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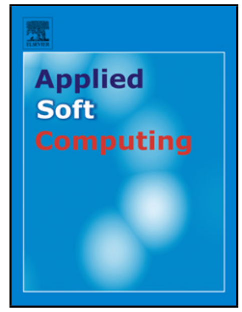

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An advanced neural network based solution to enforce dispatch continuity in smart grids

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Abstract

In energy generation systems including a photovoltaic park, fluctuations are the norm: both production and demand levels can vary on hourly basis. Hence, energy management and dispatching systems have to cope with the possibility of inadequate production while satisfying as much as possible user demands. We put forward a management solution that models the behaviour of each production plant and consumption device, and determines energy allocation. For this, gathered data are wavelet transformed to let us retain only the useful characteristics of data on both large and small scales of the signal. Models are handled by several neural networks which perform predictions in advance of 48-hour, with a granularity of half an hour. Moreover, according to realtime user demands, the management solution determines energy flows between production plants and consumption devices. Therefore, while in some cases it might be necessary to postpone the activation of some consumption devices, in others we can take advantage of a production surplus. Thanks to the proposed solution proper actuators can be programmed beforehand to improve the fairness to users, and use peaks of energy production, thus reducing green energy shortage, and extra costs.

Keywords: Integrated Generation System, Photovoltaic, Renewable energy, Cloud computing, Wavelet analysis, Neural networks, Parallel processing.

1. Introduction

Renewable energy plants, including photovoltaic (PV), wind, and bio-diesel generator, are widely used for energy production. However, such energy sources cannot provide a fixed amount of energy continuously, due to their seasonal and intermittent nature [1]. A combination of energy sources can then be more effective, if properly managed, in order to reduce energy production fluctuations.

Intelligent power management systems are paramount when dealing with renewable energy sources [2]. Basically, the management system of a plant has to include the monitoring of production and demand levels and record data with granularity, e.g. on hourly basis.

Due to the intermittent nature of the solar- and wind-derived energy, an open issue is how to minimise the effects of fluctuating green power productions, and how to satisfy the requests of consumption devices over time [3, 4, 5]. A fundamental support allowing proper allocation is reliable load and production forecasting.

Previously proposed management solutions can be examined according to whether they consider the following features: (i) energy fluctuations and adaptation, (ii) data segregation, (iii) planning of energy allocation, and (iv) distributed generation.

Firstly, several approaches build a neural network model by feeding it with *unfiltered* data gathered from PV plants and consumption devices, and resulting in a model that depicts an average behaviour, while missing fine grained details, and for a large time-frame, which results in considerable errors for more fine intervals [6, 7, 8, 9, 10, 11, 12].

Some approaches adopt data *filtering*, however the error is generally high [13, 14]. In [13], the custom network topology used counterbalance in a negative way data filtering, hence missing most of the dynamic of the signal. In [14] the neural network topology used (having no feedback and no delayed lines) is not able to handle time changing finer phenomena with enough accuracy, hence their resulting forecast suffers of a very high error.

Moreover, many existing approaches use a model that fits stationary phenomena, as autoregressive-moving average [15], or adopt mathematical tools, such as Fourier transform still capturing the stationary phenomena only [16]. Some neural network topologies have been used which are adeguate only for a stationary scenario [17, 18, 19]. on

Secondly, several approaches use aggregated data coming from power plants or consumption devices, then the corresponding model provides an average trend, while cannot perform accurate forecast for each plant, device, or place [6, 8, 20].

Thirdly, many approaches simply react to the fluctuations of energy production and demand, without planning in advance [21, 22]. Often their main goal has been an economical balance [21, 23], and in some cases an energy balance has been considered [22, 24].

Fourthly, all the above approaches are unaware of distributed generation and cannot gain advantage of the plant position with respect to the demand. In [25, 26] distributed generation has

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