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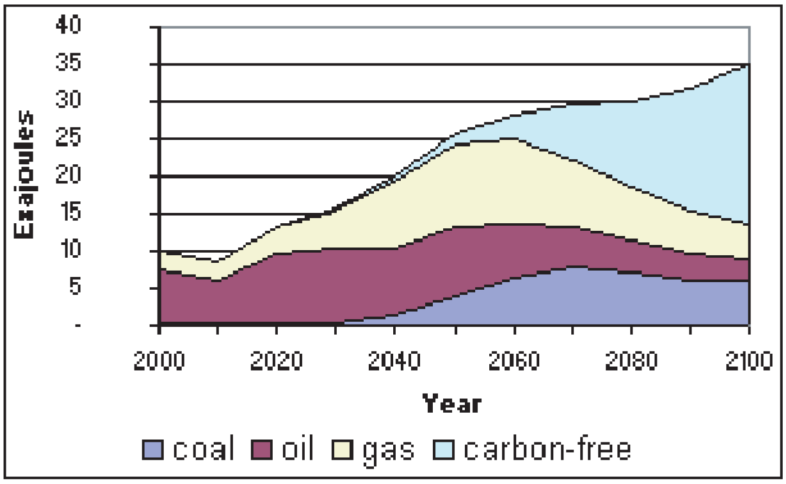
Primary energy production of Indonesia
Reference scenario



The impact of international climate policy on Indonesia

by

Armi Susandi • Richard S.J. Tol

Hamburg, November 2002

Authors

Armi Susandi — Max-Planck Institut für Meteorologie
&
Geophysics and Meteorology, Institute of Technology of Bandung, Indonesia

Richard S.J. Tol — Center for Marine and Climate Research, Hamburg University, Germany
&
Institute for Environmental Studies, Vrije Universiteit Amsterdam, The Netherlands
&
Center for Integrated Study of the Human Dimensions of Global Change, Carnegie Mellon University, Pittsburgh, PA, USA.

Max-Planck-Institut für Meteorologie
Bundesstrasse 55
D - 20146 Hamburg
Germany

Tel.: +49-(0)40-4 11 73-0
Fax: +49-(0)40-4 11 73-298
e-mail: <name>@dkrz.de
Web: www.mpimet.mpg.de

The impact of international climate policy on Indonesia

Armi Susandi [a,b*], **Richard S.J. Tol** [c,d,e]

[a] *Max Planck Institute for Meteorology, Hamburg, Germany;*

[b] *Geophysics and Meteorology, Institute of Technology of Bandung, Indonesia;*

[c] *Center for Marine and Climate Research, Hamburg University, Germany;*

[d] *Institute for Environmental Studies, Vrije Universiteit Amsterdam, The Netherlands;*

[e] *Center for Integrated Study of the Human Dimensions of Global Change, Carnegie Mellon University, Pittsburgh, PA, USA.*

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[*]Corresponding author. Tel: +49-40-41173-316; fax: +49-40-41173-298.
E-mail address: susandi@dkrz.de (Armi Susandi)

Abstract

This paper studies the impact of international climate policy on the economy and the structure of the energy sector of Indonesia. We use an extended version of MERGE to project Indonesia's (energy) development to 2100, for a business as usual and various mitigation scenarios. If OECD countries reduce emissions, Indonesia would export more gas and less oil; income would fall slightly. With international trade in emission permits, Indonesia would be an exporter of carbon permits; the energy export sector behaves almost as without emission abatement; however, Indonesia would still suffer a small loss of income. If Indonesia anticipates emission reduction targets relative to some future emissions, it would want to postpone exploiting its gas reserves and initially rely more on coal and imported oil. Indonesia would become a substantial exporter of internationally tradable emission permits. If Indonesia anticipates emission reduction targets relative to currently projected emissions, coal is still shifted forwards in time and gas backwards, but to a lesser extent. Economic losses are greater, but still not very large. International trade in emission permits would make the exploitation of Indonesia's coal reserves economically unattractive.

