

### **Impact of Different Concrete Types on Radio Propagation: Fundamentals and Practical RF Measurements**

By the 1960's, European countries faced a massive housing shortage due to changes in social structure and migration from rural areas to towns. This led to a rapid growth of suburban areas in the 1960's and 1970's. Concrete, as a building material became popular as the prefabrication techniques of precast concrete structures developed rapidly during this era, and these trends continue even today. In the near future, the number of frequency bands used by mobile wireless communication systems will increase and, in general, the trend is towards higher frequencies. This paper presents the results of measurements in which the RF attenuations of several different concrete types were determined on the basis of the permittivity of the material samples. The frequency ranges used in the measurements were 4.5 to 19 GHz and 26 to 40 GHz. In particular, at higher frequencies, the attenuation of various concrete grades is very different, and the level of RF attenuation of the outer wall cannot be predicted without knowing the age of the building and the concrete quality used in the element.

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Organisations: Electrical Engineering, Tampere University, VTT Technical Research Centre of Finland

Contributors: Asp, A., Hentilä, T., Valkama, M., Pikkuvirta, J., Hujanen, A., Huhtinen, I.

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### **Artificial intelligence yesterday, today and tomorrow**

Artificial Intelligence (AI) is one of the current emerging technologies. In the history of computing AI has been in the similar role earlier - almost every decade since the 1950s, when the programming language Lisp was invented and used to implement self-modifying applications. The second time that AI was described as one of the frontier technologies was in the 1970s, when Expert Systems (ES) were developed. A decade later AI was again at the forefront when the Japanese government initiated its research and development effort to develop an AI-based computer architecture called the Fifth Generation Computer System (FGCS). Currently in the 2010s, AI is again on the frontier in the form of (self-)learning systems manifesting in robot applications, smart hubs, intelligent data analytics, etc. What is the reason for the cyclic reincarnation of AI? This paper gives a brief description of the history of AI and also answers the question above. The current AI "cycle" has the capability to change the world in many ways. In the context of the CE conference, it is important to understand the changes it will cause in education, the skills expected in different professions, and in society at large.

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Contributors: Jaakkola, H., Henno, J., Mäkelä, J., Thalheim, B.

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### **Intelligent data service for farmers**

The agricultural sector in Finland has been lagging behind in digital development. Development has long been based on increasing production by investing in larger machines. Over the past decade, change has begun to take place in the direction of digitalization. One of the challenges is that different manufacturers are trying to get farmers' data on their own closed cloud services. In the worst case, farmers may lose an overall view of their farms and opportunities for deeper data analysis because their data is located in different services. The goals and previously studied challenges of the 'MIKÄ DATA' project are described in this research. This project will build an intelligent data service for farmers, which is based on the Oskari platform. In the 'Peltodata' service, farmers can see their own field data and many other data sources layer by layer. The project is focused on the study of machine learning techniques to develop harvest yield prediction and find out the correlation between many data sources. The 'Peltodata' service will be ready at the end of 2019.

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Organisations: Computing Sciences

Contributors: Linna, P., Narra, N., Grönman, J.

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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

### **Teaching for virtual work**

Universities are still mainly preparing students for the world, where 'do something useful', i.e. 'do something with your hands' was the main principle and work was done during strictly regulated time. But world has changed and traditional areas of human activity (what also are the main target in University courses) are rapidly diminishing. More important have become virtual products - computer programs, mobile apps, social networks, new types of digital currencies, IOT (voice in your bathroom suggesting to buy the next model of Alexa), video games, interactive TV, virtual reality etc. Most of these new areas are not present in current curricula and there are problems with involving them in curricula - (working) students know (some aspects of) these areas better than many of university teachers, since corresponding knowledge is not yet present in textbooks - it is present only on Internet. The Internet strongly influences both what we teach and how we teach.

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Contributors: Henno, J., Jaakkola, H., Mäkelä, J.  
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Source ID: 85070323079  
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

#### GIS-data related route optimization, hierarchical clustering, location optimization, and kernel density methods are useful for promoting distributed bioenergy plant planning in rural areas

Currently, geographic information system (GIS) models are popular for studying location-allocation-related questions concerning bioenergy plants. The aim of this study was to develop a model to investigate optimal locations for two different types of bioenergy plants, for farm and centralized biogas plants, and for wood terminals in rural areas based on minimizing transportation distances. The optimal locations of biogas plants were determined using location optimization tools in R software, and the optimal locations of wood terminals were determined using kernel density tools in ArcGIS. The present case study showed that the utilized GIS tools are useful for bioenergy-related decision-making to identify potential bioenergy areas and to optimize biomass transportation, and help to plan power plant sizing when candidate bioenergy plant locations have not been defined in advance. In the study area, it was possible to find logistically viable locations for 13 farm biogas plants (>100 kW) and for 8 centralized biogas plants (>300 kW) using a 10-km threshold for feedstock supply. In the case of wood terminals, the results identified the most intensive wood reserves near the highest road classes, and two potential locations were determined.

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Organisations: Materials Science and Environmental Engineering, Research group: Bio- and Circular Economy, University of Jyväskylä, Seinäjoki University of Applied Sciences  
Contributors: Laasasenaho, K., Lensu, A., Lauhanen, R., Rintala, J.  
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### **Impedance-based interactions in grid-tied three-phase inverters in renewable energy applications**

Impedance-ratio-based interaction analyses in terms of stability and performance of DC-DC converters is well established. Similar methods are applied to grid-connected three-phase converters as well, but the multivariable nature of the converters and the grid makes these analyses very complex. This paper surveys the state of the interaction analyses in the grid-connected three-phase converters, which are used in renewable-energy applications. The surveys show clearly that the impedance-ratio-based stability assessment are usually performed neglecting the cross-couplings between the impedance elements for reducing the complexity of the analyses. In addition, the interactions, which affect the transient performance, are not treated usually at all due to the missing of the corresponding analytic formulations. This paper introduces the missing formulations as well as explicitly showing that the cross-couplings of the impedance elements have to be taken into account for the stability assessment to be valid. In addition, this paper shows that the most accurate stability information can be obtained by means of the determinant related to the associated multivariable impedance ratio. The theoretical findings are also validated by extensive experimental measurements.

#### **General information**

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MoE publication type: A1 Journal article-refereed

Organisations: Electrical Engineering, Research group: Power electronics, Research area: Power engineering, Automation Technology and Mechanical Engineering, Research group: Automation and Systems Theory, Aalto University  
Contributors: Suntio, T., Messo, T., Berg, M., Alenius, H., Reinikka, T., Luhtala, R., Zenger, K.

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Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Energy (miscellaneous), Control and Optimization, Electrical and Electronic Engineering

Keywords: Grid synchronization, Power electronics, Power grid, Source and load impedance, Stability, Transient dynamics

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Research output: Contribution to journal › Article › Scientific › peer-review

### **Direct fixed-step maximum power point tracking algorithms with adaptive perturbation frequency**

Owing to the good trade-off between implementation and performance, fixed-step direct maximum power point tracking techniques (e.g., perturb and observe and incremental conductance algorithms) have gained popularity over the years. In order to optimize their performance, perturbation frequency and perturbation step size are usually determined a priori. While the first mentioned design parameter is typically dictated by the worst-case settling time of the combined energy conversion system, the latter must be high enough to both differentiate the system response from that caused by irradiation variation and match the finite resolution of the analog-to-digital converter in case of digital implementation. Well-established design guidelines, however, aim to optimize steady-state algorithm performance while leaving transients nearly untreated. To improve transient behavior while keeping the steady-state operation unaltered, variable step direct maximum power point tracking algorithms based on adaptive perturbation step size were proposed. This paper proposes a concept of utilizing adaptive perturbation frequency rather than variable step size, based on recently revised guidelines for designing fixed-step direct maximum power point tracking techniques. Preliminary results demonstrate the superiority of the proposed method over adaptive perturbation step size operation during transients, without compromising the steady state performance.

#### **General information**

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MoE publication type: A1 Journal article-refereed

Organisations: Electrical Engineering, Research group: Power electronics, Ben-Gurion University of the Negev

Contributors: Amer, E., Kuperman, A., Suntio, T.

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Issue number: 3

Article number: 399

ISSN (Print): 1996-1073

Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Energy (miscellaneous), Control and Optimization, Electrical and Electronic Engineering

Keywords: Maximum power point tracking, Perturbation frequency, Photovoltaic generators, Step size

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Research output: Contribution to journal > Article > Scientific > peer-review

## Combined experimental and theoretical study of acetylene semi-hydrogenation over Pd/Al<sub>2</sub>O<sub>3</sub>

The semi-hydrogenation of acetylene ( $C_2H_2 + H_2 = C_2H_4$ ,  $\Delta H = -172 \text{ kJ mol}^{-1}$ ) is a well-studied reaction that is important for purification of ethylene,  $C_2H_4$ , feed used in polyethylene production. Pd-based catalysts are most commonly used to remove acetylene from ethylene feed prior to Ziegler–Natta polymerization because acetylene is a poison for Ziegler–Natta catalysts. New applications of the analogous catalytic processes, with similar requirements for the conversion and selectivity, are considered for the storage of  $H_2$  within the context of the  $H_2$  economy. Here, a combination of experimental and theoretical studies was employed to explore the performance of synthesized Pd nanoparticles and the feasibility of using computational modelling for predicting their catalytic properties. Specifically, a model 5%Pd/Al<sub>2</sub>O<sub>3</sub> nanocatalyst was successfully synthesized using high-throughput flame spray pyrolysis (FSP) method. As a catalyst for acetylene semi-hydrogenation, the material shows high conversion of 97%, a modest selectivity of 62%, and a turnover frequency of ethylene formation of  $5 \text{ s}^{-1}$ . The experimental data were further supported by computational modelling of catalytic properties. Results of microkinetic simulations, based on parameters obtained from DFT calculations, over a Pd<sub>30</sub>/Al<sub>2</sub>O<sub>3</sub>(100) model system were correlated with experiments. The insights from this direct comparison of theory and experiments provide indications for future improvements of the theoretical predictions and for novel types of materials with improved catalytic properties.

## General information

Publication status: E-pub ahead of print

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Organisations: Research group: Materials and Molecular Modeling, Research area: Computational Physics, Physics, INL - International Iberian Nanotechnology, Universidade do Porto, Tethis S.p.A., Forschungszentrum Jülich (FZJ), Iowa State University, Ames Laboratory, Norwegian Univ. of Sci. and Technol.

Contributors: Gonçalves, L. P., Wang, J., Vinati, S., Barborini, E., Wei, X. K., Heggen, M., Franco, M., Sousa, J. P., Petrovykh, D. Y., Soares, O. S. G., Kovnir, K., Akola, J., Kolen'ko, Y. V.

Publication date: 2019

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Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Fuel Technology, Condensed Matter Physics, Energy Engineering and Power Technology

Keywords: DFT, Heterogeneous catalysis, Hydrogenation, Kinetics, Modelling, Nanoclusters

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Research output: Contribution to journal > Article > Scientific > peer-review

## Identification of three-phase grid impedance in the presence of parallel converters

Grid impedance is an important parameter which affects the control performance of grid-connected power converters. Several methods already exist for optimizing the converter control system based on knowledge of grid impedance value. Grid impedance may change rapidly due to fault or disconnection of a transmission line. Therefore, online grid identification methods have been recently proposed to have up-to-date information about the grid impedance value. This is

usually done by perturbing the converter output current and measuring the response in output voltage. However, any parallel converters connected to the same interface point will cause errors, since the measured current differs from the current that is flowing through the grid interface point. This paper points out challenges and errors in grid impedance identification, caused by parallel converters and their internal control functions, such as grid-voltage support. Experimental grid-impedance measurements are shown from the power hardware-in-the-loop setup developed at DNV-GL Flexible Power Grid Lab.

#### **General information**

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Organisations: Automation Technology and Mechanical Engineering, Research group: Automation and Systems Theory,

Research group: Power electronics, Electrical Engineering, Eindhoven University of Technology, DNV-GL

Contributors: Luhtala, R., Messo, T., Roinila, T., Alenius, H., Jong, E. D., Burstein, A., Fabian, A.

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Keywords: DC-AC power converters, Grid impedance identification, Power hardware-in-the-loop

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Research output: Contribution to journal › Article › Scientific › peer-review

### **Power electronics in renewable energy systems**

#### **General information**

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Organisations: Electrical Engineering, Research group: Power electronics, Research area: Power engineering

Contributors: Suntio, T., Messo, T.

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Original language: English

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Research output: Contribution to journal › Editorial › Scientific

### **Flux-Weakening Control for IPMSM Employing Model Order Reduction**

The variation of magnetic parameters due to the magnetic saturation and cross coupling can affect the efficiency and the stability of the control system in electrical machines, especially at high-speed operation. This paper presents an approach independent of the magnetic model parameters to control synchronous motors at the flux-weakening region. In this approach, a model order reduction technique is applied to reduce the finite element model of a synchronous machine. The stator current components and the flux linkage components are the inputs and the outputs of the reduced model, respectively. The reduced model and its inversion are employed to calculate the current reference components from the reference torque. Field oriented control scheme is utilized to implement the overall control system. The proposed control system is validated by means of simulation and experiment on a 2.2 kW permanent magnet synchronous machine.

#### **General information**

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Organisations: Electrical Energy Engineering, Aalto University, Tallinn University of Technology

Contributors: Far, M. F., Mustafa, B., Martin, F., Rasilo, P., Belahcen, A.

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ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering, Mechanical Engineering

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Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### **Model Order Reduction of Bearingless Reluctance Motor Including Eccentricity**

Eccentricity in a bearingless motor may occur during different operating states of the machine. This rises challenges in designing robust control for the machine with a lumped parameter model, due to the cross coupling of the windings with respect to the eccentric position of the rotor, the saturation of the ferromagnetic material, and spatial complexity. The non-linearity of the ferromagnetic material and the spatial harmonics can be considered in a finite element model of the machine, although applying it in a real time system is unreasonable. We propose a novel method based on orthogonal interpolation to reduce the order of the 2D finite element model of a bearingless synchronous reluctance motor, suitable for implementation in a real-time system. The winding currents and the eccentricity are given as inputs to the reduced model and the nodal values of the magnetic vector potential is obtained as the output, wherefrom the flux linkages, torque, and forces can be computed easily.

#### **General information**

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ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering, Mechanical Engineering

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Source ID: 85057162208

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### Quantification of bio-anode capacitance in bioelectrochemical systems using Electrochemical Impedance Spectroscopy

Understanding the electrochemical properties of bio-anodes is essential to improve performance of bioelectrochemical systems. Electrochemical Impedance Spectroscopy (EIS) is often used to study these properties in detail. Analysis of the EIS response, however, is challenging due to the interfering effect of the large capacitance of typically used graphite and carbon-based electrodes. In this study, we used flat electrodes made of conductive Fluorine-doped Tin Oxide (FTO) as anode, and monitored bio-anode performance. We show that with this configuration, it is possible to accurately separate the distinct contributions to the electrical response of the bio-anodes: charge transfer, biofilm and diffusion resistances, and biofilm capacitance. We observed that the capacitance of the biofilm increased from  $2 \mu\text{F cm}^{-2}$  to  $450 \mu\text{F cm}^{-2}$  during biofilm growth, showing a relationship with current and total produced charge. These results suggest that biofilm capacitance is a measure for the amount of active biomass in bioelectrochemical systems. At the end of the experiment, the biofilm was harvested from the FTO electrode and an average yield of  $0.55 \text{ g COD biomass/mol e}^-$  was determined.

#### General information

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MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, Research group: Bio- and Circular Economy, Wageningen University and Research Centre, Wetsus, Centre for Sustainable Water Technology, Universitat Jaume I

Contributors: Heijne, A. T., Liu, D., Sulonen, M., Sleutels, T., Fabregat-Santiago, F.

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Keywords: BES, Bioanode, Biomass yield, Capacitance, Electrochemical Impedance Spectroscopy, MET, Microbial fuel cell

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Research output: Contribution to journal > Article > Scientific > peer-review

### Automatic Meter Infrastructure (AMI) as a part of flexibility market

This paper gives an overview, how Automatic Meter Infrastructure (AMI) enable possibilities to participate flexibility markets. Paper introduces the current situation in Finnish electricity market and role of AMI for demand response. Flexibility market places available today in Finland are introduced with their technical specifications. Possibilities and development needs in AMI in respect to these requirements are discussed. These aspects need to be evaluated when planning new AMI projects. The paper proposes a novel AMI solution and business model based on requirements of flexibility market to realize large-scale demand response of small distributed energy resources. AMI-based demand response could be one of the solutions to activate customers and seems to be an interesting option to bring small scale

resources in the flexibility market in cost-efficient manner.

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Contributors: Repo, S., Pylvänäinen, J., Kauppinen, M., Repo, S., Jarventausta, P.

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Keywords: Demand-side management, Power distribution, Power system management, Smart grids

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EXT="Kauppinen, Markku"

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Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### **Comparison of innovation policies for electric vehicle business ecosystems**

Shift away from fossil fuel-based transportation is challenging countries to develop strategies for electric vehicle deployment. The transition offers countries also strategic opportunities in growing markets. Policy incentives are commonly used to help sustainability enhancing technologies to succeed in their journey from labs to markets. Electric vehicles are not standalone but require an ecosystem of related products, services and infrastructure and cannot be considered only from the transportation sector point of view. This paper compares electric vehicle innovation policies in four Nordic countries. The results show how different positions in the electric vehicle ecosystem these countries have chosen and how their choices reflect their economies.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Industrial and Information Management, Electrical Energy Engineering, Research group: Power systems, Research area: Power engineering, University of Tampere

Contributors: Valta, J., Makinen, S., Kotilainen, K., Rautiainen, A., Järventausta, P.

Number of pages: 5

Publication date: 20 Sep 2018

#### **Host publication information**

Title of host publication: 15th International Conference on the European Energy Market, EEM 2018

Volume: 2018-June

Publisher: IEEE COMPUTER SOCIETY PRESS

Article number: 8469785

ISBN (Electronic): 9781538614884

#### **Publication series**

Name: International Conference on the European Energy Market

ISSN (Electronic): 2165-4093

ASJC Scopus subject areas: Marketing, Energy Engineering and Power Technology, Fuel Technology

Keywords: Business ecosystems, Electric vehicle, Innovation policy

DOIs:

10.1109/EEM.2018.8469785

### Bibliographical note

EXT="Kotilainen, Kirsi"

Source: Scopus

Source ID: 85055507417

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### Effects of electric vehicles and heat pumps on long-term electricity consumption scenarios for rural areas in the nordic environment

Electrical energy consumption is undergoing major changes driven by several factors. Trends in electric vehicle (EV) purchases and heating system conversion indicate that changes in electricity demand can be significant between today and year 2030. For instance in Finland, the target for EVs is 250 000 passenger cars by 2030. At the same time, a significant number of heat pumps (HPs) will be installed in detached houses replacing old heating systems such as oil-fired boilers. In this paper, the effects of EVs and HPs on electricity consumption in Finnish rural areas are modeled and analyzed.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Electrical Energy Engineering, Research group: Power systems, Research area: Power engineering, Lappeenranta University of Technology, University of Eastern Finland

Contributors: Haakana, J., Haapaniemi, J., Lassila, J., Partanen, J., Niska, H., Rautiainen, A.

Number of pages: 5

Publication date: 20 Sep 2018

### Host publication information

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Article number: 8469937

ISBN (Electronic): 9781538614884

### Publication series

Name: International Conference on the European Energy Market

ISSN (Electronic): 2165-4093

ASJC Scopus subject areas: Marketing, Energy Engineering and Power Technology, Fuel Technology

Keywords: Electric vehicles, Energy consumption, Heat pumps, Load modelling

DOIs:

10.1109/EEM.2018.8469937

Source: Scopus

Source ID: 85055573281

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### Microgrids as part of electrical energy system - Pricing scheme for network tariff of DSO

In the Smart Grid environment, one novel concept is the microgrid, which can be either a very small entity or a larger one. For example, the microgrid can consist of resources of an individual small customer or of several customers each with their own energy resources inside a low-voltage network. The microgrid can also consist of a large area with various energy resources and a connection to the distribution grid. Especially, when the number of these large-scale microgrids increases, a central question is what kind of network tariff structure should be applied to them. The network tariffs can affect whether the microgrids will have a connection to the distribution grid. In this paper, a novel tariff structure for a large-scale microgrid is proposed. The results show that the benefits of the microgrid can be shared more fairly between it and the distribution system by applying a novel network tariff.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Electrical Energy Engineering, Research group: Power systems, Research area: Power engineering, Lempäälän Energia Ltd., Laboratory of Electrical Energy Engineering

Contributors: Lummi, K., Rautiainen, A., Peltonen, L., Repo, S., Järventausta, P., Rintala, J.

