The European Risk from Geomagnetically Induced Currents (EURISGIC)

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Scope

EURISGIC (www.eurisgic.eu) was the first continental-scale study of the geomagnetically induced current (GIC) hazard to Europe's electrical power transmission system. EURISGIC had a number of strands to it, including modelling GIC in the European system and understanding the possible extremes that the system could face. These various parts of EURISGIC were:

- The construction of the first ever European power transmission grid model and an update of the existing UK model
- The development of detailed conductivity models for Europe and, separately, the UK, for comparison
- The building of geomagnetic, GIC and related science databases
- The production of a GIC risk map for Europe
- The investigation of worst case scenarios and extremes in grid models
- The development of the NASA 'Solar Shield' magnetospheric and solar wind model for use in the European context
- The enhancement of a prototype GIC and geomagnetic forecast system for Europe
- The making of geomagnetic, geoelectric and GIC measurements to enhance our knowledge and validate models
- The education of the public and other stakeholders through scientific papers and other materials.

To assess and guide progress on the project a team of industry advisors was assembled. These advisors included senior power engineers from major electrical transmission system operators from across Europe, including National Grid in the UK. In this poster we demonstrate a few of the major outputs from the project.

GB and European Transmission Models

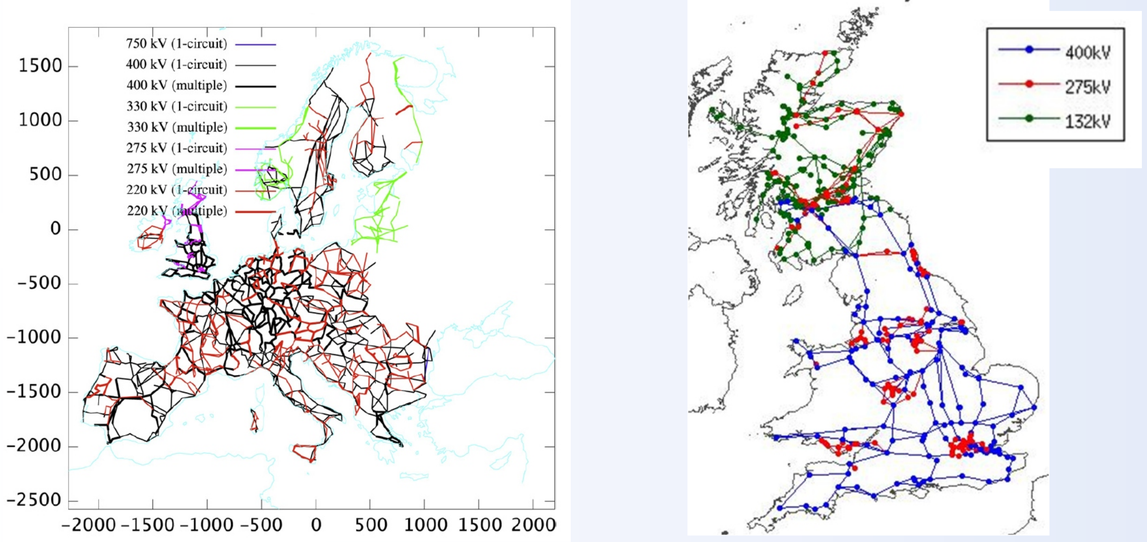

Figure 1. Left: Map of the high-voltage power grids in Europe. Number of nodes: 400kV: 1224 (and one 750 kV node), 330 kV: 170, 220 kV: 632. Number of different lines: 400 kV (1-circuit): 774 (and one 750 kV line), 400 kV (multiple): 450,330 kV (1-circuit): 162, 330 kV (multiple): 8, 220 kV (1-circuit): 451, 220 kV (multiple): 181. Right: Map of mainland UK transmission system (400 kV, 275 kV and 132 kV. The latter voltage is not included in the European map, but is part of the transmission system for Scotland). Note that line and Earth resistances are different between these two models, e.g. for the UK, National Grid helped construct the UK-only map.

