A Call for Deeper Integration Between the Electrical Systems of the United States and Mexico

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Introduction

Deeper integration between the United States and Mexican electrical systems would create a unique opportunity for the two countries to jointly manage cross-border challenges, seize economic development potential and boost competitiveness, while fostering energy security for both countries.[1]

Trade in electricity between the United States and Mexico is very modest, with U.S. imports from Mexico representing roughly 0.6% of electricity consumption in the U.S. border States of Arizona, California, New Mexico, and Texas.[2] Mexican imports from the U.S. representing less than 2% of Mexican consumption.[3] The primary reason for the low level of U.S.-Mexico trade in electricity is that the electrical systems of the two countries are not integrated, with limited exceptions.

The move toward increased use of renewable energy in both countries, together with related grid reliability challenges and extreme weather risks presented by climate change, argue for increased electrical integration between the two countries. The resulting geographical diversity will help smooth out the intermittency of renewables, reduce renewable curtailments, and lower electricity prices. Geographical diversity will also provide reliability benefits and eventually, a reduced need for reserve capacity. Further, deeper integration, coupled with increased development of renewables, could mitigate Mexican dependence on imported hydrocarbons, which is exacerbated by global geopolitical trends that affect the price of imports.

Importantly, increased electrical system integration also offers strategic benefits to the U.S. and Mexico, increasing their joint competitiveness.

This paper offers suggestions on how deeper integration might take place, with a focus on increased integration between California and Baja California and between Texas and the Mexican states on the Texas border.

[1] The U.S.-Canada cross border connections are vital for North America's energy security also, but this paper focuses on the importance of strengthening those connections between Mexico and the U.S. We hope others can offer thoughts on the Canada-U.S, electricity connectivity as part of the Wilson Center's look at North America.

[2] Electricity trade between Mexico and the U.S. exists in California, New Mexico, and Texas, where transmission lines cross the border are in place. See map: U.S. Energy Information Administration - EIA - Independent Statistics and Analysis

[3] U.S. imports of electricity from Mexico in 2020 were 4,447 GWh, while exports to Mexico in that year were 4,280 GWh, https://www.eia.gov/electricity/annual/html/epa_02_14.html. U.S. consumption of electricity for the States of California, New Mexico and Texas in 2020 was 701,815 GWh, while Mexico's consumption in that year was 267,000 GWh. International - U.S. Energy Information Administration (EIA), State Electricity Profiles - Energy Information Administration (eia.gov). Accordingly, for 2020, U.S. electricity imports from Mexico represented 0.6% of electricity consumption by the 4 U.S. border states, and U.S. electricity exports to Mexico represented 1.6% of Mexico consumption.

Potential Opportunities for Increased Exports of Clean Energy from Mexico

During his June 15, 2022 visit to Mexico, U.S. Climate Envoy John Kerry highlighted Mexico's abundance of natural resources to create and ***export*** clean energy.[4] Then, at the June 17 Major Economies Forum on Energy and Climate, President Andrés Manuel López Obrador committed to a decalogue of actions against climate change, including creation of solar parks on the border between Mexico and the U.S., as well as the construction of energy transmission networks that would allow export of electricity to California and other U.S. states.[5]

There is clearly demand for clean energy exports to California. Under California's Renewable Portfolio Standard (RPS), renewable energy projects located in Mexico near the border will satisfy California utilities' RPS obligations **if** those projects link to the California grid via a dedicated cross-border transmission line without first connecting to the Mexican grid.[6] California utilities must source 50% of their retail sales from RPS compliant resources by 2026, 60% by 2030 and now 100% (including zero carbon resources) by 2045[7] They still have a long way to go to meet these obligations.[8]

Renewable energy projects located in Mexico near the border, i.e., in Baja California, could help California utilities with their RPS obligations if the projects are export only and have the necessary direct interconnection to the California grid, without first connecting to the Mexican grid.[9] Further, Baja California has high-intensity solar and wind resources,[10] and thus will be able to sell electricity derived from these resources at a lower price.

But integration of a broad network of generation capacity across the U.S.-Mexico border could provide additional benefits as well.

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[4] "U.S. climate envoy Kerry urges Mexico to accelerate energy transition," Reuters, June 14, 2022, https://www.reuters.com/business/environment/us-climate-envoy-kerry-urges-mexico-accelerate-energy-transition-2022-06-14/

[5] Z. Flores y A. Solís, "AMLO quiere proyectos para exportar energía a EE.UU.; Sempra Infraestructura ya lo hace," Bloomberg Línea, June 17, 2022, https://www.bloomberglinea.com/2022/06/17/amlo-plantea-exportar-energia-electrica-a-eeuu-de-la-mano-de-empresas/.

[6] Regarding the California RPS, see California Public Utilities Code § 399.11(a). On the eligibility of a foreign project to meet RPS requirements, see California Public Resources Code § 25741(a)(2)(A). See also California Public Utilities Code § 399.11(e)(1) and (2) (generating resources located outside of California that are able to supply RPS eligible electricity to California end-use customers shall be treated identically to generating resources located within the state).

