The Coalition of Finance Ministers for Climate Action

IGEM's integrated approach to climate-smart economic decision-making

United Nations Environment Programme (UNEP)

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Overview

The Integrated Green Economy Modelling (IGEM) framework offers a tool for policymakers, particularly in Ministries of Finance, that is able to navigate the complex transition toward a greener, more resilient economy. By integrating three primary modeling techniques—system dynamics (SD), computable general equilibrium (CGE) models, and input-output social accounting matrices (IO-SAM)—IGEM provides a comprehensive assessment of green economy policies, with each model providing a unique contribution to analyzing their effects.[1] To equip policymakers with a comprehensive understanding of the impacts of investing in green sectors, IGEM integrates economic forecasts from the CGE model and sector-specific insights from the IO-SAM with social and environmental projections derived from SD. This combined approach ensures that all the dimensions of the impacts—economic, social, and environmental—are captured effectively.

The framework is designed to be adaptable, allowing different models to be emphasized depending on the focus of the analysis, data availability, and time constraints. For example, if the priority is on short-term economic outcomes, the CGE model might be central, whereas a long-term environmental focus might lean more on SD.

The IGEM framework is designed to serve three key purposes.

- Integration: to combine multiple modeling approaches to provide insights into the complex interactions among economic sectors during the implementation of green policies.
- Evaluation: to offer detailed assessments of the economic, social, and environmental impacts of green policies and investments, helping policymakers understand the full spectrum of effects.
- Simulation: to assess both target- and policy-driven approaches by simulating various policy scenarios, e.g., for the implementation and monitoring of the UN Sustainable Development Goals.

