Global Climate-Change Impact Studies Centre,
Ministry of Climate Change & Environmental Coordination,
Government of Pakistan

Ministry of Climate Change

– Integrated assessment of air pollution and greenhouse gases mitigation in Pakistan –

Kaleem Anwar Mir (GCISC), *Pallav Purohit* (IIASA), *Sylvain Cail* (Enerdata), *and Seungdo Kim* (Hallym Uni.)

2024. 11. 06

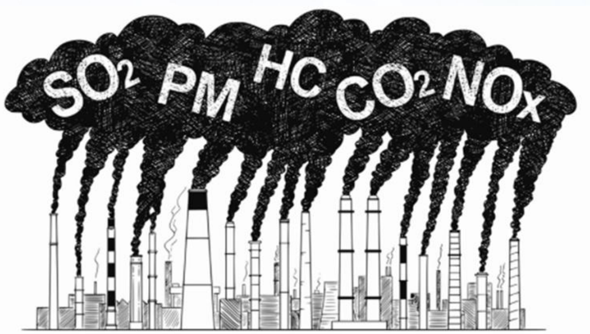
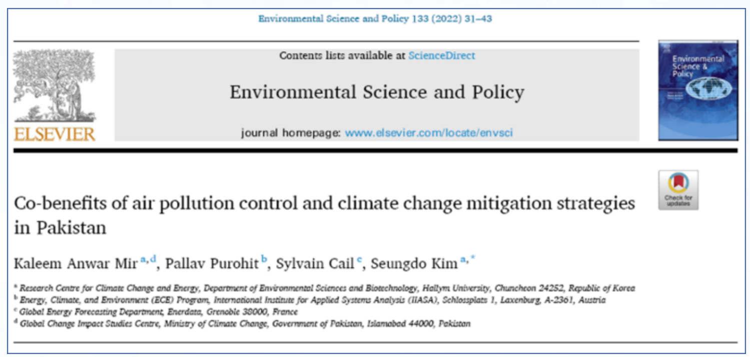


Image Credit: Zdenek Sasek/Shutterstock.com


Environmental Science and Policy 133 (2022) 31–43

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

ELSEVIER

Co-benefits of air pollution control and climate change mitigation strategies in Pakistan

Kaleem Anwar Mir[a,d], Pallav Purohit[b], Sylvain Cail[c], Seungdo Kim[a,*]

[a] Research Centre for Climate Change and Energy, Department of Environmental Sciences and Biotechnology, Hallym University, Chuncheon 24252, Republic of Korea
[b] Energy, Climate, and Environment (ECE) Program, International Institute for Applied Systems Analysis (IIASA), Schlossplatz 1, Laxenburg, A-2361, Austria
[c] Global Energy Forecasting Department, Enerdata, Grenoble 38000, France
[d] Global Change Impact Studies Centre, Ministry of Climate Change, Government of Pakistan, Islamabad 44000, Pakistan

17th IAMC Annual Meeting, November 4-6, 2024, South Korea

Integrated Assessment Modeling Consortium
Founded 2007

Speaker: Kaleem Anwar Mir

01 Introduction

Statement of the problem

- *Air pollution & climate change:*
  - ✓ Second most polluted country at global level.
  - ✓ Experiencing signs of warming climate.
  - ✓ Environmental protection act.
  - ✓ Climate change act.
  - ✓ Lacks an integrated national strategy.
  - ✓ Energy-related air pollutants and CO2.
  - ✓ Tackling both can deliver co-benefits.

Research question

<u>"How can Pakistan address both air pollution and climate change through integrated policies by 2050, achieving co-benefits??"</u>

World's most polluted countries 2020 (PM2.5)

Annual average, weighted by population based on the available data

Rank	Country/Region	2020 AVG (Unit: μg/m³)
1	Bangladesh	77.10
2	Pakistan	59.00
3	India	51.90

Specific objectives

- ✓ **Evaluate current policies (BAU scenario)**
- ✓ **Assess advanced control technologies (ACT scenario)**
- ✓ **Explore integrated approaches for sustainable development (SDS scenario)**
- ✓ **Quantify reductions in premature mortality**
- ✓ **Estimate economic savings from mitigation**

Necessity

- ✓ To integrate synergies between **air pollution** and **climate mitigation** in policy
- ✓ To simultaneously **limit global warming** and **enhance air quality**
- ✓ To address **national health and environmental challenges**
- ✓ To support **NDC implementation** and achieve **WHO GLs/NAQQS** for air quality.

