To: Garrett Martin, Oregon Public Utilities Commission
From: Eric Strid, Power Oregon
Date: Oct. 28, 2020

Thank you for the opportunity to comment on OPUC's (draft 9-22) work plans re EO 20-04.

My first comment is a request for a little top-down planning so that agencies and sectors have at least some rough GHG targets. My second comment is a request for clarification of the targets for transportation electrification (Part 3) and a discussion of those targets.

I. EO 20-04 lacks sectoral guidance

EO 20-04 is unclear whether agencies are expected to target the overall GHG emission reduction goals in Paragraph 2 in each sector, or if the goals can be specific to each sector and if so, how the target reductions are distributed.

<u>Sectoral differences</u>

It is clear that decarbonization challenges and opportunities vary widely between sectors. I created this rough plot of the cost trajectories of various clean technologies to illustrate their relative maturity, costs, and thus the likely adoption years and timing of reduction contributions.

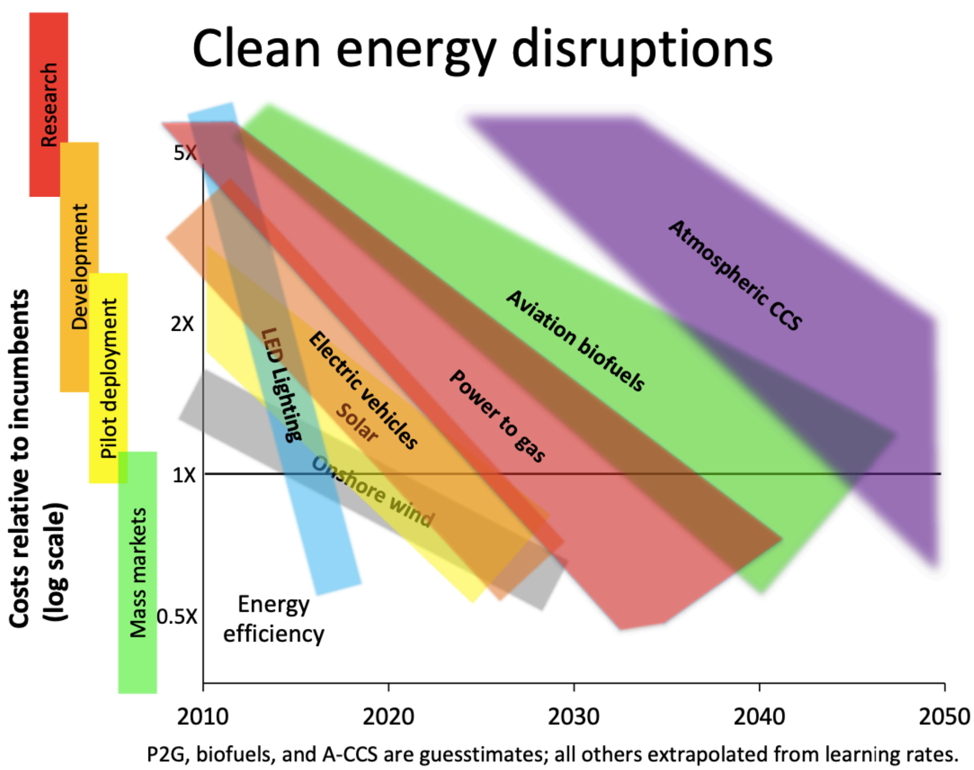


Figure 1. Approximate cost trajectories of various clean energy technologies (Strid 2017)

For example,

- Wind, solar, and battery storage for electricity generation are rapidly getting cheaper. Recent modeling for decarbonizing the US grid by 90% by 2035 illustrates savings for ratepayers plus dramatic reductions in social costs.
- Electric vehicles have proven to dramatically cut operating costs and will soon be cheaper to purchase. By 2025, mid-market electric cars will be cheaper to purchase and to operate, and automakers all see this coming. Automakers require massive investments in new battery and vehicle production lines, as Tesla, China, VW Group (and Daimler Trucks North America!) are pursuing.
- Manufacturing processes for producing zero-carbon aviation fuels or cement or steel, or for cleaning semiconductor equipment, are R&D projects. Regardless of carbon fees or usage mandates, the route to low-carbon cement is through years of R&D.
- The largest sectoral interaction is probably the grid load increase from electrifying vehicles, which is roughly 50% for Oregon.

