

# CO<sub>2</sub> Emissions from Pakistan's Energy sector

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## Introduction

Pakistan is one of the most affected countries from adverse impacts of climate change as well as air pollution. A report by research group German Watch in 2019 ranked Pakistan as the fifth most affected country due to climate change over the past two decades ([German Watch 2019](#)) while IQAir ranked Pakistan's air as the second most polluted in 2020 ([IQAir 2021](#)). In order to reduce these impacts, the country needs to take extensive adaptation and mitigation measures, while transforming the energy sector towards less polluting and carbon neutral options.

While the country is working on adaptation and mitigation, being a developing country, it is also bound to have increased energy consumption for ensuring better living conditions to its citizens and because of this reason it becomes important for Pakistan to undergo an energy transition from highly polluting fossil fuels to clean forms of energy to contribute to global efforts of reducing greenhouse gas (GHG) emissions as well as to protect public health and reduce air pollution burden within the country while fulfilling the needs for growth in energy consumption for its population.

Pakistan's energy sector is already going through a transition over the past few years where utilization of oil for power generation has been replaced by coal. However, while the sector is going through transition, it would be a wise decision to comprehensively assess and streamline this transition in Pakistan which will impact efforts for reduction of environmental, ecological, climate change and economic burden now and for future generations.

The current piece is an attempt to understand the CO<sub>2</sub> emission profile<sup>1</sup> of the energy sector in Pakistan. However, before moving to that step we need to understand the primary energy supply and fossil fuel consumption pattern across sectors.

## Data and Methods used

The analysis is based on primary data compiled by

- National Electric Power Regulatory Authority ([NEPRA, 2020](#)): Source and plant wise electricity generation data

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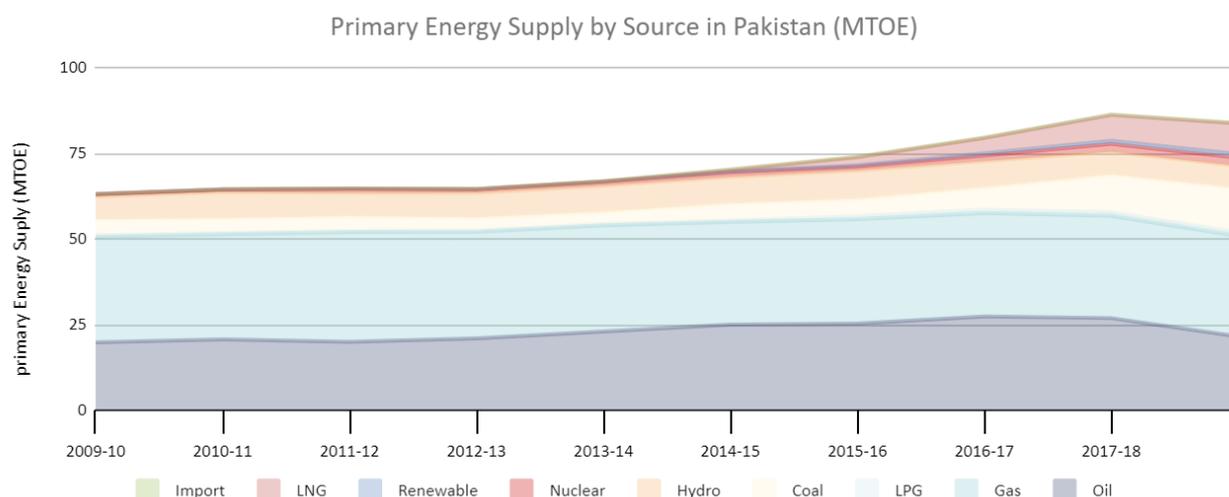
<sup>1</sup> This piece only looks at CO<sub>2</sub> emissions and does not account for CH<sub>4</sub>, N<sub>2</sub>O, NMVOC or other GHGs from the energy sector. Apart from global climate change impacts, fossil fuel combustion also leads to local air, water and soil pollution as well as social and economic costs/burden, which are beyond the scope of this article and should be assessed in detail to highlight the health burden of fossil fuel as energy sources over the cleaner renewable energy solutions.

- Finance Division, Government of Pakistan ([FD, GoP, 2020](#)): Historical fuel consumption data for past four decades
- Intergovernmental Panel on Climate Change ([IPCC, 2006](#)): CO<sub>2</sub> Emission factors for coal, oil and natural gas<sup>2</sup>

Primary fuel consumption data collected from NEPRA and FD GoP was converted to Exajoules (EJ) to have one common unit for comparative usage which then was converted to CO<sub>2</sub> emissions based on CO<sub>2</sub> emission factors developed by IPCC, 2006 for coal (97.2 MtCO<sub>2</sub>/EJ), oil (72.2 MtCO<sub>2</sub>/EJ) and natural gas (56.1 MtCO<sub>2</sub>/EJ)<sup>3</sup> till the year 2018-19. Further, emissions for the electricity sector were calculated using average CO<sub>2</sub> emission factors per unit of electricity produced (i.e., 992g/kWh for coal; 495 g/kWh for gas and 961 g/kWh for oil based power generation, derived from CO<sub>2</sub> emissions from electricity generation and units generated over past two years).

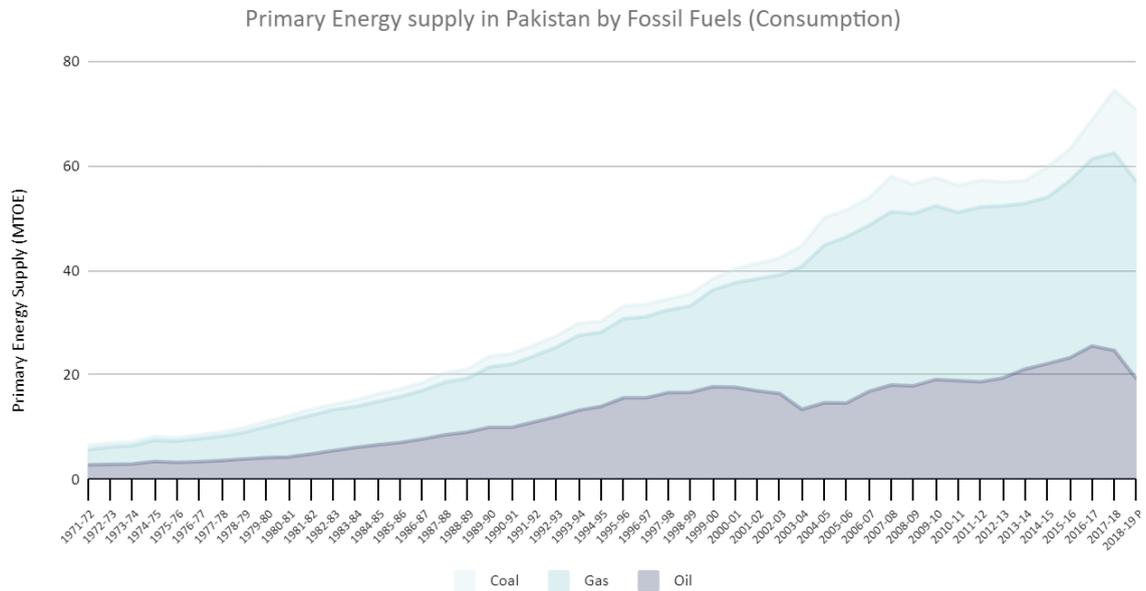
## Primary Energy Supply

The shares of gas, oil, hydro, coal, nuclear and LPG in primary energy supply for Pakistan in 2013-14 were 46.3%, 34.4%, 11.4%, 5.4%, 1.8% and 0.5%, respectively, while the remaining 0.1% was supplied by imported power. Over the past five years, the energy sector has gone through a transition. As a result, in 2019-20, the sectoral contribution shifted to 35% for gas; 26%, oil, 8%, hydro, 15% coal, 3.5% Nuclear and 1% for LPG, while LNG and renewable energy contributed 11% and 1%, respectively ([NEPRA, 2020](#)).



