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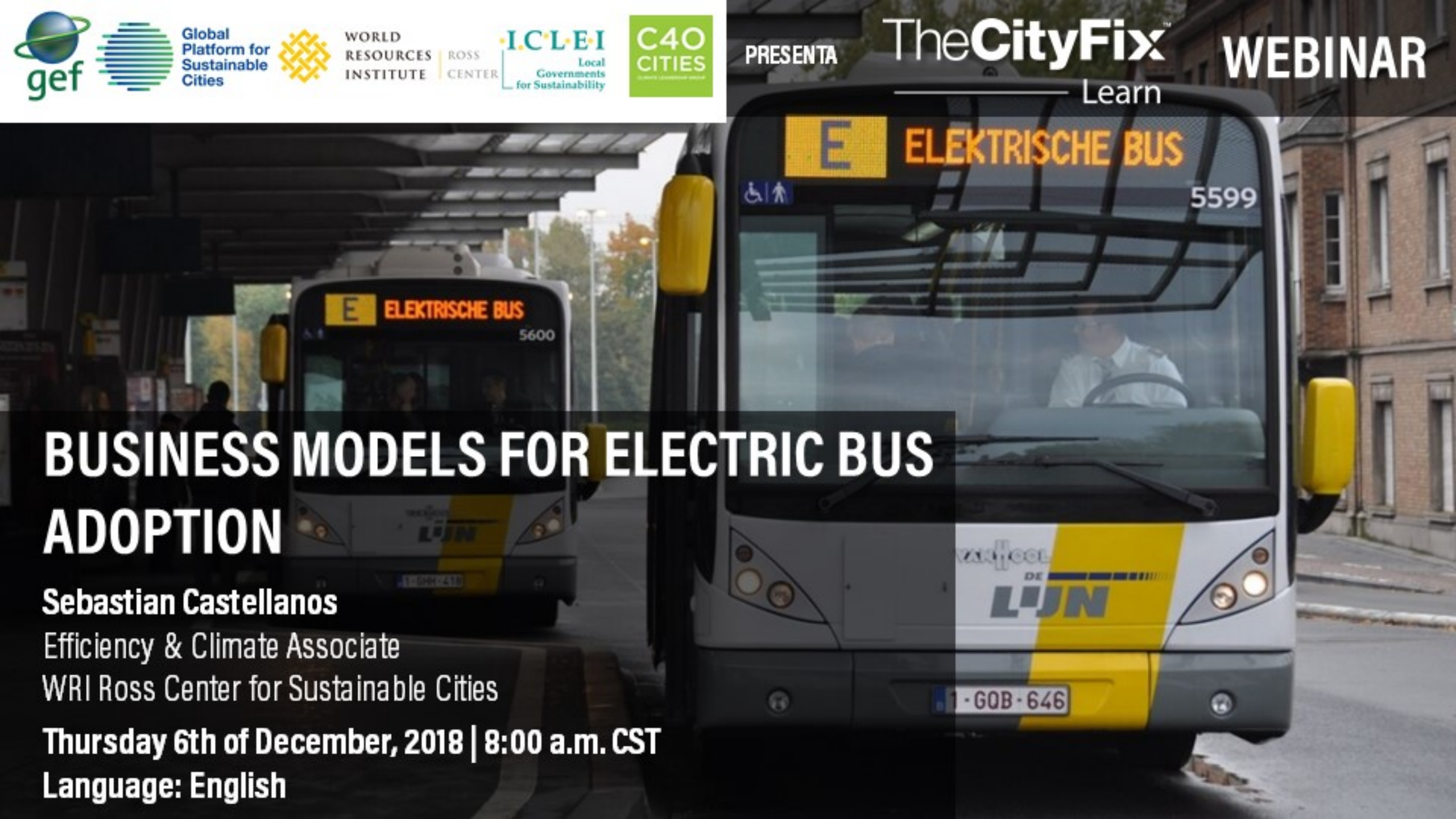
WEBINAR



BUSINESS MODELS FOR ELECTRIC BUS ADOPTION

Sebastian Castellanos
Efficiency & Climate Associate
WRI Ross Center for Sustainable Cities

Thursday 6th of December, 2018 | 8:00 a.m. CST
Language: English

PRESENTATION STRUCTURE

- What is electromobility?
- Why is its implementation important in public transport?
- What are the components of the electric bus business model?
    a. Investment components
    b. Funding sources
    c. Financial products
    d. Delivery mechanisms
- Study Case: Bogotá

MSc. Sebastián Castellanos

Urban Efficiency and Climate Associate
WRI Ross Center for Sustainable Cities

Bachelor's in Electronic Engineering from the Universidad de Los Andes (Bogotá, Colombia), a Master's Degree (Project Management and Technology) from the École des Mines de Saint-Étienne (France) and an MSc. in Transport Planning and the Environment, from the Institute for Transport Studies at the University of Leeds (UK).

As Urban Efficiency and Climate Associate he leads the vehicle efficiency solution area. Sebastian provides advice and support to cities in designing and implementing low carbon, high efficient transport solutions and policies, including electrification of the transport sector, fuel economy policies and Intelligent Transport Systems (ITS) among others.

WORLD RESOURCES INSTITUTE | WRI ROSS CENTER FOR SUSTAINABLE CITIES

Emerging trends and innovations in business models for electric bus adoption

The GPSC Resource Team

WEBINAR SERIES ON: Sustainable and Integrated Urban Development

December 2018

Sebastián Castellanos

SCastellanos@wri.org

THE CURRENT GLOBAL VEHICLE STOCK IS CLOSE TO 1.7 BILLION

WHO, "Global Health Observatory data repository", 2015
Photo: B137

AND COULD INCREASE TO 3.87 BILLION BY 2050

Sitty and Taft, “What will the global light-duty vehicle fleet look like through 2050?”, 2016
Photo: Whitehotpix

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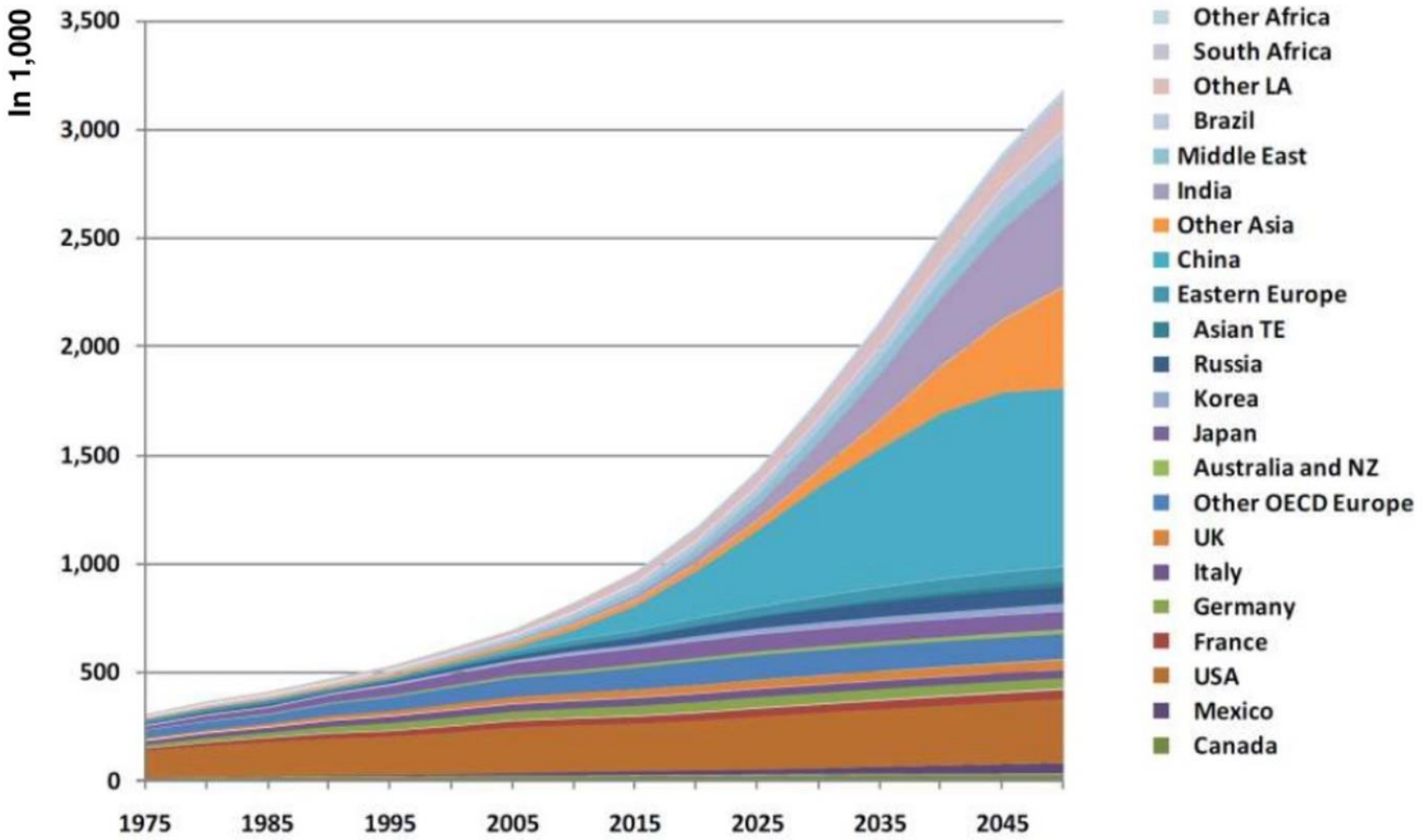
WITH MOST GROWTH HAPPENING IN DEVELOPING ECONOMIES