Optimizing affordability

To optimize affordability, policies must facilitate and accelerate these technology cost trajectories—such as rebates or fees in the piloting/adoption phase to steer capital purchases, or public/private financing structures for rapidly ramping up deployments, or public R&D funding in the R&D phases. Each productization phase has different financial challenges.

One simplification is to note that conservation—using less energy by using existing options—can achieve only incremental emission reductions. For example, cutting vehicle miles traveled (VMT) by 10% by 2035 would be wonderful, but difficult statewide and it's not nearly enough. Training consumers to drive less, drive slower, or use less electricity has minor impacts and uncertain longevity.

Energy efficiency improvements, while very useful, are also stubbornly incremental. With the excellent help of ETO, the per capita usage of electricity by Oregonians decreased an average of 0.8% per year from 2001 to 2016. But a 0.8% annual improvement for 15 years achieves less than 12% reduction. Meanwhile, population growth from 2000 to 2015 increased by 16.6%, so total electric power generation increased over that period.

Thus, the EO 20-04 goal for 2035 implies that we must replace about half of Oregon's emitting infrastructure by 2035. While that seems daunting, consider that Oregon has been replacing about 5.3% of its light-duty vehicle (LDV) fleet every year (pre-COVID). If an increasing portion of those purchases switched to zero-emission vehicles (ZEVs), ramping to 100% by 2025, we'd achieve more than 66% LDV emission reductions by 2035. (This is indeed possible, as Norway is currently demonstrating. Norway has about the same population, average income, vehicle fleet and replacement rate, and land area as Oregon.) Thus LDVs have the potential to reduce emissions faster than the 2035 goal, to allow other sectors (like cement or steel or aviation) more years to develop the clean product maturity necessary before deployment.

Also note that emitting infrastructure is the root cause of emissions, and GHG emissions are a symptom. Factories continuously work to fix problems, but they start by identifying root causes and avoid fixing symptoms. Infrastructure purchases must be steered to clean, whether vehicles, buildings, factories, or power plants, to achieve the EO 20-04 goals and to afford the upgrades necessary.

A simple sectoral modeling spreadsheet (see attached SIP model BAU.xlsx)

Successful decarbonization strategies must work on all levels—the physical, economic, and policy levels. The physical level is by far the simplest, since the goals are specified by EO

20-04, the 2018 IPCC report, or other targets. Economically, the sectors with the most mature clean technologies can generally respond the fastest and with the most competitive costs. Regardless of the economic or social costs or the types of policies enacted, adding up the physical emissions is very simple and the dependable DEQ inventory by sector relates well to the sector-specific options.

The most affordable path to replacing infrastructure is to steer the ongoing new purchases to zero-emission technologies. The policy options include mandates, rebates, fees, or other policies. (For example, Norway uses both carrots and sticks to equalize the purchase prices of EVs with comparable gas/diesel vehicles.)

This simplified emissions planning tool treats each of the DEQ emission sectors as an infrastructure replacement process, wherein the sector emissions decrease proportionally with fleet replacements that are zero-carbon (whether vehicles, power plants, furnaces, etc.) The model inputs by year are simply the portion of infrastructure purchases that are zero-carbon ("% of sales" for each sector). That annual addition rate is accumulated as a "% of fleet" for that sector, which reduces the GHG emissions for that sector and is plotted. Because the electricity sector is regulated by OPUC to meet a Renewable Portfolio Standard (RPS), the electricity inputs are "% of fleet" by year. The "% of fleet" is normalized to 0% clean in 2016; thus describing only the emitting portion of the sector.

