Asia-Pacific
Economic Cooperation

Electric Mobility Strategies for Mexicali, MX and Saint Kitts and Nevis

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Workshop: Deep Transition and Integration of Power and Transport Systems(APEC project EWG 10 2018A)

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Overview of Electric Mobility Strategy

1. Background and Local Context
2. Benefits of EVs
3. Grid Preparation and Management
   a) Spatial grid preparation
   b) Temporal grid preparation
4. Electric Mobility and Mass Transit
5. Utilizing Fleets as Early Adopters
   a) Fleet prioritization
   b) Fleet route analysis
6. Expansion to Individual Driver PEV Market
   a) Charging station location analysis
   b) PEV purchase incentives
   c) Equity issues
7. Capacity Building and Training
8. Conclusions and Next Steps

Background

Mexicali

- City of ~1.1M residents
- Numerous national and subnational goals for GHG reduction, electric mobility, air quality, traffic congestión, energy efficiency, mass transit ridership

Saint Kitts and Nevis (SKN)

- Dual-island nation of 55K citizens
- NDC goal of 35% below BAU by 2030
- Starting point of electric school bus project

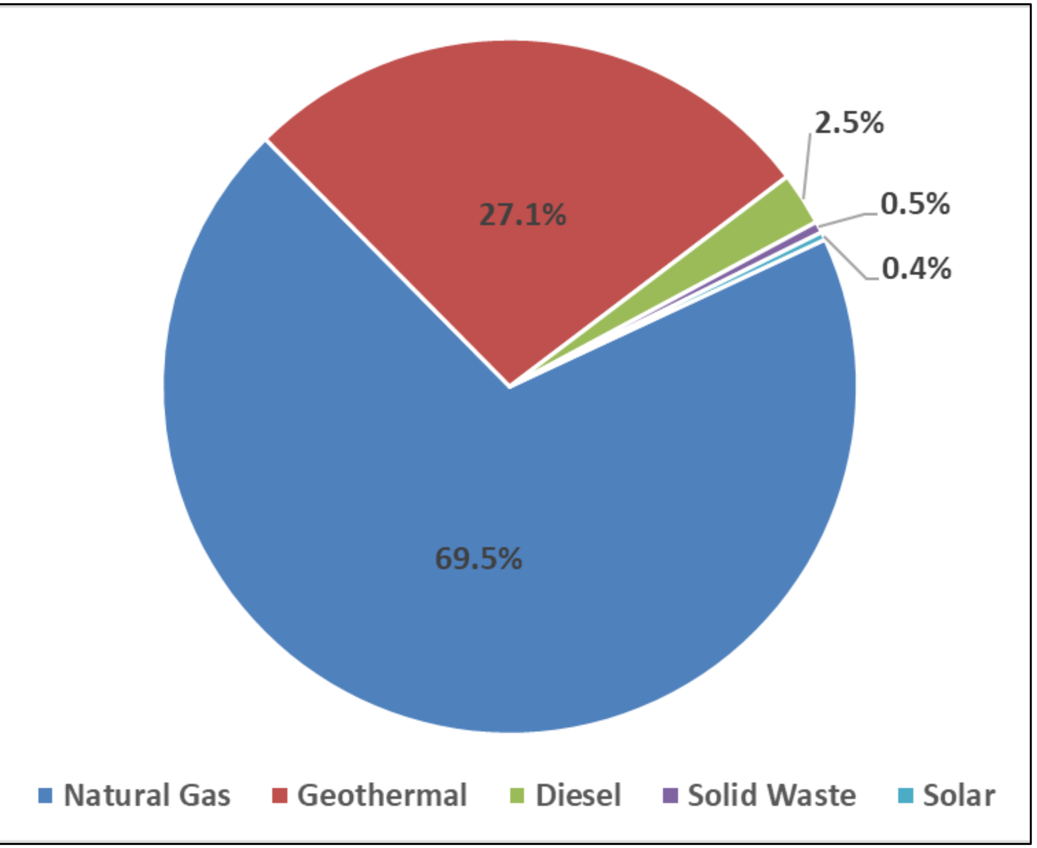
Photo source: Mario Carboni

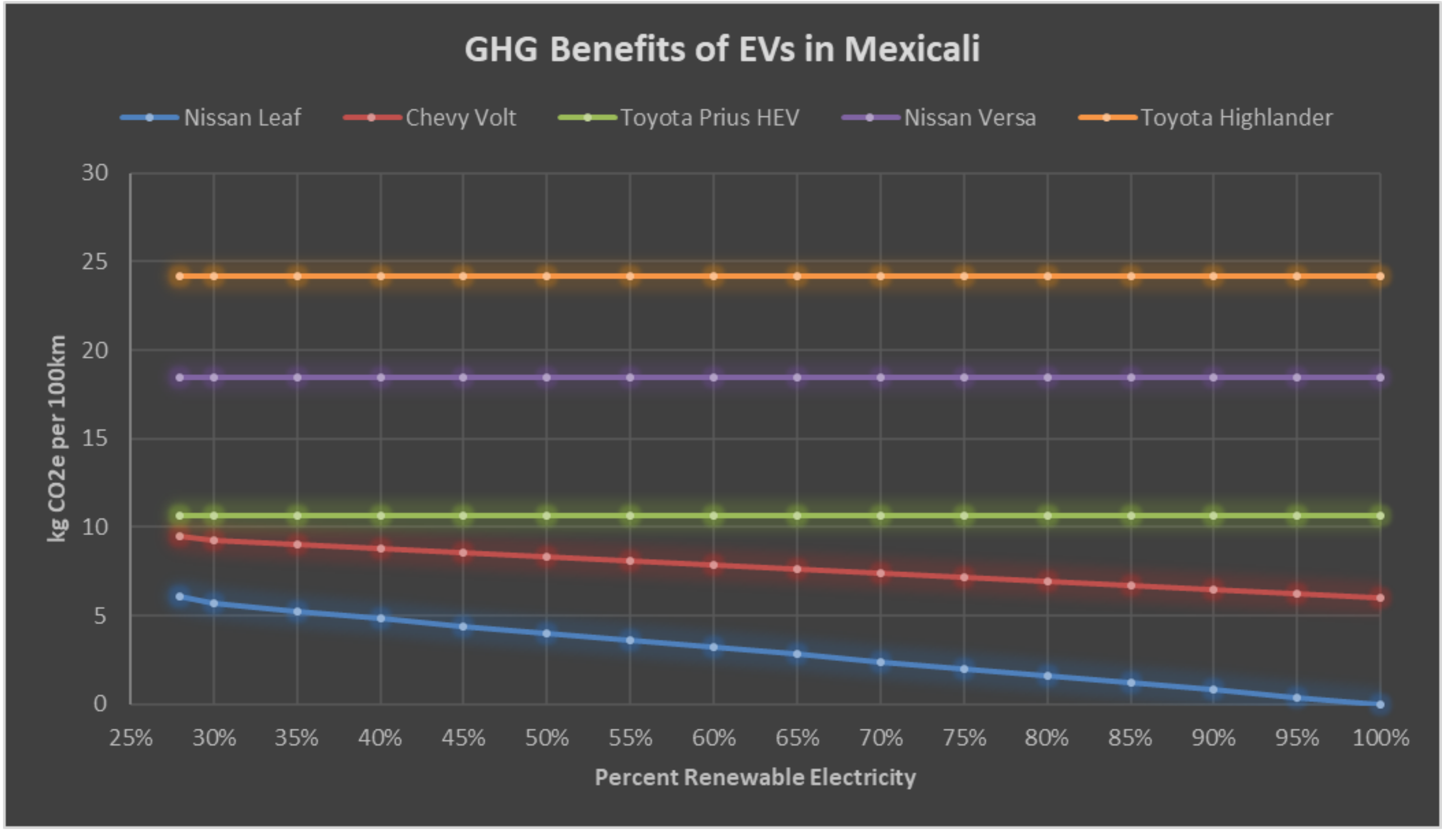

Photo source: Captain Sunshine Tours

Benefits of EVs/Reason for Strategy

- EVs are ~3X more efficient than conventional vehicles
  - Regenerative braking
- EVs emit fewer greenhouse gas emissions
  - Enable renewable energy to power transportation
- EVs remove harmful emissions from population centers
  - Nox, VOCs, PM, SOx
- EVs provide greater low-end torque
  - Improved acceleration from stops, especially on hills
- EVs reduce vehicle noise at speeds under 30 km/h
- EVs can facilitate mass transit and diversify vehicle types

