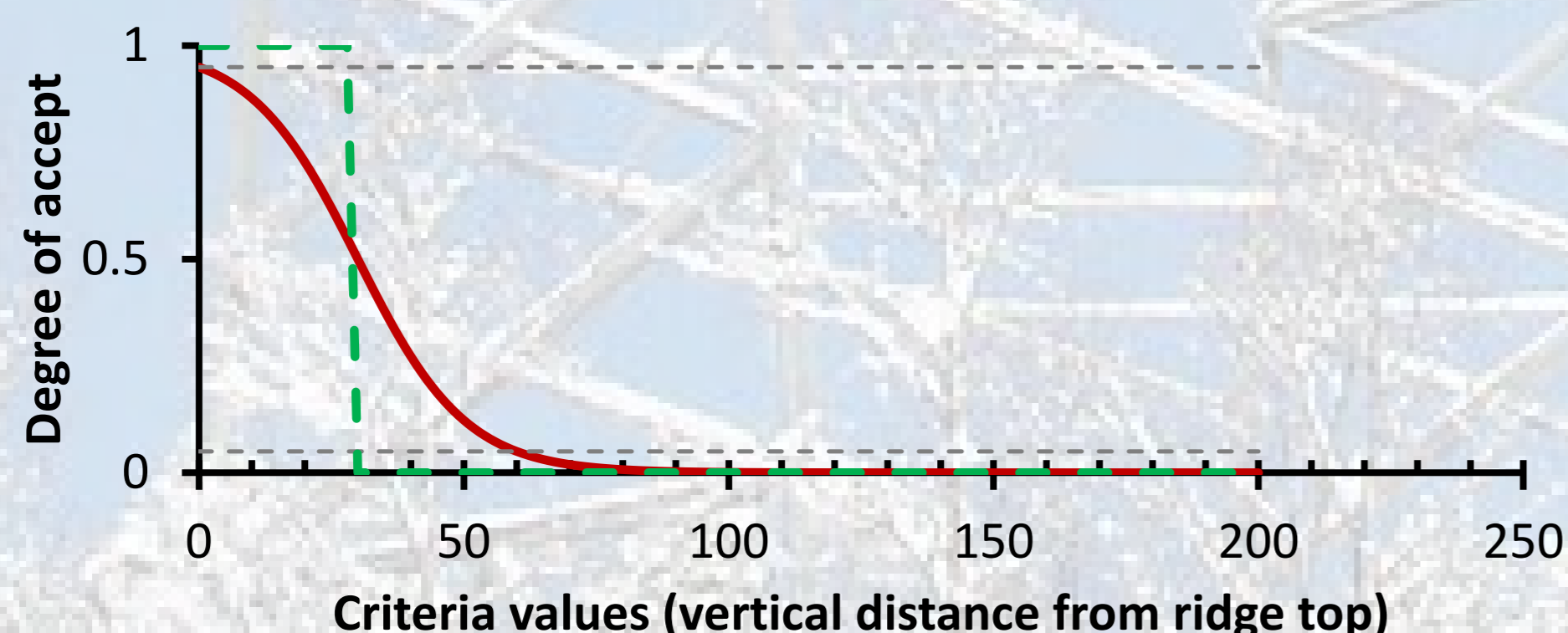
The LCP – Toolbox (version 1.0)

- The toolbox (version 1.0) is developed on the ArcGIS 10 platform with a ESRI Modelbuilder interface.
- To measure and compare the many different EIA- aspects in LCP we use a Fuzzy logic approach to standardize the criteria based on stakeholders degree of accept on a continuous scale from 0 to 1.



Example: What is the acceptable placement of power lines on ridges in order to avoid/reduce silhouette effects and visual disturbance?

- On the top of the ridge (0 meters) ?
- 15 meters below the top ?
- 1 post height (i.e.30 meters) below the top?



If the only acceptable placement is 1 post height (30 m.) below the top of the ridge the degree of accept will be binary (green graph). Lets say that we define 0 m. as unacceptable, 15 m. as fairly acceptable and >= 30 m. as most acceptable. This gives a more realistic continuous degree of accept (red graph).

$$\text{The cost surface is given by: } 1 - \left(\frac{1}{1 + \exp\left(\frac{\ln\left(\frac{2-0.1}{0.1}\right)}{(0-15)} \cdot (MAP-15)\right)} \right)$$

How to ensure consensus at an early stage in the planning of a new power line project?

We have developed a methodology for standardized dialogue seminars to achieve a high degree of consensus. The first seminar was successfully held in Stjørdal in April 2012 and the aim was to validate and review the toolbox content and its criteria. The different stakeholders considered the toolbox and a dialogue approach early in the planning process to be useful in order to reduce potential conflicts and to increase the public transparency in decision processes. We believe that the toolbox and the dialogue approach could make a change in the future EIA's both with respect to optimal siting (transmission lines and energy sources) and conflict reduction.

Proceedings

The findings from the first dialogue seminar are summarized in a report and will be implemented in the next toolbox version. The first seminar will be followed up by a web-survey and a final seminar in order to consolidate consensus. A complete toolbox will be launched in December 2013. Read more about the project at www.nina.no/archive/nina/PppBasePdf/rapport/2011/762.pdf.

Acknowledgements

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