Special Report - Session 6
DSO BUSINESS ENVIRONMENT ENABLING DIGITALIZATION AND ENERGY TRANSITION

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Introduction

The business environment and the role of the DSO is evolving as the business is going through substantial changes.

Session 6 focuses on the evolving business environment and regulation of the DSO to support active customer's and society's energy transition. This includes the fast paced and disruptive developments around digitalization, collaborative economy, market based flexibility services, integration of microgrids, storage & e-mobility and, not to be forgotten, cyber-security to ensure a sustainable and efficient electricity distribution infrastructure.

At the same time the asset/risk management and regulation optimization is still key issues for the DSOs. To understand impacts, strategic choices, implementation options and limitations is vital. Important sources for knowledge are results from demonstration projects and case studies.

Within this context, Session 6 has chosen four key blocks of papers in our selection:

- Block 1 Flexibility
- Block 2 Legacy DSO
- Block 3 Future DSO
- Block 4 Information Management

The blocks address each important issues related to the DSO business – both today and in the future.

The first block highlights different issues related to flexibility. The second block focuses on developments related to the existing role of DSOs, while the third block targets different aspects of how the DSO can and will meet future possibilities and challenges. Finally, the fourth block investigates different aspects relate toe Information management, which is becoming an increasingly important part the of the DSO business.

In the review process, Session 6 has accounted for several different stakeholders all the way from governments/regulators, through competitive market players to academia. This variety of stakeholders makes Session 6 unique in the CIRED context – covering a very broad span of stakeholders and interests.

In total Session 6 has accepted 159 papers. In the following each of the blocks of papers are presented, with briefs comments related to the contents of each paper.

Block 1: Flexibility

Block 1 deals with various issues related to *Flexibility* – loads, business models, tariff structures, technical solutions etc, giving a wide perspective for challenges and potential solutions concerning optimal utilisation of distribution grids.

0005: This paper describes the prototype of an advanced energy meter that provides two-way communication between the consumer and the operator / supplier, enabling enables a better insight into the way electricity is consumed both for the operator / supplier and for the end user.

0048: Paper 0048 is a German paper presenting effects of flexibility market models on grid management, exemplified through two flexibility model variants "regional intradayplus market" (RIM)" and "quota in proactive distribution grids (PDG)".

0051: This paper presents the concepts of local energy markets through results from an EU project DOMINOES, exemplifies by use cases that will be demonstrated during the project as a proof of the concept.

0095: The paper presents a model of a virtual power plan (VPP), exemplified through a use-case for ancillary services which is validated for flexibility provision.

0288: This paper from Iran presents a new market mechanism via BlockChain-enabled bilateral smart contracts, motivating customers to participate in demand response programs.

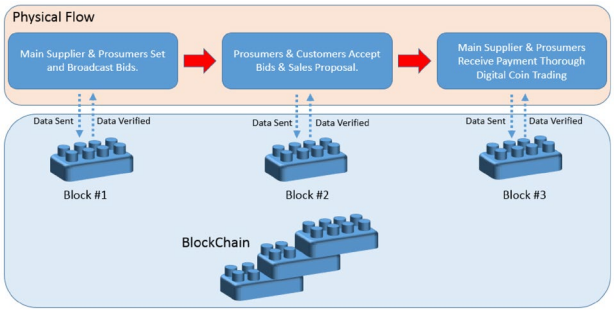

Fig. 1: Paper 0288 - The physical and Data flow schemes of the proposed BlockChain framework

0382: This paper presents local flexibility markets as a solution for increased need for flexibility, exemplified through a solution for the upcoming influence of electrical charging stations.

0411: Paper 0411 reports from an H2020 project, where a system architecture for managing congestions in distributions grids using flexibility has been developed.

0424: Paper 0424 from Portugal addresses the impact of the substantial changes in energy production driven by self-supply associated with photovoltaics (PV), regarding the tariff rates payed by adopters and non-adopters and the revenues yielded by regulated tariffs.

0512: This paper reports from a case in the US on the interoperability and interchangeability strategy for their Automated Metering Infrastructure.

0556: The paper from Greece presents a decentralized Automatic Meter Reading (AMR) system using blockchain technology and the concept of smart contracts.

0576: This paper presents a Grid Management System (GMS) which uses information concerning local flexibility on the demand-side to forecast local loads, having an algorithm to decide where and when flexibility is required to prevent congestion.

0583: This paper from Sweden addresses learnings from unlocking flexibility, bilateral treaties and digital markets, in order to support the DSOs to achieve the energy transition.

0587: This paper presents a case from investigating the potential of demand side management (DSM) in an Iranian distributing company, covering various DSM techniques, interruptible load, load shifting, and time of use tariffs.

0629: This paper from Finland addresses the incentive effect of a power-based tariff on its customers' power usage, focusing on the customers' willingness and ability to reduce their peak powers due to a power-based tariff.

0636: This paper presents a business model where an aggregator company makes the investment to the battery system and offers the system as a service for the DSO, addressing how benefits of a battery system can be used in the current regulation model for distribution system operators (DSOs).

0725: This paper from Korea reports on models to quantify economic impacts of demand response (DR) program, presenting some informative findings of Korean pilot study for residential and small commercial & industrial customers.

0746: This paper reports on how flexible demand side response (DSR) applications such as power-to-heat (PtH) can be used as an alternative to conventional grid reinforcements and feed-in management.

0816: This paper from India presents how Deep Learning algorithms can make it easier to disaggregate 15 min smart meter energy data and predict appliance level consumption more accurately.

0832: This paper presents a description of platform a architecture model, which promotes specific smart grid use cases, and integration of MultiPower research laboratory as a part of the platform.

0928: This paper presents how heat pumps in multi-family buildings can be utilised as a potential demand response solution, discussing two possible opportunities for using heat pump flexibility as demand response, to be used to manage congestion in local grids.

1371: In this paper from Japan a real-time, high-speed data transfer system of over 10 million smart meter's energy usage is described, describing the system architecture, several technologies to improve system performance and its operational results.

