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IMPACTS OF FISCAL POLICY ON GREEN TECHNOLOGIES TRANSFER

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Abstract

Under the 2016 first nationally determined contribution, the Indonesian government announced emission reduction targets of 29% and 41% by 2030 without and with international assistance, respectively. Germany, Japan, and the United States (US) are three key players among the Organisation for Economic Co-operation and Development (OECD) countries that have actively assisted the Indonesian government through several channels, such as bilateral assistance (loans and grants), and low-carbon technologies transfer. In terms of the energy efficiency sectors, in its 2017 National Energy Plan, the Indonesian government has described its intention to achieve a 17% increase in energy efficiency across industries compared to the business as usual condition (BAU). In order to achieve these energy efficiency targets, several fiscal policies were suggested to be implemented by the Indonesian government, including reducing value-added tax (VAT) and import duty on imported energy efficiency equipment and providing tax incentives for energy efficiency producers, particularly in the industrial manufacturing, building and transport sectors.

Against this background, this study assesses both the direct and indirect impacts of selected fiscal instruments in the energy efficiency sector in Indonesia in terms of low-carbon technologies (green technologies) using multi-region input–output analysis. The findings of this study reveal that fiscal policy in the energy efficiency sector would bring benefits not only for the Indonesian government as a recipient country but also for Germany, Japan, and the US as providers of low-carbon technologies (green technologies) to Indonesia.

Keywords: fiscal policy, Indonesia, green technologies transfers, input–output

JEL Classification: D57, E62, Q56

Contents

1. INTRODUCTION

In 2016, the Indonesian government submitted its first nationally determined contribution (NDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) by targeting approximately 29% and 41% emissions reduction targets by 2030 without and with international assistance, respectively (UNFCCC 2016). Among developed countries, Germany, Japan and the United States (US) are three key players that have assisted the Indonesian government in terms of climate change via several channels, including bilateral assistance (loans and grants), low-carbon technologies transfer, and other forms of market mechanisms. In addition, the Indonesian government selected five key mitigation sectors for emissions reduction targets: land-use change and forestry; energy; waste; agriculture; and Industrial Process and Product Use (IPPU). During the period 2000-2012, the energy sector demonstrated the greatest growth in emissions among the sectors. Without any mitigation actions (labeled BAU or "business-as-usual" conditions), emissions generated from the energy sector will grow to about 1,669 million tones CO_2 in 2030 (UNFCCC 2016). The Indonesian government aims to reduce emissions from the energy sector to about 11% and 14% from BAU conditions without and with the international assistance, respectively (UNFCCC 2016). The emissions reduction target from the energy sector is the second priority in Indonesia (after the land-use and forestry sector).

The details of the mitigation actions plan for the energy sector consist of both energy supply and energy demand. On the energy supply side, the importance of the energy sector for Indonesia is not only related to emissions reduction targets but also to economic growth, energy security and electrification targets. In 2014, the Indonesian government announced a revised 2014 National Energy Policy by setting a target of approximately 23% of new energy and the renewable energy sector by 2025 (Asian Development Bank (ADB) 2016). The total energy supply of Indonesia in 2016 consisted of oil (33%), coal (24%), gas (19%), hydropower (3%), geothermal (1%), biomass (20%) and biofuel (0.1%) (Ministry of Energy and Mineral Resources (MEMR) 2017a). Twenty-three per cent of the renewable energy targets consists of four sectors: bioenergy, geothermal, small and large scales of hydropower, and other sources. Aside from 23% renewable energy targets, the energy supply in Indonesia in 2025 is expected to consist of three primary energy sources: coal (30%), oil (25%) and gas (22%).

On the energy demand side, about a 17% increase in energy efficiency is targeted by the Indonesian government by 2025 under the 2017 National Energy Plan (MEMR 2017b). Under the current energy efficiency targets, a total of approximately 341 million tons of CO_2 equivalent will be reduced by 2025 (International Energy Agency 2017). The residential, industry and service and transportation sectors in Indonesia were the three largest energy consumers in 2015, consuming approximately 38%, 29% and 27%, respectively (International Energy Agency (IEA) 2017). Therefore, the Indonesian government set targets for transportation, industry, residential and commercial building of approximately 20%, 17%, 15% and 15%, respectively (Respati 2016).

In order to support the implementation of 17% energy efficiency targets by 2025, several supporting programs on energy efficiency are being implemented by the Indonesian government, including deploying low-carbon technologies, providing training for energy audit managers and providing both financial and fiscal incentives. However, under the current governmental regulation on energy conservation (Government Regulation Number 70 Year 2009), opportunities exist for several fiscal instruments to be further explored. In line with this, the Centre of Climate Change Finance and Multilateral Policy of Fiscal Policy Agency of Ministry of Finance (MoF) of Indonesia has studied and suggested several fiscal policy instruments on both the government expenditure and revenue sides to support the implementation of energy efficiency targets, such as reducing value-added tax (VAT) or import tariffs on imported low-carbon technologies and providing financial or fiscal incentives such as loans for energy efficiency producers of the industry, transport and residential sectors in Indonesia (MoF 2015a).

Against this background, this study aims to assess the impacts of fiscal policy instruments on the energy efficiency sector in Indonesia on low-carbon technologies (green technology) transfers, not only on the Indonesian side (as the recipient country) but also on Germany, Japan and the US (as three major partner countries that are green technologies providers for Indonesia), using multi-region input–output analysis. The remainder of this paper is structured as follows. The second section will briefly present the fiscal policy instruments on the energy efficiency sector in Indonesia. The third section presents the data and analytical methods including the simulation scenarios of the selected fiscal policy instruments in the energy efficiency sectors in Indonesia. The fourth section presents the results and discussion of analytical methods on the impact assessment of the fiscal policy in the energy efficiency sectors on green technologies transfers using multi-region input–output analysis. The final section is the conclusion and policy implications based on key findings and discussion mentioned in previous sections.

2. FISCAL POLICY INSTRUMENTS ON THE ENERGY EFFICIENCY SECTOR IN INDONESIA

From 1982 to 2014, several government policies regarding the energy efficiency sector (energy conservation) were implemented across the building, energy and water efficiency sectors in Indonesia. Given that the new masterplan for energy efficiency for 2016-2025 is still being finalized, Government Regulation Number 70 Year 2009 is most commonly used for reference. This regulation outlines detailed guidelines pertaining to the following: (i) sharing responsibilities among government, company and community; (ii) implementing energy efficiency measures and standards and labeling across sectors; (iii) providing incentives to support energy efficiency programs; and (iv) disseminating energy efficiency measures among the public. Although Government Regulation Number 70 Year 2009 covers several important parts of the energy efficiency sector in Indonesia, several improvements need to be considered, particularly in terms of fiscal instruments. In 2014, the Indonesian government through the Ministry of Energy and Mineral Resources (MEMR) announced Government Regulation Number 79 Year 2014, concerning the national energy plan of Indonesia. Under the 2014 National Energy Plan, the Indonesian government regulated both the energy and electricity plans of the country. The Indonesian government targeted a 1% decrease in final energy intensity annually until 2025, and a goal of nearly 100% of electrification ratios by 2050. Moreover, the Indonesian government also applied three mandatory policies for the implementation of standardization and labeling, energy audit and usage of energy efficient equipment (MEMR 2015). Moreover, the IEA has noted that the mandatory energy efficiency policies in Indonesia cover only two forms: (i) Minimum Energy Performance Standard (MEPS) and labeling of compact fluorescent light bulbs (CFLs) and air conditioners (AC); and (ii) requirements for industries to use more than 0.25 Petajoule (PJ) and to report their energy consumption annually. However, the fiscal incentives and disincentives for energy efficiency producers are not mandated by the Indonesian government.

