Arthur D Little

Viewpoint

What's next for TSOs?

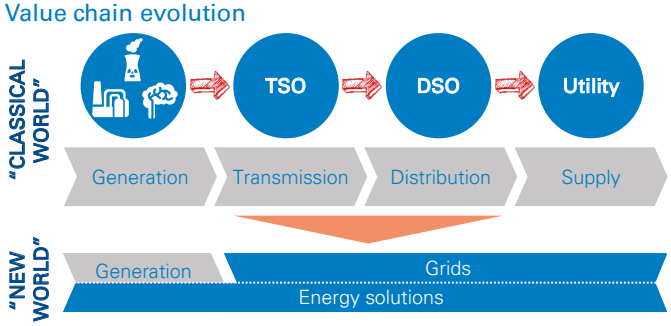
Leading the way in the energy transition

Within the energy ecosystem, the transition towards a more sustainable future mostly materializes through rapid increases in renewable energy sources, distributed generation and energy storage at large. The increasing share of intermittent generation sources is redefining the rules of the game – roles and accountability within the energy value chain are turned upside down. While the traditional role of the electricity Transmission System Operator (TSO) is more relevant than ever, fundamentally reshaping the future is equally high on the agenda, as it is triggered by game-changing factors such as new stakeholders, higher stress on the energy grid, digitalization, intermittence and flexibility. Here we share our learnings from recent Arthur D. Little projects.

New rules of the game within the energy ecosystem

Renewables and the increasing use of distributed generation sources are stretching the traditional energy grids, which were built to accommodate large central generation units and one-way distribution system operator (DSO) networks. Current prosumer reality has inverted the system, new actors have emerged (e.g., aggregators), geographies are increasingly interconnected, and all ecosystem stakeholders are rethinking their strategies. Specifically, a whole range of "energy solutions" are emerging along the value chain, forcing energy industry participants to rethink their traditional business models. In addition, central generation is transforming, with offshore wind and PV parks that mandate new "transmission highways", as well as skyrocketing asset investments in energy grid backbones.

Value chain evolution



Source: Arthur D. Little

As a result, the traditional "linear" grid structure is evolving towards a "meshed" structure, and both TSOs and DSOs need to deal with new flexibility requirements and constraints. The need for a transformation at network level is reinforced by adoption of new technologies and use cases such as (large-scale and residential) batteries and electric vehicles (smart charging, vehicle-to-grid), as well as emergence of new electricity generation models such as virtual power plants (VPPs) and demand-side response (DSR). On the one hand, this challenges traditional network operator models, but on the other, it offers opportunities to existing and new players.

TSOs: Facilitate ongoing change, or lead the way?

Although the electricity system will continue to require a central transmission backbone network (central generation, whether it is conventional or renewable, is forecasted to remain predominant in the generation mix for the foreseeable future), the rise of intermittent, decentralized generation and micro-grids could lead to a decrease in reliance on transmission networks. For grid owners, this creates the risk of stranded assets and related regulated revenues. Multiple responses exist. Rather than mere defensive moves, TSOs have the opportunity to step out of their position in the value chain by leveraging innovative technologies and new use cases. There are multiple examples of how TSOs can transcend their "traditional regulated role":

- International expansion: e.g., Red Eléctrica invests in transmission assets in Latin America
- Entry into energy system services: e.g., Elia Group provides technical consultancy services through its independent EGI subsidiary, supporting other grid operators in a range of energy system services
- Deployment of new technologies in test-and-pilot set-up: e.g., Terna and RTE invest in batteries in a range of applications for congested and imbalanced grid assets
- National Grid has developed a blockchain energy-trading platform and pushes EV fast-charging networks
- TenneT tests linking decentralized home storage solutions via blockchain to stabilize the grid

More opportunities will arise for TSOs willing to supplement the "classical" world with the emerging "transition" world, in which new priorities exist along four main axes: system operation, asset management, ecosystem facilitation and diversification (see below figure). This overview of opportunities stems from our implication in supporting TSOs in the definition and the development of their ambitions.

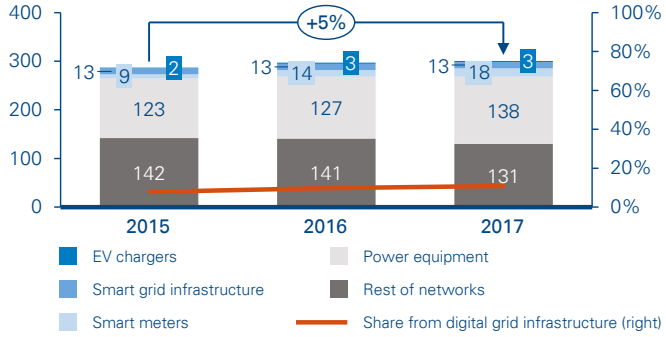
System operation

With the classical electricity transmission grid still essential for optimal functioning of electricity markets, "keeping the lights on" remains the core activity of TSOs. Additional activities do become equally important, such as optimizing market design and rules to cope with the increasing need for flexibility. Recent grid-balancing mechanisms that rely on traditional generation assets (such as DSR) and new assets (such as batteries), as well as the increasingly decentralized generation and consumption patterns, are the basis of transformation of electricity grids from linear "one-way streets" towards meshed "two-way streets". To ensure proper balancing of the network, some TSOs have developed novel, real-time platforms to provide the required flexibility. These platforms optimally define the cost and incentive associated with each transaction, taking into account real-time supply and demand.

