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Electricity Regulatory Authority of Vietnam

Comments on the draft regulation for power forecasting in Vietnam

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Abbreviations

CENACE	Centro Nacional de Control de Energía (TSO of Mexico)
emsys	energy & meteo systems
EVN	Electricity of Vietnam
ERAV	Electric Regulatory Authority of Vietnam
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GW	Gigawatt
IPP	Independent Power Producer
MAE	Mean Absolute Error
MW	Megawatt
NLDC	National Load Dispatch Centre
NWP	Numerical Weather Prediction
OC	Organismo Coordinador (TSO of the Dominican Republic)
RE	Relative Error
RMSE	Root Mean Square Error
SGREEE	GIZ project "Smart Grids for Renewable Energy and Energy Efficiency" in Vietnam
TSO	Transmission System Operator
vRE	variable renewable energies

Chapter 01

Introduction

1. Introduction

1.1. The context of this study

Vietnam experienced a massive growth of renewable energies in 2019. Driven by an attractive feed-in tariff, investors and EPC companies installed almost 5 GW of capacity in about six months. The bulk of the installed capacity is made up by large-scale solar plants which are concentrated in the South of Vietnam where the country records the highest solar irradiation. More plants are expected to start operations in the upcoming months. Especially wind power projects which have been granted more time for installation and commissioning will add further renewable capacity.

Meanwhile, the expansion of solar and wind power plants poses a significant challenge to power system operations due to their volatile energy production. Hence, a crucial issue is the necessity to forecast accurately in advance the availability of renewable energy plants. These predictions need to be provided particularly to the system operator who needs to consider production schedules of wind and solar power plants in daily dispatch processes, thus guaranteeing the stability of the power system. When experiencing a growing share of weather-dependent energy production in energy supply, it is therefore of great significance to consider how a reliable and efficient forecasting system should be designed and implemented.

In Vietnam, the power system is dominated by the public utility EVN (Electricity of Vietnam) which is responsible for generation, transmission and supply of energy. Private companies are allowed to engage in power generation, as it is the case with the solar and wind power plants. EVN NLDC (National Load Dispatch Center) is the entity of EVN responsible for system operations. EVN NLDC is particularly affected by the strong and quick expansion of weather-dependent producing power plants since it needs to integrate their variable output into the power system. The regulatory authority is ERAV (Electric Regulatory Authority of Vietnam) which oversees the regulatory framework of the energy market.

The GIZ project "Smart Grids for Renewable Energy and Energy Efficiency" (SGREEE) supports project the Government of Viet Nam in the implementation of its Smart Grid Roadmap, which aims to promote the modernization and automation of the national power transmission and distribution system. Specifically, SGREEE supports in collaboration with an international expert pool its partners ERAV and EVN with know-how transfer to guarantee a smooth integration of renewable energy resources. energy & meteo systems forms part of the consortium for the expert pool and contributes with its vast knowledge in grid integration of variable renewable energies and management of distributed energy resources.

EVN has worked on a draft regulation for power forecasting which was presented to ERAV. As experts in power forecasting, energy & meteo systems was asked to provide comments on the proposed regulation.

1.2. Current situation in power forecasting

In consideration of the rapid expansion of large-scale solar power plants, EVN decided to launch an international tender in order to receive power forecasts from a service provider.

In 2019 a tender was launched to contract a company providing centralized forecasts to EVN. A private service provider was selected who now delivers EVN NLDC with power forecasts for large solar and wind plants with a minimum installed capacity of 20 MW. Solar and wind power plants with less than 20 MW are currently not covered by the predictions.

In addition to this move towards a centralized forecasting system, there have been considerations that solar and wind power plant owners should as well be obliged to submit power forecasts for their assets to EVN NLDC.

As a first step, EVN has sent a letter no. 1404/EVN-KTSX to ERAV on 11th of March 2020 with a draft regulation denominated "On technical requirements for the forecast on vRE power plants´ power generation capacity." The document outlines a possible power forecasting regulation in Vietnam which would oblige every operator of a solar or wind power plant with more than 10 MW to provide power forecasts.

1.3. Objective and approach of this study

The above-mentioned proposal sent by EVN to ERAV aims at implementing a decentralized forecasting system. International best practices show, however, that centralized forecasting systems are perceived as beneficial and prevail on a global scale.

Hence, the approach is to split this report into two parts.

In the **first part**, the proposed regulation is reviewed and commented. The goal is to give expert advice how the regulatory framework can be improved, drawing from international state-of-the-art in power forecasting. While commenting the regulatory issues, the effort and challenges of managing a decentralized power forecasting system will become clear as well.

In the **second part**, the report raises the fundamental question of the advantages and disadvantages of a centralized versus a decentralized forecasting system. The goal is to provide decision-makers in Vietnam with crucial information on best practices of implementing an efficient power forecasting system. This is considered highly important since Vietnam is about to take fundamental decisions on its future prediction system. In order to transfer international experiences with decentralized forecasting systems, brief showcases from the Dominican Republic and Mexico are presented.

Chapter 02

Review of Draft Regulation on Power Forecasting in Vietnam

2. Review of the Draft regulation in EVN letter no. 1404/ EVN-TKSX dated 11th March 2020

2.1. Article 1: Adjustment scope

This article defines that forecasts should only be provided for vRE power plants with a minimum installed capacity of 10 MW. It is recommended, however, that also smaller solar and wind power plants should be covered, starting e.g. at 3 MW. The selection of the size depends on the current distribution of plant sizes. Even though this plant segment between 3 MW and 10 MW might currently not account for much of the installed capacity this might change in the future. Therefore, it is suggested to include them in power forecasting in order to avoid a lack of transparency regarding their power output.

Along with the development of the solar market in Vietnam, the minimum plant size probably needs to be reviewed and adjusted in the future. When considering to further significantly reduce the minimum size of the plant size it should be considered that the costs for power forecasting can become a substantial cost factor for investors.

2.2. Article 3: Interpretation of terms

In this article, the regulation lists a number of terms which are defined. Under no. 6, “available capacity” is defined as the “maximum generation capacity produced from primary energy (wind, solar radiation) and is not limited to the grid”.

It is not entirely clear how “available capacity” is defined. The gross available capacity is determined by the meteorologically possible production/feed-in. It seems the given definition takes into account limitations due to e.g. curtailments resulting from grid congestions. Nevertheless, it remains unclear if maintenance periods are considered as well in determining the available capacity of solar and wind power plants.

