Special Report
Your guide to the Session 5

PLANNING OF POWER DISTRIBUTION SYSTEMS

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Introduction

In an era of growing uncertainty and systemic interdependence, distribution network planning is undergoing a profound transformation. The 153 papers accepted by Session 5 of CIRED 2025 reflect this shift: from deterministic forecasts to scenario-based planning, from hardware-centric upgrades to software-enabled flexibility, and from centralized asset deployment to decentralized intelligence at the edge of the grid.

This year's contributions offer a rich panorama of methods, tools and field-tested strategies. A particularly strong focus emerges on low-voltage networks, now recognized as critical enablers of the energy transition. Papers explore innovative planning techniques that combine spatial analytics, probabilistic load flows, and GIS-driven models to accurately anticipate future needs and manage grid congestion at local scale.

Forecasting and flexibility are the twin pillars of modern planning. The session shows advances in AI-driven forecasting - ranging from deep learning applied to EV and heat pump behaviour to long-term load projections accounting for exogenous variables. Meanwhile, operational flexibility - whether from community batteries, heating systems, EV fleets or sector-coupled resources - is quantified, optimized and embedded into planning decisions. The boundaries between planning and operation are blurring, as DSOs increasingly use real-time data and market signals to guide investment priorities.

A third theme, emerging with clarity, is the evolution of planning tools themselves. From co-simulation environments to modular platforms for microgrid design, and from stochastic reinforcement scheduling to risk-based contract sizing, the diversity of tools reflects a sector ready to embrace complexity with structure.

This report aims to guide the reader through this dense and forward-looking material, grouping contributions by thematic blocks while highlighting the convergence of innovation across national borders, voltage levels, and professional backgrounds. The future of distribution planning is not just about managing kilowatts—but about orchestrating intelligence, resilience and value across a changing landscape.

Block 1 Risk Assessment and Asset Management

- Sub block 1: Risk Assessment and Reliability Assessment
- Sub block 2: Resiliency
- Sub block 3: Asset Management and Maintenance Strategies

Block 2 Network Development

- Sub block 1: Innovative Power Distribution
- Sub block 2: Smart Grid Systems and Applications
- Sub block 3: DC Distribution Systems and Microgrids
- Sub block 4: Flexibility Solutions

Block 3 Distribution Planning

- Sub block 1: Advanced Planning
- Sub block 2: Smart Grids and Microgrid Planning with Flexibility
- Sub block 3: EV Accommodation Planning

Block 4 Methods and Tools

- Sub block 1: Load/Generation Modeling and Forecasting
- Sub block 2: Network Modeling and Representation
- Sub block 3: Load Flow, Hosting Capacity and Short-Circuit Calculations
- Sub block 4: Energy Losses.

Block 1: Risk Assessment and Asset Management

Sub block 1: Risk Assessment and Reliability Assessment

Sub block 1 includes only two papers focused on risk assessment with respect to cyber-attacks and on LV network reliability assessment based on machine learning classification models.

In **Paper 0392** the effects of the increase of households automated loads, like heat pumps (HP) and electric vehicles (EV) and possible risks of cyber-attacks are examined. The resilience of a real Finnish distribution network with 100% penetration of domestic HP and low/high power EV chargers is tested considering load-side attacks.

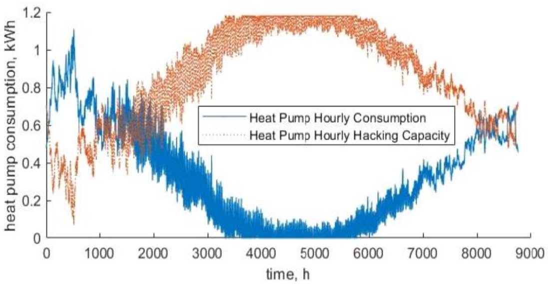

Fig. 1: Comparison of consumption versus hacking capacity of a heat pump for a random household according to Paper 0392

In order to properly allocate investments for maintenance and construction in low-voltage networks, with high penetration of DG and BSS, to improve systems reliability, **Paper 0642** proposes the use of machine learning-based classification models to predict critical distribution transformers, based on power flow processed with 60-minutes interval and historical failure and weather data.

Sub block 2: Resiliency

Sub block 2 papers address the distribution system planning including solutions to improve its resiliency against tree falling both in extreme wind or crown snow without soil frost conditions as well as during heatwaves.

A methodology to improve grid infrastructure resilience against through the maintenance program optimization to mitigate tree fall outages during windstorms is described in **Paper 0386**. The approach integrates historical network outage data and georeferenced vegetation inventories, enabling precise pruning cycle scheduling based on species growth rates and is applied to 4 Brazilian large distribution networks.

Paper 0276 focuses on assessing the resilience of Enedis MV overhead lines against tree fall during wind storm conditions and consequent tree falling. Enedis carried out a massive data processing combined with statistical learning methods to establish failure prediction models considering multiple faults in order to prioritize investments for burying overhead lines based on the risk analysis.

Fig. 2: Wind risk map used to evaluate resiliency of French overhead MV Lin**e** as for Paper 0276

The impact of climate change on electricity distribution systems in Scandinavian conditions, focusing on the effects of soil frost and crown-snow load on overhead distribution network power lines is the focus of **Paper 0876**. With climate change, soil frost days are decreasing, reducing the anchoring effect on trees, while crown-snow loads are increasing in certain regions, potentially leading to increased outage risks. The authors underline the need for DSO to incorporate higher resolution climate scenarios into their long-term planning to assess resilience of the distribution network.

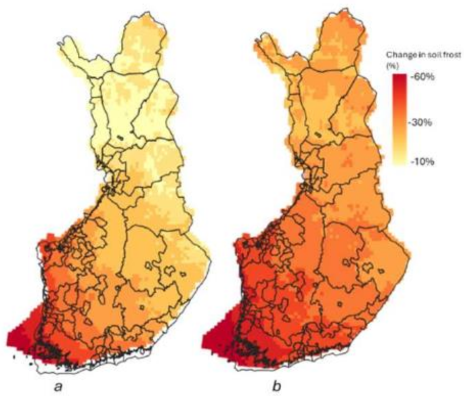

Fig. 3: Average changes in soil frost days in silt and clay-based soils in reference period 1981-2010 compared to 2021-2050 period in RCP4.5 scenario a) and RCP 8.5 scenario b) in Finnish DSO network areas as reported by Paper 0876

Paper 0686 proposes an integrated approach combining centrality metrics from graph theory with metrics developed and adapted from Kirchhoff's laws, spectral analysis, and power flow simulations. According to the authors, this comprehensive method lets to assess the resilience of critical nodes and the network's vulnerability to targeted or random faults.

Paper 1172 presents a holistic approach to increase the resilience of MV underground lines against heatwaves. It includes innovative planning criteria, components, constructive solutions and installation practices. Results of the first installations executed according to these new criteria confirmed that these advanced design solutions are effective.

Sub block 3: Asset Management and Maintenance Strategies

In Sub block 3 methodologies are proposed to evaluate asset management and maintenance strategies taking care of diagnostics on underground cables, MV pole strength measurements as well as dynamic cable rating.

In **Paper 0953** the authors present the new asset management strategy implemented by Scottish Power Energy Network to increase the resilience of Overhead Lines against extreme weather events, intensified by climate changes. The work has been based on previous projects (weather events mapping, OHL 3D modelling, drone inspections), which have provided opportunities to define the requirements of new platforms and databases, including pole strength and fault detection devices measurements, to support improved condition assessment and prioritization of work.

Fig. 4: Smart pole inspection technology proposed in Paper 0953

Diagnostic of underground power distribution cables by means of very low frequency (VLF) tanδ measures is the focus of **Paper 0503**. The replacement criteria are based on a combination of determination factors in terms of linearity and variability of measurements over the years. This allows to overcome the issue of cases where the R index could not be calculated due to missing or low-confidence measurements.

The relationship between load patterns and cable thermal characteristics, showing Dynamic Cable Rating (DCR) as an effective approach to improve the cable sizing in distribution networks with intermittent renewable energy sources, is explored in **Paper 1067**. The findings show that DCR improves cable capacity utilization, reducing the need for oversized conductors while maintaining safe operating conditions. The authors outline the significance of accounting for thermal inertia and realistic load patterns when calculating cable ampacity.

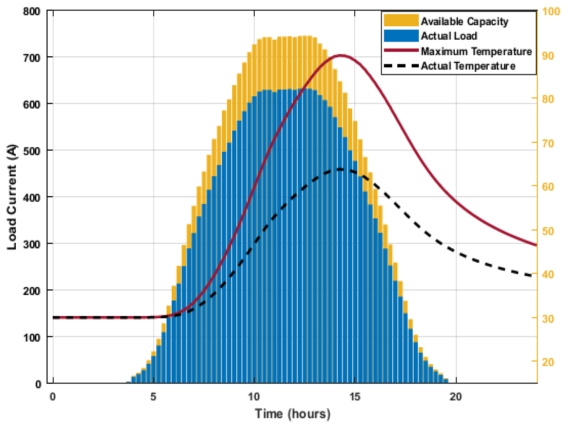

Fig. 5: Actual and available load capacity along with conductor temperature profiles as for Paper 1067

Potential scope of discussion

Climate change is a global challenge that calls for shared and agreed methodologies to be faced with the appropriate effectiveness. Do we have enough data and experiences to converge, at least in a high-level perspective, on common ground regarding resilience issues?

Table 1: Papers of Block 1 assigned to the Session

Paper No. Title	MS a.m.	MS p.m.	RIF	PS
0035: 3D modelling of temperature distribution of underground medium voltage cable in practical cases				X
0055: A new tool for a more efficient industrial planning of overhead line renovations				X
0276: Investment on Overhead MV Network for a better resilience to climate hazard, a new approach				X
0386: Extreme Weather Events: Measuring and Enhancing Resilience in Operational and Electric Grid Infrastructure				X
0392: Evaluation of Resilience of a Distribution Grid after Addition of Heat Pumps and Electric Vehicles as Home Automated Loads Operating under Multiple Case Scenarios for All Households				X
0503: A Statistical Consistency Review of the Combination of VLF Tanδ Factors for the Diagnosis of Underground Cables				X
0642: Predicting Operational Failures in Low-Voltage Distribution Networks Using Machine Learning-Based Classification Models				X
0686: Graph Theory-Based Topological and Nodal Analysis for Identifying Critical Points to Enhance Resilience in Electrical Distribution Systems			X	X
0876: Effect of climate change in electricity distribution systems in Nordic conditions				X
0953: Evolution of distribution network strategy for OHLs to reflect changing network risks	3			X
1067: Optimizing Cable Size for Cyclic Loading Using Dynamic Cable Rating				X
1172: New design criteria for MV underground feeders to enhance network resilience in the energy transition and climate change era	4			X

Block 2: Network Development

Block 2 introduces papers describing original applications within the distribution business. They may relate to the integration of new components or technical solutions, the delivery of innovative systems or the implementation of state-of-the-art functionalities.

This block includes a large number of papers discussing flexibility associated with distribution networks, a relatively recent topic, but an important one to enable energy transition. It is possible to perceive a growing interest in DC networks, and on MVDC, which are also a tool to enable the interconnection of inverter-based resources with distribution grids.

This block is also dedicated to other innovative power distribution solutions, and Smart Grids systems, on which several topics are present, including the usage of smartmeter data to increase network state estimation, TSO/DSO collaboration, local energy communities, among other papers presenting solutions for network development.

Sub block 1: Innovative Power Distribution

Sub block 1 includes innovation not explicitly connected with "mainstream" topics; therefore, the paper hosted show a high degree of diversity often dealing with specific, Country-based, projects including multi-source energy systems or referring to the adoption of a specific new component and/or technical solution.

Paper 0189 compares active and passive solutions to balance 3-phase LV network. The passive balancers are based on zig-zag transformers in parallel to the grid, while active balancers are based on active shunt filters (D-Statcom). It concludes that both solutions can solve all the analysed cases, with active balancing outperforming passive balancing when its transfer power capacity between phases exceeds 5 kW.

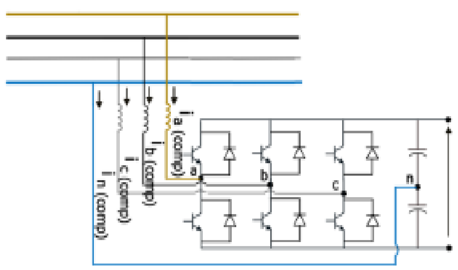

Fig. 6: Active balancer schematic presented in Paper 0189

Paper 0191 describes a digital tool supporting the decarbonisation of energy demands, facilitating the adoption of low carbon technologies. It facilitates the identification of opportunities to decarbonise transports (for instance, helping to optimise the siting of EV charging infrastructure), heat production (for instance, helping to optimise the deployment of heat pump technology), or PV installations. It also enables information exchange between local stakeholders and the DSO, supporting informed strategic decisions across multiple energy vectors.

Paper 0489 discusses the influencing factors of Renewable Energy Communities (RECs) on the planning and operation of distribution networks, by investigating its grid impact. From a grid perspective, it considers as influencing factors are the renewable potential, grid and buildings (settlement pattern); community size; PV penetration; BESS installations; EV penetration and heap pump penetration. With the analysis, it concludes that REC do not produce a large reduction in grid loading, hence not supporting a partial omission of grid tariffs.

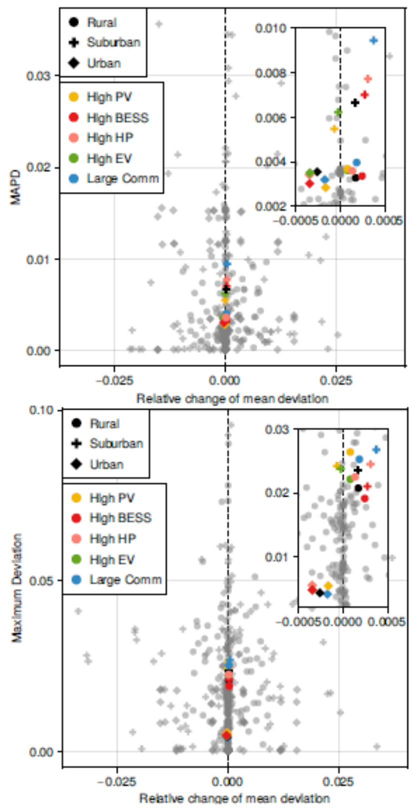

Fig. 7: Mean Absolute Percentage Deviation (MAPD), and Maximum Deviation, as function of the relative change between the Community and No Community case, from Paper 0489

Paper 0358 presents the solution to integrate Shetland Island's network with the mainland, through the construction of an HVDC interconnection (260 km). The interconnection will allow the island to reduce thermal generation by 150 GWh annually, while the island will remain self-sufficient during eventual transmission outages. The network will have a BESS (grid forming) and an AC Chopper, which is able to absorb/dissipate excess power and keep the frequency and voltage within acceptable limits during disconnection events from the transmission grid.

The topic of the TSO/DSO collaboration is addressed in **Paper 0429**, from a perspective of solving voltage constraints on the HV network and the management of HV/MV on-load tap changers (OLTC). Frequently, HV/MV OLTC are at their lowest tap, degrading downstream voltage levels. The paper focuses on HV voltage level management (by the TSO), and OLTC management, to jointly address that problem. An HV and MV (and LV) network was analysed, and several solutions for voltage level profile compared: reactive power control of MV generators; installation of coils in either side of HV/MV transformers; reduction of the voltage set point in HV/HV substations.

Paper 1013 explores a network demonstration designed to provide understanding on how DERs can build, maintain and optimise power islands, with a view to compliment DER to enable a bottom-up approach to restore a wider grid after a total shutdown. From live testing performed with a combination of synchronous and non-synchronous machines, it proposes strategies to mitigate transients associated with inrush currents, analysis the energisation of a network with very low fault levels, analysing the resulting harmonics and resonant frequency voltages, and establishes the principle that establishing a Distributed Restoration Zone (DRZ) with DER is feasible.

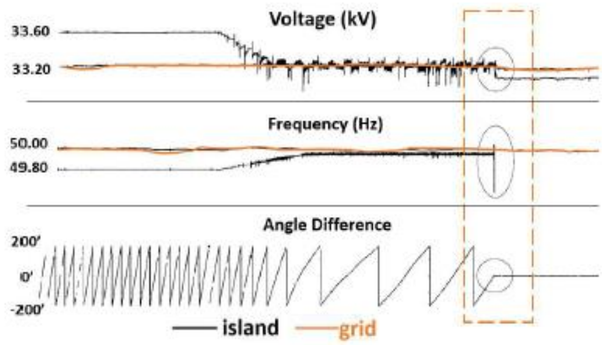

Fig. 8: DRZ Controller applying resynchronization functionality, with synchronization between island & grid in region highlighted, from Paper 1013

Paper 0983 introduces a proof-of-concept of a Large Language Models (LLM)-based agent interacting with a microgrid platform, enabling users to interact with it through text queries. The system is built to be capable of answering both general and system-specific questions. The model has data on the power system, and can analyse efficient responses to perturbations, and handle microgrid-specific tasks.

Sub block 2: Smart Grid Systems and Applications

Sub block 2 includes papers explicitly dealing with Smart Grid topics, ranging from strategic development plans to infrastructures and architectural novelties, to specific functionalities' delivery. It must be appreciated that LV networks are also considered.

Paper 1268 discusses the ability of using a Modular Static Synchronous Series Compensator (MSSSC) to mitigate frequent and short-term changes in power flows originating by renewables and powerful loads (e.g., heat pumps, EB and EVs, data centers), and to allow the delay of network reinforcements. It describes how to determine optimal locations, size, and adequacy of the concept, including an economical assessment.

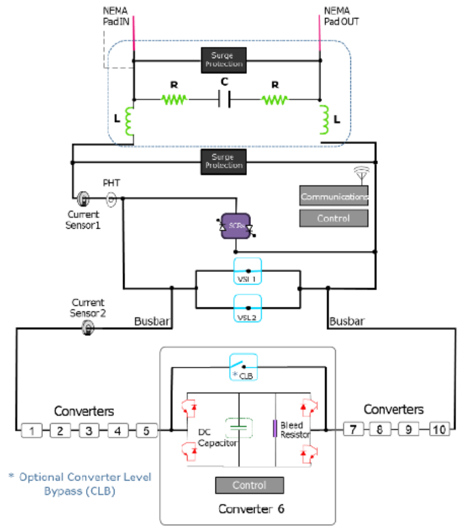

Fig. 9: Diagram of the MSSSC from Paper 1268

Paper 0393 presents the concept of dynamic interconnection limits for DER. Interconnection limits determine the allowable range of power that DER can import or export to the distribution grid, and usually a static interconnection limit is assigned, based on the hosting capacity considering the worst scenarios. However, the deployment of monitoring and control capabilities, supported by novel business arrangements such as flexible interconnection agreements, enable a more efficient approach.

In **Paper 0144**, a solution to improve DER hosting capacity, by introducing a Compact Line Voltage Regulation transformer (C-LVR), combining the functions of a Voltage-Regulation Distribution Transformer (VRDT) and Medium Voltage Line Voltage Regulator (MV-LVR), is presented. A MV-LVR is integrated in the same tank as a distribution transformer. An economic analysis is also presented, showing that a C-LVR can significantly reduce CapEx and OpEx compared with other methods.

Paper 0661 investigates how sensorization and automation can optimize MV & LV grid performance. Describes a solution that includes a consolidation of all protection and control functions of a Primary Substation (PSS), installing metering solutions in all MV bays of a PSS, upgrading overhead line reclosers to allow them to acquire energy flow data, monitorization of LV busbars in distribution substations (DSS), and acquire observability on RMUs. The paper presents a summary of initiatives enhancing the performance of the network based on existing automation, protection, control, and monitoring systems.

Sub block 3: DC Distribution Systems and Microgrids

The integration of inverter-based resources, be it RES, electric vehicles, battery storage systems, or other resources, when associated with the evolution of power electronics, has resulted in the growing interest of DC networks. Several papers were published discussing MVDC solutions. After the development of DC solutions on a transmission level, it is possible to perceive that DC applications are expected to increase on a distribution level.

In **Paper 0306** we find a proposal for resiliency increase on remote areas, by removing distribution facilities and creating islanded distribution systems (off-grid), with DER. The paper presents the impact on retail revenues, the CapEx and OpEx to implement the solution. It proposes a method to compensate for the CapEx through the retail of the off-grid energy through associated PPA. It relates the remoteness of the loads served (length of existing lines) with the willingness to invest in the off-grid system.

Paper 0668 analyses the mutual impact between AC and DC systems in hybrid distribution networks, focusing on transformer saturation and voltage fluctuations in AC power lines caused by DC-side faults. The results indicate that lower grounding resistance minimizes the impact of DC faults on the AC system, proposing a method to select grounding resistance. The study provides insights for the planning and implementation of hybrid AC/DC systems.

Fig. 10: Concept of AC/DC hybrid distribution from Paper 0668

Paper 0678 anticipates the implementation of Medium Voltage DC (MVDC) networks, whose standards are still not fully mature, nor operational decision-making algorithms are well established. The paper proposes an operational system design for MVDC ensuring flexibility to adapt to evolving conditions.

Paper 0681 proposes the utilisation of MVDC as an alternative to foster more effective grid management on a system with increasing volumes of renewable energy integration. Presents a grid management system designed with Micro Service Architecture (MSA). The MSA divides a large system into many independent, smaller services, intercommunicating between each other.

Paper 0942 describes the ongoing development of a MVDC network for connection of linear PV collector network. Linear PV can be installed along long and narrow sites, such as roads, railways, or other sites sharing that characteristic. Network architecture relies on a move from AC to DC, exploiting the advantages of DC on long distances. The project is developing a ±10kV network. The paper describes the development of converter, cable system, switchgear, monitoring, control and protection.

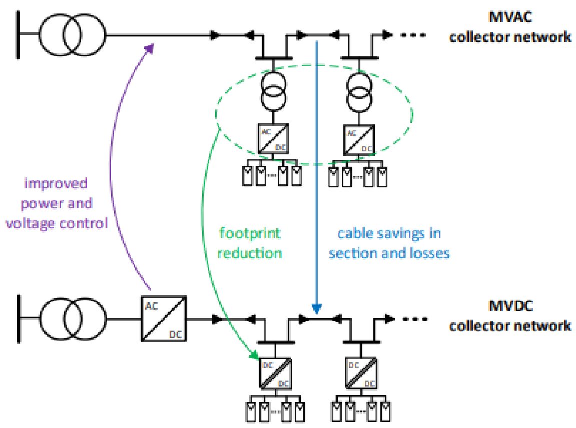

Fig. 11: Comparison of PV collector network topologies MVAC (top) and MVDC (bottom) Paper 0942

Paper 0685 presents a platform for AC/DC hybrid distribution network operation. This platform aims to address the increased complexity of AC systems associated with the integration of DC resources (generation and loads). The solution consists of an integrated software-hardware platform for hybrid distribution networks accommodating AC and DC loads. The proposed solution is designed to ensure flexibility and scalability, enhancing operational efficiency, while supporting cost-effective planning.

Paper 1001 focuses on different MVDC network configurations for a representative suburban distribution grid. It aims at finding a technically and economically viable configuration(s), evaluating the interest of DC technology. A comparison between an AC network, a DC network and a hybrid is performed, considering quantitative and qualitative KPIs. The outcome points out the necessity for selection of the right use case for MVDC.

Paper 1283 proposes a methodology for optimization of MVDC PV collection networks, minimizing costs (CapEx and OpEx), and power losses, while satisfying operational constraints such as voltage drops, current limits, and spacing. Applied to a 50 MW system, the methodology identifies 1 MW RMUs spaced every 1 km, considering the associated the associated MVDC and LVDC networks, as the most effective configuration.

Sub block 4: Flexibility Solutions

Sub block 4 deals with projects and tools related to the use of resources connected to the distribution network in order to support grid operation. The experiences shared include use cases of real generation/load dispatching as well as market models to achieve network services or decision support tools to evaluate the economic feasibility of flexibility options.

Paper 0165 investigates the P-Q curve characteristics of grid-forming converters, highlighting constraints from semiconductor properties and grid conditions. It examines the impact of control strategies, particularly fixed virtual impedance, across varying grid strengths. The results show that while the P-Q curve typically appears circular, it can deviate significantly under certain conditions, forming non-convex regions.

In **Paper 0253**, an analysis and comparison of congestion management (CM) solutions is presented. CM enables DSOs to address congestion issues. However, it also introduces challenges, as the relationships and trade-offs among these solutions are not always well understood. CM solutions can be broadly categorized into market-based approaches, namely grid reinforcement, grid tariffs, grid supporting service product, advanced monitoring, and advanced grid management.

In Paper **0355**, the impact of storage units in residencies for P2P energy trading is described. It investigates the relationship between individual home energy storage optimization and overall P2P network effectiveness, exploring whether maximizing individual storage capacity aligns with fostering robust P2P energy exchanges. A optimal solution from a household perspective is compared with a sub-optimal one, assessing the results from a system perspective. The results indicate that the sub-optimal strategy yields better cost savings, through P2P trading.

Paper 0297 discusses the business case of the installation of neighborhood batteries (NB) in the context of power systems with large integration of wind and solar generation. These batteries are designed to cover the local energy needs, as an alternative to individual consumers installing their batteries. They are also designed to provide network and energy market services. The use cases described by the paper are two greenfield developments.

Project Benefits	
Item	Benefits ($)
Reduced number of DSS	25% reduction, installed cost of one DSS = $200,000
Reduced land cost	$1,116/m^2
Reliability benefits	$45.01/kWh
Export curtailment benefits	As per AER's CECV methodology
Energy arbitrage	Wholesale prices modelled with approach to buy in daytime while low and sell in afternoon / evening while high. Revenue modelled based on stochastic model of historical spot prices and forecast for future 10 years of NB operation and 80% of usable battery capacity
Frequency Control Ancillary Service	$30,000 / MW / year revenue
Network tariff rebate	As per Jemena trial community battery tariff
Value of emission reduction	As per AER's VER guidance paper

Fig. 12: Summary of NB quantifiable benefits, Paper 0297

Paper 0348 assesses the flexibility and cost dynamics of hydrogen systems in integrated energy models, from a grid planning perspective. The integration would enable the mitigation of transmission and distribution bottlenecks. The paper quantitatively assesses integrated systems dynamics, including conversion of electricity into hydrogen and heat, and vice versa, at an hourly and annual scale.

Paper 0436 discusses the potential of dynamic forecasting in power flow reliability. The forecasting model used includes power load forecasting, dynamic forecasting, and pricing, creating dynamic pricing strategies for electric vehicle (EV) charging. Limited capacity on the network can result in restrictions in EV charging. Dynamic forecasting and dynamic pricing are the base for a booking system enabling customers to reserve a time slot for EV charging. PV generation and available grid capacity are considered to provide incentives for charging at certain times. A comparison is made on the results of using, or not, dynamic pricing and the booking system.

Paper 0483 presents the Ecoflex project, developing a platform linking multi-energy resources and e-mobility with aggregators. The platform aims at leveraging flexibility on low voltage grids, bringing together several resources such as electric vehicles, heat-pumps and battery systems. The project is being demonstrated in three sites.

Paper 0815 discusses the contribution of water systems to provide flexibility, through the management of storage tanks and backup pipelines. The management of those assets, electricity demand can be modulated, offering flexibility services on the market. This paper focus on such a case study from Italy.

Paper 1028 assesses Volt/var local control alternatives, allowing efficient integration of PV in long MV feeders, through a hardware-in-the-loop (HIL) approach. This approach is employed in rural feeders, on which PV can result in operational limits violations. The paper presents results associated with Volt/var local control assessment based on OpenDSS simulations validated through a HIL platform. The results for a real feeder highlight local control of capacitor banks and step voltage regulators, and the utilization of smart PV inverters, providing recommendations for cost-effective planning.

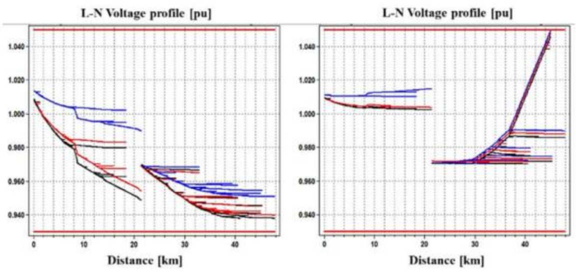

Fig. 13: Voltage profile for max load (left) and max generation (right), from Paper 1028

Paper 1273 describes the exploitation of Power-to-Hydrogen (PtH) technology, converting surplus RES to hydrogen, as a solution to increase RES hosting capacity of a MV network, through the provision of flexibility services. PtH allows addressing problems such as overvoltages, while improving the efficiency of the network. A real distribution network is analyzed, with and without the addition of a Proton Exchange Membrane electrolyser.

Paper 0867 addresses the challenge of integrating large volumes of DER in a cost-effective and timely manner through the concept of a Constraint Identification and Curtailment Assessment Tool (CItCAT), supporting connection designs and future exploratory network analysis for complex networks. It allows to understand the level of risk to a network of accommodating flexible connections and provides information to customers to justify investment decisions.

Paper 1277 deals with the non-market based redispatching in the context of European legislation. It summarizes the legislation requirements for non-market-based redispatching activation and provisions about financial compensation. A simplified calculation model is done for estimation of compensation costs and identification of activation priority of different support providers.

Potential scope of discussion

What's the future for MVDC development, and for MVDC standards to emerge? How to best exploit flexibility solutions and to set up an efficient flexibility market that allows to optimize network development CapEx? How to best exploit smartgrid data to optimize grid efficiency? How to address challenges on TSO/DSO collaboration with DSO networks having an increasing number of resources associated with?

Table 2: Papers of Block 2 assigned to the Session

Paper No. Title	MS a.m.	MS p.m.	RIF	PS
0144: Innovative approach to boosting DER hosting through a combination of distribution transformers, line voltage regulation and OT/IT integration				X
0165: Operational Limits and P-Q Capability Diagram Analysis of Grid-Forming Converters in Weak Grids				X
0189: 3-phase LV Network Load Balancing: Comparing passive and active solutions		16		X
0191: A digital solution (PRIDE) to enable decarbonisation of major energy demands and acceleration of energy transition				X

0253: Analysis and comparison of congestion management solutions of distribution grids	1			X
0297: Paving the way for network neighbourhood batteries in Australia: A business case assessment		21		X
0306: Cost consideration of installing facilities for off-grid distribution system supplied only inverter power sources				X
0348: Assessing the Flexibility and Cost Dynamics of Hydrogen Systems in Integrated Energy Models for DSO Grid Plannings			X	X
0355: Impact of Optimal Capacity of Storage Units in Residential Houses for P2P Energy Trading				X
0358: From isolation to integration: enhancing Shetland’s distribution system to connect HVDC				X
0393: Dynamic interconnection limits: key principles, implementation, and implications for utility oversight of DER-provided bulk system services	7			X
0429: TSO/DSO collaboration to solve constraints regarding voltage in HV networks and HV/MV on-load tap changers	2			X
0436: From forecasting to pricing: the potential of flexible forecasting in power flow reliability				X
0483: ECOFLEX Project: Leveraging flexibility from low-voltage assets				X
0489: Influencing factors of the development of renewable energy communities on power system planning and operation	6			X
0661: E-REDES Improve secondary MV&LV grid through Sensorization and Automation				X
0668: A study on mutual impact between AC and DC in AC/DC hybrid distribution networks				X
0678: Design Strategy for Management System for MVDC Distribution Network				X
0681: Design of an Optimization of Distribution Data Collection System for MVDC Distribution Network				X
0685: Proposal of Platform for AC/DC Hybrid Distribution Network Operation				X
0815 Flexibility Services From Water Distribution Networks: The Demonstration Project of Gruppo ACEA				X
0867: Development of A Network Curtailment Assessment Tool to Accelerate Connection of Distributed Energy Resources				X
0942: OPHELIA project: Development of MVDC network architecture for large linear photovoltaic farms		24		X
0983: Leveraging Large Language Models for a Resilient Electricity Supply System				X
1001: Possibilities and requirements on operation of future medium voltage direct current networks				X
1013: Distributed Restart	5			X
1028: Assessment of Volt/Var local control alternatives to allow efficient integration of Photovoltaic Generation in long MV feeders: a Hardware-in-Loop approach				X
1268: Use of Modular Power Flow Control to improve network efficiency in the distribution network				X
1273: Enhancing Distribution System Hosting Capacity with Hydrogen Electrolyser Technology				X
1277: Aggregated model of the distribution system for non-market based redispatching assessment and costs estimation				X
1283: Sizing and Optimization of Medium Voltage Direct Current (MVDC) Grid for Linear Photovoltaic Power System (LPVS)				X

Block 3: Distribution Planning

Sub block 1: Advanced Planning

Papers of Sub block 1 give a wide overview of advanced methodologies for distribution systems planning at various voltage levels including building collective connections or green field integrated energy systems. They exploit probabilistic load flow, automatic substation placement, GIS, sector coupling, smart meter data.

A Probabilistic Load Flow (PLF), based on Monte Carlo resampling of load/production profiles built from Smart Meters historical time series from, enables the verification of nodal voltage violation risks and line congestion considering future expected/planned installations through scenarios of HP, EV charging stations and PV adoption. This methodology is described in **Paper 0184** and has been applied to real LV networks of Lausanne in Switzerland.

Paper 0394 outlines the development of Rural Electrification (RE)and relevant social benefits in Sarawak, a geographically challenging and sparsely populated region of Malaysia. In 2009, the RE rate was 56% in rural areas and 73% statewide. Since then, it has grown to 99% and 99.6% respectively by 2024 by means of various initiatives, including construction of EHV/MV and MV/LV substation, Medium Voltage Covered Conductor lines, LV connections to 18,000 households in more than 800 villages, standalone solar systems as well as Solar-diesel hybrid stations.