Number of pages: 5

Publication date: 20 Sep 2018

### Host publication information

Title of host publication: 15th International Conference on the European Energy Market, EEM 2018

Volume: 2018-June

Publisher: IEEE COMPUTER SOCIETY PRESS  
Article number: 8469965  
ISBN (Electronic): 9781538614884

#### Publication series

Name: International Conference on the European Energy Market  
ISSN (Electronic): 2165-4093  
ASJC Scopus subject areas: Marketing, Energy Engineering and Power Technology, Fuel Technology  
Keywords: Distribution network tariff, Microgrid, Regulation  
DOIs:  
10.1109/EEM.2018.8469965  
Source: Scopus  
Source ID: 85055564419  
Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### Use case description of real-time control of microgrid flexibility

Increasing amount of distributed energy resources necessitates more flexibility at the distribution network level. One option to attain this flexibility is by aggregation of these resources within microgrids and further supervisory control of the latter in active network management. Among other reasons preventing their realization, these flexibility services lack standardized information and communication technology solution. This study assesses the required communication, information, and functional competences for such services and describes them by means of a use case modeling on smart grid architecture model planes. Specifically, the paper focuses on an information exchange built on the basis of web application programming interface called Smart API. The results of the study present a smart grid architecture that would enable real-time control of microgrid resources in active network management through flexibility market services.

#### General information

Publication status: Published  
MoE publication type: A4 Article in a conference publication  
Organisations: Electrical Energy Engineering, Research group: Power systems, Research area: Power engineering, Lappeenranta University of Technology, VTT Technical Research Centre of Finland  
Contributors: Mashlakov, A., Tikka, V., Honkapuro, S., Partanen, J., Repo, S., Järventausta, P., Kulmala, A., Abdurafikov, R., Keski-Koukkari, A., Aro, M.  
Number of pages: 5  
Publication date: 20 Sep 2018

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Publisher: IEEE COMPUTER SOCIETY PRESS  
Article number: 8469218  
ISBN (Electronic): 9781538614884

#### Publication series

Name: International Conference on the European Energy Market  
ISSN (Electronic): 2165-4093  
ASJC Scopus subject areas: Marketing, Energy Engineering and Power Technology, Fuel Technology  
Keywords: Flexibility services, Information exchange interface, Microgrid flexibility, Real-time control, Smart grid architecture  
DOIs:  
10.1109/EEM.2018.8469218

#### Bibliographical note

EXT="Kulmala, Anna"  
jufoid=70631  
Source: Scopus  
Source ID: 85055476487  
Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### Alternative Power-Based Pricing Schemes for Distribution Network Tariff of Small Customers

The development of electricity distribution pricing is becoming an increasingly relevant topic due to various factors. The Distribution System Operators (DSO) face challenges regarding their tariffs of small customers when the customers invest in energy efficiency and small-scale energy production. Thus, the DSOs must evaluate their pricing practices to maintain a profitable and sustainable business. To respond to changes in the operational environment, transitioning toward power-based pricing is seen as a potential development direction. In this paper, we study various power-based distribution tariff (PBTD) structures and evaluate them from different viewpoints. To support the analysis, we provide a study where alternative tariff structures are analyzed based on data from two Finnish DSOs to investigate the impacts of the tariffs on

the distribution fees of the customers and on the turnover of the DSO.

#### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Electrical Energy Engineering, Helen Electricity Network Ltd., Elenia Ltd., Helen Electricity Network Ltd.

Contributors: Lummi, K., Rautiainen, A., Jarventausta, P., Heine, P., Lehtinen, J., Hyvarinen, M., Salo, J.

Number of pages: 6

Pages: 581-586

Publication date: 18 Sep 2018

#### Host publication information

Title of host publication: International Conference on Innovative Smart Grid Technologies, ISGT Asia 2018

Publisher: Institute of Electrical and Electronics Engineers Inc.

ISBN (Electronic): 9781538642917

ASJC Scopus subject areas: Artificial Intelligence, Computer Networks and Communications, Energy Engineering and Power Technology, Renewable Energy, Sustainability and the Environment, Electrical and Electronic Engineering

Keywords: Demand response, Demand tariff, Distribution network business, Network tariff, Power-based pricing

DOIs:

10.1109/ISGT-Asia.2018.8467793

#### Bibliographical note

EXT="Lehtinen, Jouni"

Source: Scopus

Source ID: 85055529338

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### Constrained Long-Horizon Direct Model Predictive Control for Synchronous Reluctance Motor Drives

A finite control set model predictive control strategy for the control of the stator currents of a synchronous reluctance motor driven by a three-level neutral point clamped inverter is presented in this paper. The presented algorithm minimizes the stator current distortions while operating the drive system at switching frequencies of a few hundred Hertz. Moreover, the power electronic converter is protected by overcurrents and/or overvoltages owing to a hard constraint imposed on the stator currents. To efficiently solve the underlying integer nonlinear optimization problem a sphere decoding algorithm serves as optimizer. To this end, a numerical calculation of the unconstrained solution of the optimization problem is proposed, along with modifications in the algorithm proposed in [1] so as to meet the above-mentioned control objectives. Simulation results show the effectiveness of the proposed control algorithm.

#### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Electrical Energy Engineering, Research group: Power electronics, Universita degli Studi di Padova, Italy, Technische Universitat Munchen

Contributors: Ortombina, L., Liegmann, E., Karamanakos, P., Tinazzi, F., Zigliotto, M., Kennel, R.

Number of pages: 8

Publication date: 10 Sep 2018

#### Host publication information

Title of host publication: 2018 IEEE 19th Workshop on Control and Modeling for Power Electronics, COMPEL 2018

Publisher: IEEE

Article number: 8460173

ISBN (Print): 9781538655412

ASJC Scopus subject areas: Modelling and Simulation, Energy Engineering and Power Technology, Electrical and Electronic Engineering, Control and Optimization

DOIs:

10.1109/COMPEL.2018.8460173

#### Bibliographical note

JUF0ID=79370

Source: Scopus

Source ID: 85054503298

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### A distributed automation architecture for distribution networks, from design to implementation

With the current increase of distributed generation in distribution networks, line congestions and PQ issues are expected to increase. The smart grid may effectively coordinate DER, only when supported by a comprehensive architecture for automation. In IDE4L project such architecture is designed based on monitoring, control and business use cases. The

IDE4L instance of SGAM architecture is derived and explained in details. The automation actor are specified in terms of interfaces, database and functions. The division in these three layers boosted the implementation phase as dedicated interfaces, databases or application has been developed in a modular way and can be installed in different HW/SW. Some implementation instances are presented and the main output of the architecture is discussed with regards to some indexes as communication traffic and level of distribution of automation functions.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Electrical Energy Engineering, Research area: Power engineering, RWTH Aachen University, Surface and Corrosion Science, Catalonia Institute for Energy Research IREC, S.p.A., VTT Technical Research Centre of Finland  
Contributors: Angioni, A., Lu, S., Hooshyar, H., Cairo, I., Repo, S., Ponci, F., Della Giustina, D., Kulmala, A., Dedè, A., Monti, A., Del Rosario, G., Vanfretti, L., Garcia, C. C.

Pages: 3-13

Publication date: Sep 2018

Peer-reviewed: Yes

Early online date: 27 Apr 2017

#### **Publication information**

Journal: Sustainable Energy, Grids and Networks

Volume: 15

ISSN (Print): 2352-4677

Ratings:

Scopus rating (2018): CiteScore 4.25 SJR 0.99 SNIP 1.083

Original language: English

ASJC Scopus subject areas: Control and Systems Engineering, Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Electrical and Electronic Engineering

Keywords: Architecture, Distribution system, Smart grid

DOIs:

10.1016/j.segan.2017.04.001

#### **Bibliographical note**

EXT="Kulmala, Anna"

Source: Scopus

Source ID: 85020176163

Research output: [Contribution to journal](#) > [Article](#) > [Scientific](#) > [peer-review](#)

#### **Lessons learnt from real-time monitoring of the low voltage distribution network**

Up to now, the evolution of the distribution network toward the smart grid model has been essentially focused on two non-intersecting areas: medium voltage network automation and smart metering. The former one is mainly focused on improving the quality of service, studying and deploying fault location, isolation and service restoration systems, while the latter has been addressed to improve the customer relationship management, promote the customer awareness and enable new smart home services. In most cases a deep investigation of the low voltage network has been left disregarded, even if it represents the asset bridging the medium voltage level up to final customers. This network segment is probably the most affected by regulatory actions promoting intermittent renewable generations, distributed storage, heat pumps and the growing diffusion of electric vehicles utilization. The paper describes a field demonstrator of the FP7 European project IDE4L, where an extensive analysis of the low voltage network has been performed by means of an innovative use of smart meters and the installation of sensors on the medium-to-low voltage substation.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Electrical Energy Engineering, Research area: Power engineering, Research group: Power systems  
Contributors: Barbato, A., Dedè, A., Della Giustina, D., Massa, G., Angioni, A., Lipari, G., Ponci, F., Repo, S.

Pages: 76-85

Publication date: Sep 2018

Peer-reviewed: Yes

#### **Publication information**

Journal: Sustainable Energy, Grids and Networks

Volume: 15

ISSN (Print): 2352-4677

Ratings:

Scopus rating (2018): CiteScore 4.25 SJR 0.99 SNIP 1.083

Original language: English

ASJC Scopus subject areas: Control and Systems Engineering, Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Electrical and Electronic Engineering

Keywords: Distributed measurement system, Low voltage network, Smart grid, Smart metering

DOIs:

10.1016/j.segan.2017.05.002

Source: Scopus

Source ID: 85021196165

Research output: Contribution to journal › Article › Scientific › peer-review

### **Efficient method for the real-time contingency analysis of meshed HVDC power grids fed by VSC stations**

An efficient method for the real-time contingency analysis of meshed high-voltage direct current (HVDC) power grids fed by voltage source converter (VSC) stations is introduced here. A linearised AC/DC grid model is initially determined considering the control strategies of the various VSC units. This lays the foundations for the determination of linear sensitivity factors with which the contingency analysis is carried out to evaluate the real-time N-1 criterion in AC/DC grids, as demanded by system control centres. Distribution and power-injection factors are subsequently derived for efficiently assessing the impact of AC/DC transmission line outages and load/generator disconnections on the HVDC grid. Conversion factors are also derived to estimate the impact of the loss of VSC stations on the AC/DC network, this being another inherent contribution of this work. The efficiency and validity of this timely approach, which finds practical applicability to the real-time operation of HVDC power grids, is confirmed using a meshed DC network fed by three VSC stations. The disconnection of AC and DC transmission lines, generators, and VSC stations are dynamically simulated using Simulink and their post-disturbance steady-state conditions are compared against those computed by the introduced method where it is confirmed that both solutions concur very well with each other.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Electrical Energy Engineering, Department of Electrical Engineering

Contributors: Castro, L. M., Acha, E., Rodriguez-Rodriguez, J. R.

Number of pages: 9

Pages: 3158-3166

Publication date: 31 Jul 2018

Peer-reviewed: Yes

#### **Publication information**

Journal: IET Generation, Transmission and Distribution

Volume: 12

Issue number: 13

ISSN (Print): 1751-8687

Ratings:

Scopus rating (2018): CiteScore 4.25 SJR 1.099 SNIP 1.443

Original language: English

ASJC Scopus subject areas: Control and Systems Engineering, Energy Engineering and Power Technology, Electrical and Electronic Engineering

DOIs:

10.1049/iet-gtd.2017.1104

Source: Scopus

Source ID: 85050235242

Research output: Contribution to journal › Article › Scientific › peer-review

### **Mechanical stress analysis during a quench in CLIQ protected 16 T dipole magnets designed for the future circular collider**

Protecting the magnets in case of a quench is a challenge for the 16 T superconducting dipole magnets presently designed for the 100 TeV: Future Circular Collider (FCC). These magnets are driven to the foreseen technological limits in terms of critical current, mechanical strength and quench protection. The magnets are protected with CLIQ (Coupling-Loss Induced Quench) system, which is a recently developed quench protection method based on discharging a capacitor bank across part of the winding. The oscillation of the magnet currents and the dissipation of the high stored energy into the windings cause electrodynamic forces and thermal stresses, which may need to be considered in the magnet mechanical design. This paper focuses on mechanical stress analysis during a quench of the 16 T cos- $\theta$  and block type dipole magnets. A finite element model allowed studying the stress due to the non-uniform temperature and current distribution in the superconducting coils. Two different CLIQ configurations were considered for the cos- $\theta$  design and one for the block type magnet. The analyses of the mechanical behavior of two magnets during a quench without or with hot spot turn were separately carried out. The simulation results show that the stress related to a quench should be considered when designing a high field magnet.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Electrical Energy Engineering, Research group: Modelling and superconductivity, Lanzhou University, European Organization for Nuclear Research, Laboratorio Accelatori e Superconduttività Applicata, French Atomic Energy Commission (CEA) Saclay, Università degli Studi di Milano

Contributors: Zhao, J., Prioli, M., Stenvall, A., Salmi, T., Gao, Y., Caiffi, B., Lorin, C., Marinozzi, V., Farinon, S., Sorbi, M.

Number of pages: 8

Pages: 27-34

Publication date: 15 Jul 2018

Peer-reviewed: Yes

### Publication information

Journal: Physica C: Superconductivity and its Applications

Volume: 550

ISSN (Print): 0921-4534

Ratings:

Scopus rating (2018): CiteScore 1.46 SJR 0.463 SNIP 0.905

Original language: English

ASJC Scopus subject areas: Electronic, Optical and Magnetic Materials, Condensed Matter Physics, Energy Engineering and Power Technology, Electrical and Electronic Engineering

Keywords: Accelerator magnet, CLIQ protection system, Finite element analysis, Lorentz forces, Quench, Thermal stress  
DOIs:

10.1016/j.physc.2018.04.003

Source: Scopus

Source ID: 85045717268

Research output: Contribution to journal > Article > Scientific > peer-review

### Improved modelling of electric loads for enabling demand response by applying physical and data-driven models: Project Response

Accurate load and response forecasts are a critical enabler for high demand response penetrations and optimization of responses and market actions. Project RESPONSE studies and develops methods to improve the forecasts. Its objectives are to improve 1) load and response forecast and optimization models based on both data-driven and physical modelling, and their hybrid models, 2) utilization of various data sources such as smart metering data, weather data, measurements from substations etc., and 3) performance criteria of load forecasting. The project applies, develops, compares, and integrates various modelling approaches including partly physical models, machine learning, modern load profiling, autoregressive models, and Kalman-filtering. It also applies non-linear constrained optimization to load responses. This paper gives an overview of the project and the results achieved so far.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Electrical Energy Engineering, Research group: Power systems, Research area: Information Systems in Automation, Automation and Hydraulic Engineering, VTT Technical Research Centre of Finland, University of Eastern Finland

Contributors: Koponen, P., Hanninen, S., Mutanen, A., Koskela, J., Rautiainen, A., Järventausta, P., Niska, H., Kolehmainen, M., Koivisto, H.

Number of pages: 6

Pages: 1-6

Publication date: 27 Jun 2018

### Host publication information

Title of host publication: 2018 IEEE International Energy Conference, ENERGYCON 2018

Publisher: IEEE

ISBN (Electronic): 9781538636695

ASJC Scopus subject areas: Artificial Intelligence, Energy Engineering and Power Technology, Control and Optimization

Keywords: Active demand, Forecasting, Hybrid models, Machine learning, Optimization, Physically based models

Electronic versions:

Koponen-ENERGYCON2018-final

DOIs:

10.1109/ENERGYCON.2018.8398794

URLs:

<http://urn.fi/URN:NBN:fi:tty-201808172164>

Source: Scopus

Source ID: 85050244199

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### **Online dynamic conductance estimation based maximum power point tracking of photovoltaic generators**

In this paper, a novel method of maximum power point tracking of renewable energy generators is proposed, utilizing the sum of dynamic and static conductance as maximum power point tracking loop variable. This allows to formulate the maximum power point tracking problem as a typical closed-loop stabilization task of non-linear static plant with zero reference. Consequently, a simple integrative controller is shown to be sufficient to ensure zero steady-state maximum power point tracking error with easily determinable nominal dynamics. A recently revealed method of online photovoltaic generator dynamic conductance estimation allowing robust terminal voltage control is utilized. Moreover, it is revealed that the resulting maximum power point tracking loop plant is piecewise linear around the maximum power point, i.e. for given environmental conditions two different convergence rates are expected, depending on the relative value of operating voltage to maximum power point voltage. Presented analytical outcomes are verified by application of the proposed maximum power point tracking structure to a grid-connected photovoltaic generator system under robust voltage control.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Electrical Energy Engineering, Ariel University Center of Samaria, Ben-Gurion University of the Negev

Contributors: Sitbon, M., Lineykin, S., Schacham, S., Suntio, T., Kuperman, A.

Number of pages: 10

Pages: 687-696

Publication date: 15 Jun 2018

Peer-reviewed: Yes

#### **Publication information**

Journal: Energy Conversion and Management

Volume: 166

ISSN (Print): 0196-8904

Ratings:

Scopus rating (2018): CiteScore 7.87 SJR 2.73 SNIP 2.151

Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Nuclear Energy and Engineering, Fuel Technology, Energy Engineering and Power Technology

Keywords: Dynamic conductance, Maximum power point tracking, Renewable energy generators

DOIs:

10.1016/j.enconman.2018.04.053

Source: Scopus

Source ID: 85046490026

Research output: Contribution to journal > Article > Scientific > peer-review

### **Sustainable electric vehicle - Prosumer framework and policy mix**

Electric vehicles have pro-environmental advantages compared to traditional automobiles, or even hybrids: they can help reducing pollution and noise levels locally, and greenhouse gas emissions globally. However, there are still many challenges that the electric vehicles must overcome before reaching level of diffusion that can have significant impact on sustainability. This paper evaluates combined sustainability of electric vehicle and small-scale energy production. We propose a framework for sustainable electric vehicle - energy prosumer integration and outline a policy mix that is needed to support adoption of both renewable energy technologies and electric vehicles.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Industrial and Information Management, School of Management Politics

Contributors: Kotilainen, K., Mäkinen, S. J., Valta, J.

Number of pages: 6

Pages: 1-6

Publication date: 8 Jun 2018

#### **Host publication information**

Title of host publication: 2017 IEEE Innovative Smart Grid Technologies - Asia : Smart Grid for Smart Community, ISGT-Asia 2017

Publisher: IEEE

ISBN (Electronic): 9781538649503

ASJC Scopus subject areas: Artificial Intelligence, Computer Networks and Communications, Energy Engineering and Power Technology, Electrical and Electronic Engineering, Control and Optimization, Safety, Risk, Reliability and Quality

Keywords: Electric vehicle, Policy, Prosumer, Renewable energy, Sustainable

DOIs:

10.1109/ISGT-Asia.2017.8378406

### Bibliographical note

EXT="Kotilainen, Kirsi"

Source: Scopus

Source ID: 85050005345

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

### Inoculum pretreatment differentially affects the active microbial community performing mesophilic and thermophilic dark fermentation of xylose

The influence of different inoculum pretreatments (pH and temperature shocks) on mesophilic (37 °C) and thermophilic (55 °C) dark fermentative H<sub>2</sub> production from xylose (50 mM) and, for the first time, on the composition of the active microbial community was evaluated. At 37 °C, an acidic shock (pH 3, 24 h) resulted in the highest yield of 0.8 mol H<sub>2</sub> mol<sup>-1</sup> xylose. The H<sub>2</sub> and butyrate yield correlated with the relative abundance of Clostridiaceae in the mesophilic active microbial community, whereas Lactobacillaceae were the most abundant non-hydrogenic competitors according to RNA-based analysis. At 55 °C, Clostridium and Thermoanaerobacterium were linked to H<sub>2</sub> production, but only an alkaline shock (pH 10, 24 h) repressed lactate production, resulting in the highest yield of 1.2 mol H<sub>2</sub> mol<sup>-1</sup> xylose. This study showed that pretreatments differentially affect the structure and productivity of the active mesophilic and thermophilic microbial community developed from an inoculum.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, Natl. University of Ireland, Galway, ENEA/CREATE/Università Degli Studi Napoli Federico II, University of Cassino and Southern Lazio, Institute for Water Education, UNESCO-IHE

Contributors: Dessi, P., Porca, E., Frunzo, L., Lakaniemi, A., Collins, G., Esposito, G., Lens, P. N.

