

The effects of international standards on the design of a micro grid in rural areas

Magdalena Sandung, Electrical Engineering, ÅF International and IEA LTH 2017

Abstract—The differences between countries' electrical standards can be many and can cause major gaps, not only in functionality and design, but also in an economical point of view. By studying different countries electrical standards and by designing a grid in accordance with them, the effects on some of the technological and economical differences has been analysed.

I. INTRODUCTION

The energy sector in the world today is in the middle of a huge challenge regarding grid development and power production. Whilst a significant part of the world's population is living without access to electricity, the richer part of the world is facing the challenge of replacing existing energy sources into renewable ones, and also an aging grid in desperate need of reconstruction. When new technology is being developed, the standards will help with the design of new grids, insure the inter-connectivity of the already existing technology, and ease the transitions to the future products and methods. The development of international standards will help building bridges between countries in order to share knowledge and experience. In this study, electrical standards in Sweden and Venezuela has been studied and applied on the design of a micro grid in a rural village in Venezuela. This in order to compare the different solutions and see how the standards affect the design, structure and the economic requirements of grid development.

II. METHODS

By studying the standards regarding electrical grids in both Sweden and Venezuela, and applying the most relevant ones on the design of a micro grid, four simulations models were built. They were built in the program PowerFactory, and several simulations were made, showing voltage deviation, electrical loading, losses and short circuit currents in the grid, with the final purpose of a functioning grid in accordance with the standards and electrical requirements of each country. Using exact parameters for cables, provided by cable books and data sheets of each country, the simulations could reflect the outcome of a real grid. When having built four models in the program, including two different load profiles in both Sweden and Venezuela, the results of the grid calculations was compared, together with a cost calculation of each grid. The Swedish cost calculation was made through a calculation method provided by ÅF in accordance with the EBR cost

catalogue. The Venezuelan cost calculations were made in accordance with an offer from Venezuela on one of the grids.

III. RESULTS

The results of the study of the standards in each country immediately points out the lack of standards in Venezuela. No standards regarding voltage deviation limits or short circuit currents was found, and therefore, the corresponding Swedish standards had to be used. The voltage in Venezuela is significantly lower than the Swedish phase voltage, 127 V vs. 230 V, which caused the currents in the grid to increase a lot. This in turn caused higher losses, heavier electrical loading on the cables, and larger voltage deviation. The Venezuelan cables had to be changed in several steps in order to get close to the electrical requirements used in the Swedish grids.

The economical differences between the two countries were large, starting with the cables. The conducting material of the cables used in the Venezuelan grids were copper, which is an expensive material, compared to the Swedish aluminium cables. Also, the system was over dimensioned due to large voltage drops, which resulted in a higher cost than initially thought of. The Venezuelan cable cost were larger than the total cost of the corresponding Swedish grid which indicates a huge cost difference for the total grid.

IV. CONCLUSIONS

The ease of designing the Swedish grids, the functionality and the costs of the grids, points out the fact that well developed standards are very important when expanding old grids or building new ones. The lack of standards in Venezuela causes several problems, and gives no indication of functionality or stability requirements. The large voltage drops, the losses, and the electrical loading in the Venezuela grids seem to mainly be caused by the low voltage level, which is a standard that is not easily changed. A standard or guideline that actually can be changed is the usage of copper cables, which could be replaced with, for example, aluminium cables. This could reduce the total costs a lot and may make the Venezuelan grids in the same price category as the Swedish grids.

If more countries puts focus on the development of international standards, all compatible with another, it will expand the market in such way that the design and construction of grids in developing countries will be much easier. It will open up the market for foreign companies, that can contribute with their knowledge and experience, in order to speed up the development and create access to electricity for more people in the world. It will also create an easier way to insure

Olof Samuelsson and the department of Industrial Electrical Engineering and Automation, LTH.

Neil Hancock and all involved staff at ÅF

inter-connectivity inside between countries. This study clearly shows that much research is needed if trying to cooperate with another country's market, and the development of standards regarding new or old technology is of high importance, if wanting to create a sustainable, inter-connecting and functioning electricity grid.

REFERENCES

- [1] SEK Svensk Elstandard, *SEK Svensk Elstandard*, [Online]. Available: <http://www.elstandard.se/>
- [2] Fondonorma - Codelectra, *Código Eléctrico Normal*, 200:2004, 7a, Revisión, Venezuela
- [3] General Cable Cocesa. (2014). *SUPERFLEX / TC RV-K FOC*. [Online]. Available: <http://www.generalcable.com/latam/cl/productos-y-soluciones/baja-tension>
- [4] Onninen, *Elnät*, Katalog 2011, pp 1-27
- [5] EBR *Kostnads katalog, Lokalnät 0,4-24 kV samt optonät-KLG 1:17*, March 2017, EBR