1421: This paper reviews potential business models provided by demand response as well as the risks related to them.

1533: This paper from The Netherlands presents insights in the potential for flexibility of the electric vehicles (EVs) and in user experiences.

1590: This paper from Finland presents a methodology for observing DR from a retailer's data, exemplified through a case study where smart meter data of real customers having dynamic electricity contracts is used.

1680: This paper discusses the development of distribution network tariffs., focusing on tariffs for small customers (i.e. maximum fuse size 3x63A).

1692: This paper proposes an optimization framework to minimize the operational cost of the prosumer network while maintaining the prosumers' comfort, exemplified through a case study showing that it is possible to reduce the prosumer's operational cost while keeping their comfort

1695: This paper provides an overview of the actual architecture, performance and utilization of the advanced metering infrastructure (AMI), including required system architecture supporting the implementation of smart grid functionalities

1697: This paper proposes a locational marginal pricing (LMP) algorithm to perform congestion management in the interaction between electricity wholesale markets and transmission networks.

1775: The paper from Italy presents the Italian experience approaching a new generation smart metering system with the focus on new services made available for low-voltage customers, reporting on real-time communications between smart meters and In-Home Devices and real application of new services and the corresponding results.

1817: This paper addresses ways to increase flexibility is for electricity networks, as seen from a UK DSO perspective, aiming to deliver e.g. additional network capacity, to a lower cost.

1827: This paper results from a Cigré working group concerning a survey about smart meter deployment and use cases of data utilization.

1893: This Austrian paper presents results from the InteGrid project concerning a Traffic Light System that enables the Distribution System Operators to perform a technical validation of flexibility offers, presenting the Traffic Light Concept and the architecture implementation.

1958: This paper reports from the research project Designetz, investigating the use of flexibilities both with simulation models and with the use of pilot projects in the field.

1959: This paper presents a field-tested ecosystem architecture based on an open market for energy flexibility, where flexibility can be monetized in multiple ways, for example by trading it on the energy markets or by selling it to a DSO for congestion management.

2029: This paper addresses contracts that a distribution system operator (DSO) would find attractive given it can utilise the flexibility offered through a local electricity market environment.

2066: The paper presents an overview of technical barriers and triggers on the utilization of small active resources in demand response (DR) market and suggests requirements to novel technical solutions enabling extensive penetration of such services.

2106: The paper presents a Local Flexibility Mechanism LFM which aims to extract and utilize customers' flexibility based on pre-established economic signals through the peak coincidence network charge (PCNC).

2166: This paper presents the different approaches taken within the InterFlex project to mobilise flexibilities, identifying the challenges the stakeholders are facing and presents a series of mechanisms to foster the local use of flexibilities.

2186: This paper focuses on load disaggregation of electric vehicle charging using, among others, PQ reading of the secondary distribution feeder with and without electric vehicles.

2246: This paper from Brazil proposes an embedded system compatible with electronic power meters, which simulates the billing of dynamic tariffs, assisting the decision making of customers.

Table 1: Papers of Block 1 assigned to the Session

Paper No. Title	MS a.m.	MS p.m.	RIF	PS
0005: Advanced energy meter with load control based on ESP8266 module and MQTT protocol				X
0048: Effects of flexibility market models on grid management tasks and systems	X			X
0051: Pushing the transition towards transactive grids through local energy markets	X			X
0095: Flexibility to DSO by VPP – Benefits, Regulatory Barriers, and Potential Solutions				X
0288: An innovative distributed Demand Response strategy in smart grid via BlockChain-enabled bilateral smart contracts				X
0382: Local flexibility markets: An economic solution for the upcoming influence of electrical charging station penetration				X
0411: System architecture for managing congestions in distributions grids using flexibility				X
0424: Self-Supply and regulated tariffs: Dynamic equilibria between photovoltaic market evolution and LV rate structures				X
0512: Interoperability Strategy for an AMI deployment in the US				X
0556: Design and Implementation of a Decentralized AMR System using Blockchains, Smart Contracts, and LoRaWAN				X
0576: Grid Management System to solve local congestion				X
0583: Change and change management - unlocking power flexibility meeting Sweden's capacity challenge	X			X
0587: Investigating the impacts of Demand Side Management in Guilan Distribution Company				X
0629: Power-Based Tariff as an Incentive for Distribution System Operator's Customers to Reduce their Peak Powers	X			X
0636: Battery system as a service for a distribution system operator	X			X
0725: Demand response pilot experiment and its evaluation on residential and small commercial & industrial customers: A Korean case				X
0746: Key results of the project 'Power-to-heat in Smart grids'– A multi-objective approach for a maximized value of flexibilities in grids				X
0816: Using energy disaggregation to kickstart effective consumer engagement in India				X
0832: Architecture of integrated business platform of distributed energy resources and integration of MultiPower laboratory				X
0928: Heat pumps in multi-family buildings used as a flexibility resource for balancing frequency and congestion management				X
1371: Implementation of Real-time Transfer System of Smart Metering which supports demand-supply balancing				X

1421: New Demand Response Business Models – Opportunities and Risks				X
1533: Smart charging electric vehicles based on a flexibility market	X			X
1590: Finding Demand Response from Smart Meter Data				X
1680: Upcoming Changes in Distribution Network Tariffs – Potential Harmonization Needs For Demand Charges				X
1692: Optimal Scheduling of Adjustable Loads in Commercial Building Through Regional Electricity Market				X
1695: Enabling smart grid features by enhanced utilization of actual Advanced Metering Infrastructure				X
1697: Fast marginal pricing for congestion management in at distribution network with multiple aggregators				X
1775: Smart Metering 2.0 enhancing a new customer experience				X
1817: UK Power Network's Flexibility Market Offers New Revenue Stream for Customers & Enhances Active Operation of the Distribution Network				X
1827: Evaluation and analysis of the utilization of data from Smart Meter System				X
1893: The Traffic Light System to support Flexibility Exploitation from stressed distribution grids				X
1958: Coordinating and Live Testing Future Distribution Grid Flexibility				X
1959: Interoperability for an open energy flexibility market with congestion management services				X
2029: DSOs as beneficiaries of innovative contracts and services, facilitated through local electricity market structures				X
2066: Novel Technical Solutions as an Enabler of the Small-Scale Demand Response Resources				X
2106: Distribution-Level Flexibility Provision through Simultaneous Ascending Auctions				X
2166: Market models for local flexibility procurement: InterFlex' experience and main challenges				X
2186: Power Factor Signature Analysis for Disaggregation of EV Charging Loads From Aggregated Power				X
2246: Embedded System for Assessing the Viability of Dynamic Tariffs				X

Block 2: Legacy DSO

The block covers the challenges with business operation of the DSO legacy functions and services. Included are aspects of asset management, regulation optimization and business strategies.

