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Energy Conversion and Conservation Technology in Facing Net Zero-Emission Conditions and Supporting National Defense

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Conversion technology is a solution that was born to solve energy problems and human needs. Without energy, all human activities ranging from households and jobs to the industry cannot work as they should, but energy conversion that uses conventional fuels will cause new issues such as climate changes. Therefore, energy conservation is very important for sustainability and energy saving. So, by reducing energy use, the pollution produced will decrease. This paper focuses on the introduction of energy conversion and conservation technology based on a qualitative literature review to deal with net-zero emission conditions. The conversion technology is environmentally friendly and efficient, and is committed to following the international Net Zero Emissions (NZE) agreement, renewable energy conversion technology and new technologies (fuel cells) to meet Indonesia's defense equipment and defense needs. Indonesia's energy use (2019) consists of oil 35%, coal 37.3%, gas 18.5%, hydropower 2.5%, geothermal 1.7%, biofuel 3%, and other renewables at nearly 2%. In 2013 Indonesia's recoverable shale resources obtained a value of 8 Billion Barrels. Because of that the total CO_2 emissions resulting from energy use in Indonesia are 581 $MtCO_2$ in 2019. Efforts to fulfil Indonesia's Nationally Determined Contribution (NDC) continue to be carried out, so that Indonesia's target is to enter a state of net-zero emission by 2060. Fuel cell technology has the potential to be applied in the Indonesian National Army, because of its relatively small size, light weight, zero-emission, high specific energy and zero-noise.

Keywords: Energy Conservation; Conversion Technology; Net Zero Emission; Supporting National Defense; Fuel Cells Technology.

Introduction

The main challenges facing the world today are energy security, sustainability, pollution, and the impact of climate change. Energy security includes affordability, acceptability, accessibility and availability. The main focus of energy security in Indonesia today is the availability of energy evenly and comprehensively [1]. According to the Ministry of Energy and Mineral Resources of the Republic of

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Indonesia, hundreds of villages have not received electricity service 24 hours a day [2]. Not to mention that the current energy mix is still dominated by fossil-based power plants (coal, oil and gas) [3]. Many authors and organizations advocate the transition to 100% renewable energy with an eye on the country's economic recovery. The choice was based on the fact that renewable energy is a technology that has been proven to be rapidly developing and has the potential to have a zero-carbon footprint [4]. These benefits are a very appropriate solution to overcome climate change, which is perhaps the most pressing challenge facing the global community, so that the awareness of every country holds an international meeting to discuss a simultaneous solution on an international scale [5].

At the end of 2015, an international meeting was held in Paris to produce an international agreement (The Paris Agreement). This Convention was attended by 196 parties from various countries because it is very important in fighting global climate change and adapting to its impacts. The meeting resulted in an international agreement that is legally binding as an effort to fight climate change. The Paris Convention aims to discuss the maximum limit for global warming of 2 to 1.5 °C concerning the conditions of the earth before the industrial revolution. Efforts to implement these long-term goals by minimizing Greenhouse Gas (GHG) emissions to zero net so that the target of a neutral climate in 2050 can be achieved [6]. Global warming is influenced by several indicators, such as GHG, pollutants, forest burning and use of fossil fuel engines/technology. The Paris Agreement provides a long term framework for financial support, capacity building and technology [7].

One of the visions of the Paris Agreement is about development, transfer and conversion technology. Future technologies will focus on increasing resilience to climate change and reducing GHG emissions. Establishment of a technology framework to provide comprehensive guidance regarding environmentally friendly technology mechanisms (conversion technology) through policy tools and forms of implementation. Conversion technology is an integrated process in achieving the goal of zero waste. This technology not only creates useful products but also has the potential to reduce emissions of greenhouse gases and other air pollutants. Conversion technology refers to a variety of advanced technologies that can convert solid waste that cannot be recycled into useful products, such as green fuels and environmentally friendly renewable energy [8].

The technology diversification used in the conversion is thermal, chemical, biological, mechanical, or mixed processes. In general, the conversion technology consists of three separate and distinct components: (1) a solid waste separation and recycling process [9], (2) a conversion unit [10], and (3) an energy/chemical production system [11]. Preprocessing is used to prepare solid waste for treatment by separating and disposing of non-recyclable waste [12]. The preprocessing process (such as tearing, grinding, and/or drying [13]) varies depending on the technology. This process is required to make more homogeneous raw materials for some thermal technologies. Alternatively, water-based separation techniques can be used in biological processes [14]. The energy production module can be a gas turbine, a boiler, or a propulsion engine for the production of electric power [15]. The production module is fully subject to energy conservation, *i.e.,* energy cannot be destroyed but can be converted into other forms [16]. The utilization of electrical energy from upstream to downstream is fully subject to energy conversion and conservation technology, for example, water drives turbines to produce electricity and electrical energy is used to drive electric cars [17]. Therefore, this paper will focus on the introduction of energy conversion and conservation technology based on a qualitative literature review to deal with net-zero emission conditions.

