Innovative software modules for effective excess thermal energy recovery

November 3 2021

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After nearly two years of data collection and software development, EU-funded project, EMB3Rs, is almost ready to reveal the best ways that industry can re-use excess thermal energy.

In October 2021, EMB3Rs partners from across Europe gathered in Portugal, at Lisbon-based Information Systems business, PDMFC, to learn how the platform's all-important software modules will be integrated to the open source tool. These modules will be crucial to mapping the supply and demand of thermal energy from different stakeholders and will also determine the cheapest option to connect potential users.

PDMFC is responsible for integrating the modules to the platform and also ensuring the software interoperates seamlessly. As PDMFC researcher, David Fernandes, highlights: "Module integration is almost complete and soon, the user will be able to simply define their initial conditions and then receive a user-friendly result."

EMB3Rs initially comprises four key modules that have been programmed to handle different types of energy-related technical and economic data. A GIS module will find the best and cheapest way to connect different heat sources and sinks while a Techno-Economic module can find the least cost option for using excess thermal energy across an entire energy supply chain.

Meanwhile, the Market module calculates an overall economic analysis of a potential energy system, depending on market types such as centralized or peer-to-peer (P2P) conditions. And then a Business Model module will allow platform users to explore the financial, environmental and risk implications of any energy set-up.

On top of these four energy data-crunching modules, a simulation manager module coordinates how the modules interoperate as a user runs his or her energy simulation while a reporter module organizes the output for the end-user. "The user will want to configure a simulation, run it and then examine the results without caring what has been going on between the platform and the modules," says Fernandes.

To program the modules, partners from a range of case studies have been busy collecting vast amounts of project data from digging costs and energy flows to local energy tariffs and regulatory framework information. For example, industry-focused case studies, including an industrial park in Greece and cement plant in Portugal, have supplied data from potential providers and users of excess energy. Meanwhile, network-focused case studies have provided data from heating and cooling, and district heating networks, in Sweden, Portugal and the UK.

In the final pieces of the data puzzle, a super-user case study from the Portuguese Energy Agency adene has provided data from hundreds of thousands of commercial building and households to explore what happens to the platform when a user wants to analyze massive volumes of data. And a market-focused case study from the Technical University of Denmark has collected data associated with P2P relationships between the different energy market players.

Troubleshooting module communication

At the time of writing, data collection and development of all software modules is complete, and PDMFC researchers have been working closely with developers to integrate all software to the EMB3Rs platform so that each module can analyze data in a standardized way. As Fernandes points out: "Integration is almost complete, but we only recently realized that the modules are all 'talking somewhat differently.'"

"This is not a problem and we have been studying the inputs and outputs of the modules so we can find the middle-point between, say the techno-economic and market modules, to ensure processing takes place quickly," he adds.

As part of these activities, Fernandes and colleagues have developed so-called wrappers that developers can add to their modules. These

wrappers standardize the code for communication between modules to ensure seamless interactions between each other and the platform.

However, according to Fernandes, standardizing communications between modules is not the biggest challenge that he and his PDM colleagues have faced. Instead, scaling the EMB3Rs platform to analyze more and more data for more and more users has been a trickier task.

"It's one thing running one simulation at a time on a desktop but what if you have 100 or even 1000 simulations at any single time? This is when scalability becomes very important," he says.

Fernandes and colleagues dealt with this issue by assessing how much processing power a module needed for any particular task. "Once we understood this we could see if there was any task that was stealing the available server resources," explains Fernandes. "Even once module integration is completely finished we'll continue to run more tests to work out how much we can scale platform simulations using a single server."

In the future, more servers may be an option, but for the time being simulations continue apace. An initial platform simulation has already looked at the functions of each module using dummy data. And data analysis from EMB3Rs platform developer and partner, Portugal-based INEGI, has also confirmed that the data being generated by case studies is suitable for future platform simulations.

"We've been testing the platform manually, step by step, but now we are working on automating the simulations so each module receives the inputs and provides the outputs that the user wants," says Fernandes. "This will take around a month but then the user will be able to 'click' a button and watch as everything happens."

Hopes for industry

Without a doubt EMB3Rs project partners are excited. For example, Aristotelis Botzios and George Goumas from the Greece-based Centre for Renewable Energy Sources and Saving (CRES) have been collecting heating and cooling data from businesses at the Volos Industrial Park in Greece and residents in the nearby town of Agios Georgios, since May 2020. Botzios and Goumas hope that future EMB3Rs simulations will confirm the economic and technical viability of their proposed heat-exchange system between the industrial park and town so they can then bid for pilot study funds from Greece's Energy and Environment Ministry.

"Everything is going well so far," highlights Goumas. "We've had great results on the integration of our data and now we are looking forward to the simulation results."

Botzios concurs, saying: "With these simulation results we'll get an idea of the size of works that needs to be done, cost information and also what sort of financial policy or subsidies that may be needed to make this all possible."

"The EMB3Rs platform is going to be useful for any industrial park," he adds. "You'll be able to enter just basic data and see if your [project] is viable."

Importantly for users, EMB3Rs has also been designed as a modular platform so in the future, software developers will be able to integrate additional, different modules to the open source tool. "I see EMB3Rs as the kind of platform that is going to grow," says Fernandes. "As more and more more people use it, then of course the tool will also grow in complexity but the platform is certainly stable enough for this growth to take place… this is a pretty interesting project for us."