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A FOCUS ON INTERNATIONAL ENERGY REGULATION

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The Chronicle: Issue 7

Meeting the Challenges and Obstacles of Regulation

To be a regulator is to forever live on the leading edge of the most important issues facing a sector.

As energy regulators, we are responsible for facilitating safe, reliable, and affordable energy service in the here and now, balancing the interests of consumers and utilities and confronting challenges as they arise. Amid this day-to-day, we are also responsible for looking far down the road to understand better where energy is going and how we can fulfill our responsibility to ensure quality service in the years and decades ahead.

This task is never easy and is fraught with uncertainties and obstacles. Yet, it is our duty to respond to the world of today and help envision the world of tomorrow. In this latest edition of the Chronicle, we hear from a number of colleagues who understand this challenge.

In Japan, we hear from our regulatory colleagues about how the electricity and gas markets have transformed in the last decade, including advancements in retail markets. We as well hear from our fellow regulators about the latest in cybersecurity and supply quality.

This edition of the Chronicle also offers some thought-provoking work on how the systems we regulate are evolving right before our eyes. In Great Britain, we learn how local and community energy resources are cutting across traditional energy silos and offering new opportunities for customers to engage. We also offer a discussion on how current technologies can help to bring power to the billions of people around the world with unreliable service or no service at all.

As always, we are proud to include perspectives of some of the leading women in our field. Within our Women in Energy Initiative, we continue to seek opportunities for empowerment and education, thereby creating more equal representation in our regulatory ranks.

I want to thank our authors for their submissions, as I continue to be greatly impressed by the scholarship within our international regulatory community. I also want to express my continued appreciation to the editorial board in helping to prepare this edition.

As always, we welcome your feedback on the Chronicle. Should you have an original article that you think would be of interest for a future edition of the Chronicle, please submit it to chronicle@icerregulators.net. Thank you, and best of luck to you as we work to stay on the leading edge in our work.



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Background

In 2013, ICER Virtual Working Group (VWG) 4: Regulatory Best Practices launched the Chronicle as a means to further promote its goals of enhanced exchange of regulatory research and expertise. Under the 2016 restructuring of ICER into three new virtual working groups, the ICER Chronicle continues as a foundational project under ICER leadership.

The ICER Chronicle is published twice a year and selected articles enhance regulatory knowledge around the world. The articles provide a variety of perspectives on different technical topics. It is important to include articles from and of relevance to developing and transitioning economies.

The ICER Chronicle is open to submissions from regulators, academia, industry, consultants and others (such as consumer groups). This ensures a variety of perspectives and increases the exchange of information and messages among the various groups. Submissions will be collected on a rolling basis, in addition to formal Calls for Articles. You are invited to send your article to chronicle@icer-regulators.net.

For past editions of the ICER Chronicle or to start a subscription, please email chronicle@icerregulators.net.



Diana Day

California's energy industry is undergoing more change right now than at any time in its history. California set ambitious goals for utilities to secure 33 percent of its power from renewable energy by 2020, a goal that San Diego Gas & Electric (SDG&E) recently achieved, five years ahead of schedule. While making the grid more sustainable, utilities also continue to strengthen the core foundation of safety when providing energy to the community. With so much change underway, SDG&E has focused increasing attention on managing the risk of leading this change and thriving in California's dynamic energy and regulatory environment.

Leading SDG&E's Risk Management Efforts

That's where Diana Day comes in. Day is SDG&E's Vice President of Enterprise Risk Management and Compliance. She leads the utility team that identifies, evaluates, and creates strategies to mitigate risk with the goal of improving safety and operations at all levels. For example, SDG&E integrates risk into key decision-making processes, infrastructure investments, and daily operations. This focus on risk is a central pillar of the prudent management of the utility. It strengthens SDG&E's safety culture, maintains the reliability of its service, promotes customer service, and fosters sustainability. Risk management also helps SDG&E to understand and navigate California's regulatory environment and develop services and projects that support the state's clean energy goals and benefit customers well into the future.

"It's all about running a better business," said Day. "SDG&E is focused on identifying risk, learning how to measure it consistently, and mitigating it. When we take very accurate data on risk and combine it

with the very talented and experienced employees that we have at SDG&E, we see great results. This makes sure that our people and resources are focused on the right strategic areas, that they are constantly improving operational effectiveness and reliability, and above all, that they are promoting safety in all that we do at SDG&E."

Day's journey to SDG&E began in Seattle, Washington, where she was born. She graduated from Washington State University and received a law degree from the University of Virginia. She then worked at the law firm Latham and Watkins, focusing on corporate and transactional law. Day joined Sempra Energy, SDG&E's parent company, in 1997. After several years working in the law department, she moved to SDG&E and was tasked with forming an entirely new division focused on risk management. Day says the experience has been rewarding intellectually, and she enjoys bringing a talented group of employees together to manage the pressing issues of the day.

One of the most rewarding projects that she has worked on is managing the risk of wildfires fueled by stronger and more frequent winds and by more dry fuel conditions due to California's ongoing drought. Given the continuing and growing threat of wildfires in California, SDG&E developed the largest and most advanced utility weather sensor network in the nation to mitigate this risk. This network of more than 170 state-of-the-art weather stations measures everything from temperature and humidity to wind speed and solar radiation, all of which provides a greater awareness of the electric grid and helps prevent wildfires and other emergencies. SDG&E also replaced 4,000 wood poles with steel poles in high risk fire areas. SDG&E has brought in a massive Erickson Sky-crane helicopter equipped with a 2,500 gallon tank of

water for six years in a row to help manage the community risk of controlling a small fire before it has a chance to grow and become an uncontrollable larger fire. By understanding fire risk and identifying and taking appropriate mitigation measures, SDG&E has helped to better prepare San Diego for the threat of wildfires.

Fostering Careers for Women in Energy

Day has helped secure many achievements for the company, but she also has navigated challenges that are familiar to many young parents. The mother of eight children, Day worked an 80-percent schedule for a several years at Sempra Energy and also minimized her work travel so she could focus on raising her young children.

“As a mother, it was certainly challenging to balance work and family life,” Day said. “You have to make sure you give enough time to your family, even as you are working hard on the job. It’s manageable but you need to focus on it. I am fortunate to work at a company that provides flexibility for young mothers, and that is essential to balancing your family needs. Giving young parents the flexibility to start families creates happier and more fulfilled workers and allows more women to proceed onto senior roles in the workplace.”

Day’s advice to other women beginning their careers is to seek out new opportunities in the workplace. Women can explore new areas through multidisciplinary and cross-functional work that not only builds their skills but is also rewarding from a personal perspective. In addition, Day recommends branching out from the job and engaging more broadly in community work, external speaking engagements, and nonprofit volunteer groups.

“My advice to other young mothers is to make sure you have something outside of the job and home that is meaningful to you personally beyond core responsibilities,” said Day. “It can be anything, from physical fitness training, to volunteer work, to religious services. I also recommend forming professional networks with other women. I am involved with a great group of women who meet regularly and support each other, which means a great deal to me.”

Continuing to Shape the Future

As California’s energy industry continues its rapid transformation, assessing risk will be more important than ever. Day is looking forward to new ventures that will help SDG&E continuously improve in this area. On the horizon is a new Enterprise Risk Management Center that will feature information from every area of the company in an easily understood and accessible visual format. This will then be augmented with live feeds, news reports, and real-time data inputs from the field to give leadership greater situational awareness of many risk factors at once.

California is known for pioneering new frontiers in technology and other fields, and SDG&E is continuing this tradition by trailblazing in the energy industry. By leveraging new technology and focusing on improving its operations every day through risk management, SDG&E will continue to shape California’s energy future to benefit customers, community, the economy, and the environment.

Doina Vornicu



My name is Doina Vornicu, I am the Chief Operations Officer of CEZ Group in Romania, one of the well-known leaders of the energy sector.

I am currently involved in the transformation of CEZ Group in Romania into a smart company, with improved processes, like remote control grids,

better services and new technologies.

When I look back at the starting point of my career, I would say that the first real contact with the energy field happened after my graduation in 1985, when I started working at IRE Botosani, a subsidiary of the Industrial Plant of Energy Grids of the Energy Ministry.

Then came the year of 1991, when I became the first Romanian Technical Director of the National Energy System, this being my first big step on the career ladder.

Other top management positions followed in SC Electrica SA (the Romanian national energy company), the General Directorate of FRE Botosani in 2000, and the Manager position of International Projects at Transelectrica in 2005, where I got the opportunity to launch the project of the 400 kV Romanian-Turkish submarine cable.

My path in the energy field offered me the opportunity to encounter all sorts of great personalities, starting with the people that built the national energy system from which I had the chance to learn strategy, tactics, politics, and more important, how to improve my work.

Another important lesson I got from those times is that there's more to being a good manager than perseverance and hard work, it's about giving your colleagues a goal and convincing them to follow that goal— which will bring the whole team a well-earned success.

In 2006, a new and exciting opportunity was revealed to me in the energy private sector, this being the moment I joined CEZ Group in Romania, a company that puts a great value on its employees, helping and preparing them at a superlative level and giving them the chance to strive. I am the best proof of that, being the first Romanian manager granted the second position of importance in the group's business in Romania, that of Chief Operations Officer.

I am often asked who do I give credit for my success? And my answer is simple: to my family and colleagues, the persons I have encountered in this field, which somehow managed to shape me into the person that I am now. It's all about people and their dreams. Energy comes from people, as we at the CEZ Group in Romania, like to say.

I never had trouble in balancing work and family time because my family is very supportive of my work, they are always there, beside me, encouraging and helping me all the way. I would not have gotten so far in my career if it weren't for them; they gave me confidence and support throughout the most important moments. My husband for instance, is also an engineer in the field, so he gets the utility and importance of my job.

The main perk of my job and of those in the energy field, is the chance we get to provide an essential item in everybody's life by lighting up the bulb in their homes.

My professional life has always been a challenging

one and I confess I wouldn't have it any other way. Therefore, I cannot name the biggest challenge of my career, I prefer to say that all challenges are important when they come.

I am very proud of every single project I was involved in and if I were to mention only one, that would be the wind park that Group CEZ in Romania built at Fantanele and Cogeaalac.

In this project, displayed in the Dobrogea area, I was the Risk Manager at the largest on-shore wind park in Europe, with a capacity of 600 MW installed power that gathered 240 wind turbines that produce a large portion of the green energy requested by the EU from Romania.

I recall many hours of hard work, taking great risks and many challenges. It was the first project in Europe of this magnitude, it required a special care towards the environment and we had limited time to obtain all approvals and notices needed. The project also benefited from the engagement of many international teams.

In the energy field, a woman needs perseverance and a strong team. I remember working 10 times more than my fellow colleagues to achieve the same results as them or even better ones. Also, the team you work with is very important because success is usually gained by the effort of a team.

In the 90s for instance, the energy field was mostly a male field, but now, it's a domain where women can evolve and put their mark on the next big revolution, which might as well be grid-less energy.

I think that women are very appreciated for their commitment and that large companies like the one I work for, are the best environment that can consolidate and shape a career.

If I were to offer advice to young women in search of a career in Energy, I would say to choose books as best friends from the early stages of their academic preparation and know that people, honor, and perseverance are the key ingredients for building a long-lasting career.

A good example of must read for high-performing women to stay ahead of the curve is Dale Carnegie's "Scrisoare catre unii tineri/ Letter to some young people."

Also, someone else's experience can give you the confidence you need to achieve all your goals. Mentoring can be an inspirational source and stories of success can help its readers draw their own career path.

I think that the attitude towards women being at the helm on important businesses is starting to change and that prejudices tend to appear when the person in question doesn't think she/he is the perfect match for a certain job, therefore, confidence is the key in making someone invest in your career, closely followed by perseverance and hard work. A great leader is most likely to observe the talent of a confident woman and to help her advance further the career ladder.

In closing, I would like to share the words that guided me to make the decisions that had the potential to change my life, words written by Nicolae Iorga: "Nu spune niciodată 'nu se poate', ci începe cu 'să vedem' / Never say: "It's not possible." Say instead, "We shall try and see," which also became my favorite motto.

Quality of Electricity Supply in Serbia and the Role of the Regulator

Milica Brkić-Vukovljak,^{1*} Ljiljana Hadžibabić,¹ and Ljubo Mačić¹

Keywords: quality, regulation, commercial quality, continuity of supply, Maximum Allowed Revenue (MAR).

Abstract

One of the more important tasks of energy entities dealing in electricity transmission, distribution, and supply in Serbia is constant improvement of the quality of supply. The regulator adopts Rules for Monitoring Quality of Delivery and Supply, monitors the level of achievement and encourages energy entities to increase the quality of service. On the basis of the achieved level of quality, the regulator establishes new goals, approves funds for their achievement and controls the use of these funds. Transmission and distribution system operators are expected to plan the construction or revitalization of these facilities in their development plans, which are approved by the regulator to upgrade the voltage and reduce the number and duration of supply interruptions. Suppliers have to upgrade their centers for communication with customers and their departments for processing appeals against the level of quality of delivery and supply. The improvement of quality increases system costs and the task of the regulator is to stimulate the achievement of the level of quality adequate to affordable costs (i.e. to electricity price).

The paper presents a short review of the level of quality of electricity delivery and supply that are monitored in Serbia. In addition, the paper offers a review of the most common practices in quality regulation taking into consideration 2015 CEER Report. Special focus is put on new Rules for Monitoring

Quality Indicators that were adopted by the Energy Agency of the Republic of Serbia in 2016 on the basis of seven-year monitoring experience in Serbia. The paper also analyzes the interdependent ability of quality indicators and the maximum allowed revenue (MAR) of the energy entity.

Introduction

General activities of regulatory agencies include the regulation of monopoly businesses to ensure safe, reliable, and quality electricity delivery to the transmission and distribution system users. Transmission and distribution of electricity are natural monopolies and regulation is necessary, while production and supply are competitive activities that require a market. On the other hand, regulators have the task to enhance the development of markets in activities that are capable of competition. From the consumers' point of view, the consequences of the separation of regulated and market activities is that an eligible customer selects suppliers on a free market, whereas purchased electricity is delivered through a transmission and/or distribution system, at regulated prices.

