Northwest **Power** and **Conservation** Council

April 4, 2017

MEMORANDUM

TO: **Council members**

FROM: **Massoud Jourabchi, Steven Simmons**

SUBJECT: **Report on Electrification of Transport Systems in the Northwest**

BACKGROUND:

Presenters: Massoud Jourabchi and Steven Simmons

Summary: Council staff has been following issues related to the electrification of the transport system for the past seven years. In this presentation we will update the Council on national and regional developments and investigate opportunities and costs for electrification of public and school transportation. The analysis shows there are significant gains in terms of reduced costs for operation, maintenance and fueling buses, and there is significant reduction in CO2 emission. Staff will also present on the transportation modeling enhancements in preparation for the 8th plan.

Relevance: Electrification of transportation system impacts load forecast and increasing efficiency in transportation.

Workplan: Action item ANLYS-5 calls for enhancement of modeling of electrification of transportation system.

Background: Transportation system are major contributor to CO2 emissions. In the past reports to the Council, staff has shown that through the electrification of passenger and light duty vehicles, states can create a win-win energy/transportation policy. This presentation expands the analysis to public transportation systems (school and urban buses).

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Electrification of NW Transportation System

April 2017
Missoula Montana
Massoud Jourabchi
&
Steve Simmons

Northwest Power and Conservation Council

In this presentation

- Update on 2016 Market trends
- Economic analysis of opportunities for electrification of transport system in the NW.
  - Passenger and Light duty vehicles.
  - Public transportation system both urban transit and school buses
  - Costs and Benefits
  - 8th Plan enhancements

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National Picture

- New vehicle sales were strong in 2015 and 2016 but lower than 2014.
- Fuel economy of new cars is over 29 mpg.
- Improvement in carbon footprint for new passenger and light duty vehicles
- Operating Costs per mile total per mile ~76 cents

NW picture

- As of 2016 there were about 12.8 million automobiles and light duty trucks in the four states.
- These automobiles and trucks traveled over 115 million miles (highway travel).
- As of 2014, region spent $14 billion dollars in purchasing gasoline
- Region has spent over $223 billion dollars in purchasing gasoline over the past 20 years.
- Over the next 20 years, the current stock of vehicles is expected to be totally replaced.
- Transportation sector produces about 80 million metric tons of CO2 per year, 63 millions of metric tons of which is from motor gasoline use.

Regional Sales Continuing to Increase

MT
Montana

ZEV Sales
0.17% new vehicles sold YTD 2016
102 ZEVs sold YTD 2016
439 ZEVs sold since 2011

ID
Idaho

ZEV Sales
0.37% new vehicles sold YTD 2016
198 ZEVs sold YTD 2016
679 ZEVs sold since 2011

OR
Oregon

ZEV Sales
1.93% new vehicles sold YTD 2016
3,093 ZEVs sold YTD 2016
11,077 ZEVs sold since 2011

WA
Washington

ZEV Sales
1.83% new vehicles sold YTD 2016
4,678 ZEVs sold YTD 2016
21,256 ZEVs sold since 2011

- By end of 2016 over 34,000 all electric and Plug-in hybrid electric vehicles were operating in the region.
- That is over 6% of nationwide sales
- Regional loads represented by these vehicles is about 8 aMW
- Most of the vehicles are charged off peak. Resulting an increase of 17 MW in off-peak loads.
- Reduction in CO2 estimated at 95,000 metric tons

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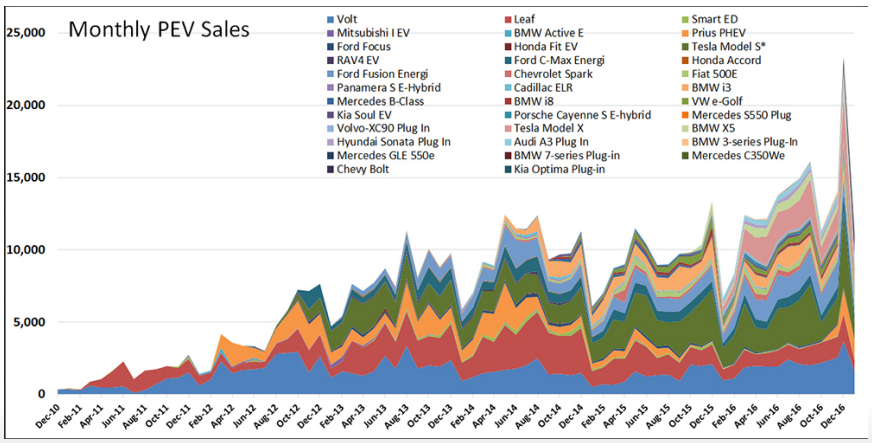
Number of options increasing



