247 ENERGY

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# LNG-Based Power Generation: The Scientific and Economic Case for a Cleaner Alternative to Diesel

Grid Congestion, Emissions Regulation, and the Role of Liquefied Natural Gas in Resilient Distributed Energy

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## FOREWORD

There is a moment in every energy transition when the gap between what the grid can deliver and what the economy demands becomes impossible to ignore. For businesses across the Netherlands and increasingly across Europe, that moment has already arrived. Connection queues stretching to the mid-2030s, waiting lists numbering in the tens of thousands, and capacity maps showing congestion across the majority of a national territory are not projections. They are the operational reality in which companies must make investment decisions today.

I have spent years working in energy infrastructure, and the lesson I return to consistently is this: solutions that function in theory but cannot be deployed within a planning cycle have limited practical value. What the market needs now is power that can be installed quickly, operated cleanly, and financed without a decade-long commitment to infrastructure that may be obsolete before it is energised. Liquefied natural gas, deployed in a properly engineered modular generation system, offers precisely that combination.

This paper is not an advocacy document for any single company or commercial product. It draws on current scientific, engineering, and economic research to examine why LNG-based power generation represents a rational and evidenced response to the congestion crisis now affecting industrial and commercial energy users across Northwestern Europe. The data on emissions reductions, safety characteristics, cost, and deployment speed stand on their own merits, independent of any specific commercial application.

What the evidence makes clear is that the diesel generator, long the default option for off-grid and backup power, has reached the practical limits of its usefulness in an era defined by tighter emissions regulation, rising carbon pricing, and an electricity system under structural pressure. The transition to cleaner, grid-independent alternatives is not a decision that can be deferred indefinitely. It is an immediate operational requirement, and the body of evidence supporting LNG as the most credible near-term replacement for diesel has never been stronger.

**James Troch**
Chief Executive Officer,
247 Energy

SECTION 1

# Grid Infrastructure

### A System Under Structural Pressure

The Dutch electricity grid has become one of the most instructive case studies in the consequences of energy transition outpacing physical infrastructure. As of early 2025, more than 14,000 businesses and institutions are on waiting lists for new electricity connections, according to Netbeheer Nederland, the association of Dutch grid operators. The National Grid Congestion Action Programme, known by its Dutch acronym LAN, confirmed in its March 2025 progress report that ninety percent of Dutch businesses are experiencing direct or indirect consequences of this congestion, a finding drawn from the national SME Monitor. Grid congestion is now identified as one of the primary obstacles to the Dutch business climate, with limited network access threatening both economic expansion and the delivery of renewable energy projects.

The structural causes of this congestion are well documented. The Dutch electricity grid was designed for centralised, fossil-fuel-based power generation flowing in one direction from large plants to end consumers. As solar and wind installations proliferated across the country, local networks were required to handle bidirectional energy flows for which they were never engineered. The national capacity map maintained by Netbeheer Nederland shows red status, indicating no available capacity for new connections, across the majority of the country's regions. Medium-voltage connection rollouts fell by twenty-five percent in 2024, even as demand continued to grow, driven by the electrification of transport, industrial processes, and heating systems.

The timeline for resolution is measured in decades rather than years. New high-voltage transmission infrastructure requires lead times of eight to twelve years from permit application to energisation, according to Netbeheer Nederland. In the most congested areas, grid operators have communicated that new connections will not be available until the mid-2030s. The March 2025 LAN progress report described the length of the waiting queue as a new reality requiring structural action, with results visible only in the medium term. In April 2025, TenneT, the national high-voltage grid operator, offered time-bounded off-peak capacity contracts and unlocked approximately nine gigawatts of latent headroom, roughly forty percent of Dutch peak load, without constructing a single new cable. This measure provided temporary relief but did not resolve the underlying structural deficit.

The economic consequences are already measurable. The Dutch Chemical Association has warned that grid constraints threaten the competitive position of the Netherlands as an industrial location. Companies are reconsidering investment plans and, in some cases, redirecting capital to countries where grid access is more predictable. New residential and commercial construction projects have stalled in growing regions including North Holland and Utrecht because local grids cannot support additional load. Public facilities including hospitals and fire stations are among the institutions on connection waiting lists. The Financial Times reported in July 2025 that new connections in some areas would only become available in the mid-2030s, a planning horizon that is incompatible with the investment cycles of most commercial and industrial operators.

