A DATASET OF ELECTRIC SCHOOL BUS ADOPTION IN THE UNITED STATES

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ABSTRACT

Transitioning to electric school buses (ESBs) from traditional diesel-powered school buses can reduce students' exposure to air pollution and decrease greenhouse gas emissions. School districts and private fleet operators around the United States are adopting electric school buses with increasing speed, but so far ESB adoption has not been tracked in a centralized, public way. WRI aims to create accessible data and analyses that can help school district staff, advocates, policymakers, and other stakeholders make evidence-based decisions and support the transition to ESBs. This technical note describes the methods used to create a first-of-its-kind dataset that tracks ESB adoption across the United States.

The dataset is organized primarily by school district and tracks the number of "committed" ESBs in each district. An ESB is considered "committed" starting when a school district or fleet operator has been awarded funding to purchase it, or has made a formal agreement to purchase it from a manufacturer or dealer. We would not consider an ESB "committed" if a school district or other fleet operator only stated that they plan to acquire ESBs. The dataset includes other details related to committed ESBs, such as the manufacturer and funding source(s). It also contains school district characteristics such as poverty, racial composition, and locale (urban, suburban, town, or rural), to enable wider analysis of the adoption of ESBs, including whether the transition to ESBs is happening equitably. ESB-related data were collected from a variety of publicly available sources, including news articles, school websites, industry publications, and social media posts. Other demographic and economic data come from reputable, public datasets, including the Environmental

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Technical notes document the research or analytical methodology underpinning a publication, interactive application, or tool.

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Protection Agency, U.S. Census, and National Center for Education Statistics. This dataset will be updated periodically over the life of WRI's Electric School Bus Initiative to include newly committed ESBs and additional indicators. This version of the dataset contains data through December 31, 2022.

MOTIVATION

In recent years, the number of ESBs across the country has been growing rapidly, but ESB adoption is not being reported in a centralized, publicly accessible way. This dataset fills that gap and includes additional data that enable researchers, policymakers, and advocates to conduct their own analysis of ESB adoption based on school district characteristics such as average income, poverty level, racial composition, region, and locale (urban, suburban, town, or rural). This is the first step toward building a central hub for information on ESBs that will be complemented by innovative data combinations (e.g., scorecards, metrics, indices) and other information (e.g., case studies, community organizing tools, social connections) to help target users push to electrify school buses. This can inform policy evaluation, future policy design, research, and advocacy. We hope that the stakeholders who engage with this dataset will help us locate additional or improved information about ESB deployment that can be included in updates to the dataset.

INDICATOR AND SOURCE SELECTION CRITERIA

Indicator Selection Criteria

The following criteria guided our selection of indicators to include. These criteria were applied especially when developing the indicators in Category 4, "Socioeconomic and demographic characteristics," but they also informed decisions about indicators in all other categories, since not all information about the characteristics of ESBs, characteristics of school bus fleets, school district administrative structures, and so on, are equally useful for the dataset's target audience and intended purpose.

1. **Prevalent**: Indicators should be widely used in other work on related topics to enable comparison with other research, alignment with ESB funding criteria, and alignment with wider consensus on the most appropriate indicators to use on these topics. For example, in Category 4, we include indicators that

have been regularly used to assess school districts' eligibility for federal funding for ESBs or other programs, such as percentage of children in poverty, which is used to assess eligibility for free and reduced school lunch and American Rescue Plan ESB funding.

2. **Curated**: Keeping in mind that we cannot predict all the ways stakeholders will want to use these data, this dataset should provide all of the information relevant to our expected use cases (see "Use Cases" section) without including so many indicators that it overwhelms nontechnical users or puts the burden on users to research and select indicators. For example, in Category 4, demographics should balance providing an adequately holistic understanding of socioeconomic and environmental health disparities and inequalities resulting from racism, wealth, geography, and other factors, but they do not need to include more than a few prevalent poverty-related indicators.

3. **Relevant to ESBs**: For health risk indicators, we selected indicators related to health issues that result from air pollutant exposure, since these are conditions that ESBs could improve. According to this criterion, we did not include factors such as water pollution, lead exposure, or proximity to Superfund sites. For indicators related to school bus fleets and school district administrative and geographic information, we included those that seemed most relevant to the adoption of ESBs, such as bus ownership structure and locale.

Source Selection Criteria

The following criteria guided our selection of the sources used to build this dataset. A full list of data sources can be found in Table A1, available for download at https://www.wri.org/research/technical-note-dataset-electric-school-bus-adoption-united-states.

1. **Reputable**: Data should come from government sources or other reputable and widely used sources such as academic journals, well-regarded industry publications, or peer-reviewed sources from think tanks or nonprofits. Some data (mainly related to ESB commitments) are only available from less verifiable sources like news articles or school district press releases. In those cases, we cross-checked information across multiple sources wherever possible and deferred to the most reputable or detailed source.

2. **Appropriate scale**: Data should either be already available at the school district level or available at a

finer-grained resolution than the school district (i.e., census block group) so that it can be accurately scaled up to the school district level.

3. **Recent**: Data should be the most recent available, be regularly updated, and have been updated in the past three to five years.

DATA DESCRIPTION AND METHODS

This section describes the contents of the dataset. It groups the data into eleven categories and, for each, provides information such as how they were collected and/or analyzed, how they can be interpreted, and why they were included (in relation to the above indicator selection criteria).

Sheet 1. District-level Dataset on ESB Adoption

Category 1: School district characteristics

This category includes the base table of this dataset, which comes from the district directory of the National Center for Education Statistics (NCES) for the 2021–22 school year. NCES is a federal entity responsible for collecting and analyzing data related to education in the United States. The directory lists the nation's local education agencies (LEAs, which this technical note refers to as "school districts" for ease of understanding) by name and unique identification number (LEA ID). The U.S. Department of Education defines a local education agency as "a public board of education or other public authority legally constituted within a State for either administrative control or direction of, or to perform a service function for, public elementary schools or secondary schools in a city, county, township, school district, or other political subdivision of a State, or for a combination of school districts or counties that is recognized in a State as an administrative agency for its public elementary schools or secondary schools" (IDEA 2017).