Methods

This article uses a qualitative descriptive literature review method. According to Onwuegbuzie and Weinbaum in Miles and Huberman [18], descriptive qualitative method is research that describes the state of the object being studied as it is, in accordance with the situation and conditions at the time the research was conducted suggesting that activities in qualitative data analysis are carried out continuously until complete so that data literacy has been repeated/already saturated. According to Sugiyono [19], the qualitative approach is a non-statistical subjective assessment, where the measure of value used in this study does not assess numbers but categorizes values or quality. Qualitative methods aim to describe the state or condition of the phenomenon of the focus of the study, especially with regard to the theme of the study being taken. Further exploration is carried out based on theories that support arguments, statements and limited searches related to the theme of conversion technology and clean (green)energy conservation. The search results generated include reviews and opinions by experts in their fields and a good scientific background.

Results and Discussion

Technology of Conventional Energy

Conventional energy is non-renewable energy, because energy sources come from nature but the amount is quite limited [20]. Two types of conventional energy can be distinguished into fossil fuels and nuclear fuels [21]. Fossil fuels are classified into coal, oil and natural gas. From 1962 to 2009, Indonesia was one of the oil-exporting countries. But Indonesia has ceased to be an oil-exporting country in 2009, because the country's internal demand for oil has increased, so Indonesia had to leave the Organization of the Petroleum Exporting Countries (OPEC) [22]. World oil reserves are quite limited, only 500 Bb in 1970 which is estimated to be exhausted in 1995. But due to continuous exploration, in the last 20 years, the world had 900 Bb of oil, and currently consumption is around 600 Bb [23]. The growth rate of oil and gas reserves due to massive exploration was 0.11 Mb or 7.4 trillion cubic meters (TCM) in 2010, as shown in Figure 1 [24].

So far, global oil, gas and coal reserves have continued to increase with no immediate threat of depletion, but fossil fuels are a finite resource. Apart from climate change, population growth, inflation and living standards increase over time. The oil reduction scenario is related to supply chain cuts as a result of the oil embargo in the 1970s, resulting in a decrease in oil demand as a result of the clean energy transition, (*i.e.,* cars using electric energy). Many energy experts have different views regarding the rate of decline after peak oil production occurred between 2000-2030 with peak rates ranging from 75 to 120 Mbpd. A significant decrease in oil production will determine the scarcity of goods. The phenomenon of scarcity of goods will be related to ultimate resources (UR) and ultimate recovery resources (URR), which are used to show the size of oil and gas reserves on earth. Total oil and gas resources are often referred to as contingent and prospective resources. Based on the results of a statistical review of BP world energy, it shows that world oil reserves in 2013 were 1,687.9 Bb. As a result, there is currently a peak in oil prices when prices fall, but will continue to increase since some have reduced the use of oil and gas-based fossil [24].

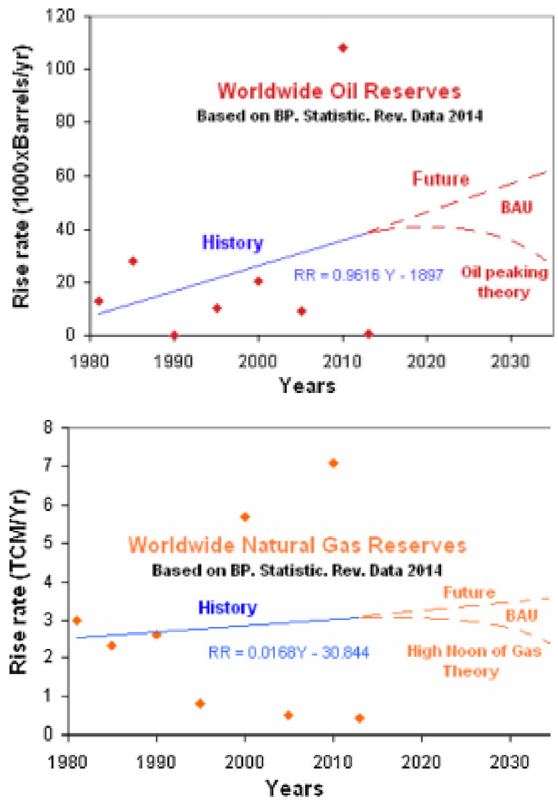

Figure 1. Oil and gas reserves increase from 1980-2013 [24]

Environmentalists advise minimizing the use of fossil fuels because of their adverse effects on nature regardless of depletion or non-depletion. Environmentalists attribute peak oil and gas production to peak CO_2 emissions, which have so far increased by 402 ppm in 2014 [25]. Until now, there is no known chemical reaction that can clean the buildup of CO_2 (gas) in the atmosphere. There are several authors who describe sustainable hydrocarbon fuels by recycling H_2O and CO_2 with renewable energy sources [26]. But there is a concrete solution, namely CO_2 capture and absorption (CCS). It can contribute to converting CO_2 back into hydrocarbon fuels in the presence of H_2O. The working principle of hydrocarbon fuels is to convert dead vegetation and animals into fossil fuels from tens of millions of years to hundreds of millions of years ago [27]. The energy conversion technology for environmentally friendly coal-based power plants is Integrated Gasification Combined Cycle (IGCC).