2.3. Article 4: Timeframe requirements for forecast on vRE power plants´ power generation capacity

Article 4 suggests to define different forecasting horizons with different requirements, starting from intraday up to month-ahead forecasting.

It is recommended not to oblige the plant owner to send month-ahead forecasts. NWP based forecasts only cover a time horizon of about 15 days. Consequently, also power forecasts do not deliver useful results beyond this timespan. Forecasts beyond this time horizon have statistical ground.

Except for the first forecasting hours which can benefit from shortest-term predictions which are based on live measurement data, the forecasting error increases nearly linearly. The increase of the forecasting error (RMSE) is shown for a portfolio of wind farms in Figure 2-1. The error of predictions after 15 days increases drastically and does not deliver useful information on the future production schedule of a wind or solar power plant.

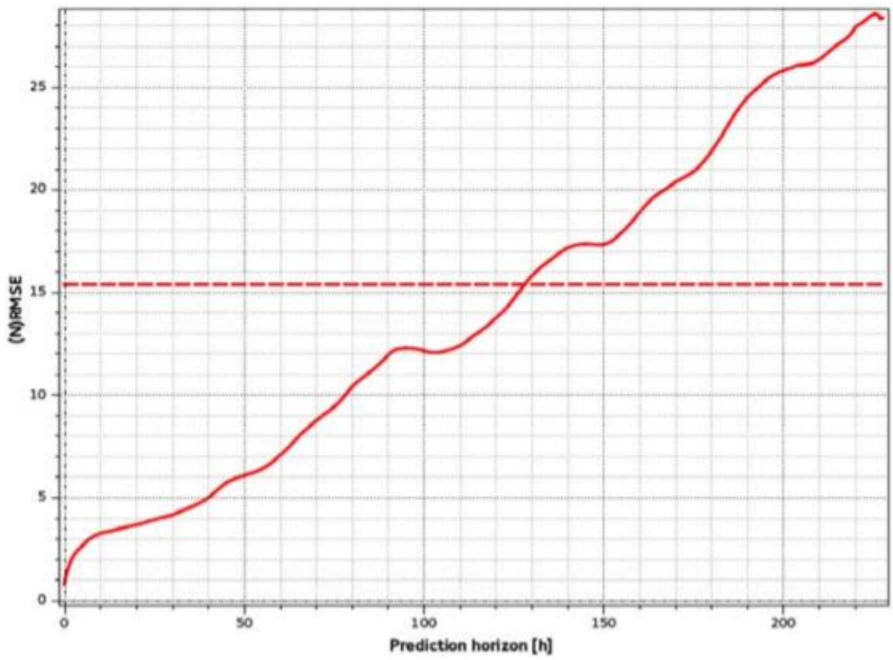

Figure 2-1: Forecast accuracies with regards to prediction horizons for large wind energy portfolio. Source: energy & meteo systems

As a conclusion, it is recommended to limit the forecasting horizon to a maximum of 15 days.

2.4. Article 5: Forecasting methods

Article 5.1 Forecasting methods

It is important to guarantee that EVN receives power forecasts with a high accuracy. Nevertheless, it is suggested not to define a choice of applicable forecasting methods. Rather, it should be left to the plant owner to choose a methodology which produces the best results. Hence, it is recommended that the regulation should not include Article 5.1 or it should simply be mentioned that state-of-the-art-technologies for power forecasting should be applied.

Article 5.2 Requirements for forecasting methods

Article 5.2. b) states that "random errors must be within the allowable limits stipulated by this Regulation". Nevertheless, the regulation does not define the consequences if the error measures are beyond the limits. A penalty scheme which could be applied is not described.

2.5. Article 6: Assessment on generation capacity forecast signals

Article 6 deals with the important issue of evaluating the accuracy of the power forecasts. The forecast accuracy is generally evaluated by considering the deviations between actual power generation and the power forecast data of a specific time period. To evaluate renewable power forecasts a variety of error measures is used which summarize the forecasting error over certain time periods.

As a method to evaluate the accuracy of power forecasts Article 6 suggests the selection of a simple relative error (RE). The formula is

$$RE_i = \frac{\left|P_i^{db} - P_i^{tđ}\right|}{P_{đm}}$$

In which:

REi: relative error of the ith forecast signal, %

Pidb: forecasted value of the ith forecast signal, MW

Pitđ: actual value of the ith forecast signal, MW

Pđm: nominal power of a power plant, MW

The relative error is the absolute error (=difference in MW between forecasts and measurement) divided by the installed capacity of the power plant. This approach, however, would lead to evaluating every single forecast and measurement value which is too complex to manage and not expedient.

It is suggested to apply instead internationally widespread and more practicable error measures which calculate error measures for a certain period of time

Widely used statistical error measures are:

- **Mean Absolute Error (MAE):** MAE is an average of the absolute difference between predicted and actual value, hence a RE for a longer period of time. The MAE provides a good overview of the average deviations that occurred in a time period. It is, in particular used for tracking imbalance costs. This error measure is most common and used by International System Operators (ISO), grid operators and power traders. This is the international standard error measure (80%)

$$\mathrm{MAE} = \frac{1}{n}\sum_{i=1}^{n}|x_i - x|$$

- **Root mean square error (RMSE)**: The RMSE represent the square root of the quadratic mean of difference between predicted and actual value. The RMSE gives a higher weight to large forecast errors, i.e. few large deviations dominate this error measure. The RMSE is used by some European TSOs.

$$\mathrm{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}$$

In addition to selecting MAE or RMSE as error measure, it is recommended to define also the **bias**. The bias indicates systematic errors, i.e. it can show a drift towards general over- or underestimation of power output by plant owners. It is, for example, very useful to detect unannounced curtailments because this leads to a permanent overestimation by the forecasts.

The normalization of the error metrics is another important issue to be able to compare the forecast accuracy of different sites or portfolios. For this purpose, the error measure can be divided by installed capacity, average output or actual forecasting values. It is up to the user to decide which normalization is required.

2.6. Article 7-9: Forecasting requirements for different time horizons

Articles 7-9 define how forecasts should be submitted to EVN for the different forecasting horizons. This includes resolution, forecasting timeframe, update frequency, required forecasting data and the calculation of the forecasting accuracy.

