Foreword

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Some of the greatest challenges of the twenty-first century include sustainable development, preservation of the quality of the environment, and viable management of our planet's natural resources. This Special Issue is devoted to the role of energy in the current debate on sustainable development and environmental concerns.

This issue has been assembled to celebrate the 40th anniversary of GERAD (Group for Research in Decision Analysis), a multi-university research center located in Montréal (Québec, Canada). GERAD's main mission is to develop all aspects of the mathematics of decision-making in complex systems. Since its creation in 1980, energy-related decisions have been an important topic for GERAD's researchers. In particular, Alain Haurie (the founder of GERAD) and Richard Loulou (one of his successors at the helm of GERAD) pioneered the development of bottom-up energy optimization models for Québec and later for Canada. Today, the development of mathematical models assessing the whole energy sector continues at GERAD. But, many more topics are covered including, for instance, the optimization of hydro plants' production and maintenance or the development of decision tools for the management of smart grids.

This Special Issue is divided into two parts. The first part presents various assessment models that are used to better understand the performance of energy systems and their transformation towards greener energy sources. The second part is devoted to models of the interaction between decision-makers in the context of energy conservation or polluting emissions reduction.

The first paper of this issue, "OPERA: a New High-Resolution Energy System Model for Sector Integration Research," by Joost N. P. van Stralen, Francesco Dalla Longa, Bert W. Daniëls, Koen E. L. Smekens, and Bob van der Zwaan, describes a bottom-up energy optimization model that has been used in the Netherlands to formulate strategic policy advice on energy decarbonization and climate change

mitigation for the Dutch government. This model allows users to examine the impact of various energy efficiency improvement processes and the effectiveness of various policies aimed at abating greenhouse gas and other air polluting emissions. The authors give a detailed description of the model and provide examples of the types of outputs and insight that can be produced using OPERA.

The second paper, "Coupling a Detailed Transport Model to the Integrated Assessment Model REMIND," by Marianna Rottoli, Alois Dirnaichner, Page Kyle, Lavinia Baumstark, Robert Pietzcker, and Gunnar Luderer, describes the integration of a detailed model of the transportation sector into the large-scale integrated assessment model REMIND. This approach allows the detailed representation of final energy supply, modal and technology choices, and transportation service demand, permitting the evaluation of transport-specific policies within a complete macroeconomic framework. The authors provide an illustration of the capabilities of their model using data for Europe.

In the third paper "Assessing a Transition to 100% Renewable Power Generation in a Non-interconnected Area: A Case Study for La Réunion Island," by Frédéric Babonneau, Stéphane Biscaglia, David Chotard, Alain Haurie, Nicolas Mairet, and Thibaut Léllatre, the authors propose an approach for assessing the feasibility of transition to renewable energy generation in non-interconnected areas, by linking together three models with different time scales. The paper is based on a case study for the French Island La Réunion, showing the feasibility of a 100% renewable energy system by 2030.

The fourth paper "Costa Rica—assessing climate mitigation pathways to support NDC implementation," by Gary A. Goldstein, Pat Delaquil, Anna Sikharulidze, Angela Ines Cadena Monroy, Ricardo Delgado Cadena, Silvia Charpentier, Felipe De Leon, Andrea Meza, Suphachol Suphachalasai, and Marcos Castro, describes how the TIMES bottom-up energy optimization model was used to evaluate alternative energy and decarbonization scenarios for Costa Rica, with a particular emphasis on demand-side actions. In particular, the authors describe how the model was used to design and evaluate enhanced mitigation scenarios to attain the country's NDC at least cost.

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The fifth paper “Upstream Fiscal Regime Incentives for Captured CO₂-EOR,” by Akil Zaïmi, introduces the second part of the Special Issue with an illustration of how fiscal incentives could be designed in order to promote CO₂ capture for enhanced oil recovery projects. The author compares several incentive schemes using simulations from a CO₂-EOR project inspired by a real case and shows that it is possible to design fiscal incentives that improve both the company’s and the host country’s income in most situations that are likely to occur.

“An Oligopoly Game of CDR Strategy Deployment in a Steady-State Net-Zero Emission Climate Regime,” by Frédéric Babonneau, Olivier Bahn, Alain Haurie, and Marc Vielle, considers a sustainable world, at the end of the twenty-first century or beyond, where development has been achieved and the economy is in a steady state. An oligopoly game is formulated to represent the competition among different regions in the supply of emissions quotas via CO₂ removal strategies in a steady-state net-zero emission climate regime. The model is calibrated to a computable general equilibrium model; the solution of this steady-state model could be used as a target for end-of-period conditions in a dynamic integrated assessment analysis studying the transition to the end of the twenty-first century.

The seventh paper “A New Rationale for Not Picking Low-Hanging Fruits: the Separation of Ownership and Control,” by Denis Claude and Mabel Tidball, proposes a strategic interpretation to the energy-efficiency gap paradox, that is, the well-documented fact that immediately profitable

investments in innovative energy efficiency solutions do not always materialize. The authors show that strategic market interaction may encourage business owners to instill a bias against energy efficiency in managerial compensation contracts, resulting in a lack of investment.

The final paper of this Special Issue, “Pareto-Improving Supply Subsidy in a Simple General Oligopoly Equilibrium Model with Pollution Permits,” by Bertrand Crettez, Pierre-Andre Jouvét, and Ludovic A. Julien, introduces a competitive pollution permit market in a two-sector oligopoly equilibrium model. In this model, one commodity is inelastically supplied by one competitive trader and another one is produced by a finite set of oligopolists, using the first commodity as an input. The production of the second commodity is a polluting activity. One interpretation is in the context of the EU emission trade system, which mostly involves energy providers. Within this strategic approach, the authors provide some conditions under which a supply subsidy given to the oligopolists that is financed by a tax on the competitive agent is Pareto-improving.

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