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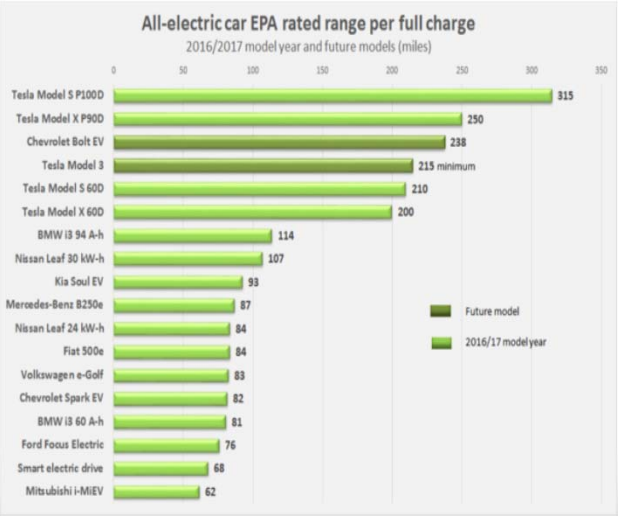
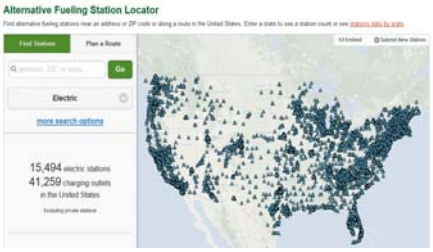
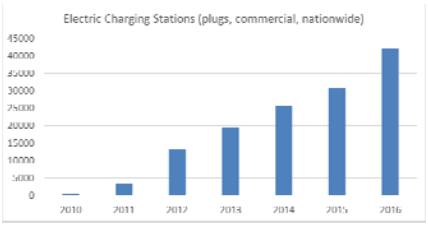
Range Anxiety is being reduced



Electric Charging Stations Expanding





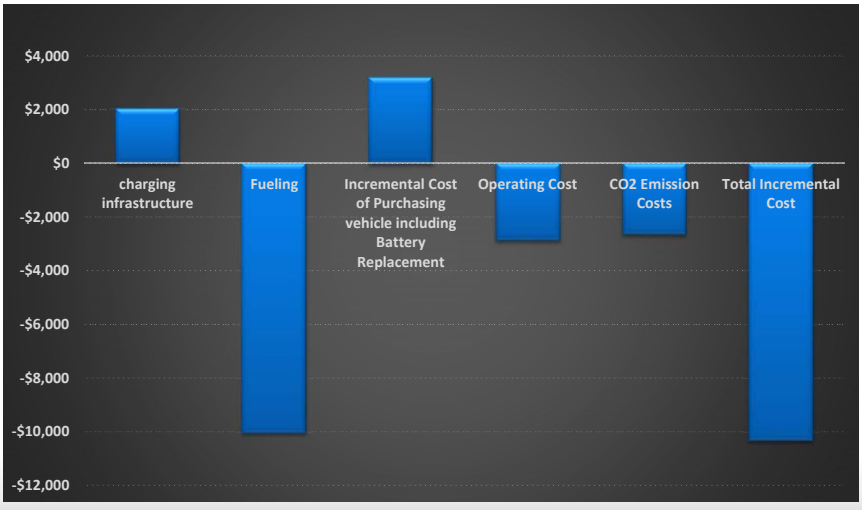
as of March 2017	Level 2	DC fast Chargers	Total *
ID	111	39	152
MT	42	44	86
OR	952	213	1314
WA	1487	154	1890
Total	2592	450	3442

*** includes 400 Level 1 chargers**

Opportunities for Electrification of the NW transportation System

- Electric and Plug-in passenger and light duty vehicles.
- Public transportation system
  - Urban transit
  - School buses

2015-2035 Sum of Annual Incremental Costs
EV over ICE Passenger and Light Duty Trucks
(millions of 2012 dollars)



Electrification of Buses

- Two types of buses were evaluated.
  - Urban Transit buses
  - School buses

How to power Buses quickly and efficiently
(Batteries + Supercapacitors)

- Buses can be powered by battery when they are at the depots.
- and they can be charged on route using supercapacitors.
- Supercapacitors can discharge lots of Current very quickly and repeatedly.
- Supercapacitors can be charged from the grid/renewable sources slowly.

