ICER
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THE ICER CHRONICLE

A FOCUS ON INTERNATIONAL ENERGY REGULATION

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The ICER Chronicle

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Table of Contents

I. Foreword

Welcome to the sixth edition of the ICER Chronicle.

As one year comes to a close and another begins, we have an opportunity to stop and evaluate our efforts in all facets of our work. As regulators, evaluation is key to our success – both in determining what is appropriate and feasible for regulated industries and in discerning the effectiveness of the rules, policies and frameworks we implement. Through evaluation, we can address shortfalls in our approach and devise new and innovative solutions to challenges we face.

With that in mind, this latest edition of the Chronicle features a number of timely and thoughtful explorations of work in the field of energy regulation. We turn our attention to Italy, for instance, where an evaluation of smart meters and time-of-use pricing provides a window into how to approach the next wave of the technology coming to the country.

We can also use evaluation to redirect our approaches as our electricity landscape continues to evolve, particularly with respect to renewable energy resources. Authors in this edition of the Chronicle highlight how solar photovoltaic technology can be maximized to offer advantages for the electricity system broadly, and how current thinking on the potential for cost reductions in wind energy could carry serious consequences.

As an organization, we are also evaluating our efforts to ensure that we are fulfilling our mission to exchange information and best practices in the regulation field and contribute to the evolution toward a sustainable planet. In the coming year, we will be working to better include voices and perspectives from emerging economies in our virtual working groups and other venues. I believe that dialogue on how we achieve our mission is critical, and I hope we can facilitate a more robust conversation on energy regulation and its role in our world.

I would be remiss if I did not take time to thank our authors, whose scholarship and dedication to evaluation and innovation allow us to learn lessons from the past and better prepare for our future. I also want to thank the editorial board for their time and effort to prepare this edition.

As always, we welcome your feedback on the Chronicle. Should you have an original article you think would be of interest for future editions of the Chronicle, please submit it to chronicle@icer-regulators.net.

Thank you, and my best to you in 2017.

John W. Betkoski III
ICER Chairman

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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@icer-regulators.net.

III. Women in Energy: Storytelling

Our Women in Energy stories offers men and women a chance to read about how their fears are the same as someone else's, and can be conquered.

In this edition, we feature two such stories. Born in apartheid South Africa in a time of racial, social and gender inequality, Ranjini Nayager's story could easily have been one of hatred or victimhood. Instead, it is about having the courage to believe in yourself and having the conviction to be true to yourself and your principles.

Commissioner Rendahl speaks of the balancing acts of being a regulator and working family member, the importance of science, technology, engineering and mathematics (STEM) education and the need to project confidence in everything you do.

Ranjini sums up that WIE is about: access to a network of experiences and story-telling so that you can get strength and succour from a regulatory community of men and woman who believe in you and your potential.

Interested in joining Women in Energy – the ICER International Network?

Connect with regulatory peers from across the globe

Share professional experiences

Benefit from our webinars and mentoring programme

The ICER WIE network is open to all staff (men and women) of ICER's energy regulatory authorities. It is free to join!

Are you a woman in energy with an inspiring story to share?

Due to repeated requests to widen our WIE story telling, ICER is pleased to open the story telling to all women in the energy sector (both within and beyond energy regulatory authorities).

To share your WIE story, please contact us at chronicle@icer-regulators.net to learn more.

Many thanks to all our storytellers.

Una Shortall
Chair of the ICER Women in Energy Steering Group

Ranjini Nayager
Chief Executive Officer
Independent Competition & Regulatory Commission
Australia

Swimming with Sharks

Of late, I get asked ‘why does an apparently normal, psychologically stable, logical human being willingly go diving in a place that has the highest concentration of great white sharks in the world?’ Yes, why indeed. The answer to this question holds a key to why I have achieved what I have on a personal and professional level and why I am choosing to share my story with you.

As I watched a few two meter sharks swim towards the heaving boat anchored off the coast of South Africa, I held onto the railing as the dive master gave instructions or something. I saw his mouth move, but did not hear the words, instead my brain was focused on the sharks and thinking that if I did not hold on, I was lunch. It was at that point I asked myself, ‘why are you doing this?’ I collected myself, reined in that sickening feeling in the pit of my stomach called ‘terror’, scrambled down the stairs and somehow tugged and squeezed into a wetsuit and was of the first to get into the cage and then lowered into the swirling green sea. The sharks circled. My brain froze. I eventually calmed down to enjoy the beauty of these amazing creatures and the serenity of the ocean. My fear returned when the sharks suddenly swam away and I thought, what can possibly scare the killers of the ocean - a bigger shark off course. A shark about five meters long appeared from the green depths of the ocean and circled us opening its mouth enough for me to realise that I could fit into its mouth and body. Strangely I was not as fearful as I was on the boat. My fear arose from a combination of watching the film ‘Jaws’ at a tender age, media, my imagination and my fear of the unknown.

A realisation hit as the boat sped back to shore to avoid being caught in the fast approaching storm. I survived the shark dive yes, but I realised that I am fortunate to have parents who reinforced to me at an early age that I should never be afraid of fear itself and being afraid to fail. The reason why I dived with sharks, why I am a chief executive in a masculine dominated field of energy and utility regulation is because I am not afraid to fail. I realised that being afraid to fail is one the things that prevents women from realising their potential.

My fears, your fears, our fears are grounded on a perception that we have to be right. I don’t. You don’t. We don’t. I make mistakes. I own

The first thing to know about me is that I am real and I am human. I was born in South Africa in the wrong hospital (hospitals were segregated) to parents who challenged the Apartheid system. I have been going against the grain ever since. I have lived my life learning from others and doing what makes my soul sing. I have taken chances, changed degrees, changed countries, changed industries and changed my perception of myself.

After university I worked for a judge, dabbled in litigation and ran as far away as I could from asking people for images of injuries to their nether regions. I entered the world of financial services, ate bbq field rat, snake 5 ways, and a ‘special’ pizza and took an amble down the Tatai River. Later I entered the world of utility regulation.

I never set out to be the Chief General Counsel or Chief Executive. I set out to enjoy my life, learn a lot and give back to the society that gave me so much. I do not believe in box ticking and see every setback as an opportunity to refine what I want to do and where I want be. Life is about learning - I will only stop learning the moment my mitochondria stops. I love to have a bit of fun every day, am comfortable in my own skin, sing loudly and badly and strive to be the consummate professional. I have a deep respect for the world and my fellow regulators.

my mistakes, learn from them and move on. I use my failures, my mistakes to challenge myself to step out of my comfort zone (shark diving), to take risks (bungy jumping), to challenge my mind and my perceptions and to take a chance on me (applying for jobs). So if you, reader, wherever you are in the world, have ever had that sickening feeling where fear holds your insides in a vice like grip, or you have ever told yourself or been told by others, that you can't or should not do something because of your gender, your age, your colour, your cultural background or just because you can't: take a chance on you. Dealing with challenges in life can be hindered by fears. Don't be afraid to realise your potential and take a chance on yourself. Why not? What is the worst that can happen? No is a word that only has power over our self-esteem when we choose to give it power.

One of the biggest challenges I faced when I started in the energy sector, was being underestimated because I am a woman. I had to recognise that those internal voices telling me in so many ways that I was an outsider, new and a woman were voices which were not mine and that these voices were holding me back. I worked hard to consciously recognise that the negativity that comes with the opinions of others were the only shackles holding me back, those external voices, I internalised. My shackles were not my gender, not my sex, not my melanin levels, not my age, but me letting the voices of others become the shackles which stopped me realising my potential. I made a choice. I chose to realise my potential. I chose to face my fears and take a chance on me.

Being born in apartheid South Africa in a time of racial, social and gender inequality, my story could easily have been one of hatred of the other or victimhood. But I was born to parents who believed in the potential of each and every human being. It is my parents and maternal grandmother who are the cornerstones of why I am the way I am and why I believe in sharing my story, which is anyone's story. It is a story about having the courage to believe in yourself and having the conviction to be true to yourself and your principles.

I was born to parents who believed in the potential of each and every human being. It is my parents and maternal grandmother who are the cornerstones of why I am the way I am and why I believe in sharing my story, which is anyone's story. It is a story about having the courage to believe in yourself and having the conviction to be true to yourself and your principles.

Above all else, I was taught to believe in myself, that I am capable of achieving my dreams if I worked hard, received formal education and learnt through the experience of others. I was told and believe that I am worthy. I was taught and believe that a girl, a woman with education has the power to shape her own life.

A life-long project I have and am working on involves education of women. Education is not just in books, the internet, but can be gleaned from stories and experiences of others. From a young age, I would always help girls in my grade who were behind at school and so it was natural for me to set up when I was at university a free tutorial programme for high school students who came from disadvantaged backgrounds. The challenges involved balancing my time with my university schedule, financial resources, self-motivation and motivation others to join the programme – I struggled to keep up with demand and needed help. The first real challenge I faced was to accept that needing help is not a sign of failure.

Asking for help is not a sign of weakness, but of strength and recognising the necessity of putting the programme's needs and benefits (the students) ahead of my ego. I did. I am proud that the programme is still operational. This programme has helped so many students and tutors in so many ways. The WIE mentoring programme to me is a normal thing to be involved in. I also see the programme as a way in which we can facilitate changes in organisational cultures to not only keep women in paid employment and help talented women advance in their chosen careers, but also to provide a safe environment for women to air their fears and come to a realisation that we all share the same fears, a shared humanity, we can be stronger together, find hope and learn how to be part of the solution and not a problem. Cultural change occurs in organisations through a number of ways, but a key is normalising the enforcement by leaders of organisation of merit-based practices of organisations. Collectively and individually, we need to diminish the power of stereotyping of women and senior managers recruiting from within: within organisations, within gender groups, within cultural groups, within age groups. This is what I want to change – stereotyping of women and this is the reason I am part of the WIE programme which at its simplest to me is about including not excluding people. I want to normalise talent, intelligence and skills in recruitment and advancement choices. Gender, age, colour, cultural background etc., should never matter. That is what I strive for every day.

And, so back to sharks of all kinds. I rarely tell people that I am a lawyer (lawyers some would say are species of shark) and a chief executive because when I do, I see the colour drain from their faces as they are either in astonishment or so afraid, they are in a state of terrified silence and they make a quick exit. Whilst I could describe what I do as diving with sharks, I am more apt to describe what I do as running crèche for adults which tends not to have the effect of draining people of their colour. I chose to dive with sharks in Shark Alley not because I am psychologically unbalanced and have a death wish, but because I chose to face my fear – fear itself. I also choose to view myself as a successful, strong woman of colour grounded in ethics, surrounded by strong, supportive men and women who have given me what I think the WIE can give you: access to experiences, access to seeing the potential of your life and your abilities and an ability to pursue your dreams. WIE is also about telling stories, so that you can get strength and succour from a community of men and woman who believe in you and your potential.

Ann Rendahl
Commissioner
Washington State Utilities and Transportation Commission, USA

Women in Energy

In 2001, when a major hearing before the Washington Utilities and Transportation Commission threatened to drag on into the night, the administrative law judge, who was at the time a new mother, faced a decision working parents still grapple with to this day: what to do when the daycare is closed but the work is not finished. When the hearing participants requested to carry on and not prolong the hearing an additional day, then Administrative Law Judge Ann Rendahl had a choice to make, recess the hearing until the next day to care for her son Nathan, or bring him to the hearing.

With open arms, attorneys and stakeholders all took turns caring for the baby, while Ann, now a commissioner of the Washington Commission, presided over the case. A move that today may have gone 'viral' made all the difference then for Commissioner Rendahl.

While pursuing her master's degree in public policy at the Goldman School of Public Policy at University of California Berkeley, Ann took a macroeconomics class that explored rate design and the elasticity of demand with inclining rate blocks, sparking her interest in the economics of energy. During her first year of law school at Hastings College of Law, she pursued an internship in the legal department of the California Public Utilities Commission and that was all it took. She's worked for regulatory commissions ever since.

Her first job after law school was with the Washington State Attorney General's office representing the Washington Utilities and Transportation Commission. She later joined the UTC as an administrative law judge. After rising to the director of the Administrative Law Division, and then of the Policy and Legislative Division, Ann was appointed as a commissioner in January 2015.

Ann has spent her career balancing her work life with the demands of home and her three children, who are now in college and high school. "My mother held a college degree in math and astronomy, and was required to leave her job at IBM when she was pregnant in the early 1960's. While she did not work again until my siblings and I were in middle school, she always encouraged us to find our paths, achieve our goals, including having a family."

Ann Rendahl was appointed to the Washington Utilities and Transportation Commission (UTC) by Gov. Inslee in December 2014 for a six-year term. She previously was the Director of Policy and Legislation for the UTC.

Prior to leading the UTC's Policy and Legislative Affairs Section, Ann served as the Director of the Administrative Law Division, as an administrative law judge for the UTC, and as an assistant attorney general representing the Utilities and Transportation Division.

Ann is a member of the Electricity and Consumer Affairs Committees at National Association of Regulatory Utility Commissioners (NARUC), and currently serves as co-chair of NARUC's Task Force on Transportation, focusing on railroad safety. She is also the chair of the Energy Imbalance Market (EIM) Body of State Regulators, an advisory body to the California ISO's EIM Governing Body.

Ann is a graduate of Wellesley College and received a master's degree in Public Policy from the Graduate School of Public Policy at the University of California, Berkeley. She received her law degree from Hastings College of the Law, University of California, San Francisco. Ann and her husband, Paul Sachs, have three children, Sarah, Sam and Nathan.

"I've found the biggest challenge facing women in our field is the need to be recognized as equals, and heard when we have something to say," says Commissioner Rendahl. "While this dynamic is changing, it is still difficult to feel comfortable speaking up on issues that matter to women, especially in industries where we are underrepresented, like energy."

As commissioner of a state public utility commission, Ann is charged with balancing the needs of consumers with the requirement of utility and transportation companies to provide safe, reliable, and affordable services.

Dedicating her career to public service, Ann's balancing act doesn't stop at work. While she has had the full support of her husband and family, over the last 23 years working with the UTC, she has put in long nights after the kids go to bed and sacrificed countless weekends to get the work done.

"Families are faced with tough choices when it comes to the delicate balance of work and family, and we must continue to advocate for working conditions that recognize the reality of our situations."

In the workplace, where women are still underrepresented in technical fields, Ann stresses the importance of science, technology, engineering and mathematics (STEM) education for young girls.

"By participating in science, engineering and math studies, more girls can have the confidence to participate in the technical conversations and initiatives happening in these fields," says Ann. "But technical knowledge must be paired with the opportunity to participate in the work."

Ann is currently the chair of the California Independent System Operator's Energy Imbalance Market Body of State Regulators, which provides a role for state regulators to participate in the governance of the Energy Imbalance Market developing in the Western states. In this role, Ann is contributing her unique perspective. Using skills she has gained in leading hearings and facilitating settlement discussions and workshops, she is fostering a vital conversation between state regulators in order to assist state utility regulators in understanding organized markets, and determining how state regulators will play a key part in the burgeoning energy imbalance market and the development of a western regional transmission operator.

"It's so important for programs like Women in Energy to give women a chance to collectively navigate a historically male-dominated industry and share experiences," says Rendahl. "I feel honored to be part of the continued upward movement of women within the energy sector."

"It's so important for programs like Women in Energy to give women a chance to collectively navigate a historically male-dominated industry and share experiences," says Rendahl. "I feel honored to be part of the continued upward movement of women within the energy sector."

In order to change organizational cultures to keep women in the workforce, Ann believes the intersection of environmental studies with improved STEM education curriculum will be the catalyst to increase interest in the energy industry.

"The younger generation is interested in economic development and more attuned to the needs of the environment. They see how mastering skills in science, math, and engineering can result in new and more efficient ways of producing, transmitting, and distributing energy," says Rendahl. "If we can continue this momentum and growth, we will attract more women to energy and energy regulatory careers."