02 Materials and methods

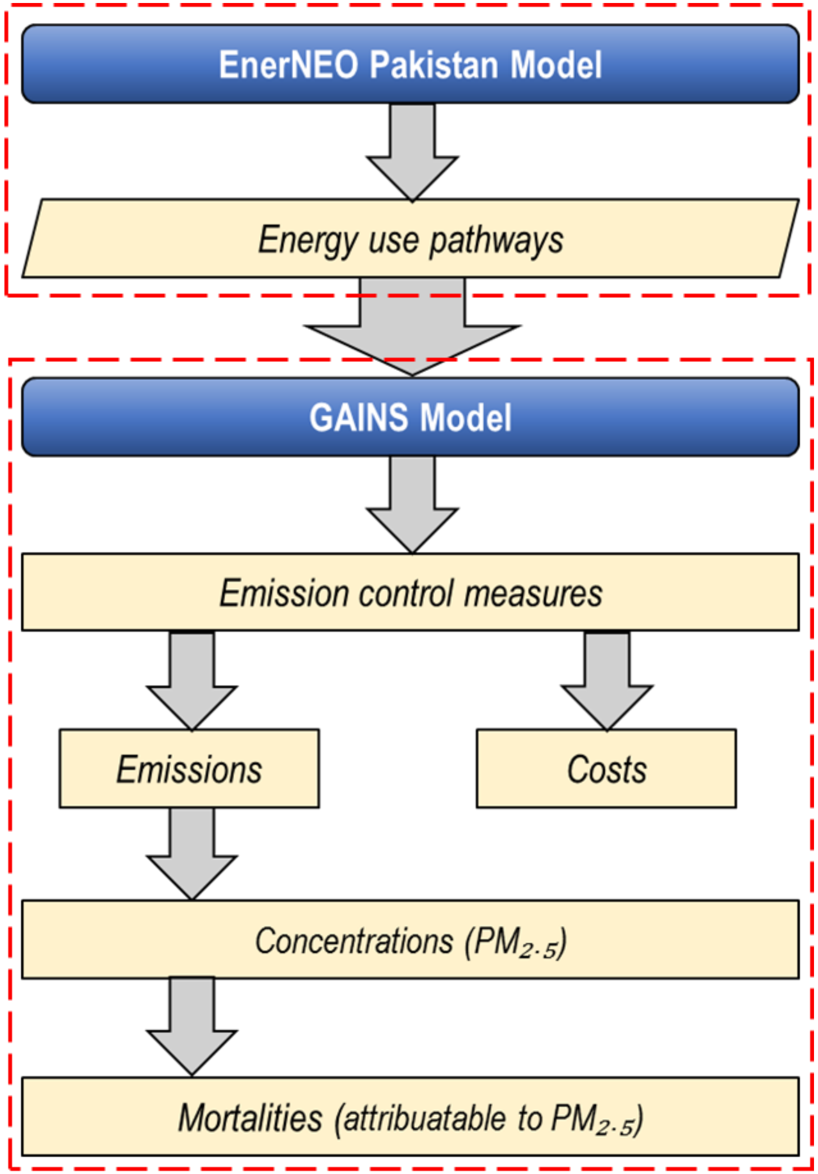
Methodological Approach

Modelling tools (soft-coupling)

- **EnerNEO Pakistan model**: An energy-economic model developed by Enerdata used to project energy use at national level (2015-2050)
- **GAINS model**: An integrated assessment model developed by IIASA, used for analyzing AP & GHG

Data sources

- **EnerNEO Outputs**: Data on GDP, population, and energy use pathways (2015-2050) at the national level.
- **Downscaling**: Data from EnerNEO is **downscaled to the GAINS regional level** using the latest provincial statistical data.
- **Sectoral Data**: Information on **industrial processes**, **agriculture**, and **waste** is sourced directly from the GAINS database.



