

## COUNTRY PROFILE PAKISTAN

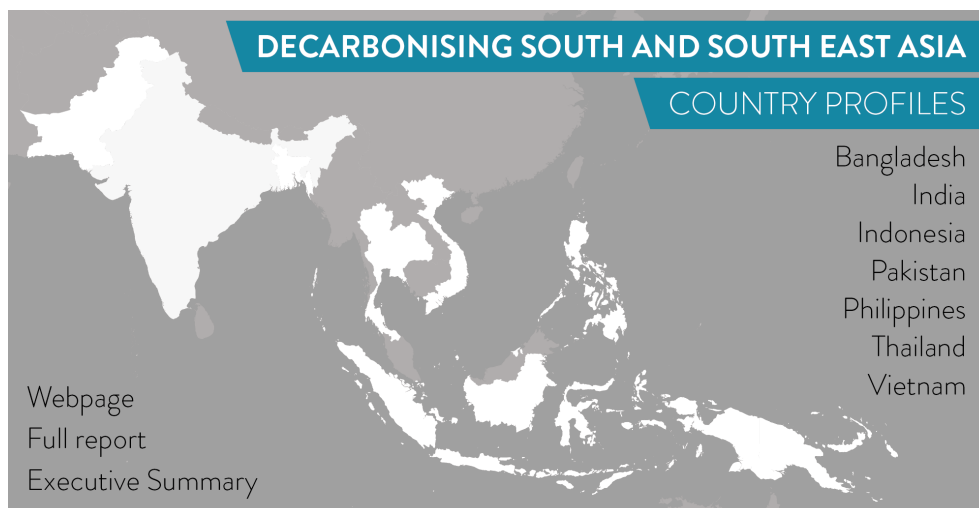
### DECARBONISING SOUTH AND SOUTH EAST ASIA

Shifting energy supply in South Asia and South East Asia to non-fossil fuel-based energy systems in line with the Paris Agreement long-term temperature goal and achievement of Sustainable Development Goals

**MAY 2019**

This country profile is part of the **Decarbonising South and South East Asia** report and examines how to shift the energy supply in South Asia and South East Asia to non-fossil fuel-based energy systems in line with the Paris Agreement long-term temperature goal and achievement of Sustainable Development Goals.

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#### Authors

Ursula Fuentes Hutfilter  
Anne Zimmer  
Fahad Saeed  
Bill Hare  
Tina Aboumahboub  
Ilsa Kelischek  
Carl-Friedrich Schleussner

Paola Yanguas Parra  
Andrzej Ancygier  
Robert Brecha  
Jessie Granadillos  
Gaurav Ganti  
Raghuveer Vyas  
Michiel Schaeffer

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## Key Messages

### *Climate change impacts – Paris Agreement temperature goal matters for Pakistan*

- Pakistan is one of the world's most vulnerable countries to climate change. Extreme events have incurred huge human and economic losses in recent years.
- Pakistan is already highly vulnerable to the climate change at present level of global warming of about 1°C above pre-industrial levels.
- In 3°C warmer world, annual precipitation is projected to increase sixfold compared with 1.5°C.
- Fatalities due to extreme heat can be avoided by limiting warming to 1.5°C.
- A warmer world beyond 1.5°C would commit the coast lines to around 2m sea level rise in the long run.

### *Pakistan's energy system: large increase in fossil fuel based infrastructure*

- Pakistan's share of fossil fuel sources in total energy consumption has risen from below 59% in 2000 to almost 62% in 2014, but the share of fossil fuels in electricity production has decreased substantially from close to 72% in 2000 to 63% in 2015.
- The share of coal in electricity production has remained low, even decreasing slightly, as oil and gas are the predominant fuels in Pakistan's energy mix.
- The utilisation of solar and wind energy resources is limited, with installed capacities representing a mere 1.5% and 3% of the total installed capacity respectively.
- Pakistan is undertaking a major expansion of electricity generation capacity to meet growing demand, as energy access progresses. Current expansion plans include a massive growth in coal capacity, in an effort to overcome the over-reliance on imported fossil fuels.
- Construction of these coal power plants could lock in Pakistan's energy system into a carbon intensive path for decades and would be a huge missed opportunity for building a carbon-free and climate-resilient energy system that would be compatible with the achievement of multiple Sustainable Development Goals.

### *Transition to renewable energy offers massive benefits for Pakistan*

- Pakistan has relatively good solar potential, and covering 1.5% of Pakistan's land area with optimally oriented PV panels could potentially generate 32 times as much electricity as the total current consumption. The Southwestern region of Pakistan also offers significant wind potential.
- Investing in renewable energy capacities can contribute to strengthening energy independence, leading to lower expenditures on fossil fuel imports, less susceptibility to international market price fluctuations or geopolitical shocks.
- The decentralised nature of many renewable technologies can foster progress with regard to reliable energy access, addressing load shedding problems and eradication of energy poverty.
- Improving access to clean technologies for cooking also contributes to reducing indoor air pollution and related health hazards. Outdoor air pollution could be reduced as well by shifting away from fossil fuel combustion.
- Renewable energy technologies provide opportunities for local employment.

