CESI Energy Journal

Issue 10 - November 2016

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Electricity's future: no killer app to be resilient

There's no one single killer application for the future of energy, but strategic vision will remain vitally important.

Climate Change: it's time to scale up in efforts

In this interview Laura Cozzi, IEA, addresses long-term global energy scenarios.

Designing a smart tariff structure

Hans ten Berge, Secretary-General Eurelectric, explains how DSOs can face new economic and financial challanges.

10

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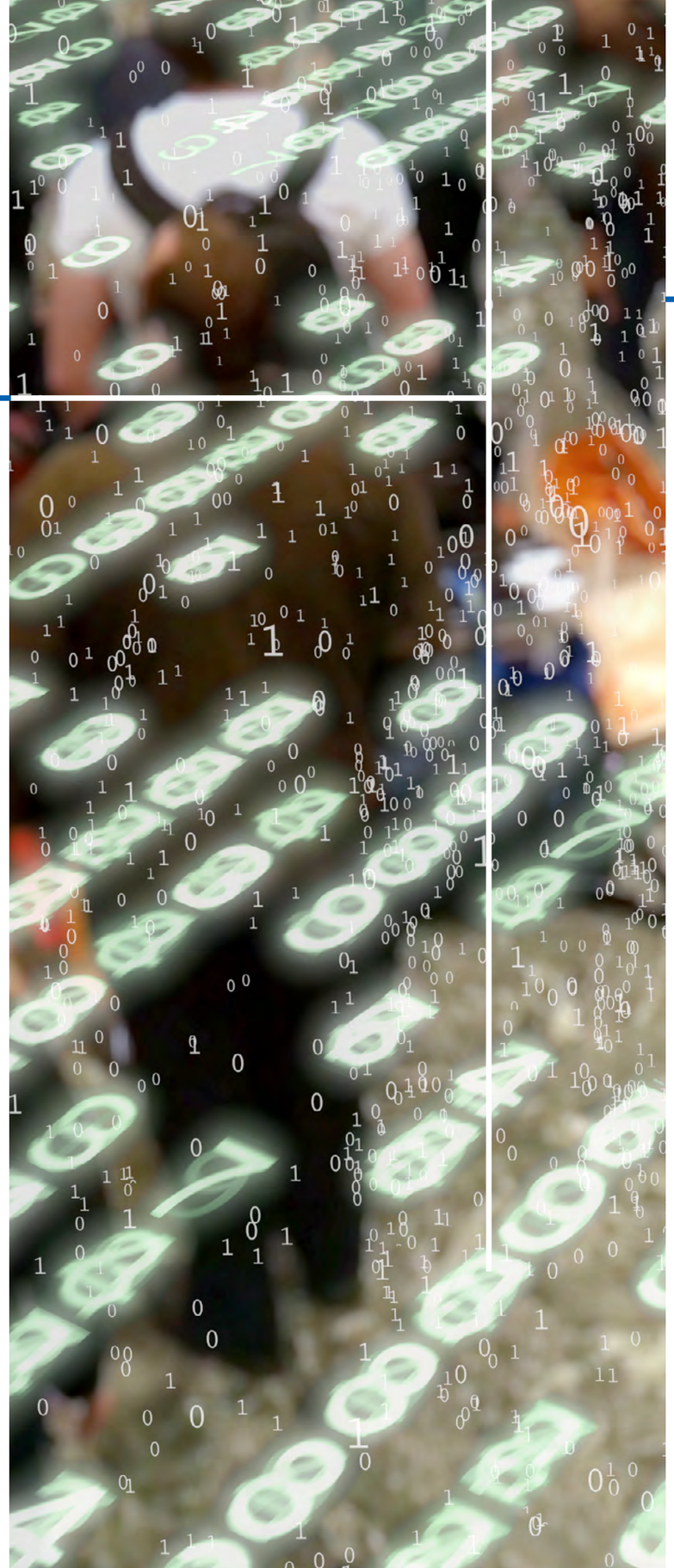

Issue 10 - November 2016

Contents

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Editorial

Salvatore Machì - Chairman, CESI
Matteo Codazzi - CEO, CESI

Anybody who works in the energy industry already knows that the ability to foresee the future, or at least the direction the future will take, is a key skill. In our sector people never work for today. They're already thinking ahead to a scenario set ten or twenty years from now. This is inevitable: we design and build complex systems that take years to realize.
But while this is an intrinsic characteristic of our sector, and even though change doesn't frighten us, we are all nevertheless stunned by the acceleration in the pace of changes that have taken place around us in recent years. At the same time, we're aware that we can neither stop change, nor slow it down. We have to keep up with it, ride the wave. Laura Cozzi, Deputy Head of the Directorate of Global Energy Economics at the International Energy Agency, closes an interview we're presenting in this issue of EJ talking about the 2100 energy scenario. That may sound surprising, but it's the right perspective. For us 2030, a date cited in plenty of European frameworks, is already yesterday. This vorticity requires us – first as individuals, even before as experts, or as companies – to muster extraordinary flexibility. It demands a degree of mental openness that will allow us to change strategies quickly when the scenario shifts unexpectedly, integrating new information within the context, instantly rebalancing relationships between parameters that were set up previously. Because there won't be any one, single killer application capable of resolving all our industry's problems. The winning system will be the one that is best equipped to integrate the most innovative technologies that we're able to invent, multiplying their potential. But we can be sure of one thing: the electric sector will continue to play a central role, and intelligent networks along with it. These networks will be so intelligent, so perfectly integrated that it would be reductive to speak of Smart Grids, as a research study conducted by Green Tech Media and presented in this issue of EJ underlines.
We'd be better off if we started thinking in terms of "Grid Edge," considering the whole as a sort of organism; an energy ecosystem. That's a fascinating idea, but will these "energy ecosystems" know how to defend themselves? Will they identify ways to guarantee safety and security for the entire network, and with it different countries' entire energy production systems? The theme of network resilience is also a theme of national security. Smart grids, along with the countless devices connected to them, especially at the peripheral level, provide numerous de facto entry points to the network, exposing the system to outside intrusions that are capable of causing serious harm, and can prove extremely costly to repair.
Neither the United States nor the European Union can consider themselves immune to these events. While the cyberattack on the Ukraine transmission network in 2015 (which left 80,000 people without energy for hours) was the worst of these kinds of attacks the world has seen in recent years, it certainly wasn't the only attack. The Federal Energy Regulatory Commission has already warned the United States about the risks the country faces on this front. Millions of research dollars are being directed at this issue, and the first early results are rising to the fore, but we need to keep up the pace and stay in step with change in order to succeed in overcoming this challenge.

THE THEME OF NETWORK RESILIENCE IS ALSO A THEME OF NATIONAL SECURITY

| TOP STORIES |

Electricity's future: no killer app to be resilient

Agnese Bertello

THERE'S NO ONE, SINGLE KILLER APPLICATION FOR THE FUTURE OF ENERGY; THERE WILL BE TOO MANY TECHNOLOGIES, TOO MANY ENERGY SOURCES, AND TOO MANY DIFFERENT COMBINATIONS AMONG THEM. BUT STRATEGIC VISION WILL REMAIN VITALLY IMPORTANT, ESPECIALLY WITHIN A EUROPEAN UNION WHERE DIVISIVE TENDENCIES REMAIN WIDESPREAD.

