Ministry of Climate Change

Emissions and Costs Modelling for Pakistan (EnerNEO Pakistan)

Final report

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Contents

1. SUMMARY OF THE ASSIGNMENT 4

2. OUTLOOK ON ENERGY AND GHG EMISSION TRAJECTORIES IN PAKISTAN 6

2.1. Historical data and trends 6

2.1.1. General overview of energy systems 6

2.1.2. General overview of agriculture, forest and food 12

2.2. GHG emission scenarios to 2050 16

2.2.1. Scenario definitions 16

2.2.2. Overview of modelling approach 19

2.2.3. Main scenario results 19

3. CAPACITY BUILDING MISSION TO PAKISTAN 25

3.1. About the mission 25

3.2. High-level workshop 25

3.3. Technical training 27

3.4. Perspectives and next steps 30

1. Summary of the assignment

Following several technical assistance assignments since 2017, including the development and transfer by Enerdata of an energy/GES emission prospective model, the AFD is continuing its support to the Government of Pakistan regarding the modelling of GHG emissions and the strengthening of the analysis of potential reductions and the assessment of their costs. To this end, Enerdata and Solagro deployed an approach which allowed to develop a comprehensive, full-GHG-coverage and decision-aid oriented modelling framework. The GCISC and the MoCC were identified as the main Pakistani stakeholders for this assignment. The project started in the summer of 2020, and is expected to be closed by February 2023, following a closing mission to Pakistan, with the capacity building component.

The objective of this assignment is to deliver a full model covering all GHG emissions, including those from agriculture, land use and forest. In addition, the model has been enhanced to allow for the determination of Marginal Abatement Cost Curves (MACCs), a powerful tool to assess mitigation efforts in the individual sectors of the economy. A set of 3 scenarios have been co-constructed by Enerdata and Solagro in close cooperation with Pakistani stakeholders. These scenarios consist in a Business As Usual scenario, a Stated Policies Scenario and a Mitigation scenario. The main outputs include detailed energy and GHG emissions balances over the time horizon of the model (2050), for each scenario, and an associated cost analysis of the available emission reductions across these scenarios. The last objective will be to ensure capacity buildings with Pakistani stakeholders, through a dedicated on-site mission planned for the end of January 2023.

Enerdata (consortium leader) has been responsible of the development of the EnerNEO tool, which enables to model energy systems and associated GHG emissions, to include the results of agriculture & LULUCF emission trajectories, and to produce MACCs. Solagro has been responsible of producing various pathways for AFOLU sectors and emissions, using their MOSUT tool. The overall coordination has been overseen by Enerdata, in close collaboration with the AFD and the GCISC.

Figure 1. Overview of the main project phases

The main successive phases of the project can be summarized as follows:

- Scenario definition: phase aiming at writing storyline and setting objectives for each scenario. Corresponding work included collecting existing and stated policies, objectives, measures, in strong collaboration with Pakistani authorities
- Data collection: update or collection of historical data for final energy consumption in each sector, for power sector, oil/gas/coal production, agriculture & LULUCF, and all GHG emissions data. Projections for GDP, population, value added by sector, surfaces, vehicles sales and other energy consumption drivers have been collected as well. Where data point or series were missing, relevant estimations were produced to fill the gaps.

- Production of the scenarios: based on the up-to-date models, with updated input datasets, Enerdata and Solagro have respectively produced the scenarios of the study. The models were indeed calibrated to match the scenario definitions, with feedback loops between scenario calibration and comments from the Pakistani counterparts, to obtain a final validated version of the three scenarios.
- Production of MACCs: GHG emission reduction costs have been assessed through the development of MACCs (marginal abatement costs). EnerNEO was adapted with a new interface allowing to simulate the energy systems with different CO_2 price trajectories, enabling to create sectoral MACCs, from a baseline scenario and with user-defined parameters for steps, etc.
- Analysis: a final report in the form of a slide deck has been produced, describing the results of the 3 scenarios, on all aspects of these: energy systems, agriculture and LULUCF, GHG emissions, economic and cost analysis. Some main elements from this full analysis are presented in section 2.2.3 of the present report. Iterations between calibration of the scenario and analysis have been performed to ensure alignment between the consortium, the AFD and the GCISC.
- Capacity building: an on-site training will be conducted as part of the final mission of the project, planned for the end of January 2023. The aim will be for members of the GCISC to understand the methodology of the EnerNEO model, and be able to produce their own scenarios autonomously using the tool afterwards. A proposition of planning for the capacity planning is presented in section **Erreur ! Source du renvoi introuvable.**.

2. Outlook on energy and GHG emission trajectories in Pakistan

2.1. Historical data and trends

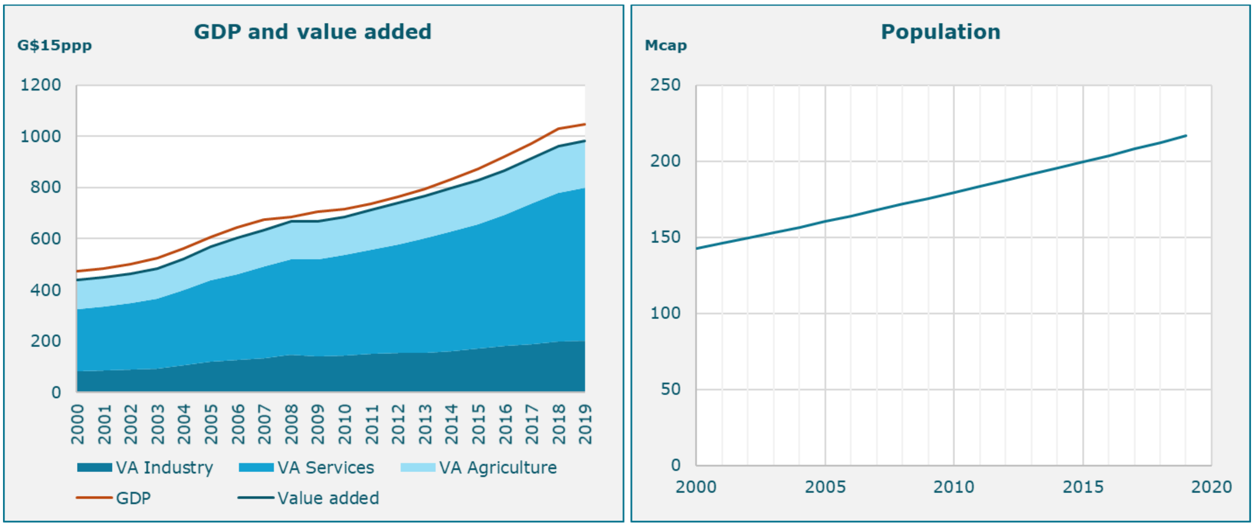
2.1.1. General overview of energy systems

Note: in this section, unless specified, all data come from Enerdata's "Global energy & CO2 database".

2.1.1.1. Macroeconomic drivers

The GDP of Pakistan is growing rapidly (4.3%/year over 2000-2019) and reached 1048 $G\$_{15ppp}$ in 2019. The service sector represents 61% of the total value added, while industry and agriculture respectively account for 21% and 18%. The population is also increasing fast: it reached 217 million in 2019 (+2.2%/year since 2000).

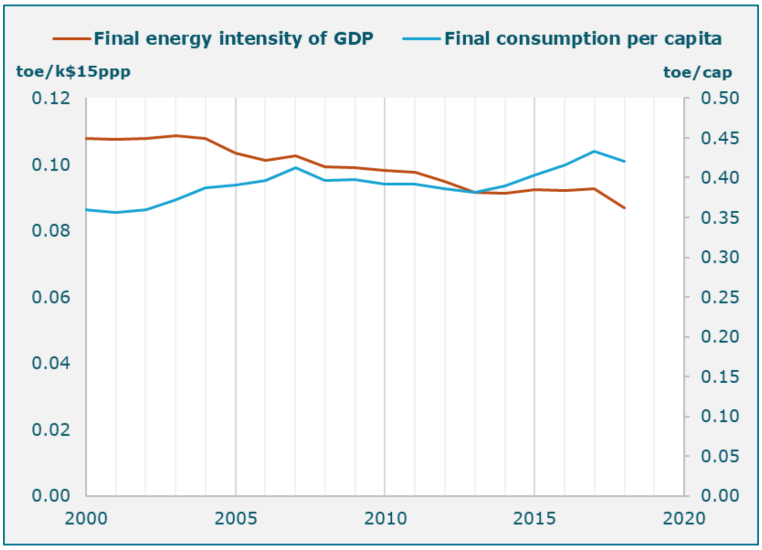
Figure 2. GDP and sectoral value added (left) and demography (right)



2.1.1.2. Final energy demand

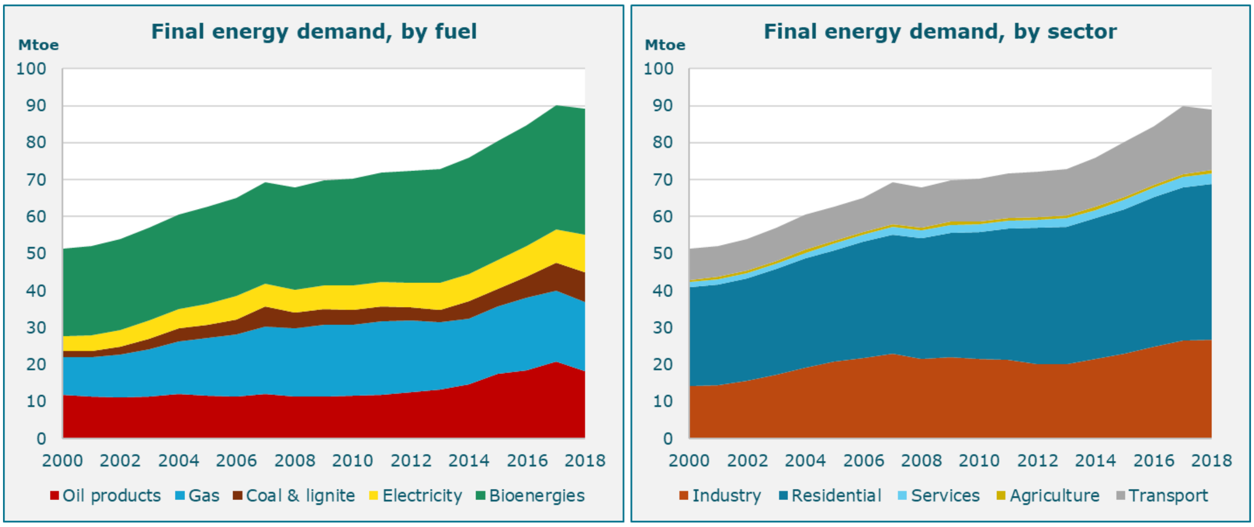
Final energy consumption per capita has been increasing at a rate of 1%/year over the past five years but remains low with about 0.42 toe/cap in 2018. The final energy intensity of GDP is decreasing (-1.2% since 2000) and reached 87 toe/M$_{15ppp}$.