The Dutch situation is widely regarded as an early indicator of the pressures that other European Union member states will face as electrification accelerates. Analysts at the Regulatory Assistance Project have identified the Netherlands as a precedent for what other countries will experience as they pursue the bloc’s decarbonisation targets. The pattern is consistent: rapid deployment of renewable generation outpaces the grid reinforcement required to accommodate it, producing congestion that denies connection to the very consumers and producers whose participation the energy transition requires. Against this backdrop, organisations that can generate power independently of the public grid occupy a structurally different and materially stronger position than those dependent on a connection that may not arrive within their planning horizon.

SECTION 2

# The Diesel Problem

### Why the Default Option Is No Longer Adequate

The diesel generator has served as the standard technology for off-grid and backup power generation for more than a century. Its reliability under load, its energy density, and the relative simplicity of its fuel supply chain made it the rational default when no cleaner alternative existed at comparable cost. Those conditions have changed materially. The regulatory environment surrounding diesel combustion has tightened significantly across the European Union, and the carbon pricing mechanisms being developed and extended across European markets are increasingly making the true cost of diesel combustion visible in operational budgets. The diesel generator is not becoming prohibited, but it is becoming progressively more expensive, more regulated, and more difficult to justify against alternatives whose performance has improved substantially.

The environmental profile of diesel combustion is well-established in the scientific literature. Diesel fuel contains sulphur compounds, the combustion of which produces sulphur dioxide, a precursor to acid rain and a contributor to ambient particulate pollution. Combustion of diesel also produces nitrogen oxides at concentrations consistently higher than those produced by equivalent natural gas combustion at the same power output. Particulate matter produced by diesel combustion, specifically the fine fraction known as PM2.5, is classified by the International Agency for Research on Cancer as a Group 1 carcinogen, representing the highest level of evidence for a substance causing cancer in humans. For site operators, particularly those in proximity to residential areas or environmentally sensitive zones, the PM2.5 profile of continuous diesel generation creates a category of health and regulatory risk that is increasingly difficult to manage.

Beyond the emissions profile, diesel fuel carries inherent operational risks that are frequently understated in conventional energy planning assessments. Diesel is flammable in liquid form at ambient temperatures, with a flash point of approximately 52 degrees Celsius. A spill results in a persistent liquid hazard: the fuel pools, spreads across surfaces, penetrates soil, and can contaminate groundwater. Diesel vapour, in the concentrations reached near a spill, is ignitable at concentrations as low as 0.6 percent by volume in air, a threshold that can be reached during routine handling events. These characteristics require specific bunding, containment infrastructure, insurance provisions, and environmental compliance procedures that add materially to the true cost of operating a diesel-powered site.

The maintenance burden of diesel generation compounds the cost disadvantage further. Diesel fuel contains sulphur compounds that deposit within engine components and degrade in storage over time.

Industry practice requires fuel polishing, a process of filtering and reconditioning stored diesel, at intervals of four to six months. Without this procedure, fuel degradation causes injector blockages and engine failures. This recurring obligation creates scheduled service windows during which generation availability is at risk, and it adds to the operational expenditure that must be factored into any honest total cost of ownership assessment. The combustion residues of diesel also accelerate wear on engine components, increasing the frequency and cost of overhauls relative to engines operating on cleaner fuels.

The volatility of diesel prices represents a further structural disadvantage. Diesel tracks crude oil markets, which are subject to geopolitical disruption, refinery capacity constraints, and speculative market pressure. The price spikes experienced across European markets during the 2022 energy crisis demonstrated the degree to which organisations dependent on diesel for critical power supply can face sudden and significant increases in operational cost with very little warning or hedging capacity. For organisations whose competitive position depends on predictable energy costs, this exposure to crude oil price dynamics introduces a planning risk that compounds the regulatory and environmental pressures already described. The cumulative weight of these factors makes a compelling case that the diesel generator, as the default solution for distributed and off-grid power, has reached the limits of its practical usefulness.

SECTION 3

# The Science of LNG

### Understanding Why LNG Burns Cleaner Than Diesel

Liquefied natural gas is natural gas, predominantly methane with the chemical formula $CH_4$, that has been cooled to approximately minus 160 degrees Celsius to reduce its volume for transport and storage. This phase transition reduces the volume of natural gas by approximately 600 times relative to its gaseous state at atmospheric conditions, making it practical to transport by cryogenic tanker and to store in ISO-standard insulated containers without the need for high-pressure vessels. When returned to its gaseous state through controlled vaporisation, LNG behaves identically to pipeline natural gas and is suitable for use in gas-fuelled reciprocating engines, gas turbines, and combined-cycle power systems designed for natural gas operation.