0038: The paper presents analysis of business risk management models in DSOs. It explores the business drivers, challenges and innovations in the electrical industry to maximize reliability in the power grid through Asset Performance Management.

0127: This paper presents the development of policy for poverty alleviation based on photovoltaic power development (PAPV) in China, the construction and financial modes of PAPV projects.

0295: The paper explains the principles of formation and transition to service considering a current state of power industry the main requirements imposed to service activity.

0405: A strategic asset plan must consider structural differences and technical, regulatory, financial and capacitive restrictions at the same time. In addition, a balanced link between different planning phases is necessary to increase acceptance and feasibility of the derived strategic asset plan. This paper shows how all this can be accomplished.

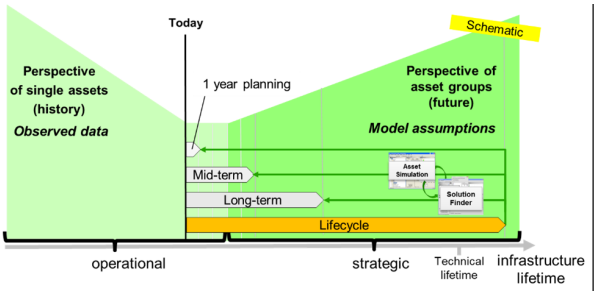

Fig. 2: Planning phases of infrastructures (paper 0405).

0418: The paper describes how ENERVIE Vernetzt, a distribution net operator located in North Rhine-Westphalia, faced the challenge to define the appropriate level of integration between long-term asset management plans over the lifespan and mid-term regulation challenges.

0889: This paper presents the CNAIM (Common Network Asset Indices Methodology) initiative and discusses the constraints and challenges faced in the process of creating a meaningful common framework. It then briefly consider global adoption of CNAIM and related asset risk modelling methodologies.

Fig. 3: Totex Investment Portfolio (paper 0889).

1106: The paper describes how to implement the T-SENSE smart platform in Elektro Ljubljana. The basis of this platform is AR–Augmented reality in connection with smart algorithms, which enable data analysis and operations, as well as predictive behavior with regard to maintenance.

1154: This paper explores the 4D digital foundation applied specifically to asset management challenges faced in the distribution of electricity through overhead assets.

1487: The paper covers a software tool was developed in PREdistribuce, a. s., which is used for the implementation of statistical measures for optimization of operation and 0583renewal of the distribution network.

1518: This paper presents the result of a DSO pilot installation taking inspiration from IEC TC57 reference architecture, with the goal to provide substation data from the sensors at the substation to central level data storage and application in order to enable asset health analytics.

1530: The paper describes a decision management platform from Nexans designed especially for the complex systems that DSO executives negotiate every day.

1595: The paper presents a different approach to digital capture power grid assets and to detect visible anomalies on components based on Artificial Intelligence technologies.

1645: The paper covers the MONICA project that is an innovation experience focused on the monitoring and control of the distribution networks of the future, where smart agents such as Distributed Energy Resources, electric vehicles or active end users play a key role.

1723: The paper describes how EDP Distribuição (EDPD), Portuguese DSO, is implementing to enhance

mobile power supply unit management. These units are part of an outsourced service that must be efficiently coordinated to assure the best Quality of Service.

1777: The papers explains how the Norwegian FASIT (Fault And Supply Interruption information Tool) system has been enhanced based on modern methods for data exchange and control.

1849: This paper presents the initial ideas for a framework to support the distribution system operators for assessing current status of network infrastructures, market/business models, and policies applicable to distribution systems, and thus identify future-readiness of their network.

1867: The papers describes means of balancing investment needs with the resources available enables asset managers and decision makers within a network operator to plan a sustainable asset management strategy with an understanding of the future skills requirements within the business.

1897: The paper describes the implementing a tool for health and risk assessment, using only existing digitized information from available systems. The objective was to ensure uniform asset management decision making and to enable the line of sight in the decision making process according to the framework of ISO55000.

Fig. 4: Totex Investment Portfolio (paper 1897).

1947: This paper aims to focus on Strategic Thinking and Corporate Governance pattern as a critical topic which will assist the managers of the electric utilities keep the trend of optimal utilization of electric equipment as continuously as possible.

2149: This paper describes how existing and new technologies combine to realize the network digital twin, its relevant applications and benefits. Several practical examples and lessons learned from proof of concepts, pilots and innovation projects carried out with start-ups, technology providers and data scientists are illustrated.

2312: This paper presents the approach of Mitnetz facing the necessary challenges of ISO 55000 in accordance with the implementation of an industrial managing process.

