



## WAYS TO INCREASE THE EFFICIENCY OF HYDROKINETIC DEVICES AND THEIR EVALUATION

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### ABSTRACT

Flow velocity measurements in the rivers of Latvia show that in most of the places which are best suitable for operation of hydrokinetic devices flow velocity is between 0.4 and 0.9 m/s. For efficient operation of hydrokinetic devices, it is advisable to place them into at least two to three times faster flows. It would increase both the efficiency and output power of the hydrokinetic devices.

There are several technical ways known which allow increasing velocity of the flow that operates the hydrokinetic device. These possibilities are ensured by diffusers, confusers, different flow guides and other special means for control of the flow. These devices can alter cross-section of used area and velocity of the flow, as well as control pressure and turbulence. All mentioned, if used properly, can substantially increase efficiency and output power coefficient of hydrokinetic devices.

The paper presents a research of the different ways for increasing the efficiency of the hydrokinetic devices. The research is performed based on the relevant scientific literature and the results of the research are taken into account to improve the methodology for the evaluation of the energy potential of a river for the development of power plants based on hydrokinetic devices, which is developed by the authors of this report. The improved methodology and the results that are obtained by using this methodology on evaluating the relevant sections of the river Daugava (the largest river in Latvia) are also presented.

**Keywords:** Hydroelectric power generation, microhydro power, hydrokinetic device, flow velocity, diffuser



## POTENTIAL OF SOLAR COOLING IN BALTIC COUNTRIES CONDITIONS

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### ABSTRACT

The national priority axis is increase of RES use in Latvian energy sector, so new solutions for electricity, heat and cool production are searched. Solar energy is available at the same time when is need to cool rooms, so solar cooling is suitable also in Latvia. In Latvia such a system is not used, so it is important to assess the potential of this system.

Heat producing part of small capacity solar cooling systems with solar collectors was estimated using PolySun modelling and dynamic simulation program.

Thermally driven chillers starts at the specified inlet temperature from heat production part. Collector yield for a fixed collector temperature was obtained to determine appropriate thermal energy benefits from solar collector for specific thermally driven chillers.

Proportion of the time that heat carrier temperature exceeds 55°C from hot accumulation tank is more than 91% during cooling season, and over 65°C – 85% of the time. The additional heat source is required in hot but cloudy hours of less than 70kWh the additional heat is necessary during cooling season in this case.

Solar collectors can almost totally provide heat requirement for chilling process, by producing about 4.2 MWh per year.

**Keywords:** renewable energy, solar energy, solar cooling



## IMPLEMENTATION OF ELECTRICAL VEHICLES FOR ELECTRICAL NETWORKS EFFICIENCY AND RELIABILITY

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### ABSTRACT

This research is focused on actual issue – smart grids development, with aim to improve efficiency and reliability of electric networks by electric vehicles implementation for aligning electrical load at night. It is include the seasonal and daily load curves typical electricity consumption estimation in Latvia from 2010 to 2013. During this study a possible electricity consumption load curves for 2020 was considered. Also the coefficient of non-uniformity of the load curve was calculated to estimate total power consumption per hour at night to increase the efficiency and reliability of electric networks.

Considered two scenarios. In scenarios are estimated electricity consumption at night, depending on the number of electric vehicles, a fully charged the battery, the average daily mileage per car. Created scenarios represent the possibilities to increase electricity consumption and to provide balancing services to the electric networks.

As well the daily household electricity consumption was examined. Allowable increase in electricity consumption by households due to the charging of electric vehicles is calculated.

**Keywords:** Electric vehicles, load curve, electric networks



## IMPACT OF PELTIER ELEMENT SUPPLIED POWER CHARACTERISTICS ON SHORT TERM COOLING PERFORMANCE

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### ABSTRACT

Peltier elements are widely used in various applications all over the world. Nonetheless a lot of different opinions occur when speaking about how the properties of supplied electrical energy influence the short term performance of Peltier elements and how these elements should be driven. Various sources suggest different approaches and there is a lot of discussion if Peltier elements can be driven with pulse width modulated current or direct current should be used. Some sources recommend not exceeding 10% ripple of supplied DC Voltage while other say that pulsed nature of electrical power can be ignored if high frequency pulses are used. Series of experiments were made to find out how does the pulse width, frequency and pulsations of direct current affect the heat conduction ability of Peltier element based cooling system. Dependences are presented and compared to theoretical analysis. Study discusses optimal characteristics for supplied electrical power that is required for reasonable operation.

**Keywords:** Peltier element, efficiency, power management, cooling performance



## FIELD-EFFECT TRANSISTOR AS PASSIVE RECTIFIER

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### ABSTRACT

As portability of electronics depends on time it can function autonomously, either its power supply must be sufficient for prolonged usage, or the device itself must operate and consume power in efficient way. One of the ways to deal with supply problem is to use energy harvesters to power electronics fully or partially, but such solutions require novel approach themselves. As generated voltage level of harvester in many occasions is low, it is dependent on effective transformation. To increase effectiveness, low voltage rectification system was previously suggested by authors, it utilized field-effect transistor as passive rectifier. In this study the proposed system is tested with different transistor models to find correlation between their parameters and rectification effect. To check existing theoretical model, experimental data is compared to SPICE models simulation. The proposed system is tested along with the active rectification system. The study discusses possibilities, drawbacks and parameters of field-effect transistor as passive rectifier.

**Keywords:** field-effect transistor, passive rectifier, low voltage rectification, efficiency, power management, energy harvesters



## EXPERIMENTAL STAND DEVICE MODELLING FOR IEAC THERMAL PERFORMANCE STUDY

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### ABSTRACT

This paper reported a review, calculations and measurements based study into Indirect Evaporative Air Cooling (IEAC) stand device parts which have influence on thermal performance, which was undertaken from a variety of aspects including background, history, current status, concept, standardization, system configuration, operational mode, research and industrialization. Experimental stand device parts have been described as equations of heat and mass transfer in primary and secondary air and water flows. Model has been validated with Menerga Sorpsolair device measurements located in Riga Technical university laboratory. The main goal have been to made working stand device for future researches of IEAC device cooling efficiency, which mostly depends on mass flow rates ratios of primary and secondary air flows and spacing between plates of wet and dry passages.

**Keywords:** IEAC stand device, indirect evaporative air cooler, cooling efficiency, heat and mass transfer from water to air trough thin wall



## USING STRAW FOR HIGH EFFIENCY DISTRICT HEATING SYSTEMS

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### ABSTRACT

The paper „Using straw for high efficiency district heating systems” contains information of common and different things in between using a gas, woodchip and straw fired boilers in district heating systems. In the paper types of straw boilers and ways for using straw as fuel for heating is collected.

The main parameters which describe the heating system are gathered and analysed. At the moment natural gas boiler is used as a primary energy source. The main problems that could appear after changing the energy source from natural gas to straw are gathered.

The main goal of the paper is to make it possible for the model show the parameters of the heating system after changing the energy source taking in account the possibilities to regulate the boiler parameters, fluctuations of the temperatures and energy production as well as heat demand by the consumers.

**Keywords:** Straw fired boiler, district heating systems, energy production, biomass boiler



## ELECTRICITY MARKET INTEGRATION AND MONITORING

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### ABSTRACT

The power markets in Baltic States were liberalized recently and they are relatively young. That is the reason why the market monitoring is not yet regularly implemented in the Baltics and none of monitoring tools are used in the Baltics. The target of this paper is to evaluate the electricity market by market power indices estimation in the Baltic States. General principles and methodology with the most common market power estimation indicators will be given in this paper.

Baltic power market will be observed as one market taking into account power system architecture as whole. Electricity markets integration and its monitoring is complex task, there is a need to estimate several key factors, and the main from them are following: demand, total available supply, large suppliers' capacity share and contract position and decision making development.

Generally, each market is establishing its own, optimum mix of renewable solutions based on geography, weather conditions, market acceptance, public supports schemes, existing and planned industrial capabilities and pricing conditions. The purpose of this research is to assist to regulatory bodies to consider the all relevant key factors to facilitate the harmonization, integration and efficiency of the European electricity market including grid requirement.

**Keywords:** electricity market, energy policy, market power

## STUDY ON CUSTOMER COSTS OF RELIABILITY AS KEY PREREQUISITE FOR POWER SUPPLY RELIABILITY LEVEL PERFORMANCE-BASED REGULATION

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### ABSTRACT

The paper presents concept of methodology for DSO power supply reliability level performance-based regulation (PBR) that includes customer costs of reliability study and enable to achieve optimal reliability level. PBR methodology is based on the author's studies and research, as well as on analysis of existing PBR practices that are in use at European countries. The main difference between proposed regulation and existing regulation approaches is in reliability optimality criteria that is used in proposed approach.

The paper also presents results of study on customer costs of reliability that has been performed in Latvia in years 2012 and 2013 by Institute of Physical Energetics. The study has been carried out on request of Ministry of Economics of the Republic of Latvia. Survey based method involving ~3000 end users classified as the largest energy users in Latvia have been used in the study. Customer damage functions (CDFs) and functions of costs deviations depending on interruption occurrence time have been created, as well as other power supply reliability related information has been obtained.

The last known similar type study in Latvia until year 2012 has been performed in 1976. Such studies, despite their relative popularity in Europe, are quite rare not only for Latvia, but also for the whole region of Baltic States. Electricity usage patterns, as well as economical situation in Baltic States are comparable and due to aforementioned facts, the results of the study could be of high interest not only for Latvian scientists, policy makers and DSOs/TSOs, but also for neighbouring countries.

**Keywords:** Customer costs of reliability, Performance-based regulation (PBR), Survey

# TRANSMISSION EXPANSION PLANNING CONSIDERING ELECTRICITY MARKET AND INTEGRATION OF RENEWABLE GENERATION

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## ABSTRACT

To foster 2020 climate targets and estimate the technical and economic impact of renewable energy sources accommodation to transmission networks, several theories based on the social impact of the investments in competitive markets and marginal pricing are created by different authors. Electricity market and Smart Grid Technology's integration in energy sector brings completely new problem setup in many countries and many recent studies are addressing this problem from different perspectives. The great majorities of studies describe only one-time static problems investment models and do not consider additional factors that can affect the network expansion in future years. A new network operation conditions creates new requirements for transmission planning which include electricity market figures and considerable integration of renewable generation.

The main point of this paper is to demonstrate the new deterministic concept for transmission planning based on technical regulation and market – economic regulation principals. Traditional approach is taken as starting point in presented research. In the next stage, the expansion/development plan is checked for other operational constraints. For this purpose AC or DC models can be implemented, both of them have pros and cons regarding load flows power losses and stability analysis etc. However, power system operation in market condition introduce new terms such as: capacity allocation and congestion management, which will significantly affect previous modelling techniques. A coordinated approach for capacity calculation including optimal power flow implementation will show the best use of the electricity transmission lines as well as it will open additional opportunities for development planning with social welfare and market power estimation.

For the proposed concept validation 98 node model of the Baltic Ring transmission grid was used. The simulation and validation results show the possibility of the AC/DC models implementation to transmission planning tasks solution.

**Keywords:** electricity market, optimal power flow, power system, power system development

## PREPARATION AND PROPERTIES OF POLYETHYLENE OXIDE COMPOSITES

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### ABSTRACT

This paper consists of two parts. The first one is theoretical part and it is about nanocomposites and fillers (such as carbon nanotubes, montmorillonite, silica) their structure, classification and use. The experimental part of this paper is about novel designed polymer composite samples with different filler percentage composition, using Polyethylene Oxide (Scientific Polymer Products inc., molecular weight 100 000 g/mol, density 1.21 g/cm<sup>3</sup>, glass transition temperature -67°C) as matrix and the fillers – tetraethylorthosilicate and silica nanoparticles as C<sub>8</sub>H<sub>20</sub>O<sub>4</sub>Si (Sigma-Aldrich ltd., molecular weight 208.33 g/mol), carbon nanotubes (Nanocyl NC7000, relative density 1.3 - 2 g/cm<sup>3</sup>, Jung module 1 TPa, stress at break 10 - 60 GPa, strain at break 10%, thermal conductivity >3000 W/m·K, electrical conductivity 106-107 Sm/m), montmorillonite (Dellite LVF clays, LAviosa Chemica Mineraria, white powder, 4-8% humidity degree, average particle size 7-9 μm in dry type, average particle size in dispersion 1-500 nm, relative density 2.2 g/cm<sup>3</sup>) and Lithium perchlorate (ChemPure, Poland, molecular weight 60.41 g/mol). A composite polymer solution was prepared by dissolving PEO in ethanol, and then by solution mixing with mechanical and magnetic mixing and additional dispersion with ultrasound. All nanocomposite samples for research were prepared by pressing the material with a hydraulic press, which was carried out at 90°C (6 minutes). The effect of nanocomposite's preparation method's and filler concentrations onto polymer nanocomposites was evaluated by Fourier transform infrared spectroscopy (FTIR), Vickers hardness, tensile strength and electrical conductivity analysis.

**Keywords:** Nanocomposites, Polyethylene Oxide, Tetraethyl orthosilicate, Carbon Nanotubes, Montmorillonite, Silica, Lithium perchlorate

## CREATION AND ANALYSIS OF CLIMATE MODEL IN VIDZEME, LATVIA

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### ABSTRACT

Weather data varies significantly from year to year. By this reason, there is a need to create typical meteorological year (TMY) data model, to represent the long term typical weather conditions over a year. TMY data is one of the main sources for successful building energy simulations. In this paper two different types of typical meteorological data models TMY and TMY-2 where compared. Both models where created by analyzing the hourly measured weather data of a 27-year period (1986–2012) in Alūksne, city in Vidzeme. TMY model was created using statistical approach, but to create second model – TMY-2, 27 year average data were applied. In TMY model creation representative typical meteorological months (TMM) were selected. TMM for each of the 12 calendar months, from the period of years, were selected by choosing the one with the smallest deviation from the long-term average weather data. The 12 TMMs, selected from the different years, were used to create a TMY for Alūksne, which represents the climatic situation in Vidzeme. Data gathered from TMY and TMY-2 where compared with meteorological data from Latvian Cabinet of Ministers regulation No. 379, Regulations Regarding Latvian Building Code LBN 003-01, that showed the change in climate conditions in this region. TMY selection process should include the most recent meteorological observations, and should be periodically renewed to reflect the long term climate change.

**Keywords:** Typical meteorological year; building energy simulations