Associated publication: Ana Lagos, Joaquín E. Caicedo, Gustavo Coria, Andrés Romero Quete, Maximiliano Martínez, Gastón Suvire and Jesús Riquelme, "A Critical Review of Wind Speed and Power Forecasting Methods Applied in Modern Power Systems"

This directory contains the details regarding the articles cited in this literature review, their belonging cluster, taxonomy and details about the input variables of the model, sampling times, data set used, country of precedence, and finally the models used to validate each of the proposed methods. According to the reviewed literature, the most used taxonomy to classify forecasting models by time horizon consists of very short, short term, medium, and long term. Therefore, in this paper, the reviewed articles are classified based on the aforementioned, and 4 tables are constructed based on very short, short term, medium, and long term.

1. Very short term

Table 1 provides details of the articles analyzed in this literature review related with very short term. Of the 80 articles studied, a total of 44 were categorized within this time horizon.

2. Short term

In the case of short-term articles, this category is made up of 31 articles. Table 2 provides further details regarding each of the categorized articles. The references with more than one time horizon and that qualify as very short and short-term models are [12], [16], [24], [61], [63], [78], these have been excluded from Table 2 considering that they are repeated and have been previously detailed in Table 1.

3. Medium term

The medium-term models include a total of 11 articles, see Table 3. The references that qualify as very short-term ([12], [24], [51]) and short-term ([11], [12], [24], [29], [62]) models have been excluded from Table 3, since they have already been previously detailed in Tables 1 and 2.

4. Long term

A total of 9 articles were established in this category. The references with more than one time horizon, and that classify within the very short-term models are ([12], [51], [55]), the short-term models ([12]) and finally the medium-term ones are ([12], [51]), these articles, as in previous cases, they have been omitted from Table 4, considering that they have been previously detailed.

Table S1. Very short-term bibliographical references.

Cluster	Reference	Prediction objective	Forecasting applied to	Forecast Horizon	Dataset (inputs; period; sampling horizon; location)	Uncertainty modelling	Forecasting method	Proposed model	Validation models
1	[9]	Wind speed	DG	1 h	Wind speed and direction, temperature, irradiation; --; 10 min average values; Serbia	Probabilistic	AI	ANN; Uncertainty: Fuzzy set theory	Compared with real wind speed data
1	[10]	Wind power	Wind farm	1 h	Meteorological data collected at different locations over the wind farm; 01.2013 - 10.2015; 1 h; Spain	Deterministic	Hybrid	Optimizacion: ACO; Forecasting: ELM	Montecarlo simulations
1	[12]	Wind power	Wind farm	1 h and can be taken in days, h, and any other format	Wind speed and direction, zonal and meridional components, weather predictions of current and past 24 h and power measurements; 3 years; 1 h; ECMWF	Deterministic	Hybrid	WN-LSTM	SVR, ARIMA, GPeANN
2	[16]	Wind power	MG energy management	1 and 5 h	Wind power; 09.2015-10.2016; 1 h; China	Deterministic	Hybrid	BP, GA	SVM and BP
3	[21]	Wind power	Wind farm	1 h	Wind power; 1 day; 5 min; Australia	Deterministic	AI	FN	ANN, Persistence model
4	[24]	Wind speed	MG	1, 24 and 48 h	Cloud parameterization, land surface models, atmosphere-ocean coupling, broad radiation models and historical wind speed data; --; 15 min; Chile	Deterministic	Physical	NWP, WRF	Wind speed measurement

4	[27]	Wind speed	MG	1 h	Wind speed; 10 min	Deterministic	AI	GA, BPNN	Compared with real wind speed data
5	[30]	Wind speed and power	Wind farm	1 h	Wind speed and power; 12.01.2003 – 11.30.2004; 1 h; Taiwan	Deterministic	Hybrid	Preprocessing: EMD; Forecasting: BPNN	ANN, ARIMA, Persistence model
5	[33]	Wind power	Wind turbines	10 min	Wind speed; 12 months; 10 min; South Africa	Deterministic	Hybrid	Optimization: GA, PSO; Forecasting: ANFIS	GA-ANFIS; PSO-ANFIS
5	[35]	Solar radiation and wind speed	Hybrid solar/wind renewable energy systems	1 h	Current time, cloud identification quality, sun angle altitude and azimuth, air temperature, relative humidity, atmospheric pressure, perceptible water; 1999 – 2019; 1 h; Jordan and Oman	Deterministic	AI	BPNN	Solar radiation and wind speed measurements
7	[45]	Wind speed	MG intelligent management	1 h	Wind speed; 01.01.2013 – 01.01.2014; 1 h; Canada	Deterministic	Hybrid	Preprocessing: MRA; Forecasting: Adaptive WNN	Persistence model
7	[46]	Wind power	Wind farm	15 min	Wind speed and direction, temperature, output power; 01.01.2012 – 12.31.2012; 15 min; China	Deterministic	Hybrid	Preprocessing: Pearson's correlation; Forecasting: BPNN, RBF, LSSVM, ANFIS	BPNN; RBF; LSSVM
7	[47]	Wind speed	Wind farm	10 min	Wind speed; 1 year; 10 min; China	Deterministic	Hybrid	Preprocessing: EMD; Optimization: BA; Forecasting: BPNN, ENN, ARIMA, SVR	EMD-ARIMA; EMD-BA-ENN; EMD-BABPNN

7	[48]	Wind speed	Wind farm	1 min	Wind speed; 05.01.2017 – 05.31.2017; 1 min; India	Deterministic	Hybrid	Preprocessing: EMD, Pearson's correlation; Forecasting: Modified fuzzy Q learning	SVR; kNN
7	[49]	Wind speed	Not specified	3, 9, and 15 min	Wind speed; 3 datasets of 1000 records and 1 dataset with 600000 records; 3 min; China	Deterministic	Hybrid	Preprocessing: EWT, Distributed computing; Forecasting: ELM	Persistence model; CEEMD-ELM; EEMD-Structural Decomposition Analysis-ENN
7	[50]	Wind direction	Wind turbines	10 min	Wind direction; 07.11.2014 – 11.22.201; 10 min; Iran	Deterministic	Statistical	ARFIMA	Wind direction measurements
8	[51]	Heat demand	Production planning	1, 72 and 168 h	Heat and weather factors, social components; 20 full weeks; 1 h; Finland	Deterministic	Statistical	Simple regression model, SARIMA	Linear Regression Models
8	[52]	Wind speed	Operation planning	10, 30 and 60 min	Wind speed; February to July; 10-30-60 min, China	Deterministic	Hybrid	Preprocessing: BSO-Ssa; Forecasting: generalized DFNN	FNN and SSa-GDFNN
8	[53]	Wind speed	Operation planning	10, 20 and 30 min	Wind speed; January to July; 10 min; China	Deterministic	Hybrid	Preprocessing: WD; Optimization: adaptive PSO -ACO; Forecasting: BP	BPNN, ELM, Elman NN, GRNN, WNN
9	[55]	Wind speed	Wind farm	20 min and 5 months	3 wind speed datasets; 120 months; 20 min; China	Deterministic	Hybrid	Preprocessing: FEEMD; Forecasting: RELM	Preprocessing: EMD, WT; Forecasting: ELM, RBF, BPNN, ARIMA

9	[56]	Wind speed	Wind farm	10 min and 1 h	Wind Speed; 720 samples; 10 min-1 h; China	Deterministic	Hybrid	Layer 1: EEL (composed by ELM, ENN, LSTM); Layer 2: ELM	BP, WNN, DBN, ELM, ENN, LSTM, EEL-MEAN and EEL-BP
10	[60]	Wind speed	Not specified	10, 30, 60 min	Wind speed; 2011; 10-30-60 min; China	Deterministic	Hybrid	Preprocessing: Ssa; Optimization: FA; Forecasting: BPNN	BP-FABP-SSABP
10	[61]	Wind speed	Wind farm scheduled and planning	10 min and 24 h	Wind speed; 1 year; 10 min-1h; China	Deterministic	Hybrid	Preprocessing: Box-plot; Optimization: MO (multi objetive) -GA-PSO; Forecasting: BPNN, WNN, GRN, ANFIS	GA-BPNN; PSO-BPNN; GAPSO-BPNN; MOPSO-BPNN
10	[63]	Wind speed	Unit commitment	1, 3, 8, 12 and 24 h	Wind speed; 2004-2014; 1 h; New Zealand and USA	Deterministic	Hybrid	ARIMA-FNN	Persistence model-ARIMA-FNN-RNN
11	[67]	Wind speed	Wind farm	10 min and 1 h	3 wind speed datasets; 4 days; 10 min; Spain	Deterministic	Hybrid	Preprocessing: VMD, NNIA; Optimization: FCM, NNIA; Forecasting: ARIMA, BPNN, GRNN, BiLSTM	Preprocessing: EMD, CEEMD, SSa, VM; Forecasting: WACD-ARIMA, WACD-BPNN, WACD-GRNN, WACD-BILSTM.
11	[68]	Wind speed	Wind farm	30 min and 1, 3 h	Wind speed; year; --; Turkey	Deterministic	Hybrid	VSES	O-SES, P-P, T-L

12	[69]	Wind speed	Wind farm	10, 30, 60 min	Wind speed; 2 months; 10-30-60 min; China	Deterministic	Hybrid	Preprocessing: SSa; Optimization: WGBA; Forecasting: BP	BP, BA-BP, WGBA-BP, SSa-BP, SSa-BA-BP
12	[71]	Wind speed	MG	1 h	Wind Speed; 1 month; 1 h; --;	Deterministic	AI	LSTM-RNN	ANN, NARX, SARIMA, ARIMA, ARIMA-ANN
13	[72]	Wind speed	Wind farm	5, 10, 15 and 30 min	Wind speed; 1201 samples; --; Brazil	Deterministic	AI and Hybrid	LFFFNN, GMDH, SVR, FIS, ANFIS, ANFIS-PSO, ANFIS-GA	LFFFNN, GMDH, SVR, FIS, ANFIS, ANFIS-PSO, ANFIS-GA
13	[74]	Wind speed	Wind speed	1, 5, 10 min	Wind speed; 01.30.2018 - 03.25.2018 (28800 data); --; China	Deterministic	Hybrid	LSTM-CNN	LSTM, CNN
14	[75]	Wind power	Wind farm	30 min	Wind power; 2 years; 10 min; USA	Deterministic	AI	E2E	SVR, kNN
14	[76]	Wind speed	Wind farm	3 h	Wind speed and direction, temperature, and surface air pressure; 1 year; 1 h; USA	Probabilistic	Hybrid	STNN-GRU-CNN; Uncertainty: VB	PR, LR, LSTM, CNN, ANN, GPR, HMM
14	[77]	Wind speed	Wind farm	10 min	Wind speed; 25 days; 10 min; China	Deterministic	Hybrid	Preprocessing: CEEMD; Optimization: MOGWO; Forecasting: ELM	ELM, MOGWO-ELM
14	[78]	Wind speed	Wind farm	1, 3, 5 h	Wind speed; 1 year; 1 h; Spain	Deterministic	Hybrid	Preprocessing: VDM; Forecasting: WSFNet-DCA	WSFNet-D, WSFNet-CA
14	[79]	Solar and wind power,	Wind farm, photovoltaic park,	30 min and 1 h	Real-time energy consumption and weather data (ISO New England website), solar and wind power	Deterministic	AI	GPR	LM-BPNN, BR-BPNN and SCG-BPNN

		consumption energy	and load curve		production data (China); --; 720-4336-4336 for energy, solar and wind samples				
14	[80]	Wind power	Wind farm	10, 20, 30 min	Wind power; 3 months; 10 min; Brazil	Deterministic	Hybrid	Preprocessing: CEEMD; Forecasting: STACKemsamble-learning: kNN, PLS, RIDGE, SVR, Cubist regression	CEEMD-kNN, CEEMD-PLS, CEEMD-Ridge, CEEMD-SVR
15	[82]	Wind speed	Wind farm	10, 30 and 50 min	Wind Speed; 8 days; 10 min; China	Deterministic	Hybrid	Optimization: AFSA-ACO; Forecasting: ES, ARIMA, BNPP, GRNN, WNN, ENN	BP, ENN, GRNN, WNN, ARIMA, ES
15	[83]	Wind speed	Wind farm	15 min	Wind Speed; 1000 samples; 15 min; China	Deterministic	Hybrid	Preprocessing: ICEEMDAN; Forecasting: BP, LSTM, GRU; Postprocessing: ARIMA	BP, LSTM, GRU, ICEEMDAN-BP, ICEEMDAN-LSTM, ICEEMDAN-GRU