The infrastructure that has developed around LNG since the first commercial shipments in the 1960s provides important context for evaluating its suitability as a distributed power fuel. As of 2025, LNG is produced and exported by twenty-two countries spanning every major hydrocarbon-bearing region, from the United States Gulf Coast and the Russian Arctic to the Persian Gulf, West Africa, and the Asia-Pacific Basin. At the receiving end of this supply chain, more than two hundred and sixteen regasification and storage terminals operate across fifty-five import nations, a footprint that encompasses Western Europe, East Asia, South and Southeast Asia, the Americas, and sub-Saharan Africa. This geographic breadth means that organisations deploying LNG generation systems across any of these markets draw on a mature, multi-supplier, globally distributed fuel supply chain rather than dependence on a single source or transit route. The scale and diversity of this network provides a level of supply security that no comparable distributed energy carrier has previously achieved at equivalent energy density.

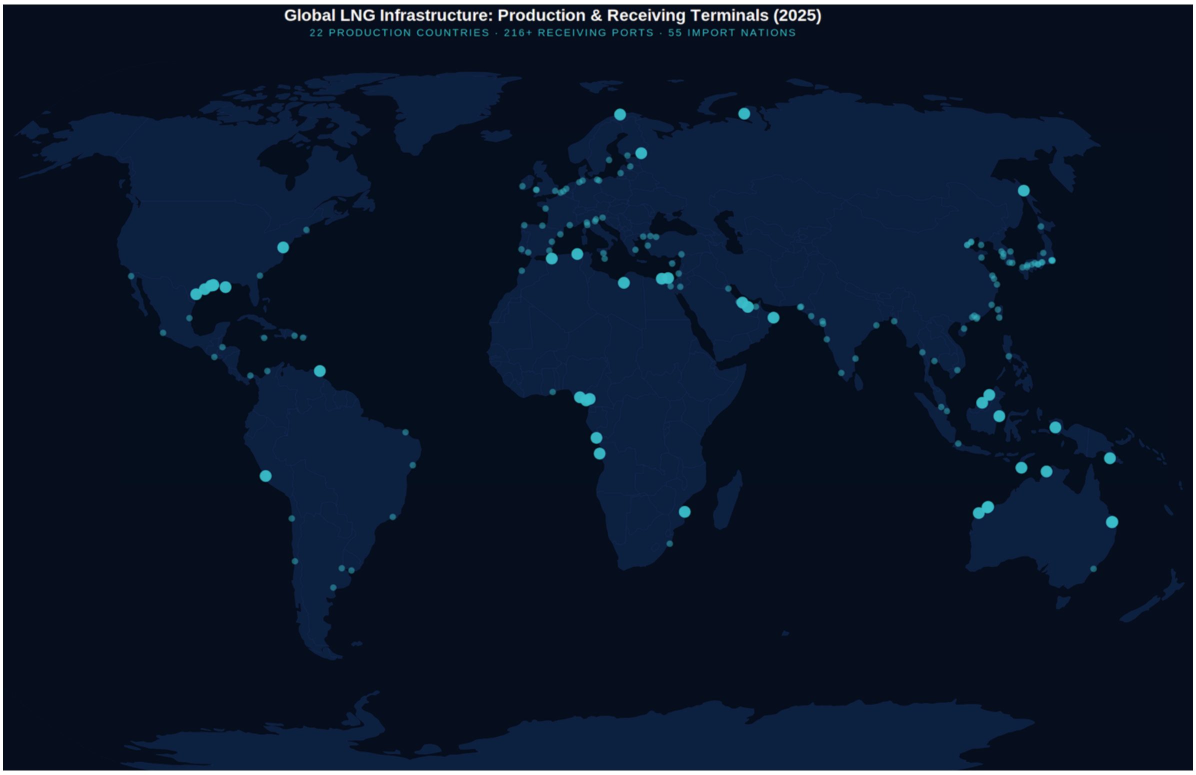


*Figure 1: Global LNG Production and Receiving Infrastructure (2025). Twenty-two production countries supply more than 216 receiving terminals across 55 import nations. The network spans every inhabited continent and provides commercially available LNG to the majority of the world's industrial economies. Interactive version at 247.energy.*

The primary chemical advantage of methane as a combustion fuel derives directly from its molecular structure. Methane has the highest hydrogen-to-carbon ratio of any hydrocarbon: four hydrogen atoms bonded to a single carbon atom. This ratio, compared with diesel fuel whose approximate molecular structure of $C_{12}H_{23}$ yields a hydrogen-to-carbon ratio of approximately 1.9 to 1, means that per unit of energy released, methane combustion produces substantially less carbon dioxide. The United States Maritime Administration measured carbon dioxide output from equivalent LNG and diesel engines at ISO-corrected test loads and recorded 405 grams per kilowatt-hour for LNG against 619 grams per kilowatt-hour for diesel, a reduction of approximately 34 percent at the point of combustion. This result is consistent with the theoretical prediction derived from the hydrogen-to-carbon ratio difference between the two fuels and has been reproduced in multiple independent studies.

