KNOW BEFORE YOU GROW:

The Energy Guide for New Industrial Plants in Mexico

BURNS McDONNELL

WHY THIS ENERGY GUIDE?

Recent changes in Mexican energy regulations are causing long delays in projects to build new industrial plants. This is mainly due to the complexity of maneuvering through the permitting and technical processes with various government agencies, in a certain sequence, with new requirements. The key to a successful project is a well-managed grid connection process, aligned with the plant's on-site energy plan.

BACKGROUND

Since Mexico started implementing energy reform in 2013, its electricity industry has been gradually opening to private investment and becoming a competitive market.

This new market bases some of its rules in part on U.S. independent system operators (ISOs) and regional transmission organizations (RTOs) like PJM, ERCOT and California ISO. Some provisions are designed to accommodate the fact that there is a major existing giant: CFE (Comision Federal de Electricidad), the government-owned, countrywide utility that has 54% of the generation market and owns all of the public transmission and distribution grids.

The electricity reform split the market into two kinds of new users:

- Smaller loads (less than 1 MW in demand) called "Usuarios Basicos," or Basic Users, and
- "Usuarios Calificados," or Qualified Users (1+ MW in demand), roughly equivalent to direct access loads in the United States.

Basic Users are served by a Basic Supply company — mainly CFE — while Qualified Users must look for a Qualified Supplier, of which there are more than 20 in the country.

The price of electricity coming from Basic Suppliers to Basic Users is regulated by the Energy Regulatory Commission (CRE), which has national reach and is equivalent to the Federal Energy Regulatory Commission in the U.S.

CRE is the only regulatory commission for electricity and supply of fuels. And there is only one electricity dispatch and system operator, Centro Nacional de Control de Energia (CENACE).

KEY CONSIDERATIONS WHEN BUILDING A NEW PLANT IN MEXICO

For an industrial company planning to build a new plant, several factors must be considered with respect to electricity supply:

1. Distance from the grid.

Being far from CFE's substation means that the user most likely will need to build a transmission line from its facility to the substation. This can be costly in terms of capital expenditures, but it also means having to deal with right-of-way and land management issues, including public engagement and cultural resources management.

2. Availability of electricity supply in the region.

Major cities bring advantages of availability of labor and other services, but in Mexico that can also mean restricted availability of electricity for a major load. Inner city distribution circuits may already be close to their capacity limit, and that could prevent the utility from allowing a new load, denying service for a new connection.

3. Price of electricity.

The creation of a competitive market in Mexico allowed more companies to offer a supply of electricity in both behind-the-meter and distance solutions. Relying solely on CFE for supply would not necessarily be the right solution. The optimal price would come from comparing alternatives from different companies; lower prices may be important for an operation with high consumption of electricity.

COMMITMENT TO SAFETY AND COMPLIANCE

Safety always comes first. Maintaining that objective depends on prioritizing its importance, planning ahead to avoid risks and paying close attention to the details. We make safety part of our requirements in everything from recruiting and training through management. That dedication knows no borders; safety is just as important to us in Mexico as it is in the United States. We obey the laws of the land, and our objective is to see that everyone who works with us is able to go home safe at the end of each day.

Compliance with best practices in proper business behavior is integral to our corporate culture. In Mexico, we adhere to Mexican laws, the U.S. Foreign Corrupt Practices Act, our own code of ethics and common sense. No cutting corners, no shortcuts: Compliance is foundational to our internal processes and requirements. We are at home wherever we work, and we keep our home neat and tidy.

4. Reliability of electricity supply.

Even if the price is right, no company that generates electricity can guarantee that there will be no service outages. This is typically due to problems in the transmission or distribution assets. CFE is the owner and operator of the grids in Mexico, and as in any system, outages anywhere are typically caused by problems in the grid.

5. Quality of electricity supply.

Sometimes availability is there, but quality may not be sufficient. Minor variations in voltage can be problematic to address depending on the site, and they can pose a major problem for sophisticated equipment and operations. Again, no power generation company can guarantee the quality of supply, as none of them — not even CFE generation companies — has control over what happens in the grid. For any operation depending on the quality of electricity supply, voltage drops in the electrical system need to be addressed.

6. Compliance with clean energy consumption mandates.

Mexican laws have mandated a percentage of electricity consumption to come from clean energy sources. Some of these sources are common, such as wind, solar and hydro, while others are atypical, like nuclear and a portion of the output of efficient cogeneration facilities. The first national target is to have 35% of all electricity consumption be from clean energy sources by 2024. However, there are already percentage targets in the lower 20s that current loads must comply with.

BOTTOM LINE

When building a new industrial plant in Mexico, a well-managed grid connection process, aligned with the plant on-site energy plan, is critical to avoid costly surprises and delays.

Burns & McDonnell understands the technical and local regulatory challenges industrial owners face. Not only are we the leading power infrastructure engineering and EPC firm in the U.S., as ranked by *Engineering News-Record*, but we also established a permanent presence in Mexico in 2016. Two years later, we became one of the few firms in the country certified by CENACE, with direct access to the national electric grid for interconnection studies.

We have developed this road map for clients to help define and manage the complex permitting and technical processes required. **We have the local capability to design and build your plant's energy solution so your industrial operation can be competitive, sustainable and reliable, with the right energy infrastructure in place.**

WHO'S WHO

With the reform of the Mexican electricity sector, a new electricity market and new roles for its participants have been established. Private generation companies can invest in supplying electrical energy to the market, and customers can shop and negotiate with suppliers. The national electric utility owned by the Mexican state is now just one participant in supplying energy to customers, although it remains the sole owner and operator of the country's transmission and distribution system.

Roles for operating and regulating this newborn market and its participants is distributed among several players.

CFE: The Federal Electricity Commission (Comision Federal de Electricidad) is Mexico's state-owned electric utility. It owns, operates and maintains the transmission and distribution system. Its general director is appointed by the Mexican president. To receive a permanent electrical supply, industrial clients must connect to CFE's grid and can then purchase power from CFE or from several qualified suppliers. CFE determines what infrastructure is required to interconnect to the grid, and the client can hire CFE or a third party to build it. All interconnection works, including switching stations and transmission lines, must be ceded to CFE to own and operate. *cfe.mx*

CRE: The Energy Regulatory Commission (Comision Reguladora de Energia) is a governmental regulatory agency. Its commissioners are appointed by the president and approved by the senate. Its tasks include drafting regulations such as the Mexican grid code and overseeing compliance. To connect to the national electricity grid, the load center (industrial plant) needs to comply with the requirements stated in the grid code. These are technical operability requirements that protect and guarantee the quality and reliability of the electric power, including such elements as power factor, harmonics and frequency deviation. *gob.mx/cre*

AGENCY ENGAGEMENT THROUGHOUT PLANNING AND PROJECT DELIVERY

- PLANNING AND FEASIBILITY
- CONNECTION REQUEST
- PERMITS AND LICENSES
- ENGINEERING, PROCUREMENT AND CONSTRUCTION
- ENTRANCE INTO COMMERCIAL OPERATION

CONNECTION REQUEST
- Impact study (CENACE)
- Facilities study (CFE)
- Connection contract (CFE)

PERMITS AND LICENSES
- Environmental impact study (SEMARNAT)
- Non-affectance of water bodies (CONAGUA)
- Non-affectance of archaeological sites (INAH)

ENGINEERING, PROCUREMENT AND CONSTRUCTION
- Approval of engineering (CFE)
- Standby letter of credit (CFE)
- Cession contract (CFE)
- Delivery-reception agreement (CFE)

ENTRANCE INTO COMMERCIAL OPERATION
- Validation of technical requirements (CFE)
- Certificate of compliance (CFE)
- Acceptance of entrance into commercial operation (CFE)

CENACE: The National Center for Energy Control (Centro Nacional de Control de Energia) is Mexico's power system operator and market operator. Its general director is appointed by the federal Secretary of Energy (SENER). CENACE is responsible for conducting system planning, interconnection planning, contingency and stability analysis. A new load center hoping to connect into the national electricity grid must request two studies from CENACE: a system impact study to determine the overall impact to the system from the new connection, and a facilities study to determine any necessary grid infrastructure upgrades before connecting into the national grid. CENACE also acts as the market operator by running the day-ahead, intraday and real-time electricity markets. *gob.mx/cenace*

CONAGUA: The National Water Commission (Comision Nacional del Agua) is Mexico's water sector regulatory agency. Its commissioners are appointed by the president, and the agency is tasked with water protection and allocating water reserve rights. *gob.mx/conagua*

SEMARNAT: The Department of Environment and Natural Resources (Secretaria de Medio Ambiente y Recursos Naturales) is a department at the federal level, and its head is part of the federal executive cabinet. SEMARNAT is in charge of protecting the environment and regulating industrial and commercial activity that affects natural resources. The department's environmental impact studies are required for any type of development in Mexico. *gob.mx/semarnat*

Other government departments and agencies that project teams sometimes need to interface with, depending on the route of the transmission line and location of the project, include:

- **SCT:** Department of Transportation and Communication (Secretaria de Comunicaciones y Transportes) *gob.mx/sct*
- **INAH:** National Institute of Anthropology and History (Instituto Nacional de Antropologia e Historia) *inah.gob.mx*
- **PEMEX:** Petroleos Mexicanos *pemex.com*

ON-SITE ENERGY TECHNOLOGIES

A critical part of the development of a new industrial facility is the selection of its energy infrastructure, including power generation and/or storage.

The following is a high-level list of power generation and storage technologies that industrial decision-makers should be aware of when defining their capital investment plans. Considerations should be based on such factors as their manufacturing process needs and facility services needs like power, water, air and steam.

Combustion turbine generators (CTG)

- High thermal-to-energy ratio
- Ideal for thermal-intensive (steam) processes — cogeneration
- Dual fuel options (natural gas and diesel)

Reciprocating internal combustion engines (RICE)

- Low thermal-to-energy ratio
- Ideal for less thermal-intensive (hot water) processes — cogeneration
- More economical for electric power-only generation

Solar photovoltaics (PV)

- Ground-mounted
- Rooftop

Battery energy storage systems (BESS)

- Customizable power-to-energy ratio
- Combination with solar PV
- Outage ride-through
- Peak shaving

Microgrids

- Combine any or all of the aforementioned assets
- Fully integrated with facility electrical distribution system
- Operable connected to the grid for energy efficiency
- Operatable while islanded (off-grid) for reliability — utility outage mitigation

Other possibilities

- Fuel cells
- Geothermal
- Microturbines

GRID CONNECTION PROCESS

Connecting an industrial project to the Mexican national electric system for electric supply presents unique challenges, compared to connecting a project in the United States. It requires significant initiative from the industrial project owner to advance and complete the various necessary administrative, technical and legal activities. The procedures, timing and costs of the connection process are published in the "Manual for the Interconnection of Power Plants and Connection of Load Centers," but they require experience and strong local representation to execute in a timely manner.

After proper due diligence, project siting and determination of the consumption needs of the industrial plant, a **connection request** for the project is filed with CENACE. For industrial users looking for reliable service from the transmission system, the following procedures apply, though they vary depending on the megawatt consumption requirements of the facility. The applicant initiating the connection request is required to be a Mexican company, and it must submit a series of technical documents, from conceptual engineering design drawings to a plant equivalent model in PSS/E.

Upon acceptance of the project technical information and payment, CENACE will first conduct an **impact study**: a power flow study that analyzes the impact of the industrial user on the grid under normal and contingency conditions, according to the Mexican grid code requirements.

The grid code is a set of regulatory technical documents that establishes connection and operational requirements to ensure the efficiency, quality, reliability, continuity and security of the national electric system. The regulations have been issued by the CRE and apply to all control regions in Mexico.

Once the study is complete, CENACE will deliver a report that outlines the required physical infrastructure for the project to connect to the grid, as well as the infrastructure required to mitigate any impacts from the project. Examples of the required infrastructure could include a new substation, a transmission line and network upgrades, such as reconductoring nearby transmission lines and updating communications and protections at neighboring substations.

Once the study results are accepted by the applicant, CFE Transmission will conduct a **facilities study**, which further details the requirements for the connection. This can include major equipment specifications, protection, control and metering requirements, as well as communication requirements. CFE also provides a cost estimate for the design and construction of the infrastructure. This facilities study report will serve as the basis for the connection contract with CFE Transmission.

Finally, after the study results are accepted by the applicant, the **connection agreement** will be signed with CFE Transmission. At that time, a **letter of credit** is due to guarantee the construction of the connection infrastructure according to the contract.

From start to finish, an industrial user can expect that the connection request process to take about six months to complete. The studies are often the critical path item in the overall project schedule, as they finalize the feasibility of the entire project and depend on a third party to complete. Proper representation during the connection request is critical.

PROJECT DELIVERY

Considerations for the delivery of the project are of utmost importance since the project is the means for delivering the power to the facilities. Large amounts of effort, time and capital resources will be needed to fulfill this endeavor, and it is important to secure the investment of the organization from the very beginning.

The first consideration involves the project delivery method, and this depends heavily on the project execution and management in-house capabilities the organization already has. An organization with a robust in-house project team most likely will only need to contract project execution services out — e.g., design-build, engineer-procure-construct (EPC), project development consultants — while an organization with less robust project management capabilities might also need to consider contracting a project management agent to lead the project on the organization's behalf.

The next consideration is the project strategy. While industries implement many different strategies, the following scheme with two main phases is recommended, in accordance with best practices developed by associations that have researched project performance — the Construction Industry Institute (CII), the Association for the Advancement of Cost Engineering (AACE) and Independent Project Analysis (IPA) — and from practical experience at Burns & McDonnell.

Phase 1: Project development.

This stage defines the project scope and develops the project site. Primary tasks during this phase include:

- Performing conceptual and basic engineering design (IFB documents).
- Developing project schedule.
- Developing project cost estimate.
- Running permitting processes.
- Performing site studies.
- Procuring long-lead items.
- Procuring execution services.

Phase 2: Project execution.

In this phase, the project is executed according to the plans developed during the previous phase, continuing through commissioning and startup. Main tasks during this phase include:

- Performing detailed engineering design (IFC documents).
- Procuring remaining items.
- Constructing facilities and installing permanent and provisional items.
- Performing tests on completed systems and facilities.
- Starting facility operations and testing their performance for final acceptance and turnover to operations and/or the utility.

Project Development

This first phase is paramount to the success of the project. Accordingly, the organization must make sure project development is set up appropriately.

Besides appointing the right people to this phase and defining the execution strategy, it is important to follow the appropriate methodology. One proven methodology guiding organizations to successful outcomes is front-end planning, or FEP. This methodology defines a series of typically three stages that go through a gate process at the end of each one to define the project scope and develop the project site. The core concept of this methodology is that as the project matures, the execution plan and cost estimate become increasingly certain, helping the project avoid cost and schedule overruns.

Generally speaking, the first stage of FEP is to define the project concept and alternatives to meet project objectives. The second stage is to select a concept, study the site and run permitting. The third stage is to develop the project scope and seek out execution services. **Burns & McDonnell has developed an FEP methodology based on industry principles and best practices; further details are available upon request.**

Some considerations to keep in mind during this phase:

- The project to connect a power supply to an industrial facility is secondary to development of the industrial facility itself. It must be remembered that the serviced facilities' power demand and redundancy requirements will drive the objectives of the power supply project, which must adjust accordingly.
- Since connecting to all utilities is part of the facility project, these processes will loom large in defining the project scope and, therefore, the cost and timing. The process to connect to the electric grid is of special consideration.
- Oftentimes, the role of developing and advancing the project cost estimate and schedule is overlooked by the organization or left to the execution bidders to define. This can be a costly mistake, because the cost estimate and the schedule are bases on which to evaluate and approve the funds for a project, not to mention managing expectations of the bids. It is fairly common in the industrial world for organizations to underestimate the cost and time to execute this type of project. This becomes a challenge to acquiring the services for the execution phase.

Design-Build/EPC

As mentioned previously, the execution of a project heavily depends on the outcome of the development phase, in which the organization also needs to define the execution strategy for the scope breakdown of execution services. Put another way, the organization must define whether to contract a single design-build or EPC contractor, or to develop separate contracts for design and construction. This decision depends on the organization's in-house or agent's capabilities to perform detailed engineering design, and on the potential execution contractors' experience in working with the utilities.

The involvement of the utilities must be taken in account throughout the entire project, especially if any of the constructed facilities will be turned over to them. In the case of the electric utility, the CFE most likely provided some input in the CENACE study. The CFE also must approve the design and supervise construction in order to provide its acceptance of facilities it will own and operate at the end of the project; this should be managed as part of the grid connection process.

Commissioning/Startup

Along with the facilities' commissioning and startup, turnover to operations is of utmost importance. It is vital to the success of the project to clearly understand the turnover procedures of each utility. Beyond the required information that is produced throughout the project, the organization will need to confirm that the facilities comply with the utilities' performance requirements, just as facilities owned by the organization must comply with its internal performance requirements.

Therefore, the ideal execution service provider should have enough experience working with these utilities to secure turnover success.

LET BURNS & McDONNELL BE YOUR GUIDE

To avoid costly surprises and delays when building new industrial plants in Mexico, a well-managed grid connection process aligned with the plant's on-site energy plan is of utmost importance.

We at Burns & McDonnell understand the technical and local regulatory challenges industrial owners face and have the practical experience to show you the way.

Our road map guides your project to define and manage the complex permitting and technical processes required. And we have the local capability to design and build your plant's energy solution so your industrial operation can be competitive, sustainable and reliable, with the right energy infrastructure in place.

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CREATE AMAZING.

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