

# Renewable energy balancing non-liberalized electricity markets

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Juan-Jose Diaz Gonzalez

Tim Mennel

Christian Hewicker

DNV Energy Systems

Zanderstr. 7

D-53177 Bonn

Germany

e-mail: Juan-Jose.Diaz.Gonzalez@dnv.com

## Overview

Our contribution analyses the regulatory options and needs for system integration of variable renewable energy (VRE) in non-liberalized electricity markets. After the initial phase-in of wind and solar power by way of fixed feed-in tariffs, many countries today move to a medium to high share of VRE in their electricity system, leading to urgent questions about their system integration (cf. IRENA 2019). Challenges include, among others, long-term security of supply, an increased need for balancing and network expansion. While the topic has been under discussion for some time in market-based electricity supply industries (ESI, see Rubino 2016 and references therein), non-market-based system integration has not attracted much attention so far. More precisely, some authors have studied the subject from a techno-economic system perspective (e.g. Bankuti et al. 2018 for Bangladesh); Jensterle et al. provide a public policy perspective including aspects of RE expansion planning, smart grid deployment and public acceptance. In contrast, we address the question which regulatory measures have to be amended or added to the governance of non-market based ESI, present in many emerging economies. Our focus is on systems with a single-buyer model, as fully vertically integrated ESI have become very rare today. We suggest alternative measures to cope with consequences of intermittency in two single-buyer countries, building on experiences from market based ESI in Europe.

## Methods

At the beginning, we analyse the single buyer model in two countries (Egypt and Malaysia) in order to identify the status quo in power scheduling and balancing. It is common that the single buyer bears responsibility for stable delivery of power supply. In many countries, the scheduling flexibility of the single buyer is limited as power supply functions under stringent PPAs, with take-or-pay clauses for conventional generation and FIT for VRE generators. Balancing is provided by flexible generation units under orders of the System Operator on a technical basis without remuneration. In the context of an increase of VRE, it can be expected that the traditional single buyer models will need to be adjusted in order to deal efficiently with a higher share of intermittency and increasing balancing needs as a consequence (as early as Phase 2 of VRE integration according to IEA scale (IEA, 2017a)). More precisely, commercial arrangements for balancing will be required to ensure sufficient supply as well as fairness in the system. We evaluate the current situation of the three example countries and their expected future VRES deployment and deduce balancing needs. On that basis we develop alternative balancing model facilitating the system integration of VRE. The methodology applied relies on qualitative and quantitative methods to evaluate the existing

situation. The outcome is compared to market and system integration efforts undertaken in liberalized electricity supply industries.

## Results

The analysis identifies different balancing model alternatives to improve the balancing model in a single buyer system compared to the status quo in which the system operator is responsible for the balancing actions, also known as technical balancing.

- Option 1: System operator is responsible for balancing but purchases balancing services, also known as commercial balancing
- Option 2a: VRE operator closes a contract with a conventional flexible power producer.
- Option 2b: VRE operator closes a contract with an energy intensive, flexible consumer.
- Option 2c: VRE operator, conventional operator and energy intensive, flexible consumer create of a virtual power plant and offer balancing services.
- Option 3: Physical bilateral contract in form of a private PPA between a VRE producer and a large consumer

The suitability of the identified options depends on the load and generation structure and VRE penetration in each country as well as the regulatory framework.

## Conclusions

Our analysis highlights the status quo of VRE system integration in two electricity supply industries based on the single-buyer model. We argue that some form of remuneration or commercialization of balancing services will be required to ensure system stability in a future with much higher shares of VRE. In addition, VRE producers will need to be confronted with balancing responsibility to incentivize them to pursue options minimizing imbalances such as closure of a balancing contract with a flexible generator/consumer or the creation of a virtual power plant. The exact solution will depend on characteristics of the electricity system.

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