Table 2: Papers of Block 2 assigned to the Session

Paper No. Title	MS a.m.	MS p.m.	RIF	PS
0038: Business Risk Management in DSOs: Asset Performance Management With Overcoming Challenges				X
0127: DSO's challenges with the poverty alleviation PV power development in China				X
0295: Reliability and service in the power industry				X
0405: Integrated Asset Management for transmission and distribution networks at Vattenfall	X			X
0418: Asset Simulation and indicator calculation – integrated link between asset management and regulation				X
0889: CNAIM asset risk modelling – implementation and opportunities	X			X
1106: How to deploy augmented reality in distribution system operator				X
1154: Digital foundation; providing the necessary vision and tools to enable the connected energy landscape	X			X
1487: Implementation of statistical measures for operation and renewal of distribution network in PREDistribuce A.S.				X
1518: Leveraging industry standards to build an architecture for asset management and predictive maintenance				X
1530: Nexans strategic asset management solution (SAMS): The powerful decision making platform dedicated to DSOs				X

1595: Digtal asset capturing (DAC): An image recognition based algorithm supporting collection and analysis of overhead power grid assets				X
1645: MONICA: Advanced monitoring and control in MV and LV distribution networks				X
1723: Enhancements and digitalization of mobile power supply assets to meet DSO requirements				X
1777: National reporting of faults and interruptions using CIM and MADES/ECP	X			X
1849: A DSO support framework for assessment of future readiness of distribution systems: Technical, market and policy perspectives				X
1867: Optimising asset risk profiles by balancing investment requirements with skills availability				X
1897: Applied health and risk assessment on a large asset base				X
1947: A model of asset management in electrical distribution companies considering the strategic thinking and corporate governance pattern				X
2149: Development, application and benefits of the network digital twin	X			X
2312: Implementation of ISO55000 at Mitnetz and lean management processes	X			X

Block 3: Future DSO

The responsibilities and functions of the traditional DSO is changing. This block covers the new and future tool (for example business models, block chain and social media) and services that the DSO need to master in order to support the energy transition.

0084: This paper analyses what human biology and electrical power distribution systems have in common and how it can inspire electrical distribution networks' design and management and risk minimization efforts.

0175: This paper describes the Vision 2050, as elaborated by the European Technology and Innovation Platform of Smart Networks for Energy Transition (ETIP SNET).

0235: This paper presents a design of the Liuheng Island SLS (street lighting system) as a part of the project. A new business model for the SLS operator with integrated energy is proposed.

0431: The paper tries to propose a conceptual framework for the management of the energies that purchased from Distributed Generation (DG) systems using the smart contract platform.

0481: This paper focuses on social media content classification and on solving data sparsity issues.

0504: In this paper, it is suggested a way to activate system users for more efficient use of contracted power.

0517: A suitable DSO model considering the characteristics of Korea's power industry is presented in this paper. Key features, business models, and operational structures of the DSO are presented.

0664: This paper proposes an electricity market structure in the distribution sector which expresses all commercial elements in the electricity system. The market structure proposed in this paper offers a macroscopic perspective in exploring markets from the perspective of entire system.

0756: The subject addressed in this paper is the impact of regulatory framework changes on the efficiency of electricity distribution and supply, in vertically integrated power companies. The case study of Serbian DSO and public supplier, integrated into the EPS Group, is presented.

0762: This paper explains how the Tata Power company (India) has been covering areas where EV users wish to have charging stations and thereby making India truly ready to usher in the EV wave.

0772: This paper presents examples of system development and demonstration where a number of disparate players can transact power through a trusted technology, block-chain. The focus is on small quantities of electricity trading are not suitable for intermediating on the power exchange.

0798: The standard assessment of the business objects needed to improve this exchange of information between DSO and TSO is illustrated in the paper. The standard assessment is based on the pertinent business and system Use Cases identified in European project TDX-ASSIST and on IEC Core Standards as defined in IEC 63097 Technical Report Smart Grid Roadmap.

0827: This paper estimates and compares ICT costs of several TSO-DSO coordination and market arrangements proposed in the SmartNet project.

0878: Quartierstrom creates a local peer-to-peer marketplace for locally generated solar power. The marketplace is implemented on a permissioned blockchain governed by all prosumers.

0922: This study presents six evaluation indexes to compare the structures of distribution system operators.

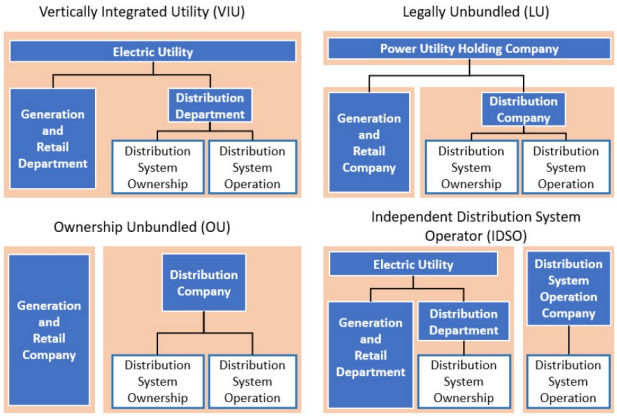

Fig. 5: Structure of ownership and operational authority for each unbundling case (paper 0922).

0942: This paper simulates operation of residential BESS when exposed to varying volumetric (€/kWh) and capacity (€/kW) tariffs.

0946: This paper describes the continuity of supply incentive scheme with extra focus on upcoming changes from Sweden's next regulatory period 2020-2023.

0948: This paper describes the efficient grid utilization incentive scheme with extra focus on upcoming changes from next regulatory period 2020-2023. This incentive scheme is divided into two parts: 1) reducing network losses and 2) reducing load flow peaks in connections to other grids (load).

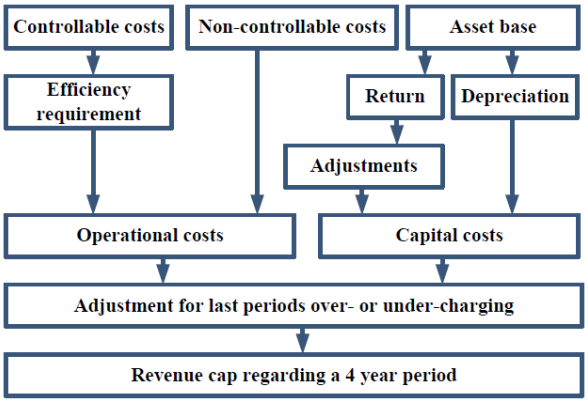

Fig. 6: Overview of the Swedish revenue cap regulation (paper 0948).

0954: This paper describes the grid and market hub (gm-hub) platform that is being developed as part of the Horizon 2020 InteGrid project and its capabilities to enable data driven services on the top of an existing smart-grid infrastructure.

