BeZero Carbon Final ex ante Risk assessment report

5002
Bangkok e-bus Program

Commissioned by the Federal Office for the Environment (FOEN)

London, 01 April 2025

BeZero

Project details

Particulars	Details
Project name	Operation of e-buses on privately owned, scheduled public bus routes in the Bangkok Metropolitan area by Energy Absolute
BeZero Carbon sector group	Industrial processes
BeZero Carbon sector	Transport
BeZero Carbon sub-sector	Transport Infrastructure & Management
Methodology	T-VER-METH-TM-05 V3 T-VER-METH-TM-06 V3
Project proponent	Energy Absolute Public Company Ltd
Location	Thailand
Project implementation period	15 June 2022 - 31 December 2030
Project commitment period	01 October 2022 – 31 December 2030
Project crediting period	01 October 2022 – 31 December 2030
Total ex ante forecast	500,000 tCO_2e
Key reference documents	BeZero Carbon ex ante Rating methodology, MADD, Validation report, verification report and monitoring report (1), financial analysis.
Report date	01 April 2025

Imprint
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The contractor bears sole responsibility for the content.

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Executive summary

Our risk factor assessment corresponds to the criteria set out under the bilateral agreement between Switzerland and Thailand, the Paris Agreement, and the Swiss CO_2 Ordinance. The key recommendations provided in this report detail how the project can further meet these requirements.

Project description

The Bangkok e-bus programme aims to deploy a fleet of electric buses across 122 existing and new privately operated bus routes within the Bangkok metropolitan area (referred to as category 1 buses)[1]. This initiative will replace the current emissions-intensive diesel and natural gas buses while also preventing the introduction of new fossil-based vehicles. The buses associated with the project began operating in 2022, coinciding with the project's crediting period, which spans from 2022 to 2030. This eight-year period aligns with the concessional licences that grant the rights to operate these routes.

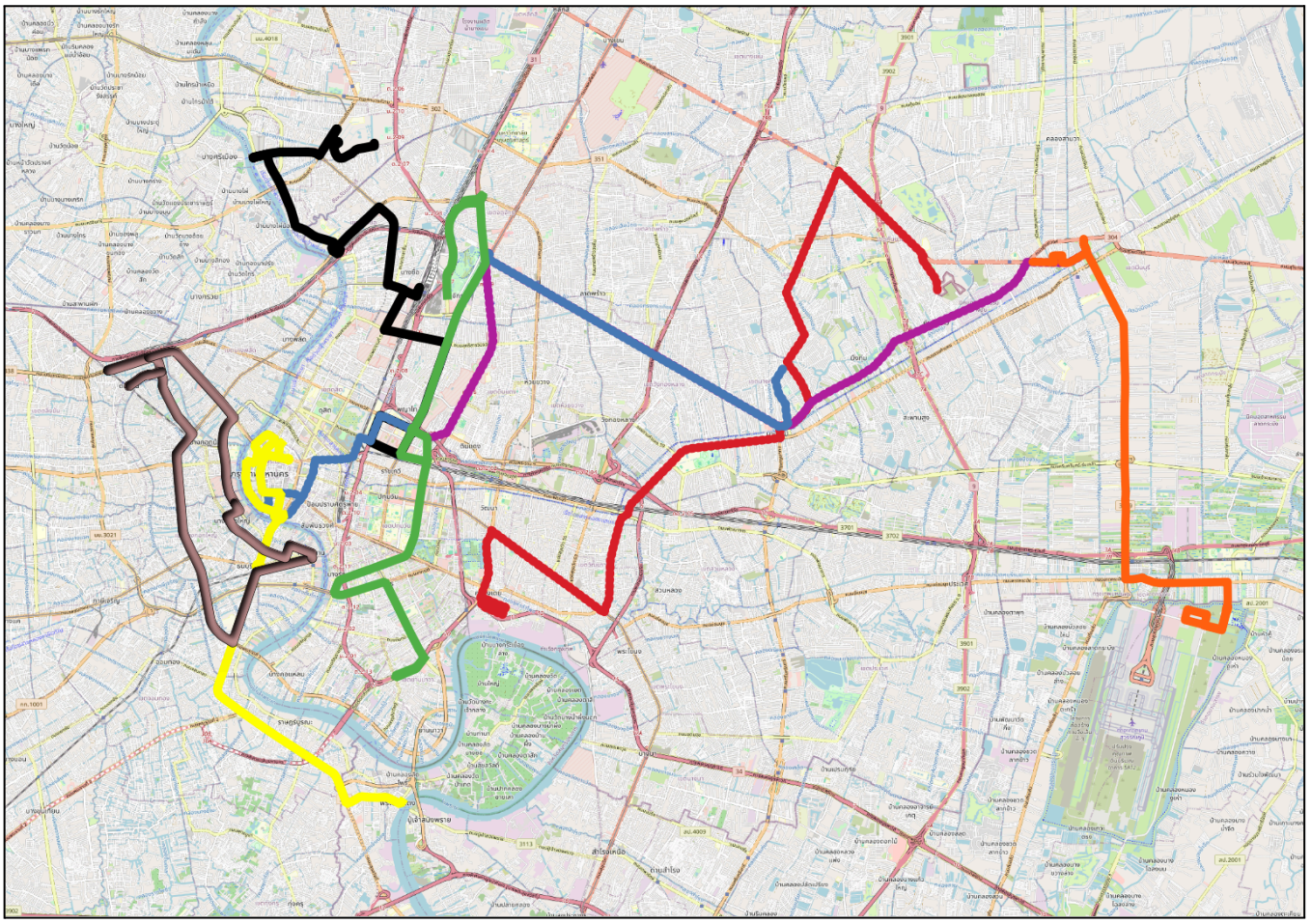


Figure 1. The initial eight bus routes contained within the project's MADD. These include: 1-37 (71), 1-39 (92), 2-38 (8), 2-15 (97), S4 (549), 3-45 (77), 4-15 (82), 4-41 (57L)[1].

The project involves multiple stakeholders, intermediaries and subsidiaries associated with the Thai-based Energy Absolute (EA) group, the project proponent. Understanding these connections is essential to grasping the full scope of the project. The details are outlined in Figure 2 below.

[1] In fact TSB holds licences on 123 bus routes however these were not operational at the time of MADD's submission)

Energy Absolute group

Energy Absolute is the project proponent and the sole recipient of revenues generated from carbon finance. The group is directly involved in the project through various subsidiaries and business arrangements. Aside from activities related to e-buses, the company is also engaged in renewable power generation, biodiesel production, and other business ventures. To contextualise the project, it is important to outline the structure of Bangkok's bus transport sector, which played a significant role in its development.

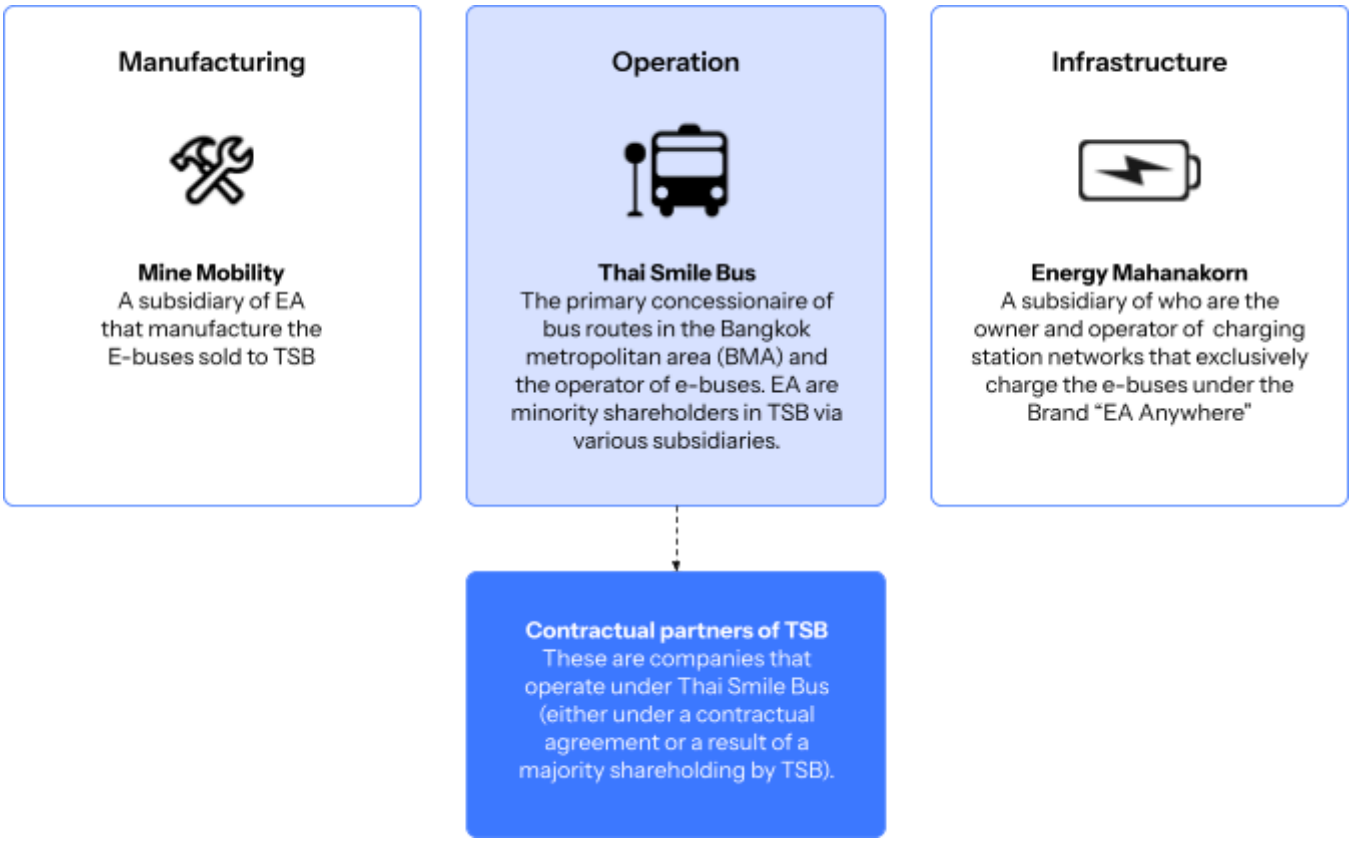


Figure 2. Parties involved in the Bangkok e-bus project related directly or indirectly to Energy Absolute group[2].

Until 2017, Bangkok's bus routes were primarily managed by the Bangkok Mass Transport Authority (BMTA) or subcontracted to small private operators. However, following years of financial losses and growing dissatisfaction with service quality, the central government reformed the city's bus system. One key reform was the revocation of a 1983 cabinet resolution that had designated the BMTA as the sole recipient of licences to operate public buses in Bangkok and surrounding areas. This move liberalised the market, transitioning it to a more privatised model. As a result, the BMTA, despite being a state-owned company, had to compete on equal terms with private companies, such as TSB, for bus route concessions[2].

These reforms also addressed the inefficiencies in the bus market by increasing the number of bus routes from 202 to 269, expanding the total distance covered from 6400 km to 7800 km, and shortening the average route length by 3km. Thai Smile Bus (TSB) emerged as the primary concessionaire of bus routes in Bangkok, replacing the BMTA[3,4].

[2] In practice this may not have been strictly true. It appears as though the BMTA got to shortlist the bus routes that they would operate and those which they would have to compete for.

Figure 3. Historic diesel buses operated by the BMTA[5].

Figure 4. Electric buses implemented under the project[6].

Carbon risk assessment

Additionality

There is a moderately high risk to the additionality of credits issued by the project. This is due to unclear project finances, the role of carbon finance across the fleet, and a regulatory environment that favoured e-bus adoption. However, the role of carbon finance and the limited penetration of electric buses lend some credibility to additionality claims.

Carbon accounting

The project faces low risk in carbon accounting, considering its reliance on monitored variables, representative sampling and appropriate inputs. Concerns remain about the accuracy of credits associated with modal shifts.

Permanence

The project has the highest likelihood of permanence due to the nature of project activities.

Information risk

Credits issued by this project face a high information risk since some key details cannot be ascertained, nor can some primary documents be accessed.

Key risk mitigation strategies

We have identified several key strategies the project could implement to reduce risk. These potential risk mitigation strategies span additionality and carbon accounting, and can also help ensure the project meets the requirements outlined in the bilateral agreement between Switzerland and Thailand, the Paris Agreement, and the Swiss CO_2 ordinance.

Additionality

- The project plans to issue credits across its entire fleet of e-buses deployed in Bangkok. However, the tests conducted to demonstrate the project's additionality only focus on a subset of these buses (in fact, only the initial 154 buses deployed). A financial analysis of each cohort of buses would be better able to ascertain their additionality.
- A more robust financial analysis may also be beneficial. For example, it would be informative to evaluate whether the issuance of 160 tCO_2e per bus is reasonable.
- TSB was awarded concessional licences to operate each bus route following a tendering system. Information regarding other participants may better demonstrate the project's additionality.
- Increased disclosure from the proponents could help corroborate the project's additionality in several areas. For example, disclosure of the total cost of ownership (TCO) gap analysis, the unredacted agreement between EA and the Asian Development Bank, details regarding the tender submitted to win concessional bus routes, and, importantly, explicit disclosure of who will receive revenues from ITMOs sales.

Carbon accounting

- As detailed above, since an uptick in the use of e-buses is reasonably likely to occur in Bangkok over the project's crediting period, using a dynamic baseline set to account for this background trend may better support both additionality and carbon accounting relative to the static 1% year-on-year technology improvement factor.
- Without robust procedures or dynamic controls, credits attributed to the modal shift of passengers may lack veracity. Incorporating a control sample to better delineate any observed modal shift with a baseline modal shift would be beneficial. For example, comparing bus ridership trends on the project against BMTA buses would add more reliability. However, we acknowledge that current monitoring processes seem stringent, reducing this potential source of risk.
- A means of ensuring that the emission intensity of grid electricity reported by TGO and applied by the project remains conservative relative to other sources may strengthen the project's carbon accounts.
- Accounting for the life-cycle impacts of batteries within the fleet would further build the credibility of the project's carbon accounts, though we acknowledge that excluding non-tailpipe emissions of the counterfactual natural gas vehicle (NGV) fleet is likely conservative.

Key monitorables

The following are important variables to monitor on an ongoing basis:

Financials

- To ensure that the project's additionality does not become less credible, the financial performance of e-buses should continue to lack independent attractiveness and remain more costly than an alternative. This means ensuring that the project's financials remain consistent with their models. In addition, ensuring that any developments (such as the tax deductions implemented) are accounted for.

Regulations

- The Bangkok City Council has sought to mandate the adoption of electric buses beyond 2030; however, this is currently under review. Whilst such a law may not explicitly focus on the reviewed crediting period, it should be considered at the point of renewal.

