



## A Comparison of Energy Profile between Castilla Leon, Spain and Aceh, Indonesia

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### Abstract

A comparative study on energy production and consumption between Aceh, Indonesia and Castilla León, Spain has been conducted. Analysis was carried out on the statistical data such as population, GDP, energy production and energy consumption. Some interesting results were obtained. An average energy production during 2001 – 2004 in Aceh is up to 28 times of the average energy production in Castilla León; however, the average energy consumption during those four years is only 16.74% of the average energy consumption of Castilla León. Aceh's average GDP from 2001 to 2004 is 3,357.16 million Euros, stands at only 8.15% of Castilla León's average GDP about 41,175.75 million Euros.

*Keywords:* economic growth, final energy consumption, GDP, primary energy production

### 1. Introduction

It has been known that there is a strong relationship between energy consumption and economic growth. Thus, energy consumption in one community evidently describes the economic growth of that community. Studies on causal relationship between energy consumption and economic growth have been performed in numerous countries, time periods and have applied several proxy variables. Some of those studies showed the unidirectional causality and the others were bi-directional causality (Kraft and Kraft, 1978; Yu and Choi, 1985; Erol and Yu, 1988; Abosedra and Baghestani, 1989; Hwang and Gum, 1991; Masih and Masih, 1996, 1997, 1998; Cheng and Lai, 1997; Glasure and Lee, 1997; Cheng, 1999; Asafu-Adjaye, 2000; Aqeel and Butt, 2001; Chang and Wong, 2001; Glasure, 2002; Soytaş and Sari, 2003; Ghali and El-Sakka, 2004; Jumbe, 2004; Oh and Lee, 2004; Wolde-Rufael, 2004).

Energy is essential to economic and social development and to improve quality of live. A cheap and stable energy supply is a prerequisite. However, to ensure the sustainability of energy consumption and production is a very difficult task. Hence, it is very important to know the energy consumption profile as an input to develop a sustainable framework in energy

consumption and production. Generally, national sustainable policy targets and strategies are defined according to what is prescribed by Conventions and Protocols. For the international level, Kyoto Protocol has been established. At the European level, there is a set of Directives [such as Directive on internal electricity market and Directive on promotion of electricity from renewable energy (RE) sources] (EC, 1999) and official documents [such as White Paper for a Community Strategy and Action Plan, Energy for the Future: Renewable Sources of Energy] (EC, 1997) that is aiming to increase the use of renewable energy sources to an amount that equal 12% of the EUs gross inland energy consumption by 2010.

To execute the European Promotion Plan of Electricity from Renewable Energy Sources (RES-E) in level national and regional, Spain has the Spanish RE Promotion Plan. By this sustainable energy strategy, the share of RE in total electricity generation (17.3 MTOE, million tons of oil equivalent) is 7.2% if large hydro (over 10 MW) is excluded. However, the state of RETs development among the territories can be deemed very irregular. In several regions certain RES have already reached the saturation point, while others have not yet even been developed. Castilla León shows much lower level of RET development which only concerns on solar thermal energy, so that the participation of

RE in the final energy consumption (FEC) consequently is low (Hernández *et al.*, 2004). Now we turn the overview to Indonesian side, the sustainable development policies and strategies are formulated in Blueprint of National Energy Management (PEN) 2005-2025. In 2004, one year before the blueprint is established; Indonesia has installed electrical-generating capacity as about 21.4 GW in which 13% came from RES (EIA, 2004). At this state, the contribution of RE in national FEC was only 1.3%. According to the blueprint, target of RE in primary energy becomes as 10.6% (optimization scenario) in 2025 from the base line of 5% in 2003 (DESDM, 2005). Especially for Aceh, the data for the share of RE in electricity generation is not clear because more than 70% of electricity consumed in Aceh is supplied from Center for Load Control and Transmission (P3B) Sumatra (Embang, 2005).

The study is addressed to analyze the FEC profile of two quite different economic growth areas, Castilla León and Aceh. Since the pattern of FEC in each territorial in Spain and Indonesia is very heterogeneous, as mentioned above, then by selecting the small region for observation the homogeneity in a concerned topic seems more achievable. The discussion will reflect how effective those two policies and strategies to reach the future targets in sustainable development. Based on the facts, some recommendations will be launched as the input to correct the policy and strategy for the future sustainable planning in energy development for both side, Castilla León and Aceh.