The International Energy Agency, in its 2025 report on LNG emissions and abatement options, confirmed that natural gas produces significantly fewer direct greenhouse gas emissions than diesel fuel at equivalent energy output. The IEA's Global Methane Tracker for 2025 further noted that more than 95 percent of the natural gas consumed globally has a lower lifecycle emissions intensity than coal, and that on a direct combustion basis, the advantage over crude-oil-derived fuels including diesel is clear and consistent. A 2024 lifecycle study conducted over four years by Berkley Research Group found that LNG used for power generation produced approximately half the greenhouse gas emissions per megawatthour of electricity generated compared with coal-based generation, confirming the relative advantage of gas combustion across a range of applications.

Sulphur dioxide emissions from LNG combustion are effectively zero. LNG, as a refined and processed product, contains virtually no sulphur compounds. The combustion of diesel, by contrast, releases sulphur dioxide in quantities proportional to the sulphur content of the fuel. Even ultra-low-sulphur diesel formulations retain measurable sulphur content, and the combustion products include sulphur dioxide and related compounds that contribute to acid deposition and secondary particulate formation. The elimination of sulphur dioxide from the emissions profile of LNG combustion represents a significant improvement in local air quality, particularly relevant to industrial sites, logistics facilities, and any location where continuous generation over extended periods would otherwise create persistent localised pollution.

Particulate matter emissions from LNG combustion are substantially lower than those from diesel. Research documented by the Southern Gas Association, drawing on comparative studies of heavy-duty generation equipment, has reported reductions in particulate matter of up to 99 percent when comparing LNG combustion against Euro VI diesel standards. The absence of sulphur in LNG fuel eliminates the particulate-forming mechanisms associated with sulphate aerosol formation in diesel exhaust. This has direct implications for regulatory compliance with ambient air quality standards and for the health outcomes of workers and communities in the vicinity of generation sites. For any operator seeking to demonstrate environmental responsibility through measurable air quality data, the particulate profile of LNG generation offers a materially stronger position than diesel.

> *“Liquefied natural gas, in its combustion chemistry alone, produces a fundamentally different emissions profile from diesel: one that is categorically cleaner rather than merely incrementally improved.”*

SECTION 4

# Emissions Control

### Near-Zero NOx Through LNG Combustion and Catalytic Aftertreatment

Nitrogen oxides, collectively referred to as NOx and comprising primarily nitric oxide and nitrogen dioxide, are among the most consequential air pollutants produced by combustion processes. They are precursors to ground-level ozone and fine particulate matter, both associated with respiratory illness and cardiovascular disease. They contribute to acid rain and photochemical smog. For stationary power generation operating continuously in industrial zones, the NOx profile of the generation system is a material factor in regulatory compliance, operating licence conditions, and the relationship between the site and its surrounding environment. It is also an area where the difference between LNG and diesel generation is most pronounced when the full capability of modern aftertreatment technology is considered.

Natural gas combustion produces lower base-level NOx than diesel combustion at equivalent power output. This advantage derives from the combustion temperature characteristics of methane and from the absence of sulphur compounds, which in diesel exhaust act as catalysts for additional NOx formation pathways. However, the more significant advance in NOx reduction for natural gas systems comes from the compatibility of gas engines with catalytic aftertreatment technologies that achieve substantially higher reduction efficiencies for gas combustion products than for diesel combustion products.

The three-way catalyst, a technology that simultaneously oxidises carbon monoxide and unburned hydrocarbons while reducing nitrogen oxides, functions most effectively in a stoichiometric combustion environment where the air-to-fuel ratio is controlled precisely to the chemically ideal point. Natural gas engines operating at or near stoichiometric conditions provide the ideal chemical environment for three-way catalyst performance. A study published in Environmental Science and Technology by researchers from the California Air Resources Board and the City of Sacramento measured real-world brake-specific NOx emissions from diesel engines equipped with selective catalytic reduction aftertreatment and from LNG engines equipped with three-way catalyst systems. The results showed that LNG engines with three-way catalyst technology produced the lowest NOx emissions of all technologies tested, including advanced diesel SCR systems operating in the same conditions. Separately, the United States Department of Energy has documented NOx reduction efficiencies exceeding 90 percent for selective catalytic reduction applied to natural gas engine exhausts across a range of load conditions.