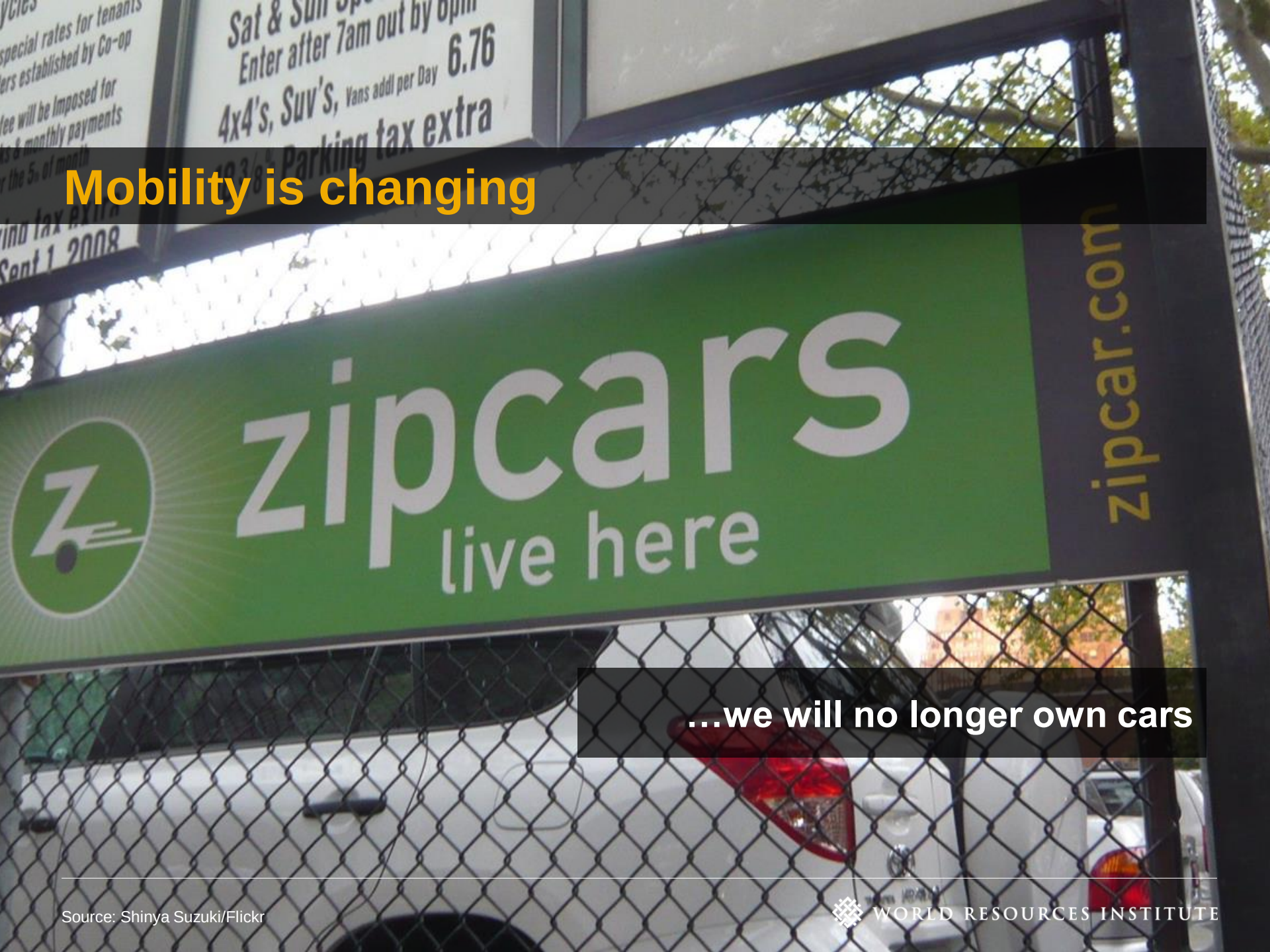
IEA, 2008

At the same time, mobility is changing

Mobility is changing

…drivers will no longer be needed

Source: Silver Blue



Source: Shinya Suzuki/Flickr

Mobility is changing

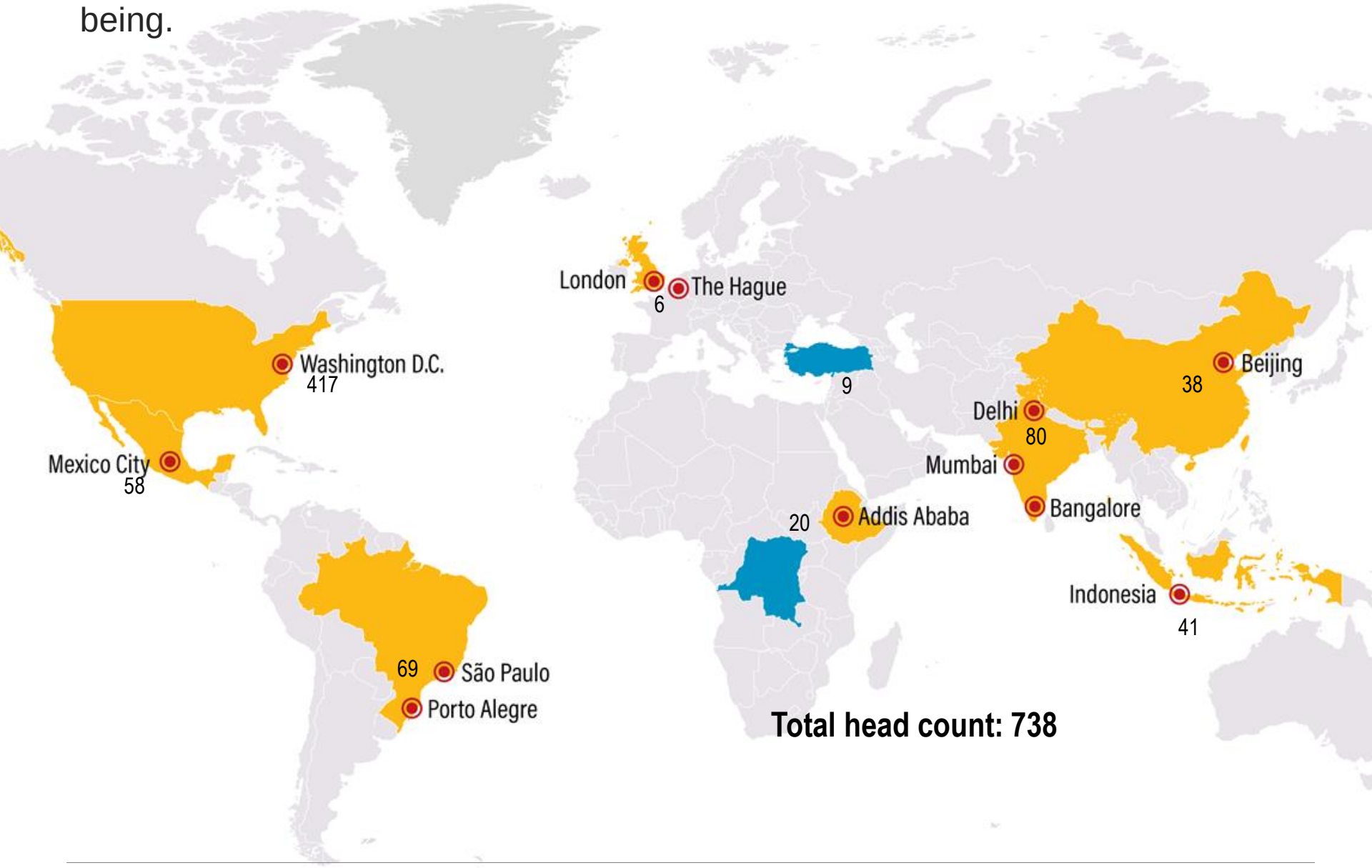
…automobiles will no longer pollute

Source: Wikimedia Commons

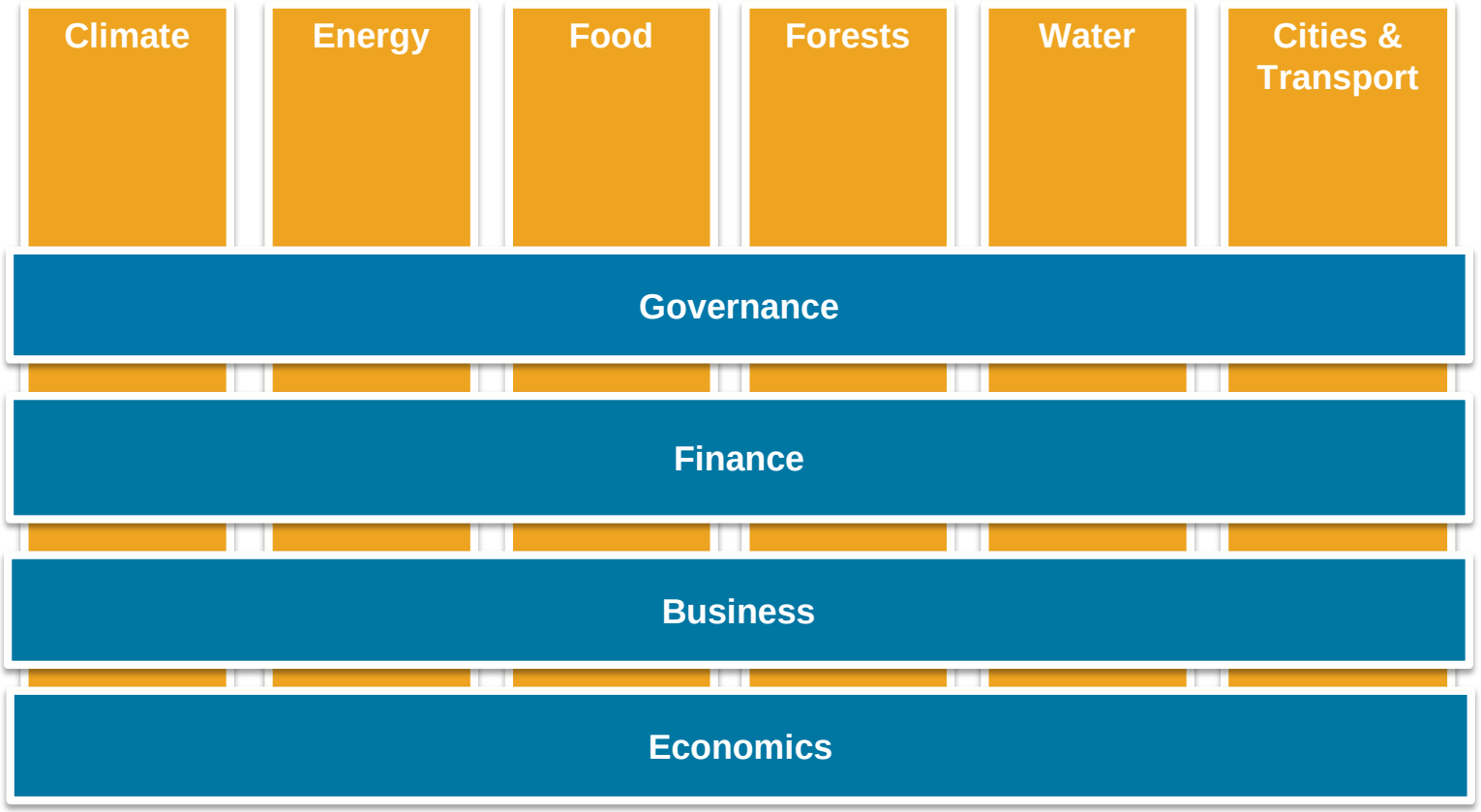
THESE DISRUPTIONS CAN LEAD TO THRIVING SUSTAINABLE CITIES… OR NOT

Much depends on how we manage and direct these transitions.

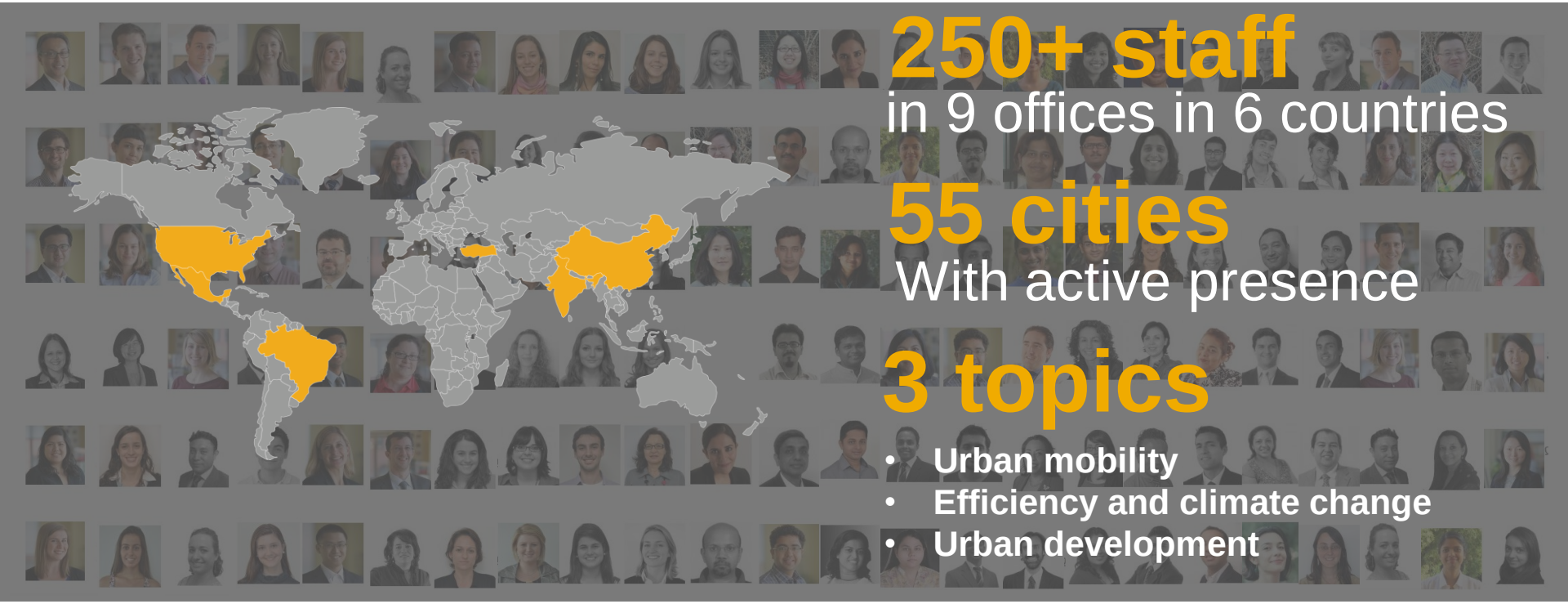
ABOUT WRI | WRI is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity and human well-being.