To complement the 2014 National Energy Plan, the Indonesian government announced its 2017 National Energy Plan through Government Regulation Number 22 Year 2017. This regulation outlined the same target for energy intensity and 17% energy efficiency targets for residential, industry and service and transportation sectors by 2025 (MEMR 2017b). In detail, the energy efficiency targets by 2025 for each sector are transportation (20%), industry (17%), residential (15%) and service or commercial building (15%). The Indonesian government selected four main target sectors owing to their substantial energy consumption. In 2015, the residential, industry and service and transportation sectors consumed approximately 38%, 29% and 27% of total energy consumption in Indonesia, respectively (IEA 2017). The highlights of the Indonesian government's regulations on the energy efficiency sector are summarized in Table 1.

Table 1: Highlights of the Indonesian Government's Regulations on the Energy Efficiency Sector

No	Year	Regulation
1.	1982	Presidential Instruction Number 9 Year 1982 on Energy Conservation.
2.	1991	Presidential Decree Number 43 Year 1991 on Energy Conservation.
3.	2002	Law Number 28 Year 2002 on Building.
4.	2005	Presidential Instruction Number 10 Year 2005 on Energy Efficiency, Ministerial of Energy and Mineral Resources Regulation No. 0031 Year 2005 on Procedure of Energy Efficiency Implementation.
5.	2006	Presidential Regulation Number 5 Year 2006 on National Energy Policy.
6.	2007	Law Number 30 Year 2007 on Energy.
7.	2008	Presidential Instruction Number 12 Year 2008 on Energy and Water Efficiency.
8.	2009	Government Regulation Number 70 Year 2009 on Energy Conservation.
9.	2014	Government Regulation Number 79 Year 2014 (National Energy Plan).
10.	2015	Energy Efficiency Master Plan 2016-2025 (in process).
11.	2017	Government Regulation Number 22 Year 2017 (National Energy General Plan).

Source: Author compilation based on previous studies (IEA 2017; Respati 2016).

The Indonesian energy efficiency programs to support the energy efficiency sector for the period from 2015 to 2025 can be categorized into seven priority programs: (i) formulating policy and regulations on energy conservation; (ii) implementing public-private-partnership (PPP) programs for the energy efficiency sector such as energy audits; (iii) implementation of labeling, MEPS and standards in industry, building and energy efficient equipment; (iv) diffusion of street lighting in approximately 22 cities; (v) monitoring the progress toward approximately 30 million tons of CO_2 emissions reduction targets by 2020; (vi) improving the awareness of various stakeholders about the important role of energy efficiency; and (vii) creating financial support for energy producers (Respati 2016).

A joint report written by the Ministry of Finance and UK Low Carbon Support Program in 2015 outlined approximately nine fiscal policy instruments to promote the energy efficiency sectors both generally and specifically in four sectors: industry, appliances, building and transport (MoF 2015b). In general, the removal of energy subsidies and acceleration of the establishment of the energy efficiency revolving fund represent two key fiscal instruments. The removal of energy subsidies is prioritized among other fiscal policy instruments to promote energy efficiency in Indonesia. Energy subsidies brought considerable budget burdens for the Indonesian government. In addition, removal energy subsidies will also encourage users to be more efficient or more selective in energy efficient technologies. However, the removal of energy subsidies in Indonesia was conducted gradually from November 2014 and was complemented by some policies such as net transfer to protect vulnerable people affected by the policy. Another high-priority fiscal policy instrument for the energy efficiency sector in Indonesia is the acceleration of the energy efficiency revolving fund (EE-revolving fund). The main motivation of this policy is to tackle the financial barrier of EE finance in Indonesia, based on the successful case of Thailand's EE revolving fund. The EE-revolving fund is under the principal authority of the Ministry of Finance. The fund will be transferred to the Indonesia Investment Agency (PIP) to further lend to prospective banks with a low interest rate (2% per year). The banks will channel the funds to finance energy efficiency projects with a range of interest rates from 7% to 9% (Setyawan 2014). Additional fiscal instruments are recommended for industry, appliances, building and transport sectors. For the industry sector, the implementation of the fiscal incentive framework is the key fiscal instrument of the industry sector in Indonesia. Currently, the fiscal incentives scheme is only available for renewable energy sectors under the Ministry of Finance regulation number 21/PMK.011/2010 (MoF 2010). The fiscal incentives scheme of the RE sector exist in forms of income tax reduction, accelerated depreciation and value-added and import duty exemption. A similar fiscal incentives scheme can be applied in the energy efficiency sector for heavy energy-use industries including the Energy Service Company (ESCO), which is able to improve energy efficiency and purchase listed energy efficiency equipment (MoF 2015b).

For the appliances, two fiscal policy instruments are to be used in the sector. First, providing subsidies to consumers who purchase energy efficiency appliances using an appliance rebate, to encourage the consumer to use energy efficiency appliances that can reduce energy consumption at the household level. The subsidy scheme should be a targeted rebate, within specific periods and disbursed through retailers (for high-value energy efficiency appliances) and manufacturers or utilities (low-value energy efficiency appliances). The Barriers Removal to the cost-effective development of energy efficiency standards and labeling program (the BRESL) found that the rebate scheme on air conditioners and refrigerators could save approximately IDR 2.77 trillion per annum (MoF 2015b). Second is the implementation of the reform of the government procurement system to purchase energy efficiency appliances such as CFLs and air conditioners. The successful implementation of this scheme will require collaboration among the three main ministries (MEMR, the Ministry of Public Works and the Government Procurement Agency of Goods and Services, or LKPP in Bahasa). The implementation of the public procurement scheme could provide as well as good demonstration on energy efficiency used in public offices or buildings to the community.

For the building sector, the fiscal incentive instruments consist of providing tax incentives for the most energy efficient buildings and linking the energy audit program with the Energy Efficiency (EE) revolving fund. Tax incentives would be allocated by the Ministry of Finance to the company that constructs the building that consumes energy in excess of the minimum standard of energy consumption (35 watt/m^2). In addition to the fiscal incentives, the linking of energy audit with the EE-revolving fund would also be implemented. The energy audit program is under the authority of the MEMR and is implemented to assist the high energy-consuming companies to freely amend their energy consumption. The energy audit program will be expanded into small energy user companies and connected with the EE-revolving fund of the MoF. This may consist of dissemination channels or capacity building around the EE-revolving fund.

For the transport sector, the fiscal policy instruments focus on controlling both the demand and supply sides. The demand for vehicles that consume large amounts of fossil fuels remains high. Setting the tax rate on these vehicles would be necessary to control or reduce the demand for these vehicles. Simultaneously, acceleration of public transport initiatives would be implemented to control the supply side (see Table 2).

Table 2: Fiscal Policy Instruments to Promote the Energy Efficiency Sector in Indonesia

No	Sector Covered	Fiscal Policy Instruments
1.	Energy efficiency sector (in general)	a. Removing the energy subsidies. b. Acceleration of the usage of the energy efficiency revolving fund.
2.	Industry	c. Implementing the fiscal incentive framework for supporting energy measures in industry and business sectors.
3.	Appliances	d. Providing subsidies for consumers who purchase energy efficiency appliances using appliance rebate. e. Implementing the reform of the government procurement system for purchase of energy efficiency appliances (technologies).
4.	Building	f. Providing tax incentives for the most energy efficient buildings in Indonesia. g. Expanding the program of energy auditing and linking it with the energy efficiency revolving fund.
5.	Transport	h. Setting a tax rate on highly fossil fuel-dependent vehicles. i. Accelerating the public transport initiatives listed in the national mitigation action plan on greenhouse gas emission reduction (named RAN-GRK in Bahasa).

