August 5, 2013

Michael Tollstrup
California Air Resources Board
1001 I Street
Sacramento, CA 95814

Submitted via CARB comments webpage:
http://www.arb.ca.gov/cc/scopingplan/2013comments.htm

RE: Environmental Defense Fund Comments on the California Air Resources Board Scoping Plan Update

Dear Mr. Tollstrup,

Please accept the following from Environmental Defense Fund (EDF) in response to the public solicitation for comments on the update to the AB 32 Scoping Plan. Over the past five years, the California Air Resources Board (CARB) has taken tremendous strides to implement the 2008 Scoping Plan – with key programs like the low carbon fuel standard and cap and trade, California has seen a tremendous drop in harmful greenhouse gas emissions, while simultaneously incentivizing clean energy innovations and green job growth.

EDF applauds CARB for significant achievements since 2008, and we also believe that the 2013 update to the original Scoping Plan has the ability to create even greater strides. To that end, EDF has written the following comments in order to assist CARB pursue the goal of maximizing climate benefits in the years leading up to the agency's 2020 goal and enhancing the post-2020 objectives. EDF firmly believes that the implementation of these recommendations will complement CARB's work in the coming years and believes that their inclusion in the Scoping Plan Update would be beneficial.

Please feel free to contact us if you have any questions. Contact information for appropriate personnel is included at the conclusion of each section.

In response to the planned 2013 Scoping Plan Update, EDF respectfully submits comments in the following areas. Additionally, for ease of reading, the overarching recommendations in the text of this document have been captured and included below. Please refer to the document text for supporting information associated with each recommendation.

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ENVIRONMENTAL DEFENSE FUND: 2013 SCOPING PLAN UPDATE
Summary of Recommendations

August 2013

Based on the information contained in this document, EDF recommends that the CARB Scoping Plan Update do the following:

1) Establish an expectation that California will have an emission reduction mandate that extends beyond 2020, and that both California's low carbon fuel standard (LCFS) and cap-and-trade program (with fuels under the cap) will be extended.

2) Develop a clear strategy for achieving Governor Brown's zero-emission vehicle (ZEV) goals pursuant to Executive Order B-16-2012 and address current electricity rate policy that will act as a deterrent to vehicle electrification.

> (a) Specify programs for achieving California's electric vehicle (EV targets), including the development of a multi-agency strategy to accelerate the commercialization of medium and heavy-duty ZEVs;
>
> (b) Engage with the California Public Utilities Commission (CPUC) on the ongoing revision of California's residential electricity rate structure; and
>
> (c) Identify additional specific measures for financing zero-emission infrastructure and technology-switching.

3) Develop a comprehensive strategy to reduce greenhouse gas (GHG) emissions and improve fuel economy from medium- and heavy-duty vehicles.

4) Include the following:

> (a) Development of a strategy to deploy the full range of existing and advanced technologies in the medium- and heavy-duty fleet;
>
> (b) Adopt fugitive methane standards to address emissions from the vehicle and fueling systems;
>
> (c) Address hydrofluorocarbon (HFC) emissions from refrigerated trailers; and
>
> (d) Consider the appropriateness of replicating successful heavy duty truck strategies like low rolling resistance tires and low friction engine oils into the passenger vehicle fleet.

5) Include a comprehensive strategy for reducing emissions from the goods movement sector, including strategies to:

(a) Incent investment in lower carbon modes of transportation;

(b) Encourage shippers to collaborate with each other to combine freight and have fewer trucks on the road;

(c) Encourage companies to design logistics to minimize delivery miles;

(d) Require stricter efficiency standards for heavy-duty vehicles; and

(e) Address methane leakage in natural gas vehicles used in goods movement.

6) Develop strategies for meeting the state's 75% recycling goal and include a Completed Waste Sector Plan to meet it.

7) Include the following:

(a) Development of additional market-based incentives for agricultural practices;

(b) Financial support for the conservation of California's farms and ranches;

(c) Clarification of the role of rangeland in the overall California strategy; and

(d) Strategic plans for additional research to quantify and model GHG emissions from land management.

8) Launch a formal rule implementation review for the state's Refrigeration Management Program (RMP), including the development of an expert working group, an enhanced outreach and education campaign to alert system operators of compliance requirements, and a significant enforcement effort to minimize non-compliance.

9) Include the development of a comprehensive, technology stimulating effort to fundamentally alter the use of climate forcing refrigerants in stationary refrigeration equipment of all sizes.

10) Utilize demand response (DR) as a system resource much like generation, particularly when demand is highest.

11) Implement wholesale market design enhancements that better enable integration of renewable resources, including:

(a) Moving to shorter scheduling intervals, along with scheduling closer to flow;

(b) Increasing balancing area coordination, for example by the Energy Imbalance Market being developed by CAISO;

(c) Better coordinating the development of renewable resources and transmission assets across balancing areas with the goal of creating synergies / complementarities across resources able to efficiently meet load while reducing our reliance on balancing resources; and

(d) Using of "a combination of energy storage devices and smart-grid technology," as recommended by CCST.

12) Expand Time-of-Use (TOU) rates in order to attract clean energy investments for residential customers, dramatically lower costs for the entire electric system, and avoid adverse environmental impacts.

13) Use on-bill repayment (OBR), which has the potential to lower the financing and transaction costs of clean energy projects, expand the pool of investors and economically attractive investments, and put people to work in good jobs that deliver real value.

14) Encourage utilities to make their investments clean, smart, and future-oriented as outlined in state policy and the loading order, while the agency fully accounts for cost implications and the need for electricity to be affordable now.

15) Develop a comprehensive state-wide methane reduction plan that includes:

(a) An update of the state's inventory of methane emissions (including natural gas) to have a better understanding of the scope, location and intensity of major emission sources;

(b) Newly formed measures to reduce methane leakage from the natural gas transmission and distribution system; and

(c) Implementation of effective short-term natural gas use reduction methods.

16) Create an expectation that additional compliance periods in California's cap-and-trade program will be created, extending the program operation beyond 2020.

ENVIRONMENTAL DEFENSE FUND: 2013 SCOPING PLAN UPDATE
Fuels and Transportation

August 2013

I. Introduction

As California's highest polluting sector,[1] transportation has properly been a key component of California's state-wide emissions reduction strategy. Direct regulations, carbon pricing, and performance-based mechanisms represented in the current Scoping Plan are critical to incentivizing the development of low-carbon fuels and efficient transportation technologies that will achieve California's 2020 and 2050 emissions reductions goals.

However, without a long-term predictable price signals, the short and medium term goals of current AB 32 programs may remain insufficient to drive the industry investment and consumer behavior change necessary to achieve transformation of the sector.

Given slow fleet turn-over rates, decades-long investment cycles, and inelastic short-term demand in the transportation sector, the majority of benefits that can be obtained from AB32 policies will likely only be accrued *after* 2020 with the implementation of additional longer-term policies.[2,3] Put simply, while California is on the right track, more is needed. Full implementation of long-term, complementary policies, including cap-and-trade and the Low Carbon Fuel Standard (LCFS) are essential to reduce price volatility, prevent burdensome cost pass-through to consumers, and minimize overall program costs, thereby ensuring a maximally efficient and politically resilient program for years to come.[4]

For these reasons, **CARB's Scoping Plan Update should establish an expectation of a post-2020 emission reduction mandate and the extension of both California's LCFS and an increasingly stringent cap-and-trade program that integrates fuels under the cap.**

In additional to establishing long-run low-carbon fuel mandates, CARB should also pursue additional actions to facilitate the shift toward electrification in the transportation sector. Accordingly, **CARB should develop a clear strategy for achieving Governor Brown's Zero**

[1] California Air Resources Board, *California Greenhouse Gas Inventory for 2000-2010* (Feb. 19, 2013) *available at* http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_scopingplan_00-10_2013-02-19.pdf

[2] Carol Dahl and Thomas Sterner, *Analysing gasoline demand elasticities: a survey*, 13 Energy Economics 203, 210 (1991).

[3] Markus Wråke, *et al.*, *What Have We Learnt from the European Union's Emissions Trading System?* 41 Ambio 12, 16 (Feb. 4, 2012), available at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3357882/.

[4] C. Knittel, *The Importance of Pricing Transportation Fuels within California's Cap-and-Trade Program*, Massachusetts Institute of Technology, at 2 (2013)

Emissions Vehicle (ZEV) goals pursuant to Executive Order B-16-2012 and addressing current electricity rate policy that will act as a deterrent to vehicle electrification.[5,6]

II. Overcoming inelastic demand and containing program costs by creating a long-term market-signal for low-carbon transportation technologies

The extension of the LCFS program and the integration of fuels into an extended cap-and-trade program will establish the long-term price signal for investment in the fuels sector necessary for overcoming inelastic short-term demand and achieving both California's 2020 and 2050 emissions reductions goals.

Cost-effectively achieving deep reductions in California's transportation sector requires both a long-term economy-wide program and a sector-specific approach. Integrating fuels under an extended cap-and-trade program will increase flexibility and aid in cost-containment, while the extension of the LCFS will provide the regulatory certainty necessary to incentivize investment directly into low-carbon fuel development and wide-spread consumer adoption of more fuel-efficient vehicles.[7]

According to CARB's own Market Advisory Committee analysis, for every $10 increment in the per-ton-CO_2-equivalent price of allowances, the effect on gas prices would be 8.8 cents per gallon—a price change unlikely to produce a very large reduction in consumer demand for gasoline.[8] However, this only tells part of the story. Though consumers may not react to relatively small price increases by decreasing their gasoline use, the permanence of such a price increase can make a difference. Analysis of consumer responses to changes in gas prices performed by Muehlegger, Linn, and Li (2012) finds that even in the near-term, consumers are nearly three times more sensitive to price increases if those changes are *perceived* to be more permanent (i.e. changes in gasoline taxes or performance-based mandates) compared to more transitory price movements (i.e. oil price spikes).[9] This analysis suggests that technology switching and early investment contributing toward California's 2020 and 2050 targets will be significantly deterred if consumers and firms perceive the integration of fuels under the cap and the extension of the program to be unlikely.

In addition to impacting consumer demand, a long term price signal can also yield additional investment in the transportation sector as technology providers strive to meet shifting consumer

[5] Governor's Interagency Working Group on Zero-Emission Vehicles, ZEV Action Plan, at 2 (2013).

[6] L.Friedman, *Electricity Pricing and Electrification for Efficient Greenhouse Gas Reductions,* Next 10 and the California Council on Science and Technology, at 4 (2013), *available at* http://www.next10.org/sites/next10.huang.radicaldesigns.org/files/FINAL%20Electricity%20Pricing%20Report.pdf.

[7] Knittel at 2.

[8] Market Advisory Committee to the California Air Resources Board,*Recommendations for Designing a Greenhouse Gas Cap-and-Trade System for California*, at 36 (2007).

[9] Shanjun Li, Joshua Linn, and Erich Muehlegger, *Gasoline Taxes and Consumer Behavior*, NBER Working Paper, Harvard University, at 1 (Mar. 2012).

trends in vehicle and modal options. Long-term signals can therefore lead to the type of technological innovation within the fuels sector to achieve long-term emission reductions.[10,11,12]

Transportation activities are diffuse, relatively insensitive to fuel price increases, and involve significant coordination and investment challenges between infrastructure and vehicles, making a long-term, sector-specific approach essential for spurring innovation and investment in new fuel technologies.[13] Accordingly, in addition to extending the cap-and-trade regulation as it pertains to transportation fuels, the AB 32 Scoping Plan should reaffirm the state's commitment to decarbonizing the transportation sector by stating the intent to extend the LCFS beyond 2020. As currently written, the LCFS regulation requires only incremental reductions in its first years of implementation and does not provide a post-2020 market signal. By creating this signal, the Scoping Plan Update would create regulatory certainty that will allow firms to make additional early investments (and longer term investments) and design optimized abatement strategies that will prevent high cost pass-through to consumers, prevent high-carbon technology lock-ins, and reduce overall program costs.[14]

III. Aligning incentives for electrification and achieving the Governor's ZEV targets

In order to meet the state's longer-run emissions reduction goals, the transportation sector must undergo a significant shift toward electrification.[15] The Governor's Executive Order issued in 2012 addresses this need, mandating the adoption of 1.5 million ZEVs by 2025 and identifying interim targets in 2015 and 2020.[16] Pursuant to this mandate, the **AB32 Scoping Plan Update should specify programs for achieving California's EV targets, including the development of a multi-agency strategy to accelerate the commercialization of medium and heavy-duty ZEVs and engagement with the California Public Utilities Commission (CPUC) on the ongoing revision of California's residential electricity rate structure**, which currently acts as a deterrent to widespread electric vehicle adoption.[17]

In addition to identifying opportunities for interagency collaboration and harmonizing electricity and transportation sector policies, the **Scoping Plan Update should identify additional specific measures for financing zero-emission infrastructure and technology-switching**. While essential for low-carbon fuel development, the flexible mechanisms represented by the cap-and-trade program and the LCFS favor lower-cost investments in fuel and vehicle technologies that

[10] Market Advisory Committee to the California Air Resources Board at 35.
[11] Knittel at 2.
[12] Alexander E. Farrell, *et al., A Low-Carbon Fuel Standard for California -- Part 1: Technical Analysis*, at 23(2007), *available at* http://www.energy.ca.gov/low_carbon_fuel_standard/
[13] Farrell at 24.
[14] Pedro Piris-Cabezas and Ruben Lubowski, *Increasing Demand by Raising Long Term Expectations: the Importance of a 2030 Target for the European Union's Climate Policy*, Environmental Defense Fund, at 2 (forthcoming 2013).
[15] Friedman at 2.
[16] Governor's Interagency Working Group on Zero-Emission Vehicles at 2.
[17] Friedman at 4 .

leverage existing capital resources (namely fuel blending and increased efficiency of traditional and hybrid vehicles).[18] Given the significant infrastructure requirements of scaled transportation electrification, the Scoping Plan Update must therefore consider technology-specific incentives and financing mechanisms to achieve the state's 2025 ZEV targets.

