Energy Policy and Implementation in Pakistan: A Gap and Energy Consumption Analysis in Pakistan

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Dedication

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Abstract

Energy is principal factor of any nation for its economic growth. In this research the relation between energy consumption and economic growth is articulated. Energy consumption in Pakistan is mainly dependent upon conventional fuels that are usually imported and also linked strongly with Gross Domestic Product. In this research, energy model Long-Range Alternatives Planning System (LEAP) is used and different scenarios are studied to evaluate energy demand for 2013 and predicted till 2040. This analysis postulates and uncovers the new horizons for the think tanks to the dissipated headway of energy sector of Pakistan to meet the widespread challenge of energy needs in coming years. This study aims to analyze the proposed and prevalent Energy policies in Pakistan and to identify conditions/gaps in the policy implementation that apparently accounted for energy crisis. The research is intended to convey messages and knowledge about the energy system and issues and improve the policy making process. This analysis will provide a useful insight for policymakers when designing policies for energy efficiency improvement. The existing Energy Policy does not prove to be successful because it is not environmentally friendly, the electricity rates appear to rise for a long-period and it has high dependence on imported furnace oil. In addition to this, a weak relation exists between electricity demand and electricity supply along. Therefore a gap analysis study will be carried out to study the energy policy and its implementation gaps and solutions to these problems will be laid down.

Key words: Energy Policy, Energy Efficiency, Energy Gap Analysis, LEAP

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As 1st Author

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National Multidisciplinary Engineering Conference (NMEC-15)

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*Attached as annex 1

List of the Abbreviations

RE	=	Renewable Energy
GHG	=	Green House Gases
IPP	=	Independent Power Producers
GDP	=	Gross Domestic Product
MMCFD	=	Million Cubic Feet Per Day
FO	=	Furnace Oil

Chapter 1

Introduction

1.1 Why Energy is important

Energy is the lifeline for sustaining economy and is vital for withstanding the domestic, commercial and industrial activities. Energy shortages and energy disruptions leads to employment loss and economic growth loss [1]. Furthermore the society's social cohesion is adversely affected. Energy is widely used in the form of electricity. It is regarded as an essential infrastructure components and it acts as a prime component in the development and growth of the nation [2]. Presently, Pakistan's electricity sector is facing an appalling disaster and crisis in nation's history. The rising speed of industrialization and urbanization has further added huge demand on electricity [3]. Energy/power policies are articulated to address the energy issues and present solutions for the energy crisis.

1.2 Main Objectives of Energy Policy

Main objectives of the Energy Policy are provisioning of adequate power generation capacity at minimum rate, avoiding shortfalls in capacity, ensuring indigenous resources exploitation comprising sustainable resources of energy, HR resources, local engineering participation and industrial abilities [4]. Moreover it provides a win-win situation for all participating stakeholders in the process along with environment protection. The scope of the Energy Policy is covered by all private and public sector projects; partnership of public-private endeavors and those established by the sector of public and divested then [4].

1.3 Energy Policy and Energy Efficiency

This study aims to analyze the proposed and prevalent Energy policies in Pakistan and to identify conditions/gaps in the policy implementation that apparently accounted for energy crisis. A useful insight for policymakers will be provided by this analysis when policies for energy efficiency improvement will be designed [4]. The existing Energy

Policy does not prove to be successful because it is not environmentally friendly, the electricity rates appear to rise for a long-period and it has high dependence on imported furnace oil [5]. In addition to this, a weak relation exists between electricity demand and electricity supply. Therefore a Gap Analysis study will be carried out to study the Energy Policy and its implementation gaps and solutions to these problems will be laid down.

1.4 Demand Analysis using LEAP Model

In this research, energy model Long-Range Alternatives Planning System (LEAP) has been adopted using various scenarios to evaluate energy demand and supply from 2013 to 2040. Electricity holds a significant position in national growth and development. Energy/power policies are formulated to address the energy issues and present solutions for the energy crisis.

Energy is principal factor of any nation for its economic growth [2]. In this research the relationship among economic growth and energy consumption is articulated. Pakistan's Energy consumption depends mainly upon fuels termed as conventional which are mostly brought by imports and also linked strongly with GDP. Oil consumption has negative impacts on economic growth of a country due to its import issues [6]. To maintain the economic growth the local traditional alternative fuels should be preferred on imported oil in order to maintain the economic growth. In this research, energy model Long-Range Alternatives Planning System (LEAP) is used and different scenarios are studied to evaluate energy demand for 2013 and predicted till 2040. This analysis postulates and uncovers the new horizons for the experts to meet the widespread challenge of energy needs in coming years of the energy sector of Pakistan.

1.5 Level of Research Already Carried Out on the Proposed Topic:

Research has been carried out on policy related issues in Pakistan on different platforms. Various researchers and economists have proposed their viewpoint. But Gap Analysis has not been done to a much larger extent. Also the LEAP software is used at local levels, in this a detailed energy consumption analysis is carried out using LEAP and shows the main areas of energy consumption and ways to achieve an efficient way of energy utilization.

1.6 Reason/Justification for the Selection of the topic:

Energy crisis and shortfall in the country is huge between demand and supply, which causes adverse repercussions as a whole for the economy. A useful insight for policymakers may be provided by this analysis for energy efficiency improvement when designing policies. Power shortage can be addressed by formulating a definite strategy for the future needed by the government (1). A Gap Analysis of Energy Policy and energy consumption using LEAP will show the energy consumption picture. It will further highlight the major sources which hinder the Energy Policy implementation. Furthermore, the analysis underscores the need for immediate reforms in the sector to bring about a relief in the future. This study aims to define the contours of a viable Energy Policy for Pakistan.

1.7 Objectives of the Research Work

The project has following objectives:

1. To recommend solution towards bridging the Gap between Energy Policy and its effective implementation.
2. The Gap Analysis of Energy Policy is to be taken into consideration through different perspectives as investment sector gaps, indigenization gaps, tariff gaps, efficiency gaps, qualified human resource gaps and regulatory gaps etc.
3. Energy consumption analysis of Pakistan using LEAP software.
4. Development of different scenarios in LEAP for the Energy Consumption.
5. To point out the keys areas of concern and suggest possible solution. For instance there are consumer collection faults also known as nonpayers, companies rent seeking behavior, power plants bad maintenance, trained staff deficiency and unstable tariffs etc.
6. There is clarity on the desired qualities of Energy Policy making, but not on how to achieve them, so attempts to embed them have failed to make notable progress.

7. Identify global or regional benchmarks for comparison. What type of policy making is taking place in advanced countries to achieve energy security.
8. Solutions to the problems can be obtained through various approaches through smart metering and smart grids and Green Buildings.
9. Analysis of the Integrated Energy Plan and its importance for the energy scenario of Pakistan.
10. Market failures and barriers that might be contributing to the gaps for energy and energy services in policy implementation of energy.
11. To address market failures in the Energy Policy options which obstruct cost effective investment in Energy Policy.

1.8 Relevance to National Needs

An unprecedented energy crisis is undergoing in Pakistan. Shortfall in the country between demand and supply is about 8000MW, this has resulted for the whole economy severe repercussions [7]. The power shortage issue necessities the formulation of a definite strategy by the government. Severe power cut backs have resulted which shows the problems in the Energy Policy [7]. Energy demand or the energy consumption analysis is vital for the economic growth of any country.

In the LEAP software the energy demand analysis would highlight the key areas of concern and would forecast the energy pattern for the distant future. By working on the policy alternatives as used in LEAP, we can easily analyze the future energy scenario and this would help to bridge the gap between energy demand and supply. LEAP model is very helpful for the Energy Policy making as scenarios can be built on any assumption [8]. LEAP graphical representation would further help to understand the required energy pattern.

Electricity generation should be enhanced through rigorous efforts, with other lower costing energy resources laying foremost priority on hydropower. Furthermore, other renewables like wind, solar, bagasse co-generation, biomass, low Btu power generation, coal and nuclear should be employed, reduction in oil dependence and a shift towards cost effectiveness should be made [2]. A major political issue is the worsening of power shortages that reflects hardships for businesses and individuals. The credibility and legitimacy of government is threatened and the social fabric of the country is stressed further. Emergence of the power crisis is not sudden [3]. It has resulted directly by energy policies over the last three decades which were reckless and imprudent. The development of cheap and abundant domestic energy sources have been impeded by these policies. Inefficient fuel-mix choices have also resulted from this, consisting of economic and energy security [9].Energy bankruptcy in Pakistan is eventually because of huge failure of governance. The research is an analysis of the difficulties encountered by Pakistan's electricity sector and recognizes the main components of a potential policy that will address severe power crisis of the country.

1.9 Advantages

Following are the advantages of the work.

1. LEAP software is used by Energy Policy makers, the scenario based approach help to study the energy demand pattern for different countries and also help bridge the gap between energy demand and energy supply [10].
2. This work will be very resourceful and helpful for the policy makers and the implementation parties as well as energy planning of the country to meet the energy requirements.
3. To help policy makers come to a solution by having a vivid picture of their country's energy demand scenario.
4. To make sure that key areas of concern in the energy sector are carefully catered for including security of supply, the competitiveness of the energy market, and the environmental protection.

1.10 Areas of Application

Following are the key areas of application

1. Gap Analysis.
2. Energy Policy implementation.
3. Energy economics.
4. Long Range Energy Alternatives Planning (LEAP) Model.

1.11 Organization of Thesis

This thesis is organized in nine chapters. Chapter 1 covers the introduction portion of thesis. This chapter presents the research problem statement, outlines the research objectives, and presents the research methodology, significance and limitation of this research. Chapter 2 documents the comprehensive review of the literature on energy policy gaps, barriers and energy related topics. It also deals with energy efficiency and the software LEAP. Chapter 3 presents the energy situation in Pakistan. Chapter 4 is about the energy sector organization of Pakistan. Chapter 5 discusses the past and prevailing energy policies of Pakistan. Chapter 6 presents the integrated energy policy of Pakistan. Chapter 7 explains the renewable energy activities in Pakistan. Chapter 8 is about LEAP energy model. Chapter 9 presents calculations and results obtained from the software analysis. Conclusion and recommendations are present at the end of the thesis; it also presents the future research direction for interested researchers.

Summary

The main objectives of the Energy Policy are provisioning of adequate power generation capacity at minimum rate, avoiding shortfalls in capacity, ensuring indigenous resources exploitation comprising sustainable resources of energy, HR resources, local engineering participation and industrial abilities. This study aims to analyze the proposed and prevalent Energy policies in Pakistan and to identify conditions/gaps in the policy implementation that apparently accounted for energy crisis. The Gap Analysis of Energy Policy is to be taken into consideration through different perspectives. In the LEAP software the energy demand analysis would highlight the key areas of concern and would forecast the energy pattern for the distant future. By working on the policy alternatives as used in LEAP, we can easily analyze the future energy scenario and this would help to bridge the gap between energy demand and supply. Renewable like wind, solar, bagasse co-generation, biomass, low btu power generation, coal and nuclear should be employed, reduction in oil dependence and a shift towards cost effectiveness should be made.

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Chapter 2

Literature Review

The first step for effective energy management in the production requires the equipment's measurement of energy efficiency performance, the processes and the factories. Cause-effective relationships are interpreted by allowing these indicators, thus supporting the companies in the decision-making process operation. The aim of the study is the strengthening of the necessary theoretical base for supporting the energy-based decision making in industrial manufacturing [1].

Improvement in energy efficiency and reduction in energy demand for provisioning of dominant contribution is expected by most analysts in order to tackle the global climate change. Energy demand reduction argument may prove harder than its generally anticipated and presented methods will be inadequate in delivering the required transformation [2].

Power distribution companies (DISCOs) play an important role in promoting energy efficiency (hereafter EE), mainly due to the fact that they have detailed information regarding their clients' consumption patterns. However, if the electricity regulatory institution seeks a higher level of minimum expected utility, it is optimal to adopt a mixed system of compensation, which takes into account the fixed cost compensation and performance-based incentive payments [3].

The existing buildings stock energy performance enhancement is a priority in the present day. The experimentation outputs reveal two main results; the zero energy target can be attained with conventional energy efficiency measures and the economical convenience is maintained but indoor thermal comfort is worsened; secondly there is a need for introduction of incentives to substitute solutions which may not be profitable economically, rather efficiency is achieved on indoor thermal comfort and energy savings [4].

The purpose of this study is to assess the viability of blanket sustainability policies, such as building rating systems in achieving energy efficiency in university campus buildings. These findings were then leveraged to devise strategies to achieve sustainable energy policies for university campus buildings and to identify potential issues with portfolio level building energy performance comparisons [5].

The study explores the trade-energy-growth connection in Pakistan by exploring data from 1973-2013 using time-series approach. Our prime results demonstrate that; (a) the existence of long-term linkage between trade performance and energy consumption; (b) optimistic impact of GDP, imports and exports on consumption of energy;(c) two way relationship which is causal and is between energy consumption and exports, and also between energy demand and imports; (d) two way connection among points of consumption in energy points with GDP to existence of Nation's feedback hypothesis. Hence we notice that trade performance will reduce due to energy conservation policies that will ultimately result in the declination of Pakistan's economic growth. The research will help the makers of policy to formulate a decisive energy and trade policy for long span of time for sustainable growth [6].

Strong policy imperatives are present in the UK for transitioning towards carbon energy systems which are low but the methods that might be realized for the transitional process will be uncertain to a large extent [7].

In this research three different scenarios were constructed based on Energy Policy of government of Taiwan. Scenarios are a) Normal b) Sustainable Energy Policy Convention(2008), New Energy Policy (2011). Further GEP i.e. general expansion planning in the long term is employed for the comparison of the three scenarios for power generation energy mix for the next 15 years to explore possible impacts on the sector of electricity. The experimentation results deliver a location for formulation of energy policies of the future and development of planned reactions [8].

The research explores the discussions of media on crisis of energy by focusing Energy Policy presentation in Poland. The research outcomes in this study demonstrate how the developing countries’ media has legalized policy of energy and energy sectors’ decision makers and the politicians’ activities [9].

Energy efficiency and conversation expansion in each and every sector countrywide remains a method of reduction in US energy imports which is cost-effective instrument. As such efficiency and energy conservation remains US Energy Policy’s imperative elements [10].

In the present day, sustainable indicators’ framework development in the path towards Energy Policy making sustainability must be categorized by transparency and clarity. The aim of the research is to show methodology integrated review and associated happenings of the indicators of energy and recommendation of framework that is operational of indicators which are appropriate and supports the makers of policy/citizens/analysts on the path to policy making in energy which is sustainable [11].

The research demonstrates an agenda for evaluating the energy policies effectiveness and provision of measures based on contextual view on policies of energy by a linkage of sustainable economy as an objective [12].

Energy Policy measures’ impact is not limited to the energy system and hence therefore should be examined within a framework which is economy-wide, while energy sectors’ details kept essential [13].

This research shows knowledge management mapping in the renewable energy endorsed through regional and international organizations with importance being put on Gap Analysis for enhancing the renewable energy deployment in countries which are developing [14].The mapping of knowledge shows that majority of exertions are focused on sharing and awareness raising campaigns of RE information that is to follow assistance in policy and transfer of technology. A generalized agenda is planned on three stages being short, medium and long-term accomplishments in the path to enhanced penetration of RE in the countries which are developing [15].

The development of sound energy efficiency policies focused on energy savings are lacking. The energy efficiency gap is the phenomenon which is discussed above and in literature it is been investigated extensively. The gap basically is explained by the barrier models and their orientation is towards energy efficiency technical aspects and frequently its social aspects are disregarded. Identification of social structures is the objective of our research and the movement of society towards greater efficiency is its prominent role [16].

EU's 20-20-20 target of primary energy savings can be reached; there is a need to increase the energy efficiency. Previously research was done on how to use energy and efficiency in energy, mainly focused on energy efficient technologies' diffusion. The inconsistencies between actual and desired execution of technologies which are energy efficient has been highlighted in abundant research papers and are frequently termed as gap of energy efficiency. A vital part for meeting EU targets for energy savings for the year 2020 and 2050 later [17].

Energy conservation issue has been given renewed attention by the policy makers, it is often been confirmed that gap of energy-efficiency lies between optimal and actual energy use. Defining the optimal level of energy efficiency is the critical question. The study shows that essential requirements for classifying energy-efficiency gap's right measure and that consists of disentangling and understanding failure of market and reasons for slow transmission of technologies which are energy-efficient [18].

The study observes the limit that inventive firms of Spain follow as an objective of innovation and improvements in energy efficiency. Energy consumption increase and its effect on GHG validate the larger consideration being paid especially to industrial EE (energy efficiency) and energy efficiency [19].

Using economically worthwhile measures and technologies has shown the amount of energy that could be saved. An effort to bridge gap between recognized technical potential and current practice for researchers and policy makers is explained in this study [20].

There is an improvement in living standard of people's living in China over the past three decades [21].Furthermore, building energy consumption has rapidly increased. The research undertook energy efficiency of rural building only and the obligatory urban building standards, energy efficiency of rural buildings can be facilitated by this development [22].

The research is an analysis of latest literature on collaboration between land-use and energy and climate change, literature databases in most relevant scientific field is based on analysis of papers. There is an argument for the presence of various gaps and nested environmental governance is needed. Understanding overlap of different environmental policies is necessary their way of integration so that conflicting targets are verified so it may cancel effect of each other in the long-term [23].

Reduction commitments fulfill rapid diffusion in 2050. For this purpose, identification and alleviation of all barriers that stop RES development is essential to the deployment of these technologies successfully. Barriers identification of this nature requires intervention of policy [24].

In this research a framework categorizing barriers in energy efficiency are proposed created on the phase where existence of barrier is. To our knowledge studies have been done on energy efficiency barriers, excluding few studies, it is found insufficient attention for interaction of barrier to barrier when energy efficiency improvement is proposed. This permits the identification and assessment of energy efficiency policies' weak links [25].

This research on renewable sources of energy fills the macroeconomic literature gap. It proposes green investment definition and trends and determinants are analyzed of such investment spread over last decade for emerging and advanced 35 countries. The rest involvements as support of biofuel do not seem to be related with high level of green investment [26].

In this we study that the goal of energy efficiency and energy conservation is the same but different approaches are used to achieve both. There is the discussion that eventually electricity consumption is reduced successfully but significant barriers have to be faced [27].

EPC i.e. Energy Performance Certificate is required by all European Union Member States when construction of building is carried out, rented and sold. Potential of existing dwellings is argued in terms of energy savings, climate change policy is commended, if the households continue to assess it subjectively then it will remain unexploited [28].

The research purposes the investigation of barriers that cause impedance to promote the Energy Efficient Building (EEB), benefits from Clean Development Mechanism (CDM) can be captured by proposing solutions to avoid these barriers [29].

Electricity shortfall can be reduced by conserving electricity and GOP in recent years has taken many steps. In this situation, measuring the influence of various policies of electricity conservation is tried in this research and this impact is calculated on services sectors and Pakistan industrial sectors' value-addition. In addition to this, incorporation of energy efficiency should be made in policy for energy mainstream and precise rules must be passed to create organizations and method to aid conservation effectiveness should be developed and consumption of limited energy resources should be efficient [30].

In firms the cost-effective energy-efficiency measures' (EEMs) distribution is surprisingly slow most frequently. This occurrence is caused by numerous barriers that's been put much emphasis of variety of research for over twenty years. Nevertheless EEMs have been treated homogenously and considered to have small number of differences inherently in addition to their cost-effectiveness [31].

Household energy use behavior and its characteristics have measures of relationship between them; a unique dataset is used for the estimation which is roughly five thousand households in ten EU countries and Norway. Highlighting these cross country differences need a common EU energy-efficiency policy framework which will balance with flexible policies of specific countries to solve specific restraints to conservation practice and energy-efficient technology adoptions [32].

To address various policy and planning concerns in developed countries, policy models have been developed and the literature is full with energy models which are both bottom-up and top-down Energy Policy models. For analysis of different issues in advanced developing and industrial countries, a good starting point is provided by these models. Moreover, policy makers of developing countries need to consider outputs from various models so that robustness of their decisions can be assessed [33].

This research presents an argument that agenda of policy research needed a change on the combination of difficulties which link development, energy and environment. The five suggested directions for research are illustrated with help of examples which are presented [34].

Re-investigation of multivariate electricity consumption function for Pakistan is the objective of this research. These functions include population growth, economic growth, foreign direct investment for time period of 36-years between 1975 and 2010.Causality test which is dynamically short-run shows that causality has been unidirectional which runs from growth of population to consumption of electricity in Pakistan [35].

In this research a relationship is analyzed among consumption of electricity, its cost and GDP at sector and aggregate level in Pakistan. The research accomplishes that production of electricity and electricity management requires overall economic planning and better integrated exercises. It is important to get rid of unplanned load shedding and electricity shortfalls [36].

Through use of an engineering-economic model, this research observes 3 different policies for energy conservation stimulation in the commercial sector of US. Creation of these policies is such that equivalent annual levels of energy use in 2000 would result [37].

Electricity demand on rise, generating systems getting stressed, and environmental quality concerns have caused rising concern energy efficiency options' potential benefits in many developing countries. Analysis of patterns of electricity consumption and electricity conservation potential, the Pakistan Household Energy Strategy Study has been managed by World Bank. As a part of that research, new of its type in a developing country, collection of household metering has been involved, and to support the estimation of hourly demand regression equations survey data is used. In addition to this simulation software is developed for energy efficiency. The methods and results is summarized in this manuscript [38].

In Taiwan an enormously imperative subject of central study is the forecasting of long-term demand and supply of energy. The reasons for this is that natural resources are very few in Taiwan, it depends mainly on import of energy, and the country's sustainable development search. In this research Taiwan's energy supply demand overview is provided, and a brief description of energy policies' current status and historical evolution. Taiwan's energy sector is modeled in model of LEAP. Demand and supply for future energy patterns of Taiwan are compared in LEAP, moreover GHG emissions are also compared, and this is studied for various energy sector and Energy Policy alternate scenarios. Results of ''Business-as-usual'' policies' scenarios are also featured, improvement policies of aggressive energy-efficiency, Taiwan's on-schedule of 3 current plants termed as nuclear are compared and provided, the effects of lesser financial development expectations are explored accompanied by sensitivity analysis. In the final section models results' implications are interpreted for Taiwan's climate and future energy policies [39].

For the analysis of energy demands and emission status of air pollutants in Islamabad and Rawalpindi, an urban transportation associated study was carried out. For the reduction of future emissions, the research consists of scenario discussions for both the past and future trends. Using LEAP software passenger transportation model has been developed. Total energy demand and vehicular emissions was estimated by LEAP model keeping 2000 as the base year and values calculated till 2030 thus predicting the future. Islamabad and Rawalpindi transport database, along with values of fuel consumption for types of vehicles and factors of emissions which are SOX, PM10,NOX matching to real types of vehicle, transport demand basis is formed, consumption of energy and emissions' aggregate is calculated. Besides the base scenario, the LEAP model was tested with three alternate scenarios studying various urban transport policy initiatives impact which will cause energy demand reduction and reduce emissions as well in the sector of transport of Islamabad and Rawalpindi. The major aim was to reach at the best policy of transport that puts a limit to consumption of fuel for the future growth in addition to pollution in air [40].

A major cause of global warming is the emission of CO_2 from fossil fuels, but in actuality it is difficult to remove it in reality. Additionally, for continuous economic development of a country consumption of energy is sure increasing that requires high energy demand for industrial formation. Consequently, a device for CO_2 mitigation not only needs consideration rather impact of mitigation device of CO_2 is functional. Three fields of CO_2 emission mitigation device are classified: reducing consumption of energy, removal of CO_2 and technology recovery development, and alternative energy technology development. Amongst the options available, recovery technology and removal of CO_2 has a value that in the near future can be applied. Consequently, study is progressing swiftly in Korea for recovery and removal of CO_2. In this research, economic and environmental calculations as regards change of Energy Policy agreement and increasing technology of CO_2 mitigation is completed, on grounds of operational data for chemical absorption for CO_2 for absorbing installed pilot plant in the steam power plant in Seoul. LEAP software alternative scenarios and results were quantitatively shown [41].

To encounter the electricity demand in Pakistan which is fast growing, system planning is required in the long term power. Both economic and environmental concerns need to be considered by the policy makers so that well-timed conclusions regarding generation mix of electrical power could be made [42]. In this research, demand of energy is forecast for the nation for the time period 2005 to 2030. Meeting this demand requires; performing energy supply modeling through LEAP software for the proposed time period. According to the government policies baseline or BAU scenario is developed. New strategies are considered by assuming three scenarios. Electrical power supply model is simulated in this research so that an economically feasible fuel mix could be found having negligible effect on the environment. In this respect, the debated policies are selected taking into consideration cost benefit analysis comparatively and emissions of CO_2 in relation to the chosen mix of fuel [43].

The development of low-carbon economy for the Chinese government, an important reference is provided by the scenario predictions. There are 4 critical factors. Consumption of energy, per capita GDP, structure of energy, CO2 emissions, are essentially brought to notice for measuring the economic development having low-carbon level as the indicators. In the meanwhile, LEAP based model, scenarios developed are; base, frustrated low-carbon and low-carbon are framed for simulation of economic development level for slow-carbon in 2050 of China. The outcomes reveal that net energy demands terminal in 3 various kinds of scenarios are; 5.236 standard coal(billion tons), 6.239 standard coal(billion tons), and 6.095 standard coal(billion tons) in the year 2050 [44]. The research shows that considerable decrease in its CO2 emissions has achieved by China primarily owing to energy intensity improvements. Moreover, fuel substituting and penetration of renewable energy also show CO2 decrease which is a positive effect [45].

