

Disruptive Energy Transition

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A dramatic sunset scene with a bright sun low on the horizon, casting a long, vibrant rainbow across the sky. The sky is filled with soft, golden clouds. In the foreground, the dark silhouette of an oil pumpjack is visible on the left side, contrasting sharply with the bright background. The overall mood is serene yet powerful, emphasizing the theme of energy.

The Sun is the Source of all Energy

Ancient Stored Sun Energy

History of Energy Transitions

Early History Powered by



First
Stored Energy Use



Industrial Revolution



Transportation
Revolution



Million years ago

400,000

1700

1760

1859

2020

Invented
Fire



Disruptive Technologies



What factors drive disruptive technologies?

1. Price
2. Crossover Price!
3. Operational costs crossover
4. The Dark Horse!

Solar Price Per Watt



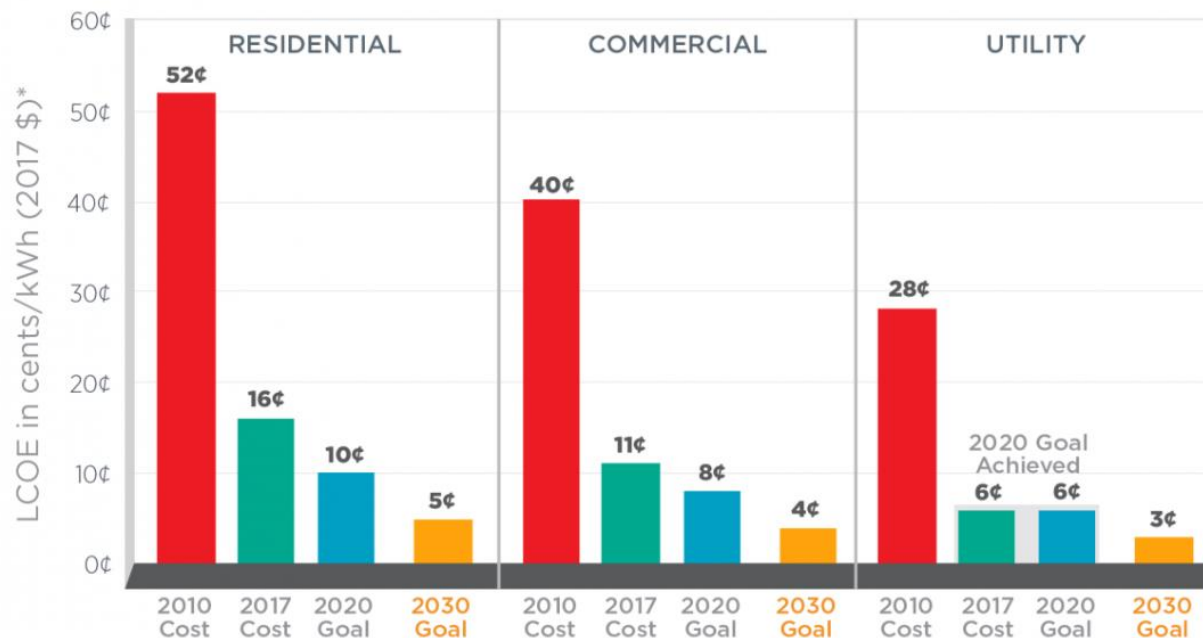
1977 - \$77

1997 - \$7

2013 - \$0.7

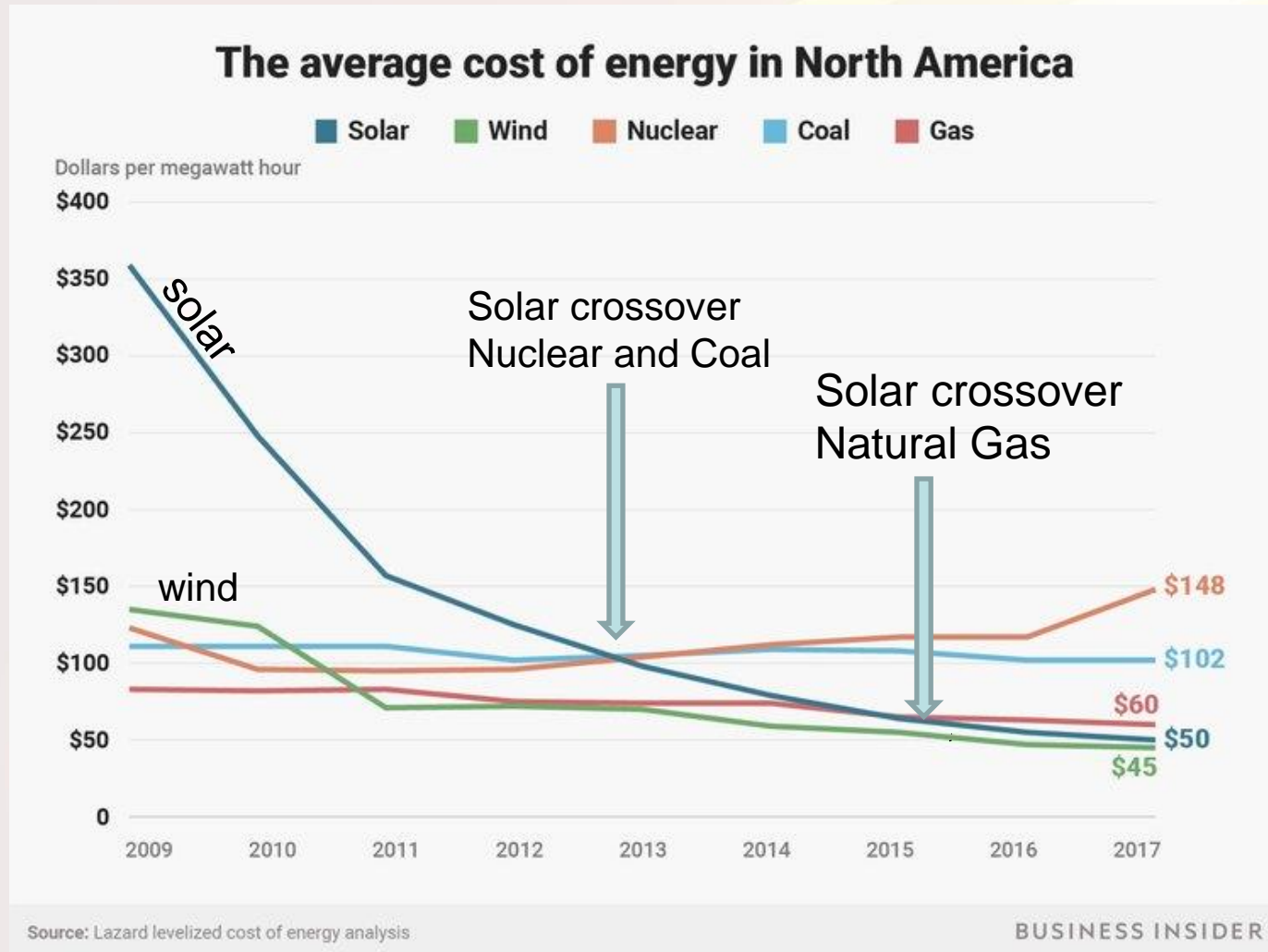
Cost of Solar – US data

SunShot Progress and Goals



*Levelized cost of energy (LCOE) progress and targets are calculated based on average U.S. climate and without the ITC or state/local incentives. The residential and commercial goals have been adjusted for inflation from 2010-17.

