

Beyond Combustion

ELECTRIC VEHICLE TRENDS, GOALS, AND RECOMMENDATIONS FOR SONOMA COUNTY

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We have endeavored to give accurate and useful information. Please direct suggestions, comments, and questions to Doron Amiran, Electric Vehicle Program Manager, Center for Climate Protection, doron@climateprotection.org

Executive Summary

This paper updates the Center for Climate Protection's 2015 White Paper on the state of Electric Vehicles (EVs) in Sonoma County.

To meet Sonoma County's climate goals, sales of vehicles with internal combustion engines must slow dramatically in the next 10 to 15 years. Additionally, internal combustion engines must become more fuel-efficient. Otherwise, efforts to curb Sonoma County GHG emissions will be swamped by tailpipe emissions. EVs are the readiest replacement for vehicles with internal combustion engines.

Sonoma County currently has about 4,500 EVs on the road, and by 2030 it will need approximately 138,000 EVs (replacing internal combustion vehicles) to meet our climate goals. We must now begin to create a future beyond combustion.

To attain the needed level of EV adoption, a number of challenges must be overcome, many of which defy local action. For example, the current federal administration and Congress threaten to undo incentives and regulations that advance clean energy and fuel-efficient vehicles.

Consequently, Sonoma County must redouble its efforts to accelerate EV adoption. Special attention must be paid to increasing the number of drivers switching from combustion vehicles to EVs rather than simply having current EV drivers replace their cars with newer EVs.

The recommended actions presented in the August 2015 white paper are still needed:

1. Advocate for policies and funding, especially at the state level, to accelerate EV use.
2. Expand EV charging, especially at workplaces, multi-unit housing, and along transportation corridors.
3. Develop and implement an EV awareness campaign.
4. Develop EV infrastructure through increased coordination.

In addition, we offer the following new recommended actions:

1. Develop and implement plans to increase and confirm the number of drivers switching from combustion vehicles to EVs; ensure that new EVs do not simply replace existing EVs.
2. Develop an EV charging station visibility campaign.
3. Work with Sonoma Clean Power, other public agencies, and the private sector to maximize daytime charging to address load management issues and maximize the use of renewable power.
4. Develop financing, insurance, and vehicle sharing mechanisms that give low-income drivers access to EVs.

5. Develop awareness programs that highlight the affordability and accessibility of EVs for people at all income levels.
6. Advocate and plan for a future that eliminates the sale of new internal combustion engine cars by 2030 at the latest.
7. Track and publicize progress toward the goals for EV adoption.

Glossary of acronyms and terms

BAAQMD	Bay Area Air Quality Management Agency
BEV	Battery Electric Vehicle
CAFE	Corporate Average Fuel Economy
CARB	California Air Resources Board
CEC	California Energy Commission
CCP	Center for Climate Protection
CVRP	California Vehicle Rebate Program
DCFC	Direct Current Fast Charger
DMV	Department of Motor Vehicles
EPA	Environmental Protection Agency
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
eVMT	Electric Vehicle Miles Travelled
FCEV	Fuel Cell Electric Vehicle
GHG	Greenhouse Gas
kWh	kilowatt-hour
Level 1 charging	110 volt (trickle) charging
Level 2 charging	240 volt (faster) charging
Level 3 (DCFC)	High-voltage (fastest) charging
MCE	Marin Clean Energy
MUD	Multi Unit Dwelling
NBEAA	North Bay Electric Auto Association
NSCAPCD	Northern Sonoma County Air Pollution Control District
PEV	Plug-In Electric Vehicle
PG&E	Pacific Gas and Electric
PHEV	Plug-In Hybrid Electric Vehicle
RCPA	Sonoma County Regional Climate Protection Authority
SCP	Sonoma Clean Power
SCTA	Sonoma County Transportation Authority
VMT	Vehicle Miles Traveled
ZEV	Zero Emission Vehicle

I. Introduction

A. Scientific imperative for climate protection and Sonoma County's leadership

In 2002, all nine Sonoma County cities and the County of Sonoma adopted resolutions recognizing the climate crisis and pledging to act to reduce greenhouse gas (GHG) emissions. In 2005, all ten jurisdictions passed resolutions setting the goal of reducing Sonoma County's GHGs 25 percent below 1990 levels by 2015, in line with the scientific imperative for a life-sustaining climate, and the boldest goal in the nation at the time.

Following the 2005 adoption of the 25 percent reduction goal, the Center for Climate Protection focused on collaborating with local governments, business leaders, technical experts, and the community at large to develop the Sonoma County Community Climate Action Plan, issued in 2008. The Plan identified Community Choice Energy as the most powerful solution under local control to significantly and cost-effectively reduce GHG emissions. Consequently, the Center for Climate Protection and local policymakers came together to create Sonoma Clean Power, a Community Choice entity, which began serving customers with cleaner electricity in May 2014. For these and other precedent-setting actions, Sonoma County is known as a leader in climate circles worldwide. The White House recognized Sonoma County as a Climate Action Champion in 2014.¹

B. Sonoma County's progress towards GHG goals

Sonoma County's most recent GHG report indicates that Sonoma County missed its 2015 GHG goal.² In 2016, the Sonoma County Regional Climate Protection Authority extended the date for achieving Sonoma County's GHG reduction goal from 2015 to 2020.³ Because carbon accumulates in the atmosphere, Sonoma County's challenge to meet the scientific imperative compounds every year it falls short of its goal.

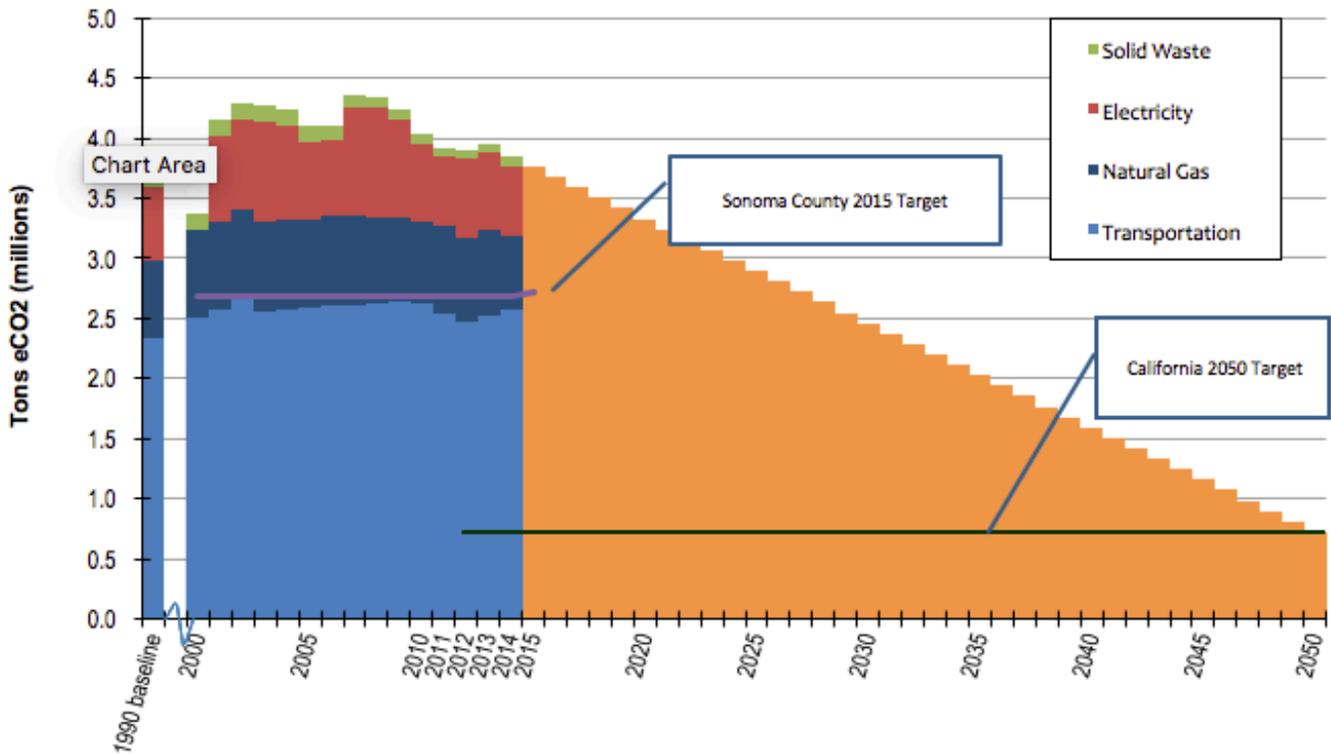
¹ <https://energy.gov/epsa/climate-action-champions>