Keeping the bidirectional meshed grid constantly balanced also requires TSOs and DSOs to increase their degree of collaboration day to day. The prosumer energy flow stimulates a shift in roles and responsibilities, which forces DSOs to perform system operation-related tasks which were previously exclusive to TSOs (e.g., congestion management, enhanced voltage management). In this context, increased collaboration would allow DSOs to benefit from the knowledge TSOs have developed over the years.

Share of spending on electricity network equipment by type

World, 2015–2017, USD bn

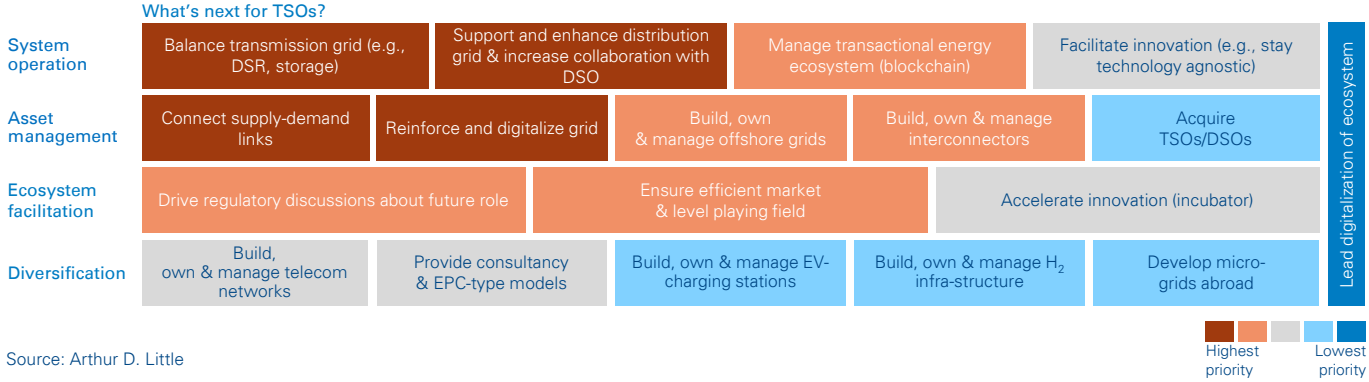


Source: EIA, Arthur D. Little analysis

In addition, the increasing complexity within the future transactional energy ecosystem advocates for central management of core grid-balancing functions. In this regard, TSOs could play an important role in managing the data hub required to keep track of all transactions (e.g., through the use of blockchain technology). However, the evolution from a couple of hundred injection points towards a couple of million will make fully central calculation and communication very challenging. As a result, a set-up in which a number of tasks are managed centrally (e.g., ensuring security of supply), while other tasks are solved on the spot by local teams, is to be expected.

Given their central position, TSOs will play an important role in shaping the technological characteristics of tomorrow's electricity system. Although they might not all directly invest in research & development, their decisions in terms of platforms, requirements towards (new) players, etc., will drive technological development and deployment. Belgian TSO Elia, for example, is applying this in practice: by designing technology-agnostic ancillary services, it is enabling new technologies such as battery systems to partake in the energy market more actively,

TSO role by priority



Source: Arthur D. Little

thereby stimulating a market boost for new energy services at large.

Asset management

Multiple European TSOs have announced/launched ambitious CAPEX plans that aim to further develop and reinforce their grids. These CAPEX plans are mainly driven by changing generation and consumption patterns (nuclear phase-out, increase in renewables, increase in distributed generation, etc.), as well as the increasing average age of assets on many transmission grids. In addition, the emergence of new technologies, combined with rising (regulatory) pressure on efficiency, increasingly requires TSOs to digitalize asset management and maintenance to ensure efficient grid management and operation. Indeed, while spending on standard equipment such as cables, transformers, switchgear and substations accounts for approximately 90 percent of total network investment, the share of smart grid technologies continues to rise (see above figure). As one of RTE's executives puts it: "We increasingly rely on silicon, not only on copper and steel".

Case study:

TenneT is investing heavily in Germany to connect offshore wind farms in the North Sea

Since 2006, TenneT has been responsible for developing and operating grid connections to offshore wind farms in its German area. TenneT will play a crucial role in connecting the offshore wind farms that the German government is planning to build (total capacity of 6.5 GW).

