Regional Energy Master-plan Base on Low Emission Scenarios: A case of Central Java Province, Indonesia

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Regional Energy Master-plan Base on Low Emission Scenarios: A case of Central Java Province, Indonesia

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Abstract

Momentum of the current energy crisis is the right time to redesign energy policy, otherwise the energy deficit will continue and influence the economic activities. This research takes Central Java Province as a case study which was to answer three things; estimate the energy demand, dominance of energy use, and energy efficiency. Energy demand is modeled by sector using intensity approach to calculate the amount of energy used per unit of activity. LEAP model is utilized to figure out the future trends of energy demand, and energy structure spanning from 2015 to 2030 under different scenarios, including Business As Usual (BAU), Moderate (MOD), and Optimistic (OPT) scenarios.

The results showed that energy demand in Central Java grows 5.6% per year and overall final energy demand is 1,683,091.24 thousands BOE. Transport and household sectors are comprised of the largest and second largest consumer while premium and electricity make the dominant composition in this province. Efficiency energy can be achieved by 2021 and 2017 respectively under MOD and OPT scenarios. From the utilization of renewable energy, Central Java contributed 1.17% to the utilization of renewable energy nationally. Overall, this research provides some important insights and highlights possible steps for policy makers in developing energy efficiency policies.

Keywords : *LEAP, Central Java, Energy Plan, Scenario*

Introduction

The current world energy crisis has occurred, and energy consumption is largely controlled only by the major industrial countries in the world (Zhao, 2008). Related to the projections of the World Energy Agency (International Energy Agency-IEA), until 2030 the world energy demand will increase by 45% or an average increase of 1.6% per year. The implication is that security of energy supplies will continue to decline, and potentially trigger a recession of the world economy again (Connolly, et al. 2009). This fact has been responded by several countries to redesign their energy planning policies, as done in China (Taoa, Zhaoa, et al. 2011), Thailand (Wangjiraniran, et al. 2011), Turkey (Karabulut, et al. 2008), Iran (Ghader, et al. 2006), and furthermore it has been carried out in Sweden (Nilson and Martensson, 2002). Developed countries such as Canada (Tubss, 2008) and California (Ghanadan and Koomey, 2005) have even anticipated the energy crisis by preparing energy plans early.

For Central Java Province, redesigning the right energy policy is also a very important agenda considering the highly consumptive energy use patterns. This can be seen from the biggest energy users in the household and transportation sectors, which accounted for 19.98% and 71.86% of the total energy used, where oil energy still dominates its use reaching 78.67% and efficiency of energy use about 1.3 (RUPED Central Java,2009). This level of efficiency shows that the use of energy is still wasteful or inefficient because to run the economic growth of 1%, it requires energy with greater growth for each year. With this phenomenon, the Central Java provincial government as the opinion of Cai, et al. (2008) and Connolly, et al. (2009) should have done the right energy planning so that the supply of energy could produce resilient energy and more efficient use of energy, if not, Central Java will face serious energy problems that will affect economic activity and social welfare (Stern, 2011).

Energy planning is needed, among others, to ensure that the availability of energy is guaranteed because energy is a vital requirement for human life (Pierce, 2006 and Winarno, 2007). Through a comprehensive plan in which energy is associated with various fields, according to Voss, (1990); Shan, et al. (2011); Feng, et al. (2011); and Cai, et al. (2008); will make energy more optimized in its utilization. Energy planning varies greatly and can be done from simple planning systems to complex systems so as to produce integrated energy planning (Leo, 2005). Furthermore Pindyck (1979), explained that various energy models have been developed to assist energy planning, both models based on econometrics or statistical techniques to make projections of long-term energy demand. Energy planning can also be done by developing and analyzing energy scenarios, as was done by Ghanadan and Koomey (2005), Shan, et al. (2011), and Feng, et al. (2011).

Energy is a variable that has a positive effect on economic growth, as stated in a study conducted by Stern (2003); Toman and Jamelkova (2003); Stern and Cleveland (2004); Momete (2007); Nature (2006); Ramos-Martini and Ortega-Cerda (2003); Nondo and Kahsai (2009); Aqeel and Butt (2001) and Sugiyono (1999). They agreed that the entire economic process requires energy, and the importance of the role of energy for economic growth and human development, and their impact on sustainable development. They further stated that sustainable development must be felt as another dimension of economic growth that can only be achieved with the production and use of sustainable energy. Meanwhile, there are quite a lot of studies that emphasize the projected energy demand which is intended to determine the continuity of energy supply and optimization as well as the impact of energy consumption on CO2 gas emissions.