² <http://climateprotection.org/greenhouse-gas-emissions-report-2014/>. The Sonoma County Regional Climate Protection Authority released a similar report using a slightly different methodology <https://rcpa.ca.gov/projects/climate-action-2020/blog/>. To be consistent with our past GHG reports, we use the Center for Climate Protection's GHG report.

³ http://rcpa.ca.gov/wp-content/uploads/2016/07/CA2020_Plan_7-7-16_web.pdf

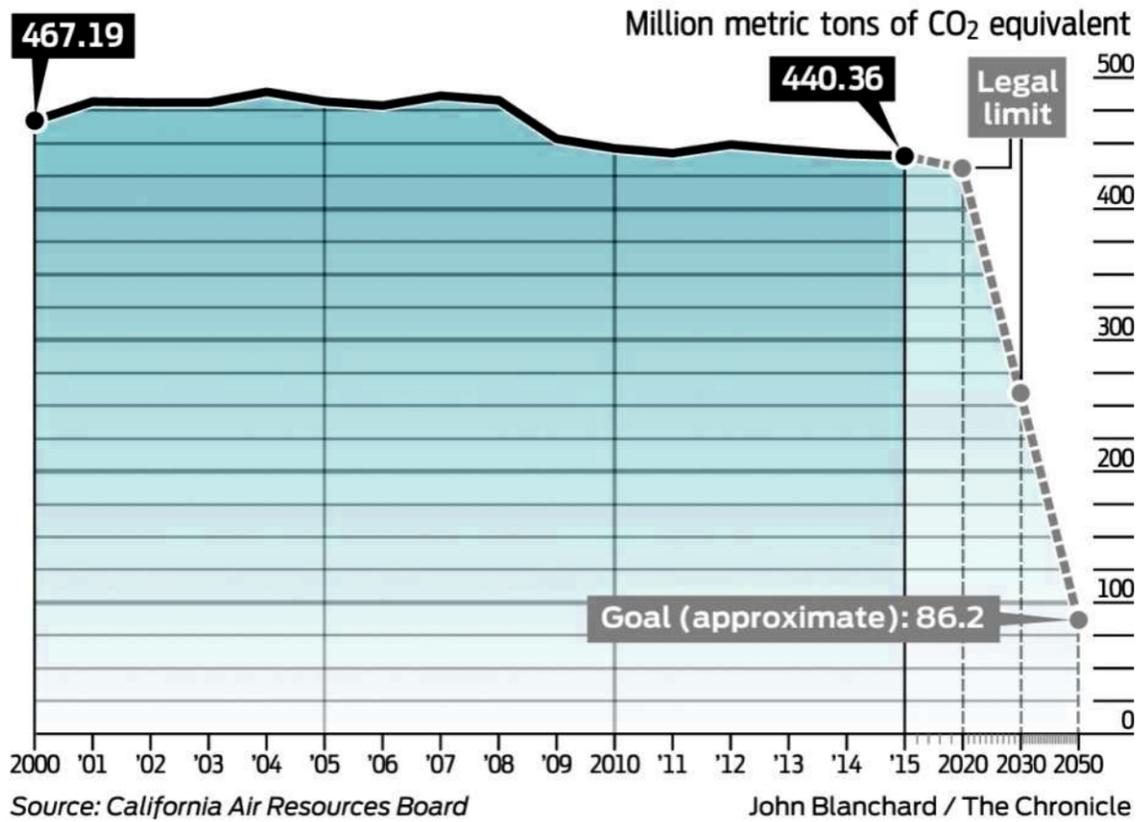
Figure 1: Sonoma County GHG emissions by source (2014)

Sonoma County is not alone in its struggle to reduce GHG emissions in line with the scientific imperative. Despite California’s gains in renewable energy deployment, energy efficiency, and EV use, its GHG emissions declined in 2015 just 0.3 percent from the prior year.⁴ California’s growing population and strengthening economy currently trump the drive for steeper emission reductions.



⁴ <https://www.arb.ca.gov/cc/inventory/inventory.htm>; <http://www.sfgate.com/business/article/California-s-greenhouse-gas-emissions-fall-by-11206585.php>

Figure 2: California GHG emissions



C. Transportation challenge

In 2014, transportation produced about 65 percent of Sonoma County’s total GHG emissions.⁵ Moreover, GHG emissions in this sector are projected to increase. According to the Sonoma County Transportation Authority’s Comprehensive Transportation Plan:

“Sonoma County transportation GHG emissions are expected to increase by about 39 percent during the period from 2010 to 2040. This is largely a factor of increased travel due to population and employment growth, and assumes that the vehicle fleet makeup and vehicle fuel economy stay about the same as they currently are by 2040. GHG emissions are expected to increase at a greater rate than VMT because of increased congestion and because of slower, and less efficient, travel speeds. State mandated fuel economy improvements (Pavley, AB 1493) could provide significant GHG reductions by 2040 because of improved vehicle fuel economies, and other developing and emerging vehicle technologies are likely to also contribute to reduced emissions from automobile travel.”⁶

⁵ <http://climateprotection.org/greenhouse-gas-emissions-report-2014/>

⁶ http://scta.ca.gov/wp-content/uploads/2016/09/CTP16_090616.pdf

Transportation is not only the largest source of Sonoma County's GHG emissions, it is also the least amenable of all sectors to local emission-reduction measures. Dependence on individually-owned, individually-driven, internal combustion vehicles is and will continue to be the greatest impediment to reducing Sonoma County GHG emissions.

D. EVs' role in electrifying everything

The quickest path to reducing fossil fuel combustion is to electrify everything from home heating to transportation, and use renewable energy for electricity generation.⁷ As the grid gets cleaner, which it is doing at a steady pace, all electrical devices, including cars, get cleaner. By contrast, no matter how fuel-efficient a combustion vehicle is, it will continue to emit a consistent amount of GHGs per mile traveled until it is replaced, usually 10 to 20 years in the future.