In the following, the most important observations are listed:

- Resolution:

The regulation proposes different resolutions of the power forecasts depending on the prediction horizon. It is recommended, however, to choose a resolution of the power forecasts of 15 minutes for every prediction horizon. Especially regarding solar power plants larger resolutions miss to reflect adequately steep ramps in solar production. **Error! Reference source not found.**2 shows that using hourly averages causes already considerable errors even though the forecast is good and describes the middle value of the corresponding hour.

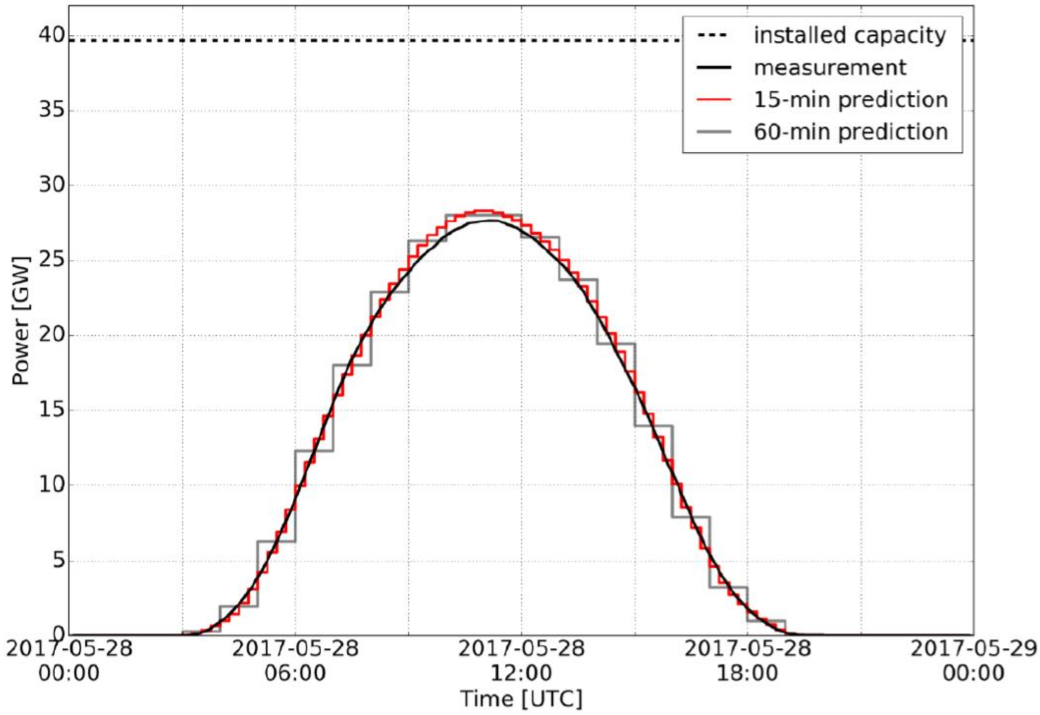

Figure 2-2: Impact of forecast resolution on prediction accuracy, Source: energy & meteo systems

- Forecast signals:

The regulation proposes to require the plant operators to send forecast data not only for power output and plant availability but also include additional data. For solar, the regulation asks for GHI and environmental temperature, regarding wind plants for wind speed and direction, environmental temperature and pressure.

It is, however, not the international standard that forecasting providers need to deliver these data in addition to the generation forecasts. Besides, the data would need to be specified. For instance, regarding pressure and wind speed the regulation would need to define for which height it should be forecasted.

Apart, it is very questionable if NLDC can deal with these data in a meaningful way and gain any valuable insights. Hence, it is strongly advised to focus on power forecasts and the availability of plants.

- Qualification of forecasts:

The proposal suggests to determine this error measure for every single forecast value submitted with every update to EVN. This approach, however, is not state-of-the-art in power forecasting. In the first place,it is a very complex procedure. The analysis will bind vast resources at the system operator which is highly inefficient. Second, the owners of the solar and wind power plant will hardly be able to maintain their forecasts within given error margins if every single of their forecast values is compared to the respective measurement value and considered in the evaluation. Eventually, experience shows that the complexity of forecast error analysis will provoke discussions with plant owners on the methodology of calculation. This is particularly the case when the forecasting systems is linked with a penalty scheme which obliges the plant owner to pay fines in case of submitting “bad” power forecasts.

Instead, it is advisable to choose the MAE as a common error measure. The value of the MAE should be defined separately for wind and for solar. The tolerance band for each technology must take into consideration that each site has its challenges regarding forecasting accuracy. In general, the **forecasting errors increase on average with increasing complexity of the terrain**, i.e. hills and mountains affect the precision of predictions. This is mainly related to the fact that Numerical Weather Prediction (NWP) models cannot consider every detail, e.g. wind speeds due to local channelling effects or solar irradiance due to the occurrence of fog in valleys. Of course, also wind and solar conditions have an impact on the level of the error measure. In particular, wind farms with very good wind conditions can generate a higher RMSE even in flat terrain or offshore. In sum, higher forecasting errors cannot be interpreted per se as bad forecasting accuracy but need to be related to technology and the individual site.

Error! Reference source not found.3 demonstrates the large spread of forecasting accuracy (day ahead forecast of wind farm) for single sites (left column) between 10 and 20 percent RMSE normalized to installed power which can be mainly attributed to their different locations.