"The only way to predict the future is to invent it." And in order to invent it, it's important to have accumulated enough history so that it's possible to read and understand the complicated mosaic that is our current reality.

The conference CESI organized on the occasion of the sixtieth anniversary of the company's foundation had precisely that objective: to reflect on the present, identifying possible future trajectories. In order to accomplish this, the company invited several of the most authoritative experts in the Italian and international energy scenes, including Patrizia Toia, Vice Chairman of the European Parliament Industry Commission; Guido Bortoni, Chairman of AEEGS, Italy's energy authority; Francesco Starace, CEO of Enel; Matteo Del Fante, CEO of Terna; Patrizia Grieco, Chairman of Enel; and Catia Bastioli, Chairman of Terna.

Their considerations on possible future energy scenarios started with sharing data that Francesco Starace highlighted during his presentation: today, the renewable energy industry is no longer a niche reality. "In just a few short years it has been transformed into a solid, global industry that has introduced an enormous technological revolution, and which continues to invest dozens of billions of euro in research and development, betting entirely on the definition of systems that guarantee efficiency, lower energy costs and a better relationship with the environment and the energy customers."

Del Fante shared specific numbers and data concerning this revolution: "In just ten years," stated the CEO of Terna, "renewable energy production capacity has increased by 28 Giga through solar and wind, reducing energy production from fossil fuels by 18 Giga. In Europe, several countries have already achieved a renewable energy production quota of 60%."

THE RENEWABLE ENERGY INDUSTRY IS NO LONGER A NICHE REALITY. IN JUST A FEW SHORT YEARS IT HAS BEEN TRANSFORMED INTO A SOLID, GLOBAL INDUSTRY.

These numbers tell the story of a phenomenon that must be evaluated in several key aspects.

"This energy revolution will not have one, single killer application," stated Del Fante. "In other words, there won't be 'a' technology capable of resolving all problems in one fell swoop. There are certainly scientific areas in which research and efforts are concentrated, including in terms of investments – the battery sector is one example – but the overall

scenario is complex enough that it will require a multiplicity of integrated responses, from batteries to smart metering, active demand, digitalization…"

THERE'S NO POINT IN WAITING AROUND FOR A SINGLE KILLER APPLICATION. IT MAKES MORE SENSE TO FOCUS ON A GROUP OF TECHNOLOGIES THAT WILL PERMIT THE ELECTRIC SECTOR TO FULLY EXPRESS ONE OF ITS KEY CHARACTERISTICS: RESILIENCE.

Therefore there's no point in waiting around for a single killer application. It makes more sense to focus on a group of technologies that will nevertheless permit the electric sector to fully express one of its key characteristics, one that distinguishes it clearly from all others: resilience. This, according to Guido Bortoni, is the added value of the electric system. "Robustness and redundancy are no longer essential characteristics of our energy system; today the overall energy system needs to integrate a characteristic that is peculiar and intrinsic to the electric system – the grand protagonist of this revolution. I'm talking about flexibility, or better yet resilience. The ability to adapt and evolve quickly in order to meet the requests of a society and production, economic and social system that is in continuous, rapid change." This approach was echoed in the interventions of Patrizia Grieco and Catia Bastioli. "What is impressive of the current times is not the change per se, as changes have always happened and will keep happening," stated the Chairman of Enel. What is truly impressive is the speed of the changes connected to the technology evolution. Moreover, resilience is an extraordinary skill, that has allowed us to survive and evolve for thousands of years, by adapting to new conditions and scenarios with enormous flexibility and intelligence. The real challenge now is to further refine these skills. "We must bear in mind," notes Grieco, emphasizing the importance of future skills and professions "that according to an estimate, 65% of children entering primary school today will end up working in completely new jobs types that currently don't exist. So how can we best prepare them? We need to teach them to be flexible, through continuous education and training."

Catia Bastioli, Chairman of Terna, underlined how Europe itself invites people to be flexible and expand the research horizon as much as possible through a program – aptly titled "Horizon 2020" – that finances different areas of innovation in a transversal manner. "It was a necessary change in approach for the European Union, precisely because we don't know which technologies will win out in the end. Multiplying the possibilities and case studies will be vital."

Europe plays a fundamental role in this challenge, and is now trying to put strong

From left to right: Matteo Del Fante, CEO of Terna, Guido Bortoni, Chairman of AEEGS, Italy's energy authority, Francesco Starace, CEO of Enel, Matteo Codazzi, CEO of CESI, Patrizia Toia, Vice Chairman of the European Parliament Industry Commission.

From left to right: Patrizia Grieco, Chairman of Enel, Catia Bastioli, Chairman of Terna, Salvatore Machì, Chairman of CESI.

drive behind the creation of both an energy union, as well as a digital union. But, as Patrizia Toia, Vice Chairman of the European Parliament Industry Commission, explains, the Union is being held back by nationalistic impulses in individual member states. "In this sphere, any strong, strategic policy cannot help but be created together with Europe.

We need to create true cooperation between member countries, a flexible, integrated network, if we're going to achieve the objectives we set for 2030, and emphasized once again at COP21 in Paris when addressing climate change, giving stability to our choices. The most challenging area for this work is market design, in other words sharing market regulations and defining the way this is set up."

It was precisely with these needs in mind that the European Union was born some seventy years ago. The wealth of the European Union is determined by the differences of the individual countries that form it: differences in history, culture and natural characteristics. These differences have led to a significant diversification of energy sources, as well as an admirable level of interconnection, and today these elements are proving to be positive factors. "What we really need to intervene on," states Starace, "is the regulatory diversification currently limiting our ability to benefit from those positive aspects which already exist. That's why it's important to improve the rules of the European energy market: what we really need is a shared European political vision. We need convergence."

WE NEED TO CREATE TRUE COOPERATION BETWEEN EU MEMBER STATES, A FLEXIBLE, INTEGRATED NETWORK.

There are at least two, and perhaps more, speeds in Europe. Therefore we need a high level of awareness on behalf of the various European players concerning the need and urgency of these reforms.
There's no doubt diversification is positive for Europe, just as there's no doubt that divisiveness damages the Union.

| INTERVIEW |

Climate Change: it's time to scale up in efforts

Interview with Laura Cozzi,
Head of the Energy Demand Outlook division, IEA

THE STUDIES DIRECTED BY LAURA COZZI FOR THE IEA DISPLAY A CLEAR POINT OF INTERSECTION: EMISSIONS. WHILE ON ONE HAND SHE EDITED OUTLOOK IEA 2015 FOR INDIA, ONE OF THE WORLD'S FOREMOST EMISSION-PRODUCING COUNTRIES, WHERE EMISSIONS HAVE DOUBLED FROM 2000 TO TODAY AND ARE FORECAST TO QUADRUPLE BY 2040; ON THE OTHER, SHE DIRECTED THE REPORT ON CLIMATE CHANGE PREPARED AHEAD OF LATE 2015 SUMMIT IN PARIS, HIGHLIGHTING IEA'S PROPOSALS FOR EMISSIONS CONTAINMENT. COZZI IS THE IDEAL INTERLOCUTOR FOR ADDRESSING LONG-TERM GLOBAL ENERGY SCENARIOS, SITUATIONS THAT INVOLVE CONTINENTAL EUROPE AS WELL, CURRENTLY STRUGGLING WITH THE CREATION OF A SINGLE MARKET.