IGCC is a coal-fired power plant technology that utilizes a high-pressure gasifier to convert coal or other hydrocarbon fuels into pressurized gas/synthesis gas (syngas). Conversion of solid coal to gas is possible to be applied in combined cycle generators, which will lead to the high efficiency of the engine. The IGCC process can also be used as a pollutant removal system, because it has become clean energy (syngas) before entering the power generation cycle. However, a difficult challenge for developing countries is that the IGCC technology is quite expensive when compared to other (conventional) hydrocarbon and coal-fired power plants. The IGCC scheme can be seen in Figure 2 [28].

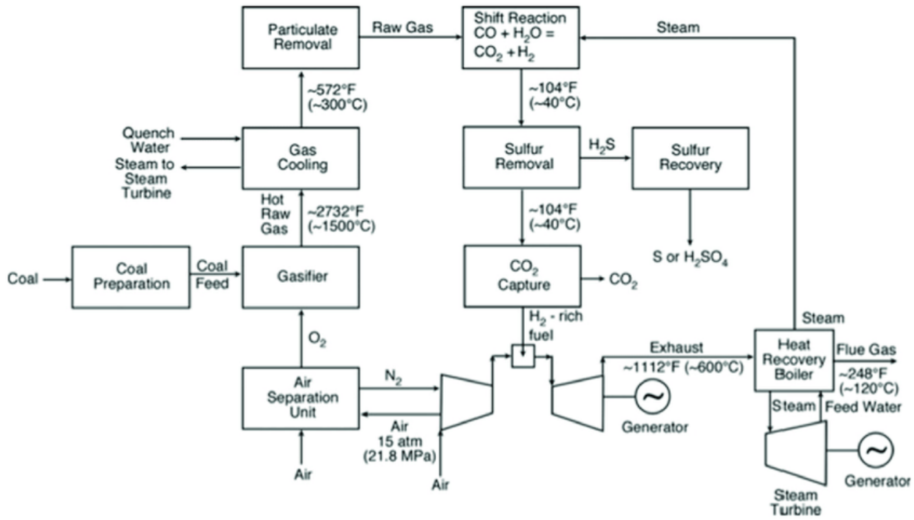

Figure 2. Coal-based Integrated gasification combined cycle (IGCC) scheme [28]

The working principle of IGCC is to separate oxygen from the air in the factory using cryogenic separation [29]. The oxygen passes through a gasifier where the coal is gasified at high pressure to produce syngas at a relatively high temperature. Next phase is the cooling and pre-cleaning phase, in which the syngas is transferred through a water gas displacement reaction in a water gas reactor so that it is later converted into H_2S, H_2, and CO_2. Cleaning is carried out by several steps to remove mercury, water, sulphur, and other impurities. This is because the composition of syngas only consists of CO_2 and H_2. The final cleaning stage of this gas mixture is passing through a CO_2 removal process where CO_2 is captured by CCS. Hydrogen is then used to generate power and drive electric turbines. Please note that most of the technologies developed today (commercial) utilize physical solvents to separate CO_2 from syngas. In the future, better technology is needed to separate CO_2 from syngas [28].

Technology of Renewable Energy

Renewable Energy Technology is divided into 2, namely New Energy and Renewable Energy. New energy is energy that utilizes technology that is relatively new in Indonesia, while renewable energy is energy that utilizes "sustainable and clean natural processes". Because in general renewable energy does not produce pollutants and greenhouse gases, it does not contribute to climate change. However, behind its environmentally friendly nature, several issues arise. For example, renewable energy is intermittent (not continuous). Because every year there will be a change in seasons which causes the energy source to change, it is rather difficult to function to meet peak energy needs [30]. Many efforts have been made to produce environmentally friendly and renewable energy-producing technologies, so it is necessary to know the types of technologies that have been developed at this time.

Solar Cell Technology

The solar panel is a series of photovoltaic cells that convert sunlight into electricity. Photovoltaic cells are semiconductor devices consisting of p-n (positivenegative) junction diodes. The junction electrons are directly transferred from the n-type semiconductor (electrons being the dominant current carrier) to the p-type semiconductor (Hole being the dominant current carrier) and vice versa for the pole movement. The movement of electrons occurs as a result of the high temperature of the sun's heat to the solar panel [29]. Based on this explanation, the electrons and the movement of the poles result in photogeneration (as shown in Figure 3).