02 Materials and methods

Emission scenarios

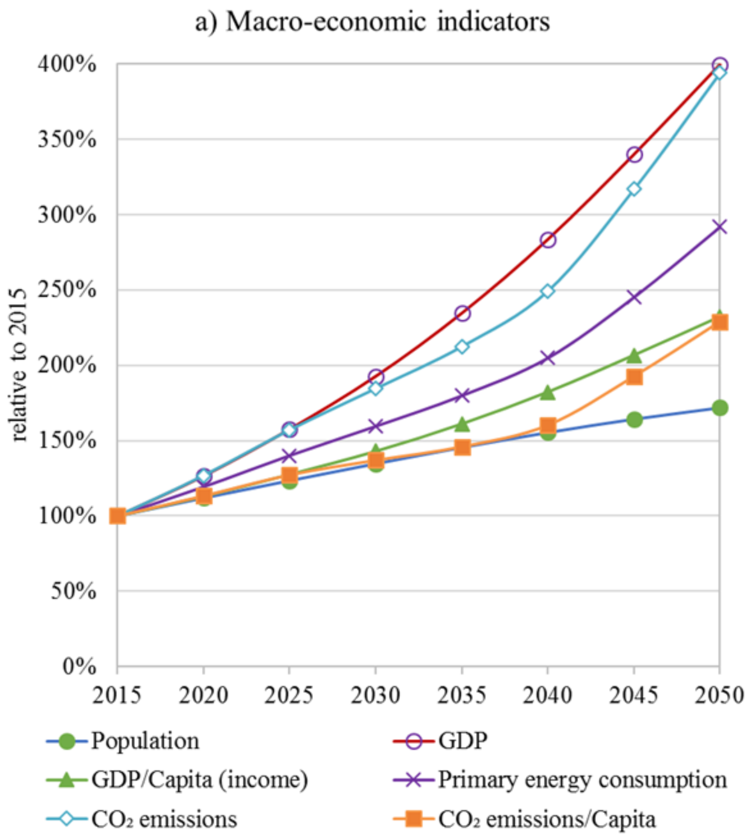
Description

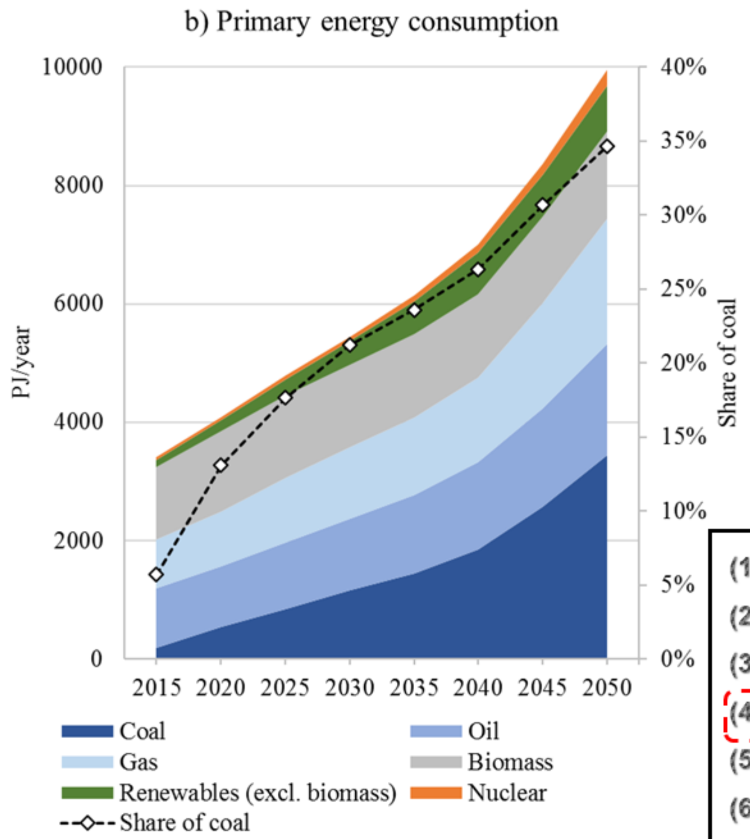
Emission scenarios	Description
1. Business-as-usual (BAU) scenario	BAU is set up based on reference energy scenario of EnerNEO Pakistan model assuming that the already implemented energy and climate policies (until the end of 2015) continue to be enforced.
2. Advanced control technology (ACT) scenario	ACT assumes full implementation of advanced air pollution control technologies (on BAU scenario) from 2025 onwards until 2050.
3. Sustainable development scenario (SDS)	SDS adopts climate policy or 2 °C decarbonization scenario of EnerNEO Pakistan model assuming lesser consumption of coal, oil, and gas, however, greater penetration of energy efficiency, renewables (hydro, solar, wind), and nuclear to compensate in the context of exploring response strategies to the 2 °C temperature increase limit by 2100. In addition, SDS assumes implementation of advanced air pollution control technologies (as in ACT scenario) to deliver on the four main energy-related SDGs (SDG 3 – reducing health impacts due to air pollution, SDG 7 – achieving access to clean and modern energy, SDG 11 – reducing air pollution, and SDG 13 – combating climate change) simultaneously in a cost-effective and integrated way.