Research using the LEAP (Long-range Energy Alternative Planning) model based on several of these scenarios, has been conducted by Shan, et al. (2011), Feng, et al. (2011); Wangjiraniran, et al. (2011); Zhaoa, et al. (2011); XianDong, et al. (2011); and several regencies / cities in Indonesia. The results of the empirical study of Shan, et al. (2011); and Wangjiraniran, et al. (2011); states that the transformation of the economic development model can slow the growth rate of energy consumption, improve energy structure, reduce the share of coal and oil in primary energy consumption, increase the share of natural gas and non-fossil energy, and significantly reduce the intensity of carbon gas emissions (Feng, et al . 2011). Research based on the LEAP model conducted by Zhao Taoa, et al. (2011) using a basic scenario, a low carbon scenario, and a pessimistic low carbon scenario which was then formulated to simulate low carbon economic development in China until 2050. The results of the study show that there is a significant reduction in CO2 gas emissions in China due to the energy intensity high.

This research is intended to analyze the energy demand by sector with the final energy approach used as a reference for regional energy planning related to the economic growth targets desired by the government. From this analysis, various efforts are made to conserve energy through scenario simulations to achieve efficient use of energy, as well as formulating policies in order to build energy use efficiency systems. For this purpose, this research tries to use an accounting model with LEAP software. LEAP is a model that meets the criteria in regional energy planning because it can be used to analyze energy supply and utilization (Winarno, 2007). As a predictor tool, LEAP is able to make projections of energy demand and supply within a certain time period in accordance with the wishes of the user.

Literature Review

Energy planning basically is an estimate of future energy demand and supply, and has a very important role because it can be used as a basis for integrated energy policy development (Schrattenholzer,2005). Basically, energy demand depends on: 1) the demand for services provided, 2) the availability and ownership of energy conversion technology or capital stock, and 3) the cost of the technology conversion used (Sweeney, 2004). Kurtubi (1997) suggested that the demand for energy resources can be seen as an effort of consumers to satisfy their needs. This can be explained by using Marshallian demand theory, which is that energy consumers are assumed to try to maximize the utility function by considering budget constraints. According to Kurtubi, if the consumer utility is expressed as U (E, O), and the income constraint is PeE + PoO = Y, the problem of consumer maximization using the Lagrange (λ) method can be stated as follows;

$$U = U(E, O) - \lambda (Y - PeE - PoO) \qquad (1)$$

and the first derivative is U - λPe = 0 and U - λPo = 0 and the second derivative is negative. After getting the values of λ by solving algebra, the energy demand function is obtained as follows:

$$E = f (Pe , Y, Po , \qquad (2)$$

E = energy demand, Pe = energy price, Y = income, Po = other goods prices, and O = other goods. This formulation can be expressed in simple static and dynamic econometric equations as follows:

$$Et = \beta 0 + \beta 1Yt + \beta 2Pt + u \qquad (3)$$

$$Et = \beta 0 + \beta 1Yt + \beta 2Pt + \beta 3Et\text{-}1 + u \qquad (4)$$

Where:
Et = energy consumption at time t; Et-1 = energy consumption at time t-1; Yt = income at time t; Pt = energy price at time t; e = confounding variable.

Guertin, et al. (2003) illustrates the energy demand by giving an example of a household purchasing electric utilities (KWh), fuel oil (liters), and gas (m^3) which is then transformed into energy services for lighting, cooling, heating, and for appliances other electricity through technology conversion. This relationship is described as a relationship of input and output energy. Energy input is related to the consumer's energy content, while energy output is related to load. So, end-uses are different from energy services. End-uses relate to unbundled input energy with its components (heating devices, air conditioners, electric lights, in other electrical equipment), while energy services are the service charge provided by end-uses categories (Barnes, et al. 1981); like hot, cold, bright, and so on.

Energy demand by consumers in the form of final energy is classified by sector. In the World Energy Model (WEM) developed by the IEA since 1993 that energy demand can be divided by sector consisting of the final energy demand of the industrial sector, the household sector, the service sector and the transportation sector (IEA, 2008). According to the IEA the final energy demand is modeled in detail by sector and end energy user scope, namely: (1) Industry is separated into five sub-sectors, so as to enable a more detailed analysis of trends and controls in the industrial sector; (2) Residential (residential) energy demand is separated into five end users according to fuel; (3) Requests for services; and (4) Energy demand in the transportation sector is modeled in detail according to modes of transportation and fuel. The final energy demand is modeled at the sector level for each WEM region, but separation is done at the end user level.

Total final energy demand is the amount of energy consumption in each end-user sector. In each sub-sector or end user, at least six types of energy will be displayed: coal, oil, gas, electricity, geothermal energy and renewable energies. In each sub-sector or end user, energy demand is assumed to be the result of the energy intensity variable and the activity variable. Energy demand analysis can use the activity based analysis method. In this method the amount of energy demand is calculated as a product of the energy activity and the energy intensity (the amount of energy used per unit of activity). This method consists of two analytical models namely Final Energy Demand Analysis and Useful Energy Demand Analysis.