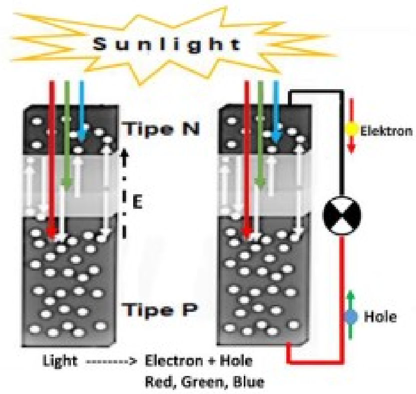

Figure 3. Solar cell photogeneration process [31]

High enough waste heat is generated by the absorption of solar radiation, causing the solar panel temperature to be quite high. The amount of radiation that can be converted into electricity in Photovoltaic (PV) panels is only 20% of the total incoming radiation. Therefore, the entire system has a fairly high temperature. As a result, the accumulation of thermal energy increases the operating temperature in the PV panels, therefore resulting in a decrease in the efficiency of the PV system. PV panels decrease by about 0.40 to 0.50% for each degree increase in temperature. The maximum power output can be calculated by equation (1).

$$P_{max} = V_{oc}\, I_{sc}\, FF \tag{1}$$

Description:
P_{max} = Maximum Power
V_{oc} and I_{oc} = open circuit electricity
FF = *fill factor*

The fill factor or can be said to be the ratio of the maximum power produced by the image sensor to the open circuit voltage circuit. Based on equations (1) and (2), the fill factor can be described as follows

$$FF = \frac{P_{max}}{V_{oc}\, I_{sc}} \tag{2}$$

$$\frac{V_{mpp}\, I_{mpp}}{V_{oc}\, I_{sc}}\, FF = \frac{V_{mpp}\, I_{mpp}}{V_{oc}\, I_{sc}}\, \frac{P_{max}}{V_{oc}\, I_{sc}} \tag{3}$$

where the voltage (V_{mpp}) and I_{mpp} are the maximum voltage and current, respectively. So that the resulting final power equation is shown by equation (4)

$$P = V \cdot I \tag{4}$$

Description: P = Power (watt), V = voltage (volt), and I = electric current (ampere)

In the previous 1-decade, commercial solar panel technology had an efficiency of around 15% and in 2020 at least the efficiency of commercial solar panels was around 20%. This is one of the main reasons why the solar industry is still struggling to compete with fossil fuels. In general, commercial solar panels rarely exceed 20%

efficiency, because it requires a fairly high cost to use advanced semiconductor materials with high efficiency. Photovoltaic cells produce a direct current which is generally used for small loads (electronic equipment). If the Direct Current (DC) from photovoltaic cells is used for remote home applications, but the electric utility uses an alternating current network, it must use an inverter or solid-state device to convert it to alternating current (AC) [31].

Many efforts to optimize solar cell systems have taken advantage of the factors of solar cell performance. The solar panel factors in question are inverters, batteries, and solar charge controllers that are used to support the electric power system. One of the interesting issues discussed is to find a model of a power generation system using solar cells for a house and the optimal arrangement to improve the performance of solar cell panels.

Turbine-based Hydroelectric Power

Hydroelectric Power Plant is a generator that relies on the potential and kinetic energy of water with a certain height difference to produce electrical energy. Hydropower is a power plant that Indonesia relies on at this time. Hydropower is more reliable, inexpensive and easy to build in the tropics and subtropics than power plants with other raw materials and is included in renewable energy. To see the electric potential generated is to calculate the potential output power [32]. Potential measurements are carried out like the calculation of Hydro Potential in general, namely using equation (5)

$$P = g \times h \times Q \times \eta \qquad (5)$$

Description:
P = Output Power (kW)
g = gravitation (9.8 m/s^2)
h = Falling water level (m)
Q = Debit (m^3/s)
η = Efficiency

The classification of hydropower types are distinguished based on the output power produced. The classification of hydropower is summarized in Table 1

Tablel 1. Hydropower is divided into several types of generating scales [4]

Classification Hydro-based Power Plant	Power Estimate
Giga	>100 MW
Mega	15-100 MW
Small	1-15 MW
Mini	100 kW-1 MW
Micro	5-100 kW
Piko	<5kW

Small hydropower plants have recently been developed and have become an alternative to fulfil electrical energy, especially in difficult, affordable and remote areas. Hydropower plants are built in areas that have river potential throughout the year. Small-scale hydropower is the most common generator in Indonesia. The advantages of small-scale hydropower are (1) hydropower plants can be built, managed independently, and owned by local consumers/communities. (2) System operation, maintenance and repair can be done by local technicians. (3) The generator can use a runoff river system with the dam height of < 2 m, without a dam or narrow dam. (4)

Constructed with components commonly used in engineering construction and available in the local market, namely generators, cables, transmission belts, pipes and others. (5) This type of turbine can be made by a local workshop (Crossflow turbine). (6) Emission-free, sustainable (sustainable/long life) and low maintenance [33].