Figure 3. Final energy intensity of GDP and final consumption per capita



The final energy mix is dominated by biomass (38%), followed by oil products (21%) and gas (21%). Electricity accounts for only 11%, and coal and lignite for 9%. Biomass is slowly losing market share (-8 pts since 2000). Over the same period, electricity and coal and lignite gained 3 pts and 6 pts, respectively.

Figure 4. Final energy consumption, by fuel (left) and by sector (right)



The residential sector accounts for almost half of the final energy consumption (47% in 2018). Industry (including non-energy uses) represent 30%, transport 18%, while services and agricultural buildings represent only 3% and 1%, respectively.

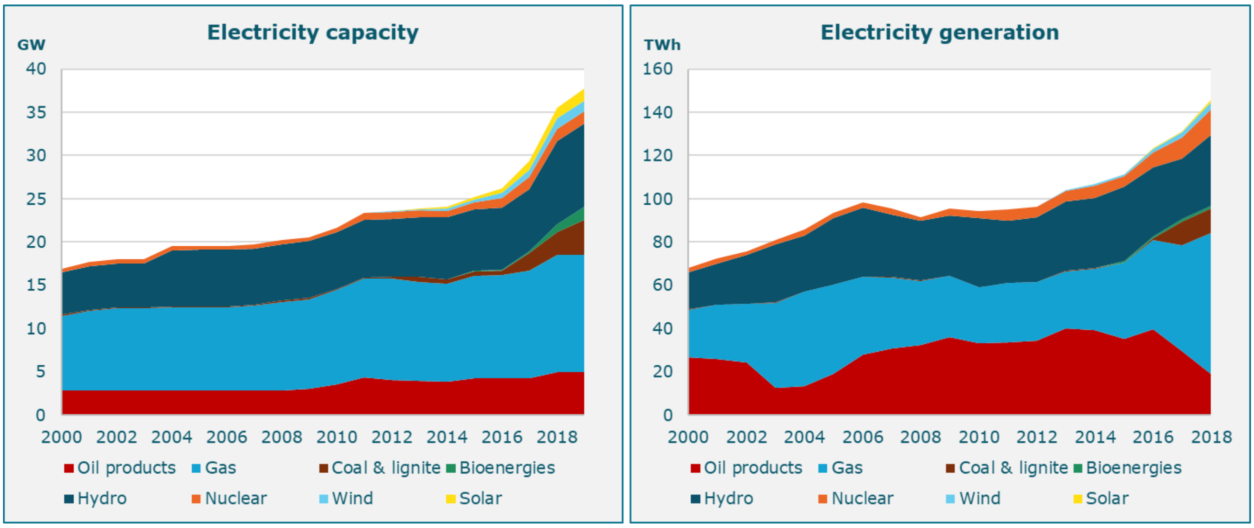
Biomass is mostly consumed by households (89%), and transport absorbs most of the oil products (81%). Coal is almost exclusively consumed by industry. The residential sector is the largest electricity consumer (51%), followed by industry (26%) and services (14%).

2.1.1.3. Electricity generation

The power generation capacity was increased by over 55% in 5 years, reaching 38 GW in 2019 from 24 GW in 2014. These important capacity additions are part of an effort to reduce the power shortages, which were partly due to insufficient generation capacity.

Gas-fired power plants account for 36% of the total capacity, followed by hydroelectric plants with 26%, oil-fired plants with 13% and coal-fired plants with 11% (end of 2019). Biomass, nuclear, wind and solar each account for between 3.3% and 4.0%.

Figure 5. Electricity capacity (left) and electricity generation (right)

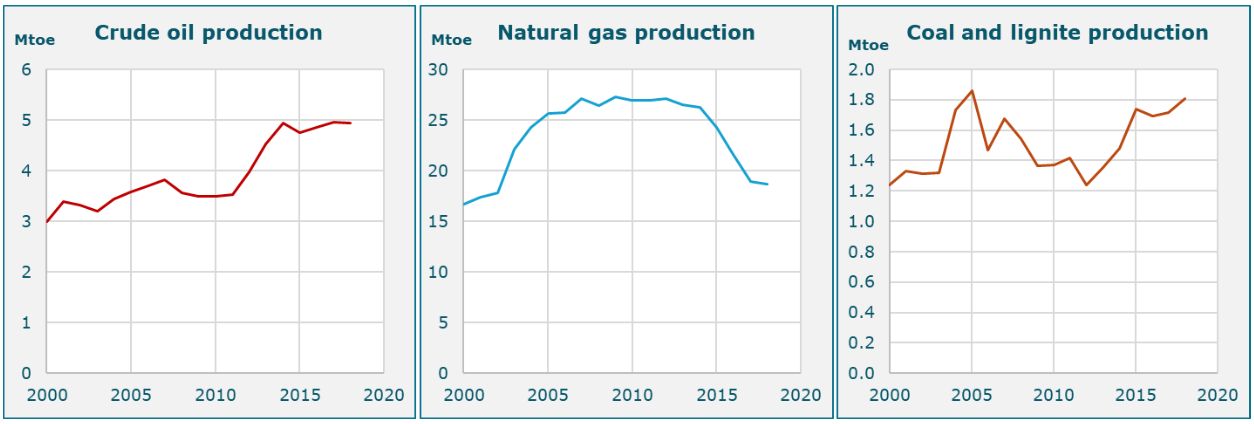


Electricity generation also increased strongly in the past few years and reached 146 TWh in 2018. The share of oil-fired generation has dropped since 2016 due to a better availability of imported gas for power generation thanks to new LNG import infrastructure. Beforehand, gas-fired power plants were frequently burning fuel oil to run due to gas supply shortages. In 2018, gas-fired generation represented 44% of the total, followed by hydro (23%), oil (13%), coal and lignite (8%), nuclear (8%), wind (2%), biomass (1%) and solar (1%).

2.1.1.4. Primary energy supply

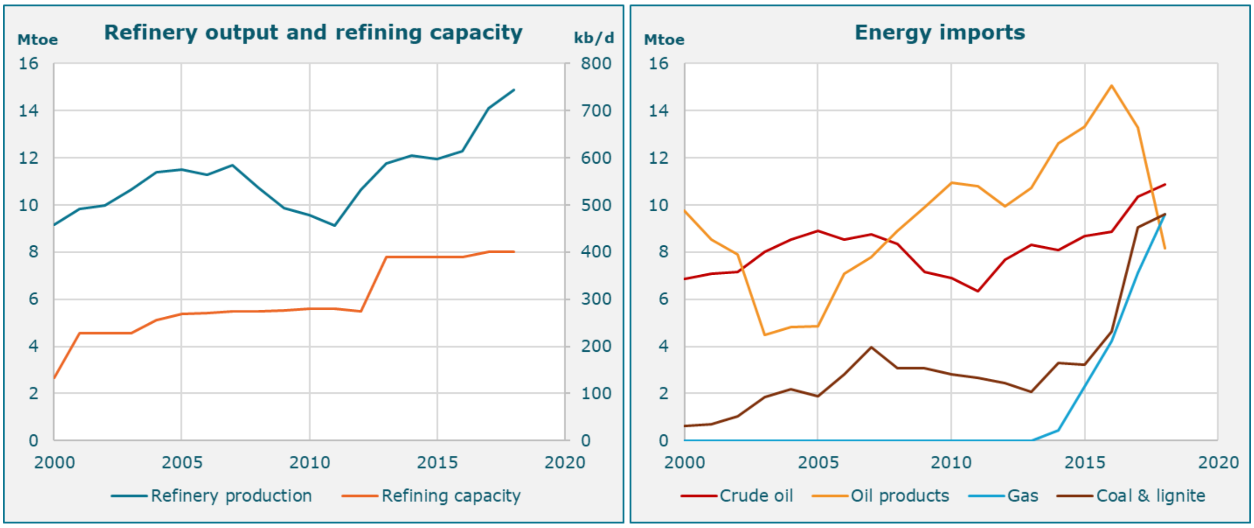
The country produced around 5 Mtoe of crude oil in 2018 (stable since 2014), 19 Mtoe of natural gas (significantly lower than its plateau level of about 27 Mtoe over 2005-2014) and 1.8 Mtoe of coal and lignite.

Figure 6. Domestic production of crude oil (left), natural gas (center) and coal & lignite (right)



The domestic refining capacity reaches 401 kb/d, with the last large increase in 2013 (+115 kb/d). In 2018, a total of 15 Mtoe of oil products were produced from domestic refineries. This figure corresponds to a large increase in 2017 and 2018 from the 2012-2016 level around 12 Mtoe.