The combination of base-level NOx reduction inherent to natural gas combustion and the high efficiency of catalytic aftertreatment systems designed specifically for gas engine exhaust creates the conditions for near-total NOx elimination at the point of generation. Advanced LNG power systems integrating precision combustion control with purpose-designed catalytic aftertreatment can achieve NOx concentrations in exhaust gas that fall below the standard detection thresholds of monitoring equipment routinely used at industrial sites. Where diesel generators, even with the most advanced SCR systems, continue to produce NOx at concentrations that trigger regulatory reporting obligations in many European jurisdictions, a properly engineered LNG system with integrated aftertreatment achieves a qualitatively different operational position.

It is important to state clearly that the emissions performance documented in the peer-reviewed literature was achieved in systems specifically designed and maintained for emissions performance, not in ad hoc diesel conversion installations. The NOx reductions referenced represent the achievable outcome of deliberate engineering rather than an automatic consequence of fuel substitution alone. The evidence supports the conclusion that LNG generation, properly engineered with integrated catalytic aftertreatment, represents a generation technology whose emissions profile is not merely compliant with current European regulation but is positioned to remain compliant as standards continue to tighten across the coming decade.

SECTION 5

# Safety Analysis

### The Physical Properties That Make LNG Safer Than Diesel in Practice

The safety profile of any fuel system is determined by a combination of physical and chemical properties: the temperature at which the fuel ignites spontaneously without an external source, the concentration range in air within which it is combustible, its behaviour in liquid form under handling and storage conditions, and the consequences of an uncontrolled release. On each of these dimensions, liquefied natural gas compares favourably with diesel fuel. The LNG industry has accumulated more than fifty years of commercial transport and handling experience. During that period, over 80,000 LNG cargo shipments have been completed with no recorded loss of primary containment and no fatalities attributable to LNG cargo, a safety record that has no equivalent in the history of liquid hydrocarbon fuel transport.

The auto-ignition temperature of LNG vapour, which is primarily methane, is approximately 540 degrees Celsius. Diesel fuel has an auto-ignition temperature of approximately 250 degrees Celsius, less than half the threshold of methane. This difference means that LNG requires significantly more energy to ignite spontaneously, and that accidental ignition from hot surfaces, compressed air, or elevated ambient temperatures poses a substantially lower risk with LNG than with diesel. The Southern Gas Association, drawing on data from the International Energy Agency and industry safety records, has described LNG's unintentional combustion as highly unlikely given its high ignition threshold. An environmental impact statement produced for the PNG LNG project, one of the world's largest LNG infrastructure developments, concluded that LNG is intrinsically less explosive than other liquid fuels as a consequence of its narrow flammability range and its behaviour on release from containment.

The flammability range of methane in air is five to fifteen percent by volume. Outside this window, methane will not ignite regardless of the ignition energy present. Below five percent concentration, the mixture is too lean. Above fifteen percent, insufficient oxygen is available. Diesel vapour, by contrast, has a lower flammability limit of approximately 0.6 percent by volume, meaning it can ignite at concentrations far lower than methane and in conditions far more likely to arise during routine handling, minor containment events, or the gradual evaporation of spilled fuel in an enclosed space. The narrow flammability window of methane provides a safety margin that diesel vapour does not offer, and it means that a methane release that fails to find an ignition source within the specific concentration range will simply disperse harmlessly into the atmosphere.

LNG in its liquid state is not flammable. It is stored at atmospheric pressure and at minus 160 degrees Celsius and does not present a fire hazard in liquid form. In the event of a spill, LNG rapidly vaporises as it absorbs heat from its surroundings. The resulting vapour, initially denser than air, warms quickly and begins to rise. If it does not encounter an ignition source within the five-to-fifteen percent concentration window during this brief period, it dissipates into the atmosphere, leaving no liquid residue, no soil contamination, and no persistent hazard. Diesel, by contrast, is flammable in liquid form and does not evaporate cleanly on release. A diesel spill results in a persistent liquid hazard, soil and groundwater contamination, a sustained fire risk, and regulatory reporting obligations under environmental protection frameworks across all European jurisdictions.

