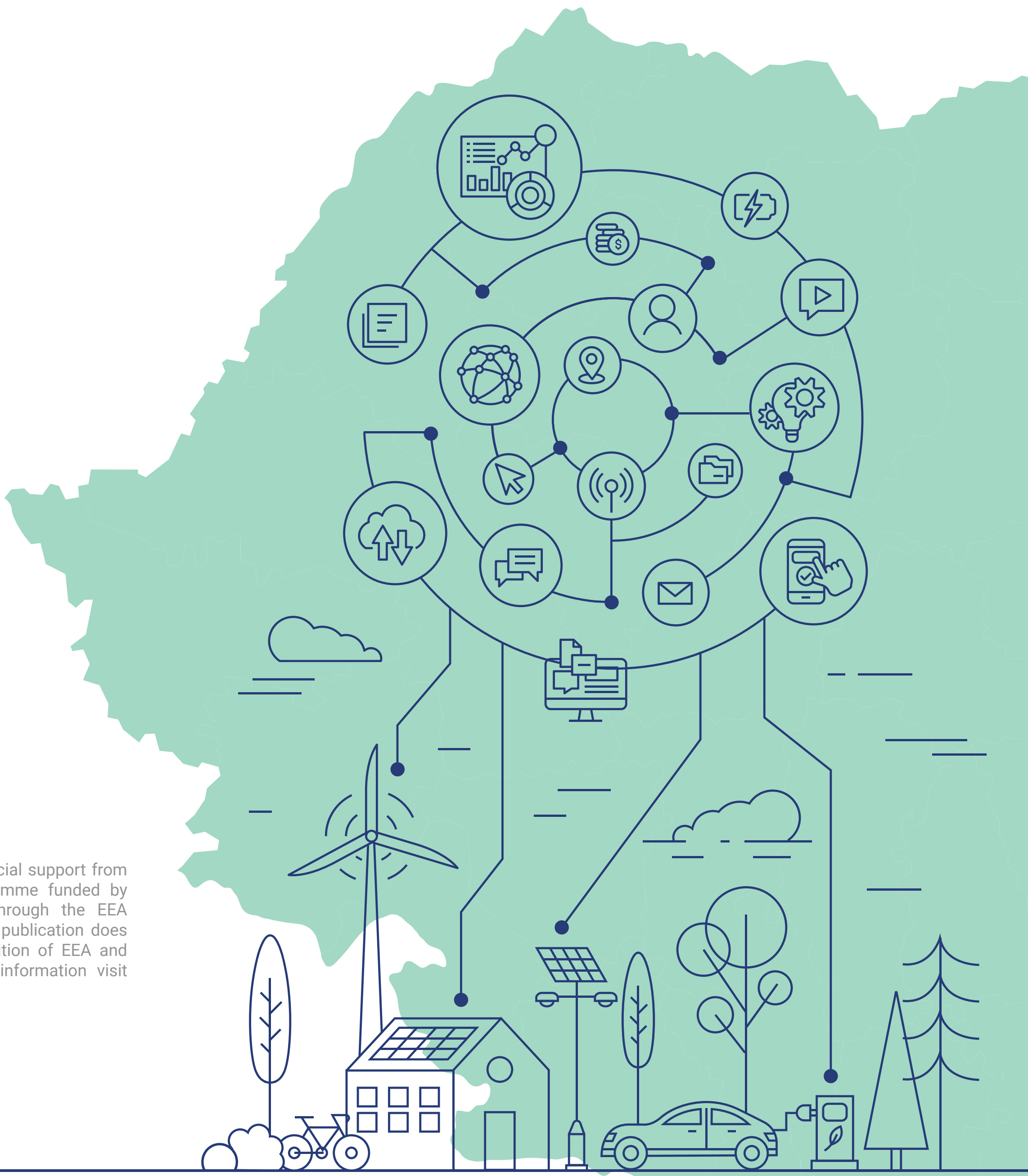
DIGITALISATION OF THE ROMANIAN ENERGY SYSTEM

November 2021



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Digitalisation of the Romanian energy system

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ACRONYM LIST

EFA	Environmental Fund Administration
ANRE	Romanian Energy Regulatory Authority
UNECE	UN Economic Commission for Europe
COP21	Conference of the Parties 21 (Glasgow 2021)
EU ETS	European Union Emissions Trading System
IoT	Internet-of-Things
IPCC	Intergovernmental Panel on Climate Change
OPCOM	Romanian Gas and Electricity Market Operator
NRRP	National Recovery and Resilience Plan
DAM	Day-Ahead Market
NES	National Energy System
SCADA	Supervisory Control and Data Acquisition
IT&C	Information Technology and Communications
V2G	Vehicle-to-Grid
VPP	Virtual Power Plant

EXECUTIVE SUMMARY

The need for immediate action to accelerate the energy transition and decarbonise the transport or building sector leads, now more than ever, to systemic shifts. The energy transition requires cross-sectoral efforts, one crucial element of which is digitalising energy systems and their interconnection, access to grids or consumption experience.

Digitalisation will consequently change the ways of producing, transmitting, distributing, integrating, storing and consuming energy. Using digital processes and technologies makes new ecosystems available. They include: the appropriate integration of rising renewable and clean energy production in the national system, decentralised energy production and consumption (prosumers), integrating and streamlining energy mobility, making transmission and distribution grid more flexible or increasing energy efficiency in buildings.

The Romanian energy sector is in a difficult position, having to mitigate the effects of a lack of decision-taking and the consequences of delaying or anyway reducing some grants or some public policies meant to generate investments in transmission and distribution grids, generation capacities, energy efficiency in buildings, transport or heating sector. These measures, long overdue, are now causing economic issues to the grid administrators and operators, to utilities suppliers and consequently to the end consumer, who is facing a steady increase in energy prices.

For these reasons and given the current technical context of the National Energy System (NES), as a whole, accelerating the digitalisation process is a mandatory prerequisite for Romania to reach its 2030 and 2050 environment goals.

Technology and digitalisation not only provide practical solutions for the energy systems, therefore having a positive impact in protecting the environment, but they also bring plenty of economic and social benefits. Producing, installing or maintaining this equipment translates into a high number of jobs bringing revenue and taxes to the state budget. Moreover, integrating the various technologies above facilitates appropriate support for vulnerable consumers. Increasing the digitalisation level is an investment not only benefitting the economic sectors implemented in, but also having positive transversal effects, solving and tackling complex social or environmental issues.

The current context offers multiple investment options and funding sources, by participating in the European Union's common efforts to make the energy consumption more efficient and increase clean energy consumption rate.

Some of the most important immediate options available to the Romanian energy sector in order to increase digitalisation include:

National Recovery and Resilience Plan (NRRP) – with the following components: sustainable transport (EUR 7.62 billion), renovation wave (EUR 2.2 billion), energy (EUR 1.62 billion), digital transformation (EUR 1.88 billion), local fund for green and digital transition (EUR 2.1 billion).

Modernisation Fund – potential projects in the areas of energy efficiency, storage and modernising energy grids. Estimated budget: 2% of the grants for 2021-2030, under the emissions trading scheme (EU ETS) → roughly EUR 200 million

Innovation fund – projects for energy storage and innovative renewable energy solutions. Estimated budget: EUR 30 billion (2020-2030)

Operational programmes – part of developing investment priorities of the European Union's Cohesion Policy

Just Transition Fund – opportunities for developing new industries bringing benefits and products/services in the field of digitalisation and smart grids. Estimated budget: EUR 1.8 billion

Connecting Europe Facility Mechanism – objectives to increase the development of efficient and sustainable transmission grids, energy and digital services.

LIFE Programme 2021-2027 – European financial instrument for the Environment and Climate Action. Estimated budget: EUR 5.4 billion (2021-2027)

Besides these opportunities Romania can take advantage of as a member of the European Union, there are also "classic" mechanisms which can lead to a quicker adoption of digitalisation in the sector. For transmission and distribution operators, these are increasing investments in digital solutions by including them in tariffs, which is always an important opportunity. Moreover, various forms of support schemes or vouchers for the final consumer are necessary, for example new and existing funds from the Environment Fund Administration (EFA) for electric or hybrid vehicles, photovoltaic panels or energy efficiency in buildings.

