

Inconsistencies in the Power Sector of Pakistan Identified through Strategic Environmental Assessment

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Abstract: Despite the sufficient available energy resources, Pakistan is facing severe power crisis. The gap between supply and demand has increased significantly over the last decade. The fundamental target of this study was to recognize inconsistencies in the existing power sector and suggest measures for incorporating sustainability in the power sector. Indicators and Strategic Environmental Assessment (SEA) objectives were developed by looking at the baseline information and national environmental objectives. SEA objectives were compared against the national environmental objectives, related national policies, plans, and programs. It was concluded that national policies, plans, and programs are made in isolation and a lack of coordination was observed between national policies, plans, and programs. The projected power generation mix has a possible negative impact on the environment as well as on the national energy security. National power policy has no commitment to reduce air emissions or to have a target for the exploitation of the available huge renewable resources. The utilization of coal is a decent alternative of the present; however, the consumption of non-renewable energy resources will make the power sector more vulnerable to climate change.

Key words: Strategic environmental assessment, Power sector, Climate change, Power crisis, Inconsistencies, Power policy, Pakistan.

INTRODUCTION

Pakistan is confronting power shortages since 2004. The gap between supply and demand has significantly increased (Fig. 1). Since then, the

government has invested more in thermal power generation and subsequently, the cost of electricity has additionally increased.

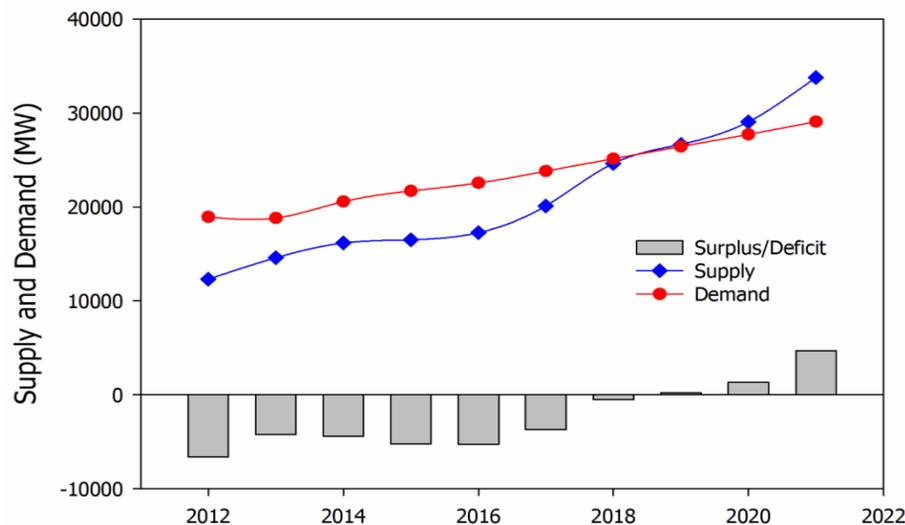


Fig. 1: Electricity shortfall.

Source: Adapted from NEPRA state of industry report 2016 (GoP., 2016).

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On June 2014, the installed capacity of Pakistan Electric Power Company (PEPCO) system was 24,953 MW with hydro 7,097 MW, thermal 16,963 MW, nuclear 787 MW and wind 106 MW. Thus, the hydropower capacity accounts for 28.4 percent, thermal 67.97 percent, nuclear 3.1 percent and a small portion of wind 0.24 percent (GoP, 2013-2014).

The loss to the economy was over \$3.8 billion in 2009 about 2.5 percent of gross domestic product (GDP) (Aziz *et al.*, 2010). Half a million jobs and exports worth \$1.3 billion were lost. Other estimates show that energy shortages have cost the country up to 4% of GDP over the last couple of years. On the other hand, the blackout of 18 to 20 hours in different areas has created panic among the people. There are

frequent strikes and demonstration which are resulting in the public and private property losses. To address this gap between supply and demand, the government has planned different projects to overcome this gap. It is anticipated that 16,564 MW will be added to the national grid system by 2018 which will decrease the present shortage of electricity.

According to the National Power System Expansion Plan 2011-2030 (GoP., 2011), the power demand in 2029-2030 will be 98,120 MW (Fig. 2). The projected power generation mix under the base case consists of 37% hydropower, 34% of steam turbines, using Thar coal, 11% Natural Gas, 6% Nuclear, 5% Wind and 2% imports.

