Contract Design and Bus Electrification: Evidence from Santiago, Chile

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Abstract

Santiago went from about 100 electric buses in 2018 to nearly 4,400 by early 2026, the largest electric-bus fleet outside China. This paper analyzes the contract design behind the transition. Successive tenders unbundled service operation from fleet ownership and charging infrastructure. They turned buses and terminals into concession-dedicated assets that transfer to the next operator. They also paid fleet financing through fixed monthly installments, administered centrally and owed regardless of which operator runs the route. This design removed the two risks that make lenders charge a premium on transit assets: stranding at contract end and operator default. It made electric capital financeable without operators bearing it. A permanent subsidy, created in 2009, made the long payment horizons credible. Competition widened accordingly: participation rose from 16 offers in 2019 to 84 in 2023, and the monthly fleet installment per electric bus fell by 10 to 25 percent. Using payment and tender records, I show that electrification did not materially change the cost per kilometer of service and did not require a new funding source. The 2019 bids priced both technologies under the same contracts. They imply that renewing the fleet with new diesel buses would not have been cheaper per kilometer. I conclude with policy lessons and the conditions under which the model transfers to other cities.

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1 Introduction

Cities must reduce the social and environmental costs of daily mobility without cutting access to jobs, education, and health care. The transport sector produces more than 20% of direct CO_2 emissions worldwide (IEA, 2023). Public transport is central to reducing them. Under most urban conditions it uses road space more efficiently than private cars, and it lowers emissions, crash risks, and energy use per passenger moved.

However, buses carry environmental costs of their own. In most countries the bus fleet runs on diesel. Emission standards have improved (e.g., the Euro VI norm), but technological change has been slow, especially in developing cities. Buses are therefore an important source of urban air pollution. Diesel buses account for about a quarter of the black carbon emitted by the transport sector, and where soot-free engines are not required a diesel bus can release more than 250 times the black carbon of a gasoline car over the same distance (Climate and Clean Air Coalition, n.d.). The problem is larger in developing regions, where the fleets are older. In much of Latin America the bus fleet still meets only Euro III standards or worse and runs without particulate filters, and until recently only Mexico City and Santiago required Euro VI engines for new buses (ICCT, 2017, 2025).

In response, many cities have been switching to electric buses. They are now a central tool for decarbonizing urban transport. Buses are a natural place to start because their fixed routes, central depots, and shared charging make electrification easier to manage than for private vehicles (Avenali et al., 2024b). Adoption has accelerated, but it remains uneven. In Europe, the electric-bus fleet grew from about 1,650 in 2018 to more than 9,500 in 2022, and the electric share of new bus sales rose from 2.5% to 10% (EAFO, 2022). Policy targets reinforce the trend. For example, the European Union requires all new urban buses to be zero-emission by 2035 (EU, 2024).

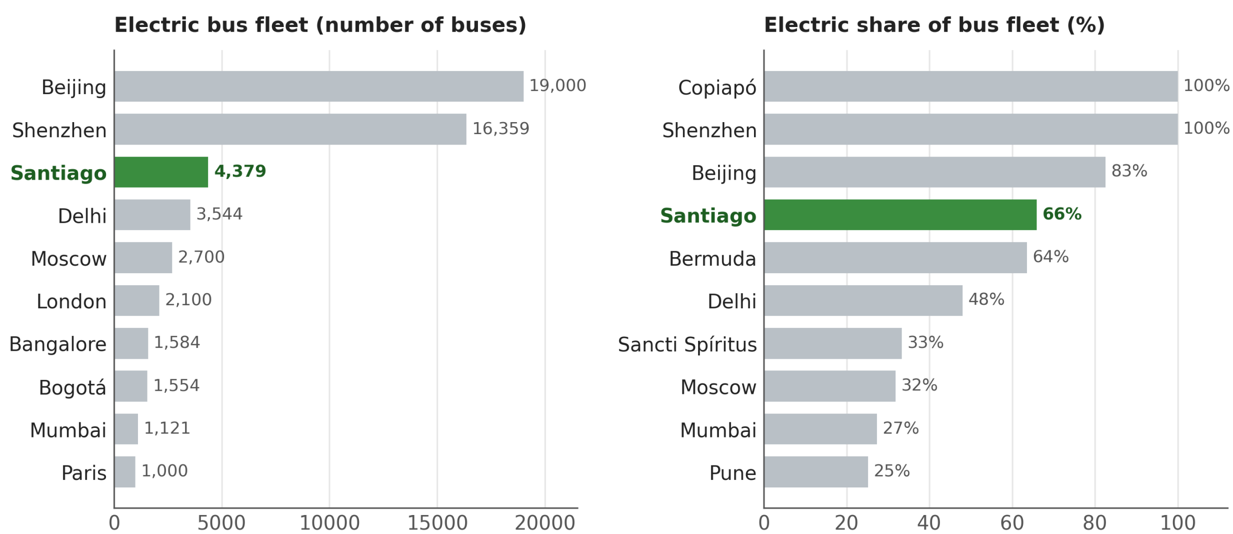
Outside China, large fleets remain uncommon and the main obstacle is cost. Electric buses carry higher capital costs for batteries and charging. Lower operating and external costs do not always offset them, so electrification is not always welfare-improving. The capital-cost gap has narrowed quickly, however: in Santiago, the financing installment for a standard electric bus in the latest tenders is close to what diesel buses commanded in 2019 (Section 5.3). Electric buses also reduce operators' margins, so operators resist them without direct public support (Giagnorio et al., 2024). Cost-competitiveness also depends on the setting. It is strongest on dense, high-frequency corridors and weakest on longer suburban routes (Avenali et al., 2023, 2024a). Santiago, with its dense network and high annual mileage per bus, is a favorable setting on both counts.

Importantly, the barriers are not only technological. They are also institutional, contractual, financial, and regulatory (Borén and Grauers, 2019; Połom and Wiśniewski, 2021). Contract length and the guarantees offered on the fleet strongly shape whether the investment is made (Avenali et al., 2024a). The organization of charging provision matters as well: in charging markets, vertical structure shapes investment incentives and access (D'Alfonso et al., 2026).

The experience also speaks to the economics of procurement and public–private partnerships, beyond the transport literature. A central question there is whether to bundle the construction and the operation of an asset in a single contract, so that the builder internalizes the consequences of its choices for operating costs (Hart, 2003; Iossa and Martimort, 2015). Santiago moved in the opposite direction. Section 3 argues that the unbundling made electric capital financeable, once contract instruments restored the lifecycle incentives. The case also illustrates a general result of that literature: private financing of public infrastructure repackages the public liability rather than eliminating it (Engel et al., 2013).

This paper analyzes the experience of Santiago, which renewed its bus fleet and went from about 100 electric buses in 2018 to the largest electric-bus fleet of any city outside China, with nearly 4,000 electric buses in 2025 and about 4,400 by early 2026. Figure 1 puts Santiago's electric fleet into context by comparing it with other cities worldwide.

Figure 1: Electric-bus fleet size (left) and electric share of the bus fleet (right) across leading cities.



Note: The left panel ranks cities by the number of electric buses and the right panel by the electric share of the bus fleet; battery-electric buses only. Source: author's elaboration from the Centro de Movilidad Sostenible (CMS) dashboard *Chile en el contexto global: comparativa de las flotas eléctricas*, a resource of the ZEBRA alliance (data as of May 2026, accessed 22 June 2026).

My main hypothesis is that two elements were key for the implementation: the long-term policy of subsidizing the transit system, and the tendering reforms that progressively replaced the operator-as-bus-owner model with the decoupling of (i) service operation, (ii) ownership/provision of the bus fleet, and (iii) depots and charging infrastructure.

The legal keystone is the treatment of the rolling stock as concession-dedicated assets (*bienes afectos a la concesión*; Art. 3 nonies, Law 18.696), with its own provision contract. Essential assets, such as the fleet and charging depots, stay tied to the system and transfer automatically to the next operator, while the central financial administrator (AFT) pays a fixed monthly fleet installment directly to the asset financiers, which decouples financing from operation.

Each tender generation reallocated fleet, infrastructure, and demand risk away from operators, mitigating part of it rather than merely transferring it to the State, and lengthened horizons. Electric capital thus became financeable without operators bearing it. The unbundling is visible in the money and in the outcome: a government evaluation attributes falling e-bus prices partly to the competitive tenders, and finds electrified scenarios have lower lifecycle cost than a non-electric baseline. Consequently, the implementation did not materially change the cost per kilometer of service and did not require a new funding source. A companion evaluation using the contract-driven timing of the rollout values the realized gains at USD 215 to 668 million per year in 2025, between one-sixth and one-half of the annual public subsidy (González and Silva, 2026).

This paper and its companion divide the labor explicitly. González and Silva (2026) estimate the causal effects of the rollout on ridership, pollution, accidents, and noise. This paper explains the contract design that produced the rollout, documents its fiscal cost, and derives the conditions for transferring it.

I describe the tendering process highlighting the critical contract-design elements that allowed fleet renewal. I also show, by analyzing the system expenses, that the technological change did not materially change the cost of running the system. I conclude by drawing relevant policy lessons with emphasis on general transferability.[1]

2 Background

2.1 Framework

The bus system in Santiago, branded RED Movilidad, is planned and run by a single public authority. The Ministry of Transport and Telecommunications (MTT) sets policy and holds the legal power to tender the use of road corridors. Within it, the Directorio de Transporte

[1] All computed numbers, tables, and figures in this paper are reproducible from the underlying payment and tender records with a single script. The replication package is available from the author.

Público Metropolitano (DTPM) plans the network, coordinates the services, leads the road-use concession processes, and supervises the operators' contracts (DTPM, 2025a). Private firms do not own routes. They hold concessions to use defined corridors and streets, the "*concesión de uso de vías*", and they must run services under operating conditions set by the authority.

Fares are integrated across buses, the Metro, and the suburban rail line between Nos and Estación Central (Tren Nos), and a central financial administrator, the AFT, collects the fare revenue and pays operators and suppliers. This paper focuses on the bus system, where the contract redesign and the electrification took place.

The financial backbone of the system is a permanent national subsidy. Chile created it in 2009 through Law 20.378, and it changed the business model of public transport. The subsidy secures long-term funding and lets the system invest in capital, not only cover operation. Eligible spending covers the system as a whole, not only buses: the operation of buses, the Metro, and the suburban rail, and investment in buses, terminals, part of the metro infrastructure, and technology (DTPM, 2025a). A regulated fare structure complements the subsidy, and a Panel of Experts reviews fares periodically to preserve the financial balance of the system and the real value of revenue.

This permanent funding was decisive for a fast and efficient move to electric buses. It let the authority coordinate operators, manufacturers, financiers, and infrastructure providers, and it lowered the financial and operational risks each of them faced (DTPM, 2025a). Turning the buses into concession-dedicated assets opened this new stage while keeping fiscal discipline.

Table 1 shows the financial situation of the public transport system by presenting fare revenue, the subsidy, and total expenditure since 2012, expressed in US dollars. The farebox ratio, fare revenue as a share of total system revenue (fares plus subsidy), fell from about 55 percent before the pandemic to about 33 percent by 2025, as ridership and fares recovered more slowly than costs. Much of this was policy-driven. Fares were frozen from October 2019, after the social unrest, until September 2023. The Panel of Experts reports that the freeze left an accumulated gap of CLP 270 per trip between the fare and the level implied by its indexation formula (Panel de Expertos, 2026).[2] The subsidy absorbs the difference.

Moreover, the subsidy rose from about 0.25 percent of GDP at the start of the 2010s to 0.38 percent by 2024 (Gómez-Lobo, 2025). The reforms studied here therefore had to deliver fleet renewal without widening an already large and growing call on public funds.

[2]See González and Prem (2023) for the origins and a description of the 2019 social unrest.

Table 1: System revenues, subsidy and expenses, 2012–2025.