[7] California Senate Bill 100 (2017-2018), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100. , The bill also provides that it is the policy of the state that eligible renewable energy resources and zero-carbon resources supply 100 percent of all retail sales of electricity to California end-use customers and 100 percent of electricity procured to serve all state agencies by December 31, 2045.

[8] See California Public Utilities Commission, 2021 California Renewables Portfolio Standard Annual Report, August 2021, p. , https://www.cpuc.ca.gov/-/media/cpuc-website/industries-and-topics/documents/energy/rps/cpuc-2021-rps-annual-report-to-legislature.pdf.

[9] These requirements are set forth as part of the State of California's renewable portfolio standard eligibility and compliance elements. See fn. 6.

[10] For a map of Mexico's solar resources, see https://solargis.com/maps-and-gis-data/download/mexico. For maps of Mexico's wind resources at different heights, see https://www.nrel.gov/gis/assets/images/mexico-wind-maps.zip.

Support for Renewable Energy; Balancing Load and Supply at Best Available Price

Large area generation networks extending across the U.S.-Mexico border would help to mitigate the intermittency and variability of renewable energy on either side of the border by taking advantage of generation resources across the entire area covered by the network. More broadly, large-area networks extending across the border could create a market for cross-border purchase and sale of power when there is a price differential between the sides of the border, benefitting both countries. Such networks could also contribute to reliability, including under emergency conditions, by providing multiple sources of power to a local balancing authority facing loads greater than available supply. A key benefit of large-area generation networks in providing all these benefits is that the buyer will be able to select among many generation resources to meet its needs at the best available price.

Potential Benefits to Mexico

Mexico has substantial electricity needs going forward. Mexico's Ministry of Energy (*Secretaría de Energía*, or SENER) foresees 2.7% annual growth in electricity demand for the country during the period 2022-2036 under its planning scenario.[11] To meet this forecasted increase in demand as well as peak demand requirements, SENER projects that Mexico will add a total of 41,076 MW of new utility-scale generation capacity during the 2022-2036 period, a majority of which will be renewables and batteries.[12] SENER also forecasts additions to distributed generation capacity of 8,981 MW (primarily solar PV) for the same period.[13]

Future electricity needs have to consider economic factors. Apart from the climate benefits, solar and wind energy have become cheaper than conventional hydrocarbon generation. According to the International Renewable Energy Association (IRENA), the global weighted average levelized costs of energy (LCOE) of new utility-scale solar PV in 2021 was 11% lower than the cheapest new fossil fuel-fired power generation option, and on-shore wind was 39% lower.[14]

However, renewable energy derived from solar and wind resources are subject to intermittency and variability (the day-night cycle and seasonality). Interconnected wide area generation networks provide a large geographic area from which generation can be drawn to take advantage of production from diverse resources across the entire area. Apart from the availability of power from multiple sources, a large, interconnected area may permit purchase of backup power at a lower cost than is otherwise available, since different generation facilities

[11] PRODESEN 2022-2036, Chapter 6, Cuadro 6.5, http://base.energia.gob.mx/prodesen22/Capitulo6.pdf.

[12] PRODESEN 2022-2036, Chapter 7, Figura 7.1 and 7.2, http://base.energia.gob.mx/prodesen22/Capitulo7.pdf

[13] The 8,981MW is the difference between the 10,996 MW of distributed generation projected to be in place by 2036 less the 2015 MW of distribution in existence at the end of 2021. PRODESEN 2022-2036, Chapter 6, Figura 6.25, http://base.energia.gob.mx/prodesen22/Capitulo6.pdf.

[14] IRENA, Renewable Energy Power Costs in 2021, p 5, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jul/IRENA_Power_Generation_Costs_2021_.pdf

within the area may have different cost profiles. This is particularly attractive if low-cost solar or wind resources that would otherwise be curtailed can be used to meet shortfalls in another part of the linked generation areas.

Potential Benefits to the U.S.

There is also a U.S. market for cross-border clean energy and reliability services in the U.S.-Mexico border region. California's RPS, noted above, is one element of the market demand. The North American Energy Reliability Corporation (NERC) -- the body responsible for overseeing the reliable operation of the interconnected electric grid for the U.S.[15] – foresees energy shortfall risks and extreme weather risks in California and the Southwest U.S. for 2022 and beyond.[16] NERC also foresees extreme weather risks in Texas. [17]

To confront these risks, both California and Texas plan on additions to generation capacity, including large amounts of renewable energy, as well as demand management. But electricity imports can also mitigate energy shortfall risks and extreme weather risks. As an example, one study of the Texas blackouts resulting from Winter Storm Uri in February 2021 found that an additional 1000 MW of transmission import capability into the ERCOT portion of Texas would have been worth US$1 billion in just the 4 worst days of Uri.[18]

Mutual Benefits: A North American Perspective

The North American Renewable Integration Study (NARIS), undertaken by the U.S. National Renewable Energy Laboratory (NREL),[19] analyzed different scenarios with respect to forecasted increases in renewable energy use within North America, including Canada, the U.S. and Mexico, and how improved transmission integration, both internationally across borders and inter-regionally within countries, might affect implementation of those scenarios. A key finding was that:

> "Regional and international cooperation can provide significant net system benefits through 2050. Increasing electricity trade between countries can provide USD $10 billion to $30 billion net value to the system. Interregional transmission expansion achieves up to $180 billion in net benefits. Although these values are a small percentage (less than 4%) of the total $5 trillion to $8 trillion total system costs (which include all capital and operating generation and transmission system costs), transmission plays an important role in minimizing costs."[20]

[15] NERC's area of responsibility spans the continental United States, Canada, and the northern portion of Baja California, Mexico. See: About NERC

[16] NERC, 2021 Long-Term Reliability Assessment, December 2021, pp. 8-9, 23-25. https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_LTRA_2021.pdf

[17] Id.

[18] https://acore.org/more-interregional-transmission-could-have-saved-nearly-1-billion-preserved-power-for-200000-homes-during-texas-freeze/

[19] For an introduction to NARIS, see https://www.nrel.gov/analysis/naris.html.

[20] Id.

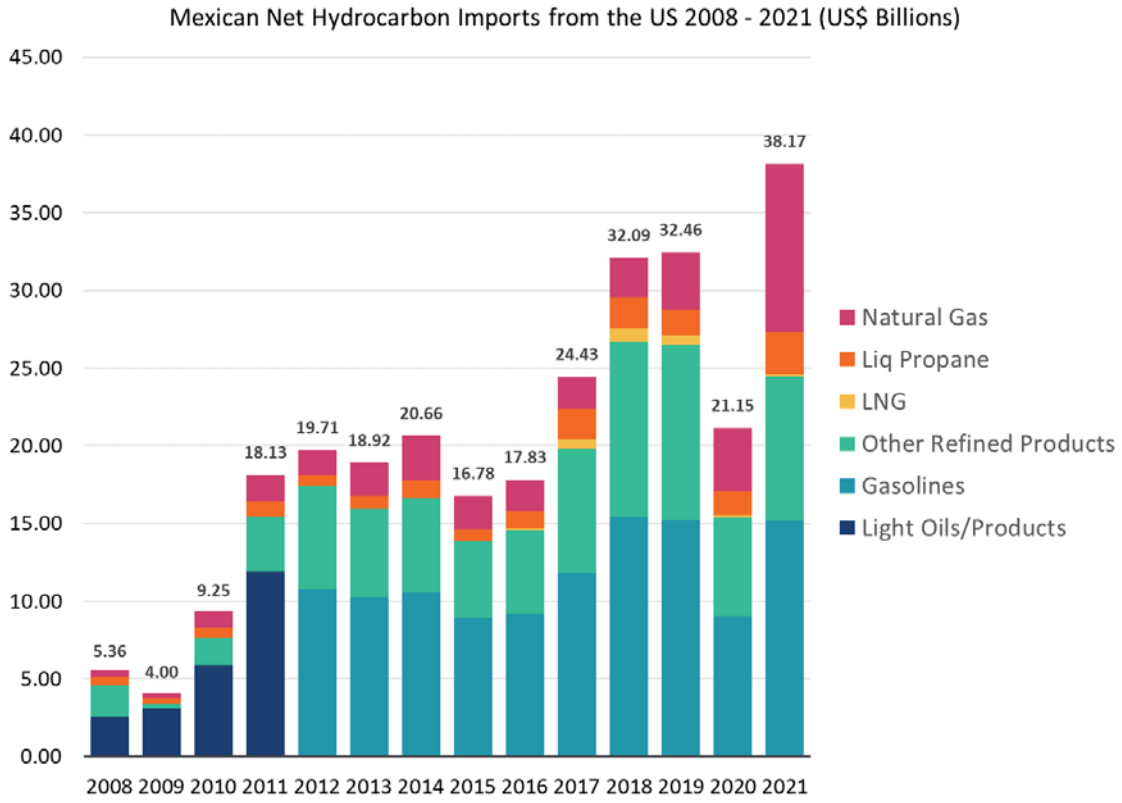
While NARIS studied the potential impact of transmission interconnections across all North America, it is indicative that both Mexico and the U.S. could benefit from increased integration between the two electric systems.

Global geopolitics and U.S.-Mexico energy integration

U.S.-Mexico electricity issues are not isolated from global geopolitical issues. The potential for greater linkage between U.S. and Mexican electrical systems, focused on renewable energy, is ever more relevant as armed conflict in Europe raises energy security concerns with respect to the supply of fossil fuels.

Also, Mexico is not immune from fossil fuel volatility, and should pursue rapid deployment of renewable energy technologies and electrification as an alternative to fossil fuel dependency.

Mexico imports large and growing quantities of gasoline, other refined products and natural gas from the U.S. See the table below. But Mexico could reduce its dependency on imported hydrocarbons, which come primarily from the U.S, by relying more on renewable energy, which Mexico could generate in enormous quantities due to its abundant solar and wind resources. [21]



Source: Data are from USA Trade Online, https://usatrade.census.gov/, State Import Data (State of Destination) and State Export Data (Origin of Movement), by Harmonized System (HS) classifications for traded products/commodities.

