DRAWDOWN GA

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ALTERNATIVE MOBILITY

TECHNICAL REPORT | **10.16.20**

ALTERNATIVE MOBILITY

OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

Replacing emissions-intensive vehicle miles traveled (VMTs) with zero- or low-carbon alternatives such as bicycling, walking, or tele-working can reduce GHG emissions. This bundle includes the following Drawdown Georgia solutions: bike infrastructure, walkable cities, telepresence, and e-bikes, with a specific focus on replacing short-distance vehicle trips with these alternatives.

TECHNOLOGY AND MARKET READINESS

These technologies are mature and market ready. Telecommuting and alternative mobility solutions such as bicycles are already widely used around the world and have some presence in Georgia. Given the minimal current presence of biking and alternative mobility, there is significant potential to reduce CO2 emissions by replacing CO2-intensive car trips with low-carbon alternatives. Telecommuting has even greater potential. With advances in video-conferencing and teleworking solutions, there is significant potential to reduce VMT by implementing teleworking policies, and many businesses and organizations already employ teleworking as a strategy to improve employee satisfaction and reduce operation costs.

LOCAL EXPERIENCE AND DATA AVAILABILITY

The Federal Highway Administration's National Transportation Survey has detailed data for VMT at the state level, which can be used to estimate reduction in VMT resulting from more widespread use of alternative mobility measures. Several cities around the state are planning or have already started implementing improvements to bicycling and walking infrastructure, such as the Transportation Alternative Program (TAP), Georgia Commute Options (GCO), and the Atlanta Regional Commission (ARC). Challenges include a lack of data relating to existing biking and telecommuting data as well as historical trends of these data.

TECHNICALLY ACHIEVABLE GHG REDUCTION POTENTIAL

The GHG reduction potential is high, assuming that VMT for urban local trips can be substituted by biking, walking and/or telepresence. For example, preliminary analysis using data from the Federal Highway Administration's National Household Transportation Survey indicates that for bike infrastructure alone, a substitution of 1 out of 10 of urban local car trips (under 3 miles) by bikes could abate over 1 Mt CO2 annually [1]. Additional substitution of vehicle trips by walking, telepresence, and/or e-bikes is expected to contribute to further abatement. In particular, telecommuting has high CO2 reduction potential because telepresence has the ability to offset longer trips and thus more VMT. Average market penetration of telepresence one day per week could reduce VMT by nearly 20 percent. Combined with other market trends such as co-working and synergies with biking and walking, there is ample achievable CO2 reduction potential.

COST COMPETITIVENESS

Review of literature and expert survey feedback indicates that this bundle is cost competitive, especially when considering the fact that new bike infrastructure will negate the need for new motorized vehicle infrastructure. Biking & bike infrastructure, telepresence, and walking are all cheaper solutions than building new automobile infrastructure. Alternative transportation and telepresence also reduce private expenditures on transportation and if managed properly, telepresence can reduce the need for physical office space. Further, reduced commuting can provide significant positive externalities related to congestion reduction and air quality.

BEYOND CARBON ATTRIBUTES

Co-benefits: Benefits include improved air quality from reduced emissions and improved water quality from reduced particulates and debris from cars that end up in stormwater runoff (Grabow et al., 2012). A drop in traditional commuting would also reduce wear & tear on local infrastructure, thereby lowering roadway construction and maintenance costs. Social co-benefits include improved public health due to increased physical activity and improved mental health, increased social interaction that could benefit local businesses, reduction in noise pollution caused by traffic, and overall reduction in local traffic & parking challenges (Grabow et al., 2012). Telecommuting would also reduce the productivity loss attributed to time lost in traffic jams, which was estimated to be $87 billion in the United States in 2018 [2]. Moreover, a co-benefit of improved health of workers would lead to a decrease in workplace accidents due to fatigue and total sick days.

Co-costs: An equity related concern is that adoption rates for this solution would vary between urban versus rural communities, which may lead to possible gentrification impacts. On the other hand, insufficient dispersion of infrastructure for alternative mobility routes may discourage communities (i.e. gender, age) from adopting these options and cause social disparity in the degree of access (Bushell et al., 2013). An additional concern involves an increased number of bikes (or other mobility devices) and car accidents if the resources and infrastructure upgrades are not made available (Bacchieri et al., 2010).