Energy Journal: According to IEA forecasts, India is the country where energy demand is destined to grow the most by 2040. Will the country continue to rely first and foremost on fossil fuels in order to satisfy this demand? What are the current plans for developing renewable energy sources?

Laura Cozzi: As many are aware, India's energy sector has grown tremendously in recent years. Energy demand has almost doubled since 2000 and is projected to almost quadruple from 2013 to 2040. Currently, the bulk of total energy demand is met by fossil fuels, which has increased in share since 2000. This growth has supported an expansion of the economy by 2.5 times, while lifting more than 180 million people out of extreme poverty. However, this development has come, as in many countries around the globe, with some side-effects: Current estimates in the *WEO 2016 Special Report on Energy and Air Pollution*[1] show that 11 of the world's 20 most polluted cities are in India and poor air quality is already a major public health issue - In 2015, air pollution attributed to around 1.6 million premature deaths, and average life expectancy was reduced by approximately 23 months.
In response to these challenges, policy-makers are looking to limit India's per-capita emissions, and introduce more clean energy sources, such as renewable energy, into the energy mix – The government has pledged in its INDC to reduce emissions intensity by at least 33% by 2030 (as compared to the 2005 level); established ambitious targets for 100 GW of solar, 60 GW of wind, 10 GW of bioenergy and 5 GW of small hydro by 2022; and rolled out plans to position itself as a global leader in the renewable industry. India has since established itself as one of the world's largest in terms of total installed wind capacity, and Solar PV deployment has ramped up significantly following the 2010 launch of the Jawaharlal Nehru National Solar Mission. Momentum, as seen in the recent state-level renewable auctions, remains strong, as with fiscal incentives and policy support. Moving forward, we foresee that coal will remain as the current dominant source for electricity generation. With that said, the use of coal will fall sharply from now till 2040 as the deployment of renewables continues to pick up steam.

EJ: Energy scenarios are increasingly supranational... With this in mind, how do you see India's role changing in the Indian and Asian continent? What contribution can India make in the energy sector for growth throughout the region?

L. C.: Personally, I feel that it is a very exciting period for the energy sector in India, as it is right in the heart of the global energy transformation: The country is home to over one-sixth of the world's population and is its third-largest economy. It's no surprise then that it has become the centre stage in many areas of international affairs, including energy: Given that an additional 315 million people are expected to move to cities by 2040, the impact on global demand trends associated with this urbanisation trend will continue to be significant. India will account for most of coal and oil demand, and will continue to shape energy markets as it modernises rapidly.

IT IS A VERY EXCITING PERIOD FOR THE ENERGY SECTOR IN INDIA, AS IT IS RIGHT IN THE HEART OF THE GLOBAL ENERGY TRANSFORMATION

We are already starting to see the effects of India's growing role and influence in several areas. Let me just single out solar power as an example: While the technology only played a limited role in power generation so far, deployments have picked up rapidly in the last two years, and the region has gained significant influence on international markets: India is one of the two leaders (the other being France) of the International Solar Energy Alliance, which was launched during COP21 to boost solar energy in developing countries. Recent solar auctions - which resulted in some of the lowest tariffs seen for solar projects - continue to set new benchmarks and provide learning points to the international community.
The government's push towards buying local solar PV components, coupled with strong domestic demand, have benefitted the domestic manufacturing industry, which has emerged in recent years to be a serious contender in the global solar PV manufacturing scene.

[1] *https://www.iea.org/publications/freepublications/publication/weo-2016-special-report-energy-and-air-pollution.html*

EJ: The new European Climate and Energy Framework includes a set of extremely ambitious objectives. Some say it can be considered the most ambitious energy project Europe has undertaken since the European Coal and Steel Community Pact: on one hand efforts to favor energy transition; on the other creating a truly united European market. What do you believe are the first steps to take in order to achieve these goals? What potential obstacles do you see blocking the way?

L. C.: The EU climate targets are indeed ambitious – By 2030, the collective goal is to cut greenhouse gas (GHG) emissions by at least 40% below 1990 level, increase the share of renewables to least 27% of EU energy consumption, and achieve an indicative energy savings target of 27%. In turn, annual additional investments required to achieve these targets are projected to amount to €38 billion for the EU as a whole over the period 2011-30.

CHALLENGES EU HAS TO FACE REQUIRE STRONG POLITICAL WILLPOWER AND CLOSE COLLABORATION BETWEEN ENERGY STAKEHOLDER.

While these steps are bold, they are absolutely necessary to achieve the overarching goals of a secure, affordable and sustainable energy supply. The EU has lined up a comprehensive framework to ensure that the decarbonisation of the region goes hand-in-hand with increased competitiveness of EU industries.

The key, however, is in the implementation and timing of its policies. One major challenge going forward is in incentivising the use of renewable and energy efficiency technologies across the power sector value-chain, while at the same time ensuring that energy markets are progressively liberalised, interconnections between member states continue to be strengthened, and the necessary supporting technologies – such as energy storage, flexible power plants an demand response - are introduced to maintain system flexibility. All these will require strong political willpower and close collaborations between energy stakeholders. Nevertheless, if managed properly, the resulting flow of investments will have positive effects on businesses, consumers and the environment alike. Realising the Energy Union will be key in achieving all these ambitions.

EJ: Paris was an important step. Adoption of the Paris accords by 195 different countries present at the conference was undoubtedly a powerful signal. Above and beyond the diplomatic success of the event, now it's up to individual countries to turn these accords into concrete action, working specifically to achieve the INDCs (Intended Nationally Determined Contributions) necessary to contain emissions. Today, six months after the treaty was signed, do you see things moving in the right direction?

L. C.: This is a very good question, and I guess it is also an opportune time for the international community to take a step back

and take stock of the global progress now that we are at the half-way mark to the next COP event. Since the signing of the Paris agreement, we have seen encouraging signs of progress around the world: the use of low-carbon energy sources, including renewables, is expanding rapidly, and there are indications that growth in the global economy and energy-related emissions have started to decouple: In 2015, the global economy continued to grow by more than 3%, while global emissions of carbon dioxide stood at 32.1 billion tonnes, having remained essentially flat since 2013. There have also been significant developments in the push towards cleaner modes of transport, with the global stock of EVs growing strongly in 2015 to surpass the 1 million mark.
Yet, the long-term transition towards an energy system consistent with the COP21 goals will most definitely require a significant scale-up in efforts. Our projections show that renewables are expected to become the leading source of electricity by 2030, but further action and policy support is needed to drive down costs, improve competitiveness, and accelerate the deployment and integration of renewables in order to deliver an earlier peak in GHG emissions. A more aggressive adoption of nascent energy technologies, such as carbon capture and storage (CCS), is equally as important in achieving these goals.
We are currently working on an in-depth feature on renewables and their prospects to 2040, which will provide detailed analyses on current situation regarding renewables policy and deployment, the competitiveness of renewables, and the opportunities and challenges in integrating large shares of renewables to the grid.
Our preliminary estimates already point towards strong growth of renewables in 2015, with capacity additions for renewables exceeding fossil fuels for the first time.
The renewables feature will be released on 16 November as part of the *WEO 2016 publication*.