The approximately 19,500 LEAs in the United States make up the rows of this dataset. There are nine types of LEAs, including several types of public education-related entities beyond what is typically referred to as a "school district," such as a state-operated agency or a service agency (see Table 1). This ESB adoption dataset includes all LEA types because there may eventually be ESBs owned by any of these LEA types. The dataset also includes any other entities (without LEA IDs) that have obtained electric school buses (i.e., private schools and private fleet operators).

However, most LEAs are "regular public school districts that are not a component of a supervisory union" and most of the data related to school bus fleet characteristics, ESB fleet characteristics, and demographics (Categories 2–5 below) are associated with this type of LEA. This LEA type, along with "regular public school districts that are a component of a supervisory union," are what are most often referred to as "school districts," including in reference to there being roughly 13,500 school districts in the United States.

This category also contains data referring to geographic and administrative characteristics of the school district, including its address, location in various regional groupings, locale (urban, suburban, town, or rural), latitude and longitude coordinates, and others.

DATA SOURCE, COLLECTION METHOD, AND/OR ANALYSIS METHOD

School districts included in this dataset come from the NCES revised preliminary directory of the 2022-23 LEA Universe Survey. All data in this category were available at the school district level, so no scaling or aggregation was necessary. See Table A1 for details.

This category, specifically the list of LEA IDs, served as the foundation for this dataset in that all other datasets were combined with the NCES LEA Directory using an XLOOKUP function in Excel that matched on LEA IDs. This was more effective than trying to match data to school districts based on name, since some school districts in different states have the same name, or are written differently in different contexts (e.g., Mt. Pleasant School District vs. Mount Pleasant School District).

Category 2: School bus fleet characteristics

These data consist of the school district's overall school bus fleet characteristics, including the number of buses and ownership model.

DATA SOURCE, COLLECTION METHOD, AND/OR ANALYSIS METHOD

Data in this section, unless otherwise specified in the district's "Sources" columns, comes from WRI's "Dataset of U.S. School Bus Fleets" (Lazer et al. 2023). This dataset contains detailed information on the composition of school bus fleets of all fuel types in the United States, compiled from state-level governmental departments. Fleet data from 46 states and the District of Columbia are included, with data on more than 450,000 school buses and around 9,000 LEAs. Data on the total number of buses used by a district and whether a contractor is involved in their fleet were merged into the ESB Adoption Dataset using the XLOOKUP function in Microsoft Excel.

Table 1 | LEA Types and Definitions

TYPE CODE	TYPE NAME	DEFINITION
1	Regular public school district that is NOT a component of a supervisory union	Local government administrative authority that governs the education system at a specified local level on behalf of the public and the state that is not component of a supervisory union.
2	Regular public school district that is a component of a supervisory union	Local government administrative authority that governs the education system at a specified local level on behalf of the public and the state that is component of a supervisory union.
3	Supervisory union	Administrative center or county superintendent's office serving as the administrative center.
4	Service agency	Agency that does not operate schools and instead provides specialized educational services (such as career and technical education) or related services (such as services in individualized education programs, or IEPs) to other education agencies.
5	State agency	State operated agency that operates schools or programs that provide public elementary and/or secondary level instruction Federal operated agency that provides elementary and/or secondary level instruction.
6	Federal agency	A federal agency that is charged, at least in part, with providing elementary or secondary instruction or support services.
7	Independent charter district	Education unit created under the state charter legislation that is not under the administrative control of another local education agency and that operates one or more charter schools and only charter schools.
8	Other education agency	Education unit that does not fall within the definitions of the other existing LEA types.
9	Independent charter district	School district that operates one or more schools that are designed for a specific educational need or purpose.

Source: Adapted from NCES (2021b).

All data in this category were available at the school district level, so no scaling or aggregation was necessary.

Category 3: Electric school bus fleet characteristics

These data include whether a school district has any committed electric school buses; if it does, the data include other information about those buses, such as the number of committed ESBs, the number of ESBs in each procurement stage (See "Sheet 2: Bus-level data"), government agencies, charging companies, and utilities involved. The data from Sheet 2 are aggregated up to the school district level from the more detailed data on ESB commitments collected at the individual bus level found in "Sheet 2: Bus-level data." These data were collected by WRI and have not previously been published in a compiled format. This dataset does not include information on alternative-fuel buses other than electric buses, such as compressed natural gas (CNG) or propane buses.
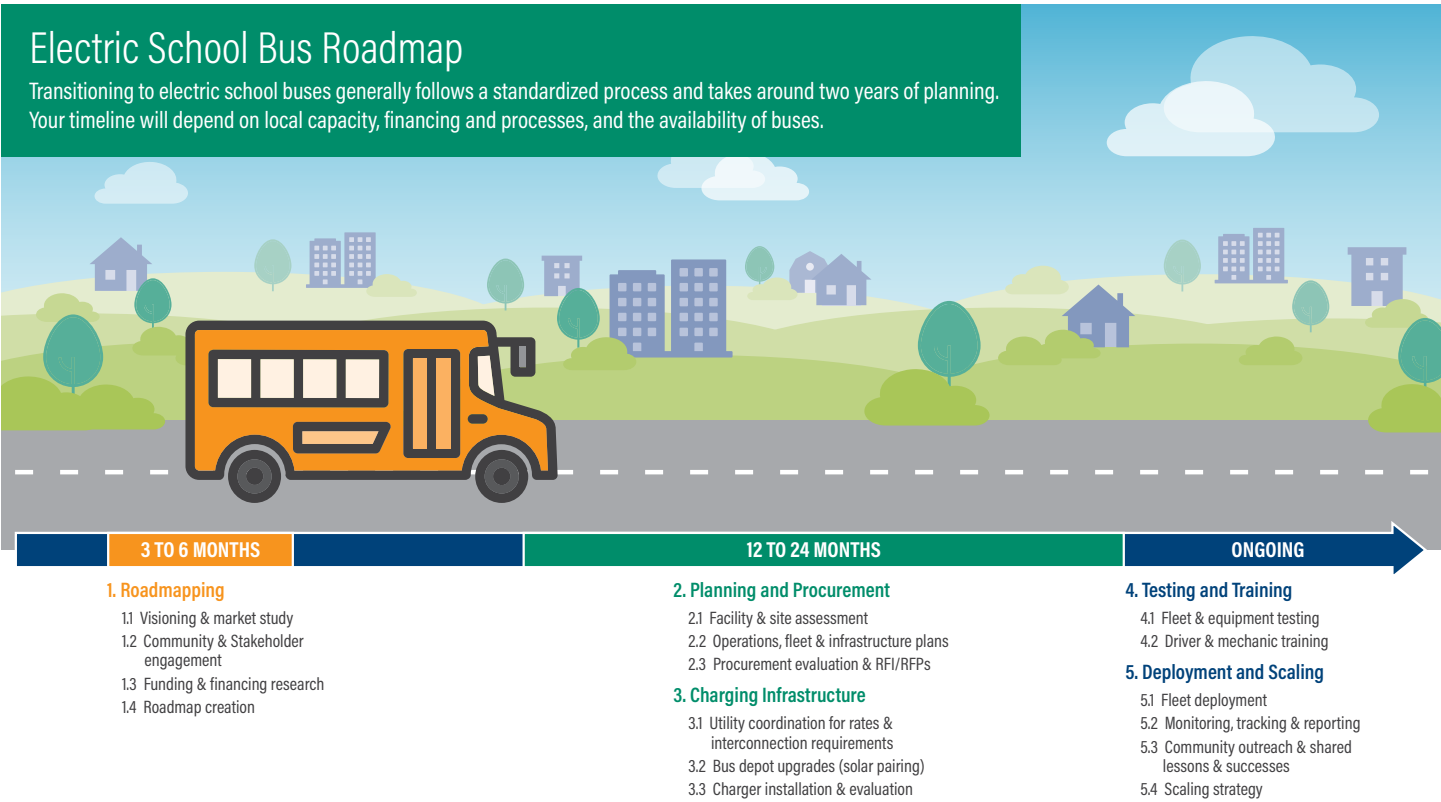
WHICH ELECTRIC SCHOOL BUSES ARE INCLUDED IN THIS DATASET?

