Jan Emil Banning Iversen - DTU Orbit (25/12/2017)

Jan Emil Banning Iversen

Organisations

PhD Student, Department of Applied Mathematics and Computer Science
27/12/2012 → 07/04/2016 Former
jebi@dtu.dk
VIP

Dynamical Systems
18/02/2013 → 03/08/2015 Former
VIP

PhD Student, Department of Informatics and Mathematical Modeling
22/06/2011 → 07/04/2016 Former
jebi@imm.dtu.dk
VIP

Mathematical Statistics
25/02/2012 → 18/02/2013 Former
VIP

Postdoc, Department of Electrical Engineering
03/03/2015 → 25/05/2016 Former
jebi@elektro.dtu.dk
VIP

Center for Electric Power and Energy
05/03/2015 → 25/05/2016 Former
VIP

Electricity markets and energy analytics
04/03/2015 → 25/05/2016 Former
VIP

Publications:

Leveraging stochastic differential equations for probabilistic forecasting of wind power using a dynamic power curve
Short-term (hours to days) probabilistic forecasts of wind power generation provide useful information about the associated uncertainty of these forecasts. Standard probabilistic forecasts are usually issued on a per-horizon-basis, meaning that they lack information about the development of the uncertainty over time or the inter-temporal correlation of forecast errors for different horizons. This information is very important for forecast end-users optimizing time-dependent variables or dealing with multi-period decision-making problems, such as the management and operation of power systems with a high penetration of renewable generation. This paper provides input to these problems by proposing a model based on stochastic differential equations that allows generating predictive densities as well as scenarios for wind power. We build upon a probabilistic model for wind speed and introduce a dynamic power curve. The model thus decomposes the dynamics of wind power prediction errors into wind speed forecast errors and errors related to the conversion from wind speed to wind power. We test the proposed model on an out-of-sample period of 1 year for a wind farm with a rated capacity of 21 MW. The model outperforms simple as well as advanced benchmarks on horizons ranging from 1 to 24 h.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Dynamical Systems, Centre for IT-Intelligent Energy Systems in Cities
Authors: Iversen, J. E. B. (Intern), Morales González, J. M. (Intern), Møller, J. K. (Intern), Trombe, P. (Intern), Madsen, H. (Intern)
Pages: 33–44
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Wind Energy
Volume: 20
Probabilistic Approaches to Energy Systems

Energy generation from wind and sun is increasing rapidly in many parts of the world. This presents new challenges on how to integrate this uncertain, intermittent and non-dispatchable energy source. This thesis deals with forecasting and decision making in energy systems with a large proportion of renewable energy generation. Particularly we focus on producing forecasting models that can predict renewable energy generation, single user demand, and provide advanced forecast products that are needed for an efficient integration of renewable energy into the power generation mix. Such forecasts can be useful on all levels of the energy systems, ranging from the highest level, where the transmission system operator is concerned with minimizing system failures and is aided by wind power forecasts, to the end user of energy where power price forecasts are useful for users with flexible power demand.

The main contributions of this thesis lie in the realm of using gray box models to produce forecasts for energy systems. Gray box models can be defined as a crossover between physical models (or white box models), that base their model on a physical understanding of the system at hand, and data driven models (or black box models) that focus on accurately describing the data without considering physical limitations of the system. Integrating these physical structures into a data driven approach allows for producing better forecasts with more accurate predictions. In this thesis we have developed and applied methodologies for gray box modeling to produce forecasts for vehicle driving patterns, solar irradiance, wind speeds, wind power, and solar power. The model for driving patterns has subsequently been used as input into an optimization algorithm for charging a single electric vehicle. In a subsequent study the behavior of a fleet of electric vehicles has been studied.

In the thesis we go through various examples of forecasts products and their applications. We emphasize that forecasting can not stand alone and should be complimented by optimization and decision making tools for an efficient integration of renewable energy. Thus forecast products should be developed in unison with the decision making tool as they are two sides of the same overall challenge.

