Evaluation concept for „100% Renewable Energy“-projects

Project 9
authors

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Introduction

Throughout Germany and internationally, there are many projects that deal with the implementation of a decentralized renewable energy supply. The evaluation and comparison of the projects is often difficult. Because of this a concept based on an evaluation matrix is presented that considers projects under different criteria. The aim of this concept is to find out which factors are decisive for the successful implementation of such "100% renewable energy“-projects. In addition, conclusions are to be drawn about promising procedures for the realization of a complete renewable energy supply.

Project Exampels

The development and application of the evaluation concept is based on a total of 22 national and international exemplary projects. 14 of these projects are located in the German-speaking countries Germany, Austria and Switzerland while the others are located in north America. The scope of the projects can range from that of a single house to that of an entire region. The concrete goals pursued by the individual projects can vary greatly in detail.

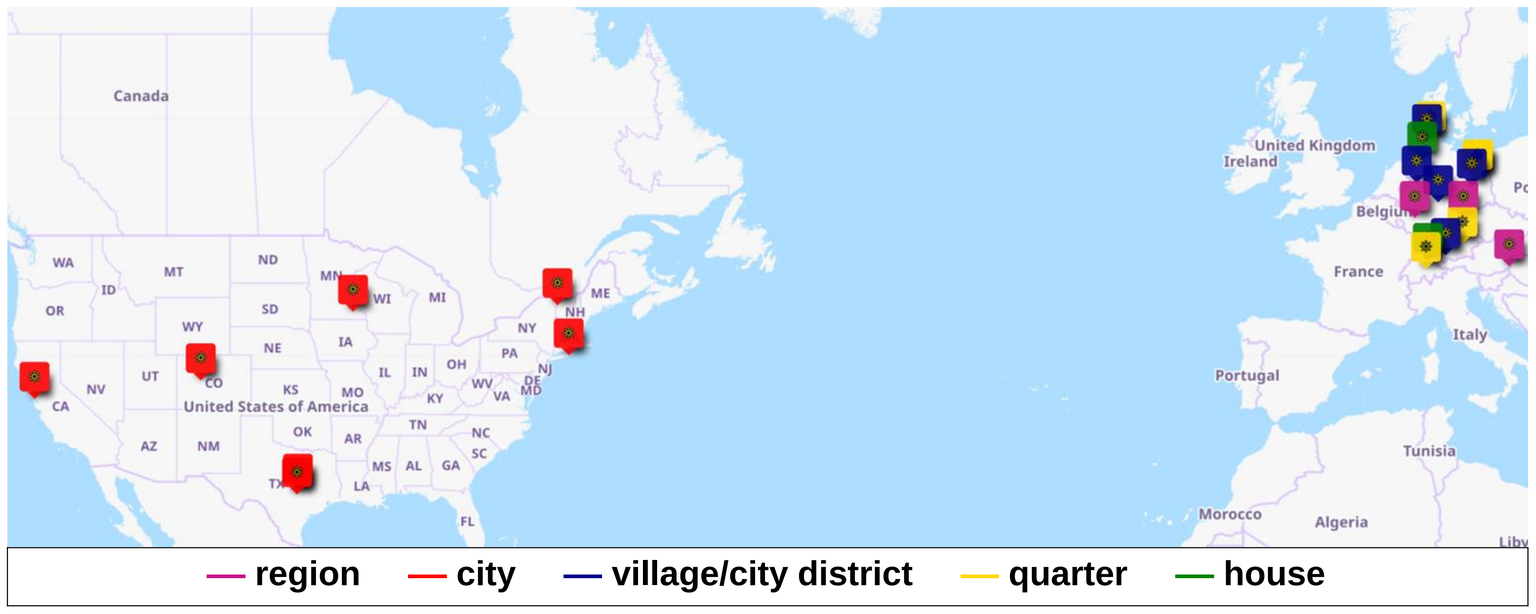

Figure 1: Project locations and scopes [1]

Evaluation Concept

- The evaluation is carried out with an evaluation matrix.
- The matrix contains different evaluation criteria, each of which is assigned a weighting factor X.
- High weighting factor - high relevance of the evaluation criterion.
- Each project is given a score A between 1 and 5 for each evaluation criterion.
- Each project receives an overall score C - comparison with other projects possible.