Earth Conductivity & Electric Field Models

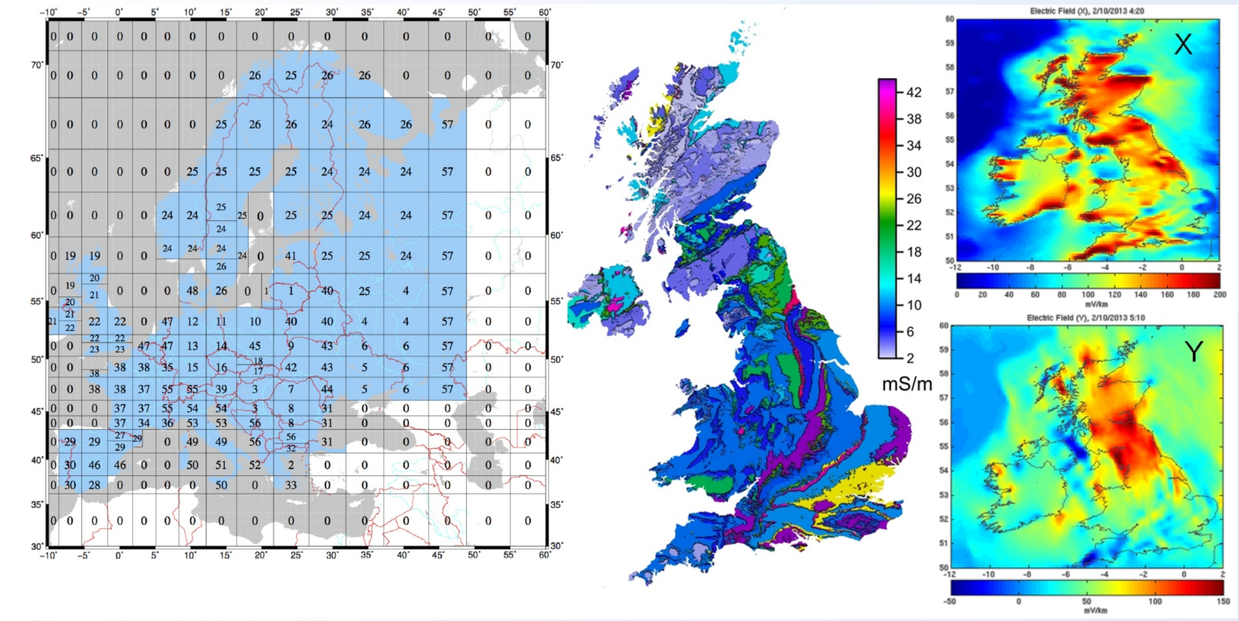

Figure 2. Left: Model of European Earth conductivity, given as numbered blocks with distinct 1D depth-varying conductivity (see http://real.mtak.hu/2957/ for details). Centre: UK 3D conductivity model, based on geological structure of GB & NI with conductivity derived from electromagnetic sounding data from low altitude aeroplane survey flights. Right: example of surface electric fields calculated with the UK conductivity model, for a storm in early October 2013 (X=north; Y=east direction).