Year	Fare revenue (US$ m)	Subsidy (US$ m)	Expenditure (US$ m)	Farebox ratio	Subsidy (% of GDP)
2012	879	803	1,682	52.3%	0.31
2013	1,042	689	1,732	60.2%	0.25
2014	1,014	810	1,824	55.6%	0.29
2015	1,036	665	1,702	60.9%	0.24
2016	943	751	1,694	55.7%	0.26
2017	941	837	1,778	52.9%	0.29
2018	1,009	927	1,936	52.1%	0.31
2019	963	1,027	1,990	48.4%	0.34
2020	369	972	1,341	27.5%	0.34
2021	479	897	1,377	34.8%	0.28
2022	578	1,114	1,692	34.2%	0.34
2023	587	1,239	1,826	32.1%	0.38
2024	626	1,278	1,904	32.9%	0.38
2025	641	1,284	1,925	33.3%	–

Source: DTPM, Informe de Gestión 2025, Tabla 38 (system revenues and expenditure), converted to US dollars at 900 CLP/USD; subsidy as a share of GDP from Gómez-Lobo (2025, Table 3). Farebox ratio = fare revenue / (fare revenue + subsidy). The % of GDP series is computed on the operational-fleet subsidy and ends in 2024.

2.2 The *TranSantiago* failure and first reforms

The public transport system in Santiago was completely reformed in 2007. It went from semi-regulated atomized bus provision to a centrally planned system. The change was abrupt: on a single day in February 2007 the reform changed routes, fares, the fleet, and the contracts with operators at once (Gómez-Lobo, 2025). The outcome was immediately poor and set off a mobility and political crisis, with protests at bus stops in May 2007 (Gómez-Lobo, 2025; Muñoz et al., 2014). Gómez-Lobo (2025) argues that the main design flaw was the lack of funding for infrastructure and for operational subsidies. Because the new system had to break even at the average fare of the old one, planners cut the fleet size and the network coverage and relied on a rigid trunk-feeder structure. Waiting and travel times rose, the generalized cost of transit increased, and user welfare fell sharply (Gómez-Lobo, 2025).

Still, with hindsight the 2007 reform was a necessary first step toward organizing and modernizing the system. It replaced an atomized, semi-formal industry with centralized planning, formal concession contracts, integrated fares, and a single financial administrator, the base on which every later reform would build (Muñoz et al., 2014).

Fixing these shortcomings required bringing waiting and travel times down, which meant running more service and enforcing the operating plan. Neither was possible without two things the original design lacked: a stable source of funding and contracts that rewarded the service delivered. The reforms described below supplied both a permanent subsidy (Section 2.1) and successive contract renegotiations that rebuilt operators' incentives. Doing so created the financial and contractual framework on which the later electrification would depend.

The right incentives did not come at once. Three rounds of renegotiation, in mid-2007, 2009, and 2012, were needed before the system of incentives became robust (Gómez-Lobo, 2025). Technology made enforcement possible. By mid-2008 the AFT could locate every bus online, which let the authority check compliance with the operational plan in frequency and reliability (Gómez-Lobo, 2025).

The reform also reshaped how operators were paid. The original contracts paid operators mainly through a fixed transfer, adjusted only slightly by ridership, which gave weak incentives to run the promised service (Beltrán et al., 2013). The renegotiations moved payment toward kilometers served and tied a growing share of revenue to quality. Once the fleet-tracking system was in place, the authority introduced compliance measures based on capacity supplied, frequency, and regularity, first by company and later by individual service (Beltrán et al., 2013). The effect was immediate. The number of buses operating in peak hours rose from about 4,600 to 5,600 within two months of the first measure (Beltrán et al., 2013). By 2012 the contracts combined a per-kilometer payment with explicit quality indicators, the structure that the later tenders would inherit.

Operators took up different options: some ran out their original terms, others accepted three-year direct contracts, and others entered successive eighteen-month arrangements. Expiration dates therefore staggered across operators and across the routes they served. This dispersion, inherited from the heterogeneous 2007 concessions and the menu of contractual options opened by Law 20.504 in 2011, provides variation in the timing of electrification across routes that is plausibly unrelated to route-level trends. Both the original terms and the 2011 options were set well before electrification entered the policy agenda, so the date at which each route reached re-tender is not related to environmental and health objectives.

Predetermined timing does not by itself rule out that expiration dates correlate with route characteristics, such as demand density or fleet condition. González and Silva (2026) exploit this variation to estimate the causal effects of the rollout and address this remaining concern: their event-study estimates show no differential pre-trends, and their results are robust to alternative exposure definitions and to unit-specific trends; Section 5.1 summarizes the findings.

3 The mechanism

The problem the contracts had to solve is known. A transit bus is a long-lived asset with a thin secondary market. A lender that finances one prices two risks. The first is stranding: if the asset is tied to one operator and that operator loses its concession, the asset loses its use and much of its value. The second is counterparty default: the payments that service the debt depend on the solvency of a single operating firm. Under the operator-as-owner model, both premia enter operators' bids, and they bias the technology choice toward diesel, the technology with the least capital at risk and the most predictable residual value. Electric buses shift cost from operation to capital, so this bias penalizes them most.

Santiago's tenders attack each friction with a specific instrument. Removing a friction lowers some party's cost of capital or cost of entry. Lower costs widen participation, and wider participation shows up in prices. Table 2 maps each instrument to the friction it removes, the party whose cost falls, and the observable outcome. Section 4 shows how the instruments were introduced, generation by generation, and Section 5.3 traces the outcomes in prices.

Table 2: The mechanism: from contractual instrument to observable outcome.

Instrument	Friction it removes	Whose cost falls	Observable outcome
Concession-dedicated assets (Art. 3 nonies, Law 18.696)	Asset stranding at contract end	Lender's collateral risk	Fleet becomes bankable collateral; assets transfer to the next operator
Fixed fleet installment paid by the AFT, assigned to the financier	Operator default; counterparty risk	Supplier's and financier's cost of capital	Lower installments; firms that do not operate buses can finance fleets
Public terminals (SERVIU / Desarrollo País)	Land as an entry barrier	Entrants' sunk cost of bidding	Participation: 16 offers in 2019, 84 in 2023
Joint bid (operator, fleet provider, charging provider)	Sequencing risk; supplier uncertainty over whether awarded buses are bought	All three parties' pricing risk	Complementarities priced into bids; process shortened to 11 months
Long horizon matched to useful life	Refinancing and rollover risk	Financier	Full amortization inside the contract term

Note: each row summarizes contract features documented in Sections 4.2 and 4.3, based on DTPM (2024, 2025b). The chain runs from instrument to friction removed, to the party whose cost of capital or entry falls, to the outcome observed in participation or prices.

Importantly, the operating concession is insulated from fleet-finance risk by construction: the fleet installment is owed through the AFT regardless of which operator runs the route, so a lender to the fleet provider is not exposed to the operator's performance, and an operator's failure does not put the fleet's financing in default. The joint bid completes the certainty. Under the separate 2019 tenders, an awarded supplier was only on a list, and operators could end up not choosing its buses. In the joint bid, the fleet provider knows that if its consortium wins, its buses will be bought, which turns an option into a firm order and lets suppliers price it accordingly.

The design speaks directly to the theory of public–private partnerships. The bundling argument holds that construction and operation belong in one contract when the builder's choices affect operating costs that are hard to specify (Hart, 2003; Iossa and Martimort, 2015). Santiago unbundled instead and dealt with the lifecycle problem directly: the supplier that finances the bus also carries the certified maintenance standards and the battery-replacement duty, both priced into the installment. The joint bid of 2023 then rebundled the pricing: the three parties price their complementarities in one offer, while each risk stays with the party contracted to bear it. Moreover, as Engel et al. (2013) argue for privately financed public infrastructure in general, private financing repackages the public liability rather than eliminating it. The installments are firm public commitments; Section 5.3 quantifies them and Table 8 allocates what remains.

4 Enabling the electrification

Chile has been an active player in climate policy, through successive Nationally Determined Contributions and a broad set of public policies. After ratifying the Paris Agreement, the country pledged in 2015 to cut the emissions intensity of its GDP by 30% by 2030 relative to 2007. In 2020, while presiding over COP25, it strengthened this commitment. It set a maximum emissions budget of 1,100 million tons of CO_2-equivalent for 2020–2030, an emissions peak in 2025, and carbon neutrality by 2050 (Gobierno de Chile, 2020). These targets are operationalized through the Long-Term Climate Strategy, which mandates that all new additions to urban public transport be zero-emission by 2035 and that urban public transport systems be fully based on zero-emission technologies across all regions by 2040 (DTPM, 2025b).

Progress toward these goals rests on a set of state policies sustained across administrations and led jointly by the Ministries of Energy, Environment, and Transport and Telecommunications. They orient mitigation in the transport sector toward electromobility in public transport and modal shift. The main instruments are the 2050 Energy Policy and its 2022 update, the National Electromobility Strategy of 2017, its 2021 revision, and its 2026 update, the Energy Efficiency Law, the Energy Storage and Electromobility Law, the Roadmap for

Advancing Electromobility (with concrete actions to 2026), and the transport sector's own Sustainable Mobility Policy and Climate Change Adaptation and Mitigation Plan.

In the bus system, action on these commitments began modestly, with a pilot. In 2017 the first two electric buses entered service in Santiago, a founding milestone for what became RED Movilidad (DTPM, 2025b). In parallel, the authority launched its first attempt to tender an electric fleet at scale. The two belong together. The pilot tested the technology under local conditions, and the tender, though it was annulled, produced the contractual template on which every later tender would build.

4.1 2017 pilot and failed tendering process

The pilot was small but informative. The two buses let the authority test how the technology performed under Santiago's own conditions: its topography, its density, and its sharp peak demand. They also tested whether the power grid could deliver the energy needed to charge the fleet. The pilot showed the operational and maintenance gains of the technology, and it let users experience a modern, quiet, and comfortable service (DTPM, 2025b). These results set the basis for a gradual but decisive move to a much larger scale.

The pilot ran alongside a more ambitious step. Four concession contracts were due to expire in 2018, and the Ministry used its power to tender the use of road corridors on grounds of congestion, environmental damage, and road safety. In 2017 it drafted the first tender rules with a structural focus on sustainability, including 90 electric buses. Thirteen offers were submitted, but the antitrust court suspended the process in January 2018, after a bus operator challenged the rules as raising entry barriers and creating conditions for agreements among bidders.[3] In March 2018 the incoming administration declared the tender void (DTPM, 2025b).

The electric fleet did not wait for the redesigned tenders. In 2018, in what DTPM records as the first large-scale step, 100 electric buses entered service, operated by the incumbent Metbus with energy supplied by Enel, and the first two smart-charging electro-terminals opened in Maipú and Peñalolén (DTPM, 2024, 2025b). In 2019, 288 more electric buses and 613 Euro VI diesel buses followed (DTPM, 2025b). In 2020 the authority went further and replaced 1,341 Euro III diesel buses with 1,229 new units, 836 electric and 393 Euro VI, through the reassignment of 41 percent of the services of the outgoing operator Express to STP and Metbus (DTPM, 2024).

[3]Transportes Santín y Compañía Limitada sued the State and the Ministry before the Tribunal de Defensa de la Libre Competencia (TDLC) on 15 January 2018. The TDLC granted the requested suspension on 25 January 2018, restricted it to two business units on 13 March 2018, and lifted it on 27 August 2018. It rejected the claim, with costs, in Sentencia 170/2019 (TDLC, 2019).

These incorporations entered through negotiated fleet renewals and service reassignments within existing concessions, not through tenders. They already prefigured the separation of roles that the tenders would later formalize: the incumbent operated the service while an energy company financed and owned the buses and charging infrastructure and supplied the energy. The tenders added the competitive and contractual form of that separation, open to entrants and priced by the market. The roughly 100 electric buses that Santiago had in 2018 entered through this early channel.