Whether the electricity company performs the activity of transmission, distribution, or supply, the quality of services provided to the network users (i.e., consumers of electricity) should be in accordance with the needs and requirements of users and their readiness to pay for such service. However, experience has shown that under conditions of the competitive market, electric power companies tend to achieve higher profits at the expense of service quality, which in some cases tends to fall below the level

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of quality that is acceptable to users. Decrease of the service quality in the monopolistic activities is the result of regulatory agencies' switching from traditionally applied rate of return method of price regulation to the incentive-based price regulation methods. Incentive-based methods are introduced to stimulate companies to run business more efficiently and to reduce costs by enabling them to earn any savings resulting from an increase in efficiency, as profit the company may then freely expend. Many countries have shown that companies tend in practice to achieve efficiency improvements and cost reductions through a decrease in service quality. To achieve the optimal level of quality and balance between the growing needs of consumers for service quality and companies' aiming to reduce costs and increase profit, the regulatory agencies in recent years paid considerable attention to monitoring and regulation of the service quality in the electricity delivery and supply, development of methods and standards that encourage companies to raise the quality of services. Experience in countries with long-standing regulatory practice has shown that strong incentive for companies to achieve the prescribed level of quality is being achieved by the introduction of financial mechanisms to reward companies in the case of reaching required quality level, and penalize when service quality does not meet the expected level. Therefore, there is a tendency among all regulatory agencies in Europe to introduce incentive-based service quality regulation methods, in line with the implementation of the incentive-based price regulation methods. The liberalization and privatization of utilities have created legitimate concerns on the effect that a generalized prevalence of the profit motivation might have on the quality of the services provided in different network sectors. Also, there is a risk that profit-oriented managers and owners would neglect investments not strictly necessary to the creation of revenues. Moreover, as incentive regulation became the norm, several observers expressed concerns on its effects on service quality: price/revenue cap mechanisms reward the firm for lowering its costs and cost reductions can also be achieved by lowering quality—incentives to reduce quality are certainly

stronger than under cost-of-service regulation.

Quality Regulation

Quality regulation in practice, however, entails complexity and subtleties. A first difficulty is created by the multi-dimensional nature of quality. Furthermore, the ideal level of quality depends on consumer preferences, and these preferences can vary widely among customers. In addition, measuring quality can be difficult; consumer behaviour can affect the quality of the network operation, and so forth. As a result, there is no simple policy indication for service quality regulation: different means are normally used to induce regulated companies to deliver the desired levels of service quality on different quality dimensions. Service quality includes a large number of different aspects. Users are very sensitive to the quality of supplied electricity in terms of:

- Technical quality
 - voltage quality and
 - continuity of supply
- Commercial quality
 - the responsiveness of companies to their requests and needs

Accordingly, the most common regulatory tools are:

- Performance Data Publication
- Minimum Quality Standards
- Incentive-based Methods
- Premium Quality Standards

Even with this classification, it is very difficult to monitor and compare service quality among companies in one country and especially between countries. Service quality regulation tends to focus on regulating outputs; namely, the indicators of those quality dimensions that are more important to customers. However, behind the outputs generated by a regulated company, there is a process concerning decisions on investment, network planning and operation, maintenance programs, and asset management. Again, it is good to point out a distinction between the deregulated market of electrical energy and the regulated market of network operation. In the deregulated market, as competition between retailers is expected to result in the sufficient quality,

there is no need for regulatory authorities to intervene. However, in some cases, a certain level of customer protection is needed. Network operators possess a natural monopoly, free or almost free from competition. The need for protection differs among different types of customers. Usually households and other small customers need more protection. Such protection can be provided through standards. To ensure a sufficient level of quality, a set of Guaranteed Standards (GSs) and Overall Standards (OSs) are needed. Another debated aspect is the incentive regulation for revenues of network operators. This price-regulation method (price/revenue cap, price formula and pricing period) provides the network companies with strong incentives to reduce their overall costs—this accounts also for operational expenditures and capital expenditures—to increase efficiency. A reduction of operational expenditures may result in a decline of the actual quality levels of network services or, at the very least, result in no improvement in line with customers' expectations. This may easily be the result in countries where the principle of incentive-based regulation in network price regulation is there just being developed or could be adopted in the near future, while no service quality standard exists or is supposed to be issued only at a later stage. Here, the involvement of customers and their representatives can make an important contribution to quality regulation; customer surveys can reveal both customer expectations and satisfaction with the current level of service, as well as appropriateness of the regulation already in place. There is also a question as to whether it is appropriate to maintain minimum standards with regard to supply when competition is fully developed, such that companies compete in providing services and performances that exceed these minimums.

CEER

Because this problem has been recognized within the EU, in the last couple of years a lot of work has been done on the harmonization of service quality monitoring and regulation systems. Accordingly, the Working Group for Quality of Electricity Supply within the Council of European Energy Regulators

(CEER) has published benchmarking reports on the quality of electricity supply in member countries for 2001, 2003, 2005, 2008, 2009, 2012, 2014, and 2015. These reports identify major trends in monitoring and regulating service quality aspects. The Benchmarking Report on the Quality of Electricity Supply provides an in-depth review of continuity of supply, voltage quality, and commercial quality. This detailed report analyzes data from EU countries and contributes to a better understanding of the quality of electricity supply levels and policy throughout Europe.

The 5th edition of the report introduces information from 10 new countries, including Switzerland and a dedicated annex on quality of supply in 9 CPs of the Energy Community, full information on national Regulations and their effects in the ECRB countries is available in the annex on "Quality of Electricity Supply in the Energy Community" (CEER, 2012).

Energy Community

The Energy Community (EnC - The Energy Community Contracting Parties are: EU, Albania, Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia, Moldova, Montenegro, Serbia, Ukraine. UNMIK (United Nations Interim Administration Mission in Kosovo), Armenia, Georgia, also Turkey and Norway are Observer Countries) contracting parties (CPs), in the first phase were only monitoring Quality of supply based on the ECRB (Energy Community Regulatory Board) Work Program from 2008. "Report on Quality of Electricity Service Standards and Incentives in Quality Regulation" was published in 2009. As aforementioned in 2011, EnC members participated in the 5th CEER Quality of Supply Benchmarking Report to which the analysis for the EnC CPs—performed based on the CEER benchmarking indicators—was added as an annex. The present benchmarking report represents an annex to the "6th CEER Benchmarking Report on Quality of Electricity Supply," covering the EnC CPs. This report covers all three aspects of quality of electricity supply: Continuity of Supply (CoS), Voltage Quality (VQ) and Commercial Quality (CQ). In general, the present report aims to present an overview and analysis of current practices in the CPs. It also provides an assess-

ment of areas where a move toward harmonization could further improve quality of supply. The analysis for the EnC is based on indicators used by CEER for its benchmarking analysis. To this extent the assessment for the CPs bases on the same definitions and theoretical background as defined for the EU Member States, in particular with a view to ensure comparability. Monitoring was performed through Customer Working Group within ECRB. CPs are working toward a more comprehensive approach in regulation of continuity of supply, some of them, including Serbia, are analysing the possibility to introduce the reward-penalty mechanism (a link between the continuity and tariffs).

Legal Framework

EU

Strong indication of the importance of service quality regulation was given in the Third Energy Package. [Article 37] of Directive 72/09 for electricity indicate, among the duties of a regulatory authority, “monitoring compliance with and reviewing the past performance of network security and reliability rules and setting or approving standards and requirements for quality of service and supply or contributing thereto together with other competent authorities.” An important call for regulation of commercial quality arises from the new EU legislative measures. Indeed, Directive 2009/72/EC [Article 27] requires that Member States shall take appropriate measures to protect final customers, to ensure that they have a right to a contract with their electricity service provider that specifies:

- The services provided;
- The service quality levels offered;
- The time for the initial connection;
- Any compensation and the refund arrangements that apply if contracted service quality levels are not met, including inaccurate and delayed billing;
- Information relating to customer rights, including:
 - The complaint handling and all of the information referred to in this point, clearly communicated through billing or the electricity undertaking’s website.

- Benefit from transparent, simple and inexpensive procedures for dealing with their complaints.
- In particular, all customers shall have the right to a good standard of service and complaint handling by their electricity service provider.

Serbia

The legal framework governing monitoring and regulation of service quality in performing activities of transmission, distribution and supply of electricity, in Serbia is the Energy Law (Official Gazette of the Republic of Serbia No. 145/14) and the Decree on Conditions for Electricity Delivery (Official Gazette of the Republic of Serbia No. 63/13), Transmission Grid Code (Official Gazette of the Republic of Serbia No. 79/14) and Distribution Grid Codes (Official Gazette of the Republic of Serbia No. 4/10, 2/14 and 41/14). The Transmission Grid Code issued by the Serbian Transmission System Operator “Elektromreža Srbije” and Distribution Grid Code issued by distribution companies regulates certain aspects of the service quality, namely technical elements such as voltage, frequency, and continuity of supply to network users and to ensure reliable and continuous delivery of electricity to network users. In addition to these documents, Rules on Monitoring Technical and Commercial Indicators and on Regulating Quality of Electricity and Natural Gas Delivery and Supply (Official Gazette of the Republic of Serbia No. 2/14) are issued by Energy Agency of the Republic of Serbia.

Voltage quality is mainly defined in standard SPRS EN 50160:2010, but aspects of voltage quality are regulated by the Decree on Conditions for Electricity Delivery, which prescribes the obligations of the transmission and distribution system operators to deliver electricity at the nominal voltage and frequency levels. Taking into account the fact that the quality of voltage in the network is affected by the activities of the transmission system operator, as well as by activities of all users who are connected to the transmission network, the Transmission Grid Code defines technical requirements that users’ facilities have to meet in the process of connecting to the transmission network to ensure prescribed voltage quality.

Technical requirements that facilities have to meet in a case of voltage and frequency deviation in the network, as well as the allowed values of over-voltages, current asymmetry and harmonics that may be caused in the network by the user's facility are defined in the Grid Code. Obligations of Distribution System Operators and distribution network users are defined in more details in terms of distribution network voltage quality in the Distribution Grid Code. Main obstacle to monitoring technical indicators of the voltage quality is the lack of appropriate metering systems that would register and monitor voltage characteristics in the network. Commercial quality is in some parts of mutual relations of the transmission/distribution system operators and customers regulated by the Energy Law and the Decree on Conditions for Electricity Delivery through certain standards that regulate the mutual obligations, primarily the deadlines that energy entities and users have to respect in the procedures of connection to the system, suspension of electricity supply, disconnection from the system, meter testing and inspection, resolving disruptions in the delivery, meter reading, billing and collection, and informing the users. For example, the Energy Law and the Decree on Conditions for Electricity Delivery stipulate the minimum standards guaranteed in terms of the time frames that companies must respect in the process of connecting users to the transmission and distribution network. As of January 1, 2009, the Energy Agency has introduced information rules (Information Code represents a set of Excel tables that define the type, scope, and format of data on technical and commercial aspects of service quality that companies must follow, as well as deadlines within which the collected data must be submitted) for the registration of data and calculation of service quality indicators in the activities of transmission, distribution, and supply of electricity. Continuous application of these rules in the previous seven years allowed for the creation of a complete and consistent database of quality indicators, companies' performance benchmarking depending on the quality and performance achieved and made room for new rules on regulation of service quality in electricity delivery and supply.

Consistent with the obligations prescribed by the law, the Council of the Agency adopted Rules on Monitoring Technical and Commercial Indicators and on Regulating Quality of Electricity and Natural Gas Delivery and Supply (Rules on Quality) in 2013. Rules on Quality were adopted on the basis of the five-year experience in data collection and monitoring electricity delivery and supply quality indicators as well as of international practice in the quality monitoring of services provided by energy entities. The rules were established to harmonize the method of data registering and calculation of quality indicators, which enables the establishment of a base of complete, reliable, and comparable data on the indicators to compare and regulate them. The collected data and calculated indicators will enable the definition of demanded indicators' values in future phases and the method of assessment of the quality that has been reached. Upon that, the procedure in case of deviation from demanded indicators' values, depending on the deviation level, will be also defined afterward. In the electricity field, the collection of data on delivery and supply quality was initiated six years ago. This is when the type, scale, and format of the data on technical and commercial aspects of quality that have to be collected by energy entities were defined. The Code also defined the deadlines for the submission of the data to the Agency. These data served for the calculation of indicators of technical and commercial aspects of quality in electricity delivery and supply field. Having the requirements of the Agency as a basis, most distribution companies have improved their practice and infrastructure necessary to register data, calculate indicators, and provide data on quality, especially in the field of registering continuity of supply.

Quality Indicators

Continuity of Supply

The continuity of electricity supply, which is characterized by the number and duration of electricity delivery interruptions is monitored regularly by the energy entities dealing with electricity transmission and distribution. The entities submit monthly re-

ports to the Agency for each unplanned and planned interruptions within the transmission and distribution grid, which lasted more than three minutes. Annual indicators of delivery continuity in the transmission and distribution grid for unplanned and planned interruptions 2009-2016 were calculated.

Transmission Network

Indicators of discontinuity of delivery in the transmission network that are monitored and calculated are the following:

- Pi [MW]: Total capacity disconnected during interruption (Fumagalli et al., 2007).
- ENS [MWh]: Energy not supplied. The energy not supplied to a customer is the integral, over the duration of the interruption, of the total capacity disconnected during interruption (capacity indicated in the customers load curve. EN Si for the interruption event i will be the sum of the energy-not-supplied to all the affected customers in the area. total undelivered electricity) (Fumagalli et al., 2007).
- ENS [%]: ENS is presented as energy not supplied as a percentage of the total energy supplied by that system in a given year (CEER, 2005).
- AIT [min]: Average interruption time is duration in minutes, a quotient of undelivered electricity and average power. AIT is expressed in minutes per year and calculated as 60 times the ENS (in MWh) divided by the average power supplied by the system (in MW) (CEER, 2012).

Distribution Network

During the monitoring period, based on the data on unplanned interruptions, the electricity distribution system operator calculates and lists the following data separately in the table:

SAIFI: System Average Interruption Frequency Index, which is calculated as a quotient of the total number of electricity delivery interruptions and the total number of electricity delivery points within the distribution system and a part of the distribution system;

SAIDI: System Average Interruption Duration Index, which is calculated as a quotient of the total duration of delivery interruptions on all electricity de-

livery points and the total number of delivery points within the distribution system and a part of the distribution system.