03 Results

1. The baseline projection up to 2050

Macro-economic development and energy consumption





(1) GDP = 4%; 4fold ↑ 2050

(2) POP = 1.6%; 72%>2015

(3) PEC = 3fold ↑ 2050

(4) Coal = 18fold ↑ 2050

(5) Renew. = 6fold ↑ 2050

(6) Nucl. = 5fold ↑ 2050

(7) Oil & Gas = 2 & 2.6fold ↑ 2050

03 Results

2. The baseline projection up to 2050

Air pollutants and CO_2 emissions by sector in the reference scenario

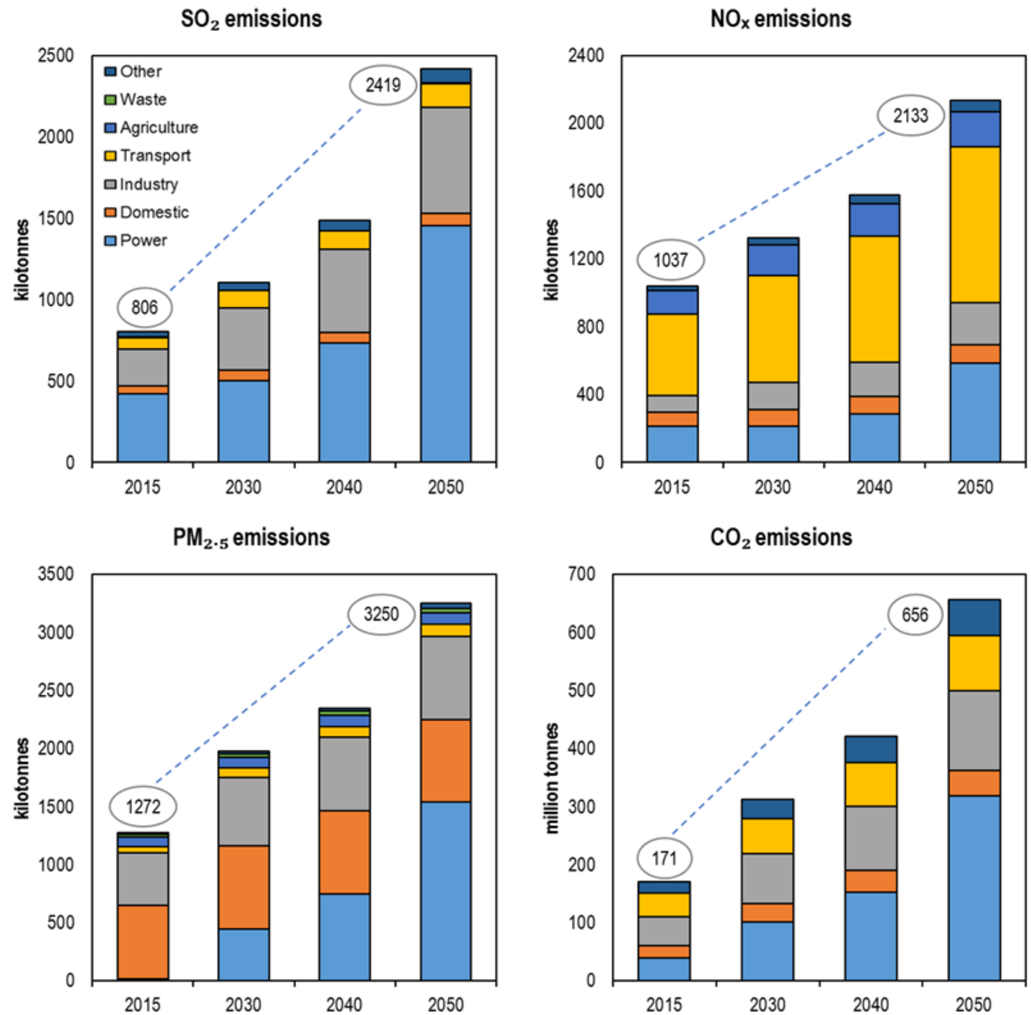
(1) SO_2 = PP & IN; 3fold ⬆ 2050

(2) NO_x = TRA & PP; 2fold ⬆ 2050

(3) $PM_{2.5}$ = PP & DOM; 2.6fold ⬆ 2050

(4) 2050 $PM_{2.5}$ = PP (47%); IN (22%); DOM (22%)

