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Promoting Economic Growth and Environmental Sustainability through Energy Efficiency: Evidence from Indonesia

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ABSTRACT

Indonesia has set a unilateral greenhouse gas emissions (GHG) reduction target by 29% and conditional targets with international support of up to 41%, compared to the business as usual by 2030. This paper aims to formulate energy conservation policies to increase productivity and promote economic growth in Indonesia. Indonesia's energy conservation policy has multiple aspects: supporting energy security, commitment to GHG emission reduction, state budget efficiency, and improving productivity and competitiveness. Using Social Accounting Matrix (SAM), this study found evidence that energy efficiency saving will positively affect ecological sustainability and economic agents in the five targeted sectors: energy, waste, industrial processes, and production use, agriculture, and forestry. Furthermore, the Corporate Social Responsibility (CSR) policy provides positive effects in increasing economic growth and reducing income disparities.

Keywords: Energy Conservation, Energy Efficiency, Economic Growth, Environmental Sustainability.
JEL Classifications: Q40, O40, Q56

1. BACKGROUND

As income level rises, there is a tendency to desire higher material comfort levels and higher demand for personal mobility, leading to greater demand for energy (Setyawan, 2020a). In this context, as a response to the greater need for energy, Indonesia's government has introduced several policy measures to improve energy efficiency-related issues (Setyawan, 2020b). One policy initiative has been to reformulate its National Energy Policy to enhance energy security and rebalance the energy mix towards indigenous energy supplies. Regarding energy security and diversification, one key focus is to reduce reliance on oil consumption by increasing gas consumption and production, escalating the usage of coal and new renewable energy sources (i.e. coal bed methane, nuclear, and oil shale).

Since 2010, Indonesia's government (GoI) has committed to reducing GHG emissions by 26% in 2020 and 41% with international support, against business as usual scenario. Indonesia has also issued policies to implement Rencana Aksi Nasional Penurunan Emisi GRK (RAN GRK) through Presidential Decree No.61 of 2011 and GHG Inventory Presidential Decree No.71 of 2011. Indonesia increases its target by 3%, and conditional marks with international support remain 41% against business as usual scenario by 2030, which can be seen in the Table 1.

Based on the target above, it can be seen that the sector with the most significant reduction target is the forestry sector, then the energy sector, the waste/waste sector, the agricultural sector, and the industrial sector. Larger emission reduction targets in the forestry sector do not require significant funding. The energy sector is the sector with the second-largest reduction target after the forestry sector, which causes the need for optimal and appropriate policies in reducing emissions.

Another approach is the energy savings target or energy conservation. The objective of energy conservation policy in

Table 1: BAU projections and GHG emissions reductions from each sector

Sector	GHG emission level 2030			Emission reduction	
	BAU	29%	41%	29%	41%
	Mton CO2e			Ton CO2e	
Energy	1.669	1.355	1.271	314	398
Waste	296	285	270	11	26
IPPU (industry)	70	67	66	3	3
Agriculture	120	110	116	9	4
Forestry	714	217	64	497	650
Total	2.868	2.034	1.787	834	1.081

Indonesia is to improve energy efficiency on the supply-demand side. The conservation energy target is to decrease energy intensity by 1% per year and decrease energy consumption by 17% lower than business as usual by 2025. The energy conservation policy has multiple benefits: supporting energy security, Indonesia's commitment to climate change, the government's budget efficiency, and improving productivity and competitiveness.

In recent years, energy efficiency often encourages as one way to increase economic development, ecological and society sustainability, and ensuring energy security as well (Bosseboeuf et al., 1997; Hu et al., 2019; Lee et al., 2019; Li et al., 2020; Liu et al., 2020; Soepardi and Thollander, 2018; Wang et al., 2019). The energy efficiency improvement, i.e. reducing energy consumption, will also improve industrial sustainability and competitiveness (Soepardi et al., 2018; Soepardi and Thollander, 2018; Worrell et al., 2001).