### *Targets, projections, and Paris Agreement benchmarks*

- Pakistan's NDC commits the country to a 20% reduction in emissions below Business-as-Usual by 2030.
- Current plans to develop domestic coal production and expansion of coal-fired power are not in line with the need to decarbonise the energy system and phase out coal for power generation by 2040, as a Paris Agreement compatible pathway for South Asia shows.
- There is significant scope to develop an ambitious long-term strategy towards 100% renewable energy power generation and electrification of end use sectors, to align Pakistan's energy future with the goals of the Paris Agreement and reap benefits for sustainable development.

## Introduction

Pakistan is one of the world's most populous countries and a large part of its population is poor; more than 75% live under 5.50\$ a day. After the green revolution in the 1960s, Pakistan constructed several dams to fulfill its irrigation and energy needs, and hydropower served as a mainstay of its energy mix for a long time afterwards. With the growing needs of its burgeoning population, the inclusion of fossil fuels kicked in, which currently has a share of approximately 62% in the country's total energy.

In the past 15 years, the country has witnessed long hours of load shedding severely impacting the industrial production, thereby hampering the exports, mainly in the textile sector, ultimately resulting in joblessness. To overcome this problem, the successive governments relied heavily on imported fuels, which is likely to continue in future. There is a serious threat that these investments, especially in coal power plants, could lock Pakistan's energy system into a carbon intensive path for decades, which ultimately would compound its vulnerability to climate change and associated extremes.

Considering the improvements as well price drop in renewable technologies in recent years, there is a huge potential for Pakistan to meet its energy requirements based on renewable technologies. Besides providing clean energy and a healthy environment, a significant co-benefit of renewables is the provision of additional jobs. With a large part of its population under the age of thirty, it is imperative for the country to ride the wave of renewables, which will have long-lasting positive effects for the economy as well as its social fabric.

## 1 Climate Change Impacts: Risks, vulnerability and benefits of limiting mean temperature rise to 1.5°C

### 1.1 Present day vulnerabilities and risks

In the past thirty years, Pakistan has seen a number of climate disasters (Table 1). Flooding events have come up as the most frequent and devastating climate disaster in the last 30 years, resulting in 11 000 fatalities and \$20 billion losses to the economy. This is followed by storm events in terms of financial losses, however recent years have seen devastating heatwaves causing score of deaths in urban centers of the country. Pakistan is one world's most vulnerable countries to climate change, ranked 8th in the Germanwatch long-term climate risk index<sup>1</sup> (Eckstein, Hutfils, & Wings, 2018).

Table 1: Climate disaster statistics for Pakistan based on EMDAT database<sup>2</sup> for the period 1989-2018

Disaster Type	Events Count	Total Deaths	Total affected (million people)	Damage (million US\$)
Drought	1	143	2.2	247
Extreme temperature	15	2759	0.08	18
Floods	75	11 104	64.3	19 911.3
Storm	18	1 424	2.2	1 710.9

1 The Germanwatch Global Climate Risk Index is an analysis based on one of the most reliable data sets available on the impacts of extreme weather events and associated socio-economic data. However, the index must not be mistaken for a comprehensive climate vulnerability scoring. It represents climate-related impacts and associated vulnerabilities but, for example, does not take into account important aspects such as rising sea-levels, glacier melting or more acidic and warmer seas. <https://germanwatch.org/en/cri>

2 <https://www.emdat.be>

## 1.2 Projections on climate impacts comparing 1.5°C and temperature increase under current pledges

If global mean temperature would increase by 3°C above pre-industrial levels, which corresponds to the warming that would result from the current NDCs, flood risks and heat extremes project a significantly higher increase than in a 1.5°C warmer world. Projections for heat extreme show that temperatures might reach up to more than 46°C in a 3°C warmer world, bearing severe implications for the population having no access to appropriate cooling facilities or outside activities and labour.

*Table 2: Future projections of different climatic variables averaged over Pakistan, based on an ensemble of CMIP5 Global Climate Models for 1.5°C and 3°C warmer than pre-industrial worlds <sup>3</sup>*

Indicator	Historical (1986–2015)	+1.5°C World (Paris Agreement)	+3.0°C World (Current NDCs)
<b>Annual Averages</b>			
Near-Surface Air Temperature (°C)	18.6	+1.5	+3.6
Precipitation (mm)	312.25	+2%	+12.2%
<b>Extreme Events</b>			
Drought: Consecutive drought days (Days)	95	+4.4	+2.1
Heat: Annual Maximum of Daily maximum Air Temperature (°C)	43	+1.2	+3.3
Flooding: Annual Maximum 5-day Consecutive Precipitation (mm)	59	+2%	+4.4%

*Table 3: Future projections of Sea Level Rise (cm) as compared to today's level for Pakistan based on the data from Robert Kopp et al. (2014). Average values of 1 tide gauged stations across Pakistan are presented. The values in the brackets in the left column are the temperature difference for each future scenario between the end of 21st century (2081-2100) and pre-industrial period (1850-1900)*

Sea Level Rise (cm)	2050	2100	2150	2200
RCP 2.6 (1.6°C)	24	50	71	96
RCP 4.5 (2.4°C)	25	60	95	128
RCP 8.5 (4.3°C)	28	81	136	199