After the failed call, the new tenders were redesigned around three lasting innovations. First, they made the separation of capital and operation explicit. They refined the provision contract (*Contrato de Provisión*), through which the operator obtains the use of the assets it needs, and they reinforced the figure of concession-dedicated assets created in 2015, so that buses and terminals could pass to a new operator when a contract ends. Second, the State took charge of terminals for the first time, which set the precedent for the electro-terminals as strategic public infrastructure. SERVIU had already acquired the first nine public terminals in 2017, for the original tender, so the removal of this entry barrier was under way before the failed call and the redesign carried it forward.

Third, the call reoriented the incentives toward service quality and clean technology. The payment formula gave more weight to supply, measured in kilometers, fleet, and standard, than to demand, in line with international evidence that supply-regulated systems are more stable and predictable (Hensher and Stanley, 2008). It rewarded zero-emission buses with extra points and a longer concession, seven years instead of five, and it set useful lives by technology, ten years for diesel, twelve for gas and hybrids, and fourteen years or 1.4 million kilometers for electric buses (DTPM, 2025b).

The new design lowered entry barriers, separated the terms of the provision and operation contracts, and let assets transfer between concessionaires. Together these features reduced financial risk, widened competition, and kept the assets essential to the service inside the system (DTPM, 2025b). The provision contracts also set maintenance and certification requirements for the fleet, verified by an independent third party (DTPM, 2025b).

4.2 First fleet tender

The first and most important step to enable the fleet renewal was the unbundling of operations, fleet provision, and depot infrastructure. The logic is simple. Risks from daily operations differ from risks on capital assets such as the rolling stock and terminals.

After the 2017 process, the authority split it into two complementary tenders. One tendered the supply of buses, the LSB, and the other the concession to use the road corridors, the LUV. Bus provision and bus operation were now contracted separately. Operators had to choose their fleet from the list of suppliers that the supply tender had already awarded (DTPM, 2025b).

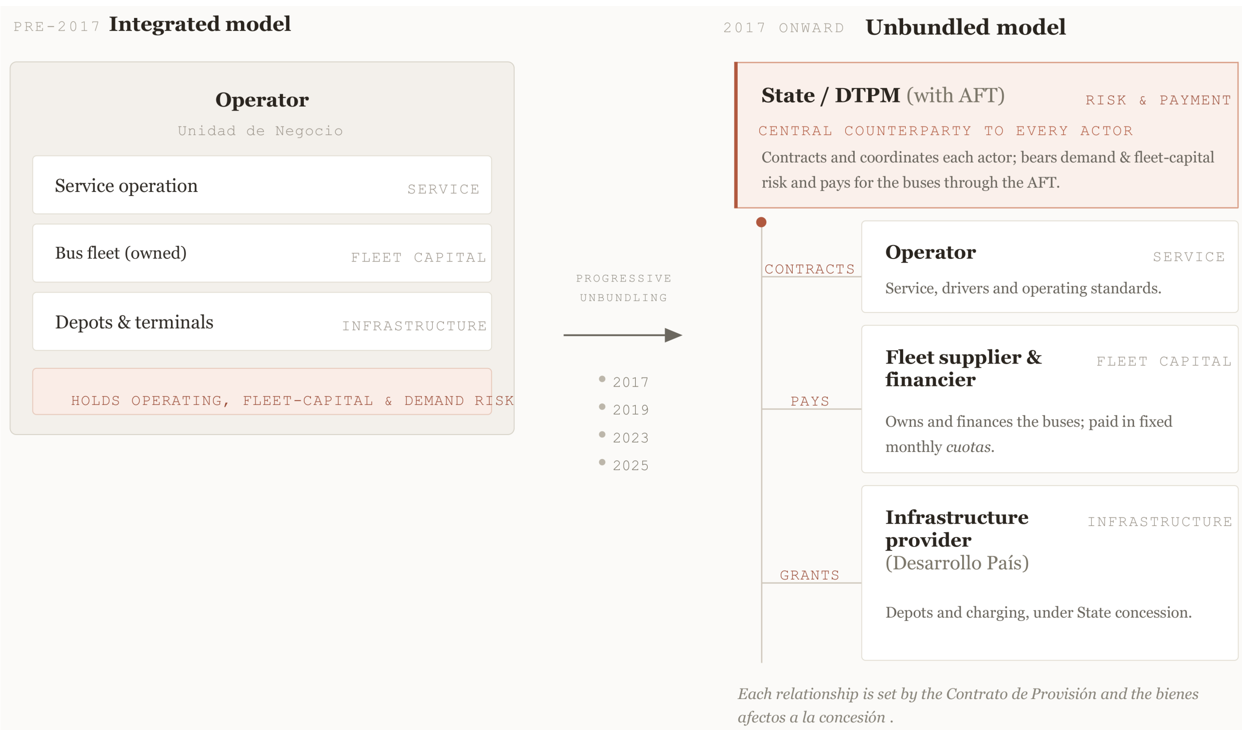
The unbundling left operating companies responsible for the transportation of passengers, operating the fleet, managing drivers, performing routine maintenance, and meeting service standards. The fleet suppliers are typically a fleet-leasing or vehicle-financing firm rather than an operating bus company. The companies are responsible for bus financing and for the asset's lifecycle obligations: they set the maintenance standards that an independent third party certifies, and they bear the battery-replacement duty. Finally, infrastructure providers manage the depots and the charging facilities. Separating these functions made it possible to give each risk to the party best able to manage it.

One consequence of the unbundling proved decisive for the technological transition. Under the original TranSantiago design, the choice of vehicle technology was effectively delegated to operators. The result was a strong preference for conventional diesel buses, whose technology and aftermarket were well understood and whose residual values were predictable. Under the unbundled design, the state sets the choice of vehicle technology through the specifications written into bus-supply contracts. The financing of the corresponding investment is borne by suppliers whose horizons can extend over the full economic life of the asset. The unbundling also made the threat of terminating an operator's contract credible. Figure 2 contrasts the two models. The change it depicts concerns fleet capital and infrastructure: demand risk had already shifted largely to the State in the 2012 renegotiations (Section 2.2).

Two legal and financial instruments make the unbundling work. The first is the figure of concession-dedicated assets (*bienes afectos a la concesión*), created by Article 3 nonies of Law 18.696 in 2015. It keeps every asset that is essential to the service tied to the system, so that at the end of a contract any asset with remaining useful life passes automatically to the next operator (DTPM, 2025b).

The second is the provision contract, approved by the Ministry, through which the operator obtains the use of the fleet and the charging assets. It sets a fixed monthly installment, the fleet installment (*cuota de flota*), that the AFT administers and pays directly to the asset financiers, so the financing of capital is separated from the operation of the service (DTPM, 2024). The installment is paid over the bus's full useful life (on the order of 120 monthly payments for a diesel bus and 168 for an electric one) and is owed irrespective of which operator runs the route, which is what lets the financier lend against it. The concessionaire assigns to the fleet provider its right to receive these payments through the AFT. The supplier is therefore guaranteed every installment over the life of the asset, which removes most of the counterparty risk a lender would otherwise price in.

Figure 2: The bus business model before and after unbundling.



Note: The left panel shows the risk bundle of the original integrated model. Demand risk had already largely shifted to the State in the 2012 renegotiations (Section 2.2); the unbundling shown on the right separates fleet capital and infrastructure from operation. Source: based on DTPM (2019).

The same contracts set useful lives by technology, ten years or one million kilometers for diesel buses and fourteen years or 1.4 million kilometers for electric buses, and they oblige the supplier to replace the batteries at its own cost when their range falls below the agreed minimum (DTPM, 2025b).

The supply tender shows how the State became the buyer of the fleet. Buses were grouped by typology, from small (A) to standard (B2) and articulated (C2), and within each typology by technology, diesel or electric. The rules awarded several suppliers in each lot and added a chassis and body diversity requirement, so that the system would not depend on a single manufacturer.

Offers were scored mostly on price, with about 70 percent on economics and 30 percent on technical merit. The price itself was a fixed monthly installment per bus, the fleet installment, which makes offers directly comparable across bidders within each lot. Across technologies, however, the monthly installment alone is not a comparable capital-cost measure, because diesel installments run over 120 months and electric ones over 168; the present value of each installment stream over its own payment term, reported in Table 3, is the relevant comparison. In present value, the electric installments ran well above the diesel ones for buses of the same size, which is the capital premium that the State chose to finance (DTPM, 2025b).

Table 3 reports the installments by bus typology, small (A), standard (B2), and articulated (C2), and by technology, listing each supplier's offer.

The incentives for operators to use a clean fleet became more specific. The concession ran for seven years instead of five when at least half of the proposed fleet was electric, a target met by three service units.

The dual process took more than three years and deepened the separation of capital and operation. It drew 23 offers for bus supply and 16 for operation. The awarded contracts financed 992 electric buses and 646 diesel Euro VI buses from three manufacturers: Foton, Mercedes-Benz with CAIO, and Volvo with Marcopolo. All 992 electric buses were Foton units supplied through K Cuatro. The diesel Euro VI fleet was 82 Mercedes-Benz through K Uno and 564 Volvo through Provebus. Three operators, RBU, STU, and Metropol, won the six service units on offer (DTPM, 2025b).

The operation tender paid for running the service and scored bidders partly on electrification. Awards weighed economics at about 87.5 percent and technical merit at 12.5 percent, with per-kilometer prices that differed by technology. A concentration cap limited any single group to two units, which forced a reassignment of units. The same contracts carried the differentiated useful lives and the battery-replacement duty on the supplier (DTPM, 2025b).

One friction in this first generation came from sequencing. Because the supply tender

Table 3: 2019 supply tender (LP SB 001/2019): monthly Cuota de Flota per bus (USD).

Typology	Technology	Supplier (bid)	Cuota de flota (US$/bus/month)	Present value (monthly rate 0.5%)
A	Diesel	VFS / Volvo	2,520–2,525	$226,985
A	Diesel	Kaufmann K1/K2	2,706–2,728	$243,739
A	Diesel	Scania	2,816–2,830	$253,647
A	Electric	Kaufmann K4 (Foton)	3,380	$383,552
A	Electric	BYD	4,760	$540,150
B2	Diesel	VFS / Volvo	2,628–2,638	$236,713
B2	Diesel	Kaufmann K1/K2	2,728–2,749	$245,720
B2	Diesel	Scania	3,096–3,103	$278,867
B2	Electric	Kaufmann K4 (Foton)	4,164	$472,518
B2	Electric	BYD	5,355	$607,669
C2	Diesel	VFS / Volvo	3,724–3,745	$335,434
C2	Diesel	Kaufmann K1/K2	3,880–3,902	$349,485
C2	Diesel	Scania	4,856–4,984	$437,397

Source: DTPM, LP SB 001/2019 evaluation record (Acta de Evaluación Económica y Final); monthly installment per bus, converted to USD at 900 CLP/USD. Present values discount the monthly installments over the useful life of each technology, 120 months for diesel and 168 months (14 years) for electric buses, at 0.5% per month.

was resolved before the operation concessions, the fleet installments were fixed at an earlier point than the per-kilometer operating prices, so that by the time operators began running the service some bid values no longer matched financial conditions on the ground. This timing gap, between committing to fleet prices and committing to operating prices, was one motivation for the next generation, in which the two were brought together in a single, jointly awarded bid. The deeper gain was the joint offer itself, which let the parties exploit complementarities across fleet, charging, and operation. The next section describes that generation, in which the three parties bid as a consortium.

4.3 Combined unbundling: 2023–2025

The 2023 tender consolidated the model and pushed it further. The authority prepared it with external studies and an unusually broad market consultation, a voluntary step without precedent in these tenders. The consultation gathered more than ninety technical questions from twelve firms on autonomy, batteries, charge management, costs, and safety. It confirmed lower maintenance costs and high fleet availability, and the participating firms reported limited battery degradation over a ten-year horizon of operation. That claim rests on supplier and market information rather than on local operating data; Santiago's own evidence, six years and 325,000 kilometers with more than 90 percent of battery capacity, is reported in

Section 5.1 (DTPM, 2025b). A parallel citizen process[4] brought accessibility and gender criteria into the design with about 15,300 participants.

