Project Deliverable Report

Smart Building – Smart Grid – Smart City

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Technology state-of-the art analysis and potential barriers identification for energy management systems in buildings and electricity distribution grids

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Executive summary

This document contains the results of an extensive survey of technological state-of the-art for Building and Grid Energy Management Systems in the Danube region. The survey covered 12 countries: Croatia, Bosnia and Herzegovina, Montenegro, Serbia, Slovenia, Austria, Germany, Czech Republic, Slovakia, Hungary, Romania, and Bulgaria.

The survey contains two major parts:

- Regulatory state-of-the-art analysis and potential barriers identification
- Technology state-of-the-art analysis and potential barriers identification

The survey was conducted by the members of the 3Smart consortium. The information was collected according to a questionnaire containing 8 sections and all together 31 questions. The sources of the answers were:

- publicly available documents,
- websites of different organizations (companies, research institutes, government authorities, etc.),
- information from experts,
- scientific literature review.

Based on the answers from all responsibles summaries have been created and barriers identifed. This document also contains all answers received from project partners.

Goal of the regulatory state-of-the-art analysis:

- Identify regulatory barriers to interoperation of building and distribution grid energy management
- Identify further regulatory barriers based on the results of the technical pilot
- Recommendations for the elimination of Regulatory barriers

The most relevant barriers of this part:

- Diverse Danube Region energy markets' regulation
- Renewable energy and load (demand side management) participation in ancillary services and in balancing needs to improve
- Smart metering is a prerequisite of dynamic pricing/demand side management
- Smart meter roll-out is carried out in a few Danube Region countries
- Technical specifications for smart meters do not cover the possibility of communication with building energy management systems

Goal of the technology state-of-the-art analysis:

- Identify technological barriers to the spreading of BEMSs and to the interoperation of building – distribution grid energy management systems.
- Analysis of grid-side systems and building-side systems. Recommendations for the elimination of technological barriers.

The most relevant barriers of this part:

- Missing international and national technological guidelines
- High cost of systems for grid and building operators
- Lack of energy storage units
- Missing standard communication technology for smart metering
- Missing industrial standards for BEMSs
- Wide range of the IT architectures and protocols used in EMS and BEMS increases interfacing, interoperability, interchangeability problems.
- Older buildings are hard to integrate into BEMS and small level of market interest in the retrofit segment of building industry

List of acronyms

- AMI – Advanced Metering Infrastructure
- AMR – Automatic Meter Reading
- BA – Building Automation
- BEMS – Building Energy Management System
- BMS – Building Management System
- CBA – Cost Benefit Analysis
- CEMS – Community Energy Management System
- DAM – Day Ahead Market
- D-EMS – Distributed Energy Management System
- DER – Distributed Energy Resources
- DMS – Distribution Management System
- DMS – Distribution Management System
- DSM – Demand Side Management
- DSO – Distribution System Operator
- EBRD – European Bank of Reconstruction and Development
- EEA – Energy Efficiency Act
- EMIS – Energy Management Information System
- EMS – Energy Management System
- EV-EMS – Electric Vehicle Energy Management System
- FEMS – Factory Energy Management System
- GIS – Geographic Information System
- HA – Home Automation
- HAN – Home Area Network
- HEMS – Home Energy Management System
- HES – Head End System
- HV – High Voltage
- HVAC – Heating, Ventilation, Air Conditioning
- HW – Hardware
- IMS – Intelligent Metering System
- IoT – Internet of Things
- IT – Information Technology
- ITO – Independent Transmission Operator
- IWT – Integrated Wireless Technology
- LV – Low Voltage
- MV – Medium Voltage
- NREAP – National Renewable Energy Action Plan
- OT – Operational Technologies
- PLC – Power Line Communication
- PQMS – Power Quality Monitoring System
- PV – Photovoltaic
- RES – Renewable Energy Sources

- RF – Radio Frequency
- SCADA – Supervisory Control and Data Acquisition
- SHMC – Smart Home Micro-Computers
- SW – Software
- TSO – Transmission System Operator

Analysis of the current technology needs and constraints for energy management systems integrating buildings and energy grids in the Danube Region

1. Introduction

The main goal of the 3Smart project is to provide a technological and legislative setup for cross-spanning energy management of buildings, energy grids and major city infrastructures in the Danube region. 3Smart will enable economically optimal interoperation of energy efficiency measures and renewable energy sources in buildings, and will motivate installation of distributed storages to improve energy security in the Danube region.

The goal of the work package 3 (WP3) of 3Smart is to provide a regulatory and technology framework for successful integration and active role of flexible distributed sources (prosumers) in low carbon energy system. The focus of this project is on demand response, however we aim to provide a wider and more comprehensive proposal to governments and national regulatory authorities, which means we engage and include all participants active at the distribution level (generation, storage, demand response etc.).

In this study the current technology status of all Danube region countries in terms of energy management systems are analyzed and discussed. Issues and challenges in the distribution system and power markets of the Danube region are in the focus.

Furthermore, WP3 addresses the state of the art technologies in energy management systems for buildings (Activity 3.1). In order to derive conclusions on which existing technologies the building-side EMS can be readily used, we go a bit further and try to find answers on existing technologies for maintaining comfort in buildings, as well as technology for local energy generation and storage on the building side. Without knowing technical capabilities, limitations and potential of buildings as potentially flexible distributed producers/consumers (prosumers) we cannot make any proposals for future development of smart systems in buildings or smart cities.

Current trends in energy management solutions on the building side show tendency towards standardization in building communication systems as well as in equipment and software open for data exchange. They are induced by the pressing need for energy efficiency improvement. These are very positive trends for enabling the EMS as planned within this project, which is modular and consists of open software modules adaptable to various underlying physical equipment in buildings. In the new environment of open systems it is however of an utmost importance to pay proper attention to information privacy and overall systems security. Within this activity most pressing technology needs (technical requirements) for the EMS in buildings will be analyzed across the entire Danube region, as well as potential constraints for its deployment in buildings (e.g. dominant existing equipment that dictates the available modes of interaction with the EMS). A special attention will be given to the building-side EMS interface towards the distribution grids. Each partner performed analyses for 2 countries, through consulting relevant documentation and regional energy agencies.

Current technology of the EMS on the grid side is very much determined by the regulatory framework as well as typical technology and standards used by distribution system operators. Technology needs of grid management in the presence of a significant amount of distributed generation in the grid are requiring more interactive approach with network users to ensure grid adherence to the technical requirements at a reasonable cost. Provisioning of smart meter installation will be very important since these devices are enabling more interactive approach. This provisioning should include legal aspects and minimum technical requirements. Especially important will be the provisions on installing the smart meters as enabling devices and which functionalities these meters should minimally have.

2. Structure of WP3 in the current status analysis

The following diagram presents the WP3 structure in its state-of-the-art assessment part, as well as the different topics put in focus.

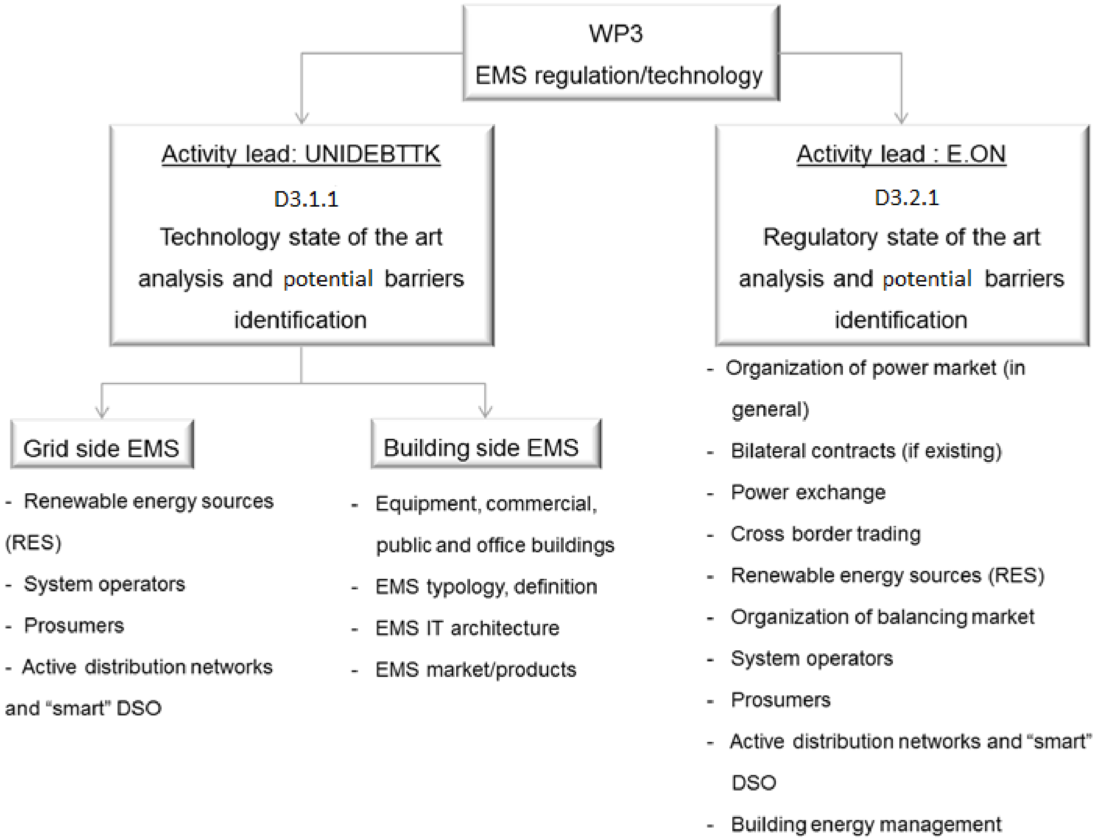


Figure 2.1 WP3 state-of-the-art assessment part

3. Study of Technology –Summary of answers

A. Summary of grid side EMS related analysis

A.1. Renewable energy sources (RES)

In general, most countries aim to utilize renewable sources. States, however, might show different attitude towards small-, medium- and large-scale producers. In some places, smaller producers are gathered into groups, and numerous smaller producers receive a single tap point from the grid operator (the tap point is the interface between the grid and the group of producers). Optimal placement of tap points is a complex task because cost and size of the utilization zone of produced power varies with the voltage level of the selected power line. The result of badly placed feedback substations (the entry points of the energy from the renewable sources into the grid) can cause more harm than good, which includes overvoltage, frequency instability, power supply instability and phase asymmetry, just to mention a few problems. Because of such reasons many countries think of RES as secondary or tertiary sources. Energy storage was proposed as a solution to this, because it would make RES much more reliable and their contribution to the power system less dependent on weather and hardly foreseeable factors. Energy storage solutions can reduce problems with the handling of peak load events, allow better utilization of existing generators and provide better control in parts of the grid.

In most of the countries DSOs are obliged to allow connection of renewable energy producers to their grid, however connection to the grid has specific technical requirements, which, if not met, do not allow the connection. In some cases the compliances with specific technical requirements are not affordable. There are also places where producers who have certificates have priority over others. In some places renewable energy producers get financial help and technical support to connect to the grid, for example: free connection to the grid in Hungary or the expansion of grid if it cannot accept more power in Germany. In many places the technical background of the producers is inspected to ensure safety and proper operation, but not in all countries.

In general, every country tries its best to utilize RESs. This is partly because many follow the European Union’s climate and energy goals that by 2020 energy consumption should be lowered by 20% and renewable energy should be increased. From the technological aspect, pretty much all types of renewable energy are used, or planned to be used, including PV, wind, biomass, water, but no countries mentioned geothermal sources. The most important thing is probably the discussion about installation of energy storage devices, because there are not many, grid oriented, large scale energy storage facilities yet (apart from pumped hydro power plants). Numerous countries plan to build storage sites. In Austria the main technology used for the balancing is pump storage hydropower and they plan to use battery storage systems.

In Slovakia hydro capacities could be used in the future to balance variable generation from neighboring countries. In Germany there are plans to use battery storage and the control of the systems via smart meters. In Hungary there is no system-size storage in the electric energy system. Ideas like smart measurement, smart meters, IoT also appear, but these ideas are new and are not yet properly implemented in practice, mostly because of financial reasons and national regulatory frameworks. But nonetheless idea of measuring as many things as possible and processing these data to get a clearer view of the energy system is spreading.

Identified barriers

One of the problems - detected in all countries and producers - is caused by the inadequate estimation of the real-time renewable energy production in the Danube region. This increases unreliability in planning and also in renewable energy production. That is the reason why RES are used only in emergency reserves in some regions. The solution could be installation of batteries, but currently this has not been yet implemented widely.

Connected generators can cause faulty operation of the grid, such as unwanted active or reactive power flow, phase asymmetry on the line, overvoltage, harmonics, frequency deviation and in general financial losses or equipment damage. Without real-time monitoring of the LV grid it is hard to detect these anomalies.

Problems might include that every country has its own solutions to the problems related to RES production, distribution, EMS operation, etc., so there are no international, standard guidelines. Furtheremore, many people consider grid stability an issue, because systems that have a remote access possibility raise some IT security questions. The above summarized barriers make a clear need for active management on the grid side possibly interconnected with buildings to further substatiation.

A.2. System operators

In this section, communication and cooperation between TSO and DSO from technology point of view is studied. The questions from the questionnaire were: what information do they exchange; how often, how do they coordinate their operation, how does this change with the introduction of active distribution management. In the studied countries, information exchange between TSO and DSO can be analyzed from the following two points: one is financially oriented and includes data exchange about energy parameters; the second is technically oriented, including information about system operation. In all studied countries communication is needed for uninterrupted operation. This includes power data exchange on reactive power, apparent power, effective power, current voltage, frequency, phase symmetry. Some countries have highly developed technical information exchange, including information on the status of switching equipment, such as circuit breakers, disconnectors, grounding and regulating switches, if necessary for system management or for evaluation of

the system, or information related to the protection, control and alarm devices. In Germany, for example, such data is encoded very effectively. Information exchange also spreads to different fields of electricity grid, like bigger scale maintenance of networks operated by multiple operators, planned shutdowns and coordinated work for highest efficiency.

In some countries information exchange is very limited due to privatization (Romania, Serbia). Also in Montenegro co-operation of the DSO and TSO is mandatory by law. Altough the information exchange is not necessarly abundant or, at least, sufficient.

In all cases we can state that cooperation is mostly technical due to connection point of their networks (common interface) but they still do not exchange enough information required for establishment of active distribution management.

Technical descriptions about the physical or any layers of the communication are not defined.

Identified barriers

In many cases energy management systems are not installed because of financial difficulties, because they involve huge costs. It is possible, that the financial support from the state is needed to develop a standardized energy management system that can be installed. Another problem could be that countries develop and improve their power grid reactively, so when a problem arises it is solved. To prevent co-operation problems a set of EU guidelines for grid management and metering systems should be developed to make inter-connectivity of high voltage lines and systems easier and to make smart metering possible across the whole EU. The exchange of data also raises cybersecurity issues, because a lot of devices can be remotely controlled, this means an entire electrical system can be influenced, which is a safety risk. Also an EU scale standardized metering system could help make real-time decisions about balancing the energy in the grid more quick, accurate and convenient.

A.3. Prosumers – generation, storage and flexible demand connected to the distribution network)

In most of the analyzed countries of the Danube Region grid connection regulations and rules are defined by the Regulator DSOs. Differences can be found in the grid connection regulation of Danube Region countries. In some countries technical requirements are set in Grid Code (Croatia, Slovenia and Serbia) but grid connection contracts differ according to basic technologies . In some countries DSOs are not allowed to limit RES generation fed into the grid after allowing DER connection to the grid (Slovenia), in other countries minimum conditions of the connection are regulated and responsibilities of DSOs and the customers are defined (Germany) while in Montenegro two contracts are used: one for the electricity supply that power plants take from the distribution system and the other for the purchase of electricity. The grid connection costs can be fully (deep connection fee) or partially (shallow connection

fee) reimbursed by generators connected to the grid. Regulator would like to increase renewable generation, RES generators may have lower grid connection fees.

In some cases built-in power capacity is limited according to the DERs owner classification, like in Hungary where household owners are allowed for power of 50kVA as maximal. Unfortunately we have limited information on the storage capacity permission. In Hungary DSOs are allowed to use 0.5 MW storage capacity exclusively for grid balancing purposes and not for energy trading. So this application of the storage cannot be characterized as a classical prosumer as they will act only in case of grid technology needs, nevertheless in some cases the behavior of these storages from the grid - building EMS side view looks like a prosumer.

Identified barriers

There are no specific contracts for building-grid interaction. Contracts only cover abnormal operation of the grid (curtailment or disconnection).

DERs are not compensated in any way for providing any services other than injecting active power into the grid and being passive participants in the distribution network.

A.4. Active distribution networks and "smart" DSO

In most of the analyzed countries smart meter installations / replacements in the distribution network have started. In Austria rollout starts in autumn 2017. In Croatia by the end of 2020, all consumers with connection power over 20 kW should be monitored by AMR. In Romania there are more than 30.000 smart meters installed in the last few years. In Hungary this number is 11.737. In Slovenia there are currently 40.000 smart meters in the system. In Slovenia there is a testing period and they installed 6.000 smart meters by April 2015. In Bosnia and Herzegovina the "Power IV" project was started in 2007 and at the end of 2016 approximately 28% of metering points is covered by smart meters. In Montenegro they have already built 164.000 smart meters from 2010. Commonly these works are carried out from the largest (greater than 10-20 kW in power) towards smaller consumers. In practice every country has its own set of meter types. The most popular communication variants are power-line communication (PLC: G3-PLC, PLC S-FSK, BPL), GPRS, GSM, LTE, DSL (broadband connection), point-to-point communication. Usual topology is PLC communication from customer site to data concentrator built in the substation (PLC) and then communication via GPRS network to the appropriate HES (Head End System) on the DSO side. Replacements are continuously performed but the process is often retarded because meter change is suspended until the calibration period expiration of the existing meter on the site. CBA was made in most of the countries. CBA results of smart meter usage are different: from certain benefits to negative results.

Identified barriers:

National regulations regarding installation / replacement of smart meters as well absence of standardized communication technology are considered are barriers.

CBAs in different countries of the Danube region resulted in very different standpoints. In countries where CBAs were negative enabling of grid-building EMS was not taken into account. According to 3Smart experiences CBAs based evaluations are suggested to be revised.

B. Summary of building side EMS related questions

B.1. Building side equipment: especially within commercial, public and office buildings

In the analyzed Danube Region countries:

1) Dominant HVAC technologies (this order does not reflect the penetration):
   a) Radiator heating
   b) Fan coil heating and cooling
   c) Split units (for heating and cooling)
   d) Centralized ventilation
   e) Heat pumps
   f) Electrical heaters
2) Dominant architecture of HVAC systems
   a) Dominant architecture is central units. More common for heating.
   b) District heating is present in most of the countries.
   c) Radiator heating is often combined with local split cooling units.
   d) Electrical heating is applied locally.
3) Dominant technologies used in local architectures
   a) Electrical heaters, split air-conditioning unit
4) Dominant medium used for heating and cooling in central architectures
   a) The dominant medium is water.
5) Devices used for central medium preparation for heating
   a) The dominant device is gas boiler.
6) Devices used for central medium preparation for cooling
   a) The dominant device is water chiller.
7) Use and spread of local energy production, percentage, number of buildings, production capacity, consumption/exportation details
   a) The most dominant locally produced energy is electricity.
8) Use and spread of energy storage technologies
   a) Thermal energy storage in heating systems is used.
   b) Electricity storage is very rare.
9) Dominant energy carriers (primary energy sources) for heating / cooling
   a) In some countries (Croatia, Romania, Hungary, Germany) the dominant carrier is natural gas.

Identified barriers

Older systems do not contain control units. To provide control abilities one needs to replace working units. Individual units are harder to integrate into a BEMS.

Another barrier for grid-building EMS is the fact that often heating or other facilities are not provided by the electricity grid operator, but other operators. For example if a building is heavily reliant on water, gas, or central heating, then the EMS is supposed to communicate with these operators. However, at the level of information exchange and pricing, these are not as flexible as the electrical grid, so the transfer of data might be cumbersome or not reliably available. This makes the operation of building EMS systems less efficient and the interaction with these systems very limited. Without the possibility of dynamic pricing, cost reduction is also limited.

B.2. Building side EMS typology, definition

Energy management is a complex process. With the use of Energy Management Systems (EMSs) we can lower energy consumption, improve energy performance and operational efficiencies, reduce our impact on the environment and possibly save energy.

The most important functionalities of current EMSs are the following: Precise measurement and monitoring of consumption (e.g. electricity, gas consumption), environmental data collection and processing (e.g. temperature, air pressure, etc.). One of the most important ability is the analysis of the measured data and finding a way to decrease the energy consumption based on the analyzed data. With EMS we can evaluate miscellaneous factors governing the consumption, predict the consumption and calculate the expenses using the measured data. Furthermore, an EMS also allows remote control of electrical systems and when needed allows direct control to provide better regulation.

It should be noted that EMSs are compliant with legal regulations. The use of the ISO 50001:2011 standard is widespread, which is an international standard for EMS. The standard was developed by the International Organization for Standardization and specifies requirements for establishing, implementing, maintaining and improving EMSs.

Building Energy Management Systems (BEMSs) are computer-based systems that help to manage, control and monitor technical services (e.g. HVAC, lighting, natural lighting, safety systems, pneumatic systems, audio & video systems, etc.) and the energy consumption of devices used in a building. They provide the information and tools that help to understand the energy usage of the building and to control and improve the building's energy performance.

A few of the functions that a building energy management system might include are:

- Advanced building analytics - A feature that analyzes the energy performance of the building using in-depth data and real time data, and that can detect and correct performance issues automatically.

- Advanced metering infrastructure (AMI) analysis - This feature allows AMI data to be collected from a utility at specific time intervals. This provides a more accurate understanding of the building's energy consumption.

- Automated demand response (AutoDR) - This feature helps to automatically reduce energy use during peak load events by automating the control of the building's components or systems.

- Automated building control - This feature allows the energy management system to interact with the building's devices and systems in an active manner.

- Basic energy information portal - This refers to either a website or standalone portal that displays the building's basic energy consumption information. It can also provide tips and suggestions for energy savings.

- Maintenance programs - This refers to replacing building equipment to make the building more energy efficient. For example, replacing light bulbs with more energy efficient versions or upgrading HVAC equipment.

- Energy consumption benchmarking - A feature that compares the building's historical energy consumption with current energy consumption to help understand the building's on-going performance.

- Building optimization - This is a functionality that allows the energy management system to interact with the building's systems to optimize their performance on a real time basis.

- Ongoing performance analysis - This ensures the system is working optimally.

- Demand response - This feature allows the system to respond to changing factors, such as high energy costs or system resource capacity needs.

- Energy dashboard - A display that allows to easily access and understand energy consumption data.

- Measurement and verification - This ensures that the energy efficiency measures or system improvements are producing the results that are expected. It is particularly important to identifying the system's ROI.

- Notifications and alerts - A feature that notifies different issues, from maintenance needs to problematic equipment.

In some countries BEMSs are still considered equivalent to systems that collect energy consumption data on a longer time scale and enable off-line analysis. However, the real-time control of the subsystems is still not evident. Modern BEMSs are expected to fully automatically perform specific operations or to be remotely controllable from a monitoring system. The BEMSs are mostly accessible from the Internet, and there are cases where connection can also be established easily from smart phone applications. These facts make them and the entire managed buildings also vulnerable to cyber attacks. Most BEMSs can be installed with great flexibility into already existing building environments. Good systems are often fully integrated and offer all-in-one solutions, but in some cases, they can be easily extended with the products of other manufacturers thanks to their modular design.

In the Republic of Croatia, there are no commercially available projects with BEMS. Building Management Systems (BMSs) are usual in commercial and in some large public buildings. These BMSs have a 3-level topology: Building Management Level, Automation Level and finally Field Equipment Level.

In Slovenia, there are fully integrated systems, which are used in some households, churches and retirement homes. There are also BEMSs suited for industrial use, because of that they are more flexible, robust and have wider ranges of application. These systems are custom tailored, fully open and can be extended, thanks to their modular design. There are also cheap and very easy to install devices and systems, but these plug-and-play solutions show slow performance and unreliable communication.

In Bulgaria, the companies focus on applications of BEMS to different types of buildings. There are BEMSs available for buildings, swimming pools, hotels, etc.

The Hungarian producers and system integrators can be divided into three different groups, by whose products they install into the BEMS: own hardware and own software; own software, but other manufacturer’s hardware and other manufacturer’s hardware and software.

In Germany, there are similar producers and system integrators as in Hungary, but there is a special group of companies that offer BEMS/EMS specifically for energy storage systems. It is common for these systems to be extended with solar arrays systems.

Identified barriers

There are no industrial standards used for BEMSs. Large variety of systems makes harder to define a common baseline for these systems.

Large-scale usage makes the BEMSs atractive for cyber attacks, and thus after proving functional validation of BEMSs it will be very important to make them prone to such attacks by implementing them in an IT secure digital environment.

B.3. Building side EMS IT architecture

There is a massive overlapping in the IT technologies of EMS and BEMS in the countries of the Danube region.

Physical media used for data transmission in BEMS are radio frequency, twisted pair and Cat cable. The most widespread communication protocols are TCP/IP, Modbus (RTU or TCP), M-Bus, RS-485, RS-232, Z-Wave, BACnet, Dali, ZigBee, KNX, GSM, HTTP and LonWorks. Even though there is a large variety of available technologies, the most common is communication with TCP/IP protocol over an Ethernet network.

The use of VPN tunnels is common. The communication is in most cases done with SSL protocol, which is one of the most widespread safety protocols in the world of IT communication. By looking at the hardware background of the systems, we can find various solutions. Some manufacturers offer unique hardware as the central element of their system, while others offer software that can be installed on PCs or servers. Data acquisition devices with built-in and expandable memory slots can also be found. These devices have built-in web servers which can be accessed through an Ethernet network. A major part of the systems provides cloud-based web interface to become platform-independent.

Systems that have Android and iOS apps also exist.

The field devices are mostly PLC and microcontroller-based units.

The modularity of the systems is achieved with I/O devices on the hardware side and with communication server modules on the software side.

Very few special, local systems are used in the region.

Nowadays most of the systems are equipped for wired communication. In the future it is possible that the devices become mobile and able to perform wireless communication. The most expected protocols and architectures by answering countries are Wi-Fi, LoRaWAN, 4G, and 5G. The developers are focusing on software, to be modular, easy to integrate. They are moving from SCADA based solutions, to proprietary, in-house developed SW. All such SW are running on web servers, written in Java or PHP.

Hardware is going to be minimized. Low power RF communication technologies on free spectrum are becoming popular, because of low licenses fee. RF based devices are becoming popular in industrial field, too.

Identified barriers

Wide range of the IT architectures and protocols used in EMS and BEMS increases interfacing problems and problems related to interoperability and interchangeability of devices and systems. Generally, connectivity is possible if all the devices are on the same protocol. This can be easily set in a household size system, but it can cause substantial interfacing problems in a large public building automation system or even more in an industrial plant where wide range of sensors and actuators should be used. Initially, the EMS systems have been developed for specific hardware, but with advancement in technology, newer EMS systems are compatible with different devices.

It seems to be a good solution to establish communication between EMS and the existing automation systems via data-bases.

B.4. Building side EMS market/ products

a.) The main/known producers/system integrators of BEMS in the Danube region are the following ones:

In Croatia (BMS only): Klimaoprema d.d., Siemens, Honeywell, Sauter, Johnson Controls, Trane, Schneider Electric, GE, and ABB
In Bulgaria: Raytex Engineering, Bulgaria, Sectron Bulgaria, ABB Bulgaria, Siemens Building Technologies, and Schneider Electric
In Serbia: Siemens (Desigo, Simatic), Schneider (TAC)
In Romania: Siemens AG
In Hungary: Berg Energy Ltd., Müller Automation, Prolan Ltd., ON-Energy Ltd., KONsys Ltd., MolControl Automation and Development Ltd., Evopro System Engineering Ltd., Sb-controls Ltd., Energrade Ltd., Elcon Ltd., Fubo Ltd., Elecon Ltd., Schneider Electric Hungária Electrical Ltd., Provicon Ltd., WAGO Hungária Ltd., Festo Ltd., Bosch Energy Storage Solutions
In Germany: ADS-TEC GmbH, Solarwatt GmbH, econsolutions GmbH, Berg GmbH, FENECON GmbH, R.I.E.MPP, IndustrieserviceElektrotechnik GmbH, Siemens AG, PROVICON GmbH, WAGO Kontakttechnik GmbH & Co. KG, Festo AG & Co. KG, Robert Bosch GmbH
In Slovenia: Metronik, Solvera Lynx, Amibit, E 3, d.o.o, Sisteh, ElektroPirnat
In Austria: the same as for Germany.
In Slovakia: WETRON automatizacná s.r.o., BUILDSYS, a.s., Siemens AG
In Bosnia and Herzegovina: Siemens, Toshiba, Hitachi
In Montenegro: Siemens

b.) Short characterization of openness of BEMS provided by above producers/system integrators

In Croatia no producer or system integrator offers BEMS. The existing BMSs are claimed to be open, but in practice only KNX protocol for versatile automation level connection is ensured. In Bulgaria the producers can provide full equipment of BEMS, and they are usually open for versatile automation levels. In Serbia BEMS providers claim to be open for versatile baseline control equipment. In Hungary about 50% of the systems are open to third-party sensors and actuators. Some systems comply with KNX/EIB standards. There are companies creating their own software and using third-party hardware. There are other companies developing only software for BEMS. In Germany most of the systems are open to integration with different systems thanks to the I/O modules and modular design. Software-only system integrators manage to bridge the gap between different field devices using building automation software modules. The vast variety of communication protocols enables easy ways to establish communication. In Slovenia there are developed cloud solutions with OPC UA connectivity, which can be used on mixed hardware: their equipment and regular PLCs.

c.) Introduction of BEMS for existing buildings

In Croatia, according to the operative regulations, systems of automation and management of the building (BMS) have to be designed in compliance with EN 15232: 2012. Systems of automation and management of the building are defined in the four categories of efficiency: (A) building with a high-performance BMS, (B) building with an advanced BMS, (C) standard BMS, (D) energy inefficient BMS systems. In new buildings and when reconstructing existing buildings it must be designed and constructed in efficiency class A or B or C according to EN 15232: 2012. In Bulgaria BEMS is not introduced very often. All existing non-residential buildings with a total floor area of over 250 square meters and the existing buildings, with some exceptions, are subject to a mandatory energy audit and certification. The owner of any non-residential building is bound to implement the measures prescribed by the first energy audit for achieving the minimum required energy efficiency class within 3 years from the date of acceptance of the results of the audit. When a building undergoes major renovation, its energy performance certificate shall be upgraded after implementation of recommended measures in order to meet minimum energy performance requirements in so far as this is technically, functionally and economically feasible. The BEMSs are not very often found within these prescribed measures. Fairly less than 10% of building renovation cases include also an improvement of the building automation system. In Hungary it is not common to install BEMS. In Bosnia and Herzegovina there are applicable standards during planning construction of new buildings and performing retrofit of existing buildings. They provide minimum technical or energy parameters that the facilities need to reach. In Montenegro, there is a lack of energy management in buildings because of the lack of regulation and implementation support, the lack of direct financial contribution for consumers and a lack of information and knowledge about the low cost or no cost to improve efficiency.

Identified barriers

In the above topics we have limited information from several countries but it seems the main problem is more marketing oriented than technically oriented. There are producers and system integrators in the region but BEMSs are missing from the market. The reason probably is the small level of market interest in the retrofit segment of building industry.