Moreover, Indonesia is one of the countries with a low energy efficiency score, compared to China, India, Iran, and Russia (Wang et al., 2019). However, Indonesia also witnessed an improvement in energy efficiency, but the growth was insignificant (Wang et al., 2019). Therefore, the GoI has issued regulation regarding Energy Conservation that required energy source users and energy users who use energy sources and energy more than or equal to 6000 (six thousand) TOE per year to carry out energy conservation through energy management. The government should provide a fiscal policy to support energy-saving or energy conservation activities, but it is necessary to understand these economic impacts.

However, studies of the relationship between energy conservation and economic growth show inconclusive results. Sener and Karakas (2019); (Rajbhandari & Zhang, 2017) study finds that "economic growth decreases energy intensity" experienced by high income and upper-middle income country groups countries but is not valid for the lower-middle-income country group. It means that energy efficiency will increase Indonesian economic growth as Indonesia is one of the upper-middle countries. Soares, Kim, & Heo (2014) revealed that a causal relationship between GDP and energy consumption does exist in the short run, but not in the long run. In Indonesia's case, Jafari, Othman, & Nor (2012) argue a weak correlation between economic growth and energy consumption. Further indicated that energy efficiency causes economic growth in the case of Malaysia and Canada, respectively. Therefore, it is essential to design appropriate energy conservation policies that can produce an optimal impact on the economy and the environment.

This paper seeks to determine the financial implications of energy-saving or energy conservation activities. This study aims to recommend an energy conservation policy that could positively impact environmental sustainability and economic growth in five targeted sectors: energy, waste, industrial processes, and production use, agriculture, and forestry. This study recommends that the GoI add a requirement that energy efficiency savings are returned to the sector in the form of additional capacity and the community in the condition of CSR. The rest of this paper is organized as follows. Section 2 presents the literature review. Section 3 describes the research methodology used to calculate the impact of energy efficiency policy in consumers with 6000 TOE consumption and more. Section 4 offers the economic impact of energy efficiency, and section 5 concludes the paper.

2. LITERATURE REVIEW

Business actors conducting energy efficiency activities have their respective considerations in determining the energy savings results. Gains in energy consumption efficiency will result in an effective reduction in the price per unit of energy services. As a result, consumption of energy services must increase (e.g. "rebound" or "take-back") to offset the impact of increased efficiency in fuel use (Greening et al., 2000).

Energy efficiency activities will reduce national energy consumption, and hence an effective policy to reduce national CO2 emissions. (Herring, 2006). Energy efficiency and conservation are considered the main ways to reduce greenhouse gas emissions and achieve other energy policy goals. Still, related market behavior and policy responses have generated debate in the economic literature (Gillingham et al., 2009).

GHG emissions have reached an alarming level, and the international energy system has to be transformed to limit global climate change (Bruckner et al., 2014). Many studies have assessed the relationships between energy policies, economic activities, and emissions reduction (see, e.g. Bloch et al., 2015; Chen et al., 2016; Narayan et al., 2016). There is a growing debate between environmentalists and economists about economic growth and sustainable development. In this debate, it is often viewed that "green growth" should become a standard of living to promote while GHG emissions decrease (e.g. Garret-Peltier, 2017; Pollin et al., 2014).

Both fiscal policies and "command and control" regulations have been used in the energy sector. Budgetary policies include tax incentives, direct government spending, loans, grants, guarantees, specific financing mechanisms, investments in research and development, and other forms of supports and incentives. At the same time, energy regulations include, *among other things,* energy efficiency and renewable energy. It is widely recognized that energy efficiency has become one of the primary ways to reduce GHG emissions (Shove, 2017). Governments in various countries have promoted energy as an essential part of their climate mitigation policy strategy.

Researchers have acknowledged energy efficiency prospects that could create instrumental contributions towards reducing GHG emissions. For example, the International Energy Agency (IEA), in its scenario to achieve the global Paris Agreement target, found that energy efficiency could contribute around 44% of the required GHG emissions reduction in 2040 (IEA, 2018). The Natural Resources Defense Council also found that energy efficiency could provide approximately two-third of its 80% emissions reduction target in the United States comparative to the 1990 level (Gowrishankar and Levin, 2017). Therefore, the IEA asserts that energy efficiency is the key to achieving a 'sustainable energy system in the future and is 'the least costly way of addressing energy security, environmental and economic challenges (See http://www.iea.org/topics/energyefficiency/).

