STANDARDIZATION: JOURNAL OF RESEARCH AND INNOVATION

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RESEARCH ARTICLES

Moving Ahead with Gender Diversity at the IEC

By Catherine Bischofberger

The International Electrotechnical Commission (IEC) is committed to helping raise awareness among its members and stakeholders of the value of gender diversity. The organization seeks to meet the objectives of the Sustainable Development Goals (SDGs) of the United Nations–including SDG 5, which is to achieve gender equality and empower all women and girls—throughout its work.

In 2019, the IEC Board established a task force on diversity to assess the current situation, including gender in governance and IEC activities, and make recommendations for improvement. One of key outputs of the task force is the IEC diversity statement, which speaks about the need for diversity in the IEC.

The statement acknowledges that the representation of women in standards development is almost always below parity and that the outcomes for men and women are not explicitly addressed during the standards development process. It also recognizes that the content of standards and engaging in the standards development process are opportunities for women's empowerment. In the statement, the organization agreed to create and proactively implement a gender action plan as well as track progress by collecting and sharing data, success stories and good practices.

THE 'WOMEN AT IEC' CAMPAIGN

Sharing success stories was at the heart of the #WomenatIEC campaign, which was launched on 11 February 2021, the International Day of Women and Girls in Science. Women from the IEC community were asked to produce a video of themselves explaining their work and highlighting the contribution of women to the IEC. At least 50 videos from around the world were shared during the month of March, coinciding with International Women's Day on March 8. The videos were disseminated on all major IEC social media platforms and generated huge interest.

A special area on the IEC website has been specifically dedicated to the issue of women in standardization. A session on the role of gender in standards work was organized at the IEC General Meeting in Dubai in October; a year later, on 8 March 2022, a webinar titled "Building on the Momentum of #WomenatIEC" took place, featuring some of the women who took part in the campaign.

GENDER-RESPONSIVE STANDARDS

In recognition of the need for gender-responsive standards, the IEC and the International Standards Organization (ISO) created a Joint Strategic Advisory Group (JSAG), which was mandated to produce tools for technical committees that ensure standards are gender-responsive. A report has been published with recommendations, some of which are immediately applicable.

Sonya Bird, past President of SES, was an active member of the JSAG and is the

director of international standards at Underwriters Laboratories, where she is responsible for developing and implementing the company's international standards strategy. In this role, she leads a team of regional managers located around the world, including in the ASEAN region, China, India, the Middle East, North Africa, and Europe. She is active in American National Standards Institute (ANSI) international forums, in the U.S. National Committee of the IEC, and in IEC itself, where she represents the United States on the IEC Standardization Management Board (SMB).

"Through participating in the JSAG, I've learned that some technical committees have historically been made up of male contributors and did not consider the unique, specific needs of women in standards development," Sonya says. "The individuals participating in the work of the IEC and ISO are experts in their respective fields but are not necessarily experts on gender differences. The JSAG recognized that guidance is needed to help all experts understand the value of gender-responsive standards, while also encouraging them to think about gender implications for new and revised standards.

"Physical differences between men and women other than sizing dimensions may include body fat percentage, peripheral vision, sensitivity to sound, pain tolerance, hormones, or various strength characteristics such as upper body strength and grip strength," she says. "Each of these conditions could have an impact on the suitability of requirements contained in a standard. Add to that mixture the traditional differences around roles played by men and women, and the evolving roles of women today, and it is obvious that the needs with respect to standards are changing."

Inclusion has become one of the IEC strategic pillars, as reflected in a new governance structure that has been streamlined to become more effective and transparent. This includes a new body under the IEC Board called the Diversity Advisory Committee that aims to support the IEC Board and national committees in leveraging the power of diversity and inclusion at the level of IEC governance.

IEC MEMBERS ALSO AT THE FOREFRONT

The Standards Council of Canada (SCC), which hosts the IEC national committee, has been implementing changes related to gender diversity and is one of the models for other organizations to follow. In 2020, the SCC published a report, *When One Size Does Not Protect All: Understanding Why Gender Matters for Standardization*, that used data from 106 countries to convey the impact of gender on standardization.

Lynne Gibbens is the IEC manager of international standards development at the SCC. She is also the national secretary of the Canadian National Committee of IEC (CANC/IEC) and a member of the IEC SMB. She explains the actions taken by the SCC.

"To effect positive change, first we needed to understand exactly how standardization impacted women," she says. "There is a lack of literature on this topic, and this gap is often highlighted as a challenge. So, conducting research became a key goal of the SCC's five-year strategy. I'm proud to say that our research has been vital in building the case for change and has put us in a great position to measure and track progress.

"The SCC has prioritized raising awareness," she continues. "We leverage speaking engagements with our partners to raise awareness of the value that gender-responsive standards would bring to addressing socioeconomic issues, building back better from the pandemic, and helping industries secure a sustainable talent pool for the future. We ground our advocacy in facts and data that demonstrate how a more gender-equal approach benefits the quality of life for everyone—including men, businesses, national and international economies, and underrepresented groups."

Nationally, the SCC is supporting the Government of Canada's 50-30 Challenge. This initiative asks organizations to aspire to have 50% gender parity on boards and senior management and 30% representation on boards and senior management of underrepresented groups. The SCC oversaw the development of a publicly available specification to enable organizations to track their progress against the 50-30 Challenge. On an international level, the SCC is leading a working group at the United Nations Economic Commission for Europe to develop guidelines for gender-responsive standards.

While the IEC and its members recognize that much work still must be done to be fully gender diverse, big steps have already been taken. The commitment to implement change is acknowledged throughout the organizations and the #WomenatIEC campaign was successful in making gender diversity an issue which cannot be ignored.

Catherine Bischofberger is a writer and technical communications officer at the IEC. Previously she worked as a journalist and editor on the IBC daily and wrote for many B2B publications. Before coming to Switzerland and joining the IEC, Catherine worked for 15 years in Paris for The Film Français, the French Variety. Prior to that she edited several broadcast technology magazines in London.

