CanInfra Challenge
and Canadian Transformational Infrastructure Summit

TAKING THE HIGH ROAD

Reimagining Canada's Highways

Team Name // Limitless
Applicant Representative // Jing Guo
Sunday, April 15th 2018

10% CANADA IS LAGGING BEHIND IN ITS GREEN AGENDA

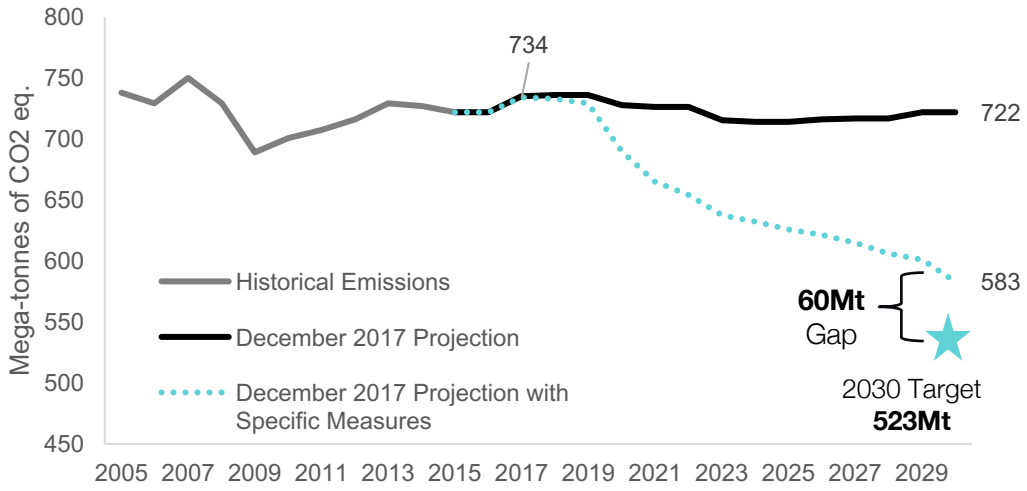
Why are Canadians slow to adopt electric vehicles (EVs)?

Canada is committed to reducing its greenhouse gas (GHG) emissions

- **40%** reduction **by 2030** (from 2005 levels), to 523 Mega-Tonnes of CO2.
- With accelerated reduction in future years (80% reduction by 2050)

Gasoline transportation "drives" GHG emissions

- The transportation sector accounts for **24% of Canadian GHG emissions**.
- **85%** of these emissions are attributed to **cars and trucks**.



ALL gasoline powered **vehicles have an EV alternative** today.

Global EV adoption is on the rise

- 63% YOY growth in sales 2016-2017.

But, EV adoption in Canada is still very low

- EV sales accounted for **less then 1%** of total vehicle sales in 2017.

Canada is not on track to achieve its EV adoption target of 30% by 2030

- At the current rate only a 6% share of all vehicles sold can be achieved by 2030.
- Canada faces unique barriers to greater EV adoption.

Range anxiety

- On average, Canadians drive 294km per week.
- **44% of Canadians** cite range anxiety as the **biggest barrier to adoption**

Low battery life during winter

- Up to **40% of charge is lost** in sub-zero temperatures
- An **additional 25% is lost** if the car's heater is used

High EV price

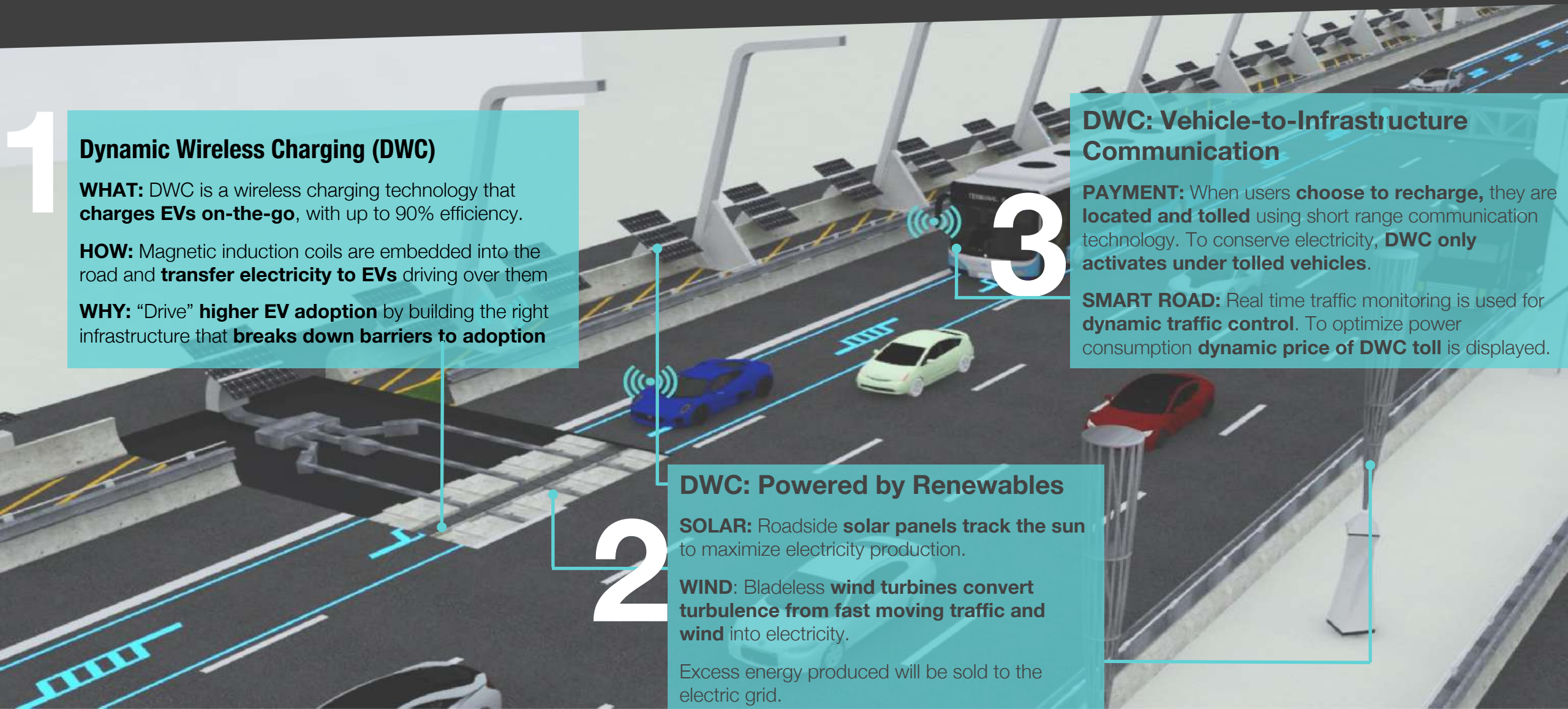
- Ontario, Quebec, and British Columbia subsidize up to $14K dollars of EV costs.
- Despite subsidies, **32% of Canadians** still **cite cost as a barrier**.

Inconvenient public charging options

- Canada only has **138 "fast" charging stations**
- Fast charging: up to 1 hour
- regular charging: up to 4 hours

INTRODUCING DYNAMIC WIRELESS CHARGING (DWC)

Paving the way towards a greener transportation solution for Canada



1

Dynamic Wireless Charging (DWC)

WHAT: DWC is a wireless charging technology that **charges EVs on-the-go**, with up to 90% efficiency.

HOW: Magnetic induction coils are embedded into the road and **transfer electricity to EVs** driving over them

WHY: "Drive" **higher EV adoption** by building the right infrastructure that **breaks down barriers to adoption**

2

DWC: Powered by Renewables

SOLAR: Roadside **solar panels track the sun** to maximize electricity production.

WIND: Bladeless **wind turbines convert turbulence from fast moving traffic and wind** into electricity.

Excess energy produced will be sold to the electric grid.

3

DWC: Vehicle-to-Infrastructure Communication

PAYMENT: When users **choose to recharge,** they are **located and tolled** using short range communication technology. To conserve electricity, **DWC only activates under tolled vehicles**.

SMART ROAD: Real time traffic monitoring is used for **dynamic traffic control**. To optimize power consumption **dynamic price of DWC toll** is displayed.

30%

UNDERSTANDING HOW DWC WORKS

Proven technology ready for implementation in Canada

A simple two-part system

- **Primary coils are embedded in the road** and transfer electricity to the **secondary coils in the EV** (uptake mechanism).
- **All parts are modular** – installation and maintenance is piecewise.

Better than "fast" charge plug in solutions

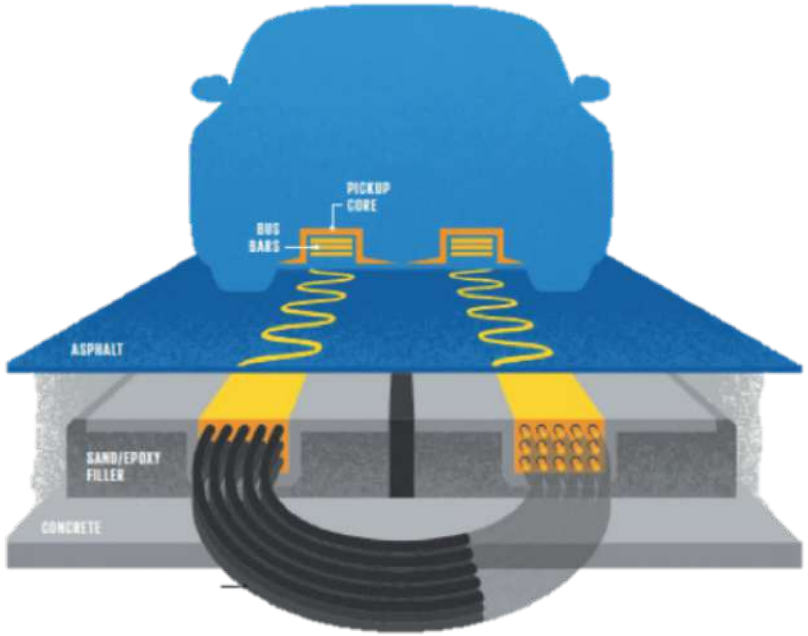
- Transfers electricity with **up to 90% efficiency** – takes 20 minutes to charge 80% of a 30KWh battery.
- Primary coils with capacity of **up to 200 KW** are currently available
- The system is **underground so it is protected** from physical damage, theft, precipitation, and salt.

Manufacturing of parts is standardized

One system fits all - **DWC is cross-compatible** across a variety of vehicles including trucks and buses

Wireless charging standards for primary coils exist:

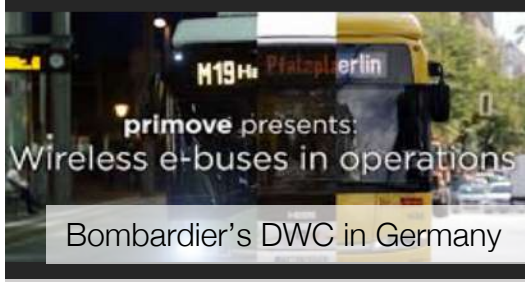
- In use in home wireless charging stations. Secondary coil mechanism are standardized:
- Older EVs can be **retrofitted for as low as $600**.
- Most newly produced EVs are equipped for DWC use.



Dynamic Wireless Charging System

OLEV's DWC in South Korea

Qualcomm's DWC in France



Bombardier's DWC in Germany

DWC in Canada – Coming in 2020

DWC BREAKS DOWN ADOPTION BARRIERS

A one (non) stop solution for Canadian drivers

No more range anxiety

Suitable for Canadian winters

Makes EVs affordable

Convenient and easy to use

Eliminates range anxiety
- Use of DWC **extends effective EV range**.
- Only 17% of Canada's highways need to have DWC to guarantee unlimited EV range.

Maintains battery charge in winter
- DWC overcomes the shortcoming of battery sensitivity to cold weather though continuous charging.
- **EV range remains high in winter**, without the need for frequent charging stops.

Affordable EV
- With easy access to recharge, EVs require smaller batteries, translating to a **30% reduction in the overall cost** of an EV.
- Increases battery lifetime, thereby reducing replacement and maintenance costs.

Keeps Canadians mobile
- No time wasted waiting for EV recharge.
- No discomfort from handling outdoor recharge station equipment in poor weather.

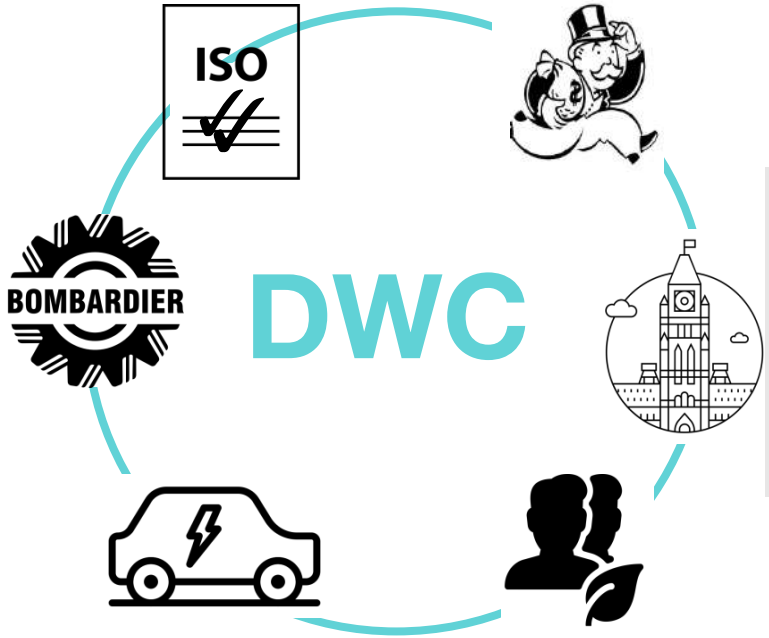
DWC WILL BOOST EV ADOPTION

Dedicated efforts are in-place to provide a new fueling solution for Canadians

Manufacturing standards are in place – standardization of all DWC parts increases efficiency and lowers costs.

EV market growth and confidence motivates investment – over 90 billion dollars has already been committed globally.

DWC manufacturing capacity exists – DWC has been tested, produced, and implemented by several companies, including Bombardier – a Canadian DWC manufacturer



Regulatory support already demonstrated – Canada's government is committed to promoting growth in the EV market through subsidies, investments, and legal support.

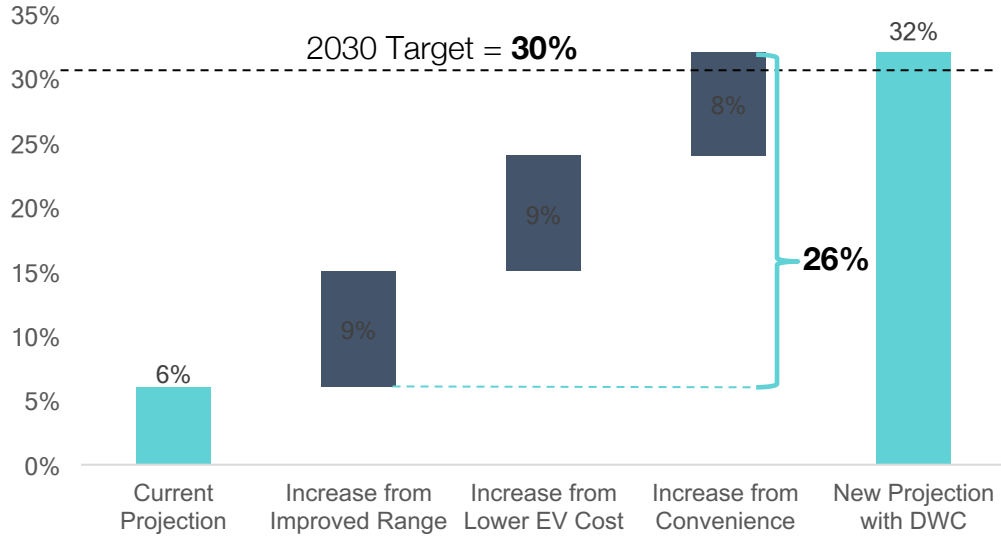
Newly produced EVs are compatible with DWC – global EV manufacturers are rolling out EVs with wireless charging.

Demand for EVs is growing – Canadian consumers are environmentally conscious and know the benefits of saving on gasoline.

DWC is a feasible, convenient, and weather proof solution to range anxiety.

- If DWC is implemented by 2020,
  - **2030 share of EV sales will increase** from 6% to 32% - a 26% percent increase from the status-quo forecast.
  - Canada's EV adoption target will be met!

9% increase from improved range + **9%** increase from lower EV costs + **8%** increase from time savings and convenience = An additional **26%** of all cars sold are EVs by 2030



60% DWC IS AN ALL-ENCOMPASSING SOLUTION FOR CANADA

For Canada's people, economy, and future

DWC deployment → **More EVs on Canada's roads** → **Government's 30% by 2030 goal achieved**

Economical Benefits

Primary benefit

- Aggregate household savings of $6B from replacing gasoline powered vehicles with EVs by 2030:
- Non-consumed gasoline is made available for export.
- Money saved by EV owners increases consumption spending on Canadian goods and services.

Secondary benefits

- In Ontario alone, 154,000 new FTE green collar jobs are created by 2030, given the 30% EV adoption target is met.
- Annual productivity gain from not visiting "fast" charging stations exceeds $966 per EV owner.

Social Benefits

Primary benefit

26 Mt of GHG emissions (in CO_2 equivalents) are eliminated by 2030:

- Cleaner air in dense Canadian cities
- Enables Canada to meet its GHG reduction target, and strengthens Canada's position as a global green energy champion

Secondary benefits

- Smaller batteries reduce overall EV costs, which expands EV adoption to Canadian from all income levels.
- EV usage becomes feasible for rural communities near highways with DWC.

Technological Benefits

Primary benefit

Growth of thought leadership in EV infrastructure design and management:

- Motivates the expansion of Canada's auto industry into the EV market
- Fosters innovation in other types of transport (indoor robots, closed system utility vehicles, electric rail) and lays the foundation for a future transportation model (single person EVs, autonomous road vehicles, outdoor drones).

Secondary benefits

- Increased reliability of EVs during Canadian winters.
- On-site production and consumption of renewable electricity is efficient and encourages the development

By the Year **2030**

$ 6 BILLION SAVED
By not buying non-renewable petrol

154,000 NEW JOBS
Are created in Ontario alone

26Mt OF GHG DISPLACED
In pursuit of Canada's GHG reduction targets

RURAL COMMUNITIES CONNECTED
To Canada's EV infrastructure

TECHNOLOGICAL KNOW-HOW
Fosters innovation in other sectors of the Canadian economy

70% FROM HIGHWAYS, TO URBAN STREETS, TO RURAL COMMUNITIES

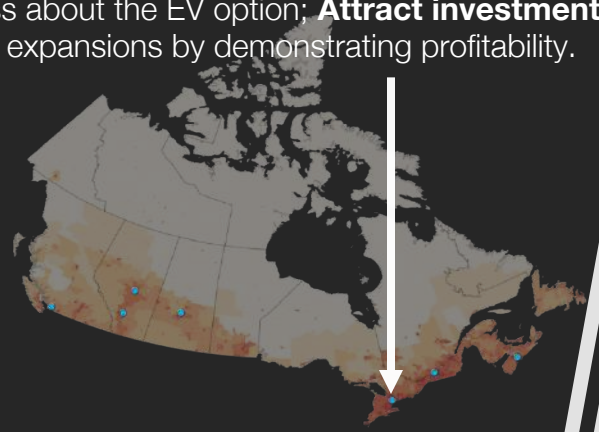
Moving all Canadians toward greener mobility

Goal: Gradually expand DWC coverage across Canada to progressively increase the range of all EVs.
Benefit: DWC scales up – through optimized choice of location, **only 17% of Canada's main roadways need DWC** to provide limitless range to most drivers.
Result: Canadians never have to stop to fuel their vehicle.

PHASE 1

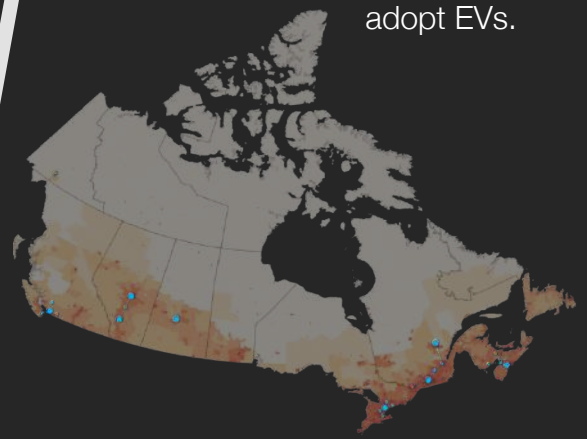
Where: High usage highways around urban centers.
Users: Daily commuters – personal vehicles and express busses.
Outcome: many commuters in Canada's metropoles adopt EVs.

Toronto Pilot Project – 401 HWY
Located on North America's busiest highway - 377,400 Canadians drive on the 25km segment each day.
The pilot will: **Prove the suitability of DWC** for Canadian roads; **Expose a large number of Canadians to DWC** technology and increase awareness about the EV option; **Attract investment for DWC** expansions by demonstrating profitability.



PHASE 2

Where: Busy urban and suburban roads.
Users: Intracity traffic – cars, transit, short range trucks, and urban utility vehicles.
Outcome: limitless range achieved for all intracity transport, including utility vehicles and some trucks. Most metropole residents adopt EVs.



PHASE 3

Where: Primary transportation corridors between high density populations.
Users: Intercity and rural traffic – cars, intercity busses, large trucks, and transports used by rural residents.
Outcome: Limitless range for all intercity transport, including heavy long range vehicles. Rural communities and trucking industry adopt EVs.

80%

GO FORWARD APPROACH

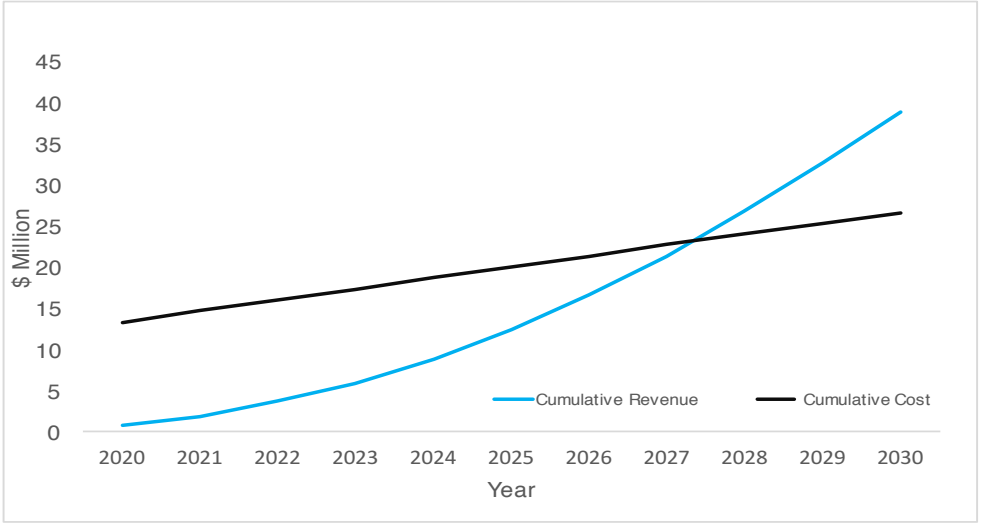
Financing

P3 for DWC

- P3 is an effective method for infrastructure project financing – In Ontario, **96%** of P3 projects stay within budget, and **73%** are completed on time.
- Cooperation between specialized firms, technology innovators, and government is required for success
  - Road construction companies provide unique expertise – Blackbird Infrastructure Group, LINK401, and West Corridor Constructors are preapproved and specialized in 401 construction.
  - DWC manufacturers provide technological know-how – Bombardier and Qualcomm are world leaders in DWC.
  - The Ontario government provides a guarantee –EV owners and investors are assured in engaging with and investing in the new technology.

Financing for DWC

- **$325M** will be allocated by the Ontario government over the next 5 years through the Green Investment Fund to support GHG emissions reduction.
- **$120M** for technology demonstration projects is available through the federal Green Infrastructure Fund.
- **$30M** is made available by Natural Resources Canada for the development of innovative EV charging infrastructure.
- Additional funding can be secured from EV manufacturer and private investors who are interested in increasing EV adoption in Canada.



Piloting DWC on the 401:

- **377,400** daily commuters on 401
- 20% of EV drivers utilize DWC technology at a rate of $0.25 per kWh.
- Recharge of electricity **increases** as the use of fast uptake mechanism spreads.
- Overtime, a higher adoption of **electrical trucks and buses** will occur, where they can take up to 22.7 kWh on the DWC pilot strip.

Costs:

- Fixed cost: **$13.3M one time construction cost**, representing a 40% as compared to a typical highway construction cost (per km).
- Cumulative cost by 2030: **$26.6M**

Excluding the cost of capital and taxes, the pilot

break-even after year 7,

10 year-ROI: 46%

With the cost of capital included at the prime rate of 3.45%, the pilot

break-even at year 10,

10 year-ROI: 4%

Key Facts at 2030:

- Annual electricity recharged: **38 GWH**
- Annual charging events: **1.69 M**
- Annual profit: **$4M**
- Cumulative revenue by 2030: **$38.8M**

90%

REASONS FOR STALLING AND METHODS FOR BOOSTING

Potential risks and mitigation tactics

Competition
Stationary “fast” charging plug-in stations compete with DWC

Optimize DWC location
- Analyze traffic patterns to identify optimal locations for DWC – target busiest roads to maximize marginal benefit.
- Avoid locating DWC near existing stationary charging stations – target drivers with partially discharged batteries.

Promote retrofitting of plug-in-only EVs to make them DWC compatible
- Partner with government and EV manufacturers to subsidize the cost of the retrofit – the subsidy also grows the EV service sector and strengthens the manufacturer’s brand.
- Advertise the benefits of DWC compatibility to owners of plug-in-only EVs – synchronize the awareness campaign with the completion of DWC construction.

Encourage wireless charging as the preferred EV charging option
- Promote the benefits of wireless charging over plug-ins – stress time savings and convenience.
- Ally with EV manufacturers and retailers to favor wireless over plug-in charging – sample promotions include test drives on DWC roads and discounts for home wireless charging systems.

Construction and Maintenance
Busy roads cannot be closed for construction and maintenance of DWC

Leverage existing road construction and maintenance plans to benefit from economies of scale
- Combine DWC deployment with existing road construction plans.
- Include DWC maintenance in routine road maintenance operations.

Prioritize working during low traffic hours to reduce inconveniencing drivers
- Analyze traffic patterns to identify the least disruptive time slots – work at night whenever possible.
- Renewable energy generators can be installed and maintained separately from DWC – this requires smaller crews and less equipment.

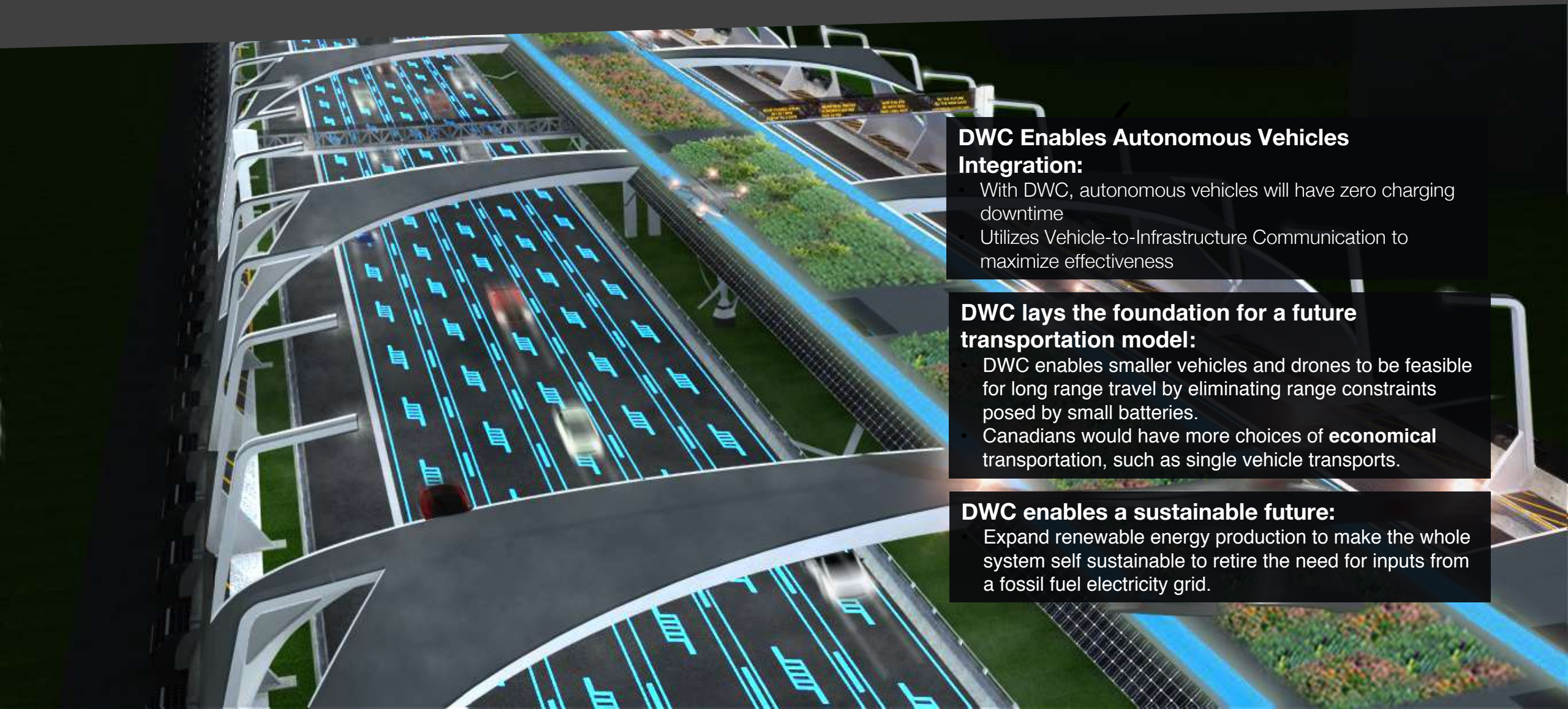
Lack of support from municipalities
Interest groups opposing DWC lobby local governments to block implementation

Demonstrate the benefits of DWC to local residents and businesses
- Engage local companies in the construction and maintenance of the DWC system – hire local labor, equipment, or supporting services, whenever possible.
- Stress the benefits of higher adoption of EVs – focus on direct time and fuel savings for households and business owners.

Ally with local organizations that rely on transportation
- Present the cost savings from the use of EVs and DWC – target delivery companies, public transit, school boards, and garbage collection services.

100% DWC PREPARES CANADA FOR THE FUTURE OF MOBILITY

Relevant, transformational, economical, and sustainable.



DWC Enables Autonomous Vehicles Integration:

- With DWC, autonomous vehicles will have zero charging downtime
- Utilizes Vehicle-to-Infrastructure Communication to maximize effectiveness

DWC lays the foundation for a future transportation model:

- DWC enables smaller vehicles and drones to be feasible for long range travel by eliminating range constraints posed by small batteries.
- Canadians would have more choices of **economical** transportation, such as single vehicle transports.

DWC enables a sustainable future:

- Expand renewable energy production to make the whole system self sustainable to retire the need for inputs from a fossil fuel electricity grid.