The energy transition pushes DSOs to optimize the development of network infrastructures. **Paper 0534** is focused on ENEDIS methodology/applications for sizing vertical collective connections i.e. the LV lines from the main circuit breaker to various consumers or producers within the same building making use of smart meter data.

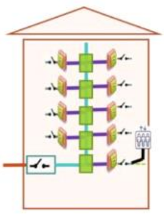

Fig. 14: Schematic representation of a vertical Collective Connection Infrastructure of Paper 0534

Paper 0542 proposes a two-stage method to automate distribution substation placement and integration. The first step identifies suitable areas for distribution substation (DS) placement based on load projections and geographic metrics. The second one identifies optimal positions in a smaller scale Low Voltage Network Area topology, where the new DS can resolve the most violation of technical constraints and therefore minimize overall network expansion costs.

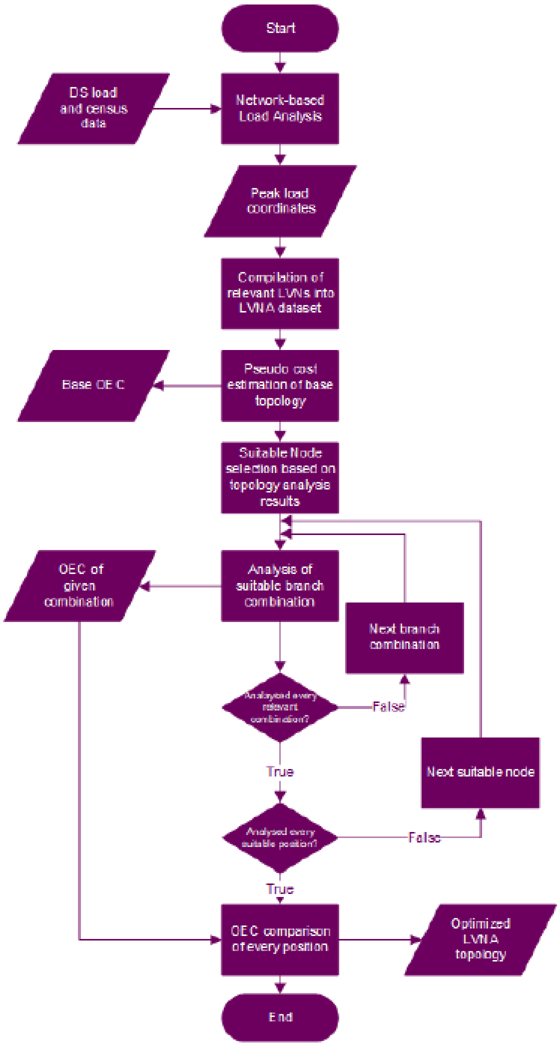

Fig. 15: Flowchart of the two stages method for optimal placement of substations proposed in Paper 0542

Primary substations represent a critical reinforcement of the electrical distribution network in terms of investment and construction time. Therefore, consistent planning activity can improve strategic scheduling for network development in the future. **Paper 0790** deals with a two levels methodology developed by EDF R&D together with Enedis. The high-level spatial analysis defines the influence zone of the primary substation; the low-level one examines the individual connection of specific grid users who can be served by different substations in order to plan an optimized network configuration.

BKW, a Swiss DSO, developed an application described in **Paper 0854**, accessible to all stakeholders, to facilitate stochastic network planning, addressing the challenges posed by the integration of renewable energy sources and the electrification of heat and transport. It includes scenario definition, consumption (including EV and HP) and renewable generation time series, stochastic network assessment. The tool facilitates informed decision-making and fosters collaboration among stakeholders.

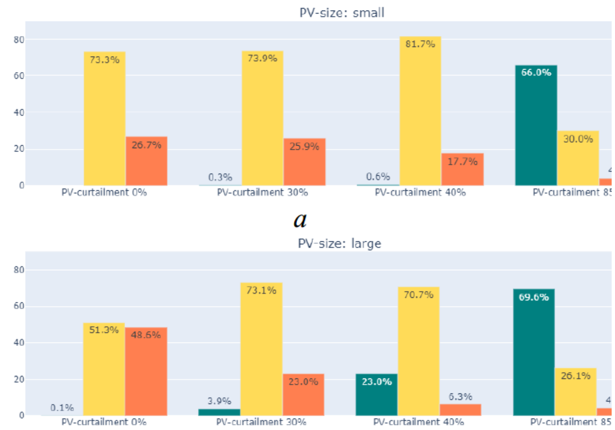

Fig. 16: Evaluation of required expansions for all LV-network and all scenarios as for Paper 0854: (a) for a PV distribution prioritizing small rooftops and (b) for a PV distribution prioritizing large rooftops

Paper 0887 presents a comprehensive approach to Graph Neural Networks (GNN)s that enables a robust uncertainty quantification of the n-1 contingency criterion that's crucial for DSOs in network reliability evaluation. This approach can support the decision-making in distribution system operations and has been validated on a real dense or sparse distribution Dutch networks.

The impact of five different planning horizons (PHs) on the grid planning of low-voltage (LV) networks is analyzed in **Paper 0916**. Detailed ramp-up scenarios for PV, HP and EV charging were developed for three Austrian Distribution Systems using regionalization techniques. The analysis reveals that a significant proportion of the grids require reinforcement due to the additional generation and load. These reinforcement measures vary depending on the chosen PH.

Paper 0949 explores the potential for optimizing investment in the connection of residential buildings by leveraging data from low voltage smart meters. The study revealed that the peak power demand for a residential collective building is significantly lower than the requested connection power submitted to the DSO at the time of the connection request. So, E-REDES developed a solution that allows customers to be connected to the LV distribution network with reduced initial investment in connection infrastructure. If needed, the infrastructure can be developed later by means of a MV connection optimizing CAPEX.

A methodology for determining the evolution of distribution networks based on correlations with publicly available data is presented in **Paper 1007**. The approach has been developed initially on French territory, for which detailed information on distribution infrastructure are available. Then, the identified correlations have been applied to the Italian system where such type of information are not public. The methodology offers notable advantages, providing geographically detailed results (1 km²) and enabling rapid scenario-based assessments without complex models.

The authors of **Paper 1019** propose a single stage process on the basis of a modified genetic algorithm (GA) avoiding complex processes or pre-planning to develop LV networks managing the uncertainty in future grid utilization. The results display an emphasis on early step expansion, whilst still curative measures are scheduled for later steps. The proposed utilization of a modified GA with a multi-Gene Sequence can provide support in grid extension planning.

The process for building geospatial MV power system models of a UK is shown in **Paper 1051**. Initially a Proof of Concept (PoC) model was created to demonstrate how data from a Geographic Information System (GIS) could be used to create accurate power system models.

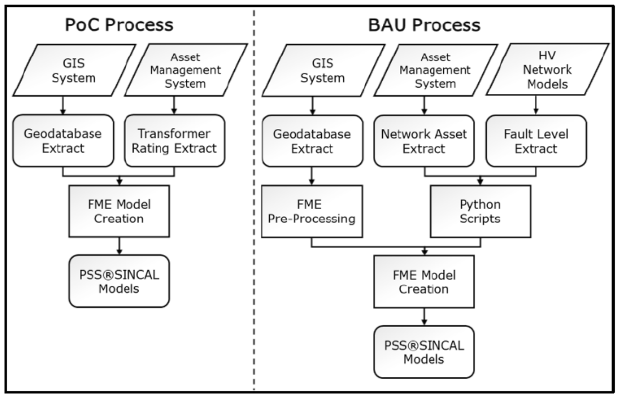

Fig. 17: Simplified Model Creation Process proposed in Paper 1051

In a second stage the process has been automated to create over 1,000 MV networks models, enabling power system analysis to be undertaken regularly by over 50 network planning engineers. The automated model process is being used to manage assets and plan improvements to networks that are changing dynamically over time.

Paper 1160 investigates if coupling a distribution grid with a district heating network could mitigate reinforcement needs while lowering district heating's carbon footprint. This presented Proof of Concept shows that taking District Heating (DH) can contribute to mitigating the distribution grid reinforcement needs and facilitates the usage of renewable generation. At the same time, it allows DH to lower its own ecological impact, by reducing gas consumption.

A quasi-dynamic approach, modelling the grid using historical data and renewable generation patterns at hourly intervals, is proposed by **Paper 1195** in order to deliver a clearer picture of the grid's utilization resulting in a more accurate and resource-efficient planning.

This approach is compared to the worst-case scenario currently adopted by ESB. The authors demonstrate that it can facilitate the connection of more renewable projects by challenging conservative assumptions, lowering connection costs, and enhancing the utilization of existing network infrastructure.

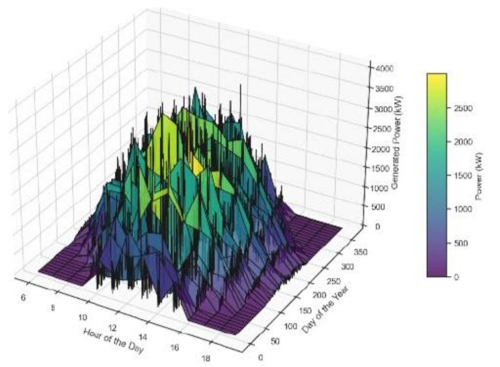

Fig. 18: Hourly PV forecasted generation pattern used in Paper 0854

Paper 1288 illustrates the ENOWA ambitious green field project of a fully integrated energy system to supply the sustainable Saudi Arabian NEOM region using 100% renewable energy, with very high reliability and resiliency, supported by smart grid technology, battery storage, demand response, making use of the existing distribution grid when required. The network is designed with careful consideration of local conditions, including varying load densities, challenging terrain and extreme weather conditions.

Sub block 2: Smart Grids and Microgrid Planning with Flexibility

Sub block 2 illustrates how distribution operators are moving from traditional "build-more-copper" approaches toward flexibility-oriented smart-grid planning. The contributions span advanced algorithms that combine local grid controls, demand-side measures and adaptive curtailment to postpone reinforcement, alongside decision tools that guide the placement of battery storage and community-scale resources. Authors highlight the growing role of data-driven forecasting, behaviour-aware EV-charging models and GIS-based scenario pipelines for allocating flexible assets under uncertain renewable growth. Case studies also show how partitioning networks into island-ready microgrids strengthens resilience, confirming flexibility as a cornerstone of efficient, low-carbon distribution planning.

Paper 0015 proposes a heuristic MV/LV planning algorithm that compares classical reinforcement with "flexibility-first" options: on-load tap-changers, reactive-power-capable PV inverters and demand-side load-shifting. Tested on a real Egyptian feeder, the method meets voltage and thermal limits while cutting reinforcement CAPEX by 35.2 %. Results confirm that exploiting operational flexibility can be a cost-effective substitute for traditional grid upgrades under high-RES scenarios.

The authors of **Paper 0058** propose a multi-criteria model for siting BESS in MV networks, balancing technical metrics (losses, congestion relief, renewable hosting) with revenue streams (arbitrage, ancillary services). Two Portuguese case studies show that the economically optimal node differs from the one that maximises renewable integration, highlighting the need for scenario-dependent placement. The framework delivers robust, operator-oriented siting decisions.

In Paper 0073 the authors present a UK Power Networks in-house machine-learning platform able to produce 30-min probabilistic forecasts refreshed every 30 min for 7 days ahead. Three live applications—dynamic outage management, curtailment forecasting and day-ahead flexibility scheduling—avoided 23 GWh of generation curtailment and 4.682 t CO_2 in 12 weeks. The study demonstrates how asset-level short-term forecasting underpins smart-grid operation and unlocks flexible market participation.

Paper 0105, through time-series Monte-Carlo simulations on the IEEE European LV test feeder, shows that uncoordinated, price-driven dispatch of behind-the-meter batteries for system-wide energy-flexibility quickly breaches the +10 % voltage threshold. Reserving part of the fleet for local voltage support raises the admissible storage penetration and defers feeder reinforcement, proving that hybrid global/local control maximises flexibility while respecting LV constraints.

Results of thousands of Monte-Carlo simulations on Belgian LV feeders in Paper 0121 are presented to quantify how a single three-phase 45 kWh/15 kVA battery at the feeder end regulates over-voltage from high PV penetration. Phase-balancing with minimal energy throughput (<1.5 kWh) resolves 99 % of cases; reactive-power-only control also succeeds but demands higher kVA. The work offers practical sizing guidance for DSO-owned community storage.

Paper 0166 investigates a two-stage "ML-Guided Optimisation" embeds a neural-network surrogate of distribution-connected storage bidding into a quadratically-constrained AC-OPF for NYISO. Training data from thousands of mixed-integer scheduling runs capture complex DER behaviour; the embedded linearised model halves day-ahead market-clearing time while preserving optimality. The framework scales TSO-DSO co-optimisation with high DER penetration.

The residential optimisation model in **Paper 0236** quantifies EV flexibility while explicitly modelling driver's behaviour, SOC preferences, workplace charging and manufacturer limits. Belgian smart-meter profiles show that behavioural constraints can cut theoretical EV flexibility by up to 40 %, leading DSOs to misjudge available demand response if user heterogeneity is ignored. The authors advocate behaviour-aware flexibility assessments for planning.

Using GAN-generated wind-solar scenarios and CVaR risk metrics, the study presented in **Paper 0324** frames flexibility allocation in a distribution network as a distributionally-robust optimisation. Coordinated demand response and storage placement on the IEEE-33 bus reduce worst-case operating cost and enhance flexibility margins under extreme renewable fluctuations. The method captures spatio-temporal correlations without heavy data dependence.

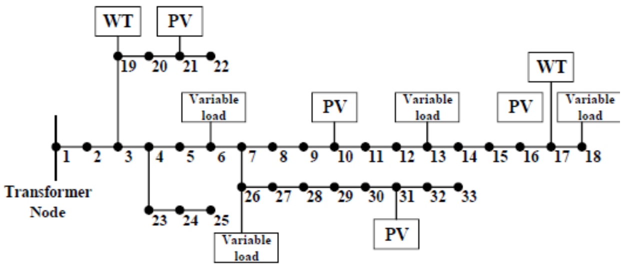

Fig. 19: IEEE 33-node system used in Paper 0324 study

In **Paper 0388** the authors compare traditional reinforcement with a flexibility-integrated plan using batteries, P2G, G2P and curtailment for two Dutch regions (high demand vs. high DER). Simulation plus expert design show that flexibility options achieve supply-demand security with lower net-present cost and reduced spatial footprint, underscoring the value of embedding flexibility in long-term DSO CAPEX planning.

Paper 0525 presents two screening tools fed with hourly data from 611 Finnish MV points (2017-2024): linear regression to detect price-responsive demand and a statistical power-comparison model to gauge shiftable megawatts. Combined analysis flags customers whose consumption inversely tracks day-ahead prices and quantifies the tariff impact on response profitability, enabling DSOs to anticipate price-induced peaks and target flexibility programmes.

Two control algorithms for 5 multi-boiler arrays at Oslo Airport shift electric-heater demand from peak hours ("Maximum Load Shifting") or shave peaks ("Peak Avoidance") are presented in **Paper 0995**. Simulations on 12 months of measured data move 61 % of consumption—182 MWh—to valleys or cut 88 kW from peaks, saving €5.7 k and €3.7 k yr^{-1} respectively, proving water-heaters are a cost-effective commercial flexibility asset.

Urban, suburban and rural 10 kV feeders in Bosnia-Herzegovina (hosting capacities 4.6 MW, 3.1 MW, 2.0 MW) are modelled in DIgSILENT and presented in **Paper 0630**. Optimised charging of behind-the-meter BESS with curtailed PV energy (GAMS simulation, July profile) recovers significant curtailed-energy and raises feeder hosting limits, with greatest benefit on urban and suburban circuits, demonstrating PV-curtailment + BESS as a pragmatic route to higher RES penetration before reinforcement.

Paper 0637 describes a coordinated electricity-heat-gas optimisation links CHP, heat-pumps, boilers and electric storage to real-time voltage constraints in a Finnish distribution network. The mixed-integer model minimises cost while maintaining voltage within statutory limits, reducing deviations, losses and total operating cost versus electricity-only dispatch, and showcasing MES flexibility as an effective tool for high-RES voltage management.

Suburban, urban and rural Austrian community models (20–120 prosumers) feed the MILP optimal-sizing routine for shared BESS presented in **Paper 0751**. Grid-aware control of the economically sized battery (vs household units) eliminates transformer overloads and improves voltage KPIs, proving that community-storage with coordinated control provides superior grid support and cost efficiency compared with uncoordinated household batteries.

Paper 0899 presents the findings of grid planning studies for 50 HV/MV substations (256 k buildings) ETH Zürich, using models 15-min time-series for PV, EVs, heat-pumps and demand, assessing classical reinforcement versus flexibility levers - PV curtailment, reactive-power support, smart transformer taps. Results show that targeted flexibility markedly defers cable/transformer upgrades, varying by urban/semi-rural/rural topology, guiding Swiss DSOs towards cost-optimal, flexibility-rich investment portfolios.

The Slovenian framework described in **Paper 0700** combines high-resolution (15 min) demand/RES forecasts, bottom-up LV modelling (CIM grid-model manager) and quantified flexibility availability to balance traditional reinforcement with demand-side or generation curtailment. A hybrid-scenario case study shows how DSOs can embed flexibility in 10-year plans, minimising

TOTEX while ensuring security-of-supply and data-driven regulatory justification.

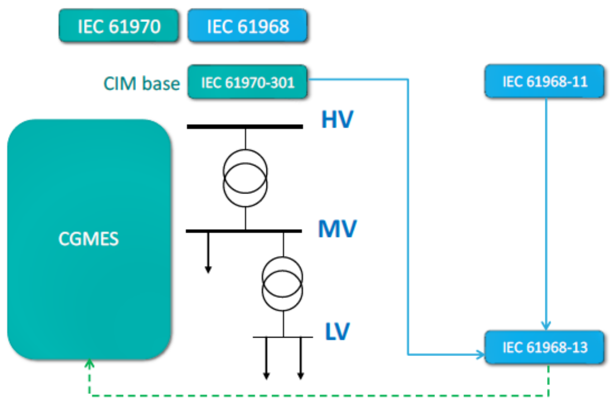

Fig. 20: CIM standards for the grid modelling used in Paper 0700

The authors of **Paper 0869** present a Simulation of the "Aardehuizen" community, to evaluate its $LiFePO_4$ storage needs under scenarios of controlling e-boilers, heat-pumps, EVs and white-goods. Flexible-load control alone raises autarky and trims peaks; adding storage plus full load control lowers required capacity from 10 to 4 × 4.3 kWh modules, cuts CO_2 and delivers the only positive annual profit, informing practical ESS investment decisions.

Paper 0930 strives to develop an optimal sizing method for DSOs. Hour-step simulations on the CIGRE MV feeder over 30 years test three conductor sizes and renewable-growth scenarios. Introducing controlled curtailment (CVA) alongside line reinforcement identifies a CVA threshold beyond which further curtailment is uneconomic. Integrating temporal detail with flexibility postpones or downsizes reinforcements, lowering total life-cycle cost while maintaining voltage and current limits.

A mosaik-based platform that couples SIMONA (agent-based grid simulator) with a central OPF is described in **Paper 1103**. Local EMS aggregate PV, batteries and loads; the OPF assigns set-points that minimise deviation from prosumer preferences while enforcing grid constraints. On a modified Simbench feeder, the coordinated scheme cuts transformer peaks 22 % versus uncoordinated control, with no PV-energy loss.

Paper 0945 describes how E-REDES extends its probabilistic load-growth planning by treating market-based flexibility contracts as risk-mitigation rather than investment deferral. Using quarter-hour simulations, planners define flexibility requirements that guarantee load supply for percentiles below the 100 % peak—allowing selective acceptance of congestion risk and better prioritisation of scarce CAPEX while complying with concession obligations.

In **Paper 0937**, GB-wide techno-economic modelling couples enhanced curtailment forecasts (12 seasonal profiles, V2G, storage) with power-market simulations. In the "best-view" scenario, relieving distribution constraints to cut renewable curtailment yields £2.5 bn whole-system benefit by 2034 through lower wholesale prices, emission costs and ancillary-service spending, evidencing the macro-economic case for strategic capacity upgrades.

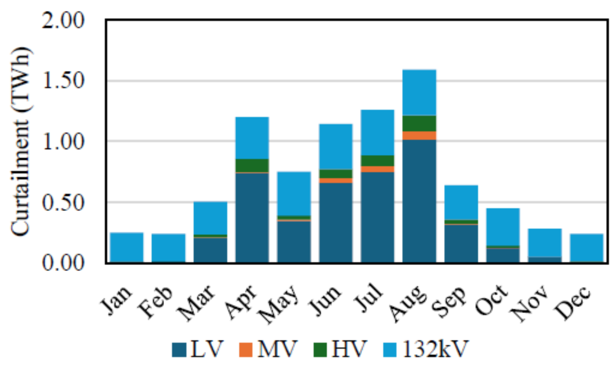

Fig. 21: Curtailment volume forecasted in Paper 0937, shown by voltage level

Paper 1109 describes three Portuguese case studies where probabilistic wind forecasts and historical data are used to schedule grid-asset outages with minimal renewable curtailment. Dynamic generation transfers between substations kept voltages and n-1 transformer reserves within limits, avoiding load shedding and preserving up to 13 MW of distributed generation during week-long outages.

Paper 1165 proposes a GA-based optimisation that clusters feeders of the IEEE-69-bus system into islandable microgrids by minimising Expected Energy Not Supplied. The optimal four-microgrid layout cuts EENS from 35 MWh yr^{-1} to 2.8 MWh yr^{-1} when only critical loads are considered and remains robust under ±50 % load/DG variations.

Paper 1193 develops a two-phase (success-potential + feasibility) reference process combining systems-engineering, requirements-engineering and the St-Gallen business-model navigator. The checklist-driven framework accelerates pre-planning, reduces errors and supports stacked-service valuation, providing investors with a replicable path to deploy BESS as diesel-genset replacements on contaminated industrial sites.

Authors of **Paper 1098** present a two-stage SOCP scheme that first sets time-block power limits for existing customers, then allocates firm/non-firm capacity to waiting-list applicants. Tested on the IEEE 33-bus feeder, the method connects all new loads without thermal or voltage violations while honouring priority rules, demonstrating TBB-NFCCs as a fast alternative to reinforcement in congested Dutch grids.

A linear-programming day-ahead tool jointly optimises DER curtailment/demand response and soft-open-point (SOP) power exchange across adjacent MV feeders. **Paper 1245** describes how on an Italian rural network with high PV, introducing one SOP halved the required upward-flexibility procurement and eliminated over-voltage in N-1 states, proving SOPs cost-effective for DSO flexibility markets.

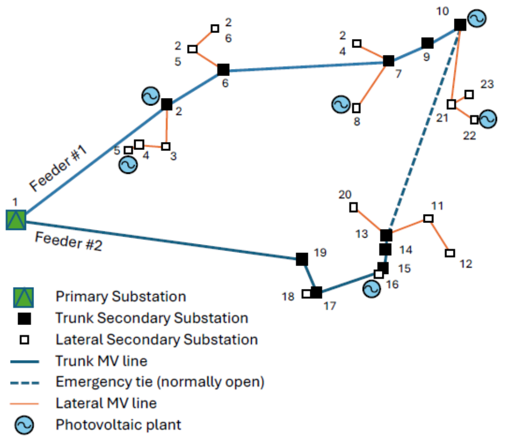

Fig. 22: Test case network used in Paper 1245

Paper 1266 introduces a GIS-driven pipeline that builds synthetic LV models around every MV/LV substation, down-scales national DER/EV scenarios, and runs unbalanced load-flows to screen networks for flexibility provision. Case studies show the method identifies feeders where LV flexibility can safely support MV needs, avoiding hidden competitions between DSOs and the TSO.

Time-series simulations (15-min steps) on the IEEE European LV feeder compare no-curtailment, full and partial dynamic curtailment. **Paper 1271** shows how partial curtailment maintains voltages 0.9-1.1 pu and limits power losses, enabling ~60 % PV penetration before losses and curtailment escalate sharply. Results advocate adaptive envelopes over static limits to balance utilisation and stability.

Sub block 3: EV Accommodation Planning

Sub block 3 deals with the specific planning problem related to the integration in the distribution grid of the public and/or private infrastructures needed to ensure charging of electric vehicles, for both individual and collective transportation purposes. The evolution of electric mobility can easily be appreciated by noticing that heavy-duty vehicles, such as trucks, and high-power charging, are being considered as part of the framework while developing dedicated planning methodologies and tools.

Paper 1025 presents an in-depth analysis of EV recharging patterns collected from more than 2000 Charging Stations (CS) in Italy in 2022, comprising both slow AC and fast DC charging points operating in different urban and rural environments. Smart meter readings are used to analyze recharging data, finding notable expressions for typical AC and DC recharging patterns which can be useful to grid operators and CPOs for monitoring and forecasting activities as well as a surveillance tool for automatic fault and fraud detection. Meaningful parameters to characterize Charging Stations (average daily energy and power, EUF, stand-by time, …) are proposed, noting that, for infrastructures with low utilization rates, it is important to normalize certain quantities with respect to the actual time of operation, discarding the time spent in stand-by. Significant evidence provided is that most CS regularly experience days without any recharging activity.

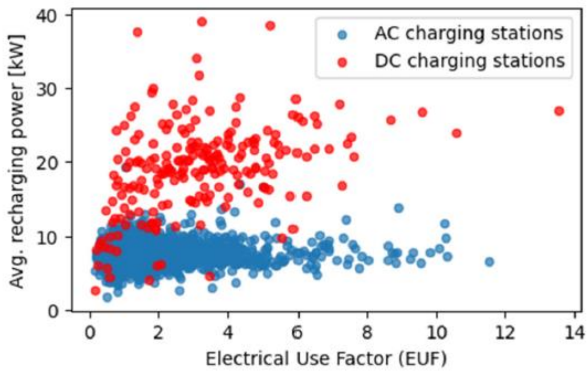

Fig. 23: Average recharging power (excluding stand-by) VS Electrical Use Factor according to Paper 1025

Paper 1211 reviews electric vehicle (EV) profiling at the distribution substation level in the UK, focusing on eight EV charging trials and projects conducted between 2010 and 2022. It examines current profiling methods and highlights key challenges and opportunities in mapping EV charging demand across distribution substations, including the risk of data drift, the need to consider the interaction between multiple sociodemographic and locational factors, poor visibility of EV adoption, and the inherent uncertainty in the system. The findings emphasize the need for improved data collection and the development of predictive profiling techniques to support seamless EV integration and inform future network planning.

Paper 0056 analyzes the possible evolution of charging loads based on the hypothesis that end-users preferences shift from domestic to public recharge. The paper adopts an improvement to a previously developed bottom-up approach for the modelling of the charging demand of electric passenger cars, examining the effects of the hypothesis on the aggregated charging load in Baden-Wuerttemberg. Results show that there is a visible shift of the total charging load during the day, which may lead to a better integration of renewable energies and a reduced evening load peak.

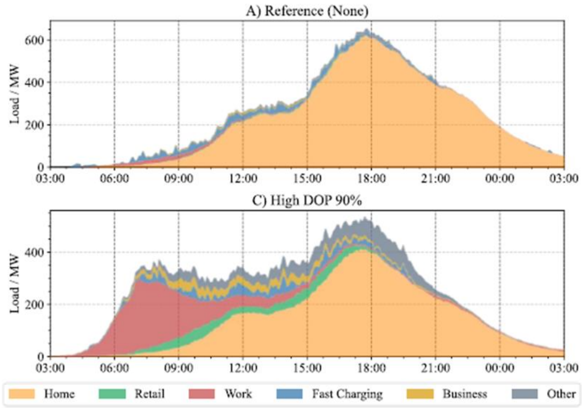

Fig. 24: Charging load profile by location type in Baden-Wuerttenberg.at 7% penetration DOP of electric passenger cars as for Paper 0056

Paper 0964 describes the impact of the integration of collective residential EV charging into the distribution network according to a multi-step approach developed by Enedis to simulate the progressive arrival of EVs in residential parking lots and the ramping-up of their load. Calculations have been run on a 30-year timeframe, for the totality of Enedis' LV network, incorporating highly localized characteristics, down to the building level, finally showing that the resulting adaptation needs are neither a challenge for Enedis nor sizeable compared to the costs of on-site construction and installation of charging infrastructures in parking lots. However, as the real adaptation works will be caused by a whole accumulation of effects on the network (EV charging, heat pumps, natural evolution of existing loads, energy efficiency…), a more comprehensive impact assessment is needed to describe the full picture.

Paper 0760 describes a specific application of the citiwatts, a platform developed under the OpenGIS4ET ERANET project. citiwatts contains an open-source toolbox, designed to support energy planning during the energy transition, offering tools for flexible, data-driven analyses, enabling modelling of complex energy scenarios, such as heating and cooling density, or EV and PV coupling, and facilitating assessments like EV charging strategies coordinated with local PV generation. A case study in Sion, Switzerland, is described, comparing the outcomes deriving by two different scenarios (namely, “Comfort” and “Flexible”), thus demonstrating citiwatts capabilities in comparing current EV infrastructure with future requirements for 2050.

The same citiwatts platform is used in **Paper 0884** to investigate the potential of storing photovoltaic (PV) electricity in Electric Vehicle (EV) batteries and reinjecting the stored electricity into the grid (V2G) during high electricity demand periods. A geographical methodology to quantify the mobility and EV charging needs across Europe is first presented. Scenarios of charging behaviour are then used to distribute the charging needs among locations corresponding to residential areas, workplaces, or points of interest. Resulting load curves and maps of the charging demand are then compared to a potential PV contribution, conducted hourly over one year, monitoring the evolution of the daily storage capacity of the EV fleet. Three case studies are presented, based on three cities in Switzerland: Sion, Neuchâtel, and Zürich. Three scenarios are used to compare home charging behaviour, balanced home and work charging behaviour, and charging at points of interest. Results highlight the impact of charging behaviour on the flexibility potential, with higher potential when charging at work and point of interest is privileged.

Paper 0851 introduces a probabilistic planning approach that incorporates various stochastic uncertainties such as charger location, arrival times, and energy demands to enhance grid management. By simulating realistic EV charging profiles and their impacts on the grid, this methodology facilitates more accurate predictions of potential grid violations and allows grid operators to explore flexible grid integration strategies and make informed decisions about infrastructure investments and EV demand response requirements. Results include a quantitative example from the perspective of a utility to select the optimal EV charger integration strategy. Future developments are foreseen, focusing on integrating real-time data and machine learning techniques to refine predictive accuracy and operational responsiveness.

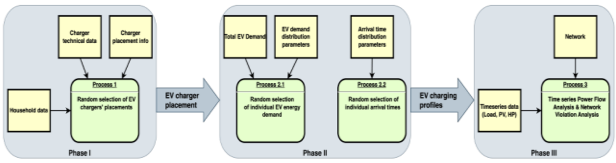

Fig. 25: Methodology with three phases (EV charger placement, demand forecast and grid load analysis) described in Paper 0851

Paper 0631 proposes a framework for Electric Vehicles Charging Stations (EVCS) placement in distribution systems considering the system impact of charging demand. To evaluate the system impact accurately, the charging demand is modeled to reflect the charging pattern according to area type and time-series characteristics. Finally, the placement of EVCS is determined based on the impact assessment. Future developments include heuristic methods (e.g., GA and PSO) to reduce the computation burden and time. Furthermore, a framework for the optimal sizing of EVCS will be included.

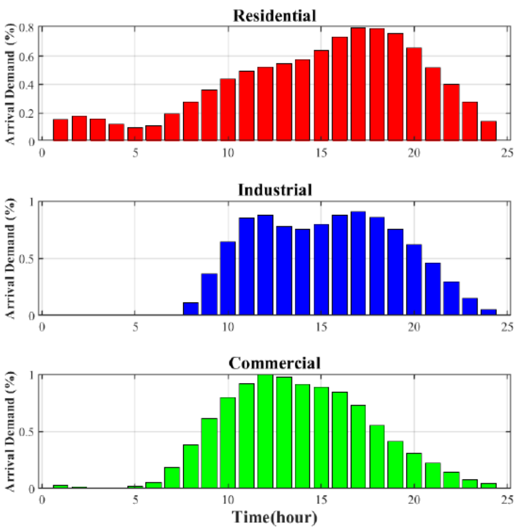

Fig. 26: Arrival demand by regional type and time due to EVs, according to Paper 0631

Paper 0085 presents a method for determining the power demand for charging infrastructure on motorways in Europe, with specific reference to high power charging for electric heavy goods vehicles (HGV). The charging demand itself is derived by a co-simulation approach that combines the simulation of HGV traffic and the simulation of the energy system. The paper focuses on the part of determining the power demand of HGV. A case study shows the approach can estimate the power demand of HGVs charging stations. Future developments are foreseen for integrating this approach into an energy system simulation framework, to generate different charging scenarios on a real grid with current and future traffic data.

Paper 0826 presents a comprehensive methodology for modeling and analyzing the energy demand of electric truck fleets in the urban general cargo sector, utilizing real-world delivery data. The approach is organized into four steps and enables the identification of routes suitable for electrification based on factors such as battery capacity and dwell time limitations. For routes that remain viable for electrification, the charging process's flexibility is analyzed at each site. For most charging scenarios, significant time flexibility exists, especially if the charging process is shifted to night-time. This approach reduces the electrical load without disrupting logistical operations. The model forms a base for further investigations regarding the potential analysis of the charging flexibility of electric truck fleets in terms of power grid operations.