4. Study of Technology – Answers to questionnaire from countries of Danube region

A. Grid side EMS related analysis

A.1. Renewable energy sources (RES):

A.1.1. RES balance and technologies used for the balancing

***Country** (A.1.1.)*	***Analysis and study results***
Croatia	In Croatia balancing services are procured and activated by the Croatian transmission system operator (HOPS). Currently these services are bilaterally contracted and regulated (in line with HERA's methodologies for defining prices of balancing energy and ancillary services). Imbalance netting cooperation on Slovenia border is operational. HOPS contracts the following types of reserves: - secondary reserves; - tertiary reserves; Electricity Market Act defines HOPS as a sole responsible party for balancing energy and activating provision of balancing services. All network users that are technically capable and have been tested and approved by HOPS can provide balancing energy and ancillary services. The legislation enables market based procurement of balancing energy and ancillary services. Some interest, apart from the incumbent dominant producer (HEP-Proizvodnja d.o.o.) has been expressed for the provision of reserve capacity and balancing energy. RES/CHP generators within the feed-in support system will be part of the EKO balancing group that will be managed by HROTE. This will commence no later than 1 January 2018.
Bulgaria	Bulgaria is one of the few European countries where there is a level playing field between RES and conventional producers when it comes to their delivery commitments for the market.
Serbia	Subsidized RES are balanced within the Universal Service Supplier balance group. The balance entities are used by the Joint Stock Company „Elektromreže Srbije" for balancing the deviations of all the balancing groups, independently of their RES share.
Romania	CN Transelectrica SA, the Romanian Transmission System Operator (TSO) is the Balancing Market Operator and responsible for the organization and management of the balancing market.[1,2]
Hungary	Most of the renewable generation are entitled for feed-in tariff and the generation of these power plants are taken over by a special balancing group for feed-in tariff entitled generation operated by the TSO. This generation now is sold on the organized energy market by the TSO and the balancing is made similarly to any other balancing groups. However, the cost of balancing the 'feed-in tariff balancing group' is allocated to the other balancing groups in ratio of their consumption (sale). In Hungary, conventional power plants take part in the system balancing: a lignite/biomass power plant, gas-fired power plants (out of which there are 8 virtual power plants with cogeneration gas engines and gas turbines). There is no system-size storage in the electric energy system and there are no energy storage units used for offering ancillary services.

***Country** (A.1.1.)*	***Analysis and study results***
	Storage was not incentivized at distributed generation sites – neither in household scale, nor in utility scale. Consumers (DSM), renewables do not take part in balancing. They are not aggregated for balancing purposes.
Germany	The feed-in of regenerative electricity generation is governed by a German law the so called ErneuerbareEnergienGesetz (EEG). Most of the EEG plants feed the energy by fixed feed-in tariffs into the distribution network, the DSO passes on the energy to the TSO which sells it on the market. The difference between the market revenues and the much higher feed-in tariff is financed by the end customer via the EEG reallocation charge. Renewable energies have feed-in priority. Their generation must preferably be utilized as long as the network is technically capable of absorbing the energy. Otherwise, the network must be extended immediately. The balance between production and consumption is still mainly achieved by conventional power stations as well as controlled export of electricity.
Slovenia	Reactive power characteristics are prescribed, active power according to connection obligations depending on the state of the grid. RES are priority dispatched. For this reason high portion of total production means potentially high risk for TSO in whole system balancing. TSO should commit secondary frequency regulation to manage schedule deviation. Q/U regulation used for the balancing. Secondary frequency regulation (ancillary service) operated by TSO.
Czech Republic	According to the Renewable Energy Law the DSOs and the TSO are obliged to purchase all RES-E eligible for support under the terms and conditions given by the law. This includes also assumption of responsibility in the case of imbalances Hence, there is no balancing responsibility for RES-E producers, no matter which support design they use. The DSOs are responsible and have to adjust imbalances in the grid the costs resulting from settlement are passed on to the customers. TSO: The Czech transmission system operator has the legal authority to control the amount of electricity generating sources in the system to maintain a balanced budget, a stable network, etc. TSO does set an annual connection limit for volatile energy sources. Grid operator may refuse the connection approval to new RES. Data are one-minute averages [MW] obtained from instantaneous production values measured at the output of wind power plants generators and at the output of solar power plants. Subsequently, estimated production in facilities not equipped with on-line measuring systems is added to these measured values in the ČEPS control system. As regards the "Hour" aggregate value, average output equals energy [MWh].
Austria	Renewable electricity injected into the grid in accordance with the statutory requirements by supported generating stations attracts subsidies in the form of feed-in tariffs. These are paid out by the green power clearing and settlement agent, OeMAG. The tariffs themselves are laid down in the Ökostrom-Einspeisetarif-Verordnung (Feed-In Tariff Ordinance). The green power settlement agent OeMAG is the body that checks the eligibility of all funding applications and verifies whether each additional application still fits within the available support budget. Where this is the case, it concludes contracts with the operators of the green power plants, purchases their electricity and disburses the corresponding feed-in tariffs.

***Country** (A.1.1.)*	***Analysis and study results***
	Operators of supported green power plants sell their electricity to OeMAG for the feed-in tariffs that have been set by ordinance. The system operators are obliged to distribute this electricity through their networks. Austrian Power Grid (APG) is responsible for the entire market-based procurement of regular reservations by means of weekly invitations to tender. Participants in procurement must meet technical and organizational requirements (prequalification). The secondary regulation (also secondary reserve) within the individual control zone limits is responsible for the compensation of power deficits or surpluses. Main technology used for the balancing is pump storage hydropower.
Slovakia	In general, the Rules for the Functioning of the Electricity Market and the Operational Order of the SEPS, a. s. company which is approved by the Regulatory Office, defines in more detail rights and obligations of the parties involved in the system balancing. The territory of Slovakia represents one integrated area for balancing any deviations. Delivery of regulatory electricity is provided by the transmission system operator on the basis of the agreement on supply of regulatory electricity concluded with the supplier of regulatory electricity. On a daily basis until 11.00 a.m. TSO finds the overall amount of supplied regulatory electricity and the costs for provided regulatory electricity delivered by individual suppliers of regulatory electricity and that is for each trading hour of a previous day. The amount of supplied regulatory electricity is determined as the difference between electricity supplies from the registered daily diagram of the supplier of regulatory electricity, based on the requirement of the TSO Energy Dispatch Centre. The shares in costs for procurement of regulatory electricity are not regulated by the Regulatory Office. The Transmission System Operator SEPS is responsible for the system stability and provides dispatching control of the system. Due to the minor share of fluctuating generation in the total RES-E production, balancing responsibility is not a major issue yet in Slovakia. There is no balancing responsibility or forecast obligation for RES-E in Slovakia (Fraunhofer ISI 2008). The distribution system operators are required to take all electricity generated from renewable energy sources to cover their losses. Detailed information about further cooperation between the RES-E producers and system operators are regulated by system operators in their operational procedures. If the electricity from RES-E exceeds the amount needed to cover losses in the distribution system, the distribution system operator is entitled to sell the electricity at the market price (NREAP 2010). With more than 70% cumulated share of coal and nuclear, the Slovak power system is dominated by inflexible base load generation. As long as the share of variable renewables remains low as planned in the NREAP, the Slovak system is able to balance the domestic variable generation, though its substantial hydro capacities could be used in the future to balance variable generation from neighboring countries like Poland and Hungary, that have less favorable conditions for storage and balancing capacities.
Bosnia and Herzegovina	RES are balanced by the electric utility on which grid they are connected. RES are still not registrated with "Nezavisni operator sustava u Bosni I Hercegovini" - NOSBiH (Independent System Operator in Bosnia and Herzegovina) as a market participants, though, in the document which relates to „Tržišnapravila" [3] (Market rules) is predicted that RES are balanced and accordingly pay fees for it as well as

***Country** (A.1.1.)*	***Analysis and study results***
	all other participants in the market. For balancing is used energy available on daily energy market – there may be a contracted capacity of secondary and tertiary regulation and voluntary offer of tertiary regulation (what is defined in documents relating to procedures for ancillary services and balancing energy market of tertiary regulation on daily basis „Procedure zapomoćneusluge“ [4] i „Pravilnik o radudnevnogtržištabalansneenergijetercijarneregulacije“ [5]).
Montenegro	Article 78 of the Law on Energy [6] envisages that a privileged producer may sell its energy on the market under the same conditions and regulations as applicable to any other producer, while its participation on a market shall not be shorter than 12 months. All privileged producers are, according to the Law on Energy, members of one balancing group that is not charged for imbalances by the respective system operator. A privileged producer has the obligation to submit to the transmission/distribution system operator and the market operator monthly and yearly production plans related to average metrological conditions and anticipated monthly deviations in production based on metering which determined production potential of renewable energy source. According to the Transmission Grid Code in case of overloads in the transmission system, producers have the obligation to adjust the production level as instructed by the transmission system operator. The Energy Development Strategy envisages an analysis of electricity market operations and proposal for modifications, and consequently implementation of legislative-regulatory changes. The model of the existing support scheme for electricity generation from renewable energy sources should be further developed and adapted to the market model in order to meet the national macroeconomic and social objectives within "Energy Community acquis".

A.1.2. Grid priority access of RES from network connection point of view

***Country** (A.1.2.)*	***Analysis and study results***
Croatia	RES/CHP generators that have obtained the status of an eligible electricity producer have grid priority meaning that when curtailment is necessary, eligible producers are the last to be curtailed. Eligibility status is given for generators that use RES or are high-efficiency CHP units. Conditions of eligibility are defined by legislation and status is given automatically for so-called “simple generators” (for now exclusively PV installed on buildings) or is obtained by a ruling given by the Croatian Energy Regulatory Agency (HERA). No particular discrimination exists, in relation to technology or primary energy, for connecting new generators to the network.
Bulgaria	Yes, this is guaranteed to all eligible producers/RES (both connection to the grid and priority network access/dispatch – Table 9 of CEER April 2017. report). The transmission access price for producers generating power from wind and sun is justified by the need of additional reserve capacities in order to balance the intermittent electricity from solar and wind farms. In this regard and in view of the need to maintain the power system balance and to offset the impact of these types of renewable energy, the transmission operator has justified the additional cost of purchasing secondary regulation reserve to be able to pay to the thermal power plants for their full participation in primary and secondary regulation, voltage regulation and "switching on/off cycles". ESO EAD has justified the necessary reserve of 170 MW with an increased secondary regulation range of photovoltaic power plants (PvPP) and wind power plants (WPP), where PvPP increase of the

***Country** (A.1.2.)*	***Analysis and study results***
	secondary regulation range is 9.5 MW for every 100 MW of installed capacity and for WPP – 7.8 MW for every 100 MW of installed capacity. This in turn resulted in connection costs reflecting above stated additional expenses. RES are not compensated for the curtailed electricity (allowed to maintain network security). Producers of electricity from renewable sources are contractually entitled against the grid operator to the purchase and payment of electricity at a guaranteed price. The feed-in tariff may not be received on top of other incentives – The scheme is awaiting for evaluation from World Bank in 2017. RES/DG in Bulgaria are connected under the deep connection charge regime.
Serbia	The operator of transmission and distribution system is obliged to grant an approval for connection of RES in accordance with the grid code.
Romania	The system for promoting electricity production from renewable energy sources applies to electricity generated from: • Hydro energy used in the power stations whose installed power is less than 10 MW • Wind energy • Solar energy Geothermal energy • Biomass • Bio-liquids • Waste fermentation gas • Gas from the fermentation of sludge from the used water cleaning plants. + Renewable energy – Rule system. An important aspect of Promotion of Electricity produced from Renewable Energy Sources (E-SRE), established by law, is that transmission system operators and distribution system operators must provide with priority the access to the grid system of electricity produced from renewable energy sources.[7]
Hungary	In household size (<50 kVA) RES licensing, the DSO must provide access for the RES and pay its cost. The owner of the RES have the right to connect till reserved capacity for consumption (for example 3x25 A), above this capacity for production the owner has to pay additional cost for network investment. The problem of this is the big loop impedance of the low voltage network, the asymmetry caused by this type of household generation (they can feed in to one single phase), the effect of more generators, and the lack of voltage regulation at low voltage. Above 50 kVA and in case of medium or high voltage connection, the DSO run grid analysis to determine the closest possible connection point. The DSO must perform the analysis in the order of application, so RES has no priority access to the grid connection and those applying earlier get closer (and thus cheaper) connection possibility. The connection cost must be paid by the generator. The advantage of this is that the DSO always give a recommendation for connection but on the other hand, sometimes it is not acceptable for the investors/power plant owners as this connection can be relatively far and thus expensive.
Germany	Electricity from renewable energy sources must preferably be utilized, in cases where the grid connection or the upstream grid does not have sufficient capacities, a grid expansion must be carried out.
Slovenia	They are treated like every network user (consumer/prosumer/production). In comparison to consumers connection they do not pay fee for connecting to a grid.
Czech Republic	According to Czech legislation, the grid operator is obliged to give priority connection to renewable energy sources and to conclude connection agreements with the RES-E producers. The transmission system operator (TSO) and the three

Country ***(A.1.2.)***	***Analysis and study results***
	distribution system operators (DSOs) are obliged to connect the RES-E installations within the area delimited in their license.
Austria	Approved power plants (by OeMAG) have priority. The system operators are obliged to distribute this electricity through their networks.
Slovakia	A producer of electricity, who qualifies for support has a right to priority connection to the distribution grid, priority transmission of electricity, priority distribution of electricity and priority supply of electricity if the electricity generating installation meets the technical conditions of the system operator under special legislation and does not compromise the safety and reliability of the grid.
Bosnia and Herzegovina	End-users have priority access from grid connection point of view.
Montenegro	The transmission/distribution system operator is obliged to ensure priority in connection of generation facilities that use renewable energy sources, provided that the connection is in accordance with all the technical requirements (Article 151 of the Law on Energy). According to the Article 79 the privileged producer is entitled to the purchase price for electricity in accordance with the tariff system and priority in delivery for total electricity generated and connected to the transmission or the distribution system. Further it is stated that in the process of operating the transmission and distribution system and related dispatching, the operator of the electricity transmission and distribution system shall give preference to privileged producers, in accordance with the technical capabilities of system. It is prescribed that if due to security of system operation reasons, operators of transmission and distribution system may not give precedence to a privileged generator, and in that case they shall inform the Energy Regulatory Agency and determine corrective measures for prevention of further denials of access to the system.

A.1.3. Future plans for RES integration, technical strategy for RES integration, technology priorities?

Country(A.1.3.)	***Analysis and study results***
Croatia	Croatia has an Energy Strategy adopted in 2009. However, it is evidently outdated and the Government has announced the development of a new strategy which should be finished by the end of 2018. In addition, a strategy on low-carbon economy is currently in public discussion. Also, there is a National Action Plan for Renewable Energy Sources created in line with Directive 2009/28/EC (although predominantly concerned with the feed-in support scheme which ended by the end of 2015). Current construction of RES/CHP generators is based on feed-in contracts signed by the end of 2015. Technological issues of RES are mentioned in the Industry strategy and the Smart specialization strategy.
Bulgaria	The CEER report for 2017 states that Bulgaria generated 47.485 GWh of electricity, however there is not information of any electricity generated from RES (the field is left blank). In addition, while Energy and Water Regulatory Commission of Bulgaria in the report “Tariff of the fees collected by the state energy and water regulatory commission (sewrc) under the energy act” (available at http://www.dker.bg/files/DOWNLOAD/ewrc-fees-tariff-en.pdf) list tariffs for cogeneration and electricity producers of different sizes (installed power), CEER report of April 2017 states that at the moment, only photovoltaic units are subsidized in Bulgaria under the feed-in-tariff scheme (and no changes since 2014).

***Country**(A.1.3.)*	***Analysis and study results***
	National Bulgarian strategy for 2020 indicates a goal of 16% of RES in final energy consumption, however there is no goal set beyond 2020.
Serbia	The National Renewable Energy Action Plan of the Republic of Serbia (NREAP) (28.06.2013.) is the document that encourages investment in renewable energy sources (RES), and sets targets for utilization of renewable energy sources by 2020 and the ways to achieve it. By signing this contract, the Republic of Serbia have accepted to apply directives from the field of renewable energy sources. Here, binding targets are accepted, in line with the Directive 2009/28/E3, to provide 20 % share of renewables in the gross final energy in EU, as well to improve and increase the energy efficiency by 20 % in the same period. In the accordance to the Directive 2009/28/E3 and Decision of the Ministerial Council of the Energy Community (18/10/2012), Republic of Serbia has set an ambitious goal of 27 % share of renewables in the gross final energy consumption in 2020. Relating to that, Serbia has passed a series of laws, regulations, and administrative provisions, which was one of its obligations by the end of 2013 [8,9]]. According to the Energy Sector Development Strategy of the Republic of Serbia for the period by 2025 with projections by 2030 (2012), the strategic development of the energy sector is based on establishing a balance between the energy production from the available sources and a financially and socially sustainable energy consumption, as well as efficient and, as more as possible, „clean"- energy production from renewables. In other words, a sustainable energy system is achievable with more efficient energy production from available and renewable sources, and with planned and cost-effective placement. On the other hand, strategic approach to the energy sector is a way to reduce the ecological threats and economic costs. [10].
Romania	Necessary steps for starting-up a generation capacity based on E-RES • obtaining the authorizations and approvals needed for building-up the generation capacity; • building up the generation capacity; • obtaining the generation license; • obtaining the qualification certificate for the electricity priority production; • registration at the Electricity Market Operator (SC OPCOM SA) – for selling E-RES on the DAM (Day Ahead Market); • registration at TSO (CN TRANSELECTRICA SA) – for obtaining the green certificates (GC); • Registration at the Green Certificates Market Operator (SC OPCOM SA) – for participating on the centralized market of the green certificates. [7]
Hungary	The DSO analyses the following solutions: • PV inverter control to handle distribution network problems (e.g. voltage control). Controllable inverters are wide spread over 50 kVA (conditions are regulated in the DSO Network Code), under 50 kVA it is not a common solution and there is no obligation. • Monitoring distributed generation in the distribution grid's system control, above 50 kVA. • Testing inline voltage regulators on the distribution grid, on LV. We are now clearing the conditions of operating this equipment.

***Country*(*A.1.3.*)**	***Analysis and study results***
	• Testing how to use local (building scale or microgrid scale) energy management systems to handle network problems. Our legacy Radio Control System can be further developed, to be able to control the local energy balance (e.g within MV/LV tr. district area could be separated consumer groups established for DSM.) • Testing On Load Tap Changer technology in case of MV/LV transformers, if the network constraints are generated on the MV network or in all LV circuits. On the other hand, usage of the energy storage for mitigating the impact of the RES has just been included in the Electric Energy Act.
Germany	A number of techniques are tested and used to optimally integrate electricity from renewable energies into the grid. Examples include the use of controllable local power transformers, the use of battery storage and the planned control of systems via smart meter infrastructure.
Slovenia	Implementing DMS state-estimation technologies and investments in the grid. On-line power flow control, voltage regulation also of the low-voltage grid.
Czech Republic	In 2013 the share of renewable energy sources in gross final energy consumption reached 12.4% and the Czech Republic is very close to reach its 13% target of RES share by 2020. However this development has caused a great level of costs due to regulatory failures in design of the feed-in tariff system. The amendment Act No 310/2013 Coll. cancels support provided to new RES electricity installations from 2014, with one-year transition, allowing completion of projects in progress. As of 2016 feed-in tariff payments to operators of PV power, gas heating and biomass plants were suspended because it was suspected that payments to renewable plants commissioned in the period 2006 to 2012 and up from 2016 might not conform to EU state aid regulations. In December 2015 the Czech Government decided that supporting payments to renewable power plants will be continued over 2016 and will be stopped only on specific request of the EU.
Austria	Currently, a number of possibilities is discussed, such as battery storage systems, system control via smart meters, DSO side regulation of power plant capacities (when out of the OeMAG approved priority period).
Slovakia	The development of the transmission system is based on the following basic documents in force in Slovakia: · Energy Security Strategy of the Slovak Republic · Energy Policy of the Slovak Republic These documents set out the medium- and long-term plans for electricity use, including use of RES, while maintaining the secure operation of the electricity grid. In order to ensure electricity grid stability and the security of the electricity supply, capacity limits have been imposed for MoEC SR certification in relation to applications for the construction of photovoltaic power plants. Every year, the transmission system operator, Slovenská elektrizaná prenosová sústava, a.s., draws up and updates the medium- and long-term Transmission System Development Programme. This programme draws on the basic documents above and is prepared in keeping with the requirements of individual users, especially distribution system operators (DSOs) and electricity producers connected to the transmission system. It also specifies the impact of renewable sources on the development of the transmission system and proposes measures for their implementation. The development of distribution systems ready for the connection of renewable sources is carried out within the scope of development plans, with reference to connection requirements.

Country(A.1.3.)	***Analysis and study results***
	Distribution systems are developed in accordance with the “Five-year DSO Development Plan”. The target quantities of renewable electricity planned under the current Energy Security Strategy can be gradually incorporated into the electricity grid on a year-by-year basis so that they have no significant direct impact on the development of the transmission system while maintaining security criteria. At present, there is a risk of hazardous effects on the development of the transmission and distribution system and on the maintenance of security criteria because the current construction of renewable energy facilities may exceed the planned amount of installed RES capacity envisaged in the current Energy Security Strategy. Any such excessive unplanned capacity could jeopardize the safe management of the Slovak grid for the following reasons in particular: · The construction of RES will be too fast for the RES implementation infrastructure to keep up · The planned capacity of renewable sources will also place demands on the infrastructure which cannot be covered financially · The storage of electricity from RES is not adequately secured. RES investors should also arrange for the storage/backup of their own electricity
Bosnia and Herzegovina	(„Akcijski plan Federacije BiH za korištenje obnovljivih izvora energije – APOEF“ (Action Plan of the Federation of Bosnia and Herzegovina for the use of renewable energy sources) - Federal Ministry of Energy, Mining and Industry (SN FBiH 48/14 [11]). This document determines policy, plans and indicative targets of the Federation of Bosnia and Herzegovina which relates to the share of RES in gross final consumption of electrical energy. It is synchronized with the power system strategy of the Federation of Bosnia and Herzegovina and, among other things, defines an overview of energy consumption from renewable sources in 2005. (reference year), and in the period from 2010. to 2020., including: • planned total final energy consumption from renewable sources in heating and cooling, electricity and transport, taking into account the effects of energy efficiency and energy savings, expressed in kilotons of oil equivalent (ktoe), • planned share of RES in final energy consumption from renewable sources in heating and cooling, electricity and transport expressed in percentages, • share of renewable energy of each sector in final energy consumption, • share of renewable energy in transport, • assessment of the total share (installed capacity of total electricity generation) expected from each renewable energy technology, • the maximum level of installed capacity of privileged producer for each technology (hereinafter referred to as the dynamic quota), • policy and measures to promote and encourage the use of energy from renewable sources, in accordance with the regulations in the domain of competition and state aid, • common measures of ministries and institutions. *See Appendix A.1.3. Bosnia and Herzegovina*
Montenegro	Montenegro has a national strategy for RES integration called “National Renewable Energy Action Plan to 2020 Montenegro” **Hiba! A hivatkozási forrás nem található.**. Utilization of RES represents a priority in the Montenegrin energy policy: (a) Creating a favorable environment for development and utilization of RES and reaching the national target regarding the RES share in the gross final consumption of energy;

Country(A.1.3.)	*Analysis and study results*
	(b) Continued researches on RES potentials and study work on researching the possibilities to use remaining available RES potentials; (c) Increased share of RES utilization in transport aimed at securing the achievement of RES share in overall consumption of energy in transport, in accordance with the obligations of the state.

A.2. System operators:

A.2.1. Communication and cooperation between TSO and DSO from technology point of view (what information do they exchange, how often, how do they coordinate their operation, how does this change with the introduction of active distribution management)

Country(A.2.1.)	*Analysis and study results*
Croatia	The regulatory framework (in essence the Act on the Electricity Market) defines the relationship between the Croatian distribution system operator (HEP-Operator distribucijskog sustava d.o.o., HEP-ODS) and Croatian transmission system operator (Hrvatski operator prijenosnog sustava d.o.o., HOPS. Both the Croatian DSO and TSO are daughter companies of national utility company HEP d.d. and they exchange information needed for continuous power system operation. With regards to unbundling of transmission system operators, the Independent Transmission Operator (ITO) model has been chosen.
Bulgaria	The electricity sector in Bulgaria is managed by the State Energy Regulatory Agency (www.dker.bg). Under the Agency, the Nationalna Elektricheska Kompania (NEK) was split into six independent generators, a national transmission system operator, and seven regional distribution system operators. Three distribution regions in western Bulgaria (including the Sofia region) are owned and operated by CEZ, two distribution regions in northeastern Bulgaria are owned and operated by Energo - Pro, and two distribution regions in southeast Bulgaria are owned and operated by EVN. Currently, most of the thermal electricity generation capacity is privatized (the hydropower and nuclear plants are still state owned), all of the electricity distribution companies are also in private hands. Currently, there is about 12,668 MW of installed capacity in Bulgaria including thermal, nuclear, and hydroelectric resources. The existing generation assets in Bulgaria have been sufficient to supply domestic demand and have created opportunities for a significant export of electricity. Bulgaria's green power plants have 5013 MW total capacity. The wind power parks amount at 860 MW. The photovoltaic systems in the country have a total capacity of 1040 MW where NEK's and private operational hydroelectric power plants have a total capacity of 2,713 MW, including 47 MW in micro plants (under 1 MW each), and other hydro and RES – approximately 400 MW. Based on the Bulgarian Grid Code (which can be found in English at http://www.dker.bg/files/DOWNLOAD/bggridcode_en.pdf) the ESO EAD carries out unified operational planning, coordination and management of the electricity system. The main tasks to be performed by ESO EAD and associated with the centralized operational management of EPS, include operational management of EPS, power and energy regimes and electrical loads forecasting, generation capacities planning and EPS operational mode. ESO EAD is thus the transmissions service provider and it exchanges and includes DSO in the planning procedure (load forecasting, notifications received from distribution companies). The independent transmission operator and the operators of the electricity distribution networks

Country(A.2.1.)	***Analysis and study results***
	exchange information at the end of the current month, in regards to the range of the balancing services (http://www.dker.bg/files/DOWNLOAD/el_market_rules_en.pdf)
Serbia	From the point of DTR, the cooperation is carried out in the context of the exchange of the accounting data for the purpose of the deviation calculation of the balancing groups that DSO sends to TSO monthly. They communicate for the process of changing the balancing groups, as well. Also, TSO is charging the access to the DSO transmission system.
Romania	SunE stressed that information exchange even between the association and its members is very difficult and RES-E producers as well as TSO and DSO consider several pieces of information confidential and thus not to be shared with external actors. For this reason, centralized and well-accessible information concerning the electricity sector is missing in general (SunE 2011). [2]
Hungary	Electrical data are remotely read by the measurement center each day between 0:00 PM and 5:00 AM, and an aggregated database is sent to TSO (MAVIR) daily in xml format on a dedicated line. Gas data is quite similar, the difference is that for MOL (gas wholesale) a short data format change is requested. Regarding gas data another system connection is in operation to FGSZ (gas TSO) where the nomination is prepared.
Germany	Between DSO and TSO, a master data exchange takes place. Network security calculations are coordinated between DSO and TSO, and online values are exchanged for this. The planning of shutdowns takes place in coordination. Data is exchanged between the network control points using the protocol TASE.2.
Slovenia	TSO is given all the data concerning the production in the distribution network. Data of the network (state of equipment – closed, opened, measurements – current, voltage, flows, protection signals) are exchanged between both; connection established via IT and regular reporting - monthly. On the other hand DSO and TSO exchange only those power measurement data from connection points between transmission and distribution network. These points are mainly main supply substations HV/MV. Total real time production from all RES in distribution network is unavailable.
Czech Republic	The exchange and coordination of all relevant operating states that interact with the 400, 220 and 110 kV networks (in the Czech Republic 400 and 220 kV networks, 110 kV transmission lines and 110 kV lines) are part of the distribution systems. We synchronize the switching off of 400/110, 220/110 kV transformers with DSO, all important 110 kV lines (DSO) are also subject to coordination. In cooperation with 4 distribution system operators and with producers (power plants), we coordinate all necessary data (operating states) on an annual, monthly, weekly and daily basis. During real-time operation, they collaborate and modify all operations that affect another system (including requests of Operational planning).
Austria	TSO – Energy Burgenland DSO – Energy Güssing The distribution system operator („Energy Burgenland Electricity“ as grid operator) captures data like power, consumption, etc. at the supply terminals of the grid of Energy Güssing through an appropriate measuring system. Those data is transferred to the balance group representative (Energy Burgenland) where the grid of Energy Güssing is connected to. The Energy Burgenland transfers the data to the superordinate distribution system operator. Ultimately the data reach the transmission grid operator – the APG (clearing, forecasting, etc.).

***Country**(A.2.1.)*	***Analysis and study results***
	This is regulated in the „Market regulations electricity“ of the E-Control chapter 10 „Information transfer of grid operators and other market actors – principles of the 1st and 2nd clearing“ and chapter 11 „Data format for the transfer of consumption data of intelligent measurement devices from the grid operator to the electric utility according to § 2 DAVID-VO“
Slovakia	SEPS, as the sole TSO, is responsible for: • the operation of the transmission system; • the balancing of the transmission system in accordance with international rules; • the transmission of electricity using the principles of transparency and non-discrimination; and • cross-border electricity transmission. The connection of generators to the transmission and distribution grids is regulated by the RONI Act and relevant secondary legislation. The generators are connected to the transmission grid on the basis of a connection agreement with SEPS. Connection is usually subject to fulfilment of the grid operator’s technical and commercial terms and conditions. Access to the grid, including fees, is regulated by the RONI. The operation of the transmission grid is administered by SEPS, who also provides system operating services at regulated prices and is obliged to ensure the purchase of ancillary services. As part of its system management duties, SEPS prepares ten-year network development plans in accordance with the Energy Act. These are based on current and future supply and demand and transmission system capacity, taking into account reasonable assumptions on electricity demand, consumption, and electricity exchanges with other countries, EU network development plans and regional investment plans. The network development plans are prepared in cooperation with the RONI and are subject to consultation with existing and potential users of the transmission system, who may make reasonable objections or suggestions.
Bosnia and Herzegovina	DSO has the right and responsibility for the management of intermittent elements of medium power lines - 10kV, 20kV and 35kV, which are owned by the Transmission Company of Bosnia and Herzegovina „Elektroprijenos BiH“, and in this sense it is an everyday communication and exchange of orders for exclusion and inclusion, information about electric measurements in the grid, as well as the coordination of planned exclusions. All details are provided in the document related to the grid rules of distribution system of "JP Elektroprivreda HZ HB" dd Mostar – „Mrežna pravila“.
Montenegro	The way of data exchange in real time and communication between TSO and transmission system is regulated by the contract of connection. TSO and transmission system user must install communication equipment in order to transfer the following types of data in real time for use in the management EES: - information on the status of switching equipment, such as circuit breakers, disconnectors, grounding and regulating switches, if necessary for system management or for evaluation of the system, - measured values (current, voltage, frequency, active power, reactive power) - information related to the protection, control and alarm devices, - other data of interest, depending on the specifics of the transmission system users who are connected. The entire range of data related to the process of the plant users who need exchange in real time must be jointly defined and must be an integral part of the contract of connection.

