ComForEn 2021

BIFROST - A narrative simulation tool for Smart Energy scenarios - Tutorial and hands-on

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Abstract – BIFROST is a narrative Smart Grid simulation tool for exploring, building, and presenting stories about settlements, communities and quarters pushing to adapt to the climate crisis. It offers simulation orchestration and creative tools to quickly explore variegated scenarios, with the ultimate goals of reducing complexity and presenting technological solutions. It fosters engagement in decision processes, and enables integrative discussions across a range of expertise levels. With this workshop, we want to introduce BIFROST, show some successfully realized projects and applications, and give the participants the chance to build and explore their own virtual community.

1. BIFROST Introduction

BIFROST is a web-based tool for the construction of visually engaging settlements, communities and quarters backed by Smart Energy Infrastructure [1]. External modules can interact with the BIFROST platform to emulate complex smart energy infrastructure-related scenarios and create compelling stories. Conveying hard technical facts in a compelling fashion is challenging. The effects of a warming climate on a city district; higher grid loads through renewable energy installations; benefits of local energy sharing; e-car loading control through unreliable wireless channels – whatever your narrative, BIFROST provides the tools to design and visualize a compelling Smart Infrastructure story, as it can be seen in Figure 1. The Figure shows the UI of BIFROST presenting an exemplary use case about novel energy community concepts, which compares different strategies and visualizes the resulting KPIs.

Figure 1: BIFROST UI: You can see an energy community scenario consisting of multiple different stakeholders (residential buildings, commercial buildings, battery storage), the simulation timeline at the bottom, and some simulation results on the right side.

BIFROST consists of a core simulation engine to drive dynamic data generation and a 3D web UI for the construction of settlements [2]. Its main components can be seen in Figure 2. The BIFROST backend orchestrates the internal data model, which stores all information about available structures and parameters (BIFROST *directory*) as well as the realized settlements and the corresponding simulation data (BIFROST *state*). The BIFROST core itself does not make any assumption about the content of the directory. Both structures, as well as their parameters can be adjusted to the user's needs, who can access the simulation environment through the BIFROST frontend.

The BIFROST core does not generate any simulation data but provides a unified REST API interface to any software component (BIFROST *module*). Modules can introduce any kind of behavior necessary for the current simulation run (e.g., load flow solver, weather generator, energy community controller, etc.). This flexibility allows BIFROST to tackle various use cases from CO2-efficient energy community concepts to intelligent e-car loading controllers or optimized pricing strategies.

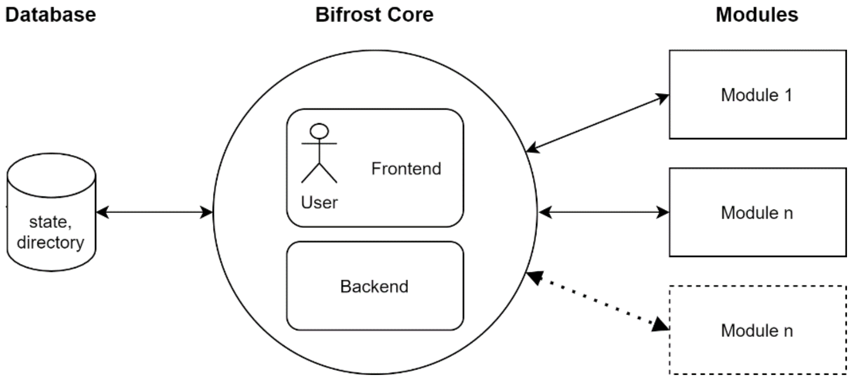

Figure 2: Main BIFROST components: The BIFROST core consists of a frontend for the human interaction and the backend for the orchestration of the internal database. BIFROST modules can interact with the core via a unified REST API interface and can provide any kind of simulation behavior.

Besides the landscape view shown in Figure 1, BIFROST also includes different layers (electrical grid, thermal grid, communication, etc.) for a clear and structured visualization as well as a geo-mode, which allows to include geospatial relations (see Figure 3).

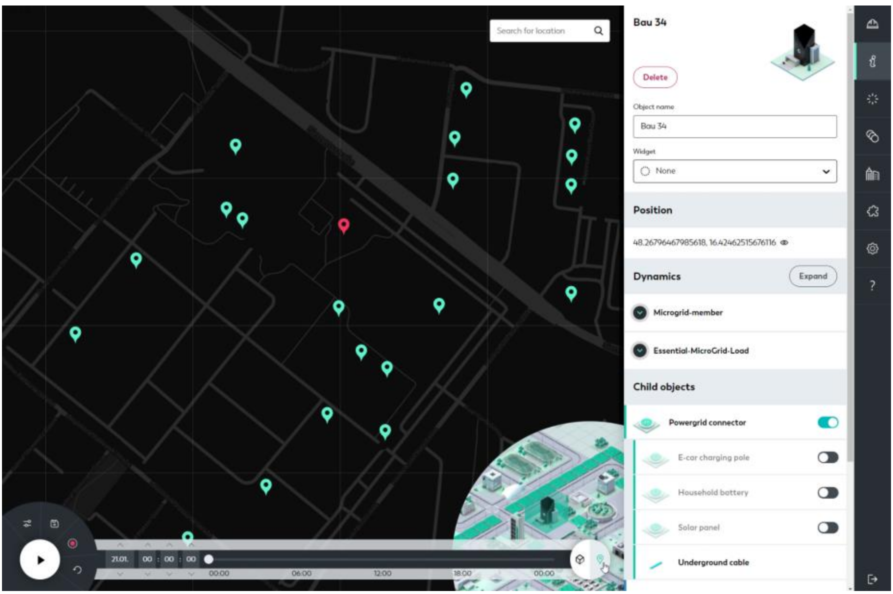

Figure 3: BIFROST UI representation of geospatial relations in BIFROST

2. BIFROST projects and applications

BIFROST is currently used in many national and international research projects, including CLUE [3] and SONDER [4], both focusing on novel concepts for energy communities. In this workshop we want to show some hands-on demonstrations and give anyone the chance to build and explore their own virtual community. Therefore, in this chapter, we introduce some of the exhibited demonstrators you will see at ComForEn 2021.

