

The background of the entire page is a night-time photograph of a city, likely Budapest, featuring the illuminated Chain Bridge over the Danube River. The city lights and bridge structure are reflected in the water. Overlaid on this image are several digital graphics: concentric red circles emanating from points in the sky, suggesting signal transmission or connectivity, and a network of white dots connected by thin lines, resembling a data or communication network. In the lower foreground, there are stylized, glowing blue and white lines that look like digital data streams or fiber optic paths.

SIEMENS

Ingenuity for life

Smart Hungary 2025

Realizing the Potential of
Digitalization

June 2017

Digitalizing Hungary's Cities today, to make them competitive
for tomorrow.

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Introduction



Hungary is a modern day national success story. The Government of Hungary took some very tough decisions over the past 20 years that have transformed its economy, replaced some of its most aging infrastructure and improved the quality of life for its people. Hungary is now a major hub for European manufacturing with some of the world's most cutting edge car production facilities. Hungary, has become a competitive place for doing business, but now the rules governing economic competitiveness are changing, and changing quickly. Digitalization is quickly redefining how industries, cities and people will stay competitive over the coming 10 years. If governments and cities intend to retain cutting edge businesses then now is not the time to wait and see how digitalization is working someplace else.

Smart Hungary 2025, is intended to bring together ideas from Siemens, other leading Hungarian businesses, academics and practitioners in the built environment, on where and how to maximize the opportunities coming from

digitalization through real, actionable, projects. These ideas are intended as a starting position that national, city and local leaders can use to build a roadmap for how Hungary will digitalize its infrastructure, homes and businesses, in a coordinated and transparent manner that targets investment where it can deliver the most positive impact.

Cities will be fundamental to Hungary's digital transformation. Many cities around the globe are already starting to digitalize their infrastructure for a number of reasons, the key driver being economic. Digital technology is allowing city services to cost efficiently expand the types of services they can provide to more people. It is also improving the efficiency of their urban transport, buildings, and energy networks. Improving efficiency in these areas can mean reductions in energy demand and cleaner air, reduced building operational costs and the opportunity to boost local energy generation and network resilience.

Budapest, Hungary's major city and home to nearly one-third of its total population has already started to embrace digitalization. Smart Budapest is already bundling together some local, home-grown, digital initiatives across the city. Using digitalization in Budapest could help to manage the growth related burden being placed on local infrastructure.

Many global car producers have located facilities outside of Budapest, and delivering digital projects there could go a long way towards improving the types of job opportunities available in smaller cities and support wider governmental aims to balance growth across all of Hungary. The large global manufacturers operating in Hungary are already digitalizing their processes, but the small and medium-sized business that supply components and materials to the large producers will have to also make the digital leap to keep pace with their clients. How they achieve this will be critical for Hungary to retain its global position as a manufacturing hub and to move up the economic value chain and expand into corporate R+D and higher value-added services.

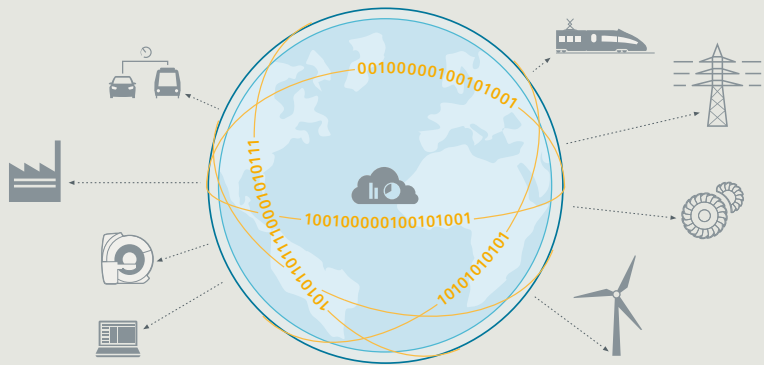
Smart Hungary 2025 is a first step in developing a digitalization strategy for Hungary. The ideas and concepts within this document are based on Siemens' knowledge of the digital transformation taking place, and then extend beyond it with ideas coming from other businesses and organizations as part of this initiative.

Digitalization

The digital leap – greater efficiency by merging the real and virtual worlds.

The world has never been as connected. From gas turbines to trains, to manufacturing and medical imaging equipment, our physical world is taking on a digital dimension.

The increasing convergence of the physical and virtual worlds offers boundless opportunities – in almost all areas of society.



Digitalization is the process that turns activities, information and results into data that can be compiled, analyzed and shared. A growing number of devices allow users track various processes via the Internet or the Cloud. Examples of this trend include fitness-tracker armbands, sensors that monitor plants’ moisture levels, and houses that learn to set their heat and lighting to fit their residents’ living patterns. As this progresses, it is realistic to expect that eventually every object will be equipped with an Internet address, thus opening up whole new ways to interact with those “things”.

All the same, factories, traffic networks and utility grids are a good deal more complex than smartphones and tracker armbands. All are examples of real and virtual systems that have been intermeshed and that often even involve critical infrastructures. Cities and organizations want to harness the advantages of digitalization and integrated data. That’s why Siemens has expanded the concept of the Internet of Things (IoT) for industrial applications to create the Web of Systems, meaning systems that are digital, communicate with each other, and can act autonomously. Siemens’ vision is that as this ecosystem takes shape its elements will be managed via future Web technologies that use standardized protocols and

languages of the kind that are used for the Internet today.

This linking up of the real world and the virtual world of data offers multiple advantages. It offers infrastructure organizations the ability to capture and analyze the current status of a system and its parts anytime, in detail. This in turn yields immense opportunities for savings through predictive maintenance, as well as major potential for optimizing systems. Using today’s technologies from the World Wide Web environment, systems can often be implemented and commissioned faster and more economically. A system’s intelligence can be distributed as needed between real components and virtual systems in the Cloud, resulting in enhanced robustness and customer data protection. Finally, as the digital landscape is transformed along these lines, it will become easier to update systems with new functions, or to update system software on the fly, in much the same way as smartphones and other devices are updated through apps.

Hungary today has started down the path towards digitalization and multi-national car manufacturers are bringing in their cutting edge digital technologies, and local companies must bridge this important knowledge divide.

Only companies with advanced software, equipment and user know-how can generate performance improvements across the entire value chain, for themselves and their customers.

Design & engineering: higher productivity and accelerated time to market

DIGITAL TWINS AND SIMULATION
New products and production processes are designed, simulated and optimized virtually before being built

Production & operations: new levels of efficiency and resilience

0.0012 százalék

NETWORKED SYSTEMS:
At Siemens’ Digital factory in Amberg, products tell machines their next production steps, resulting in the lowest possible defect rate: 0.0012 percent.

SELF-LEARNING SOFTWARE:
Complex systems like wind turbines can learn to become more efficient through data analysis, high-performance computing and advanced intelligent algorithms.

Maintenance & service: reduced downtime through predictive and prescriptive analytics

300,000 rendszer

INNOVATIVE SERVICE CONCEPTS:
From skyscrapers to gas turbines and the traffic control centers, Siemens monitors and checks around 300,000 systems worldwide, via a secure connection.

Digital technologies enable many sectors to improve their performance.

Future of manufacturing

30% TIA portal reduces engineering costs by up to 30 %.

50% PLM software and automation reduce time to market by up to 50 %.

Networked energy

40% Smart grid technologies enable the integration of renewable energy sources into the grid at up to 40 % lower costs.

90% Self-learning software can predict the electricity output from renewable sources over a 72-hour period with 90 % accuracy.

Intelligent infrastructure

40% Intelligent building technologies reduce energy costs by up to 40 %.

20% Intelligent traffic control systems reduce congestion, accidents and CO₂ emissions by up to 20 %.

Healthcare IT

73% Intelligent data management systems can reduce laboratory test errors by 73 %.

77% Software accelerates cardiac CT examination reporting by an average of 77 %.

Hungary's Industry 4.0 National Technology Platform is working to bridge this gap through initiatives that promote co-operation between industry and research universities. It's aim is to help smaller businesses make the leap to the 4th industrial revolution, the current digital one, by transforming the basics of local production and logistic systems. Siemens Hungary and other industrial leaders are part of this initiative

Digitalization happens in steps, and these include:

- Electrification** – The basis of intelligent infrastructure is electrification. Through electrification power systems can be more precisely controlled, which leads the way towards automation. Very importantly, the electrification of infrastructure means that there is now the opportunity to use cleaner grid or renewable power.
- Automation** – Once automated, processes across infrastructure and industry, will be able to operate without direct control. Automation increases speed, efficiency and often times accuracy across sectors.

Digitalization – Digitalization is the process that turns activities, information and results into data. Smart cities will need to run on smart data, meaning that there is the need to pull the valuable data from the cacophony of data that organizations are generating. The ability to source and compile the right data will be a key differentiator for successful organizations in the future.



Data analytics

The focus of data analytics is changing from descriptive to prescriptive, meaning that systems that only a few years ago would be able to offer fault reports or other general reports can now predict those faults and potentially change operations in order to stop those very same faults from ever happening. The growth curve of data analytics builds upon the descriptions by offering diagnostic tools that can explain why something has happened, to predictive and now prescriptive actions.

Data Platforms and Integration – across the city and in key industries

The key to the smart city or to a successful business in the digital future will be in their ability to collect, integrate and share data that allows systems to optimize and efficiencies to be achieved. It is not yet clear the full benefits of digitalization, but the potential is huge. How digitalization is to be achieved, security of the systems, data ownership and the interoperability of systems are some of the biggest questions surrounding data integration and smart cities. Through Siemens’ leading role as a supplier of software and technology for industry, it has developed a cloud based integration platform, MindSphere, that can be used by cities, industries, infrastructure agencies and any other organization wanting to cost effectively integrate and build upon the vast amounts of data that come from within an organization as well as the countless other organizations that it’s linked to either as citizens, customers or service providers.

MindSphere – the cloud-based, open IoT operating system – from Siemens

With MindSphere, Siemens offers a cost-effective, scalable cloud platform, in the form of a Platform as a Service (PaaS), for the development of applications. Designed as an open operating system for the Internet of Things, this platform makes it possible to improve the efficiency of plants by recording and analyzing large volumes of production data. MindSphere provides a solid foundation for applications and data-based services from Siemens and third-party providers, for example in the areas of predictive maintenance, energy data management, and resource optimization.

MindSphere offers the ability to immediately develop, deploy and run digital services, create applications, or even new business models. Being a cost-efficient data hosting platform, it combines:

- Encrypted fast data processing across company boundaries
- Safe and global large-scale data storage
- Visualization of analytical results
- Connectivity of assets regardless of manufacturer
- Boundless opportunities for third party application developers to create business specific apps

Benefits for machine builders

- Increase service efficiency and lower warranty expenses
- Offer additional services (e.g. availability)
- Enable new business models
- Product enhancement via feedback loop to R&D

Benefits for plant operators

- Increased uptime and asset availability
- Asset optimization
- Maintenance efficiency

Benefits for app developers

- Rapid development of own applications due to an open API
- Scalable development environment

Why a Smart Infrastructure Plan for 2025



Today, we generally assume that most successful cities have both infrastructure and economic strategies, which support regional and national targets, and that these strategies reinforce the other. City managers certainly have ambitions and targets for their cities; however, a well considered infrastructure plan that supports a city's economic goals is very rare. Rarer yet is an integrated city strategy delivered in partnership with the local businesses and key stakeholders. Siemens is challenging this norm, and it is actively seeking engagement with potential public and private sector partners to look beyond Budapest and create a smart city focused infrastructure delivery strategy for total Hungary.