The central change was the joint bid. Each offer now had to be presented together by three parties: the operator that runs the service, the provider that supplies and finances the fleet, and the provider of the charging infrastructure. Fleet and charging were again held as concession-dedicated assets (*bienes afectos a la concesión*) under provision contracts, transferable between operators, with monthly cuotas paid directly by the AFT and independent of demand or operational indicators (DTPM, 2025b). Bidding as one team let each of the three parties price in what each knew best, from battery cycles and maintenance to financing currency. It removed the uncertainty of running two consecutive tenders, and it gave financiers and suppliers certainty about the scale of the business from the start (DTPM, 2025b).

It also gave fleet providers certainty that, if the consortium's offer won, their buses would be bought. Under the separate supply tender, an awarded manufacturer was only on a list: it still depended on operators choosing its fleet, and in practice every electric bus purchased came from a single maker. Joint bidding also spared suppliers from keeping bid guarantees immobilized through two consecutive processes.

The joint design also compressed the process. The 2023 tender took eleven months from the call to the award, against more than three years in the previous generation, which shortened the period of immobilized capital (DTPM, 2025b). The five service units drew 84 offers, more than five times the participation of 2019, with an average of about seventeen offers per unit.[5] Bidders came from nine countries on the operating side, with five China-based manufacturers, four financiers, and two charging providers. The tender awarded 1,267 new electric buses, and the added competition cut fleet installments by 7 to 15 percent relative to earlier purchases (DTPM, 2025b).[6]

Competition also widened the set of operators. Gran Américas, a Colombian firm with experience in TransMilenio, entered in service unit 16, and Consorcio Conecta, which joins Hualpén of Chile with Avanza of Spain and ADO of Mexico, took units 17 and 18. Voy Santiago won the remaining two units.

[4] The process was called "*¿Qué te mueve?*", Spanish for what moves you?

[5] The Acta de Evaluación Económica y Final of LPCUV 001/2023 lists 84 offers: 18 for US14, 12 for US15, 18 for US16, 21 for US17, and 15 for US18. The competition authority reports the same total and the same split (FNE, 2026). DTPM (2025b) reports 86. I follow the tender record here, as I do for the 2019 diesel fleet count.

[6] The same source reports an estimated saving of about USD 60 million per year for the system from this tender (DTPM, 2025b), without breaking down its coverage. The figure is far larger than the installment reduction alone can deliver: the awarded fleet installments in Table 4 sum to roughly USD 50 million per year, so a 7 to 15 percent reduction in installments amounts to a few million dollars per year. The USD 60 million must therefore rest on a broader cost base, and I report it only as the official estimate.

On the supply side, each operator bid jointly with a fleet provider-financier and a charging provider. In public reporting, Grupo Cabal supplied and financed about 895 Zhongtong electric buses, around 70 percent of the tender, for the Gran Américas and Conecta units. Yutong built Voy Santiago's fleet. Copec, through Copec Voltex, won about 70 percent of the new charging infrastructure and built fourteen electroterminales under fourteen-year contracts, while the fleet-provision contracts run ten years. The rollout began in May 2025 and is in its final stage, with 81 percent of the electric buses and 75 percent of the new electro-terminals already in service. With this tender and the parallel fleet renewals, RED Movilidad is set to reach about 4,400 electric buses by March 2026, close to two thirds of the operating fleet (DTPM, 2025b).

The State also took charge of the depots and the charging sites. Terminals are now strategic public infrastructure rather than purely private facilities, and the State company Desarrollo País acquires and owns a growing share of them. By the end of 2025 Desarrollo País had acquired 24 terminals, about a third of the total, for RED Movilidad (DTPM, 2025b). In the 2023 process alone it acquired 19 terminals, four of them already in use under lease and four newly built and electrified (DTPM, 2025b). The first public terminals date back to the 2017 process, when SERVIU acquired nine of them. Public provision of terminals removes a large entry barrier, because an operator no longer needs to own land or build charging sites to bid. This is the charging-side counterpart of the bus-supply tender (DTPM, 2025b).

The economic record for the 2023 tender shows how far competition had broadened. Nine operating groups bid, several of them international entrants, with multiple variant bids per unit; all winning bids were fully electric. The two-unit concentration cap shaped the final allocation: Voy Santiago posted the highest score in four of the five units but could keep only two (US14 and US15), so US16 passed to the third-ranked Gran Américas and US17–US18 went to Consorcio Conecta. Competition was strong enough that the binding constraint on the leading bidder was the anti-concentration rule, not price.

The fleet installments reveal the price of the electric capital the State was financing. Across the serious bids the monthly fleet installment converged to about CLP 2.3–2.5 million (about USD 2,500–2,800) per bus for a standard electric vehicle and CLP 3.1–3.4 million (about USD 3,400–3,800) for a larger one. Bids were quoted in US dollars and in UF, converted at the rates set in the Acta. The per-kilometer operating prices awarded ranged from about CLP 1,100 to CLP 1,400 per commercial kilometer, lowest for Voy Santiago and highest for Conecta.

Taken together, the awarded bids financed 1,267 electric buses across the five units. The concessions run for ten years from the end of the transition period, adjustable to between seven and fourteen years at scheduled reviews of the operator's performance and of the condition of the buses and their batteries. Because the fleet installments are paid through the AFT independently of demand and operating indicators, these figures also fix the State's fleet-capital commitment for the life of the contracts, separately from what it pays operators to run the service.

Table 4: 2023 tender (LPCUV 001/2023): monthly fleet installment per bus, awarded bids (10-year installments).

Service unit	Awarded operator	Bus type	Bid currency	Cuota de flota (US$/bus/month)	Present value (monthly rate 0.5%)
US14	Voy Santiago	A	UF	2,771	$249,594
US15	Voy Santiago	A	USD	2,703	$243,469
US15	Voy Santiago	B	USD	3,744	$337,235
US16	Gran Américas	A	UF	2,524	$227,345
US16	Gran Américas	B	UF	3,509	$316,068
US17	Consorcio Conecta	A	UF	2,524	$227,345
US17	Consorcio Conecta	B	UF	3,509	$316,068
US18	Consorcio Conecta	A	UF	2,524	$227,345
US18	Consorcio Conecta	B	UF	3,509	$316,068

Note: Awarded (winning) bids only; all five service units are 100% electric. Type A is the smaller standard electric bus, type B the larger. The cuota is the monthly installment per bus; its present value discounts 120 monthly installments at 0.5% per month. Currency conversion, the reference rates, and the useful-life conventions are in Appendix A.1. Source: DTPM, LPCUV 001/2023, Acta de Evaluación Económica y Final (Anexos pp. 21–26).

The 2025 tender (LPCUV 001/2025) extended the same model to three further units, US20 to US22, under the same long concession term as 2023: ten years from the end of the transition period, adjustable to between seven and fourteen years at scheduled performance and fleet-condition reviews. The financial amortization term matches the base useful life: the 120 monthly installments repay the electric capital over the ten-year base useful life (800,000 km), while the scheduled reviews can extend the concession, and with it the buses' service life, to a maximum of fourteen years.

The design tightened the rules: the abnormally-low-bid ('temeraria') threshold was lowered from 20 to 15 percent below the peer average, while the two-unit concentration cap was retained. Eight operating groups competed. They submitted 63 offers, of which 54 were admissible and reached the economic evaluation: 21 for US20, 17 for US21, and 16 for US22.[7]

[7] The 54 admissible offers and their split across units are my own count from the Acta de Evaluación Económica y Final of LPCUV 001/2025 (pp. 5–6), which lists the economic value of every offer that passed admissibility and technical evaluation. The total of 63 offers received, and the nine set aside on admissibility grounds, are reported by the competition authority in its submission on this tender (FNE, 2026), which gives the same 21, 17, and 16 split.

Buses Vule swept the scoring, posting the best bid in all three units, but the concentration cap again reshaped the award: Vule kept US20 and US21, and US22, the unit where its margin over the runner-up was smallest, passed to Consorcio Conecta. The awarded fleet installments were about CLP 2.4–2.5 million (about USD 2,700–2,800) per electric bus per month, and the per-kilometer operating prices ran from roughly CLP 1,035 to CLP 1,360, again with Vule posting the lowest.

Table 6 collects the awarded per-kilometer prices and charging installments across the three tenders. In the 2023 and 2025 tenders every new bus is electric; the diesel price (PKd) remunerates the pre-existing diesel buses that each concessionaire takes over from the outgoing operators through the assignment of their provision contracts, notably during the transition period. As in 2023, the installments are paid through the AFT independently of demand. On the charging side, Copec Voltex was again awarded electroterminal infrastructure for these perimeters (six further electroterminales).

Table 5: 2025 tender (LPCUV 001/2025): monthly fleet installment per bus, awarded bids (10-year installments).

Service unit	Awarded operator	Bus type	Bid currency	Cuota de flota (US$/bus/month)	Present value (monthly rate 0.5%)
US20	Buses Vule	B	UF	2,692	$242,478
US21	Buses Vule	B	UF	2,692	$242,478
US22	Consorcio Conecta	B	UF	2,786	$250,945

Note: Awarded bids; all three service units are electric. The winning bids are standard (type B) electric buses; the US22 award also includes articulated (padrón alto) buses at the same cuota. The present value discounts 120 monthly installments at 0.5% per month. Currency conversion, the reference rate, and the useful-life conventions are in Appendix A.1. Source: DTPM, LPCUV 001/2025, Acta de Evaluación Económica y Final (Anexos pp. 16–18).

Table 6: Awarded per-kilometer operating prices and charging-infrastructure cuota, by tender.

Tender	PKe (electric) (real CLP/km, 2025)	PKd (diesel) (real CLP/km, 2025)	CIC (charging-infra) cuota (UF/unit)
2019 (LP CUV 001/2019)	1,017–1,175	1,365–1,558	≈ 780–2,420
2023 (LP CUV 001/2023)	1,121–1,439	1,599–2,258	≈ 1,480–3,060†
2025 (LP CUV 001/2025)	1,035–1,359	1,312–1,506	≈ 0–260

Note: Awarded bids; each cell is the min–max across the tender's awarded service units. PKe and PKd are the per-kilometer operating prices for electric and diesel service, in real 2025 Chilean pesos (deflated by the UF). CIC is the per-unit monthly charging-infrastructure installment in UF, not a per-bus or per-km rate. †Voy Santiago's 2023 CIC bids were in US dollars. The deflation method, the CIC scaling, and the diesel-price (PKd) treatment are in Appendix A.2. Source: DTPM Actas de Evaluación Económica y Final, LP CUV 001/2019, 001/2023 and 001/2025.

4.4 Summary

Section 4 has followed a single institutional idea through four tender generations. A 2017 pilot of two buses proved the technology locally, and a parallel, though annulled, tender drafted the template: separate the capital from the operation, tie essential assets to the system, and pay for the fleet through a contract independent of service revenue. The 2019 generation put this into practice as two complementary tenders, one for bus supply and one for the road-use concession, so that the State, not the operator, chose and financed the technology.

The 2023 and 2025 generations then folded the pieces back into a single joint bid by the operator, the fleet provider that also finances the buses, and the charging provider, lengthening contract horizons and reaching fully electric fleets. Santiago thus met the national goal of fully zero-emission fleet additions, set for 2035, more than a decade early: the 2023 and 2025 tenders required 100 percent electric new fleets.

Read as a sequence, the tenders implement the mechanism of Section 3. Each generation added an instrument, and each instrument left its trace in participation or prices (Table 2).

The cumulative effect is visible in the fleet. From two electric buses in 2017, RED Movilidad reached 3,849 by the end of 2025 and about 4,400 by early 2026, well over half of the operating fleet, without operators having to carry the electric capital on their own balance sheets. Figure 3 shows this trajectory. The growth through 2021 corresponds to the direct incorporations described in Section 4.1; the tendered fleets arrive from late 2022.

