INDONESIAN ENERGY POLICY PATHWAYS: FROM PAST TRENDS TO FUTURE ALTERNATIVES

A thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Resource and Environmental Planning

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Abstract

The main achievement of this thesis has been the development of an operational system dynamics model of the Indonesian energy system. This model attempts to *integrate* a wide range of data so that policy-makers can understand the connections between economic, environmental and energy policy objectives. This is the first such model to be developed for Indonesia, building on previous modelling efforts that have been restricted to regression-based forecasting and optimisation modelling.

The first part of the thesis provides a systematic analysis of background data, information and the context for the model development. These chapters review the historical and political context of energy developments in Indonesia; review past energy policies as well as emerging energy policy objectives; analyse the determinants of energy demand (by regression and divisia decomposition methods) and review energy supply options. The regression analysis concluded that GDP and household income had the most significant effect on energy demand. The effect of fuel price rises, on the other hand, did not exert a significant effect on energy demand. The divisia decomposition method found that, over the entire Indonesian economy, technical change was found to give a greater contribution to energy efficiency improvements (as measured by the energy:GDP ratio) than structural changes.

The system dynamics model was developed and validated using the extensive data collected, refined and analysed in the first part of the thesis. The model consisted of an economic module (17 sector input-output model), energy demand module, electric power module, heat and transport fuel module, primary energy supply module and an environmental module.

Five scenarios were developed from this model in order to analyse possible energy development pathways for Indonesia, over the 1998-2020 period. These scenarios reflected five themes Business-as-Usual, Environmentally Beneficial, Economic Efficiency, Self-Sufficiency and Balancing Trade-Offs. These scenarios were assessed using a number of policy evaluation criteria to measure various energy, economic and environmental policy objectives. All of these scenarios indicated that Indonesia's energy demand and hence CO_2 emissions will grow significantly over the scenario period, even if Indonesia introduces some quite stringent polices to restrict these trends – eg, $C0_2$ emissions are expected to increase by 189% under the 'Business-as-Usual' scenario; and even though they can be reduced to a 85% increase under the 'Environmentally Beneficial' scenario, this is still a significant and

somewhat alarming increase in CO_2 emissions. The scenarios also highlighted the trade-offs between different sets of policy objectives as an aid to energy planning and policy-making.

Finally, further areas of research that could improve the model and its use were identified: improving the data on energy supply and demand (particularly the end-use characterisation), endogenise the economic growth dynamics into the model rather than depending on regression analysis, possibly converting the input-output structure into a computable general equilibrium model, including more sectoral detail, making the model at least partly spatially-specific, and investigating more participatory approaches for further developing the model so as to enhance its uptake.

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