POWER GENERATION

WHITE PAPER

# Power Demand for Industrial Facilities:

## PLANNING ONSITE POWER GENERATION WITH NATURAL GAS

CANUSA EPC

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## SUMMARY


Power planning for industrial facilities in North America is a critical component of project success and long-term operational efficiency. When selecting power solutions, facility operators face various challenges: balancing upfront capital expenditures (CapEx) with long-term operational costs (OpEx), ensuring power reliability in harsh environments, and designing systems that can scale with changing production demands. As utility connections become more costly and interconnect delays stack up, onsite power generation with natural gas fuel is becoming more attractive.

By integrating these insights, facility operators can make informed decisions that minimize risk, optimize costs, and ensure reliable, scalable power solutions for industrial infrastructure.

- Power generation solutions have varying CapEx due to reliability and installation costs
- Natural gas pricing contributes to 80% of the operating cost of the facility
- Planning for peak site demand can allow for savings over the long term


## HIGHLIGHTS

- **Compare generation cost based on driver of the genset -** consider reciprocating engines, single cycle turbines, and combined cycle power plants
- **Develop full total cost of ownership** - balance the cost of reliability and efficiency with total investment costs

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# Introduction

**Power System Projects By CANUSA EPC: canusaepc.com/onsite-power-generation/**

Critical path for industrial infrastructure projects are focusing around power systems. Ensuring that power capacity will be available for the startup of the facility as well as the investment plan for the power system are requiring as much focus as the mechanical systems and processing equipment. On top of the increasing importance, trends toward electrification and growing interconnect queues for power is increasing the cost and lead time for generation equipment.

One of the solutions that is seeing strong consideration to solve the demand for increased electricity is that of onsite power generation. Operators are considering building their own power generation assets that may be collocated onsite for their facility or developing agreements with 3rd parties to supply power over a long term contract, Purchase Power Agreement (PPA). Understanding and incorporating the costs for these power assets is critical in ensuring the overall project goals are achieved.

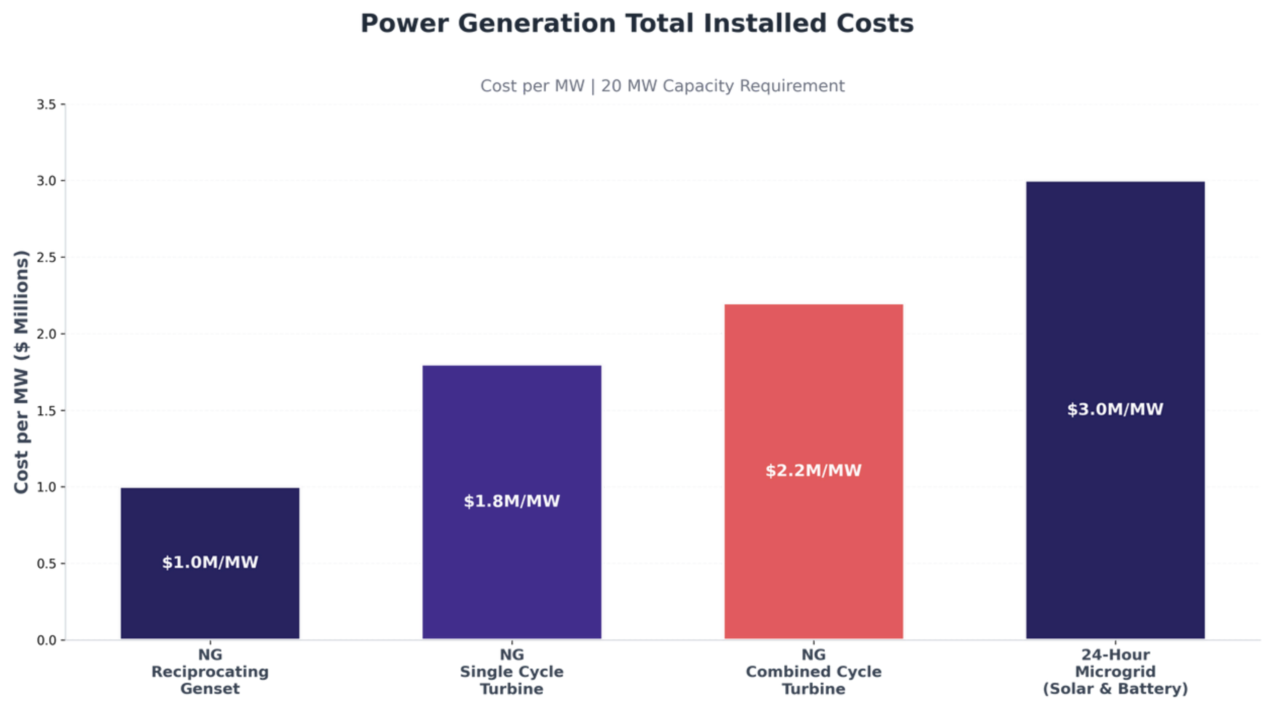
In this technical document, CANUSA EPC will share key metrics to support the evaluation of the correct power deployment strategy for your project.