Table 1: Evaluation methodology

evaluation criteria	weighting factor X	score A	score B	overall score C
evaluation criterion 1	X_1	A_1	$\mathbf{B_1} = X_1 * A_1$	$\mathbf{C} = B_1 + B_2 + B_3$
evaluation criterion 2	X_2	A_2	$\mathbf{B_2} = X_2 * A_2$	
evaluation criterion 3	X_3	A_3	$\mathbf{B_3} = X_3 * A_3$	

Table 2: Evaluation criteria and their weighting factors

evaluation criterion	weighting factor X
autarky rate – electricity	6
autarky rate – heat	7
autarky rate – transport	8
project scope	5
settlement density	2
settlement structure	2
technology portfolio	5
project progress	3
project ambitions	2
citizen participation	6

Energy self-sufficient village Feldheim

Feldheim is a village with about 130 inhabitants in Brandenburg, Germany. 100% real autarky is achieved here in the electricity and heat sectors. The energy demand can be covered at any time with the help of a battery storage and the base-load capable biogas plant as well as the woodchip heating plant. Besides that, there is a wind and a solar park. In the transport sector no known efforts have been made so far. The village has separate distribution networks for electricity and heat, which, like the renewable energy generation plants, were partly co-financed by the residents. Hence, the citizen initiative and participation is very high. Further future ambitions are the implementation of a traffic concept as well as the production of green hydrogen. The energy self-sufficient village Feldheim achieves an overall score of 180 points. [2, 3]

Hawaii

Hawaii achieved an overall score of 126 in the evaluation-matrix calculation because of its steadily progressing toward ending its dependency on fossil fuels and transitioning to a renewable portfolio standard of 100% renewable energy by 2045. The interim objectives are 30% renewable energy by 2020, 50% by 2030 and 70% by 2040. The amount of renewable electricity on Hawaii's systems rose, with a renewable portfolio standard of 36.07% for the calendar year 2020. [4] As of October 2020, Hawaii has one of the highest per capita rates of electric cars, with over 12000 electric vehicles registered. The Hawaii State Energy Office is trying to execute methods that will make a transformational investment in Hawaii's clean energy economy in order to reduce Hawaii's petroleum consumption in the ground transportation sector. Hawaii approved legislation to offer incentives for the addition and upgrade of charging infrastructure. [5]

Pellworm

Pellworm is an isle-community with about 1250 inhabitants in Schleswig-Holstein, Germany. The energy supply is mainly based on the following renewable energy technologies: 12 wind turbines, PV systems, 30 solar thermal systems, 35 heat pumps, a woodchip heating plant and a biogas plant. [6, 7] The self-sufficiency rates for the electricity, heat and transport sectors can only be roughly estimated due to the lack of available data. According to the community website Pellworm is not only striving for climate neutrality, it is also well advanced in this direction, [18, 19] while other sources state that the project has failed. Even though more electricity is produced than demanded the storages aren’t big enough to guarantee a power supply at any time. Since the project was mainly carried by E.on and the additional cost could not be covered by any of the worked-out models, E.on closed the unfinished project. [8, 9]
The project achieves an overall score of 100 points.

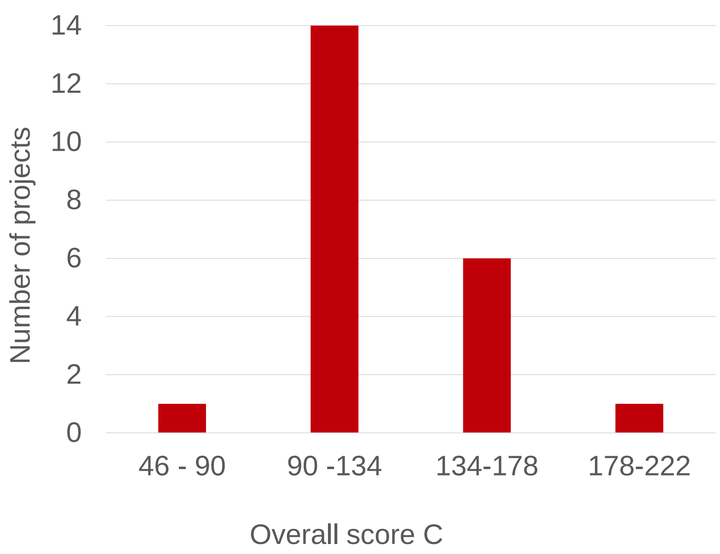

Figure 2: Distribution of the project examples across the evaluation ranges

Conclusion

- Weaknesses of the matrix: Definition of categories within the evaluation criteria can or should be refined.
- Although the respective weighting factors could be validated to a certain extent based on the researched projects and their comparison with each other, the number of projects is manageable and should be expanded in future investigations and further development of the matrix.
- Despite these criticisms, the evaluation matrix can be used as a tool to categorize, evaluate and compare "100% renewable energy"-projects. Strengths and weaknesses of the projects can be revealed.
- Projects in the medium evaluation range are strongly represented, while only two projects are in the good or poor evaluation range.
- Especially large projects have difficulties in implementing transport concepts based on renewable energies.
- Self-sufficiency in the heat sector is also still far less common than in the electricity sector.
- Well-rated projects have in common that they are based on strong citizen initiative or at least participation.
- In addition, they have a broad technology portfolio (including baseload capable technologies and storages).

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