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# Technical and Economic Feasibility of a CNG-Based City Gas Distribution Network in Cinere District Indonesia

**Pramudita Satriya Sotama**
Universitas Indonesia

**ABSTRACT***:* This study examines the technical and economic feasibility of developing a natural gas distribution network in Cinere District, Depok City, West Java, Indonesia. The research addresses the growing energy demand of 4,213 household customers and 98 commercial customers, requiring 2,954,160 m³/year of natural gas supply. Using PipelineStudio software for hydraulic simulation, the optimal pipeline configuration was determined: MDPE 80 SDR 11 Ø 180mm for the backbone pipeline, and MDPE 80 SDR 11 Ø 90mm and Ø 63mm for distribution to customer clusters. Compressed Natural Gas (CNG) transported via Gas Transport Modules (GTM) serves as the supply source. Economic analysis reveals that the project becomes viable when utilizing subsidized CNG at Rp 3,100/m³, with selling prices of Rp 6,800/m³ for households (RT-2) and Rp 7,600/m³ for small commercial customers (PK-2). Under a Public-Private Partnership (KPBU) funding scheme with 30% government subsidy of CAPEX, the project demonstrates feasibility with NPV of Rp 2,076,329,000, IRR of 12.05%, and payback period of 7.22 years. Sensitivity analysis indicates that CNG purchase price has the most significant impact on project viability. The study concludes that natural gas distribution networks represent a technically feasible and economically attractive alternative to LPG for residential and commercial sectors in densely populated urban areas.

**KEYWORDS:** City Gas Distribution, CNG, Natural Gas Network, Economic Feasibility, Pipeline Design, Public-Private Partnership

## I. INTRODUCTION

Indonesia's energy landscape faces significant challenges in meeting domestic liquefied petroleum gas (LPG) demand. In 2020, the country imported 6.84 million tons of LPG, while domestic consumption reached 8.81 million tons, creating a considerable financial burden through both imports and subsidies (OEI, 2019). This growing dependence on imported LPG has long-term implications not only for the national budget but also for energy security and balance of payments. The increasing gap between domestic production and consumption highlights Indonesia's structural vulnerability in maintaining reliable energy access for households and small businesses. Therefore, developing indigenous energy resources particularly natural gas has become a strategic imperative to reduce import dependence, stabilize subsidy expenditures, and enhance national energy resilience. Given Indonesia's substantial natural gas reserves, the development of natural gas as a domestic energy source has emerged as a strategic priority in reducing reliance on imported fuels.

Natural gas distribution networks, or city gas systems, provide a viable solution to meet residential and commercial energy needs in a safer, cleaner, and more efficient manner. The system operates by channeling natural gas directly from the source or compressed natural gas (CNG) storage to end users through a network of medium-density polyethylene (MDPE) pipelines. Compared to conventional LPG distribution, city gas systems offer multiple advantages: lower operational pressures that enhance safety, continuous supply that eliminates storage requirements, non-toxic characteristics, economic benefits from reduced costs, and significantly lower environmental impacts (Mokhatab & Poe, 2015). In addition, city gas systems minimize logistical complexity by removing the need for cylinder refilling and transportation, which often constitutes the major cost and safety risk in LPG-based systems. Recognizing these environmental and economic advantages, the Indonesian government issued Presidential Regulation Peraturan No. 10 Tentang Penetapan Harga Gas Bum (2019), which designates the construction of natural gas distribution networks as part of the National Strategic Projects (*Proyek Strategis Nasional*). This legal framework places natural gas infrastructure within the broader context of national energy diversification and sustainability policies, supporting the transition toward low-carbon urban energy systems.

The Cinere District in Depok City, West Java, represents an area with high potential and pressing need for natural gas infrastructure development. Strategically located in the southern part of the Jakarta Metropolitan Region, Cinere has experienced rapid population growth and urban expansion. With a population of 85,330 inhabitants and a density of 7,728 persons per square kilometer consisting of 26,260 households across four sub-districts (BPS Kota Depok (2020) continues to grow due to residential development, commercial expansion, and improved transport connectivity. This demographic and economic dynamism directly translates into escalating energy consumption, particularly for cooking, water heating, and small business operations. Yet, despite its proximity to major gas transmission corridors serving Greater Jakarta, Cinere still lacks a city gas distribution network, forcing its residents and businesses to rely entirely on subsidized LPG cylinders. The absence of such infrastructure not only perpetuates inefficient energy use but also increases household expenditure volatility due to fluctuating LPG prices.