The electric school bus adoption process consists of many phases, including visioning, technical preparations, awarding of government funding to purchase an ESB, placing an order, taking delivery of the bus, and using the bus to transport students, among others (see Figure 1). Before any of these steps are taken, some school districts may announce their intention to acquire ESBs, while other districts set long-term targets for full fleet electrifica-

tion. We therefore had to determine when in this process to include an ESB in this dataset. This dataset tracks "committed" ESBs.

■ **Definition:** An ESB is considered "committed" when a school district or fleet operator has been awarded funding to purchase it, or has made a formal agreement to purchase it from a manufacturer or dealer. We would not consider an ESB "committed" if a school district or other fleet operator only expressed interest in ESBs or stated that they plan to acquire ESBs, without having been awarded funding or having reached a formal agreement with a third party. Previously, this dataset included in its definition of "committed" buses the contract for SEA Electric to provide Midwest Transit Equipment with 10,000 buses repowered to electric over the course of five years. We have since determined that this contract is a unique arrangement that does not fit into our definition of the "awarded" subcategory of "committed" as it does not include a school district or fleet operator to date, or into any of the other three categories (ordered, delivered, or operating; see "Sheet 2: Bus-level data" for more information about these stages). Therefore, the repowered buses from this contract are no longer included in our definition of a "committed" electric school bus. They are still included in "Sheet 2: Bus-level data" with the status designation of "Dealer

Figure 1 | Electric School Bus Roadmap

Electric School Bus Roadmap

Transitioning to electric school buses generally follows a standardized process and takes around two years of planning. Your timeline will depend on local capacity, financing and processes, and the availability of buses.

3 TO 6 MONTHS

1. Roadmapping
1.1 Visioning & market study
1.2 Community & Stakeholder engagement
1.3 Funding & financing research
1.4 Roadmap creation

12 TO 24 MONTHS

2. Planning and Procurement
2.1 Facility & site assessment
2.2 Operations, fleet & infrastructure plans
2.3 Procurement evaluation & RFI/RFPs

3. Charging Infrastructure
3.1 Utility coordination for rates & interconnection requirements
3.2 Bus depot upgrades (solar pairing)
3.3 Charger installation & evaluation

ONGOING

4. Testing and Training
4.1 Fleet & equipment testing
4.2 Driver & mechanic training

5. Deployment and Scaling
5.1 Fleet deployment
5.2 Monitoring, tracking & reporting
5.3 Community outreach & shared lessons & successes
5.4 Scaling strategy

Source: WRI (2022).

repower contract," and once we are aware of the school districts or entities that purchase these buses, we will update their details accordingly.[1]

- **Examples**: Examples of information that would lead to a designation of "committed" include a public announcement that a school district has been awarded funding from a federal school bus rebate program like the one created by the Diesel Emissions Reduction Act (DERA), or a news article stating that a school district has placed an order for ESBs from a manufacturer. An unsuccessful or pending funding application for ESBs, or a 2035 full-fleet electrification target that is not substantiated by funding or formal agreements, would not be considered "committed" (though it may be included in Category 6, "Expressions of interest in ESBs").

- **Rationale**: We chose this starting point for considering an ESB "committed" for two main reasons: good data availability and to avoid overcounting. Relatively good data are available about when an ESB reaches this phase because there are official announcements when school districts and private fleet operators are awarded public funds for ESBs, and nearly all ESBs tracked to date are supported by public funds. We also chose this starting point because our research and school district engagement suggest that when an ESB reaches this phase of the adoption process, there is a step-change increase in the likelihood that it will continue advancing through the adoption process and be put into operation in due course. Therefore, this starting point helps avoid overcounting, giving a more accurate estimate of the ESB adoption.

DATA SOURCE, COLLECTION METHOD, AND/OR ANALYSIS METHOD

See "Sheet 2: Bus-level data" for the sources and collection methods of these data.

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1. As of December 2022, there are 9,999 ESBs with the designation of "Dealer repower contract" because we now know the school district by which one of the repowered buses was purchased.

Category 4: Socioeconomic and demographic characteristics

These data describe the social, economic, and demographic characteristics of the school district. As described in "Indicator Selection Criteria," we tried to include data that would provide an adequately holistic understanding of socioeconomic and environmental health condition disparities among school districts, in alignment with wider thinking on the topic and what is relevant to ESBs, without including so many indicators that they burden nontechnical users with researching and selecting indicators. This section includes data on each school district's number of enrolled students, whether the district is controlled by an Indian Tribe or the Bureau of Indian Education (Bureau of Indian Education n.d.), median household income, percentage of households below the federal poverty level, and the distribution of the population among race and ethnic categories.