A.3. Prosumers – generation, storage and flexible demand connected to the distribution network):

A.3.1. Technical rules/standards for connecting DERs to the distribution network, types of conditional contracts for DERs regarding grid connections, basic technologies of the contracts (e.g storage, curtailment technology/procedure,…)

Country(A.3.1.)	***Analysis and study results***
Croatia	Generators are legally obligated to provide ancillary services, in compliance with technical requirements set in the Grid Code. When connecting a generator to the distribution network, the investor pays for the entire grid upgrade/reinforcement (connecting lines and interface to the grid but also grid reinforcements due to new connection). However, in some cases the investor may waive the n-1 criteria in favor of a cheaper connection. The network usage contract concluded by the DSO and producer/prosumer may include limitations for the generator depending on actual network conditions (e.g. limitation of production in certain conditions).
Bulgaria	Transmission and distribution network tariffs to end consumers are approved by EWRC upon the companies' proposal in time and form. Different consumers' groups and tariff structures are specified according to companies' proposals and are grouped according to the voltage level and daylight zones. Network services are paid based on electricity consumption. Transmission services and access are paid by consumers connected to the electricity transmission and distribution networks, distribution companies, traders with export transactions and traders with transactions on behalf of a network services user. It doesn't seem to be any type of specific connection contracts, in fact the Electricity Market rules (http://www.dker.bg/files/DOWNLOAD/el_market_rules_en.pdf) suggest that the distribution system operator takes over the role of balancing RES and DER connected to the distribution network in case they do not belong to any other balancing group. Interesting to notice that the Electricity Market Rules say "Hourly generation schedules shall be sent to the coordinators of balancing groups by all producers connected to the electricity distribution network, on the day preceding the delivery day, in a form approved by the coordinator of the balancing group…." – this implies that DER in Bulgaria can be active market participants. Self-consumption is defined as the use of power generated on-site by an energy consumer in order to reduce, at least in part, the purchase of electricity from the grid. Self-consumption is highly relevant in the context of the drive towards greater consumer empowerment and engagement, and the realization of Europe's renewable energy targets. Self-consumption is allowed in Bulgaria, however no specific schemes for self-consumption are in place, i.e. the volume of self-produced RES electricity is not being measured nor being subject to any financial contribution to the overall system costs. It should be mentioned that Annex 14 of the CEER report gives a value of 1% self-consumption in Bulgaria and that the net-metering is executed by the owner of the grid (assumption is this refers to the DSO). No information on storage or demand response could be found.
Serbia	Regulation on operation of the distribution system and network (grid) rules of the system operator regulate the technical requirements for connecting RES.
Romania	In the context of grid connection, four legislation pieces are considered relevant: *Electricity law nr.13/2007* (legea energie electrice nr. 13/2007), *decision on the approval of the regulation for the connection of users to the electricity grid of public*

Country(A.3.1.)	**Analysis and study results**
	interest nr. 90/2008 (Hotarare pentru aprobarea Regulamentului privind racordarea utilizatorilor la retelele electrice de interes public, hotarare nr. 90/2008), *law nr. 220/2008 for establishing the promotion system for renewable energy sources amended by law nr. 139/2010* (Legea nr. 220/2008 pentru stabilirea sistemului de promovare a producerii energiei din surse regenerabile de energie), and *regulation nr. 129/2008 for the approval of the regulations regarding solutions for connecting to the electricity grid of public interest* (Ordin nr. 129/2008 pentru aprobarea regulamentului privind stabilirea solutiilor de racordare a utilizatorilor la retelele electrice de interes public). In general, for plants with capacity up to 50MW, connection request are addressed to the DSO, for plants with capacity above 50 MW, requests are addressed to the TSO (Ordinance 90/2008 Article 6, paragraph 1.2). The grid operator, TSO or DSO is obliged to connect a RES-E plant to the grid (Art. 25 Abs 1 Law 220/2008). A grid connection contract is a pre-condition for connection (SunE 2011, wpd Romania 2011). TSO and DSO specified that wind power plants have to follow some technical requirements, such as voltage regulation, the active power with regard to certain grid frequencies etc. (ANRE Regulation nr. 51/2009, FDEE 2011, Transelectrica 2011). Curtailment is foreseen in the context of the general technical regulations for grid operation in case of excess of supply and for grid security reasons (FDEE 2011, Transelectrica 2011).
Hungary	In household scale (<=50 kVA) there is a list of allowed inverters requiring frequency-dependent generation curtailment according to the patents EN 50438/VDE-AR-N 4105. In case of bigger built-in capacity 4 from A to D groups are differentiated with 0.5, 5, and 50 MW limits respectively, for special frequency-sensitive operation modes. The limits are the following which must be realized by 14 April 2019. The groups used have the following limits: A 0,8-500 kVA, B 0,5-5 MVA, C 5-50 MW, D >50 MVA. Storage capacity is not prescribed. There are no conditional contracts only for abnormal operation of the grid (curtailment or disconnection). The energy law has been completed by the definition of storage and the new regulation allows up to 0,5 MW storage capacity for the DSO exclusively for grid usage purposes mot allowing energy trading. *See Appendix A.3.1. Hungary*
Germany	There are several documents existing (technical connection conditions = TechnischeAnschlussbedingungen TAB) in which the minimum requirements for the connection of power generation systems to the grid are defined [15]: • TAB High Voltage • TAB Medium Voltage • TAB Low Voltage • TAB Measurement Units Principally the customer is responsible to enable the house connection and the DSO has on the other hand to enable the network.
Slovenia	Standards and connection rules are prescribes in Grid code (System operational rules) for distribution network. In general, it is not allowed that DSO limit RES operation after confirming DER connection to the grid.

***Country**(A.3.1.)*	***Analysis and study results***
Czech Republic	Standards and connection rules are prescribes in Grid code for distribution network. In general, it is not allowed that DSO limit RES operation after confirming DER connection to the grid.
Austria	The technical design of the connection is a matter of contract between the grid user and the DSO The installation of the facilities of a network user has to be carried out in compliance with the relevant statutory provisions regulations and any regulatory requirements as well as in accordance with company-specific regulations of the DSO. The DSO may demand proof of the proper implementation of agreed measures by the network user or check them themselves. For power connections, the following points must be taken into account: • Network connection (type of execution), • Maximum amount of network usage • Limited scope of grid usage in case of replacement supply • Startpoint treatment, • Minimum and maximum power failure, Last update: October 2009 - Version 2.0 16 TOR - Part C • Maximum and minimum operating voltage, • Protection concept, • Connection conditions, • Voltage quality at the transfer point, • Permissible network effects, • Measuring and counting devices. [16]
Slovakia	Relevant legal sources The Act No. 309/2009 Coll. on the Promotion of Renewable Energy Sources and High-efficiency Cogeneration (Zákon o podpore obnoviteľných zdrojov energie a vysoko účinnej kombinovanej výroby, in the following “RES Act”) is the main national instrument laying down the general principles of the country’s renewable energy policy. Other relevant legal sources are the general Energy Law No. 656/2004 Coll. (Zákon o energetike, in the following “Energy Act“), the Government Decree No. 317/2007 Coll. on the Regulation of the Electricity Market (Nariadenie vlády 317/2007 Z.z. ktorým sa ustanovujú pravidlá pre fungovanie trhu s elektrinou, in the following “Decree No. 317/2007”), and the Decree No. 2/2008 by the regulatory authority URSO on the regulation of prices in the energy sector. Connection procedures, deadlines, and information management A RES plant is connected to the distribution under three conditions: the distribution grid has the technical capacity for the connection, the distribution grid is nearest located to the electricity generating installation and other grids are not in a technically and economically better location for the connection. The distribution grid is considered to have technical capacity even if the collection of electricity without detriment to the priority is only possible by the economically efficient extension of the grid, in which case the DSO, at the request of the electricity producer, is required to extend the grid (NREAP 2010). If the system complies with the technical requirements and the terms and conditions, the grid operator shall connect the installation to its grid within five working days (§ 3 par. 5 Decree No. 317/2007, URSO 2011).

***Country**(A.3.1.)*	***Analysis and study results***
	The grid operator is obliged to supply the RES plant operator with information about the technical conditions and the operation rules of the grid (URSO 2011). Even though RES plants are generally entitled to this priority connection to the grid, investors are struggling with several problems during the connection process. According to the Slovak Association of Photovoltaic Industry (SAPI), the connection to the grid is in many cases either technically impossible or the whole process is severely delayed (SAPI 2011). The waiting time can amount to more than one year. Some applications dating back to January 2010 have still not been processed by the DSO in charge until May 2011 (SAPI 2011). The regulatory authority URSO also stated that the main problem during the connection process lies in the very time-consuming processing of the applications for grid connections and the conclusion of a connection agreement, allegedly due to the high amount of applications in recent months (URSO 2011).
Bosnia and Herzegovina	The main criterion for the connection of the RES to the distribution grid is a voltage change at the connection point. There are no conditional contracts.
Montenegro	During the procedure of connecting power plants to the distribution system of electricity, distribution system operator (DSO) is responsible for: a) Giving an opinion on the possibilities of connection; The distribution system operator is obliged to give an opinion to the applicant on the possibility of connecting the planned facility to the distribution system, within 30 days of the receipt of a request. b) Issuing requirements for connection; The distribution system operator is obliged to issue to the applicant requirements for connection to the distribution system (based on preliminary solution for power plant) within 45 days of the receipt of a request. c) Issuing a decision on granting consent for the connection; The distribution system operator is required to resolve the request for issuance of consent for connection to the distribution system within 90 days of receipt of proper request (based on revised preliminary or main design). d) Conclusion of grid connection agreement After completion of construction of power plant and facilities for connection to the distribution system, the investor is obliged to attend the trial period, technical inspection and to obtain an exploitation permit, in the manner and under the procedure provided by the Law on Spatial Planning and Construction. Upon meeting the conditions from the decision on issuing consent for connection to and before the continuous commissioning of the power plant, the investor and DSO conclude the grid connection agreement. If a proper request is submitted by an investor and all the conditions from the decision on issuing consent for connection, as well as from the grid connection agreement are met, the distribution system operator is obliged to issue a permit for connection to the distribution system, and to connect the power plant to the system in the presence of the investor, within 15 days from the date of application. Connection of facilities to the distribution network is made after the conclusion of two contracts: a contract on electricity supply that power plants take from the distribution system and the power purchase agreement. The distribution system operator is obliged to connect the facility to the distribution system within 15 days of the conclusion of the supply contract.

A.4. Active distribution networks and "smart" DSO

A.4.1. Smart meter installations/replacements in the distribution network, numbers, type, communication, strategy and CBA of smart meter roll out.

Country(A.4.1.)	***Analysis and study results***
Croatia	Installations of AMR is well on the way with over 70.000 units installed and collecting data. The initial step was setting AMRs for consumers with contracted power over or equal to 20 kW and all producers. By the end of 2020, all consumer sites with connection power over 20 kW should be equipped with meters with remote metering. Furthermore, the DSO has an internal strategy, dictated by the regulatory framework, of installing AMRs/smart meters at all consumer sites by the end of 2030, with a planned ratio of technologies involved at PLC/GPRS = 90%/10%. Potential technologies that are planned for the national scale rollout are PLC communication (preferably G3-PLC) from customer site to data concentrator built in the substation and then communication via GPRS network form data concentrator to the appropriate HES (Head End System) on the DSO side. Ongoing Smart metering pilot projects are in Split distribution area (Elektrodalmacija Split - volume of app. 3000 metering spots supplied from 7 substations) and Zadar distribution area (Elektra Zadar - volume of app. 500 metering spots supplied from 1 substation). Also, a Smart metering pilot project is on the way in Osijek distribution area (Elektroslavonija Osijek - volume of app. 800 metering spots supplied from 6 substations). All of the projects mentioned are based on G3-PLC meters and communication technology. Each substation involved is equipped with a PLC concentrator and a smart meter used for total energy consumption measurement of the associated substation area. HERA has carried out a CBA of a smart-meter roll-out, and now the ministry in charge of the energy sector is supposed to define a smart-meter roll-out program. .
Bulgaria	Smart grid implementation has begun in Bulgaria. Since 2009 CEZ has already installed more than 18,000 smart meters costing some 66 Million BGN ($46.5 Million). The smart meters will enable more efficient use of energy by adapting consumers' supplies to changing daily demand patterns and enabling consumers to feed unused electricity back into the grid. Initially, these smart meters will be used only for remote metering of power consumption until the country fully liberalizes its power market and consumers start choosing between different providers.
Serbia	The smart meter installations/replacements in the distribution network have started from the largest towards smaller consumers. There is a plan for purchase of the „smart"systems, but those tenders have failed a number of times.
Romania	Italy's National Regulatory Authority for Energy ANRE has given Enel permission to install an additional 110,000 smart meters as part of a pilot in Romania. A local Romanian subsidiary of the Italian utility company installed smart meters for more than 30,000 clients last year. Enel is said to have plans to install similar meters for all 2.7 million clients in Romania, paving the way for larger smart cities and infrastructure. (https://www.metering.com/news/enel-110000-smart-meters-romania/) The CBA considered is that undertaken by AT Kearney in September 2012 for the European Bank of Reconstruction and Development (EBRD). The evaluated model in Romania is designed with a "middleware layer", consisting of data concentrators and balancing meters placed on each substation, with data communication occurring through PLC wiring from the meters to the concentrators

Country(A.4.1.)	***Analysis and study results***
	and through various communication channels from concentrators to the central application. Some key lessons from the Romanian analysis are that: • Where commercial losses are high relatively low cost forms of smart metering solutions can provide strong net benefit. • To undertake an analysis most consistent with the methodological requirements of Recommendation 2012/148/EU, including minimum functionality, costs reflecting this functionality should be included the analysis. In the case of Romania, while the analysis is logically coherent by neither including the costs of providing customer feedback nor any respective benefits, a more comprehensive result may be obtained by including all impacts.
Hungary	A cost-benefit analysis has been carried out in 2010 with negative result; therefore no roll-out has been made. Our DSO has 11.737 smart meters installed currently. The types used: both PLC (first generation) and GSM communication. Old meters are replaced by smart meters by our DSO if there is household distributed generation as well as for advance payment meters.
Germany	The equipment of measuring points is regulated in the measuring point operating law (Messstellenbetriebsgesetz). Smart Meters are mandatory for all power consumers above 6,000 kWh / a and for generating plants above 7 kW. The devices to be used consist of a counter and a gateway, the technology of which is explained in detail in the BSI guideline TR 3109. The communication technology is not standardized, mainly LTE (4G), PLC (power line) and DSL (broadband connection) are used.
Slovenia	Yes. 130.000 as a whole, currently included in the system 40.000. Types Landys-gyr and Iskra – 1 and 3 phase with communication modules, PLC and point-to-point technology. Goal to include all of the meters is 2025. CMA done by SODO and Energy agency - regulator.
Czech Republic	Below described data is integrated to CEPS´s control system. Moreover they run Common Awareness System, where users are TSO, DSO and producers in CZ. Control room of CEPS has online data from 110 kV (distribution) system covering topology and state monitoring of lines (close/open). An operation in DS is a matter of distribution company. Measured values (voltage, current etc.) are only exchanged / shared in case of important parts of DS („feeding" substation with transformers TS/DS, interconnected areas DS with 2 and more transformers from TS – normally we operate system 110 kV in separated / insulated islands).
Austria	Energy Güssing has a project plant for the gradual implementation of intelligent measuring instruments according to IME-VO (Smart meter initiation regulation). The comprehensive introduction of smart meter systems in Austria and also in the grid area of Energy Güssing is based on legal reasons. The introduction of Smart Metering is executed by Energy Güssing due to economic reasons in cooperation with numerous other grid operators in Styria, as well as other bordering provinces. The following graphic gives an overview on the smart meter concept and responsibilities. *See Appendix A.4.1. Austria.* Energy Güssing focuses on meter type 3 and 4 according to the chart 1. To bundle synergies more than 30 small and middle sized distribution system operators in Styria, Upper Austria, Lower Austria and Burgenland will the smart meter rollout be conducted in the course of a project community, together with the company „Energy Services“.

***Country**(A.4.1.)*	***Analysis and study results***
	According to the project plan that was commonly elaborated, the Energy Güssing is actual 6 months behind schedule, because of supply difficulties of the chosen smart meter types. There are actual only 10 smart meters implemented, that have been installed within a first pilot phase. The rollout starts in autumn 2017. The Smart Meter type that will be implemented is the "Sagecom" meter plus converter counter plus front end processors (in the transformer stations). The transmission from the data concentrator to the single meters occurs via PLC communication. From the data concentrators to the data collection system or rather the offsetting and administration via GSM modules. The next graphic shows the concept of transmission.
Slovakia	Intelligent metering systems (IMS) promote the active involvement of end users on the electricity market. They are one of the ways of achieving the national targets for energy efficiency and represent a basic component of future intelligent networks. New tariff products approved in Slovak legislation facilitated by the deployment of IMS will contribute to increased efficiency in the end use of electricity and will motivate end users to decrease their consumption by saving on electricity costs. The objective of introducing an IMS is to create the required prerequisites for the active management of consumption by end users, the integration of distributed sources of electricity, the smoothing of power demand curves by shifting consumption to off-peak hours and efficiently controlling distribution systems while developing e-mobility, increasing the deployment of RES, etc. IMS development is focused at the level of low voltage systems. More significant points of supply at higher voltage levels are currently covered by technologies that include portions of IMS functionalities and will be fully replaced by IMS technologies in the future. The Energy Efficiency Directive (2012/27/EC) supports the roll out of intelligent metering systems to provide end users with a sufficient quantity of information on actual consumption in a timely manner and at a sufficient frequency to efficiently manage consumption and optimize their costs. Slovakia committed to implement IMS on the basis of the completed Economic Assessment of Long-Term Costs and Benefits. The economic assessment stipulates the introduction of IMS for electricity consumers with annual consumption of at least 4 MWh at the low voltage level. This represents approximately 23% of all expected points of supply in 2020 with approximately 53% of the annual consumption of electricity at the low voltage level. Details for the roll out and operation of IMS in the power industry are defined in Ministry of Economy Decree No. 358/2013 Coll. The Regulatory Office, in cooperation with the Ministry of Economy, completed methodology guidelines for power and gas undertakings with respect to optimizing the use of electricity and gas including providing services to electricity consumers focused on energy efficiency and IMS support. Subsequent action and the schedule for preparing and implementing IMS deployment in the power industry in Slovakia is based on the conclusions of the economic assessment and from the "Proposed solution for introducing intelligent metering systems in the Slovak energy sector", submitted by the Ministry of Economy and approved by the Slovak government. Subsequent action and IMS implementation is divided into two phases according to this material: i) Implementation 1 (testing) – involves the deployment of approximately 6,000 intelligent meters by April 2015; ii) Implementation 2 (wide scale deployment) – a target of approximately 620,000 intelligent meters by the end of 2020.

***Country**(A.4.1.)*	***Analysis and study results***
	The purpose of the testing phase implemented as a pilot project is in particular to verify the following parameters: • IMS functionality in practice; • installation processes and IMS integration processes into the distribution network; • costs and benefits of IMS for the individual parties on the market. The testing phase will also be used to optimize and standardize technologies and communication and software solutions and to test tariff and business models and products. Wide scale deployment of the IMS will be based on the results of the testing in Phase I in compliance with the schedule until the end of 2020. IMS deployment is planned in a gradual manner beginning with the most significant points of supply depending on the magnitude of annual electricity consumption or depending on the quantity of maximum reserve capacity. The framework schedule for subsequent preparation and implementation of the IMS in the energy sector to 2020 was approved by the Slovak government in Resolution No. 358/2013 titled "Proposed solution for the roll out of intelligent metering systems in the Slovak power industry".
Bosnia and Herzegovina	In 2007 through project „Power IV“ has started the installation of summation meters with remote communication via GSM network, in 2650 distribution substations (ZMD type, manufacturer Landis + Gyr), as well as the procurement and commissioning of the complete hardware (HW) and software (SW) of the AMR Center (AMR software advance, manufacturer Landis + Gyr). From 2010 to today, through several stages, the customer's billing metering points have been equipped by advanced meters with PLC S-FSK communication, PLC data concentrators placed in distribution 10 (20) / 0,4 kV substations, meters for large consumers with point-to-point communication . At this moment (end of 2016.), approximately 28% of metering points is covered by smart meters. Installed equipment includes meters (types: ZCF, ZMF, ZCX, ZMX, ZMD; manufacturer Landis+Gyr) and concentrators AC-RG1A and DC450 (manufacturer Landis+Gyr). Cost Benefit Analysis (CBA) of smart metering system implementation in EPHZHB is made largely in line with the document „Guidelines for Cost Benefit Analysis of Smart metering deployment“, which recommends a list of costs and benefits, as well as the method of their calculation within CBA. Executed analysis of the roll-out of smart meters, in accordance with previously stated objectives of implementation, takes into account all relevant costs of smart metering system installation, while on the other hand takes only part of the benefits provided by above mentioned document.
Montenegro	In 2010, the European Bank for Reconstruction and Development (EBRD) signed the original loan of 35 million euros to finance 45 million euros worth project of introducing 175,000 smart meters, out of which 164,000 have already built. The original project has already proved to be very successful in terms of improving energy efficiency and reducing CO_2 emissions, and as a result, increased efficiency in distribution and responsibility for revenues realized consumption. EPCG also requested an additional loan to finance the purchase and installation of smart meters throughout the rest of the country. Investments in new measuring points with smart meters are already in the past pilot projects proved to be economically justified investment. With smart meters and relocation of metering points, problems of commercial losses is solved to a large extent. This investments in metering infrastructure are considered as quickly

Country*(A.4.1.)*	***Analysis and study results***
	profitable investments. Also, data from smart meters are considered as very valuable inputs for better planning. Since the reduction of losses is in the top of the priority development of distribution, it is considered as of strategic importance and to intensively invest in measurement infrastructure, both in the meter and the measuring points. With the investment in primary and secondary network, this represents the largest investment worth over 43 million euros. This would all consumers switched to smart meters, which would provide the basis for further development and distribution of its services to consumers.

A.4.2. Plans for making a transition to active distribution networks. National Smart Grid Strategy (or national Implementation/Action plan). Strategy of TSOs/ DSOs to become active TSOs/DSOs

Country*(A.4.2.)*	***Analysis and study results***
Croatia	A national Smart Grid strategy does not exist. However several Smart Grid pilot projects have been initiated (they are in different stages, several of them completed) where different solutions are being tested in different operating conditions.
Bulgaria	Smart grid project announced last year indicated the implementation of the FlexNet system, implemented by the American SENSUS and telecom operator Mobiltel. The FlexNet™ system is an Advanced Metering Infrastructure (AMI) solution that empowers electricity, gas, water or combination utilities to conserve resources by providing accurate and efficient meter reading and enhanced customer service. Upon full implementation, the FlexNet communications system will contribute to building mutual trust between the customers and the utility companies. It will allow not only remote measuring, but also control over the entire network. The use of the FlexNet system will raise the transparency of the monthly bills for the end consumers, reducing mistakes and fraud and resolving issues with meter access.
Serbia	The transmission system operator has developed “Smarter grid” study, which included analysis of the conditions of consumption management on the operation performance of the transmission system.
Romania	In 2015, E.ON plans to invest more in Romania, especially in upgrading the distribution networks. For this, the German company has a EUR 400 million budget (EUR 90 million).
Hungary	E.ON Hungary has derived its own strategy from the strategy of E.ON Innovation Center. *See Appendix A.4.2. Hungary* Based on the above approach, we are planning/running pilot/R&D projects. The DSO analyses the following solutions: • PV inverter control to handle distribution network problems (e.g. voltage control). Controllable inverters are wide spread over 50 kVA (conditions are regulated in the DSO Network Code), under 50 kVA it is not a common solution and there is no obligation. • Monitoring distributed generation in the distribution grid’s system control, above 50 kVA. • Testing inline voltage regulators on the distribution grid, on LV. We are now clearing the conditions of operating this equipment.

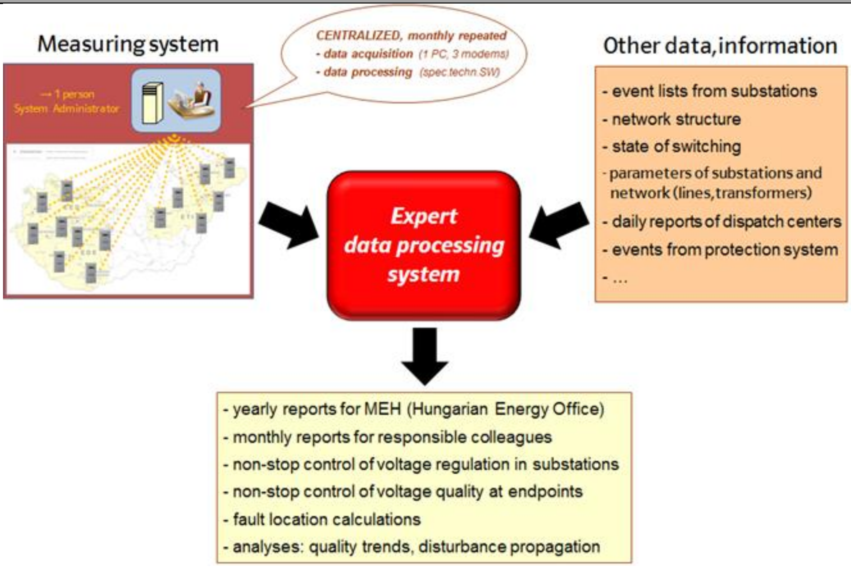
Country(A.4.2.)	***Analysis and study results***
	• Testing how to use local (building scale or microgrid scale) energy management systems to handle network problems. Our legacy Radio Control System can be further developed, to be able to control the local energy balance (e.g within MV/LV tr. district area could be separated consumer groups established for DSM.) • Testing On Load Tap Changer technology in case of MV/LV transformers, if the network constraints are generated on the MV network or in all LV circuits. • LV dispatching system • LV measurement sensor system with new communication technology • E-mobility charging/control system, involvement of the charging procedure into DSM
Germany	A national smart grid strategy does not yet exist in Germany. The government is promoting research projects in which concepts are developed by industry and science (SINTEG program). The smart meter infrastructure according to TR 3109 is to play an essential role.
Slovenia	YES. Several studies have been done. SODO issued a document "Plan of introduction of the advanced measurement system in Slovenia" Strategies to become active TSO/DSO: ELES and SODO probably yes.
Czech Republic	No information.
Austria	From the actual point of view it is not planned to integrate the DSOs.
Slovakia	An important condition for resolving support for intelligent networks is standardization of suitable technologies for local conditions in Slovakia and a possibility of the interchangeability of their primary components so as to allow the integration of solutions and devices from different manufacturers. There is interest in managing national pilot projects in connection with the pilot project led by network companies. The role of the laboratory in this case would be to test new technologies on the side of the network, consumption and production, and interoperability. The laboratory center should also be a presentation center for educational purposes. The priority in energy research and development is safeguarding sustainable energy in Slovakia. Research and development objectives in energy comply with the "Research and Innovation Strategy for the Intelligent Specialization of the Slovak Republic" (2013) document. Research and development in this area will be focused on new and renewable, ecologically friendly energy sources, rationalization of energy consumption in all sectors of the economy and energy distribution such as: • exploration of domestic reserves of energy raw materials, geothermal energy and their efficient exploitation; • development of technologies to obtain electricity and heat from RES (hydro, solar, wind and biomass); • research in nuclear energy focused on security and the storage of spent fuel; • research into fourth generation reactors and nuclear fusion (Slovakia's involvement in the worldwide ITER and DEMO projects); • development of new energy transmission systems (power cabling without stray electric and magnetic fields); • development of technology to increase energy efficiency and to decrease energy intensity. Measures to achieve these objectives:

Country*(A.4.2.)*	***Analysis and study results***
	• create a strategic plan for energy research and development based on the strengths of the country and aligning the use of public finances with production and consumption priorities, in particular with respect to energy efficiency, fourth generation nuclear reactors and RES such as biomass; • introduce a mechanism for monitoring and assessing advances made in research and development in the energy sector in the interests of maximizing the cost effectiveness of public expenditures; • consider increasing public expenditures on research and development in the energy sector so as to reach a comparable level to other member states of the IEA; • support more intensive research and development activities on the part of industry also by providing fiscal stimuli and facilitating partnership between the government, industry and the academic community; • increase efforts in the area of technical education with the goal of covering future demand for researchers, engineers and technicians.
Bosnia and Herzegovina	Priority medium-term strategic commitment of electric utility "Elektroprivreda HZ HB dd Mostar" is reduction in the purchase /import of electric energy balancing the imbalance of its production and consumption, through a permanent reduction of losses in the distribution network and by the construction of new power sources and application of new technologies. EPHZHB is committed to continuous adaptation to the modern business requirements and open elexctric energy market. Implementation of remote meter reading and power consumption management will enable a reduction of losses, the cost of reading and illegal consumption, and improve the charge of delivered electric energy. Purchase of advanced meters is planned for a years, as well as the continuous improvement of SW and HW support AMR / AMM center. Annually, there is a procurement of relevant quantity of meters (and related equipment) needed for regular and extraordinary (failures and similar) replacement of existing electromechanical meters, installation to the new measuring points, and replacement of existing meters where it is justified from an economic point of view (non-technical losses, large reading costs...).
Montenegro	"The Energy Development Strategy of Montenegro" **Hiba! A hivatkozási forrás nem található.**envisages the development of a "smart grid". In addition to a number of system features like functions of DMS (e.g. Automatic Fault Detection and System Restoration), installation of smart meters with AMR (Automatic Meter Reading) and network automation, it is proposed such a smart grid will take into consideration additional functions that will support introduction of RES. The smart grid system itself will enable long-term connection of numerous producers of energy from RES at different locations and production plants of different capacities and production characteristics without damaging the reliability and stability of overall functioning of the distribution system in the process, as it will take over many of the functions of an operator in order to perform automatic control and system balancing during normal operation as well as during malfunction.

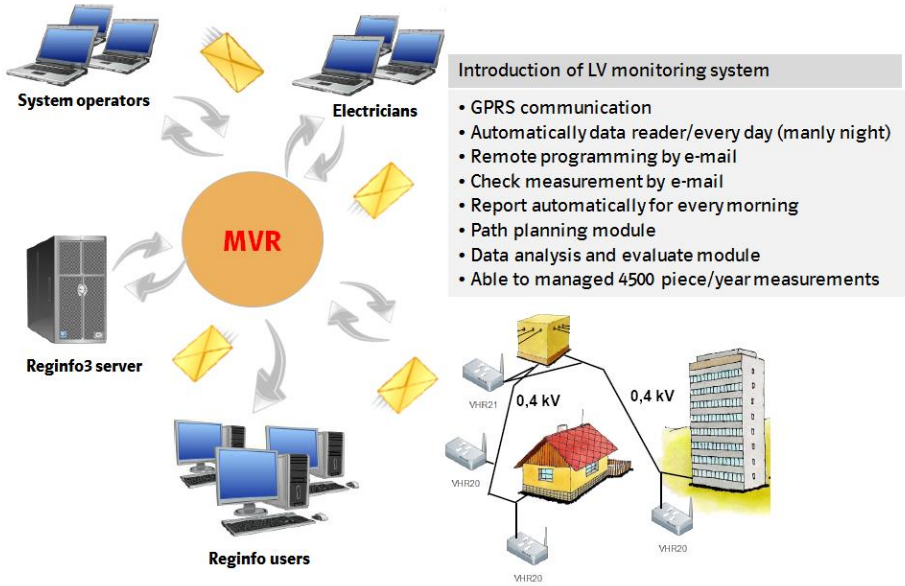
A.4.3. Continuous monitoring of the distribution grid, data available at the MV/LV nodes, etc.)

Country*(A.4.3.)*	***Analysis and study results***
Croatia	For all HV/MV and MV/MV substations there are continuous measurements of multiple values (such as current, voltage, event log, power) and historic

***Country**(A.4.3.)*	***Analysis and study results***
	measurements are stored in a SCADA system database. In addition, some MV/LV nodes are incorporated in the DSO's SCADA. Some form of monitoring is also available via AMR. In addition, (larger) distributed generation is usually equipped with voltage quality monitoring.
Bulgaria	Although it is not entirely clear if the monitoring is continuous, from the metering requirements which can be found at http://www.dker.bg/files/DOWNLOAD/rules_el_en3.pdf, HV/MV and MV/MV substations haves continuous measurement of several values (such as current, voltage, event log, power). All enterprises which are registered at the balancing energy market have continuous measurements, however those who are not members of the balancing market are not obligated to have those.
Serbia	For certain distribution networks there are detailed data on MV/LV network as well as on consumption in all nodes.
Romania	Romanian Power Grid Company "Transelectrica" is Transmission System Operator (TSO), the Metering Operator of the Wholesale Electricity Market (WEM) and the coordinator for the Smart Grids implementation project in Romania. During the last two years TSO performed the necessary steps to implement a nationwide Power Quality Monitoring System (PQMS) that integrates all the old systems. Transelectrica, coordinator for the Smart Grids implementation project in Romania, has a sustained investment plan for modernizing and strengthening the transmission system, as of 2010, 44% of its 79 substations have already gone through this process. Transelectrica Metering Branch OMEPA is the first class A Metering Operator for Wholesale Market and is interest in developing Smart Grids networks from producers to customer power, including the integrated online monitoring systems for metering and PQ monitoring, according with "Transelectrica's Metering and Power Quality monitoring strategy during 2011-2020" [19]
Hungary	The medium voltage SCADA system is in minute resolution. It collects voltage data from remotely operated pole-mounted switches, measured outgoing lines from HV/MV substations. These are the data available currently in the distribution system operation of the DSO: MV information: • MV line data in the substation for all lines: o Status info o Measurements o Protection and status signals • MV overhead switches (for ~3500 medium voltage units): o Status info o Measurements o Shor circuit signals There is no information in the monitoring system from MV/LV stations. There is no information either about the LV grid currently On MV network, DSO has partly online sampled measurement system, but not every MV lines measured. Related to the amount of the measures, there is a technical proposal of HEA. Yearly the amount of the 1% of HV/MV substations and the 1% of consumers on MV.