Summary

The goal of energy efficiency and energy conservation is the same but different approaches are used to achieve both. Measuring the influence of various policies of electricity conservation is tried in this research and this impact is calculated on services sectors and Pakistan industrial sectors' value-addition. To address various policy and planning concerns in developed countries, policy models have been developed and the literature is full with energy models which are both bottom-up and top-down energy policy models. To encounter the electricity demand in Pakistan which is fast growing, system planning is required in the long term power. Both economic and environmental concerns need to be considered by the policy makers so that well-timed conclusions regarding generation mix of electrical power could be made. The National Energy Policy in Pakistan energy models are used as planning tools and exploration of their feasibility is the prime objective of the work. Therefore in the perspective of sustainability concerns and energy security for the country, future energy scenarios are analyzed. Electricity demand on rise, generating systems getting stressed, and environmental quality concerns have caused rising concern energy efficiency options' potential benefits in many developing countries.

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Chapter 3

Energy Situation in Pakistan

According to the latest data available, during the financial year 2013-14 [1]

1. There was a significant increase of 9.7% in oil supplies.
2. Slight decrease by 0.6% in gas supplies.
3. Increase in commercial energy supply mix by 3.5% in the overall primary as compared to the previous year.

Each source in primary energy supplies share of for 2013-14 was:

1. Gas:46.3%
2. Oil: 34.4%
3. Hydroelectricity:11.4%
4. LPG:0.5%
5. Imported Electricity:0.1%
6. Nuclear Electricity:1.8% [1]

3.1 Oil and Gas Production

There is decrease by 0.8% of natural gas production in 2012-13 from 4,126 MMCFD to its value in 2013-14 as 4,092 MMCFD while oil production moved up by 13.5% from 76,277 barrels per day in 2012-13 to 86,533 barrels per day in 2013-14 [1]. Fifty exploratory and fifty development/appraisal wells were drilled in the upstream sector in an Extensive activity. 28 discoveries resulted by gas/condensate drilling efforts.

Increase in import crude oil to a value of 8.6% by the refineries and the increase in motor spirit import spirit was by 26%; petroleum products overall import increased 3% in comparison to the past year [2]. The oil import bill for the year 2013-14 was US $15.47 billion.

Oil consumption during 2013-14 was up by 8.9% as per LDO consumption, furnace oil and motor spirit increased by 39.2%, 15.7% and 12.8% correspondingly. Industrial sector oil consumption has fell by 6% as compared to the 2012-13 [1]. Consumption of natural gas was down by 3.75%. Gas consumption declined in Pak Steel, transport and cement sectors by 13%, 12.6% and 11% correspondingly in comparison to the past year.

3.2 Production of Coal

Growth in coal production was reported to increase by 8.15% while import of coal decreased by 15.9% in 2013-14 as compared to previous year that caused decrease in overall coal consumption/supplies by 4.8% over the last year [3].

In the power sector, hydel generation was reported to increase by 6.8% as compared to the last year which was mainly due to the addition of two new WAPDA hydel power plants and one hydel IPP in the national grid having combined installed capacity of 123.4 MW [4].

During 2013-14, 103,670GWh electricity was generated as against 96,122GWh in 2012-13, which included 64.3% thermal, 30.7% hydel and 4.9% nuclear. However, the consumption of electricity increased and reached 83,409GWh from 76,789GWh last year. Major increase in consumption was in domestic sector (9.5%) followed by industrial (9.2%), agriculture (7.7%) and commercial sector (6.1%).T&D losses reduced from 17.6% to 16.9% during 2013-14 [3].

During 2013-14, two new wind power projects with a joint installed capacity of 105.9MW became operational in Village Jhampir, District Thatta, Sindh and collectively generated 97GWh of energy [2].

3.3 Energy Sector of Pakistan in the Most Recent Scenario 2014-2015

Since 2006, severe energy shortage is being faced by Pakistan. Inadequate capacity additions, ineffective exploitation of hydro and coal, ineffective use of energy resources, renewable potential and limited exploration are the main reasons [3]. Load shedding of electricity and gas is the result of this demand supply gap. Our country is incessantly suffering from power crisis as electricity supply fails to fulfill constraints posed by demand side [5]. The supply deficit of around 5000 MW was experienced on an average, though 7000 MW peak was touched last July.

Renewable sources development for example hydro, coal and renewable and alternate sources are serious aspects for economic growth sustainability as projected in the 2025 Vision. Hydro power share is 31% of the 2014-2015 total generation, in comparison to almost 70 percent in the decade 1980s [3]. The hydro power development slowed down because of disagreements regarding major dams regardless of the large hydro power generation potential. Estimates suggest that hydro potential of Pakistan is nearly 60,000 MWs out of which merely 6750 MW (11.25%) has been utilized. Thus, country relied upon thermal power, since NG was plentiful and inexpensive as compared to oil. Though indigenous gas depletion lead to enhanced use of costly FO and HSD oil for generating electricity, nonetheless, it will yield badly results in terms of affordability in the long run [6]. Therefore hydropower projects development is stressed, for instance Diamer Bhasha (4500 MW), Neelum Jhelum (969 MW) and Dasu (2500 MW). Moreover, domestic and imported coal “Thar Coal” has gained greater importance [3]. Additionally, sustainable potential (solar and wind) are exploited actively. Efforts are being made to bridge the gap in least plausible time by increasing the domestic exploration efforts accompanied by RLNG import [5].

In a similar manner, present primary energy supplies of Pakistan are greatly tilted towards more costly fuels like gas and oil in place of hydro and coal which are regarded as an indigenous resource. Total primary energy mix out of 67 MTEO for 2013-14 includes 35% share of oil, 11.4 % hydro,46.4% share is of natural gas,2% nuclear and 5.4% coal, including energy obtained through import [4]. Balance of payments is disproportionate further making the energy mix disapproving.

3.4 Performance Review 2014-2015

Oil and gas production overall targets set for 2014-2015has almost been met. Private sector played an important role in enhancing development and exploration efforts of gas and oil sector. Additionally, autonomy has been given to public sector organizations and divested from the projects under PSDP, which are now financed from their own funds. For the Geological Survey of Pakistan (GSP) an allocation of Rs.166.720 million was made for their coal exploration projects [4]. The production of oil and gas targets and achievements are tabulated below.

Table 3.1: Production of Oil and Gas Targets and Achievements

Items	Units	Targets 2014-15	Expected achievement up to 30-06-2015	Achievement (%)
Production				
Crude Oil	Million barrels	35.62	35	98.26
Gas	Trillion cft	1.470	1.460	99.32
LPG	Tons	4,38,000	5,11,000	116.67
No. of wells drilled	Numbers	104	80	76.92
Exploratory	Numbers	54	40	74.07
Development	Numbers	50	40	80

3.4.1 Gas and LNG

Under the Fast Track LNG services Project, The Sui Southern Gas Company (SSGCL) and Engro Elengy Terminal (Pvt.) Limited (EETPL) for design, construction and operation of three million tons per annum (equivalent to 400 MMCFD) as well as its re-gasification and storage.

The terminal has been completed and is operational since March 2015. The terminal capacity can be enhanced up to 600 MMCFD.

Moreover, the Gawadar-Nawabshah LNG terminal and pipeline Project envisage laying of 42, 700 kilometer pipeline along with the terminal at Gawadar for importing 500 MMCFD.

A framework agreement for the project has been signed on Government to Government basis with China during the last visit of Chinese President to Pakistan in April 2015.

A total of 4,18,419 new consumers were added to the Sui Gas Companies, i.e. Sui Northern Gas Company Limited (SNGPL) and SSGPL.

Moreover, these companies have also added 6,799 kilometers of new transmission and distribution pipelines in their respective jurisdictions.

Figure 3.1: Gas and LNG Production

3.4.2 Coal

High priority is being given to Thar Coal development, an airport has already been built by the government of Sindh and roads have been widened and improved for heavy machinery and equipment movement from port of sea to Thar coalfield. In the current year, the provincial government has embarked Rs.21 billion for wind, coal and other energy based projects. The mining work by the Sindh Engro Coal Mining Company (SECMC) at the Thar Block II has started and an overburden of about three million cubic meters has been removed. Three coal exploration projects led by GSP in Sindh, Baluchistan and Punjab are as follows:

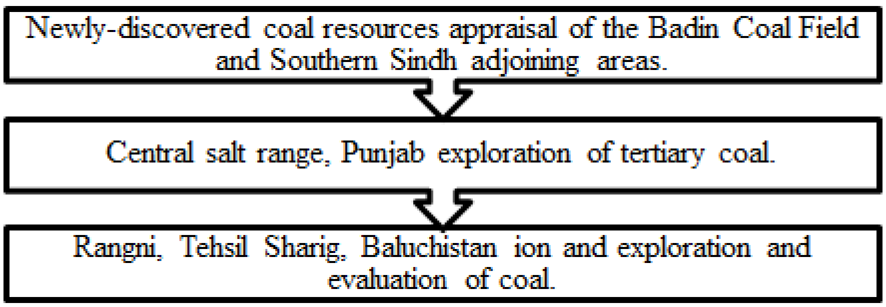

Figure 3.2: Coal Exploration Projects

3.4.3 Power Sector

In 2014-15 development projects of the energy sector were allocated an amount of Rs.240 billion [6]. Out of 675 MW, addition of 536.2 MW intended in 2014-15 was realized. Remaining capacity of 138.8 MW of Nandipur combined cycle power plant is likely to be commissioned till June 28, 2015. Renewable resources power addition in the system is shown below:

Table 3.2: Renewable Resources Capacity Additions

Name of project	Agency	Fuel	Capacity(MW)
425 MW Combined Cycle Power Plant, Nandipur	NPGCL	FO	286.2
425 MW Combined Cycle Power Plant, Nandipur	NPGCL	FO	138.8
M/s Three Gorges First Wind farm Pakistan Pvt. Ltd	AEDB	Wind	49.5
M/s Foundation Wind Energy-I Ltd	AEDB	Wind	50
M/s Foundation Wind Energy-II Ltd	AEDB	Wind	50
Solar Power Park Bahawalpur	NPGCL	Solar	100
Total additions 2014-15			675

3.4.4 Transmission and Distribution System

During the year 2014- 2015 the NTDC transmission has been enhanced by adding 3,150 MVA and 6,277 MVA on 500 kV and 220 kV systems respectively.

The transmission lines were extended by 1,944 kilometers accordingly.

The distribution network has been enhanced by adding a total of 12,865 MVA distribution transformers matching 3,477 kilometers of transmission line to cater to the growing demand of all ten distribution companies, which have also improved their feeders by optimization.

Enhancement has been made in NTDC transmission with the addition of 6277 MVA on 220 kV systems and 3150 MVA on 500 kV systems.

During the year 2014-2015, extension of 1944 kilometers of the transmission lines accordingly was further made.

Enhancement of distribution network has been made with the addition of distribution transformers of 12865 MVA matching transmission line of 3477 kilometers, to take care of increasing demand of 10 distribution companies, that improved their feeders through optimization.

Figure 3.3: Transmission and Distribution System

3.5 Outlook 2015-16

By the year 2015-16, generation projects of 1027 MW are likely to be functional. The supply-demand gap shall continue to stay around same level, since demand will increase, that is anticipated to grow at 4-5% rate. The project of Neelum Jhelum is in progressive phase and will be completed and start functioning in fiscal year 2016-2017 with addition of 969 MW to the national grid, reducing the gap of supply-demand [6].

A program is being launched by the government with help of China. This program places high priority to the energy sector for overcoming shortage of energy by 2017-18. By the year 2018, addition of 10400 MW is expected to the national grid according to the project CPEC i.e. China-Pakistan Economic Corridor [6]. This joint venture project contains hydro, wind and coal. It will amplify supplies and will significantly change the energy mix and hence expensive oil will be replaced and average cost of generation will be reduced [7]. An essential feature of these projects (CPEC) is the implementation of projects in the private sector. Equity, debt and finance fall under project financial domain. Thar coal project has already been initiated.

Substantial decrease in international oil prices has resulted in reduction in the local petroleum product prices by 29%. Electricity and transport costs dropped due to aforementioned development owing to oil based electricity generation.

The Parliament has passed a bill called Gas Infrastructure Development Cess (GIDC). The average cost of gas will increase for all segments excluding the domestic [6].

During 2015-16 oil and gas demand is anticipated at 473000 barrels per day (23 million tons) and six billion cubic feet per day (2.1 trillion cubic feet). If we keep in view 110000 barrels per day of indigenous oil and 1.5 trillion cubic feet gas planned supply, supply-demand gap during 2015-16 in gas and oil sectors together is necessary to be satisfied by importing eighteen to nineteen million tons of petroleum and crude oil products. In addition to this, supplementation of gas supply indigenously by imports of LNG to adjust 400 MMCFD will result in closing the widening gap of shortfall to some extent which is over 2 billion cubic feet per day. About 9551 MW hydro power projects are at different construction phases resources in line with the Vision 2025.

Table 3.3: Hydropower development Projects Vision 2025

Diamer Bhasha	4500 MW
Keyal Khwar	128 MW
Golan Gol	106 MW
Dasu Hydropower Project(stage-1)	2160 MW
Harpo	34.5 MW
Neelum Jhelum	969 MW
Terbela 4th Extension	1410 MW

18875 MW hydro projects' feasibility and pre-feasibility studies have been completed approximately. These ventures are at different phases of endorsement, funds are being arranged for these projects.

Table 3.4: Hydropower Projects at various stages of Development

Bunji Hydropower project	7100 MW
Refurbishment and up gradation of the Mangla Generating unit 1	310 MW
Kohala	1100 MW
Shyok Dam	690 MW
Lower Plas Valley	665 MW
Lower Spat Gah	496 MW
Basho	40 MW
Pattan	2300 MW
Thakot	4000 MW
Dasu stage-II	2100 MW
Jagran	48 MW
Shagarthang	26 MW

A total of approximately 4445 MW thermal projects initiated by the public sector are under construction. These plants are expected to be completed by 2017-18.

Table 3.5: Under construction Thermal Projects

Power project Nandipur	425 MW
Coal fired power plant Jamshoro	1320 MW
LNG-based power plant at Haveli Bhadur Shah and Balloki	2400 MW
Power plant Gawadar	300 MW

In order to encourage the use of energy efficient LED lights and air conditioners, the Planning Commission has considered different proposals to facilitate the use of aforementioned technologies by reducing duty on imports [8]. A reduction in rate of taxes will increase the quantity demanded, given the nature of the appliances, resulting in overall tax revenue increase. To explore more options for energy conservation and efficiency, consultative meetings are being carried out. For implementation to improve energy conservation, in collaboration with the government departments and ENERCON the Pakistan Engineering Council has outlined Building Code of Pakistan.

Summary

The Energy situation in Pakistan has been described in this chapter. The share of sources in primary energy supplies for the year 2013-14 are shown which include gas, oil, hydroelectricity, LPG, imported electricity and nuclear electricity. Also the production of oil, gas and coal is included for the same year. Oil and gas production overall targets set for 2014-2015has almost been met. Private sector played an important role in enhancing development and exploration efforts of gas and oil sector. High priority is being given to Thar Coal development. Finally outlook for the year 2015-16 is presented. By the year 2015-16, generation projects of 1027 MW are likely to be functional. The supply-demand gap shall continue to stay around same level, since demand will increase, that is anticipated to grow at 4-5% rate. A program is being launched by the government with help of China. This program places high priority to the energy sector for overcoming shortage of energy by 2017-18. By the year 2018, addition of 10400 MW is expected to the national grid according to the project CPEC i.e. China-Pakistan Economic Corridor. This joint venture project contains hydro, wind and coal. It will amplify supplies and will significantly change the energy mix and hence expensive oil will be replaced and average cost of generation will be reduced. In order to encourage the use of energy efficient LED lights and air conditioners, the Planning Commission has considered different proposals to facilitate the use of aforementioned technologies by reducing duty on imports.

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Chapter 4

Energy Sector Organization of Pakistan

In Pakistan the power sector is controlled by two vertically integrated public sector utilities which are a combination of Hydel and Thermal units. One is responsible for all Pakistan except Karachi and is known as WAPDA(Water and Power development Authority), while the other is responsible for Karachi and its adjacent zones known as K-Electric (Karachi Electric) [1]. A large number of IPPs contribute considerably to electricity generation in the country. It has continued to be a baffling problem to attain balance between electricity supplies of Pakistan against demand for years[2]. The country is facing a significant challenge for restoring a sound network that will be accountable for electricity supply.

4.1 Importance of Electricity for Pakistan

Electricity is imperative for proper functioning of equipment in industrial and manufacturing units. It is used for powering our vehicles and lighting our cities. The key issue for any government is to meet the challenge electricity provision for industrial access and poor parts of the population.

Demand of energy has increased enormously, owing to tremendous development in the industrial sector and growth in the population [3]. Infrastructure of Pakistan's energy is thought to be poorly managed and underdeveloped [2]. Presently Pakistan is faced with energy crisis of great severity. In spite of the fact that economic growth is strong and energy demand on rise in last ten years, efforts to install new generation capacity have not been made [4]. In addition, transmission losses caused by old-fashioned substructure, hydropower seasonal unavailability, power theft and rapid demand growth have further deteriorated the situation. Therefore, demand surpasses supply and so power shutdown phenomenon is common in the shape of load-shedding.

4.2 Structure of Electricity Sector of Pakistan

The restructuring of the power sector in 1998 was done with PEPCO creation. Two combined services, before 1998 i.e. WAPDA and KESC (now K-Electric), the prior served the whole country apart from Karachi which was served by the later [3]. WAPDA's power wing was later on divided into separate commercial units including 10 DISCOs, 01 Trans CO (NTDC) and 4 GENCOs [1].

The Distribution to the end users is the responsibility of 10 DISCOs [5]. Overall demand of K-Electric is met through its own generation and additional purchasing from National Transmission and Dispatch Company, Karachi Nuclear Power Plant and IPPs [3].

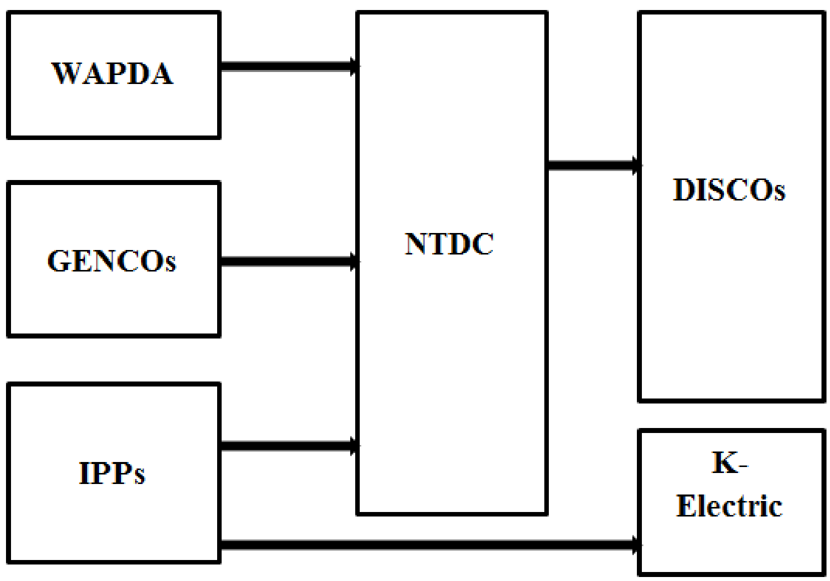

Figure 4.1: Generation, Transmission and Distribution of Pakistan

4.3 Power Generation through Different Source

4.3.1 Thermal Generation

Current thermal power generation stands around 8300 MW. Low conversion efficiency is shown by these plants and maintenance and operation is expensive [5]. IPPs have installed most of the thermal power plants that have been using highly expensive furnace oil. The FO is imported and foreign reserves are consumed. Natural gas can also be used by these plants. Nonetheless shortage of gas supplies has been felt by the country.

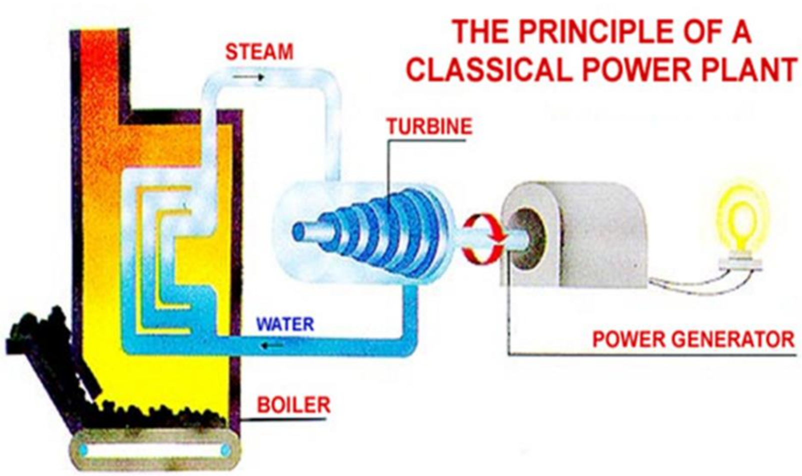

Figure 4.2: Thermal Power Plant

4.3.2 Hydro Power

Generation of electricity by extracting energy from running water is called the Hydro-power. Hydel power resource is very rich in Pakistan. Electricity generated from hydropower is only around 34% [5].

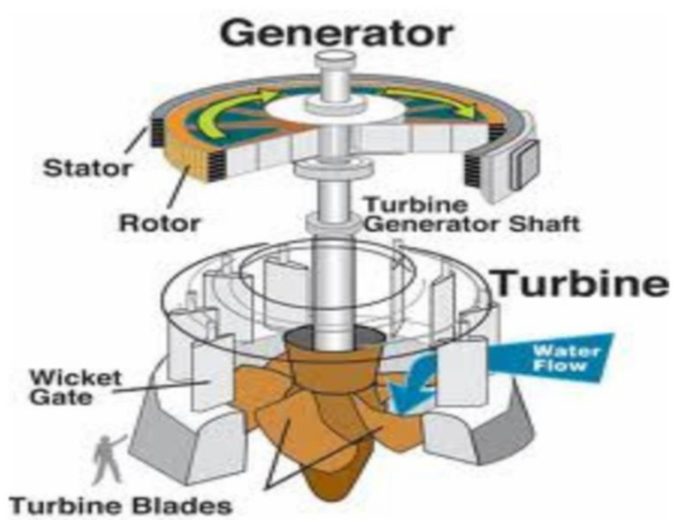

Figure 4.3: Hydropower Turbine

4.3.3 Wind

Harnessing the power of wind by propelling the wind turbine blades is termed as wind power. Rotation of turbines magnets generates electricity. Potentials of wind energy in

Pakistan range from five to ten thousand megawatts [5]. Hence wind based power generation in Pakistan is in its initial stages and presently six megawatts in first place is installed in the area known as Jhampir in collaboration with a Turkish company and fifty megawatts shall be shortly installed. Additional power plants of Wind shall be constructed in Gharo, Bin Qasim Karachi, Jhampir and Keti Bandar.

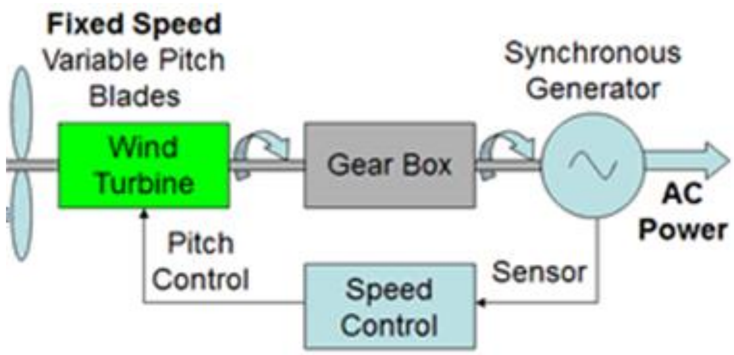

Figure 4.4: Wind Power

4.3.4 Solar

Converting sunlight into electricity by use of solar cells is termed as solar energy. Potential of solar energy of Pakistan is over 100,000 MW. Building solar based power plants is in progress in Punjab, Baluchistan, Kashmir and Sindh. Import of solar water heaters/panels is carried out by private companies for intake in the commercial sector. In Gilgit Baltistan, twenty thousand solar water heaters are operational in AEDB. The government has asked the mobile companies to alter their energy supply to transmission towers by shifting to solar energy panels from petroleum.