Not only do EVs directly result in emissions reductions, they can also provide a critical buffer to one of the growing challenges inherent with renewable energy: intermittent supply. Electricity produced by sun and wind rarely matches consumers' real-time demand for electricity. A means to store electricity is needed when too much is produced, and to access it during less sunny or windy times.

Large numbers of EVs connected to the grid through smart charging technology offer a perfect place to store excess electricity and make it available when needed. Programs, incentives, and infrastructure designs that foster daytime EV charging will help accelerate even more solar power generation. MCE and SCP are at the forefront of exploring EV deployment with smart-charging incentives and prospective rate designs that incentivize daytime charging.⁸

The quickest path to reducing fossil fuel combustion is to electrify everything.

⁷ <https://www.vox.com/2016/9/19/12938086/electrify-everything>

⁸ <https://sonomacleanpower.org/sonoma-clean-power-enters-world-electric-vehicles-new-incentives/>

II. Summary of 2015 EV White Paper

The fastest way for Sonoma County to reduce transportation emissions is to accelerate the shift from gasoline and diesel fuel to electricity, as described in the 2015 “Electric Vehicles in Sonoma County: Status and Paths to Adoption.”⁹ This paper presented the following findings and recommendations.

Findings:

- A. For reducing GHG emissions, fuel shift is significantly more powerful than mode shift. This means that changing the fuel powering vehicles is easier to impact than is changing the types of ways people get around.
- B. Workplace chargers significantly increase electric vehicle miles travelled (eVMT). For example, employees are twenty times more likely to use an EV if they can charge their EVs at work.¹⁰
- C. Renewable power boosts GHG reductions from EVs. If the electricity powering EVs is greener, GHG emissions from transportation decreases.
- D. More affordable, desirable EVs are on the horizon.
- E. Meeting state goals requires significantly more EV chargers in Sonoma County.
- F. Local and regional policies can accelerate EV use.
- G. Many potential EV users are unaware of EVs and related infrastructure.
- H. Increased funding to accelerate EV adoption will soon be available.

Recommendations:

- 1. Advocate for policies and funding, especially at the state level, to accelerate EV use.
- 2. Expand EV charging, especially at workplaces, multi-unit housing, and along transportation corridors.
- 3. Develop and implement an EV awareness campaign.
- 4. Develop EV infrastructure through increased coordination.

The 2015 White Paper also provided details regarding the history of EVs in Sonoma County, economic and environmental benefits, and a technical review.

This new report updates the 2015 EV White Paper for Sonoma County with goals and trends for EV adoption, and recommendations for meeting the proposed goals.

⁹ <https://climateprotection.org/wp-content/uploads/2015/08/EVWhitePaper-SonomaCounty-Final.pdf>

¹⁰ https://energy.gov/sites/prod/files/2014/11/f19/progress_report_final.pdf

III. Proposed goals for EV adoption in Sonoma County

How many EVs are required for Sonoma County to meet the scientifically mandated GHG reductions in the transportation sector? The answer is approximately 138,000 by 2030.

First, some caveats regarding this proposed EV goal. Many of the assumptions for it, such as future trends in car ownership and VMTs, are difficult to estimate. We have used publicly available national figures in our calculations wherever possible. It must also be noted that Sonoma County is already well behind its initial GHG reduction goals, and may fall further behind as a growing population drives more cars more miles on local roadways.

It is also difficult to estimate the impact that the impending SMART train service and proposed expansion of HOV lanes on local freeways will have on driving habits. Lastly, the anticipated rapid growth of autonomous driving technologies is expected to coincide with the timeframe used in this report, and may completely transform driving habits in the coming decade and a half, in ways that defy prediction.

Despite these difficulties, setting a goal for where we want to be in the future is worthwhile because it can inspire, align, and mobilize action toward our desired future. We therefore offer the following calculations based on Sonoma County's current and desired levels of GHG emissions.

1. Sonoma County's goal for total GHG emissions in 2015 = 2.6 million metric tons¹¹
2. Total GHG emissions in Sonoma County in 2014 = 3.6 million metric tons¹²
3. Total required GHG reduction: 1.0 million metric tons¹³
4. Transportation equals ~65% of total GHG emissions.¹⁴ Therefore, 1.0 million metric tons X .65 = 650,000 metric tons of GHG emissions need to be reduced from transportation.
5. Total number of light vehicles in Sonoma County in 2014: 417,076.¹⁵
6. The average vehicle over a year of driving has tailpipe carbon dioxide emissions of about 4.7 metric tons for 11,400 miles driven.¹⁶
7. 650,000 metric tons divided by 4.7 = **138,298 light vehicles need to switch from gas to electricity.**

*138,000 EVs
must supplant
that many
combustion
vehicles by 2030
to meet Sonoma
County's climate
goals*

¹¹ <https://climateprotection.org/wp-content/uploads/2015/07/2014-GHG-REPORT-Sonoma-County-072815-Final.pdf>.

¹² Ibid

¹³ Ibid

¹⁴ Ibid

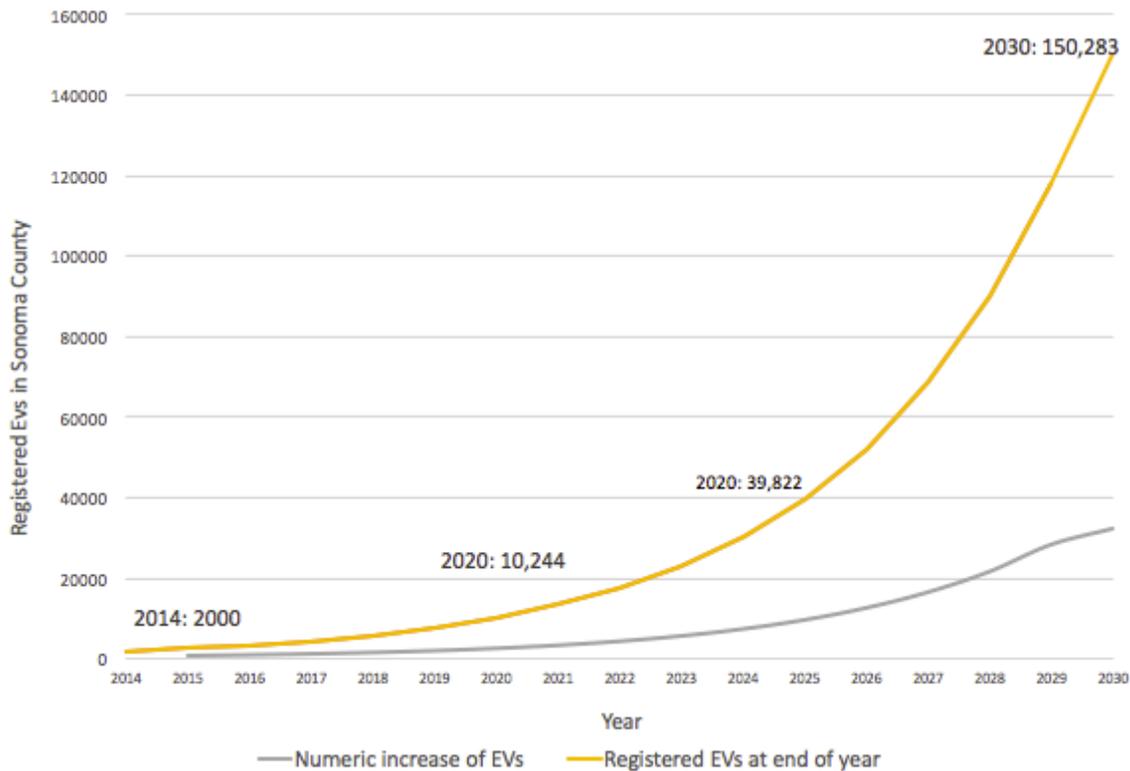
¹⁵ DMV Estimated Vehicles Registered by County: January 1-December 31, 2014, CA DMV, provided by Brock Wells via email on 4/18/16.

