Low-carbon society: an enhanced modelling tool for the transition to sustainability

Results in Brief

An improved multidimensional sustainability modelling tool

A new open-source integrated assessment model will help policymakers, academia, NGOs and the public chart our path to a sustainable future.

Climate change risks and impacts are becoming increasingly complex and difficult to manage. Moving towards a low-carbon, zero-emissions future requires an equally complex integration of socioeconomic, energy and environmental considerations.

Integrated assessment models (IAMs) do precisely this. The EU-funded LOCOMOTION project developed WILIAM, a new IAM that addresses key limitations of current models. It is a fully open source and it can model both global and regional scenarios with all model variables separated into nine world regions. The European Union is one, although some modules model the 27 EU Member States separately.

Modelling realistic and detailed socioeconomic, energy and environmental interactions
“WILIAM models the economy dynamically with detailed representation of production (based on input-output tables for 62 sectors) and consumption (including 60 household types in the EU) as well as government, investment, labour, international trade and finance,” explains project manager Nathalie Wergles of the University of Valladolid, Group of Energy, Economy and Systems Dynamics. WILIAM captures interactions among energy, the economy, materials and land use, with changes in the physical models affecting the economic model and vice versa.

WILIAM also includes modules for demography, society and climate. It computes the energy return on investment (EROI) (the ratio of usable energy returned to the energy invested to make it over a system’s lifetime) considering the material requirements of green technologies.

“In contrast to current models that assume very high renewable and non-renewable energy potentials, WILIAM considers constraints on biophysical systems, geography, natural resources and EROI when assessing the techno-sustainable potential of renewables,” adds scientific project coordinator Iñigo Capellán Pérez, also of the University of Valladolid, Group of Energy, Economy and Systems Dynamics.

Finally, WILIAM addresses the challenges of systems based on 100 % renewables. It keeps track of sub-annual timescale effects on annual energy balances depending on the generation and flexibility capacities and contains hydrogen-based energy capabilities.

**A groundbreaking IAM for all stakeholders**

LOCOMOTION developed three versions of the software, all open source, to enable easy use by those not familiar with modelling software. The most complex, the Model Analyser, targets policymakers and academia and enables detailed model parametrisation for customised scenarios.

The Model Explorer is a simple, user-friendly application to provide environmental NGOs or similar organisations with data to support their arguments. The Global Sustainability Crossroads II Game is designed to help educators and NGOs raise awareness among young people about the difficult political and societal choices required to achieve global sustainability.

**Data-backed policy scenarios and more**

“WILIAM is a complex, new IAM rather than an extension of the MEDEAS model as originally planned,” notes Capellán Pérez. The WILIAM model is already producing relevant results of policy scenario simulations, for example, on the decarbonisation of passenger transport, dietary shifts, the potential hydrogen use in the energy system,
raw materials required for the green transition, the integration of high shares of renewables and the effect of introducing a universal basic income in the EU. It has also been used to explore the techno-sustainability limits of renewables for biofuels and electricity.

As the team continues to improve and validate modules and incorporate them into the highly comprehensive model, all updates are published as they become available. The LOCOMOTION tool assists global decision makers in designing a successful path to sustainable energy systems.

**Keywords**

LOCOMOTION, model, energy, sustainability, integrated assessment model, EROI, renewables, modelling tool, hydrogen
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