Economic linkages between infrastructure and competitiveness

The link between infrastructure and economic competitiveness is proven. The strength of any economy is based on the productivity of its human capital and its access to natural resources. In a world where capital and jobs flow to the most efficient market, modern, reliable, high-tech infrastructure is the primary way to ensure a city remains competitive. Most importantly, infrastructure is a sector where government, at both the national and local levels, has the most ability to impact. Government must often fund these projects or provide the necessary land or permissions. The private sector is generally tasked for delivery, but to do so they need to have an understanding of the infrastructure strategy as they can add expertise to the discussions and reduce potentially costly problems at the earliest of the design phases.

Importantly for any economy, infrastructure projects can also produce positive spillovers in other areas such as public health and they can have a positive environmental impact. In the short-term, investing in infrastructure provides good jobs at varying skills levels. Infrastructure investment is a powerful government tool for counteracting an economic downturn like the one experienced globally in 2009. In the long-term, investing in infrastructure cuts costs, creates value, and benefits the environment.

Investments in cleaner sources of energy, energy efficiency in buildings, public transport, and intermodal freight transport have positive environmental benefits. In European cities buildings and traffic typically constitute about 90% to 95% percent of emissions. However, given the scale of manufacturing in Hungary it is highly likely that manufacturing creates a higher proportion of carbon

emissions. This means that achieving reductions in carbon emissions across the country requires private sector engagement from the outset. Retrofitting old buildings and improving the public transport systems can go a long way towards reducing energy use and harmful air emissions. If planned correctly, many investments in energy, transit and buildings can have a secondary benefit of improving local resilience to expected changes in precipitation, flooding, and temperature.

Why involve Siemens and the Private Sector



Siemens is proud that it has been in Hungary for the past 130 years, that it provided vehicles for Budapest's very first metro line and that 70% of the country's electricity backbone is comprised of Siemens technology. Siemens has a 3,000 strong Hungarian team, and 70% of what it manufactures is exported boosting Hungary's position as an important European trading hub. Crucially, in the newly digitalizing world, Siemens is developing a base for its most innovative team, Next47, in Budapest, Hungary. This is a team of software engineers who are global leaders in developing digital technologies, including one of the world's first electric airplanes.

Siemens' Hungarian manufacturing plants source materials and components from local small and medium sized enterprises. It is our wish to take advantage of the opportunities coming from digitalization to improve productivity along the value chain as a whole.

A large portion of local carbon and air emissions are generated by the private sector and any national aim to reduce emissions and reduce energy intensity in manufacturing will require that the private sector is addressed in a positive way. A strategy to digitalize industry could help to achieve both economic and environmental aims. Siemens globally is taking actions to achieve carbon neutrality by 2030 and cut CO₂ emissions by 50% as early as 2020.

The vision for *Smart Hungary 2025* is being produced with the same community spirit in mind. Siemens hopes Hungary will take advantage of the opportunities available from digitalization, and that the benefits of investment spread beyond Budapest into regional cities, and create stronger, widespread growth across the country.

Delivering digitalization projects will require technologies and skills beyond what Siemens can provide. These projects will need other private sector partners, public agencies, universities, grassroots organizations and leaders to deliver. Hungary 2025 is the beginning of a wider intra-sector dialogue.

Siemens to be climate neutral by 2030

- CO₂ emissions to be cut 50 percent as early as 2020
- €100 million investment in improving energy efficiency
- Annual savings of €20 million expected

Siemens aims to be the world's first major industrial company to achieve a net-zero carbon footprint by 2030. Siemens will invest some €100 million over the next three years in order to reduce the energy footprint of its production facilities and buildings. By investing in innovative technologies – such as energy management systems and automation systems for buildings and production processes as well as energy-efficient drive systems for manufacturing – Siemens expects to slash its energy costs by €20 million a year. These actions are on top of the continued digitalization investments that Siemens had already been making into its manufacturing

facilities in order to improve productivity and quality of our manufactured goods and reduce waste and energy use.

The three key actions Siemens will be taking in order to make these reductions, include: the use of distributed energy systems at its production facilities and office buildings to optimize energy costs. Second, it will systematically employ low-emission vehicles and eMobility concepts in its global car fleet. And third, it will move toward a clean power mix by increasingly tapping sources of energy – such as natural gas and wind power – that emit little or no CO₂.

"Cutting our carbon footprint is not only good corporate citizenship, it's also good business", said Joe Kaeser, President and CEO of **Siemens AG**.

Developing the Vision for Smart Hungary 2025

Hungary 2025
Hungary today is a country that has dramatically changed over the last 25 years. It has experienced significant growth, modernized much of its infrastructure, and invested in its people with a wealth of educational and cultural opportunities. Hungary has a positive trade balance and it is well connected through roads, rail and air networks. Its virtual connectivity is growing and it has the basics to become a software powerhouse. Hungary is ranked 12th of out 140 countries in the 2016 DHL Global Connectedness Index, that measures the relative connectivity of a country along key parameters such as trade, information, capital and people.

Hungary has been successful in building on its historic manufacturing base because it has been open to international business, it has continued to nurture and support local companies, and it has invested in its universities.

The result is that the Hungarian economy can be characterized as having a:

Highly skilled workforce – Hungary has very highly skilled workforce relative to its population. The availability of highly skilled employees is a key reason that more high-tech manufacturing has located in Hungary in recent years. Hungary could leverage these people and start to more thoroughly digitalize its infrastructure in Budapest and in other key cities.

High tech manufacturing base – Hungary is manufacturing base for many international companies due to its highly skilled workforce, location and competitive cost base. Hungary has been successful in attracting a specialization in car manufacturing. Today Győr is home Audi’s factory that employs 11,500 people and Kecskemét is home to a large Mercedes Benz factory.

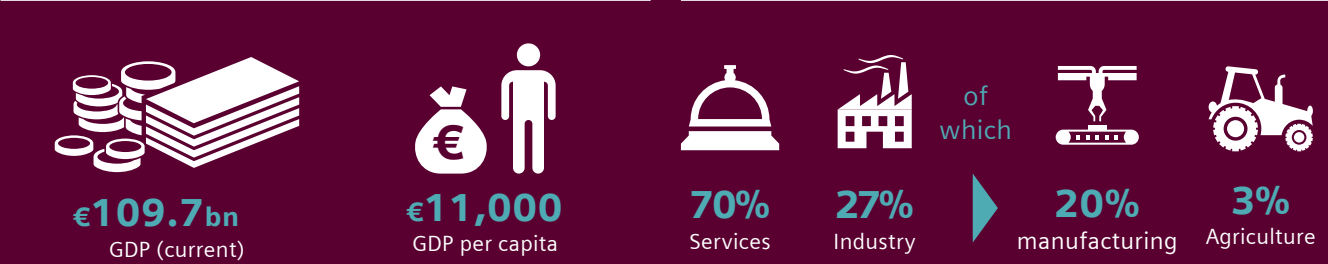


Hungary Today

Population



GDP



Origins of GDP

Employment structure



Government spending (2013)

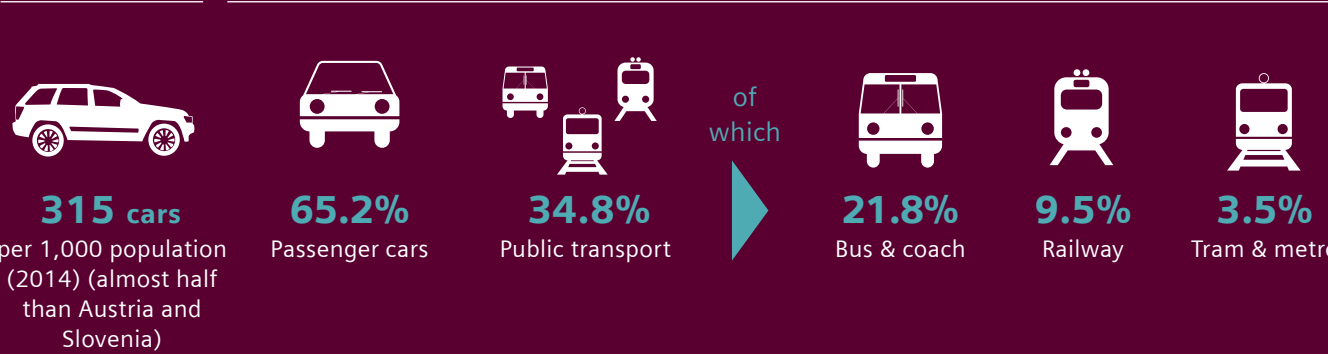
Consumption (2015)



Emissions per capita

Transport

Modal share





Key Challenges

Like all countries, Hungary is facing challenges, which are driving some aspects of national policy. Hungary must find its place in an increasingly digitalized world, maintain its manufacturing edge, improve its environmental performance and continue to deliver economic growth.

Hungary's manufacturing trade surplus is counteracted to some degree by its heavy dependence on foreign energy imports for electricity and heat. Today, nearly 74% of total energy is imported. Hungary's housing stock is comprised predominantly of high density apartment blocks, many dating from the 60s, 70s and 80s, and many city centers still retain historic buildings from the 19th century. Much of the housing stock needs upgrading and many residents in apartment blocks are still unable to regulate the heat in their homes during the winter months. There are new mobility apps sprouting up across Budapest yet inter-city connectivity remains a challenge and many of the routes connecting other Hungarian cities still require a journey into Budapest. The main infrastructure challenges affecting Hungary today include:

Energy dependency – Hungary is heavily dependent on imported energy. It imports natural gas for heat and electricity generation, and it imports additional electricity from other countries. Hungary does not have many natural energy resources or clear opportunities for renewable power through hydro or solar sources. A large proportion of its electricity is generated by nuclear power. The Government of Hungary has given permission for the construction of new nuclear generation capacity that will by and large replace existing capacity in aging plants. Thus, the new investment will not resolve the energy dependency issue.

Natural gas is very important to Hungary as it is used to create both electricity and heat for homes and businesses. Hungary does have a unique natural resource in the form of geothermal power, however, often times the heat close to the surface, even in areas with good geothermal potential, is simply not hot enough to create cost effective electricity, only heat. There are additional elements that could be included in a geothermal system to boost the quality of heat, but detailed analysis is required to determine how viable future investment in geothermal energy could be.

There is some installed on-shore wind capacity, but the market has not grown significantly. Biomass and bio fuels are the renewables with the most market share, coming from the local agricultural sector. Together they comprise about 8% of total energy demand.

Increasing per Capita GDP – Income levels in Hungary have increased significantly over the past 15 years; however, only in the region of Central Hungary have income levels exceeded the EU average. The benefit has been that Hungary remains a very price competitive manufacturing base. However, a lower tax base limits the public sector's ability to invest in the regions such as Northern Hungary that fall well below the EU average.

Research and development – developing local knowledge through targeted research and development, whether it is public or privately funded, requires a very highly-skilled workforce that is globally competitive. Transitioning a manufacturing excellence into R&D leadership will require a specialised workforce and strong links with local research universities.