STANDARDIZATION: JOURNAL OF RESEARCH AND INNOVATION

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A Common Vocabulary and Change Process to Bridge Theory and Praxis

By Alexis Shoemaker

Primarily concerned with "purpose, vision, and direction,"[1] leaders focus on the "'where' and the 'why' rather than the 'how.'"[2] But how does a leader accomplish such a complex and high-level task?

This seven-part series on leadership will cover leadership fundamentals and change theories; leadership theories, styles, and approaches; and guiding principles and visioning. It will also cover topics such as communication, team development, strategic planning, building capacity, and reflexivity. These articles are intended to be used together and offer a conceptual framework and guide for incorporating theory into practice. The purpose is to inspire productive and rewarding analysis of current leadership practices, with the goal of encouraging perpetual leadership growth.

LEADERSHIP FUNDAMENTALS

Often, an adjustment in leadership approach is prompted by internal or external changes, pressures, or opportunities, or some combination of these forces. Although these reasons for change are certainly logical, they are also highly reactionary. An alternative approach is to adopt an action-oriented attitude toward fine-tuning leadership practices. This "continual optimization" approach leads to increased process efficiencies, enhanced outputs and, perhaps most importantly, increased satisfaction among team members.

A general approach to leadership will include the leader's dedication to both personal and team development and to molding the cultural environment in which the team functions. These responsibilities rest on an indispensable foundation of trust built by the leader while working with and for the team.

Effective leaders are assiduous in their desire to grow and learn from experience. They reflect on their own successes and failures and those of others in the interest of continuously developing leadership acumen. Leaders should be the antithesis of passive learners, actively engaging with other leaders around them and incorporating their stories of decision making, delegating, engaging with people, and setting visions into their own practice.

CHANGE THEORIES

Leading through change is the ultimate test, as it relies on a leader's ability to engage with others, commit to a vision, and persevere to see the vision through. By understanding and considering one's leadership practice in the context of leadership and change theories, cultural shifts become more easily surmountable.

Change leadership theories generally fall into three categories: leader-centered, follower-centered, and change-centered.[3,4] Establishing a taxonomy for leadership, especially change leadership, allows for discussion and reflexive analysis based on a common vocabulary. Empowered with an understanding of how to approach change leadership, it becomes easier to establish tactics to anchor desired change in the organization's culture and to ensure broad and successive adherence to the change.

Existing change leadership theories suggest the following sequential steps to "ensure momentum for change is not overwhelmed by the inertia of existing culture and practices and to make certain the change is real and permanent."[5]

1. Establish a sense of urgency
2. Create a guiding coalition
3. Develop a vision and strategy
4. Communicate the change vision
5. Empower broad-based action
6. Generate short-term wins
7. Consolidate gains and produce more change
8. Anchor new approaches in culture[6]

By following these steps and "not moving on to the next until the previous has been solidly accomplished,"[7] leaders will be able to effectively institute their desired change and ingrain it into the organizational culture.

CONCLUSION

Leading through change crystalizes the need for effective leadership. Conceptualizing one's leadership practices begins with establishing a common vocabulary rooted in theory. This serves as the foundation upon which the bridge between theory and praxis is built and empowers leaders to institute lasting and meaningful change. The next article in this series will expand on the change leadership theories covered in this article to include more specific leadership theories, styles, and approaches.

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7. Worth, pg. 125.

Alexis Shoemaker is a Senior Specialist of Technology & Standards at the Consumer Technology Association (CTA). She is responsible for the management of CTA's Artificial Intelligence Committee, Audio Systems Committee, Television Manufacturers Caucus, and Video Systems Committee, and their associated working groups that develop standards, bulletins, and other technical publications. Prior to joining CTA's Technology & Standards Team, Alexis served as a Sr. Analyst in CTA Market Research. There, she focused on self-driving vehicles, health technology, and artificial intelligence. Alexis holds a Bachelor of Arts in anthropology from Scripps College and a Master of Science in Research Administration from Johns Hopkins University.

This series represents excerpts and expanded analysis from the author's master's capstone project submitted to Johns Hopkins University, titled *Leadership in Research Insights and Business Intelligence: A Conceptual Framework and Guide*.

STANDARDIZATION: JOURNAL OF RESEARCH AND INNOVATION

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RESEARCH ARTICLES

Mexico's Electric System: Challenges and Opportunities

By Héctor Beltrán

Mexico, like many countries around the world, has committed to ambitious targets in terms of sustainability. Because of those commitments, the Mexican power system must integrate a large share of clean energy sources (mainly renewable and nuclear) into its power generation portfolio as the main component of an energy transition. In 2020, the Mexican government endorsed specific targets for the short and long term. Among those targets, it was established that Mexico would generate 35% of its electricity from clean energy sources by 2024. But according to most recent National Electric System Development Program 2022 – 2036 (known as PRODESEN by its Spanish acronym) issued this May 2022 by the Ministry of Energy, the targets for clean energy integration won't be met until 2035, causing an important delay in Mexico's path toward an energy transition.
This article discusses the current condition of the Mexican power system and identifies the main challenges it is facing in terms of generation and transmission, both in the technical and regulatory arenas. Along with those challenges, it is also important to identify opportunities to overcome those challenges, understanding that both the public- and private-sectors need to find new ways to complement each other to return Mexico to the path of meeting its energy transition goals.

Key words: Mexican Power System, Energy Transition, Regulatory Uncertainty, Technical Pain points, Ancillary Services, Complimentary Technologies.

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The Mexican power system (MPS) has the inalienable task of expanding and modernizing its infrastructure (generation, transmission, and distribution) to meet the country's growing electricity demand over the coming years. In so doing, it must overcome technical and regulatory challenges that are not necessarily facilitating these endeavors. These challenges include growing pressure from numerous government stakeholder agencies to increase the participation of private actors in the wholesale electricity market (WEM), reduce electric tariffs, improve grid reliability and performance, and increase the share of variable (not intermittent) renewable energies (REs) in the system.

