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

May 1, 2018

MEMORANDUM

TO: **Council Members**

FROM: **Steven Simmons**

SUBJECT: **Demand Forecasting and the Transportation Sector**

BACKGROUND:

Presenter: Steven Simmons, Senior Economic Analyst

Summary: Staff has been working to implement a transportation module into the long term load forecasting model Energy 2020. The initial modeling results will be shared; including forecasts of sales, market shares, and electricity demand for light duty electric vehicles in the Northwest.

For the Seventh Plan, the demand forecast for electric vehicles was performed outside of the Council's long term, end-use load forecasting model Energy 2020. Implementing the transportation module will allow forecasting to be done within the model and will allow for full integration with the other demand sectors.

Relevance: Though demand for electricity from the transportation sector is relatively small now, the increasing sales and operation of light duty electric vehicles will result in a growing electrical load for the region's utilities. Electric vehicles are more efficient, emit less pollution, and in many cases offer lower ownership costs than traditional internal combustion engine powered gasoline cars. As more fully electric car models are made available for purchase or lease along with infrastructure buildout, the resulting long term load in the region could become significant.

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Workplan: ANLYS 5 Enhance modeling of electrification of transportation system

Background: The Council's long-term demand forecast is developed in Energy 2020. Energy 2020 is a fully integrated, all-fuel, end-use energy model based on principles of consumer choice theory and system dynamics. In the Seventh Plan, demand for electric vehicles was forecast exogenously. By implementing the transportation module in Energy 2020, the forecast for electric vehicle demand may be fully integrated with other forecasts.

Demand Forecasting and the Transportation Sector

Steven Simmons

Power Committee

May 8, 2018

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Today's Content

1. Introduction
2. Background
3. Economics
4. Modeling
5. Results
6. Next Work

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Introduction

1. We've newly implemented a Transportation Module in Energy 2020 – our long term demand forecasting model
2. The modeling work and resulting forecast for transportation demand is an evolving project – not a "one & done"
3. We'd like to share some results to date – focused on light duty vehicles (cars & ld trucks)

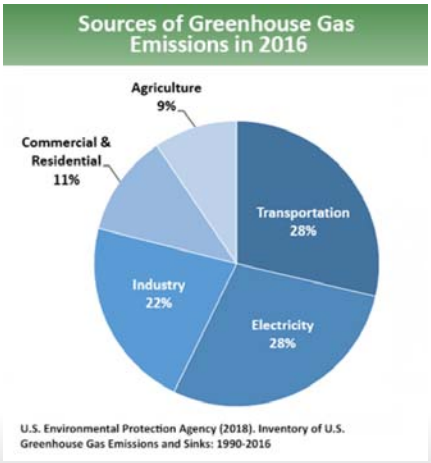
Demand Forecasting and the Transportation Sector

BACKGROUND

Transportation & Energy

- **28 %** of the energy consumption in the U.S. is for Transportation and **92 %** of that is petroleum based
- **17 %** of household expenditures in the U.S. are for Transportation
- Nationwide GHG emissions from transportation have reached parity with the power generation sector
- In the Northwest, electricity demand from electric cars is not significant now – but it's growing
- Electrification of transportation could be a source of growing electric load for the region's utilities – in an environment of flat load growth

Transportation & GHG Emissions



Transportation Emission Breakout

- 60 % Light Duty Cars & Trucks
- 23 % from Heavy and Medium duty Trucks
- 9 % Aircraft
- 2 % Rail
- 2 % Ships & Boats

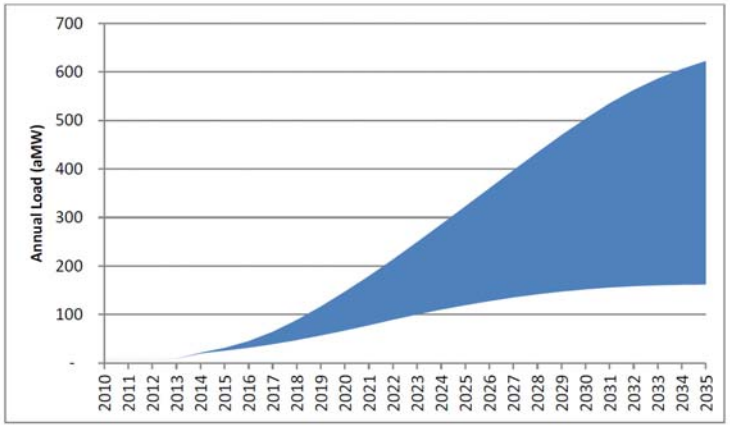
Demand Forecasting

- The Council's long term end-use load forecast is developed using ENERGY 2020
- ENERGY 2020 is fully integrated all-fuel end-use energy model based on principles of consumer choice theory and system dynamics
- In the Seventh Plan – the demand for electric vehicles was forecast exogenously based on
  - IHS-Global Insight light duty vehicle sales forecast
  - Estimates on electricity usage per EV, and efficiency trends
- Forecast for electricity demand for electric vehicles:
  - Ave annual growth of 10 to 16 % (2015 through 2035)
  - Growing load, but relatively small in overall magnitude