Previous studies have successfully demonstrated the implementation of city gas networks in several parts of the Jakarta Metropolitan Region (*JABODETABEK*), including Kebayoran Baru (Asep et al., 2015), apartment complexes in Depok (Satriaperdana et al., 2018), Summarecon Serpong (Nico et al., 2019), and Kelapa Gading (Putri et al., 2020). These earlier projects have provided valuable technical and economic precedents for urban gas distribution in Indonesia. However, most of these cases are situated in high-density or premium residential areas where customer clustering enables shorter pipeline networks and faster cost recovery. In contrast, Cinere District represents a medium-density, mixed-use urban zone with varying consumption patterns and spatial distribution. Consequently, assessing its feasibility requires a more nuanced technical design and financial model that account for both residential and commercial load profiles. This distinct context presents a valuable opportunity to test and refine the economic viability of city gas networks under more realistic urban conditions.

Against this backdrop, the objectives of this study are threefold: first, to design a technically optimal natural gas pipeline distribution system for residential and commercial sectors in Cinere District; second, to evaluate the economic feasibility of the proposed project using established investment appraisal indicators; and third, to identify funding schemes and pricing strategies that ensure the project's long-term sustainability. The study integrates hydraulic simulation, network optimization, and financial modeling to provide a comprehensive assessment framework. This research is expected to contribute to Indonesia's energy diversification agenda by providing empirical evidence of the technical and economic viability of city gas networks in medium-density urban areas. The results will offer practical insights for policymakers, energy companies, and urban planners in formulating strategies, determining design parameters, and implementing natural gas distribution systems in similar contexts across the country. Moreover, it advances the academic discourse on urban energy transition by contextualizing the deployment of CNG-based gas systems within developing-country settings where infrastructure, policy, and affordability constraints coexist

## II. LITERATURE REVIEW

Natural gas is a hydrocarbon mixture predominantly composed of methane ($CH_4$) at around 90%, with smaller amounts of ethane, propane, butane, nitrogen, and carbon dioxide. It is widely recognized as an efficient fossil fuel due to its high heating value, ranging between 42 and 55 MJ/kg, comparable to gasoline and diesel but with significantly lower carbon emissions (Mokhatab & Poe, 2015; World Nuclear Association, 2020). Owing to its clean-burning nature, natural gas is used extensively in residential cooking and heating, commercial activities, industrial processes, and power generation.

City gas distribution systems are integrated networks that transport processed natural gas from supply sources to end-users through pipelines. According to the American Gas Association (2020), these systems typically include supply infrastructure, high-pressure transmission pipelines, medium- and low-pressure distribution lines, and customer service connections. In Indonesia, construction and operational guidelines are regulated under SNI 13-3507-1994 and SNI 13-3474-2002. City gas systems operate under low-pressure conditions (below 0.4 barg) for end-users, ensuring high safety standards through natural gas's physical properties: it is lighter than air, disperses quickly in case of leakage, and has a narrow flammability range of 5–15% in air (OEI, 2019)(ESDM, 2015). Additionally, odorization is applied to facilitate leak detection. These factors make city gas networks safer and more efficient than conventional LPG cylinder systems that rely on high-pressure storage and manual refilling.

Compressed Natural Gas (CNG) technology serves as an alternative distribution method for areas where pipeline construction is not economically feasible. CNG is produced by compressing natural gas to 200–250 bar, enabling its transport through specialized trailers to receiving facilities where pressure is reduced before distribution (World Bank Group, 2015). This system offers logistical flexibility for regions without established pipelines, though its cost-effectiveness must be evaluated against permanent network options depending on distance, customer density, and infrastructure scale.

The design of gas pipelines is based on principles of compressible fluid mechanics. The general gas flow equation (Mohitpour et al., 2007) considers variables such as inlet and outlet pressures, pipe diameter, length, and friction factor, with the latter determined using the Colebrook–White equation. Modern low-pressure distribution networks typically use Medium-Density Polyethylene (MDPE) pipes due to their corrosion resistance, flexibility, and cost-effectiveness Plastics Pipe Institute Handbook

(2008). Among various grades, MDPE 80 SDR 11—rated for a maximum operating pressure of 4 bar—is widely applied for residential and commercial pipelines operating below 0.4 bar.