Table 7 summarizes the reallocation of ownership and risk across the four generations. Reading down a column shows who provided each input and who bore each risk in each generation; reading across a row shows how responsibility shifted, steadily, from the operator toward the State and its specialized counterparties.

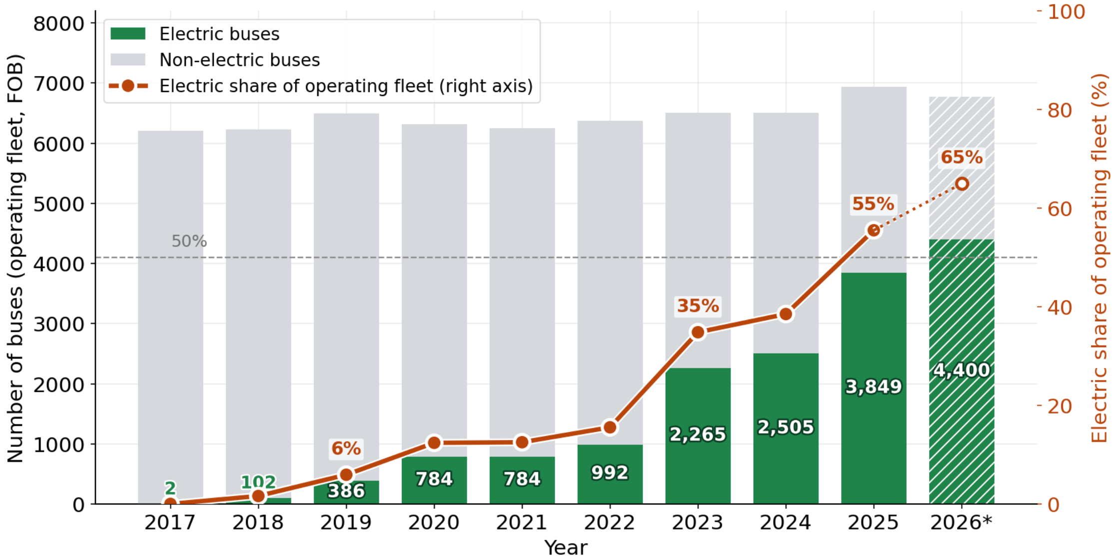
Moving risk off operators does not make it vanish. Table 8 lists the main residual exposures and who ultimately bears each one. The pattern is deliberate. The design removes the causes of the premia that lenders would otherwise charge, stranding at contract end and operator default, which lowers the total cost of the system. What remains, notably the payment commitment itself, lands on the State. Mitigation and transfer are therefore both at work, and the two should not be conflated: part of the risk disappears because the contract removes its cause, and the rest is a public liability.

Table 7: Ownership and risk structure.

Dimension	**Pre-2017 (integrated UN)**	**2019 (dual tender)**	**2023 (joint bid)**	**2025 (joint bid)**
Panel A. Who provides / owns				
Service operation	Operator	Operator	Operator	Operator
Bus fleet	Operator owns	State-tendered; concession-dedicated asset	State-tendered; concession-dedicated asset	State-tendered; concession-dedicated asset
Depots / terminals	Operator	State-provided (SERVIU); operator manages	State-provided (SERVIU / Desarrollo País); operator manages	State-provided; Desarrollo País owns ∼33% by 2025; operator manages
Charging	n/a (diesel)	Concession-dedicated asset; monthly CIC via AFT	Concession-dedicated asset; provider in joint bid; monthly CIC via AFT	Concession-dedicated asset; provider in joint bid; monthly CIC via AFT
Panel B. Who bears risk				
Demand risk	Operator → State (2012)	Mostly state	Mostly state	Mostly state
Fleet-capital risk	Operator	State / supplier (installment via AFT)	State / supplier (installment via AFT)	State / supplier (installment via AFT)
Fare revenue	AFT-centralized	AFT-centralized	AFT-centralized	AFT-centralized
Panel C. Contract terms				
Operator payment	per-pax → per-km + quality (2012)	per-km (commercial, by tech) + per-pax + quality indicators; charging/terminal installments (CIC/PCT)	per-km (commercial, by tech) + per-pax + quality indicators; charging installments (CIC)	per-km (commercial, by tech) + per-pax + quality indicators; charging installments (CIC)
Contract length	Variable	5 yr (+5); 7 if >50% electric (+7)	10 yr (range 7–14)	10 yr (range 7–14)

Note: each generation reallocated fleet, infrastructure, and demand risk away from operators, in part mitigating it rather than transferring it, and lengthened horizons, making electric capital financeable without operators bearing it. Desarrollo País (state company) owning terminals is the charging-side counterpart to the supply tender on the fleet side. Table 8 details the residual exposures.

Figure 3: Electrification of Santiago's bus fleet, 2017–2026.



Note: Bars show the operating base fleet (FOB), split into electric (green) and non-electric (grey); the line shows the electric share of the operating fleet (right axis). The electric fleet grew from 2 buses in 2017 to 3,849 at the end of 2025 and about 4,400 by March 2026, reaching 55% of the operating fleet in 2025 and about 65% in early 2026. The fleet-count details and the provisional 2026 figures are in Appendix A.3. Source: DTPM, Informe de Electromovilidad 2025 (Gráfico 1), and Informe de Gestión 2025 (p. 55).

Table 8: Residual risk after the reallocation: who ultimately bears each exposure.

Residual exposure	**Ultimately borne by**	**Contractual treatment**
Fleet-installment payment	State	Firm 10-to-14-year commitment paid via the AFT, independent of demand and operation; backed by the statutory subsidy (Law 20.378)
Asset underuse or redeployment at contract end	State	Concession-dedicated assets transfer to the next operator with their remaining useful life
Battery health	Supplier	Battery-replacement duty when autonomy falls below the agreed minimum, verified by independent certification
Technology obsolescence	State	Scheduled reviews condition the extension from ten to fourteen years on bus and battery condition
Operator or supplier insolvency	State	Assets and provision contracts transfer between operators; supplier-diversity rule; performance guarantees
Currency and indexation	State	Fleet installments quoted in UF or US dollars; operator payments indexed by a cost polynomial
Charger downtime	Charging provider and operator	Availability standards; backup generation of at least 25 percent of installed load

Note: exposures and instruments as documented in DTPM (2024, 2025b) and in the 2023/2025 tender bases (concession term reviews, battery guarantee, certification, and backup requirements). "Ultimately borne by" identifies who pays if the mitigant is exhausted.

5 Impacts

This section focuses on what the electrification delivered. I group the impacts in three parts: the direct effects of renewing the fleet on emissions, noise, maintenance, and reliability (Section 5.1); the role of terminals and charging infrastructure (Section 5.2); and the financial outcome for the system, comparing the electric model with a diesel counterfactual (Section 5.3).

5.1 Fleet renewal

The most direct effect of fleet renewal is on emissions. Between 2018 and 2025 the bus system's greenhouse-gas emissions fell by about 37 percent, its fine-particulate ($PM_{2.5}$) emissions by about 74 percent, and its nitrogen-oxide emissions by about 94 percent, even as service levels were maintained (DTPM, 2025b). The buses are now a small part of the transport sector's footprint: in the order of 3 to 4 percent of its CO_2-equivalent and particulate emissions, against roughly 90 percent from cars and motorcycles. The reports value the greenhouse-gas emissions avoided in 2025 alone at about CLP 19 billion, and attribute part of the city's avoided air-pollution mortality to the cleaner fleet.

Electrification also changed the day-to-day quality of the service. Along the central Alameda corridor, acoustic energy in the morning peak fell by about 44 percent between 2019 and 2023, consistent with measurements in which an electric bus is several times quieter than a diesel one at urban speeds (DTPM, 2025b). Operating performance improved as well: maintenance costs per kilometer are around 44 percent lower for electric than for diesel buses (DTPM, 2024), and breakdown rates are markedly lower. Concerns about battery durability have so far not materialized: average state of health is about 91 percent, and buses that have already been used for six years and 325,000 kilometers still retain more than 90 percent of capacity (DTPM, 2025b).

These operational gains matter. Lower maintenance and high availability are the savings that make the electric option competitive over the life of the asset, despite its higher purchase price. The contracts allocate them along the same line that divides the risks. Routine maintenance and availability are the operator's cost and duty, so the roughly 44 percent saving per kilometer accrues first to operators and reaches the system through competitive per-kilometer bids. Battery replacement and end-of-life risks are the supplier's, and are priced into the fleet installment. Third-party certification of maintenance standards aligns the two.

The figures above are system-level accounting. Causal evidence comes from a companion paper (González and Silva, 2026) that exploits the staggered, contract-driven timing of electrification across routes described in Section 2.2. The estimates compare the same route or location before and after its service becomes more electric, holding total bus activity fixed. Fully electrifying a route raises ridership by 4 to 6 percent, with no change in operating speed. It also lowers $PM_{2.5}$ and nitrogen-oxide concentrations near electrified service, cuts accident and injury rates by about 20 percent, and reduces peak-hour noise by about 1.4 dB(A) near the busiest corridors.

On the service-supply side, the same estimates show that operators deploy more buses as a route electrifies, about 8 percent more in peak hours and 10 to 17 percent more off-peak and on weekends, while passenger capacity per kilometer falls moderately, consistent with electric buses replacing higher-capacity conventional units. The higher ridership therefore comes from the broader service upgrade that fleet renewal brings. Trips were not faster, since the speed effect is a precise zero, and capacity did not rise. Stated-preference evidence points the same way: in a choice experiment in Rome, travelers value the cleaner, quieter, and smoother ride of electric buses, and regular public transport users value these attributes most (Giagnorio et al., 2026).

The pollution reductions imply roughly 240 avoided premature deaths per year at the 2025 electric share. Valued at Chile's official social prices, the gains amount to USD 215 to 668 million per year in 2025, depending on how avoided deaths are valued, between one-sixth and one-half of the annual public subsidy (González and Silva, 2026).

5.2 Terminals and charging

Electrification changed what a terminal is. A diesel bus can refuel in minutes at dispersed fueling points, so a depot is mainly a place to park and maintain the fleet. An electric bus depends on the charging capacity installed where it is based, which makes the terminal a binding constraint on operations. The DTPM now treats the electro-terminals as critical infrastructure: they concentrate the charging of batteries, the planning and control of the operation, the maintenance of the fleet, and the management of personnel, and their location, capacity, and backup determine the reliability of the service (DTPM, 2025b).

The scale-up was fast. After the first two electro-terminals opened in 2018 (Section 4.1), five were enabled in 2019, with the arrival of the first large lots of electric buses; fourteen more entered in 2023 with the first tendered fleet, and seventeen in 2025 alone, the largest single-year addition. By the end of 2025 the system had 73 terminals, of which 45 are electro-terminals (61 percent of the total), spread over 15 municipalities and with about 125 MW of installed charging capacity. Ten more electro-terminals are expected by March 2026, for a total of 55 (DTPM, 2025b).

Ownership moved with the scale. Section 4.3 described the mechanics: SERVIU bought the first nine terminals in 2017, and by the end of 2025 the State company Desarrollo País owned 24, about a third of the total, 16 of them electro-terminals (DTPM, 2025b).

The impact is easiest to see against the model it replaced. When terminals were the operators' private assets, their location and capacity were the operators' decisions, which created rigidity in network planning, gave incumbents an advantage in re-tenders, and added cost through non-commercial kilometers (DTPM, 2025b). Part of the stock was leased from private owners: four of the nineteen terminals Desarrollo País acquired for the 2023 tender had been under lease. DTPM attributes lower costs and more flexible service planning to the shift toward public ownership (DTPM, 2025b).

