A brief study on the energy condition of Germany and their future prospect in the energy sector

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Abstract— Germany is one of the powerful countries in the world. With many respect Germany is holding their position with dignity. They are rich in almost every sector of power and energy sector. This paper aims at analyzing the power and energy scenario of this country and their future probable prospect in the energy world.

Index Terms— Nuclear Power, Electricity, Coal, Energy Edfficiency etc.

1 Introduction: Germany

LOCATED in central Europe, Germany is made up of the North German Plain, the Central German Uplands (Mittelgebirge), and the Southern German Highlands. The Bavarian plateau in the southwest averages 1,600 ft (488 m) above sea level, but it reaches 9,721 ft (2,962 m) in the Zugspitze Mountains, the highest point in the country. Germany's major rivers are the Danube, the Elbe, the Oder, the Weser, and the Rhine. Germany is about the size of Montana [1]. This country consists of 16 states and its capital and largest city is Berlin. Germany covers an area of 357,021 square kilometers (137,847 sq mi) and has a largely temperate seasonal climate. With 81.8 million inhabitants, it is the most populous member state in the European Union. Germany is one of the major political and economic powers of the European continent and a historic leader in many theoretical and technical fields [2].

2 Overview

Germany is the largest energy consumer in Europe [Except Russia], and the seventh largest energy consumer in the world. It is also the fourth largest economy in the world by nominal gross domestic product (GDP) after the United States of America, China, and Japan. Its size and location give it significant influence over the European Union's energy sector. Oil continues are Germany's primary source of energy. They are making up 38% of Germany's total primary energy consumption in 2011. The transportation sector makes up the majority of petroleum product demand [3].

The table below shows the average picture of energy situation in Germany [6].

Energy in Germany						
Years	Capita	Prim. energy	Production	Import	Electricity	CO_2-emission
	Million	TWh	TWh	TWh	TWh	Mt
2004	82.5	4,048	1,582	2,509	580	849
2007	82.3	3,853	1,594	2,344	591	798
2008	82.1	3,899	1,560	2,453	587	804
2009	81.9	3,705	1,478	2,360	555	750
2010	81.8	3,807	1,528	2,362	590	762
Change	-0.9 %	-5.9 %	-3.4 %	-5.9 %	1.7 %	-10.3%
Mtoe = 11.63 TWh, Prim. energy includes energy losses that are 2/3 for nuclear power						

3 Electricity

In the field of electricity generation Germany is already leading one of the topmost positions among the world leaders. In the year of 2009 the electricity produced from the fossil fuel sector was 61%, neuclear power 21% and renewable energy (which includes wind, solar and hydro electricity) was almost 18% of the total electricity production. Germany has defined a planned policy of phasing-out nuclear power by 2022. Comparing 2009 to 2004, nuclear power production has declined 19%. Its share has declined from 27% to 23% of total power production, partly being substituted with a rise in renewable electricity: wind power, biomass and solar power but also an increase in coal and natural gas consumption. The planned phase out of nuclear power may increase coals share of power production to over 50% [4][5]

3.1 Capacity

Germany had over 120 gigawatts (GW) of capacity in 2005[7]. Coal made up the largest share; together, bituminous coal and lignite had 36% of capacity. Installed nuclear capacity comprised 17% of total capacity. While combined renewables (excluding hydro) provided about 10% of electricity generation [8], it represented a large share of capacity, with wind alone totalling 15%. This reflects the low capacity factor – the percentage of time a plant is generating power out of the maximum – of renewable energy technologies, a consequence of their intermittency. Natural gas, which provides about 11% of generation, had 14% of installed capacity.

3.2 Generation

In 2005, over 613 terawatt-hours (TWh) of electricity were generated in Germany, a slight increase from 2004 and an 8.1% increase from 2000 (see Table 18). Over the last decade, total electricity consumption has grown by over 15%, at an average annual rate of 1.4%. In 2005, the largest share of electricity (50%) was generated from coal. This represents a general decline since 1985, when nearly 62% of electricity was generated from coal. At the same time, the amount of electricity generated from natural gas has nearly doubled, from 5.4% in 1985 to 11.3% in 2005. The share of electricity generated from nuclear (27%) has remained mostly steady since 1985. The largest growth has been in electricity generated from renewables (including biomass, solar, hydro and wind, and excluding non-renewable waste). The share has grown at an average annual rate of 9% since 1995, rising from 3.9% in 1985 to 4.9% in 1995 to 10.1% in 2005. In order to match declining demand, from 2010 to 2030, total electricity generation is forecast to fall by an average annual rate of 0.3%, reflecting decreases in electricity produced from coal, oil and nuclear, along with increases in all other fuels.[9]