¹⁶ <https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle>

8. 138,298 divided by 16 years = 8,644 average EV increase per year, or we can reach the 138,000 vehicle goal in 2030 by increasing EV adoption by 30.3 percent annually.¹⁷

The following graph reflects this calculation.

Figure 3: Minimum number of EVs required to meet GHG goal by 2030¹⁸



As mentioned above, projected population growth in Sonoma County and a commensurate growth in the total number of vehicles and vehicle miles traveled will also factor in to Sonoma County’s trends in transportation. In addition, uncertainties such as the impact of autonomous vehicles, ride-sharing, and car-sharing, will affect the size and use of the overall automobile fleet in Sonoma County.

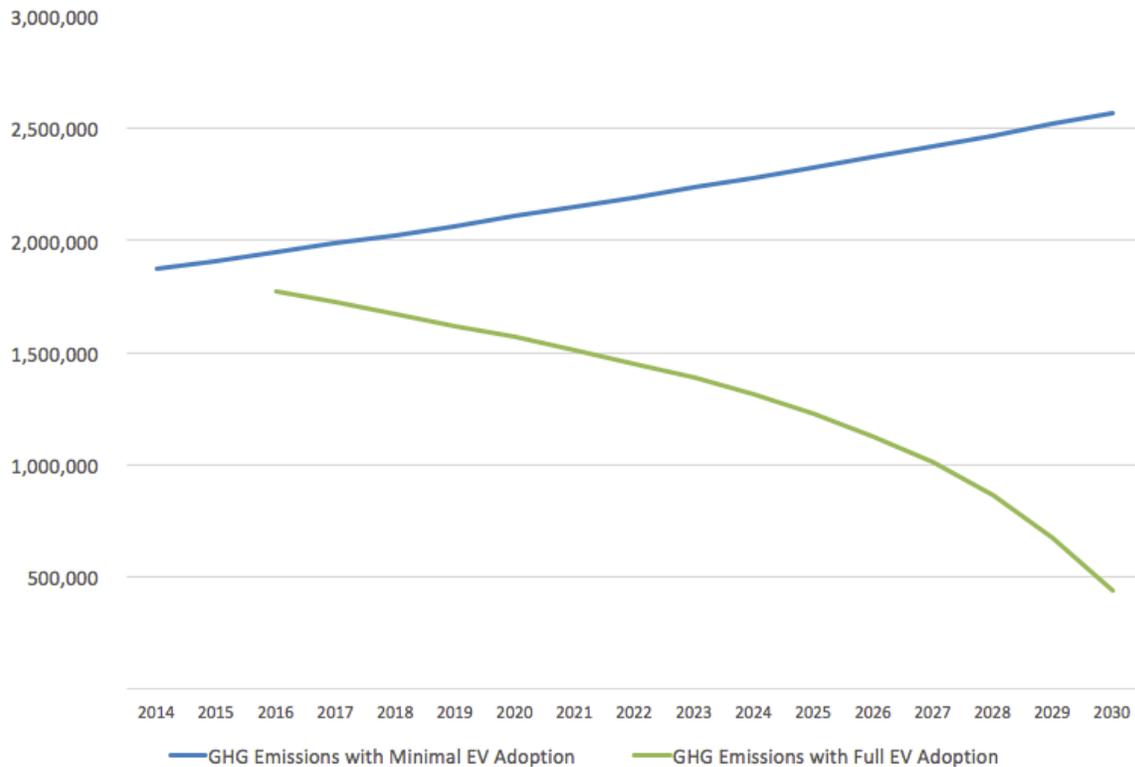
Sonoma County can achieve a dramatic reduction in GHG emissions from transportation through increased EV adoption. If EV adoption rates grow at a steady 30 percent annual rate, as described above, EVs will comprise the vast majority of new car sales by 2030. Under this assumption, by 2025, EV sales will outstrip the sale of combustion cars, and by 2030 the sale of new combustion cars would essentially end.

¹⁷ 16 years is approximately two average car “lifecycles.”

¹⁸ The Center for Climate Protection: https://climateprotection.org/wp-content/uploads/2017/08/EV_adoption.xls

The GHG reductions under the scenario outlined in Figure 3 are shown in Figure 4.

Figure 4: GHG reductions from a 30 percent annual increase in EV adoption in Sonoma County¹⁹



A more likely scenario is that EV adoption grows while new combustion cars become more fuel efficient. Improved Corporate Average Fuel Economy (CAFE) standards from the US Department of Transportation are set to rise dramatically in the next decade.²⁰ However, this will be reversed if the Trump administration lowers CAFE standards, as they have proposed.²¹

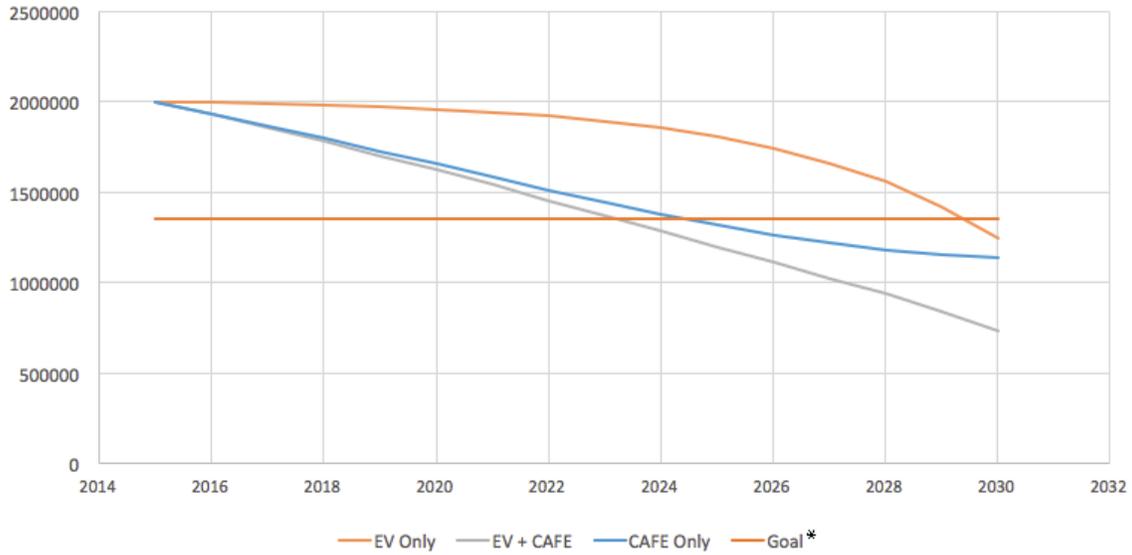
Figure 5 reflects multiple factors for reducing Sonoma County’s transportation emissions to reach its goal. Although it is possible to achieve these goals with increased fuel efficiency only or with EVs only, Sonoma County will achieve its goal most quickly and achieve the deepest and most sustainable reductions in GHGs by combining the two strategies.