The system operator records the total duration, the time when an unplanned interruption in electricity delivery from the producer to the system begins and ends, as well as the causes of interruption (an event within the system operator's facilities, within producer's facilities, force majeure, etc.).

The system operator also calculates and lists the following data in a relevant table:

- Pp: Outage power, total capacity disconnected during interruption for each unplanned interruption;
- ENPp: Producer's Energy - Not - Supplied, which is calculated for each unplanned interruption as a product of "Outage Power" and the duration of interruption in minutes;
- Nip: Number of delivery points that were unsupplied, number of delivery points (of final customer, neighboring system, etc.), which were unsupplied due to interruptions in electricity delivery from the producer, for each unplanned interruption.

Commercial Quality

The fact is that some commercial quality aspects (e.g., times for connections) relate to distribution networks and therefore, given their monopolistic nature, they should still be regulated. In a liberalized electricity market, the customer concludes either a single contract with the supplier (SP) or separate contracts with the supplier and the system operator (DSO or TSO), according to the existing national regulations. In both cases, however, commercial quality is an important issue. Commercial quality is directly associated to transactions between electricity companies (either DSOs, TSOs or suppliers, or both) and customers, and covers not only the supply and sale of electricity, but also various forms of contacts established between electricity companies and customers. There are several services that can be requested or expected by customers, such as new connections, increase of the connection capacity, disconnection upon customer's request, meter reading and verification, repairs and elimination of voltage quality problems, answering phone calls, etc. Each of these ser-

vices is a transaction that involves some commercial quality aspect. The most frequent commercial quality aspect is the timely response to services requested by customers.

Guaranteed Standards (GSs) refer to service quality levels that must be met in each individual case. If the company fails to provide the level of service required by the GS, it must compensate the customer affected, subject to certain exemptions.

The definition of GSs includes the following features:

- Performance covered by the standards (e.g., estimation of the costs for the connection);
- Maximum time before execution of the performance;
- Commonly determined in terms of response;
- Fulfilment time (e.g., five working days); and
- Economic compensation to be paid to the customer in case of failure to comply with the requirements.

Overall Standards (OSs) refer to a given set of cases (e.g., all customer requests in a given region for a given transaction) and must be met with respect to the whole population in that set. OSs are defined as follows:

- performance covered (e.g., connection of a new customer to the network);
- minimum level of performance (commonly in percent of cases), which has to be met in a given period (e.g., in a 90 percent of new customers have to be connected to the distribution network within 20 working days).

Other Available Requirements (OARs)

In addition to GSs and OSs, regulators (and/or other competent parties) can issue requirements to achieve a certain quality level of service. These quality levels can be set as the regulatory authorities want (e.g., a minimum level that must be met for all customers at all times). If the requirements set by the regulators are not met, the regulatory authorities can impose sanctions (e.g., financial penalties) in most of the cases.

Only Monitoring (OMs). Before issuing GSs and OSs, regulators (and/or other competent parties) can monitor performances of DSOs, suppliers, universal

suppliers and metering operators, in order to understand the actual quality level and to publish—when deemed appropriate—the actual data on services provided to the customers.

Main Groups of Commercial Quality

To simplify the approach to such a complex matter as commercial quality, indicators relating to commercial quality have been classified into four main groups:

1) Connection

- Deciding upon filed requests for the issuance of an approval for connection, including the deadlines for acting upon appeals filed against an act of a first instance body (appeal approval or dismissal);
- Connecting a facility to a certain voltage level when a final customer complies with all prescribed conditions for the connection of a facility and setting an average timeframe necessary for the connection of a facility to the system;
- Adopting an argued certificate when the operator dismisses requests for access, including deadlines for acting in line with appeals filed against the first instance body (appeal approval or dismissal);
- Suspending delivery to a final customer upon a supplier's request;
- Restoring electricity delivery to a final customer's facility upon removal of reasons that lead to suspension (i.e., approval of objection to suspension or disconnection).
- Submitting contract on electricity sales to a final customer within a prescribed deadline from the day the supply of the last resort was initiated;
- Notifying on the day when a customer loses his right to the supply of the last resort before the right to the supply of the last resort is terminated.

2) Customer Care

- Submitting an admonition to a final customer prior to delivery suspension;
- Submitting a notification to a final customer before a facility is disconnected from the system unless it is disconnected because it may jeopardize

human life and health;

- Submitting a notification on the day when the operator will disconnect a facility upon a request of a final customer;
- Acting upon an objection filed due to the suspension or disconnection of a facility from the system;
- Submitting a warning to a final customer to comply with due contracting obligations regarding payments a day prior.

3) Technical Service

- Technical service includes indicators that are related to technical service. All indicators relate to distribution activities; therefore, the standards of Group III exclusively refer to DSOs. Coping with voltage complaints normally involves two steps. The first step in the remedy of voltage complaints is to verify, through performing measurements, whether any regulation or norm in force has been violated. The second step of the remedy is the correction of voltage problems through appropriate works on the networks. It is important that any customer complaint related to voltage disturbance is rectified without undue delay. Part of this includes implementing temporary measures when and where appropriate. The exact time needed to rectify the problem or to implement temporary solutions will vary a lot and will depend on the complexity of the situation. "Time between the date of the answer to the VQ complaint and the elimination of the problem. Removing disruptions in delivery that are not caused within a final customer's facility."

4) Metering and Billing

- Time for meter inspection in case of meter failure;
- Time from notice-to-pay until disconnection;
- Information on disruptions or damages of a meter within a facility of a final customer; including the deadlines for removing them since the day they are being noticed (i.e., since a notification was sent to a final customer);
- Acting upon an objection of a system user against the submitted bill on the service of system access;

- Acting upon objections of final customers filed against a supplier's bill;
- Yearly number of meter readings by the designated company
- Time for restoration of power supply following disconnection due to non-payment.

Voltage Quality

Information rules for monitoring the voltage quality are based on collecting commercial data on:

- Number of customers' voltage complaints
- Response time to customers' voltage complaints
- Number of justified customers' voltage complaints
- Number of resolved voltage problems.

Present Situation in Serbia

From 2008, service quality indicators have been individually analysed by the Serbian Energy Agency when deciding users' appeals against refusal of connection to the transmission/distribution network rather than collecting or monitoring them on a regular basis. On the other hand, the electricity transmission/distribution entities register and analyze the performance achieved and accordingly have data available for the calculation of service quality indicators. However, systems for registration of data and calculation of service quality indicators were not harmonized among different network companies, resulting in incomplete, inconsistent and non-comparable data that cannot meet the requirements of successful benchmarking of companies' performances depending on their quality level reached. Accordingly, before the service quality monitoring and regulation system was implemented by the Agency it was necessary to implement amendments to the Energy Law, which clearly defined the responsibilities of individual institutions within the area of regulation of service quality. As of January 1, 2009, the Energy Agency has introduced information rules for the registration of data and calculation of service quality indicators in the activities of transmission, distribution, and supply. Continuous application of these rules made possible creation of a complete and consistent database of quality indicators, companies' performance benchmarking depending on the quality

and performance achieved, and regulation of service quality in electricity delivery and supply, until 2013 when Rules on Monitoring Technical and Commercial Indicators and on Regulating Quality of Electricity and Natural Gas Delivery and Supply were issued by the Energy Agency of the Republic of Serbia.

Continuity of Supply

Information rules for monitoring the continuity of supply included rules for:

- 1) Registration of interruption, and
- 2) Calculation of continuity of supply indicators.

Rules for registering interruption defined which data on interruption had to be registered and by what criteria. In the case of a planned interruption, it was

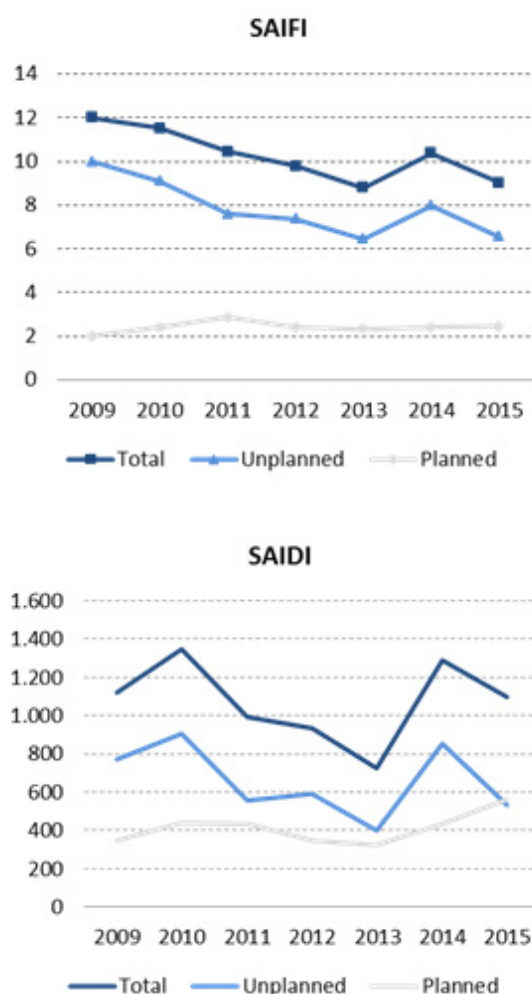
necessary to specify whether the cause of the interruption was due to works in one's own network, users' facility, or neighboring network. For unplanned interruptions, it was required to register if an interruption occurred because of: network operator's activities, activities of the other network operator, third party, animals, force majeure, or of unknown causes. Based on the data collected in this way, indicators of continuity of supply are calculated. For interruptions in the transmission network, continuity indicators AIT and ENS are calculated, whereas for interruptions in the distribution network, continuity indicators SAIDI, SAIFI, and CAIDI are calculated. A lack of harmonization in the basic monitoring rules is also identified, but it is not predominant. The lack of emphasis on monitoring of continuity at the transmission level in some CPs may be result of an underestimation of its importance due to the robust network design enabling high reliability ("n-1" operational criteria), apparent low number of customers connected to the transmission network, the problem of weighting (atypical customers, specifics in calculation of certain continuity indexes), and the estimation.

Commercial Quality

Information rules for monitoring commercial quality are based on collecting data on:

- The number of requests from users/customers
 - The number of company's responses to requests of the users/customers within the prescribed period and average response time of the company to user/customer request, in providing on-time services;
 - Deciding request for connection to the transmission or distribution network of electricity based on:
 - » the existing legal framework;
 - » international practice in monitoring and regulation of service quality;
 - » company's existing practices with regard to data collection;
 - » informal monitoring of the needs and demands of users/customers, aimed at:
- Harmonizing of rules for recording data and calcu-

Figure 1. SAIDI and SAIFI for the period 2009-2015



lation of service quality indicators;

- Continuous monitoring service quality indicators;
- Connecting the user's facility to the transmission or distribution network;
- Regular services;
- Billing and collection;
- Occasional services;
- Suspending electricity supply;
- Disconnecting from the system;
- Resolving metering problems;
- Resolving voltage problems; and
- Responding to users/customers questions and requests.

Voltage Quality

The survey in the Energy Community has shown that CPs are undertaking activities towards implementation of EN 50160 as the main instrument for voltage quality regulation. EN 50160 has been introduced in the majority of CPs, mainly as a voluntary standard or through national legislation and regulation, either through a reference to EN 50160 or by adopting the limits given in EN 50160. However, voltage quality regulation is still primarily applied only on LV and MV level. Main obstacle to monitoring technical indicators of the voltage quality is the lack of appropriate metering systems that would register and monitor voltage characteristics in the network. Improvements are needed in Voltage Quality regulation, although there is no metering on distribution level, and there is a clear picture there will be none until smart meters are implemented.

Development Prerequisites

International experience in the monitoring and regulation of service quality has shown that the introduction of systems for monitoring and regulating service quality is the long-term process that requires gradual implementation in accordance with the knowledge of the regulatory authorities and energy entities, development of metering and information systems, databases, and relevant legislative framework. Given the complexity of this process, the implementation of a system for monitoring and regulation of service quality must take place through active

participation and cooperation of all relevant institutions both within countries and internationally. Implementation of quality standards, accompanied by compensation payments in the event companies fail to meet prescribed standards, is possible according to new Energy Law and modifying the Rules on Monitoring Technical and Commercial Indicators and on Regulating Quality of Electricity and Natural Gas Delivery and Supply. Apart from changes to the legal framework, a period of several years of continuous monitoring of quality indicators based on rules harmonized among companies was necessary to precede the implementation of the system for quality regulation.

Adoption of the new 2014 Energy Law, which fully transposed the Third Energy Package, was the basis for the adoption of new Rules on Monitoring Technical and Commercial Indicators and on Regulating Quality of Electricity and Natural Gas Delivery and Supply.

On the other hand, in the past six years, quality monitoring improved the methods for data collection and storage significantly. The adoption of the Rules in 2009 encouraged and forced system operators to develop metering systems so as to get more precise input data for the determination of quality indicators. Besides, databases have been developed and all the dilemmas and weaknesses of the data collection methods have been removed in the past. Therefore, a more efficient quality benchmarking of system operators in Serbia was enabled. Both in legal and technical terms, all the above has provided a good background and preconditions to bring the monitoring of quality on a higher level. In this way, it became possible to introduce a penalties scheme for system operators in Serbia.

Energy Agency is in the process of adopting new version on Rules on Monitoring Technical and Commercial Indicators and on Regulating Quality of Electricity and Natural Gas Delivery and Supply. For the first time in Serbia, the regulator will introduce penalties when quality indicators values are below expected values. Introduced penalties will have an impact on the maximum allowed revenue that is determined by Methodology for Setting Tariff Elements

for Calculations Prices for Access to and Use of System. Methodology determines ways of setting tariff elements for calculating prices for access to and use of system for electricity transmission and distribution systems. Methodology is based on the mechanism for use of electricity system price control; that is, by application of the regulatory “cost plus” method used.

Maximum allowed revenue in the regulatory period for energy entity for electricity transmission (distribution) and operation, i.e., the price, that enables a return on justified operating costs as well as a return on assets employed.

Maximum allowed revenue of energy entity is allocated to tariff elements based on:

- 1) Planned energy parameters, structure and values of energy facilities, and
- 2) Contribution of variable and fixed costs to the total costs of energy entity.