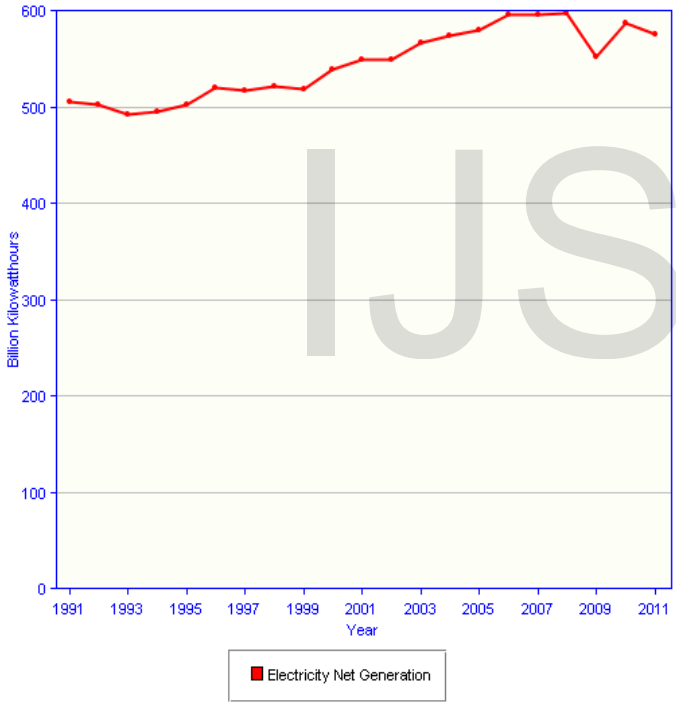


Figure 01: Net Electricity Generation from the year 1991 to 2011[10]

3.3 Demand

Total final consumption of electricity was 44.5 Mtoe in 2005, reflecting an average annual increase of 1.4% over the last decade (see Figure 14). Growth in the last decade outpaced growth from 1985 to 1995, which averaged 0.4% annually. The largest share of electricity, 45%, is used in the industry sector, followed by the residential sector and other sectors. Total final consumption (TFC) of electricity is expected to hold flat between 2010 and 2030. Small increases in consumption in the industrial sector are expected to be offset by small decreases in residential and other sectors. Germany's highest peak load in 2005 was recorded on 15 December at 76 700 MW, a slight decrease from the 2004 peak of 77 200 MW.

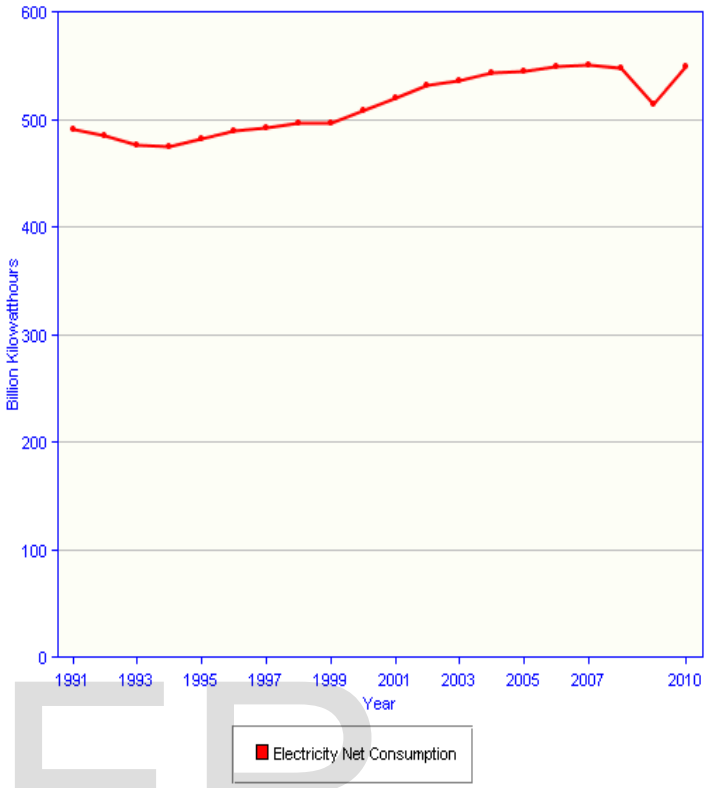


Figure 02: Net Electricity consumption from the year of 1991 to 2011[10]

4 Coal

Coal is one of the major important sources for energy generation. It is a conventional energy source of energy generation. The efficiency is higher but this source has some negative sides too. Coal is a fossil fuel. And the reservation of the fossil fuel is going to be finished within the near future. On the other hand the generation process is also polluting environment. So this is a threat to the global environment too. From the energy servey report of the year 2007 it is seen that Germany has only used 49% of the coal as the fuel to generate electricity where at the same time Africa and China have produced 94% and 84% electricity from coal [9].

