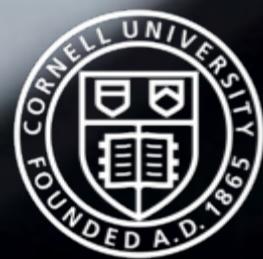




# Electromovilidad: ¿hacia un futuro más sostenible?

**Cornell  
Engineering**

Ricardo A. Daziano



# Volvo's Electric Future

The automaker says starting in 2019 it will make only electric or hybrid cars.



# France to ban sales of petrol and diesel cars by 2040

the guardian

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 New Diesel and Gas Cars by 2040*

By STEPHEN CASTLE JULY 26, 2017

The New York Times



Victoria Embankment in London. There are rising concerns over air pollution in Britain, particularly in large cities. Daniel Leal-Olivas/Agence France-Presse — Getty Images



# Tecnología y Mercado





# El mercado en Estados Unidos

2008

Se empieza a vender el  
Tesla Roadster

2011

Se empieza a vender el  
Nissan LEAF

570.000

Autos eléctricos, a  
diciembre de 2016

0,9%

Participación de  
mercado de PEVs  
(ventas veh nuevos 2016)



# 1900

28% de los autos en Estados Unidos  
son eléctricos.  
1/3 en Nueva York.

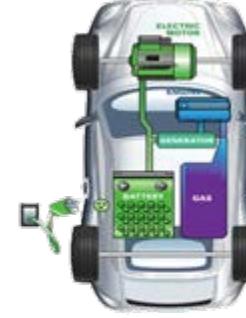


# Electrificación – Taxonomía

## “xEV vehicles”



Parallel PHEV  
(Parallel Plug-In Hybrid Electric Vehicle)



Series PHEV  
(Series Plug-In Hybrid Electric Vehicle)



BEV  
(Battery Electric Vehicle)



Híbrido  
(HEV)



Híbrido Enchufable  
(PHEV)



100% Eléctrico  
(BEV)

uso de electricidad

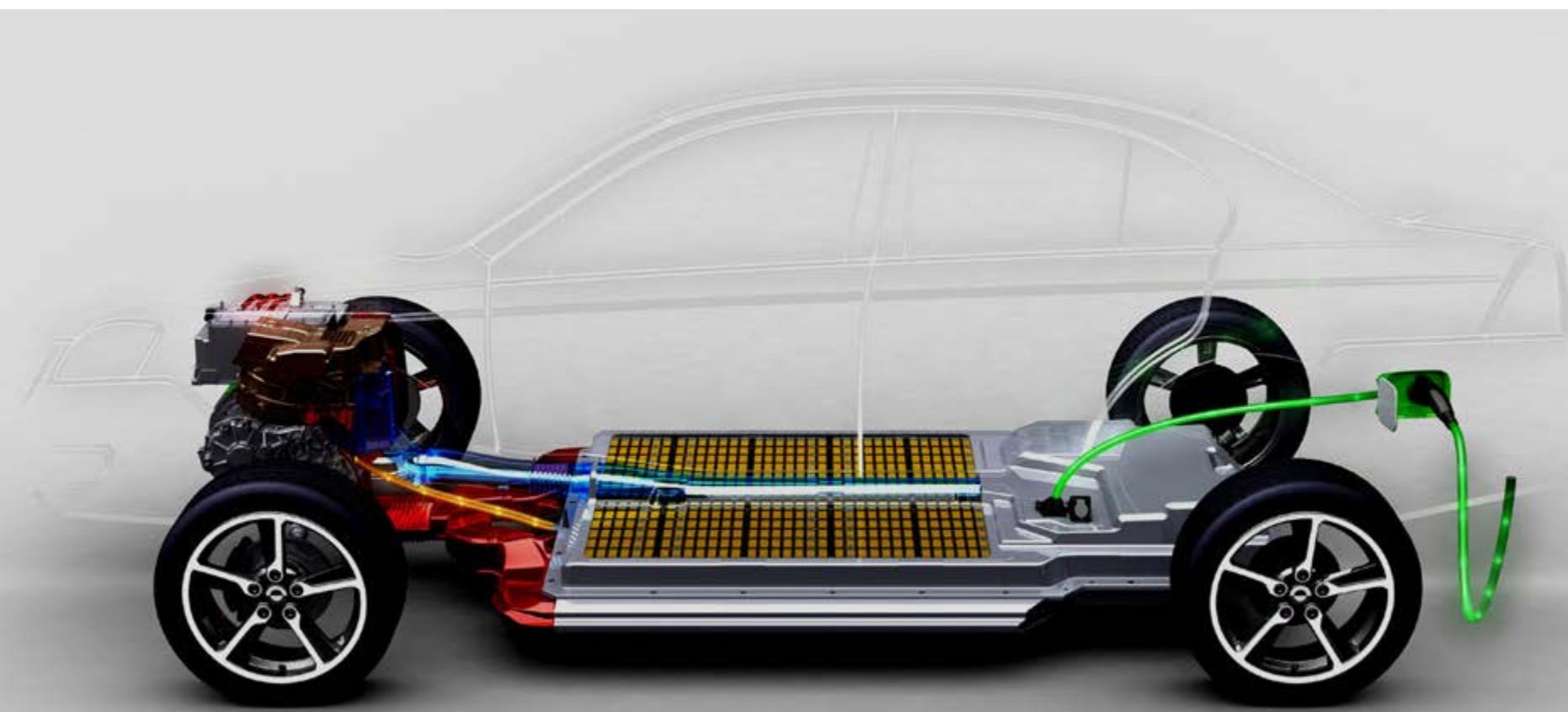


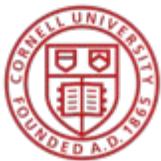
# Batería Eléctrica (ion de litio)

Eficiencia: 80-85%

Batería más grande: mayor autonomía (+ costo, + peso)

Peso batería Tesla Modelo S: 1.200 libras





# Chevy Volt (Híbrido Enchufable I EREV)

A partir de:

**21 millones**

Autonomía eléctrica:

**85 km**

Autonomía bencina:

**675 km**



68°

7:07

## Engine Maintenance

Due to low use, your engine needs to run on this trip for up to 15 minutes to perform engine maintenance. Once started, if the vehicle is shut down before completion, engine maintenance will run again on the next trip. You may delay engine maintenance for up to 24 hours.

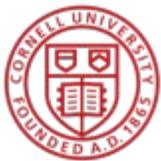
See Owner's Manual for further detail.

**Start  
Maintenance**

**Postpone**



Vehículos  
100% eléctricos



# Nissan LEAF

A partir de:

**20 millones**

Autonomía:

**172 km**

## 2017 NISSAN **LEAF**

STARTING MSRP\*  
**\$30,680**

A range of up to  
**107** Miles \*

HOW MUCH COULD YOU SAVE WITH LEAF



**VIEW  
COLORS  
& 360**





# Tesla Model X

A partir de:

**50 millones**

Autonomía:

**381 km**



**75D**

Model X

75 kWh Battery

Dual Motor all wheel drive

237 miles

6.0 seconds 0-60 mph

2017 | 50 miles | 049604



# Tesla Model X

A partir de:

**88 millones**

Autonomía:

**465 km**

**P100D**

**The Ultimate Tesla. Max Performance. All Premium.**

---

Model X P100D is the world's fastest accelerating production SUV and the safest ever. It comes standard with our best options and upgrades including **Ludicrous Speed Upgrade**, our **best interior**, and the **Premium Upgrades** package.

**100 kWh** Battery with Performance All-Wheel Drive

**289** mile range (EPA)

**155** mph top speed

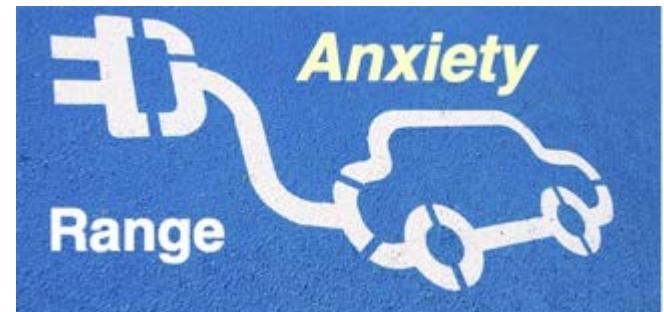
**2.9** seconds 0-60 mph

**1.4** seconds passing speed, 45-65 mph



# Gran heterogeneidad en autonomía

Fenómeno de 'range anxiety'