Source: Author's compilation using the report published by the MoF (2015b).

In addition to the aforementioned fiscal policy instruments, the Fiscal Policy Agency of the Ministry of Finance of Indonesia has also studied and categorized the fiscal policy instruments to support the energy efficiency sectors in Indonesia into two types: (i)short-term and (ii) long-term fiscal instruments. In the short-term, fiscal instruments cover the following policies: (i) reduction of VAT and import tariffs on energy efficient equipment, and income tax for energy efficiency companies or producers and (ii) providing soft loans for energy efficient equipment and green building. In the long term, the suggested fiscal instruments are in line with the short-term fiscal instruments. However, the focus of the long-term fiscal instruments will be on the reduction of sales tax and providing subsidies for energy efficient equipment purchases and providing loan guarantees for renewable energy industries. In general, both the short-term and long-term fiscal instruments listed in Table 3 are similar to the instruments in Table 2. However, two additional fiscal instruments on energy efficiency equipment and one fiscal instrument on the transport sector are added. Indeed, two additional fiscal instruments on energy efficiency equipment (reduction of VAT and import tariffs) are added. These fiscal instruments aim to complement the rebate or subsidy system on energy efficiency equipment. The targeted equipment comprises split AC and refrigerators due to their high energy consumption levels at the household level in Indonesia. In addition, reduction of the sales tax on luxury motor vehicles (L3-category motor vehicles) will also be applied having ascertained their energy performance. L3-category motor vehicles are categorized as luxury goods and are thus subject to tax. Given that these vehicles have large engines and superior energy efficiency than fossil fuel-powered motor vehicles, the reduction in sales tax would promote energy efficiency in the transport sector (see Table 3).

Table 3: Additional Fiscal Instruments to Support Energy Efficiency Targets in Indonesia

No	Type	Fiscal Policy Instruments
1.	Short-term	Reducing the value-added tax and import tariffs on energy efficiency equipment; and the income tax for energy efficiency service companies; and providing soft-loans to purchase energy efficiency equipment and green building.
2.	Long-term	Reducing sales tax on luxury motor vehicles (such as the L3-category of motor vehicles) after considering their energy efficiency performance and the subsidy on energy efficiency equipment.

Source: Author's compilation based on the lists of fiscal policy options mentioned by the MoF (2015a).

The summary of the combination of fiscal policy instruments based on the two studies mentioned above is presented in Table 4.

Table 4: List of Fiscal Policy Instruments for Energy Efficiency Sectors in Indonesia

No	Sector	Fiscal Policy Instruments	Type	Priority
1.	Energy efficiency sector (in general)	a. Removal of energy subsidies.	a. Medium-term	a. High
		b. Acceleration of the usage of the energy efficiency revolving fund (can be used to provide soft-loan to purchase energy efficiency equipment and green building).	b. Short-term	b. High
2.	Industry	c. Implementing the fiscal incentive framework for supporting energy measures in the industry and business sectors (such as through reducing the income tax of a company or industry).	c. Short-term	c. High
	Appliances	d. Providing subsidies for consumers who purchase energy efficiency appliances using appliance rebate.	d. Short-term	d. Medium
		e. Implementing the reform of the government procurement system for purchase of energy efficiency appliances (technologies).	e. Short-term	e. Medium
		f. The reduction of the value-added tax on energy efficient equipment, namely split AC and refrigerators.	f. Short-term	f. Medium
		g. The reduction of the import tax on energy efficiency equipment, namely split AC and refrigerators.	g. Short-term	g. Medium
	Building	h. Providing tax incentives for the most energy-efficient buildings in Indonesia.	h. Short-term	h. High
		i. Expanding the program of energy auditing and linking it with the energy efficiency revolving fund.	i. Short-term	i. Low
	Transport	j. Setting a tax rate on heavily fossil fuel-dependent vehicles.	j. Short-term	j. Medium
		k. Accelerating the public transport initiatives listed in the national mitigation action plan on greenhouse gas emission reduction (named RAN-GRK in Bahasa).	k. Medium-term	k. Medium
		l. Reducing sales tax on luxury motor vehicles.	l. Long-term	l. Medium

Source: Author's compilation based on reports published by the MoF (2015a, 2015b).

In addition to these reports, several previous studies on the potential implementations of two-step loans under the emission reduction investment and energy efficiency revolving fund (Setyawan 2014; Syaifudin et al. 2015a) and impacts analysis of fiscal policy on the energy and energy efficiency sectors in Indonesia (Hartono and Resosudarmo 2008; Syaifudin et al. 2015b, 2015c) have been conducted. These studies have shared four important implications: (i) the energy efficiency revolving fund under the emissions reduction investment program is economically viable and beneficial in supporting the energy efficiency sector in Indonesia; (ii) the clear arrangements on fund sources, institutional and discussion among stakeholders particularly with bank and other financial resources are necessary to smoothly implement the energy efficiency revolving fund for energy efficiency sector; (iii) fiscal instruments in the energy efficiency sector bring positive impacts for the economy, emissions reduction and poverty reduction in Indonesia; and (iv) the fiscal incentives should be disbursed as a lump sum, target the less developed regions and prioritize the specific sectors in line with the national emissions reduction targets such as industry and transport.

In addition, two recent studies found that carbon tax, hometown investment trust fund (community-based funds) and fiscal policy reform, as well as the spillover tax of energy supply can be utilized as alternative financial sources of green energy (renewable energy) projects in Asia (Yoshino and Taghizadeh 2017, 2018). Theoretically and empirically, the utilization of the carbon tax revenue into community-based green funds (such as hometown investment trust funds) would increase the rate of return of green energy projects. This will then attract the private sector investors to invest in green energy projects (Yoshino and Taghizadeh 2017). Furthermore, the spillover effects originally generated from electricity supplies can be used to support investors in increasing the rate of return and provide investment incentives in green energy projects. Thus, this fiscal policy reform has a positive impact in finding alternative financial sources for green energy projects (Yoshino and Taghizadeh 2018).

Although several previous studies have examined the impacts of fiscal instruments on green energy (energy efficiency sector) both in general and in more specific Indonesian cases using both quantitative and qualitative approaches (such as economic analysis, cost-benefit analysis, bottom-up computable general equilibrium and in-depth interviews), they have not explored the impacts of fiscal instruments of energy efficiency implemented by the Indonesian government on other countries. This study combines two issues into a single analysis: fiscal policy on energy efficiency and low-carbon technologies transfers. This study examines the impacts of fiscal policy instruments on the energy efficiency sector in Indonesia on both the Indonesian economy (as a recipient) and on Germany, Japan and the US (as providers of low-carbon technology transfers to Indonesia).

3. DATA AND ANALYTICAL METHODS

3.1 Data

This study utilized detailed lists of both renewable energy and energy efficiency technologies mentioned in studies conducted by Glachant et al. (2013) and Wind (2010) (see Table 5).

Table 5: Categories of Selected Low-carbon Technologies in This Study

No	Main Categories	Sub Categories of Low-carbon Technologies
1.	Renewable energy	Bio-ethanol, solar thermal, wind power, geothermal power, biomass, solar PV, hydropower.
2.	Energy efficiency	Energy storage, insulation, efficient heating, lighting, electric and hybrid vehicles, energy efficiency in the cement industry (heavy industrial process).

Source: Author's compilation based on previous studies (Glatchan et al. 2013; Wind 2010).