The MPS is faced with the conundrum of meeting electric demand while also meeting stakeholder expectations all within the context of an energy transition that aims to achieve sustainable development goals. This article neither attacks nor defends the government measures intended to change the structure of the WEM and the way the private and public sectors interact with each other. The intent of this article is to present a factual account of the current challenges the MPS is facing and highlight the opportunities that lie

Table 1. Installed Capacity and Energy Generation in Mexico

Capacity (MW)

Technology (MW)	2019	2020	2021
Hydro	12,612	12,612	12,614
Geothermal	899	951	976
Wind	6,050	6,504	6,977
Solar PV	3,646	5,149	5,955
Bioenergy	375	378	378
CLEAN RENEWABLE	**23,582**	**25,594**	**26,899**
Nuclear	1,608	1,608	1,608
Efficient Cogeneration	1,710	2,305	2,305
CLEAN NON-RENEWABLE	**3,318**	**3,913**	**3,913**
TOTAL CLEAN ENERGY	**26,900**	**29,506**	**30,812**
% Porcentage	34.29	35.50	35.76
Combined Cycle	30,402	31,948	33,640
Thermal Conventional	11,831	11,809	11,793
Turbogas	2,960	3,545	3,744
Internal Combustion	891	850	701
Coal Power	5,463	5,463	5,463
TOTAL	**78,447**	**83,121**	**86,153**

Energy (GWh)

Technology (GWh)	2019	2020	2021
Hydro	23,602	26,817	34,717
Geothermal	5,060	4,574	4,242
Wind	16,726	19,702	21,074
Solar PV	9,964	15,835	20,194
Bioenergy	1,886	2,206	1,595
CLEAN RENEWABLE	**57,220**	**69,136**	**81,825**
Nuclear	10,880	10,864	11,605
Efficient Cogeneration	3,378	4,295	3,415
CLEAN NON-RENEWABLE	**14,262**	**15,163**	**15,024**
TOTAL CLEAN ENERGY	**71,483**	**84,229**	**96,850**
% Porcentage Clean	22.20	26.60	29.50
Combined Cycle	175,506	185,637	186,715
Thermal Conventional	38,057	22,446	22,241
Turbogas	11,053	8,824	11,400
Internal Combustion	3,501	3,205	2,499
Coal Power	21,611	12,525	8,704
Cogeneration	372	331	187
TOTAL Fossil Fuels - Based	250,101	232,968	231,747
% Fossil Fuels-based	77.80	73.40	70.50
TOTAL	**321,584**	**317,268**	**328,597**

ahead to overcome those challenges by taking advantage of available technology and an innovative regulatory framework.

FIRST THINGS FIRST: THE CONTEXT

To gain a better understanding of the current situation of the Mexican power sector, it is necessary to describe, from a technical point of view, the current condition of the electrical infrastructure. According to PRODESEN 2022 – 2036, at the end of 2021, Mexico had an installed capacity of 86.15 GW and annual generation of 328, 597 GWh (Table 1).[1] As can be seen in Table 1, Mexico's electricity generation is still very dependent on fossil fuels— natural gas, coal, oil and diesel fuel account for 70% of the electricity generation).

The purpose of every power system in the world is to serve its load in a reliable manner. In these terms, reliability encompasses two fundamental principles known as resource adequacy[2] and system security.[3] The load drives the growth of generation infrastructure (MW), transmission (km-c), transformation (MVA) and compensation (MVAr). In the case of Mexico, the maximum demand registered in 2021 was 45, 244 MW during the summer period (Figure 1).

The transmission grid in Mexico is quite extensive. The bulk power system (BPS) includes an infrastructure that operates from 69 kV up to 400 kV. According to PRODESEN 2022, there are 110, 549 km of transmission lines, 190,000 MVA capacity substations operating in the WEM, and a distribution grid with more than 878,000 km of medium voltage lines (2.4 kV up to 34 kV).

CHALLENGES FACING THE MPS

"Pain Points" in Generation

Now that we have described the main technical characteristics of the MPS, it is necessary to discuss the main challenges it faces to continue operating in a reliable manner. First, we must mention the challenges related

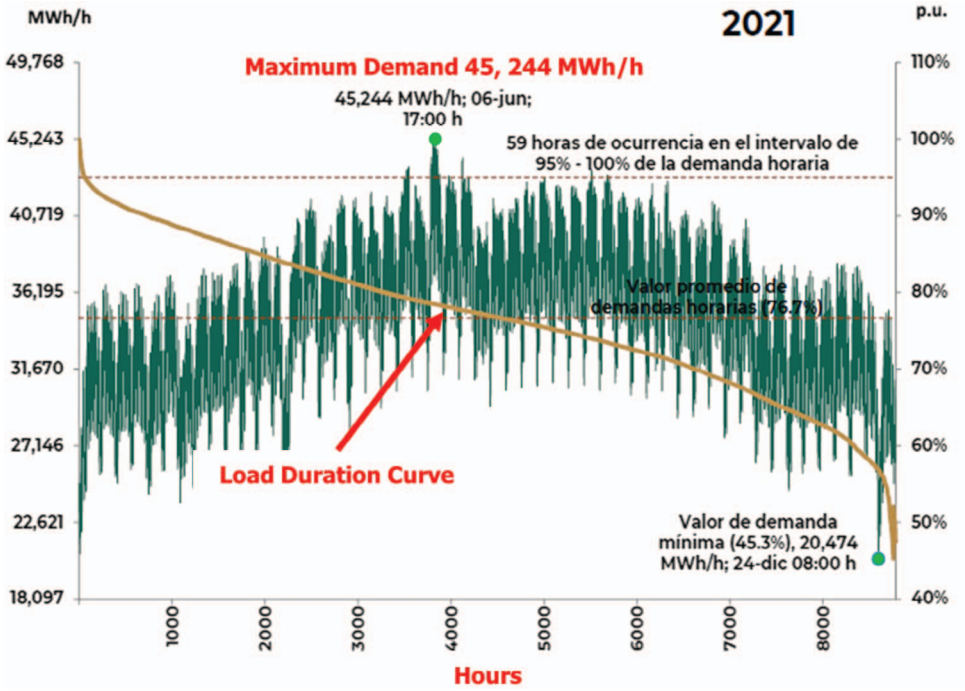

Figure 1. *Demand in the MPS.*

to electricity generation. As a consequence of energy reforms that began to be implemented in 2013, the electricity generation sector was fully opened to competition. The national electric utility (CFE) and private companies begun competing in the WEM for electricity dispatch.

