Chapter 2

Objectives and Methodology

August 2023

This chapter should be cited as
ERIA study team (2023), 'Objectives and Methodology', Saswata Chaudhury, Raktimava Bose, Debanka Samanta, and Venkatachalam Anbumozhi (eds.), *Renewable Energy Transition in South Asia: Role of Regional Energy Trade*. ERIA Research Project Report FY2023 No. 10, Jakarta: ERIA, pp.7-12.

Chapter 2

Objectives and Methodology

1. Objectives

Given this background, this study explores the potential of renewable energy trade in South Asia and its challenges. It also wants to quantify the benefits of renewable energy trade at national and regional levels. In brief, the objectives are as follows:

- Mapping of energy surplus/deficit for South Asian countries and estimating energy trade (especially renewable energy) potential in South Asia.
- Identifying barriers and enabling factors for regional cooperation and trade in renewable energy in the South Asian region.
- Estimating the regional and individual country benefits.

The study also seeks to define the research questions corresponding to the above research objectives for proper formulation of the study approach and methodology. The research questions, in the context of renewable energy trade and cooperation in South Asia, will incorporate the regional issues, and the advantages and agreements to satisfy the broad objectives of this study. The research questions are as follows:

A. Is there a significant potential for regional renewable energy in South Asia?

B. What are the major barriers and enablers for regional energy cooperation in South Asia?

C. Can regional renewable energy lead to regional and national economic benefits? Are regional energy cooperation initiatives more beneficial than bilateral energy agreements?

After formulating the objectives and the consistent research questions, the study focuses on designing compatible hypotheses that will simplify the complex issue of cross-border renewable energy trade in South Asia. The hypotheses will test the plausibility and bona fides of the research questions already defined.

The hypotheses are as follows:

Hypotheses corresponding to research question A.

A. H0: There is significant renewable energy trade potential in South Asia.

H1: Renewable energy trade potential in South Asia is not significant.

Hypotheses corresponding to research question B.

B1. H0: Lack of mutual trust and political tension are the major barriers to cross-border renewable energy trade in South Asia.

H1: Lack of mutual trust and political tension are not the major barriers.

B2. H0: Complementarity in demand–supply of renewable energy is the major enabler for cross-border renewable energy trade in South Asia.

H1: Complementarity in demand–supply of renewable energy is not a major enabler for cross-border renewable energy trade in South Asia.

Hypotheses corresponding to research question C.

C1. H0: Regional renewable energy trade leads to regional and national benefits.

H1: Regional renewable energy trade does not lead to national and regional benefits.

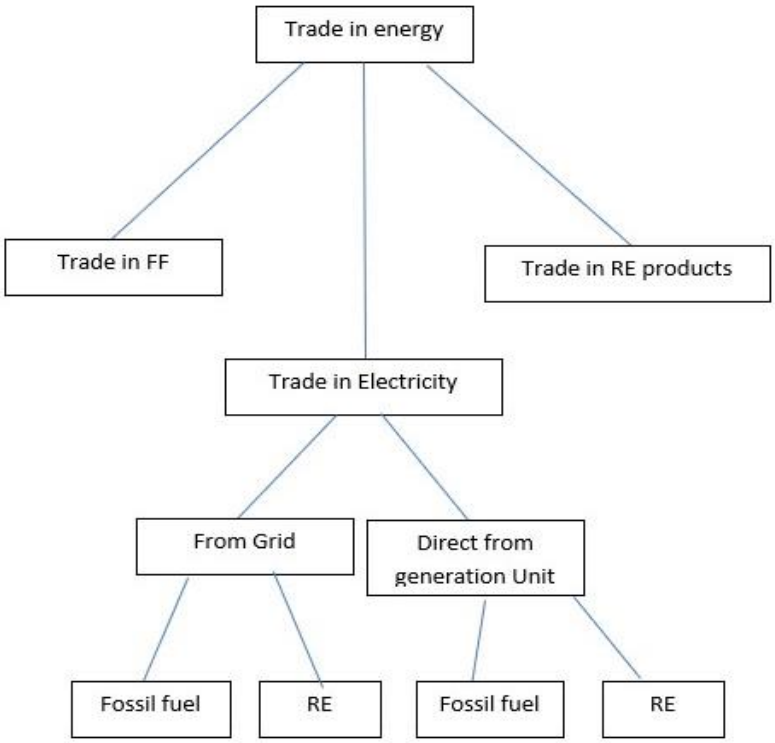
C2. H0: Regional/multilateral renewable energy trade/energy cooperation are more beneficial than bilateral agreements.