In the final energy demand analysis (energy demand analysis) the energy demand is calculated as a result of the multiplication of the total energy use activities with the energy intensity in each branch of technology (technology branch). In the form of a mathematical equation the calculation of energy demand using final energy demand analysis is:

$$D_{b,s,t} = TA_{b,s,t} \times EI_{b,s,t} \quad \text{......(5)}$$

Where D is Demand, TA is total activity, EI is Energy Intensity, b is "sector" while s is a type of scenario, and t is the year in which the calculation (starting base year to the final year of calculation). Energy intensity is the annual average energy consumption (Energy Consumption = EC) per unit of activity (activity level). Mathematically shown by the following equation:

$$EI = EC/\textit{Activity Level} \quad \text{......(6)}$$

Total technological activity is the result of the activity level in all branches of technology that will affect the demand branch.

$$TA_{b,s,t} = A_{b',s,t} \times A_{b'',s,t} \times A_{b''',s,t} \quad \text{......(7)}$$

Where Ab is the activity level at a particular branch b, b 'is the parent of branch b, b' 'parent branch b', and so on. Planning is a foresight that concerns resources, so energy planning will relate to allocative planning and strategy planning (Voss, 1990). Good energy planning can integrate all energy sub-sectors, including the rural energy sector, and aspects related to the energy sector as a whole (Schrattenholzer, 2005; Nilsson and Martensson, 2002). The aspects related to energy planning are socio-economic, environmental, balance of payments, and so on (Morse, 2001). Energy planning is needed, among others, to ensure that the availability of energy is guaranteed because energy is a vital requirement for human life (Pierce, 2006; Winarno, 2007; and Muhammad, 2009). Through a comprehensive plan in which energy is associated with various fields, according to Voss, (1990); Shan, et al. (2011); Feng and Zhang (2011); and Cai, et al. (2008); will make energy more optimized in its utilization.

Various energy models have been developed to assist energy planning, both models based on econometrics or statistical techniques to make long-term energy demand projections (Meier,1993). Energy planning can also be done by developing and analyzing energy scenarios, as was done by Ghanadan, et al. (2005); Shan, et al. (2011); and Feng, et al. (2011). As for the energy supply strategy, optimization techniques with certain objective functions are widely used

(Sugiyono,1995). The use of Markal (Market Allocation) Model will determine the optimal energy supply based on linear programming techniques by considering the choice of available energy resources and technology so that energy needs are met (Sugiyono,2006). Based on the optimum results, the amount of emissions from energy use can be calculated using the emission coefficient data from each technology. In his study, Kleeman (1994) used the DEMI (Demand Energy Model for Indonesia) Model to project energy requirements in the form of useful or final energy. This model calculates all energy used by end-use technology but does not cover energy used for mining, energy conversion, auto-generation and losses from energy use. Basically the energy used is in the form of useful energy. If the useful energy cannot be applied to a particular part then the final energy is used. In the concept of useful energy, the energy price is not calculated. This is because the useful energy does not depend on the type of final energy it produces.

Energy planning research in China conducted by Shan et.al (2011) is intended to project energy demand in China for the next 20 years. The initial step in the study is to analyze the existing energy conditions in China, then using the LEAP model they simulate energy demand and primary energy mix in 2020 and 2030. Projections use different scenarios, namely economic development, energy efficiency, and energy structure scenarios. The results showed that the total primary energy demand reached 4840-5070 Mtce in 2020, and 5580-5870 Mtce in 2030. The share of coal in the composition of the primary energy mix decreased, while oil, natural gas, and non-fossil energy increased

Feng, et al. (2011) in his study also used the LEAP model to predict the impact of different development alternatives on future energy demand for energy structures, and carbon emissions, from the base year 2007-2030, based on three scenarios, namely: the Business As Usual (BAU) scenario, based on policy (BP), and low carbon (LC) scenario. Based on the policy scenario and low carbon, the industrial sector is recorded as having the greatest potential in terms of reducing energy consumption and carbon gas emissions, compared to the BAU scenario. Ghader, et al. (2006) building models and predicting electricity demand in Iran. This study is motivated by the effort that to realize a stable economy, energy production and exploitation need to be programmed, as important as human resource factors, raw materials, financial sources and other inputs. Considering current energy conditions many countries focus more on limited energy availability. To realize electricity as a source of clean energy, the alignment between supply and demand is a challenge for policy makers

In Thailand, an energy planning study using the LEAP model was conducted by Wangjiraniran, et al. (2011), to examine the impact of changes in economic structure on energy consumption patterns and the effects of greenhouse gases on energy use, based on two different scenarios. Based on the study of Wangjiraniran et al. (2011), assured that national energy planning and policy must be adjusted more coherently to the economic development and social conditions of the country. The study results also said that energy planning should focus more on the use of alternative energy to replace petroleum consumption, as well as improve efficiency in the transportation sector. In addition, community-based bio-fuel production is increasingly being considered to mitigate the impact of unsustainable oil supply in the agricultural sector, and narrow the gap between the economy, climate and energy policy.