GHG Benefits with Mexicali Grid

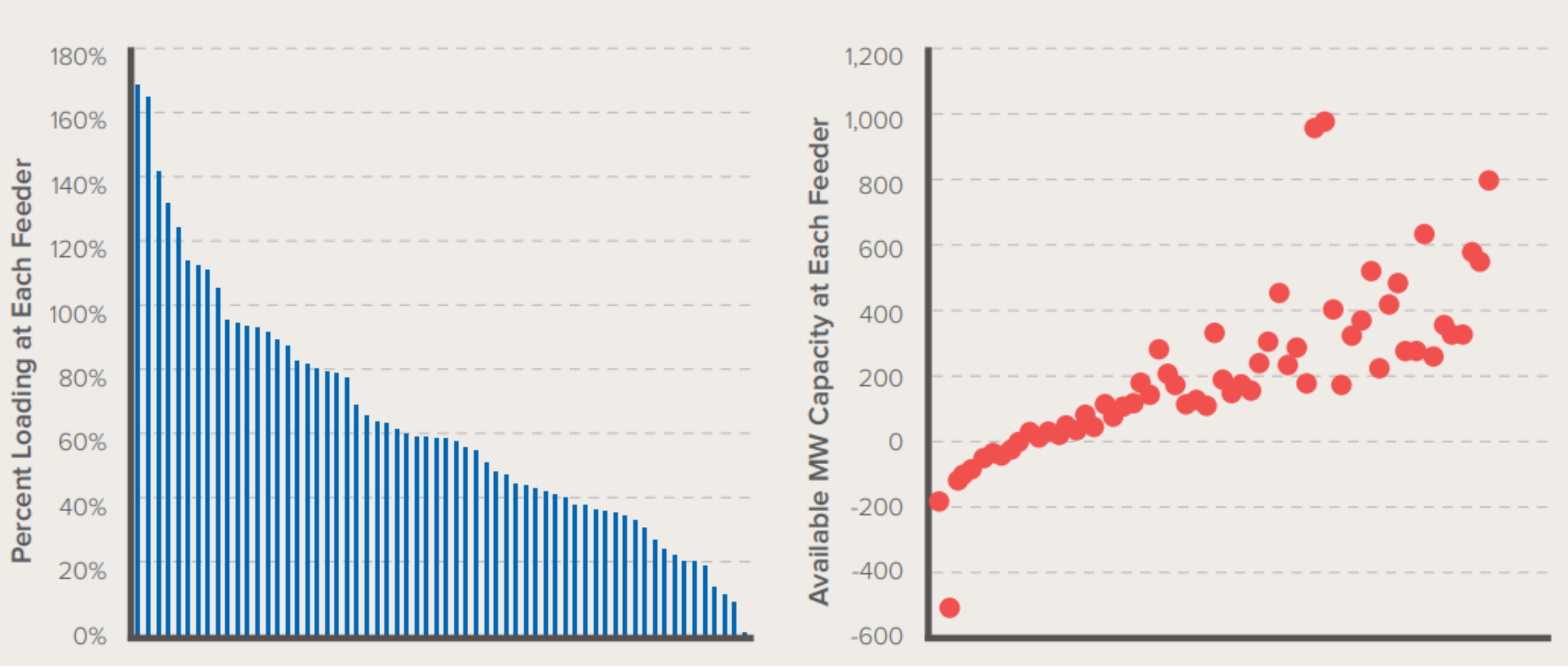




- Starting at 28% renewables
- Faster drop in emissions between 28 and 30% because phasing diesel out first
- National goal of 50% by 2050

