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An App for Calculating the Electric Field outside Electrical Installations

Overview

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Introduction

- Specifications of electrical installations often come with limitations on electrical fields in the vicinity, where humans are allowed access.
- Different limits apply at different frequencies. Here the focus is on low frequency electric fields.
- For low frequency fields the verification of the design is normally done through simulation.
- It would be a major benefit for the design process if this simulation was easily accessible for the design engineer. A good case for a COMSOL app.

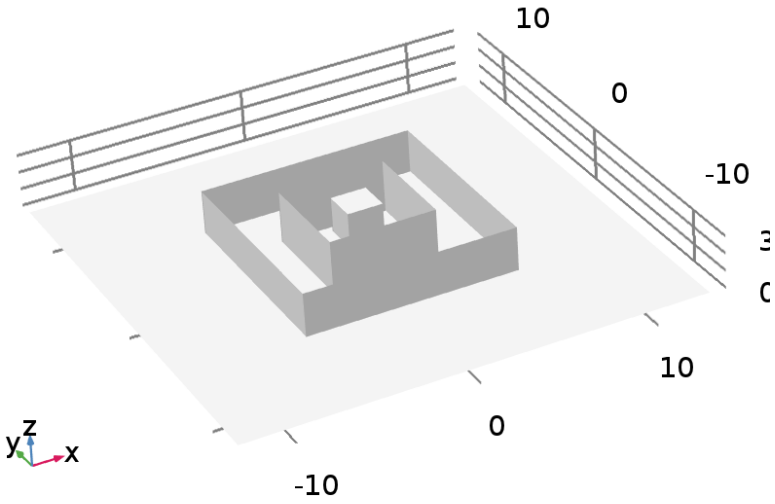
ABB shut capacitor bank

Problem Description

- Several international bodies have done studies and come up with recommendations for low frequency electrical field exposure, based on heath and safety.
- The two main studies are from IEEE and ICNIRP (International Commission on Non-Ionizing Radiation Protection)
- Recommendations are currently being implemented in EU law and customers can often have additional requirements.
- It is expected that this type of limits will become increasingly common in tenures for electrical installations.
- Typical reference values from ICNIRP are
  - 5 kV/m for the general public
  - 10 kV/m for authorized staff

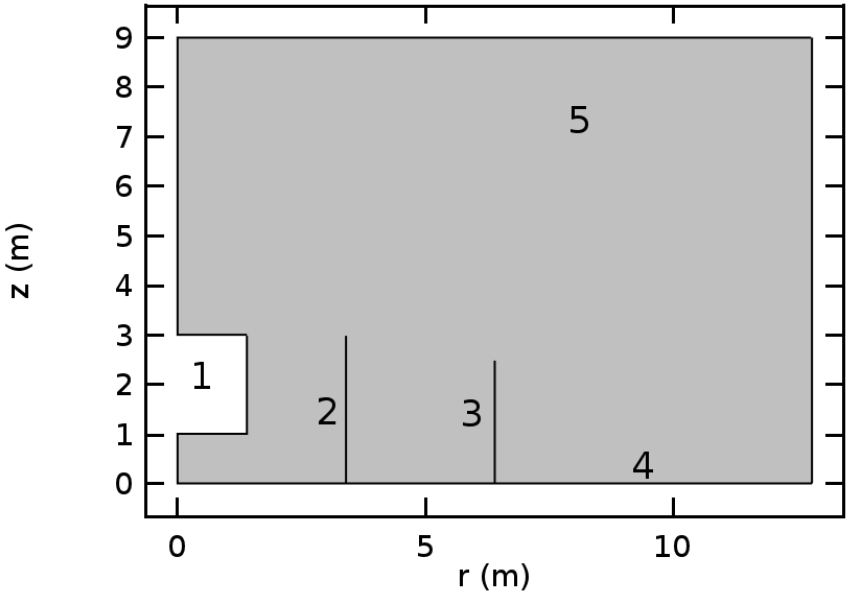
Method

- Low frequency electrical field can be simulated using the Laplace equation as implemented in the electrostatic module in COMSOL
- The main challenge with such simulations are finding a good geometry representation.
- The drawings of the installations are normally available in CAD format, but using CAD import involves a lot a manual work simplifying the geometry.
- The usual method is instead to draw a geometry using simplified geometrical shapes, but this is still too complicated for implementation in an app.



