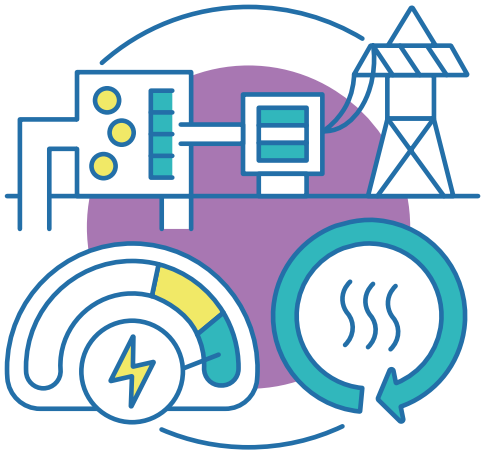
09
26
Issue: 17

SHURA AGENDA

Digitalisation



The transformation of the energy system and the transition to clean energy are progressing in parallel with the digital revolution. With the widespread adoption of distributed renewable energy and electrification, digital technologies are also reshaping the power value chain.

The report published by SHURA in 2022, titled "Analysis of Business Models, Technologies, and the Needed Regulatory Scheme for Power System Digitalisation in Turkey" , foresees that the adoption of digital technologies will not only transform business operations in the energy sector but also unlock new employment opportunities. The report highlights that digital activities and technologies are becoming more widespread to help transform the power sector value chain in parallel with the transition in energy systems.

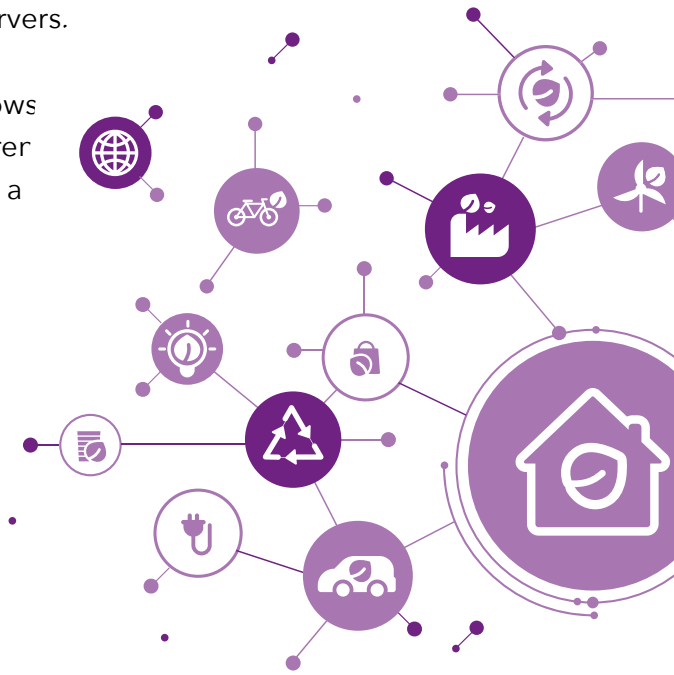
Why is digitalisation essential for the transtition of the energy sector?

As the transition of the energy sector unfolds and digital technologies bring new solutions to the industry, previously non-existent opportunities are emerging alongside new requirements. Foremost among them:

- Integration of Distributed Energy Resources (VRE) into the grid,
- Managing the increasing electrification load,
- Maintaining grid reliability,
- Addressing changing consumer demands,
- Effective management of data.

At this point, digitalisation enables the simultaneous management of energy resources, grid, data, and energy markets. The technologies listed below step in to address these emerging needs:

- **Robotic Process Automation (RPA):** RPA Focuses on automating repetitive, rule-based processes and handles activities such as data processing, data verification and extraction, form filling, report generation, system operations, and processing simple queries.
- **Internet of Things (IoT):** IoT connects devices, data, and processes to enable seamless communication with one another. The integrated control of electric vehicles and vehicle-to-grid (V2G) solutions represent another key application area of IoT.
- **Big data:** Big data enables energy companies to collect, store, and analyze vast amounts of information (e.g., energy generation/consumption) using analytical tools.
- **Artificial Intelligence (AI):** AI enables automated control solutions that address the needs of diverse stakeholders—ranging from consumers and power producers to transmission and distribution system operators (TSOs/DSOs) and retail companies. In systems with a high penetration of distributed energy resources, AI reduces operating costs while optimizing system integration with even greater shares of distributed generation.
- **Machine learning:** Machine learning Allows computers to learn from massive datasets and take action by making decisions without explicit programming
- **Blockchain:** It provides a mechanism for recording and validating transactions without relying on a centralized authority.
- **Digital twins:** It is used for simulation, performance monitoring, and scenario analysis by creating exact digital replicas of power plants, energy storage systems, and power grids powered by live data.
- **ADMS / DERMS:** An integrated software architecture combines Advanced Distribution Management Systems (ADMS) with Distributed Energy Resource Management Systems (DERMS). ADMS governs end-to-end grid operations while DERMS monitors and optimizes distributed energy resources such as rooftop solar PVs and battery storage.
- **Cloud-Edge Computing:** It is an hybrid computing infrastructure that processes time-sensitive grid decisions locally at the edge while executing big data analytics and centralized optimizations on high-capacity cloud servers.
- **Common Information Models (CIM):** CIM is an internationally standardized data architecture. It allows software, smart meters, and grid systems from differer manufacturers to communicate seamlessly by using a unified data language.



How does digitalisation contribute to the energy transition?

As a vital complement and core enabler of the energy transition, digitalisation seamlessly integrates renewable energy, energy efficiency, and electrification to optimize overall system performance.

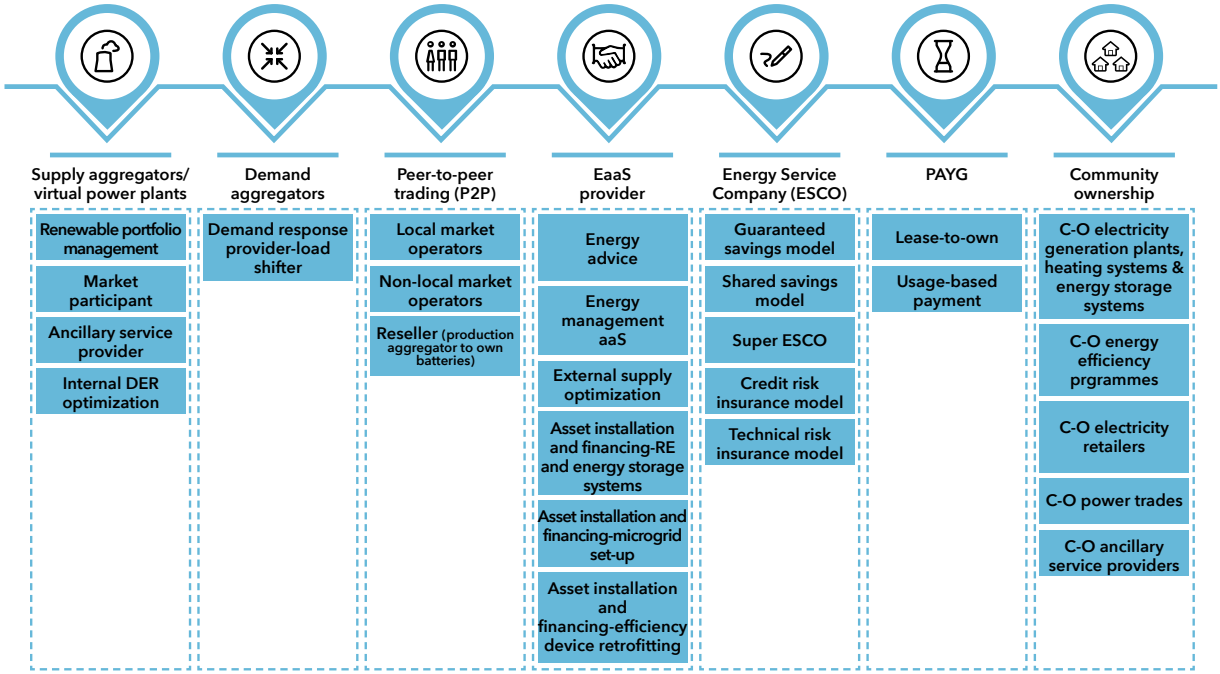
Figure 1. Contribution of digitialization to the energy transition process