Crossover Price for New Projects



Alberta Major Projects since

2017	Brooks	17 MW	4.8 cts / kwh
2020	Vulcan	500MW	?

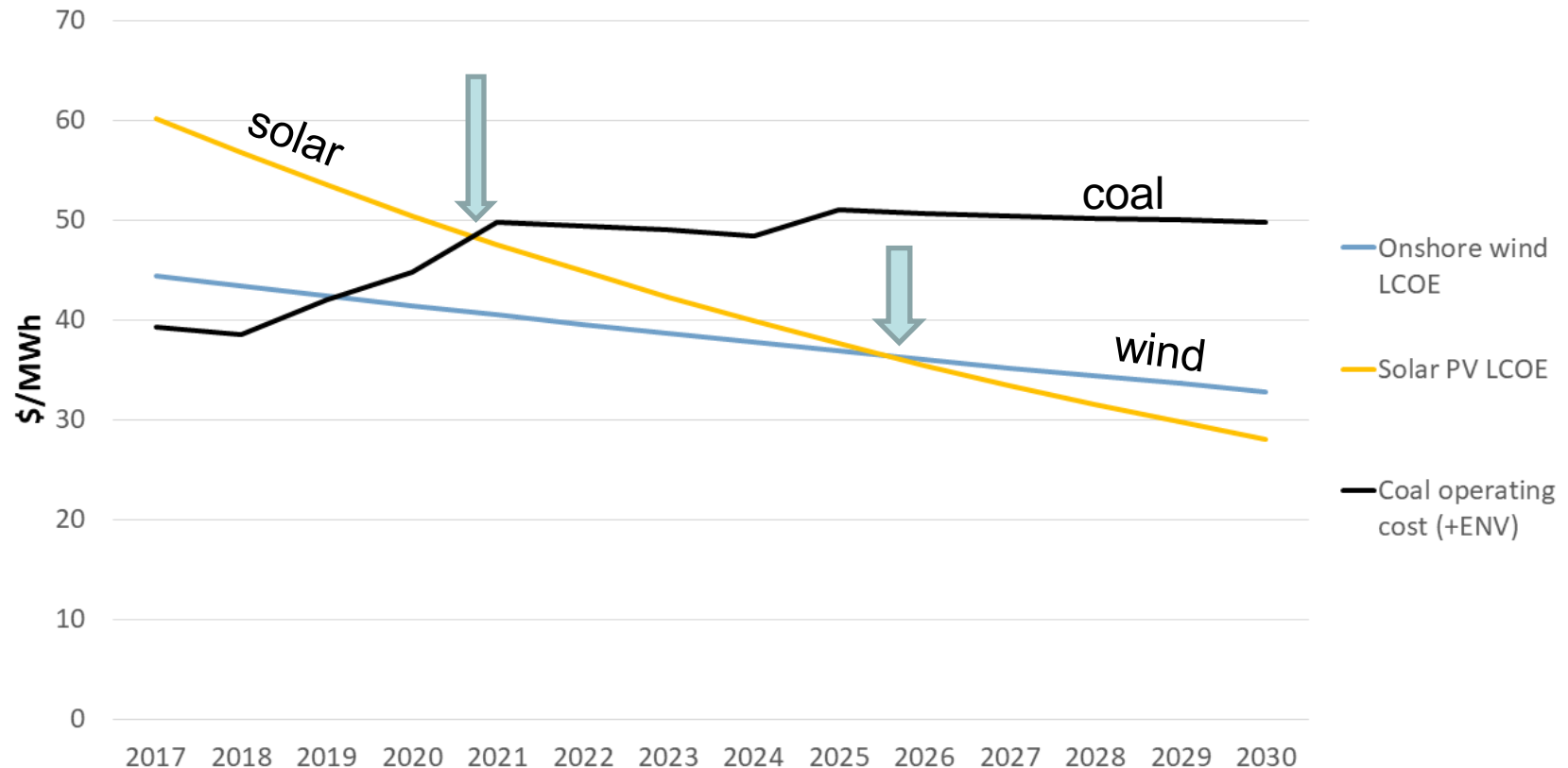


What about energy storage?

2.3 Cents Per KWh
including Storage



Operational costs crossover

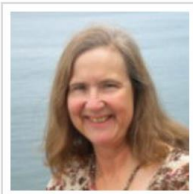


Crossover in 2019 in the U.S

OHIO

Analysis: New wind, solar cheaper than operating most existing coal plants

WRITTEN BY



Kathiann M.
Kowalski
March 25, 2019

PHOTO BY

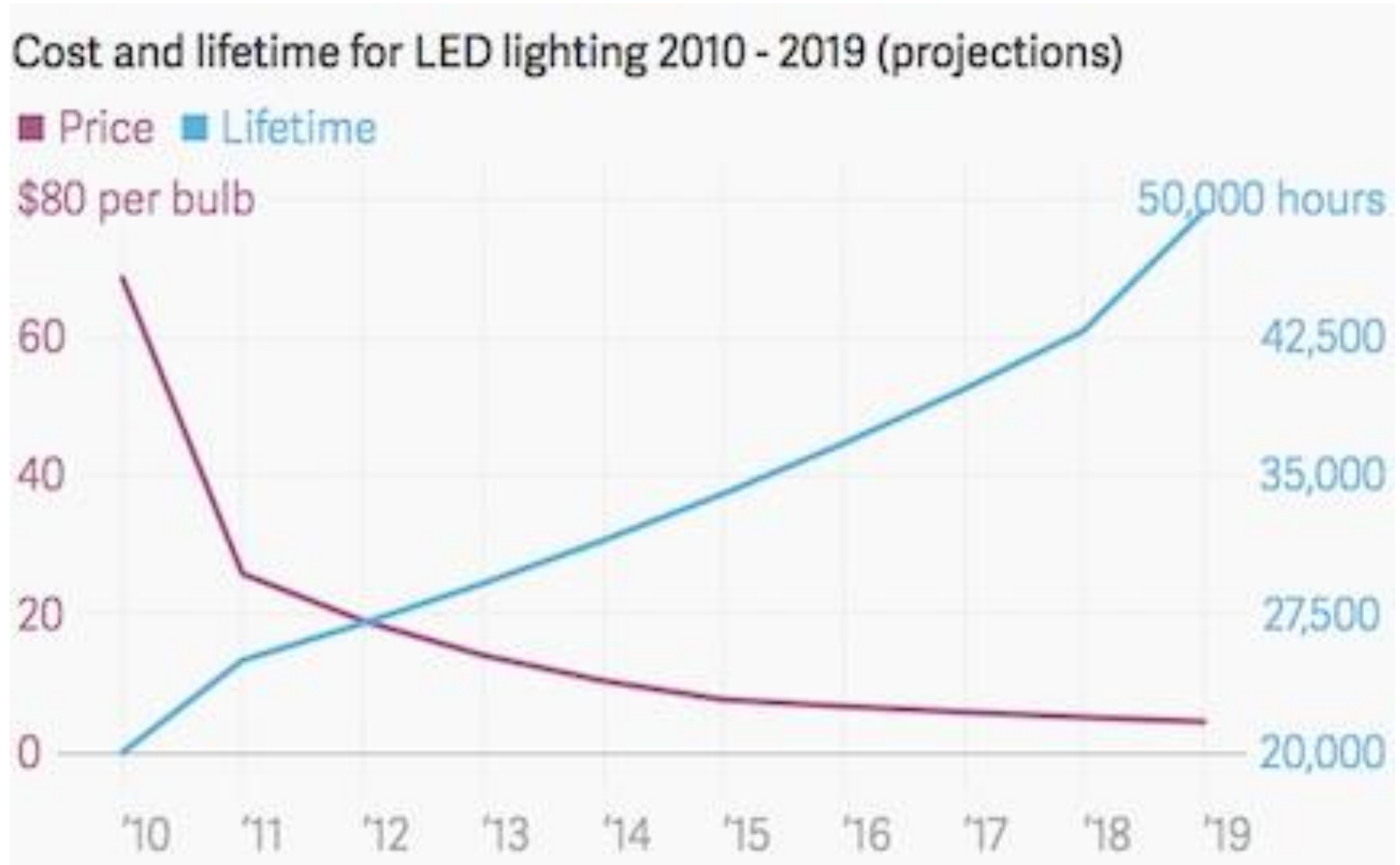
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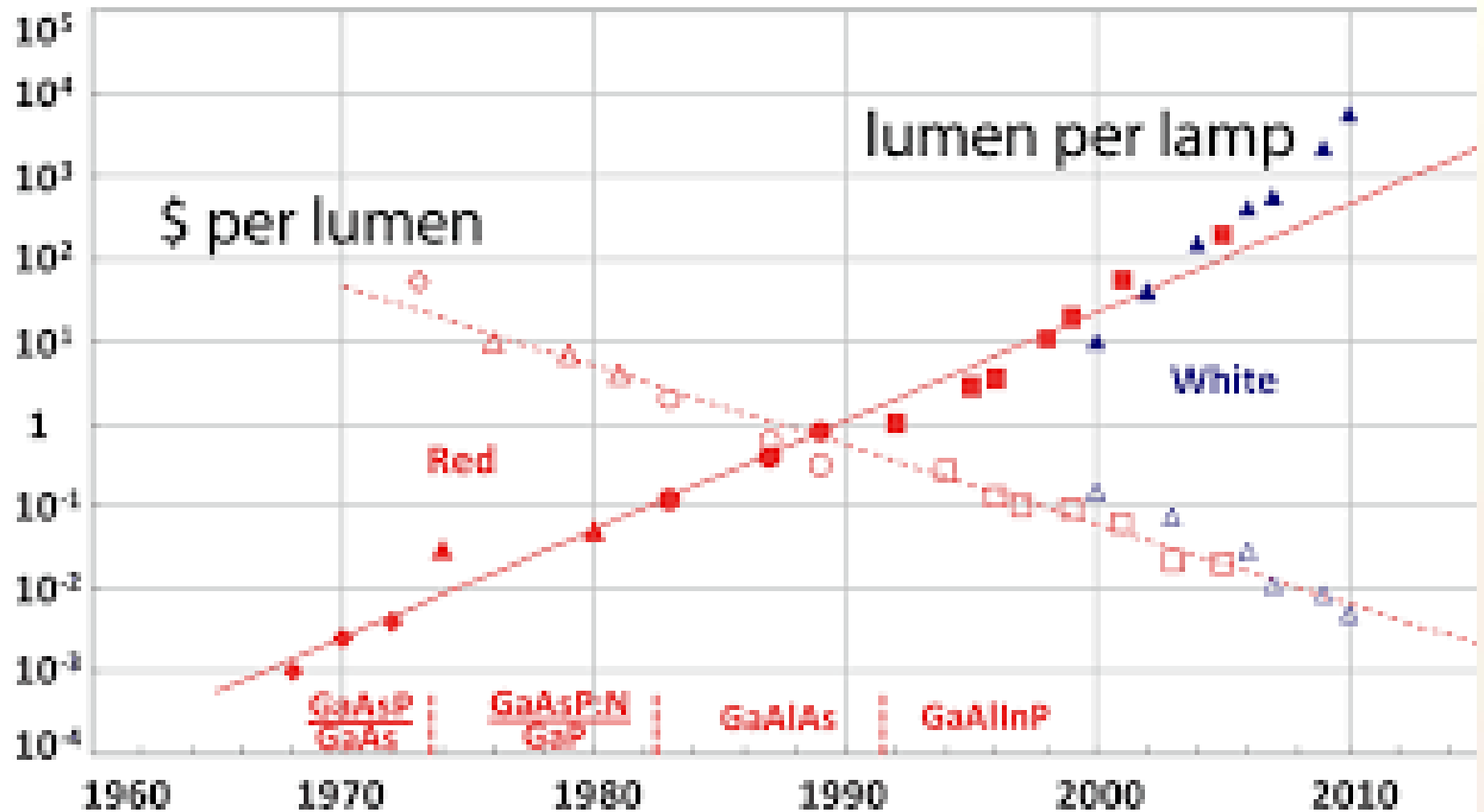
Change
the World
of Energy
One Light
bulb at a
time