## 2. Methodology

The study was conducted by analyzing the static data such as energy resources, energy productions, energy consumptions and regulation documents on policy and planning for both states, Castilla León and Aceh.

## 3. Results and Discussion

### 3.1 General Views of Area

#### **Aceh**

Aceh (full name: Aceh Province) is a special

territory of Indonesia, located on the northern tip of the island of Sumatra. Usually, the special territories have more autonomy from the central government than other provinces. Population in Aceh according to National Social Economy Survey (Susenas) 2004 is 4,075,599 with the total area is 57,365 km<sup>2</sup>. By these population and total area, the density of population is about 71/km<sup>2</sup>. Energy resources in Aceh can be said as an abundant such as oil, natural gas, coal (lignite and sub-bituminous), hydropower, geothermal, wind, solar and biomass. However, primary energy produced in Aceh is only crude oil, natural gas, and biomass. The FEC in 2004 was dominated by oil as much as 90% (Khairil *et al.*, 2006).

Estimated reserves of oil in Aceh are approximately 17.5 billion barrels, most of which is in northern offshore. Meanwhile, natural gas reserves in Aceh are predicted as 17,137.5 billion standard cubic feet. Largest part of produced natural gas in Aceh is exported to Japan and South Korean. Historical summary of oil and natural gas lifting is shown in Table 1. Another un-renewable energy resource in Aceh is coal in which the hypothetical reserves are estimated as 1.7 billion tons (Khairil *et al.*, 2006). Unfortunately, coal is not commercially mined yet. To utilize that coal, a 15 MW of coal-fuel electric power generation was installed and a 2×110 MW is under construction in Nagan Raya district now.

Moreover, for renewable energy resources, Aceh has a considerable potential such as hydropower, geothermal, wind, solar and biomass. There are many rivers in Aceh. Total of hydropower potential is about 2,050 MW. Until the end of 2005, Aceh had 12 micro and mini-hydroelectric power plants in operation with the total installed capacity 2,661 kW, ranging in size from 15 to 1,880 kW. In 2012, two hydroelectric power generations with the capacity of 2×84 MW will be established through the Peusangan projects. Geothermal potential is predicted as 862 MWe and there is no exploitation activity yet on this energy resource. Today, Aceh has installed solar capacity about 39.85 kWp (797 units in the whole province). Development of solar cell seems has a high possibility since

**Table 1.** Oil and natural gas lifting in Aceh, 2001-2004 (Directorate General of Oil and Gas in Khairil *et al.* (2006)).

	2001	2002	2003	2004	2005
Oil (thousands of ton per year)	812.76	1,273.43	1,349.06	1,117.16	783.97
Natural gas (million of m <sup>3</sup> per year)	4,597.35	7,833.19	8,671.43	6,878.55	7,050.93

Aceh got the average radiation of 4.10 kWh/m<sup>2</sup> day (Khairil *et al.*, 2006).

About wind energy, the available data are only wind velocity for three representative cities: Banda Aceh, Meulaboh and Sabang with the interval velocity 1 - 6.5 m/s. Another plentiful resource for renewable energy in Aceh is biomass, which is possible to produce about 140 thousands TOE of energy per year. This number of biomass potential was only accounted base on the rice husk, bagasse, palm shell and stem of an ear of corn (Khairil *et al.*, 2006). There are hundred of other biomass resources from agriculture waste and forestry such straw, palm empty bunch, palm stem, wood, coconut fiber, coconut shell, sawdust, etc., however, their accurate data are not available yet.