[21] President López Obrador is building a new refinery to reduce imports, but even with new capacity, Mexico could benefit and further reduce imports with electrification and renewable energy.

With respect to gasoline and other refined products, Mexico's net import cost was US$24.49 billion in 2021, when prices were lower than at present. However, in 2022, Mexico has been impacted by sharply rising prices for these commodities due to high global crude oil prices affected by the Ukraine war and other market disruptions.

In response, electrification of transportation could reduce dependence on imported gasoline and diesel, supplementing Mexico's self-sufficiency strategy based on development of increased domestic refining capacity.

In President López Obrador's decalogue of climate actions, he commits to producing 50% zero-emission vehicles by 2030 and refers in this regard to Mexico's own lithium reserves as a foundation for battery manufacturing.[22] Increased generation of renewable energy in Mexico could fuel the new electric vehicles, with support from the integrated U.S.-Mexico electrical system. [23] Related renewable energy, emissions and other environmental commitments are embodied in the November 2021 work agenda approved by all three North American Leaders at their summit meeting and in the July 2022 Biden-López Obrador statement released following their White House meeting.[24]

With respect to natural gas, as of March 2022 Mexico's average imports were 5,563 million cubic feet per day (MMcfd) and its total consumption was 8,190 MMcfd.[25] Comparing import and consumption figures, imports constituted 68% of total consumption.

Substantially all of Mexico's natural gas imports come from the U.S. In 2021, Mexico paid a total of US$10.95 billion for natural gas imported from the U.S. This heavy reliance on imports makes Mexico dependent on U.S. pricing and Mexico has already suffered substantial price increases. Henry Hub spot prices increased from US$1.74 per million Btus (MMBtus) in April 2020 to US$6.59 per MMBtu in April 2022.[26]

But Mexico's vulnerability to imported natural gas may increase further. It is at least possible that as more U.S. natural gas is shipped to Europe in the form of LNG to help Europe reduce its

[22] The Mexican government has indicated a strong interest in converting its extensive lithium potential into Li-ion battery production. Consensus among industry representatives is that it will be difficult to achieve in the short-term.

[23] Speech of President Andrés Manuel López Obrador at the Major Economies Forum on Energy and Climate | Secretaría de Relaciones Exteriores | Gobierno | gob.mx (www.gob.mx)

[24] https://www.whitehouse.gov/briefing-room/statements-releases/2021/11/18/fact-sheet-key-deliverables-for-the-2021-north-american-leaders-summit/ b) https://www.whitehouse.gov/briefing-room/statements-releases/2022/07/12/president-biden-and-president-lopez-obrador-joint-statement/)

[25] Secretaría de Energía, Prontuario Estadístico, Mayo 2022, p. 22; https://www.gob.mx/cms/uploads/attachment/file/736103/202205_Final.pdf.

[26] Secretaría de Energía, Prontuario Estadístico, Mayo 2022, p. 32; https://www.gob.mx/cms/uploads/attachment/file/736103/202205_Final.pdf.

dependency on natural gas from Russia, the U.S. supply of natural gas to Mexico could be subject to availability and pricing shocks.

In response, electricity derived from renewable sources could partially take the place of electricity from conventional generation that burns natural gas and other fossil fuels. One analysis calculated that 69% of all natural gas imported into Mexico was used for electricity generation.[27]To the extent that clean energy replaces natural gas as a source of electricity, this would reduce Mexico's dependence on imported natural gas.

Deeper Integration Will Foster Economic Development and Competitiveness.

Deeper integration between the electrical systems of the U.S. and Mexico, with a focus on renewable energy, will foster economic development in Mexico, particularly in the manufacturing sector. It will also increase the competitiveness of integrated U.S.-Mexico supply and co-production chains as against other economic blocs.

A key building block for increased economic development in Mexico is low-cost, reliable electricity. This is particularly important for manufacturing because electricity is an input in the manufacturing process, where cost and reliability are critical. Renewable energy meets this need.

As noted above, the global weighted average levelized costs of energy (LCOE) in 2021 for new utility-scale solar PV and on-shore wind was lower than the cheapest new fossil fuel-fired power generation option.[28] But Mexico can do better than the global weighted average LCOE. The winning bids in Mexico's final clean energy auction in 2017 averaged US$20.57 per Megawatt hour (MWh) for electricity from solar and wind – among the lowest prices ever bid internationally.[29] To ensure reliability, deeper integration between the U.S. and Mexican electrical systems can help to manage the intermittency and variability of renewable resources, together with other tools such as batteries and backup fast-ramp conventional generation.[30]

[27] J. McNeece, The Economic and Strategic Arguments for Renewable Energy in Mexico (2020), Institute of the Americas & Woodrow Wilson Center, Mexico Institute, https://www.wilsoncenter.org/sites/default/files/media/uploads/documents/The%20Economic%20and%20Strategic%20Arguments%20for%20Renewable%20Energy%20in%20Mexico.pdf

[28] IRENA, Renewable Energy Power Costs in 2021, p 5, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jul/IRENA_Power_Generation_Costs_2021_.pdf

[29] Secretaría de Energia, Comunicación de Prensa, November 22, 2017, "En la tercera Subasta Eléctrica mexicana se obtuvo uno de los precios más bajos internacionalmente: PJC," https://www.gob.mx/sener/prensa/en-la-tercera-subasta-electrica-mexicana-se-obtuvo-uno-de-los-precios-mas-bajos-internacionalmente-pjc.