4.1 Production

Germany produces about 70% of its coal supply on an energy-equivalent basis, more than two-thirds of which is lignite, or brown coal, with the remainder being hard coal (including anthracite and bituminous coal). Since 2000, production of hard coal has declined by 25%. This decline in production has been offset by a revival in the production of lignite, which has risen by over 6% since 2000, and is a significant domestic energy source in Germany. On a tonnage basis, 2005 coal production in Germany totalled 28.0 million tonnes (Mt) of hard coal and 177.9 Mt of lignite[9].

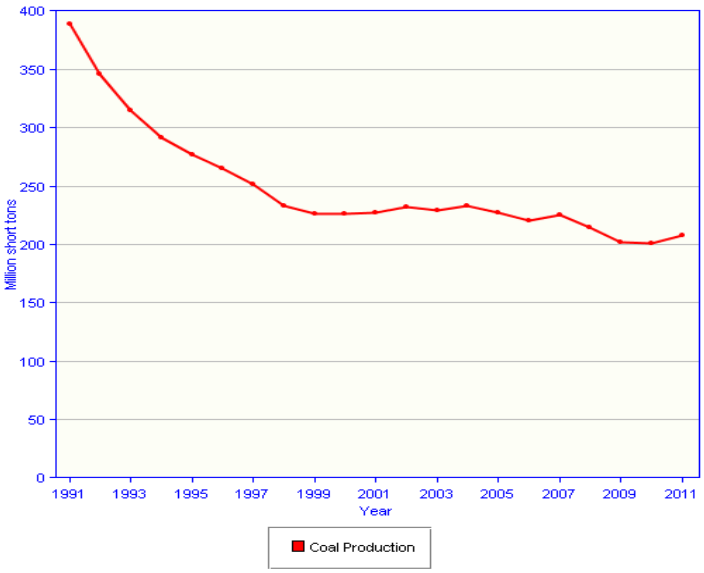


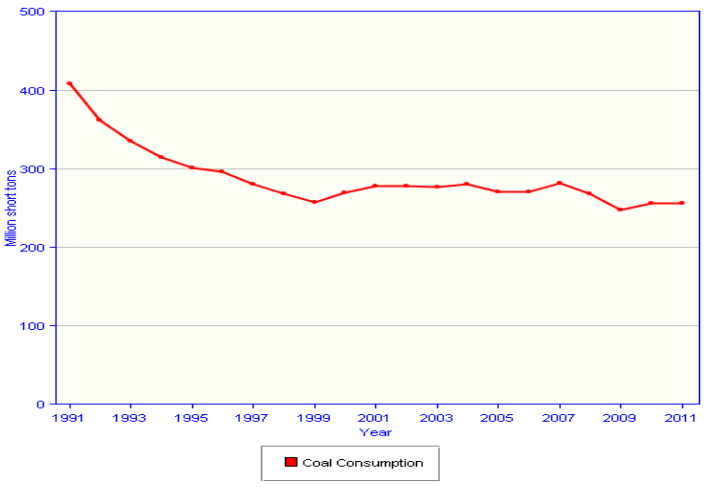
Figure 03: Net Coal production from the year 1991 to 2011[10]

4.2 Reserves

The Federal Institute for Geosciences and Natural Resources (BGR) reports that German hard coal reserves totalled 152 Mt at the end of 2005,12 a figure that should be treated with some caution given that current production is uneconomic. The same report indicates that German lignite reserves are 41.2 billion tonnes, ranking Germany first globally. Of the total, 6 556 Mt are reserves of opencast lignite in permitted, operational sites with planning provisions. Germany's substantial national lignite resources are around 76 billion tonnes.

4.3 Consumption

Nearly all coal is used in the electricity and industrial sectors.



In 2005, the electricity sector accounted for 83% of consumption, with 11% used in the industrial sector. Total hard coal

Figure 05: Net Coal Consumption from the year 1991 to 2011[10]

consumption, including for electricity generation, has fallen by nearly 6% between 2000 and 2005 and by nearly 20% since 1990. Lignite consumption decreased by nearly 50% between 1990 and 2005, though it has increased by nearly 6% in recent years, between 2000 and 2005.

5 Nuclear Power

Nuclear power in Germany accounted for 23% of national electricity consumption,[11] before the permanent shutdown of 8 plants in March 2011. German nuclear power began with research reactors in the 1950s and 1960s, with the first commercial plant coming online in 1969.