### Castilla León

Castilla León, known formally as the Autonomous Community of Castile and León is one of the seventeen autonomous communities of Spain. The autonomous community of Castile and León is the largest in Spain and almost in the European Union. It covers an area of 94,223 km<sup>2</sup> with an official population of 2,510,849. The density is 26.65/km<sup>2</sup>. Primary energy produced in Castilla León are coal (bituminous and anthracite), oil, natural gas, hydropower, nuclear, wind and biomass. Proven reserves of coal are approximately 275 million tons (MINER, 1992). The share of coal in the primary energy production in 2005 was more than 55% and total of energy production contributed at 16.63% of national energy production. Similar to Aceh, the FEC in 2005 was mostly oil (58.11%) (JCYL

The highest potential of renewable energy resource in Castilla León is on-shore wind energy which is possible to install the electric power as high as 188,000 MW. Solar

photovoltaic integrated into buildings stand at the second position with the estimated capacity of 34,000 MW. Further, hydroelectric power can reach a capacity of 5,865 MW or 31.2% of national hydroelectric potential. The last rank is occupied by biomass with the probable electric power capacity of 4,203 MW (GP, 2005). Total of biomass use in 2004 was accounted as 448.21 KTOE and the installed electric power plant from biomass is some of 11 MWe. In 2007, a big electric power generation (2,840 MWe) will be constructed in Castilla León from the co-combustion of coal and biomass. The share of biomass in this plant is predicted about 10%. In addition, the capacities of existing bioethanol and biodiesel plants (to treat the used vegetable oil) are 335,000 and 5,200 tons/year, respectively. A new biodiesel plant from sun flower oil with the capacity 65,000 tons/year will be built in the year 2007 (MITYC).

### 3.2 Energy production and consumption profiles

Production of primary energy in Aceh is generally oil, natural gas and biomass as presented in Table 2. It is seen that the production of primary energy in Aceh is dominated by oil in which its share is higher than 90% in each year. On the other hand, the Castilla León primary energy production was dominantly occupied by coal during last five years as shown in Table 3. An average energy production during four years from 2001 to 2004 in Aceh as high as 122.28 MTOE is a fantastic data because this energy production level is up to 28 times of the average energy production in Castilla León of 4.35 MTOE.

A very good pattern of data in Table 2 is exhibited by biomass that tends to increase year by year. Based on this fact, the use of

**Table 2.** Primary energy production in Aceh, 2001-2004, in KTOE (Khairil *et al.*, 2006).

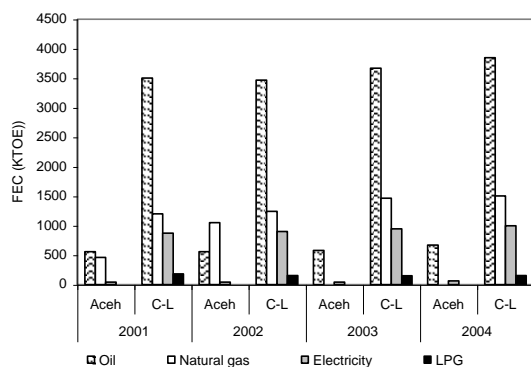
Year	Oil	Natural gas	Biomass	Total
2001	81,275.52	8,886.67	127.59	90,289.79
2002	127,343.04	8,357.29	130.50	135,830.84
2003	134,906.17	8,499.72	151.98	143,557.87
2004	111,716.25	7,571.53	153.11	119,440.88

**Table 3.** Primary energy production in Castilla León, 2001-2004, in KTOE (JCYL)

Year	Coal	Oil and natural gas	Hydropower	Nuclear	Wind energy	Total
2001	2,626.77	8.41	1,092.48	931.73	55.43	4,714.81
2002	2,420.54	9.11	517.95	1,041.01	92.69	4,081.30
2003	2,398.58	7.89	1,093.82	974.39	133.48	4,608.16
2004	2,339.35	6.91	776.41	1,055.32	201.28	4,379.28

biomass as a future energy source in Aceh must be paid a high attention by the local government beside the hydropower, solar and geothermal if Aceh wants to achieve the target in PEN. The possible total capacity of electrical power from biomass is around 200 – 250 MW. In Castilla León, the very beautiful patterns of data are presented by coal and wind energy that tend to decrease and increase, respectively year by year (see Table 3). These evidences indicate the planning in energy production is going well in order to meet the target of White Paper of 12% of renewable energy sources. Average increasing rate of wind energy production for period of 2001 – 2004 is 54% per year. Hydropower still shows a fluctuating data.