At first glance, it might seem odd that there are problems to be solved when there are 86 GW of installed capacity to serve a 45 GW demand load. However, we must distinguish between "installed capacity" and "available capacity." The former term refers to the sum of the nameplate capacities of all generators within power plants in the country, whereas the latter refers to power plants that are in suitable condition to generate electricity.

The gap between those two concepts can explain the events (fuels shortages, unit failures, and corrective maintenances, to name a few) that prevent power plants from generating energy. For instance, according to the Reliability Report 2020 (RR2020) issued by the Energy Regulatory Commission (CRE),[4] there was an average of 15 GW of unavailable generation capacity during high demand hours,[5] of which 7.4 GW was related to natural gas shortage.

Another hurdle comes from the regulatory point of view, since obtaining a generation permit from the CRE has become an uphill task. In recent years, the number of generation permits granted has decreased (see Figure 2) and interconnection studies carried out by the National Energy Control Center[6] (CENACE) are delayed—and, when completed, usually request a copious amount of grid reinforcements, making generation projects (especially renewables) economically unfeasible.

"Pain points" in transmission.

For electrical engineers, it is reasonable (if not mandatory) to expect bulk power system (BPS) expansion to be linked to generation expansion. However, this has not been the case in Mexico, where the transmission sector is not open to competition and, as a result of Constitutional reforms in 2013, is fully under the government´s control through different agencies. Those agencies include the Ministry of Energy (SENER), which approves expan-

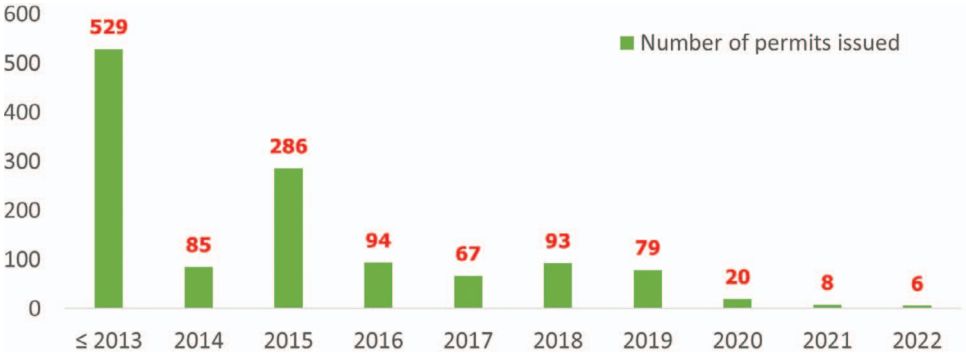

Figure 2. *Generation Permits Granted by CRE.*

sion and modernization; CENACE, which oversees control and proposes expansion; CFE, which is responsible for system operation, construction, and maintenance; and CRE, which regulates tariffs and performance metrics. In recent years, the BPS has practically not grown (see Table 2), resulting in a more congested and overloaded grid trying to manage a growing share of RE and serve growing demand.

Again according to RR2020, CENACE declared an "alert condition" 1,808 times in the MPS during 2020.[7] The lack of transmission infrastructure and failures in one of its elements (lines or substations) were the root cause of these alerts and accounted for 98.3% of the reasons why CENACE had to declare those conditions. A weak BPS has negative impacts both on the operation of the MPS and the performance of the WEM. On one hand, CENACE and CFE have to operate the MPS with congested lines and overloaded elements; on the other hand, congestion and energy losses costs increase, resulting in higher LMPs.[8]

The Regulatory Framework

In recent years, the energy sector in Mexico has experienced numerous changes. Since 2018, there have been various initiatives by the current government to modify the regulatory framework of the electric industry.[9]

For example, Mexico has halted long-term energy auctions specifically designed for the CFE to buy clean energy, taking advantage of a power purchase agreement with the private sector. Three such auctions were successfully implemented between 2015 and 2017, enabling the MPS to award 7.6 GW of new installed capacity (solar and wind) and attracting investment in excess of 9 billion USD. During the 2017 auction, Mexico set a world record for the lowest electricity price coming from RE (20.57 USD/MWh) offered to CFE (Figure 3). Meanwhile, SENER was conducting transmission auctions to help CFE built new transmission lines in the south part of the country[10] and to connect Sonora with Baja California using HVDC technology.

In addition, the government has attempted to modify the regulatory framework through different policies and rules proposed by SENER and especially CRE. However, the vast majority of those initiatives have been blocked by judicial action and are still pending resolution.

Within this context, it is necessary to highlight the fact that President Lopez Obrador proposed a constitutional reform in September 2021 trying to reverse the energy reforms of 2013. Although the reform was not approved by the Mexican Congress, in March 2021 the Congress did pass several amendments to the Electric Industry Act to permit CENACE to give priority to the energy produced by CFE within the economic dispatch process. Those amendments are still being challenged in court by numerous stakeholders. The resulting regulatory uncertainty has become a major hurdle to investment in Mexico, preventing private sector participation in

Table 2. BPS expansion 2018 – 2021. *CAGR = Compound annual growth rate

	Grid Extension (km)				CAGR
Voltage	2018	2019	2020	2021	2018 - 2021
161 - 400 kV	55,089	55,865	56,338	56,342	0.564%
400 kV	25,455	25,921	26,097	26,098	0.626%
230 kV	29,115	29,425	29,722	29,722	0.517%
161 kV	519	519	519	521	0.095%
69 - 138 kV	52,930	53,044	54,158	54,207	0.598%
138 kV	1,779	1,779	1,620	1,620	-2.313%
115 kV	48,013	48,127	48,456	48,496	0.251%
85 kV	795	795	1,747	1,756	21.910%
69 kV	2,343	2,343	2,335	2,335	-0.085%
TOTAL	**108,019**	**108,909**	**110,496**	**110,549**	**0.580%**

MPS expansion and modernization and leaving the sole responsibility for those activities to CFE, which does not seem to have a sufficient budget to carry them out.