¹⁹ Source: Center for Climate Protection: https://climateprotection.org/wp-content/uploads/2017/08/EV_GHG_reductions.xlsx

²⁰ <https://www.nhtsa.gov/laws-regulations/corporate-average-fuel-economy>

²¹ <http://www.nbcnews.com/business/autos/trump-rolls-back-obama-era-fuel-economy-standards-n734256>

Figure 5: Scenarios for reducing Sonoma County transportation emissions ²²



* Goal of 650,000 metric ton GHG emissions reduction in Sonoma County transportation sector, as described on p.11 of this report.

Our proposed EV goal aligns favorably with goals set by others. They all point to the need for rapid EV adoption.

Table 1: Local EV goals	
Entity	EV goal
Center for Climate Protection	138,000 by 2030
Sonoma County Transportation Authority/ Regional Climate Protection Authority	110,000 - 140,000 by 2040 ²³
Sonoma Clean Power	100,000 by 2030 ²⁴
Bay Area Air Quality Management District	~34,500 by 2025 ²⁵ (to reach the goal of 138,000, we project 39,822 EVs by 2025)

²² Center for Climate Protection: https://climateprotection.org/wp-content/uploads/2017/08/personal_transport.xlsx

²³ Draft Comprehensive Transportation Plan states that to meet Sonoma County’s GHG emission reduction goal of 60 percent below 1990 levels by 2040 we must increase the zero emissions vehicle share to 40-50% of total fleet. http://scta.ca.gov/wp-content/uploads/2016/09/CTP16_090616.pdf

²⁴ <https://sonomacleanpower.org/timeline/scp-launches-new-drive-clean-drive-evergreen-program/>

²⁵ <http://www.baaqmd.gov/~media/Files/Strategic%20Incentives/EV%20Ready/Summary%20PEV%20Readiness%20Plan%20FINAL.ashx> Figure extrapolated using total 247,000 EVs in the Bay Area by 2025, and Sonoma County = 14% of Bay Area population.

IV. Sonoma County EV status and trends

The number of EVs owned by Sonoma County drivers continues to grow. The total number of electric cars in Sonoma County is now about 4,500, an increase of more than 200 percent since summer 2015 when the initial version of this White Paper was issued. This EV growth exceeds that of the State of California as a whole, which saw an increase of slightly less than 60 percent during the same time period.

The approximately 4,500 EV owners in Sonoma County are saving over \$5 million in gasoline costs annually

These numbers are derived from statistics provided by the California Vehicle Rebate Program (CVRP) to which new EV owners apply for their \$2,500 state rebate.²⁶ The CVRP data, while useful, are incomplete. According to the California Energy Commission (CEC), in July 2016 there were over 225,000 registered EVs in California, but only 152,000 received rebates.²⁷ This means that approximately 33 percent of EV owners do not apply for or receive rebates.

Assuming that only two-thirds of new EV owners apply for rebates, we extrapolate from CVRP data to determine the approximate number of EV owners in Sonoma County. By the end of April 2017, the total number of Sonoma County residents who had applied for rebates was 3,185.²⁸ This suggests total EV ownership in Sonoma County was approximately 4,500 at that time. Sonoma County now accounts for over 2 percent of California's EVs, which is an uptick from the 1.6 percent level reported in 2015.

November and December 2016 were the biggest months for EV rebate applications in Sonoma County, with over 200 vehicles purchased directly through SCP's program during that time. This is probably attributable to the very attractive incentives offered by Sonoma Clean Power from October 2016 to January 2017.²⁹

One of the biggest co-benefits of switching from gasoline to electric driving is the money that is saved, and redirected from multinational fossil fuel corporations, and paid instead to local electricity providers, or not spent on fuel at all. The approximately 4,500 EV owners in Sonoma County are saving over \$5 million in gasoline costs annually.³⁰ Instead of leaving the county, much of this \$5 million remain in circulation in the local economy. If we extrapolate to our projected

²⁶ <https://cleanvehiclerebate.org/eng/rebate-statistics>

²⁷ http://www.energy.ca.gov/renewables/tracking_progress/documents/electric_vehicle.pdf

²⁸ <https://cleanvehiclerebate.org/eng/rebate-statistics>

²⁹ <https://sonomacleanpower.org/wp-content/uploads/2017/04/Drive-EverGreen-EV-Incentive-Pilot-Evaluation-Report.pdf>

³⁰ \$513,000,000 fuel cost/417,000 vehicles = \$1,230 per car fuel cost average x 4,500 = \$5,535,000.

number of EVs for 2030, the switch to electric vehicles could save Sonoma County drivers over \$150,000,000 per year, keeping that money in local circulation.

The economic drain on Sonoma County from internal combustion engine driving has decreased in the past two years, mostly due to lower gasoline and diesel prices. The total amount spent by Sonoma County drivers on gasoline and diesel purchases in 2016 was approximately \$500 million compared with \$850 million in 2013.³¹

The switch to electric vehicles could save Sonoma County drivers over \$150,000,000 per year

V. Factors influencing EV adoption

The discussion below addresses some of the main factors that influence EV adoption, as identified in a recent study by the University of Hawaii.³²

Availability of charging stations

Easily accessible EV charging, especially at workplaces and also at destinations such as shopping centers and hotels, increases the likelihood that people will purchase EVs, increases the amount EV owners will drive their cars, and reduces the amount of gasoline burned in PHEVs.

In Sonoma County between August 2015 and December 2016, the number of publicly available chargers grew from 76 public Level 2 stations and 8 DC Fast Charging (DCFC) stations in 2015, to over 170 Level 2 chargers in over 90 separate locations, and 26 DCFC in 10 locations. Of these 26 DCFC stations, 10 are Tesla Superchargers at one Petaluma location. Almost all of the DCFC stations are along Highway 101. In general, there is a lack of chargers outside the 101 corridor, especially in the coastal regions of Sonoma County.³³

Several workplaces installed EV charging in the past year, including Amy's Kitchen corporate headquarters in Santa Rosa, SOMO Village in Rohnert Park, and Vivint Solar in Sebastopol. EV chargers are also becoming more prevalent at high-end destinations such as wineries and hotels.

The State of California remains committed to assisting its residents in making the switch to EVs. The \$2,500 state rebate typically gets oversubscribed, but the legislature has in the past always allocated additional funds.³⁴ State Senate Bill SB

³¹ 417,000 vehicles x 11,400 miles per year / 25 average mpg x \$2.70 average fuel cost = \$513,000,000

³² "Factors Affecting EV Adoption," Coffman et al, 2015, Electric Vehicle Transportation Center, University of Hawaii, 2015, <http://evtc.fsec.ucf.edu/publications/documents/HNEI-04-15.pdf>

³³ <http://www.arcgis.com/home/webmap/viewer.html?webmap=fbe75444a0f94b8f9cbf9074a6c35ec2&extent=-123.6588,38.1192,-122.2196,38.8609>

³⁴ <http://www.pluginars.com/california-ev-rebates-are-back-effect-132148.html>

350, enacted in September 2015, directs the California Air Resources Board to initiate a variety of policies to reduce emissions and promote EV adoption.³⁵

EV charging infrastructure continues to receive support from regional and state agencies, including the California Energy Commission (CEC) and the Bay Area Air Quality Management District (BAAQMD).³⁶

Battery costs and range

In 2015, lithium-ion battery prices were falling from \$500-600/kWh towards a projected “tipping point” of around \$200/kWh.³⁷ In October 2016, Bloomberg News reported that “the price of lithium-ion battery packs has fallen 65 percent since 2010 and is likely to keep declining.”³⁸ Their more recent analysis, “The electric car revolution is accelerating,” predicts that battery prices will continue their precipitous price decline, and that the per-kilowatt-hour price of lithium-ion batteries will fall to \$73 by 2030.³⁹

Electric cars will cost the same or less to buy than gasoline cars by 2025

Both Tesla and GM are currently manufacturing or purchasing battery packs for under \$200/kWh.⁴⁰ As battery prices continue to fall, EVs will become more affordable for consumers, and more profitable for the car makers. Lower battery prices will also facilitate longer-range EVs at increasingly lower prices. A recent report by Bloomberg predicts that due to falling battery prices, electric cars will cost the same or less to buy than gasoline cars by 2025.⁴¹

Policy incentives

The \$7,500 federal tax credit for new EVs remains intact, although it is uncertain whether the current administration will continue it.