15	[85]	Wind speed	Wind farm	10, 20, 30 min	Wind Speed; Jan.1 to Jan.16 (2304 samples); 10 min; China	Probabilistic	Hybrid	Preprocessing: VMD; Optimization: MOMA; Forecasting: ARIMA, BP, ELM, ENN, ANFIS, GMDH, LSSVM; Uncertainty: Extreme Value, Logistic, Rician, Weibull	ANFIS, ARIMA, BP, DBN, ELM, ENN, GMDH, LSSVM, LSTM, EMD-MOMA-EM, ICEEMDAN-MOMA-EM, VDM-MOGWO-EM
15	[86]	Wind speed	Wind farm	1 h	Wind Speed; 1464 samples; 1 h; China	Probabilistic	Hybrid	Preprocessing: ICEEMDAN; Optimization: MOMVO; Forecasting: BP, ELM, BiLSTM	BP, ELM, BiLSTM, ICEEMDAN-BP, ICEEMDAN-ELM, ICEEMDAN-BiLSTM
15	[87]	Wind speed	Wind farm	5, 10, 30 min	Wind Speed; 9000 samples; 5 min; USA	Deterministic	Hybrid	Preprocessing: ICEEMDAN, 1D-RNN, Forecasting: BiLSTM	ICEEMDAN-LSTM, ICEEMDAN-CNN, ICEEMDAN-MLP, CNN, LSTM
15	[88]	Wind speed	Wind farm	10 min	Wind Speed; 3000 samples; 10 min; USA	Deterministic	AI	CWRNN	LSTM, BiLSTM, RNN
15	[89]	Wind speed	Wind farm	10 min	Wind Speed; 2880 samples; 10 min; China	Probabilistic	Hybrid	Forecasting: BiLSTM; Optimization: IMOTa	SSa-PSr with (QrLASso, QrLSTM, QrGRU, QrCNN, QrBiLSTM, GPr, BLGM)

15	[90]	Wind speed	Wind farm	1 min	Wind Speed; 1500 samples; 1 min; China	Deterministic	Hybrid	Preprocessing: EWT; Forecasting: Q-GRU-BiLSTM-DBN; Postprocessing: WPT-ORELM	GRU, BiLSTM, DBN, Q-GRU-BiLSTM-DBN, EWT-Q-GRU-BiLSTM-DBN

Table S2. Short-term bibliographical references.

Cluster	Reference	Prediction Objective	Forecasting applied to	Forecast Horizon	Dataset (inputs; period; sampling horizon; location)	Uncertainty modelling	Forecasting Method	Proposed model	Validation models
1	[11]	Wind power	Wind energy utilization in general	17 and 34 h	Wind speed; 150-300 h; 10-20 min; China-Spain	Deterministic	Hybrid	Optimizacion: PSO; Forecasting: LSTM-ANN, ARMA, KDE	Compared with real wind speed data
2	[14]	Wind power	Operation plan for a MG	24 h	Not specified	Probabilistic	Not specified	Wind forecast; Uncertainty: Normal distribution	Not specified
2	[15]	Wind power	Control scheme in MG	12 h	Wind power; --; 15 min; China	Probabilistic	Statistical	Sparse online warped Gaussian process	Not specified
3	[17]	Wind speed	MG	24 h	Wind speed; 1 year; 1 h; --	Deterministic	Not specified	Temporal Series	Compared with real wind power data
3	[18]	Wind speed	Wind farm	24 h	Not specified	Deterministic	Statistical	Weibull	Not specified
3	[19]	Wind speed	Unit commitment of MG	24 h	Not specified	Deterministic	Statistical	Weibull	Not specified
3	[20]	Wind power	Wind turbine	24 h	Wind power and direction, power generated, temperature; 190 days; 1 h; --	Deterministic	AI	ANN-PLM	Naive approach, ANN