2.1 External Configuration Tool

The goal of this project is to create different scenarios for an existing BIFROST settlement. This is done by changing the configuration of buildings such as single-family via an external configuration tool – the *BIFROSTExtConfigTool*. Using this tool, users can easily vary different parameters and analyse the results. For example, different battery storage sizes of a community battery influence the price savings and level of self-sufficiency. With the *BIFROSTExtConfigTool* those influences can be simulated and visualized semi-automated. The tool offers a modern user interface and can be used offline and in conjunction with an active BIFROST instance. Figure 4 shows different profiles which have been reconfigured using the *BIFROSTExtConfigTool.*

Figure 4: BIFROSTExtConfigTool: Different profiles (basic load, PV, EV) can be configured via the external configuration tool. After a reconfiguration, different profiles can be observed in the right graphs.

2.2 BIFROST Bricks

This project was created with the goal of providing an interactive and illustrative experience of Smart Cities. Anyone can place building bricks on a designated board and watch them be recreated as buildings in their own (see Figure 5). This is made possible due to the combination of object detection, grid auto-routing and the communication with a server for the BIFROST simulation. The project has an educational background, as it was designed for strengthening the awareness of current Smart Grid concepts such as energy communities as well as current and future challenges, such as renewable energy sources.

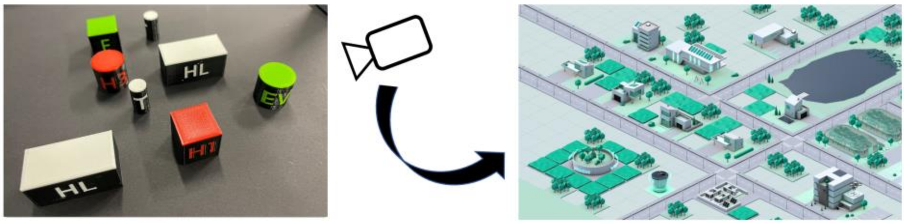

Figure 5: BIFROST Bricks concept: After placing building bricks on a surface, the different types and positions are detected and a BIFROST settlement is automatically created, including the electrical grid.

2.3 BIFROST House

Figure 6: Bifrost House

Bringing simulations into reality has never been more intriguing by combining BIFROST with the popular open-source energy management system called *OpenEMS*. It is used for energy management applications such as controlling electric storages or solar power systems, enabling real-world sensor data to be fed into the simulation. This 3D-printed physical model of a single household (see Figure 6) with integrated environmental sensors and actors allows the interactive demonstration of different household-based energy management strategies within BIFROST.

2.4 Energy Community Evaluation

Energy communities provide the possibility to share energy among their participants with the goals of cost optimization, grid support, and sustainable operation. Community members can share flexibilities (e.g., PV overproduction) or use communal energy storage systems. Depending on the variety of its participants, different strategies can lead to more or less optimal results. With BIFROST, these strategies can be evaluated and compared with each other by building and configuring an energy community and visualizing the results. During the workshop, our visitors will have the chance to build and explore their own virtual energy community.

References

[1] https://bifrost.siemens.com, accessed: 01.11.2021

[2] Mosshammer, Ralf & Diwold, Konrad & Einfalt, Alfred & Schwarz, Julian & Zehrfeldt, Benjamin. (2019). BIFROST: A Smart City Planning and Simulation Tool: Proceedings of the 2nd International Conference on Intelligent Human Systems Integration (IHSI 2019): Integrating People and Intelligent Systems, February 7-10, 2019, San Diego, California, USA. 10.1007/978-3-030-11051-2_33.

[3] https://project-clue.eu/, accessed: 01.11.2021

[4] https://www.project-sonder.eu/, accessed: 01.11.2021

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Dipl.-Ing. (FH) Dr.-Ing. Ralf Mosshammer joined the "Smart Embedded Systems" group at Siemens Technology Austria in 2011, initially working on simulation coupling for Smart Grid controllers, which eventually evolved to include human-centered monitoring and control concepts. He is the principal developer and maintainer of BIFROST, a Smart Infrastructure modelling and simulation tool with a strong focus on interactivity and narrative design.

Dipl.-Ing Thomas Leopold finished his master's degree in Embedded Systems in 2020 at the TU Wien. He joined the Institute of Computer Technology at TU Wien in 2018, where he started to work on several projects. Beginning with June 2021, he started his Predoc at the ICT. He is currently working on the SONDER, Clue, cFlex and Bifrost lab projects concerning problems in energy communities. His interests range from renewables and power electronics to autonomous pest control in agriculture. Currently, he is teaching at the TU Wien and the FH Technikum. For his PhD, he is pursuing pest control via machine vision and autonomous driving in agriculture.

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