<table>
<tr><th>Country(A.4.3.)</th><th>Analysis and study results</th></tr>
<tr><td></td><td>


MV monitoring system

On LV grid DSO has offline sampled registered measurements. With this solution the voltage quality parameters (voltage level, transformer load, flicker, sag..) can be controlled and analyzed.
There is a technical proposal of HEA, 1 % of LV grids should be measured every year.


LV monitoring system

There is a planned pilot by our DSO to test LV sensor.
</td></tr>
<tr><td>Germany</td><td>MV: Measurements are carried out in substations, network nodes and relevant 20 kV transformer stations.
LV: Power quality measurements in the low-voltage network are currently being carried out at single selected locations. The smart meters to be used in the future have included functions for measuring power quality data.</td></tr>
<tr><td>Slovenia</td><td>Real-time completely HV an MV grid and (some) several MV/LV stations. By 2025 all MV/LV stations will have installed summary meters on transformers.</td></tr>
<tr><td>Czech Republic</td><td>Below described data is integrated to CEPS´s control system. Moreover they run Common Awareness System, where users are TSO, DSO and producers in CZ.</td></tr>
</table>

***Country**(A.4.3.)*	***Analysis and study results***
	Control room of CEPS has online data from 110 kV (distribution) system covering topology and state monitoring of lines (close/open). An operation in DS is a matter of distribution company. Measured values (voltage, current etc.) are only exchanged / shared in case of important parts of DS („feeding" substation with transformers TS/DS, interconnected areas DS with 2 and more transformers from TS – normally we operate system 110 kV in separated / insulated islands).
Austria	The grid of Energy Güssing should be equipped with superordinate smart meters at the nodal points (transformer stations 20 kV and 0,4 kV). Based on this a load flow analysis (and in a further step a controlled variable) in the grid of Energy Güssing exists. The question on which format the data for a „smart grid“ will be used is actual open.
Slovakia	THE SMART METERING IN SLOVAKIA IS SMART GRID READY POWER ENGINEERING. Unpredictability of DER (Distributed Energy Resources) and their negative impact to the grid system could cause serious problems in the management of the transmission and distribution system. The transmission system of Slovak Republic reached in extreme cases up to 2500 MW, representing an increased load on virtually all cross-border profiles, especially between Slovak and Ukraine, Czech and Slovak and Slovak and Hungary. Slovak government decided to implement smart meters for consumers with annual consumption above 4 MWh till 2020. TECHNICAL FEATURES OF THE SMART METERING IN SLOVAKIA Features Basic Advanced Special Two-way communications. • Monitoring of electricity consumption to final consumers • Continuous measurement of consumption and supply of active energy • Basic measurement interval is 15 minutes • The basic interval for remote reading and processing of measured data at least once per month • The registration of consumption and supply of electricity in "time of use" tariffs • Regular and on-demand meter reading • Date and time synchronization • Switching tariffs according to the current rate • The registration of alarms, outages, non-standard events and faults • Remote parameterization of the meter and updating software • Measuring of the active and reactive power • Remote disconnection • Current and power limiting in the specified scale • Measuring of voltage and current in each phase • Evaluating the power factor • The possibility of exchange communication module without affecting to the measuring section of the meter. • Apparent power • Power quality measurements • Interface to communicate with the dispatcher control systems (SCADA) The system should achieve in order to efficiently respond to the three major challenges: 1. How to improve the distribution grid monitoring to cope with volatile states in the grid. 2. How to integrate the “smart” substation automation devices to increase the distribution grid efficiency. 3. How to interoperate with the different roles e.g. operation of smart meters, power and grid operation.

***Country*(A.4.3.)**	***Analysis and study results***
	The set of functionalities are not directly related only with the Smart Metering but system architecture is designed as a Smart Grid ready that allow a more efficient monitoring and automatic way of operating the LV (Low Voltage) / MV (Medium Voltage) power grid are also considered. Many of these functions are related with information gathered in the SS (Secondary Substations) through external devices as sensors. Functionalities beyond Smart Metering might be very valuable for DSO and TSO. Operational Technologies (OT) is typically associated with field-based devices connected to the distribution system, and the infrastructure for monitoring and controlling those devices. This includes control center based systems such as Supervisory Control and Data Acquisition (SCADA) and Distribution Management Systems (DMS). Most communications are performed device-to-device, or device-to-computer, with relatively little human interaction. Advanced Metering Infrastructure AMI (IT) is traditionally associated with back-office information systems used for conducting business-type transactions, such as cost and tax accounting, billing and revenue collection, asset tracking and depreciation, human resource records and time-keeping, and customer records. Manual data entry is often involved, and the computing resources have tended to be centered in offices, server rooms and corporate data centers.
Bosnia and Herzegovina	Advance System, AMM control and network monitoring functionalities of smart meters.
Montenegro	According to the available information from Montenegro's DSO "CEDIS Podgorica" we can assume that DSO within their AMS system collects some information from LV transformer side. From available information we assume that at the distribution level currently there is no SCADA system for continuous monitoring of distribution grid. The Energy Development Strategy of Montenegro foresees that in the next few years the distribution network will switch to remote control from a modern control center. This modern distribution control center is planned to have the functionalities of SCADA in the first phase, which will be complemented with DMS (Distribution Management System) set of functions, GIS (Geographic Information System) functions and Asset Management functions and with the set of functions for work (Work Permits/Instructions and Crew Management). It also involves building of associated communication systems.

A.4.4. Plans for installing smart meters and collecting continuous measurement in the test buildings and test distribution grid, planned information available for sites. (This is compulsory for all test sites and test networks of the 3Smart project)**.**

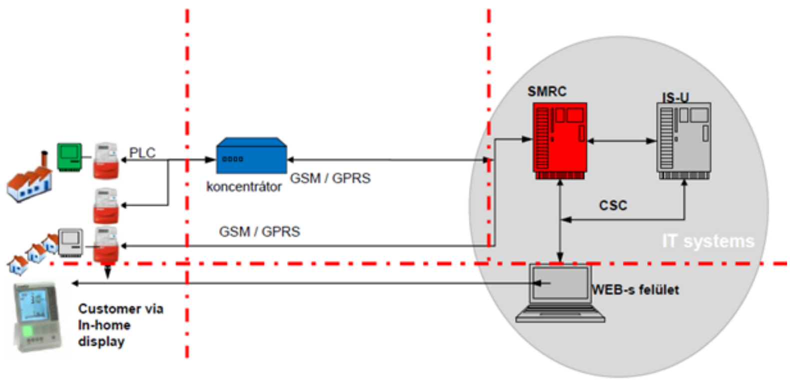
***Country*(A.4.4.)**	***Analysis and study results***
Croatia	Smart meters are already installed at both locations, with historical data being recorded in HEP-ODS databases. This information is however on the interface of the consumer and distribution grid. Since for UNIZGFER only one of the Faculty buildings will be analyzed additional smart metering system has been installed for the pilot building as well as for each floor of the building. For both PV units (HEP and UNIZGFER) additional continuous measurement devices are installed.
Bulgaria	Not relevant.
Serbia	Not relevant.
Romania	Not relevant.

Country(A.4.4.)	***Analysis and study results***
Hungary	The test buildings have one single infeed through a MV/LV transformer. A 15 minute resolution remotely readable meter is already installed for the site. We are planning smaller resolution (1 min.) smart meters per building to provide voltage, current and phase information that would let us monitor asymmetry, voltage regulation and the load level. Moreover, non-electrical parameters – like temperature, humidity and solar radiation will be also measured on the site. Moreover, in the pilot conception we would like to install smart meters at the MV/LV station next to the pilot site. Furthermore we are planning to install smart meters at the transformer districts, which are fed by the same MV cable line as the pilot site.
Germany	Not relevant.
Slovenia	Continuous yes – daily – real time no. In some pilot projects – energy and voltage measurements, phase angle, interruptions etc.
Czech Republic	Not relevant.
Austria	See answer A4.3
Slovakia	Not relevant.
Bosnia and Herzegovina	The plan is to install the smart meters and to collect the results of continuous measurements on the test building. All substations in the test distribution grid are integrated into a system of automatic meter reading and the strategy of EPHZHB in the future is to cover all of 10 (20) / 0.4 kV substations and all consumers by AMR system. However, additional investment in the surrounding test distribution grid are not planned so far.
Montenegro	Not relevant.

A.4.5. National level CBA for smart meter rollout, potential technologies from meter and communication point of view. Short overview of the completed in the past Smart metering pilot projects and of technologies used in these projects

Country(A.4.5.)	***Analysis and study results***
Croatia	In accordance with the Energy Act, the Croatian Energy Regulatory Agency (HERA) carried out a Cost Benefit Analysis (CBA) of introducing advanced metering systems for electricity in 2017. The basis for CBA was the document of European Commission entitled Guidelines for Cost Benefit Analysis of Smart Metering Deployment (hereafter: Guidelines). Of course, national conditions were taken into consideration for preparing the cost benefit analysis in order to get a relevant analysis. The CBA considers HEP-ODS (the Croatian DSO) as the implementer of the smart meter rollout and the owner of the metering equipment since the metering point and associated metering equipment is under the authority of the DSO, as prescribed by the Act on Electricity market. Regarding this cost benefit analysis, the smart meter roll-out relates to the introduction of advanced metering equipment and systems for electricity end users (consumers) instead of existing metering equipment of households and entrepreneurs without power measurements. The roll-out also includes the installation of data concentrators at 10(20)/0,4 kV substations and implementation of advanced meter reading and meter data management.

Country(A.4.5.)	***Analysis and study results***
	The CBA was performed using a 16 year period, a period equal to the lifetime of an advanced metering device. Three scenarios were taken into the consideration: – Basic scenario - considers the case without the implementation of the advanced metering equipment, – Scenario 1 considers implementation of advanced measuring equipment in a period of 4 years and – Scenario 2 considers implementation of advanced measuring equipment in the period of 11 years. HEP-ODS provided HERA with the technical requirement and cost estimation of implementing the advanced metering equipment and systems for their interconnection. The technical requirements are in accordance with the Recommendation 2012/148/EU. The CBA envisions installation of 85% of advanced metering devices using PLC data concentrators and 15 % of advanced metering devices using digital mobile phone networks. The financial and economic indicators of the CBA ascertained that Scenario 1 and Scenario 2 have a positive B/C ratio. In accordance to the provisions of the Act on energy, the analysis was submitted to the Ministry of environment protection and energy. Based on the CBA, the Ministry will prepare a plan and program of measures for implementation of the advanced metering equipment for the final consumers.
Bulgaria	Unknown, no information was available.
Serbia	No
Romania	The CBA considered is that undertaken by AT Kearney in September 2012 for the European Bank of Reconstruction and Development (EBRD). The evaluated model in Romania is designed with a “middleware layer”, consisting of data concentrators and balancing meters placed on each substation, with data communication occurring through PLC wiring from the meters to the concentrators and through various communication channels from concentrators to the central application.[20]
Hungary	Yes – both the regulator and the DSOs has been performed. The regulator and the alliance of 6 HU DSOs also prepared a CBA analysis in a parallel way which underpinned the discussion between DSOs and regulator. The regulatory analysis has many assumption with which the DSOs id nit agree (e.g network loss reduction from not only illegal consumption but technology point of view as well, etc.), the regulatory analysis found the roll-out profitable only if the consumer behavior would be changed according to information provided by Smart meter. Therefore the regulator proposed a smart metering pilot project for DSOs to prove this statement. In order to prove this statement a poll company was involved into the pilot investigation. The result of the poll was not so significant in terms of consumer behavior. Beside of regulatory analysis the 6DSOs also prepared a common study which stated that without any subsidy or incentives for DSO the smart meter roll-out was not beneficial for DSOs (the big amount of investment could not balance some positive effect, such as network loss reduction, avoiding of reading cost, etc.)

Country*(A.4.5.)*	***Analysis and study results***
	 The technology of the meters: Communication: PLC, BPL, GPRS Types of the tested meters: ELSTER AS 220 PLC ELSTER AS 1440 PLC ITRON ACE 4000 PLC ISKRA ME 381 ISKRA MT 381 L+G E350 ITRON RF1 (gas) Reliability of the data reading was not so successful in case of PLC technology than GPRS technology.
Germany	The Federal Ministry of Economics has commissioned the company EY to carry out a cost-benefit analysis for smart metering. The study is available for download in the Internet. The energy savings are to low to justify are 100% smart meter roll out. With the above mentioned limits (consumer > 6,000 kWh / a, plant > 7 kW) it is expected that 20% of the households will receive a smart meter. http://www.ey.com/de/de/industries/power---utilities/power-and-utilities_ey-studie---kosten-nutzen-analyse-smart-meter E.ON is carries out the EniM program in Germany, which has the task to develop and implement the technology for the Smart Meter rollout. 1.3 million intelligent measuring systems will be installed in the end. One Part is a complex software system with components from the manufacturers Siemens, SAP, ATOS, etc. The communication with the gateways is via an IPv6 connection based on BPLC (broadband power-line) and LTE (4G). The counters and gateways used correspond to TR 3109.
Slovenia	Energy agency – regulator, some kind of, we think.
Czech Republic	No.
Austria	To get an overview and gain experience in the implementation of the complex smart meter infrastructure and IT-landscape, a project community was founded under the coordination of a service company called „Energy Services“ to initiate a common pilot project for a timeframe of about two years. Practical application, necessary reorganization in the company, logistic concepts, handling of the end users etc. have been the focus topics beside the technical aspects.

***Country**(A.4.5.)*	***Analysis and study results***
	The pilot project has been performed operatively from the Energy Services and 13 DSOs (including Energy Güssing). The results of the pilot project have been shared by all participants of the project community and represent an important basis for the decisions on the system and the productive mass-rollout. The project included implementation and operation of a central software (Meter Data Management System with four integrated Head End Systems) in the computing center of the Energy Services as well as the provisioning of an end-user web portal and the installation of the smart meter infrastructure (meter, data concentrators, router, switches, etc.) in the grid territories of 13 distribution grid operators. To transfer the smart meter data through different communication channels to the computing center of the Energy Services, a Power Line Communication (PLC) as well as a Radio Mesh with single Point-to-Point GPRS connections on the First Mile was tested, as well as existing data lines (LWL, copper-control cables) and wireless communication (GPRS) on the Second Mile. Four different at the Austrian market existing meter technologies have been used. To exhaust the availabilities, the data transfer was tested on long overhead lines with pv-feeders, in urban grounding cable grids as well as urban areas of settlement. The implemented meter types are 600 PLC- three-phase meters, 130 PLC- AC electrical energy meters, 15 GPRS- three-phase meters as well as 5 GPRS-converter meters. The self-consumption of the implemented meters amounts up to 7 Watt.
Slovakia	Slovakia has set a detailed smart metering plan to fulfil the EU requirements in the area of energy efficiency by 2020. The country`s goal is to install around one million smart meters that will enable utilities to perform demand response and allow consumers to better manage their energy consumption. DSOs have already started the process of exchanging electromechanical meters with smart technology. Stredoslovenská energetika - Distribúcia, a. s. (SSE-D) is one of the three largest Slovak utilities (together operating a network of 2.35 million metering points) delivering and managing electric energy for the middle region of Slovakia. SSE-D`s network consists of more than 650,000 metering points. With the implementation of smart metering the utility aims to modernize and optimize its existing network. After a rigorous technical qualification process, Iskraemeco smart meters based on GSM/GPRS were chosen for the first phase of smart meter installation. SSE-D`s plans is to equip more than 120.000 metering points with smart meters by the end of 2020. Iskraemeco smart meters with a 3G module, that enables much faster communication, will be installed in households and smaller commercial environments. Demand response will enable the utility to improve their energy demand and consumption planning and shift energy consumption to off-peak hours. The introduction of a smart metering system will enable the utility to operate with detailed information on customer energy behavior. Consumers, on the other hand, will have the opportunity to get actively involved in their daily consumption activities and reduce their electricity related costs.
Bosnia and Herzegovina	Cost Benefit Analysis (CBA) of smart metering system implementation in EPHZHB showed a high rate of return on investment and a relatively short payback period. The best indicators for that are savings in the reduction of illegal consumption and savings in costs of meter readings that are given on the basis of actual savings achieved in the first five years of the roll-out. This significant savings also shows that cost benefit analysis is dependent on the price of electric energy and that in the case of price increase the payback period and rate of return on investment would also be enhanced.

Country(A.4.5.)	***Analysis and study results***
	During the realization phase, several factors proved crucial. First, the quality of the meters themselves, whereat the most important is contractual guarantee of a high percentage of meter readings (by bank guarantee of vendor is provided 95% of the readings within the first three days of the monthly period) and resistance to atmospheric overvoltage (small number of defects). See APPENDIX A.4.5. Bosnia and Herzegovina.
Montenegro	According to available data, Crnogorskielektrodistributivnisistem DOO Podgorica (“DSO” or “CEDIS”) already has implemented smart metering system and intends to apply for a loan from the European Bank for Reconstruction and Development (“the Bank’’) and use its proceeds completion of the modernization of the distribution network in order to transit towards a fully functioning smart grid system. The investments will include: Modernization and/or replacement of existing low voltage infrastructure, including overhead and underground power lines, cable distribution boxes and LV network poles; Modernization of the smart metering software system and installation of a modern utility management energy management software system; Installation of the remaining 45,000 smart meters with reconstruction and/or relocation of metering points, with the aim to reach around 85% coverage of the consumers in Montenegro, which could be not achieved with the previous project financed by EBRD. The proposed project, which has a total estimated cost of about 39 million euros will require the procurement of the following goods, works an services: • Supply and Installation of low voltage overhead and underground lines, cable distribution boxes and LV network poles; • Supply and Installation of utility management and energy management software and modernization of smart metering software; • Installation of smart meters with supply and installation of meter boxes. Tendering for the above contracts is expected to begin at the end of 2016.

A.4.6. Possible technical requirements for smart meters already posed, coupling energy management on the building and the grid side, e.g. communication from the meter available on both sides in order to simplify installations, etc.

Country(A.4.6.)	***Analysis and study results***
Croatia	There are no technical requirements set specifically for smart meters in Croatia.
Bulgaria	There are no technical requirements so only some general requirements for the smart meters are in fact listed in the Electricity Metering Rules (http://www.dker.bg/files/DOWNLOAD/rules_el_en3.pdf). However, these rules are rather general and do not refer to any type of smart metering in sense that these meters receive any type of signals which could encourage consumers to alter their behavior (at best, some consumers receive regular information of the consumed active and reactive power).
Serbia	No
Romania	According with “The Electricity Transmission power grid- Technical code” TSO has performed the following PQ necessary steps: -In 2006, after metering system was operational, the first temporary and then first permanent PQ monitoring systems were dedicated to the PQ monitoring of the interface between TSO - DSO and TSO – EC;

***Country**(A.4.6.)*	***Analysis and study results***
	-Since 2006 TSO's specialists attended annual PQ "working meeting" and were involved in the Leonardo Power Quality Initiative Vocational Education System (LPQIVES) training programs. At present they are certified "International Power Quality 1st and 2nd Degree Experts"; -In 2007 the WEM has been total liberalized and the third PQ monitoring systems has been dedicated to the OMEPA permanent monitoring at the interface between TSO and EC. In 2007 Electricity Regulatory Authority (ANRE) issued "The Electricity Transmission Power grid– Standard of performance" including more PQ aspects from international standards EN 50160, CEI 61000-4-30 and, since then, TSO has performed the following PQ necessary steps: -In 2008 TSO has approved its own PQ Policy, taking under consideration the Voltage Quality, Continuity of Supply and Commercial Quality; -In 2008 Institute Study Design Engineering, Romania, designed for Transelectrica the study "Fezability Study and Tender Specification for development a system for integrating the existing PQMS"; -In 2009 ANRE has issued the Technical Regulations named "Technical conditions for the connection of wind power plants to electricity grids of public interest", completing the Technical Code for the Electricity Transmission Grid and the Technical Code for the Electricity DistributionGrid; -In 2010 the "Action Plan for implementation in the national power system of the Smart Grid concept" has been approved by the Ministry of Economy, Commerce and Business Environment. The aim of the plan is to set a roadmap towards implementation of the smart grid concept, starting from feasibility studies and requisite legislation. -In 2011 according to TSO's PQ strategy, has been implemented "The system for integrating the existing PQMS", according with the new standards, upgrading the instruments and the communication infrastructure; -In 2011 Transelectrica Metering Branch OMEPA has issued a Technical Regulation regarding the PQ instruments. New instruments were purchased in order to increase the number of permanent monitoring sites in the system.
Hungary	There are no such requirements. There were multi-utility (electricity, water, gas, heat) smart meter pilots where the electricity meter was the master meter collecting data from the other meters.
Germany	See above
Slovenia	No information found.
Czech Republic	No information found.
Austria	In terms of communication infrastructure, the following goals are pursued: • Use of the existing infrastructure and transmission medium (low-voltage-network, fibred optic cable, copper cables and wireless communication) • Uniform equipment of the transformer stations (power distribution cabinets, mounting plates incl. Protective elements and active components) for mounting and operation of the gateways/data concentration • Assurance of a stable and secure data transmission in a predefined time (on a daily basis) in the computing center • Operation of the data grid with uniform tools (monitoring, debugging, etc.) for a standardized and resource-saving running • Support of all use-cases (like firmware-updates, load limitation, remote disconnection, etc.)
Slovakia	With the implementation of smart metering the utility aims to modernize and optimize its existing network. After a rigorous technical qualification process, Iskraemeco smart meters based on GSM/GPRS were chosen for the first

Country(A.4.6.)	***Analysis and study results***
	phase of smart meter installation. SSE-D`s plans is to equip more than 120.000 metering points with smart meters by the end of 2020. Iskraemeco smart meters with a 3G module, that enables much faster communication, will be installed in households and smaller commercial environments. Demand response will enable the utility to improve their energy demand and consumption planning and shift energy consumption to off-peak hours. The introduction of a smart metering system will enable the utility to operate with detailed information on customer energy behavior. Consumers, on the other hand, will have the opportunity to get actively involved in their daily consumption activities and reduce their electricity related costs.
Bosnia and Herzegovina	Remote access to advanced meters is possible at any time, especially the part that relates to power consumption management and power quality monitoring.
Montenegro	Not available

B. Building side EMS related questions

B.1. Building side equipment: especially within commercial, public and office buildings

B.1.1. Dominant technologies in HVAC, heating/cooling, ventilation air conditioning

Country(B.1.1.)	***Analysis and study results***
Croatia	HEP-ESCO: o Radiator heating o Fan coil heating and cooling o Split units (for heating and cooling) o Ventilation with air handling units REGEA: Heating: heat production in the central boiler. Cooling: individual split air conditioners. Ventilation and air conditioning: central air handling units. MENEA: Dominant technology in heating in Medjimurje County are single stoves and furnaces (mainly households) on wood or nature gas and central heating systems (mainly public buildings) also on wood or natural gas. For cooling, split systems are most commonly used. Ventilation and air conditioning is not much represented in buildings in Medjimurje county. Only larger, newly built buildings have a ventilations system, such as for example new hospital building which has centralized mechanical ventilation system with heat recovery. REA: (i) heating: gas boilers (ii) cooling: small scale split systems (iii) ventilation: natural ventilation (opening / closing doors / windows) CYBROTECH:

***Country**(B.1.1.)*	***Analysis and study results***
	Dominant are classic gas/fuel heaters/exchangers. Vapor/compression and solar (mainly electrical) systems are gaining momentum. ELMA: - MERKANTILE: Dominant are: chillers, heat pumps, air handling units and VRV/FC systems. Conclusion: Dominant technology for heating are central gas boilers with distribution in zones where radiators or fan coils are located. Dominant technology for cooling are local split systems while these are dominantly also used for heating on the Adriatic part of Croatia. Regarding ventilation, dominant is natural ventilation while only newly built buildings often have forced ventilation with central preparation of air in air handling units.
Bulgaria	MERB:- EAP: For new commercial and office buildings, the dominant technology for HVAC is centralized systems as VRF, VRV, heat pumps, centralized ventilation, etc. The public buildings are mainly heated by electricity, centralized heating, and natural gas. The cooling is performed by individual air conditioners. The internal heating installations are mostly performed with heating units as radiators, fan coils and electrical heaters (when electricity is used). DLAEM: The dominant technologies used for the systems are as follows: 1. Heating – single split and multisplit systems 2. Air conditioning – single and multisplit systems 3. Ventilation – the minimum requested by law system is used In most cases heat exchanger is used only for the winter period. Conclusion: For new commercial and office buildings, the dominant technology for HVAC is centralized systems as direct evaporation systems (either VRF – Variable Refrigerant Flow or VRV – Variable Refrigerant Volume), heat pumps, centralized ventilation, etc. The public buildings are mainly heated by electricity, centralized heating, and natural gas. The cooling is performed by individual air conditioners. The internal heating installations are mostly performed with heating units as radiators, fan coils and electrical heaters (when electricity is used).In the north-eastern part of Bulgaria single and multi-split systems are often used for heating and cooling, while ventilation is used in minimally requested configurations by different technical requirements.
Serbia	Subject to the basic purpose of the system, i.e. whether it is a system of heating, cooling, ventilation or air conditioning, depends the representation of technology i.e. equipment. When it is about the heating, then it can be said that the most commonly used system is district heating, and then followed by heating with electricity through electric boilers, furnaces, as well as heat pumps i.e. split systems operating in heating mode. In the field of cooling facilities, the highest presence if of split systems with outdoor and indoor units. For larger business facilities, multi-split systems are used, as well as central air-conditioning systems in which the working medium is prepared on one place (air or water). In terms of ventilation, the dominant systems are fans with on/off control.

Country*(B.1.1.)*	***Analysis and study results***
Romania	Two models currently exist in Romania for the value chain of thermal energy, from generation to final consumption of thermal energy, as follows: **a)** The **district heating system** (SACET), consisting of the district heating systems ensuring heat generation, transport and distribution, as well as supply to end users in a centralised manner. The public service of district heating in administrative units is under the management, coordination and responsibility of operators delegated by local public administration authorities, and is directly monitored and controlled by the National Regulatory Authority for Municipal Services (ANRSC), which has a regulatory role in this sector. The purpose of the service is to provide thermal energy necessary for heating and for preparing domestic hot water for the population, public institutions, social and cultural facilities as well as economic operators; **b)** **Decentralised system** for thermal energy generation and supply, including two consumer categories: 1. Consumers *without access* to the district heating system, consisting in a large part of the population of Romania mainly living in rural areas, in isolated localities or localities remote from urban centres, where district heating systems have not been developed; these consumers mainly use firewood in order to generate heat; 2. Consumers *having opted out* from the district heating system and the consumers from towns and localities where district heating systems were removed; these consumers use various individual heating systems.
Hungary	The dominant technologies: radiator heating, fan coil heating and cooling, split units (mainly for cooling), ventilation with air handling units. Renewable energy consumption is keep growing. In Hungary the energy consumption of the residential buildings are represented nearly 60% of the buildings energy demand. The distinct heating consumption has been decreasing since 2003. The use of district heating for households decreased by 30 % as a result of the building energy programs. Within the energy consumption for domestic use both natural gas and district heating consumption is decreasing, meanwhile firewood use is increasing. District heat cost up 30% more than heat from individual gas boilers. Many households have therefore switched to natural gas for their heat and hot water requirements. Recently, disconnections from district heating have been growing at a faster rate than connections. Industrial customers have also tended to switch away from district heating networks. The public and commercial sectors are the only growing market for district heating today. All newly installed domestic boilers should be high efficiency condensing boiler. Total floor area of heated and/or cooled buildings owned and used in the government at least 3 % annually to be renewed in such a way as to meet the minimum requirements for energy efficiency.
Germany	The dominant technologies: radiator heating, fan coil heating and cooling, split units (mainly for cooling), ventilation with air handling units. Renewable energy consumption is already present in most places.

Country(B.1.1.)	***Analysis and study results***
Slovenia	Radiator heating is dominant in old buildings, with split units for cooling and heating in transitional period. Fan coil heating and cooling is dominant in new buildings.
Czech Republic	Radiator heating is dominant in old buildings, with split units for cooling and heating in transitional period. Fan coil heating and cooling is dominant in new buildings. Energy supplies for heating are Natural gas and oil.
Austria	Heating: Hot water circulating systems; electric convectors Cooling: Cold water circulating systems
Slovakia	Heat energy sector in Slovakia with its specific features does not belong to the energy industries where the liberalization processes took place. It is also characterized by local so called district heating systems or centralized heat supply systems (hereinafter as „DH systems"), operated mainly by undertakings in monopoly or almost monopoly position within certain geographical territory. This kind of market structure predetermines possible existence of problems in relation to the final consumers. Heat and hot water consumers, including households, public facilities (hospitals, schools, culture centers), commercial sphere, services and industrial undertakings/zones are generally supplied by heat in a form of: i) decentralized heat production source – heat produced and distributed from energy production facilities of undertakings or individual domestic boilers producing heat only for their own consumption j) centralized heat production source – larger production facilities such as heating plants, local heating facilities and central boiler houses supplying heat to more than one object through the heating networks. In villages where the family houses predominate the heat is supplied mainly by individual heating facilities which are not mutually interconnected and do not represent more complicated heating systems. On the other hand the functioning of centralized systems of heat production, distribution and supply, already labelled as DH systems, occurring in various size and structure in all towns and bigger municipalities is becoming increasingly problematic. As it was mentioned in introductory part of this document the Office focused its investigation work just on this part of heat industry.
Bosnia and Herzegovina	Heating system - conventional systems - individual furnaces or power plants - district heating. Air conditioning system - mostly "SPLIT" air conditioning system. Ventilation - mostly mechanical ventilation, except newer larger commercial buildings, such as shopping centers and some new administration buildings in which is air conditioning system is centralized.
Montenegro	In most buildings in service sector, dominant technology for heating and cooling is air conditioning system. [22] There is a noticeable increase in the number of heat pumps for the air conditioning, especially in the central and southern areas of Montenegro.

