Measuring sustainable development in energy communities: Policy implications for sustainable and optimized community behaviour

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Overview

Sustainable development in communities requires the introduction of indicators to classify sustainable behaviour. Work from [1] and [2] analyze different sustainability indicators that can be applied for measurement. The sustainable development goals of the United Nations (UN SDG) [3] are an efficient means to measure sustainable development in the community. However, these indicators are difficult to quantify, as the UN proposes a list of 169 potential actions for sustainable development. The OECD Council introduces indicators for sustainable development regarding the UN SDG [4], but their indicators are better suitable for national than for community measurement. [5] introduce UN SDG indicators for municipalities. However, these indicators might be too extensive for a wider implementation in communities. Therefore, we present a simple UN SDG classification system based on a literature review, where each SDG indicator represents one percentual contribution value to the respective SDG. This approach shall make different communities comparable and enable benchmarking. To validate the applicability of the proposed indicator system, we apply it in an existing sustainable community in Lower Austria. In that context, different policy actions are analyzed. The analysis aims to test the proposed indicator system and propose policy actions that can help improve the communities' contribution to the UN SDG.

Methods

An optimization model respresenting the sustainable community is developed to investigate the proposed system. The community participants are aggregated for the analyses. We consider mainly the operational SDG, related to energy, resources and environment for the analysis, as they can be improved by technology utilization and efficient operation. The community has the option to invest in sustainable technologies, such as a PV system and a heat pump. Considered energy sectors in the analysis are the electricity and heat sector. Moreover, as sustainable development requires efficient resource utilization in communities, the water and waste sector are considered in the study. The investigation setup of the community optimization is presented in Figure 1. To assess policy actions, we include the proposed SDG measuring system as model constraints, where each operational SDG is represented as a constraint. Different goals are tested in a sensitivity analysis to identify required community actions for improvement in sustainable development. Moreover, the dual variables of the SDG constraints are evaluated to define the required costs for specific SDG contributions.

Figure 1 Community SDG investigation setup

Results

Heat pumps and greywater systems are increasingly implemented at higher SDG targets. Greywater installation provides immediate improvement of SDG6, clean water and sanitation. However, as not the total water demand can be covered by greywater, SDG6 has a limit at 45% contribution. SDG6 is the first operational SDG that becomes active, which can be seen in the value of the respective dual variable. SDG7, affordable and clean energy, and SDG13, climate action, directly correlate in the proposed system. SDG13 is represented by emission reductions, whereas increased contribution to SDG7 leads to increased renewable energy technology and thus to emission reductions. Therefore, policy actions for one of these SDGs results in an improvement of both. SDG12, responsible consumption and production, is represented by the share of waste recycling. The goal can be improved by efficient waste management. Policymakers must therefore promote recycling to increase SDG12 contribution. However, SDG target setting always leads to cost increases for the community. Therefore, SDG1, no poverty, must also be considered in the operational analyses to avoid disproportionally high cost increases. The graphical representation of the community analysis with the proposed measuring system is presented in Figure 2.

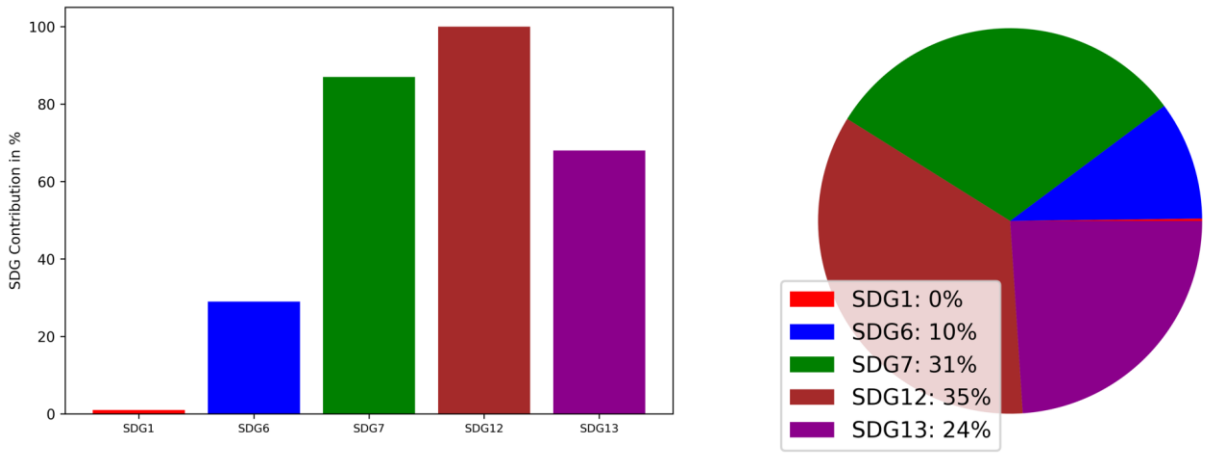

Figure 2 SDG measuring results

Conclusions

The proposed classification system is applicable in energy or sustainable communities, which was validated by an application in an existing community. SDG target setting leads to improved SDG contribution. However, the costs for the community rise with increasing SDG targets. Therefore, SDG1 must also be considered in the analysis and must be part of the analyses on the sustainable operation.

Acknowledgement

Acknowledgement: This work is done in the “Hybrid Local Sustainable Communities” project [6] and is supported with the funds from the Climate and Energy Fund and implemented in the framework of the RTI-initiative “Flagship region Energy” within Green Energy Lab.

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