Having selected these low-carbon technologies, this study utilized the following four data sources for model construction and analysis: (i) the 2011 OECD inter-country input-output (ICIO) released on 2 June 2 2015 (2015 edition), which represents economic transactions among 68 countries in 34 industries, and the 2011 OECD ICIO table, used as the main data in this study (OECD 2015). (ii) the UN COMTRADE database, which covers bilateral trade for the selected low-carbon technologies among the chosen countries in the year 2011. This was used to calculate the bilateral trade ratios of selected low-carbon technologies included in this study. The bilateral trade ratios were then used to disaggregate the foreign intermediate input account of the selected low-carbon technologies of the 2011 OECD ICIO. (iii) the 2016 United Nation Industrial Organization (UNIDO) International Yearbook of Industrial Statistics, which provides data on the output of selected low-carbon technologies in the year 2011. The abovementioned data of the 2016 UNIDO International Yearbook of Industrial Statistics were used to calculate the disaggregation ratios of the following accounts: domestic intermediate inputs, output, value-added, and final demand of selected low-carbon technologies of the 2011 OECD ICIO table (UNIDO 2016). And (iv) the UN STAT correspondence tables for mapping ISIC Rev 3 of the 2011 OECD ICIO Table with HS 1996 code of UN COMTRADE data and ISIC Rev 4 of UNIDO industrial data (UN STAT). The low-carbon technologies extended of the 2011 OECD ICIO table was used as the main data to conduct the impacts assessment of fiscal policy on green technologies transfers in this study.

3.2 Analytical Methods

3.2.1 Model Construction

To accommodate the analytical purpose of this study, a low-carbon technologies extended 2011 OECD inter-country input-output (ICIO) table was constructed. As mentioned in subsection 3.1, the main data used in this study comprised the 2011 OECD ICIO table, which was published on 2 June 2015. The 2015 OECD ICIO table represents economic transactions among 67 countries for 34 industries' classifications. The 2011 OECD ICIO table consists of three main accounts: (i) intermediate inputs (domestic and foreign); (ii) final demand (domestic and foreign) of economic actors; and (iii) value added (tax, subsidy, and wage). The 2011 OECD ICIO table and its detailed structure is freely available from the OECD homepage (OECD). To construct the low-carbon technologies extended 2011 OECD ICIO table, the following three steps were conducted. First, the countries included were reclassified and reduced to 19 to meet the analytical needs of this study. Indeed, some European countries excluding Germany and France were aggregated into one group of European countries, and other non-focus countries such as South Africa were aggregated into a rest of the world classification (see Table 6).

Table 6: Country Classifications Used in the Study

No	Country Classification	Country Members
1.	Similar to that mentioned in the 2011 OECD ICIO table (country classification numbers 1–17)	Australia, France, Germany, Japan, UK, US, Republic of Korea, Indonesia, Malaysia, Thailand, Singapore, Brunei, the Philippines, Viet Nam, Cambodia, India and the People's Republic of China (PRC).
18	European countries	Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Bulgaria, Cyprus, Croatia, Lithuania, Latvia, Malta, Romania and Russian Federation
19	Rest of the world	All remaining countries of the 2011 OECD ICIO table

Source: Author's compilation based on country classifications of the 2011 OECD ICIO table.

Second, the industry classifications used in the 2011 OECD ICIO table (ISIC Rev 3) were mapped with the commodity classifications used in the UN COMTRADE database (HS 1996) using the correspondence tables of UNSTAT. The mapping process was undertaken as follows: (i) ISIC Rev 3 (2011 OECD ICIO table) was mapped with CPC 1.0 (UN STAT); (ii) CPC 1.0 (UN STAT) was mapped with HS 1996 (UN COMTRADE); and (iii) ISIC Rev 3 (OECD ICIO table) and ISIC Rev 3.1 was mapped into ISIC Rev 4 (2016 UNIDO International Yearbook of Industrial Statistics). Third, the disaggregation ratios were calculated to identify the selected low-carbon technologies from their parent sectors in the 2011 OECD ICIO table. The disaggregation was conducted in four stages: (i) domestic intermediate inputs; (ii) foreign intermediate inputs; (iii) value added and output; and (iv) final demand. The disaggregation ratios were calculated using two main data: (i) 2011 bilateral trade data of UN COMTRADE; and (ii) 2011 output data of the 2016 UNIDO International Yearbook of Industrial Statistics. For countries with no available data, the disaggregation was conducted using disaggregation data of countries that are most similar in economic size (see Table 7).

Table 7: Disaggregation Ratios Used in Model Construction

No	Accounts of 2011 OECD ICIO Table	Disaggregation Ratios	Data Source
1.	Domestic intermediate inputs, value added and output accounts	Output and export ratios	(i) 2011 UNIDO Industrial Statistics Yearbook; (ii) 2011 UN COMTRADE database.
2.	Foreign intermediate inputs	Bilateral trade ratio	(i) 2011 UN COMTRADE database.
3.	Domestic and foreign final demand accounts	Output and export ratios	(i) 2011 UNIDO Industrial Statistics Yearbook; (ii) 2011 UN COMTRADE database.

Source: Author's compilation.

3.2.2 Simulation Scenarios

Having constructed the low-carbon technologies extended 2011 OECD ICIO table mentioned in subsection 3.2.1, we set four simulation scenarios that present the selected fiscal instruments in the energy efficiency sectors in Indonesia. This study only included the short-term fiscal instruments in the energy efficiency sectors in Indonesia (see Table 2 and 3). In addition, the simulation scenarios used in this study were focused on three sectors covered in the model: insulation, energy efficiency technologies used in heavy production processes (such as the cement industry), and lighting. The selected simulation scenarios were then used as policy shocks that change the values of domestic final demand in Indonesia for the three selected sectors above (see Table 8).

Table 8: Selected Fiscal Instruments and Simulation Scenarios Used in the Study

No	Sectors Covered	Fiscal Policy Instruments	Simulation Scenarios
1.	Three sectors (insulation, energy efficiency technologies used in heavy production process, and lighting).	Reduced VAT for energy efficiency technologies used in appliances, industry and building sectors.	SIM 1: the consumption of household, enterprise and government for three sectors covered are assumed to increase by 50% each. Consequently, the value of domestic final demands of Indonesia for three covered sectors are assumed to increase by 50% from their original values.
2.	Insulation and lighting	2.1 Providing soft loans to purchase energy efficiency appliances and green building. 2.2 Providing an appliance rebate for the consumer.	SIM 2: household consumptions for insulation and lighting are assumed to increase by 50% each. Consequently, domestic final demands in Indonesia for insulation and lighting are assumed to increase by 50% from their original values.
3.	Energy efficiency technologies used in the heavy production process	Reducing the income tax for energy efficiency service companies	SIM 3: company consumption for energy efficiency technologies used in heavy production process is assumed to increase by 50%. Consequently, domestic final demand of Indonesia for low-carbon technologies used in the heavy production process is assumed to increase by 50% from its original value.
4.	Insulation, energy efficiency technologies used in the heavy production process and lighting	Reducing the import tariffs of energy efficiency equipment imported from Germany, Japan and the US.	SIM 4: the imported demands of Indonesia from Germany, Japan and the US for insulation, energy efficiency technologies used in heavy production process, and lighting are assumed to increase by 50% each. Consequently, foreign final demand in Indonesia for three sectors from Germany, Japan and the US are assumed to increase by 50% each from their original values.

Source: Author's compilation.