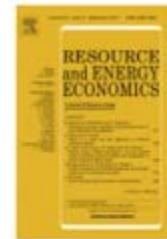




ELSEVIER

# Resource and Energy Economics

Volume 35, Issue 3, September 2013, Pages 429-450



## Conditional-logit Bayes estimators for consumer valuation of electric vehicle driving range

Ricardo A. Daziano  

US\$96.8

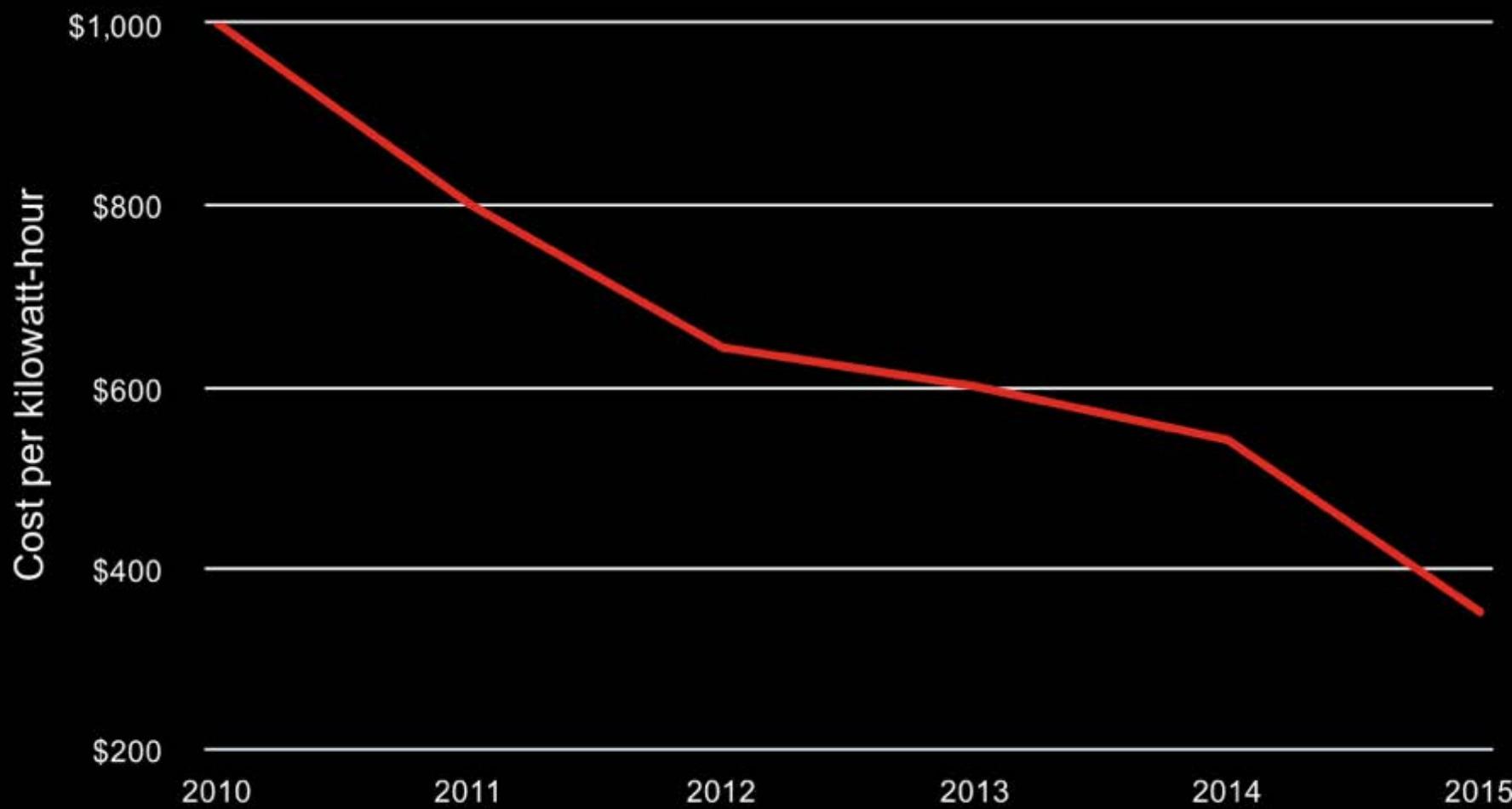
adicional en el valor de compra por una milla más de autonomía (en un auto con autonomía de 100 millas)

US\$160

costo para el productor de agregar una milla (en un auto con autonomía de 100 millas)  
Asumiendo un costo de 475 US\$/kWh

## A Better Battery Bargain

The cost of battery packs for electric cars and plug-in hybrids is on a steady decline.



Source: Bloomberg New Energy Finance

Model 3

US\$1.000

Depósito (reserva)

31 marzo 2016

200.000

Reservas el **primer día**

31 marzo 2016

555.091

Reservas en total

25 octubre de 2017

ESLA.COM



# Tesla is delivering more Model 3 vehicles while working through 'production hell'



## First Production

310 mile range with Rear Wheel Drive

\$49,000

Nov 2017 - Jan 2018

## Standard Battery

220 mile range with Rear Wheel Drive

\$35,000

Jan - Mar 2018

## Dual Motor All-Wheel Drive

Choice of 220 or 310 mile range

Sep - Nov 2018

500 km  
31 millones

350 km  
22 millones

# US\$35.000

22 millones | 350 km autonomía

Precio de entrada



# US\$1.000

Color distinto al negro

# US\$9.000

Autonomía de 145 km adicionales (500 km)

# US\$5.000

Auto-piloto medio

# US\$8.000

Conducción 100% automatizada

# US\$37.500

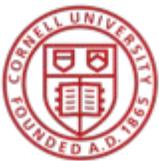
24 millones

Precio de entrada

# 380 km

Autonomía





En lo que va de 2017...

**45%** de las ventas de EVs son **Tesla modelos S / X**



**16%** Chevy Bolt



**15%** Nissan LEAF



# Where Are EVs Taking Off?

While California remains the country's largest EV market in terms of cars on the road, it is no longer the fastest-growing. More states are encouraging EV driving by offering incentives such as tax credits, HOV lane access, utility rebates and special rate plans for EV charging.

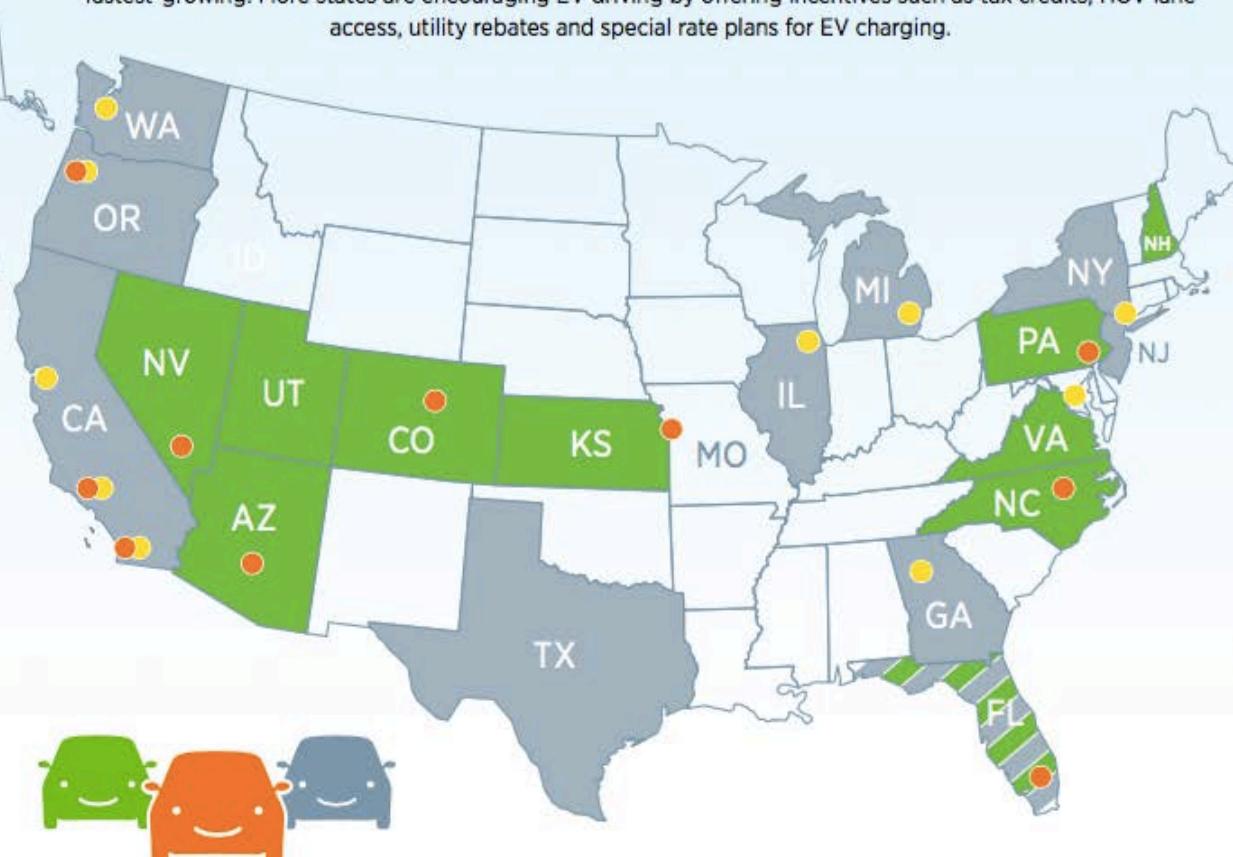
## Top 10 States

### Total EVs in Operation

1. California
2. Georgia
3. Washington
4. Florida
5. Texas
6. New York
7. Michigan
8. Illinois
9. Oregon
10. New Jersey

### EV Growth

1. Utah
2. Nevada
3. North Carolina
4. Colorado
5. Kansas
6. New Hampshire
7. Pennsylvania
8. Virginia
9. Florida
10. Arizona



- Top 10 states for total EVs in operation
- Top 10 states for EV growth
- Top 10 metro areas for total EVs in operation
- Top 10 metro areas for EV growth

## Top 10 Metro Areas

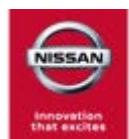
### Total EVs in Operation

1. Los Angeles
2. Bay Area
3. New York Metro
4. Atlanta
5. San Diego
6. Seattle
7. Chicago
8. Washington, D.C.
9. Detroit
10. Portland

### EV Growth

1. Las Vegas
2. Kansas City
3. Raleigh/Durham
4. Denver
5. Miami
6. Phoenix
7. Philadelphia
8. Portland
9. San Diego
10. Los Angeles

# Costos de operación más baratos vs. un precio de compra más elevado



NISSAN LEAF

## AUTO ELÉCTRICO V/S AUTO CONVENCIONAL

AUTO

ENERGÍA

COSTO ANUAL  
CL \$

CO2 ANUAL

[CL\$/km]

NISSAN LEAF

\$110 [kWh]

\$200.000

0 [kg]

\$ 13

VEHÍCULO  
CONVENCIONAL

\$750 [l]

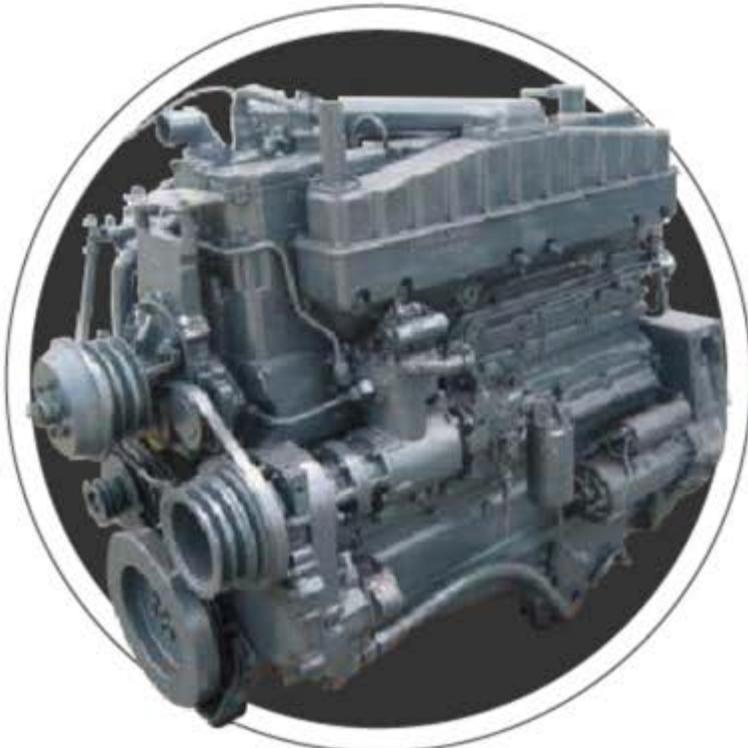
\$990.000

3.053 [kg]

\$ 66

\*Autos recorriendo 15.000 kms/año. Valores aproximados

# Costos de mantenición más baratos



vs.