Introduction

Indonesia holds a special position in international climate policy. Tropical, poor, crowded and archipelago, it is very vulnerable to climate change (Smith *et al.*, 2001). But, Indonesia is also an OPEC member and holds large coal reserves (some 40 billion tonnes; DGEED, 1999). Indonesia is also vulnerable to climate policy. Its industry is inefficient and deforestation continues largely unabated, making the country a potentially big supplier of projects under the clean development mechanism, a prospect Indonesians may welcome if urban air quality would improve as a by product. Despite all this, Indonesia and its role in international climate policy is not well studied, perhaps because the country has had different things on its mind. This paper studies part of the complexity sketched above. We analyze the implications of emission reduction in the OECD on the economic and energy structure of Indonesia; the implications of where flexibility; and the effects of Indonesia adopting an emission reduction target in the future.

Emission reduction in the OECD would drive down the demand for oil and coal, but increase the demand for gas (e.g., Babiker *et al.*, 2000; Bernstein *et al.*, 1999; Tulpule *et al.*, 1999). Having reserves of all three, would Indonesia substitute coal exports for gas exports, and use coal to satisfy its domestic needs? (Other OPEC members do not have this luxury.) This would mitigate the pain of the export losses. It would also increase Indonesian emissions of carbon dioxide, making it an even more attractive target for CDM projects. (Note the moral hazard.) Would the CDM substantially affect Indonesian energy production and consumption, or even development (Rose *et al.*, 1999)? And how will this all change if Indonesia would one day commit itself to emission reduction?

An analysis of questions like these requires a model with three properties. Firstly, the model has to have a reasonably detailed energy sector. Secondly, the model has to cover the whole world, but include Indonesia as a separate region. Thirdly, the model must be calibrated to real data. There is one model that almost satisfies these criteria: MERGE, developed by Manne and Richels (1992, 1995, 1996, 1998, 1999, 2001; Manne *et al.*, 1995). The only problem is that MERGE includes Indonesia in its ROW region. We therefore developed a new version of MERGE that separates out Indonesia.

Section 2 gives an overview of the MERGE model, and specifies the changes we made to the model. Section 3 presents the business as usual scenario, and Section 4 the cases in which only the OECD has emission reduction targets. Section 5 presents the cases with emission reduction targets for the Non Annex B countries, including Indonesia, as well. Section 6 concludes.

The MERGE4.3I model

MERGE (a Model for Evaluating the Regional and Global Effects of greenhouse gas reduction policies) is an intertemporal general equilibrium model which combines a bottom-up representation of the energy supply sector with a top-down perspective on the remainder of the economy. See Manne and Richels (1992) and Manne *et al.* (1995) for a detailed description. Our starting point is MERGE, version 4.3 (Manne and Richels, 2001).

MERGE consists of four major parts: (1) the economic model; (2) the energy model; (3) the climate model; and (4) the climate change impact model. The model is benchmarked with energy and economic statistics for 2000. The model runs in 10-year intervals to 2050 and, after that, in 25-year steps during the following century and a half. The first commitment period of Kyoto Protocol is represented as 2010 in the model.

The economic model is used to assess the economy-wide cost of alternative emission constraints at the regional and global level (cf. Hourcade *et al.*, 1996). The economy is modeled through nested constant elasticity production functions. The production function determine how aggregate economic output depends upon the inputs of capital, labor, electric and non-electric energy. A social planner governs each region; alternatively, the economy is represented as a perfect market with long-lived economic agents. The social planner maximizes the discounted utility of consumption subject to an intertemporal budget constraint. A region's wealth includes not only capital, labor, and exhaustible resources, but also its negotiated international share in emission rights, allowing regions with high marginal abatement cost to purchase emissions rights from regions with low marginal abatement costs. Oil and gas are viewed as exhaustible resources. (Note that this option can be switched off). The model has also international trading of gas, and energy-intensive goods. International coal trade will be added in a later version of the model.