[30] J. McNeece, The Economic and Strategic Arguments for Renewable Energy in Mexico (2020), Institute of the Americas & Woodrow Wilson Center, Mexico Institute, https://www.wilsoncenter.org/sites/default/files/media/uploads/documents/The%20Economic%20and%20Strategic%20Arguments%20for%20Renewable%20Energy%20in%20Mexico.pdf.

It is also important that the low-cost electricity provided will be ***clean*** energy. This is a selling point for attracting businesses to Mexico. A March 2021 study by the Energy and Climate Intelligence Unit (ECIU) and Oxford Net Zero found that, as of the date of the study, 21% of all companies in the Forbes Global 2000 list, representing sales of almost US$14 trillion, said they had made net-zero pledges.[31]

These companies will insist upon clean energy to meet their pledges. And if clean energy is not available, they will not come to Mexico. In November 2021, for example, Francisco Garza, CEO of GM Mexico, stated that if Mexico does not put in place conditions enabling investment in renewables, then Mexico won't be a destination for investment since GM would not be in a position "to meet our objective of having zero emissions in the long term."[32]

Clean energy is a selling point for investors as well. Blackrock, the largest asset manager in the world, has emphasized that sustainability-related factors will affect investment decisions. "The most significant of these factors today relates to climate change, not only in terms of the physical risk associated with rising global temperatures, but also transition risk – namely, how the global transition to a low-carbon economy could affect a company's long-term profitability. . . . [T]he investment risks presented by climate change are set to accelerate a significant reallocation of capital, which will in turn have a profound impact on the pricing of risk and assets around the world."[33]

In summary, clean, reliable and affordable energy will be an important competitive advantage for countries seeking investment from companies and the investors backing up those companies. Mexico can improve the likelihood of investments by major manufacturers and other companies by fostering renewable energy and deepening U.S.-Mexico grid integration to support renewables.

Fostering renewables and cross-border grid integration will also strengthen U.S.-Mexico supply chains and heighten the competitiveness of those supply chains against other economic blocs. The U.S.-Mexico-Canada agreement (USMCA), as the successor to NAFTA, facilitates U.S.-Mexico trade relations and building supply chains across the border. Those supply and co-production chains already exist. But the supply chains will be greatly impacted by the net zero movement. The type of power utilized in industrial operations is now crucial to how competitive businesses are and how easy it is for them to get capital. U.S.-Mexico supply

[31] R. Black, K. Cullen, B. Fay, T. Hale, J. Lang, S. Mahmood, S.M. Smith, "Taking Stock: A global assessment of net zero targets," Energy & Climate Intelligence Unit and Oxford Net Zero (2021), https://ca1-eci.edcdn.com/reports/ECIU-Oxford_Taking_Stock.pdf.

[3232] S. Angulo, "GM flags concern over renewable energy in Mexico, sees investment risk," Reuters, Novemnber 19, 2021, https://www.reuters.com/business/energy/gm-flags-concern-over-renewable-energy-mexico-sees-investment-risk-2021-11-20/. The GM Mexico CEO goes on to say that in such case, the "dollar that was going to be invested in Mexico will go to the United States, Brazil, China or Europe, and Mexico will no longer be a key destination."

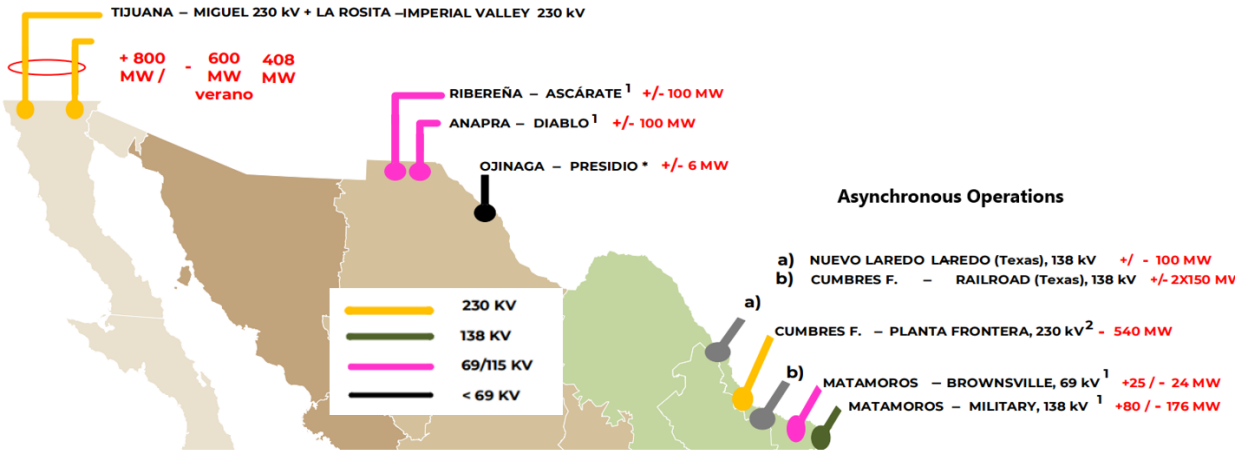
[33] Blackrock's 2020 Letter to Clients, "Sustainability as BlackRock's New Standard for Investing," https://www.blackrock.com/us/individual/blackrock-client-letter.

