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Reducing greenhouse gases through green industry: Indonesia's commitment with WHRPG technology in the cement industry sector

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ABSTRACT
Background: Infrastructure development is a one aspect of measuring the progress of a country. Unfortunately, the process of making cement as one of the main raw materials requires a lot of energy and pr produces exhaust gases which can increase the potential for greenhouse gases. In line with the government's desire to, independently reduce around 29% CO2-equivalent. So with this, the industrial sector is committed to reducing GHG from three emission sources, namely energy, industrial processes and product use as well as industrial waste management. With the Waste Heat Recovery Power Generation (WHRPG) technology, production costs can save IDR 120 billion per year. Where this breakthrough utilizes residual exhaust gas from cement production to save energy use in cement production. It also has the potential to reduce GHG from the remaining production gas. The cement industry generally requires an efficient amount of energy in production, around 50% of production costs come from energy purchases. The objectives of this research are to study the effective and more efficient energy for cement production with WHRPG. **Methods:** The study method in writing is a literature review. **Findings:** With Waste Heat Recovery Power Generation (WHRPG) technology, IDR 120 billion per year can save production costs. Where this breakthrough utilizes the remaining exhaust gas from cement production to save energy use in cement production. It also has the potential to reduce GHG from the remaining production gas. **Conclusion:** Increased costs in energy use and contributors to global warming emissions are the basic foundations in developing energy systems to improve efficiency and reduce emissions. With that, the use of WHRPG is an alternative solution by striving for operational efficiency and reducing exhaust emissions so that it is more environmentally friendly. Where WHRPG utilizes the exhaust gas of cement production.

KEYWORDS: cement; green industry; WHRPG

1. Introduction

Provide Related to climate change action, they Indonesian government is a also committed to becoming one of the countries that contribute to reducing Greenhouse Gases (GHG) in 2030 by 834 million tons or 29% CO2- equivalent independently, and if it gets international assistance, the government is committed to reducing it by 41% or equivalent to 1.08 billion tons of CO2 equivalent. So hereby the industrial sector is committed to reducing GHG in three emission sources, namely energy, industrial processes, and product use, and industrial waste management. this commitment is in line with the Paris agreement,

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the Indonesian government is therefore increasingly aggressive in carrying out sustainable development by environmental values. One of them is in the industrial sector as one of the main contributors to greenhouse gases, the Industrial sector continues to grow to contribute to solving existing problems, one of which is the Green Industry (Wahidah et al., 2023). In simple terms, green industry cthe an be interpreted as a development and production activity of an industry that does not have an impact on the sustainability of environmental life and does not harm human health (UNIDO, 2011).

As one of the driving sectors of the economy, the industrial sector is a forum where industrial activities occur that develop in line with needs. The existence of industrial estates cannot be separated from a industrial activities that utilize resources and energy as raw materials as well as the waste and pollution they produce [Oláh et al., 2020]. With the increasing scale of the existing industry, the resources needed also increase. Waste and pollution generated by the industrial sector have also increased. It is fris situation that will cause environmental damage and change globally (Sa'adawisna & Putra, 2022). The concept of Green Industry answers human needs to face problems that occur in the environmental and economic fields. In 1989 in Canada this concept was first introduced, and in 1990,12 industrial estates in Canada were able to create sustainable socioeconomic conditions by applying the concept of Green Industry (Li and Yang, 2016).

2. Methods

The study method in writing is a literature review. A literature review was conducted to obtain references and improve understanding. The study will be related to regulations, as well as the application of existing regulations. The types of literature sources studied include national and international journals, textbooks, theses, dissertations, final project reports, and books.