IV. Conclusion

Avoiding disruption to the regulatory certainty must remain a guiding principle to ensure the program's overall success, control overall program costs, and incentivize the early investments that will enable the achievement of California's 2020 and 2050 emission reduction targets.[19]

Extending the cap-and-trade program and the LCFS as complementary, long-term policies in the transportation sector will provide the market drivers and regulatory certainty necessary to spur the early investments in long-term infrastructure, research and development, and the adoption of low-carbon transportation technologies essential for achieving the state's long-term climate stabilization goals.[20] Further clarifying and developing strategy for integrated EV deployment across California is also necessary for transformation of the sector.

EDF contact person(s) related to this section:

Tim O'Connor, toconnor@edf.org, 415-293-6132

[18] Farrell at 24.
[19] Environmental Defense Fund,*Public Comment to CARB on Cost Containment*, at 1 (2013),
[20] Farrell at 24.

ENVIRONMENTAL DEFENSE FUND: 2013 SCOPING PLAN UPDATE
Medium and Heavy-Duty Vehicles

August 2013

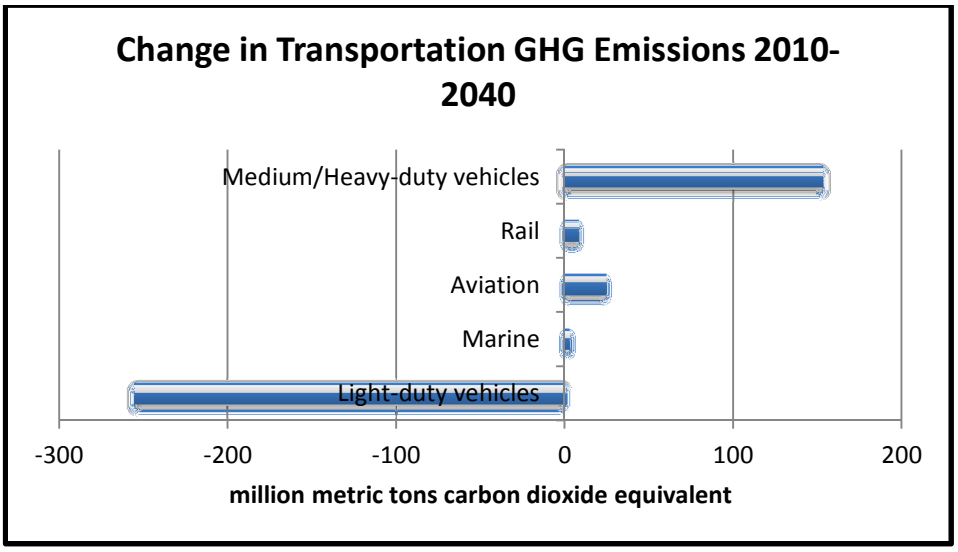
I. Introduction

As part of the Scoping Plan Update, **CARB should develop a comprehensive strategy to reduce greenhouse gas (GHG) emissions and improve fuel economy from medium- and heavy-duty vehicles.**

In 2011, the transportation sector was responsible for 28 percent of our nation's carbon pollution – second only to electric generation.[1] And freight movement is the largest growing source of greenhouse gas emissions and fuel consumption in the United States.[2] Further improving the efficiency of the medium and heavy-duty sector is one of the most effective steps that can be taken in the short term to curb climate pollution and reduce our nation's oil consumption, while driving innovative technologies that will stimulate economic growth and create high-quality domestic jobs.

Existing GHG pollution and fuel economy standards for light-duty vehicles will significantly reduce fuel consumption and climate emissions from these vehicles over the next 20 years by more than 250 million metric tons below 2010 levels (Figure 1).[3] Emissions from the medium- and heavy-duty fleet, however, continue to rise despite first-ever fuel efficiency and greenhouse gas standards ("Phase 1") finalized in 2011 by the US Environmental Protection Agency (EPA) and the National Highway Traffic and Safety Administration (NHTSA).[4] Current U.S. Energy Information Administration (EIA) projections show medium- and heavy-duty (GHG emissions increasing by more than 150 million metric tons – an additional 40 percent – by 2040, due primarily to an increase in miles traveled (Figure 1).[5] Unchecked, emissions from these vehicles will grow from 22 percent of transportation-related emissions today to more than 30 percent in 2040.[6]

[1] U.S. Environmental Protection Agency, *Sources of Greenhouse Gas Emissions,* http://www.epa.gov/climatechange/ghgemissions/sources.html
[2] Cristiano Façanha and Jeff Ang-Olson, *Policies to Reduce Greenhouse Gas Emissions Associated with Freight Movements*, U.S. Department of Transportation Federal Highway Administration, http://www.fhwa.dot.gov/policy/otps/innovation/issue1/policies.htm.
[3] U.S. Energy Information Administration, Annual Energy Outlook (2013), Table 19, *available at* http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2013ER&subject=0-AEO2013ER&table=22-AEO2013ER&region=0-0&cases=full2012-d020112c,early2013-d102312a.
[4] 40 C.F.R § 85, 86, 1036, *et seq.*; 40 C.F.R. 523, 535, available at http://www.gpo.gov/fdsys/pkg/FR-2013-06-17/pdf/2013-11980.pdf.
[5] U.S. Energy Information Administration, Table 19.
[6] *Id*.



Information Source: 2013 Annual Energy Outlook.

California can play an important role in altering the trajectory of emissions from this sector. Though overarching strategy for accomplishing this will necessarily contain several components, we encourage **California to include the following in the Scoping Plan Update:**

(1) A strategy to deploy the full range of existing and advanced technologies in the medium- and heavy-duty fleet;

(2) Fugitive methane standards to address emissions from the vehicle and fueling systems; and

(3) A plan that addresses hydrofluorocarbon (HFC) emissions from refrigerated trailers.

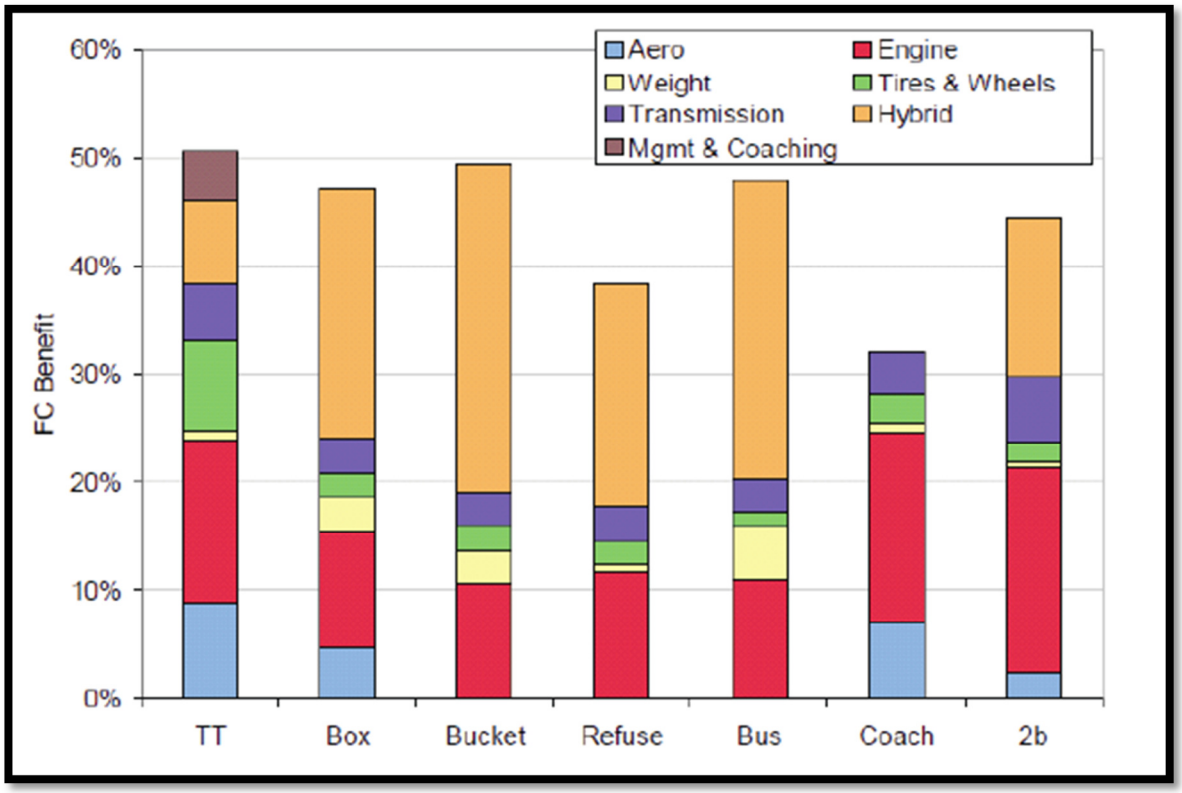
(4) Consideration to replicate successful heavy duty truck strategies like low rolling resistance tires and low friction engine oils into the passanger vehicle fleet

II. Deploying available and emerging technologies can put trucks on a path to absolute GHG reductions

Rigorously deploying available and emerging technologies can help to fundamentally alter the path of medium- and heavy-duty GHG emissions. The list of efficient technologies for the medium- and heavy-duty market is long and well known. It includes lightweight materials, engines with waste-heat recovery, hybrids, advanced transmissions, aerodynamic packages, and

more.[7] Some of these technologies are on highways today and others are still in the development and testing phase. However, in order to make meaningful reductions in freight climate pollution, each one of these technologies will be needed.

A 2010 study conducted for the National Academy of Sciences (NAS) by TIAX, LLC assessed current and future technologies for reducing fuel consumption from heavy-duty vehicles.[8] The study estimated that the included technologies combined are capable of a 40-50 percent reduction in fuel consumption over 2008 levels in the 2015-2020 timeframe. Figure 2 below, created by TIAX, summarizes new-vehicle potential fuel-saving technologies from 2015 to 2020 for seven vehicle types: tractor trailer (TT), Class 3-6 box (box), Class 3-6 bucket (bucket), Class 8 refuse (refuse), transit bus (bus), motor coach (coach), and Class 2b pickups and vans (2b). Aggressively deploying new technologies can reduce fuel consumption by 40 to 50 percent for most vehicle classes in a 2015 to 2020 time frame.



Source: TIAX (2009) at ES-4.

[7] National Research Council and Transportation Research Board *Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles* 186 (2010) *available at* http://www.nap.edu/catalog.php?record_id=12845.
[8] National Research Council and Transportation Research Board *Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles* 186 (2010) *available at* http://www.nap.edu/catalog.php?record_id=12845.

Current EPA standards, applicable to model years 2014-2018 engines and vehicles, capture only some of the available technologies referenced in the NAS study, and do not require full fleet-wide penetration of those technologies.[9] Accordingly, these standards will result in an estimated 13 percent reduction in fleet-wide fuel consumption over a 2010 baseline. While these reductions are a meaningful first step, California can help drive full deployment of existing and emerging technologies. Indeed, projects like the US Department of Energy "Supertruck" Program have demonstrated that 40-50 percent fuel consumption reductions are entirely feasible in the near term.[10] Accordingly, we urge California to:

- Adopt standards that advance the development and deployment of the most advanced technologies and fully reflect the efficiency gains achievable by existing technologies as well as those in development; and

- Ensure rigorous standards drive innovation across the entire vehicle, including the engine, the transmission, the components, the trailer and the vehicle as a whole.

III. Establishing a fugitive methane standard

Natural gas trucks may become a significant part of the new truck market in the coming years. While the combustion of natural gas results in fewer CO_2 emissions than the combustion of gasoline or diesel fuel, natural gas vehicles have the potential to leak methane – a potent climate forcer that must be accounted for in a rigorous program to reduce greenhouse gas emissions from medium- and heavy-duty vehicles. Accordingly, we urge California to adopt strong tailpipe and fugitive methane standards for these vehicles.