Balancing growth – this vision for Hungary 2025 intends to look beyond Budapest and identify growth opportunities in other cities. Today, Budapest is home to about 1.7 million

people within its administrative boundaries and about 3.3 million in its wider metropolitan area. The population concentration in Budapest is significant. Debrecen the next largest city in Hungary by population is home to just over 200,000 people. Budapest remains the aspirational location for Hungarians despite its having one of Europe's highest population densities, and the other Hungarian cities have to work harder to retain their best natural talent.

Linking economic growth to local strengths and economic diversification – The process industries, namely food and beverage and manufacturing, are the largest contributors to Hungary's economy and are major national target sectors. A challenge for Hungary is how to continue to support manufacturing but also diversify its employment base and offer opportunities to more people. Identifying policy linkages to car manufacturers and incentivizing moving up the R&D value chain is a real opportunity.

Aging population – Hungary, like many of its European neighbours has an aging population and will experience a relative decrease in its workforce. Hungary will need to find ways to deliver key services to more people in the coming years, this is where technology could play a role in cost effective service delivery.



The Hungarian national government has set out a number of key targets coming from its National Energy and Transport Strategies as well as the S3 Innovation Strategy. The targets have an emphasis on electrifying infrastructure and transport and meeting key European Union goals for carbon emissions and increased renewable power. *Smart Hungary 2025* must leverage investment into digitalization as a way to support government in meeting these aims in a cost efficient way. A key goal of *Smart Hungary 2025* is to establish the types of projects and investments needed to make these targets a reality, through the creation of a strategy and project based roadmap. This roadmap needs to address more than just government targets as there are other key aims that come out of national policy, but do not appear to be linked to a particular target, including the need to:

- Increase energy independence
- Increase economic GDP

- Balancing economic and physical growth
- Support Hungary’s manufacturing sector

These targets are positive as they will conserve energy, embrace new technology and benefit the environment. However, these targets do not directly link to how Hungary will continue to boost quality of life for its residents, better connect its cities and balance urban growth, raise per capita GDP to European levels and provide opportunities that local Hungarian businesses can deliver.

Delivering a vision for Hungary requires building on the benefits from initial seed projects and re-investing those benefits back into those cities, compounding their value. This brochure highlights possible key projects that fall within the energy, building and transport sectors that could be build upon existing capabilities leveraged through smart technologies.

Key sectors

This brochure highlights seed projects in the key infrastructure sectors of energy, buildings and transport. New project ideas are proposed and information is provided on what increased electrification and digitalization could mean for these sectors. These ideas also need to be measured in reference to the other key objectives that are coming from a mix of government, public and private sector voices across Hungary, including a need for:

- Increased energy independence
- Improve quality of life
- Support balanced economic growth
- Support local manufacturing base.

A City Focused, Key Sector Approach to Smart Hungary



The world is digitalizing at tremendous speed. Today in Budapest there are already numerous transport Apps to help people move around the city and local manufacturers are already using some of the most sophisticated digital technologies. However, Budapest and world leading manufacturers are not representative of the national whole. Like all countries, the move towards digitalization is still in its early years and cities are often surging ahead. The European Union is calling for high speed internet access and Hungary is developing its own innovation strategy that considers national strengths and R&D foci. However, Hungary has one unique strength that is not shared by its Central European neighbors, its large number of highly-skilled software engineers. Siemens is proud that it employs 100 software engineers within its local corporate technology team, and that this team is delivering some of the company's most innovative solutions.

Smart City development is starting across Hungary through grassroots initiatives such as Smart City Budapest, Smart City Győr, and Hungary's National Innovation Offices' Smart Specialization Strategy (S3). The S3 is starting from the position of where Hungary's research and innovation is actually taking place today and using these areas as a base

for innovation growth. The following two charts taken from the S3 strategy highlight firstly which parts of the Hungarian economy are contributing most to local Gross Value Add (GVA) and where there is the most collaboration between the private sector and university research projects.

Smart Hungary 2025 is intended to build on the government's current targets and identify a range of possible actions and projects that could create more momentum and scale for building an infrastructure that is even more strategically linked to growing the local economy. There are numerous ways that infrastructure could be targeted to more efficiently strive to deliver the government's key aims and achieving improvements. Central to all scenarios should be a plan to distribute activities and benefits across Hungary and create a network of targeted activities that build on the other.

Process Industries are by a very large margin adding the most GVA and this sector is also where the most crossover appears to be happening between private industry and Hungarian higher education institutions. The S3 highlights the national priorities for smart innovation with a focus on:

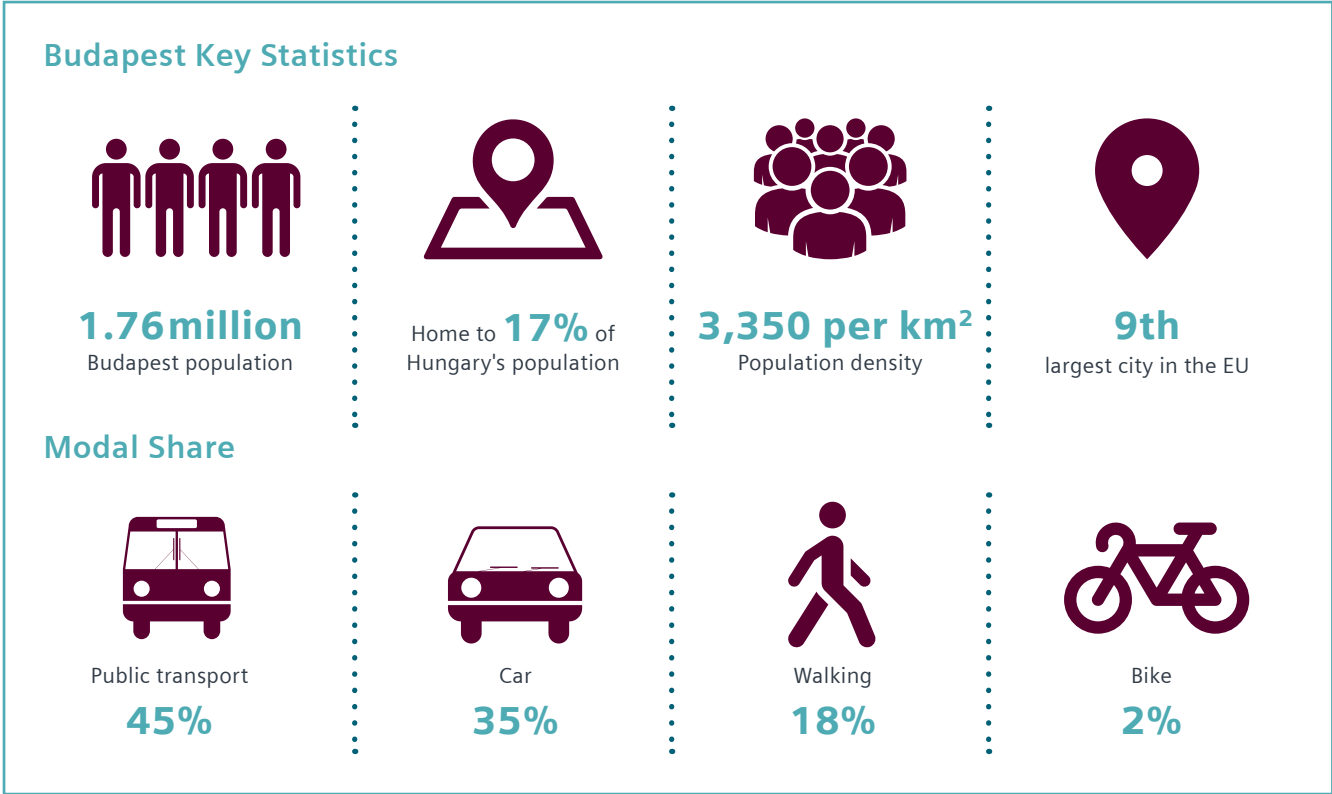
- Healthy society and well-being
- Advanced technology in the vehicle and other machine industries
- Clean and renewable energy
- Sustainable environment
- Healthy local food
- Agricultural industry
- Information and Communications Technology
- Inclusive and sustainable society

The Role of Cities

How cities have real opportunities to expand infrastructure and offer more services without significant financial investments through digitalization. Each city will likely focus on areas of its own unique interest, but there will be real benefits in integrating transport ticketing and other similar systems to allow for seamless travel across the country. The following describes some of the key statistics of Hungary's cities and offers some ideas of how these city managers may choose to use digital technologies.

Smart Hungary 2025 must engage with all Hungarian cities as the backbone of a national, digital strategy. The following cities section highlights the strengths of Hungary's other key cities and proposes some possible projects specific to those cities.

A wider approach that encompasses all of Hungary's cities and villages would include a need for creating a high-capacity digital network, upgrading of traffic management systems and raising the performance standards of buildings and incorporating more automation, particularly in commercial buildings.



The Capital City: Budapest
Budapest has the highest population density, wealth and infrastructure in Hungary. Budapest and its wider metropolitan area have a total population of nearly 3.3 million which roughly equals one third of the country's population. Budapest is the center of Hungary's road and rail network. It is also where cutting edge technology is being developed and delivered. The Central European University just opened its most high tech, fully automated campus building. The Metro Line 4 will

showcase some of the world's leading mobility technologies. Transport is generally considered to be good and air quality, with the exception of PM10 levels, are within EU limits. Budapest is attracting new residents from across the country and digitalization, particularly in transport, could offer ways to bring public transport into the new and growing areas and e-government could speed up local government procedures and offer more information to residents.





Győr



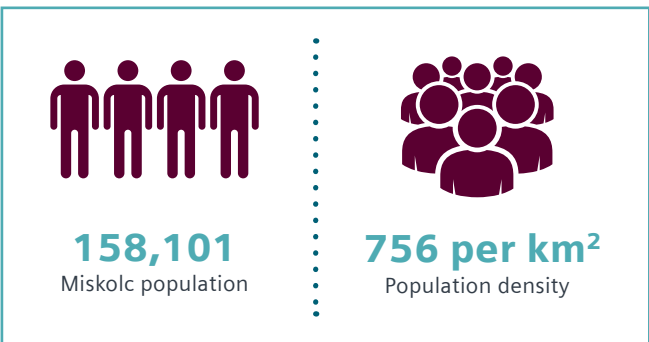
Audi has chosen Győr as the location for its engine and assembly factory. Over 90% of all Audi engines are made here, and the factory employs over 11,500 people.

Pécs



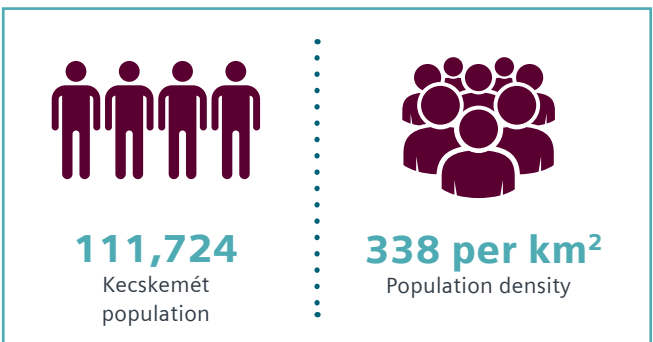
Pécs is located in the heart of Hungary’s southern agricultural region. The city is well connected to Budapest along the M6 motorway.