Pages: 9233-9245

Publication date: 10 May 2018

Peer-reviewed: Yes

Early online date: 1 Jan 2018

### Publication information

Journal: International Journal of Hydrogen Energy

Volume: 43

Issue number: 19

ISSN (Print): 0360-3199

Ratings:

Scopus rating (2018): CiteScore 4.16 SJR 1.1 SNIP 1.128

Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Fuel Technology, Condensed Matter Physics, Energy Engineering and Power Technology

Keywords: Biohydrogen, Clostridium, Lactobacillus, MiSeq, pH shock, Temperature shock

Electronic versions:

Inoculum pretreatment differentially affects the active microbial community

DOIs:

10.1016/j.ijhydene.2018.03.117

URLs:

<http://urn.fi/URN:NBN:fi:tty-201901231146>

Source: Scopus

Source ID: 85045538153

Research output: Contribution to journal › Article › Scientific › peer-review

### Coordinated voltage control as a replacement for passive network reinforcements-A case study

The paper presents the results of a case study conducted on a real-life distribution system, in which an active network management solution is compared against passive network reinforcements. A methodology for assessing the hosting capacity of medium voltage network for distributed generation is presented and results of two calculation cases (Active Network Management and equivalent passive investment) are compared from investment cost-benefit perspective. The results of the paper show significant economic benefits in Active Network Management based solutions against passive reinforcements.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Electrical Energy Engineering, VTT Technical Research Centre of Finland  
Contributors: Supponen, A., Repo, S., Kulmala, A.  
Number of pages: 6  
Pages: 326-331  
Publication date: 17 Apr 2018

#### Host publication information

Title of host publication: 2017 IEEE International Conference on Smart Grid Communications, SmartGridComm 2017  
Publisher: IEEE  
ISBN (Electronic): 9781538640555  
ASJC Scopus subject areas: Artificial Intelligence, Computer Networks and Communications, Energy Engineering and Power Technology, Safety, Risk, Reliability and Quality  
Keywords: Active Network Management, Coordinated Voltage Control, Distributed Generation, Hosting Capacity Assessment  
DOIs:  
10.1109/SmartGridComm.2017.8340714

#### Bibliographical note

INT=eee,"Supponen, Antti"  
EXT="Kulmala, Anna"  
Source: Scopus  
Source ID: 85050893763  
Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### A new method to assess the contribution of VSC-HVDC connected wind farms to the primary frequency control of power networks

This paper introduces a new method to assess the contribution of VSC-HVDC connected wind farms to the primary frequency control (PFC) of power networks. This is a formulation that enables the estimation of the post-disturbance conditions of the power system, including its electrical frequency, after the incidence of power imbalances, where various VSC-HVDC connected wind farms may be simultaneously simulated. As opposed to a full dynamic simulation, which may be time-consuming, the developed method resorts to modelling all power system components for the PFC time frame by using enhanced steady-state power-flow models which are solved for a power system operating point that agrees well with the operating conditions of the network after the action of the PFC. Therefore, models of DFIG and PMSG are first derived by following a proposed procedure for the determination of the frequency regulation of the wind turbines, often called statism, whose value varies with the wind speed, as opposed to that of conventional power plants which is constant. Because the power reserve of the wind generators is used to counteract the frequency deviations in the AC power network, a VSC-HVDC link model is also developed which enables a free power transfer to conform to the output power of the wind farm. The proposed method is validated using a 9-bus power system comprising a 120-MW VSC-HVDC connected wind farm and whose results are compared against those computed by a full time-domain dynamic simulation, obtaining a very good agreement between the two quite distinct approaches where, for instance, the post-disturbance system frequency computed by the proposed method only differs by 0.092% with respect to that obtained by the full dynamic simulation. The IEEE 57-bus test system, slightly modified to incorporate two VSC-HVDC connected wind farms, is also simulated to show that the impact of the frequency regulation of the wind farms on the PFC may be assessed in a very quick, effective manner.

#### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Electrical Energy Engineering, Department of Electrical Engineering  
Contributors: Castro, L. M., Acha, E.  
Number of pages: 11  
Pages: 48-58  
Publication date: 2018  
Peer-reviewed: Yes  
Early online date: 1 Sep 2017

#### Publication information

Journal: Electric Power Systems Research  
Volume: 154  
ISSN (Print): 0378-7796  
Ratings:  
Scopus rating (2018): CiteScore 4.05 SJR 1.037 SNIP 1.391  
Original language: English  
ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering  
Keywords: DFIG, Newton–Raphson method, PMSG, Post-disturbance conditions, Power imbalances, Primary frequency control, Variable speed wind turbines, VSC-HVDC links, Wind farms

DOIs:

10.1016/j.epsr.2017.08.011

Source: Scopus

Source ID: 85028060536

Research output: Contribution to journal › Article › Scientific › peer-review

### **A novel strategy for optimal placement of locally controlled voltage regulators in traditional distribution systems**

In this paper, an approach for placement of voltage regulators (VRs) in traditional distribution systems by considering a local controller model is presented. The main aims of this paper are controlling the voltage level in its permitted range and decreasing the costs imposed to the distribution system companies, such as costs that stem from power losses, VRs' investment and maintenance. Genetic algorithm (GA) has been used as a tool to determine the number, location and rated power of VRs. Since in traditional distribution systems, tap position determination of VRs is achieved by local controllers, local controller model is established to determine tap operations. A 70-bus distribution system is considered to prove the value of the presented approach. Effectiveness of the proposed approach and ineffectiveness and infeasibility of conventional approaches are presented in numerical studies. The presented approach allowed to eliminate voltage violation in all load conditions and a reduction of power losses of about 6% for the maximum load level.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Electrical Energy Engineering, Iran University of Science and Technology, University of Birjand, Università di Salerno

Contributors: Attar, M., Homaei, O., Falaghi, H., Siano, P.

Number of pages: 12

Pages: 11-22

Publication date: 2018

Peer-reviewed: Yes

Early online date: 29 Sep 2017

#### **Publication information**

Journal: International Journal of Electrical Power and Energy Systems

Volume: 96

ISSN (Print): 0142-0615

Ratings:

Scopus rating (2018): CiteScore 5.79 SJR 1.26 SNIP 1.994

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

Keywords: Distribution systems planning, Genetic algorithm, Local controller, Set point, Tap position, Voltage regulator

DOIs:

10.1016/j.ijepes.2017.09.028

Source: Scopus

Source ID: 85030472698

Research output: Contribution to journal › Article › Scientific › peer-review

### **Dynamic modeling and analysis of PCM-controlled DCM-operating buck converters-A reexamination**

Peak-current-mode (PCM) control was proposed in 1978. The observed peculiar behavior caused by the application of PCM-control in the behavior of a switched-mode converter, which operates in continuous conduction mode (CCM), has led to a multitude of attempts to capture the dynamics associated to it. Only a few similar models have been published for a PCM-controlled converter, which operates in discontinuous conduction mode (DCM). PCM modeling is actually an extension of the modeling of direct-duty-ratio (DDR) or voltage-mode (VM) control, where the perturbed duty ratio is replaced by proper duty-ratio constraints. The modeling technique, which produces accurate PCM models in DCM, is developed in early 2000s. The given small-signal models are, however, load-resistor affected, which hides the real dynamic behavior of the associated converter. The objectives of this paper are as follows: (i) proving the accuracy of the modeling method published in 2001, (ii) performing a comprehensive dynamic analysis in order to reveal the real dynamics of the buck converter under PCM control in DCM, (iii) providing a method to improve the high-frequency accuracy of the small-signal models, and (iv) developing control-engineering-type block diagrams to facilitate the development of generalized transfer functions, which are applicable for PCM-controlled DCM-operated buck, boost, and buck-boost converters.

#### **General information**

Publication status: Published

MoE publication type: A2 Review article in a scientific journal

Organisations: Electrical Energy Engineering, Research group: Power electronics, Research area: Power engineering

Contributors: Suntio, T.

Number of pages: 18  
Pages: 1-18  
Publication date: 2018  
Peer-reviewed: Yes  
Early online date: 15 May 2018

#### Publication information

Journal: Energies  
Volume: 11  
Issue number: 5  
Article number: en11051267  
ISSN (Print): 1996-1073  
Ratings:

Scopus rating (2018): CiteScore 3.18 SJR 0.612 SNIP 1.156

Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Energy (miscellaneous), Control and Optimization, Electrical and Electronic Engineering

Keywords: Discontinuous conduction mode, Duty-ratio constraints, Dynamic modeling, Peak-current-mode control

Electronic versions:

energies-11-01267-v2

DOIs:

10.3390/en11051267

URLs:

<http://urn.fi/URN:NBN:fi:ty-201811282777>

Source: Scopus

Source ID: 85054989951

Research output: Contribution to journal > Review Article > Scientific > peer-review

#### Thermophilic versus mesophilic dark fermentation in xylose-fed fluidised bed reactors: Biohydrogen production and active microbial community

Dark fermentative biohydrogen production in a thermophilic, xylose-fed (50 mM) fluidised bed reactor (FBR) was evaluated in the temperature range 55-70 °C with 5-degree increments and compared with a mesophilic FBR operated constantly at 37 °C. A significantly higher ( $p = 0.05$ )  $H_2$  yield was obtained in the thermophilic FBR, which stabilised at about  $1.2 \text{ mol } H_2 \text{ mol}^{-1} \text{ xylose}$  (36% of the theoretical maximum) at 55 and 70 °C, and at  $0.8 \text{ mol } H_2 \text{ mol}^{-1} \text{ xylose}$  at 60 and 65 °C, compared to the mesophilic FBR ( $0.5 \text{ mol } H_2 \text{ mol}^{-1} \text{ xylose}$ ). High-throughput sequencing of the reverse-transcribed 16S rRNA, done for the first time on biohydrogen producing reactors, indicated that *Thermoanaerobacterium* was the prevalent active microorganism in the thermophilic FBR, regardless of the operating temperature. The active microbial community in the mesophilic FBR was mainly composed of *Clostridium* and *Ruminiclostridium* at 37 °C. Thermophilic dark fermentation was shown to be suitable for treatment of high temperature, xylose-containing wastewaters, as it resulted in a higher energy output compared to the mesophilic counterpart.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, Research group: Bio- and Circular Economy, Natl. University of Ireland, Galway, The James Hutton Institute, Hydraulic and Environmental Engineering (IHE) Inst. for Water Education

Contributors: Dessi, P., Porca, E., Waters, N. R., Lakaniemi, A., Collins, G., Lens, P. N.

Pages: 5473-5485

Publication date: 2018

Peer-reviewed: Yes

Early online date: 2018

#### Publication information

Journal: International Journal of Hydrogen Energy

Volume: 43

Issue number: 11

ISSN (Print): 0360-3199

Ratings:

Scopus rating (2018): CiteScore 4.16 SJR 1.1 SNIP 1.128

Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Fuel Technology, Condensed Matter Physics, Energy Engineering and Power Technology

Keywords: Active community, Biohydrogen, FBR, MiSeq, *Thermoanaerobacterium*, Thermophilic

Electronic versions:

Thermophilic versus mesophilic dark fermentation in xylose-fed fluidised bed reactors

DOIs:

10.1016/j.ijhydene.2018.01.158

URLs:

<http://urn.fi/URN:NBN:fi:tty-201901231143>

Source: Scopus

Source ID: 85042365131

Research output: Contribution to journal › Article › Scientific › peer-review

### **Effect of hydraulic retention time on continuous electricity production from xylose in up-flow microbial fuel cell**

Aerobic wastewater management is energy intensive and thus anaerobic processes are of interest. In this study, a microbial fuel cell was used to produce electricity from xylose which is an important constituent of lignocellulosic waste. Hydraulic retention time (HRT) was optimized for the maximum power density by gradually decreasing the HRT from 3.5 d to 0.17 d. The highest power density (430 mW/m<sup>2</sup>) was obtained at 1 d HRT. Coulombic efficiency decreased from 30% to 0.6% with HRTs of 3.5 d and 0.17 d, respectively. Microbial community analysis revealed that anode biofilm contained known exoelectrogens, including *Geobacter* sp. and fermentative organisms were present in both anolyte and the anode biofilm. The peak power densities were obtained at 1-1.7 d HRTs and xylose degraded almost completely even with the lowest HRT of 0.17 d, which demonstrates the efficiency of up-flow MFC for treating synthetic wastewater containing xylose.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, Research group: Bio- and Circular Economy, Feng Chia University

Contributors: Haavisto, J. M., Kokko, M. E., Lay, C., Puhakka, J. A.

Pages: 27494-27502

Publication date: 1 Nov 2017

Peer-reviewed: Yes

#### **Publication information**

Journal: International Journal of Hydrogen Energy

Volume: 42

ISSN (Print): 0360-3199

Ratings:

Scopus rating (2017): CiteScore 4.1 SJR 1.116 SNIP 1.292

Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Fuel Technology, Condensed Matter Physics, Energy Engineering and Power Technology

Keywords: Continuous operation, Hydraulic retention time, Microbial community, Microbial fuel cell, Up-flow, Xylose

Electronic versions:

Effect of hydraulic retention time on continuous electricity production from xylose in up-flow microbial fuel cell. Embargo ended: 2/11/19

DOIs:

10.1016/j.ijhydene.2017.05.068

URLs:

<http://urn.fi/URN:NBN:fi:tty-201907151963>. Embargo ended: 2/11/19

#### **Bibliographical note**

EXT="Lay, Chyi-How"

Source: Scopus

Source ID: 85019734862

Research output: Contribution to journal › Article › Scientific › peer-review

### **Real-time hardware- and software-in-the-loop simulation of decentralised distribution network control architecture**

This study introduces a laboratory test set up developed to evaluate the functionality of a novel decentralised distribution automation architecture. The demonstration system consists of a simulated distribution network in real-time simulation environment including simulated monitoring and control devices as well as physical devices interfaced with the simulator as hardware-in-the-loop test devices. System involves also substation automation units for real-time monitoring and control that are interfaced with the simulator and physical devices. The operating principle of the system is demonstrated with an example simulation case. The main goal for this system was to test the functionality of the decentralised distribution automation architecture and track out any potential interfacing issues of automation system before implementing the concept to actual field demonstrations. Based on the tests executed with the system described in this study, the proper functionality of all the features of the automation architecture was verified and successfully deployed at the field test sites.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Electrical Energy Engineering, Research group: Power systems, VTT Technical Research Centre of Finland

Contributors: Tuominen, V., Reponen, H., Kulmala, A., Lu, S., Repo, S.

Number of pages: 8

Pages: 3057-3064

Publication date: 24 Aug 2017

Peer-reviewed: Yes

### Publication information

Journal: IET Generation, Transmission and Distribution

Volume: 11

Issue number: 12

ISSN (Print): 1751-8687

Ratings:

Scopus rating (2017): CiteScore 3.31 SJR 0.907 SNIP 1.333

Original language: English

ASJC Scopus subject areas: Control and Systems Engineering, Energy Engineering and Power Technology, Electrical and Electronic Engineering

DOIs:

10.1049/iet-gtd.2016.1570

### Bibliographical note

EXT="Kulmala, Anna"

Source: Scopus

Source ID: 85029745746

Research output: Contribution to journal > Article > Scientific > peer-review

### Exhaust emissions of non-road mobile machine: Real-world and laboratory studies with diesel and HVO fuels

Exhaust emissions emitted by a non-road mobile machine were studied chasing a tractor in real-world conditions and repeating the same transient tests with a similar engine on an engine dynamometer where additionally, non-road steady state tests were carried out. The engines were equipped with an oxidation catalyst (DOC) and a selective catalytic reduction (SCR) system, and they were fuelled by fossil diesel fuel with ultra-low sulphur content and hydrotreated vegetable oil (HVO). By substituting diesel fuel with HVO the on-road emissions of nitrogen oxides ( $\text{NO}_x$ ) reduced 20% and particle number 44%, the emission factors being  $\text{EF}_{\text{NO}_x} = 1.62 \pm 0.04 \text{ g/kWh}$  and  $\text{EF}_N = (28.2 \pm 7.8) \times 10^{13} \text{ \#/kWh}$ . Similar trend was observed for  $\text{NO}_x$  at laboratory although the emissions were somewhat smaller than on-road. In contrast to real-world, in the laboratory experiment the  $\text{EF}_N$  was only 2% smaller with HVO than with diesel, and these emission factors were almost one order of magnitude smaller than observed on-road. The number size distribution and volatility measurements showed that in real-world experiments small nucleation mode particles were formed during uphill and during downhill in engine braking conditions. These were not observed at laboratory. However, nucleation mode particles were observed in the laboratory experiments at high load steady driving conditions. At steady state tests the emissions strongly depended on engine load and engine speed with both fuels.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Physics, Research area: Aerosol Physics, University of Helsinki, Turku University of Applied Sciences

Contributors: Pirjola, L., Rönkkö, T., Saukko, E., Parviainen, H., Malinen, A., Alanen, J., Saveljeff, H.

Number of pages: 11

Pages: 154-164

Publication date: 15 Aug 2017

Peer-reviewed: Yes

### Publication information

Journal: Fuel

Volume: 202

ISSN (Print): 0016-2361

Ratings:

Scopus rating (2017): CiteScore 5.4 SJR 1.891 SNIP 2.127

Original language: English

ASJC Scopus subject areas: Chemical Engineering(all), Fuel Technology, Energy Engineering and Power Technology, Organic Chemistry

Keywords: Diesel engine, Exhaust emissions, HVO, NO, Particle size distribution, Real-world emissions, Tractor

Electronic versions:

Fuel\_Pirjola\_rev2\_TUTCRIS. Embargo ended: 13/04/19

DOIs:

10.1016/j.fuel.2017.04.029

URLs:

<http://urn.fi/URN:NBN:fi:tty-201712192400>. Embargo ended: 13/04/19

Additional files:

Appendix A\_Pirjola\_rev\_TUTCRIS

Source: Scopus

Source ID: 85017566506

Research output: Contribution to journal > Article > Scientific > peer-review

### Electropolymerized polyazulene as active material in flexible supercapacitors

We report the capacitive behavior of electrochemically polymerized polyazulene films in different ionic liquids. The ionic liquids in this study represent conventional imidazolium based ionic liquids with tetrafluoroborate and bis(trifluoromethylsulfonyl)imide anions as well as an unconventional choline based ionic liquid. The effect of different ionic liquids on the polymerization and capacitive performance of polyazulene films is demonstrated by cyclic voltammetry and electrochemical impedance spectroscopy in a 3-electrode cell configuration. The films exhibit the highest capacitances in the lowest viscosity ionic liquid ( $92 \text{ mF cm}^{-2}$ ), while synthesis in high viscosity ionic liquid shortens the conjugation length and results in lower electroactivity ( $25 \text{ mF cm}^{-2}$ ). The obtained films also show good cycling stabilities retaining over 90% of their initial capacitance over 1200 p-doping cycles. We also demonstrate, for the first time, flexible polyazulene supercapacitors of symmetric and asymmetric configurations using the choline based ionic liquid as electrolyte. In asymmetric configuration, capacitance of  $55 \text{ mF}$  ( $27 \text{ mF cm}^{-2}$ ) with an equivalent series resistance of  $19 \Omega$  is obtained at operating voltage of  $1.5 \text{ V}$ . Upon increasing the operating voltage up to  $2.4 \text{ V}$ , the capacitance increases to  $72 \text{ mF}$  ( $36 \text{ mF cm}^{-2}$ ).