3	[22]	Wind speed	MG	24 h	Wind speed; 1 year; 1 h; --	Deterministic	Not specified	Temporal Series	Compare with real wind power data
4	[26]	Wind speed	Energy box in a house (EMS for minigrid-micro turbine)	24 h	Wind speed and direction measurement; 2 months data of one weather station (sampling of 3 h) and 1 month data of an anemometer (sampling of 5 min); Portugal	Deterministic	AI	Multilayer feed-forward BPNN	Compared with real wind speed data
4	[29]	Wind speed	Wind farms	1 to 3 days	Wind speed and direction, temperature, relative humidity, pressure, and precipitation; 2015-2017; 1 min; India	Deterministic	AI	MLP BPNN	Compared with real wind speed data
5	[31]	Wind speed	Micro-wind turbines	24 h	Temperature, solar radiation, air pressure, and wind speed; 01.01.2012 - 31.12.2012; 10 min; India	Deterministic	AI	BPNN	Compared with real wind speed data
5	[34]	Wind speed	Not specified	24 h	Wind speed and direction, spatial coordinates, altitude; 01.01.2016 - 31.12.2017; 1 h; Romania	Deterministic	Hybrid	NWP and generalized additive model	Compared with real wind speed data
6	[36]	Wind speed	MG	24 h	Wind speed; --; 1 h; Holland	Probabilistic	AI	ANN; Uncertainty: Confidence Intervals	Compared with real wind speed data
6	[37]	Wind speed	Distribution electricity market	24 h	Wind Speed	Probabilistic	Not specified	Not specified – Uncertainty: Standard normal PDF	Compared with real wind speed data
6	[38]	Wind speed	Smart grid	24 h	Wind speed; --; 1 h; --	Deterministic	Statistical	PDF of Rayleigh	Not specified

6	[39]	Wind power	MG	24 h	Wind Speed; 1 year; 1 h; USA	Probabilistic	Hybrid	Preprocessing: WNN; Forecasting: ANN; Uncertainty: APCCI	ANN	

6	[40]	Wind power	MG	24 h	Wind power; 2 months; 10 min; China	Deterministic	Hybrid	Preprocessing: CEEMDAN; Optimization: IBA; Forecasting: GPR	WT-GA-SVM, EEMD-PSO-BPNN, EMD-NN
6	[41]	Wind speed	Smart grid	24 h	Wind Speed; --; 1 h; --	Deterministic	Statistical	PDF of Rayleigh	Not specified
6	[42]	Wind speed	MG	24 h	Wind Speed	Deterministic	Hybrid	Optimization: RNWC; Forecasting: DLANN	ANN
6	[43]	Wind speed and power	Smart grid	24 h	Historical data and forecasting wind speed; 10 years of historical data and 9 months of forecasting data (30-day window for a day); North Sea offshore platforms	Probabilistic	Statistical	PDF of Rayleigh, Nonlinear PDF, Composite distribution; Uncertainty: Normal distribution	Historical PDF
6	[44]	Wind power	MG	24 h	Wind Power; 1584 points; 10 min intervals averaged over 1 h; China	Probabilistic	Hybrid	Preprocessing: CEEMDAN; Optimization: CSBA; Forecasting: LSSVM; Uncertainty: ACCI	CSBA-LSSVM, CEEDAN-LSSVM, EEMD-GA-GPR
8	[54]	Wind speed	Unit commitment and operation offshore wind farms	24 h	Wind speed of 3 sites; Jan.2018 - Dec. 2018; 1h; Scotland	Deterministic	Statistical	SARIMA	GRU, LSTM

10	[62]	Wind speed	Operation planning	6 to 72 h	Data from NWP model; 1 year; 3 h; -	Deterministic	AI	BNN	LASSO
11	[64]	Wind power	Wind farm	24 h	Wind speed; 24 h; 1 min; China	Deterministic	Not specified	Wind energy conversion model to convert the wind fluctuation into the electric power fluctuation. A simplified frequency-domain equivalent model	Measurements of an actual wind farm (frequency-domain)
12	[70]	Wind speed	Wind farm	24 h	Wind speed, max, min tempetura, VP, RHMIN, RHMAX, sunshine hs, precipitation; 10 years; 24 h; Iran	Deterministic	Hybrid	Grey ELM	NN-SFLA, NN-GA, NN-SA, ELM

Table S3. Medium-term bibliographical references.