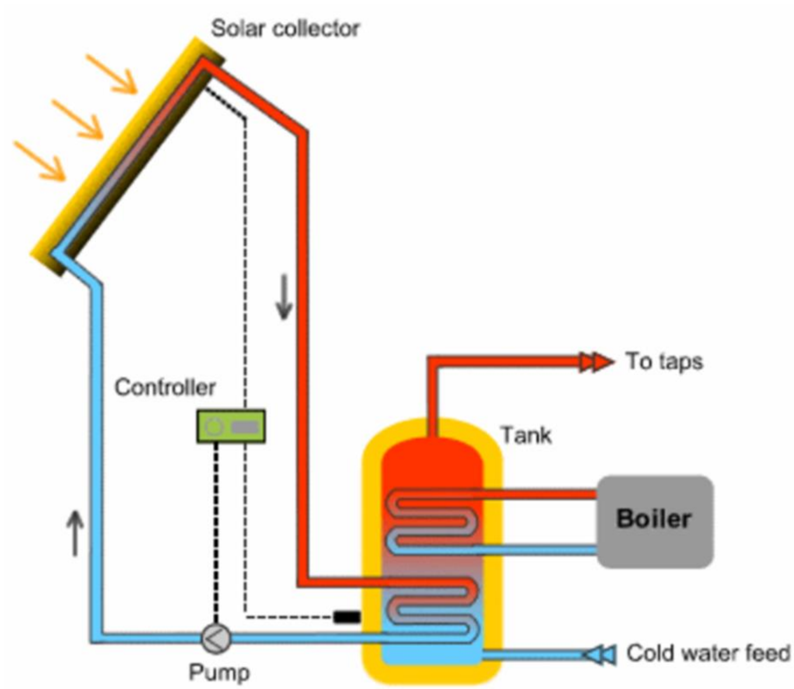

Figure 4.5: Solar Energy Conversion

4.3.5 Biodiesel/ Biomass

Using debris or other sources termed as renewable is regarded as biomass production involving stalks of corn, wood pieces or sugarcane for electricity generation [4]. As garbage is decomposed, production of methane starts and enters pipes and electricity is produced by later burning it. To generate energy, wood and vegetation is burned directly and processed to form alcohols or fossil fuels. From biomass/biodiesel in the world, renewable energy programs in Brazil are one of the largest; USA is next in the list [5]. Pakistan's Alternate Energy Development Board has vowed generation of 10MW electricity from waste of municipal in the city of Karachi, to be followed in twenty cities of country for similar projects.

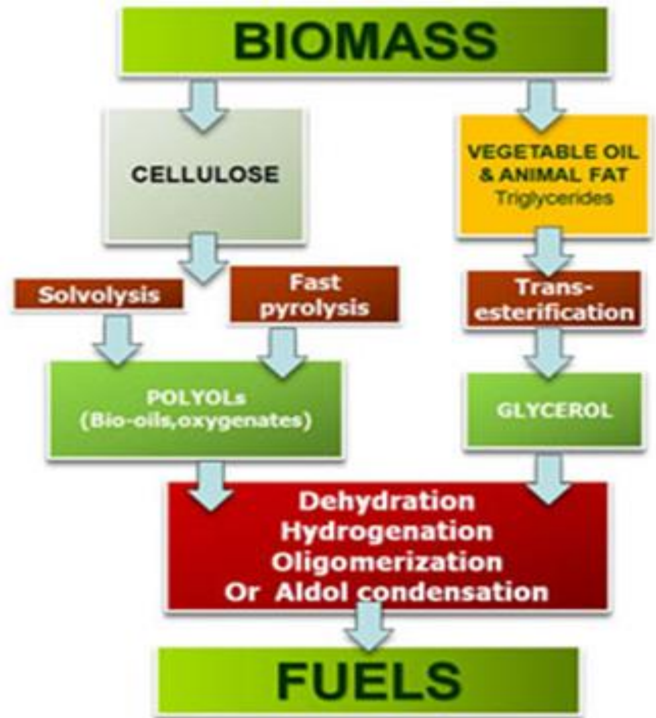

Figure 4.6: Biodiesel/Biomass Conversion

4.3.6 Nuclear Energy

Nuclear fission reaction is used by nuclear power stations for energy generation, reacting inside a nuclear reactor of Uranium. Nuclear Power programs in Pakistan are small, having capacity of about 425 MW, substantial capacity increase is planned. Nuclear energy development issues include uranium chain reaction enrichment from Uranium-235 to Uranium-238, controlling and solid waste dumping [5].

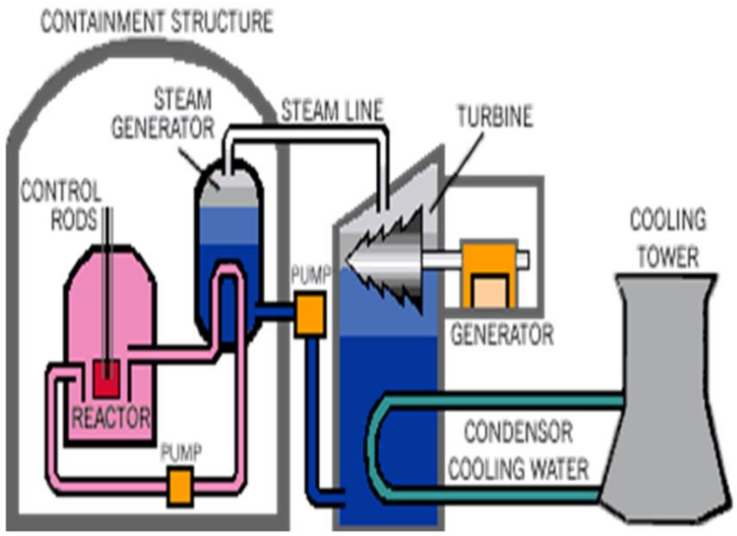

Figure 5: Nuclear Reactor

4.4 Solutions to End Electricity Shortage

Overcoming crisis by short measures is not possible in view of the existing ground realities. Nevertheless, short term measures implementation causes reduction in crisis. Addressing this situation requires two dimensional measures implementation.

4.4.1 Measures (Short Term)

Reducing existing power crises requires short term measures to be taken immediately:

1. To cater for immediate power needs, suitable option is wind turbine as they install in lesser time in comparison to the nuclear plants and dams which require at least 5 to 6 years for their completion and another 2 years' time is required for building the thermal power plants. To put an end to Pakistan's energy shortages, wind power can play a vital part. Comprehensive wind maps are being researched [3].
2. Country wide power plants renovation of existing infrastructure ought to be ensured by the government authorities for attaining maximum generation. Furthermore the overloading is prevented that causes major power outages.
3. Private sector based power plants setup ought to be allowed. These plants will be mutually funded by their own loans and equity established by feasibility of the project with limited role of the government defining power's fair price by

representatives of autonomous command of the government, power industry, citizens experts and power producers by agreement.

4. Many non-operational power stations exist in the country that requires mere technical improvements and little investment for their recovery and restoration. Rendering such power units effective will boost the economy. Consequently, the smooth flow of energy will be maintained by these projects and shall avoid any additional demand-supply gap widening.
5. Enforcing closing time restriction till 10 pm for business, shopping centers and markets will further improve the situation. Such measures will save the power which can be used by consumers domestically with the help of an effectively administered local system.
6. Considering and declaring electricity theft as heinous crime and its violation by either industrial or domestic user must make them liable to complete power cut offs and legal penalties.
7. Workers and stakeholder's education in the agricultural and industrial sectors on acceptance of efficient and new water and energy consumption practices shall lead to reduction in energy wastage.

4.4.2 Measures (Long Term)

Keeping in view the projected power consimption increase in future, the below mentioned measures should be taken in the long term:

1. More nuclear plants and dams should be built by Pakistan in the long-term. The Chinese and Norwegian companies'technical expertise could benefit government in hydro electricity production and dam construction.New dams and water reservoirs construction hold extra importance for overcoming problem of rising water shortages [5,6].
2. Transmission and distribution systemswhich are outdatedshould be replaced and rehabilitated. The perennial problem of line losses and electricity theft can be avoided by dishonest electricity consumers [7].
3. Natural gas power generation is approximately Rs. 6kWh.Natural gas allocation for powerin the last five years reduced to 27 % from 53% and power generation

from furnace oil increased to 38% from 17%. Cost of generation has increased in 2010 by Rs 130 billion, causing increase in circular debt which led to greater rates of power [5].By reallocating gas towards power production,power crisis can be alleviated because production of power should be the foremost priority over any other aspect or sector [1].

4. In the long term, the most essential goals and planning should be laid in the country's foreign policy with prime focus on energy and economic needs. Increasing and improving collaboration with energy rich countries of the future should be promoted [6].

Summary

The key issue for any government is to meet the challenge electricity provision for industrial access and poor parts of the population. In Pakistan the power sector is controlled by two vertically integrated public sector utilities which are a combination of Hydel and Thermal units. WAPDA’s power wing is divided into separate commercial units including DISCOs, TransCO (NTDC) and GENCOs. While K-Electric is responsible for power supply to Karachi. Power is generated through different sources which are thermal generation, hydro power, wind, nuclear, solar and biomass. The electricity shortage crisis can be overcome by adoption of both short-term and long-term measures. The key short-term measure is that many non-operational power stations exist in the country that requires mere technical improvements and little investment for their recovery and restoration. Rendering such power units effective will boost the economy. The key long-term measure may be the transmission and distribution systems which are outdated and should be replaced and rehabilitated. The perennial problem of line losses and electricity theft can be avoided by dishonest electricity consumers. These measures can be included only through proper policy adoption with prime focus on energy and economic needs.

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Chapter 5

Past and Prevailing Energy Policies of Pakistan

Energy policy is the method in which a given entity (mostly governmental) stresses prime concerns of development in energy; production of energy, circulation and utilization. The qualities of energy policy might contain legislation, international agreements, motivations towards investment, strategies for conservation of energy, taxation and other public policy procedures.

5.1 Methods and techniques to produce an energy policy

1. National policy declaration that concerns the energy planning, its usage, transmission and generation.
2. Procedures for activities of energy that are marketable for instance; storage, trading and transport.
3. Procedures that have an effect on the use of energy, for instance; emission and efficiency criterions.
4. Instructions for the establishments and possessions that the nation possess.
5. Contribute actively in motivations for and coordination of mineral fuels investigation and other R&D energy-related policy expertise.
6. Energy related products' and services' fiscal policies such as; subsides, taxes and exemptions.
7. International policy and energy security procedures for instance; associations and agreements of international energy sector, energy-rich countries special associations encompassing control or existence of military common worldwide contracts in trade energy security and international policy procedures such as; international energy sector agreements and associations, general international trade contracts, Special associations with energy-rich countries, comprising military existence and/or control [1].

5.2 Energy Policy Formulation and Advocacy

A visible thoughtful phase of policy procedure is the policy formulation which lies in under vivid policy design subject. Pre-decision section of policy making part is the energy policy formulation, it comprises of crafting energy sector goals, options and priorities, benefits of every energy field option and related concern [2].

The energy policy formulation responsiveness is fixed in community's policy work and networks of policy. We may also say that the method of formulation requires contribution and inspiration of various innovative performers performing their respective parts in the process of policy design and development. The policy formulation conditions of the developing countries and forms of viable options or results for policy problems' resolutions have vital contributions in the complete procedure.

For the purpose of influencing the policies; the policy makers, non-governmental organizations and activists around the world use an approach termed as "Advocacy". Reforming or formation policies revolve around advocacy [3]. Moreover, advocacy focuses on execution and effective implementation of the policies [4]. We may term policy as a set of regulations, strategy or course of accomplishment that the government implements, for institution or business, or is intended to impact and determine judgments or actions. Putting an end to something is advocacy, addressing problems in another way which we focus to attain or resolve with various strategic programming techniques [3].

Unintended support of a class of policies or a specific policy, dynamic or concealed is the definition of Policy Advocacy [3, 4].Even if it's suitable for experts and other technology specialists to act as advocates for their individual inclinations towards policy is thought-provoking. In the world of science, advocacy is regarded to surround policy by defining the appropriate part of researchers and science in the process of politics. Many researchers decide to perform as supporters of policy, whereas such a role is regarded by others as inappropriate.

In Pakistan many energy policies have been introduced, the main aim of these policies is to increase power production capacity, although the emphasis should be more towards the increase in efficiency of the existing capacity in the short term, while in the long run the capacity additions seems to be inevitable as the demand will surpass the supply by a large margin, and this increase can only be catered through increase in supply of electricity.

Following are the energy policies that have been introduced in Pakistan so far starting from 1994 to Energy Policy 2015:

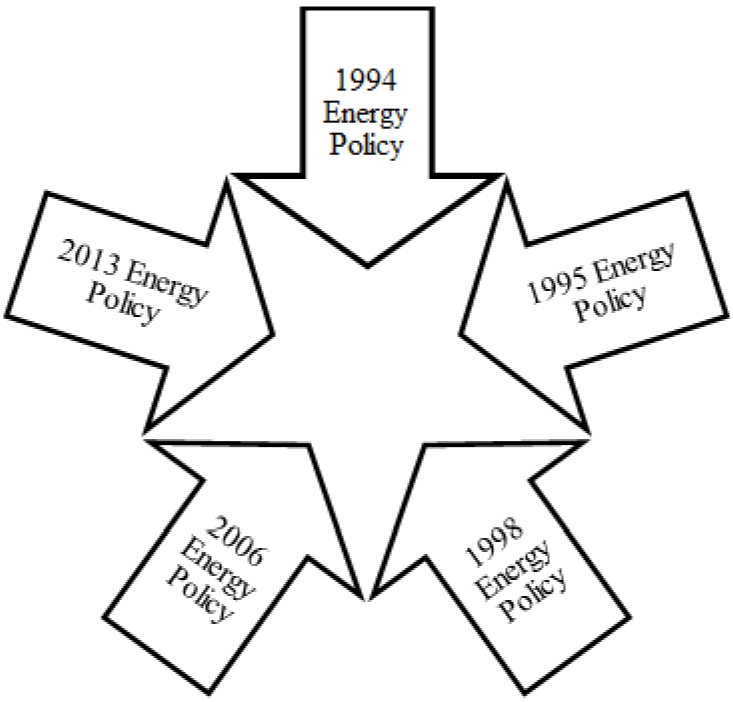

Figure 5.6: Energy Policies-Pakistan

Policies along with their summary are listed below:

Table 5.1: Past and Prevailing Energy Policies of Pakistan

Power Policies	Main Features
1994 Energy Policy	• WAPDA was charged US cents 6.5/kWh bulk tariff, an entity of state, for electricity sale. • Based on energy sold US cents 0.25/ kWh premium for the projects higher than 100 MW was sold and by the end of 1997 will be commissioned. • Guaranteed payment of a fixed "Capacity Price" irrespective of its generation of electricity.

	• Fixed "Capacity Price" payment guarantee irrespective of electricity generation. • Exemption from corporate income tax, customs duties, sales tax, and other surcharges equipment. • Purchase agreement of power. • Fuel supply agreement. • Simplified procedures for IPPs.
1995 Energy Policy	• In addition of the fiscal incentives of 1994 Energy Policy, model implementation (concessions agreement for private hydropower projects). • Implementation of the model (power purchase agreement and concessions). • Agreement for hydropower projects. • WAPDA to be charged US cents 6.1/kWh as bulk tariff, a state entity, for the sale of electricity. • Hydropower project ownership free of cost shall be shifted to the government of Pakistan after twenty five years. • Projects provision alongside particular risk termed as force majeure. • Provide protection against changes in certain taxes and duties • Guarantee foreign exchange conversion facility.
1998 Energy Policy	• Tariffs will be based on open bids, dominated in rupees. • Bidders will be asked to quote their tariff in two parts: (1) Energy purchase price (2) Capacity purchase price. • Provide protection against changes in certain taxes and duties. • Parties may raise local and foreign finances. • Guaranteed foreign exchange conversion facility.
2006 RE Policy	• No customs duty or sale tax for machinery meant for the initial installation or for balancing, modernization, maintenance, replacement, or expansion after commissioning of renewable energy projects. • Exemption from income tax. • Repatriation of equity along with dividends freely allowed. • Parties may raise local and foreign finance.

	• Non-Muslims and non-residents shall be exempted from payment of Zakat on dividends paid by the company.
2013 Energy Policy	• Upfront tariff and competitive bidding to lower the cost of electricity. • Reduction of subsidies. • Shift to cheaper fuels (i.e. indigenous coal and hydro projects). • Gradual shifting of fuel supply to IPPs. • Improved efficiency and better control of loss/ theft of electricity.

5.3 2015 Energy Policy

A developing economy like Pakistan has ever increasing energy requirements. One of the most relevant economic welfare indicators is the per capita electricity consumption. Our country is gifted with a huge coal and hydro potential that can eventually ensure our future security if exploited carefully [5]. The country has remained behind in meeting the increasing electricity demand, hindering the growth of economy [6]. The Government of Pakistan is working on multi-pronged strategy for overcoming the electricity crisis, comprising expansion of power projects in both private and public sector grounded on import based and indigenous resources. The generation capacity planned expansion needs abolishing extension in the infrastructure of transmission for power evacuation [7].

The Government of Pakistan has taken the initiative of private sector based transmission lines development.

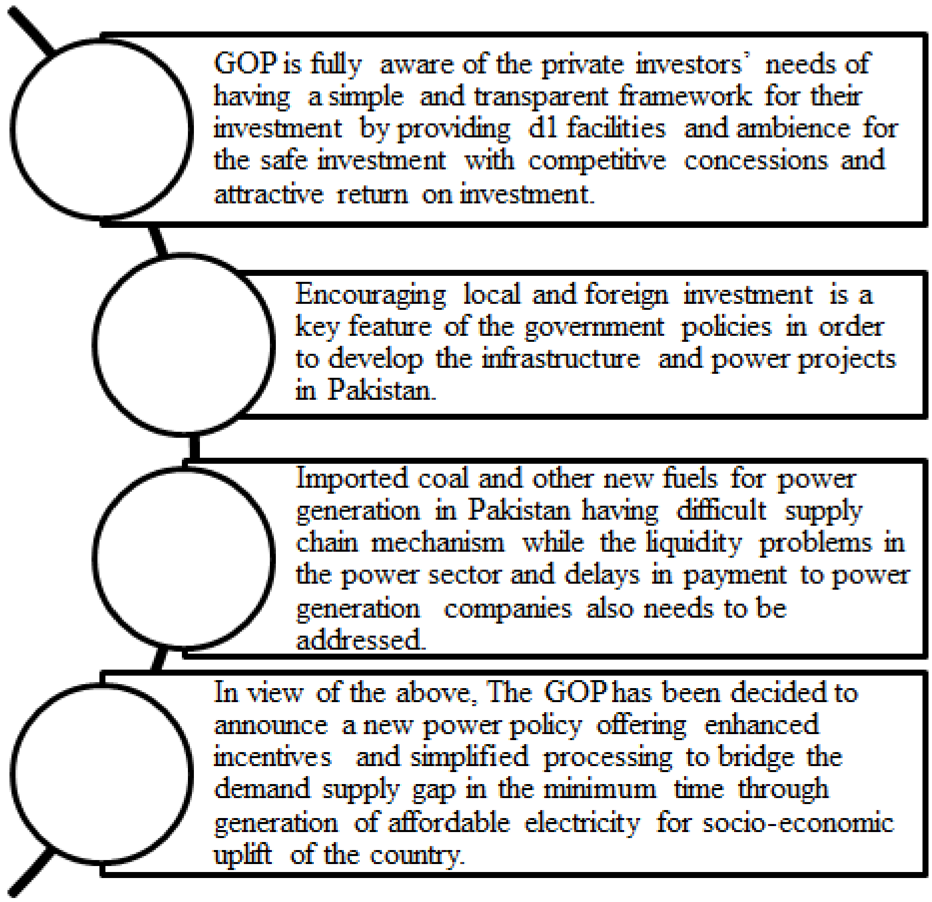

Figure 7: Steps taken by GOP in the Private Power Sector

5.3.1 Main Objectives of 2015 Power Policy:

1. Providing adequate power generation capacity at minimum rate.
2. Ensuring and encouraging indigenous resourcesexploitation [8].
3. Ensuring that in the process all stakeholders are taken care of.
4. Agreeing to environment protection.

5.3.2 Scope of the 2015 Power Policy

1. Providing Power projects in the power sector.
2. Power projects in the public sector, where ever the project sponsor requires.
3. Power projects in the public-private partnerships (PPP).
4. Power projects developed by the public sector and subsequently divested.
5. Public sector developed power projects and divested subsequently.

Summary

During the process of policy making there are two steps which are of prime importance. One is policy formulation and the other is policy advocacy. Likewise in the energy policies making these are used. The energy policy formulation comprises of crafting energy sector goals, options and priorities, benefits of every energy field option and related concern. Advocacy focuses on execution and effective implementation of the policies. In Pakistan different energy policies put its focus on some important points. The 1994 energy policy focused on provision of fiscal incentives to the IPPs'. The 1995 energy policy laid emphasis on the private hydropower projects enhancement. The 1998 energy policy ensured a clear pathway for the allocation of different types of tariffs. In the 2006 RE policy, the renewable were incorporated for the first time in the energy policy of Pakistan. The 2013 energy policy focused on lowering the cost of electricity and ways to improve energy efficiency and reduce electricity theft. Finally the 2015 energy policy's main objective is providing adequate power generation capacity at minimum rate. The government should ensure that all the points given in the energy policies should be implemented and the results are examined so that a better policy may be adopted which caters to the energy needs of the nation.

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Chapter 6

Integrated Energy Policy

6.1 Introduction and Purpose of Integrated Energy Policy

The Integrated Energy Policy ensures harmonization and close consistency amongst the energy sub sectors [1]. It supplements energy sector plans, strategies and policies to meet national socioeconomic objectives [2]. It provides a comprehensible set of energy policies in significant regions for instance:

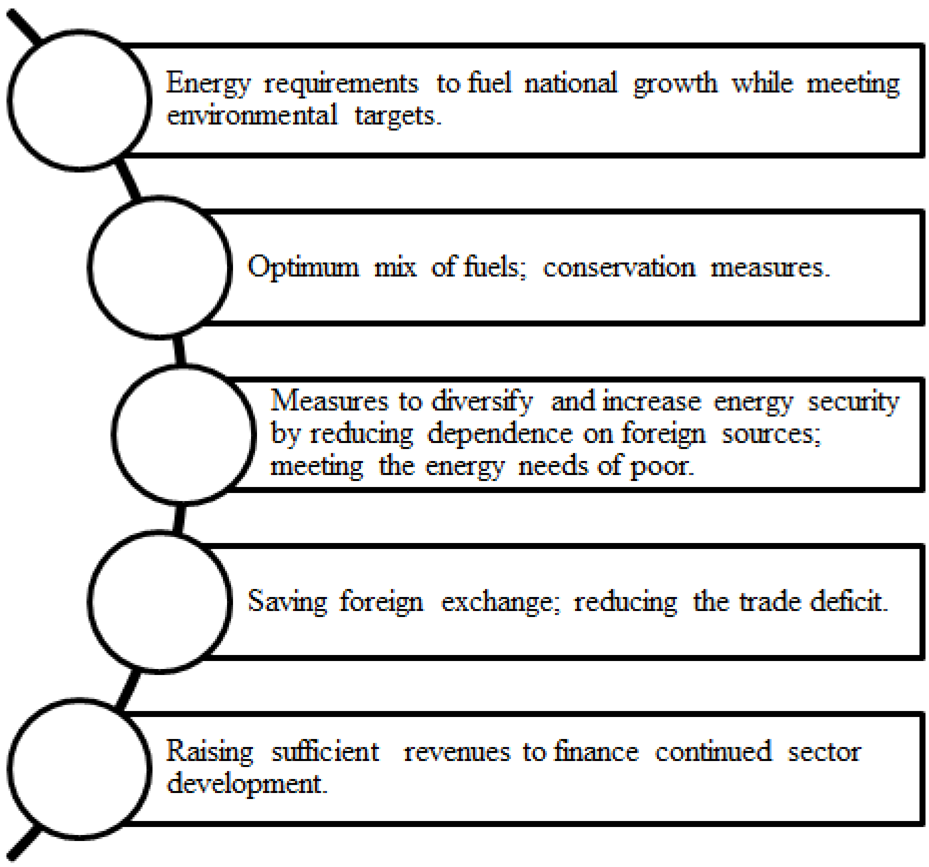

Figure 6.8: Energy Policies in significant regions

It aims to improve the energy sector and is focused towards economic strengthening and expansion [3]. To achieve its main objective, various secondary objectives are postulated. These are grouped into three main categories.

1. Providing Energy supplies enhancement
2. Energy security improvement
3. Energy sector strengthening

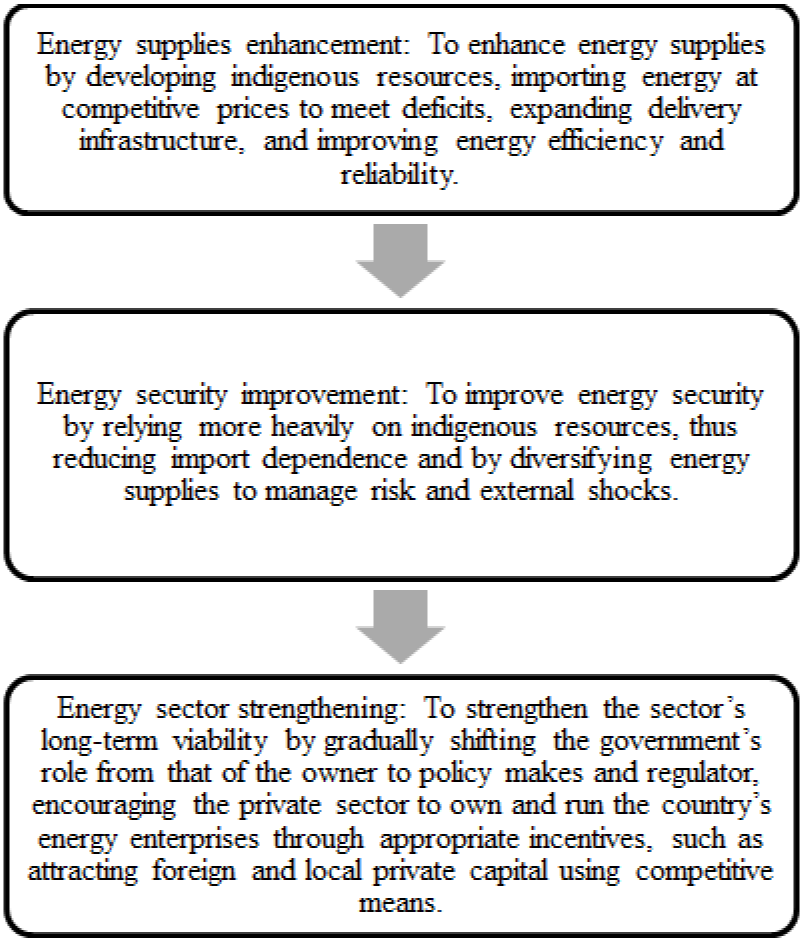

Figure 6.2: Secondary Objectives in Integrated Energy Policy

It aims to support sustainable and environment friendly policies with prime focus on energy conservation and security [3].

The energy policies embraced since independence to serve the financial and social needs have stimulated much inefficiency in energy production and consumption.

In terms of purchasing power parity, Pakistan is paying one of the highest energy prices. This has gnarled the effectiveness of numerous economic sectors [4]. Ensuring adequate energy supply in minimum cost is the biggest challenge. Another significant challenge is provision of energy to the poor [1]. This requires a comprehensive and effective energy policy.

An integrated energy policy should be implemented which is expected to explore sources of energy encompassing all sustainable development, alternative technologies and meets requirement for energy services which include access and availability, affordability and pricing, energy security and in addition environmental and efficiency concerns [1].

To meet Pakistan's energy requirement over the next twenty long years and support a growth rate of 4.5%, a coherent approach is desired that will be aimed at developing all existing sources of energy. Detailed policies recommendations have been made in the main areas of action are the following:

Reducing energy requirements through energy efficiency and conservation.
Augmenting energy resources and supply.
Rationalization of fuel prices to mimic fee market prices that promote efficient fuel choice and substitution.
Promoting coal imports.
Accelerating power sector reforms.
Cutting cost of Power.
Encouraging renewable and local solutions.
Enhancing energy security.
Promoting and focusing energy R&D.
Promoting household energy security, gender equity and empowerment through targeted entitlements for the poor.
Creating and enabling environment and regulatory oversight for competitive efficiency.

Figure 6.3: Energy Policy Recommendations

6.2 Why an Integrated Energy Policy is Needed

The sustainable development demands for policies that make the best use of renewable energy sources available to it [24]. The requirement for integrated policy grows as both in production and consumption various fuels can substitute each other [1].Policies must be assimilated for an efficient energy system.

6.2.1 Fuel Prices

Diverse fuel types are available, each with dissimilar calorific values, convenience and consumption efficiency. Furthermore, they produce different types and quantities of pollution. Nevertheless they are often used as alternatives for each other in particular uses. Therefore while setting relative fuel prices, economically and socially desirable inter-fuel choices are considered. Thus equivalence must be achieved in “marginal use values per rupee of fuel”. Consequently different fuels prices should be regulated dependently of each other.

6.2.2 Tax and subsidies Organization

Comparative rates can be influenced by subsidies and taxes. Consistent exercise and duties on imports for diverse fuels are desired.

6.2.3 Equal Opportunity

All energy projects and players should be treated alike for building an efficient sector.

6.2.4 Externalities

Various fuels require different externalities for production and consumption. Cohesive view must be incorporated within our policy for attaining environmental objectives at minimum possible cost [3].

6.2.5 Regulation of Public Infrastructure

Numerous features within an energy system create a public infrastructure. Means of public transportation and transmission networks play a leading role in the energy system. Their coordinated development and regulated functioning is desired.

6.2.6 Strategy for Transition, R&D and Long Gestation Lags

Various energy ventures have long gestation lags and encompass hefty investments. Integrated energy policy is to deliver a structure of expansion, and a transition approach. Providing support and long term commitment, setting priorities and outlining an optimum strategy for R&D necessitates an integrated outlook on the impending energy system.

6.2.7 Unfailing Regulation

To ensure efficiency, gain stability between producer and customer interests and to generate a situation in which everyone has a fair and equal chance of succeeding, an integrated policy is desired. This will promote consistent regulation across different areas and diverse energy sources.

6.2.8 Nationwide Priorities

Policies have to factor in countrywide priorities.

6.2.9 Energy Availability in all Regions

To achieve balanced development of region, availability of energy must be made in all regions. Factors causing regionally distorted development should be ignored. Direct instruments linking incentives with outcomes must be promoted. Various resources and fuels are geographically distributed; therefore, a unified methodology can lessen the cost of incentives and distortions.

6.2.10 Energy subsidies

Goods for the poor must be provided with subsidy and is justified. Subsidies provided have to be steady, progressive, self-limiting and achievable.

6.3 What Is Energy Security?

Defining energy security by the report of The World Energy Assessment is: “The continuous availability of energy in varied forms in sufficient quantities at reasonable prices” [5]. Modification in the definition is required for reflecting our situation in a better way. Energy security is described as: “We are energy secure when we can supply lifeline energy to all our citizens irrespective of their ability to pay for it as well as meet their effective demand for safe and convenient energy to satisfy their various needs at competitive prices, at all times and with a prescribed confidence level considering shocks and disruptions that can be reasonably expected” [6].

Noted parts shall be of this description: “all her citizens”, “lifeline energy”, “effective demand”, “safe and convenient energy”, “at competitive prices”, “at all times”, “various needs”, “prescribed confidence level”, “shocks and disruptions” and “reasonably expected” [7, 8].

The following considerations motivate the above mentioned points:

1. Providing energy supply to all people is essential. The situation cannot be sustainable when provision of energy is limited to only some of the citizens [8].
2. Provisioningof energy to everyone is imperative, regardless of their paying capability. Provision of energyis a basic necessityup to a particular level. The energy requirements of the country should be fully met and this is what is required from energy security [8].
3. Demand supported by the capacity paying at determined market pricesmust be fully met and is the effective demand. If that’s not the case, the poorer classes wont get what they desire but the rich will do [8].
4. Inability to meet demand at reasonable rates advocates Pakistani economy’s incompetitiveness.
5. Traditional fuels utilization for instance dung cakes and wood is desireable as safe and convenient energy, it results in air pollution in the house and results in bad effect on the human health, specially for children and women.
6. Various forms of energy are required to fulfill the various needs. It is not easy to substitute energy with other forms.
7. Availability of energy should be made at all time. Disruptions in availability of energy may inflict higher rate on human well-being and economy.
8. Energy security should be ensured at all times. Disturbances and shocks which should be expected [8]. It is essential for the energy security to be able to endure such disruptions and shocks. Though, we may not protect against all likely shocks at reasonable rates. Energy supply cannot be ensured 100%. We can only ensure supply merely within a certain prescribed level of confidence.

6.4 Research and Development in Energy

Energy Sector Research and Development is essential for amplifying resources, meeting the needs in the long-term, attaining energy independence, energy security enhancement and promoting efficiency [9]. Pakistan's energy requirements are swiftly growing as compared to world's gross fossil fuel supply growth, so the country shall find it very difficult to cope with it [10].

Pakistan solution is proposed in the following figure:

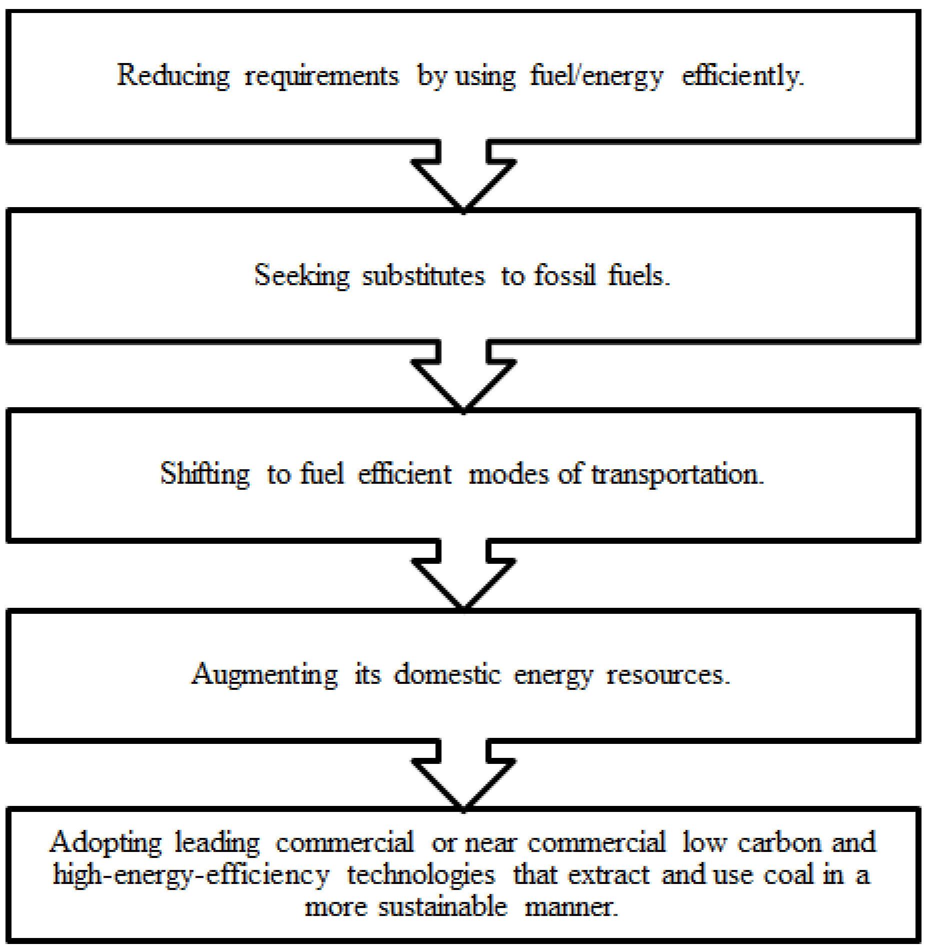

Figure 9.4 : R&D in the Energy Field

Energy research and development plays a domineering role in all the areas.

6.5 Energy-Environment Linkages

For the purpose of attaining sustainable energy-chain, it is essential to value, recognize measure and integrate the influences of environmental sector activities on energy [11]. Environmental concerns are linked to complete energy profile which contains renewable, fossil fuels and nuclear energy, all the way through the chain of energy. Though, the specific nature, strength and environmental impact extent differs longitudinally across various energy forms [12]. These special effects come at different levels as global, local, national, regional and household. Pakistan's current magnitude, pace of growth and diversity calls for development and use of all forms of energy optimally, especially ability to fulfill goals of poverty alleviations [13].

Summary

The Integrated Energy Policy has certain objectives which are providing Energy supplies enhancement, Energy security improvement and Energy sector strengthening. The requirement for integrated policy grows as both in production and consumption various fuels can substitute each other. Policies must be assimilated for an efficient energy system. A very essential aspect of the integrated energy policy is the energy security which is the continuous availability of energy in varied forms in sufficient quantities at reasonable prices. In addition to this the Energy Sector Research and Development is essential for amplifying resources, meeting the needs in the long-term, attaining energy independence, energy security enhancement and promoting efficiency. Pakistan's energy requirements are swiftly growing as compared to world's gross fossil fuel supply growth, so the country shall find it very difficult to cope with it. Finally we talk of energy and environment linkages in which environmental concerns are linked to complete energy profile which contains renewable, fossil fuels and nuclear energy, all the way through the chain of energy. Though, the specific nature, strength and environmental impact extent differs longitudinally across various energy forms. So the integrated energy policy is imperative to achieve the maximum goals in the energy sector in terms of energy efficiency and energy conservation.

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Chapter 7

Renewable Energy Activities in Pakistan

The activities of Pakistan Council of Renewable Energy Technologies (PCRET) can be classified as

1. National Regular Activities
2. R&D Activities
3. Promotional Activities pertaining to Renewable Energy Technologies [1,2].

7.1 Description of the Main Activities

The main activities will now be described in some detail.

7.1.1 Regular Activities

1. Fabrication of solar cells and PV panels of mono-crystalline structure.
2. PV system designing and installation of demonstration units for the promotion of solar energy technologies.
3. Microhydel power plants designing after potential assessment of the site, their installation and electrification of remote area houses/ college industry.
4. Domestic and commercial scale biogas plants designing and installation for meeting fuel energy demands and power generation for water pumping to irrigate agri-land.
5. Wind energy system installation for electrification of remote and coastal areas of the country.
6. Solar water heater and solar trough designing and installation for hot water process heat in domestic and industrial area.
7. Solar dryers for drying designing and installation of fruits and vegetables.
8. Solar desalination systems designing and installation for clean water in remote areas.
9. Provision of consultancy and testig services to cater for private and public sector organizations.

7.1.2 Research and Development Activities

Research and development activities include:

1. 540 watts and 810 watts big solar panels fabrication first time in Pakistan.
2. 4500 wafers cutting in newly installed wafering labs of 80 kW project.
3. Cutting of 1500 solar cells with laser cutter for laser land leveling system of Atomic Energy Commission and small solar panels for private industries.
4. PV panels and solar Cells of 100 kW capacity fabricated in its labs.
5. PCRET Solar testing lab tested 7 solar panels of different capacities and 3 solar water heaters of private clients.
6. 25 Sun tracked solar trough design and installed at PCRET for hot water first time in Pakistan.
7. Construction of commercial scale hybrid type biogas plant of 250 m^3 capacity using fiber glass technology first time in Pakistan.
8. Achievement of power generation using dish strilling technology by PCRET and IUIC first time in Pakistan.
9. PCRET solar testing lab certification with PNAC (under process).
10. solar water heaters have been fabricated and handed over to the beneficiaries.
11. 10 solar concentrators have been fabricated and dissiminated.

7.1.3 Promotional Activities

Promotional activities include:

1. Working on ultra low head micro hydel power. In this regard a small micro hydro has been successfully tested in Rawal Lake Canal.
2. Construction of commercial scale hybrid type biogas plant of 250 m^3 capacity using fiber glass technology. The plant will use agri-waste, animal waste and kitchen waste at a time for generation of bio-gas and bio-fertilizer.
3. Design and development of sun-tracked solar dryer of one tonne capacity for drying of fruits and vegetables has been installed at Lahore.

On account of these activities, energy generation and energy savings along with carbon abatement value comes in the range of millions of rupees during this fiscal year.

7.2 Steps Taken By Alternative Energy Development Board (AEDB)

All possible measures are taken by the Government of Pakistan ensuring in the country sustainable development and energy security. In its effort to diversify its energy mix, the government has been paying much attention en route for fast track development in the country of Alternate/Renewable Energy resources [3,4].

The quantity of helpful measures for promoting alternate/renewable energy technologies and attracting investment of private sector consists of:

1. Announcement of upfront tariffs for solar, wind,biomass projects. Upfront tariff for small/mini hydel developments is in progress.
2. Announcement of framework for power co-generation(Biomass/Bagasse)2013 for generation of power fromsugar mills for supply to national grid.
3. Detailed resource assessment of wind, solar and biomass in the country is being carried out through ESMAP (World Bank) assistance.
4. Standardized project agreements (EPA/IA) for investors have been developed.
5. Grid code has been amended for solar power projects.
6. Ensuring availability of grid infrastructure.
7. Encouraging local manufacturing.
8. Use of solar energy for power generation and water heating in domestic, commercial and industrial sectors is being promoted.

7.3 Sector wise Progress

Progress in the following sectors have been made

7.3.1 Wind

The number of IPPs wind projects is 31, AEDB has issued LOIs to these firms and these projects are at different phases of development [5, 6].

7.3.1.1 Operational Projects

Electricity Generation by Renewable Energy Projects (2013-14).

Table 6.1: Wind Energy Projects in Operation

Technology: Wind Energy	Province	Villages	Capacity (MW)	Generation GWh/Year
FFC Energy Limited	Sindh	Jhampir	49.5	136.811
ZorluEnerji (Pvt) Limited	Sindh	Jhampir	56.4	180.234

Micro Wind Turbine Total Capacity: 105.9 MW Micro Wind Turbine Total Generation: 297.045MW

7.3.1.2 Projects in Construction Phase:

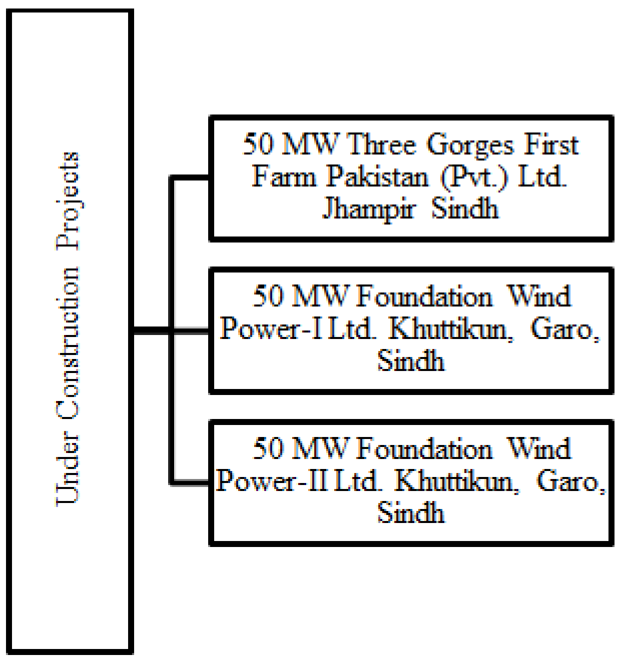

Figure 10.1: Wind Energy Projects in Construction Phase

7.3.1.3 Pipeline Projects

13 projects (680 MW capacities) are expected to achieve financial close by 1st quarter 2015:

1. 540 Cost-plus tariff 03 projects 150 MW
2. Upfront tariff 10 projects 530 MW

NEPRA declared a US cents 13.52 new upfront tariff of per kWh on 24th April, 2013. As per the terms and conditions of the upfront tariff, the IPPs that are awarded upfront tariff by NEPRA are required to achieve financial closing of their respective projects by March, 2015.

7.3.2 Solar

Solar energy accounts for a cumulative capacity of around 888.1MW for 33 LOIs and is using power plants known as On-Grid. Feasibility studies have been submitted by 4 companies and AEDB has approved 1 feasibility study. Feasibility studies are at preparation phase by other sponsors.

For solar power projects upfront tariff announced on 21st January by NEPRA of cumulative capacity 50M.

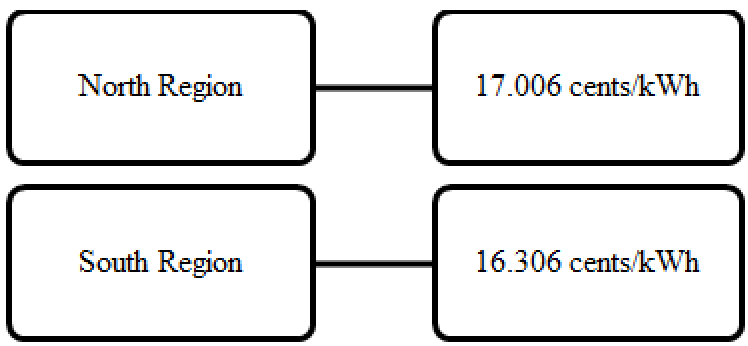

Figure 7.2: Upfront Tariff by NEPRA to Solar Projects

7.3.3 Waste (biomass) to Energy

Under the IPP mode projects are at different phases of implementation in the Biomass/Waste-to-Energy.

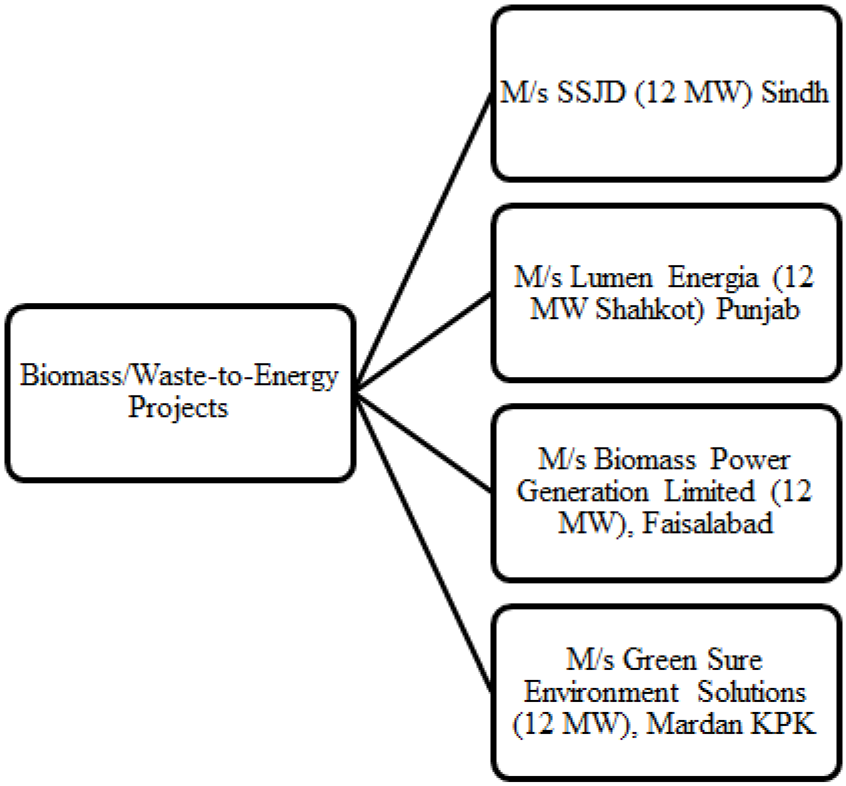

Figure 7.3: Biomass/Waste-to-Energy Projects

Economic Coordination Committee (ECC) has approved structure for Biomass/Bagasse power co-generation 2013 for sugar industry based on biomass/bagasse. Generation is expected in the next two to three years of power 1500-2000 MW [1, 7]. Several sugar mills/companies have been issued LOIs and the details of them as presented:

1. M/s JDW Sugar Mills Limited (Unit-II), 26 MW, District Rahim Yar Khan, Punjab
2. M/s JDW Sugar Mills Limited (Unit-III), 26 MW, District Ghotki, Sindh
3. M/s RYK Mills Limited, 30 MW , District Rahim Yar Khan, Punjab
4. M/s Chiniot Power Plant, 57 MW, District Chiniot, Punjab.
5. M/s Alliance Sugar Mills Limited, 19 MW, District Ghotki, Sindh.
6. M/s Kamalia Sugar Mills Limited, 15 MW, District Toba Tek Singh, Punjab.

7. M/s Layyah Sugar Mills Limited, 30 MW, District Layyah, Punjab.
8. M/s Safina Sugar Mills Limited, 20 MW, District Chiniot, Punjab.
9. M/s Al-Moiz Industries Limited, 45 MW, District Mianwali, Punjab.
10. M/s Etihad Power Generation Limited, 67 MW, District Rahim Yar Khan, Punjab.
11. M/s Etihad Power Generation Limited, 67 MW, District Rahim Yar Khan, Punjab.
12. M/s JDW Sugar Mills has started generation and supply of electricity to National Grid

The upfront tariff for these projects under the framework as announced by NEPRA is US cents 10.62 per kWh.

Summary

In Pakistan consistent development is being made in the renewable energy sector. For this various activities are going on in different levels. These activities are categorized as National Regular Activities, R&D Activities and Promotional Activities pertaining to Renewable Energy Technologies. All possible measures are taken by the Government of Pakistan ensuring in the country sustainable development and energy security. In its effort to diversify its energy mix, the government has been paying much attention en route for fast track development in the country of Alternate/Renewable Energy resources. In addition to this there are projects which are divided sector wise. These include projects in Wind, Solar and Biomass. All of these projects are at various stages of development i.e. some are at construction phase, some are operational and some are pipeline projects and are expected to be started soon.

References

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Chapter 8

Leap Energy Model

The requirement planning energy in the Long term is essential for meeting the electricity demand in Pakistan which is growing at a fast pace. Consideration of both environmental and economic concerns by the policy makers should be to make well-timed judgments about the generation mix of electrical power system. LEAP i.e. The Long-range Energy Alternative Planning system is a model categorized as econometric which is devised by Boston University in the USA and the Stockholm Environment Institute (SEI) [1, 2]. It is modeling tool based on energy-environment with focused on following approaches

1. Scenario Analysis Approach
2. Energy Demand Analysis
3. Equivalent and Cost-benefit Analysis and
4. Environmental Impact Analysis [3]

8.1 LEAP (Long Range Energy Alternatives Planning) Introduction

For the purpose of both energy as well as environment analysis LEAP software is used. LEAP software is based on windows platform and is used for forecasting and modeling energy by means of background energy data [4].

8.2 LEAP Main Views

Following are the eight views discussed above which can be viewed one by one with a mere click:

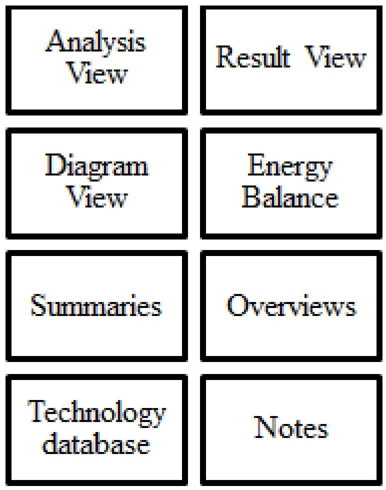

Figure 8.1: LEAP software Main Views

1. Providing Energy supplies enhancement
2. Energy security improvement
3. Energy sector strengthening

8.2.1 The Analysis view

In the Analysis View the following functions can be performed:

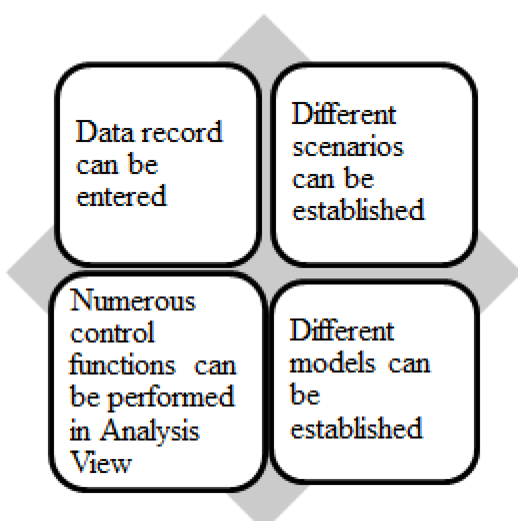

Figure 8.11: Analysis View Functions

8.2.2 The Result view

Various tables and can be obtained in this view and comparison is made with the results with variables both dependent and independent [5, 6]. In the software LEAP differing scenarios under different conditions are built followed by results exploration and analysis and a comparison can be established between these graphs and tables [1].

8.2.3 Diagram View

Representation of energy system models is done under the Reference Scenario selection box.

8.2.4 Energy Balance

Production and Energy use in specific year using different table is performed in the energy balance selection box.

8.2.5 Summary View

It is primarily created as a general purpose tool. Summary view allows creation of customized tabular and graphical reports. Reports may consist of any results or values in addition to your own headings for purpose of comments [2].

8.2.6 Overview

The main function of overviews view is grouping of multiple "Favorite" charts .We can simultaneously examine different important results with this view, for instance; resource requirements, costs and environmental impacts.

8.2.7 Technology and Environmental Database (TED)

It is included in LEAP and it provides broad information relating to the technical features, environmental impacts and costs [1,6].

8.2.8 Notes

Documentation and references for each branch can be entered in the here.

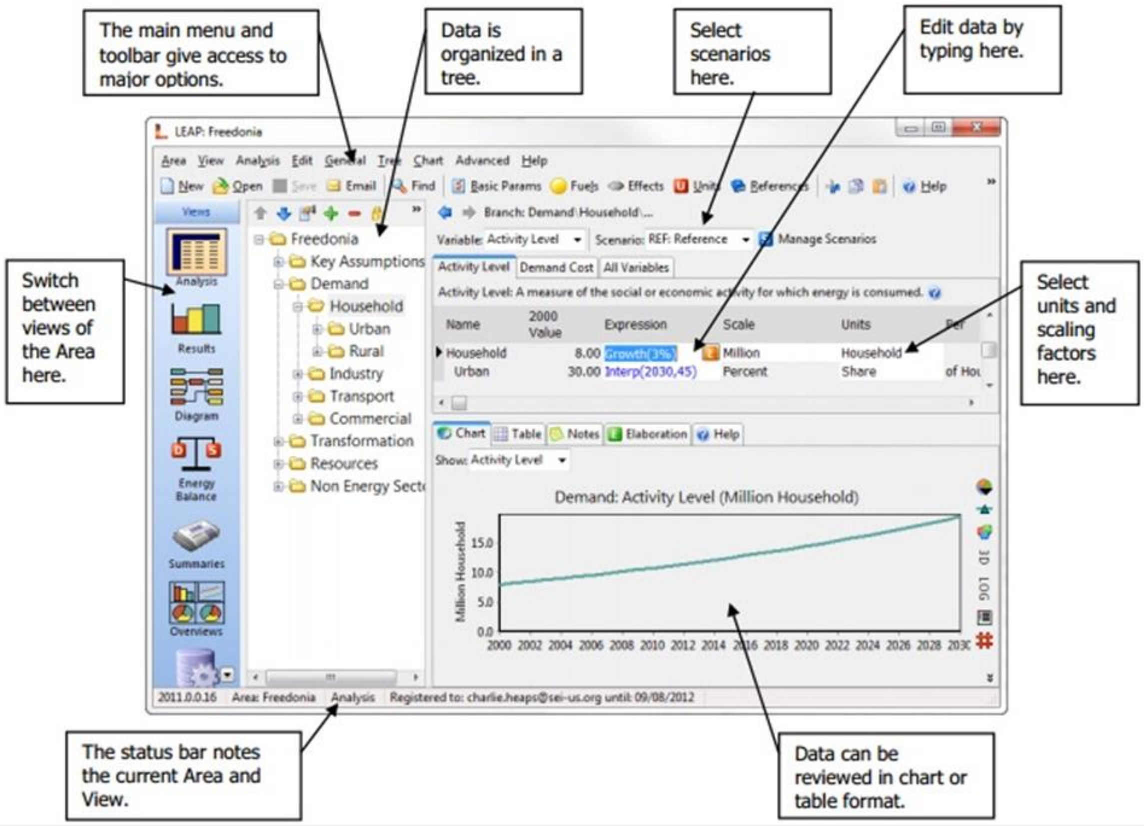

Figure 8.3: LEAP software Screenshot

Analysis view major parts presented in screenshot above and more details of above screenshot are explained later.

Different branches in the Tree are

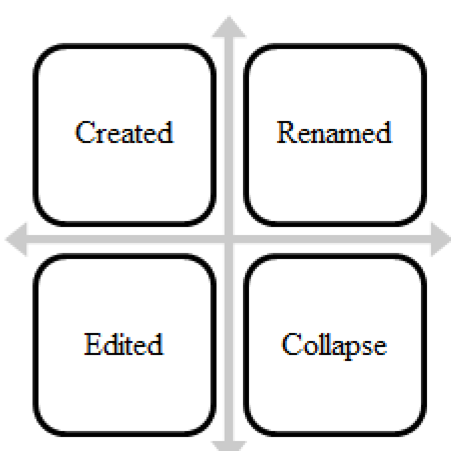

Figure 8.4: Different Branches in a Tree

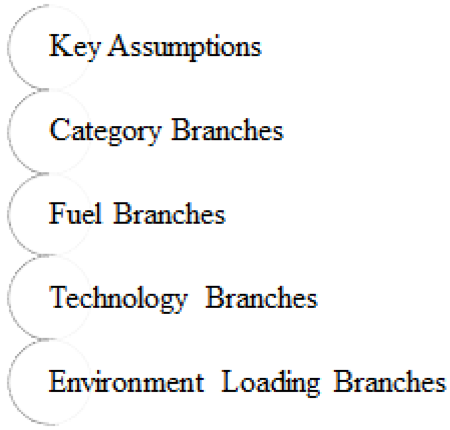

Figure 8.5: Types of Branches

8.2.9 Technology Branches

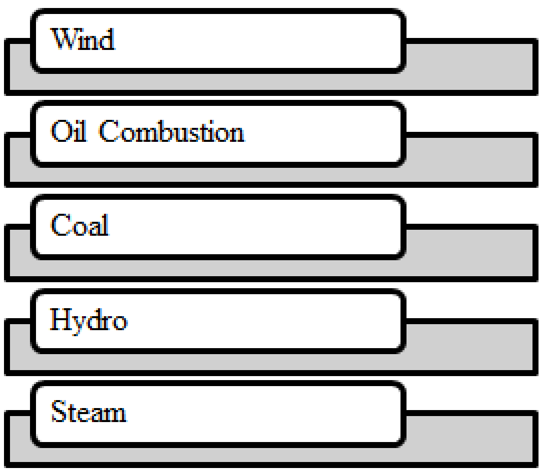

Figure 8.6: Electricity Generation Module Different Processes

Demand analysis technology branches are divided into 3types given below (methodology based):

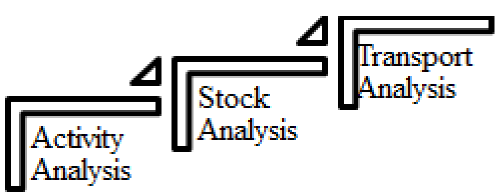

Figure 8.7: Technology Branches of Demand Analysis

8.2.10 Category Branches

The category branches are the type of branches used in the tree and are used in organizing hierarchical type of data.

In Energy converting in Supply Analysis the following Modules are used:

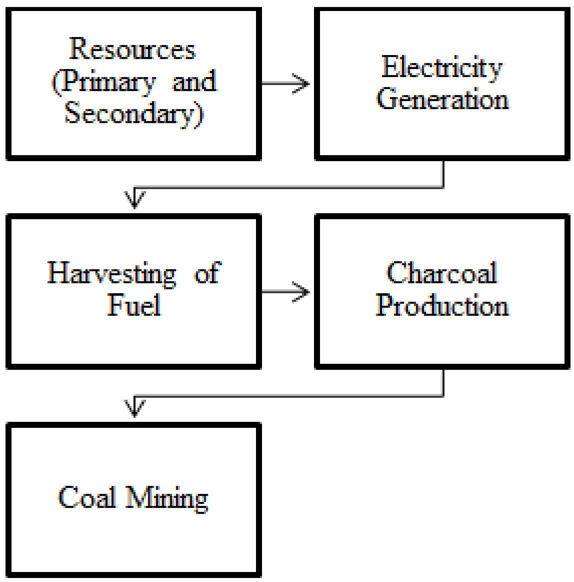

Figure 8.8: Modules in Supply Analysis

8.2.11 Key Branches

Branches for “Key Assumptions” are:

- Income
- Population
- Household size
- GDP
- Growth Rate of Income
- Population Growth Rate
- End Year Urbanization etc.

Figure 8.9: Branches of Key Assumption

Primary and Secondary Resources
Coal un-specified
Natural Gas
Coal
Solar
Hydro
Wood

Figure 8.10: Fuel Branches

8.3 Requirements for Installation of LEAP software

Windows 8 or further upgrade version
Pentium personal computer at least 400 MHz
Random access memory of 64MB
Internet Explore version 4 or above
Microsoft Office and internet connection are optional

Figure 8.11: Minimum software and hardware requirements for LEAP

8.4 Highpoints of LEAP

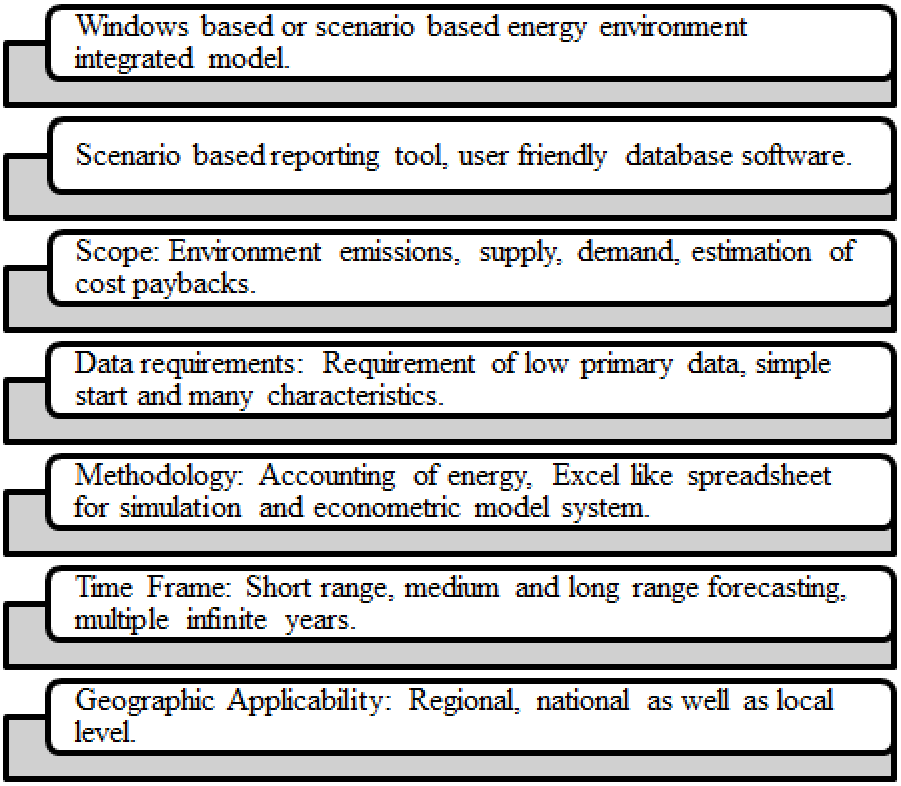

Figure 8.12: Highpoints of LEAP

8.5 LEAP Characteristics

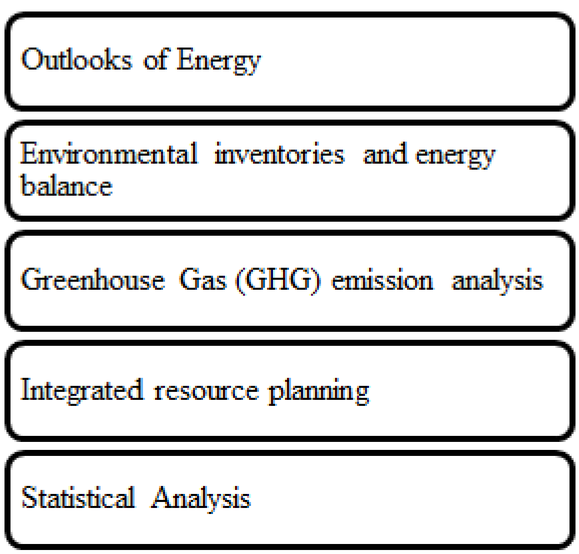

Figure 8.13: LEAP Characteristics

8.6 Energy Scenarios

Different scenarios may be created are:

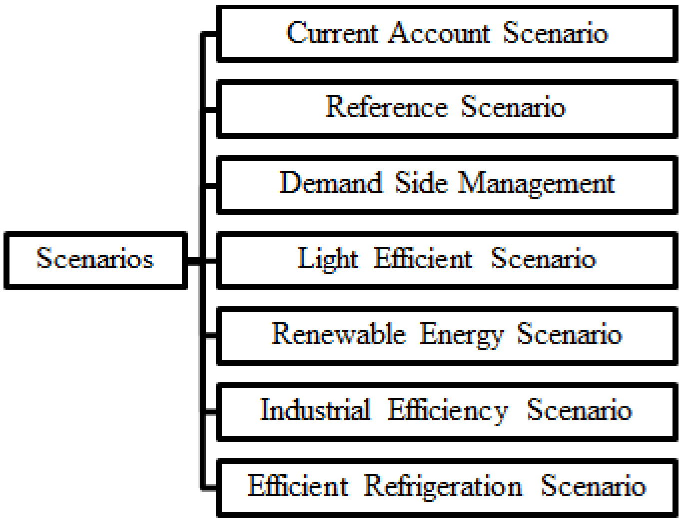

Figure 8.14: Different Energy Scenarios

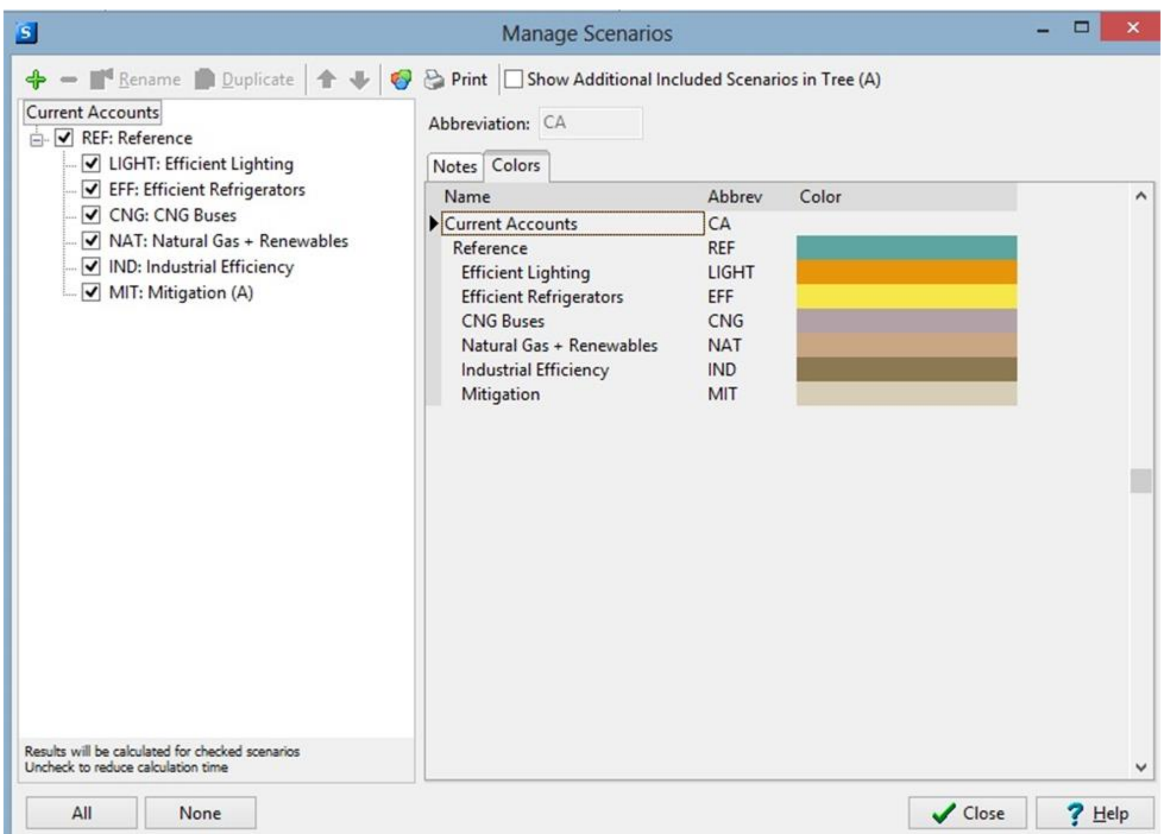

Figure 8.15: Energy Scenarios in LEAP Screenshot

Summary

The Long-range Energy Alternative Planning system is a model categorized as econometric which is devised by Boston University in the USA and the Stockholm Environment Institute (SEI). It is modeling tool based on energy-environment with focused on different approaches. These approaches and analysis are Scenario Analysis Approach Energy Demand Analysis, Equivalent and Cost-benefit Analysis and Environmental Impact Analysis. In LEAP we can create different scenarios and we can study the effect of different policy options being implemented. It is user friendly software and helps to forecast energy demand for any number of future years. The results can be obtained in tabular as well as graphical forms. Changes can be made at any stage with results being displayed instantaneously after changes are made. LEAP is a good software for the energy policy makers and helps in the decision making when future energy demand is forecasted. Environmental effects are also studied i.e. GHG mitigation effects and policies to reduce the environmental effects can also be done in LEAP.

References

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[5] Song, H.-J., et al., *Environmental and economic assessment of the chemical absorption process in Korea using the LEAP model.* Energy Policy, 2007. **35**(10): p. 5109-5116.5.

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Chapter 9

Calculations and Results

9.1 Methodology and Data Used

LEAP software is adopted to attain main displays of this research. Main scope of work in this research includes:

1. The key value of LEAP is that low initial data input is required [1]
2. The primarily objective of implementation of LEAP in this research is to evaluate and forecast energy consumption in Pakistan for the duration of 2013 to 2040 because this software relies on simpler accounting principle.
3. The first depletion year and monetary year in basic parameters of LEAP are taken as 2014.
4. In LEAP model only two year values are required one is base year values and other is future year values.
5. For this purpose, different scenarios are constructed.
6. In this research two scenarios were built, one is called current account scenario and the second is called reference scenario. These scenarios represent how an energy system evolve over time. Most research manipulate forecast period between 20 and 50 year

Most research manipulates period between 20 and 50 years. Primary as well as secondary data were collected from:

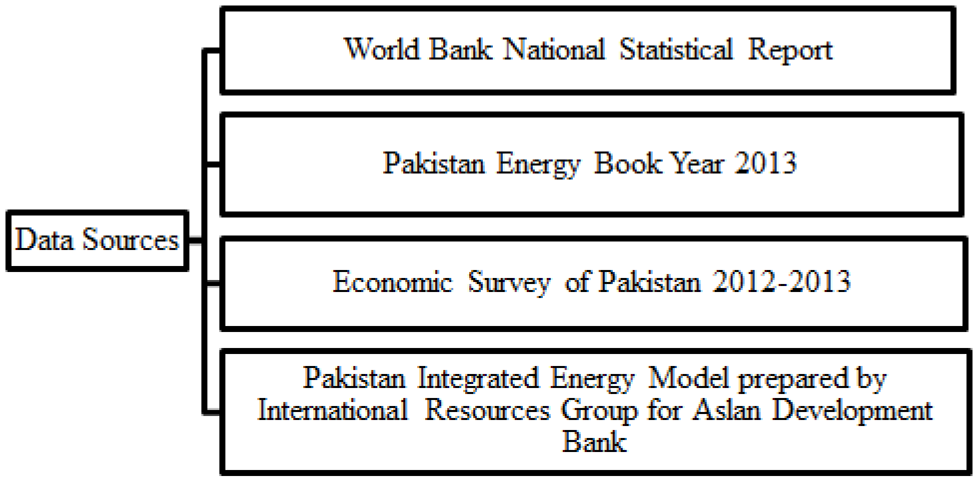


Figure 9.1: Primary and Secondary Data Sources

9.2 Key Assumptions

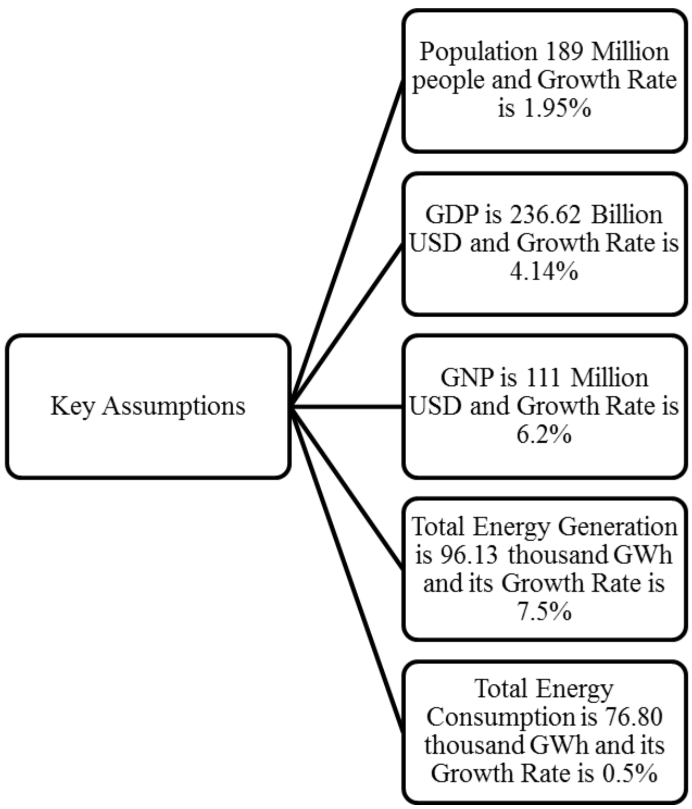


Figure 9.2: Key Assumptions Values

9.3 Current Account and Reference Scenarios

Demand analysis in tree of the LEAP software is distributed into several sectors like household, commercial, industrial, transportation and agriculture [1,2]. Table shows energy consumption of five sectors and their annual cumulative growth rate. ACGR is used in reference scenario in order to forecast energy consumption in future years.

Table 9.1: Base Year Values of Different Sectors

Sector	2012-13 Unit=TOE	ACGR
Household	10119014	4.7%
Commercial	1644845	2.6%
Industrial	14256099	-3.3%
Transportation	12713300	1.8%
Agriculture	659986	2.1%

In 2012-13 the total electricity generation in Pakistan was 96122 GWh

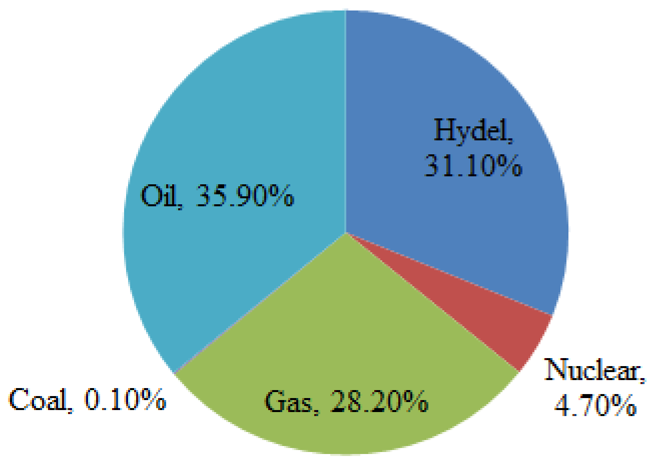


Figure 9.12: Electricity Generation 2012-13 in Pakistan

The following data set is used for Electricity Generation in LEAP

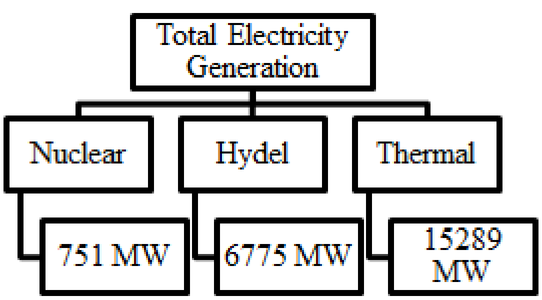


Figure 9.4: Data set used for Electricity Generation in LEAP

In reference scenario, estimated energy produced from different energy source till the end of 2040 is given below:

Table 7.2: Renewable and Fossil fuel potential of Pakistan (estimated)

Source of Energy	Estimated Power from Source (Mega Watt)
Hydro	20000
Solar	2500
Wind	6000
Biogas	1500
Coal	5000
Nuclear	15000

Two sub branches of the transformation sector are:

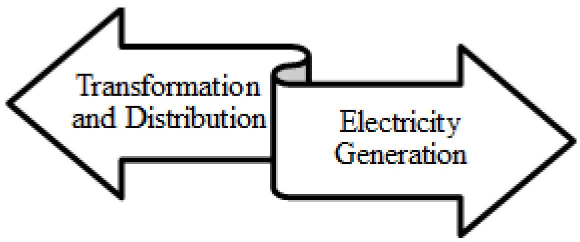


Figure 13.5: Sub branches of the Transformation sector

One sub category called “Process” in transmission and distribution which is categorized further into Electricity and Natural Gas losses [3,4].