3. Result and Discussion

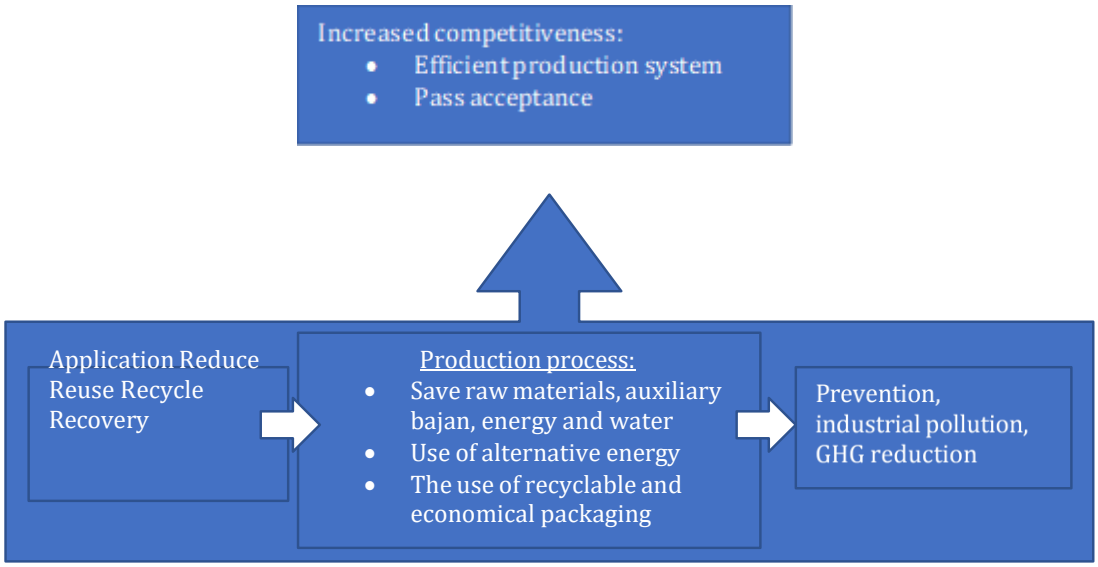

Fig 1. Relationship between green industry and product competitiveness (ministry of industry)

Through this illustration, we can see that implementing a green industry that uses the best practices and technology, it will increase product competitiveness. UseUsingst practices and technology, will increase product competitiveness. The application of best practices is carried out with the principle of reduce, reuse, recycle, recand overy (4R), so that it will be able to increase the efficiency of both raw materials and resources (Cao et al, 2020). Coupled with the use of recyclable and more economical packaging, it will prevent

and reduce pollution in the industrial sector and will ultimately reduce greenhouse gas emissions and participate in maintaining environmental sustainability (Putra et al., 2021). The has standards by which the industry in the use of raw materials, auxiliary materials, energy, production processes, products, business management, waste management and other aspects is standardized, and compiled consesus by all parties related aconsensusto realize a green industry (UU No 3 Tahun 2014 Tentang Perindustrian). The Green Industry Program has been around since 2010, but has not significantly reduced greenhouse gas concentrations. This is because there are various inhibitors such as:

For industries that do not implement green industry programs, or limit the domestic machinery industry, the legal substance is still voluntary, there is no sanctions, there are still much neglect in industries that have not implemented. Green industry programs (Taba et al, 2020), Recommendations include the need to move towards mandates, create incentive,s and raise environmental awareness(Naqi and Jang, 2019) among producers and consumers (Aminah and Yusriadi, 2018). In the Industrial Processes and Product Use (IPPU) sector, the mineral industry emits the most emissions, mostly resulting from cement production. In response to this, the government seeks to implement regulations, cooperation and assessment through various mechanisms including PROPER (Putradewi and Rizal 2021). PROPER is a Public Disclosure Program for Environmental Compliance. PROPER is not a substitute for existing conventional compliance instruments, such as civil and criminal environmental law enforcement. This program is complementary and synergizes with other compliance instruments (Sa'adawisna & Putra, 2023).

In the field of Civil Construction, cement is used as a material for making concrete and mortar. Cement becomes a hydraulic adhesive for building materials, meaning it becomes an adhesive when mixed with water (Puppy and Sandra, 2015). The development of cement technology has triggered the growth of the cement industry in the world with the emergence of cement factories. But unfortunately,, this growth affects the existing environmental conditions (Nurbaiti et al, 2021). Referring to the Indonesian Cement pollution program there are several pollution prevention and monitoring effortbyth environmental regulations through (Martadiastuti, 2022):

a. Installation of pollution prevention facilities
b. Penanaman Green Belt & Green Barrier
c. B3 & 3R waste management
d. Non-B3 & 3R waste management
e. RKL & RPL compliant Environmental Monitoring
f. Post Mining Reclamation

And also to participate in the reduction of greenhouse gas emissions to minimize the effects of global warming, through:

a. Innovating environmentally friendly cement products using AFR
b. Utilization of biomass as an alternative fuel to replace fossil fuels (coal)
c. Utilization of exhaust hot gas as a power plant: Waste Heat Recovery for Power Genetor (WHRPG)
d. Implementasi Clean Development Mechanism(CDM) project

Table 1. Semen Indonesia Group energy quantity data table per year

Semen Indonesia Group	Energy Quantity(GJ)		
	2018	2017	2016
Bussiness Unit Tuban	47.465.089	47.350.297	44.944.046
PT Semen Padang	23.367.971	25.461.256	21.632.917
PT Semen Tonasa	21.781.468	23.211.556	22.679.325
Thang Long Cement	8.065.502	7.745.362	7.617.158
PT Semen Gresik	6.154.405	3.157.381	N/A
Total	109.834.435	106.880.852	96.873.446

(Source: PT Semen Indonesia, 2018)

3.1 AFR (Alternative Fuel and Raw Material)

One of the efforts that can be made to create environmentally friendly cement is the AFR (Alternative Fuel and Raw Material) method. In addition to supporting SDG point number 11, using AFR innovations also supports SDG number 7 to get clean energy. Whereas AFR itself is the use of energy with alternative materials such as distance, biomass from animal waste, used oil, and even used cloth. Palm oil is a substitute for the use of coal stone from power plants. (Nugrahdi et al, 2021). The use of AFR in cement production will reduce gas emissions in suppressing global warming. From an economic point of view, the use of AFR (Lestianingrum et al, 20222) can reduce basic costs by reducing energy use costs and social value by utilizing renewable resources from where the factory is located Ningrum et al., 2023). A major challenge in biomass supply chain management is the collection of biomass on farmland. Many problems arise due to its low biomass composition and specific gravity, as well as improper tillage for the subsequent seeding of crops (Tzelepi et al, 2020).