Miskolc



Miskolc has been the base for Hungary’s heavy industry since the 1960s. The city has experienced recent employment growth as multinational industrial companies have located manufacturing facilities here.

Kecskemét



Kecskemét has an industrial history, and today it is home to a Daimler AG's manufacturing plant. The plant was an investment of €800 million that created 3,000 jobs for the region. The city won a competitive bid for EU funding that has been invested into new trolley bus lines and pedestrianization of the historic center.

Smart Hungary 2025 - in Győr

Digitalization is already a key aspect of local production in the Audi plant, and educating local smaller producers about digital technologies could improve the local skills and small-scale manufacturing base.

Smart Hungary 2025 - in Pécs

Digital technologies such as real-time arrival and departure information could be a part of the new tram line currently being considered. The tram passenger information could be linked to the bus system and the combined result could boost local public transport ridership.

Smart Hungary 2025 - in Miskolc

Educating local industry about digitalization and supporting their efforts to learn the appropriate skills could be a real priority.

Smart Hungary 2025 - in Kecskemét

Kecskemét's small and medium sized enterprises, particularly those that engage with Daimler, could potentially benefit from understanding more about digital technologies for industry and create local digital industry expertise.



Debrecen



Debrecen is home to Hungary’s second city in terms of population. Debrecen has the second largest airport after Budapest. Debrecen is the commercial hub in Hungary’s eastern region, and it is a regional center for international companies. It is also home to 4 industrial parks with a new one under construction, one of which is owned by the university.

Local public transport consists of buses and trams. The recent completion of the M35 highway puts Budapest within a two-hour drive time.

Smart Hungary 2025 - in Debrecen

Digitalization of the local transport lines to provide real-time information and linking with university programs to build local knowledge on digitalization could be two focus areas.

Szeged



Szeged is Hungary’s third largest city, and it is home to its most distinguished university. The number of its academic research and teaching staff reaches 2,300 with up to 25,000 students. Szeged is also the center of Hungary’s food industry. Public transport is extensive with 42 bus lines, 4 tram lines and 5 trolley bus lines.

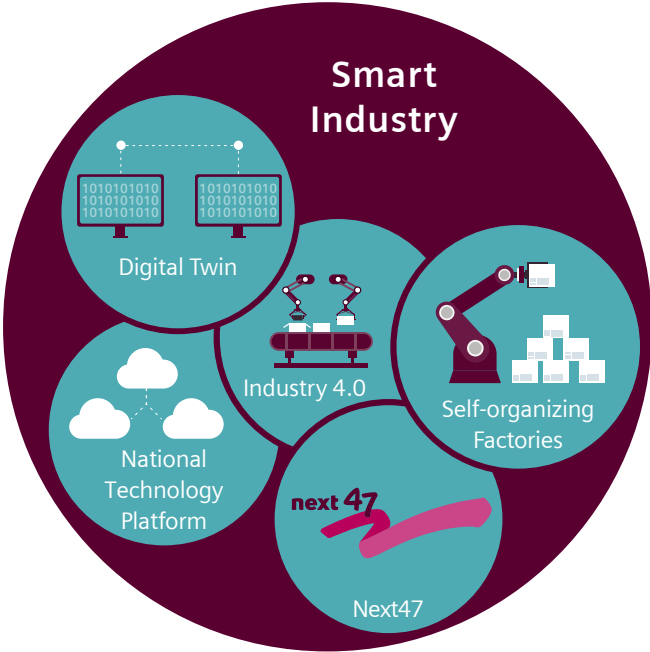
Smart Hungary 2025 - in Szeged

Investment into the digitalization of Food and Beverage industries is a national priority, and there could be a local initiative to support digital technologies in this sector in Szeged.

Szeged could be another good location for providing real time arrival and departure and connection information for the local transport network. Students could also create a local energy and digital grid demonstration project.



Smart Industry



Hungary is one of Europe's major production locations, and the manufacturing industry is integral to Hungary's continued economic growth. Digitalization is transforming industry, so much so that there is a term for this new, 4th industrial revolution of smart/digital factories, Industry 4.0.

To draw on all the benefits of digitalization, businesses must first achieve an end-to-end integration of their data. This requires the integration of industrial software and automation, the expansion of communications networks, security in the area of automation and the use of business-specific industrial services. Companies that have completely digitally integrated their business processes and those of their suppliers can generate a digital representation of their entire value chain.

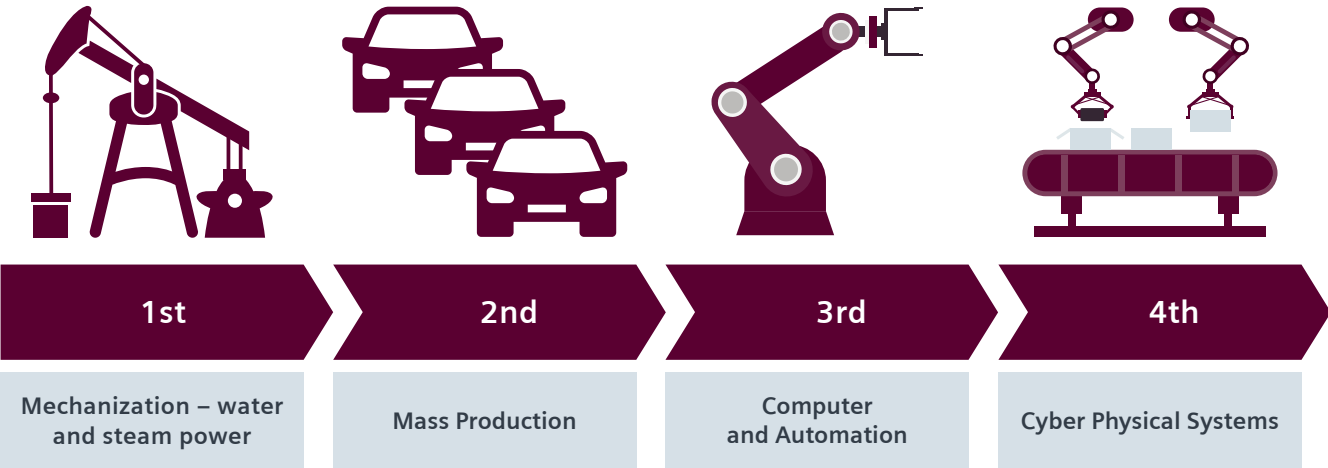
Digitalization in industry is about:

- **Reducing time-to-market**
Due to faster-changing consumer demands, manufacturers have to launch products faster despite rising product complexity. The primacy of the large enterprise might be eroded by faster, more flexible competitors.

- **Enhancing flexibility**
Consumers want individualized products at the prices they pay for mass-produced goods. As a consequence production has to be more flexible than ever before.
- **Improving quality**
Consumers reward high quality by recommending products on the Internet – and they punish poor quality the same way. To ensure high product quality and to fulfill legal requirements, companies have to install closed-loop quality processes, and products have to be traceable.
- **Increasing energy efficiency**
Today, it is not only the product that needs to be sustainable and environmentally friendly – energy-efficiency in manufacturing and production becomes a competitive advantage, too.
- **Ensuring security**
Another general requirement is security. Digitalization also leads to increasing vulnerability of production plants to cyber attacks – and this increases the need for appropriate security measures.

In digital manufacturing, software solutions exist to address the four key areas including: creating a central data platform for digitally supporting the entire value chain for discrete manufacturing; intelligent networks for industrial communication as a basis for simple data exchange within

the different production modules and for collecting operational data; and, due to the growing number of networked systems, effective solutions to protect digital factories against security threats.





Digitalization is critical across the value chain in industry and includes:

Design and engineering – accelerated time to market

- Digital Twins and Simulation – new products and production processes are designed, simulated and optimized virtually before being built.

Production and operation – efficiency and resilience

- Networked systems, Digital Factories – at a digital factory products will tell machines their next production steps resulting in the lowest possible defect rate.
- Self learning software – complex systems can learn to become more efficient through data analysis, high performance computing and advanced intelligent algorithms.

Maintenance and service – reduced downtimes through predictive and prescriptive measures

- Monitoring and checking of systems globally via a secure connection.

The digitalization of the manufacturing industry is a topic of global interest – these are some of the ways that industry will operate in the future.

Data-Driven Manufacturing

Machines, systems, and sensors worldwide will communicate with each other and share information. This will not only enable companies to make production significantly more efficient, it will give them greater flexibility when it comes to tailoring production to meet market requirements.

Virtual Production

Product Lifecycle Management (PLM) is used to virtually develop and extensively test products before even a single screw is turned in real life. With this technology, products can reach the market as much as 50 percent faster, with at least the same level of quality achieved without PLM. This is possible thanks to simulation with a digital twin – a virtual image of the product into which different designs of its individual components can be inserted and tested along the entire development chain. This approach was used to simulate the landing of the Mars Curiosity Rover in 2012. The landing was tested 8,000 times using Siemens PLM software.

Pilkington, United Kingdom

The Siemens and Pilkington engineering teams carried out a series of in depth energy audits and due diligence across the company's UK-wide manufacturing sites. Ten energy management projects were identified with works including the installation of new drive technologies and automation controls at a Scottish production site, new pump system upgrades and a major program to install an intelligent lighting solution at one of the company's prime warehousing locations.

Using an innovative tailored investment funding package and sharing the risk, the strategic partnership with Siemens allowed Pilkington to achieve the savings without having to tap into existing cash reserves, impair day-to-day cash flow health or even resort to traditional bank funding. The holistic approach looking across the manufacturing facility is set to reduce energy costs and save Pilkington £1m over three years.

Self-organizing Factories

Information technology, telecommunications, and manufacturing are merging, as the means of production become increasingly autonomous. Yet it is impossible to say exactly what smart factories will look like in the course of time. One possible scenario: In the factory of the future, the machines will organize themselves to a great extent, delivery chains will automatically assemble themselves, and orders will transform directly into production information and flow into the production process. Nonetheless people will remain essential in an Industry 4.0 world – as the creative leaders and thinkers who will use their intelligence to conceive of all the processes and procedures, in advance and who will write software to convey that information to machines.

Full automation

Siemens' plant for industrial controls in the Bavarian city of Amberg is already considered to be the company's most state-of-the-art plant worldwide. There, products and machines communicate with each other, enabling the products themselves to control their production. One result is that in the same amount of production space, and with a workforce that has changed only slightly in number, the plant has increased its production volume eightfold in the past 20 years. Humans and machines are eight times more productive today than 20 years ago.

The solutions for digitalizing the processes upstream and downstream of machines and making them more flexible are already very tangible, especially for parts and materials handling. The networking of machines with each other and with higher-level systems is also making great progress. For instance, resources and production data can be managed centrally. A great benefit here is the ability to connect life cycle management and manufacturing execution systems for even greater productivity. This ensures cost benefits in procurement and operation. Order data are thus available throughout the entire company, and it is possible to identify optimum production strategies for allocating orders to the various production sites in the organization. Moreover, material stocks, logistics processes, and tool availability can be seen at a glance

and efficiently coordinated.

While the simple “plug-and-produce” addition of machines to a line, analogous to the USB connection of external devices to a computer, is still a long way off in the manufacturing environment, it is one important goal for development in the areas of automation and industrial communication. Machines should then be able to identify themselves and connect to the network, making the required modification of lines faster and more efficient.

Smart Manufacturing in Hungary 2025

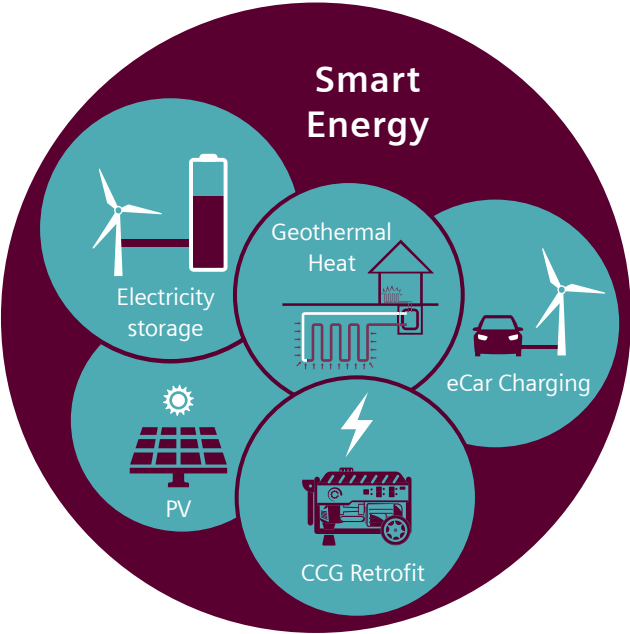
Smart Hungary 2025 is about bringing digitalization into new areas and parts of Hungary. Both the National Technology Platform and the IRINI Plan target digitalizing and upgrading all segments of Hungarian industry. This means delivering initiatives to support small and medium enterprises across all industrial sectors.

The output of manufacturing and the cost per unit are still the driving determinants of a successful enterprise. But governments and cities are also looking at the levels of energy going into the per unit production levels and the emissions coming out.

There are many upgrades that can happen within a manufacturing plants that are not digital, but are smart from a cost-benefit and environmental air quality perspective. Motors, drives and frequency controllers can be upgraded to improve energy efficiency and plant operations. Across the spectrum of industry there are numerous opportunities to keep production facilities competitive and efficient, three possible actions that could arise from *Smart Hungary 2025* including:

- Demonstration projects at selected small and medium sized companies
- Digital skills training (focus on manufacturing)
- Large-scale energy efficiency retrofit programs

Smart Energy



Energy is transitioning globally, as renewables play a growing role and more energy is generated through decentralized systems, with an increasing proportion of electricity coming from renewables. Today, more of our demand for energy is being met through electrifying, and the ways in which we generate, distribute and even sell electricity is changing fast. Digitalization is part of that change. It is changing how and where we generate power and technology and policy trends are driving the growth of local distributed energy networks and self-healing grids. The traditional centralized model of linear power generation and delivery through limited market or monopoly conditions is giving way to a more diverse, dynamic and complex system with multiple actors and multilayered energy, information and financial flows.

In recent years, electricity per capita use across most of Europe has decreased. However, as Hungarians opt for cleaner cars in the future and eCars become the norm, combined with even a small proportion of homes shifting from gas-fired heat to electric heat; than electricity demand will increase.

Today, Hungary uses about 1,000 PJ of total energy, 74% of which is imported. This includes petrol for vehicles and natural gas for heat and electricity generation. In terms of electricity, only 40% is imported.

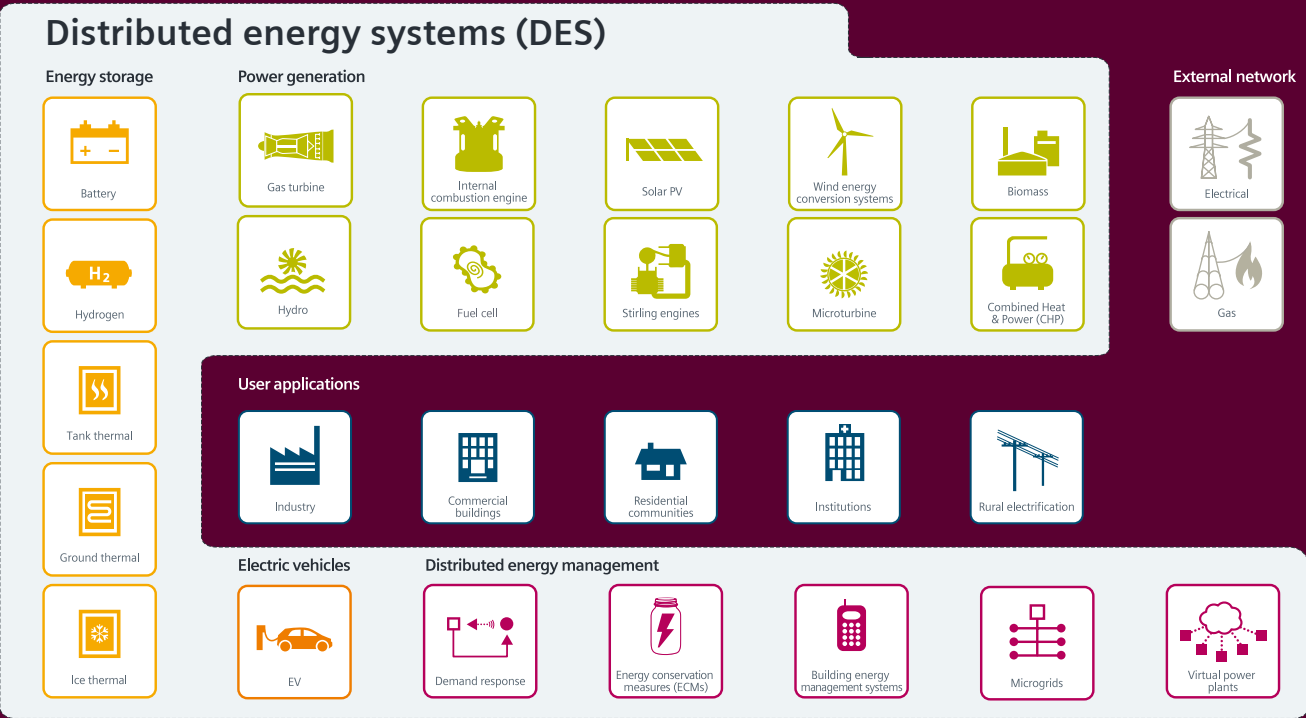
Even with the new nuclear power stations Hungary will require additional electricity generation to meet its future needs. Achieving energy independence will necessitate new projects and ideas. This is particularly important if Hungary plans to

meet the EU renewable and national heat target through local renewable generation.

Energy independence requires that all power generation sources must become more efficient. Digitalization will play a key role in making this happen. Making the most of energy production will require that the local grid be able to flexibly manage bidirectional power flow and intermittency. The entire system and all its operations must be kept absolutely safe and secure at all times. At the same time, new capacities need to be added, existing equipment updated, and grid operation optimized to make the entire infrastructure fit for the future. The integration of renewable energy into existing grids poses new challenges due to the increasing distances between power generation and consumption, the need for more cost-efficient in-feed of power from renewable sources, and fluctuating demand. Digitalizing Hungary's national grid is therefore essential.

Distributed Energy Systems

Distributed Energy Systems (DES) is a term which encompasses a diverse array of generation, storage and energy monitoring and control technologies. The concept is that electricity and heat can be generated and managed within a smaller system, similar to a microgrid, and limit the number of local grid connections. DES can be tailored to very specific requirements and users may be using DES to target a number of issues including cost reductions, energy efficiency, security of supply and carbon reduction.



Distributed energy systems

DES categories include: power generation, combined heat and power, energy storage and distributed energy management systems. DES covers energy in the forms of electricity, heating and cooling. The diagram above illustrates the varied use cases, types of generation and storage that can be part of a DES network.

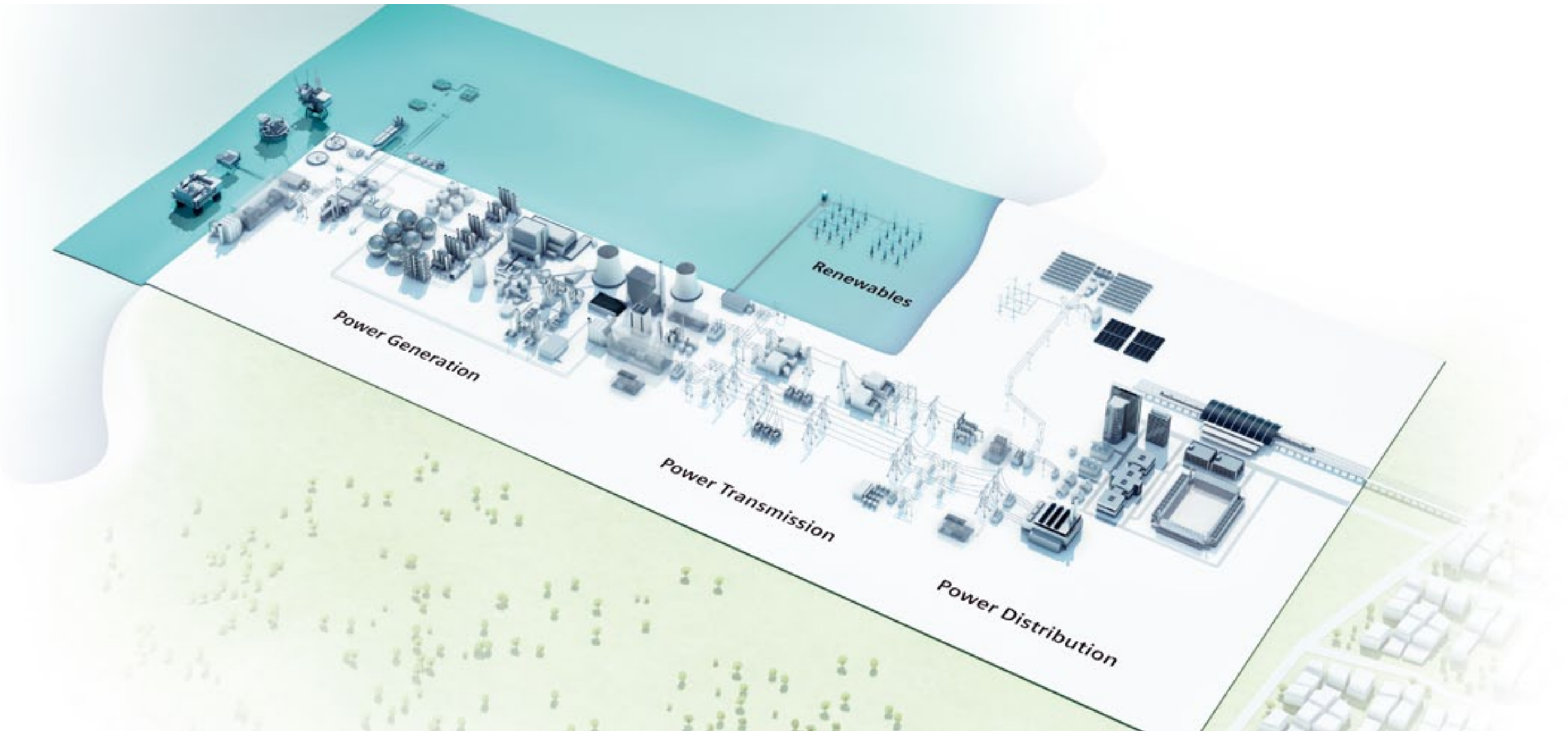
An optimized balance of generation and demand (e.g. demand response, microgrids, virtual power plants) helps reduce the overall consumption of electricity by directly regulating devices or influencing consumer behavior by offering special tariffs. As a consequence, the need for costly peaker plants is also reduced. Decentralized, interconnected generators allow for more control and precise planning of supply. Smart information technologies and the smart use of economic mechanisms lower operating costs, ensure reliability and help establish predictability. The types of technologies that make it possible to balance the electricity load within the DES system include: virtual power plant and demand response technologies as well as building energy management systems.