Energy planning studies using the LEAP model were also conducted by Bao Guo et al. (2011), by designing three scenarios of China's economic growth, and simulating the level of electrification in China in 2030. The results show that the electrification rate of China has the potential for greater increase in the medium-long term and there is a rapid change of economic development patterns that are can help increase the level of electrification. An interesting study has been carried out by Zhao Taoa, at al. (2011), in the headline for the prospect of low carbon economic development in China. The prediction results based on the scenario become an important reference for the Chinese government to develop a low carbon economy. The results showed that the total energy demand based on the three scenarios were 6095 billion tons of standard coal, 5236 billion tons of standard coal and 6239 billion tons of standard coal in 2050, respectively.

Methodology

a. Research Approach.

Estimation of energy demand in Central Java Province is carried out using a demand approach, meaning that energy demand is calculated from energy demand by each energy user sector. The demand approach is complicated to do and requires more data, but this demand approach can better describe the actual energy demand and can be more detailed in calculating energy demand per usage sector. This research uses an end-use approach also known as an engineering model approach, which is combined with a scenario method. This approach will be more detailed even though the calculation uses a simpler function.

b. Research Assumptions

Energy demand is divided into five (5) activity sectors, namely the household, commercial, industrial, transportation, and other sectors. The calculation of energy demand is based on two scenarios, namely Business as Usual (BAU) and Energy Efficiency (EE) scenarios which consist of moderate (MOD), and optimistic (OPT) scenarios. The Energy Efficiency Scenario was developed based on the BAU scenario with energy policy interventions in terms of energy efficiency and renewable energy. Energy conservation targets in the form of increasing energy use efficiency for the MOD scenario are based on rational targets that can be achieved at a medium cost. Whereas in the OPT scenario, the energy conservation target is the maximum target that might be achieved in accordance with the existing energy efficiency potential.

The Energy Efficiency Scenario is based on the potential for energy efficiency obtained from the previous research.

Table1.
Potential of Energy Efficiency in Central Java Province

No	Sector	Energy Efficiency Potential (%)
1	Household	14 - 20
2	Industry	10 – 25
3	Commercial	25 – 30
4	Others	25 - 30

Source : RUPED, Central Java,2009)

The lower limit of energy saving potential will be used for the Moderate energy efficiency scenario, while the upper limit of the energy saving potential is used for the Optimistic energy efficiency scenario. For the transportation sector, energy efficiency is carried out by shifting modes with the aim of optimizing the use of public transportation to meet the needs of trips in the km-passenger. The target of shifting modes from private modes to public transportation modes is to increase the bus mode load factor from 24.34% to 60% in 2030. Increasing the load mode of the bus mode is done through the transfer of the use of motorbikes and private passenger cars. The amount of diversion from motorcycles and private passenger cars is 14% and 11% in 2030, respectively.

The renewable energy scenario is based on the renewable energy potential in Central Java, while development of renewable energy potentials for the MOD and OPT scenarios based on the results of the Forum Group Discussion (FGD). Biogas and biodiesel are used on the demand side to replace some suitable types of energy. It is assumed that biogas can be used to replace part of the demand for LPG, firewood and coal briquettes in the household sector. The biogas system developed in this study is a household biogas system with 2 head of cattle. Biodiesel is implemented to replace some of the demand for diesel oil in the commercial, industrial, transportation and other sectors.

Table.2
Renewable Energy Development for the Energy Efficiency Scenario (MOD)

No	Types of Renewable Energy	Utilizing Targeted of Renewable Energy				
		2010	2015	2020	2025	2030
1	Solar	25kWp	250kWp	2000kWp	2.500kWp	3.000kWp
2	Water	25kW	50kW	600kW	650kW	750kW
3	Wind	20kW	40kW	80kW	120kW	160kW
4	Bio-gas	300 units	1,000 units	2,500 units	4,000 units	5,000 units
5	Bio-diesel	0	05% solar	1% solar	1.5% solar	2% solar
6	Bio-mass	0	100kW	500kW	750kW	2 MW

Source: FDG

Table.3
Development of Renewable Energy for Energy Efficiency Scenarios (OPT)

No	Types of Renewable Energy	Utilizing Targeted of Renewable Energy				
		2010	2015	2020	2025	2030
1	Solar	25kWp	2MWp	5MWp	7.5MWp	10MWp
2	Water	25kW	600kW	750kW	1,300kW	1,800kW
3	Wind	20kW	50MWp	50MWp	75MWp	100MWp
4	Bio-gas	300 units	1,000 units	2,500 units	4,000 units	5,000 units
5	Bio-diesel	0	2.5% solar	5% solar	7.5% solar	10% solar
6	Bio-mass	0	10 MW	500kW	750kW	20 MW

Source: FDG

Renewable energy scenarios also base on the Minister of Energy and Mineral Resources Regulation, No. 32 of 2008, that every Oil Business Entity and Direct Users are obliged to use pure biofuels in the country as presented in Table 4. and Table 5.

