



**HAL**  
open science

# Forecasting Extremes of Aggregated Production from a RES Virtual Power Plant

Simon Camal, Andrea Michiorri, Georges Kariniotakis

► **To cite this version:**

Simon Camal, Andrea Michiorri, Georges Kariniotakis. Forecasting Extremes of Aggregated Production from a RES Virtual Power Plant. Proceedings of the Wind Energy Science Conference 2019, EAWE - European Academy of Wind Energy, Jun 2019, Cork, Ireland. hal-02158589

**HAL Id: hal-02158589**

**<https://hal.science/hal-02158589>**

Submitted on 18 Jun 2019

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Keywords: Probabilistic Forecasting, Virtual Power Plant, Extreme Values.

## Forecasting Extremes of Aggregated Production from a RES Virtual Power Plant

S.Camal<sup>a</sup>, A. Michiorri<sup>a</sup>, G. Kariniotakis<sup>a</sup>

Transmission System Operators (TSOs) expect Renewable Energy Sources (RES) to participate to the provision of Ancillary Services (AS), in order to substitute conventional dispatchable power plants. A promising solution to ensure a sufficiently reliable provision of AS by weather-dependent RES is to aggregate dispersed plants into a Virtual Power Plant (VPP), so that the total production shows reduced uncertainty. Most AS markets operate at short-term horizon, typically for the day-ahead, and require that the service shall be provided with a minimal frequency of underfulfilment (i.e. reliability close to 100%). Therefore a Wind-PV-based AS offer must be based on an accurate forecast of the production uncertainty. A probabilistic forecasting model of the aggregated Wind-PV production based on machine learning has been developed in [1] and proved reliable down to the 1%-quantile of the production distribution. However for rare events (quantiles below 1%), the reliability of state-of-the-art machine learning models is known to deteriorate, mostly because of their lack of generalization on unobserved data [2]. We propose here two models specifically designed for a better forecast of the extremes of the distribution: the first model is based on the Extreme Value Theory (EVT) [3], and the second model is based on a quantile regression by a Deep Neural Network (DNN).

The EVT extrapolates extreme production levels from a collection of observations over a threshold, which is used to generate a probabilistic forecast following a Generalized Pareto Distribution. A specific challenge is to assess which inference method (Maximum Likelihood, L-Moments, Bayesian) is the most adapted to the problem of aggregated production forecast. The motivation behind the use of a DNN is to capture regular patterns of interdependence between energy sources at different spatio-temporal scales, which could not be detected by tree-based machine learning models such as Quantile Regression Forests, and explain the multiple conditions leading to very rare production levels.

We evaluate our forecasting models on a VPP of 200 MW comprising Wind, PV and run-of-river hydro plants in operation in France and Germany, with 2 years of data available. We find that the EVT and DNN approaches show improved reliability on the lowest quantiles when compared to a state-of-the-art machine learning model (Quantile Regression Forest).

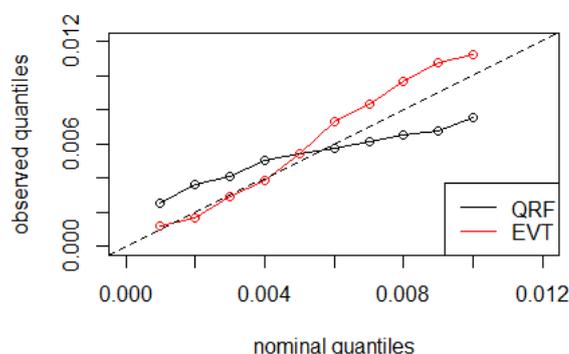


Figure 1: Reliability Diagram for forecasting model EVT and QRF (state-of-the-art)

[a] Mines ParisTech, PSL University, Center PERSEE, 1 rue Claude Daunesse, Sophia Antipolis, France

[1] Camal et al., *IEEE Transactions on Power Systems* **33-6**, p.6155-6170 (2018)

[2] Matos et al., *PMAPS 2016*, p.1-7 (2016)