Conclusions

The comparative analysis of the monitoring schemes and the continuity of supply regulation across European Union through CEER benchmarking reports or even CPs of Energy Community and Serbia, shows that regulators have generally approached continuity issues with emphasis on long interruptions first, treating the planned and unplanned interruptions separately. Distinction is made between different voltage levels and the classification of the interruptions by its cause is applied. In Serbia, the number and duration of interruptions are available and harmonized combinations of indicators (SAIDI, SAIFI) are used as in most European Countries. Unfortunately, short interruptions are barely recorded in Serbia. The same situation exists in most CPs of Energy Community, and in some EU countries.

In Serbia, monitoring of long interruptions on transmission and distribution networks is on a satisfactory level. In the beginning of 2008, there were a lot of barriers, lack of metering, not precise qualification of the data causes, etc. The problem that persists is in the definition of force majeure or exceptional events, like in all countries. Compared to EU countries and values of indicators that are presented in

the last CEER benchmarking report, Serbia has higher values of all indicators than EU countries. On the other hand, there is significant improvement in monitoring: all of the misunderstanding in definitions of indicators and misleading information on monitoring are eliminated. Commercial quality monitoring has significantly improved since 2011, although values of some indicators are still far from EU countries’ levels. As we can conclude, now, when definitions are well set and with good monitoring practice in place, it is a good time to start implementing a new Rules on Quality Monitoring based on a penalties mechanism as a link between tariffs and incentives.

References

Jasmina Trhulj: Service Quality Monitoring and Regulation,” International Conference on Deregulated Electricity Market Issues in South-Eastern Europe-DEMSEE, Belgrade, Serbia, 2009.

E. Fumagalli, L. Lo.Schiavo, F. Delestre: Service Quality Regulation in Electricity Distribution and Retail (Springer Berlin, 2007), pp. 53.

Third Benchmarking Report on the Quality of Electricity Supply (CEER, 2005), pp. 25.

5th CEER Benchmarking Report on the Quality of Electricity Supply (CEER, 2012), pp. 3, 32.

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Milica Brkić Vukovljak has more than 10 years of experience in the Serbian energy sector. She has been an Electricity Expert in the Energy Agency of the Republic of Serbia since 2013. Prior to her engagement in the agency, she worked in the Serbian transmission system and market operator for 10 years, mostly in the Market Department as an allocation manager. She worked in the Serbian national transmission system and market operator for seven years, mostly in the Market Department as an allocation manager. She holds a Certificate of Completion from the Florence School of Regulation 2014 and FSR Trans European Energy Networks Regulation Course 2016. She graduated from the Faculty of Electrical Engineering at the University of Belgrade in 2004.



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Ljubo Mačić has been the President of the Council of the Energy Agency of the Republic of Serbia since 2005. From January 2008 to March 2010 he was the President of the South East Europe Energy Community Regulatory Board.



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He was a member of government committees for energy strategy, energy prices, power sector restructuring, etc. He is also the author of many papers about energy development issues, restructuring, energy market and organization of the energy sector, energy efficiency, and environmental issues.

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Ljiljana Hadžibabić

She completed Mathematical Grammar School and the Faculty of Electrical Engineering in Belgrade in 1978.



From 2005 until being elected a Council Member, she worked in the Energy Agency as the Head of Energy and Technical Department. She primarily deals with electricity and natural gas market. Prior to her engagement in the Agency, she worked in the Electric Power Industry of Serbia (Elektroprivreda Srbije) for 24 years. She was appointed Assistant Minister in the Power Department and was employed by a consultancy organization, Energy Saving Group from Belgrade.

In Elektroprivreda Srbije, she held different positions, primarily involved in transmission network analysis and operations, maintenance, and development of power plants.

In the Ministry of Mining and Energy (December 2002–May 2004), as the appointed Assistant Minister in the Power Department, she participated in the power sector restructuring process and in the preparation phase of the power market establishment in Serbia.

In Energy Saving Group, Ms. Hadžibabić was engaged in the preparation of the documents for the establishment of Elektromreža Srbije and in the preparation of draft bylaws.

Local Energy in a Transforming Energy System

Kevin Baillie, Christopher McDermott, Thomas Bearpark, and Karen Mayor

Abstract

Local energy, and the overlapping concept of community energy, are growing features of the GB energy system. Local energy projects have a range of characteristics and often cut across traditional sector boundaries such as generation, supply, and consumption. These schemes stem from the desire to involve local communities in delivering energy outcomes and, in many cases, contribute to broader local social, economic, and environmental objectives.

In this paper, we assess the current local energy landscape and the market entry models that are emerging. We focus on those involving supply to local or community groups, including with associated generation, not on issues associated with distributed generation more generally. We consider the potential benefits and risks for consumers and the implications for us as a regulator.

We conclude that the emergence of local energy is a welcome development and one that is likely to increase consumer engagement and choice. We recognize that local schemes need proportionate treatment and that regulatory arrangements should enable the emergence of business models that are in the long-run interests of consumers. But that should not be at the expense of customers who aren't included in a local scheme and will need to provide appropriate protection (such as opportunities to switch) if service standards and value aren't maintained to the satisfaction of those customers.

The views expressed in this paper are emerging thinking from the project and do not represent established Ofgem or Gas and Electricity Market Authority positions.

What is Local Energy?

Introduction

'Local' means different things to different people. From an administrative perspective, local can mean anything from a neighborhood to a local authority district, a city, or even reach across different administrative boundaries.

In energy terms, there's no universally accepted definition of 'local energy,' nor a comprehensive register of schemes. The phrase may refer to arrangements that operate at a scale lower than the traditional centralized model, such as generation connecting at the distribution level (also known as embedded or decentralized generation). But it is also used to describe energy activities that explicitly set out to maximize social benefits for people or organizations in a specific geographical area or community. There are overlaps between local and community energy and differences, too. In this paper, we focus on models that address the needs of local groups of energy consumers.

So, for the purpose of this paper, we define local energy as

Energy arrangements led by (or for the benefit of) a local group and for the benefit¹ of local consumers. A local group is a collection of people and organizations with shared interests in local energy outcomes within a common geographical area.²

What's Driving Local Energy?

As with any business model, local energy schemes require a financially viable business case, which may hinge on support schemes or incentives. However, many projects are also driven by other considerations

often concerned with consumer involvement and maximizing benefits within a local area; these include:

- Devolution: For some projects, the broader devolution agenda is an underlying motivation for a move away from the current centralized system.
- Consumer preferences and involvement: A powerful motivation for some consumers may be the desire to be more independent and have greater control over their own energy affairs.
- Trust: General consumer dissatisfaction with larger energy utilities may mean a greater proportion of those disengaged consumers willing to engage with entities they trust (such as local authorities).

The benefits of local energy schemes for the developer and for consumers will depend on the type of project, locational characteristics, and the relevant commercial arrangements that provide a value stream. It does not necessarily follow that all local models can be scaled significantly or replicated in areas without similar characteristics.

Consumer and Retail Market Implications

Retail Market Developments

Many local energy schemes can enhance consumer choice and competition. The GB supply market has diversified significantly over the last decade. Independent suppliers now have a 14 percent share of the electricity supply market, compared to just 1 percent in 2012.³ Between December 2012 and March 2016, the number of active domestic gas or electricity suppliers more than doubled from 20 to 43.

We're seeing new types of suppliers with an explicit local benefit focus (although their market activities extend GB-wide). Other local authorities and community groups have entered into white-label-type arrangements with existing suppliers to provide energy to their consumers.

At the same time, retail market regulation is moving from a prescriptive rules-driven environment to one based more on principles.

Accessing Consumers

At present, there are five main regulatory options for supplying end consumers. These options are summarized in Table 1:

Market Entry		Features
Route	Model	
Direct	Licensed Supplier	<p>Licence awarded by Ofgem for gas and/or electricity and domestic and/or non-domestic consumers.</p> <p>Obligations include consumer protection, social and environmental obligations, industry code compliance.</p> <p>Duty to offer terms to all domestic consumers that request them.</p> <p>A restricted supply licence (by location or consumer type) may be sought.</p>
	Licence Lite Supplier	<p>Reduces entry costs by outsourcing some code compliance to another supplier.</p> <p>Supplier is fully licensed and responsible for all other aspects of licence.</p>
	Exempt Supplier	<p>Legislation allows supply without a license up to certain thresholds and in particular circumstances.</p> <p>Requires commercial agreement with a licensed supplier to provide key industry services.</p> <p>Consumer protection measures set out in legislation.</p>
Indirect	White Label	<p>Partnership between licensed supplier and third party to offer branded tariffs.</p> <p>Models vary, but the white label typically recruits and manages the consumer interface. Licence requirements, including code compliance and consumer protection, sit with the licensed supplier.</p>
	Sleeving	<p>Licensed supplier provides commercial peer-to-peer services for participants.</p> <p>Used by corporates with own-generation on one site seeking to supply load on another. Supplier manages the imbalance risk.</p>

Regulatory Implications of the Growth of Local Energy Supply

The scale of local supply activity is currently limited; however, interest is growing steadily. Community energy schemes accessing feed-in-tariffs are growing in numbers and many are keen to supply their power directly to their local area. Local providers can offer new choices to consumers, enhance competition, and bring pressure on incumbents to better understand and respond to their customers' needs.

The traditional GB licensed supplier model tends not to be a viable proposition for very small-scale supply-compliance with industry codes; in particular, requires significant upfront costs. Instead, many schemes are exploring commercial white-label and sleeving-type arrangements with licensed suppliers and exempt-supply options.

Among the regulatory issues we see are:

- Whether suppliers should be allowed to supply only local customers.
- Whether off-grid models should be welcomed as promoting energy independence.
- Whether exempt supply undermines consumer protection.
- How local suppliers can offset key risks such as energy imbalance.
- How new business models alongside supply will alter the position.

We address each in turn before summarizing the overall challenges to regulation.

Local-only?

A local offer suggests that some domestic consumers might be 'in' and others 'out.' Although localized approaches may lead to more services specifically tailored to the needs of those experiencing vulnerability, there is also the potential for models seeking to offer services only to more active, lower-risk consumers.

Licensed energy suppliers are currently subject to a duty to supply and have to offer terms to any domestic consumer that requests them. This requirement is in place for good reason, ensuring that consumers aren't cherry-picked. However, in a more diverse supplier landscape, arrangements that allow

supply exclusively to a subset of consumers may help to deliver the benefits of local.

Energy Independence

Some consumers desire greater control over their energy affairs and more independence from familiar utility arrangements, and some may be willing to pay a premium for this capability. Greater control and independence could serve the interests of those consumers.

Historically, 'off-grid' micro-grids have emerged to serve the needs of communities which could not feasibly connect to the national grid. However, if consumers place increasing value on independence we may see them choosing off-grid solutions even where a national grid connection is available. Under this scenario, households may make an informed choice to forego some of the benefits associated with a grid connection, such as the ability to choose a different supplier, etc. We should also be mindful to broader consequences, for example, subsequent occupiers may inherit this choice.

Offsetting Risk

Under many of the models described, the local energy supplier outsources responsibility for imbalance risk to the licenced supplier and is charged accordingly. To enhance the value and viability of smaller-scale business models, some are integrating small generators, consumers, and demand-side providers into virtual private networks (VPN). These aim to reduce risk by closely matching the available generation and load in aggregate. The risk of imbalance for the parties could, therefore, be lessened, reducing the costs incurred by National Grid to balance the system and the imbalance charges for which the parties involved in the VPN would be liable.

New Business Models

The transformation facing the energy system may lead to the advent of new business models built on third-party intermediaries, peer-to-peer, flexibility services, and multi-utility bundled services. This may raise fundamental questions about the function of supply, the roles of suppliers and consideration of

which activities should be licensed. In answering these questions, we believe that to maximize consumer benefits, regulatory structures (e.g., licencing, industry codes, etc.) should not unduly prevent the emergence of business models (local or otherwise) that are in the long-run interests of consumers. Our current move to a more principle-based form of regulation could improve the regime's compatibility with a more general legislative or authorization-based regulatory framework, if we were to move away from licences.

Overall Challenges to Regulation

The developments set out previously raise some difficult questions that we, consumer groups, government, and broader civil society will need to wrestle with:

a) Is it in consumers' interests for greater consumer differentiation/segregation (by location or other characteristic)?

b) Should the right to consumer choice be a universal principle?

c) New approaches may bring with them new risks; should all consumers bear the risk of failure of these approaches, or only those that benefit?

d) Should domestic consumers expect the same standards of protection irrespective of the type of service or provider they choose?

e) Conversely, should consumers be allowed to choose less protection if they determine the benefits are worth it?

Although we do not want to prejudge this debate, it seems to us that guiding considerations should be to reduce entry barriers where practical and that one consumer's choice should not be constrained unfairly as a result of the choices of other consumers.

Network Impacts and Implications

Introduction

There are unique features of the electricity system that make understanding the implications of local energy models more complex compared to most other products/sectors.

The electricity system is an interconnected system

that needs to be balanced continuously in real-time. Electricity can be produced using different technologies and consumed in a range of ways, but once produced, it is a homogeneous product that flows in accordance with physical laws, not commercial arrangements. In this sense, 1 MW flowing through the network is the same as any other, regardless of whether it's produced by a local energy project. As system and network impacts arise regardless of the commercial relationship involved, the impacts on the system for a given generation and consumption pattern are unaffected by commercial characteristics such as a local supply model. Of course, commercial arrangements may cause changes in generation and consumption patterns.

What are the Potential Network Benefits of Local Energy?

The pattern of generation and consumption on a network can affect the costs of the network in two main ways:

- **Network losses:** Reducing flows on the network by matching generation and demand, particularly at times of high energy flows, has benefits to consumers through reducing losses and therefore costs. However, adding generation in a generation-dominated area (or the equivalent for demand) will increase losses. To a large degree these benefits are already factored into the market arrangements we have, and are independent of whether the local generation is contracted with local customers or not—only the physical location, quantity, and timing relative to the system matter.
- **Network constraints and investment:** Again, reducing flows, at times when local peak flow approaches system capacity, can help avoid situations where network constraints are reached, and hence avoid costly action. Reinforcement investment is driven by expected future capacity limits (constraints) being reached, so deferring investment is the longer term analogue of avoiding constraints. Whereas the regulatory framework enables network companies to remunerate these benefits, this practice is currently not well established.