EJ: What will the energy sector look like in 2030 if all INDCs are implemented fully? Will it be sufficient to put the energy sector on a pathway consistent with the world's agreed-upon global climate goal?

L. C.: Given that the energy sector accounts for two-thirds of the world's GHG emissions, full implementation of the INDCs will most certainly have a material impact in achieving climate goals: the link between economic growth and energy-related GHG emissions should continue to weaken, led by a declining share of fossil fuels in world energy mix, and a higher adoption of energy-efficiency and renewable technologies. In all, we estimate that the carbon intensity of the power sector would improve by around 30%.

SINCE THE SIGNING OF THE PARIS AGREEMENT, WE HAVE SEEN ENCOURAGING SIGNS OF PROGRESS AROUND THE WORLD: GROWTH IN THE GLOBAL ECONOMY AND ENERGY-RELATED EMISSIONS HAVE STARTED TO DECOUPLE.

With that said, neither the scale nor the composition of energy sector investment associated with the national pledges is suited to move the world onto a 2 °C path. Global energy-related emissions will continue to rise from 2013 to 2030, albeit at a slower rate, and the estimated remaining carbon budget consistent with a 50% chance of keeping below 2 °C will be consumed by around 2040 – only eight months later than expected in the absence of INDCs. In short, if stronger action is not forthcoming, full implementation of the INDC pledges will only result in a global temperature increase of around 2.7 °C in 2100.

Laura Cozzi

Head of the Energy Demand Outlook Division, Directorate of Sustainability, Technology and Outlooks, International Energy Agency (IEA).
Laura Cozzi is in charge of the quantitative analysis and modelling of the IEA flagship publication World Energy Outlook and has been co-author of sixteen editions of the World Energy Outlook as well as leading the WEO special reports on energy and climate, investment and Africa.
Ms. Cozzi has also been leading the World Energy Outlook analysis on climate change and the environment, energy demand and energy efficiency for over a decade.
Prior to joining the IEA in 1999, Ms. Cozzi worked for the Italian oil company ENI S.p.A.
She has a Master Degree in Environmental Engineering (from Polytechnic Milan) and a Master's Degree in Energy and Environmental Economics (from Eni Corporate University).

| INDUSTRIES & COUNTRIES |

Designing a smart tariff structure for a smart energy system

Hans ten Berge, Secretary-General EURELECTRIC

TODAY, RECOVERING NETWORK COSTS HEAVILY DEPENDS ON HOW MUCH ELECTRICITY IS SOLD. BUT MANY EUROPEAN COUNTRIES ARE EXPERIENCING A SIGNIFICANT REDUCTION IN DISTRIBUTED ENERGY VOLUMES. THIS INFLUENCES THE CAPACITY OF THE DSO TO GARANTEE ADEQUATE NETWORK INVESTEMENTS. MORE CAPACITY-BASED TARIFFS, BETTER REFLECTING THE NATURE OF DISTRIBUTION COSTS, WOULD PROVIDE MORE STABLE REVENUES AND CASH FLOWS FOR DSOS.

Distribution system operators (DSOs) are responsible for delivering reliable and quality service to their customers. With the transition to the low carbon economy, additional network investments will be necessary to maintain the high level of service that European customers expect. Investments by DSOs will account for most future network investments as their networks need to accommodate an increasing amount of distributed generation, including renewables and other distributed energy resources like electric vehicles. In order to optimally accommodate increasingly volatile production and demand and to recover the cost of the necessary investments, new approaches to network pricing must be considered.

Network costs are mainly capacity driven

In most countries, network tariffs make up a significant share of a household customer's electricity bill, and they are expected to grow further. Most direct network costs are determined by peak demand (kW) and are largely independent of the actual energy delivered. Those costs are unlikely to fall with the rise of decentralised generation. Thus, the grid must still be designed to cover peak demand when there is no local production.

Current volumetric network tariffs impact DSO income and investment ability

The structure of the distribution network tariffs, and in particular the balance between the capacity (€/kW) and the volumetric (€/kWh) tariff components, is an important issue for the entire electricity system.

IN MOST COUNTRIES, NETWORK TARIFFS MAKE UP A SIGNIFICANT SHARE OF A HOUSEHOLD CUSTOMER'S ELECTRICITY BILL, AND THEY ARE EXPECTED TO GROW FURTHER.

Distribution network tariffs in low voltage are still largely based on the volume of energy used, while infrastructure costs are mainly driven by the topology of the network and by capacity.Today, recovering network costs heavily depends on how much electricity is sold. In the majority of countries, network tariffs for households and small businesses are almost entirely based on energy volume (kWh). About 50- 70% of the allowed DSO revenue is usually recovered using such volumetric charges. While volumetric tariffs set signals to reduce energy consumption, they do not reflect cost arising from consumption at peak hours.

Recently, many European countries have been experiencing a significant reduction in distributed energy volumes. This is mainly due to the increase in the number of prosumers, increasing energy efficiency and a prolonged economic stagnation. These changes affect the DSOs' ability to recover their allowed revenues within reasonable time, which can lead to cash flow issues in addition to potential tariff fluctuations over time.

Network tariff structures designed for a smooth energy transition

More capacity-based tariffs, better reflecting the nature of distribution costs, would help address this issue by providing more stable revenues and cash flows for DSOs. They would also reflect the higher network costs associated with peak demand and incentivise customers to reduce their peak load, resulting in a more efficient use
of the network. Also, as a result of better peak load management, further investment in available grid capacity can be deferred or reduced in the longer run, with a positive effect on overall system cost to the benefit of electricity customers.

Balancing the interests of utilities, prosumers and DSOs

Network tariffs should allocate distribution costs in a fair way among users, taking into account their individual grid impact, not only energy volume and capacity, and send the right signals for efficient grid usage. Tariff design should reflect the link between connection and use of system charges as well as network customer diversity.

CUSTOMERS SHOULD BE EMPOWERED BY NEW PRODUCTS AND SERVICES CREATED BY SUPPLIERS, ELECTRICITY SERVICE COMPANIES AND AGGREGATORS TO ACTIVELY MANAGE THEIR CONSUMPTION.

As previously mentioned, self-generated electricity is one of the major factors contributing to the current decrease in the amount of grid-distributed electricity. However, self-generation per se does not necessarily reduce grid development/management costs. In fact, in many cases the opposite is true due to the need for connection and use of the distribution grid and sometimes further network extension, as well as increased automation investment.

Prosumers are, in general, no less dependent on a reliable access to the grid than traditional customers, because they still use the grid, especially at peak hours. Therefore, as long as customers are connected to the grid and use its services, they should contribute to its costs.