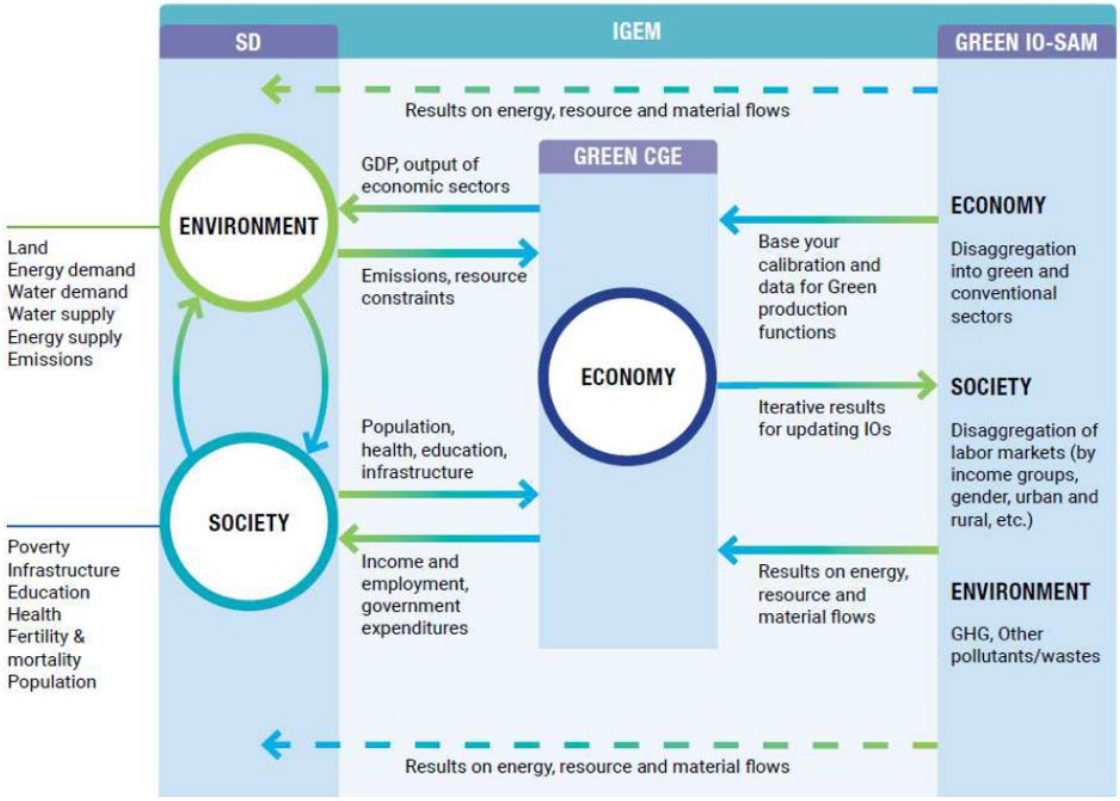
Strengths and limitations

The strength of the IGEM framework lies in its ability to connect three modeling tools, enabling policymakers to explore a wide range of policy questions from different perspectives. It offers two key pathways: the target-driven approach, which focuses on achieving specific policy outcomes such as CO_2 reduction targets, and the investment-driven approach, which emphasizes the costs associated with implementing policies, considering financial constraints or revenue generation goals. The CGE model provides insights into immediate economic effects, such as how green tax reforms impact growth, sectoral outputs, consumption, income distribution, employment, and trade. Meanwhile, the SD model adds depth by assessing long-term environmental and social impacts, capturing complex system-wide feedback loops, and ensuring that policies align with long-term sustainability goals. IO-SAM further enhances the analysis by revealing sector-specific responses to economic changes, offering a detailed view of how sectors contribute to economic resilience.

By integrating these approaches, policymakers can better understand the trade-offs between economic growth and sustainability, offering a holistic evaluation of the short- and long-term impacts of green policies. For MoFs, this integration is particularly valuable as it can inform fiscal strategies, guide budget allocations, and support long-term economic planning, ensuring policy decisions are both economically sound and environmentally responsible.

1 SD, for instance, helps to understand long-term interactions by analyzing the environmental and social impacts of policies. In contrast, CGE models provide a broader economic perspective, examining how different sectors respond to policy changes. Meanwhile, IO-SAM models track the flow of income and production between sectors and households, offering insights into the interconnectedness of the economy.

Figure 1. IGEM framework



Source: PAGE (2017a)

The IGEM framework, while robust, is complex and requires the involvement of diverse experts in both conducting the modeling and interpreting the results to communicate findings effectively to policymakers. In addition, turning these findings into actionable recommendations requires a deep understanding of the assumptions underpinning each model. For instance, traditional model assumptions such as perfect information, rational decision-making by economic agents, product homogeneity within sectors, and instantaneous market clearing, may not fully capture the complexities of real-world dynamics, leading to potential inaccuracies in predictions.

The integration of SD with CGE offers a way to address some of these limitations.[2] System dynamics adds nonlinear, dynamic interactions and feedback loops, which are often absent in traditional CGE models, allowing more realistic policy simulations. However, achieving full integration between CGE and SD models is challenging due to limited customization capabilities. Currently, the IGEM framework relies on "soft linking," where the outputs of one model are fed sequentially into the next. Looking ahead, the aim is to develop a stronger linkage system that enables deeper integration, moving beyond the existing soft-linking approach. This also involves enhancing the framework to include additional tools, such as biophysical models or Geographic Information System-based systems, which would introduce spatial and environmental dimensions into the analysis.

2 The IGEM framework can employ two types of linkages between the CGE and SD models: a soft linkage and a hard linkage. In the soft linkage approach, the models run independently, where scenarios are executed in one model (either SD or CGE) and the results are subsequently fed into the other model. This iterative process of behavior assessment and model revision continues until the model behaviors converge to an acceptable level, although it does not allow direct input between the models during execution, limiting full harmonization. In contrast, the hard linkage involves a manual coupling of the models, with each model running for two-year iterations. After each iteration, designated output values from one model are transferred as inputs to the other, enabling a more integrated analysis of results. This series of two-year iterations continues over the entire time horizon, simulating system behavior more cohesively than in the soft linkage.

Table 1. Comparative analysis of IGEM component models

Model	Focus	Strengths	Contribution to economic resilience
CGE (Computable General Equilibrium)	Short-term economic impacts of policy changes	Analyzes economy-wide effects on production, trade, employment, and income distribution	Shows how sectors adapt to policy changes and assesses the immediate economic impacts
SD (System Dynamics)	Long-term dynamic effects and feedback loops	Captures interconnections between economic, social, and environmental factors over time	Evaluates system-wide resilience by analyzing long-term impacts and policy feedback loops
IO-SAM (Input-Output social accounting matrix)	Sector-specific relationships between industries and income flows	Provides detailed insights into how resources and production inputs are distributed across sectors	Identifies key sectors critical to building economic resilience

Finally, the IGEM approach remains data-intensive,[3] necessitating detailed data for accurate results. This requirement can pose significant challenges, particularly when applying the model in different countries or regions, as it may require substantial adaptation and recalibration to consider local economic, social, and environmental conditions.