At present, aggregate flows on GB electricity networks are falling, so in most locations capacity limits and constraints are not a current issue and the benefits of action to avoid them are low. However, in some locations either demand or generation may be increasing toward capacity limits and the benefits of avoiding constraints or deferring investment can be substantial. With the expected growth of electric transport and heating, locational hotspots and flexible options to resolve them are likely to increase substantially.

In both cases, it is important to consider impacts on network costs, rather than the short-hand of ‘use’ of the network, or a particular part thereof. Most network costs are sunk and fixed, and not reduced through lower network flows. It is often misleading, in terms of economic signals, to focus on ‘use’ of the network.

As noted in the previous chapter, balancing generation and consumption can also help reduce energy imbalances managed by the system operator. Again, the costs and benefits relating to imbalance are reflected in current market arrangements (i.e., available to market participants). Nonetheless, local markets or local balancing arrangements that allow local suppliers to better manage the risks they face (such as imbalance risk) are valuable, not least because simpler access requirements can increase the ability of smaller businesses to participate.

The network benefits that local projects might create are not, therefore, universal; they are determined by the prevailing physical system characteristics and consumer behaviors in a specific area and can change over time (real-time, daily, seasonally, etc.).

Implications for Network Regulation

Similar to retail markets discussed previously, the growth of local energy may challenge ‘status quo’ regulatory arrangements for networks and the wider system.

We want to ensure as far as possible that our regulatory framework provides a level playing field for all business models, fairly reflecting cost and benefit impacts. We recognize some regulatory change may be needed to facilitate this—particularly to reflect

the value of relieving constraints and deferring investment where that applies. We also note potential interactions with recovery of sunk and fixed network costs. The remainder of this chapter explores these two issues.

Incentives to maximise the value of local projects

We want to ensure that the growth of local energy is incentivized where system benefits can be realized. This will depend on incentives and price signals that are reliable over investment time-frames. The main options for providing this signal are a contract with or tariff from the network company/system operator, which signals the value of the project to the system, or an established liquid market.

Contractual relationships and geographic variation in tariffs are feasible in the near term to reflect the network benefits of local resources—albeit more practical experience is needed to establish these as common practice. We see some interesting developments beginning to emerge, but more action is needed at both the distribution network operator (DNO) and national level.

An interesting alternative solution is that, if market conditions (and technological capability for local trading infrastructure) permit, liquid local markets could emerge. This would involve a system of local trading and balancing, analogous to the way national balancing arrangements work (where we try to keep as much balancing activity as possible in the market).

For this to work at local levels, there would need to be a high penetration of local trading (which may occur in some situations but seems less likely to be widespread in the next few years) or a system of pricing signals that allows generation and demand to operate independently. We see more prospect for local balancing to emerge as a response to wholesale market price signals rather than network constraints. This will allow local energy projects to net-off their contractual obligations cost effectively rather than having a large supplier balancing for them.

Network cost recovery arrangements

Although some consumers may wish to completely defect from the grid for non-cost related reasons, it seems unrealistic that we will see such a shift from the majority of GB consumers, even if we look decades ahead. A more likely outcome (in the short term at least) is the emergence of local micro-grids, where parties may seek to avoid certain network costs but still maintain a connection to the grid (either as an ‘insurance policy,’ or to sell surplus generation).

Parties engaging in these models, or proposing virtual alternatives across the network, are already seeking to offer discounted tariffs to consumers, for example, by only paying for (and hence needing to recover) the marginal cost of their activities. In particular, they seek to avoid paying for the sunk costs associated with pre-existing network infrastructure.

From a regulatory perspective, this highlights the fundamental tension between economic efficiency and fairness. There are efficiency arguments for charging consumers (including local energy consumers) only the marginal impact of their activities. However in practice, continued growth of these models could have considerable implications for how other network costs are recovered. Whilst the immediate consumers of such local schemes will benefit from reduced costs, the remaining consumers may increasingly have to pay a higher proportion of the costs of the infrastructure needed to maintain this essential service for all consumers. These changes in cost burdens seem likely to have distributional effects—for example with relatively less well-off consumers being less able to take advantage of such offerings and bearing higher costs as a result.

We believe that making incremental price signals as cost-reflective as possible and minimizing distortions from the recovery of fixed and sunk costs will lead to the most robust system possible, to foster sustainable business models (including local energy) that deliver value to the system, to market participants and to consumers.

Where consumers are able (and willing) to change their energy arrangements to realize the benefits of local energy (e.g., by avoiding certain network costs), we consider:

a) Network cost charging models should reflect the value (and cost) of any connection to the main network being predominantly in the form of ‘insurance’; and,

b) On efficiency grounds, distortions are minimized if network users who have more realistic options to avoid costs make less contribution to revenue recovery, so that they do not act to avoid costs entirely (for example by moving to a private wire or behind the meter arrangement that is less efficient). This would ensure the broader consumer experiences a smaller cost increase than could otherwise be the case if those with the choice decided to defect from the grid. In translating these considerations into specific regulatory decisions, considerations other than economic efficiency (such as distributional consequences) will be important.

Conclusions

This paper explored the complex and rapidly evolving world of local energy. In particular, we have sought to illuminate and identify some of the circumstances in which they may drive consumer benefits.

We believe that the viability of local energy models should be founded on improving consumer outcomes. Consumers should be fully informed about the choices they are making and the potential risks and rewards. The viability of projects should not be based on avoiding fair contributions to the system’s shared infrastructure. In general, consumers’ interests (standards of protection, market and system integrity) are likely to be better served by all consumers being part of an integrated system that allows for diversity of size and scope. Where possible, we aim to ensure that price signals are cost-reflective, and to use a market-based approach to investment allocation. All of these requirements can be delivered through local balancing or market arrangements, provided they are designed with those requirements in mind.

The regulatory framework will need to evolve to ensure consumers’ interests are realized in the future energy system. Although no-one can be certain about what the system will look like, we believe that we can best protect consumers’ interests by adopting a flexible

approach to regulation which relies on learning over time. Moving toward a regulatory framework based more on principles and outcomes seems likely to be more robust to future developments. At the same time, we will need to ensure that regulatory arrangements enable the emergence of business models that are in the long-run interests of consumers.

End Notes

- 1 In this context, a benefit can relate to enhanced local energy outcomes, or broader social, economic, environmental, or other outcomes identified as an objective by the local participants.
- 2 The geographical scale of local is ultimately determined by the shared interests of the parties involved. The shared interests of some parties might mean that they develop schemes that operate across different DNO borders (possibly some local supply schemes). But it is more likely that local schemes will operate in areas smaller than individual distribution licence areas.
- 3 Information about supply market shares is available [here](#).

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Energy Market Reform and Surveillance Commission in Japan

Takehiko Matsuo and Yutaro Fujimoto

Since the Great East Japan Earthquake in 2011, Japan has undertaken significant energy market reform. The reform consists of multiple steps. As of April 1, 2017, the electricity and gas retail markets were fully liberalized, and our regulatory commission, the Electricity and Gas Market Surveillance Commission (EGC), was established to surveil energy markets, which have seen significant changes with this market reform. In this article, we describe the overview of this energy market reform and explain our commission's role and achievements.

Overview of Energy Market Reform in Japan

Electricity

In the past, the electricity used in homes and businesses was sold exclusively by the single power company in each region with a monopoly (General Electric Utility (GEU), such as Tokyo Electric Power Company, Kansai Electric Power Company, etc.) After 2000, we began incrementally liberalizing the Japanese electricity market and finally, full liberalization was introduced to the Japanese electricity market in 2016. This allows families, shops, and all consumers to choose freely from a variety of power companies and price plans. In 2020, the transmission sectors of GEUs are to be legally unbundled from their generation or retail electricity business sectors to maintain neutrality and fairness in transmission sectors.

As of May 11, 2017, 380 non-GEU business entities have been registered as electricity business retailers under the Electricity Business Act. These entities are from various business sectors including natural gas, telecommunications, broadcasting, railways, and so on. Some of these entities are supported by regional

governments. The share that new entities represent of the entire electricity market is about 8 percent as of January 2017, whereas the share of GEUs is 92 percent.

As for the wholesale market, the Japan Electric Power Exchange (JEPX), a wholesale power exchange market in Japan, was established in 2003. JEPX's current share of total wholesale trades is only around 3 percent, but GEUs, who have more than 90 percent of the generation capacity and retail market share, have committed to start purchasing 20-30 percent of the electricity they sell via JEPX (so-called "gross bidding") within a few years, so the volume of transactions at JEPX will increase dramatically. Furthermore, it has been decided that implicit auctions for use of interconnection lines between each GEU will be introduced in 2018, which is expected to contribute to further increasing transactions at JEPX as well as more efficient use of interconnection lines.

Gas

In Japan, gas is supplied to consumers through pipeline networks in certain areas of Japan (Pipelined Areas), whereas it is supplied in gas cylinders in other areas where pipelines have not yet been constructed due to lower demand volume or any other deciding factor. In the past, each region of the Pipelined Area (which covered approximately 6 percent of the land area, but accounted for approximately 60 percent of consumption in Japan as a whole as of fiscal year 2015) was monopolized by one gas company (General Gas Utility (GGU)) as was the case with the electricity market. In advance of electricity market liberalization, the pipelined Japanese gas market was partially liberalized, beginning in 1995 and finally, full liberalization was introduced on the pipelined Japanese gas

market in April 2017. In 2022, the pipeline sectors of major GGUs are to be legally unbundled from their manufacturing or retail gas business sectors.

As of May 24, 2017, 37 business entities (mainly power companies) have been registered as new gas business retailers based on the Gas Business Act and are now launching their gas retail business.

The Commission

Japan's electricity and gas markets have been changing dynamically in recent years. Our organization was established as a response to the situation on September 1, 2015.

Electricity and Gas Market Surveillance Commission (EGC)

The Role of EGC

In the implementation of energy market reform, our independent and highly expert commission was established as a new regulatory organization with the aim of greatly improving surveillance capability and securing adequate transaction volumes in the energy market. Actually, we were established as the Electricity Market Surveillance Commission on September 1, 2015, and, subsequently, the mission expanded to gas and heat power, which meant changing the name to the Electricity and Gas Market Surveillance Commission on April 1, 2016.

To ensure proper transactions in the energy market, our commission has two roles. The first is to conduct surveillance of the behavior of market participants to ensure that competition is maintained and that consumers are protected. This role also includes examining applications made by potential new entrants into the energy market and determining their suitability before advising the Minister on their registration.

The Commission's second role is to make the initial proposals to the Minister of Economy, Trade and Industry for changes to market rules. The Minister is not obliged to follow every recommendation we make; however, our recommendations must always be released publicly, and we can ask the Minister to report on policies the Minister has created that take our recommendations into consideration. Thus, rule-making

is made completely transparent, and our initial proposals are an important step in maintaining independence of the market rules from interest groups.

The EGC Commissioners

The EGC commissioners have various backgrounds in economics, law, engineering, finance, and accounting. They are independent of interest groups as well as political and governmental agencies.

Achievements

On the date of this article's submission, we had been operating for more than one and a half years. In this time, we have had various accomplishments. The following is a partial list of accomplishments.

Market Surveillance to Ensure Proper Energy Transactions

In the beginning, we made significant efforts to construct mechanisms to monitor the energy market and collect accurate information, such as a framework of regular reports to our commission and a framework of regular audits of certain electric power and gas companies. During such monitoring and information collection activities, we found some problematic company conduct and provided administrative guidance and issued admonitions in response to some of the cases.

Preparation for the Launch of Full Electricity and Gas Retail Market Liberalization

Although full electricity and gas retail market liberalization had already been determined by legislative law, there were a number of practical arrangements that were necessary before the actual launch of liberalization was feasible.

For instance, we conducted a screening process for applicants in registering as electricity or gas business retailers, which has now reached 380 entities as of May 11, 2017, and 37 as of May 24, 2017, respectively, as described previously. Also, to ensure proper and fair transactions, we reviewed electricity and gas transmission and distribution tariffs and general terms and conditions for transmission and distribution services in 2015 and 2016. Moreover, to demon-

strate both problematic and preferable practices within the new electricity and gas market in complying with relevant transactional regulations, we proposed guidelines for the electricity and gas business and transactions in 2016 and 2017.

In addition, to successfully achieve full retail liberalization, it is quite important that consumers have an adequate understanding of liberalization and make appropriate choices without experiencing trouble. For that purpose, we conducted PR activities both before and after the electricity and gas retail liberalization, including workshops and PR events, creation and distribution of PR posters and leaflets, media advertising, and a portal website and call center.

Activities Promoting Economic Efficiency and Active Competition

As explained, one of our missions is to make the initial proposals to ensure proper energy transactions. As part of this mission, we have conducted policy planning.

For example, we have planned for the reform of the electricity transmission and distribution tariff structure to provide correct investment incentives for the generators and for large-scale consumers (manufactures, etc.) who will receive discounted rates based on the distance from their facilities to the generators. Activation of power exchanges is another one of our big challenges (in December 2016, the power exchange's share of total electricity sales in Japan was only 3.4 percent) and we have promoted transferring surplus electricity power from GEUs to the wholesale market. GEUs have also made commitments to this "gross bidding" process after significant discussion between GEUs and the EGC, which should allow for progress in activation. Additionally, we prepared for negawatt transactions and auctions for procurement of balancing reserves and evaluated the competition in the electricity market.

International Affairs

Because we are still in the early stages after our establishment, we have an emphasis on international affairs to learn from foreign practices. We have participated in various international regulatory confer-

ences, such as the Organisation for Economic Co-operation and Development Network of Economic Regulators and the Asia Pacific Energy Regulatory Forum 2016 (APER) to learn from that international experience. Also, we have communicated with many foreign energy regulators and professionals, and signed a memorandum of understanding with the U.S. Federal Energy Regulatory Commission to share know-how, practical experience, and other information in September 2016. In 2018, we are going to host APER 2018 and hope to strengthen our international relationships in various ways.

Takehiko Matsuo

Takehiko Matsuo has been working as Secretary General of the Electricity and Gas Market Surveillance Commission (EGC) since the establishment of the Commission in September 2015.