Innovative pricing for demand response

The future challenges which the power system is facing lead to a quest for flexibility, which is shared by all actors in the energy supply chain. Flexibility is important as it contributes to balancing the increasing share of variable generation in the system as well as to network optimisation.

In this respect, demand response is a way to tap into the potential of energy efficient use of infrastructure. Demand response can be defined as the changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the electricity price or incentive payments designed to alter timing, level of instantaneous demand or total electricity consumption. Customers should be empowered by new products and services created by suppliers, electricity service companies and aggregators to actively manage their consumption.

Encouraging customer responsiveness and efficient grid use

More capacity-based network tariffs reflect the higher network costs associated with peak demand. They can provide customers with incentives to reduce their peak load to an optimal level, resulting in a more efficient use of the network. As a result of better peak load management, further investment in available grid capacity can be deferred or reduced in the longer run, with a positive effect on overall system cost to the benefit of electricity customers.

Particularly in the presence of time-of-use (ToU) network tariffs for consumers connected to medium or high voltage distribution lines, an increased price signal on capacity and associated incentives to transfer energy consumption out of peak hours would encourage consumers to moderate their peak demand levels. The effects of ToU capacity-based tariffs at household level must be explored further.

It would also incentivise consumers to choose energy saving appliances that can help consumption management in order to reduce peak levels.

More capacity-based network tariffs can also activate demand-side behaviour that is good for the network, while ToU network tariffs can be applied to the capacity component. Smart meters (especially for industrial customers) allow setting different capacity network tariffs for predefined (peak/off-peak) time schedules. ToU network tariffs are still possible in the presence of an increased capacity component. This is already the case with traditional meters for larger industrial consumers, businesses or even households.

In conclusion, as DSOs strive to integrate distributed energy resources into their networks in view of changing requirements in terms of network use, they must increase their efficient network expenditure. Regulation must therefore ensure that DSOs can recover their allowed costs in an efficient way, including a fair rate of return that is commensurate with the risk involved by such investment, via network tariffs in an adequate and timely manner.

Beyond the Smart Grid

Agnese Bertello

THE WORLD OF ENERGY IS EXPERIENCING A PERIOD OF PROFOUND CHANGE. MANY DIFFERENT PLAYERS ARE INVOLVED IN THE PRODUCTION, DISTRIBUTION AND CONSUMPTION OF ENERGY, OFTEN FULFILLING ROLES THAT CHANGE FROM ONE SITUATION TO THE NEXT. TODAY IT'S INCREASINGLY IMPORTANT TO ANALYZE THE ENERGY SECTOR IN A HOLISTIC MANNER, TO APPROACH IT AS AN ECOSYSTEM. THIS NEED HAS GIVEN RISE TO THE NEW "GREEN EDGE" PARADIGM, DEVELOPED BY GREEN TECH.

Green Tech Media, an American scientific research institute, has published a study of the modernization process for electricity networks currently underway in different states around the nation. The data presented in the study underlines clearly indicates that the US energy system is experiencing a moment of profound transformation. While the methods change from state to state, all are headed in a shared direction.

RESEARCHERS COINED THE TERM GRID EDGE, AN EXPRESSION WHICH REASSUMES THE IDEA OF AN "ECOSYSTEM" THAT INVOLVES ALL THE OPERATORS IN THE SECTOR AND WHICH MUST FUNCTION IN A COHERENT AND PERFECTLY INTEGRATED MANNER IN ORDER TO SUPPORT THE DEVELOPMENT OF RENEWABLE ENERGY SOURCES

According to GTM researchers, even the term "smart grid" can no longer be considered appropriate to explain what is happening. Smart grids are one piece, albeit an important piece, of this mosaic. Instead, researchers coined the term "Grid Edge": an expression which, starting from the widespread awareness that we are inexorably moving toward a system of distributed generation, reassumes the idea of an "ecosystem" that involves all the operators in the sector – from energy-producing businesses to researchers, consumers, technicians, regulatory bodies and utility companies – and which must function in a coherent and perfectly integrated manner in order to support the development of renewable energy sources and guarantee achievement of environmental goals which are now, following COP21 in Paris, considered priorities for the international community.

Green Tech Media's Research

Distributed energy production is spreading extremely quickly across the United States: in 2016, a new PV panel was installed every 8 seconds somewhere in the US.
Over the past two and a half years, overall more panels were installed than in the preceding fifty years combined, and according to estimates produced by Green Tech Media, over the next two years that number will double yet again.
Will networks, but also utilities and regulatory agencies, be able to keep up with this epochal transformation; to take full advantage of it? How are they organizing for this massive change?

GREEN TECH MEDIA HAS IDENTIFIED THREE DIFFERENT MODELS FOR GRID TRANSFORMATION IN USA. THIS MODELS ARE DEFINED AROUND THE PROTAGONIST, THE ENGINE DRIVING CHANGE.

Today, twenty-three of the fifty-one states in America have initiated a process of network transformation. Some of them – for example California, Hawaii, Arizona and Texas – are acting as precursors, initiating experiments that are innovative from many different points of view, elaborating models, defining strategies and progressively adapting their approaches. Other states are following suit, while still others are less inclined to embrace change, and are currently watching from the sidelines. While it's true that each state in the union must necessarily develop an original, unique model – one determined by that state's history, consumer characteristics, availability of renewable energy resources, consumer attitudes, environmental morphological characteristics and urban population density – it is equally true that it is possible to follow three main pathways that individual routes inevitably lead back to. And this is precisely what GTM's research has accomplished. The models that Green Tech Media has identified, and of which it analyzes the most pertinent characteristics, are defined around the protagonist, the engine driving change: this can shift from the consumer, to the regulator or producer.

The Advanced Energy Consumer

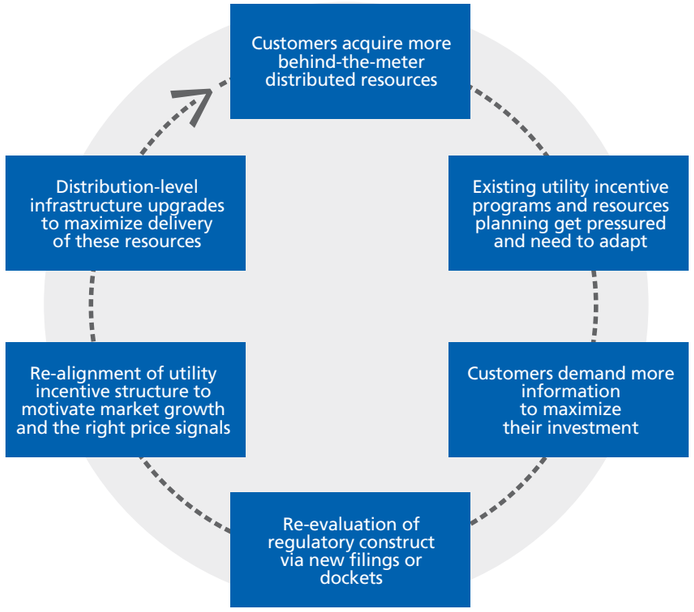
This is a Customer-driven pathway led by early adopters in particular, who are the first to embrace avant-garde commercial and technological methods, as seen in Hawaii and Arizona, as well as in Colorado, California and Florida.