Disclaimer: This spreadsheet is the architect's dull pencil for initial sketches. Any plan is better than no plan, because it can be analyzed and optimized. The inputs and outputs on this spreadsheet are purposely oversimplified, to focus on the large rocks in the box. It ignores conservation and efficiency contributions, as discussed above. It does not calculate any costs, although the infrastructure replacement inputs illustrate how much money is available to be steered (0 to 100% of current purchases), as opposed to additional funding (if "% of sales" is larger than 100%). It does not presume any policy structures. It ignores interactions between sectors, the largest being the increased grid load from electrification of transportation and the indirect electric vehicle emissions from electricity generation.

And those are just the major inaccuracies. But we're at the dull-pencil phase, and sharp pencils are only distracting in this phase.

The business-as-usual (BAU) numbers in the input cells are also subject to lots of differing forecasts and arguments. EV forecasts are particularly wide-ranging, but it's increasingly evident that EVs will be a large portion of global fleets by at least 2040, so the BAU should indicate significant GHG reductions from vehicles. Similarly, coal power plants are being shuttered because they're increasingly uneconomic, and gas peaker plants are being replaced by utility-scale batteries. Figure 2 is a screen capture of the spreadsheet with some BAU numbers, illustrating for this case a 25% reduction by 2035 due to existing policy and market forces.

So what is necessary to achieve the EO 20-04 reductions by 2035? Figure 3 illustrates the effects of changing the inputs for three sectors: 1) copying what Norway is doing for light-duty vehicles (this is aggressive), 2) assuming the same is possible 5 years later for medium- and heavy-duty vehicles, and 3) adopting the 2035 Report emissions trajectory for cleaning up the grid. This scenario achieves the EO 20-04 target; it does not indicate that the work is done, but it can provide guidance on useful directions to pursue.

A serious modeling tool that links specific policies to emission reductions and economic effects is the Energy Policy Simulator from Energy Innovations. This is open-source and online for the US, California, and other countries; an Oregon adaptation is under development with the Northwest Economic Research Center at PSU.

