The Lab

Global Innovation Lab for Climate Finance

PAY AS YOU SAVE FOR CLEAN TRANSPORT

INSTRUMENT ANALYSIS

SEPTEMBER 2018

Pay As You Save for Clean Transport

LAB INSTRUMENT ANALYSIS
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DESCRIPTION & GOAL —
To accelerate the electrification of transport, starting with transit bus fleets in cities.

SECTOR —
Transportation

PRIVATE FINANCE TARGET —
Commercial debt

GEOGRAPHY—
Prospective first applications: Mexico, Chile, South Africa, Jordan
Additional candidates: Colombia, Brazil, Uruguay India, Southern Africa, Southeast Asia

The Lab identifies, develops, and launches sustainable finance instruments that can drive billions to a low-carbon economy. It is comprised of three programs: the Global Innovation Lab for Climate Finance, the Brasil Innovation Lab for Climate Finance, and the India Innovation Lab for Green Finance.

AUTHORS AND ACKNOWLEDGEMENTS

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1. CONTEXT

Electric buses must move from 1% annual market share to 100% in less than a decade, and instruments uniquely available to utilities can capitalize that transition and more.

Electrifying transportation at scale is critical to fighting climate change and urban pollution. In the context of both near-term Paris Agreement commitments through 2030 and long-term greenhouse gas mitigation paths through the end of the century, rapid electrification is vital to success in every conceivable climate stabilization scenario (Dennis, Colburn and Lazar, 2016; Huizenga, 2016). Mass adoption of electric vehicles (EVs) also contributes to the reduction of harmful urban pollutants that contribute to seven million pollution-related deaths each year and cause nine in ten people around the world to breathe polluted air (WHO, 2018).

Within the transportation sector, electrification of buses is one of the best places to start. Relative to other electric vehicles, buses offer high passenger occupancy and utilization rates. Relative to diesel buses, they offer lower maintenance costs, while their electricity usage patterns are regular and predictable. They can often charge during off-peak periods of excess electricity supply, and thus minimize both the cost of electricity and the strain potentially placed on the grid by the presence of other electric vehicles and/or intermittent energy sources. Emissions benefits depend on the source of electricity, but in all but the dirtiest electrical grids, electric buses significantly reduce greenhouse gas emissions, while also mitigating harmful atmospheric pollutants from heavy-duty diesel engines linked to respiratory illnesses and premature death (Minjares, Wagner, and Akbar, 2014).

In order to meet targets already pledged by leading cities around the world, investment must shift quickly to electric buses. Dozens of major cities around the world have published targets for decarbonizing public transport by 2030 (see C40 Cities, 2015; CCA Coalition, 2018; Global Covenant of Mayors, 2018). Given the 12-year operating lives of most buses and untenable costs of stranded diesel bus assets, achieving these targets requires switching procurement from diesel to electric buses immediately (McKinsey and C40 Cities, 2017).

Electric buses are competitive with diesel on a lifecycle basis in many geographies, yet a high upfront cost barrier is expected to persist into the next decade. Electric buses convert stored energy into power at the wheels over four times more efficiently than equivalent diesel buses (California Air Resources Board, 2018) and thus can generate significant fuel savings across a range of diesel and electricity prices in different markets. However, they have up to 40% higher upfront costs than their diesel competitors – primarily due to the installed cost of batteries and charging infrastructure (BNEF, 2018).

Utilities can play a key role overcoming this barrier, catalyzing investment on terms that are unique to the industry, and providing a path to ownership for more EVs, starting with transit buses. Many utilities are struggling in the context of stagnant revenues and changing business models around the world, but they stand to gain significant new electricity sales from deploying EVs, and electric bus fleets are key potential revenue sources in the transportation sector. Utilities can also invest and offer services on competitive terms, and operate highly reliable cost recovery mechanisms. By leveraging these tools, utilities can lower the upfront cost of electric buses, while also providing a pathway to ownership for customers seeking to transition from fossil fuels to clean transport.

CONCEPT

2. INSTRUMENT MECHANICS

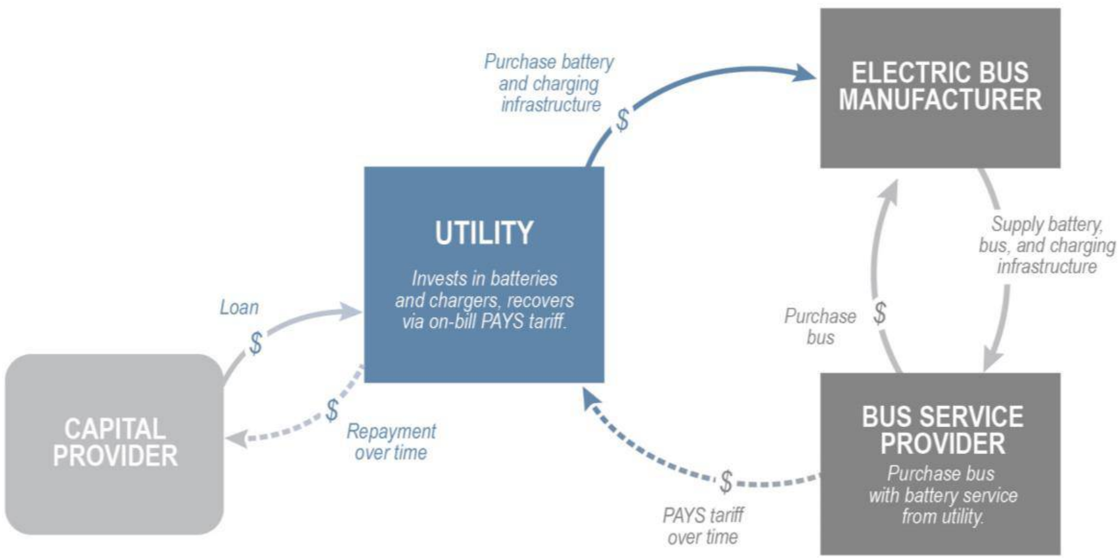
PAYS for Clean Transport accelerates clean transit in cities by lowering the upfront costs of electric buses through a Pay As You Save mechanism where the utility invests in batteries and charging stations, and recovers costs through a charge on the bus service provider's electric bill that is less than the estimated savings.

Pay As You Save (PAYS®)[1] is an existing, proven financing approach that has been implemented previously by utilities to increase investment in a range of climate-relevant solutions.[2] PAYS has consistently overcome the primary barriers to investment that are now facing electric buses -- high upfront costs and limited access to finance for customers unqualified or unwilling to take on more debt for new equipment.

In a basic transaction that applies *PAYS to clean transport*, there are several key stakeholders[3]:

- Utility – supplies electricity; holds direct relationship with bus service provider;
- Bus service provider (BSP) – purchases and/or operates buses, often a municipal transit agency;
- Electric bus manufacturer – sells buses, including batteries, and charging equipment;
- Capital provider(s) – provides debt finance to the utility, if required.