Pakistan has a coastline, which makes it vulnerable to sea level rise (SLR) due to global warming. Paris Agreement limit of 1.5°C would result in substantially lower sea level rise than for higher levels of warming, in particular in the long run, with a sea level rise of around 2 meters instead of 1 m by the end of the 22<sup>nd</sup> century in a 4.3°C world compared with a 1.6°C warmer world (Table 3)<sup>4</sup>. Risks posed by

<sup>3</sup> The presented values are based on an ensemble of general circulation models (GCMs) from CMIP5 archive. Global Mean Temperature (GMT) increase of 1.5°C and 3°C above pre-industrial levels are derived for 20-year time slices with the respective mean warming for each model separately. The warming levels are derived relative to the historical period 1986-2005 and this period is considered to be 0.6°C warmer than pre-industrial levels (1850–1900). For definitions of extremes indicators, please see (Schleussner et al., 2016)

<sup>4</sup> Due to a lack in the scientific literature, we cannot yet provide projections for a 1.5°C scenario. However, global sea level rise by 2100 is about 10cm lower under a warming at 1.5°C compared to a 2°C scenario [IPCC 1.5°C Special Report]. Beyond 2100, only limiting warming to 1.5°C may limit global sea level rise to below 1m, at least 0.5m less than what a 2°C would entail.

tropical cyclones for Pakistan are projected to increase substantially. Under a 2.4°C scenario, the number of Category 4 and 5 cyclones will increase by about 130% (Bhatia, Vecchi, Murakami, Underwood, & Kossin, 2018). The severity of the tropical cyclone hazard will be further amplified by increases in extreme precipitation and sea level rise.

## 2 Socio-economic context

### 2.1 Economic background

Table 4: Overview on socio-economic characteristics and development over time (Pakistan)

Indicators on economic and human development		Source	2000	2010	Most recent (2017)
<b>Per capita income</b>	GDP/capita in current US\$	WB-WDI	534	1,040	1,548
	GDP/capita adjusting for purchasing power (in PPP, constant 2011 international \$)	WB-WDI	3,495	4,284	5,035
<b>Economic growth</b>	GDP growth rate per capita (annual, in %)	WB-WDI	1.9%	-0.5%	3.7%
<b>Human development</b>	Human Development Index (HDI)	UNDP	0.450	0.526	0.562 (Rank 150)
<b>Population</b>	Population in millions	WB-WDI	139	171	197

Notes: PPP – Purchasing Power Parity. GDP – Gross Domestic Product.

Sources: WB-WDI – World Bank World Development Indicators (The World Bank, 2019). UNDP – United Nations Development Program (United Nations Development Program, 2018a).

Pakistan has a population of almost 200 million people. The World Bank has classified it as a “lower middle-income country” since 2008. Between 2000 and 2017, Pakistan has almost tripled its per capita income (in US\$); adjusting for purchasing power it has increased its per capita income from below 3500 to over 5000 (PPP) (Table 4). After a period of slow or even negative economic growth rates (per capita), Pakistan’s per capita GDP growth has accelerated again in recent years with rates of above 2% since 2013 increasing to 3.7% in 2017 (The World Bank, 2019). Yet, with widening macroeconomic imbalances, the World Bank sees macroeconomic stability as a major concern for Pakistan’s near term economic future (The World Bank, 2018a).

Pakistan made progress in reducing poverty, decreasing the share of people living in extreme poverty (with less than 1.90\$ (2011 PPP) a day) from 28.6% in 2001 to 4% in 2015 (The World Bank, 2019). However, in 2015 still over 75% of the people in Pakistan lived on less than 5.50\$ (2011 PPP) a day, compared with over 93% in 2001 (The World Bank, 2019).

Between 1990 and 2017, Pakistan has increased its Human Development Index (HDI) value from 0.404 to 0.562, an increase of about 39% (United Nations Development Program, 2018b). Pakistan’s 2017 HDI is below the average of all countries in the HDI-category of ‘medium human development’, and also below the average for countries in South Asia (United Nations Development Program, 2018b). When Pakistan’s 2017 HDI value is discounted for inequality, it falls to 0.387, a loss of almost 31% due to inequality (United Nations Development Program, 2018b).

## 2.2 Energy System status and historic development

Table 5: Energy system indicators for Pakistan: current status and recent development

Energy system indicators		Source	2000	2010	Most recent	
					Value	Year
<b>Primary Energy intensity of the economy (energy / GDP)</b>	Energy intensity level of primary energy (MJ/\$2011 PPP GDP)	WB-WDI*	5.54	4.87	4.57	2017
<b>Carbon intensity of energy</b>	kg CO <sub>2</sub> per MJ energy use	WB-WDI	69.57	79.48	77.46	2014
<b>Carbon emissions per capita<sup>+</sup></b>	t CO <sub>2</sub> /population	EDGAR	0.78	0.89	0.92	2016
<b>Fossil fuel share in total energy</b>	Share in total primary energy (%)	WB-WDI	58.57	60.27	61.59	2014
<b>Electricity use</b>	Electric power consumption (kWh per capita)	WB-WDI	372.40	465.16	471.04	2014
<b>Fossil fuel share in electricity production</b>	Electricity production from oil, gas and coal sources (% of total)	WB-WDI	71.83	62.67	63.09	2015
<b>Share of coal in electricity production</b>	Electricity production from coal sources (% of total)	WB-WDI	0.35	0.09	0.14	2015
<b>Modern RE share in electricity production</b>	Electricity production from renewable sources, excluding hydroelectric (% of total)	WB-WDI	0.00	0.00	0.76	2015
<b>Renewable energy capacities</b>	Installed RE capacity (in MW)	IRENA				
	<i>Wind (onshore)</i>		0	0	792	2017
	<i>Wind (offshore)</i>		-	-	-	-
	<i>Solar (Concentrated)</i>		-	-	-	-
	<i>Solar (Photovoltaic)</i>		0	0	730	2017
	<i>Biogas</i>		0	0	9	2017
	<i>Bioenergy (Solid Biomass)</i>		216	254	365	2017
	<i>Hydropower</i>		4,978	6,743	7,407	2017
	<i>Geothermal</i>		-	-	-	-

Notes: \*Calculation of most recent value based on latest available WB-WDI data and growth rates from BP (BP, 2018). <sup>+</sup>CO<sub>2</sub> emissions do not include emissions from LULUCF. PPP – Purchasing Power Parity. GDP – Gross Domestic Product.

Sources: WB-WDI – World Bank World Development Indicators (The World Bank, 2019). IRENA – International Renewable Energy Agency Database (IRENA, 2019). EDGAR emissions database (JRC, 2016).



Total energy use in Pakistan has increased by 40% between 2000 and 2014 (The World Bank, 2019). In per capita terms however, Pakistan's energy use has increased only by about 5% between 2000 and 2014 and was only about a quarter of the world average in 2014 and only about 75% of the average lower middle income country energy use (The World Bank, 2019).

Pakistan has managed to substantially decrease the energy intensity of its economy between 2000 and 2017. However, the carbon intensity of energy has increased between 2000 and 2014, Pakistan's share of fossil fuel sources in total energy consumption has risen from below 59% in 2000 to almost 62% in 2014 (see Table 5).

Pakistan's CO<sub>2</sub> emissions per capita<sup>5</sup> have risen from 0.78 to 0.92 metric tons of CO<sub>2</sub> per capita between 2000 and 2016 (see Table 5), but remaining very low compared to the world's average of 4.8 tCO<sub>2</sub>/capita (JRC, 2016).

Between 2000 and 2014, electricity consumption per capita has only increased rather moderately in Pakistan. With 471 kWh per capita, Pakistan's electricity consumption remains comparably low, amounting to below 15% of the world's average per capita electricity consumption (3127 kWh/capita) and only 61% of the average electricity consumption of lower middle income countries (767 kWh/capita) in 2014 (The World Bank, 2019). The CIA World Factbook estimates that Pakistan's electricity consumption has risen to 478 kWh/capita in 2016 (CIA, 2019).

The share of fossil fuels in electricity production has decreased substantially from close to 72% to 63% between 2000 and 2015, and the share of coal in electricity production has remained at a low level, even decreasing slightly from 0.4% (2000) to 0.1% (2015), as oil and gas are the predominant fuels in Pakistan's energy mix. At the same time, the share of electricity produced from renewable sources (excluding hydro) has increased slightly from 0% in 2010 to 0.8% in 2015, yet remaining very low despite recent added capacities in wind (onshore), solar PV and also solid biomass. Hydropower capacities have almost doubled between 2000 and 2017 (see Table 5). Including hydro, the share of RE in total electricity output was 31.4% in 2015 (The World Bank, 2019).

Between 2000 and 2014, Pakistan achieved to decrease the share of electric output lost due to transmission and distribution losses from 24% to 17% (WDI). However, the World Bank estimates that power sector inefficiencies still cost Pakistan's economy around 18 billion USD or 6.5% of its GDP (The World Bank, 2018b).

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5 Excluding carbon emissions from land-use, land-use change and forestry.

## 2.3 Energy system and sustainable development – potential for benefits of a transition to renewable energy

Table 6: Indicators showing sustainable development implications of the current energy system and potential for benefits of a transition to renewable energy (co-benefits) (Pakistan)

Indicators for co-benefits potential		Source	Most recent	
			Value	Year
<b>Fuel import dependency</b>	Share of national income (GDP) spent on fuel imports (%)	WB-WDI +	4.5	2017
	Public expenditures spent on fuel imports (in billion current US\$)	WB-WDI +	13.8	2017
<b>Reliability of electricity supply</b>	Share of firms experiencing electrical outages (%)	WB WDI	81.1	2013
	Power outages in firms in a typical month (number)	WB WDI	75	2013
	Share of sales lost for firms subject to power outages (%)	WB WDI	33.8	2013
<b>Access to modern energy</b>	Share of population with access to electricity (in %)	WB WDI	99.1	2016
	Share of rural population with access to electricity (in %)	WB WDI	98.8	2016
	Share of urban population with access to electricity (in %)	WB WDI	99.7	2016
	Share of primary schools with access to electricity (in %)	SDG-database	NA	NA
	Share of population with access to clean fuels or technologies for cooking (in %)	WB WDI	43.3	2016
<b>Indoor air pollution and health impacts</b>	Number of deaths attributed to indoor air pollution* (per 100 000 inhabitants)	SDG-database	101	2016
<b>Outdoor air pollution and health impacts</b>	Share of population exposed to levels of fine particulate matter (PM 2.5) exceeding WHO guidelines (in %)	WB WDI	100.0	2016
	Number of deaths attributed to ambient air pollution* (per 100 000 inhabitants)	SDG-database	98	2016

Note: \*age standardised mortality rate of WHO. +Own calculations based on WB-WDI. GDP – Gross Domestic Product. WHO – World Health Organisation.

Sources: WB WDI – World Bank World Development Indicators (The World Bank, 2019). SDG-database -Sustainable Development Goals data base (United Nations, 2019).

Facing limited possibilities to expand domestic natural gas production, Pakistan has to meet gas demand by imports. In 2016, it signed a long-term (15 years) import agreement with Qatar on annual liquified natural gas (LNG) imports (IRENA 2018). Additionally, almost one third of Pakistan's oil demand needs to be met by imports (IRENA 2018). The substantial decrease in international oil prices in recent years has contributed to Pakistan's success in improving its economic situation, but with natural gas and oil

being the predominant energy sources in its fuel mix, this increasing import dependency is not only a budgetary burden, it also exposes Pakistan to the risks of price volatility on international markets (IRENA - International Renewable Energy Agency, 2018). In 2017, Pakistan has spent about 4.5% of its GDP on fuel imports, amounting to public expenditures of about 13.8 billion USD (see Table 6). A transition to renewable energy could contribute to reducing energy security concerns and public expenditures on fossil fuel imports freeing resources for other investments.

The unreliability of electricity supply is very a serious issue in Pakistan, affecting private households as well as businesses and industry. Electricity supply falls far short of electricity demand with a demand-supply-gap of about 6 GW in 2016 (IRENA 2018), leading to serious load shedding issues. In many regions electricity supply is limited to only a few hours a day (Wakeel & Jahangir, 2016). Over 80% of businesses in Pakistan report to have been affected by power outages in 2013, with on average 75 outages every month (see Table 6). These firms are estimated to have about a third of their sales (33.8%) due to the outages.

While official data on the share of population with access to modern energy suggest that Pakistan had almost full coverage in 2016 (around 99% of the population), the IEA energy access database<sup>6</sup> estimates the share to be only around 73.6% in 2016 (63.2% in rural areas and 89.6% in urban areas), leaving about 50.9 million people without access to electricity. Given the poor quality and reliability of electricity supply, also many households with access to electricity still suffer from energy poverty.

In 2016, the share of people with access to clean cooking fuels was still officially 43.3%, leaving more than four fifths of the population exposed to health hazards from indoor air pollution due to the burning of traditional biomass inside of dwellings. Accounting for age structure, about 101 out of every 100 000 inhabitants in Pakistan die due to indoor air pollution. The World Health Organisation (WHO) estimated the number of deaths attributed to indoor air pollution in Pakistan to amount to over 127 000 in 2016 (World Health Organisation, 2018).

Outdoor air pollution is also a serious health concern in Pakistan, especially in urban areas. In 2016, all of its population was exposed to fine particulate matter concentration levels exceeding recommended limits by the WHO. The number of deaths attributed to outdoor air pollution in Pakistan is estimated to amount to about 121 000 in 2016 (World Health Organisation, 2018) – with about 98 out of 100 000 inhabitants dying because of outdoor air pollution.

### 3 Policies and projections on future development

In its NDC Pakistan states that its GHG emissions are expected to increase by 300% between 2015 and 2030. It commits to reduce its 2030 emissions by 20% compared with this scenario. This is conditional on availability of international grants “to meet the total abatement cost for the indicated 20 percent reduction amounting to about US\$ 40 billion at current prices” (The Government of Pakistan, 2015).

Pakistan’s electrification rate in 2016 was 99.15%, with 99.67% of the urban population and 98.81% of the rural population having access to electricity (ESMAP, 2019). Electricity in Pakistan is generated in roughly equal shares from natural gas, furnace oil and hydropower (Perwez, Sohail, Hassan, & Zia, 2015). To increase the share of other sources of energy in 2006 it adopted Alternative and Renewable Energy Policy 2006, which led to the initiation of renewable energy infrastructure projects (IRENA, 2018).

In 2015, NEPRA (National Electric Power Regulatory Authority) approved the implementation of a net metering program, which will allow for solar and wind generators to sell produced electricity back to the national grid, provided the generators have a capacity of less than 1MW. Residential, commercial and industry owners that meet these standards are eligible to engage in the scheme (NEPRA, 2015). The

6 <https://www.iea.org/energyaccess/database/>

State Bank of Pakistan also released a financing scheme in 2016 that will finance renewable energy projects with a capacity of between 1MW and 50MW. Up to 100% refinancing of debt is available through the project (State Bank of Pakistan, 2016).

#### BOX: relevant key policies related to energy supply sector

- **Nationally Determined Contribution:** A target of reducing the projected GHG emissions in 2030 by 20%, conditional on financial support in the range of USD 40 billion necessary to finance the costs of achieving this target (The Government of Pakistan, 2015).
- **Net metering:** instituted a net metering program to allow renewable energy generators smaller than 1 MW to sell their energy into the national grid at the average off peak rate (NEPRA, 2015).
- **Financing Scheme for Renewable Energy:** Financed by the State of The State Bank of Pakistan it is available for projects between 1-50 MW (State Bank of Pakistan, 2016).
- **Auctions for wind and solar:** The auctions introduced in 2016 replaced the fixed feed-in tariffs. So far a limited number of auctions took place (PVTech, 2017).

## 4 Projections on planning for coal

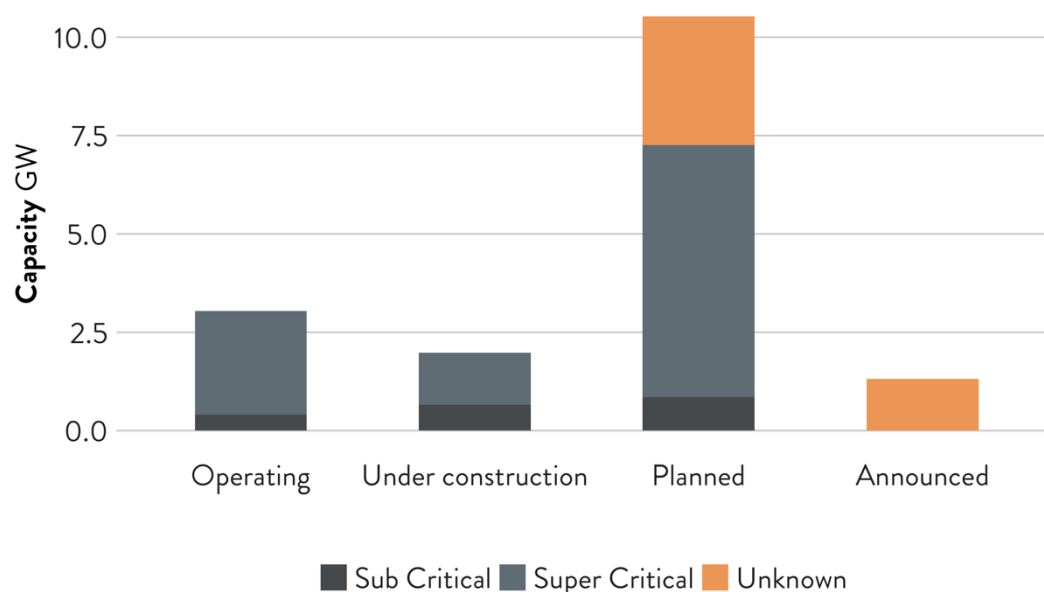
Pakistan is undertaking a major expansion of electricity generation capacity to meet growing demand, as energy access progresses. However, despite price advantage and domestic availability of renewable energy resources, current expansion plans favour fossil fuels based generation, and include a massive growth in coal capacity. Current plans for construction of polluting power plants relying on fossil fuel imports poses a number of problems going forward. Growing emissions and other externalities associated to coal will increase substantially under current plans, exacerbating Pakistan's vulnerability to climate change impacts. Moreover, the current energy planning put Pakistan on a path to deepening its over-reliance on imported fossil fuels, which bring significant risks to the national economy in the context of its weakening currency, growing current account deficit, declining foreign exchange reserves and escalating circular debt, thus reducing its energy security (Nicholas & Buckley, 2018).

#### Focus: Planned generation capacity additions

The most recent State of the Industry Report from the National Electric Power Regulatory Authority (NEPRA) includes a summary of planned generation capacity additions out to 2025. Pakistan plans to add 35.9 GW of generation capacity, of which over 30% is coal-fired capacity, until 2025.

## COAL FLEET IN PAKISTAN

### POWER PLANT CAPACITY BY STATUS AND TECHNOLOGY



SOURCE : PLATTS WEPP GCPT

Figure 1: Pakistan's coal fired power generation capacity

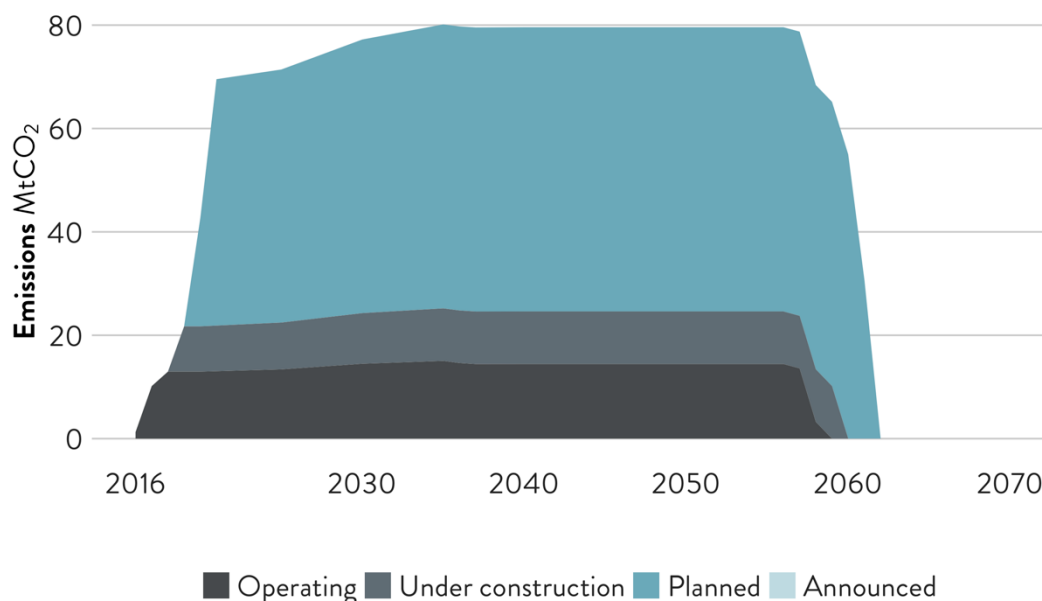
Historically, coal-fired power has played a minor role in Pakistan's power system but this is set to change in the future. Pakistan's coal expansion plans amount to nearly 236% of the current capacity<sup>7</sup> (Figure 1). This expansion accounts for over 3% of the global total. Nearly all the existing capacity is super-critical, with relatively lower emission intensity. Over 60% of the units which are under construction, or planned are super-critical.

The committed emissions from coal-fired power plants are likely to peak only by 2055, with an eventual phase-out only by 2061, reflecting the large expansion status relative to the existing capacity (Figure 2). This far exceeds any Paris Agreement compatible pathway for the energy sector as discussed in Chapter 3, which requires South Asia countries to phase out coal-fired power by 2040 at the latest.

<sup>7</sup> Here, we define current capacity as total operating capacity + capacity under construction, and to expansion plans as planned capacity (permitted and pre-permitted units that have not started construction) + announced capacity.

## COAL PLANT EMISSIONS IN PAKISTAN

ORDERED BY STATUS



SOURCE : OWN CALCULATIONS BASED ON PLATTS WEPP , GCPT

Figure 2: Committed emissions from Pakistan's coal plants

## 5 Transition to renewable energy – pathway characteristics, benchmarks, options, potentials, benefits

### 5.1 Potential and technology options for renewable energy

#### Potentials and costs

Pakistan has relatively good solar potential, with many regions receiving higher than 6 kWh/m<sup>2</sup> of Global Horizontal Irradiance on an average daily basis as shown in Figure 3. Covering 1.5% of Pakistan's land area with optimally oriented PV panels could potentially generate 3011 TWh of electricity, which is equivalent to 32 times the total consumption of electricity in 2016 (BP, 2018; NREL, 2014). The Southwestern region of Pakistan also offers significant wind potential, with average wind power densities greater than 600 W/m<sup>2</sup>. However, the utilisation of these resources is limited in Pakistan, with installed capacities of 400 MW (Solar) and 785 GW (Wind) in 2017 (NEPRA, 2018). These represented a mere 1.5% and 3% of the total installed capacity respectively.

Scenarios for Pakistan in the OneEarth framework (combined in a sub-region with Afghanistan, Nepal and Bhutan) (Teske et al., 2019) show renewable electricity shares reaching 73% and 88% in 2030 and 2050, respectively. For the non-OECD Asia region as a whole, significant increases in energy efficiency allow the decarbonisation of the entire energy system. For example, final energy consumption in the transport sector declines by nearly 50% in 2030 compared to a business-as-usual scenario, and even further by 2050. Whereas petroleum products still make up the majority of transportation energy by 2030, the transition to a split between electricity and biofuels takes place by 2050. In the heating sector a mix of energy sources including biomass, electricity, geothermal heat pumps and direct solar heating are used to achieve 100% renewables by 2050. Both of these sectors demonstrate as well the synergies



found in moving to renewable electricity, which can then also be used for transportation and heat supply.

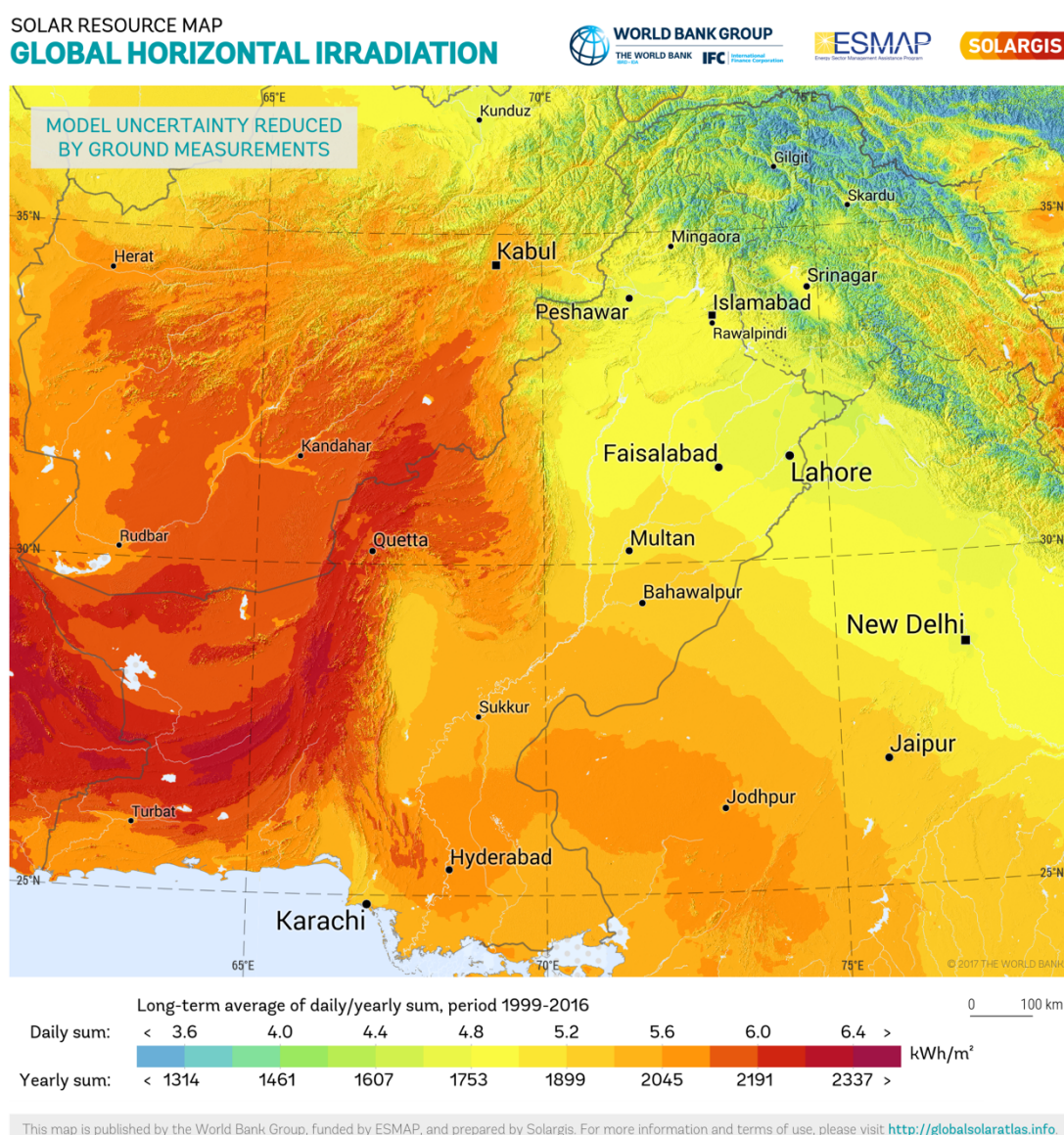


Figure 3. Global horizontal irradiation based on Global Solar Atlas (The World Bank Group, 2016)

The Lappeenranta University of Technology (LUT) model (Sadiqa, Gulagi, & Breyer, 2018) achieves 100% renewable energy for Pakistan and the region. In the case of Pakistan, the model also considers linking the power sector to desalination and industrial gas production. As is the case with all of their studies, the LUT group finds lower costs for the electricity in the future system than the current one; in the OneEarth model electricity generation costs initially rise on the 100% renewable pathway, although less quickly than for business-as-usual, before falling again somewhat by mid-century.

## 5.2 Reaping opportunities of transitioning to renewable energy: Implications for local jobs and affordability of energy

While there are no IRENA estimates of benefits from an energy transition in Pakistan, renewable energy can contribute to addressing several of the socioeconomic challenges it is facing.

Investing in renewable energy capacities can contribute to strengthening energy independence, leading to lower expenditures on fossil fuel imports, less susceptibility to international market price fluctuations or geopolitical shocks.

The decentralised nature of many renewable energy technologies can moreover foster progress with regard to reliable energy access, addressing load shedding problems and eradication of energy poverty.

Improving access to clean technologies for cooking also contributes to reducing indoor air pollution and related health hazards. Outdoor air pollution could be reduced as well by shifting away from fossil fuel combustion.

Moreover, renewable energy technologies provide opportunities for local employment.

## 6 Gap analysis: targets, projections, and Paris Agreement benchmarks

Pakistan's NDC commits the country to a 20% reduction in emissions below Business-as-Usual emissions by 2030.

According to government reports, Pakistan's objectives for the power generation sector include reduced dependence on imported fossil fuels, increased use of renewable energy, diversification of fuel resources, and security of fuel supply. The current massive expansion of coal-based power generation stands in stark contrast with all these objectives.

Pakistan has a dedicated ministry of climate change, which recently has fulfilled its commitment under Bonn Challenge<sup>8</sup> of planting one billion trees in one of the provinces, and the government is undertaking another ambitious plan of planting 10 billion trees across the country, taking pride in the fight against climate change. Simultaneously however, it is planning to increase the share of fossil fuels in its energy mix manyfold, hence undermining all its climate friendly initiatives.

An analysis of a Paris Agreement consistent pathway for Asia shows that 75% share of power generation needs to be decarbonised by 2030, with full decarbonisation by 2050. Scenarios for Pakistan and the region show that a pathway towards 100% renewable energy is achievable, including a decarbonised energy system through electrification of end use sectors, direct use of renewable energy for heat, and linking the power sector with desalination and industrial gas production.

There is thus significant scope for enhanced NDC ambition and developing an ambitious long-term strategy towards 100% renewable energy power generation and electrification of end-use sectors, to align Pakistan's energy future with the goals of the Paris Agreement and reap benefits for sustainable development.

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<sup>8</sup> See <http://www.bonnchallenge.org/content/challenge>



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