Price Reduction of LED Lights



Price per Lumen Reduction



Price crossover for New Projects



The Edge building in Amsterdam

Question?



If the energy saved from upgrading 2000 4-foot tube to LED from 2014-2018

How far would an EV travel?

1. Around the world (40,000 kms)
2. On the moon (385,000 kms)
3. Pass the moon.

How far can an EV travel with the saved energy to date?





Alberta's First Zero Waste
Fluorescent light Retrofit and Recycle
system

Operational Crossover in 2019



T8 LED Tube Light

Plug and Play Lights
are \$20. Electrician
not required.



The Dark Horse of Light Retrofit

Clean Water



Question?

How much water can be contaminated by mercury from one tube?



1. 5 Litres
- 2 50 Litres
- 3 500 Litres
- 4 5000 Litres



BILL C-238 - NOW LAW!

The National Strategy for Safe and Environmentally Sound Disposal of Lamps Containing Mercury Act

Just one residential 13 watt CFL bulb contains up to 5mg of mercury.



With over 3/4 of Canadians using CFLs, they contribute 1150kg of mercury per YEAR in landfills!



Toxic mercury causes health problems like birth defects- It can also be fatal.



Not all provinces have end-of-life plans for CFL bulbs. They're thrown into landfills.

BILL C-238 IS ABOUT WORKING TOGETHER

C-238 calls upon the Minister of Environment and Climate Change to work with the provinces, territories and all interested and appropriate governments & organizations to develop a robust national strategy.



"With a **robust national strategy** we can **protect our lands and our waterways** from toxic mercury.

This is a government that **cares about the environment**.

But more so, Canada is a country that deeply **cares about the world** we leave for future generations."

Darren Fisher, MP Dartmouth-Cole Harbour
Sponsor, Bill C-238

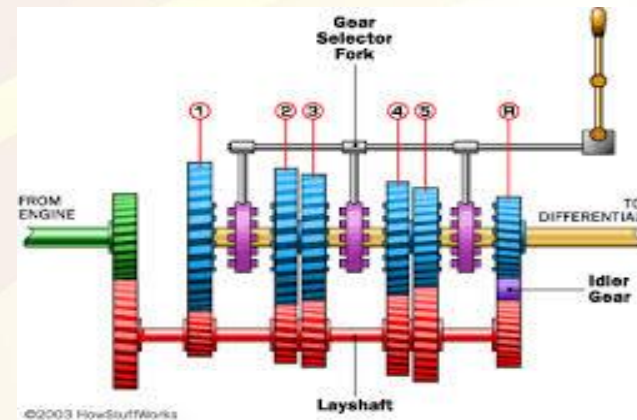
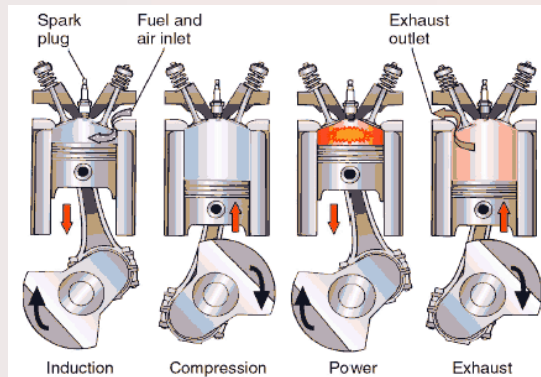