Figure 7. Refinery output and capacity (left) and energy balance of trade (right)

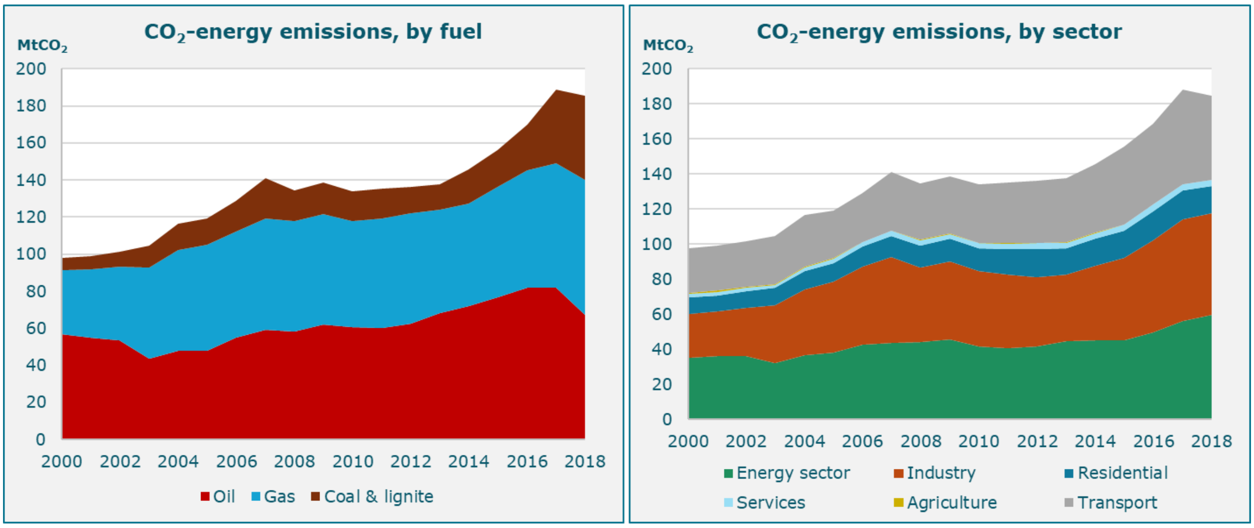


The country is a net importer of oil, gas and coal. Crude oil imports are progressively rising since 2012 and amounted to 11 Mtoe in 2018. Oil products imports contracted to 8 Mtoe in 2018 from 15 Mtoe in 2016, partly due to increased production from refineries, and from a decrease in energy consumption. Gas imports started in 2014, in the form of LNG, following the commissioning of LNG import terminals. Since then, these imports have surged steadily to reach 10 Mtoe in 2018. Coal and lignite imports have more than doubled since 2015, in order to supply the newly constructed coal-fired power plants. They reached 10 Mtoe in 2018.

2.1.1.5. GHG emissions from energy systems

CO_2-energy emissions (i.e. CO_2 emissions from fuel combustion) have increased significantly between 2013 and 2017 and reached 185 $MtCO_2$ in 2018. Gas is responsible for 39% of the total, followed by oil with 36% and coal & lignite with 24%. The share of coal & lignite surged over the past 5 years by 14 pts, driven by increasing coal- and lignite-fired power generation.

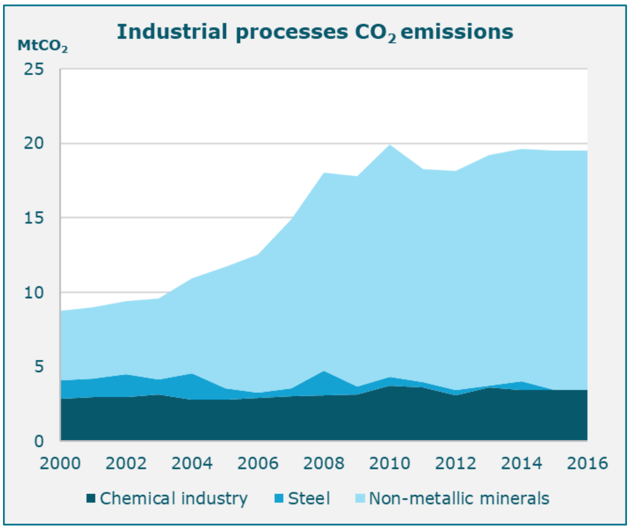
Figure 8. CO_2-energy emissions by fuel (left) and by sector (right)



The energy sector (including electricity) accounts for 32% of the CO2-energy emissions, closely followed by industry with 31%, and transport with 26%. Buildings represent 11% of the emissions.

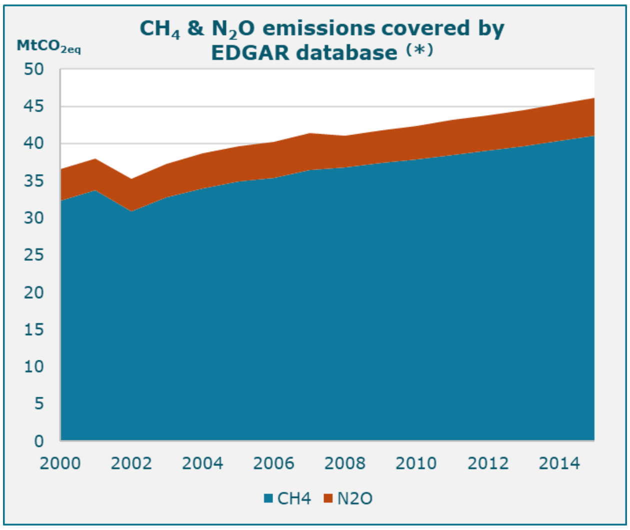
CO_2 emissions from industrial processes amounted to roughly 20 $MtCO_2$ in 2016, most of which are associated to the non-metallic minerals subsector: 16 $MtCO_2$, while chemical industry accounted for the remaining 3.4 $MtCO_2$.

Figure 9. Industrial processes CO_2 emissions



The following figure shows the CH_4 and N_2O emissions covered by the EDGAR database [1]and relative to energy systems and industrial processes. These will be completed with national data and/or estimations to reach a full EnerNEO GHG coverage.

Figure 10. CH_4 & N_2O emissions covered by the EDGAR database



[1] https://edgar.jrc.ec.europa.eu/overview.php?v=50_GHG

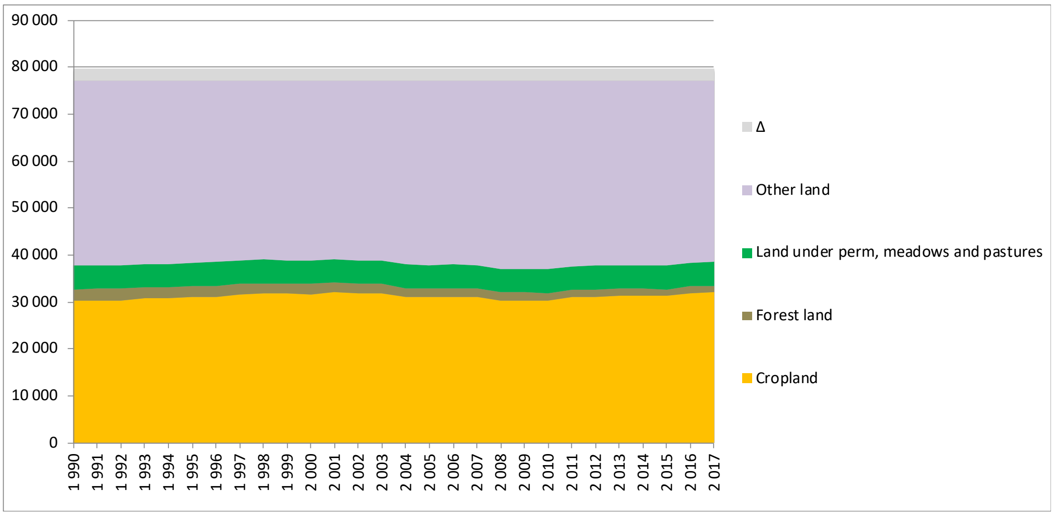
2.1.2. General overview of agriculture, forest and food

Note: for this section, all the data come from FAOSTAT, year 2018 or mean 2016-2018 when relevant, unless specified.

2.1.2.1. Land use

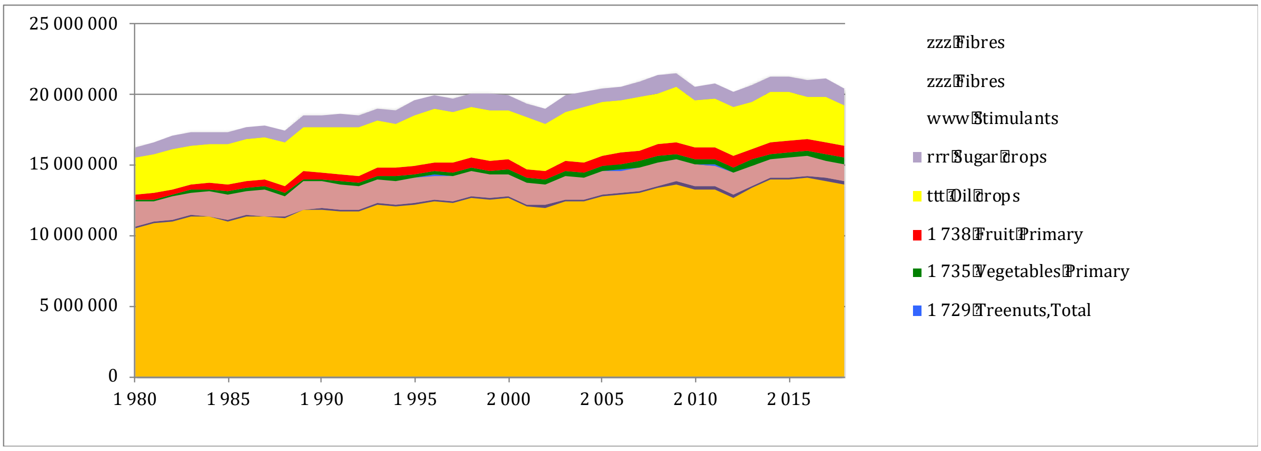
The total area of Pakistan is 796 000 km2, i.e. 80 million hectares. It is divided between 40% of cropland (32 Mha), 6% of permanent pasture and meadows, 5% of forest, and 49% of “other land” (natural areas as mountains, bush, urbanized areas, etc.). Cropland area slightly increases by 0.1% per year (+47 kha/year), as forest land decrease (-42 kha/year).

Figure 11. Land use (kha)



Cultivated area grows by 85 kha/year and reaches 21 Mha. Agriculture production is dominated by cereals in terms of surface (13.7 Mha: wheat 8.8 Mha, rice 2.8 Mha), cotton (2.4 Mha), sugar cane (1.1 Mha).

