

TECHNICAL APPENDIX FOR BLOG ON “RENEWABLE ENERGY CAN FUEL INCREASED ENERGY SECURITY”

To compute the energy supply security index (ESSI), we use the Jansen et al. (2004) approach based on a simple dual concept Shannon-Wiener diversity indicator which was additionally augmented with energy import dependency, socio-political stability, and resource depletion factors. The resource depletion factor was excluded from our analysis due to the limited data availability.

$$ESSI = - \sum_{i=1}^M [c_i \times p_i \times \ln (p_i)]$$

where:

$$c_i = 1 - m_i \left(1 - \frac{S_i^m}{S_i^{m,max}}\right)$$

p_i = share of primary energy source i in total energy consumption

$i = 1, M$ (primary energy sources index, M energy sources are distinguished)

c_i = correction factor to p_i

m_i = share of net import in primary energy supply of source i

$$S_i^m = - \sum_{j=1}^N [h_j m_{ij} \times \ln (m_{ij})] \text{ (Shannon index of import flows of resource } i \text{)}$$

$j = 1, N$ (regions of import of energy sources, N number of regions are distinguished)

$S_i^{m,max}$ = maximum value of Shannon index of import flows of resource i

h_j = extent of political stability in region j , ranging from 0 (extremely unstable) to 1 (extremely stable)

DATA

The index is constructed by using annual data from Eurostat energy statistics, the World Bank, and the United Nations databases. Along with fossil fuels (oil, gas, and solid fossil), the analysis also covers nuclear power and renewable energy sources. Renewable sources are divided into hydro power, traditional (solid biofuel and charcoal), and modern sources (wind, solar, liquid biofuels, biogas, geothermal, marine, and renewable waste).¹ While the International Energy Agency categorises hydropower as a part of the modern renewable energy source category, we have chosen to assess it separately to capture the additional effects stemming from climate change.

¹The International Energy Agency (2020). Reports. Modern-Renewables: <https://www.iea.org/reports/sdg7-data-and-projections/modern-renewables>

Energy trade balances are considered between the euro area countries and thirteen other world regions and are based on the annual imports of three major energy sources, such as oil, natural gas, and solid fossil fuels from 165 countries that have been aggregated into thirteen regions.² For countries that have not identified imports from Russia, additional assumptions were made.³

The final steps of the ESSI included the calculation of political risks in the thirteen regions. Political stability was measured based on the World Bank Stability and Absence of Violence/Terrorism indicators (2010)⁴ and weighted according to each country's population share in the specific region.

² Countries are grouped into selected regions based on location (same geographically specified area). Some of the largest countries, such as the United States, Canada, and Russia, are listed separately due to their importance to energy trading.

³ Based on Eurostat data, the following assumptions have been made: Estonia - 80% of imports from Latvia are assumed to be from Russia; Austria - 80% of net imports are assumed to be from Russia; Slovenia - 80% of imports from Austria are assumed to be from Russia, Finland - 80% of imports from Estonia are assumed to be from Russia (Eurostat, 2020). EU energy mix and import dependency: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:EU_energy_mix_and_import_dependency#Oil

⁴ Detailed documentation of the Worldwide Governance Indicators, interactive tools for exploring the data, and full access to the underlying source data available at www.govindicators.org