He has more than 25 years of experience working for the Ministry of Economy, Trade and Industry (METI) in Japan and has been involved in energy policy issues throughout most of his career.

He also held a position of Counsellor of Cabinet Secretariat from 2010 to 2012 and was in charge of the government's decision process to start negotiation with TPP (Trans Pacific Partnership Agreement) member countries to join the TPP, as well as the adjustment of electricity supply and demand in eastern Japan just after the Great East Japan Earthquake.

From 2008 to 2010, he served as Special Adviser to the Executive Director of IEA (International Energy Agency), and contributed to the IEA's input to the G8 Summit in 2008.

He graduated from the University of Tokyo with a degree in Law and Paul H. Nitze School of Advanced International Studies (SAIS), Johns Hopkins University with a Master of International Public Policy.

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He is a lawyer in both Japan (since 2008) and the U.S. (New York,

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He graduated from Kyoto University with a Bachelor of Law degree in 2007, the Legal Training and Research Institute with a qualification to Practice Japanese Law in 2008, and University of Pennsylvania Law School with an LLM with distinction in 2014.

Utilities, Regulators, and Cybersecurity

What Regulators Actually Need to Know

Andreas D. Thanos¹

Introduction

I started planning this essay while preparing for a cybersecurity-related presentation to my colleagues at Mexico's Comisión Reguladora de Energía last November.

Over the years, I have sat in on desktop exercises, in presentations that have listed all of the attacks *du jour*, and presentations where the speakers explained how easy it is for IT systems to get compromised. I have read position papers and looked at “toolkits.” This is not that bad if you enjoy information overload—I do. In fact, it helped me identify what is truly useful and what is not.

Before proceeding, it is important to appreciate why regulators are concerned with cybersecurity. It is understood that a cybersecurity breach of a utility's IT infrastructure will have a detrimental effect on the affected region. Although it is often difficult to measure the non-monetary impact of power outages, a fairly recent example from the Boston, Mass. area in the U.S. provides a solid reference point—at least on the financial costs. On March 13, 2012, a fire erupted in a transformer station in downtown Boston. This accidental transformer fire affected approximately 22,000 customers, some of whom were left without power for three days. The financial cost of this isolated accident was estimated between \$2.5 million and \$3 million. The event was not part of an organized attack on the company's system; thus, it was fairly easy for the utility to identify, isolate, and fix the problem. Experts predict that a cyber-attack

on a utility will not affect one single transformer or section of the distribution system; rather, they expect that it will have multiple targets deliberately affecting the distribution system and shutting power, gas, or water to hundreds of thousands of customers. Thus, it is expected that the financial cost can easily rise to hundreds of millions or more.

Background

The role of the regulatory agency is to work with the distribution companies, electric, gas, steam, or water to ensure the delivery of utility services to consumers reliably, safely, and at the lowest possible cost. Until recently, most regulators have been comfortably providing economic oversight. This legislated oversight ensured that as long as utilities maintained their reliable, safe, and low-cost service, they would be guaranteed the recovery of reasonably incurred costs. Rate design and cost of service—the two pillars of utility regulation have remained unchanged for generations. Economics and accounting are two disciplines not known for dramatic and/or rapid changes.

Enter technology. As the technology used to deliver utility services evolved, it shifted from manually operated valves and switches to computer-based functions in all areas of operations: from customer information to billing and everything in between. Regulators have previously approved recovery of the costs associated with the acquisition of information technology (IT) resources needed to perform those tasks electronically. As the use of technology

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expands, these IT resources can now be accessed remotely, which brings up the question of what needs to be done to ensure that this technology is beyond the reach and eventual control of unauthorized users; how is it understood by the regulators and ultimately, how will it be paid for—including the efforts to keep the technology safe from potentially disruptive activity.

It is very common, when we talk about cybersecurity, to focus narrowly on the electricity sector. Recent developments in the electricity sector, especially with the introduction of the smart-grid concept, seem to have put the sector in a more vulnerable position. However, the telecommunications, gas, and water sectors also rely heavily on technology. For instance, once we recognize that natural gas is not just used for cooking and heating, it becomes easier to realize that a well-orchestrated attack on the natural gas infrastructure leading to disruption, will have a costlier economic and social impact than an attack on the electric grid alone. In the United States, an attack on the gas grid has the potential to knock off more than 27 percent of electricity generation.² The same applies to water, where a malicious breach can affect a significant part of the population working and living in urban centers.

Viruses and threats to computer systems go back to the early days of computing, leading to the 1980 FBI call for the First Computer Misuse Act. Since then, a series of events have brought awareness of the existence of cyber-threats to regulators and consumers. For regulators, the 23 December 2015 incident in Ukraine³ helped drive the point to the proverbial home.

This is where the confusion on what regulators should know and should or can do, arises.

The question that seems to concern many regulators today is “How to stay up-to-date?” Some regulators and staff have taken it upon themselves to dig deeply into all aspects of cybersecurity. The tabletop exercises, the toolkits, the presentations I mentioned previously, all provide seemingly useful information. However, none of them can provide the know-how to help evaluate the specific tools used by utilities to ensure the integrity of their systems. Cybersecurity is not only a continuously evolving field; it is a fast evolving, highly technical field. By the time a regulator has started understanding it, technology has already advanced to its next iteration.

To add to this, there is a large group of federal and industry organizations that are working, sometimes together other times independently, to share existing or develop their own sets of standards, technologies, and policies. In the United States alone, a quick, off-the-top listing includes DHS (TSA & ISCD), NIST, NERC, FERC, AGA, DOE, GTI, PHMSA, WSCC and a few entities with National Lab at the end of their names.⁴ These organizations are truly and genuinely working to help their affiliated and member industries. They provide solid information and advice. In addition to these industry groups, consultants and academic institutions have sprung up offering security training and awareness, adding to the fears and confusion, which have regulators wondering whether they are doing enough.

Understandably, regulators want to know what is going on. In doing so, they are bombarded with jargon and more information that they should actually

² Source: <https://www.eia.gov/electricity/data.cfm#generation>.

³ On December 23, 2015, Kyivoblenergo, a regional electricity distribution company in Ukraine, reported service outages. The outages were due to a third party's illegal entry into the company's computer and SCADA systems. The outages were originally thought to have affected approximately 80,000 customers. However, the actual number of customers who lost power as a result of the breach reached approximately 225,000. (Source: NERC)

⁴ DHS: Department of Homeland Security; TSA: Transportation Safety Administration; ISCD: Infrastructure Security Compliance Division; NIST: National Institute of Standards & Technology; NERC: North American Electric Reliability Corporation; FERC: Federal Energy Regulatory Commission; AGA: American Gas Association; DOE: Department of Energy; GTI: Gas Technology Institute; PHMSA: Pipeline & Hazardous Materials Safety Administration; WSCC: Water Sector Coordinating Council.

care for. A simple comparison can highlight the point. For that, I will use a “gas-related” subject. A regulator should understand that poor planning can leave a utility with insufficient resources to meet its peak demand resulting in system pressure loss, possibly shutting down sections of the system and other unpleasant and potentially dangerous consequences. The gas regulator has clearly understood and accepted that, as long as the gas distribution company follows standard industry practices, the safety and wellbeing of the utility’s customers are ensured. The utility shows compliance and the regulator allows a certain rate of return. Regulators rarely, if ever, receive training or visits by econometricians or gas traders updating them on the latest tools available to the utility to forecast load demand or how to acquire commodity and capacity. Regulators accept industry standards as they are presented to them.

However, when the topic is cybersecurity, regulators allow experts to deluge them with detailed information; information that more often than not is too complicated and/or will soon become outdated or get revised.

In the cybersecurity sphere, when looking back, one will notice that little has changed in regards to what regulators can actually understand and address. The same general classification of players as Mainstream, Organized, and Terrorist/Sates has existed for several years. Even if the labels changed, they would still describe the same groups. The tools used by these players have not changed much either: Denial of Service, Malware, Phishing, Social Engineering, and Zero Day Exploits remain the general classifications of the attackers’ tools and techniques. In fact, even the hacking tools themselves, are irrelevant to regulators as neither now, nor in the future, will they possess the technology or expertise necessary to defend against them. All regulators need to understand, and the 2007 Idaho National Labs’ “Project Aurora” showed, is that a serious cybersecurity breach can cause severe damage.⁵

My position is that as we have accepted the wis-

dom that investment in the physical safety of the infrastructure is an intelligent choice, we should also accept that utilities need to invest in strengthening their cyber-related operations.

Today—Now

So, what is a regulator to do? A quick answer is to continue with business as usual but understand that investment in cybersecurity is something that needs to be addressed by regulators for the utilities they regulate. Therefore, all reasonably incurred costs need to be recovered by the utilities. It does not only sound simple, it actually is simple. And here is the reason.

A regulatory agency has four fundamental goals: (1) ensure that consumers receive reliable service; (2) the service consumers receive is provided safely; (3) consumers are protected both in terms of pricing as well as personal financial information; and (4) a utility is allowed to recover all reasonably incurred costs and earn a profit.

Because cybersecurity is the “plate du jour” a regulator’s first reaction would be to acquire the technical expertise that allows for a proper review of the jurisdictional utilities’ proposals. This is a noble and commendable idea, but it lacks merit. State/local and federal/national agency budgets are rarely adequate to properly compensate such expertise. Even when an agency has the funds to hire and train someone on cybersecurity, it is not uncommon for individuals to acquire the expertise and relevant security clearances while working for a government agency and move on to the private sector, where their skills and security clearance can be rewarded handsomely.

Although not having the technological expertise in-house sounds like a losing proposition, it actually is not. Looking at the various areas we regulate it becomes obvious that, in some, regulators lack specific expertise. Many regulatory agencies approve retirement plans and proposals but do not have retirement experts to review the utility’s proposals. Regulators do not have IT experts determining whether the cur-

5 The 2007 Idaho National Labs’ Project Aurora demonstrated how a cyber-attack can destroy physical components of the electric grid. In fact, the project showed how a computer program can cause a diesel generator to destroy itself.

rent IT infrastructure is ideal, but at the end of the day, these regulators approve most of what utilities propose. Finally, regulators do not have the engineering expertise to determine whether the pipes laid in the ground to transport water or natural gas or the wires hanging overhead are of the stated or ideal (whatever the definition may be) quality. We accept certain utility and industry proposals as facts.

Further, regulators recognize that in addition to lacking the technical expertise there is a fine line between regulating and micromanaging.

Having understood their role, many regulatory agencies developed guidelines that are primarily based on the principles of communication and education. The review of cybersecurity-related efforts should be based on these same principles.

Communication and Education

Being concerned about energy delivery is understandable. According to ICS-CERT,⁶ energy comprises approximately 56 percent and water 5 percent of the United States' critical infrastructure. Rarely if ever, state regulators supervise interstate commerce (pipelines or transmission lines). In regards to critical assets, the majority of state regulatory commissions only have oversight of the level's critical assets at the local distribution level. These critical assets include:

- Utility IT systems: all computers, modems, clients, servers;
- Utility Control Systems: SCADA, Communications, Controller Devices; and
- Utility Infrastructure: pipes in the ground, lines, transformers, etc.

In regards to cybersecurity, regulators and utilities need to consider the following: jurisdiction, liability, confidentiality, and understanding of the technology.

Jurisdiction is very closely guarded by both federal/national and state/local regulators. Because, under certain circumstances, oversight may overlap regulators should recognize that an entity may be subject to oversight by several agencies. In most

instances, the various regulatory bodies cooperate for the benefit of the customer.

Liability is another area of concern. What is the role of the regulatory agency? Does the approval of a proposed cybersecurity defense strategy provide a utility with adequate protection against future liability claims? How liable is the commission in the event a proposed strategy does not prove successful?

Confidentiality is of utmost concern to most utilities. By divulging its cybersecurity strategy, whether during a rate proceeding or during the course of cybersecurity-related communications, a utility may end up rendering its defense plan weaker. In addition to being targeted by hackers frequently, government agencies are subject to Freedom of Information Act requests that may result in information being unnecessarily shared with potential perpetrators.

Finally, **understanding the technology** and the costs associated with it, may be the biggest challenge the parties encounter, for the reasons mentioned earlier.

Many regulatory agencies (including those in Iowa, Massachusetts, New Jersey, New Hampshire, and New York, to name a few) have established general guidelines regarding the activities and steps that need to be undertaken by utilities to demonstrate that they are addressing cybersecurity-related concerns. For the most part, they follow the Critical Infrastructure Protection (CIP) standards developed by NERC.

The review processes established by the various regulatory commissions incorporate regular and emergency meetings between regulators and utilities, to ensure compliance to NERCCIP standards and some type of certification (self-certified or third-party certified) regarding compliance with established standards and incident reporting protocols. It is not necessary for regulators to delve deeper into cybersecurity. As the technology evolves, regulators will be, inadvertently, left behind. For the purposes of the state utility regulator, it does and should not matter whether a threat comes from a terrorist group in a hostile country or an adventurous teenager in a sub-

6 ICS-CERT: Industrial Control Systems Cyber Emergency Response Team, part of the U.S. Department of Homeland Security.

urban basement. We do not possess the knowhow to determine the geo/political impact of a cyber-attack. All regulators need to know is that the utilities should be and are prepared; that the utilities' corporate culture and governance, foster an environment that has elevated cybersecurity to a high enough level that the utilities' Chief Executive Officer understands the concerns and embraces the proposed solutions.

Moving Forward

Regulators must accept that the utilities under their jurisdictions will be attacked. In fact, they are constantly and daily under attack, regardless of whether the regulators are aware of it or not. On occasion, these attacks will be successful. Because cybersecurity is a fast-evolving field and regulators cannot constantly remain up-to-date, guidelines are preferable to regulations. Due to their nature, guidelines provide more flexibility for adjustments than regulations do. Ensuring reliance on guidelines versus strict adherence to regulations will allow the regulators to become comfortable that the utilities they oversee have developed and adjust or will develop and adjust cybersecurity policy that incorporates preparedness, prevention, response, and recovery.

The jurisdictions that have already established a set of guidelines should periodically review them in cooperation with the utilities and revise them—if necessary. This way, utilities will know what is expected of them. For regulators, this is of equal importance for two reasons: first, the safe and reliable delivery of utility services is one of the regulators' goals; second, a good understanding of cybersecurity activities will allow the regulators to better inform the public if necessary.

