Editorial

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Biographical notes: Colin Vance is a Senior Research Scientist with RWI Essen's Division of Environment and Resources, where his primary fields of specialisation are in quantitative microeconomic analysis and in regulatory issues related to transport policy. Following completion of his doctoral degree in economics from Clark University, he was a member of the US Environmental Protection Agency's National Center for Environmental Economics from 2000 to 2003.

The rapid evolution of renewable energy technologies is said to hold great potential for meeting one of the most pressing challenges confronting the 21st century: the attainment of energy security and mitigation of climate change via environmentally benign production methods. But with an increasing number of countries launching ambitious programmes and landmark legislation to increase the output of renewable energies, the debate concerning the economic, environmental and energy benefits remains highly contentious. Aside from the fundamental question of whether the manufacture of renewables is cost effective, additional questions pertaining to sustainability and regional development have yet to be resolved.

The aim of this special issue of the *International Journal of Environment and Pollution* is to marshal evidence on the regional environmental and economic impacts associated with a large-scale shift to renewable energy production. In selecting the contributions, an effort was made not only to represent a range of analytical approaches, but also to ensure broad geographical coverage grounded in the analysis of salient policy issues. The result is a compendium of articles providing a comprehensive overview of the economic, environmental and social dimensions of renewable energy adoption, with a particular focus on regional scale implications.

1 Modelling applications

The first half of the issue presents contributions whose primary aim is to advance novel modelling techniques, the first two of which use Agent-Based Modelling (ABM) approaches to assess the economic and environmental viability of biofuels. ABM approaches attempt to determine behaviour as a sequence of strategic decisions. A distinguishing feature of the ABM approaches developed in the present articles is the use of geographic information systems to capture the role of spatially related system dynamics in decision making. Jürgen Scheffran and Todd BenDor's paper focuses on the agricultural sector in the American state of Illinois, examining the land use portfolios of individual farmer agents under alternative scenarios that introduce changes in transportation costs, demand levels and subsidies for energy crops. Reinhard Madlener

and Christian Schmid examine the dissemination of biogas technology from 2006 to 2025 in Switzerland. A unifying theme emerging from both studies is the analytical gains to be garnered by combining principles from landscape ecology and the social sciences to account for how human decision-making, ecosystem function and their interaction effect landscape changes across different spatial scales.

While ABM approaches study the relationships between the micro- and the macro-level via artificial agents, experimental economics investigates individual behaviour by means of human-subject experiments, with the ultimate aim of discerning aggregate regularities (Richiardi et al., 2006). The third contribution of this edition, by Roland Menges and Stefan Traub, employs this approach to investigate individual willingness to pay for green electricity and the associated implications for free-riding. A key result from the analysis is that participants are willing to pay far higher contributions to green electricity under a public choice scenario than under the individual choice treatments, which is interpreted as reflecting the large extent of free-riding in the private provision of environmental quality.

The final modelling paper, by Napat Jakrawatana, Stephen Moore and Iain MacGill, advances our empirical understanding of bioenergy systems by developing a multi-objective tool that combines a material flow analysis with an economic model. The tool's light data requirements and straightforward interpretability facilitates the planning of new bioenergy plants, allowing decision-makers to take into account both cost-effectiveness and various dimensions of environmental impacts, including greenhouse gas emissions and the avoidance of hazardous substances. Applying the tool to the Murrumbidgee Irrigation Area in Australia, a region of abundant biomass waste, the authors calculate that the addition of several bioenergy plants has a positive net present value despite the high costs of construction.

2   Policy analysis

The second half of the special issue focuses on various issues relating to the political economy of renewable fuels, beginning with an analysis by Alan C. Brent, Russell Wise and Henri Fortuin of the South African biofuels industrial strategy. This strategy, which is predicated on the use of surplus agricultural capacity to replace 2% of the country's total liquid transportation fuels by 2013, is analysed with respect to its environmental and socioeconomic viability. Several dimensions of biofuels use are considered, including greenhouse gas emissions, biodiversity, poverty alleviation, infrastructure and rural development. The authors conclude with recommendations for a policy-based research agenda specifically targeted at reducing the economic uncertainties associated with investment in and management of the biofuels sector.

The three closing papers of the special issue focus on operational aspects of renewable fuel production and consumption in the European Union, a region which has committed to reducing its overall carbon dioxide emissions by at least 20% by 2020 and by half by 2050. Two of these are country case studies drawn from the Italian and Austrian experiences with renewable energy. The analysis by Arturo Lorenzoni and Laura Bano studies renewable electricity plants in Italy, and highlights the importance of considering not only construction and maintenance costs when assessing cost effectiveness, but also the indirect costs arising from the risks perceived by investors. They advocate an institutional commitment on the part of government to ensure a clearly

defined and stable investment environment, defined by less onerous regulatory conditions, a shortened authorization process and improved management of the relationship with local authorities. Carlo Obersteiner and Lueder von Bremen implement a forecast tool based on principal component regression to estimate wind power among 22 wind sites in Austria, which they use to assess the influence of forecast accuracy on the market value of wind under different marketing options. Their analysis suggests that the introduction of continuous day-ahead trade on Central European power exchanges would not only increase the market value of wind power, but also improve market integration by lowering barriers for new actors to enter the market.

The concluding contribution, by Sharad B. Karmacharya and Laurens J. de Vries, analyses the unintended consequences emerging from a decentralised approach to support schemes for renewable energy in the European Union. Specifically, they address the complexities inherent in coordinating different national policies in the presence of cross border trade in renewable electricity. Complementing Lorenzoni's and Bano's analysis, these authors stress the potentially detrimental effect of policy fluctuations, as they increase the investment risk for renewable energy sources. Their prescription for mitigating this risk is to develop a standard tracking mechanism with which to integrate regional renewable policies. To this end, they propose a roadmap for establishing a consistent and standard system for tracking electricity while affording Member States flexibility in formulating individual policy goals.

3 Conclusion

The articles of this special issue all address a topic that will become increasingly important over the next decade given (1) the urgency of identifying environmentally benign and cost-effective energy sources that can reliably sustain economic growth and (2) associated concerns about global warming and biodiversity loss. Finding solutions to these challenges will require integrative analytical approaches that assimilate economic, environmental and geopolitical perspectives. It is hoped that this special issue will serve to highlight promising avenues of inquiry that provide insights which are not only of scientific value, but also of immediate use to decision makers.

Reference

Richiardi, M.G., Leombruni, R. and Contini, B. (2006) 'Exploring a new ExpAce: the complementarities between experimental economics and agent-based computational economics', *Journal of Social Complexity*, Vol. 3, p.1.