Renewable Energy 87 (2016) 430–436

Contents lists available at ScienceDirect

Renewable Energy

journal homepage: www.elsevier.com/locate/renene

Prediction of site specific wind energy value factors

Mark Capellaro

Wind Energy Institute, Technische Universität München, Boltzmannstr. 15, 85478 Garching, Germany

ARTICLE INFO

Article history:
Received 30 September 2014
Received in revised form
15 July 2015
Accepted 12 October 2015
Available online xxx

Keywords:
Wind energy
Market value
Prediction method

ABSTRACT

This paper demonstrates a method to predict the value factor and market value of a wind turbine production. This will allow for the estimation of the economic viability of a turbine subject to pure market prices and also allow for prediction of the necessary financial support for turbines under subsidy schemes. The value factor is a common metric used to determine the value of variable energy sources. Research has shown that wind speed profiles that with a high value factor, or have a positive correlation with the market electricity price, have an economic advantage. However, previous research has determined overall value factors for wind in electricity networks at the macro level. This paper details a method at the micro level, since the wind conditions and therefore the value factor are themselves a site specific property. The data necessary to predict the value factor is the same as used to predict the energy production of the site. This allows for the prediction to be used before turbine installation and can be used as an optimization parameter for researchers and for turbine siting with regards to the electricity price/market.

1. Introduction

The electricity market is highly regulated in most countries and the increasing integration of renewables an obligation for network operators. The simplest method to promote renewables is a guaranteed feed in tariff (FIT) along with the obligation of network operators to buy renewable sources, whenever they are produced [1]. The simple FIT method can increase prices for consumers, ceteris paribus, as costs for the difference between the FIT and market price need to be paid by consumers. This amount generally will increase with the amount of renewables in the network. Therefore new market oriented reforms are being sought and implemented. One variation is a 'premium price FIT' where the FIT price can be reduced when the market price is greater than a set amount.

The specific subsidy method varies by country. However, since turbine operators/owners are guaranteed a price for their production in most markets (or minimum price in the case of the premium price FIT) regardless of market price, they maximize their profit my maximizing production. If the owners are not dependent upon the market price, there is little interest in methods for predicting the market value of the wind turbine generation. However, as wind energy increases penetration, this may need to be revisited. Market mechanisms can be an efficient method of regulation.

1.1. The market

The wholesale electricity price is allowed to vary with supply and demand in many markets. Fig. 1 demonstrates one week of price data from the European Electricity Index market price (ELIX Spot) [2]. The electricity price/demand curve is a stochastic but predictable function that will be specific to each region/country. Since the focus on this paper is the improved analysis of the wind conditions and predictions, the Average Price curve in Fig. 1 is used throughout this paper as the daily market price prediction.

1.2. The supply – wind

The velocity of the wind varies but it is predictable (Figs. 2 and 3). Statistical tools and estimation methods used to site turbines improve based upon the length of the measurement campaign. The procedure proposed in this work uses a variation of the same methods. The variability of renewables impose a cost upon the existing electricity networks as the networks were built with the assumption that large slow reacting thermal producers would provide most, if not all, of the supply. The cost of variability for wind produced electricity in existing electrical networks is dependent upon the amount of wind energy penetration in the market, capacity factor and other factors. An estimate for integration of a limited amount of wind energy into the ERCOT network region (Texas, USA) has been estimated to be $4.35 per MWh for 2009 [3].

E-mail address: mark.capellaro@tum.de.