WE WORK AROUND 6 GLOBAL CHALLENGES



WORLD RESOURCES INSTITUTE | ROSS CENTER



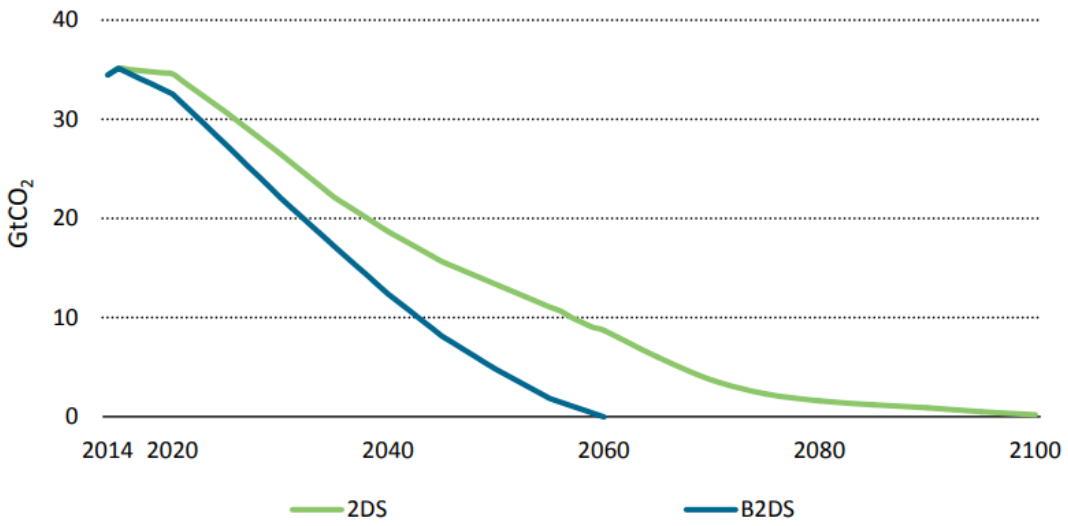
250+ staff
in 9 offices in 6 countries

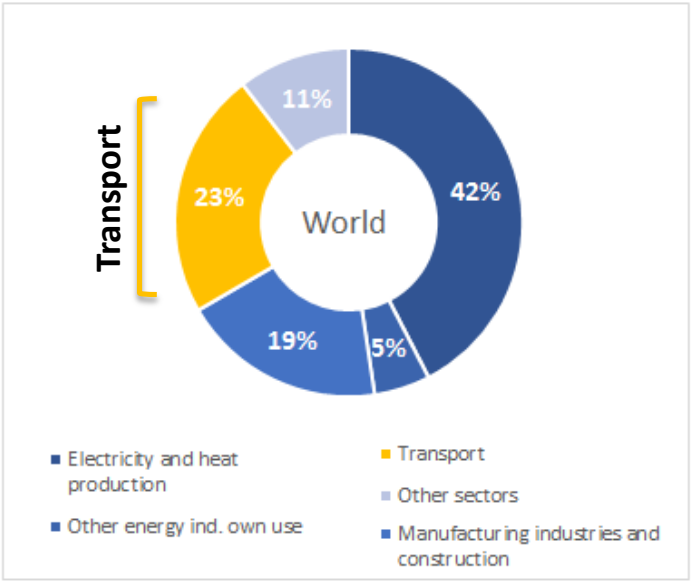
55 cities
With active presence

3 topics

- **Urban mobility**
- **Efficiency and climate change**
- **Urban development**

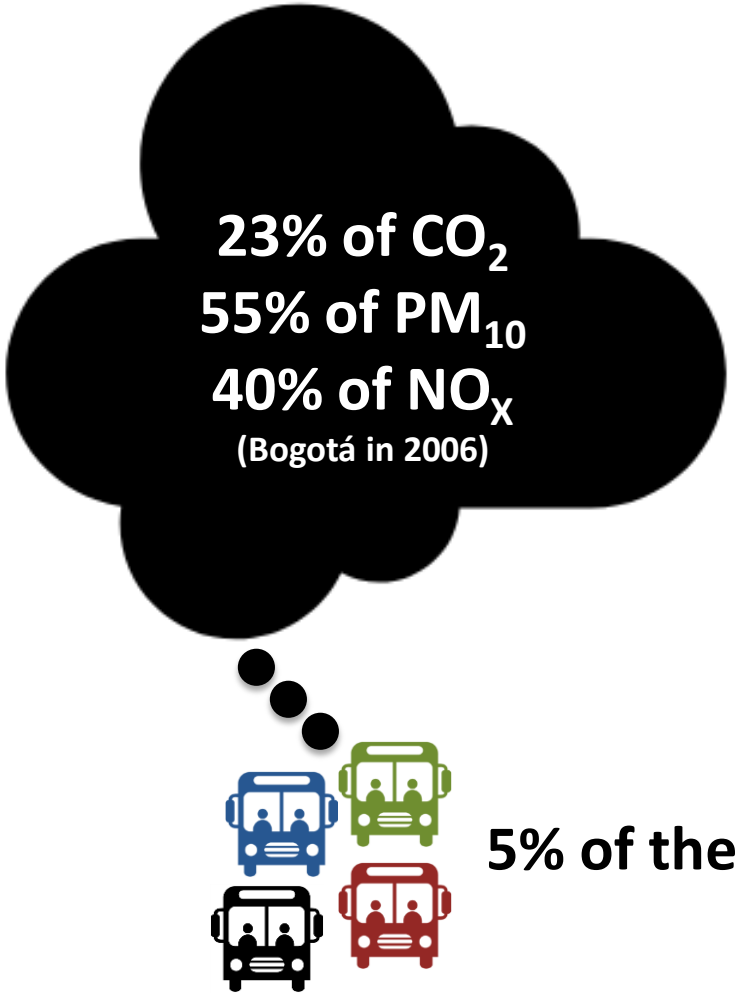
TO COMPLY WITH A <2DS, THE TRANSPORT SECTOR MUST BE COMPLETELY DECARBONIZED BY 2060





[Left] IEA, "Global EV Outlook", 2017.
[Right] IEA, authors with data from "CO_2 Emissions from fuel combustion: Highlights", 2015

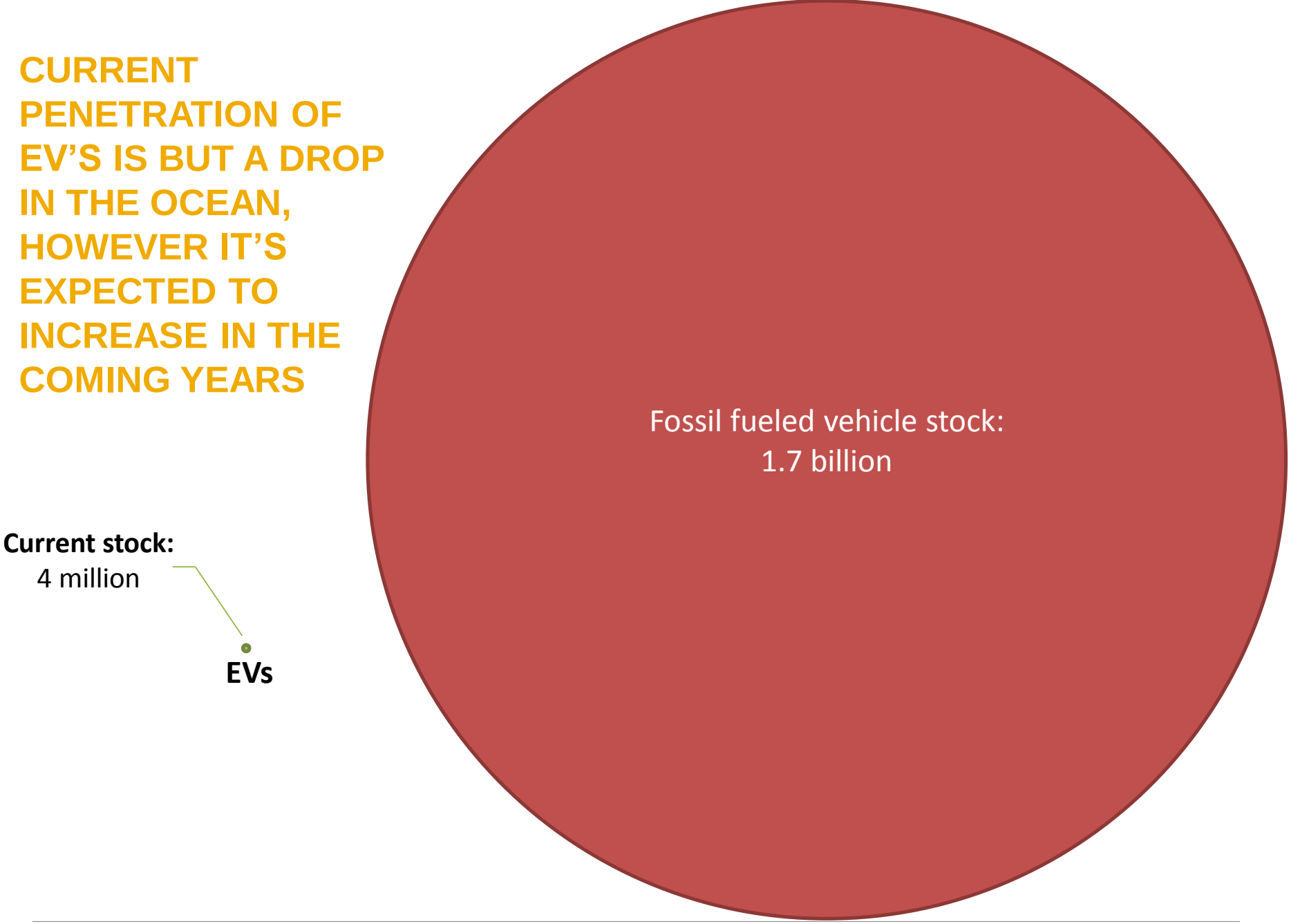
BUSES ARE A PREDOMINANT MODE OF TRANSPORT FOR LARGE PARTS OF THE POPULATION, AND THEY GENERATE AN IMPORTANT PART OF THE EXTERNALITIES FROM THE TRANSPORT SECTOR