Economic feasibility analysis for infrastructure projects generally employs Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PBP) as the principal indicators (Mokhatab & Poe, 2015). A positive NPV reflects profitability, an IRR higher than the Minimum Acceptable Rate of Return (MARR) denotes financial viability, and the PBP indicates the duration required to recover the initial investment. In Indonesia, natural gas pricing is regulated by BPH Migas through Regulation No. 10/2019, setting maximum retail prices at Rp 4,250 per cubic meter for social housing and Rp 6,000 per cubic meter for residential and commercial consumers in Depok City.

Several previous studies have examined the technical and financial aspects of city gas projects in Indonesia. Satriaperdana (2018) developed a system for apartments in Depok using MDPE 80 SDR 11 Ø63mm for main pipelines and ¾-inch galvanized pipes for service lines. Nico et al (2019) evaluated Summarecon Serpong's gas network and reported an IRR of 11.02% with a payback period of 7.5 years, while Putri et al (2020) found that the Kelapa Gading project achieved an NPV of Rp 5.3 billion, an IRR of 12.29%, and a seven-year payback period. These findings consistently indicate that MDPE pipes dominate city gas designs due to cost efficiency, that project viability depends heavily on gas pricing and customer density, and that IRR values of 11–13% with payback periods of seven to eight years are typical for medium-density urban developments. Collectively, this literature provides a strong empirical foundation for assessing the feasibility and potential implementation of a natural gas distribution network in Cinere District

## III. METHODOLOGY

This study employs a quantitative feasibility analysis that integrates technical pipeline simulation with comprehensive economic evaluation. The research framework utilizes multiple software tools to ensure methodological accuracy and analytical depth. PipelineStudio is employed for hydraulic simulations to model gas flow behavior and pressure distribution; AutoCAD is used for generating isometric drawings and pipeline schematics; while Google Earth Pro supports route planning, spatial visualization, and geographic feasibility assessment. This integrative approach ensures that both technical and financial dimensions of the proposed city gas project are examined systematically.

The study area is located in Cinere District, Depok City, West Java, Indonesia, which comprises four sub-districts Cinere, Gandul, Pangkalan Jati, and Pangkalan Jati Baru. According to the 2020 census, the district has 85,330 residents living in 26,260 households, with a population density of 7,728 persons per square kilometer (BPS Kota Depok, 2020). From this population, a total of 4,213 household customers and 98 small commercial establishments were identified as potential end-users. These were selected based on accessibility, type of building, and development density to ensure representativeness and technical feasibility for connection to the city gas network.

Gas demand estimation follows the provisions of BPH Migas Regulation No. 22/2011, which limits maximum gas consumption to 50 cubic meters per month for residential customers and 1,000 cubic meters per month for small commercial users. Peak-hour demand was calculated using the formula Q=W/GHVQ = W/GHVQ=W/GHV, where WWW denotes appliance power and GHVGHVGHV represents the gross heating value of natural gas. Assuming an average cooktop power of 1.9 kW and a gross heating value of 1,034 BTU/scf, the estimated peak demand is approximately 0.2 cubic meters per hour per household and 1.5 cubic meters per hour per commercial customer. These values serve as key input parameters for network sizing and pressure regulation design.

Two alternative supply sources were evaluated to determine the most feasible gas input option for Cinere District: a direct connection from the PT Perusahaan Gas Negara (PGN) transmission line along Jalan Raya Bogor and the use of Compressed Natural Gas (CNG) transported via Gas Transport Modules (GTM) from the nearest filling station (SPBG) at Cilandak KKO, approximately eight kilometers away. Based on economic analysis and technical reliability, CNG transportation was selected as the preferred option. The system uses 10-foot GTM trailers with a capacity of 1,000 cubic meters at 200 barg pressure. The CNG composition adheres to standard specifications consisting of 89.55% methane, 3.52% ethane, 1.18% propane, and small proportions of heavier hydrocarbons, carbon dioxide, and nitrogen.

Pipeline routing was designed to minimize capital expenditure and optimize operational efficiency. Several factors guided the route selection, including the shortest possible total length, existing road infrastructure for construction accessibility, regulatory approval feasibility, and the ability to maintain adequate pressure across the distribution network. Three preliminary routes were modeled and compared through simulation to identify the most effective layout. The location of the Pressure Reducing Station (PRS) was also optimized to ensure uniform pressure distribution throughout the service area and minimize energy losses.

