Wind Power Forecasting Data Definitions and Exchange Standards –

An Approach for a Recommended Practice Built Upon International Standards and an Eye Towards the Future

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***Abstract*—The current state of data definition standards in the wind power forecasting industry is presented. A recommended approach drawing from an established IEC standard is best suited to meet the two main type of forecast consumers. However, there are significant implementation differences based on the consumer experience level. The forecast provider (as well as the large portfolio consumer) will be critical to the education and successful adoption of data model standards in existence.**

Keywords—Forecasting, data standards, IEA, IEC

I. INTRODUCTION

The cost of integrating wind power forecasts today is higher than what it could be if efficiencies in data definitions and exchange were standardized. The cost is financial as it must be recovered by the forecast provider for additional human resource requirements (i.e., prolonged communication and education of consumers) or through imbalance penalties experienced by an energy market participant receiving a sub-optimal forecast configuration (i.e., less accurate wind power forecasts).

There have been significant advances in wind power forecast accuracy, timeliness of data exchange, and improvements to the underlying numerical weather prediction (NWP) models that form the foundation of these forecasts. However, these advances have not extended to general efficiencies or standards on how data is exchanged between the forecast provider and end user. Adding to this complication is that input observation and forecast data is defined differently by geographic region, turbine OEM, and commercial energy management systems (EMS). The lack of standards or best practices in data exchange and data definitions impacts the level of effort required to communicate properly forecast inputs or, more severely, a sub-optimal wind power forecast configuration that yields larger forecast errors than what would be achieved with a common data definition and understanding.

The International Energy Agency (IEA) research task 36 is focused on wind power forecasting. There are several work packages within this task geared towards both the improvement of weather prediction and the optimal usage of the forecasts [1].

II. CURRENT DATA DEFINITION MODELS

There are over 30 commercial providers of wind power forecasts with at least twenty times the number of end users globally. Commercial forecast providers take it upon themselves to streamline the data collection process which usually involves creating templates in email, spreadsheet, or API form. The terminology used by a commercial provider of wind power forecast to define the inputs required to configure the forecast system does not reference a common international standard or data model. Similarly, end users of forecasts who issue requests for proposals or conduct trials or benchmarks of wind power forecasts fall back to internally used definitions that, in many cases, are adopted from load forecasting or from terminology used for electric energy nomination from fossil fuel sources. Thus, the potential for mis-communication is quite high. Of course, the earlier the common understanding of the data definitions is reached between provider and consumer in the forecast set up process, the less costly.

The European Network of Transmission System Operators for Electricity (ENTSO-E) has established data definition standards using a common information model (CIM) with adherence to the IEC 62325-450 methodology [2]. This IEC standard is related to deregulated energy market communications of which most of the ENTSO-E members currently operate. The main advantages of adopting this standard are data definitions are unambiguously defined, the XML Schema Definition is well documented, the attribute-value tables structure is extensible to other renewable resources, and the documentation is publicly available.

No other standard for data definitions has been established internationally, but there are national and international wind and solar power forecasting activities that are implementing or publishing best practices with their own data models. One such activity is the US Department of Energy Solar Forecast Arbiter [3]. The Solar Forecast Arbiter is an open-source platform for conducting solar power forecast benchmarks. Data definitions are clearly articulated in the data model defined for this project. Wind energy operators have for years dealt with non-standard SCADA tag list names and have thus formed a coalition called ENTR that aims to establish an open source technology standard to benefit the wind industry (see https://www.entralliance.com/). This coalition represents wind power forecast end-users that will adopt data models that improve the efficiencies of data communication and dissemination.

III. Data exchange methods currently in use

Due to the diversity of forecast consumers (e.g., energy traders, TSOs/ISOs, independent power producers, utilities), there are several methods of exchanging meta-, realtime- and forecast data. This includes (s)FTP, REST API, SOAP messaging protocols, and even email. For most small users or those that are new to wind power forecasts, the normal mode of exchange is by (s)FTP or, in rarer cases, email. For larger end users with a portfolio of wind assets or experience using wind power forecasts, a number of different methods may be used, but the most common are (s)FTP and API. There currently doesn't exist a standard nor a best practice for the method of data exchange. This might be partly due to the fact that IT security protocols and regulations vary by country and even by company. What is clear is that the prevalence of REST APIs is growing as it's an open source solution and not binded to any particular programming language, tool or computer platform.

IV. A model to support most use cases

With the continued and accelerated increase in the number of renewable energy power plants globally, a ramp up in the number of wind power forecast consumers is occurring. Many new users have little to no experience interacting with forecast information. To develop best practices for data definitions and exchange methods, a model needs to be developed that accounts for this growing and large user group that might not be equipped to handle the technical details or structured requirements put forth by ENTSO-E.

We propose two levels of standardization: (i) high level with standard terminology and (ii) repeatable / scalable with standard terminology. The latter level of standardization is suited for TSOs, DSOs and large portfolio owners. For this more experienced group of users, the ENTSO-E model satisfies the objectives of putting forth a best practice for both data definitions and exchange. For the "high level with standard terminology" level geared towards new, less experienced users, it's still important to use the CIM established by IEC, but the logical layers of the different data need to be articulated and illustrated in an easy-to-interpret document. Figure 1 illustrates the natural segregation between master (or static) data, dynamic data, forecasts, and forecast metadata.

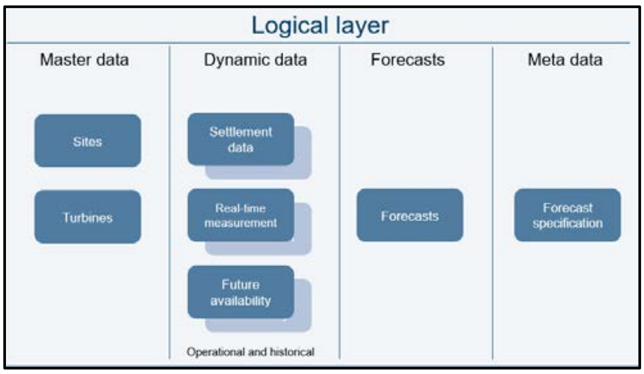

Fig. 1. Illustration of the different data layers required for wind power forecast configuration.

The four distinct labels are important to note since similar data fields might appear in both historical observations, real-time observations and in the forecasts.

Both levels of standardization proposed will use the CIM in existence today, but for high level users not participating in energy markets, there's an additional layer for communicating the definitions that sits between the forecast provider's standard data interface (e.g., spreadsheet) and the forecast engine.

V. Outlook for the future

Probably the most forward-looking example of data definitions and exchange standards is being formulated by the European Telecommunications Standards Institute (ETSI) in coordination with other organizations and projects such as the ambitious Horizon 2020 research and innovation initiative (https://ec.europa.eu/programmes/horizon2020/). This is a broad effort across many industries, but energy, IoT and Smart Appliances will encompass data standards in use today by organizations such as ENTSO-E. In fact, the Smart Appliances REFerence (SAREF) ontology has already developed extensions to align to existing standards in energy management [4]. As the proliferation of rooftop PV, electric vehicles and smart appliances and meters continues, the impact on the electric grid and the need for standard data definitions and exchange methods will become ever more essential.

Considerable thought and careful documentation have already been put into establishing a wind power forecasting data model standard (i.e., 62325-450). And, even with the best of intentions, without adoption and "buy-in" by both forecast providers and end-users, the transition to the standard will be haphazard. Sadly, this is the current state and a pressing issue. Focused Task force groups like the International Energy Agency (IEA) could, and perhaps should, serve in the capacity as bridging and promoting standard adoption by members that include both forecast providers and consumers.

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