



for Advanced Innovation and Development

Agent-based Simulation and Emulation

Tutorial

Cyber-physical multi-agent systems

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EUROPEAN UNION



Our vision: Climate neutral Europe by 2050

https://ec.europa.eu/energy/en

NEWS | 22 May 2019 | Brussels | Energy

Clean energy for all Europeans package completed: good for consumers, good for growth and jobs, and good for the planet





Today 22 May, the Council of ministers of the EU formally adopted four new pieces of EU legislation that redesign the EU electricity market to make it fit for the future. This concludes the remaining elements of the <u>Clean energy for all Europeans package</u> and represents a major step towards completing the Energy Union, delivering on the priorities of the Juncker Commission.



2030 FRAMEWORK FOR CLIMATE AND ENERGY — AGREED TARGETS

	GREENHOUSE GAS EMISSIONS	RENEWABLE ENERGY	ENERGY	INTER- CONNECTION	CLIMATE IN EU-FUNDED PROGRAMMES	CO2 FROM:
2020	-20%	20%	20%	10%	²⁰¹⁴⁻²⁰²⁰ 20%	
2030	≤ -40%	≤ 32%	≤ 32.5%	15%	2021-2027 25%	CARS -37.5% Vans -31% Lorries -30%

Upwards revision clause by 2030



Introduction





- The EU aims to be climate-neutral by 2050 – an economy with net-zero greenhouse gas emissions
- This objective is at the heart of the <u>European Green Deal</u> and in line with the EU's commitment to global climate action under the <u>Paris</u> <u>Agreement</u>

https://ec.europa.eu/clima/policies/strategies/2050

• Entered into force on 4 November 2016



• Keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius

> https://unfccc.int/process-and-meetings/theparis-agreement/the-paris-agreement

22 May 2019

- boost the efficient use of resources by moving to a clean, circular economy
- restore biodiversity and cut pollution

https://ec.europa.eu/energy/topics/energystrategy/clean-energy-all-europeans_en

SEDC. Mapping Demand Response in Europe Today



Energy in the era of smart grids & microgrids



H Morais, P Kádár, P Faria, ZA Vale, HM Khodr, Optimal scheduling of a renewable micro-grid in an isolated load area using mixed-integer linear programming, Renewable Energy 35 (1), 151-156





Energy in the era of smart grids & microgrids

New opportunities

- Resource sharing
- Peer-to-peer transaction
- Transactive energy

New organizations and markets

Agreggators

Local markets

Energy communities

BOOK

Local Electricity Markets 1st Edition Editors: Tiago Pinto,, Zita Vale, Steve Widergren Paperback ISBN: 9780128200742 Imprint: Academic Press Published Date: 1st April 2021 https://www.elsevier.com/books/lo cal-electricity-markets/pinto/978-0-12-820074-2



Lezama, Fernando, Joao Soares, Pablo Hernandez-Leal, Michael Kaisers, Tiago Pinto, and Zita Vale. 2019. "Local Energy Markets: Paving the Path Toward Fully Transactive Energy Systems." IEEE Transactions on Power Systems 34(5):4081–4088. <u>https://doi.org/10.1109/TPWRS.2018.2833959</u>

Abrishambaf, Omid, Fernando Lezama, Pedro Faria, and Zita Vale. 2019. "Towards Transactive Energy Systems: An Analysis on Current Trends." Energy Strategy Reviews <u>https://doi.org/10.1016/j.esr.2019.100418</u>

Santos, Gabriel, Pedro Faria, Zita Vale, Tiago Pinto, and Juan M. Corchado. 2020. "Constrained Generation Bids in Local Electricity Markets: A Semantic Approach." Energies 13(15): 3990. <u>https://doi.org/10.3390/en13153990</u>

J Soares, MAF Ghazvini, M Silva, Z Vale, Multi-dimensional signaling method for population-based metaheuristics: Solving the large-scale scheduling problem in smart grids, Swarm and Evolutionary Computation 29, 13-32



Energy in the era of smart grids & microgrids



AI and Power&Energy systems



Funding & Partnerships



Funding & Partnerships







MARTINE: Multi-Agent based Real-Time INfrastructure for Energy



MARTINE: Multi-Agent based Real-Time INfrastructure for Energy





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MARTINE: Multi-Agent based Real-Time INfrastructure for Energy