Hydraulic simulations were conducted using PipelineStudio under steady-state conditions to evaluate each proposed route. Input parameters included gas composition as per CNG supply standards, an ambient operating temperature of 25°C, supply pressure of 0.5 barg (PRS Type 750 output), minimum delivery pressure of 0.1 barg at the furthest customer, maximum gas velocity of 60 ft/s (to avoid erosion), and minimum velocity of 10 ft/s (to prevent liquid dropout). The Colebrook–White equation was applied to compute friction factors based on a pipe roughness coefficient of 0.0000015 ft for Medium-Density Polyethylene (MDPE) pipes. Pipe diameters of 63 mm, 90 mm, 125 mm, and 180 mm were iteratively tested to achieve optimal pressure and velocity profiles, ensuring both technical feasibility and cost efficiency of the distribution network.

Economic feasibility analysis followed standard engineering economic principles. Capital Expenditure (CAPEX) included costs of MDPE pipes, fittings, valves, construction labor and equipment, Pressure Reducing Station installation (PRS Type 750), service line and meter connections, testing and commissioning, and administrative expenses such as permits, inspections, and insurance—estimated at 2.5% of total investment. Operational Expenditure (OPEX) comprised annual recurring costs such as CNG procurement, GTM rental and transport fuel, PRS operation including personnel and security, land rental for the PRS site, and maintenance under operations and maintenance (O&M) contracts. Inflation and cost escalation were factored into the analysis to reflect long-term project dynamics.

Financial evaluation employed three main indicators: Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PBP). The NPV was calculated over a 20-year project lifespan using an 11% discount rate as the Minimum Acceptable Rate of Return (MARR). The IRR was defined as the discount rate at which NPV equals zero, while the PBP measured the number of years required for cumulative cash flows to recover the initial investment. Project acceptance criteria were set as follows: NPV must be positive, IRR must exceed 11%, and PBP must be less than 10 years. These benchmarks align with standard investment thresholds for urban gas infrastructure projects in Indonesia.

To examine project robustness under uncertain conditions, a sensitivity analysis was conducted by varying six key parameters CNG purchase price, household selling price, commercial selling price, household demand, commercial demand, and CAPEX costs within a range of ±40% in 10% increments. The objective was to identify the most influential variables affecting project viability and to quantify the level of vulnerability to market fluctuations and cost deviations.

Risk assessment complemented the sensitivity analysis by identifying potential threats to project implementation. A risk matrix was employed to evaluate each risk in terms of probability and impact severity, rated on a five-point scale. The product of these two factors determined the overall risk score. Scores above 10 indicated high-priority risks requiring immediate mitigation; scores between 5 and 10 required active management and monitoring; and scores below 5 were considered acceptable but subject to periodic review. This structured risk assessment ensured that both technical and financial uncertainties were managed proactively, enhancing the reliability of the overall feasibility evaluation.

## IV. RESULTS AND DISCUSSION

### A. *Gas Demand Characteristics*

The total annual gas demand in Cinere District, Depok City, is estimated at 2,954,160 m³, comprising 2,424,960 m³ (82%) from 4,213 residential customers and 529,200 m³ (18%) from 98 small commercial users. Peak hourly demand reaches 989 m³/hr, calculated under an eight-hour daily operating window in accordance with BPH Migas Regulation No. 22/2011. This demand estimation derived from appliance power ratings and natural gas heating values provides conservative yet reliable input for system design, ensuring adequate supply capacity under peak conditions.

**Table 1. Annual Gas Demand for Cinere District**

| *Customer Type* | *Units* | *Hourly (m³/hr)* | *Monthly (m³)* | *Annual (m³)* |
|---|---|---|---|---|
| Residential | 4,213 | 842 | 202,080 | 2,424,960 |
| Commercial | 98 | 147 | 44,100 | 529,200 |
| **Total** | **4,311** | **989** | **246,180** | **2,954,160** |

Residential consumers average 50 m³/month per household, while small commercial establishments range between 100 and 1,000 m³/month, depending on business activity and operational hours. These figures establish the foundation for pipeline sizing, pressure regulation, and compressor station capacity, ensuring technical reliability and economic scalability of the system.
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### *B. Route Optimization and Hydraulic Performance*

Three pipeline configurations were simulated with varying Pressure Reducing Station (PRS) locations. Route 1 (PRS at Jl. Cinere Raya) was rejected due to negative pressures at distal nodes, even with enlarged Ø180 mm backbone diameters. Route 2 (PRS at Jl. Bukit Cinere) demonstrated marginal performance, producing excessive pressures at several nodes when operating at 0.5 barg, and pressure drops below 0.1 barg at 0.4 barg supply. Route 3, with PRS positioned at Jl. Meruyung Raya, successfully maintained delivery pressure above 0.1 barg for all customers and exhibited a maximum gas velocity of 13.72 ft/s, well below the erosional velocity limit of 60 ft/s. This route was therefore selected as the optimal configuration.

**Table 2. Hydraulic Simulation Results – Selected Route (Route 3)**

| *Parameter* | *Value* | *Specification Limit* |
|---|---|---|
| Total pipeline length | 98,140 m | – |
| MDPE Ø180 mm (backbone) | 5,730 m | Backbone |
| MDPE Ø90 mm (distribution) | 38,950 m | Distribution |
| MDPE Ø63 mm (clusters) | 53,460 m | Cluster feeds |
| Supply pressure | 0.5 barg | PRS output |
| Minimum delivery pressure | 0.11 barg | >0.1 barg (Pass) |
| Maximum velocity | 13.72 ft/s | <60 ft/s (Pass) |
| Supply flow rate | 989 $m^3$/hr | Peak demand |

The optimized configuration employs a three-tier pipe hierarchy Ø180 mm backbone, Ø90 mm distribution, and Ø63 mm cluster lines—balancing capital investment with hydraulic performance. The centralized PRS location minimizes maximum pipeline length and equalizes pressure gradients across the network. Material selection of MDPE 80 SDR 11, rated for 4 bar maximum operating pressure, provides a substantial safety margin and significant advantages over steel pipes, including corrosion resistance, flexibility for trenchless installation, fusion-welded leak-proof joints, and reduced life-cycle cost.

### *C. Economic Feasibility and Sensitivity Evaluation*

The total Capital Expenditure (CAPEX) is estimated at Rp 49.69 billion (2021 values), dominated by distribution pipelines and service connections (≈84%). The Operational Expenditure (OPEX) for the first year totals Rp 2.90 billion, escalating annually by 1.9% for inflation. CNG logistics including GTM trailer rental, transportation fuel, and drivers constitute approximately 34% of OPEX, underlining the cost sensitivity of non-pipeline supply routes.

Three economic scenarios were simulated:

- **Scenario 1** (Commercial CNG, Rp 9,000/$m^3$): Marginally profitable (NPV Rp 3.59B; IRR 12.24%; PBP 7.29 years) but commercially infeasible due to uncompetitive retail tariffs exceeding BPH Migas caps.
- **Scenario 2** (Subsidized CNG, Rp 3,100/$m^3$): Economically viable with residential and commercial selling prices of **Rp 6,800/$m^3$** and **Rp 7,600/$m^3$**, respectively, yielding **NPV Rp 4.60B**, **IRR 12.59%**, and **PBP 7.05 years**.
- **Scenario 3** (Crowdfunding at Rp 6,000/$m^3$): Financially weak (IRR 8.8%; PBP 9.2 years) and administratively complex.

**Table 3. Summary of Economic Feasibility**

| *Scenario* | *CNG Price (Rp/$m^3$)* | *NPV (Rp)* | *IRR* | *PBP (Years)* | *Feasibility* |
|---|---|---|---|---|---|
| 1. Commercial supply | 9,000 | 3,588,094,000 | 12.24% | 7.29 | Marginal |
| **2. Subsidized CNG** | **3,100** | **4,599,004,000** | **12.59%** | **7.05** | **Viable** |
| 3. Crowdfunding | 6,000 | 2,184,000,000 | 8.80% | 9.20 | Not feasible |

To ensure affordability under the BPH Migas price ceiling (Rp 6,000/$m^3$), a Public–Private Partnership (KPBU) model was assessed. A 30% government subsidy (≈Rp 14.9 billion) enables price compliance while maintaining profitability (NPV Rp 2.08B; IRR 12.05%; PBP 7.22 years). This funding mix establishes a replicable benchmark for medium-density gas distribution projects, balancing public welfare objectives and private sector incentives. Sensitivity testing indicates CNG purchase price as the most critical determinant of project viability. A ±40% price fluctuation results in NPV variation from –Rp 9.2B to +Rp 18.4B, where each Rp 100/$m^3$ increase reduces NPV by approximately Rp 295 million. The next most influential variable is the residential selling price, followed by CAPEX, while demand parameters exhibit low sensitivity, confirming robustness against moderate customer uptake variations.