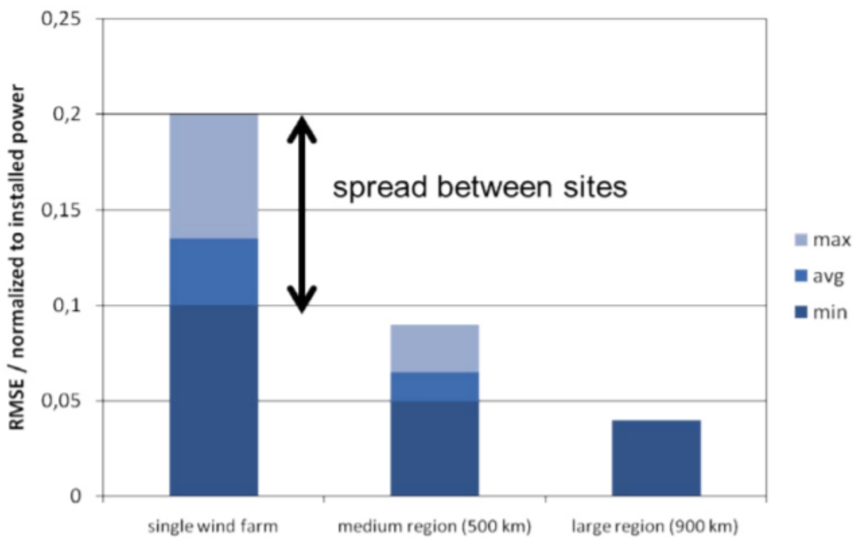

Figure 2-3: Forecast accuracies for different aggregation types and sites, Source: energy & meteo systems

A concrete example can be given from Mexico where energy & meteo systems provided as part of a GIZ consultancy project solar and wind power forecasts to the Mexican system operator CENACE. In the diagram below the development of the MAE for short-term, intraday and day ahead forecasting of single wind parks in Mexico is presented. While for example the 5 hours-ahead MAE was on average between 11-12 %, the MAE results for individual farms ranged between 7% and 17%. This demonstrates the huge effect of climatic and geographical conditions in individual sites on the accuracy of power predictions.

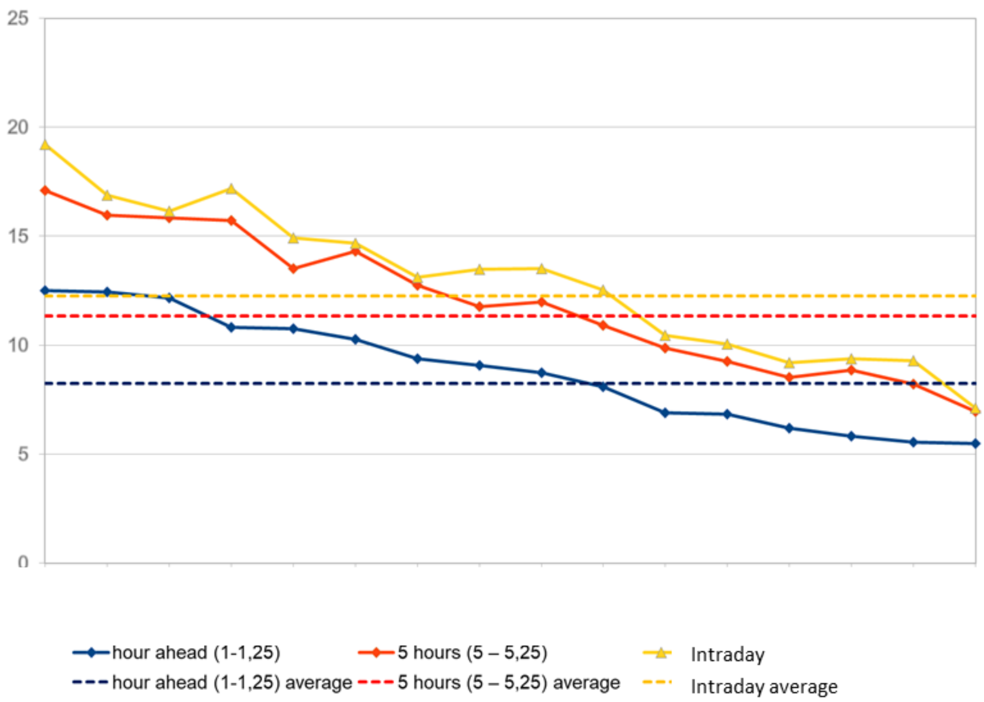

Figure 2-4: Spread of forecast accuracies for different sites in Mexico, Source: energy & meteo systems

Furthermore, it should be considered to adjust the MAE to climatic seasons. For instance, the forecasting error for wind power in Germany is continuously lower in summer than in autumn. This effect is shown in the diagram below for a day ahead forecast for a single wind park. The chart shows that the MAE and RMSE are generally higher between September and February than between March and August.

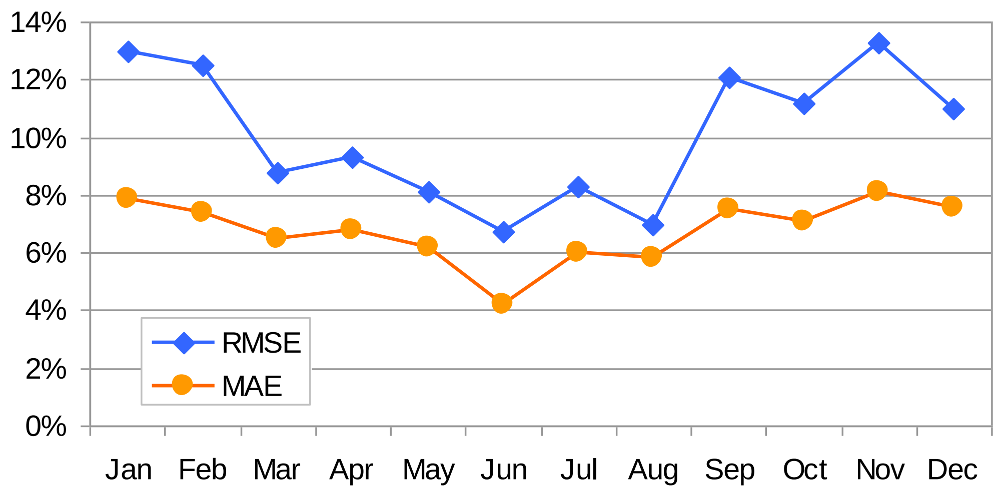

Figure 0-5: Day ahead MAE and RMSE for single wind park in Germany. Source: energy & meteo systems

As a conclusion, it is suggested to define corridors for forecasting errors for each technology, wind and solar, which reflect the diversity of site characteristics in Vietnam.

Please find further details on forecasting of variable renewable energy sources in the Best Practice Study [1].

2.7. Article 10: Month-ahead (M+1) forecasting

As mentioned previously, month-ahead forecasts do not provide useful information which is why this article should not be considered.

2.8. Article 12: Connection requirements

This article suggests that plant owners should send their forecasts using IEC 60870-5-104 protocol. Compared to the usual standard it is considered too detail-oriented to define interfaces which can change with technological progress in the future.