Grid Preparation- Spatial

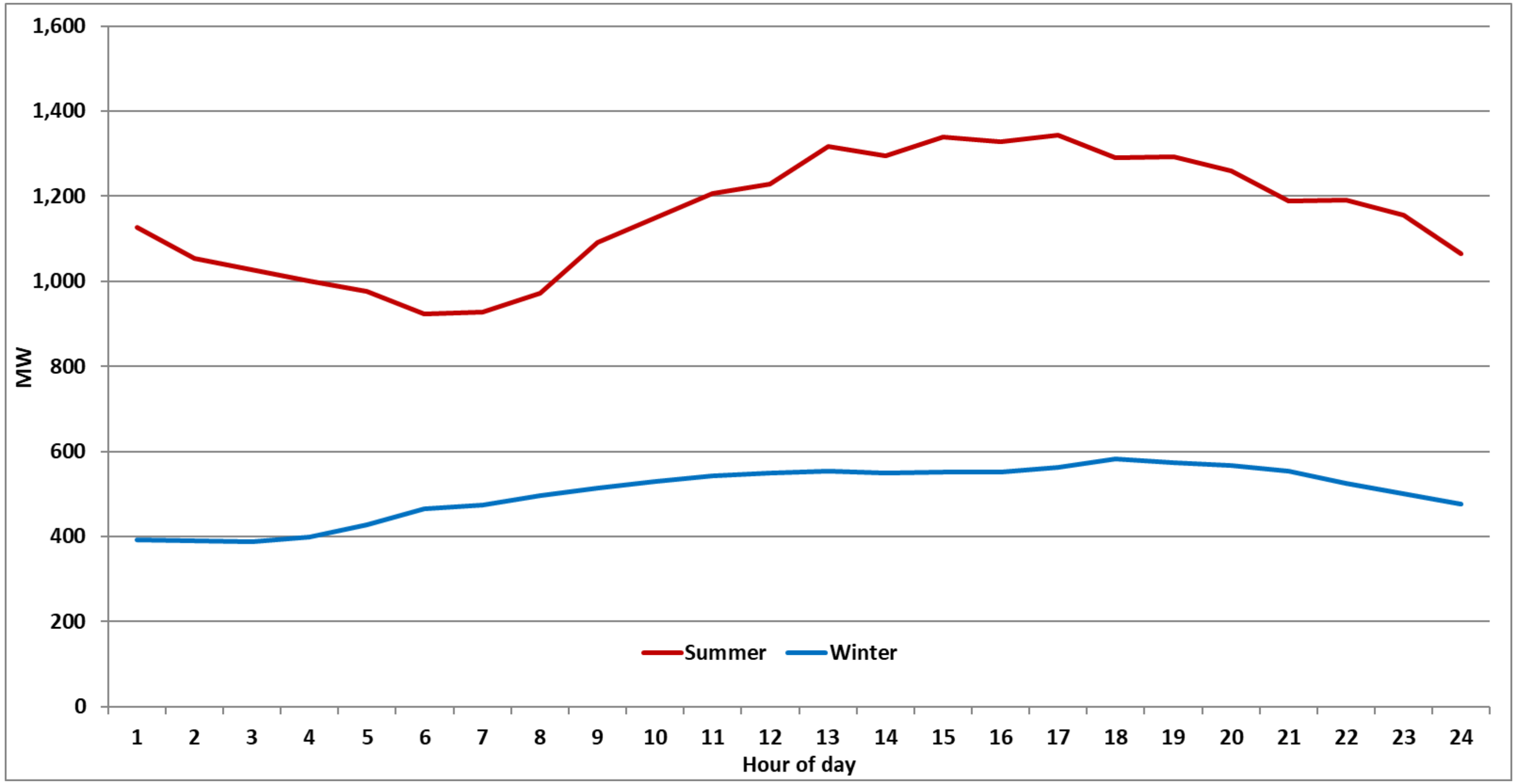
- Overall increase in demand will be manageable for most countries (per ADB meta-analysis)
- Identify feeders that are below capacity and reach out to fleets on those feeders (like done by Seattle in example below)



Percent loading and Available Capacity (MW) at all feeders assigned to certain regions in Seattle. The X-Axis represents unique feeder ID.
(source: SEATTLE CITY LIGHT TRANSPORTATION ELECTRIFICATION STRATEGY)

Grid Preparation- Temporal

Electric Load by Time of Day in Mexicali



- Prioritize fleets that drive less in summer (ie. School buses)
- Prioritize fleets that can avoid charging between 11:00 and 21:00
- Control timing of flexible fleets and individual EVs

Controlling Charge Timing

	PEV Interface	EVSE Network	Facility Energy Management	Price Signals
Administrator	Consumer, fleet manager	Consumer, fleet manager, facility manager, utility	Facility manager	Utility, facility manager
Application	Control individual vehicle	Control individual or multiple vehicles	Control building and vehicles	Influencing charging using electricity price
Benefits	No cost, simple	Programmable for multiple vehicles, simple, flexible	Improved facility load control	Aggregated at utility level, relies on downstream controls
Drawbacks	Does not offer aggregation	No facility integration, not standardized across brands, added cost	Distance of control from users, administrative costs	Potential rebound peaks or complex price signals and automated controls, communication

PEV Charge Timing Control Mechanisms
Source: Hodge 2018

Electrification's relationship with mass transit

- Electric trains and buses
  - Existing trains and buses powered from electric catenary lines
  - Buses are the most developed heavy-duty battery EV market
- Diverse EVs provide many solutions to first/last-kilometer dilemma
  - Electric scooters and skateboards can be carried on mass transit
  - eBikes can be parked at stations more easily than cars
  - Neighborhood electric vehicles (or electric mototaxis or e-rickshaws)
  - Early market for autonomous shuttles

Electric trolley bus in Mexico City.
Source: Quinto Poder

eRickshaw in Manila.
Source: LivingAsean

Lime electric scooters.
Source: Paul Sawers/VentureBeat

Utilizing fleets as early adopters

Vehicle fleet type	Electric vehicle availability	Compatibility of routes and charging needs	High kinetic intensity	Idle reduction opportunity	Valuation of ancillary benefits	Quantity of fuel consumed	Compatibility with grid timing and feeder location*
Transit bus							
School bus							
Airport GSE							
Refuse truck							
Taxi							
Shuttle bus							
Campus/resort							
Delivery truck							
Bucket/utility truck							
Semitrailer	[2020]						