The largest area of concern for increased EV adoption is the proposed rollback of Corporate Average Fuel Economy (CAFE) standards by the Trump administration.⁴² This could potentially slow EV development, although California and other states will likely push back hard against this proposal.

³⁵ <http://www.sfchronicle.com/opinion/openforum/article/SB350-gives-electric-vehicles-a-charge-6556868.php>

³⁶ <http://www.baaqmd.gov/grant-funding/businesses-and-fleets/charge>

³⁷ <http://reneweconomy.com.au/battery-storage-costs-plunge-below100kwh-19365/>

³⁸ <https://www.bloomberg.com/news/articles/2016-10-11/battery-cost-plunge-seen-changing-automakers-most-in-100-years>

³⁹ <https://www.bloomberg.com/news/articles/2017-07-06/the-electric-car-revolution-is-accelerating>

⁴⁰ <https://electrek.co/2017/02/18/tesla-battery-cost-gigafactory-model-3/>

⁴¹ <https://www.bloomberg.com/news/articles/2017-05-26/electric-cars-seen-cheaper-than-gasoline-models-within-a-decade>

⁴² <http://www.nbcnews.com/business/autos/trump-rolls-back-obama-era-fuel-economy-standards-n734256>

Automakers, car dealers, and the availability of cars people want

EV adoption will increase only if people are sufficiently motivated to overcome their present driving habits and fueling behavior. To do this, they must have attractive, convenient, reasonably-priced EV choices. Tesla has demonstrated that the demand for high-range, moderately priced, appealing EVs is strong. Tesla has collected over 370,000 cash deposits of \$1,000 to reserve their upcoming Model 3.⁴³

Gasoline and diesel prices

In recent years, the correlation between fuel prices and sales of fuel efficient vehicles has weakened.⁴⁴ Similarly, correlations between fuel prices and EVs are also surprisingly weak.⁴⁵ California and Sonoma County have directly experienced this, as gasoline prices fluctuated from over \$4.00 a gallon to \$2.50 to \$3.00 per gallon while sales of EVs continued to grow. As the EV market grows as a percentage of total car sales, and EV ownership becomes “normalized,” the correlation between fuel prices and EV sales could plausibly strengthen.

Inspiration from abroad

Norway has the highest per capita number of all-electric cars in the world, more than 100,000 in a country of 5.2 million people. Last year, EVs constituted nearly 40 percent of Norway’s newly registered passenger cars.⁴⁶

Elsewhere on the international stage there have been some bold policy proposals. The Netherlands’ lower house of Parliament has passed a draft of a law that would impose a complete ban on internal combustion engine car sales beginning in 2025.⁴⁷ Germany’s Bundesrat has passed a non-binding resolution aimed at ending all combustion car sales by 2030, a notable feat given that Germany is the fourth largest car maker in the world.⁴⁸ France and Great Britain recently announced plans to ban all gasoline and diesel vehicles by 2040.⁴⁹

Factors influencing EV adoption that are under local control

Using a list of factors that influence EV adoption from a recent study, we identified which of these factors are or might be, in general, under local control, as shown in

⁴³ <https://www.yahoo.com/tech/tesla-electric-lineup-now-includes-205704977.html>

⁴⁴ <http://www.rff.org/blog/2016/how-do-gasoline-prices-affect-new-vehicle-sales>

⁴⁵ <https://pluginamerica.org/do-gas-prices-correlate-plug-vehicle-sales/>

⁴⁶ <https://www.theguardian.com/environment/Norway>

⁴⁷ <http://www.independent.co.uk/environment/climate-change/netherlands-petrol-car-ban-law-bill-to-be-passed-reduce-climate-change-emissions-a7197136.html>

⁴⁸ <https://www.forbes.com/sites/bertelschmitt/2016/10/08/germanys-bundesrat-resolves-end-of-internal-combustion-engine/#5c72c77660bd>

⁴⁹ <http://www.independent.co.uk/environment/france-petrol-diesel-ban-vehicles-cars-2040-a7826831.html>

the following table.⁵⁰ Distinguishing these factors is important when developing Sonoma County’s actions to accelerate EV adoption.

Table 2: Factors influencing EV adoption	Generally under local control?	
	Yes	No
Purchase price		X
Driving range		X
Charging time		X
Fuel prices		X
Battery prices		X
Incentives for vehicle ownership ⁵¹	X	X
Incentives for charging systems ⁵²	X	X
Vehicle features and characteristics		X
Availability of charging stations	X	
Travel distance		X
Public visibility	X	
Vehicle diversity		X

VI. Local policies and programs

Within the context of the need to dramatically accelerate EV adoption in Sonoma County to meet our goal to reduce GHG emissions, and the limits of control that Sonoma County has over the factors that influence EV adoption, we turn our discussion to the local programs and policies currently underway to help meet the challenge of accelerating EV adoption.

In early 2014, the Sonoma County Regional Climate Protection Authority (RCPA) and its parent agency, the Sonoma County Transportation Authority (SCTA), were awarded a Strategic Growth Council Planning Grant to develop Shift Sonoma County. Shift is a strategic action plan to promote a shift in both the mode and fuel used for personal transportation—through car share, bike share, rideshare, transit integration, education, incentives, and land use—as well as strategies to promote electric vehicle use.

This work, scheduled to be formally approved in Fall 2017, will assist local agencies in planning for the coming changes in transportation in Sonoma County. The plan outlines strategies for cutting GHG emissions from transportation in half. Proposed efforts include planning, policy, coordination, deployment, education and

⁵⁰ “Factors Affecting EV Adoption,” Coffman et al, 2015, Electric Vehicle Transportation Center, University of Hawaii, 2015, <http://evtc.fsec.ucf.edu/publications/documents/HNEI-04-15.pdf>

⁵¹ Some local agencies, including Sonoma Clean Power and Bay Area air districts, have created vehicle and charger incentive programs. These programs, although more limited in scope and resources than federal and state programs, can provide an additional boost to EV sales.

⁵² Ibid

awareness programs for local governments to consider. Funding must be secured in order for the programs and infrastructure outlined in Shift Sonoma County to be implemented.

