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Classification of Windstorms and Their Impacts on the Electricity Grid System in Finland

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Windstorms related to low-pressure systems cause intensive damages every year to the Finnish energy sector mostly because of trees falling over the transmission lines. It is known (based on forecasters' experience) that the storm impacts depend besides the intensity of the storm, also on many other parameters such as soil characteristics, tree snow load, time of the year and the arrival direction of the storm. The motivation of this study was to develop a method for characterizing the windstorm impacts for electricity networks in Finland, which would help in the impact forecasting of these events. With this classification method for windstorms, in the future also other sector's impact applications are possible (the civil protection.)

First, we developed a method to classify low-pressure windstorms based on their storm tracks and arrival directions. A total of 51 low-pressure windstorms in Finland were examined between years 2005-2016. Second, interruption data from the Finnish electricity providers were combined with the meteorological data including observations, analysis charts and ERA-Interim-reanalysis. Then, the meteorological features of the windstorms were studied as well as their impacts on the electricity grid system in Finland. As a result, a total of six storm classes were identified as well as their differences (e.g., the typical geographical maximum wind gust distribution and its relation to the impacts on the electricity grid). Also, the most severe storm classes were defined for both, summer and winter seasons. We found out, that the windstorms arriving to Northern Finland from North-West (class B-NW) seem to be the most severe regarding the impacts on the electricity grids especially during the winter. B-NW- storms tend to have rapid cycle in development and strong gusts caused by a deep low center. Another significant storm class was identified occurring especially during summer; the windstorms arriving to Southern Finland from South-East (class A-SE). The typical characteristics of the A-SE-storms were the slow-motion and less strong gusts. Because of the slow-motion, the damages tended to accumulate on a specific area. Finally, Combined Impact Index was developed. This index explains the relations between meteorological and non-meteorological factors that cause trees falling, interruptions in power distribution and translate it to an impact estimation and a tool for risk analysis benefiting the electricity companies.

In this work we demonstrate the six storm classes found in the study, their meteorological and socio-economical characteristics and the Combined Impact Index developed for better impact and risk analysis. The work is related to H2020 project ANYWHERE (2016-2019) with the purpose to co-design with the stakeholders (such as energy providers) better response methods to face extreme and high-impact weather and climate events.