In this context, several recommendations to increase digitalisation in the national energy system arise – pertaining to primary and secondary legislation but also to the general area of public policy:

Public and private governance

- Placing the digitalisation process as the main segment in various strategic documents supporting the development of the national energy system.
- Developing and improving the digital channels and platforms between energy suppliers and distributors and their customers / consumers.
- Streamlining the process to connect consumers and prosumers to the grid – joint effort of ANRE and grid operators.

Electrical grids

- Accelerating the deployment of smart meters, in order to take advantage of the various benefits they unlock.
- Increasing the adequacy level of energy transmission and distribution grids by developing large energy storage capacities and integrating them through digital instruments and platforms

Transport

- Continuing to grant subsidies for electric vehicles. In order to reach the decarbonisation targets, additional programmes dedicated for commercial fleets are crucial.
- Subsidies for electric vehicles charging stations, especially in small and medium municipalities.
- Drafting dedicated legislation for vehicle-to-grid (V2G) solutions – allowing electric vehicles owners to inject energy back into the grid when the system needs it and compensating them for the service.

Prosumers and energy communities

- Maintaining the current efforts to develop an improved compensation system for prosumers.
- Prioritising subsidies towards vulnerable consumers. In this scenario, increasing the subsidies from 90% of the required amount to 100% of the required amount is needed (so that the consumer does not have to also fund the prosumer system).
- Promoting battery systems is crucial, by drafting clear regulations on how battery-stored energy should be transferred to energy suppliers and by subsidising those systems.
- Developing similar subsidy systems for off-grid household or industrial consumers.
- Streamlining the bureaucratic process for granting subsidies and approving the prosumer status.

Demand response

- Drafting dedicated legislation to ensure the demand response mechanism performs efficiently.
- The efficient performance mentioned above requires a critical mass of smart meters installed in the grid.

Energy efficiency

- Overcoming legislative obstacles to apply energy performance contracts.
- Decarbonising household heating through smart integration of renewable energy solutions.
- Increasing the share of refurbished public buildings and blocks of flats and implementing digital instruments and services to automatically monitor, analyse, control and adjust thermal and electrical energy consumption.
- Drawing up subsidy programmes for the transition towards smart and energy efficient equipment (lightning, sensors, appliances, etc.).

Delaying the adoption of these digital elements will increase the number of issues the national energy system already faces today: the difficult and late integration of renewable energy sources; increased greenhouse gas emissions in the whole system, increased energy prices or missing the opportunity to create new jobs.

INTRODUCTION. CURRENT CONTEXT

The latest report, published in august 2021, of the Intergovernmental Panel on Climate Change (IPCC) – a structure of the UN with the specific purpose of providing scientific information to understand human impact on climate change – brings concerning proof and perspectives on the environment and climate.

The need for immediate action to accelerate energy transition and decarbonise the transport or building sector leads, more than ever, to systemic shifts. In this context, increasing the electrification share – now at 20% of the total world energy consumption – combined with expediting the adoption of renewable and clean energy sources are crucial elements to reach the climate targets committed to in the Paris Agreement at the COP21 conference in 2015.

These processes, pertaining to both the energy production and consumption sectors, are the challenges of the next decades, equally impacting economic, social or ethical aspects. To make these processes faster and more efficient, **the energy transition requires cross-sectoral efforts, one crucial element of which is digitalising energy systems and their interconnection, access to grids or consumption experience.**

Just in the same way that digitalisation contributed to the development and transformation of various economic sectors, energy will as well. Digitalisation already facilitated several industry developments and the penetration rate of these solutions is expected to increase until 2050 up to roughly EUR 38 billion market size.[1]

Digitalisation will consequently change the ways of producing, transmitting, distributing, integrating, storing and consuming energy. Using digital processes and technologies makes new ecosystems available. They include: the appropriate integration of rising renewable and clean energy production in the national system, decentralised energy production and consumption (prosumers), integrating and streamlining energy mobility, making transmission and distribution grid more flexible or increasing energy efficiency in buildings. Moreover, energy markets – both wholesale and retail – as known today, will transform into more efficient, functional and inclusive markets with increased competition.

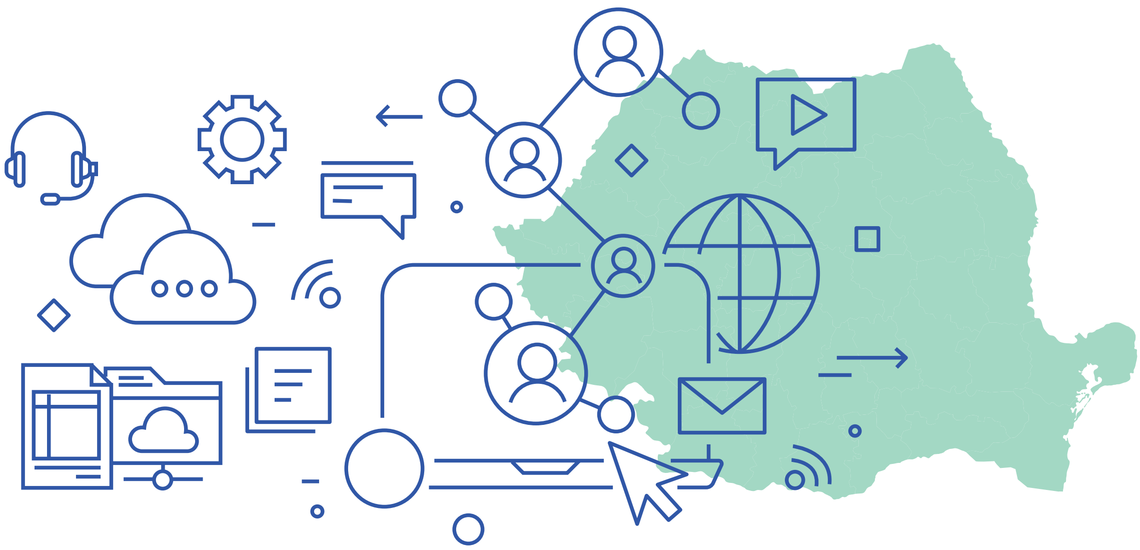
The Romanian energy sector is in a difficult position, having to mitigate the effects of a lack of decision-taking and the consequences of delaying or anyway reducing some grants or some public policies meant to generate investments in transmission and distribution grids, generation capacities, energy efficiency in buildings, transport or heating sector. These measures, long overdue, are now causing economic issues to the grid administrators, operators and utilities suppliers and consequently to the end consumer, who is facing a steady increase in energy prices.

1. BNEF, Costs and Benefits of Digitalizing Energy, 2018

However, the European Union's targets generate the urgency of drawing up national strategies and objectives so that the climate targets committed to at the EU level are met. As a result Romania will develop public policies to stimulate investments in clean energy (through various subsidy schemes), both regarding production and consumption. For these reasons and given the current technical context of the National Energy System (NES), in its entirety, **accelerating the digitalisation process is a mandatory prerequisite for Romania to reach its 2030 and 2050 environmental targets.**

Technology and digitalisation not only provide practical solutions for the energy systems, therefore having a positive impact in protecting the environment, but they also bring plenty of economic and social benefits. Producing, installing or maintaining this equipment translates into a high number of jobs bringing revenue and taxes to the state budget. Moreover, integrating the various technologies above facilitates appropriate support for vulnerable consumers. Contrary to what may be expected, digitalisation is a crucial element, in all its forms, in tackling energy poverty, through energy efficiency, monitored and predictable consumption or by changing, automatically or otherwise, the customer's consumption behaviour.

In Romania's case, the opportunity to increase the digitalisation rate in the energy sector has several specific advantages. Given that IT&C contributes roughly 7% to the country's GDP, Romania has a competitive advantage allowing it not only to rapidly adopt digitalisation in the energy field, but also to become a regional and European provider of digital services for the energy industry. Some more reasons for Romania to seize this opportunity include: Romania's already extensive experience in the IT sector, its highly qualified human resource, the relatively low workforce costs or the beneficial fiscal framework, as well as the already existing large-scale technology and IT services providers operating in the country.



1. DIGITAL TECHNOLOGIES AND SERVICES

Digitalisation can be defined as the process of connecting various pieces of equipment, through digital communication, in order to collect, share and analyse data to improve processes or operations. [2]

Alternatively, the UN Economic Commission for Europe (UNECE) defines digitalisation as **the process of converting physical or analogue information into a systematic digital format that can be stored as well as processed for business or policy decisions for advancing the overall productivity, cost, safety and sustainability.**[3]

If correctly implemented, digitalisation does not threaten the current economic or social structure. On the contrary, digital technologies and services increase energy security and energy and environmental equity, while also generating economic added value.

Smart meters

Although current energy systems already contain basic digital technologies, without which the whole system would not work, **the foundational element to develop new energy ecosystems is the smart meter.**

The smart meter is a device allowing to monitor, record and send, in real-time, the energy consumption from end consumers to energy utility companies.

Their large-scale integration – not only in pilot projects or by randomly connecting consumers – generates multiple direct benefits for consumers, utility companies or energy systems as a whole. Moreover, significant indirect benefits regarding environmental protection are gained, by appropriately integrating renewable energy producers and through energy efficiency.

Future systems for energy production and consumption, including prosumers, for energy storage, energy management, demand-side response, vehicle-to-grid (V2G) technology or Internet-of-Things (IoT), these systems are all based on the smart meter.

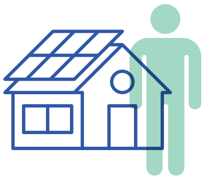
2. BNEF, Digitalization of Energy Systems, 2017
3. UNECE Group of Experts on Energy Efficiency, Digitalization: enabling the new phase of energy efficiency, 2020

Concrete benefits include[4]:

Individual consumption monitoring	the end consumer equipped with a smart meter is able to understand the consumption behaviour and thus its associated energy costs. The displayed information directly predicts the energy invoice amount and thus translates to informed decisions, by purchasing new, energy efficient products, by rescheduling energy-intensive activities (such as washing laundry or dishes) outside peak hours or by halting useless consumption
Efficient integration of renewable energy sources	optimised energy consumption (which in practice equals to reduced demand in the system's peak hours) also facilitates an improved forecast of the population's aggregated consumption. This process leads to employing less of the fuel-based power plants for peak generation, as well as avoiding additional investment in such capacities, resulting in several benefits when it comes to greenhouse gas emissions. Predictable consumption also decreases forecast errors, which translates into lower energy bills due to reduced supplier costs.
Benefits brought by optimising distributor processes	smart meters do not need local reading, so manual readings (both by the customers and by the distribution company's employees) can be eliminated, which will decrease distribution tariffs. Moreover, the time needed to detect outages and grid failures, on one side, and to solve these issues remotely, on the other side, will be decreased significantly by the smart meters technology.
Benefits provided by energy suppliers	having a much better understanding of its customer's energy consumption habits, a supplier will be able to better tailor its products and services. For instance, a customer with an unusual high consumption could be directed towards energy efficient solutions (more efficient appliances, LED lightning, etc.). Moreover, suppliers could offer customised tariff plans, based on the energy demand profile. • Additionally, smart meters offer high data security and privacy, as the personal information goes automatically to the utility companies for billing and optional marketing services (if the customer had agreed beforehand), without the need of a manual reading by a human operator.
Protection of vulnerable consumers	as it will be possible to monitor the individual energy consumption, suppliers can detect unusual consumption during winter, which is often a solid indicator of energy poverty. Identified vulnerable customers can be offered various state subsidies or specific contractual clauses, such as invoice payment in instalments.

4. Energy Policy Group, The little smart-meter that could, 2017

Prosumer ecosystem
(including off-grid, battery, energy management solutions)



Decentralised energy production, most often by photovoltaic panels on buildings, generates a whole ecosystem of opportunities and options for their users, but also with immediate benefits for the whole grid.

The capacity to produce energy in a decentralised manner through photovoltaic panels – which is possible thanks to the digital technologies the system is based on – provides medium and long term financial benefits to the user. The prosumer manages to avoid energy consumption from the local grid, which implies transmission and distribution fees, support schemes (green certificates, highly efficient cogeneration bonus), as well as taxes and excise duty. Moreover, the electricity surplus is injected into the grid, taken over by the supplier and the photovoltaic panel system user is compensated for this contribution.

This is beneficial not only for the prosumer, but also for the distribution grid, which is used less, partially solving the local system congestion. Moreover, as the prosumer now needs a reduced energy consumption from the grid, centralised production is also lowered. Quite often, especially in peak hours, this energy demand now "saved" by the prosumer comes from fossil fuel plants, which generate CO_2 and other pollutant gas emissions during the production process.

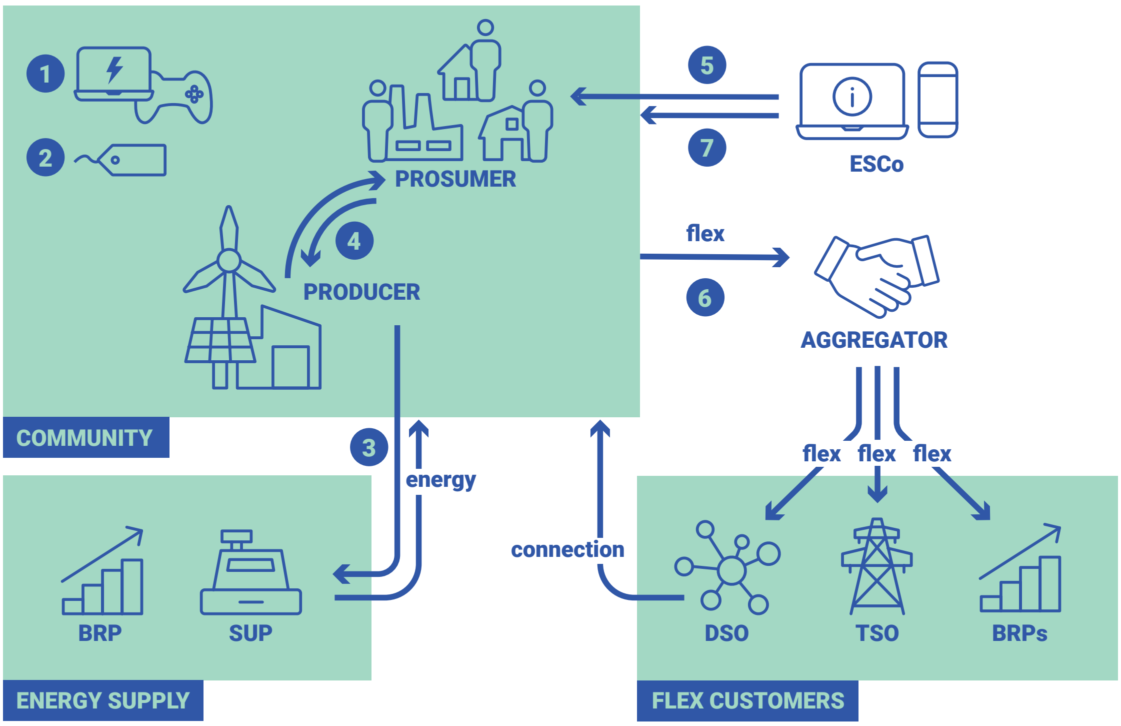


Figure 1
The prosumers and energy communities ecosystem[5]

1. Services to increase energy awareness
2. Joint purchase and maintenance of (shared) assets
3. Supply of (shared) energy
4. Peer-to-Peer supply
5. Optimize individual Prosumers' energy profiles
6. Provide explicit demand-side flexibility services
7. Optimize the community energy profile

5. Elke Klaassen, Marten van der Laan, Energy and Flexibility Services for Citizens Energy Communities, USEF, 2019

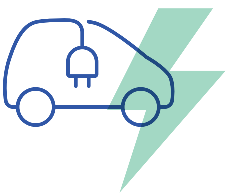
The benefits of prosumers multiply in the case of local prosumer communities/cooperatives – prosumer groups which aggregate their energy production and consumption in order to optimise revenues and costs regarding these utilities. Trading between prosumers, when the consumption is higher than their own production, mass trading (including by virtual power plant system, VPP) the aggregate production or the ability to be flexible are just some of the benefits of prosumer communities.

Although purchasing an additional storage system (batteries) can be costly for a prosumer, these technologies unlock a new frontier in decentralised energy production management. In practice, the energy surplus produced during the day (the difference between the instant production and consumption of the household) is stored in batteries and used during the evening, without local production. In this manner, the user not only avoids an increased energy consumption in peak hours, mostly at a higher price than in off-peak hours, but also continues to directly contribute to decreasing congestion in the energy distribution grid.

Additionally, an intelligent energy management system (photovoltaic panels – batteries) is capable of automatically optimising energy consumption and storage, based on the system consumption forecast, price fluctuations or the user's consumption habits.

In the same manner, technologies and technological services allow various local production/consumption ("peer-to-peer") points to be interconnected in off-grid systems, which leads to optimised renewable energy production and consumption in remote locations far from the energy grid. For example, an intelligent energy management system with photovoltaic panels and batteries can efficiently supply irrigation systems not connected to the grid by also taking into account the optimal irrigation period of different cultures.

Electric mobility and V2G

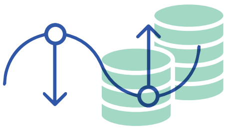


Transitioning to sustainable transmission systems depends mainly on digital technologies and services. Integrating charging stations of varying powers – an important challenge regarding distribution systems congestion – in the already existing grid, managing dynamic – and less predictable (at least until the maturity period of electric vehicles) – energy demand can both be solved by digital electrical grid management systems.

Beyond these technical aspects, the users' experience, who will want to charge their electric vehicles from any charging station supplier, must be facilitated by digital platforms, available on their phones.

Additionally – especially in the context of energy communities – the vehicle-to-grid technology, where the user supplies electricity to the grid in specific moments based on the vehicle's battery capacity, is an important technological and commercial innovation. This will make the decision to purchase an electric vehicle easier – both for the household consumer, but especially for company fleets – and will facilitate the adoption of electric vehicles in the distribution grids.

Demand-side response



An important element made available by adopting digital solutions is demand-side response. The flexibility to stop or lower the energy consumption for relatively short periods of time, especially in peak hours, enables the transmission operator to compensate those involved in this system. Integrating these elements – which can often be part of prosumers and energy communities ecosystems – is done by digital systems suppliers.

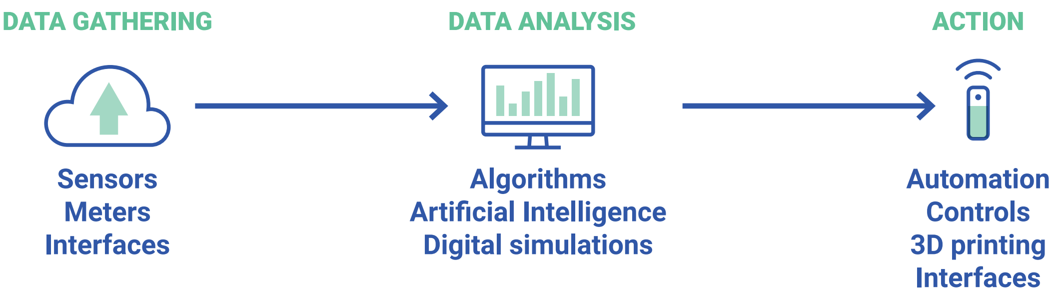
For example, for industrial consumers, demand-side response can mean slightly increasing the temperature in cold storage rooms or decreasing the speed of conveyor belts in automated processes. For household consumers, participating in this system could mean changing the energy consumption schedule, based on price signals by the transmission operator. Moreover, in the case of IoT devices (devices equipped with sensors and able to analyse data and communicate and exchange information with other devices and systems, through the internet or other telecommunication networks), these processes happen automatically, and the digital platform maximises the consumption potential in the case of energy market signals.

Energy efficiency

Digitalisation – through digital technologies and services – brings the opportunity to improve energy efficiency by acquiring and analysing data, as well as by providing automated processes in residential, public or industrial buildings.

Acquiring data, through various sensors and technological measuring instruments, allows a better understanding of the consumption trend, as well as of its context (the state of the energy system, of the energy markets, etc.). Data is analysed so that various algorithms are developed for devices used at the location, as well as for simulating the effects on energy consumption. Lastly, decisions can be taken through the automation facilitated by some technologies (e.g. turning lights off in a room where no movement is detected) or through a user's input (e.g. opting for short or long washing machine programmes, based on that particular moment's market conditions.

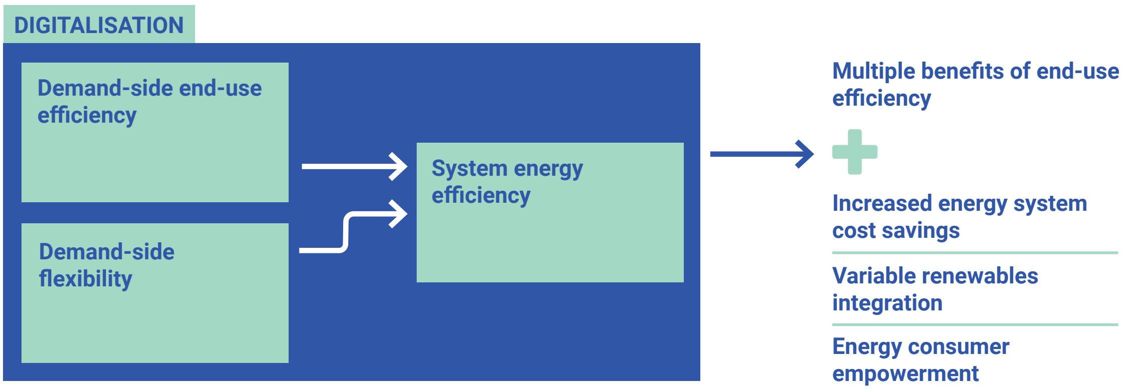
Figure 2
Digitalisation to increase energy efficiency[6]



6. International Energy Agency, Energy efficiency and digitalisation, 2019

Although the benefits of using various technologies are easily noticeable and quantifiable at the individual level (e.g. a household, a public building, a factory), the interconnection of these systems brings additional benefits to the whole energy system, which generate multiple positive externalities. The digitalisation of buildings means not only more efficient local consumption, but it also transforms these locations in flexible elements of the national energy system capable to inject electricity, produced by photovoltaic panels, back into the grid, when the system needs it, or to reduce the energy demand, based on the market dynamic or on the grid congestions. These elements combined make the whole energy system more efficient, which leads to optimal usage of the generation capacities, thus avoiding excess use of fossil fuel plants and as such significantly reducing the system's emissions.[6]

Figure 3
Digitalisation – Benefits for end-user consumption but also for the whole energy system[7]



Moreover, digitalisation has an essential role in manufacturing, operating or maintaining various installations, physical elements or processes of the energy system. Concepts such as building information modelling (BIM), 3D printing, predictive maintenance (including through digital twin systems) and artificial intelligence (AI), LIDAR measurements (Light Detection and Ranging), using drones for maintenance activities, advanced remote control (including through 5G communication), using data centres for information management or cybersecurity are only some of the digital elements essential to the functioning of today's energy systems.

Energy efficiency, especially in the case of public and residential buildings, has an immense potential to reduce Romania's environmental impact. Digital technologies and processes are needed to reach this objective. In this context, it is essential to use digital solutions to manage building energy consumption with the help of sensors and to manage production/consumption in real-time.

7. International Energy Agency, Energy efficiency and digitalisation, 2019

2. DIGITALISATION FOR SUPPORTING THE INTEGRATION OF RENEWABLE ENERGY

2.1 The current digitalisation level of Romania's National Energy System

Although many of the previously mentioned aspects refer to emergent technologies or future ecosystems, digitalisation – as a basic concept – is not a new element in the energy sector, in general, and the Romanian energy sector, in particular. The grids of the transmission operator, Transelectrica, as well as those of electricity distributors, were subjected to significant digital transformations in the latest years. Those include SCADA systems (Supervisory Control and Data Acquisition) or remote management. At the same time, grid operators' investment plans include complex infrastructure digitalisation projects, from investments in cybersecurity to Smart Grid and Asset Management standards, up to establishing research and development centres in the digital field.[8]

However, the steps taken for the Romanian energy system's digitalisation and upgrade, in order to continuously and rapidly integrate renewable energy or to improve electricity consumption, which will unlock opportunities to the sector's new frontiers, were scarce and shy. One argument often present in the regulatory authorities' discourse about accelerating the digital transition is the consumers' capacity to finance these projects. In other words, increased digitalisation investments would immediately translate into higher transmission and distribution tariffs, which will be paid by all consumers. Although the reasoning is sound, analysing the benefits brought by digital systems should not only consider costs and should not be done on the short term. Increasing digitalisation brings long-term benefits. Moreover, digitalisation is able to decrease cost elements currently paid by the consumers (for example, manual readings, long duration and complex procedures to remediate grid outages) and even cancel future costs caused by a low digitalisation rate.

Smart meters, a basic element of modern energy systems, entered Romania's distribution grids as part of successive pilot projects. The projects were supposed to help the regulatory authorities understand the benefits of this technology. However, the way install plans were approved – randomly, and not throughout the whole distribution area – did not immediately reveal those benefits, instead leading to scrambled results. Although modern energy systems in Western Europe started or are preparing to replace the first generation of smart meters with the second one, more efficient and more modern generation, the Romanian authorities provide extended schedules to adopt this technology. According to the current implementation calendar approved by the authorities, the share of smart meters is set to increase until 2028 only to values between 33% and 70%, depending on the distribution area.[9] This delays the benefits a critical mass of installed smart meters would have brought.

8. Transelectrica, Development Plan of the Electrical Transmission Grid for the 2020-2029 period, 2020
9. ANRE, Decision No. 778 of 8 May 2019

The concept of prosumer – largely debated in Romania for many years – was defined and included in primary legislation in 2018, but secondary legislation and implementation methodologies were delayed. The programme granting subsidies for photovoltaic panels, implemented by the Romanian Environment Fund Administration (EFA), also recorded significant delays, with less than 20% of the projects receiving actual funding, until 1 July 2021, from a total of 12,668 approved applications[10].

Although they enjoy a series of benefits in the relationship with the supplier (they are exempted from paying distribution and transmission tariffs or VAT for the energy injected back into the grid), at the moment prosumers receive a fixed compensation per MWh for the excess energy injected into the grid. It is defined in the law (average weighted DAM price of the previous year) and is independent of the prosumer's activity or from a potential negotiation with the contracting utility company.

Prosumers have often highlighted that the selling price of decentralised production (average weighted DAM price of the previous year) is lower than the buying price for the energy consumed from the supplier. The current situation of the DAM will cause this weighted price to rise, which will result in increased revenue for prosumers. Although this also causes the supplied energy price to increase, this situation underlines yet again the importance of decentralised production and reduced supplier consumption.

Moreover, neither the status of prosumers owning storage solutions nor how to handle the energy from these batteries is clearly defined.

Additionally, although decentralised prosumer-type production is a fitting solution for vulnerable consumers (connected to the national grid or not), there are no viable programmes to prioritise this technology for vulnerable categories. In other words, the grant offered today by EFA is largely attractive for the population segment with relatively high income, who can afford to copay roughly 2000 RON (EUR 400) for the prosumer kit.

Demand response is equally far from achieving its technological potential. Although current procedures allow, in theory, to control and, if necessary, gauge the consumption of big consumers, there is no experience and no real market for such services. Additionally, the concept of demand-side response for household consumers is not yet regulated and technically possible.

Similarly, there are no specific technical or legislative solutions for electric vehicles to inject energy into the grid (vehicle-to-grid), which could promote electric mobility in the country's large cities.

10. Roxana Petrescu, Not even 20% of the grant contracts signed through the "Green House" programme were settled. The others are still in pre-approval state, Ziarul Financiar, July 2021

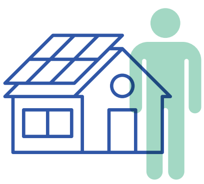
2.2. Necessary investment areas to sustainably develop smart electrical grids

The digitalisation potential of the energy transmission chain is far from being achieved. Increasing the digitalisation level is necessary both to streamline the use of the current renewable energy producers, but also to integrate new such capacities.

One of the technical obstacles to rapidly increase installed renewable energy production capacities is the inability of the energy transmission grid to handle these new volumes. Given that renewable energy production is distributed mainly in the Dobrogea region (where major nuclear energy production is also present), handling new energy volumes in this geographic area is difficult. In this regard, massive investments are needed for new high voltage lines, to decrease grid congestion and increase grid adequacy.

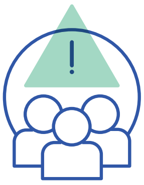
Although new digital technologies and services cannot replace the massive benefit future transmission lines must bring, there are multiple solutions to make energy management more efficient in order to decrease the need for the investments above.

Accelerating the adoption of **smart meters** will bring plenty of benefits. Smart meters contribute to a better energy demand forecast, as well as reducing the demand (as a result of changing the consumption habits), which leads to optimised renewable energy usage, as well as avoiding energy production from fossil fuel power plants, thus avoiding significant greenhouse gas emissions. The cost increase associated with accelerated smart meter installation will be cancelled by reducing costs with manual reading, rapidly solving technical issues remotely or decreasing technological losses of energy grids, for example.

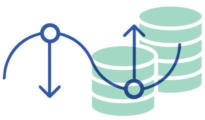


In the case of **prosumers**, expanding the current programmes granting subsidies brings various technical, economic, social or environmental benefits. Independent production reduces the transmission and distribution grid congestion level, which translates into increased integrated capacities of other renewable energy producers. Moreover, prosumers can reduce the production from fossil fuel power plants, avoiding financial (on average, electricity invoices decrease) and environmental (diminished emissions) costs. At the same time, facilitating the installation of battery systems for overnight storage will enhance previously mentioned benefits by prolonging energy independence throughout the evening demand peak.

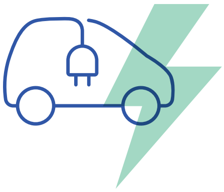
Meanwhile, energy communities can extrapolate the benefits of the concept of prosumer. The local aggregation of multiple prosumers and consumers leads to additional reductions in grid loads and centralised production.



However, given the historic context of the **vulnerable consumer** in Romania (associated energy vulnerability level between 32% and 45%)[11], as well as the current energy prices increase, prioritising subsidies for vulnerable customers is essential. Often, vulnerable consumers have higher energy consumption (old, inefficient appliances; no thermal insulation, which leads to using electric radiators or heaters), and without local production they will request higher energy quantities from the grid, which increases grid congestion and invoice value and often generates additional emissions. Granting subsidies, even covering the full costs, for decentralised production systems (including battery systems) will bring significant financial savings for the vulnerable consumer. These savings can be redirected for energy efficiency measures (efficient lightning and appliances, building thermal insulation, etc.), which will reduce even further the need for additional energy from the grid, avoiding mentioned previously negative externalities.



Demand response also has an immense potential to integrate variable renewable energy production. A well-structured system – correlated with the total production of the national energy system, aligned to spot energy market changes – with both industrial and household consumers in mind, will generate an optimised balance between consumption and the variable renewable energy production.



The **vehicle-to-grid** (V2G) system also extends the concept of demand-side response. Beyond already mentioned benefits, developing a compensation system for V2G users will increase the electric vehicle adoption rate. This can happen first and foremost in the case of commercial fleets (couriers, distributors, suppliers, sales agents, etc.), where one of the largest urban transport pollution is recorded.

11. Democracy Study Center, Energy poverty and the necessary paradigm shift from Vulnerable consumer to Energy entitled citizens. CSD Study: The current level of energy vulnerability is 32%, but according to other indicators it reaches 45%, Investenergy.ro, September 2021

2.3 Case study

The benefits of digitalisation for the energy community

GridFlex Heeten (The Netherlands)[12]

In Heeten municipality in the Netherlands, **47 households are organised in an energy community. All these houses are provided for by a single energy transformer. The role of this pilot project started in 2017 is to decrease the impact of energy consumption on the local distribution grid – by producing, managing and consuming local clean energy.**

The partners consortium designed a grid with digitally connected technologies and services, by employing the flexibility of storage solutions and individual consumption, combined with dynamic price mechanisms. Part of the inhabitants from this project own photovoltaic panels for decentralised energy production and others „contribute" in the community with 5 kWh batteries. Digitalisation allows for automatic usage of batteries, based on the weather forecast, historic consumption or information about other users in the grid.

Additionally, all participants have access through a mobile app to real-time data collected by smart meters. As such, they can understand the consumption profile, based on historical data, production and consumption from the photovoltaic panels or the usage rate of storage solutions. Using the app the consumers also receive a price forecast for the next 24 hours, which allows customers to manage their consumption to diminish the potential cost associated with purchasing energy from the grid. Displayed prices also take into account grid congestions, encouraging energy consumption when the grid is less loaded by other clients.

As energy management is fully automatic (photovoltaic panels production, loading and unloading of batteries), the only element adjustable by the customers is the consumption timeframe, guided by the price forecast.

In order to understand the benefits of those integrated systems unlocked by digitalisation, the consortium also analysed the evolution of a control group of 28 consumers who were not part of the project. Initial conclusions of the study indicate economic and technical benefits for the community. Using the battery and price forecast system, the community saved the equivalent of EUR 1500/ year, while the grid operator improved its performance indicators, reducing from 34% to 18% the period of grid average load (equivalent to the 15-25 kW interval).

The example of Heeten community can be continued by increasing the number of participants and the included area, thus taking advantage of the significant contribution of increased participants count. Moreover, the already built digital system (photovoltaic panels, batteries and energy management system) can be enhanced with additional technologies such as electric vehicles and vehicle-to-grid (V2G) charging, heat pumps, Internet-of-Things (IoT) or sensors for automatically making consumption more efficient. These elements will maximise the potential of digitalisation, generating an efficient renewable sources consumption and a significant contribution for energy distribution and transmission systems

12. Victor M.J.J. Reijnders, Marten D. van der Laan, Roelof Dijkstra, Chapter 6 - Energy communities: a Dutch case study, Behind and Beyond the Meter, Academic Press, 2020

3. DIGITALISATION FOR ENERGY EFFICIENCY

3.1 Current digitalisation level

In the case of **industrial buildings** – on one side, those built before 1989 and improved in recent years, on the other side those newly built – relatively high levels of automation and digitalisation are present, with direct benefits for energy efficiency. The first wave of investments (basic digital modernisation) in this type of solutions was made due to evident cost reasons. These investments immediately translated into increased productivity, more efficient production processes, decreased production costs, so higher revenues. However, a superior digitalisation and automation level, employing part of the technologies mentioned in the previous sections, is reached by only a handful of companies.

In the case of **public or residential buildings**, the situation is more dramatic. Public buildings have a high average energy consumption, whereas old residential buildings are in dire need of urgent improvements. According to Energy Policy Group figures, public buildings consume on average 200-250 kWh/m2 yearly and residential buildings 180-400 kWh/m2. In order to reach the 55% emissions reduction target, the European Union should decrease final energy consumption in buildings by 14%. In Romania, 2.4 million flats built before 1985 need to be refurbished and modernised. In other words, one in seven families face major housing energy efficiency issues.[13] [14]

In this context, the digitalisation level of these two types of buildings (public and residential) is low, with the exception of only a few municipalities implementing various energy efficiency pilot projects and of new blocks of flats or houses, whose owners have medium-high income, which exhibit a medium digitalisation level (thermal and electrical energy sensors and automation or smart appliances).

Renewable energy sources are very rarely integrated in new or refurbished old buildings. Renewable solutions for heating/cooling/cooking energy consumption – such as solar panels, heat pumps, energy storage systems, V2G charging – are rather present in individual homes, where high income owners experimented with integrating them.

However, energy efficiency must firstly be directed towards intensive consumers, often the case of vulnerable categories. Using energy efficiency measures, and thus increasing building digitalisation level, is a crucial element to diminish energy poverty, to decrease grid congestion and reduce the emissions generated by today's high energy consumption.

The relatively dire situation of some electrical grids, as well as their reduced digitalisation and monitoring level, causes technical grid issues to be critical and hard to reduce.

13. Energy Policy Group, Ten priority areas for Romania's post Covid-19 recovery, November 2020
14. Energy Policy Group, Creşterea eficienţei energetice în clădiri în România, September 2018

3.2 Necessary investments for energy efficiency

Romania and the other member states of the European Union will implement the measures included in the new European initiative „Renovation wave", a strategy developed to accelerate deep renovation activities, thus increasing energy efficiency and significantly curbing the current emissions level. While the EU energy renovation rate is 1% per year, deep renovation does not exceed 0.2%. In this context, the initiative aims to at least double the energy renovation rate until 2030 and accelerate deep renovation. In Romania's case, the National Recovery and Resilience Plan dedicates a significant amount for the building renovation process, roughly EUR 2.2 billion out of the EUR 5 billion of the whole Renovation Strategy until 2030.

Investments in renovating buildings and implementing digital solutions aimed to complement basic measures to increase energy efficiency will translate into multiple benefits for users, for the national energy system and for the Romanian socio-economic context. First and foremost, energy invoices values will drop significantly, both for thermal and electrical energy, which is essential to solve energy poverty issues in Romania. The needed centralised thermal and electric energy production will therefore drop, resulting in avoiding significant CO_2 emissions at a national level.

An analysis published in 2017 by the Ministry of Regional Development, Public Administration and European Funding discusses the various scenarios to accelerate investments in building renovation, where different levels of digitalisation are also included.

Figure 4

Benefits of different investment scenarios in building renovation[15]

	SCENARIO	BASIC	MODERTAE	INTERMEDIARY	AMBITIOUS
ENERGY SAVINGS					
Energy savings in 2050	TWH/year	8.5	31.1	44.8	63.2
Energy savings in 2050 compared to 2010	%	8.3 %	30.4 %	4.8 %	61.8 %
CO_2 EMISSIONS					
Yearly CO_2 emissions in 2050	$MtCO_2$/year	3	22	24	25
CO_2 avoided in 2050	%	12%	79 %	83 %	89 %
CO_2 avoidance costs	€ / tCO_2	- 138	- 40	- 54	- 70
BENEFITS FOR SOCIETY					
New jobs	Average number of new jobs created / year	4,403	15,854	24,888	39,736

The simulation highlights impressive figures regarding saved energy, avoided emissions or financial benefits. Additionally, based on already mentioned aspects, investing in energy efficiency and digitalisation has the potential to raise the number of jobs available.

However, energy efficiency is not only beneficial for consumers and the buildings they live or work in. Operational efficiency is an opportunity also for grid operators, who still face a high level of technical and commercial losses.

Investing in the continuous digitalisation of transmission and distribution grids for complex monitoring and measuring the transmitted/distributed electricity, pinpointing grid congestions, handling commercial losses or anticipating and managing maintenance and servicing processes are measures which will lead to a decrease of grid losses. This decrease means the reduction of transmission and distribution tariffs for the end consumer, as well as lowering the total system energy production, thus avoiding additional emissions.

15. Ministry of Regional Development, Public Administration and European Funds, Strategy for boosting investments in renovating residential and commercial buildings, both public and private, at a national level, October 2017

3.3 Case study

Digitalisation for increasing energy efficiency for social housing in Bronte (Italy)[16]

Researchers from Environmental Technical Physics carried out in the early 2010s a project in a social housing neighbourhood (block of flats with 4 stories and loft), in a suburban region, Sciarotta, from the city of Bronte (Italy). The residential complex of 54 flats was built between 1978 and 1981. The objective of the project was to assess the impact of energy efficiency measures – most of them integrated through various digital technologies and platforms – taken to increase the comfort of this complex's inhabitants.

Besides insulating the buildings, all adopted measures involved implementing digital systems and technologies. 1) The water heating system, based on using thermal solar panels, relies on sensors measuring water temperature in the water storage tank. If the temperature drops below a specific threshold, the automated system starts the thermal solar panels, which efficiently makes use of solar energy. 2) Solar energy is also used for photovoltaic panels disguised as solar „trees" installed around the buildings. The system is connected to the local energy grid and the production is used both to cover local demand and to inject the excess electricity produced back into the grid. 3) Lastly, the rainwater harvesting system – where collected water is used for non-drinkable purposes (toilet, laundry, irrigation) – also uses an automated platform to curb the water consumption from the centralised grid.

Moreover, this system also uses a digital weather monitoring system (measuring solar radiation, air temperature, humidity and precipitation level) which records and analyses hourly values.

The results of this project reveal the clear benefit of digitally integrated technologies and systems to increase energy efficiency in buildings. 2,400 m3/year of water was saved, as well as 9.5 MWh/year of heating energy. Additionally, heating water through solar panels led to an energy consumption decrease of 2.5 MWh/year, while 20 MWh/year were generated by photovoltaic panels. This last aspect reduces centralised production, always associated with CO_2 emissions (values differ from one national generation portfolio to another).

The benefits of such projects are obvious, especially in the case of social housing, often in dire energy situations. However, given the implementation time period of the project mentioned in the case study above, some technologies were not available or had a prohibitive implementation price, even for a pilot project. Today, besides the measures above, there are feasible options (including from a financial point of view, given that technology costs decreased dramatically) which can be implemented easily, for example Internet-of-Things (IoT), storage capacities, integrating electric vehicles (including V2G technology), advanced artificial intelligence (AI) options or simple mobile apps for users.

16. A. Gagliano, F. Nocera, F. Patania, G. Capizzi, A Case Study of Energy Efficiency Retrofit in Social Housing Units, Energy Procedia, Volume 42, 2013

4. AVAILABLE FUNDING SOURCES

Increasing the digitalisation level is an investment not only benefitting the economic sectors, but also having positive transversal effects, being able to solve complex issues. Similar to many sectors, digitalisation investments in energy brings economic, social and environmental benefits.

The current context offers multiple investment options and funding sources, by participating in the European Union's common efforts to make the energy consumption more efficient and increase clean energy consumption rate.

As such, some of the most important immediate options available to the Romanian energy sector in order to increase digitalisation include:

The National Recovery and Resilience Plan (NRRP)[17]

- General objective: the main financial mechanism developed in the COVID-19 context, for the economic recovery of European Union member states
- Guidelines and components (applicable to energy digitalisation): Sustainable transport; Renovation Wave; Energy; Digital transformation; Local fund for green and digital transition
- Potential projects: alternative transport and electric vehicle charging infrastructure, renovation and increased energy efficiency measures, renewable energy projects, energy grid digitalisation, smart grids
- Estimated budget for these components:
    - Sustainable transport: EUR 7.62 billion
    - Renovation Wave: EUR 2.2 billion
    - Energy: EUR 1.62 billion
    - Digital Transformation: EUR 1.88 billion
    - Local fund for green and digital transition: EUR 2.1 billion

Modernisation Fund

- General objective: Supporting 10 EU member states with reduced economies, including Romania, in the transition process towards climate neutrality
- Potential projects: energy efficiency, storage, energy grid modernisation
- Estimated budget: 2% of the grants for 2021-2030, under the emissions trading scheme (EU ETS) → roughly EUR 200 million

17. European Commission, Analysis of the recovery and resilience plan of Romania, September 2021

Innovation Fund
- General objective: supporting innovative technologies with low carbon emissions
- Potential projects: energy storage and innovative renewable energy solutions
- Estimated budget: EUR 30 billion (2020-2030)

Operational programmes
- General objective: funding the development of investment priorities of the European Union's Cohesion Policy
- Potential projects: energy efficiency, energy grid modernisation and digitalisation, energy storage solutions

Just Transition Fund
- General objective: financial support for areas and communities facing social and economic difficulties during the energy transition process (for example mining operations, coal-based energy generation areas).
- Potential projects: developing new industries bringing benefits and products/services in the field of digitalisation and smart grids.
- Estimated budget: EUR 1.8 billion

Connecting Europe Facility Mechanism
- General objective: increasing the development level of efficient and sustainable transmission grids, energy and digital services.
- Potential projects: developing smart grids and integrating renewable energy sources, handling grid congestions using smart grids, cybersecurity projects, blockchain.

LIFE Programme 2021-2027
- General objective: European financial instrument for the Environment and Climate Action Programme
- Potential projects: projects for adapting to climate change, environmental information exchange and management
- Estimated budget: EUR 5.4 billion (2021-2027)

Besides these opportunities Romania can take advantage of as a member of the European Union, there are also „classic" mechanisms which can lead to a quicker adoption of digitalisation in the sector.

For transmission and distribution operators, increasing investments in digital solutions, starting with accelerated installations of smart meters by including them in tariffs, is always an important opportunity. Naturally, any such investment translates into tariff increases in the final invoices. However – given the mentions until now – digitalisation has multiple, medium and long term effects for energy grids. They include energy transmission and distribution efficiency, technological and commercial loss decrease (thus reducing this cost in the customers' invoices), automatically sending grid data (which reduces yet again the tariffs) or detection and faster solving of technical issues. As such, careful medium and long term analyses including all aspects of these investments will reveal positive benefits at the energy system level and consequently for the final consumer.

Additionally, various support schemes / vouchers are available to the final consumer (one source of which are EFA funds), be it a legal or individual person, to promote energy digital solutions, which will bring benefits regarding energy efficiency or adopting clean energy. The funding programmes carried out by the EFA at the moment include:

Programme to increase energy efficiency and smart energy management in public buildings[18]

- Eligibility for administrative territorial units such as, cities, municipalities, counties, for administrative territorial subunits of Bucharest and for public institutions
- Funds to modernise and increase energy efficiency in public buildings
- The amount for this funding session is RON 1.4 billion (roughly EUR 280 million) and grants cover up to 100% of eligible expenses

„Rabla Plus" programme for electric vehicles

- Eligibility for individuals or legal persons
- Funds for purchasing new electric or hybrid vehicles (RON 45,000 ≈ EUR 9,000 for purchasing a new electric vehicle, or RON 20,000 RON ≈ EUR 4,000 for purchasing a new hybrid vehicle)
- Total budget: RON 600 million, for 2021

„Green House" programme

- Eligibility for individuals
- Funds to install photovoltaic panels for energy production and injecting the excess to the grid (90% per project, up to RON 20,000)
- Total budget: RON 656 million, for 2021[19]

Moreover, various subsidy systems can be implemented for different energy management sensors categories or for devices employing IoT solutions, etc.

In addition to the above aspects, but also to complement the objectives supported by the funding sources mentioned previously, research and development activities must be encouraged. This happens both by developing a regulation framework generating innovation in the field, but also by increasing and ensuring permanent availability of various funding sources: public, private or mixed. Improving digital technologies and services, better integrating them with all the energy system's components, revealing new solutions in this spectrum or just reducing costs with current equipment are only some of the benefits of investing in the local research and development sector.

18. Environmental Fund Administration, Launching the Programme for raising energy efficiency in public buildings, September 2021
19. Economica.net, The "Green House" programme, for installing panels with up to 20,000 RON, was modified, February 2021

5. RECOMMENDATIONS. NECESSARY REGULATIONS AND SUPPORT MECHANISMS

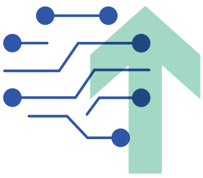
A part of the regulations needed to implement or accelerate the digitalisation level in the national energy systems already exists. However, aspects pertaining to secondary legislation, technical procedures or simply day-to-day practice are causing delays in adopting various digital systems, platforms or instruments.

Postponing the implementation of these solutions will lead to increasing the disparity between the national energy system and the systems of neighbouring countries, which will amplify Romania's current difficult situation, with regard to energy independence, CO2 emissions or energy price.

Given the context laid out in previous chapters and the significant potential which can be reached by increasing the sector's digitalisation level, several recommendations arise – pertaining to primary and secondary legislation but also to the general area of public policy:

Public and private governance

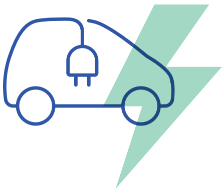
- Prioritising the digitalisation process as a main segment in various strategic documents for the development of the national energy system, by the Ministry of Energy and other energy central authorities. Consequently, prioritising the investments for digitalisation projects of the energy system by the same central entities.
- Encouraging investments in digitalisation and transition towards digital platforms for system operators by the Romanian Energy Regulatory Authority (ANRE).
- Enhancing trading platforms in wholesale energy markets, as well as integrating and facilitating access to public data by the Romanian electricity and gas market operator (OPCOM).
- Developing and improving the digital channels and platforms between energy suppliers and distributors and their customers / consumers.
- Streamlining the process to connect consumers and prosumers to the grid – joint effort of ANRE and grid operators.