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ELECTRIC VEHICLES

OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

Electric vehicles are powered by electric batteries instead of conventional fuels such as gasoline and diesel. The emissions profile of these vehicles is lower; however, the exact emissions vary depending on the generation mix providing the electricity

TECHNOLOGY AND MARKET READINESS

Electric vehicles are available in the marketplace in LDV applications (Note: there are electric vehicles for other transportation solutions that are not included under this solution). Over the last decade, Georgia provided state subsidies (in the form of a tax credit on new EVs) that led to significant new EV sales yet allowed those subsidies to expire in 2016. Adoption rates during the subsidy period demonstrate a huge potential for EVs in the Georgia market. In 2018, about 14,000 electric vehicles were registered in Georgia [1]. The projected percentage share of new vehicle sales for EVs range from anywhere from around 20% [2] to nearly 50% [3] of total LDV sales in 2030. We assume that Georgia's adoption will fall within this national range, depending on future technology and policy scenarios.

LOCAL EXPERIENCE AND DATA AVAILABILITY

From 2017-2018, Georgia had 122.64% year-on-year share percentage increase and was a leader in EV adoption [4]. Consequently data is readily available and local markets have experienced high rates of adoption.

TECHNICALLY ACHIEVABLE CO_2 REDUCTION POTENTIAL

EVs are readily capable of achieving significant CO_2 reductions when the electricity generated comes from renewable or net-neutral carbon energy sources (Cox, et al., 2018). CO_2 reductions are still possible compared to conventional internal combustion vehicles when the electricity derives from natural gas generation. Reduction potential is heavily contingent on grid portfolio and emissions associated with manufacturing and resource extraction. Large potential reductions are possible in the 2050 timeframe, in particular under high renewable penetration scenarios (Cox, 2018). Current EV technology can reduce CO_2 emissions (including upstream) by 50gCO_2e/km for a small, light duty passenger vehicle using weighted average for the CO_2 emissions intensity of the Georgia grid [5]. As technology and efficiency continues to improve, these CO_2 reductions are expected to be even greater (by up to 50% more) by 2030 [6]. Even with modest penetration, electrification of Georgia's light duty personal & commercial vehicles shows significant potential for reduction. Additional carbon emissions associated with increased electricity demand warrants further study.

COST COMPETITIVENESS

As reflected by sales projections, the cost of a new EV is expected to be comparable to that of internal combustion engine vehicles (ICEVs) over the next decade. Cost competitiveness will increase as manufacturing economies of scale are realized and adoption rates grow. Costs and benefits vary with regard to usage patterns but are broadly positive as technology becomes cheaper and more commonplace (Simmons, 2015). Reduced operation and maintenance costs should offer significant savings to consumers over vehicle lifetimes [7]. More study is likely needed to determine the impact of charging infrastructure costs and electricity generation/rates and how these should be allocated to users or society as a whole.

BEYOND CARBON ATTRIBUTES

Co-benefits: The solution offers benefits to environmental and public health from localized air quality improvements (Smit, et al., 2018), recognizing that such benefits may not exist or may be limited in energy generation/producing locations. Other benefits include the creation of jobs associated with selling, installing, and maintaining batteries for electric vehicles [8]. Another positive consideration emerges from research that highlights the storage locations of commercial trucks in low income communities – with electrification and movement in/out of these facilities offering localized public health/air quality benefits (versus emission vehicles).

Co-costs: Potential adverse impacts include disposition of end-of-life of batteries (Ai, et al., 2019). Also, large scale EV adoption will necessitate charging/related infrastructure investments that have the potential to increase electricity rates. As with other solutions such as solar, the higher costs of EV vehicles may make access to this solution challenging for low-income communities [9].

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ENERGY-EFFICIENT CARS

OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

A range of cost-effective technologies are available to reduce or replace petroleum fuel use in light duty vehicles, including cars and pickups. Among these, hybrid cars deliver the most substantial reductions, by pairing an electric motor and battery with an internal combustion engine. The combination enables the vehicle to regenerate braking loss, and operate both engine and motor at greater efficiency, improving fuel economy and lowering emissions.

TECHNOLOGY AND MARKET READINESS

Hybrid cars and fuel-efficient light duty vehicles (LDVs: cars, SUVs, pickups) are readily available and have secured a strong presence in the market (EPA, 2019). All vehicle manufacturers are currently developing technologies to improve fuel economy [1]. CO_2 emissions from cars and light duty trucks have been steadily declining, reaching record lows nearly every year since 2004. Fuel economy has likewise improved drastically over the same time period and is projected to continue to increase into the future. The U.S. Environmental Protection Agency's (EPA) GHG regulations and corporate average fuel economy (CAFE) standards have encouraged innovation and continue to stimulate the market for increased efficiency [2]. Many advanced technologies are now standard equipment on new LDVs (EPA, 2019).

LOCAL EXPERIENCE AND DATA AVAILABILITY

Currently, approximately 3.6% of all vehicles in the United States are registered in Georgia [3]. About 6,225,000 passenger vehicles are registered in the state. There is readily available data on fuel efficiency and emissions for light-duty and energy efficient hybrids [4]. The Georgia dealer network and marketplace are very familiar with fuel saving and alternate vehicle technologies.