2.9. Article 13: Network security and safety requirement

The article aims at obliging plant owners to meet certain IT security standards but the formulation that they “should be equipped with firewalls and security control systems” is not very precise. It should rather be defined that the sender of the data needs to procure that the submitted data do not harm the IT system of the receiver of the forecasts, e.g. caused by computer viruses.

Furthermore, the article could refer to the general availability of the forecast data. For example, it could be defined that on average at least 99.5 per cent of the forecast data need to be submitted on time as defined in the regulation.

2.10. Appendix

In the appendix of the regulation several tables suggest how the plant owners should submit the forecasting data to the system operator. It is generally a good idea to standardize the format of the forecasts (especially, as here, in case of several forecast providers) to enable an efficient processing of the data. Two aspects are missing in the tables:

First, it should be agreed if the forecasts should be sent in .csv, .xml or another format.

Second, it needs to be defined if the timestamp marks the beginning or the end of the forecasting value, e.g. if the value for 7:30 am refers to the time period between 7:15 and 7:30 am or between 7:30 and 7:45 am.

Appendix 10 describes the forecasting methods. As discussed earlier, the regulation should not define forecasting methods but focus on the forecasting results.

Chapter

03

Introduction to international best practices in power forecasting

3. Introduction to international best practices in power forecasting

3.1. Centralized versus decentralized forecasting systems

Vietnam is about to take the fundamental decision how to design its future power forecasting system. For this reason, it is considered important to provide essential information on possible forecasting approaches and respective international experiences.

In general, two forecasting concepts can be distinguished, the centralized and the decentralized forecasting system.

In the **centralized forecasting system**, one central entity, most often the transmission system operator, organizes directly the prediction process. This can be done by either setting up an inhouse solution or by contracting a professional service provider (external solution).

- In case of the inhouse solution, the software is operated on the TSO´s servers to generate forecasts. This requires, among others, extensive training of staff, recruitment of meteorologists, investment in IT infrastructure and the purchase of weather forecast data from meteorological service providers.

- In case of the external solution, the TSO conducts a tender to contract one or more professional vendors of solar and wind power forecasts. The needs of the TSO are specified in the tender and the vendor receives the standing data from the solar and wind power plants and, if available, historical measurements, to set up his forecasting model. The vendor then sends the power forecasts with defined resolution, updates and in the required format to the TSO.

Few grid operators decided for in-house solutions, e.g. the TSO of Denmark Energinet.dk. This TSO employs several forecasting experts and operates its own forecasting system. It was a strategic decision to put a lot of effort into the forecasting system. In addition to the in-house system, Energinet.dk also contracts forecasting vendors to improve the accuracy and to achieve a higher level of redundancy.

All of the German TSOs have changed to service solutions after they had supported the development of in-house systems 20 years ago. In co-operation with research institutes the in-house systems were only used for the first years. Since about 15 years the TSOs have switched over to contracting commercial forecasting vendors. The main reasons for this were higher forecasting accuracy of the vendors, high quality of service and the flexibility to change suppliers. Some of the TSOs carry out a strict benchmarking of the forecasting vendors, i.e. they produce evaluation reports on a regular basis, weekly or monthly, and send them anonymised to the different vendors. This puts pressure on each of the vendors to keep a good performance.

The vast majority of the TSOs worldwide chooses external service providers instead of building up in-house forecasting system. In the figure below the data flow is visualized for the centralized forecasting system where a professional forecasting vendor is contracted. In this case, the forecasting user receives measurement data from the solar and wind power plants and provides them to the forecasting service provider. The service provider, in turn, selects weather predictions from different NWP models. Based on the standing data, measurement data and the weather data, the forecasting provider creates power forecasts and provides them in the agreed format to the user.

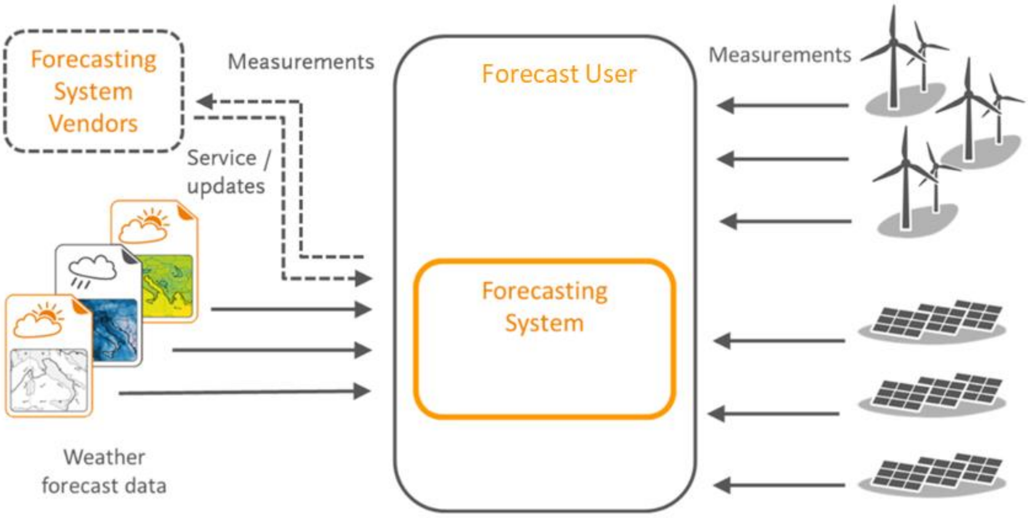

Figure 3-1: Data flow in centralized forecasting system with external service provider. Source: energy & meteo systems

In the **decentralized forecasting system**, the owners of solar and wind power plants are obliged to submit power forecasts to the TSO. The regulatory authority or TSO defines which plants (minimums size) need to send in which resolution, quality, update frequency etc. the forecasts. The plant operators, on their hand, either produce the power forecasts themselves or contract a professional service provider. In case there is a quality control established combined with a penalty scheme, the plant operators will tend to contract a service provider to procure a certain quality level and to avoid penalties.

In the figure below the data flow is visualized for the decentralized forecasting system. In this case each plant owner creates predictions for his solar and wind power plants and sends them to the user. The origin is denominated "black box" since it remains unclear for the system operator who creates the power forecasts which he receives.