A. Increasing the availability of EV charging stations

As part of Shift Sonoma County, an analysis of future charging needs was conducted and hundreds of additional locations were identified where charging is needed in the short term.⁵³ This planning work will aid local businesses and governments in selecting the best locations for additional charging infrastructure. Funding for the installation of the chargers is not included in the Shift plan, but completion of this planning work will ensure that chargers are installed where they are most needed, as public and private funding becomes available.

One large source of funding that is expected to become available soon is from the large investor-owned utilities. The California Public Utilities Commission recently approved PG&E's application for an Electric Vehicle Infrastructure and Education Program that will fund the installation of 7,500 Level 2 chargers throughout PG&E's territory, with an emphasis on workplaces and multi-unit dwellings (MUDs).⁵⁴ Although PG&E has not yet announced where they will locate these chargers, extrapolating from population data, and assuming Sonoma County receives a share of chargers commensurate with our share of the population in PG&E's service territory, Sonoma County should expect somewhere on the order of 200 to 250 new chargers in workplaces, and 200 to 250 new chargers in MUDs.

Bay Area Air Quality Management District's Charge! Program is an incentive program that offers grant funding to help offset a portion of the cost of purchasing, installing, and operating new publicly available charging stations at qualifying facilities within the Air District's jurisdiction.⁵⁵ Both public and private entities are eligible to apply. For 2017, \$5 million is allocated to this program, and awards are made on a first-come, first-served basis.⁵⁶ This program will contribute up to 75 percent of the cost of purchasing and installing charging stations. The minimum allocation is \$10,000. Businesses, non-profits and public agencies can apply, and must both make the chargers publicly available and meet minimum usage requirements. The funding is sufficient to pay for many hundreds of new chargers throughout the Bay Area. Although it is difficult to predict how much will flow to Sonoma County, this funding will certainly accelerate EV charger installations here.

Additional funding will also likely be available from Volkswagen, as a consequence of their multi-billion-dollar settlement over their diesel emissions scandal. It is expected that half of the \$2 billion that VW has committed to invest in EV infrastructure will be spent in California.⁵⁷

⁵³ <http://scta.ca.gov/planning/shift/>

⁵⁴ http://www.greencarreports.com/news/1107854_california-approves-pge-utility-plan-for-7500-electric-car-charging-stations

⁵⁵ <http://www.baaqmd.gov/grant-funding/businesses-and-fleets/charge>

⁵⁶ www.baaqmd.gov/charge

⁵⁷ <https://electrek.co/2017/02/08/vw-electric-vehicle-charging-infrastructure-dieselgate-settlement/>

The CEC has funded the installation of additional fast chargers along the northern portion of the Highway 101 corridor, all the way to the Oregon border. This includes fast charge locations in both Healdsburg and Cloverdale. The installation of these chargers will begin in 2017, and they will be available in 2018.⁵⁸

The Northern Sonoma County Air Pollution Control District (NSCAPCD), as part of their 3-2-1 Go Green program, is offering assistance for businesses that wish to install publicly available chargers in rural regions in the north and west of Sonoma County, as well as along the coast.⁵⁹ As of July 2017, four applications have been approved for public charger installation through this program.⁶⁰

B. Local EV rebate and incentive programs

The following are other Sonoma County programs and policies that were initiated in the past two years to accelerate EV adoption.

Sonoma Clean Power (SCP) approved an allocation of \$3 million for a variety of efforts related to accelerating EV adoption, bundled under the name “Drive Evergreen.” From October 2016 to January 2017, SCP offered incentives, discounts and rebates for EV purchases in Sonoma County. This program has been completed and evaluated.⁶¹ In total, 206 new EVs were purchased or leased through the program, including 35 that were obtained by low-income customers. Estimates indicate that the operation of these vehicles over their lifetime will reduce GHG emissions equivalent to 7,726 to 13,640 metric tons of CO₂, with an average reduction of 1.8 metric tons per \$100 of incentive funding spent.

SCP will roll out a second phase from August to October of 2017 that will include a wider variety of model makes as well as used EVs. Funding of \$1.5 million is available as incentives for over 500 additional vehicles.⁶²

SCP customers also can receive free Level 2 electric car chargers that connect to the Internet and enable SCP to track use and even throttle back charging during times of high demand. Over 570 chargers have been deployed through this program, with over 90 percent of those receiving chargers signing up for the still-in-development demand response program. In addition to providing another incentive to EV adoption, this portion of the program will allow SCP to conduct a real-world field test of demand response management.

The Northern Sonoma County Air Pollution Control District (NSCAPCD) also launched a 3-2-1 Go Green program in August 2016 to offer rebates and incentives

⁵⁸ <https://www.mendovoice.com/2017/04/fast-charging-stations/>

⁵⁹ <http://sonomacounty.ca.gov/Go-Green>

⁶⁰ Rob Bamford, NSCAPCD, July 20, 2017

⁶¹ <https://sonomacleanpower.org/wp-content/uploads/2017/04/Drive-EverGreen-EV-Incentive-Pilot-Evaluation-Report.pdf>

⁶² <https://sonomacleanpower.org/wp-content/uploads/2016/12/2017.07.06-SCPA-BOD-Agenda-Pkt-reduced.pdf>

for the purchase of EVs (as well as the installation of both residential and commercial chargers) within their jurisdiction. Over 60 vehicle rebates have been approved through this program as of July 2017.⁶³

C. Public visibility and EV promotion

Sonoma Clean Power has mounted a range of EV promotion efforts, including distribution of brochures and pamphlets, information on their website, and a series of six ride-and-drive events at large employers held in the fall of 2016.

The North Bay Electric Auto Association (NBEAA), a chapter of the national Electric Auto Association comprised of local EV drivers and advocates, holds monthly meetings to keep members abreast of the latest programs and technologies and to coordinate advocacy efforts. The NBEAA also hosts an annual ride-and-drive event during National Drive Electric Week. In 2016 the event attracted over 500 participants. Plans are underway for the 2017 event, which will take place September 9 for the first time in Courthouse Square in Santa Rosa.⁶⁴

Sonoma Clean Power, the Center for Climate Protection, the NBEAA, NSCAPCD, and the County of Sonoma have collaborated regularly to promote EVs in Sonoma County.

VII. Discussion and findings

Many forward-thinking people, such as businessman Richard Branson, predict that EVs will overtake combustion cars in 10 to 15 years as battery prices fall, vehicle ranges increase, and the climate imperative drives policies favoring electricity over gasoline and diesel.⁶⁵ Volvo recently became the first major automaker to announce a complete phase out of gas-only cars, announcing that all models they introduce after 2019 will be either hybrids or pure electrics.⁶⁶ Can Sonoma County and the rest of the world wait for such forces to cause the transformation needed in transportation to reduce GHG emissions and meet the scientific imperative, or is more needed?

For Sonoma County to achieve its GHG emission reduction goal a rapid acceleration of EV adoption is required. This will take something much more than a “business-as-usual” effort. The currently-offered programs at national, state, and local levels represent a good foundation, but are insufficient to meet the problem at the speed and scale required.

⁶³ Rob Bamford, NSCAPCD, July 20, 2017

⁶⁴ <https://driveelectricweek.org/event.php?eventid=963>

⁶⁵ <http://edition.cnn.com/2016/07/08/motorsport/richard-branson-formula-e/>

⁶⁶ <https://www.nytimes.com/2017/07/05/business/energy-environment/volvo-hybrid-electric-car.html>

Sonoma County is presently 15 years behind in achieving its goal to meet the scientific imperative for climate in the transportation sector. Moreover, Sonoma County's GHG emissions are projected to increase, as mentioned above. Sonoma County controls only a small number of factors that influence EV adoption, and the present local programs and policies are probably insufficient to accelerate EV adoption to the level needed.