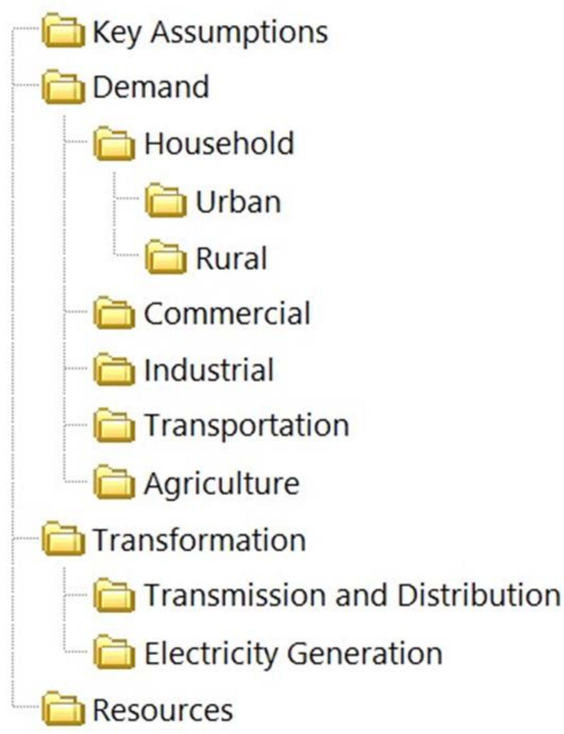


Figure 9.6: Screenshot of Tree development in LEAP

Energy sources from which electricity is generated are:

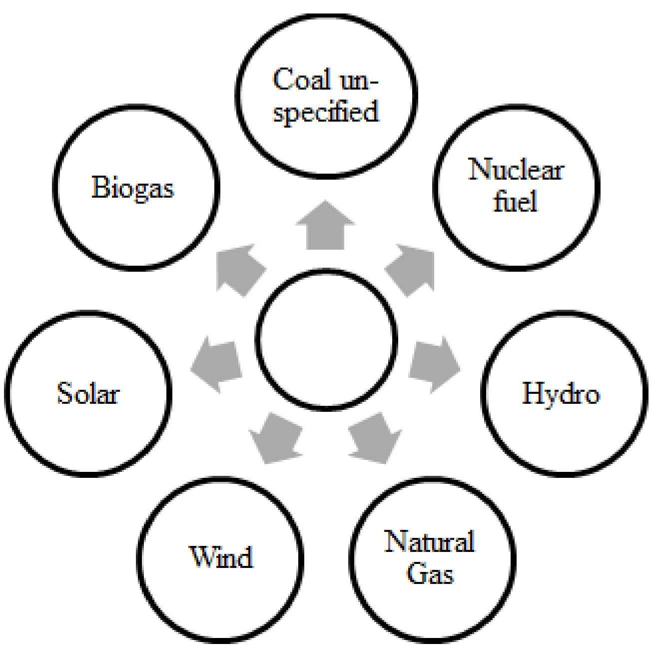


Figure 9.7: Fuels from which Electricity is generated

System energy diagram for electricity generated from various types of energy source

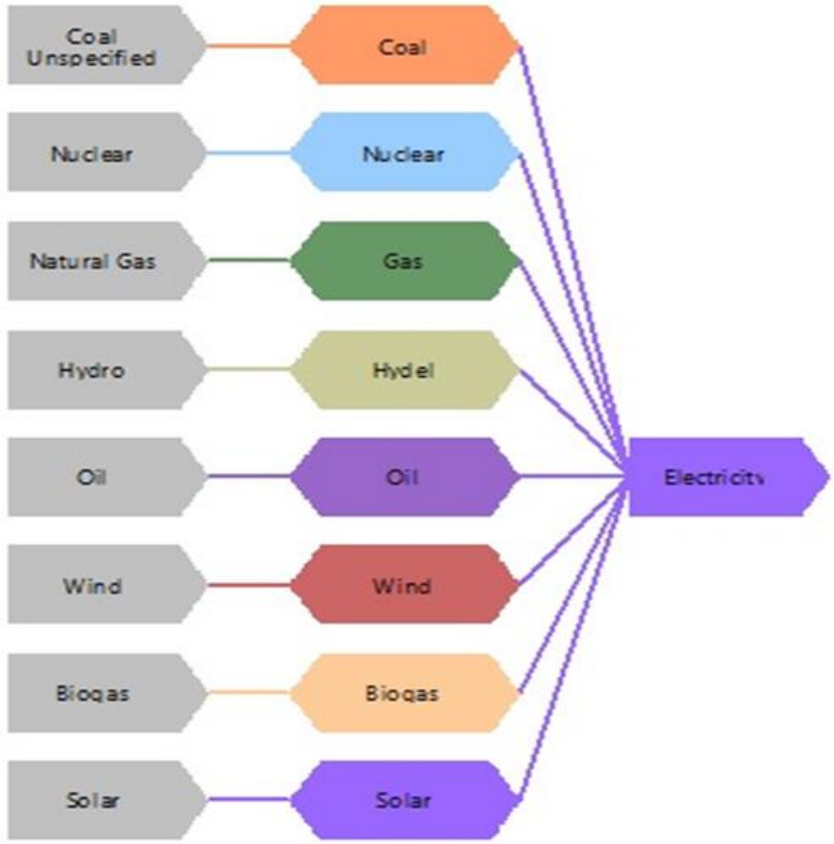


Figure 9.8: Energy System Diagram for Electricity Generation

The model which to be studied will be instigated on settlement of two scenarios which consist of transformation, demand analysis and key assumptions. In various scenarios energy demand was calculated for the current as well as for any future year at any particular technology branch as product of energy intensity and activity level equation discussed in LEAP software help [5].

$$D(b, s, t) = EI \times TA$$

Equation 1: Leap Activity Level Equation

Where D specifies demand, b represents technology branch, s for scenario and t represent from base year to any future year. “EI” represent energy intensity and “TA” stands for activity level.

9.4 Results of Key Assumptions

9.4.1 Gross Domestic Product Calculations and Results

The economy of Pakistan is faced with rises and falls since 2007 to onwards due to reasons as rains, security issues, floods and crises of energy. The figure shows GDP growth rate of Pakistan from period 2006-07 to 2013-14.

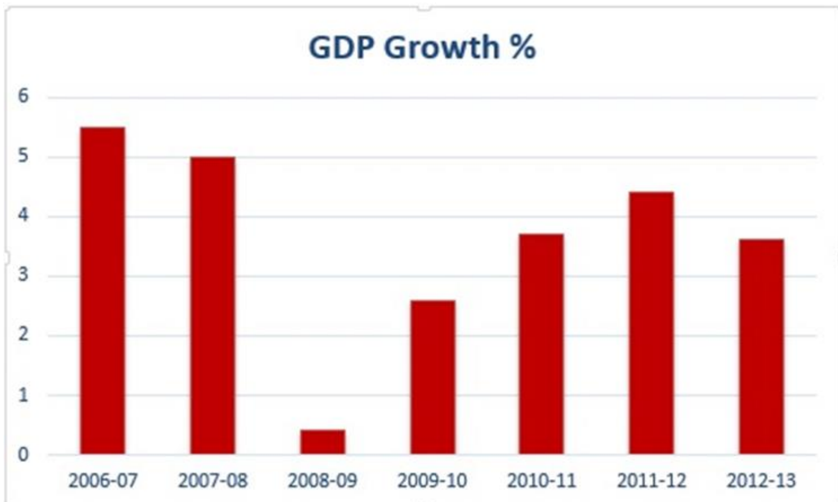


Figure 9.9: GDP Growth Rate of Pakistan

The Graph above explores that GDP of Pakistan in 2008-09 fell to very low value of just 0.40. In 2013-14 GDP growth rate of Pakistan is 4.14 and GDP is 236.62 billion US dollar. If this GR (growth rate) is used in BAU also known as reference scenario then Pakistan's GDP would be $2633.1billion. The figure represents the GDP of Pakistan starting from 2014 up to the year 2040.

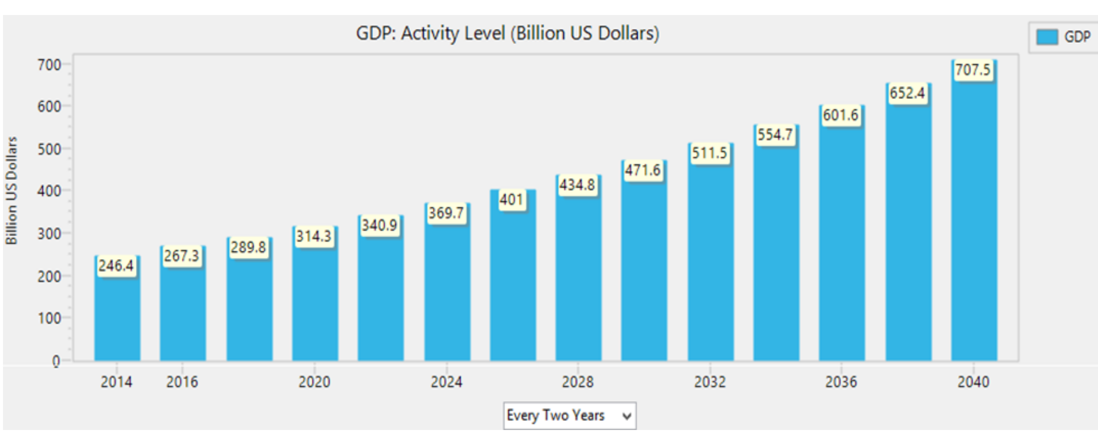


Figure 9.10: LEAP generated GDP of Pakistan

Table below represents Pakistan's GDP from period 2014 and forecasted till year 2040. GDP in 2014 is projected at $246.6 billion, while in 2019 its $301.8 billion, in 2029 and $452.8 billion and in 2040 being quite large then the GDP of the year 2014. LEAP generated below mentioned table reviews several conditions that are used both in scenario of current accounts and the reference scenarios. 4.1% is the Growth Rate from 2014 to 2040.

Table 9.3: Pakistan's GDP tabulated (Billion USD)

Branches	2014	2019	2024	2029	2034	2040	Total
GDP	246.6	301.8	369.7	452.8	554.7	707.5	2633.1
Total	246.6	301.8	369.7	452.8	554.7	707.5	2633.1

9.4.2 Gross National Product (GNP) Calculations and Results:

In 2013(the base year) Pakistan's Gross National Product i.e. GNP is $10 million dollars and the rate of GNP is 6.2 percent that is being utilized for the reference scenario. The figure shown is the calculated GNP of Pakistan from LEAP for the period 2013 to 2040.

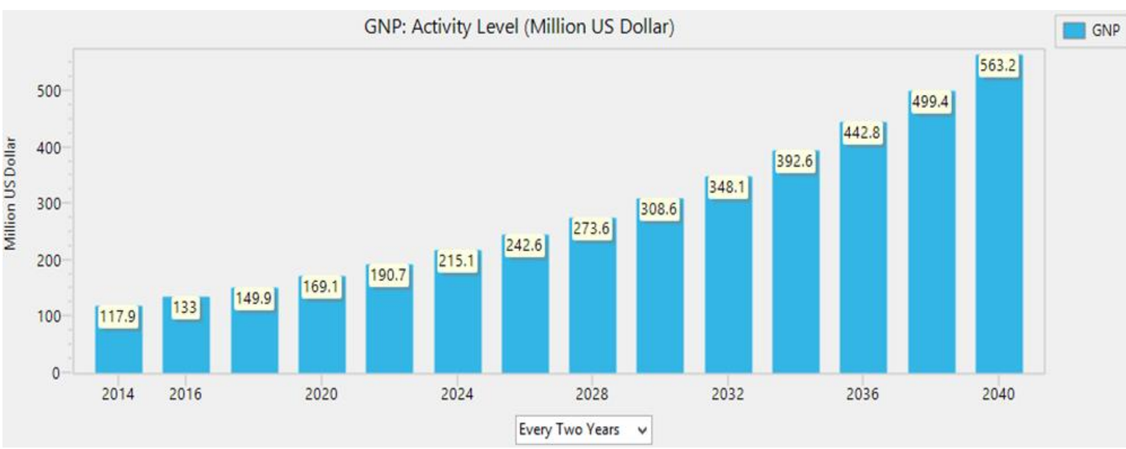


Figure 9.11: Pakistan's GNP generated from LEAP

GNP of Pakistan is calculated using LEAP and is shown in the table .The Gross National Product of Pakistan increases from 2014 to 2040 possessing the Growth Rate at 6.2 % using the LEAP software model. Total GNP forecasted of Pakistan is in7857.1 million dollars when we calculate the GNP from 2014 to 2040.

Table 9.4: Pakistan's GNP (Million USD)

Branches	2014	2019	2024	2029	2034	2040	Total
GNP	117.9	159.2	215.1	290.6	392.6	563.2	1738.6
Total	117.9	159.2	215.1	290.6	392.6	563.2	1738.6

As seen from the table above the GNP of Pakistan in 2014 is 117.9 million US dollar (using forecasting) and $563.2 million end forecasted ye ar 2040 is. The figures below show the Gross National Products of various countries in their native currencies.

Table 9.5: GNP of various countries in own currency

Countries	GNP	Previous	Highest	Lowest	Unit
Australia	379020.00	379326.00	379365.00	52637.00	AUD Million
Bangladesh	4773.82	4488.39	4773.82	2483.46	BDT Billion
Belgium	96788.00	97014.00	97014.00	21890.00	EUR Million
Brazil	1269988.29	1249600.80	1269988.29	343088.00	BRL Million
Canada	1962696.00	1939496.00	1962696.00	343088.00	CAD Million
Finland	45812.00	46039.00	46299.00	22765.00	EUR Million
Germany	745.71	739.97	745.71	375.74	EUR Billion
Hong Kong	564807.00	526531.00	576845.00	303627.00	HKD Million
India	99956.15	89328.92	99965.15	103.60	INR Billion
Japan	519768.70	522218.10	534393.80	263297.50	JPY Billion
Malaysia	195.70	191.60	195.70	127.10	MYR Billion
Pakistan	11175600.00	10565132.00	11175600.00	3778155.00	PKR Million
Sri Lanka	8438960.00	7423623.00	8438960.00	4115.00	LKR Million
United Kingdom	438428.00	437062.00	438428.00	4776.00	GBP Million
United States	16299.30	16189.80	16399.30	2096.40	USD Billion

Figure below shows World Bank of Pakistan's data is used to represent the Gross National Product in Pakistani Rupees.

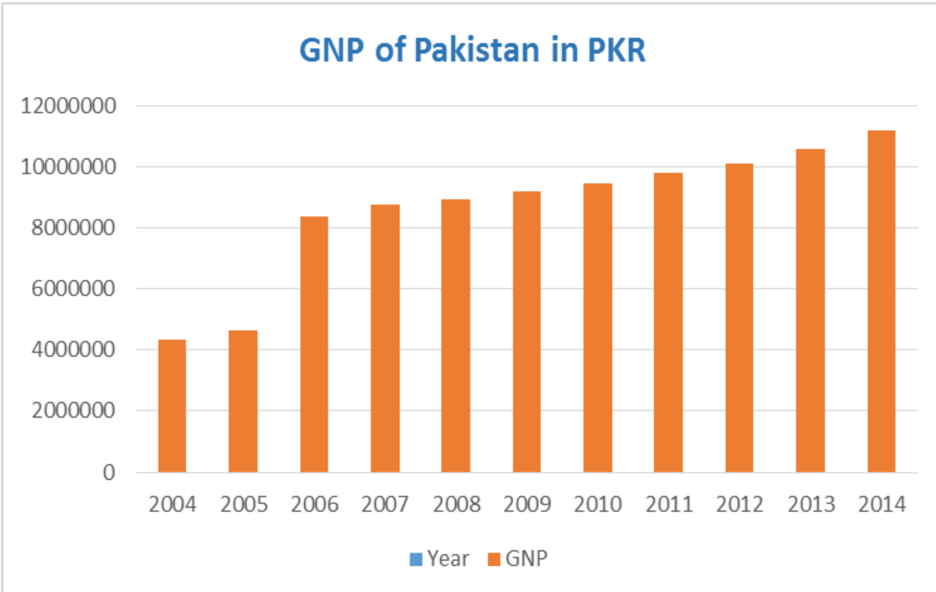


Figure 9.12: GNP Pakistan (PKR)

9.4.3 The Total No. of Person (Population) of Pakistan

189 million persons is the calculated population of Pakistan in 2013 is and with a growth rate of 1.95%. In 2012 1.97 % was the Growth Rate which decreased in 2013 to the mentioned value. The value 1.95% indicates that the population will be 233.7 million in 2024 and in 2040 it will be almost 318.4 million.

Table 9.6: Pakistan's Population (Million Persons)

Branches	2014	2019	2024	2029	2034	2040	Total
Population	192.7	212.2	233.7	257.4	283.5	318.4	1497.9

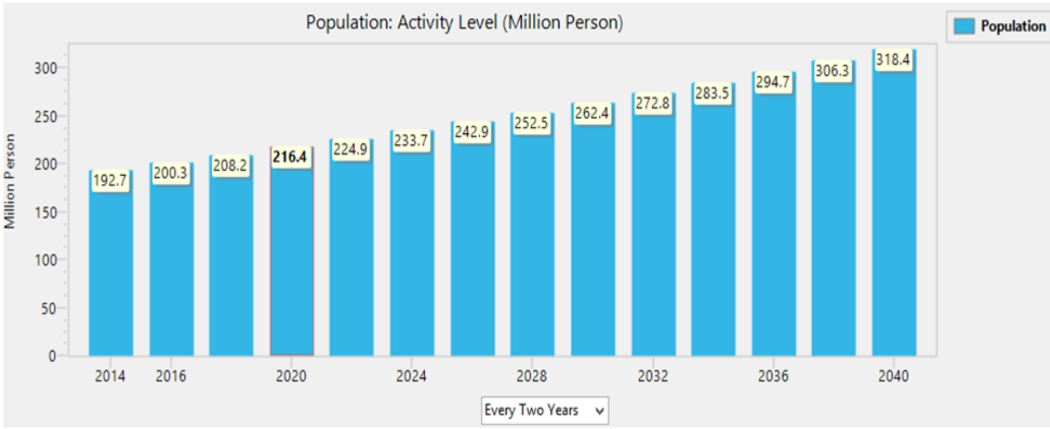


Figure 14: LEAP calculated population of Pakistan

9.4.4 The Total Energy Generation

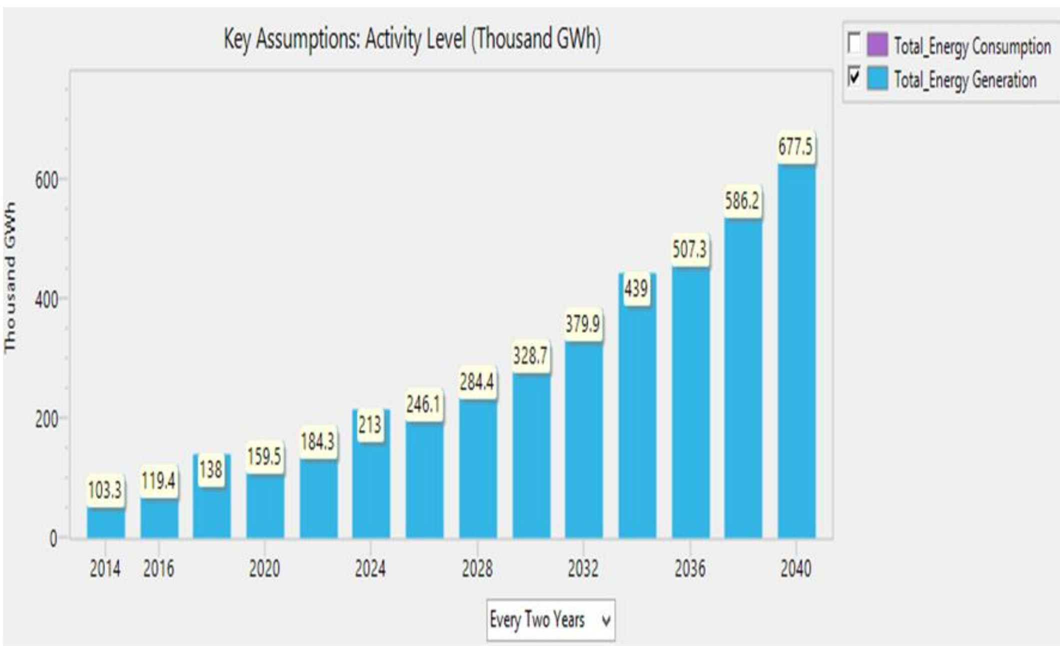


Figure 9.14: Total Energy Generation of Pakistan

Table 9.7: Total Energy Generation Pakistan (Thousand GWh)

Branches	2014	2019	2024	2029	2034	2040	Total
Energy Generation	103.3	148.4	213	305.8	439	677.5	1887

9.4.5 The Total Energy Consumption

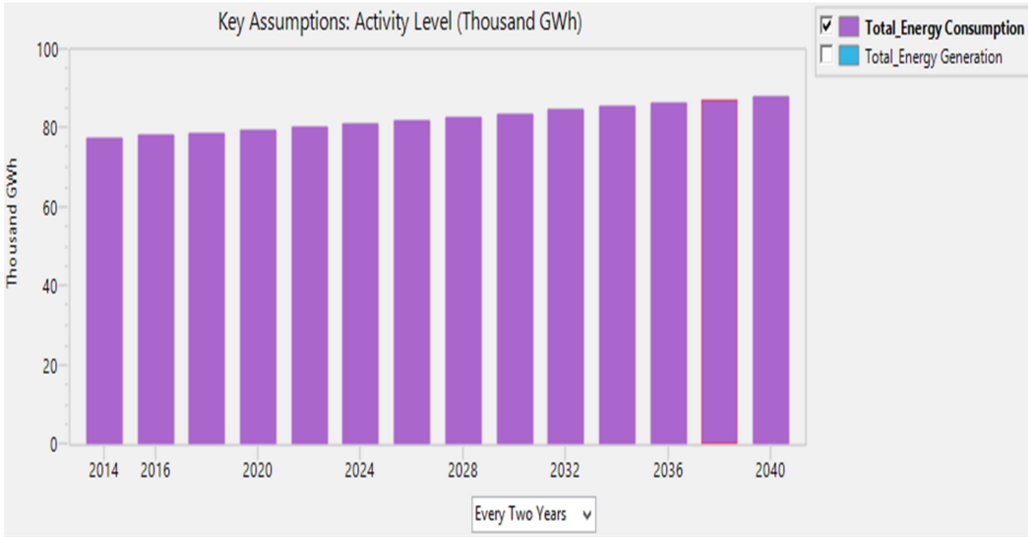


Figure 9.15: Total Energy Consumption of Pakistan

Table 9.8: Total Energy Consumption of Pakistan (Thousand GWh)

Branches	2014	2019	2024	2029	2034	2040	Total
Energy Consumption	77.2	79.1	81.1	83.2	85.3	87.9	408.5

9.5 Demand Analysis:

In our analysis the base year is taken as 2013 and last forecasted year as 2040 for the total consumption of energy in Pakistan. Table below shows the energy consumption in Energy Demand subsector analysis in which the following entities are examined and calculations carried out.