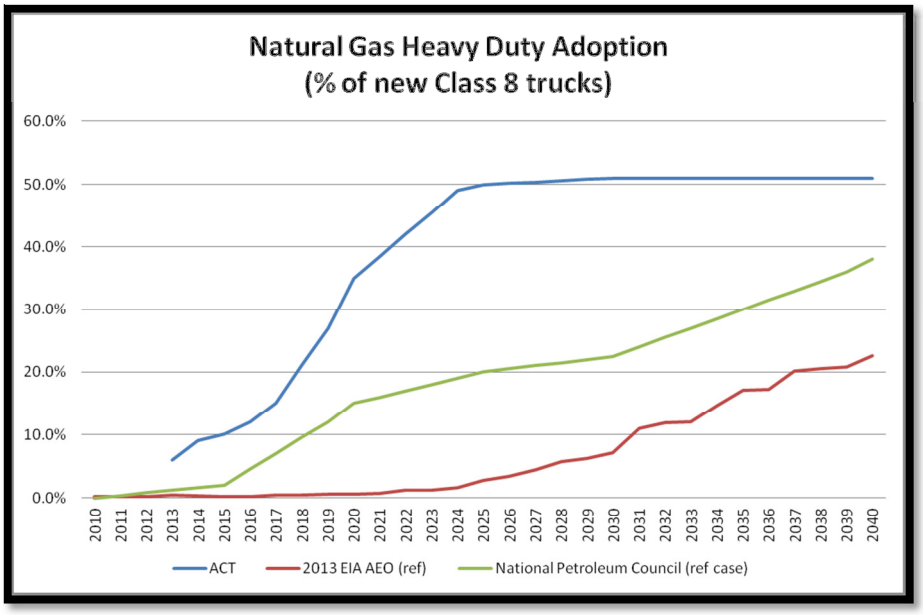
Studies project significant growth in natural gas vehicles in the heavy-duty sector

There are varying projections of natural gas truck adoption in the medium- and heavy-duty marketplace. One study estimates that as many as 100,000 Class 8 natural gas trucks could be sold each year by 2020.[11] Sales of this volume would be a notable shift from current market dynamics where there are just over 2,600 natural gas powered freight tractors in operation today, mostly used in port drayage and regional haul operations.[12]

The figure below displays projections from the EIA,[13] National Petroleum Council,[14] and ACT Research.[15] In 2020, the market share projections for Class 8 natural gas trucks are 1%, 15% and

[9] U.S. Environmental Protection Agency, *EPA and NHTSA Adopt First-Ever Program to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium- and Heavy Duty Vehicles*, at 2 (Aug. 2011), http://www.epa.gov/otaq/climate/documents/420f11031.pdf.
[10] U.S. Department of Energy, *Vehicle Technologies Program: Multi-Year Progmra 2011-2015*, at ES-1 (Dec. 2010), *available at* http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/vt_mypp_2011-2015.pdf
[11] ACT Research, *The Future of Natural Gas Engines in Heavy Duty Trucks: The Diesel of Tomorrow*?, at139 (August 2012).
[12] Stephe Yborra, *Snapshot of US NGV Market Today*, NGV America (Spring 2012).
[13] U.S. Energy Information Agency, *Annual Energy Outlook 2013: Early Release,* Table 68: Freight Transportation Energy Use (Dec. 2012).
[14] National Petroleum Council, *Advancing Technology for America's Transportation Future* (Aug, 2012)

35%, respectively. In 2030, these numbers increase to 7%, 23%, and 51%, respectively. There are several market developments that may lead to adoption rates at the higher end of this range during the time the Phase 2 rules are in effect including the increased availability of natural gas engines,[16] a national build-up of a fueling infrastructure,[17] and a shrinking payback period.[18]



Source: EIA, National Petroleum Council, ACT Research

Fugitive methane leaks could offset climate benefits of natural gas

Fugitive methane emissions from natural gas vehicles are especially concerning in light of the potential fleet transition described above. Even small leaks of methane – a greenhouse gas many times more powerful than carbon dioxide – will undermine the climate benefit of switching from diesel to natural gas trucks.[19] Fugitive emissions of methane can and do occur from both compressed natural gas (CNG) and liquefied natural gas (LNG) fueled vehicles. The issue is likely the greatest with LNG as LNG tanks vent when pressure inside them exceeds 40 psi.[20]

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[15] ACT Research at 139.

[16] Tom Berg and Deborah Lockridge, *Natural Gas: What Fleets Need to Know, Part 2 - New Engines, More Options* (Sep. 2012), TruckingInfo.com; Cummins-Westport, ISZ12G Overview. http://www.cumminswestport.com/models/isx12-g.

[17] Sandeep Kar, *What's going on with the natural gas truck market?*, Frost and Sullivan (Jun. 13, 2012).

[18] Truck Buyers' Acceptable Payback Timeframe for Investments in New-Truck Fuel Economy Technology, American Trucking Association survey (1997); Anna Lee Deal, *National Energy Policy Institute: What Set of Conditions Would Make the Business Case to Convert Heavy Trucks to Natural Gas? – A Case Study* (Nov. 5, 2012).

[19] *2013 Revisions to the Greenhouse Gas Reporting Rule and Proposed Confidentiality Determinations for New or Substantially Revised Data Elements*, 70 Fed. Reg. 19802, 19809 (Apr. 2, 2013), available http://www.gpo.gov/fdsys/pkg/FR-2013-04-02/pdf/2013-06093.pdf; Environmental Defense Fund, *Natural Gas – A Briefing Paper for Candidates* at 6.

[20] Deal.

Currently, EDF is working with West Virginia University and industry leaders, including Cummins, Volvo, Waste Management and PepsiCo to study methane leak rates from current MGV truck models.[21] Regardless of the current levels of leakage, efforts should be made to minimize future leaks. Accordingly, we respectfully recommend that CARB establish a fugitive methane standard to address vehicle and fueling systems.

IV. Establish rigorous standards for HFC emissions from refrigerated trucks

In addition to climate emissions from fuel combustion and methane emissions associated with natural gas vehicles, medium- and heavy-duty vehicles are also responsible for significant fluorinated gas emissions. Fluorinated gases have very high global warming potentials and long atmospheric lifetimes.[22] In medium- and heavy-duty vehicles, these gases are primarily used as refrigerants, in both air conditioning units in tractor cabs as well as refrigeration in trailers. We respectfully encourage CARB to provide rigorous emissions standards for refrigerated transport – one of the largest remaining sources – and to incentivize replacement of fluorinated gases with low global warming potential substitutes.

Taking action on fluorinated gas emissions from the transportation sector would support the Obama Administration's Climate Action Plan call for EPA to use its authority under the Significant New Alternatives Policy (SNAP) Program to encourage private sector investment in identifying and approving climate-friendly HFC alternatives and prohibiting the use of the most harmful chemical alternatives.[23]

Fluorinated Gases are a Growing Contributor to Overall Climate Forcing

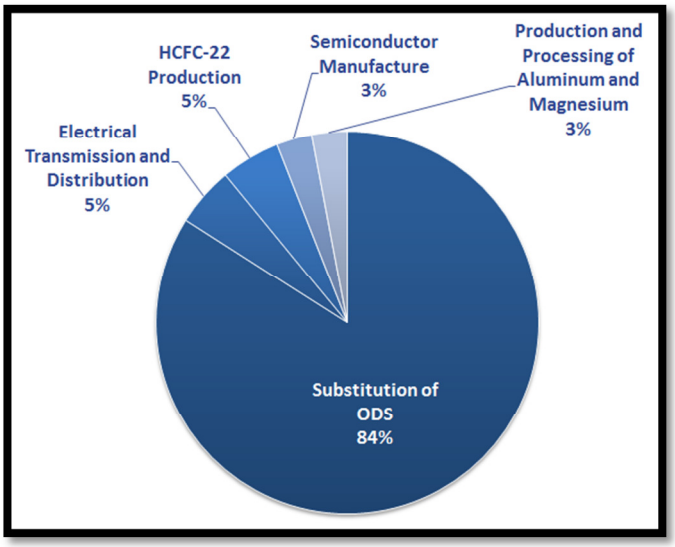
Fluorinated gases are manmade compounds with no natural sources. These gases, including HFCs, perfluorocarbons (PFCs), and Sulfur Hexafluoride (SF_6) have very high global warming potentials and long atmospheric lifetimes.[24] In fact, HFCs have atmospheric lifetimes between 1 – 270 years and global warming potentials (GWPs) ranging from 140 – 11,700; PFCs lifetimes range from 800 – 50,000 years with GWPs of 6,500 – 9,200; and SF_6 has an atmospheric lifetime of 3,200 years and a GWP of 23,900.[25] In general, fluorinated gases are the most potent and long-lived of all the GHGs emitted by human activities.

[21] *New collaborative study at WVU will measure methane emissions associated with natural gas vehicles and fueling stations* (Mar. 4, 2013), http://wvutoday.wvu.edu/n/2013/03/04/scemr-release.
[22] U.S. Environmental Protection Agency, *Overview of Greenhouse Gases: Emissions of Fluorinated Gases*, http://epa.gov/climatechange/ghgemissions/gases/fgases.html.
[23] The White House, *The President's Climate Action Plan* (Jun. 2013), http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf.
[24] U.S. Environmental Protection Agency, *Overview of Greenhouse Gases: Emissions of Fluorinated Gases*, http://epa.gov/climatechange/ghgemissions/gases/fgases.html.
[25] *Id.*

While these gases currently represent a relatively small portion of overall emissions (2 percent),[26] they are swiftly growing, and absent rigorous control measures will pose a significant problem in the future. Indeed, the most rapidly growing fluorinated gas across all sectors, HFC-134a, is used as a refrigerant and a substitute for ozone depleting substances (ODS) like chlorofluorocarbons (CFCs), which are being phased out under the Montreal Protocol. Unchecked, in 2050, HFCs like 134a, would equal 7-19 percent of 2050 CO_2 emissions in a business as usual scenario and 18-45 percent of CO_2 emissions in the IPCC 450ppm stabilization scenario. Mitigating HFC emissions plays an important role in limiting warming to below 2°C and could help avoid warming of 0.35°C to 0.5°C by 2100. However, if the current growth rates of HFCs continue, the increased warming from HFCs could be as high as 0.5°C by 2100.[27]

Medium- and heavy-duty vehicles are a significant source of fluorinated gases

In the United States, fluorinated gases used as ODS substitutes represent 84 percent of total fluorinated gas emissions and are by far the largest source.[28] These fluorinated gases – mostly HFCs – are used as refrigerants, aerosol propellants, solvents, and fire retardants, though refrigeration is by far the largest emissions source.[29]



Source: U.S. EPA Annual Greenhouse Gas Inventory of Emissions Sinks.

[26] U.S. Environmental Protection Agency, *National Greenhouse Gas Emissions Data*, http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html.
[27] Y. Xu, *et al.*, *The role of HFCs in mitigating 21st century climate change*, 13 Atom. Chem. Phys. 13 6083, 6087 (June 2013), *available at* http://www.atmos-chem-phys.net/13/6083/2013/acp-13-6083-2013.pdf.
[28] U.S. Environmental Protection Agency, *Overview of Greenhouse Gases: Emissions of Fluorinated Gases*, http://epa.gov/climatechange/ghgemissions/gases/fgases.html.
[29] *Id.*

Of the 121.7 million metric tons CO_2e of HFCs emitted as ODS substitutes, 103.9 million metric tons were attributable to refrigeration.[30] This sector includes motor vehicle air-conditioning, retail food refrigeration, refrigerated transport (including ships, truck trailers, and railway freight cars), residential and small commercial air-conditioning and heat pumps, chillers (large comfort cooling), cold storage facilities, and industrial process refrigeration (e.g., systems used in food processing, chemical, petrochemical, pharmaceutical, oil and gas, and metallurgical industries). As ODS are being phased out, HFCs are being deployed as replacements in many of these applications and can be emitted to the atmosphere as leaks during equipment operation and when equipment is disposed.[31]

More than 57 million metric tons CO_2e of HFC emissions are attributable to the transportation sector. The second largest transportation source of HFC emissions, however, is refrigerated transport in the medium- and heavy-duty sector, accounting for 11.7 million metric tons of CO_2e, or more than 20 percent of all transportation-related refrigerant emissions and almost 10 percent of all emissions associated with ODS substitution.[32]

Lower global warming potential substitutes are available

Lower GWP substitutes are on the market today and these substances could significantly reduce both near-term and projected future warming. For example, HFO-1234yf, with a GWP of 4, and carbon dioxide (R-744), with a GWP of 1, have both been approved by EPA through its SNAP program as substitutes to ODS for use in light-duty vehicles. Currently, HFO-1234yf is under consideration for use in transport refrigeration models beyond 2014; R-744 has limited use in road settings and is under evaluation for use in intermodal carriers. In 2007, Norway introduced R-744 refrigerant-based cryogenic systems into the road transport refrigeration market. By 2011, 16% of new refrigerated trucks sold in Norway contained a cryogenic refrigeration system.[33] However, there have been no approvals of lower GWP substitutes for use in heavy-duty vehicles.

Accordingly, we respectfully recommend that CARB adopt fluorinated gas standards for refrigerated transport, and, as part of those standards encourage the development and deployment of low GWP substitutes.

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[30] US Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011* (Apr. 12, 2013), 4-80, http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf.
[31] *Id.* at 4-80.
[32] *Id.* at 2-26.
[33] US Environmental Protection Agency, *Transitioning to Low-GWP Alternatives in Transport Refrigeration*, http://www.epa.gov/ozone/downloads/EPA_HFC_Transport.pdf.