Technologies and practices can be applied as energy efficiency opportunities to reduce the use of energy. Examples of energy efficiency programs include using LED lights, using smart electrical grids, using electric cars, designing ergonomic vehicles to reduce air resistance, biking, and walking rather than driving and reducing travel. These programs and activities provide extensive opportunities to save money on energy bills or other benefits. These opportunities need government policies to support better investments in the energy sector. Policy options to spur private investments include setting efficiency standards, labeling energy efficiency certification, providing incentives and preferences, charging fees, providing loans, education and training, and funding research and development (Nadel and Ungar, 2019).

Literature shows the benefits of energy efficiency strategies in social sciences, economics, and engineering. Gupta and Ivanova (2009) assert that energy efficiency is perceived as popular, non-controversial, and politically desirable as an energy policy strategy. Energy efficiency provides a wide range of benefits such as energy savings, environmental sustainability, industrial productivity, and energy security (Cole et al., 2018; Geller, 2003; Rosenow and Bayer, 2017; Boyd and Pang, 2000; Porter and Van der Linde, 1995; Worrell et al., 2003). Nowadays, many international organizations such as the IEA and the World Bank acknowledge that energy efficiency reduces energy demand growth and creates energy savings (OECD/IEA, 2014; World Bank, 2017).

However, there have been long debates about those perceived benefits, especially in economics. First, energy price reductions from energy efficiency will increase energy demand directly through price elasticity or indirectly through repurchase energy-intensive goods and services (Khazzoom, 1980; Khazzoom, 1987; Khazzoom, 1989; Brookes, 1978; Brookes, 1979; Brookes, 1990; Brookes, 2000). Secondly, a growing literature shows the reduction of expected energy savings through energy efficiency strategies, known as the 'rebound effect' (Turner, 2013). Third, energy efficiency policy is not an effective measure to mitigate climate change, as energy efficiency mechanisms do not guarantee fossil fuel reduction (Bruckner et al., 2014).

Moreover, the trade-off between energy efficiency and economic growth is still an issue for poor and developing countries that need high growth to alleviate poverty (Dercon, 2014). However, the conclusion is a positive relationship between energy efficiency and economic growth results from (Cantore, Cali, & Velde, 2015) (Bataille & Melton, 2017) (Go, Lau, & Yii, 2019) can strengthen the basis for the formulation of green growth policies in countries including Indonesia.

Comprehensive policies are needed to ensure the success of energy efficiency in driving inclusive economic growth, including reforming energy subsidies policy (Li & Solaymani, 2021) (Barkhordar, Fakouriyan, & Sheykhha, 2018) (Cockburn, Robichaud, & Tiberti, 2018), and the government's strong commitment to encourage innovation for GHG reduction (Raybould, Cheung, Connor, & Butcher, 2020). In addition to that, the government needs to design the policy to increase public awareness and engagement on energy efficiency (Schönwälder, 2021), which among others, can be done through the role of Corporate Social Responsibility (Pfau, Haigh, Sims, & Wigley, 2008), and the involvement of knowledge brokers as government agencies in the implementation of policies on energy efficiency especially in the rural regions (Apostolopoulos, Chalvatzis, Liargovas, Newberry, & Rokou, 2020)

3. METHODOLOGY

This study uses quantitative methodology by processing data on the Social Accounting Matrix (SAM) data. The data are collected from Statistics Indonesia (BPS), the Ministry of Finance, and the Ministry of Energy and Mineral Resources.

SAM is a data framework that can describe socioeconomic variables in a compact and integrated matrix. The SAM framework is compiled and presented to provide details on various classifications of production factors, economic actors (actors), and economic activities. SAM can provide an overview of a community's socioeconomic condition in a particular year, the process of income formation and distribution, and partially shows the economic conditions of classified households according to income and expenditure for each household class (BPS, 2005). As a comprehensive macroeconomic data framework, SAM is a powerful tool for studying energy issues (Liu et al., 2019).