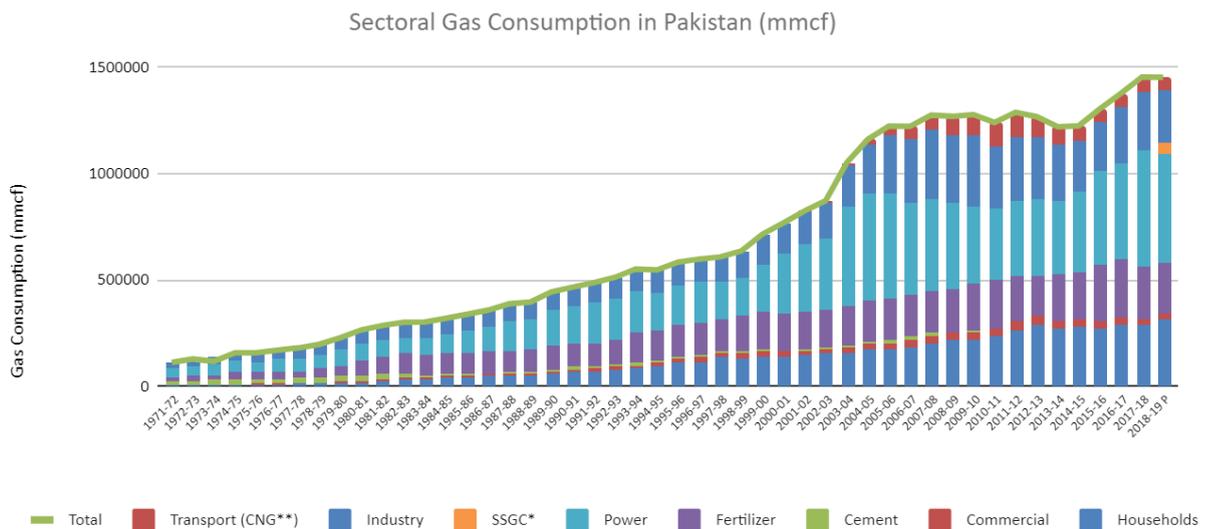
<sup>2</sup> 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 Energy

<sup>3</sup> Average derived factors from fuel usage in different forms as categorised by IPCC, 2006



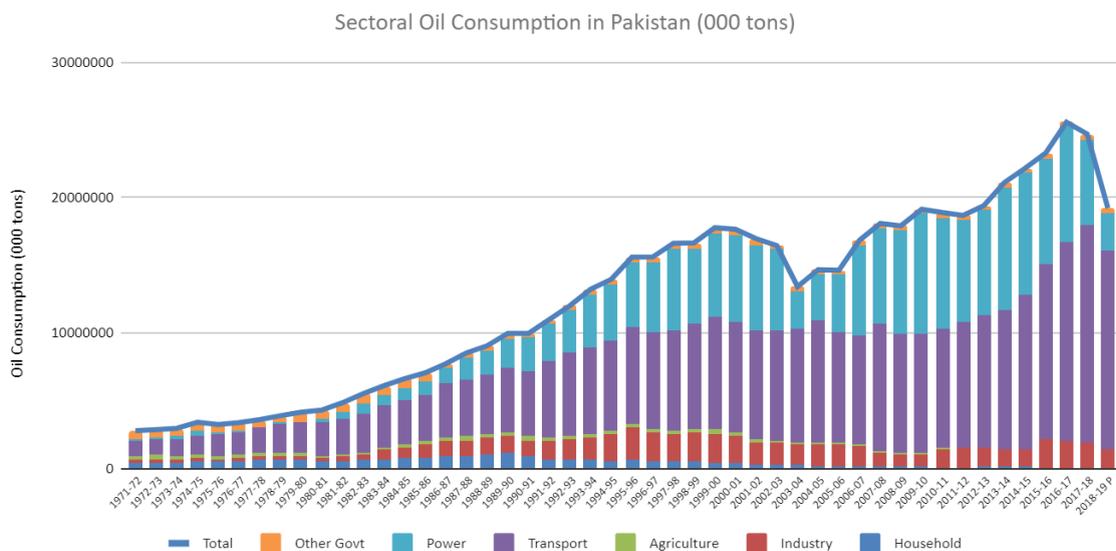
## Gas

Gas consumption occupies the largest share in primary energy supply in Pakistan with approximately 53% share in 2018-19 annual consumption at 14,53,519 mmcf with power (35%), household (21%), industry (17%) and fertilizer (16%) being the major consumption sectors ([GoP, 2020](#)).



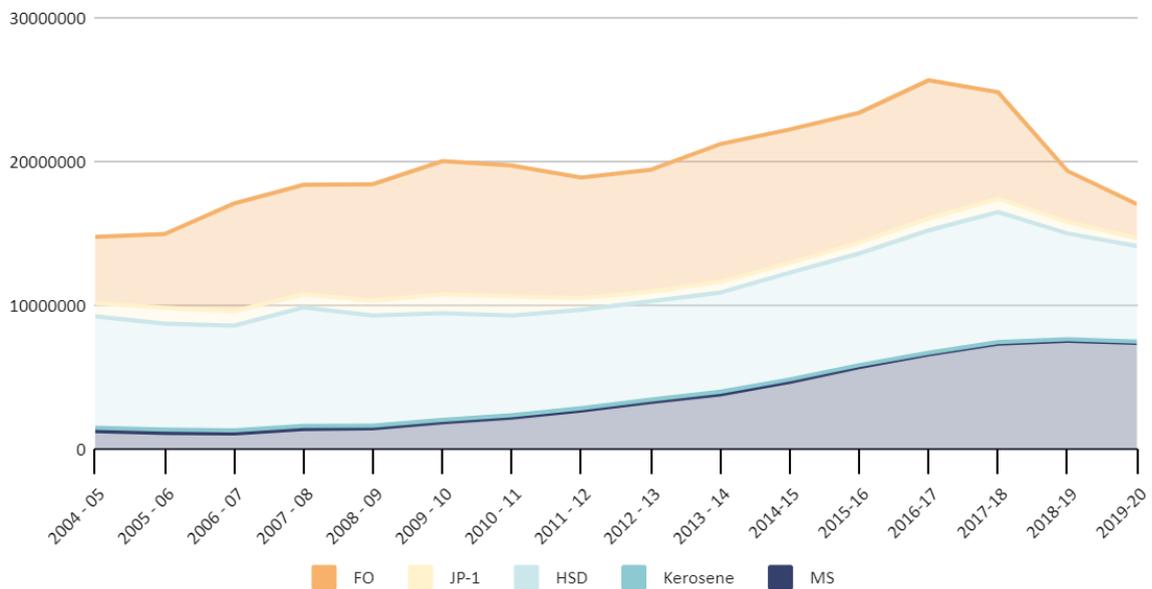
## Oil

Oil accounted for 27% of the total primary energy needs of the country with total consumption of approx. 19.2 million tons in 2018-19 showing a sharp drop in consumption over the past years compared to the period between 2013-14 to 2016-17 when the fuel's share was around 37% (in the range of 21.2 to 25.6 million tons) ([GoP, 2020](#)). The primary reason for such drop is reduced consumption of oil for power generation as coal took over as the dominant fuel source in terms of growth over past years.