V. Consider the appropriateness of replicating successful heavy duty truck strategies like low rolling resistance tires and low friction engine oils into the passenger vehicle fleet

Currently, low rolling resistance tires are required for heavy duty vehicles under California's Smartway regulation, but there are no programs in place for the replacement tire market. It would be prudent for CARB to consider extending this heavy duty program to passenger vehicles, in order to enable reductions in long-term GHG and fuel consumption by 4 percent or more. In addition, CARB should consider low friction engine oils to reduce engine load and fuel consumption, as well as to see up to a 2 percent GHG reduction. Both of these measures were mentioned in the 2008 Scoping Plan, but not implemented – their adoption by CARB now build on the adopted tire inflation early action measure and result in additional emission reductions of greater than 3 million metric tons per year and consumer cost savings of greater than $750 million per year.

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ENVIRONMENTAL DEFENSE FUND: 2013 SCOPING PLAN UPDATE
Goods Movement

August 2013

I. Introduction

The ability to ship goods globally has without a doubt enabled consumers to have access to a wider array of products at a lower cost. However, the benefit of this convenience comes with a significant downside – not only are the companies responsible for shipping the costs facing high oil prices, but the movement of goods also carries a significant carbon footprint.[1] Indeed, "the global freight transportation and distribution system accounts for nearly three billion metric tons of heat-trapping carbon emissions each year."[2] To put this in perspective, those emissions are equal to over 700 coal plants or the pollution from Japan, Germany, Canada, and Mexico combined.[3]

As the demand for goods and services increases, so do emissions – between 2005 and 2035, the United States can expect to see a rise in freight emissions of 74 percent.[4] Not only will this increase in emissions have a negative impact on human health, but the increase in the demand for fossil fuels could also raise costs for the companies themselves.[5] In order to mitigate the harm that can result from the increased movement of goods, the **AB32 Scoping Plan Update should include a comprehensive strategy for reducing emissions from the goods movement sector, including the following strategies:**

1) Incent investment in lower carbon modes of transportation;

2) Encourage shippers to collaborate with each other to combine freight and have fewer trucks on the road;

3) Encourage companies to design logistics to minimize delivery miles;

4) Require stricter efficiency standards for heavy-duty vehicles; and

5) Address methane leakage in natural gas vehicles used in goods movement.

[1] Jason Mathers, *Smart Moves: Creative Supply Chain Strategies Are Cutting Transport Costs and Emissions*, Environmental Defense Fund 1 (2012).
[2] *Id.* (citing Doherty et al., *Supply Chain Decarbonization—The Role of Logistics and Transport in Reducing Supply Chain Carbon Emissions*, World Economic Forum (2009)), *available* https://members.weforum.org/pdf/ip/SupplyChainDecarbonization.pdf.
[3] Mathers at 1.
[4] *Id.*
[5] *Id.*

II. Investment in Lower Carbon Modes of Transportation

Currently, air and ocean freight are the most common choices for transcontinental transportation, while freight trucks, rail, and barges are the most widely used means of transporting goods domestically. Different methods have vastly different carbon footprints – planes produce 47 times as much tons of carbon per mile than container ships, while trucks produce 6 times as much carbon as trains.[6] In addition, more carbon intensive modes of transportation often cost more.[7]

Companies that are changing their modes of transportation to less carbon intensive transportation are seeing significant cost and emission reductions. For example, Nike, by switching from air freight to ocean freight more frequently, saw a drop in emissions per product of four percent and saved $8.2 million in one year.[8] If CARB implements these changes more widely, and requires companies to use the most carbon-efficient mode of transportation whenever possible, the impact on cost and pollution reduction has the potential to be enormous.

III. Encourage shippers to collaborate with each other to combine freight and have fewer trucks on the road

Companies can operate more efficiently if they collaborate with other companies – such partnership will "enable greater use of assets, from trucks to warehouses, resulting in economies of scale that lower cost."[9] Under such a collaborative distribution arrangement, companies that operate in the same commercial sectors can use the same warehouses and other distribution assets, allowing trucks to be loaded more efficiently and deliveries to be made on a more frequent basis, while at the same time lowering the total number of miles that trucks travel. On balance, this results in significantly lower emissions.[10]

The success of such collaboration has been exemplified by Hershey's and Ferrero. The two companies, who formed a partnership on warehousing, transportation, and distribution, cited cost reductions and emission reductions as the primary benefits of the partnership.[11] To date, Hershey had claimed a 7 percent reduction in its greenhouse gas (GHG) emissions as a result of more energy efficient transportation solutions.[12] This trend is expected to grow because, according to the president of Hershey, companies that "seek to fully leverage their logistics infrastructure"

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[6] Mathers at 3 (citing Peter Dizikes, "The Six-percent Solution," MIT News November 8, 2010. http://web.mit.edu/newsoffice/2010/corporategreenhouse-gas-1108.html).
[7] Mathers at 3.
[8] Nike, Inc., *Corporate Responsibility Report FY 07-09*, 113, *available* http://www.nikebiz.com/crreport/content/pdf/documents/en-US/full-report.pdf.
[9] Mathers at 7, *citing* Jean-Paul Rodrigue, *et. al., The Geography of Transport Systems*, New York: Routledge (2009).
[10] Mathers at 7.
[11] *Id.*
[12] Carbon Disclosure Project, *CDP 2012 Investor CDP 2012 Information Request: The Hershey Company,* https://www.cdproject.net/Sites/2012/59/18859/Investor%20CDP%202012/Pages/DisclosureView.aspx.

will increasingly turn to collaboration as a logical step.[13] Because these combined partnerships have the potential to reduce emissions by as much as 58 percent in certain scenarios,[14] it would be valuable for CARB to encourage these relationships in its Scoping Plan Update.

IV. Encourage companies to design logistics to minimize delivery miles

Minimizing delivery miles for companies involves changing the way the distribution network is laid out - in other words, changing a network design based on "proximity to consumers, access to transportation modes, and inventory requirements…[with a goal to] strive to deliver goods accurately and on time while minimizing costs."[15]

If a corporation has a greater number of warehouses from which transport can collect goods, inventory will more often be closer to clients. This means fewer vehicle miles traveled, and ultimately, a lower carbon footprint. Ocean Spray demonstrated the practicality of this network optimization when they opened a new distribution center in Florida in response to a growing demand for their products in the Southeast United States.[16] This measure, in addition to realigning which distribution centers serve which retail stores, reduced the number of vehicle miles traveled by 4.5 million. All in all, this significant reduction has saved Ocean Spray an estimated 14,000 tons of CO_2 per year.[17]

Similarly, moving a distribution network closer to a supplier can greatly cut down on carbon emissions and costs to the supply chain. When a supplier to Independent Purchasing Cooperative was moved closer to the redistribution center, that supplier was able to cut their annual transportation miles by over 1 million and eliminated 2,000 metric tons of GHG emissions, all while reducing supply chain costs.[18]

These companies are prime examples of the behavior that CARB should be encouraging – through simple changes in their distribution network, businesses are positively impacting public health by significantly reducing CO_2 emissions, while lowering their costs in the process.

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[13] William B. Cassidy, *Hershey, Ferrero Sign Supply Chain Pact*, Journal of Commerce (Oct. 5, 2011), http://www.joc.com/international-logistics/distribution-centers/hershey-ferrero-sign-supply-chain-pact_20111005.html.

[14] Russell D. Meller, *et al., From Horizontal Collaboration to the Physical Internet: Quantifying the Effects on Sustainability and Profits When Shifting to Interconnected Logistics Systems"* (Sep. 24, 2012), 20, *available* http://faculty.ineg.uark.edu/rmeller/web/CELDi-PI/Final%20Report%20for%20Phase%20I.pdf.

[15] Mathers at 8.

[16] Environmental Defense Fund, *MIT-EDF Case Study Summary – Ocean Spray,* http://business.edf.org/sites/business.edf.org/files/OceanSpray_factsheet_02_0.pdf

[17] Dr. Edgar E. Blanco, *Case Studies in Carbon-Efficient Logistics: Ocean Spray – Leveraging Distribution Network Redesign* 1 (2013), *available* *http://ctl.mit.edu/sites/default/files/library/public/MIT%20CTL%20Ocean%20Spray%20Case%20Study_FNL_0.pdf.*

[18] Mathers at 8.

V. Require stricter efficiency standards for heavy-duty vehicles

As referenced above in comments related to the transportation sector more generally, heavy-duty vehicles are the second highest source of GHG emissions in the transportation sector and are projected to have emissions that grow faster than any other end-use source of GHG pollution – estimates state that they will account for 80 percent of the anticipated freight emissions increase. Recognizing the need to reduce emissions from current levels, federal agencies have implemented measures to start to reduce emissions from current levels by putting more efficient trucks on the road. In particular, the US Department of Energy (DOE) has developed a test truck that achieves a 50% improvement in efficiency through improved engine technology, better trailer aerodynamics, and lighter weight materials. Such trucks can save a company approximately $40,000 a year in fuel costs. Scaled over the economy, this translates to tens of billions of dollars per year.[19]

The technology exists for more energy efficient trucks to have a greater presence on the road but there needs to be state standards set by CARB that mandate the use of greener trucks. In other words, CARB needs to require heavy-duty vehicle standards that "push the established fuel-savings technologies we have today, such as hybrid work trucks and aerodynamic trailers…[and] will be good for business and good for society."[20]

V. Address methane leakage in natural gas vehicles

As referenced above in comments related to the transportation sector more generally, there is a pressing need to address methane leakage in natural gas vehicles. Because natural gas vehicles are expected to become increasingly prominent, comprising about 10 percent of transportation energy needs by 2018,[21] it is imperative to minimize methane leakage in order to capitalize on the climate benefits that natural gas can promise over oil and gas. In order for the benefits of natural gas to bear fruit – including being able to use domestic fuel and greatly reduce CO_2 emissions – methane leakage should be reduced as much as possible on a system-wide basis. A minimal rate of leakage has not been achieved as of yet -- at the rate of leakage that the EPA is estimating, transitioning a fleet of heavy-duty vehicles to natural gas would mean increased global warming for over 250 years before climate benefits would start to be realized.[22]

Because methane leakage in natural gas vehicles has not been precisely quantified, CARB should follow the lead of organizations like EDF that are working to quantify the emissions with the aim of helping the industry develop improvements to minimize leakage to the greatest extent

[19] Jason Mathers, *Let's Build a 21st Century Transportation Sector* (Jun. 26, 2013), http://blogs.edf.org/innovation/2013/06/26/lets-build-a-21st-century-transportation-sector-2/.
[20] *Id.*
[21] Sarah Kent, *Natural Gas Seen as Major New Transport Fuel,* Wall Street Journal (Jun 20, 2013), http://online.wsj.com/article/SB10001424127887323393804578556650833190508.html.
[22] Ramon A. Alvarez, et al., *Greater focus needed on methane leakage from natural gas infrastructure*, 109 Proceedings of the National Academy of Sciences 6435, 6435 (Apr. 24, 2012), http://www.pnas.org/content/109/17/6435.full.pdf+html.

possible.[23] As a potent short-term pollutant that has 72 times more global warming potential over 20 years when compared to CO_2,[24] CARB needs to work with industry immediately to address this issue.

VI. Conclusion

In order to move towards an emissions neutral movement of goods, CARB must invest in lower carbon modes of transportation, encourage shippers to collaborate with each other to combine freight and have fewer trucks on the road, encourage companies to design logistics to minimize delivery miles, require stricter efficiency standards for heavy-duty vehicles and address methane leakage in natural gas vehicles. By implementing measures to address this area, CARB will be able to facilitate significant CO_2 reductions and enable companies to conduct business in a more cost-effective manner.

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[23] *See generally University of Texas at Austin Study Measures Methane Emissions Released from Natural Gas Production* (Oct. 10, 2012), http://www.engr.utexas.edu/news/7416-allenemissionsstudy; *New collaborative study at WVU will measure methane emissions associated with natural gas vehicles and fueling stations* (Mar. 4, 2013), http://wvutoday.wvu.edu/n/2013/03/04/scemr-release.

[24] Environmental Defense Fund, *Natural Gas – A Briefing Paper for Candidates* at 6.

ENVIRONMENTAL DEFENSE FUND: 2013 SCOPING PLAN UPDATE
Waste

August 2013

I. Introduction

As submitted in sector specific to CARB in mid-July, EDF recommends the **AB32 Scoping Plan update include strategies for meetings the state's 75% recycling goal and includes a Completed Waste Sector Plan to meet it.** The implementation plan for this includes the diversion of 10 million tons of compostable/ digestible materials from landfills in 2020 that will generate valuable greenhouse gas (GHG) reductions, helping the state meet its GHG reduction goal.

EDF acknowledges and agrees with the short-term challenges laid out in the current version of the Waste Sector Plan and supports the proposed solutions outlined therein. Our comments are focused on three key areas of the Plan –

(1) Developing markets for compost;

(2) Developing offsets for compostable materials; and

(3) Permitting new composting and anaerobic facilities.