The SAM publication provides information and a general description of Indonesia's socioeconomic performance, such as the Indonesian economy's performance, income distribution (factorial income distribution), household income distribution, and household expenditure pattern (household expenditure pattern).

The SAM framework in Figure 1 consists of three endogenous balance sheet blocks and one exogenous balance block. The endogenous balance sheet consists of the production factor balance block, the institutional balance block, and the production sector balance block consisting of the balance block and the capital investment block. Furthermore, an exogenous balance sheet is an overseas balance sheet or the rest of the world. All of these balance sheet blocks are arranged in a matrix consisting of rows and columns. Rows show receipts, and columns represent expenses. Each cell that is a cross between rows and columns illustrates the interaction between the balance sheet blocks.

This framework is then decomposed in the matrix as follows

$$S = [A0CV000YH]$$

Where: S = SAM coefficient matrix
A = technical coefficient matrix
V = value added coefficient matrix
Y = matrix value added distribution coefficient
C = Expenditure coefficient matrix
H = matrix distribution coefficient of institutions and households.

We can do a multiplier analysis in the SAM model, which consists of (i) an accounting multiplier that shows the effects of changes in a sector on other sectors of all linkages in the SAM, (ii) a transfer multiplier that shows the impacts of a balance sheet block on itself, (iii) open-loop multiplier or cross effect which shows the direct effects of one block to another, and (iv) closed-loop multiplier which shows the impacts of one block to another, then back to the original block.

Stone adds variations to the decomposition variable created by Pyatt and Round, where Stone's version is as follows (Holland and Wyeth, 1993):

$$(I-S)^{-1} = I + (M_1 - I) + (M_3 - I)M_1 + (M_2 - I)M_3M_1$$

The details of the multiplier number are as follows:
1. *Transfer multiplier*: $N_1 = M_1$
2. *Open-loop multiplier*: $N_2 = M_2M_3M_1 - M_3M_1$
3. *Closed-loop multiplier*: $N_3 = M_3M_1 - M_1$

Where the forms for matrices M1, M2, and M3 are as follows:

$$M_1 = [(I-A)^{(-1)}000I000(I-H)^{(-1)}]$$

$$M_2 = \begin{bmatrix} I(I-A)^{-1}C(I-H)^{-1}Y(I-A)^{-1}CV\,IV(I-A)^{-1} \\ C(I-H)^{-1}YV(I-H)^{-1}YI \end{bmatrix}$$

$$M_3 = \begin{bmatrix} [I-(I-A)^{-1}C(I-H)^{-1}YV]^{-1}000[I-V(I-A)^{-1}C \\ (I-H)^{-1}Y]^{-1}000[I-(I-H)^{-1}YV(I-A)^{-1}C]^{-1} \end{bmatrix}$$

The scenario uses several approaches as follows:
1. Scenario 1, the results of energy efficiency savings are returned to the sector in the form of additional capacity
2. Scenario 2, the result of energy efficiency savings is returned 50% to the sector in the form of additional capacity, and 50% is saved in the format of the company retained earnings
3. Scenario 3, the results of energy efficiency savings are returned 50% to the sector in additional capacity, and 50% returned to the community in corporate social responsibility.

Energy efficiency savings based on energy management report from Ministry of Energy and Mineral Resources. The company reporting their amount of energy saving, then this amount is monetized by multiplying it with the energy cost per kWh. This scenario is a policy choice for companies that have succeeded in energy efficiency.

3.1. Research Limitations

Data processing uses SAM data in 2005 because it is the latest official data released by BPS.

4. THE ECONOMIC IMPACT OF ENERGY EFFICIENCY

Data processing was carried out using the Indonesian Socio-Economic Balance System table, with several scenarios. The scenario used several approaches, namely based on the company's utilization policy of energy efficiency savings.