Geothermal Power Plant (GPP)

Geothermal Power Plant is a power plant that uses geothermal energy as its energy source. Electricity from geothermal power is currently used in several countries that cover the ring of fire. Geothermal Power Plants (GPP) can produce a constant power output based on the installed capacity in geothermal power plants [34]. GPP generally consists of three types of geothermal systems, namely:
(1) a binary system is characterized by a fluid-dominated flow,
(2) a flash system characterized by a two-phase flow-form,
(3) a dry system characterized by a vapour-dominated flow [35].

One of the geothermal power plants (GPP) in Indonesia is the Dieng Geothermal Power Plant in Dieng, Central Java, Indonesia. Geothermal Power Plant (GPP) utilizes single-flash steam system technology, which is indicated by the large-scale use of brine found in geothermal wells [36]. The process flow diagram for the single-flash system at the Dieng Geothermal Power Plant is shown in Fig. 4

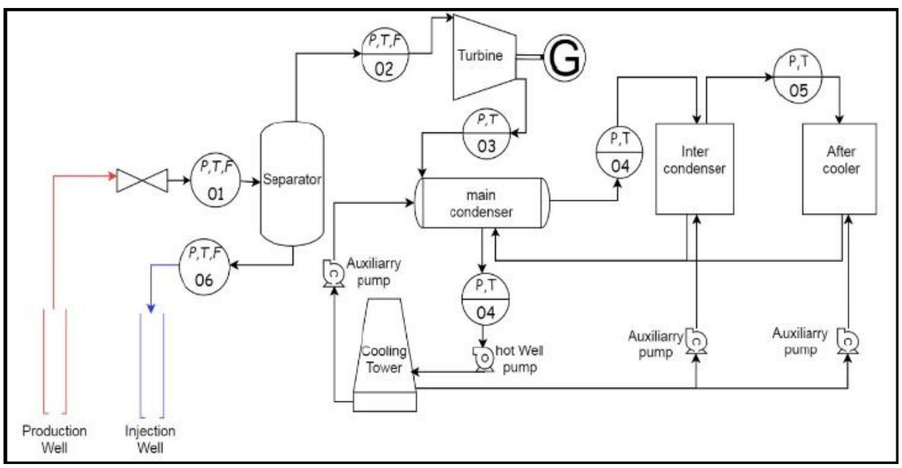

Figure 4. Dieng geothermal power plant schematic diagram [36]

Figure 4 shows a component flow diagram of the Dieng Geothermal Power Plant single-flash system. The figure shows data collection points for the pressure, temperature, and flow rate parameters for each component. There are five injection wells and seven production wells. The flow rate (F) is measured using a flow meter in a distributed control system (DCF). The temperature parameter (T) is measured using a variety of temperature instruments, including element temperatures, bimetals, temperature gauges, and temperature transmitters. The pressure (P) in the power plant is measured using a pressure gauge and a pressure transmitter. Parameters (pressure, temperature, and flow rate) are measured in the production section (well to the separator). Under normal circumstances, the measured temperature, pressures and flow rates are 100–190 °C, 9–10 bar and 70–250 tons/hour, respectively. These parameters are derived from the two flow phases in each well. The flow rate from the separator to the turbine is obtained from a steam flow of 20–150 tons/hour. In the power plant section, the parameters recorded are flow rate of 250–350 kg/s, the pressure of 8–29 bar, and temperature of 40–140°C. Each parameter mentioned is the value of Geothermal Power Plant under normal conditions for operation [36].

Wind Energy Turbine

A wind power plant is a power plant that uses wind as a source to generate electrical energy. This plant can convert wind energy into electrical energy using wind turbines or windmills. In general, the wind power plant is divided into 2, namely on-shore wind power plant (wind power plant which is installed in inland areas, both high and low land) and off-shore (wind power plant which is installed in coastal or sea areas). According to Watson *et al.* [37], the offshore wind power plant has greater efficiency in generating electricity than on-shore one, because of the tendency for continuous wind movement to occur in coastal areas. Figure 5 shows the types of wind power plant-offshore which are often found commercially.