RESGen: Renewable Energy Scenario Generation Platform

Space-time scenarios of renewable power generation are increasingly used as input to decision-making in operational problems. They may also be used in planning studies to account for the inherent uncertainty in operations. Similarly using scenarios to derive chance-constraints or robust optimization sets for corresponding optimization problems is useful in a power system context. Generating and evaluating such spacetime scenarios is difficult. While quite a number of proposals have appeared in the literature, a gap between methodological proposals and actual usage in operational and planning studies remains. Consequently, our aim here is to propose an open-source platform for space-time probabilistic forecasting of renewable energy generation (wind and solar power). This document covers both methodological and implementation aspects, to be seen as a companion document for the open-source scenario generation platform. It can generate predictive densities, trajectories and space-time interdependencies for renewable energy generation. The underlying model works as a post-processing of point forecasts. For illustration, two setups are considered: the case of day-ahead forecasts to be issued once a day, and for rolling windows with regular updates, with application to the western part of the United States, with both wind and solar power generation.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science , Dynamical Systems
Authors: Iversen, J. E. B. (Intern), Madsen, H. (Intern), Morales González, J. M. (Intern), Møller, J. K. (Intern)
Number of pages: 175
Publication date: 2016

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English

Series: DTU Compute PHD-2015
Number: 363
ISSN: 0909-3192
Main Research Area: Technical/natural sciences
Electronic versions: phd363_Iversen_JEB.pdf

RESGen: Renewable Energy Scenario Generation Platform
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Electricity markets and energy analytics
Authors: Iversen, J. E. B. (Intern), Pinson, P. (Intern)
Short-term Probabilistic Forecasting of Wind Speed Using Stochastic Differential Equations

It is widely accepted today that probabilistic forecasts of wind power production constitute valuable information for both wind power producers and power system operators to economically exploit this form of renewable energy, while mitigating the potential adverse effects related to its variable and uncertain nature. In this paper, we propose a modeling framework for wind speed that is based on stochastic differential equations. We show that stochastic differential equations allow us to naturally capture the time dependence structure of wind speed prediction errors (from 1 up to 24 hours ahead) and, most importantly, to derive point and quantile forecasts, predictive distributions, and time-path trajectories (also referred to as scenarios or ensemble forecasts), all by one single stochastic differential equation model characterized by a few parameters.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Dynamical Systems, Centre for IT-Intelligent Energy Systems in Cities
Authors: Iversen, J. E. B. (Intern), Morales González, J. M. (Intern), Møller, J. K. (Intern), Madsen, H. (Intern)
Pages: 981-990
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Forecasting
Volume: 32
Issue number: 3
ISSN (Print): 0169-2070
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.45 SJR 1.685 SNIP 2.21
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.232 SNIP 1.84 CiteScore 1.89
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.146 SNIP 2.182 CiteScore 2.08
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.509 SNIP 1.623 CiteScore 1.59
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.278 SNIP 1.772 CiteScore 1.67
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.436 SNIP 1.711 CiteScore 1.92
Strategies for Charging Electric Vehicles in the Electricity Market

This paper analyses different charging strategies for a fleet of electric vehicles. Along with increasing the realism of the strategies, the opportunity for acting on the regulating market is also included. We test the value of a vehicle owner that can choose when and how to charge, by presenting a model of four alternative charging strategies. We think of them as increasing in sophistication from dumb via delayed to deterministic and stochastic model-based charging. We show that 29% of the total savings from ‘dumb’ are due to delayed charging and that substantial additional gains come charging optimally in response to predicted spot prices, and – in some settings – additional gains from using the up and down regulating prices. Particularly, strategies are chosen from uncontrolled charging through deterministic optimization, to modelling the charging and bidding problem with stochastic programming. We show that all vehicle owners will benefit from acting more intelligently on the energy market. Furthermore, the high value of the stochastic solution shows that, in case the regulating price differs from the expected, the solution to the deterministic problem becomes infeasible.