VEHICLE ELECTRIFICATION

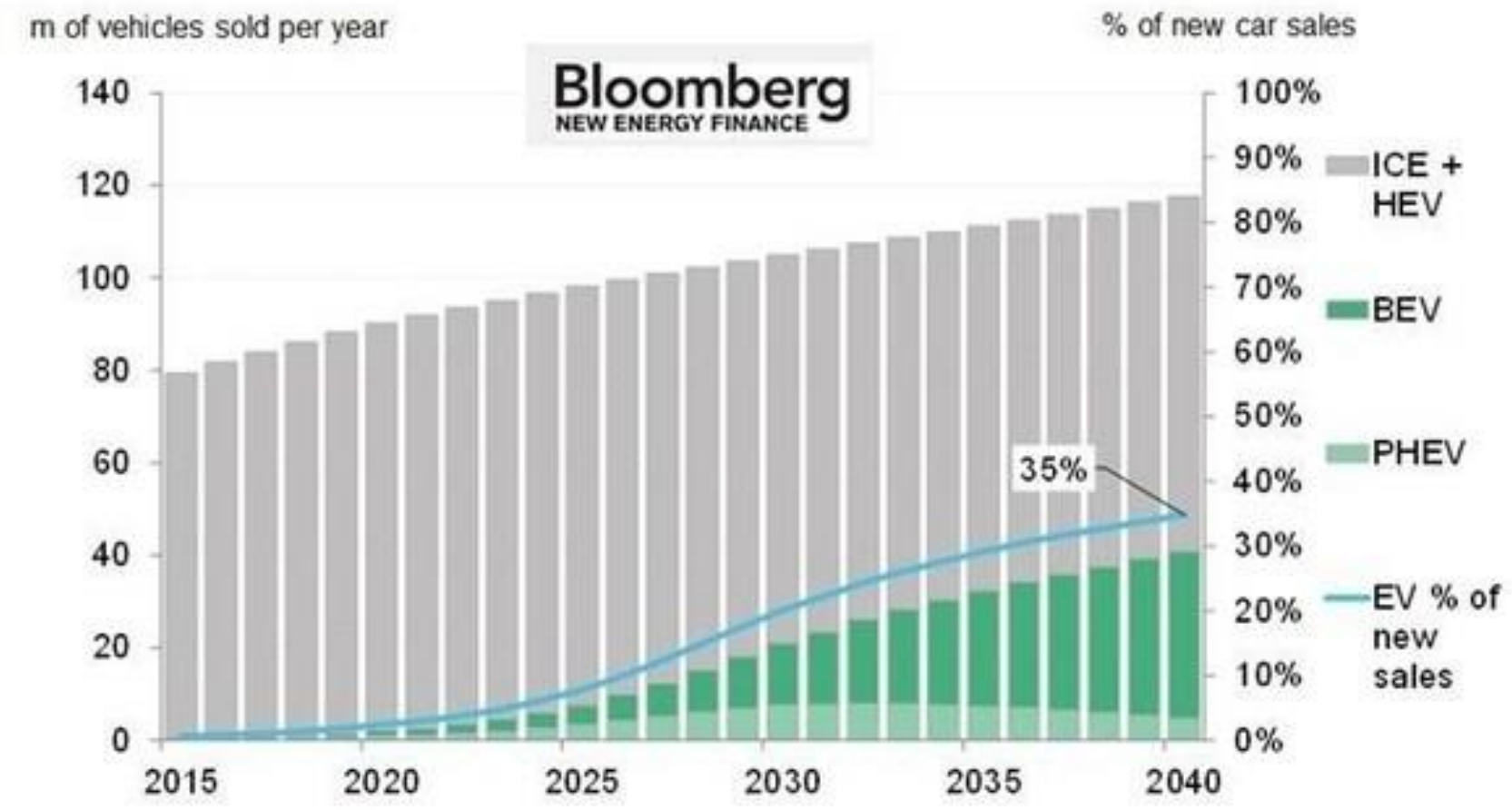
A NEW HOPE

CURRENT PENETRATION OF EV'S IS BUT A DROP IN THE OCEAN, HOWEVER IT'S EXPECTED TO INCREASE IN THE COMING YEARS



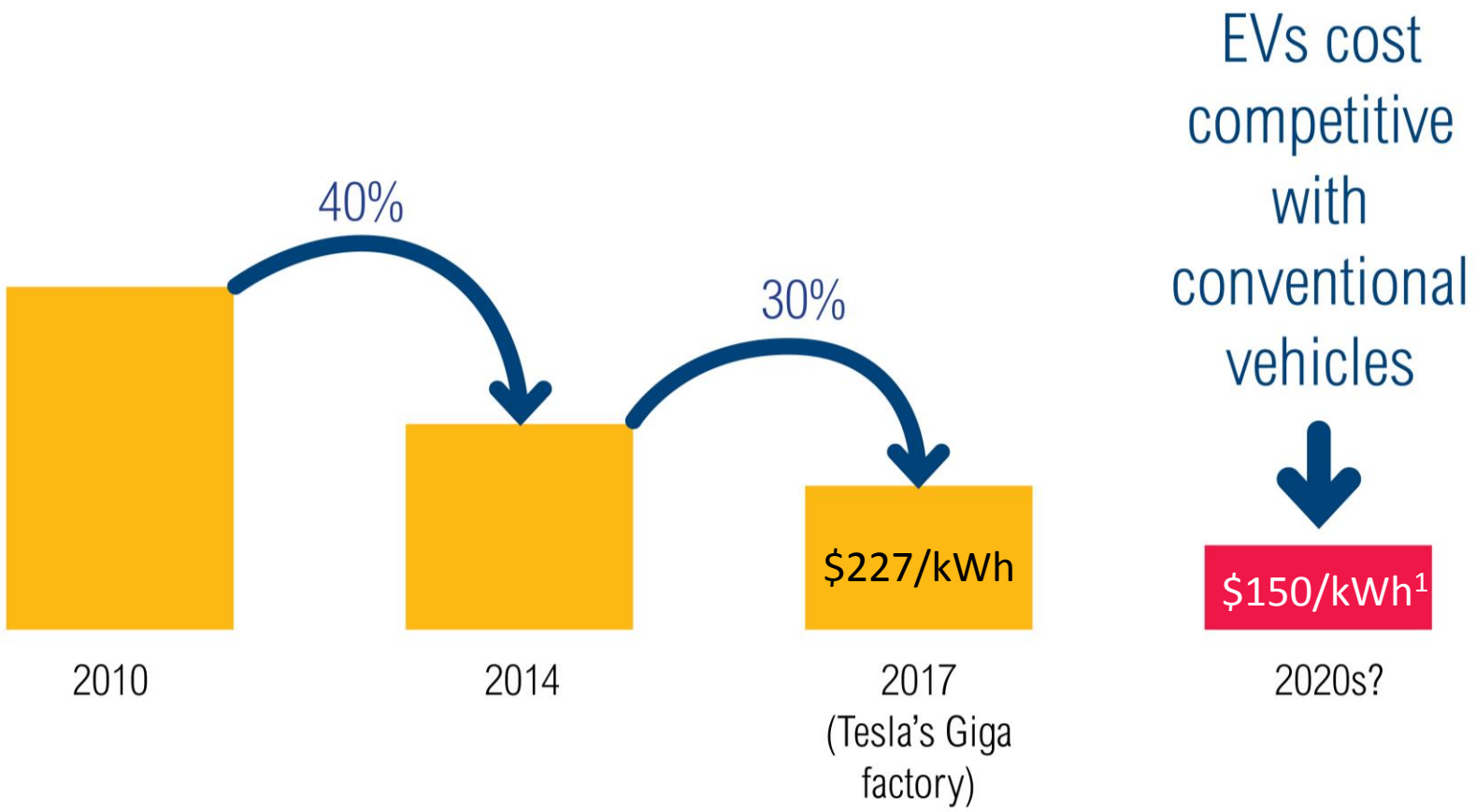
Authors with data from IEA, "Global EV Outlook", 2017.

NEW VEHICLE SALES ARE EXPECTED TO BE 35% ELECTRIC BY 2040



Source: BNEF, “Electric Vehicle Outlook”, 2017

ELECTRIC VEHICLE BATTERY PRICES ARE FALLING FAST



1. Nykvist and Nilsson "Rapidly falling costs of battery packs for electric vehicles", 2015,

THE MARKET IS GEARING UP FOR THE CHALLENGE

All Volvo cars to be electric or hybrid from 2019

Landmark move as first big manufacturer says it will stop making vehicles solely powered by internal combustion engine

Sales of Volvo's hybrid XC90 have been stronger than expected. Photograph: Volvo

In Pivotal Moment, Tesla Unveils Its First Mass-Market Sedan

By BILL VLASIC JULY 29, 2017

The Tesla Model 3 sedan. Tesla Motors, via Associated Press

AND SO ARE SOME GOVERNMENTS

France to ban sales of petrol and diesel cars by 2040

Move by Emmanuel Macron's government comes a day after Volvo said it would only make fully electric or hybrid cars from 2019

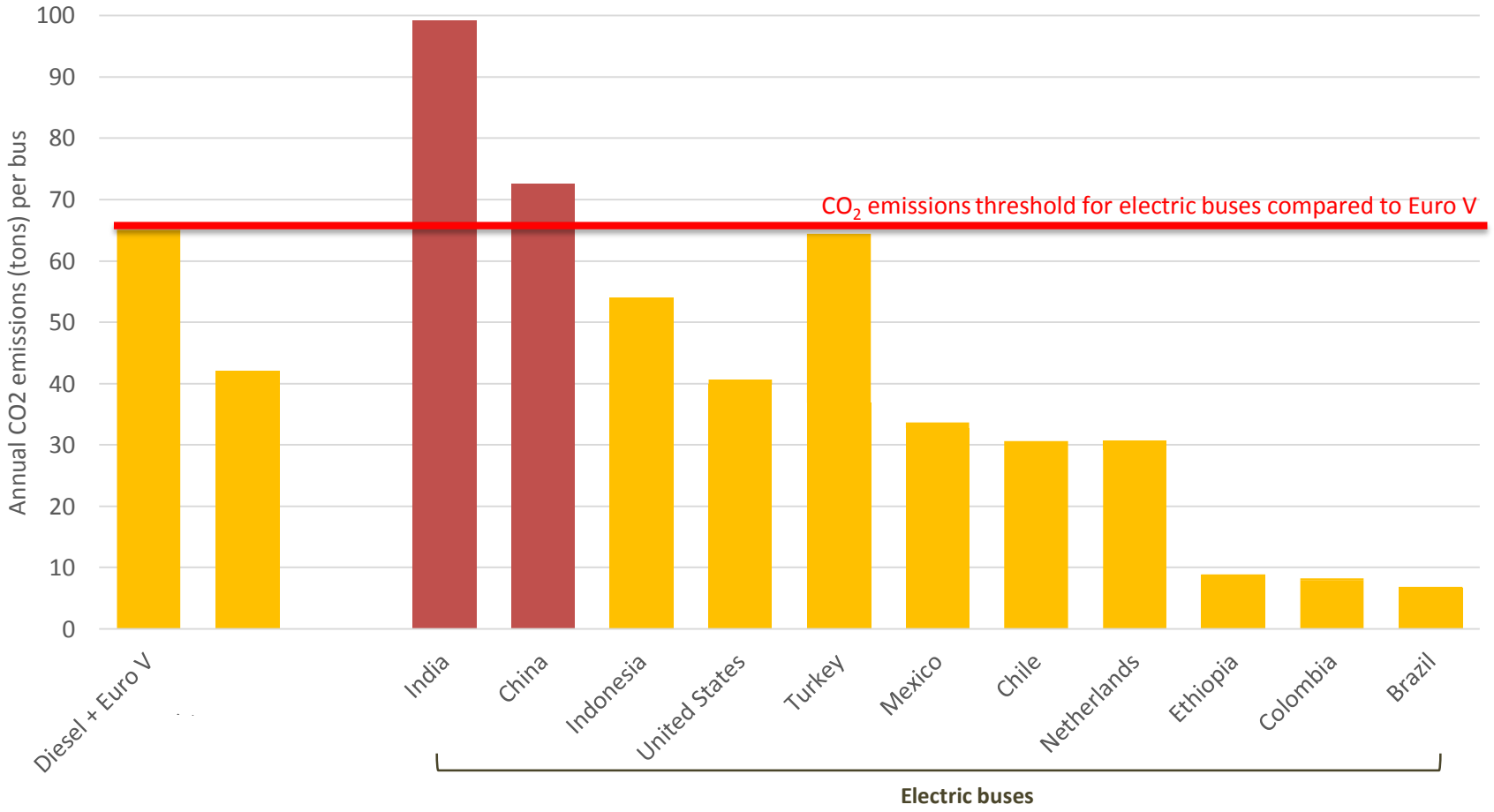
Renault's Zoe electric car will escape France's ban after 2040. Photograph: Renault

Britain to ban sale of all diesel and petrol cars and vans from 2040

Plans follow French commitment to take polluting vehicles off the road owing to effect of poor air quality on people's health

Ministers believe poor air quality poses largest environmental risk to public health in UK. Photograph: Peter Macdiarmid/Getty Images

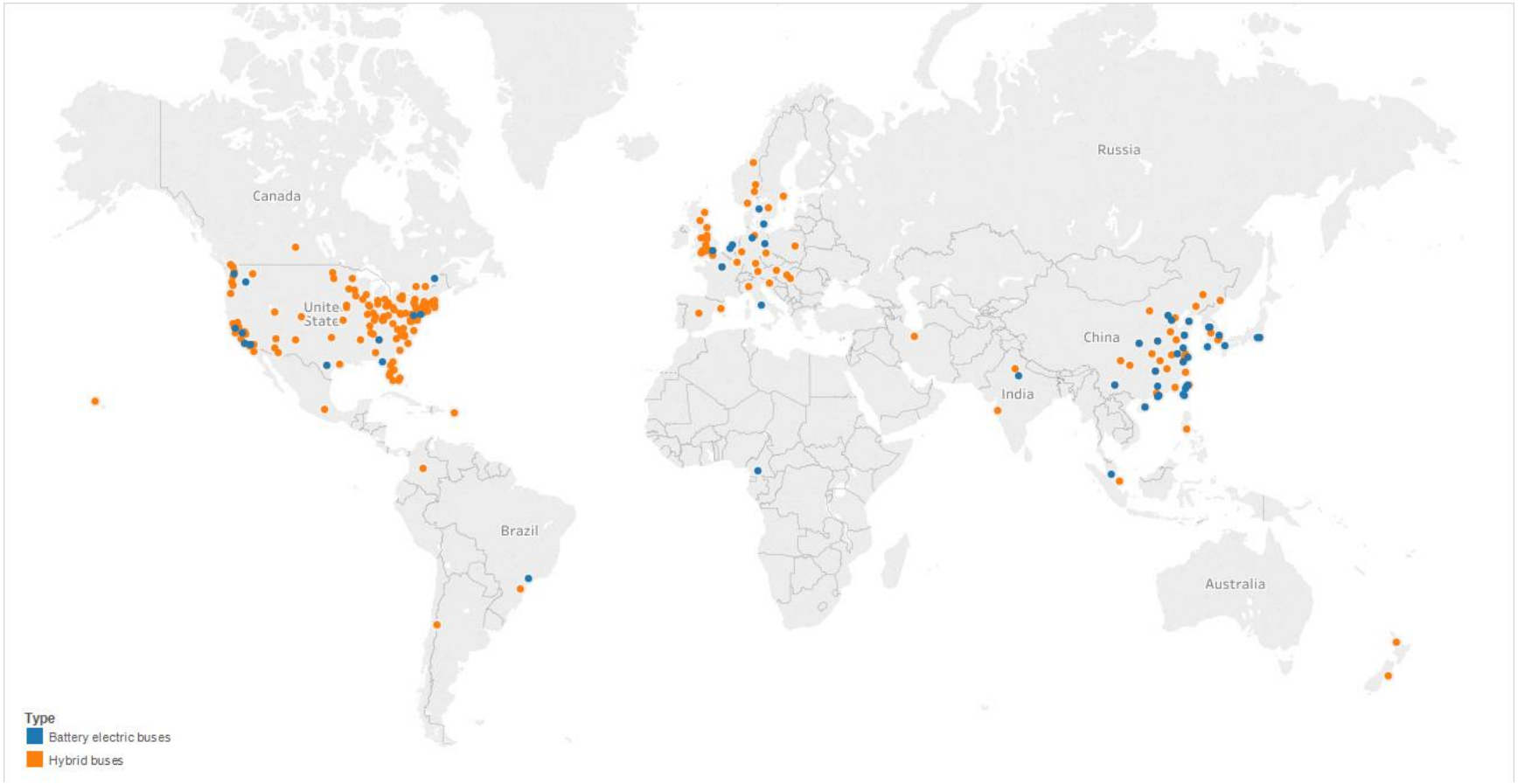
ELECTRIFYING BUSSES ALREADY MAKES SENSE FROM A CO2 PERSPECTIVE IN MANY COUNTRIES



Source: authors with information from IEA

WILL THIS BE ENOUGH?