Ann's advice for young women in the energy sector? "Project confidence in everything you do."

IV. The Italian Case on Smart Meters in the Electricity Market: a New Wave of Evolution is Ready to Come

Eleonora Bettenzoli, Domenico Cirillo, Marco De Min, Luca Lo Schiavo, and Alessandro Pitì

Abstract

This article provides an update on recent developments of the Italian case for smart metering, which is heading for the second generation, and on the role played by the Italian Regulatory Authority for Electricity Gas and Water (AEEGSI), the country's national regulation authority (NRA). Starting in 2001, Italy has been the first case of deployment of smart metering systems on large scale in Europe: currently more than 35 million customers have their smart meter (SM) installed and working.[1] This has also conducted to the largest experiment so far with Time-of-Use (ToU) electricity prices[2][3].Now Italy is preparing a new further upgrade in the technology of smart meters, according to functional requirements established by AEEGSI with the decision 87/2016/R/eel, that will enable greater efficiency in the supply chain and allow customers to benefit of new innovative services.

Smart meters in Italy: a history at the forefront of European regulation

Italy has been one of the first countries to implement a large scale roll-out plan of smart meters in the electricity market in late 2001. Although the initial decision of E-distribuzione (previously named as *Enel distribuzione,* the distribution company of the former monopolist and currently the major incumbent in the Italian electricity market) to start the substitution of traditional, electromechanical meters, was actually led by cost efficiency,[4] the focus of the NRA AEEGSI has been driven since the beginning also by service quality and effectiveness in customer service. The Availability of a first generation large-scale smart metering system enabled the Italian NRA to introduce a number of regulations for DSOs exploiting smart meter's functionalities. For instance, since 2008 smart meters are to be used to leave a minimal, vital service to the final customers in the event of non-payments (0.5 kW for an ordinary household customer, normally

[1] CEER, Council of European Energy Regulators Report on Smart Metering with a Focus on electricity Regulation, October 2007, http://www.energy-regulators.eu/portal/page/portal/EER_HOME/ EER_PUBLICATIONS/CEER_PAPERS/Customers/2007/E07-RMF-04-03_SmartMetering_2007-10-31_0.pdf

CEER, Council of European Energy Regulators Status review on Regulatory aspects of smart metering, May 2009, http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/ CEER_PAPERS/Customers/Tab/E09-RMF-17-03_SmartMetering-SR_19-Oct-09.pdf

[2] Which has been mandated from 2009 for all low-voltage households and small-business customers, who are served in the Universal Supply Regime (*Maggiore Tutela*) as they don't choose their own supplier in the free retail market

[3] S. Maggiore, M. Gallanti (2013) Impact of the enforcement of a time-of-use tariff to residential customers in Italy. 22nd International Conference on Electricity Distribution (CIRED)

[4] According to the Italian regulation, the DSOs' investments in smart metering have been recuperated adjusting the tariff component that corresponds to capital investment (taking into account also the stranded value of residual depreciation, if any, of existing traditional meters). On the other hand, the efficiency factor which governs the reduction of operating costs has been hugely increased (from 5% per year in the regulatory period 2008-2011 up to 7.1% per year in the regulatory period 2012-2015)

supplied with 3 kW of contracted power). Moreover, smart meters are to be employed to remotely re-establish the contracted power as soon as the customer has completed the payment; this operation must be carried out in a very short time, or an automatic compensation is to be paid to the customer.

The Italian case of smart metering raised a lot of interest in scholars and a seminal study of the former President of CEER[5] was at the root of the provisions of the European directive 2009/72/CE. All European Union (EU) member States have been required to make a cost/benefit analysis to introduce smart meters in large scale, in order to have an economic assessment of all the long-term costs and benefits to the DSO, to the market players (like suppliers and aggregators) and the individual consumer. Where roll-out of smart meters is assessed positively, Directive 2009/72/CE requires that at least 80 % of consumers shall be equipped with intelligent metering systems by 2020.[6]

The European Commission (EC) has accompanied this Europe-wide extensive process with many initiatives: among them it is worth citing the recommendation n. 2012/148/EU, a publication that contains a mandate to CEN/CENELEC/ETSI for smart metering standardization, that in turn produced several progresses in this field.[7] In particular, Recommendation n. 2012/148/EU indicates ten functional requirements that are intended to be of common interest for all Member States;[8] however, the details of the roll-out strategies on technical and regulatory criteria are defined independently by each member State.

[5] J. Vasconcelos (2008) Survey on regulatory and technological developments concerning smart meters in the European Union electricity market, RSCAS Policy Papers, n. 2008/01, http://cadmus.eui.eu/bitstream/handle/1814/9267/RSCAS_PP_08_01.pdf?sequence=2

[6] Annex 1 of Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0055:0093:EN:PDF

[7] European Commission (2009), Mandate M/441 "Standardization mandate to CEN, CENELEC and ETSI in the field of measuring instruments for the development of an open architecture for utility meters involving communication protocols enabling interoperability" http://www.cen.eu/cen/Sectors/Sectors/Measurement/Documents/M441.pdf ;

CEN/CLC/ETSI (2011). Technical Report 50572: Functional reference architecture for communications in smart metering systems ftp://ftp.cencenelec.eu/EN/EuropeanStandardization/HotTopics/SmartMeters/CEN-CLC-ETSI-TR50572%7B2011%7De.pdf

[8] European Commission (2012) Recommendation of 9 March 2012 on preparations for the roll-out of smart metering systems. Official Journal of the European Union http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012H0148&from=EN.

Table 1: Ten common minimum functional requirements recommended in EC Recommendation n. 2012/148/EU[9]

Area	Functional requirement
Consumer	a) Provide readings directly to the consumer or any designated party
	b) Update readings frequently enough to use energy saving schemes
Metering operator	c) Allow remote reading by the operator
	d) Provide two-way communication for maintenance and control
	e) Allow frequent enough reading for networking planning
Commercial aspects of supply	f) Support advanced tariff systems
	g) Remote On/off control supply and/or flow or power limitation
Security – Data protection	h) Provide secure data communications
	i) Fraud prevention and detection
Distributed generation	l) Provide import/export and reactive metering

In most of the European countries where a smart metering system has been already installed or is going to be, the EC Benchmarking report shows that smart metering requirements satisfy a common set of functionalities such as: fine granularity of metering data, remote reading and AMM installation with bi-directional communication for DSOs, ToU (time of use) pricing schemes, data encryption techniques for preserving privacy, tamper-proof hardware, and capability to provide readings directly to the user or any authorized third party.[10]

The original architecture and its evolution

The current architectural configuration of smart meters in Italy, that we refer to as "first generation," or "SM1G" smart meters, were devised by NRA in order to achieve a series of improvements in metering effectiveness, the introduction of service level agreements on some customer services, as well as support the extensive and mandatory adoption of ToU pricing in the whole country, and was incentivised by the NRA with schemes for cost recovery of the investment.

In the current SM1G architecture the remote control system is composed of two parts: first, each MV/LV transformer station is equipped with a data concentrator that collects data coming from meters connected to LV feeders coming out from the MV/LV transformer, via power-line carrier technology (PLC), and is capable to send instructions to individual meters thanks to a two-way communication on the PLC[11]; second, from the concentrator upwards, communication is mainly based on the public TLC network (GSM/GPRS). One of the main limits of the current configuration is that a real time control of the end-point meters is not allowed.

[9] European Commission (2012), Commission staff working document, Cost-benefit analyses & state of play of smart metering deployment in the EU-27 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0189

[10] European Commission. (2014) Benchmarking smart metering deployment in the EU-27 with a focus on electricity. Report from the Commission http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0356&from=EN

[11] Mainly requests of spot or massive reading, but also other types of instructions, related to customer management – for instance, to energise the point of connection or, more rarely, to solve firmware problems.

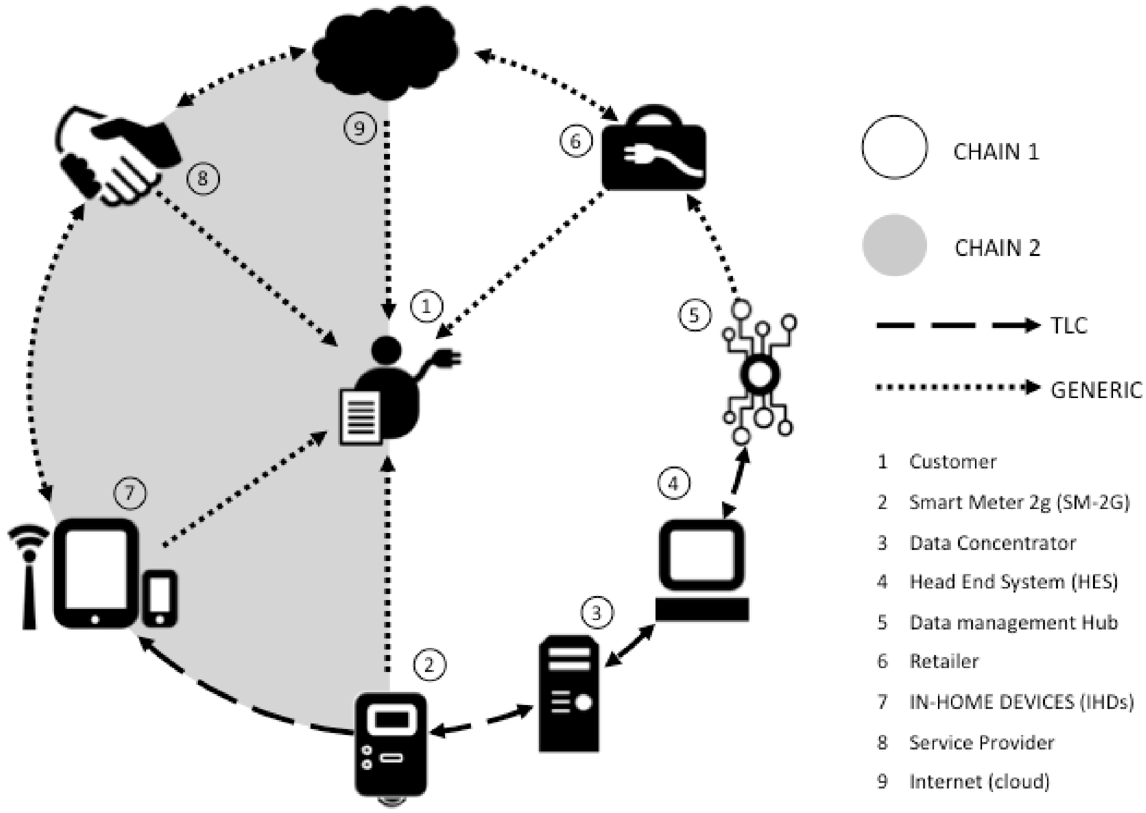

Figure 1*: Advanced Metering Infrastructure -AMI- for second generation of Smart Metering*

On the other hand, the importance of the use of In-Home-Devices (IHD) in driving a potential saving of 3 to 4 % of yearly consumption[12] has been shown thanks to AEEGSI's initiatives for smart grid demonstration pilots,[13] developed and tested on a small scale (around 5.000 customers). Such pilots were based on IHDs communicating with SM1G through the same PLC link used for remote metering and meter management: this represents another limit of the current architecture, since it implies that in the SM1G there is no full interoperability with 3rd parties IHDs.

Based on these considerations the Italian NRA has recently approached the issue of devising a "second generation" of smart metering architecture, that we refer to as "SM2G." SM2G has been thought for improving services for the customers and to overcome consumptions estimation, enhancing accuracy and precision of the metering data for all the customers connected in LV. The new Advanced Metering Infrastructure -AMI- is showed in Figure 1.

Metering data exchanged between SM and the Head-End System (HES) of the DSO usually require two links: as for the SM1G, the first link connects the SM with the so-called "data concentrator" (usually situated in a Secondary Substation where the MV/LV transformer is

[12] M. Lombardi (2014). Enel Smart Info after one year on field: lessons learned, evolution and results of the pilot. Rome: CIRED workshop.

[13] L. Lo Schiavo et al. (2012), Changing the regulation for regulating the change. Innovation-driven regulatory developments in Italy: smart grid, smart metering, electromobility (ICER Distinguished regulatory scholar Award 2012), http://www.iern.net/portal/page/portal/IERN_HOME/ICER_HOME/ABOUT_ICER/Distinguished_Scholar_Award_2012

located), while the second link enables the acquisition of the measurements from the concentrators to the HES. The concentrator is an intelligent station, which receives hundreds of measurements coming from all the served meters, processes and repackages the data before sending them to the HES. It can even asks for a new data acquisition whether the communications with some SMs failed. Once reached the HES, raw measurements are analysed in the so-called "validation process," which checks if the collected data are complete and valid or, failing that, uses advanced algorithms for missing-data reconstruction. Finally, the validated measurements can be forwarded downstream for the billing phase managed by retailers. Data are conveyed through the so-called "data management hub," a centralised information system regulated by the Italian NRA that acts as a switch in a star network and is in charge of exchanging metering data between DSOs and retailers avoiding direct exchange of information between them.

The infrastructure of the system encompasses now 2 communication channels, or "chains:" the "chain 1," that represents an evolution of the 1G smart meter solution, used to convey metering data to be used for billing operations and shows metering data only after DSOs' validation, and a new "chain 2," that exposes raw non validated metering data in "near real time" mode directly to the customer in order to develop services of consumption awareness and home automation. The main advantage of this new chain is the reduced time used to make the customers aware about their consumption: in fact chain 1 metering data may take even a day or more before reaching customers due to the validation process, while chain 2 provides raw non-validated measurements within a few seconds.

The major improvement in chain 1 is that it will now allow a greater granularity of data collected. For the time being, with SM1G technology, due to limitation in concentrators and existing HES, consumption data from almost all LV customers are collected only on a monthly basis and only with reduced granularity, according to three predefined time bands. Hence, with SM1G, retailers can offer only contracts based on the same fixed time bands. Thanks to SM2G, all data recorded, for every quarter-hour, will be collected by DSOs on a daily basis and transferred, after the validation process, to retailers. Thanks to the large amount of measurements acquired, retailers will be enabled to offer more customized schemes of ToU prices, up to a Real-Time-Pricing (RTP) regime, in which customers pay energy according to the same price fluctuations imposed by the wholesale energy market. The scope of a similar strategy is to enhance loads shifting that can produce bill savings.

In addition, with SM2G DSOs could inform final users about a network outage even in the LV network (with SM1G is already possible for MV network) and retailers may build Demand-Response schemes, providing extra-payment for flexibility services provided by the customers that are able to modify their consumption profile on request (according to system-balancing needs). Integrated with a more evolved home-automation system, IHDs can allow automatic scheduling consumptions and thus savings, even with no human interaction and can be a communications channel between the retailer and his customer.

The main differences in terms of metering data acquisition between the SM2G and the previous SM1G are reported in Table 2.

***Table 2**: A comparison between metering data recorded by SM2G and SM1G in Italy*

Metering data	2G	1G
Active energy withdrawn	15 min	3 values per month
Active energy Injected	15 min	3 value per month
Reactive energy withdrawn	15 min	3 values per month
Reactive energy Injected	15 min	3 values per month
Active power withdrawn	15 min (peak) and instantaneous value (1s)	15 min (peak)
Active power Injected	15 min (avg)	No
Min/max voltage	1 per week	Only occasionally
Voltage in limits	Yes, compliant with EN50160	Only occasionally and not compliant with EN50160
Outages	On event occurrence	No (fw available but not used due to memory restriction)

<u>The chain 2</u>, which represents the major novelty in the new SM2G architecture, has been conceived to supply near real-time metering data directly to the customers exploiting new IHDs for data visualization and utilization. It can supply instant active power, daily energy curves, alerts and contractual information. The sampling frequency for data acquisition can be chosen accordingly to the customer needs and the capacity of the communications channel. Examples of IHDs can be either simple external displays used by those customers having their SM in the basement, or a more evolved dashboard showing the daily energy curves of the past days, or smart appliances (e.g., connected washing machines, electric vehicles) or even an Energy Management System (EMS). Moreover, dashboards and automated systems can receive information coming from other players (e.g., energy market, service providers, cloud services) and couple them with the metering data in a sophisticated system aiming to make customers aware about the advantages of a responsible use of the energy resource.

