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Ametepey Daniel Kafui
Lands Commission 407 Sekondi-Western Region

Economic cost of radical innovations necessary to transition to 100% renewables by 2030 in USA. Applicable in Italy and Ghana

The unsustainability and environmentally-unfriendly nature of fossil fuels has necessitated a shift to renewable energies. Considering the limited time left to fully transform energy systems to escape the snares of energy-related greenhouse gas emissions, the needed shift to renewable energies has to take a radical form. Due to the complete integration of energy in the macroeconomic structure, the transition paths proposed by researchers must take into account the possibility of minimizing the costs and maximizing the benefits of each transition path adopted. Energy producers and consumers are both concerned with costs and benefits of transitioning to renewables and estimating the dollar values of each pathway would help both parties in making informed decisions. Though a number studies have proposed estimates of cost and benefits, there is little evidence of works that allow for variety in transition pathways. Here, we first explore the linkages between renewable energy supply, economies of scale and national output for both short- and long-term; and based on established relationship estimate the radical innovations in renewable-energy needed to transition to a 100% sustainable energy by 2030.

Methods: The study considered an economy where total energy demand by the entire population is supplied from renewable energy sources. In order to estime the energy-economic-population system in a completely renewable energy-driven economy, we learn from history particularly in periods where fossil fuel dominated. Total population (POP), total renewable energy consumption (REC) and gross domestic product (GDP) were considered as proxies for economic scale, sustainable energy and economic value of production in the country respectively. Yearly data spaning 1949 to 2018 on POP (in number of people), REC (in trillion British thermal unit - TBtu) and GDP (in real billion 2012 US dollars) were extracted from the US Energy Information Administration (EIA). Prior to running tests on long- and short-run relationships [though the log forms, identified as 'NEW' on the figure below, of the variables were used] between POP, REC and GDP problems relating to unit root, stationarity, cointegration, autocorrelation, heteroscadasticity and multicollinearity were checked and corrected. Variables that depicted seasonality were deseasonalized before conducting further diagnostics and analysis. Both the vector error-correction (VECM) and vector autoregression (VAR) were adopted to study the dynamic links between the variables all based on LR, FPE and AIC lag selection criteria. Based on the results from the VECM and VAR models, a variance decomposition analysis (VDA) and impulse respone funtions (IRF) are used to estimate the innovations in REC, POP and GDP in response to Chelesky one standard deviation (degree of freedom adjusted) shock to REC for a ten-year period. We then perform VDA, IRF and forecast (starting from 2019 to 2030) for reactions following a shock on REC that equivalent to innovations necessary to achieving 100% renewable energy supply by 2030 (i.e., a period of 12 years). We then estimate the economics costs and benefits of such corresponding innovations that are required to achieve the 100% renewable energy by 2030 target.

-RWEC gap of ~17.94 -27.75TWh towards 100% renewables by 2030.

Keywords — climate change, renewable energy, radical innovation, energy transition, energy policy,

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