Within the scope of Variable renewable energy sources;	• leverages AI-powered weather forecasting models to predict power generation in advance, • activates battery energy storage systems during periods of low generation, • establishes the supply-demand balance through smart grids.
Within the scope of Energy efficiency;	• detects energy waste through smart metering technology, • utilizes Digital Twin technology to create a virtual replica of a facility, optimizing machinery for maximum productivity with minimal energy consumption, • dynamically manages demand-side response in real time through IoT, AI, and smart meters.
Within the scope of Electrification;	• shifts electric vehicle charging to off-peak hoursa using smart charging technologies, • digital software identifies energy-intensive industrial processes and shifts production schedules to hours with peak renewable energy generation, • utilizes Vehicle-to-Grid (V2G) technology to feed electricity from plugged-in electric vehicles back into the grid in order to maintain power balance.

Digitalisation creates new business models

As the transformation of the energy sector introduces new requirements and challenges, digital technology-enabled solutions are paving the way for next-generation business models and service structures. In the report, SHURA categorizes these innovative models under seven key areas based on structural, product, and user-experience needs.

Figure 2. Business models within the scope of energy system transition

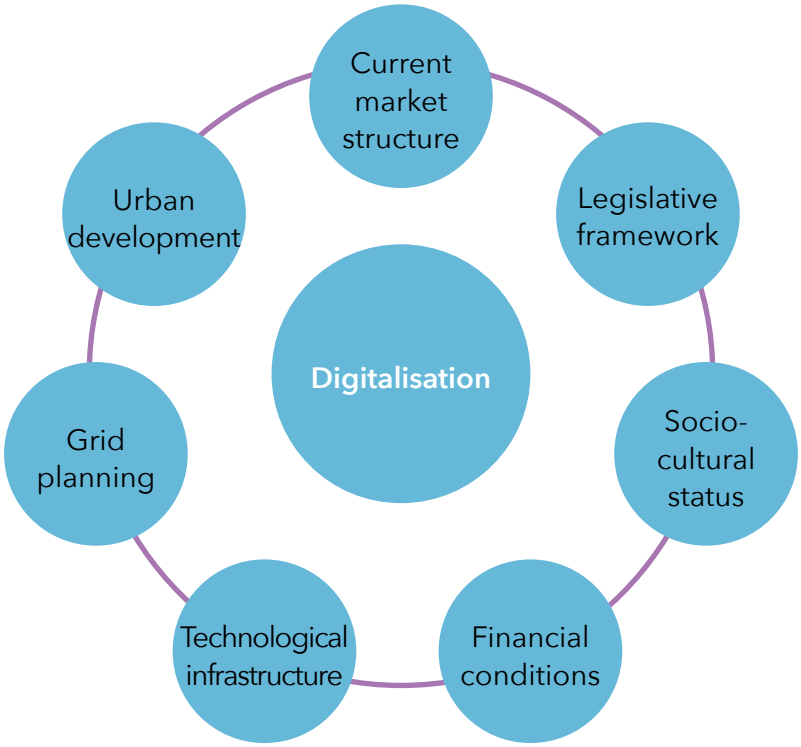


Source: SHURA (2022)

Digitalisation and the green transition are reshaping the workforce landscape. The World Economic Forum's Future of Jobs Report 2025 report highlights technological change and the green transition as the primary drivers shaping and transforming the global labor market through 2030. According to the report, AI and machine learning specialists alongside renewable energy engineers will rank among the fastest-growing roles through 2030. Additionally, demand for AI and data skills in the energy sector is projected to increase by 91%.

In this context, the SHURA's report recommends prioritizing viable business models that offer potential for all stakeholders in Türkiye's energy transition by analyzing them under seven key areas tailored to the dynamics of the Turkish energy market.

Figure 3. Key considerations for implementing new business models[1]



Source: SHURA (2022)

1. **Existing market structure:** A significant milestone was achieved with the transition to the Aggregator model. Regulations by the Energy Market Regulatory Authority (EMRA) and Energy Exchange Istanbul (EXIST) defined aggregator licenses and integrated their operations into the Energy Markets Management System (EPYS). Consequently, small-scale renewable and distributed capacities can now be traded in portfolios across the Day-Ahead, Intraday, and Ancillary Services Markets. However, dynamic pricing and peer-to-peer (P2P) energy trading are not yet widespread.