As required by European Directive 2012/27/EU, technological, performance and privacy requirements for the new architecture have been formalised by Italian NRA in its decision 87/2016/R/eel: in there it is stated that both communications channels (between SM and IHD and between SM and the concentrator) must ensure confidentiality, authenticity and integrity. Moreover, it is required to use encryption techniques for all the communications.

Smart meters implementation: a framework that looks comprehensively at the supply chain

The previously cited EC Recommendation 2012/148/UE states, among other things, that "*implementation of those metering (smart metering) systems may be subject to an economic assessment of all the long-term costs and benefits to the market and the individual consumer or which form of smart metering is economically reasonable and cost-effective and which timeframe is feasible for their deployment*"; moving from that, the Joint Research Center (JRC) of European Commission has contributed by publishing in 2014 "Cost Benefit Analysis of Smart Metering Deployment." The document provides methodological guidelines and best practices for conducting a cost benefits analysis of SM deployment, to tailor assumptions and parameters to local conditions, to identify and monetize benefits and costs and to perform sensitive analysis of several variables.[14]

In JRC's guidelines the beneficiaries (customers, system operators, retailers, etc.) are identified associated with each cost and benefits' calculation formulas are typically related to economic values or directly to emissions reduction. These benefits typically appear related, directly or indirectly, to the reduction of electric energy absorbed by / from the network, and they can be obtained thanks to increased awareness and understanding of consumptions.

With its consultation paper 468/2016/R/eel, Italian NRA AEEGSI provides a different approach, to integrate in the analysis even the most intrinsic aspects to the power system as a whole and to take into account the relationships among different actors in the power supply chain. In particular, keeping a role at the forefront of European regulation in the area of smart metering, Italian NRA AEEGSI, with its consultation document 468/16/R/eel, integrates JRC's guidelines and extends the scope proposed by European Commission, suggesting a wider and more organic comprehensive methodological framework. At the core of this approach there is the consideration that increasing efficiency (in terms of swift availability of meter data), effectiveness (in terms of greater reliability in metering performances), and granularity (in terms of sampling frequency) of the metering chain is likely to affect, at different levels, the whole power supply chain in the downstream market.

Starting from the technological potentialities of the new SM-2G, Italian NRA therefore identifies a set of opportunities that are likely to improve existing both business and non-business processes or even spawning completely innovative services that can be introduced in the market.

In particular, while considering specificity and regulatory constraints of internal market, Italian NRA suggests the way the new SM2G can be the mean for major improvements in current processes like:

- the invoicing and billing process, both for accounts receivable and accounts payable (the availability of metering data with daily frequency allows traders and retailers to adopt a rolling approach in invoicing customers, and, in turn, DSOs in invoicing traders and retailers, therefore representing a strategic leverage to optimise the cash flow and reducing the overall financial exposure for the whole power supply chain)
- Switching, transfers and other contractual services
- Energy forecasting
- Settlement of balancing services
- Quality of service

Moreover, the Italian NRA also identifies innovative services that can be offered by third parties and are specifically enabled by SM2G; among them:

[14] Benefits identified by JRC are the following: Reduction in meter reading and operations costs; Reduction in operational and maintenance costs; Deferred/avoided distribution / transmission / generation capacity investments; Reduction of technical losses of electricity; Electricity cost savings; Reduction of commercial losses; Reduction of outage times; Reduction of CO2 emissions and air pollution.

- The possibility of providing customers with information and feedbacks on their consumption behaviour, both in real time (using the chain 2 of the architectural solution[15]) or in terms of reports attached to the invoice, aimed at increasing customers' awareness towards more conscious energy consumption habits opening up the way to further possibilities given by the emerging services of analytics and pattern recognition.
- The introduction of prepaid contracts in the Italian market, also intended as an instrument to contrast the phenomenon of arrears.

The approach encompasses a qualitative and quantitative evaluation of the benefits deriving from them, drawing a scenario where all the synergies and reciprocal dependencies among processes and new services are explored in detail. This is the aspect where AEEGSI methodology gets closer to the JRC's proposition. However the Italian NRA has identified further benefits, in addition to effects related to energy consumption reduction, ranging from a valuation of the increased efficiency of processes and of financial securities for cross-operators relations

The third and last step in the framework has more to do with the specific role of AEEGSI in leading a regulatory reform capable of driving and enabling the benefits identified: a preliminary gap analysis on regulation has been performed, asking stakeholders opinions on which aspects have to be prioritised and starting paving the path for the introduction of the new SM2G. In first instance, AEEGSI acknowledges that most of the benefits can reach their full potential only when synergies among regulatory instruments, technologies and the market will release their effects on a substantial number of SM2Gs installed in customers' premises. However, the most important regulatory aim, as expressed in the cited consultation document, is to assure that Italian market can benefit from the new AMI as soon as DSOs start rolling out the new meters to Italian customers.

Conclusion

The Italian way of approaching the case of smart meters represents an effective case study of how technology can improve performances and services in the distribution of electricity, and how those improvements can extend along the supply chain and towards customers. In particular the new architectural configuration designed by the Italian NRA AEEGSI will be at the basis of a series of new innovative services for customers, opening scenarios partially or completely new for European electricity markets.

The novelty of the Italian approach is not just on technology: in order to evaluate systematically impacts and benefits related to the introduction of SM2G, AEEGSI has proposed a framework that, though drawn on European Commission JRC's methodology, represents a step forward at least for two reasons:

- in terms of broadness of the approach: the evaluation is extended to the whole power supply chain, instead of strictly focusing on benefits immediately related to consumer habits;

[15] IHD has been mentioned as a tool that the customer buys. Another commercial configuration of such a device could be as a bridging tool of data released through the chain 2 to an authorised 3rd party (i.e. the retailer). Customers could buy services by a 3rd party authorizing it to install such a bridge device that collects their own consumption data coming out from the SM through the chain 2. The 3rd party could sell advanced services to those customers based on their real time data by using apps on smart phones/tablets/smart TV.

- in terms of depth of the approach: the analysis conducted for the SM2G undertakes a profound detailing of business processes, achievable synergies, and operational and financial aspects.

In conclusion, Italy is on the verge of a second major wave of evolution in the electricity market after liberalisation, and regulation is to drive this technological and market discontinuity ensuring a release of the benefits to customers as fast as possible, along with a transition of the whole power system to the new paradigm as smooth as possible.

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At the beginning of her arrival in Autorità, she was involved in the “Market department”. In 2009, she took on the responsibility of the Unit named “Processes in the liberalized Energy markets” where she accomplished the reform of the regulation of the settlement of imbalances of both Electricity and Gas and set out the foundations for the Italian meter data management hub (SII). For a certain period she had been called at the “Infrastructures department” to head the group in charge of regulating the deployment of the Gas Smart Metering.

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Since February 2016 he has been collaborating with AEEGSI, the Italian NRA, where he is involved into the development of the SII (the integrated informative system used by traders and distribution companies to exchange metering and customers’ data both in the energy and the gas sector) and into the regulatory stream related to the introduction of the new generation of smart meters in the energy sector.

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Throughout his career he has been working also as researcher, consultant in civil and energetic sector and, occasionally, teacher at Politecnico of Milan.

Since 2005 he has been officer Italian Regulatory Authority for Electricity Gas and Water (AEEGSI), the Italian Energy and Water Regulator. For 8 years officer in the Energy Efficiency Policy Division for the creation and the development of the Italian scheme of white certificates, for technical assessment of energy efficiency projects and development of standard procedures for accounting energy savings associated with common measures.

Since 2013 officer in the Markets Division for AEEGSI for energy demand side management, white and green certificates, renewable energies and energy efficiency and electricity production. For the Markets Division he has been defining functionalities and benefit evaluation for the second generation of electricity smart metering national deployment.

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He is member of the ACER Electricity Working Group (Infrastructure TF) and of CEER Working Group on Distribution Systems (DS WG).

He is an expert of quality of service and smart grids. He is co-author of the book "Service quality regulation in electricity distribution and retail" (Springer, 2007). In 2012 he was awarded with the ICER (International Confederation of Energy Regulators) Distinguished Scholar Award for the paper "Changing the regulation for regulating the change. Innovation-driven regulatory developments in Italy."

In 1986 he obtained a degree in Industrial Engineering at Politecnico di Milano and in 1999 a post graduate qualification in public policy analysis at IDHEAP (Lausanne, CH).

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He received a bachelor in software engineering and a master of science in energy engineering from Politecnico di Milano in 2011 and 2015 respectively.

He is a member of the working group instituted by the Italian Committee for Electrotechnical Standardization (CEI, the equivalent of CENELEC and IEC at national level) with the purpose of defining a standard communications protocol for "near-real time" measurements exchanged between smart meters and customers' in-home devices.

He is also author of several scientific and technical papers on energy management, energy optimization, smart grids, smart metering and metering communications technologies.

V. Electricity Regulatory Incentive Mechanism

Eng. Fayez Al Jabri and Eng. Shareef Al-Barrak

Institutional Background

In the Kingdom of Saudi Arabia (KSA), the Electricity and Co-generation Regulatory Authority (ECRA) is responsible for the regulation and monitoring of quality in electricity sector. The Saudi Electricity Law pays close attention to quality regulation. Customer protection and quality improvement are among the main goals pursued by ECRA, which has the legal powers for setting compulsory quality standards, associated either with individual compensations or with general performance related to quality actual achievements.

In 2008, the Electricity & Co-Generation Regulatory Authority (ECRA) for the Kingdom of Saudi Arabia (KSA) developed a Key Performance Indicators (KPIs) regulatory framework. The intention was for these KPIs to be used by ECRA, as the regulatory body for the electricity sector, to monitor licensed companies involved in the generation, transmission and delivery of electricity supply to customers in the KSA. The study established the following 26 KPIs that were most relevant and in line with international best practices.

Generation		**Distribution**	
G1	Availability Factor (AF)	D1	SAIDI
G2	Forced Outage Factor (FOF)	D2	SAIFI
G3	Scheduled Outage Factor (SOF)	D3	MAIFI *[2011]*
G4	Equivalent Forced Outage Rate (EFOR)	D4	Network Losses *[2012]*
G5	Starting Reliability (SR)		
G6	Gross Capacity Factor (GCF)		
G7	Net Capacity Factor (NCF)		
Transmission		**Customer Service**	
T1	ENS	C1	Average Time to Supply – Existing Connections *[2013]*
T2	SAIDI-T	C2	Average Time to Supply – New Connections
T3	SAIFI-T	C3	Average Time to Reconnect After Payment
T4	MAIFI-T	C4	Notification of Interruption of Supply *[2012]*
T5	Out100 km	C5	Frequency of Complaints
T6	Voltage Dips *[2012]*	C5	Frequency of Billing Complaints
T7	Network Losses *[2012]*	C7	Average Time to Resolve Billing Complaints
		C8	Average Waiting Time Call Center

Key Performance Indicators Data Measurement

ECRA introduced a KPI regulatory framework for service providers to record interruptions of supply. Interruptions have been classified as planned, unplanned, Generation/Transmission and Force Majeure. For each interruption, a list of items that must be recorded has been set, among which include:

- the cause of interruption;
- the voltage level of the fault that originated the interruption;
- number of customers affected;
- the duration of the interruption; and

- location and feeder

All of the information recorded for each interruption must be documented and kept by the service providers. Each year, the service providers shall submit main reliability indicators to ECRA: that is, System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI) and Momentary Average Interruption Frequency Index (MAIFI) per Customer per year. The reliability indicators are obtained as the weighted sum of the single recorded interruptions events, using the number of customers affected as weights. Yearly, reliability indicators provided by the service providers are used to assess the improvement and to distribute incentives. ECRA makes regular audits to check that interruptions are recorded in accordance with compelling requirements and that provided data are consistent with single records. Some indices are used to determine whether data provided by the service providers have to be considered valid or not.

REGULATORY INCENTIVE SCHEMES

The reliability regulation was enforced in 2009 devising a link between the reliability of supply and the service providers performance against the target set by ECRA, through ECRA's regulatory incentives schemes. The main objectives of the regulatory incentives scheme were the following:

- enhance the overall level of reliability in the KSA and bring the country's average level closer to best international benchmarks;
- bridge the gaps between the areas, reducing the differences among regional reliability levels; and
- avoid reliability deterioration in those areas where actual levels were already good

A detailed description of regulatory mechanisms for reliability of supply enforced in the KSA in the first regulatory period can be found in ECRA's web site. There are four main methods adopted by ECRA's incentive schemes under which such incentives can be provided, namely:

(1) Performance publication;

(2) Overall standards;

(3) Guaranteed standards, and

(4) Penalty and reward schemes.

These four methods are now described in more detail.

Figure 1: Regulatory Incentive Schemes

(1) Performance Publication

Performance publication is when the regulator requires the licensee to disclose information about (trends in) its performance to the regulator and/or the general public. Overviews of the licensee's performance are reported to the regulator and published, for example, in the company's annual reports, in dedicated regulatory publications, or on the licensee's or regulator's website.

Performance publication is relatively simple to implement and does not require the regulator to develop a view on what should be an appropriate performance target. Such an approach can be useful in the case where the formulation of a meaningful target is difficult. Even through there are no financial incentives, the fact that the company is exposed by making public its performance already creates incentives to maintain a high level of performance.

Currently, ECRA is publishing the service provider's performance in an attempt to create an incentive and motivation towards its improvement.

(2) Overall Standards

An overall standard relates to the performance of the service providers averaged over all customers being served. Here, a minimum target level to be achieved is specified for a certain performance indicator. However, the utility is generally not exposed to any financial penalties in case of not meeting the targets. The idea of the overall standard is that the specification of a target level provides the service providers with a tangible objective to achieve that is in line with regulatory expectations.

Acknowledging that performance improvement is difficult to achieve overnight, a distinction can be made between long-term and short-term targets. ECRA recommended to apply six years for the long-term target and three years for the short-term target.

The short-term target acts as an intermediate performance target for the service providers that should be achieved in three years. After this, the service provider can improve further aiming towards the level of the long-term target in the next three years. The short-term target can thus be interpreted as the period of time considered reasonable for the service provider to improve up to the final target. The expected performance level can be gradually increased each year over the duration of the time period in which the long-term target should be achieved.

For deriving the benchmark target, international data samples have been used. Information about performance of the sample is used as a reference to set the target. Even though one could opt for the best performing utility in the sample, this is generally problematic as sometimes this can be driven by data issues or the best utility simply being an outlier. On the other hand, the mean generally provides a more realistic indication of the target but at the same time, performance better than the mean should also be considered. For identifying the KPI target, ECRA have selected an approach based on the central limit theorem. This states that the distribution of a sum of many independent, identically distributed random variables tends towards the normal distribution theory of normal distributions. A pragmatic approach is to focus on the so-called peer group which is defined as the companies that are located two quartiles around the mean outside the standard deviation as basis for setting the target. This approach provides more robust information about the range where the target should be located. It should be noted however that the process of setting the target is not a mechanic one and will involve utilization of the experience and knowledge.

For both System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI), a target set near the "median international level" seems to be a realistic objective and these targets can serve to develop local targets based on the local characteristics of each department in order to contribute to the identification of zones where there is a potential for improvements.

Setting a target at the level of median for each KPI brings the above comparison to indicate improvements to be made for SAIDI and SAIFI indices, at least for some regions. The target for these two KPIs is as follows:

KPI	Short Target	Long Target
SAIDI (Min/Customer/year)	120	150
SAIFI (#/Interruption/year)	2	2

As a result of the KPI submission, ECRA has noted from SAIFI and SAIDI data provided that the distribution network performance is variable, with the poorest performance exhibited in areas which are serviced by less secure networks. For completeness, we show the Saudi Electricity Company[1] (SEC) SAIDI and SAIFI performance indices for 2012, 2013 and 2014 in Figure (2) and Figure (3) below. The significant variance between the best and worst performing regions is quite apparent and is understood to reflect nature of the worst performing regions.

The overall objective of this paper is to present a thorough review of the power system performance and establish regulatory measures to reduce both the frequency and duration and thus the impact of future distribution network outages and/or disturbances.

[1] SEC is the dominant player in the Saudi Arabian electricity utility industry. It is a vertically integrated electricity utility and the company is engaged in power generation, transmission and distribution. It operates oil, gas, steam, and diesel generation plants. SEC Distribution supplies electricity to some 8 million customers in four operating areas.

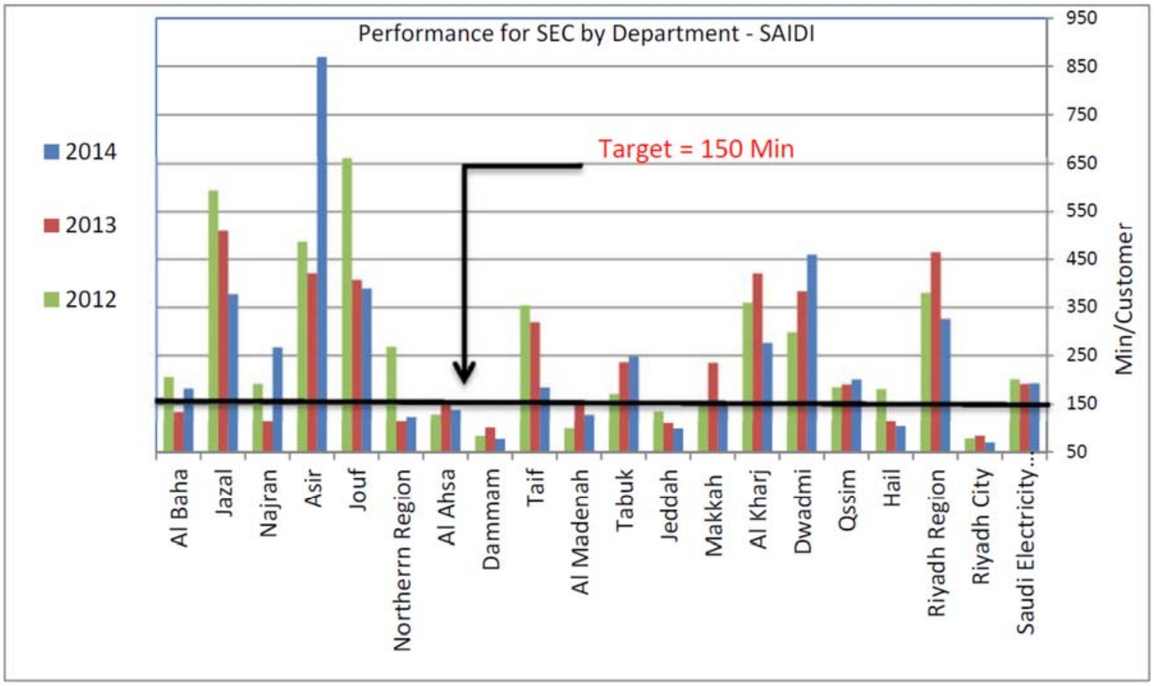


Figure 2 : Performance for SEC by Electricity Departments – SAIDI

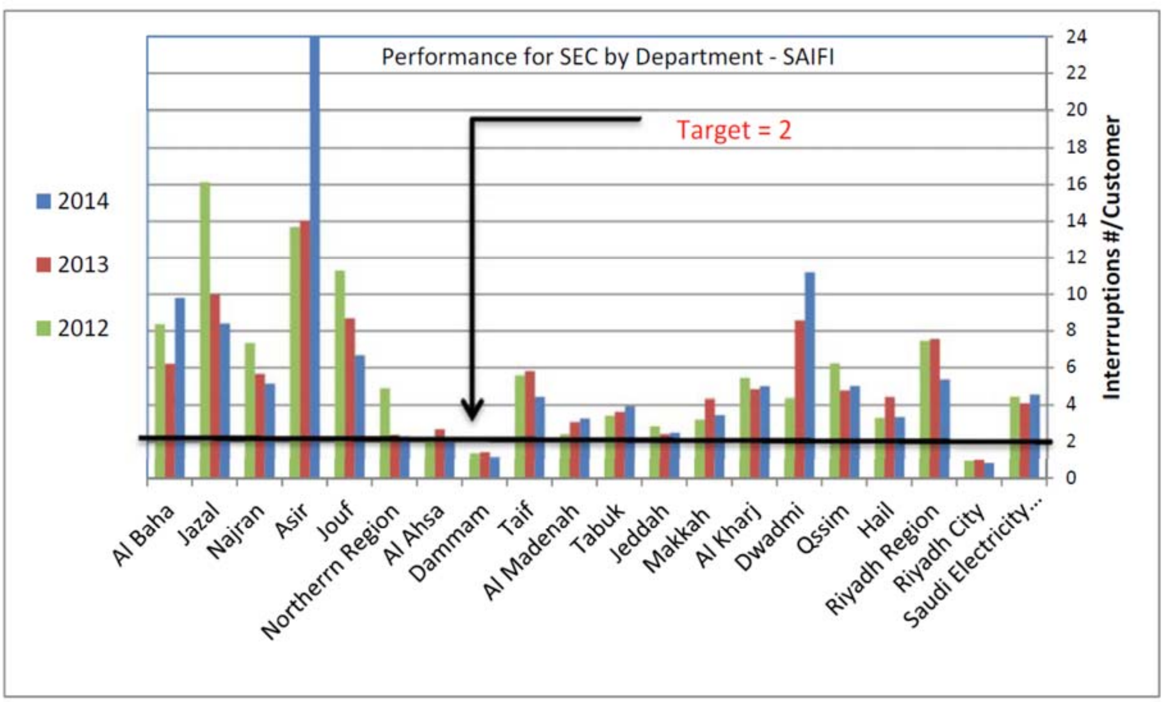


Figure 3: Performance for SEC by Electricity Departments – SAIFI

(3) Guaranteed Standards

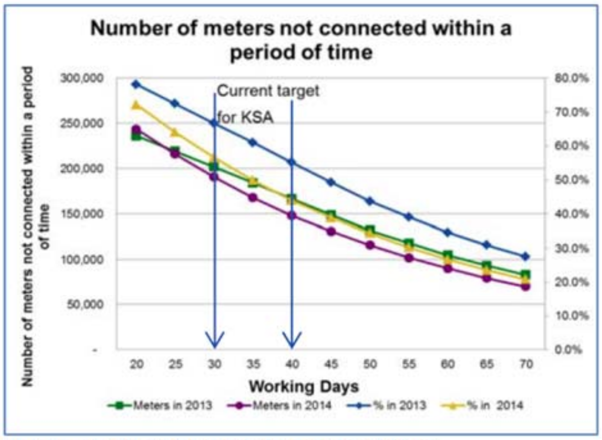
Complementary to KPIs regulatory framework, ECRA will introduce the guaranteed standards of services. They are essentially an incentive mechanism designed to improve customer services. Guaranteed Standards are standards of service that must be provided to any customer and therefore must be met by the service providers to guarantee a level of service that is reasonable to expect. If a licensee fails to meet the minimum standard of service required, it must make a payment to the customer subject to certain exemptions. Therefore, guaranteed standard schemes set a minimum level of service with respect to customer service that is enforced through a threshold level, and service below the threshold will be penalized.

It can be stated that, internationally, most countries have a guaranteed standard scheme in place, and these schemes are very similar in nature. With respect to the setting of the threshold values for the guaranteed standards, the approach taken by ECRA is as a first step to consider international practice applied for the relevant guaranteed standards in terms of threshold values and compensation levels. In a second step, the potential level of compensations to be paid by the licensees should be estimated to assess their impact on the financial performance of the licensees. However, historical data are not available for each of the guaranteed standards, so that the second step analysis cannot be executed. In this case, the recommendations for the guaranteed standard threshold and the compensation level are based on international practice.

The table below presents the recommended guaranteed standards. In particular, these standards are designed to complement ECRA's customer service KPI framework and will incentivize customer service providers to deliver better services.

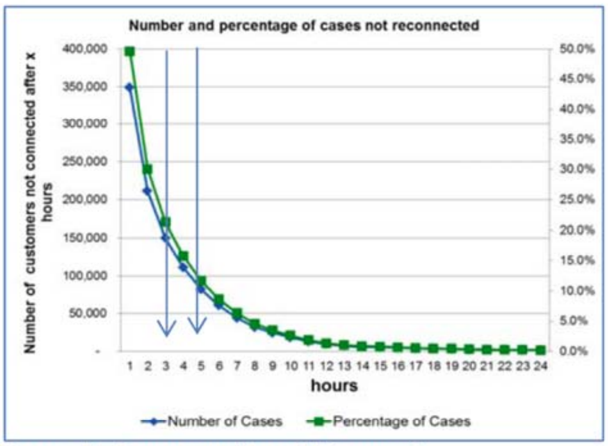
Guaranteed Standards	The Standard
GS1	Time to Register and Supply – Existing Connections (Working Days)
GS2	Time to Supply – New Connections
GS3	Time to Reconnect after Payments (Hours)
GS4	Notification of Planned Interruption of Supply
GS5	Time to Resolve Billing Complaints (Working Days)
GS6	Supply Restoration – Normal Conditions (Hours/Case)
GS7	Frequency of Interruptions

In the following charts, the recommendations regarding some of the above guaranteed standards will be explained. With respect to the setting of the threshold values for the guaranteed standards, the approach taken is as a first step to consider international practice applied for the relevant guaranteed standards in terms of threshold values and compensation levels. In a second step, the potential level of compensations to be paid by the licensees should be estimated to assess their impact on the financial performance of the licensees.



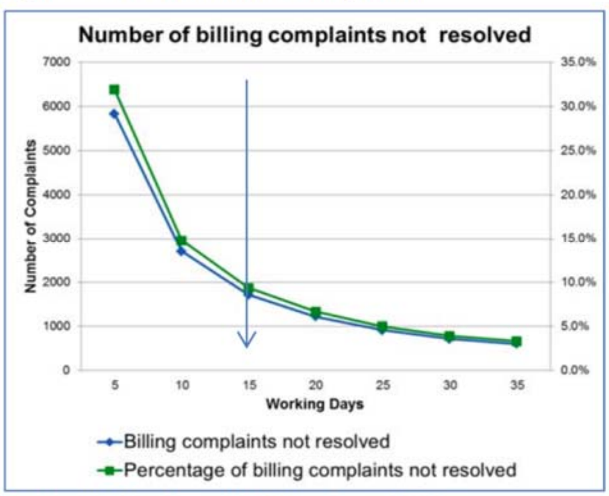
- About 337,000 meters were connected in 2014 (302,000 in 2013)
- Internationally the standard is in the range of 15 to 20 Workdays.
- Abu Dhabi has a standard of 43 Workdays
- Average value in KSA in 2014 is 49 Workdays
- Considering the compensation at 200 SAR per case and the current target in KSA (30 Workdays) result for 2014 in a payment of SAR 38

- **Figure 4: New Electricity connection**



- About 700,000 total cases were reported for SEC in 2013
- Not all departments seem to have reported in this respect
- Reconnection is an important issue given local conditions
- Standard at 4 hours after payment leave some 110,000 cases (or some 16%) of the cases unresolved.
- Considering a compensation of SAR 50 in this case the total compensation will be 5,500,000 SAR based on 2013 figures

- **Figure 5: Reconnection of Payment**



- More than 10% of the Billing Complaints are resolved on the same day
- In international average the standard for resolving billing complaints is at 15 days
- Staying with this standard means that some 1,700 complaints (or 9.4%) are not resolved within that standard
- Considering a 50 SAR compensation payment will result in a total compensation of 85,000 SAR

- **Figure 6: Number of billing complaints**

In summary, ECRA adopted implementing the following guaranteed standards:

Guaranteed Standard (GS)	Comment	Standard	Compensation Amount
(GS1) Time to Register and Supply – Existing Connections	Time between customer request and the moment where customer has access to electricity	5 Working Days (WD)	75 SAR once the standard has been exceeded, 20 SAR for each additional Working Day
(GS2) Time to Supply – New Connections	For LV customers if no network enforcement is required	40 Working Days	200 SAR once the Standard is exceeded. 200 SAR for each further 40 Working Days
(GS 3) Time to Reconnect following Lack of Payment	Time between account balance has been settled and the actual access to electricity is reestablished.	Urban: 3 hours Sub-urban / rural: 5 hours	75 SAR once the Standards has been exceeded. Further compensation for each 3 hours
(GS 4) Notification of Interruption of Supply	Noticifaction can be by email, text message, or any other means approved by ECRA	2 calendar days in advance	75 SAR once the Standard has been exceeded.
(GS 5) Time to Resolve Billing Complaints	Billing complaints to be treated immediately, but in difficult cases response can take longer	15 calendar days	75 SAR once the Standard has been exceeded.
(GS 6) Supply restoration – normal conditions	Service provider fails to restore electricity supply within a certain period of time after becoming aware of the interruption	24 hours	75 SAR for domestic and 150 SAR for commercial consumers once the Standard has been exceeded.
(GS 7) Frequency of Interruptions	Applies to interruptions for at least four hours within one financial year	4 interruptions	200 SAR once the Standard has been exceeded

(4) Penalty/Reward Schemes

Under a penalty/reward scheme, a more continuous relation is imposed between price and performance. Each performance level results in a financial incentive, which varies with the gap between actual performance level and some predefined target level. In case the company performs below the target, the incentive is a financial penalty, while if the company exceeds the target the incentive comes in the form of a financial reward. This financial incentive is proportional to the gap between the actual and targeted performance.

Different types of penalty/reward schemes exist. Price and performance can be mapped continuously or in a discrete fashion, the level of the penalty or reward can be capped, dead bands may be applied.

An important question is the type of incentive mechanism ECRA should adopt for each of the selected KPIs. As mentioned, performance publication can be considered the default approach and where targets can be clearly specified, this was also extending into overall standards. The question however is whether it is desirable to move further into the direction of penalty/reward schemes. Doing so would introduce an element of risk to the service providers and also lead to a higher regulatory burden. If, for some reason, the service providers is not able to meet the target levels, this can trigger high penalties and could cause financial trouble. Such a situation may occur if the standard level is set at too high a level or large fluctuations around the average performance over time.

Simply stated, regulators are more willing to take the risks of introducing more complex and intrusive mechanisms if there are sufficient concerns that the utility will not improve performance on its own or that performance may even be reduced.

Through the KPI system, ECRA will nevertheless be able to closely monitor the performance of the service providers and assess whether performance is satisfactorily. In the future, when a move to stricter price control forms is made, the implementation of penalty/reward schemes can be considered.

Conclusion

There is regulatory room to improve the network reliability looking to the regulatory incentives tools to ensure that reliability is better. The performance indicators currently used by SEC to improve reliability do not directly align with the SAIDI and SAIFI KPIs. The quality of electricity network service is of paramount importance to electricity service providers. Actual service quality and incentives to improve quality vary dramatically from country to country. ECRA establishes current incentives and targets regulatory schemes and identifies trends associated with policy and the treatment that are affects SEC in its mission for the performance improvement to protect the consumers.

It can be concluded that developing and implementing the regulatory incentives tools will significantly improve the overall reliability and achieve the approved target of SAIDI and SAIFI.

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Prior to ECRA, he worked at SABIC, the giant petrochemical and metal company, in various positions ranging from maintenance, operations, and projects and held the position of Chief Electrical Engineer before leaving SABIC. Mr. Al Jabri graduated from King Abdulaziz University with an Electrical engineering degree in 1997 with Honor. In 2009, he obtained his Master of Business Administration from the same university.

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He has a diverse work experience in various projects and vital responsibilities, including development of Smart Meters and Smart Grids Strategy in the Kingdom of Saudi Arabia, Network Reliability Improvement Plan, Incident investigation and developing electricity industry regulation. His interests include regulation of quality of service, technical standards and power system analysis.

VII. Innovation and Energy Regulation: Lessons Learned and Messages of the ERRA Regulatory Innovation Day

Gábor Szörényi and Mariusz Swora

Introduction

The European Union has ambitious energy and climate policy goals regarding reduced CO_2 (Green House Gas) emission, increased ratio of renewable sources (RES) and strong energy efficiency measures. The global climate framework achieved on the Paris Climate Summit could accelerate these movements World-wide.

Based on ambitious targets and the introduced incentive schemes the renewable energy sources are spreading, and that will result in strategic and behavioural change of electricity system and market participants. Especially the high ratio of intermittent renewable energy (wind and solar) created new challenges and increased the value of flexibility (both supply and demand side + storage technologies).

These climate policy targets which are closely related to energy policy accelerated the restructuring of grid based energy supply, especially for electricity and gas. Some countries made clear steps to shift the electricity supply system from a centralized to a decentralized one, and the transformation of the energy sector is taking shape.

The decentralized energy supply system of the future is characterized by a two way flow of information and energy. Significant changes are also taking place on the customer side: passive energy consumers are increasingly becoming "prosumers", who are actively assisting to shape the energy supply system. These changes are requiring the advanced measurement and communication technologies as well as the data processing systems. Such changes apart from promises of efficiency gains, poses also some threats from the point of view of data privacy, cyber-security and safety. Though considering potential benefits, regulators must take into account certain technological and financial risks associated to new and innovative technologies. Dealing with those technologies, in most cases they have to find right balance between innovativeness and 'traditional' goals they protect and promote like security of supply, competition and sustainable development. Another important problem is to adjust regulatory policy so as to enable and/or promote innovative approach of regulated entities.

In practice, regulators deploy various approaches to incentivize utilities, like revenue cap with rate of return, yardstick regulation, price cap based on allowed revenues or hybrid solutions. There are also examples of performance based models, clearly referring to stimulation of innovations like the British RIIO (Revenue = Incentives + Innovation + Outputs) regulatory model for setting the network companies' price controls.

There are new expectations, changing behaviours and real actions at the demand side as well. Some end-user formations (like: Smart Energy Demand Coalition) and energy service companies offer its clients state-of-the-art services for an integrated management of their energy issues along the entire value chain. These services include energy efficiency, portfolio management and green power supply, direct marketing of power from renewable energy resources and flexible management of distributed power plants, consumers and storage technologies. The implemented new technologies enable the customers to manage and monetise flexibilities in real-time and to optimize the energy costs and their consumption comprehensively.

New and innovative technologies (e.g. smart metering, smart grids, smart appliances, energy storage, demand response methods, distributed and self/micro generation, interactions of electric vehicles and grid (V2G), new energy efficiency methods and information technology developments) have become increasingly important topics across the world. The achievement of new energy and climate policy goals regarding reduced CO_2 emission, increased ratio of renewable sources and electric vehicles as well as strong energy efficiency measures accelerate these technology changes. Regulators should be familiar with the potential challenges of deployment and the benefits of using these technologies. Supporting this innovation and assisting consumers to utilize these new possibilities regulators have to provide adequate incentives to the energy industry and to end-users. In order to enable ERRA member regulators to fully understand the possible scope of new innovations and to be able to adapt to the new situation, ERRA has decided to support its members in this field as well.

Report

ERRA prepared a Report[1] introducing the industrial tendencies, the required new smart technologies and innovative operation models together with their necessary regulatory support. The supportive legal and regulatory framework is necessary to achieve the energy and climate policy goals.

The Report introduces the ERRA internal survey-questionnaire and the evaluation results of the answers on the present position of ERRA members regarding innovation, regulatory support of development and implementation of new innovative technologies and solutions.

At the end of the Report there are some general recommendations for the regulators[2].

Innovation and Energy Regulation Forum (ERID)

ERRA - together with the Polish Energy Association (PKEE) – organized a Forum in Poznan, Poland: the “ERRA Regulatory Innovation Day” (ERID) on 12-13 May, 2016 as a part of Energy Future Week, which focused on the new “smart” technologies, the innovative operation modes and the necessary regulatory support (if any) for them.

ERID was designed as a platform for the exchange of experience and information between energy policy makers, regulatory authorities, utilities, research institutions and end-users. Under

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[1] The editors would like to thank all those experts, who volunteered to prepare some chapters of ERRA report and participate in commenting and finalisation of the collected lessons learned and messages of the ERRA Regulatory Innovation Day (ERID), namely Grzegorz Benysek, Professor, Univeristy of Zielona Gora, Poland; Dr. Mark A. Jamison, Director, Public Utility Research Center, Florida; Carlo degli Esposti, Principal Consultant, Pöyry Management consulting; István Táczi, Electrical Engineer, Intern of ERRA, MSc. student at Budapest University of Technology and Economics; Professor Giuseppe Bellantiono, University of Trento; Professor Peter Fox-Penner, Boston University, David Elzinga, Economic Affairs Officer, Sustainable Energy Division; United Nations Economic Commission for Europe.

[2] The Report “Innovation and Energy Regulation – Including Report on ERRA Survey in 2016” is available on the ERRA website (www.erranet.org).

the broad umbrella of the program, the staff of regulatory agencies, research institutions, utilities and representatives of the financial sector interested in development and innovation was encouraged to participate.

The purpose of this forum was to promote innovativeness and cooperation in the energy sector amongst regulators and other actors of the ecosystem of innovations in ERRA countries by enhancing the cognizance of various approaches to innovations. The forum also aimed to promote cross-border cooperation with the goal of providing a better understanding of regulatory approach to energy innovators as well as a better understanding of innovation-related problems for regulators. The forum allowed to identify regulatory and energy policy related aspects connected with introducing of new technologies and innovative operations and putting special emphasis on the dissemination of knowledge about various types of innovation, roles of different actors in the innovation ecosystem and incentives (incl. regulatory ones) to innovations.

The Forum concentrated on the following issues:

- Creating the culture of innovations in the energy sector
- How to incentivize innovations in the energy sector?
- Acceleration of innovation and the development of the electricity networks of the future (smart grid and smart meters)
- Demand Side Response and system operators
- Energy storage
- Integration of e-mobility & its regulation
- New smart appliances and their system effects
- Changing expectation and behaviour of customers.

The Forum was a successful event organized in 14 different sessions, where the moderators and panel members discussed the related topics. The structure of the panels ensured highlighting the different aspects of innovative solutions and smart technologies among innovators, technology developers, energy companies, end-users, policy makers and regulators. The more than 400 participants of the Forum received information on industry trends, new expectation of stakeholders, innovation processes and potential regulatory supports of new technologies.

Messages of the Innovation Forum

- Innovation could give consumers a greater value/cost proposition.
- Regulation and Innovation are interlinked: Innovation could come on the scene easier with predictable and forward looking regulatory regime; the predictability is important demonstrating stability in monopoly type network regulation and in support of competition in the market segments, while the forward looking regulation means flexibility allowing new innovative solutions. The implementation of innovative technologies and solutions require adequate adjustment of regulation; flexibility for experimentation and regulatory tolerance. Higher risk associated with innovations should be accepted (together with the potential losses of pilot projects) and the regulator should learn to tolerate higher profit (in case of success with new, innovative technologies).

- The energy innovation chain does not work well because of weak incentives on the supply side and the demand side. One of the consequences of the barriers to energy innovation is that energy R&D public and private investments are too limited compared to non-energy industries. This problem should be acknowledged at the outset and the whole innovation policy in the energy sector should be geared to solve it.
- The policy makers and regulators have to understand the mind/thinking of consumers, innovators and technology developers to be proactive; the best way for obtaining knowledge about technological innovations and the impact they have on the regulatory system is consultation with these stakeholders. Due to the complexity of these issues the energy transition requires strong analytic and implementation capabilities. Therefore, the regulators have to consider new approaches. Fora (place for information exchange) of the stakeholders are essential to reduce the overall knowledge asymmetry regarding the impact of innovation on the energy system.
- The policy makers and regulators should enable creation of new markets (room for innovation) in every segment of energy supply chain. Competition with the existing energy companies could come from outside of the energy industry through innovation.
- The rigid legal framework sometimes ties the hand of regulators adjusting the regulation to the changing environment. The rigid regulatory environments could limit the chance of the regulated companies to invest in new innovative technologies risking “stranded asset”; that is why new solutions often come from outside of the regulated activities.
- Innovators do not wait for regulators to be ready to innovate, but innovators need regulators to adapt regulation so that innovations and associated services are efficiently provided. Let the new, consumer-oriented and innovative services grow (limit the sphere of monopoly activities)! Supporting complex solutions instead of different technologies and/or providing long term goals; industry, customers and innovators will find the solutions!
- During the transition toward carbon free economy; if no complete regulatory and market design revolution is needed, a constant adaptation of regulation and market design is necessary. Comprehensive revision of the regulatory decision-making process is important. Innovative regulation could mean more flexible regulatory framework; not forcing/accepting such market models, which are limiting the freedom of new entrants.
- Some flexible and proactive energy companies introduced “open innovation” philosophy involving all the employees and those interested innovators who are outside of the company. The energy companies could (should) cooperate and find common standards/protocols regarding smart grid and smart metering solutions, like the telecom industry did it several years ago (e.g. GSM standards).
- Energy companies should better utilize the wide range of technology solutions offered by the IT industry. The digital grid allows better communication and information exchange between energy companies and consumers in both ways.
- Regulators should allow different pilot projects (accept the cost of them) to learn the potential benefits of new solutions. Those energy companies (network and supply as well) which are continuously testing and implementing the new innovative technologies and solutions could better satisfy the changing expectation of their customers.
- The regulators – beside the traditional regulatory models, which focus on long term investments – should find new regulatory elements which support/ accept the research, development, test, analysis of results and implementation of new and fast developing technologies (e.g. Pilot Projects, Cost Benefit Analysis, shorter depreciation).

- The innovation needs clear mandate instead of subsidies; clear future targets set by policy makers and regulators (reducing regulatory risks) give adequate signal to the industry taking the commercial risk of innovative solutions.
- The transition in the energy supply chain can be “brutal” or manageable, but – most likely – we cannot avoid it! The regulators should ask themselves whether elements of regulation hamper the support of the smooth transition process!
- One of the big challenges of the regulators during the transition processes lays in not sacrificing those “old” infrastructure elements, which could ensure security of supply and adequately handle investment security issues (avoiding huge stranded asset).
- The US PJM pool test-performance figures demonstrate that the Demand Side Response (DSR) activity is reliable for the TSO. In the PJM pool and in other US regional markets the volume of DSR has already reached 7 – 12% of peak demand in 2010 (percent of peak demand covered by DSR). This cost-effective and liable solution has a lot of applications! The general consumers saved 10 to 20 % due to the DRS programs and even 30% in the constrained regions.
- The capacity/availability payment paid to those end-users (or to energy pools) who offer flexible capacity to system operators could stimulate customers to enter into reserve and balancing markets. In case the spread between the on peak and off peak prices are relative small special balancing rules could assist end-users to participate in these markets.
- Instead of telling consumers how to participate in the system-regulation (demand side respond), tell them the system-regulation goals and ask them about the conditions of demand participation!
- The new storage technologies could be implemented – beside the TSOs and DSOs – on the generation/supply and demand side as well. The clear definitions of storage technologies in the relevant legal frameworks are important to support more effective regulatory positions. It should be added to different regulations as well. Transmission and distribution grid investment deferrals by storage technologies are possible in limited countries. In these countries the regulation allows the system operators to deploy small storage systems on investment deferral purpose and the system operators are allowed to operate a storage system if it is proven to be the most efficient solution for a problem.
- The charging profile of electric vehicle (EV) batteries is similar to the general end-user profile; without time of use (or zone) tariff the e-mobility could hinder the system-regulation! Already 2-3 % EV of the whole car park could have huge effect on system-regulation; the aggregation of the (distributed) storage capacity through smart charging could help compensating the negative system effects of the intermittent renewable capacities. The optimisation of smart charging will be important with substantial number of EVs, but – in most ERRA member countries – not today! Tariff incentives of EVs could help system-regulation.
- The policy makers and the regulators should announce the advantages of EVs; saving the environment, reduce fuel (energy) dependence and save the health of the population.
- The smart grid and smart metering systems could enhance the communication and cooperation between DSOs/suppliers and consumers. Some smart metering pilot projects did not demonstrate active consumer interest. Positive results occurred, when massive information campaign and market based tariff assisted end-users to be active.

- When deploying smart technologies, energy companies should respect privacy and take cyber-security seriously. Cyber-security shall be addressed as a priority by public authorities, regulators (e.g. when considering costs of smart projects or setting requirements) and last but not least – by energy companies.
- The opinion of the network operators shows that reduced commodity (energy) prices and increasing capacity payment is the general tendency assisting the deployment of smart grid elements and reflecting to the changing cost structure. The regulators should consider how the consumers should pay for their capacity demand!
- The continuous consultation – on consumer expectation and satisfaction and on technical possibilities – among involved parties could enhance supply quality regulation. The clear understanding and methods on data collection, data management, calculation and requirements is essential!

Recommendations

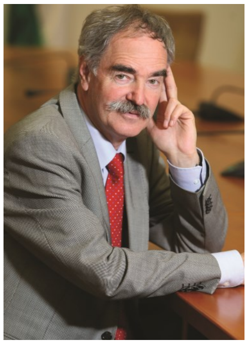
The deployment of introduced new smart technologies and operation modes require new, innovative regulatory framework, which is adjusted to the new formulating industry model, assisting the achievement of new policy goals and supporting the fulfilment of changing customer expectation.

The results of the ERRA internal survey show, there are possibilities for regulatory development in the field of supporting innovation, deployment of new, smart technologies for the benefit of consumers and for the operation safety of the energy systems.

The regulators should discover the possibilities adjusting the existing price-regulation systems and other types of incentives to support resolving different challenges, like;

- consulting with researchers, academic institutions, innovators, energy industry experts and customer representatives on the available new technologies, innovative methods, behaviour-changes and the related regulatory challenges,
- building internal capacity of regulatory staff in the area of new and innovative technologies and the impact they have on the regulatory system,
- accepting higher risk and higher profits to the extent of tested and implemented new innovative activities,
- supporting smart grid development (without accusing too much burden on end-users),
- supporting smart meter deployment in those consumers segments, where the pilot projects and the cost benefit analysis shows positive results; empowering consumers and addressing data privacy and cyber-security concerns,
- preparing special definitions and supportive regulation (and network tariff) system for the different storage technologies allowing these technologies to compete on the ancillary service markets assisting system operators and customers to keep the balance,
- developing (or just implementing) such regulatory incentives of the network operators, which give them impetus to support the end-user in energy efficiency measures (e.g. decoupled rates) and in different demand side response activities,
- adjusting the regulation to the special requirements of e-mobility deployment,
- reducing administrative authority burdens, setting requirements and providing incentives for DSOs smoothly connecting the distributed generators,

- creating such pricing regimes, which support the “prosumers” managing the surplus of their self generated power,
- continuously measuring the expectation and satisfaction of customers and adjusting the relevant regulation accordingly.



Dr. Gábor Szörényi, General Secretary of ERRA, graduated in 1971 from the Technical University of Budapest and started his career at the Hungarian Power Companies (MVM). He spent 23 years there working on coordination of R&D, energy system planning, power plant investment, restructuring and privatization related issues. In 1979 he received his PhD in Budapest and in 1999 the degree of MBA from the British Brunel University. Between 1992 and 94 he was President of the Vértesi Power Plant.

Since August 1994, Mr. Szörényi has been Deputy Director and since 2002 Director of the Hungarian Energy Office (HEO), regulating electricity, gas and district-heating sectors. He lead the licensing, monitoring, service quality regulation, energy industry market model building, market opening and market coupling related regulatory activities.

In 2008 the General Assembly of the Energy Regulators Regional Association (ERRA) elected him to be Chairman - his term was extended twice. At the end of 2012 he retired from the HEO, and was elected as General Secretary of ERRA.

He was active member of the Council of European Energy Regulators (CEER) GA and ACER (Agency for the Cooperation of Energy Regulators) Board of Regulators during 2011-12. He chaired the CEER Task Force for Quality of Supply.

He advised different governments and regulatory authorities in issues of restructuring, market structure, operation models and roles of regulators (Mongolia, Indonesia, Romania, Croatia, Rep. Moldova, Georgia, UNMIK Kosovo).

In 2016 together with Mariusz Swora he organised the ERRA Energy Innovation and Regulation Days in Poznan, Poland with success.

Mariusz Swora, PhD., DSc, is an attorney at law and a member of Board of Appeal at the Agency for the Cooperation of Energy Regulators (from October 2016). Swora was an assistant professor at Jagiellonian University (Chair of Business Law) in Krakow, Department of Law and Administration, from 2011 to 2014. He was also an adjunct at Adam Mickiewicz University in Poznan from 2001 to 2011.

Swora has authored and edited over 140 publications in the fields of energy law, competition law, public management, administrative law and procedure. As an attorney at law he advises corporate clients, represents them and prepares legal and regulatory opinions. He was the President of Energy Regulatory Office in Warsaw and member of the board and vice president of Energy Regulators Regional Association in Budapest (2007 -2010). Now, he is a honorary member of that association. He gives lectures, speeches, keynotes and presentations at international conferences on energy.

Swora is an author of 'Han Within smart grids' – a regulatory report prepared with AT Kearney for the World Bank and co-editor or ERRA Innovation and Regulation report (2016). He was also chairman of Energy Future Week 2015 and 2016 – a international forum on innovations in energy (Poznan, Poland). He actively investigates problems related to innovativeness in the energy sector. He is also a chairman of steering committee of a sectoral program for energy at The National Center for Research and Development (Warsaw).

VII. Auctioning Losses

Anthony Walsh

Abstract

In this paper the author outlines a radical, market based, approach to treatment of Network electrical losses in the electricity market.

A saving in Network losses produced by use of more efficient but marginally more expensive plant could be regarded as the equivalent of the installation of a mixture of base and peaking generation plant. However it would have no running or fuel costs, and typically last for 40 -60 years with little maintenance.

If such savings in Network losses were treated in the settlement system as the equivalent of a generator then the output of this 'equivalent generator' could be auctioned off by the Distribution Network Operator (DNO) in the open market for its full economic value.

The result would be optimal investment in losses reduction by network operators, funded by market participants.

(In practice the use of Distribution Loss Adjustment Factors to compensate Wind Farms for their impact in reducing losses has already proved much of this approach, but without a market element.)

Background

Electricity losses on networks are an intrinsic part of the operation of Transmission and Distribution systems, and can account for up to 15% of the units generated, with Distribution losses in the UK running at 6.5% (20TWh) and costing up to £600m per annum.

The 'optimal' level of losses on a network depends on the nature of the network and the cost of generation – some networks may have optimal loss levels of say 4%, others would have optimal levels of over 10%. The real answer is that '*the optimal level of losses is that which results in the marginal cost of reducing losses being less than/equal to the long term marginal cost of supplying these losses from generation.'*

Whilst it is easy to state the principle it is much more complicated to actually calculate the appropriate target level, as most of the factors involved are themselves very difficult to assess e.g., what is the marginal long term cost of generation over the next 25 years?

However despite the difficulty in calculating the optimal target it is in society's interest that losses are reduced toward the optimal target.

In the days of vertically integrated utilities this was much easier as the one DNO optimised the overall long term marginal cost of the electricity unit, making the necessary tradeoffs between investment in Generation, Transmission and Distribution. However with the introduction of competition, Generation has been separated from the 'wires' business so that any investment in the 'wires' business are in a framework set by the Regulator.

The reason a Regulator is used is that ‘wires’ businesses are natural monopolies where economies of scale are critical, so that lowest price can be achieved through Regulation, rather than through competition amongst DNO groups that have no economies of scale.

Effectively the Regulator represents the customer and sets rules which encourages the ‘wires’ DNO to operate in a manner which is both in the best interests of the DNO and of the customer.

From the Regulators viewpoint incentivising the DNO to make the appropriate level of investment in losses is very difficult, as it not only requires estimation of long term marginal costs from generation but also the cost/benefit of specific networks investments on losses.

Regulatory Incentives

UK Approach:

The UK led the way on the introduction of Regulation and Competition in Europe and the strategies adopted were copied by many other Regulators around the world.

The general approach used was to set a target level for losses and then assess the DNO’s performance against the target. The actual losses are shared between suppliers/generators in the market according to their volume, and are not a cost to the ‘wires’ business.

The main drawback with this approach is that the entity controlling the losses (i.e. the DNO) does not benefit from the full economic gains produced by a reduction in losses, only from their performance against Regulatory targets.

This means that society as a whole is disadvantaged as the monetary award set in the Regulatory target is always only a small portion of the gain to society from decreased losses.

Thus the DNO will look at an investment strategy for the development of the network, assess a ‘normal’ loss option and a ‘low’ loss option and then compare the marginal cost of each against the benefit allowed in the regulatory target.

This will not bring about an optimal reduction in losses for society as it will be limited to the level set by the Regulator, which may or may not be correct, and also by the utilities view on the attractiveness of the losses investment.

French Approach

A more economically sophisticated approach has been adopted in France where the Regulator requires EdF to purchase the losses incurred, and funds the allowed level of losses in DUoS.

The benefit of this approach is that the optimal level of network investment required to reduce losses is now within the control of the entity whose networks incur the losses, and the required investment in the overall network, including losses, is optimised.

The regulator’s role is then simply to reduce the overall cost of DUoS to the customer by requiring a cut of X% in overall DUoS over the regulatory period. In this case however DUoS includes the cost of losses, which are now a cost to the ‘wires’ business and are not attributed to the Suppliers/Generators.

However it also means that the utility must buy on the market the residue of losses which remain, and as losses may account to, say, 8% of units sold, this now means that the ‘wires’ business is the largest ‘customer’ in the market. It also means that the ‘wires’ business is exposed to trading risk and must develop skills in this area.

Review of Regulator’s options

Between the UK approach where the Regulator puts up a small amount of money as an incentive to reduce losses and the French approach where the losses are paid for through DUoS, there is a very wide divergence.

From the Regulator’s viewpoint the criteria which must be fulfilled by a satisfactory framework are that:

(a) the incentive is sufficient to drive the behaviour required
(b) the benefit to the utility is proportional to the effort required and does not deliver windfall gains
(c) the results achieved are those that are desired i.e. no dysfunctional behaviour.

It is clear that much of the problem with losses incentives stems from the fact that it is difficult to evaluate the real cost of losses and hence assess their economically optimal level.

In situations where the utility capitalises the cost of losses over (say) 25 years and adds these capitalised costs to the purchase cost of the transformers bought so that the least cost option on a life cycle basis is chosen, debate abounds over the correct capitalisation rate and the cost of long run marginal cost of the electricity unit to be used.

An alternative approach which would let the market decide these questions would give a more economically correct answer.

‘Auctioning losses’ – a radical market based, alternative

Utilities, in making investment decisions, can choose between options which meets the technical criteria such as capacity and voltage drop etc. and have low losses, or ones which also meet these criteria but have higher losses.

A simple example would be the decision to purchase MV/LV transformers with high or low loss levels.

The marginal cost between a low loss and a high loss transformer may be small as a percentage of the overall purchase price, but the gain received for this extra cost may not be compensated by the Regulator under current incentive schemes. Accordingly, this investment may not be made, although from society’s point of view it would be beneficial.

However if the actual savings in losses from the use of such transformers were calculated, then this would correspond to an equivalent amount of generation plant and fuel saved, as well as a reduction in emissions.

Can the savings in losses be calculated for such instances? The answer is ’Yes’ – they can be calculated to a level which is approximately correct and this is all that is required.

Once an approximate level of losses saved has been estimated (and this can be made more or less precise according to the effort made) then by applying a suitable 'Safety factor' proportional to the estimate's reliability, an assured minimum value of losses saved can be calculated.

Such estimates are already accepted and done at a macro level in calculating Loss Load Factors for generation. Other areas in which estimates are used and accepted for significant amounts include the cost of unmetered loads such as public lighting.

The losses calculated for the transformer group will vary according to the typical load they feed, their initial loading and will vary on an hour by hour day by day basis. In the case of MV/LV pad mounted transformers they are mainly used to feed housing loads, and are sized to meet the peak load *ab initio* i.e. the trafo is connected to its ultimate load of, say, 200 houses on day one and if load growth occurs it will be on a geographical basis, with extra houses, which will be fed from a new transformer.

So this means that the losses saved can even be forecast/calculated on a day to day basis according to how the system load for the domestic load profile varies.

In effect the losses saved are the equivalent of the output of a small generator, except that this generator has no running or operational costs and requires no fuel!

If the Regulator agrees with Market participants that this 'virtual generator' can partake in the settlement system then no special IT requirements are necessary – it is just input as another generator.

More correctly, it would be input as two generators –one generator, called the ' Iron Losses Generator' would be priced at base load as its output is always on and constant, and the second, the 'Copper Losses Generator' would be priced as 'peaking plant' as it increases its output in response to load, and is greatest at highest load.

The output of such 'virtual generators' would be very valuable and attractive to Suppliers, as the zero fuel costs mean that they provide a valuable hedge against volatile fuel prices, and as the output of the generator increases with the square of the load would be particularly beneficial at time of system peaks.

Having established the characteristics of such 'virtual generators' the next step would be to auction their output over (say) a five year period. This would be done in a simple public auction process at which Suppliers or Generators could bid.

The benefit of this last step is that the marginal investment in lower loss transformers as now covered by the monies received from the auction, so that the utility is immediately recompensed for their extra investment. In fact as the utilities marginal expenditure is really only on extra kilograms of Iron and Copper, and as the benefits are in kWh saved, then the monies received from the auction are likely to be many times greater than the original investment.

Essentially, the auction is allowing market forces to forecast the price of electricity over the next five years and discount this at the appropriate interest rate! By using five years the risk for the buyers is reduced and the income derived from the investment by the utilities will more closely track the real value of the losses saved i.e. there will be no major windfall gains or losses for Suppliers/Generators.

The optimal amount of investment in losses by the utility can be assessed by the auction returns – if these are higher than the marginal investment cost then further investment in losses is still economically sound. As the auction product is essentially a financial instrument it can subsequently traded in the market, so that the market price at any time can then act as an up to date estimate of the value of losses.

From the above it would seem that such an approach is even better for the utility and would allow the utility to recoup the full market value of the losses saved, and as the 'wires' utility is the only source of such investments, it would be a perfect business to be in.

Of course this is why there is a Regulator! The Regulator looks at the excess return earned in the auction and, having allocated some to the utility as an incentive, uses the remainder to reduce DUoS.

This means that whilst the utility will earn a good, safe return, it will not earn any super-normal profits.

This sounds as if it is a 'win/win' for all participants, so who loses out? Obviously fuel suppliers – essentially energy which would have been wasted has now been saved, with less fuel being consumed as a result.

The benefits of such an economically transparent system would be that:

(a) the market would determine the optimal investment in loss reduction, not the regulator or the utility
(b) supplier/generators would be able to buy 'generation capacity' which had no fuel costs and thus helped hedge their fuel exposure, and, by definition at a price below which they would have been able to generate these units themselves
(c) the 'losses equivalent generator' has the attraction of following the system load curve 365 days a year an increasing output at times of peak (due to I^2R)
(d) the siting of the 'virtual generation' is geographically spread and is proportional to the load in the area
(e) Overall system losses would decrease which would be of benefit to all customers and even those generators who did not bid at the auction
(f) Utilities would be incentivised to do extra work to decrease losses and as a by product would have low loss plant which was more reliable (lower temperature operation).
(g) Environmental costs such as CO2, NOX, SOX are implicitly catered for insofar as these costs are included in electricity unit costs
(h) Customers would save on DUoS and on Generation costs.

Further Areas for Losses Savings

In the above section a situation has been considered where the marginal extra cost of low loss plant has been funded by the market.

Currently, losses incentives in any jurisdiction would never justify network investments to minimise losses only. However with this new approach this may no longer be the case.

Consider a situation where a heavily loaded network is within all planning standards- capacity is adequate, voltage is within limits and security of supply criteria are met. However as a rough estimate the optimal loading on these circuits to minimise losses might be 30%, whereas their actual loading could be 50 – 60% +.

Splitting such circuits would dramatically reduce losses, and in fact such reinforcement could well be what is planned in 10 years' time.

So measuring the load and losses on such circuits and then carrying out the investment (with half hourly metering being installed on circuit outlets) would give an accurate model of losses saved. Again this could be auctioned for the 10 year period.

Are There Risks?

The main risk would be the impact of a serious discrepancy between the losses expected to be saved and those which actually were, but the impact of this risk actually quite minor.

The losses estimated can be over or under estimated. This 'error' can only persist for five years at which time a new auction takes place, so that there is a time limit on the impact of such errors.

If under estimated then the auction results will be less than anticipated and the 'wires' business will receive a lower return. More losses will actually be saved than expected and so overall losses will reduce and the benefit will accrue to Suppliers in general, and, in an efficient market, will also pass to customers.

If overestimated then the 'Wires' business will receive extra money, although the auction buyers will just receive the amount of losses bought i.e. auction participants will neither gain nor lose. The extra losses not saved by the 'virtual generator' will then end up allocated to all participants in the market. This is what happens with residual losses anyway, except that the residual losses will be less than what would have been the case if no auction had occurred.

Furthermore, most of the excess gained in the auction by the 'wires' business will automatically pass back to customers via a reduction in DUoS.

However underestimation can be easily avoided by a conservative estimate of losses saved in the first place.

Scope for application

The scope for application will be limited by the amount of network refurbishment and new works being carried out by the utility, as in the past loss reduction projects on their own will normally not have a high enough return to justify their introduction.

However, this also means that there could be a wealth of projects which have not previously been investigated, and which under more favourable terms would now be justified.

The introduction of the methodology is simple and low cost. No IT changes need to be made to the settlement system as the 'virtual generator' simply plugs in as a normal generator (if bought by a Generator) or is netted off the demand (if bought by a Supply company).

The greatest time delay would be in setting up term contracts for the purchase of low loss equipment.

Overall the scheme could be operational within a year!

It wouldn't work because...

(a) Where do you set the baseline for the losses?

- This is nearly a political decision and whilst it involves discussion is really just a negotiation. If you set a low baseline then you might create a large market, which might be another way of raising funding for a utility i.e. instead of the customer paying directly the market pays for the benefits of these 'negawatts.' There may be some economic efficiency in this approach e.g. you would have initial scale to cover set up costs and keep going. Typical Network losses in Western Europe are 6-8% of generation. So if a utility with revenue of €4b have saved 2% of losses over the years through voltage uprating from 10kV to 20kV etc., you could say that this is 2% of €4b pa and auction this.

(b) How do you assess the amount of losses saved?

- This is really just an engineering calculation and needs to be reviewed periodically as a change in power flow will change the losses up or down. If worthwhile recording equipment could be used, but this is probably unnecessarily complicated, although for other reasons much such equipment is probably already in place.

(c) How do you implement this solution in the market?

- Rather than rewrite a market system you just set up a data feed representing the 'virtual' generator and feed the kWh and kW in as if from a small hydro generator. You could change the whole market system to accommodate this but it wouldn't be worthwhile and shouldn't be tolerated as a proposed solution.

(d) Is there enough scope to reduce losses further?

- This is a significant question as a certain level of losses is always present due to the physics associated with electrical power flows. Usually the acceptable level of losses is that which it is economic to meet, so if the economic incentive presented is appropriate the optimum level of losses will be achieved. In this model the optimum level of losses is set by the market. In the cases of any utility carrying out a large scale investment program there is very significant scope for saving, as the cost of effecting reduced losses is normally only a small marginal cost on the cost of the investment.

(e) Is there anything similar already on the market?

- The closest may be PJM nodal pricing model in the US where pricing is on an LMP basis - i.e. Locational Marginal Pricing- i.e., the full costs to the system associated with the losses, capital requirements and congestion associated with the generators position on the network is incorporated in the price paid. This is also used in Singapore. From an economists viewpoint it is perfection. Regulators in Europe looked at using LMP but found that it was so complex that no Supplier could understand it and required a level of modelling complexity that made the current Market system seem as simple as a slotmeter. However PJM took 15 years to develop their system and they would never dream of approaching a full implementation from scratch!

(d) Are there any trends on the horizon that would influence losses?

- The EU EcoDesign Directive seeks to bring about Minimum Energy Performance Standards for all transformers. However this approach optimises losses in one network component only, so it is sub-optimal for the overall network - at the margin better returns could be made in alternative network investments. Having an extra price paid for losses saved in any area by being able to sell them on the market would make the use of lower loss equipment and lower loss network configurations much more attractive to utilities.

(e) What expansion is possible?

- All market systems will need some adjustment to incorporate Demand Side Management. This beyond the scope I've looked into so I won't comment further. Obviously all parties anyone who sees money in this scheme it will want to participate! e.g., '*if I install energy efficient lighting can I claim under this scheme?*' - ANSWER is NO because you're rewarded by lower energy costs and the savings in losses is incorporated in these. So only utility investments which decrease losses which the utility would not have the economic incentive to do so are incorporated.

Summary

Objectives

- Reductions in Network Losses are the equivalent of installing generation. **So set up a 'virtual generator' in the Settlement System and auction the output so that Market sets optimum output**

Approach

- Estimate the amount of losses that can be saved through optional network investments (such as Low Loss Transformers)
- Input the losses saved as a 'virtual generator' in the Settlement System
- Auction the Output in the Market
- Use funds gained to reduce DUoS

Results

- Market sets Optimal Value of Network Investment to Reduce Losses
- Market pays directly for this extra investment – no extra cost to customer
- Full economic value of Losses realised from Auction so correct incentives
- Excess funds used to reduce DUoS charges
- More efficient Network reduces impact of congestion and promotes competition

Anthony Walsh is an experienced ESB Networks engineer, whose current role is Manager, Materials Introduction and Innovation in ESB Asset Management. Following various roles in HQ, Walsh worked for 10 Years as a Manager in Dublin City, with responsibility for Construction, Design and Operation of all ESB Dublin networks. Walsh was then appointed to ESB's Business Process Re-engineering Team which initiated the formation of ESB Networks, and continued onto the Transform Project which implemented this reorganization, developing the business case for adopting Asset Management.

Following involvement on the team negotiating the 2001 Price Review, he was appointed Networks Investment Manager (North), and his responsibilities included the selection and justification of approximately €1b network investments in the northern half of the country (including Dublin). Since 2005, he has worked as Specifications Manager, Procurement to help achieve greater effectiveness and economy in network design through innovations in areas such as HV station design, HV lines, SmartGrids and LV Housing Scheme Design. In 2011 he was key in ESB's Fibre initiative, in assessing the technical and economic feasibility of using ESB infrastructure to support FTTB which is now being rolled out under a JV (SIRO) with Vodafone. Recently he has assessed the capability of ESB Networks to support the rollout of the electrification of heat and transport.

Walsh holds the BE, MIE and MBA degrees from University College, Dublin, is a Chartered Engineer and Fellow of the Institution of Engineers of Ireland and an ACCA accountant. He has authored various CIRED Technical papers and is a Member of the Eurelectric Group of Experts on Standardization, a Member of the CENELEC TC14, WG 21, 29and 32 dealing with Transformer Efficiency under EU EcoDesign Directive, and of CIGRE A2.56 Transformer Efficiency.

VIII. Are We Understating the Potential for (and Uncertainty in) Wind Energy Cost Reductions? Berkeley Lab study shows greater potential than many other recent assessments

Ryan Wiser, Joachim Seel, and Bentham Paulos

Prices for wind energy have hit rock bottom, thanks to technological advances and learning. Are the opportunities for significant additional cost reductions tapped out, or are much-lower costs still possible? Recent research by Berkeley Lab suggests that some energy planners, analysts, and policymakers may be underestimating both the potential for and uncertainty in wind energy cost reductions. The consequence may be under-prediction of wind deployment, under-appreciation of the uncertainty in that deployment, and under-investment in wind R&D.

The new study, recently published in the journal *Nature Energy*, summarizes a global survey of 163 of the world's foremost wind energy experts to gain insight into the possible magnitude and sources of future wind energy cost reductions. It represents the largest-ever "expert elicitation" survey on an energy technology, and was led by Berkeley Lab, NREL, University of Massachusetts, and participants in the IEA Wind Technology Collaboration Programme Task 26. Though the study includes both land-based and offshore wind, here we focus exclusively on the former.

Significant Historical Cost Reductions

The cost of wind energy in the United States has declined by an order of magnitude since the industry's beginnings in the early 1980s (see Figure 3, later). As a result, and leveraged by the federal production tax credit, wind is currently being sold at rock-bottom prices. According to the U.S. DOE's Wind Technologies Market Report, wind power sales prices now average roughly $20/MWh in the large interior wind-belt, lower than the 20-year levelized expected cost of burning fuel in a natural-gas power plant (Figure 1). These $20/MWh deals equate to almost $40/MWh were the production tax credit excluded. (It is important to note that these deals reflect excellent conditions, in terms of wind resource, ease of development, and supportive policies).

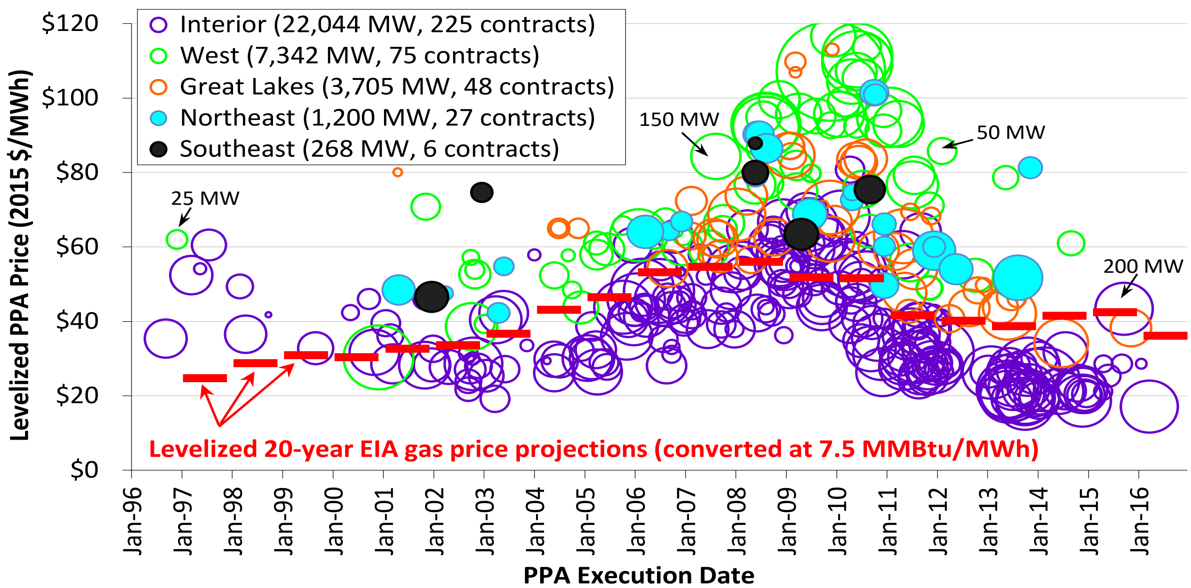


Figure 1. Wind Power Sales Prices vs. Natural Gas Fuel Costs in the United States

With such dramatic historical advancements, it is tempting to believe that the opportunity for significant additional cost reductions might be tapped out. Perhaps the technology has largely reached its limits, maturity has set in, and only small improvements are possible. Survey findings, however, and the broader academic literature suggest room for optimism, but also significant underlying uncertainties.

Survey Findings Are More Bullish than Much of the Broader Literature

As shown in the *Nature Energy* article, survey respondents anticipate cost reductions for land-based wind, on average, of 24% by 2030 and 35% by 2050 under a median or 'best guess' scenario. Costs could be even lower: respondents predict a 10% chance that reductions will be 44% by 2030 and 53% by 2050. On the other hand, under a 'high cost' scenario, survey respondents also note a 10% chance that costs will largely be in stasis to 2050.

These levelized cost of energy (LCOE) values are shown in Figure 2. The figure also presents the results of a literature review, summarizing 26 different recent estimates of wind energy cost reductions that originate from a diversity of government, academic, and industry sources.

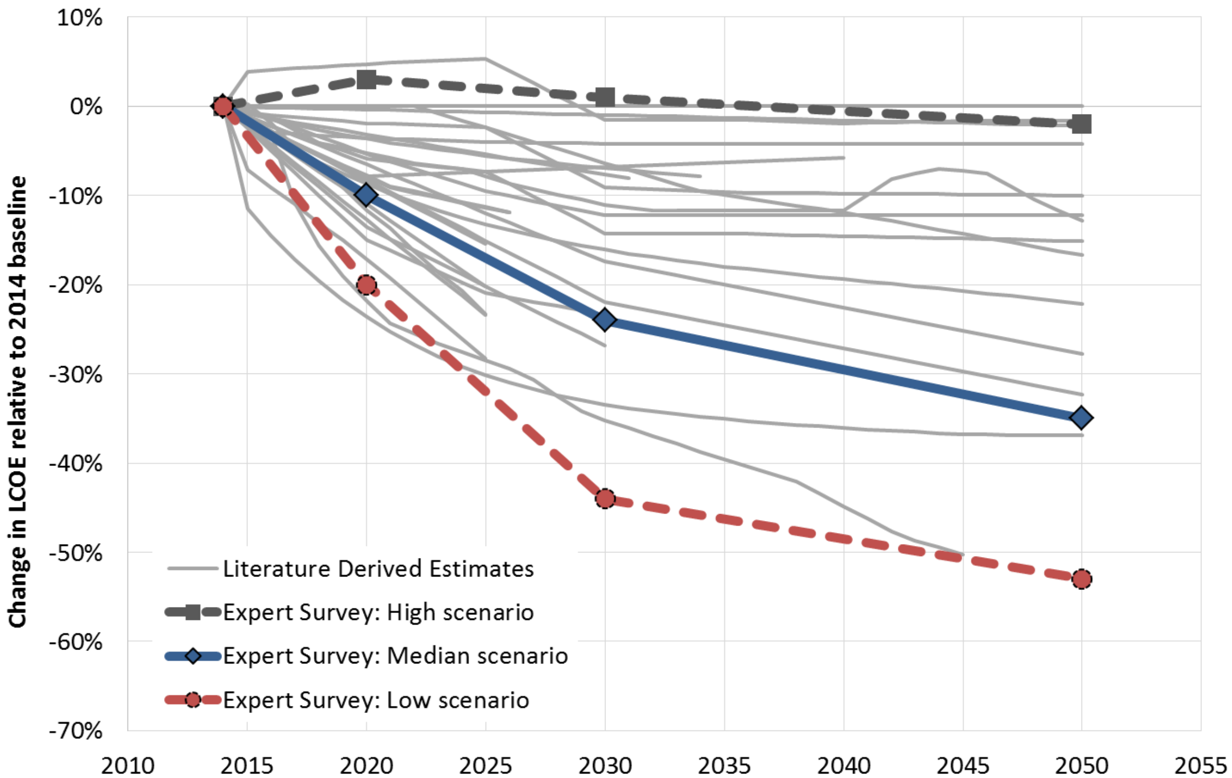


Figure 2. Estimated Change in LCOE over Time for Land-Based Wind: Survey Results vs. Other Forecasts

The "cloud of uncertainty" over future wind energy costs is large, with a wide range of possible outcomes presented both by the survey and by the broader literature—to a degree, this motivates R&D to maximize the chance of achieving the lower-cost scenario. Reassuringly, the survey results largely span the values of the broader literature; of course, some of the same experts who responded to the survey also generated some of the other literature summarized in Figure 2, so perhaps this should come as no surprise.

Viewed in more depth, two additional conclusions emerge from this comparison.

First, most of the literature estimates (the grey lines in the figure) are more pessimistic than the 'best guess' or median result from the survey. Specifically, the median forecast from the broader literature shows an 11% LCOE reduction by 2030 and 13% by 2050, compared to 24% by 2030 and 35% by 2050 from the survey. Survey respondents are clearly more bullish about the prospects for continued cost reductions than much of the recent literature.

Second, several reports from the U.S. Government are notably more pessimistic than the median-scenario from the survey. The U.S. EIA's Annual Energy Outlook, for example, shows the capacity-weighted wind LCOE (excluding tax incentives) increasing by 13% between 2018 and 2022 ($51.9/MWh to $58.5/MWh), before decreasing by 16% in 2040 (to $43.7/MWh). The U.S. EPA, in their assessment of the Clean Power Plan, seemingly predicts virtually no change in wind costs from 2016 to 2050. And finally, even the U.S. DOE Wind Vision study's "mid-point" estimates of 16% reductions by 2030 and 22% by 2050 are more conservative than the survey results.

Though conservatism might be appropriate in some cases, and there are large uncertainties about future wind costs that must be acknowledged, one is still left with the view that the energy community may be under-estimating the potential for wind energy cost reductions.

Defending the Survey Results: Counterarguments to the Possibility of Bias

A skeptic might argue that the survey results are unreliable, perhaps prone to bias by only surveying individuals with a vested stake in the success of the wind sector or to other forms of inaccuracy. To a degree, a dose of skepticism is warranted: there is no way to directly test for bias, after all, and so expert elicitation findings might best be a complement to other approaches to understanding cost reduction.

That being said, two aspects of the survey results should offer some solace even for the skeptic.

First, though past performance is no guarantee of future results, the survey results are consistent with historical LCOE trends: The “learning rate” measures the decrease in cost for each doubling of cumulative production, and has been used extensively to understand past cost trends for a wide range of products, and to forecast future costs. As discussed later, the vast majority of learning rates used in the wind sector have focused exclusively on up-front capital costs.

Figure 3, however, presents the historical LCOE and calculated learning rates (LRs) for four estimates of LCOE; past land-based wind energy costs have declined by, on average, 10.5% to 18.6% for each doubling of cumulative capacity. The figure compares that to the survey results. More important than the absolute cost estimates from the survey (which represent, in effect, an averaging of U.S. and European costs) is the learning rate: the median survey estimates for LCOE reduction have an implicit learning rate of 14% to 18%, squarely in the range of past estimates.

Though learning rates can be controversial and should be applied with caution, the fact that survey results are consistent with historical LCOE learning provides some assurance that those results are within the bounds of reason. (Note, by the way, how much longer it takes to reduce costs in the future than in the past; this is because each additional doubling of cumulative installations is progressively harder to achieve).