II. Developing markets for compost

EDF acknowledges that markets are required to absorb the additional 3.75 million tons of compost which will be generated in 2020. One market of particular interest is the application of compost to rangeland. Applying one-half inch of compost to grazed rangelands can generate GHG emission reductions of 1.3 to 3.2 Mg CO2e per hectare per year.[1] With approximately 23 million hectares of rangeland in California,[2] there is an enormous potential market to purchase the increase in compost generated.

III. Developing offsets for compostable materials

To ensure the success of AB32, EDF supports the development of additional compliance offset protocols. Over the past two years, EDF has managed a Natural Resource Conservation Service Conservation Innovation Grant entitled "Development of Protocols and Accounting Methods for Carbon Sequestration on U.S. Rangelands." One of the deliverables of this grant is rangeland offset protocols. In the upcoming months, EDF and its partners will submit an offset protocol to

[1] W.L Silver, *et al.*, *Climate Change Mitigation Potential of California's Rangeland Ecosystems*, *A draft report to the California Air Resources Board*, at 27 (Apr. 30, 2013), *available at* http://nicholasinstitute.duke.edu/sites/default/files/w_silver_et_al_april_3013_carb.pdf.

[2] *Id.*

the American Carbon Registry for its review and approval. This is well suited to serve as the foundation for an AB32 compliance offset protocol.

IV. Permitting new composting and anaerobic facilities

EDF agrees that some of the key barriers to the development of new facilities are the "multiple permits and regulatory compliance requirements, the length of time for approval processes, CEQA issues, and local community and regional planning and acceptance"[3] of facilities. We recommend that a working group be developed to work with the state agencies involved in permitting new facilities (including CalRecycle, the California Air Resources Board, California Department of Food Agriculture, and the Natural Resources Agency) to better coordinate the permitting process. Permit coordination must be done in a manner that does not compromise environmental quality or public health.

V. Conclusion

EDF believes that the thoughtful adoption of the Plan is a strong step forward in meeting two of the state's most important 2020 environmental goals – 75% recycling and reducing the state's GHG emissions to 1990 levels.

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[3] California Air Resources Board, *2013 Update to AB 32 Scoping Plan*,

ENVIRONMENTAL DEFENSE FUND: 2013 SCOPING PLAN UPDATE
Agriculture and Natural and Working Lands

August 2013

I. Introduction

As identified in the CARB Scoping Plan Update workshops, creating an overarching strategy for decreasing greenhouse gas emissions from agriculture and natural and working lands is critical to meeting California's 2050 GHG emission reduction targets while also providing essential ecosystem co-benefits. The implementation of best management practices on agricultural, as well as natural and working lands, will also help California meet its short-term 2020 GHG emission reduction goals. In particular, EDF recommends the AB 32 Scoping Plan Update should include the development of market-based incentives such as agricultural-based offsets that maximize benefits to producers, the ecosystem, and the atmosphere, while generating real, additional, permanent, and enforceable offsets for compliance entities in California's cap-and-trade program.

According to a recent report, the existing four compliance offset protocols will only generate one-third of the offset potential demand.[1] As the largest uncapped sector in the cap-and-trade program, agricultural and land-based offsets offer a timely opportunity to ensure future success of the cap-and-trade program and are an important source of GHG emission reductions. The 2013 Scoping Plan Update can provide the structural framework to put these kinds of offset projects and other financial incentives to work.

In order for California to generate the long-term GHG reductions required to minimize the impacts of climate change in a timely and effective manner, EDF suggests that the **Scoping Plan Update should include:**

(1) Development of additional market-based incentives for agricultural practices;

(2) Financial support for the conservation of California's farms and ranches;

(3) Clarification of the role of rangeland in the overall California strategy ; and

(4) Strategic plans for additional research to quantify and model GHG emissions from land management.

[1] Sam Stevenson *et. al*., *Compliance Offset Supply Forecast for California's Cap-and-Trade Program (2013-2020)*, American Carbon Registry, at 13 (Sep. 2012), *available at* http://americancarbonregistry.org/acr-compliance-offset-supply-forecast-for-the-ca-cap-and-trade-program

II. Market-Based Incentives for Agricultural Practices

Agriculture is the proverbial backbone of California's economy, running up and down the state and offering strong potential to contribute to the reduction of GHG emissions and sequestration of carbon in vegetation and soils. As new information becomes available, EDF encourages CARB to take advantage of opportunities to manage agricultural lands in order to reduce GHG emissions and provide lasting ecosystem benefits that support California's agricultural industry.

Incentives

EDF endorses the development and implementation of market-based incentives to reduce GHG emissions from agriculture. Under the cap-and-trade program, agriculture is the largest uncapped sector with the potential to provide a large volume of near-term greenhouse gas reductions with the development of agricultural offset protocols. Agricultural offsets offer the opportunity to restore ecosystem functions, reduce GHG emissions, sequester carbon, and increase producer productivity. CARB has initiated a rulemaking to adopt an offset protocol for rice management. The rice protocol will serve as the gateway to future agriculture, natural, and working land offset protocols by providing the necessary framework for GHG reductions from other land management practices, such as nutrient management on upland crops.

Regulation

EDF believes market-based incentives have the potential to allow agricultural producers to efficiently meet environmental targets and invest in solutions to reduce GHG emissions.

Research Needs

Reliable science is the foundation of effective and long lasting programs to reduce GHG emissions from agriculture. Therefore, EDF supports research towards better understanding, quantifying and modeling GHG emissions. Precision agriculture techniques have the potential to meet environmental goals while allowing farmers to deliver higher yield. These techniques need to be further researched and developed in order to maximize both yield and environmental benefits.

Natural and Working Lands

EDF supports the conservation goals outlined in the Natural and Working Lands sector for the 2013 Scoping Plan Update. Market-based offset protocols, in combination with conservation efforts, present a unique opportunity for greenhouse gas reductions that provide multiple co-benefits at low cost. The implementation of offset protocol management practices on conserved lands can help meet immediate state reduction goals by 2020 and provide a solid foundation for future reductions as California looks to 2050 reduction targets.

III. Financial Support for the Conservation of California's Farms and Ranches

Protecting existing natural and working lands from development, in combination with best management practices, can preserve and potentially increase carbon sequestration and reduce GHG emissions. Furthermore, protecting farms and rangelands from unplanned development can mitigate increases of greenhouse gases by preventing the locking in of long term unsustainable development patterns. Accordingly, AB 32 Scoping Plan update should include a discussion of opportunities and measures for increasing funding for agricultural conservation easements. One such mechanism may be through the use of cap-and-trade auction proceeds.

EDF urges the use of market-based incentives to implement management practices on conserved rangeland which can ensure environmental co-benefits while reducing GHG emissions. For example, a study that was partially funded by EDF has demonstrated that a one-time application of compost to rangeland can sequester carbon in the soil while improving water retention and forage production.[2] Currently, EDF is developing two rangeland offset protocols that will harness these benefits while supporting the long-term GHG reduction goals of AB 32 and we encourage CARB to consider them for adoption as compliance offset protocols.

IV. Clarification of the role of rangeland

California rangeland ecosystems play a unique role in the framework of the Scoping Plan Update as they reside in two sectors: Agriculture and Working Lands. EDF is interested in grazed rangelands for agricultural offset generation. In order to work effectively in the Scoping Plan Update framework, a clearer definition of the role of rangelands is necessary.

V. Strategic plans for additional research to quantify and model GHG emissions from land management

EDF acknowledges the gaps in current research and supports continuation of research and technology advancement in this sector. In order to meet state goals by 2020 and to develop practices to achieve 2050 targets, research to quantify and model the carbon and GHG dynamics of California's rangeland must be continued and expanded. EDF supports additional research specifically focused on the GHG emissions reductions from integrated conservation efforts, including improved grazing management and compost amendments, and market-based incentives.

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[2] Rebecca Ryals and Whendee L. Silver, *Effects of organic matter amendments on net primary productivity and greenhouse gas emissions in annual grasslands*, 23 Ecological Applications 46, 56 (2013).

ENVIRONMENTAL DEFENSE FUND: 2013 SCOPING PLAN UPDATE
High-GWP Gases from Stationary Refrigeration Equipment

August 2013

As part of the first AB 32 Scoping Plan, CARB included the development of a series of initiatives to reduce the emissions of high-GWP materials from refrigeration equipment in the state. In 2009, CARB adopted a regulation titled the Refrigerant Management Program (RMP) aimed reducing leaks of refrigerant from large, medium and small pieces of equipment located in the state (with a staggered implementation timeline). As mentioned in the Executive Summary of the ISOR associated with the RMP, this single regulation is the sixth largest for reductions reduction listed in the original Scoping Plan. In addition to emissions reductions, the RMP facilitates dramatic cost savings for California businesses, creating an important win-win for the state. For example, the RMP is calculated to save business owners $2 per ton reduced.

The RMP works by requiring registration, inspection and repair (when found to be leaking) of high-GWP containing refrigeration equipment in California. Unfortunately, based on the numbers of pieces of equipment currently registered with the state, (nearly 2 years after initial registration was required for large equipment) implementation of the RMP is not going according to plan. Accordingly, public data shows that the RMP is currently not yielding the emissions reductions planned from large equipment operators - since it appears that less than 10% of the equipment believed to be in existence in California (and required to be registered) is actually registered. In addition, with the staggered implementation for medium equipment operators beginning in 2014, it appears that the regulation effectiveness will be impacted for years to come.

Expected number of pieces of equipment [1]

	Best Estimate	Low Range Estimate	High Range Estimate	2010 BAU Emissions
Large commercial Refrigeration	2,000	2000	13,000	5.0 MMTCO2e
Large commercial A/C	2,700	800	4,900	0.3 MMTCO2e
Total amount of large equipment that should be registered with CARB by	4,700	2,800	17,900	5.3 MMTCO2e

[1] California Facilities and Greenhouse Gas Emissions Inventory – High-Global Warming Potential Stationary Source Refrigerant Management Program, (2009) http://www.arb.ca.gov/cc/reftrack/APPENDIX_B_10_22_.pdf

Number of pieces of equipment registered with the state as of August 5, 2013[2]

	Number of large facilities registered	Emissions from all registered pieces of equipment
Facilities Registered with CARB	297	0.7 MMTCO2e
Facilities expected to be registered	2,800 – 17,900	5.3 MMTCO2e
Amount of under-reporting (compliance rate)	**10.6% - 1.6%**	**4.6 MMTCO2e**

As the South Coast AQMD Rule 1415 data shows, without a strong compliance and enforcement mechanism, anticipated reductions from a refrigerant program may not materialize. This is mostly due to the fact that lack of oversight by the state, and required dialogue between the regulated community and state enforcement officers, opens the door for significant non-compliance with the leak check and repair provisions which make up the core of the RMP program. Without system registration, the state has no way to know what refrigeration systems are currently in use and which need to be checked for leaks and subsequently repaired.

As an example of the level of non-compliance possible for this sector, in 2004 the South Coast AQMD audited their Rule 1415 for compliance rate. Rule 1415 is a refrigerant use reporting rule similar to the currently proposed RMP. Though it went into effect in 1991, compliance with the reporting requirement in 2004 averaged between just 15 and 20% - which seems to be even better than the current RMP program. Further, of facilities reporting to the District, an average annual leak rate between 20 and 30% was discovered (compared to a target leak rate of 8 – 10%). [3]

For the RMP to achieve the reductions planned, California businesses of various sizes and levels of sophistication must become aware of various provisions of the rule, secure the services of professionally trained inspection and maintenance personnel, and comply with reporting and operational requirements. However, since many of these businesses have not been subject to regulatory provisions such as the RMP, a significant compliance assistance and regulatory

[2] ARB RMP Home Page – Data, https://ssl.arb.ca.gov/rmp-r3/public_form_reports/reports_forms_download
[3] See letter from EDF to CARB, November 30, 2009 in Support of adoption of the Refrigerant Management Program (RMP) regulation

oversight program is required. Further, to accomplish the goals of the RMP, both CARB and local agencies will need resources to train agency staff and maintain a lasting general business awareness campaign. In addition, CARB will need to ensure adequate training and oversight of refrigerant system maintenance contractors is present.

Based on the above data, EDF recommends, as part of the Scoping Plan Update, **CARB should launch a formal rule implementation review for the state's RMP program, including the development of an expert working group, an enhanced outreach and education campaign to alert system operators of compliance requirements, and a significant enforcement effort to minimize non-compliance.** For maximum effectiveness, CARB should focus not only on the causes of non-compliance for the large equipment sector, but also for potential sources of non-compliance with the medium and small equipment sector as well.

In addition to focusing on compliance with the existing regulation, the **Scoping Plan Update should include the development of a comprehensive, technology stimulating effort to fundamentally alter the use of climate forcing refrigerants in stationary equipment of all sizes.** Although a leak check and repair program is a good first step, this type of emissions reduction approach is insufficient on its own to achieve the kind of reductions necessary to transform the high-GWP sector and attain overall climate goals. After all, approximately 8MMT CO2e will still be emitted from the refrigeration sector after full implementation of the rule is achieved. Chasing down leaks across thousands of businesses is an imperfect solution that will only slow the growing emissions from stationary refrigeration. Eventually, California must devise solutions that will eliminate the need to use these dangerous pollutants in the first place by catalyzing the transition to climate-friendly alternatives.