Seventh Plan Figures

Chapter 7, and Appendix E

Figure E - 22: Forecast of Load from PHEV/Electric Vehicles (aMW)



Sector	2012	2015	2020	2035	Average Annual Growth Rate 2015-2035
Residential	8,313	8,339 – 8,375	8,100 – 8,400	8,100 – 9,300	-0.2% - 0.5%
Commercial	6,377	6,700 – 6,900	6,900 – 7,200	8,000 – 8,600	0% - 1.1%
Industrial	5,618	5,350 – 5,650	5,400 – 5,900	6,100 – 7,200	0.7% - 1.2%
Transportation	8	26 - 31	67-147	162 - 623	10% to 16%
Street lighting	348	351	354	361	0.1%

Demand Forecasting and the Transportation Sector

PERSONAL VEHICLE ECONOMICS

Vehicle Cost Calculator Example

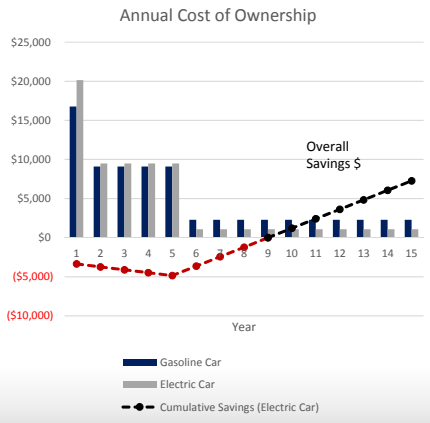
- Cost $ comparison between an average new gasoline (ICE) car with an average new electric car (EV) purchased in 2018
- Assumes a 20% down payment with a new car loan of 5 years
- Assumes purchase and installation of a home charging station
- With and without incentives
- Conservative values for fuel prices

Vehicle Cost Comparison

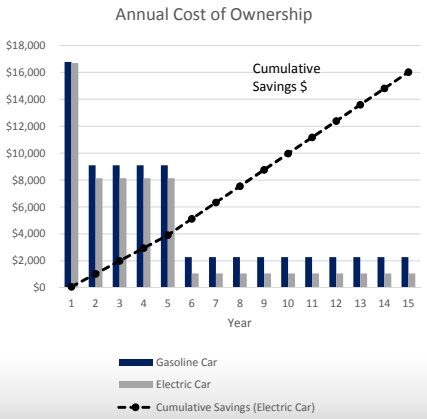
- Cost crossover occurs around year 9 but over the car lifetime, the Electric Car saves over $7,000
- Upfront costs are much higher for the Electric Cars than Gasoline Cars – based on averages, not necessarily comparable models
  - Capital costs are higher ~ 23%
  - Results in a larger down payment, loan payments, and one time installation costs for electric cars
- Operating costs are much lower for Electric Cars
  - Large savings in annual fuel costs and maintenance costs
  - Even with conservative gasoline fuel costs
- Incentives for Electric Cars have a big impact in lowering the upfront costs – with incentives cost parity occurs nearly immediately

Vehicle Cost Comparison

Zero Incentives included
(EV purchase price $9k higher)
Cost cross-over year 8/9



With Electric Vehicle & Charger Incentives
(Or same purchase price between vehicles)
Cost cross-over is immediate



Vehicle Comparison Assumptions

Zero Incentives

Car Financing Assumptions	Gasoline Car	Electric Car
Down Payment (%)	20%	20%
Loan Interest rate (%)	4.20%	4.20%
Loan Period (months)	60	60
Vehicle Incentives ($)	0	0
Charger Incentive ($)	0	0

Operating Assumptions	Gasoline Car	Electric Car
Car Lifetime (years)	15	15
Annual Vehicle Miles	16,500	16,500
Annual Maintenance Cost per Mile ($)	0.055	0.035
Fuel Price ($/gallon equiv)	2.95	3.26

Vehicle Assumptions	Gasoline Car	Electric Car
Vehicle Capital Cost ($)	38,371	47,290
Vehicle Efficiency (mpg)	36	111
Level 2 Charging Station Install Cost ($)	0	1,200

Vehicle Purchase Costs	Gasoline Car	Electric Car
Vehicle Cost after incentives ($)	38,371	47,290
Down Payment ($)	7,674	9,458
Loan Amount ($)	30,697	37,832
Monthly Loan Payment ($)	568	700
Annual Loan Payment ($)	6,817	8,402
Level 2 Charging Station Install - one time ($)	0	1,200

Vehicle Operating Costs	Gasoline Car	Electric Car
Annual Fuel Cost ($)	1,370	486
Annual Maintenance Cost ($)	908	581

With Electric Vehicle & Charger Incentives

Car Financing Assumptions	Gasoline Car	Electric Car
Down Payment (%)	20%	20%
Loan Interest rate (%)	4.20%	4.20%
Loan Period (months)	60	60
Vehicle Incentives ($)	0	7,500
Charger Incentive ($)	0	600

Operating Assumptions	Gasoline Car	Electric Car
Car Lifetime (years)	15	15
Annual Vehicle Miles	16,500	16,500
Annual Maintenance Cost per Mile ($)	0.055	0.035
Fuel Price ($/gallon equiv)	2.95	3.26

Vehicle Assumptions	Gasoline Car	Electric Car
Vehicle Capital Cost ($)	38,371	47,290
Vehicle Efficiency (mpg)	36	111
Level 2 Charging Station Install Cost ($)	0	1,200

Vehicle Purchase Costs	Gasoline Car	Electric Car
Vehicle Cost after incentives ($)	38,371	39,790
Down Payment ($)	7,674	7,958
Loan Amount ($)	30,697	31,832
Monthly Loan Payment ($)	568	589
Annual Loan Payment ($)	6,817	7,069
Level 2 Charging Station Install - one time ($)	0	600

Vehicle Operating Costs	Gasoline Car	Electric Car
Annual Fuel Cost ($)	1,370	486
Annual Maintenance Cost ($)	908	581

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Crude oil prices have been extremely volatile over the past few decades. World events can disrupt the flow of oil to the market or cause uncertainty about future supply or demand for oil, leading to volatility in prices. Supply disruptions caused by political events, such as the Arab Oil Embargo of 1973-74, the Iranian revolution in the late 1970's, and the Persian Gulf War in 1990, were accompanied by major oil price shocks. Excess supply in 2014 caused a decline in crude oil prices.

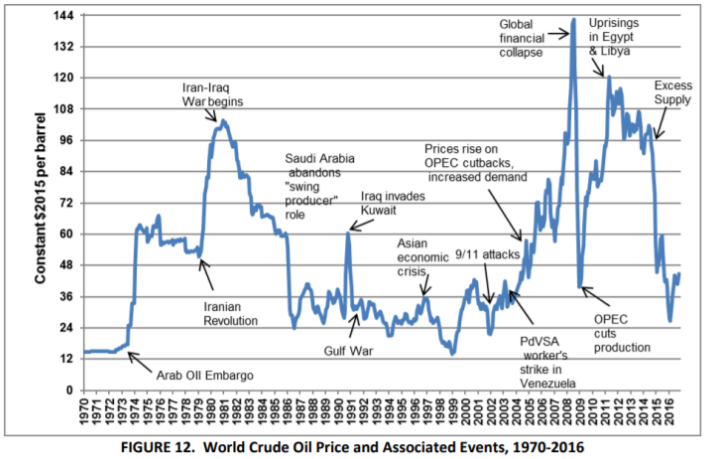

FIGURE 12. World Crude Oil Price and Associated Events, 1970-2016

2016 Vehicle Technologies Market Report

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Demand Forecasting and the Transportation Sector

MODELING

Modeling

- By implementing the Transportation Module in ENERGY 2020 – we can integrate the transportation sector demand forecast with the other sectors
- Demand Forecast Scenarios based on economic growth futures can be fully integrated across sectors
- We are now modeling the entire transportation sector - meaning all fuels are included such as gasoline, diesel, and natural gas as well as electricity

Model Flow – New Requirements

1. Transportation requirements – vehicle miles – are forecast based on economic drivers such as personal income
2. New Transportation requires come from two sources
   a. Economic growth (see #1)
   b. Stock retirements (vehicles) based on vehicle lifespans

Model Flow – Consumer Choice

1. New requirements can be met by various technologies/fuel types – such as
   a. Gasoline ICE
   b. Diesel ICE
   c. Electric (BEV, PHEV)
   d. Natural gas (CNG)
2. Each option has a unique forward looking cost estimate – the combination of
   a. Capital costs $
   b. Maintenance costs $
   c. Fuel costs
   d. Efficiency- miles per gallon equivalents

Model Flow – Price & Non Price Effects

1. The economic choice would be to choose the most cost effective option
2. However in transportation, non-price effects have a large influence
3. Consumers may have preferences other than cost

   Example – sedan may offer better efficiency and lower capital price – but SUVs are popular even though more expensive to buy and operate
4. Electric cars – though cost effective – currently have barriers to wide spread adoption such as range and corridor charger concerns

Model – Some Key Inputs

KEY INPUTS

1. Economic growth and Transportation Requirements
2. Technology/Fuel options
3. Vehicle efficiency – miles per gallon equiv.
4. Fuel price - $/gallon equiv.
5. Vehicle price $
6. Maintenance cost $
7. Vehicle turn over

Demand Forecasting and the Transportation Sector

RESULTS

Results Summary

- This Base Forecast may be on the conservative side as far as electric vehicles go
- The electricity demand is similar to the exogenous 7th Plan Forecast
- Forecasting new technology demand in the long term model can be challenging due to a lack of history
- Issues with moving between “units” and demand for stock estimates

Electric Vehicle Results Summary

Northwest - Light Duty - Electric Vehicles	Actuals 2016	Forecast 2020	Forecast 2025	Forecast 2030	Forecast 2035	Forecast 2040
Demand - aMW		60	205	376	563	809
Sales of Electric Vehicles	9,263	26,756	60,174	77,192	104,171	133,560
Market Share (%) - Electric Vehicle Sales	1.5	4.1	8.9	10.9	14.0	17.2
Stock of Electric Vehicles	35,455	73,253	268,533	512,530	778,000	1,123,955
Market Share (%) - Electric Vehicle Stock	0.3	0.8	2.8	5.0	7.2	9.9

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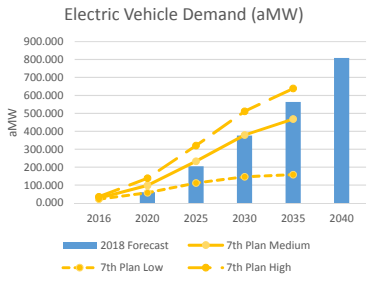
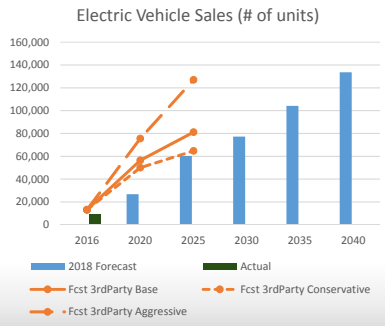
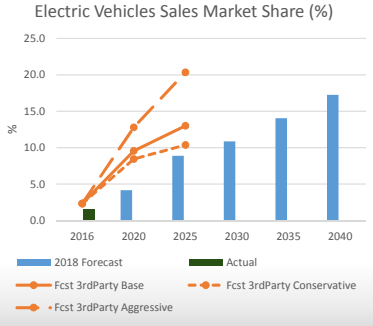
Forecast Results – Electric Vehicles Total

Compared to 7th Plan Forecast & other 3rd Party Forecast







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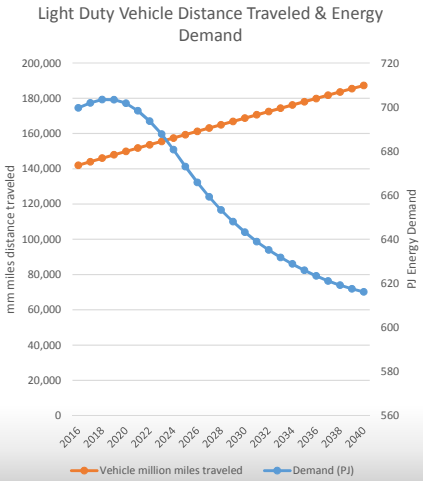
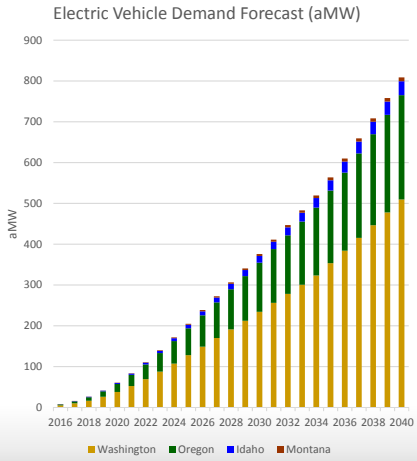
Overall efficiency of transporation expected to improve



Electric vehicles more concentrated in the western portion of the Northwest



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Next Work & "Tune-ups"

- Expect to run some scenarios – potentially around
  - Fuel price futures
  - Vehicle incentives & cost declines (EV battery cost reductions)
  - Attempt to capture effect of a build-out of electric vehicle infrastructure
- "Tune-ups" to estimates on vehicle stock calculations, maintenance costs, vehicle incentives,...

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