Figure 1 - PAYS for Clean Transport instrument mechanics



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[1] Pay As You Save® (PAYS®) is a registered trademark in the United States of Energy Efficiency Institute (EEI). Co-Principals Harlan Lachman and Paul A. Cillo created the PAYS system between 1998 - 1999, The trademark applies within the U.S. Aspects of EEI's PAYS system have been applied by Energy Efficiency Services Ltd. (EESL) in India, to finance energy efficiency upgrades including LED lightbulbs, street lights, fans, and water and sewage pumps.

[2] See, for example, Ouachita Electric Cooperative's HELP PAYS® program and the Town of Windsor's Windsor Efficiency PAYS® program. See Annex 7.2 for a full list of relevant PAYS programs.

[3] See Section 4, "Implementation Pathway and Replication".

2.1 PAYS TRANSACTION PATH FOR TRANSIT BUSES

The utility and BSP initially agree to terms-of-service that allow the utility to pay for the primary components of the incremental upfront costs of electric buses – namely batteries and charging stations – and recover its costs over time through a tariffed, fixed charge on the BSP's regular monthly electric bill – the PAYS Program Services charge ("PAYS charge").

The PAYS tariff is designed to ensure that (1) the operating costs of an electric bus will be less than the estimated operating costs of an equivalent diesel bus[4]; and (2) the utility will fully recover its investment cost within the warrantied period of the battery and charging equipment, subject to the restriction in (1). The utility is protected from technology risk by the manufacturer's equipment warranty, and its investment is both cost-effective and secure, with the ability to disconnect service in the case of non-payment. The BSP is required only to ensure it pays its electricity bills, facing no additional liability.[5]

Once the tariff is in place, the utility can leverage external debt lent against its balance sheet to pay for the cost of electric bus batteries and charging infrastructure. This allows the BSP to obtain new electric buses from a manufacturer debt-free with an off-the books investment, paying roughly the same upfront cost as it would for equivalent diesel buses. If the upfront cost is still higher than diesel, the remaining fraction of the gap is met with grant funding from the concessional capital provider or utility incentives.

The utility recovers its investment costs (including its cost of capital) from the BSP via the PAYS charge on its monthly electric bills, and once those costs are recovered, the BSP gains ownership of the battery and charger assets.

2.2 BENEFITS OF PAYS AND ENGAGEMENT CRITERIA

Table 1 - Benefits of the PAYS approach for each stakeholder and criteria for engagement

Stakeholder	Key benefits of PAYS involvement for stakeholder	Criteria for Engagement
Bus service provider	• Accelerates bus fleet electrification • Unchanged capital expenditure vs. diesel buses and immediate operational savings • Upfront capital expenditure on batteries and charging infrastructure moved from balance sheet debt to a lower monthly operating expense with no liability • No additional financial liability (unlike a loan or lease) on BSP's balance sheet[6]	Private or public BSPs or operators, with reliable utility-bill repayment record.
Utility	• Secure on-bill payment with the ability to treat unpaid bills similarly to other services, including disconnection of service in case of non-payment of electricity bills, yielding exceptionally high cost recovery rates[7]	For debt-financed transactions lent against utility balance sheets, any utility that is solvent and creditworthy may offer a PAYS tariff to BSPs. Future

[4] In the PAYS system, this is based upon current and expected future rates for diesel and electricity.
[5] The BSP is assumed to be willing to meet upfront costs equivalent to those of a diesel bus. If the cost of an electric bus without batteries or charging infrastructure is below that of a diesel bus, the BSP makes up the difference. If, due to the constraints on the tariff design, the utility cannot cost-effectively capitalize the full cost of the battery and charger, *and* the BSP is unwilling to meet the remaining costs, concessional capital or grant support is introduced to bring down financing costs, or close remaining funding gaps, respectively.
[6] Accounting standards to be formally adopted in 2019 will require that previously off-balance sheet leases be treated as on-balance sheet, strengthening the case for PAYS. See Deloitte's guide to IFRS 16.
[7] Expert interviews.

	• Leverages a stronger balance sheet and access to affordable capital (relative to BSPs) • Achieves cost recovery for deployed capital within warranty period of the equipment (eliminating exposure to real or perceived technology risk) • Significant additional revenue from electricity sales to BSPs as a result of PAYS[8]	iterations will be able to accommodate insolvent utilities.[9]
Capital provider	• Access to a more creditworthy counterparty (the utility), and insulation from balance sheet of ultimate payer (the BSP) • Benefits from improved allocation of technology risk for batteries and chargers, which may have kept other lenders from entering the market • Gains exposure to an important growth industry (EVs and charging infrastructure)	Any source of debt capital can be tapped by the utility for PAYS investments.
Bus manufacturer	• Increased product sales in new markets where upfront costs would otherwise have prevented sales • Experience and expertise in new markets, and ongoing business relationships	Product meets BSP needs and battery & charger have warranty periods long enough for the utility to completely recover its costs.

3. INNOVATION

PAYS applies an approach already proven in other sectors to overcome the biggest barriers to electric bus deployment at scale – high upfront costs, high financing costs, inefficient allocation of technology risk, and inefficient use of public subsidies.

3.1 THE UPFRONT COST DILEMMA: ADDRESSING BARRIERS TO ELECTRIC BUS PROCUREMENT

PAYS for Clean Transport overcomes major barriers to electric bus procurement in developing countries including the high upfront cost of electric buses relative to diesel; high financing costs for clean transit investments; a lack of engagement with utilities in electrifying transport; and partial allocation of technology risks for electric drivetrain and charging technology to capital providers (instead of manufacturers).

PAYS also addresses barriers to achieving scale in deploying electric buses, including vastly reduced reliance on subsidies and grants to finance the higher upfront costs; quantification of non-financial benefits of electric buses; and other obstacles to widespread adoption (See Table 2).

[8] This varies by geography and market conditions, but can be estimated conservatively at US$ 250,000 per bus. See Section 5.1 "Quantitative Modelling."
[9] See Section 5.3, "Private Finance Mobilization and Replication Potential."