Energy Transition

The fundamental driver behind energy transitions in most countries is to increase the share of clean energy sources while satisfying the needs of end users. The SENER sees Mexico's energy transition (ET) as a planned expansion of the energy matrix within a 30-year horizon. The SENER's view is that an ET implies a sustainable change of the current energy, industrial, technological and economic systems based on the transformation of non-renewable energy sources toward a new energy system based on the progressive consumption of clean electricity (including RE and nuclear energies).

In February 2020, the SENER updated the Transition Strategy to Promote the Use of Technologies and Cleaner Fuels,[11] in which it endorsed a clean energies target of generating 35% of electricity with clean sources (RE

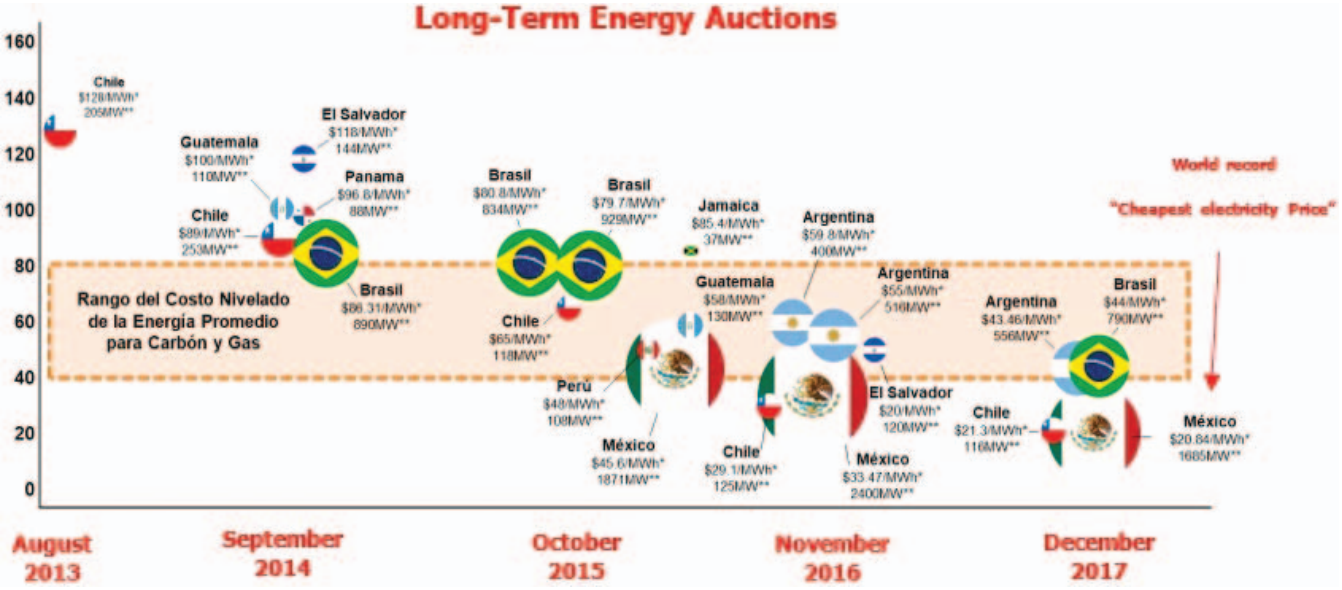

Figure 3. *Energy Auctions.*

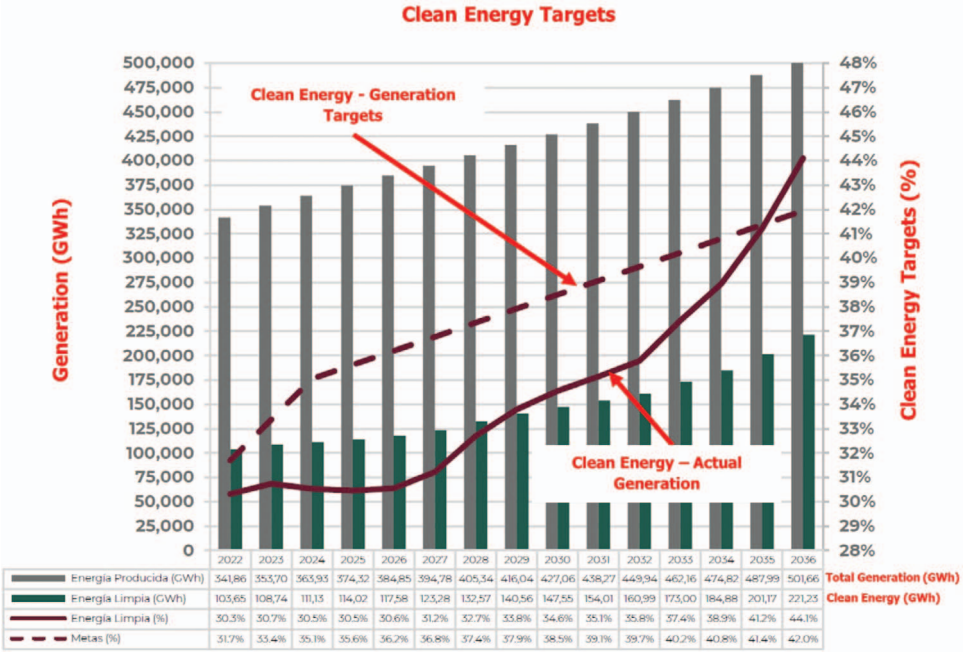

Figure 4. *Clean Energy Targets for the MPS.*

and nuclear). According to PRODESEN 2022 – 2036 (published by the SENER at the end of May), Mexico will not achieve the goals that the current government endorsed two years earlier (Figure 4).