TECHNICALLY ACHIEVABLE CO_2 POTENTIAL

Given the high number of single-occupancy trips, potential reductions in car emissions derived from efficiency improvements will prove significant. Aggressive GHG regulations such as CAFE standards have reduced the amount of CO_2 emitted per mile by the average light duty vehicle by about 14% from 395 grams per mile in 2009 to 348 grams per mile in 2018 [2]. (EPA, 2019). Assuming the next decade of GHG regulations are only half as effective, then the average light duty vehicle in 2030 would emit around 323 grams per mile. It is estimated that there will be approximately 556,000 new light duty vehicle sales in Georgia in 2030 [5]. The average vehicle travels 13,000 miles per year,[6] thus new vehicles sold in 2030 that follow this trend in compliance with efficiency standards will avoid CO_2 emissions by 180,700 metric tons in 2030 alone compared to 2018 levels. If it is assumed that the impacts of new vehicle sales in model years that precede 2030 are also added, then the cumulative CO_2 reductions of these new technologies in the fleet will exceed 1 $MMTCO_2$/year.

COST COMPETITIVENESS

Many fuel saving technologies are available at attractive paybacks. Since a vast majority of Georgia's fleet operates on the traditional internal combustion engine (ICE), a focus on steady increases in average fuel economy from ICEs and hybrids (as quantitatively described above) will make significant contributions to drawdown goals and demonstrate economic viability. Depending on miles travelled and fuel prices, the cost of fuel economy technologies can be offset by operational cost savings on a net present value basis (Simmons, et al., 2015). Compared to other means of mitigating CO2 in transportation, cars and the suite of fuel efficiency technologies pose a relatively low-cost solution for a significant impact.

BEYOND CARBON ATTRIBUTES

Co-benefits: This solution offers benefits to the environment and public health from the improvement in air quality [7]. Additional benefits include the creation of jobs associated with selling, installing, and maintaining hybrid vehicles and improved fuel economy [8]. Co-costs: In terms of potential adverse impacts, there are some concerns regarding the disposition of end-of-life of batteries (Ai, et al., 2019). There are also concerns regarding upward pressure on electricity rates to fund the investment in infrastructure required to charge hybrid batteries, because some (not all) hybrids require electric charging. Also, there are some accessibility challenges as lower income drivers are often not able to afford the latest or most energy efficient vehicle options [9].

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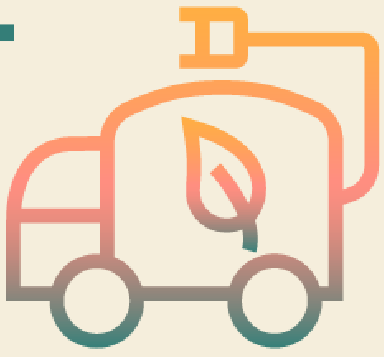
ENERGY-EFFICIENT TRUCKS



OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

U.S. trucks consume about 50 billion gallons of diesel fuel each year. Trucks consume a disproportionate quantity of fuel relative distances travelled. Increasing fuel efficiency for both new and existing trucks can lead to significant emission reductions. Numerous fuel-saving technologies are available at compelling paybacks.

TECHNOLOGY AND MARKET READINESS

Fuel efficient medium duty (MD) and heavy duty (HD) trucks are available and already a strong presence in the market. Vehicle technologies and improved connectivity and routing can all be subsets that contribute to reductions within this solution category. Because of the compelling economics and prevalence of a range of truck applications within the economy, market forces encourage technological innovation.

LOCAL EXPERIENCE AND DATA AVAILABILITY

There are around 4 million registered MD and HD trucks in Georgia [1]. Logistics account for 18% of the state's gross state product (GSP), supporting 5,000 companies, employing 110,000 Georgians and generating over $50 billion in sales annually [2]. The National Highway Traffic Safety Administration (NHTSA) and the EPA periodically publish information on fuel efficiency and emissions for MD and HD vehicles, as well as draft regulatory policy setting efficiency and emission standards [3].

TECHNICALLY ACHIEVABLE CO2 POTENTIAL

Improving freight movement efficiency and reducing congestion, particularly in bottleneck congestion sites, will yield significant fuel savings and emissions reductions. According to the Georgia Department of Transportation (GDOT), long-haul trucks emit around 1,345.4 gCO_2/mile [3]. By reducing idle time and increasing route and operating efficiency via infrastructure and technological improvements, this number can be reduced substantially. Significant opportunities exist in converting MD vehicles to alternative fuels such as compressed natural gas (CNG) and hybrid-electric powertrains (Quiros et al., 2017) showing emissions reductions in excess of 20%. Additional opportunities exist to substitute MD diesel trucks with electric or hybrid-electric vehicles, as many are centrally garaged, rarely require operation outside of a defined area, and have routes (i.e., predictable, start-stop, urban) that can exploit the CO_2 reducing benefits of hybridized or electrified powertrains.

