

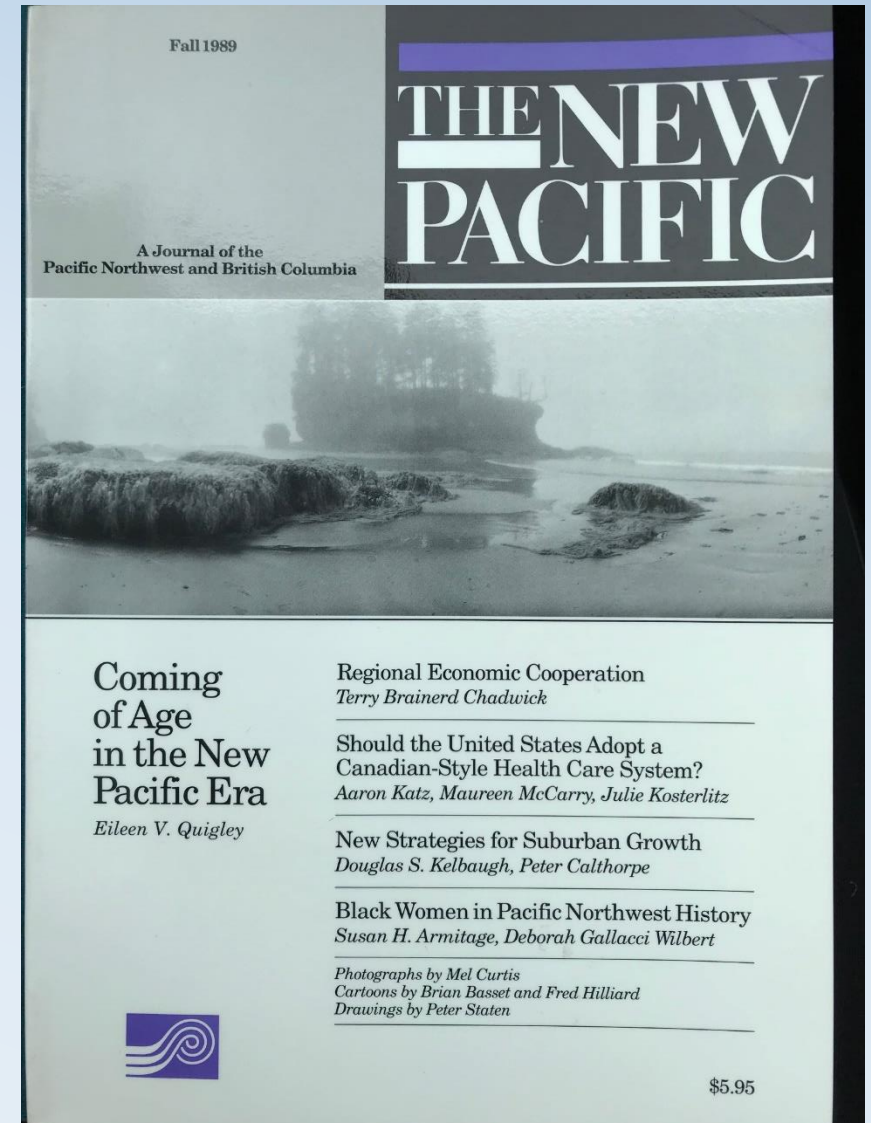
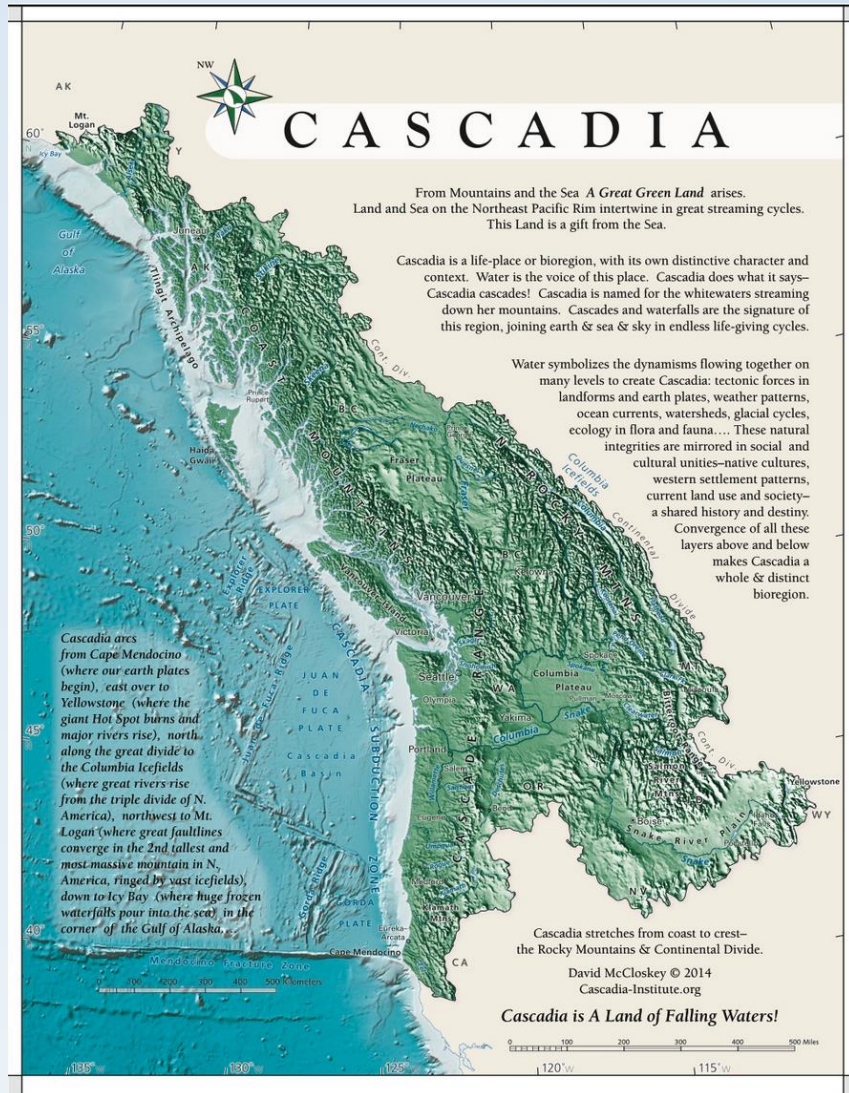
Build it and They Will See