Table 2 - Barriers to transit bus electrification and how PAYS for Clean Transport addresses them

Barrier	Explanation	How PAYS addresses this barrier
High upfront costs relative to diesel	Electric buses initially cost more than diesel buses, due to battery and charging infrastructure costs. Procurement regulations often prioritize options with lowest upfront cost. Grants or subsidies are typically required to meet these additional costs.	Utility purchases battery and charging infrastructure (with internal or external capital), reducing upfront costs relative to diesel buses. Investment is recovered through PAYS tariff, which puts a PAYS charge on BSP's electricity bill. Once utility costs are fully recovered, assets pass into BSP's ownership.
High financing costs or lack of access to finance for clean transit investments	BSPs (private and public) can face challenges in accessing low-cost financing owing to poor or non-existent credit ratings, unsustainable business models, and low-cost recovery ratios.	BSPs do not need to be creditworthy. In addition, electricity bill payments to the utility are operating expenses and not debt, separate from the utility's obligations to capital provider. By lending to a utility, the capital provider reduces risk exposure and can provide financing on better terms. The utility's cost recovery mechanism is more secure than a standard loan or lease to a BSP because of the utility's ability to treat unpaid electricity bills similarly to any other service, including disconnection for non-payment.
Lack of scalability of electric bus purchase programs	Achieving scale is capital-intensive. BSPs are often weakly profitable or loss-making, with little investment capital. Public bus providers depend on budget allocations from city governments.	Utilities can access capital internally (investment capital) or externally (debt) at lower cost, as a routine operation. PAYS leverages utilities' access to finance to facilitate scalability.
Lack of utility engagement in transport electrification	Despite convergent interests in clean transit, utilities and BSPs remain largely uncoordinated on electrification.	PAYS builds stronger relationships between utilities and bus service providers and facilitates utility expansion into the clean transport market.
Reliance on subsidies and grant funding to incentivize electric bus purchases	Incremental cost of electric buses is usually met with subsidies or grants – limited in scale, politically controversial, and an inefficient use of public resources.	PAYS accelerates the path to commercial viability. Some grant funding or utility incentives may be required initially to meet any incremental costs that cannot be recovered through a PAYS tariff, but would diminish over time as battery costs decline. Subsidies or grant requirements would be a fraction of what would otherwise be needed to catalyze electric bus purchases.[10]

Electric bus adoption rates are far below what is needed to meet 2030 transport decarbonization targets. The PAYS mechanism, tried-and-tested in accelerating energy efficiency upgrades in buildings, effectively addresses the key barriers to accelerating the shift to clean transport.

3.2 PRIOR APPLICATIONS OF PAYS AND ALTERNATIVE APPROACHES TO FINANCING CLEAN TRANSPORT

3.2.1 PRIOR APPLICATIONS OF PAYS

PAYS has been implemented in other climate-relevant sectors to overcome barriers to investment now faced by electric buses. Implementation to date in the U.S. and India has focused predominantly on energy efficiency, solar water heating, and water efficiency. The eight PAYS programs examined by the Lab Secretariat have achieved a steady transition

[10] See comparison of grant support required for electric buses with and without PAYS in Annex 7.6.

from concessional capital to commercial capital, moving from ratepayer funds and internal utility financing (using operating revenues) to market loans priced against utility balance sheets.

3.2.2 EXISTING ELECTRIC BUS FINANCING APPROACHES

The Lab Secretariat examined thirty-two electric vehicle financing programs, finding that the most consistent barrier to both execution and scale of these projects is upfront cost. Existing electric bus procurement programs outside China (home to 99% of the current global electric bus fleet) are concentrated in Latin America (Chile, Mexico, Colombia, Uruguay) and South Asia (India, Sri Lanka, Vietnam), with additional projects under way in Egypt, Jordan, and Georgia. These projects have seldom deployed capital on commercial terms; most of the two dozen cases in leading cities reported by the Financing for Sustainable Cities Initiative have been dependent on grants and concessional loans.[11] Upfront costs are a consistent barrier to these projects' execution, and even when parties are willing to meet upfront costs for project execution, capital constraints heavily restrict scalability. Further, aside from minor rebate programs, utility capital resources are not currently being used to leverage investment in electric buses.[12]

An alternative financing approach that is gaining some momentum is battery leasing, however, this approach requires BSPs to assume long-term liabilities. The BSP leases batteries from a separate entity that owns them. This in turn requires sufficiently large pools of high-risk capital to finance the leasing entity, assume the costs of underwriting and complete due diligence on the BSP, which is, in most contexts, is unlikely to be deemed a strongly creditworthy counterparty. Leasing also places long-term liabilities on the BSP's balance sheet, whereas there is no such liability under a PAYS transaction since the utility is repaid directly through the BSP's electricity bill as an operating expense. Leasing is also relatively unattractive to larger entities with access to capital markets, being typically more expensive than other loan products. See Annex 7.3 for further detail on differentiating PAYS from leasing, as well as other financing options.

3.3 CHALLENGES TO INSTRUMENT SUCCESS

The most important potential risks in a PAYS transaction, and options for mitigating them are detailed in Table 3. See Annex 7.4 for additional discussion on risks.

Table 3 - Challenges to instrument success and options for mitigation

Challenge	Description	Mitigation Strategy
Utility only pays for battery and charger costs up to the point of cost effectiveness within their warranty period, while also delivering operating cost savings to the BSP. This may be less	The need to deliver operational savings over diesel determines the maximum monthly charge, and the battery and charger warranty lengths determine the time period within which the utility can recover its costs. The cumulative payments over that duration may not be large	Remaining cost of battery and charger, and any remaining upfront cost premium over an equivalent diesel bus, is bridged by the BSP (if the electric bus cost without battery and charger is below that of diesel), by grant funds. Using grants to close this gap, rather than to meet entire incremental costs, is far more effective. Such gaps will

[11] See Li, Castellanos, and Maassen (2018 forthcoming); and Financing Sustainable Cities Initiative (FSCI) portal cataloguing low- and zero-emissions bus projects currently in progress. FSCI is a collaboration between the World Resources Institute (WRI) and C40 Cities, with support from Citi Foundation and the Global Environment Facility.

[12] See Annexes 7.1 and 7.2 for an abbreviated summary of comparable electric bus financing approaches currently in operation, and relevant PAYS transactions in other sectors.

than the total cost of the equipment.	enough to pay for the full cost of the battery and charger.	decline and close over time with battery price declines.
Insufficient warranty length for battery and charger	Electric vehicle batteries and chargers are emerging technologies with few heavy-duty transport applications. Investors may be concerned that the utility is assuming high technology risks if the battery and charger warranty does not fully cover the required cost recovery period.	Invite manufacturers to offer extended warranties to ensure utilities do not bear technology risk. Alternatively, equivalent guarantee sought from export credit agency of the equipment's country of origin.
Perceived counterparty risk	Risks can be perceived from the perspective of: (a) the lender (regarding the utility's ability to meet debt obligations if the BSP defaults on its electricity bill) (b) the utility (regarding the BSP's ability to pay and the effectiveness of denial-of-service as a means of ensuring security of payment)	Appropriate strategies, that address perception of risk: (a) utility establishes reserve fund to meet unexpected shortfalls in cost recovery program; or (b) first-loss or equivalent guarantee on an appropriate proportion of the PAYS investment, taking effect if the utility is unable to fully recover its costs.

MARKET TEST AND BEYOND

4. IMPLEMENTATION PATHWAY AND REPLICATION

PAYS is an effective near-term solution for procuring hundreds of electric buses in a single investment program. The measured benefits from initial programs will facilitate scaling up to the fleet level, and replication in other cities and regions.

An initial PAYS investment program for 100 electric buses can finance batteries and charging infrastructure, and several promising locations in developing countries with good conditions for the innovation have already been identified.[13] The first PAYS transaction will reinforce understanding that PAYS for Clean Transport is a low-risk approach to financing electric buses that aligns the incentives of utilities, BSPs, investors, electric bus manufacturers, and city governments.

In order to ultimately purchase and deploy electric buses at scale using a PAYS mechanism in developing countries, there is need for both a program development process (ongoing through the Lab process), and an individual transaction path for a pilot and subsequent PAYS implementations.[14] We discuss steps and progress on each of these processes in the following sections.

4.1 LAB PROGRESS TO DATE ON PAYS PROGRAM DEVELOPMENT

The analytical foundation laid by the Lab, and the field expertise of the instrument's proponent, Clean Energy Works, will cut the time and cost to implementers of PAYS and in-country partners approaching an initial application. Activities carried out by the Lab to date include:

[13] The size of a transaction can vary substantially based on actual fleet and retirement needs. In Section 5.1 "Quantitative Modelling" we have presented modeled results for a fleet of 100 buses in Santiago.
[14] The transaction path for a PAYS pilot does not necessarily need to follow the steps listed here.

(1) Refining instrument mechanics and confirm with field experts how its attributes are different from comparable instruments or efforts to finance transit bus electrification.
(2) Defining criteria for target geographies and key stakeholders, and apply these criteria to highlight a promising subset of target cities for initial implementation.
(3) Creating program-level models of PAYS financial returns to different stakeholders, cost recovery periods, and financing needs and leverage, as well as models of GHG and local pollutant impact.
(4) Tailoring city-specific implementations of the program model using publicly available data.

4.2 TARGET CONTEXTS

The PAYS approach to overcoming the upfront cost barrier to electric bus adoption is compelling in many geographies around the world. However, because PAYS has not yet been applied to the clean transport sector in developing countries, we have focused on target contexts for implementation that include the following particularly desirable conditions:

(1) Strong national and municipal policy support for electrification of transportation and/or reducing diesel pollution;
(2) Comparatively high diesel prices and/or low electricity prices;
(3) Creditworthy utilities;
(4) Comparatively clean electricity grid with a low grid emissions factor;
(5) Willing and able implementation partners who meet the criteria for engagement.

Based on these conditions, a number of cities were identified as promising contenders for a PAYS pilot. These include cities in Latin America (Santiago, Chile; Mexico City, Mexico; Bogotá, Colombia; Belo Horizonte, Brazil); Southern Africa (Cape Town); and the Middle East (Amman, Jordan). Advanced discussions are ongoing with potential implementation partners in Cape Town and Bogotá, and emerging interest in Ecuador, India, and Vietnam may lead to future opportunities.

4.3 DEVELOPING THE TRANSACTION PATH IN A SPECIFIC LOCATION

The Lab identified several key steps for developing a city-specific PAYS program:

(1) Engage relevant key stakeholders (utility, utility regulator, BSP, bus manufacturer, capital providers, and champions for clean transit), developing relationships and informal agreements.
(2) Undertake localized financial and environmental impact analysis, informed by data from key stakeholders and with localized consideration of key sensitivities.[15] Present business case to BSP, utility, commercial capital provider(s), and if applicable, concessional capital provider.
(3) Seek non-binding agreement with utility, bus manufacturer, BSP and capital providers to seek regulatory approval for a PAYS tariff and provide financing for a pilot project.
(4) Advise utility on development and design of PAYS tariff and submit proposal to utility regulator for approval. Support stakeholder participation in review process as needed.
(5) Seek agreement with BSP to opt in to the PAYS tariff if approved.
(6) Obtain approval for the PAYS tariff from utility regulator.
(7) Close binding agreements between all parties and participate in competitive procurement process for buses.

[15] See Annex 7.5 for details.

(8) Take delivery of electric buses 12-15 months after orders are placed and begin operations; PAYS tariff and pilot is activated with bus delivery and runs through the end of the cost recovery process, depending on agreed terms.

Initial projects will use a simple debt instrument whereby the capital provider lends directly to the utility. This will restrict the first PAYS transactions to solvent utilities, since creditworthiness will be required for them to take on loans directly. Once the instrument has been demonstrated successfully, the concept can be extended to tackle cases where the utility is less creditworthy (e.g. most utilities in Southern Africa) using a project finance structure. This will likely involve a separate entity (Special Purpose Vehicle) holding the battery and charging infrastructure assets, insulating capital providers from weak utility balance sheets through a project finance structure.

Near-term implementation challenges include:

- Ensuring that the BSP can procure electric buses on competitive terms while also meeting any public sector requirements for domestic procurement (variable by country);
- Access to competitive local currency debt (preferred to avoid foreign exchange risk) at a cost appropriate to the low level of risk to the lender;
- Ensuring quick regulatory approval for the utility to offer the opt-in PAYS tariff.

Based on interviews with key stakeholders and prior PAYS experiences with regulatory approval processes, these challenges appear to be surmountable, and we do not expect them to present significant risks to successful implementation of an initial PAYS program. Lab members – particularly representatives of development banks in target geographies – will be similarly important in championing the concept within government and the private sector.

4.4 THE TEAM

PAYS is an approach that could be championed by any of the actors that stand to gain from it. However, because it is a new model in the sector, in practice it does require a champion to get off the ground. Clean Energy Works (the primary proponent of PAYS, led by Dr. Holmes Hummel), has significant experience in designing and implementing PAYS in the energy efficiency sector, and specializes in providing advisory services to utilities and in-country partners to ensure the effective design and adoption of PAYS throughout the transaction path outlined in the following section.

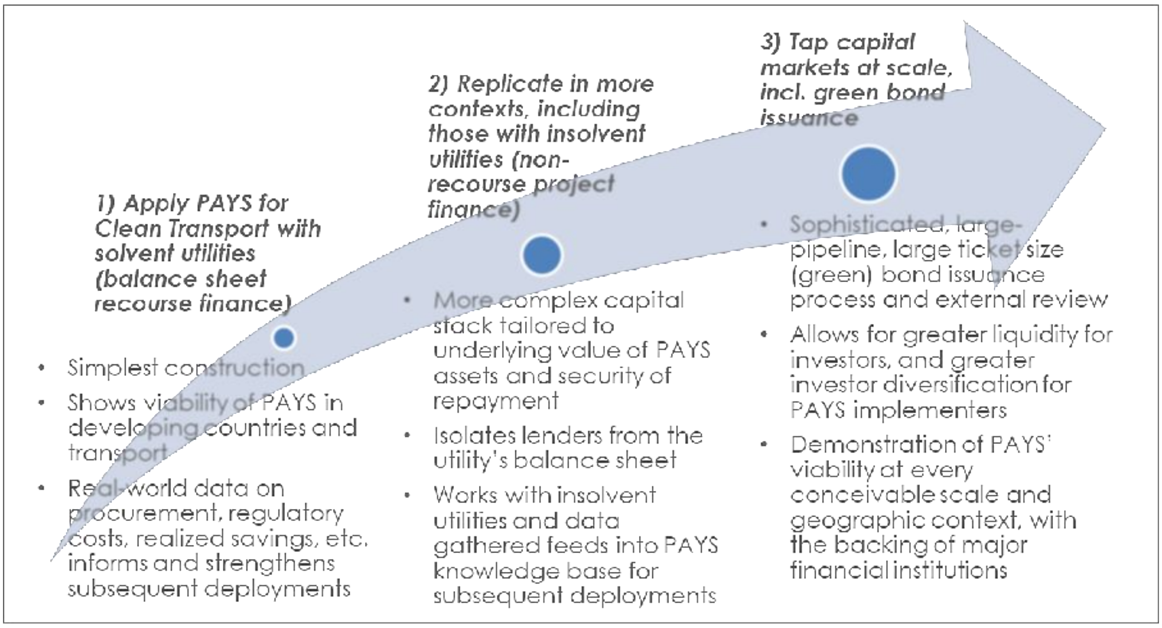
4.5 SCALING UP PAYS IMPLEMENTATION

As the benefits of PAYS are proven in an initial pilot, implementation can be scaled in that same city or country. A first PAYS transaction could target the purchase of ~100 electric buses – a fraction of the typical fleet size for a large city (e.g. roughly 1.5% of the current transit fleet in Santiago, Chile). Even at that scale, the initial pilot can demonstrate measurable benefits to all key stakeholders in the transaction (e.g., operational savings, cost recovery security, and other aspects of tariff design) and the benefits of clean transit to the city as a whole. The BSP in that city may then work with its utility to undertake a larger investment on PAYS terms, and/or the utility may choose to undertake similar clean bus investments in other cities in its service area. Once PAYS tariffs are commonly accepted, it will be quite easy to either scale the transaction in the same city, or to scale similar transactions within the service area of the same utility.

4.6 REPLICATION OF PAYS IN OTHER GEOGRAPHIES

Subsequent PAYS transactions will grow in size, geographic breadth, and diversity of implementation partners. As detailed in Figure 2, PAYS for Clean Transport can be modified to accommodate entities of varying balance sheet strength and creditworthiness. Implementation costs and technology costs will continue to fall, eliminating the need for concessional capital over time, and increasing the appeal of PAYS to cities, utilities, and BSPs around the world.

Figure 2 - Paths to accelerating PAYS across utility types, geographies and markets



PAYS for Clean Transport's potential impact and scale will expand as markets for other types of EVs continue to grow, and as pressure for decarbonizing transport intensifies in concert with global climate goals and attempts to curb urban pollution.

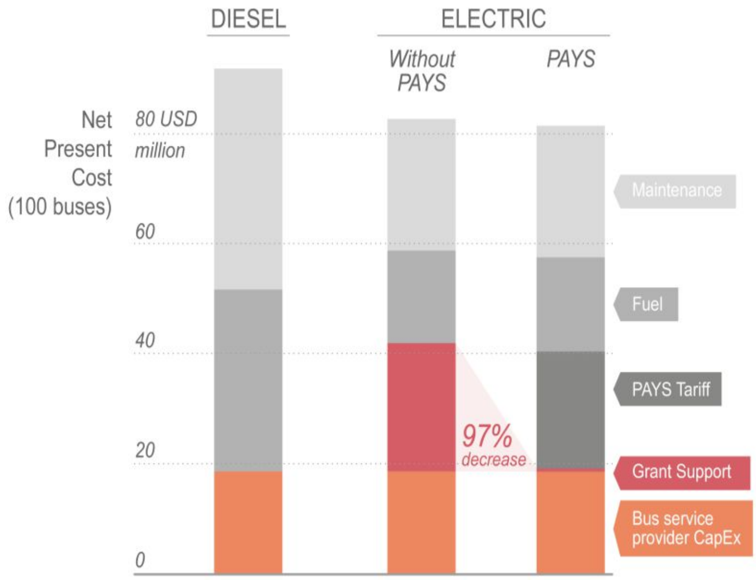
5. IMPACT

The total cost of ownership for an electric bus using PAYS is cheaper than diesel, leverages more than 70 dollars in private finance for every grant dollar provided, and dramatically reduces fleet GHG and urban pollutant emissions.

5.1 QUANTITATIVE MODELLING

Lab Secretariat modeling has examined potential PAYS implementation against alternatives (diesel and upfront electric bus financing) in six different cities. The results presented in this section primarily reflect outputs from Santiago, Chile as a promising set of outcomes in terms of total cost of ownership, grant support, electricity sales, and other variables. See Annex 7.6 for detailed results from all cities.

Figure 3 - Total cost of ownership for a 100-bus transaction in Santiago, Chile



Even under conservative assumptions of battery prices and capital costs,[16] the total cost of ownership of electric buses under a PAYS program is significantly less than that of diesel in most contexts. Electric buses financed through PAYS are cheaper than diesel buses by about US$ 104,000 over their lifecycle in the Santiago test case, detailed in Figure 3. This advantage will continue to grow as battery and other technology costs decline.

The PAYS programmatic-level modelling exercise undertaken here provides insight on PAYS viability in various cities. Key sensitivities that can eliminate the remaining gaps in viability include lengthier battery warranties (allowing the tariff to be extended) and greater annual mileage (increasing the operational savings of electric buses versus diesel, hence raising the maximum PAYS charge). The viability gap will decline over time regardless, as technology costs fall. See Annex 7.5 for recommendations on further customizing the modelling process to specific contexts.

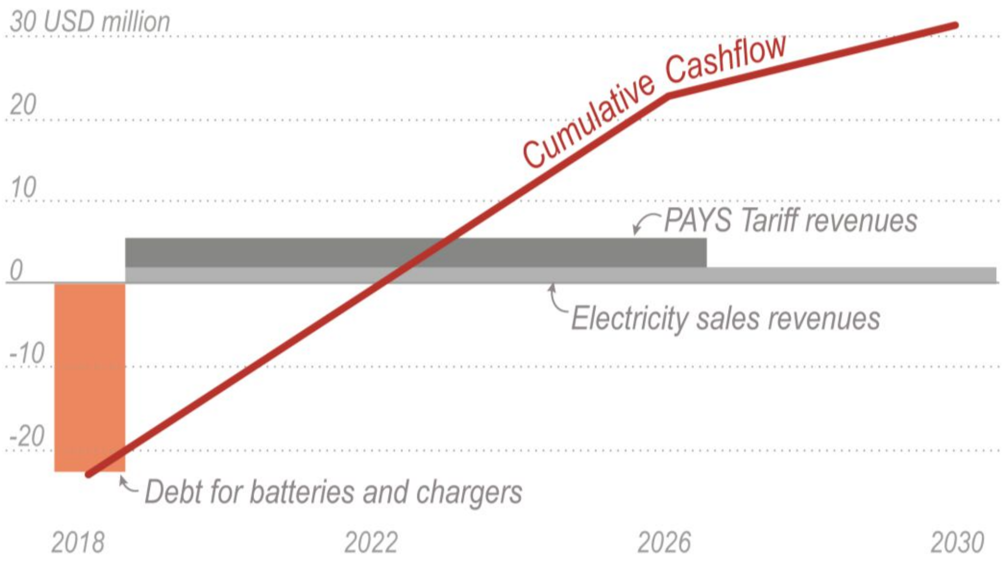
PAYS can deliver immediate operational savings to BSPs, while accelerating fleet electrification and multiplying the impact of grant funding by several times. Because the amount that can be invested through a PAYS program is constrained by both the estimated net savings compared to a diesel bus, and by the warranty period of the equipment, there may still be a capital gap where the warranty periods are not long enough to allow the entire investment to be recovered through the PAYS tariff alone. In the Santiago example, the utility cannot recover the full cost of batteries and charger under the twin constraints of an eight-year tariff duration (aligned with currently available battery warranties) and a limit placed on the tariff such that electric bus operating expenses do not exceed 95% of the operating costs for diesel buses. The shortfall is US$ 5,681 per bus.

Bus electrification generates significant additional electricity sales revenues for utilities. Electrification of buses in Santiago would generate additional utility revenues of about US$ 256,000 per bus, or US$ 25.6m (from the additional 1,216 MWh of electricity sold) over the useful life of 100 buses (see Figure 4). Utilities with surplus capacity may be willing to provide

[16] Even the most-recent battery cost data publicly-available typically trails actual market conditions by 12-15 months.

incentive payments to BSPs to eliminate or significantly reduce the need for grant funding in order to facilitation participation in a PAYS electrification program and additional sales.

Figure 4 – Nominal cash flows from BSP to utility, for a 100-bus transaction in Santiago, Chile



5.2 ENVIRONMENTAL AND SOCIAL IMPACT

PAYS mobilizes capital for investment in electric buses that mitigates greenhouse gas emissions and reduces local urban air pollutants, contributing directly towards the achievement of the Paris Agreement Nationally Determined Contribution (NDC) targets. In the Santiago case, 100 electric buses deliver 62,000 tons of CO_2 emissions reductions over twelve years, producing 45% less emissions than the diesel equivalent. Greenhouse gas emissions savings will grow over time as the resource portfolio for grid electricity gets cleaner. Replacing Santiago's entire fleet of more than 6,600 transit buses would yield over four million tons in CO_2 emission savings over an equivalent diesel fleet. Even when running on a carbon-intensive electricity grid (e.g. South Africa), electric buses still produce 15% greenhouse gas emissions savings.[17] At scale, electric buses with 12-year lifetimes could produce far greater environmental impact (see Table 4).

If cities are to meet targets for decarbonization of public transport, the market for electric buses outside the U.S. and Europe alone will be 127,000 units a year, saving over 57 million tons of CO_2, almost 13,000 tons of particulate matter and over 2.2 million tons of nitrogen oxides.

[17] Modeling relies on emissions factors from IGES (2018).

Table 4 - Environmental impact potential for PAYS for Clean Transport at scale

Scale	Number of buses[18]	CO_2 emissions abated (million tons)[19]	Local Pollutant emissions abated (tons)[20]	
			PM 2.5	NO_x
Pilot program (Santiago)	100	0.06	5	200
Fleet replacement (Santiago)	6,646	4.13	350	13,500
Annual transit bus procurement (LatAm)	7,000	5.56	700	124,000
Annual transit bus procurement (global excl. US and Western Europe)	127,000	57.2	12,900	2,250,000

Tailpipe emissions of certain local pollutants are entirely avoided. The Santiago 100-bus fleet would generate emissions savings of 761 tons of carbon monoxide; 66 tons of hydrocarbons; 203 tons nitrogen oxides (NO_x) and 5 tons fine particulate matter (PM 2.5). NO_x and PM 2.5 have been particularly strongly linked to cardiopulmonary disease, asthma and lung cancer. Note that the figures given here are for the Santiago case, where the diesel bus fleet is relatively clean (meetings Euro VI emissions standards). The gains are much greater (particularly for particulate matter and carbon monoxide emissions) for cases where electric buses are replacing older, dirtier diesel fleets (see Annex 7.6). "Black carbon" is a particularly harmful component of particulate matter with a global warming impact of 900-3200 times that of CO_2 and severe human health impacts (Minjares, Wagner, and Akbar, 2014).

5.3 PRIVATE FINANCE MOBILIZATION AND REPLICATION POTENTIAL

5.3.1 PRIVATE FINANCE MOBILIZATION

PAYS will use capital at market rate terms to finance the vast majority of its investments and will leverage significantly greater private capital over time as (1) the difference in the total cost of ownership between electric and diesel buses falls, then disappears (likely within the next few years) and (2) warranty coverage for batteries and charging stations are offered over longer periods, allowing a greater proportion of electric bus costs to be recovered through the PAYS tariff.

In Santiago, each dollar of PAYS grants leverages more than 70 dollars of private investment in electric buses, vastly exceeding equivalent grant leverage from non-PAYS programs. Grant funding of US$ 568,000 would catalyze a utility investment of US$ 23 million in the purchase of 100 buses that cost a total of US$ 42 million. By comparison, the same amount without PAYS would be able to cover the full upfront cost premium for just 1.4 buses, and meeting the additional upfront costs for 100 electric buses directly would cost a grant provider upwards of US$ 25 million. PAYS reduces this grant need by 97% (see Annex 7.6).

5.3.2 MARKET DYNAMICS

An initial deployment of 100 electric buses in Santiago through a PAYS investment program would represent a small fraction of the regional market (~1.4% of the estimated 7,000 transit buses sold annually in Central and Latin America in 2016), and a miniscule portion of the overall global transit bus market of over 145,000 buses sold in in 2016, of which 127,000 were sold outside the U.S. and Western Europe (Freedonia Group, 2017).

[18] Santiago figures: See Global Mass Transit Report (2017). Regional and global figures: Freedonia Group, 2017.
[19] Country and regional average emissions factors from IGES, 2018.
[20] Based on conservative assumption that current diesel fleets in Santiago are Euro VI standard, and average diesel fleet regionally and globally are Euro IV standard.

As the benefits of PAYS become more widely accepted it can accelerate critical changes in growing Latin American and global transit bus markets. Demand for transit buses in Latin America is projected to nearly double between 2016 and 2021, and grow annually at a compound growth rate of roughly 12.7% (Freedonia Group, 2017). Under the status quo today, the majority of these new buses purchased in growing transit bus markets – both in Latin America and globally -- will be diesel buses that lock in future emissions for more than a decade. PAYS can help to disrupt this status quo by solving some of the most important challenges to financing and deploying electric buses at scale around the world.

6. KEY TAKEAWAYS

Innovative: PAYS applies an approach tested and proven in other sectors to electric buses for the first time. It addresses the key barriers to electric bus deployment by providing low-cost, low-risk financing for electric buses through the right entities (utilities) with the right financing options (stronger balance sheets) and payment security (established electric bills).

Financially Sustainable: PAYS is financially sustainable, relying primarily on commercial capital, and uses a small fraction of the concessional finance per bus compared with similar initiatives, even at pilot stage. Near-term technology cost decreases will make electric buses with PAYS competitive without any grant support in certain markets, and when applied in combination with project finance vehicles that are fit for use with less-creditworthy utilities, PAYS for clean transport may be applicable in numerous markets throughout the developing world.

Catalytic: An initial application of PAYS for clean transport in Santiago, Chile, to a 100-bus transaction, would leverage more than 70 dollars of private finance for every 1 dollar of grant support, while delivering tangible environmental benefits and dramatically reducing grant requirements. An initial successful PAYS for clean transport application for transit buses will pave the way for PAYS terms to be offered by more utilities and reach a larger share of the transportation sector. Electrifying transit bus procurement in developing world cities alone would reduce CO_2 emissions by an estimated 57 million tons per year, with many more reductions possible as the instrument is applied in additional locations and to more vehicle types.

Actionable: PAYS delivers financial and environmental benefits around the world and an initial application could be implemented quickly in many places, with city governments, utilities, banks, bus manufacturers, and consultants aligned to help implement and scale it over time.

7. ANNEX

7.1 SUMMARY OF COMPARABLE INSTRUMENTS REVIEWED

Project Title	Location	Description	Barriers to scale	Financing source	No. of buses
Transantiago Electric Bus Program	Santiago, Chile	Public procurement via tender	High upfront cost No path to ownership of charging infrastructure	City government (buses) Utility (charging infrastructure)	90
BMTC Electric Bus Tender	Bengaluru, India	Public procurement via tender for purchase, deployment & operation of buses	High upfront cost	Private investors	150
Eje 8 Sur Green Corridor	Mexico City, Mexico	Technical study for electric bus corridor	High upfront cost Under-capitalized BSP	[TBC] Ministry of Finance Private capital Development banks	~50
Bogotá Technological Transformation Program	Bogotá, Colombia	Hybrid and electric bus procurement for Transmilenio fleet	High upfront cost Perceived technology risk Lack of maintenance suppliers/expertise	Concessional long-term loans	300
Alexandria Electric Bus Tender	Alexandria, Egypt	Public procurement via tender	High upfront cost Competition from second-hand diesel buses Low diesel fuel cost	Chinese Development Bank (concessional loans)	15
Low Carbon Bus Fund	Vietnam	Low Carbon Bus fund covers incremental electric bus costs with phase-out approach	High upfront cost Lack of supporting infrastructure Lack of government planning capacity	Ministry of Environment and Transport NAMA facility (grants)	250

7.2 SUMMARY OF MAJOR PREVIOUS PAYS TRANSACTIONS IN OTHER SECTORS[21]

Program Name	Location	Start Year	Description	Financing sources
SmartSTART®	New Hampshire	2002	US$ 10.8m utility-led energy efficiency PAYS program led by regional utility Eversource, and a US$ 0.2m pilot led by an electric cooperative.	Utility conservation budget funded by ratepayers and re-use of revenue from PAYS charges
Solar Saver Pilot	Hawaii	2007	US$ 2.9m solar water heater PAYS pilot program funded for 3 years. Oversubscribed by demand within 2 years.	Internal utility financing from Conservation Budgets funded by ratepayers
How$mart	Kansas	2008	US$ 14.6m utility-led energy efficiency PAYS program. Tariff capped at 90% of savings.	Various third-party sources
How$martKY	Kentucky	2011	US$ 2.3m third party-operated PAYS for buildings program operated by coalition of electric cooperatives.	Various third-party sources
Windsor Efficiency PAYS®	California	2012	US$ 0.6m town/utility-led PAYS for water use and efficiency in buildings, reaching half of multi-family buildings.	Utility operations
Upgrade to $ave	North Carolina	2015	US$ 2.3m residential energy efficiency PAYS program in a persistent poverty area, led by Roanoke Electric.	US Dept. of Agriculture Energy Efficiency and Conservation Loan Program
HELP PAYS®	Arkansas	2016	US$ 2m utility-led efficiency portfolio that includes energy efficiency and demand management upgrades, with solar now under consideration.	Non-concessional loans from Cooperative Finance Corporation based on balance sheet
UJALA LED bulb program	India	2015	Distribution of 237 million LED bulbs, later expanded to street lights, fans, and water and sewage pumps. Endorsed by IEA as example of best practice.	Commercial capital and multilateral loans with credit enhancements (World Bank, GEF), with ~30% equity capital from Energy Efficiency Services Ltd (EESL).

[21] For a detailed analysis of PAYS programs in the United States, see Hummel, H. and H. Lachman, 2018 (forthcoming). "What is inclusive financing for energy efficiency, and why are some of the largest states in the country calling for it now?". *2018 Summer Study on Energy Efficiency in Buildings*, American Council for an Energy-Efficient Economy.

7.3 DIFFERENTIATING PAYS FROM TRADITIONAL LEASES, LOANS, AND GRANTS

Leasing is the most commonly proposed alternative to PAYS.

In a leasing model, a separate entity or fund would usually purchase and own the buses, then lease them to the bus company (though it is possible that manufacturers could lease them to customers directly without external financing). While the principle of shifting upfront cost to an operating expense is similar to PAYS, leasing is more limited in terms of the markets it can be applied to and the stakeholders engaged.

Leasing is often most appropriate for markets with sufficient pools of risk capital to raise the fund that purchases the buses. More importantly, a lease still places a long-term liability on the BSP's balance sheet, and is also more sensitive to the strength of the BSP's balance sheet. This is not the case in a PAYS transaction, since the utility's investment is repaid directly through the electricity bill, payments towards which are not considered liabilities. Leasing is also unattractive to larger entities with access to capital markets, since the terms are usually inferior to those they have access to through a traditional loan.

Chinese electric bus manufacturer BYD and capital provider Generate Capital recently announced a joint venture to lease entire electric buses.[22] While the program is not yet operational, the barriers to implementation in developing world contexts applicable to battery leasing are still present and may even be intensified due to the larger capital requirements for the leasing entity.

Loans are a good option for entities with good access to capital markets, but still impose significant long-term liabilities on the BSP's balance sheet. Since BSPs are typically less creditworthy and have less (or no) access to capital markets, a direct loan would be more expensive than a utility-financed PAYS tariff. By shifting the capital investment to a creditworthy utility (which can either self-finance or borrow at lower rates), the PAYS system lowers overall financing costs, transforms the BSP's long-term liability into an electric bill payment, and isolates lenders from the BSP's balance sheet.

Grants, rebates and tax credits have historically been a popular means of meeting the incremental upfront costs of electric buses.[23] The sums involved are significant: in the Santiago case, the grant funding needed to meet the incremental costs of 100 electric buses is US$ 23.2 million without a PAYS system, and under US$ 3.5 million with it. The PAYS system dramatically reduces the need for grant funding by leveraging utilities' interest in transport electrification to meet the majority of this incremental cost.

[22] Martin, C., 2018. "Buffett-backed BYD forms venture to lease electric buses." Bloomberg. https://www.bloomberg.com/news/articles/2018-07-10/buffett-backed-byd-forms-venture-to-lease-electric-buses-in-u-s
[23] See Financing Sustainable Cities Initiative (FSCI) portal.

7.4 ADDITIONAL RISKS RELEVANT TO FINANCING FOR ELECTRIC BUSES

Risk	Description	Risk Bearer	Mitigation Options
Grid robustness	Utility cannot meet demand for additional electricity supply	BSP	None: If utility is unable to guarantee service, this pre-empts financing for additional loads.
Electricity prices	Rate structures can affect the instrument's value proposition	BSP, utility	Base PAYS charge on current electricity rate, and encourage utility adoption of smart charging rates
Maintenance savings uncertainty	Sensitivity analysis required to compensate for relative lack of data for electric bus maintenance costs	BSP, utility	Robust modelling to demonstrate flexibility of value proposition under different scenarios
Foreign exchange risk	[If applicable] Unfavorable FX fluctuations may affect utility obligations to lender if loan not in domestic currency	Utility	Use internal FX hedging facility or solicit from Export Credit Agency / primary lender
BSP existential risk	If BSP ceases operations, cost recovery must transfer to the provider that replaces it	Utility	Link cost recovery to the metered location, not the specific bus provider, and ensure utility ownership stake in the equipment is recognized by new BSP.

7.5 MODELLING AND DUE DILIGENCE CONSIDERATIONS

The modelling undertaken for this paper is intended to represent the general case for PAYS to Clean Transport. For robustness, the model explicitly uses very conservative assumptions on the benefits of electric buses. The actual capital and operating costs of both electric and diesel buses are highly city-specific, however, and in some cases can materially affect the analysis. Some key variables to consider are listed below:

- Fuel economy for diesel buses. This can vary substantially according to the route, elevation change, usage cycle and average speed of a bus, by as much as 50%.
- Average annual mileage. Operating costs for fuel and maintenance (hence also tariff payments) are highly sensitive to the vehicle miles traveled each year. This will vary by city but large cities with long service hours typically see their transit buses travel 75,000-85,000 kilometers per year.
- Capital costs for diesel and electric buses. Capital costs vary widely across different country and city contexts, influenced by factors including import restrictions and tariffs, in-country manufacturing availability and technical/safety requirements for buses in each jurisdiction.
- Staggered charging. We have assumed conservatively that there is one charger needed per bus, and at least one point each month where all the buses in a given fleet are charging at the same time. To reduce demand charges by avoiding large peak loads, the operator may employ smart charging responsive to pricing, schedule staggered charging, or install supplemental stationary storage at the charger stations.
- Electricity rate schedules. We have included volumetric and demand charges in on- and off-peak variants, but different utilities will offer different rate structures that may include a range of time-of-use prices, as well as fixed charges. We have assumed that the charging stations are placed on an existing meter and the tariff is added on top of the existing electricity bill for that meter.
- Local incentives and procurement regulations. Incentives (e.g. tax breaks) provided to electric bus manufacturers and purchasers will vary from country to country and even city to city. In addition, some countries impose restrictions on the content of public sector contract that can be sourced from abroad, requiring that a certain percentage of the contract's value be produced domestically to qualify.
- Concessional or subordinated debt. If the cost of capital is too high, the utility can seek concessional capital (e.g. from regional development banks) or offer a subordinated or first-loss debt position within the capital stack in order to reduce its overall cost of capital.

7.6 MODELLING RESULTS FOR A PAYS PROGRAM IN SIX MAJOR CITIES

City	No. of Buses	Total Cost of Ownership advantage of electric bus with PAYS over Diesel ($000/bus)[24]	Grant support required to meet incremental electric bus costs ($000/bus)			Ratio of grant support to private finance		Utility		Emissions Avoided (tons)		
			Without PAYS[25]	With PAYS	Percent reduction in grants With vs. Without PAYS	Without PAYS	With PAYS	Electricity sales revenue, total (US$m)	Cost of capital	CO_2	PM 2.5	NO_x
Santiago	100	104	232	6	97%	0.8:1	73:1	25.6	6.0%	62,000	5	200
Amman	75	-121	400	259	35%	1:1	2:1	40.4	7.9%	52,500	105	4,900
Bogota	100	-47	280	129	54%	0.7:1	3:1	22.3	8.3%	55,200	5	180
Belo Horizonte	100	10	280	62	78%	0.7:1	7:1	18.2	8.1%	83,800	4	170
Cape Town	100	169	280	26	91%	0.7:1	17:1	14.3	11.83%	21,000	10	1,800
Mexico City	100	130	180	0	100%	1.1:1	n/a	20.0	8.9%	96,000	10	1,800

These results demonstrate that at a 100-bus scale, electric buses with PAYS are already cheaper over their lifecycle than diesel buses in some cities. Electric buses with PAYS support require far less grant funding to be viable, and are a significantly more effective use of grant funds, also leveraging a greater proportion of private finance than a non-PAYS transaction. PAYS generates substantial revenues for the utility and supports tens of thousands of tons of CO_2 emissions reductions, in addition to reductions in tailpipe emissions of harmful fine particulates and nitrogen oxides.

[24] A positive (negative) number indicates that electric buses with PAYS have a lower (higher) total cost of ownership than diesel.

[25] This column captures the difference in upfront capital expenditure for an electric bus including batteries and charger, and an equivalent diesel bus -- which is the presumed amount of grants required in a non-PAYS scenario.

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