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Advancements in OSeMOSYS – the Open Source energy MOdelling SYStem

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This work provides a review of the latest developments and applications of OSeMOSYS energy systems model generator.
OSeMOSYS was launched at Oxford university in 2011, including co-authors from UCL, UNIDO, UCT, Stanford, PSI and other institutions. It was designed to fill a gap in the energy modelling toolkit, where no open source optimising model generators were available at the time.
OSeMOSYS is free, open source and accessible. Written in GNU MathProg programming language, it can generate from small village energy models up to global multi-resource integrated – Climate, Land, Energy, Water - models. In its most widespread version it calculates what investments to make, when, at what capacity and how to operate them, to meet given final demands and policy targets at the lowest cost.

OSeMOSYS is structured into blocks of functionalities, each consisting in a stand-alone set of equations which can be plugged into the core code to add specific insights for the case-study of interest. Originally, seven blocks of functionalities for the objective function, costs, storage, capacity adequacy, energy balance, constraints, emissions were provided, documented by plain English descriptions and algebraic formulations.
Recently, the block for storage was deeply revised and developed, while new blocks of functionality for studying short-term implications of energy planning onto the electricity system were designed. These include equations for computing 1) the reserve capacity dispatch; 2) the costs of flexible operation of power plants and 3) the reserve capacity demand as a function of the penetration of intermittent renewables were introduced.
Additionally, a revision of the whole code was completed, as the result of a public call launched and led by UNite Ideas. This allowed the computational time to be greatly reduced and opened up the path to refinements of the scales of analysis.
Finally, the code was made available in Python and GAMS programming languages, thus engaging two of the widest existing communities of programmers.

Such developments allowed a number of applications to be produced at different scales. Regional and country models were generated for the whole of South America and Sub-Saharan Africa. A Pan-European model is under development. Models of Cyprus and Tunisia, detailed down to the individual power plant, are among the latest applications.
Finally, integrated assessment water-energy models have been generated for regions in Central Asia and the Balkans, in the framework of the UNECE Water Convention. These look into trans-boundary issues related to the water and energy management along river basins, including detailed representations of water storage and cascading power plants.

This multiplicity of developments and applications of OSeMOSYS engages a wide community of users and decision-makers and fosters the use of modelling tools for energy planning. This fulfils a scientific and social mission to empower communities with the development of solutions for a better access to energy.