H1: Regional/multilateral renewable energy trade/energy cooperation is not more beneficial than bilateral agreements.

The consecutive chapters will explore the above-defined research questions; based on the findings, the validity of the hypotheses will be evaluated.

The study begins with an overview of the renewable energy trade, which is represented in Figure 2.1. In the figure, trade in energy is classified based on generation and has been further subcategorised into the sources of trade in electricity.

Figure 2.1. Classification of Trade in Energy



Note: FF= Fossil Fuel, RE= Renewable Energy.
Trade in FF indicates trade in fossil fuels, for example coal, petroleum products.
Trade in RE products implies trade in renewable energy products, for example solar PVs, batteries, generators, turbines, etc.
Source: TERI, 2022.

2. Trade in Renewable Energy

Renewable energy trade comprises products and green electricity generated by renewable sources. Trade in renewable energy products is not a continuous process and usually occurs as and when required. However, trade in green electricity is somewhat the same as traditional trade in fossil fuels. While trade in both green electricity and fossil fuels is deemed as continuous or regular interval trade, unlike fossil fuels, trade in green electricity cannot be stored for a long period. Moreover, trade in green electricity needs specific infrastructure for the execution of the trade. Thus, for this study, renewable energy trade indicates trade in electricity generated from renewable sources and transmitted through the grid. This renewable energy trade, which is trade in services by nature, is significantly different from any other commercial trade in goods and services, which is already dynamic.

Electricity, despite being a service product, has various characteristics similar to merchandise trade and can be generated, transmitted, and consumed across borders. Countries or regions with surplus electricity can export to those with a deficit, resulting in trade in electricity. However, once electricity is exchanged through grid-based transmission, the ambit and

convenience of classifying electricity-generation sources becomes futile because it is not possible to distinguish among electricity produced from various sources. Trade in renewable energy proposed in this study can only be realised through trade in electricity. However, if the electricity generated in the source/exporting country is not fully generated through renewable energy sources, trade in electricity will not be identical to trade in renewable energy. In the context of South Asia, the majority of electricity generation comes from fossil fuel-based sources (except Bhutan and Nepal). However, all countries have their own decarbonisation plans and are accordingly moving their electricity generation away from fossil fuel to renewable energy sources. Once the exporting/source country achieves its decarbonisation target, i.e., 100% of electricity generation through renewable energy, trade in electricity will be identical to trade in renewable energy. In the case of electricity export from Bhutan or Nepal, electricity trade implies trade in renewable energy as a source of generation for electricity, which is almost 100% for these countries. But, for trade in electricity for other source/exporting countries, this study estimates the potential of renewable energy trade.

Next, the study will explore the current and anticipated status and potential of renewable energy trade in South Asia, with a focus on how key factors can be leveraged to foster greater cross-border collaboration in South Asia. To address the research questions, a mixed-method approach (quantitative and qualitative) has been taken, which will provide a more nuanced and detailed understanding of how stakeholders can work together to promote greater cooperation and investment in the same.

3. Methodology

This study employs quantitative research techniques. Moreover, in-depth consultations with relevant experts were conducted to fill the data and information gap in addition to a detailed literature review.

In particular, to address the first objective of the study, the study team undertook a comprehensive review of peer-reviewed research articles and multilateral/bilateral research reports, along with various government reports.

For the second objective, the study undertook a detailed review of the literature. Expert consultation (with a group of experts in energy and trade sectors from government, industry and research, business sector, international organisations, and academia) was conducted for the identification of various factors that influence inter-regional and intra-regional trade and cooperation in energy.

Further, this study has employed the use of Global Trade Analysis Project (GTAP)[1] to estimate the regional and individual country benefits. It is the third and most important objective of the study. GTAP is a global database and modelling framework for quantitative analysis of various global/regional economic policy issues, including trade policy, climate policy, and globalisation linkages to inequality and employment. GTAP is a multi-region, multi-sector, Computable

[1]A brief description of the structure of the GTAP framework has been provided in Annex 3.

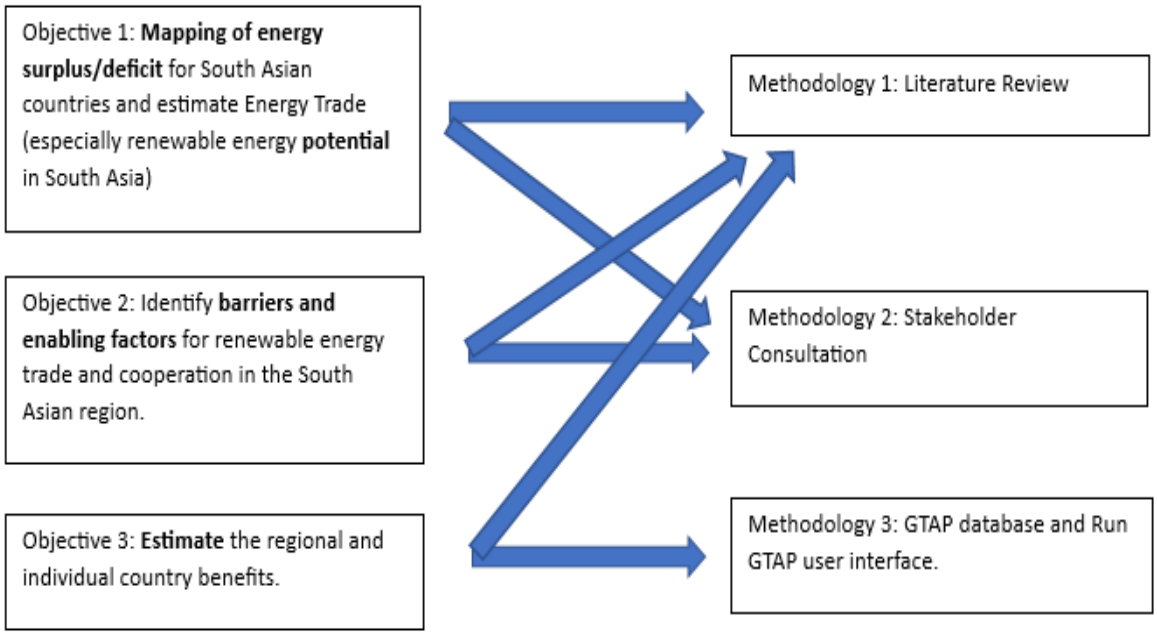
General Equilibrium model, and many recent studies have used GTAP to analyse regional and intra-regional trade issues. Using an inter-regional social accounting matrix, Effendi and Resosudarmo (2020) have analysed the socio-economic and environmental impact of an increased generation of renewable energy in the context of ASEAN countries. The effect was compared with increasing power generation from fossil fuels. Using GTAP-E and GTAP-power database, the study analysed the impact for individual ASEAN member countries. Based on this, the study inferred that the use of renewable energy not only promotes higher gross domestic product (GDP) but also reduces the adverse environmental impact associated with the use of fossil fuel for power generation in the region. The study also measured the impact of higher renewable generation on poverty.

Abrell and Rausch (2016) measured the impact of the expansion of electricity transmission infrastructure and penetration of renewable energy on gains from trade and emissions from power generation in the context of European Union (EU) member countries. The study observed that environmental degradation caused by transmission infrastructure depends on the level of renewable energy penetration. Expansion of transmission infrastructure leads to significant gains from trade, but the level of gains depends on the scale of renewable energy penetration. However, the expansion of transmission infrastructure and an increase in renewable energy share will ensure no adverse impact on regional equity.

In our study, we have used the latest version of GTAP 10 as it provides a database for the world economy aggregated in 141 regions, 65 sectors, and five factors. For each country/region, the database reports production, intermediate, and final uses, international trade and transport margins, and taxes/subsidies (Chepeliev et al., 2019). The values of production, intermediate, and final consumption are all provided in terms of millions of US dollars.

In GTAP 10, out of eight South Asian countries, separate data are only available for Bangladesh, India, Nepal, Pakistan, and Sri Lanka. Data for Afghanistan, Bhutan, and Maldives have been clubbed as the 'Rest of South Asia'. As only Bhutan among the three countries is predominantly engaged in electricity trade, the study assumed that, in the case of renewable energy/electricity trade with Bangladesh, India, and Nepal, 'Rest of South Asia' indicates Bhutan only (as electricity trade for Afghanistan and Maldives are almost negligible). In the case of Pakistan–Afghanistan trade, 'Rest of South Asia' indicates Afghanistan. Figure 2.2 gives a pictorial representation of the broad study approach. In the subsequent chapters, the findings of the study have been discussed at length.

Figure 2.2. The Approach of the Study



Source: TERI, 2022.