Eileen V. Quigley
Portland State University
February 19, 2018

Clean Energy
Transition

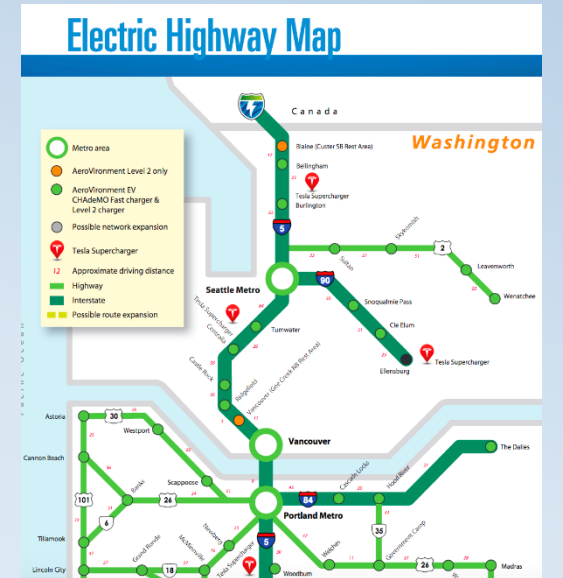


Cascadia 1989



Agenda

- Low-Carbon Pathways
- Cascadia Electricity Advantage
- Cascadia Transport Opportunities
- Cascadia Green Building
- Discussion



Low-Carbon Pathways

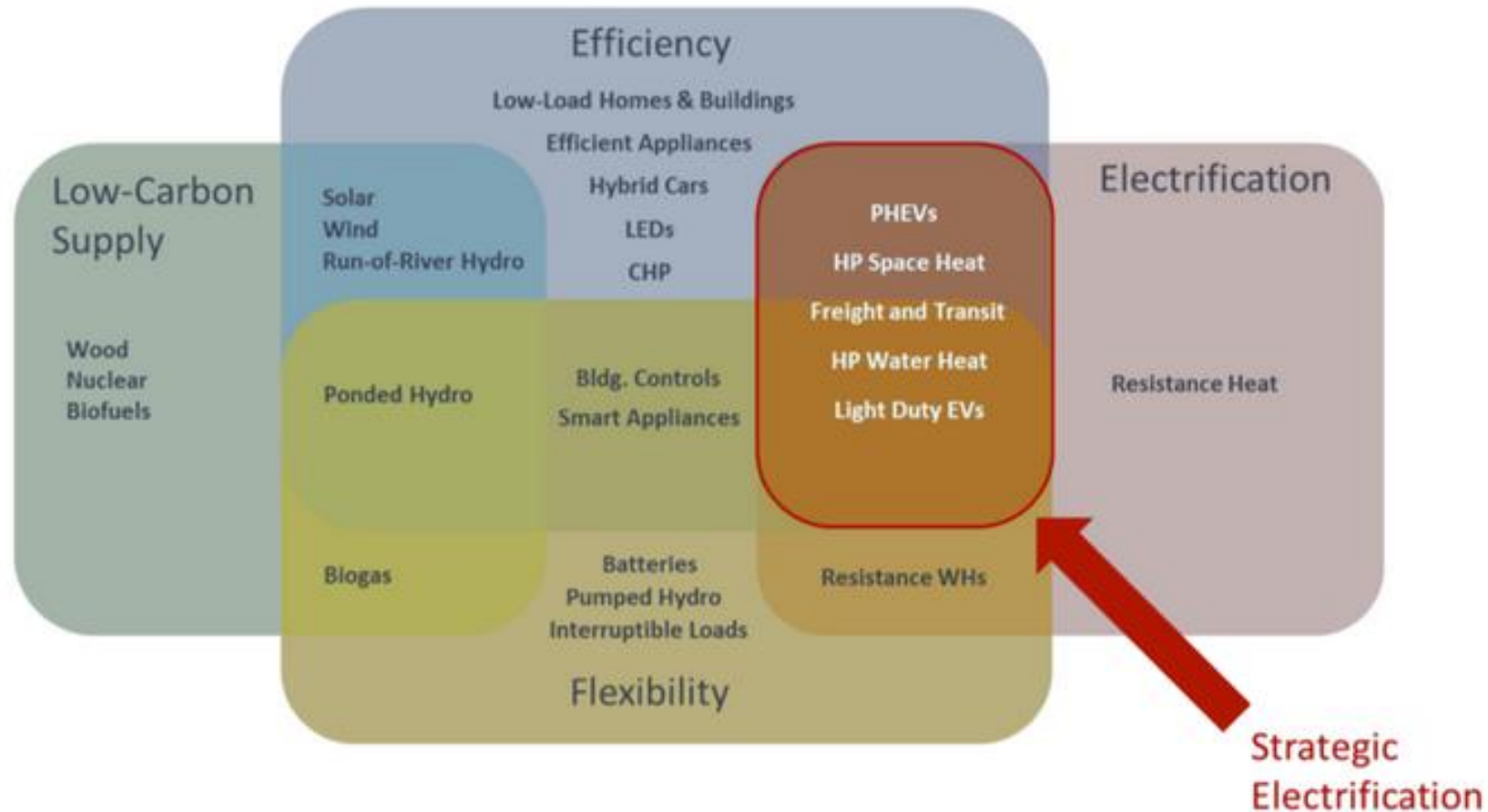
- Efficiency & Conservation
- Fuel-Switching
- Decarbonizing Electricity
- Decarbonizing Liquid & Gas Fuels
 - Applied to all sectors



