

Penetration Impact Policy Against Reduction of Coal Power Plant CO₂ Emissions in Development Acceleration Program in Indonesia

¹Muhammad Nawir, ²Henny Pramoedyo, ³Bagyo Yanuwiadi and ¹Syarifuddin Nojeng

¹Department of Electrical Engineering, Faculty of Engineering, Indonesian Muslim University, Makassar, Indonesia

²Department of Statistics, Faculty of Mathematics and Natural Sciences,

³Department of Biology, Faculty of Mathematics and Natural Sciences, Brawijaya University, Malang, Indonesia

Abstract: In the last decades, the contribution of thermal power plants to CO₂ emissions is a crucial issue, especially those fueled by coal. This is the reason commitments to CO₂ gas reduction are consistently being pursued through the implementation of methods and technologies to improve thermal power plant efficiency. Various research has been conducted with regard to controlling CO₂ emissions and related recommendations to curb the utilization of coal as fuel in power generation include, strengthening the supervision and regulation of air pollution with the clean air act program and the implementation of penalty against the companies this is in the form of a tariff based on the excess emissions produced.

Key words: Power plant, coal, CO₂ emissions reduction, power purchase rates, companies, utilization

INTRODUCTION

In a bid to support economic growth, the Government of Indonesia is to accelerate infrastructural development in various fields including the electric energy sector. The development of the electrical interconnection system is necessary for the anticipation of the needs increasing yearly. This amounted to 199 TWh in 2014 and is predicted to rise to 358 TWh by 2021, growing an average of 8.65% per year while the non-coincident peak load in 2020 will be 61,750 MW or grow an average of 8.5% per year. Furthermore, the number of customers in 2014 amounting to 57.4 million will increase to 70.6 million in 2021 or a rise of an average of 2.5 million per year. These additional customers will hike the electrification ratio of 84.35% in 2014-92.3% in 2021 (NEC, 2014). The reduction of CO₂ emissions at power plants is conducted primarily through the development of technologies and methods of increasing efficiency. Among these are the application of the co-generation hybrid system and the improvement of fuel quality through the use of technology on coal (Shaoyuan *et al.*, 2009). Some countries, especially developed countries such as America and Europe, have implemented a quality standard distribution of electrical energy under the Kyoto Protocol (1997) which has been ratified by almost every country in the world. This has become the benchmark for emissions reduction of greenhouse gas producers (GHS). One article of the Kyoto Protocol set the “carbon market”

which compensates plant operators in determining the price of electrical energy. Carbon trading mechanisms are reinforced by the EU Emission Trading Scheme (EU-ETS) which imposes the monitoring and supervision of the perpetrators of the electricity industry. The European Union (EU) countries had a commitment to reduce CO₂ emissions from 5.2% in 1990-8% in the period 2008-2012. Yamashita *et al.* (2011) reported that Indonesia as a consequence of adopting the Kyoto Protocol, targeted gradual reduction by 5, 10, 20 and 30% in the period between 2012-2035.

Penetration coal plants: Thermal power plants (especially coal-based) contribute largely to CO₂ emissions which is detrimental to the environment at large. As a result, various methods and technologies are continuously applied to improve the efficiency of these plants. In view of the development program of a 35,000 MW coal power plant in Indonesia, the use of coal to generate power significantly increases the emission of CO₂. Depending on the load, the quality of customer utilization of electric power will be able to increase losses.

Increased global demand for cheap electricity and public concern about environmental issues leads to greater efficiency and operating flexibility of coal power plants. Because the boiler or steam generator is an important part of each one, research efforts in engineering therefore aim to improve the economic benefits of thermal efficiency for

Table 1: Composition of electrical energy production in indonesia by fuel type year 2011-2020 (GWh)

No.	Fuel type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	HSD	29.846	17.346	8.658	4.331	2.549	2.465	2.316	2.261	2.428	2.635
2	MFO	10.037	4.807	2.385	556.44	56	51	65	85	65	
3	Gas	32.017	42.691	46.158	46.002	43.441	43.118	35.657	25.992	28.331	30.879
4	LNG	-	7.578	6.113	10.970	14.817	15.068	20.874	29.394	30.088	31.541
5	Coal	93.049	110.043	134.578	151.524	163.311	178.749	193.084	207.868	221.392	238.432
6	Hydro	11.149	11.204	12.363	12.791	13.841	16.292	17.704	19.349	20.429	21.429
7	Solar/hybrid	2	4	4	5	6	6	6	7	7	
8	Biomass	63	63	63	63	63	63	63	63	63	
9	Import	-	-	-	709	721	733	737	738	314	317
10	Geothermal	9033	8.650	9.828	11.939	19.814	23.078	29.405	36.302	42.828	46.005
Total		185.197	202.387	220.150	238.891	258.606	279.628	299.897	322.038	348.964	371.374