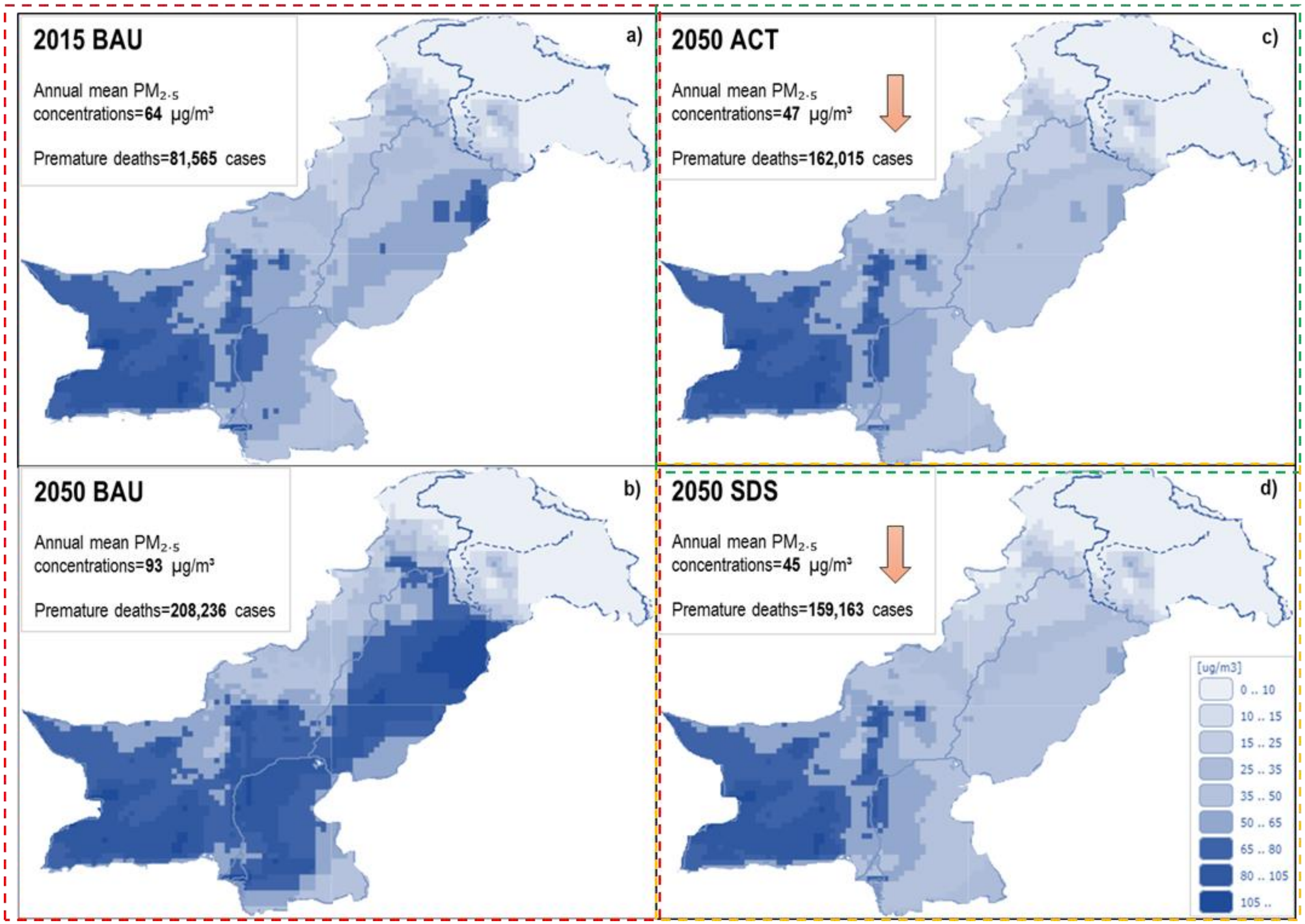
(5) CO_2 = 4fold ⬆ 2050



03 Results

3. The baseline projection up to 2050 (and comparison)

Ambient concentrations of $PM_{2.5}$ and related mortalities



(1) Conc. = 65–105 & >105 μg/m³; 1.5X ↑ 2050
(2) Mort. = 2.6X ↑ 2050