Using supercapacitors for urban transportation in Geneva Switzerland

Chariot bus

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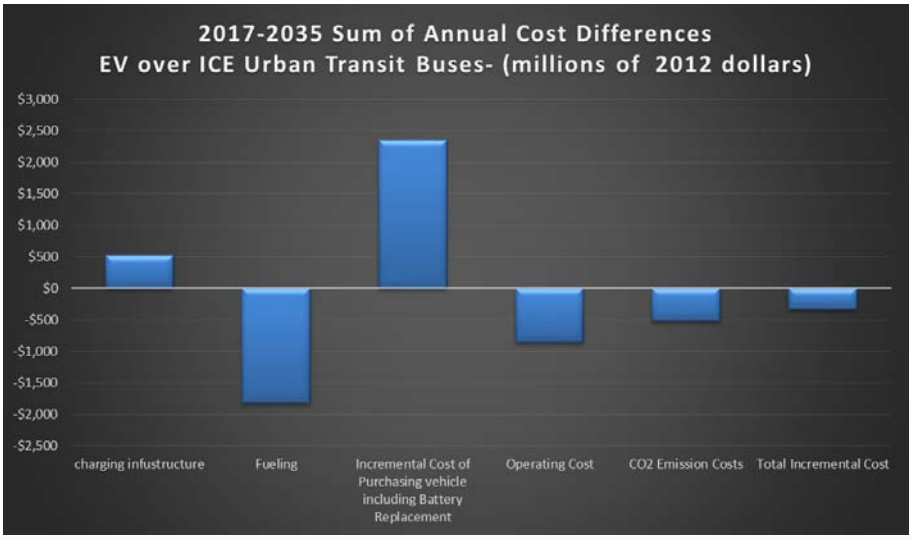

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School Buses

Variable definition	Value Used
Cost of diesel bus	$110,000
Cost of Electric bus (including charger)	$260,000
Diesel Carbon Emission Rate	22.38 lbs/gallon
Miles driven per day	55 miles
Days of school year	177 days
Battery storage capacity	80 kwh
Range of battery	100 miles
Battery Efficiency	747 wh/mile
Diesel Engine Efficiency	6.35 mpg
Per-mile Diesel Bus Maintenance Rate	$1
Per-mile Electric Bus Maintenance Rate	$0.20
Battery life	7,000 cycles (10 years)
Bus lifetime	18 years

level 2 fast charger price included in the cost of bus

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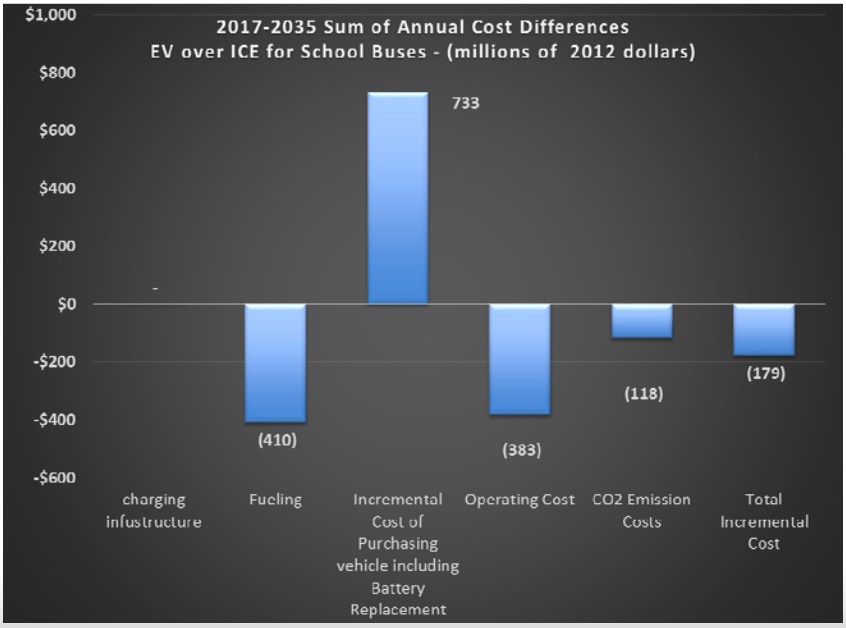

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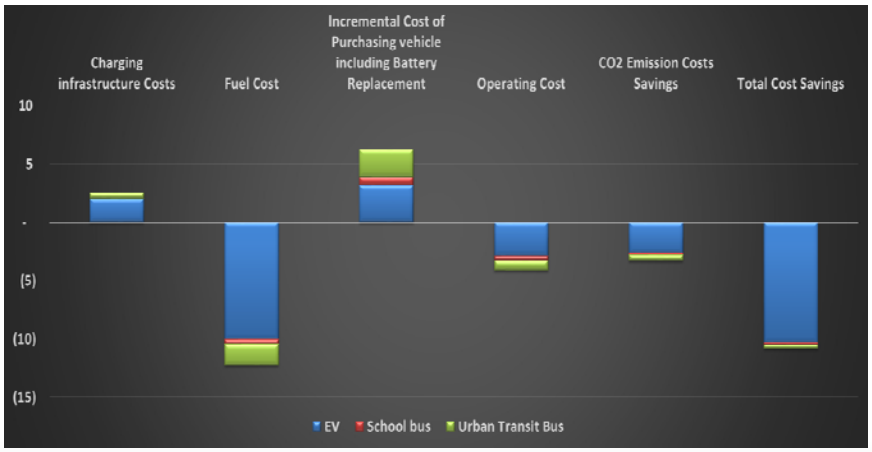
Total Costs and Benefits



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Potential Economic and CO2 Reduction Impacts of Electrification 2017-2035 (in Billions of 2012$)

	Charging infrastructure Costs	Fuel Cost	Incremental Cost of Purchasing vehicle including Battery Replacement	Operating Cost	CO2 Emission Costs Savings	Total Cost Savings	Cumulative CO2 reduction in Millions of Metric Tons
EV	2	(10)	3	(3)	(3)	(10)	34
School bus	-	(0.4)	0.7	(0.4)	(0.1)	(0.2)	1
Urban Transit Bus	1	(1.8)	2.4	(0.9)	(0.5)	(0.3)	7
Total	3	(12)	6	(4)	(3)	(11)	42

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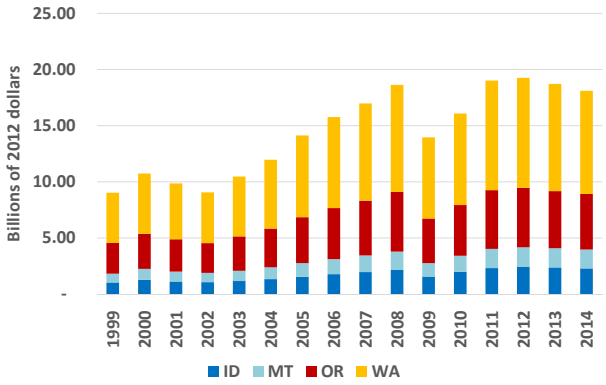
On Average Region spends $14.5 billion dollars a year in Gasoline Expenditure

(Billions of 2012 dollars)



Billions 2012$	Since 2010	since 1999
ID	$ 11	$ 27
MT	$ 8	$ 21
OR	$ 25	$66
WA	$ 46	$118
4 states	91	$223

By 2035, annually over $1.6 billion dollars can be saved from electrification of transport system.

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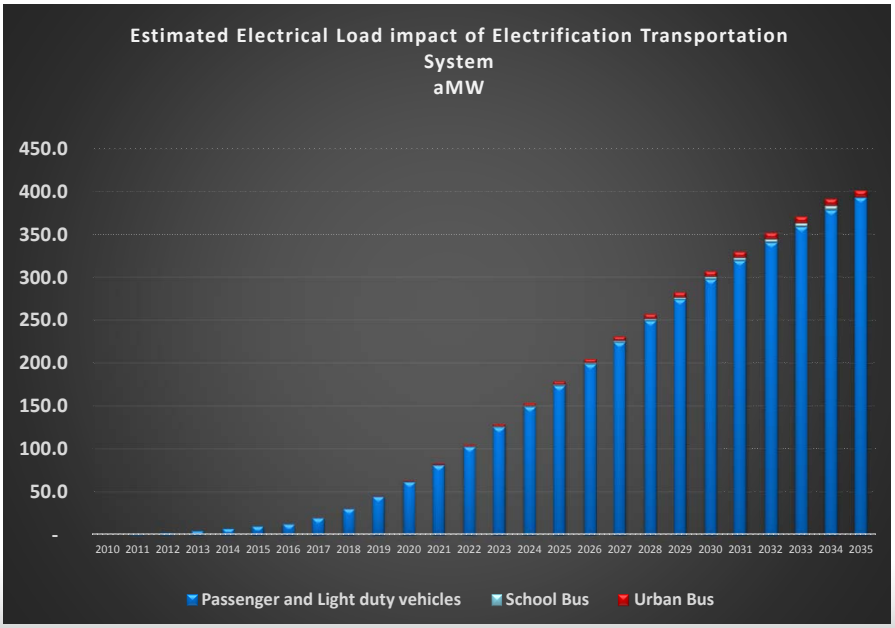

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Enhancements for the 8th Plan

- Background on transportation module of Energy2020
- Current activities
- Planned model enhancements

Transportation Modeling for the Long Term Demand Forecast

Demand Forecasting & Transportation

- Currently working on implementing the transportation module in the Energy2020 long term forecasting model – have a few initial results to share
- Consumer choice model
  1. Incorporates past consumer behavior – how much do people factor in fuel and vehicle prices when choosing a transportation technology
  2. Non-price effect variables in the model – can reflect consumer sentiments, for example comfort over efficiency (purchase of car over motorcycle, purchase of SUV during times with high prices,...)
- Challenges
  1. New to the Council's model
  2. Historical lack of available choices for alternative vehicle technologies

Demand Forecasting & Transportation

Goal – ability to investigate how demand for electricity might react to future transportation related scenarios and policies in the region

1. Changes in efficiency standards – MPG
2. Potential fuel price shocks with electric vehicle options now available
3. Emission goals and tradeoffs

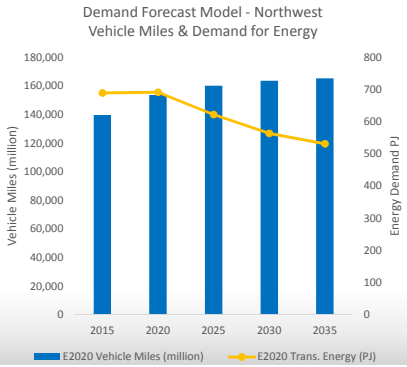
Demand Forecasting & Transportation

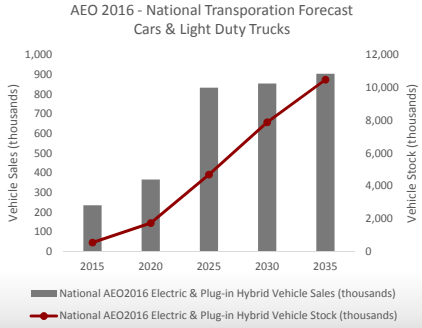
Example of Vehicle Technologies (Cars and Light Duty Trucks)	Key Drivers for Model	Key Outputs
Gasoline	Fuel Prices – gasoline, electricity, …	Market Share by the technologies
Diesel	Vehicle prices by technology	Energy demand – gasoline, electricity,…
Electric	Vehicle efficiency	Vehicle unit sales & stock by technology
Plug-In Hybrid	Vehicle life (stock turnover)	Emissions
Natural Gas	Macro economic drivers such Personal Income	

Initial Findings

- Initial results from the base model for the Northwest
- US Energy Information Administration – Annual Energy Outlook 2016 forecast for the nation
- Demand for electricity to power electric vehicles expected to grow significantly – though starting from a really low number
- Transportation is getting more efficient as stock turns over
  1. Improving efficiency (MPG) for conventional gas fueled cars and light duty trucks
  2. Electric vehicles have significantly better efficiency than conventional gas cars and trucks – and more are becoming available to purchase
  3. Increasing vehicle miles yet decreasing energy consumption

Forecast Source	Vehicle Miles Traveled	Energy Demand	Electricity Demand	Vehicle Stock – Gasoline	Vehicle Stock – Electric
Energy2020 – Region	+ 1.1 %	(-) 1.2 %			
AEO 2016 (Ref Case) - Nation	+ 1.2 %	(-) 1.3 %	+ 72 %	+ 0.5 %	+ 91 %





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Summary

- As the analysis shows, it is economically and environmentally beneficial to electrify the transportation system for passenger, light duty truck, public and school buses.
- Consumers can lower their transportation bill over$11 billion dollars over next 20 years as the transportation system is electrified.
- During the development of the 8th Plan, we continue monitoring trends and incorporate them in our long-term model forecast.

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