These data were sourced from NCES, which draws on U.S. Census data to publish these demographic, social, and economic data at the school district level.

Category 5: Environmental justice and health

This section includes five variables that are the result of WRI analysis and have not previously been published at the school district level (to the best of the authors' knowledge): percent low-income, percent non-white and/or Hispanic, average ozone concentration (parts per billion, ppb), average concentration of fine particulate matter (PM2.5, measured in micrograms per cubic meter, $\mu g/m^3$) and the average rate of asthma among adults aged 18 and older. This section also includes the percent of students in each district with a disability, data on whether the district qualified for various funding sources, and whether WRI considers the school district a priority outreach district (POD), defined in the next section. Together with the data from Category 4, the data in this section can be used to understand the extent to which ESBs are being adopted equitably among school districts with differing racial and economic characteristics and with different pollution burdens.

Percent low-income is defined as the percent of households with a household income less than or equal to twice the federal poverty level. Percent non-white and/or Hispanic is defined as percent of individuals who identified as anything other than "white alone" and Non-Hispanic

on the American Community Survey. Average ozone concentration is defined as summer seasonal average of daily maximum 8-hour ozone concentration in air (ppb). Average PM2.5 concentration is defined as annual average concentration of PM2.5 fine particulate matter ($\mu g/m3$).

These four variables were based on data from the Environmental Protection Agency (EPA)'s Environmental Justice Screening tool, 2021 release (EPA 2021a), which collects data from various sources, including the U.S. Census. Census block groups were associated with a school district (LEAID) based on the Geographic Relationship Files published by NCES (NCES 2022b). All variables were calculated as the population-weighted average of the values for all census block groups within the school district's geographic boundaries for which data were available. If a census block group was included in multiple school districts, it was included in the averages for all of those school districts.

Using the four variables described above (percent low-income, percent non-white and/or Hispanic, average ozone concentration and average PM2.5 concentration), WRI created a list of Priority Outreach Districts (PODs) as a starting point for outreach to ensure that we are working to bring the benefits of school bus electrification to the students who would gain the most from a clean ride to school. WRI offers PODs deep technical assistance at no cost. School districts were designated PODs if they either 1) were in the top quartile nationwide for percent low-income, were in the top quartile for percent non-white and/or Hispanic, and were in the top quartile for either average ozone concentration or average PM2.5 concentration, or 2) were tribal districts. All tribal districts were included as PODs because data was not available to estimate their values for the above criteria. WRI identified 1,007 PODs.

Several factors influenced the focus on these characteristics. Low-income communities and black and brown communities have faced historic disinvestment and under-resourcing, and black and brown communities often bear the brunt of harmful on-road air pollution (Union of Concerned Scientists 2019). PM2.5 or ozone pollution levels help identify districts with the most acute need for clean-running electric school buses. Evidence suggests Native American children disproportionately suffer from health conditions linked to air pollution, such as asthma (Wen et al. 2019).

The list of PODs was created to guide equity-focused outreach, not to serve as a comprehensive analysis of the extent of the disinvestment, discrimination, or historic under-resourcing that school districts or communities have experienced. Other limitations of this methodology include that school district-level averages can mask heterogeneity within districts, and that the characteristics of students that ride school buses may differ from socioeconomic characteristics of the school district's total population.

The variable "Percent of school children with a disability" comes from NCES, which draws on U.S. Census data to publish these demographic, social, and economic data at the school district level.

The variable "Current asthma among adults aged 18 and older" is based on PLACES data from the Centers for Disease Control and Prevention (CDC 2022). Census tracts were associated with a school district (LEAID) based on the Geographic Relationship Files published by NCES (NCES 2022b). It was calculated as the population-weighted average of the values for all census tract within the school district's geographic boundaries for which data were available. If a census tract was included in multiple school districts, it was included in the averages for all those school districts.

Category 6: Expressions of interest in ESBs

This category includes data that could help identify school districts that have expressed interest in ESBs or environmental sustainability, or school districts in cities or towns that have expressed interest in electric public vehicles. These include whether, to our knowledge, the school district previously applied for funding for ESBs but was not awarded that funding, whether the city where the school district is located is a member of the Climate Mayors Electric Vehicle Purchasing Collaborative, and whether the school district has made a sustainability commitment. A sustainability commitment can refer to several types of commitments, such as membership in the Green Schools National Network or Schools for Climate Action. We also indicate if the school district has a Generation 180 Solar School and if the district is participating in Trust for Public Land's Active Community Schoolyard Program. See Table A1 for details.

Once an indicator was selected, the data were collected from the website of the relevant program or commitment and manually entered into the corresponding cells. Some of these indicators were already at the school district level, such as the Green Schools National Network, in which case no scaling or aggregation was necessary. Data on a school district's participation with Generation180 and Trust for Public Land were provided directly from the respective organizations.

Some indicators were at the city level, such as the Climate Mayors Electric Vehicle Purchasing Collaborative, in which case we associated the commitment with the school district(s) in that city.

Category 7: Sources

This category includes links to sources that are not included in Table A1, such as unawarded applications for ESB funding (Category 6) and groups involved in ESB adoption (Category 3).

Sheet 2. Bus-level data

This sheet includes detailed information on ESB commitments at the individual bus level. Unlike the district-level sheet, each row of this table represents a single ESB, identified by a "Bus ID" that was assigned based on the bus operator's LEA ID (See Table A1 for details). This data structure enables us to capture elements that would be difficult or confusing to demonstrate at the district level. This sheet includes the most recently known adoption stage of the bus as well as the quarter, if known, that the bus entered each stage. We note to which "batch" (see definition in following paragraph) each school bus belongs. The table also contains bus characteristics, funding sources and amounts, and bus charger information. Finally, each ESB includes the date of the most recent source that we have found and links to the sources of the adoption data.

ESB BATCHES

A "batch" is a group of ESBs from a single school district that went through the adoption process at the same time. ESBs are in the same batch, numbered chronologically, if any of their time-series data (when they were awarded, ordered, delivered, or first operating) occurred in the same quarter or in adjacent quarters (i.e. 2020 Q1 and 2020 Q2). We used the following methodology to assign ESBs to batches.

1. If a district has only one ESB, there can only be one batch, therefore the assigned batch is "1."

2. If a district has more than one ESB:

   ☐ We first assigned districts in which every bus had time series data in the same stage (i.e. all buses had time series data for either "Awarded," "Ordered," "Delivered," or "First operating"). We compared the time series within the same stage, not across stages, starting with the earliest available stage; if no buses in the district had time series data for "awarded," we moved on to "ordered," then "delivered," then "first operating."

      ▪ In the example in Table 2a, Albemarle County Public Schools has 4 buses, and we know the quarter awarded for each bus. By comparing the dates in column 3p using the criteria described above, buses 5100090-1 and 5100090-2 are in the first batch, and buses 5100090-3 and 5100090-4 are in the second batch.

   ☐ If every bus had at least one time series data value (i.e. no bus had all blanks in columns 3p to 3s), we started with the earliest available stage for which the district had data. For the buses that did not have data for that stage, we used the framework described in the next section ("Estimating quarters and years based on known data") to extrapolate backward from the closest available stage.

      ▪ In example 2 in Table 2b, Chico Unified has four buses, three of which have "awarded" data, one of which has "delivered" data. Using the delivered year and quarter of bus 0608370-4, we extrapolate backward to an awarded year and quarter, which would be 2017 Q4, seen in gray text. The resulting batches based on that extrapolation are shown in column 30.

   ☐ If there are buses in a district with no time series data at all (i.e. all blanks in columns 3p to 3s), we assigned a quarter and year to these buses based on the current operating status and date of most recent source. For example, if the most recent source is 7/15/2022 and the current operating status is "ordered", we estimated "ordered" to be 2022 Q3. Then, if needed, we extrapolated back to the earliest stage in which other buses have time

series data, using the framework described in the next section. We compare these estimated and known quarters to assign batches.

   ▪ In example 3 in Table 2c, Columbia Elementary has three buses, two of which have time series data (0609450-1 and 0609450-2), one of which (0609450-3) does not. Using the date of most recent source (column 7a) for 0609450-3, we assign 2022 Q2 to the quarter delivered (column 3r), since the current status of bus (column 3n) is Delivered. Then, we extrapolate the quarter awarded using the methodology described below, since the other two buses have a known quarter awarded. The resulting batches are shown in column 30.

   ▪ In example 4 in Table 2d, Amherst County Public Schools has three buses, two of which have time series data (5100210-1 and 5100210-2), one of which (5100210-3) does not. Using the date of most recent source for 5100210-3, we assign 2022 Q3 to the quarter awarded, since the current status of bus is awarded. No extrapolation is needed to compare the three "Awarded" dates to assign batches, which are written in the last column.

   ▪ In example 5 in Table 2e, neither of Del Norte County Unified's buses have any time series data. Using the date of most recent source, we assign 2022 Q3 to "Quarter delivered" for both buses, since "Current status of bus" for both buses is Delivered. Batches are assigned by comparing the "Quarter delivered" dates.

Other considerations:

■ If more than 2 buses have sequential time series data in a given stage (i.e. 3 buses awarded in 2020 Q1, 2020 Q2, 2020 Q3), we assigned all to the same batch.

■ If the comparison involves year-only data and year-with-quarter data, we assigned the buses to the same batch if the year was the same, and to different batches if the year was different. For example, buses awarded in 2020 and 2020 Q2 would be in the same batch, while buses awarded in 2020 and 2021 Q1 would be in different batches.

■ Each batch belongs to only one entity; there are no batches that contain buses from more than one district.

Table 2a | **Batch data example 1**

0A. BUS ID	1B. LEA OR ENTITY NAME	3P. QUARTER AWARDED	3Q. QUARTER ORDERED	3R. QUARTER DELIVERED	3S. QUARTER FIRST OPERATING	3O. BATCH
5100090-1	ALBEMARLE CO PBLC SCHS	2021 Q2	2022 Q2			1
5100090-2	ALBEMARLE CO PBLC SCHS	2021 Q2	2022 Q2			1
5100090-3	ALBEMARLE CO PBLC SCHS	2022 Q1				2
5100090-4	ALBEMARLE CO PBLC SCHS	2022 Q1				2

Source: Authors.

Table 2b | **Batch data example 2**

0A. BUS ID	1B. LEA OR ENTITY NAME	3P. QUARTER AWARDED	3Q. QUARTER ORDERED	3R. QUARTER DELIVERED	3S. QUARTER FIRST OPERATING	3O. BATCH
0608370-1	Chico Unified	2017 Q3				1
0608370-2	Chico Unified	2019 Q3				3
0608370-3	Chico Unified	2020 Q1				4
0608370-4	Chico Unified	2017 Q4		2019 Q2		2

Source: Authors.

Table 2c | **Batch data example 3**

0A. BUS ID	1B. LEA OR ENTITY NAME	3N. CURRENT STATUS OF BUS	3P. QUARTER AWARDED	3Q. QUARTER ORDERED	3R. QUARTER DELIVERED	3S. QUARTER FIRST OPERATING	7A. DATE OF MOST RECENT SOURCE	3O. BATCH
0609450-1	Columbia Elementary	Delivered	2018 Q3				5/13/2022	1
0609450-2	Columbia Elementary	Delivered	2020 Q2				5/13/2022	2
0609450-3	Columbia Elementary	Delivered	2020 Q4		2022 Q2		5/13/2022	3

Source: Authors.

Table 2d | Batch data example 4

0A. BUS ID	1B. LEA OR ENTITY NAME	3N. CURRENT STATUS OF BUS	3P. QUARTER AWARDED	3Q. QUARTER ORDERED	3R. QUARTER DELIVERED	3S.QUARTER FIRST OPERATING	7A. DATE OF MOST RECENT SOURCE	3O. BATCH
5100210-1	AMHERST CO PBLC SCHS	Operating	2021 Q4			2022 Q3	11/15/2021	1
5100210-2	AMHERST CO PBLC SCHS	Operating	2021 Q4			2022 Q3	9/14/2022	1
5100210-3	AMHERST CO PBLC SCHS	Awarded	2022 Q3				9/14/2022	2

Source: Authors.

Table 2e | Batch data example 5

0A. BUS ID	1B. LEA OR ENTITY NAME	3N. CURRENT STATUS OF BUS	3P. QUARTER AWARDED	3Q. QUARTER ORDERED	3R. QUARTER DELIVERED	3S.QUARTER FIRST OPERATING	7A. DATE OF MOST RECENT SOURCE	3O. BATCH
0610770-1	Del Norte County Unified	Delivered			2022 Q3		7/26/2022	1
0610770-2	Del Norte County Unified	Delivered			2022 Q3		7/26/2022	1

Source: Authors.

The batch variable was designed to approximate the perspective of the school district or fleet operator. It can serve as an input to analyses that answer questions like: do school districts typically pilot a few ESBs and then scale up their ESB fleet? Are there differences between states in terms of the size and frequency of ESB batches? What is the average time between batches and how is it changing?

ESTIMATING QUARTERS AND YEARS BASED ON KNOWN DATA

Based on our research as of December 2022, we have calculated the average time it takes to move through the different stages of adoption, measured in quarters:

- From "Awarded" to "Ordered:" **2 quarters** (n=331)
- From "Awarded" to "Delivered:" **6 quarters** (n=593)
- From "Awarded" to "First operating" **6 quarters** (n=115)
- From "Ordered" to "Delivered:" **4 quarters** (n=186)
- From "Ordered" to "First operating:" **4 quarters** (n=44)

- From "Delivered" to "First operating:" **1 quarter** (n=95)

These data were used when extrapolating the quarter and year of unknown adoption stages. For example, if we know a bus was first operating in 2022 Q2 and we want to estimate when it was awarded, we counted back 6 quarters and assign the awarded date to 2020 Q4. When we only know the year of a bus's adoption stage, the following estimates were used:

- From "Awarded" to "Ordered:" **1 year**
- From "Awarded" to "Delivered:" **2 years**
- From "Awarded" to "First operating" **2 years**
- From "Ordered" to "Delivered:" **1 year**
- From "Ordered" to "First operating:" **1 year**
- From "Delivered" to "First operating:" **0 years** (i.e. assign "Delivered" to same year as "First operating")

These time periods may change as more data is collected.

ESB COMMITMENT STAGES

Based on the definition of a "committed" ESB (see Category 3) and the available data on ESB adoption, we identified four stages of the adoption process through which most ESBs move. These are:

1. **Awarded**: A fleet operator is awarded funds, most often from a public entity, to purchase an ESB. This award is publicly announced.

2. **Ordered**: The fleet operator submits an order with a bus dealer to purchase an ESB.

3. **Delivered**: The ESB arrives at the fleet operator's bus depot, yard, or other transportation hub.

4. **Operating**: The ESB is now used on regular routes transporting students.

We indicate the quarter (for instance, 2021 Q4) that the ESB was awarded, ordered, delivered, and first operating when the data are available; otherwise, these fields are left blank. Where the quarter is not known, some stages note only the year. This enables tracking of the time it takes buses to reach each stage of adoption and tracking the number of commitments at different stages by quarter. The most recent known adoption stage is indicated in the column labeled "Current status of bus."

DATA SOURCE, COLLECTION METHOD, AND/OR ANALYSIS METHOD

As there is no known public, centrally available dataset on ESB adoption, we used Google with the search term "electric school bus" (quotes included) to find sources that reported ESBs that had been committed, including news articles, school websites, social media posts, government funding announcements, and datasets from government or nonprofit entities. We also gathered some information from correspondence with our partners, which we confirmed with published sources wherever possible. The sources for ESB adoption are listed at the end of the row of each fleet operator, as indicated in Category 7 of Table A1. Once we completed a comprehensive initial collection of ESB adoption data, new ESBs were identified using Google news alerts with "electric school bus" to receive notifications of news related to ESB adoptions. We also tracked the disbursement of funds from major ESB funding opportunities, such as the Volkswagen Diesel Emissions Environmental Mitigation Trust (n.d.) and the EPA's Diesel Emissions Reduction Act rebates and grants (EPA n.d.a.).

Sheet 3. Utilities

Category 8: Utility data

This category includes information on the electric power utilities operating in each school district. The "Utility name" variables include the names of all utility companies that operate within the boundaries of the school district. Variables covering the possible utility ownership structures include "Cooperative ownership," "Municipal ownership," "Investor ownership," and the like. These variables indicate whether any utility of the specified ownership model operates anywhere in the school district. For example, a "Yes" under "Cooperative ownership" indicates that one or more cooperative electric power utilities operate in that school district. The "RTO/ISO variable" indicates which regional transmission organization or independent system operator serves that school district. Additional research is underway to determine which utilities serve the schools and bus depots in each school district, since some school districts have multiple electric power utilities, meaning that different utilities could serve school buildings and bus depots.

DATA SOURCE, COLLECTION METHOD, AND/OR ANALYSIS METHOD

Spatial data on utility company boundaries in 2020 was sourced from Homeland Infrastructure Foundation-Level Data (HIFLD 2020). GIS analysis was conducted using these shapefiles and shapefiles of school districts from NCES (2020b) to determine which utility service areas intersect with which school districts. The resulting dataset was exported from ArcGIS as a spreadsheet and merged into this dataset using an XLOOKUP Excel function based on LEA IDs.

Sheet 4. Counties

Category 9: County data

This category lists all the counties that intersect with each school district. Some school districts are entirely con- tained within one county, but more than 4,000 LEAs contain two or more counties. These data are important because certain funding opportunities, data-sets, or decision-making powers relevant to ESBs are at the county level and not the school district level. School districts that contain more than one county are listed in multiple rows. For example, a district that contains two counties will appear in two rows, one with three counties will appear in three rows, and so on. Where school districts contain more than one county, the order of the

counties listed with each school district is not meaningful (i.e., the county with the most area in the school district is not necessarily listed first).

These data come from the school district Geographic Relationship Files published by NCES, which list the counties associated with each school district (NCES 2022b). For school districts not included in the Geographic Relationship Files, we used the county listed in the NCES school locations & geoassignments file for public school districts for the 2021–22 school year (NCES 2022c).

Sheet 5. Congressional districts

Category 10: Congressional district data

This category lists all of the congressional districts that exist within a school district, as well as the number of congressional districts that are within the LEA, if known. Similar to Sheet 4, school districts appear in as many rows as the number of congressional districts that they contain. The order in which congressional districts are listed with a school district is not meaningful.

These data come from the School District Geographic Relationship Files published by NCES, which list the congressional districts associated with each school district (NCES 2022b). For school districts not included in the Geographic Relationship Files, we used the congressional district listed in the NCES school locations & geoassignments file for public school districts for the 2021–22 school year (NCES 2022c).

Sheet 6. State school bus fleets

Category 11: State school bus fleet data

This section compiles school bus fleet data at the state level. It includes the total number of school buses in each state, the number of committed ESBs in each state, and the percentage of the statewide school bus fleet that is electric. It also contains data on the number of students who use the school bus as their primary mode of transportation, whether the state has a pupil transportation requirement, and the pupil transportation funding method.

We include three sources, School Bus Fleet Magazine (2022) the Federal Highway Administration (2021), and WRI's dataset of U.S. school bus fleets (Lazer et al. 2023) for the total number of school buses in each state. The total number of ESBs per state is based on the number of committed ESBs recorded in Sheet 1. We calculated the percentage of the state school bus fleet that is electric using these same sources, as well as school bus registration data from Atlas EV Hub (2019). The data on primary modes of transportation to school come from the National Household Travel Survey (Federal Highway Administration 2017). The data on pupil transportation requirements and funding come from various sources that are listed in Sheet 6.

USE CASES

A main value-add of this dataset is its compilation and organization of data on ESBs (Category 3) in a useful, cohesive structure that enables comparison between school districts and with other datasets (such as U.S. Census or other demographic data). Many users may want to filter the data to identify only school districts with ESBs, and then filter or sort based on other characteristics. This could answer questions such as "How are ESBs distributed across school districts of different income levels or racial compositions?" or "How are ESBs distributed across different regions of the country, states, or urban and rural areas?" Users can also take a deeper look into data trends in the bus-level sheet to answer questions such as "What funding sources have been used most frequently to fund ESBs?", "How many committed buses are from a given operator?", or "How many buses were awarded in the fourth quarter of 2020?" This data can also be used to better understand the rate of adoption of ESBs in a given school district—including, for example, if they piloted a few buses and then scaled up by ordering many more.

This dataset includes all school districts, not only school districts with ESBs, to enable comparisons between school districts with ESBs and the wider universe of school districts, such as "Do school districts with ESBs have a higher percentage of people of color than the average school district?"

Examples of Use Cases

- A staff member or student in a school district is trying to find information about how their school district compares to others with regard to sustainability and

equity outcomes. They would use this information to assess the feasibility of transition to ESBs based on their similarity to other school districts with ESBs or to advocate for cleaner bus fleets if similar schools have been able to make the change.

- A journalist is looking for the most up-to-date data on ESB adoption in the United States and wants to run analyses that compare ESB adoption against other indicators, such as air pollution exposure of children. The journalist would use the data to write a piece on the case for ESBs from a health perspective.

- A congressional staffer wants to know how the district or state of their member of Congress compares to others when it comes to ESB adoption. That staffer would use the data to advocate for full appropriations of zero-emissions school bus funding allocated in federal legislation, such as the 2021 infrastructure bill and/or the Reconciliation bill.

- ESB advocates working at the local, state, or federal government level want to know characteristics of their school bus fleet and how many are ESBs. They would use the data to create a snapshot of the current status in order to bolster efforts to write ESB-friendly policy. They can also see which congressional districts overlap with their school district so that they can determine which congressmembers to contact.

We see very limited potential for misuse of these data or use of the data for efforts not aligned with the goals of WRI's Electric School Bus Initiative. It may be possible to use these data to advocate against the use of public funding to support ESB adoption, if ESB adoption is not deemed to be widespread, equitable, or cost-effective enough to justify the investment. It may also be possible for an advocate or school district or state official to use these data to argue against the adoption of ESBs in their jurisdiction (i.e., to argue for other alternative-fuel buses like propane or CNG) if they deem there to be insufficient nationwide piloting or use of ESBs. We anticipate that these risks will decrease as the number of ESBs committed and in operation increases in the early 2020s.

LIMITATIONS

Limitations in Data Availability (Data Gaps)

A current major data gap regards school bus fleet characteristics at the school district level. While WRI's forthcoming "Dataset of U.S. School Bus Fleets" has filled this gap for many districts' total fleet size and use of a private fleet operator, there are still many districts where this data is unknown. There are also gaps in socioeconomic data relating to some LEA types like charter schools and tribal schools, and in the socioeconomic characteristics of school districts served by ESBs that are owned by a private fleet operator, in cases where we do not know where those ESBs operate.

Quarters are used to track ESB adoption stages because sources often do not include specific dates. Very few of the ESBs that are listed in Sheet 2 have a known quarter for each of the four commitment stages. It is uncommon for news outlets, districts, or dealers to announce each stage, leading to gaps in our knowledge of the full adoption timeline of every ESB. For example, an ESB delivery may be covered by local news or announced on a school district website, but the date that the bus first began operating on regular routes was not. Sometimes sources may also mention the status of the bus without indicating the specific time period that the bus entered that stage.

Uncertainty and Potential Bias

Data on the number and location of electric school buses in the United States were aggregated from hundreds of news articles, funding announcements, press releases, and other disparate online sources. This method of data collection is a source of uncertainty in the dataset. We are unable to quantify the amount of uncertainty; this section explains where and how error may have been introduced, how that impacts the use of the findings, how we are working to counteract that source of uncertainty, and how users might counteract that uncertainty in their use of the data.

- **Outdated information:** The real-world situation may have changed since the source was published (as is the case with any static dataset). To counteract this uncertainty, users can search for additional or more recent sources about ESBs in particular districts of interest. We intend to update the dataset periodically to limit the accumulation of out-of-date information across the entire dataset.

- **Omitted information:** Given the disparate and numerous sources used to collect these data, the dataset may inadvertently omit ESBs (or details about ESBs) for which data are publicly available. We hope that the publication of this dataset will lead users to provide WRI with missing information that can be included in updates.

- **Unknown location of buses owned by private fleet operators:** Several private fleet operators have committed to ESBs. Some of these operators serve school districts around the country, and in some cases, there is not information about where the ESBs will operate. In such cases, the ESBs are listed as owned by the fleet operator, but no associated geographic or demographic information is provided. This means the school buses are included in the total number of ESBs and number of entities with ESBs (and in some cases in the count of ESBs by funding source), but they would not be represented in analyses of the distribution of ESBs by region, income, and so forth. To counteract this uncertainty, the Electric School Bus Initiative is working to build partnerships with fleet operators so that, among other things, we can access more accurate information on the school districts that these ESBs serve. As we learn about the location of these ESBs, updates to this dataset will list those ESBs with the school district they serve, and the fleet operator will be noted in the school district's "Fleet operator" column.

- **Double-counting of school buses owned by private fleet operators:** In other cases, we may have information that the ESBs owned by a private fleet operator will serve a given school district. However, some school districts have a hybrid model of school bus ownership where they own some buses and contract with a private operator for others. Given the fragmented nature of information available, this could potentially lead to double-counting. For example, a news article from the local newspaper covering a school district may indicate that the district is "getting" a certain number of ESBs, while funding allocation announcements (for example, from the EPA's DERA program) may state that the fleet operator will be purchasing those same buses. This could potentially lead to the same bus(es) being listed under both the school district and the fleet operator. To counteract this uncertainty, the Electric School Bus Initiative is working to build partnerships with fleet

operators so that, among other things, we can access more accurate information on the school districts that these ESBs serve. As we learn about the location of these ESBs, updates to this dataset will list those ESBs with the school districts they serve, and the fleet operator will be noted in the school district's "Fleet operator" column.

Consistency among Data Sources

This dataset draws from multiple data sources that differ in their method, time of publication, and other characteristics. Combining these to produce new insights presents a potential quality risk. We used the criteria described in "Indicator Selection Criteria" (Section 2) to ensure that all the data are as consistent, accurate, and fit for purpose as possible. We also describe the limitations of this dataset above, and include information in Table A1 that informs users of the specific characteristics and caveats of each included dataset.

Comprehensiveness of Indicators

The social, economic, environmental, and demographic data included in this dataset are ones that we determined to be relevant and robust, but they are by no means comprehensive. A nuanced understanding of the disadvantages or environmental injustices a community has experienced would require a wider array of information on topics such as exposure to various pollutants, health outcomes, access to services, employment, the policy and historical context, and many others. It would also benefit from a look at spatial scales larger and smaller than the school district level. However, we hope that the data provided here can help identify areas for further research. Updates to this dataset may include additional social, economic, environmental, and demographic indicators.

APPENDIX A. DATA DESCRIPTION AND SOURCES

Descriptions of Major Sources

- **The National Center for Education Statistics (NCES)** is an entity of the U.S. Department of Education responsible for "collecting and analyzing data related to education in the U.S. and other nations." Many of the data are updated yearly and presented in Excel or comma-separated value files at the school, district, and state levels, based on U.S. Census data. We collected data from NCES largely at the district level and use its district identifier number, known as a local education agency (LEA) ID, to ensure accurate data merging and tracking.

- *School Bus Fleet* is a pupil transportation trade publication that releases various surveys and statistics. Most of our data come from the magazine's survey of the top 100 school district fleets of 2019.

- **Homeland Infrastructure Foundation-Level Data (HIFLD)** is a public-domain website containing a variety of nationwide geospatial data. We used this source to determine utility boundaries so we could see how they overlap with school district boundaries using GIS analysis.

Table A1_Data description and sources for the ESB adoption dataset_v5, available for download at https://www.wri.org/research/technical-note-dataset-electric-school-bus-adoption-united-states, contains a detailed list of all variables in the dataset with explanations and sources.

APPENDIX B. 2019 AND 2020 DERA SCHOOL BUS REBATES – ELECTRIC BUS SUMMARY

WRI received the following information on the 2019 and 2020 DERA electric school bus rebates as a response to a Freedom of Information Act (FOIA) Request submitted to the EPA in November 2021. This information is included as an appendix here because it is included in the dataset and not publicly available elsewhere.

2019 Selectees (1 bus total)

- Reynolds School District #7 (OR) – 1 ZEV bus
  - □ $20,000 paid out for ZEV bus
  - □ 2020 Blue Bird

2020 Selectees: (20 buses total)

- Center Unified School District (CA) – 5 ZEV buses
  - □ o $300,000 to be paid out
  - □ o 2021 Lion buses
- Elk Grove Unified School District (CA) – 4 ZEV buses
  - □ $260,000 to be paid out
  - □ 2021 Lion buses
- River Delta Unified School District (CA) – 4 ZEV buses
  - □ $260,000 to be paid out
  - □ 2021 Lion buses
- Robla School District (CA) – 1 ZEV bus o $65,000 to be paid out
  - □ 2021 Lion bus
- School District of Philadelphia (PA) – 2 ZEV buses
  - □ $130,000 to be paid out for ZEV buses
  - □ Lion buses
- Berkeley Unified School District (CA) – 4 ZEV buses
  - □ Note: Fleet is no longer participating in the 2020 Rebates

2020 Waitlist: (28 buses total)

- Burnett Transit (WI) – 1 ZEV bus for $65,000
- Pajaro Valley Unified School District (CA) – 5 ZEV buses for $300,000
- Esparto Unified School District (CA) – 1 ZEV bus for $65,000
- Shawnee Heights USD-450 (KS) – 2 ZEV buses for $130,000
- Fairfax County Public Schools - APP 2 (VA) – 4 ZEV buses for $260,000
- School District of Philadelphia (PA) – 2 ZEV buses $130,000
- Salt Lake City School District (UT) – 4 ZEV buses for $260,000
- Escondido Union High School District (CA) – 2 ZEV buses for $130,000
- Steamboat Springs School District (CO) – 1 ZEV bus for $65,000
- Fairfax County Public Schools – APP 1 (VA) – 4 ZEV buses for 260,000
- Croton-Harmon UFSD (NY) – 2 ZEV buses for $130,000

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ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

Maps are for illustrative purposes and do not imply the expression of any opinion on the part of WRI, concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries.