For the energy transition to become a reality cities and communities must become smart. A smart city is a place “where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business”¹. A smart city is likely to contain various technology solutions, including smart digital grids, microgrids, data interoperability, cybersecurity and electro-mobility². Smart energy infrastructure will positively contribute to energy optimisation in several key areas of smart cities, including environment, transport, resilience, energy, digitalisation, governance and business. What are the hurdles to successfully optimising energy? And what can be done to remove them?

As almost three quarters of the European population lives in urban areas, city and local authorities have an important impact on energy consumption and on the EU meeting its mandatory 2030 European target of a 32.5% improvement in energy efficiency.

A European city of 1 million inhabitants could save €70 million per year or more through a 10% reduction in energy consumption.
THE PRIZE

The rewards from energy optimisation and efficiency are considerable. One urban hospital in London, UK, has struck an energy performance contract ⁴ (where the supplier guarantees the level of savings) which will reduce consumption by 25%. This deal is now commonplace.

Some statistics help to indicate that the ‘size of the prize’ is very substantial indeed, putting the incentive for investment in transformation as much at the top of the financial manager’s list as that of the principled and politically driven policymaker. According to an analysis by the International Energy Agency (IEA)⁵, the gradual evolution of urban transport systems to encourage walking, cycling and public transit could save $21 trillion globally by 2050, while at the same time making a significant dent in greenhouse gas emissions. EU-wide investment in district energy could reduce heating costs by €51.4 billion per year⁶. LED lighting can cut costs by 50% ⁷.

Perhaps some numbers around very modest targets help to model the attractiveness of even very basic energy savings for an individual city. A typical European city of 1 million inhabitants could save in the region of €70 million per year or more through a city-wide 10% reduction in energy consumption⁸. Extrapolated to all 110 EU cities with over 300,000 people inside their city limits, that would represent an energy cost saving of €6.16 billion per year. And those savings mount up annually. A business case model⁹ for Scottish city Aberdeen indicates a cumulative (multi-year) saving of over €1.3 billion from investment in smart grid technology. Moreover, our starting point of 10% savings is very conservative. By 2020, Amsterdam aims to reduce energy consumption by 20% compared with 2013 ¹⁰. Wolfhagen, a small town in Germany, took back control of its local grid and has made substantial reductions in energy usage ¹¹. Berlin, the capital, has been running its Energy Saving Partnership scheme since the 1990s, exploring potential for 40% CO₂ reduction through to 2020.

According to the most recent published figures from the European Environment Agency ¹², the industrial sector has made huge strides in reducing energy consumption, equivalent to 32% since 1990. This contrasts (unfavourably) with household energy consumption, which has risen marginally, and transport energy consumption, alongside the services sector. Both of which have risen by over 30% over the same period.

So, in this respect, our cities have never been more under the spotlight. Clearly, cities throughout Europe can make a significant contribution to reducing energy consumption in the household, transport and services sectors.

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² More detailed discussions on these issues are available on the T&D Europe website, https://www.tdeurope.org/publications/brochures.html
⁴ St George’s University Hospitals, New energy facility at St George’s Hospital, 2 Jul 2018; Osborne Clarke, Smart Cities in Europe, 2015
⁵ IEA, Energy Technology Perspectives 2016 (ETP 2016)
⁷ ibid
⁸ Based on an average European price per KwH of 20 Eurocents and a city of one million inhabitants consuming MwH 3.5m annually
⁹ Siemens, The Business Case for Smart Cities: Aberdeen, 2017
¹⁰ City of Amsterdam, Renewable Energy Policy
T&D Europe has analysed smart city activities and identified the six key smart city themes relevant to energy infrastructure and management.

1. ENERGY

As the main location of the population and businesses, cities are a key target for decarbonisation of the energy infrastructure. Driven by government commitments, there will be an increase in renewable and low carbon generation in cities as municipalities look to minimise their carbon footprint. Maximising the benefit and minimising the cost of this investment will drive cities towards smart solutions, including smart digital grids and microgrids.
Energy efficiency measures will tend to reduce overall energy consumption but a move to electrification of usages previously powered by fossil fuels will increase electricity demand and consumption. This will drive electricity networks to increase their capacity with the least additional cost whilst increasing reliability. Smart cities will facilitate this by making local trading, flexibility responses, inter-energy vector balancing, amongst other measures, possible.

The UK, for instance, is seeing an increase in metropolitan ownership of services with a number of examples of local authorities setting up energy companies. This is being done to provide better services for inhabitants and to also increase the attractiveness of the area to businesses. The ownership structures in other European countries – Germany for example – is split into multiple municipal utilities and therefore already well prepared to take control of change. Denmark already has examples of decentralised project control that are fully operational.

Communal energy schemes are also introducing experiments in the use of peer to peer trading to facilitate trading between energy users. Distributed ledger and Blockchain technology are currently much in the press and this technology offers support for peer to peer trading. This could create new trading platforms and business opportunities, especially at the same voltage level within a power network and this is being trialled in the UK. Initially this would match generators and consumers but Internet of Things (IoT) technology should support the extension of wider flexibility services.