Electrical grids

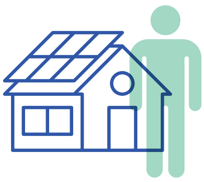
- Increasing investments in digital solutions for transmission and distribution operators, by including them in the corresponding tariffs. These will reduce technical and commercial losses, will decrease the count and duration of energy outages and will reduce energy transmission and distribution associated costs.
- Accelerating the deployment of smart meters, to take advantage of the various benefits they unlock. Implementing them brings consumption predictability for the user, as well as increased consumption forecasting capacity for the energy suppliers. These aspects lead to an optimised renewable energy consumption, as well as a better integration of new clean energy capacities.
- Increasing the adequacy level of energy transmission and distribution grids by developing large energy storage capacities. Integrating them, through digital instruments and platforms, in the national energy system, will unlock the expansion of renewable energy production capacities.

Transport

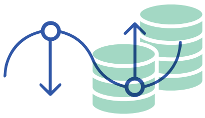


- Continuing to grant subsidies for electric vehicles. In order to reach the decarbonisation targets, additional programmes dedicated for commercial fleets are crucial.
- Offering grants for electric vehicle charging stations is also important, especially in small and medium municipalities, where alternative transport requires additional aid from central and local authorities.
- Drafting dedicated legislation for vehicle-to-grid (V2G) solutions and purchase procedures for the surplus they inject in the grid. This regulation framework will additionally encourage the adoption of electric vehicles.

Prosumers and energy communities



- Maintaining the current efforts to develop an improved compensation system to encourage prosumers. Quantitative compensation (comparing the consumed energy with the energy injected into the grid) is a solution, although current DAM prices also bring appropriate income levels for prosumers in the current remuneration formula (financial compensation, so different prices for the energy consumed from the grid and the energy injected into the grid).
- Regardless of the remuneration formula, prioritising subsidies must take into account the future prosumer's context. In this regard, prioritising subsidies towards vulnerable consumers can be an important element to manage energy poverty in the country. In this scenario, increasing the subsidies from 90% of the required amount to 100% of the required amount is needed (so that the consumer does not have to also fund the prosumer system).
- In order to accelerate the decentralised energy production adoption and also to optimise the local consumption of prosumers, encouraging battery systems is essential. In this regard, clear regulations on how battery-stored energy should be transferred to energy suppliers and subsidising those systems are measures which must be prioritised.
- Meanwhile, regulations to facilitate aggregating into energy communities, which will manage their consumption and production through digital platforms, are needed to increase the local optimisation rate.
- Developing similar subsidy systems for off-grid household or industrial consumers. Through various digital energy consumption/production management instruments, the communities currently not connected to the electricity grid can find a solution. Developing off-grid irrigation systems in farms remote from the energy grid will be equally possible by funding these systems.
- Moreover, streamlining the bureaucratic process for granting subsidies and approving the prosumer status is a crucial element to prevent unnecessary delays in increasing the consumed and produced renewable energy share in the national system.

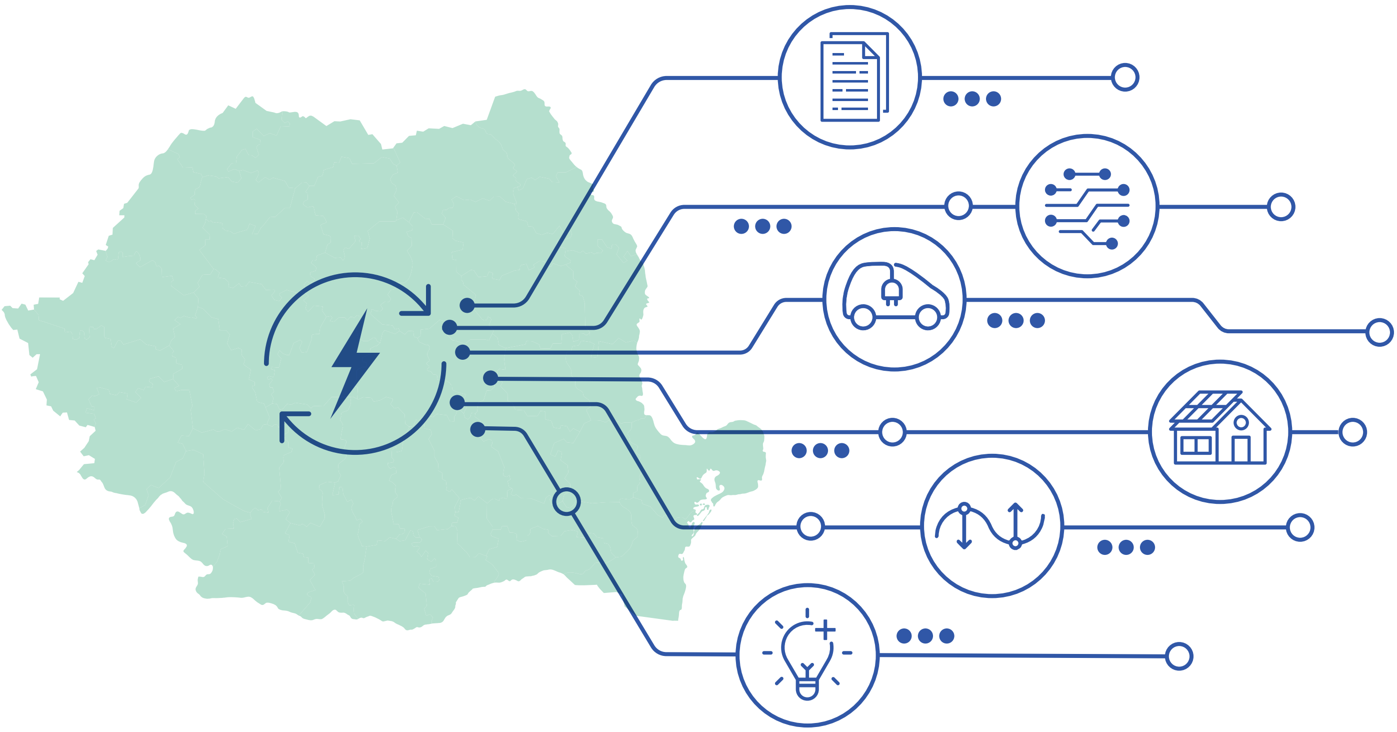


Demand response

- Drafting dedicated legislation to ensure the demand response mechanism performs efficiently is necessary.
- Besides the current (limited) solutions of commercial operators, household consumers must benefit from the option to change their energy consumption based on market signals of the energy system.
- This efficient performance requires a critical mass of smart meters installed in the grid.

Energy efficiency

- Overcoming legislative obstacles in applying energy performance contracts, in order to accelerate adopting measures with major impact on energy efficiency.
- Decarbonising household heating by intelligently integrating renewable energy solutions.
- Increasing the share of refurbished public buildings and blocks of flats and implementing digital instruments and services to automatically monitor, analyse, control and adjust thermal and electrical energy consumption.
- Drawing up subsidy programmes for the transition towards smart and energy efficient equipment (lightning, sensors, appliances, etc.).



6. CONCLUSIONS

Digitalisation in energy systems is an essential element to meet climate targets in the next decades.

For Romania, the digitalisation of the energy system is imperative, given the striking difference compared to the equipment of European energy systems. However, the digitalisation process is also a unique opportunity, as Romania can use its latest years' competitive advantage in the IT&C sector to develop local industries.

Currently the national energy system is in a delicate context, with old generation capacities still dependent on burning fossil fuels, with rising prices and serious energy efficiency issues, with significant energy poverty areas. Although various digital technologies or services have started to be adopted, their adoption rate is still low.

However, accelerating digitalisation does not necessarily depend on massive legislative changes, but rather on drafting procedures to integrate them in the energy sector. Beyond legislative aspects, there are numerous European funding sources to finance various projects focusing or including different digital elements.

Delaying the adoption of these digital elements will increase the number of issues the national energy system already faces today: the difficult and late integration of renewable energy sources; increased greenhouse gas emissions in the whole system, increased energy prices or missing the opportunity to create new jobs.