chains can benefit from low cost, reliable clean energy, derived from renewable energy sources supported by grid integration.

It is also noteworthy that with the current stresses between the U.S. and China, and the movement toward increased supply chain resilience coming out of the COVID-19 pandemic, there are great opportunities for nearshoring in Mexico, where U.S.-Mexico supply chains may well replace Chinese manufacturing, but the ability to seize these opportunities depends, once again, on the availability of low cost, reliable clean energy. The Inter-American Development Bank recently released a study highlighting Mexico's great advantages over other countries in the region for attracting nearshoring investment.[34]

Limited Interconnections between the U.S. and Mexico and Opportunities for Expansion

Transmission infrastructure between the U.S. and Mexico is currently very limited. The following map shows the principal transmission links between the two countries as of 2021, according to the Mexican Ministry of Energy (SENER).[35] The total capacity of 1,511 MW in northbound deliveries and 1,936 MW in southbound deliveries is not impressive given the size of both countries' installed utility scale generation capacity at the end of 2021: 1.14 million MW in the U.S.[36] and 86,000 MW in Mexico.[37]



1. Emergency links, operation with isolated load
2. Electric power plant physically in the U.S. and interconnected to the SEN with a Generator Interconnection Contract

\+ Exportation from Mexico
\- Importation into Mexico
* Distribution Circuit 13.8 KV

[34] Inter-American Development Bank, "Nearshoring can add annual $78 bln in exports from Latin America and Caribbean," June 2022 https://www.iadb.org/en/news/nearshoring-can-add-annual-78-bln-exports-latin-america-and-caribbean.

[35] S&P Market Intelligence. Prodesen 2019. Nera Analysis.

[36] U.S. Energy Information Agency, Electricity explained, Electricity generation, capacity, and sales in the United States, https://www.eia.gov/energyexplained/electricity/electricity-in-the-us-generation-capacity-and-sales.php.

[37] PRODESEN 2022-2036, Chapter 5, Cuadro 5.4, http://base.energia.gob.mx/prodesen22/Capitulo5.pdf.

The California transmission grid is already linked and synchronized with the grid of Baja California, within the regulatory framework of the Western Electricity Coordinating Council (WECC). As indicated in the map above, the transmission link between the two grids is rated at 800 MW northbound and 600 MW southbound. However, the Baja California grid is not linked with the electrical system for the rest of Mexico, the National Interconnected System (*Sistema Interconectada Nacional* or "SIN") so California's linkage with Baja California does not provide a further pathway into the SIN.

There are also a series of privately owned transmission links across the California-Baja California border for the export of electricity from generation facilities in Baja California to the California grid, without passing over the Baja California grid. These private transmission links are not shown on the interconnection map above.

The opportunities for expansion lie in (1) an increased number of private dedicated transmission lines across the border to support Baja California renewable energy projects selling clean energy to California utilities to meet the utilities' RPS obligations, and (2) additional capacity over the existing interconnect, known as WECC Path 45, which links the synchronized California and Baja California grids.

Unlike the case with California and Baja California, ERCOT in Texas is not directly linked to the Mexican grid and the two grids are not synchronized. This means the grids cannot be operated together. According to the SENER map above, there are nine principal interconnections over the length of the Texas-Mexico border, as follows:

- Four emergency interconnections, which require disconnection from the home system before connecting with the system on the other side of the border.

- Three asynchronous interconnections, which require special technology to link the non-synchronized transmission grids in Texas and Mexico, consisting of either back-to-back high voltage direct current (HVDC) connections or connection via a variable frequency transformer (VFT); of the three links, 2 have 150 MW capacity and one has 100 MW capacity.[38]

- A dedicated export interconnection, which links the Frontera Generation 540 MW power plant in Texas directly to the Mexico grid; this plant was developed solely to export electricity to Mexico. [39]

[38] See DOE Presidential Permit PP-285, Sharyland Utilities, L.P., January 21. 2005 (Cumbres F – Railroad (TX) / HVDC, 138 kV); DOE Presidential Permit PP-423, AEP Texas, Inc., February 13, 2017 (Nuevo Laredo-Laredo/VFT, one 230 kV line operated at 138 kV and one 230 kV line, operated at 230 kV).