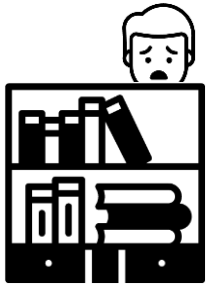
ALREADY OVER 300 CITIES HAVE IMPLEMENTED ELECTRIC OR HYBRID BUSES AS PART OF THEIR FLEETS



Source: authors

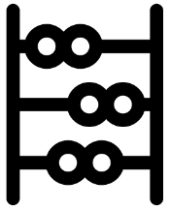
HOWEVER, THERE ARE STILL BARRIERS FOR THIS TRANSITION TO BECOME MASSIVE

More expensive vehicles and infrastructure



Fear of change and lack of knowledge

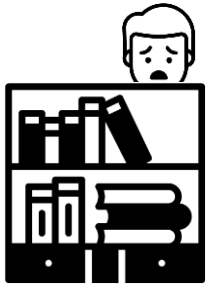
Technology readiness (e.g. range)



Outdated procurement models

DURING THIS SESSION WE WILL EXPLORE HOW CITIES AROUND THE WORLD HAVE ADDRESSED THE FIRST BARRIER

More expensive vehicles and infrastructure



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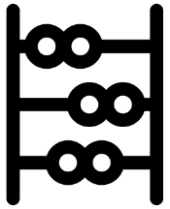
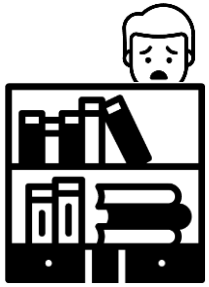


Outdated procurement models

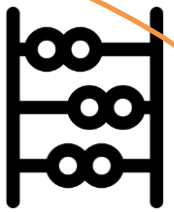
AND HOW IN DOING SO, MANAGED TO ADDRESS SOME OF THE OTHERS

More expensive vehicles and infrastructure



Fear of change and lack of knowledge

Technology readiness (e.g. range)



Outdated procurement models

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Emerging trends and innovations for electric bus adoption—a comparative case study of contracting and financing of 22 cities in the Americas, Asia-Pacific, and Europe

Xiangyi Li*, Sebastian Castellanos, Anne Maassen

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Keywords:
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Alternative funding mechanism
Urban finance
Grants
Risk mitigation
Contract
Electric vehicle*Jel classification:*
H81
L92
R42
R51
R53

ABSTRACT

Electric buses have local environmental benefits, which has incentivized cities to transition their fleets from diesel to electric. However, the adoption of electric bus globally is geographically uneven and limited in scale. One issue is the high upfront cost of electric buses. However, few studies have analyzed the contracting and financing mechanisms that can help accelerate electric bus adoption. As part of the initial information collection process, the paper is based on real-world experiences and evidence, applies a comparative multi-case study to 22 cities in 14 countries. A framework is used for analysis, which includes identifying technical components that require investment, non-reimbursable funds and investment capital applied, and legal arrangements supporting the implementation. Results show that three key elements are seen in electric bus adoption across the globe, despite regional differences. First, both public and private grants, when dedicated to cleaning the fleet, appear as a strong factor underpinning existing clean bus systems. Second, less costly sources of financing, which may come from different stakeholders, can reduce financial risks, and it is where innovation can happen. Third, innovative ways of structuring contractual implementation effectively connect stakeholders and involve third-party players, which leads to shared risks, increased efficiency and improved performance.

1. Introduction

Electric buses[1] reduce local air pollution, can improve service quality by reducing vibration and noise, and increase vehicle efficiency through reduced energy consumption and lower fuel requirements (United States Department of Transportation, 2016). However, uncertainties still exist in the lifecycle cost-competitiveness of electric buses compared to diesel buses. These uncertainties are due to local operational cost variations and a lack of methodologies that would help account for the social benefits of electric buses (Quarles & Kockelman, 2018). According to Bloomberg New Energy Finance (2018), electric buses are cost-competitive with certain battery content and operational conditions, and the competitiveness improves in larger cities, with longer annual distances travelled. Also, the climate benefits of electric buses are largely determined by the grid emissions factors of the electricity used (Mulley, Hensher, & Cosgrove, 2017), and the end of life disposal of used batteries is a question that still needs to be addressed on a large scale (Nordelöf, Messagie, Tillman, Ljunggren Söderman, & Van Mierlo, 2014). While these concerns exist, more and more cities are considering electric buses as an increasingly desirable alternative to conventional buses.

Despite recent growth in the market and interests in electric buses, worldwide implementation is geographically uneven and limited in scale (Fig. 1). For example, the North American market for electric and hybrid buses grew by more than 400% from 2005 to 2010 (Marlay, 2013). In 2016, more than 40 cities worldwide were operating battery-powered electric buses (Castellanos & Maassen, 2017), with 87% of the buses in China (International Energy Agency, 2017). Shenzhen, China, home to the largest urban electric bus fleet (International Energy Agency, 2017), has fully upgraded all urban transit buses into electric

* Corresponding author.
E-mail address: xiangyi.li@wri.org (X. Li).

[1] Electric buses, in this paper, refer to battery electric buses in general. But this terminology may include several types of technology, based on different energy sources, engine types, charging mechanisms, etc. In this paper, hybrid electric bus is also included in the conversation and can be seen in some of the cases, due to the innovation part of its contracting and financing mechanism, and similarity to battery electric bus compared to conventional diesel buses. Detailed explanations and case selection criteria can be seen in the methodologies part of the paper.

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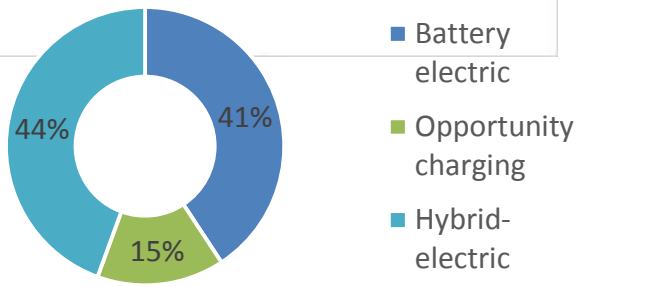
Xiangyi Li, Sebastian Castellanos, Anne Maassen

August 2018

Research in Transportation Economics

WE CONDUCTED RESEARCH TO UNDERSTAND WHAT 22 CITIES AROUND THE WORLD HAVE BEEN DOING TO ACHIEVE IMPLEMENTATION

Americas		Asia/Pacific		Europe
N. America	S. America	Asia	Oceania	Europe
6	2	7	1	9

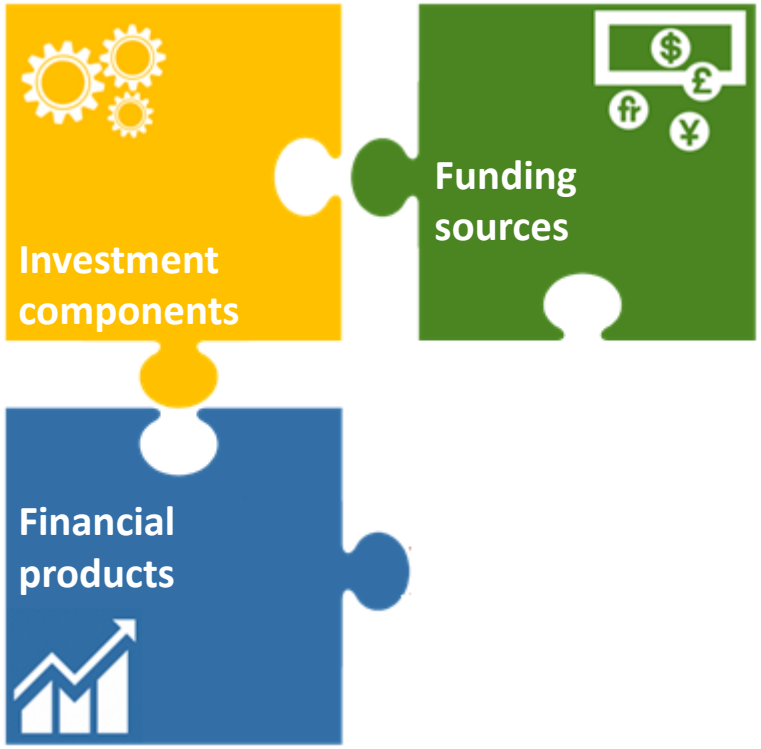


AND WE BUILT A FRAMEWORK TO ANALYSE OUR FINDINGS

The elements that make-up an investment in low emission buses

AND WE BUILT A FRAMEWORK TO ANALYSE OUR FINDINGS

The elements that make-up an investment in low emission buses



The sources of funding available to pay for these investments

Financial products that can be used to mobilize third-party capital

AND WE BUILT A FRAMEWORK TO ANALYSE OUR FINDINGS

The elements that make-up an investment in low emission buses

The sources of funding available to pay for these investments

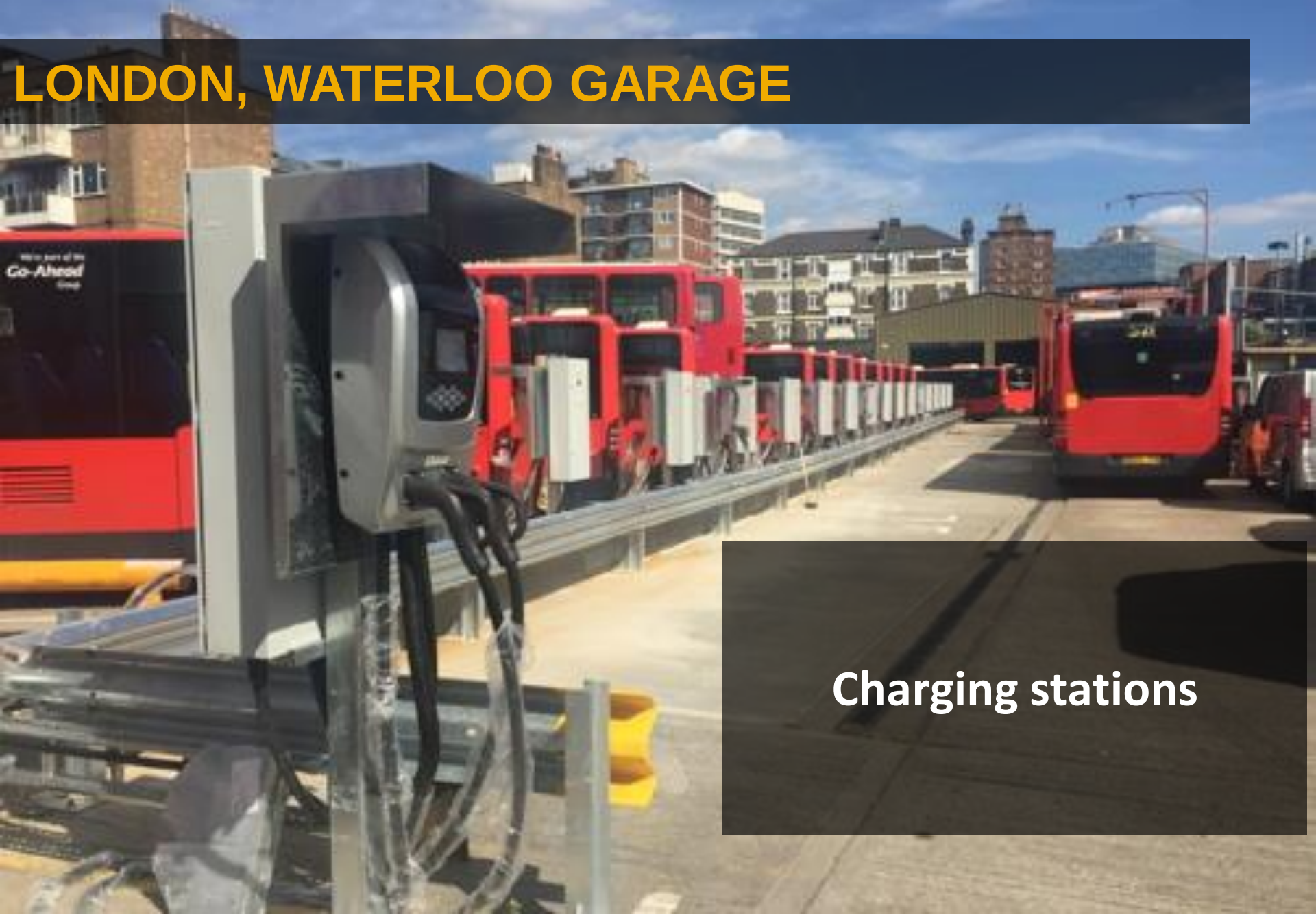
Financial products that can be used to mobilize third-party capital

The distribution of risks and responsibilities among involved parties

WHAT ARE CITIES INVESTING IN WHEN TRANSITIONING TO ELECTRIC FLEETS?