The availability of detailed usage data will also much better inform network planning and management decisions, making them more cost effective.
2. TRANSPORT

There is already support for electric vehicles both for their carbon and local air quality benefits. Additionally, urban traffic congestion and lack of parking space will put pressure on car ownership and improved car sharing business offerings. Combined with greater use of public transport this will reduce the number of cars and facilitate EVs and support public charging infrastructure. In turn this will mean that a simple mapping of current transport energy use to a 2030 or 2050 world will be very misleading.

Cities are introducing more public transport and new public transport options (such as bikes) and there will be greater integration of transport vectors. Smart cities will use open systems to integrate the different vectors. Cities are also introducing low emission zones, restricting access to more polluting transport.

We might expect a shift from competitive to cooperative planning; for instance, currently we see public transport versus private cars whereas in the future we may see more optimisation of route planning using all options and based on consumer's personal prioritisation (cheapest, fastest, safest, cleanest).

Smart cities are promoting remote working and local shared offices to promote more flexible working and home working to reduce congestion and travel. Alongside this a growth in communal working based on ubiquitous communications. According to global research from Regus, over 50% over workers spend over half their week working outside the office, and flexible remote working is reported by around seven in ten respondents to improve their productivity.

Looking at 'heavier modes of transport, for maritime cities, eHarbours and the extension of electrification to waterways can be expected to reduce local emissions and noise.
3. ENVIRONMENT

There is growing concern over urban air quality both as a result of increased emissions and greater awareness of local pollutant levels. The recent revelations on diesel emissions has driven this trend. Many cities are introducing congestion zones and restricting access for older motor vehicles. Most cities are seeking to drive a reduction in the use of private vehicles and increase the availability and use of public transport by connecting different transport vectors. For smart cities this is leading to increasing the provision of real time information on buses, trains and linking these to offer end to end guidance for journeys.

As opposed to historical data that was hidden and of limited use, the public now have access to real time air quality data. This will increasingly put pressure on Local Authorities to address air pollution sources such as transport.

4. RESILIENCE

Society and business are increasingly becoming dependent on the internet and cloud-based IT services. As delivery of these relies on electricity this will further increase our reliance on the power infrastructure. Digitalisation, however, brings with it new threats and increases the risk of cyberattacks. This is widely acknowledged and subject to detailed attention across the world. Conversely, digitalisation also offers new tools and opportunities for network surveillance and defence.

Smart cities will need to be resilient. Smart cities will expect that electricity networks limit power failures, but they will also expect to see well designed and managed ‘black start’ and system recovery plans after ‘normal’ faults as well as from cyberattacks. We can also expect to see more use of local fall-back operation in case of system disturbances, supported by distributed generation. The effects of climate change, increasing incidences of severe weather, will present further challenges for resilient infrastructure.

Smart cities are developing wider quality of life measures covering all aspects of city life and these can be expected to increasingly influence public opinion and behaviour as well as becoming key selling points for cities. Local power reliability can be expected to appear on these lists.

SMART CITIES WILL EXPECT THAT ELECTRICITY NETWORKS LIMIT POWER FAILURES

https://tfl.gov.uk/modes/driving/car-clubs
https://www.zap-map.com/live/
Regus, The workplace revolution, Jan 2017
https://www.ratp.fr/en/infos-trafic
5. DIGITALISATION

The advent of big data and new businesses based on it will have deep impact on all aspects of life, including power networks. Key developments that can be expected are much better understanding and prediction of consumer behaviour – leading to more agile demand management.

The roll out of smart metering for electricity, gas, heat and water will provide far more detailed data about the local usage of each vector with greater potential to manage this load. Appliances are increasingly smart enabled and can readily be incorporated into the Internet of Things (IoT), offering major opportunities for providing flexibility services. There are numerous examples of trials of this technology and competing appliance control platforms.

There is renewed interest in the role of energy service companies, both as a response to the market opportunity created by the IoT and for offering flexibility services. A main offering of the energy service companies will be providing energy efficient products as well as energy management.

The increasing dependence on electricity arising from digitalisation has been dealt with under resilience. However, data privacy is already a major public topic and will impact on the way that industry uses data.
6. GOVERNANCE AND BUSINESS

The opening up of commercial data systems will create new business opportunities and new combinations of businesses allowing more complex, interconnected, businesses. One illustration of this is the development of waste disposal in cities. Originally this was a simple exercise in collecting waste and shipping it out of the city to dispose of. Now there is a complex chain of recycling steps where waste is separated and sold off into a variety of material markets, the remainder being burnt for power generation or disposed. This business becomes very dependent on the values of each waste stream, the value of generated electricity and heat and the cost of disposal.\textsuperscript{28}

As organisations open up their data this will create opportunities for other companies to integrate more closely with them leading to an increasing integration of commercial services. For electricity, this would be reflected in the power networks making visible their system status and connected business responding via open flexibility markets.

