Increasing the Share of Electricity from Renewables - Lessons for the Latecomers

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See footnotes at end of text.

Among all sustainability indicators, the share of electricity from renewable sources (SEFRS) is the one that arguably receives the most attention both in the media and in public policy debates. While an increase in this indicator is desirable in principle, the transition to renewables involves much more than increasing RE electricity generation alone. There are a few lessons that policy makers in developing countries need to consider as they strive to increase their reliance on wind and solar energy in their quest for more affordable and secure energy supplies.

Electricity from renewables is a complement, not a substitute to conventional generation: Renewable generation technologies have characteristics that make it difficult to consider them as a pure alternative to thermal generation. Electricity from RE is intermittent, difficult to predict accurately, and is non-dispatchable (supply cannot be increased at will to meet an increase in demand, but is rather driven by the availability of sun and wind). Therefore, an increase in SEFRS does not necessarily imply a decrease in the need for back-up capacity reserves.

Electricity from renewables interacts with conventional generators in complex ways: Renewable generation not only depends on conventional reserves to back it up, it affects incumbents in other ways: First, since electricity from RE has nearly zero marginal cost (the cost of producing one extra unit of electricity), and in the absence of means to store electricity economically, supply priority is usually given to RE, forcing thermal power generators to reduce their production thus reducing their plants' capacity factors (as well as their profits). Second, an overall increase in electricity from RE is likely to decrease average electricity prices, reducing conventional generators' profits further. Third, increased electricity production from RE negatively affects them by reducing thermal plants' efficiency and service life due to the more frequent plant load cycling[1].

A substantial rise in SEFRS involves other considerable hidden costs: The transition to RE will require major expansion of transmission lines in order to connect distant and dispersed sources to centers of demand; for example, Europe needs an estimated 14,000 km of overhead transmission lines directly attributed to the growth of power generation from RE[2]. There is also the cost of road constructions to these sources as well as eventual storage capabilities (whether household or grid level). Then there is the increasingly complex grid management infrastructure that needs to accommodate these wind farms as well as a large number of households with photovoltaic production capacity. While at low shares, integration costs may be zero or even negative, they increase quickly with the share of renewables to the point of potentially becoming a barrier to higher penetration[3]. Of course, these costs may be totally justified in the long run, but are the financial and institutional resources available?

Increasing renewable generation capacity is the (relatively) easy part: For a given RE project, an investor can easily estimate the cost of producing one unit of electricity by averaging the total expected electricity production over the life-cycle cost of the project (which, for this type of projects, is overwhelmingly upfront capital expenditures). If offered a fixed feed-in tariff that exceeds that cost, the investor will effectively have a buyer committed to buying all his or her production at a profit – a very generous opportunity! But from a market's perspective, the value of a unit of electricity is not fixed; in fact the difference between high and low wholesale market prices can differ by four orders of magnitude over the course of a year in some liberalized electricity markets[4]! Thus, a simple feed-in tariff program may turn out to be more successful than anticipated, not only in terms of excessive production at uncompetitive prices, but also because of the choice of less and less optimal locations for projects (with lower capacity factors and higher construction and transmission costs). A study by Siemens found that Europe could save EUR 45 billion by 2030, by choosing optimal locations for sun and wind energy projects[5].

Increasing SEFRS induces positive externalities but they need to be rigorously evaluated: Of course, a rise in RE may induce many positive externalities such as reducing GHG emissions, attracting foreign investment or creating job opportunities. But these benefits cannot just be *assumed* to occur with an increasing SEFRS; they need to be rigorously validated and quantified during the program appraisal phase.

SEFRS can rise without any increase in generation capacity: SEFRS is the ratio of electricity generated from renewable sources to the *gross electricity consumed*[6]. The denominator (gross electricity consumed) largely depends on factors such as a country's surface area, total population and distribution, extreme weather conditions and industrial energy intensity. But one critical determinant of gross electricity consumption is energy efficiency; indeed there is room for efficiency improvements on both the supply and demand sides that can have a large effect on consumption. In other words, for a given country, SEFRS as an indicator may grow without any change in RE generation - simply by improving efficiency! Substantial gains may be achieved through the modernization of power generation plants, building efficiency programs, energy efficiency standards for appliances[7] and behavioral interventions[8].

The endeavor to increase reliance on renewables also requires building massive institutional capacity and know-how: Designing and controlling a robust grid with high RE penetration, creating and managing a liberalized, efficient and fair electricity wholesale market, designing and reliably evaluating energy programs – all of these are necessary, albeit less salient, requirements for a successful transition to renewables.

Despite their popularity, renewable energy projects can meet local opposition: Noise generated by wind farms, landscape disfigurement due to overhead transmission lines, endangerment of the local fauna, threat to local tourism, encroachment on private property are among the many factors that can generate popular resistance to RE projects, ultimately leading to stalled or canceled projects and frustrated investors.

Priority should be given to the most effective programs: No country has infinite resources, and policy makers are faced with a wide range of (often conflicting) interventions to achieve their goals; making the right choice requires rigorous ex ante evaluations to compare proposed programs according to valid criteria. There is no reason to bypass effective but less glamorous programs without proper evaluation and comparison. Side effects and interactions need also to be considered; merely focusing on subsidizing RE may lead not only to over-capacity but to "overconsumption of electricity and disincentives for energy efficiency."[9] Furthermore, successful design and selection of future programs is highly dependent on the evaluation of past and current ones, a process that would be much more effective if programs were built for evaluation, and if results were made available to all stakeholders.

The purpose of energy policy is to enhance citizens' wellbeing by providing safe, secure, affordable and sustainable energy. This is far from being achieved through increasing SEFRS alone; apart from the prudent increase of that indicator, policy makers need to work on the institutional capacity and know-how this transition requires, as well as choosing the most cost-effective, evidence-based interventions.

Footnotes

[1] Eser, Patrick e al. "Effect of increased renewables generation on operation of thermal power plants." *Applied Energy,* vol*.* 164, 2016.

[2] Cohen et al. "An Empirical Analysis of Local Opposition to New Transmission Lines Across the EU-27", *The Energy Journal*, vol. 37, no. 3, 2016.

[3] Ueckerdt et al. "System LCOE: What are the costs of variable renewables?" *Energy* vol. 63, 2013.

[4] Joskow, Paul L. "American Economic Review: Papers & Proceedings, vol. 100, no. 3, 2011.

[5] Siemens press release, http://www.siemens.com/press/pool/de/pressemitteilungen/2013/energy/E201305035e.pdf

[6] Eurostat, http://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics#Electricity

[7] Houde, Sebastien and Anna Spurlock. Minimum Energy Efficiency Standards for Appliances: Old and New Economic Rationales. *Economics of Energy & Environmental Policy*, vol. 5, no. 2, 2016.

[8] Hahn, Robert and Robert Metcalfe. "The Impact of Behavioral Science Experiments on Energy Policy." *Economics of Energy & Environmental Policy*, vol. 5, no. 2, 2016.

[9] Borenstein, Severin. "The Private and Public Economics of Renewable Electricity Generation", *Journal of Economic Perspectives*, vol. 26, no. 1, 2012.