GIC Risk Map

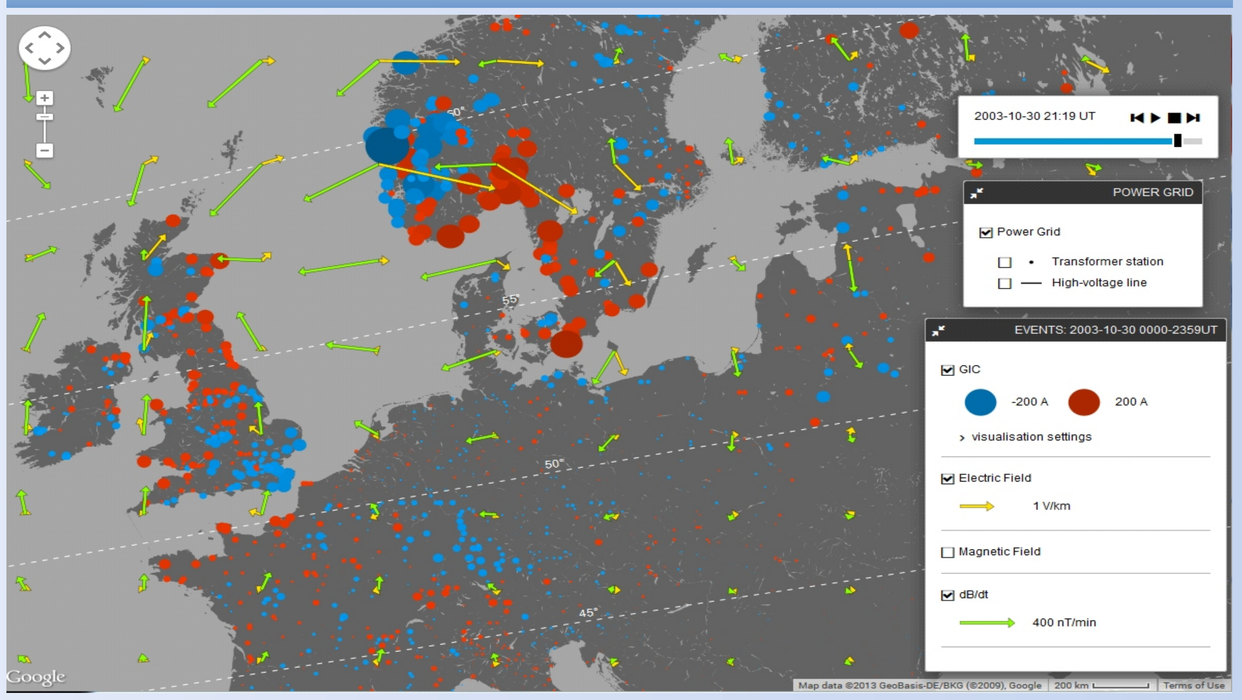

Figure 3: Modelled *E*-fields, d*B*/dt and estimated geomagnetically induced current levels at 21:19UT during the severe geomagnetic storm of 30th October 2003, as represented in the online risk map web tool (see http://riskmap.eurisgic.eu/.)

Forecast dB/dt

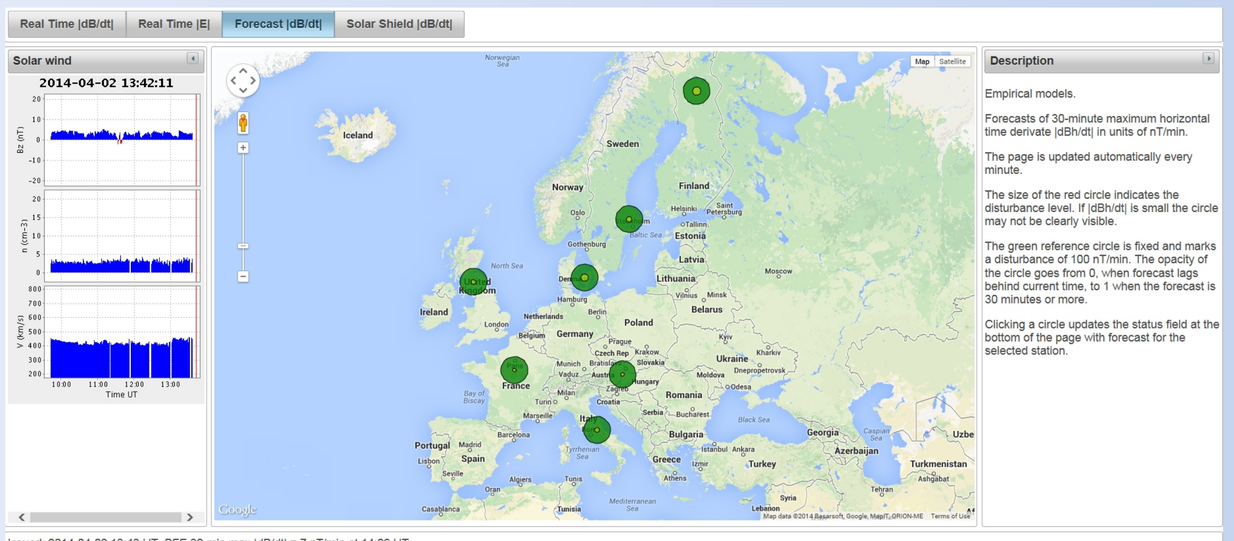

Figure 4: Snapshot of output of forecast server (see http://src.irf.se/eurisgic/faces/service.xhtml), showing forecast of maximum dB/dt in the next 30 minutes, based on a neural network model with solar wind input. Other tabs show outputs from, e.g. the NASA 'Solar Shield' model and real time data.