The pace of the ET that the current government has endorsed is posing challenges that the MPS has not addressed successfully, considering that the clean energy integration goals won't be met for the period 2022-2034.

OPPORTUNITIES FOR THE MPS

This article has described how technical challenges such as the low integration of RE, the widespread unavailability of power plants during high demand periods, and a congested and overloaded BPS are affecting reliable operation of the MPS. This article has also described how regulatory uncertainty is preventing investment in the energy sector. Both the technical challenges and the regulatory uncertainty are creating a "perfect storm" that is preventing Mexico from moving forward toward the fulfillment of its ET goals.

Despite the challenges Mexico is facing, it is necessary to look ahead and take advantage of the opportunities that exist to meet out ET goals. Over the coming years, we are obligated to accelerate an orderly integration of clean energy sources into the MPS, so a set of opportunities should be studied and developed.

Complimentary Technologies

The integration of clean energies will focus mainly on solar photovoltaic (SPV) and wind power generation, but we must not fail to consider other technologies (such as hydro, geothermal, and nuclear) that can contribute significantly to our ET goals. With the integration of such resources, it will be necessary to develop "complementary technologies" to ensure that reliable operation of the MPS is never at risk for any reason. Among those technologies are energy storage systems,[12] which should be developed further since they are able to provide services that will allow the CENACE to control and operate the MPS in a reliable and safe manner.

However, within the storage technology sector, the use of batteries (BESS) and green hydrogen (H_2), which can also be used by the transmission sector, will soon stand out. On its ET journey, the MPS must consider tech-

nological improvements in renewable generation equipment and contemplate the intensive use of storage systems. First BESS, then green H_2.

These technologies can provide ancillary services related to primary frequency regulation (active power control), voltage control (reactive power control), and contingencies (fault-ride-through capabilities). Those services could provide more flexibility to the MPS and allow it to improve the integration of variable sources of energy such as SPV and wind.

Reinforce the BPS

Expansion plans come and go, but the transmission infrastructure has remained the same. The issue that needs to be solved is not related to better planning, but to the implementation of that planning. It has been demonstrated that the CFE alone has not been able to meet the transmission expansion requirements proposed by the CENACE and approved by the SENER, so it is advisable to revisit the transmission investment opportunities to help the CFE be more effective. Mechanisms such as public-private partnerships and Fibra-E, which in 2018 raised around 800 million USD,[13] have proven useful. If the government insists on excluding the private sector from participating in the BPS expansion, then it should provide the CFE with suitable mechanisms to finance and build the transmission grid that the MPS so badly needs.

Create Regulatory Certainty

Stable and transparent policies and regulations are fundamentally important for continued investment in the RE sector in Mexico. Unfortunately, investors' confidence in the energy sector plummeted because of a changing regulatory framework that has hampered RE projects in Mexico. There is an opportunity to strengthen investors' confidence by having a more open process wherein the SENER and CRE would solicit the participation of stakeholders during the early stages of a policy and regulation formulation process. This would very likely reduce private sector lawsuits and court appeals.

There is already some regulation in place on RE projects' interconnection and permitting, ancillary services provided to the WEM, the ESS and their participation in the WEM, and transmission expansion through regulated tariffs. The CRE does not have to start from zero; indeed, it has the opportunity to further develop regulations to create an environment of regulatory certainty that encourages the participation of the private sector and complements (not replaces) the CFE to achieve our ET targets.

CONCLUSIONS

Due to numerous factors, including technical and regulatory challenges, Mexico's ET goals that were previously endorsed by the current administration are not being met. As a result, the government is facing critical choices in terms of implementing its ET agenda.

The positive side (if any) of being late with RE integration is that we can learn from other countries' experience. Mexico does not have to reinvent the wheel, since there is a vast international experience to draw on in terms of ancillary services markets, BESS integration and operation, and mechanisms to finance transmission grid expansion. It is important to learn from international experience, but it is more important to dispense with the idea of "copy – paste" solutions, since a mechanism that works in some other countries may not necessarily work in Mexico.

Finally, all stakeholders in the energy sector, both private and public, need to do some soul searching about why we are in this situation. The government must consider providing regulatory certainty to create a more suitable environment for private investment. Such investment is needed for BPS expansion and RE integration and will signal to the private sector that Mexico once again is an attrac-

tive investment choice for their zero carbon plans.

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NOTES

1. PRODESEN is issued by the Ministry of Energy on an annual basis. It contains the expansion planning of the power sector, considering a planning horizon of 15 years.
2. According to the NERC, resource adequacy is the ability of the electric system to supply the aggregate electrical demand and energy requirements of end-use customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.
3. System security should be understood as the ability of the electric system to withstand disturbances such as short circuits or the unanticipated loss of system elements (generators, transmission lines, substations, etc.).
4. Reliability Report 2020 of the Mexican Power Sector issued by the Energy Regulatory Commission available at: https://www.gob.mx/cms/uploads/attachment/file/693799/RCSEN_2020_VF.pdf
5. This analysis was made during the 100 critical hours (referring to the top 100 hours when demand was the highest during 2020).
6. CENACE is the Independent System Operator in Mexico responsible for MPS Operation and WEM administration.
7. The Mexican Grid Code defines “alert condition” as one in which electric variables in the system may still be within reasonable limits but (n-1) criterion is not met.
8. Local marginal price is the sum of the costs of energy, congestion and losses.
9. The electric industry includes activities such as generation, transmission, distribution, planning and control of the MPS and the administration of the WEM.
10. Mainly in Oaxaca and Chiapas, where Mexican hydro and wind resources are most abundant.
11. Federal Order issued by the the Sener (Ministry of Energy) to approve the update of the Transition Strategy to Promote the Use of Cleaner Fuels and Technologies according to the Energy Transition Law available at: https://www.dof.gob.mx/nota_detalle.php?codigo=5585823&fecha=07/02/2020#gsc.tab=0
12. Energy Storage services such as BESS, re-pumping systems and flywheels, etc.
13. According to CFE Capital which is a subsidiary of the CFE with the objective of administrating all trusts and CFE´s assets, including investment trusts in energy and infrastructure.