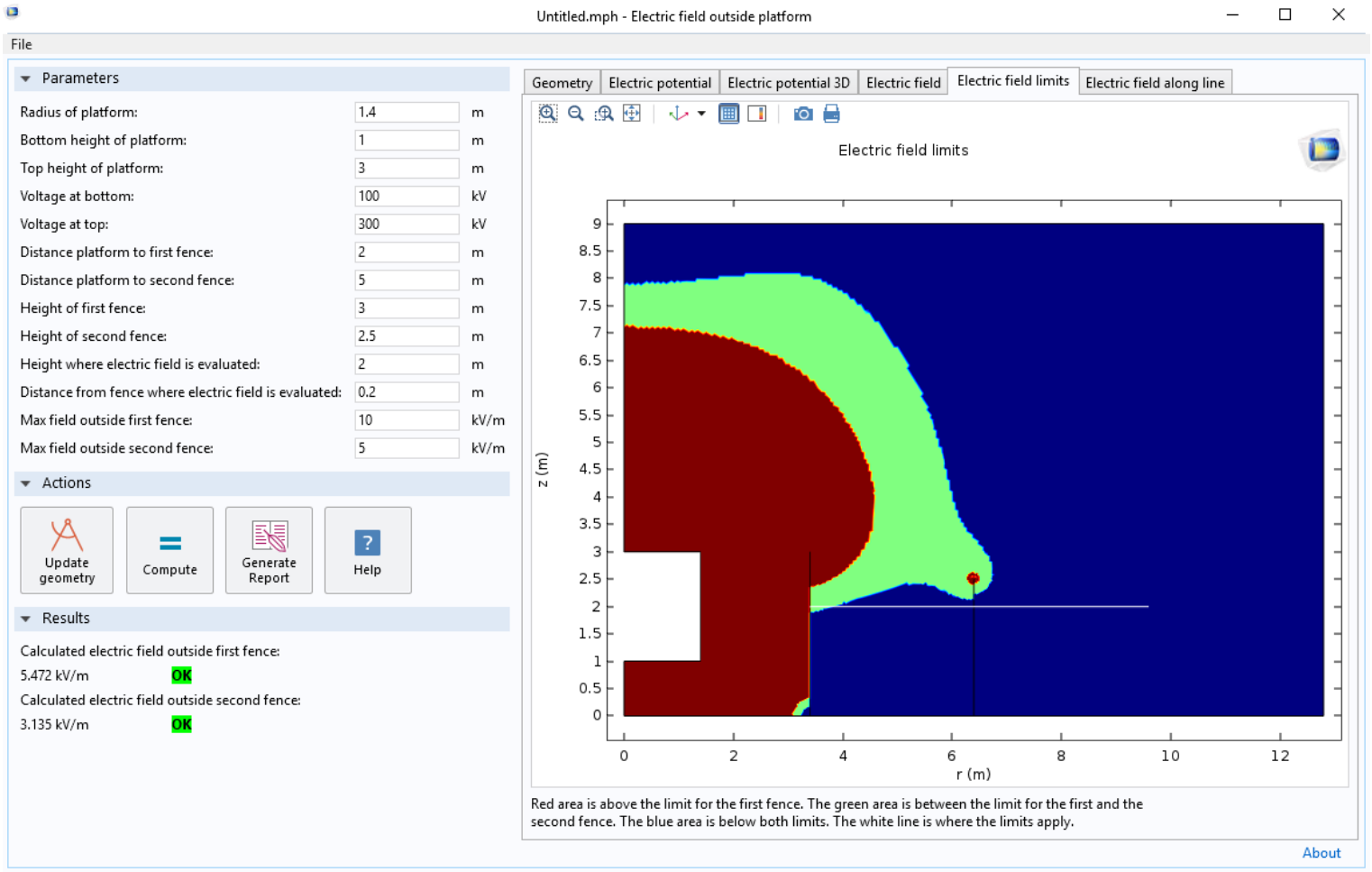
Method

- The most common type of installation is a tower surrounded by two grounded fences (one for the public and one for staff).
- This type of installation can be approximated using a 2D axisymmetric geometry. This geometry forms the basis of the app.
- Some loss of accuracy is unavoidable but with careful choice of parameters one can make sure that the 2D results become larger than the 3D results.