# On the problem of measuring discount rates in intertemporal transportation choices

Authors

[Authors and affiliations](#)

Chen Wang, Ricardo A. Daziano [✉](#)

**6,9%** Interés promedio para la  
compra de un vehículo

**29,9%** Tasa de descuento  
subjetiva promedio

**Los consumidores son ‘miopes’**  
Evidencia de una **paradoja energética**

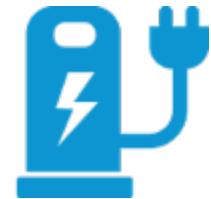


# Infraestructura





# Niveles de Recarga



## Nivel 1

Recargar en casa (US: 120 V, CA)  
7 km en 1 hora



## Nivel 2

Hogar, lugares públicos (US: 240 V, CA)  
40-110 km en 1 hora



## Nivel 3

DC (US: 500 V, CA)  
65 km en 10 min



## The World's Fastest Charging Station

The Supercharger network is your answer to long distance travel. Superchargers enable travel to your favorite destinations and charge Model S and Model X in minutes. Stations have multiple Superchargers to get you back on the road quickly and are located near restaurants, shopping centers, and Wi-Fi hotspots.

Hasta **270 km** en 30 min



**Navigate**



**Plug In**



**Journey On**

Enter your final destination and Trip Planner automatically routes you through

Plug in for about 30 minutes and grab a cup of coffee or a quick bite to eat while

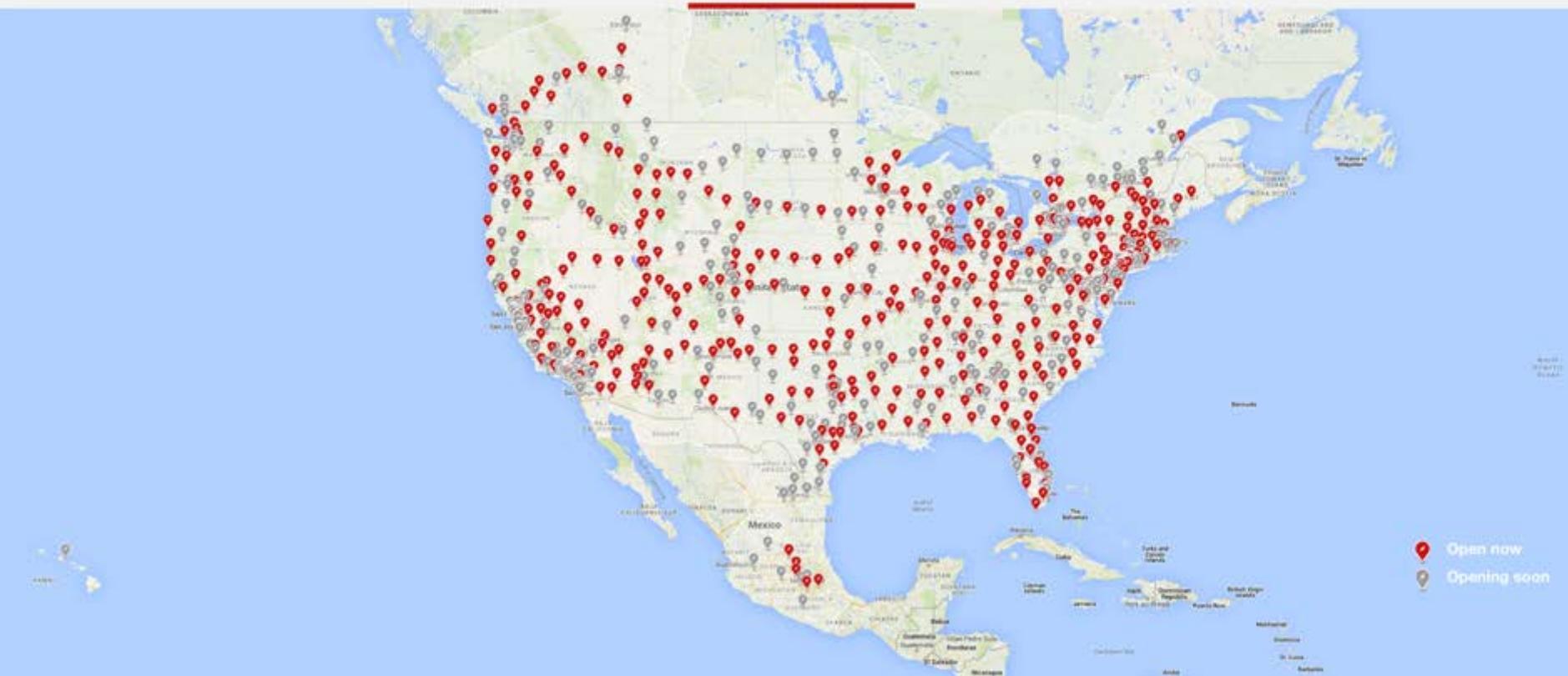
Your Tesla app will notify you when your vehicle is done charging.