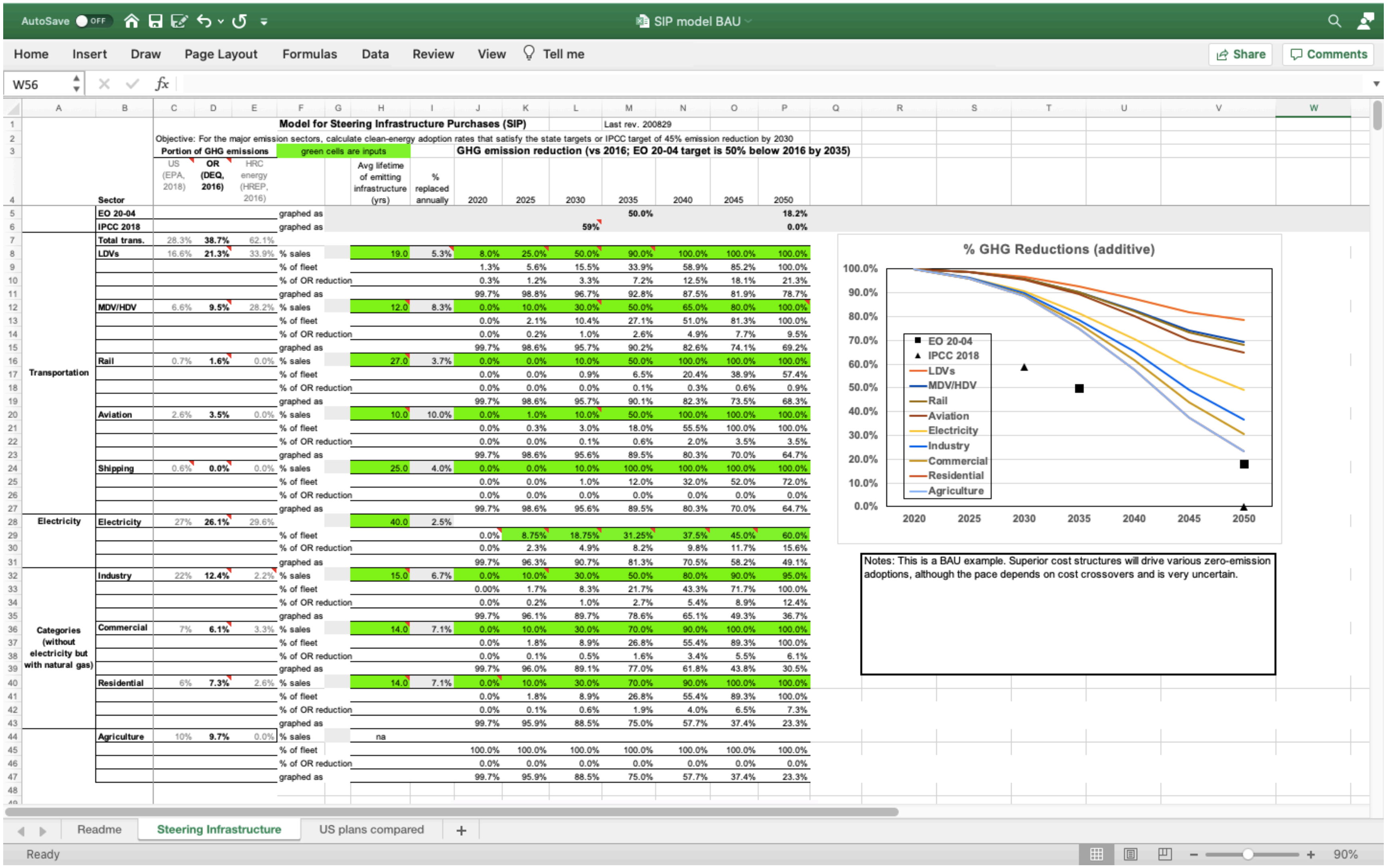