This conclusion is corroborated by the North Bay Clean Energy Forum in their white paper, "Data Driven Path to Economic and Ecological Sustainability." While supporting Community Choice Energy efforts to achieve wider EV adoption, they sound a cautionary note. "In the context of the rapidly evolving and dynamic EV marketplace, Community Choice policy assumptions need to avoid producing expensive programs that apply public resources to areas where scaled private investments are forthcoming. Therefore, the Forum recommends that Community Choice agencies carefully coordinate with private sector efforts. To ensure a balance between the growing number of EVs and their need for public charging stations requires ongoing data-based monitoring of the type and volume of local EVs (i.e., short range vs. long range) and public charging station capacity. To support market forces driving technological innovation requires instituting a strategy to incentivize EV investment based on a simple formula: Dollar value per GHG reduction per capita vehicle miles traveled (VMT)."⁶⁷

To maintain its leadership position, Sonoma County must accelerate its transition from fossil-fuel based transportation, and prepare for the world beyond combustion. By 2030, sales of new combustion cars must be drawing to an end. To do otherwise will not only cede our position as climate leaders, but will negate all other efforts to curb GHGs.

The highest leverage action that Sonoma County can take may be to call attention to the gap in meeting the scientific imperative for climate in the transportation sector, and to advocate for more rapid change. Sonoma County's status as a local climate leader will lend credibility to this sounding of the alarm.

We must not only add many more EVs, and do so much more quickly, but we must also replace and remove the combustion cars from our roads. In fact, combustion cars, considered normal for a century now, must become a niche product. In the same way that smoking, once completely acceptable in the home and workplace, is now rightly stigmatized, we must develop a new consciousness where the costs of combustion to individual and community health, and to the planet, are rightly understood. After all, if we don't smoke around our kids anymore, why do we not think twice about strapping them into a highly polluting combustion machine? This change in thinking must be at the root of the transformation toward cleaner transportation.

⁶⁷ http://cleanpowerexchange.org/wp-content/uploads/2017/01/NBCEForumWhitePaper_CCA_2017-0124_FINAL.pdf

VIII. Recommendations

The recommended actions presented in the August 2015 white paper were:

1. Advocate for policies and funding, especially at the state level, to accelerate EV use.
2. Expand EV charging, especially at workplaces, multi-unit housing, and along transportation corridors.
3. Develop and implement an EV awareness campaign.
4. Develop EV infrastructure through increased coordination.

Our findings indicate that the recommended actions from 2015 are still needed.

In addition, we offer the following recommended actions:

1. Develop and implement plans to increase and confirm the number of drivers switching from combustion vehicles to EVs; ensure that new EVs do not simply replace existing EVs.
2. Develop an EV charging station visibility campaign.
3. Work with Sonoma Clean Power, other public agencies, and the private sector to maximize daytime charging to address load management issues and maximize the use of renewable power.
4. Develop financing, insurance, and vehicle sharing mechanisms that give low-income drivers access to EVs.
5. Develop awareness programs that highlight the affordability and accessibility of EVs for people at all income levels.
6. Advocate and plan for a future that eliminates the sale of new internal combustion engine cars by 2030 at the latest.
7. Track and publicize progress toward the goals for EV adoption.

IX. Conclusion

Despite progress made over the past two years, much work remains to be done to ensure that Sonoma County addresses its transportation emissions. We estimate that the County will need between 100,000 and 150,000 EVs by 2030 to reach our goals. This means that by the end of the next decade, the ***sales of new combustion cars must effectively end.***

If public agencies, elected officials, consumers, and the business community at local, state, and national levels work together, we can achieve our goals. We must not only continue current efforts, but we must also increase them dramatically.

Appendix A: Current mix of EVs in Sonoma County

The current mix of EV types remains largely the same as it was in 2015, with the Nissan Leaf and Chevy Volt leading the way in the battery-electric vehicle (BEV), and plug-in Hybrid Vehicle (PHEV) categories, respectively.⁶⁸ Other makes that have significantly increased local sales include Ford, Fiat, and Honda. VW jumped six spots up the list, and is now the eighth most popular EV in Sonoma County. Other brands, however, have sold very few models. Notable among these is Toyota, which currently offers no BEVs at all, and has sold very few PHEVs.

Table 3: Cumulative Sales of EVs in Sonoma County by Major Brands		
	March 30, 2015	April 30, 2017
Nissan Leaf	543	956
Chevy Volt	264	529
Prius Plug-In	238	298
Ford Energi	142	315
Tesla Model S and X	135	295
Fiat 500e	79	220
Ford Focus EV	50	90
BMW I3	27	81
Smart FourTwo	25	33
Toyota RAV4 EV	24	26
Chevy Spark	21	64
Kia Sol	17	47
Honda Fit	15	15
VW e-Golf	6	100
TOTAL	1586	3069

⁶⁸ Ibid

Appendix B: The challenge of used EVs

The retention or loss of used EVs is of increasing importance as a large number of first-generation EVs reach the end of their lease. Many of those EV owners are leasing newer models, releasing their cars into the used car market.

Should those EVs leave the county, or be taken out of service completely, the benefits of additional sales of new EVs will be diluted. However, a number of barriers exist to the widespread retention of used EVs.

1. **Rebates and incentives** are available for new vehicles, but not for used vehicles. Although there are many good reasons for this, the gap between the prices of new and used EVs is smaller than it would be otherwise, which reduces the attractiveness of buying a used EV.
2. Those who are looking to replace an older, highly polluting car with a used EV may have to increase their **insurance coverage**. This is because many owners of older cars only carry basic liability coverage. If they invest in an EV, be it new or used, they will need increased insurance. If they lease or finance their car, they will need to purchase comprehensive collision insurance, which could be an excessively burdensome cost for some. This is not true for more affluent buyers, who are often replacing a newer, fully-insured car with their EV.
3. Many buyers of used cars are lower income and therefore rent rather than own homes. This creates a two-layered problem when they are considering an EV. Renters are reluctant to make investments in their housing, including paying to install charging infrastructure. Subsequently, renters are likely to be limited to Level 1 charging. Renters who reside in multi-unit housing face a further hurdle in that their parking is often too far from their apartment to even have a Level 1 charging option. This challenge of **providing charging opportunities for residents of multi-unit housing** is a national issue. The US Department of Energy has issued guidelines for MUD EV charging,⁶⁹ but there are as yet only a few scattered instances of MUD charging in Sonoma County. Furthermore, even when renters are able to charge at their current dwelling, they may be reluctant to invest in an EV due to uncertainty about charging availability at their future home, should they move. The continued lack of workplace charging further complicates the charging situation for Sonoma County drivers.

A program to retain used EVs is needed, ideally making them available to low-income buyers who would otherwise be excluded from the benefits of EVs. This program should not, however, simply offer the cars as a stand-alone program. The car, the financing, the insurance, and the charging should be offered as a bundled package to maximize adoption. Combining the program with a trade-in of an old polluting vehicle that then gets permanently retired will maximize the climate and air pollution benefits of the program.

⁶⁹ http://www.afdc.energy.gov/fuels/electricity_charging_multi.html