Multi-Agent Systems Society



- AiD-EM Adaptive Decision Support for Electricity Markets negotiations MASCEM - Multi-Agent Simulator of Competitive Electricity Markets
- MASGriP Multi-Agent Smart Grid Platform
- IDeSMAS Intelligence and Decision Support Multi-Agent System
- PLCMAS Programmable Logic Control Multi-Agent System





AiD-EM

ONLINE MAY 3-7



smart distribution grid



TOOCC – TOOls Control Center





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Open data sets and algorithms

Take a look at some relevant publicaly available data sets

Sponsored by the IEEE Task Force on Open Data Sets – IEEE Power and Energy Society Intelligent systems subcomitee

http://sites.ieee.org/pes-iss/data-sets/

And please feel free to contribute with additional open data sets http://sites.ieee.org/pes-iss/files/2017/07/ODS-Call-for-Open-Data-Sets.pdf

Competition

http://www.gecad.isep.ipp.pt/ERM-competitions/

Do you want to validate and compare your algorithms? (machine learning, optimization, etc.)

Let's experiment them in our platform

Contact us: zav@isep.ipp.pt, tcp@isep.ipp.pt







LARGE SCALE OPTIMIZATION IN SGs WITH INTENSIVE PENETRATION OF EVs

Competitions on Energy Resource Management

http://www.gecad.isep.ipp.pt/ERM-competitions/

2017-2021 (different test beds)

2021: http://www.gecad.isep.ipp.pt/ERM-competitions/2021-2/

[1] F., Lezama, J. Soares, Z. Vale, J. Rueda, S. Rivera, & I. Elrich, 2017 IEEE competition on modern heuristic optimizers for smart grid operation: Testbeds and results. Swarm and evolutionary computation, *44*, 420-427, 2019

[2] F. Lezama, J. Soares, P. Hernandez-Leal, M. Kaisers, T. Pinto, and Z. Vale, Local Energy Markets: Paving the Path Towards Fully Transactive Energy Systems, IEEE Transaction on Power Systems, IEEE (2018).

[3] Joao Soares, Bruno Canizes, M. A. Fotouhi Gazvhini, Zita Vale, and G. K. Venayagamoorthy, "Two-stage Stochastic Model using Benders' Decomposition for Large-scale Energy Resources Management in Smart grids," IEEE Transactions on Industry Applications, 2017.

[4] F. Lezama, J. Soares, E. Munoz de Cote, L. E. Sucar, and Z. Vale, "Differential Evolution Strategies for Large-Scale Energy Resource Management in Smart Grids," in GECCO '17: Genetic and Evolutionary Computation Conference Companion Proceedings, 2017.

[5] Joao Soares, Mohammad Ali Fotouhi Ghazvini, Marco Silva, Zita Vale, "Multi-dimensional signaling method for populationbased metaheuristics: Solving the large-scale scheduling problem in smart grids", Swarm and Evolutionary Computation, 2016.

[6] Joao Soares, Hugo Morais, Tiago Sousa, Zita Vale, Pedro Faria, "Day-ahead resource scheduling including demand response for electric vehicles", IEEE Transactions on Smart Grid 4 (1), 596-605, 2013.

[7] F. Lezama, J. Soares, B. Canizes, Z. Vale, Z., Flexibility management model of home appliances to support DSO requests in smart grids. Sustainable Cities and Society, 55, 102048, 2020.





Worldwide Competitions

Call for Competition on

Evolutionary Computation in the Energy Domain: Smart Grid Applications 2021

Joint competition

- IEEE Congress on Evolutionary Computation CEC 2021, 28.06-1.07.2021 Kraków, Poland (VIRTUAL)
- The Genetic and Evolutionary Computation Conference GECCO 2021, July 10-14, 2021

Fernando Lezama, Joao Soares, Bruno Canizes, Zita Vale, Ruben Romero Website Link: <u>http://www.gecad.isep.ipp.pt/ERM-competitions/2021-2/</u>

Important deadline: May 31, 2021

- Submit your results to one of the two tracks
- Optional: Submit short descriptions of algorithms and results as 2-page papers to be included in the GECCO Companion April 12, 2021

Our competition will offer an **IEEE Computational Intelligence Society (CIS) prize** of 1000 \$ (500 \$ for the winner of each track). Thanks IEEE CIS for being our sponsor once again!













"What a joy it must be to come here to work everyday"

4+1

Contra a la sua a



Thank you

Please contact me for any questions or comments

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https://scholar.google.com/citations?user= wEw0Ex0AAAAJ&hl=pt-PT&oi=ao

P.PORTO



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