*Column incomplete because further research required

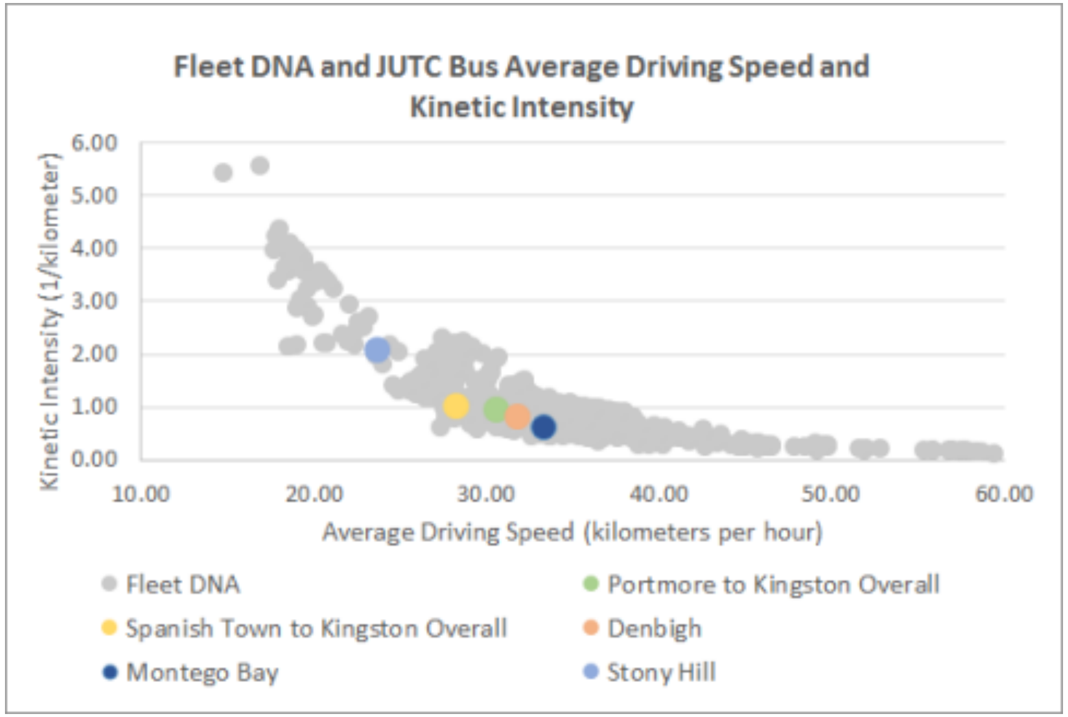
Fleet Route Analyses

To Determine best routes (length and kinetic intensity), vehicle ranges, and charger location

Mexicali Taxis

Real-world travel by EV Taxi

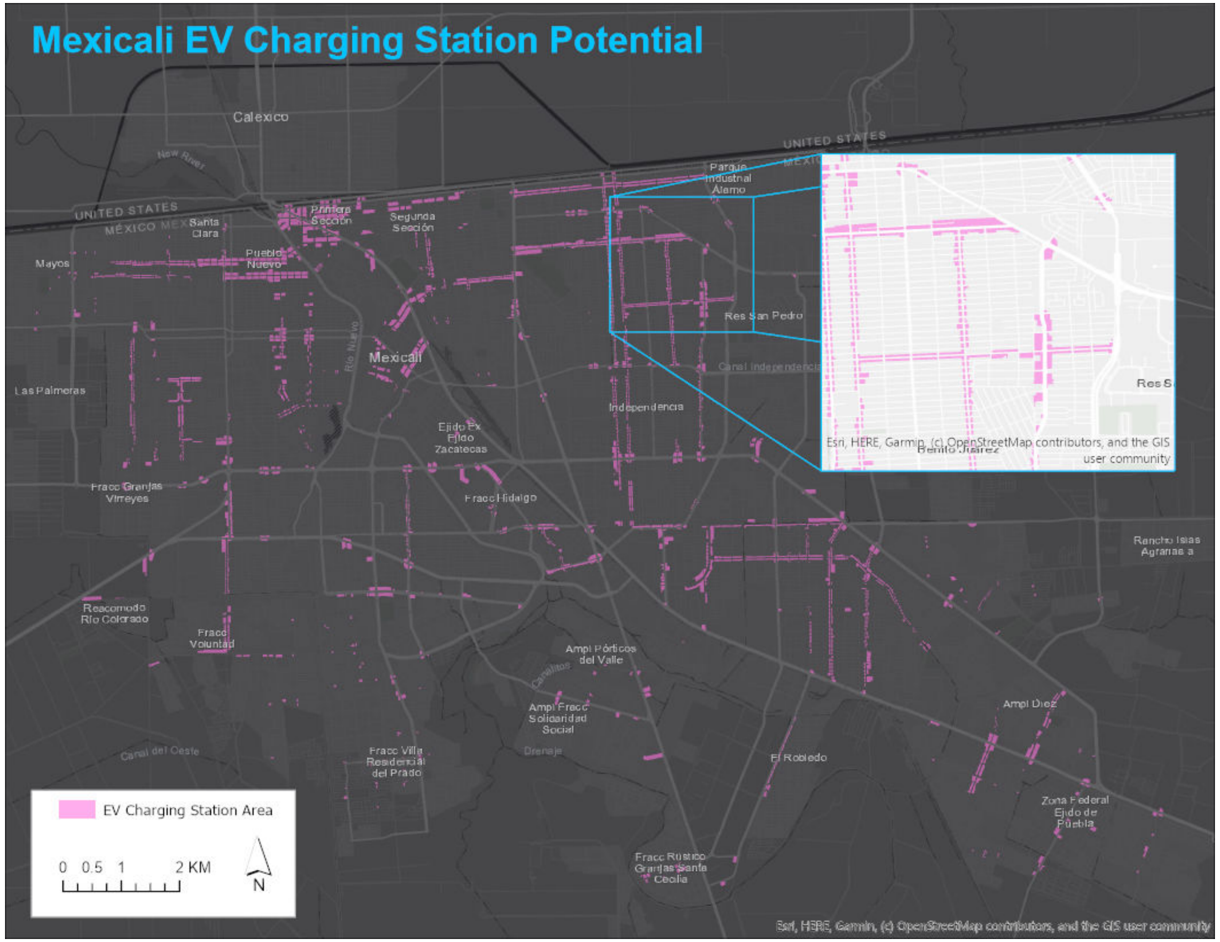
Jamaican Transit buses



Source: Singer and Johnson 2019. Jamaican Urban Transit Company Drive-Cycle Analysis. NREL.

Market expansion from fleets to independent drivers

- Charging Infrastructure
  - Locating chargers
    - Traffic patterns [need data]
    - Land use zones [backup plan]
  - Charger host institutions
    - Economics
    - Policies to incentivize charger installation
  - Charging standards
  - Charging networks and communication
- Equity issues
  - Use PEVs to bolster public transportation
  - HOV lanes with access to PEVs
  - EVSEs in underserved communities



Policies to Incentivize Individual EV Purchasers

State Level Correlation of PEV Market Variables on Per capita PEV Purchases		PEV	PHEV	BEV
Explanatory Variables	Increase/Decrease by	Increases purchases by	Increases purchases by	Increases purchases by
Charging stations per hundred thousand population	1	3.1%	2.6%	7.2%
Tax credit (in dollars)	$1000	2.3%	Not significant	5.3%
Rebate (in dollars)	$1000	4.8%	Not significant	7.7%
Sales tax waiver (in dollars)	$1000	3.6%	Not significant overall; 1.6% for Volt	5.9%
HOV Lane Exemption (Yes or No)	if Yes	8.5%	8.4%	14.5%
Home EVSE credit	If Yes	Not significant	Not significant overall; 26.0% for Volt	Not significant
Home charging discount	If Yes	Not significant	Not significant	Not significant
Gasoline price	1%	0.6%	0.5%	0.8%
Environmental awareness (based on LCV house scores)	1-point increase	Not significant	Not significant overall; 0.1% for Volt and 0.2% for Prius	Not significant overall; 0.1% for Tesla Model S
Median Household Income	1%	0.3%	0.4%	0.5%
Unemployment rate	1%	Not significant	Not significant	Not significant
Vehicle miles traveled per capita	1%	Not significant	Not significant	Not significant

Statistical significance
***p<0.01; **p<0.05; *p<0.1

Source: Narassimhan and Johnson 2018. The role of demand-side incentives and charging infrastructure on plug-in electric vehicle adoption: analysis of US States

Capacity Building/ Training

EV Technicians

Tesla's START program

College program could be modeled after the 45 local programs in US (https://afdc.energy.gov/vehicles/electric_maintenance.html)

Charger installation electricians

EVSE networks such as ChargePoint have installer certification programs

First responders

Enlist the National Alternative Fuels Training Consortium or the National Fire Protection Association

Follow-on Analyses

- Assessment of the feeders of the Mexicali grid in order to determine what areas can accept additional electric load without costly improvements
- Selection of the most appropriate fleets to electrify to pilot the concept
- Drive cycle analysis of fleet vehicles to help determine the most appropriate PEVs to purchase and the best locations to place EVSEs
- Economic analysis for fleets and EVSE hosts to determine the payback of PEVs
- Conduct a household mobility survey that helps determine which electrified mobility options would be most effective in encouraging the citizens of Mexicali to ride mass transit, e-bikes, e-scooters, and carpool
- Find and incorporate geographical data such as parking availability, potential EVSE host companies, garages, and demographic information into the EVSE planning maps
- Promote the design of incentives and in general public policies to accelerate the adoption of electric technologies into the city mobility system, enhancing the creation of alliances with stakeholders
- Case study of Mexicali can be replicated in other cities of the region, including the State, to increase the PEV benefits

Questions?