General information

State: Published
Organisations: Department of Management Engineering, Energy Economics and Regulation, Department of Applied Mathematics and Computer Science, University of Copenhagen
Authors: Juul, N. (Intern), Pantuso, G. (Intern), Iversen, J. E. B. (Intern), Boomsma, T. K. (Ekstern)
Pages: 71-78
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information

Journal: International Journal of Sustainable Energy Planning and Management
Volume: 7
ISSN (Print): 2246-2929
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.326 SNIP 0.114 CiteScore 0.84
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.302 SNIP 0.039
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Original language: English
Optimal charging of an electric vehicle using a Markov decision process

The combination of electric vehicles and renewable energy is taking shape as a potential driver for a future free of fossil fuels. However, the efficient management of the electric vehicle fleet is not exempt from challenges. It calls for the involvement of all actors directly or indirectly related to the energy and transportation sectors, ranging from governments, automakers and transmission system operators, to the ultimate beneficiary of the change: the end-user. An electric vehicle is primarily to be used to satisfy driving needs, and accordingly charging policies must be designed primarily for this purpose. The charging models presented in the technical literature, however, overlook the stochastic nature of driving patterns. Here we introduce an efficient stochastic dynamic programming model to optimally charge an electric vehicle while accounting for the uncertainty inherent to its use. With this aim in mind, driving patterns are described by an inhomogeneous Markov model that is fitted using data collected from the utilization of an electric vehicle. We show that the randomness intrinsic to driving needs has a substantial impact on the charging strategy to be implemented.
Probabilistic Forecasts of Solar Irradiance by Stochastic Differential Equations

Probabilistic forecasts of renewable energy production provide users with valuable information about the uncertainty associated with the expected generation. Current state-of-the-art forecasts for solar irradiance have focused on producing reliable point forecasts. The additional information included in probabilistic forecasts may be paramount for decision makers to efficiently make use of this uncertain and variable generation. In this paper, a stochastic differential equation framework for modeling the uncertainty associated with the solar irradiance point forecast is proposed. This modeling approach allows for characterizing both the interdependence structure of prediction errors of short-term solar irradiance and their predictive distribution. Three different stochastic differential equation models are first fitted to a training data set and subsequently evaluated on a one-year test set. The final model proposed is defined on a bounded and time-varying state space with zero probability almost surely of events outside this space.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Dynamical Systems
Authors: Iversen, J. E. B. (Intern), Morales González, J. M. (Intern), Møller, J. K. (Intern), Madsen, H. (Intern)
Pages: 152-164
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmetrics
Volume: 25
Issue number: 3
ISSN (Print): 1180-4009
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.944 SNIP 1.045 CiteScore 1.59
BFI (2015): BFI-level 1
Inhomogeneous Markov Models for Describing Driving Patterns

It has been predicted that electric vehicles will play a crucial role in incorporating a large renewable component in the energy sector. If electric vehicles are integrated in a naive way, they may exacerbate issues related to peak demand and transmission capacity limits while not reducing polluting emissions.

Optimizing the charging of electric vehicles is paramount for their successful integration. This paper presents a model to describe the driving patterns of electric vehicles, in order to provide primary input information to any mathematical programming model for optimal charging. Specifically, an inhomogeneous Markov model that captures the diurnal variation in the use of a vehicle is presented. The model is dened by the time-varying probabilities of starting and ending a trip and is justified due to the uncertainty associated with the use of the vehicle. The model is tied to data collected from the actual utilization of a vehicle. Inhomogeneous Markov models imply a large number of parameters. The number of parameters in the proposed model is reduced using B-splines.
Projects:

**GenScen - Variable generation production scenario generation for planning and integration studies**
Department of Electrical Engineering
Center for Electric Power and Energy
Electricity markets and energy analytics
Period: 01/01/2015 → 31/12/2015
Number of participants: 2
Project participant:
Pinson, Pierre (Intern)
Iversen, Jan Emil Banning (Intern)

**Multivariate Probabilistic Forecasting for Energy Systems**
Department of Applied Mathematics and Computer Science
Period: 01/10/2011 → 21/09/2015
Number of participants: 7
Phd Student:
Iversen, Jan Emil Banning (Intern)
Supervisor:
Morales González, Juan Miguel (Intern)
Møller, Jan Kloppenborg (Intern)
Main Supervisor:
Madsen, Henrik (Intern)
Examiner:
Pinson, Pierre (Intern)
Dent, Chris (Ekstern)
Lindström, Erik (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD