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Regulatory and Policy Aspects for a Cellular Design of Electricity Markets

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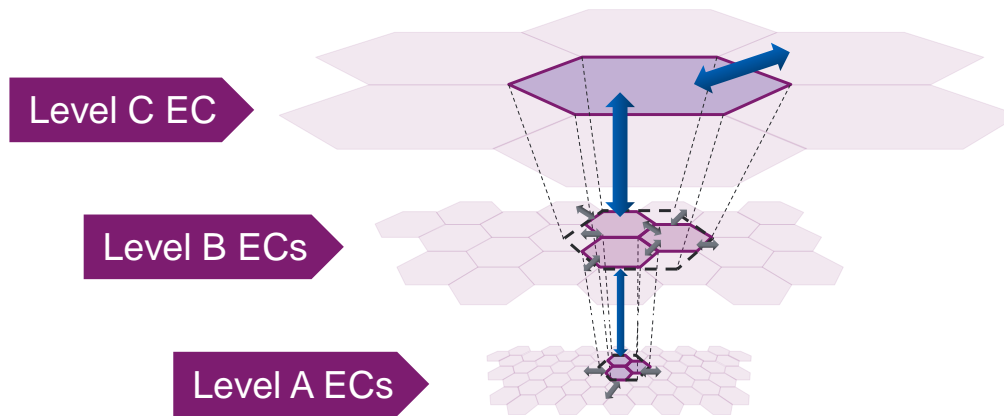
Electricity balancing, reserve procurement & ancillary services

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1 Cellular approach and proposed market design



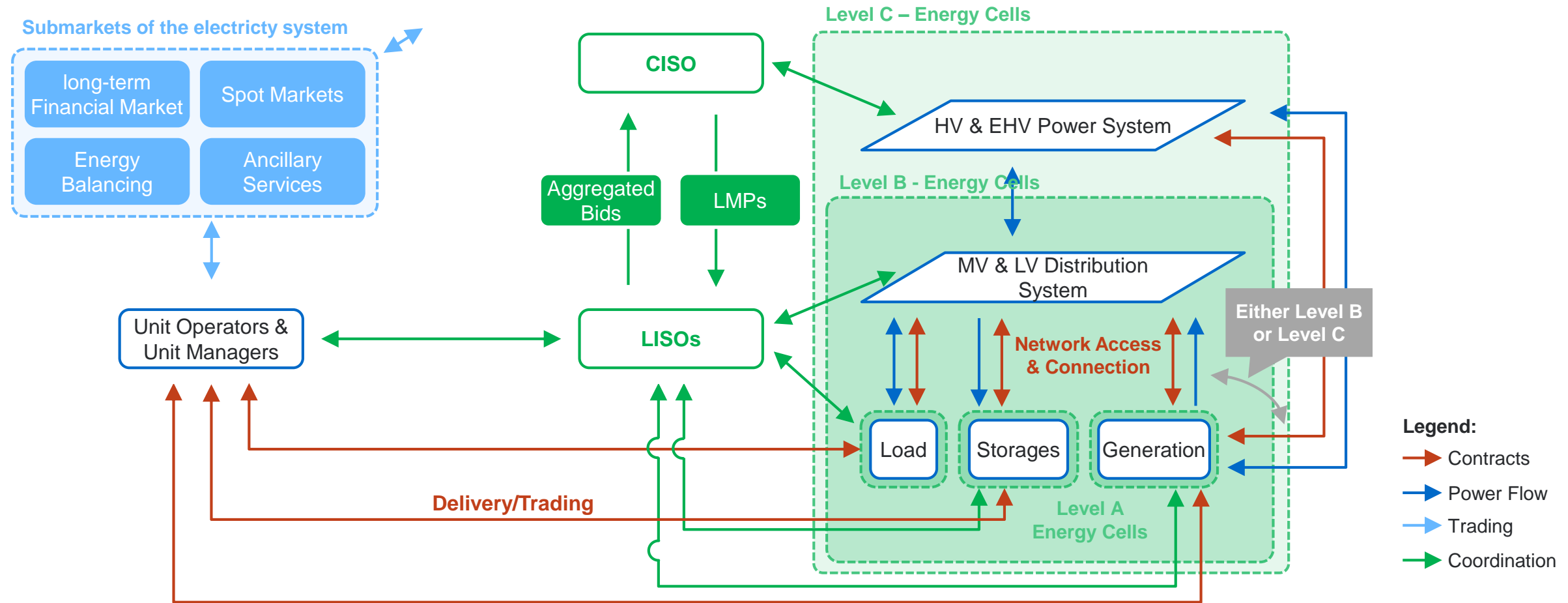
Uhlemeyer, B. et al. (2020): "The cellular approach as a principle in integrated energy system planning and operation", CIRED Workshop, Berlin.