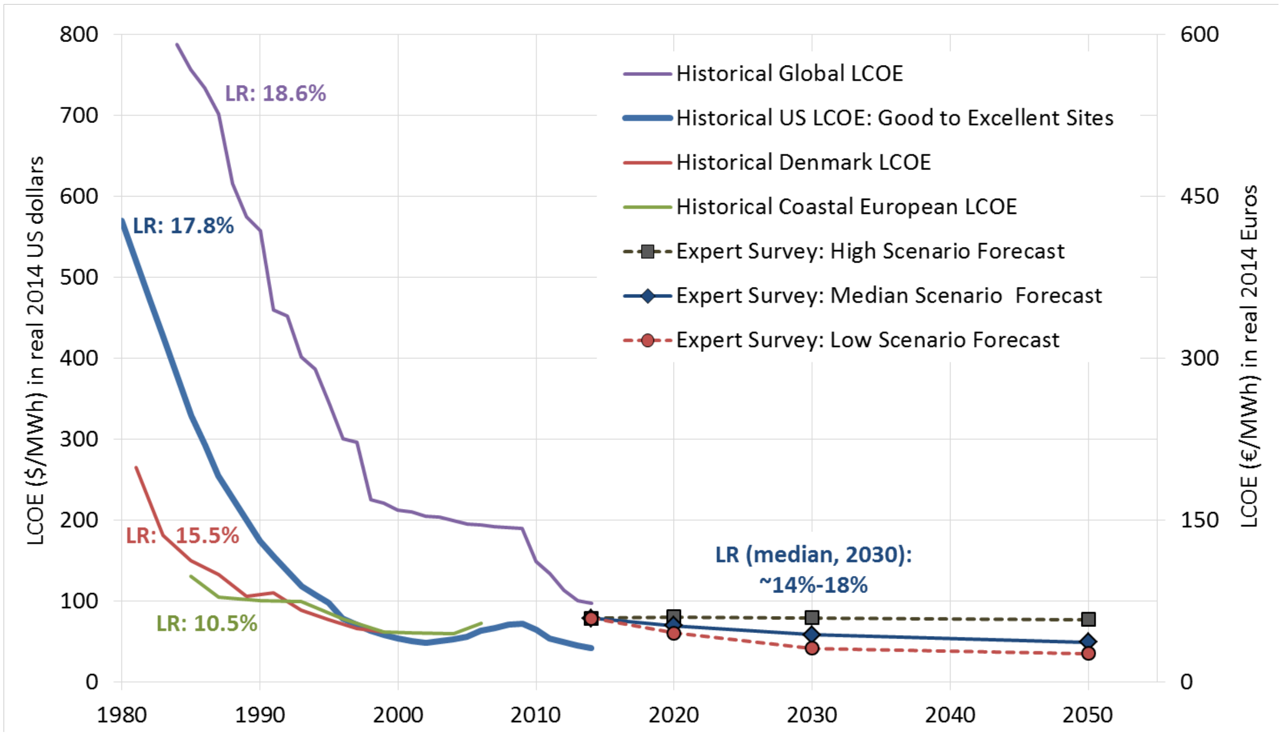


Figure 3. Historical and forecasted land-based wind levelized cost of energy and learning rates (LRs)

(The log-log learning rate formulation of this graphic can be found in the *Nature Energy article*)

Second, survey respondent views are broadly consistent across different respondent groupings, with 'leading experts' being even more bullish on the prospects for cost reduction: The study investigated whether certain respondent groupings are more, or less, optimistic than others. In most cases, median responses were broadly consistent. Those working for wind developers or manufacturers expressed views generally similar to those working in government-funded research labs. And respondents with expertise in North America, Europe or other locations tended to have comparable views.

The single most-significant difference came from the so-called 'leading experts': a hand-selected group of 22 individuals who are among the wind sector's most knowledgeable and senior leaders. Those experts were, on average, even more optimistic about wind energy cost reduction, expecting LCOE to decline by 27% by 2030 and 48% by 2050 in the median scenario, and by 57% and 66% in the low scenario (Figure 4). The views of this group suggest even greater potential for cost reduction than noted earlier.

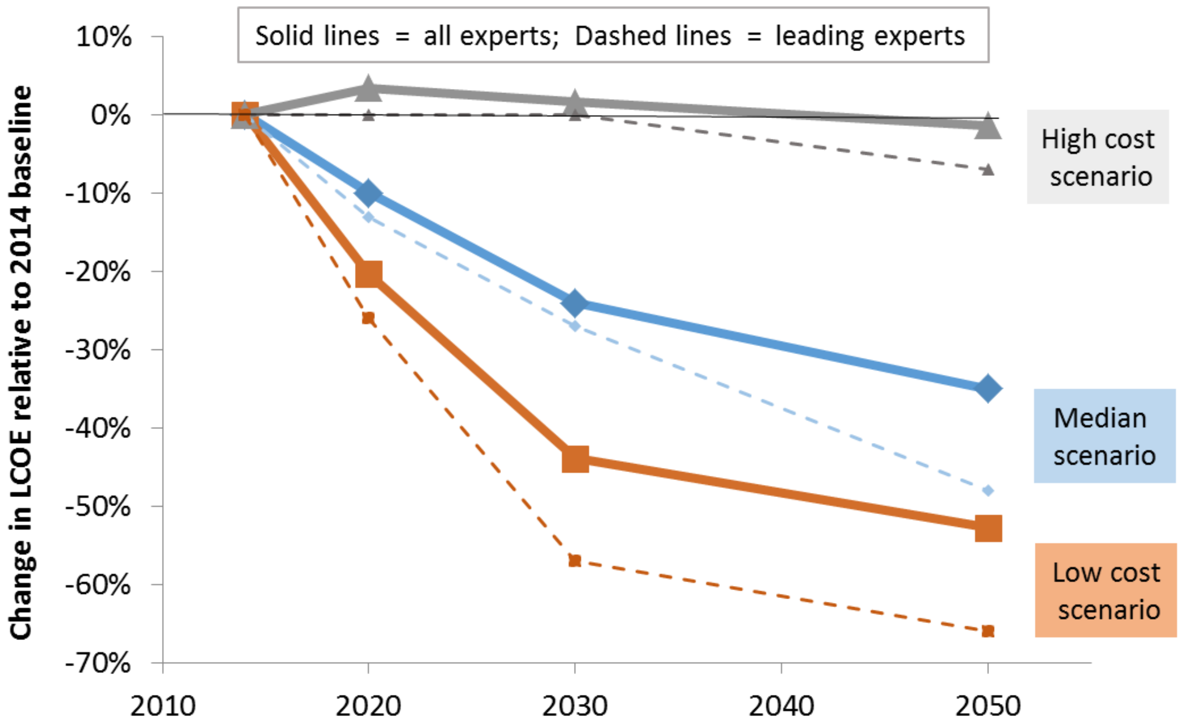


Figure 4. Expert Assessment of Future Costs: All Respondents vs. Leading Experts

The Why and How

Why might the survey results demonstrate greater potential for cost reduction than some of the existing literature? To some extent this may reflect an understandable desire for conservatism, especially among government prognosticators. More broadly, it may also reflect a misapplication, in some circles, of traditional learning rate calculations.

In particular, some of the past literature has focused primarily on reductions in the up-front cost (CapEx) of wind projects, with recently calculated historical learning rates of 6-9% when focused on CapEx. But the bottom line for the wind sector is not CapEx, it is LCOE. The DOE's Wind Technologies Market Report demonstrates very clearly that performance improvements, leading to higher capacity factors, have been a key trend in recent years. And this is—in part—why historical LCOE-based learning, shown earlier to be 10.5% to 18.6%, exceeds CapEx-only learning.

There are five key components that impact the LCOE: up-front capital cost (CapEx), ongoing operating costs (OpEx), cost of financing (WACC), performance (capacity factor), and project design life. As shown in Figure 5, survey respondents anticipate improvements in all of these cost drivers under the median and/or low-cost scenario, with the most impactful improvements coming from capacity factor increases and CapEx reductions. Forecasts that focus primarily on CapEx are missing at least half the story.

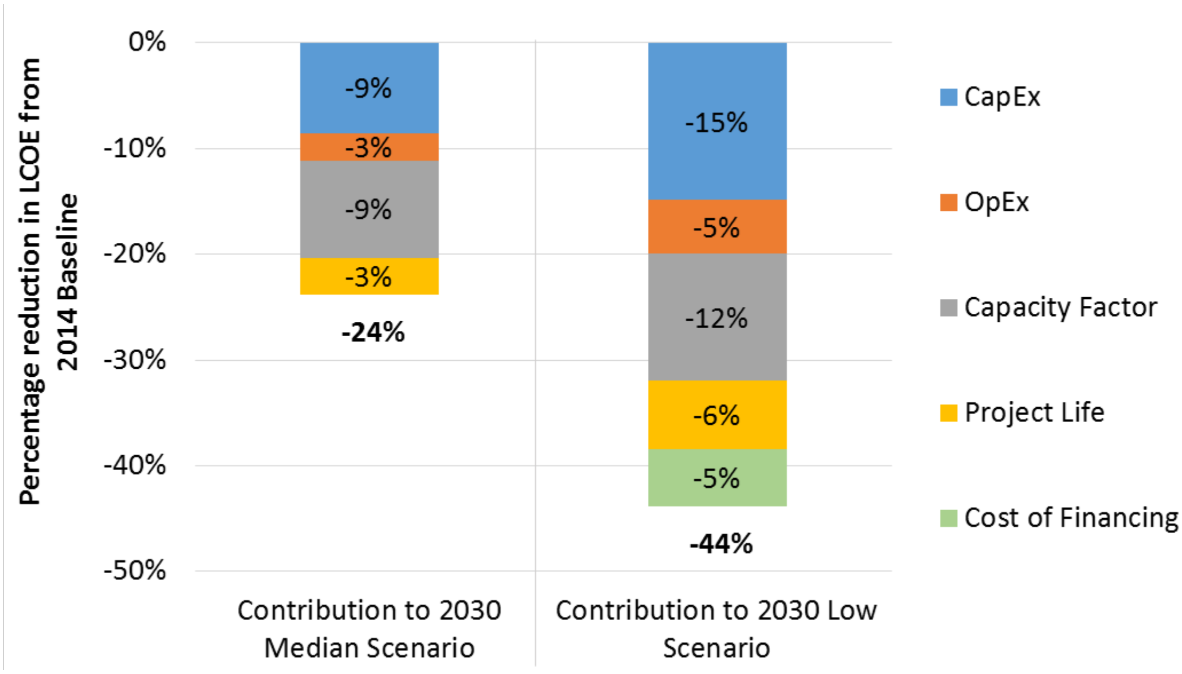


Figure 5. Relative Impact of Changes in Each of Five Components on LCOE in 2030

Implications and Uncertainties

To be clear, expert elicitations are only one means of gazing into the crystal ball. And, as with all other forms of prognostication, expert surveys have their limitations. Sadly, the energy community does not have a strong history of successfully predicting the future, a fact that the experts reflect in their wide range of responses. But two key implications emerge from the present work.

First, there is significant uncertainty about future wind energy cost reduction, illustrated by the range in expert views between the 'high cost' and 'low cost' scenarios shown earlier. The experts highlight deployment-oriented learning and wind R&D as the two most important enabling conditions likely to move us towards the low-cost scenario. An expansive range of possibilities exist, and those uncertainties deserve greater consideration in energy sector models, energy planning, and R&D decisions.

Second, the survey provides evidence that some notable models and forecasts may be understating wind's cost reduction potential. The findings from such models and forecasts may undermine planning and policy development, as well as private sector behavior.

If these implications are true, then we might not only be underappreciating the uncertainty in future outcomes, but also understating the potential role of wind in the future energy system and the contribution of R&D in enabling that future by moving us towards lower-cost scenarios.

Additional Information

The survey was conducted under the auspices of the IEA Wind Technology Collaboration Programme. Berkeley Lab's contributions to this work were funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

The *Nature Energy* article can be found here.

A full report on the survey findings is also available, as are presentation-style slide decks summarizing the results; a pdf version of this blog is also available. All of these files can be downloaded at the bottom of this page.

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Ryan has published over 350 journal articles, research reports, book chapters, and conference papers. Ryan regularly advises state and federal agencies on issues related to renewable energy; is an advisor to the Energy Foundation's China Sustainable Energy Program; is on the Corporate Advisory Board of Mineral Acquisition Partners; and serves on numerous other advisory committees. Ryan has been a lead author for the Intergovernmental Panel on Climate Change, and his work has received numerous awards, and been a consultant to international and state agencies, foundations, NGOs, and private companies..

Ryan holds a B.S. in Civil Engineering from Stanford University and an M.S. and Ph.D. in Energy and Resources from the University of California, Berkeley.

Joachim (Jo) Seel is a Senior Research Associate at the Electricity Markets and Policy Group at the Lawrence Berkeley National Laboratory. His research focuses on solar and wind market developments, and the integration of high shares of intermittent and distributed renewable generation into the electricity grid and electricity markets. Of special interest to him are international comparative studies and the deduction of best practices, such as in his study explaining PV pricing trends in both the United States and Germany. He presented in front of the California Governor, the California Energy Commission, the California Public Utilities Commission and at academic and industry conferences.

His past work experience includes stations at the European Parliament in Belgium, the American Wind Energy Association in Washington, D.C., the Commission for Renewable Energy Development at the Chinese Energy Ministry in Beijing and the German Federal Ministry for Energy and the Economy in Berlin. He has consulted a number of private and public sector clients on energy economics, renewable energy technologies and energy policy including a major American utility, a multinational electrical device manufacturer, solar thermal project developers and enterprises in the biogas sector.

Joachim Seel holds a MS of Energy and Resources and a Master in Public Policy from UC Berkeley and is pursuing a PhD at the Energy and Resources Group at UC Berkeley in parallel to his work at LBNL. A native of Hamburg, Jo came to the Bay Area from the international Jacobs University in Germany, where he studied environmental policies and international relations.

Bentham Paulos is the principal of PaulosAnalysis, consulting and writing on clean energy policy, technology, and trends, for clients in the non-profit, media, industry, and philanthropic sectors. He is an affiliate with the Electricity Markets and Policy Group at Lawrence Berkeley National Lab and a contributor to Greentech Media, POWER Magazine, and the Energy Transition blog.

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He previously worked for the Energy Center of Wisconsin, the Union of Concerned Scientists, and Abt Associates, and has an MA in Energy Policy from the University of Wisconsin-Madison and a BA from Tufts University.

IX. ICER Reports

Reports

ICER's Virtual Working Groups prepare reports on various topics, including Reliability and Security of Supply, Smart Meters, Consumers, Market Integration and Managing Investment Uncertainty. Find published reports in ICER website's publication page.

Distinguished Scholar Award

ICER established its Distinguished Scholar Award in 2010 with a view to contributing to an increased reflection on energy regulation policy issues. These Awards acknowledge important contributions made to enhance electricity and gas regulation around the world. Two recipients are selected each cycle. The Awards are now held every three years in conjunction with the World Forum on Energy Regulation (WFER).

Find more information and past winners on ICER's website.

ICER Chronicle

All past editions of the ICER Chronicle are available online. Learn more about ICER by viewing its Brochures and Press Releases.

X. World Forum on Energy Regulation

Call for Articles
Edition 7: July 2017
Deadline for Submission: April 15, 2017

ICER Chronicle provides a means to further promote the organization's goal to enhance the exchange of regulatory research and expertise throughout the international regulatory community and beyond. The Editorial Board is seeking articles for the seventh edition of the Chronicle, scheduled for publication in July 2017.

The articles should be shorter than those solicited for the ICER Distinguished Scholar Award and provide a variety of perspectives on defined technical topics. As with the ICER Distinguished Scholar Award, 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.

The articles or papers should not exceed 3,500 words in length. In accordance with the official working language of ICER, papers must be submitted in the English language. New papers and papers previously published or delivered in other venues after January 1, 2015 will be considered.

The papers may be authored by one or more persons. The submission should include a description by the applicant of if/when the paper was published and/or delivered at a conference. The paper must also be accompanied by a brief curriculum vitae of the author(s). The papers may have been published elsewhere with a reference to this effect in the Submission Form. Members of the Editorial Board are not precluded from submitting articles.

All entries will remain the property of the author(s). Papers selected for The ICER Chronicle may be published and diffused on ICER's and its members' websites.

For more information on the submission and selection process as well as other pertinent information, please email chronicle@icer-regulators.net