Presents:
The GPSC Resource Team WEBINAR SERIES

with the support of:
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.
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
WITH MOST GROWTH HAPPENING IN DEVELOPING ECONOMIES
At the same time, mobility is changing
Mobility is changing

...drivers will no longer be needed
Mobility is changing

...we will no longer own cars
Mobility is changing

...automobiles will no longer pollute
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

- Climate
- Energy
- Food
- Forests
- Water
- Cities & Transport

- Governance
- Finance
- Business
- Economics
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

[Right] IEA, authors with data from “CO₂ 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.

- 23% of CO₂
- 55% of PM₁₀
- 40% of NOₓ  
  (Bogotá in 2006)

5% of the fleet
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.

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

ELECTRIC VEHICLE BATTERY PRICES ARE FALLING FAST

2010 → 40% → 2014 → 30% → 2017

- $227/kWh (Tesla’s Giga factory)
- $150/kWh

1. Nykvist and Nilsson “Rapidly falling costs of battery packs for electric vehicles”, 2015,
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 20, 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

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 BUSES 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
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
- Fear of change and lack of knowledge
- Technology readiness (e.g. range)
- 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
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
August 2018

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

<table>
<thead>
<tr>
<th>Technology mix</th>
<th>Americas</th>
<th>Asia/Pacific</th>
<th>Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery electric</td>
<td>6</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Opportunity charging</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hybrid-electric</td>
<td>1</td>
<td></td>
<td>41%</td>
</tr>
</tbody>
</table>

Bus Type & Charging System
- Battery Electric Bus
- Hybrid Electric Bus
- Opportunity Charging Bus

Source: World Resources Institute
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

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

The sources of funding available to pay for these investments
AND WE BUILT A FRAMEWORK TO ANALYSE OUR FINDINGS

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

Investment components

Funding sources

Financial products

Delivery mechanisms

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?

Investment components

Funding sources

Financial products

Delivery mechanisms
Largest fleet in the world: 14,500 electric buses
LONDON, WATERLOO GARAGE

Charging stations
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 (Singapour)
HOW ARE CITIES PAYING FOR THESE INVESTMENTS?

Investment components

Financial products

Funding sources

Delivery mechanisms

WORLD RESOURCES INSTITUTE
KING COUNTY, SEATTLE

Operational savings
4% maintenance
27% fuel
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
- **Incentives**: Subsidies (NAMA Sri Lanka)
- **Other budgets**: Intergovernmental transfers (Korea)
- **Proceeds**: Land value capture in depots and stations (Singapour)
- **Incentives**: Fiscal (Bogotá)
- **Other budgets**: Dedicated taxes (Paris)
- **Proceeds**: Advertising in stations and infrastructure
- **Incentives**: Preferential pricing (e.g. electricity tariffs) (China, Foothill, Colombo)
- **Other budgets**: Sale of assets and scrapping (Brazil)

**SOURCES**

- **Operational savings** (London)
WHAT FINANCIAL PRODUCTS HAVE CITIES BEEN LEVERAGING?
BOGOTÁ, COLOMBIA

Private investors own more than half the hybrid bus fleet
Green bonds that can be used for public transport financing
The Clean Technology Fund gave a $40M loan to purchase hybrid buses.
BNDES gives concessional loans to buses produced in Brazil
HOW ARE RISKS ALLOCATED BETWEEN THE DIFFERENT STAKEHOLDERS
Bus companies and third parties purchase buses and lease them to operators
PARIS, FRANCE

Bus2025:
20% of the fleet completely electric by 2025
Bogotá case study
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
Transmilenio
• Infrastructure
• Planning
• Supervision

Operators

Manufacturers
Sell buses

Supervises

Provides:
• Service
• Maintenance
• Drivers

Passengers

Fare collection company

$/km (90%)
$/PAX (10%)

Trustfund

Supervises

SITP

SITP

Operators

Manufacturers

Passengers

Trustfund

Manufacturers

Supervises

Operators

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SITP
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 CO₂
- **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
CTF transfers $USD 40M to IADB.

IADB lends to Bancoldex.

Bancoldex lends to commercial banks.

Commercial banks lend to operators.
Delivery mechanisms

Institutional frameworks

- Technology improvement plan (Plan de ascenso tecnológico)

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

- **Mayor**
  - Decree
  - Transmilenio
    - Supervises
    - Infrastructure
    - Planning
    - Supervision

- **Manufacturers**
  - Sell buses
  - Maintenance
  - Training

- **Operators**
  - Provides:
    - Service
    - Maintenance
    - Drivers
  - Supersedes
  - $/km (90%)
  - $/PAX (10%)
  - Extra $

- **Passengers**
  - Fare collection company
  - Trustfund
  - $
Emerging trends and innovations in business models for electric bus adoption

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December 2018

Sebastián Castellanos
SCastellanos@wri.org
THANK YOU FOR PARTICIPATING!

Questions or comments:

terra.virsilas@wri.org  valeria.hurtado@wri.org