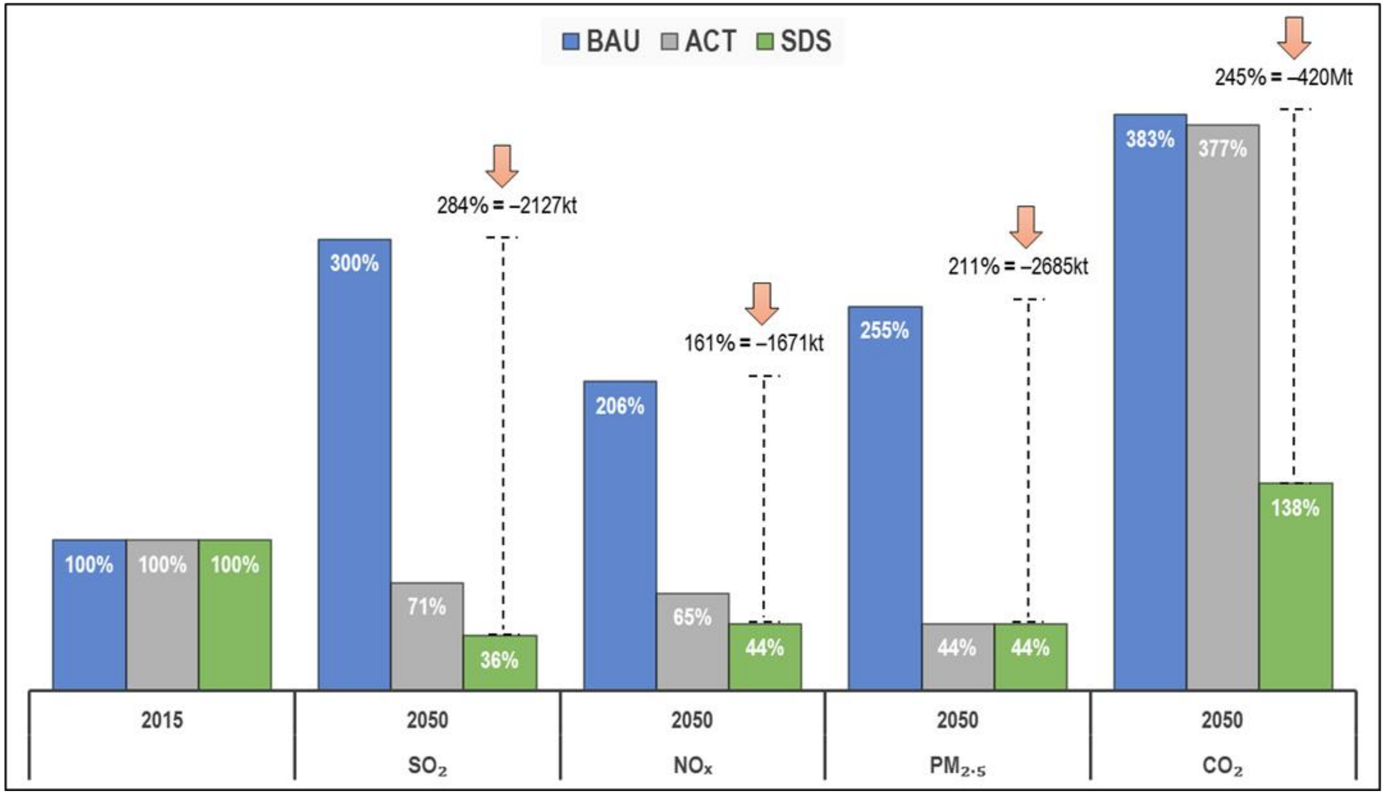
(1) Conc. = 49% ↓ 2050
(2) Mort. = 22% ↓ 2050

(1) Conc. = 51% ↓ 2050
(2) Mort. = 24% ↓ 2050

03 Results

4. Alternative policy scenarios

Comparison of air pollutants and CO_2 emissions (relative to 2015)