0957: In this paper the technical requirements to implement a dynamic electricity tariffs are presented. Additionally, a Demand-Response-Interface for the communication between retailer and industrial process is described.

1018: This paper will illustrate how incentivizing capacity network tariffs, especially for low voltage customers, can support the energy transition in many ways.

1140: This paper explains the type of challenges the Portuguese DSO is facing in cities, specifically in Lisbon, the data that is being collected, how it will be shared and how different stakeholders, including the citizen will be impacted.

1144: The paper sets forth that artificial intelligence is seen as potentially disruptive and ten electricity distribution activities are identified where artificial intelligence could be usefully applied.

1152: This paper shares the insight that monopoly grids can expect their share of demand to decrease. For the Netherlands, a decrease of two-fifth appears possible mainly due to self-generation and the rise of microgrids.

1174: This paper presents four local energy market design options and introduces the specific configurations for both an auction-based and a central coordinator approach.

1192: In this paper, new business models enabled by smart grid technologies are presented and discussed.

1197: The paper explore how the incumbents of the energy sector are exploring a technology that they deem disruptive and with what research questions.

1313: The paper covers the Pebbles project that aims to develop a Blockchain-based platform for enabling both local energy markets directly accessible to prosumers and distribution grid services.

1331: This paper conducts an analysis of PV rooftop potential for domestic application in Indonesia.

1347: This paper proposes a methodology that performs a feasibility study on whether a consumer-centric market can be deployed at a specific location.

1381: This paper proposes a decision-making model to maximize the profits for the distributed renewable generators.

1448: The paper describes how the local DSO of Helsinki, Finland, manages the compensation of reactive power in an urban city network by various means.

1543: This paper designs distributed source-load transaction rules under the transactive energy mechanism and proposes a trading strategy under the rules.

1544: This paper put forth pertinent considerations that advocate the need for actively managed allocation of System Service, substantiating NIE Networks' vision of evolving from a Distribution Network Operator (DNO) to a Distribution System Operator (DSO).

1547: The importance of blochchain for smart cities is looked into in this paper. It, among other things, points to the importance of smart meters.

1579: The objective of this paper is to describe the business model implemented by Nama Group Capitalizing on Nama Shared Services (NSS) to provide AMR Services to the five distribution companies for their most valuable customers.

1629: This paper will demonstrate how the future DSO in the UK can be modelled, explore the possible options, understand how to analyse them and describe next steps for accelerating the transition.

1653: A repository of 109 mini scenarios has been developed and the paper describes the process, the structure of the driving forces and show examples of mini scenarios and their impact on the future development of the distribution grid.

1679: The paper proposes a simulation framework for investigating microgrids controlled by a multi-agent system and equipped with a Blockchain market platform.

1684: With the issues linked to digitalization (smart grids,

smart metering and data analytics) and to the integration of new technologies on medium and low-voltage grids (renewable energy sources and electric mobility), this paper looks into how the largest French distribution network operator (DSO) Enedis strives to enable the energy transition.

1702: The paper investigates the evolving role of the DSO, in light of the increasing need for TSO-DSO cooperation, by looking into real-life research projects in Europe.

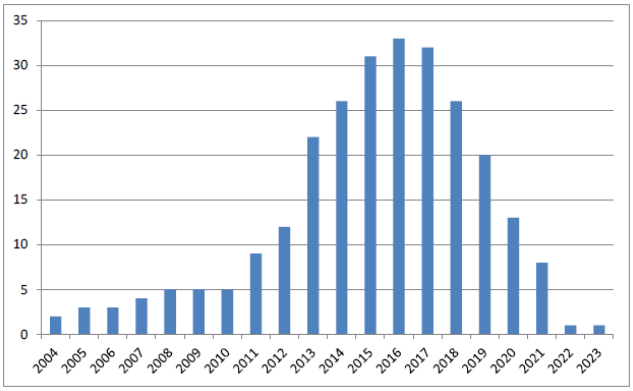

Fig. 7: Number of running projects per year, related with DSO-TSO cooperation (paper 1702).

1715: This paper considers the problem of the effective integration and deployment of DERs for both economic and network operations purposes.

1719: This paper proposes simple and efficient criteria to evaluate possible future distribution system architectures.

1748: This paper presents an innovative methodology for the practical implementation of the Smart Grid Architecture Model (SGAM) to represent alternative holistic model options for the DSO of the future by describing the business and functional specifications associated with them.

1786: The paper looks at the services DSO delivers and aims to identify and to reduce the gap between academic research and practical application.

1807: The paper is highlighting the conclusions and the lessons learnt from EU FP7 demonstration project "Ideal grid for all, IDE4L" from Distribution System Operator's viewpoint.

1839: In this paper the aim is to create type consumer load models that can be used to calculate average distribution charges with a wide variety of distribution tariffs.

1840: The result presented show how Enedis has used a holistic bottom-up approach, resulting in more than 50 Proof of Value (POVs) addressing use cases in key business divisions.

1844: The aim of this paper is to develop a model, which depicts the individual investment decisions regarding the purchase of decentralized energy resources.

1870: This paper present a comprehensive econometric analysis of the total stock of network equipment in France in relation to local consumption patterns and to the geographical spread of users.

1876: This paper focuses on studying the risks that possible grid defection customers' decision to go off-grid would cause for DSO in rural environment.

1880: This paper focuses on studying effects of present night time tariff customers' load control actions on distribution grid loads. The network analysis is performed on secondary transformer level with real hourly customer load demand data.

1929: The paper looks at a holistic architecture for energy communities and how to integrate them into the electrical energy system through the minimization of data exchange requirements and allowing them to provide ancillary services to the system.

1999: An energy data flow model and mechanism is provided in this paper for the data flow within the smart grid infrastructure in order to organize the integration process of the renewable energy within the existed energy utilities.

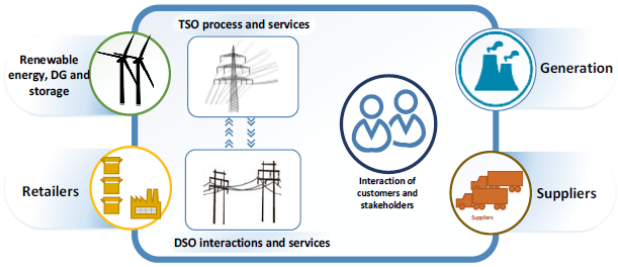

Fig. 8: The interaction between the different stakeholders in the electrical energy market (paper 1999).

2010: A significant amount of information is generated by the meter system and applying the right methods on the data it can be used to identify patterns and recognize the value of the data. The paper presents basic methods that can lead us to the learned models and developed algorithms for predicting the maintenance of smart meters.

2026: This paper presents information on how European DSOs operate their business, including management of smart grid features.

2027: This paper proposes a flexibility control framework of non-utility microgrids for congestion management.

2028: This paper sets out the system operation challenges that UK DNOs face in the transitions to a low carbon future, and the SP Energy Networks vision of the key ways in which DNOs will need to evolve into DSOs in order to meet these challenges.

2083: This paper presents a methodology being tested in the RESOLVD project to create and validate new business models using business model canvas and a stakeholder innovation group.

2148: This paper will look at innovation cooperation in the Smart Grid and its influence on the energy transition. The theory of boundary objects is used as a main approach for decoding the way of cooperation between Smart Grid actors.

2157: This paper proposes a novel methodology integrating the concepts of time-based and locational costs in order to enhance the knowledge of "Distribution Use of System Costs" and enable tariff setting in the presence of DG.

2192: This paper illustrates how the regulatory can incentivise improving network planning to consider the weather risk,
increasing network capability to cope with this kind of events, and promoting faster supply restoration even under emergency conditions.

2213: This paper presents a methodology for evaluating the value proposition for the microgrids by a comprehensive techno-economic calculation based on economic dispatch optimization of Consumer specific solution.

2232: The paper presents a common understanding of a large set of stakeholders regarding the structures needed for the introduction of renewably powered electric mobility on Saint Vincent and the Grenadines.

2254: This paper describes a proposal for the implementation of binomial tariff for low voltage consumers that guarantees a fair allocation of costs of the grid and has a stabilizing effect on distribution companies' revenue.

2264: This paper shows the absence of technical debt research in the domain of smart grid and argues why there is a need for change.

Table 3: Papers of Block 3 assigned to the Session

Paper No. Title	MS a.m.	MS p.m.	RIF	PS
0084: How to build smarter electrical substations by mimicking biology				X
0175: ETIP-SNET Vision 2050 – Integrating smart networks for the energy transition				X
0235: Study on the New Business Model and the AC-DC System Design of an Island Street Lighting System				X
0431: Distributed generation management using blockchain: Iran power distribution study				X
0481: Analysing Thai social media content to improve customer satisfaction				X
0504: Rational use of connected capacities in purpose of more electricity efficient power distribution networks				X
0517: A study on the Korean distributed system operator model considering the new environment with distributed energy resources				X
0664: Electricity market structure in the distribution sector				X
0756: Improving the regulatory framework in order to increase the efficiency of				X

electricity distribution and supply				
0762: Role of distribution system operators in the future of e-mobility in India				X
0772:Block chain based electricity power trading system mechanisms and operating methods				X
0798: Standards assessment of business use cases proposed in TDX Assist				X
0827: An ICT cost comparison of different market structures for distributed ancillary services				X
0878: Quartierstrom: A decentralized local P2P energy market pilot on a self-governed blockchain				X
0922: Alternative structures of distribution sector for neutral distribution system operation in Korea				X
0942: Technical and economic impact of residential BESS on distribution systems under alternative tariff regimes				X
0946: Incentive scheme for continuity of supply in the Swedish revenue cap regulation from 2020				X
0948: Incentive scheme for efficient grid utilization in the Swedish revenue cap regulation from 2020		X		X
0954: Grid and market hub platform to enable a data driven smart grid economy				X
0957: Technical requirements and practical implementation of a dynamic priced electricity tariff				X
1018: Incentivizing capacity grid tariffs as a building block for energy transition				X
1140: DSO role in the deployment of smart cities solutions: The case of the Lisbon urban sharing platform as a service provider				X
1144: An industry survey: Artificial intelligence potential disruptiveness and usefulness for electricity distribution				X
1152: The perfect storm for monopoly grids: The dual disruptive impact of distributed generation and local competition		X		X
1174: Engaging prosumers in local energy market business models				X
1192: New business models enabled by smart grid technology and their implications for DSOs				X
1197: How does the energy sector explore disruptive innovation: A blockchain case study				X
1313: The Pebbles project – Enabling blockchain based transactive energy trading of energy & flexibility within a regional market				X
1331: Profitability assessment of PV rooftop implementation for prosumer under net metering scheme in Indonesia				X
1347: Feasibility study on the adoption of peer-to-peer trading integrated on existing retail market and distribution grid				X
1381: Research on distributed renewable energy transaction decision-making based on multi-agent bilevel cooperative reinforcement learning				X
1448: Control of reactive power in electricity distribution companies				X
1543: Research on distributed transaction strategy based on cooperative game nucleolus method				X
1544: Impact of system services deployment in distribution systems: NIE networks case study				X
1547: Digitization of smart cities with blockchain technology				X
1579: An innovative business model to provide services to distribution companies through an automatic meter reading system				X
1629: Understanding future scenarios to facilitate the DSO transition				X
1653: Driving forces for intelligent distribution system innovation – results from a foresight process				X