This also makes it possible for smart cities to begin to optimise across networks, using power, gas and heat network flexibility to balance overall loads. It is worth noting that this might see less competitive behaviours between services (gas versus electricity, for instance) and a more cooperative and integrated regime.

Feedback across Europe reports that municipalities are generally under strong funding pressure and there is a shift away from smart city developments as prestige projects to more cost-conscious approach seeking to reduce costs.

Smart cities are using digital technologies to measure return-on-investment, and to increase the involvement of the public in decision making and to make engagement more local. This will promote local approaches to energy and other infrastructures, pushing to development of micro-grids.

\textsuperscript{28} See, for instance:
- Smart Energy International, France's Linky electricity meters, 27 Dec 2018
- Electrification by Design, BEAMA, Dec 2017
- Electra_The_Smart_World_Brochure_FIN.pdf (p25)
ENERGY OPTIMISATION IN CITIES – HURDLES TO SUCCESS

What, then, is standing in the way of all cities throughout Europe adopting energy optimisation programmes to deliver substantial reductions on energy consumption and carbon emission reduction? Three inter-related hurdles are holding back the pace of adoption of smart energy transition in Europe’s cities: Infrastructure, Standards and Finance. First, smart cities need major investments in the required energy infrastructure, including renewable energy generation, distribution, interoperation, optimisation and electric vehicle charging.

Second, smart cities need common standards for interoperability to control and manage demand versus supply both within small area microgrids and between those ‘distributed’ energy management units. Common operating data standards are essential for ‘big data’ analysis that identifies areas for optimisation (reduction of consumption, or price, or both). Without such common, regulated standards interoperability is impossible.

Third, smart cities need access to sustainable finance, preferably tied into some form of energy performance contracting, to invest in the necessary development. Energy performance contracting captures future energy cost savings and then uses those to fund the initial capital technology investment. Expressed simply, this enables a city to upgrade and transform its energy infrastructure without having to raise capital. Over the financing period of transformation, the city ends up with zero-net-cost compared to its current operational budgets. At the end of the financing period, the ongoing annual energy cost savings revert to the city.\(^\text{26}\)
T&D EUROPE RECOMMENDATIONS

T&D Europe has developed several recommendations for immediate action that can positively impact and support overall smart city development. These are recommendations where T&D Europe members can provide expertise in technology to policymakers, regulators, and smart city associations.

The recommendations are:

- Develop a model and standards for cross-infrastructure energy operation and planning. Cross-system optimisation should be expected to reduce the current opposition between energy vector competition (gas v. electricity) and result in more cooperation between vectors.

- Develop a model for the energy subcomponents to feed meaningfully into city quality-of-life indicators. This would include electric vehicle penetration and air quality improvement from advancing electrification.

- Establish standards for the ‘resilience profile’ of smart products applications and solutions. This is a set of criteria which smart city technology should meet and should be designed to aid the purchasing decisions of smart city decision makers.

- Map the journey towards a more decentralised, complex, localised energy structure, which nevertheless operates to a set of open standards that make interaction between public bodies and commercial suppliers as open and co-operative (but also meritocratically competitive) as possible.

- Raising awareness of smart city developers and policymakers about the limits of the ‘technically possible’, drawing on the collective technological expertise and the practical experience.

European smart cities have an enormous potential for energy savings. Saving just 10% of electricity consumption in Europe’s 110 cities of over 300,000 inhabitants would save over €6 billion per year. This is equivalent to an average of €56 million per city per year. In fact, EU targets for reducing energy consumption are several times this modest calculation.

Through smart energy management European cities can become ‘smarter’ and make a significant contribution to saving energy, reducing greenhouse gas emissions and improving the quality of life. Smart cities typically involve various solutions, including smart digital grids, microgrids, data interoperability, cybersecurity and electromobility. T&D Europe has published a series of papers setting out our vision for the future and we will continue to explore this with other stakeholders.

This paper does not examine financing issues any further as they are ably dealt with in a variety of other studies, such as for instance: Deloitte, Smart Cities Funding and Financing Strategies, Oct 2018; Norton Rose, Financing smart sustainable cities, Apr 2018; Siemens Financial Services, Smart start for smart buildings, Sep 2018; World Economic Forum, Circular Economy in Cities, Mar 2018

INFRASTRUCTURE, STANDARDS AND FINANCE ARE THE KEY INGREDIENTS FOR A SMART CITY
ABOUT T&D EUROPE

T&D Europe is the European Association of the Electricity Transmission & Distribution Equipment and Services Industry, which members are the European National Associations representing the interests of the electricity transmission and distribution equipment manufacturing and derived solutions. The companies represented by T&D Europe account for a production worth over €25 billion EUR, and employ over 200,000 people in Europe. Further information on T&D Europe can be found here:

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