Based on the three scenarios aforementioned (see the methodology section), an analysis of utilization policies' effect is made from energy efficiency savings on the economy. The impact on the economy will have a different impact on each economic agent. In this study, several alternative policy scenarios for using energy efficiency savings are provided as consideration for decision-makers whether the energy efficiency program needs government supports. The following will explain the comparison of each policy scenario's impact on the economy to determine the best policy option.

4.1. Data Processing Results, Comparison of Several Policies

Various policy scenario applied for an economic agent makes a different impact for other economic agents. Data processing in this study analyzes some company policies on energy efficiency savings. The results of data processing of the scenario use of the energy efficiency savings are as follows.

Table 2 shows the results of data processing the impact for each scenario policy of using the energy efficiency savings for every economic agent. It shows that the entire policy positively impacts the economy and each agent of the economy. Furthermore, if we analyze the impact for each policy, the policy that has the most significant impact is the policy based on scenario 3, which is a policy where the results of energy efficiency savings are returned 50% to the sector in additional capacity, and 50% returned to the community in corporate social responsibility.

Further analysis data is the impacts on each economic agent. This analysis is required to find out the expected impact by the government from each of its policies. Scenario 1 energy efficiency savings are returned to the sector in the form of additional capacity,

Table 2: Results of impact data processing for each economic agent

Classification	Impact (%)		
	Scenario 1	Scenario 2	Scenario 3
Factor Production	0.15	0.09	0.15
Institution	0.14	0.15	0.17
Production Sector	0.11	0.07	0.13
Total	0.12	0.09	0.14

Source: Own calculation

and scenario 3 energy efficiency savings are returned 50% to the sector in additional capacity, and 50% returned to the community in corporate social responsibility, will give the most significant positive impact on production factor income. The result of the impact of scenarios 1 and 3 on production factor income is 0.15% for both.

The most significant impact for institutional income came from scenario 3, energy efficiency savings are returned 50% to the sector in additional capacity, and 50% returned to the community in corporate social responsibility. Scenario 3 has the most significant positive impact on increasing income distribution from both production and institutions.

Another economic agent, namely the production sector, will receive the most significant positive impact in increasing total output with scenario 3, energy efficiency savings are returned 50% to the sector in additional capacity, and 50% returned to the community in corporate social responsibility.

Furthermore, we can elaborate the impact of each scenario on every economic agents' criteria, as we can see in the following Table 3:

Based on the results of advanced data processing in Table 3 the impact on each economic agents' criteria, it can be seen that economic agents will experience the most significant positive effects if we apply scenario 3 energy efficiency savings are returned 50% to the sector in additional capacity, and 50% returned to the community in corporate social responsibility. This scenario has the most significant impact on almost all economic agents, namely, factor production of labor, household institutions, the business sector, the production sector, trade margins, transportation margins, and domestic and imported commodities.

Scenario 2 energy efficiency savings is returned 50% to the sector in the form of additional capacity, and 50% is saved in the format of the company retained earnings, which has the most significant positive impact on corporate and government institutions in the forms of tax payments. Scenario 1 has the most significant positive effect on factor production non-agriculture and unskilled labor, non-labor, and production sector.

This study argues that the policy with the most positive impact on the income households is scenario 3 energy efficiency savings are returned 50% to the sector in additional capacity, and 50% returned to the community in corporate social responsibility. While the policy that increases the most on income for corporate and government institutions is scenario 2, the result of energy efficiency savings is returned 50% to the sector in the form of additional capacity, and 50% is saved in the format of the company retained earnings.