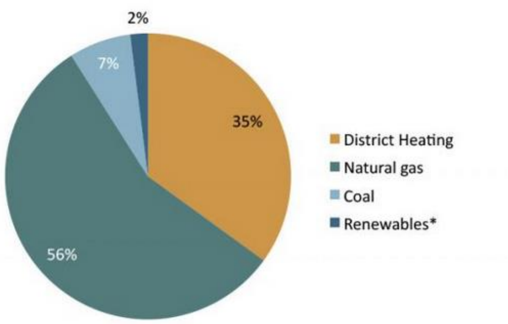
B.1.2. Dominant architecture of HVAC systems: central/local/combined and their percentages

Country(B.1.2.)	***Analysis and study results***
Croatia	HEP-ESCO: o Local – 50%

***Country**(B.1.2.)*	***Analysis and study results***
	o Central – 20% o Combined (central heating combined with local/zone cooling, i.e. split units) – 30% REGEA: Dominant for north-western Croatia is central heating preparation in the central boiler room. Estimation is that 90% of the buildings has a central boiler room for heating, and only 10% has local preparation of thermal energy for heating. Regarding cooling, it is estimated that 90% of the installed cooling systems are actually local split systems while only 5% of systems use central cooling (from experience these systems are not widely used due to induced high cost for electricity). About 5% of buildings does not have any cooling system installed. MENEA: In Medjimurje county dominating system is centralized (percentage is not known). REA: Local, more than 80 %. CYBROTECH: Central heating/cooling in solid majority. ELMA:- MERKANTILE: 30% of objects have central preparation of the heating medium connected to district heating systems. Conclusion: In the Adriatic part of Croatia dominant is local for both heating and cooling. In the continental part office and public buildings dominantly have central heating medium preparation while cooling is either provided also centrally in case of fan coils used in zones or locally via split systems. Central configurations dominate in the continental part (80-90%) due to availability of natural gas distribution and higher requirements for heating. The percentages estimation on the level of the whole country are 50% local configurations, 20% central configurations, 30% combined (central heating and local cooling).
Bulgaria	MERB:- EAP: Local architectures are dominant for heating and cooling energy providing. The energy is produced mainly by coals, wood, natural gas, electricity. DLAEM: Central heating is used only in the 4+star hotels (bound by the law) and in the big trade centers (shopping centers, malls, supermarkets, etc.). Conclusion: In Bulgaria dominant is local preparation of both heating and cooling medium. In big cities district heating is used very often and the 2020 Energy Strategy from 2008 stipulates “The prevailing quantity of heat is produced on the basis of natural gas and the risks for the final consumers are much lower. The district heating

***Country**(B.1.2.)*	***Analysis and study results***
	companies are obliged to maintain stocks of alternative fuels which would create a buffer between the supply of natural gas and heat supply to the consumers.”. Priority number 8 for Energy security axis from the named strategy reads: “Preservation and development of the centralized district heating also remains a task. In order to perform it the companies must be technically modernized and financially stabilized. The methods for highly efficient co-generation of heat and electricity with emphasis on technologies using RES, including waste biomass, vegetable and animal waste, will be actively supported.”. Priority number 5 for the Improvement of energy efficiency axis of the named strategy reads: “Apart from being an important factor for our energy security, centralized district heating is a means of energy saving. Co-generation of heat and electricity will be further supported and encouraged, subject to meeting the requirements for high efficiency (at least 10% economy of energy resources).”.
Serbia	The most common system, applied for heating in the Republic of Serbia are distant heating systems with a heat source like a boiler house and/or heating plant. Also, for heating and preparation of hot and technological water, the gas from the distribution network is used. For air conditioning of the commercial buildings, electric central air conditioning systems are applied and electric individual air conditioners for the residential buildings. Ventilation is performed mainly in the garages of commercial and residential buildings, shopping malls, in some industry facilities, and in medical institutions. Local (zone level) - share is about 80%.
Romania	Of the total permanent population of Romania of 19 043 767 inhabitants, according to the 2011 census, approximately 3 822 000 inhabitants were connected to the district heating system in 2014, which represents 20%; Of the total population receiving district heating, an average percentage of approximately 45 % are connected to and supplied through the district heating network; Taking into account the data shown above, it may be stated that the useful heat demand in Romania is concentrated in the big cities. The estimates show that the residential area consumes approximately 80 % of the total heat supplied via the district heating system. Moreover, at national level, the consumption of energy in the residential area and in the tertiary sector (offices, commercial areas and other non-residential buildings) stand together for 45 % of total energy consumption. Romania is one of the important markets for District Heating in the European Union (9th place in total heat delivered). In Romania 91 % of the heat from District Heating grids is delivered to residential customers, 7 % is delivered to public buildings and customers from the area of business, trade and services and 2% to the industrial sector. The heat delivered in 2008 account for approximately 60.000 TJ
Hungary	Households: District heating 16 % Central heating system 26 % Individual room heaters and water heaters 57 % Heating control options: Each room 51 % One room per building 27 % No control 22 % Office buildings:

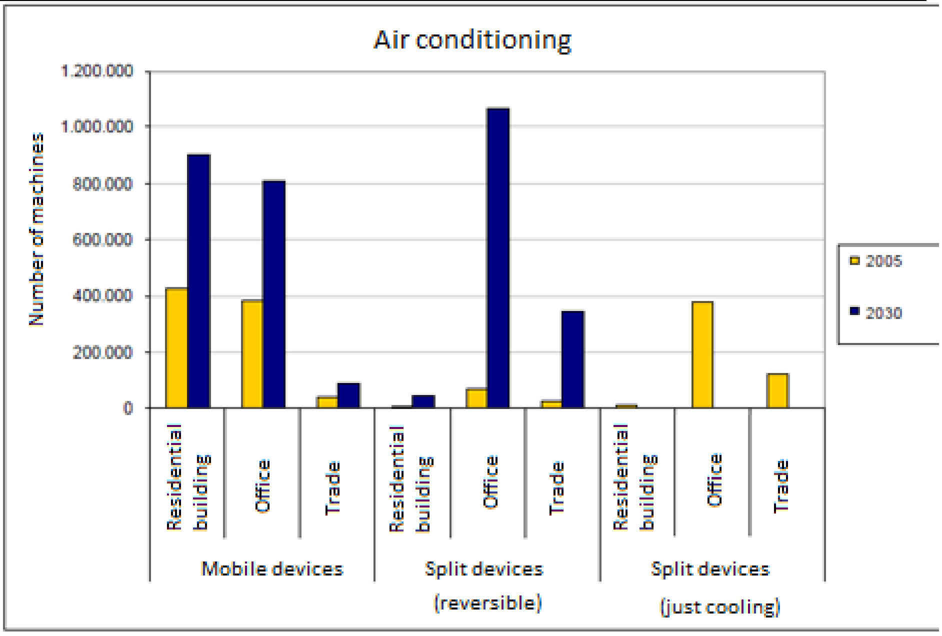
Country(B.1.2.)	***Analysis and study results***
	District heating 14 % Central heating system 86 % In Office buildings, the individual room heaters are not usual. The ratio of district heating is similar to the households'. The remaining part is central heating system with gas boiler.
Germany	Households: District heating 5,2 % Central heating system 78,4 % Convector 6,4 % Other 10 % Residential buildings with central heating: Natural gas 51,67 % Oil 36,85 % Wood 2,8 % Heat pump 2,8 % Other 5,88 % Block of flats: District heating 13,5 % Central heating system 70,4 % Convector 9,8 % Other 6,3 % Block of flats with central heating: Natural gas 51,28 % Oil 37,22 % Wood, wood pellets 2,84 % Heat pump 2,98 % Other 5,68 % Water heating : Water boiler 67,7 % Solar panel 10,34 % Electric water heater 12,88 % Natural gas 9,08 % From the tables above, we can conclude that the blocks of flats mainly use central heating, while the presence of convectors and central heating is strong in detached houses. Besides it is also important to mention that the result may vary in different regions of Germany.
Slovenia	Local: 5%, central: 50%, Combined central with local split units: 45%.
Czech Republic	Central.
Austria	Central.

***Country**(B.1.2.)*	***Analysis and study results***
Slovakia	In 2013 approximately 1.9 million citizens, 35% of the total population of Slovakia, were served by district heating, 78% of which came from direct renewables and recycled heat. However, the last five years are characterized by the acceleration of disconnections of multi-apartment buildings from the district heating networks. This is due to a failure of government policies after 1989 and it is expected that two thirds of the existing district heating systems will collapse. As a result, Slovak district heating systems are unlikely to contribute to meeting EU climate objectives and individual natural gas boilers, currently the main supply of heat in Slovakia, will still dominate. **Energy sources used to satisfy heat demand**  **Source:** https://www.euroheat.org/knowledge-centre/district-energy-slovakia/
Bosnia and Herzegovina	So far specific studies have not been done. According to data from the energy certificates registry, total number of certificates is 700 and dominant number of them refers to district heating systems (central heating) 400 (57%), local systems (individual boiler room) 210 (30%) and the rest (13%) refers to the individual furnaces.
Montenegro	According to the data of energy consumption in the service sector, the dominant structure is the local heating and cooling (about 80% of facilities), while the rest refers to the central and combined architecture. [22]

B.1.3. Dominant technologies used in local architectures(electric heaters, air conditioners with indoor and outdoor unit) and estimation of percentages

***Country**(B.1.3.)*	***Analysis and study results***
Croatia	HEP ESCO: o Gas boilers – 60% o Air conditioners – 30% o Electric heaters – 8% o Biomass boilers – 2% REGEA: Dominant is heating with radiators. Air conditioners are used mainly for cooling. Estimation is that 95% of the building has built-in radiators. In the estimated 10% of buildings with local heating energy preparation most usual way of preparation of the heating medium is through gas boilers with supply to several rooms/zones with radiators, but also there are gas furnaces or furnaces on solid fuels which are still used in a number of public buildings in rural areas, e.g. in schools and kinder gardens. MENEA:

Country*(B.1.3.)*	***Analysis and study results***
	Technology dominantly used is outdated wood, rarely natural gas, stoves and furnaces for heating and split systems for cooling (percentage not known). REA: If air conditioning is the case topic, electric air conditioning is predominant technology. CYBROTECH: Split-system air conditioners were used in the past, today they are still very popular in the Adriatic region. ELMA: - MERKANTILE: For heating dominant is radiator heating, for cooling local units with inverters. Conclusion: For local architectures dominant in the continental part of Croatia are gas boilers that supply several rooms with a heating medium. In the Adriatic part dominant in local preparation are split systems for both heating and cooling. Electric heaters are used in smaller percentages, as well as gas/wood furnaces. The overall percentages assessment for local heating/cooling architectures are: gas boilers 60%, air conditioners (split systems) 30%, others 10% (including gas or solid fuel furnaces and electric heaters).
Bulgaria	Electric heaters and air conditioners are mostly used in the local architectures. In public buildings the dominant technologies are single and multi-split systems for air conditioning for both heating and cooling.
Serbia	Electric heaters, air conditioners with indoor and outdoor unit, with estimated ratio of 50%:50%.
Romania	In the literature listed below we did not find any appropriate answer to this question. There is no available information.
Hungary	Households: Natural gas 55-60 % Central heating burning wood 17 % Electrical heating/cooling 5 %

Country(B.1.3.)	***Analysis and study results***
Germany	
Slovenia	Air conditioners with indoor and outdoor unit.
Czech Republic	Split system.
Austria	District heat, underfloor cooling.
Slovakia	District heat, air conditioners with indoor and outdoor unit.
Bosnia and Herzegovina	In predominantly own central heating of FB&H households is dominant share of fuel wood with 45.1%, in urban area 40.7% and 50.0% in rural. Followed by coal with 38.8%, in urban area 31.5% and 46.9% in rural, while the natural gas is represented with 13.4% of households, in urban area 25.1% and 0.6% in rural. Electricity is represented with 1.2%, in urban area 1.7% and 0.6% in rural, and fuel oil and other petroleum derivatives are represented with 1.4%. In predominantly room heating of FB&H households is dominant share of wood with 84.0%, in urban area 76.7% and rural 88.2%. Then follows coal with 8.6%, in urban area 5.7% and rural 10.2%, while the natural gas is represented with 1.4% of households, only in urban area with 3.9%. Electricity is represented with 5.9%, in urban area 13.7% and rural 1.4%.The fuel oil and other derivatives are represented with 0.1%, also in other area. [23]
Montenegro	In the service sector, conditioners with indoor and outdoor unit is dominantly used technology. [22]

B.1.4. Dominant medium used for heating and cooling in central architectures

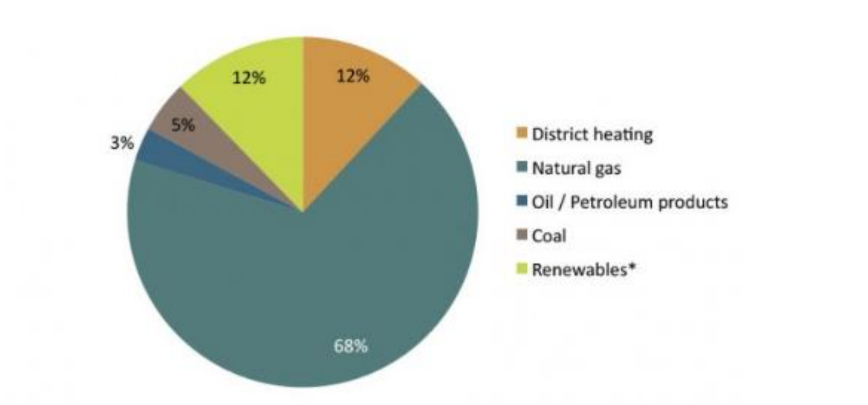
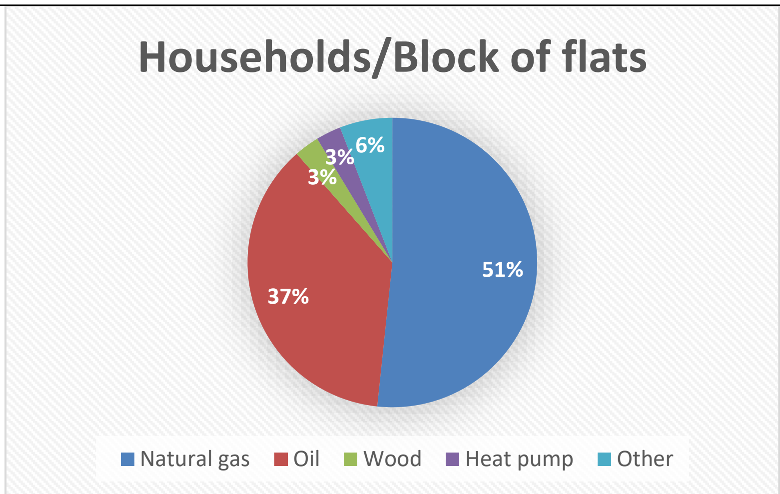
Country(B.1.4.)	***Analysis and study results***
Croatia	HEP-ESCO: o Predominantly water with AHU support on some of the buildings o Water as a medium is present in 90% of buildings, while systems with air as dominant medium is present in 10% of buildings REGEA: For heating is used water due built-in radiators, and for cooling air due built-in individual split air conditioners. Estimation is that only 10% of buildings use air for heating.

***Country*(B.1.4.)**	***Analysis and study results***
	MENEA: Medium used in central architectures is mainly water for heating and air for cooling (percentage not known). REA: Water, 90% or more. CYBROTECH: Both air and water are present, water is more common. ELMA:- MERKANTILE: Used are air, water and glycol. Conclusion: In central heating and cooling architectures, water (often mixed with glycol) as a medium for heating/cooling energy distribution is present in about 90% of installations, and air in about 10%.
Bulgaria	MERB:- EAP: Heating installations are mainly performed with radiators or fan coils. DLAEM: The heat transmitters are ranked as follows: 1. Freon, 2. Water, 3. Air (when a fresh air flow is required). It should be mentioned that in most cases Freon systems are of air – air type. Conclusion: As freon is only used locally within the devices for preparation of the heating/cooling medium, the answer is: water. Since radiators and fan coils are dominant in heating installations, the dominant medium for heating/cooling energy distribution in the buildings is water.
Serbia	Water, dominantly.
Romania	Water
Hungary	Commercial and public billings: heating and cooling mainly use water. Residential buildings: water for heating and air for cooling (if spit cooling unit is present). In case of individual room heating the heating medium is air.
Germany	In central architectures: water and air is used for heating and air for cooling.
Slovenia	Water is mainly used. Air in very new buildings and in hotels and gyms.
Czech Republic	Water is mainly used.
Austria	Water
Slovakia	Water
Bosnia and Herzegovina	The common medium used for heat distribution is water.
Montenegro	The common medium used for heat distribution is water.

B.1.5. Devices used for central medium preparation for heating

Country(B.1.5.)	*Analysis and study results*
Croatia	HEP-ESCO: o Gas boilers – 40% o Heat exchanger connected to district heating – 30% o Heat pumps – 20% o Electric boilers – 5% o Biomass boilers – 5% REGEA: Mostly used are boilers supplied with natural gas. Small part of boilers still uses oil for heating (about 5-10%). Estimation is that 10% of buildings uses heat exchangers with energy supplied from district heating, and 90% uses boilers. MENEA: Mostly furnace rooms equipped with natural gas or wood furnaces or boilers with the belonging periphery devices (percentage not known). REA: Gas boilers, 90% or more CYBROTECH: Heat exchangers were used mostly in the past, heat pumps are recently gaining momentum. Heat pumps are beginning to become popular. ELMA: - MERKANTILE: Heat pumps, and heat exchangers for district heating connection. Conclusion: Among devices for central heating medium preparation gas boilers are estimated to dominate with more than 60%. A considerable amount of buildings in larger cities on the continent (Zagreb, Osijek, Karlovac, Varaždin) uses heat exchangers supplied from district heating – the percentage on the level of the whole country is estimated to be between 10% and 30% among the buildings with central heating medium preparation. The remaining devices are heat pumps which are often used in new buildings in the Adriatic part of Croatia. Other devices like boilers that use oil, crude fuel or electricity exist but are quite rare.
Bulgaria	MERB:- EAP: For central heating supplied buildings, there are substations with heat exchangers for the secondary heat line. DLAEM: As for the central heating the following systems are used: 1. Boilers heated by natural gas (where there is a possibility to connect to the gas supply grid) 2. Central heating (where there is a possibility to connect. Natural gas is favored where there is a gas grid available).

<table>
<tr><th>Country(B.1.5.)</th><th>Analysis and study results</th></tr>
<tr><td></td><td>3. Heat pumps.
Conclusion: The mentioned three technologies are expectedly dominant for central preparation of the medium or heating: gas boilers, heat exchangers within heating substations connected to the central heating system, and heat pumps.</td></tr>
<tr><td>Serbia</td><td>Heat exchangers with energy supplied from district heating, dominantly.</td></tr>
<tr><td>Romania</td><td>The heat distributed via SACET is mainly generated in boiler stations (CT), using hot water (with temperature above 115 °C) or average parameter steam (pressure of 6 ÷ 16 bars) as thermal agent, and in conventional and high efficiency cogeneration power plants (TEPP). The statistical data concerning the status of the capacities of heat generation for the population reveal that the structure by plant categories is dominated with a percentage of 94 % by boiler stations, while thermoelectric power plants (TEPPs) only account for 6 %.
Heat generation capacities decreased in number during the period 2009 - 2014, from 684 in 2009 to 601 in 2014, which is a decrease by 12.13 %, or, in other words, 83 plants ceased to generate heat, of which 58 boiler stations and 25 thermoelectric power plants. Table below shows the evolution of the generation sources belonging to the SACET during the period 2009 ÷ 2014.
Table: Evolution of the heat generation capacities belonging to the SACET
<table>
<tr><th>Source type</th><th>2009</th><th>2010</th><th>2011</th><th>2012</th><th>2013</th><th>2014</th></tr>
<tr><td>Boiler stations</td><td>643</td><td>638</td><td>621</td><td>577</td><td>584</td><td>585</td></tr>
<tr><td>Thermoelectric Power Plants</td><td>41</td><td>41</td><td>36</td><td>36</td><td>23</td><td>16</td></tr>
<tr><td>Total</td><td>684</td><td>679</td><td>657</td><td>613</td><td>607</td><td>601</td></tr>
</table>
Next table below shows the boiler stations, except for cogeneration plants, existing in each administrative unit in 2015.
Table: Heat generation capacities, except for cogeneration plants, belonging to the SACET, in 2015
<table>
<tr><th rowspan="2">Boiler stations</th><th rowspan="2">Number of stations</th><th>Rated thermal input</th><th>Operational thermal input</th></tr>
<tr><th>[MW]</th><th>[MW]</th></tr>
<tr><td>Area stations</td><td>46</td><td>1 029</td><td>969</td></tr>
<tr><td>District stations</td><td>394</td><td>1 570</td><td>1 164</td></tr>
</table>
</td></tr>
<tr><td>Hungary</td><td>Households (based on data from 2013):</td></tr>
</table>

***Country*(B.1.5.)**	***Analysis and study results***
	 75 % of district heating energy is produced by natural gas. In some cases this means cogeneration of heat and electricity. 17.5 % produced from solid biomass, 3.75 % from waste, and 2.5 % of geothermal energy.
Germany	
Slovenia	electric heaters: 4%, biomass boilers, Heat Pump and renewable energy: 45%. district heating: 10% heating oil: 27%
Czech Republic	electric heaters, CHP, biomass boilers, Heat Pump and renewable energy, district heating, oil, Natural gas
Austria	Heat exchangers for district heating.
Slovakia	The heat consumption represents only 8,2% compared to the consumption of other sources of energy in Slovakia. Share of energy resources in end energy consumption in Slovakia are: - gaseous fuels - oil and oil products - electricity - solid fuels - renewable resources Gas boilers, Oil-fired boilers, Heat exchanger connected to district heating grid, Heat pumps, Electric boilers, Biomass boilers
Bosnia and Herzegovina	For central medium preparation for heating, the most commonly used devices are heat exchangers with energy supplied from district heating.
Montenegro	Heat exchangers with energy supplied from district heating.

B.1.6. Devices used for central medium preparation for cooling

Country(B.1.6.)	***Analysis and study results***
Croatia	HEP-ESCO: o Water chillers – 100% REGEA: In central preparation for cooling mainly are used heat pumps which are connected with chamber for air preparation. Cooling through heat exchangers with energy supplied from district cooling is not available. MENEA: Mostly split systems (percentage not known). REA: Small scale chillers, 90% or more. CYBROTECH: Diverse. ELMA:- MERKANTILE: Chillers. Conclusion: Practically the only used technology are heat pumps or chillers.
Bulgaria	MERB: - EAP: There is no district cooling supplier, but some buildings are cooled through absorption installation which transform thermal energy (from central supplier) into cooling and powered air conditioning in the building. DLAEM: The following devices are ranked: 1. Direct evaporation systems type VRV (variable refrigerant volume), VRF (variable refrigerant flow), DVM 2. Chillers (air/water) Conclusion: Dominant devices for central cooling medium preparation are direct evaporation systems (VRV or VRF type) and air/water chillers.
Serbia	Heat pumps and chillers.
Romania	Chillers
Hungary	The majority of cooling energy is supplied by water chillers for public and commercial buildings. There is a small amount of district cooling systems already available for public and commercial buildings. For residential buildings central cooling medium preparation is not common. There is an increasing number of heat-pumps installed for this purpose.

<table>
<tr><th>Country(B.1.6.)</th><th>Analysis and study results</th></tr>
<tr><td>Germany</td><td>Cooling and Air Conditioning in Germany
Installed cooling capacity [MW], 2002
<table>
<tr><th>technology</th><th>industry</th><th>offices</th><th>service</th><th>sports</th><th>hotels</th><th>gastro-nomy</th></tr>
<tr><td>window units</td><td>0</td><td>0</td><td>893</td><td>0</td><td>0</td><td>383</td></tr>
<tr><td>split units</td><td>0</td><td>2,871</td><td>883</td><td>0</td><td>0</td><td>663</td></tr>
<tr><td>mobile units</td><td>0</td><td>390</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>absorber</td><td>233</td><td>100</td><td>226</td><td>0</td><td>47</td><td>0</td></tr>
<tr><td>chiller</td><td>9,900</td><td>6,500</td><td>8,250</td><td>1,650</td><td>6,600</td><td>0</td></tr>
<tr><td>condenser</td><td>1,548</td><td>387</td><td>1,548</td><td>387</td><td>0</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>Slovenia</td><td>chillers</td></tr>
<tr><td>Czech Republic</td><td>chillers</td></tr>
<tr><td>Austria</td><td>Vapor compression refrigeration.</td></tr>
<tr><td>Slovakia</td><td>For central medium preparation for cooling, the most commonly used devices are heat pumps and chillers. District cooling in Slovakia has started to develop over the last years. This development is limited in practice to new residential, shopping center and industrial projects. However, the main expected driving for the development of district cooling in the residential sector is a growth of the purchasing power of the population.</td></tr>
<tr><td>Bosnia and Herzegovina</td><td>For central medium preparation for cooling, the most commonly used devices are heat pumps.</td></tr>
<tr><td>Montenegro</td><td>For central medium preparation for cooling, the most commonly used devices are heat pumps.</td></tr>
</table>

B.1.7. Use and spread of local energy production, percentage, number of buildings, production capacity, consumption/exportation details

<table>
<tr><th>Country(B.1.7.)</th><th>Analysis and study results</th></tr>
<tr><td>Croatia</td><td>HEP-ESCO:
o Electrical (< 10%)
o Thermal (< 1%)
o Cogeneration and Trigeneration (< 0,5 %)
Electric energy is exported to grid while thermal is used for self-consumption.

REGEA:
Local production of energy in buildings is not very widespread. There are systems of electricity generation by photovoltaic panels but on a small scale. These capacities are managed to cover own consumption, not to be exported to the grid.

MENEA:
In Medjimurje we do not have a widespread local energy production. Rare buildings (mostly private firms) have PV systems and use some of the produced electric energy for their own needs and sell the rest of it to the grid. Public buildings in Medjimurje county do not have its own local energy productions (apart from their own furnace rooms).</td></tr>
</table>

***Country**(B.1.7.)*	***Analysis and study results***
	REA: PV and thermal solar. Capability for covering local energy needs with local production is estimated to be 50% or more. Systems are predominantly utilized for building's own consumption. CYBROTECH: Some buildings have solar panels. Don't have the exact number, my estimate is below 1%. Most of the energy is contracted and exported to the grid. ELMA:- MERKANTILE: Solar photocells in a rather small percentage, used for heating of domestic hot water tanks. Conclusion: Local energy production is not widespread for now. Less than 10% of public/commercial buildings have photovoltaic (PV) installations. Early installations from the feed-in tariffs era sell the entire amount to the grid, and of course mostly use that energy actually locally for their consumption through another metered connection. As the PV prices become competitive and feed-in tariffs can no longer be contracted, more and more installations are performed that are used to cover own consumption without intermediate selling. Less than 1% of public/commercial buildings have thermal energy production based on solar energy, and this energy is exclusively used for own consumptions (handing over that energy to the heat distribution grid is something not yet practiced, but is seriously discussed as an option in the future).
Bulgaria	MERB:- EAP: Approximately 15% of the real-time electrical energy mix comes from RES. The local energy production of electricity is predominant due to the legislative incentives. Still, the incentives schemes for electricity are being redrawn, because the electricity production through PVs is interfering with basic energy production facilities and destabilizing the system. All electrical production is fed to the grid through balancing groups on local and regional level. Other RES production is also available (by their share in the mix) – water power plants, wind power plants, biomass-based heating plants, cogenerations, etc. DLAEM: 1. Electricity 2. Central heating 3. Natural gas 4. Other (pellets, wood, coal) Conclusion: Electrical, thermal and biogas are three most common types of local energy production. The local energy production of electricity is predominant due to the legislative incentives. Still, the incentives schemes for electricity are being redrawn, because the electricity production through PVs is interfering with basic energy production facilities and destabilizing the system. Majority of local electrical energy production is fed to the grid through balancing groups on local and regional level. Only electricity production is currently possible to be used both

Country(B.1.7.)	***Analysis and study results***
	locally and to be exported to the grid while the other two are currently only possible to be exploited locally. The National Energy Efficiency Action Plan for the period 2014-2020 explains the role of the Act for Energy from Renewable Sources. The mentioned Act requires the introduction of systems for the production of energy from RES, when this is technically feasible and economically justified, as part of the construction of new buildings or the reconstruction, major renovation, rehabilitation or rebuilding of existing buildings. This requirement applies to public services buildings as from 1 January 2012 and applies to all other buildings as of 31 December 2014. The analysis of the options for the use of renewable energy is part of the estimation of the annual energy consumption of the building. At least 15 % of the building's overall demand for heating and cooling energy must be met by renewable sources though the introduction of: • a central heating source using biomass or geothermal energy; • individual biomass combustion equipment with transformation efficiency of at least 85% in residential or commercial buildings and at least 70% in industrial buildings; • solar heat systems; • heat pumps and ground-connected geothermal systems. The Energy Efficiency Act stipulates the following for the new buildings (Article 31(2)): The development-project designs for new buildings must take into account the technical, environmental and economic feasibility of high-efficiency alternative installations and systems for the use of: 1. decentralized systems for energy production and use from renewable sources; 2. electricity and heat cogeneration installations; 3. district or block heating and cooling, as well as such that are based entirely or partially on energy from renewable sources; 4. heat pumps. The National Energy Efficiency Program for Multifamily Residential Buildings (the Program in this cell) is aimed at renovating multifamily residential buildings by implementing energy efficiency measures. The objectives of the Program are to provide better living conditions for the citizens, thermal comfort and higher quality of the living environment. The Program provides for the possibility of free-of-charge construction of renewable energy sources, provided that the energy efficiency audit demonstrates the effect of energy saving on the inclusion of a renewable energy source in the energy balance of the building. If the effect is quantified by engineering calculations and the RES investment is economically justified, the renewable energy source measure is combined with other measures, assessing which is the most economically advantageous package that can be used to reach the statutory requirement for annual energy consumption. The Methodical Instructions, which are Annex 2 to Decree 18 of 2015, lay down the following technical requirements for the energy performance of solar collectors and systems that use solar energy to heat domestic water for buildings. Taking into account the level of technology recommended for the technical specifications are the following requirements: **Flat solar collectors** ✓ Absorption coefficient (α) >/= 90% ✓ Emission factor (ε) </= 5% ✓ Summary heat loss coefficient (U_L</= 5 W/m²K)

<table>
<tr><th>Country(B.1.7.)</th><th>Analysis and study results</th></tr>
<tr><td></td><td>

✓ The transparent insulation used is made of tempered glass with low iron content
✓ Collector working pressure - 6 bar

Vacuum tube solar collectors

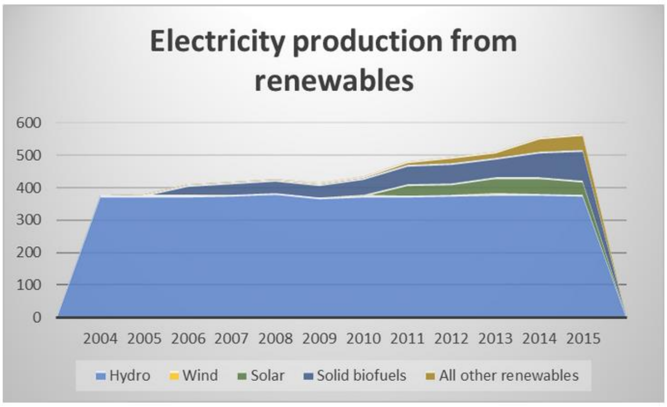
✓ Absorption coefficient (α) >/= 90%
✓ Emission factor (ε) </= 5%
✓ Summary heat loss coefficient (U_L</= 1.5 W/m^2K)

Technical requirements for heat pumps
The technical requirements refer to a minimum COP (Energy Conversion Ratio). Depending on the type of heat pump it is recommended to set the following requirements:
<table>
<tr><th>Type of heat pump:</th><th>COP</th></tr>
<tr><td>Salt solution – water</td><td>3.5</td></tr>
<tr><td>Water – water</td><td>4.0</td></tr>
<tr><td>Water-air</td><td>3.5</td></tr>
<tr><td>Air-water</td><td>3.5</td></tr>
<tr><td>Direct land exchange associated with water</td><td>4.0</td></tr>
</table>
In addition, in most of the buildings energy saving measures have been implemented in order to achieve high-quality, energy efficient and reliable lighting of common areas in residential buildings, and for over 50 buildings participating in the Program measures for the construction of different types of renewable energy sources are planned.
</td></tr>
<tr><td>Serbia</td><td>Electrical and thermal and just exported to the grid.</td></tr>
<tr><td>Romania</td><td>National Institute of Statistics Romania has no available information on this issue.</td></tr>
<tr><td>Hungary</td><td>The two main local sources of local energy production are solar and geothermal. The geothermal energy is used for central medium preparation for heating and cooling. The solar energy is used for hot water and electricity generation. The solar systems for electricity production are usually connected to the public grid but usually they sized to cover the consumption of the building in yearly balance.
The use of renewable energy (solar, heat pump, etc.) is spreading, but in terms of the total building stock is not yet detected.</td></tr>
<tr><td>Germany</td><td>In 2012 1,15 million square meters of solar panels were installed in Germany, which is 9% less than in the previous year, also the retail sales also decreased. Between 1990 and 2012 the energy produced by solar panels increased from 130 GWh/year to 6700 GWh/year.

The heat pump systems offer an efficient way to make hot water if they can be powered by green power. The market share of such system was between 8 and 10% between 2008 and 2012. Sale of such systems shows a stable trend in the recent years and the sales were increasing till 2013.</td></tr>
<tr><td>Slovenia</td><td>no information found</td></tr>
<tr><td>Czech Republic</td><td>Household sector:

Electricity savings in household lightning (overall benefit 2016: 52,2GWh)

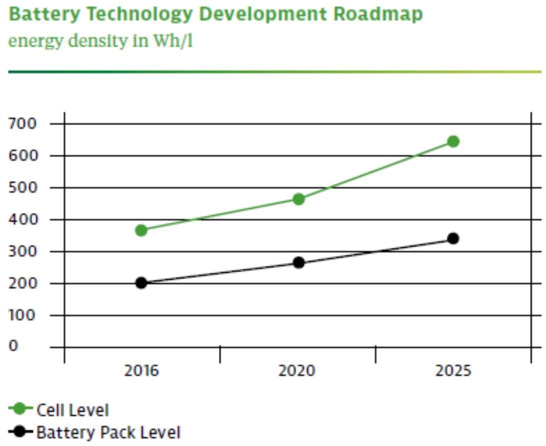
</td></tr>
</table>

Country(B.1.7.)	***Analysis and study results***
	• Green Savings Programme: Energy savings for heating, new construction to nearly zero energy standard, use of renewable energy sources for heating and hot water (overall benefit 2016: 2419,1GWh) Tertiary sector: • Electricity savings in tertiary sector lightning and in public street lightning (overall benefit 2016: 201,8GWh) • Application of Energy Star Agreement on office equipment (overall benefit 2016: 1484,1GWh) Industry: • Promotion of energy efficiency under the Operational Programme Industry and Enterprise (OPIE): facilities for the separate production of electricity and heat or cold, improvements in the thermal properties (overall benefit 2016: 28GWh) Transport sector: • Reduction in the emission and energy intensity of passenger vehicles placed on the market (overall benefit 2016: 437GWh) Agriculture sector: • Systemic opportunities to use combined renewable energy sources, especially biomass, solar and wind power • Biofuels for mobile energy resources, principled and systemic opportunities for the production and commercial use of biodiesel and ethanol from energy crops and agricultural and food waste (overall benefit 2016: 316GWh)
Austria	Electricity (PV, biogas CHP) could cover full demand but are exported to the grid.
Slovakia	One of the biggest hurdles in the liberalization of the Slovak electricity sector is the dominant role of nuclear power, producing almost 15000 GWh covering 77 % of the total national electricity production. The share of renewable energy is coming closer to its 14% target and is mostly covered from Slovakia's traditional clean energy sector based on large hydropower plants. Although there is a steep increase in the number of small hydropower plants (incentivized mostly by subsidies), their installed capacity is rather limited and their environmental impact on river ecosystems quite negative. Given the natural conditions, wind power potential is limited, while the shares of photovoltaic and biomass are growing.  *Source: Eurostat, 2014* *Source:* [*https://energytransition.org/2017/05/the-slovak-energy-transition-decarbonisation-and-energy-security/*](https://energytransition.org/2017/05/the-slovak-energy-transition-decarbonisation-and-energy-security/)
Bosnia and Herzegovina	The most widespread are hydroelectric power plants, followed by thermal power plants. It is not possible to estimate the percentage because their production capacity is not known. It is known that the EP BIH and ERS have sufficient generating capacity to supply their own customers and for export / sale to other systems.
Montenegro	The most widespread are hydroelectric power plants, followed by thermal power plants.

Country(B.1.7.)	Analysis and study results
	Consumer needs for electricity are greater than production capabilities EPCG, both in energy and in the power capacity; [24]

B.1.8. Use and pread of energy storage technologies

Country(B.1.8.)	Analysis and study results
Croatia	HEP-ESCO: o Regarding energy storage technologies only Ice Banks are present in the Republic of Croatia. Approximately, there are less than 20 installed in the whole country, mainly for concert halls, sports halls and shopping centers. REGEA: According to estimates there are no buildings that can store energy. MENEA: Most common thermal energy storages used are hot water tanks and reservoirs (percentage not known). REA: Thermal energy – buffers of various size. Capability = 90% or more. CYBROTECH: I would say that storage systems are close to non-existing. ELMA:- MERKANTILE: Mostly storage of electrical energy. Conclusion: Regarding existing technologies, here one can only say that thermal storages exist. Most usual are short-term hot/chilled water storage tanks and many buildings have them, but usually their size does not make them a relevant thermal storage for the building. There are overall about 20 installations of longer-term ice bank storages for larger buildings to prevent high energy peaks for cooling during mass events in them.
Bulgaria	MERB:- EAP: Storage is seldomly used. DLAEM: There are no energy storage technologies used in buildings. Conclusion: Even in the National Energy Efficiency Action Plan for 2014-2020 period energy storages on the side of buildings are almost completely disregarded. In several places in the mentioned Plan the need for shifting end-consumers load from peak to off-peak times is mentioned and energy storage is not explicitly mentioned as a means to perform that on the building side. However, distribution systems operators are encouraged to interact with the end-customers in the following ways: 1. encouraging end-users to transfer their loads from peak to off-peak hours, taking into account the availability of energy from renewable sources, electricity from cogeneration plants and that from decentralized plants;

***Country**(B.1.8.)*	***Analysis and study results***
	2. saving energy by optimizing the consumption of decentralized end-users by means of energy clustering; 3. reducing consumption by means of energy-efficiency measures implemented by providers of energy services. The 2014-2020 Energy Efficiency Action Plan also stipulates that the legislation provides for the introduction of dynamic tariffs as a measure for the final clients to optimize their electricity use by means of: 1. tariffs that take into account the period in which energy is used; 2. tariffs for the critical peak-load periods; 3. pricing in real time; 4. discounts for reducing the use of energy during peak-load periods. Having that in mind, it is expected that mature energy storage technologies will have a plethora of possibilities for exploitation in buildings in the coming time.
Serbia	Thermal energy storages.
Romania	Energy storage will have significant impact on Romanian energy system, but for now it is not implemented on large scale.
Hungary	Energy storage technologies have no significant application at this moment.
Germany	Main renewable energy production: solar power, onshore- and offshore wind power. Energy storage system: small and large-scale batteries, hydrogen and power to gas technologies (see the Figures below). 

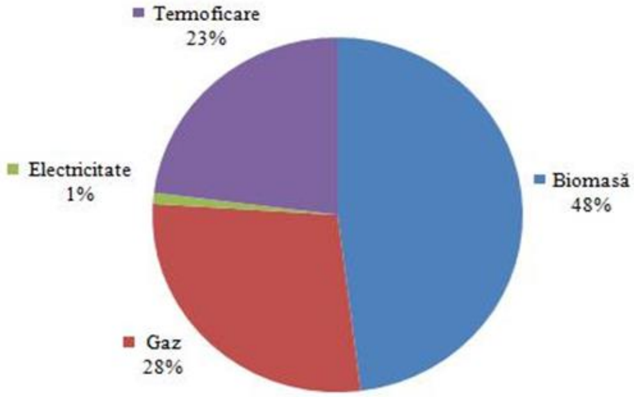
<table>
<tr><th>Country(B.1.8.)</th><th>Analysis and study results</th></tr>
<tr><td></td><td>
Installed Battery Capacity in Germany for Primary Control Power 2016-2017
<table>
<tr><th>Installed Capacity</th><th>Type of Project</th><th>Operated by</th></tr>
<tr><td>15 MW</td><td>Li-Ion second life</td><td>Daimler, enercity</td></tr>
<tr><td>6 x 15 MW</td><td>Li-Ion</td><td>STEAG (different sites)</td></tr>
<tr><td>13 MW</td><td>Li-Ion second life</td><td>Daimler</td></tr>
<tr><td>6 MW</td><td>Li-Ion</td><td>SWW, Siemens</td></tr>
<tr><td>5 MW</td><td>Hybrid: Li-Ion, high-temperature, lead-acid</td><td>Eon Energy Research Centre</td></tr>
<tr><td>5 MW</td><td>Li-Ion</td><td>Upside Group</td></tr>
<tr><td>5 MW</td><td>Li-Ion</td><td>Younicos, Wemag</td></tr>
<tr><td>3 MW</td><td>Li-Ion, ads-tec</td><td>Statkraft</td></tr>
<tr><td>2 MW</td><td>Li-Ion second life</td><td>Vattenfall, BMW, Bosch</td></tr>
</table>
</td></tr>
<tr><td>Slovenia</td><td>hot water buffers (tanks)
ground (when heat pump is used)
batteries in EV</td></tr>
<tr><td>Czech Republic</td><td>hot water buffers (tanks)
ground (when heat pump is used)
batteries</td></tr>
<tr><td>Austria</td><td>Heat: hot water store; electricity: currently none.</td></tr>
<tr><td>Slovakia</td><td>Heat: hot water boilers, Electricity: batteries</td></tr>
<tr><td>Bosnia and Herzegovina</td><td>Most often stored is electrical energy.</td></tr>
<tr><td>Montenegro</td><td>no information found</td></tr>
</table>

B.1.9. Dominant energy carriers (primary energy sources) for heating / cooling

Country(B.1.9.)	*Analysis and study results*
Croatia	HEP-ESCO: o Heating – gas (90%), electricity (5%), biomass (5%) o Cooling – electricity (100%) REGEA: Primary energy source for heating is natural gas, and for cooling is electricity. Estimation is that 85% of buildings use natural gas for heating, about 10% use central heating system, which also use natural gas for production of thermal energy and electricity (cogeneration), and 5% is others (wood and biomass, renewables, liquid fuels, electricity). MENEA: Dominant energy sources are natural gas and wood in a 50 – 50 percent ratio (estimated percentage - 90%).

***Country*(*B.1.9.*)**	***Analysis and study results***
	REA: Natural gas for heating (90% or more), electricity for heating (2 % or more), electricity for cooling – 100%. CYBROTECH: In the falling order: gas, electricity, diesel. ELMA:- MERKANTILE: For heating/cooling dominant sources of energy are gas and electricity. Conclusion: In the continental part of Croatia heating is either directly (through gas boilers) or indirectly (through natural gas –based cogeneration plants) provided through natural gas, with the percentage estimated at about 90%. Electricity and biomass are present in the remaining 10%. Cooling is based on electricity entirely. In the Adriatic part of Croatia both heating and cooling are dominantly ensured by electricity.
Bulgaria	MERB:- EAP: The predominant energy carriers on national level are coal, natural gas, biomass / chips. Regarding heating consumption on local level, i.e. public and residential sector – it is electricity, wood and coal, natural gas. For cooling, electricity is used. DLAEM: 1. Electric energy 2. Central heating (based dominantly on gas and coal) 3. Natural gas 4. Other (pellets, wood, coal) Conclusion: According to BULLETIN ON THE STATE AND DEVELOPMENT OF THE ENERGY SECTOR IN THE REPUBLIC OF BULGARIA for 2015 the following ratios and percentages are stated: The largest relative share of input fuels for heat production was occupied by gaseous fuels - 44 %, followed by imported coal - 33%, local coal - 18% and biofuels - 4 %. The other input fuels represent minor share. Regarding cooling, the Energy Efficiency Action Plan 2014-2020 stipulates that cooling in Bulgaria has a secondary role at present and is applied only in specific cases such as certain manufacturing processes, healthcare buildings and buildings in the services sector.
Serbia	Coal in thermal plants (KolubaraiKostolac), electric power (from the thermal and hydro plants) and gas from Russia.
Romania	There are three main heating sources in the residential and non-residential sector in Romania, as follows: a) biomass (mainly wood), b) natural gas and c) district heating system (see Figure).

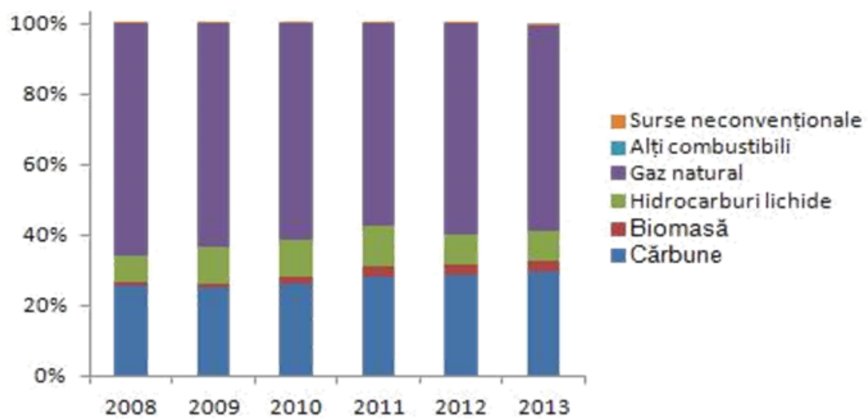
Country(B.1.9.)	***Analysis and study results***



RO	**EN**
Gaz	**Gas**
Electricitate	**Electricity**
Termoficare	**District heating**
Biomasă	**Biomass**

Figure **:** Heating sources in the residential and non-residential sector in Romania
Literature: Report on the assessment of the national potential to implement high-efficiency cogeneration and efficient district heating and cooling

As to the type of fuel used for heat generation, hydrocarbons account for the highest percentage, namely more than 60 % of the fuel used, and coal accounts in average for more than 25 %. Unconventional energy sources account for less than 1 % in heat generation. The types of sources used for heat generation during the period 2008 ÷ 2013 are shown in Figure below.



<table>
<tr><th>Country(B.1.9.)</th><th>Analysis and study results</th></tr>
<tr><td></td><td>

<table>
<tr><td>RO</td><td>EN</td></tr>
<tr><td>Surse neconvenţionale</td><td>Unconventional sources</td></tr>
<tr><td>Alţi combustibili</td><td>Other fuels</td></tr>
<tr><td>Gaz natural</td><td>Natural gas</td></tr>
<tr><td>Hidracarburi lichide</td><td>Liquid hydrocarbons</td></tr>
<tr><td>Biomasă</td><td>Biomass</td></tr>
<tr><td>Cărbune</td><td>Coal</td></tr>
</table>

The fuels used by District Heating: natural gas – 48%, coal and coal products – 41%, oil and petroleum products – 10%, renewables close to 1%.

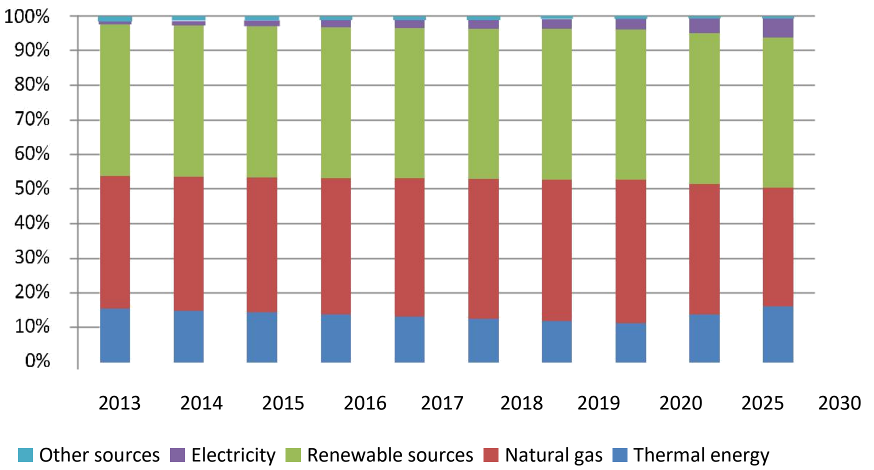
Combined Heat and Power units supplying DH accounts for approx. 10% of the Romanian electricity production.

Natural gas and coal are the main types of fuel being used in Combined Heat and Power with biomass gaining in importance. (Coal and coal products – 53%, Natural gas – 38%, Oil/Petroleum products – 9%).

The shares of the different types of energy resources used in the SACET in 2015 are:

- Natural gas 80.18 %;
- Coal 17.67 %;
- Other resources (combustible waste, etc.) 1.06 %;
- Renewable energy sources (plant and wood biomass, geothermal energy, sun energy) 0.64 %;
- Black oil 0.45 %.

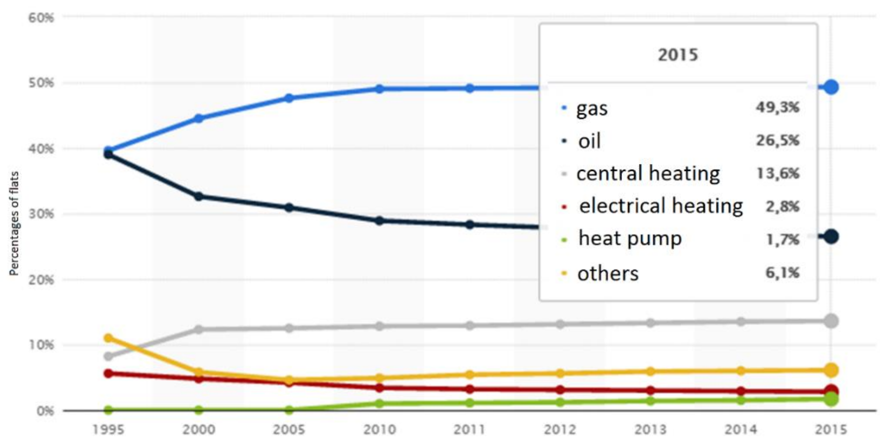
Figure below shows the forecast evolution and the structure of thermal energy consumption.



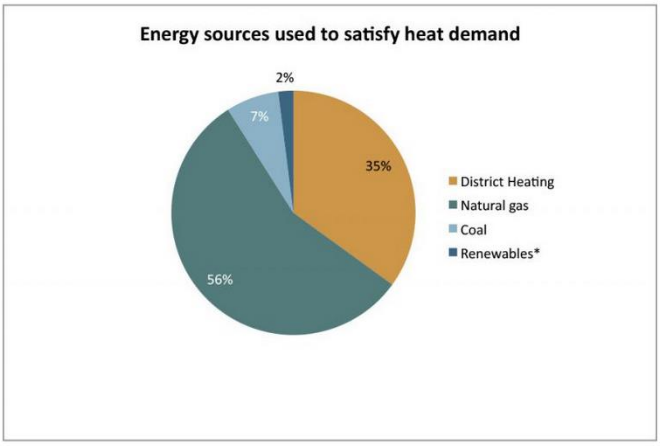
</td></tr>
<tr><td>Hungary</td><td>Building's energy consumption mix: 50% natural gas, 20% electricity, 10% district heating, 10% others (wood, coal, etc.). Most of natural gas used for heating. The electricity is used for lighting, heating, cooling, and for hot water.</td></tr>
<tr><td>Germany</td><td>Heating of residential buildings</td></tr>
</table>

<table>
<tr><th>Country(B.1.9.)</th><th>Analysis and study results</th></tr>
<tr><td></td><td>
Natural gas 49,3 %
Oil 26,5 %
Central heating 13,6 %
Electrical heating 2,8 %
Heat pump 1,7 %
Other (Wood, wood pellets, coal, biomass) 6,1%

Heating structure of flats from 1995 to 2015



</td></tr>
<tr><td>Slovenia</td><td>No information found.</td></tr>
<tr><td>Czech Republic</td><td>Electricity.</td></tr>
<tr><td>Austria</td><td>District heat and vapor compression cooling.</td></tr>
<tr><td>Slovakia</td><td>
In 2013 approximately 1.9 million citizens, 35% of the total population of Slovakia, were served by district heating, 78% of which came from direct renewables and recycled heat.



Source: https://www.euroheat.org/knowledge-centre/district-energy-slovakia/

The electricity mix is:
- 21% oil
- 26% Natural gas
- 22% coal
- 22% nuclear fuel
9% RES + Water
</td></tr>
</table>

***Country**(B.1.9.)*	***Analysis and study results***		
Bosnia and Herzegovina	Mainly used emergent source [23]	Heating type	
		Rooms heating	Own central heating
	Electricity	5,9%	1,2%
	Natural gas	1,4%	13,4%
	Fuel oil	0,1%	1,4%
	Coal	8,6%	38,8%
	Wood	84,0%	45,1%
Montenegro	The dominant resource in the structure of energy sources used for heating is electricity, while the use of wood is much less prevalent. The use of heating oil and natural gas is insignificant. [25] The dominant carrier of energy for cooling in the service sector is also electricity.		

B.2. Building side EMS typology, definition

B.2.1. Definitions used in the area of Energy Management Systems

***Country**(B.2.1.)*	***Analysis and study results***
Croatia	HEP-ESCO: o In the Republic of Croatia there are no commercially derived projects with BEMS (Building Energy Management System). BMSs (Building Management System) are usual in business and in some large public buildings. REGEA: According to [26], BEMS are products, software and technical services for the automatic control, monitoring and optimization, human intervention and management, in order to achieve energy efficient, economical and safe operation of equipment and building systems, and include electrical control systems for heating, cooling, ventilation, lighting, etc. According to [26], BEMS are defined in the four classes of efficiency: - A: building with high-efficiency systems - B: building with advanced system - C: standard system - D: energy-inefficient systems MENEA: Some buildings have energy consumption monitoring systems installed but most of them do not. Energy management system for public buildings in Medjimurje county is based on monitoring of energy consumption through entering of the bills in centralized IT energy monitoring system (ISGE). This monitoring and bill entering is being monthly done for all of the public buildings in Medjimurje. Reports on energy consumption of named buildings is generated on a yearly basis and is being sent to national control agency. REA: Energy management system is a system used for centralized management of various energy systems in building. CYBROTECH:-

***Country**(B.2.1.)*	***Analysis and study results***
	ELMA: In Croatia, something that can be named "Energy Management System" culture does not exist, or only exists in traces. In Croatia we are on the level of BMS (Building Management System), and yet a non-configured one. In majority of cases BMS serves for alarms which are minimalistic, rarely can one find commissioning or equipment monitoring; building operators mostly do not see what is the purpose of such a system except that from their perspective they paid a lot for it. Company management uses it even less. Knowledge of engineers as far as energy phenomenon is concerned is on the level of general culture, and users know about it even less. I did not hear that before the system handover analysis of sequences performed by the supervising engineer is being performed (it does not necessarily mean that this is not done), and checked for proper functioning. Most of the BMSs that I have seen had only alarms and set-up of parameters which were never changed. Often subsystems are not mutually interconnected, and after few years one may find many sensors indicating temperature -50. Most of the today's infrastructure is built such that proper control covers the boiler room, air handling units and chillers. In the last five years things are getting better, but only for big investments. In many companies the maintenance service removes zone controllers and replaces them with simple mechanical devices, also smart lighting is being shut off since they don't know how to maintain it and do not want to pay those companies who know that. Energy is even not being considered; on my question posed to one of the hotel complexes do they have problems with regulation of building variables they said they have many such problems, and when they are asked are they doing something about it they claim that they do not have financial resources available. I know a public museum building with very sophisticated regulation, but never maintained, and who knows how these systems non-maintained for years operate now – the owner did not have in its plan to maintain that equipment. Stores are not much better. In a great number of cases air handling units are after few years started and shut down manually because the control system is not maintained. MERKANTILE: Monitoring and control of heating, cooling and ventilation systems. Conclusion: Building Energy Management System exists as definition according to [26], but currently there are no commercial projects of building automation performed that include also centralized building energy management. The definitions are versatile. Energy management system is a system that centrally manages different energy subsystems in buildings. Besides this correct definition, one also often considers that monitoring of energy consumption on a rather sparse time-scale (e.g., once per month) and storing it in a database for controlling and comparing with historical measurements is a form of a building energy management system. Such a monitoring system is established in Croatia for public buildings and it is called Information system for Energy Management (ISGE) and public institutions are obliged to fill in monthly consumption

***Country**(B.2.1.)*	***Analysis and study results***
	data in it. Further, one can see from responses that any control system present in the building might be considered as BEMS, although only perhaps some basic zone-level controls are provided (e.g., level C from [26]). From the first-hand experience of company operating in the field of different building data integration through a set of tools named Brightcore, one cannot talk about energy management systems in Croatia, and even building management with alarms and central commissioning via SCADA is often not well understood or properly maintained by the building operators, and building operation resembles to on/off commands to devices that override the BMS.
Bulgaria	MERB: Section V of Chapter III in Bulgarian Energy Efficiency Act (EEA), promulgated, SG No. 105/30.12.2016 regulates the energy demand management. According to the provisions, the owners of buildings shall be bound to implement energy efficiency management. Energy efficiency management shall be implemented by means of (Article 63(2)): • organizing the implementation of programs and measures leading to fulfilment of energy savings; • preparing annually energy demand analyses; • preparing monthly and annually energy balances, including purchased and sold energy. For energy efficiency management in state- or municipal-owned buildings, expert councils may be established with the regional and municipal administrations to assist the activity of regional governors and municipal mayors. More detailed information can be found in the EEA. EAP: There is no specific definition for BEMS in Bulgaria. BEMS are not widespread in Bulgaria, especially in old buildings. For newly built buildings, there is always some type of automated facility management system (i.e. lighting, water management, consumption metering). As a rule, a BEM should include energy equipment to monitor and manage parameters of the surrounding environment – i.e. light, temperature, heat/cold, etc. DLAEM: The Energy Efficiency Act sets the process for the energy management for public and municipal buildings. Following this, expert committees can be established within the regional and local administrations to support the activity of regional governors and mayors. There is a definition of „intelligent energy management system“. The intelligent energy management system is determined as an electronic system which provides much more information than a traditional measuring device and can send and receive data through electronic communication. Conclusion: It is noticed that building energy management systems are still considered equivalent to systems that collect energy consumption data on a longer time scale and enable off-line analysis of energy consumption performance. The recognition of the real-time execution part providing feedback in real time to coordinate different building subsystems is still not evident.
Serbia	Application of Energy Management Systems in buildings is not common practice or industrial standard in the Republic of Serbia, therefore industrially accepted terminology and definitions do not exist. There is an ongoing project (2015 to 2020) targeting the introduction of the concept of Energy Management Systems in industry and wider community (UNDP/GEF

Country *(B.2.1.)*	***Analysis and study results***
	Project "Removing Barriers to Promote and Support Energy Management Systems in Municipalities throughout Serbia"). Project objectives are: 1. Establishing an enabling legal framework for introduction and efficient operation of the energy management system in LSG and implementation for relevant EE measures; 2. Establishing the institutional framework, or functional central and local units to support the energy management system with built capacities for implementation of the Energy Management Information System and implementation of EE projects; 3. Implementation of at least 10 demonstration energy efficiency projects, identified and implemented within the energy management system with the use of Energy Management Information System; 4. Signing of the Energy Efficiency Charter by towns and municipalities by 80% of local governments in Serbia in order to raise public awareness and capacities for implementation for the energy management system and increase investments in energy efficiency.
Romania	1. An energy management system (EMS) is a system of computer-aided tools used by operators of electric utility grids to monitor, control, and optimize the performance of the generation and/or transmission system. 2. If the definition of efficient energy management system has to be drawn in practicality, it would essentially have: • Metering and collecting the data of energy consumption • Finding opportunities and implementing methods to save energy • Analysis and tracking of the meter data to find out the efficiency of energy management system 3. An energy management system is a set of software tools used to monitor, control, and analyze a building's energy consumption. Energy management systems help property managers and engineering teams optimize energy consumption. 4. An energy management system (EnMS) is a systematic process for continually improving energy performance and maximizing energy savings. The principle of an EnMS is to engage and encourage staff at all levels of an organization to manage energy use on an on-going basis.
Hungary	Power management solve the energy problem dilemma. Energy management is a complex process, the aim of which is to harness the available resources in the most efficient way while also considering the trade-offs posed by technological, financial and comfort requirements. Energy management consists of the following steps, or technological levels: Precise measurement of energy consumption Precise documentation of energy consumption in time and determination of energy consumption profile or trend Analyzing the measured consumption, finding ways to decrease it Evaluating miscellaneous factors governing the consumption Predicting the consumption using the measured data An energy management system also accomplishes the precise monitoring of the electrical energy's quality, which allows the evaluation of the harmonic content of the network and the creation of error analyses. Furthermore it also allows for the

***Country**(B.2.1.)*	***Analysis and study results***
	remote control of electrical systems and when needed allows direct intervention into the systems operation to provide safety and better regulation. Modern Energy Management Systems are expected to fully automatically perform specific operations or to be remotely controllable from a monitoring system.
Germany	With the use of EMSs we can save energy which lowers the energy expenses, and also help the environment. The most important abilities of an EMS software are the collection, the organization, the storage and The graphical visualization of various measurement data. Measurement, in many cases, doesn't only include the electricity consumption but also various relevant values as well, for example: temperature, air pressure, humidity, gas consumption etc. The EMS software packages perform different kinds of analyses, which give us more sophisticated and up-to-date information. By processing the analyses we can find the areas of energy wastage and work out ways to eliminate them. In addition to this the software can also calculate the expenses and give us help with load management. The control of the systems also happens through these software. If a manufacturer offers energy storage systems with the EMS, the management of the energy storage systems also performed by the EMS software. The systems are mostly accessible from the Internet, but there are numerous cases where connection can also be established from mobile apps, both from Android and iOS. Most EMS systems can be installed with great flexibility into already existing building environments, and can also be easily extended with the products of different manufacturers thanks to their modular design. The various EMS systems are sold in differently equipped packages that have different capabilities. It should be noted that these EMS systems are compliant with legal regulations, most importantly the ISO 50001.
Slovenia	EMS is a part of BA – building automation or BMS – building management system). All-in-one supervision system to manage illumination, energy consumptions, climate and security.
Czech Republic	EMS, BA, BMS, KNX, MODBUS, BACnet, LORA, energy efficiency, automation, comfort, fire safety and security, MQTT
Austria	The standard EN 16001 "Energy management systems - Requirements for guidance on application" was published as a European standard on 1 August 2009 and adopted by the Austrian Standards Committee. This standard is not compulsory for companies in the Member States. The aim of the standard is to help organizations build systems to improve their energy efficiency by: • Certification of an environmental or quality management system according to ISO 14001 or ISO 9001 - Accreditation body for the certification of certification companies is a department in the Federal Ministry of Economics, Family and Youth. • Assessment or validation of an environmental management system according to the EMAS Approval Office for environmental assessors acc. EMAS is the Federal Ministry of Agriculture, Forestry, Environment and Water Management (Lebensministerium). [27]

Country(B.2.1.)	***Analysis and study results***
Slovakia	In July 2009, The European Standard EN 16001 on the Energy Management Systems was issued. In 2011 the European Standard EN 16001 turned into ISO 50001. The two Standards have a similar structure to facilitate the passage from the EN 16001 to the new ISO 50001. The structure is also able to guarantee the integration with other management tools, in particular with the ISO 14001 Standard on the Environmental Management System. ISO 50001:2011, international standard for energy management systems, was developed by the International Organization for Standardization (ISO). ISO 50001:2011 specifies requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use and consumption.
Bosnia and Herzegovina	An energy management system (EMS) is a system of computer-aided tools used by operators of electric utility grids to monitor, control, and optimize the performance of the generation and/or transmission system. ISO 50001:2011, international standard for energy management systems, was developed by the International Organization for Standardization (ISO). ISO 50001:2011 specifies requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use and consumption.
Montenegro	An energy management system is a series of processes that enables an organization to use data and information to maintain and improve energy performance, while improving operational efficiencies, decreasing energy intensity, and reducing environmental impacts ISO 50001:2011, international standard for energy management systems, was developed by the International Organization for Standardization (ISO). ISO 50001:2011 specifies requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use and consumption.