Relevance to Ministries of Finance

The IGEM framework enables a comprehensive evaluation of green economy policies by integrating economic, social, and environmental dimensions. It provides the capacity to estimate the economic impacts of green policies on critical indicators such as GDP, employment,[4] investment, and Government revenue, which is crucial for MoFs in assessing the fiscal and economic implications of environmental strategies. Furthermore, the IGEM framework facilitates the comparison of scenarios incorporating inclusive green economy principles —reducing carbon emissions and pollution, enhancing energy and resource efficiency, preventing biodiversity and ecosystem service loss, increasing decent jobs, and ensuring equitable income and wealth distribution— with Business-As-

3 Potential data requirements to run the model may include the following.

- Economic data: Input-output tables and social accounting matrices (SAM), GDP and its main determinants, sectoral economic data (production, consumption, and trade), and investment data across sectors
- Environmental data: Natural resource stocks and flows, greenhouse gas emissions data, land use and land cover information, and energy production and consumption data
- Social data: Population data, demographic trends, employment data across sectors, human capital indicators (education, skills), and social indicators related to poverty, inequality, and well-being
- Policy and institutional data: Existing policies and regulations related to the green economy, institutional frameworks, governance structures, and national development plans and strategies
- Sector-specific data: Energy sector data (renewable energy potential, energy efficiency), agricultural data (crop yields, water use), industrial sector data (production processes, technology adoption), and transportation data (vehicle fleet, infrastructure).

4 The IGEM model incorporates green jobs variables by tracking how shifts toward sustainable practices—such as renewable energy adoption, resource efficiency, and circular economy initiatives—affect labor markets. It captures both direct job creation in green sectors and indirect effects on employment in other areas. By integrating these employment outcomes with broader economic and environmental analysis, IGEM helps policymakers assess how green economy policies contribute to job growth while aligning with sustainability objectives.

Usual (BAU) models, aiding in the identification of investment and expenditure strategies that enhance economic resilience to external shocks.

Through its detailed sectoral analysis, IGEM clarifies how various economic sectors respond to green policies. This insight allows finance ministers to target their interventions and optimize resource allocation effectively. The framework also aligns with national and global sustainability goals, including the Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs) under the Paris Agreement, helping develop strategies that balance economic growth with sustainability.

Moreover, the framework's capacity to simulate potential outcomes across multiple policy scenarios supports evidence-based policymaking, which is essential for finance ministers when justifying and implementing policy measures. The framework can also be integrated with other economic models used by MoFs, providing a more comprehensive view of policy impacts. Ultimately, IGEM serves as a decision-support tool, grounding policy decisions in robust data and analysis and offering evidence and insights that can inform political discussions by bridging the gap between economic and sustainability considerations.

Key policy/analytical questions addressed

- How can the impact of investments (new and shifted) and policies be assessed?
- What benefits might investments and policies generate across sectors in terms of economic opportunities, inclusiveness, and environmental sustainability?
- Are the impacts likely to be long- or short-term?
- How will green subsidy reforms likely impact productivity in green economy sectors?
- How will tax reforms and removing fossil fuels subsidies mobilize domestic revenues for green investment? What will be the implications of such reforms on environmental, economic/fiscal, and social fronts?
- What trade policies and regulations enhance investments in green economy sectors?
- What are the potential areas where policy measures can create multiplier effects across the economy goals?
- Which labor market interventions deliver more (quantity) and better (quality) green jobs, and how can these interventions improve access for the unemployed and underemployed? What are the potential impacts on income distribution and inequality?
- How can governments achieve a specific target reduction in CO_2 emissions by a certain year?