BeZero Carbon ex ante carbon risk assessment

Additionality

BeZero Carbon assesses that credits issued by project 5002 are likely to encounter a moderately high risk regarding additionality. This assessment is influenced by the project's unclear financial structure and the role of carbon finance across the entire fleet, compounded by a regulatory environment favouring e-bus adoption. Nonetheless, the significant role of carbon finance and the historically low penetration of e-buses in the region add some credibility to the project's additionality claims.

Prior consideration

Our analysis of prior consideration examines whether carbon finance was seriously considered before investment decisions were made. We find that:

There is some evidence that carbon finance was seriously considered before the project's investment decision. For project 5002, these considerations were integrated throughout the project's developmental phases. For example, the project's 'Mitigation Activity Design Document' was submitted in May 2022, soon after Thai Smile Bus (TSB) was awarded concessional licences and before the bus purchase agreement was finalised. Studies analysing the business model of e-bus operators in Bangkok have also explored the use of carbon finance or related incentives to enhance investment viability [4,7,8]. Additionally, the methodology applied has been available under the Thailand Greenhouse Gas Management Organisation since 2021. These factors lend credibility to the argument that carbon finance was a deliberate consideration throughout the project's development. Nonetheless, this could potentially be better evidence, for example, within the minutes of board meetings.

Financial analysis

Our financial analysis assesses whether the project's activities were financially viable without the inclusion of carbon finance. We find that:

The uncertain role of carbon finance introduces additionality risk. Project 5002's additionality is primarily asserted on financial grounds – that is, the project activities were not attractive enough to justify the investment without carbon finance. This aligns with existing literature, which similarly finds that the business model for an electric bus operator in Bangkok is not particularly appealing. The project demonstrates this through an investment analysis of its first cohort of 154 buses. Without carbon finance, the project's internal rate of return (IRR) is 1.33%. With ITMOs, this rises to 9.3%, making the project bankable against a weighted average cost of capital (WACC) of 5.24%. ITMOs also contribute to an 18% increase in total project revenues. While many of the inputs used to derive these figures appear reasonable and have been validated by third parties, there remains considerable uncertainty, suggesting that the role of carbon finance may be overstated.

The project plans to issue credits for at least 1,913 buses, whilst the investment analysis focuses solely on the first 154 buses. Such a sample may not be sufficiently representative. In addition, the large role attributed to carbon finance is based on a forecast of 160 tCO_2e of emission reductions per bus per year[3]. This figure is a critical input in the financial analysis, yet its derivation lacks detail. Based on the project's ex ante forecast of issuance, ex post issuance to date, and comparative literature, this figure appears overstated [8]. The financial model also assumes revenues from credit sales over 14 years (2022–2035), but the agreement with Switzerland only covers the period up to 2030, meaning carbon revenues may not be guaranteed beyond that year. These points underscore the substantial uncertainty surrounding the role of carbon finance in the project's financial framework.

[3] This assumption appears notional and does not reflect how emission reductions are calculated by the project (therefore does not impact our view of carbon accounting).

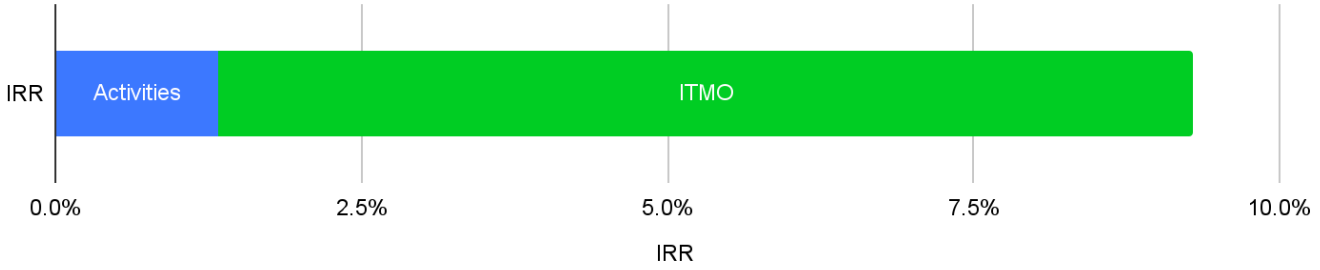


Figure 5. Financial assessment provided for 5002.

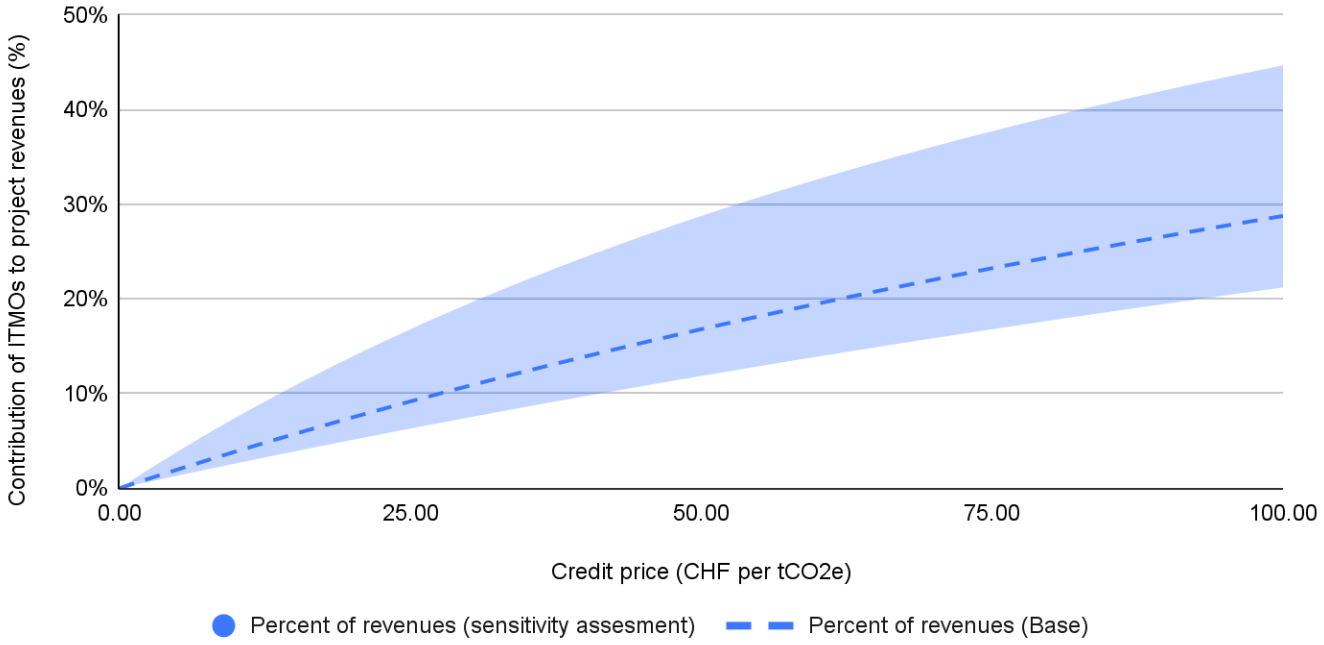


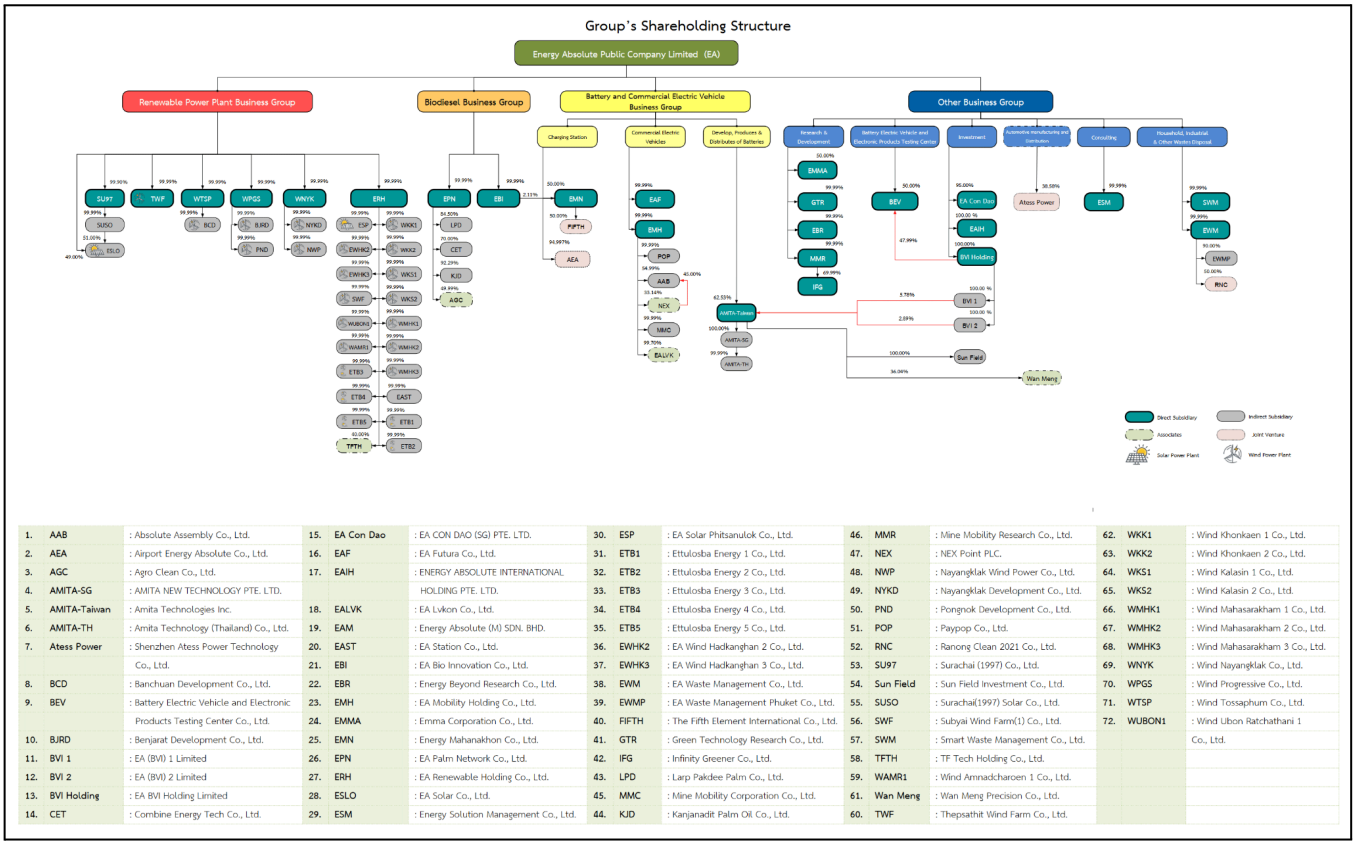
Figure 6. Revenue assessment considered for 5002 based on inputs provided. The shaded region indicates sensitivities to ticket sales ±50% of forecast.

Further opaqueness restricts our ability to confidently assess the significance of ITMOs. Further sources of uncertainty that limit our confidence in the project's additionality include:

1. It is unclear whether carbon-related revenues are being directed to the entity with the weakest investment case – TSB, the bus operator. The Mitigation Activity Design Document (MADD) identifies the beneficiary of the payments as the project activity operator, who bears the total cost of ownership (TCO) that otherwise hinders e-bus adoption. While this suggests TSB should be the beneficiary, the project activity operator is explicitly defined as 'Energy Absolute Public Company Limited (EA)', which includes: Energy Absolute, Energy Mahanakorn (EMN) as well as TSB. Given the complex structure of Energy Absolute (depicted below), it is difficult to ensure that the presented and provided investment case encapsulates the full motivations of the e-bus investment.

2. EA's activities are supported by a loan from the Asian Development Bank, with key financial information redacted, making certain figures impossible to verify. Furthermore, ITMOs or carbon finance are not discussed in publicly available documents[9].

3. It cannot be independently verified whether the revenue forecasts from ticket sales are accurate. As shown in Figure 9, bus usage in Bangkok in the early 2020s has been volatile, influenced by COVID-19, subsequent lockdowns, and broader shifts in passenger behaviours. There is a risk that anticipated ticket sales were based on data from a period of low usage, which may not be representative over the concessional period of the licence [10,4].



1.	AAB	: Absolute Assembly Co., Ltd.	15.	EA Con Dao	: EA CON DAO (SG) PTE. LTD.	30.	ESP	: EA Solar Phitsanulok Co., Ltd.	46.	MMR	: Mine Mobility Research Co., Ltd.	62.	WKK1	: Wind Khonkaen 1 Co., Ltd.
2.	AEA	: Airport Energy Absolute Co., Ltd.	16.	EAF	: EA Futura Co., Ltd.	31.	ETB1	: Ettulosba Energy 1 Co., Ltd.	47.	NEX	: NEX Point PLC.	63.	WKK2	: Wind Khonkaen 2 Co., Ltd.
3.	AGC	: Agro Clean Co., Ltd.	17.	EAIH	: ENERGY ABSOLUTE INTERNATIONAL	32.	ETB2	: Ettulosba Energy 2 Co., Ltd.	48.	NWP	: Nayangklak Wind Power Co., Ltd.	64.	WKS1	: Wind Kalasin 1 Co., Ltd.
4.	AMITA-SG	: AMITA NEW TECHNOLOGY PTE. LTD.			HOLDING PTE. LTD.	33.	ETB3	: Ettulosba Energy 3 Co., Ltd.	49.	NYKD	: Nayangklak Development Co., Ltd.	65.	WKS2	: Wind Kalasin 2 Co., Ltd.
5.	AMITA-Taiwan	: Amita Technologies Inc.	18.	EALVK	: EA Lvkon Co., Ltd.	34.	ETB4	: Ettulosba Energy 4 Co., Ltd.	50.	PND	: Pongnok Development Co., Ltd.	66.	WMHK1	: Wind Mahasarakham 1 Co., Ltd.
6.	AMITA-TH	: Amita Technology (Thailand) Co., Ltd.	19.	EAM	: Energy Absolute (M) SDN. BHD.	35.	ETB5	: Ettulosba Energy 5 Co., Ltd.	51.	POP	: Paypop Co., Ltd.	67.	WMHK2	: Wind Mahasarakham 2 Co., Ltd.
7.	Atess Power	: Shenzhen Atess Power Technology	20.	EAST	: EA Station Co., Ltd.	36.	EWHK2	: EA Wind Hadkanghan 2 Co., Ltd.	52.	RNC	: Ranong Clean 2021 Co., Ltd.	68.	WMHK3	: Wind Mahasarakham 3 Co., Ltd.
		Co., Ltd.	21.	EBI	: EA Bio Innovation Co., Ltd.	37.	EWHK3	: EA Wind Hadkanghan 3 Co., Ltd.	53.	SU97	: Surachai (1997) Co., Ltd.	69.	WNYK	: Wind Nayangklak Co., Ltd.
8.	BCD	: Banchuan Development Co., Ltd.	22.	EBR	: Energy Beyond Research Co., Ltd.	38.	EWM	: EA Waste Management Co., Ltd.	54.	Sun Field	: Sun Field Investment Co., Ltd.	70.	WPGS	: Wind Progressive Co., Ltd.
9.	BEV	: Battery Electric Vehicle and Electronic	23.	EMH	: EA Mobility Holding Co., Ltd.	39.	EWMP	: EA Waste Management Phuket Co., Ltd.	55.	SUSO	: Surachai(1997) Solar Co., Ltd.	71.	WTSP	: Wind Tossaphum Co., Ltd.
		Products Testing Center Co., Ltd.	24.	EMMA	: Emma Corporation Co., Ltd.	40.	FIFTH	: The Fifth Element International Co., Ltd.	56.	SWF	: Subyai Wind Farm(1) Co., Ltd.	72.	WUBON1	: Wind Ubon Ratchathani 1
10.	BJRD	: Benjarat Development Co., Ltd.	25.	EMN	: Energy Mahanakhon Co., Ltd.	41.	GTR	: Green Technology Research Co., Ltd.	57.	SWM	: Smart Waste Management Co., Ltd.			Co., Ltd.
11.	BVI 1	: EA (BVI) 1 Limited	26.	EPN	: EA Palm Network Co., Ltd.	42.	IFG	: Infinity Greener Co., Ltd.	58.	TFTH	: TF Tech Holding Co., Ltd.			
12.	BVI 2	: EA (BVI) 2 Limited	27.	ERH	: EA Renewable Holding Co., Ltd.	43.	LPD	: Larp Pakdee Palm Co., Ltd.	59.	WAMR1	: Wind Amnadcharoen 1 Co., Ltd.			
13.	BVI Holding	: EA BVI Holding Limited	28.	ESLO	: EA Solar Co., Ltd.	45.	MMC	: Mine Mobility Corporation Co., Ltd.	61.	Wan Meng	: Wan Meng Precision Co., Ltd.			
14.	CET	: Combine Energy Tech Co., Ltd.	29.	ESM	: Energy Solution Management Co., Ltd.	44.	KJD	: Kanjanadit Palm Oil Co., Ltd.	60.	TWF	: Thepsathit Wind Farm Co., Ltd.			