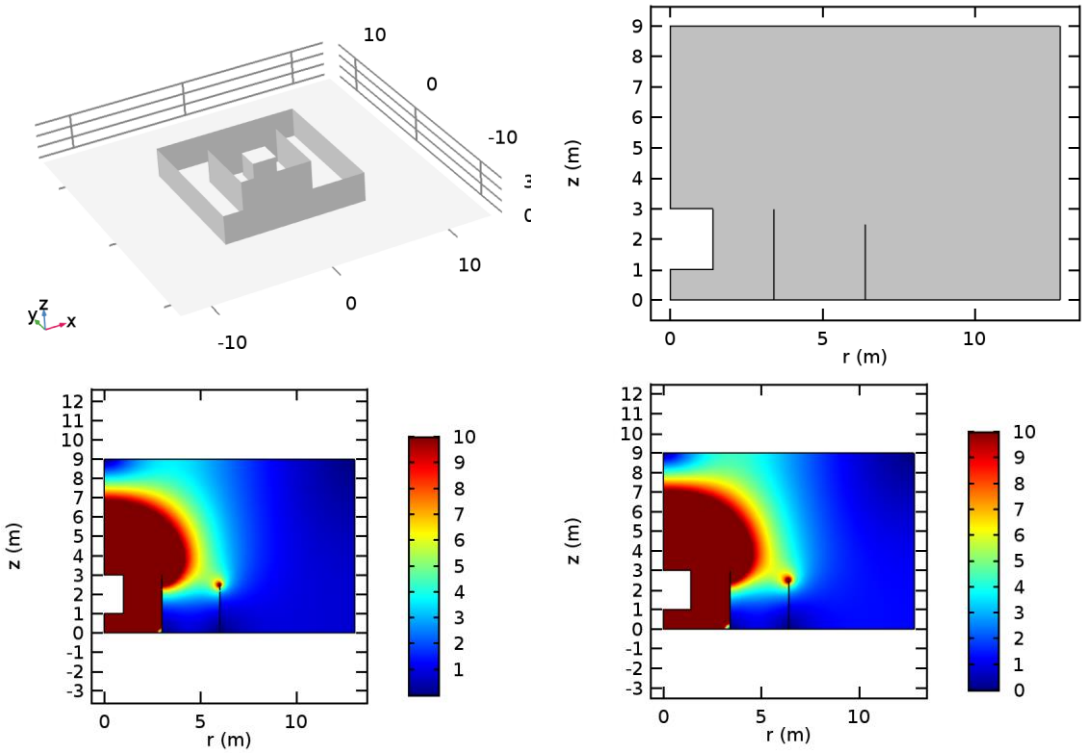
Parameterized geometry. (1) tower or platform, (2-3) fences (4) ground and (5) air.

App Screenshot



Results

- The results for the app are verified by comparing a selected 3D geometry to the equivalent 2D results from the app.
- The geometries along with the electric field at the symmetry plane are shown on the right.



Results

- The maximum field is specified outside the respective fence 2 m above the ground.
- The relevant maximum field levels are shown on the right for the 2D and 3D model.
- The 2D values exceed those from the 3D model, which is intentional to make sure that the limited accuracy of the 2D model does not lead to too low values.

Area	Maximum electric field
Outside first fence 3D	4.6 kV/m
Outside first fence 2D	5.5 kV/m
Outside second fence 3D	2.5 kV/m
Outside second fence 2D	3.1 kV/m

Summary and Conclusions

- An app has been constructed for calculating the low frequency electric field outside electrical installations that can be used without prior experience of electrical simulations.
- The app is based on a parameterized axisymmetric geometry of a tower or platform surrounded by two fences, which represents the most common case.
- The results of the app is verified by comparing to a sample 3D geometry. The lower accuracy of the 2D geometry is mitigated by choosing the parameters such that the 2D results slightly exceed those from the 3D model.
- The accuracy is judged to be good enough so that the app can be implemented in a production environment. If higher accuracy is needed, the results can be complemented with a dedicated 3D simulation.

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