## Aligning CapEx and OpEx for Power Generation

When planning power systems for industrial facilities, operators face a critical trade-off between Capital Expenditures (CapEx) and Operational Expenditures (OpEx):

### Upfront Capital Costs (CapEx):

These include the purchase and installation of generators, transformers, switchgear, and supporting infrastructure. The total installed cost for a power solution needs to account for the generator as well as the cost to land and install the units. For onsite power generation we see the following base line costs per unit of capacity for 24 hour power service.



## Long-Term Operational Costs (OpEx):

Operating costs cover fuel consumption, maintenance, spare parts, and operations labor over the life of the system. Cheaper systems may have lower CapEx but can lead to:

- Higher fuel costs due to poor efficiency
- Frequent maintenance and unplanned repairs
- Downtime costs if reliability is compromised

**INDUSTRY METRICS**

**Thermal Efficiency of Generators**

**Natural gas fuel cells 6000 BTU/kWh,**

**Reciprocating engines 7600 BTU/kWh,**

**Single cycle turbine units 9,000 BTU/kWh.**

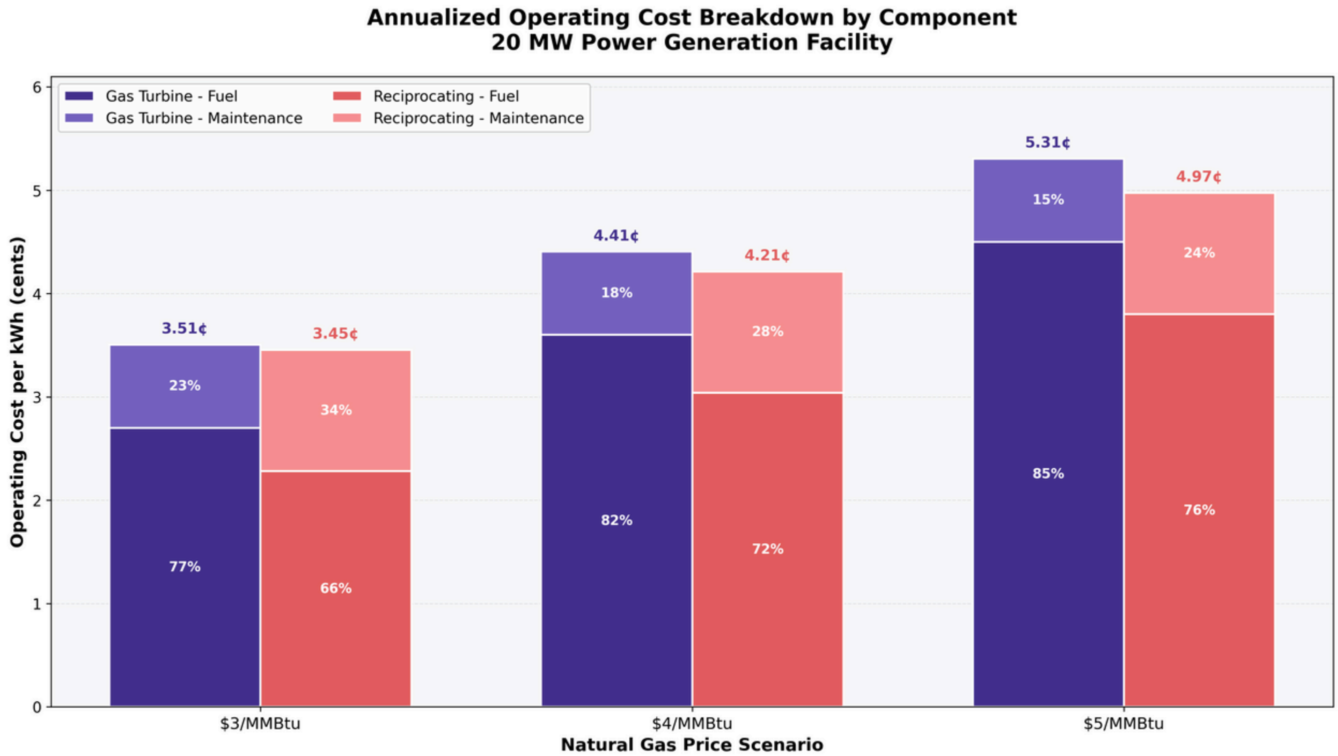