The impact on competition follows directly. Two distinct barriers fell. First, the Ministry makes the required sites available to the awarded operators, so bidding no longer requires owning land. Second, the charging provider in the consortium supplies the chargers as concession-dedicated assets, paid through monthly CIC installments via the AFT, so the operator does not need to finance or build the charging either. Charging provision stays inside the bid, but the operator no longer has to carry it. The DTPM credits the removal of this entry barrier with a direct effect on participation and on the resulting prices (DTPM, 2025b). The participation record in Section 4 is consistent with this: 16 offers for the 2019 operation tender, 84 in 2023, and 54 in 2025 for only three service units.

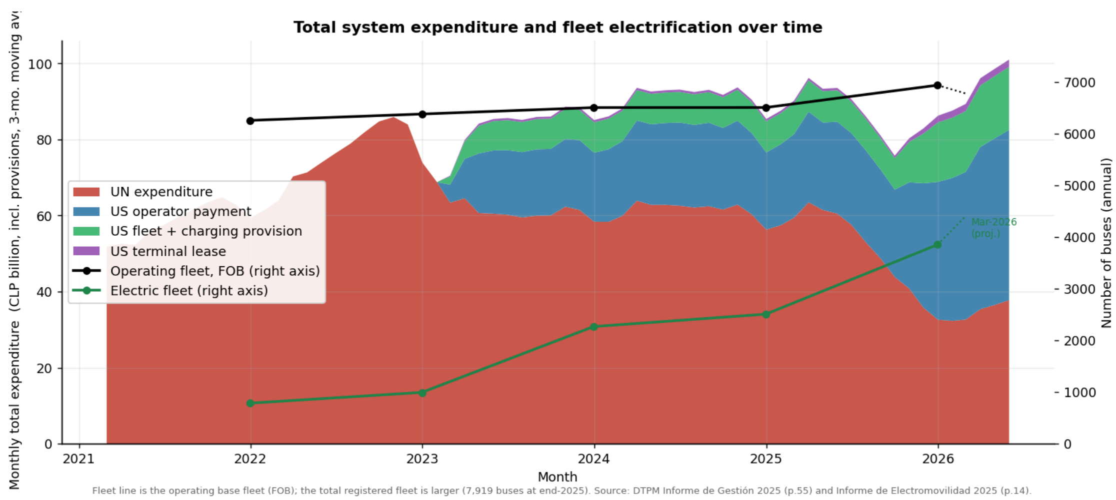
The open issues are on the energy side. Charging concentrates large electricity demands at single points of the distribution network, so commissioning an electro-terminal requires early coordination with the distribution companies and the national grid coordinator; for the largest sites, distributors have reinforced feeders and built dedicated lines (DTPM, 2025b). Resilience has held up so far. Every electro-terminal carries backup generation, typically at least 25 percent of its installed load, and most supply interruptions in the last year lasted under three hours, with brief voltage dips proving more disruptive than long outages (DTPM, 2025b). Finally, charging is now part of daily operations: charging windows, contracted power, electricity tariffs, and battery care all enter service planning, a management layer that did not exist under diesel.

5.3 Financial (electric vs diesel)

The central financial question is whether electrifying the fleet raised the cost of running the system. Measured per kilometer of service, it did not: the tendering changed the technology, from diesel to electric, without a material change in unit cost. Figure 4 shows the path of total bus expenditure and its composition, with service and spending migrating from the old concession (UN) units to the new tendered (US) units as the fleet electrified. The series is in nominal pesos, and its growth is almost entirely indexation rather than volume. The cost per kilometer of the new electric units is about the same as that of the units they replaced, as the next paragraphs and Figure 5 show.

Comparing January through November of 2022 with the same months of 2025, DTPM's total outlay on the bus system grew 17.7 percent in nominal pesos. Billed kilometers did not change (335.2 million in both windows), and the UF, the CPI-indexed unit in which the contracts are denominated, rose 18.7 percent between the midpoints of the two windows. In real terms the total therefore fell slightly, by about 0.8 percent, while the capital items DTPM funds directly went from zero to 10.3 percent of the total as the tendered units entered: 9.6 percent for the fleet and charging installments and 0.7 percent for the terminal leases. Figure 4 thus shows a change in the composition of a roughly constant real total.[8]

Figure 4: Total system expenditure over time, by contract family and component (operator payments, fleet and charging provisions, and terminal leases).



Note: The four bands sum DTPM's total outlay on the bus system. UN operators own their buses and hold their own terminals, so UN expenditure is their operator payment alone; for the tendered (US) units the fleet and charging cost DTPM funds directly, and the lease payments on the terminals it rents for each unit, are shown separately from the operations payment. The right axis shows the operating base fleet (FOB) and the electric fleet. The series is in nominal Chilean pesos; the composition of its growth and its comparability with Table 1 are in Appendix A.4. Source: author's calculations from DTPM operator-payment, fleet-supply, and terminal-lease records.

Measured as system cost per kilometer, including the fleet, charging, and terminal costs, the new tendered units cost about the same as the old concession units. Over the panel the

[8]Author's calculations from the same unit-by-month payment panel as Figures 4 and 5. Nominal totals: CLP 808 billion (January–November 2022) against CLP 951 billion (January–November 2025), +17.7 percent; billed kilometers 335.2 million in both windows; UF 33,086.83 on 30 June 2022 against 39,267.07 on 30 June 2025 (Servicio de Impuestos Internos), +18.7 percent. Deflating by the UF, the 2025 total is about 0.8 percent below the 2022 total. Note that Figure 4 is in nominal pesos while Table 1 converts annual totals to US dollars at a fixed 900 CLP/USD, so the two are not directly comparable.

first wave (U8–U13) averages about CLP 2,710 per kilometer and the newest, fully electric perimeters (U14 onward) about CLP 2,800, against roughly CLP 2,540 for the UN units; in the most recent months, the only window in which all three cohorts operate, they range from about CLP 2,800 to CLP 2,950 and the newest units are the cheapest of the three (Figure 5). The comparison is like-for-like, putting the full fleet and terminal cost on both families: embedded in the per-kilometer rate for the UN units, which own their buses and hold their own terminals, and added as separate fleet, charging, and terminal payments for the US units, which do neither. The technology change was therefore achieved without materially changing the cost of a kilometer of service.

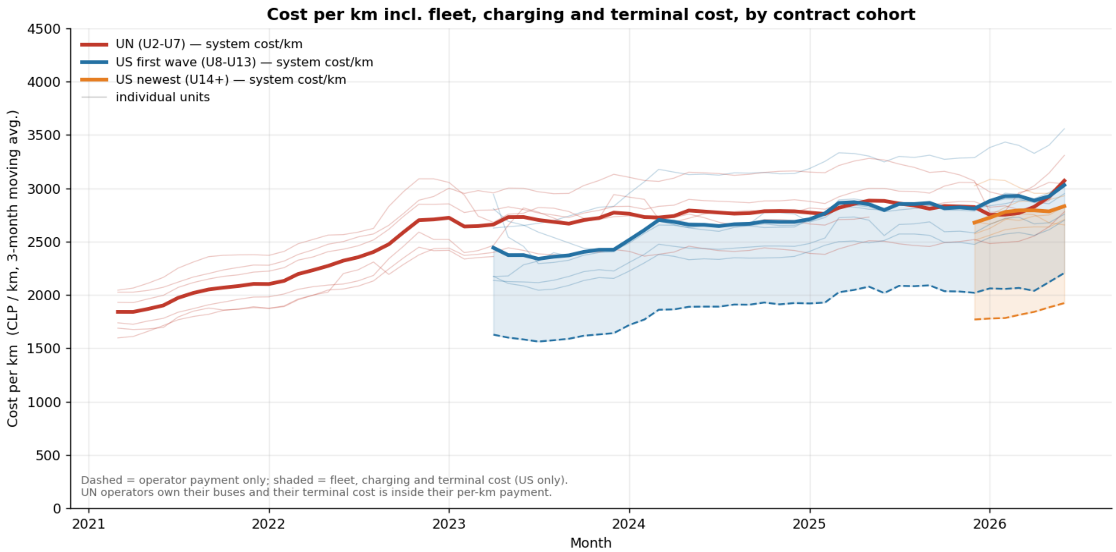
The accounting boundary of this comparison should be explicit. For every unit the metric includes the operator payment, which covers labor, energy, and routine maintenance; energy is paid by the operators under both technologies, and the payment's indexation formula carries an electricity component for electric buses. For the tendered units it adds the fleet and charging installments (the cuota de flota and the CIC) that DTPM pays through the AFT, and the lease payments on the terminals DTPM rents for each unit; for the UN units, whose operators own their buses and hold their own terminals, the equivalent capital is embedded in the per-kilometer rate.

Terminal leases used to sit outside this boundary. They are now inside it. DTPM leases 33 terminals covering 798,075 square meters, at a combined UF 48,691 per month over 25-year terms. The file that records these payments carries no unit identifier, so I match each terminal to the unit whose ficha técnica lists it. Twenty-nine of the 33, worth 94.8 percent of the monthly total, belong to a tendered unit. That is CLP 55 per billed kilometer for the first wave and CLP 126 for the newest perimeters, or 2.0 and 4.5 percent of their cost per kilometer. Appendix A.4 gives the matching rule and the four rows it cannot place.

Two exclusions remain, and both are small. The first is the purchase price of the terminals SERVIU and Desarrollo País own outright, which is capital already spent rather than a recurring payment; the leases priced here are the closest available measure of what that land and building capacity is worth per year. The second is the grid reinforcement the distribution companies carry, which no public source reports at the unit level. Neither exclusion is symmetric across the two families, and both work in the same direction, understating the cost of the tendered units.

Figure 5 compares the electric units with the units they replaced. The economically relevant counterfactual is different: renewing the fleet with new diesel buses under the same contracts. The 2019 tender priced exactly this alternative, and because bus supply and operation were tendered separately that year, neither price could cross-subsidize the other. On the capital side, the contractual useful lives imply the same annual mileage for both

Figure 5: System cost per kilometer (including provisions) by contract cohort.



Note: System cost per kilometer is DTPM's full outlay for a unit divided by its billed kilometers. It includes the fleet and charging provisions and the terminal leases for the tendered (US) units and, for the older concession (UN) units whose operators own their buses and hold their own terminals, the fleet and terminal capital embedded in the per-kilometer payment. Billed kilometers are compliance-adjusted on both sides, making the comparison like-for-like. The outlay construction, the terminal-to-unit matching, and the remaining excluded public capital are in Appendix A.4. Source: author's calculations from DTPM records and the Actas de Evaluación Económica y Final.

technologies, 100,000 kilometers per year, so the present values in Table 3 translate directly into capital cost per contractual kilometer: CLP 213 to 251 for a standard (B2) diesel bus against about CLP 304 for the electric buses actually deployed, a premium of CLP 53 to 91 per kilometer. On the operating side, the awarded per-kilometer prices in the same tender ran CLP 190 to 541 higher for diesel than for electric service (Table 6, in real 2025 pesos), reflecting the energy and maintenance costs that operators bid. The operating advantage the market assigned to electric service is therefore at least twice its capital premium, and the conclusion survives measuring capital per billed rather than contractual kilometer (Appendix A.5). On the 2019 awarded prices, a new diesel fleet would have cost more per kilometer than the electric fleet the system bought; this is the tender-price counterpart of the lifecycle evaluation reported below.

The fleet installments themselves fell as competition intensified. The per-bus monthly fleet installment came down across successive tenders (Figure 6), and the electromobility evaluation attributes the decline directly to the competitive process, describing the fall in electric-bus prices as strongly influenced by the recent tender processes and their high competition (DTPM, 2024).

Two objects should be distinguished here. The monthly installment is the term-free price measure, and it fell on its own: by 18 to 25 percent for the smaller type A and 10 to 16 percent for the larger type B, relative to the 2019 electric installments. The present value is a different object, the State's committed capital per contracted bus under each tender's own payment term. That commitment fell from about USD 384,000–473,000 per electric bus actually deployed in 2019 to about USD 227,000–337,000 in 2023–2025 (Tables 3–5), a larger fall that combines the price decline with the shorter payment term, 120 months against 168.

An annualized measure puts the tenders on a like-for-like footing: dividing each present value by its base useful life, the commitment per year of bus life fell from about USD 27,400–33,800 in 2019 (fourteen years) to about USD 22,700–33,700 in 2023–2025 (ten years), a large decline at the bottom of the range and a small one at the top. The shorter base life also means the bus must be replaced sooner, unless the scheduled reviews extend the concession to fourteen years; in that case the extension years carry no installment, because the 120 payments complete the amortization.

The 2019 range covers the buses the system actually bought, all Foton units supplied through K Cuatro; across all suppliers awarded in the 2019 framework the range reaches USD 608,000 (Table 3), so the decline measured from the full awarded set is larger, and the headline figure is the conservative one.

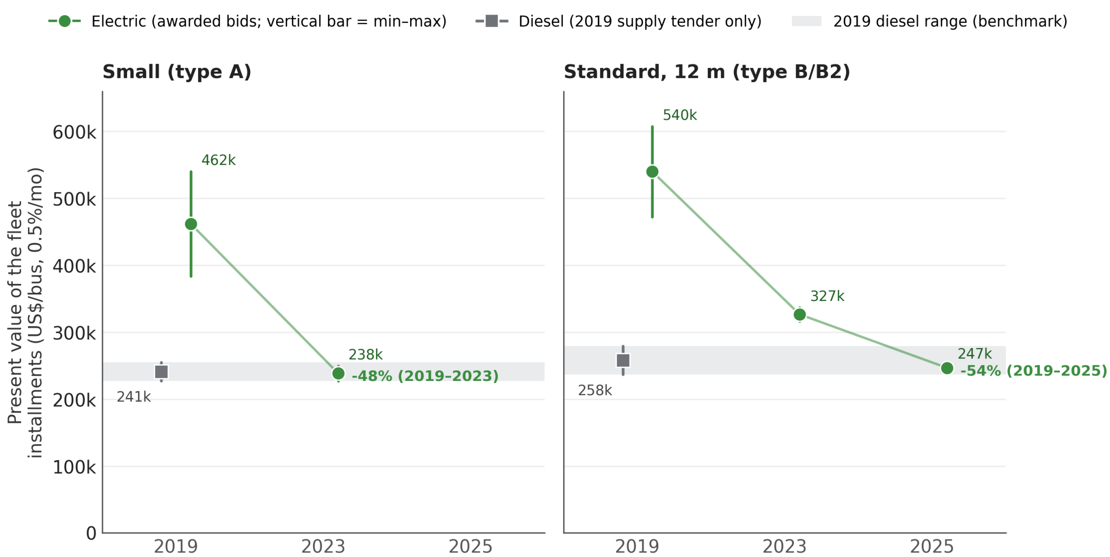
The attribution to competition needs a caveat, because between 2019 and 2025 several forces moved together: global battery and electric-bus prices fell, the payment term shortened from 168 to 120 months, bus specifications differ across tenders, and bids were quoted in different currencies.

A benchmark puts the decline in context. The volume-weighted average lithium-ion battery pack price fell 26 percent between 2019 and 2024, from USD 156 to USD 115 per kilowatt-hour (BloombergNEF, 2019, 2024). Batteries are only a fraction of an electric bus's cost, so pass-through of that decline alone would cut the installment by well under ten percent. The awarded monthly installments fell more: 18 to 25 percent for the smaller type A and 10 to 16 percent for the larger type B, holding the payment term fixed. The tenders therefore passed at least the full global price decline through to the State, and the participation record points to competition as the channel.[9] The official estimate is a reduction in installments of roughly 7 to 15 percent relative to earlier purchases (DTPM,

[9]The evaluation records support the competition channel from within the tenders. Across the nine 2023 bidders, the offered monthly installment for the larger type-B electric bus ranged from CLP 3.08 to 3.46 million (converting UF- and USD-denominated bids at the Acta's own rates), a spread of about 12 percent from lowest to highest. The installment awarded in US16 to US18 (CLP 3.16 million) is the second lowest of that distribution; Voy Santiago's higher installment in US15 (CLP 3.37 million) was paired with the lowest per-kilometer operating prices of the tender. For the smaller type A the range is CLP 2.15 to 2.44 million, excluding one outlier at CLP 2.83 million. Source: DTPM, LPCUV 001/2023, Acta de Evaluación Económica y Final, Anexos.

2025b) (Section 4.3 discusses the official USD 60 million per year savings estimate and its coverage).

Figure 6: Present value of the fleet installments per bus.



Note: Fleet installment discounted at 0.5% per month over the bus useful life, by tender, technology, and bus type. Bars show the min–max across awarded bids; the shaded band is the 2019 diesel range. The useful-life terms (168 months in 2019 against 120 in 2023–2025), the deployed-versus-awarded 2019 range, and the per-year-of-life comparison are in Appendix A.1. Source: author's calculations from the DTPM Actas de Evaluación Económica y Final (LP SB 001/2019, LP CUV 001/2023 and 001/2025), at 900 CLP/USD.

Over the full life cycle the electric path is the cheaper one. Cumulative investment in electromobility reached about USD 227 million by 2024, with a further USD 809 million in vehicles and USD 79 million in infrastructure projected to 2040 (DTPM, 2024). Against this, the present value of system costs to 2040 is lower under electrification than under a non-electric baseline, about USD 9.19 billion in the trend-electrification scenario versus USD 9.96 billion with no electrification, so the higher capital cost is more than offset by lower energy and maintenance costs. Realized private savings were about USD 174 million over 2015–2024, with roughly USD 2.8 billion more projected for 2025–2040, alongside monetized greenhouse-gas benefits above USD 411 million. The technological change therefore did not raise the system's cost and most likely lowered it. Setting the externality and ridership gains against this near-zero incremental cost, González and Silva (2026) find net benefits of USD 215 to 668 million per year at 2025 electrification levels. Their cost arithmetic points the same way: at social prices, the present value of the energy saving alone over the 14-year fleet contract is about twice the capital premium of an electric bus.

The cost record has a fiscal counterpart. The guarantee that makes the fleet bankable is, symmetrically, a long-term public payment commitment: the awarded installments are owed through the AFT for 120 months regardless of demand, operating performance, or who runs the route. In present value, the fleet installments awarded in the 2023 and 2025 tenders commit on the order of USD 430 million (the installments in Tables 4 and 5 times the awarded fleets), before the charging installments. These are debt-like obligations of the system, not contingent transfers, and Table 8 details who bears what remains after the contractual mitigants. The design lowers the total risk premium the system pays. The residual exposure is a public commitment.

6 Policy lessons

Santiago's electrification was a sequence of contract redesigns built on a funding base that already existed. The experience transfers for that reason: the tools are procurement tools, available to any authority that tenders bus services. This section draws the main lessons and states the conditions under which they travel.

The first lesson is that stable funding comes before technology. The permanent subsidy created in 2009 preceded the first electric tender by almost a decade. The subsidy did not pay a green premium; Section 5.3 shows that the cost per kilometer of service did not materially change. It made long horizons credible. A financier that lends against a stream of 120 or 168 monthly installments needs to believe that the system will be there, and solvent, for that long. Cities that attempt electrification on year-to-year budgets ask private capital to bear a commitment risk that it will price heavily or refuse.

The second lesson is to unbundle capital from operation and move the technology choice to the authority. When operators chose the fleet and carried it on their balance sheets, they rationally chose diesel: a known technology, a deep aftermarket, and predictable residual values. Under the unbundled design, the State sets the technology in the supply and provision contracts, and suppliers finance it over the full economic life of the asset. Operators run buses they do not own, and competition shifts to the cost of operating rather than the capacity to finance vehicles.

The third lesson is that the guarantee structure does most of the work. Two instruments matter. The concession-dedicated assets keep the fleet and the charging infrastructure tied to the system and transfer them to the next operator when a contract ends. The fixed monthly installment, paid by the AFT directly to the asset financiers, is owed irrespective of which operator runs the route. Together they remove the two risks that make lenders charge a premium on transit assets: stranding at the end of a contract and operator default. The effect was visible in prices. In present value, the financing cost per electric bus actually deployed fell from about USD 384,000–473,000 in 2019 to about USD 227,000–337,000 in

2023–2025 (Section 5.3). The monthly installment fell 10 to 25 percent on its own, with the term held fixed, a decline the official evaluation attributes to competition in the tenders (DTPM, 2024).

The fourth lesson is that competition must be designed, not assumed. Participation rose from 16 offers in 2019 to 84 in 2023 because the barriers fell: public terminals removed the land requirement, the provision contract removed the fleet-financing requirement, and the joint bid let operators, financiers, and charging providers price what each knows best. The rules also disciplined the outcome, with a concentration cap that limited any group to two units and a threshold for abnormally low bids. The official evaluation attributes the 7 to 15 percent fall in fleet installments to this widened competition, not to a larger subsidy (DTPM, 2025b), and the participation record is consistent with that reading.

The fifth lesson is continuity. The model was built across three administrations from both sides of the political spectrum: the pilot and the first tender under one government, the 2019 generation under the next, and the 2023 and 2025 generations under a third. It survived the annulment of its first tender, a collusion complaint, the 2019 social unrest, and the pandemic; the administration that annulled the 2017 call kept its contractual template and built the 2019 tenders on it. A legal architecture persisted throughout: the subsidy law of 2009, the concession-dedicated assets of 2015, and contract templates refined tender by tender. For a financier lending against 120 monthly installments, that record is part of the collateral. Cities where each administration rewrites its predecessor's transport policy cannot substitute contract clauses for it.

These lessons travel with conditions, and the conditions are not all of the same rank. Four are essential prerequisites. The first is a statutory, permanent funding base and the public solvency behind it. Santiago's subsidy is set by Law 20.378, and a financier lending against 120 monthly installments must believe the State will honor a ten-year payment promise. Sovereign or state-backed creditworthiness is therefore foundational. Cities without an equivalent of the AFT can use a trustee or escrow arrangement, but such an arrangement only relocates creditworthiness; it does not create it.

The second is a single authority with the legal power to tender the use of roads and to enforce ten-year contracts. The third is a legal device that keeps essential assets tied to the system across operators; cities without concession-dedicated assets would need to create them, as Chile did in 2015 by amending Law 18.696. The fourth is a credible central payment channel, the AFT or its substitute, through which the installments are guaranteed. Other conditions helped Santiago but are not prerequisites: a dense network and high annual mileage per bus favor cost-competitiveness (Avenali et al., 2023, 2024a), public land for terminals lowers entry barriers further, and coordination capacity with the power sector speeds up deployment.

The regional record offers one out-of-sample check on these conditions. Bogotá built the second-largest electric fleet in the Americas, about 1,550 buses by May 2026 (Figure 1), on the same core design: TransMilenio contracted fleet provision separately from operation, and providers such as Enel X and Celsia own and finance the buses and charging and lease them to the operators under long-term agreements (Sustainable Bus, 2021; Walker, 2021). The stated rationale mirrors Santiago's: the owner receives fixed payments against collateralizable assets, while the operator carries little capital risk (Walker, 2021). Santiago and Bogotá together hold about two thirds of Latin America's electric buses (ICCT, 2025). That the regional fleet is concentrated in the two cities that moved the buses off the operators' balance sheets supports the reading that the binding constraint is financing, not technology.

The model also has a downside, and Santiago's own record makes it plain. By centralizing fare revenue in the AFT and paying operators per kilometer, the design moves the demand and revenue risk onto the State, and with it the cost of fare evasion. Operators are paid whether or not riders pay, so none of them internalizes fare collection, and the loss falls on the public subsidy.

Santiago has found this risk hard to contain. Evasion on the buses reached 46.2 percent in 2020, the highest on record, under a measurement method the authority revised to be more precise. A sustained anti-evasion plan then brought it down for five consecutive semesters, but it still stood at 34.9 percent in the second half of 2025 (DTPM, 2025a). That level is among the highest of any large regulated bus system. It is comparable only to New York City, where more than a third of bus riders did not pay in 2022 (MTA, 2023), and far above well-enforced networks such as London, at about 3.5 percent across all modes (Transport for London, 2025), or Sydney, at about 11 percent on buses (Transport for NSW, 2023); Paris sits in between, at about 8 percent network-wide and higher on buses (Île-de-France Mobilités, 2025). A city adopting this model inherits the enforcement problem along with the risk transfer. Moving demand risk to the State improves welfare only if the State can also collect the fare, and Santiago shows that collection is not guaranteed.

The general lesson is that fleet electrification is mainly a financing problem, and financing problems can be solved with contract design. Santiago reached the largest electric-bus fleet outside China without a dedicated electrification fund and without materially changing the cost of a kilometer of service, and with externality gains worth one-sixth to one-half of the annual subsidy (González and Silva, 2026). The instruments that delivered it (unbundling, concession-dedicated assets, guaranteed installments, and competitive joint bids) are procurement instruments, and they travel wherever the essential prerequisites above hold or can be created. Where the State's long-term payment promise is not credible to lenders, the guarantee structure has no anchor, and the model does not transfer as it stands.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process.

During the preparation of this work, the author used Claude to identify typos, detect articles that were cited but not in the reference list and vice versa, improve grammar and write calculation scripts. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

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A Data and methods

This appendix collects the construction and conversion details behind the figures and tables in the main text. Each subsection is referenced from the note of the exhibit it documents.

A.1 Fleet installments: present values and useful lives

This subsection documents the fleet-installment figures in Tables 3, 4, and 5 and in Figure 6.

Cuotas are quoted in different units across bids. In the 2019 supply tender the installment is a monthly amount per bus, converted to US dollars at the paper's reference rate of 900 CLP/USD. In 2023 and 2025 bids were quoted in UF (Unidad de Fomento, Chile's CPI-indexed unit) or in US dollars. Each is first converted to Chilean pesos at the Acta's own reference rates (UF = CLP 37,564.36 at 28 June 2024 and USD = CLP 926.08, June 2024 average, for the 2023 tender; UF = CLP 38,384.41 at 31 January 2025 for the 2025 tender) and then to US dollars at 900 CLP/USD, for comparability across tables. In Table 4, US14 has type-A buses only, while US15–US18 are mostly type B.

Present values discount the monthly installments at 0.5% per month over the useful life set for each technology in the tender bases. Diesel runs over 120 months. The 2019 electric installment runs over 168 months (14 years). The 2023 and 2025 electric installments run over 120 months, the ten-year base useful life the bases set for electric buses (800,000 km), which the scheduled reviews can extend with the concession to a maximum of fourteen years; the 120 payments complete the amortization, so the extension years carry no installment.

Because the 2019 and 2023–2025 present values run over different terms, the like-for-like comparison is per year of base useful life. Dividing each present value by its base life gives about USD 27,400–33,800 per year for the deployed 2019 electric buses (over fourteen years) against about USD 22,700–33,700 in 2023–2025 (over ten years). The 2019 electric range in Figure 6 spans all suppliers awarded in the supply framework (Foton and BYD), and the fleet actually deployed (all Foton, via K Cuatro) sits at the lower edge of that range, USD 384,000–473,000; across the full awarded set the range reaches USD 608,000 (BYD, Table 3), so the headline figure is the conservative one.

The discount rate matters for levels more than for comparisons. The 0.5 percent monthly rate compounds to about 6.2 percent per year. Moving it by 0.1 percentage point changes the 120-month present values by 5 to 6 percent and the 168-month ones by 7 to 8 percent, but it changes the ratio of the 168-month to the 120-month annuity factor by less than 2 percent. The cross-tender comparisons, the per-year-of-life figures, and the counterfactual in Appendix A.5 are therefore not sensitive to this choice.

A.2 Per-kilometer prices and charging installments

This subsection documents Table 6. The per-kilometer operating prices for electric (PKe) and diesel (PKd) service are deflated to real Chilean pesos of the 2025 price base using the UF: real = nominal $\times$ $\mathrm{UF}_{2025}/\mathrm{UF}_{\mathrm{tender}}$, taking each Acta's own UF (CLP 29,756.68 in 2019, 37,564.36 in 2023, and 38,384.41 in 2025; deflation factors 1.290, 1.022, and 1.000). The 2019 tender separated bus supply from operation, so its per-kilometer prices exclude fleet capital, as in 2023 and 2025.

CIC is the per-unit Cuota de Infraestructura de Carga, the monthly charging-infrastructure installment, reported in UF, which is already inflation-indexed. It scales with the unit's size and with whether the operator builds new charging or reuses terminals (Buses Vule's winning 2025 bids quoted CIC near zero), so it is not a per-bus or per-kilometer rate. Voy Santiago's 2023 CIC bids were in US dollars ($\approx$ 270–2,219).

In the 2023 and 2025 tenders every new bus is electric, so the awarded PKd remunerates the kilometers run by pre-existing diesel buses that the new concessionaire takes over from the outgoing operators, with their pending installments, through the assignment of the corresponding provision contracts, notably during the transition period (Contrato de Concesión de Uso de Vías 2023/2025, cl. 4.1 and 4.4.1).

A.3 Fleet trajectory

This subsection documents Figure 3. Over the period the operating base fleet (FOB) stayed near 6,200 to 6,900 buses, while the electric fleet grew from 2 in 2017 to 3,849 at the end of 2025. The total registered fleet is larger than the operating base, 7,919 buses at the end of 2025. The 2026 figures are provisional: electric buses are reported to March 2026 and the operating fleet to February 2026.

A.4 System expenditure and cost per kilometer

This subsection documents Figures 4 and 5.

In Figure 4 the four bands sum DTPM's total outlay on the bus system. UN operators own their buses and hold their own terminals, so UN expenditure is their operator payment alone. For the tendered (US) units the fleet and charging cost that DTPM funds directly (Buses Provision and CIC, bundled in the operator payment, plus the first-wave 2019 fleet-supply cuota) and the terminal leases are shown separately from the operations payment. The series is in nominal Chilean pesos, and the contracts are UF-indexed, so the text decomposes the nominal growth into indexation, billed kilometers, and composition. Table 1 instead converts annual totals to US dollars at a fixed 900 CLP/USD, so the levels of the two are not directly comparable.

In Figure 5 the outlay for a unit is the operator's payment (the corrected ING final, which already bundles the fleet and charging cuotas Buses Provision and CIC) plus, for the first wave (U8–U13) that runs the 2019 supply-tender fleet, the supplier-side fleet installment (cuota de flota) the AFT pays the bus suppliers, plus the terminal leases described below. That fleet installment is recorded in a separate file and allocated across the six units by each winning offer's fleet (operating base plus reserve) from the operation-tender evaluation record (Acta, LP CUV 001/2019). The older concession (UN) units carry no separate provision: their operators own the buses and hold their own terminals, so the capital is embedded in their per-kilometer payment. Billed kilometers are the kilometers the per-kilometer rate is paid on, compliance-adjusted on both sides: KM a pago for the US units and operated kilometers scaled by the compliance index (KM $\times$ ICT) for the UN units, which makes the cost per kilometer like-for-like.

The terminal leases come from DTPM's payment record for the 33 terminals it rents, which gives each terminal's owner, area, year of incorporation, canon per square meter, and monthly cuota in UF, payable over 25 years. The record carries no unit identifier. I match each terminal to a unit through the "Terminales" section of the fichas técnicas, which lists the terminals each concessionaire must use (Res. Ex. 1144–1149 for US1–US6 and 5144–

5148 for US14–US18). The 2019 fichas report both the total and the assigned area, and two terminals are shared, so their cuotas are split in proportion to the assigned area: Av. Santa Clara 555 splits 10,051.56 to US3 and 17,869.44 to US5, and Av. José Arrieta 9540 splits 9,234.50 to US4 and 10,840.50 to US6. The 2023 fichas report a single area plus a terminal identifier running sequentially by unit, and no terminal is shared. Twenty-nine of the 33 rows match, twelve of them exactly on area, and they carry UF 46,166 of the UF 48,691 monthly total. Each cuota is fixed in UF, so it enters the panel from January of its year of incorporation at that month's value of the UF.

Four rows appear in no ficha: Lo Espejo, Mujica, Departamental, and OGM, together UF 2,525 per month. All four belong to Desarrollo País, and they are the candidates for the UN units or for the 2025 perimeters still in evaluation. I leave them unallocated, because under the UN contracts the terminal cost is inside the per-passenger rate PPT_0 until the State buys the terminal. Resolución Exenta 6/2026 makes this explicit for UN5: PPT_0 is revised each time Desarrollo País acquires a terminal the operator runs. Charging the canon to a UN unit on top of its operator payment would therefore double count. Assigning all four to the UN units anyway would add CLP 3.7 per UN billed kilometer, which changes nothing.

Three features of the record deserve note. First, it is not the universe of terminals but the subset DTPM leases, so about a quarter of the terminals the tendered contracts require have no row and the measure understates terminal cost rather than bounding it. Second, the US payment sheets carry a separate PCT line, the installments on additional terminals. PCT is paid only to U11, which is precisely the one tendered unit with no leased-terminal row, so the two streams cover different terminals and both are counted. Third, three of the terminals incorporated in 2026 carry a canon of 0.12 to 0.25 UF per square meter, two to five times the others, because the payment bundles the construction of the site rather than renting an existing one. All three serve the newest perimeters, and they account for CLP 30 of that cohort's CLP 126 per kilometer. Excluding terminal cost altogether returns the cost per kilometer to CLP 2,650 for the first wave and CLP 2,670 for the newest units, against CLP 2,540 for the UN units.

One exclusion remains on the capital side: the purchase price of the terminals SERVIU and Desarrollo País own outright, and the grid reinforcements borne by the distribution companies. Because the UN operators' terminal costs are embedded in their per-kilometer payment, while that public capital sits outside the metric, this exclusion still understates the full cost of the tendered units.

A.5 A diesel-renewal counterfactual from the 2019 bids

This subsection documents the counterfactual in Section 5.3. The 2019 bases set useful lives of 120 months or 1,000,000 kilometers for diesel buses and 168 months or 1,400,000 kilometers for electric buses, so both imply 100,000 kilometers per year and each present value divides by its own lifetime mileage. For standard (B2) buses, the awarded diesel present values of USD 236,713 to 278,867 (Table 3) give USD 0.237 to 0.279 per contractual kilometer, or CLP 213 to 251 at 900 CLP/USD. The deployed electric buses (Foton, present value of USD 472,518) give USD 0.338, or CLP 304. The capital premium of the deployed electric fleet is therefore CLP 53 to 91 per contractual kilometer. The awarded operating-price gap in the same tender is a PKd of CLP 1,365 to 1,558 against a PKe of CLP 1,017 to 1,175 (real 2025 pesos, Table 6), that is, CLP 190 to 541 per kilometer.

Buses run fewer commercial kilometers than the contractual total. Billed kilometers of about 366 million per year over an operating base of about 6,300 buses give roughly 58,000 commercial kilometers per bus per year. Scaling capital cost from contractual to billed kilometers multiplies both technologies by about 1.7, and the premium becomes CLP 91 to 156 per kilometer, still below the smallest awarded operating-price gap of CLP 190.

Three caveats apply. First, the per-kilometer operating prices are full operating bids, not direct measurements of energy and maintenance, so they embed each bidder's expectations about utilization by technology. Second, the calculation uses the deployed (Foton) electric prices; the awarded but never deployed BYD bid (present value of USD 607,669) implies CLP 391 per contractual kilometer, a premium of CLP 140 to 178, which rises to CLP 241 to 306 per billed kilometer. The awarded operating gaps cover that range at their midpoint but not at their minimum; since the system bought no BYD units, the deployed prices are the relevant counterfactual. Third, the 2019 diesel and electric lots differ in supplier and specification details within each typology.