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Electronics and Communications Engineering, Faculty of Biomedical Sciences and Engineering, Research area: Microsystems, Research area: Measurement Technology and Process Control, Research group: Sensor Technology and Biomeasurements (STB), BioMediTech, Turun Yliopisto/Turun Biomateriaalikeskus

Contributors: Suominen, M., Lehtimäki, S., Yewale, R., Damlin, P., Tuukkanen, S., Kvarnström, C.

Number of pages: 10

Pages: 181-190

Publication date: 15 Jul 2017

Peer-reviewed: Yes

### Publication information

Journal: Journal of Power Sources

Volume: 356

ISSN (Print): 0378-7753

Ratings:

Scopus rating (2017): CiteScore 7 SJR 2.202 SNIP 1.557

Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Physical and Theoretical Chemistry, Electrical and Electronic Engineering

Keywords: Choline, Electropolymerization, Flexible supercapacitor, Ionic liquid, Polyazulene

Electronic versions:

Suominen\_2017\_Revised\_Manuscript. Embargo ended: 15/07/19

Suominen\_2017\_Supplementary\_information. Embargo ended: 15/07/19

DOIs:

10.1016/j.jpowsour.2017.04.082

URLs:

<http://urn.fi/URN:NBN:fi:tty-201706021571>. Embargo ended: 15/07/19

URLs:

<http://www.scopus.com/inward/record.url?scp=85019024216&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 85019024216

Research output: Contribution to journal > Article > Scientific > peer-review

### **Aspects of advancement of distribution tariffs for small consumers in Finland**

This paper discusses the development of distribution tariffs of small consumers in Finland. Changes in the electricity sector have created pressures for the Distribution System Operators (DSO) to develop their pricing practices in order to better reflect their cost structures. In this context, power-based distribution tariffs (PBDT) have been seen as a potential direction for development. This paper analyses the EU and Finnish legal framework for distribution tariffs with an aim to identify potential regulatory barriers and incentives for developing PBDTs in Finland. To support this analysis, the paper also provides results of a survey conducted in Finland in 2016 in the EL-TRAN project, reflecting the will of Finnish consumers to improve their ability to affect the distribution fees. The results indicate that the consumers are interested in having this opportunity.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Electrical Energy Engineering, Itä-Suomen yliopisto, School of Management (JKK)

Contributors: Lummi, K., Rautiainen, A., Järventausta, P., Huhta, K., Talus, K., Kojo, M.

Publication date: 14 Jul 2017

#### **Host publication information**

Title of host publication: 2017 14th International Conference on the European Energy Market, EEM 2017

Publisher: IEEE

ISBN (Electronic): 9781509054992

ASJC Scopus subject areas: Marketing, Energy Engineering and Power Technology, Fuel Technology

Keywords: Electricity distribution pricing, Energy efficiency, Legislation, Power-based distribution tariff

Electronic versions:

aspects\_of\_advancement\_of\_distribution\_2017

DOIs:

10.1109/EEM.2017.7981937

URLs:

<http://urn.fi/URN:NBN:fi:tuni-20191115870>

#### **Bibliographical note**

jufoid=70631

Source: Scopus

Source ID: 85027141816

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

### **Attractiveness of demand response in the Nordic electricity market - Present state and future prospects**

During the past few years demand response (DR) has appeared in the spotlight in a new way. This is due to general technological advancement, development of electricity infrastructure, especially roll-out of smart meters, and rapidly increasing amount of renewable intermittent energy sources. This paper analyzes the attractiveness of DR in the Nordic electricity market. The results show that in many market places the attractiveness of DR is improving in the long term, although variations between different years exist. Two case studies presented in the papers show that DR has economic potential for some of the customers, especially for medium to large actors, but in a large scope, number of obstacles still hinder a wide scale deployment of DR solutions.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Electrical Energy Engineering, Research area: Power engineering, Research group: Power systems, VTT Technical Research Centre of Finland

Contributors: Rautiainen, A., Koskela, J., Vilppo, O., Supponen, A., Kojo, M., Toivanen, P., Rinne, E., Järventausta, P.

Publication date: 14 Jul 2017

#### **Host publication information**

Title of host publication: 2017 14th International Conference on the European Energy Market, EEM 2017

Publisher: IEEE

ISBN (Electronic): 9781509054992

ASJC Scopus subject areas: Marketing, Energy Engineering and Power Technology, Fuel Technology

Keywords: Demand response, Electricity market

Electronic versions:

Attractiveness of demand response in the Nordic electricity market

DOIs:

10.1109/EEM.2017.7981925

URLs:

<http://urn.fi/URN:NBN:fi:tty-201802141219>

#### **Bibliographical note**

INT=eee,"Supponen, A."

EXT="Rinne, E."

jufoid=70631

Source: Scopus

Source ID: 85027168719

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

#### **Development options for distribution tariff structures in Finland**

In this paper, we study the development options of tariff structures in electricity distribution in Finland. We compare the impacts of three different tariffs from the viewpoints of customers, distribution system operator (DSO), electricity supplier, and society. Analyzed tariffs are (1) energy oriented tariff, which is currently in use, (2) power limit tariff, and (3) power tariff. Based on the analyses, it seems that it is justified to include power based price component in distribution tariff. Generally, the impacts of both analyzed power based tariffs are quite similar. However, it seems that power tariff is a bit stronger candidate. Nevertheless, it should be noted that the benefits of the power-oriented pricing, illustrated in the paper, could be achieved only by well-designed tariff system. Although analyses are based on Finnish case, most of the results are generalizable to other countries also.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Electrical Energy Engineering, Lappeenranta University of Technology

Contributors: Honkapuro, S., Haapaniemi, J., Haakana, J., Lassila, J., Belonogova, N., Partanen, J., Lummi, K., Rautiainen, A., Supponen, A., Repo, S., Järventausta, P.

Publication date: 14 Jul 2017

#### **Host publication information**

Title of host publication: 2017 14th International Conference on the European Energy Market, EEM 2017

Publisher: IEEE

ISBN (Electronic): 9781509054992

ASJC Scopus subject areas: Marketing, Energy Engineering and Power Technology, Fuel Technology

Keywords: Demand response, Distribution tariffs

Electronic versions:

Development options for distribution tariff structures in Finland

DOIs:

10.1109/EEM.2017.7981930

URLs:

<http://urn.fi/URN:NBN:fi:tty-201802141220>

#### **Bibliographical note**

jufoid=70631

INT=eee,"Supponen, Antti"

Source: Scopus

Source ID: 85027133346

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

#### **Understanding consumers' renewable energy behaviour beyond 'homo economicus': An exploratory survey in four European countries**

Climate change is putting global pressure for energy consumption and production to move towards sustainable solutions based on clean energy sources. Rapid advancements in technology make energy generation and storage solutions available and affordable for consumers and enable them to become relevant actors in the energy process. The actual success of sustainable energy solutions is however not so much dependent on technological readiness, which is already in place to large extent, but rather on influencing consumer adoption in an impactful way. This article explores consumers' behavioral drivers for the adoption of renewable energy solutions by comparing the economic, ecologic and social preferences of consumers in four European countries.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Industrial and Information Management, Electrical Energy Engineering

Contributors: Kotilainen, K., Valta, J., Mäkinen, S. J., Järventausta, P.

Publication date: 14 Jul 2017

### Host publication information

Title of host publication: 2017 14th International Conference on the European Energy Market, EEM 2017  
Publisher: IEEE  
ISBN (Electronic): 9781509054992  
ASJC Scopus subject areas: Marketing, Energy Engineering and Power Technology, Fuel Technology  
Keywords: Consumer, Incentives, Policy, Prosumer, Renewable energy  
DOIs:  
10.1109/EEM.2017.7981932

### Bibliographical note

jufoid=70631  
Source: Scopus  
Source ID: 85027150084  
Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### The effects of calcium and potassium on CO<sub>2</sub> gasification of birch wood in a fluidized bed

Birch wood was leached of its naturally occurring ash forming elements and doped with three concentrations of calcium or potassium before being gasified in a laboratory bubbling fluidized bed reactor. The wood samples were pelletized and inserted into a fluidized bed reactor where they were first pyrolyzed with N<sub>2</sub> and then gasified with CO<sub>2</sub>. In addition to tracking the gas concentration of the exit gas, char samples were taken from the fluidized bed and analyzed to study the char properties. The presence of potassium in the biomass was found to have a significant influence on the structure of the resulting char, however potassium did not have an observable catalytic effect on the overall gasification reaction rate with CO<sub>2</sub> due to the formation of a unreactive coke layer on the char surface. In contrast, calcium did increase the char conversion rate and is likely the primary active catalyst in gasification of birch wood with CO<sub>2</sub>.

### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Research group: Industrial Bioengineering and Applied Organic Chemistry, Chemistry and Bioengineering, Research group: Power Plant and Combustion Technology, Universidad de Sevilla, Johan Gadolin Process Chemistry Centre, Abo Akademi University, Univ of Oulu  
Contributors: Kramb, J., Gómez-Barea, A., DeMartini, N., Romar, H., Doddapaneni, T. R. K. C., Konttinen, J.  
Number of pages: 10  
Pages: 398-407  
Publication date: 15 May 2017  
Peer-reviewed: Yes

### Publication information

Journal: Fuel  
Volume: 196  
ISSN (Print): 0016-2361  
Ratings:  
Scopus rating (2017): CiteScore 5.4 SJR 1.891 SNIP 2.127  
Original language: English  
ASJC Scopus subject areas: Chemical Engineering(all), Fuel Technology, Energy Engineering and Power Technology, Organic Chemistry  
Keywords: Biomass, Catalysts, Char, Fluidized bed, Gasification  
DOIs:  
10.1016/j.fuel.2017.01.101  
Source: Scopus  
Source ID: 85012050856  
Research output: Contribution to journal > Article > Scientific > peer-review

### The IDE4L Project: Defining, Designing, and Demonstrating the Ideal Grid for All

The Purpose of the IDE4L project was to define, design, and demonstrate the ideal grid for all, with an active distribution network that integrates renewable energy sources (RESs) and new loads and guarantees the reliability of classical distribution networks. The active distribution network consists of the infrastructure of power delivery, active resources, and active network management (ANM) and combines passive infrastructure with active resources, ANM functionalities, and distribution automation information and communication technology infrastructure. Active distributed energy resources (DERs) include distributed generation (DG), demand, response, and storage. The concept of a commercial aggregator offering flexibility services is also integrated in an ANM.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Electrical Energy Engineering, Research area: Power engineering, Research group: Power systems, RWTH Aachen University, Unareti SpA, Schneider Electric, Catalonia Institute for Energy Research (IREC), Danish Energy Association (Dansk Energi), Universidad Carlos III de Madrid, VTT Technical Research Centre of Finland  
Contributors: Repo, S., Ponci, F., Della Giustina, D., Alvarez, A., Corchero Garcia, C., Al-Jassim, Z., Amaris, H., Kulmala, A.

Number of pages: 11

Pages: 41-51

Publication date: 1 May 2017

Peer-reviewed: Yes

### Publication information

Journal: IEEE POWER AND ENERGY MAGAZINE

Volume: 15

Issue number: 3

ISSN (Print): 1540-7977

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Scopus rating (2017): CiteScore 1.93 SJR 0.942 SNIP 1.34

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

DOIs:

10.1109/MPE.2017.2662329

### Bibliographical note

EXT="Kulmala, Anna"

Source: Scopus

Source ID: 85018954673

Research output: Contribution to journal › Article › Scientific › peer-review

### Determining maximum MPP-tracking sampling frequency for input-voltage-controlled PV-interfacing converter

A maximum-power-point tracking (MPPT) algorithm is essential in all controllers of solar power electronic converters due to the nonlinear current-voltage characteristics of a photovoltaic generator. One of the most widely utilized algorithms are perturbative MPPT techniques such as perturb and observe and incremental conductance methods due to their simple implementation with relatively good tracking performance. However, in order to optimize the performance of such algorithms, the design parameters - sampling frequency and perturbation step size - need to be designed in respect to interfaced power electronic converter. Recent studies have provided state-of-art MPP-tracking design rules for single and two-stage grid-connected PV systems. Unfortunately, the analysis of those studies does not provide analytical results for PV power transient response under feedback-controlled converters. This paper provides reduced-order transfer functions for the converters equipped with either I-type or PID-type controllers in order to approximate the maximum sampling or perturbation frequency for MPP-tracking algorithms. The analysis reveals the factors affecting the transient behavior similarly as in open-loop converter providing valuable tools for optimizing MPP-tracking perturbation frequency design.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Electrical Energy Engineering, Research area: Power engineering, Ariel University

Contributors: Kivimäki, J., Sitbon, M., Kolesnik, S., Kuperman, A., Suntio, T.

Publication date: 13 Feb 2017

### Host publication information

Title of host publication: 8th Annual IEEE Energy Conversion Congress & Exposition (ECCE 2016)

Publisher: IEEE

ISBN (Electronic): 9781509007370

ASJC Scopus subject areas: Control and Systems Engineering, Electrical and Electronic Engineering, Energy Engineering and Power Technology, Control and Optimization

Electronic versions:

Determining maximum MPP-tracking sampling frequency for input-voltage-controlled PV-interfacing converter

DOIs:

10.1109/ECCE.2016.7855036

URLs:

<http://urn.fi/URN:NBN:fi:tty-201802141221>

Source: Scopus

Source ID: 85015446286

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

### **Cavitation erosion, slurry erosion and solid particle erosion performance of metal matrix composite (MMC) coatings sprayed with modern high velocity thermal spray processes**

Thermally sprayed metal-matrix composite (MMC) coatings are widely used to protect components and surfaces against wear in various applications. Hard and wear resistant coatings increase the component lifetime and allow the refurbishment of the worn components. This produces significant savings and promotes ecological manufacturing. The current state-of-the-art coatings are produced with high velocity oxygen-fuel (HVOF) spray processes, while modern high velocity air-fuel (HVOF) spray process has become increasingly available in production and research. The current study focuses on the performance of tungsten carbide (WC-10Co4Cr) and chromium carbide ( $\text{Cr}_3\text{C}_2$ -25NiCr) based MMC coatings sprayed with gaseous and liquid fuelled HVOF processes and a modern HVOF spray process. Two powder feedstock types, i.e. dense particles with fine carbides and porous particles with coarse carbides, were selected for both compositions. The results show significant improvements especially for WC-10Co4Cr coatings sprayed with HVOF when compared to HVOF sprayed coatings. In addition,  $\text{Cr}_3\text{C}_2$ -25NiCr coatings sprayed from the dense powder resulted in improved wear resistance compared to conventional feedstock powder.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Materials Science, Research group: Surface Engineering, Research group: Materials Characterization, VZÚ Pízeň, University of West Bohemia

Contributors: Matikainen, V., Rubio, S., Ojala, N., Koivuluoto, H., Schubert, J., Houdková, S., Vuoristo, P.

Number of pages: 3

Pages: 1161-1163

Publication date: 1 Jan 2017

#### **Host publication information**

Title of host publication: Materials Science and Technology Conference and Exhibition 2017, MS and T 2017 : October 8-12, 2017, Pittsburgh, Pennsylvania USA

Volume: 2

Publisher: Association for Iron and Steel Technology, AISTECH

ISBN (Electronic): 9781510850583

ASJC Scopus subject areas: Mechanics of Materials, Materials Science (miscellaneous), Energy Engineering and Power Technology

Keywords: Cavitation erosion, Coating, Metal matrix composite, Slurry erosion, Thermal spray

URLs:

<http://toc.proceedings.com/36807webtoc.pdf>

Source: Scopus

Source ID: 85047650405

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### **Particle emissions characterization from a medium-speed marine diesel engine with two fuels at different sampling conditions**

Particle emission characteristics for a medium-speed four-stroke marine diesel engine were studied using a variety of sampling systems. Measurements were conducted at 25% and 75% load employing a heavy fuel oil (HFO) and a lighter marine distillate oil. The measurements, especially with HFO, revealed that marine exhaust particles mostly consist of nanometer sized ash particles on which heavy volatile species condense during exhaust dilution and cooling. The soot mode number concentration was low with both fuels tested, in particular when HFO was used. Total particle number emissions ranged in the order of  $5.2\text{--}6.9 \times 10^{15}$  per kg of fuel and formed a monomodal size distribution when a porous tube diluter combined with an ageing chamber and operating at low dilution ratio was used for sampling. The levels and size distributions obtained in the lab using a porous tube diluter were similar to the ones reported in the literature studying ship plumes following atmospheric dilution. Lab measurements with ejector-type diluters mostly led to bi-modal distributions that did not well resemble atmospheric size distributions. Moreover, the nucleation mode formed with the ejector diluters was variable in size and concentration. When used with dilution air at ambient temperature, ejector diluters were inappropriate for primary dilution due to clogging.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Physics, Aerosol Physics Laboratory, VTT Technical Research Centre of Finland, Finnish Meteorological Institute

Contributors: Ntziachristos, L., Saukko, E., Lehtoranta, K., Rönkkö, T., Timonen, H., Simonen, P., Karjalainen, P., Keskinen, J.

Number of pages: 10

Pages: 456-465

Publication date: 15 Dec 2016

Peer-reviewed: Yes

### Publication information

Journal: Fuel

Volume: 186

ISSN (Print): 0016-2361

Ratings:

Scopus rating (2016): CiteScore 4.9 SJR 1.736 SNIP 2.185

Original language: English

ASJC Scopus subject areas: Chemical Engineering(all), Fuel Technology, Energy Engineering and Power Technology, Organic Chemistry

Keywords: Heavy fuel oil, Light fuel oil, Marine emissions, Particle emissions, Soot particles

DOIs:

10.1016/j.fuel.2016.08.091

Source: Scopus

Source ID: 84984817885

Research output: [Contribution to journal](#) › [Article](#) › [Scientific](#) › [peer-review](#)

### A Unified Modeling Approach of Multi-Terminal VSC-HVDC Links for Dynamic Simulations of Large-Scale Power Systems

This paper introduces a new and general frame-of-reference for dynamic solutions of multi-terminal VSC-HVDC systems using the Newton-Raphson method. Three VSC dynamic models are derived to conform to each pairing AC sub-network- the slack converter whose aim is to control its DC voltage, the scheduled-power converter which injects a scheduled amount of power and the passive converter which is connected to an AC network with no frequency control equipment. Each VSC unit makes provisions for the phase reactor, AC filter, DC capacitor, DC smoothing inductor and LTC transformer. The VSC itself is a positive-sequence lumped-type model whose core elements are a phase-shifting transformer and an equivalent shunt susceptance which account for the phase-shifting and scaling nature of the PWM control. In turn, the DC side of each pairing VSC unit is linked to a DC system of an arbitrary configuration. All this enables the assembly of any number of VSCs, giving rise to a comprehensive formulation of multi-terminal VSC-HVDC systems. The prowess of the proposed multi-terminal dynamic model is demonstrated by carrying out a comparison against the widely-used EMT-type package Simulink, using a three terminal VSC-HVDC system, with very good results. Furthermore, a six-terminal VSC-HVDC system forming a DC ring is used to show the applicability of the proposed unified approach when solving multi-terminal VSC-HVDC links for system-wide dynamic studies.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Electrical Engineering, Research area: Power engineering, National Autonomous University of Mexico

Contributors: Castro, L. M., Acha, E.

Number of pages: 10

Pages: 5051-5060

Publication date: 1 Nov 2016

Peer-reviewed: Yes

### Publication information

Journal: IEEE Transactions on Power Systems

Volume: 31

Issue number: 6

ISSN (Print): 0885-8950

Ratings:

Scopus rating (2016): CiteScore 8.17 SJR 3.368 SNIP 3.597

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

Keywords: Multi-terminal VSC-HVDC systems, Newton-Raphson method, VSC-HVDC dynamic modeling

DOIs:

10.1109/TPWRS.2016.2527498

Source: Scopus

Source ID: 84959422989

Research output: [Contribution to journal](#) › [Article](#) › [Scientific](#) › [peer-review](#)

### Elimination of arsenic-containing emissions from gasification of chromated copper arsenate wood

The behavior of arsenic in chromated copper arsenate containing wood during gasification was modeled using thermodynamic equilibrium calculations. The results of the model were validated using bench-scale gasification tests. It is shown that over 99.6% of arsenic can be removed from the product gas by a hot filter when the gas is cooled below the predicted condensation temperature.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry, Energy Technology and Thermal Process Chemistry, Gasification Technologies Inc., Gas Technology Institute

Contributors: Kramb, J., Konttinen, J., Backman, R., Salo, K., Roberts, M.

Number of pages: 6

Pages: 319-324

Publication date: 1 Oct 2016

Peer-reviewed: Yes

### Publication information

Journal: Fuel

Volume: 181

ISSN (Print): 0016-2361

Ratings:

Scopus rating (2016): CiteScore 4.9 SJR 1.736 SNIP 2.185

Original language: English

ASJC Scopus subject areas: Fuel Technology, Energy Engineering and Power Technology, Chemical Engineering(all), Organic Chemistry

Keywords: Arsenic, CCA wood, Equilibrium modeling, Gasification

DOIs:

10.1016/j.fuel.2016.04.109

Source: Scopus

Source ID: 84965081806

Research output: [Contribution to journal](#) > [Article](#) > [Scientific](#) > [peer-review](#)

### Power flow solutions of AC/DC micro-grid structures

This paper presents a new and general frame-of-reference for the unified, power flow solution of AC and DC micro-grids using the Newton-Raphson method, where the quadratic convergence towards the solution is preserved. The cornerstone of this modeling development in power flow theory is the so-called multi-terminal VSC-HVDC system. In this frame-of-reference, an AC micro-grid of arbitrary configuration is connected to the high-voltage side of the LTC transformer of a VSC station. In turn, the DC side of each VSC is linked to a DC system of arbitrary configuration. Any number of AC micro-grids may exist and the DC system may contain single load or generation points such as a PV installation. Each VSC model takes into account, in aggregated form, the phase-shifting and scaling nature of the PWM control. It also accounts for the VSC current design limits, PWM limits within the linear range, switching losses and ohmic losses.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Electrical Engineering, Research area: Power engineering, National Autonomous University of Mexico

Contributors: Acha, E., Rubbrecht, T., Castro, L. M.

Publication date: 10 Aug 2016

### Host publication information

Title of host publication: 19th Power Systems Computation Conference, PSCC 2016

Publisher: IEEE

ISBN (Print): 978-1-4673-8151-2

ASJC Scopus subject areas: Computer Networks and Communications, Energy Engineering and Power Technology

Keywords: Micro-grids, multi-terminal HVDC systems, Newton-Raphson method, power flows, VSC modeling

DOIs:

10.1109/PSCC.2016.7540815

Source: Scopus

Source ID: 84986550301

Research output: [Chapter in Book/Report/Conference proceeding](#) > [Conference contribution](#) > [Scientific](#) > [peer-review](#)

### Comparison of photovoltaic and wind generators as dynamic input sources to power processing interfaces

The paper reveals that while the equivalent circuit, representing the load side reflected low-frequency dynamics of a wind turbine generator, is similar to the electrical equivalent circuit of a photovoltaic generator, their dynamic resistances possess different behavior. While the incremental conductance of a photovoltaic generator does not change sign with terminal voltage variations, zero-crossing dynamic conductance characterizes wind turbine generator. The findings points out the complications arising during interfacing a wind turbine generator by different power processing interfaces.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Electrical Engineering, Research area: Power engineering, Ariel University Center of Samaria

Contributors: Kolesnik, S., Sitbon, M., Agranovich, G., Kuperman, A., Suntio, T.

Publication date: 25 Jul 2016

### Host publication information

Title of host publication: 2016 2nd International Conference on Intelligent Energy and Power Systems, IEPS 2016 - Conference Proceedings

Publisher: IEEE

ISBN (Electronic): 9781509017690

ASJC Scopus subject areas: Energy Engineering and Power Technology, Renewable Energy, Sustainability and the Environment, Control and Systems Engineering, Electrical and Electronic Engineering

Keywords: dynamic resistance, equivalent electrical circuit, Photovoltaic generator, wind turbine

DOIs:

10.1109/IEPS.2016.7521859

Source: Scopus

Source ID: 84983341165

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### Cost-causation based approach in forming power-based distribution network tariff for small customers

This paper discusses the development of electricity distribution network tariffs. In the paper, the present state of distribution network tariffs of small customers is discussed together with key future challenges of the distribution network business. As a potential solution to these challenges, power-based tariffs of the small customers are discussed and preliminary results of a case study are presented where tariffs are formed by applying data of one Finnish Distribution System Operator (DSO).

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Electrical Engineering, Research area: Power engineering, Helen Ltd.

Contributors: Lummi, K., Rautiainen, A., Järventausta, P., Heine, P., Lehtinen, J., Hyvärinen, M.

Publication date: 25 Jul 2016

### Host publication information

Title of host publication: 2016 13th International Conference on the European Energy Market, EEM 2016

Publisher: IEEE COMPUTER SOCIETY PRESS

ISBN (Electronic): 9781509012978

ASJC Scopus subject areas: Marketing, Energy Engineering and Power Technology, Fuel Technology

Keywords: Electricity distribution business, electricity distribution network tariff, power-based distribution tariff

DOIs:

10.1109/EEM.2016.7521251

Source: Scopus

Source ID: 84983343584

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### Network impacts of distribution power tariff schemes with active customers

In this paper we study the network impacts of power based distribution tariff which has been widely discussed in Finland as a future electricity distribution tariff also for small customers. The abundance of smart meters in Finland has enabled new forms of electricity pricing schemes, most notably hourly based energy pricing utilized by many Finnish retailers presently. However, the distribution pricing schemes are currently virtually same as during pre-deregulation and before the automatic meter reading (AMR) infrastructure. The paper presents the network impacts (voltage and current violations) of proposed tariff scheme based on load flow simulation of large-scale real-life distribution network from Finland. Simulations include the impact of both the retail and the distribution tariffs. Customers having large enough energy consumption (electric heating customers) are simulated to have a home automation for energy management. The results show that customer energy optimization can cause significant investment needs to the network and that power based distribution tariff can mitigate these issues.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Electrical Engineering, Research area: Power engineering

Contributors: Supponen, A., Rautiainen, A., Lummi, K., Järventausta, P., Repo, S.  
Publication date: 25 Jul 2016

#### Host publication information

Title of host publication: 2016 13th International Conference on the European Energy Market, EEM 2016  
Publisher: IEEE COMPUTER SOCIETY PRESS  
ISBN (Electronic): 9781509012978  
ASJC Scopus subject areas: Marketing, Energy Engineering and Power Technology, Fuel Technology  
Keywords: Electricity Distribution Pricing, Energy management/optimization, Network Impacts, Power Tariff  
DOIs:  
10.1109/EEM.2016.7521237

#### Bibliographical note

AUX=DEE,"Supponen, Antti"  
Source: Scopus  
Source ID: 84983371980  
Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### The role of residential prosumers initiating the energy innovation ecosystem to future flexible energy system

This paper explores prosumer role in Smart Grid innovation ecosystem as part of the energy market transition from traditional energy system to future flexible energy ecosystem based on renewable energy sources. This transition is facilitated by international agendas and government actions to slow down climate change globally and technological advancements in multiple areas like consumer electronics (e.g. smart appliances) and Information and Communication Technologies (ICT). These developments render industries to converge and traditional structures are changing. Despite the technology developments and top-down policy push, the Smart Grid innovation ecosystem diffusion has not reached mass-market adoption yet. We review theoretical basis for energy system transition based on which we suggest a series of exploratory propositions for prosumer role in initiating the Smart Grid innovation ecosystem.

#### General information

Publication status: Published  
MoE publication type: A4 Article in a conference publication  
Organisations: Department of Industrial Management, Research group: Center for Innovation and Technology Research, Department of Electrical Engineering, Research area: Power engineering  
Contributors: Kotilainen, K., Mäkinen, S. J., Järventausta, P., Rautiainen, A., Markkula, J.  
Publication date: 25 Jul 2016

#### Host publication information

Title of host publication: 2016 13th International Conference on the European Energy Market, EEM 2016  
Publisher: IEEE COMPUTER SOCIETY PRESS  
ISBN (Electronic): 9781509012978  
ASJC Scopus subject areas: Marketing, Energy Engineering and Power Technology, Fuel Technology  
Keywords: demand response, diffusion of innovation, Flexible electrical energy system, innovation ecosystem, prosumer, Smart Grid  
DOIs:  
10.1109/EEM.2016.7521325  
Source: Scopus  
Source ID: 84983320429  
Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### A generalized frame of reference for the incorporation of, multi-terminal VSC-HVDC systems in power flow solutions

This paper introduces a new and general frame-of-reference for true unified, iterative solutions of AC/DC power flows using the Newton-Raphson method. The emphasis is placed on the so-called multi-terminal VSC-HVDC systems. This frame-of-reference accommodates quite naturally any number of AC/DC sub-networks generated by an arbitrary number of VSC converters. Besides, each AC sub-network may contain any number of FACTS devices. The modeling approach adopted for the multi-terminal VSC-HVDC systems is incremental in nature. An AC system of arbitrary configuration is connected to the high-voltage side of the VSC's LTC transformer. In turn, the DC side of each pairing VSC is linked to a DC system of arbitrary configuration. The new model represents a paradigm shift in the way the fundamental frequency, positive sequence modeling of VSC-HVDC links are modeled, where the VSCs are not treated as idealized, controllable voltage sources but rather as compound transformer devices with which key control properties of the PWM-based converters are linked. In contrast to other contemporary approaches, the power flow iterative solutions carried out using the reference frame put forward in this paper exhibits a true quadratic convergence characteristic - in most credible cases, convergence to a tight power mismatch tolerance of  $e^{-12}$  would be achieved in five or less iterations.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Electrical Engineering, Research area: Power engineering, Department of Electrical Engineering

Contributors: Acha, E., Castro, L. M.

Number of pages: 10

Pages: 415-424

Publication date: 1 Jul 2016

Peer-reviewed: Yes

### Publication information

Journal: Electric Power Systems Research

Volume: 136

ISSN (Print): 0378-7796

Ratings:

Scopus rating (2016): CiteScore 3.32 SJR 1.032 SNIP 1.506

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

Keywords: MT-HVDC systems, Newton-Raphson method, Power flows, VSC-HVDC modeling

DOIs:

10.1016/j.epsr.2016.03.009

Source: Scopus

Source ID: 84962658013

Research output: Contribution to journal > Article > Scientific > peer-review

### Modeling of the catalytic effects of potassium and calcium on spruce wood gasification in CO<sub>2</sub>

Using previously reported thermogravimetric analysis measurements, the effects of calcium and potassium on the char gasification rate of spruce wood were modeled. Spruce wood was leached of inorganic ash elements and doped with measured amounts of potassium and calcium. The wood was gasified in an isothermal thermogravimetric analysis device in CO<sub>2</sub> where the devolatilization of the wood, char formation and char gasification all occurred inside the preheated reactor. A new method for separating the effects of devolatilization and char gasification is presented. Kinetic models were evaluated for their ability to describe the observed catalytic effects of potassium and calcium on the gasification rate. Two modified versions of the random pore model were able to accurately describe the measured conversion rates and the parameters of the kinetic models were found to be dependent on the calcium and potassium concentrations. Empirical correlations were developed to predict the char conversion rate from only the potassium and calcium concentration of the sample.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry, Johan Gadolin Process Chemistry Centre, Abo Akademi University, VTT Technical Research Centre of Finland

Contributors: Kramb, J., DeMartini, N., Perander, M., Moilanen, A., Konttinen, J.

Number of pages: 10

Pages: 50-59

Publication date: 1 Jul 2016

Peer-reviewed: Yes

### Publication information

Journal: Fuel Processing Technology

Volume: 148

ISSN (Print): 0378-3820

Ratings:

Scopus rating (2016): CiteScore 4.15 SJR 1.397 SNIP 1.729

Original language: English

ASJC Scopus subject areas: Fuel Technology, Energy Engineering and Power Technology, Chemical Engineering(all)

Keywords: Biomass, Gasification, Modeling, Reaction kinetics

DOIs:

10.1016/j.fuproc.2016.01.031

### Bibliographical note

EXT="Moilanen, Antero"

Source: Scopus

Source ID: 84959431503

Research output: Contribution to journal > Article > Scientific > peer-review

### **The formation and physical properties of the particle emissions from a natural gas engine**

Natural gas engine particle emissions were studied using an old gasoline engine modified to run with natural gas. The tests were steady-state tests performed on two different low loads in an engine dynamometer. Exhaust particle number concentration, size distribution, volatility and electric charge were measured. Exhaust particles were observed to have peak diameters below 10 nm. To get the full picture of particle emissions from natural gas engines, size range 1-5 nm is relevant and important to take into consideration. A particle size magnifier (PSM) was used in this engine application for measuring particles smaller than 3 nm and it proved to be a useful instrument when measuring natural gas engine exhaust particles. It is concluded that the detected particles probably originated from the engine cylinders or their vicinity and grew to detectable sizes in the sampling process because a small fraction of the particles were observed to carry electric charge and the particles did not evaporate totally at 265°C.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Physics, Research area: Aerosol Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Engineering materials science and solutions (EMASS), Urban circular bioeconomy (UrCirBio), Atmospheric Composition Research, VTT Technical Research Centre of Finland, Finnish Meteorological Institute

Contributors: Alanen, J., Saukko, E., Lehtoranta, K., Murtonen, T., Timonen, H., Hillamo, R., Karjalainen, P., Kuuluvainen, H., Harra, J., Keskinen, J., Rönkkö, T.

Number of pages: 7

Pages: 155-161

Publication date: 15 Dec 2015

Peer-reviewed: Yes

#### **Publication information**

Journal: Fuel

Volume: 162

ISSN (Print): 0016-2361

Ratings:

Scopus rating (2015): CiteScore 4.46 SJR 1.781 SNIP 2.091

Original language: English

ASJC Scopus subject areas: Fuel Technology, Energy Engineering and Power Technology, Chemical Engineering(all), Organic Chemistry

Keywords: Fine particle emission, Internal combustion engine, Natural gas, Particle formation

DOIs:

10.1016/j.fuel.2015.09.003

URLs:

<http://www.scopus.com/inward/record.url?scp=84941782885&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84941782885

Research output: Contribution to journal › Article › Scientific › peer-review

### **Suboptimal search strategies with bounded computational complexity to solve long-horizon direct model predictive control problems**

Search algorithms that reduce the time to solve the direct model predictive control (MPC) problem are proposed in this paper. By allowing for suboptimal solutions, the computational complexity of the underlying optimization problem can be significantly reduced, albeit by sacrificing (to a certain degree) optimality. Two approaches are presented and discussed. The first approach requires quadratic time, making it a very efficient candidate for solving the examined problem. Thanks to the second approach, a preset upper limit on the operations performed in real time is not exceeded, thus guaranteeing realtime termination in all runs. To highlight the effectiveness of the introduced strategies, a variable speed drive system with a three-level voltage source inverter is used as an illustrative example.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Smart Energy Systems (SES), Institute for Electrical Drive Systems and Power Electronics, Technische Universität München, ABB Corporate Research Center - Switzerland

Contributors: Karamanakos, P., Geyer, T., Kennel, R.

Number of pages: 8

Pages: 334-341

Publication date: 21 Sep 2015

### Host publication information

Title of host publication: 2015 IEEE Energy Conversion Congress and Exposition, ECCE 2015

Publisher: Institute of Electrical and Electronics Engineers Inc.

ISBN (Electronic): 9781467371506

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

DOIs:

10.1109/ECCE.2015.7309707

Source: Scopus

Source ID: 84963626563

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

### Searching for a robust strategy for minimizing alkali chlorides in fluidized bed boilers during burning of high SRF-energy-share fuel

To meet the increasing volume of waste to be treated via energy recovery, high SRF-energy-share fuel is being fired in conventional waste-to-energy facilities. In this work, corrosion related risk during firing of 70 e-% share (target fuel) is studied and compared against the base case fuel containing 50 e-% share. Cl and S concentration is highest in the target fuel as a direct result of increasing the proportion of SRF in the fuel mixture. Br, Zn and Pb showed the same trend. Meanwhile, the concentration of Na, K, Al and Si are highly dependent on the type of the SRF fired. The corrosion risk of the base and target fuels are analyzed using the composition of the fine aerosol fraction and deposit samples measured near the vicinity of the superheater. Surprisingly aerosols for the target fuel are less risky - having less Cl and more S, than that of the base fuel. The effects of sulfur based additives - elemental sulfur and sulfate injection, and fuel substitution on the risk of superheater corrosion are likewise analyzed. All these strategies can reduce the concentration of Cl in the aerosols, however it is concluded that sulfate injection is considered as a robust strategy for mitigating alkali chloride formation. Sulfate injection is able to reduce Cl in the aerosols and deposits regardless of the quality of the fuel mixture. Robust strategies are important in ensuring the boiler performance during high SRF-energy share firing. An attempt of linking the quality of the deposits and the properties of the flue gas and aerosols around the superheater using partial least squares regression is also presented.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Urban circular bioeconomy (UrCirBio), University of Jyväskylä, Valmet Technologies Oy, VTT Technical Research Centre of Finland, Department of Chemistry, Renewable Natural Resources and Chemistry of Living Environment, Stora Enso

Contributors: Bajamundi, C. J. E., Vainikka, P., Hedman, M., Silvennoinen, J., Heinanen, T., Taipale, R., Kontinen, J.

Number of pages: 12

Pages: 25-36

Publication date: 1 Sep 2015

Peer-reviewed: Yes

### Publication information

Journal: Fuel

Volume: 155

ISSN (Print): 0016-2361

Ratings:

Scopus rating (2015): CiteScore 4.46 SJR 1.781 SNIP 2.091

Original language: English

ASJC Scopus subject areas: Fuel Technology, Energy Engineering and Power Technology, Chemical Engineering(all), Organic Chemistry

Keywords: Alkali chloride mitigation, Corrosion, SRF, Waste-to-energy

DOIs:

10.1016/j.fuel.2015.03.087

URLs:

<http://www.scopus.com/inward/record.url?scp=84928243284&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84928243284

Research output: Contribution to journal › Article › Scientific › peer-review

### Low-Voltage DC Distribution-Utilization Potential in a Large Distribution Network Company

Low-voltage direct-current (LVDC) distribution is a promising solution whose benefits are large power transfer capacity with low voltage, high cost savings potential, and improvements to reliability and voltage quality. Tests by the pilot implementation in the distribution system operator (DSO) Elenia Oy have given promising results. The power transfer capacity of the system has been calculated in this paper using voltage drop and maximum load of cable as boundaries. The branches of the medium-voltage network that can be replaced by LVDC distribution are determined based on the calculations and mass computation of the entire distribution area of Elenia Oy. Based on the electrotechnical and

customer outage costs (COC) analyses made, it can be inferred that LVDC distribution has good utilization potential. Based on the power transfer capacity calculations, it is technically possible to replace branch lines up to 8 km long by LVDC distribution which means about 20% of the total medium-voltage network length in the distribution area of Elenia Oy. This means also huge potential in improving the overall reliability of electricity supply and in reducing outage costs of customers which are these days taken into account in the regulation of network business.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Electrical Engineering, Research area: Power engineering, Smart Energy Systems (SES), Elenia Oy

Contributors: Hakala, T., Lähdeaho, T., Järventausta, P.

Number of pages: 8

Pages: 1694-1701

Publication date: 1 Aug 2015

Peer-reviewed: Yes

#### Publication information

Journal: IEEE Transactions on Power Delivery

Volume: 30

Issue number: 4

ISSN (Print): 0885-8977

Ratings:

Scopus rating (2015): CiteScore 3.96 SJR 1.788 SNIP 2.57

Original language: English

ASJC Scopus subject areas: Electrical and Electronic Engineering, Energy Engineering and Power Technology

Keywords: Direct-current distribution, low-voltage direct current (LVDC), LVDC distribution system, power transfer capacity calculation

DOIs:

10.1109/TPWRD.2015.2398199

Source: Scopus

Source ID: 84937893206

Research output: Contribution to journal › Article › Scientific › peer-review

#### Improved adaptive input voltage control of a solar array interfacing current mode controlled boost power stage

Nonlinear characteristics of photovoltaic generators were recently shown to significantly influence the dynamics of interfacing power stages. Moreover, since the dynamic resistance of photovoltaic generators is both operating point and environmental variables dependent, the combined dynamics exhibits these dependencies as well, burdening control challenge. Typically, linear time invariant input voltage loop controllers (e.g. Proportional-Integrative-Derivative) are utilized in photovoltaic applications, designed according to nominal operating conditions. Nevertheless, since actual dynamics is seldom nominal, closed loop performance of such systems varies as well. In this paper, adaptive control method is proposed, allowing to estimate photovoltaic generator resistance online and utilize it to modify the controller parameters such that closed loop performance remains nominal throughout the whole operation range. Unlike previously proposed method, utilizing double-grid-frequency component for estimation purposes and suffering from various drawbacks such as operation point dependence and applicability to single-phase grid connected systems only, the proposed method is based on harmonic current injection and is independent on operating point and system topology.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Electrical Engineering, Research area: Power engineering, Smart Energy Systems (SES), Dept. of Electrical Engineering and Electronics, Ariel University

Contributors: Sitbon, M., Schacham, S., Suntio, T., Kuperman, A.

Number of pages: 7

Pages: 369-375

Publication date: 1 Jul 2015

Peer-reviewed: Yes

#### Publication information

Journal: Energy Conversion and Management

Volume: 98

ISSN (Print): 0196-8904

Ratings:

Scopus rating (2015): CiteScore 5.24 SJR 2.023 SNIP 2.057

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Fuel Technology, Nuclear Energy and Engineering, Renewable Energy, Sustainability and the Environment

Keywords: Adaptive control, Dynamic resistance, Photovoltaic generators

DOIs:

10.1016/j.enconman.2015.03.100

Source: Scopus

Source ID: 84927949172

Research output: Contribution to journal › Article › Scientific › peer-review

### **A real-time electrically controlled active matching circuit utilizing genetic algorithms for biomedical WPT applications**

In this research, the feasibility of a real-time active matching circuit for biomedical WPT applications is discussed. Also, the genetic-algorithm based matching circuit design method utilizing discrete circuit components is introduced and the practicality of active matching circuits for WPT is verified with preliminary measurement results featuring a maximum of 3 dB of improvement in transmission coefficient for a range of spanning a coil to coil distance of 10 to 12 cm, which was achieved by inserting the active matching circuit.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Sensing Systems for Wireless Medicine (MediSense), Georgia Institute of Technology, School of Electrical and Computer Engineering

Contributors: Bito, J., Jeong, S., Tentzeris, M. M.

Publication date: 29 Jun 2015

#### **Host publication information**

Title of host publication: 2015 IEEE Wireless Power Transfer Conference, WPTC 2015

Publisher: Institute of Electrical and Electronics Engineers Inc.

Article number: 7140168

ISBN (Electronic): 9781467374477

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

Keywords: Impedance matching, Power transmission, Real-time systems

DOIs:

10.1109/WPT.2015.7140168

URLs:

<http://www.scopus.com/inward/record.url?scp=84942939382&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84942939382

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

### **Catalytic effect of Ca and K on CO<sub>2</sub> gasification of spruce wood char**

Gasification is one route to produce chemicals and liquid fuels from biomass. The gasification of the char is catalyzed by alkali and alkaline earth metals in the biomass. In this work the catalytic effect of calcium (Ca) and potassium (K) on CO<sub>2</sub> gasification of spruce wood was studied using a thermo gravimetric analyzer (TGA). The ash-forming elements were first removed from the wood using an acid leaching method. Then, various concentrations of K and Ca were absorbed to the wood by ion-exchange to carboxylic and phenolic groups, impregnation of K<sub>2</sub>CO<sub>3</sub> or physically mixing of CaC<sub>2</sub>O<sub>4</sub>. The prepared spruce samples were placed in a mesh holder and gasified in the TGA at 850 °C in 100% CO<sub>2</sub>. The results demonstrate that the gasification rate of the char increased linearly with an increase in the concentration of Ca or K. Crystalline CaC<sub>2</sub>O<sub>4</sub> distributed only at the surface of the wood particles resulted in low catalytic activity. The catalytic activity of Ca was higher than K in the beginning of char gasification but the catalytic effect of Ca decreased earlier than the catalytic effect of potassium. Further, the char structure was investigated by SEM-EDX. The SEM analysis from interrupted gasification experiments showed the formation of CaCO<sub>3</sub> and K<sub>2</sub>CO<sub>3</sub> layer on the char surface. By adding corresponding levels of Ca and K as the original spruce to the acid washed sample, a similar gasification reactivity was obtained at 850 °C.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Urban circular bioeconomy (UrCirBio), Abo Akademi University, Åbo Akademi University, University of Jyväskylä, Process Chemistry Center, VTT Technical Research Centre of Finland

Contributors: Perander, M., DeMartini, N., Brink, A., Kramb, J., Karlström, O., Hemming, J., Moilanen, A., Konttinen, J., Hupa, M.

Number of pages: 9

Pages: 464-472

Publication date: 15 Jun 2015

Peer-reviewed: Yes

### Publication information

Journal: Fuel

Volume: 150

ISSN (Print): 0016-2361

Ratings:

Scopus rating (2015): CiteScore 4.46 SJR 1.781 SNIP 2.091

Original language: English

ASJC Scopus subject areas: Fuel Technology, Energy Engineering and Power Technology, Chemical Engineering(all), Organic Chemistry

Keywords: Biomass, Calcium, Char reactivity, CO, Gasification, Potassium

DOIs:

10.1016/j.fuel.2015.02.062

URLs:

<http://www.scopus.com/inward/record.url?scp=84924100908&partnerID=8YFLogxK> (Link to publication in Scopus)

### Bibliographical note

EXT="Kramb, J."

Source: Scopus

Source ID: 84924100908

Research output: Contribution to journal > Article > Scientific > peer-review

### Effect of Multilevel Inverter Supply on Core Losses in Magnetic Materials and Electrical Machines

The effect of multilevel inverter supply on power losses in magnetic cores and electrical machines is studied. A dynamic numerical model for the hysteresis, eddy current, and excess losses in a core lamination is first developed. By both measurements and simulations for a ring-core inductor, we demonstrate how increasing the number of inverter voltage levels decreases the iron losses when compared with traditional two-level supply. Although the switching frequency has a significant impact on the iron losses in the case of a traditional two-level inverter, using three or five voltage levels makes the losses almost independent of the switching. Finally, finite-element simulations show that similar reductions are also possible for the core losses of 150-kVA and 12.5-MW wound-field synchronous machines, in which rather low switching frequencies are typically used. Calorimetric loss measurements are also presented for the 150-kVA machine in order to confirm the significant effect of switching frequency on the core losses with two-level inverter supply.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Smart Energy Systems (SES), Aalto University, Universiteit Gent, Ghent University, Zwijnaarde, Belgium, Cairo University

Contributors: Rasilo, P., Salem, A., Abdalh, A., De Belie, F., Dupré, L., Melkebeek, J. A.

Number of pages: 9

Pages: 736-744

Publication date: 1 Jun 2015

Peer-reviewed: Yes

### Publication information

Journal: IEEE Transactions on Energy Conversion

Volume: 30

Issue number: 2

Article number: 6980114

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Ratings:

Scopus rating (2015): CiteScore 5.22 SJR 1.454 SNIP 2.615

Original language: English

ASJC Scopus subject areas: Electrical and Electronic Engineering, Energy Engineering and Power Technology

Keywords: Eddy currents, electrical machines, excess loss, finite-element analysis, iron loss, magnetic hysteresis, magnetic materials, multilevel converter, pulse width modulation

DOIs:

10.1109/TEC.2014.2372095

URLs:

<http://www.scopus.com/inward/record.url?scp=84930207311&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84930207311

### **A novel VSC-HVDC link model for dynamic power system simulations**

This paper introduces a new RMS model of the VSC-HVDC link. The model is useful for assessing the steady-state and dynamic responses of large power systems with embedded back-to-back and point-to-point VSC-HVDC links. The VSC-HVDC model comprises two voltage source converters (VSC) linked by a DC cable. Each VSC is modelled as an ideal phase-shifting transformer whose primary and secondary windings correspond, in a notional sense, to the AC and DC buses of the VSC. The magnitude and phase angle of the ideal phase-shifting transformer represent the amplitude modulation ratio and the phase shift that exists in a PWM converter to enable either generation or absorption of reactive power purely by electronic processing of the voltage and current waveforms within the VSC. The mathematical model is formulated in such a way that the back-to-back VSC-HVDC model is realized by simply setting the DC cable resistance to zero in the point-to-point VSC-HVDC model. The Newton-Raphson method is used to solve the nonlinear algebraic and discretised differential equations arising from the VSC-HVDC, synchronous generators and the power grid, in a unified frame-of-reference for efficient, iterative solutions at each time step. The dynamic response of the VSC-HVDC model is assessed thoroughly; it is validated against the response of a detailed EMT-type model using Simulink<sup>®</sup>. The solution of a relatively large power system shows the ability of the new dynamic model to carry out large-scale power system simulations with high efficiency.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Electrical Engineering, Research area: Power engineering, Smart Energy Systems (SES), Universidad Michoacana de San Nicolás de Hidalgo

Contributors: Castro, L. M., Acha, E., Fuerte-Esquivel, C. R.

Number of pages: 10

Pages: 111-120

Publication date: 30 May 2015

Peer-reviewed: Yes

#### **Publication information**

Journal: Electric Power Systems Research

Volume: 126

ISSN (Print): 0378-7796

Ratings:

Scopus rating (2015): CiteScore 2.74 SJR 0.962 SNIP 1.579

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

Keywords: Dynamic power system simulations, FACTS, HVDC, Newton-Raphson method, VSC

DOIs:

10.1016/j.epsr.2015.05.003

Source: Scopus

Source ID: 84930658938

Research output: Contribution to journal › Article › Scientific › peer-review

### **Driving pattern analysis of Nordic region based on National Travel Surveys for electric vehicle integration**

Electric vehicles (EVs) show great potential to cope with the intermittency of renewable energy sources (RES) and provide demand side flexibility required by the smart grid. Furthermore, EVs will increase the electricity consumption. Large scale integration of EVs will probably have substantial impacts on power systems. This paper presents a methodology to transform driving behavior of person into one of the cars in order to analyze the driving pattern of EVs based on the National Travel Surveys. In the proposed methodology, a statistical process is used to obtain the driving behavior of cars by grouping the survey respondents according to the driving license number and car number, and mapping the households with similar characteristics. The proposed methodology was used to carry out the driving pattern analysis in the Nordic region. The detailed driving requirements and charging/discharging availability of vehicles along the day were obtained. Two types of EV availabilities were studied in this paper considering different charging/discharging conditions of EVs for the power system integration, i.e. EV availability all day and EV availability at home. The results show that the daily driving requirements of the Nordic region are not very intensive. The driving patterns of vehicles in the Nordic region vary on weekdays and weekends. The two types of EV availabilities are quite different from each other.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Electrical Engineering, Research area: Power engineering, Smart Energy Systems (SES), Danmarks Tekniske Universitet, DTU Informatik, State Grid

Contributors: Liu, Z., Wu, Q., Christensen, L., Rautiainen, A., Xue, Y.

Number of pages: 10  
Pages: 180-189  
Publication date: 1 Jan 2015  
Peer-reviewed: Yes

#### Publication information

Journal: Journal of Modern Power Systems and Clean Energy  
Volume: 3

Issue number: 2  
ISSN (Print): 2196-5420

Ratings:

Scopus rating (2015): CiteScore 2.45 SJR 0.898 SNIP 1.412

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Renewable Energy, Sustainability and the Environment

Keywords: Driving pattern, Electric vehicles (EVs), EV availability, Nordic, Power system integration

DOIs:

10.1007/s40565-015-0127-x

URLs:

<http://www.scopus.com/inward/record.url?scp=84945363932&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84945363932

Research output: Contribution to journal > Article > Scientific > peer-review

#### Enquête de la variabilité cycle-à-cycle du NO dans la combustion homogène

Cyclic variability of spark ignition engines is recognized as a scatter in the combustion parameter recordings during actual operation in steady state conditions. Combustion variability may occur due to fluctuations in both early flame kernel development and in turbulent flame propagation with an impact on fuel consumption and emissions. In this study, a detailed chemistry model for the prediction of NO formation in homogeneous engine conditions is presented. The Wiebe parameterization is used for the prediction of heat release; then the calculated thermodynamic data are fed into the chemistry model to predict NO evolution at each degree of crank angle. Experimental data obtained from literature studies were used to validate the mean NO levels calculated. Then the model was applied to predict the impact of cyclic variability on mean NO and the amplitude of its variation. The cyclic variability was simulated by introducing random perturbations, which followed a normal distribution, to the Wiebe function parameters. The results of this approach show that the model proposed better predicts mean NO formation than earlier methods. Also, it shows that to the non linear formation rate of NO with temperature, cycle-to-cycle variation leads to higher mean NO emission levels than what one would predict without taking cyclic variation into account.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Urban circular bioeconomy (UrCirBio), Aristotle University of Thessaloniki, Laboratory of Applied Thermodynamics

Contributors: Karvountzis-Kontakiotis, A., Ntziachristos, L.

Number of pages: 13

Pages: 111-123

Publication date: 2015

Peer-reviewed: Yes

#### Publication information

Journal: OIL AND GAS SCIENCE AND TECHNOLOGY : REVUE DE L'INSTITUT FRANCAIS DU PETROLE

Volume: 70

Issue number: 1

ISSN (Print): 1294-4475

Ratings:

Scopus rating (2015): CiteScore 1.01 SJR 0.361 SNIP 0.74

Original language: French

ASJC Scopus subject areas: Chemical Engineering(all), Fuel Technology, Energy Engineering and Power Technology

DOIs:

10.2516/ogst/2013199

URLs:

<http://www.scopus.com/inward/record.url?scp=84924341440&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84924341440

### **On the benefit of long-horizon direct model predictive control for drives with LC filters**

Even though direct model predictive control (MPC) schemes almost exclusively use a prediction horizon of one in power electronics applications, the use of longer horizons offers significant performance benefits. This statement is underlined in this paper for a medium-voltage variable speed drive system, which consists of a three-level inverter, an LC filter and an induction machine. The proposed MPC controller simultaneously regulates the inverter current, capacitor voltage and stator current along given references, by manipulating the switch positions of the inverter. As will be shown, extending the prediction horizon significantly reduces the oscillations due to the filter resonance. For sufficiently long horizons, such as ten, low total harmonic distortions of the stator current can be achieved at low device switching frequencies. An additional active damping loop is not required, adding to the conceptual simplicity of the proposed control scheme.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Smart Energy Systems (SES), ABB Corporate Research Center - Switzerland, Technische Universitat Munchen

Contributors: Geyer, T., Karamanakos, P., Kennel, R.

Number of pages: 8

Pages: 3520-3527

Publication date: 15 Sep 2014

#### **Host publication information**

Title of host publication: 2014 IEEE Energy Conversion Congress and Exposition, ECCE 2014

Publisher: Institute of Electrical and Electronics Engineers Inc.

ISBN (Electronic): 9781479956982

ASJC Scopus subject areas: Fuel Technology, Energy Engineering and Power Technology

DOIs:

10.1109/ECCE.2014.6953879

Source: Scopus

Source ID: 84934300239

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

### **Reformulation of the long-horizon direct model predictive control problem to reduce the computational effort**

For direct model predictive control schemes with current reference tracking, the underlying integer least-squares (ILS) problem is reformulated to reduce the computational complexity of the solution stage. This is achieved by exploiting the geometry of the ILS problem and by reducing the computations needed for its formulation and solution. A lattice reduction and a sphere decoding algorithm are implemented. A variable speed drive system with a three-level voltage source inverter serves as an illustrative example to demonstrate the effectiveness of the proposed algorithm.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Electrical Engineering, Smart Energy Systems (SES), Technische Universitat Munchen, ABB Corporate Research Center - Switzerland

Contributors: Karamanakos, P., Geyer, T., Kennel, R.

Number of pages: 8

Pages: 3512-3519

Publication date: 15 Sep 2014

#### **Host publication information**

Title of host publication: 2014 IEEE Energy Conversion Congress and Exposition, ECCE 2014

Publisher: Institute of Electrical and Electronics Engineers Inc.

ISBN (Electronic): 9781479956982

ASJC Scopus subject areas: Fuel Technology, Energy Engineering and Power Technology

DOIs:

10.1109/ECCE.2014.6953878

Source: Scopus

Source ID: 84934300237

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

### **Variable Switching Point Predictive Torque Control of Induction Machines**

This paper introduces an approach to include a variable switching time point into predictive torque control (PTC). In PTC, the switching frequency is limited by the sampling frequency; its theoretical maximum value is half the sampling frequency. However, in reality the switching frequency is lower than this value, and thus, high current and torque ripples occur

compared with modulator-based control methods. In order to overcome this, an optimization problem is formulated and solved in real time. Thereby, apart from the regulation of the torque and the flux magnitude to their references, an additional control objective should be met: the minimization of the torque ripple. To do so, the time point at which the switches of the inverter should change state is calculated. Further advantages of the proposed method include the design flexibility and great performance during transients. Experimental results that verify the performance of the presented control strategy are included.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Smart Energy Systems (SES), Institute for Electrical Drive Systems and Power Electronics, Technische Universität München, National Technical University of Athens, University of Stellenbosch

Contributors: Karamanakos, P., Stolze, P., Kennel, R. M., Manias, S., Du Toit Mouton, H.

Number of pages: 11

Pages: 285-295

Publication date: Jun 2014

Peer-reviewed: Yes

#### Publication information

Journal: IEEE Journal of Emerging and Selected Topics in Power Electronics

Volume: 2

Issue number: 2

ISSN (Print): 2168-6777

Ratings:

Scopus rating (2014): SJR 0.806 SNIP 2.202

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

Keywords: AC motor drives, direct torque control (DTC), induction machines (IMs), low-voltage (LV) drives, model predictive control (MPC)

DOIs:

10.1109/JESTPE.2013.2296794

Source: Scopus

Source ID: 84922790918

Research output: Contribution to journal > Article > Scientific > peer-review

#### Bioprocessing of enhanced cellulase production from a mutant of *Trichoderma asperellum* RCK2011 and its application in hydrolysis of cellulose

A mutant strain of *Trichoderma asperellum* RCK2011 was developed through UV-irradiation for enhanced cellulase production and lower catabolite repression. The production of FPase, CMCase and  $\beta$ -glucosidase was optimized under solid state fermentation; up to 20 mM of glucose did not inhibit cellulase production. The mutant strain *T. asperellum* SR1-7 produced FPase (2.2 IU/gds), CMCase (13.2 IU/gds), and  $\beta$ -glucosidase (9.2 IU/gds) under optimized conditions, which is, 1.4, 1.3, 1.5-fold higher than the wild type. The wild as well as mutant strain produced the cellulases at pH range, 4.0-10.0. Saccharification of pretreated corn cob, wheat straw, and sugarcane bagasse by cellulase from mutant strain SR1-7 resulted in release of reducing sugar at the rate of 530.0 mg/g, 290.0 mg/g, and 335.0 mg/g of substrate, respectively; this is 1.6-fold higher than the wild type strain. © 2014 Published by Elsevier Ltd.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry, Tampere University of Technology, Urban circular bioeconomy (UrCirBio), Department of Microbiology, University of Delhi South Campus, Lignocellulose Biotechnology Laboratory

Contributors: Raghuwanshi, S., Deswal, D., Karp, M., Kuhad, R. C.