#BrightIdea

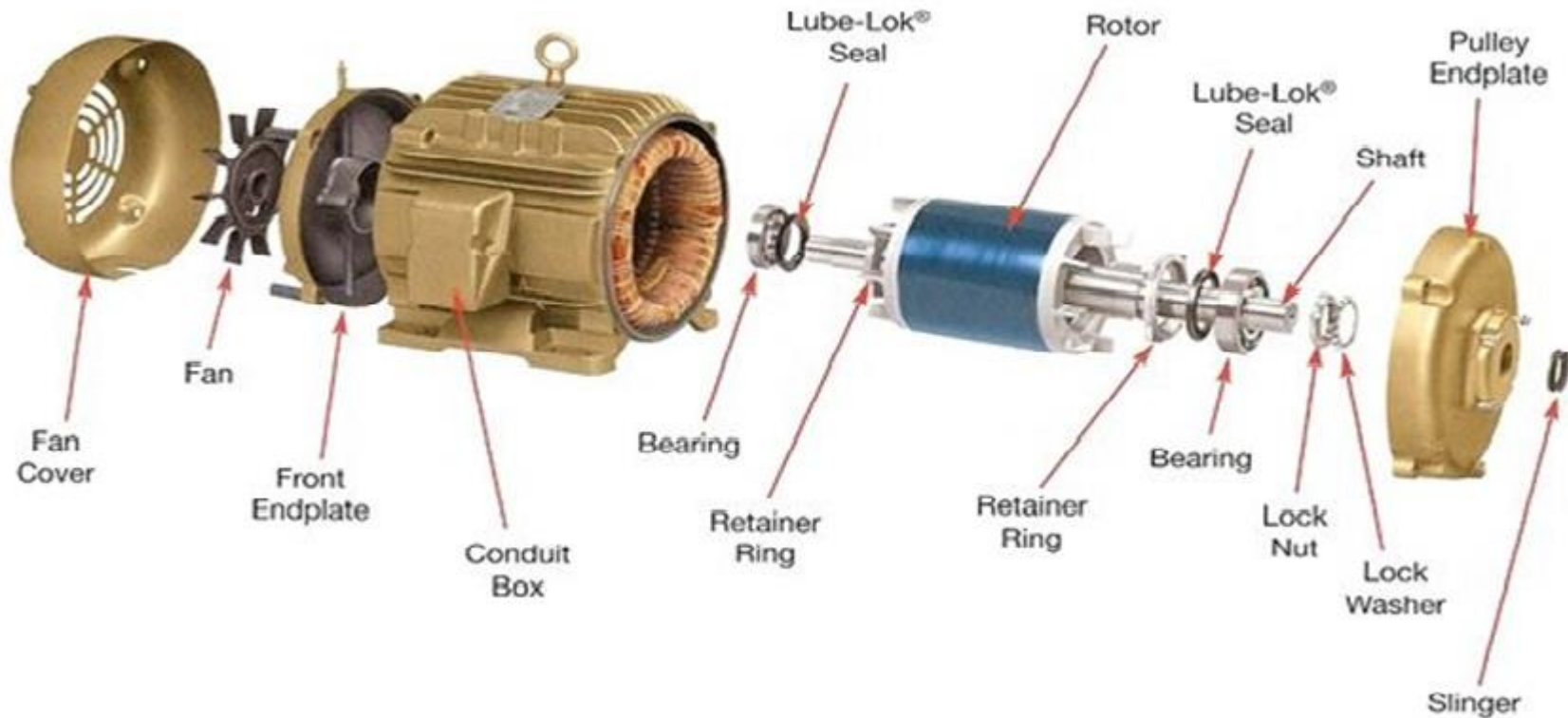
The Coming Disruptive EV revolution



The Internal Combustion Engine(ICE)

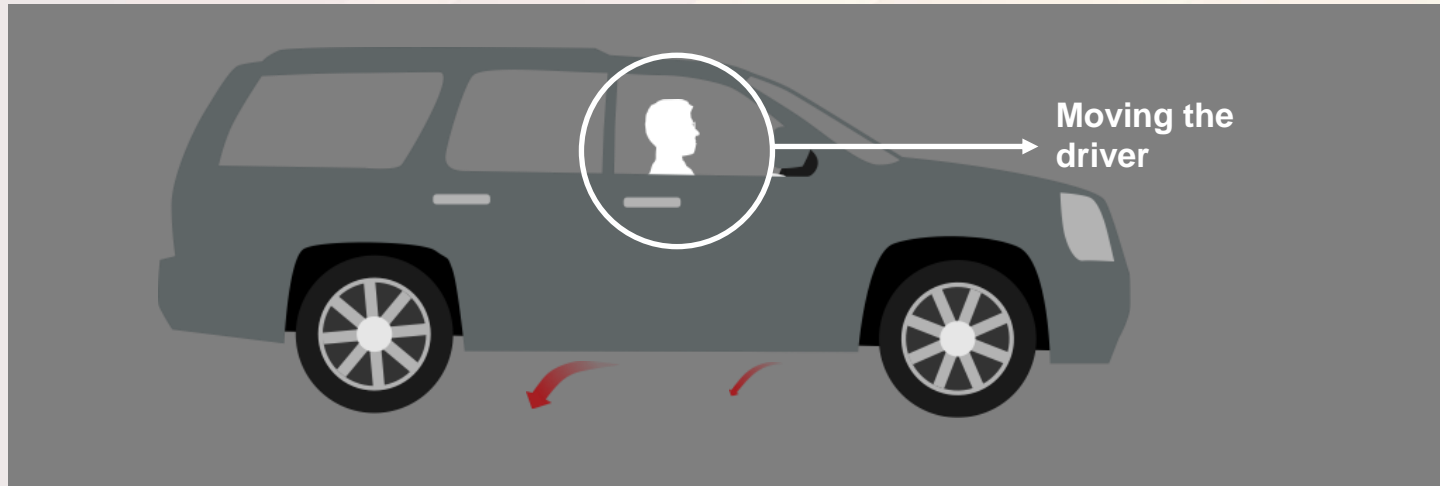


The disruption of vehicle manufacturing logistics



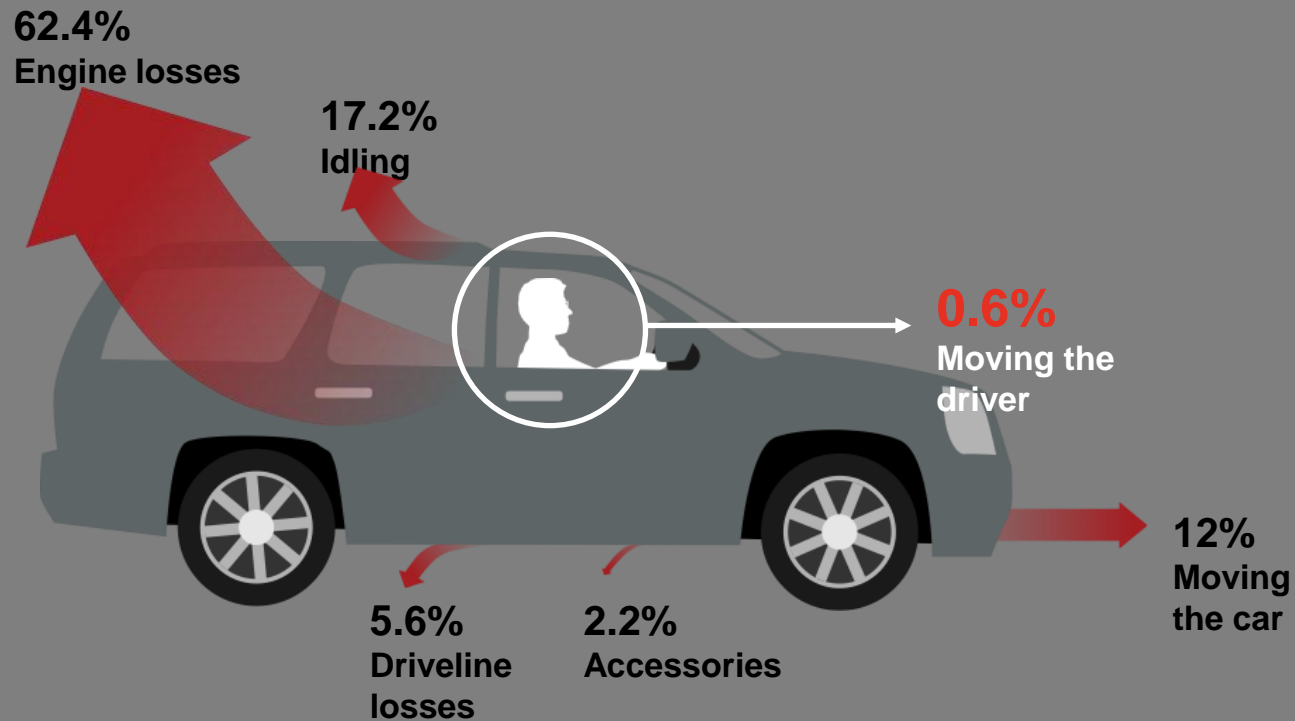
What percentage of the energy is used to move the driver in a gasoline car?

