Grinding out renewables for RE100: The impact of true-up policy on the economic efficiency and local air pollution in a renewable energy credit market

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Overview

Renewable Energy Credits (RECs), a widely used policy tool in many countries, have become a standard practice to encourage the energy sector, utilities, or private companies to comply with renewable energy policies and towards the goal of 100% renewable (RE100). The policy typically involves a monthly, quarterly, or annual true-up period to reconcile the obligation by matching renewable production with consumption. A longer true-up period provides flexibility to meet obligations, which can help lower compliance costs. On the other hand, a real-time true-up can create meaningful emission benefits but could be costly for the energy sector, as firm energy is unlikely to be provided by renewable producers due to renewable intermediacies unless coupled with energy storage.

One emerging question is the impact of the true-up policy on the effectiveness of emission reductions. More recently, there has been a growing push within academia and the energy sector toward a 24/7 true-up policy [1]. In other words, this policy would require an instantaneous match between the MWh supplied by renewable energy providers and the consumption by companies as stipulated under their contracts. This push is motivated by two key concerns. First, the concerns of greenwashing, contract reshuffling, or a lack of additionality – where claimed emissions reductions do not actually materialize – are central to the discussion. The argument is that the marginal cost of renewable energy is nearly zero, and the renewable energy included in contracts that is not consumed by one company will be consumed elsewhere anyway. This raises questions about its actual impacts on the emissions reductions. Second, the anticipated growth in energy demand, driven by new datacenters to support generative AI services, is expected to have significant implications, especially growing demand in inference [2]. The energy load induced by generative AI is projected to increase to 6.7-12.0% of the total load in the U.S. by 2028 [3].

The REC market in Taiwan provides an interesting case study for at least two reasons. First, its unique design of renewable energy policy, which is based on bilateral transactions, does not allow for the decoupling of energy from renewable attributes, thereby enticing the affected companies, such as TSMC (Taiwan Semiconductor Manufacturing Company), to search for more economical solutions. Second, the island is the home to 15 datacenters [4]. The number of datacenters is expected to increase significantly. This expansion coincides with the already strained power grid, largely driven by the high energy demand from chip manufacturing giants like TSMC, placing the electricity system under continuous pressure. Third, the local power system includes several pump storage plants that allows for intertemporally moving renewables to satisfy renewable obligations.

Methods

This study investigates the effects of Renewable Energy Certificate (REC) true-up policies on market efficiency and local air pollution. The market is modeled with two entities: brokers and the Independent System Operator (ISO). We develop cost-minimizing optimization problems for both entities, with the broker's problem being subjected to different true-up policy scenarios. Using publicly available data, the electric system is represented as a four-node network (North, Center, South, and East) interconnected by four transmission lines. Power flows within the network are modeled using empirically derived Power Transfer and Distribution Factors. Given the convex nature of the optimization problems, the optimal solution is characterized by a set of first-order conditions. Combined with the market-clearing condition, which determines bilateral contract prices, this yields a linear complementarity problem (LCP). The LCP can be solved efficiently using commercially available solvers, such as PATH. The model is then applied to examine the impacts of various true-up policies on the operation of systems, including production costs and local pollutants: NO_x (Nitrogen Oxides) and SO_2 (Sulfur Dioxides).

Results

A true-up policy that mandates a 2800 MW real-time renewable output (exceeding the minimum available to the system, as shown in Figure 1) induced by the RE100 by companies located in the North node (e.g., TSMC) leads to a 1% increase in production costs compared to the baseline scenario. To meet the RE100 (Renewable Energy 100%) commitment, pumped-hydro and battery storage units enter contracts with renewable energy providers to charge their facilities, store energy, and shift renewable generation over time. This shift in operations forces non-renewable units—predominantly fossil fuel-based power plants—to increase production in order to meet system demand during periods when renewable generation is insufficient. Figure 2 illustrates the energy output profile across four system nodes: North, South, East, and Central. Notably, there is no change in the output profiles at the South and East nodes. However, the Central node experiences the most significant increase in generation, as shown by the widening gap between the solid and dashed green lines. This increase is primarily due to the fact that the Central node hosts a substantial share of low-cost, coal-fired power plants. These plants are typically at the margin during hours when storage is charging from renewable energy sources. As a result, they are required to ramp up output to compensate for the variability introduced by renewable energy storage operations, particularly the charging and discharging cycles of hydro and battery storage.

However, this comes at the cost of increased local pollution, specifically SO_2 and NO_x emissions, which are reported to increase by 0.2% and 0.12%, respectively while CO_2 emissions declined by 0.05%. This shift in energy supply not only increases the operational costs but also exacerbates the environmental footprint of the system through elevation in local pollution.

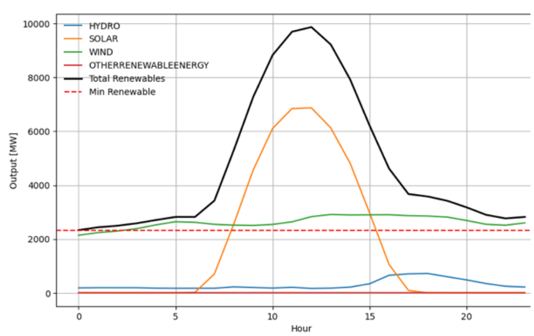

Figure1: Renewable outpt by technologies: the red dashed line represents the minimal amount of hourly renewable available to the system: 2330 MW.

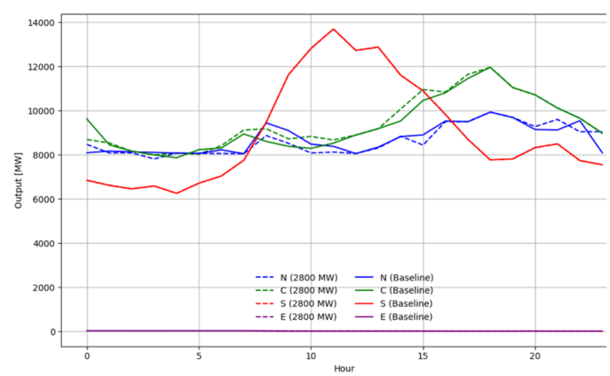

Figure 2. Hourly output profile by nodes: the solid lines represent the baseline while the dashed lines correspond to the case with 2800 MW in order to satisfy RE 100 goal.

Conclusions

Trueup policies play a key in helping the industry towards RE100. This study highlights the trade-off between mitigating CO_2 and increased emissions from local pollution as well as the impacts on increases in production costs.

References

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