These properties do not mean that LNG storage and handling can be treated as without technical demands. Cryogenic temperatures require appropriate materials and insulation standards, and the potential for vapour cloud ignition within the flammability window requires disciplined management of exclusion zones and ignition source control in the vicinity of storage and vaporisation equipment. The relevant comparison, however, is not between LNG and a hypothetical zero-risk energy carrier. It is between LNG and diesel, the technology it would most commonly replace in distributed and off-grid power generation applications. On that specific comparison, both the fundamental physical chemistry and the accumulated operational safety record of the LNG industry support the conclusion that LNG presents a materially lower risk profile across the dimensions that matter most to site operators, insurers, and regulators.

SECTION 6

# Cost Analysis

**Total Cost of Ownership: LNG Versus Diesel for Distributed Power**

The economic case for LNG as a replacement for diesel in distributed and off-grid power generation rests on three distinct but interrelated cost dimensions: direct fuel cost per unit of energy produced, maintenance and operational costs over the system lifetime, and total cost of ownership when capital expenditure and all recurring costs are considered together across a comparable operational period. Analysis of each dimension consistently points toward a material advantage for LNG, with the magnitude of that advantage increasing over longer operational horizons as the cumulative savings from lower fuel cost and reduced maintenance expenditure compound.

On a direct fuel cost basis, natural gas has consistently traded at a discount to diesel on an energy-equivalent basis across most major markets. The United States Department of Energy Alternative Fuel Price Report has tracked these differentials over extended periods and confirmed that LNG fuel cost per unit of energy has typically been lower than the equivalent cost of diesel. The Enerdata analysis of LNG versus diesel for heavy transport applications documented a cost advantage of approximately 0.138 United States dollars per kilometre for LNG-powered operation versus diesel, a differential that, when translated to the context of stationary power generation, represents a persistent structural advantage in favour of gas. While fuel price differentials vary with geography and market conditions, the underlying advantage of natural gas as a cheaper thermal energy source than crude-oil-derived diesel has been durable across multiple phases of the commodity price cycle.

The maintenance cost advantage of LNG over diesel generation is perhaps less immediately visible than the fuel price differential, but it is equally real and accumulates materially over an operational lifetime. The absence of sulphur in natural gas eliminates the need for fuel polishing, a recurring maintenance procedure that diesel operators must undertake at four-to-six-month intervals to prevent fuel degradation and protect engine components. The cleaner combustion products of methane extend the intervals between engine overhauls, reduce the frequency of oil changes, and lower the rate of component wear attributable to combustion residue. Industry experience with natural gas generator maintenance programmes consistently documents longer service intervals and lower per-operating-hour maintenance costs compared with equivalent diesel systems, particularly in continuous or high-utilisation applications where the cumulative advantage is greatest.

The total cost of ownership comparison, incorporating capital expenditure, fuel cost, and operational maintenance across a ten-year horizon, presents a composite picture substantially more favourable to LNG than a fuel price comparison alone would indicate. The Crowley Energy analysis of LNG versus diesel power generation concluded that LNG systems offer a materially lower total cost of ownership than diesel counterparts across typical operational scenarios. When carbon pricing mechanisms, which are progressively raising the effective cost of diesel combustion across European markets, are incorporated into the projection, the economic case for LNG strengthens further with each successive planning cycle. Organisations that lock in LNG generation capacity now are effectively hedging against a carbon cost trajectory that is widely expected to increase.

> *"When fuel cost, maintenance, operational autonomy, and the trajectory of carbon pricing are considered together, LNG generation presents a total cost of ownership that diesel cannot match across a comparable operational horizon."*

Supply reliability represents a further economic dimension that is frequently underweighted in conventional energy procurement analysis. Diesel generators depend on a supply chain that can be disrupted by logistics failures, road closures, or competing demand during crisis periods. Standard diesel fuel storage provides approximately three days of operational autonomy before resupply becomes necessary. LNG in ISO-standard cryogenic tanks provides fuel autonomy measured in weeks to months rather than days. This extended autonomy is not merely an operational convenience. In scenarios where grid connection is unavailable, where road infrastructure is compromised during adverse weather or civil disruption, or where an industrial operation must maintain continuity through a period of supply chain stress, the difference between three days and several months of stored energy represents a material difference in operational resilience with direct economic consequences.

The global infrastructure supporting LNG supply reinforces this resilience further. With twenty-two producing nations, more than two hundred and sixteen receiving terminals, and fifty-five countries that have committed capital to domestic regasification infrastructure, the LNG supply chain has achieved a geographic diversity that significantly reduces exposure to any single point of disruption. Operators in Western Europe can access supply from the United States Gulf Coast, Qatar, Norway, Algeria, Nigeria, and a growing number of additional sources. The plurality of supply origins and maritime routes available to a European LNG consumer is structurally different from the position of an organisation dependent on road-delivered diesel from a regional refinery network subject to the same regional disruptions. Organisations drawing on this global network benefit from the optionality that multiple supplier relationships and multiple trade routes provide, a structural advantage that regional fuel supply chains dependent on refinery capacity cannot replicate.