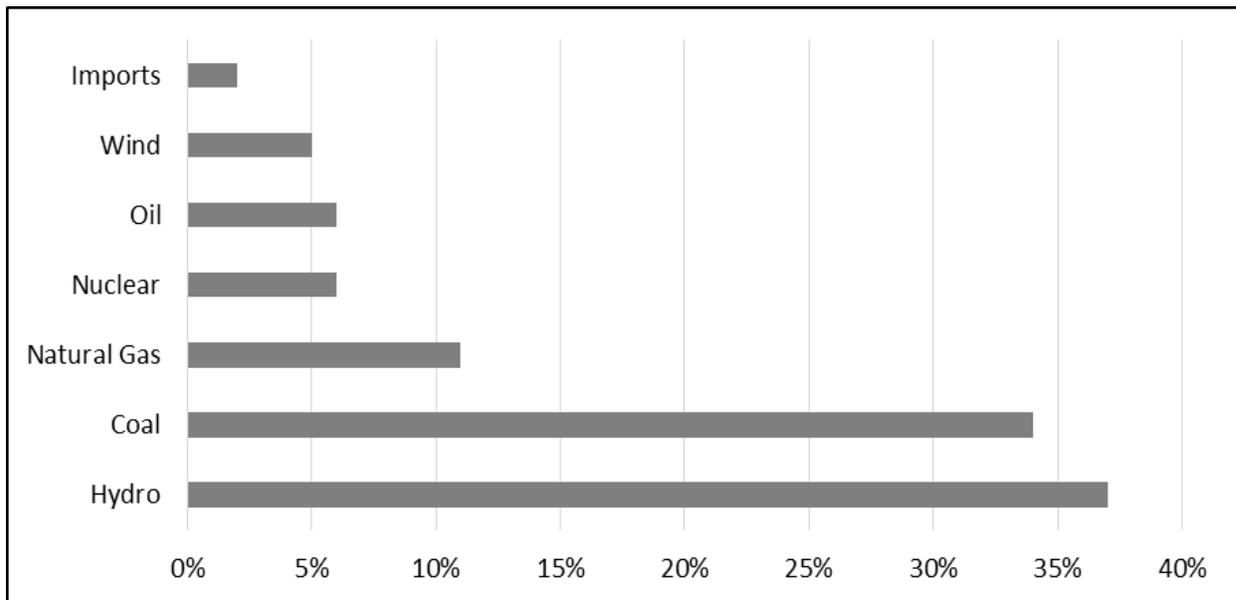


Fig. 2: Power generation mix 2029-2030 (base case).

Source: National Power System Expansion Plan 2011-2030 (GoP., 2011).

The energy sector plays an important role in the national economy and its development, being fundamental to production and population well-being (Pererira *et al.*, 2008). To assess the impacts related to the energy infrastructure and activities, Environmental Impact Assessment (EIA) is commonly applied to projects; however, there are questions about the ability of EIA to deal adequately with the challenges now associated with energy supply. EIA comes into force when the decision is already being made. The necessity to assess the environmental consequences of higher decision-making level is being pointed (Tolmasquim *et al.*, 2001), especially based on uncertainties about EIA ability to deal with energy supply and security (Jay, 2010). Strategic Environmental Assessment (SEA) has become one of the most widely discussed issues in contemporary environmental assessment, for instance, Marsden, 2002, Partidário, 2000, and several authors have noted the value of SEA in support of the sustainable policy,

plan, and program (PPP), and decision-making (Noble, 2002). SEA indicated as an important instrument to deal with these challenges earlier (Jay, 2010), but SEA has not yet been widely adopted in relation to energy production (Dalal-Clayton and Sadler, 2005). In Pakistan, despite SEA is not mandatory the National Environmental Policy of 2005, and the recently launched National Climate Change Policy 2012, reflect commitment for SEA. Sustainable development requires integration of environmental considerations into policies, plans, and programs. However, the prevailing systems of decision-making tend to separate economic and social aspects, forgetting the environmental needs at the strategic level. The last decades are witnessed by poor and isolated power policies, plans and programs based on the political parties' interest. For a sustainable and rational power plan, policy and program, it must be integrated with other related local and national policies and plans. The main aim of this study was to

identify inconsistencies and incompatibilities in national power policy and national power expansion plan 2011-2030.