The Innovative Regulator

The regulatory-driven pathway initiates largely with regulators. The most notable current example is New York, but additional examples can be found in Massachusetts, Minnesota, New Jersey, Pennsylvania, Maryland, Ohio, Washington, Oregon and California.

The Proactive Energy Provider

In this third model the transformation is utility-led, as is the case for example in upgrades underway at Duke and Southern California Edison. This model is spreading quickly, and has currently been adopted in Illinois, Texas, Oklahoma, North Caroline, South Caroline, Tennessee, California and Florida as well.



Advanced Energy Consumer Adoption Pathway
Source: GTM Research

THE THREE MODELS

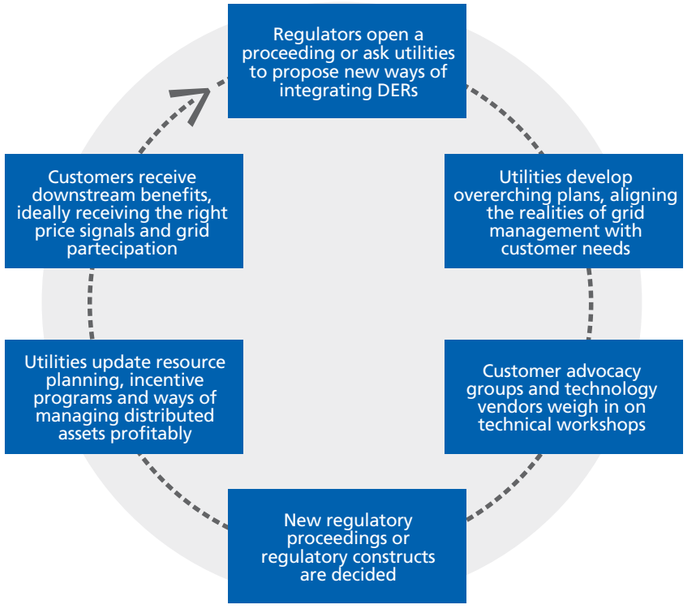
The Advanced Energy Consumer

Not by chance, emphasize GTM's researchers, this model has taken shape in states like Hawaii and Arizona, where the abundance of renewable resources is stimulating interest among consumers, who then decide to transform themselves into producers by putting the extra energy they produce back into the network.

When this kind of linked process is put in movement, when the consumer is the one driving it, the progression is unstoppable. The consumer discovers that he or she can receive a visible, tangible savings in monthly energy bills by installing solar panels; can directly control how much he or she produces and consumers; can receive benefits directly as a protagonist within the system; now begins to choose increasingly advanced systems, searching for an increasing range of flexibility. For this reason, Hawaii is not only among the most advanced states in terms of distributed generation, but also in terms of distributed, or "behind the meter" energy storage. California has followed closely along the Hawaiian model, establishing a number of ad hoc initiatives like the Californian Solar Initiative and the Power Purchase Agreement.

CONSUMERS' PROACTIVE ATTITUDE SPURS UTILITY COMPANIES TO EQUIP THEMSELVES TO SATISFY DEMAND, WHILE AT THE SAME TIME REDEFINE TARIFFS AND RATES

What does all this mean for utility companies? According to GTM, this proactive attitude among consumers spurs utility companies to equip themselves to satisfy demand, while at the same time redefine tariffs and rates, and the modality through which the contribution of each individual producer will be paid back. Maximizing returns for the consumer is the main objective of this reorganization of the network, but for this reason utility companies will also have to adopt an increasingly refined, as well as user-friendly, system for analyzing consumption practices. Consumers will have to be able to easily interface with this system, and will insist it provides all the information they desire. The role and trend toward innovation among ICT companies will prove fundamental.



The Innovative Regulator Adoption Pathway
Source: GTM Research

The Innovative Regulator

Within the three models GTM highlights, the Innovative Regulator undoubtedly the most traditional, with a top-down approach starting from the regulator, moving through utility companies and ultimately involving the end consumer.

"REFORMING THE ENERGY VISION", THE PROGRAM SET UP IN NEW YORK, PROVIDES A TYPICAL EXAMPLE OF HOW THE THIRD MODEL, CALLED THE INNOVATIVE REGULATOR, MOVES FORWARD

For GTM, this model can be found in those states where consumer pressure has not yet reached critical levels, though other factors contribute to highlighting the trend underway, and regulators move as a consequence, anticipating the other players involved. The regulator, aware of the fact that the status quo is no longer enough, pushes utility companies to develop new models that are capable of integrating the distributed production of FER.

In the next phase of this model, utility companies assume the protagonist's role. Based on indications from the regulator, they develop a general plan and launch pilot projects designed to align the reality of managing networks with the consumer's needs and the strategic objectives defined by the regulator. Consumer associations and businesses are involved at this point, attending meetings and workshops. Here the entire market is set in motion, initiating a virtuous circle that includes technological innovation, increasingly autonomous demand and participation from consumers, progressive interventions on the regulatory system, and the development of software and measurement systems that lead to the construction of a new "energy ecosystem."

"Reforming the Energy Vision", a program set up in New York, provides a typical example of how this method moves forward: in addition to ambitious objectives – for example the reduction, by 2050, of 80% of all emissions compared with 1990 – emphasis is placed on network resilience, including its reliability and safety. The plan makes explicit reference to off-grid or micro-grid systems that allow individual citizens to be autonomous, and also to realities like hospitals, schools, businesses and research centers that must continue to function, even in the event of major, high-impact weather phenomena.

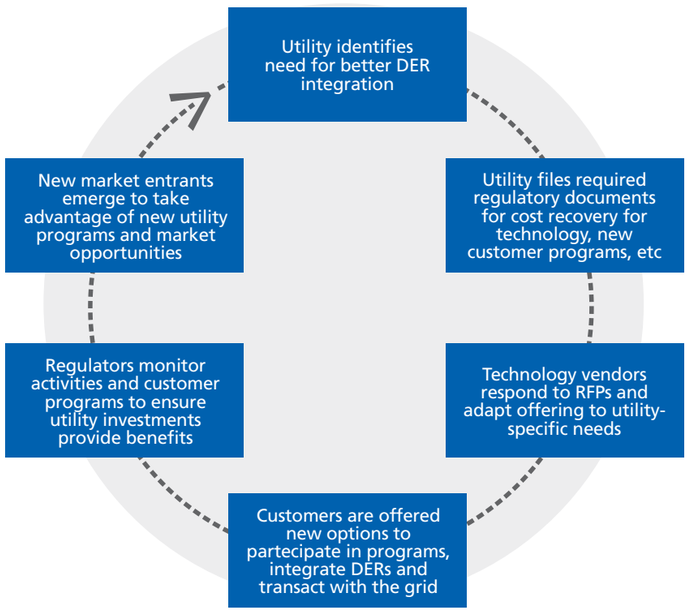
The Proactive Energy Provider

n the third and final case analyzed by Green Tech Media, utility companies providing the driving force of change. They recognize the need to better-integrate distributed production within the current energy system, and guide the transformation process.
In this case, the push for change can come from the need to respond to a specific infrastructural need, or the desire to play a leadership role; define the agenda and the steps for change (which is viewed as inevitable), rather than remaining at the mercy of change. Here the accent is placed primarily on network efficiency.
Technology and energy companies embrace stimuli coming from utility companies, and begin providing offers and products designed to satisfy the need expressed.