The energy model distinguishes between electric and *non*electric energy. There are 10 alternative sources of electricity generation (hydro; remaining initial nuclear, gas fired, oil fired, coal fired; gas advanced combined cycles; gas fuel; coal fuel; coal pulverized; integrated gasification and combined cycle with capture and sequestration), plus two "backstop" technologies: high and low-cost advanced carbon-free electricity generation. There are four alternative sources of *non*electric energy in the model (oil, gas, coal, renewables) plus a backstop technology, which is available in unlimited quantities, does not emit greenhouse gases, but is fairly expensive.

The climate submodel is limited to the three most important anthropogenic greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The emissions of each gas are divided into two categories: energy related and non-energy related emissions. The model includes net emissions from land use and forestry. Greenhouse gas concentrations influence the global mean temperature. In this paper, we only consider emission reduction of carbon dioxide.

The damage assessment model is divided into market and non-market damages, which determine the regional and overall welfare development. Market effects reflect categories that are included in conventionally measured national income and can be valued using prices and observed demand and supply functions. Non-market effects have no observable prices and so they must be valued using alternative revealed preference or attitudinal methods (e.g., Pearce *et al.*, 1996). Climate change impacts play no substantial role in the analyses of this paper.

The original MERGE model has 9 regions. We separated out Indonesia to form a tenth region. This required changes in the databases and the scenarios. However, no conceptual changes were needed.

To analyze the impact the international climate policy on Indonesia, we analyze eight scenarios, specified in Table 1. We assume that all Annex B countries adopt the Kyoto Protocol. We assume that Kyoto will be succeeded by emission reductions of 5% per decade in the years after 2010. In some scenarios, we assume that non Annex B countries adopt binding targets of a similar nature at a later date. For instance, we assume that Indonesia accepts a target in 2050. Indonesia's 2050 target is its 2040 emissions. After 2050, Indonesia's emissions fall by 5% per decade.

Note that these scenarios are neither predictions nor policy advices. These scenarios are simply projections that may or may not occur, and may be more or less desirable. This paper is limited to the implications to Indonesia of certain scenarios.

The business as usual scenario

Indonesia is currently the fourth most populous nation in the world, after China, India and United States. The 2000 population was about 212 million in 2000. The growth rate of the population was 1.6 percent in the period of 1990-2000. In 1994, per capita GDP was some US$ 930 at market exchange rate. Although growing rapidly at that time (7% a year or so), the East Asian crisis, the political instability, and the global economic recession have slowed down Indonesia's growth. In the MERGE model, growth picks up again in the current decade, and continues strongly throughout the century. In 2100, Indonesia's population is projected to grow to 389 millions and per capita income to 20 thousand dollars.

Households, transport and industry accounted for approximately 35 – 60 percent of carbon dioxide, methane and nitrous oxide emissions between 1990 and 1994. The forestry sector was the second largest contributor, responsible for between 20 and 50 percent of emissions; agriculture contributed some 15 percent. In the MERGE model, without emission reduction policies, current carbon dioxide emissions rise from 64 million tons in 2000 to 197 million tons in 2100. The energy intensity falls by 91 percent over the century, an impressive feat of technological change.

In the energy sector, Indonesia currently produces primarily oil and some natural gas. Gas production is to increase substantially to the middle of the century but then starts falling gradually. After an initial decrease up to 2010 – a continuation of current trends (EUSAI 2001) – oil production stays more or less constant through the first half of the century and then starts falling gradually. In the second half of the century, coal production increases dramatically. As of 2020, carbon-free energy technologies start to make inroads in the Indonesian market, and are dominant at the end of the century. Oil exports are negligible for the coming 30 years, but then start to pick up again. Gas exports vary little over the century.