1. Less than 1%
2. About 10%
3. Between 10% - 20%



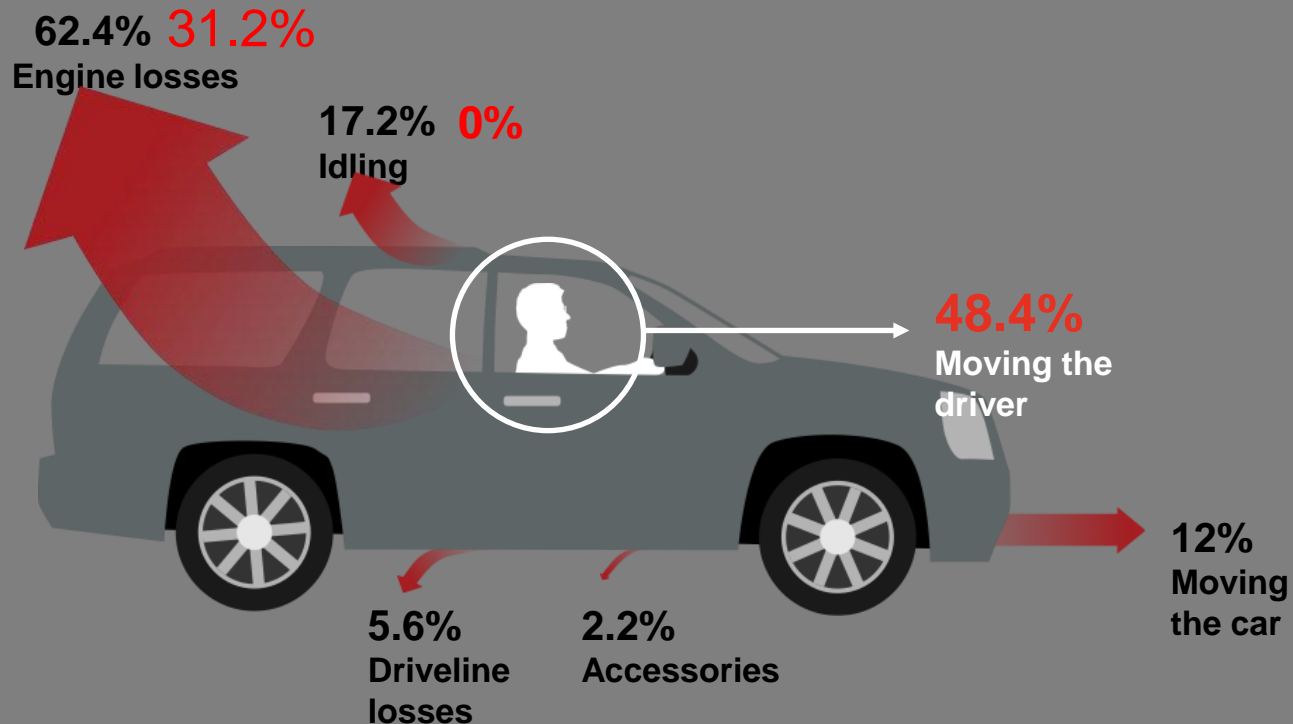
Source: U.S. Department of Energy; Amory Lovins, Rocky Mountain Institute

Gasoline Energy Efficiency?



Source: U.S. Department of Energy; Amory Lovins, Rocky Mountain Institute

Where Does the Energy Go in an EV?

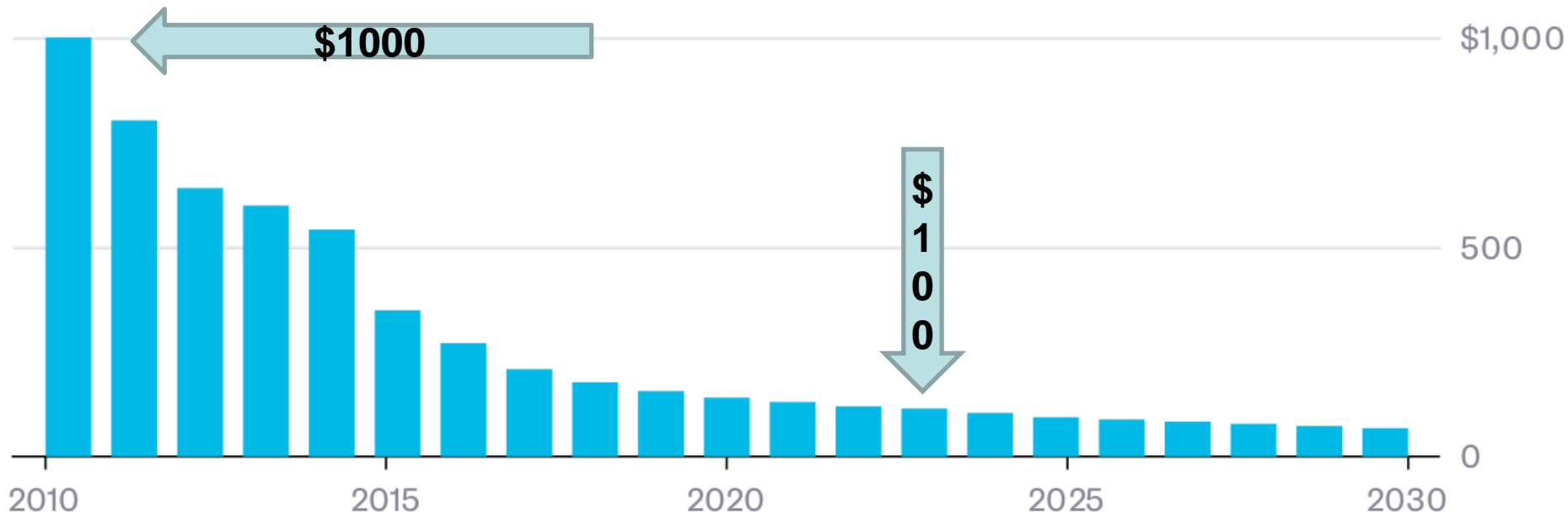


Source: U.S. Department of Energy; Amory Lovins, Rocky Mountain Institute

Battery Cost Reduction

Cheaper Batteries

The cost of storing a kilowatt-hour of electricity has plunged and is expected to drop further