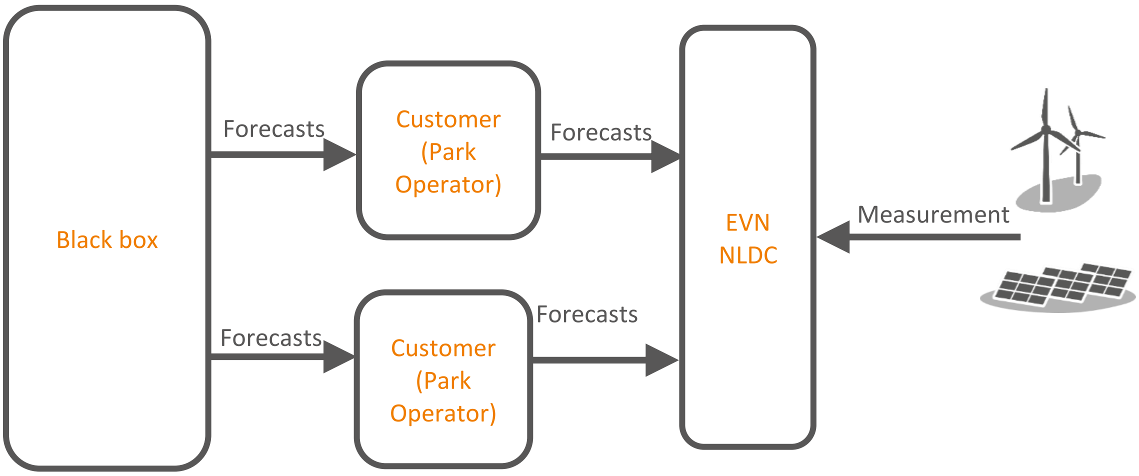

Figure 3-2: Data flow in decentralized forecasting system with predictions provided by plant owners. Source: energy & meteo systems

It is obvious that the centralized and the decentralized forecasting concept define different roles and responsibilities among the stakeholders. The characteristics and consequences of both approaches are compared in the following table.

	Centralized Prediction System	Decentralized Prediction System
Responsible entity	○ Administered by one entity, e.g. transmission system operator (TSO)	○ Administered by individual plant owner
Concept	○ Centralized forecasts provide system-wide forecasts for all VRE generators within a balancing area.	○ Decentralized forecasts provide plant-level forecasts which need to be aggregated
Forecasting costs	○ Inhouse solution: TSO has to invest in itsown forecasting system ○ External solution: TSO contracts via tender one or more external service providers ○ Smaller plants – especially solar – can as well be cost-efficiently integrated in the forecasts when plant data are available	○ Forecasting costs passed on to power producers ○ Likely to be more expensive on a system level since every single RES power producer needs to invest in power forecasts (no economies of scale effect) ○ Forecasting of smaller pv plants can be a cost burden for plant owner
Organization of forecasts	○ Standing data need to be collected and provided to forecasting provider ○ Sometimes no complete register with standing data available ○ Access to measurement data required to improve forecasts	○ Each plant owner creates power forecasts by himself or contracts a service provider ○ Standardized forecast data format needed for all power plants to facilitate data processing by the user

	Centralized Prediction System	Decentralized Prediction System
Quality aspects	○ Lower uncertainty due to the system operator's ability to aggregate uncertainty across all generators ○ Greater consistency in results due to the application of a single methodology ○ Independent and neutral results ○ Competition between forecasting providers ensures high quality ○ Comparison of different forecasts for the same plant is possible ○ Creation of optimized meta-forecasts which combine different forecasts is possible	○ Origin and applied methodologies for forecasting are unknown ○ Risk of systematic bias incentivized by penalty regime or market conditions ○ Diversity of accuracy levels ○ Usually only one forecast per plant available
Management of forecasts	○ Selected forecasting providers are only and direct point of contact ○ Small number of forecast providers facilitates data aggregation and processing	○ TSO has to deal with a high number of plant owners who on their hand need to coordinate with their providers ○ Time-consuming evaluation and penalty management ○ Complex task to implement suitable incentive scheme to guarantee a high forecasting accuracy but taking into account as well site-specific prediction challenges

Figure 3-3: Characteristics of centralized and decentralized power forecasting systems.
Source: energy & meteo systems

3.2. International experiences: Dominican Republic and Mexico

This chapter features some international experiences with different forecasting approaches in order to provide the Vietnamese decision-makers with information on international trends and best practices. For more information and examples please see [1].

In the following, two brief cases studies on the Dominican Republic and on Mexico will be presented which are considered illustrative for Vietnam. Both countries started with a decentralized forecasting system, obliging solar and wind plant operators to submit forecasted production schedules to the TSO. Yet, based on the experiences made so far, the decision-makers decided to switch to a centralized forecasting strategy. These country cases are representative for the international trend in power forecasting where the centralized approach now clearly prevails. According to own estimates, almost all of the power systems rely on a centralized power forecasting system. In less than 20%, the TSOs *additionally* receive power forecasts from the plant operators, for instance in India. Even in these cases, however, the data from the centralized forecasting systems are more accurate and therefore generally preferred for dispatch planning.

3.2.1 Shift towards centralized power forecasting: the case of the Dominican Republic

In 2019, energy & meteo system analysed the forecasting system of the Dominican Republic and provided expert advice to GIZ and the system operator how to improve the forecasting quality. The motivation for the consultancy was to identify the reasons why the power forecasts provided by the plant operators do not achieve a satisfying level of accuracy and which measures can be taken to improve the quality.

As of October 2018, a total of 264.2 MW of wind and solar plants were installed in the Dominican Republic, representing 7.4% of the installed capacity in the National Interconnected Electric System (SENI). From the energy point of view, the contributions of these technologies made up around 4.2% of the total energy generated. According to the information provided for the preparation of the long-term operation program of the SENI (2018-2021), it is expected that in the coming years some 391 additional MW will be added for a total of 662 MW. (12% of the total installed and 8% in energy).

The Dominican Republic currently has a decentralized forecasting system, obliging plant operators to submit power forecasts to the system operator OC (Organismo Coordinador). The plant operators submit their forecast every day the latest at 10:00 am for the next day with an hourly resolution. The agent can have an own estimation (in-house solution) or hire a provider, detailed information about where the forecast exactly comes from is not available to OC. This forecast can be used to plan the economic dispatch of the plant, but if OC considers it for some reason not to be useful, OC can decide to not use it.

There is no incentive in the regulations of the Dominican Republic for the plant owners to submit accurate power forecasts. OC reports that in some cases the plant owners fail to provide forecasts and that several forecasts have a poor or very poor quality.

Since the forecasts are used for the dispatch, OC reports that several problems are identified due to the low forecasting accuracy: mistaken planning of the plant economic dispatch, inaccurate planning of the reserve, inadequate results for nodal pricing and grid congestion. According to OC these issues lead to unnecessary high costs.

By creating own power forecasts and comparing them with the predictions submitted by plant owners for their wind and solar parks, energy & meteo systems could evaluate the level of accuracy and potential for improvement.

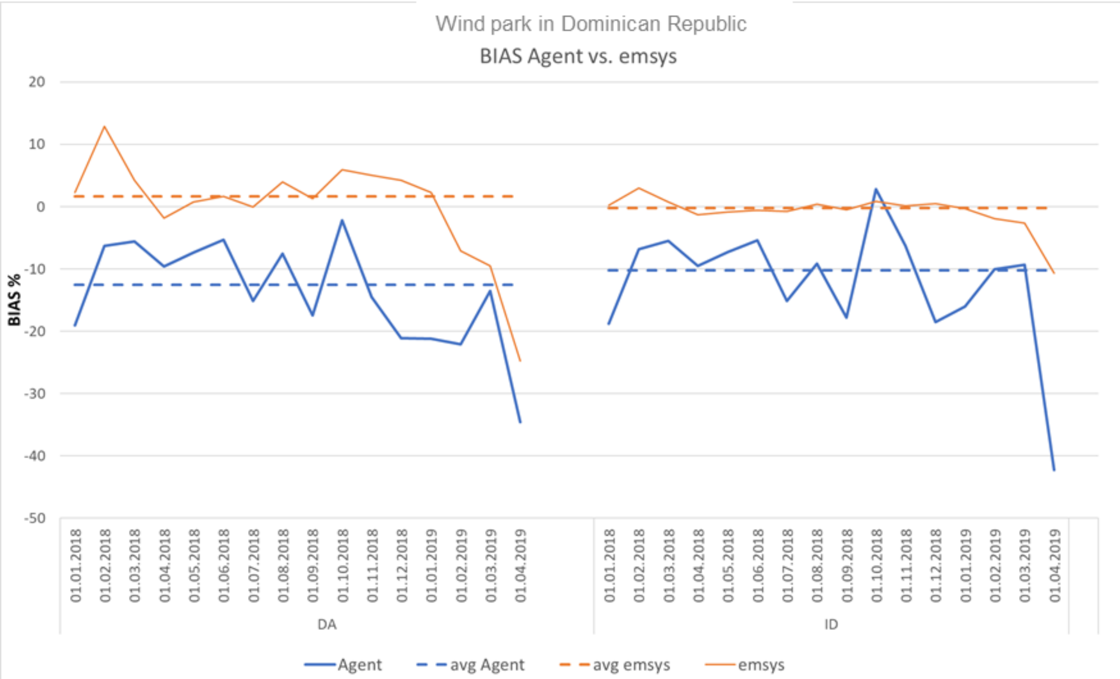

Figure 3-4: Day ahead and intraday BIAS for power forecasts from plant owner and energy & meteo systems in the Dominican Republic. Source: energy & meteo systems

As can be observed in the comparison of the forecasts provided by energy & meteo systems (emsys) and the plant operators (agents) the bias for day ahead forecasts and intraday forecasts of the agents is continuously negative. This indicates that plants operators systematically underestimate the production output of their plants. The MAE is given in the chart below and shows that centralized forecasts lead to substantially better results in comparison to the forecasts provided by the plant operators.

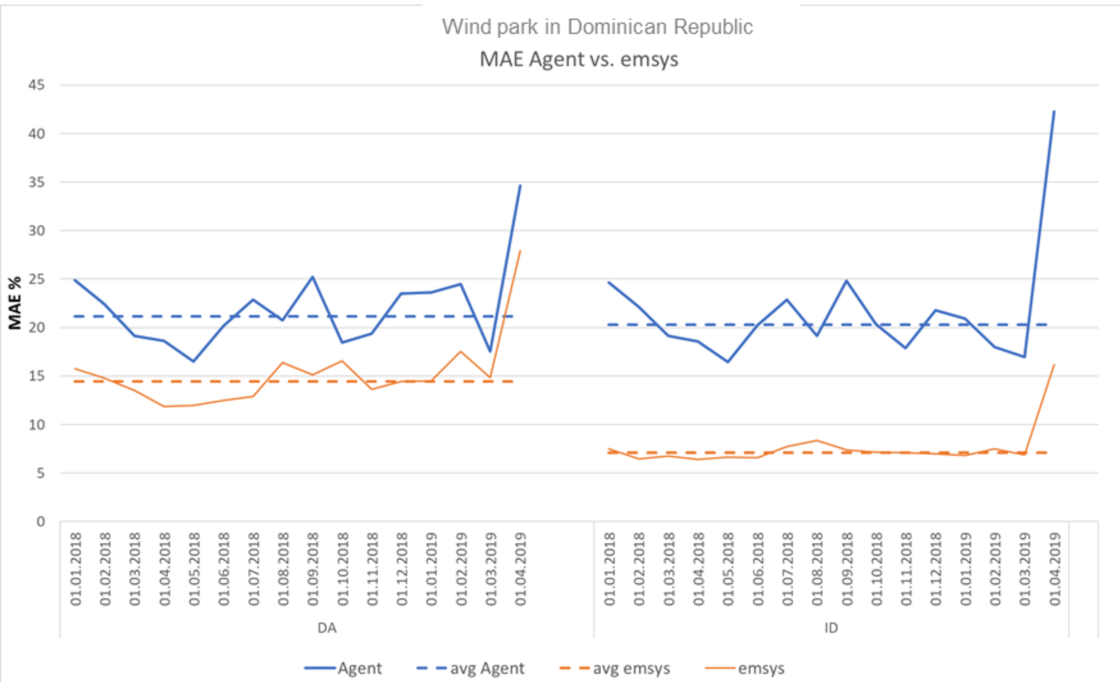

Figure 3-5: Day ahead and intraday MAE for power forecasts from plant owner and energy & meteo systems in the Dominican Republic. Source: energy & meteo systems

3.2.2 Shift towards centralized power forecasting: the case of Mexico

Mexico aims at rapidly diversifying its energy supply. Until 2024, power generation from renewable energies is set to reach 35 per cent. The long-term target is to achieve a share of 50 per cent by 2050. In the process of liberalization of the energy market and unbundling of the public utility CFE, private companies are now allowed to participate as well in the generation of energy. Driven by public tenders, large-scale solar and wind farms have been commissioned. At the end of 2019, more than 6.2 GW and about 4 GW of solar power were installed.