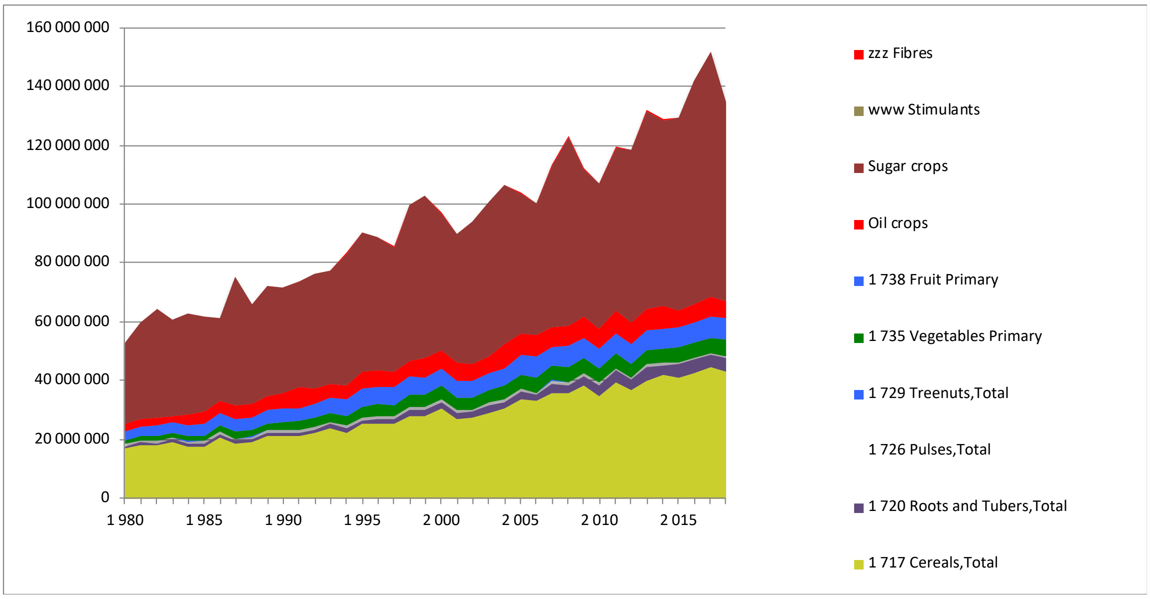
Figure 12. Cultivated areas (kha)



2.1.2.2. Agricultural production

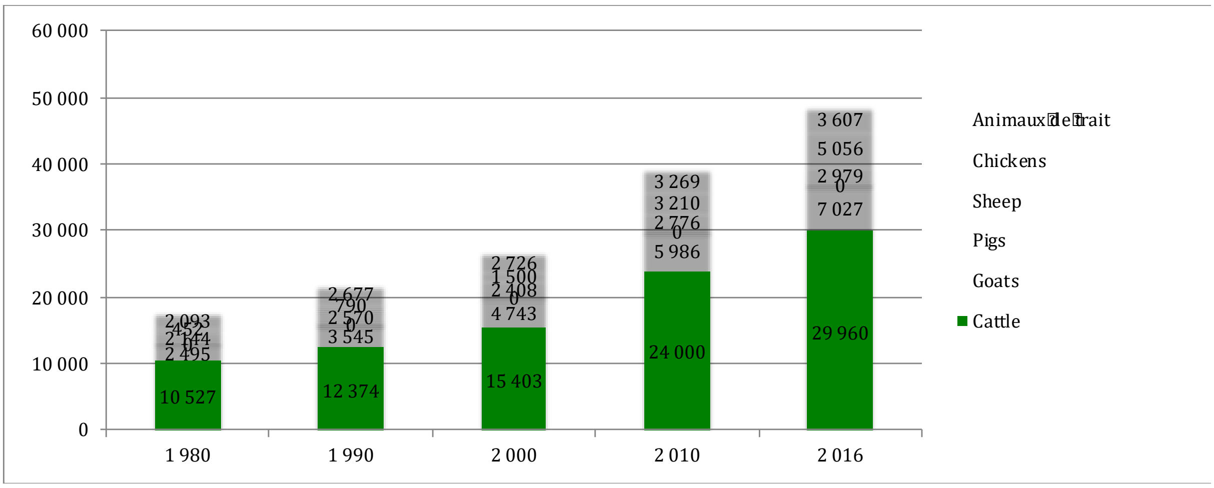
The main productions are sugar cane (67 Mha), cereals (43 Mt: 25 Mt wheat, 11 Mt rice, 6 Mt corn), cotton (5 Mt), fruits (7 Mt: mango, orange...), vegetables (5 Mt: onion...), roots (5 Mt: potato...). The yields are globally increasing, by about 39% between 2000 and 2016: +42% for the cereals, +43% for sugar cane, +10% for cotton, and more or less stability for most other productions. The yields for wheat are about 28 quintals/hectare.

Figure 13. Production (t)



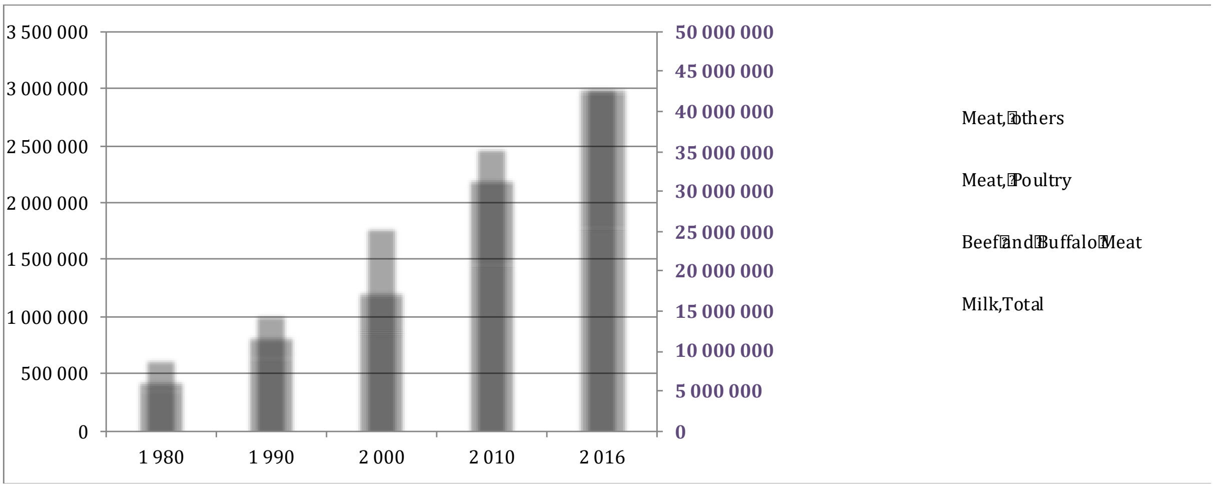
The breeding includes 46 millions of cattle heads, 39 million buffaloes, 74 million goats, 30 million sheep, and 7 millions of working animals (camels, asses, donkeys, horses, mules). The poultry is mainly made up of chicken farms with 530 million heads. Expressed as LU (livestock Unit), the size of the herd passed from 24 to 45 millions LU from 2000 to 2016.

Figure 14. Livestock unit (k)



The production of meat increased from 1.7 to 2.5 Mt, and the milk from 26 to 43 Mt.

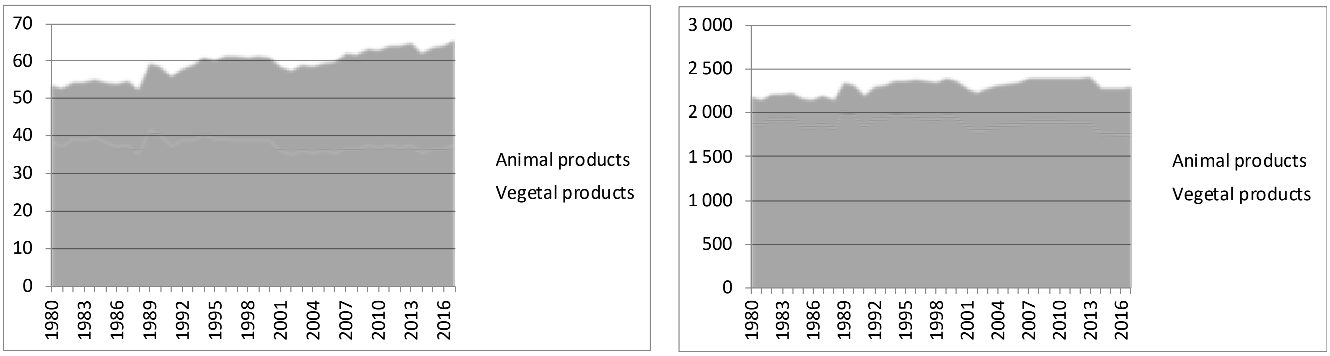
Figure 15. Meat and milk production (t)



2.1.2.3. Food balance and supply balance

The food supply is 2326 kcal per day and per capita. This value is stable. Animal proteins represent 42% on a total of 66 grams per day and per capita of protein intake. These values were respectively 36% and 62 g in 2000. The increase of protein intake is entirely due to animal products.

Figure 16. Protein (g, left) and energy (kcal, right) intake per day and per capita



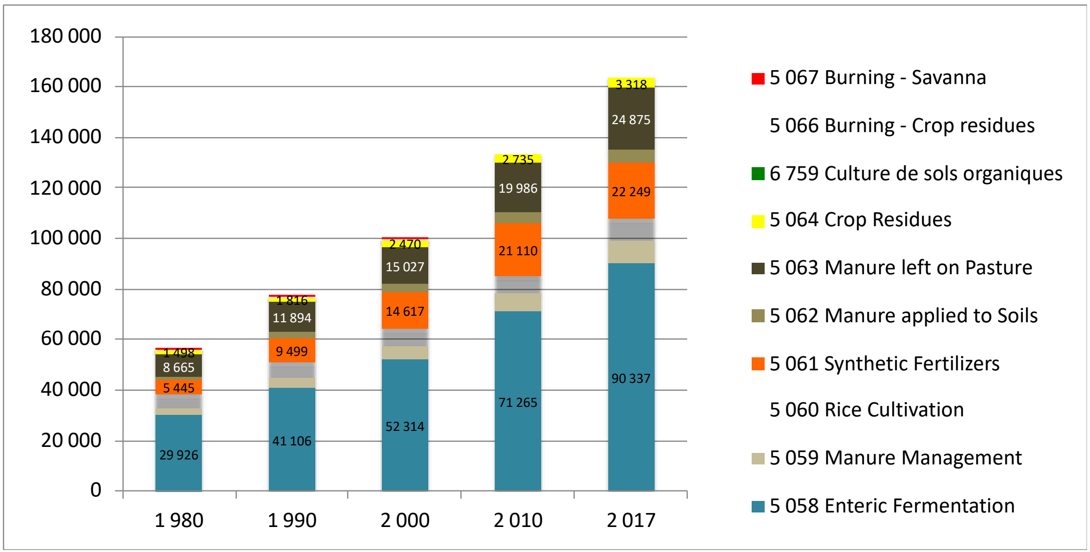
Expressed in energy value (kcal), the agricultural production of the country increased by 62%, the food needs by 37%, the feed needs by 130%, exportations by 178% and importations by 336%. The coverage rate of the county decreased from 94% in 2000 to 86% in 2017. The exportations are mainly cereals, and the importations oil, legumes, coffee.