3.2.3 Methodology

This study used multi-regional input-output analysis based on low-carbon technologies extended from the 2011 OECD ICIO table. The input-output analysis was developed by Leontief in 1936. The details regarding theoretical frameworks and applications are provided by Miller and Blair (2009). Moreover, some remarkable studies have utilized the input-output analysis in various ways as mentioned in detail in Malik et al. (2018). The diverse application of IO analysis can be summarized as follows: (i) at the global level (Andrew and Peters 2013; Murray and Lenzen 2013; Timmer et al. 2014, 2015; Tukker and Dietzenbacher 2013), (ii) at the sub-national or multi-regional level (Faturay et al. 2017; Lenzen et al. 2014; Su and Ang 2014); (iii) using hybrid IO type or LCA-IO analysis (Malik et al. 2015; Merciai and Schmidt 2017), or (iv) linking with some environmental accounts (Duarte and Yang 2011; Hertwich 2011; Hoekstra et al. 2015; Wiedmann 2009); (v) linking with social footprint (Gloria et al. 2017; McBain and Alsamawi 2014);

and linking with disaster analysis (Hallegatte 2008; Okuyama 2003; Okuyama and Santos 2014; Rose 2004).

Specifically, several studies have assessed the impacts of fiscal policy or fiscal stimulus packages on output, employment and so forth. using IO analysis (Anghelache et al. 2017; Borges and Montibeler 2014; He et al. 2009; Liskova 2014).

The basic assumption of IO analysis is fixed price. The basic structure of the IO table consists of three main parts: (i) intermediate inputs transaction, (ii) final demand, and (iii) value added and output. For the multi-region input-output table, the intermediate inputs, final demand and value added, and output are separated into domestic and foreign transactions (see Table 9).

Table 9: Simplified IO Table of Two Regions and Two Sectors Transactions

No Sector	Country A Sector 1 (A1)	Country A Sector 2 (A2)	Country B Sector 1 (B1)	Country B Sector 2 (B2)	Country A Final Demand (FA)	Country B Final Demand (FB)	Output (X)
A1	Intermediate input transactions (A)				Final demand transaction (f)		Output (x)
A2							
B1							
B2							
VA.TAX	Value added (v)						
X	Output (x)						

Source: Author's compilation.

Intermediate inputs and outputs are considered endogenous accounts and final demand is deemed an exogenous account. The exogenous account is used to imply certain simulation scenarios that reflect any policy changes. The standard input-output analysis to assess the impacts of any policy changes is "accounting multiplier analysis." The core of the accounting multiplier analysis is the Leontief inverse matrix, which is the inverse matrix of the intermediate input transactions (matrix A). There are four detailed steps for conducting the accounting multiplier analysis. First is calculation of matrix A from the intermediate input transaction. Matrix A is calculated as the ratio of each sector input from each sector's total output (a_1/x_1). Second is to compile the Identity matrix (I), a matrix that has a value of 1 at diagonal. Third is to calculate the inverse matrix of $(I-A)^{-1}$. Fourth is to set the simulation scenarios to be used as changes of final demand account (Δf). The formula of the total changes of any policy shock using the standard accounting multiplier is written as follows

$$\Delta \mathrm{x} = (I-A)^{-1}\Delta y \quad (1)$$

Where:

$\Delta \mathrm{x}$ = total change in output

I= the Identity matrix (matrix with diagonal elements as 1). It can be written as

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

A= matrix coefficient from the intermediate input transaction. It can be written as

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

Δy= any shock or changes on selected exogenous account due to simulation scenarios.

In this study, the accounting multiplier analysis only calculated direct and indirect impacts of a change in final demand unit. The definition of direct and indirect impacts used in this study are the impacts on Indonesia and other countries, respectively. Final demand is set as an exogenous account in this study (see Table 8).

4. RESULTS AND DISCUSSION

As mentioned in section 1, this study aims to assess the impacts of fiscal policy instruments on the energy efficiency sectors in Indonesia on both Indonesia as a recipient country of green technologies and on three selected green technologies' provider countries (Germany, Japan and the US) and other countries. This subsection will present the direct and indirect impacts of each simulation scenarios representing the fiscal policy instruments on energy efficiency sectors at both country and sectoral (industry) levels based on the results of the accounting multiplier analysis.

4.1 Direct and Indirect Impacts at the Country Level

The findings from all four simulation scenarios show that the implementation of each four fiscal policy instruments on the energy efficiency sectors in Indonesia generate a positive economic impact (in terms of output impact) in Indonesia and beyond. The total output impacts under the implementation of fiscal policy instruments on two or three energy efficiency sectors (insulation, EE technologies used in heavy production process or industry and lighting) are also greater than the results under the implementation of fiscal policy instruments in one specific energy efficiency sector. The total output impacts under the implementation of reduction of value-added tariffs on insulation, EE technologies used in heavy pr$oduction process or industry and lighting are 18,217 billion US dollars. In other words, a 50% increase of domestic final demand of each energy efficiency sector (insulation, EE technologies used in heavy production process and lighting) will increase the total output by approximately 18,217 Billion US dollars (see Table 8). The lowest increase in total output is found under the implementation of a reduction in import tariffs on lighting and insulation technologies from three main partner countries (Germany, Japan and the US).

The total output impacts at the country level can be further deconstructed as: (i) total output impacts on Indonesia (direct impacts) and (ii) total output impacts on other countries (indirect impacts).

The findings show that the total output impacts on Indonesia under four simulation scenarios are smaller than the total output impacts on other countries. The total output impacts on Indonesia under four simulation scenarios are similar (approximately 224.8 billion US dollars). However, the reduction of import tariffs on imported insulation and lighting technologies from Germany, Japan and the US show slightly higher total output impacts on Indonesia. In other words, a 50% reduction of import tariffs of insulation and lighting technologies from Germany, Japan and the US (see Table 8) will increase the total output of Indonesia by approximately 224.81711 billion US dollars.

Contrarily, the findings show that the total output impacts of four simulation scenarios on fiscal policy instruments on energy efficiency sectors in Indonesia on other countries are larger than the total output impacts on Indonesia. Among three selected key partner countries of Indonesia, the total output impacts on the US under all simulation scenarios are most significant. For example, the reduction of value-added tariffs on insulation, EE used in heavy production process or industry and lighting generated total output impacts in the US of approximately 1,851 billion US dollars. This means that a 50% increase in domestic final demand of each insulation, EE used in heavy production process and lighting in Indonesia will increase the total output in the US by approximately 1,851 billion US dollars. The total output impacts on Germany for all four simulation scenarios were larger than the total output impacts on Japan. A 50% increase in domestic final demand of the three aforementioned energy efficiency sectors in Indonesia will increase the total output in Germany by approximately 1,447 billion US dollars. No differences in total output impacts on Germany among four simulation scenarios were identified. Although the findings indicate that the total output impacts on Japan were smaller than on the US and Germany, they were larger than on other developed countries (the Republic of Korea and the UK). In addition, the pattern of total output impacts on Japan for each simulation scenarios were different. The reduction in value-added tariffs on the aforementioned EE sectors in Indonesia had greater total output impacts on Japan compared to the other three policies. A 50% increase in domestic final demand of each of the above EE sectors in Indonesia will increase the total outputs on Japan by approximately 1,121 billion US dollars.

Surprisingly, the findings also show that the total output impacts on China were the most significant. A 50% increase in domestic final demand for each of the three aforementioned EE sectors in Indonesia will increase the total output on China by approximately 2,528 billion US dollars. The slightly smaller values can be seen under the three remaining simulation scenarios (SIM 2, 3 and 4).