Cluster	Reference	Prediction Objective	Forecasting applied to	Forecast Horizon	Dataset (inputs; period; sampling horizon; location)	Uncertainty modelling	Forecasting Method	Proposed model	Validation models
2	[13]	Wind power	Unit commitment of wind farm	3 days	Wind power and speed, May.2002 - Apr.2003; 10 min; USA	Probabilistic	AI	ANN; Uncertainty: Normal distribution	ANN network structures
3	[23]	Wind speed	MG	72 h	Wind speed; 1 year; 1 h; Canada	Deterministic	Hybrid	SARIMAX-LSTM	LSTM, SARIMAX
9	[57]	Wind power	Wind Farm	2 days with 15 min intervals	Measured wind speed and wind turbine output power, NWP data; 3 months, 7393 points; 15 min; China	Probabilistic	AI	LSTM; Uncertainty: GMM	RBF, Wavelet, DBN, BP, ELMAN, MDN, RVM
9	[58]	Wind speed	Electrical energy production	48 h	Mean wind speed and direction, maximum pressure and temperature, time and relative humidity; 2 months; 10 min; Cameroon	Deterministic	Hybrid	MLP, NARX	Compares with wind speed measurements
11	[65]	Wind speed	Wind farm / wind turbines	3 days	3 wind speed datasets; 18 days; 10 min; China	Deterministic	Hybrid	Preprocessing: ICEEMDAN; Optimization: NNCT; Forecasting: BPNN, ENN, WNN, GRNN	ICEEMDAN, ICEEMDAN-BPNN, ICEEMDAN-ENN, ICEEMDAN-WNN, ICEEMDAN

Table S4. Long-term bibliographical references.

Cluster	Reference	Prediction Objective	Forecasting applied to	Forecast Horizon	Dataset (inputs; period; sampling horizon; location)	Uncertainty modelling	Forecasting Method	Proposed model	Validation models
1	[8]	Wind speed	Renewable energy resources	100 days	Mean daily Wind speed; 12 years; --; Saudi Arabia	Deterministic	AI	SVM	MLP ANN
4	[25]	Wind speed	MG and Smartgrids	10 days (daily average)	Daily wind speed, daily maximum and minimum ambient temperature; 2010-2012; Italy	Deterministic	AI	FTDNN, NARX	Expected outputs
4	[28]	Wind speed	Wind farms, power systems	1 year	Monthly average wind speed and direction measurement; 1 year; 1 month; India	Deterministic	AI	kNN, MLP-ANN	Monthly wind speed measurement
5	[32]	Wind speed	Not specified	1 month	Atmospheric pressure, heating and cooling degree-days elevation, earth and air temperature, relative humidity, latitude, longitude; 12 months; 1 month average; India	Deterministic	Hybrid	Preprocessing: EMD; Optimization: Tabu search; Forecasting: GRNN	EMD-Fruit fly optimization-GRNN; EMD-GRNN; Tabu search-GRNN; Fruit fly optimization-GRNN
9	[59]	Wind speed	Utilization of wind energy and the reduced required wind farm reserves	12 months	Maximum and minimum temperature, precipitation values, maximum and minimum humidity, wind speed and sunshine hours; 10 years; average monthly values; Iran	Deterministic	Hybrid	NN-GA, NN-SA, NN-SFLA	Moving Average

11	[66]	Wind speed and solar irradiation	MG	10 days	Wind speed and solar irradiation data; 1 year; 1 h; Italy	Probabilistic	Hybrid	Preprocessing: WT method, NNMFOA; Optimization: MOMFOA; Forecasting: GMDH neural network	NN-GA, NN-PSO, NN-ACO, NN-FOA

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