Figure 7. Energy Absolutes structure (accessed August 2024)[11].

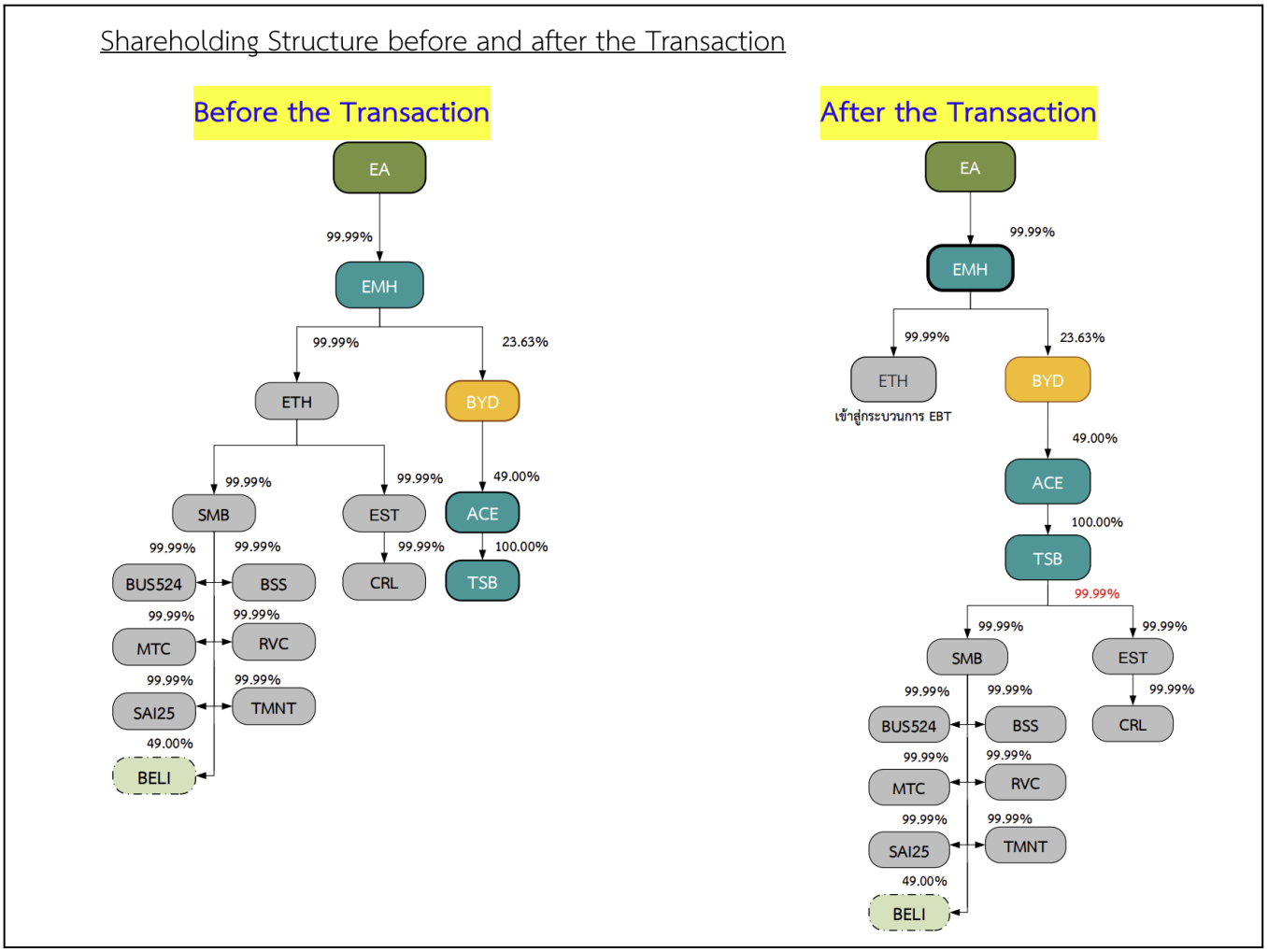


Figure 8. Energy Absolute's relationship with TSB [12].

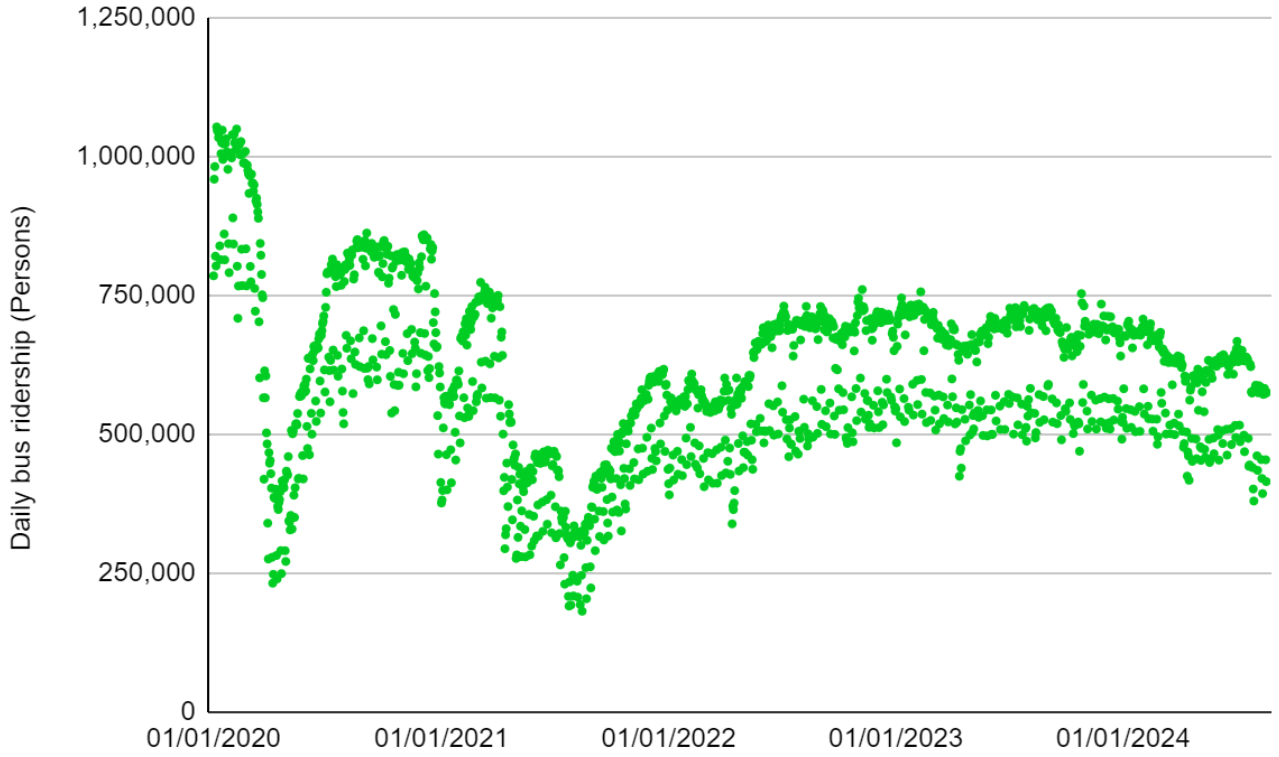


Figure 9. Bus usage on BMTA buses (2020–2024). Troughs align with periods of COVID-19 restrictions, whilst the bifurcation of data points is explained by passenger behaviour patterns on weekdays versus weekends [13,14].

The implementation of pilot activities by TSB presents only a minor risk to the project's additionality. Before project 5002 began, TSB had already deployed some electric buses in Bangkok without leveraging carbon finance. This is substantiated by time-stamped images and corroborated by official statistics from the Department of Land Transport. Some may interpret this as evidence that TSB's business model was already viable. However, we believe this does not adequately refute the necessity of ITMO involvement for the full-scale operations envisioned by the project, which are ten times larger than the pilot phase. The 120 e-buses deployed before the project are better understood as a pilot initiative, which BeZero finds more credible than disputable [15]. It's worth noting that TSB was a new entrant in a historically challenging market, deploying relatively novel technology[16].

Slight risk to additionality considering the potential longer-term affordability of electric vehicles (EVs). Whilst the case above suggests that TSB's investment might be below the market benchmark, it is not clear that investing in a more emission-intensive alternative, like natural gas vehicles (NGVs), would be significantly more attractive. Some studies have confirmed that the total cost of ownership (TCO) for e-buses in Bangkok (22.50 THB per km) exceeds that of NGVs (20.50 THB per km)[17]. This cost difference primarily stems from the higher upfront costs of e-buses, despite operational savings in fuel and maintenance. However, these conclusions are sensitive to assumptions about the future electricity and natural gas prices. In practice, TSB's electricity costs (4.57 THB per kWh) are lower than modelled, while natural gas prices have surged, requiring government intervention to cap prices and consumption for buses [18,19]. Although EA has reportedly conducted its own TCO analysis, BeZero has not had access to this data and thus cannot verify accuracy. Therefore, the adoption of electric technologies may be reasonable for an investor in Bangkok's bus system with sufficient access to capital, which presents a slight risk to the project's additionality.

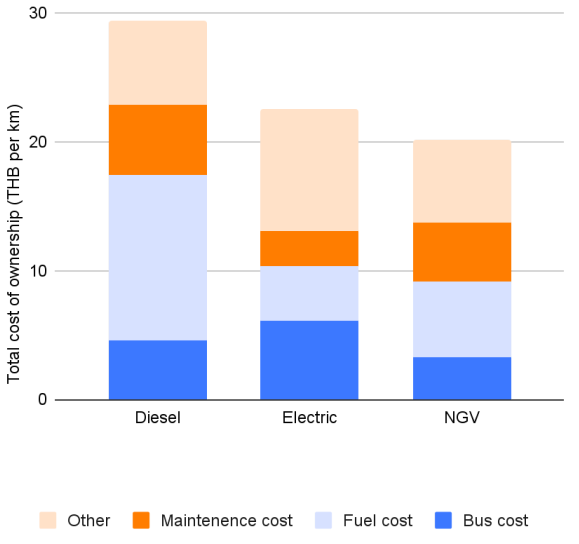


Figure 10a. TCO analysis for diesel, electric and NGV buses in Bangkok[20].

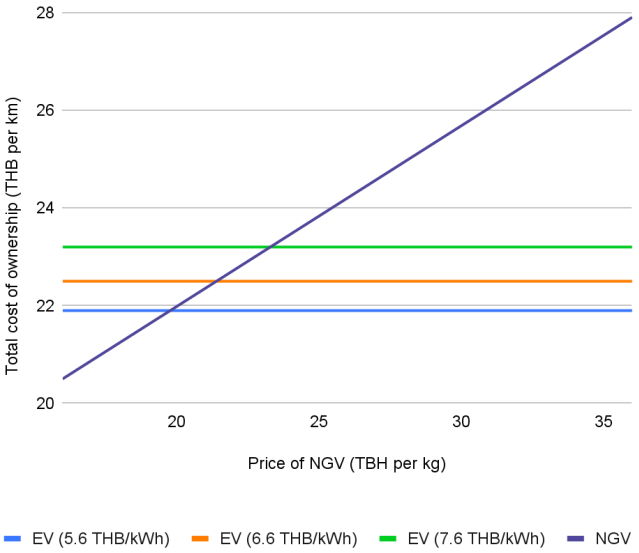


Figure 10b. TCO for NGV and EV buses versus fuel cost [20].

EVs face inherent drawbacks that may hinder their adoption, such as limited range. Solutions like oversizing fleets for adequate charging or focusing on specific routes can mitigate these limitations, but these measures often increase costs at the fleet level. Some studies on e-bus adoption in Bangkok found that e-buses were the best option for only two of five Bangkok Mass Transport Authority (BMTA) routes, indicating they might not always be the most attractive choice. Despite this, TSB's implementation of e-buses has been indiscriminate, suggesting that EVs may not be the optimal option in all cases, supporting additionality [21,22].

The most significant barrier to TSB's investment likely lies in the broader challenges of Bangkok's bus market. For example, the BMTA has been notoriously unprofitable. Private companies like TSB have also faced historically inefficient systems and competition from overlapping bus routes, compounded by declining passenger numbers [23,24]. The COVID-19 pandemic led to the collapse of several companies, whose operations were subsequently absorbed by TSB. Specific to Thai Smile Bus, while other parts of the e-bus infrastructure might offer attractive returns, operators likely face the greatest financial struggles. Consequently, the project's seemingly weak absolute returns may well have dissuaded the adoption of unconventional and more capital-intensive technologies like EVs without ITMO support.

In addition, although EA has been recognised as a pioneer in the Thai renewable energy sector, and its recent expansion into new markets (including electric vehicles and buses) was seen as promising[25], it may have overextended the company. Since 2023, Energy Absolute's share price has steadily declined, a trend attributed to the low order volume[4] and the company's increasing debt burden from funding its expansion into these new markets. Considering the observed challenges EA has faced, the supposed lack of attractiveness of the e-bus venture would appear evident.

[4] This is explored in more detail in the 'Project execution risk' section.

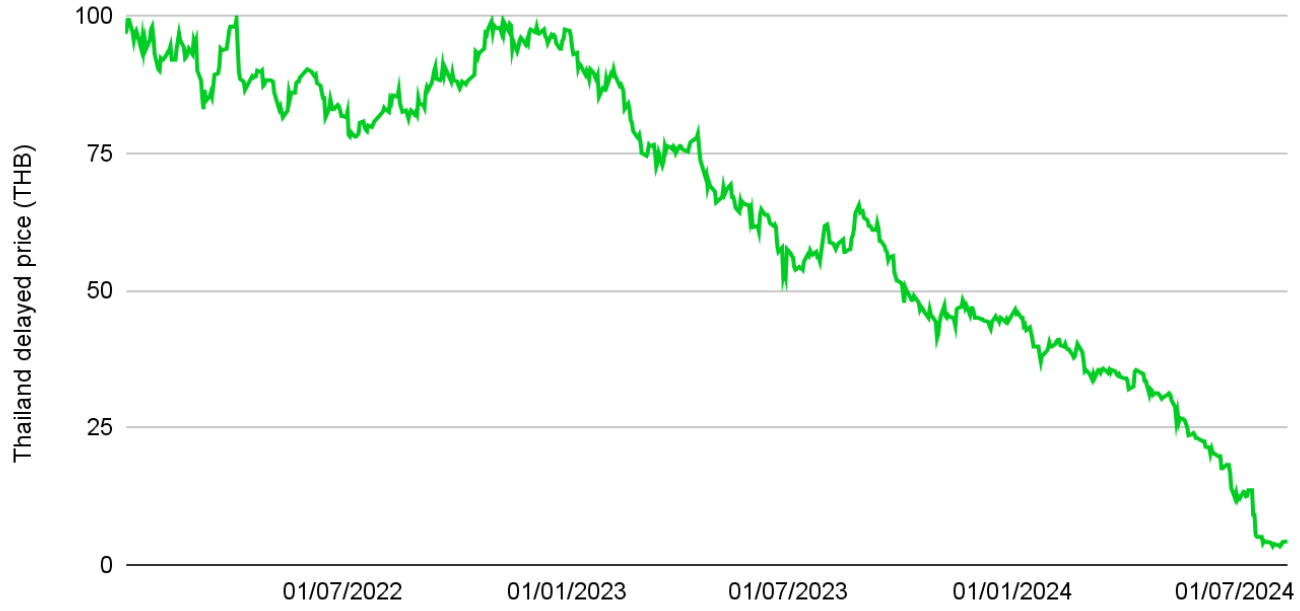


Figure 11. Energy Absolute Public Company Limited (EA.BK) share price, January 2022 - July 2024[26]

Activity analysis

Our activity analysis evaluates the extent to which project activities are common and likely to occur independently of carbon finance. We find that:

The technological nascence of EVs in Thailand supports the project's additionality. As noted, before 2017, the BMTA primarily operated bus routes in Bangkok, and the use of electric vehicles was virtually non-existent[16]. Even now, e-buses are at the industry's periphery, making up only 5% of new bus registrations in Bangkok in 2023 and just 1% of buses outside of Bangkok. These statistics highlight the significant barriers to e-bus deployment. Given these factors, independent literature and market reports strongly suggest that carbon finance likely bolstered the investment case for an e-bus operator facing a challenging market [7,8,24,27].

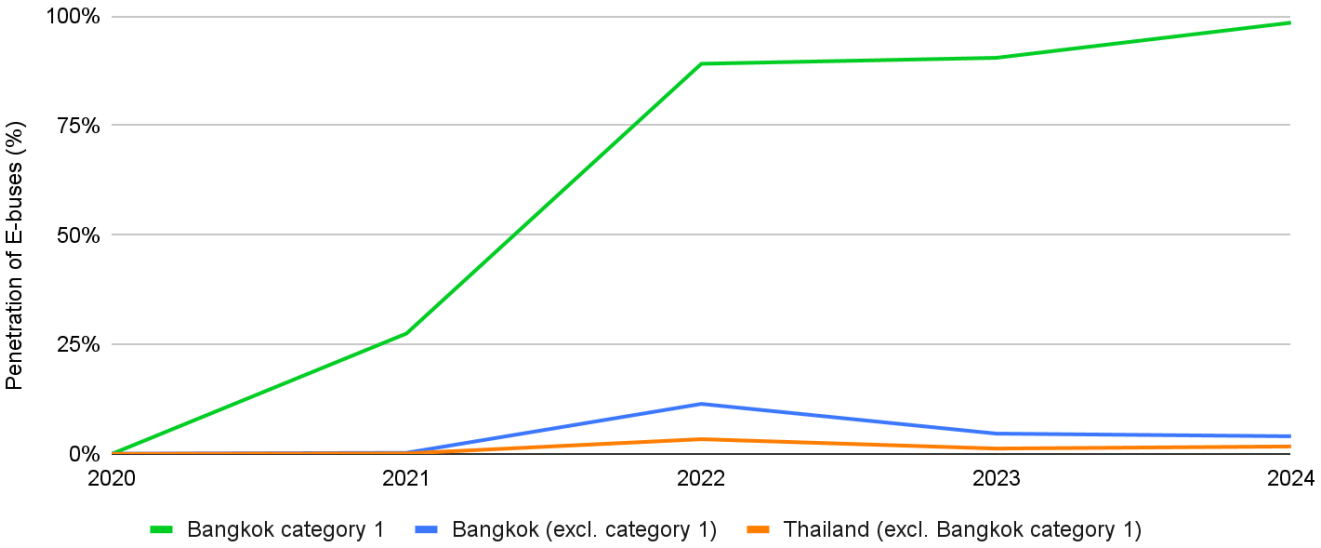


Figure 12. Penetration of electric buses in new bus registrations in Thailand.

The limited adoption of electric vehicles may be attributed to factors less relevant to TSB. Contrary to previous interpretations, our activity analysis suggests that the trend mentioned above should not be viewed in isolation. As previously discussed, given the elevated upfront costs of EVs,

access to capital remains the most significant barrier to deployment. For instance, the BMTA faced severe capital constraints due to consecutive years of financial losses and the high costs needed to maintain its existing fleet. Small sub-contracted firms, on the other hand, likely found it difficult to justify the cost of EVs due to the inefficiencies in the routing system – where multiple firms often operated on the same route – and their small scale, often being family-run businesses. More broadly, the market outside of Category 1 buses is highly fragmented, consisting of smaller companies and individuals. Therefore, as a significant market entrant and now its largest actor, TSB is likely to encounter fewer barriers than might be assumed. While this does not override the lack of common practice, it potentially mitigates the impact this has on our assessment.

The BMTA's adoption of EVs could demonstrate the viability of an e-bus operator. Following the Bangkok bus system reforms, the BMTA itself underwent a significant restructuring, which is still ongoing. A key component of this was the transfer of licences to TSB and a few other private companies. In addition, the BMTA's restructuring aimed to replace their ageing fleet of buses, which had led to substantial maintenance costs and ultimately the reforms [28,29,30]. Despite multiple proposals to replace the fleet, the BMTA adopted EVs over other modern bus types. Although the BMTA's transition to e-buses is behind schedule, their decision to engage in activities comparable to the project suggests that these activities could reflect a viable business model independent of carbon credits.

Regulatory analysis

Our regulatory analysis evaluates the extent to which project activities have resulted from regulatory measures. We find that:

Activities appear to be appropriately outside of NDC commitments. Thailand's latest nationally determined contributions (NDC #2) seek to (unconditionally) reduce the emissions of covered sectors by 30-40% by 2030 relative to business-as-usual[31]. Of these, 45.61 million tCO_2e will arise from the transport sector [32,33]. Electrification of transport will account for 28.3 $MtCO_2e$ of these. A specific list of activities that will facilitate this reduction is not readily available, however, the project appears to be additional to these. Specific references in government presentations inform this conclusion. The project also appears outside the scope of the Ministry of Transport's plans. For example, while the 2023-2030 transport action plan (Revised edition) similarly targets transport electrification, it focuses specifically on the BMTA's fleet without reference to private organisations[34]. Considering these factors, the project appears to be additional to Thailand's NDC commitments.

Broader government targets present limited risk considering the current underperformance. Thailand's 30@30 policy, announced in 2021, aims for 18,000 electric buses and trucks, 225,000 electric cars and 360,000 electric motorcycles by 2025 [35,36]. To support this, specific tax deductions for e-buses were introduced in February 2024, including a tax deduction equivalent to twice the vehicle's value if produced domestically or 1.5 times if manufactured abroad[37]. As of December 2024, progress toward these targets has been observed[5], but they are unlikely to be met. Therefore, although the project aligns with government targets – which could suggest an additionality risk – the lack of incentives to meet these targets indicates a continued role for carbon finance, in our view.

[5] 2025 figures are an interim target towards the broader 2030 goal. Here the objective is 33,000 buses and trucks, 440,000 cars and 650,000 motorcycles. Unlike the 2025 target, the 2030 has a reasonable likelihood of being achieved.

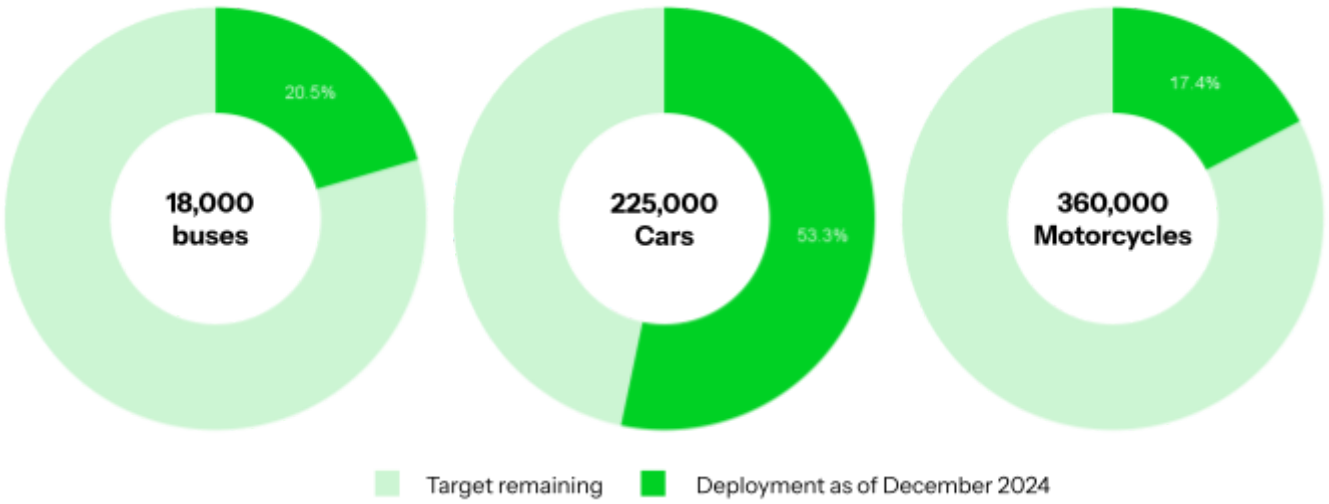
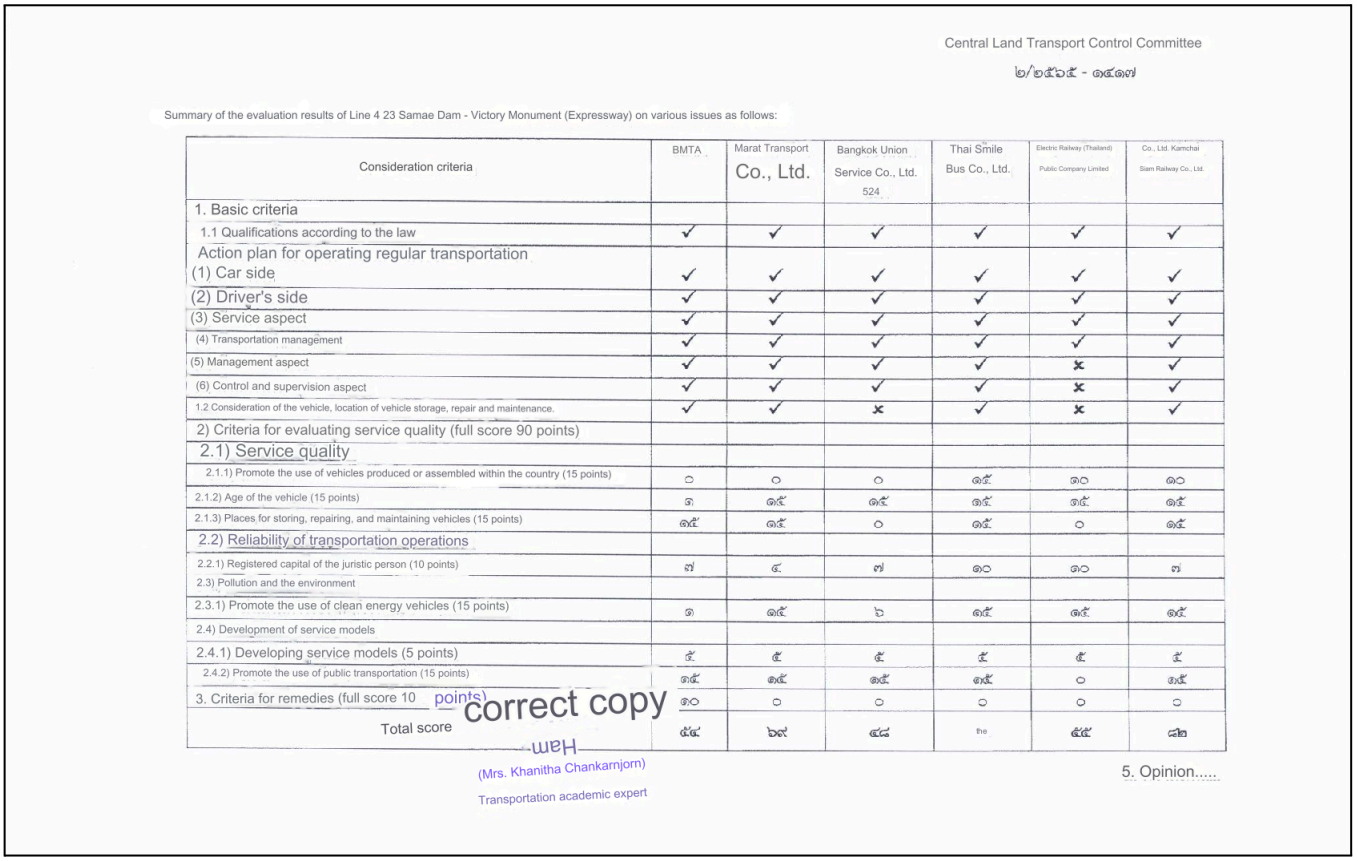


Figure 13. Thailand's performance against EV use targets as of December 2024 (Deployment excludes hybrid vehicles) [36] .

Recent mandates contribute a slight risk towards additionality. In October 2023, the Bangkok City Council approved a draft city code seeking to replace all fossil fuel-powered public buses with electric vehicles within seven years to protect the environment and public health [38,39]. This mandate presents a potential challenge to the project's additionality since using EVs over fossil-based alternatives would become a requirement, superseding any economic rationale for additionality. However, this rule is pending legal review, as it is unclear whether the City Hall is authorised to enforce such a code. In addition, the rule predates TSB's bus route concessions and would only take effect at the end of the project's first crediting period (2030). While this development signals regulatory interest in e-buses and presents a significant risk to additionality, it does not fully undermine the project's claim to additionality, at least not at this time.

Opaqueness surrounding concessional licence allocation drives additionality risk. A final consideration is the allocation of concessional licences held by TSB, which were awarded through a tendering process managed by the Department for Land Transport, Land Transport Committee and Central Land Transport Control Board. The selection criteria for awarding concessions are not entirely transparent. However, we understand that concessionaires must meet basic criteria and are then scored against a service quality rubric, which includes a preference for 'clean energy vehicles', contributing 15 of the 90 available points. This is supported by the Department for Land Transport presentations, which suggest that operators who opt for EVs are scored more favourably [40,41].

Therefore, there is a risk that, if TSB could not fulfil bus routes with EVs, another company might have done so without requiring ITMOs. Moreover, if all tender participants proposed using e-buses, their adoption would appear inevitable. To assess whether TSB's involvement prevented the use of non-EV alternatives, it would be useful to evaluate each bus route independently, considering who would have been awarded the concessions in TSB's absence. Unfortunately, no information is available on this. As a result, there is considerable uncertainty regarding the extent to which TSB's buses represent EV usage that would not have occurred without TSB. In addition, this mechanism would challenge the credibility of the TCO argument, as even if alternative technologies were cheaper and more profitable, any business case using such an alternative might not win the concession, making it less practical as a comparator.



Central Land Transport Control Committee

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Summary of the evaluation results of Line 4 23 Samae Dam - Victory Monument (Expressway) on various issues as follows:

Consideration criteria	BMTA	Marat Transport Co., Ltd.	Bangkok Union Service Co., Ltd. 524	Thai Smile Bus Co., Ltd.	Electric Railway (Thailand) Public Company Limited	Co., Ltd. Kamchai Siam Railway Co., Ltd.
1. Basic criteria						
1.1 Qualifications according to the law	✓	✓	✓	✓	✓	✓
Action plan for operating regular transportation (1) Car side	✓	✓	✓	✓	✓	✓
(2) Driver's side	✓	✓	✓	✓	✓	✓
(3) Service aspect	✓	✓	✓	✓	✓	✓
(4) Transportation management	✓	✓	✓	✓	✓	✓
(5) Management aspect	✓	✓	✓	✓	✗	✓
(6) Control and supervision aspect	✓	✓	✓	✓	✗	✓
1.2 Consideration of the vehicle, location of vehicle storage, repair and maintenance.	✓	✓	✗	✓	✗	✓
2) Criteria for evaluating service quality (full score 90 points)						
2.1) Service quality						
2.1.1) Promote the use of vehicles produced or assembled within the country (15 points)	๐	๐	๐	๑๕	๑๐	๑๐
2.1.2) Age of the vehicle (15 points)	๑	๑๕	๑๕	๑๕	๑๕	๑๕
2.1.3) Places for storing, repairing, and maintaining vehicles (15 points)	๑๕	๑๕	๐	๑๕	๐	๑๕
2.2) Reliability of transportation operations						
2.2.1) Registered capital of the juristic person (10 points)	๗	๔	๗	๑๐	๑๐	๗
2.3) Pollution and the environment						
2.3.1) Promote the use of clean energy vehicles (15 points)	๑	๑๕	๖	๑๕	๑๕	๑๕
2.4) Development of service models						
2.4.1) Developing service models (5 points)	๕	๕	๕	๕	๕	๕
2.4.2) Promote the use of public transportation (15 points)	๑๕	๑๕	๑๕	๑๕	๐	๑๕
3. Criteria for remedies (full score 10 points)	๑๐	๐	๐	๐	๐	๐
Total score	๕๘	๖๗	๔๘	the	๕๕	๘๒

correct copy

(Mrs. Khanitha Chankarnjorn)

Transportation academic expert

5. Opinion.....

Figure 14. Selection criteria for Bangkok bus concessionaires used for 4-23E (Samaedam - Victory Monument (Tollway))[42].

Additionality conclusion

In our view, the project faces a moderately high risk in relation to additionality. This conclusion is based on our findings that, although e-buses are an emerging technology and carbon finance may be material to the project's investment case, credible risks exist regarding the appropriateness of all financial inputs, alongside the market structure nuances that favoured the adoption of e-buses.

Carbon accounting

BeZero Carbon assesses that the credits issued by Project 5002 face low risk in terms of carbon accounting. This assessment is based on the use of monitored variables, representative sampling, and appropriate inputs. However, despite these strengths, there are concerns about the accuracy of credits linked to the modal shift and the potential lack of nuance in the assumed baseline.

Overview

The issuance of 5002 is based on two impacts of the project. Most substantially is that the project activities replace natural gas vehicles (NGVs). These emission reductions are supplemented by a modal shift of some consumers that it is believed would previously have used other (emission-intensive) modes of transport. Project emissions relate to the charging of the buses using electricity. As depicted below, emission reductions are influenced predominantly by the claim that e-buses replace NGVs, whilst modal shift and project emissions are smaller. Leakage deductions appear notional.

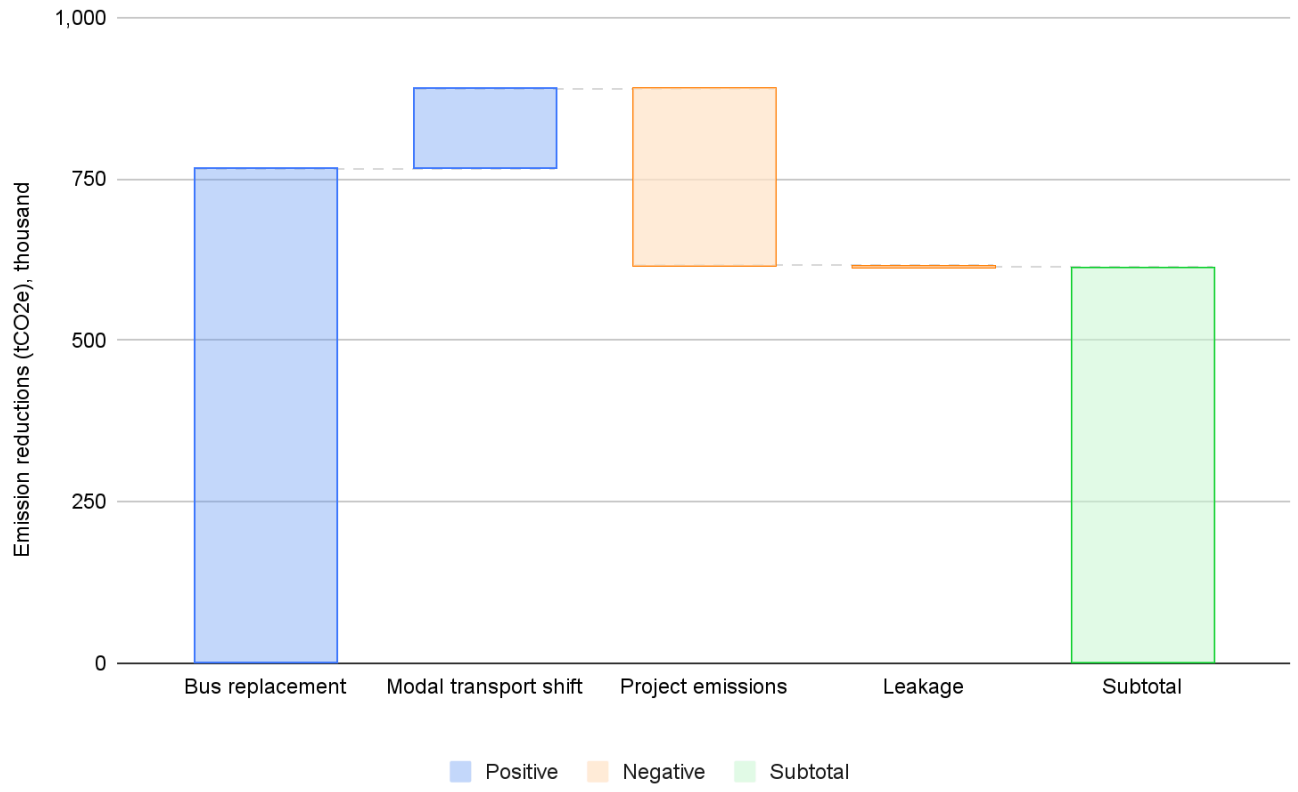

Figure 15. Waterfall chart depicting how issuance is forecast to be calculated.

Baseline scenario

Our evaluation of the project's baseline scenario focuses on whether it has adequately characterised and quantified emissions associated with the most plausible counterfactual. In this regard, we find that:

The assumed baseline may lack some temporal relevance, introducing some associated risk. Characterising the counterfactual for transport-related projects is particularly challenging due to the constantly evolving nature of industries and technologies. In Project 5002, it is assumed that the routes would be serviced by buses fueled by natural gas. NGV buses are slightly less emission-intensive than other fossil-fuel-based bus types, making them a conservative counterfactual choice [17.43]. As shown in Figure 16, NGVs are visibly being phased out in favour of e-buses, also supporting the project's characterisation of the non-electric vehicle (EV)

counterfactual. However, the assumption that without Thai Smile Bus (TSB), no e-buses would operate on these routes is likely a slight oversimplification. Some operators may have still opted for e-buses, albeit on a smaller scale or with delayed implementation. This simplification also overlooks that e-buses have accounted for some new bus registrations in Bangkok. Furthermore, the concessional licences that allow TSB to operate their routes are issued at discrete intervals and are valid for seven years. However, the Bangkok Mass Transport Authority (BMTA; a potential comparator) is seeking to replace its emission-intensive fleet with EVs before 2030, though progress has been slow. It is worth acknowledging that the project has made some attempts to account for a general improvement in baseline technology. This takes the form of a 1% year-on-year improvement in efficiency. However, the absence of a more dynamic control to account for external EV adoption could mean this risk is not sufficiently accounted for, especially in later vintages.

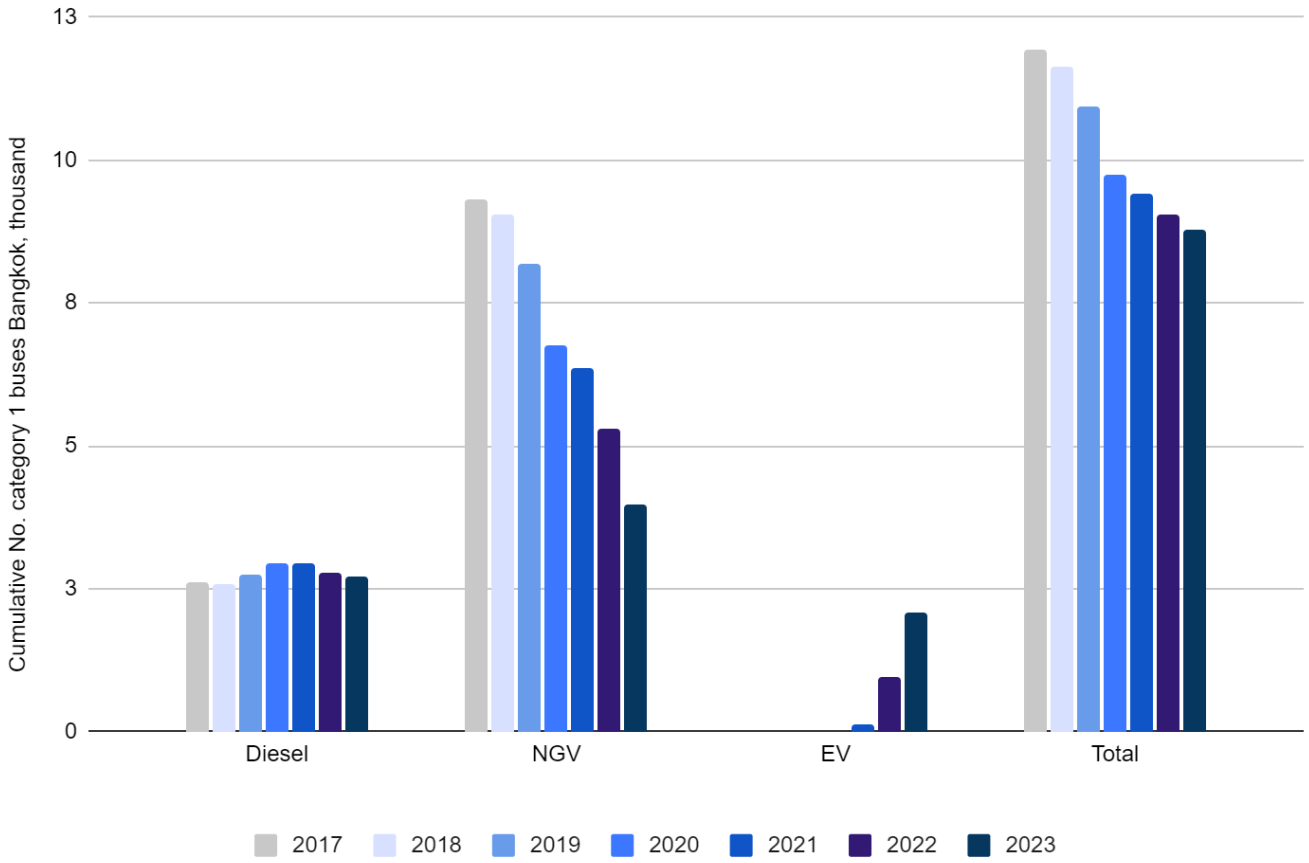

Figure 16. Cumulative number of fixed-route buses by fuel type in Bangkok.[44]

The use of in situ and industry-standard inputs enhances the credibility of the baseline carbon accounts. The project's baseline reflects a direct 1:1 mapping of (1) the number of buses and (2) the distance travelled by buses. Given that bus routes and the minimum number of buses per route are specified in the bus route concessions, we find this 1:1 mapping to be appropriate. Additionally, counterfactual fuel usage is modelled by extrapolating in situ data from existing NGV buses operating on these routes. The specificity of this data, relative to the project scenario, increases confidence in the project's quantification of counterfactual emissions. Fuel consumption is converted to emissions based on the net calorific value of natural gas and its emission factor. The assumed calorific value (36.67 TJ per kg) is lower than independently reported figures. Meanwhile, the emission factor used to convert to CO_2 equivalents (56.1 tCO_2e per TJ) has relatively low uncertainty (54.3–58.3 tCO_2e per TJ), and is therefore unlikely to pose a significant risk of over- or under-crediting [45,46,47,48,49]. Considering all these factors, the emissions per kilometre for counterfactual NGV buses (approximately 1150 g CO_2e per km) appear well-aligned with independently reported figures, as summarised in Table 1. In our opinion, this substantiates the project's baseline carbon accounts [50,51].

Table 1. Carbon intensity of compressed natural gas buses per unit distance

Source	Carbon intensity (gCO_2 per km)
Project (ex ante)	1280
Project (ex post)	1150
Posada 2009	1385 - 3650
Lowell, 2012	2300*
O'Dea, 2018	1470
Pan et al., 2020	1080
Prati et al. 2022	971 - 1282

*includes non-tailpipe emissions

The exclusion of associated methane leaks is a conservative measure. In the counterfactual scenario, methane would inevitably be released during its extraction, transportation, and use in vehicles. Although these emissions are excluded from the baseline accounts, they can be significant, as methane is a much more potent greenhouse gas than CO_2 (with a global warming potential 30 times greater over 100 years). There is some uncertainty about the extent of CH_4 leaks within NGVs; while the IPCC estimates that 0.4% of natural gas consumed is uncombusted and released, a study on NGVs in China suggests this figure could be as high as 3%, constituting an additional 25% of emissions during use. Although this 3% figure may be less severe in Thailand, where NGVs are not retrofitted as they are in China, it indicates that emissions attributed to a counterfactual NGV fleet could be understated in this regard.

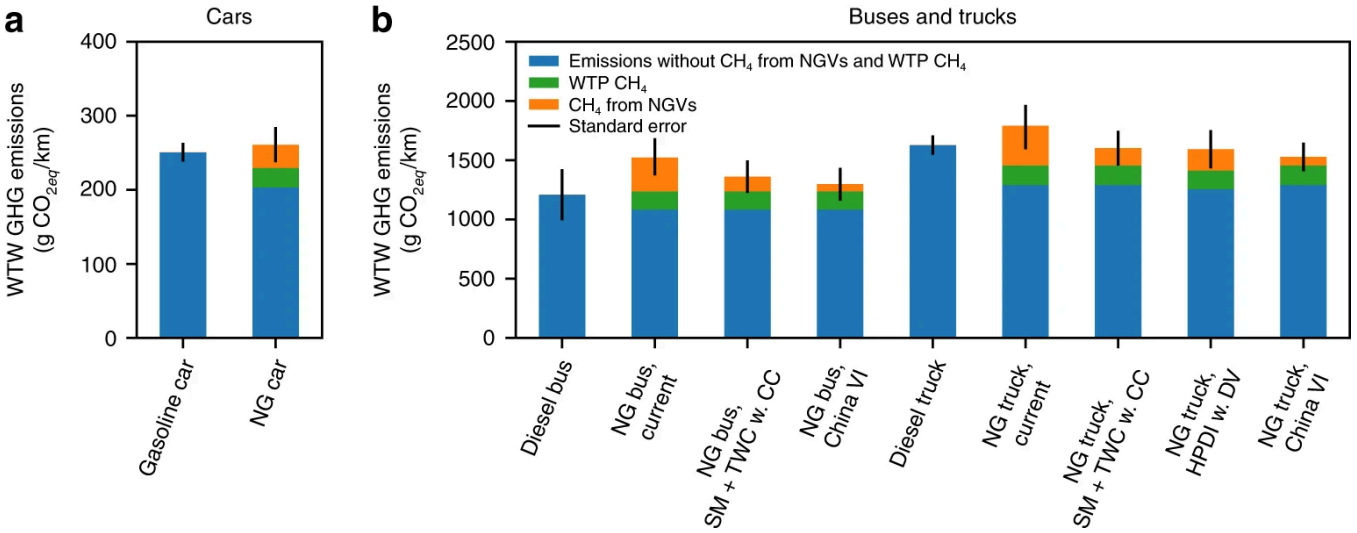

Figure 17. Well-to-wheels greenhouse gas emissions of vehicles powered by gasoline, diesel, and natural gas in China. Taken from Pan et al. 2020 [52].

Emission reductions attributed to a modal shift for passengers may lack veracity. The project's claim that emission reductions are due to a modal shift of passengers toward e-buses and away from more emission-intensive transportation methods is questionable. This shift is only considered in cases where the Thai Smile Bus (TSB) has replaced services on existing bus routes[6]. The justification is that project activities provide a better passenger experience and improved connectivity at a similar cost. However, we find insufficient evidence to suggest that such a shift would not have occurred in the baseline scenario. While a modal shift could occur, it is equally plausible that it would have happened even without the project, given the lack of a representative control group. Moreover, existing literature suggests that environmental benefits are not the primary drivers of modal shift. Given that Bangkok's bus network was already undergoing significant renovation, improvements in the network are likely to have occurred regardless of the project[7]. Therefore, we believe that the impact of the project's modal shift cannot be confidently disaggregated from the baseline scenario.

Whilst this aspect is forecast to account for 20% of issuance, we believe that this is unlikely to come to fruition since a modal shift has reportedly not been observed to date. This has been confirmed via external communications up until the project's second monitoring period. This indicates, in fact, that ex post monitoring procedures are functioning effectively. Considering this, whilst we believe that credits attributed to a modal shift may be a primary source of potential over-issuance, the risk is unlikely to be as severe as was forecast ex ante.

Project scenario

Our evaluation of the project scenario considers whether the project has adequately characterised and quantified the direct flow of greenhouse gases associated with the project. In this regard, we find that:

The accounting of project emissions is reasonable. Emissions from the project are almost exclusively associated with the electricity used to charge the buses. Since electricity usage is directly metered, it will likely be relatively free from the risk of over- or understatement. The emission intensity of this electricity is modelled using the most up-to-date demand-side emission factor for electricity consumption, as reported by the Thailand Greenhouse Gas Management Organization (TGO). Determining the emission intensity of electricity is inherently imperfect when based on a grid mix, as the specific generation sources cannot be definitively identified. Several reasonable approaches can be taken, and the imperfections of this modelling are illustrated in the chart below, where different credible bodies report varying figures.

Ember, an independent energy think tank, finds Thailand's grid mix to be 17% more emission-intensive than Thailand's Ministry of Energy, whose figures align with the project's emission factor source, TGO [53,54]. Meanwhile, the technical Working Group of the International Financial Institutions (IFI TWG; an organisation led by the UNFCCC) reports Thailand's marginal emission intensity below the project's model [53]. Compared to the most conservative dataset available, the project may have understated its emissions by 17%, corresponding to an 8% overstatement of emission reductions. While this does present a risk of over-crediting, it is relatively minor. Although the project recalibrates its emission factor as new data becomes available, we note that TGO has stopped reporting its figure annually, which could indirectly force the project to maintain an emission factor aligned with the most recent 2022 figure. Across all datasets, emission factors have generally declined over time, making their application more conservative the longer they are applied. However, this will depend on how Thailand's grid mix continues to evolve. Historical trends are shown in the figure below.

[6] i.e. modal shift impacts are actively excluded on the new routes that TSB will be the first-ever operators for.
[7] There is a clear financial incentive for any bus operator to maximise ridership. Considering the project's choice to adopt EVs relative to a natural gas vehicle, any TCO gap would close were EVs likely to experience higher ridership due to heightened ticket sales.

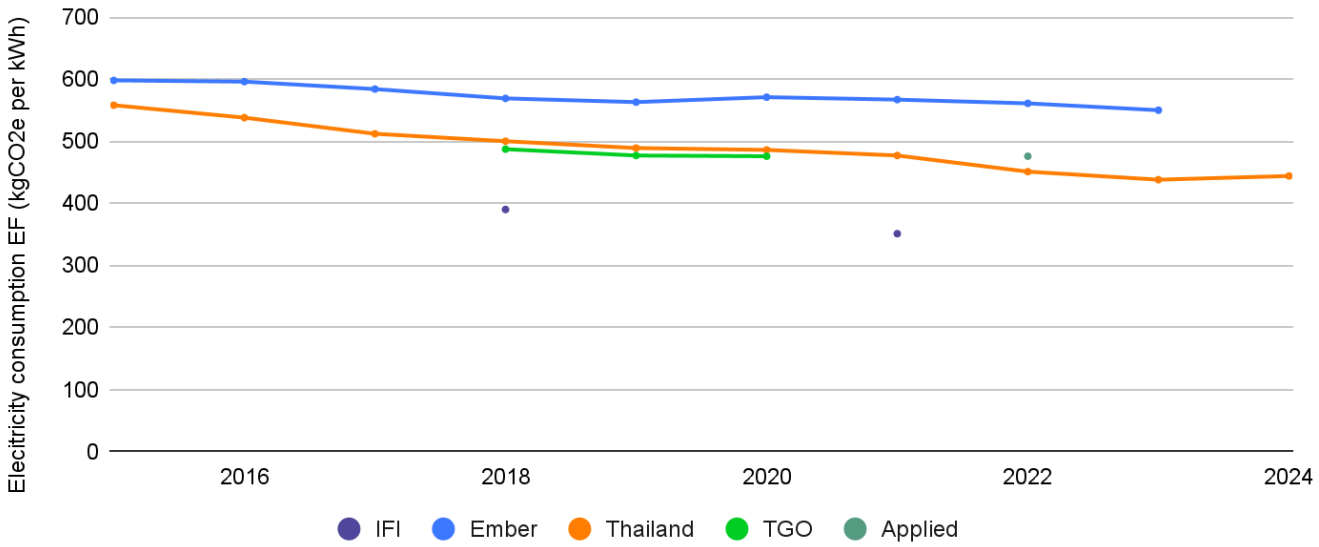

Figure 18. Emission intensity of electricity consumption by source (Thailand) [53–56].

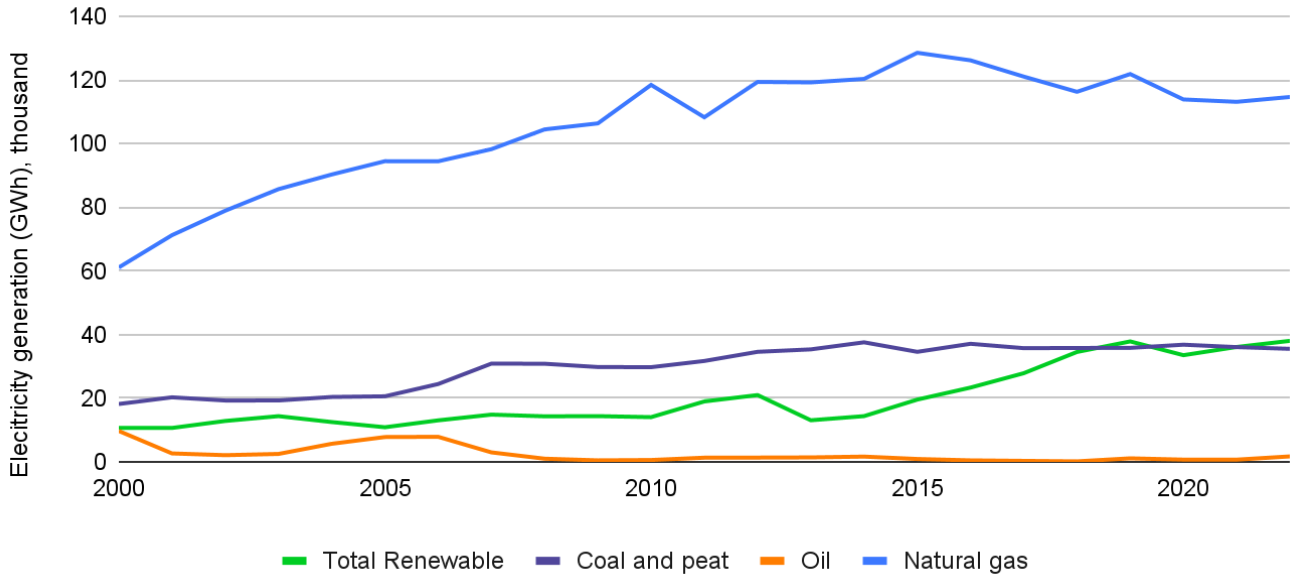

Figure 19. Electricity generation in Thailand by source (2000–2022) [57].

Leakage

Our assessment of leakage focuses on whether the project has adequately accounted for the indirect greenhouse gas emissions that are attributable to the project but fall outside the primary scope of the project boundary. We find that:

Emissions associated with batteries are unaccounted for. The project excludes upstream emissions from the manufacturing of its buses, particularly the batteries. While the manufacturing footprints of e-buses and conventional buses are relatively comparable, the inclusion of batteries significantly increases the carbon footprint of e-vehicles. These emissions are particularly substantial given the resource-intensive nature of battery production. Although these emissions are small compared to the project's credited carbon impact, they are still observable. Assuming an emission intensity of 0.1 tCO_2e per kWh, the project's fleet of 302 kWh Li-Ion e-buses may have a one-time impact of approximately 30 tCO_2e. This aligns with a life-cycle assessment of electric buses in Bangkok, which found that production emissions for e-buses were about 23 tCO_2e higher

than for NGVs. When levelised over a 10-15 year battery lifespan, this exclusion amounts to 1.5-3 tCO_2e per year, compared to emission reductions of 40-80 tCO_2e per bus per year. However, this exclusion is consistent with the exclusion of comparable emissions in the baseline scenario, such as methane leaks, making the overall approach conservative.

Other theoretical sources of leakage are likely notional. Additional theoretical leakage impacts, such as the potential increase in traffic caused by buses, which could indirectly affect the efficiency of other transport modes, have been identified in the literature [58]. A deduction of 0.5% of issuance is made in reference to these (which specifically arises from a 2.63% discount to the project's modal shift baseline). In our view, since this project involves a 1:1 replacement of buses, accounting for such an indirect impact seems both theoretical and notional, and hence, we have little direct concern regarding this.

Carbon accounting conclusion

In our view, 5002 faces a low risk due to the use of monitored variables, representative sampling, and appropriate inputs. In addition, the exclusion of upstream impacts for both the project and baseline scenarios is likely conservative. However, the claims underlying credits associated with modal shift may lack veracity, and the baseline may lack some nuance.

Permanence

BeZero Carbon is of the opinion that credits issued by the 5002 project carry the highest likelihood of permanence over its seven-year crediting period. This conclusion is based on the view that the emissions avoided by the project face no technical risk of reversal due to the nature of the project activities.

Information risk

We define information risk as the potential impact on our assessment of a project's carbon efficacy due to the reliability and robustness of the available information. A project's commitment and enforceability are closely tied to the dependability of this information.

Our assessment of information risk considers the extent, quality, and sources of the data provided, incorporating both a top-down analysis and a project-specific evaluation. Based on the level of detail disclosed by the project developer, we assess that this project faces a high level of information risk.

Key areas where missing or unclear data have potentially impacted our assessment or increased uncertainty include:

- Lack of transparency concerning alternative tenders for bus route concessionaires, which could significantly affect the project's additionality.
- Absence of disclosure regarding the total cost of ownership (TCO) gap analysis used to demonstrate the cost disparity between e-buses and NGVs.
- The lack of clarity on the distribution of ITMO revenues among the various entities involved in the project (e.g., EA, EMN, and TSB).
- Uncertainty regarding the appropriateness of financial inputs regarding the project's initial 154 buses relative to the entire fleet.
- Various intricacies of the project's organisational structure and whether these are captured in the financial picture presented.
- Redacted information contained within the loan with the Asian Development Bank that may attest or contest the role of carbon finance and the independent financial viability of the project.

Safeguards

Summary analysis

Our assessment of this project, based on the BeZero-identified safeguards, suggests that the risk of negative impacts on people and the environment is likely to be **moderate**.

BeZero defines safeguard risk levels as follows:

- **High:** Significant evidence that the safeguard is not effectively incorporated into the project design. This may include the absence of the safeguard in the project design, improper implementation, or project design which breaches the safeguard.
- **Moderate**: Evidence that the safeguard may not be fully effective. This includes partial incorporation of the safeguard or unclear safeguard design.
- **Low**: Evidence the safeguard is effectively incorporated into the project design, with full inclusion and consideration of the project context in the safeguard's implementation plan.

BeZero analysts evaluated the potential risk of negative impacts using the information provided in the project documents, assuming the developer adheres to the safeguard designs outlined in the Project Design Document (PDD). Table 2 provides an overview of the evaluated safeguards and their associated risk levels, while Appendix A contains detailed safeguard definitions.

Out of the 15 BeZero-identified safeguards, six apply to this project. BeZero's assessment assigned four of the relevant safeguards as low risk, two as moderate risk of not being effectively implemented. The only applicable environmental safeguard relates to the project's provision to address potential pollutants or environmental contaminants, while the moderate and risk safeguards are primarily social. These risks are mainly due to vague monitoring practices and information-related challenges.

Overall, the risks associated with safeguards are mitigated by the developer's Environmental and Social Management Framework (ESMF), which complies with the environmental and social criteria of the Thailand Greenhouse Gas Management Organisation (TGO). The ESMF includes six assessment forms, each evaluating the likelihood and severity of social and environmental impacts. For example, assessment form E-2 indicated no expected impact from water, soil, air, or noise pollution. Further details on the potential risks related to the BeZero-identified safeguards are discussed in the sections below.

Table 2. Summary of safeguards risk.

	Safeguard	Risk level	Key outstanding risks
1	Obtainment of free, prior, and informed consent (FPIC)	Not relevant	N/A
2	Provision to prevent the displacement of people	Not relevant	N/A
3	Translation of project activities and impacts to local language	Low	The project design document is publicly available in Thai on the Thailand Carbon Credit registry
4	Involvement of Indigenous Peoples	Not relevant	N/A
5	Explicit legal recognition of communities' rights to carbon	Not relevant	N/A
6	Recognition of communities' land and resource rights	Not relevant	N/A
7	Provision to respect labour rights and working conditions	Low	The project design includes insufficient information on work or safety training for employees
8	Formal feedback and grievance/redress mechanism	Low	None identified
9	MRV provisions regarding rights and safeguards	Moderate	Safeguards MRV not reported in monitoring report
10	Proportion of project revenues shared with local communities	Not relevant	N/A
11	Mechanism or provision to ensure gender equity	Moderate	The project design does not include project-specific provisions to address gender equity
12	Provision to address pollutants and environmental contaminants	Low	None identified
13	Use of multiple species for planting activities	Not relevant	N/A
14	Exclusion of Genetically Modified Organisms (GMOs)	Not relevant	N/A
15	Use of native species	Not relevant	N/A

Social and economic safeguards

The project, which introduces electric buses to public transport routes in Bangkok, takes place within a metropolitan area, necessitating robust social safeguards. During the stakeholder engagement process, the developer identified key stakeholders likely to be affected by the project, including bus and charging station operators along bus routes.

The risk of negative social and economic impacts due to ineffective safeguard implementation ranges from **low to moderate.** The primary concern stems from information risk, as several social safeguards in the project documents lack appropriate measures to mitigate potential negative impacts. For example, the project does not adequately address gender equity or target benefits for women. However, the project's safeguards generally align with the Paris Agreement, the CO_2 Ordinance, and bilateral agreements, as discussed below.

1. Obtaining free, prior, and informed consent (FPIC)

This safeguard is likely **not relevant**, as the project involves implementing electric buses in Bangkok and does not threaten land or resources traditionally owned or used by local communities.

2. Provision to prevent the displacement of people

This safeguard is likely **not relevant,** as the project does not involve involuntary relocation or resettlement. The implementation of e-buses does not result in the physical displacement of people from their homes.

3. Translation of project activities and impacts to local language

There is a **low** risk that this safeguard may not be effectively implemented. The project design document has been made publicly available on the Thailand Carbon Credit registry in Thai, which is crucial for ensuring that relevant stakeholders fully understand potential impacts. In addition, local stakeholder consultations were conducted in Thai, and positive responses were recorded. Best practices would include disclosing the languages spoken by project participants as identified during the stakeholder consultation process.

4. Involvement of Indigenous peoples

This safeguard is **not relevant,** as the project does not involve indigenous peoples.

5. Explicit legal recognition of communities' rights to carbon

This safeguard is **not relevant,** as the project stakeholders do not have rights to the carbon credits generated by the project.

6. Recognition of communities' land and resource rights

This safeguard is **not relevant**, as the e-buses are privately owned by Energy Absolute Public Company Ltd., and the project does not involve the use of land or resources.

7. Provision to respect labour rights and working conditions

The project design includes adherence to labour and working rights, presenting a **low** risk of ineffective implementation. The developer plans to follow the Labour Protection Act, which aligns with bilateral agreements and the CO_2 Ordinance to minimise social impacts. However, the project does not explicitly include existing training or employee plans in the design. Although non-public documents reveal that regular safety training for bus drivers is conducted, disclosing this safety plan would better address this safeguard.

8. Formal feedback and grievance/redress mechanism

The risk of ineffective implementation of this safeguard is **low**, as the project design includes a grievance mechanism for stakeholders. This system allows for complaints to be raised via a call centre or a website accessible on each e-bus, with grievances monitored and addressed weekly by the Thai Smile Bus operator. However, best practices would include a clear, documented process for addressing grievances, such as a flowchart in project documents.

9. MRV provisions regarding rights and safeguards

The project documents include information on MRV procedures for key safeguards, creating a **moderate** likelihood that this safeguard may not be effectively implemented. While some monitoring of labour rights and working conditions occurs, this information is not documented in project materials. In addition, there are no reports of monitoring grievances as part of the project design document. Therefore, ensuring ongoing monitoring and documentation of safeguards throughout the project's lifetime would be best practice.

10. Proportion of project revenues shared with local communities

This safeguard is **not relevant**, as local communities do not play a direct role in generating carbon credits for this project.

11. Ensure gender equity

The risk that gender equity provisions are not effectively implemented is **moderate**, primarily due to the absence of measures to mitigate against gender discrimination and support female participation. The developer has not taken steps to ensure women benefit equally from the project, such as setting targets for female employment in managerial positions. Identifying women as separate stakeholders and establishing goals for female participation would mitigate these risks. However, risk is mitigated by the project's effort, including female labour participation. To align with best practices, the project could disclose adherence to gender discrimination and sexual misconduct policies.

Environmental safeguards
Since the project does not involve planting activities, most environmental safeguards related to planting are not applicable. However, the following environmental safeguard is relevant:

12. Provision to address pollutants and environmental contaminants

There is a **low** risk that this safeguard will not be effectively implemented. The developer's Environmental and Social Management Framework (ESMF) assessment identifies no significant impacts on water, soil, noise, or air pollution. However, potential waste pollution from disposed batteries, classified as chemical waste, has been recognised. The project design adheres to the 'Waste Management Law' by the Pollution Control Department of the Ministry of Industrial Works, ensuring best practices for waste management, including the appropriate disposal of used batteries and electronic waste.

13. Use of multiple species for planting activities

Not relevant, as the project does not involve planting activities.

14. Exclusion of Genetically Modified Organisms (GMOs)

Not relevant, as the project does not involve planting activities.

15. Use of native species

Not relevant, as the project does not involve planting activities.

Table 3. Summary of SDG contributions analysis.

SDG claim	Likelihood	Key outstanding risks
SDG 8 Decent Work and Economic Growth	Moderate	Lack of baseline data and durability of impacts
SDG 11 Sustainable Cities and Communities	Moderate	Lack of data to evidence a causal link and durability of impacts
SDG 13 Climate Action	N/A	N/A

Social SDG claims

The project claims one social-related SDG, SDG 11, which has a **moderate** likelihood of making high-integrity SDG impacts. The project aims to contribute to SDG 11 via reducing emissions of particulate matter of less than 2.5 microns in diameter (PM2.5). The SDG received a moderate likelihood score due to the following factors: moderate robustness, impact, and durability scores. The moderate robustness score is due to the strong SDG impact metric but lacking data transparency. Most of the SDG robustness data characteristics are included in the project design, except baseline data and verification. Thus, SDG 11 received a moderate robustness score.

As the project impacts SDG 11 targets most relevant to the Thai Bus project , this SDG has a moderate impact likelihood score. The durability of the SDG 11 contributions also received a moderate score, as the project design includes a plan to monitor impacts annually. However, there is no plan in place to continue sustaining such impacts beyond the crediting period. In addition, there is no evidence that the reduction in particulate matter (PM) levels is attributed to the project activities. Therefore, measuring the true impact of the project contributions towards SDG 11 over time would be challenging.

Table 4. Summary of social SDG contributions analysis.

SDG claim	Project objective	Impact metric
SDG 11 Sustainable Cities and Communities	The activity contributes to the reduction in the environmental impact of cities, in particular particulate matter of less than 2.5 microns in diameter (PM2.5) through the elimination of tailpipe emissions from ICE buses.	Monitor the ambient annual mean level of $PM_{2.5}$ and PM_{10} in the Bangkok Metropolitan area.

SDG 11 Sustainable Cities and Communities

The project aims to contribute to SDG 11 by replacing internal combustion engine (ICE) buses and reducing levels of local air pollution levels, in particular $PM_{2.5}$ and PM_{10}. The likelihood this project will have high integrity SDG 11 impacts is **moderate** due to the lack of project baseline data.

Table 5. SDG 11 integrity factor summary.

Integrity factor	High-integrity contribution likelihood
Robustness	Moderate
Impact	Moderate
Durability	Moderate

Robustness

The likelihood the project data transparency will support high-integrity SDG 11 claims is **moderate.** The project provides information on how SDG 11 contributions will be measured. This includes monitoring $PM_{2.5}$ and PM_{10} levels in Bangkok, retrieved from an external data source, Thailand's pollution control department. The project's monitoring report only included ex post data for $PM_{2.5}$ and PM_{10} concentrations from October to December 2022 and did not provide ex ante data. This data will be monitored annually to provide quantitative evidence for SDG 11 impacts. Despite the lack of baseline data, in project documents, the project developer shared the annual $PM_{2.5}$ and PM_{10} for 2021 in non-public documents. However, this data is not compared to baseline levels.

Table 6. SDG 11 project data transparency summary table.

SDG data point	Transparency status
Quantitative and qualitative evidence provided	Quantitative evidence provided in project design
SDG impact provided at target scale	Included in project design
Identified impact metric	Included in project design
Impacts compared to a baseline	Not included in project design
Ex post and ex ante assessment provided	Ex post provided in project design
Monitoring data provided	Included in project design
Validation/verification by a third party	Not included in project design
Additionality considered	Not included in project design

The likelihood the project metric appropriateness will support SDG 11 claim robustness, is **moderate**. The project documents identify $PM_{2.5}$ and PM_{10} concentrations collected by external data sources as the metric which has a strong connection to the target and indicator (see Table 7). The chosen SDG metric is appropriate for directly measuring impacts related to SDG 11 at the project level. However, only one metric was identified to measure one SDG 11 target, focusing on air quality rather than other aspects of SDG 11, such as providing accessible transport systems (11.2.1).

Table 7. SDG 11 project metric appropriateness summary table.

SDG target identified	SDG indicator identified	Impact metric(s) identified	Appropriateness
11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	**11.6.2**: Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)	Data relating to the ambient annual PM2.5 levels in Bangkok Metropolitan area, as published by the Bangkok metropolitan authorities.	Moderate

Best practice would be to disclose baseline data in project documents to demonstrate the significance of the project's impacts on SDG 11 over time. In addition, identifying more than one metric to monitor the projects' contributions toward decreasing pollution levels can increase the robustness of achieving the identified indicator.

Impact

The likelihood that the projects' SDG 11 impacts are additional is **moderate** due to the lack of project baseline data in project documents. However, data provided outside of project documents includes the previous annual $PM_{2.5}$ and PM_{10} levels recorded by Air4Thai. Nevertheless, the annual statistics cannot be used to directly compare the monthly PM levels monitored by the project. Thus, conclusions regarding the project's contribution towards PM reduction levels cannot be drawn with this data. Therefore, the progress of SDG 11 in Thailand primarily informs the additionality analysis. According to the SDG Index, significant challenges remain, but progress is moderately increasing towards Thailand's overall achievement of SDG 11 (see Figure 20). Although the indicator progress most related to the project's SDG 11 contribution is not on track, and is stagnating, 'annual mean concentration of PM2.5'. Thus, the potential additionality of the project's SDG 11 contributions is moderate.

The developer has not established a causal link between PM levels and the project activities. There is no clear evidence that reductions in PM concentrations are attributed to the e-bus program or how much is caused by the program. Therefore, it is challenging to determine the additionality of SDG 11 impacts.

The likelihood that the project's SDG 11 impacts cover a wide SDG scope is **high**, due to the number of SDG targets impacted. The project activities address 1/2 of the targets that are directly relevant to the Thai bus project. The other metric that could be measured is 11.2.1 'Proportion of population that has convenient access to public transport, by sex, age, and persons with disabilities' to address accessibility to sustainable transport systems. Thus, the best practice would be to include all relevant metrics to monitor the project's SDG 11 contributions as this would better address the objective of the goal. Note, the overall impact likelihood score is outweighed by additionality over SDG scope.

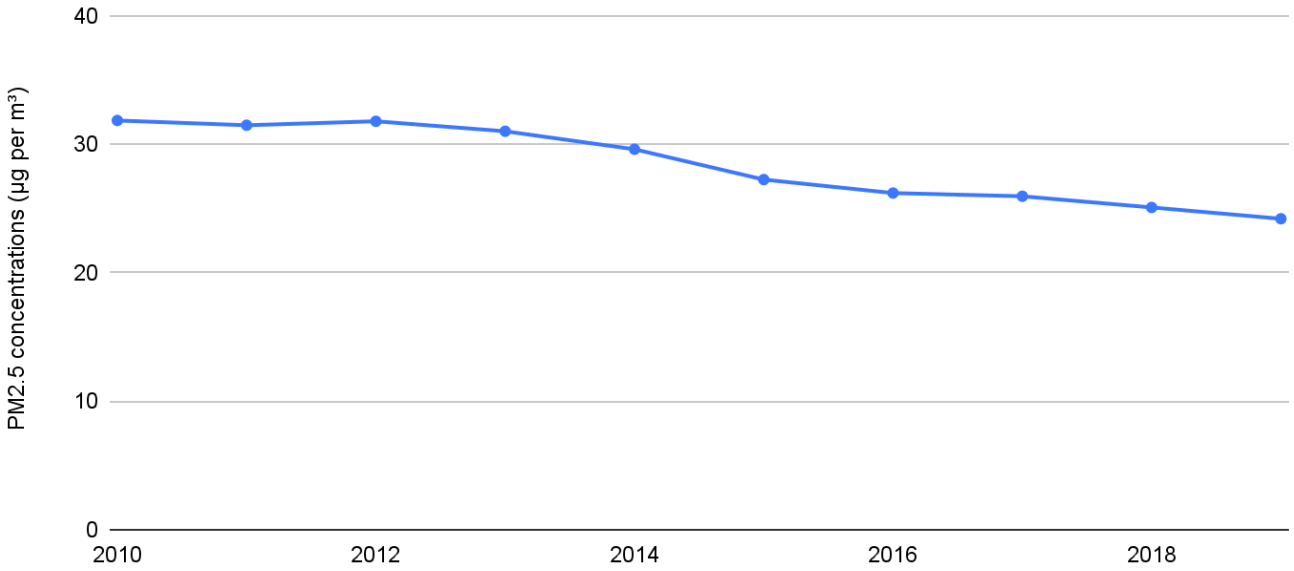

Figure 20. Annual concentrations of PM2.5 moderately improved in Thailand. This illustrates the SDG 11.6.2 progress indicator sourced from the SDG Index tracking [59].

Durability

We find a **moderate** durability for the project's SDG 11 claim. The project document includes plans to monitor the publication of PM levels by Bangkok metropolitan authorities on an annual basis. However, the project has not defined plans to sustain any of the project's SDG 11 contributions beyond the crediting period. The crediting period of the project activity is limited to seven years, at the end of Thailand's NDC period (31 December 2030). Thus, the project's durability for SDG 11 impact is limited to this timeline. Furthermore, the evidence to support the project's true SDG 11 impact is challenging to measure over time, as other factors may influence the reduction of PM concentrations such as climate and agricultural activities [60]. However, the use of electrical buses will likely continue beyond the project's crediting period; thus, there is potential the project will positively affect pollution levels as they emit less particulate matter than traditional buses.

Economic SDG claims

The project claims one economic SDG, with a **moderate** likelihood of having high-integrity SDG 8 impacts. The claim largely relates to the direct employment benefits of the project. The project has identified a metric for measuring SDG impacts over the project lifetime and plans to monitor the impacts monthly. However, there is no plan in place to sustain related impacts beyond the crediting period, although the Thai Smile Bus company will likely continue to employ staff members.

The SDG received moderate likelihood scores for all integrity factors. For robustness and impact, this is primarily due to available impact data for the identified metric which is appropriately relevant at the project level. In addition, the project's impacts have some potential to be additional to Thailand's SDG 8 achievement, as the country's progress is stagnating with significant challenges [61]. However, the project documents lack baseline data for SDG 8, thus it is challenging to assess the comparisons of SDG impacts prior to project implementation.

Table 8. Summary of economic SDG contributions analysis.

SDG claim	Project objective	Impact metric	Likelihood level
SDG 8 Decent Work and Economic Growth	Create jobs with higher wages for bus drivers and assistants.	The number of staff operating the Bangkok e-bus Program by gender and wages for staff	Moderate

SDG 8 Decent Work and Economic Growth

The project plans to contribute to SDG 8 by creating new job opportunities, with higher wages.[2] The likelihood that this project will have high-integrity SDG 8 impacts is **moderate** due to available SDG data and monitoring plans in place. Additionally, the project proponent shared information regarding the staff's wages outside of the project documents. However, specific baseline data is lacking to compare the SDG impacts.

Table 9. SDG 8 integrity factor summary.

Integrity factor	High-integrity contribution likelihood
Robustness	Moderate
Impact	Moderate
Durability	Moderate

Robustness

The likelihood that the project data transparency of the project data will support high-integrity SDG 8 claims is **moderate,** as the project has identified and included SDG impact and metrics as well as monitoring data in project design. The project will monitor and record the number of Thai Smile Bus employees and staff members operating the e-bus program. This data will be monitored monthly to provide quantitative evidence for SDG 8 impacts. Furthermore, this data is disclosed in the first monitoring report; however, there is a lack of baseline data to assess the project-level additionality of the impacts.

Table 10. SDG 8 project data transparency summary table.

SDG data point	Transparency status
Quantitative and qualitative evidence provided	Quantitative in project design
SDG impact provided at target scale	Included in project design
Identified impact metric	Included in project design
Impacts compared to a baseline	Not included in project design
Ex post and ex ante assessment provided	Ex post provided
Monitoring data provided	Included in project design
Validation/verification by a third party	Not included in project design
Additionality considered	Not included in project design

The likelihood that the project metric appropriateness will support SDG 8 claim robustness, is **moderate**. The project metric used to measure SDG 8 impacts is the number of staff operating the Bangkok e-bus Program by gender and staff wages which is linked to the identified target 8.5 'By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value' and indicator 8.5.2 'Unemployment rate, by sex, age and persons with disabilities'. The chosen SDG metric is appropriate for measuring contributions to economic growth as the project impact is directly measurable to the SDG target and provides accurate insight to the SDG contribution.

Table 11. SDG 8 project metric appropriateness summary table.

SDG target identified	SDG indicator identified	Impact metric(s) identified	Appropriateness likelihood
8.5: By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	**8.5.2:** Unemployment rate, by sex, age and persons with disabilities	The number of staff operating the Bangkok e-bus Program by gender and wages for staff	Moderate

Best practice would be to identify multiple metrics to monitor the project's SDG 8 contributions such as including evidence for wages for staff, which is directly relevant to indicator 8.5.1 'Average hourly earnings of employees, by sex, age, occupation and persons with disabilities'. Furthermore, to establish a baseline metric, the project should also collect data on the metric before the project activities are implemented. This baseline could be used to compare the significance of the project's impacts on SDG 8 over time.

Impact

The likelihood the project's SDG 8 impacts are additional is **moderate** due to a lack of project-specific baseline data availability and the stagnating progress Thailand has made towards achieving SDG 8. As the project provided no baseline data, the additionality analysis is primarily informed by the SDG 8 progress in Thailand. Currently, the SDG Index reveals significant challenges to Thailand's SDG 8 achievement and the progress is stagnating (see Figure 21). Therefore, there is some potential for the project to make additional impacts on the country's overall achievement of SDG 8.

Best practice would be to include baseline data measuring the number of people employed in the transport sector in the project area to compare whether the project's implementation decreases the unemployment rate.

The likelihood that the project's SDG 8 impacts cover a wide SDG scope is **moderate**, due to the number of SDG targets impacted. The identified SDG target impacted by the project is 8.5 'By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value'. Only one out of five targets relevant to carbon projects is addressed by the project activity. Thus, best practice would be to identify multiple metrics to monitor the project's SDG 8 contributions, as this would better address the objective of the goal. For instance, another indicator that could be tracked is indicator 8.5.1 'Average hourly earnings of employees, by sex, age, occupation, and persons with disabilities', which is directly related to the impact metric to monitor the project's SDG 8 contributions.

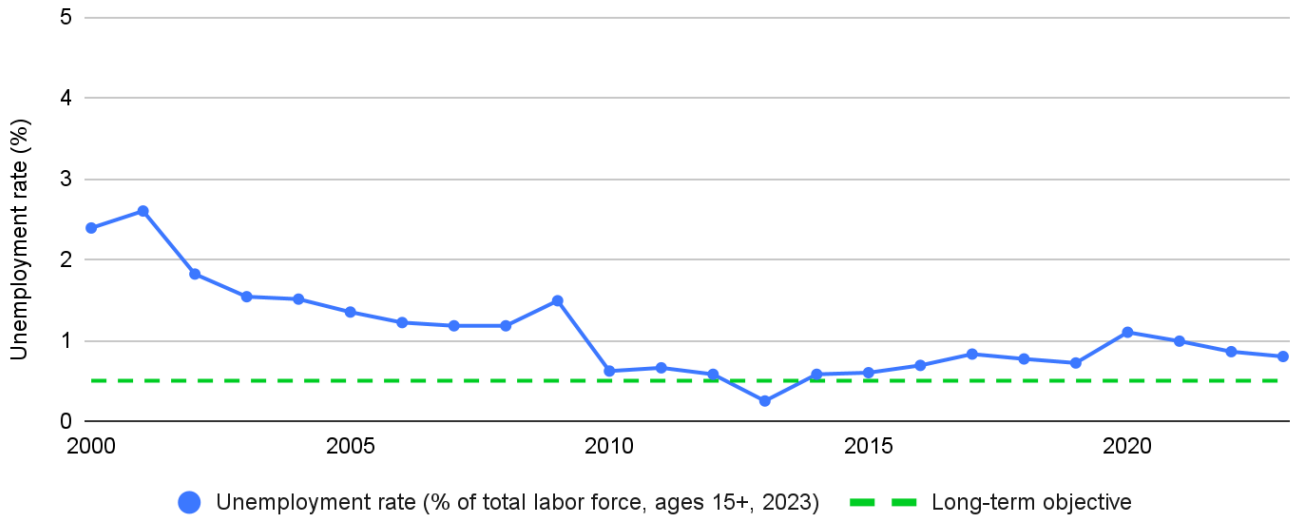

Figure 21. Unemployment rates in Thailand lowered but increased and stagnated since 2015[62]

Durability

We find a **moderate** durability for the project's SDG 8 claim. The project has defined plans to monitor SDG 8 impacts monthly, by recording the number of staff operating the e-bus program. Although not explicitly stated in the project design, the Thai Smile Bus will likely continue to employ people in the future, therefore increasing employment growth and contributing to SDG 8. Nevertheless, best practice would be to include a clear plan for maintaining SDG 8 impacts in the PD, such as plans for continuing employment.

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Appendix A.

Safeguard definitions

1. Provision to prevent the displacement of people

Provisions to prevent the displacement of people safeguard against project activities that could lead to involuntary relocation or resettlement. While this typically refers to the physical displacement of people from their homes, it could also refer to economic displacement if project activities replace means of income for community members. Measures to prevent displacement typically involve acknowledgement by project developers that community members shall not be economically or physically displaced. At times, provisions only exist for property owners.

2. Translation of project documents to local languages

Translation of project documents to local languages involves communicating the potential impacts of a project on local community(ies) and project area via local languages fully understood by the people in and surrounding the project area. This safeguard extends beyond the national language of the country in which the project takes place and instead should be in the local language(s) widely spoken by people living in the community.

3. Free, prior, and informed consent (FPIC)

The concept of free, prior, and informed consent (FPIC) originates from the UN Declaration on the Rights of Indigenous Peoples (UNDRIP), which sets forth that any activity that affects indigenous people shall be done with the free, prior, and informed consent of those impacted.[63] There are four main elements of FPIC that constitute its definition, according to the Food and Agriculture Organization (FAO) of the United Nations:

- **Free**: *'refers to a consent given voluntarily and without coercion, intimidation or manipulation. It also refers to a process that is self-directed by the community from whom consent is being sought, unencumbered by coercion, expectations or timelines that are externally imposed.'*[63](p.15)
- **Prior**: *'means that consent is sought sufficiently in advance of any authorization or commencement of activities, at the early stages of a development or investment plan, and not only when the need arises to obtain approval from the community.'*[63](p.15)
- **Informed**: *'refers mainly to the nature of the engagement and type of information that should be provided before seeking consent and also as part of the ongoing consent process.'*[63](p.15)[8]
- **Consent**: *'refers to the collective decision made by the rights-holders and reached through the customary decision-making processes of the affected Indigenous Peoples or communities. Consent must be sought and granted or withheld according to the unique formal or informal political-administrative dynamic of each community. Indigenous peoples and local communities must be able to participate through their own freely chosen representatives while ensuring the participation of youth, women, the elderly and persons with disabilities as much as possible.'*[63](p.16)

As defined by FAO, the IFC Performance Standards, and the ICVCM, FPIC is required when any project uses land, territory, and/or resources that are traditionally owned, occupied, or otherwise used by indigenous peoples and/or local communities for livelihoods or cultural purposes.[64–66]

Because of the sensitive and distinct nature of FPIC, projects and standards bodies must explicitly state that they are following the FPIC process to be considered compliant with the FPIC requirement. Thus, indigenous peoples and local communities should be given the right to actively consent voluntarily, before the implementation of the project, and with sufficient information regarding any positive/negative impacts of the project.

4. Involvement of indigenous peoples

This safeguard involves including indigenous peoples in project design and consulting indigenous peoples throughout the project. Involvement should be inclusive and comprehensive to ensure that the project is implemented in a way that is consistent with indigenous peoples' rights to self-determination.

5. Explicit legal recognition of communities' rights to carbon

This safeguard involves project developers explicitly recognising that communities have the right to the carbon emissions saved by the project. This recognition can be implemented via a contract signed by community members that waives their rights to carbon reductions and transfers them to the project developer.

6. Recognition of communities' land and resource rights

This safeguard recognises that local communities often have rights to the land and resources involved in the project, such as land, timber, and other resources. Thus, these rights must be maintained in the project design and implementation and/or the rights transferred to the project developer via a legal agreement.

7. Provision to respect labour rights and working conditions

Many projects employ local community members or others to work on the project. Thus, this safeguard protects the rights of workers to ensure that local, national, and international labour laws are being followed.

8. Formal feedback and grievance/redress mechanism

This safeguard involves a mechanism which allows for local community members and those impacted by the project to be able to file grievances about the project which are acknowledged by the project developer. This involves the community/other stakeholders understanding how to file grievances and having the ability to do so throughout the project's lifetime.

9. MRV provisions regarding rights and safeguards

This safeguard requires that measurement, reporting, and verification (MRV) measures are followed for each safeguard implemented in the project. Any safeguard administered by the project, such as a grievance mechanism, should be subject to MRV provisions to ensure its ongoing efficacy.

10. Proportion of project revenues shared with local communities

This safeguard involves the establishment and follow-through of a mechanism to share project revenues with local communities. The sharing of project revenues can come in multiple forms including the distribution of revenues directly with community members and the establishment of communal pots for distribution by committees or to fund community projects.

11. Mechanism or provision to ensure gender equity

The gender equity safeguard is evidence that the project design has incorporated systems to ensure gender equity is supported by the project design and upheld throughout the project's lifetime.

12. Provision to address pollutants and environmental contaminants

The safeguard requires a system in place which avoids the release of pollutants and environmental contaminants where possible. If pollutants and environmental contaminants are released, there is a provision in place to mitigate them and ensure that they will not have a negative effect on the project area.

13. Use of multiple species rather than monoculture for planting activities

For projects that involve planting activities, this safeguard involves utilising multiple species when plating. This safeguard may not apply to projects that plant only native species.

14. Exclusion of Genetically Modified Organisms (GMOs)

This safeguard is in place for projects that involve planting species, when GMOs are not used as part of the planting activities.

15. Use of native species

For projects that involve planting activities, this safeguard involves utilising species native to the project area.

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