## 909 Supercharger Stations with 6,118 Superchargers

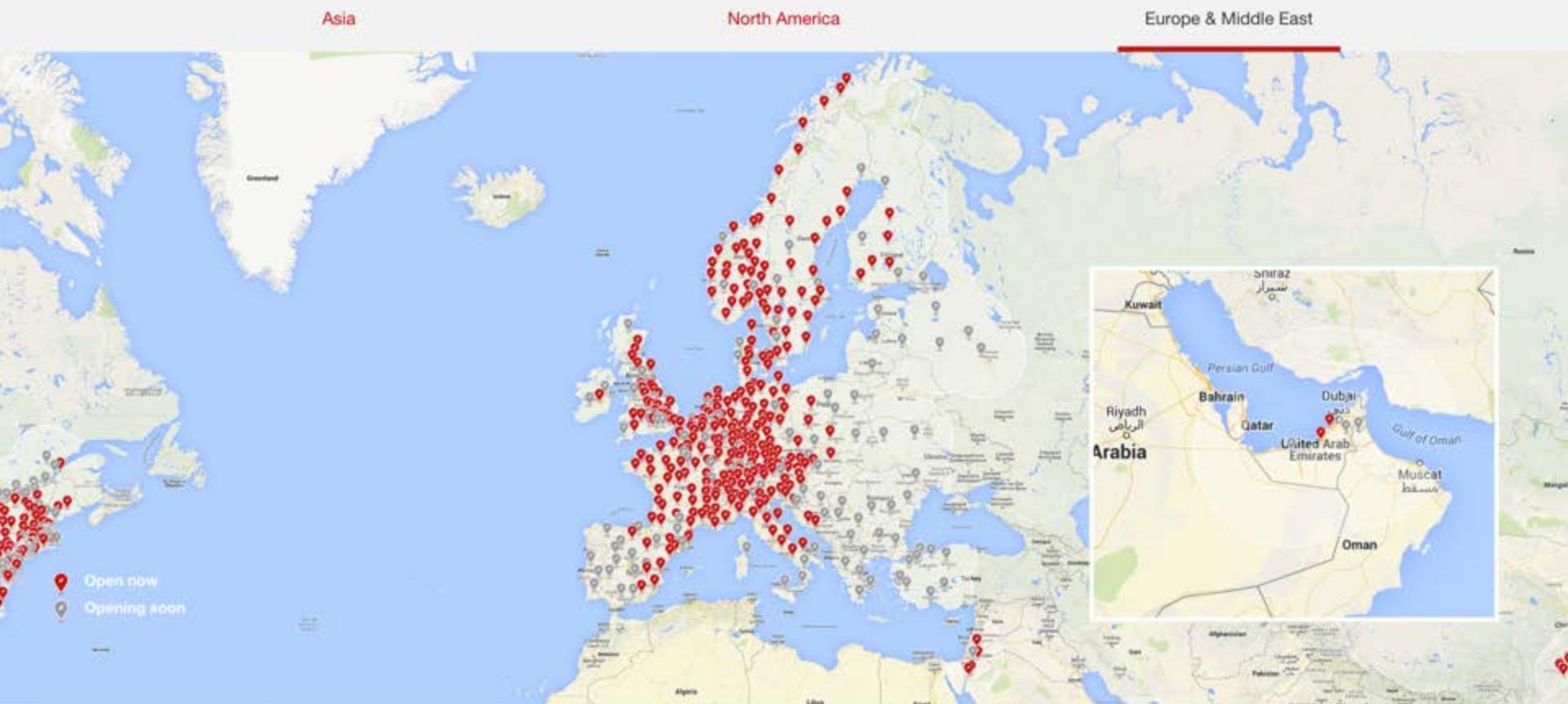
Asia

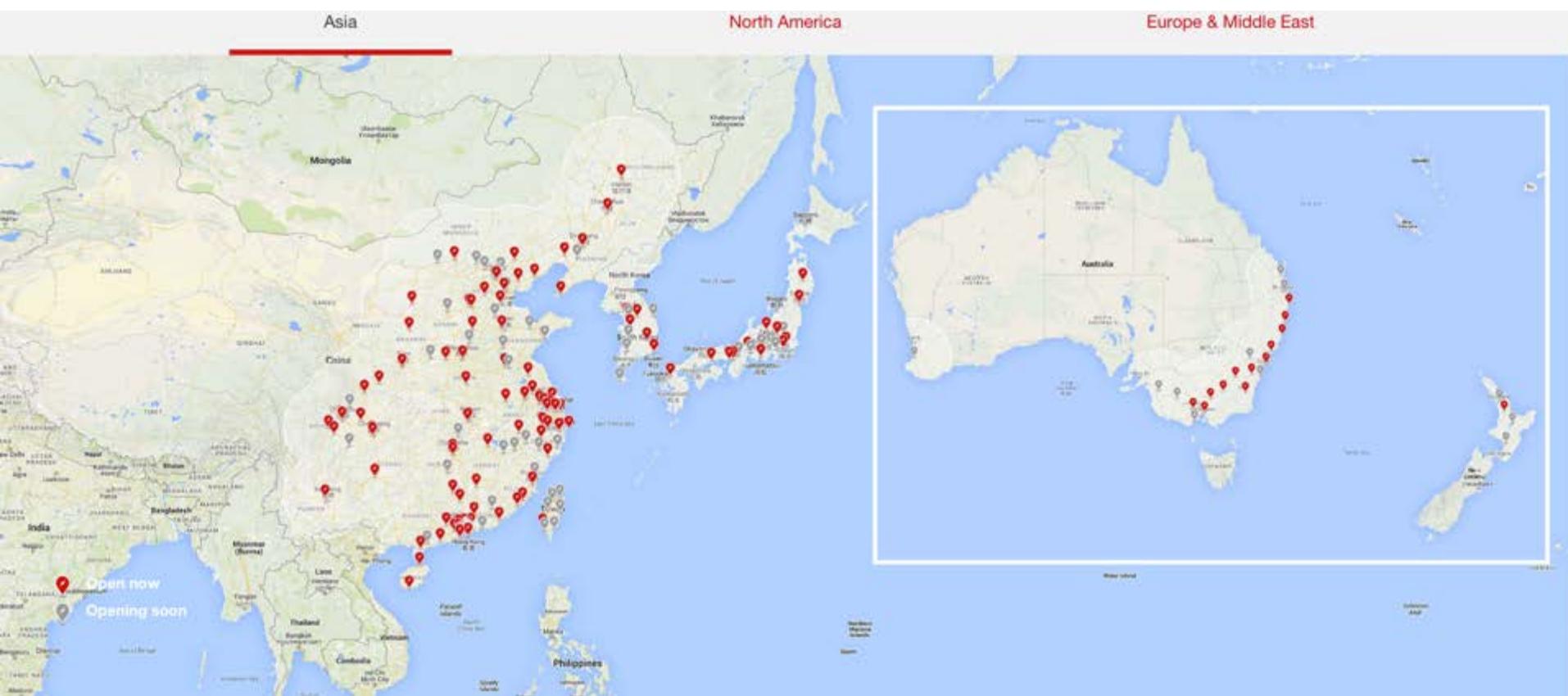
North America

Europe & Middle East



909 Supercharger Stations with 6,118 Superchargers





# Para manejar 65 km



Wall Connector - 75 kWh  
11.5 kW

01:19  
Time

\$1.82  
Cost

\$3.32  
Gasoline Savings

Wall Connector - 100 kWh  
17.2 kW

00:52  
Time

\$1.82  
Cost

\$3.32  
Gasoline Savings

Supercharger  
120 kW

00:07  
Time





	Electrolineras de 50 kW o más
	Electrolineras de 20 kW o más (y menor a 50 kW)
	Electrolineras de menos de 20 kW



## Tiempos estimados de carga

### Potencia punto de carga

### Tiempo estimado de carga al 100%

50 kW

25 - 35 minutos.

22 kW

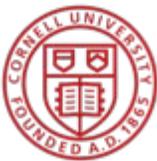
60 - 90 minutos.

7,0 kW

3 - 4 horas.

3,5 kW

6 - 8 horas.



# Provisión de infraestructura como incentivo

Usando ventas de EVs en 2011-2013, colegas en Cornell (Li & Tong) encontraron que:

**10%**

de aumento en el  
número de puntos de  
carga

**10.8%**

de aumento en la  
participación de  
mercado

# **TRANSPORTATION SCIENCE**

## Forecasting Adoption of Ultra-Low-Emission Vehicles Using Bayes Estimates of a Multinomial Probit Model and the GHK Simulator

Ricardo A. Daziano

School of Civil and Environmental Engineering, Cornell University, Ithaca, New York 14853

Martin Achtnicht

Centre for European Economic Research, D-68161 Mannheim, Germany

Permalink: <https://doi.org/10.1287/trsc.2013.0464>

Received: January 2012

Accepted: December 2012

Published Online: June 25, 2013

**~ CL\$200.000 más en precio de compra  
por un 1% más de densidad de electrolineras**

## Charge At Home

[Overview](#)[At Home](#)[Supercharger](#)[Destination Charging](#)

## The Best Way to Charge

Charging your Tesla is as easy as charging your phone. Just plug in when you get home and when you wake up, your Tesla will be fully charged and ready to go.

# 97% Of LEAF Charging Done At Home & Work When Both Available

November 1st, 2015 by [Zachary Shahan](#)





# Medioambiente

0 emisión ?



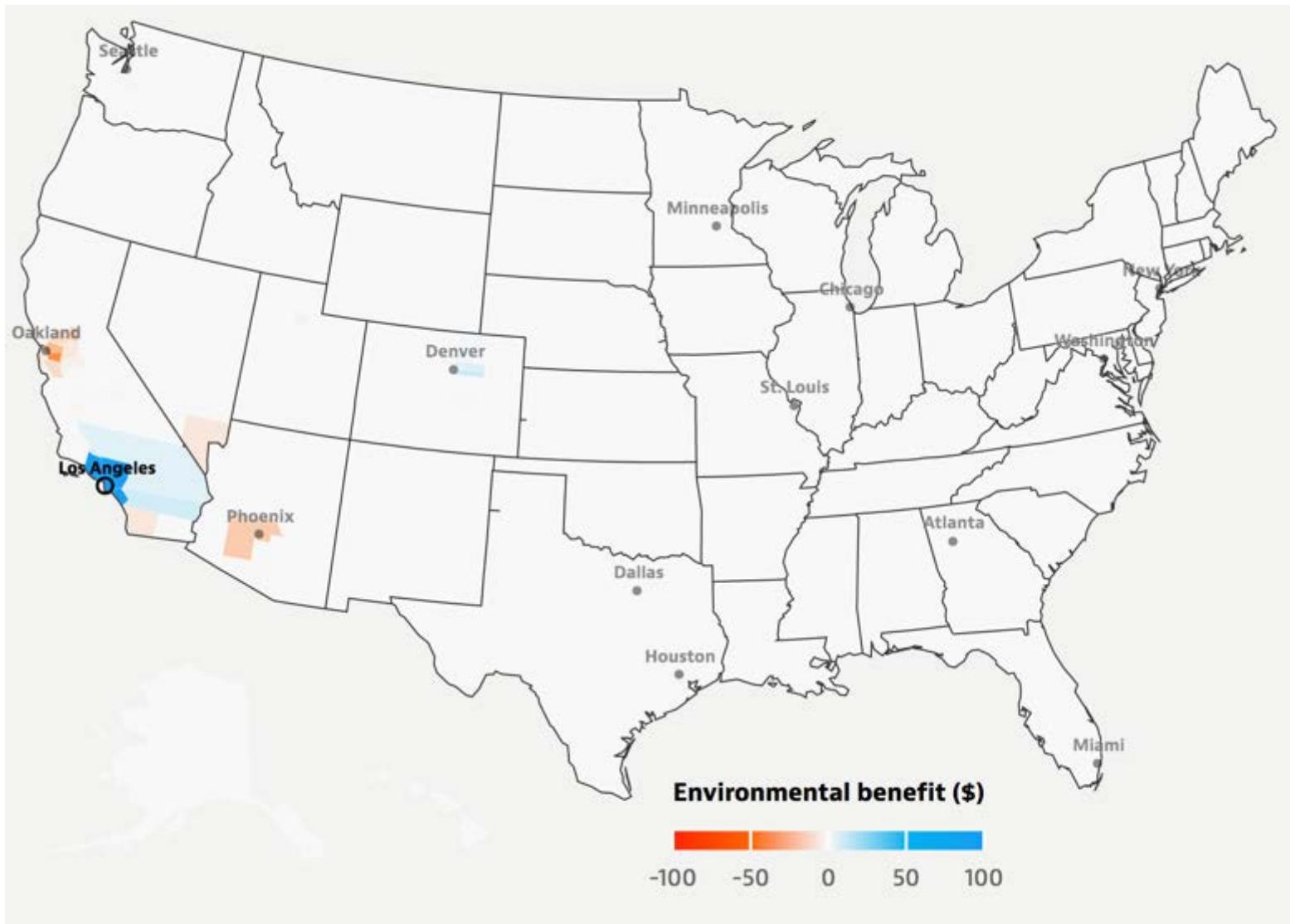
# Are There Environmental Benefits from Driving Electric Vehicles? The Importance of Local Factors<sup>†</sup>

By STEPHEN P. HOLLAND, ERIN T. MANSUR, NICHOLAS Z. MULLER,  
AND ANDREW J. YATES\*

*We combine a theoretical discrete-choice model of vehicle purchases, an econometric analysis of electricity emissions, and the AP2 air pollution model to estimate the geographic variation in the environmental benefits from driving electric vehicles. The second-best electric vehicle purchase subsidy ranges from \$2,785 in California to -\$4,964 in North Dakota, with a mean of -\$1,095. Ninety percent of local environmental externalities from driving electric vehicles in one state are exported to others, implying they may be subsidized locally, even when the environmental benefits are negative overall. Geographically differentiated subsidies can reduce deadweight loss, but only modestly. (JEL D12, D62, H23, L62, Q53, Q54, R11)*

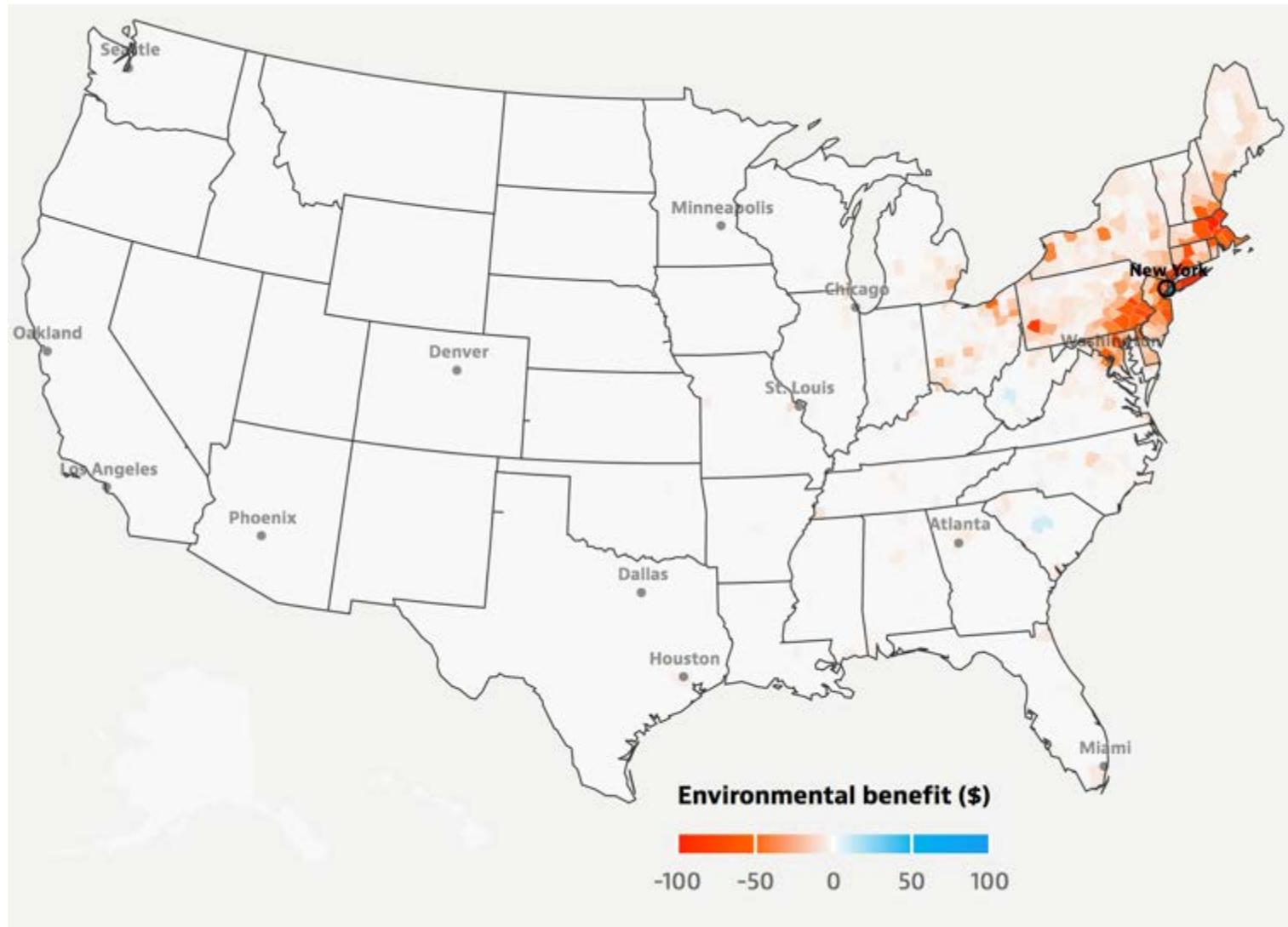


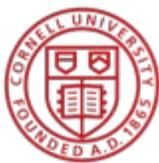
# Si compro un Ford Focus eléctrico en vez de uno a bencina, y lo manejo por 240.000 km



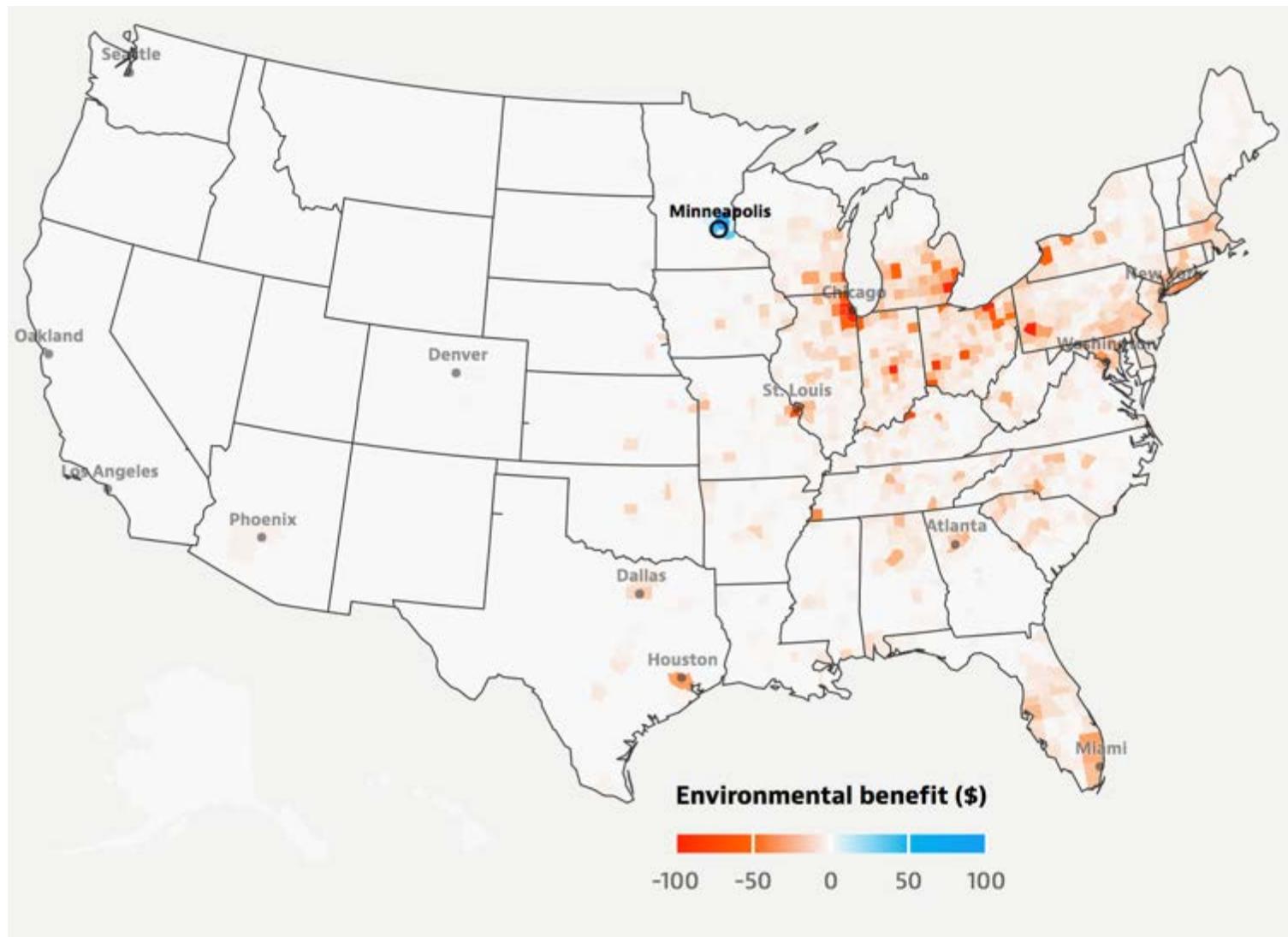


# Si compro un Ford Focus eléctrico en vez de uno a bencina, y lo manejo por 240.000 km





# Si compro un Ford Focus eléctrico en vez de uno a bencina, y lo manejo por 240.000 km





# Exportando polución

Holland et al (AER 16) encuentran que en promedio:

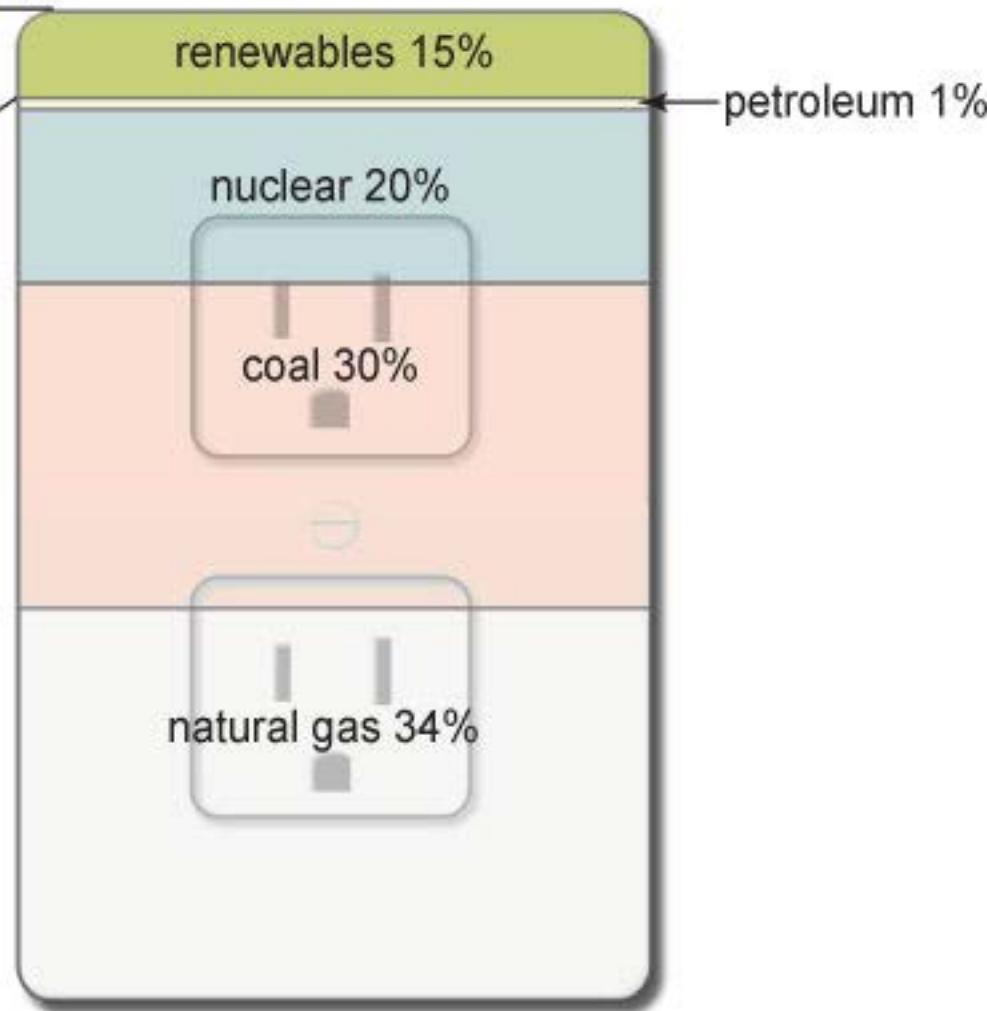
**“ Just about every electric vehicle, in just about every place, creates global environmental benefits relative to gasoline vehicles. In contrast, the local environmental benefits from electric vehicles can be positive or negative depending on the place... Focusing solely on global environmental benefits provides a misleading impression of the environmental consequences of electric vehicles.**

**Holland et al. (2016)**

# Sources of U.S. electricity generation, 2016

Total = 4.1 trillion kilowatthours

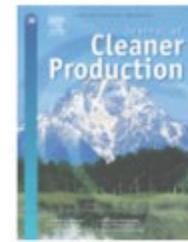
hydro	6.5%
wind	5.6%
biomass	1.5%
solar	0.9%
geothermal	0.4%



Note: Electricity generation from utility-scale facilities.

Source: U.S. Energy Information Administration, *Electric Power Monthly*, February 2017, preliminary data for 2016





## Increasing the influence of CO<sub>2</sub> emissions information on car purchase

Ricardo A. Daziano <sup>a</sup>✉, E.O.D. Waygood <sup>b</sup>✉, Zachary Patterson <sup>c</sup>✉, Markéta Braun Kohlová <sup>d</sup>

**Valoración privada de la reducción de emisiones  
CL\$18.000 - CL\$125.000 por tonelada de CO<sub>2e</sub>**



## Accounting for uncertainty in willingness to pay for environmental benefits

Ricardo A. Daziano <sup>a</sup>✉, Martin Achtnicht <sup>b</sup>✉

# EPA DOT Fuel Economy and Environment



Plug-In Hybrid Vehicle  
Electricity-Gasoline

## Fuel Economy

Electricity  
Charge Time: 4 hours (240V)

**98** MPGe  
34 kW-hrs per 100 miles  
combined city/highway

## Gasoline Only

**38** MPG  
2.6 gallons per 100 miles  
combined city/highway

## Driving Range

All electric range



Annual fuel **cost**  
**\$900**

## Fuel Economy & Greenhouse Gas Rating (tailpipe only)

1

10

10

Best

## Smog Rating (tailpipe only)

1

8

10

Best

This vehicle emits 84 grams CO<sub>2</sub> per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel & electricity also create emissions; learn more at [fueleconomy.gov](http://fueleconomy.gov).

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 22 MPG and costs \$12,600 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at \$3.70 per gallon and \$0.12 per kW-hr. This is a dual fueled automobile. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

# fueleconomy.gov

Calculate personalized estimates and compare vehicles

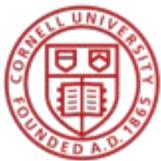


Smartphone  
QR Code™



# El caso de Noruega





# Mercado global EVs & PHEVs (2016)

2 millones

750 mil ventas en 2016

1,5%

Participación de  
mercado en China,  
Francia, Reino Unido

3,4%

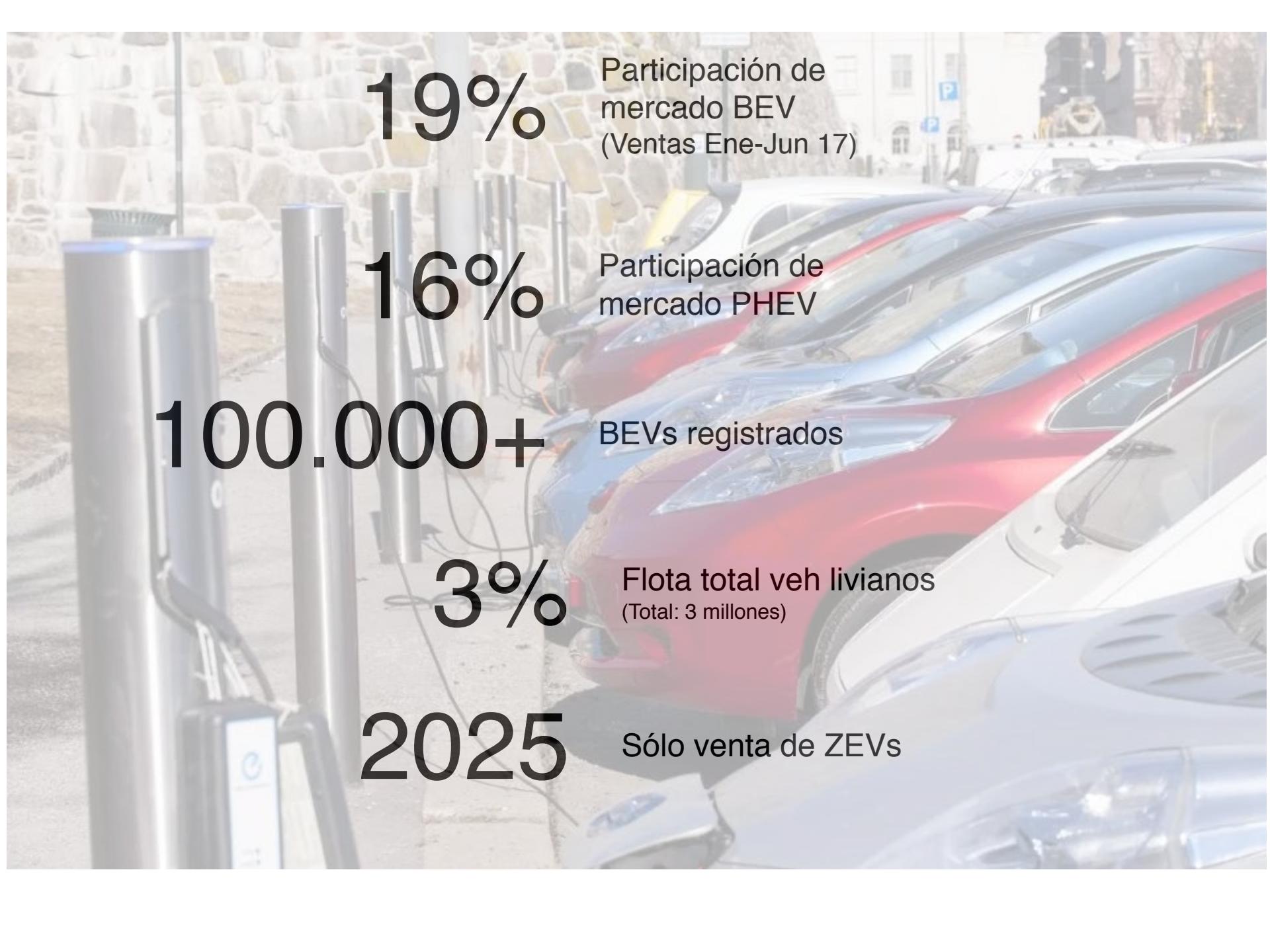
Suecia

6,4%

Holanda

29%

Noruega



19%

16%

100.000+

3%

2025

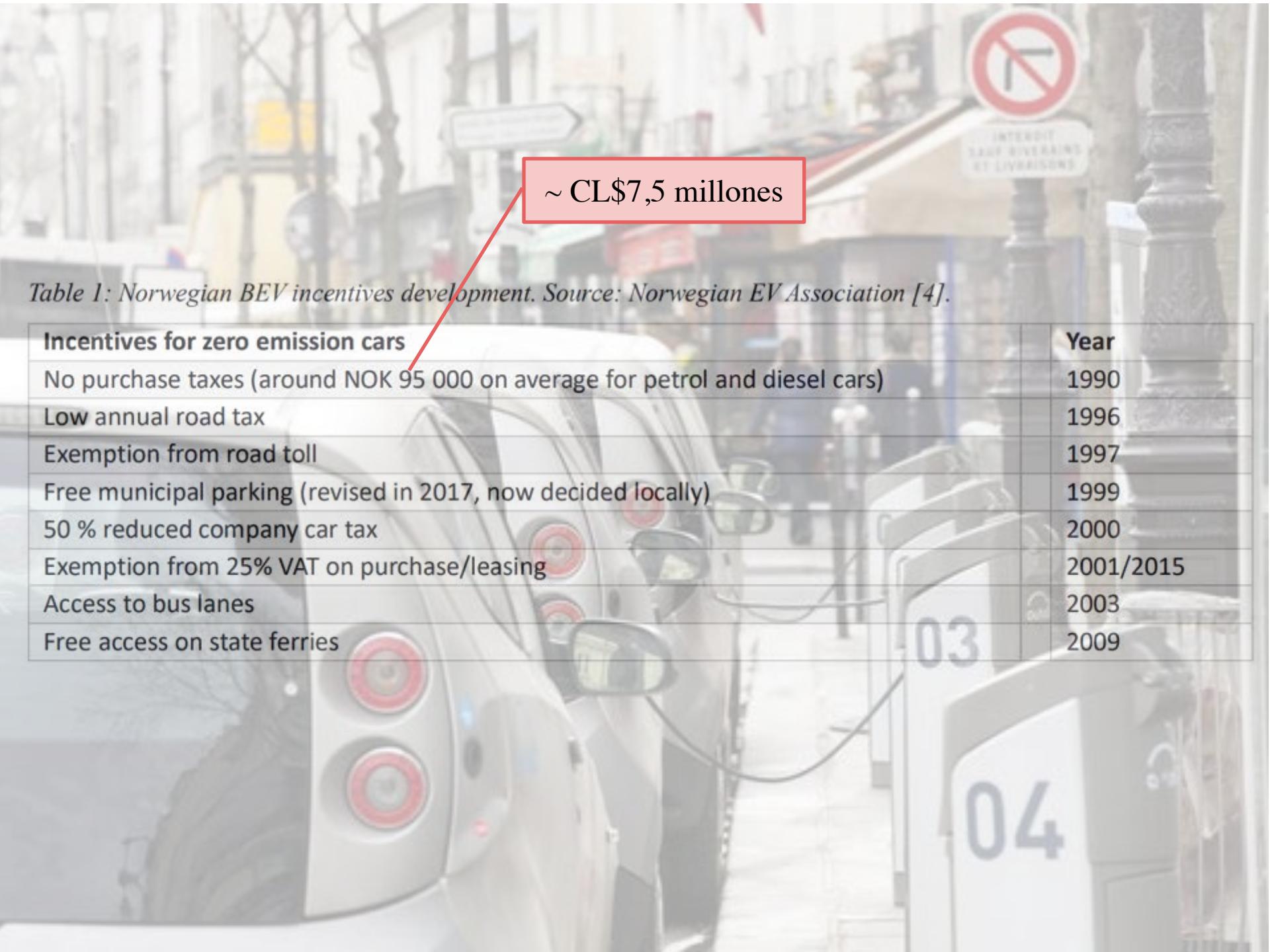
Participación de  
mercado BEV  
(Ventas Ene-Jun 17)