Table 4.
Target Stages Percentage of Biodiesel Use

Sector	2010	2015	2020	2025	2030
Transportation PSO	2.5%	5%	10%	20%	20%
Transportation Non PSO	3%	7%	10%	20%	20%
Industry & Commercial	5%	10%	15%	20%	20%
Power Plants	1%	10%	15%	20%	20%

Source: Minister of Energy and Mineral Resources No.32, 2008

Table 5.
Target Stages Percentage of Bioethanol Use

Sector	2010	2015	2020	2025	2030
Transportation PSO	3%	5%	10%	15%	20%
Transportation Non PSO	7%	10%	12%	15%	20%
Industry & Commercial	7%	10%	12%	15%	20%

Source: Minister of Energy and Mineral Resources No.32, 2008

c. Energy Demand Model

Energy demand modeling in this research uses the final energy approach (final used) where the final energy demand by sector is stated as follows. Aggregate energy intensity (et) can be written as a function of energy use by sector (eit) and activity by sector (ait):

$$et = \frac{Et}{Yt} = \sum \left(\frac{\mathrm{Eit}}{\mathrm{Yit}}\right)\left(\frac{Yit}{Yt}\right) = \sum eit\,.\; ait \qquad (8)$$

In the end-use approach, aggregate energy demand is obtained by summing energy demand at the sector level. Thus the energy demand per sector is designed as follows:

1. Household Sector Energy Demand Model :

$$Ed_h = \sum_1^4 Ih\,x\,(H_{t-1}\;x\;g)\;x\;A_{Ih}\;x\;K_h \qquad (9)$$

2. Transportation Sector Energy Demand Model :

$$Ed_T = \sum_{h=1}^6 IT x\,(T_{t-1}\;x\;g)\;x\;A_i\;x\;K_h \qquad (10)$$

3. Industrial Sector Energy Demand Model :

$$Ed_I = \sum_{h=1}^8 ID x\,(T_{t-1}\;x\;g)\;x\;A_i\;x\;K_h \qquad (11)$$

4. Commercial Sector Energy Demand Model :

$$Ed_I = \sum_{h=1}^6 IK\,x\,(T_{t-1}\;x\;g)\;x\;A_i\;x\;K_h \qquad (12)$$

5. Other Sector Energy Demand Model :

$$Ed_I = \sum_{h=1}^3 IL\,x\,(T_{t-1}\;x\;g)\;x\;A_i\;x\;K_h \qquad (13)$$

Where :

Ed: Energy Demand per Sector
Ih: Energy intensity of the household sector
IT: Energy intensity of the transportation sector
ID: Energy intensity of the industrial sector
IK: Energy intensity of the commercial sector
IL: Energy intensity of other sectors
Ai: Sectoral activity
Kh: Number of sub sectors
g : Sectoral growth

Results and Discussion

a. Estimated Overall Final Energy Demand

A series of analyzes on energy demand and energy efficiency that have been done, in general give an illustration that the simulation of the implementation of energy efficiency programs through the utilization of energy efficiency potential and the development of renewable energy becomes more efficient. Road map implementation of conservation programs through the development of renewable energy and the utilization of energy efficiency potential into the simulation projection scenario for energy use, shows that overall energy use is decreasing every year. Overall energy demand in Central Java uses a BAU scenario, Moderate Energy Efficiency, and an Optimistic scenario showing diminishing use. This condition can be seen in Table 6.

Table 6.
Impact of Efficiency Potential Utilization and Renewable Energy Development on Energy Use in Central Java Province (Thousand SBM)

Scenarios	Year				Growth (%)	Total Energy Use
	2015	2020	2025	2030		
BAU	61.608,51	79.949,81	105.000,94	121.890,90	6,65	1.683.091,24
MOD	59.410,38	75.040,74	94.412,92	106.758,65	5,45	1.554.163,05
OPT	58.252,66	66.511,66	75.441,62	85.401,03	4,72	1.405.829,46

Overall final energy demand in Central Java Province based on the BAU scenario reached 1,683,091.24 Thousand SBM. Based on the Moderate and Optimistic energy efficiency scenario energy use has decreased, respectively by 1,554,163.05 Thousand SBM and 1,405,829.46 Thousand SBM. This means that the use of the OPT scenario has reduced energy use by 16.47% compared to the energy demand using the BAU scenario. This condition can be seen from the Figure 1:

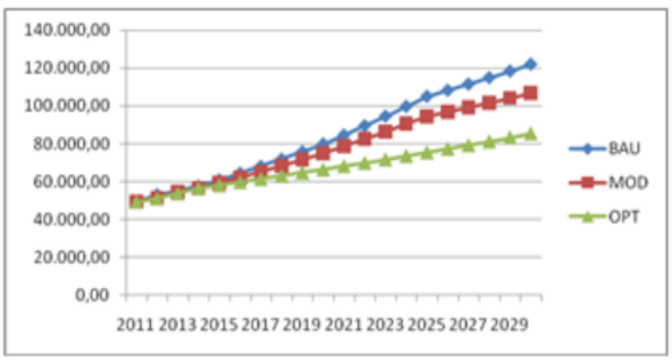

Figure 1: Estimated Final Energy Demand for Central Java Province

Decreasing in total energy use during the projected year through the utilization of energy efficiency potential and renewable energy development programs, in line with the energy mix out-look issued by the Ministry of Energy and Mineral Resources of the Republic Indonesia in 2011-2030. Based on out-look, at the end of 2030 the share of fossil energy will decrease, while the role of renewable energy will increase, from 4.7% in 2010 to 13.5% in 2030 (see Figure 2). From the use of renewable energy, Central Java Province contributes 1.17% to the utilization of renewable energy nationally. As an integrated energy development system, the Central Java Province cannot be separated from the national energy policy. Therefore, one basic policy that needs to be emphasized in energy efficiency planning in this region is to support the implementation of national energy policies.

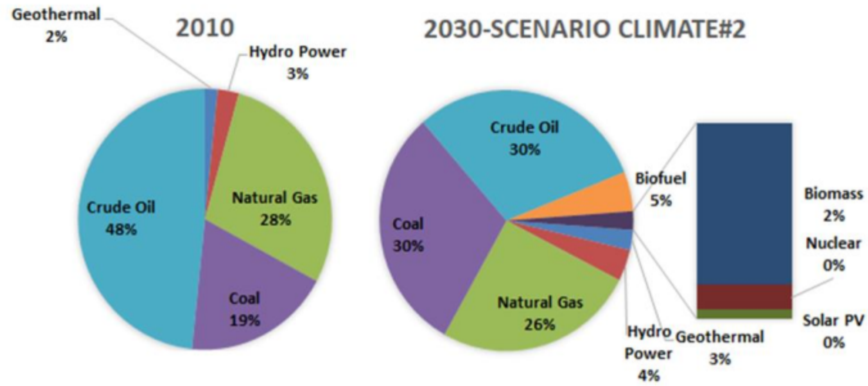

Figure 2: Energy Out-Look

b. Estimated Final Energy Demand by Sector

By sector, energy use in Central Java Province is dominated by transportation sector as the largest consumer, with energy use reaching more than 60% of overall final energy. While the household sector is the second largest consumer at 20.67% of final energy overall. By type of the transportation, two-wheeled modes and private cars dominate energy use, while by income groups in the household sector, the middle-income group is the largest consumer, accounting for 43.34% of the overall final energy demand. This condition can be understood because the number of middle class households is the largest of the total number of households. This condition can be seen in Figure 3 and Figure 4. The implications of the final energy estimation by sector in Central Java Province, the government must be able to provide energy needs in order to guarantee energy supply in this regions.