3.2 Waste Heat Recovery for Power Generators (WHRPG) is an Innovation for Cement

The cement manufacturing process requires a very high temperature to be processed, one of which is when the raw meal preparation of the initial material combustion with a temperature of up to 900 degrees Celsius in the calciner. And the process that requires the most energy is Clinker Production which will be burned inside the rotary clin (Wirawan and Sinaga, 2021) until it reaches a temperature of 1,500 degrees Celsius. Referring to the use of energy needed is very large, the rest of the product is in the form of gas and hot air that is no longer needed, which is often referred to as exhaust gas (Yansuri, 2018). Where the exhaust gas will be reused for the production process. By the principle of work:

a. The raw water tank gets water supply from the collecting tank which is pumped into the sand filter to be filtered and then goes to the raw water tank.
b. Raw water will enter into the demineralization process. To reduce the content of minerals, calcium, magnesium, oxygen, and conductivity to meet water standards for boilers. Water will be stored in a denim tank which will be used as filler water for the vacuum condenser. (Xie et al,2022)
c. In the vacuum condenser, the condensate pump will pump denim water with condensate that has been circulating to the flasher. And it will be pumped again by the Boiler feed pump (BFP) to the economizer so that the temperature increases from 55-200 degrees Celsius and then enters the steam drum. Furthermore, the water will be circulated with a Boiler Circulating Pump (BCP) through a bank generator that can be passed by hot gas from the Clin. Which caused the water just now to have a temperature change from 200 degrees Celsius to 300 degrees Celsius. The steam produced at this stage will flow to the superheater.

d. The steam that is advertised will enter the turbine through nozzles and fixed blades. Where will produce rotating power that will produce electrical energy?
e. The steam used to rotate the turbine that has gone through several processes will experience a decrease in temperature and will enter the vacuum condenser. And there is a change of fluid from steam to condensate.
f. The cooling water from the cooling tower is circulated for cooling condensate in the vacuum, oil cooler, and air cooker.
g. The exhaust gas from the oiler will be sucked in by the suction fan so that the electrostatic precipitator with the Tujunga reduces pollution.
h. The filtered gas will be discharged through the chimney.

The latest development of green technology in the European cement industry and PT. Semen Indonesia including new installations in Rembang plants is described and compared. Qualitatively, all new developments in the European cement industry are also developed by PT. Semen Indonesia. Quantitatively, green technology in PT. Indonesian cement is better than selected cement plants in Europe (Sismoro and Anggraeni, 2021) for reclamation and biodiversity after excavation, alternative fuel use, and Waste Heat Recovery Power Plant (WHRPG). Meanwhile, in terms of alternative raw materials at the level of substitution and development of green products, the technology in PT. Indonesian cement is still lagging behind Europe (Aini et al., 2023). Total gross CO2 per ton of cement products from PT's existing plant. Indonesian cement is inferior to others from Asia and North America (Ummi, 2017). The cement manufacturing process itself produces 0.97 Kg equivalent CO2 / day (Sangkertadi, 2017). According to China's Handbook of Pollution Discharge Coefficient in the Cement Industry, the exhaust emissions from the cement clinker process are approximately 3275 m 3t1(clinker) for vertical shaft kilns with an output of less than 100,000 t per year (Lü et al. 2015). Several studies have been carried out aimed to utilize alternative materials and alternative fuels in the European cement industry. In Portugal, Kikuchi has 454 reported technology for producing cement from incineration ash of municipal solid waste, incineration ash of sewage sludge, and other wastes such as aluminum dross and copper slag[Mokrzycki et al. studied the ecological and economical features of utilizing alternative fuels made from waste in the Lafarge Cement, Poland. Prisciandaro et al. (Kikuchi, 2001), analyzed the experimental results of the emission of alternative fuels replaced with conventional fuel in two different cement plants in Italy (Calvo et al, 2021). Results indicated that if less than 20% of regular fuel is replaced with the tire, stack emissions (NOx, SO2, and CO mainly) were slightly increased. (Winarso, 2019) The indicator is the production process, emissions or waste management performance, and enterprise management affects the greening of the industry in the cement industry (Hossain et al, 2020). So in determining the green industry standard for the cement industry in the environment, its performance can be seen from the production process, emission or waste management performance, and company management (Farhaini et al., 2022). For future research, minimizing the subjectivity of researchers in understanding annual report data greatly influences researchers in measuring the number of information disclosures required by variables.

4. Conclusion

Increased costs in energy use and contributors to global warming emissions are the basic foundations in developing energy systems to improve efficiency and reduce emissions. With that, the use of WHRPG is an alternative solution by striving for operational efficiency and reducing exhaust emissions so that it is more environmentally friendly. Where WHRPG utilizes the exhaust gas of cement production.

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