2.1.2.4. GHG emissions from agriculture and LULUCF-sector

The GHG emissions form agriculture are 164 MtCO2e in 2017, and have increased by 59% since 2000. The main contributors are breeding (79%: enteric fermentation 90 Mt, manure 39 Mt) and crops (rice:

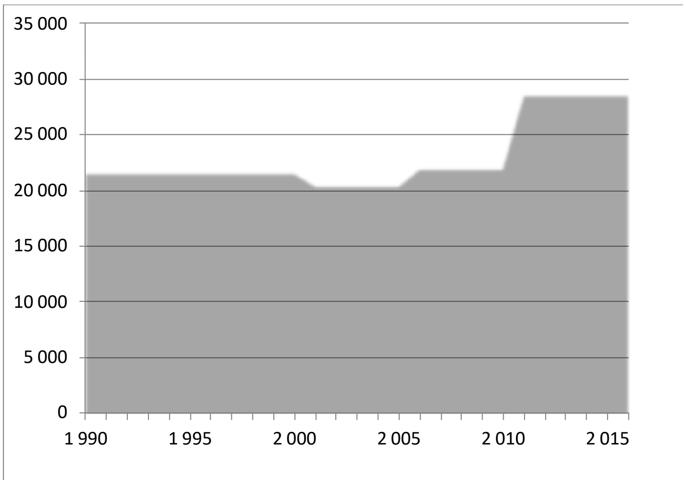
9 Mt, synthetic fertilizers: 22 Mt). The nitrogen use in agriculture increased from 2.4 Mt in 2002 to 3.4 in 2017, i.e. 108 kgN/ha.

Figure 17. GHG emissions from agriculture in ktCO2eq



The "land use, land use change and forest" sector (LULUCF) is a net source of GHG. Due to the loss of forest area, the forest emits 29 $MtCO_2$ per year.

Figure 18. Emissions from LULUCF, ktCO2eq



The total emissions of the AFOLU sector (agriculture forest and land use) is 193 $MtCO_{2e}$.

2.2. GHG emission scenarios to 2050

2.2.1. Scenario definitions

Three scenarios have been produced using EnerNEO and MoSUT, covering all GHG emissions from energy, industry, agriculture and LULUCF, with contrasted emissions mitigation ambition levels:

- Business As Usual scenario (BAU)
- Stated Policies Scenario (SPS)
- Mitigation Scenario (MIS)

The scenarios and their ambition levels are illustrated on the figure below.

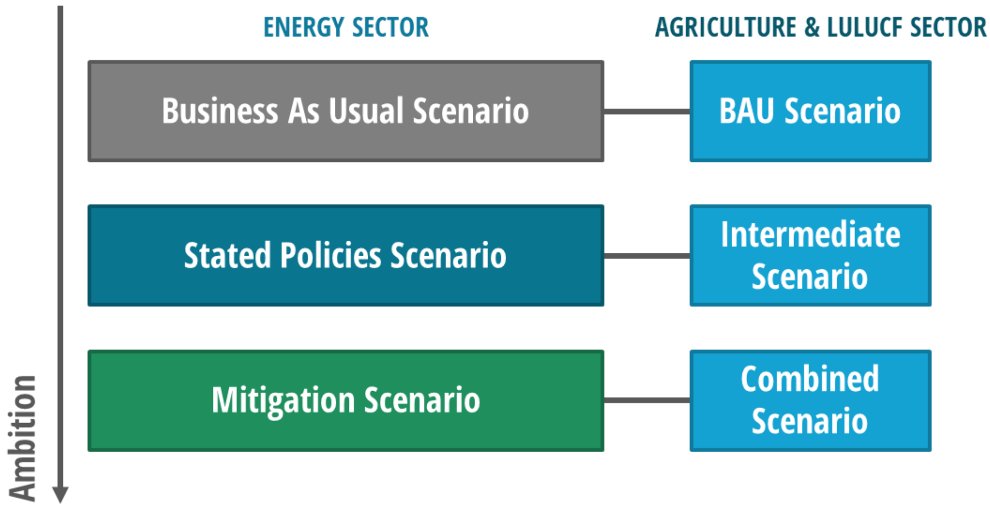


Figure 19. Overview of the developed scenarios

Common assumptions

The three scenarios rely on common socioeconomic (GDP, population) and international fossil fuel price assumptions.

GDP projections consider both mid-term issues (including the impact of the Covid-19 sanitary crisis) and long-term pathways, and are derived from the IMF's World Economy Outlook (October 2020) projections for mid-term (2019-2025), as well as Oxford economics' projections for the long term (2025-2050).

Population forecasts are based on the United Nations' Medium variant of the World Population Prospects 2019. Pakistani population is expected to continue to grow by 2050, reaching almost 350 million inhabitants.

International fossil fuel prices are derived from Enerdata's EnerFuture projections (2020) and are illustrated on Figure 20. They do not account for recent developments in energy prices, as projections were realised, and therefore assumptions set, in 2020.

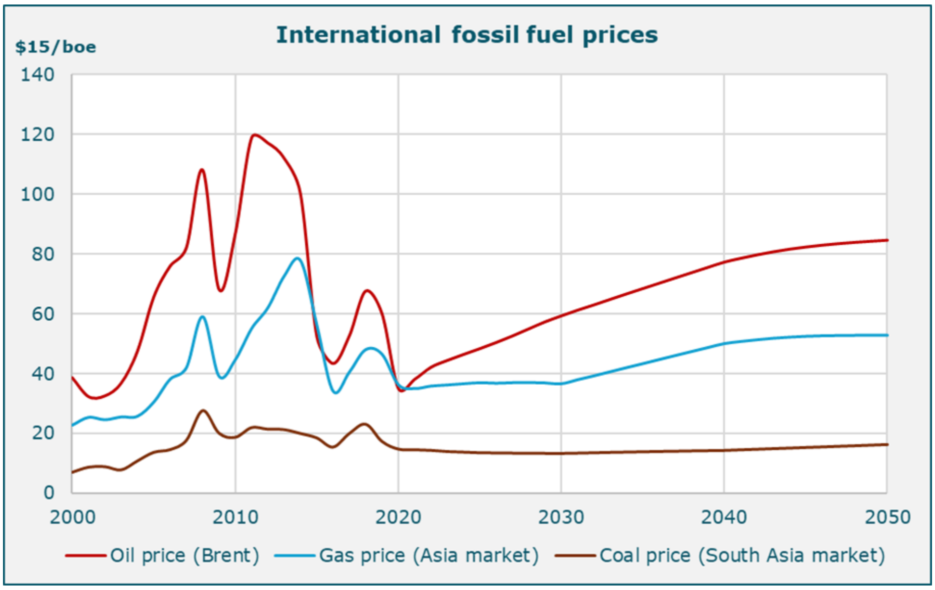


Figure 20. Fossil fuel price assumptions

Business As Usual scenario

The BAU scenario is defined as follows. Regarding energy systems, it features a continuation of past demand trends and limited climate ambition. Energy consumption is therefore expected to grow significantly in all sectors, without strong efforts to improve energy efficiency. In general, conventional energy sources keep a larger market share over cleaner fuels. Mobility demand increases strongly, especially in the road transportation sector, both for passengers and freight.

The BAU scenario also includes a loss of forest surface in terms of LULUCF, and a low ambition on both demand and production sides for agriculture, with also increased yields, productions and exports, and slightly less nitrous oxides emissions.

Stated Policies Scenario

The SPS scenario assumes, on the energy side, that all currently implemented and most announced policies are followed (including the Alternative and Renewable Energy Policy), with a similar level of ambition continued until the end of the simulation period (2050). In this scenario, energy demand growth is limited through energy efficiency measures, and electricity demand increases faster than total demand due to increased electrification.

The SPS features a slight increase in forest area and vegetables production, as well as slightly higher efforts on production and demand in the agricultural sector, compared to the BAU.

Mitigation Scenario

The MIS scenario envisions a high climate ambition for energy systems, with significantly lower GHG emissions than in the other scenarios, compatible with a NDC target in the Paris agreement framework. This includes strong energy efficiency measures, as well as a decarbonation of energy consumption and supply. Renewable energy sources are encouraged (especially in power generation), while development of new coal projects is much lower than in the SPS scenario.

In terms of LULUCF emissions, the MIS sees a significant increase in forest surfaces and vegetables cultures, and a decrease in protein crops. High efforts are made in the agricultural sector on both the demand and production sides, with reduced food waste and imports, limited increase in milk and meat production and consumption, and increased yields.

Synthesis of scenario definition

The table below summarizes the definition of the three scenarios.

	BAU Business As Usual Scenario	SPS Stated Policies Scenario	MIS Mitigation Scenario
Demography	Population projections from UN's *World Population Prospects 2019*		
Economy	GDP projections from IMF's *World Economy Outlook (October 2020)* & Oxford economics		
International fuel prices	Projections of international fossil fuel prices from POLES-Enerdata model, 2020		
Technology assumptions	Technology assumptions from POLES-Enerdata model database, based on IEA's *World Energy Outlook* 2019 assumptions and *TECHPOL* database 2020		
Energy demand	Historical trends	Some energy efficiency efforts in line with Pakistan Vision 2025 (15% to 20% gains by 2025)	Ambitious energy efficiency measures in all sectors
Power sector	Historical trends	Renewable energy development in line with AREP 2019 Capacity expansion according to NTDC's plan 2021-2030 (including domestic coal-fired capacities)	Strong efforts towards renewables energies No new coal-fired capacity, phase-out in 2050
LULUCF	Historical trends	Slightly higher efforts on demand and production	Increase in forest area
Agriculture	Historical trends	Slightly higher efforts on demand and production	Ambitious demand control & production methods assumptions

2.2.2. Overview of modelling approach

Two separate models were used to produce the projections: the MOSUT model represents the agricultural, forestry and land-use systems and emissions, while the EnerNEO model covers the energy systems. The results from MOSUT have been added to EnerNEO to obtain a full picture of emissions directly in the tool.

MOSUT (Model for systemic land-use) provides a comprehensive modelling framework for agriculture and land-use (LULUCF) up to 2050, allowing to prepare various scenarios. It relies on prospective, physical, recursive, ascending balance modelling describing land-use and the use and production of bioenergy. Outputs from MOSUT are then integrated into the EnerNEO global modelling framework.