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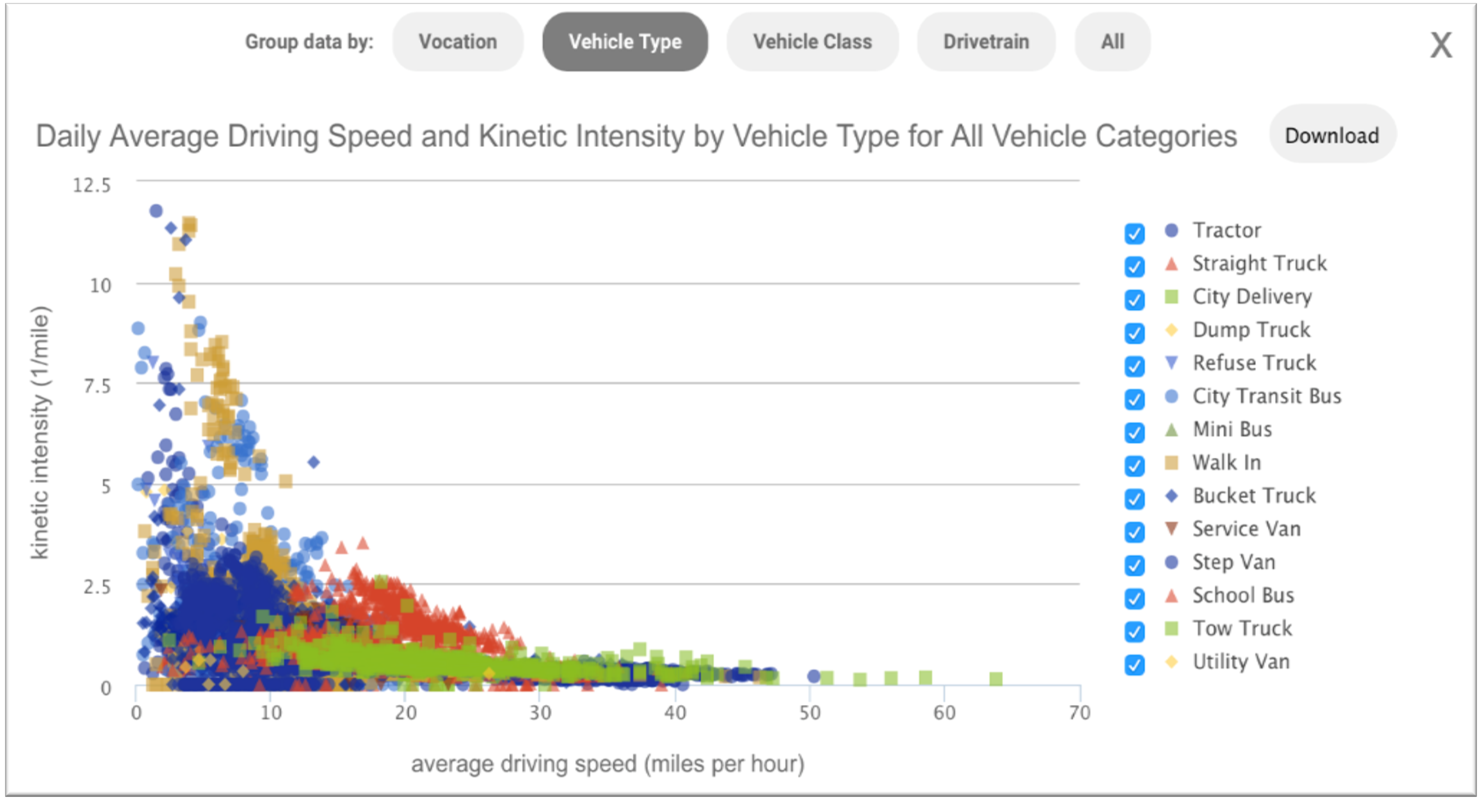
Mexicali Taxi Fleet—Problem Solving

- How to improve range in hot conditions?
  - Use EVs in routes with higher speeds and less idle
  - Target downtime in the shade (such as lines to pick up passengers)
  - Add window film for solar control
  - Charge in lower temperatures (in a garage)
  - Switch to EVs with liquid-cooled batteries
  - Switch to EVs with smaller cabin size
  - Switch to EVs with larger batteries
- How to improve driver acceptance and satisfaction?
  - Find drivers with EV-compatible routes
  - Give home chargers to key drivers
  - Price EV leases to reflect their lower maintenance costs
  - Add fast chargers at strategic locations
  - Purchase EVs with higher range
  - Compensate drivers for downtime
- What are the best EVs to purchase in the future?
  - Match range with routes

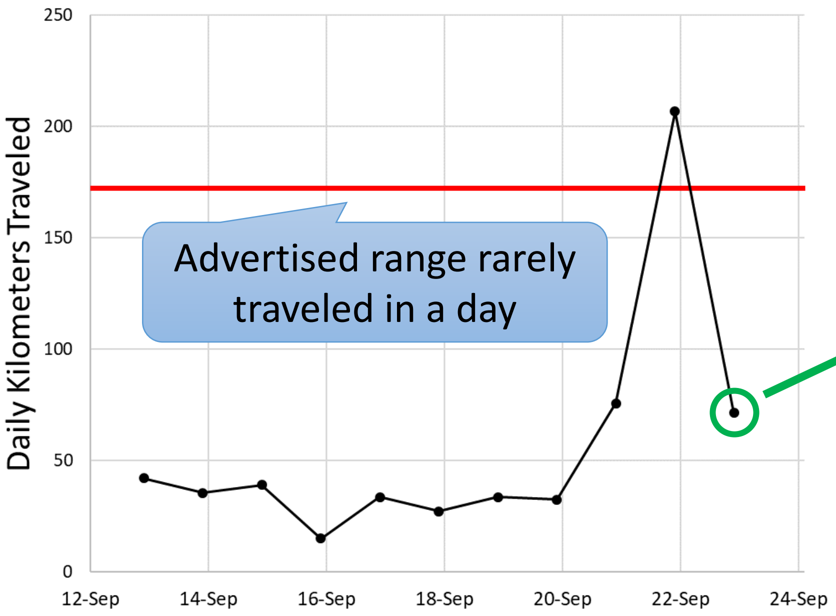
Fleet DNA's Kinetic Intensity



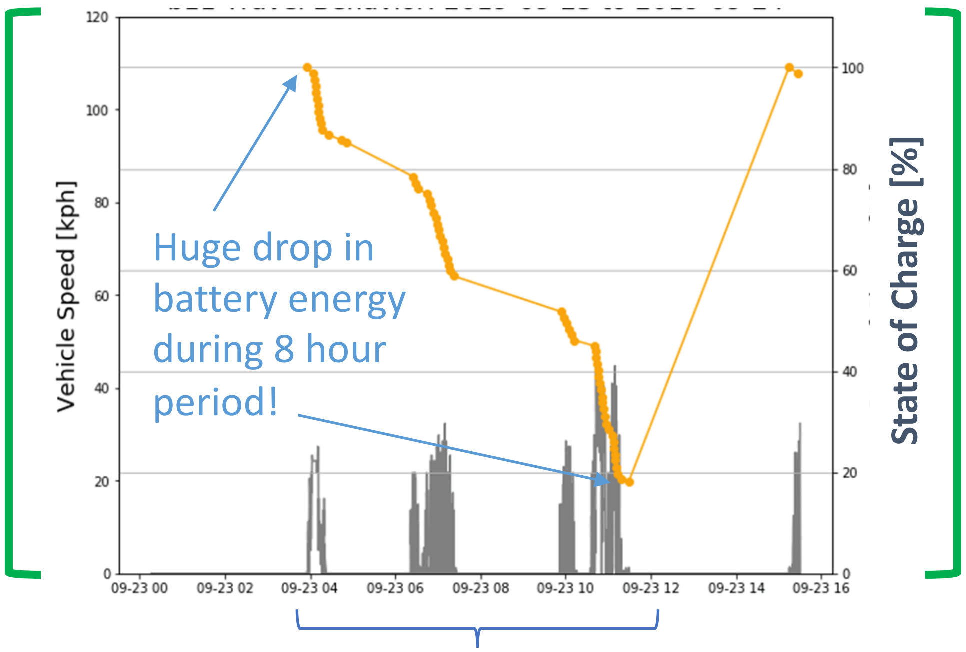
- Kinetic Intensity (KI) is the amount that a vehicle starts and stops per km
- Greater KI drive cycles hold greater potential fuel savings for Evs
- EVs are more efficient at accelerating
- EVs have regenerative braking

Mexicali Taxi Electrificiation, cont.

- **Data analysis shows significantly reduced range in Mexicali compared to manufacturer-cited range** (likely due to hot climate)
- Fleet considering replacing Nissan Leafs with Chevy Bolts
- Opportunity to use real-world data to confirm adequate performance



Vehicle Data, September 23



Only 50km traveled during this time…