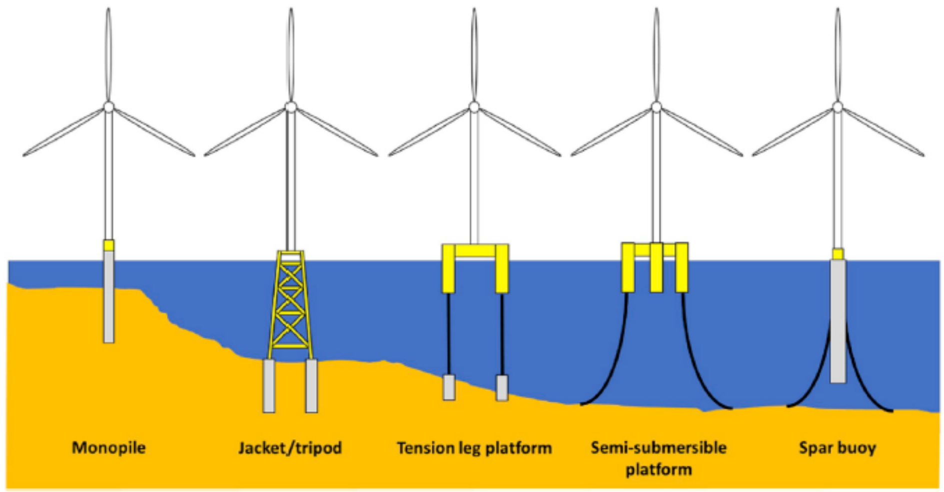

Figure 5. Off shore wind power plant [37]

Figure 5 shows the shape and type of wind power plants, and it can be seen that the farther the windmill is located from the coastline, the longer the supports and cables are required. But it should be noted that the effective distance of the wind is the best and is continuous. Most of it is not directly on the shoreline, but slightly closer to mid-ocean [37].

Biomass Energy

Biomass's Power Plant is a power plant that uses fuel converted from biological and organic materials by thermochemical and biochemical processes such as combustion, gasification, pyrolysis and anaerobic/aerobic digestion. The utilization of wastes for power generation can also avoid the production of methane gas if the waste is disposed in a landfill. Biomass-based energy technology consists of briquettes, biogas, biodiesel, biofuels, and microbial technology. If sufficient biomass resources are available, biomass is a clean and reliable resource for electricity generation. The conversion of chemically bound energy from fuel to electricity takes place in a plant called CHP (combined heat and electricity) [38].

The report presented will provide an overview of the technology available for power generation from biomass sources, because it has been widely used in Germany and is also applicable in Asian countries, especially Indonesia. Biomass fuels in general are all organic materials (excluding fossil fuels), which have been or are living organisms and can potentially be used as an energy source. Biomass material has a wide range of moisture content (on a wet basis) from less than 10% for cereal straw to 50–70% for forest residues. Examples for Biomass fuel are: (1) wood and wood waste, (2) forest and factory residues, (3) crops and agricultural waste, (4) animal manure, (5) remains of livestock operations, (6) crops water, (7) fast-growing trees and plants, and (8) municipal and industrial waste [39]. The scheme for the biomass power plant can be seen in Figure 6.

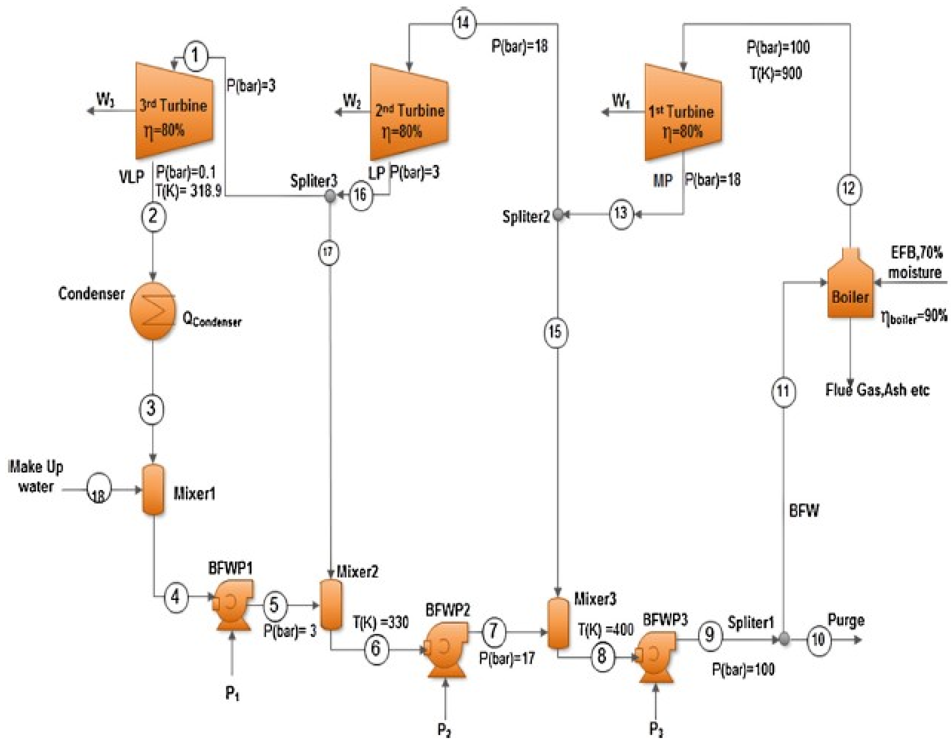

Figure 6. Biomass Power Plant Scheme with Direct Heating [39]