Electrify (almost) Everything



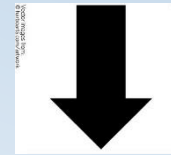
Strategic Electrification



Strategic electrification in the context of decarbonization. Graphic: Northeast Energy Efficiency Partnerships

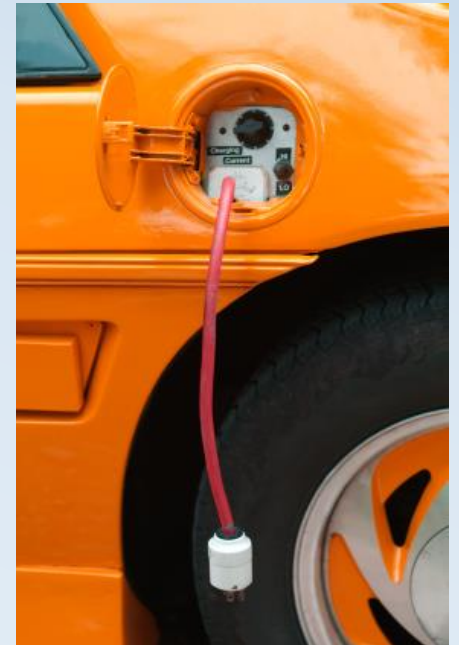
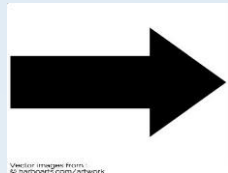
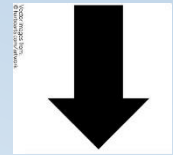
Why Electrify Everything?

- Growing understanding of the need for a path to zero-carbon electricity
- Know how to achieve zero carbon electricity (wind, solar, nuclear, hydro, geothermal, coal/gas with CCS)



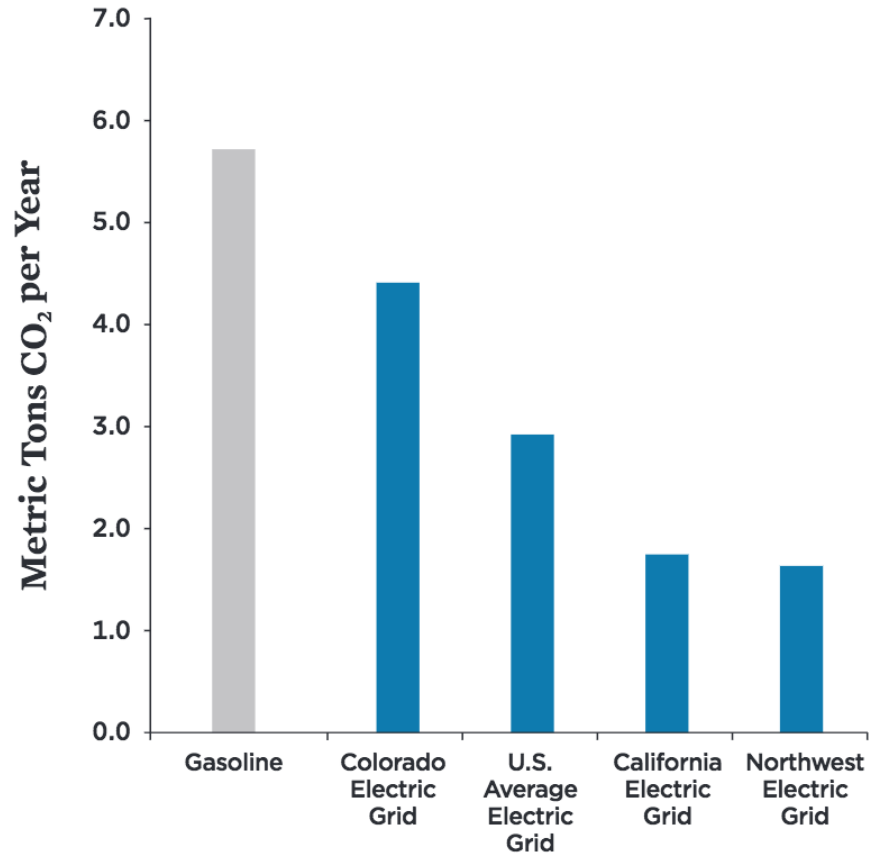
How Clean the Grid is Crucial

- As the grid gets cleaner, whatever is powered by it, gets cleaner
- Profound implications



Fuel Switching: Electricity

FIGURE 19. Electricity Is Cleaner than Gasoline



Cars that run on gasoline put out more emissions than even electric cars charged in areas where coal is the biggest source of electricity. When electricity is created from cleaner sources, emissions are reduced further.



EVs as Storage

- Cars parked an average of 95% of the time
- Leave EV plugged in when electricity could flow to power lines and back
- Decentralized storage of electrical energy
- Throttle charging rate (known as vehicle-to-grid (V2G))
- Need the batteries to get to the stage where they can provide this service

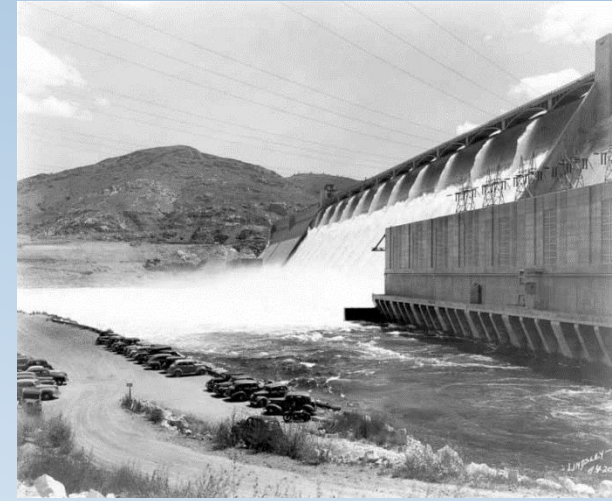


Cascadia's Electricity Advantage



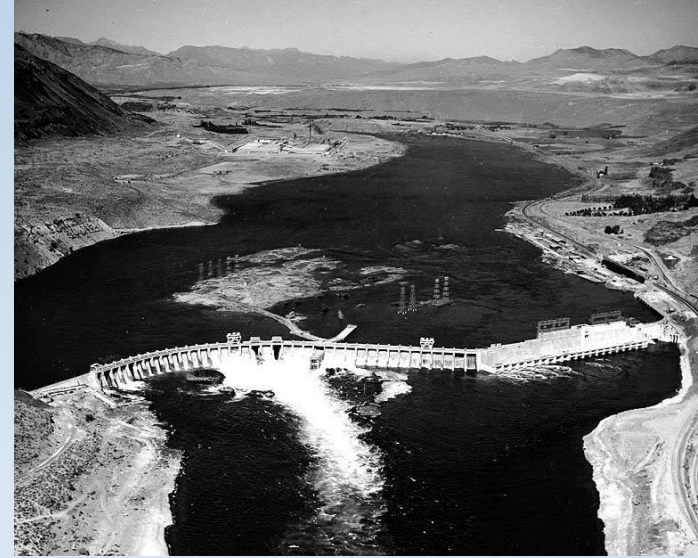
Cascadia's Key Characteristics

- History of federal power
- Cheap largely clean electric power
- Public (hydro) versus private (fossil)
- Nuclear
- Early clean energy leadership



Grand Coulee and Bonneville Dams

- 1932 FDR and New Deal-post-Depression work program
- In 1933 Puget Sound Power & Light Company completed Rock Island Dam, first dam to span the mainstem Columbia River
- 1933 FDR approved Grand Coulee and Bonneville dams
- In 1934 construction began on the first two federal dams
 - ✓ Bonneville (first power house 1938:526.7 MW; second power house 1983 (558.2 MW)
 - ✓ Grand Coulee dam (first and second power house 1941: 2,280 MW; third power house 1974: 3,900 MW later upgraded+ 315 MW) Also 600MW of pumped hydro capacity.