EnerNEO (National Energy Outlook model) is a long-term energy system modelling framework suited for the assessment of energy & climate policies. It features a thorough modelling of energy demand (econometric), supply (bottom-up electricity sector, primary supply) and energy-related GHG emissions. EnerNEO incorporate all MOSUT results, making it a comprehensive model with full GHG coverage and capturing in detail all underlying mechanisms.

Additional details on the modelling are provided in other deliverables of the project, including the final report slide deck, and the EnerNEO userguide.

2.2.3. Main scenario results

This section summarizes the main results from the scenarios. A more detailed analysis was produced and shared in the form of a comprehensive slide deck.

Demand indicators

Primary energy intensity (ratio of primary energy consumption to GDP) will continue to decrease over the projection period, from about 380 toe/M$15 historically to between 250 and 175 toe/M$_{15}$ by 2050 depending on the scenario, with an increased ambition driving the intensity further down.

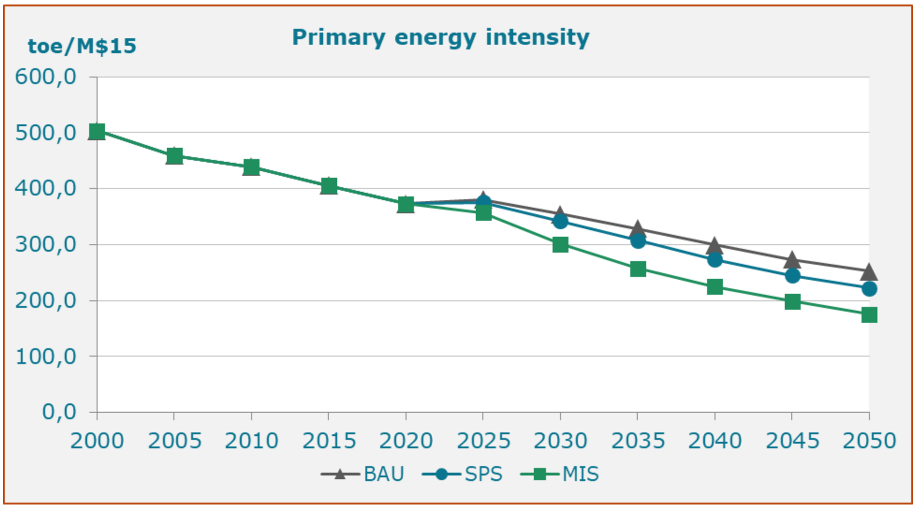


Figure 21. Primary energy intensity evolution to 2050

Final demand of energy historically includes a 11% share of electricity. The electrification of demand is expected to increase by 2050, reaching about 18% in the BAU. While stated policies enable to reach 19%, the mitigation scenario requires a further increase to 23%.

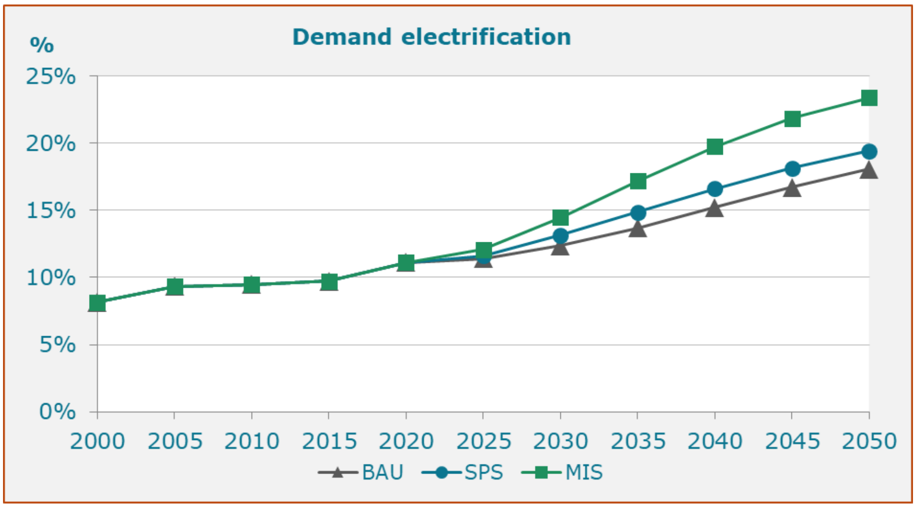


Figure 22. Share of electricity in final demand, evolution to 2050

Electricity sector

Coal capacities are expected to increase significantly if no measure are taken against this development. The SPS foresees around 35 GW of coal-fired capacity by 2050. However, a strong mitigation scenario requires to limit coal capacity to around 5 GW to 2040 with a phase out by 2050 (in the MIS).

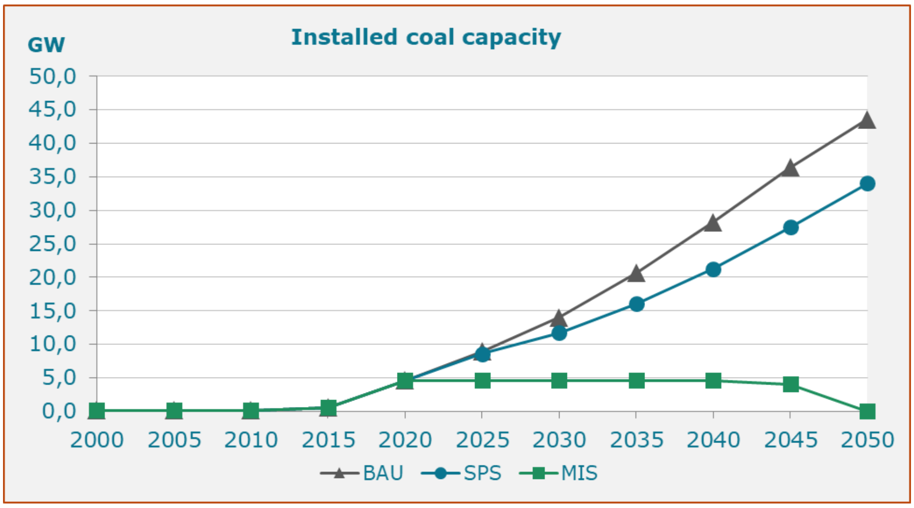


Figure 23. Coal capacity evolution to 2050

On the flipside, the share of renewable energy in power generation will need to increase significantly to achieve the MIS scenario, with around 60% by 2040-2050. This is significantly higher than the 40% reached in 2050 in the SPS, and the 20% from the BAU.

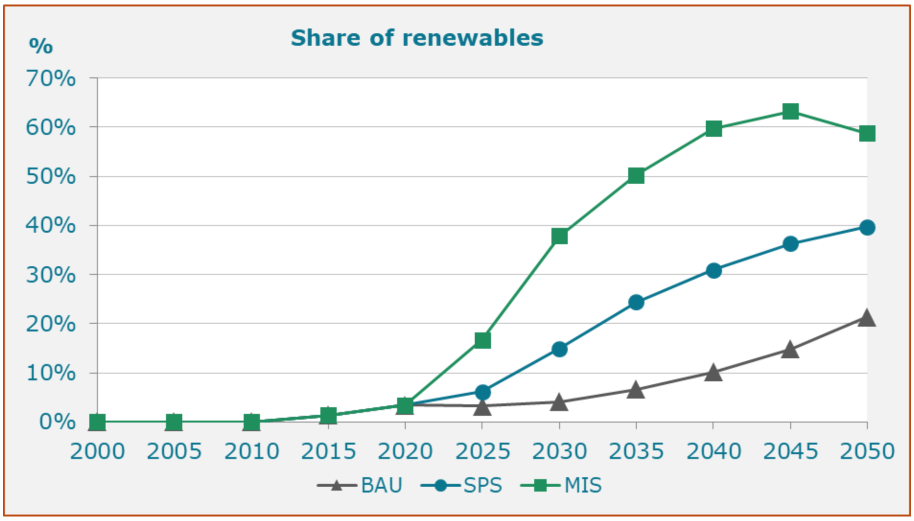


Figure 24. Share of renewables in power generation, evolution to 2050

Agriculture and land use

Direct emissions from agriculture reach 265 $MtCO_{2eq}$ in 2050 in the BAU, from around 180 $MtCO_{2eq}$ historically. Additional efforts in the SPS and the MIS enable to limit the increase to 242 $MtCO_{2eq}$ and 204 $MtCO_{2eq}$, respectively, with decrease in enteric fermentation and fertilization being the main levers to limit the emissions.

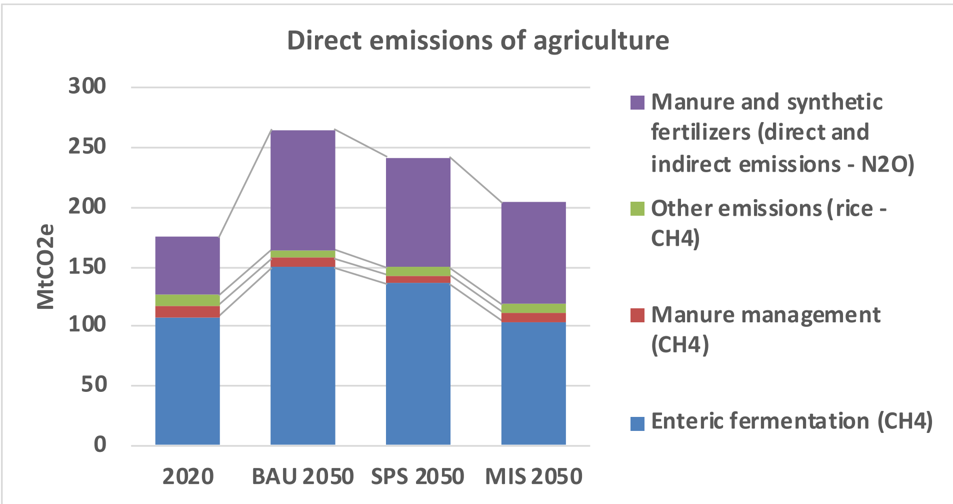


Figure 25. Direct emissions of agriculture, evolution to 2050

In terms of land use, only the MIS shows a significant increase in forest area. It also relies on an important reduction of cereals and an increase of vegetables production surfaces.