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RESEARCH ARTICLES

Increasing Diversity in Innovation

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The world is embroiled in a global innovation race. Both countries and companies have recognized that innovation is a clear driver of national competitiveness (defined as economic and technological competitiveness) and national security.

In the 1970s, the United States accounted for roughly 70% of global research and development (R&D). Today, the U.S. accounts for only 16%, well below China's 25%. The National Science Board recently reported that in addition to lagging behind China in R&D output, the U.S. share of international patents dropped from 15% to just 10% from 2010 to 2020. In contrast, China's share of international patents increased from 16% in 2010 to 49% in 2020.

How can we compete with China and other emerging nations in the area of innovation? By embracing and nurturing diversity and inclusivity and their impact on innovation teams.

According to the U.S. Patent & Trademark Office's Progress and Potential report, looking only at gender, innovation teams primarily consist of men. The women inventor rate – that is, the share of women among all U.S. inventor-patentees– only grew from 12.1% in 2016 to 12.8% by 2019.[1] While this was an improvement, it suggests we are essentially keeping many of our innovators on the sidelines. At this rate, the United States will not be able to compete effectively in the global innovation race.

Diversity efforts have been underway at most large corporations for the past 5 to 10 years, so why haven't things improved? This question is at the heart of a new initiative between the U.S. Intellectual Property Alliance (USIPA) and the University of California Berkeley's School of Engineering called The Diversity Pledge. The pledge aims to create a set of best practices to help companies Increase diversity in innovation.

Over the past year, we have been working with companies on this issue to understand the issues they are facing and the successes and failures they have experienced. Here are a few things we have learned about how teams invent and innovate and how to increase under-represented inventor (URI) participation.

HOW INNOVATION OCCURS

While we tend to think of innovation as a "Eureka" moment, for most inventors, innovation rarely happens that way. Instead, within companies, most innovations are the result of problem-solving brainstorms, often called "innovation sprints." We define "innovation sprints" as the generation, by a person or group of persons, of an idea previously not conceived by the person or persons.

There are numerous ways that innovation sprints are conducted and categorized. For purposes of this article, we categorize innovation sprints/brainstorms into three

different groups based on who generates an idea: (1) an individual person ("individual brainstorming"); (2) a group of persons ("group brainstorming"); and (3) a combination at different times of an individual person and a group of persons, possibly including that individual person ("hybrid brainstorming"). We have found these different approaches to brainstorming useful, depending on the situation and the people involved.

Individual brainstorms are typically beneficial in situations where (1) attendees think better in silence, (2) the issue/problem is controversial, (3) there's an existing conflict between attendees, (4) there's a need to address multiple problems/features in one meeting, and/or (5) attendees dislike structured ideation.

Group brainstorming is helpful where at least some attendees are new to a team or company, a core problem exists that needs to be solved, ideation meetings occur frequently, or team members do not prepare ideas in advance.

Finally, **hybrid brainstorming** is particularly beneficial where some attendees are more vocal than others, there are concerns around implicit bias (e.g., for an underrepresented population), attendees typically are not engaging, a large quantity of ideas is needed, there's a power-imbalance between facilitator and attendees, or coverage of competitor products is sought.

As we've worked with the companies that have signed the Diversity Pledge, we've learned that the vast majority use group brainstorming in their innovation sprints to try to generate important new innovations, expand their innovator population, and grow their IP portfolios. In these sprints, first described and popularized by Alex Osborne in the 1950s, an existing team or a specially created group will be brought together to synchronously ideate. Such sessions will typically adhere to a set of brainstorming "rules" the participants are supposed to follow, such as no criticism of ideas, strive for a large quantity of ideas, build upon ideas put forth by others, and welcome wild ideas.

An intellectual property (IP) lawyer commonly serves as both a facilitator and scribe to capture the ideas put forth by the group and subsequently helps determine which idea(s) warrant further development or IP protection. Anecdotally, a 45- to 60-minute session containing 6-10 participants can be expected to explore 15-20 discrete ideas, of which 1 to 2 may warrant patent protection. The results can vary greatly based on factors such as the topic explored and the dynamics of the group.

DRAWBACKS OF TRADITIONAL APPROACHES

A small but growing number of Diversity Pledge companies, however, have moved away from such traditional brainstorming approaches toward hybrid approaches. Consistent with brainstorming literature[2] (see, e.g., Girotra), these companies have seen that synchronous brainstorming presents several inefficiencies and drawbacks that particularly affect URI participants, as follows:

First, when working in groups synchronously, only one person can speak at a time, leading to **production blocking** that naturally limits the number of ideas that can be explored.

Second, **free riding and regression to the mean** are commonly observed, whereby participants either do not contribute strongly if they feel that others are already contributing for the team or scale back their output to match that of their peers.

Third, **evaluation apprehension** often prevents participants from surfacing the ideas that they do have.

Fourth, many innovators simply don't enjoy presenting their ideas in front of a group, so **the pool of willing participants may be limited by the format**.

Finally, groups can gravitate toward–or away from–a contributed idea because **the identity of the speaker overshadows the merits of the idea**, owing to unconscious

biases, existing team dynamics, or other such factors.

Each of these drawbacks of traditional brainstorming affects the extent to which the innovation sprints generate important new innovations for the company, the company expands its innovator population and increases URI participation, and the company grows its IP portfolio.

ADVANTAGES OF HYBRID APPROACHES

Companies that have moved to hybrid methods to better achieve the objectives of their innovation sprints have generally employed one of two related approaches. In the first approach, a group is brought together for a session in which individuals first work independently to generate as many ideas as they can to solve a given prompt, commonly recording their ideas either on Post-It notes or electronically in Google Docs. The ideas are then collated and grouped by a facilitator, who then leads a discussion of a subset of ideas for further refinement and improvement by the group at large.

In the second approach, a structured idea generation method such as the 635 method is employed in a first phase to generate and record a very large number of diverse ideas, which the group can then further develop and refine in the second phase. In the 635 method, 6 innovators attempt to individually propose 3 ideas apiece to a problem prompt every 5 minutes, with the solutions captured on a shared document. Every 5 minutes, each innovator either adds 3 new ideas or builds on ideas previously proposed by others. In 30 minutes, 6 innovators potentially can propose 108 discrete ideas using this approach.

The approach used to generate initial ideas is often driven by factors that include the nature of the problem statement, the location of the participants, and the number of participants. A 635 approach may be preferred, for example, when the problem statement lends itself to being "solved" by 3 ideas in 5 minutes, the participants are all co-located and able to work off of shared hard copies or able to access the same collaborative document, the size of the group is 4-7 people, and a facilitator is not present.

The self-reported results from companies that have shifted to a hybrid approach show significant advantages over traditional group brainstorming, especially in terms of increasing URI participation. These advantages include the following:

Hybrid approaches **generate significantly more ideas**, with some reporting three times as many ideas per unit time compared to group brainstorming. We attribute this increase to less production blocking, free riding, and evaluation apprehension as well as to the increased efficiency of the 635 method. By extension, this means that companies are also likely to get significantly more ideas from URI participants per unit time using hybrid approaches.

Hybrid approaches also generate a **greater diversity of ideas**, owing both to the increased number of ideas generated as well as to less evaluation apprehension and a reduced tendency for the group's later ideas to norm to those already surfaced. As these trends can often affect the contributions of URI participants, moving to a hybrid approach can make it more likely that companies benefit from diverse ideas. Anecdotally, the diversity of ideas generated when the first phase is conducted using Post-Its or Google Docs can be even greater than when using 635, as individuals often have no visibility into others' ideas while generating their own.

The ideas generated by hybrid approaches also are of **higher quality**, consistent with literature suggesting the best ideas from a hybrid approach have average quality 30% greater than those from other group ideas. We attribute this to the greater number of ideas and greater diversity of those ideas as well as to the important second phase, in which the group seeks to discuss and improve upon the best subset of ideas that were generated during the first phase.

Participants who use hybrid approaches are also **better able to discern idea quality** than participants in a traditional group structure. The individual portion of the hybrid approach forces participants to be highly engaged in the problem-solving task, thereby increasing the acuity of their judgments when evaluating the quality of ideas in the group phase. Further, in the group portion, evaluating an idea without knowing its history/origin may result in more accurate judgments and has great benefit in reducing implicit biases.

It is also generally **easier to introduce new individuals to innovation sprints and have them participate** when using a hybrid approach, as the format obviates the reluctance participants may feel about presenting their ideas in front of an unfamiliar group. With hybrid approaches, the origin of an idea generally isn't known to the group for the second phase. In fact, as only the best ideas are discussed within the group setting, participants whose ideas are selected are generally more willing to speak up, as their contributions have already been validated. Indeed, one approach tried by several companies is to have past participants invite someone new to an upcoming innovation sprint as a way to further expand the reach of the innovation process.

Hybrid approaches also **improve the documentation and capture of each idea generated** during the session, as the first phase necessarily includes a "brainwriting" portion in which each idea is captured. In contrast to group brainstorming, in which an individual attempts to capture the ideas generated verbally by the group, a significantly greater percentage of ideas generated are captured in a hybrid approach. This makes it substantially easier for the full breadth of ideas to be distributed to product teams for possible implementation, helping companies turn the ideas into actionable innovation. Further, those ideas can also be shared with other innovators in the company who can further improve upon them asynchronously, further expanding the impact of the innovation session.

Finally, hybrid approaches allow teams to **conduct the first phase in the absence of a facilitator**, particularly when employing a 635 method. That is, any group of 4-7 individuals could readily follow a 635 method once introduced to it and could, in a 30-minute session, create a significant number of ideas that could be further refined (with the help of an IP lawyer facilitator) during a subsequent second session. This can help make the overall process of innovation sprints more scalable for IP teams.

CONSIDERING LESSONS LEARNED

Companies report that these advantages, taken together, have meaningfully increased URI participation in their innovation sprints. By adopting a hybrid format, companies generally received a greater number of contributions—and a greater diversity of contributions–from their URI participants on a unit time basis. The format also seems to better lend itself to getting URI participation in the first place, which we attribute to greater comfort owing to reduced evaluation apprehension. Anecdotally, companies have found that individuals who participate in a hybrid innovation sprint are far more likely to participate in subsequent sessions, which we believe stems from the participants seeing the value of the sessions in terms of the amount of ideas generated, as well as comfort with the format. At some companies, URI innovation teams have even self-assembled and conducted 635 sessions independently, with a second session then held with IP lawyer facilitators.

That said, a lack of awareness of company holds such innovation sprints was reported as a challenge in securing URI participation. There may be many willing participants within a company who do not participate simply because they have not previously engaged with the innovation sprint process and are unaware of such opportunities.

While there are a significant number of benefits reported by companies that have adopted hybrid approaches, companies considering trying a hybrid approach should nevertheless be aware of some lessons learned. First, while the format naturally lends itself to surfacing a greater number of diverse ideas from each participant, group dynamics and unconscious biases may still be extant and affect the willingness of URI participants to engage, particularly during the group discussion section. Effective facilitation and transparency as to how ideas are selected for discussion or ultimate patenting can potentially help.

Second, while we've seen that hybrid approaches can lead to quantifiable benefits (such as an increased number of patent filings or ideas considered for implementation by the business), participants need to see the value and understand the importance of innovation sprints to consider them an effective use of their time. Individuals whose ideas are not further explored or patented may grow discouraged and not participate.

The Diversity Pledge has highlighted the need for companies to evaluate and measure who is innovating in their company and to create, measure and reward processes that provide more inclusive access and participation by under-represented inventors. Companies and our nation can no longer afford to lose good ideas by not including everyone in the innovation process.

Identifying bias in the innovation and invention system and then eradicating it helps all, and adopting hybrid brainstorming approaches appears to be one way to help eliminate such bias. Additionally, measuring the patenting output of the process is a new way to independently verify the inclusivity of a company's invention process. With this new metric, inventors can determine where they want to work and how their participation will be utilized.

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