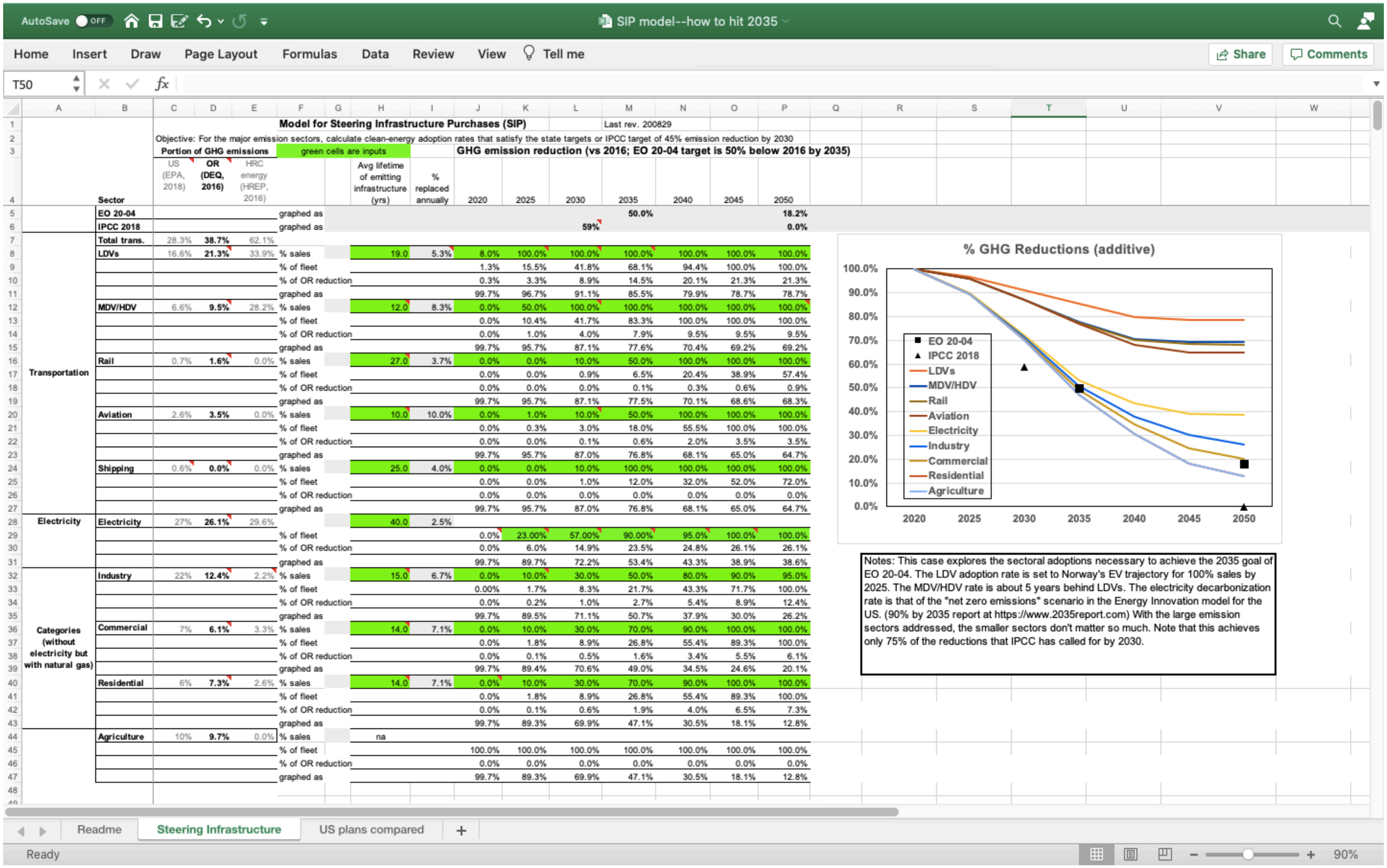