1. Household Sector
2. Commercial Sector
3. Industrial Sector
4. Transportation Sector
5. Agriculture Sector

All the above mentioned sectors are established by LEAP [2,6]. The aforementioned subsectors further divide into various fuel branches and end uses. The items included in the fuel branches contain the following:

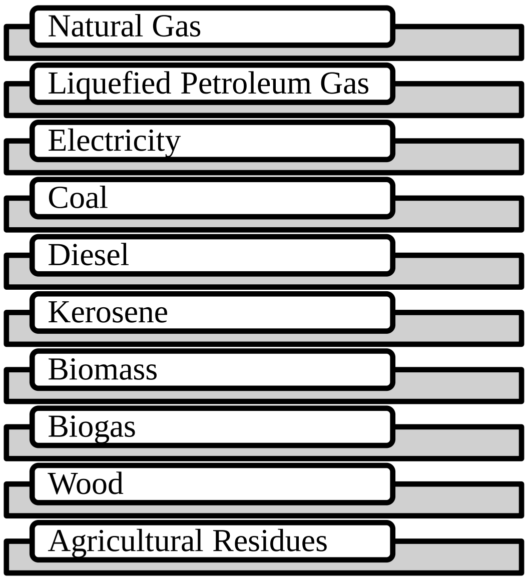


Figure 9.16: Items of Fuel Branches

Table 9.9: Energy consumption Demand Analysis (Million Giga Joules)

Branches	2014	2019	2024	2029	2034	2040	Total
Household	18.9	26.4	36.9	51.7	72.7	109.7	316.3
Commercial	1.3	1.8	2.3	3.1	4.2	6.0	18.7
Industrial	71.3	51.0	37.1	27.6	21.0	15.8	223.8
Transportation	66	82.2	118.1	191.2	335	696.6	1489
Agriculture	0.4	0.4	0.4	0.4	0.4	0.4	2.4
Total	158	161.8	194.8	273.9	433.3	828.4	2050.2

9.5.1 Household Sector

Household Energy demand is split into two categories which are as below:

1. Urban Sector
2. Rural Sector

These are further divided into two parts as:

1. Electrified
2. Non- Electrified

Figure below describes complete data of urban as well as rural energy demand till forecasted year 2040. Urban population consists of 38.57 million people and remainder belongs to rural areas. It is rough estimated that 100 % of rural and urban population use natural gas for cooking. 93% of urban population are electrified that use electricity for refrigeration, lighting and other appliances. Rural population consists of fraction it is electrified. Percentage for refrigeration for urban and rural household is 66 percent (Urban Refrigeration in Electrified Population) and 17 percent (Rural Refrigeration in Electrified Population) and increase steadily till the end forecasted year 2040. In some urban household LPG, wood and biomass is used, but their percentage is not much considerable. While in rural household LPG, wood, agriculture residues and animal dung is used however their share in cooking percentage is almost negligible.

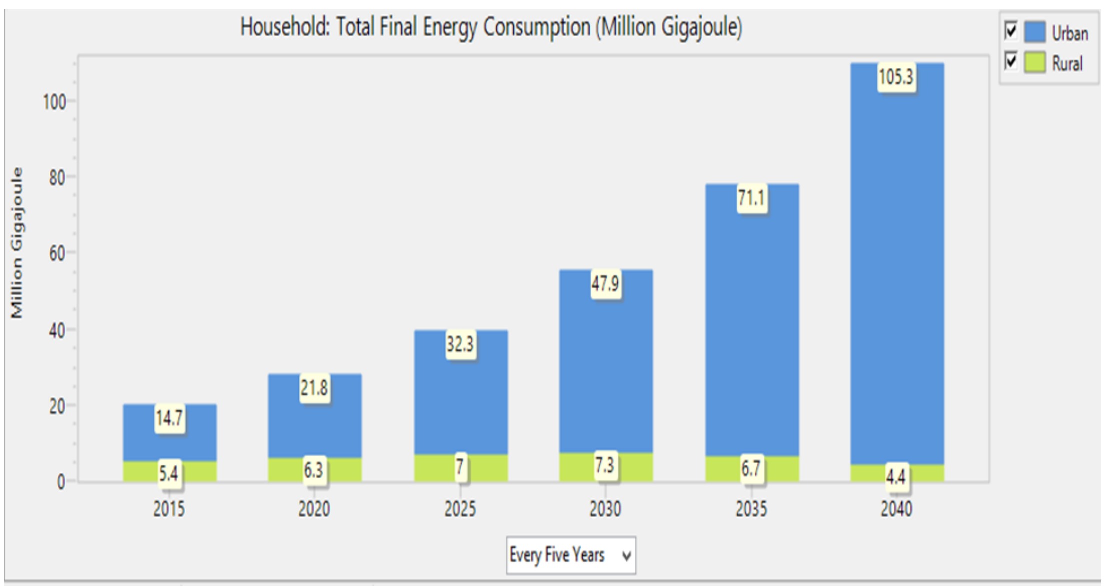


Figure 9.17: Comparison of Household Energy Consumption (Urban and Rural)

9.5.1.1 Urban Sector

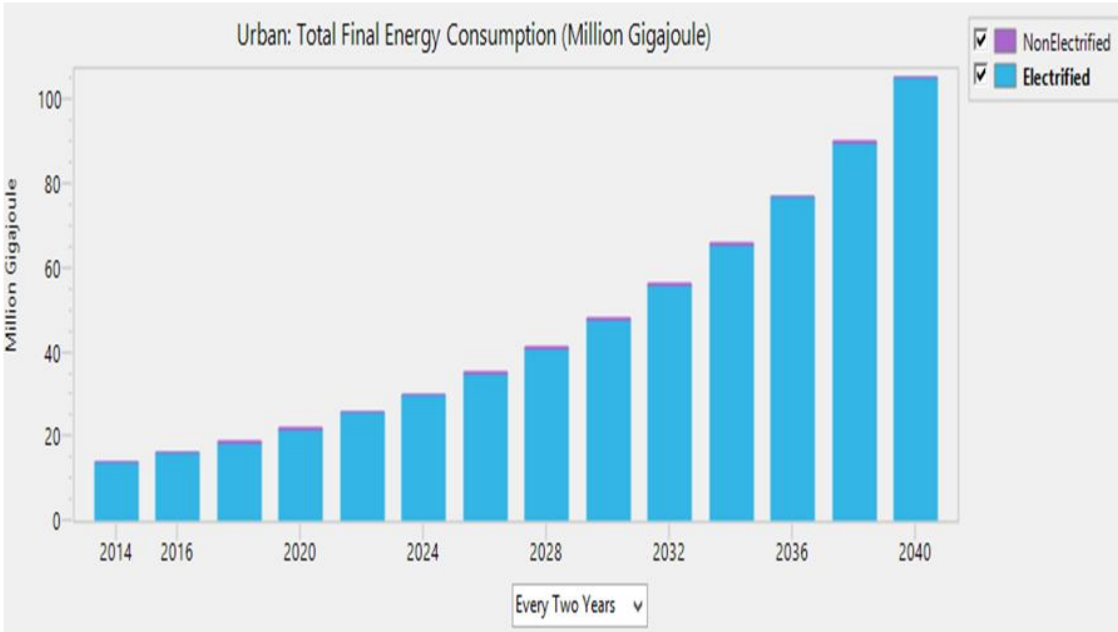
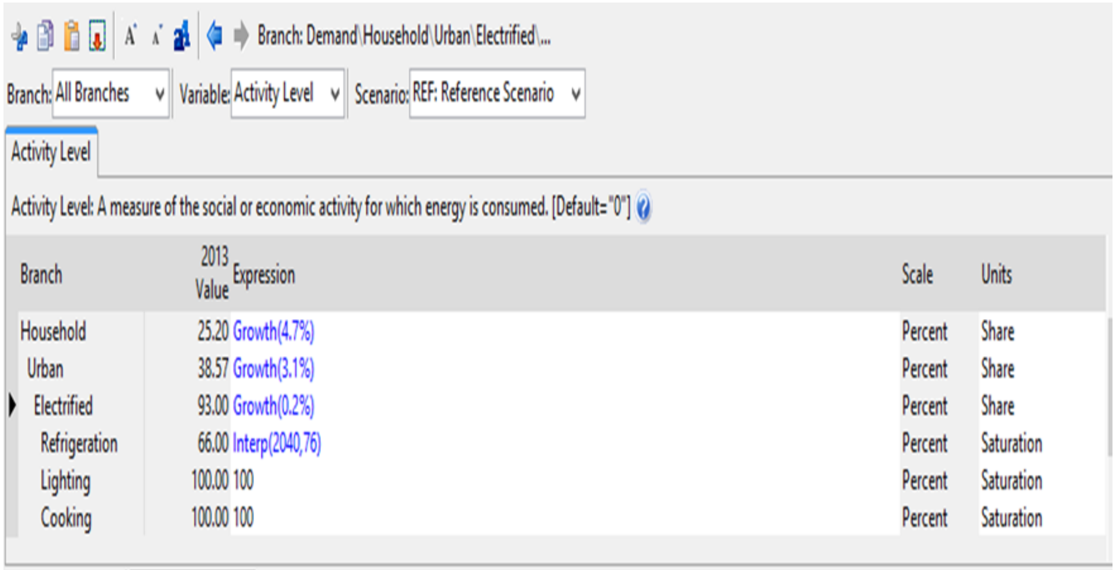


Figure 9.18: Urban Sector Energy Demand (Electrified and Non-Electrified)

The Screenshot below show that electrification in the urban sector is 93 %. This electrification zone comprise of the equipment used in cooking, lighting and refrigeration. Electric stoves used for cooking particularly by the class of people called elite. For cooking purposes other people use Gas. For preserving food ,milk , vegetables and icing purposes refrigeration is used which is again electricity based and its percentage is 66 % of urban electrified families. Electricity for lighting purposes by urban population is also estimated at 100 %.



Branch: Demand\Household\Urban\Electrified\...

Branch: All Branches Variable: Activity Level Scenario: REF: Reference Scenario

Activity Level

Activity Level: A measure of the social or economic activity for which energy is consumed. [Default="0"]

Branch	2013 Value	Expression	Scale	Units
Household	25.20	Growth(4.7%)	Percent	Share
Urban	38.57	Growth(3.1%)	Percent	Share
Electrified	93.00	Growth(0.2%)	Percent	Share
Refrigeration	66.00	Interp(2040,76)	Percent	Saturation
Lighting	100.00	100	Percent	Saturation
Cooking	100.00	100	Percent	Saturation

Figure 9.19: Urban Sector Electrification Data

9.5.1.2 Rural Sector

Typically rural zones comprise the most population of Pakistan. The Electricity in Rural areas is just fraction of total electricity of the country the rest of the rural population is un-electrified. The estimation suggests that 63 percent of rural population enjoy electricity and the rest do not. The use of refrigerators is foreseeable only for 17 percent of electrified households, and use of lighting is 96 percent. The Screenshot from LEAP below shows the rural zone data for both electrified and un-electrified areas.

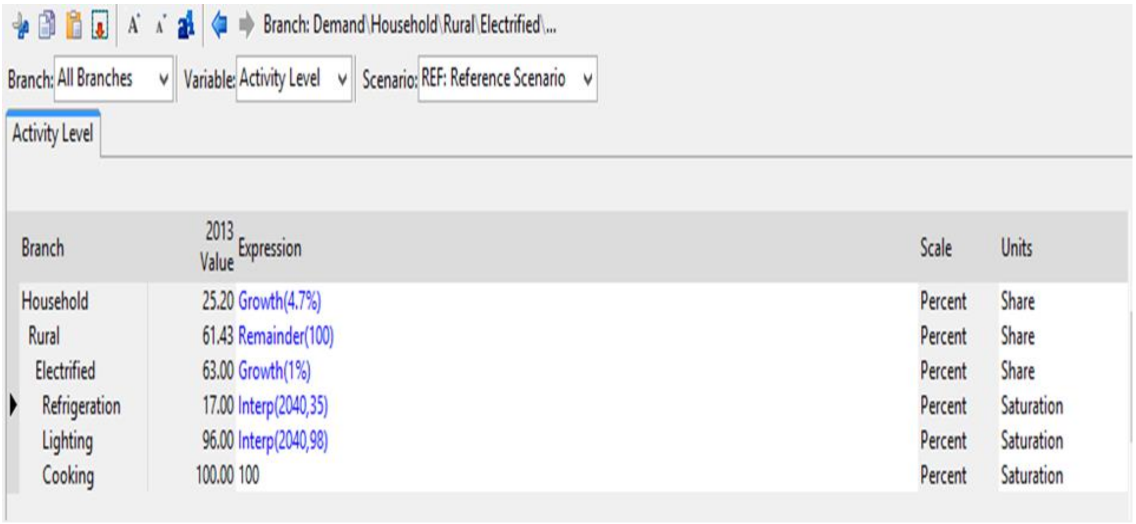


Figure 9.20: Data in Rural Households

From table below it is clear that there is a gradual growth in the percentage of electrified population. In 2014 the percentage of electrified population was 63.6 % population as a facility for their lives which will be improved to 82.4 % with just one percent of the Growth Rate. Electricity will be utilized for various purposes alike, refrigeration, heating, cooking and other useful purposes.

Table 9.10: Rural Households Electrified Population

Branches	2014	2019	2024	2029	2034	2040
Electrified	63.6%	66.9%	70.3%	73.1%	77.6%	82.4%

Diagram below shows the increasing demand of electricity trend for the rural population. With the passage of time, the people of rural areas of Pakistan facilitate themselves with electricity. The diagram below displays the growth of population with electricity and which depicts a positive trend.

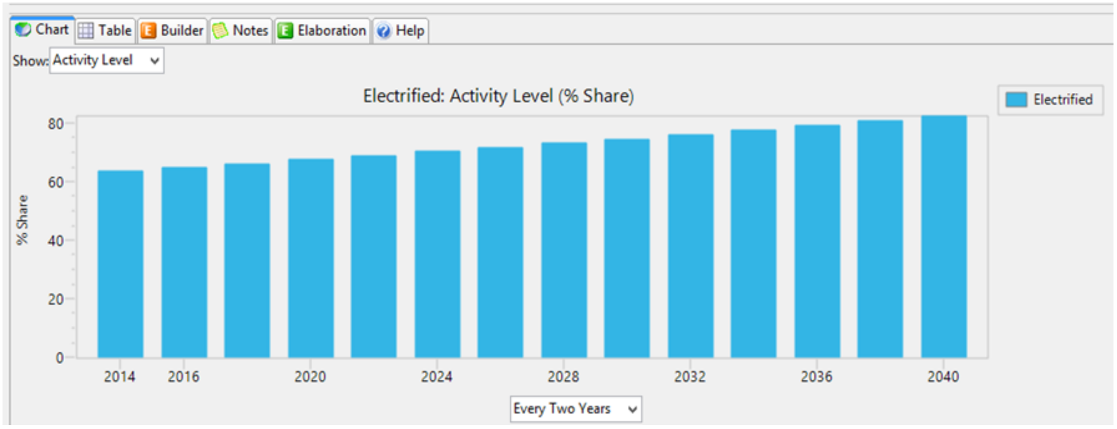


Figure 9.21: Rural Electrified areas (Activity Level)

9.5.2 Industrial Sector

For economic development of any country, industrial sector plays primary role. Since 2006, woefully, energy deterioration results badly, hitting on industrial sector's performance of Pakistan. Especially CNG is supplied to transportation sector. Energy consumption in industrial sector of Pakistan relies on oil, natural gas, electricity and coal but mostly industrial output of Pakistan depends hugely on natural gas [3]. Therefore, most of industry in Pakistan is shifting into other Asian countries owing to acute shortage of natural gas.

Table 9.11: Industrial Sector Energy Consumption (TOE)

Source	2012-13 TOE	ACGR%
Oil	1384435	5.2%
Natural Gas	7393303	-3.1%
Electricity	1817174	1.6%
Coal	3661195	-7.6%
Total	14256009	-3.3%

Figure below represents Energy Demand of various fuels in Industrial Sector.

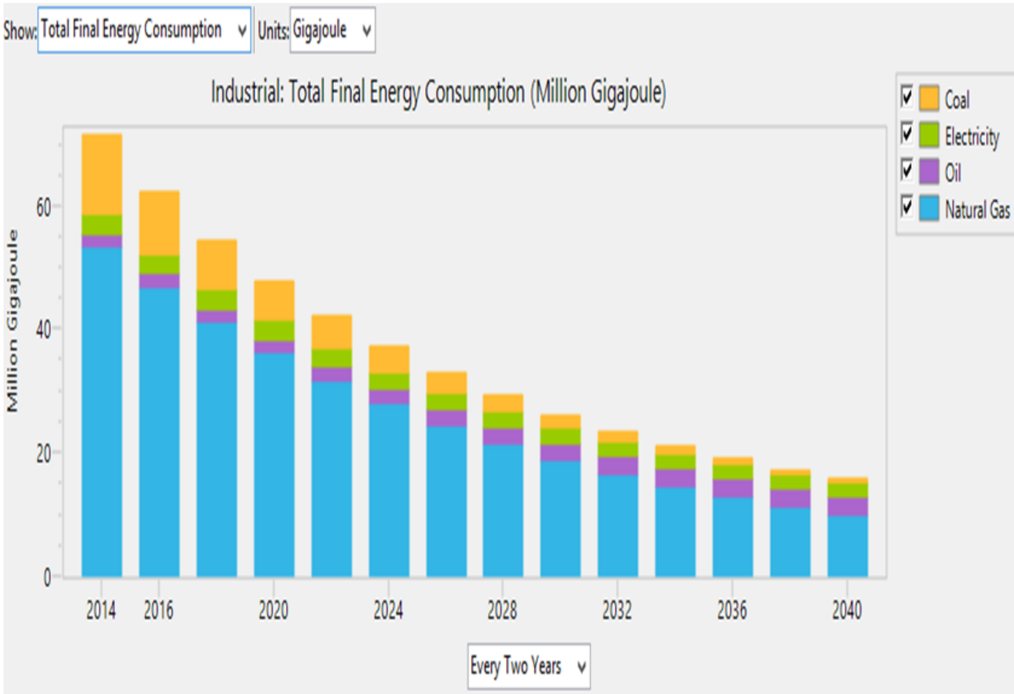


Figure 9.22: Industrial Sector (Energy Demand)

Table below shows the Energy Demand Variation which is developed by LEAP. Total energy consumption by industrial zone using various types of fuel in 2014 is 71.3 Million Gigajoules and will be 15.8 Million Gigajoules in 2040. And total consumption from first depletion year to end year is 223.7 Million Gigajoules.

Table 9.12: Total energy consumption by industrial zone using various types of fuel

Branches	2014	2019	2024	2029	2034	2040	Total
Electricity	3.3	3.0	2.8	2.6	2.3	2.1	16.1
Coal	12.7	7.2	4.1	2.3	1.3	0.7	28.3
Natural Gas	53.3	38.5	27.8	20.1	14.5	9.8	164
Oil	2.0	2.2	2.4	2.6	2.9	3.2	15.3
Total	71.3	50.9	37.1	27.6	21	15.8	223.7

9.5.3 Commercial Sector

Commercial sector consumes 4.1 percent of total energy for year 2012-13 which is almost equal to the last year's energy consumption that is 4 percent. Its annual compound growth rate has been slowed down from 2.9 percent to 2.6 percent as compared to fiscal year. Table below shows consumption of commercial sector using LPG, gas and electricity. The units of these sources are TOE. ACGR value used in business as usual scenario.

Table 9.13: Consumption of commercial sector using LPG, gas and electricity

Source Name	Year 2012-13	Percentage Growth or ACGR
Electricity	489208	1.6%
LPG	203525	-0.5%
Gas	952118	3.8%
Total	1644845	2.6%

The figure below shows the comparison between energy consumptions from 2013 to 2040 and we see that energy consumption for 2040 greater than that of energy consumption in 2015 by about three times. Increase in Energy Demand is the main reason for this higher energy consumption which is due to increase in utilization of appliances used air conditioning, cooking, water heating, and other appliances.

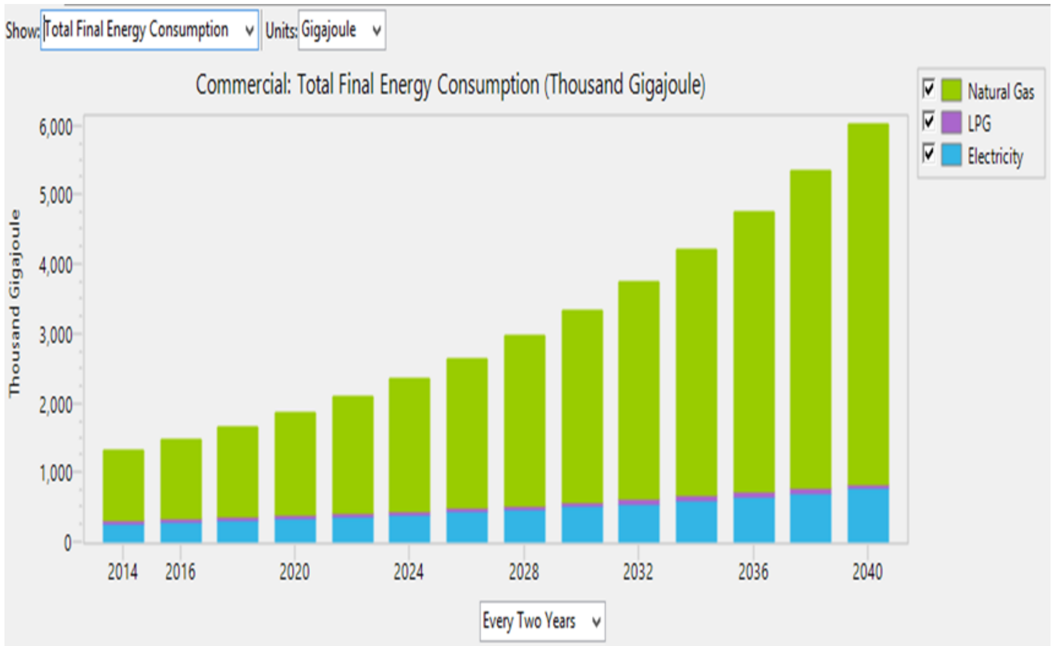


Figure 9.23: Commercial Sector Energy Demand by LEAP

Below shown table shows the consumption of energy for the year 2014 to 2040. In 2014 Electricity consumption is 259.6 thousand gigajoules and in 2040 it is enlarged to 764.4 thousand gigajoules in 2040.In the same way consumption of natural gas varies from 1009.6 Thousand Giga Joules to 5189.1 Thousand Gigajoules. Likewise consumption of LPG is slowly raised from 44 to 75.4 Thousand Gigajoule.

Table 9.14: Commercial Sector Energy Demand (Thousand Gigajoules)

Branch	2014	2019	2024	2029	2034	2040	Total
Electricity	259.6	319.5	393.2	484.0	595.7	764.4	2816.4
LPG	44.0	48.8	54.2	60.0	66.6	75.4	349
Natural Gas	1,009.6	1,383.1	1,894.9	2,596.0	3,556.5	5,189.1	15629.2
Total	1313.2	1751.4	2342.3	3140	4218.8	6028.9	18794.6

9.5.4 Transportation Sector

In the economy of Pakistan the subsector transport plays a vital role and its contribution percentage share in services area overall is about 23.74%.

Table 9.15: Transportation Fuel Consumption (TOE)

Fuel	Energy Consumed (TOE) Base Year	Percentage	Growth Reference Year
Electricity	0	0	0
Natural Gas	2345335	18.35	6.9%
Kerosene	188	.0017	-18.1%
Non Energy	4006229	31.69	12.3%
Diesel	6361184	49.95	-4.5%
Total	12712936		

Table above illustrates the various fuel consumptions that are being used in transport section as a base year (2013) Values. In reference scenario, the growth rate of these fuels is used as a forecast of energy consumption in transport section. The growth rate of category non-energy, which encloses aviation fuel, motor spirit, High Speed Blending Component (HOBC) and E-10, is 12% which is alarming situation for divesting the natural resources. Diesels the primarily constituent that is used in transport section. Diesel contains the sub categories as HSD, LDO and furnace oil. Figure below shows various fuel consumptions by transportation for 2013 to 2040.

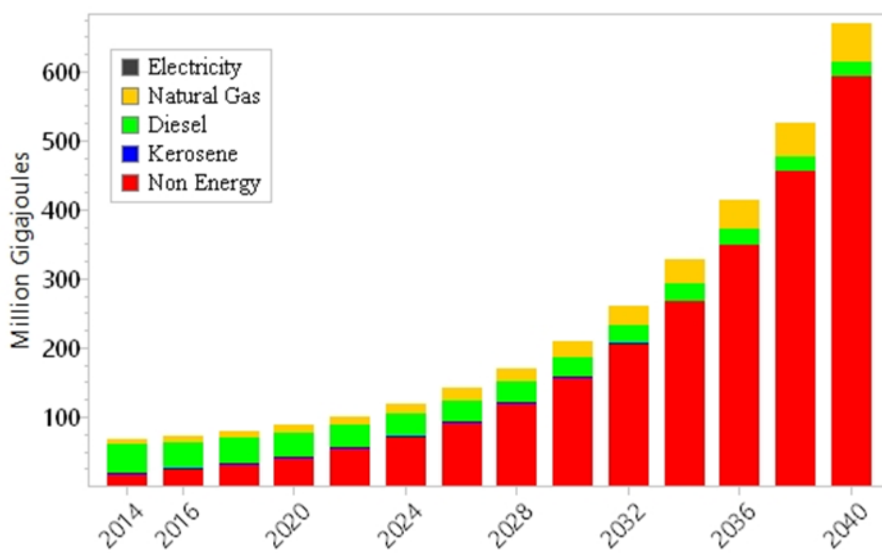


Figure 9.24: Transportation Sector (Energy Consumption)

Table 9.16: Energy Demand Transportation Sector (Million Gigajoules)

Branches	2014	2019	2024	2029	2034	2040	Total
Electricity	-	-	-	-	-	-	-
Natural Gas	6.2	9.4	14.4	22	33.5	55.7	146.2
Diesel	40.7	35.4	30.7	26.7	23.2	19.6	176.3
Kerosene	-	-	-	-	-	-	-
Non Energy	19.1	37.4	73.0	142.5	278.3	621.3	1171.6
Total	66	82.2	118.1	191.2	335	696.6	1489.1

9.5.5 Agriculture Sector:

About 61.43% of Pakistan's population belongs to rural areas and depends directly or indirectly on agriculture. Agriculture, instead of persistently slowing down GDP, plays a role of back bone in economic activity of Pakistan and it accounts for nearly 24% of GDP of Pakistan that is largest contribution.