Regulators must maintain a cybersecurity-related function that does not only allow the communications between the regulated entity and the regulatory agency, but also fosters cooperation among the regulated utilities. Utilities use similar hardware and software. If one utility detects an issue with its technology it should be encouraged to share the information with all utilities in a safe and secure manner. But regulators do not need to be experts in the technology used to combat cyber threats. They need to under-

stand and appreciate that others less technologically challenged have, in cooperation with the intelligence agencies, developed recommendations on policies and technology to secure, as confidently as possible, the IT infrastructure of the regulated utilities.

However, it is very important that regulators continue their communication with the regulated utilities because they need to understand the costs associated with cybersecurity efforts. A good understanding of the utilities' efforts will allow regulators to reach an educated conclusion when determining cost recovery of cybersecurity-related efforts.

Finally, in regards to regulatory agencies and utilities that have not developed solid cybersecurity plans, it is important to follow the lead of those who have already developed such policies and plans. The threat exists and will remain. There is no need to reinvent the proverbial wheel—just follow the lead of your colleagues in other states and countries.

Closing Thought

Master Sun in the Adaptations chapter of the book, *The Art of War* said: *So, the rule of military operations is not to count on opponents not coming, but to rely on having ways of dealing with them; not to count on opponents not attacking, but to rely on having what cannot be attacked.*"

Regulators are constantly bombarded with information. Cybersecurity has become, and rightfully so, a top priority. Attacks on utilities will take place. What the attackers' target is, what their goal is, or what specific hardware and code exists to fend off hackers is not necessarily something that regulators need to know. The utility CTO or CIO should know, but a commissioner or commission staffer does not necessarily need to. The intelligence community possesses a lot of information on past, current and, possibly, future cyber-attacks. It is better that regulators facilitate communications between the intelligence community and utilities than it is to receive information that is of no use to them. All regulators need to know is that: (a) the threat is real; (b) the utilities under their jurisdiction have adopted a set of guidelines consistent with the recommendations of the intelligence community; (c) the guidelines are

implemented; (d) cybersecurity is a continuously evolving space; and (e) utilities that follow the guidelines must recover the associated costs.

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Regulating ‘Energy Ladder’ Products and Services

Delivering Vital Energy Services Using Off-Grid, Mini-Grid, and Micro-Grid Power Systems

Tom Stanton¹ and Erik E. Nordman, Ph.D.²

Abstract

The technical means already exist for providing electricity’s benefits to both the estimated 1.2 billion people presently without service and the estimated billion more with unreliable grid service worldwide. Depending on the end uses served and equipment used to serve them, systems using neither long-distance transmission nor extensive local distribution can already prove fully cost-effective, compared to the alternatives they will replace. Some of those alternatives are liquid or solid fuels, like kerosene for lighting and charcoal, dung, or wood for cooking fuel. Or, a conventional alternative could use centralized power plants and extensive networks of wires, similar to the technologies used to serve most consumers in Europe and North America and in large cities and other developed areas in most of the rest of the world.

This paper briefly catalogs some of the current technologies available for providing electricity services, whether or not interconnected to a larger utility grid. And, it outlines one possible business model for regulated utilities and competitive providers delivering services using such technologies. For example, utilities or other regulated suppliers might provide financing, quality control and quality assurance,

operations and maintenance, and enforcement of performance guarantees and equipment warranties. The paper also explores one basic approach that regulators can take, supporting utility participation where desirable while providing oversight to prevent monopoly abuses.

A major premise is that all utilities have important and potentially profitable roles to play in advancing rapidly growing markets for off-grid, stand-alone, and dual-use products and services. Dual-use equipment can operate either in tandem with the existing grid or in stand-alone mode. There is an opportunity for all utilities to create value for their stakeholders by enabling and implementing a well-designed energy ladder, meaning a sequence of products and services that leads to increasing well-being for customers that are presently unserved or underserved.

Introduction and Scope of the Problem

Up to two billion people presently live in chronic conditions of energy poverty. They lack access to reliable and affordable energy for meeting even the most basic human needs. For some, the grid has not yet reached their villages. For others, especially in cities, grid-based electricity may technically be available

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but is unreliable and often prohibitively expensive (Clean Energy Solutions Center 2017). They often depend on technologies that are expensive, dangerous, and only marginally satisfactory for meeting their needs. Improving electricity access and use can improve a community's quality of life and increase economic activity (Phadke, Jacobson, et al. 2015; World Bank 2017). Energy access is closely linked to "other sustainable development challenges—notably, health, education, food security, gender equality, poverty reduction, and climate change" (World Bank 2017, p. xi). For these reasons, the United Nations Development Program (2017) set a goal of ensuring universal access to affordable electricity by 2030.

Electricity access can be improved by either: (1) extending the centralized transmission and distribution grid system; or (2) using decentralized, off-grid approaches ranging from solar lanterns and phone chargers to village-scale micro-grids. In this paper, the first approach is called "conventional," and the existing grid the "macro-grid." These two options are not mutually exclusive but they do "have different capital requirements, serve different population densities, and use different technologies" (World Bank 2017, p. xvi).

There is some debate over whether the distributed energy options are steps on an "energy ladder" leading toward a centralized grid or a "leapfrog" over 20th century energy-service delivery to a new paradigm (Levin and Thomas 2016). Centralized power systems are no longer a necessary condition of universal access to modern energy services. Developing countries, where centralized electricity infrastructures are less developed, may be able to adopt these new technologies more quickly. We first review the costs of grid extension and distributed solar home systems (SHSs) (Figure 1). In either case, there are important reasons for standardizing distributed energy systems to ensure they will be compatible and scalable, so they can be incorporated in either larger-capacity distributed systems or with a centralized grid (Banerjee, Barnes, et al. 2015; Palit and Bandyopadhyay 2016; Saghir 2017). World Bank (2017) notes that the two approaches can and should be designed to be complementary with thought given to a long-term

plan for transforming remote off-grid and mini-grid systems by absorbing and consolidating them into the larger distribution system.

New and emerging technologies produce and deliver electricity economically, at a much smaller scale, and without the centralized, traditional fuel delivery or macro-grid wires infrastructure that electric utility companies typically have deployed. The costs of PV systems, batteries, and end-devices (such as LED lanterns and mobile phones) have fallen rapidly in recent years. These stand-alone options are often cost-competitive compared to, for example, kerosene lamps (Phadke, Jacobson, et al. 2015). Systems ranging in size from "pico scale" solar lanterns to large area micro-grids can be implemented relatively quickly, to deliver vital electricity services to potential customers in remote areas. As Savage et al. (2010) document, direct current (DC) systems and equipment can provide services more efficiently, with fewer losses, compared to alternating current (AC). They envision a future system where AC electricity is used for its strengths in high-voltage, long-distance transmission, and DC is produced and used locally in integrated mini- and micro-grids.

Enhancing electricity access, whether grid, off-grid, or some combination, will require institutions, policies, regulations, and incentives that create and maintain a conducive enabling environment (World Bank, 2017). Although many of the technical and economic dimensions of grid extension and decentralized generation have been analyzed thoroughly, the regulatory dimension has received less attention. Many utilities have reservations about micro-grids and are unsure whether they are "friend or foe" (Assmus 2015). This paper represents a preliminary attempt to fill that gap by assessing one approach by which utilities and regulators can facilitate movement up the energy ladder.

This paper addresses two major questions:

1. What are the appropriate roles for utility companies or other licensed providers, in delivering stand-alone and dual-use systems in an energy ladder hierarchy of products and services?; and,
2. What are the appropriate roles for utility regulators in this context, in providing the guidance and

oversight necessary to prevent adverse monopoly behaviors that could otherwise reduce benefits and increase costs?

Table 1 lists examples of stand-alone electricity systems at all scales from the smallest single-function or dual-function solar plus battery powered devices commonly called “solar lanterns” to the largest micro-grids, that sometimes cover large campuses up to 100 MW or more. The major focus, for this paper, is on systems that are capable of operating independently of any macro-grid, but a secondary focus is on eventual macro-grid integration, if and when

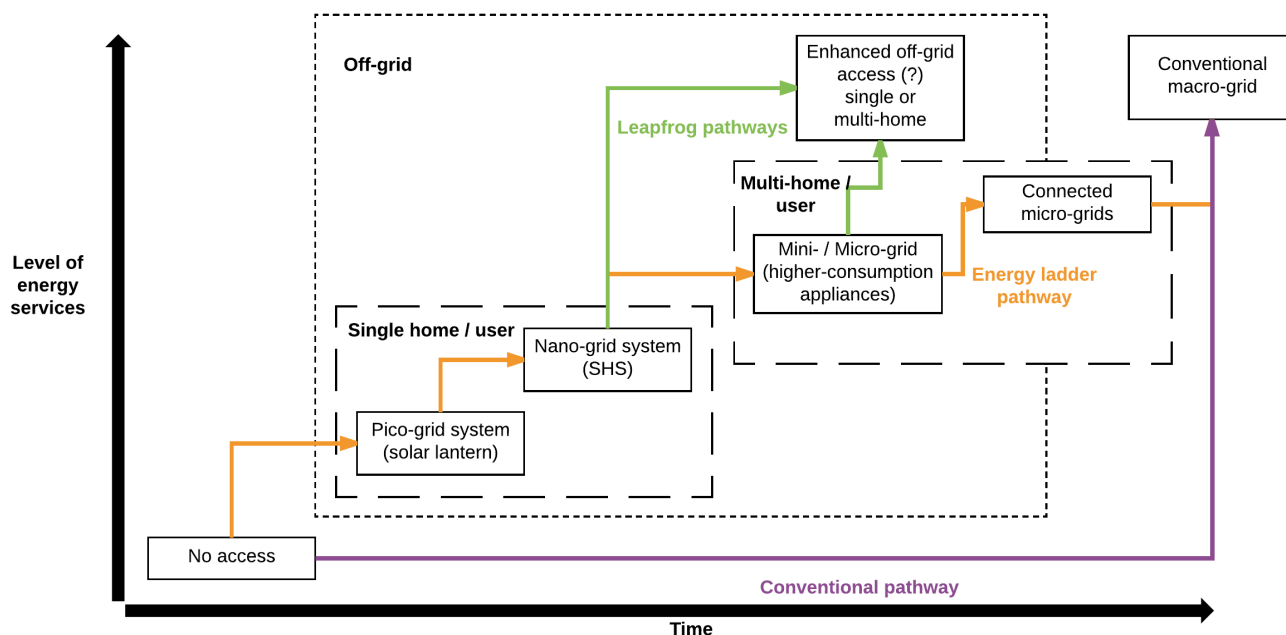
that proves practical.

Figure 1 illustrates the three different pathways for electricity development: conventional, energy ladder, and leapfrog. The conventional, macro-grid pathway is to have a utility build-out its transmission and distribution grid to serve new, previously unserved customers. The energy ladder approach might begin with the smallest systems, intended for single home uses, and then could eventually expand to systems serving multiple buildings. The leapfrog pathway is included in Figure 1 to spur thinking about whether innovative options might provide sufficient

Table 1: Examples of stand-alone electricity systems at multiple scales

Common name	Scale (in Watts)	Common usage
pico-grid	10 ¹ (10 W)	Typically solar plus battery DC systems, often with LED light and cell-phone charger.
nano-grid or sometimes SHS (solar home systems)	10 ² (100 W)	Typically solar plus battery DC systems LED light and cell-phone charger, other small electronics. A/C inverters, appliances powered by automotive batteries and generators. Stand-alone street lamps, for example Soulardarity 2017.
mini-grid	10 ³ –10 ⁴ (1–10 kW)	100–200W “utility in a box” mini-grid model, for community-based off-grid systems for low-income agricultural communities; e.g., from Development Ventures 2017. Often as backup or emergency power, for use during macro-grid outages. Can be either AC or DC.
micro-grid	10 ⁵ (100 kW)	Micro-grid “kiosk” for charging portable batteries, as described in Louie, O’Grady et al., 2015. ABB modular microgrid in a box.
	10 ⁶ (1 MW)	Frost Valley Summer Camp micro-grid (NY) (Asmus 2015)
	10 ⁷ –10 ⁸ (10–100 MW)	Micro-grid (e.g., a major university campus or military base)
Sources: Alstone, Gershenson, Kammen 2015, pp. 308–09; Development Ventures 2017; Louie, O’Grady, et al., 2015; Schneider Electric 2017; Soulardarity 2017; World Bank 2017, p. xvi; Zinaman et al., 2015, pp. 32–33.		

**Figure 1: Illustrating three possible pathways for electricity development:
Conventional, energy ladder, and leapfrog**



service so that connections to a macro-grid might never be necessary.

Regulatory Challenges and One Option for Discussion

Utilities and regulators have important roles to play in advancing electricity access, whether through grid connections, an incremental energy ladder, or a “leapfrog” paradigm of high-level service based on distributed generation. However, existing regulatory rules and practices can make it difficult for regulated utility companies to have any formal role in deploying off-grid power systems. Many jurisdictions have operated for a century on the premise that an electric utility is a natural monopoly that serves all comers in a particular service territory: Some jurisdictions could find that existing laws impede some of the avenues for utility participation. This discussion elucidates the roles that utilities, regulators, and interested parties need to consider. Each jurisdiction will have to study its own regulatory regime and history and determine which, if any, functions that a regulat-

ed utility might be authorized to conduct. Savage et al. (2010) point out, a review can start with systems that are owned by end-users, are behind the utility meter, and never export power to the utility. Stanton (2012) proposes a systematic review of existing laws, rules, and regulations to determine whether barriers exist and start investigating whether and how existing barriers might be removed. Each jurisdiction will ultimately decide whether each function will be served by a regulated utility company or a separate entity, which will or will not be subjected to regulatory or licensing provisions.

Regulating agencies can, as Zinaman et al. (2015) note, define the market, unlock financing gaps, and enforce technical standards and quality control for generation equipment, especially in community mini- and micro-grids. Regulating agencies and utilities can work together to facilitate movement up the energy ladder or leapfrogging by:

- Curating products and services to offer and setting rates, conditions, financing, and terms of service;
- Setting and enforcing codes and standards for

component parts and systems;

- Educating consumers about product and service choices;
- Performing operations and maintenance (O&M); and
- Monitoring and evaluating progress toward regulatory goals and objectives.