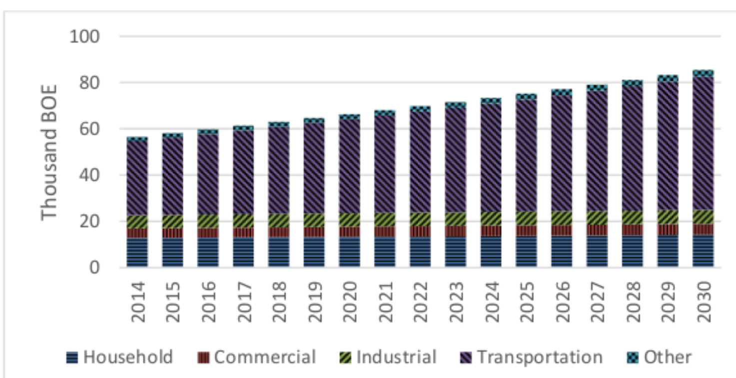

Figure 3: BAU Final Energy Demand by Sector

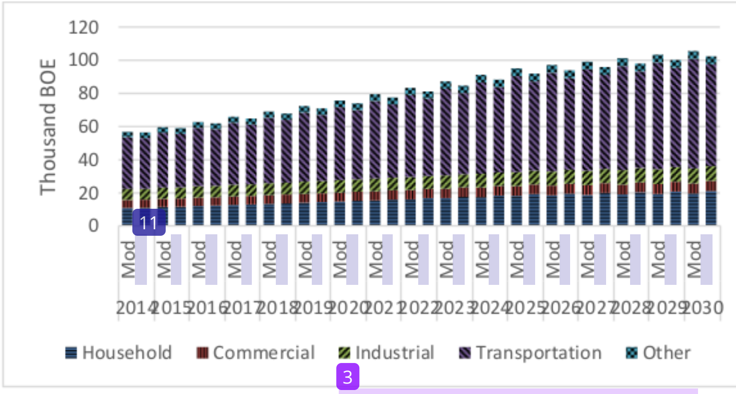

Figure 4: MOD and POT Final Energy Demand by Sector

c. Estimated Final Energy Demand by Types of Energy

Final energy demand by type of energy for all activity sectors under BAU scenario is shown in Figure 5. The demand for premium types of energy in Central Java Province is the biggest use of energy during the projection period. In 2030 premium demand is 33,342.88 thousand SBM or 39.04% of the total energy demand. The use of diesel oil or Automotive Diesel Oil (ADO) is a type of fuel energy with the second largest use after premium, which reaches 25,638.15 thousand SBM or 30% of the total final energy use. Kerosene is the third largest type of energy usage, reaching 7,942.88 thousand SBM, or 9.3% of the total final energy in 2030. Under the MOD and OPT energy efficiency scenarios, premium is also the biggest energy use during the projection period, reaching 33,342.88 thousand SBM or 39.04% of the total final energy demand. The use of electricity during the projection year is also still quite large, due to the large population and the large number of middle class industries in this province. In detail this condition can be seen in Figure.6. As the price of kerosene is released through the market mechanism, and converted to LPG, the use of firewood becomes greater during the projected year. This condition indicates that not all communities targeted by the government to use LPG use this energy. This is because the community feels less familiar with the use of gas stoves as cooking tools, as well as many industries or household businesses that are still loyal to use firewood for cooking.

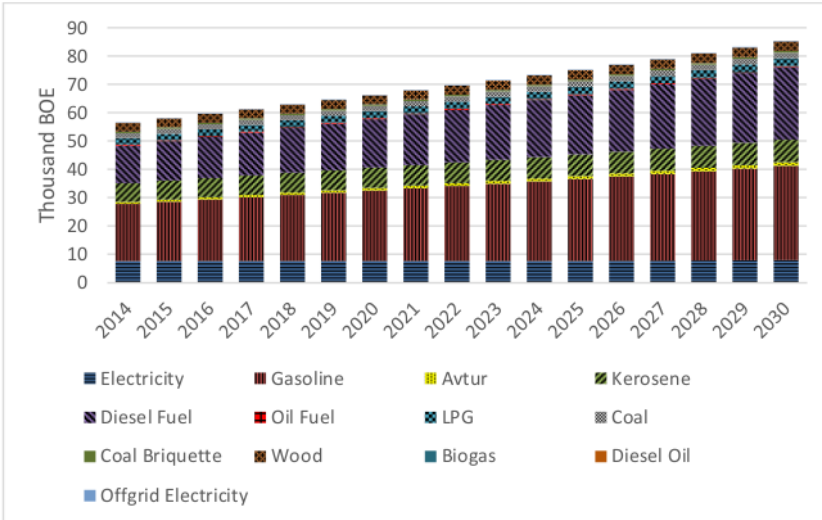

Figure 5: BAU Final Energy Demand by Types of Energy

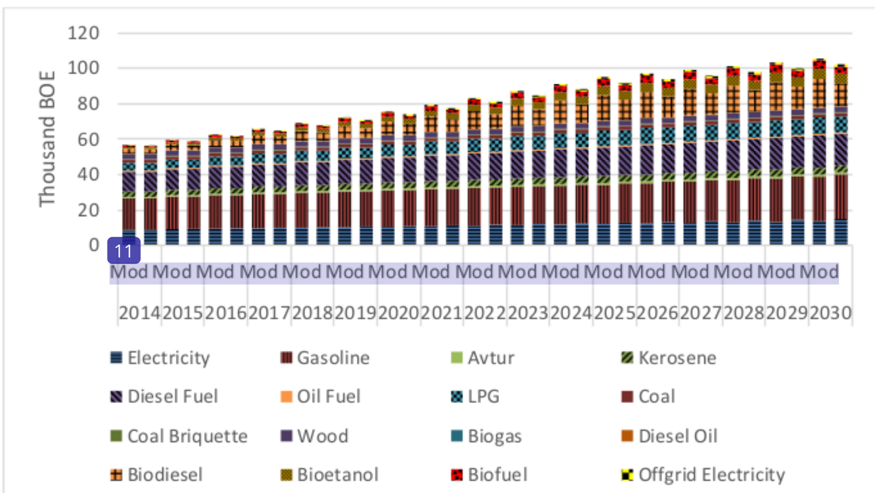

Figure 6: MOD and POT Final Energy Demand by Types of Energy

Implications of the final energy estimates per sector in Central Java Province, then to ensure energy supply in this region, the government must be able to provide energy needs as shown in the following Table 7.