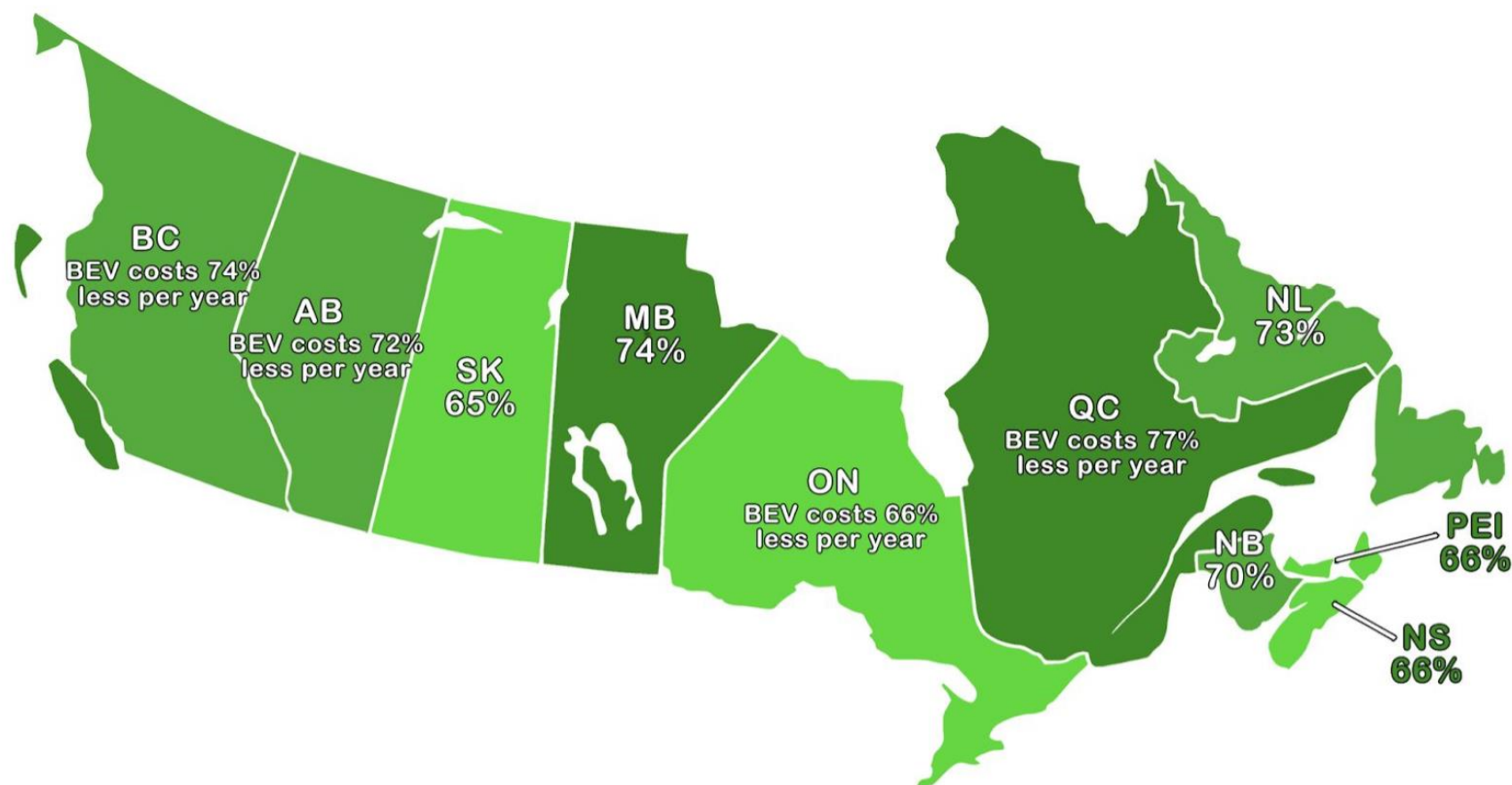


Note: Figures for 2018 and beyond are projections

Source: BNEF

BloombergQuickTake

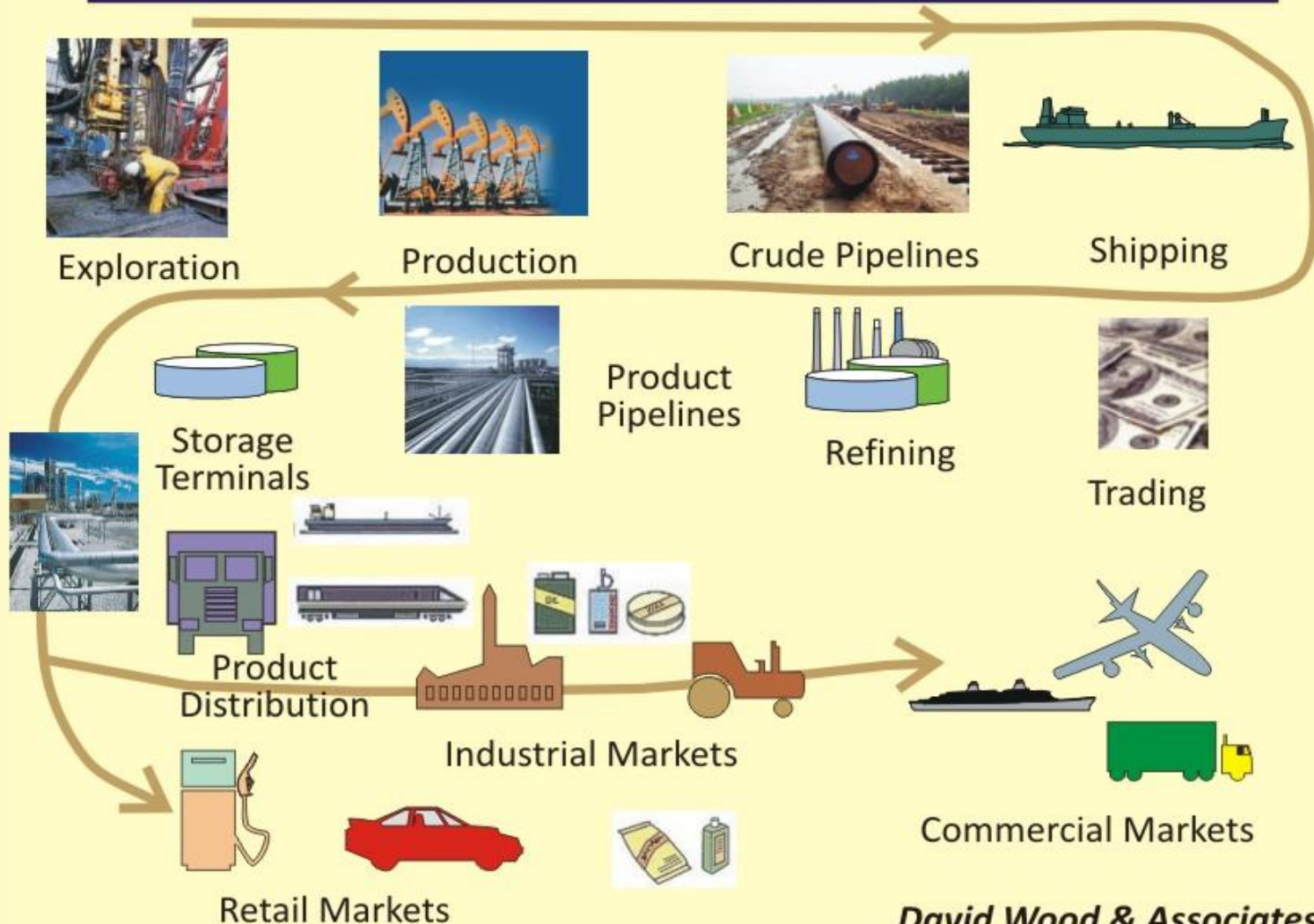
Figure 1: Annual Savings in Fuel and Maintenance of BEVs Compared to ICEVs by Province



How would you know about operational crossover?



Oil Supply Chain



David Wood & Associates

More Sustainable Energy Production



Paradigm Shift



50,000 Kms

The Dark Horse of EV Adoption



London's Clean Air Drive

ADVERTISEMENT FEATURE



LET'S CLEAR THE AIR

London's air quality is damaging our health. Here, we fill you in on all you need to know about the air quality crisis in the capital, and tell you what we can all do to improve it

So, how bad is our air?
Air pollution affects every borough in London. In fact, more than 2 million of us – including around 400,000 London children – are living in areas which exceed the legal limits for air pollution.

Why is it a problem?
The huge levels of pollutants in London's atmosphere are causing thousands of premature deaths, costing our economy up to £3.7 billion every year. Being exposed to these high levels can increase your risk of developing a number of health problems. But the worst thing is that children are the most vulnerable to the effects of air pollution. A recent study showed that children who grow up in polluted areas have a five per cent smaller lung capacity than those who live in areas with cleaner air.

What's causing it?
The single biggest contributor to London's air pollution levels is road vehicles. It's estimated that 5.8 million car journeys are carried out in the city daily, and many of these vehicles are pumping out deadly levels of nitrogen oxides. These can cause headaches and coughs, reduced immunity and can worsen lung conditions such as asthma and chronic obstructive pulmonary disease (COPD). Vehicles also emit minute particles, such as bits of metal, which are tiny – but can still have a massive impact on our health. They are small enough to bypass our nose and throat – which usually filter out larger particles – and find their way into the lungs and can pass into the bloodstream.