### *D. Policy, Risk, and Comparative Insights*

The project yields several significant policy and technical implications. Economically, conversion from LPG to piped natural gas reduces household energy expenditure by ~30%, from Rp 145,500/month to Rp 102,000/month per household, with aggregated community savings exceeding Rp 2.2 billion per year. For commercial users, energy savings reach 22%, demonstrating clear affordability and sustainability benefits. Beyond cost, users benefit from continuous fuel availability, reduced indoor emissions, and improved safety due to low-pressure operation.

Risk assessment identifies CNG price escalation as the only high-impact factor (risk score 15/25). Mitigation strategies include long-term capped supply contracts, supplier diversification, and eventual transition to direct pipeline interconnection. Moderate risks include logistical disruption and weather-related construction delays, while permit and third-party interference risks remain minor. This confirms the project's operational resilience under foreseeable conditions.

From a comparative perspective, the Cinere project exhibits superior financial and technical performance relative to previous Indonesian studies. Putri (2020) reported IRR 12.29% and PBP 7.0 years in Kelapa Gading (dense urban area), while Nathanael (2019) observed 11.02% IRR and 7.5-year PBP in Summarecon Serpong (suburban). Cinere's IRR of 12.59% and PBP of 7.05 years demonstrate improved outcomes attributable to higher customer density, optimized three-tier pipeline design, and inclusion of commercial users (18% of volume). Unlike earlier projects relying solely on transmission pipelines, this study pioneers an economically viable CNG-supplied network model, expanding the applicability of city gas systems to peri-urban areas lacking pipeline access.

Policy implications extend beyond project-level feasibility. First, reallocating a portion of Indonesia's LPG subsidy budget (Rp 50–60 trillion annually) toward city gas infrastructure would yield permanent assets with multi-decade benefits. Second, formalizing CNG allocation frameworks for residential gas distribution under regulated cost-plus pricing would ensure equitable access and market transparency. Third, the 30% KPBU subsidy ratio established here offers a standardized reference for future medium-density networks. Lastly, incorporating "gas-ready" building codes in urban developments would substantially reduce per-connection costs (currently 34% of CAPEX) and accelerate national energy diversification goals

## V. CONCLUSION

This study evaluated the technical and economic feasibility of developing a city gas distribution network in Cinere District, Depok, Indonesia, using Compressed Natural Gas (CNG) transportation as an interim supply source. The integrated approach—combining hydraulic simulation, financial modeling, and policy analysis demonstrated that CNG-based systems can be a viable transitional solution for urban areas not yet connected to transmission pipelines.

The optimized configuration (Route 3, PRS at Jl. Meruyung Raya) achieved stable pressure distribution (>0.1 barg) and acceptable gas velocity (13.72 ft/s) across a 98.14 km MDPE network. The selected three-tier pipeline design (Ø180–Ø90–Ø63 mm) provided the best balance between performance and cost, while MDPE material ensured durability and corrosion resistance. Economically, the system achieved positive viability indicators under subsidized CNG pricing (Rp 3,100/m$^3$), with an NPV of Rp 4.6 billion, IRR of 12.59%, and payback period of 7.05 years. A 30% government subsidy within a Public–Private Partnership (KPBU) framework further enabled compliance with BPH Migas' tariff ceiling of Rp 6,000/m$^3$ without compromising investor returns.

Sensitivity analysis identified CNG purchase price as the dominant variable affecting project feasibility, followed by residential tariffs and capital costs. The risk assessment confirmed the project's robustness, with only one high-impact risk—fuel price escalation—requiring contractual and policy-level mitigation. Comparative evaluation with previous Indonesian studies showed improved efficiency and profitability, driven by higher customer density, network optimization, and inclusion of commercial users.

Beyond technical and financial validation, this research contributes to energy transition policy design. Redirecting a portion of Indonesia's LPG subsidy toward city gas infrastructure could yield long-term social and fiscal benefits. Institutionalizing CNG allocation for residential gas distribution and adopting standardized KPBU subsidy ratios would accelerate the scaling of medium-density networks. The Cinere model demonstrates that small-scale CNG-based city gas projects can serve as effective bridging infrastructure toward a fully integrated natural gas distribution system, promoting energy equity, urban resilience, and sustainable economic development.

Future studies should explore life-cycle carbon assessments, long-term maintenance economics, and social acceptance dimensions to complement the current engineering–economic findings and support national replication of the Cinere model across similar urban clusters in Indonesia

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