Unlike coal, which is often used as a fuel for thermal power generation, biomass contains much higher moisture levels. High moisture content increases the difficulty of operation, reduces combustion efficiency and threatens environmental limitations. Most of the newer biomass power plants are often integrated with drying facilities where the biomass is chopped and/or thermally dried before being sent to the boiler plant. Not a few power plants also use biomass briquettes that have been carbonized beforehand, so that the humidity, ash content and water content can be reduced. Therefore, the efficiency of the biomass power plant is higher and is more environmentally friendly [39].

Energy Conservation

Energy conservation or energy saving is an action to reduce the use of new, renewable and non-renewable energy for the sake of the sustainability of human life and the surrounding environment. Saving energy means not using electrical energy for something that is not useful. Energy savings can be achieved by using energy efficiently, the same benefits are obtained by using less energy, or by reducing consumption and activities that use energy. Energy savings lead to cost reductions, this will result in increased environmental sustainability, national and personal security and safety. As a result, industries that require large amounts of energy (commercial users) can increase efficiency and profits by saving energy [40]. One of the big problems related to energy conservation occurs in the combustion process of fossil fuel engines.

Modern Internal Combustion (IC) engines have very high efficiency. About 98% of the energy contained in the fuel is released during combustion in diesel engines and 95-98% in gasoline engines. However, the energy used leaving the engine (called 'brake work') is usually only 40% of the fuel energy. The energy used to provide drive to the wheels is much less than the work of the brakes. This is because a small part of the energy needs to be used for other things such as alternators and water pumps. The system's inability to convert all the chemical energy into brake work is termed "gross indicated thermal efficiency" [41]. The magnitude of the overall efficiency of the engine is called the 'fuel conversion efficiency and is defined in Eq. (6):

$$Ef = EP \times ET \tag{6}$$

Description: Ef = Fuel conversion efficiency
EP = Combustion efficiency
ET = Gross Indicated Thermal Efficiency

The best efficiency is produced by lubricants with good characteristics. Lubricating properties are quite dependent on temperature. The most efficient engine oils can operate at steady temperatures/conditions ranging from 100 C to 110 C. The high viscosity of the lubricant at low temperatures results in high friction losses. During the preheat stage there is friction loss in the engine or engines at a temperature of 20 C. This can be up to 2.5 times higher than that observed when the lubricant is completely warm. If the engine temperature is lowered to the cold-start scenario (0 C). this can lead to an increase in fuel consumption of up to 13.5% of the course will result in less efficiency value [41].

Future Challenges and Opportunities

Efforts to Prevent Climate Change with a Net Zero Emission (NDC Indonesia) Scenario

The use of fuel from petroleum, coal and natural gas produces exhaust emissions in the form of carbon dioxide (CO_2), carbon monoxide (CO), sulphite/sulphur oxide (SO_x), nitrogen oxides (NO_x), and several other elements or compounds in the form of heavy metals. Note that the main parameter as an indicator of pollution, especially the cause of global warming is carbon dioxide. Carbon dioxide is trapped in the earth's atmosphere, which causes solar radiation to be absorbed, giving rise to the phenomenon of a smog layer or air pollution layer consisting of a combination of smoke and fog containing carbon dioxide (CO_2) and other pollutants.

According to Briefing [42] and Asian Development Bank (2020) [52], Indonesia's energy use consists in 2019 consisted of oil 35%, coal 37.3%, gas 18.5%, hydropower 2.5%, geothermal 1.7%, biofuel 3%, and biogas, solar, wind, and other renewables at nearly 2%. In 2013 regarding recoverable shale resources of Indonesia, a value of 8 Billion Barels. Indonesia has 72% of total coal production in other non-OECD Asian countries. Throughout the period ahead, Indonesia will continue to dominate regional coal production. According Climate Transparency Report (2020) The number of CO_2 emissions resulting from energy use in Indonesia is 581 $MtCO_2$ in

2019 [51]. To overcome this, every nation's agreement is needed to combat climate change, one of which is the Paris Convention. The Paris Convention aims to discuss the maximum limit for global warming of 2 to 1.5 °C concerning the conditions of the earth before the industrial revolution. Efforts to implement these long-term goals by minimizing Greenhouse Gas (GHG) emissions to 0 net.