WHAT'S BEING DONE?
TfL and the Mayor of London are taking action to help clear up our toxic air:

- The world's first Ultra Low Emission Zone (ULEZ) in Central London has been introduced, which is expected to reduce harmful nitrogen oxide emissions by 45 per cent.
- All new licensed taxis must be much cleaner 'zero-emission capable' vehicles.
- Major extensions to London's cycle superhighways have been opened and free cycle skills training is being provided to make cycling easier for Londoners.
- £48 million has been pledged to help small businesses, charities and those on low incomes switch to a greener car, and rapid charge points for electric vehicles are being installed across the city.
- The £22 million Mayor's Air Quality Fund helps support boroughs tackling pollution hotspots. Projects already funded include the creation of Low Emission Neighbourhoods and a pan-London anti-idling campaign.
- 75 per cent of all TfL double-deck buses now meet or exceed new emissions standards.

MYTH BUSTERS
Let's clear up a few myths about London's air quality:

- 31 per cent of people believe only central parts of London are affected by air pollution – this is false. All areas of London are affected by pollution at high levels.
- 32 per cent of Londoners don't believe switching their engines off while stationary can help reduce pollution – this is false too. Switching engines off has been shown to significantly reduce pollution levels.
- Over 90 per cent of people believe they can see when air pollution is bad in London. This is false – sometimes pollutants can cause the air to be hazy, but most of the time you can't see it.

TIPS FOR YOU
Make a difference to London's air quality by making small changes to your daily routine. Check out these easy tips:

- Improve your fitness, save yourself some money and avoid polluting the air by choosing to cycle or walk wherever and whenever possible.
- Make the most of TfL's public transport services 24 hours a day with its night-time services, like the Night Tube, which is available at off-peak rates.
- Consider joining a car club – it's a cost-effective and flexible alternative to owning a car. Many car-clubbers also offer cleaner vehicle options.