RUPTL PT. PLN (Persero) 2011-2020

more than 250 years with the main goal to achieve higher efficiency by increasing steam pressure and temperature. According to the Geological Agency Ministry of Energy and Mineral Resources in 2010, Indonesia's coal resources are 104.8 billion tons spread mainly in Kalimantan (51.9 billion tons) and Sumatra (52.5 billion tons) but only 21.1 billion tons in coal reserves. Approximately 22% of Indonesian coal is of low quality (low rank) with a heat content of <5,100 kcal kg⁻¹ while 66% is of medium quality (between 5,100 and 6,100 kcal kg⁻¹) and only about 12% is of high quality (6,100-7,100 kcal kg⁻¹). Although, Indonesia's coal reserves are not too big, the level of coal production is very high, reaching 320 million tons in 2010. Most of the coal production is exported to China, India, Japan, South Korea and Taiwan (265 million tons) and also from various countries but only a fraction is used for domestic purposes (60 million tons). It is expected that production in the coming years will rise in line with increasing domestic demand and more interestingly the international coal market. Assuming the rate of annual production is 400 million tons, the entire Indonesian coal reserves of 21.1 billion tons will be exhausted in 50 years if new exploits are not carried out. To ensure the supply of domestic demand continues to increase, the government has issued a policy called the Domestic Market Obligation (DMO) which requires coal producers to sell part of their production to domestic users (Table 1).

Reducing emissions at coal plants in several countries:

In order to reduce the level of environmental pollution, a few steps are to be taken, one of which is the control of CO₂ emissions through increased energy efficiency. A study on the impact of environmental regulations on coal power plants in China which contribute almost 40% and 60% of CO₂ and SO₂ emissions respectively, showed Command Control Regulation (CCR) and market-based regulation significantly reduce CO₂ emissions. Also, subsidies (GS) positively impact electrical efficiency and emissions reduction in general (Zhao *et al.*, 2015). The

economic implications in China show that the emissions reduction policy in coal plants is conducted step by step in tandem with research development involving the industry. Forcing coal power plant energy diversification and long-term coal should gradually change the dependency by substituting it with renewable energy such as water, wind, etc. Furthermore, a large energy tax on high pollution and subsidy policies supports the price of clean energy (Liu *et al.*, 2017).

A survey of the national economy of China which aimed to reduce CO₂ emissions by 52% in 2004 and 70% in 2008, indicated that the coal power plant consumption ratio significantly affects the efficiency of the environment (Du and Mao, 2015). Additionally, the analysis of health risks from coal burning in China showed that the emissions produced from extracts of NDMA (dimethylnitrosamine) and NDEA (diethylnitrosamine) influence the concentration in the atmosphere and wind direction under certain conditions may destabilize environmental health.

Various research has been conducted with regard to controlling the emissions as current power plants became a major source due to excessive dependence on coal. Industrial electricity generation accounted for 44% of global CO₂ emissions based on data from the International Energy Agency (IEA) in 2015, a huge increase compared to data from ASEAN outlook 2007 which was in the range of 27-28%. Efforts to reduce these emissions include optimizing excess air and controlling the furnace. The efficiency of electrical energy generating equipment can reduce the overall additional power by approximately 1.5-2.1% or about 3.5 MW for a 210 MW power plant spread in India.

In Indonesia, several scientific studies have been carried out in various parts regarding carbon dioxide emissions resulting from coal-fired power generation. Some conclusions associated with these include: the utilization of coal as a fuel for power plants has externalities that affect people's lives and the sustainability of the surrounding environment. This makes

the command and control or regulatory approach necessary to control emissions using electric precipitators and flue gas desulfurization. In addition, the application of low-carbon technologies, energy efficiency as well as Carbon Capture and Storage is conducted in the hope that coal power plants overcome the crisis by maintaining their functions thereby sustaining the environment.