http://dx.doi.org/10.1016/j.renene.2015.10.019
0960-1481/

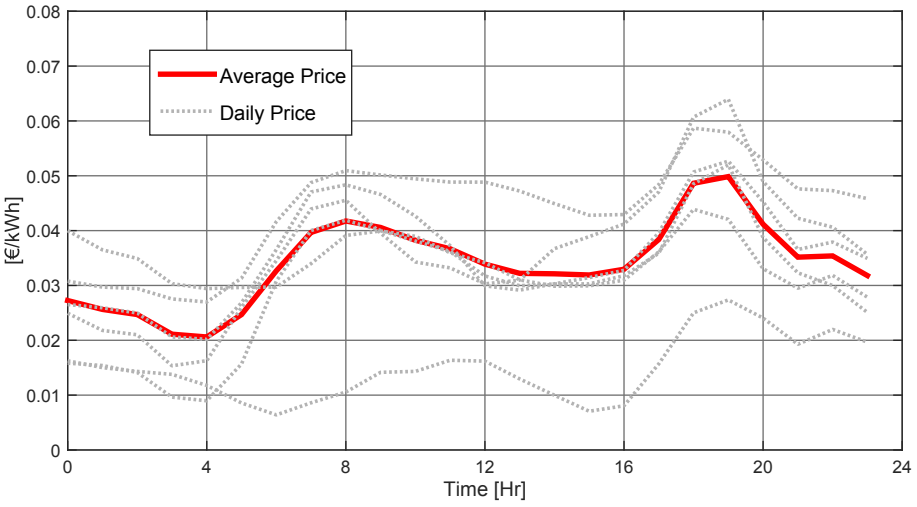

Fig. 1. EPEX spot market March 2015.

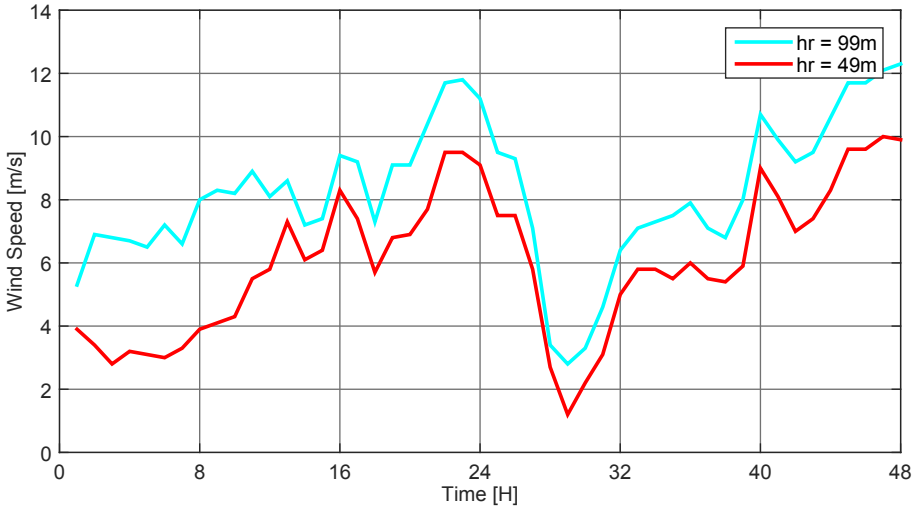

Fig. 2. Representative wind measurement data.

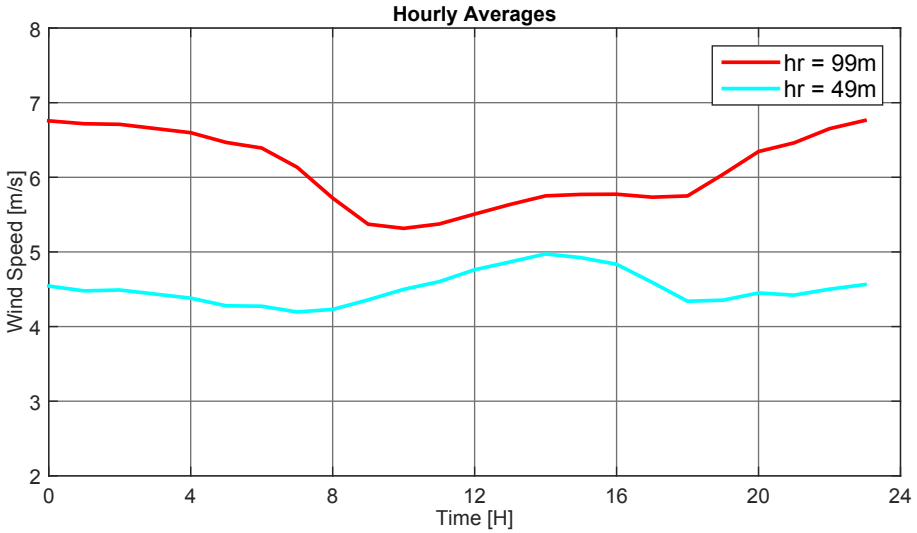

Fig. 3. Hourly wind speed average.