Emission reduction in the OECD

If the countries of the OECD reduce their emissions as specified above, Indonesia expands the production of gas and, to a lesser extent, oil (Figure 1). More gas is exported, but oil exports fall sharply; the falling oil price on international markets even lead Indonesia to import some oil (Figure 2). Per capita consumption in Indonesia falls by a maximum of 0.6%; at the end of the century, the gap with the reference scenario becomes smaller (Figure 4). The net present value of the consumption loss is about $21 billion (Figure 5).

International trade in emissions permits among Annex B countries hardly affects these results. The loss of income in Indonesia is smaller (Figure 4), because the costs of emission reduction in Annex B fall; the net present value consumption loss falls to $23 billion (Figure 5).

If all countries engage in trade in emission permits – non-Annex B countries are allotted their business as usual emissions – then the income loss of Indonesia falls further (Figure 4); the net present consumption loss is only $2 billion (Figure 5). This is partly because total emission reduction costs fall – and partly because Indonesia sells emission permits. Indonesia reduces carbon dioxide emissions by reducing coal consumption (Figure 1).

Emission reduction in Indonesia

In the fifth scenario, not only the OECD countries but all other countries have emission reduction targets. Emission reduction targets are set relative to the emission reduction scenario. As agents in MERGE are forward-looking, this implies that there is an incentive to increase emissions in the pre-regulation period so as to increase absolute emission allowances in later years. Under this scenario, Indonesian fossil energy production peaks earlier than in the other scenarios, and starts to fall sharply after 2060 (Figure 3). Coal production is shifted forward in time, and gas production is postponed (Figure 1). Oil is imported, as oil demand falls sharply in the rest of the world (Figure 1). Per capita income increases, relative to the scenario in which only Annex B countries have emission reduction obligations, in the first half of the century, but falls thereafter (Figure 4). The later periods dominate; the net present consumption loss is $27 billion (Figure 5).

With international emission permit trade, Indonesia’s fossil fuel production falls more rapidly after 2040, as the country becomes a net exported of emission permits; indeed, the expansion of carbon dioxide emissions provide for plenty of cheap emission reduction opportunities (Figure 1). Gas exports increase, as other developing countries sell emission permits as well, and oil is again exported, as the oil price increases (Figure 2). Per capita income increases (Figure 4), and the net present consumption losses fall to $15 billion (Figure 5).

In the sixth scenario, emission reduction targets are set relative to the business as usual scenario, taking away the incentives to increase pre-regulation emissions (Figure 3). Nonetheless, Indonesia increases its pre-regulation fossil fuel production and shifts coal consumption forward in time, so as to reduce emission reduction costs later on (Figure 1). Gas exports increases slightly, and oil imports fall a bit compared to the previous scenario (Figure 2). Per capita income falls first, but is then greater than in the previous Indonesian emission reduction scenario (Figure 4). Nonetheless, the net present consumption loss is larger, as the emission constraint is stricter (Figure 5).

With international emission-permit trade, coal production remains virtually nil (Figure 1). It is more economic not to use coal, and export the resulting emission permits. As a result, slightly less gas is exported. Oil exports increase, however, as the switch from coal to gas yields emission permits for exported elsewhere in the developing world (Figure 2). Per capita income rises (Figure 4); the net present consumption loss falls to $18 billion (Figure 5).

Discussion and conclusion

We adopt the MERGE model to make Indonesia a separate region. The revised model allows us to investigate the implications of greenhouse gas emission reduction in Annex B countries and elsewhere for the Indonesian economy. The following results emerge.

Emission reduction in the OECD reduces economic growth in Indonesia, primarily through suppressing Indonesian oil export. Gas exports increase, but only slightly so and not enough to offset the loss of oil revenues. The loss of income is small, however: Consumption is never less that 99% of what it would have been without emission reduction. International trade in emission permits within Annex B, but particularly global emissions trade would reduce the income loss of Indonesia.

If Indonesia were to accept emission reduction targets at some future time, its economy would grow slower. However, emission reduction of 5% per decade would lead to income losses of less than 1%. If Indonesia were to anticipate future emission reduction targets (relative to a future base year), it would have an incentive to increase emissions. This would not only soften its emission reduction target, but it would also provide cheap emission reduction permits to be sold at the international market.

Overall, it appears that the effects of greenhouse gas emission reduction on Indonesia are fairly small, particularly compared to the level of uncertainty in long-term projections of economic development. Indonesia may even be able to afford emission reduction targets of its own. As, on the other hand, Indonesia is likely to be vulnerable to climate change, is should actively support international climate policy as member of G77 countries.

Acknowledgements

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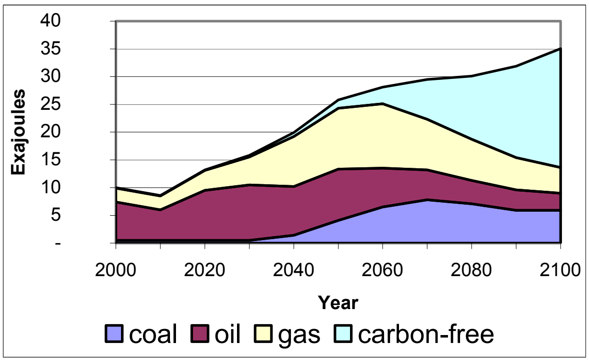
Table 1. The scenarios

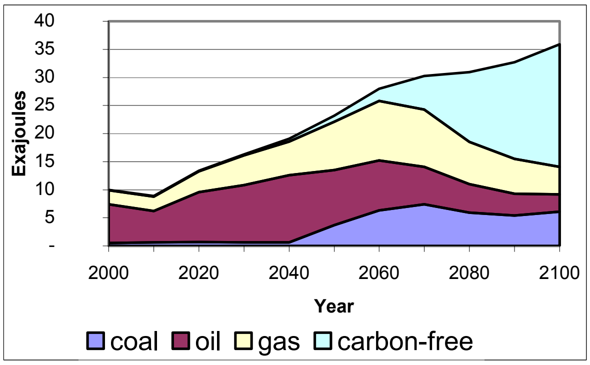
Scenario	Emission reduction	Start date	Emissions trade
REF	No		No
KAB	Annex B countries	2010	No
KBT	Annex B countries	2010	All participating countries
KBG	Annex B countries	2010	All countries
KAA	Annex B countries	2010	No
	China, India and MOPEC	2030	
	Indonesia	2050	
	ROW	2070	
KRA	Annex B countries	2010	No
	China, India and MOPEC, relative to reference scenario.	2030	
	Indonesia, relative to reference scenario	2050	
	ROW, relative to reference scenario	2070	
KAT	Annex B countries	2010	All participating
	China, India and MOPEC.	2030	countries
	Indonesia	2050	
	ROW	2070	
KRT	All Annex B countries	2010	All participating
	China, India and MOPEC, relative to Reference scenario.	2030	countries
	Indonesia, relative to reference scenario	2050	
	ROW, relative to reference scenario	2070	

Figure 1. Primary energy production of Indonesia

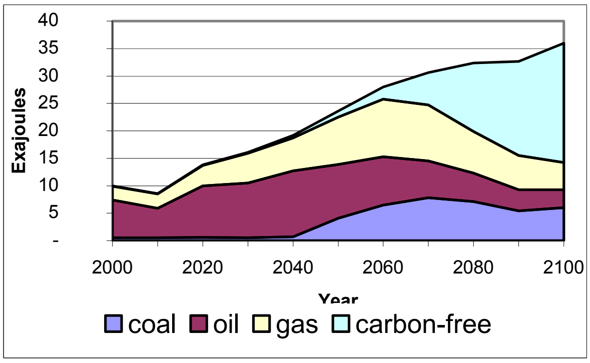
Reference scenario



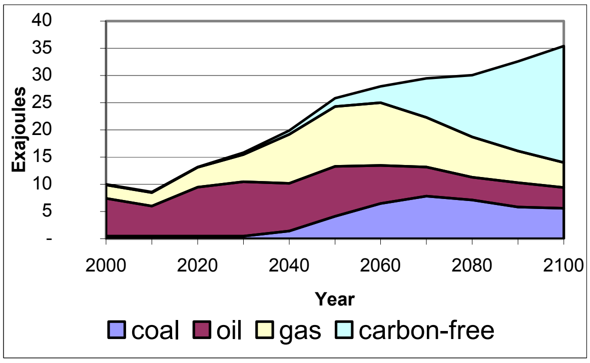
KAB scenario



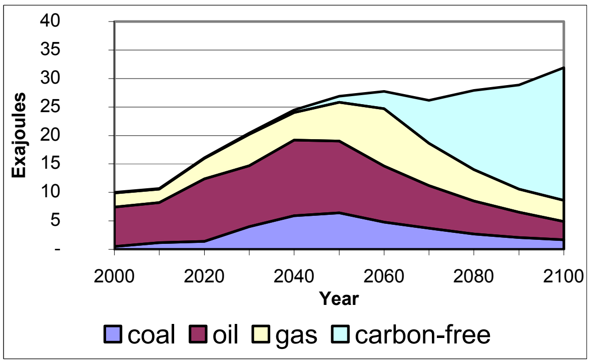
KBT scenario



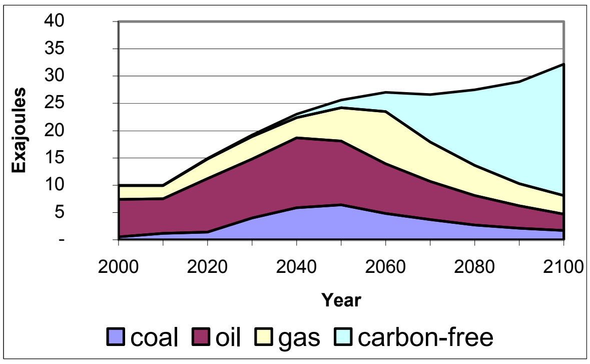
KBG scenario



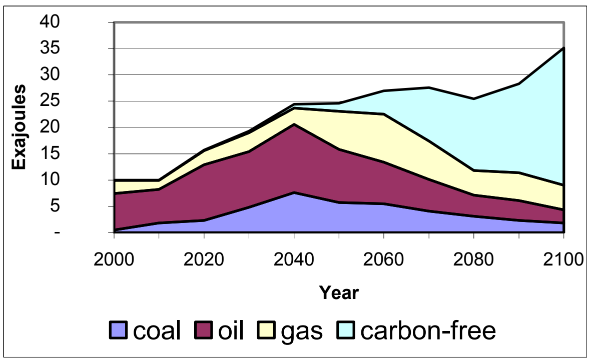
KAA scenario



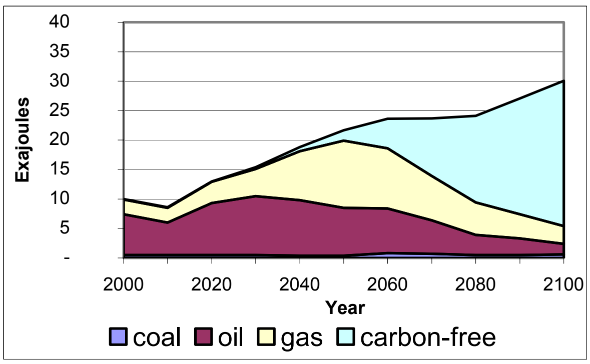