Alternative efforts to reduce carbon emissions can be undertaken by lowering the magnitude of the emission source activities or with the application of more efficient and environmentally friendly technologies. The main factors affecting these emissions are the need for energy and fuel, efficiency of thermal power plants, energy growth, price of electric energy and fuel, climate and the amount of electrical energy derived from non-thermal power plants. Other factors include an increase in economic activity and consumer convenience, all of which will raise the demand for energy needs. In general, the carbon intensity is strongly influenced by the intensity of the end-users of energy, fuels and the emission of electrical energy produced. The plunger is influenced by population growth and the demand for modern equipment such as vehicles, etc. In the determination of emissions reduction policies, the existing factors must be considered and directed to:

- More efficient energy use
- The use of fuel with lower carbon content
- Increased use of renewable energy or low-emission energy conversion technologies
- Reduction activities such as subduing the number of potential activities that produce carbon dioxide emissions

An increase in the surface temperature of the earth would cause climate change which would have a major impact on the survival of human beings. This is caused by the use of coal as a fuel resource for industrial activities as well as producing electricity. In calculating the amount of CO₂ emissions per electric energy generation, data emissions of the power plant are very important as the value in kilograms is easily determined by multiplying the emission factor by fuel energy used and the rate of fuel. This data is difficult to obtain although there may be average data for a few plants. Some developed countries such as Japan, Germany, the United States and China have been conducting research in the separation of CO₂ from flue gases by the separation of SO₂ and nitrogen oxide (NO_x) which use an absorbent chemical mixture of amino. This requires considerable energy and cost because design tools need to be integrated with a system

known as Carbon Capture and Storage (CCS) technology development and the Integrated Gasification Combined Cycle (IGCC). Moreover, in Indonesia, there was the development of a 1200 MW power plant in North Jakarta, 531 MW in Priok, 2280 MW in East Java and 452 MW in Central Java.

PROPOSED EMISSION REDUCTION POLICIES IN INDONESIA

Several recommendations related to the utilization of coal as fuel in power generation include: improve supervision and regulation of air pollution with the Clean Air Act program in real time. The Ministry of Environment needs to manage the environmental impact assessment by considering aspects bordering on health and the environment each plant must carry out epidemiological surveys on the health effects and environmental pollution near the power plant and then publish the results as a transparent and sustainable measure to reduce environmental damage applying a charge as a penalty for pollutants and sanctions to electricity producers that are responsible for excess emissions of air pollutants, in order to discourage them from breaking the law conversely, in order to encourage efforts to reduce emissions, the government may set electricity purchase rates for coal plants (IPP) taking into account the CO₂ emissions produced the government needs to introduce a management system that makes emission sources accessible to the public based on research and monitoring data. Included requirements should be regular checkups with pollution control devices on power plants and strengthening the monitoring and punishment of plants with excess pollutant emissions.

CONCLUSION

Monitoring air pollutant emissions should be improved by more stringent measures such as imposing heavy fines on the power plant concerned, increasing supervision and regulation with the clean air act program and implementing penalties against owners in the form of tariffs based on the quantity of the resulting emissions. These efforts, if effectively put in place will encourage a sustainable reduction in CO₂ emissions.

ACKNOWLEDGEMENT

The researcher is grateful to the Rector of UMI and Brawijaya University Graduate Leadership for supporting

this research as well as the leadership of the PT. Bosowa energy that has given access to data for this study.

REFERENCES

- Du, L. and J. Mao, 2015. Estimating the environmental efficiency and marginal CO₂ abatement cost of coal-fired power plants in China. *Energy Policy*, 85: 347-356.
- Liu, Y., X. Hu and K. Feng, 2017. Economic and environmental implications of raising China's emission standard for thermal power plants: An environmentally extended CGE analysis. *Resour. Conserv. Recycl.*, 121: 64-72.
- NEC., 2014. The national energy security. National Energy Council, South Jakarta, Indonesia.
- Shaoyuan, L., H. Yang, Y. Dai and L. Han, 2009. A model for CO₂ emission tax and the government control in electric power supply chain. *Proceedings of the International Transmission & Distribution Conference & Exposition on Asia and Pacific*, October 26-30, 2009, IEEE, Seoul, South Korea, ISBN:978-1-4244-5230-9, pp: 1-4.
- Yamashita, D., T. Niimura, R. Yokoyama and Y. Nakanishi, 2011. Thermal unit scheduling for CO₂ reduction including significant wind power penetration. *Proceedings of the 2011 IEEE Power and Energy Society General Meeting*, July 24-28, 2011, IEEE, Detroit, Michigan, USA., ISBN:978-1-4577-1000-1, pp: 1-5.
- Zhao, X., H. Yin and Y. Zhao, 2015. Impact of environmental regulations on the efficiency and CO₂ emissions of power plants in China. *Appl. Energy*, 149: 238-247.