It has been high on the political agenda in recent decades, with continuing debates about when the technology should be phased out. The topic received renewed attention at the start of 2007, due to the political impact of the Russia-Belarus energy dispute and in 2011, after the Fukushima I nuclear accidents.

6 Energy Efficiency

The energy efficiency bottom-up index for the whole economy (ODEX) in Germany decreased by 18% between 1991–2006, which is equivalent to an energy efficiency improvement by 1.2% per annum on average based on the ODEX, which calculates technical efficiency improvements. Since the beginning of the new century, however, the efficiency improvement measured by the ODEX slowed down. Whereas between 1991 and 2001, a continuous decrease by 1.5%/y could be observed, the decrease in the period 2001-2006 only amounted to 0.5%, which is below the EU-27 level[12]. By 2050 Germany projects a 25% drop in electricity demand[13].

7 Energy Policy and Trends

1. Germany will expand the share of renewable energies. For electricity from renewable an expansion target of 25 - 30 percent by 2020 was agreed. It was also agreed to increase the share of renewables in the heat sector to 14 percent by 2020. A biogas feed-in act rounds off the measures relating to renewables. In this way we are ensuring that there is an increased use of biogas as a fuel and in power plants in future.

2. Germany will substantively expand the environmentally friendly and particularly efficient generation of electricity and heat in combined heat and power (CHP) plants. With an amendment to the law we aim to achieve our long-stated aim of doubling the share of CHP in electricity generation by 2020, to approximately 25 percent. This is bolstered by an average funding volume of 750 million euro. The expansion of local and distance heating is included in the support with an investment grant of up to 20 percent and a volume of 150 million euro.

3. Germany will stride ahead with more stringent requirements for energy efficiency in buildings. The energy efficiency requirements placed on buildings will be progressively adjusted to reflect the latest technological developments and movements in energy prices. As of 2020, new buildings should be heated as far as possible without the use of fossil energy sources. Therefore as a first step the energy requirements for buildings will be raised by an average of 30 percent in the coming year (2008), with up to another 30 percent increase envisaged for 2012. This provides a major impetus for the construction industry and gives tenants substantial savings in their heating costs. Allowances are forseen for cases of finan-

cial hardship among those affected. Exceptions, in particular, for buildings protected by heritage-conservation law or scheduled for demolition. Retrofitting obligations will cease to apply if retrofitting is uneconomic even when funding options are taken into consideration. Appropriate transitional periods for the cost intensity of the measures. Funding under the modernisation programme to reduce CO2 emissions from buildings.

4. The German Government will act rapidly to formulate its position in order to develop a stable legal framework for CCS at the European level. The European Commission will present proposals for a directive intended to put in place a legal framework for CCS before the end of the year. As concerns the measures for the development of CCS technology being pursued at the moment in Germany, current mining and environmental law provides a basis for the conduct of the forthcoming research projects. A suitable legal framework for underground CO2 storage on an industrial scale (including the planned demonstration power stations), transport and capture must be developed in Germany on the basis of the European directive announced for November 2007. To make sure that industrial-scale projects for the permanent storage of carbon dioxide can be realised while taking account of European targets, binding standards are to be drawn up that ensure the carbon dioxide is sealed off permanently from the atmosphere and otherwise guarantee its secure, environmentally compatible storage over the long term.[14]

5. Germany's Critical Agenda

"Energiewende (Energy turnaround)" takes place in the country, and it seems to further accelerate the building of new power plants as they have decided to fully exit out of nuclear power by 2022. "Energiewende" is not Germany's sole issue, and it might affect other neighbour countries as it is not confined within the country. With 30GW of Solar PV plus 20GW of wind power installed, on windy sunny holidays, the German electricity transmission network might need to get ready for more frequent cross-border exchanges of power with its neighbours while conventional plants have to stop and stay in stand-by. It would also require the grid expansion of transmission and distribution lines as well. All of them would result in costing consumers much. Energy price is significant issue. The investors to renewables are well covered as they have guaranteed fixed prices for 20 years ahead, they get paid whether or not the power has been picked up, and they will not pay the transportation of electricity. The country has been paying 5 cents/kWH for wholesale plus the premium of above 5 cents/kWH for renewables. The necessary action includes that the market model/grid need to be re-designed. Though some investment is happening, it is mostly encouraged by the feed-in tariffs, and the down side is the country or most of other Europe countries can't cope with it so easily. The removal of trade barriers and the protection of intellectual property rights for inventions [patents and license] are priorities as the country is more tied to China/India economy[15].

7 EPILOGUE

Germany is a leading country in almost every sector of the world economy and energy. This is quite impossible to describe almost every part of the energy scenario of germany in one paper. Here only three parts of the energy, Electricity, Coal and Nuclear Power has been discussed shortly.

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