In addition, TenneT has developed a vision for a hub-and-spoke concept for large-scale wind energy on the North Sea. The company suggests building an artificial island to centralize electricity from multiple wind farms and using HVDC cables to transport electricity to the mainland. The cables would also interconnect North Sea countries.

Although it is not unusual for TSOs to deal with offshore grids, they often follow different regulatory frameworks. As such, offshore grid management offers a greenfield diversification opportunity.

Aside from this, development of offshore renewable generation assets leads to increasing grid development and reinforcement requirements, and also generates new opportunities. TSOs can capture new revenues from owning and operating offshore transmission assets outside of their home countries, thanks to a regulatory context which is often less restrictive than that for the mainland. In this context, multiple TSOs are developing the required capabilities to design and build offshore grids (see German case study). However, this also creates opportunities for new actors to enter the transmission value chain: companies such as Diamond Transmission Corporation, part of the Mitsubishi group, now own transmission assets, which they acquired through offshore wind developments in Western Europe.

Another CAPEX-intensive area for TSOs is the increasing international coupling of transmission grids. Numerous European projects of common interest involve building electric interconnections between the transmission grids of adjacent countries. Given that interconnectors have become part of the transmission networks of multiple TSOs, they are often built and operated in close collaboration. TSOs, having built one or multiple "local" interconnectors, can leverage the specific capabilities they have developed to build, and potentially own and manage, interconnectors in other countries.

TSOs willing to further leverage their asset management capabilities can also acquire grid companies (both TSOs and DSOs) abroad. This will allow them to optimally leverage the grid development, system operation and asset management capabilities they have developed in their respective markets – such as Elia's acquisition of 50Hertz. These types of initiatives will allow them to maximize shareholder value and diversify their portfolios of activities from a geographical and regulatory point of view.

Ecosystem facilitation

The energy ecosystem as a whole is undergoing fast-paced evolution. On the one hand, this questions the traditional role of each player in the value chain, but on the other hand, it creates opportunities for new/emerging roles. If traditional players are

Case study:

Initiatives to foster and support innovation within the energy ecosystem

Elia has launched a number of initiatives to stimulate innovation within the context of the energy transition:

- Elia stimulates innovation by investing in start-ups, such as energy software company Enervalis. The start-up's software enables "passive customers" to become an active part of the energy ecosystem. More specifically, Enervalis designs software to enable smart microgrids, smart buildings, smart EV charging and smart settlement.
- Elia has launched its second open innovation challenge for start-ups. The aim of the second edition is to improve forecasting of electricity production and consumption, while the first edition of the challenge focused on innovative solutions to increase public acceptance of the electricity grid.

not vigilant, these new roles may be fulfilled by new types of players (e.g., aggregators, new – offshore – transmission entrants). These new players might gradually conquer a share of the value in the market, decreasing the value left for traditional players.

In this context, it is of utmost importance for TSOs to reflect about the role they want to have in the future energy ecosystem and drive regulation in the right direction. TSOs are in the perfect position to facilitate and steer the ecosystem. As such, they should ensure the market as a whole is efficient and considered to be a level playing field by all potential players. In addition, TSOs could drive and accelerate innovation within the electricity ecosystem. They can achieve this by acting as incubators for new technologies (see Belgian case study), and ultimately by taking a leading role in the enhancement of the entire ecosystem.

Diversification

To maximize shareholder value, TSOs can pursue diversification opportunities outside of their core activities. On the one hand, they can leverage their specific skills and know-how by building, owning and managing telecom/utility networks, providing consultancy and EPC-type services or contributing to developing and building micro-grids in remote areas. On the other hand, they can leverage their long(er) investment horizons and technical knowhow to invest in infrastructure potentially adjacent to their transmission networks, such as electric vehicle (fast) charging stations and H2 infrastructure.

Key takeaways

While traditional grid management will remain necessary, the energy transition will challenge the historical allocation of roles in the electricity ecosystem and create new opportunities. We have seen from recent projects that these opportunities can be exploited by either existing players or new ones, especially considering new evolutions such as the emergence of micro-grids. Decentralized generation, as well as new, digitally-enabled use cases (DSR, V2G, P2P networks, etc.), will contribute to blurring the distinction between the roles of TSOs and DSOs. It will stimulate grid operators to increase their collaboration and partner with new players (e.g., aggregators) to achieve win-win situations.

In this context, TSOs will need to clearly define which role they want to play and stimulate regulatory clarity. While TSOs will never be service companies (as they are not allowed to own or operate generation units or provide flexibility services), they must make use of their current position in the value chain to evolve towards central facilitators, driving the development of electricity ecosystems across multiple facets and ensuring the system is capable of supporting all kinds of new players and use cases.

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