Transport (48.8%) and power (42.7%) sector cumulatively accounted for about 91% of the total oil consumption in Pakistan in FY14, while the two sectors cumulatively still account for nearly 90% (FY 2018-19) of total oil consumption, the relative share has changed significantly with transport contributing to the bigger share in consumption of about 76% and power sector at 14% of the total consumption ([GoP, 2020](#)).

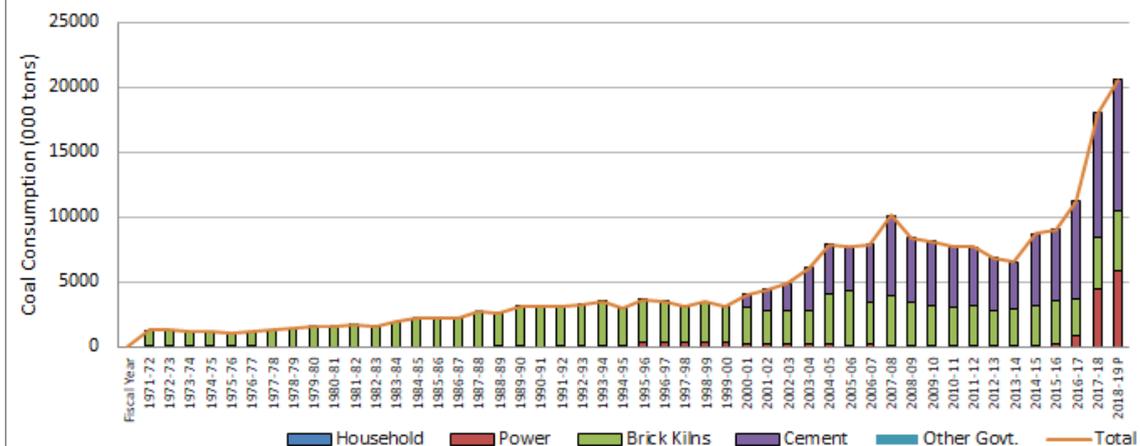
Product Wise Petroleum Product Consumption in Pakistan (2003-04 to 2019-20)



## Coal

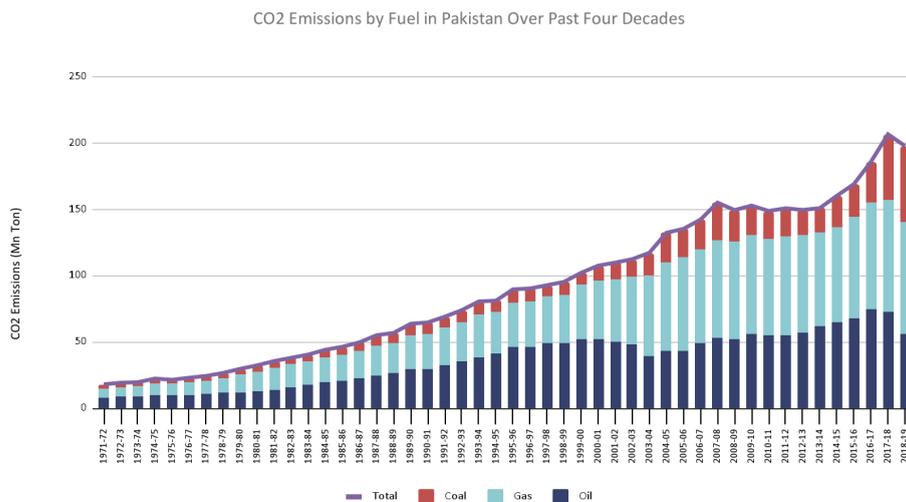
Coal, which contributed less than 10% share in overall fossil based energy for the country till 2013-14, was responsible for 19% of the emissions in 2018-19 (GoP, 2020). Cement (49%), Power (28%) and Brick Kilns (22%) were the biggest coal consuming sectors with power sector’s consumption increasing by nearly 28 times between 2015-16 (204, 000 metric ton) to 2018-19 (5900, 000 metric tons).

Sectoral Coal Consumption in Pakistan (000 tons)

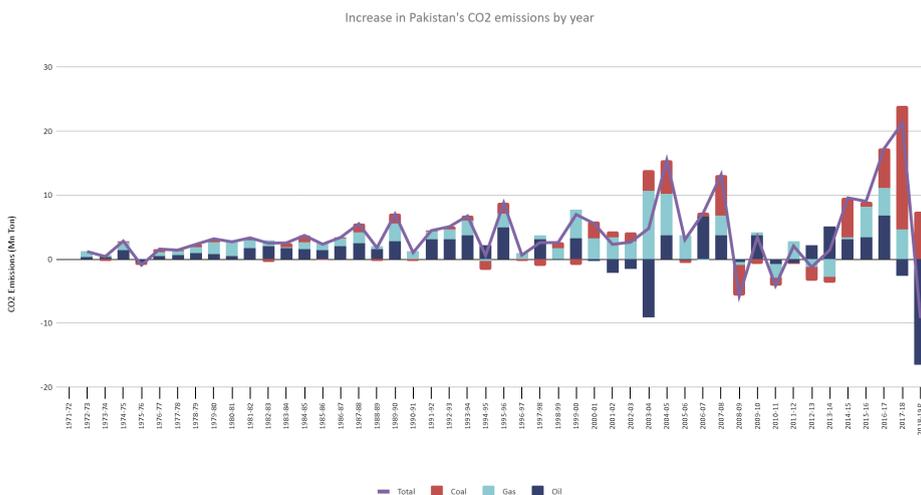


## CO<sub>2</sub> Emission Trends

CO<sub>2</sub> emissions from consumption of fossil fuels, i.e., oil, gas and coal in Pakistan have more than doubled over the past two decades. Emissions from coal saw the highest growth rate, increasing more than five-fold over the past two decades, followed by gas which has shown a more than two-fold increase and oil with approximately 50% increase in CO<sub>2</sub> emissions compared to two decades ago.