COST COMPETITIVENESS

Fuel efficient vehicles can incur higher upfront costs, but paybacks can be attractive (Gelmini and Savaresi, 2018). MD applications may exploit technologies that have been developed for LDVs and are now competitive at scale for selected use cases. Relative to the price tag of other emissions reductions solutions, the cost is relatively minimal and fuel-saving technologies in freight result in concurrent economic benefits and emissions reductions.

BEYOND CARBON ATTRIBUTES

Co-benefits: The solution offers benefits to the environment and public health from improvements in air quality [5]. Other benefits include the creation of jobs for the manufacturing and engineering of fuel-efficient trucks (One study estimated that widespread national deployment of more-efficient trucks would create 63,000 additional jobs by 2020, and 124,000 jobs by 2030) [6]. Additionally, there are benefits for truck drivers and owners from reduced spending on fuel from improved fuel efficiency [7].

Co-costs: These include higher initial upfront investments, early depreciation and sunk costs associated with incumbent assets, and other market barriers for adoption.

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MASS TRANSIT

OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

Public mass transit includes modes such as buses, trains and streetcars. When people rely on mass transit instead of cars, it reduces GHG emissions.

TECHNOLOGY AND MARKET READINESS

The technology for mass transit options is readily available and there are well-established markets for it in Georgia. Behavioral shifts, however, will be required to achieve maximum GHG reduction potential [1]. More specifically, the trend in public transit ridership has not followed a favorable trajectory as compared with competing travel options (e.g., ride-hailing). If ridership can be sustained or increased, it could open the door to large emissions reductions from this solution, driven by more advanced vehicle technology and routing intelligence.

LOCAL EXPERIENCE AND DATA AVAILABILITY

Georgia has MARTA, GRTA and Cobb County Transit in the Atlanta metro area and Chatham in Savannah. As a result, significant data is available on ridership demand and vehicle and system efficiency. While large deployments of electric vehicles have not been undertaken in Atlanta, a growing dataset is available from other urban transit systems which would be relatively translatable.

TECHNICALLY ACHIEVABLE CO2 POTENTIAL

For a rough order of magnitude comparison, it is estimated that mass transit options in Georgia (MARTA in Atlanta in particular) releases .245lbs CO2/passenger mile, compared to .891lbs CO2/passenger mile for a single occupancy vehicle personal vehicle.[2] While a true trip comparison and consideration of ridership would be required to complete the analysis, this notional difference suggests that CO2 potentials are technologically achievable. This figure decreases further as ridership percentages rise, since the system increases in efficiency. There is potential for significant avoided emissions for most trips so long as ridership is sufficiently high. Beyond directly replacing existing trips, the availability of transit alters land use patterns that result in fewer or shorter vehicular trips, which in turn helps to reduce tailpipe emissions. In reviewing the literature, one comprehensive study found that CO2 emissions can be on the order of 70% lower than diesel emissions for EV bus applications in a simulation of European and California contexts (Lajunen and Lipman, 2016).

COST COMPETITIVENESS

Government subsidies for transit can reduce the cost per trip. For passengers, mass transit can frequently be the cheapest mode of travel (and the lowest CO2 option), replacing the financing, operating, and maintenance costs associated with owning personal vehicles with a small fare or a monthly pass. While this option may incur longer commutes, the direct cost savings can be considerable. In a given benefit cost comparison, an EV bus was found to have a capital cost of 2 to 3x that of a diesel bus in an identical application, but a net operating cost of less than 1.5x, due to reduced energy, maintenance and operating expenses (Lajunen and Lipman, 2016). Finally, the EV-Diesel transit bus cost gap is expected to approach parity by about 2030.

BEYOND CARBON ATTRIBUTES

Co-Benefits. These include improved air quality from reduction in higher emission vehicles [3], potential for increased business and property values in areas around mass transit stations (Stjernborg and Matisson, 2016), improved quality of life and reduced obesity (She, et al., 2017), and reduced vehicle traffic and congestion in cities (Stjernborg and Matisson, 2016). Potential equity benefits include low-cost access to transportation in low-income communities and for those who cannot drive or do not have a driver's license [4].

Co-Costs: In terms of potential adverse impacts, there will likely be concerns resulting from the acquisition of new corridors and consequential segmenting of land and neighborhoods. Other concerns include the potential for an increase in crime related activities in neighborhoods around stations (Di, 2017).

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