Participación de  
mercado PHEV

BEVs registrados

Flota total veh. livianos  
(Total: 3 millones)

Sólo venta de ZEVs

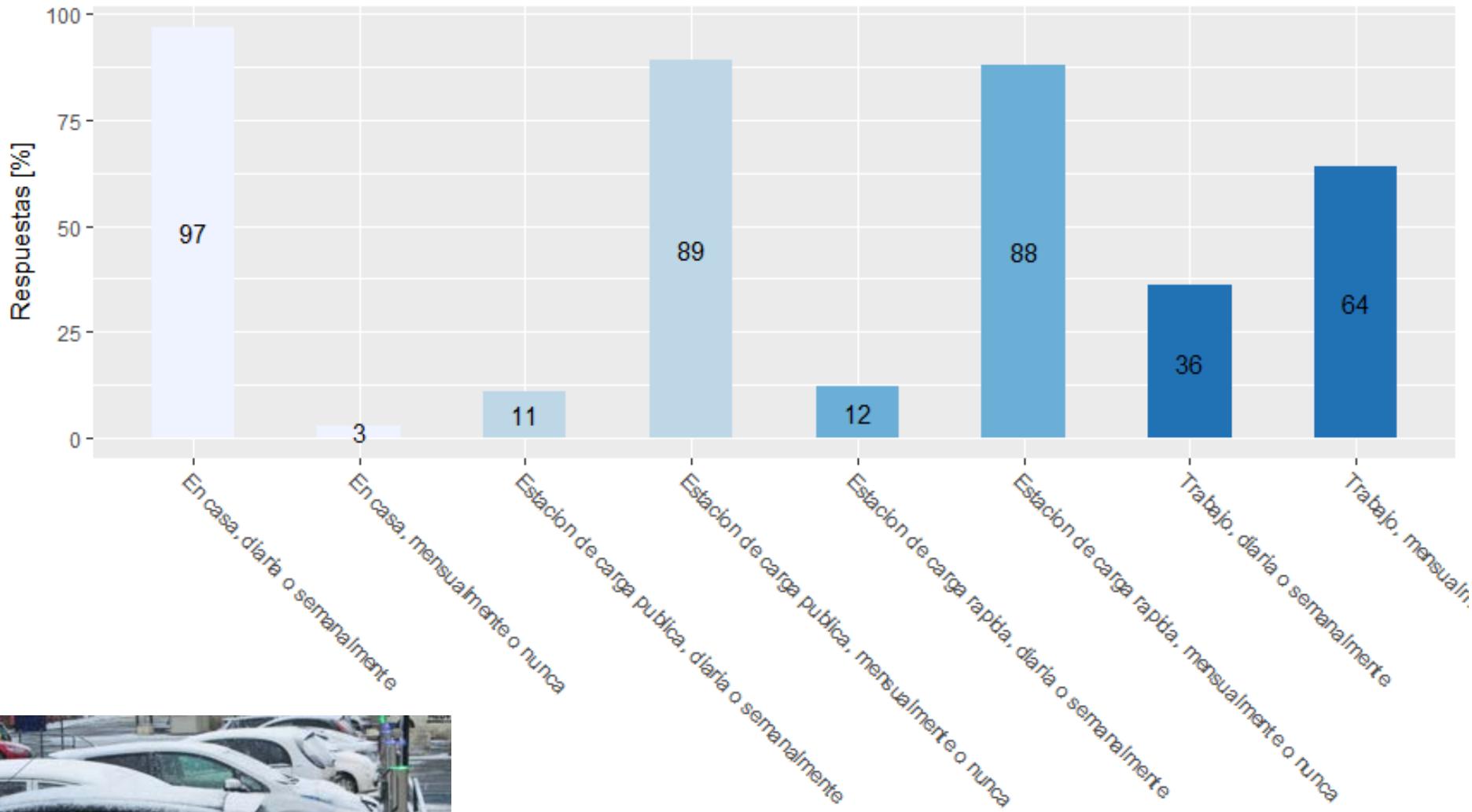


~ CL\$7,5 millones

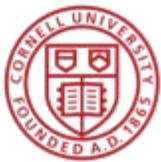
Table 1: Norwegian BEV incentives development. Source: Norwegian EV Association [4].

Incentives for zero emission cars	Year
No purchase taxes (around NOK 95 000 on average for petrol and diesel cars)	1990
Low annual road tax	1996
Exemption from road toll	1997
Free municipal parking (revised in 2017, now decided locally)	1999
50 % reduced company car tax	2000
Exemption from 25% VAT on purchase/leasing	2001/2015
Access to bus lanes	2003
Free access on state ferries	2009

## Frecuencia de carga en Noruega, usuarios que viven en Casa



Pregunta: ¿Qué tan frecuentemente carga?  
Fuente: Norwegian EV owner survey 2017



# Y en Chile?

109

vehículos 100%  
eléctricos

Ventas hasta mayo

55

vehículos 100%  
eléctricos

Ventas enero-mayo 2017

0,1%

mercado

(100% eléctricos, híbridos  
enchufables, híbridos)





Más allá de  
vehículos privados





© Royal Mail

**Royal Mail is trialling nine British-made fully electric commercial vehicles this month, transporting packages between mail and distribution centres in the capital**

# Uber: London drivers must use hybrid or fully electric cars from 2020

theguardian

Friday 8 September 2017

Ride-hailing service says it is aiming to tackle pollution by banning vehicles that do not have an electric motor



 Uber's 40,000 licensed drivers in London will be offered grants of up to £5,000 towards a hybrid or fully electric car. Photograph: Laura Dale/PA

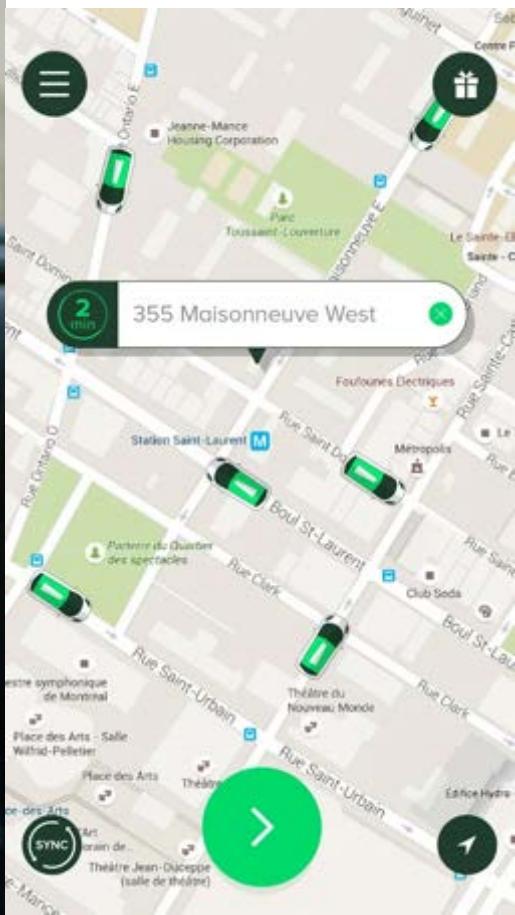
Uber drivers will be banned from using vehicles that are not a hybrid or fully electric in [London](#) from 2020, as part of a plan to help tackle illegal levels of air pollution in the capital.

Taxi

Téo

8 000 000 km  
parcourus à Montréal

1 680 tonnes  
d'émissions de CO<sub>2</sub> en moins





**PROTERRA**

OUR STORY

PRODUCTS

TECHNOLOGY

PERFORMANCE

NEWS & RESOURCES

AMERICA'S MOST POPULAR ELECTRIC BUS



# PROTERRA CHARGING SYSTEMS



## PROTERRA CATALYST ELECTRIC VEHICLES ACHIEVE 21.4 MPGe

Proterra's focus on advancing electric vehicle technology to deliver the world's best performing transit vehicles has led to the development of a number of impressive features. Chief among these is a drivetrain and propulsion system that have demonstrated a remarkable 21.4 MPGe and typical fleet operation of > 17 MPGe.\* This enables a substantial improvement over conventional combustion engines. Combined with the inherently lower volatility of electricity prices over the life of the bus vs. CNG, diesel and hybrid, we offer best-in-class efficiency, reduced operating costs and refined budgeting accuracy.

\*MPGe based on in-service customer fleet operation.

HYBRID

**4.58**

MPG



**63¢**

PER MILE

DIESEL

**3.86**

MPG



**84¢**

PER MILE

CNG

**3.27**

MPG



**74¢**

PER MILE

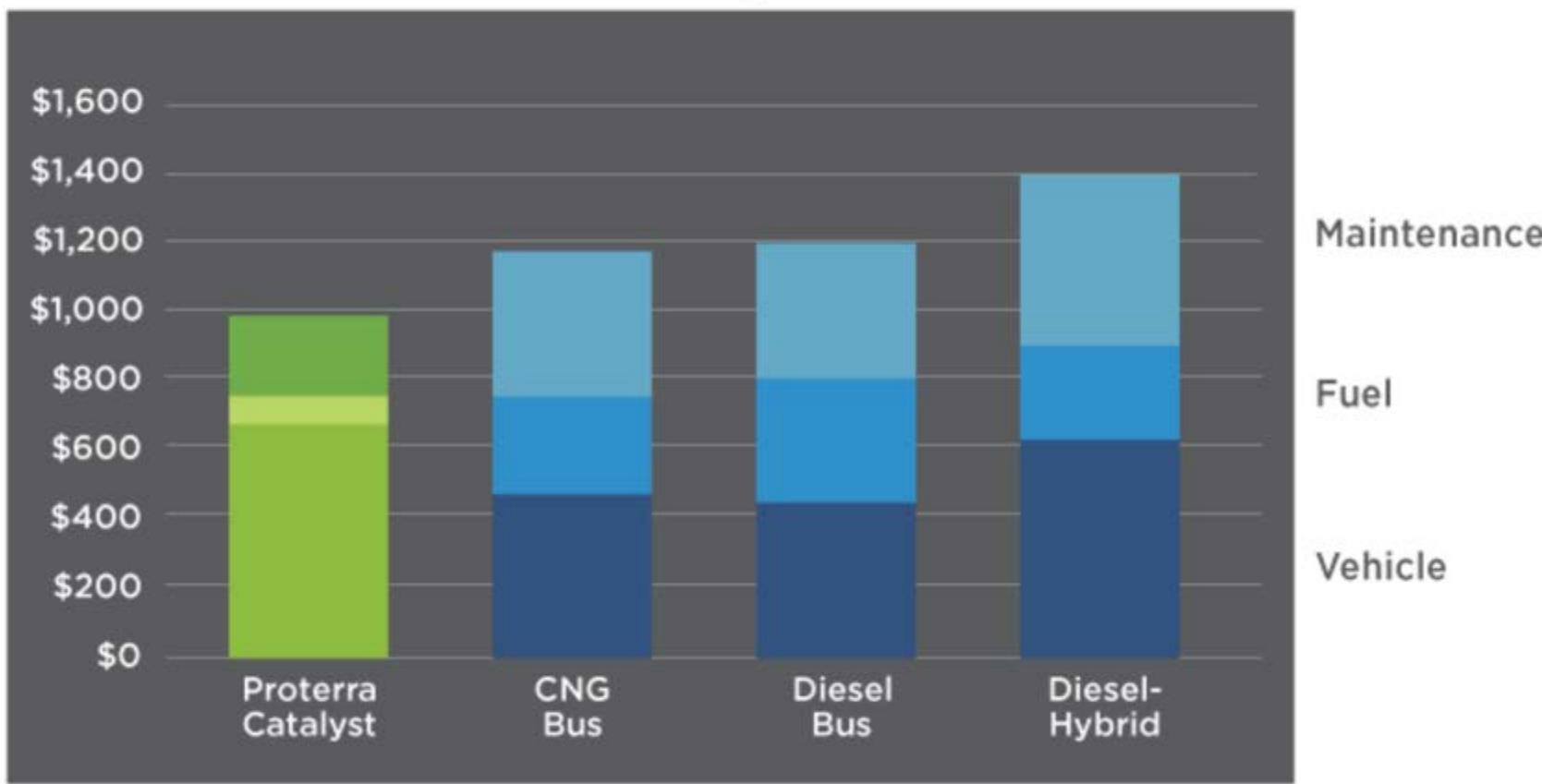
# PROTERRA 21.4 MPGe



# 19¢ PER MILE

## PROTERRA 35-FOOT CATALYST® VEHICLE LIFETIME OPERATIONAL SAVINGS

\$448K vs. Diesel • \$459K vs. Hybrid • \$408K vs. CNG



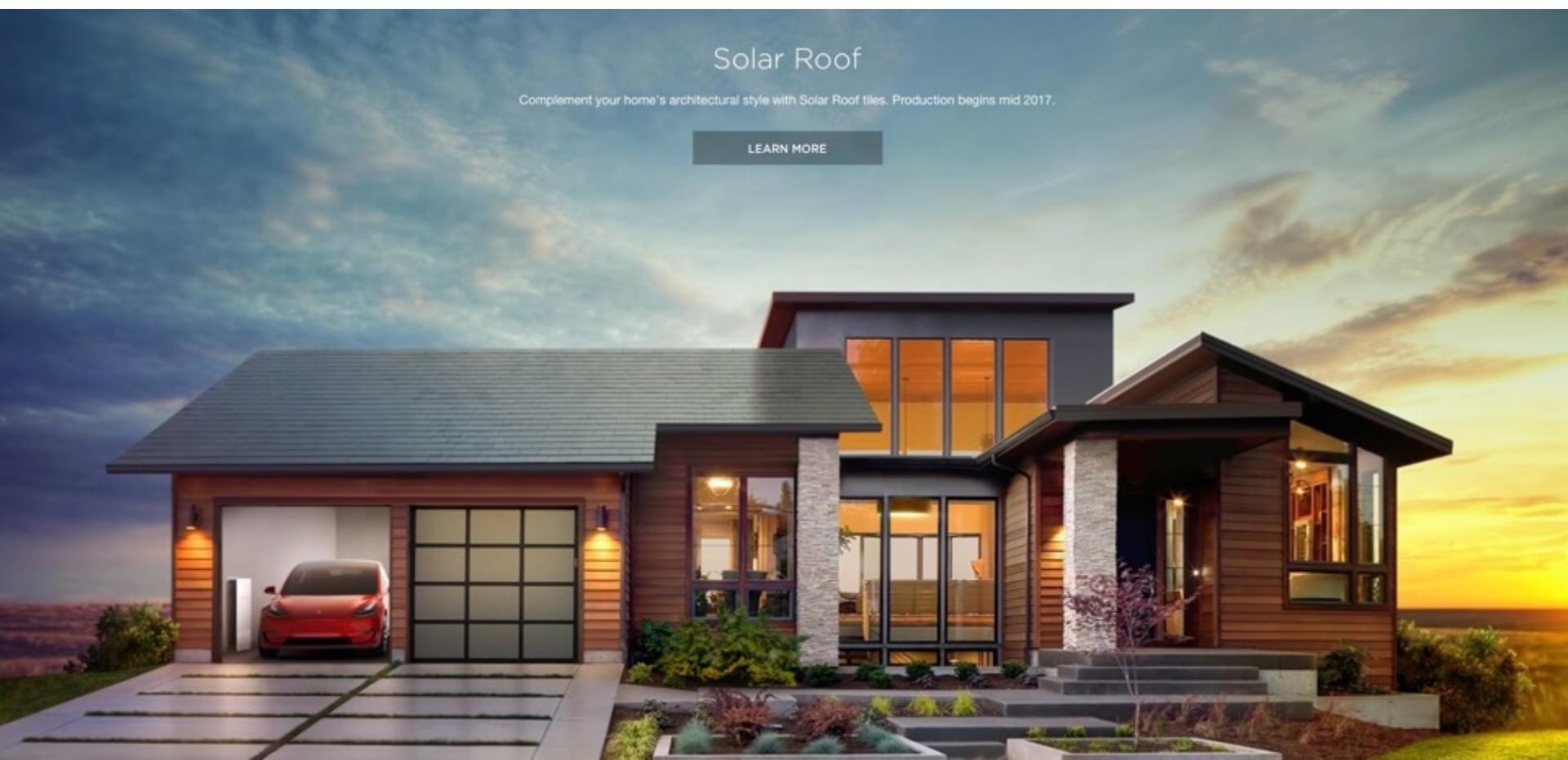


# ¿La casa del futuro?

## Solar Roof

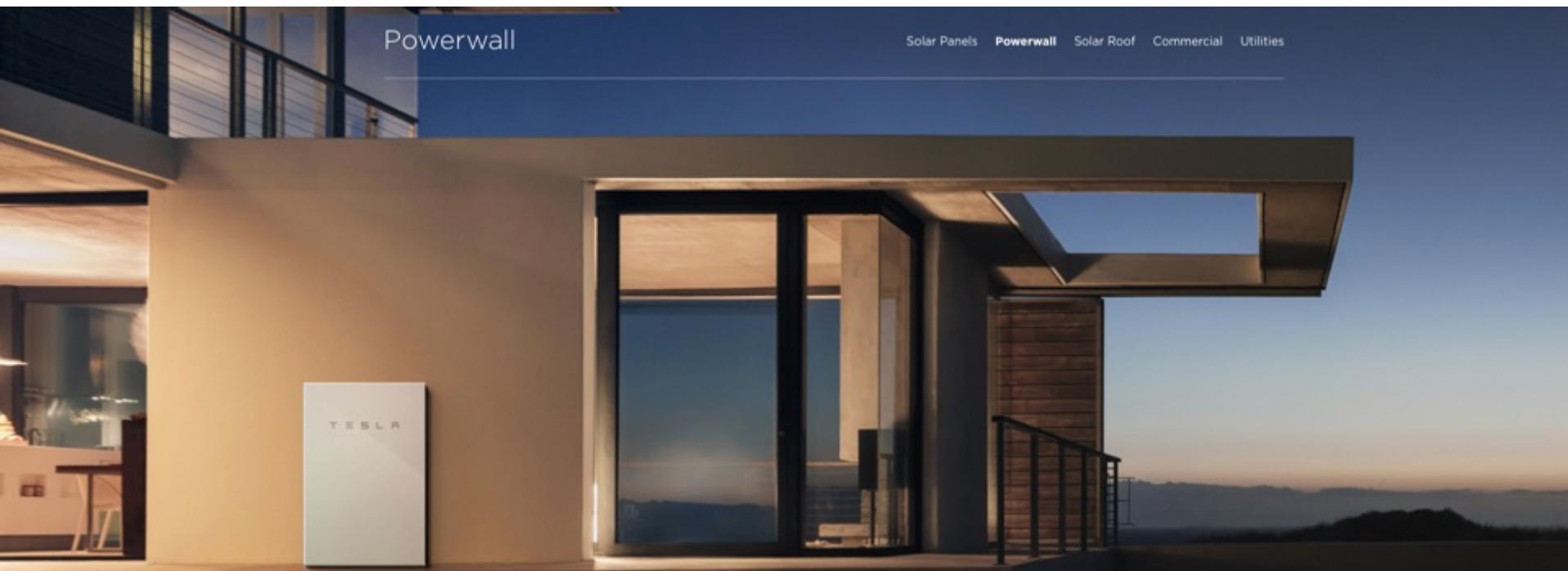
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# ¡Gracias!

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