Number of pages: 7

Pages: 183-189

Publication date: 15 May 2014

Peer-reviewed: Yes

#### Publication information

Journal: Fuel

Volume: 124

ISSN (Print): 0016-2361

Ratings:

Scopus rating (2014): CiteScore 4.14 SJR 1.634 SNIP 2.281

Original language: English

ASJC Scopus subject areas: Fuel Technology, Energy Engineering and Power Technology, Chemical Engineering(all), Organic Chemistry

Keywords: Alkaline cellulase, Catabolite repression, Saccharification, Solid state fermentation

DOIs:

10.1016/j.fuel.2014.01.107

URLs:

<http://www.scopus.com/inward/record.url?scp=84894571819&partnerID=8YFLogxK> (Link to publication in Scopus)

#### **Bibliographical note**

Contribution: organisation=keb,FACT1=1<br/>Portfolio EDEND: 2014-03-15

Source: researchoutputwizard

Source ID: 1327

Research output: Contribution to journal > Article > Scientific > peer-review

#### **Inhibitory effects of substrate and soluble end products on biohydrogen production of the alkalithermophile *Caloramator celer*: Kinetic, metabolic and transcription analyses**

In this study the tolerance of the alkalithermophile *Caloramator celer* towards substrate (glucose) and soluble end product (acetate, formate and ethanol) inhibition was assessed employing nonlinear inhibition models. In addition, the effects of subinhibitory concentrations of end products on fermentative metabolism and regulation of 12 key genes involved in pyruvate catabolism were studied. Optimal growth and H<sub>2</sub> production were found at 50 mM of glucose and the critical substrate concentration was observed at 290-360 mM. Two inhibition models revealed that ethanol had a higher inhibitory effect on growth rate, whereas H<sub>2</sub> production kinetics was more sensitive towards increasing concentrations of acetate and formate. Acetate, the main soluble metabolite of the fermentation, inhibited the H<sub>2</sub> production by increasing the ionic strength in the medium. Subinhibitory concentrations of soluble end products induced changes in the metabolite profile of *C. celer*, specifically exogenous acetate (80 mM) and ethanol (40 mM) slightly increased the H<sub>2</sub> yield by 4 and 7%, respectively. However, despite the observed metabolic shifts, gene regulation was minimal and not always in agreement with the measured product yields. Overall, the results suggest that further optimization of the H<sub>2</sub> production process from *C. celer* should focus on methods to evolve adapted osmotolerant strains and/or remove soluble metabolites, especially acetate, from the culture. Copyright © 2014, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry, Urban circular bioeconomy (UrCirBio)

Contributors: Ciranna, A., Ferrari, R., Santala, V., Karp, M.

Number of pages: 11

Pages: 6391-6401

Publication date: 15 Apr 2014

Peer-reviewed: Yes

#### **Publication information**

Journal: International Journal of Hydrogen Energy

Volume: 39

Issue number: 12

ISSN (Print): 0360-3199

Ratings:

Scopus rating (2014): CiteScore 3.54 SJR 1.207 SNIP 1.484

Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Fuel Technology, Condensed Matter Physics, Energy Engineering and Power Technology

Keywords: Acetate, Dark fermentation, End product inhibition, Gene expression, Kinetic model, Substrate inhibition

DOIs:

10.1016/j.ijhydene.2014.02.047

URLs:

<http://www.scopus.com/inward/record.url?scp=84897389272&partnerID=8YFLogxK> (Link to publication in Scopus)

#### **Bibliographical note**

Contribution: organisation=keb,FACT1=1<br/>Portfolio EDEND: 2014-04-29<br/>Publisher name: Elsevier Ltd; International Association for Hydrogen Energy

Source: researchoutputwizard

Source ID: 235

Research output: Contribution to journal > Article > Scientific > peer-review

### Comparison of finite-element-based state-space models for PM synchronous machines

An interior permanent-magnet (PM) motor is modeled by a combined analytical-numerical approach, in which the relationships between the stator currents and flux linkages are identified with static finite-element (FE) analysis. In addition to the previous approaches using the current space vector as the state variable, new models are also developed using the flux-linkage space vector, which leads to more convenient time-integration of the voltage equations. In order to account for the zero-sequence effects in delta connection, the models also include either the zero-sequence flux or current as an additional state variable. Finally, the possibilities of deriving the required quantities as partial derivatives of the magnetic field energy are discussed. The energy-based approaches avoid inaccuracies related to torque computation and thus allow better satisfying the power balance in the state-space model. We show the ability of the developed state-space models to predict the currents and torque equally to a nonlinear time-stepping FE model with much less computational burden. The results are validated by means of measurements for a prototype machine in both star and delta connections. In addition, we also demonstrate the effect of the zero-sequence current on the torque ripple in case of a delta-connected stator winding.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Smart Energy Systems (SES), Aalto University, Polytech Nantes

Contributors: Rasilo, P., Lemesle, M. A., Belahcen, A., Arkkio, A., Hinkkanen, M.

Number of pages: 9

Pages: 535-543

Publication date: 2014

Peer-reviewed: Yes

#### Publication information

Journal: IEEE Transactions on Energy Conversion

Volume: 29

Issue number: 2

ISSN (Print): 0885-8969

Ratings:

Scopus rating (2014): CiteScore 5.03 SJR 1.471 SNIP 2.767

Original language: English

ASJC Scopus subject areas: Electrical and Electronic Engineering, Energy Engineering and Power Technology

Keywords: Field energy, finite-element methods, magnetic saturation, permanent-magnet (PM) machines, reluctance machines, state-space methods, torque ripple, variable-speed drives

DOIs:

10.1109/TEC.2014.2307472

Source: Scopus

Source ID: 84901470308

Research output: Contribution to journal › Article › Scientific › peer-review

### Design driven world of cellulose-from bulk to luxury?

Tekes-the Finnish Funding Agency for Innovation has granted funding 4,5 million funding for a project targeting on new approaches for use of wood-based cellulose. Project "Design Driven Value Chains in The World of Cellulose" (DWoC) launched by VTT Technical Research Centre of Finland, Aalto University and Tampere University of Technology integrates design and design processes into the strategic development of businesses operating in the field. The aim is to create a business ecosystem to serve both existing industry and a new, growing cellulose-based industry, and to brand Finland as a producer of refined, cellulose-based products. This manuscript summarises the future visions and background aspects and facts that have led to the initiation of the project. The presentation based on the manuscript also presents some of the first demonstrator processes and products developed during the first operational year of the project. These demonstrators include: Fibre yarn process that produces yarn from cellulose pulp fibres without traditional spinning process using novel wet extrusion technique (figure on right). Foam forming method for manufacturing well-formed foamed structures for new product applications 3D-printing technology enabling customisable on demand production of fibre structures and components using modified cellulosic raw materials.

#### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Materials Science, Research group: Plastics and Elastomer Technology, Engineering materials science and solutions (EMASS), VTT Technical Research Centre of Finland, Aalto University

Contributors: Qvintus, P., Kataja, K., Heikkilä, P., Salmela, J., Lehmonen, J., Ketoja, J., Hänninen, T., Harlin, A., Härkäsalmi, T., Vuorinen, J., Vuorinen, T.

Number of pages: 8

Pages: 67-74  
Publication date: 2014

#### Host publication information

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Publisher: Appita Inc.  
ISBN (Print): 9780987168443  
ASJC Scopus subject areas: Industrial and Manufacturing Engineering, Energy Engineering and Power Technology, Renewable Energy, Sustainability and the Environment  
Keywords: Cellulose, Design, Design driven research, Ecodesign, New business, New cellulose technologies  
URLs:  
<http://www.scopus.com/inward/record.url?scp=84923271599&partnerID=8YFLogxK> (Link to publication in Scopus)

#### Bibliographical note

EXT="Harlin, Ali"  
EXT="Heikkilä, Pirjo"  
Source: Scopus  
Source ID: 84923271599  
Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### Nickel-based HVOF coatings promoting high temperature corrosion resistance of biomass-fired power plant boilers

There are over 1000 biomass boilers in Europe, and the number is increasing due to actions for reducing greenhouse gas emissions. Biomass boilers often experience strong corrosion due to harmful elements in fuels. In biomass burning, detrimental components include especially chlorine, potassium and heavy metals, which can cause chlorine-induced active oxidation or hot corrosion by molten phases even at fairly low temperatures. In order to increase the corrosion resistance of heat exchanger components, either more alloyed steels or protective coatings should be applied. High velocity oxy-fuel (HVOF) sprayed coatings may provide corrosion protection for low alloy tube materials. Three nickel based thermal spray coatings (Ni-24Cr-16.5Mo, Ni-22Cr

#### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Engineering materials science and solutions (EMASS), VTT Technical Research Centre of Finland  
Contributors: Oksa, M., Auerkari, P., Salonen, J., Varis, T.  
Number of pages: 10  
Pages: 236-245  
Publication date: 2014  
Peer-reviewed: Yes

#### Publication information

Journal: Fuel Processing Technology  
Volume: 125  
ISSN (Print): 0378-3820  
Ratings:  
Scopus rating (2014): CiteScore 3.96 SJR 1.612 SNIP 2.206  
Original language: English  
ASJC Scopus subject areas: Fuel Technology, Energy Engineering and Power Technology, Chemical Engineering(all)  
Keywords: Biomass combustion, Chlorine induced corrosion, Corrosion protection, High temperature corrosion, HVOF, Thermal spray coating  
DOIs:  
10.1016/j.fuproc.2014.04.006  
URLs:  
<http://www.scopus.com/inward/record.url?scp=84899841098&partnerID=8YFLogxK> (Link to publication in Scopus)  
Source: Scopus  
Source ID: 84899841098  
Research output: Contribution to journal > Article > Scientific > peer-review

#### Direct model predictive current control strategy of DC-DC boost converters

A model predictive control (MPC) algorithm for DC-DC boost converters is proposed in this paper. The proposed control scheme is implemented as a current-mode controller. Two control loops are employed, with the inner loop being designed in the framework of MPC. Two different objective functions are formulated and investigated. The control objective, i.e., the regulation of the current to its reference, is achieved by directly manipulating the switch, thus a modulator is not required. As a prediction model, a hybrid model of the converter is used, which captures precisely the continuous and the discontinuous conduction modes. The proposed control strategy achieves very fast current regulation, while exhibiting only a modest computational complexity. Simulation and experimental results substantiate the effectiveness of the proposed

approach.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Smart Energy Systems (SES), Institute for Electrical Drive Systems and Power Electronics, Technische Universität München, ABB Corporate Research Center - Switzerland, National Technical University of Athens

Contributors: Karamanakos, P., Geyer, T., Manias, S.

Number of pages: 10

Pages: 337-346

Publication date: 1 Dec 2013

Peer-reviewed: Yes

#### Publication information

Journal: IEEE Journal of Emerging and Selected Topics in Power Electronics

Volume: 1

Issue number: 4

ISSN (Print): 2168-6777

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

Keywords: Current control, DC-DC converter, Hybrid system, Model predictive control (MPC), Optimal control

DOIs:

10.1109/JESTPE.2013.2279855

Source: Scopus

Source ID: 84947231690

Research output: Contribution to journal › Article › Scientific › peer-review

#### Non-sterile process for biohydrogen and 1,3-propanediol production from raw glycerol

Raw glycerol is a tempting substrate for fermentations, but contains impurities that can be inhibitory for organisms. In this study, raw glycerol tolerance and contamination risk of pure bacterial culture at hypersaline process conditions were evaluated. The inhibitory effect of raw glycerol was similar to a halophilic (*Halanaerobium saccharolyticum*) and a non-halophilic (*Clostridium butyricum*) bacterium implying the inhibition originating from methanol or other impurities rather than salt. The hypersaline process conditions decreased efficiently contaminations and no growth of contaminants was observed at and above 125 g/l NaCl. Halophilic H<sub>2</sub> and 1,3-PD production from raw glycerol were studied separately as 1-stage processes and jointly as 2-stage process in non-sterile conditions. Non-sterile conditions were successfully applied and the highest production yields obtained were 3.0 mol H<sub>2</sub>/mol glycerol and 0.66 mol 1,3-PD/mol glycerol (1-stage processes), whereas the highest cumulative production was 74 mmol H<sub>2</sub>/l culture and 31 mmol 1,3-PD/l culture (2-stage process). © 2013, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry, Tampere University of Technology, Urban circular bioeconomy (UrCirBio)

Contributors: Kivistö, A., Santala, V., Karp, M.

Number of pages: 7

Pages: 11749-11755

Publication date: 10 Sep 2013

Peer-reviewed: Yes

#### Publication information

Journal: International Journal of Hydrogen Energy

Volume: 38

Issue number: 27

ISSN (Print): 0360-3199

Ratings:

Scopus rating (2013): CiteScore 3.38 SJR 1.265 SNIP 1.442

Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Fuel Technology, Condensed Matter Physics, Energy Engineering and Power Technology

Keywords: Biodiesel by-product, Clostridium, Contamination risk, Halanaerobium, Halophilic fermentation, Raw glycerol tolerance

DOIs:

10.1016/j.ijhydene.2013.06.119

URLs:

<http://www.scopus.com/inward/record.url?scp=84882722439&partnerID=8YFLogxK> (Link to publication in Scopus)

#### **Bibliographical note**

Contribution: organisation=keb,FACT1=1<br/>Portfolio EDEND: 2013-09-29<br/>Publisher name: Elsevier Ltd

Source: researchoutputwizard

Source ID: 2576

Research output: Contribution to journal › Article › Scientific › peer-review

#### **Prospecting hydrogen production of Escherichia coli by metabolic network modeling**

Genome-scale model was applied to analyze the anaerobic metabolism of Escherichia coli. Three different methods were used to find deletions affecting fermentative hydrogen production: flux balance analysis (FBA), algorithm for blocking competing pathways (ABCP), and manual selection. Based on these methods, 81 E. coli mutants possessing one gene deletion were selected and cultivated in batch experiments. Experimental results of H<sub>2</sub> and biomass production were compared against the results of FBA. Several gene deletions enhancing H<sub>2</sub> production were found. Correctness of gene essentiality predictions of FBA for the selected genes was 78% and 77% in glucose and galactose media, respectively. 33% of the mutations that were predicted by FBA to increase H<sub>2</sub> production had a positive effect in experiments. Batch cultivation is a simple and straightforward experimental way to screen improvements in H<sub>2</sub> production. However, the ability of FBA to predict the H<sub>2</sub> production rate cannot be evaluated by batch experiments. Metabolic network models provide a method for gaining broader understanding of the complicated metabolic system of a cell and can aid in prospecting suitable gene deletions for enhancing H<sub>2</sub> production. © 2013, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry, Tampere University of Technology, Department of Signal Processing, Prostate cancer research center (PCRC), Urban circular bioeconomy (UrCirBio), Aalto University

Contributors: Seppälä, J. J., Larjo, A., Aho, T., Yli-Harja, O., Karp, M. T., Santala, V.

Number of pages: 10

Pages: 11780-11789

Publication date: 10 Sep 2013

Peer-reviewed: Yes

#### **Publication information**

Journal: International Journal of Hydrogen Energy

Volume: 38

Issue number: 27

ISSN (Print): 0360-3199

Ratings:

Scopus rating (2013): CiteScore 3.38 SJR 1.265 SNIP 1.442

Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Fuel Technology, Condensed Matter Physics, Energy Engineering and Power Technology

Keywords: Escherichia coli, Flux balance analysis, Hydrogen production, Metabolic engineering, Metabolic network modeling

DOIs:

10.1016/j.ijhydene.2013.07.002

URLs:

<http://www.scopus.com/inward/record.url?scp=84882724445&partnerID=8YFLogxK> (Link to publication in Scopus)

#### **Bibliographical note**

Contribution: organisation=keb,FACT1=0.5<br/>Contribution: organisation=sgn,FACT2=0.5<br/>Portfolio EDEND: 2013-09-29<br/>Publisher name: Elsevier Ltd

Source: researchoutputwizard

Source ID: 3397

Research output: Contribution to journal › Article › Scientific › peer-review

#### **Model predictive control of the interleaved DC-DC boost converter with coupled inductors**

This paper proposes a model predictive control (MPC) scheme for the interleaved dc-dc boost converter with coupled inductors. The main control objectives are the regulation of the output voltage to its reference value, despite changes in the input voltage and the load, and the equal sharing of the load current by the two circuit inductors. An inner control loop, using MPC, regulates the input current to its reference that is provided by the outer loop, which is based on a load observer. Simulation results are provided to highlight the performance of the proposed control scheme.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Smart Energy Systems (SES), National Technical University of Athens, ABB Corporate Research Center - Switzerland

Contributors: Karamanakos, P., Geyer, T., Manias, S.

Publication date: Sep 2013

### Host publication information

Title of host publication: 2013 15th European Conference on Power Electronics and Applications, EPE 2013

Article number: 6632006

ISBN (Print): 9781479901166

ASJC Scopus subject areas: Energy Engineering and Power Technology, Fuel Technology, Electrical and Electronic Engineering

Keywords: Converter control, Non-linear control, Optimal control

DOIs:

10.1109/EPE.2013.6632006

Source: Scopus

Source ID: 84890168092

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### Variable switching point predictive torque control for the three-level neutral point clamped inverter

In this paper the recently introduced control strategy referred as variable switching point predictive torque control (VSP<sup>2</sup>TC) is employed to control a three-level neutral point clamped (NPC) voltage source inverter driving an induction machine (IM). Based on a predictive torque control (PTC) scheme, the controller aims to reduce the high current and torque ripples that occur. In order to actualize this, a variable switching point is calculated based on an optimization problem formulated to reduce the torque ripple. At this switching point the switches of the inverter change their state to meet all the control objectives, i.e. minimization of the torque ripple, regulation of the torque and the flux magnitude to their references, and balancing of the neutral point potential. Experimental results that verify the performance of the proposed control algorithm are presented.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Smart Energy Systems (SES), Technische Universitat Munchen, National Technical University of Athens, University of Stellenbosch

Contributors: Stolze, P., Karamanakos, P., Kennel, R., Manias, S., Mouton, T.

Publication date: Sep 2013

### Host publication information

Title of host publication: 2013 15th European Conference on Power Electronics and Applications, EPE 2013

Article number: 6631894

ISBN (Print): 9781479901166

ASJC Scopus subject areas: Energy Engineering and Power Technology, Fuel Technology, Electrical and Electronic Engineering

Keywords: Adjustable speed drive, Direct torque and flux control, Optimal control, Voltage Source Inverters (VSI)

DOIs:

10.1109/EPE.2013.6631894

Source: Scopus

Source ID: 84890166712

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### Mismatch losses in PV power generators caused by partial shading due to clouds

Clouds cause spatial and temporal variability of solar radiation which is the main cause of fluctuating photovoltaic power fed into the grid. TUT solar PV power station research plant has been designed to enable systematic and thorough analysis of the dynamic phenomena in energy conversion processes of grid-connected solar PV power systems. Its climatic and electric measuring systems comprise an accurate weather station as well as an extensive mesh of solar radiation and module temperature measurements located through the PV facility. In this paper, we propose a method to generate a spatial irradiance map from an array of solar radiation measurements. Additionally, we utilize it as a tool to evaluate the mismatch losses in the operation of different PV generators due to partial shading caused by moving clouds.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Electrical Engineering, Research area: Power engineering, Smart Energy Systems (SES)  
Contributors: Lobera, D. T., Valkealahti, S.  
Publication date: 2013

#### Host publication information

Title of host publication: 2013 4th IEEE International Symposium on Power Electronics for Distributed Generation Systems, PEDG 2013 - Conference Proceedings

Publisher: IEEE COMPUTER SOCIETY PRESS

Article number: 6785587

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

Keywords: maximum power point, mismatch losses, moving clouds, partial shading, PV power generator configurations

DOIs:

10.1109/PEDG.2013.6785587

URLs:

<http://www.scopus.com/inward/record.url?scp=84899443069&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84899443069

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

#### Model predictive control of the internal voltages of a five-level active neutral point clamped converter

In this paper, model predictive control (MPC) is introduced to control the internal voltages of an active neutral-point clamped five-level converter (ANPC-5L). The proposed control scheme aims to keep the neutral point and phase capacitors voltages of the converter within given hysteresis bounds while at the same time minimizing the switching frequency. An additional benefit of the controlled voltages is a reduced level of output current distortion. The large number of redundant states that exist in multi-level converters makes it possible for all the objectives to be achieved. A short horizon is employed in order to ensure a manageable level of complexity. At the same time extrapolation is used to bring the performance to the desired level. Simulation results that substantiate the effectiveness of the proposed approach are presented.

#### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Smart Energy Systems (SES), ABB Corporate Research Center - Switzerland, Department of Electrical and Computer Engineering, National Technical University of Athens, ABB Switzerland

Contributors: Kieferndorf, F., Karamanakos, P., Bader, P., Oikonomou, N., Geyer, T.

Number of pages: 8

Pages: 1676-1683

Publication date: Sep 2012

#### Host publication information

Title of host publication: 2012 IEEE Energy Conversion Congress and Exposition, ECCE 2012

ISBN (Print): 9781467308014

ASJC Scopus subject areas: Energy Engineering and Power Technology, Fuel Technology

Keywords: five-level converter, model predictive control, neutral-point clamped

DOIs:

10.1109/ECCE.2012.6342611

Source: Scopus

Source ID: 84870932750

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

#### Model predictive pulse pattern control for the five-level active neutral point clamped inverter

In this paper, the recently introduced control strategy referred to as model predictive pulse pattern control ( $MP^3C$ ) is adapted to the ACS 2000 five-level power converter of ABB. The drive consists of an induction machine and a five-level active neutral-point clamped (ANPC-5L) inverter. The power inverter is fed with optimized pulse patterns (OPPs) that produce minimum harmonic distortion in the stator winding of the ac machine. An optimal stator flux trajectory is calculated from these OPPs and a trajectory controller tracks it in real-time. In the proposed approach, trajectory tracking is based on model predictive control (MPC): a constrained optimal control problem is formulated and solved in real-time in a time-efficient manner. An event-based prediction horizon is employed in order to ensure fast tracking of the stator flux trajectory. The advantages of the proposed method are optimal steady-state behavior in terms of harmonic distortion and fast torque response. The method was tested on a pilot ACS 2000 power converter coupled to a general-purpose 1.21-MW induction machine. Experimental results were obtained from this industrial setup; they are presented in this paper to demonstrate the high performance of  $MP^3C$ .

#### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Smart Energy Systems (SES), ABB Corporate Research Center - Switzerland, ABB Switzerland, Department of Electrical and Computer Engineering, National Technical University of Athens

Contributors: Oikonomou, N., Gutscher, C., Karamanakos, P., Kieferndorf, F., Geyer, T.

Number of pages: 8

Pages: 129-136

Publication date: Sep 2012

#### Host publication information

Title of host publication: 2012 IEEE Energy Conversion Congress and Exposition, ECCE 2012

ISBN (Print): 9781467308014

ASJC Scopus subject areas: Energy Engineering and Power Technology, Fuel Technology

Keywords: AC drive, five-level active neutral point inverter, model predictive control, optimized pulse pattern

DOIs:

10.1109/ECCE.2012.6342832

Source: Scopus

Source ID: 84870916807

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

#### Impact of biodiesel application at various blending ratios on passenger cars of different fueling technologies

The effect of biodiesel on emissions of diesel passenger cars is a combination of the fuel properties, the blending ratio, and the vehicle technology. In this study, saturated and unsaturated biodiesel fuels were tested neat (B100) and in 30% blend with fossil diesel (B30) on two Euro 3 diesel passenger cars of different engine technologies, namely common rail and unit injector. The measured dataset is enlarged by introducing B10 results from an earlier study [15] in order to produce generalized conclusions over a wider range of blends. None of these vehicles was equipped with a particle filter and different conclusions might be reached for filter-equipped vehicles. The results indicate that the influence of biodiesel on pollutant emissions primarily depends on the blending ratio and secondly on the level of unsaturation and engine technology. Tailpipe CO<sub>2</sub>, NO<sub>x</sub> and PM emissions with biodiesel varied from -1% to +3%, -1% to 14%, and -18% to -35%, respectively, compared to fossil diesel. The difference over fossil diesel generally increased with an increasing blending ratio. CO and HC emissions increased over the fossil diesel but remained at low levels and did not threaten the compliance of the vehicles with their respective emission limits. Use of biodiesel on the common rail vehicle led to a smaller NO<sub>x</sub> increase and a higher PM reduction than in the unit-injector case. The unsaturated fuel generally led to higher NO<sub>x</sub> emissions from both engine technologies. However, the maximum blending ratio of saturated biodiesel is limited to around B30 due to cold-flow limitations. Hence, the saturated vs. unsaturated species ratio should be carefully designed in market fuels in order to optimize environmental and operational benefits. Overall, it appears that blends up to 10% v/v may be introduced with limited urban air quality implications.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Urban circular bioeconomy (UrCirBio), Aristotle University of Thessaloniki, Laboratory of Applied Thermodynamics, European Commission-JRC

Contributors: Kousoulidou, M., Ntziachristos, L., Fontaras, G., Martini, G., Dilara, P., Samaras, Z.

Number of pages: 7

Pages: 88-94

Publication date: Aug 2012

Peer-reviewed: Yes

#### Publication information

Journal: Fuel

Volume: 98

ISSN (Print): 0016-2361

Ratings:

Scopus rating (2012): CiteScore 3.99 SJR 1.813 SNIP 2.387

Original language: English

ASJC Scopus subject areas: Chemical Engineering(all), Fuel Technology, Energy Engineering and Power Technology, Organic Chemistry

Keywords: Biodiesel, Fuel injection technology, Unsaturation level, Vehicle emissions

DOIs:

10.1016/j.fuel.2012.03.038

URLs:

<http://www.scopus.com/inward/record.url?scp=84861986728&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84861986728

### Hydrogen and methane yields of untreated, water-extracted and acid (HCl) treated maize in one- and two-stage batch assays

In the present study, two-stage H<sub>2</sub> and CH<sub>4</sub> production was compared with one-stage CH<sub>4</sub> production from maize subjected to water extraction and acid (HCl) treatment. In addition, the effect of duration (2 and 14 days) of the first-stage H<sub>2</sub> process on the H<sub>2</sub> yields and subsequent CH<sub>4</sub> yields from the second-stage was also investigated. Results showed that the average H<sub>2</sub> yields from untreated maize were 5.6 and 9.9 ml/g volatile solids added (VS<sub>added</sub>) after 2 and 14 days, respectively. On the other hand, H<sub>2</sub> yields from water-extracted and HCl-treated maize were 18.0 and 20.5 ml/gVS<sub>added</sub> (14 d), respectively. On comparison to one-stage CH<sub>4</sub> assays, the average increase in CH<sub>4</sub> yields from two-stage assays with 2 d H<sub>2</sub> stage were 7, 9 and 27% for untreated, water-extracted and HCl-treated maize, respectively.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Urban circular bioeconomy (UrCirBio), Jyväskylän yliopisto, University of Jyväskylä

Contributors: Pakarinen, O. M., Kaparaju, P. L. N., Rintala, J. A.

Number of pages: 7

Pages: 14401-14407

Publication date: Nov 2011

Peer-reviewed: Yes

#### Publication information

Journal: International Journal of Hydrogen Energy

Volume: 36

Issue number: 22

ISSN (Print): 0360-3199

Ratings:

Scopus rating (2011): CiteScore 4.42 SJR 1.443 SNIP 1.828

Original language: English

ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Fuel Technology, Condensed Matter Physics, Energy Engineering and Power Technology

Keywords: Anaerobic digestion, Hydrogen, Maize, Methane, Pre-treatment, Two-stage

DOIs:

10.1016/j.ijhydene.2011.08.028

Source: Scopus

Source ID: 80054013006

Research output: Contribution to journal > Article > Scientific > peer-review

### Trace compounds affecting biogas energy utilisation - A review

This paper investigates the trace compounds affecting energy utilisation in biogas that come from different production sites. With biogas being more widely used in different energy applications more interest has arisen for the specific composition of biogas. In traditional energy applications, methane and hydrogen sulphide contents have had the most influence when energy utilisation application has been considered. With more advanced processes also the quantity and quality of trace compounds is more important. In regards to trace compounds, it was found that the concentrations and the variations of volatile organic compounds (VOCs) can be high in different landfills, especially, with compounds originating from the biological degradation process (like aromatics and terpenes) as seasonal variations affect the biological degradation. Trace compounds produced by direct volatilisation (halogenated and silicon compounds) show a smaller seasonal variation. Halogenated compounds are rarely present in high concentrations in waste water treatment plant (WWTP) biogas, but the concentrations of organic silicon compounds and their variation is high. Organic silicon compounds are usually detected only in low concentrations in co-digestion plant biogas, when no WWTP sludge is used as a raw material.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Urban circular bioeconomy (UrCirBio), Jyväskylän yliopisto, University of Jyväskylä

Contributors: Rasi, S., Läntelä, J., Rintala, J.

Number of pages: 7

Pages: 3369-3375

Publication date: Nov 2011

Peer-reviewed: Yes

#### Publication information

Journal: Energy Conversion and Management

Volume: 52

Issue number: 12

ISSN (Print): 0196-8904

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Scopus rating (2011): CiteScore 3.03 SJR 1.24 SNIP 1.82

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Fuel Technology, Nuclear Energy and Engineering, Renewable Energy, Sustainability and the Environment

Keywords: Biogas, Biogas production sites, Biomethane, Energy utilisation, Organic silicon compounds, Trace compounds removal

DOIs:

10.1016/j.enconman.2011.07.005

Source: Scopus

Source ID: 80052255401

Research output: Contribution to journal > Article > Scientific > peer-review

### Power flow initialisation of dynamic studies with induction motor loads

The initialisation of most power system stability studies is carried out with the outcome of a power flow solution using a constant power representation of the load that may contain voltage dependency. However, such an approach may not be suitable when an important component of the system load is made up of induction motors because of a natural mismatch between the power flow scheduled power and the actual induction motor power, which is computed using the final converged value of the motor terminal bus voltage. To solve this problem, a method for incorporating the non-linear model of induction motors in Newton-Raphson power flow algorithm is put forward in this study. The prowess of the improved power flow algorithm is demonstrated using the Ward-Hale, the IEEE 30-bus and the New-England test systems in connection with industrial motor subsystems. The results show that the extended power flow algorithm provides the correct steady-state initialisation and still preserves the basic Newton-Raphson's quadratic convergence characteristics.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Smart Energy Systems (SES), Thammasat University, University of Glasgow

Contributors: Aree, P., Acha, E.

Number of pages: 8

Pages: 417-424

Publication date: Apr 2011

Peer-reviewed: Yes

### Publication information

Journal: IET Generation Transmission and Distribution

Volume: 5

Issue number: 4

ISSN (Print): 1751-8687

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Original language: English

ASJC Scopus subject areas: Electrical and Electronic Engineering, Energy Engineering and Power Technology, Control and Systems Engineering

DOIs:

10.1049/iet-gtd.2010.0442

URLs:

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Source: Scopus

Source ID: 79956318336

Research output: Contribution to journal > Article > Scientific > peer-review

### Manganese-cobalt spinel coatings for SOFC metallic interconnects manufactured by conventional plasma spraying (PS) and suspension plasma spraying (SPS)

Protective coatings are used on ferritic stainless steel interconnects of solid oxide fuel cells (SOFCs) to prevent the oxidation and evaporation of volatile chromium compounds. Oxide scale is formed of chromium oxide ( $\text{Cr}_2\text{O}_3$ ) which tends to react with the oxygen and water, forming chromium trioxide ( $\text{Cr}_2\text{O}_3$ ) and chromium hydroxides ( $\text{Cr}_2(\text{OH})_2$ ). These compounds will migrate to the triple phase barrier (TPB) of a cathode and reduce back to  $\text{Cr}_2\text{O}_3$ . This reaction pathway is a notable reason for the degradation phenomena of the cell. Plasma spraying (PS) and suspension plasma spraying (SPS) were studied as possible manufacturing processes for thin Mn-Co-(Fe) spinel coatings. Powder for PS was manufactured by using a solid state reaction method from carbonates and oxide to form a  $\text{MnCo}_{1.8}\text{Fe}_{0.2}\text{O}_4$  and powder

for SPS by co-precipitation process from nitrates to form a  $\text{MnCo}_2\text{O}_4$  spinel structure. Using PS, coatings with thin and relatively dense structures were obtained. The composition of the coatings was homogeneous although, the decomposition of the spinel structure was noticed. The crystal structures of the PS coatings were partially restored by a separate annealing process. The spray parameters had a strong influence on the coating structure and the composition when SPS was used. The most homogenous coating structure was formed when low energy spraying parameters were used, whereas high energy parameters formed a columnar structure with larger cobalt rich areas. The decomposed spinel structure of the SPS coatings were fully restored by the annealing treatment. In SPS, more process optimization is needed to improve the coating quality and especially denseness.

#### General information

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MoE publication type: A4 Article in a conference publication

Organisations: Department of Materials Science, Facilities and Infrastructure, Materials Science, Engineering materials science and solutions (EMASS), VTT Technical Research Centre of Finland

Contributors: Puranen, J., Hyvärinen, L., Lagerbom, J., Kylmälahti, M., Koivuluoto, H., Vuoristo, P.

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Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### Modeling the effect of inverter supply on eddy-current losses in synchronous machines

The effect of inverter supply on the eddy-current losses in the laminated core of a synchronous machine is studied. A 2D finite element model including a dynamic model for the eddy currents in the core laminations is applied to predict the machine losses by numerical simulations. A synchronous extruder motor is simulated both with sinusoidal and pulse-width modulated voltage supplies in different operating points and the eddy-current losses both in the stator and the rotor are studied. The rotor additional inverter losses are found to be load-dependent while the stator additional losses remain constant independent of the loading.

#### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Aalto University

Contributors: Rasilo, P., Arkkio, A.

Number of pages: 5

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#### Trace compounds of biogas from different biogas production plants

Biogas composition and variation in three different biogas production plants were studied to provide information pertaining to its potential use as biofuel. Methane, carbon dioxide, oxygen, nitrogen, volatile organic compounds (VOCs) and sulphur

compounds were measured in samples of biogases from a landfill, sewage treatment plant sludge digester and farm biogas plant. Methane content ranged from 48% to 65%, carbon dioxide from 36% to 41% and nitrogen from <1% to 17%. Oxygen content in all three gases was <1%. The highest methane content occurred in the gas from the sewage digester while the lowest methane and highest nitrogen contents were found in the landfill gas during winter. The amount of total volatile organic compounds (TVOCs) varied from 5 to 268 mg m<sup>-3</sup>, and was lowest in the biogas from the farm biogas plant. Hydrogen sulphide and other sulphur compounds occurred in landfill gas and farm biogas and in smaller amounts in the sewage digester gas. Organic silicon compounds were also found in the landfill and sewage digester gases. To conclude, the biogases in the different production plants varied, especially in trace compound content. This should be taken into account when planning uses for biogas.

#### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Jyväskylän yliopisto, University of Jyväskylä  
Contributors: Rasi, S., Veijanen, A., Rintala, J.  
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Publication date: Aug 2007  
Peer-reviewed: Yes

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ISSN (Print): 0360-5442  
Ratings:  
Scopus rating (2007): SJR 0.902 SNIP 1.339  
Original language: English  
ASJC Scopus subject areas: Energy(all), Energy Engineering and Power Technology, Fuel Technology, Nuclear Energy and Engineering, Renewable Energy, Sustainability and the Environment  
Keywords: Biogas plant, Landfill, Methane, Sewage treatment plant, Volatile organic compounds  
DOIs:  
10.1016/j.energy.2006.10.018  
Source: Scopus  
Source ID: 34247160816  
Research output: [Contribution to journal](#) › [Article](#) › [Scientific](#) › [peer-review](#)

#### Input Invariance as a Method to Reduce EMI Filter Interactions in Telecom DPS Systems

Distributed power supply (DPS) systems are extensively used to supply different electronic equipment and systems such as e.g. telecom switching systems where switched-mode converters are supplying other switched-mode converters. Stringent electromagnetic compatibility (EMC) requirements necessitate the use of input filters as an individual filter for a converter, and as a common filter for a group of converters in order to suppress the electromagnetic interference (EMI) to acceptable level. The ratio of input and output impedances of the associated subsystems known as minor-loop gain is typically used to define the stability and performance indices for the DPS systems. Even if certain design rules may be established for the ratio, the associated impedances may be difficult quantitatively to be defined. This may force the system designers to use conservative design in order to avoid instability and degrading of dynamic performance. This paper proposes methods by means of which the interactions between the subsystems may be significantly reduced making the converters invariant to input phenomena in small-signal sense. This means that the input filter stability would be the only concern, and may be ensured based on the input power of the associated converters.

#### General information

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MoE publication type: Not Eligible  
Organisations: University of Oulu  
Contributors: Suntio, T.  
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Scopus rating (2003): SJR 0.264 SNIP 0.274

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering  
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<http://www.scopus.com/inward/record.url?scp=1542330113&partnerID=8YFLogxK> (Link to publication in Scopus)

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Source ID: 1542330113

Research output: Contribution to journal › Conference article › Scientific › peer-review

### **The effects of intermittent charging on VRLA battery life expectancy in telecom applications**

A survey of a 2.5-year testing of VRLA batteries at elevated ambient temperature of 43°C is reported. The batteries were charged using float charging and standby charging or intermittent charging principles. The goal of the research was to verify the assumed adverse effects of continuous float charging in respect to intermittent charging. No clear correlation with the charging modes was noticed. The shorter than expected life of VRLA batteries may be addressed to the shortages in charging procedures rather than to continuous float charging. It was also noticed that the ineffective charging might be more harmful when using intermittent charging than when using continuous float charging.

#### **General information**

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MoE publication type: A1 Journal article-refereed

Organisations: ABB Oy, Aalto University, University of Oulu

Contributors: Waltari, P., Suntio, T., Tenno, A., Tenno, R.

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Scopus rating (2002): SJR 0.549 SNIP 0.466

Original language: English

ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

Source: Scopus

Source ID: 0036907399

Research output: Contribution to journal › Conference article › Scientific › peer-review

### **Use of unterminated two-port modeling technique in analysis of input filter interactions in telecom DPS systems**

A methodology to model and analyze input filter-interactions in Telecom distributed power system is presented based on the use of two-port unterminated modeling technique. Switched-mode converters and input filters are modeled using G-parameter representation where the input port is represented using Norton's equivalent circuit, and the output port using Thevenin's equivalent circuit. The used approach results in a unified model applicable to any converter regardless of topology, and the mode of operation or control. The two-port models are first defined as unterminated models where the effect of load is excluded but may be easily included using the developed reflection rules.

#### **General information**

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MoE publication type: Not Eligible

Organisations: Aalto University, University of Oulu

Contributors: Suntio, T., Gadoura, I.

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ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering

Source: Scopus

Source ID: 0036911643

### AC-UPS reliability and availability performance: Comparison of available solutions

Uninterruptible power supply (AC-UPS) systems are studied from the reliability and availability (R&A) performance point of view. The objective is to find out the basic reason for using a UPS system as well as its impact on the optimal solution; and how the basic mission can be carried out in an optimal way. The alternatives are series power processing (also called true UPS) and parallel power processing (also called stand-by UPSW or line-interactive UPS). It is shown that the available UPS solutions are nearly equal from the R&A point of view and that if high reliability is of prime concern, optimal results can be obtained by means of line-interactive UPS.

#### General information

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Organisations: FISKARS OY AB Electron Power Syst, Fiskars Oy Ab  
Contributors: Suntio, T., Uusitalo, J., Jonsson, L.  
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ASJC Scopus subject areas: Energy Engineering and Power Technology, Electrical and Electronic Engineering  
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10.1109/INTLEC.1989.88298  
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Source ID: 0024932058

Research output: Contribution to journal › Conference article › Scientific › peer-review

### Theoretical studies of structural properties of the high- $T_c$ superconductor $Y_1Ba_2Cu_3O_{7-x}$

Structural properties of the high temperature oxide superconductor  $Y_1Ba_2Cu_3O_{7-gc}$  have been studied by static lattice simulation methods. Empirical (ionic) potentials, derived on the basis of experimental data, are used to describe the basic structural properties of the superconductive oxides. Several potential models, with different location of the extra charge for the  $O_7$  compound, have been tested with respect to experimental lattice parameters. Fair parametrizations have been found in almost all cases, but they are usually valid only for a specific oxygen content. However, potential models, consistent both for  $O_6$  and  $O_7$ , have been found. We present the best of our ionic models, where, in  $O_7$ , two thirds of the holes are distributed in the sheet-site oxygens and one third in oxygens between the sheet and chain planes.

#### General information

Publication status: Published  
MoE publication type: Not Eligible  
Organisations: Brookhaven National Laboratory  
Contributors: Valkealahti, S., Welch, D. O.  
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Peer-reviewed: Yes

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DOIs:  
10.1016/0921-4534(89)91145-3  
Source: Scopus  
Source ID: 0024887115

Research output: Contribution to journal › Article › Scientific › peer-review