DES solutions could be applied to manufacturing facilities, office buildings, urban residential districts and rural communities across the globe. The numbers speak for themselves. Operational cost reductions ranging between 8% and 28% and a return on investment (ROI) between 3-7 years compared to a business as usual as usual are possible. CO₂ emissions can also be reduced at similar scales.

Smart and Self-Healing Grids

Until just a few years ago, electric power grids were organized in a strict hierarchy. But today they've become decentralized systems. Photovoltaic installations and other renewable energy sources feed electricity into the grid on an unregulated, fluctuating basis, at voltage levels that used to apply only to consumers, not generators. In a worst-case scenario, that can make a grid unstable. The challenge is to be able to retain power quality and flow across the grid while integrating renewable, distributed generation systems and traction power networks when electric rail systems are part of the local energy demand mix.

Smart grids can further reduce transmission losses and they can significantly reduce electricity through better identification of electricity flow and usage. A smart grid's ability to shift electricity flow away from hotspots is essential in its ability to prevent a fault from ever happening. However, extreme weather and other events could mean that even in a well balanced grid a fault could occur. When faults do occur then remote monitoring and control of substations can enable a fast recovery, but automated failure isolation and service restoration means that faults would be corrected through an automated system, this additional technological step is what turns a smart grid into a self-healing grid.



Remote monitoring and control of substations

Remote-control technology enables faults and failures to be detected and located more quickly. It is possible to remotely isolate faults and failures from the control center and also to manage the restoration of service. Through remote monitoring and control, the control center can field-deploy maintenance personnel directly to the grid segment affected. All of this reduces grid operating costs and protects grid operators from incurring blackout penalties.

This requires remote-control equipment with communication connections (RTUs) and smart grid condition monitoring devices. Working together, they monitor the actual state of the grid by measuring key electrical indicators such as voltage, current, and frequency. They reliably detect electrical faults in grounded, insulated, or compensated distribution

grids and send fault and failure information to local or central control centers. The control centers, in turn, transmit appropriate commands to the RTUs and switch the primary operating equipment – such as load-disconnect switches in substations at the secondary distribution grid level – accordingly.

Grid faults and failures always pose major challenges for control center personnel. In these situations a broad number of tasks have to be performed simultaneously in order to rapidly restore power to the failure-free segments of the grid. To do this, personnel need to collect and analyze all necessary information, define and initiate appropriate countermeasures, isolate the fault or failure, restore service, inform and coordinate operating personnel and, once repairs have been completed, restore normal grid operation.

Self-healing grid solutions automatically perform the necessary switching, isolate the fault or failure, and then independently restore power, thus enabling staff to focus on the necessary repairs and coordinate the work. These solutions also make it possible to restore power to critical consumers such as industrial installations and computer data centers in less than one minute.

Smart Distribution Transformer

A critical component within a smart grid is the distribution transformer and these need to adjust independently and cooperatively in order to smooth out voltage fluctuations within their local areas. However for that they need their own intelligence and communication capability – in other words, they need to be “smart” and networked.

The smart distribution transformer is already being used in practice for voltage regulation in the low-voltage grid, and is thus a key part of a future system known as an Intelligent Secondary Substation Node (ISSN). With its computing power and optional communication connection, the ISSN will provide the possibility for far more than supplying households with the right voltage. It will enable the power grid to cope with additional feed-ins or loads with no need for massive infrastructure expansions.

But a distribution transformer needs other components in the electric network – meters, building distribution systems, photovoltaic systems, electric cars. These must also be equipped with sensors, local intelligence, and the ability to communicate.



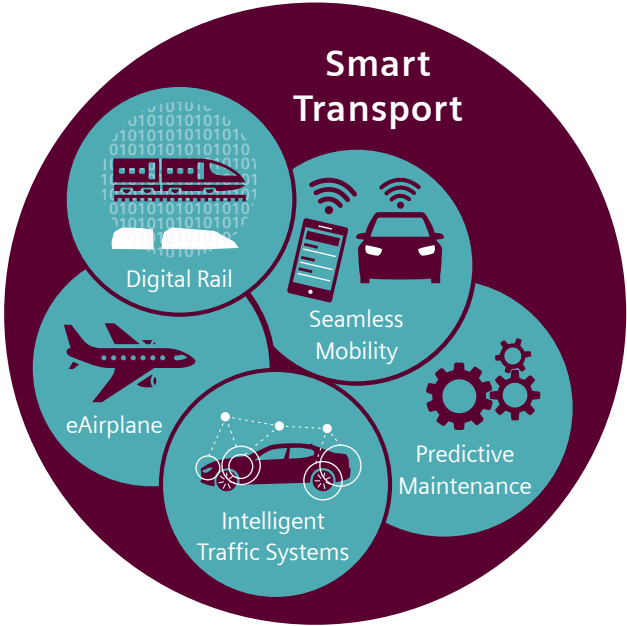
Smart Energy in Hungary 2025

Smart Energy in Hungary 2025 will mean leveraging the benefits of grid improvement and planning for and delivering distributed energy systems. However, Hungary needs to fill a generation capacity gap that cannot be overcome through ‘smart’ software, there will be a need to invest in generation technologies. However, the scale and costs of these investments could be moderated through the use of smarter grid controls, more efficient generation technologies such as combined cycle gas turbines, increased use of local geo-thermal power for heat, and energy reduction measures across the board in buildings, industry and transport.

- Geothermal Heat – Geothermal heat has real commercial potential in Hungary.**
In Hungary today, the Böny Heat Distribution Center is using geothermal power to commercially heat 24,266 households, 1,046 other users and provides 60% of the total heat needed by the local Audi car production factory. The geothermal plant produces 52MW of heat (1,100 – 1,200 terajoules) and can heat water to 100°C - 105°C. → Cost – HUF 10.2 billion.
- Electricity storage –** Central to creating a distributed energy system or a smart grid is the ability to store electricity. Energy and electricity storage in particular is advancing quickly and batteries are able to store electricity for ever longer periods of time. Grid level

- battery storage can enable grid companies to better maintain the electricity quality across the grid and at the building level battery technologies paired with the day making a positive PV rooftop cells are enabling building operators to economically generate renewable electricity that can be stored and used when needed.
- Commercial Solar Farms –** Solar energy is starting to be used at scale, within Hungary today, and significant increases in solar PV electricity generation is expected within the next 5 years. At the Mátra Power Plant, solar generation has been paired with the coal fired-station, where hardened coal waste has been formed into a large soil covered hill crowned with PV cells with the capacity to generate 16 MW of electricity.
- eCar Charging –** Delivering eCar charging stations across Hungary is central to meeting the government’s aim of having 50,000 eCars on Hungarian roads by 2020. Delivering the charging network across all Hungarian cities is critical for creating confidence in the technologies. Siemens’ Center of Competence for Energy Management in Italy focuses on delivering Backend IT software.
- Combined Cycle Gas (CCG) Turbine Retrofit –** The efficiency of existing natural gas electricity production plants in Hungary can be significantly improved through upgrades to CCG turbines that utilize waste heat and generate additional electricity. Efficiency improvements of 40% are possible.

Smart Transport



Digitalization is changing how we move around our cities, and our expectations of transport services – private and public. Digitalization is creating apps that are telling us how to find our way across our cities, and it is reducing the costs of running transport services and increasing the availability of public and private services. New transport apps are changing how we connect the first and last mile of travel and they are blurring the line between public and private transport services. These are the obvious changes that most of us see every day, but digitalization is having a massive impact on how public transport operators maintain their fleets, improve traffic flow across our cities, charge us for the privilege to park our cars and prioritize emergency vehicles at key intersections. Digitalization is reshaping how, where and when we move around and between our cities.

Digital or intelligent transport means having the ability to maximize the full capacity of all modes of existing transport, and cost efficiently bring services to new areas, improve services in existing areas, and increase the comfort and safety of every journey. Transport as a sector is quickly moving through the three technological phases, electrification, automation and digitalization, as rail, bus and now cars are being electrified, our metros are becoming driverless, and our ticket purchasing and parking payments are becoming digital. Some of the key benefits of digitalization include:

- 30% increase in rail capacity – digitalization in signaling allows shorter distances between trains and an increase in

potential capacity on an existing rail line

- 20 % improved road traffic flow
- Better use of all transport offerings, integrated travel and information apps
- Reduce operational costs
- Improved user experience

Digitalization is impacting all aspects of transport and these are some of the ways that digitalization is reshaping our rail system, our roads, and our transport choices and ease of travel.

Digital Rail

Digitalization in the rail sector is intended to boost reliability, availability, and efficiency across the network – by means of predictive maintenance, optimization of existing vehicles, and efficient operation. Vehicles, components, and sensors across rail lines – all supply data that can be used to monitor the status of trains, identify when maintenance will be required. Here are some of the key ways that digitalization is improving rail transport:

- Digitalization of signaling in metro systems means that distances between trains can be reduced so more trains can be on the track at the same time, which results in more overall capacity and reduced time between services.
- Automatic train operation systems – operate systems at optimum efficiency levels.

- Passenger information systems inform riders on arrival and departure times, key interchanges, and delays.
- Smart monitoring – aims to lower maintenance costs and improve availability of vehicles.
- Predictive maintenance – Digital connectivity makes it possible to anticipate errors before they occur and boost performance and reduce the time it takes for maintenance.
- Crowd management – sensors can monitor the density of passengers and send passengers to areas where the train is less busy.
- Improved asset management – using mobility platforms, such as Railigent, rail operators have the information at hand to improve availability, reduce operational costs and prescribe when maintenance is required. It makes it possible for operators to arrange maintenance to suit operational targets – not when circumstances demand it.

Velaro RUS – Value of Predictive Maintenance

Siemens has a contract to deliver 99% availability and reliability on 16 trains through its predictive maintenance technology. Trend analyses and the evaluation and linking of data (data mining) are used to detect fault sources at an early stage, and all maintenance activities are planned, carried out and monitored with the Computerized Maintenance Management System (CMMS).

Digital Rail Maintenance – Hungary with the support of the European Union has invested into upgrades of the Hungarian rail system, including electrification, digital signalling, carriages and track. The key to sustaining the benefits of these investments will be in maintaining the upgraded systems and ensuring that there are people trained to do the maintenance. Digitalization and predictive maintenance will improve the productivity of any maintenance team and would likely result in far fewer trains being taken offline for repair and improve overall availability.

Freight Rail

Optimized operation planning – with up to 20% fewer delays

Digital freight diagnostic systems analyze data points from the operation control systems, interlockings and point machines. Data is used to detect delays and the track segments potentially causing the service reductions and the system can propose countermeasures to fix the root causes and improve performance.