Use in practice

The IGEM framework was developed under the Partnership for Action on Green Economy (PAGE) with support from UN agencies including UNEP, UNDP, ILO, UNIDO, and UNITAR. It is designed to be adaptable, allowing MoFs to customize it to their specific economic contexts. Ministries can also access online and in-person training, with experts providing guidance on defining the framework configuration, identifying support needs, collecting data, and interpreting results. This ensures the insights gained from IGEM are directly applied to form actionable financial policy recommendations.

Reports and resources are available through PAGE, and MoFs can contact the PAGE Secretariat at UNEP for additional information or support. By being part of the PAGE network, Ministries also benefit from technical assistance and access to international best practice and knowledge exchanges, which improve policy coordination and comparability with other countries pursuing green economy goals.

Analysis in action

The IGEM tool has been tested to model a carbon tax in Mexico,[5] simulating the impacts of different tax rates on emissions. By combining two key models—CGE and SD—the study explored how different carbon tax rates on fossil fuels affect GDP, investment, and consumer welfare. The analysis demonstrated that while a carbon tax might cause small drops in GDP and consumer welfare in the short term, long-term benefits emerge if the revenues are invested in renewable energy. In a "feebate" scenario, where carbon tax revenues are used to support renewables, the economy and investment in clean energy perform better by 2036, compared with a scenario where revenues are simply returned to consumers as rebates. The CGE model captured economic shifts, with renewable energy sectors growing, while fossil fuel industries such as extraction and refining experienced declines. Meanwhile, the SD model highlighted social benefits, particularly health improvements from lower pollution, which increased productivity. The study found that without additional policies, there might be a bias toward benefiting capital owners, so measures are needed to support more vulnerable populations. Overall, the analysis shows that combining carbon taxes with investments in renewables can reduce emissions and improve economic performance with minimal negative impact on GDP.

Conclusions

The IGEM framework stands out by offering a complete analysis of economic, social, and environmental impacts, thanks to its integrated modeling techniques. What makes it particularly useful for green economy strategies is its strong focus on sustainability and alignment with global goals such as the SDGs and NDCs. Unlike models that address only one aspect, IGEM enables MoFs to simulate policy scenarios that weigh trade-offs across different sectors. 'It is also highly adaptable to each country's specific needs and, with support from the PAGE network, it has become a practical tool for developing actionable and locally relevant green policies. Finally, IGEM's detailed analysis of labor markets and fiscal instruments, along with its ability to assess both short- and long-term outcomes, offers clear insights into employment effects and the broader impacts of various reforms, providing a comprehensive understanding of policy implications.

A real-world example, such as Mexico's carbon tax modeling, highlights how IGEM can uncover trade-offs and long-term benefits, showing that well-designed green policies can drive both economic and social progress. However, for IGEM to maintain its effectiveness, it requires regular updates, regional adjustments, and ongoing collaboration with global partners to share insights and enhance its adaptability. By further applying the model, MoFs can contribute valuable data and feedback, improving its accuracy and usefulness in shaping sustainable economic strategies. As IGEM evolves with input from MoFs and global partners, it will remain an important tool for helping governments navigate the shift to a green economy.

Further reading

PAGE (2017a) *The Integrated Green Economy Modelling Framework—Technical Document.* https://wedocs.unep.org/bitstream/handle/20.500.11822/21863/Green_Economy_Modelling_Framework.pdf

PAGE (2017b) *The Integrated Green Economy Modelling Framework: An Overview*. https://www.un-page.org/static/e861110b50f436502100629f7e510094/2017-the-integrated-green-economy-framework-measurement-an-overview.pdf

PAGE (2017c) *Inclusive Green Economy (IGE) Modelling Facilitator Guide for a Higher Education Course.* https://www.un-page.org/static/4c0b23e1d0ab3a122bea06e7a0add0d5/facilitator-guide-for-higher-education-course-on-ige-modeling.pdf

UNEP (2014) *Using Models for Green Economy Policymaking*. https://www.un-page.org/static/2eb65e4ad79fdbecf183dff03d0bc9f7/2014-using-models-for-green-economy-policy-making-unep-models-ge-for-web.pdf

5See the 5th Asian Energy Modelling Workshop presentation "Introduction of the Integrated Green Economy Modelling Framework and its application to modelling a carbon tax in Mexico" by Dr. Xin Zhou, Institute for Global Environmental strategy.