In the following discussion, each of these elements is discussed based on one possible set of ideas about appropriate utility roles. This should be considered a preliminary proposal intended to promote more dialogue.

Curating Products and Services to Offer

In this role, the regulatory authority develops a catalog of products and services that defines each step of the energy ladder and determines the role of the utility, if any. Banerjee, Barnes, et al. (2015) recommend establishing a new planning agency for off-grid electrification and propose that third parties will compete for the regulator's approval to provide off-grid products and services in particular territories

For rate setting, the regulator determines whether a regulated rate applies or if rates will be established through bilateral contracts between competitive suppliers and customers. If a regulated rate applies, the regulator determines the rate, terms, and conditions of service. For bilateral contracts, even if the regulator does not approve prices, the regulator could approve standard contract terms and conditions, or minimum requirements. Pre-paid services and/or micro-payments can be helpful, especially where the upfront costs are a substantial burden to increasing electricity access (Banerjee, Barnes, et al. 2015).

For financing, the regulator needs to determine the utility role(s), if any. Roles range from utility participation in billing and collections only, to having the utility itself provide the financing and earn a regulated return on its investment. The return can be the same as for all utility expenditures, as recommended by TFC Utilities (2017) in its "Million Rate Base" concept, or a rate of return can be established, commensurate with risk, for the specific investments in energy ladder products and services.

Setting and Enforcing Codes and Standards

Standards ensure equipment interoperability, enable individual pieces of equipment to work well in both stand-alone and grid-connected modes, and ensure that equipment will work in various-size networks. Bhattacharyya (2013) notes the importance of making sure off-grid equipment does not become stranded or obsolete. Phadke, Jacobson, et al. note that "standardization and centralized production of complete systems can reduce component and [balance of system] mismatch issues and enable more careful control of overall system quality" (2015, p. 14).

The regulator can invite utilities, competitive suppliers, or both to present proposals for product or service standards. The regulator can have a role in identifying what authorities will be responsible for setting and enforcing codes and standards. This could involve various combinations of international and national standards-setting organizations, approved equipment testing laboratories, national or subnational consumer protection agencies, the regulatory authority itself, and the regulated utility.

Many relevant standards are international in scope, including the engineering societies, groups of manufacturers, electrical and building code officials, and fire protection agencies. For example, the eMerge Alliance industry association is working on standards for DC power systems for both residential and commercial buildings. Automotive manufacturers are working on standards for electrical vehicle battery charging (Patterson 2016). In addition, the uniform system bus (USB) standard, widely used in cellular telephones, portable computers, and many other small appliances, already has a "Power Delivery Specification" (USB-PD) that covers two-way DC power flows up to 100 watts, including battery charging applications (USB Implementers Forum 2017). In the U.S., many power tools across brands use standardized battery blocks. Similarly, standardized battery blocks for use with solar, wind, hydro, or human powered generators could "hot swapped" for charging and use in a variety of small appliances.

Ultimately, each step of the energy ladder needs to be considered, and standards developed, so that the process of integrating equipment and systems at each

step, from pico- to nano- to mini- to micro-grid sizes, can be accomplished without forced obsolescence and without any pieces of equipment that are used at an earlier step of the ladder being incompatible with higher steps. For example, Banerjee, Barnes, et al. recommend, “[w]here the main expected household uses of electricity are lighting and small appliances...there is no reason to apply design standards used for more heavily loaded urban systems” (2015, p. 63).

Consumer Education

Consumer education will be an important component of successful energy ladder efforts, especially for those consumers with little or no previous experience using electrical devices. Basic education may be needed to prevent accidents and avoid equipment damage. Consumers must be partners in this effort identifying needs and planning.

The regulator’s role could be in approving a consumer education plan based on input from interested parties that include utilities, consumer group representatives, manufacturers, and retailers. The regulator could approve basic information for a consumer education program, such as load shifting in systems with variable generation.

Operations & Maintenance

The regulator approves details, including cost recovery, for a utility or other licensed service provider’s O&M program for specific products and services. For O&M performed by competitive product and service suppliers, the regulator could approve basic minimum requirements, as a requisite for licensing.

Monitoring and Evaluating Performance

The regulator sets clear guidelines for expected performance by each regulated entity, and sets requirements for program reporting. Regulators can consider performance-based metrics – penalties and rewards – associated with variations in performance by utilities and other licensees.

Roles for Government Outside of Utility Regulation

The regulator also works closely with other govern-

ment agencies, such as code officials, economic development agencies, and others.

Government might also engage in research, development, and demonstration, as China has been doing (Zeng, Zhao, et al., 2014). And another potential role is for government to engage in bulk purchasing, as suggested by Phadke, Jacobson et al. (2015, p. 15), which could help to speed learning and reduce costs.

Ideas for Next Steps, Moving Forward

This brief paper presents only one approach where regulators take an active, participatory role in defining and implementing a series of products and services, designed for systematic integration in an energy ladder. This is not the only possible approach, but it does appear plausible, and the long-term benefits associated with the proposed regulatory oversight could well exceed the extra costs of standardizing and regulating such products and services. Regulators should strive to make this happen in a way that does not wind up stifling the very innovations that are creating these opportunities in the first place.

There are already multiple examples where progress is being made towards the goal of universal access to basic energy services by 2030. For just a few examples:

- Bangladesh has integrated its governmental efforts with non-governmental organizations specializing in microfinancing and rural electrification (Sadeque et al., 2014).
- China is presently developing more than 500 micro-grids as applied research and demonstration facilities, and has begun setting policies for micro-grids (Zeng, Zhao, et al., 2014).
- India, Rwanda, and Tanzania have established basic regulatory provisions for stand-alone systems for rural electrification, and Kenya has similar provisions for locations where connection to a macro-grid cannot occur (Bhattacharyya 2013, p. 498).

This paper posits a possible role for other utilities, that already have mature macro-grid systems. Those utilities could provide stand-alone or dual-use systems for customers that prefer extra flexibility and portability of use for a variety of electric appliances. This approach provides an opportunity for utilities to

grow their businesses by offering customers a premium, added-value service on a voluntary basis. Utilities could also offer stand-alone or dual-use systems for specific end uses where customers demand the highest reliability and resilience in the event of any problems in the macro-grid. These activities could be closely aligned with several existing efforts to develop what are called “public purpose microgrids,” that serve first responders and other critical infrastructure. As Sklar (2016) suggests, there could be many situations where a nano-grid or mini-grid could provide ultra-high reliability service to one or more particularly important end uses in a building or a cluster of buildings, rather than trying to design a fail-safe system to serve the entire loads.

Banerjee, Barnes, et al. (2015) recommend the formation of new agencies, specifically charged with the task of planning for off-grid electrification. They propose a systematic appraisal of grid-based or off-grid solutions, as a prerequisite to deciding how best to serve new customers and needs. Rahmann, Nunez, et al., 2016 have proposed a set of metrics that can be used to determine the success of these kinds of energy systems in meeting long-term community sustainability criteria.

All utility regulators should be concerned with finding the least-cost means of providing the services that customers want and need. In locations with well-developed macro-grids, there is still a pressing need to determine when wires-based approaches are most cost-effective and when they might be overtaken by multiple distributed energy resources. That question is fast becoming a mainstream concern in many utility service territories that have pressing needs to replace existing, aging infrastructure. If these stand-alone and dual-use systems are capable of providing valuable services at lower cost, then it is incumbent upon regulators to help develop the environment where those choices will be made and the products and services delivered.

To start with, regulators can:

1. Stay attuned to the progress being made in other jurisdictions and watch for opportunities to learn best practices;
2. Pick one or more geographic locations in each reg-

ulated utility service territory, where energy ladder services can be modeled; and,

3. Identify one or more opportunities and begin experimental or pilot projects to start developing energy ladders in their jurisdictions.

References

- Alstone, Peter, Dmitry Gershenson, and Daniel M. Kammen. (2015). “Decentralized energy systems for clean electricity access,” *Nature Climate Change* 5(4), 305-314. doi: 10.1038/NCLIMATE2512
- Asmus, P. 2015. Microgrids: Friend or Foe for Utilities? *Public Util. Fortn.* Available online at: <https://www.fortnightly.com/fortnightly/2015/02/microgrids-friend-or-foe-utilities>; last accessed June 12, 2017.
- Banerjee, Sudeshna Ghosh, Douglas Barnes, et al. (2015). *Power for All: Electricity Access Challenge in India*. World Bank Study 92223. Washington, DC: World Bank. doi: [10.1596/978-1-4648-0341-3](https://openknowledge.worldbank.org/handle/10986/20525), <https://openknowledge.worldbank.org/handle/10986/20525>
- Bhattacharyya, Subhes C. 2013. “To Regulate or Not to Regulate Off-Grid Electricity Access in Developing Countries,” *Energy Policy*, Volume 63(December 2013), 494-503. doi: 10.1016/j.enpol.2013.08.028
- Chattopadhyay, D., M. Bazilian, and P. Lilienthal. 2015. More Power, Less Cost: Transitioning Up the Solar Energy Ladder from Home Systems to Mini-Grids. *Electr. J.* 28(3):41-50.
- Clean Energy Solutions Center. (2017). *Best Practices for Decentralized Energy Solutions Focusing on Lighting and Power in Humanitarian Settings (Webinar)*. Retrieved 29 May 2017 from <https://cleanenergysolutions.org/training/best-practices-decentralized-energy-solutions-focusing-lighting-power-humanitarian-settings>.
- Development Ventures. (2017). Briefing: Community Accelerators, a vehicle for infrastructure investment in ‘off-grid’ agricultural communities [Electronic document, retrieved 30 May 2017]. <http://developmentventures.net/index.php/our-work>
- Levin, T., and V. M. Thomas. 2016. Can developing countries leapfrog the centralized electrification paradigm? *Energy Sustain. Dev.* 31:97-107.
- Louie, Henry, Elizabeth O’Grady, et al. (2015). “Rural Off-Grid Electricity Service in Sub-Saharan Africa,” *IEEE Electrification Magazine*, March 2015, 7-15.
- Palit, D., and K. R. Bandyopadhyay. 2016. Rural electricity access in

South Asia: Is grid extension the remedy? A critical review. *Renew. Sustain. Energy Rev.* 60:1505–15.

Patterson, Brian. 2016. *Existing Codes and Standards* [Presentation]. eMerge Alliance. www.emergealliance.org

Phadke, A. A., A., Jacobson, et al. (2015). *Powering a Home with Just 25 Watts of Solar PV: Super-Efficient Appliances Can Enable Expanded Off-Grid Energy Service Using Small Solar Power Systems*. Lawrence Berkeley National Laboratory, LBNL-175726. <https://pubarchive.lbl.gov/islandora/object/ir%3A175726/>

Rahmann, Claudia, Núñez, et al. (2016). “Methodology for Monitoring Sustainable Development of Isolated Microgrids in Rural Communities,” *Sustainability* **2016**, 8, 1163. doi:10.3390/su8111163

Sadeque, Z., D. Rysankova, R. Elahi, and R. Soni. 2014. *Scaling Up Access to Electricity: The Case of Bangladesh*. World Bank Other Operational Studies, The World Bank. Available online at: <http://econpapers.repec.org/paper/wbkwbooper/18679.htm>; last accessed June 6, 2017.

Saghir, Jamal. 2017. “The Opportunity for Off-Grid Solar Revolution,” *LinkedIn Pulse*, 28 May 2017 [Electronic article, retrieved 6 June 2017]. <https://www.linkedin.com/pulse/opportunity-off-grid-solar-revolution-jamal-saghir>

Savage, Paul, Robert R. Nordhaus, and Sean P. Jamieson. 2010. “DC Microgrids: Benefits and Barriers,” in *Silos to Systems: Issues in Clean Energy and Climate Change*, Leslie Parker, Rachel Maxwell, et al. (Eds.), Chapter 5. New Haven, CT: Yale School of Forestry & Environmental Studies. <http://environment.yale.edu/publication-series/5981.html>

Schneider Electric. (2017). *Access to Energy* [Web page, retrieved 29 May 2017]. <http://www.schneider-electric.com/accesstoenergy> and <http://www.schneider-electric.com/accesstoenergysolutions>

Sklar, Scott. (2016). *Distributed Energy, Efficiency, & Storage to Harden Critical Infrastructure: To Address Resiliency, Cybersecurity, and Water Conservation, and Emissions Reduction* at Dupont Summit 2016 on Science, Technology, and Environmental Policy Issues. Washington, DC: Policy Studies Organization. <http://www.ipsonet.org/conferences/the-dupont-summit/dupont-summit-2016-program>

Soulardarity. (2017). *Let There Be Light* [Web page, retrieved 30 May 2017]. <https://www.ourpowerandlight.com/>

Stanton, Tom. (2012). *Are Smart Microgrids in Your Future? Exploring*

Challenges and Opportunities for State Public Utility Regulators. National Regulatory Research Institute, Report No. 12-15.

TFC Utilities. (2017). *The Million Rate Base Model* [Web page, retrieved 15 May 2017]. Twenty First Century Utilities, LLC. <http://tfcutilities.com/approach/the-million-rate-base-model/>

United Nations Development Program. (2017). *Sustainable Development Goals / Goal 7: Affordable and Clean Energy* [Web page, retrieved 15 May 2017]. <http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-7-affordable-and-clean-energy.html>

USB Implementers Forum. 2017. *USB Power Delivery* [Web page, retrieved 12 June 2017]. http://www.usb.org/developers/power_delivery/

World Bank. 2017. *State of Electricity Access Report 2017*. World Bank, Washington, DC. <https://openknowledge.worldbank.org/handle/10986/26646>

Zeng, Zheng, Rongxiang Zhao, et al. 2014. “Policies and Demonstrations of Micro-Grids in China: A Review,” *Renewable and Sustainable Energy Reviews* **29**(January 2014), 701-18. doi: 10.1016/j.rser.2013.09.015.

Zinaman, Owen et al. (2015). *Power Systems of the Future—A 21st Century Power Partnership Thought Leadership Report*. National Renewable Energy Laboratory, NREL/TP-6A20-62611. <http://www.nrel.gov/docs/fy15osti/62611.pdf>

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