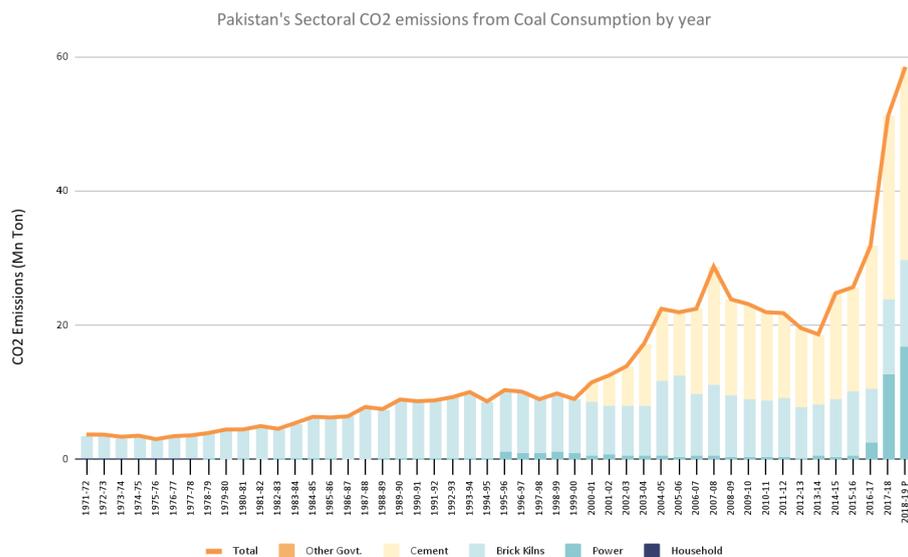


2018-19 saw the highest ever recorded year-on-year drop in CO<sub>2</sub> emissions levels over the last four decades when consumption of gas was nearly stagnant as compared to past year and coal consumption grew slightly compared over the same period but wasn't enough to cover the drop due to lower oil consumption which ensured the steep drop in CO<sub>2</sub> emissions.

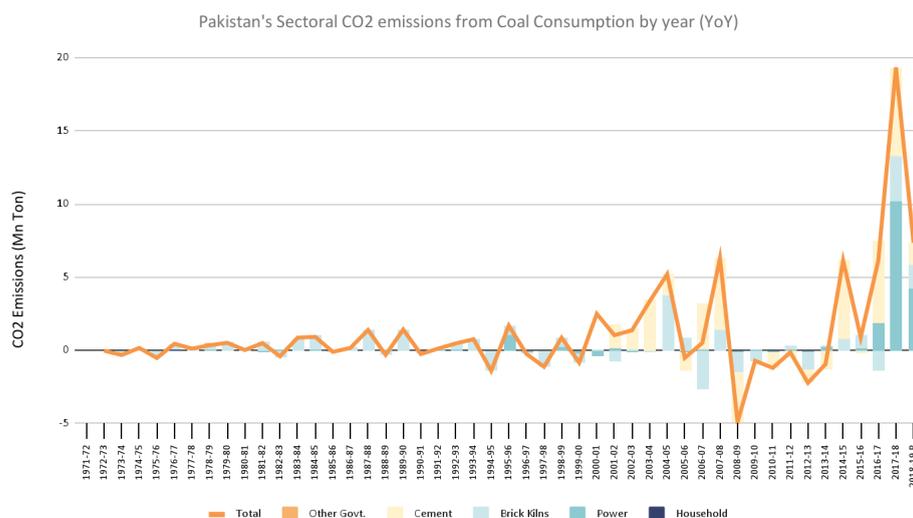


## Coal

Coal contributed nearly a quarter to the total CO<sub>2</sub> emissions from fossil fuel consumption in 2018-19 (198 mn ton), which was up from less than the 10%, 20 years back. The primary reason for the increase in share of coal in the CO<sub>2</sub> emissions was its increased usage for power generation over the past 3 years with installation of new coal based power generation capacity alongside increased consumption of the fuel for cement sector.

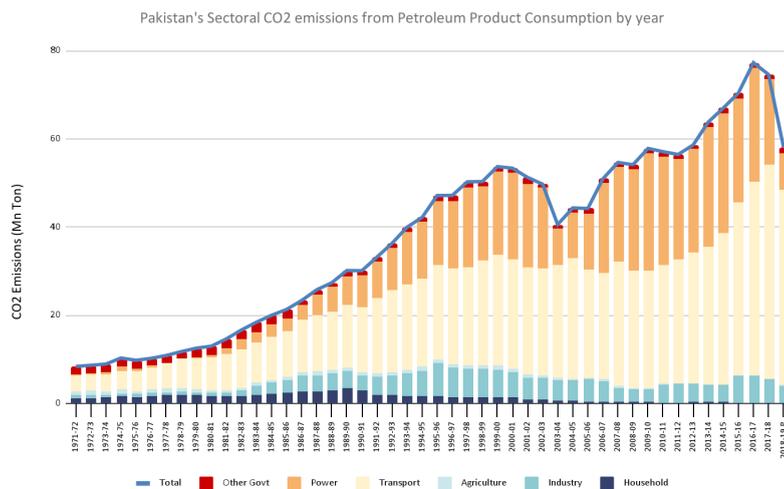


Cement (49%), Power (28%) and Brick Kilns (22%) were the three biggest sectors responsible for coal-burning CO<sub>2</sub> emissions during 2018-19 in Pakistan with power's share increasing over past few years and taking over as the second largest sector when it comes to CO<sub>2</sub> emissions from coal combustion.

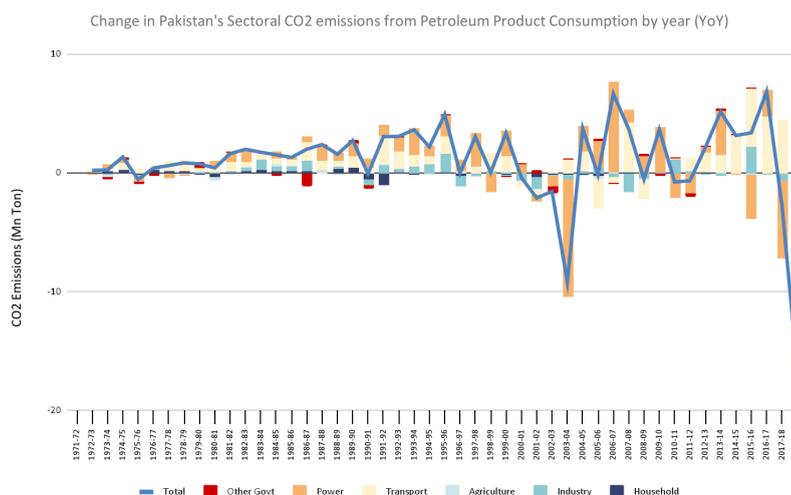


## Oil

Oil/Petroleum product consumption contributed to about 35% of CO<sub>2</sub> emissions from fossil fuel consumption in Pakistan mainly for Transportation, Industrial and power generation requirements. The share of oil products consumed in industry and power sector seems to have been reducing over the past few years but the increasing demand from the transportation sector has increased significantly over past years.