1679: Blockchain local markets for the distributed control of microgrids				X
1684: From operating the network to managing the system: How electricity distribution firms commit to becoming enablers of the energy transition for smart and sustainable cities – a focus on the case of France				X
1702: The role of TSO-DSO cooperation towards the energy transition				X
1715: Leveraging DERs for network and commercial dispatch – Lessons learned and a path forward				X
1719: Impact assessment criteria of distribution system architecture				X
1748: Modelling the transition to distribution system operator using the smart grid architecture model				X
1786: Unleashing surveillance and control potential in smart distribution systems – The NET2DG approach-				X
1807: What should be done to make revolution in smart distribution grids?				X
1839: Load models for electricity distribution price regulation				X
1840: Going beyond the AI hype with bottom-up holistic approach focused on improving business processes and services		X		X
1844: Investment decision of households in distributed energy resources with regard to price degression of PV and battery systems				X
1870: Econometric Estimation of a Cost Function of the Power Distribution Grid				X
1876: DSO tariff driven customer grid defections – techno-economical risks for DSO?				X
1880: Powet-based distribution tariffs for residential customers _ A risk for overloading of network in areas with high penetration of time-of-use DSO tariffs?				X
1929: Embedding of energy communities in the unified link-based holistic architecture				X
1999: Energy data flow in smart grids – a conceptual model for addressing various use cases				X
2010: Elektro Ljubljana: Big data challenges in the field of advanced electricity metering				X
2026: Business Models for Electricity Distribution in Europe: Evidence from the JRC DSO Observatory 2018		X		X
2027: Role of microgrids in distribution network congesting management				X
2028: SP Energy Networks: Our vision of future DSOs		X		X
2083: Identification and validation of new business models for DSO business environment using business model canvas and stakeholder groups				X
2148: Relevance and boundaries of innovation cooperation in the smart grid and its influence on energy transition				X
2157: Time-based and locational distribution use of system tariffs with selective consideration of network components				X
2192: Regulatory incentives for improving the resilience of electricity distribution grids in Italy		X		X
2213: Evaluating value proposition of microgrids for utilities				X
2232: Stakeholder alignment: Key to enable renewably powered electric mobility on island states - a Caribbean island state case study				X
2254: Binomial tariff: An alternative modality to Brazilian low voltage consumer drawing on the load factor to segregate its application ranges				X
2264: Introducing the concept of technical debt to smart grids: a system engineering perspective				X

Block 4: Information management

With digitalization comes new opportunities and solutions for more cost-efficient operation of the DSO business e.g. cloud services, voice bots, GIS, block chain etc.

However, information management, data privacy and cyber security is important topics for DSOs in an even more digitalized future supporting the integration and grid connection of renewables at DSO level, operation of smarts grids, comply with new regulation, implementation and use of new IoT devices, supplying new flexible consumption, customer service etc.

This block gives an insight to new digital DSO-solutions as well as information management and cyber security in the DSO business.

50: This paper presents the trail application of SDN (Software Defined Network) technology in a cloud environment at the State Grid Shanghai Data Center.

78: This paper present considerations when deploying an enterprise cloud platform or deploying an information system on the cloud.

117: This paper presents a real-life implementation of a Cyber Security Management System (CSMS) at Dutch DSO Enexis. The CSMS is based on the international standards ISA/IEC-62443 and ISO/IEC-27001.

141: This paper presents the Dutch DSO Enexis method to assess cyber-security risks that integrates with their Risk and Opportunity Based Asset Management process.

272: This paper presents the "State Grid Cloud" in State Grid Shanghai Data Center, the principal of information security protection was studied, and the requirements of information security protection on "State Grid Cloud".

655: This paper presents the requirement to consider cyber risks holistically across a complex environment, such as the distribution of power. Organizations typically use technology as a prevention against a cyber-attack. However, organizations are more than just technology they comprise of people, processes, information, technology and facilities.

681: This paper contains details of how the Metropolitan Electricity Authority (Thailand) improves electricity services by using technology to capture and manipulate data to achieve the maximum benefit when responding to customer requirements to access information and services.

810: This paper proposes a solution to maintain the energy energy-usage history of a consumer at a global level independent and irrespective of the utilities and regions using Blockchain technology with an emphasis on the data standards. The consumer who is the owner of the historical data can authorize the market participants to access and utilize the data for a meaningful purpose.

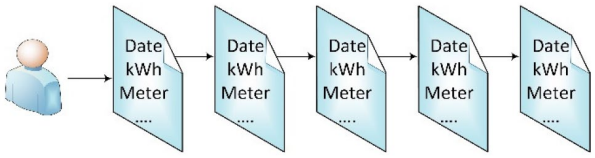

Fig. 9: Energy-usage details are added to the block linking to the chain of blocks from the past submission (Paper no. 810).

813: This paper discusses the use of private 4G Long Term Evolution (LTE) as an enabler to solve the performance needs of higher demand service aggregation points in Smart Grid deployments.

934: This paper describes a CIM project in Elektro Ljubljana (Slovenia), which includes integration of technical information systems using CIM standards, detected challenges during the project, the approach to them and outcomes.

1054: This paper proposes a cloud-edge architecture for distribution systems, and specifically illustrate the logic design of the edge computing device.

1060: This paper addresses the assessment of the cyber security requirements in terms of standards and architectural solutions needed by the evolution of the digitalized power infrastructure.

1147: This paper presents a general overview of relevant cross-cutting issues and fundamental requirements to be considered while tackling important digital and security challenges in the implementation of prominent smart grid use cases.

1241: This paper presents a computational tool which purpose is to identify anomaly in the information registered in the database of a distribution system operator. This tool has as methodology the application of multiple heuristics to identify incorrect data and estimate the most credible scenario for the context.

1340: This paper introduces the Finnish Smart Otaniemi piloting platform and concentrates especially on describing the development of a technical data platform that is a central component in the piloting platform development.

1436: This paper discusses connected, intelligent, efficient, reliable and sustainable digitalization as a tool to improve the whole productivity, accessibility, safety and Sustainability of the DSO business.

1441: This paper proposes an additional testing to detect and prevent backdoor threats in smart meters. The security testing proposed is called White-box Firmware Testing. White-box testing is done by checking the internal firmware meter system.

1451: This paper presents an ongoing project of enterprise GIS platform implementation at the electricity distribution company Elektro Primorska, Slovenia. The main stress is placed on data modelling and system integration. Besides this, the advantages in reports building as well as the end user Web-based GIS application are discussed.

