



Multi-Objective Auctions for Utility-Scale Solar Battery Systems: Lessons for ASEAN and East Asia

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East and Southeast Asia (ASEAN) are dynamic regions undergoing transitions into sustainable growth pathways, especially concerning energy. The International Monetary Fund (IMF), as of October 2022, forecasts Asian economy to expand much more slowly than in the preceding two decades while Asia's economic performance remains relatively sound in an increasingly sluggish global economy (IMF, 2022). Among the 16 Least Developed Countries (LDC) in the United Nations' category of being on the path to graduation, ten are World Trade Organization (WTO) members, including ASEAN members Cambodia, Lao PDR, and Myanmar. The phasing-out of international support measures associated with LDC status may present challenges to graduating LDCs attempting to integrate into the global economy, such as stricter compliance with climate and other environmental, social, and governance (ESG) regulations. Six global brands that source garments and footwear from Cambodia wrote to its government in August 2020, stating that its proposed increase in coal-fired electricity could reduce the country's prospects for attracting future investment (Voice of America, 2020).

According to the International Energy Agency (IEA, 2022), Southeast Asia will see rapid growth in energy demand. In its Stated Policies Scenario (STEPS), based on a business-as-usual assumption, the region's oil-dominated demand rises more than 3 percent annually from 2021 to 2030, faster than in the previous decade. Renewables, natural gas, and coal demand all rise rapidly, with coal continuing to dominate, although its share of generation declines from 42 percent today to 39 percent by 2030.

The International Renewable Energy Agency (IRENA) has estimated average annual investment needs for renewable energy and energy efficiency in East and Southeast Asia totaling US\$582 billion under its Planned Energy Scenario (PES) and US\$830 billion under the Transformative Energy Scenario (TES) during 2016-2050 (IRENA, 2020a; base year for US\$ prices unavailable). These needs are despite decreasing renewables costs, as seen in IRENA reporting that total installed costs for utility-scale solar PV plants fell 81 percent

between 2010 and 2020, from US\$4,731 per kilowatt (kW) to US\$ 883/kW (IRENA, 2022; information on nominal or real prices unavailable).

Power systems aspiring to high renewables penetration rates with mostly variable renewable resources will require a variety of storage technologies, whose owner should procure through

a competitive process to meet the power system least-cost objective. As the renewable energy sector progresses, policies must take changing market conditions and new technical and socioeconomic challenges into account to ensure a just and inclusive transition encompassing the energy sector and more. Falling costs of new technologies, expanding growth in variable renewables, i.e., solar and wind, and greater emphasis on climate and other ESG objectives by policymakers and stakeholders have altered the conditions for new market entrants and new power generation projects. One instrument on the rise is auctions to promote competition for the market as policymakers seek to procure renewable electricity at the lowest possible price while fulfilling other social or economic objectives.

Morality in competitive markets is increasingly important for investors, shareholders, and consumers (Tirole, 2017, 2021; Dewatripont and Tirole, 2022). Financiers' demand for return on ESG is on the rise, with global debt issued for ESG purposes forecast to reach US\$1.3 trillion in 2022 (Institute of International Finance, 2022) from the approximately US\$30 billion in 2013 reported by Bloomberg New Energy Finance (BloombergNEF). The European Union (EU) will require funds to disclose information about how they reduce potential negative impacts of their investments beginning in 2023.

According to a 2022 report, major impediments to institutional investments in emerging and frontier markets are that institutions and fund managers are increasingly applying ESG considerations in their investment strategies that exclude or down-weight emerging and frontier markets (Theobald, 2022). However, some investors use an active ESG approach in addition to, or instead of, ESG screening, in which they identify investment opportunities to improve ESG outcomes using the Sustainable Development Goals (SDGs) as their targets (Theobald, 2022). This study concentrates on auctions for procuring utility-scale solar photovoltaics (PV) and battery energy storage systems (BESS) with long-term power purchase agreements (PPA) on the order of 15-25 years or other sufficient cost recovery periods as some East Asian and ASEAN countries still retain a single buyer model of electricity markets.

A review of 602 publications on renewable electricity auctions identified in March 2022 (del Río and Kiefer 2023) finds that study's focus on multicriteria auctions and auctions on solar PV plus BESS, i.e., dispatchable renewable energy sources (RES) electricity generation, are almost non-existent in their reviewed academic literature. This review's finding is consistent with this study and the facts that in April 2023, the UK government issued a call for evidence on introducing non-price factors into the contracts for difference scheme, such as ESGs (Government of United Kingdom 2023) and that the United States Federal Energy Regulatory Commission (FERC) has issued only broad electric storage rulings that are not yet specific to hybrid resources such as solar PV and BESS as of May 2023.

A theoretical and conceptual framework of auction markets discusses the following. The static framework finds that the higher the number of participants, the higher the competition, the higher the ESG, and that ESG irresponsible bidder will result in higher costs. The dynamic framework finds that bidders who do not participate in the first auction to see the outcome and decide to participate in the next auction is disadvantaged in the next auction and that participation in the auction give the bidder experience and more information for the bidder's advantage in the next auction. Incentive framework proposes staged product-

matching auctions. The first stage is a reverse auction to determine a price at which coal-fired power producers voluntarily relinquish their coal power capacity and indicate the amount of carbon dioxide equivalent (CO₂e) emissions avoided by said retiring coal-fired power capacity. The second stage is a forward auction for avoided CO₂e emissions, which may be repeated until the supply prices of avoided CO₂e equal the purchase prices, or the difference is reduced enough for the host government or donors to make up the remaining shortfall.

The review of literature for integration of ESG in solar PV plus BESS auctions provides lessons for East and ASEAN countries. First, theoretically and empirically proved auction market design with low levels of complexity for bidders may facilitate bidding strategies intended to optimize outcomes, including ESG. A design strategy intended to improve realization rates might include high financial prequalification and adjusted physical prequalification relative to sunk costs, penalties covered by financial prequalification, and increased competition. Designs incorporating multiple select policy instruments rather than one policy instrument would enable said instruments to complement each other, e.g., PPAs awarded through long-term contract auctions, wholesale markets, etc.

Second, ESG goals in renewable auctions should be part of project definition and as such should be preconditions for project qualification, allowing awards based solely on price. Auction planners might integrate auction designs within geospatial least-cost electrification roll-out plans, which could facilitate exploiting synergies between the energy sector and the broader economy to optimize the benefits of green transitions. Designs that integrate ESG and just and inclusive energy transitions may require policy support and grants that recipients win competitively and adhere to MRV requirements.

Third, the transition to 24/7 clean energy may drive higher ESG scores, which might facilitate access to cheaper capital in financial markets eager to greenify investment portfolios. An initial step for enterprises in ASEAN and East Asia to build 24/7 clean energy would be allowing enterprises to trade RECs or equivalent, and building capacity for monitoring and reporting types and amounts of energy used, would help such firms remain in global value chains and make themselves more competitive.

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