MAYOR OF LONDON  TRANSPORT FOR LONDON
© 2017. LONDON AIR QUALITY

For more information visit tfl.gov.uk/air-quality



 **Transport for London**

Ultra low emission

ZONE

At any time

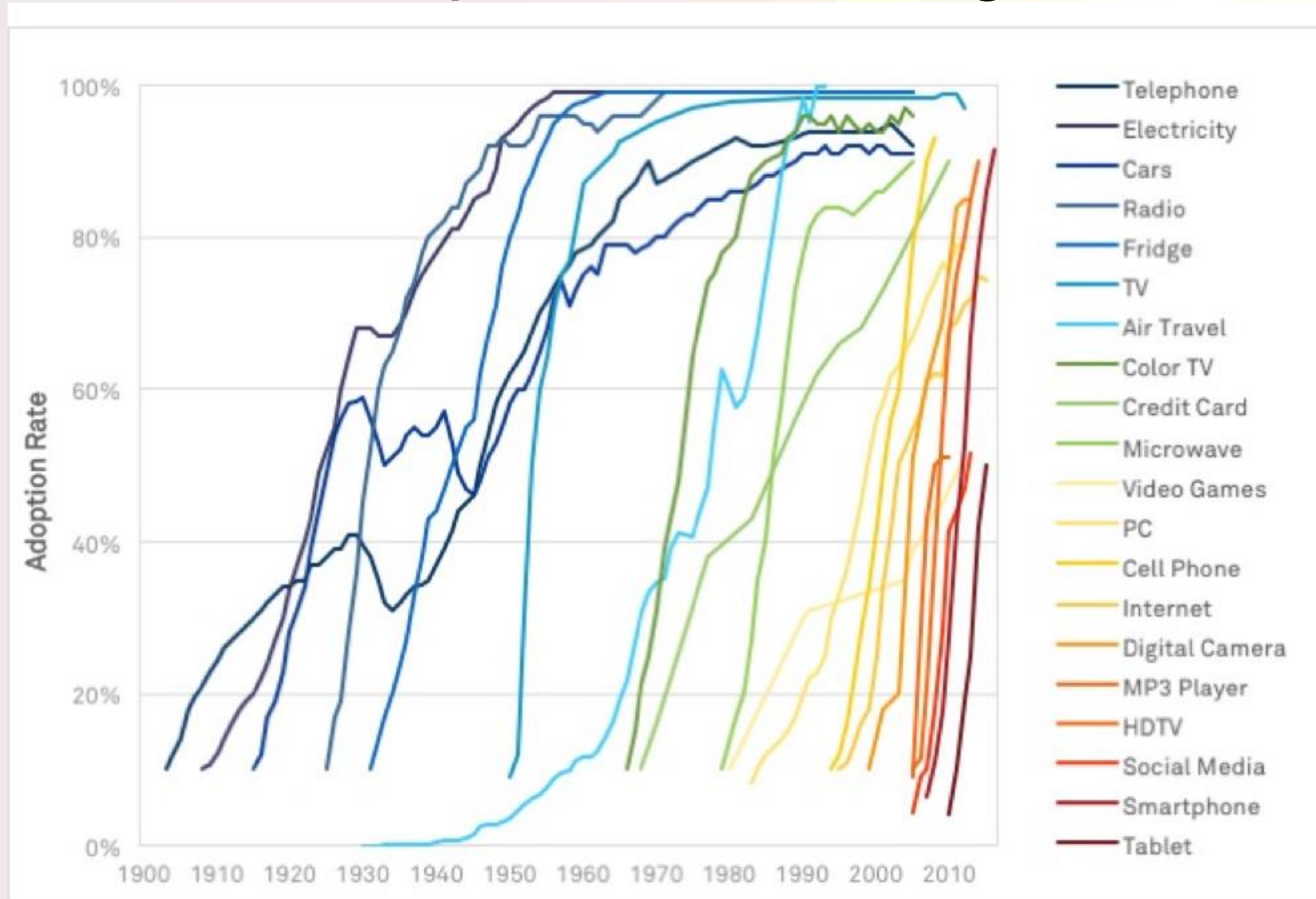
London's plan to fight Poor Air Quality



The Mayor of London
just announced 50,000
EV chargers by 2025



Disruptive Technologies



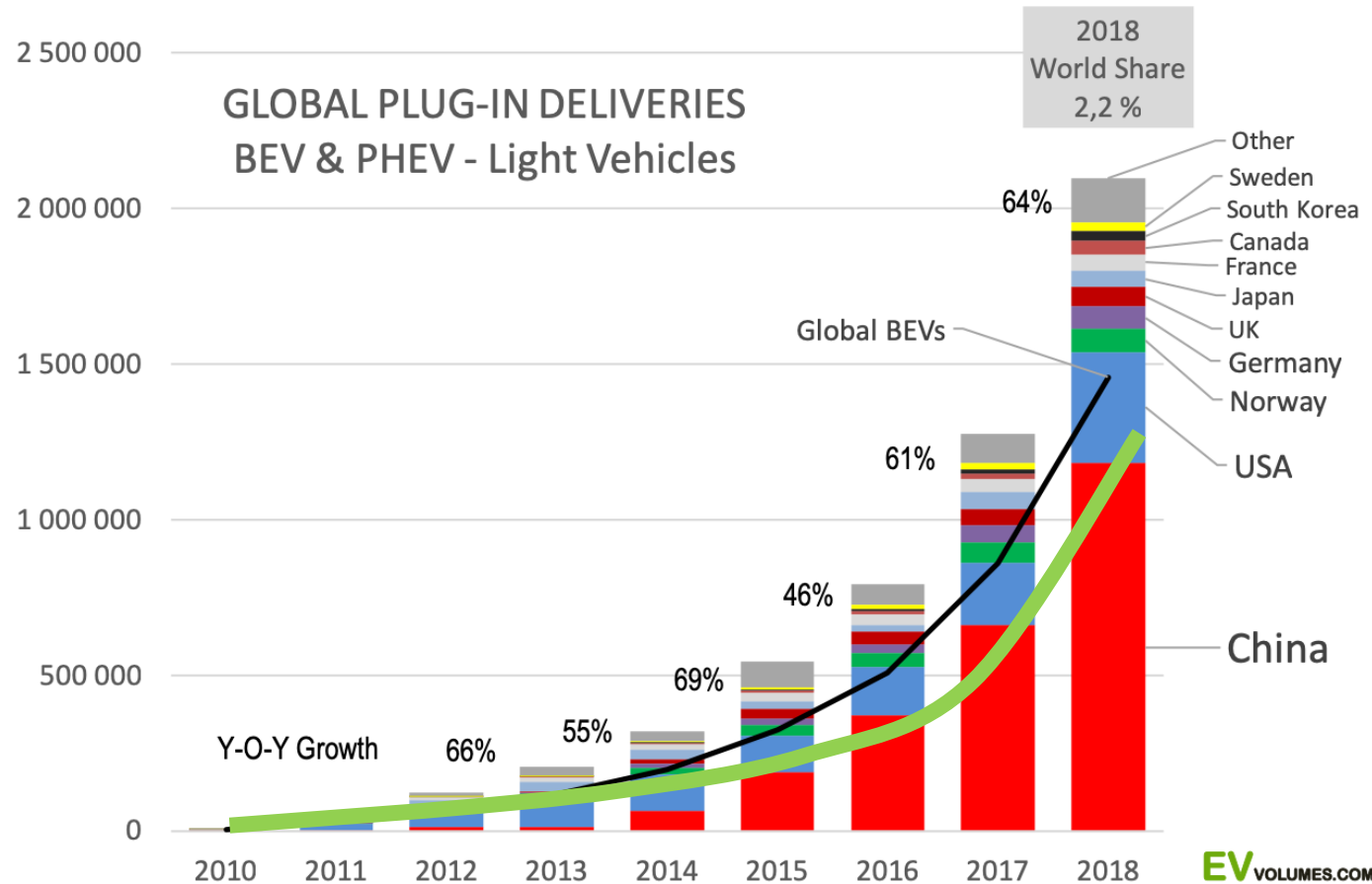
Source: Asymco

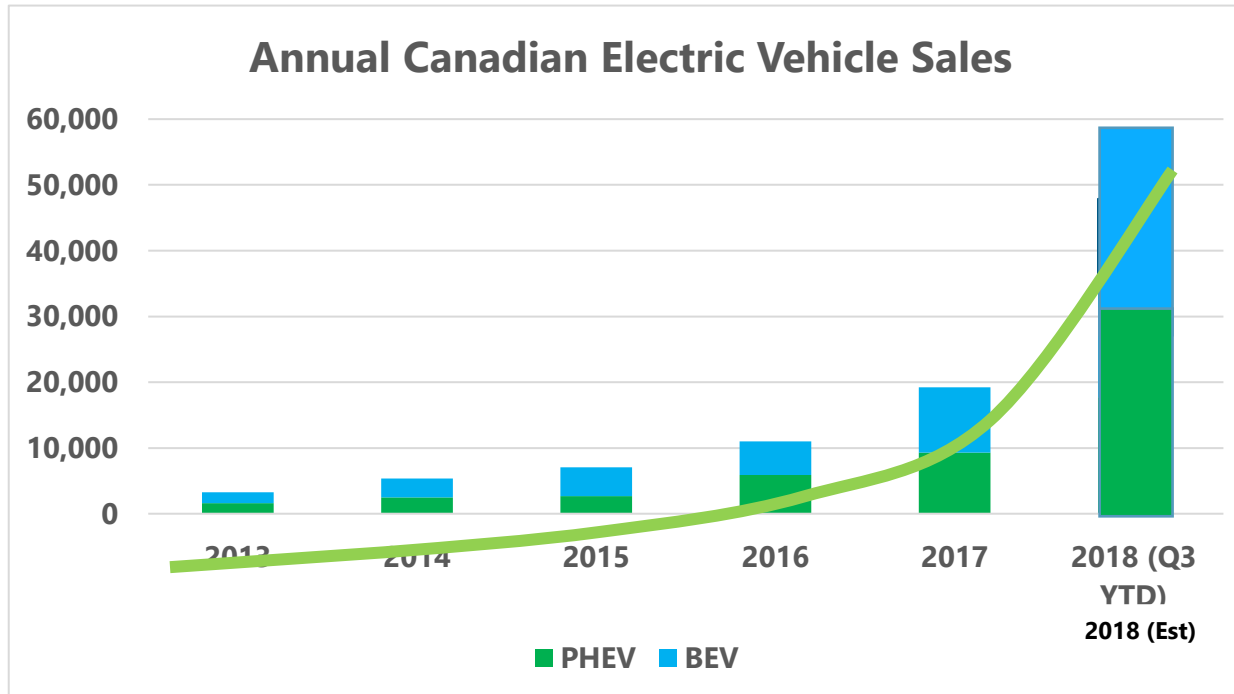
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What of those 3 factors is the most important in driving EV sales?



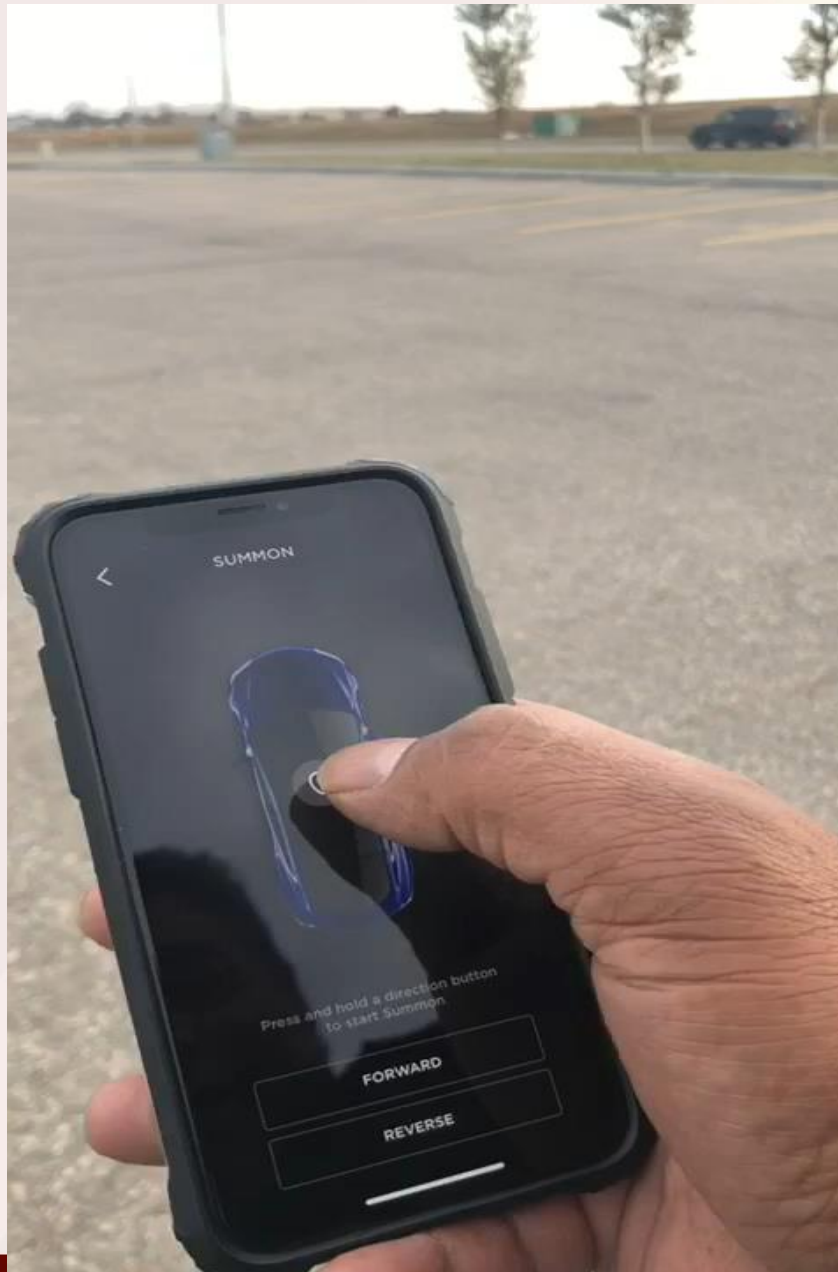
4. None of the above





<https://www.fleetcarma.com/>

TAAS



**Transportation
as a
service**