SHENZHEN, CHINA

LONDON, WATERLOO GARAGE



BEIJING, CHINA

Battery depots and swapping machines

INFRASTRUCTURE DEPLOYMENT

Volvo-Siemens

BOGOTÁ, COLOMBIA

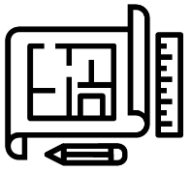
Training for drivers

GOTHENBURG, SWEDEN

Reputation: Silence

INVESTMENT COMPONENTS

Tangible assets



Land
(Charging Zones)
(Foothill)

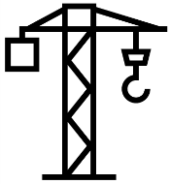
Charging Stations & Infrastructure
(Turin, Paris)

Buildings & Additional Infrastructure
(e.g. battery swapping, Rome)

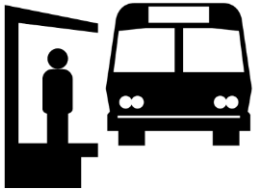
Buses & Batteries

Processes

Planning & Preparation
(Gumi)



Building & Installing
(Sweden: Siemens-Volvo)

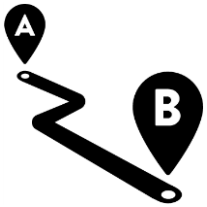


Operating, and training
(Bogota)

Maintenance
(Shenzhen)

Intangible assets

Safety & Health
(Turin)

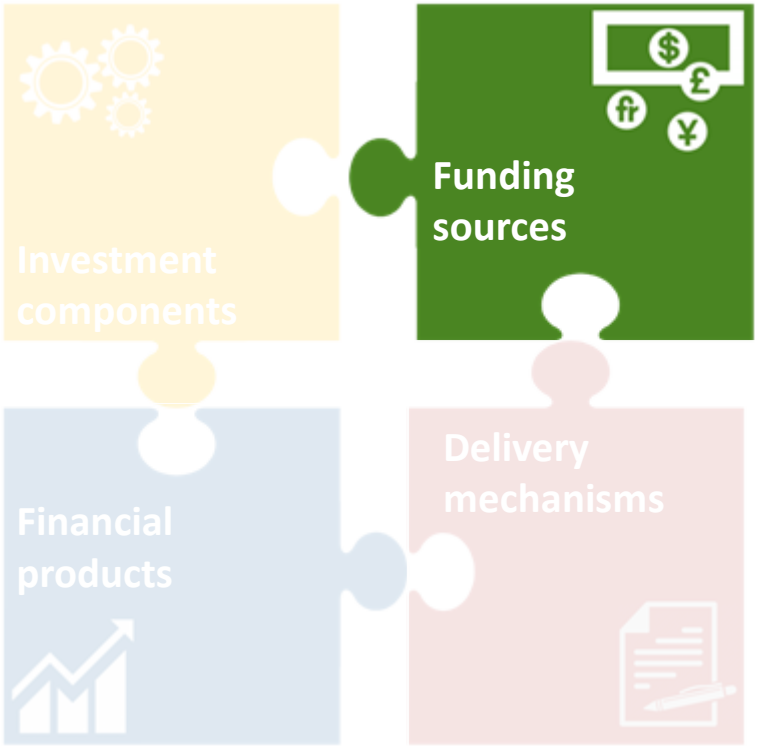


Resource Efficiency
(Fuel / Foothill)

Reputation & Brand
(Noise, Air Quality, Appropriation, Driver's Experiences)
(Turin, Gotenburg)

Affordability
(Singapur)

HOW ARE CITIES PAYING FOR THESE INVESTMENTS?



KING COUNTY, SEATTLE

Operational savings

4% maintenance

27% fuel

FOOTHILL, CALIFORNIA

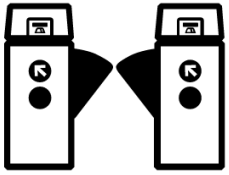
No-cost lease for land where charging stations are located

LONDON, U.K.

Clean Bus Technology Fund at the national level, used at the local level

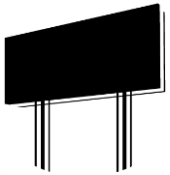
FUNDING SOURCES

Proceeds



Fare-box revenues

Land value capture in depots and stations
(Singapur)



Advertising in stations and infrastructure

Operational savings
(London)

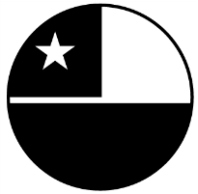
Incentives

Subsidies
(NAMA Sri Lanka)

Fiscal
(Bogotá)

Preferential pricing
(e.g. electricity tariffs)
(China, Foothill, Colombo)

Other budgets



Intergovernmental transfers
(Korea)

Dedicated taxes
(Paris)

Sale of assets and scrapping
(Brazil)

WHAT FINANCIAL PRODUCTS HAVE CITIES BEEN LEVERAGING?

BOGOTÁ, COLOMBIA

Private investors own more than half the hybrid bus fleet

TIANJIN, CHINA

Green bonds that can be used for public transport financing

BOGOTÁ, COLOMBIA

The Clean Technology Fund gave a $40M loan to purchase hybrid buses

CURITIBA, BRASIL

BNDES gives concessional loans to buses produced in Brazil

FINANCIAL PRODUCTS

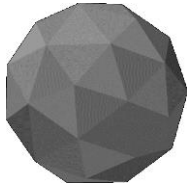
Equity

Private investors
(Direct or indirect)
(Bogota)

Public equity
(Italy)

Debt

Bank Loans
(Public or Private)
(Bogota)



International climate finance
(Bogota)

Green Bonds
(Tianjin)

De-risking

Contingency Funds
(Bogota)

Provision Contracts

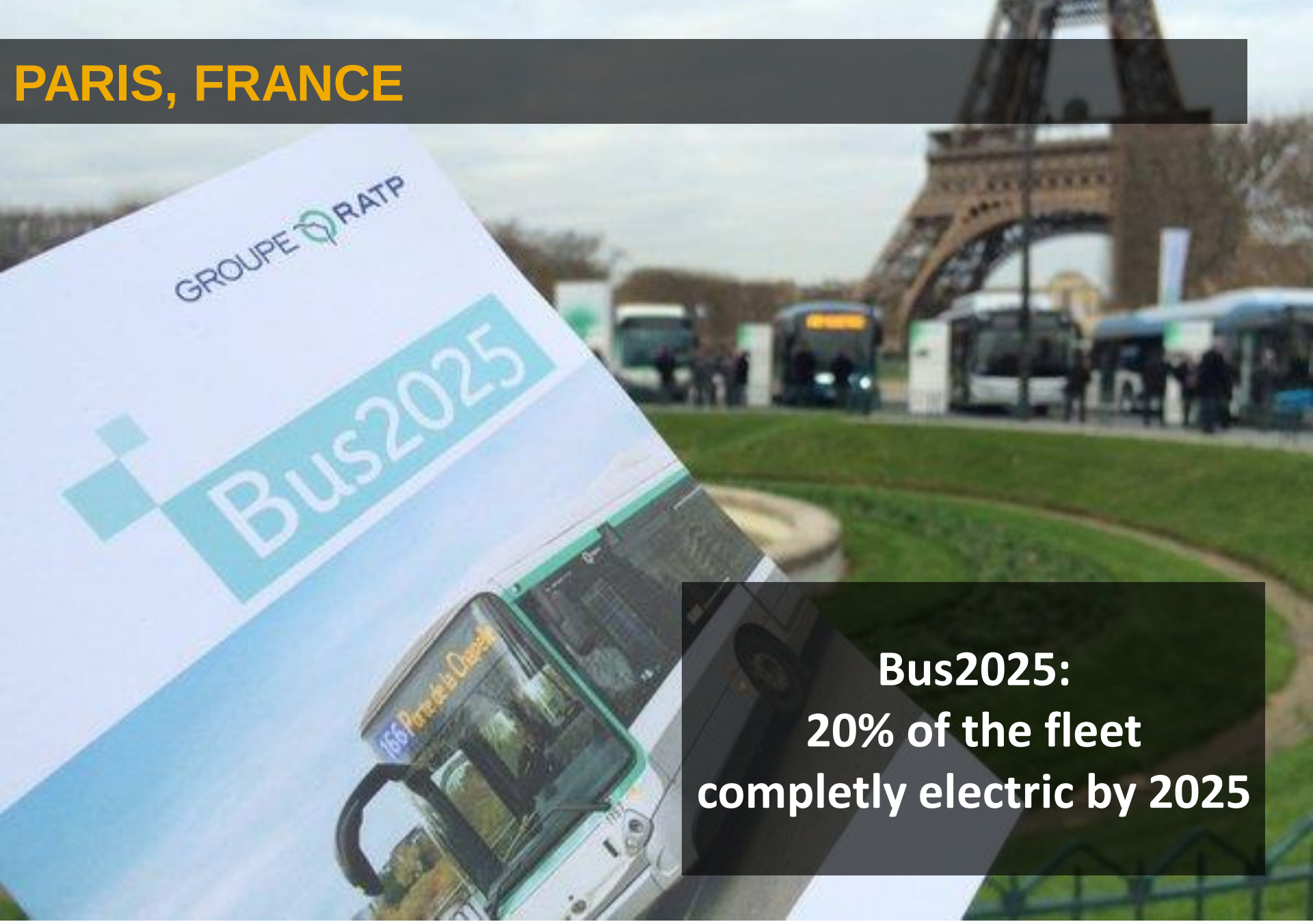
Concesional loans
(Curitiba)

HOW ARE RISKS ALLOCATED BETWEEN THE DIFFERENT STAKEHOLDERS

SHENZHEN, CHINA

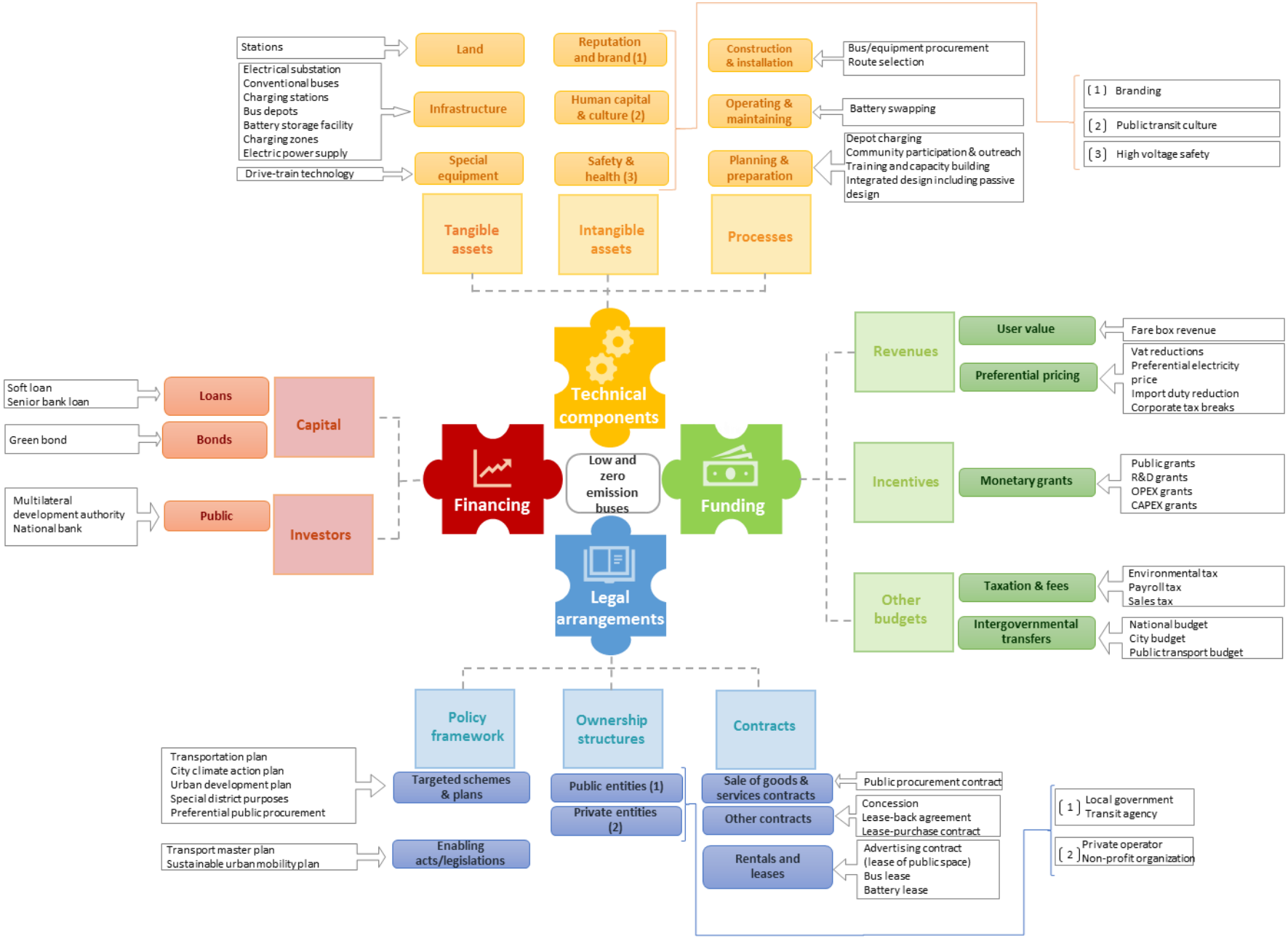
Bus companies and third parties purchase buses and lease them to operators

PARIS, FRANCE



Bus2025:
20% of the fleet
completly electric by 2025

Summary


Stations
Electrical substation
Conventional buses
Charging stations
Bus depots
Battery storage facility
Charging zones
Electric power supply
Drive-train technology
Land
Infrastructure
Special equipment
Tangible assets
Reputation and brand (1)
Human capital & culture (2)
Safety & health (3)
Intangible assets
Construction & installation
Operating & maintaining
Planning & preparation
Processes
Bus/equipment procurement
Route selection
Battery swapping
Depot charging
Community participation & outreach
Training and capacity building
Integrated design including passive design
(1) Branding
(2) Public transit culture
(3) High voltage safety
Technical components
Soft loan
Senior bank loan
Green bond
Multilateral development authority
National bank
Loans
Bonds
Public
Capital
Investors
Financing
Low and zero emission buses
Funding
Legal arrangements
Revenues
User value
Preferential pricing
Fare box revenue
Vat reductions
Preferential electricity price
Import duty reduction
Corporate tax breaks
Incentives
Monetary grants
Public grants
R&D grants
OPEX grants
CAPEX grants
Other budgets
Taxation & fees
Intergovernmental transfers
Environmental tax
Payroll tax
Sales tax
National budget
City budget
Public transport budget
Policy framework
Ownership structures
Contracts
Transportation plan
City climate action plan
Urban development plan
Special district purposes
Preferential public procurement
Transport master plan
Sustainable urban mobility plan
Targeted schemes & plans
Enabling acts/legislations
Public entities (1)
Private entities (2)
Sale of goods & services contracts
Other contracts
Rentals and leases
Public procurement contract
Concession
Lease-back agreement
Lease-purchase contract
Advertising contract (lease of public space)
Bus lease
Battery lease
(1) Local government
Transit agency
(2) Private operator
Non-profit organization

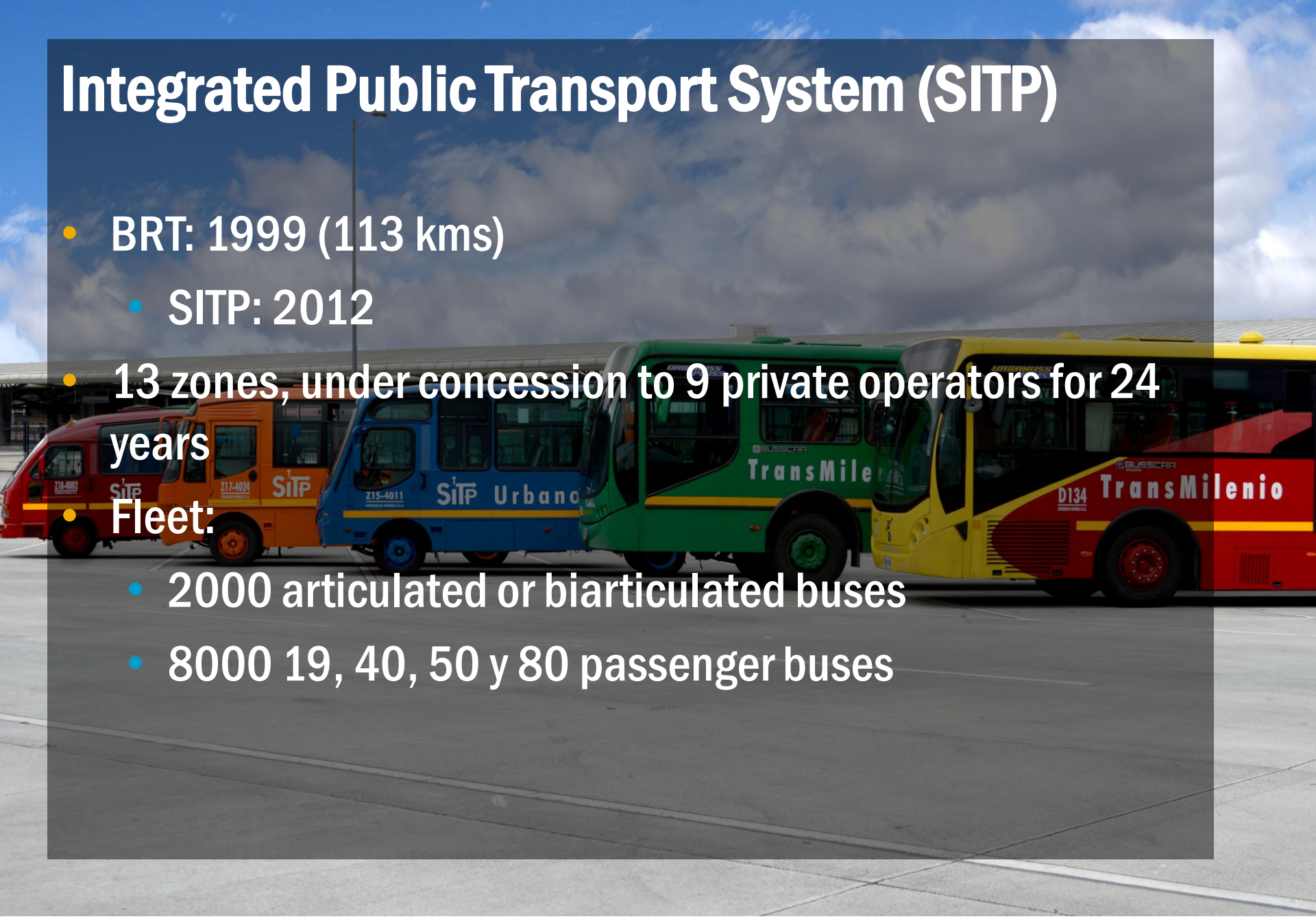
Bogotá case study

BOGOTÁ

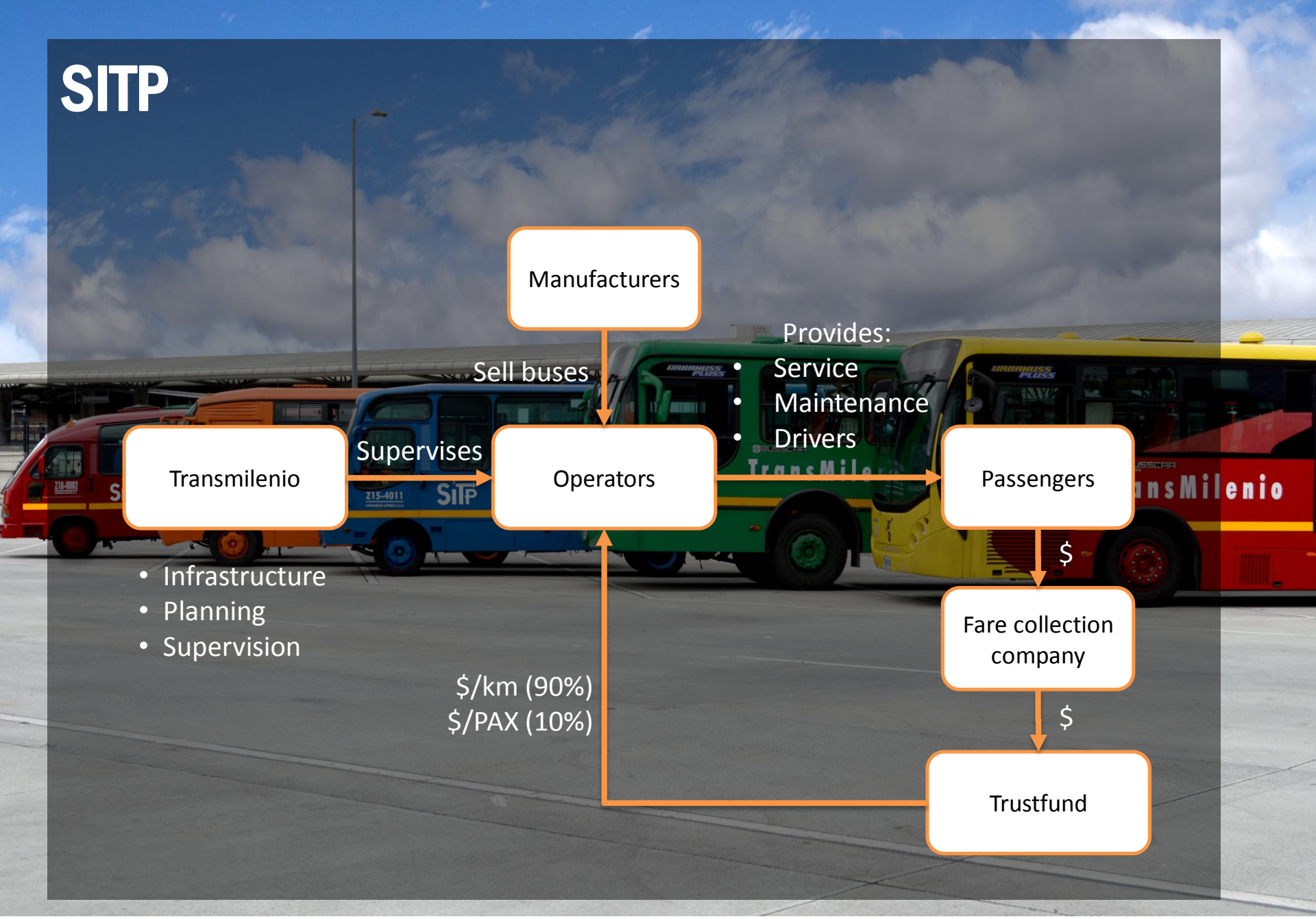

SITP
SITP
SITP Urbano
TransMile
TransMilenio
D134

Integrated Public Transport System (SITP)

- BRT: 1999 (113 kms)
  - SITP: 2012
- 13 zones, under concession to 9 private operators for 24 years
- Fleet:
  - 2000 articulated or biarticulated buses
  - 8000 19, 40, 50 y 80 passenger buses

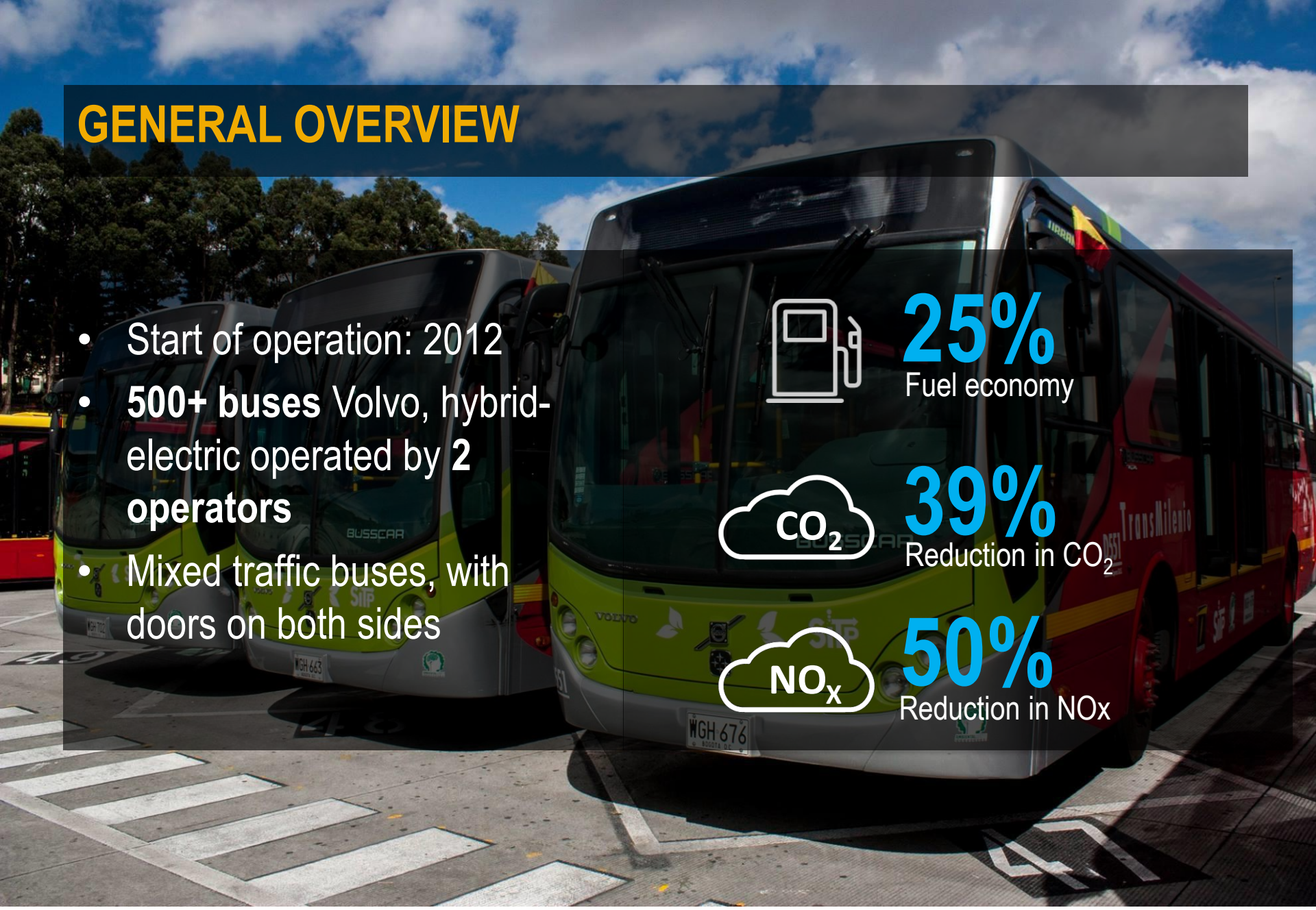


SITP


Manufacturers
Sell buses
Provides:
• Service
• Maintenance
• Drivers
Transmilenio
Supervises
Operators
Passengers
$
Fare collection company
$
Trustfund
$/km (90%)
$/PAX (10%)
• Infrastructure
• Planning
• Supervision

HYBRID BUSES IN BOGOTÁ

GENERAL OVERVIEW



- Start of operation: 2012
- **500+ buses** Volvo, hybrid-electric operated by **2 operators**
- Mixed traffic buses, with doors on both sides

25%
Fuel economy

39%
Reduction in CO_2

50%
Reduction in NOx

Investment components

Tangible assets

- Hybrid buses with regenerative braking
- Batteries

Intangible assets

- User perception of Bogotá as a “low carbon city”

Processes

- Planning by Transmilenio with operators
- Training by Volvo
- Maintenance with Volvo

Funding sources

Investment proceeds

- User fare

Incentives

Fiscal incentives

- No VAT – 16%
- Corporate tax reduction up to 100% of cost of bus
- Import duties reduced from 38% to 5%