The findings also reveal the significant values of total output impacts on the remaining countries such as the Republic of Korea, UK, India, the rest of the EU and the rest of the world (see Table 10). The findings of total impacts at the country level have two important implications. First, the supply of the three aforementioned EE technologies in the Indonesian market rely more on foreign supply than on domestic supply. The implementation of each of the four selected fiscal policy instruments will create total output impacts that are superior for other countries than the domestic market. Second, China and the US are the two largest foreign markets, with strong trade relationships with Indonesia. Germany and other European countries are also big players in the Indonesian market for the three EE sectors above. However, further analysis is necessary.

Table 10: Total Impacts on Indonesia and Other Countries
(billion US dollars)

Country	SIM 1	SIM 2	SIM 3	SIM 4
Germany	1,447.25	1,447.25	1,447.25	1,447.25
Japan	**1,121.02**	1,120.99	1,120.98	1,120.98
Republic of Korea	**795.17**	795.16	795.16	795.16
UK	738.28	738.28	738.28	738.28
US	1,850.72	1,850.71	1,850.71	1,850.71
PRC	**2,527.95**	2,527.93	2,527.93	2,527.93
Indonesia	**224.81710**	**224.81710**	**224.81710**	**224.81711**
India	412.92	412.92	412.92	412.92
Other EU	3,289.72	3,289.70	3,289.70	3,289.70
Rest of the world	3,718.57	3,718.54	3,718.54	3,718.53
Total	18,216.76	18,216.61	18,216.59	18,216.57

Source: Author's compilation.

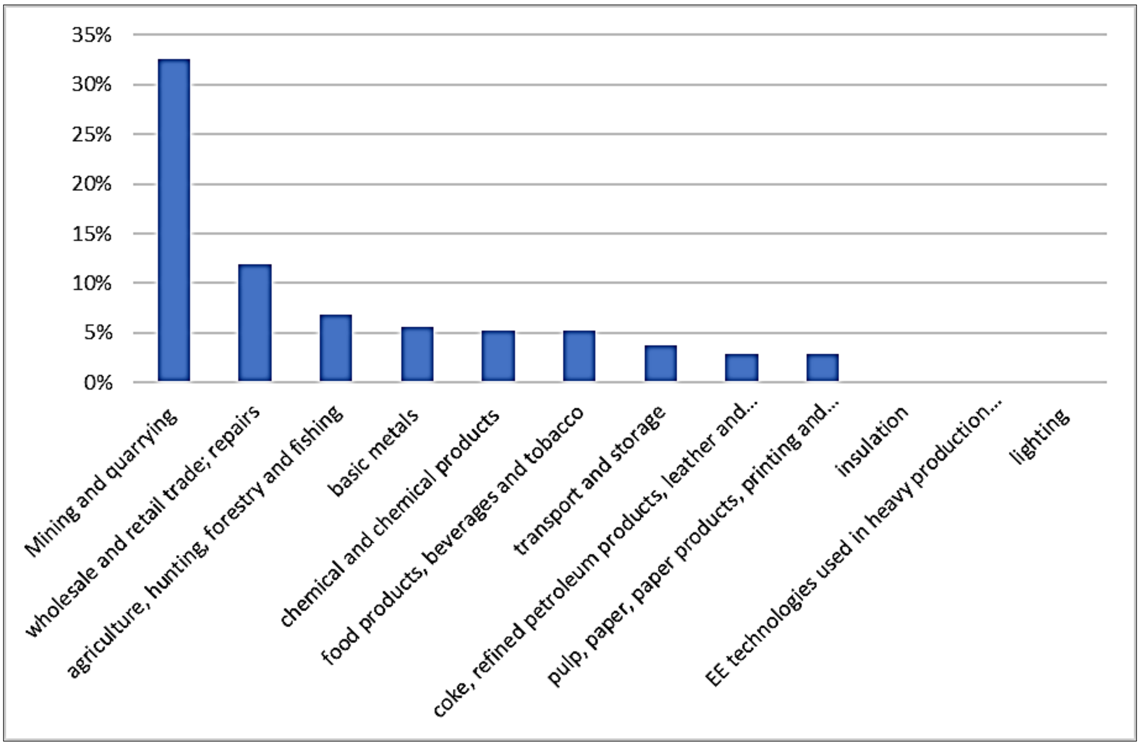
4.2 Direct and Indirect Impacts at the Sector Level

The total output impacts on both Indonesia and other selected key partner countries can be further deconstructed into two categories: (i) direct impacts on selected sectors that received a policy shock (change); and (ii) indirect impacts either the upstream or downstream sectors. This subsection presents the breakdown of total output impacts into either sector or industry classifications both in Indonesia and selected partner countries (Germany, Japan and the US). In addition, China is also selected due to its significant total output impacts.

4.2.1 Direct and Indirect Impacts at the Sectoral Level in Indonesia

The findings show that the total output impacts on Indonesia under four simulation scenarios are smaller than the total output impacts on other countries. In other words, the direct impact of total outputs of four fiscal policy instruments on the energy efficiency sectors in Indonesia are smaller than the indirect impacts (impacts on other countries). Although the direct impacts of fiscal instruments on energy efficiency sectors on Indonesia are smaller, it is necessary to further deconstruct the direct impacts of Indonesia at the sectoral level. The findings at the sectoral level show that the output impact on three selected EE sectors (insulation, EE technologies used in heavy production process or industry and lighting) are smaller than the output impacts on other sectors. This also mean that the direct impacts at the sectoral level in Indonesia are also smaller than the indirect impacts. The findings displayed in the figure below are based on the deconstruction of output impacts under simulation scenario number 4 (the reduction of the import tariffs on three selected EE sectors from Germany, Japan and the US). The main reason for using the deconstruction results of output impacts under simulation scenario 4 are because the output impacts at the country level under SIM 4 are found to be slightly higher compared to other results. This indicates that the reduction in import tariffs on the three aforementioned EE sectors would benefit Indonesia more significantly. The findings show that a 50% reduction in import tariffs on insulation, EE technologies used in the heavy production process and lighting from Germany, Japan and the US yield indirect impacts (output increase) in the following four sectors: (i) mining and quarrying; (ii) wholesale and retail trade and repair; (iii) agriculture, hunting, forestry and fishery; and (iv) basic metals. The detailed shares of each impacted sectors are presented in Figure 1.

Figure 1: Details of Total Output Impacts on Indonesia by Sector
(%)

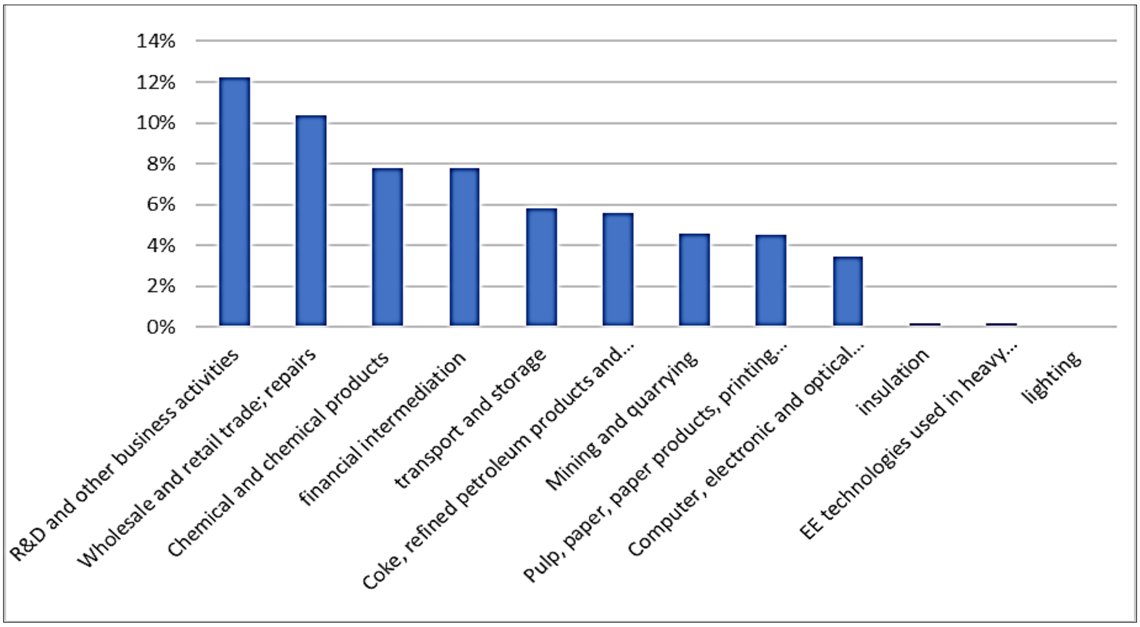


Source: Author’s compilation.