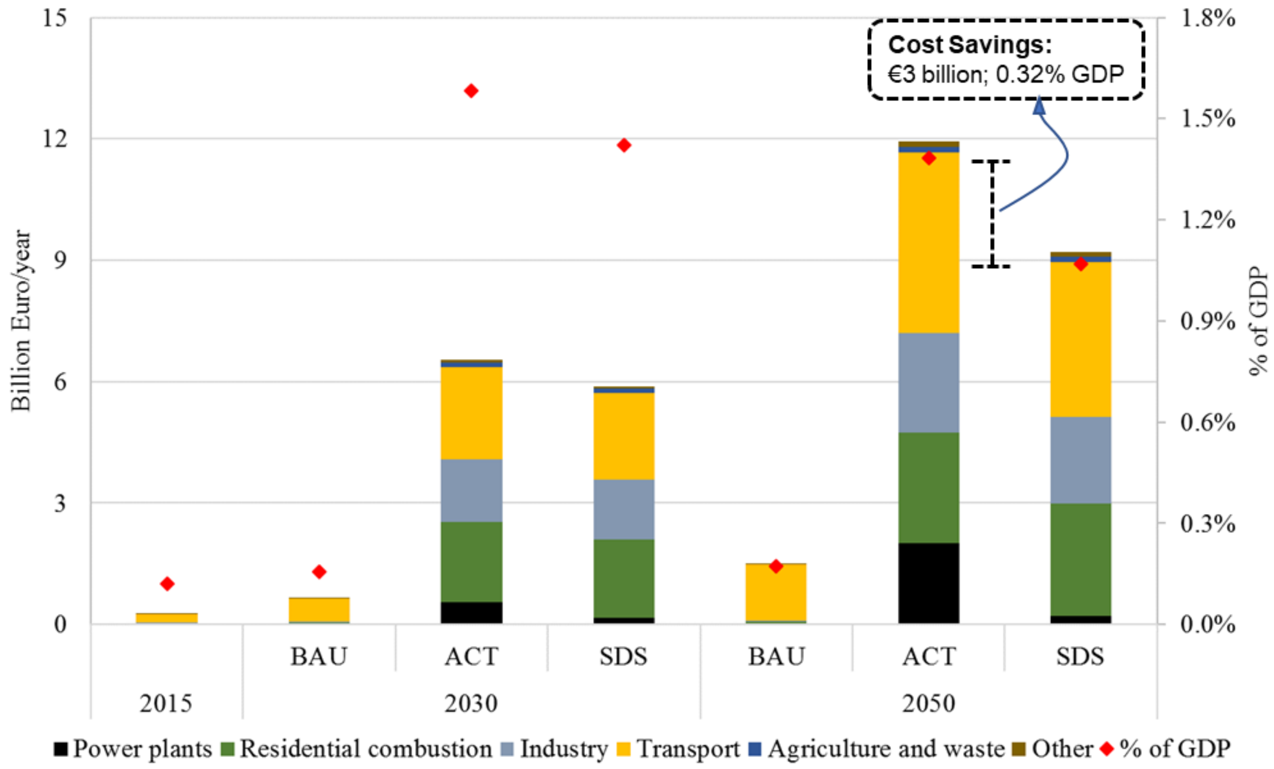


(1) SO_2 = 64%↓ 2050 SDS
(2) NO_x = 56%↓ 2050 SDS
(3) $PM_{2.5}$ = 56%↓ 2050 SDS
(4) CO_2 = 64%↓ 2050 SDS

03 Results

5. Cost-effectiveness analysis

Air pollutant emission control costs for the alternate scenarios



(1) BAU 2015 = €0.26 billion; 0.12% GDP; 84% TRA

(2) BAU 2050 = €1.5 billion; 0.17% GDP; 92% TRA

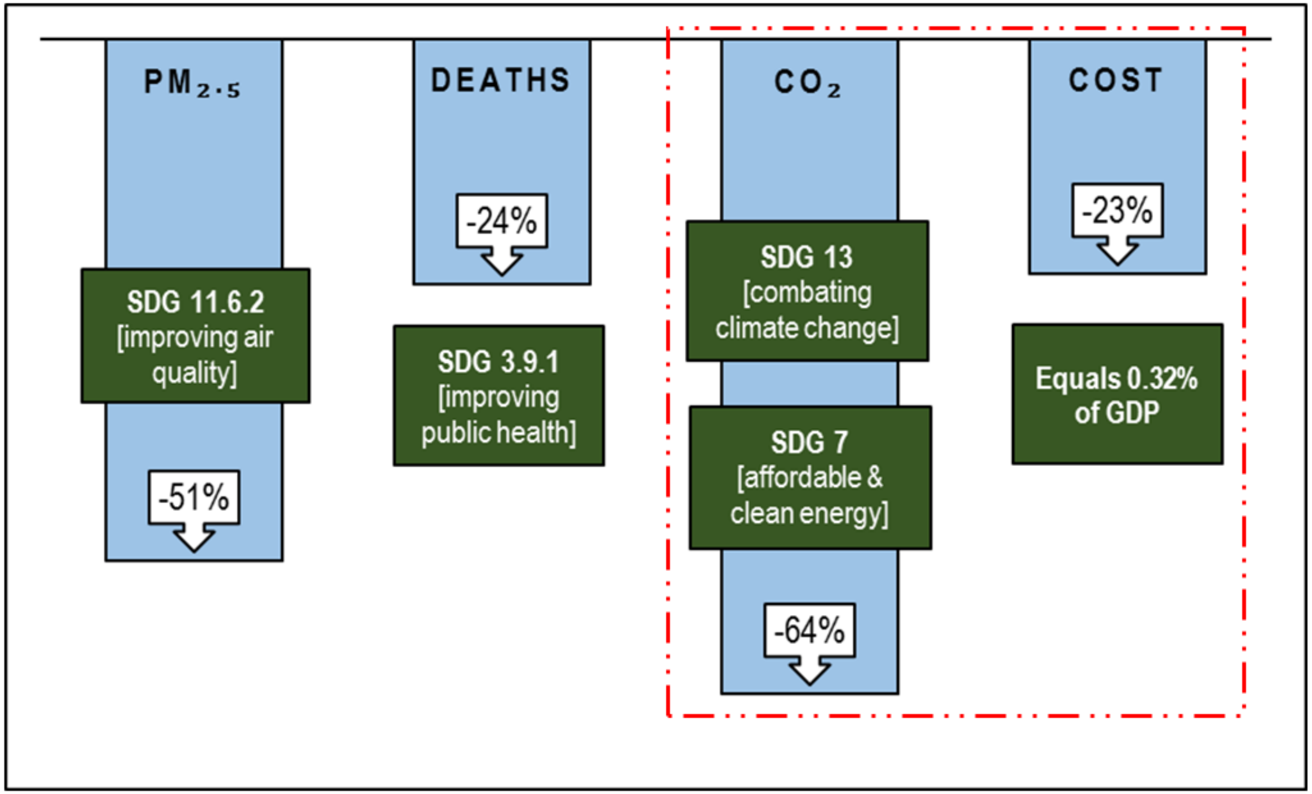
(3) ACT 2050 = €12 billion; 1.4% GDP; 37% TRA-23% IND-21% DOM-17% PP

(4) SDS 2050 = €9 billion; 1.1% GDP; 42% TRA-30% IND-23% DOM-2% PP

03 Results

6. Co-benefits analysis

Co-benefits of SDS by 2050 in comparison to the reference scenario



Integrated policies (such as in SDS) address multiple SDGs while highlighting co-benefits.

Other SDGs benefits:

(1) **SDG 6** = water availability due to reduced coal use

(2) **SDG 9** = infrastructure development

(3) **SDG 8** = creation of new jobs

(4) **SDG 12** = reduction of natural resource depletion due to increased renewable energy use

04 Conclusions & Limitations

a. **Integrated Approach:** Combining air pollution control and climate mitigation (SDS) is the most effective strategy.

b. **Health & Economic Benefits:** SDS reduces premature deaths and saves up to 0.32% of GDP in health-related costs by 2050.