Table 7. Energy Needs in 2030

No	Central Java Province	
	Energy Types	Energy Needs
1	Electricity (MWh)	12.837.719,22

2	Oil/Premium (KL)	8.087.759,69
3	LPG (Ton)	1.050.735,52
4	Coal (Ton)	459.523,92
5	Coal Briquettes (Ton)	134.101,24

d. Energy Use Efficiency

Conservation actions and programs for energy use, in accordance with the scenarios used, namely efficiency measures by utilizing existing potential efficiency, conservation and diversification of energy through the development of renewable energy have resulted in more efficient use of energy. The efficiency of energy use is indicated by the level of elasticity of the use of energy to economic value added. Energy elasticity below 1.0 will be achieved if the available energy has been used productively. High energy efficiency figures indicate that energy use is inefficient or wasteful. This condition also indicates the low competitiveness of the industry due to energy inefficiencies that have an impact on high production costs. Energy Efficiency in Central Java Province can be seen in Figure .

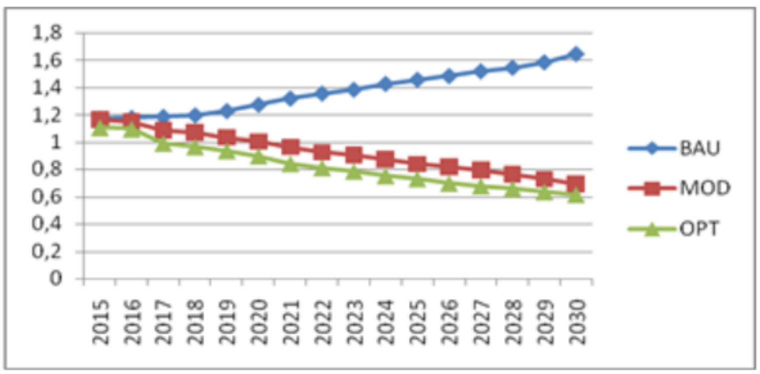

Figure 7. Energy Use Efficiency in Central Java Province

From the Figure 7 confirmed that Energy Efficiency in the Central Java Region by using the BAU Scenario until the end of the year the projection is still greater than 1 (e> 1), both for electricity and fuel energy. This condition illustrates that the use of energy in the Central Java Province has not been efficient or wasteful, because to increase 1% of economic growth requires greater amounts of energy. Meanwhile based on energy efficiency scenarios, both moderate and optimistic by including aspects of energy conservation policies as stated above, Energy Efficiency in Central Java Province until the end of the year is projected to be less than 1 (e <1), both for electricity and oil . Efficiency of energy use based on the MOD scenario starts to be achieved in 2021 until the end of the projection year, whereas based on the OPT scenario energy efficiency has been achieved in 2017. This shows that with various implementation of conservation programs the Central Java Province can optimize energy use to be more efficient. The implication is that to increase economic growth by 1% will only require the use of less energy, and the available energy will be used productively.

Conclusion

a. Based on the projected final energy demand per sector, in 2030 the use of energy in the Central Java Province region increased by an average of 5.6% per year with overall final energy demand of 1,683,091.24 thousand SBM, 1,554,163 thousand SBM and 1,405,829.46 thousand SBM for each BAU, MOD, and OPT scenarios. The decline in overall energy use based on the scenarios developed occurred due to the utilization of energy efficiency potentials and the development of renewable energy potentials contained in the Roadmap of the 5 year renewable energy development program up to 2030.

b. Energy demand in Central Java is still dominated by the transportation sector, with the percentage of use of more than 60% of overall final energy demand. The household sector is the second largest consumer at 20.67%.

c. Under BAU scenario, energy use in the Central Java during the projection year is still inefficient (e> 1). This condition indicates the low of economy sector competitiveness due to energy inefficiency that will have an impact on high production costs. Energy use in the Central Java Province began to achieve efficiency in 2021 and 2017 respectively based on Moderate and Optimistic scenarios. This indicates that energy efficiency programs where energy use is efficient and rational without reducing the energy that is really needed to support regional economic development

d. In this study, the end-use approach is used as a parameter of energy demand for each sector, where the amount of energy that is actually used or consumed by the economic sector to carry out its activities. Thus this approach can be used as a reference in developing non-price-based energy demand models or non-price-based energy policies.

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