4.2.2 Direct and Indirect Impacts at the Sectoral Level in Three Selected Countries and China

The indirect impacts at the sectoral level are focused on three selected key partners’ countries and China, taking into consideration their indirect total output impacts (see Table 10). Figure 2 shows the output impacts on the US at the sectoral level. The findings of total output impacts show that the indirect total output impacts on the US are more significant than on Germany. At the sectoral level, the output impacts on three selected EE sectors are smaller than the indirect sectors. The findings of the output impacts at the sectoral level presented in Figure 2 are based on the findings of the reduction of value-added tariffs for three selected EE sectors (simulation scenario 1). The largest indirect outputs on the US can be seen in the following four sectors: (i) R&D and other business activities; (ii) wholesale and retail trade and repair; (iii) chemical and chemical products; and (iv) financial intermediation. This means that a 50% reduction in value-added tariffs on three selected EE sectors would increase R&D and other business activities in the US by approximately 226 billion US dollars. The degree of output increase in R&D and other business activities accounts for about 10% of total output impacts on the US (see Figure 2).

Figure 2: Details of Total Output Impacts on the USA by Sector
(%)

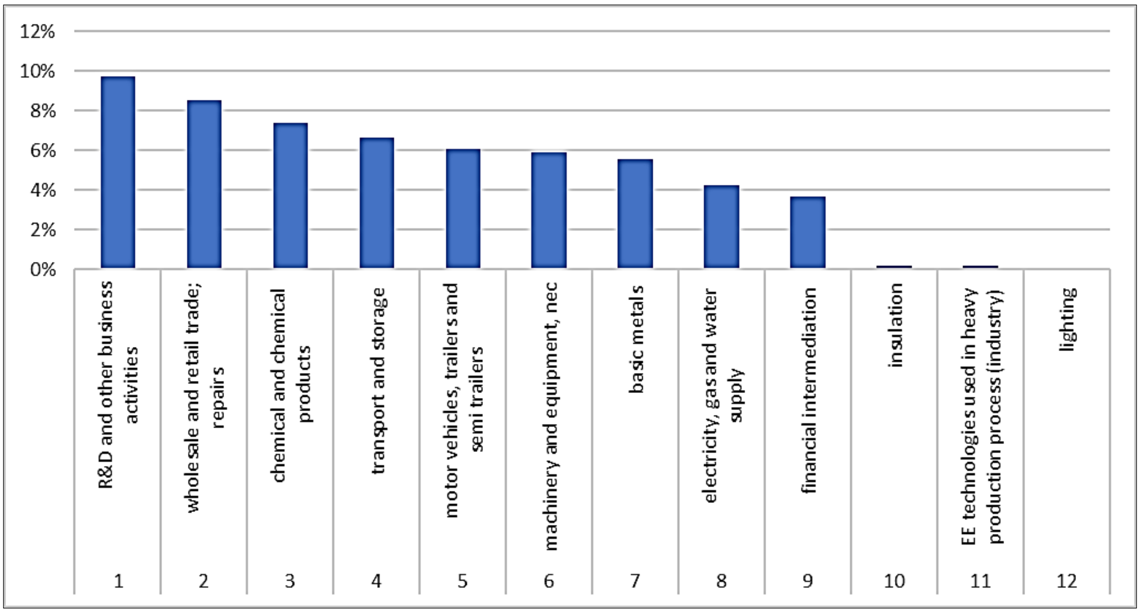


Source: Author's compilation.

The findings on output impacts under four simulation scenarios at the country level show that the output impacts on Germany are larger compared to Japan (see Table 10). The findings of output impacts on Germany at the sectoral level show a similar pattern with the US. The output impacts on other sectors (indirect impacts) are found to be larger than the output impacts on three selected EE sectors (direct impacts). The findings presented in Figure 3 are based on the deconstruction of output impacts on Germany by sector under 50% reduction of value-added tariffs of each of the three selected EE sectors (SIM 1). The findings show that a 50% reduction of value-added tariffs in each selected EE sector would bring the greatest output increase in R&D and other business activities. This pattern is similar to the output impacts on the US at the sectoral level (see Figure 2). However, the output impacts on the financial intermediation on Germany are not as great as the impacts of the sector in the US case. Surprisingly, the output impacts are also found on electricity, gas and water services in Germany (see Figure 3).

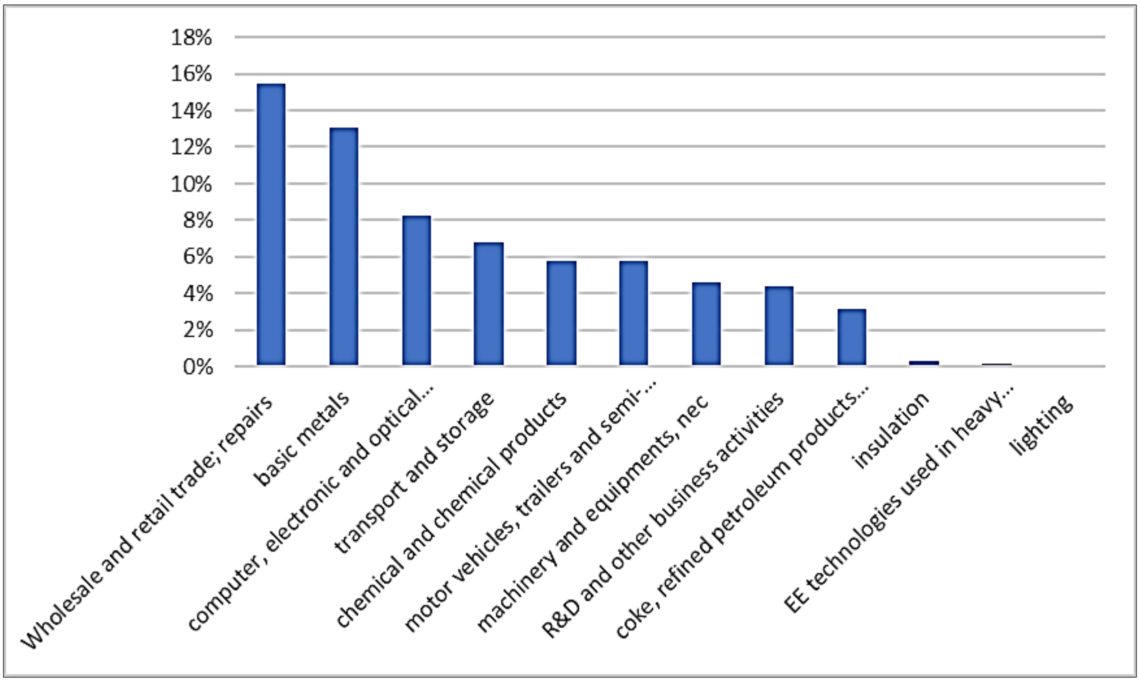
The indirect output impacts of four simulation scenarios on Japan are smaller than the total output impacts on the US and Germany (see Table 10). The findings of total output impacts on Japan by sectoral level also show patterns that are different from those of the US and Germany. The findings presented in Figure 4 are based on the deconstruction of output impacts by sector under 50% reduction of the value-added tariffs of each selected EE technology or sector (SIM 1). The largest share of output impacts on Japan at the sectoral level is found in wholesale and retail trade and repair (about 15%). Others are found in sectors of basic metals, computers, electronics and optical equipment, and transport and storage. In contrast, the output impacts on R&D and other business activities are smaller than the impacts of similar sectors in the US and Germany (see Figure 4).