c. **Cost-Effective Emission Control:** Advanced technologies (ACT) offer valuable emissions reductions and health benefits when full SDS isn't feasible.

d. **Maximized Co-Benefits:** SDS aligns with sustainable development goals, supporting health, economy, and environment.

e. **Policy Implementation Needed:** Strong policies for cleaner fuels, energy efficiency, and sustainable technologies are crucial.

f. **NDC & WHO Compliance:** SDS supports Pakistan's climate commitments (NDCs) and WHO air quality standards.

i. **Limited Local Data:** Lack of Pakistan-specific emission inventories and $PM_{2.5}$ measurements; key emission factors need local data.

ii. **Natural Sources Excluded:** Model focuses only on anthropogenic $PM_{2.5}$ sources; source apportionment for natural vs. human-made sources is needed.

iii. **Indoor Emissions Excluded:** Health impacts of indoor $PM_{2.5}$ emissions not assessed; further research needed on household contributions.

iv. **Cost Analysis Gaps:** Model lacks a benefit-cost comparison between base and alternative energy strategies.

Acknowledgements

Thank you!

kaleemanwar.mir@gmail.com
kaleem.anwar@gcisc.org.pk

한림대학교 HALLYM UNIVERSITY

GCISC

Ministry of Climate Change

International Institute for Applied Systems Analysis IIASA

IAMC Integrated Assessment Modeling Consortium Founded 2007

Enerdata intelligence + consulting

RICARDO