- Level A: Individual or related *units* (e.g. households, industrial sites etc.) possibly multi-energy units
 - may comprise several kinds of generation loads and storages
 - providing different types of flexibility (e.g. short-term or long-term)
 - These ECs do not include (public) grid infrastructure
 - Individual unit (respectively portfolio) optimization in advance to the posterior market clearing whereby each EC on level A has its own Unit Operator (UO)

- Level B & C: Contain parts of the energy system → operation of network infrastructure and market(s)
 - Level **B** ECs: Distribution system → Level **C** EC: Transmission system
 - All related heat and gas networks of the covered area are, depending on their characteristics, part of either an EC in Level B or C
 - Contrary to the UO of level A, the SO of level B and C are aiming to optimize their ECs
 - Focus: **public welfare**; analogously to an independent system operator (ISO)
 - Hence, the SO of level B is named **local ISO** (LISO) and on level C **central ISO** (CISO)

Overview – Market design

1 Cellular approach and proposed market design



Schinke-Nendza et al. (2020): "A Novel Design for Electricity Markets based on the Cellular Approach", 17th International Conference on the European Energy Market (EEM), IEEE.

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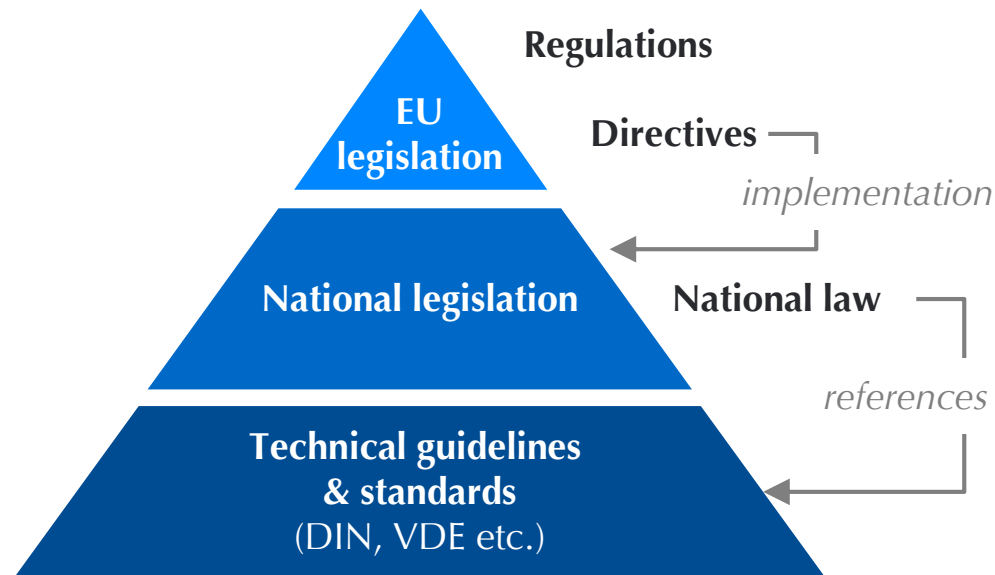
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2 Status quo of the regulatory framework

- Simplified hierarchy of legislation and standards
 - European legislation: Basis of regulatory and policy framework for all member states
 - National legislation implements the European requirements with a certain degree of freedom



Following: Schlecht et al. (2020): "Effizienzprüfung marktgestützter Beschaffung von nicht-frequenzgebundenen Systemdienstleistungen (NF-SDL)", Report for the Federal Ministry for Economic Affairs and Energy.

- Liberalization of the electricity sector
 - Initialization in 1996 by directive 96/92/EC
 - Adoptions by two directives in 2003 and 2009 (2003/54/EC and 2009/72/EC)
 - In 2019: Clean energy package
 - Regulation 2019/943 on the internal market for electricity as a is applicable in its entirety in all member states while **overruling national laws**
 - Directive 2019/944 defines the common rules for the internal market for electricity while **setting objectives that all EU countries must reach and translate into their national legislation** by January 1st, 2021
 - open access to the electricity system for customers and independent producers, respectively,
 - establishment of objective and non-discriminatory criteria for dispatching of power
 - Regulation 2019/942 establishes the EU agency for the cooperation of energy regulators (ACER) with extended competences for regulation

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- Electricity markets
 - „markets for electricity, including over-the-counter markets and electricity exchanges, markets for the trading of energy, capacity, balancing and ancillary services in all timeframes, including forward, day-ahead and intraday markets”, cf. EU 2019/944
 - Bilateral trade & OTC trade in the EU
 - Already directive 96/92/EC obliged all member states to offer customers the possibility to conclude bilateral supply contracts with individual producers
 - In 2019 regulation 2019/943 tightened this requirement by introducing bilateral contracting possibilities as an obligation for all member states
- The EU sets the following basic principles
 - competitive, consumer-centered, flexible and non-discriminatory electricity markets for all member states
 - transparency, proportionality and non-discrimination regarding market rules, fees, and treatment
 - customers’ free choice of suppliers and market-based supply prices, with minimized public interventions
- These principles especially apply to
 - access to wholesale markets and to data,
 - balancing responsibility and switching processes,
 - billing regimes and if applicable, licensing

3 Key regulatory aspects

1. Pool-based trading
 - All (or most) of the trading activities are coordinated and observed by the responsible system operator
2. Bilateral trading
 - Relies on decentralized and voluntary markets, organized as over the counter (OTC) markets or power exchanges
 - Consumers, generators and traders are capable to trade electricity in an unrestricted manner
- Additional features
 - Both patterns are typically supplemented by an imbalance settlement process
 - Exchange-based trading
 - In pool-based trading systems an exchange-based trading is typically mandatory for the spot market
 - In bilateral trading systems there may be competing marketplaces including OTC markets
- Requirements for a novel market design
 - The proposed market design would introduce the **pool-based trading** as organizational pattern
 - The EU tends to **prefer a bilateral trading system** for the internal market in electricity, hence, being applicable for the individual electricity markets of all member states as well

1. Novel electricity market design with pool-based trading as organizational pattern
 - Obligation of the EU to enable bilateral trading as organizational pattern encourages multiple (OTC) trading platforms
 - Possibility to integrate this requirement into the proposed market design:
 - Market participants are **obliged to report physical flows resulting from OTC trading** to the responsible system operator

AND

 - **participation** in the **imbalance settlement** process is **binding**
 - Enabling an efficient allocation of capacity
2. Basic principles of transparency, proportionality and non-discrimination for electricity markets
 - The novel market design is capable to match the basic principles of electricity markets, especially customers' free choice of suppliers and market-based supply prices
 - Further work on the foundations is required:
 - Already existing frameworks for such multi-staged market clearing processes, e.g., by Caramanis et al. [5], are highly complex
 - **Balancing responsibility** of individual market participants has been neglected so far
 - Market design and its rules must be **clearly defined, transparent, non-discriminatory** and **verifiable** for market participants

3.1 Cross-border electricity trade

- Basic framework for cross-border electricity trade in the EU
 - Regulation 2019/943 and directive 2019/944 assign duties and tasks for the relevant entities in the energy market,
 - regulations 2019/942 and 2015/1222 define detailed operational rules and methods
- EU agency for the cooperation of energy regulators (ACER)
 - Complementing and coordinating the work of national regulatory authorities in accordance with the European framework for the internal market
 - Hence, jointly developed and published network codes of the system operators become regulations
 - E.g., regulation 2015/1222 is based on the guideline on capacity allocation and congestion management
- Flow-based market coupling (FBMC)
 - The relevant procedure for calculating cross-border electricity flows, based on trading of market participants, while ensuring system security
 - A *market coupling operator* (MCO) is responsible to **match bids and offers** from different bidding zones, for day-ahead and intraday markets in an optimal manner
 - FBMC results are published on a non-discriminatory basis to all power exchanges
 - Hereby, bidding zones may be modified by adjusting, merging, or splitting zone borders
 - This configuration should be consistent for all market timeframes,

Two perspectives on integrating the novel market design in a subset of countries or bidding zones in the EU

1. Technical perspective

- FBMC process (carried out by the MCO) can be maintained, e.g., by applying distributed parallel optimization techniques [20]
 - Algorithms of the corresponding regulation 2015/1222 may need to be adopted to fit the proposed market design
 - General structure will not change → Optimal capacity allocation for cross-border electricity trade can be achieved
- **Further investigation** in this field is required since there **might be some counterintuitive effects** arising when coupling multiple markets for cross-border trading in case the individual market design relies on different organizational patterns

2. Institutional perspective

- On the regulatory and policy side, the question arises whether the proposed market design matches the implicitly defined idea of an internal market for electricity or not
 - Current legislation definitely offers the possibility to introduce the required changes
 - Implementation of the required changes strongly **depends on the idea and the understanding of the internal market on electricity**, thus **a corresponding political will** to promote the novel market design is necessary

- Intra-zonal congestion management
 - Several measures in European electricity markets available to avoid congestions
 - In Germany: redispatching (incl. RE curtailment) and countertrading → accounting for annual costs of **more than one billion Euro**¹ over the past three years
 - Regulation 2019/943 defines regulatory framework for intra-zonal redispatching:
 - Resources used for redispatching, shall be selected based on a **market-based mechanism** among generation assets, energy storages, or demand response
 - Alternative: Non-market-based downward redispatching, i.e. cost-based redispatching
 - **Balancing units** utilized for redispatching, are **omitted** when settling the **balancing energy prices**
- Status quo in Germany
 - Challenges of a market-based redispatch:
 - Possible threats and disadvantages due to **inc-dec-gaming** in the case of **coexisting zonal electricity markets** and **local redispatch markets**
 - Policy makers decided in close coordination with the regulatory authority, transmission system operators and experts to proceed using the cost-based redispatch
 - Assessment
 - Proposed market design can reduce drawbacks
 - In a market clearing based on a **nodal pricing** regime, congestions are considered in a market-based manner
 - coexistence of zonal electricity markets and local redispatch markets can be precluded

¹ Bundesnetzagentur und Bundeskartellamt (2020): "Monitoringbericht".

3.3 Electricity balancing, reserve procurement & ancillary services

- Balancing responsibility of market participants
 - Regulation 2019/943 and directive 2019/944, request transparent proportionate and non-discriminatory market rules, fees and treatment
 - Regulation 2019/943 defines the framework for balancing markets, including e.g., the prequalification processes, pricing methods, and dimensioning of reserve capacity
 - Applicable areas of the imbalance prices (reflecting the real-time value of electricity) should correspond to the bidding zones
 - In terms of central dispatching models, e.g., used by system operators in the EU, imbalance price areas constituting partial biddings zones are allowed
- Assessment
 - Novel market design fulfills the generic requirements of prequalification etc.
 - Regarding the **balance responsibility** of individual units, the question arises how to ensure non-discrimination and transparency.
 - **Bids** are made on a **unit level** and not on a balancing group level
 - Hence, **aggregators** in the novel market design will **face a higher volatility** for the scheduled power demand and supply, e.g., regarding intermittent RES, compared to the status quo
 - **Further research on the interrelations are required**
 - Existing frameworks for multi-staged market clearing processes **incorporate reserve procurement** as part of the energy balancing
 - **Appropriate instruments** for UMs and UOs to cope with the higher volatility **are missing**

- Procurement of ancillary services (AS)
 - DSOs and TSOs are obligated to procure AS based on non-discriminatory, transparent, and **market-based procedures**
 - **Non-frequency AS** are incorporated unless the regulatory authority granted a derogation
 - Examples: steady state voltage control, inertia for local grid stability and black start capability
 - Prior to a derogation the market-based provision of non-frequency ancillary services must be evaluated as economically inefficient
- Present market design in Germany:
 - Partial market-based solution for two services
 - **Steady state voltage control** (short-term procurement)
 - Black start capability (long-term procurement)
- Assessment
 - The proposed market design can complement the market-based **short-term** procurement of some ancillary services by **incorporating the requirements** in the **market clearing process**
 - **Additional LMPs**, e.g., for reserve procurement or for reactive power to provide a steady state voltage control
 - **Transparent and verifiable financial incentives** for UMs and UOs to ensure security of supply and local grid stability
 - Long-term auctioning or contracting of other ancillary services, such as black start capability can be carried out regardless of the underlying market design

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- The novel market design:
 - is **in line** with the existing **main principles and rules** for electricity markets of the European legislation
 - facilitates opportunities for an **improved market-based congestion management**, by utilizing a nodal pricing regime instead of cost-based redispatching and for the market-based procurement of ancillary services
 - introduces a different organizational patterns for electricity markets, utilizing a **pool-based trading** scheme
 - seems to be in line with the European legislation, if the possibility for **OTC trading** is ensured
 - requires an **amendment** of the current legislation to **introduce local and central ISOs** into the European framework
- In the longer term, adoptions are required
 - Implementation process strongly depends on the political willingness at the European
- Future work:
 - Bids on a unit level are required, hence, **forecasting errors** affecting the settlement of energy imbalances **potentially increase**
 - **Cross-sectoral market coordination** (comprising the electricity, heat and gas sector) needs to be **addressed in more detail**

Thank you for your attention!

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