SECTION 7

# Rapid Deployment

### Grid-Independent Power Within Hours: The Case for Modular LNG Generation

The deployment timeline of a power generation system is, in many industrial and commercial contexts, at least as important as its performance characteristics. A system with excellent emissions performance and competitive operating costs provides no operational or economic value if it requires years of planning and construction before it can be energised. Diesel generators have traditionally been preferred partly on the grounds of relative simplicity: a standard diesel generator set can be delivered and brought into service within days. The engineering development of modular, containerised LNG generation systems has changed this comparison significantly, while simultaneously offering a better emissions and cost profile than the diesel equipment they can replace.

Modern modular LNG power systems are engineered within standard shipping container dimensions, allowing them to be transported by road or rail without specialist haulage infrastructure and positioned on prepared surfaces at a target site with minimal civil engineering works. ISO-standard cryogenic tanks provide the fuel storage, eliminating the need for fixed tank construction or piped gas connection. The electrical connection to the site distribution system is the primary installation task, and in systems designed for rapid commissioning, the process from equipment arrival to live generation can be completed within hours. A large-scale illustration of this deployment capability was documented in the United States in 2024, when modular natural gas generation equipment was delivered to a major data centre facility and brought to operational status for several hundred megawatts of generation within 122 days from equipment arrival, a timeline that is structurally incomparable to the multi-year process required for permanent grid connection in a congested market.

The tri-generation capability of advanced LNG power systems extends the value proposition materially beyond simple electricity supply. Tri-generation, also known as combined cooling, heat and power, recovers waste heat from the generation process to provide space heating or process heat, and uses absorption chilling technology to derive useful cooling from the same waste heat stream. A conventional diesel generator discards approximately 60 to 70 percent of the chemical energy contained in its fuel as waste heat to the environment. An LNG tri-generation system recovers a substantial portion of this waste for productive application, increasing the effective energy efficiency of the fuel consumed and reducing the total delivered cost of energy across the site. For manufacturing facilities, pharmaceutical production sites, data centres, hospitals, and food processing operations that require electricity, heat, and cooling simultaneously, this multi-output capability represents a fundamentally different value proposition from a single-output diesel generator.

Hot-swap maintenance capability is an operational feature of modular parallel LNG generation configurations that has significant consequences for uptime-critical applications. In a modular system where multiple generation units operate in parallel, individual units can be taken offline for scheduled or corrective maintenance while others continue to supply load. The total generation capacity available to the site is reduced during the maintenance window, but power supply to the process is not interrupted. This contrasts with the experience of operating a single large diesel generator, where any maintenance event requires either a complete site shutdown or the cost of maintaining separate backup provision. For operations where continuity of power supply is a contractual obligation, a regulatory requirement, or a commercial necessity, the hot-swap capability of a well-engineered modular LNG system eliminates a category of operational risk that a diesel installation cannot address without significant additional capital investment.

Both LNG-based and diesel-based generation systems can operate independently of the public grid. This grid-independent characteristic is the foundation of their relevance to operators in a congested-grid environment. However, the combination of grid independence, rapid deployment capability, tri-generation output, hot-swap maintenance resilience, and the materially superior emissions and cost profile described throughout this paper creates an overall proposition for LNG generation that is superior to diesel across virtually every dimension that a site operator is required to weigh when making an energy infrastructure decision. For organisations that have concluded that waiting for a grid connection is not a viable operational strategy, modular LNG generation offers the most credible currently available alternative.

SECTION 8

# Strategic Pathway

**From LNG to Green Hydrogen: Building Toward Zero-Carbon Generation**

The role of LNG in the energy transition is most accurately understood as that of a bridge fuel rather than a destination technology. The term bridge fuel carries specific technical meaning in this context: a fuel that reduces emissions materially relative to the technology it displaces, while the infrastructure, engineering experience, and operational knowledge it develops remain applicable to the lower-carbon or zero-carbon fuels that will succeed it over time. In the case of LNG used for power generation, the bridge leads toward green hydrogen, and the path is more direct than the distance between those two fuels might initially suggest.