At this point, the utility company is ready to offer the consumer new opportunities to participate in planning, as well as programs that make it possible to integrate renewable resources and interact with the network in a different manner. In this case, the regulator plays a role increasingly defined by oversight and controls, verifying that the choices made are congruent, economically and financially sustainable, and that they achieve the determined objectives.

In this manner, a more open, transparent distributed market rises to the fore, supporting technological innovation and the exchange of data with the end consumer.

The Proactive Energy Provider Adoption Pathway
Source: GTM Research



A Unique Horizon

As we've seen, GTM has elaborated three models of reference that are useful for understanding the macro trends underway, but the processes in play can be quite different. But all seem to share the same direction and the future scenarios (if the perspective provided by the researchers proves correct) will wind up being rather homogeneous. What appears to be taking shape is a new, highly integrated ecosystem in which consumers are no longer viewed as taxpayers entitled to nothing more than the minimum required, but as an active partner and fundamental asset that contributes to the success of the entire ecosystem.

AS WE'VE SEEN, GTM HAS ELABORATED THREE MODELS OF REFERENCE THAT ARE USEFUL FOR UNDERSTANDING THE MACRO TRENDS UNDERWAY, BUT ALL SEEM TO SHARE THE SAME DIRECTION AND THE FUTURE SCENARIOS.

This factor – the unpredictable ability of consumers to join and take an active, creative part in the process – is what will make the difference when it comes to choosing which model to adopt.

Increasingly Intelligent, Increasingly Fragile

Agnese Bertello

AT ONCE EXTRAORDINARILY SOPHISTICATED AND FRAGILE, SMART GRIDS ARE A DELICATE ISSUE FOR NATIONAL SECURITY. FOLLOWING THE EVENTS IN GERMANY AND THE UKRAINE, TODAY THE US HAS RECOGNIZED THE COUNTRY IS AT RISK, AND IS INVESTING MILLIONS OF DOLLARS TO PROTECT ITSELF. MEANWHILE, IN EUROPE, THE FIRST CYBERATTACK SIMULATOR IS UP AND RUNNING.

Electric energy transmission and distribution networks are our backbone, the framework supporting the entire production, economic and social structure of any industrialized country.

The increasingly advanced process of transforming these networks through the application of ICT technologies to the basic infrastructure, has on one hand rendered them incredibly sophisticated, efficient and adaptable to the complexity of today's overall energy systems. But on the other hand, it has also made them more vulnerable, exposing them to potential outside intrusions in a massive manner. Every new element – every device that is integrated into the network, whether it's a smart meter, transformer or monitor – represents a new potential entry point for malicious hackers.

THE RESILIENCE OF TRANSMISSION AND DISTRIBUTION NETWORKS IS CONSIDERED A NATIONAL SECURITY ISSUE.

Control and oversight for such a capillary system is extremely complex to manage. At an international level, people are paying close attention: simply put, the resilience of transmission and distribution networks is considered a national security issue.
The most recent warning bells were rung last month by the United States FERC (Federal Energy Regulatory Commission), when it noted that simply disabling nine of the 55,000 electric transmission substations spread out over US territory at the same time would be enough to create a blackout capable of covering the country coast-to-coast, wreaking damage that is difficult to quantify with any precision from an economic point of view. Such an event is considered improbable, but not impossible, given the growing incidence of cyberattacks on electric networks.

Over the past five years there have been a dozen cyberattacks on the energy networks of industrialized countries. Europe and the US have been the hardest hit, but attacks of this nature have also been registered in South Korea, Israel, Saudi Arabia and Australia.
In Europe, the first cyberattack of memory was probably the one directed at Germany in 2012, when the network managed by 50Herts – one of the country's main TSOs – was put in checkmate. At the time Germany was undergoing a delicate period: the Energiewende, or energy transition phase. Energiewende was designed to spur the country toward an energy system based on renewable sources and distributed production, sustained by an intense process of infrastructural network renewal, with HVDC corridors running the extent of the country. The initiative had only just begun, and public sensibility to the effort was at its peak.

Perhaps even more significant in terms of real damage was the attack that transmission networks in the Ukraine experienced in 2015. For hours, tens of thousands of people (roughly 80,000) were left without electricity. Officially, only two companies declared that they had been hacked from the outside. But another six companies experienced problems and blackouts during the same period, leading experts to believe that all were victims of a single, concerted attack. In addition to this, the hackers acted in such a way that the blackout was only discovered after the fact, and blocked all toll-free lines that the companies had set up to talk to their clients. But according to technicians, things could have gone a lot worse. On that occasion, the Ukrainian network was protected to a certain extent by its aging technologies.
For a Europe now pushing to construct a single, shared energy market and betting on cross-border interconnections that will make it possible to bring renewable energy produced at the far ends of the continent all the way into the heart of its production areas, where demand is highest, it has become clear that guaranteeing an international safety standard is of paramount importance. Otherwise an attack in any single country in the European Union could reverberate throughout the entire system.

According to experts, there are several critical elements in this connection between networks and ITCs. These elements are clear by nature, but complex and difficult to deal with because they require responses on multiple levels. There are also other aspects that are potential weak points, and have yet to be fully understood. For these reasons, it's important to invest, and invest now.
In 2011 the United States adopted an official "Roadmap to Achieve Energy Delivery Systems Cybersecurity," and over the past

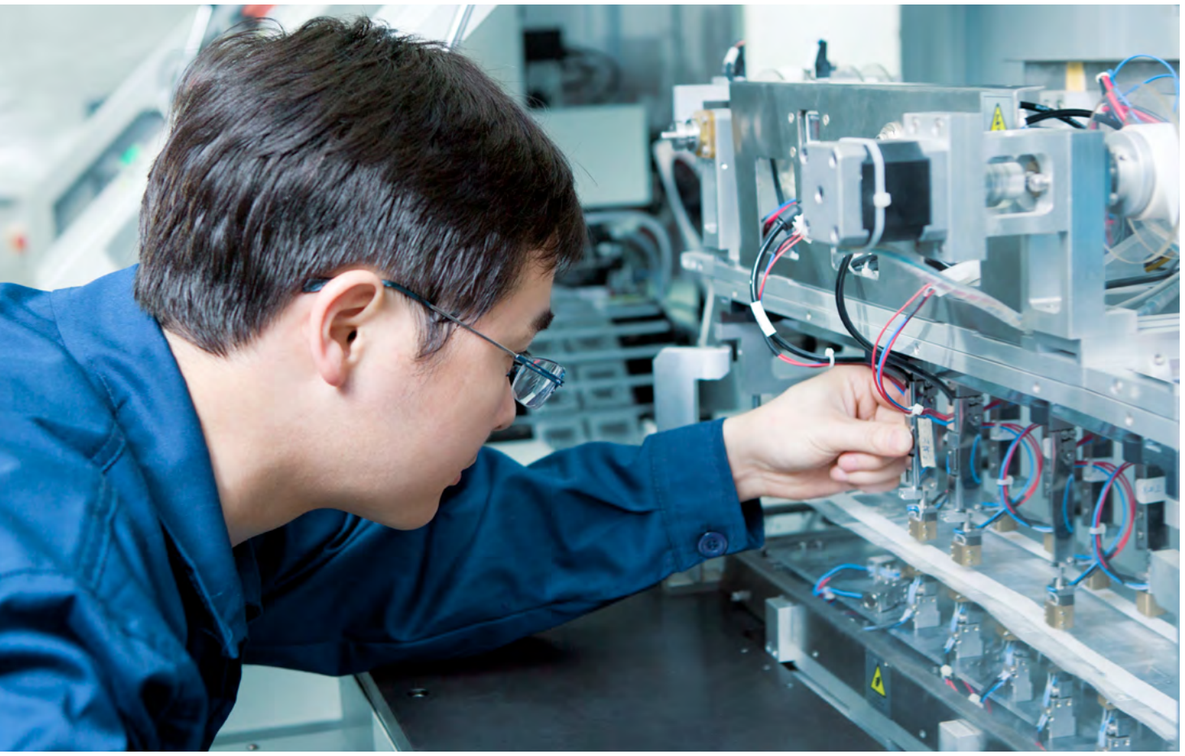
seven years the country has invested 210 million dollars in research programs focused on these issues. The most recent investment plan, totaling 15M dollars, involved the final link of the chain: utilities like the APPA (American Public Power Association) and the NRECA (National Rural Electric Cooperative Association), agencies that combine to serve roughly 26% of the country's population.

TO ACHIEVE AN IDEAL LEVEL OF SECURITY IN WHICH 95 PERCENT OF ATTACKS ARE THWARTED, UTILITIES AND ENERGY COMPANIES SURVEYED IN A 2012 BLOOMBERG STUDY WOULD HAVE TO INCREASE AVERAGE ANNUAL SPENDING MORE THAN SEVEN- FOLD.

To achieve an ideal level of security in which 95 percent of attacks are thwarted, utilities and energy companies surveyed in a 2012 Bloomberg study would have to increase average annual spending more than seven-fold to $344.6 million per company from the current level of $45.8 million.

Over recent years Europe has also promoted several different community research programs dedicated to the safety and resilience of transmission networks. As always, the objective is to limit risks, outline possible developments, the multiple, concrete materializations and develop – as a consequence – technologies and intervention models that make it possible to reduce the risk of an attack on the smart grid. Such models need to be able to identify an attack in real time, as well as increase the infrastructure's level of resistance while the attack is underway.

In December 2015, for example, Tacit – the first simulator for cyberattacks on the smart grid – was unveiled. The product of a multiyear European research project (CIPS), Tacit makes it possible reproduce, within a specific smart network, the effects of the most recent cyberattacks, thereby making it possible to concretely evaluate specific risks and propagation odds based on the design of the network adopted, quickly remodeling it in order to make it more resistant.



An ENISA (The European Network and Information Security Agency) report offered 10 recommendations for protecting power grids from cyber-threats, including:

- an improved EU and member state regulatory and policy framework,
- the development of a minimum set of security measures by ENISA, in collaboration with member states and the private sector,
- security certification schemes for smart grid components, products and organisational security,
- empowering the Consortium for Electric Reliability Technology Solutions to advise on cyber security incidents affecting power grids.

However it must be noted that the indications proposed by ENISA are anything but easy to apply, especially because they call for close, concrete and effective collaboration between private companies, national agencies and international entities. The importance of increased cooperation between the different players has also been underlined by the WEC (World Energy Council) in its report "The Road to Resilience – Managing Cyber Risks," published in late September 2016.

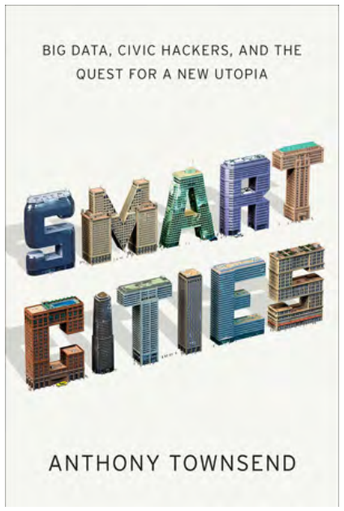
According to the WEC, any resilience strategy must involve every link in the supply chain, one after the other. Energy companies need to start taking into consideration this kind of risk the same way they evaluate core business risks, in other words as a risk that can compromise the heart of their economic activity. This means they need to earmark specific investments design to prevent them. National governments, meanwhile, need to commit to creating dedicated norms and regulations that are both effective and elastic enough to cover risk typologies that are difficult to foresee and identify. International bodies and organizations need to commit to sharing information and best practices, thereby favoring international cooperation as a whole. Working together, each covering its specific area, these groups must contribute to increasing awareness about the industrial, social and economic impacts that cyberattacks can have, creating a true energy community in the broadest sense of the term, as well as one that knows how to defend itself.

In order to prevent the very foundation of the new energy transmission and distribution systems, in other words ITC technologies, from becoming its Achilles heel, we need to act and act quickly. Within this sphere, as already happened with the fight against climate change, Europe has the power to point the way and impose a strict roadmap to completion.

| REVIEW |

Smart Cities
Big Data, Civic Hackers and the Quest for a New Utopia

Anthony M. Townsend



Anthony M. Townsend

Is an advisor to industry and government at the Silicon Valley–based Institute for the Future and directs urban research at New York University's Rudin Center for Transportation. He lives in Hoboken, New Jersey.

"[A] TIMELY AND NECESSARY GUIDE TO THIS AGE OF THE FRANKEN-CITY."
Daniel Brook, New York - Times Book Review

In Smart Cities, urbanist and technology expert Anthony Townsend takes a broad historical look at the forces that have shaped the planning and design of cities and information technologies from the rise of the great industrial cities of the nineteenth century to the present. A century ago, the telegraph and the mechanical tabulator were used to tame cities of millions. Today, cellular networks and cloud computing tie together the complex choreography of mega-regions of tens of millions of people.
In response, cities worldwide are deploying technology to address both the timeless challenges of government and the mounting problems posed by human settlements of previously unimaginable size and complexity. In Chicago, GPS sensors on snow plows feed a real-time "plow tracker" map that everyone can access. In Zaragoza, Spain, a "citizen card" can get you on the free city-wide Wi-Fi network, unlock a bike share, check a book out of the library, and pay for your bus ride home. In New York, a guerrilla group of citizen-scientists installed sensors in local sewers to alert you when stormwater runoff overwhelms the system, dumping waste into local waterways.
As technology barons, entrepreneurs, mayors, and an emerging vanguard of civic hackers are trying to shape this new frontier, Smart Cities considers the motivations, aspirations, and shortcomings of them all while offering a new civics to guide our efforts as we build the future together, one click at a time.

Shaping a Better Energy Future

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