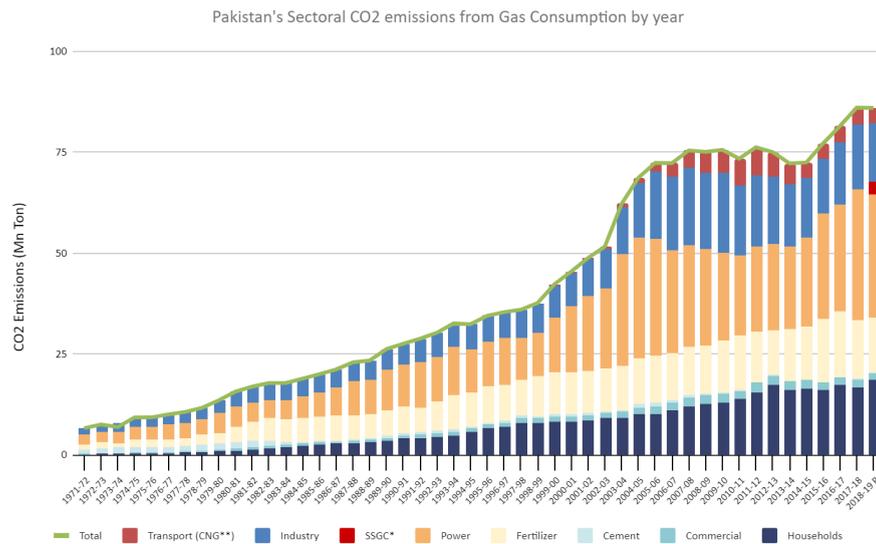
CO<sub>2</sub> contribution from oil consumption decreased over the past two fiscal years mainly because of reduced oil consumption for power generation and industry, however a resurgence in these emissions is expected this year as the power and industrial sector return to furnace oil to meet their energy demands after a slump in energy production from the hydel and RLNG sector.<sup>4</sup>



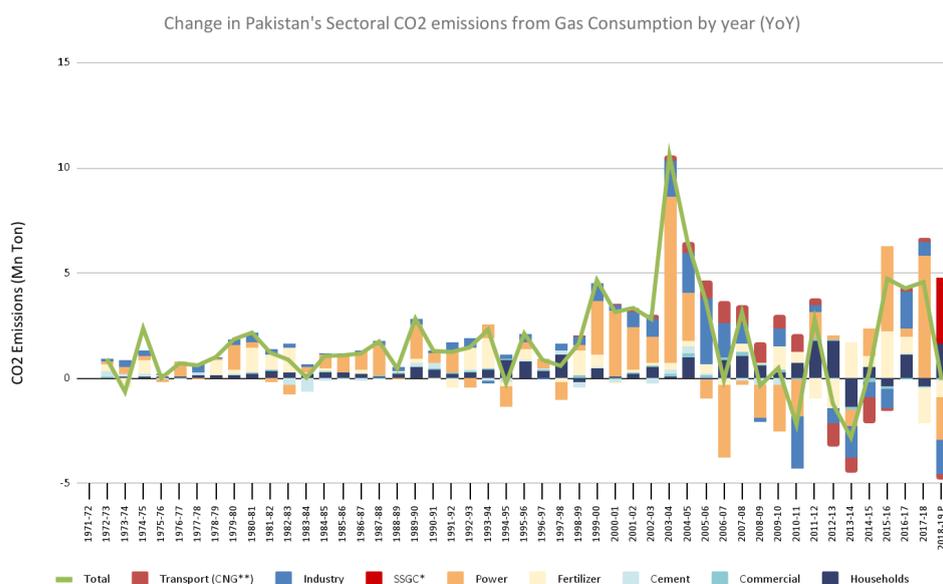
<sup>4</sup> [Petroleum consumption in FY21 - BR Research - Business Recorder \(brecorder.com\)](https://www.brecorder.com/energy/petroleum-consumption-in-fy21-br-research)

## Gas

Natural Gas contributes highest to the CO<sub>2</sub> emission from fossil fuel consumption in Pakistan with a share of more than 40% in 2018-19. Power, household and industrial sectors are the biggest contributor sectors to the CO<sub>2</sub> emissions from gas consumption followed by the fertilizer sector.



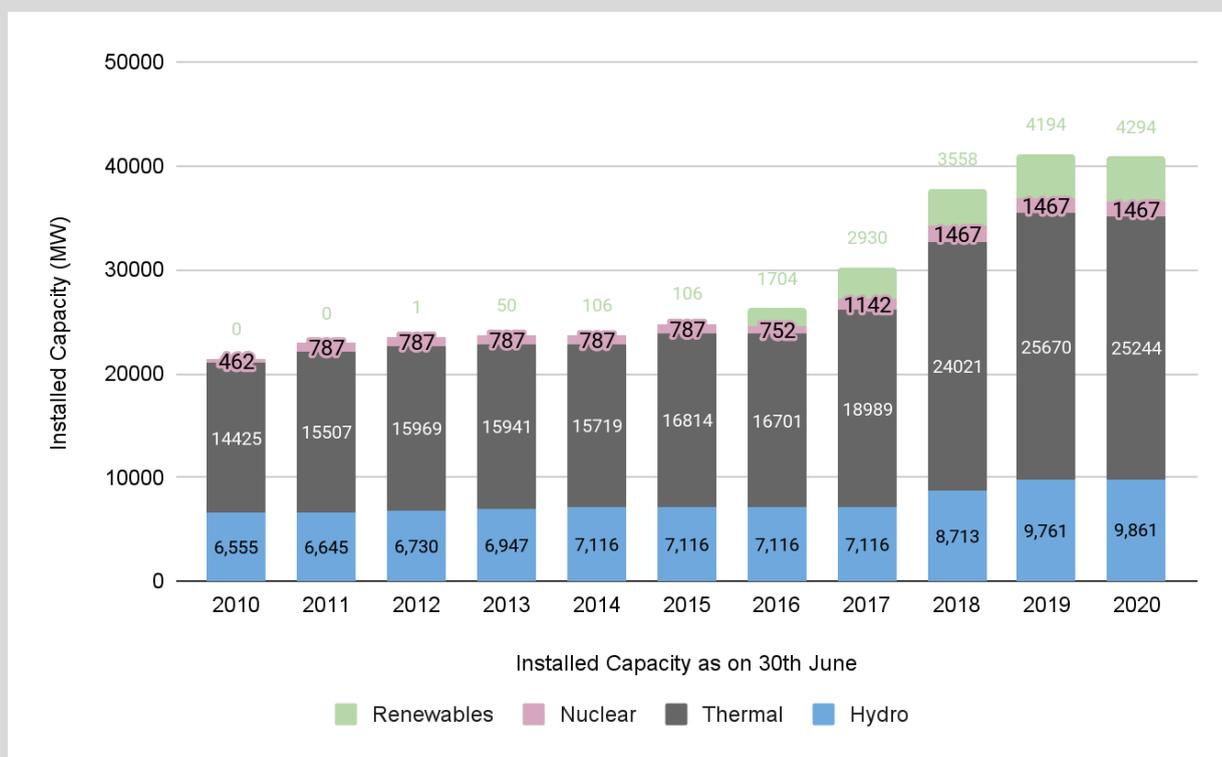
Although the consumption of gas in the industrial, power and fertilizer sector reduced in 2018-19 compared to previous year, consumption in SSGC and household sectors resulted in flat or insignificant reduction in CO<sub>2</sub> emissions from combustion of the fuel.



## Spotlight

### Electricity Generation

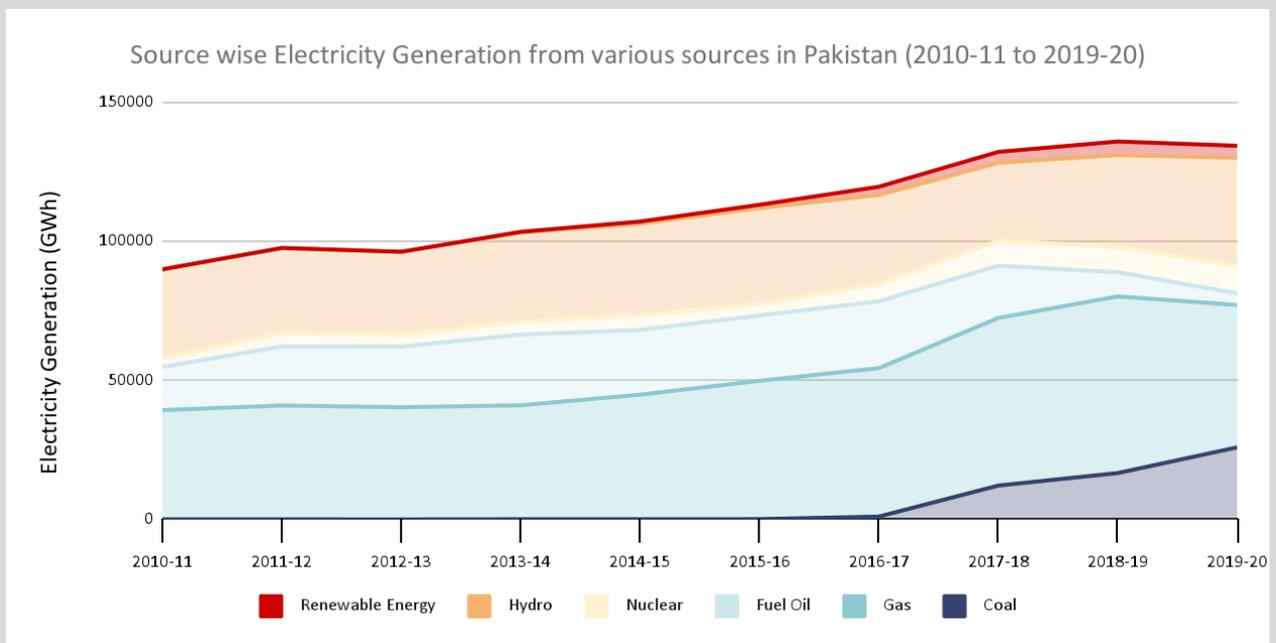
As of 30th June 2020, total installed electricity generation capacity in Pakistan was 38.5 GW with thermal sector contributing about 25.2 GW, Hydro 9.8 GW, Renewable energy 4.3 GW and remaining 1.5 GW came from nuclear.



Pakistan's electricity sector has gone from a power deficit situation to a power surplus condition over the past decade, while moving on that journey the share of various generation sources has changed, having implications on the environment, economics, climate change and health. The following data represents the current situation of Pakistan's electricity Sector ([NEPRA, 2020](#))

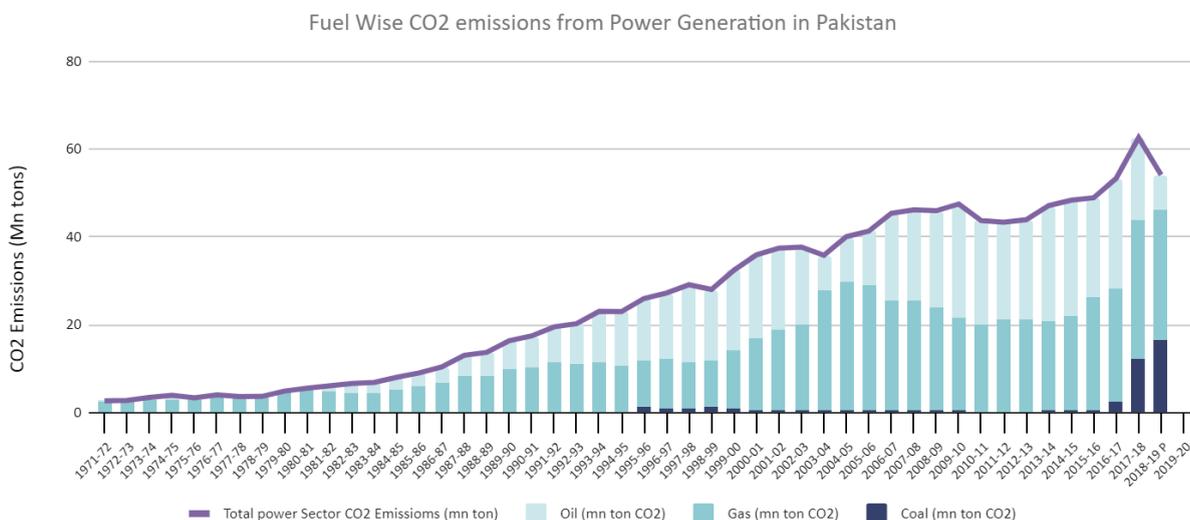
- **Coal Generated** about 112 Million Units (MUs) in 2013-14 which has increased to 26,000 million units in 2019-20 from 6 coal plants (4822 MW) across the country.
- **Gas generated** about 41,000 MUs in 2013-14 which increased to 51,250 MUs in 2019-20 from 37 Plants with cumulative installed capacity of 15301 MW across the country.

- **Fuel Oil** generated about 25,460 MU in 2013-14 which decreased to 4183 MU in 2019-20 from an installed capacity of 4388 MW.
- **Nuclear generated** about 4695 Mus of electricity in 2013-14 which increased to 9897 MU in 2019-20 from an installed capacity of 1467 MW.
- **Hydro generated** about 32,000 MU in 2013- 14 which increased to 38,900 MU in 2019-20 from an installed capacity of 9861 MW across the country.
- **Renewable Energy** Generated 272 MU in 2013-14 which has increased to 4304 MU in 2019-20 from an installed capacity of 2147 MW.



## CO<sub>2</sub> Emissions from Power Sector

Natural gas and oil (RFO) were the dominant contributors to CO<sub>2</sub> emission from the power sector in Pakistan till very recently, but with addition of coal capacity for power generation over past years, now coal and natural gas contribute to more than 90 % of the power sector CO<sub>2</sub> emissions with coal contributing the highest share with 25.8 Mn tons of CO<sub>2</sub> followed by gas with 25.4 Mn tons and oil 4 Mn ton CO<sub>2</sub> emissions in 2019-20. The overall CO<sub>2</sub> emissions from power generation have been increasing consistently over the last four decades with a drastic increase in 2017-18 and then a similar drop when the first few big coal based power projects were added to Pakistan's power generation fleet.



With increasing demand for electricity, high tariff for electricity from fossil fuel project and associated environmental and climate change hazards, it seems that the energy transition which is underway in Pakistan of shifting the electricity generation from oil to coal might jeopardize the huge economic investments made in the sector as well as the quality of air and environment for future generations. With the share of renewable energy generation still being around 3.2%, it holds a huge scope for expansion in power generation from wind and solar sources in the country to fuel the future growth in electricity demand.

## Discussion and inference

The trends unearthed by this study present a great story of how consumption priorities within Pakistan's energy sector have changed over the course of years. Coal, which was primarily used in brick kilns in the 1970's, became a major energy source for the cement sector by 2010 and lately is increasingly being used for power generation. Similarly, natural gas which used to supply almost 50% of Pakistan's primary energy between 2013-2018, is now only responsible for 35% of the consumption, owing to declining domestic reserves and high spot market prices for LNG. The patterns for carbon emissions have subsequently been changing with these emerging trends. The cement sector is often absent from the discourse in place when it comes to curtailment of carbon emissions and other greenhouse gases in Pakistan, yet as we've learned in this report it is the biggest contributor of coal-related carbon emissions in Pakistan and is bound to increase coal consumption according to proposed plans<sup>5</sup>. Similarly, the transportation sector is the single largest sector responsible for oil-related CO<sub>2</sub> emissions, indicating the need for a shift in our approach towards the need for change in transportation and mobility infrastructure and plans away from a highly fossil intensive transport sector to more sustainable modes for mobility. Strengthening public transportation, last-mile

<sup>5</sup> <https://www.dawn.com/news/60553/use-of-coal-as-cement-kiln>

connectivity, aggressive penetration of electric vehicles, integration of e-mobility plans with decentralised renewable energy and development of NMT (Non-Motorised-Transport) modes for short distance commutes are few of the options which can be adopted aggressively to reduce consumption of oil in passenger transportation sector, alongside similar changes from polluting oil to electrification and efficiency standard improvements in freight transport (railway and cargo) which will cumulatively lead to reduction in the CO<sub>2</sub> footprint of the sector, while improving public health through air pollution reduction while reducing foreign exchange bill through reduced imports of the expensive energy source.

There's also been a marked increase in power related emissions from coal consumption in the past 3 years, which can only be expected to continue in the years that follow as more coal fired power plants are brought online under the China Pakistan Economic Corridor. The addition of this coal fired generation has been deemed crucial to Pakistan's energy diversity and security, while there is enough evidence that this poorly planned addition of new fossil fuel capacity has led to an installed power surplus situation in Pakistan, yet the pollution and health impacts associated with these plants have largely been ignored. The emergence of these trends also points to the disconnect between energy planning and climate change considerations within Pakistan's energy sector. The link between rising carbon emissions and climate change is undeniable, but it seems that discussions around these links have been very limited in Pakistan so far, as is evident from the energy choices the country has made. It seems the energy mix has been vacillating from one fossil fuel to another, without climate consciousness guiding any of these shifts.

Two thirds of Pakistan's electricity generation is based on fossil fuels, and this share remained constant over the past 10 years. The power sector is responsible for more than a quarter of the country's CO<sub>2</sub> emissions and represents the most significant opportunity for decarbonization, as zero-carbon technologies are mature and economically competitive.

One of the most pressing challenges in the transition to clean energy in Pakistan is the misplaced preference for coal as a fuel source for electricity generation. As proposed in the IGCEPs 2019-2047 and 2020-2030 prepared by NTDC, this preference will see the share of coal rising in the fuel mix over the next decade.<sup>6</sup> This choice of coal, which is one of the most polluting fuel sources, comes in spite of Pakistan's INDC submission under the Paris Agreement and its own commitments for phasing out carbon-based energy as outlined in the recent Alternative and Renewable Energy Policy. The sharp rise in coal's contribution to CO<sub>2</sub> emissions from 2018 onwards will likely increase by orders of magnitude if the present trajectory on capacity addition plan is not drastically altered in favor of a renewables based mix.

The present focus on coal also comes at the cost of solar and wind energy which will pose challenges to the expansion of renewable, clean energy transition required for future and will be a big hindrance to the target of minimum 30% of installed on grid electricity generation capacity from renewable energy sources, as set by the Federal Government under ARE policy in 2019.<sup>7</sup> This disjunct between policy goals and planning outcomes explains in part some of the controversies the recently proposed capacity expansion plans have been mired in with both the IGCEP 2019 and 2020 being denied approval by the Regulatory Authority. This

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<sup>6</sup>

<sup>7</sup> Section 1.4.1 Alternative & Renewable Energy Policy, 2019

failure of the policy planning process points to the need for an integrated approach to environmental impact reduction and redressal.

With the sector undergoing major transitions with a shift to a wholesale electricity market scheduled for operation in April 2022<sup>8</sup>, an evaluation and streamlining of preset efforts for reduction of environmental, ecological, climate change and economic burdens (in terms of both present and future costs) is an urgent need of the hour. In particular, there is a need for an evidence based and data-backed assessment of how present industry trends and planned future expansion plans could impact the emissions profile and resultant ecological costs in the years to come.

The CO<sub>2</sub> emissions trends analyzed here make plain the need for incorporating environmental and CO<sub>2</sub> emissions cost in the decision making process -- especially when evaluating the least cost options for the future fuel mix in the energy sector and the choice of technologies in the transport and cement industries. It also reveals the need for a cross-industry audit of present and future trends in CO<sub>2</sub> emissions and the anticipated carbon loads under the net zero journey for Pakistan, which shouldn't just have a final target year, but interim milestones for 5 to 10 years, so that planning process can be aligned to long term goals..

It is evident from the data presented above that Pakistan is going through transition in sources of electricity generation over past years, however, the transition does not follow the sustainable, economical and environmental rationale. At a time when the generation of electricity from cleaner and sustainable renewable energy sources is transforming the electricity and energy markets across the globe Pakistan is still favouring one fossil fuel over the other one and not boarding the train to a clean and sustainable transition. Following the current trajectory Pakistan is locking in huge investments in future stranded assets and bad investments which will never be able to compete with renewable energy both in terms of sustainability and economics and would be left unutilised due to environmental, climate change and economic constraints.

Transition from oil to coal does not necessarily reduce the CO<sub>2</sub> emission from the sector and also makes it a prominent source of pollution which adversely impacts public health and increases the economic burden on the country. Having installed coal based electricity generation capacity of 5 GW, most of which was installed over past couple of years and another ~ 7.5 GW capacity in construction and pre construction stage ([GCPT, 2021](#)), along with huge coal consumption in cement sector and anticipated increase in consumption due to proposed cement plants<sup>9</sup> **if course correction isn't done with time in hand to cancel all such fossil fuel projects in early construction and pre construction stage Pakistan is on road to high GHG and air pollution emissions from the energy sector in coming years, which will not only hamper it's progress towards net zero, but would lead to huge ecological, environmental, human health and economic loss to the country.**

### ***Additional Information:***

<sup>8</sup> <https://nepra.org.pk/Press%20Release/2020/CTBCM%20Final%20PR.pdf>

<sup>9</sup> <https://www.dawn.com/news/1594817>



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The interactive graphs and data used in the analysis can be accessed at the following link:-

<https://datastudio.google.com/reporting/2dd0581b-aaa5-4fea-b6ad-2e3abb62aa43/page/t3DTC>

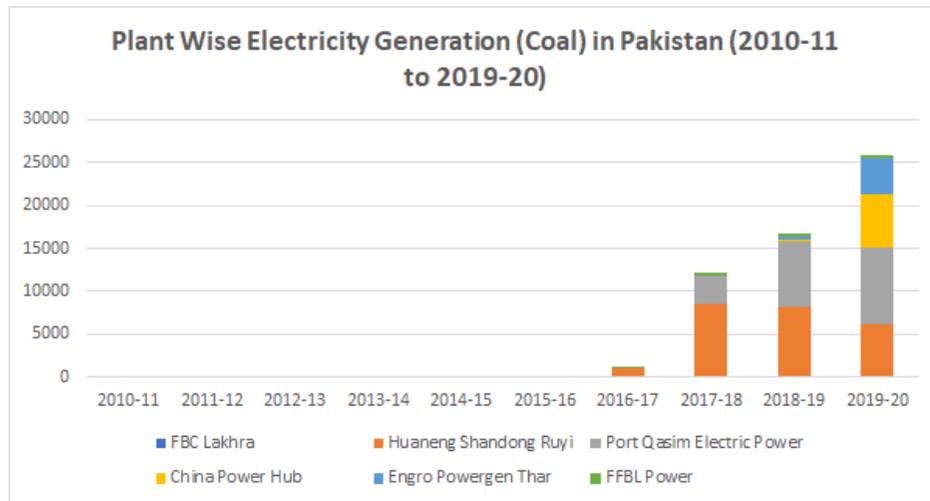
***Acknowledgement:***

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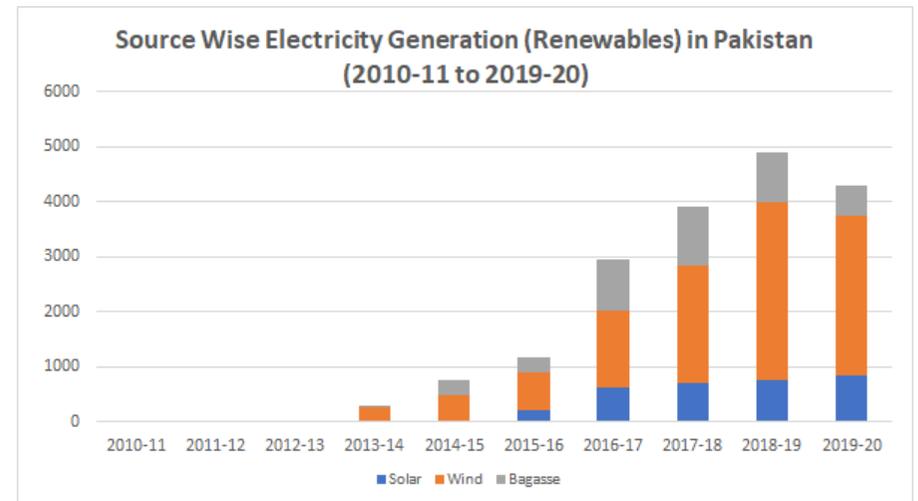
## Appendix

### Annex-I- Plant Wise Electricity Generation from various sources

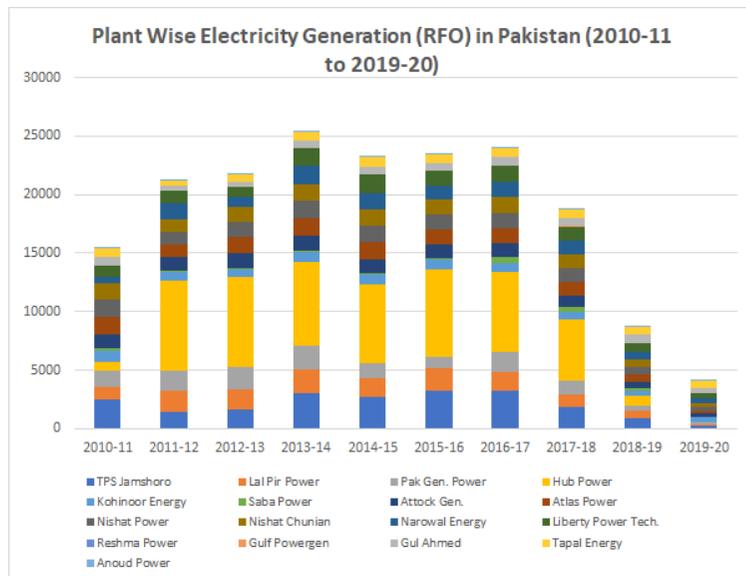
- Coal



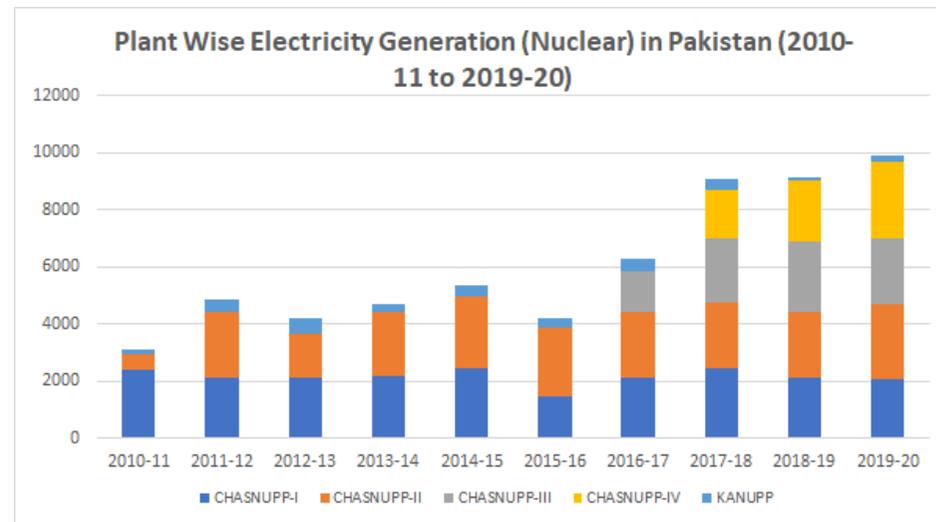
- Renewable Energy



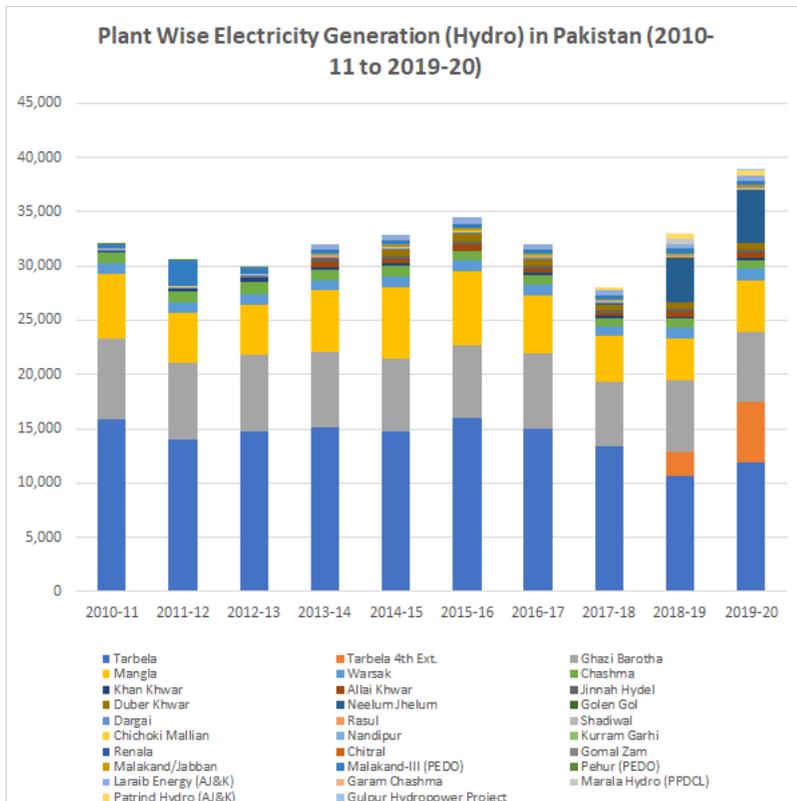
- Fuel Oil



- Nuclear



- Hydro



- Gas