The molecular relationship between methane and hydrogen is fundamental to this transition pathway. Both methane and hydrogen share the property of producing no sulphur dioxide, no particulate matter, and no carcinogenic combustion products. Methane releases carbon dioxide as a combustion product, while hydrogen combustion produces only water vapour. The generation equipment designed for natural gas combustion, including the reciprocating engine types, turbine architectures, and fuel delivery systems used in LNG generation systems, is in many configurations capable of operating on hydrogen-natural gas blends, and in some designs on pure hydrogen, with modifications whose scope depends on the hydrogen concentration and the specific engine architecture. This engineering compatibility means that capital invested in LNG generation infrastructure is not committed to a dead-end asset but to a platform that can evolve toward hydrogen operation as green hydrogen supply becomes commercially available at scale.

Green hydrogen, produced by electrolysis of water using electricity from renewable sources, represents the logical terminus of the transition pathway that begins with replacing diesel with LNG. Several European projects are developing the capability to blend hydrogen into natural gas distribution infrastructure at concentrations of ten to twenty percent by volume, with some demonstration projects testing higher concentrations. The IEA has noted in its energy transition analyses that the infrastructure being built and expanded for natural gas, including LNG terminals, cryogenic storage, and gas engine generation equipment, can serve as part of the physical and operational foundation for hydrogen energy systems once green hydrogen production reaches the cost and scale at which it becomes commercially competitive with fossil gas.

The timeline for green hydrogen reaching commercial scale at competitive cost is expected to develop progressively through the latter part of this decade, with meaningful availability at industrial scale in the early 2030s in jurisdictions with strong policy support and abundant renewable generation capacity. This timeline creates a planning horizon of approximately eight to twelve years during which LNG, as the generation fuel of choice, delivers the operational and environmental performance described throughout this paper. After that horizon, the same modular infrastructure, with appropriate engine and fuel system modifications, provides a credible pathway to hydrogen-fuelled operation. This sequence is not a theoretical projection. It is the stated strategic direction of multiple major engine and turbine manufacturers who are investing in hydrogen-capable variants of gas generation equipment available today.

For organisations making energy infrastructure decisions in the context of the congestion crisis described in the opening sections of this paper, the relevant choice set is effectively: to continue waiting for a grid connection that may not arrive within their operational planning horizon; to continue operating diesel generators under an increasingly burdensome regulatory and carbon cost regime; or to invest in LNG generation that delivers immediate emissions improvements, competitive total cost of ownership, rapid deployment, and a credible long-term pathway toward hydrogen operation. The evidence reviewed in this paper supports the conclusion that LNG, as an interim measure within a coherent long-term energy strategy, is the most defensible choice currently available to commercial and industrial power users who require reliable, grid-independent generation and who cannot responsibly defer that decision to await a grid resolution that remains years away.

> *“Investing in LNG power generation today is not a choice between emissions reduction and operational continuity. It is a mechanism for achieving both simultaneously, while building the infrastructure foundation for a hydrogen future.”*

## 247 Energy NV

247 Energy NV is a developer, builder, and co-investor in modular energy infrastructure, headquartered in Beveren-Waas, Belgium. The company operates across Belgium and the surrounding markets of Northwest Europe with a current development pipeline exceeding 505 megawatts of distributed and utility-scale energy capacity.

247 Energy holds patents on a proprietary energy production system engineered to enable commercial and industrial organisations to deploy liquefied natural gas as a primary fuel for on-site power generation in environments where solar energy, wind power, and public grid connection are unavailable, insufficient in capacity, or unavailable within an operationally relevant timeframe. The patented system integrates LNG fuel supply, combustion optimisation, catalytic aftertreatment, and modular electrical output in a self-contained configuration deployable without permanent grid connection and without the infrastructure requirements associated with conventional gas-fuelled generation.

The system is designed specifically to address the conditions that now define the energy landscape for a growing number of industrial and commercial operators: grid connections that are congested, delayed, or simply unavailable; emissions standards that are tightening; carbon costs that are rising; and a need for reliable, dispatchable power that renewable sources alone cannot consistently satisfy. The patented technology allows organisations to use LNG as a generation fuel in precisely those circumstances where solar generation is intermittent or insufficient, where wind power is unavailable, and where the public grid cannot provide the connection or capacity required. It is the combination of fuel, engineering, and operational architecture that distinguishes the 247 Energy system from both conventional diesel generation and from standard gas generator installations.

247 Energy retains a co-investment position alongside its capital partners in each project it develops, maintaining direct operational and financial skin in the game throughout the asset lifecycle. The company invites engagement from industrial operators, energy-intensive businesses, logistics platforms, data centre developers, and infrastructure investors seeking exposure to distributed, grid-independent power generation with a clear pathway toward lower-carbon and ultimately hydrogen-fuelled operation.

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