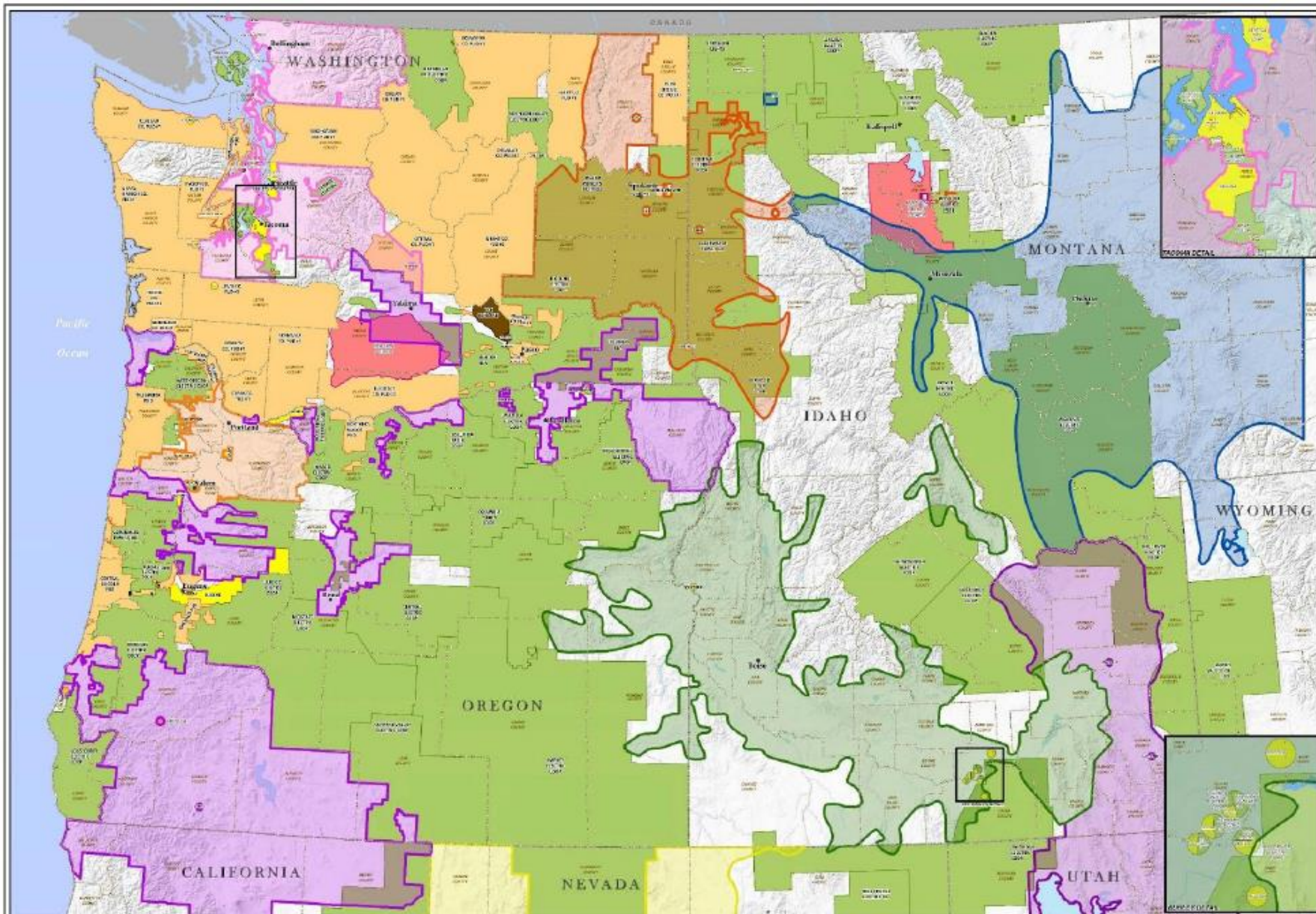


Development of Columbia River System

- Pacific Northwest Regional Planning Commission—1 rep each WA, OR, ID, MT—part of National Resource Planning Board (1933)
- PNW commission 12/28/35 report recommended independent federal agency market the power from Bonneville and Grand Coulee dams.
 - ✓ Modeled after the Panama Canal Company; operate generators; build & operate regional transmission
 - ✓ Commission recommended power be sold for its cost of generation, not at a market rate, and preference given to public utilities for the federal power.
- Congress passed The Bonneville Project Act in 1937







Public, Tribal and Investor Owned Utility Service Areas

Tribal Utilities

Tribal

Public Utilities

Cooperative
Public Utility District
Municipality
Federal

Investor Owned Utilities

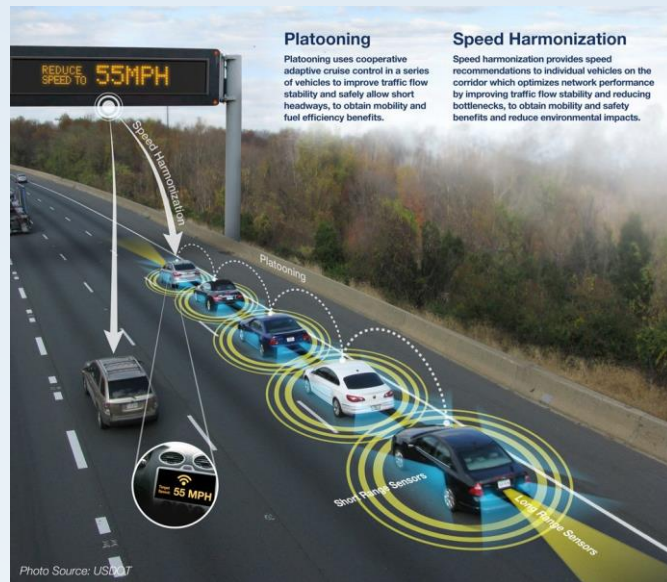
Avista Energy
Baker Power Company
Northwestern Energy
PacifiCorp
Portland General Electric
Puget Sound Energy
Rocky Mountain Power (PacifiCorp)
Salem Pacific Power



Comparative Electricity Rates

State	Average Retail Price (cents/kWh)
Idaho	8.08
Montana	8.84
Oregon	8.83
Washington	7.68
Average Northwest	8.36
Average United States	10.27
California	15.23

Electric Highway and High Speed Rail

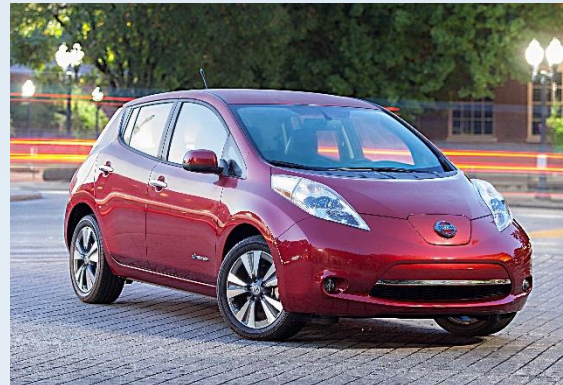


Cascade High-Speed Rail



Passenger Vehicles—EVs and AVs

- Light duty vehicles account for 61% of transportation emissions in the U.S.
- United States EV sales increased 37% in 2016 compared to 2015.
- Autonomous vehicles are an emerging opportunity and challenge

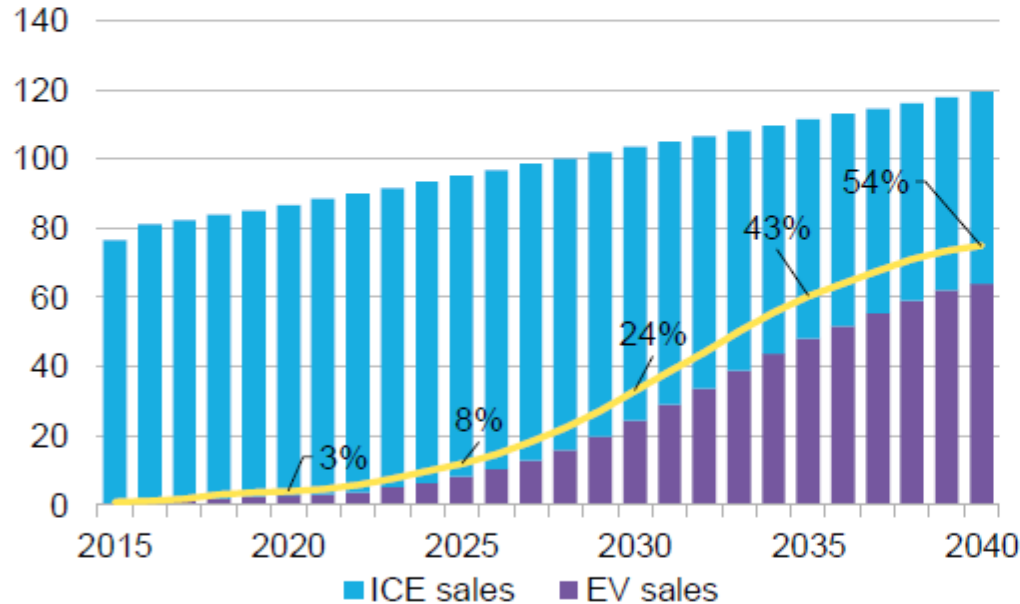


Bloomberg 2040 EV Outlook

Electric vehicle outlook to 2040

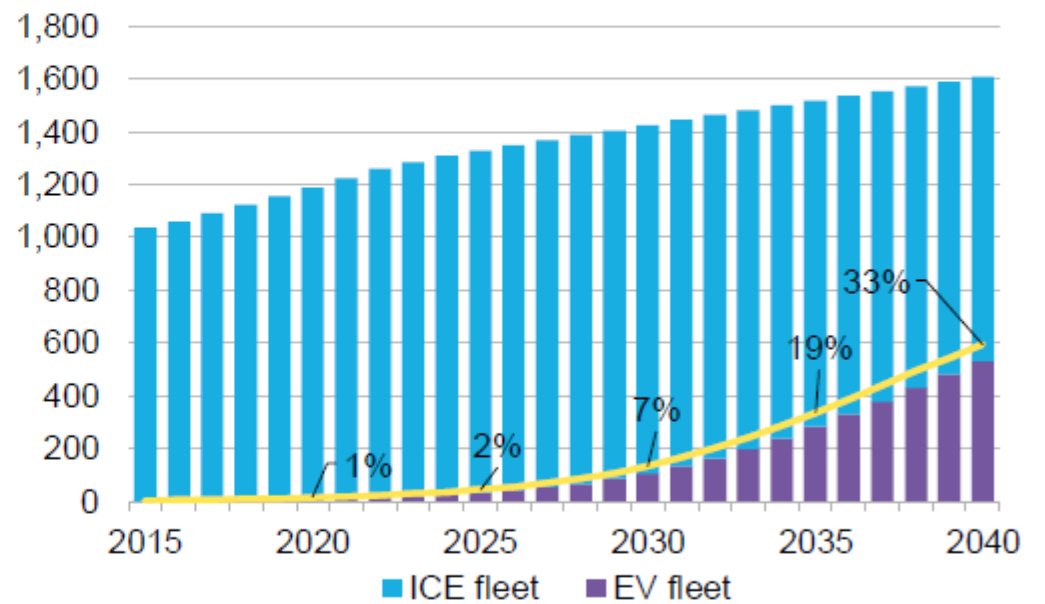
Annual global light duty vehicle sales

million vehicles



Global light duty vehicle fleet

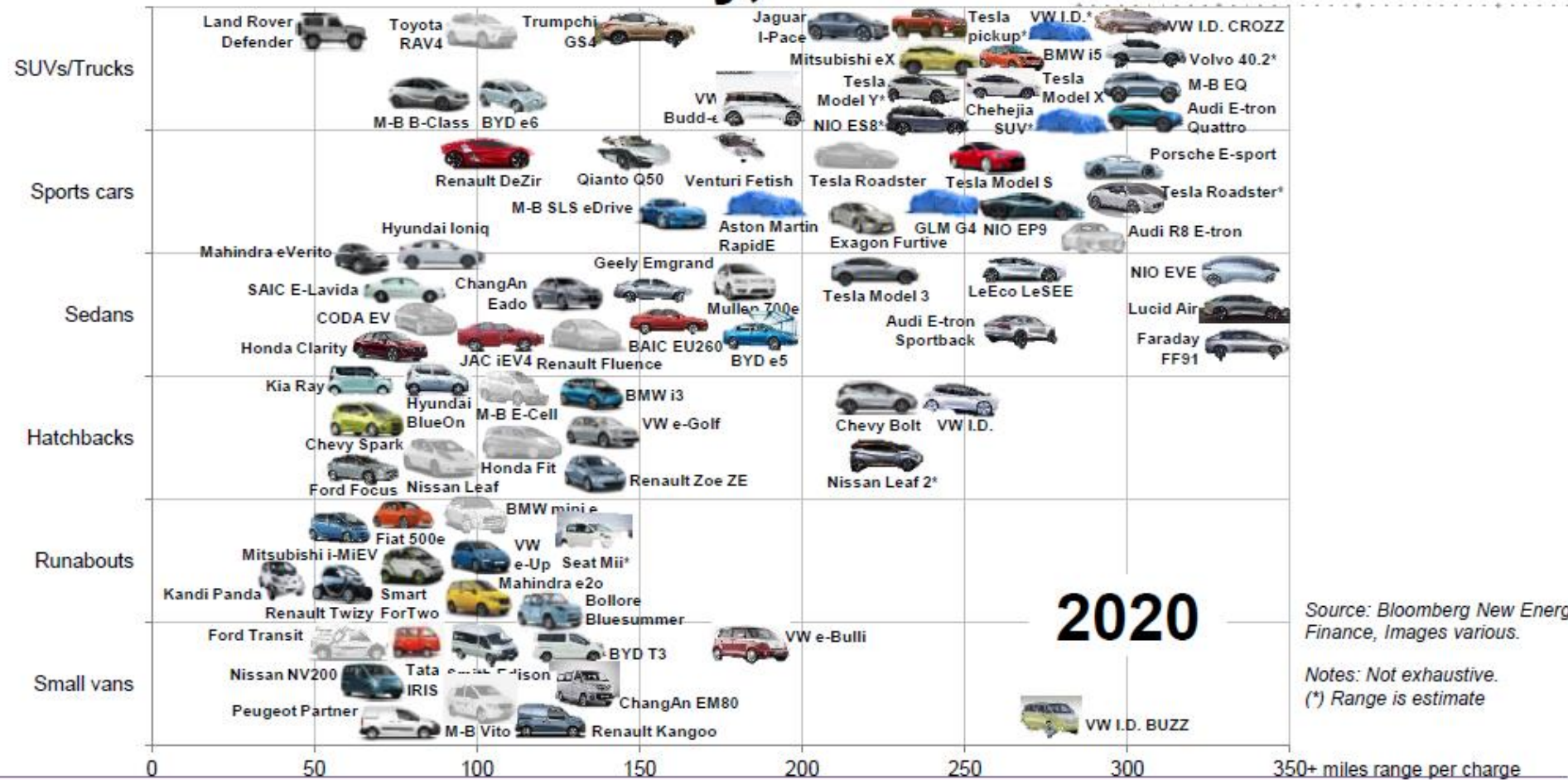
million cars on road



Source: Bloomberg New Energy Finance EVO 2017

Battery Electric Vehicle Model Availability

BEV model availability, 2008-20



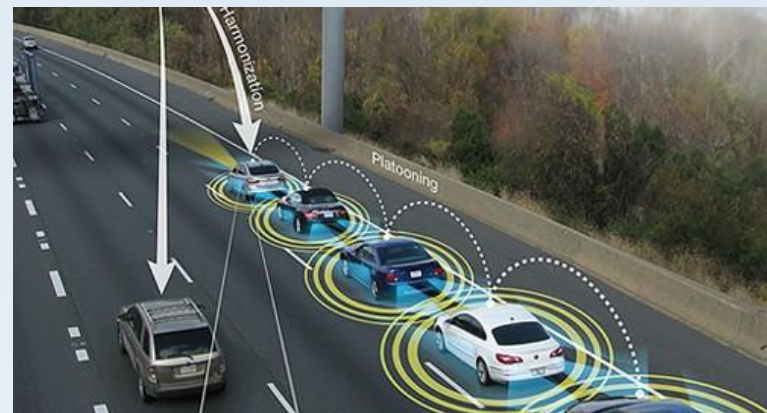
Source: Bloomberg New Energy Finance, Images various.

Notes: Not exhaustive.
(*) Range is estimate

2017 Electric Car Models

- [EMVC SOLO](#) \$15,500, 16 kWh battery, 100 miles (EPA), 150 MPGe, kW motor
- [Mitsubishi i-MiEV](#) \$23,845, 16 kWh battery, 59 miles (EPA), 112 MPGe, 49 kW motor
- [Ford Focus Electric](#) \$29,995, 33.5 kWh battery, 115 miles (EPA), 107 MPGe, 107 kW motor
- [Nissan Leaf](#) \$31,545, 30 kWh battery, 107 miles (EPA), 112 MPGe, 80 kW motor
- [Fiat 500e](#) \$32,780, 24 kWh battery, 84 miles (EPA), 112 MPGe, 83 kW motor
- [Kia Soul EV](#) \$32,800, 27 kWh battery, 93 miles (EPA), 105 MPGe, 81 kW motor
- [Chevrolet Bolt EV](#) \$37,495, 60 kWh battery, 238 miles (EPA), 119 MPGe, 150 kW motor
- [Mercedes-Benz B250e](#) \$40,825, 28 kWh battery, 87 miles (EPA), 84 MPGe, 132 kW motor
- [BMW i3](#) \$43,395, 22-33 kWh battery, 81-114 miles, 118-124 MPGe, 125 kW motor
- [Tesla Model S](#) \$69,200-\$135,700, 60-100 kWh battery, 210-315 miles (EPA), 98-104 MPGe, 234-396 kW motor

Autonomous Vehicles



Cause Traffic and More Driving



Brown's EV target for California

- 5 million EVs by 2030
- \$2.5B in next 8 years
- 250,000 charging
- 200 hydrogen fueling



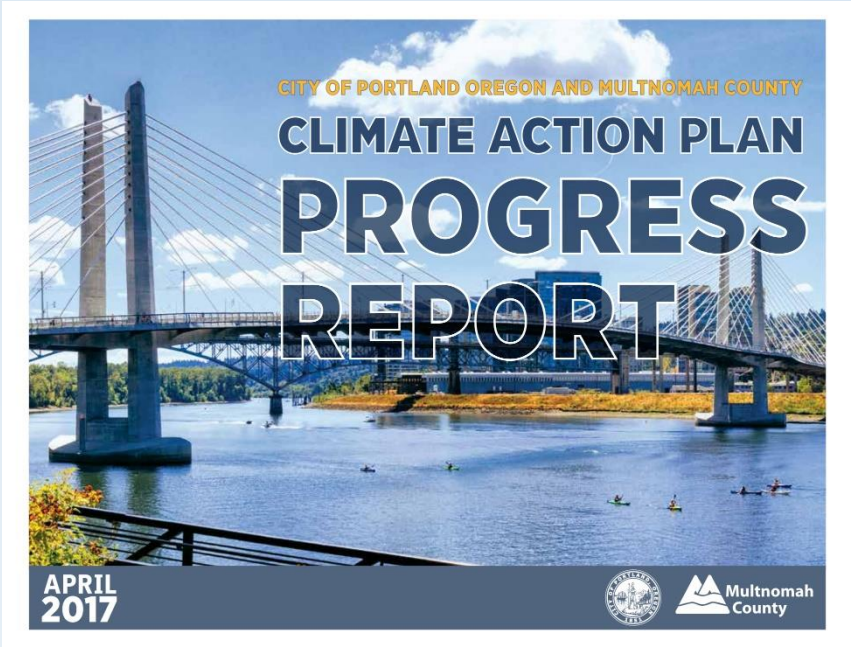
Cascadia Technology Assets



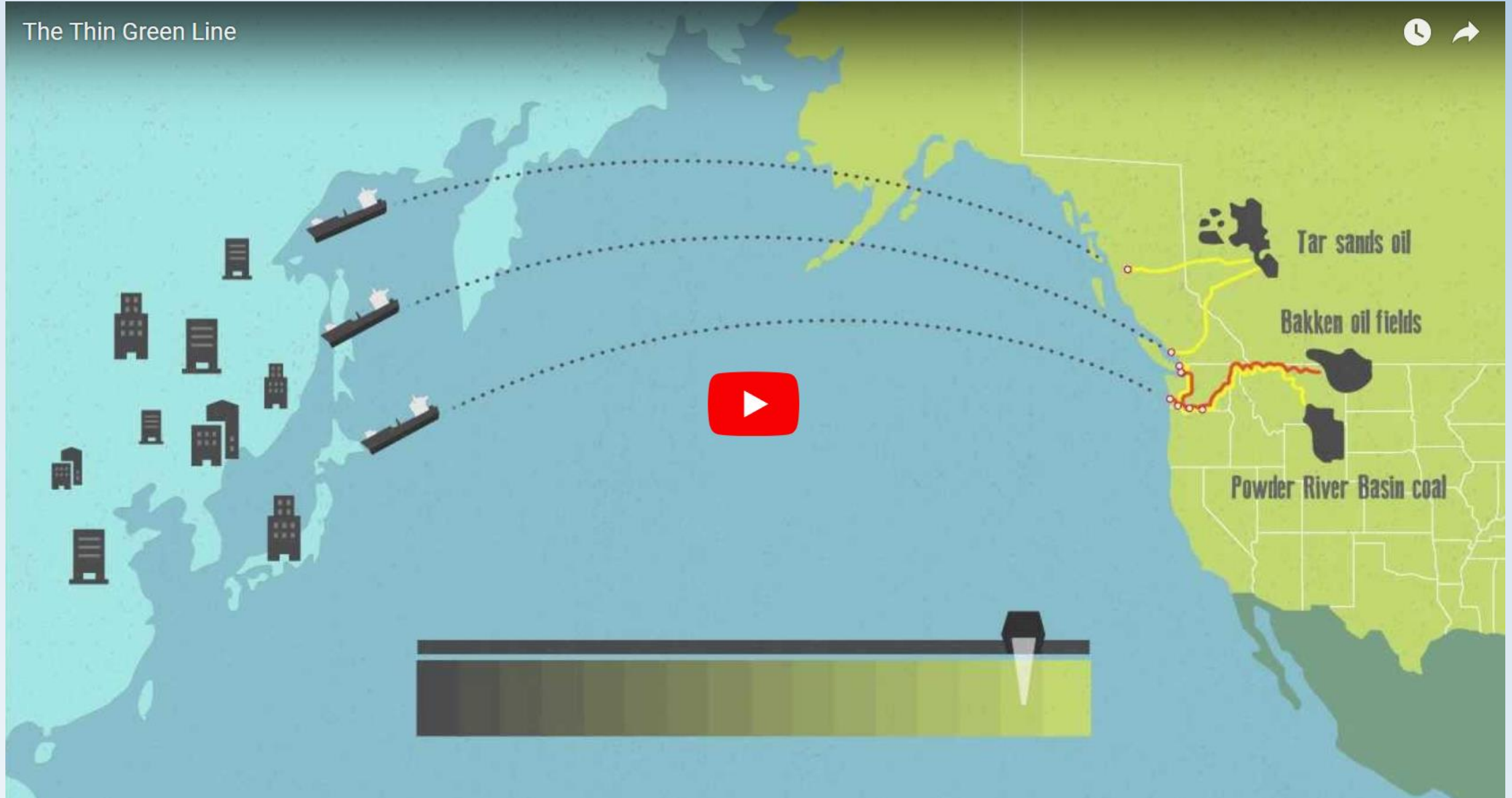
Cascadia Electric Highway



Cascadia Climate Leadership



Cascadia Thin Green Line



West Coast Climate Action

- Price on Carbon
 - ✓ Vancouver, B. C.: Carbon tax
 - ✓ California: Cap & trade
 - ✓ Washington & Oregon: Bills in session now
- Clean Grid
 - ✓ Oregon: 50% Renewable Grid by 2030
 - ✓ California: 50% Renewable Grid by 2030
 - ✓ Washington: 100% Clean Grid by 2050-bill in session now
- Clean Fuels Standard
 - ✓ Requires refineries to achieve carbon intensity reduction in fuels of 10% by 2028
 - ✓ Washington the only West Coast state without CFS





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