## OpEx Exposure to Natural Gas Pricing

When considering OpEx projection models for the generators there are two major costs associate with each unit:

- Fuel costs due to thermal efficiency of the unit
- Maintenance costs associated with the generator (oil, water, head swings, rod replacements, zero hour overhauls, etc)

CANUSA EPC generated a cost model for a reciprocating engine site compared to a turbine unit for 20 MW of generation with the following considerations.

- Various gas price scenarios are analyzed
- 5-year annualized maintenance cost for the units are estimated

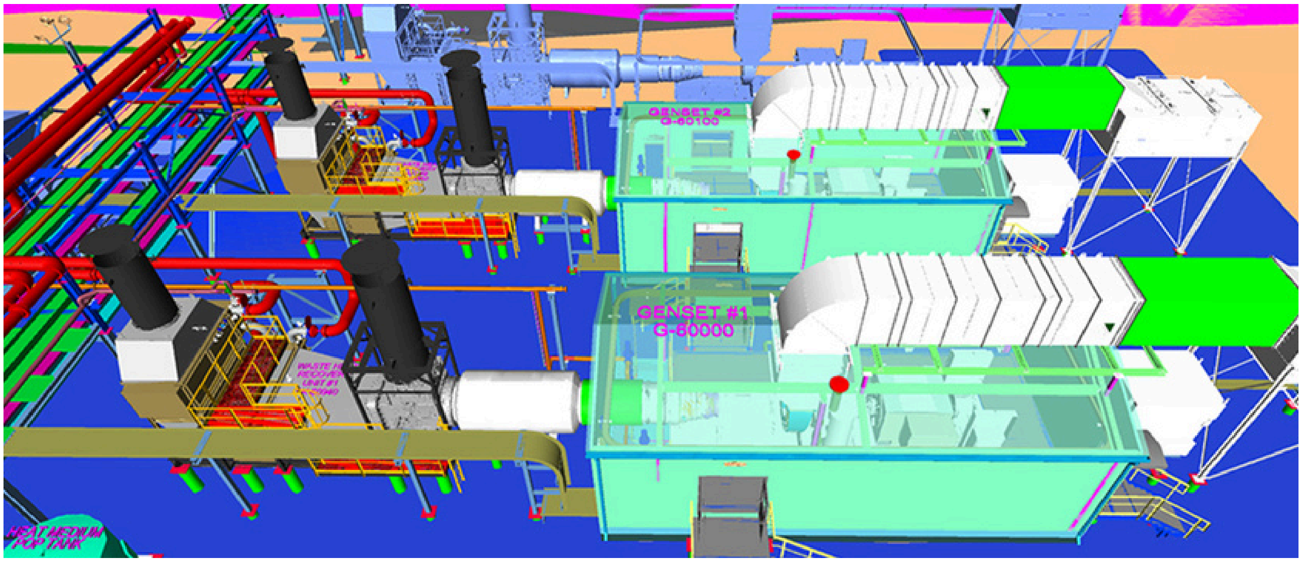



### CANUSA EPC INSIGHT

- **Reciprocating engines have a higher OpEx for maintenance compared to turbines, but gas pricing exposure will make reciprocating engines a lower operation cost solution**
- **Larger facilities will tend to deploy turbines due to their longer operation periods, increasing the amount of power availability and reliability beyond those of reciprocating engine sites**