2. **Regulation:** Significant progress has been made in regulations targeting energy storage and hybrid facilities. While licensing processes for wind and solar power plants integrated with storage have been streamlined, legal uncertainties surrounding digital facilities, artificial intelligence, and aggregation activities have been largely eliminated.

3. **Financial conditions:** Although high borrowing costs continue to suppress investments, Battery Energy Storage Systems (BESS) and energy efficiency software benefit from easier access to international green financing. Digital transformation investments are increasingly prioritized in return on investment (ROI) calculations, as they are viewed as a key instrument to hedge against high balancing costs.

4. **Technological infrastructure:** The adoption of international standards such as the International Electrotechnical Commission (IEC) has expanded in hardware and software integration. While data security is being reinforced through the EMRA's Cybersecurity Capability Model, IoT and AI-based predictive maintenance applications are becoming widespread across Electricity Distribution Corporation (EDAŞ).

[1] For SHURA's detailed analysis on these topics, see: SHURA, 2022. "Türkiye'de Enerji Sektörünün Dijitalleşmesi Kapsamında İş Modellerinin, Teknolojilerin ve Gerekli Mevzuat Altyapısının Değerlendirilmesi". https://shura.org.tr/turkiyede-enerji-sektorunun-dijitallesmesi-kapsaminda-is-modellerinin-teknolojilerin-ve-gerekli-mevzuat-altyapisinin-degerlendirilmesi/

5. **Grid planning:** The rollout of remotely readable, bidirectional smart meters is advancing under EPDK's National Smart Metering System (MASS) regulations. As renewable power plants now account for over 60% of total installed capacity, grid flexibility and real-time load balancing have become critical for the Turkish Electricity Transmission Corporation (TEİAŞ) and EDAŞ, placing heightened operational pressure on digital infrastructure.

6. **Urban development:** The expanding adoption of electric vehicles requires the rapid growth of charging infrastructure and smart charging solutions. Although energy management systems are increasingly deployed in smart buildings and commercial real estate, smart grid integration at the municipal and zoning levels has yet to fully evolve into a holistic smart city framework.

7. **Socio-cultural conditions:** As unlicensed solar power (GES) capacity surpasses 20 gigawatts (GW), the 'prosumer' concept has become widespread across the commercial and industrial sectors. Although digital energy management capabilities are advancing, residential data privacy concerns, low awareness of automated demand response, and a shortage of qualified digital energy talent remain key challenges.

Over the past four years, key regulatory initiatives—including the Aggregation Regulation, the National Smart Metering System (MASS), and storage legislation—have largely resolved the regulatory and market structure barriers identified in SHURA's report. Moving forward, the strategic priority is to ensure that this established framework is fully translated into operational grid flexibility, effective data governance, and financial sustainability on the ground.

The heart of the data ecosystem: Data centers

Through digitalisation, energy systems are transitioning from traditional, centralized architectures toward dynamic, distributed, and smart networks. A robust data ecosystem serves as a fundamental pillar of this transformation. In line with this, IRENA's report 'Digitalisation and AI for Transforming Power Systems' highlights the development of data ecosystems as a critical step to maximize the value of digitalized power systems.

The efficient operation of this ecosystem requires a robust physical infrastructure capable of securely storing, processing, and analyzing data. Managing real-time supply-demand balance, forecasting renewable generation fluctuations through AI, proactively detecting faults, and integrating the growing volume of electric vehicles and battery storage systems demand increasingly high computing power and reliable data infrastructure.

Digitalisation unlocks opportunities but expands the cyber threat landscape. With millions of smart devices, distributed energy resources, and digital platforms interconnected, data integrity and system resilience are critical. Advanced encryption, AI-driven threat intelligence, and network segmentation protect the grid against malicious data and unauthorized control commands.

Consequently, data centers are emerging as critical infrastructure not only for the digital economy but also for the digitalizing energy system. By aligning resilient data infrastructure with robust cybersecurity, energy systems can achieve smarter, more flexible, secure, and seamless operations.

