ISGAN
INTERNATIONAL SMART GRID ACTION NETWORK

Flexibility for resilience in integrated systems

Authors: Irina Oleinikova (NTNU), Antonio Iliceto (ENTSO-E) and Martha Symko-Davies (NREL).

Based on the ISGAN and IEA Digital Demand-Driven Electricity Networks (3DEN) cooperation initiative and an international high-level expert workshop "Flexibility for resilience in integrated systems" on 03-04 October 2022, to enhance international collaboration and research, share best practices and provide policy guidance on deploying flexibility for resilience.

Power system infrastructure is becoming more digitally connected to ensure safer, more efficient, and decarbonized future. The challenge is that this infrastructure is becoming increasingly vulnerable the more connected it becomes. As geopolitical tensions and security of energy supply shape power system this decade, energy professionals are ready to offer different solutions to keep the lights on towards a reliable and resilient future.

The role of flexibility and need for resilience. Climate risks and impacts on energy assets are on the rise. The increasing incidence, duration and magnitude of heat waves are already causing escalating cooling demand, affecting power system operation and reliability. Cold winters in combination with electrification of heating will in other regions put increased pressure on the system. There is a need for sufficient flexibility for system balancing, congestion management and a need of resilience for facing emergency events while keeping costs affordable. Traditional sources of flexibility are being reduced with a shift away from fossil fuels. Meanwhile in some countries balancing comes primarily from hydropower but might not be sufficient in the future because of increased demand, as well as climate impacts on hydropower assets.

Flexibility has traditionally been utilised in the operation stage, for balancing power flows, solving congestions, maintaining stability; now, the next level of flexibility can be defined as its full deployment and utilisation since the planning stage of the power system, being integrated into procedures for long-term planning and correspondent market mechanisms for procuring and adequately rewarding the flexibility providers also in terms of resilience increase.

Concrete examples of mechanisms implemented for flexibility but also improving the resilience can be:

- Load shedding today is undesired experience, and even interruptible customers, who are voluntarily included in such scheme, wish to minimise the number of these occurrences. Tomorrow, smart load shedding, offering modulated load reductions vs a proper compensation on an ad hoc market represents a paradigmatic case of flexibility (demand response) being conveniently used also for system resilience. The next level to abandon prescription / obligation towards a free choice of each customer about how much of her own flexibility she is willing to give away in exchange of proper economic compensation,
- Today, black start capabilities are provided only by large generation plants, realizing a top-down process, from high-voltage networks; tomorrow, the energy stored in electrical vehicles, in hydrogen tanks and in heat sinks (typical flexibility means available in future energy systems) can trigger bottom-up energization, enhancing the intrinsic resilience of the grid; on top of that, micro-grids architecture could reduce blackout footprint straight away.

- N-1 criterion as minimum safety (sometimes N-2) is a non-smart approach to security; tomorrow, even N condition can become acceptable if the automatic reactions of some flexibility devices/processes are taken into consideration.

In the last two cases, expensive assets are avoided, while resources for resilience can be made available at almost no extra cost, being decided and paid for reasons of providing flexibility.

While electrification is essential to decarbonization, it also means that more sectors are put at risk in the case of outages. Several technical, market and regulatory aspects that were discussed during the workshop are summarized in the table below:

Summarizing barriers to leverage flexibility for resilience	
Technical	• A framework should be designed through modeling and analysis providing illustrative options of various scenarios for flexible energy systems integration. • Technologies to enable data collection, asset management, automated demand response and the frameworks to utilize these (like TSO-DSO coordination) are largely still not deployed. Digital technologies that have been deployed are still not fully leveraged, for instance smart metering for data acquisition and dynamic tariffs. • Considering the complexity of the new risk landscape facing power systems and uneven geographical distribution of flexibility sources within the network, planning, and implementing resilience measures will require increased coordination, the establishment of new roles and responsibilities, business models and supportive regulatory frameworks, which are not yet in place. • It is expected that much of the needed flexibility of future power systems will have to come from behind the meter assets. Robust solutions are needed to create dependable flexibility in terms of demand response from privately held distributed energy resources. This calls for new approaches in engaging consumers, communicating and providing appropriate incentives, as well as ensuring protection and fair and equitable access to benefits and services.
Economical/ Market	• If the power system is to be able to get reliable flexibility services from the demand side, further focus is needed on consumer engagement, tariff design, markets and roles of service providers or intermediaries such as aggregators. • It is important to make strides in placing a value and business model on resilience and flexibility and resolve who ultimately needs to pay to ensure a secure and functioning power system as costs, benefits and risks are not evenly distributed across stakeholders. Equity issues need to be resolved and regulation needs to be adapted to enable utilities to invest in necessary technologies. It is key to solve the issue that investment and integration of systems need to be made today to get flexibility from consumers that will pay off in the future. • Utilities in many countries, particularly developing and emerging countries, are in difficult financial situations and do not have funds for investments. New mechanisms need to be developed to enable investments in power system modernization, and resilience.
Standardization/ Regulatory	• Interoperability of technologies, systems and data is crucial for resilience and for being able to access new flexibility sources. While numerous

	standards exist and national, regional, and international standardization processes are ongoing, lead-times are long and proprietary protocols are still pervasive. The need for a comprehensive and sustainable plan for communication of these technologies is critical towards a resilient future. • There is a need to better understand how the growing need for resilience can be better integrated into our energy system. It can be argued that resilience is not compatible with markets, as its costs and benefits are difficult to assess and to be priced, and thus needs to be integrated into decision making through regulatory processes. What is needed is to find a way to put a price to resilience, embedding it into regulation and decision making.

Discussions during the workshop pointed out a set of priority actions and potential solutions that can facilitate the progress. Potential roles and actions that could be taken by **academia and society, international organisations, policy makers, regulators, urban planners, system operators, retailers and consumers** contributing to:

- Urgent need of PS resilience and flexibility role in it
- New approach to PS planning
- Roles of consumers and energy communities
- Role of market and regulation
- Potential actions and ISGAN T&D WG relevance

Therefore, a new ISGAN T&D WG activity is proposed in 2023 with focus on ***Flexibility for resilience in integrated systems*** *to* ***share best practices, learn trough collaboration, and provide policy guidance on deploying flexibility for operation in integrated systems.***