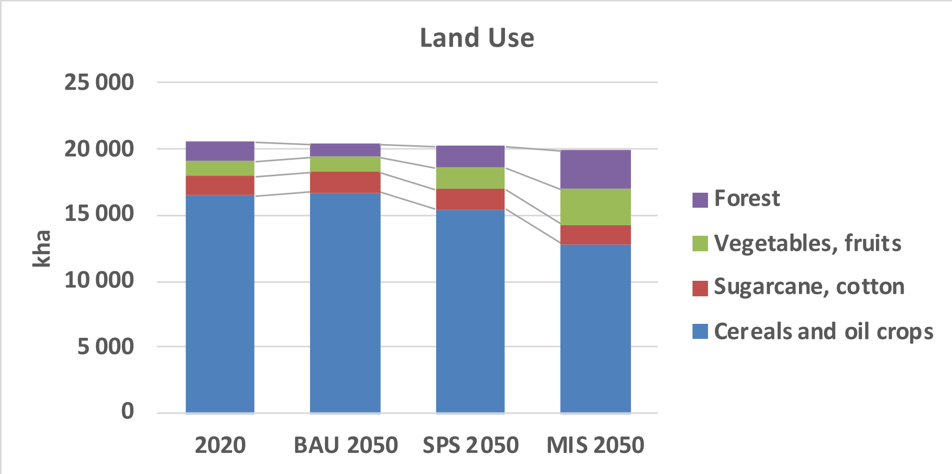


Figure 26. Land use by type, evolution to 2050

Decarbonization

GHG emissions significantly increase in the BAU, reaching 861 $MtCO_{2eq}$ in 2050. While stated policies allow for an expected 15% reduction vs BAU (728 MtCO2e), the mitigation scenario provides a pathway to 441 MtCO2e in 2050 (49% below BAU and comparable to the 2020 level).

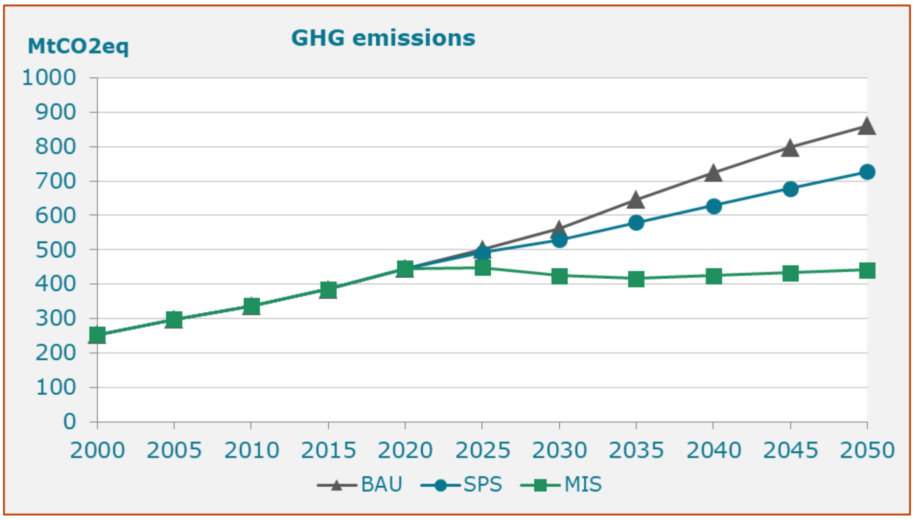


Figure 27. GHG emissions, evolution to 2050

The carbon intensity of energy-related emissions (ratio of GHG emissions from energy systems to GDP) is expected to continue its decline in all cases, from about 1400 $tCO_{2e}/M\$_{15}$ currently. The MIS is however achieving the largest decrease, with 456 $tCO_{2e}/M\$_{15}$ in 2050 (vs 753 $tCO_{2e}/M\$_{15}$ in the SPS).

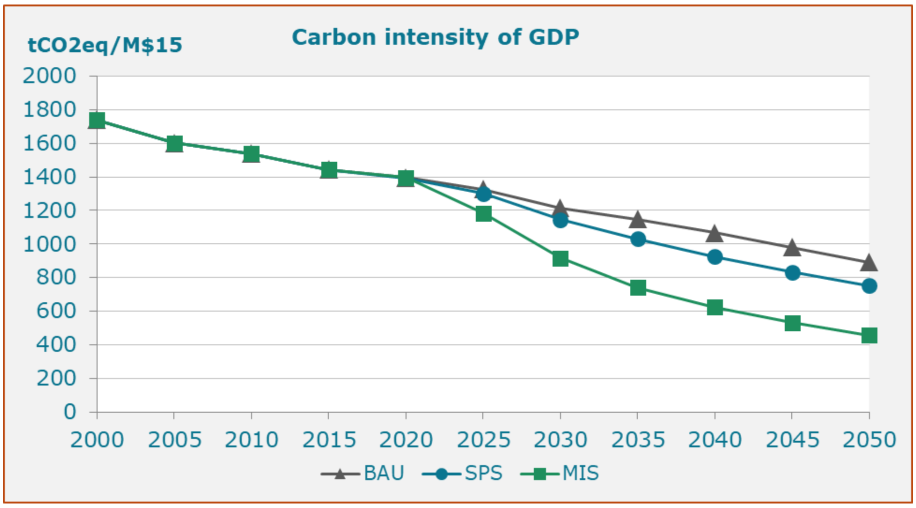


Figure 28. Carbon intensity of energy systems, evolution to 2050

Economic analysis

All scenarios show a necessary rise of the investment in electric capacities. The cumulative investment up to 2050 in the SPS and MIS are respectively 8% and 27% higher than in the BAU scenario. However, assuming that the power generation sector's carbon revenues are reinvested in the power sector, the MIS ends up being the cheapest scenario (-19% in 2050 vs BAU), despite a short-term higher necessary effort (+10% in 2030 vs BAU).

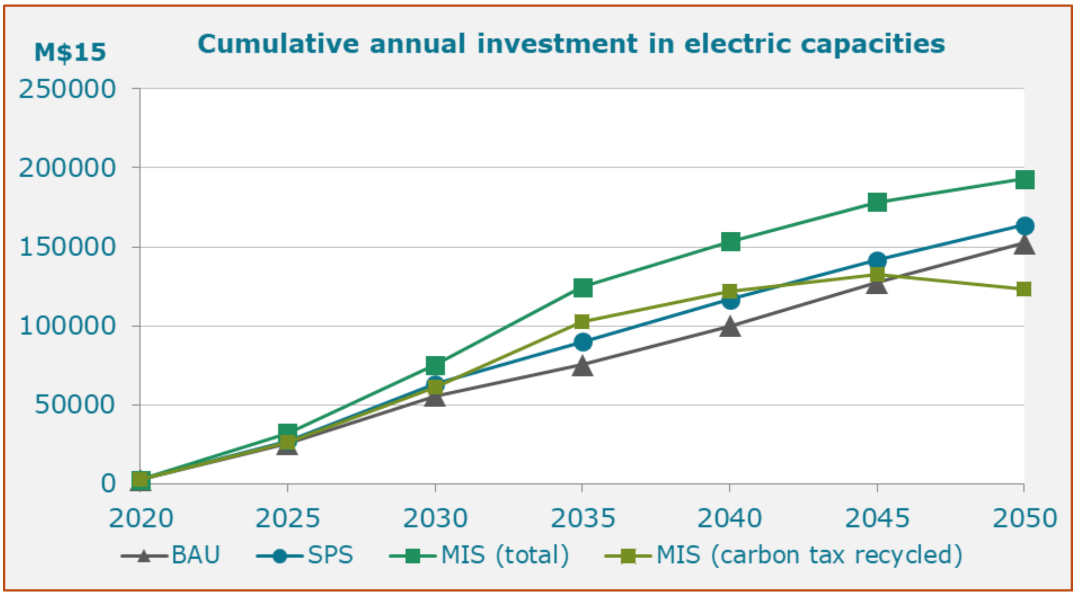


Figure 29. Investments in electric capacities, cumulative to 2050

The average LCOE of the power system is expected to slightly decrease in the BAU and SPS scenarios, to reach around 20% below the 2020 level by 2050. In the MIS, the average LCOE is in line with the other scenarios between 2030 and 2045, after which it increases back to around 95% of the 2020 level by 2050, with increased gas-fired generation and due to a ramping up of carbon price. However, when excluding the carbon tax from the LCOE, the MIS features the cheapest average electricity price over 2030-2045, and gets back to the SPS level in 2050.

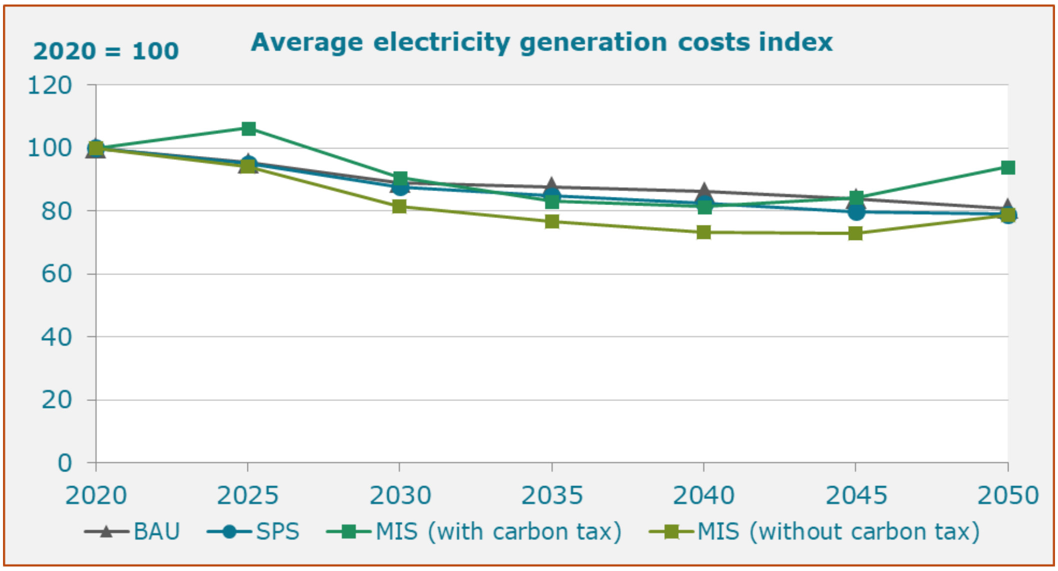


Figure 30. Average electricity generation costs, evolution to 2050

In the BAU, the hydrocarbon import bill surges overs the period, reaching over $33bn in 2050. Reduced demand in the SPS compared to the BAU enables to limit import costs to around $26bn in 2050. The MIS allows to stabilise hydrocarbon import costs much closer to historical levels: $14bn in 2050.