B.2.2. Typologies of Building Energy Management System (BEMS), definitions of R&D institutes, producers, system integrators

Country(B.2.2.)	***Analysis and study results***
Croatia	HEP-ESCO: o In the Republic of Croatia most BMSs have a 3-level topology. Starting from higher to lower, they are: Building Management Level, Automation Level and finally Field Equipment Level. o The only two known R&D institutes working on BEMS in Croatia are Faculty of Electrical Engineering and Computing and Faculty of Mechanical Engineering and Naval Architecture, both University of Zagreb. REGEA: No information available. MENEA: Private companies are offering their monitoring systems to be installed in buildings so that owners can keep track of energy consumption. Some energy distributers also have their own systems which were developed by

Country(*B.2.2.*)	***Analysis and study results***
	private companies and by which they monitor the consumption of electric or heating energy. REA: We don’t have the knowledge on that. CYBROTECH:- ELMA:- Conclusions: Commercially many systems are named “... for energy management”. Often simple monitoring through a regular SCADA or monthly/yearly consumption data collection is called building energy management for marketing purposes. R&D institutes have more progressive definitions where some central intelligence needs to exist to orchestrate different energy-relevant subsystems of a building by feeding back commands to them that are centrally decided based on control algorithms that often reside on optimization.
Bulgaria	MERB:- EAP: There are no definite typologies for the BEMS. The BEMS realized within R&D projects include sensors (light, heating/cold, presence), metering devices (plug, smart meters, etc.) and automatized/management solutions (technical devices to reduce consumption, and platforms to manage the environment). The BEMS offered by companies are highly customizable, i.e. the market systems have different components that can be orchestrated in various BEMS solutions. DLAEM: The BEMS typologies are split according to their application, for instance there are BEMS available for: - Buildings, - Swimming pools, - Hotels, - Industrial systems, - Administrative buildings Conclusion: Since no responses from R&D institutes, hardware producers and system integrators were obtained, this question cannot be completely answered, although obviously differences will exist where these mentioned groups will have a more structured definition on typology stemming from the information technology background. Energy agencies are disregarding the common IT background as well as different levels of functionalities offered from BEMS (from data collection and visualization to real-time feedback for coordination in order to preserve comfort and reduce cost) and focus on applications of BEMS to different types of buildings.
Serbia	Energy Management Systems in buildings are not widely used or accepted in industry in Serbia, so it is not possible to talk about their typologies, manufacturers etc.
Romania	There are many different types of building energy management systems available. But not every energy management system is suitable for every building. Different systems have different functions, and the types of functions in energy management system depend on the building’s specific needs. A few of the functions that a building energy management system might include are:

***Country*(B.2.2.)**	***Analysis and study results***
	• Advanced building analytics - A feature that analyzes the energy performance of the building using in-depth data and real time data, and that can detect and correct performance issues automatically. • Advanced metering infrastructure (AMI) analysis - This feature allows AMI data to be collected from a utility at specific time intervals. This provides a more accurate understanding of the building's energy consumption. • Automated demand response (AutoDR) - This feature helps to automatically reduce energy use during peak load events by automating the control of the building's components or systems. • Automated building control - This feature allows the energy management system to interact with the building's devices and systems in an active manner. • Basic energy information portal - This refers to either a website or standalone portal that displays the building's basic energy consumption information. It can also provide tips and suggestions for energy savings. • Retrofit programs - This refers to replacing building equipment to make the building more energy efficient. For example, replacing light bulbs with more energy efficient versions or upgrading HVAC equipment. • Energy consumption benchmarking - A feature that compares the building's historical energy consumption with current energy consumption to help you understand the building's on-going performance. • Building optimization - This is a functionality that allows the energy management system to interact with the building's systems to optimize their performance on a real time basis. • Ongoing performance analysis - This ensures the system is working optimally. • Demand response - This feature allows the system to respond to changing factors, such as high energy costs or system resource capacity needs. • Energy dashboard - A display that allows you to easily access and understand energy consumption data. • Measurement and verification - This ensures that the energy efficiency measures or system improvements are producing the results that you expect. It's particularly important to identifying your system's ROI. • Notifications and alerts - A feature that notifies you of any issues, from maintenance needs to problematic equipment.
Hungary	Hungarian R&D institutes definition for Building Energy Management System: BEMS means (software and hardware) which allows the interconnection of electric devices in a building in order to further increase personal comfort, safety and energy efficiency. System integrators and manufacturers definition for Building Energy Management System: The Building Energy Management System is used to make a building energy efficient and operate at the same time a high degree of comfort. To do so, the different energy uses are to be brought into line somehow.

***Country**(B.2.2.)*	***Analysis and study results***
	A Building's Energy Management System does the following things: measurement data collection; data processing and evaluation; Proposals; Automatic active power management. The Hungarian companies can be divided into three groups, by whose products they install into the BEMS: • they use their own hardware and software, • they use their own software, but other manufacturer's hardware, • they use other manufacturer's software and hardware. We can consider Building Energy Management systems as a package but they consist of different elements which can operate as a standalone unit or system. These elements are the following: • HVAC (heating, ventilation, air-conditioning, also involves temperature and humidity control) • Lighting • Natural lighting (position control of shutters, curtains, and different shading elements) • Audio (distribution and switching of music and talk) • Video (sharing and distribution of video signals) • Safety (unification and control of safety systems) • HSE (heat and smoke control system) • Pneumatic system control • Measurement of electric network for the purpose of further analyses (3F)
Germany	Building energy management systems are used for the joint control and automation of the entire energy-relevant technical building equipment with energy storage systems and sources. After inspecting the systems we could separate them into three different groups: The first group includes those manufacturers or system integrators that only offer software, the hardware has to be provided by the user. The second group contains those manufacturers/system integrators whose product palette includes both hardware and software. The third groups is made of those system integrators or manufacturers that offer EMS specifically for energy storage systems. It is common for these systems to be extended with solar arrays.
Slovenia	Good systems are often fully integrated. Integrator or supplier offer all-in-one system which consists of Hardware (controller, switches, relay cards, sensors, and communication gateways) and software (web server on controller, Mobile APP, Cloud APP). These systems are mostly used in some household, churches, and retirement homes. Another widely used solution in cheap and very easy to install. Usability is low, slow performance, unreliable communication. This plug-and-play solutions consists of wireless sensors, cloud gateway and wireless master, plug switches. Accuracy of measurements is low. Third solution is custom tailored, robust industrial design, fully open, can be extended, modular design, SCADA with Energy module plug-in, communication redundancy, ...

***Country*(*B.2.2.*)**	***Analysis and study results***
	Fourth topology is not BEMS, but rather only EMS. It is robust industrial design, with wireless sensors, communication gateways, wireless actuators (like el. valve) and M-Bus interface. All data is stored to cloud and accessible over Internet. Analysis are integrated on server side.
Czech Republic	Energy systems for buildings are dependent on the mechanical and energetic scope of the bearing structures. Monitoring, diagnostics and intelligent control of efficient buildings reflects the trend to use ultra-modern electronics to observe, evaluate and actively control newly-constructed buildings. The aims are: • Monitor and diagnose the structure of buildings. • Monitor and diagnose energy souces • Observe the behaviour of users • Control systems for heating, ventilation and cooling, based on a model of the building • Adapt energy consumption to the state of the external power network • Model the communication networks in buildings
Austria	BEMS are offered by various companies, which usually are bound to company specific products. These products are operated by a company-specific software which often is not compatible to other BEMS components, provided by different companies. There are various approaches to generate an open source software for BEMS which provide a compatibility of components of different producers
Slovakia	Common functional capabilities of Building Energy Management Systems are: - Optimization of building and plant operations. - Provision of energy management information - Remote monitoring and control of services and functions of one or several buildings - Possibility of automatic control of services and functions. For instance, automatic switch-on, switch-off of appliances - Monitoring of building status and environmental conditions BEMS are offered by various companies, which usually are bound to company specific products. These products are operated by a company-specific software which often is not compatible to other BEMS components, provided by different companies. There are various approaches to generate an open source software for BEMS which provide a compatibility of components of different producers. The "Building Energy Management Systems (BEMS) - Global Strategic Analysis" reports 77 companies including many key and niche players on the BEMS market: ABB Group (Switzerland), Azbil Corporation (Japan), BuildingIQ (Australia), C3 Energy (USA), Carma Industries Inc. (Canada), Cylon Active Energy (Ireland), Daikin Industries Ltd. (Japan), Daintree Networks, Inc. (USA), Echelon Corp. (USA), Ecova, Inc. (USA), Elster EnergyICT (Germany), EnerNOC, Inc. (USA), eSight Energy (UK), FirstFuel Software, Inc. (USA), GridPoint, Inc. (USA), Honeywell International, Inc. (USA), IBM Corporation (USA), Ingersoll-Rand PLC (Ireland), Johnson Controls, Inc. (USA), Jones Lang LaSalle Incorporated (USA), Optimum Energy LLC (USA), Schneider Electric SE (France), Siemens AG (Germany), SkyFoundry LLC (USA), Toshiba Corporation (Japan), Verisae (Israel).
Bosnia and Herzegovina	Building energy management system (BEMS) is a sophisticated method to monitor and control the building's energy needs. Next to energy management, the system can control and monitor a large variety of other aspects of the building regardless of whether it is residential or commercial.

***Country**(B.2.2.)*	***Analysis and study results***
Montenegro	Building Energy Management Systems (or BEMS) are computer-based systems that help to manage, control and monitor building technical services (HVAC, lighting etc.) and the energy consumption of devices used by the building. They provide the information and the tools that building managers need both to understand the energy usage of their buildings and to control and improve their buildings' energy performance.

B.3. Building side EMS IT architecture

B.3.1. System/ IT architectures in the area of Energy Management Systems

***Country**(B.3.1.)*	***Analysis and study results***
Croatia	HEP-ESCO: o LON-Bus over Ethernet o LON-Bus over BACnet o KNX over Ethernet o BACnet over Ethernet o Ethernet o Wi-Fi o M-Bus o Modbus REGEA: Most common is temperature control via a thermostat in the room if there is any. Heating boilers typically have systems of regulation depending on the outdoor temperature. Lighting is not controlled centrally but only by hand on the premises via a switch. MENEA: BEMS located on a single building or smaller building complexes is most common in Medjimurje. REA:- CYBROTECH:- ELMA: Zone control is in most cases interconnected with LonWorks or KNX technology. Calorimeters are on M-bus. BACnet started to appear more seriously 5 years ago, but it is only indeed pursued by Siemens. There where zone control is established, today often KNX is used. How much today BACnet is being used in Croatia in comparison to the rest of the world, one can well see by analyzing the downloads of the Brightcore BACnet Lookout software that we developed – in last few years it has been downloaded 6454 times from all over the world, and only 108 downloads were from Croatia. For comparison numbers are also given for other countries in the Danube region (the first is dominantly US with 1.631 downloads): Germany 751 downloads, Austria 120 downloads, Hungary 54 downloads, Czech Republic 49, Romania 33, Slovakia 24, Slovenia 16, Serbia 11, Bulgaria 5, Bosnia and Herzegovina 2. In our impression, these numbers very much correlate with the state of development of energy management for buildings in different countries.

***Country**(B.3.1.)*	***Analysis and study results***
	MERKANTILE: Systems are made such that there exists a central computer which is used for system monitoring, on this computer controllers are connected which control equipment in the field. Conclusion: Systems are made such that there exists a central computer which is used for system monitoring, on this computer controllers are connected which control equipment in the field. LonWorks and KNX communication systems are dominating, but also BACnet is gaining momentum.
Bulgaria	MERB:- EAP: There is not definite BEMS architecture due to reasons described in 1.2.2. DLAEM: Cloud SaaS (software as a service), BUS systems - C-Bus, KNX, M-Bus, Profibus, LON, N2Open, CAN, etc. Conclusion: Although the DLAEM answer is region-specific, the named implementation variants and communication backbones are expected to be similar for the entire country, so: Cloud SaaS (software as a service), BUS systems - C-Bus, KNX, M-Bus, Profibus, LON, N2Open, CAN, etc.
Serbia	Home Area Network (HAN) architecture, which can be Utility managed, and Utility and Consumer managed. A. The Utility Managed Architecture In this architecture, the utility monitors, controls and manages smart home appliances via its private network. Smart appliances are connected to the utility control server via its utility gateway and network. Home owners or other authorized users can access and view the status of home appliances from the utility server using an Internet gateway. The appliances send information to the smart meter using a suitable communication protocol. The smart meter then collects and stores the information and transfers it to the utility control server through the utility gateway. The communication between the utility and utility gateway is bidirectional, hence the utility is not only capable of monitoring the power consumption for billing purposes, but it is also able to control the appliances (ex: switching off the air conditioning units during peak demand).In this architecture, the user only has access to information that is provided by the utility. Therefore, the user has no control and can only monitor the performance of the appliances. It should also be noted that the user is connected to the utility through the Internet. Furthermore, the isolation of the two networks is mainly due to two major reasons: the difference in functionality of the two networks and cyber security. B. The Utility and Consumer Managed Architecture This architecture was proposed by the U.S. Department of Energy; it addresses the shortcomings of the aforementioned architecture. The Internet gateway within a home is connected to common gateway/hub, which acts as an intermediate device between the utility, home owners, third party service providers and the home appliances. The users and the appliances can exchange data and control commands through this common gateway/hub. Home owners can access their home appliances' control system directly through Internet gateway as well as through the utility server. Furthermore, any relevant information about the appliances can also be delegated to a third party through the Internet. [28,29]

***Country**(B.3.1.)*	***Analysis and study results***
Romania	The ***s***EMSA™ is an energy management system with an original architecture. With the increasing use of distributed energy sources such as photovoltaic power generation, cogeneration systems, and storage batteries, this system can be used to control different resources and reduce electricity costs. The ***s***EMSA™ enables an aggregator, such as an electric power service provider, to build a system that bundles demand and to collectively manage energy resources and adjust power supply with demand response, thereby obtaining economic benefits.
Hungary	Physical media used for data transmission in BEMS are radio frequency, twisted pair and Cat Ethernet cable. The most widespread communication protocols are TCP/IP, Modbus (RTU or TCP), RS-485, BACnet, ZigBee, KNX, GSM, HTTP and LonWorks. The most of systems can use TCP/IP protocol, therefore Ethernet networks are common. Because most BEMS and EMS packages include a central control software, therefore PCs are almost always present in the systems. The systems can be reached using smartphone and tablet applications. The field devices are mostly controlled by PLCs or microcontrollers. At least half of the systems are multi-platform (Windows, Linux, macOS, iOS, Android). Most of systems are web-based, so the control panels can be reached from any device.
Germany	For the EMSs and BMSs found in Germany, the most common media for data transfer is Ethernet cable (Cat5 or better), twisted pair cable and radio frequency technologies. In most cases communication happens with TCP/IP, Modbus RTU, Modbus TCP, RS485, RS-232, Z-Wave or BACnet protocol. Even though there is a large variety of available technologies, the most common is communication with TCP/IP protocol over an Ethernet network. The German manufacturers/system integrators put great emphasis on the safety of data. The use of VPN tunnels is common and communication, in most cases, done with SSL protocol, which is one of the most widespread safety protocols in the word of IT communication. By looking at the hardware background of the systems, we can find various solutions. There are manufacturers that offer unique hardware as the central element of their system and also those who offer software that can be installed on PCs or servers. Of all the inspected systems there were two where the data is stored on German based server centers. Data acquisition devices with built-in and expandable memory slots can also be found. These devices have built-in web servers which can be accessed through an Ethernet network. A major part of the systems provide cloud based web interface to become platform-independent. Systems that have Android and iOS apps also exist. The field devices are mostly microcontroller-based units. The modularity of the systems is achieved with I/O devices on the hardware side and with communication server modules on the software side. The communication server modules can also handle CSV files coming from other systems.
Slovenia	LON, KNX, M-Bus, Modbus RTU, Modbus TCP, Ethernet (wired and wireless)
Czech Republic	LON, KNX, M-Bus, Modbus, Ethernet (wired and wireless), BACnet, DALI
Austria	The most common media for data transfer are Ethernet cable (Cat5 or better), twisted pair cable and radio frequency technologies.

***Country**(B.3.1.)*	***Analysis and study results***
	In most cases communication happens with TCP/IP, Modbus RTU, Modbus TCP, RS485, RS-232, Z-Wave or BACnet protocol.
Slovakia	Ethernet Wifi M-Bus Modbus BACnet
Bosnia and Herzegovina	Energy Management Information System EMIS – UNDP BiH EMIS is a web application for monitoring and analyzing energy and water consumption in public buildings. An analysis of the data entered in EMIS enables experts to identify and implement energy efficiency measures that result in lower energy consumption and significant financial savings for municipal budgets. EMIS is currently being implemented in nine cities/municipalities in BiH. [30]
Montenegro	BEMS : Building and Energy Management System CEMS : Community Energy Management System D-EMS : Distributed Energy Management System DMS : Distribution Management System DSM : Demand Side Management EMS : Energy Management System EV-EMS : Electric Vehicle Energy Management System FEMS : Factory Energy Management System HEMS : Home Energy Management System [31]

B.3.2. Common Building Energy Management System (BEMS) System/ IT architectures in the regions

***Country**(B.3.2.)*	***Analysis and study results***
Croatia	HEP-ESCO: o Future is Internet of Things or IoT protocol over WiFi or LAN. REGEA: Trend is to be installed central control and management system that regulates the work of heating, cooling and lighting, depending on the given scenarios. With this system must be done all the necessary sensors and cabling so to make it work properly (weather stations, temperature sensors, lighting sensors, etc.) MENEA: As the technology goes forward so do the needs to follow it so in our opinion, BEMS will become more and more inclusive in modernization of buildings. It is already visible that in projects and plans for construction of new or modernization and refurbishment of older buildings such technology is planned to be installed. REA: We don't have the knowledge on that. CYBROTECH:- ELMA:-

***Country**(B.3.2.)*	***Analysis and study results***
	MERKANTILE:- Conclusion: As in the other countries of the EU, reaching ambitious targets for nearly zero energy buildings included in legislation cannot be achieved without exploitation of potentials of smart controls and major building subsystems orchestration with BEMS. That is the reason for an obvious trend of increasing BEMS importance. On the BEMS IT architecture side, future is Internet of Things or IoT protocol over WiFi or LAN, also modularity of BEMS for easy add-on to different configurations of the baseline automation equipment in buildings and optimization procedures for enabling orchestration of building subsystems via real-time feedback.
Bulgaria	MERB:- EAP: On market level, the BEMS are becoming more elaborate and complex as new technologies occur and become closer to the end user. Moreover, BEMS clients understand the benefits of such systems and, properly encouraged, are ready to invest in them. The arising barrier with the BEMS solutions is the availability of personnel ready to operate, maintain and manage them. For different types of buildings, a facility manager is supposed to be appointed. Quite often that person is not fully knowledgeable on how to operate the BEMS; additional training is needed. And also, BEMS offer a wide range of monitoring and management possibilities but yet not all of them are well-understood by the end user, and thus the end user prefers simpler systems that do not require such great attention to the complex, all-inclusive fully automatized systems. DLAEM: Cloud SaaS (software as a service), BUS systems - C-Bus, KNX, M-Bus, Profibus, LON, N2Open, CAN, etc. Conclusion: Although the DLAEM answer is region-specific, the named implementation variants and communication backbones are expected to be similar for the entire country.
Serbia	In accordance with the European Committee of Standardizations, communications within an intelligent building may be divided into three areas: Level 1: Field level, covering sensor and actuators, lighting systems Level 2: Automation level, covering the outstation/controllers Level 3: Management (i.e. supervisory) level
Romania	There are three levels of BMS: 1. Field level 2. Automation level 3. Management level
Hungary	The most common solution is that IT architecture is based on Ethernet network and TCP/IP communication. Modbus RTU is also a common solution. Web-based user-interface is also very common.
Germany	The most widespread communication method is TCP/IP protocol over Ethernet network. Web-based data access is a feature for most of the systems.
Slovenia	LON, KNX, M-Bus, Modbus RTU, Modbus TCP, Ethernet (wired and wireless)
Czech Republic	Field level – Automations level – management level.
Austria	The most widespread communication method is TCP/IP protocol over Ethernet network. Web-based data access is a feature for most of the systems.
Slovakia	Ethernet

***Country**(B.3.2.)*	***Analysis and study results***
	Wifi M-Bus Modbus BACnet
Bosnia and Herzegovina	The most relevant technologies for smart homes were grouped according to the following four categories: Integrated wireless technology (IWT); Home energy management system (HEMS); Smart home micro-computers (SHMC); Home automation (SHS/HA). [32]
Montenegro	Typical systems components in BMS are: 1. Field level (sensors, room control, chillers, actuators…) 2. Automation level (router/gateway, automation level controllers) 3. Management level (workstation, server, web browser)

B.3.3. Expected future trends/plans about IT architecture of BEMS in regions

***Country**(B.3.3.)*	***Analysis and study results***
Croatia	HEP-ESCO: o Generally connectivity is possible if all the devices are on the same protocol. In the real systems this is possible if all the devices are on KNX protocol. Also some open platforms for integrating devices from versatile network protocols are developed, like the platform Brightcore developed by Elma Kurtalj company. REGEA: EMSs of the new generation with their protocol being used are available for connecting to different equipment and devices, i.e. they are open. Protocols that are commonly used are: MBUS, MODBUS and KNX. MENEA: EMSs are available and open to add on different level devices. REA: We don't have the information. CYBROTECH: Most systems are declared as open, but effort is made to effectively disable interconnection with competition systems. The ways of doing so are numerous, most often it is lack of documentation and lack of compatibility. ELMA: When the sole technology is put in focus, what is installed in a great majority of cases is a classical SCADA system, and on a protocol level it is mostly „vendor locked". One can say that we are in that respect on the level of the US from 1995. MERKANTILE: Honeywell systems are verified for correct operation with devices of different vendors: Siemens, Loytec, Beka…

Country(B.3.3.)	*Analysis and study results*
	Conclusion: Although openness of the basic IT in buildings installed by using equipment of different producers is declaratively guaranteed, practical experiences of equipment producers and system integrators with a clear tendency towards openness are that still “vendor lock-in” is present. Besides the possibility of using KNX protocol, ways of integration of building data communicated via different communication protocols exist. One such way is the Brightcore tool offered by company Elma Kurtalj which enables to centrally communicate data from/to (bidirectionally) different communication networks present in the building.
Bulgaria	MERB:- DLAEM: The liberalization of the electricity market has just started in Bulgaria, so our expectation is increasing the future trends for BEMS application. Conclusion: The expectations expressed by the local energy agency are also backed by the national energy efficiency action plan 2014-2020 where demand response is stipulated and correspondingly systems on the side of end-consumers need to be present to support it.
Serbia	No
Romania	No detailed plan developed yet.
Hungary	There are an increasing demand in Building Energy Management in Hungary. Companies are interested in energy consumption and electrical power quality monitoring. Most of the new systems are based on Ethernet or RF (WiFi, GSM/3G/4G, LoRaWAN) communication.
Germany	The majority of the systems is equipped for wired communication. In the future it is possible that the devices become mobile and able to perform wireless communication (LoRaWAN, 4G, 5G).
Slovenia	The suppliers are becoming developers are focusing on software, to be modular, easy to integrate. They are moving from SCADA based solutions, to proprietary, in-house developed SW. All such SW are on web servers, written in Java or PHP. Hardware is going to be minimized. Low cost radio solutions. Zwave and RF on free spectrum are becoming popular, because of low licenses fee. Especially RF based devices are becoming popular in industrial field.
Czech Republic	No.
Austria	The future trend is the connection of applications by IoT protocol over WiFi or LAN.
Slovakia	Internet of Things or IoT protocol over WiFi or LAN.
Bosnia and Herzegovina	Institute for Standardization of Bosnia and Herzegovina (BAS) adopted, among others, the following standards related to energy efficiency of buildings: BAS EN 15232: 2013 Energy performance of buildings - Impact of building automation, controls and building management BAS EN 15500: 2009, Control for heating, ventilation and air conditioning - Electronic equipment for individual zone control BAS ISO 13153: 2013, Guidelines for the design of energy savings for family houses and small businesses BAS ISO 23045: 2010, Building environmental design - Guidelines for assessing energy performance of new buildings BAS EN ISO 13790: 2008 Energy performance of buildings - Calculation of energy required for heating and cooling BAS ISO 18292: 2012 Energy performance of fenestration systems for residential buildings - Procedure for the budget [33]

***Country**(B.3.3.)*	***Analysis and study results***
Montenegro	According to „Energy development strategy of Montenegro by 2030“ [34], one of the key strategic commitments of the Energy Policy of Montenegro is: Improved heating and/or cooling systems in buildings by: (i) substitution of direct transformation of electricity into heat and (ii) use of new technologies acceptable from the environmental aspect, which implies increased use of renewable energy sources and use of high-efficient cogeneration.

B.3.4. Interoperability and interchangeability (integration possibility) of different digital devices and different EMSs

***Country**(B.3.4.)*	***Analysis and study results***
Croatia	Generally connectivity is possible if all the devices are on the same protocol. In the real systems this is possible if all the devices are on KNX protocol. Also some open platforms for integrating devices from versatile network protocols are developed, like the platform Brightcore.
Bulgaria	MERB:- DLAEM: It is possible additional devices to be used together with the comfort regulation devices. Conclusion: In order to come to a consolidated conclusion answers from technology providers (either hardware or software producers or system integrators would be needed). However, from the answer one may conclude that openness is a trend which s actually a reflection of a similar trend globally.
Serbia	Typically, available EMS tied to the digital devices used for comfort regulation have the ability to add interfaces to connect devices that communicate via KNX, LonWorks®, Modbus, M-bus, etc. ensure an open system architecture. This makes it possible to also integrate third-party systems and components easily and cost-effectively.
Romania	EMSs are capable to connect and function with different digital devices and EMSs, but in order to perform properly they need to be adjusted (i.e. to have the same communication protocol)
Hungary	Most of the systems are capable of interacting with lighting control systems. Most of cases connection with other systems is possible. Technical details are not mentioned in the documentation.
Germany	There are solutions where different field devices are operated through I/O modules.
Slovenia	Closed systems and tied to particular vendor are popular because of aggressive advertising and marketing.
Czech Republic	Closed systems and tied to particular vendor are popular because of easy integration.
Austria	There are little solutions which are offering real Interoperability and interchangeability. In most cases the solution are product specific.
Slovakia	Mostly the devices and solutions are product specific. Real interoperability and interchangeability is often not given.
Bosnia and Herzegovina	Initially, the EMS systems have been developed for specific hardware, but with advancement in technology, newer EMS systems are compatible with different devices.
Montenegro	EMS systems are compatible with different devices.

B.4. Building side EMS market/ products

B.4.1. Main/known producers/ system integrators of BEMS in the regions

Country(B.4.1.)	***Analysis and study results***
Croatia	HEP-ESCO: o In Croatia there is only one producer of BMS (and by that also BEMS) equipment. That is Klimaoprema d.d. Other present manufacturers on Croatian market are: Siemens, Honeywell, Sauter, Johnson Controls, Trane, Schneider Electric, GE and ABB. REGEA: - HFC grupa d.o.o., Zagreb - Grič-Automatika d.o.o., Zagreb MENEA: There are few private firms that produce BEMS in north-west part of Croatia. They are SmartWay Ltd. and Međimurje IPC Inc. REA: We don't have the information. CYBROTECH: Siemens, ABB, Schrack Technik. System integrators are typically small. ELMA: Siemens is present in higher than 50% of buildings with any management in Croatia, there is some old Jonson Control which was already obsolete when it was sold, also Train and Honeywell. Schneider Electric can be found in traces. MERKANTILE: Honeywell and Siemens. Conclusion: Most dominant producers that provide building automation equipment on the Croatian market are: Siemens (SBT d.o.o.), Johnson Control, Train (Termoservis d.o.o.), Honeywell (Merkantile d.o.o.), Schrack Technik, Klimaoprema d.d. System integrators are: Elma Kurtalj (with Brightcore platform for integration), HFC Grupa, Grič automatika, Smartway, Međimurje IPC etc.
Bulgaria	MERB:- EAP: Some big companies as Siemens and Schneider electric provide BEMS solutions in Bulgarian market. Bulgarian producers (e.g. Alterco) offer BEMS solutions that are based on ready components. The market offers imported components that can be applied by the end-user without the need of a specialized installation company. DLAEM: Raytex Engineering Bulgaria, Sectron Bulgaria, ABB Bulgaria Conclusion: Besides the companies mentioned, web search also shows presence of other international corporations like Siemens Building Technologies and Schneider Electric.
Serbia	Known producers active in the region: Siemens (Desigo, Simatic)

***Country*(*B.4.1.*)**	***Analysis and study results***
	Schneider (TAC)
Romania	Siemens AG
Hungary	These manufacturers and system integrators are completely Hungarian companies. Name — Type Berg Energy Ltd. — system integrator Müller Automation — system integrator Prolan Ltd. — system integrator ON-Energy Ltd. — system integrator KONsys Ltd. — manufacturer MolControl Automation and Development Ltd. — system integrator Evopro System Engineering Ltd. — system integrator Sb-controls Ltd. — system integrator Energrade Ltd. — system integrator Elcon Ltd. — system integrator Fubo Ltd. — system integrator Elecon Ltd. — system integrator The following manufacturers and system integrators are Hungarian companies too, but they are only subsidiaries of German companies. Name — Type Schneider Electric Hungária Electrical Ltd. — system integrator Provicon Ltd. — system integrator WAGO Hungária Ltd. — system integrator Festo Ltd. — system integrator Bosch Energy Storage Solutions — manufacturer
Germany	Firm — Manufacturer/system integrator ADS-TEC GmbH — manufacturer (hardware and software) Solarwatt GmbH — manufacturer (hardware and software) econsolutions GmbH — manufacturer (hardware and software) Berg GmbH — manufacturer (hardware and software) FENECON GmbH — system integrator (own software, hardware from BYD and WAGO) R.I.E.MPP IndustrieserviceElektrotechnik GmbH — system integrator (own software) Siemens AG — manufacturer (hardware and software) PROVICON GmbH — system integrator (own software) WAGO Kontakttechnik GmbH & Co. KG — manufacturer (hardware and software) Festo AG & Co. KG — manufacturer (hardware) Robert Bosch GmbH — manufacturer (hardware and software)
Slovenia	Producers: Metronik, Solvera Lynx, Amibit and some less known. Integrators: E 3, d.o.o, Sisteh, ElektroPirnat, and many many more.
Czech Republic	Atos IT Solutions and Services, s.r.o., EP INDUSTRIES, České Radiokomunikace a.s., DATASYS s.r.o., OMEXOM GA Energo s.r.o., Schneider Electric CZ, s.r.o., Technologické centrum Písek s.r.o., mySCADA Technologies.

Country(B.4.1.)	*Analysis and study results*
Austria	Same as for Germany: ADS-TEC GmbH manufacturer (hardware and software) Solarwatt GmbH manufacturer (hardware and software) econsolutions GmbH manufacturer (hardware and software) Berg GmbH manufacturer (hardware and software) FENECON GmbH system integrator (own software, hardware from BYD and WAGO) R.I.E.MPP IndustrieserviceElektrotechnik GmbH system integrator (own software) Siemens AG manufacturer (hardware and software) PROVICON GmbH system integrator (own software) WAGO Kontakttechnik GmbH & Co. KG manufacturer (hardware and software) Festo AG & Co. KG manufacturer (hardware) Robert Bosch GmbH manufacturer (hardware and software)
Slovakia	WETRON automatizacná s.r.o. / manufacturer BUILDSYS, a.s. . / manufacturer and software Siemens AG / manufacturer and software)
Bosnia and Herzegovina	Known producers active in the region are: Siemens, Toshiba, Hitachi
Montenegro	Well-known producer is Siemens.

B.4.2. Short characterization of openness of BEMS provided by above producers/ system integrators

Country(B.4.2.)	*Analysis and study results*
Croatia	HEP-ESCO: o At the moment no producer or system integrator is offering BEMS. Usual BMS system can be provided by any vendor/producer. They are claiming to be open, but practice is varying (only with KNX protocol versatile automation level connections is ensured). Introduction of BEMS requires no change of automation or field level devices. REGEA: HFC grupa d.o.o. implements KNX standard. KNX, as a single protocol and international standard in automation and management is a technology that makes it easy to connect all elements of lighting, mechanical engineering, heating, ventilation and cooling up to the entrance telephone, security systems and / or system of multimedia. MENEA: Mentioned producers (Smartway, Međimurje IPC) are able to be installed on various devices and can be adapted to suite most of the demands. REA: We don't have the information. CYBROTECH:- ELMA:- MERKANTILE:-

***Country**(B.4.2.)*	***Analysis and study results***
	Conclusion: Producers and system integrators that rely on KNX protocol can accomplish openness. Small system integrators present in the country offer solutions that can alleviate connectivity problems of the baseline automation level of different producers, a very good example for that is the Brightcore platform developed and marketed by Elma Kurtalj.
Bulgaria	MERB:- DLAEM: The producers can provide full equipment of BEMS. Yes usually they are open for versatile automation level, but this issue is a topic for additional discussion. It is possible to change on top, but it also depends of the concrete situation, concrete building and/ or energy performance. Conclusion: Open, but some barriers still exist.
Serbia	Typically, BEMS providers claims to be open for versatile baseline control equipment. Depending on type and functionalities of existing digital devices, they may be introduced to BEMS or they need to be changed. Each particular application needs to be considered.
Romania	No information available.
Hungary	About 50% of the systems are open to third-party sensors and actuators. Some systems comply with KNX/EIB standards. There are companies creating their own software and using third-party hardware (custom-made or provided by large manufacturer). There are other companies developing only software for BEMS. These software are compatible hardware from large manufactures.
Germany	The majority of the systems is open to integration with different systems thanks to the I/O modules and modular design. Software-only system integrators manage to bridge the gap between different field devices using building automation software modules. The vast variety of communication protocols enables easy ways to establish communication.
Slovenia	All of them developed cloud solution with OPC UA connectivity. So it can be used on mixed hardware: their equipment and regular PLCs.
Czech Republic	No information.
Austria	Each particular application needs to be considered. There are product related barriers for tailor suit solutions, consisting of components of various suppliers.
Slovakia	No information on that.
Bosnia and Herzegovina	We don't have sufficient information.
Montenegro	There are no information.

B.4.3. Introduction of BEMS for existing buildings

***Country**(B.4.3.)*	***Analysis and study results***
Croatia	HEP-ESCO: o According to Technical Regulation on energy and thermal protection in buildings (Tehnički propis o racionalnoj uporabi energije i toplinskoj zaštiti u zgradama, NN 128/15 [26]) when doing retrofit of existing buildings it is necessary to apply a Building Management System (Article 7, point 13). o According to Article 2 of the same Technical Regulation: Requirements of this regulation have to be met when designing and

***Country*(B.4.3.)**	***Analysis and study results***
	constructing new buildings or designing reconstruction and reconstruction of existing buildings. o Article 39 of the Technical Regulation: (1) Systems of automation and management of the building (BMS) have to be designed in compliance with EN 15232: 2012 (2) Systems of automation and management of the building are defined in the four categories of efficiency: - A: building with a high-performance BMS, - B: building with an advanced BMS, - C: standard BMS, - D: energy inefficient BMS systems. (3) In new buildings and when reconstructing existing buildings in which the BMS is designed, it must be designed and constructed in efficiency class A or B or C according to EN 15232: 2012. o According to EN 15232:2012, class A is actually a fully programmable BEMS, class B corresponds to the pre-programmed control devices depending on different internal and external conditions (e.g. occupancy, outside temperature), and class C corresponds to solely the zone controls. Class A (what can be considered under BEMS in the sense of the 3Smart project) is currently not commercially offered, such that only different pilot applications have been performed on isolated buildings. REGEA: From experience, not often and in fact very rare (only individual cases). MENEA:- REA: We don't have the information. CYBROTECH: Most reconstructions include some level of energy management. Unfortunately, the primary goal is often to get the certificate and incentives, rather than ensure the real savings. Most systems are good on the project level, acceptable on execution, but failing on long-term maintenance. ELMA:- MERKANTILE: BMS systems are mostly implemented in new buildings (80% new buildings, 20% old buildings) Conclusion: Technical regulations in place [26] require introduction of BMS (Building Management System) when doing retrofit of existing buildings. BMS are split in 4 classes with respect to the energy-efficiency induced [26], and class A corresponds to BEMS (high performance BMS). Class A is currently not commercially offered, such that only different pilot applications have been performed on isolated buildings. There is also a tendency to ensure compliance with the technical regulation while the actual performance is of secondary importance. Long-term maintenance of

***Country*(B.4.3.)**	***Analysis and study results***
	BEMS is pointed out as an important issue, previous answers by system integrators put also into focus that maintenance of even currently fairly complex systems in buildings is problematic which finally leads to the fact that the BMS or, in future BEMS, is installed for the needs of getting appropriate certificates, but indeed is not operational due to poor maintenance.
Bulgaria	MERB:- EAP: To our knowledge, it is extremely rare in all public buildings, almost never applied in residential buildings; while industry and tertiary sector businesses already have some level of automation that is “refreshed” from time to time. DLAEM: It is not introduced very often. Yet it happens when the building owner has special requirements. In addition it is not binding by the law. Conclusion: The Energy Efficiency Act stipulates that all existing non-residential buildings with a total floor area of over 250 square metres and the existing buildings, with some exceptions, are subject to a mandatory energy audit and certification. The owners of any non-residential buildings are bound to implement the measures prescribed by the first energy audit for achieving the minimum required energy efficiency class within 3 years from the date of acceptance of the results of the audit. When a building undergoes major renovation, its energy performance certificate shall be upgraded after implementation of recommended measures in order to meet minimum energy performance requirements in so far as this is technically, functionally and economically feasible.. BEMS are not very often found within these prescribed measures. Inspection of different building renovation projects co-funded by the Energy Efficiency and Renewable Sources Fund available on the web pages of the Fund (http://www.bgeef.com/display.aspx?page=buildings) reveals that fairly less than 10% of building renovation cases include also an improvement of the building automation system. An introduction of a BEMS that would go beyond data acquisition and storing is not evidenced in these projects. In the provisions of Art. 31, para. 2 of the Energy Efficiency Act the scope of the requirements for the investment projects for new buildings is set as follows: *“The investment projects of new buildings under par. 1 must be compliant with the technical, environmental and economic feasibility of alternative high-efficiency units and systems for using:* *1. decentralized systems for generation and consumption of energy from renewable sources;* *2. electricity and thermal energy co-generation plants;* *3. central or local heating and air-conditioning systems, as well as such fully or partially using energy from renewable sources;* *4. thermal pumps.”* The body responsible for the quality of building structures in Bulgaria is the National Construction Control Directorate, which is directly subordinated to the Minister of Regional Development and Public Works. National Construction Control Directorate exercises control over requirements of the Spatial Development Act, as well as the legislative acts for its implementation in design and construction, incl. the incorporation of quality building materials and products in order to ensure the safety, accessibility and other requirements for the construction works. National Construction Control Directorate exercises control:

***Country**(B.4.3.)*	***Analysis and study results***
	• the lawfulness of the implementation and use of the first, second and third category constructions; • the lawfulness of issued building papers for all categories of construction, and • the actions of the municipal administrations and the participants in the investment process for compliance with the spatial planning provisions for all categories of construction; • on the lawfulness of the permitted and executed construction, the commissioning of the first, second and the third category constructions and the lawful use of the buildings put into operation. Regarding the national plan for the implementation of the requirement for Nearly zero-energy building: the requirement for this kind of buildings is regulated in § 1, item 28 of the Supplementary Provisions of the Energy Efficiency Act and in § 1, item 31 of Ordinance No. 7 of 2004 on Energy Efficiency of Buildings. The national definition for Nearly zero-energy building of Bulgaria is as follows: *"Nearly zero-energy building" is a building that meets the following terms and conditions at the same time:* *a) energy consumption of the building, determined as primary energy meets class A of the energy consumption scale for the respective type of buildings;* *b) minimum 55 per cent of the consumed (supplied) energy for heating, cooling, ventilation, hot water for domestic use and lighting is energy from renewable sources, located on-site on a building level or nearby.* Pursuant to Art. 5, para. 3, item 2 of the Energy Efficiency Act, a National Plan for Buildings with Near-zero Energy Consumption 2015-2020 was developed, which was adopted by Decision No. 1035 of 30 December 2015 of the Council of Ministers. The plan was developed according to the requirement under Art. 9 of Directive 2010/31/EC on the energy performance of buildings, according to which: Member States shall ensure that: (a) by 31 December 2020 all new buildings have close to zero net energy consumption; and (b) after 31 December 2018, new buildings occupied or owned by public authorities have close to zero net energy consumption. Member States shall draw up national plans to increase the number of buildings with close to zero net energy consumption.
Serbia	There are no current information how often BEMS is introduced when performing retrofit of existing buildings.[36]
Romania	No information available.
Hungary	Not common to install BEMS.
Germany	No information found.
Slovenia	No information found.
Czech Republic	No information.
Austria	Within the regulatory framework of the Austrian Energieeffizienzgesetz (energy efficiency act) BEMS can be introduced in an efficiency-measure trading system. Energy suppliers, selling more than 20 GWh per year need to register at the national

***Country**(B.4.3.)*	***Analysis and study results***
	energy monitoring agency and have to provide information on a certain amount of energy efficiency measures. These measures can also be traded between private investors and the energy suppliers. This fact promotes the implementation of BEMS
Slovakia	No information found – only general information energy efficiency measures of buildings. Not on the introduction of BEMS.
Bosnia and Herzegovina	In the Federation of Bosnia and Herzegovina since 2009, through secondary legislation adopted by the FMPU (Federal Ministry of spatial planning), there is applicable standards during planning construction of new buildings and when performing retrofit of existing buildings. They have been defined in the "Ordinance on technical requirements for thermal protection of buildings and rational use of energy", and provide minimum technical or energy parameters that need to reach the facilities.
Montenegro	In Montenegro, there is a lack of energy management in buildings because of the lack of regulation and implementation support, the lack of direct financial contribution for consumers and a lack of information and knowledge about the low cost or no cost to improve efficiency. There are no information about frequency of the BEMS introduction in new buildings.

5. Conclusion

Twelve countries in the Danube region (namely: Germany, Czech Republic, Slovakia, Austria, Hungary, Romania, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Serbia, Bulgaria) has been examined in order to identify regulatory and technological state of the art for Building and Grid Energy Management Systems. The goal of this analysis was to identify barriers that prevents wider spread of these systems. Based on the analysis we have found the following barriers.

The most relevant barriers of regulation:

- Diverse Danube Region energy markets' regulation
- Renewable energy and load (demand side management) participation in ancillary services and in balancing needs to improve
- Smart metering is a prerequisite of dynamic pricing/demand side management
- Smart meter roll-out is carried out in a few Danube Region countries
- Technical specifications for smart meters do not cover the possibility of communication with building energy management systems

The most relevant barriers of technology:

- Missing international and national technological guidelines
- High cost of systems for grid and building operators
- Lack of energy storage units
- Missing standard communication technology for smart metering
- Missing industrial standards for BEMSs
- Wide range of the IT architectures and protocols used in EMS and BEMS increases interfacing, interoperability, interchangeability problems.
- Older buildings are hard to integrate into BEMS and small level of market interest in the retrofit segment of building industry.

This document will used as a base for creating a strategy to remove the regulatory framework barriers for Energy Management Systems adoption in the Danube Region.

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Appendix A:

A.1.3. Bosnia and Herzegovina

Table 1. Overview of electricity produced from renewable energy (which will be encouraged by 2020.).

	work annually	2012		2013		2014		2015		2016		2017		2018		2019		2020	
		MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh
HYDROPOWER:	**4100**	**20,723**	**86,12**	**20,723**	**86,120**	**23,918**	**98,062**	**28,747**	**117,862**	**30,052**	**123,212**	**36,585**	**150,000**	**39,024**	**160,000**	**40,244**	**165,000**	**50,000**	**205,000**
< 1 MW	**4100**	7,830	35,330	7,830	35,330	8,371	34,322	8,624	35,359	9,016	36,964	10,976	45,000	11,707	48,000	12,073	49,500	15,000	61,500
small - from 1 to 10 MW	**4100**	12,893	50,790	12,893	50,790	15,546	63,740	20,123	82,503	21,036	86,248	25,610	105,000	27,317	112,000	28,171	115,500	35,000	143,500
large > 10 MW		0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SOLAR ENERGY:	**1500**	**1,265**	**1,856**	**1,265**	**1,856**	**3,900**	**5,850**	**5,230**	**7,850**	**5,900**	**8,850**	**8,000**	**12,000**	**9,330**	**14,000**	**9,670**	**15,000**	**12,000**	**18,000**
Photovoltaic		1,265	1,856	1,265	1,856	3,897	5,845	5,230	7,845	5,900	8,850	8,000	12,000	9,333	14,000	9,667	14,500	12,000	18,000
micro - from 0,002 to 0,023 MW		0,081	0,011	0,081	0,011	1,169	1,754	1,569	2,354	1,770	2,655	2,400	3,600	2,800	4,200	2,900	4,350	3,600	5,400
mini - from 0,023 to 0,150 MW		1,185	1,845	1,185	1,845	1,559	2,338	2,092	3,138	2,360	3,540	3,200	4,800	3,733	5,600	3,867	5,800	4,800	7,200
small - from 0,150 to 1 MW		0,000	0,000	0,000	0,000	1,169	1,754	1,569	2,353	1,770	2,655	2,400	3,600	2,800	4,200	2,900	4,350	3,600	5,400
Concentrated		0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
WIND ENERGY:	**2500**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**24,000**	**60,000**	**30,000**	**75,000**	**38,000**	**95,000**	**42,800**	**107,000**
on-shore		0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	24,000	60,000	30,000	75,000	38,000	95,000	42,800	107,000
BIOMASS ENERGY:	**6500**	**0,000**	**0,000**	**0,000**	**0,000**	**0,923**	**6,000**	**1,846**	**12,000**	**2,154**	**14,000**	**2,769**	**18,000**	**3,385**	**22,000**	**3,846**	**25,000**	**4,615**	**30,000**
compact		0,000	0,000	0,000	0,000	0,923	6,000	1,846	12,000	2,154	14,000	2,769	18,000	3,385	22,000	3,846	25,000	4,615	30,000
TOTAL:		**21,934**	**87,976**	**21,934**	**87,976**	**28,741**	**103,912**	**35,823**	**137,712**	**38,106**	**146,062**	**71,355**	**240,000**	**81,739**	**271,000**	**91,760**	**300,000**	**103,415**	**360,000**

INCENTIVE	2012		2013		2014		2015		2016		2017		2018		2019		2020	
			(GWh)	(%)	(GWh)	(%)	(GWh)	(%)	(GWh)	(%)	(GWh)	(%)	(GWh)	(%)	(GWh)	(%)	(GWh)	(%)
Hydro power plants			86,12	97,89%	98,06	89,22%	117,86	85,56%	123,21	84,36%	150	62,50%	160	59,04%	165	55,00%	205	56,94%
Solar power plants			1,86	2,11%	5,85	5,32%	7,85	5,70%	8,85	6,04%	12	5,00%	14	5,17%	15	5,00%	18	5,00%
Biomass power plants			0	0	6	5,46%	12	8,14%	14	9,59%	18	7,50%	22	8,19%	25	8,33%	30	8,33%
Wind power plants			0	0	0	0	0	0	0	0	60	25,00%	75	27,68%	95	31,67%	107	29,72%
TOTAL			87,98	100%	109,91	100%	137,71	100%	146,06	100%	240	100%	271	100%	300	100%	360	100%

A.3.1. Hungary

Requirements of general VTB for syncron VTB and power plants VTB						
Reference	Name of requirements	Kind of requirements	A	B	C	D
13. (1) a)	Interval of system frequency	Stability of frequency	x	x	x	x
13. (2)	Limited Frequency System Mode response for Overfrequency (LFSM-O)		x	x	x	x
13. (1) b)	Required rate of change of frequency (RoCoF)		x	x	x	x
13. (3)	Constant active power-output specified keeping the target value		x	x	x	x
13. (4)	Permissible decreasing active power-output in case of decreasing frequency		x	x	x	x
13. (7)	Ability of automatic connection		x	x	x	
13. (6)	On/Off switching with remote controling by logical interface		x	x		
14. (2)	Reducibility of active power-output			x		
14. (5) c)	Artificial inertia (If needed)			x	x	x
15. (2) a)	Regulable and interval of regulation of active power-output				x	x
15. (2) f)	Disconnected response for Underfrequency				x	x
15. (2) e)	Ability of regulation for frequency restoration				x	x
15. (2) d)	Frequency System Mode				x	x
15. (2) c)	Limited Frequency System Mode response for Underfrequency (LFSM-U)				x	x
15. (2) g)	Monitoring of frequency response				x	x
14. (5) a)	Regulation systems and options	Regular system level of requirements		x	x	x
14. (5) d)	Exchange of informacion			x	x	x
14. (5) c)	Priority sequence of relay and regulations			x	x	x
15. (6) f)	Handling of block transformer				x	x

A.4.1. Croatia

Table 1. Advanced meter investment costs

Single smart meter investment cost	Price
Smart meter with PLC communication	
single-phase meter	868 [HRK]
three-phase meter	1.210 [HRK]
Smart meter with GPRS communication	
single-phase meter	1.256 [HRK]
three-phase meter	1.808 [HRK]

Figure 1 visually presents the state of progress in installing AMR devices in other EU countries.

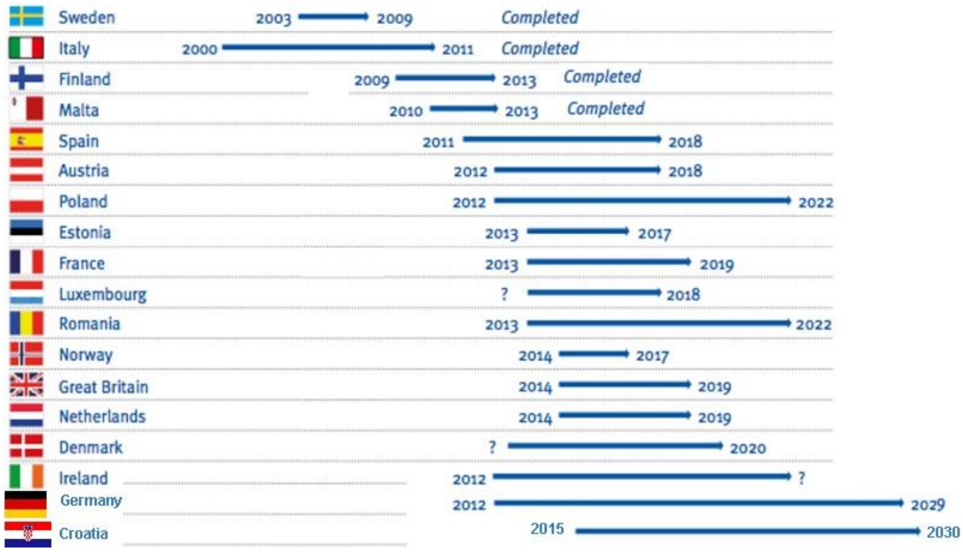
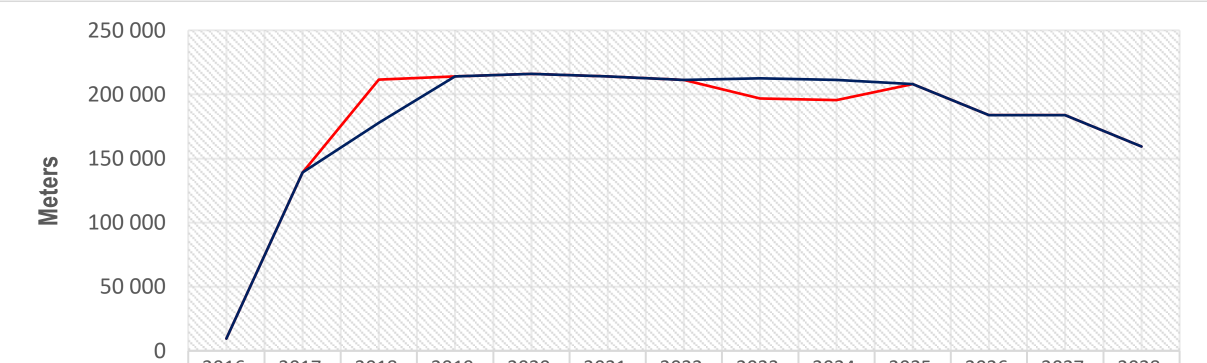


Figure 1. Installation of advanced meters in EU countries

The dynamics of transition to smart meters is shown in Figure 2.

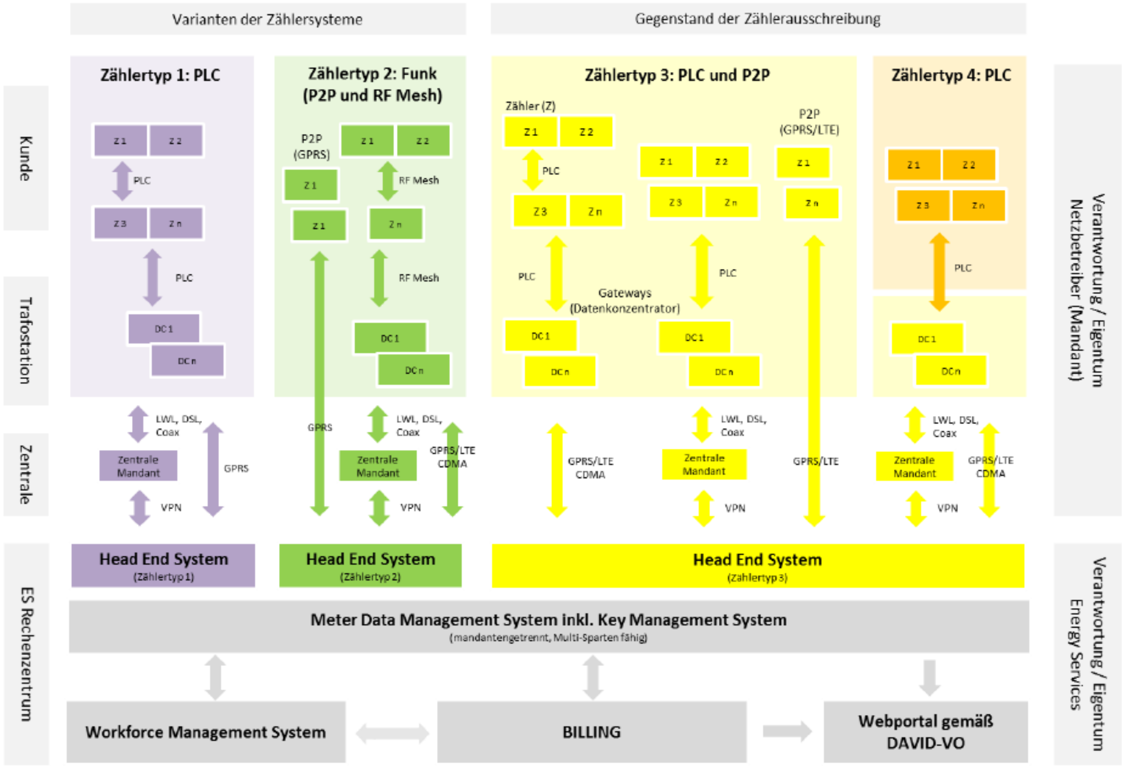


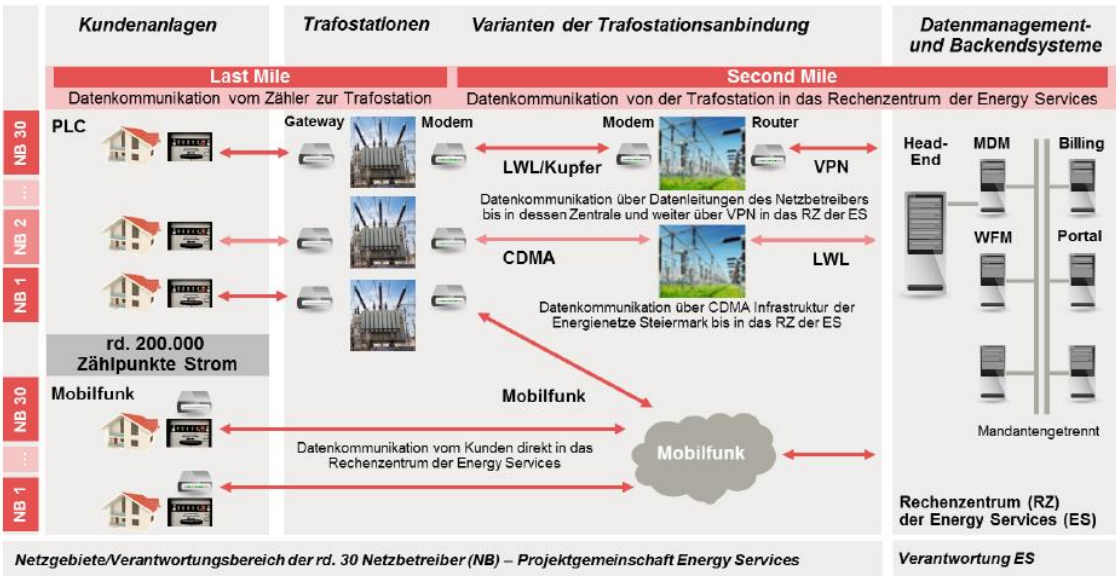
	2016.	2017.	2018.	2019.	2020.	2021.	2022.	2023.	2024.	2025.	2026.	2027.	2028.
Model 1	9 535	139 200	211 678	214 106	216 033	214 151	211 356	196 871	195 661	208 082	183 899	183 884	159 462
Model 2	9 535	139 200	177 809	214 106	216 033	214 151	211 356	212 621	211 314	208 082	183 899	183 884	159 462

Figure 2. Dynamics of advanced meter installations in Croatia by 2030.

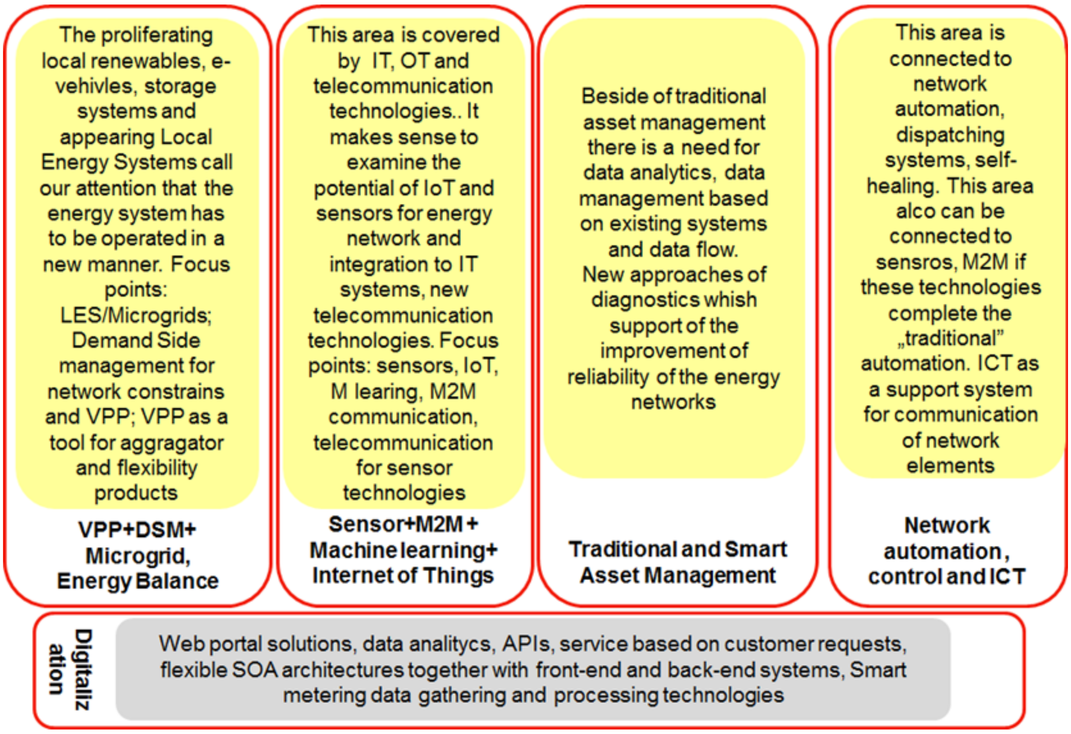
A 4.1. Austria

Abbildung 1: Smart meter concept and areas of responsibilities





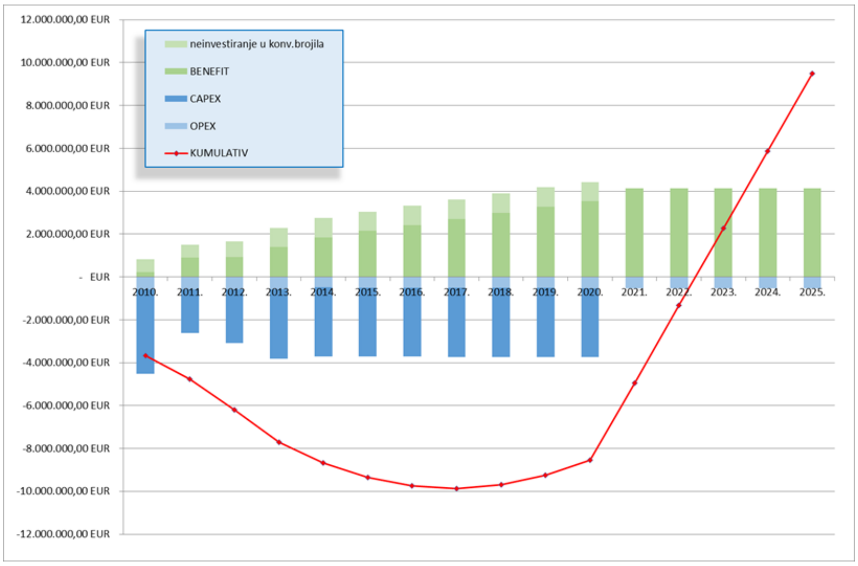
A.4.2. Hungary



Innovation strategy

A.4.5. Bosnia and Herzegovina

CAPEX (Capital costs)	OPEX (Operating costs)	BENEFITS
Investment in the smart metering system	System maintenance	Reduction of reading costs
Investment in IT	The communication cost / data transfer	Reduction of billing costs
Investment in the communications infrastructure	Staff trainings	Reduction of illegal consumption
Avoided investment in induction meters (negative cost, added to the list of benefits)	Revenues decrease (through more efficient consumption)	The profit from the increased contracted power
The stranded cost of previously installed induction meter	Replacing/failures of meters	Avoided cost of intervention at the customer location



A.4.6. Croatia

Table 1. Substation smart meter requirements

	CHARACTERISTICS OF SMART METERS THAT WILL BE INSTALLED IN THE SUBSTATIONS
1.	***Measurement features***
-	Power outage detection
-	Active, reactive and apparent power measurements
-	Current measurement in the neutral wire
-	Direct connection or via measuring transformers
-	Registration of maximum power for all energy measurements
2.	***Power Quality parameters***
-	Power factors and phase angles
-	RMS values of current and voltage per phase
-	THD measurements
-	Voltage sag and swell detection
3.	***Protection from misuses***
4.	***15-minute reading period***
5.	***Log event***
6.	***Creation of load curves (power or energy)***
7.	***Communication using following interfaces (CS, RS232 or RS485)/modems (GSM, PSTN, ISDN)/Ethernet***
	Smart meter investment cost per substation ~ 8200 HRK

Table 2. End-user smart meter requirements

	CHARASTERISTICS OF SMART METERS THAT WILL BE INSTALLED IN END-USERS PREMISES
1.	*Local reading via display*
2.	*Remote reading of measurement and control data*
3.	*Frequent enough reading of measurement data which enable their use to achieve energy savings*

4.	*Supporting advanced tariff system*
5.	*Remote connection and disconnection and limiting peak power*
6.	*Bidirectional measurement of active and reactive energy*
7.	*Prevent and detect fraud and unauthorised use of energy*
8.	*Secure data communication and protection of privacy*
9.	*PLC communication*
10.	*Single-phase meter*
Smart meter investments cost per end-user ~ 1500 HRK	