Extreme Event Analysis

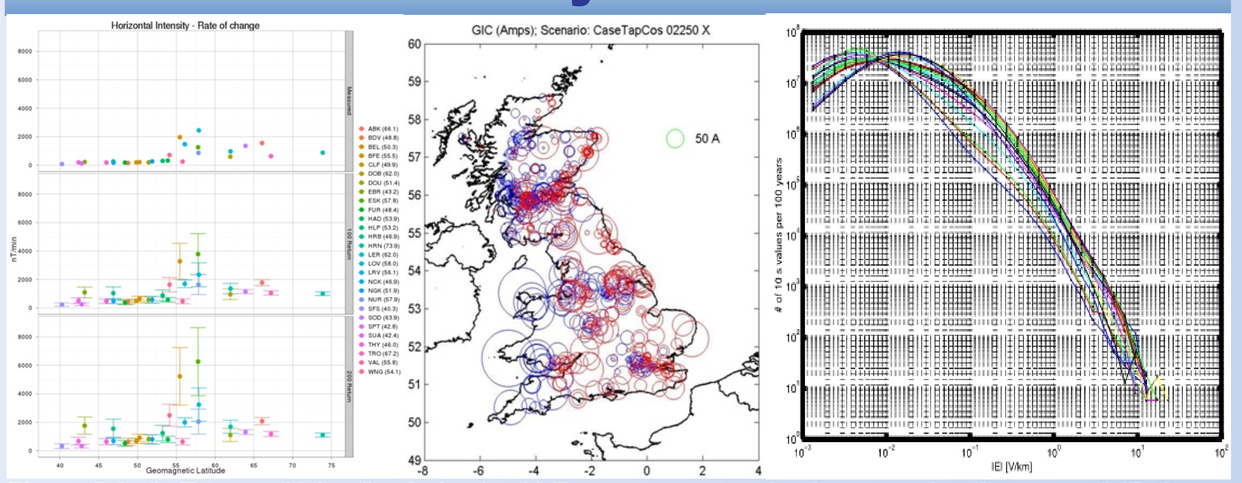

Figure 5. Left: Extreme Value Statistics for 30 European magnetic observatories (in terms of dB/dt, top is measured maxima, middle and lower plots are then 100 and 200 year return levels). Centre: 200 year return level of GIC estimated from extreme dB/dt for UK. Right: IMAGE magnetometer data coupled with a resistive Canadian conductivity model to estimate the 1 in 100 year surface electric field.

Geoelectric and GIC Measurements

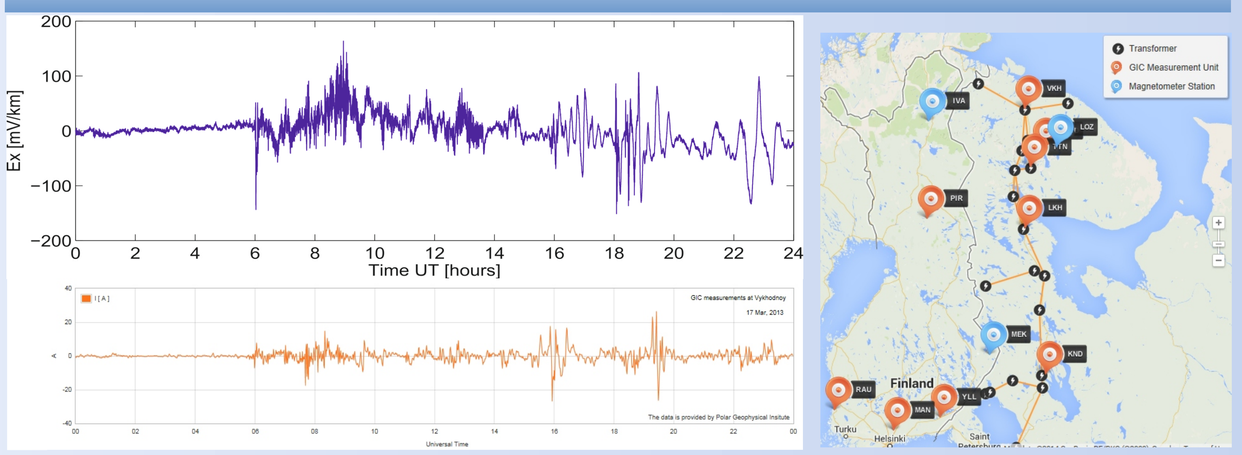

Figure 6. Left: Geoelectric measurements made at Eskdalemuir (UK) in support of validation of UK electric field models, for a storm on 17th March 2013 (see www.geomag.bgs.ac.uk/data_service/space_weather/geoelectric.html). Right: GIC measurements made in North-west Russia and Finland for the same event (see www.eurisgic.org).

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