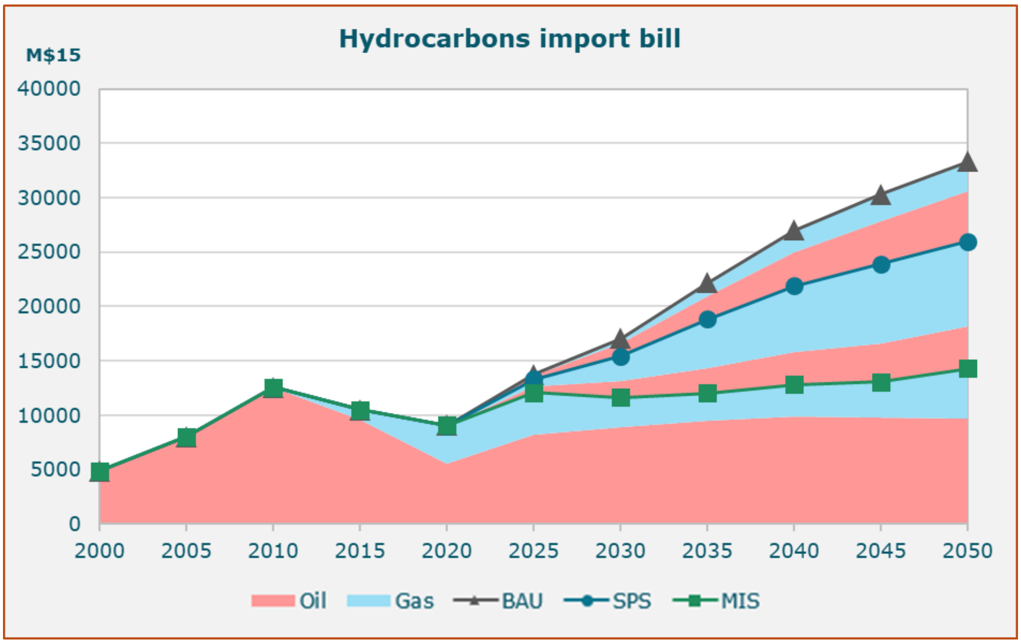


Figure 31. Cost of hydrocarbon imports, evolution to 2050

3. Capacity building mission to Pakistan

3.1. About the mission

A week-long mission was co-organized by the GCISC, the AFD and Enerdata (supported by local expert Areeb Hussain) to conclude the assignment. It was held in the Serena hotel in Islamabad from January 17th to January 20th, 2023.

The objectives were the following:

- Formally conclude the assignment;
- Present the results from the study and advertise it;
- Deliver the EnerNEO modelling tool along with a technical training for selected organizations.

The mission was broken down into:

- a high-level workshop on 17/01/2023, with a large audience, with the aim to give an overview of the work done during the project, present the main study results and the capabilities of the developed modelling tools.
- A 3-days capacity building workshop from 18/01/2023 to 20/01/2023, with a smaller audience, with the aim to train relevant experts to the concrete use of the EnerNEO model.

The next sections present these two components of the mission in more details, and the final section recaps the potential next steps and perspectives.

3.2. High-level workshop

The first day of the missions was dedicated to the restitution of the work to a large audience. Around 50 people attended the workshop, from the following organizations:

Workshop On Greenhouse Gas Emissions and Cost Modeling for Pakistan – Reduction Strategies, 17 January 2023, Nazara Hall, Serena Hotel, Islamabad

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Syed Raheel Haider	GCISC		raheelgcisc@gmail.com	03455080401

The agenda for the high-level workshop was the following:

Tuesday, January 17th		
09h-09h30	*Arrival of the guests*	
09h30-10h00	Welcome Remarks Remarks by Enerdata Remarks by AFD Address by the Chair	M. Arif Goheer, GCISC Aurélien Peffen Steinmetz Philippe Syed Mujtaba Hussain (TBC) Additional Secretary, MoCC
10h00-10h30	Overview of the project	Enerdata
10h30-10h45	*Tea and Coffee break*	
10h45-11h30	Overview of the methodology	Enerdata
11h30-12h00	Recap of the policy context	Areeb Hussain
12h00-12h30	Presentation of the scenario definition	Enerdata
12h30-14h00	*Lunch break*	
14h00-15h30	Presentation of the scenario results	Enerdata
15h30-15h45	*Tea and Coffee break*	
15h45-16h30	Discussion on other projects / synergies / opportunities	
16h30-16h35	Closing remarks	Mr. Asif Sahibzada, Director General (Env), MoCC

The overall level of engagement from the audience was satisfactory, interesting questions were brought to the table, showing interest from the participants in the study results, and especially in how the modelling tools work, what their scope was, etc.

3.3. Technical training

The technical training lasted over 3 days and was targeted to a smaller audience, initially planned to be around 12 people. In practice, it was attended by around 20 people on average, from diverse organisations, listed below. The objective of the training was for the participants to be able to independently use EnerNEO and understand its main features.

Name	Organisation	Designation	Email	Day 1	Day 2	Day 3
Muhammad Arif Goheer	GCISC	Head (Agriculture & Coordination)	arifgoheer@gmail.com	x		
Ahsan Paracha	GIZ			x		
Syed Muhammad Areeb Hussain	Enerdata		areebhussain@lumsalumni.pk	x	x	

Dr Irfan Ashraf	PMAS-UAAR	Assistant Professor	drirfancanada@gmail.com	x		x
Muhammad Amjad	GCISC	Senior Scientific Officer		x	x	x
Muhammad Ijaz	GCISC	Senior Scientific Officer		x	x	x
Dr Ali Imran Jehangir	NEECA	Director (IT)		x		x
Beenish Akram Khan	PMAS-UAAR	Student	beenishakramkhan85@gmail.com	x	x	x
Muhammad Ahtasham	PMAS-UAAR	Student	chahtasham184@gmail.com	x	x	x
Fatimah Mahmood	WWF-Pakistan	Senior Project Officer	fmahmood@wwf.org.pk	x	x	x
Haseeb Khan	WWF-Pakistan	Project Officer-TNC	mhkhan@wwf.org.pk	x	x	x
M Usama Umer	NTRC, M/o Communication	Research Officer	usamaumar@outlook.com	x	x	x
Khizer Javaid	NTRC, M/o Communication	Deputy Chief	khizerja@gmail.com	x	x	x
Engr. Muhammad Asif	PARC-NARC	Senior Engineer	asifbukhari1@gmail.com	x	x	x
Samia Akhtar	PCRET, MoST	Deputy Director	ddwindpcret@gmail.com	x	x	x
Aneeqa Ejaz	PCRET, MoST	Assistant Director (Technical)	aneeqaejaz@gmail.com, aneeqa.ejaz@pcret.gov.pk	x	x	x
Farhan Ahmed Memon	EPRC, M/o Planning Development & Special Initiative	Senior Research Analyst (Policy)	farhanmemon86@gmail.comm	x	x	x
Nauman Hafeez	M/o Planning, Development & Reforms	Research Analyst IEP		x	x	x
Dr. Abdul Wahab	CEWRI, NARCPARC	PL/SSO	wahab_siyal@hotmail.com	x	x	x
Sabeeqa Malik	PMAS-UAAR	Lecturer	sabeeqa.usman@uaar.edu.pk sabeeqamalik@hotmail.com	x	x	
Sohaib Aqib	GIZ	Consultant	sohaibaqib@yahoo.com	x		
Syed Raheel Haider	GCISC		raheelgcisc@gmail.com	x	x	x

The detailed agenda of the technical training was the following:

Date	Title	Content
Tuesday - 16/01	General presentation of the study and EnerNEO tool	General overview of the model's capabilities, structure, use cases
Wednesday - 17/01 Morning	Technical training – Session 1	Overview of the tool structure Loading main scenarios Visualization of results
Wednesday - 17/01 Afternoon	Technical training – Session 2	Presentation of the model's methodology Creating basic custom scenarios
Thursday - 18/01 Morning	Technical training – Session 3	Focus: final demand sector Focus: electricity generation
Thursday - 18/01 Afternoon	Technical training – Session 4	Presentation of MOSUT and the agriculture and LULUCF emission trajectories
Friday - 19/01 Afternoon	Technical training – Session 5	Creation of advanced custom scenarios
Friday - 19/01 Afternoon	Technical training – Wrap-up & Conclusions of the mission	Recap of the training and final Q&A session Conclusions of the mission

The training was design to regularly mix theoretical parts with practical exercises, with an increasing difficulty and level of required mastery of the tool. The final exercise aimed at showing to the participants how to build fully custom scenarios, reproducing (not strictly, but in the method) the unconditional and conditional targets of the updated NDC of Pakistan.

The session related to modelling of AFOLU sectors was held in visioconference by Solagro (no delivery of the MOSUT model was included, hence no need for practical exercises).

The full training program was followed, and the vast majority of participants provided a very positive feedback in the concluding session. A significant part of them showed promising mastery of the model during the practical exercises, but a continued support would probably be needed to ensure a full appropriation.

3.4. Perspectives and next steps

A number of perspectives have been identified and discussed during and after the workshops, for the good appropriation and use of the EnerNEO tool in Paksitan, including the following elements:

- Production of a scientific paper about the current study methodology and outcomes, by the GCISC, with limited support from Enerdata;

- Full update of the model (recent historical data, economic assumptions, etc.) and production of scenarios to illustrate the NDC of Pakistan, with a potential publication of a second scientific paper, by the GCISC. This would probably require a more important support from Enerdata.

- The previous idea could also be implemented using the following format: 1 member of the GCISC could join Enerdata's team in Grenoble for a given period (2 weeks-1 month), to ensure a full appropriation of the model and a smooth support from Enerdata's team. The expert from GCISC could either work exclusively on EnerNEO to perform the above task, or could also be introduced to the other modelling work done at Enerdata.

- Another idea could also be to try to engage with provincial governments using EnerNEO. This could be achieved through two main routes:

    - Adding a territorialization module to the current version of EnerNEO, enabling to calculate estimations of what the national scenarios mean in the different regions. This would require some developments of the model, but is the simpler approach. The idea would then be to engage with provincial governments, and having an idea of what the national commitments mean province by province.

    - Creating province-based versions of EnerNEO. This approach would be much more complicated, with questions of availability of data arising. Also, this would require provincial governments to show a strong interest in the process and to allocate resources to this. The GCISC could keep a focal point role in this situation, but the allocation of responsibilities would need to be defined more precisely.