Fig. 10: GIS-centric enterprise information system (Paper 1451)

1482: The paper details the system technology involving IoT sensor nodes, bidirectional communication protocols, data architecture and predictive data analytics. The paper concludes with details on DSO achieved return on investment on the pilot project and the next steps in the enhancement of machine learning algorithms on the system data.

1548: This paper provides a strategic solution for enhancing the cybersecurity of power distribution system operations. In this paper, various security challenges and threats are discussed with respect to their possible sources of occurrence. These threats are classified and then a strategy for achieving more secured electricity distribution grids is suggested by DSO perspective.

1616: This paper presents The Tata Power Company Ltd's (India) approach to listening to the voice of the customers, so that systems and processes can be improved for enhanced Customer Experience.

1621: This paper presents the Tata Power Company Ltd's (India) platform where consumers can raise complaints using self-service options such as through Customer Portal, Mobile Application, Push Pull SMS Service & Chat Bot.

1655: This paper focuses on the development and implementation of a mobility application that will increase the efficiency of both field maintenance team and operator at DSO's dispatch centers, by reducing inefficacy associated with time spent communicating through phone.

1797: This paper aims to describe the main outcomes of the ADMS4LV project – Advanced Distribution Management System for Active Management of LV Grids. ADMS4LV is a R&D project that targets the development and demonstration of a system with adequate tools to optimise the management and operation of Low Voltage (LV) networks towards the effective implementation of Smart Grids.

1803: This paper discusses today's competitive energy and utility markets, where companies may fail to prioritize their customer experience efforts may suffer from customer dissatisfaction as well as a negative reputation with customers.

1822: This paper enumerates possible solutions to privacy issues in the Smart Building domain. Tightly connected are privacy issues introduced by Smart Meters, currently being rolled out in many member states of the European Union, including households not being part of a Smart Building. As their privacy issues have been heavily discussed in the literature, they serve as the main example for described privacy-preserving solutions.

1883: This paper gives an insight into the CIM based integration pilot project at the DSO Elektro Celje (Slovenia). The main goal of the project was to utilize IT integration standards based on the IEC CIM (Common Information Model – family of standards IEC61970, IEC61968 and IEC62325).

2086: This paper provides some approach to ease definition and analysis of Cybersecurity requirement during Projects for Distributed Automation Products & Systems, while still taking into account Utility specificities. It is based on appropriate usage of IEC 62443 standard.

2105: This paper introduces a theoretical planning and operation More-complex urban energy models integrating more than one intervention area are reviewed, outlining their advantages and energy demand, existing trends and challenges, and some relevant applications. Lastly, a methodology for developing an improved energy model in the smart-city context is proposed, along with some additional final recommendations.

2261: This paper describes the development of a low-cost and low-power LoRaWAN wireless solution for remote management and analysis of consumers' measurement data located in regions with difficult access and low load density. The solution was developed to Sulgipe, a small distribution system operator that supplies energy to around 150,000 consumers in northeastern of Brazil.

2273: This paper focuses on the coupling mechanism between power system information flow and energy flow. Based on the analysis of power grid cyber physical system (GCPS), a formal modeling and verification method is proposed. By decomposing GCPS into power and load subsystems, the behavior and state modes are expressed mathematically, and network structure diagrams are constructed.

Table 4: Papers of Block 4 assigned to the Session

Paper No. Title	MS a.m.	MS p.m.	RIF	PS
50: Trial application of SDN (Software Defined Network) technology under Cloud environment in State Grid Shanghai Data Center				X
78: Research on Enterprise Cloud Platform Security System				X
117: Implementing an ISA/IEC-62443 and ISO/IEC-27001 OT Cyber Security Management System at Dutch DSO Enexis				X
141: Managing OT cyber security risks using BowTies and Risk & Opportunity Based Asset Management at Dutch DSO Enexis		X		X
272: The principle of Information security protection on "State Grid Cloud" in State Grid Shanghai Data Center				X
655: A holistic review of cyber risks for the distribution of power		X		X
681: Using technology and sharing data to improve electricity services				X
810: Global System of Record and Framework to Preserve Energy Consumption with Blockchain				X
813: Private LTE to enable Smart Grid evolution		X		X
934: Implementing CIM model in Distribution System Operator				X
1054: Data collecting and processing method in distribution system using edge computing technology				X
1060: Assessment of Cyber Security Requirements for the Future Digital Power System				X
1147: Cross-Cutting Issues in EPES's Digitisation and Security: An Overview of Prominent Smart Grid Use Cases				X
1241: Computational tool to improve the information's quality of the DSO's geographic database (BDGD) for regulatory purposes				X
1340: Data Platform as an Enabler for Piloting in Smart Otaniemi Ecosystem		X		X
1436: Digitalization for Sustainably Smart Electricity Distribution System				X
1441: Security Testing for Preventing Backdoor Threat in Smart meter Implementation In Indonesia				X
1451: Aspects of implementing GIS as a centralized system in enterprise IT/OT environment		X		X
1482: First of its kind implementation of IOT system in Indian Power Sector				X
1548: Implementing Cybersecurity Strategy for Distribution System Operator Perspective				X
1616: Capturing Post Transactional Customers Feedback across Key Customer Touch-points using Online and Real Time Platform.				X
1621: Implementation of IVR for Complaint Management.				X
1655: CheckIn – Work Force Management Platform		X		X
1797: (ADMS4LV) – Improved observability of LV grids based on advanced analytics				X

1803: Implementation of Chat bot & Voice Bot				X
1822: Privacy Issues in Smart Buildings by examples in Smart Metering				X
1883: CIM-based systems integration project at Elektro Celje DSO				X
2086: Cybersecurity in Distribution Automation: approach for common referential leveraging Standardization				X
2105: The role of distribution network in promoting cost-effective Smart City based on IoT				X
2261: A low-cost LoRaWAN wireless IoT solution for remote management and analysis of consumers' measurement data				X
2273: Formal Modeling and Verification Method of Power Grid Cyber Physical System Based on Coupling of Information Flow and Energy Flow				X