Digital Roads

Digitalization is happening across our road networks. It is happening in traffic signals that base times on real traffic density, emergency vehicles can move faster through intersections, it is street lighting that senses movement and can even tell us if there is available parking nearby, and it is cameras that can monitor the license numbers and types of vehicles



entering our cities and charge them if they are entering a special charged for use zone.

Congestion is a common problem across cities and many cities are utilizing digital technology to try and speed traffic and reduce travel times. However, improving traffic flow can also have the negative consequence of simply creating more journeys, so digitalization also plays a role in reducing these other journeys by shifting them to public or shared transport.

City traffic today is often designed primarily to serve motorists, however, digital technology is also making it possible to provide more road transport choices by promoting cycles through special ‘Green Wave’ apps or to make it simple to rent a bike through city shared cycle schemes.

Digital car GPS systems are making it ever easier for us as drivers to navigate roads and find our destinations and to guide freight vehicles and manage when they arrive at busy airport or port hubs.

Smart traffic signals

Managing traffic flow starts with the individual traffic signal and builds up to a network encompassing numerous intersections across a city. As these signals become smarter and work together, they can improve traffic flow. Traffic management centers use digital, real time data, to adjust timings or to allow special vehicles to pass through cities faster in times of emergency. On specified routes, timings can be linked to the presence of public transport vehicles or other vehicles that the city wishes to promote such as cyclists. Across a city, an emergency vehicle will need faster access through busy intersections, as these routes are not planned, and only the most digitalized of systems combined with a traffic management center can ensure a fast journey.

- **Intelligent traffic signals and systems** – LED based signals with digital applications are networked across a

city and create the foundation for applying layers of smart technologies. Depending on a city’s needs, the systems can be upgraded to incorporate different timing patterns, modify wait times depending upon the actual density of traffic and prioritize different vehicles such as public buses or specific users like cyclists.

STREAM stands for “Simple Tracking Real-time Application Management”, and STREAM benefits from satellite navigation technology and works without extensive and costly roadside installations. In a STREAM system, every bus may carry an on-board unit (OBU), and the OBU uses GPS to determine the vehicle’s exact position, and GPRS to transmit the positioning data and its passage by one of the pre-defined registration points, to the traffic control center. The control center is then able to automatically switch the traffic lights on the bus route to green as the bus approaches.

- **Traffic detectors** – The quality of almost all traffic systems depends on the detector, as the control systems can only work reliably if the traffic data provided is reliable. The more effective this information is, the better the centers are able to reduce traffic jams, travel times, fuel consumption and emissions. Possible applications include:
 - Intersection control
 - Recognition of traffic jams and disruptions
 - Traffic data collection
 - Selection of signal program
 - Travel time measurement
 - Strategic control

Road pricing and congestion charging

Digitalization has made it possible to deploy road pricing or congestion charging infrastructure across cities without slowing traffic flow. These systems are intended to limit the

number of individual car journeys, improve the speed of public transport and incentivize a shift of journeys to public transport. In the cases where people still choose to drive then they will pay the congestion charge. In the most successful cases of road pricing, revenues are fed back into public transport to fund future improvements. Digitalization means that pricing can be dynamic and users pay for the incremental or relative value, for example a tolled road where a car can move significantly faster than the free road may be charged at a higher price than when the free lane is also flowing quickly.

Smart Parking

Cars searching for parking spaces or those that are parked illegally can significantly slow traffic flows in busy areas, and smart parking can have a positive effect in these congested areas. Smart parking systems can include technology that guides drivers to areas with available parking, pay for parking through their smart phones and top-up the length of their parking stay without returning to the car. Smart parking systems also reduce the amount of street furniture such as parking meters or parking signs that can clutter street side areas.

Transport Choices and Ease of Mobility

Digitalization is creating new forms of transport, such as on-demand services and car sharing and it is making our public transport journey simpler and faster. Digitalization is creating seamless mobility across multiple transport types, it is making it possible to pay for transport without ever having to purchase a ticket or top-up a smart card, and it is creating the opportunity for vehicle platooning, the likely pre-cursor of autonomous vehicles.

Seamless Mobility

Traveling through cities with a number of transport options can be complex and to gauge the faster option. In these cases a traveler may need to use three different types of transport modes in order to reach their destination, and the

timing of each interchange and the ability to find the journey with the shortest wait times is important and different options may also impact the price of a journey.

Cities need to ensure that with transport apps, there is an equally transparent pricing system. Digitalization is impacting how users pay for their travel, and eTicketing and electronic payment systems are an increasingly important aspect of city infrastructure. Budapest has initiated eTicketing, and this type of service is needed across the country.

- **eTicketing** – electronic ticketing, smartcard systems, that use either a contactless debit/credit card or a card dedicated to a particular transport system. These systems debit the exact cost of your journey based upon where and when you entered and left the transport system. In some cases, your route across the city will be monitored through additional contact points to prove whether the user travelled via the central area or across the city on a more peripheral path as the actual journey taken could affect the overall journey cost.
- **Integrated Transport Apps** – a journey planner application that provides information on the fastest way to reach a particular destination using local transport services and displays expected arrival and departure times. In 2014, BKK launched its FUTÁR app, and in 2016 it had more than 275,000 daily users. BKK has incorporated 1597 buses, 551 trams and 141 trolley buses (2014), as well as MOL Bubi bicycle rental stations into the app.
- **Integrated Journey Planner with Automatic Payment** – Siemens’ SiMobility is taking seamless travel another step further by combining an eTicketing system with a journey planner that will allow users to truly seamlessly move from different transport modes and all payments will happen automatically via the user’s smartphone.

In order to incentivize the private sector to create apps or for the city to be able to manage an integrated transport



app, the municipal transport agencies need to first provide a platform that enables the integration of the mobility services of various providers into a single-source portfolio for the user. The platform provides system interfaces for transport operators and mobility service providers as well as integrated processes such as real-time passenger information, multimodal journey planning, booking, ticket purchase and payment – across various transport modes. The means of transport covered can include not only public transport (railways, ferries, cable cars, etc.) but also private transport services such as car sharing, bike sharing and taxis.

Hands-free ticketing with automatic fare calculation

The future of eTicketing is ticketing through your smartphone with automatic payments being made based upon sensor detection of your actual route. This technology means that there is no need to purchase a ticket, no hassle with vending machines, no gates, no need to top-up, no check-in and no additional charges or duplication of charges.

JustGo is "Be-in/Be-out" (BiBo) ticketing. A smartphone with the BiBo app detects installed Bluetooth, low-energy, transmitters (beacons) and sends the data to the backend for processing the route taken. Billing takes place on the basis of the route actually traveled, and the cheapest fare would be automatically applied.

Vehicle choice and platooning apps

Digitalization is making it possible for new types of transport services to be created. On-demand taxis and public transport services are digital services as well as the creation of convenient car sharing programs. Provision of

information about best routes and now the Green Wave across city traffic signals is attracting more cyclists. Digitalization is creating more choices in transport.

Cycling Green Wave

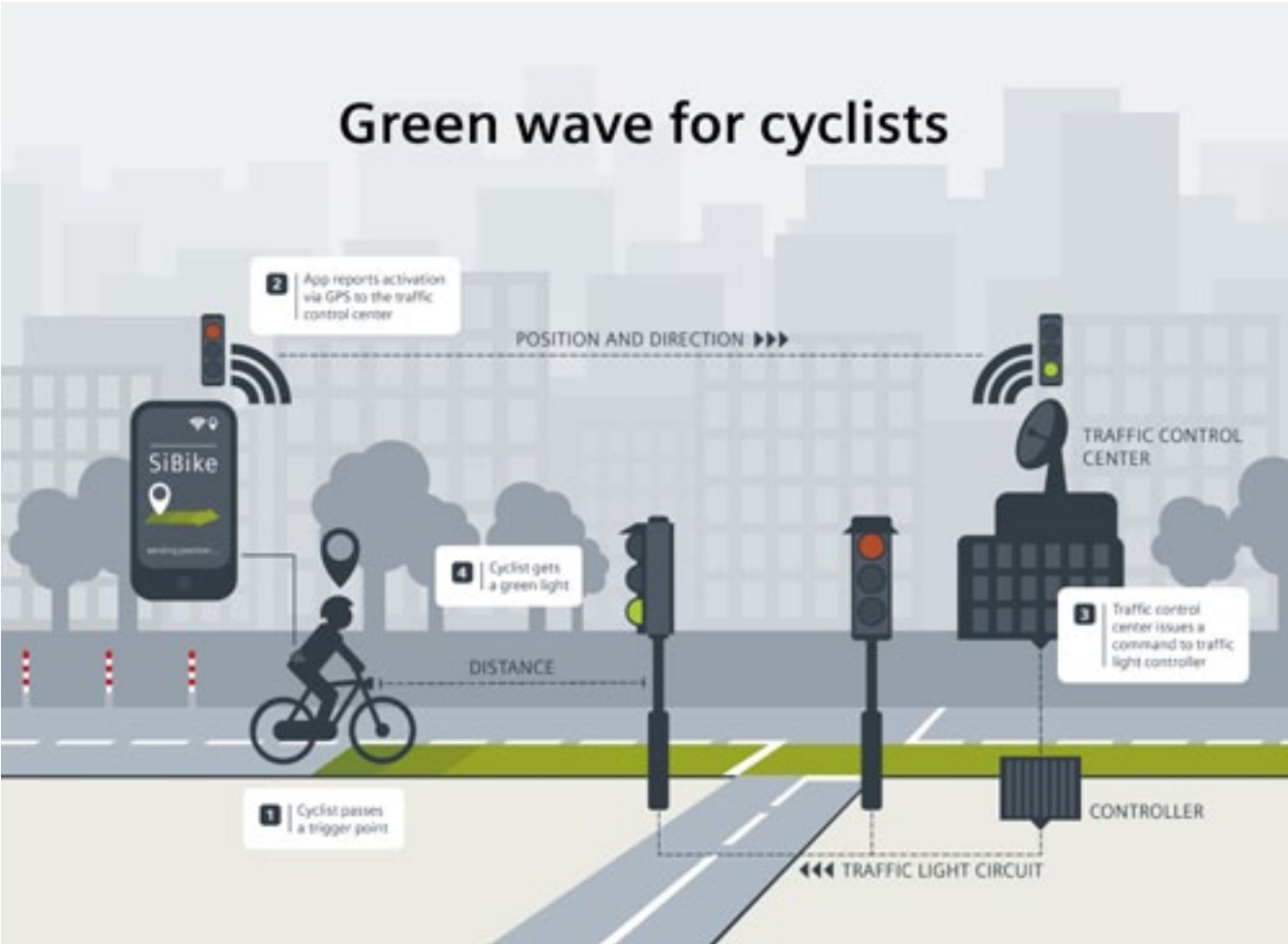
There are smartphone apps that are making city roads more bike friendly. Cyclists can use these apps to trigger a wave of green traffic lights. The cyclist's smartphone determines his or her position and speed via GPS. If the bike passes a specific, virtual trigger point near a traffic light at a predetermined speed, the app reports this to a traffic control center. The traffic light is then set to green or the green phase is extended to ensure that the cyclist can pass. The underlying traffic system is simple to implement and requires no additional hardware. All that changes is how the traffic lights are programmed.

Cycling Platooning

Some of the Green Wave app services that prioritize cyclists only do so if there is a quorum of cyclists. A large number of cyclists on a road can slow cars and bunching the cyclists together and providing them with a shared green wave, makes traffic move faster for all users.

Car Platooning Technologies

The pre-cursor to autonomous vehicles may be the platooning technologies that are currently being tested. These technologies allow for one car to lead a group of vehicles that follow the lead vehicle. These vehicles communicate between each other and are able to move with a relatively short following distance. This means, not only autonomous vehicles in the future platooning apps, but could also be a way to avoid the congestion that new, autonomous journeys could create.





Here are some examples of these types of services:

Electrification of cars in Hungary

Recent trends have shown a reduction in per capita energy use, however, electrification of transport will increase demand. Siemens has estimated that meeting the government’s targets for 50,000 eCars by 2020, would increase electricity demand by 32% and require around 16,000 charging stations.

Incentivizing eCar take-up would require the roll-out of a national charging point delivery program and would require:

- Roll-out of a national charging point program that ensures that electricity charging stations are available across the country.
- Ensuring that electricity is competitively priced and stable.
- Grid and substation improvements – The grid company must develop an assessment of the additional demand eCars could place onto the local grid. There may be a

requirement to incorporate smarter elements into the grid to better manage local demand if multiple chargers are installed with the aim of using eCars at a scale for a portion of future electricity storage.

- Increase local and renewable generation – Electrification of vehicles lends itself to smaller scale electricity generation, particularly renewables if the full benefits of eCars are to be realized. There could be opportunities for small scale solar or wind in each of Hungary’s key cities.
- City Car Fleets – For the market to grow, there needs to be a first mover who proves to everyone that it is possible to have an eVehicle, power it and, most importantly, not to be let down by a lack of charging points. Cities can start by mandating that all city-owned cars and buses are to be electric.

Smart Transport in Hungary 2025

Digital transport technologies are already a part of the Hungarian transport network, but they are focused on Budapest and need to be expanded across the country. Transport in Hungary is being electrified and there are government targets to have 9% of all rail and road transport electrified as well as to bring 50,000 eCars into circulation.

Hungary’s targeting of electrification is a key first step towards deeper digitalization across the traffic sector. Budapest has also been a leader in promoting eBuses and has already delivered smart traffic systems. These systems can be built upon to prioritize types of traffic and improve flows. Hungary’s aim to promote eBuses for both boosting local industrial growth and improved environmental impact is a significant step towards cleaner transport. Siemens, through its City Performance Tool, has been able to estimate the air quality impacts of eBuses versus diesel and Compressed Natural Gas CNG buses in other European cities. The results, highlight that there are indeed carbon emissions

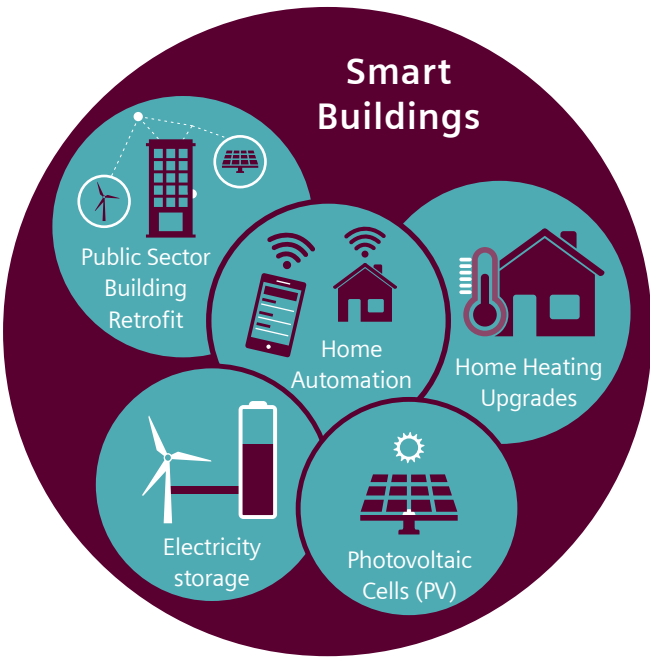
reductions, but that the truly compelling story for a city comes from the very significant reductions in harmful NOx and PM10 emissions.

eBus – eBuses are being tested in Hungary and with overhead charging in stations, they could be rolled out across all cities without additional overhead lines. eBuses will improve air quality, which is a health risk in some of Hungary’s manufacturing hub cities.

eCar Charging – Delivering eCar charging stations across Hungary is central to meeting the government’s aim of having 50,000 eCars on Hungarian roads by 2020. Delivering the charging network across all Hungarian cities is critical for creating confidence in the technologies.

Intelligent Traffic System – Upgrade the existing system in Budapest and create a system in other cities that times signals based on actual traffic densities, prioritizes public transport, and allows for the faster travel of emergency vehicles.

Smart Buildings



Buildings are the major components of smart or digital cities where most of our energy is consumed and account for about 75% of a typical European City's carbon emissions. The ability of smart grids and smart buildings to communicate is a major factor in being able to balance supply and demand of electricity or energy at the very local levels. The digitalization process will start with buildings that can learn occupants' energy needs, integrate vehicle charging batteries into their energy forecasts, respond to changing weather conditions, and automatically alter their behavior to maximize their efficiency. The world's most advanced buildings have brains – a kind of central nervous system that balances and reconciles competing interests such as energy minimization, occupant comfort, and grid stability.

Siemens has already developed an intelligent building automation system that can make the link between a building and a smart grid. It's the first management station that allows all building systems to be integrated into a single platform and can be operated intuitively. Fire protection, heat, ventilation and climate control, lighting, video surveillance – all of a building's systems are still usually controlled separately today, and this is changing through digitalization.

When Buildings and Cars Communicate

For years, energy experts have questioned how urban power grids will be able to support large numbers of

electric vehicles. Today, answers are on the horizon. Within the framework of the EU's Artemis research project for the Internet of Energy, and with the help of the Desigo platform, Siemens researchers have demonstrated how a fleet of electric vehicles can be integrated into the management of a building.

The basis for this is known as the Internet of Energy, in which vehicles communicate with charging stations. But in this case, a building management system obtains information from the stations regarding the charging requirements of the vehicles. It then uses this information, as well as data from climate-control, heating units and other consumers, to generate an energy demand forecast for the next day. If the building fails to conform with its demand forecast, it may have to pay a penalty. In order to prevent this from happening, Desigo uses the electric vehicles at the charging stations as electricity storage or supply units, thus making it possible to keep an entire building's electricity demand stable and the interlinked eVehicles available for use.

A truly smart building is also one that is considered in terms of its local context, its design should reflect local climate and take advantage of natural opportunities for solar, geothermal and small scale wind energy. Cities are comprised of buildings and the digitalization of each building should be part of a city's digitalization strategy.



Integrated applications for more energy efficiency

Integrated building applications can increase a building's energy efficiency, thus lowering significantly its operating costs – without a loss of comfort. Individual room control alone can deliver 30% energy savings. The automatic exchange of data from room control, with the primary heating and cooling plant, provides for significant energy savings and builds the basis for what is considered best in class for buildings or 'energy efficiency class A'.

Smart building applications are flexible and can be easily adapted and extended, depending on individual needs. For example, a presence and motion detector with an integrated brightness sensor offers an additional opportunity to save energy through constant lighting control. This technology maintains the level of lighting at a preset or user-defined value to optimally utilize the available daylight and reduce energy costs. The scale of energy savings that can be achieved through smart building technologies are:

- Up to 30% energy savings from individual room control
- Up to 20% energy savings from time- and presence-dependent temperature control
- Up to 70% energy savings from demand-controlled ventilation
- Up to 45% energy savings from time-, presence- and daylight-dependent control of lighting

- Up to 30% energy savings from time- and daylight-dependent control of shading

Meeting the government's aim to reduce heat energy use in buildings by 30% is a real challenge and digital technologies are likely to be the only way that this target could be achieved at any significant scale.

However, building retrofit is notoriously hard to deliver in private homes, and most cities start with their own public stock and commercial properties.

The City of Berlin in partnership with Berlin Energy Agency (BEA) has delivered energy savings in buildings across the city through the "Berlin Energy Saving Partnership" (ESP). The ESP offers efficient refurbishment of public and private buildings and it does so through Energy Service Companies (ESCOs) where the ESCO delivers and finances the investment and is repaid through energy cost savings. This means that there are no upfront costs for owners. So far 1,300 buildings have been upgraded, delivering nearly 30% reductions in both carbon emissions and energy costs.

The standard EN 15232 for Smart Buildings

A European standard EN15232: “Energy performance of buildings – Impact of Building Automation, Control and Building Management” is one of a set of CEN (Comité Européen de Normalisation, European Committee for Standardization) standards, which are developed within a standardization project sponsored by European Community.

Building Automation and Control System (BACS) and Technical Building Management (TBM) have impact on building energy performance from many aspects. BACS provides effective automation and control of heating, ventilating, cooling, hot water and lighting appliances etc.,

that leads to increased operational and energy cost savings. Complex and integrated energy saving functions and routines can be configured on the actual use of a building depending on users need to avoid unnecessary energy use and CO₂ emissions. Building Management (BM) systems provide information for operation, maintenance and management of buildings, with a focus on energy management.

EN 15232 defines four different efficiency classes (A, B, C, D) for building automation and control systems, as illustrated in the diagram below.

| Class | Energy efficiency |
|-------|---|
| A | Corresponds to high energy performance BACS and TBM <ul style="list-style-type: none">▪ Network room automaton with automatic demand control▪ Scheduled maintenance▪ Energy monitoring▪ Sustainable energy optimization |
| B | Corresponds to advanced BACS and some specific TBM functions <ul style="list-style-type: none">▪ Networked room automation without automatic demand control▪ Energy monitoring |
| C | Corresponds to standard BACS <ul style="list-style-type: none">▪ Networked building automation of primary plants▪ No electronic room automation, thermostatic valves for radiators▪ No energy monitoring |
| D | Corresponds to non energy efficient BAC. Building with such systems shall be retrofitted. New buildings shall not be built with such systems <ul style="list-style-type: none">▪ Without networked building automation functions▪ No electronic room automation▪ No energy monitoring |

EN15232 Standard Building Classification

A

B

C

D

Smart Buildings in Hungary 2025

Budapest is home to several smart buildings, which are integrating high performance building management systems. Smart Hungary project ideas could further incentivize the market to deliver high quality buildings.

Policy on local development controls could incentivize the construction of buildings that utilize:

Integrated Building Electricity Storage - Smart Buildings will be both generators and users of electricity, and rooftop Photovoltaic Cells (PV) are already commonplace in many sunny parts of the world. Storage means that energy can be stored during the times with plentiful, cheaper electricity and stored for more expensive times.

Home Automation – Include home automation in a new large-scale residential development that includes a microgrid (including technologies that automate heating, cooling, ventilation and lighting).

The public sector itself could initiate the following projects:

Public Sector Building Retrofit - Energy efficiency upgrades could be delivered across the public building stock including all offices, schools, and social housing. Financing is available so that there are no upfront charges and repayments are made through energy savings.

Thermostats and thermostatic valves – Ensure that all homes are equipped with heat control valves and thermostats to reduce heat waste.



Notes

Siemens can work in partnership with the government and cities to develop and deliver technology solutions across a wide range of sectors.

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