Other budgets

- Advertising on buses proceeds go directly to the operator

Financial products

Equity

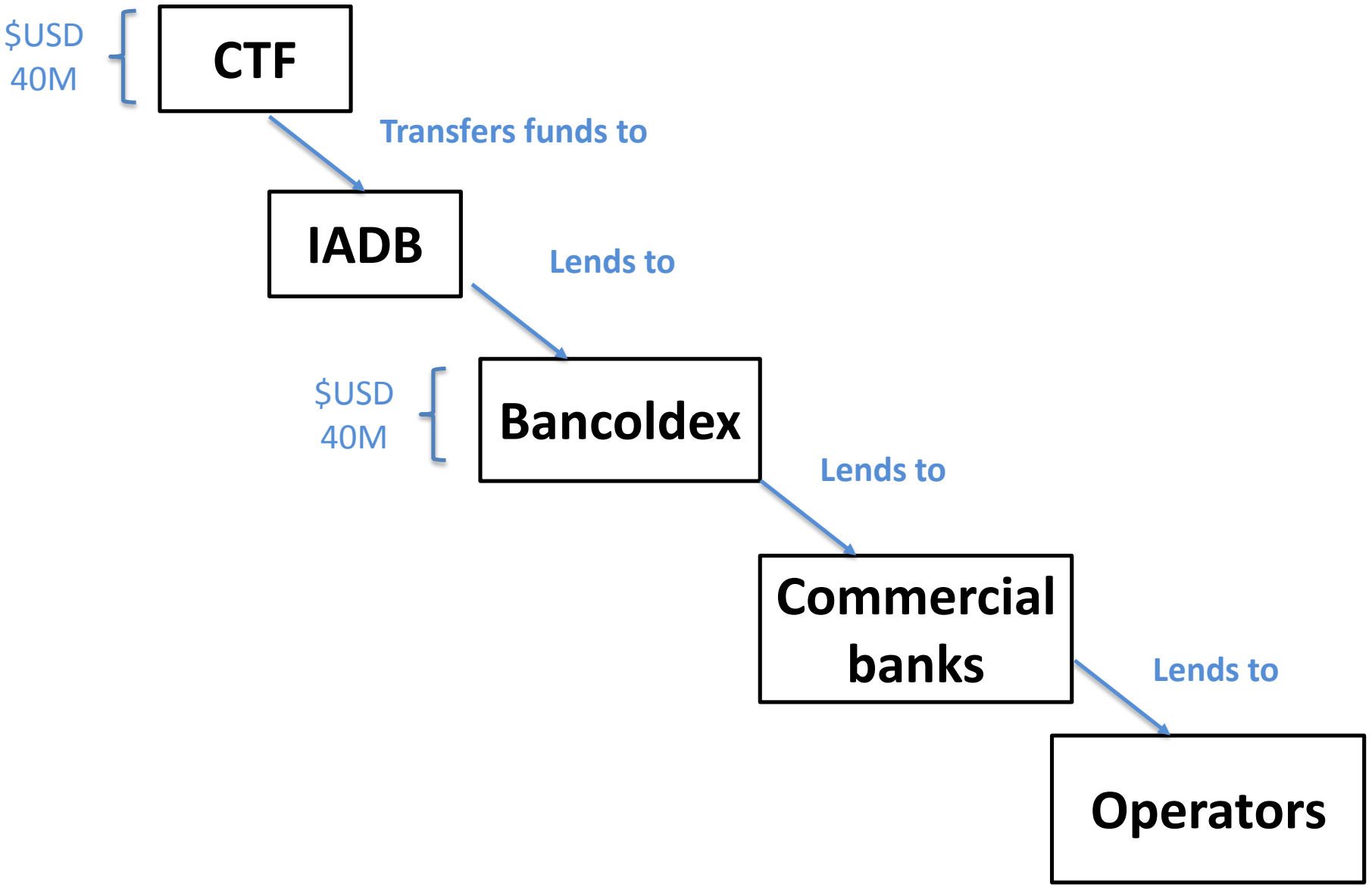
- Private investors

Debt

- Clean Technology Fund
- Bancoldex (Colombian development bank)
- Commercial banks

De-risking

- Contingency fund


$USD
40M
CTF
Transfers funds to
IADB
Lends to
$USD
40M
Bancoldex
Lends to
Commercial
banks
Lends to
Operators

Delivery mechanisms

Institutional frameworks

- Technolgy improvement plan (Plan de ascenso technológico)

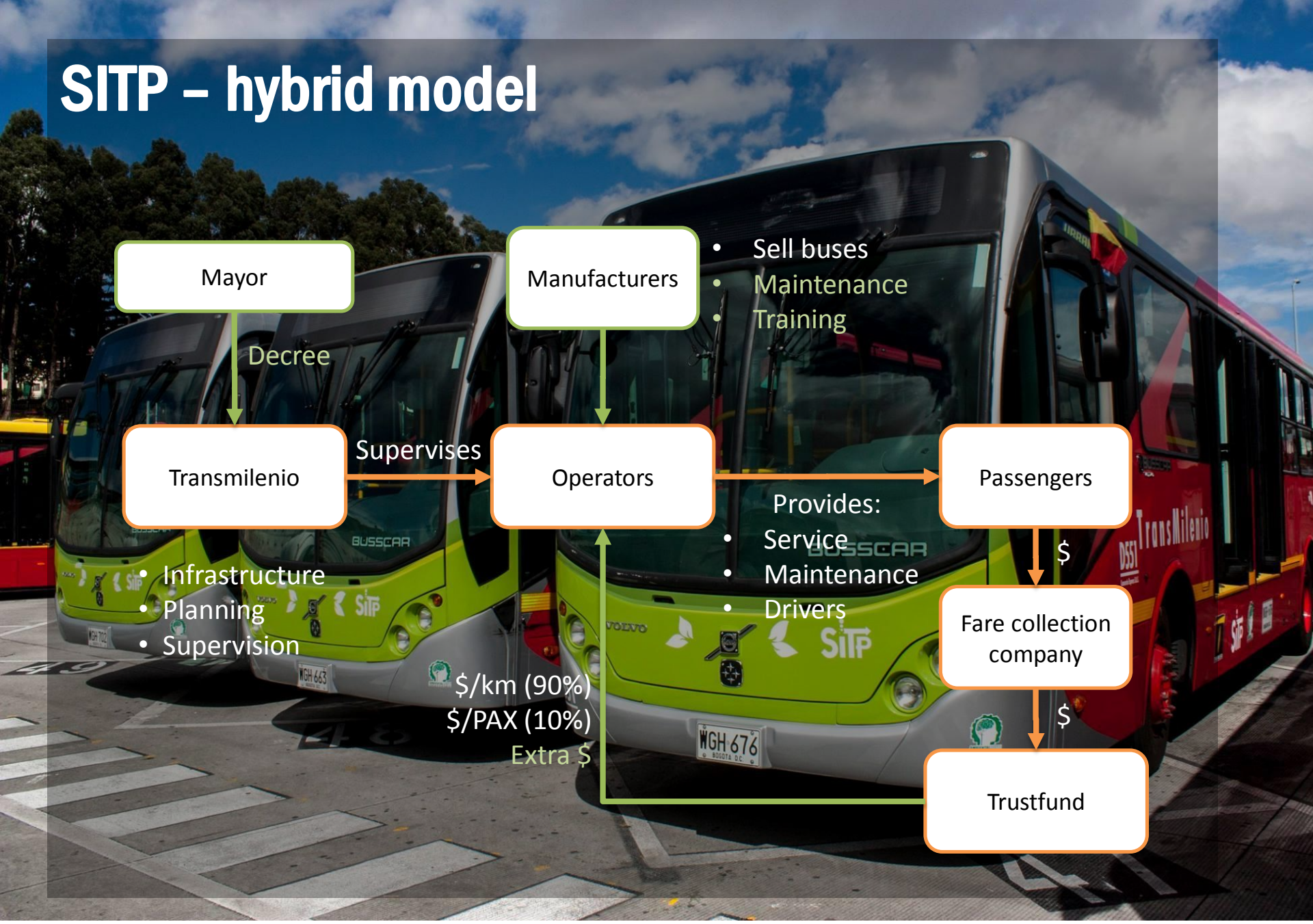
Legal entities

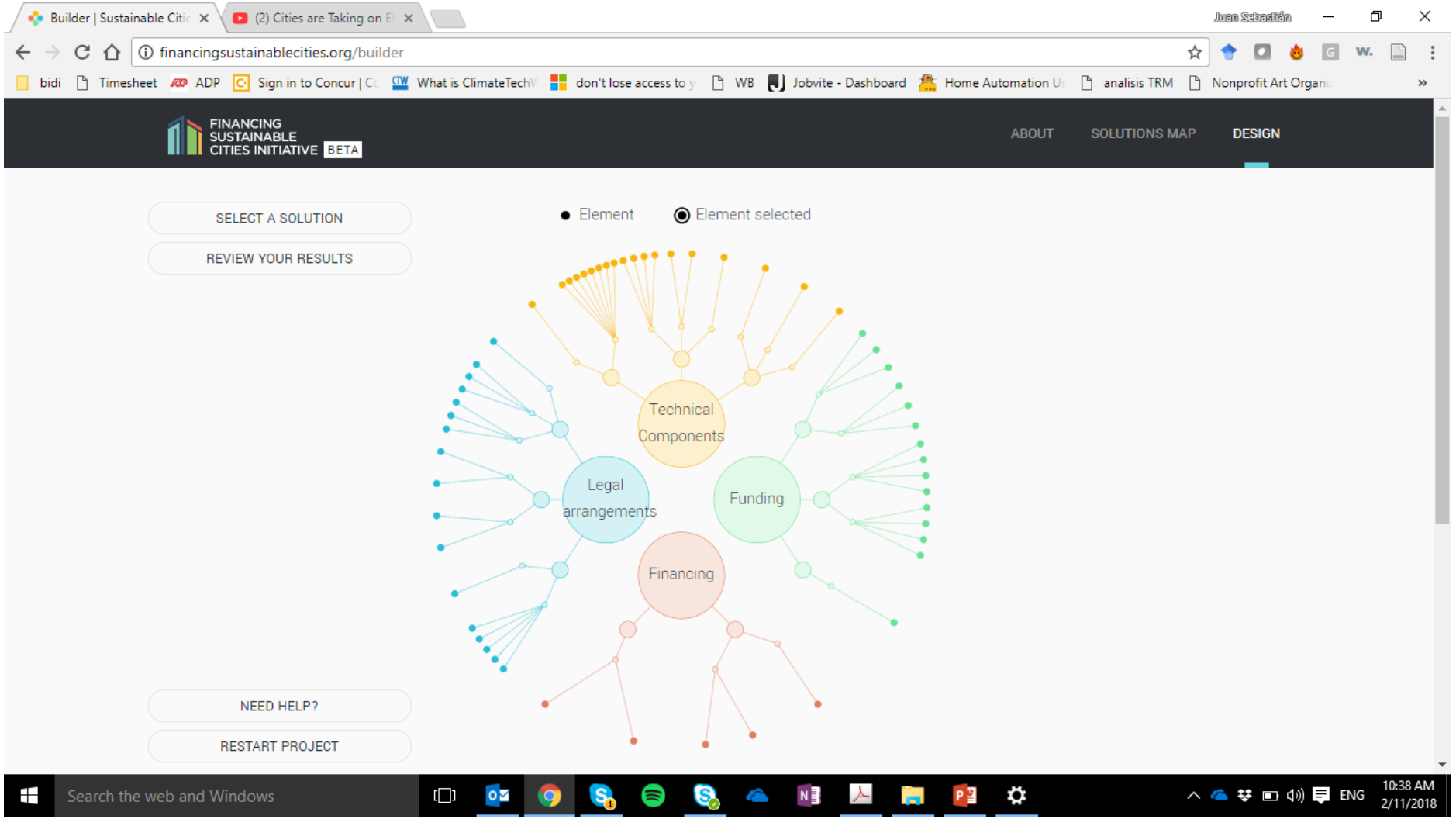
- Mixed
  - Concession involving private operators

Contracts

- Purchase + maintenance + training contract between operators and Volvo
  - Vehicle purchase + 5-year maintenance contract + training
- Battery leasing:
  - Separate from purchase, at U$D 0,15/km

SITP – hybrid model




Builder | Sustainable Citie
(2) Cities are Taking on El
Juan Sebastián
financingsustainablecities.org/builder
bidi
Timesheet
ADP
Sign in to Concur | Co
What is ClimateTechV
don't lose access to y
WB
Jobvite - Dashboard
Home Automation Us
analisis TRM
Nonprofit Art Organi
FINANCING SUSTAINABLE CITIES INITIATIVE BETA
ABOUT
SOLUTIONS MAP
DESIGN
SELECT A SOLUTION
REVIEW YOUR RESULTS
Element
Element selected
Technical Components
Legal arrangements
Funding
Financing
NEED HELP?
RESTART PROJECT
Search the web and Windows
ENG
10:38 AM
2/11/2018

WORLD RESOURCES INSTITUTE | WRI ROSS CENTER FOR SUSTAINABLE CITIES

Emerging trends and innovations in business models for electric bus adoption

The GPSC Resource Team

WEBINAR SERIES ON: Sustainable and Integrated Urban Development

December 2018

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THANK YOU FOR PARTICIPATING!

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