METHODOLOGY

Strategic Environmental Assessment (SEA) methodologies vary from sector to sector and from case to case. A method has to be selected to cover each of the different stages of the process. These may include different types of scenario exercises, systems analysis, risk assessments, economic appraisal tools, and multi-criteria analysis (Nilsson *et al.*, 2005). This can also be lifecycle assessment (Finnveden *et al.*, 2009; Manuilova *et al.*, 2009; Salhofer *et al.*, 2007; Björklund and Finnveden, 2007), cost-benefit analysis (Abaza *et al.*, 2004), fore- and back-casting modeling (Fischer, 2010), carrying capacity analysis (Zhao *et al.*, 2008), and Monte Carlo techniques (Liu *et al.*, 2010). This section suggests methods and approaches, used to predict and assess environmental effects within the SEA framework for the sustainable power sector in Pakistan. The proposed modified methodology is organized into three phases: (A) Development of SEA objectives and indicators, (B) External coherence analysis and (C) internal coherence analysis (Naddeo *et al.*, 2013).

1. SEA objectives and indicators
2. External coherence analysis
3. Internal coherence analysis

SEA objectives and indicators: These objectives and indicators were developed by reviewing the baseline information focusing on the past and present environmental quality of the country. The development of SEA objectives and indicators are very helpful for the evaluation, description, and comparison of the environmental impacts of PPPs.

External coherence analysis: The fundamental objective of the SEA is to check whether the proposed policies, plans, and programs (PPPs) are environmentally sustainable (McCluskey and João, 2011). The external coherence analysis is used to affirm if the PPPs general objectives are in line with the environmental objectives. A double entry matrix is used for the assessment of this aspect, environmental goals of the plans or programs are listed in rows, and columns. In this way, elements of

the PPPs that are not harmonized with their super-ordinate objectives are determined (Naddeo *et al.*, 2013).

Internal coherence analysis: Coherence between the local and national policies plans and programs is vital for the accomplishment of the national targets. Compatibility between the National Power Policy and National Power System Expansion Plan, 2011-2030, objectives and SEA objectives were analyzed. Objectives of the National Power Policy 2013 and National Power System Expansion Plan 2011-2030 were placed in rows and SEA objectives were placed in columns.

RESULTS AND DISCUSSION

SEA objectives and indicators: It is not the requirement of SEA Directive to develop SEA objectives. However, Strategic Environmental Assessment (SEA) objectives are used to confirm that the right level of consideration is accomplished. The following SEA objectives were developed from the review of baseline information (Table 1). Variations in the indicators show whether the execution of the National Power Policy and National Power System Expansion 2011-2030 would be or have been effectively consistent with the national environmental quality. However, changes in the indicators could be the result of external factors outside the range of National Power Policy 2013, and National Power System Expansion 2011-2030.

External coherence analysis: As per SEA directive, environmental report must provide information on the PPP relationship with other relevant plans and programs. According to the National Power System Expansion Plan 2011-2030, the power demand will be 98,120 MW consisting of 35.7% of hydropower, 38.1% of steam turbines using Thar coal, 10.3% of CCGT (Combined Cycle Gas Turbines), 6.7% of nuclear, 2% of interconnections, 7.2% from gas turbines and renewable energy sources (GoP., 2011). The generation of almost 35000 MW from hydro will possibly pose threats to the biodiversity. It is also incompatible (Table 2) with the national resettlement policy because the policy is committed to reducing the involuntary resettlement, but the construction of dams will force the local community to migrate.

Table 1: SEA objectives and indicators.

Areas	SEA objectives	SEA indicators	Concern departments
Air	To reduce emissions in accordance with the National Environmental quality standards (NEQS) and international agreements	Emission values from the power sector Consistency in air parameters with NEQS	Environmental Protection Agency Pakistan (Pak-EPA), SUPARCO
Soil	To avoid land contamination during the transportation and construction activities	Land contamination at specific sites at the project level; Number of oil spill incidents	Environmental Protection Agency Pakistan (Pak-EPA)
Material assets	Promote generation of energy from renewable resources Minimize production of hazardous waste Create awareness regarding energy conservation and sustainable utilization	Number of projects, funds and initiatives implemented that support renewable sources Hazardous waste produced by energy infrastructure Biofuel consumption (increase)	Alternative Energy Development Board, Ministry of Finance, Ministry of Petroleum and Natural Resources
Cultural heritage	Preserve historic buildings, monuments, archaeological sites and other culturally important features	Number of operations located away from cultural heritage sites/areas or areas with known cultural archaeological remains Status and number archaeological sites	Ministry of Information, Broadcasting and National Heritage, Heritage Foundation of Pakistan
Climate change	Reduce greenhouse gases emissions from the power sector in compliance with the national targets and international agreements	Emissions of greenhouse gases from energy Increase in the use of renewable energy resources	Ministry of Climate Change, EPA, Planning Commission of Pakistan, SUPARCO, Pakistan Meteorological Department
Water	Reduce pollution to the marine and freshwater environment from power generation.	Quality of the marine environment; Quality of groundwater; Number of water pollution accidents; Status of water availability per capita, per sector and per dependent habitat	EPA, WARSA, PCRWR, IRSA
Population and Human health	To reduce negative health impacts arising from air and water pollution Protect vulnerable consumers Create recreation facilities	Emission values from the power sector Number patients suffering from air and water-related diseases near power generation activities Rate of mortality size of population and changes in demography years of healthy life expectancy/infant mortality rate	Ministry of National Health Services Regulations and Coordination, Provincial Health Departments
Biodiversity, Flora, and Fauna	To avoid damages to biodiversity (including terrestrial and marine) in line with national objectives and international agreements	Status, percentage, and coverage of protected areas, Status and number of species Status of the forest cover	EPA, IUCN, WWF, Ministry of Environment
Economy	To achieve national and international developmental goals in a sustainable way.	Status of the lifestyle Status of the GDP and NDP	Ministry of Finance, Pakistan Bureau of Statistics
Environmental Justice	To involve the affected community and public at an early stage of planning	Number of consultation studies and public involvement in the power sector PPPs	Planning Commission of Pakistan, EPA

Table 2: Compatibility of National Power Policy, National Power System Expansion Plan 2011-2030 objectives with relevant national PPPs objectives.

S. No.	Relevant PPPs	Relevant PPPs Objectives	National Power Policy and National Power System Expansion Plan 2011-2030 Objectives									
			Build a power generation capacity that meets the needs in a sustainable manner	Create a culture of energy conservation and responsibility	Use of inexpensive indigenous resources such as coal (Thar coal) and hydel	Promote efficiency in power generation	Minimize financial losses	Minimize pilferage and adulteration in the fuel supply	Align the ministries involved in the energy sector and improve the governance	Minimize inefficiencies in the distribution system	To meet the expected load up to the year 2030 by utilizing the available resources	Create a cutting-edge transmission network
1	National Climate Change Policy 2012	To integrate climate change in the vulnerable sectors of the economy to ensure climate resilient development	√	√	X	√	0	√	0	0	X	0
		To minimize the risks arising from the extreme weather events such as floods, droughts, and tropical storms.	√	√	√	0	0	√	0	√	X	0
		To promote conservation of natural resources and long-term sustainability.	√	√	X	√	0	√	0	√	X	√
2	Policy for Development of Renewable Energy for Power Generation, 2006	To increase the use of indigenous sources and diversify the energy mix.	√	0	X	0	0	0	0	0	√	0
		To ensure human health and environmental protection by reducing the use of traditional biomass and fossil fuel electricity generation.	√	√	X	0	0	X	0	√	X	0
		Increase the deployment of renewable energy technologies 9,700 MW by 2030	√	0	X	0	0	0	0	0	X	0
3	National Resettlement Policy, 2002	To avoid minimize social impacts and involuntary resettlement from developmental activities	0	√	X	√	0	0	0	0	X	0
4	National Environmental Policy, 2005	Promote energy efficiency and the use of renewable resources.	√	√	X	√	0	x/√	0	√	√	√
		To ensure protection of regional and global environment.	√	√	X	√	0	√	0	√	X	√
		Conservation, protection and sustainable use of biodiversity.	√	√	X	√	0	√	0	0	X	√
		Prevent and reduce air and noise pollution.	√	√	X	√	0	√	√	0	X	√
5	National Disaster Reduction Policy, 2013	Promoting development planning that considers and addresses disaster risks alongside environmental and climate change concerns	√	√	X	√	0	√	0	√	X	√
6	National Drinking Water Policy, 2009	To ensure protection and conservation of water resources	√	√	X	√	0	0	0	√	X	√
7	National Wetlands Policy, Final draft 2009	Conservation and sustainable use of wetlands	√	√	X	√	0	0	0	√	X	√
8	National Biodiversity Action Plan, 2000	Sustainable use of biological resources and the maintenance of biodiversity	√	√	X	√	0	√	0	√	X	√
9	Natural Gas Allocation and Management Policy, 2005	Assured gas supply to all existing consumer in Power Sectors will be on nine months basis and for the remaining period, gas supply will be on the best effort basis	X	0	√	√	0	√	√	√	X	√
10	Energy Security and Affordability Annual Plan 2014-2015	Tap Pakistan's huge potential for alternative energy.	√	√	X	0	0	0	√	0	√	0

Key: Compatible √, Incompatible X, No link 0.

National Climate Change Policy 2012

The national climate change policy is dedicated to integrating climate change in the vulnerable sectors of the economy to ensure climate resilient development and to minimize risk arising from the extreme events floods, droughts, and storms. The policy is also devoted to conserve the national resources and long-term sustainability. The National Power Policy 2013 lacks the climate change integration, adaptation, and mitigation in the power sector. The energy sector is contributing 50% of greenhouse gases (GHGs) and it is one of the most vulnerable sectors to the negative impacts of climate change. Electricity generation of 38.1% from coal will produce more GHGs and consequently will contribute to alter the local climatic parameters.

Policy for Development of Renewable Energy for Power Generation 2006

Policy for Development of Renewable Energy for Power Generation 2006 is devoted to protect human health and environmental protection by reducing the traditional electricity generation from fossil fuel and biomass. To increase the renewable share (excluding the hydel) in the national energy mix to 9700 MW by 2030. The current fossil fuel share in the power generation is 68%, which will be reduced to almost 49% by the end of 2030, including the major share of coal 38.1%. This will produce a negative impact on the human health and environment, as the Thar coal has a high sulfur content. The National Power Policy 2013 has no specific objective for the utilization of renewable energy, but the national power system expansion has several wind and solar projects. The national power expansion plan has projected that 5000 MW will be generated from wind in contrast with the committed generation of 9700 MW in Policy for Development of Renewable Energy for Power Generation 2006.

National Resettlement Policy 2002

The National Resettlement Policy is committed to avoid, minimize social impacts, and involuntary resettlement from the developmental activities. However, the National Power Policy 2013, is keen to utilize hydel and coal for the generation of electricity. The construction of such a huge number of dams (23 Water and Power Development Authority and 18 Independent Power Plants) will possibly force the communities to migrate from the project areas. On the other hand, it will also cause some social and political issues like Kalabagh dam.

National Environmental Policy 2005

The national policy is keen to protect biodiversity, regional and global environment, by reducing air and noise pollution and promoting the use of renewable resources. According to the National Power System Expansion Plan 2011-2030, the power demand will be 98,120 MW, consisting of 35.7% of hydropower,

38.1% of steam turbines, using Thar coal, 10.3% of CCGT (Combined Cycle Gas Turbines), 6.7% of nuclear, 2% of interconnections, 7.2% from gas turbines and renewable energy sources. This energy mix has a small portion of renewable energy only 5000 MW, which is very negligible as compared to the Pakistan renewable energy potential. The construction of dams and the use of coal will pose threats to the biodiversity and will deteriorate air quality.

National Disaster Reduction Policy 2012

The national disaster reduction policy is dedicated to promoting development planning that considers and addresses disaster risks alongside environmental and climate change concerns. The national power policy is devoted to utilize hydel and coal more than other power generation options. The construction of dams will reduce the risk of floods; however, dams can be detrimental for the downstream areas especially in earthquake-prone areas.

National Wetlands Policy (Final draft) 2009

The policy is devoted to the conservation and sustainable use of wetlands. The construction of dams as planned in the National Power System Expansion Plan 2011-2030 has a negative impact on the wetlands. The construction of dams and diversion of water flow from the water-dependent habitats will pose possible threats to the biodiversity. On the other hand, electricity generation from nuclear power can also affect the marine environment.

Natural Gas Allocation and Management Policy 2005

Pakistan has the natural gas capability of 282 trillion cubic feet and generation of about 4 billion cubic feet daily. Gas stores are exhausting and if gas utilization develops every year even at moderate rates, the present recoverable capacity will generally be depleted by 2025 (GoP., 2005). In contrast, as projected in the National Power System Expansion Plan 2011-2030, 7370 MW electricity will be generated from the natural gas. This communication gap needs to be addressed in the future. On the other hand, Compressed Natural Gas (CNG) vehicles are growing day by day and there are 2.7 million CNG converted vehicles. This increase will further limit gas supply to the power sector.

Energy Security and Affordability Annual Plan 2014-2015

This plan is devoted to tap Pakistan's huge potential for alternative energy, while the National Power Policy 2013 lacks such commitment. On the other hand, the projected electricity generation from renewable resources is 7370 MW by 2030, which is a small portion of the available wind capacity of the country. About 60,000 MW wind potential only at Gharo Keti Bandar Wind Corridor spreading 60 km along the coastline of Sindh province (GoP., 2015).

National Biodiversity Action Plan, 2000

National Biodiversity Action Plan 2000 is committed to maintaining biodiversity. The projected electricity generation mix has a possible impact on the biological diversity at the project level. The generation of such huge number of dams (23 Water and Power Development Authority and 18 Independent Power Plants) will possibly affect flora and fauna directly at the project level.

Internal Coherence Analysis

The purpose of testing the National Power Policy 2013 and National Power System Expansion Plan

2011-2030 objectives against SEA objectives is to look for potential synergies and inconsistencies. What the National Power Policy 2013 and National Power System Expansion Plan 2011-2030 are trying to achieve and what are the main concerns for the environment and important questions to be addressed. This is important to ensure that the National Power Policy 2013 and National Power System Expansion Plan 2011-2030 are consistent with the environmental objectives (Table 3).

Table 3: Compatibility of the SEA and National Power Policy, National Power System Expansion Plan 2011-2030 Objectives.

S. No.	SEA objectives	National Power Policy 2013 and National Power System Expansion Plan 2011-2030 Objectives									
		Build a power generation capacity that meets the needs in a sustainable manner	Create a culture of energy conservation and responsibility	Use of inexpensive indigenous resources such as coal (Thar coal) and hydel	Promote efficiency in power generation	Minimize financial losses	Minimize pilferage and adulteration in the fuel supply	Align the ministries involved in the energy sector and improve the governance	Minimize inefficiencies in the distribution system	To meet the expected load up to the year 2030 by utilizing the available resources	Create a cutting-edge transmission network
1	To reduce emissions in accordance with the NEQs and international agreements	√	√	X/√	√	0	√	√	√	X	√
2	To avoid land contamination during the transportation and construction activities	√	√	X	√	0	√	√	√	X	√
3	Preserve historic buildings, monuments, archaeological sites and other culturally important features	√	√	X	0	√	√	√	√	X	√
4	Promote generation of energy from renewable resources	√	√	√/x	√	0	0	√	√	X	√
5	Reduce greenhouse gases emissions from the power sector in compliance with the national targets and international agreements	√	√	√/x	√	0	√	√	√	X	√
6	Reduce pollution to the marine and freshwater environment from power generation	√	√	x	√	0	√	√	√	X	√
7	To reduce negative health impacts	√	√	X	√	0	√	√	√	X	√
8	To avoid damages to biodiversity (including terrestrial and marine) in line with national objectives and international agreements	√	√	X	√	0	√	√	√	X	√
9	To achieve national and international developmental goals in a sustainable way	√	√	√	√	√	√	√	√	√	√
10	To involve the vulnerable community and general public at an early stage of planning	√	√	√	0	0	0	√	√	√	0

Key: Compatible √, Incompatible X, No link 0

Incompatibilities:

Overall objectives of the National Power Policy and National Power System Expansion Plan 2011-

2030 were compatible with the SEA objectives. However, following objectives of National Power Policy 2013 and National Power System Expansion

Plan 2011-2030 were incompatible with most of the SEA objectives.

National Power Policy objective: To generate inexpensive and affordable electricity for domestic, commercial, and industrial use, using indigenous resources such as coal (Thar coal) and hydel.

National Power System Expansion Plan 2011-2030 objective: To meet the expected load up to the year 2030, utilizing the available resources.

SEAO-1: The above-mentioned objectives are not compatible with the SEA objectives. Coal is the dirtiest fossil fuel that produces 2.08 pounds of CO₂ per kWh, as compared to natural gas 1.22 pounds CO₂ per kWh and distillate oil 1.81 pounds CO₂ per kWh (US Energy Information Administration, 2015). By 2030, the government will produce 37383.72 MW (38.1%) of electricity from coal. The utilization of coal for power generation will cause more air emission.

SEAO-2: According to the National Power System Expansion Plan 2011-2030, the electricity demand will be 98,120 MW consisting of 35.7% of hydropower, 38.1% of steam turbines using Thar coal, 10.3% of CCGT (Combined Cycle Gas Turbines), 6.7% of nuclear, 2% interconnections, 7.2% from gas turbines and renewable energy sources. The construction of dams, extraction of coal, transportation of coal and waste disposal from power plants will possibly contaminate land and soil.

SEAO-3: The construction of 43 new dams has the potential to affect archeological sites directly and indirectly. The utilization of coal for power generation will also affect the air quality and eventually, acid rain will affect the historic buildings, monuments, archaeological sites and other culturally important features.

SEAO-4: The power policy is committed to generating electricity from indigenous resources especially the Thar coal but lacks any aspiration to utilize renewable energy like wind and solar. On the other hand, the National Power System Expansion Plan 2011-2030 has projected to generate only 5000 MW from wind, although Pakistan has more than 60,000 MW only at Ghoro Ketu Bandar Wind Corridor and of 2.9 million MW solar potential (GoP., 2015).

SEAO-5: Pakistan is a small GHGs producer and its share is 0.8% in total global GHGs. The present power system of the country is highly dependent on the thermal power generation. In June 2014, the share of thermal electricity was 67.97%. According to the National Power System Expansion Plan 2011-2030, the share of thermal will be reduced to 51% including a major portion of coal 38.1%. The generation of 37383.72 MW from coal will increase the GHGs. As projected by the planning commission of Pakistan energy sector will be the leading CO₂ producer (2685 Mt CO₂ equivalent) by 2050.

SEAO-6: The construction of 43 new dams, as planned in the National Power System Expansion Plan 2011-2030, will divert the flow and will cause serious threats to the freshwater systems. On the other, the new nuclear power plants will possibly affect marine life.

SEAO-7: The planned power generation mix has the potential to affect human life negatively. The major concern will be regarding the coal's extraction and emission from coal power plants as they produce CO₂, CO, NO_x, SO_x, and heavy metals, which are injurious to human health.

SEAO-7: National Power Policy has no clear objective, regarding the protection and conservation of biodiversity. The planned power generation mix for 2011-2030 is likely to affect the biodiversity both directly and indirectly. The construction of the projected dams, the utilization of coal and nuclear energy may affect the aquatic and terrestrial ecosystems.

CONCLUSION

Pakistan has sufficient supply of renewable energy. However, the national power policy 2013 has no commitment to reduce air pollution or to have a realistic objective for the utilization of renewable energy resources. According to the policy for Development of Renewable Energy for Power Generation, 2006, a total of 9700 MW electricity will be generated from the renewable resources, including small-scale hydro projects (50 MW or less than 50 MW) by 2030. This is a very small portion of the renewable energy resources, as compared to the projected power demand 98120 MW by 2030. Political forces and interests can be one of the main reasons for non-utilization of the renewable resources.

It may, therefore, be concluded that SEA can play a great role in reducing the gaps between different departments dealing with the power sector. There is an urgent need to assess the future energy demands by taking into consideration the changing climatic conditions and the available energy options. SEA can make national power policies, plans, and programs less vulnerable to political influences thus resulting in the sustainability and security of the power sector. It is fortunate that the SEA is mandatory for all provinces except Punjab, which is the biggest power consumer as well as the most populous province of Pakistan. The provincial and the federal governments need to make SEA mandatory for power related policies plans and programs.

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