TradeRES

New Markets Design & Models for 100% Renewable Power Systems

NEWSLETTER #6

TradeRES 6th semester achievements

Closing of the second semester of the third year of the project. This period from July 2022 to January 2023, was full of accomplishments, several publications, participation in conferences, and the organization of the project's second workshop. In this newsletter, we also interview a project participant.

The TradeRES Workshop

The second TradeRES workshop occurred on November 28th, 2022 and aimed at bringing together different views on some of the primary research and development questions related to the project, including discussions on wholesale market design, retail markets, ancillary services, system adequacy, sector coupling, and congestion management. The valuable insights gathered, and the discussion conclusions were used to complement and improve the project ideas and vision. Consequently, the workshop outcomes were reflected in the market designs currently under development so that the different perspectives and needs can be incorporated into TradeRES comprehensive market designs.

The workshop was a success with almost 200 people, and we provide recordings of the Second TradeRES Public Workshop, so if you miss some part, you can still take advantage of the session. Click here to see the recording.

Dissemination

Journals

- Meysam Khojasteh, Pedro Faria, Fernando Lezama, Zita Vale, "Optimal strategy of electricity and natural gas aggregators in the energy and balance markets", Energy, 257, July 2022.
- Hugo Algarvio, "Agent-Based Model of Citizen Energy Communities Used to Negotiate Bilateral Contracts in Electricity Markets", Smart Cities, 5, August 2022.
- Hugo Algarvio, "Risk-Sharing Contracts and risk management of bilateral contracting in electricity markets", International Journal of Electrical Power & Energy Systems, 144, September 2022.
- Dawei Qiu; Jianhong Wang; Zihang Dong; Yi Wang; Goran Strbac, "Mean-Field Multi-Agent Reinforcement Learning for Peer-to-Peer Multi-Energy Trading," in IEEE Transactions on Power Systems, October 2022.
- António Couto, Ana Estanqueiro, "Enhancing wind power forecast accuracy using the weather research and forecasting numerical model-based features and artificial neuronal networks", Renewable Energy, 201, November 2022.

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- Hugo Algarvio, “Strategic Participation of Active Citizen Energy Communities in Spot Electricity Markets Using Hybrid Forecast Methodologies”, Eng, 4, December 2022.
- Meysam Khojasteh, Pedro Faria, Fernando Lezama, Zita Vale, A hierarchy model to use local resources by DSO and TSO in the balancing market, Energy, December 2022.
- Hugo Algarvio, Fernando Lopes, “Bilateral Contracting and Price-Based Demand Response in Multi-Agent Electricity Markets: A Study on Time-of-Use Tariffs”, Energies 16, January 2023.

Conferences

- Hugo Algarvio, Fernando Lopes, "Strategic Bidding of Retailers in Wholesale Energy Markets: A Model Using Hybrid Forecast Methods." Highlights in Practical Applications of Agents, Multi-Agent Systems, and Complex Systems Simulation. The PAAMS Collection: International Workshops of PAAMS 2022, L'Aquila, Italy, July 13-15, 2022.
- Vitor Silveira, Bruno Canizes, Zita Vale, "Demand Response and Electric Vehicles as Services to Provide Support to the Distribution Network Operation", IEEE Power & Energy Society General Meeting (PES-GM), July 17–21, 2022.
- Rui Carvalho, Gabriel Santos, Zita Vale, "Open-access Tools for the Modelling and Simulation of Electricity Markets", Energy Informatics.Academy Conference (EI.A 2022), 24-25 August, 2022.
- Gabriel Santos, Ricardo Faia, Helder Pereira, Tiago Pinto, Zita Vale, "Blockchain-based Local Electricity Market Solution", 18th European Energy Market Conference, Ljubljana, September 13-15, 2022.
- Fernando Lezama, Ricardo Faia, Zita Vale, "The impact of variable renewables' heterogeneity on their market values in the Iberian wholesale electricity market", 18th European Energy Market Conference, Ljubljana, September 13-15, 2022.
- Silke Johanndeiter, "The impact of variable renewables' heterogeneity on their market values in the Iberian wholesale electricity market", 18th European Energy Market Conference, Ljubljana, September 13-15, 2022.
- Nikolaos Chrysanthopoulos, Dimitrios Papadaskalopoulos, Goran Strbac, "Non-Mutually Exclusive Business Models for LES: A Quantitative Assessment", 13th Mediterranean Conference on Power Generation, Transmission and Distribution and Energy Conversion (MEDPOWER 2022), Malta, November 07-09, 2022.

More details at: https://traderes.eu/papers

Deliverables

- D2.3 How to use TradeRES optimization models database
- D4.4 - New actor types in electricity market simulation models Edition 2
- D4.5 - New market designs in electricity market simulation models Edition 2
- D5.2 - Performance assessment of current and new market designs and trading mechanisms for Local Energy Communities (Case Study A)
- D5.3: Performance assessment of current and new market designs and trading mechanisms for National and Regional Markets

More details at: https://traderes.eu/documents/

Ph.D. thesis

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Two participants of TradeRES's project concluded their Ph.D., namely:

- Ana Silva, at the University of Lisbon, with the title: "Towards near 100% renewable power systems: Improving the role of distributed energy resources using optimization models".
- Ricardo Faia, at the University of Salamanca with the maximum classification, with the title: "Decision Support for Participation in Electric Markets considering the Transaction of Services and Electricity at the Local Level".

Events

We participated in several events, such as:

- EURO Conference (EURO 2022), 2022-07-03 to 2022-07-06;
- 2022 IEEE PES Innovative Smart Grid Technologies Conference Europe (ISGT-Europe), 2022-07-17 to 2022-07-21;
- Energy Informatics. Academy Conference (EI.A 2022), 2022-08-24 to 2022-08-25;
- International Conference on European Energy Markets (EEM 2022), 2022-09-13 to 2022-09-15;
- IAEE European Energy Conference (IAEE 2022), 2022-09-21 to 2022-09-24;
- WindEnergy Hamburg 2022, 2022-09-27 to 2022-09-30;
- International Conference on Energy Economics and Technology (ENERDAY 2022 probably), 2022-09-30-09;
- Wind Berlin 2022, 2022-11-07 to 2022-11-08;
- Mediterranean Conference on Power Generation, Transmission and Distribution and Energy Conversion (MEDPOWER 2022), 2022-11-07 to 2022-11-09;
- Joint PhD seminar by the chair of energy systems and energy economics, (EXCO LNEG), 2022-11-07 to 2022-11-10;
- Tomorrow Summit 2022, 2022-11-11.

More details at: https://traderes.eu/events/

Interview

Q: Who is Christoph Schimeczek?

Christoph Schimeczek has a diploma in Physics which he received in 2010 from the University of Stuttgart, Germany. In 2014 he received a Ph.D. in Physics from the same university. Since 2014 he has been a researcher at the German Aerospace Center (DLR). He contributed to the modeling and assessment of electric vehicle market uptakes until 2017. Since then, he has been coordinating the development of the agent-based electricity market model AMIRIS at the Department of Energy Systems Analysis of DLR's Institute of Networked Energy Systems. His main research focus is modeling dispatch strategies for energy storage and other flexibility options.

Q: What are your main responsibilities in TradeRES?

I lead Work Package 4, which deals with developing open-access market simulation models and tools. Judging from its budget, this is the largest work package in TradeRES. I am thus hosting a lot of online meetings with most of the partners to coordinate their efforts concerning model development and model coupling. This task is almost complete by now, so I am currently switching towards coordinating the development of the market design web decision tool in Work Package 7. This tool will summarize the findings of project TradeRES neatly and will be available to the open public.

Q: What kind of model developments are done in Work Package 4?

This work package has two aspects. First, it covers the enhancement and adaptation of the six models within TradeRES. These model enhancements regard the representation of new temporal flexibility, like shorter lead times between market closure and delivery or real-time pricing for demand-side flexibility. This is due to considering related sectors, like hydrogen, residential heating, or electric mobility, and the improved modeling of spatial flexibility, e.g., with dynamic line rating. In addition, the models are extended to represent new actors, e.g., household prosumers and their behavior, as well as new markets like local energy markets.

Furthermore, new energy policy options are integrated into the models, like new support instruments for producers of renewable electricity or capacity subscriptions for consumers. As you can see, there are many activities within TradeRES concerning model enhancements. However, the second main aspect of Work Package 4 is to couple these models within individual coupling workflows and thus enable the broad assessments of market designs within the European power systems.

Q: You mentioned that you employ six models within TradeRES. Why so many?

Each of the six models has a different focus and different capabilities. For example, two models are based on optimization, enabling them to find the optimal power systems under certain assumptions. This type of model is prevalent in the energy system analysis field. Such models are often quite well developed, comprise a wide range of technologies and many energy-related sectors, and often consider grid infrastructure. However, these models often assume perfect competition and thus are not ideally suited to capture real-world market dynamics caused by market imperfections. The other four models in TradeRES are agent-based simulations. Such models usually do not yield a perfect solution but are suited to incorporate more details about the markets and their actors. Within TradeRES, we first employ both model types to find optimal solutions (for a given set of scenarios) using optimization models. Then, based on these results, we use the agent-based models to assess market dynamics more precisely and how different market designs can help to improve these market dynamics. I forgot to mention that each agent-based model has another focus, so we can use them individually to assess specific market performance aspects. For example, EMLab examines long-term investment decisions, whereas MASCEM focuses on clearing day-ahead or short-term markets. In TradeRES, we also couple models to achieve an even better and broader assessment of market performance within the scenarios.

Q: How does this model coupling work?

Coupling our models in TradeRES is one of the most ambitious tasks. We want to provide an open-access toolbox of workflows that comprises the execution of individual models and coupled models. This requires a powerful workflow management tool and automatic data transfer between the models and the scenario database. We are lucky to have the developers of the Spine-Toolbox (https://github.com/spine-tools/Spine-Toolbox) with us in the TradeRES project, which is why we chose this powerful workflow manager to coordinate the execution of models and the dataflows between them. All of the created model workflows in TradeRES are on a public GitHub repository (https://github.com/TradeRES), and I encourage interested researchers to have a look. Work Package 6 also provided detailed instructions and tutorial videos for the available tools.

Q: What are the greatest challenges in the coupling of different models?

To achieve an automatic data exchange between the models, all partners worked hard to provide details about their model's interfaces. This can be rather tedious work as the models in TradeRES do not use the same standards for describing their input and output parameters. Once there is a common understanding of model interfaces, one

must create specific transfer scripts to adapt for different formatting, units, scoping, or data resolution. A typical example of different formatting is the timestamp in time-series data. Many different ways to format a timestamp exist, thus, timestamps from one model need to be reformatted to serve as input for another model or to be compared with its output. In this case, a simple transformation function suffices. Different units for model parameters can also be quite easily accounted for. However, the issue is more complicated if the model parameters refer to different resolutions or scoping. For example, in one model, a parameter could refer to the national electricity demand in hourly resolution, whereas in another model, the most similar parameter would refer to a local energy demand in quarter-hourly resolution. Harmonizing these models requires the aggregation or disaggregation of data, making it more complex and may introduce additional assumptions depending on the availability and resolution of the underlying data.

Q: From your experiences, how could the task of model coupling be simplified?

I think a major improvement toward simplifying and speeding-up model coupling endeavors would be the definition of a common standard for describing models and their inputs and outputs. Such standards are currently developed but are not yet used by many models. Thus, a second step would be to apply these standards to existing models. This would pave the way for the creation of automatic tools to identify how different models may interact with each other and assist scientists during the setup of model coupling workflows. In this way, I could envision a future with many highly specialized models interacting in various different workflows, each addressing different research questions.

Q: What are the next steps in TradeRES?

Regarding Work Package 4, we look forward to presenting our models to relevant stakeholders during the workshops organized in Work Package 6. Then, based on the stakeholders' feedback, we will adopt the models and model-coupling workflows to give them the final touch before employing them in the assessments of market designs within Work Package 5. These results will then be fed into the web decision tool of Work Package 7, as I mentioned earlier. So, you could say we are approaching the harvest season within the TradeRES project and shed light on some of the most pressing questions of European power market designs.

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Info

The TradeRES project will develop and test innovative electricity market designs that can meet society's needs of a (near) 100% renewable power system. The market design will be tested in a sophisticated simulation environment in which real-world characteristics such as actors' limited foresight into the future and risk aversion are included.

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1 February 2020

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