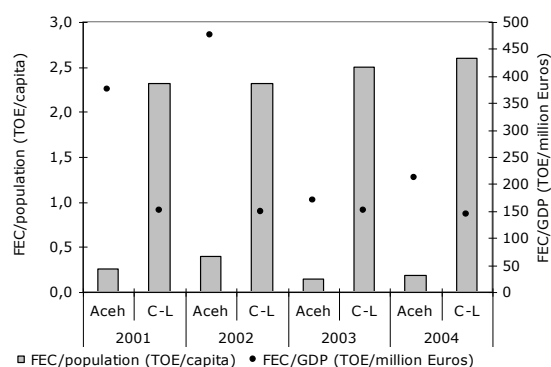
The opposite phenomena will be faced when it is talking about the FEC. Fig. 1 indicates that the average energy consumption during the same four years in Aceh is only 16.74% of the average energy consumption of Castilla León. Particularly for the years of 2003 and 2004, the data on natural gas consumption in Aceh are not available. It should be note that, the actual energy consumption in Aceh may higher than this number when natural gas and LPG take into account. More and more, the leak of data on use of LPG is also faced at the moment. Even though, it is obvious that Aceh people consume less energy than Castilla León. Less in energy consumption means less in the economic growth. This statement is supported by the GDP data. Aceh's average GDP from 2001 to 2004 (3,357.16 million Euros) (Khairil *et al.*, 2006) stands only at 8.15% of Castilla León's average GDP (41,175.75 million Euros) (MAP). It is seen that, the high production of energy in Aceh does not ensure the positive economic growth. This is one reason among the many reasons which prove that the fully centralization of government is not effective in economic development process.



**Figure 1.** Comparison of the FEC between Aceh and Castilla León (C-L)

An un-expected fact from Figure 1 is that the dependence upon oil is still high both for Aceh and Castilla León. This is not good since the world oil price goes up year by year. A reasonable behavior is given by natural gas and electricity consumptions in Castilla León, which starts to increase slightly. It is expected the share of renewable sources in electricity also rises by taking into consideration the Spanish RE Promotion Plan. In regard to this program, some RES electric power generations will be built in the near future as was mentioned in part 2. By this way, the dependence upon oil can step by step be minimized.

Figure 2 presents more clearly the less economic growth and un-efficient of energy used in economic activities in Aceh province. Fortunately, Castilla León provides the reverse behaviors. An economic indicator of FEC/population of Aceh is much and much lower than Castilla León. According to Masih and Masih (1996) who provided the study on the causality of energy consumption and economic growth in Indonesia in 1996, they concluded that the real income causes energy consumption, than the low GDP for Aceh corresponds exactly to the low energy used as can be seen in Fig. 2. Furthermore, Asafu-Adjaye (2000) is also performing the same investigation in 2000. The study found that Indonesia shows the unidirectional causality: energy consumption causes income (economic growth). Therefore, the data in Figure 2 say frankly the lowest income for Aceh people compare to Castilla León people. It may below the standard of life.



**Figure 2.** Comparison of the FEC between Aceh and Castilla León (C-L).

Sharp decline of FEC/population in the years of 2003 and 2004 for Aceh are one more time due to the leak of information on natural gas consumption. Higher of FEC/GDP (known as energy intensity) in Figure 2 brings Aceh to un-efficient use of energy statement. Aceh

spends a lot of energy to produce a few incomes. This may also be influenced by the system of government management. A lot of income-generating sectors are prone to corruption and manipulation. To reduce this crucial parameter, it is essential for Aceh government to implement simultaneously the high efficiency use of energy and good governance programs, besides doing the deep effort to develop continuously RE utilization technology.

#### 4. Conclusions

Utilization of energy and use of renewable energy sources in Aceh do not reflect a good profile yet, therefore, the proper energy model is very important for the future of Aceh besides doing the PEN Blueprint and any others Indonesian government regulations. The average energy consumption during the four years (2001 to 2004) in Aceh is only 16.74% of the average energy consumption of Castilla León. Moreover, Aceh's average GDP from 2001 to 2004 is 3,357.16 million Euros, stands at 8.15% of Castilla León's average GDP about 41,175.75 million Euros. Lower GDP (economics growth) for Aceh corresponds exactly to low energy used, in opposite higher GDP for Castilla León relates to high energy consumption. FEC/population, as an economic indicator, of Aceh is much and much lower than Castilla León.

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