Policy scenarios that can increase total output are scenario 3 energy efficiency savings are returned 50% to the sector in additional capacity, and 50% returned to the community in corporate social responsibility. All criteria included in the business sector's economic agents, namely the production sector, trade

Figure 1: SAM framework

			Expenditures				
			Endogenous accounts			Exogenous Account	Total
			Production factors	Institutions	Production activities		
Receipts	Exogenous account	Production factors	0	0	T_{13}	Z_1	y_1
		Institutions	T_{21}	T_{21}	0	Z_2	Y_2
		Production activities	0	T_{32}	T_{33}	Z_3	y_3
	Exogenous account		T_{41}	T_{42}	T_{43}	Z_4	z
	Total		y'_1	y'_2	y'_3	y'_4	

Source: BPS (2010)

Table 3: Impact for each economic agent criteria

Classification			Impact %		
			Scenario 1	Scenario 2	Scenario 3
Factor Production	Labor	Agriculture	0.13	0.09	0.18
		Non-agriculture unskilled	0.11	0.07	0.11
		Clerical and services	0.12	0.08	0.14
		Professional workers	0.13	0.10	0.15
	Non-labor		0.19	0.11	0.15
Institution	Household	Agriculture	0.13	0.09	0.22
		Non-Agriculture	0.13	0.09	0.20
	Company		0.18	0.25	0.1
	Government		0.12	0.16	0.11
Sector	Sector		0.14	0.08	0.14
	Trade Margins		0.10	0.06	0.13
	Transport Margins		0.09	0.06	0.11
	Domestic Commodity		0.09	0.06	0.12
	Import Commodity		0.11	0.07	0.12

Source: Own calculation

Table 4: The impact of the policy option in utilizing energy efficiency savings

Policy target	Scenario		
	1	2	3
Production Factors: Labor			√
Production Factors: Capital	√		
Institutions: Household			√
Institutions: Company		√	
Institutions: Government		√	
Production Activities			√

Source: Own calculation

margins, transport margins, domestic commodities, and imported commodities, will increase their total output if the policy is implemented under scenario 3.

In summary, three scenarios carried out in the data processing stage present the government's expected policy design to be carried out by companies in utilizing their energy efficiency savings. This study found that the best scenario is scenario 3 in increasing economic growth, expanding the business sector's total output, the added value of labor production factors, and household income. That policy scenario is 3 energy efficiency savings are returned 50% to the sector in additional capacity, and 50% returned to the community in corporate social responsibility.

On the other hand, if the government expects to increase its income and company revenues, the suggested scenario is scenario 2. In this scenario, energy efficiency savings are returned 50% to the sector in the form of additional capacity, and 50% is saved in the format of the company retained earnings. Suppose the government requires the company's capital to increase; in that case, the scenario selected is scenario one, where the results of energy efficiency savings are returned to the sector in the form of additional capacity.

The positive impact on the Indonesian economic agents based on policy options in utilizing energy efficiency savings can be seen in Table 4.

4. CONCLUSION

This study recommends an energy efficiency policy that could positively impact environmental sustainability and economic growth. This paper employs a SAM multiplier model to formulate energy efficiency policies to increase productivity and promote Indonesia's economic growth. This method can overview the impact of energy efficiency policy for the consumer with 6000 TOE consumption and more. From that result, this study can estimate the effect on environmental sustainability and economic growth.

Based on data processing results, it is found that energy efficiency activities positively impact, regardless of company policies taken to utilize these savings products. However, suppose the government expects the energy efficiency policy to impact environmental sustainability and economic agents positively. In that case, the government should add a requirement for energy efficiency savings utilization by returned the savings 50% to the industry in the form of additional capacity and 50% returned to the community in the form of Corporate Social Responsibility. Furthermore, the government should also follow Indonesia's development goals, namely economic growth and reducing income disparities, and the incentive for energy efficiency activities. This research helps policymakers to formulate energy efficiency policies to increase productivity and promote economic growth. At the same time, it also can sustain environmental preservation.

However, the limitation of this study is because it uses the 2005 SAM data. This data may not reflect the current condition. However, it is the latest official data released by BPS Indonesia. Furthermore, another issue is the Indonesian SAM's reliability and validity since there are many underground economies in Indonesia. Therefore whether or not the Indonesian SAM covers the whole of the Indonesian economy, including those in rural areas and informal sectors (Hartono and Resosudarmo, 2008; Setiawan et al., 2020). However, BPS attempts to overcome this issue by a possible survey on the informal sectors and rural economies in the socio-economics survey, one of the primary input sources for the SAM data.

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