[39] https://www.proyectosmexico.gob.mx/proyecto_inversion/561-cenace-subasta-electrica-de-largo-plazo-planta-frontera-06pft-pta/.

- A small interconnection owned by the Mexican power company CFE, with only 6 MW of capacity for exports and imports.

This system of interconnections presents only a starting point for expansion, since the bi-directional asynchronized interconnections -- the primary links between the grids on each side of the border – have only 400MW of capacity. More capacity, probably through additional asynchronous interconnections, will be needed to deepen integration between ERCOT and Mexico.

Potential Next Steps

Export-Only Renewable Energy Projects in Baja California

Building export-only renewable energy projects in Baja California to help California utilities meet their RPS obligations is an attractive, short-term opportunity. California utilities will be planning soon how to meet their 2026 and 2030 obligations. Pursuing this opportunity means the development of suitable export-only renewable energy projects in Baja California. The following are potential first steps:

- Identify prospective sites in Baja California based on the quality of the available solar or wind resource and access to the border, and obtain site control.

- Evaluate the availability of access on an existing dedicated transmission line across the border or identify the necessary steps to build a new dedicated transmission line, including obtaining a Presidential Permit.[40]

- Develop a financial analysis on what price might be charged for electricity from the site, taking into account the quality of the solar or wind resource at that site and the cost of cross-border transmission and interconnection with the California grid.

- Confirm the export opportunity by seeking power purchase agreements with one or more California utilities for the renewable energy to be generated by the Baja California project, based on the anticipated pricing.

[40] U.S. presidential permits are required for the construction, connection, operation, and maintenance of certain facilities that cross the United States' borders with Canada and Mexico. Issuance of permits for electricity transmission lines and associated facilities is delegated to DOE.

Mexico to Pursue Northern Baja California Participation in the Western Energy Imbalance Market

The Western Energy Imbalance Market (WEIM) includes numerous balancing authorities across the western U.S. and western Canada.[41] It manages "fluctuations in supply and demand across the WEIM footprint by automatically finding lower-cost resources to meet real-time power needs."[42] The WEIM provides a ready-made wide-area generation network to which Baja California would have access if it were a participant.[43] Such access could provide backup power to help with the intermittency and variability of Baja California's planned renewable resources, and otherwise meet electricity shortfalls, all at the lowest available price. Baja California could also sell any excess power into the WEIM.

Since the grid in northern Baja California is already synchronized with the California grid, and that grid is part of the WECC, Mexico has an opportunity for northern Baja to apply to be a participant in the WEIM. The Mexican electric system operator, the Centro Nacional de Control de Energía or CENACE, announced in 2016 that it would explore participation by Baja California in the WEIM.[44] It should renew its exploration of WEIM participation.

Mexico and Texas to Evaluate Additional Links between ERCOT and the SIN

Texas and Mexico could both benefit from increased electricity trade across the border. But that will require deeper integration between Texas' ERCOT and Mexico's SIN, and expanded interconnections across the border.

A key issue in planning for increased transmission capacity between ERCOT and the SIN is Texas and ERCOT's determination ***not*** to be subject to the plenary jurisdiction of the U.S. Federal Energy Regulatory Commission (FERC).[45] FERC has ruled that the current asynchronous interconnections between ERCOT and Mexico, and transmission of electricity over those connections, do not cause ERCOT or the owners of the interconnections to be subject to FERC plenary jurisdiction.[46] That decision, however, makes clear that it pertains to transmission service over the asynchronous ties between ERCOT and Mexico that are "pre-existing and in operation."[47] Accordingly any ***new*** transmission capacity between ERCOT and Mexico could raise a problem and would require careful analysis.

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[41] https://www.westerneim.com/pages/default.aspx.

[42] WEIM, "How it Works," https://www.westerneim.com/Pages/About/HowItWorks.aspx.

[43] WEIM, "How it Works," https://www.westerneim.com/Pages/About/HowItWorks.aspx. See also WEIM Fact Sheet, https://www.westerneim.com/Documents/WEIM-2-Billion-in-Benefits-Fact-Sheet.pdf

[44] Marketwired release, October 18, 2016, "Mexico grid operator CENACE to explore EIM participation for Baja California Norte," https://finance.yahoo.com/news/mexico-grid-operator-cenace-explore-170100158.html.

[45] http://www.ercot.com/mktrules/issues/NPRR861#background.

[46] AEP Energy Partners, Inc., 164 FERC 7 61,056 (2018). A copy of this decision is attached to the comments of Sharyland Utilities, L.L.C. on DC ties, filed September 3, 2021, in the PUC-Texas Project No. 52373 "Review of Wholesale Market Design." https://interchange.puc.texas.gov/Documents/52373_80_1151585.PDF.

[47] Id.

Subject to this regulatory constraint, Texas and Mexico would benefit by pursuing the following steps to consider deepening the integration between ERCOT and the SIN. Each side should:

- Evaluate its own generation plans and determine to what extent it could benefit from electricity exports and/or imports across the border.

- Evaluate the flexibility and carrying capacity of the existing HVDC and VFT interconnections between ERCOT and the SIN.