Indonesia's NDC has an emission target based on Business As Usual (BAU) conditions in 2030 of 2,869 MtCO2e, while Indonesia's projected emissions in 2030 are 2,037 MtCO2e (29%) below the unconditional target and emissions as low as 1,693 MtCO2e below the conditional target. Efforts to achieve these goals require the government to implement priority actions to reduce climate change [43]. Reduce GHG emissions to 41% below BAU 2030 levels, subject to international assistance for finance, technology transfer and capacity building. This is not easy, but with the cooperation of all parties, the Net Zero Emission scenario can at least be fulfilled in 2060.

Develop Green Conversion Technology in Various Sectors

Development of environmentally friendly (green) conversion technology in the transportation, household and NRE sectors. Green technology in question is environmentally friendly and efficient technology both in terms of price and device efficiency. The development of green technology has been carried out for a long time but along with technological developments, technological development will not stop, development begins with the diversification of energy output, whether it is the result of chemical, physical, and biochemical reactions. This is in line with efforts to improve (1) high efficiency based on solar cells with surface functionalization methods as intelligent materials [44]. (2) Increase the efficiency of combustion/co-firing of the best biomass [45]. (3) Geothermal power plant technology developed with relatively inexpensive equipment [46]. (4) Finding windmill designs and a combination of both offshore and onshore windmills [47]. (5) The most efficient water turbine design in generating power output [48].

Development of Hydrogen Fuel Cells Technology

Green hydrogen is clean energy that has a very high calorific value (120 MJ/ almost 2.5 times higher than the calorific value of gasoline and LNG/CNG and is very flexible to be used in various energy sectors as well as raw materials for the chemical industry. On the other hand, H_2 has a low volumetric energy density, so it is necessary to be careful (in-depth study) in planning development, especially logistics planning (storage, transportation, and distribution). To achieve logistics that is more cost-effective and efficient, it is necessary to take into account further processes: H_2 to H_2 liquid and H_2 Carrier (Ammonia, MeOH, etc.) The scenario proposed in the implementation of GREEN HYDROGEN production is Power to H_2 or Power to X with electrolyzer technology where "X" is a variety of chemical products and synthetic fuels resulting from the further conversion of H_2. The need for GREEN HYDROGEN is certain to increase drastically due to NZE requirements, so it is projected as a big business opportunity for energy sector business actors [49].

Opportunity:

1. H_2 as fuel produces clean emissions in the form of water (H_2O) (clean energy)

2. H_2 is recognized worldwide as beyond/future energy” the main focus in mitigating climate change (Global Pathway to Net Zero Emissions)
3. Mitigation of carbon emissions in sectors that are harder to electrify”, for example, industry and transportation (Decarbonization Solution “Hard to abate Sector”)
4. Seasonal Storage Media (Seasonal Storage) H_2 stored can be converted into electricity to meet demand

Threat:
1. The electrolyzer system and the price of electricity from renewable sources is still relatively expensive (High Cost).
2. High requirement for storage & transport because of the low energy density of H_2, it needs compression to 700 bar for storage/transport.; transport. long distances need conversion to H_2 carrier (e.g., Ammonia, MeOH)
3. Hydrogen only has 60% energy efficiency (High Energy Losses) from the production process to the final use.
4. Volatile and flammable so safety measures are required to prevent leakage and explosion (Safety Issues).

Fuel Cells technology has the potential to be applied in the defense sector because of its relatively small size, some fuel cells are quite light, have no emissions, have high specific energy, do not make noise, etc. Based on the context of the defense equipment application, the requirements can be a wearable, portable, or distributed power supply. Fuel Cell Powering unmanned aerial vehicles, ground vehicles and autonomous underwater vehicles form separate regimes. High levels of efficiency, reliability, reproducibility, durability to meet military standard environmental tests can be met so that the prerequisites for military hardware are almost completely met. A prominent and current issue of fuel cell technology is the design of air-independent propulsion (AIP) systems for submarines [50].

Conclusion

Conversion technology will continue to evolve. These developments started from the industrial revolution 1.0 to the industrial revolution 4.0, but in these developments even though technology solves a problem, it has the potential to cause new problems such as environmental problems. Environmental problems that can occur starting from energy conversion that is not environmentally friendly as well as the use of several technologies that cause pollutants that are quite dangerous if high intensity can even cause health problems, acid rain and climate change. Therefore, currently, the development of energy conversion is environmentally friendly and besides that energy conservation is very important for energy saving and security for the community at large. Fuel cell technology has a high level of efficiency, reliability, reproducibility, durability. This is because the military standard environment is a very dangerous, steep and durable field in every environmental condition and temperature. For now, fuel cell technology is the design of the AIP system for high technology submarines.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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