KRA scenario



KAT scenario

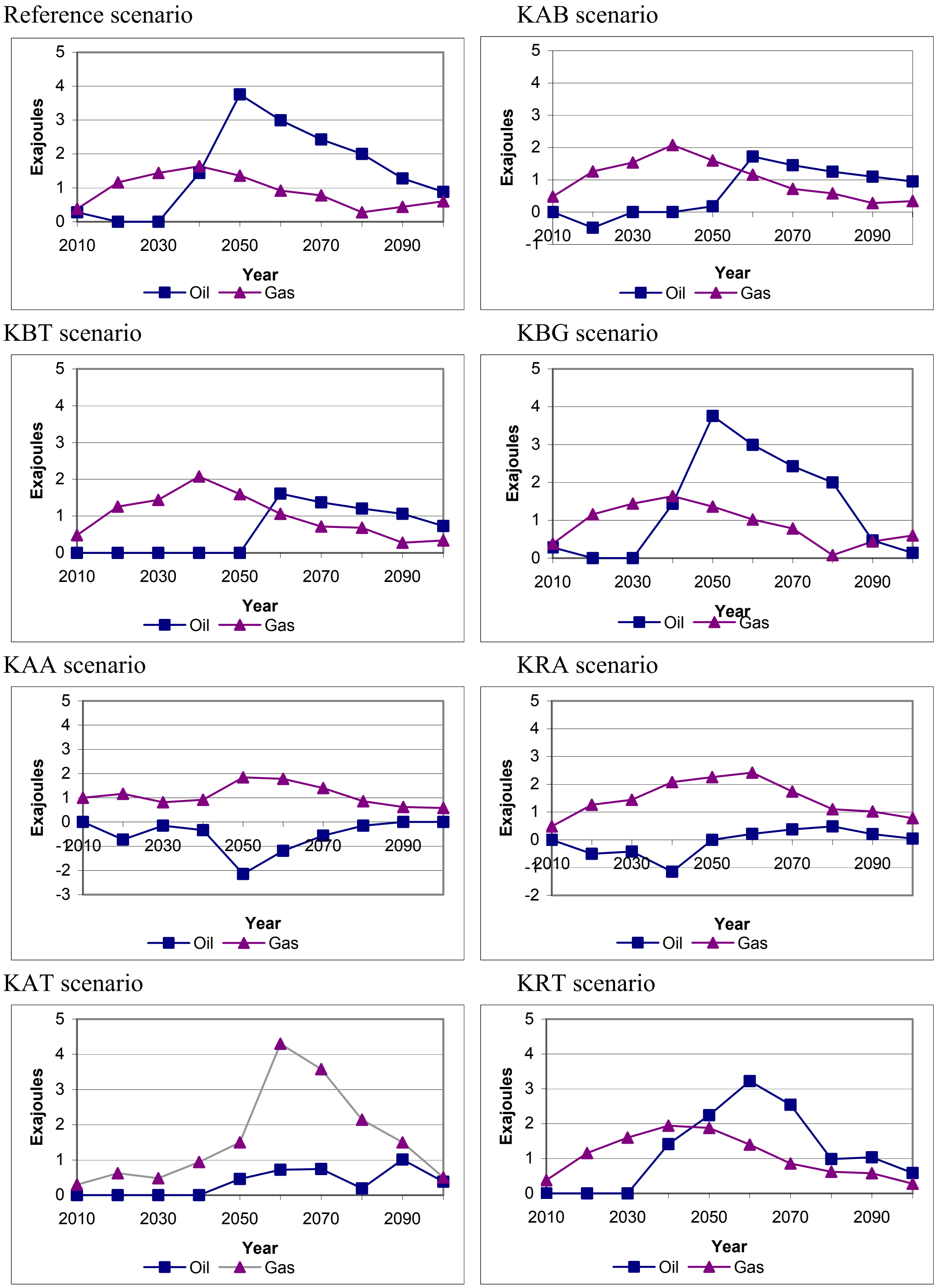


KRT scenario



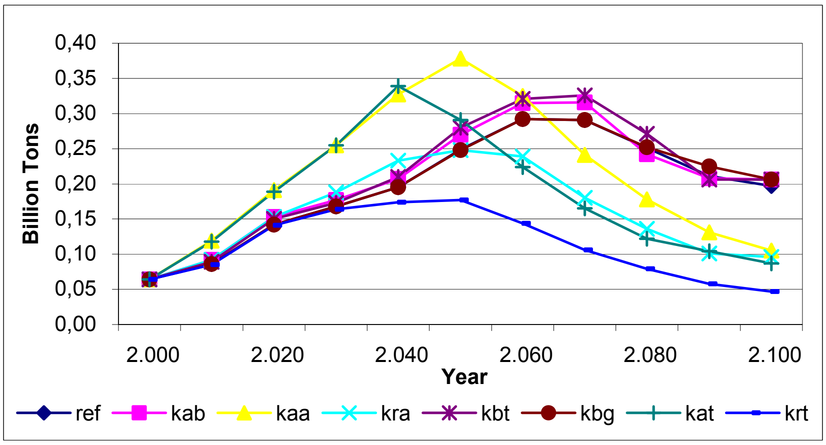
Source: Authors' model results.

Figure 2. Net exports of Indonesia



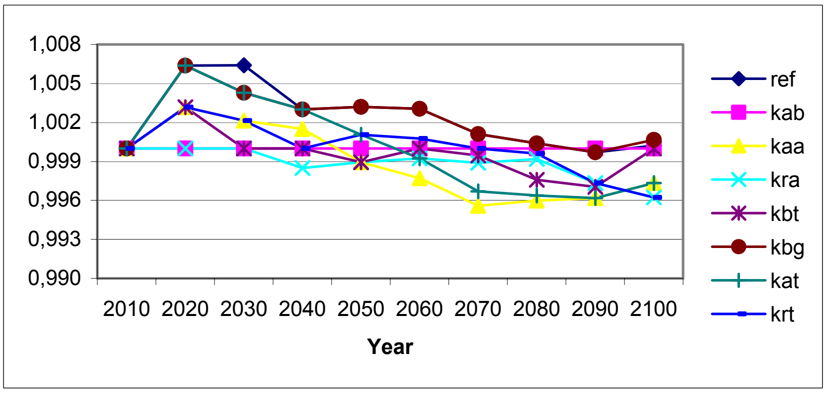
Source: Authors' model results.

Figure 3. Total carbon emissions of Indonesia



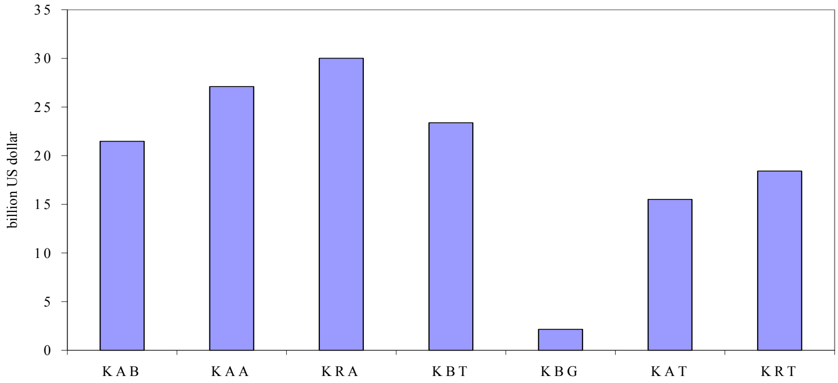
Source: Authors' model results.

Figure 4. Per capita consumption relative to the KAB scenario



Source: Authors' model results.

Figure 5. Net present value of the consumption losses relative to reference scenario – 5% discount rate



Source: Authors' model results.

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Ben-Jei Tsuang, Chia-Ying Tu, Klaus Arpe

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