Within a Public Private Partnership (develoPPP) executed with the GIZ in Mexico, energy & meteo systems transferred know-how in power forecasting. The project included a one-year pilot phase during which energy & meteo systems provided the system operator CENACE with predictions for selected solar and wind power plants which accumulated to more than 2 GW of installed capacity. By then, CENACE only received power forecasts from the plant operators which are used to organize the dispatch process.

Notably, the forecasts sent by energy & meteo systems showed overall a significantly higher accuracy than those provided by wind and solar plant operators. CENACE compared both forecasts during the pilot phase and analysed that the medium error of the plant operators´ forecasts was 17 % in comparison to 13% for energy & meteo systems. The same was true for solar power where the forecasts of the plant operators showed an average deviation of 9 % while energy & meteo systems forecasting error of 6% was half as high. In the following, the evaluation elaborated by CENACE for the MAE regarding solar power in different Mexican areas is presented.

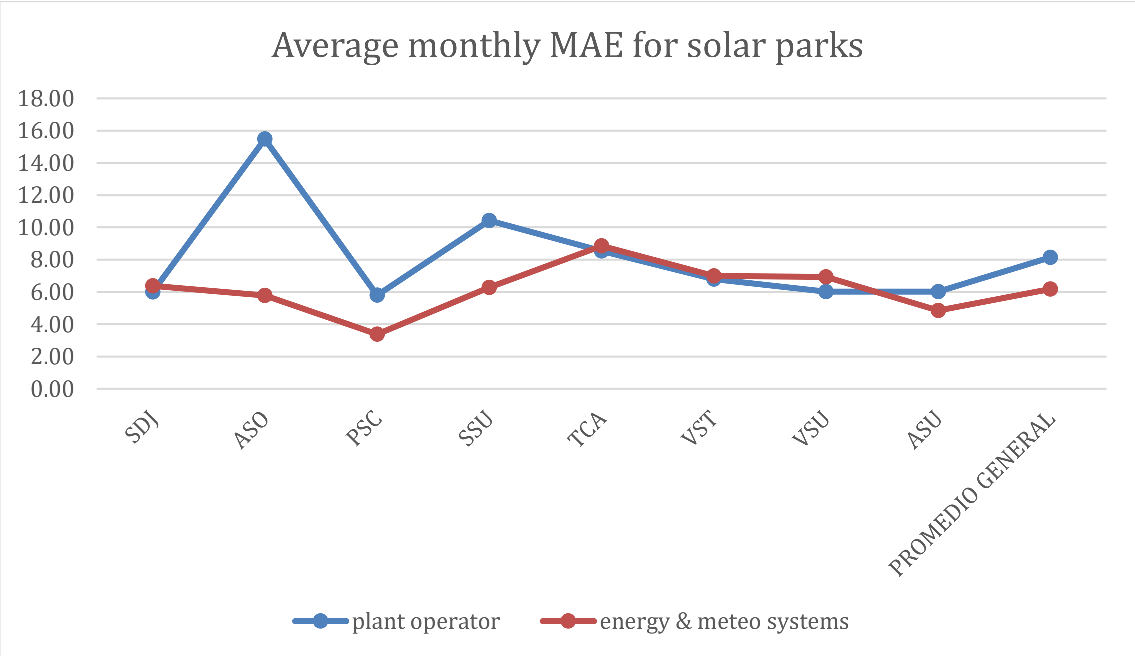

Figure 3-6: Average monthly MAE for solar parks in different regions of Mexico.
Source: energy & meteo systems

In general, plant operators tend to submit very low production forecasts. CENACE detected that the notorious sub estimation of forecasted production schedules led to the dispatch of more expensive conventional power units. CENACE considered higher dispatching costs a main consequence of inaccuracies in power predictions.

Drawing from this experience, CENACE decided to soon launch a tender in order to obtain neutral and independent power predictions from a professional provider.

Chapter

04

Conclusions

4. Conclusions

One crucial aspect when choosing a RE forecasting system is to weigh advantages and disadvantages of a centralized and a decentralized concept. Taking into consideration the international best practices, it can be stated that grid operators are in favour of contracting an external power forecast supplier instead of in-house power forecasting or decentralized power forecasts provided by plant operators.

Having external forecasters is generally considered to be beneficial because of the following reasons:

- they are neutral and forecasts are not distorted by incentives of plant owners
- having one or at least only few providers guarantees higher consistency and comparability of forecasted sites
- yearly contracts allow high flexibility in selecting power forecast providers (they can be conveniently changed upon nonperformance)
- if more than one forecast provider is contracted, optimized combination forecasts can be created
- no aggregation, quality control and management of a penalty system is required
- in-house systems are difficult, time-consuming and costly to operate and maintain
- due to economies of scale-effects, a centralized approach is more economic on a system level

With regard to the current situation in Vietnam, two further observations need to be considered as well.

First, considering the fact that current power purchase agreements with RE generators do not include the forecast liability, good decentralized forecasting may be difficult to implement in retrospect.

In addition, smaller to medium-sized solar plants would not be covered in a decentralized forecasting system. Nevertheless, these solar plants – which range from small rooftop PV systems to e.g. a 3 MW plant – can soon account for a substantial amount of the produced solar power in Vietnam. In Germany, for example, the contribution of rooftop PV systems to the energy supply has increased from 0.5 % in 2007 to 7.4% in 2019.

Hence, it is recommended that Vietnam should opt for a centralized forecasting system. Instead of obliging plant operators to submit power forecasts, it should be evaluated to hire a second external forecast service provider. This would enable EVN NLDC to compare the forecasting accuracy and create as well a competitive situation between both providers.

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