The rising importance of digitalisation on the path to COP31

In terms of the sustainability and effectiveness of the energy transition and climate action, digitalisation has become a strategic leverage point for COP processes. Indeed, the "Green Digital Action" initiative launched under the leadership of the International Telecommunication Union (ITU) at COP28, alongside the "Green Digital Action Declaration" adopted at COP29, placed the potential of digital technologies to both reduce the carbon footprint and strengthen early warning and data-driven solution mechanisms against the climate crisis high on the global agenda.

At COP31, to be hosted by Türkiye, digital infrastructure is expected to play a central role in driving smart grids, emissions tracking, AI-driven energy management, and circular economy integration. Moving beyond the high-level declarations of past summits, digitalisation can thus serve as a core operational framework that enables the transparent, measurable, and seamless execution of global climate commitments.

Recommendations for Türkiye within the scope of digitalisation

On the path toward Türkiye's 2053 net-zero emission target, digital transformation serves not merely as an operational convenience, but as a strategic lever to achieve emission reduction and sustainability goals. In line with Türkiye's climate objectives, elevating energy management, data transparency, and infrastructure efficiency to the highest level is achievable only through the proper integration of innovative digital technologies. In this context, priority digitalisation steps that will both strengthen Türkiye's standing in international climate diplomacy and accelerate its green transition process are outlined below:

Grid modernization must be designated as a priority of the energy transition. In line with the updated Nationally Determined Contribution (NDC 3.0) and the net-zero emissions target, grid investments must be executed in parallel with scaling up renewable energy capacity, enhancing energy efficiency, and accelerating electrification. Concurrently, the deployment of smart grids, microgrids, and other alternative grid solutions should be actively supported.

The deployment of technologies that accelerate the digitalisation of energy systems should be actively incentivized. The integration of IoT, artificial intelligence (AI), machine learning (ML), big data, Advanced Metering Infrastructure (AMI/MASS), advanced sensor networks, and battery storage systems into energy networks should be supported. Specifically, to reduce grid losses; enable real-time load monitoring, enhance fault management, and improve security of supply, the nationwide deployment of AMI/MASS and sensor infrastructure must be accelerated.

Data standardization and cybersecurity must be strengthened during the grid digitalisation process. Common data formats and data-sharing standards should be established among distribution companies. Mandatory cybersecurity testing, certification, and minimum security standards for smart meters and grid-connected IoT devices must be deployed at scale. Furthermore, national data security standards should be fully integrated into energy legislation.

Strategic data infrastructure must be strengthened to secure critical energy data. To secure the storage and processing of Türkiye's critical grid and consumption data, the localization of strategic data centers within national borders should be actively supported. Data center investments planned under the 2030 roadmap should be co-located with renewable energy sources, utilizing battery storage and flexible load management to enhance power grid flexibility. Furthermore, an 'Smart Data-Energy Center' model—where data center battery storage systems provide frequency response services—should be evaluated.

A conducive investment climate must be established to incentivize new business models and drive digital transformation. Targeted incentive and financing mechanisms must be developed to offset the high upfront capital costs of digital grid infrastructure, energy storage, data centers, microgrids, and other emerging technologies. In parallel, existing market structures, regulations, financial conditions, technological infrastructure, grid planning, and urban development frameworks should be reviewed to enable new digital business models.

A qualified workforce for digital infrastructure and cybersecurity must be developed. To build specialized talent in AI, data analytics, digital grids, and cybersecurity for Türkiye's energy sector, universities should launch targeted training programs and update curricula for emerging skill sets. In parallel, Research & Development partnerships among energy companies, academia, and industry must be strengthened to accelerate the development and commercialization of digital technologies.

The development of open data protocols, common integration standards, advanced metering infrastructure, and responsible AI governance must be actively supported. While legal uncertainties surrounding artificial intelligence, digital assets, and aggregation have largely been addressed, several critical gaps must still be resolved to realize digital transformation. First, establishing neutral data platforms and adopting common data standards (such as CIM) will be essential to ensure transparent data access and seamless system interoperability. Second, smart metering infrastructure must be widely deployed to verify flexibility services. Finally, creating a clear governance and liability framework will be vital to manage the operational and cybersecurity risks associated with autonomous AI decision-making.