Table 9.17: Energy Demand of Agriculture Sector (TOE)

Source	2007-08	2012-13
Oil (TOE)	113889	33160
Electricity (TOE)	689948	626829

Table shows the energy consumption major source in Agricultural Sector of Pakistan for the period 2007-08 and 2012-13, it relies on Oil and Electricity. The electricity is utilized for running tube wells, etc. and oil is utilized for running tractors for, harvesting, plaguing and other purposes. Figure below identifies agricultural consumption during forecasted year.

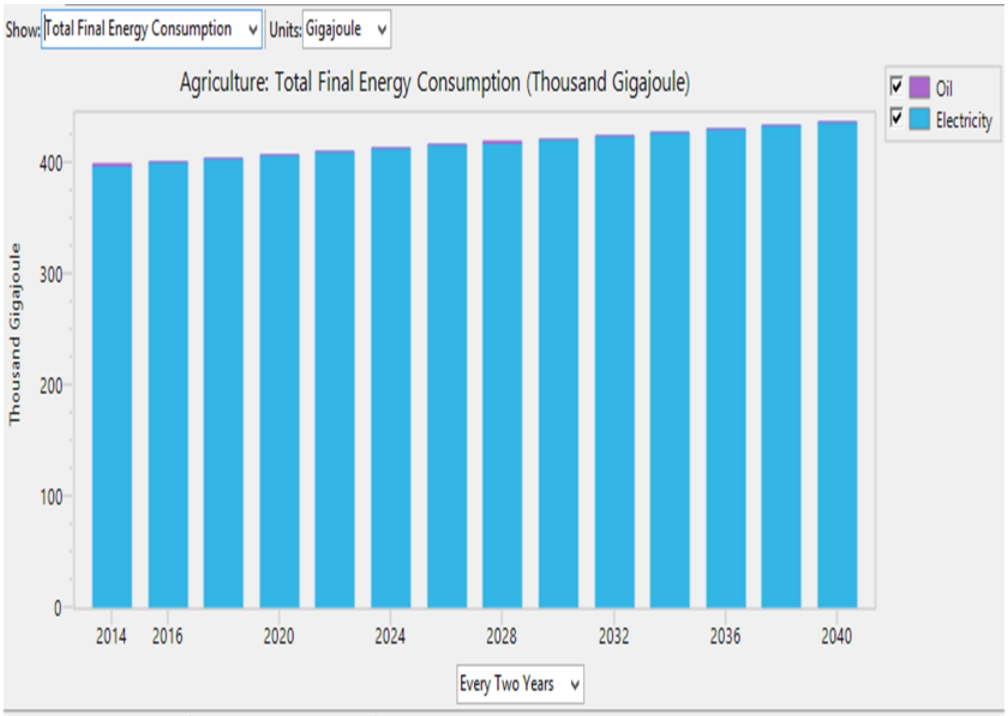


Figure 9.25: Agricultural Sector Energy Consumption (Thousand Gigajoules)

Though, there is a declination in Growth Rate of Agriculture as regards the Economic Survey of Pakistan and its value has declined to 2.1% in 2013-14 which was earlier at 2.7% a year before. Below mentioned table explains the Agricultural Sector Energy Consumption for the period 2014 to 2040.

Table 9.18: Agricultural Sector Energy Demand (Thousand Gigajoules)

Branch	2014	2019	2024	2029	2034	2040	Total
Electricity	397.3	404.6	412	419.6	427.3	436.7	2497.5
Oil	1.0	0.4	0.2	0.1	0.0	0.0	1.7
Total	398.3	405	412.2	419.7	427.3	436.7	2499.2

9.5.6 Transformation: Electricity Generation:

Figure depicts of electricity generation for base year 2013 and end forecasted year 2040 developed from LEAP. Fossil fuels play predominant role in Pakistan electricity generation. In current year, share of fossil fuels in electricity generation is 64.1 percent which will be slowed down to 46.8 percent in end year 2040 and will be shifted to nuclear, hydro and some renewable for instance wind , solar, biogas etc. Figure below displays the progressively variation of generation of electricity for the period 2013 to 2040.

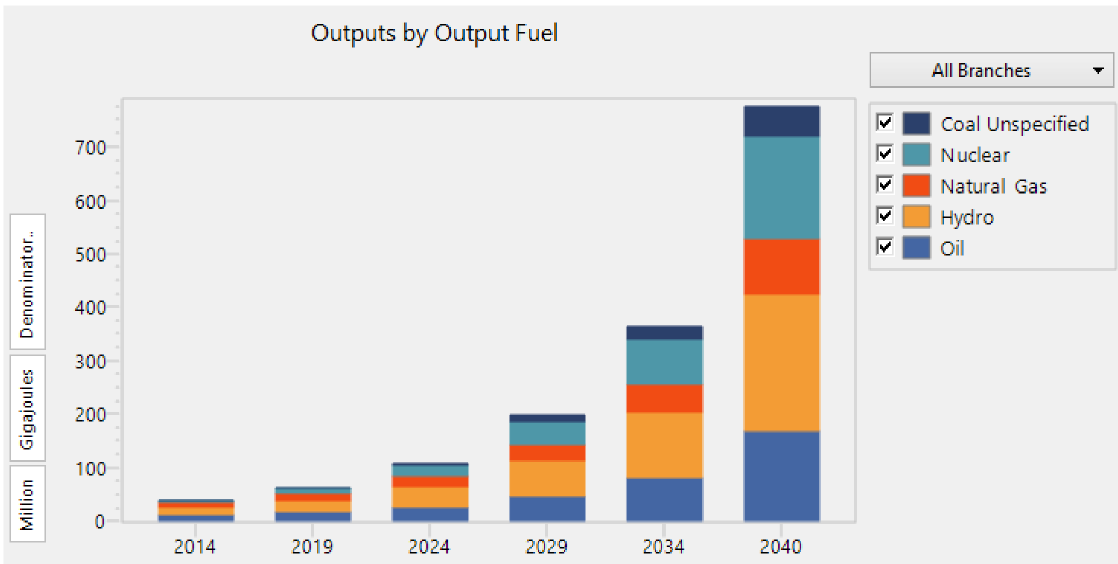


Figure 9.26: Electricity Generation mix(Million Gigajoules)

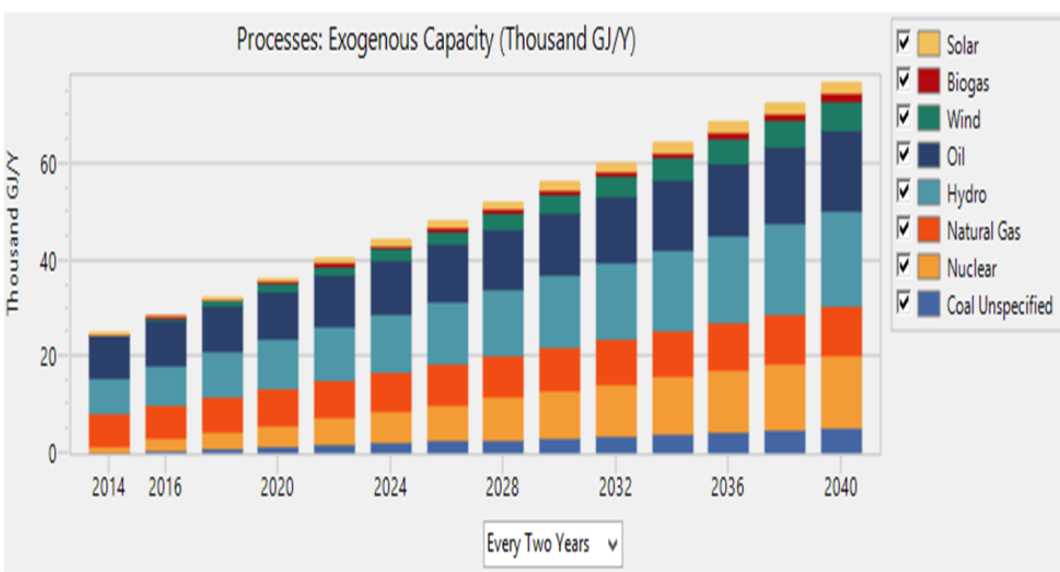


Figure 9.27: Variation in Electricity Generation Thousand GJ/Y)

9.5.7 Resources

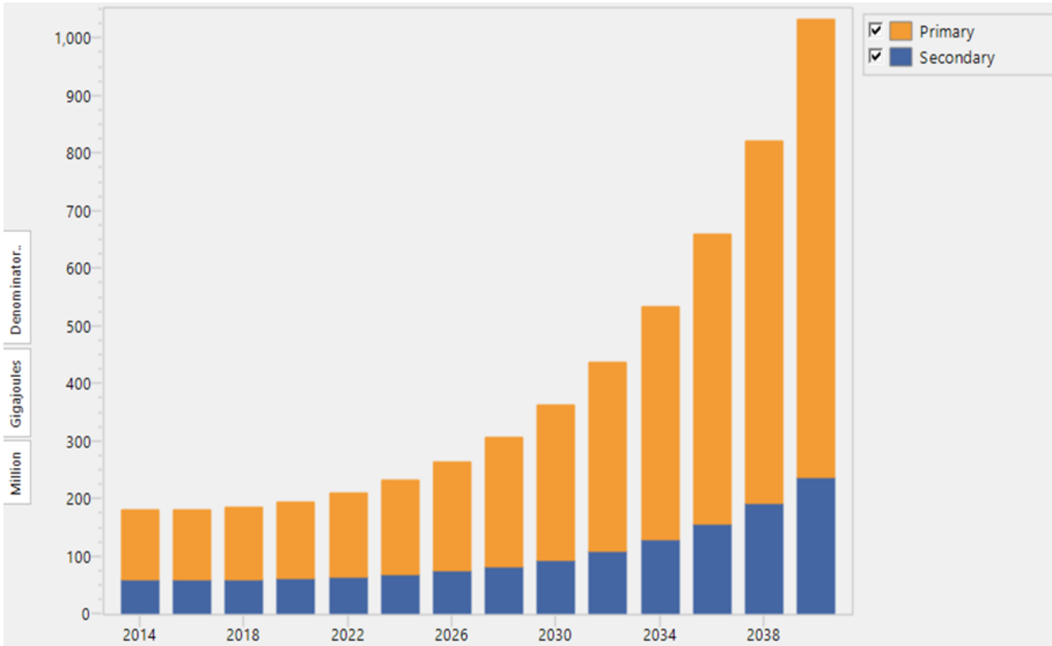


Figure 9.28: Forecasting of Total Energy Resources (Million Gigajoules)

9.5.7.1 Energy Resources (Primary)

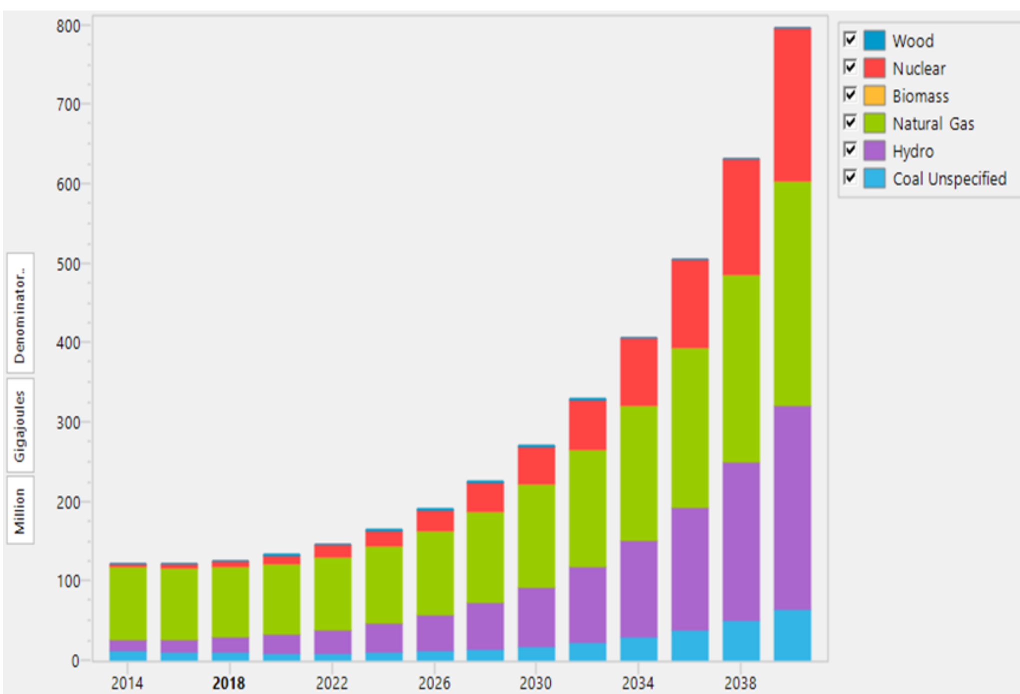


Figure 9.29: Energy Resources Primary (Million Gigajoules)

9.5.7.2 Energy Resources (Secondary)

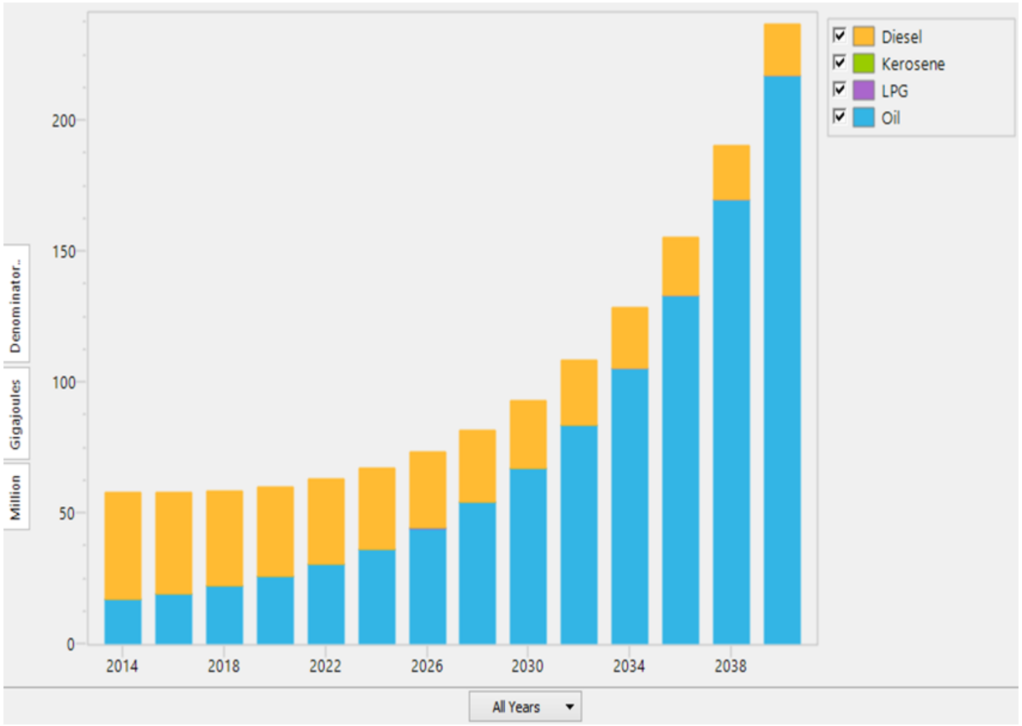


Figure 9.30: Energy Resources Secondary (Million Gigajoules)

9.6 Solutions and Conclusion

The below mentioned diagrams are included to make a comparison between the energy consumption patterns for the forecasted years. For the energy demand analysis for all the sectors we see that there is a significant increase in the energy demand in 2040 as compared to 2014. In addition to this the electricity generation mix is also been shown. It signifies that there is a decrease in the percentage of usage of Oil in the generation mix; this is due to the fact that the renewable will be incorporated more in the generation mix and dependence on oil will be reduced as shown by the pie charts shown below. Finally an energy flow diagram is included which shows the flow of energy from the supply side with electricity generation and T&D in the middle with the final demand side. The energy flow lines show the amount of energy flowing through that respective point.

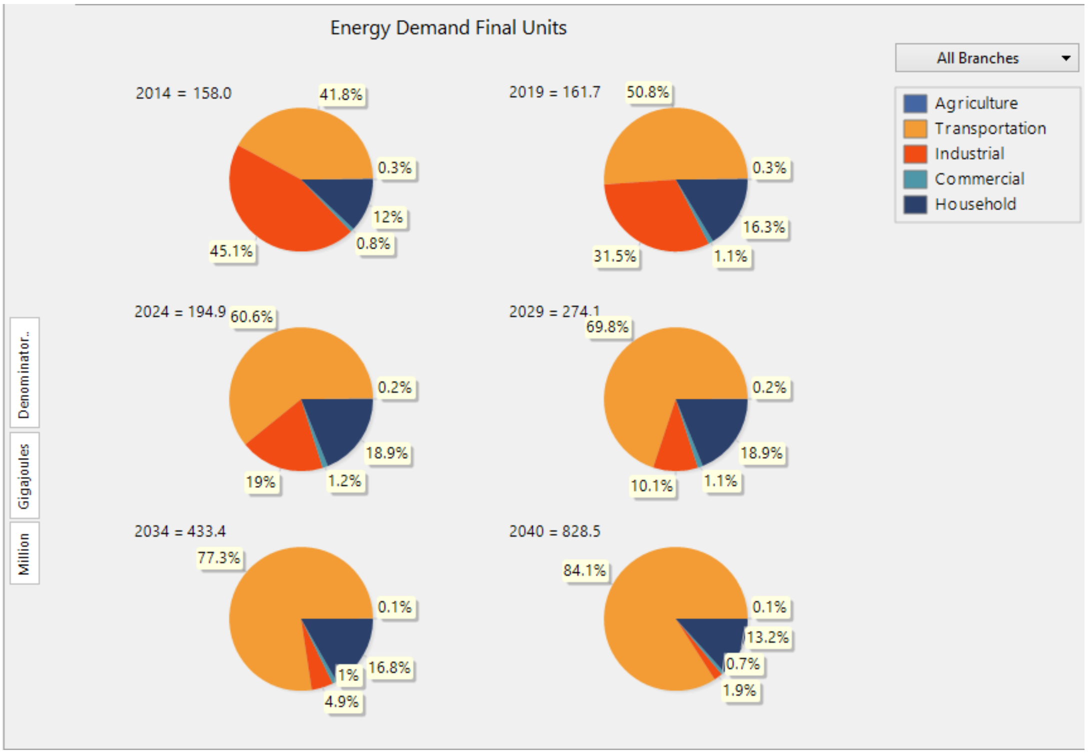


Figure 9.31: Final Energy Demand by All Sectors

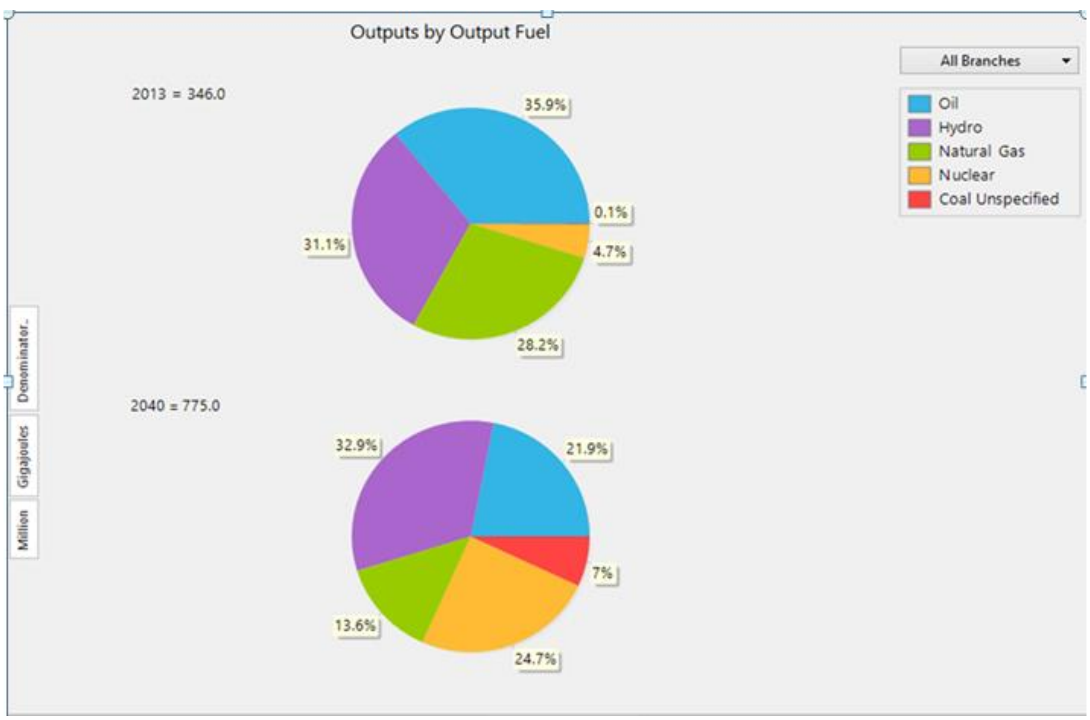


Figure 9.32: Generation Mix Comparison

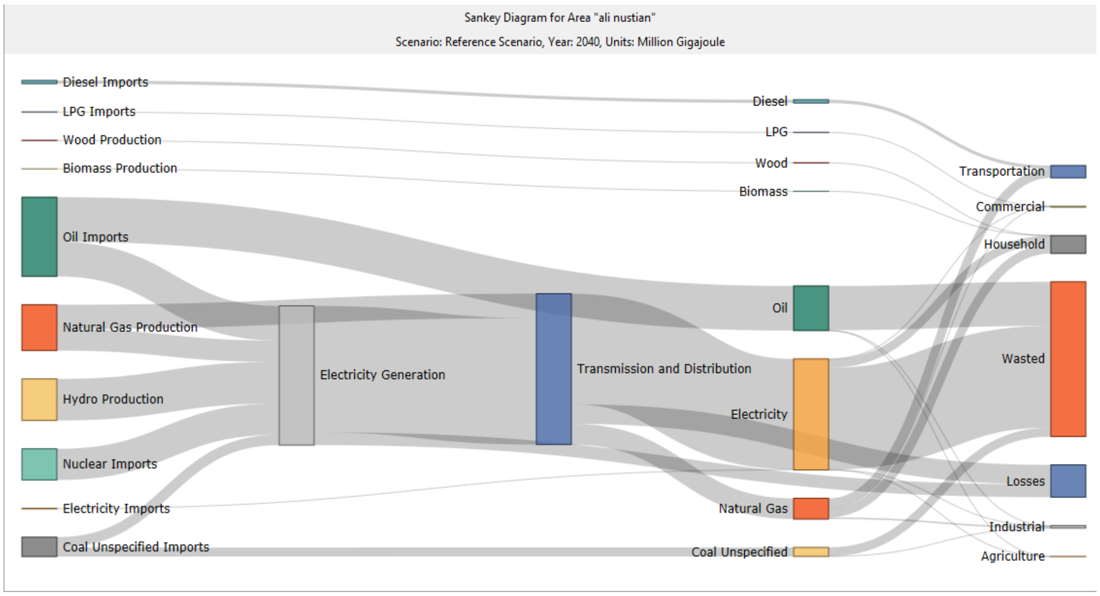


Figure 9.33: Energy Flow Diagram (Sankey Diagram)

Summary

The LEAP software is used for calculation of the energy consumption analysis. The sectors that were taken into consideration were Household, Commercial, Industrial, Transport and Agriculture. From the demand analysis we saw that there is a decrease in demand in the industrial and agriculture sector, while there is an increase in the energy demand in the transport, commercial and household sectors. In LEAP values for the energy demand were entered in both Current and Reference Scenarios in the Analysis View. The results were shown in the results view both graphically and in tabular form. Comparisons of different types can be made and accordingly policy options can be chosen that take into consideration both the demand-side and supply-side.

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Conclusion & Recommendation

Policy makers need to take measures to increase energy supply to the Industrial and Agricultural sector to stimulate economic growth in the country. Need for increased collaboration between industry-government-academia in forming affective long-term energy policies. Proper policy adoptions and implementations are vital for overcoming the highlighted barriers/gaps. Policy making must ensure improvements in the quality of life styles, environmental safeguards and energy security. Scientific approach and tools i.e. TIMES and LEAP etc. must be adopted to explore various useful policy options. Since one unit of energy saved equals two units of energy generated, therefore considerable savings in investment can be achieved through proper energy conservation and efficiency policies. Energy Policy making should engage informed consumers to achieve demand side load reduction through Green Buildings, Smart Grids and Smart Metering etc.

The inclusion of Integrated Energy Policy will solve many problems of the energy sector. The Integrated Energy Policy ensures harmonization and close consistency amongst the energy sub sectors. It supplements energy sector plans, strategies and policies to meet national socioeconomic objectives. There are some policy recommendations in the Integrated Energy Policy, some of these might include; reducing energy requirements through energy efficiency and conservation, augmenting energy resources and supply, promoting coal imports; enhancing energy security, cutting cost of power and accelerating power sector reforms.

We know that Pakistan has huge investment potential. There are some key areas that needs to be considered here; first of all there is a need for a regionally competitive tariff, security of fuel supply and environmental safeguards must be there, policies should be there to mandate investors to develop local manpower, ensuring minor risk profile, development of project proposals, minimizing risk of exchange rate variation and to encourage investment in development of indigenous resources.