Figure 3: Details of Total Output Impacts on Germany by Sector
(%)



Source: Author's compilation.

Figure 4: Details of Total Output Impacts on Japan by Sector
(%)



Source: Author's compilation.

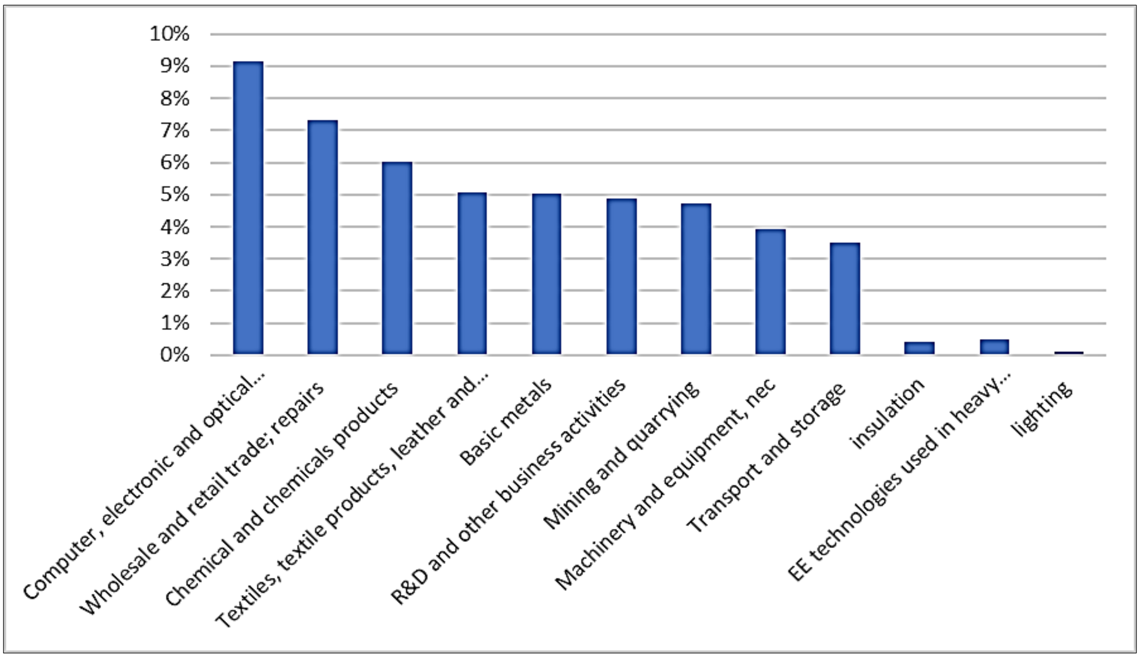
In addition to the findings of deconstruction of output impacts at the sectoral level on the three selected countries mentioned above, the findings of the deconstruction of output impacts on China are presented. This is because the total indirect output impacts of four simulation scenarios in China were the most significant of the countries (see Table 10).

Therefore, the deconstruction of output impacts on China at the sectoral level offers important insights and complements the findings of the selected countries.

The patterns of deconstruction of output impacts on China at the sectoral level show a similar pattern to the impacts on Japan (see Figure 4). The findings presented in Figure 4 are based on the deconstruction of output impacts under 50% reduction of value-added tariffs on three selected EE technologies (SIM 1). The largest output impacts on China at the sectoral level under 50% reduction of value-added tariffs on three selected EE technologies are found in the sector of computers, electronics and optical equipment, while others comprise the wholesale and retailed trade, chemical and chemical products and textiles and basic metals sectors. Congruent with the Japan case, the output impacts of 50% reduction of value added tariffs on R&D and other business activities in China are not the most significant (see Figure 5). This is clearly different from the US and German cases. It would be interesting to examine this issue further in future research.

Figure 5: Details of Total Output Impacts on China by Sector

(%)



Source: Author's compilation.

5. CONCLUSION AND POLICY RECOMMENDATIONS

This study selected three energy efficiency sectors: insulation, energy efficiency used in heavy production process and lighting. It aimed to assess the impacts of fiscal policy on energy efficiency sectors to green technology transfer. To conduct the analysis, four short-term fiscal policy instruments to promote the energy efficiency sectors in Indonesia were selected. These four short-term fiscal policy instruments were then translated into four simulation scenarios (reduction of value-added tax, provision of appliances rebate; reduction of income tax of energy service companies; and reduction of import tariffs of imported equipment of insulation, heavy production process and lighting from Germany, Japan and the US).

The findings of this study reveal that implementing fiscal policy instruments on the energy efficiency sector in Indonesia (also called green fiscal policy) would bring economic benefits (in terms of output increases) not only in Indonesia but also in three selected partners countries (Germany, Japan and the US), as well as in China and other countries. Interestingly, the indirect impacts at both the country and sectoral levels are larger than the direct impacts on Indonesia and the three selected EE sectors. Although the findings of output impacts under all simulation scenarios were found to be positive, the reduction in import tariffs on three selected EE sectors may bring more balanced output impacts on Indonesia (direct impact) and other countries (indirect impacts).

Considering this win-win solution, the implementation of a reduction in import tariffs on imported equipment could be the first priority of fiscal policy instruments for the Indonesian government. The reduction of value-added tax on the equipment of insulation, heavy production process and lighting could then become the second priority option of fiscal policy instruments for the energy efficiency sector in Indonesia. The findings show that the reduction of value-added tax on energy efficiency equipment would generate the most significant output impacts compared to other fiscal policy instruments.

Moreover, the findings also indicate that the implementation of fiscal policy instruments on three selected EE sectors (insulation, EE technologies used in heavy production process or industry and lighting) simultaneously may generate superior output impacts. However, this would be expensive for the Indonesian government. This may constitute a barrier to implementing the fiscal policy instrument. To overcome this barrier, the Indonesian government might prioritize the sector. The findings of providing subsidies to consumers to purchase insulation and lighting (SIM 2), as well as reducing import tariffs on these two sectors (SIM 4), may also represent options for the Indonesian government.

6. LIMITATIONS AND FUTURE WORK

This study has the following limitations. First, the disaggregation ratios used to construct the low-carbon technologies extended the 2011 OECD ICIO table for some countries, especially in terms of intermediate input transactions are based on a fixed ratio assumption. This may influence the technological coefficient of the model. Second, the simulation scenarios of the fiscal policy instruments in promoting the energy efficiency sectors in Indonesia were translated into the IO model using a very simplistic method. Indeed, the changes in final domestic demand are assumed by the values of the author, which may lead to inaccurate estimations. In the future, improvements to disaggregation ratios and applying econometric analysis may produce better and more robust estimation results.

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