- Work through the regulatory issues, particularly with respect to potential FERC plenary jurisdiction, which could arise in building additional cross-border transmission capacity.

- Coordinate in development of a strategic plan for increased cross-border trade in electricity, a feasibility study for construction of the corresponding new interconnections and transmission lines, and a financial model for the additional interconnection and transmission capacity, including both costs and benefits.

- With the foregoing information, evaluate whether the necessary additions to capacity could be financed and how such additions would be built.

Synchronization of the U.S. and Mexican Grids

The ultimate step for integration of the U.S. and Mexico electrical systems would be to directly link and synchronize the two systems.

There are major issues with ERCOT's determination not to be subject to FERC plenary jurisdiction since full synchronization would fully link ERCOT with other states of the U.S. and subject ERCOT to such FERC jurisdiction. But a starting point would be for Mexico to link the Baja California grid to the SIN and synchronize those two systems. By that means, the California grid and hence the entire Western Interconnect would be linked with Mexico. ERCOT could still maintain its distance from Mexico and the Western Interconnect by continuing to insist on asynchronous interconnects with Mexico (which it also maintains with the Western Interconnect and the Eastern Interconnect).

Synchronization between the U.S. and the Mexican electrical systems, or at least the California grid / Western Interconnect with the Mexican electrical systems, would be a major undertaking. To pursue this opportunity, Mexico and the U.S. should undertake the following initial steps:

- Mexico and the North American Electric Reliability Corporation (NERC) should deepen their engagement. Any discussion of grid integration between the U.S. and Mexico must include NERC– the body responsible for overseeing the reliable operation of the

interconnected electric grid for the U.S.[48] NERC's long-term strategy includes working with Mexico toward integration as connections with the North American grid occur.[49] NERC entered into an MOU with CENACE and Mexico's *Comisión Reguladora de Energía* (CRE) for this purpose in 2017 with the objective of fostering continued growth of the cooperative relationship between Mexico and NERC to enhance reliability.[50] NERC and Mexico should accelerate their discussions to deepen Mexico's ties with NERC.

- Mexico should engage more fully with the North American Renewable Integration Study (NARIS), undertaken by the U.S. National Renewable Energy Laboratory (NREL), discussed above. To date, NREL has prepared reports only from a U.S. perspective,[51] and from a Canadian perspective.[52] It would be fruitful to seek a report from a Mexican perspective, including an analysis of deeper cross-border interconnection linkages between the U.S. and Mexico.

Conclusion

Deepened integration between the U.S. and Mexican electrical systems would support a transition to clean energy, enhance reliability and reduce costs for both the U.S. and Mexico. This in turn will make the U.S.-Mexico manufacturing platform more competitive in the world market and would facilitate nearshoring in the U.S. Mexican and U.S. manufacturers would benefit enormously, as would citizens with more reliable near-shore supplies.
Moreover, leveraging the abundance of renewable energy resources in both countries would be critical to companies and governments as they pursue Net-Zero targets. Access to clean, reliable and affordable electricity will be essential to expansion of supply chains, manufacturing and competitiveness. Enhanced integration between the U.S. and Mexican electrical systems is a necessary foundation to make this happen.

[48] https://www.nerc.com/AboutNERC/Pages/default.aspx.

[49] NERC, "ERO Enterprise Long-Term Strategy," approved December 12, 2019. https://www.nerc.com/gov/Annual%20Reports/ERO%20Enterprise%20Long-Term%20Strategy%20(Approved%20December%2012,%202019).pdf

[50] NERC 2017 Annual Report, pp. 6, 13, https://www.nerc.com/gov/Annual%20Reports/2017%20Annual%20Report.pdf. A copy of the text of the MOU (English version) may be found at https://www.nerc.com/AboutNERC/keyplayers/Documents/MOU%20Clean%20NERC_CRE_CENACE_EN%20FINAL.pdf. See also the "Principles to Promote the Reliability and Security of the Interconnected Power Systems of the United States of America and the United Mexican States," dated January 7, 2017, which provides for implementation through NERC. https://www.energy.gov/sites/prod/files/2017/01/f34/Principles%20to%20Promote%20the%20Reliability%20and%20Security%20of%20the%20Interconnected%20Power%20Systems%20of%20the%20U.S.%20and%20Mexico%20%28English%29_1.pdf.

[51] See The North American Renewable Integration Study: A U.S. Perspective, NREL Technical Report (2021), https://www.nrel.gov/docs/fy21osti/79224.pdf; The North American Renewable Integration Study: A U.S. Perspective — Executive Summary, NREL Technical Report (2021), https://www.nrel.gov/docs/fy21osti/79224-ES.pdf.

[52] See The North American Renewable Integration Study: A Canadian Perspective, NREL Technical Report (2021), https://www.nrel.gov/docs/fy21osti/79225.pdf; The North American Renewable Integration Study: A Canadian Perspective — Executive Summary, NREL Technical Report (2021), https://www.nrel.gov/docs/fy21osti/79225-ES.pdf.