## Future Considerations: Waste Heat Recovery for More Efficiency with Turbines

As clients evaluate future power needs, the attractiveness of increased output from existing sources is becoming attractive both from a permitting perspective and de-risk strategy.  Waste heat recovery in applications is a solution in retrofit and greenfield facilities to improve the output of energy from the high value heat exhaust of a turbine. These projects require an analysis that is reliant on emissions improvements and burner fuel offsets that improve overall power output from the unit.  Although each installation is specific to the facility layout and process heat needs, it is best to consider these options upfront to ensure that turbine performance and site operations can incorporate the future waste heat recovery plan.




**WASTE HEAT RECOVERY DESIGN FROM TURBINE EXHAUST**

# MEETING RELIABILITY AND AVAILABILITY

Power generation assets will have reliability and availability considerations that are either contractually required or directly impact the amount of revenue that a facility can generate.  This can be incorporated into a high capacity charge for the power or even used as a contract differentiator for competitive development opportunities.

## Reliability Designation through Tiering

Remote facilities often operate far from established infrastructure, where grid power is either unavailable or subject to frequent outages. In these conditions, power reliability becomes mission-critical because:

- Production Losses: Even short outages can halt production, whether it is the flow of a product, compression equipment to move gas, or compute processes for datacenters.  No power means no revenue.
- Safety Risks: Power failures can disable critical systems such as emergency shutdowns, heating, and monitoring equipment.
- Logistical Challenges: Repair crews and spare parts may take days to reach remote sites, amplifying downtime costs.

## Defined Tier Schedule for Power Generation

| METRIC | TIER III - CONCURRENTLY MAINTAINABLE | TIER IV - FAULT TOLERANT |
|---|---|---|
| Annual Uptime | 99.98% | 100.00% |
| Annual Downtime | 1.6 hours | 0.4 hours (26.3 minutes) |
| Planned Downtime | 0 hours (maintenance without shutdown) | 0 hours (maintenance without shutdown) |
| Unplanned Downtime | 1.6 hours | 0.4 hours |
| Concurrent Maintenance | Yes | Yes |
| Fault Tolerance | No (single fault causes impact) | Yes (single fault = no impact) |
| Power Path Redundancy | N+1 (dual path, one active) | 2(N+1) or 2N (dual active) |
| Cooling Redundancy | N+1 | 2(N+1) or 2N |

The reliability designation of the system can indicate a small change in unplanned downtime, but provide a large impact to the design, operation, and cost of the power system. A doubling of generation units, can lead to more than a doubling of capital because the internal busing between units, fuel conditioning system, additional onsite fuel storage costs, and zero hour maintenance programs will be included in the contract cost, but the delivered power will remain the same.

## Strategies to Ensure Reliability for Power Generation Systems

There are various solutions to be considered in a power generation system that can improve the reliability. Each solutions has impacts to costs, emissions, and operating inputs that should be incorporated into the financial investment decision.

Redundant Power Systems (N+1 Configuration)

- Installation of one additional generator beyond the required capacity to maintain operations if a unit faults
- Serviceable switchgear and tiebreakers for backup cutover for multiple generator designs
- Ring distribution networks for generated power to the demand users

Microgrid Architecture

- Localized power networks that can operate independently from the main grid and manage load across multiple clients, lower the cost of reliability across multiple demand users
- Ideal for remote sites where grid tie-in is impractical and future expansion is a consideration
- Aligning multiple demand profiles with load shedding ability

Preventive Maintenance and Remote Monitoring

- Implement predictive analytics and IoT sensors to detect issues before failure.
- Some generator suppliers offer monitoring as a service for increased reliability

Black Start/Fuel Supply Security

- Ensure reliable fuel logistics for generators (natural gas or diesel)
- Consider on-site fuel storage to mitigate supply chain disruptions
- Plan for island power starting and design start up sequencing for equipment to manage inrush

Environmental Hardening

- Design systems to withstand extreme temperatures, snow, and wind
- Use enclosures, heating systems, and weatherproof cabling

## The Value of Reliability - Understanding Lost Production

When operators are evaluating the cost of the power generation system, the added cost of reliability can be easily associated with increased facility production and a return on the investment. A simple example can highlight this prinicple.

- A single day of downtime in a mid-sized oil facility can cost $250,000–$500,000 in lost production.
- With an engine that has 95% availability, the lost production over a year could be 18 days. Adding an additional unit (2.5 MW unit at a cost of $2.5M) could increase the availability and reduce downtime planning to 1 day, resulting in the ability to have an additional $4.25M in additional production review.
- This would equate an internal rate of return (IRR) of 158% over three years, which would clear most financial investment hurdles.
- Increasing the generator reliability with additional beyond the N+1, would reduce downtime related to lost power to 1 hour, resulting in an IRR of -7.4% over three years. This would not be recommended for investment if increased revenue was the only goal.

**CANUSA EPC INSIGHT**

- **Understand the cost of reliability and incorporate it into the return on investment related to the facility revenue generation model.**

# SCALING POWER SYSTEMS FOR FACILITY DEVELOPMENT

Demand profiles for industrial infrastructure depend on various factors; the operational procedures during startup, steady state, and shutdown scenarios, environmental conditions of the site for minimum heating and cooling for optimal performance, and the projected throughput capacity of the facility production trains.  Aligning this demand profile with power generation capacity supports efficient capital deployment and reduced expenses for the operating length of the asset.

## Understanding the Demand Profile of Development

Growing assets, such as oil and gas assets and mines, rarely have static power requirements. Their lifecycle typically follows three phases:

- Early Development:
  - Lower power demand during initial infrastructure setup.
  - Core unit operations are built for future expansions.
- Peak Production:
  - Significant increase in power needs for pumps, compressors, processing equipment, and camp facilities.
  - Reliability and redundancy become critical as the facility operations are more integrated.
- Decline Phase:
  - Power demand decreases as production is depleted.
  - Oversized systems become inefficient and costly to maintain.

## Considering Modular Generation Development

Modular deployment strategies can involve the staged installation of packaged units as the demand loads increase.  There are a few considerations with planning that are important to consider.

- Package Sizing
  - Standard packages from generator suppliers can be incorporated for lower cost installation and staggered delivery
  - Larger sized units can be deployed for the longer baseload profile
  - More units typically means more operating costs for compliance, maintenance, and installation
- Electrical Distribution Planning
  - Key distribution infrastructure should be installed with the initial build out; transformers, fuel gas condition, electrical bus bar systems, building space for disconnection switches
  - There are standard commercial capacitance units in transformers, bus bars, relays, cables, that should be leveraged instead of custom designed equipment that will add lead time and cost to your project
- Rental Strategies
  - Rental units can be deployed to lower capital outlay
  - Permitting for the full buildout should be considered at the onset of development

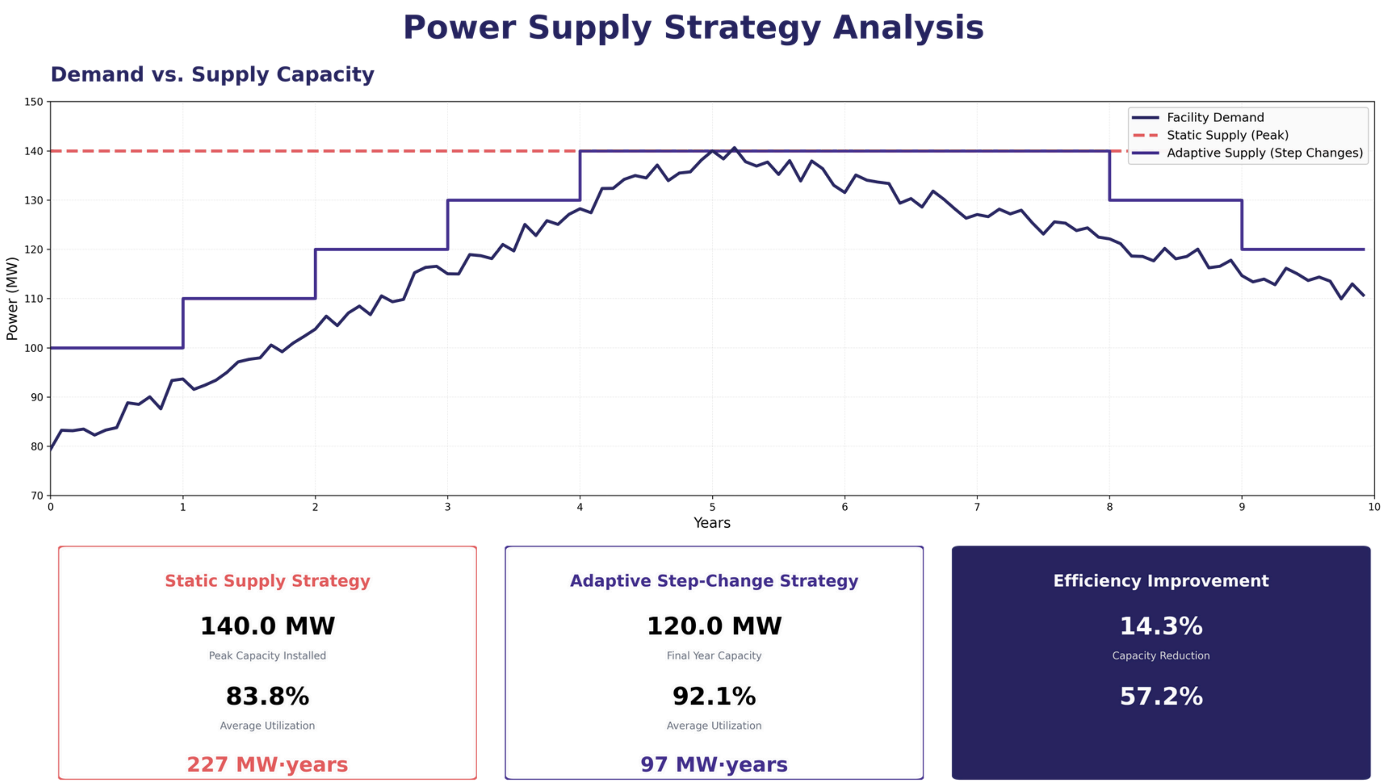
**CANUSA EPC INSIGHT**

- **Packaged equipment improves time to deployment**
- **Savings are only realized if facility execution accounts for modular deployment**

**Modular Power Project By CANUSA EPC: canusaepc.com/cryogenic-electrical-system/**

## Comparing Static Generation to Modular Development

Considering the scenario where power demand will increase overtime at a site and then decline towards the end of life production. This highlights where a modular deployment can save millions on lifecycle costs by avoiding unnecessary CapEx and reducing OpEx. Following the demand profile below, deploying a 100 MW base load system with 10 MW modular additions over the next four years and demobilization of 20 MW at the end of the production cycle can save over 57% of the total power generation costs.




# Planning for Your Power Generation Needs

The previous strategy of negotiating a demand charge and rate with utilities are no longer the only viable option for meeting your power needs. Consider the option of onsite power generation to support your project financial model and schedule. Planning for the impact of future fuel costs, land requirements, reliability, and emissions are all important factors that don't show up in a kW capacity number.

Reach out to CANUSA EPC to develop a plan to accelerate your power project and ensure it contributes to your project financials and doesn't hinder them.

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- Industry benchmark ranges from EIA, NREL, and IEA reports



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