Figure 2. Screen shot of the model with some business-as-usual assumptions.



Model for Steering Infrastructure Purchases (SIP) — Last rev. 200829

Objective: For the major emission sectors, calculate clean-energy adoption rates that satisfy the state targets or IPCC target of 45% emission reduction by 2030

Portion of GHG emissions — green cells are inputs — GHG emission reduction (vs 2016; EO 20-04 target is 50% below 2016 by 2035)

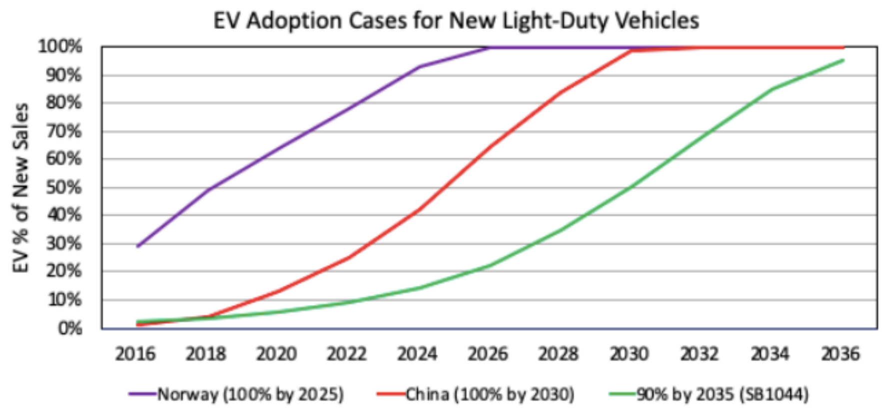
	Sector	US (EPA, 2018)	OR (DEQ, 2016)	HRC energy (HREP, 2016)		Avg lifetime of emitting infrastructure (yrs)	% replaced annually	2020	2025	2030	2035	2040	2045	2050
	EO 20-04				graphed as						50.0%			18.2%
	IPCC 2018				graphed as					59%				0.0%
Transportation	Total trans.	28.3%	38.7%	62.1%										
	LDVs	16.6%	21.3%	33.9%	% sales	19.0	5.3%	8.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
					% of fleet			1.3%	15.5%	41.8%	68.1%	94.4%	100.0%	100.0%
					% of OR reduction			0.3%	3.3%	8.9%	14.5%	20.1%	21.3%	21.3%
					graphed as			99.7%	96.7%	91.1%	85.5%	79.9%	78.7%	78.7%
	MDV/HDV	6.6%	9.5%	28.2%	% sales	12.0	8.3%	0.0%	50.0%	100.0%	100.0%	100.0%	100.0%	100.0%
					% of fleet			0.0%	10.4%	41.7%	83.3%	100.0%	100.0%	100.0%
					% of OR reduction			0.0%	1.0%	4.0%	7.9%	9.5%	9.5%	9.5%
					graphed as			99.7%	95.7%	87.1%	77.6%	70.4%	69.2%	69.2%
	Rail	0.7%	1.6%	0.0%	% sales	27.0	3.7%	0.0%	0.0%	10.0%	50.0%	100.0%	100.0%	100.0%
					% of fleet			0.0%	0.0%	0.9%	6.5%	20.4%	38.9%	57.4%
					% of OR reduction			0.0%	0.0%	0.0%	0.1%	0.3%	0.6%	0.9%
					graphed as			99.7%	95.7%	87.1%	77.5%	70.1%	68.6%	68.3%
	Aviation	2.6%	3.5%	0.0%	% sales	10.0	10.0%	0.0%	1.0%	10.0%	50.0%	100.0%	100.0%	100.0%
					% of fleet			0.0%	0.3%	3.0%	18.0%	55.5%	100.0%	100.0%
					% of OR reduction			0.0%	0.0%	0.1%	0.6%	2.0%	3.5%	3.5%
					graphed as			99.7%	95.7%	87.0%	76.8%	68.1%	65.0%	64.7%
	Shipping	0.6%	0.0%	0.0%	% sales	25.0	4.0%	0.0%	0.0%	10.0%	100.0%	100.0%	100.0%	100.0%
					% of fleet			0.0%	0.0%	1.0%	12.0%	32.0%	52.0%	72.0%
					% of OR reduction			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					graphed as			99.7%	95.7%	87.0%	76.8%	68.1%	65.0%	64.7%
Electricity	Electricity	27%	26.1%	29.6%		40.0	2.5%							
					% of fleet			0.0%	23.00%	57.00%	90.00%	95.0%	100.0%	100.0%
					% of OR reduction			0.0%	6.0%	14.9%	23.5%	24.8%	26.1%	26.1%
					graphed as			99.7%	89.7%	72.2%	53.4%	43.3%	38.9%	38.6%
Categories (without electricity but with natural gas)	Industry	22%	12.4%	2.2%	% sales	15.0	6.7%	0.0%	10.0%	30.0%	50.0%	80.0%	90.0%	95.0%
					% of fleet			0.00%	1.7%	8.3%	21.7%	43.3%	71.7%	100.0%
					% of OR reduction			0.0%	0.2%	1.0%	2.7%	5.4%	8.9%	12.4%
					graphed as			99.7%	89.5%	71.1%	50.7%	37.9%	30.0%	26.2%
	Commercial	7%	6.1%	3.3%	% sales	14.0	7.1%	0.0%	10.0%	30.0%	70.0%	90.0%	100.0%	100.0%
					% of fleet			0.0%	1.8%	8.9%	26.8%	55.4%	89.3%	100.0%
					% of OR reduction			0.0%	0.1%	0.5%	1.6%	3.4%	5.5%	6.1%
					graphed as			99.7%	89.4%	70.6%	49.0%	34.5%	24.6%	20.1%
	Residential	6%	7.3%	2.6%	% sales	14.0	7.1%	0.0%	10.0%	30.0%	70.0%	90.0%	100.0%	100.0%
					% of fleet			0.0%	1.8%	8.9%	26.8%	55.4%	89.3%	100.0%
					% of OR reduction			0.0%	0.1%	0.6%	1.9%	4.0%	6.5%	7.3%
					graphed as			99.7%	89.3%	69.9%	47.1%	30.5%	18.1%	12.8%
	Agriculture	10%	9.7%	0.0%	% sales	na								
					% of fleet			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
					% of OR reduction			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					graphed as			99.7%	89.3%	69.9%	47.1%	30.5%	18.1%	12.8%

Figure 3. Screen shot of the model with aggressive adoptions of clean vehicles and electricity.

Comments on Part 3 (Transportation Electrification)

<u>The % of sales and % of fleet targets in SB 1044 (2019) describe two different trajectories</u>

EO 20-04 directs DEQ, OPUC, and DAS to the EV targets in SB 1044, but the targets in SB 1044 describe two significantly different EV adoption curves. Figure 4 illustrates these.



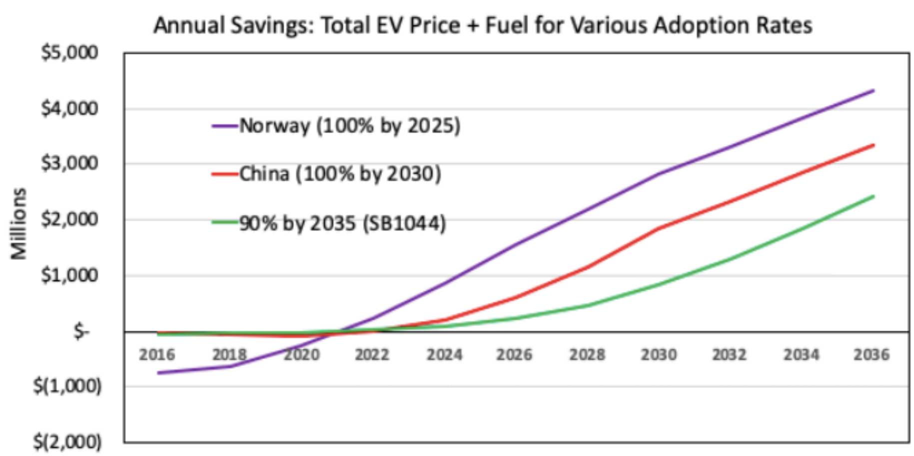


Figure 4. (Top) Three potential EV adoption cases, emulating Norway in violet, China (close to the % of fleet targets in SB1044) in red, and the % of sales targets in SB1044 in green. From [Nov. 2019 Strid Energy Report](#).

(Bottom) A basic comparison of annual savings from electrifying Oregon's 170,000 new vehicles per year for three cases: Norway's pace, China's pace, and the SB 1044 % of sales target. This models EV purchase price trends for a medium-segment electric vehicle, and fuel costs at $3 per gallon or $0.10 per kWh for electric fuel. Not included are infrastructure costs, savings on vehicle maintenance, savings on social costs of toxic or climate emissions, or economic benefits of keeping energy spending local or increased resilience in emergencies.

The % of fleet targets in SB 1044 correspond to accelerating Oregonians saving around $1 billion annually more than the SB 1044 % of sales numbers, after 2030. Neither achieves the EO 20-04 2035 goal or the IPCC 2030 target (a bit more aggressive than EO 20-04), but Norway's trajectory does.

Market forces will decarbonize most vehicles by 2040

I managed a company through decades of Moore's Law technology disruptions. The EV transition is a classic technology disruption, where the market share of all suppliers is reset to zero. Wall Street is already betting on the winners, with Tesla and various Chinese suppliers pouring in resources and VW Group claiming to outspend all of them. VW is promising to build 20 million EVs annually by 2028 (the red line), which is about 20% of global new car sales. Tesla is planning on building 20 million vehicles a year, and China already builds more EVs than any other country. Automakers who are late will not survive—thus, the green line is unlikely.

Business-as-usual (BAU) for EVs is arguably the red line in Figure 4, because that is the likely global EV adoption average. Oregon could pursue a faster pace, more like Norway's, which also accelerates savings on operating costs.

Oregon GHG planning should embrace the uncertainties in EV forecasts, but also the certainties—all automakers will electrify or die. Gas stations will be scarce by 2050. Vehicle BAU emissions will decrease, and it's the largest sector. If the red line is BAU, what should a state target? Adoptions faster than the global average? Faster adoptions to save more money?

Utilities must plan for the red line or faster

Electric infrastructure planning needs to step up to the likely BAU, plus contingency plans for faster growth. Even the green trajectory is higher than Navigant's High case in PGE's 2019 IRP.

We must plan for EV chargers at all residences and plenty of fast-charging networks. Building codes should adopt EV-ready requirements ASAP.

Thank you for your efforts on these critical issues.

Eric Strid