Paper 0646 also deals with HGVs, assessing the impact of installing HGV chargers at depot sites across Scotland. Using spatial mapping, the study associates existing depot sites with their primary substations and applies a probabilistic methodology to distribute chargers across depots based on fleet size under different future scenarios. The impact of this new demand on substation loading is then evaluated. Results show that significant upgrades to network infrastructure will be necessary to support the high-power demands of HGVs, particularly at substations near major depots. The study also emphasizes the importance of coordinated planning among fleet operators, policymakers and distribution network operators to address these challenges.

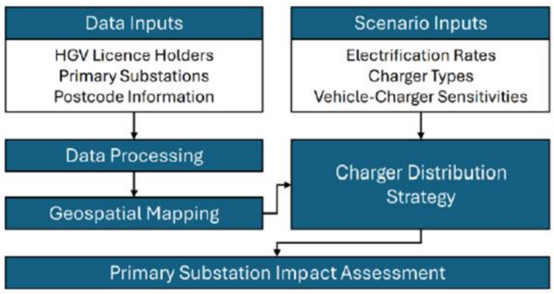

Fig. 27: Summary of the assessment methodology developed in Paper 0646

Paper 0862 examines the current state and future development of the distribution network in the city of Omiš, focusing on two scenarios: one excluding EV charging stations and another incorporating them. The analysis forecasts that, by 2035, the peak load could increase significantly if EV charging infrastructure is included, necessitating substantial investments in grid capacity. As an alternative solution, the integration of Zero-Emission Hydrogen Power Generator (GEH2) technology into EV charging stations is examined. This technology could enable on-site electricity production using hydrogen fuel cells, mitigating grid strain, providing mobility for seasonal energy demands, and supporting the transition to renewable energy sources. Advantages and disadvantages of this technology when applied to EV charging stations, including initial investment costs, are then detailed.

Paper 0397 deals with optimal Vehicle-To-Grid (V2G) scheduling for Electric Vehicles. To achieve that, the authors have developed a 2-Stage EV Uncertainty Deep Reinforcement Learning model (2-Stage UDRL). In the first stage, a prediction model is employed to estimate the EV's departure time and travel distance for the next steps.

In the second stage, the optimal target SOC for each vehicle is calculated by considering charging/discharging costs, battery degradation costs, and user satisfaction.

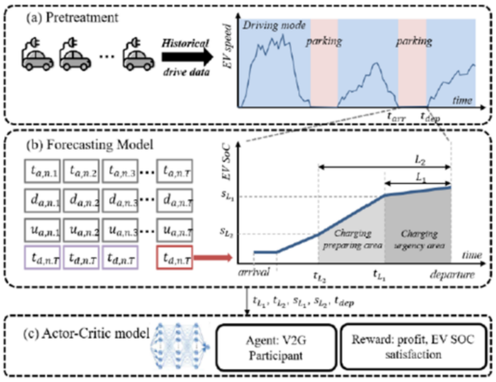

Fig. 28: 2-stage uncertainty reinforcement learning model framework as in Paper 0397

The model was tested in an environment based on real-world data with 200 EVs exhibiting different characteristics: the proposed model achieved the highest overall benefits, the highest user satisfaction, and a reduction in battery degradation costs in long-term evaluations. In future research, the existing actor-critic model will be extended by incorporating various techniques and comparing it with other studies.

Potential scope of discussion

Flexibility is becoming an ordinary tool on which network planners rely while analysing the development of the distribution infrastructure. However, practical applications of flexibility, either in sandbox environment or in real operation, are relatively scarce compared to the ongoing simulation work. Are we already using our theoretical deep-dives to deliver all the available benefits of flexibility to the network users, or are we still in a preliminary phase in which supposedly mature reflections cannot provide substantial modifications in real life?

Table 3: Papers of Block 3 assigned to the Session

Paper No. Title	MS a.m.	MS p.m.	RIF	PS
0015: Effect of Operational Flexibilities on Economic Expansion Planning of Distribution Networks				X
0056: Impact of Shifting Electric Vehicle Charging Behavior from Private to Public Infrastructure on Aggregated Substation Load Profiles				X
0058: Battery Energy Storage Systems (BESS) Optimal Location Site Framework Application				X
0073: Short-term forecasting use cases: UK Power Networks innovations under a new Distribution System Operator model				X
0080: Decision-making support in the presence of uncertainty in Advanced Distribution Management Systems: A wisdom hierarchy-based perspective				X
0085: Evaluation for necessary power demand for electric truck charging on motorways				X
0092: Automated grid expansion and decommissioning planning of low-voltage and low-pressure grids for sector-coupled scenarios in an existing German district				X
0105: Investigating the LV Network Capacity for Flexible ES, Considering Energy Flexibility Provision and the Role of Local Flexibility				X
0110: A three-dimensional risk matrix to support investment strategies for network planning by analyzing the impact from congestion on the remaining lifetime of assets				X
0121: Improving LV networks hosting capacity via the use of batteries – A Monte-Carlo analysis				X
0154: pyorps: An open-source tool for automated power line routing				X

0157: Automated Greenfield-Planning of integrated Low-Voltage Distribution Network Structures				X
0166: Enhancing TSO-DSO Coordination: A Machine Learning Approach for Efficient Operations Planning				X
0184: Perspectives and planning of the Lausanne low voltage grid via probabilistic load flow analysis	10			X
0236: End Users Flexibility Potential Estimation Under Differing Prosumers' Characteristics and Constraints				X
0324: Robust Optimization Of Distribution Flexibility Distribution In Distribution Networks Considering Multiple Uncertainties			X	X
0388: Redefining grid investment planning: leveraging flexibility for cost-effective integrated distribution networks	8			X
0394: Rural Electrification (RE) in Sarawak: Towards Achieving Full State-Wide Electricity Coverage and Post Full Coverage Initiatives				X
0397: Optimal V2G Scheduling Method for Individual EV Considering Departure Uncertainty and User Behavior Using Reinforcement Learning				X
0525: Smart metering data-based tools to identify flexible medium voltage customers in a distribution network		19		X
0534: Using smart meters data to optimize vertical Collective Connection Infrastructure (CCI) sizing				X
0542: Two-stage method for optimal placement and integration of distribution substations in low voltage networks				X
0630: Enhancement of Grid Capacity with Photovoltaic Peak Curtailment and Battery Usage: A Case Study in Bosnia and Herzegovina				X
0631: Electric Vehicle Charging Station Placement Framework: Scenario Generation, Impact Assessment, and Placement				X
0637: Optimal Utilization of Multi-Energy Systems in Future Distribution Networks				X
0646: Siting eHGV Charging Infrastructure in Scotland: Balancing Demand Requirements with Grid Capacity				X
0700: Long-term Distribution Grid Planning Framework leveraging Flexibility and DSO Digitalisation	9			X
0751: Can community scale energy storage save distribution grids?				X
0760: Secure Data-Driven Solutions for Energy Planning				X
0790: Primary Substation Planning Based On Spatial Analysis				X
0826: Modeling Energy Demand and Load Profiles of Electric Truck Fleets in Urban Transport: A Case Study from Stuttgart		18		X
0851: Probabilistic Assessment of EV Charging Impacts on Distribution Grid Planning				X
0854: Enhancing Stochastic Network Planning for Future Energy Systems: The BKW ProgRés Explorer				X
0862: Planning the Distribution Network of the town Omis conditioned by the need to build Electric Vehicle Charging Stations and Analysis of a mobile electro-hydrogen Generator as an alternative Solution				X
0869: Energy Storage Sizing While Considering Flexible Loads in a Dutch energy community				X
0884: Potential for EV charging from PV: A geographic assessment				X
0887: GNN ensemble for robust assessment of medium-voltage energy grids			X	X
0899: Distribution grid planning with local flexibilities in Switzerland	12			X
0916: Influences of different planning horizons on strategic grid planning in low-voltage grids		13		X

0930: Long-term planning in distribution networks: methods of combining levers in reinforcement and flexibilities				X
0937: Whole System Thinking: Power Market Drivers For Releasing Benefit To The Whole System By Increasing Network Headroom		22		X
0945: E-REDES Probabilistic Characterization of the Distribution Network Planning to Foster Flexibility	11			X
0949: E-REDES Low voltage investment optimisation in the connection of residential buildings				X
0964: Planning the integration of electric mobility into the French distribution network: the specificity of EV charging in multi-unit residential buildings				X
0995: Energy system flexibility through scheduling hot water heaters – valley filling versus reducing peak power demand				X
1007: Estimate Network Expansion Needs Through Correlations With Territorial Characteristics				X
1019: Benefits and application limits of optimisation methods for grid expansion planning in distribution grids due to future uncertainties of grid utilisation				X
1025: In depth analysis of public EV recharging patterns and load demand from a real world dataset of more than 2000 public recharging stations in Italy				X
1051: Development of geospatial power system planning models				X
1098: An Optimization Framework for Time-Block Bound-Based Non-Firm Capacity Contracts for Congestion Management				X
1103: Co-simulation approach for optimizing flexibility usage in an agent-based discrete-event simulation environment				X
1109: Maximize renewable capacity during planned outages of grid assets – the E-REDES experience				X
1160: Integrated multi energy optimization for sector coupling decarbonation				X
1165: Reliability-Oriented Optimal Partitioning of Active Distribution Grids into Multi-Microgrid Systems				X
1193: Development of high-tech sites focuses on the security of supply of microgrids				X
1195: Enhancing Hosting Capacity for renewable generation projects: A Comparative Study of Quasi-Dynamic and Static Simulations in Planning Network Analyses				X
1211: Mapping Electric Vehicles Load at the Distribution Substation Level: Challenges and Opportunities				X
1245: Adoption of Soft Open Points for increasing the flexibility perimeter exploitation on power distribution networks		23		X
1266: Predicting flexibility from LV networks by using geospatial forecasting and synthetic networks		14		X
1271: Dynamic Flexibility Strategies for Enhancing PV Hosting Capacity in Low-Voltage Distribution Networks				X
1288: Greenfield Planning Supporting the Energy Transition – ENOWA's Case-Study in NEOM				X

Block 4: Methods and Tools

Sub block 1: Load/Generation Modeling and Forecasting

Sub Block 1 deals with modeling and forecasting of load, generation or both. While load forecasting has long been a traditional activity in which refinements were only expected from statistic enhancements and smart meter data usage, the emergence of new kinds of uses (Electric Vehicles, Heat Pumps to name a few) poses different challenges and invites potential re-consideration on the issue. On the other hand, generation forecast (particularly photovoltaic) is becoming a more established practice for DSOs, leading to more accurate and reliable results. In some cases, combined forecasts are attempted, and flexibility needs or potentials are explored.

The increasing electrification and DER adoption ask for more sophisticated capabilities to forecast loads with increasing granularity, precision and over longer time periods. **Paper 1249** presents the results of a survey on load forecasting practices - and associated gaps and needs – based on input from DSOs in North America and internationally. Firstly, the paper maps industry forecasting practices in terms of methodologies, tools, and data sources applied; how weather impacts are considered; and various spatial and temporal aspects. Gaps and needs associated with the current DSO forecasting practices are then discussed. Finally, the authors highlight select research efforts in the U.S. to address the gaps and needs with the focus on how to account for transportation and building electrification loads in DSO forecasting.

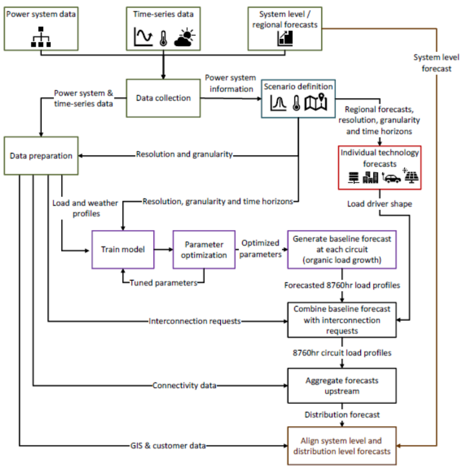

Fig. 29: General distribution planning forecasting framework as in Paper 1249

In **Paper 0090**, a methodology is presented that allows improved estimations of the peak load of distribution transformers, while remaining easy to implement. This methodology is already in use for both operations, evaluating transformers potentially overloaded or underloaded, and planning purposes, to assess whether connecting new customers would potentially overload existing transformers. Future work will include periodically re-running the supervised learning algorithm to update the coefficients based on new smart metering data.

Paper 0232 investigates the impact of exogenous variables on long-term load forecasting accuracy. To do so, fourteen exogenous variables were selected, and each one of them was uniformly perturbed in isolation by fixed variation ranges 100 times. In the case of active power, features related to the average household size, mean humidity, and GDP are found to be the most influential on the accuracy of the forecast. For the reactive power, maximum temperature, household size and GDP exhibited higher variability in forecast errors compared to the base case. These results indicate the significance of these features as the main factors that drive the accuracy of the long-term load forecasts, even though they do not affect it significantly.

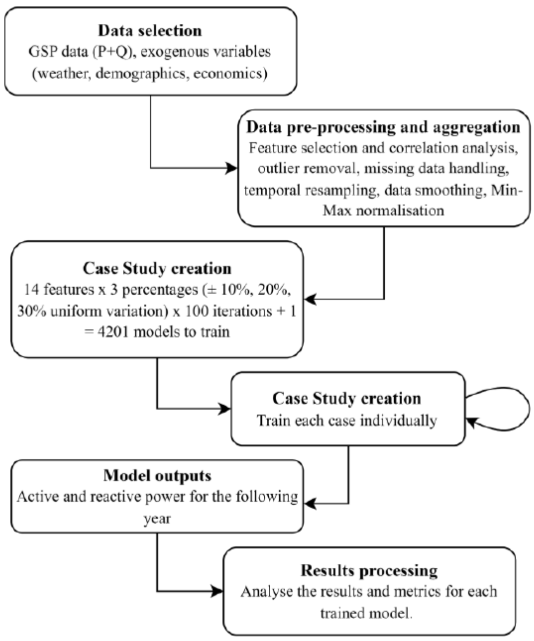

Fig. 30: Methodology to study the sensitivity of the prediction of active/reactive power to the exogenous variables according to Paper 0232

Paper 0095 presents a methodology to optimize the correlation between energy consumption and events related variables, using unstructured textual data extracted from social media through Non-Linear Programming techniques. The described methodology is meant not only to enhance forecasting accuracy by "neutralizing" the special days and stopping it to interfere with other variable estimation, but also to help monitoring the overall impact of some events on electricity consumption. Results show that certain events have significant impact on local energy consumption and incorporating these event variables in baseline model helps in reducing the prediction error up to 7%.

Paper 0174 presents three methods for the application of simultaneity factors and compares the resulting limit violations and expansion costs. In Method 1, one simultaneity factor for each feeder is calculated, Method 2 determines simultaneity factors for each individual line, and Method 3 identifies a specific number of loads operating at full nominal power, based on the simultaneity factors assigned to each feeder. Results show that for radial network Methods 2 and 3 result in higher limit violations and increased line expansion costs compared to Method 1. Furthermore, the discrepancies in limit violations and line expansion costs between Method 1 and Methods 2 and 3 increase with both the line length and the density of house connection points in the respective feeders. In meshed networks, the limit violations and line expansion costs associated with Method 3 are consistently higher than those resulting by the application of Method 1.

Paper 0288 benchmarks clustering-based and optimization-based methods to identify Representative Periods (RPs) for fast distribution network analysis. A framework is proposed to evaluate the performance of these methods using metrics that assess chronological alignment, energy approximation, and extreme load representation. The results show that clustering-based methods (namely, k-medoids approach with Euclidean Distance), perform best in terms of the RMSE metric, as it preserves the chronological aspects of the load profiles, while an optimization-based method (LDC-opt) excels in approximating maximum loads, which is critical for HC evaluation, as it leverages the load-duration curve. Adding extreme days to RPs enhances the performance of clustering methods, making k-medoids with extreme period selection a preferred approach for distribution network analysis.

In **Paper 0322**, a load forecasting method based on massive heterogeneous data fusion, which successfully copes with the complexity of power demand-side resources, is proposed, including an adjustable load data integration method to approach the data mismatch problem. The paper also provides a characteristic parameter identification model of multi-type user energy use behaviour and uses the CNN-LSTM algorithm to make accurate day-ahead forecasts of demand-side loads. The experimental results show that the proposed method has significant advantages in improving the accuracy of load forecasting, can adapt to more complex load forecasting tasks, and has strong application potential. Future developments are envisaged, such as further specific modelling for different types of load data, to improve the load forecasting accuracy.

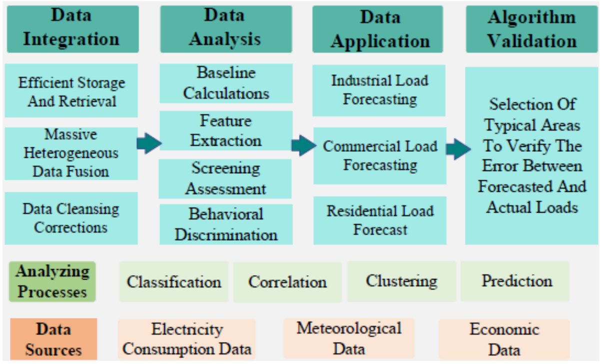

Fig. 31: Research framework diagram of Paper 0322

Paper 0549 investigates peak power demand in 8,800 apartments across 175 residential buildings in Pirkanmaa region, Finland, using hourly consumption data of seven years and the Monte Carlo method for sampling. The apartments were categorized by type, including variations with and without electric sauna heaters. The analysis found that while peak consumption varies significantly between individual apartments, grouping apartments together reduces variation in aggregate peak demand, particularly in the case of bigger groups. The study highlights the significant impact of saunas on both peak power demand and timing, with apartments containing saunas showing more predictable peak times. The findings provide valuable insights for accurately sizing electrical connections in multi-apartment buildings, particularly when considering varying apartment configurations.

The availability of direct measurements of power flows through assets such as distribution substations provides improved network visibility and a greater insight into LV network utilization, that are crucial to forecast future demands and support network investment decisions. **Paper 0603** describes refined approaches for using LV monitoring data in network planning, avoiding simplistic assumptions to reduce uncertainty risk in investment decisions. Data analytics techniques of LV monitoring data streams are presented that have proved successful. Learnings from the application of LV monitoring data analysis to the planning of network interventions are considered and opportunities for alternative solutions are explored.

In **Paper 0627**, a load forecasting method for EV Charging Stations based on deep learning techniques is proposed to improve the forecasting accuracy. Simulation results on a real-world dataset demonstrate that the proposed method achieves superior forecasting accuracy across various time horizons compared to baseline models. However, factors such as electricity prices and traffic flow have not been fully considered yet; in the future, these variables will be incorporated into the proposed model to further enhance the forecasting performance.

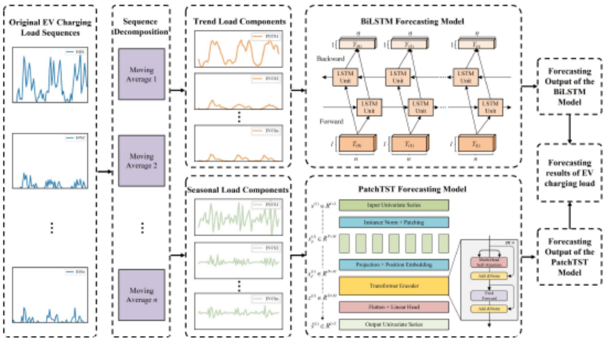

Fig. 32: Load forecasting method as proposed in Paper 0627

Paper 0286 deals with the forecast of a specific class of loads, namely those coming from EVs. The authors propose an individual residential EVs multi-charging algorithm based on the observed charging behaviour of 500 measured residential EVs located in the Hydro-Québec service region. Probability functions are derived from the analysis of these charging patterns. These can be used to model daily charging profiles of individual EV to assess, in a quasi-static time-series perspective, their impact either on a single customer or a whole network. The resulting profiles were integrated into Hydro-Quebec planning tool, performing activities in a distribution network including 3,500 MV/LV transformers, 16,000 customers, and 15 feeders.

Paper 0738 presents an application of structured state space models for probabilistic day-ahead power forecasting in the MV grid. The model incorporates historical power measurements, historical weather measurements and weather forecasts to generate a power forecast. The proposed approach was validated on real data covering 10 years of measurements from 312 substations across the Dutch distribution grid. Results show that the proposed approach can achieve better performance compared to traditional machine learning methods. Future work will focus on extending model capabilities by incorporating additional grid topology information and deploying these models in operational settings.

Paper 0769 presents a generic method to compute an LV load profile from raw data to reduce the number of load flow computations needed to size the distribution grid. The same tool can also build a deforming profile that can be added to the current profile to consider a new usage. The method is tested specifically on heat pump usage by studying actual LV load chronicles and chronicles including heat pumps to assess the relevance of those models. Further activities are expected regarding other new uses' deforming profiles (EV charging, energy demand management, …) and the possible correlations between deforming profiles that can affect their combination.

Paper 0794 focuses on the contribution of EVs, heat pumps, batteries, and PV to the size and timing of low-voltage feeder peaks. This is done by sampling from a large, recent smart meter dataset measured in 2023, containing many profiles with EV, HP, batteries, and PV. Each one of these devices' type implies different contributions to feeder peaks, according to their size, timing, and weather dependency. Results can be assumed to be valid within the context and the rules of the Flemish energy market: for example, feeder peaks at night have been observed in case of feeders with EVs, which is (partly) caused by a cheaper night tariff.

Load forecasting based on machine learning models, traditionally relying on historical data, may fail in representing disruptive changes in energy consumption patterns. As a significant non-linear growth in electrical energy consumption, mainly due to the increasing electrification of heating and transportation, can be expected, specific methodologies are needed. In **Paper 0922**, the authors propose a multilevel approach to energy consumption forecasting that is more suitable to represent the development of emerging technologies. The method follows a two-step process in which the overall consumption is split into different consumers; the emerging technologies are then predicted separately to the base load; finally, the different consumptions are combined to get the final result.

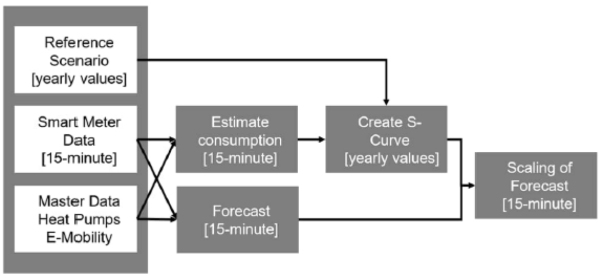

Fig. 33: Overview of the process to get a forecast with 15-minute resolution as exposed in Paper 0627

The transition from fossil-fuel based heat generation to electrical heat pumps implies a significant increase in electricity demand and grid power. **Paper 0935** describes the findings of a working group of the Smart Grid

Switzerland Association (VSGS), examining the influence of the increased penetration of heat pumps on the resulting grid load and evaluating the optimisation potential for reducing the necessary grid expansion. The study shows that the grid load across Switzerland may increase by around 60% as an average, and possibly more in some Regions. According to the working group experts, the potential for reducing the necessary grid expansion through control is limited.

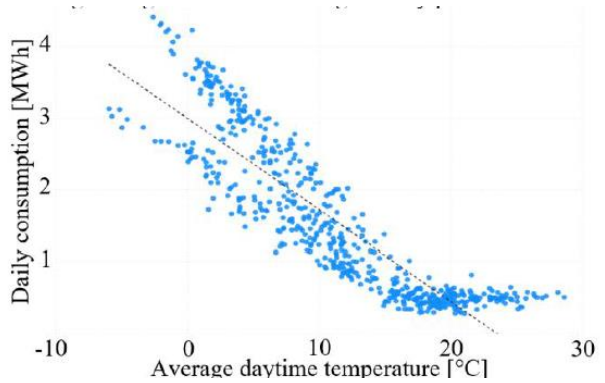

Fig. 34: Regression analysis of daily energy consumption as a function of outside temperature (Paper 0935)

Load forecasting in residential buildings is significantly impacted by the increase of electricity demand from heat pumps; understanding the power behaviour of retrofitted heat systems is critical to support the efficient operation of distribution networks. **Paper 0936** explores methods for identifying and analyzing retrofitted ground-source heat pump (GSHP) installations in apartment buildings using electricity consumption and outdoor temperature data. To address this, three analytical methods - hourly average maximum power analysis, temperature correlation analysis, and persistence curve analysis - were applied to data from seven buildings in Tampere, Finland. Results confirm GSHP activity through significant peak-power (hourly average maximum power) increases and stronger temperature dependency after installations. While the methods effectively identify heat pumps, challenges remain in predicting individual building power changes due to varying system designs, auxiliary heating sources, and other loads.

Short-term forecasting of peak load is crucial for ensuring grid stability and avoiding overloads. **Paper 0997** presents a short-term load forecasting approach based on a rolling 24-hour prediction framework, combining time series forecasting with hyper-local indicators and external factors, including weather conditions, social events, and industrial activity, to provide actionable insights for grid operators. The ability to predict extreme demand events, potentially compromising network reliability, supports grid operators in proactively managing resources such as fast EV chargers and to avoid overloads or service interruptions. The approach is being applied in the town of Vík í Mýrdal, Iceland, and could be extended to other regions, especially those with highly variable demand drivers. This project is part of a broader initiative leveraging Battery Energy Storage Systems and flexibility solutions to mitigate local grid constraints.

Load profiles in residential areas are becoming increasingly uncertain and hard to predict. At the same time, forecasts are more and more important to quantify and activate the flexibility potential of several types of loads, especially in long-term planning. **Paper 1092** proposes a tool to generate residential electric load profiles stochastically, including a baseload on which controllable appliances can be added, potentially providing flexibility. These load profiles are used to model neighborhoods or small villages, to represent the reaction of a complete low-voltage grid to different tariffs. This allows to evaluate the effects of the regulations for grid tariffs on the customers' energy bills, the grid congestion and the DSO revenues.

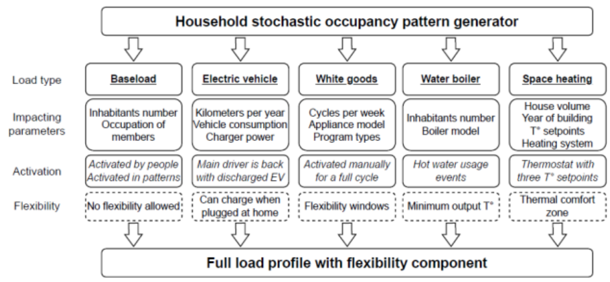

Fig. 35: Organization of the load profile generator developed in Paper 1092

Paper 0759 outlines a survey-based methodology to determine EV demand profiles to be included within forecasting residential demand. A survey was conducted to capture average daily driving distances, at-home durations, and other behavioural factors. The response from 180 participants was analyzed to develop weekday and weekend demand profiles for summer and winter by employing robust data cleansing, state-of-charge (SoC) calculations, realistic battery specifications, and ambient temperature effect on EV energy consumption. Results show high evening peaks and low early-morning demand with seasonal influences on overall demand probabilities.

Paper 1252 introduces a detailed residential end-use modelling framework that allows for the disaggregated characterization of residential end-use loads and their interactions with environmental factors and stochastic customer behaviours. Selected use cases for the modelling framework are introduced to illustrate how the framework can help inform distribution planning and design decisions, including scenarios related to various climate conditions and adoption levels of electric vehicles (EVs), heat pumps, and other electric end-use equipment. Electrification impacts on residential diversified peak demands, annual, seasonal and daily load shapes, as well as the demand diversity at different levels of the distribution system are also discussed. Developments are expected to refine the modelling framework, validate against DSO measurement data, and apply it to distribution planning and design decisions.

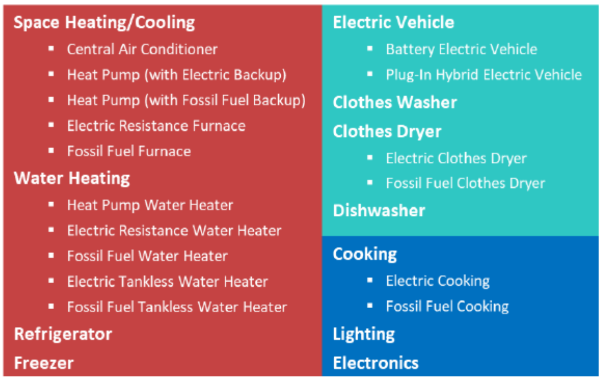

Fig. 36: Thermostatically controlled (red), deferable (green), and uninterruptible (blue) end-uses, clustered according to Paper 1252

Paper 0089 describes the process of gathering and assessing the data to determine an appropriate diversity factor to be applied to solar PV installations, resulting in lower average output and decreased loading on the transformers. The analysis is based on hourly records of solar radiation and PV output spanning a multi-year period from 2005 to 2020 for 18 different locations in Ireland. As the most appropriate for Ireland, the diversity factor has been determined as the mean PV output after grouping max values. The proposed factor (0,78) is meant to be used for network planning and its adoption, when considering that most nodes and stations are designed to operate in N-1 scenarios, can ensure a more efficient utilization of assets.

Paper 0871 investigates the impact of photovoltaic (PV) systems on electricity consumption and grid dynamics in Norwegian households. Using hourly smart meter data from 81 households, the study compares two years before and after PV system installation to quantify changes in load profiles, feed-in electricity, coincidence factors, and aggregated peak power. The results reveal seasonal and daily variations in feed-in and grid load, with higher feed-in during summer months. The study also highlights challenges posed by the coincidence of feed-in across households, potentially leading to higher aggregated feed-in peaks than grid load peaks. Strategies such as self-consumption optimization can help mitigate grid challenges as the number of prosumers increases. In addition, energy curtailment, either static or dynamic, could reduce the feed-in peak by reducing the yearly feed-in for prosumers to a few percentage points.

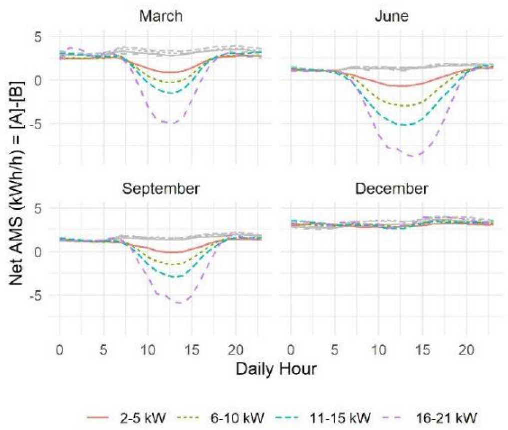

Fig. 37: Average daily energy profiles before PV system installation (2018-19, in grey) and as prosumers (2022-23) as documented by Paper 0871

Paper 1274 investigated how the integration of Renewable Energy Communities (REC) at LV level impacts the flexibility requirements for DSOs in MV networks. The study considers the variable nature of power generated by RECs and the different ways in which REC members consume the energy they produce. Through a rough unbalanced load flow calculations on LV networks involved in a REC and the implementation of a distribution management system based on multi-agent optimisation algorithm, the study assesses the flexibility reductions and their impact on the network. By quantifying the additional flexibility required for network stabilization, a correlation between the flexibility demand and REC self-consumption levels is highlighted. The findings emphasize the critical need for DSOs to implement sophisticated grid management approaches and strategically invest in flexibility solutions to ensure appropriate level reliability and efficiency of distribution networks are maintained as the adoption of RECs increases.

Paper 0803 aims at simulating how market driven electricity consumption may affect LV networks. The simulation is performed through OpenDSS software using Monte Carlo method and allows calculation of MV/LV transformer load and customer voltage. Customer groups used in simulations are formed from a dataset which consists of real hourly customer data; customers were divided into two groups (flexible/non-flexible). Flexibility was determined with two criteria: spot-price-based contract and negative correlation between spot price and electricity consumption during extremely high and low-price weeks. This simulation can be used to identify worst case conditions, as extremely high and low-price events are rare. Results show that market driven electricity consumption may adversely impact voltage depending of network topology characteristics.

Sub-block 2: Network Modelling and Representation

Sub-block 2 collects papers focused on how distribution networks can be digitally modelled, simulated, and represented to support the energy transition. The papers demonstrate how network models are evolving to better reflect actual operating conditions, enabling reliable planning under increasing electrification and uncertainty. Contributions are grouped thematically to highlight shared approaches and complementary insights.

A clear understanding of phase connectivity and network topology is fundamental for accurate state estimation, loss calculation, and operational planning in low-voltage grids. However, many DSOs still face incomplete or outdated information, especially in regions with limited instrumentation or legacy GIS systems. The papers in this cluster present innovative methodologies based on smart meter data, statistical learning, and AI to automatically infer or validate network structure. They demonstrate how phase association errors and topological uncertainties can be corrected using only voltage measurements, reducing the need for costly field verification and enhancing the quality of grid models used in planning and control.

Paper 0582 investigates the use of 15-minute phase measurements from 59,000 customer smart meters to better understand and manage phase imbalance in the LV power distribution grid. It demonstrates that these measurements can identify errors in grid topology data and reveal significant phase imbalances, with the highest loaded phase carrying 24% more load than the average. The study tests two methods for reducing phase imbalance by rotating phases, finding that both can reduce maximum load by 16–20%, though practical feasibility varies. The findings suggest that phase measurements can improve grid observability and support more efficient grid management.

Paper 0030 presents a novel phase identification method for distribution grids using Graph Neural Networks (GNN), leveraging synthetic data generated through Monte Carlo power flow simulations. The proposed GNN approach is compared to state-of-the-art methods (k-Nearest Neighbors and LASSO) and demonstrates superior accuracy and robustness, especially under challenging conditions such as noise, photovoltaic integration, unmetered consumption, and multi-phase loads. The study concludes that GNN outperforms existing techniques, maintaining high accuracy across various scenarios, but its performance can be significantly affected by incorrect phase labels during training.

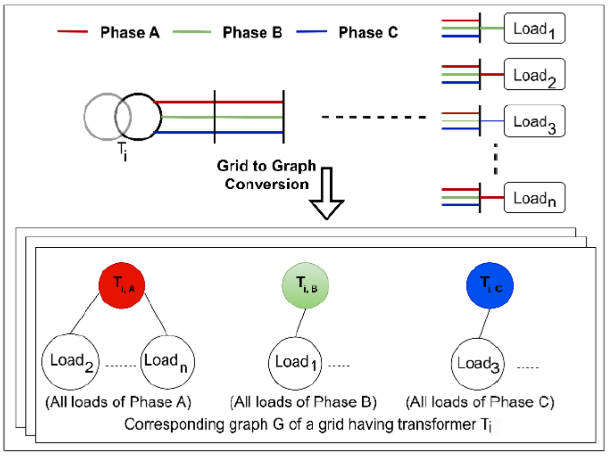

Fig. 38: The process to convert distribution grids to GNN graphs (Paper 0030)

Paper 0831 presents a novel, interpretable algorithmic approach for verifying the topology of low-voltage distribution power grids using dynamic data from smart meters, even when smart meter coverage is limited and transformer measurements are unavailable. By clustering voltage time series based on Pearson correlation, the method identifies potential errors in existing network topology assignments and suggests corrections. Tested on real-world data from a Belgian DSO with less than 20% smart meter coverage, the approach demonstrated promising results, correctly identifying ambiguous situations and providing logical outputs from a human perspective. The study also highlights practical challenges and suggests future improvements to enhance the methodology.

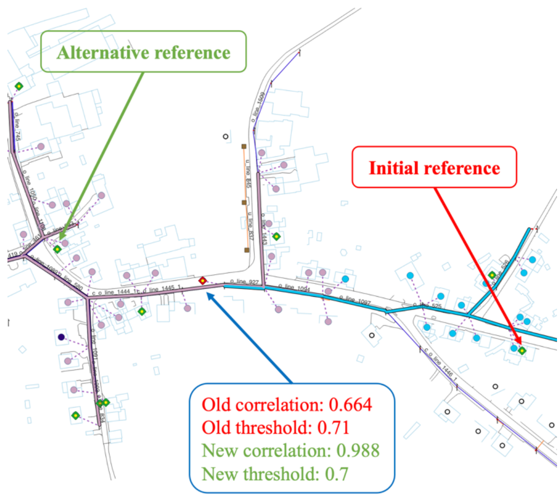

Fig. 39: Positive result achieved by the algorithmic solution in Paper 0831

Paper 1083 presents a robust, data-driven methodology for identifying customer phase connectivity in low-voltage (LV) distribution networks using voltage measurements from smart meters. By applying a machine learning pipeline with spectral clustering and comprehensive data pre-processing, the method enables automatic phase mapping without the need for costly on-site data collection. The approach is validated on real-world datasets, demonstrating high accuracy in phase identification and offering a scalable, cost-effective solution for distribution system operators to improve network planning and operations, especially where traditional phase identification methods are impractical or expensive.

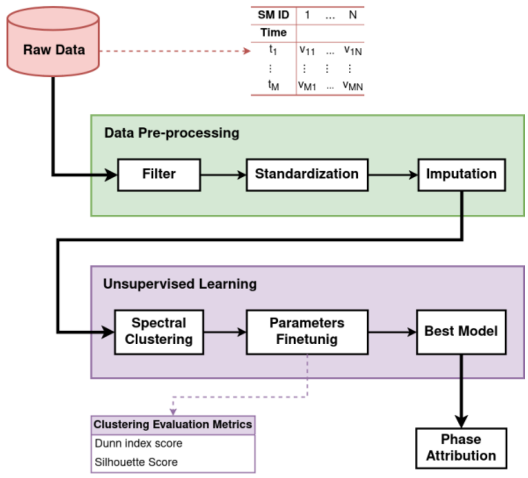

Fig. 40: Methodology flowchart depicting the machine learning pipeline developed for phase identification using voltage measurements (Paper 1083).

Access to realistic grid models is critical for scenario simulation, DER hosting studies, and flexibility assessments. When actual grid data is inaccessible or incomplete, synthetic or reconstructed network models become valuable assets for research and planning. This cluster brings together contributions that develop systematic approaches to generate MV and LV networks using open data, geospatial mapping, and electrical modelling techniques. The papers highlight advances in topology synthesis, GIS data cleansing, and algorithmic model generation, all aiming to produce simulation-ready network models that reflect real-world constraints and variability.

Paper 0295 presents a systematic methodology for generating synthetic low voltage electrical distribution networks, combining algorithms for both network topology creation and automated electrical model construction in OpenDSS. The approach uses data from open sources and utility databases, applies clustering and minimum spanning tree algorithms to respect real-world constraints, and validates the resulting models through load flow analysis. The study demonstrates that the generated synthetic networks closely align with actual network topologies and can be valuable for planning, simulation, and research in scenarios where real network data is limited or unavailable.

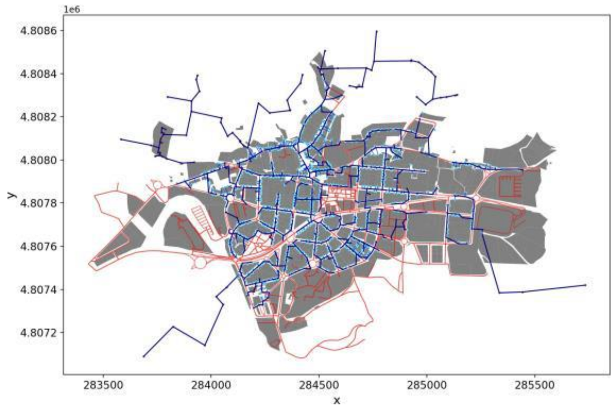

Fig. 41: Full Network Topology using the Caja General deproteccion CGP placement based on actual Utility database Paper 0295

Paper 0586 presents a set of algorithms that use smart meter data, geocoded address open data, and network topology and geometry data to detect and correct inconsistencies in Geographic Information System (GIS) data for the French LV electricity distribution network. By accurately positioning customer connections and analyzing network maps, the methods improve the reliability of network planning and asset utilization. The approach has already led to the correction of over 100,000 GIS records, with plans to scale up to millions of connections, aiming to reduce manual work and enhance the quality of network data.

Fig. 42: The network facing customers represented by the green-filled squares is red in the ENEDIS's GIS, when it should be green (Paper 0586). Network planners could incorrectly conclude that the red network needs reinforcing without the proposed methodology.

Paper 0893 presents an open-source tool for generating realistic Dutch medium-voltage (MV) and LV distribution grid models using open geographic data, archetypal neighborhood data, and building registries. The tool extracts MV grids, assigns cable types based on statistical analysis of real network data, and matches LV grids to archetypal configurations using graph similarity measures. The generated grids are formatted in the Energy System Description Language (ESDL) for simulation and analysis. Validation through load flow simulations demonstrates that the tool can produce MV grid models that accurately reflect real network behavior.

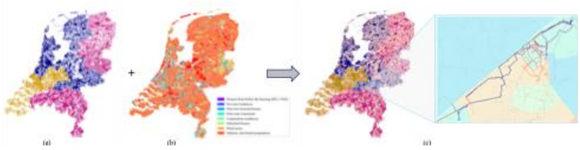

Fig. 43: Visualisation of the open geographic information system (GIS) data of the Dutch DSOs, the archetypical neighborhood dataset and a visualization of the extraction of the MV (blue/purple) and its connected LV (red/orange) grids (Paper 0893)

Distribution planning increasingly depends on the ability to manage topological uncertainty, integrate heterogeneous datasets, and reuse analytics across use cases. The papers in this cluster offer practical tools and frameworks to support scalable and robust planning in this context. From topology-aware congestion analysis using stochastic modelling to CIM-based data standardisation and analytics integration in large-scale platforms, these contributions demonstrate how data-driven infrastructure can enhance visibility, coordination, and decision-making in distribution system operations. Together, they address core challenges in planning under uncertainty, interoperability, and digitalisation.

Paper 0711 developed a standardised, model-oriented approach to Big Data analytics for power distribution networks by integrating the Common Information Model (CIM) directly into the Spark Dataset API using Scala. This integration improved code robustness, data management efficiency, and facilitated code reuse across various use cases such as predictive maintenance and network resilience. The approach also enabled easier integration of new data sources and advanced topological calculations through custom CIM extensions, providing a scalable and robust solution for Distribution System Operators (DSOs) aiming to optimize their analytics workflows. Despite challenges like CIM's complexity and staff onboarding, the benefits in maintainability, collaboration, and scalability were significant in ENEDIS.

Paper 0821 presents a case study of Northern Powergrid's implementation of the CIM to improve data standardisation and interoperability for electrical distribution network data sharing. The study details the methodology for integrating CIM into the Long-Term Development Statement (LTDS), including data mapping, system upgrades, and interoperability testing. Key outcomes include improved data quality, compliance, and seamless data exchange between systems, providing practical guidance for other distribution network operators considering similar modernisation efforts.

Paper 704 presents a framework for improving expansion planning in LV distribution grids by accounting for topology uncertainty due to changing and undocumented switch configurations. It introduces an efficient Markov Chain Monte Carlo (MCMC) method to generate plausible alternative network topologies and a congestion identification procedure that analszes these topologies to identify congestion hotspots and prioritsze grid interventions. The approach is demonstrated on a real 3042-bus German network, showing that considering multiple topologies provides more robust and reliable planning insights than relying on a single topology.

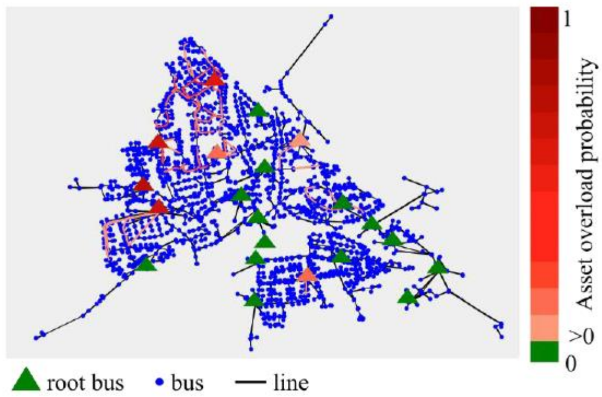

Fig. 44: Network model with marked congestion hotspots as produced by the methodology in Paper 0704

Sub block 3: Load Flow, Hosting Capacity and Short-Circuit Calculations

Sub-block 3 focuses on methods and tools used to quantify operational limits in distribution networks, such as voltage violations, thermal overloads, and fault currents, by combining probabilistic simulations, advanced optimization, and machine learning to address planning needs under growing uncertainty from DERs and new load types.

As distribution networks accommodate increasing volumes of DERs, planners must assess technical constraints under conditions of variability and uncertainty. This cluster gathers contributions that move beyond static, worst-case assumptions by incorporating time-series data, probabilistic models, and AI-driven estimations into hosting capacity and load flow analysis. These papers provide scalable tools for evaluating voltage violations, transformer loading, and PV hosting limits with greater accuracy. Their methods, ranging from copula-based PLF to physics-informed neural networks, highlight the need to account for operational diversity, real-world measurements, and data uncertainty in modern grid planning.

Paper 0313 presents a novel approach for assessing PV hosting capacity in distribution networks using a physics-informed graph neural network (PIGNN). By integrating physical laws and network topology into a GNN framework, the method provides fast and accurate voltage estimates, enabling efficient large-scale planning for active distribution grids. The proposed approach achieves a 30-fold speed-up and maintains approximately 95% accuracy compared to traditional numerical methods, as demonstrated through case studies on realistic distribution feeders. This work bridges the gap between model-based and model-free methods, offering a scalable and interpretable solution for PV hosting capacity analysis.

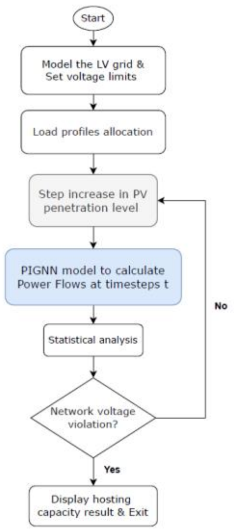

Fig. 45: Hosting capacity assessment framework in Paper 0313

Paper 0195 discusses the challenges and importance of Hosting Capacity Assessment (HCA) for integrating distributed energy resources (DERs) into distribution networks. It reviews the lack of a universal HCA definition, classifies HCA objectives for different stakeholders, and examines model attributes such as data requirements and uncertainty handling. The paper also explores various HCA use cases, emphasizes the need for regular updates due to dynamic grid conditions, and identifies key challenges like data quality, computational demands, and balancing short- and long-term goals. Overall, it provides a structured approach to standardize and improve HCA practices for effective DER integration.

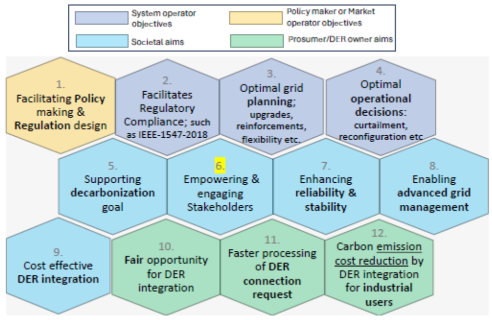

Fig. 46: The different use cases for performing HCA of power networks in Paper 0195

Paper 0567 analyses the impact of lowering the MV setpoint at HV/MV substations on distribution network technical losses and reactive power flows, as part of a new voltage management scheme being implemented by the French DSO Enedis to increase distributed generation hosting capacity. Using detailed modelling and sensitivity analyses on four real grid cases, the study finds that a 2% reduction in MV voltage setpoint generally results in very limited changes to technical losses, often a slight decrease, especially when accounting for voltage-dependent loads. The reduction also consistently decreases reactive power injection into the high voltage grid, which is beneficial for both distribution and transmission system operators. The paper notes that the main methodological limitation is the simplified estimation of LV grid losses.

Paper 0155 proposes a fast and sufficiently accurate algorithm to estimate the hosting capacity of mainly radial MV grids. The method involves two main steps: tracing relevant grid elements and estimating capacity based on grid impedance and current margins. Implemented using the Neplan loadflow tool and automated with C#, the approach is about 40% faster than the built-in Neplan module and shows acceptable accuracy, with 98.8% of tested nodes within predefined deviation limits. This estimation can be used for capacity mapping, preliminary cost estimation, and identifying locations for future grid expansion.

Paper 0443 proposes an analytical calculation method based on a power supply path matrix to efficiently estimate the PV hosting capacity of active distribution networks. By modelling the PV hosting capacity as a feasible region in high-dimensional space and expressing network constraints in matrix form, the method enables rapid and accurate evaluation of PV integration potential.

The approach is validated on the IEEE 123-bus system, demonstrating strong adaptability to different scenarios and topologies, as well as significant improvements in computational efficiency compared to traditional methods.

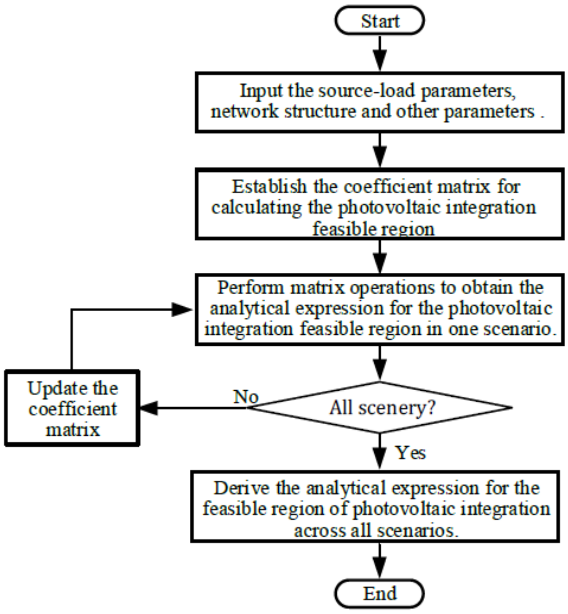

Fig. 47: Hosting capacity assessment framework in Paper 0443

Paper 0868 presents a case study applying probabilistic load flow (PLF) analysis to a rural low-voltage distribution grid with high photovoltaic (PV) penetration. Using smart meter data, the authors model customer load and PV generation as probability distributions, incorporating correlations via a Gaussian copula. The PLF results for transformer loading are compared to actual measurements and standard load profile calculations, showing that the proposed method provides promising and more accurate results for grid planning. The study highlights the importance of accurate input and correlation modelling and suggests further research to improve generalizability and address limitations.

Paper 0772 presents a two-step methodology to improve distribution grid planning by moving from traditional worst-case power flow calculations to time-series-based analysis using detailed PV system modelling and feeder line measurements. The approach is validated with two rural German low-voltage networks dominated by PV systems, showing that traditional methods overestimate grid utilisation by 65-87%, while the time-series approach reduces deviations to about 26%. Simple calibration with measurement data improves overall agreement but does not enhance modelling of high current scenarios. The findings suggest that integrating measurement data and time-series calculations can lead to more accurate and efficient grid planning, supporting better infrastructure investment decisions during the energy transition.

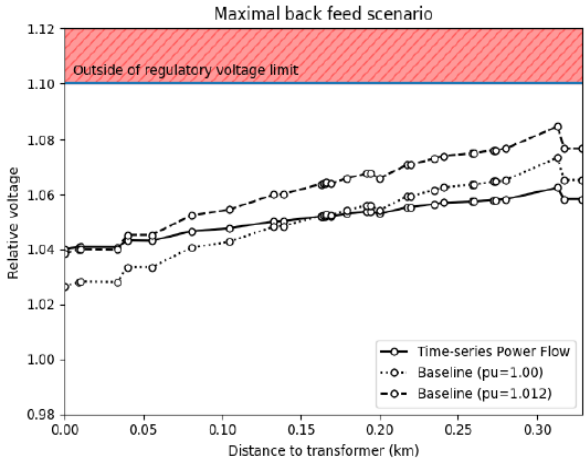

Fig. 48: Visualisation of the relative voltage in the LV grid depending on the distance to the transformer. The baseline evaluation without (and with) the correct transformer voltage setting is shown in a black dashed (dotted) line, the time-series power flow result is shown in a solid line (Paper 0772).

Visibility and topological accuracy are foundational to planning and operating resilient distribution networks. This cluster features papers that propose advanced methods to reconstruct network topology, perform state estimation, and quantify uncertainty using limited or noisy data. Whether by combining smart meter measurements with statistical learning or applying D-PMU data for DSSE, these contributions enable more informed decision-making in networks with sparse instrumentation or evolving configurations. They reflect a broader shift toward probabilistic planning and adaptive modelling under imperfect knowledge.

Paper 0877 describes the development and implementation of automated capacity workbooks for Ireland's HV distribution network, created by ESB's Network System Services Group. These workbooks use PSS®Sincal, Python, and Excel to provide a comprehensive, data-driven overview of network demand and generation capacity under various load growth scenarios, supporting transparency and compliance with EU and UK regulatory requirements. The methodology includes modeling substations, applying tailored capacity rulesets, simulating N-1 contingencies, and incorporating planned network reinforcements. The results highlight how future projects impact network capacity and identify when and where additional capacity will be needed to meet ESB's Net Zero 2040 strategy. The workbooks are intended for annual publication to inform stakeholders and guide network planning.

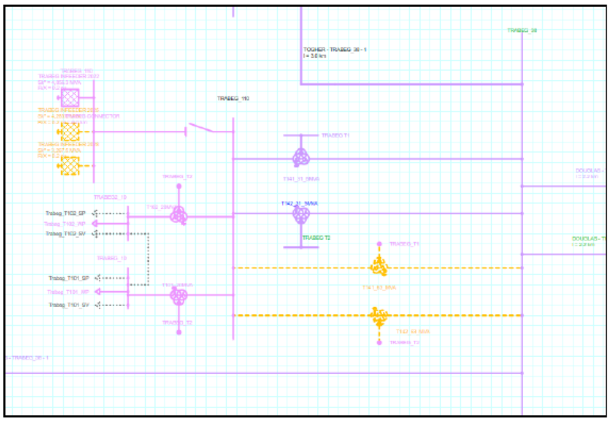

Fig. 49: Sample of network reinforcement projects in **Paper 0877**

Paper 0449 investigates how grid topology affects the calculation of Operating Envelopes (OEs) in LV distribution networks, which are crucial for managing congestion and optimising flexibility as more renewable energy sources and flexible loads are integrated. Using a relaxed unbalanced three-phase Optimal Power Flow (UTOPF) method with Second-Order Cone Programming (SOCP) relaxation and a loss-minimisation parameter (λ), the study analyses both benchmark and real-world LV feeders. It identifies three feeder types and demonstrates that optimal selection of λ enhances grid flexibility while ensuring fair and practical OE allocation. The findings provide Distribution System Operators with a robust methodology for adapting OE calculations to diverse network scenarios, supporting the evolving demands of modern power systems.

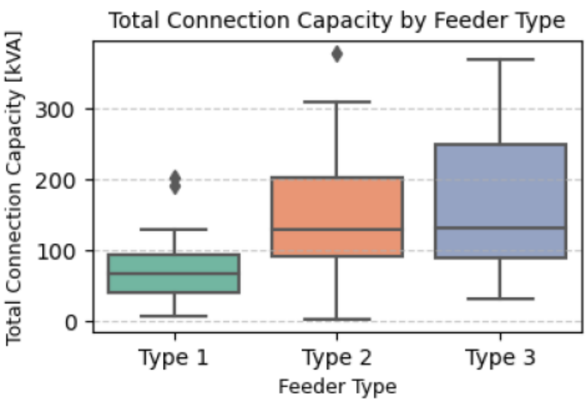

Fig. 50: Boxplots for significant topological characteristics of networks in Paper 0449

Paper 1057 examines the importance of estimating uncertainty in Distribution System State Estimation (DSSE) using real data from a medium-voltage network in Switzerland equipped with Distribution Phasor Measurement Units (D-PMUs). It demonstrates how considering the uncertainty of state estimates improves the reliability of detecting key grid events, such as reverse power flows and line congestions. The study validates the accuracy of computed uncertainties and shows that including uncertainty information helps avoid misinterpretation of DSSE results, especially in areas with limited measurement redundancy.

Paper 1052 presents a three-level approach for estimating the hosting capacity (HC) of low-voltage distribution networks, particularly in the context of increasing adoption of electric vehicles and photovoltaic systems. The method reconstructs network topology using limited static and metering data, builds an equivalent electrical circuit, and then estimates the network's capacity to accommodate new loads or generation. This approach helps distribution system operators optimise investment planning and manage networks efficiently, even when data is incomplete or inaccurate. The methodology is demonstrated on real network sections in collaboration with a Belgian DSO.

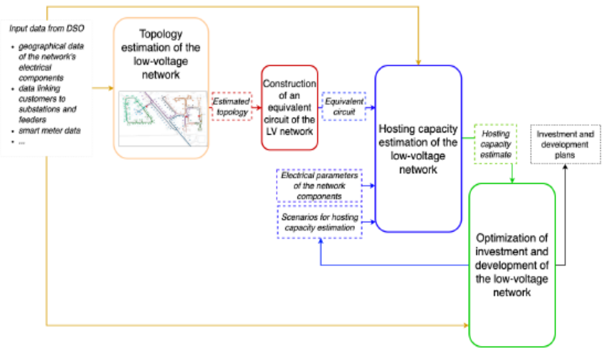

Fig. 51: Multi levels for topology and hosting capacity estimation for investment optimization in Paper 1052

This cluster focuses on the development of applied tools to support capacity forecasting, long-term network planning, and flexible operation. The papers present workflow automation for high-voltage network assessment, as well as advanced optimisation methods for allocating operating envelopes in low-voltage grids. These contributions bridge the gap between planning analytics and operational needs, providing transparent, scalable, and regulation-aligned tools that can be adapted to real DSO environments.

Understanding how real-world infrastructure behaves under changing demand patterns and structural modifications is critical for safe and cost-effective planning. This cluster addresses two complementary themes: the risks introduced by meshing in MV networks, especially in relation to short-circuit current levels and equipment constraints; and the statistical characterisation of EV charging behaviours in multi-point charging hubs.

Together, they highlight the importance of ground-truth data and empirical analysis in supporting infrastructure deployment, safety, and control strategies.

Paper 0515 analyses arrival and departure data from three electric vehicle (EV) charging hubs in Scotland to classify electrical demand profiles and understand user behaviour. Using data analytics and probabilistic methods, the study develops a framework to evaluate charging hub performance, focusing on metrics like occupancy and capacity factors. The findings reveal that AC charge points generally have lower utilisation compared to DC rapid chargers, and highlight the importance of site-specific factors in planning cost-effective EV infrastructure. The proposed framework offers practical tools for optimising grid connections and future EV charging site development.

Paper 0028 investigates how different meshing concepts in medium-voltage grids affect short-circuit current levels. Using realistic grid models and calculations based on IEC 60909, the study finds that all meshing types increase short-circuit currents, with the most significant rise (up to 86.9%) observed in urban 10 kV grids. In these urban grids, the resulting short-circuit currents can exceed equipment limits by up to 50%, indicating that meshing cannot be applied without additional current limiting measures. In contrast, meshing in 20 kV semi-urban and rural grids does not exceed permissible limits, making it feasible in those cases.

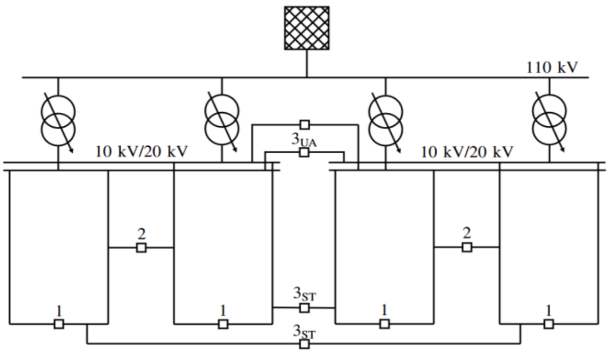

Fig. 52: Overview of different meshing concepts in the MV grid (Paper 0028**)**

Sub block 4: Energy Losses

Paper 0550 introduces a new tool developed by Enedis to estimate and visualise technical and non-technical losses across different voltage levels and geographic areas, using daily metering data. The tool leverages smart meter measurements of both consumption and generation to compute flow balances, enabling the DSO to localise losses at the substation, feeder, or regional level. Unlike conventional annual or aggregate assessments, this tool allows for a granular, intraday analysis of loss behaviour, making it possible to identify anomalies or trends that may not be apparent at higher aggregation levels. The methodology distinguishes between technical and non-technical losses and can track their evolution over time. The tool was applied to three substations with varying load and generation profiles, demonstrating its ability to support decision-making related to maintenance, asset replacement, and fraud detection. The paper highlights how this solution supports Enedis' broader CSR objectives and operational goals, especially in a context where energy costs are high and the economic incentive for energy theft is rising. Enedis positions this tool as a critical enhancement to the transparency and effectiveness of loss management in modern, decentralised grid environments.

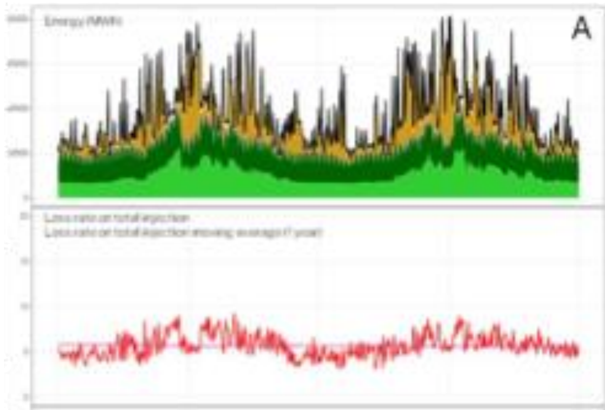

Fig. 53: Example of the impact of generation on the total losses rate Paper 0550

Potential scope of discussion

Hosting Capacity (HC) is a crucial parameter to support transparent management and effective "ex-ante" coordination in the presence of a huge number of independent connection requests. However, HC definition is not universally agreed and calculations methodologies, including estimations through "proxys", still largely differ according to DSOs' data availability and historical heritage. Do we expect to converge on shared, standardized solutions in the short term, and how?

Energy efficiency is now seen as one of the most valuable assets in any decarbonization strategy. Are losses evaluation and management strategies developed enough to cope with the challenges of a net-zero society?

Table 4: Papers of Block 4 assigned to the Session

Paper No. Title	MS a.m.	MS p.m.	RIF	PS
0028: Investigation of the Development of Short-Circuit Currents with Increasing Meshing of the Medium-Voltage Grid				X
0030: Phase identification in distribution grids with Graph Neural Networks (GNN)				X
0089: The Effect of Solar Diversity Factor on the Capacity for Renewable Generation on the Distribution Network				X
0090: Leveraging daily smart meter data to estimate the peak load of distribution transformers				X
0095: Modelling local electricity consumption by incorporating unstructured textual data obtained from social media as time series using natural language processing				X
0155: Algorithm to Estimate Hosting Capacity in a radial Medium-Voltage-Grid				X
0174: Analysis of different methods for the application of simultaneity factors for Low-Voltage Network Planning				X
0195: DER hosting capacity for distribution networks: definitions, attributes, use-cases and challenges		20		X
0232: Sensitivity of the accuracy of long-term load forecasting to exogenous variables				X
0286: Integrated Modeling and Forecasting of Electric Vehicles Charging Profiles Based on Real Data				X
0288: Benchmarking methods for identifying representative load periods for fast distribution network analysis				X
0295: Development and implementation of algorithms for synthetic generation of reference low voltage electrical distribution networks				X
0313: Solving scalability issues in PV hosting capacity assessment through physics-informed neural networks			X	X
0322: A Demand-Side Load Forecasting Approach Considering Heterogeneity of Massive Resources				X
0443: PV Hosting Capability Calculation of Active Distribution Networks Based on Power Supply Path Matrix				X
0449: Influence of grid topology on the Operating Envelope using three phases unbalanced Optimal Power Flow with Second-Order Conic relaxation			X	X
0515: Classifying ADMD at public EV charging hubs: insights from arrival and departure data				X
0549: Leveraging Smart Meter Data and Monte Carlo Simulation for Peak Power Demand Estimation in Multi-Apartment Buildings				X
0550: Estimating local grid losses: a tool enabling daily losses estimation and visualisation at different grid levels, fostering a deeper understanding of them				X
0567: Decreasing the MV voltage setpoint to increase hosting capacity: impact on the grid losses and reactive power				X
0582: The use of phase measurements for understanding the state of the low voltage power distribution grid				X
0586: Improving network planning and asset utilisation via automated GIS error detection				X
0603: Analysis of LV monitoring data for application in network planning and forecasting				X
0627: EV Charging Stations Load Forecasting by BiLSTM and PatchTST				X
0704: Probabilistic generation of topology configurations for reliable planning in distribution grids				X

0711: Leveraging on Common Information Model (CIM) for Big Data Analytics				X
0738: Structured state space sequence models for probabilistic day-ahead power forecasts in the medium-voltage grid				X
0759: Electric Vehicle (EV) Demand Profiling for Assessing Residential Load Patterns in Qatar				X
0769: Assessment of low voltage load profiles considering future end-use evolution		17		X
0772: Enhancing Distribution Grid Planning with Time Series-Based Analysis: A Case Study from Germany				X
0794: Effect of heat pumps, batteries, EVs, and PV on low-voltage feeders: results from a Monte Carlo study on 202,659 Flemish smart meter profiles				X
0803: The impact of extremely high and low electricity prices on the low-voltage network of rural areas in Finland				X
0821: Integration of Common Information Model in Distribution System Operations: A Case Study				X
0831: Smart Meters Phase Identification for Topology Verification: Practical Challenges and Insights from a Case Study		15		X
0868: Application and measurement-based verification of probabilistic load flow analysis methods for the integration of decentralized generation in PV-rich rural low-voltage grids				X
0871: From customers to prosumers: PV systems impact on residential load profiles, coincidence, and peak power				X
0877: Automated Assessment of Ireland's HV Distribution Network Forecasted Capacity				X
0893: An open-source tool for generating representative Dutch distribution grid models using graph similarity measures and open data				X
0922: Energy Consumption Forecasting for Emerging Technologies				X
0935: Influence of the expansion of heat pumps on the distribution grid				X
0936: Impacts of Ground Source Heat Pumps on Peak Power in Apartment Buildings: A Case Study from Finland				X
0997: Short-Term Forecasting of Peak Electrical Demand in Iceland: A Data-Driven Approach for Enhanced Grid Management				X
1052: Estimating Network Topology and Hosting Capacity: A Multi-Level Approach				X
1057: On The Value of Estimated State Uncertainty in Distribution System State Estimation				X
1083: Smart-meter phase clustering in low-voltage distribution network				X
1092: Residential flexible load profile generator to estimate the impact of tariffs and demand response on distribution grids and energy bills				X
1249: Current State and Future Needs of Load Forecasting for Distribution Planning – U.S. Perspective				X
1252: Methodology and Assessment of Electrification Impacts on Residential Demand Characteristics				X
1274: Assessing the Impact of Low-Voltage Energy Communities Self-Consumption on Grid Flexibility provision				X