As stated above, EDF believes the RMP regulation is a step in the right direction, but must be coupled with incentives for technology innovation and other market-based mechanisms to create a market signal that rewards transformative technology adoption. Such a program should eventually lead to a societal shift in the use of refrigerants toward non-High GWP substances. To advance this process, CARB should continue to explore other programs, including, but not limited to, market based instruments, deposit and refund programs, monetary fees, performance standards, loan funds and state subsidized research to demonstrate and scale up low-GWP systems.

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ENVIRONMENTAL DEFENSE FUND: 2013 SCOPING PLAN UPDATE
Smart Power

August 2013

I. Introduction

Any credible plan for California to have a thriving sustainable economy thru 2050 (and beyond) points to the need to reduce GHG emissions dramatically from the energy, while electrifying the transportation sector. Currently roughly 40% of statewide greenhouse gas emissions come from electricity and natural gas systems; another third from transportation.[1] These are not symptoms of a healthy energy system, but rather one that still contributes too heavily to imminent global climate change.[2] It is imperative that California's world-leading economy – take the next steps to demonstrate how clean, reliable, home-grown power will allow it to thrive.

At this critical junction – where the choices we make (and the infrastructure we build) will have implications far into the future – each choice we make should be a step on the path to a sustainable and secure energy future. Fortunately, the state has already started this process: the 2008 Scoping Plan helped to implement the 33% Renewable Portfolio Standard (RPS) and broad-scale energy efficiency.[3] For the 2050 goal, CARB is appropriately considering growth of low carbon generation (renewables), localized renewable generation, sustainable bioenergy systems, a flexible and robust transmission infrastructure, near zero net energy buildings, and solar space and water heating.

We commend CARB for its continued focus on the demand side of the equation, expanding beyond energy efficiency to include demand response (DR), and acknowledging the importance of price information for consumers. We strongly support these solutions, along with other enhancements to wholesale market design, noting that when adopted across forums and brought to bear in the state's planning processes, they directly reduce the need for construction and operation of expensive fossil-fuel power plants. By avoiding new infrastructure investments, for example, DR can bring down pollution and lower consumers' electricity bills.

CARB and the participating agencies have begun to transition the existing electricity system and identify challenges.[4] We believe that some challenges should be characterized as key near-term

[1] CARB, *2013 Update to AB 32 Scoping Plan*, 19 (July 2013), http://www.arb.ca.gov/cc/scopingplan/meetings/061313/spu_workshop_presentation_final.pdf.
[2] "Scientists estimate that humans can pour roughly 565 more gigatons of carbon dioxide into the atmosphere by midcentury and still have some reasonable hope of staying below two degrees. ("Reasonable," in this case, means four chances in five, or somewhat worse odds than playing Russian roulette with a six-shooter.)" Bill McKibben, *Global Warming's Terrifying New Math*, (July 19, 2012), http://www.rollingstone.com/politics/news/global-warmings-terrifying-new-math-20120719?page=2.
[3] *See* CARB, *Climate Change Scoping Plan* (Dec. 2008), http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf.
[4] CARB, *2013 Update to AB 32 Scoping Plan*, at 31-36.

policies that can unlock multiple possibilities. We do not attempt to identify all of these opportunities here. Instead, we focus on a few concepts that are critical.

II. Enabling High Market Penetration of DR

In addition to its ability to integrate renewables, DR can function as a system resource much like generation, particularly when demand is highest. CARB notes "[m]ost demand response does not participate in the CA ISO wholesale energy market, is not visible or dispatchable to CA ISO; Enabling technologies needed for automatic control, auto demand response."[5] EDF agrees that dispatchability and automatic control are helpful and should be explored further. We note that the high market penetration of DR in other parts of the country demonstrates that it is policy – not technology – keeping California from having a more significant DR resource to meet resource adequacy needs.

Critical to increasing the role of demand response in California are consistent, stable and transparent market rules. Such rules will enable third-party Demand Response Providers (DRPs) and utilities to identify and deliver upon value propositions. At this point in California, restrictions keep DRPs from directly participating in or bidding the load from independently-owned utility (IOU) bundled customers into the California Independent System Operator (CAISO)'s wholesale market. In contrast, PJM on the East Coast provides clear rules and price signals to market participants, and– through capacity payments – creates a stable environment within which to make DR investments.[6]

III. Integrating Renewables Without Increasing Emissions

As noted by the California Counsel on Science and Technology (CCST), "if electric generation is predominantly intermittent renewable power, using natural gas to firm the power would likely result in greenhouse gas emissions that would alone exceed the 2050 target for the entire economy."[7] In addition to DR, above, **we suggest wholesale market design enhancements that better enable integration of renewable resources:**

- **Moving to shorter scheduling intervals, along with scheduling closer to flow;**
- **Increasing balancing area coordination, for example by the Energy Imbalance Market being developed by CAISO; and**
- **Better coordination in the development of renewable resources and transmission assets across balancing areas with the goal of creating synergies / complementarities across resources that can efficiently meet load while also reducing our reliance on balancing resources.**

[5] *Id.* at 31.
[6] While a portion of the demand response resources in PJM rely on backup diesel generation, which is not a viable approach to getting to California's 2050 goal, the majority do not.
[7] California Counsel on Science and Technology, *California Energy Future - The View to 2050*, 4 (May 2011), http://www.ccst.us/publications/2011/2011energy.pdf.

- **"A combination of energy storage devices and smart-grid technology," as recommended by CCST.**

IV. Price Responsive Demand / Consumer Price Information

Expansion of Time-of-Use (TOU) rates will attract clean energy investments for residential customers, dramatically lower costs for the entire electric system, and avoid adverse environmental impacts. New price signals will promote the development of new services and technologies while enabling utilities and ratepayers to better manage load.[8]

EDF estimates that if half of the IOUs' residential customers were on the TOU rate currently offered by Southern California Edison (SCE), reductions in peak demand each year would produce a total system savings of nearly $500 million.[9] Upwards of twenty 100-megawatt (MW) fossil fuel power plants would be avoided and almost one hundred fifty thousand tons of CO_2 emissions would be avoided per year.[10] However, these benefits could be even greater. If half of all residential customers adopted SCE's TOU structure, upwards of thirty-three 100-megawatt plants would be avoided and almost one quarter of a million tons of carbon dioxide emissions would be avoided per year.[11]

V. Energy Efficiency Flexible Financing: On Bill Repayment (OBR)

OBR is a platform for third party, private investors to underwrite and finance energy efficiency (EE) and distributed generation (DG) projects at competitive rates of interest and with long term repayment schedules by attaching the repayment obligation to the utility meter via a rate tariff. The program creates a marketplace for clean energy lending, allowing contractors to provide customers with an integrated package of building upgrades and financing. **If done correctly, OBR can lower the financing and transaction costs of clean energy projects, expand the pool of investors and economically attractive investments, and put people to work in good jobs that deliver real value.**

OBR for non-residential properties is currently the subject of a CPUC Proposed Decision. EDF strongly commends the CPUC for moving to authorize OBR as a pilot program for California. The nonresidential OBR pilot with disconnection rights, as described in the Proposed Decision, has nearly all of the elements necessary to make the program successful.[12] EDF views OBR as a

[8] EDF, *Residential Rate Design Proposal*, R.12-06-013, at 6 (May 29, 2013), http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M066/K295/66295654.PDF.
[9] *Id.*
[10] EDF, *Reply Comments*, R.12-06-013, at 5 (July 26, 2013), http://delaps1.cpuc.ca.gov/CPUCProceedingLookup/f?p=401:56:1084407089056201::NO:RP,57,RIR:P5_PROCEEDING_SELECT:R1206013
[11] *Id.*
[12] Proposed Decision of Administrative Law Judge Melanie Darling, A12-07-001 et al. Decision Implementing 2013-2014 Energy Efficiency Financing Pilot Programs. Agenda ID #12219.

key part of any strategy to achieve DG and EE investments at the scales needed to achieve 2050 GHG goals.

VI. Smart Utility Investments

In CPUC proceedings, utilities should be heartily encouraged to make their investments clean, smart, and future-oriented, as outlined in state policy and the loading order, while the agency fully accounts for cost implications and the need for electricity to be affordable now. One such investment is in technologies that regulate voltage and reactive power (Volt/VAR). These investments can improve system reliability, while reducing the need for energy procurement and operation maintenance, and lowering GHG emissions.

VII. Transportation electrification

As discussed above in the transportation sector, **credible plans to get to 2050 GHG goals involve the decarbonization of the transportation sector. Electrification with clean electricity sources and biofuels are the leading solutions**. One of the major challenges – and opportunities for world-leading success – is the comingling of CPUC and CARB policies, while CAISO and the Federal Energy Regulatory Commission (FERC) expand their definitions of flexible resources to be more inclusive of self-generation and storage (from electric vehicles or other resources). Curtailment of self-generation, vehicle-to-home (V2H) and vehicle-to-grid (V2G) can be utilized as flexibility and ramping resources. CARB should work with CAISO to determine what policies, practices and associated informatics will allow for V2G and V2H to help with ramping and flexibility needs. At the CPUC, there will be a need to rethink the next generation of building and home metering infrastructure to provide adequate telemetry from CAISO (and wholesale markets). Current advanced metering infrastructure (AMI) does not enable CAISO to observe self-generation or vehicle charge status. CAISO would need telemetry at the meter; CPUC and IOUs have made huge initial investments in AMI; it is now appropriate to consider what additional investments and policies are needed to better integrate EVs. In addition, the CEC has a vital role to play in establishing and revising rules for defining and verifying resources that meet the requites of the Renewable Portfolio Standard (RPS), and, for municipal utilities, the CEC takes over the role of the CPUC. Furthermore, the CEC will establish the vision for the role of EVs and DR in the 2013 Integrated Energy Policy Report (IEPR).

V. Conclusion

The transition to a next-generation electricity grid will take place over time, but we must begin the journey down this path as soon as possible. The state has high-level guidance from several key places: (soon) this updated Scoping Plan, the IEPR, and the loading order to name a few.

Many agencies, including the CPUC, CEC, and CAISO, will have critical roles to play in the state's success.[13]

How these forward-thinking agencies will design and implement policies in line with guidance is critical. In the realm of on-the-ground decision-making, habit and political impasse can mean a lack of momentum for change. For example, the projected increase in renewables has led to the now infamous "duck chart," showing suppressed energy prices midday along with a steep ramping demand in the afternoon which – in combination with the need to integrate the variability of renewables – is tempting some important decision makers to rely on *more* natural gas. In fact, policy guidance already in law points to a clear preference for clean energy resources.

DR should be considered hand-in-hand with renewable integration as it can be used to balance both their variability and the potential afternoon ramping and suppressed midday energy prices being anticipated. Sharing cost-based price information with consumers through TOU rates will directly reduce the need for costly peaking power plants – among the least efficient and most polluting resources on the system. In combination with flexible financing options for energy efficiency, these low-cost options can meet the need for new generation or transmission – including in areas affected by the retirement generation facilities like San Onofre Nuclear Generation Station (SONGS). Put plainly, targeted "demand-side" resources should be seriously considered anytime new generation or transmission is being considered, putting state policy into action.

For these reasons, cross-agency coordination and close and consistent application of state policy is essential to ensuring that California's clean energy policies obtain their vast potential in a timely manner. Each decision we make should put us on the path to a low-carbon future. This requires declaration of and adherence to measured, cost effective steps in the path to the state's 2050 goal, with a close watch for unintended consequences and backsliding. Each agency can provide the leadership necessary to address diverse stakeholder needs – utilities, consumer and environmental groups, as well as those responsible for balancing the grid – while moving the state toward a sustainable energy system.

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[13] In updating the Scoping Plan, CARB can also refer to studies that have examined policy and technology pathways for California to achieve a 2050 emissions cap at 80% below 1990 levels. The two most significant of these studies were conducted by researchers at Lawrence Berkeley National Labs on behalf of the California Council on Science and Technology, California Energy Future – The View to 2050 (CCST, May 2011), and at E3, The Technology Path to Deep Greenhouse Gas Emissions Cuts by 2050: The Pivotal Role of Electricity (E3, Nov, 2011).

ENVIRONMENTAL DEFENSE FUND: 2013 SCOPING PLAN UPDATE
Natural Gas

August 2013

I. Introduction

As stated above, reducing methane and natural gas emissions is an important, and at times, overlooked part of the set of solutions necessary to mitigate climate change. Accordingly, in the Scoping Plan Update, CARB should include a comprehensive strategy to reduce methane emissions from sources across the state – both from sources associated with natural gas use and that release methane as a byproduct of decomposition. As a gas that, pound for pound, is newly estimated to have a GWP 25 times that of carbon dioxide over a 100-year span,[1] and an even higher 20-year GWP of 72 times,[2] even relatively small amounts of methane emissions can have a significant impact on climate change.

Although current estimates require additional study because they are thought to be too low, it is likely that methane accounts for at least 9 percent of the state's greenhouse gas emissions.[3] This comes from a variety of sources, including natural gas use in residential, commercial and industrial operations; and also from animals, landfills, and biological processes. Thus, fully dealing with methane emissions will require a coordinated and far-reaching approach within the scoping plan, and should be a priority.

Inclusion of a methane reduction package in the AB 32 Scoping Plan update should not come as a surprise. Strong evidence has begun to emerge that the state is already recognizing the importance of better understanding of and the need to mitigate methane emissions. For example, a proposed Assembly bill (AB 1257) recognizes that the use of natural gas needs to be strategically evaluated and planned for, by requiring the CEC to report to the Governor every four years on "strategies to maximize the benefits obtained from natural gas as an energy source."[4] Furthermore, both AB 1257 and newly formed initiatives at the CPUC focus attention on the integrity of a neutral gas transmission and distribution system – a system in need of repair and maintenance to reduce leaks from worn infrastructure. It is apparent from both these initiatives that California recognized that while the use of natural gas has the potential to be beneficial, failure to prevent emissions of methane to the greatest degree possible, especially as use of natural gas is poised to grow, will quickly negate any advantage garnered by replacing coal and oil with natural gas.

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[1] 2013 Revisions to the Greenhouse Gas Reporting Rule and Proposed Confidentiality Determinations for New or Substantially Revised Data Elements, 70 Fed. Reg. 19802, 19809 (Apr. 2, 2013), available http://www.gpo.gov/fdsys/pkg/FR-2013-04-02/pdf/2013-06093.pdf.

[2] Environmental Defense Fund, *Natural Gas – A Briefing Paper for Candidates* at 6.

[3] Julie Chao, *Measuring the "Other" Greenhouse Gases: Higher Than Expected Levels of Methane in California – Berkeley Lab scientists develop new method for evaluating short-lived pollutants*, Lawrence Berkeley National Laboratory News Center (June 12, 2012), http://newscenter.lbl.gov/news-releases/2012/06/12/measuring-higher-than-expected-levels-of-methane-in-california/.

[4] Assem. B.1257 (2013)

Accordingly, **CARB should include a comprehensive state-wide methane reduction plan within the Scoping Plan Update that includes:**

1) **An update of the state's inventory of methane emissions (including natural gas) to have a better understanding of the scope, location and intensity of major emission sources;**

2) **Measures to reduce methane leakage from the natural gas transmission and distribution system; and**

3) **Implementation of effective short-term natural gas use reduction methods.**

II. Update of the inventory for methane emissions in California (from both natural gas and non-natural gas related sources)

Recent advancements in conducting GHG inventories and understanding the potential impacts of unabated emissions of methane makes it clear that California needs to update the statewide inventory for methane. Doing so will enable the state to better understand the scope, location and intensity of major sources of methane emissions, as well as set abatement goals and track progress towards meeting those goals. Such a process involves developing better emission estimates for major point and area sources, movement toward a systematic mapping of utility systems, and having access to and using the best available data and data acquisition systems.

Emissions Inventory

The EPA has recognized that an up-to-date inventory of emissions is critical to creating an informed climate strategy, stating that "accurate and timely information on GHG emissions is essential for informing some future climate change policy decisions."[5] In California, it is documented that the major point and area sources of methane emissions are from landfills, enteric fermentation, manure management, wastewater treatment, natural gas systems, stationary combustion, rice cultivation, biological material decomposition generally, mobile combustion, and petroleum systems.[6] However, less well-documented is emissions data from these sources – indeed, the latest emissions inventory completed by CARB (2010) has been characterized as inaccurate by up to one-third, due to uncertainties in both emissions source characterization and measurement error.[7]

[5] Mandatory Greenhouse Gas Reporting Rule, 70 Fed. Reg. 56,260 (Oct. 30, 2009), available http://www.gpo.gov/fdsys/pkg/FR-2009-10-30/pdf/E9-23315.pdf.
[6] Jeff Kuo, *Clearinghouse of Technologies for Reducing Non-CO2 Greenhouse Gas Emissions*, CARB-funded presentation, slide 26, available http://www.arb.ca.gov/research/seminars/kuo/kuo.pdf.
[7] Ying-Kuang Hsu, *et al.*, *Methane emissions inventory verification in southern California*, 44 Atmospheric Environment 1, 6 (2010).

Of course, working from an inventory that may be 33% off, and possibly up to 50% (based on informal conversations with industry experts), is problematic, given the fact that methane is such a potent short-term pollutant – spikes that are not documented can have a detrimental effect extremely quickly. After a period of stable levels of methane, global levels have been rising[8] with no indication thus far that they will stop going up. Failure to have an up-to-date emissions inventory that accounts for upswings from such sources and allows for fully-informed mitigation measures ultimately makes meeting 2020 and post-2020 goals more difficult.

Systematic Mapping of Utility Systems

Because natural gas is a large contributor to methane emissions, and the second largest energy source in California,[9] it is imperative to have an adequate knowledge of where natural gas transmission and distribution (T&D) lines are located, where they lead, and how far they extend. This knowledge can lead directly to identifying and fixing leaks in the system and reducing the danger to the public health and climate.

As was made evident by the San Bruno Pipeline disaster in 2010, utility companies often do not possess such data. In that particular instance, in which over 100 homes were damaged and 58 people were injured when a pipeline exploded,[10] it came to light that "PG&E [Pacific Gas & Electric] had *literally no idea that the flawed pipeline sections were there* [emphasis in original]."[11] This led to a delay of well over an hour before the first valve on the pipeline was pinpointed and shut off,[12] resulting in the escape of a significant amount of natural gas.

Furthermore, as was made clear in a study of the transmission and distribution system in Boston Massachusetts, (when researchers identified 3356 methane leaks with concentrations exceeding up to 15 times the global background level), leaks in the T&D system are commonplace.[13]

Having an accurate map of urban pipelines "would benefit diverse stakeholders, including companies, municipalities, and consumers"[14] by making disasters more easily preventable, leak points more easily traceable, and in the end, supervision of the entire system more manageable.

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[8] Justin Gillis, *The Puzzle of Rising Methane*, New York Times (Dec. 29, 2011), http://green.blogs.nytimes.com/2011/12/29/the-puzzle-of-rising-methane/?_r=0.

[9] California Air Resources Board, Overview of Natural Gas in California, http://www.energyalmanac.ca.gov/naturalgas/overview.html

[10] California Public Utilities Commission, *September 9, 2010 PG&E Pipeline Rupture in San Bruno, California* at 1 (Jan. 12, 2012), available http://www.cpuc.ca.gov/NR/rdonlyres/28720A78-1DC7-4474-B51F-00C5E8BB5069/0/AgendaStaffReportreOIIPGESanBrunoExplosion.pdf.

[11] Opening Brief of the Consumer Protection and Safety Division on Fines and Remedies (May 6, 2013) at 2, available at http://www.cpuc.ca.gov/NR/rdonlyres/1865E039-2482-43A4-91A5-E9E28C40A00A/0/I1201007etalCPSDOpeningBriefonFinesandRemedies.pdf.

[12] California Public Utilities Commission at 115-16 (Jan. 12, 2012).

[13] Nathan G. Phillips, *et al., Mapping urban pipeline leaks: Methane leaks across Boston*, 173 Environmental Pollution 1,1 (2012).

[14] *Id.* at 3.

Best Available Data and Data Acquisition Systems

CARB needs to ensure in its Scoping Plan Update that regulation of the natural gas sector is equipped with the best possible data and data acquisition systems. Having sufficient and accurate data can help ensure that appropriate sites for future pipelines are chosen that minimize risks to the environment and public to the greatest extent possible, as well as ensuring that potentially dangerous leakages and ruptures are quickly detected and reported. Currently, natural gas transmission pipelines are not required to report the existence of leak detection systems (LDS), and are only required to report whether or not they have a supervisory control and data acquisition (SCADA) system.[15] As will be discussed below, not requiring that pipelines have an LDS system misses an economical opportunity to prevent a great deal of harm.

SCADA is widely used in gas systems "to collect data from pipeline sensors in real time and display these data to humans (controllers) who monitor the data from remote sites"[16] and allows the input of commands for the remote operation of pipeline control equipment.[17] However, it is not tremendously accurate in detecting pipeline accidents. Among 126 incidents in transmission pipelines in which SCADA was in place, the system only assisted in detection approximately 32% of the time.[18] The National Transportation Board uncovered 5 areas of potential improvement for the hazardous liquid pipeline industry – display graphics, alarm management, controller training, controller fatigue, and leak detection systems – and it would be proper for CARB to require similar upgrades for natural gas pipelines in its Scoping Plan Update.

III. Reducing methane leakage from natural gas pipelines

Reducing methane leakage from pipelines has a benefit from a public safety, environmental safety, and economic standpoint. While leaks (a slow release over a relatively small area), do not generally cause immediate injury or fatalities, ruptures (a breach in the pipeline that may occur suddenly) often cause damage, due to an associated explosion.[19] From a safety standpoint, these releases can be incredibly harmful - a leak detection study that documented 22 above-average leaks in pipelines across the country found that of those 22 leaks, 7 resulted in an explosion and resulting injury to as many as 51 people.[20]

From an environmental perspective, uncombusted natural gas that leaks out is extremely detrimental in terms of short term change to the climate – methane has a GWP that is 72 times that of carbon dioxide, such that even a small amount of leaking natural gas is highly significant.

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[15] US Department of Transportation Pipeline and Hazardous Materials Safety Administration, *Final Report: Leak Detection Study – DTPH56-11-D-000001*, at 3-75 (Dec. 10, 2012).
[16] National Transportation Safety Board, *Supervisory Control and Data Acquisition (SCADA) in Pipelines: Safety Study*, at vi, (Nov. 29, 2005) *available at* http://www.ntsb.gov/doclib/safetystudies/SS0502.pdf.
[17] *Id.*
[18] US Department of Transportation Pipeline and Hazardous Materials Safety Administration at 3-83-3-84.
[19] US Government Accountability Office, *Report to Congressional Committees – Pipeline Safety: Better Data and Guidance Needed to Improve Pipeline Operator Incident Response*, at 8 (Jan. 2013).
[20] US Department of Transportation Pipeline and Hazardous Materials Safety Administration, at 3-83 to 3-84.

By some estimates, 7 percent of total production is lost through leaks. If this figure is accurate, leaks could negate the climate benefit that is gained by replacing one-third of the nation's coal plants with cleaner energy solutions.[21]

Reducing the amount of leakage is also cost effective, as it prevents costs to companies related to repairs, environmental remediation, and loss of product. For instance, a leak as a result of a construction defect that went undetected for seven days cost the operator an estimated $106,000 in repairs and $22,000 in lost product.[22]

Comprehensive Pipeline Map

As discussed above, utility companies often do not have an adequate understanding of where pipelines are located. This can lead to significant delays in pinpointing the source of a leak, documented by the US Government Accountability Office to be as much as 7 days.[23] While reaction time to a leak is affected by multiple variables,[24] knowing the exact location of a pipeline is an important first step towards ensuring a more rapid response. Pipeline operators and industry stakeholders agree that this is necessary in order to reduce the amount of product lost and "reduce the amount of property and environmental damage stemming from an incident and, in some cases, the number of fatalities and injuries."[25] In New York, research has shown that the coupling of remote methane sensing mapping technologies and GIS technologies "can produce system wide maps that can be the basis of a systematic effort to find and fix leaks."[26] The Scoping Plan Update should require utility companies to utilize similar technology to have a comprehensive map of pipeline locations and thereby avoid harm to the greatest extent possible.

Implementation of Feasible Measures

Currently, "best practices for leak detection for gas pipelines are lacking, as are best practices for external sensor-based leak detection."[27] Indeed, "up to 99% of all distribution network leaks are detected not by leak-detection technology, but by on-the-ground personnel and the public."[28] By some estimates, maintaining a one percent methane leakage rate would ensure that natural gas

[21] Environmental Defense Fund, *Natural Gas – A Briefing Paper for Candidates* at 6.
[22] US Government Accountability Office, *Report to Congressional Committees – Pipeline Safety: Better Data and Guidance Needed to Improve Pipeline Operator Incident Response*, at 13, 17 (Jan. 2013).
[23] *Id.* at 17.
[24] Response time is affected by such factors as leak detection capabilities, location of qualified operator response personnel, types of valves, control room management, and relationships with first responders. *Id.* at 13-15.
[25] *Id.* at 13.
[26] *Proceeding on Motion of the Commission as to the Rates, Charges, Rules, and Regulations of Consolidated Edison Company of New York, Inc. for Natural Gas Service*, *Before the State of New York Public Service Commission*, at 9 (2013) (revised direct testimony and exhibits of Mark Brownstein, Associate Vice President and Chief Counsel, US Climate and Energy Program, Environmental Defense Fund).
[27] US Government Accountability Office at 8.
[28] *Proceeding on Motion of the Commission as to the Rates, Charges, Rules, and Regulations of Consolidated Edison Company of New York, Inc. for Natural Gas Service*, *Before the State of New York Public Service Commission* at 8.

would have an advantage over oil and gas in terms of production of fewer GHG emissions over any period of time, and would ensure that heavy-duty vehicles fueled by natural gas and compressed natural gas vehicles would have immediate GHG reductions in comparison to vehicles that are powered by conventional fuels.[29] There are a number of feasible measures that can be implemented in order to reduce the risk of leakage to this threshold that allows these companies to see a return on their investment within three years or less,[30] and in some cases as little as a few months.[31] A study by the World Resources Institute demonstrated that implementation of plunger lift systems used during unloading of liquids, leak monitoring and repair, and installation of low-bleed pneumatic devices throughout natural gas systems, along with five other-cost effective solutions, would enable the one percent goal to be achieved easily.[32] Cost-effective measures such as these are already being implemented in states like Colorado and Wyoming,[33] and California should follow suit.

In addition, CARB should investigate market mechanisms to incentivize leakage reduction. If methane leakage rates are measured, a market mechanism such as a leakage "cap" or a tax on fugitive emissions should be considered as a means to encourage use of the aforementioned leakage reduction technologies.

III. Implement short-term natural gas use reduction methods that are clearly effective

Harmonizing and Updating Boiler Rules Across the Air Districts

Current rules that require reductions of NO_x emissions from boilers act as a surrogate for greenhouse gas measures to the extent they require increased efficiency and optimized utilization of fossil fuel burning equipment throughout the state.

Over the past three months, EDF has undertaken a comprehensive assessment of regulations pertaining to boiler rules across the various local air districts in California. According to our research, it is evident that local rules vary wildly across the different air districts, in terms of the NO_x limits that are imposed and the size of the boilers that are covered. Accordingly, California has an inconsistent patchwork of regulations for boilers, and is missing an opportunity to both improve public health and reduce GHGs.

NO_x limits in the different districts vary from 5 parts per million by volume (ppmv)[34] to 115 ppmv,[35] depending on the size and type of boiler. In addition, the type and size of boilers that

[29] James Bradbury, et al., *Clearing the Air: Reducing Upstream Greenhouse Gas Emissions from U.S. Natural Gas Systems*, World Resources Institute, at 2, 13 (Apr. 2013).
[30] *Id.* at 2.
[31] Environmental Defense Fund at 7.
[32] Bradbury, *et al.* at 6.
[33] Environmental Defense Fund at 7.
[34] *See, e.g.,* Bay Area Air Quality Management District, Rule 9.7: Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional and Commercial Boilers, Steam Generators and Process Heaters*, available at* http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Rules%20and%20Regs/reg%2009/rg0907.ashx .

are covered by the rules are inconsistent. Some air districts only cover industrial boilers,[36] while others have rules that cover natural gas powered residential boilers.[37] Similarly, certain districts only cover boilers that are greater than or equal to 5,000,000 Btu/hour,[38] while others cover smaller boilers in the 2,000,000 to 5,000,000 Btu/hour range.[39]

For those rules that only include larger boilers, opportunities for emission reductions and cost savings are being missed. According to rulemaking support documents, facilities can save an estimated $160/year for every million Btu fired,[40] meaning that facilities with 2,000,000 Btu/hour boilers that don't retrofit or replace their boilers are missing out on significant amounts of monetary savings a year. In addition, lack of reduction means that critical NO_x and GHG emission reductions are not being achieved. Such reductions, especially NOx, a precursor to PM10 and PM2.5 (known to cause severe health problems like respiratory irritation, asthma, and cardiovascular disease),[41] are essential to prevent negative health impacts.

Recommended Measures for Boilers

EDF recommends that CARB, in consultation with the California Air Pollution Control Officers Association (CAPCOA), do the following: 1) identify air district regulations that are most effective at shifting boiler operations to high efficiency technology; 2) establish a model rule for use in the air districts; and 3) investigate new incentive programs for boiler retrofit and replacements.

Certain districts have recently re-worked their rules to set more stringent limitations, with the result that emission reductions are being documented by the air districts. For instance, the Bay Area Air Quality Management District now includes boilers between 2 and 5 MM Btu and sets a NO_x emissions limit for these boilers of 30 ppmv, resulting in a reduction of 1.15 tons per day.[42] Similarly, under South Coast Air Quality Management District amendments, boilers in the same range would have a limit of either 9 or 12 ppm, resulting in a reduction of 0.29 tons per day of

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[35] *See, e.g.,* Shasta County Air Quality Management District, Rule 3-26: Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters Oxides of Nitrogen Control Measure, *available at* http://www.arb.ca.gov/DRDB/SHA/CURHTML/R3-26.HTM.

[36] *See, e.g.,* Shasta County Air Quality Management District, Rule 3-26.

[37] *See, e.g.* San Diego County Air Pollution Control District, Rule 69.5, http://www.arb.ca.gov/DRDB/SD/CURHTML/R69-5.HTM.

[38] *See, e.g.,* Mojave Desert Air Quality Management District, Rule 1157: Boilers and Process Heaters, *available at* http://www.arb.ca.gov/DRDB/MOJ/CURHTML/R1157.htm.

[39] Bay Area Air Quality Management District, Rule 9.7.

[40] Communication with Randy Consolacion, San Diego Air Pollution Control District.

[41] Bay Area Air Quality Management District, *Public Workshop/Webcast: Reducing Particulate Matter in the SF Bay Area* (Feb. 6, 2012), Slide 11, 15, available at http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Plans/PM%20Planning/Reducing%20Particulate%20Matter%20in%20the%20SF%20Bay%20Area.ashx.

[42] J. Julian Elliott, *Proposed Amendments to BAAQMD Regulation 9, Rule 7: Nitrogen Oxides and Carbon Monoxide From Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters* (June 2008), at 13-14.

NO_x emissions by 2015.[43] These regulations, because they result in greater efficiency of combustion, reduce GHG emissions and costs associated with gas combustion.

The demonstrable reductions from including these smaller boilers means that those districts that do not have similar requirements are missing out on substantial NO_x reductions, as well as sizeable cost reductions. Bearing that in mind, CARB should work with CAPCOA to follow the lead of more progressive air districts and establish a model rule for use in the air districts that enables uniformity among the air districts and that is inclusive of smaller boilers where applicable.

Finally, CARB and CAPCOA, in conjunction with the CPUC, should investigate new incentive programs to enable energy efficient technology. Technology exists that makes boilers more efficient – for example, boilers are being retrofitted with flue gas recirculation and ultra low NOx burners,[44] and a California hotel has put into place an innovative new laundry system that drastically reduces the amount of natural gas used.[45] However, such technology is relatively expensive, and for those entities that are not covered by a district's boiler rules, such measures may not seem like a worthwhile or even a possible investment. Because natural gas will be under the cap in 2015, CARB can use revenue from the sale of those credits to fund such a program.

IV. Conclusion

A comprehensive approach to reducing emissions of methane must be a part of the AB 32 Scoping Plan Update process. Updating the inventory of methane emissions, making sure that methane leakage is prevented to the maximum extent possible, and implementing efficiency measures that will reduce the short-term use of natural gas should all be a part of the overarching effort.

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[43] Rizaldy Calungcagin, *Final Staff Report: Proposed Amended Rule 1146.1- Emissions of Oxides from Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters* (Aug. 2008) at ES-2.
[44] Elliot, at 7-8.
[45] PG&E, *Four Points by Sheraton Reaps Savings with PG&E Rebates,* http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/hospitality/FourPointsBySheraton%20vFinal.pdf.

ENVIRONMENTAL DEFENSE FUND: 2013 SCOPING PLAN UPDATE
Cap and Trade

August 2013

I. Introduction

To reach both 2020 and 2050 greenhouse gas emission reduction targets, California must establish long-term policy drivers for investments that reduce emissions from existing pollution sources and grow new business opportunities within the clean economy. Accordingly, the forthcoming 2013 Scoping Plan Update presents CARB with an opportunity to support both of these objectives: enhance the effectiveness of cap and trade from now to 2020, and also support the predictable, long-term policy necessary to drive innovation and low-carbon investment in California over the next four decades. Pursuant to these objectives, **a central component of CARB's Scoping Plan Update should be the creation of an expectation that California's cap-and-trade program will be extended beyond 2020.**

In addition to clarifying CARB's authority and intention to extend the cap-and-trade regulation, the AB 32 Scoping Plan Update should make clear the state's intent and schedule to pursue mechanisms that increase flexibility and contain program costs, including expanded availability of approved, high-quality offsets, and linkage with jurisdictions that adopt comparable rules and objectives.

By clearly stating the intent to extend the existing cap-and-trade regulation and enumerate the progress that will be pursued to enhance cost containment and linkage in the current Scoping Plan Update document, CARB will help drive early emissions abatement, spur essential investments in low-carbon technologies, and contribute to a cost-effective and politically durable climate policy in California.

II. Supporting the Effectiveness of the Existing Cap-and-Trade Regulation (pre-2020) by Creating the Expectation That It Will Be Extended Beyond 2020

The extension of cap and trade beyond 2020 will establish a long-term and predictable price signal upon which firms can base investment decisions, while still maintaining sufficient flexibility to achieve the state's environmental objectives cost-effectively.[1] Extending the market signal therefore supports the operation of the program pre-2020, as well as results in longer term effectiveness beyond 2020.

[1] Christian Egenhofer, et al., *The EU Emissions Trading System and Climate Policy towards 2050: Real incentives to reduce emissions and drive innovation?* CEPS Special Reports, at 2 (2011), *available at* http://www.ceps.eu/book/eu-emissions-trading-system-and-climate-policy-towards-2050-real-incentives-reduce-emissions-an.

A longer policy horizon with banking between trading periods will contribute to a robust demand for banked allowances beyond 2020, incentivizing early investment and preventing carbon-intensive technology lock-ins.[2] Pursuant to economic modeling conducted by EDF and others, the current program design (and the implicit lack of value for banked allowances post-2020) will lead to a significant decline in allowance value leading up to the year 2020. As submitted to CARB in December 2010:

> *"If firms have no incentive to bank allowances for the post-2020 period, there is a significant likelihood that allowance prices will fall to their minimum possible levels."*

The expectation of a future carbon price can contribute to deeper reductions in the current phase of the program as regulated entities invest with the expectation that banked allowances will retain and (appreciate in) value. Based on our analysis,[3] a post-2020 carbon market with banking allowed between compliance periods would help prevent allowance prices from falling too low in the early (pre-2020) years. Although California appears to have a healthy market,[4] even if demand for AB 32 credits is weak (as a result of unusually ample abatement opportunities and offset supply), the prospect of the future market, whose price is taken to be exogenous, provides sufficient incentive for firms to over-comply and bank the resulting excess allowances, providing some price buoyancy.

When taken in a different context, a long-term policy horizon can also contribute to a more politically durable emissions reduction program, as early investors will have a vested interest in maintaining an active allowance market.[5]

Early investments also put the program on a path toward decreasing costs as they spur a cycle of dynamic innovation and competition amongst regulated entities and technology developers to further reduce program costs.[6] By smoothing price volatility and decreasing uncertainty, a long-

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[2] Pedro Piris-Cabezas and Ruben Lubowski, *Increasing Demand by Raising Long Term Expectations: the Importance of a 2030 Target for the European Union's Climate Policy*, Environmental Defense Fund, at 2 (forthcoming 2013).

[3] See EDF's "Cost Containment through Offsets in the Cap-and-Trade Program under California's Global Warming Solutions Act," July 2011, *available at* http://www.edf.org/sites/default/files/EDF%20AB%2032offsetsmodelingmemo%20final2_updated_3Jan2012_v2.pdf.

[4] In the first three cap-and-trade auctions, the settlement prices for allowances were $10.09, $13.62, and $14.00, respectively. In 2 of the 3 auctions, the clearing price was significantly higher than the floor price. *See* California Air Resources Board, *Auction Information*, http://www.arb.ca.gov/cc/capandtrade/auction/november_2012/updated_nov_results.pdf; http://www.arb.ca.gov/cc/capandtrade/auction/february_2013/updated_feb_results.pdf; http://www.arb.ca.gov/cc/capandtrade/auction/may-2013/updated_may_results.pdf.

[5] Markus Wråke, *et al.*, *What Have We Learnt from the European Union's Emissions Trading System?* 41 Ambio 12, 16 (Feb. 4, 2012), *available at* http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3357882/.

[6] Dallas Burtraw, *Cap and Trade Policy to Achieve Greenhouse Gas Emission Targets*, *in* Civil Society Institute, *Growing the Economy Through Global Warming Solutions*, at 12 (Dec. 2007), available at http://www.civilsocietyinstitute.org/reports/GEGWS-BurtrawChapter.pdf.

term horizon therefore contributes to more efficient reductions and will allow California to achieve more ambitious targets at a lower cost.[7]

As currently written, the cap-and-trade regulation does not provide a post-2020 market signal. Even though California's actions to date have been nothing short of visionary and forward-thinking with respect to progress occurring in other parts of the world, without a clear signal that the program will extend past 2020, the perception of climate policy measures as short-sighted and volatile can make investments in new and, in some cases, unproven technologies that are excessively risky when compared to traditional high-emitting technologies. This is particularly relevant to many of the capital-intensive sectors regulated under California's cap-and-trade program that face decades-long investment cycles and significant fixed costs.[8]

III. Lessons Learned from the EU

Since only a few economic models are capable of predicting current and future California Carbon Allowance (CCA) prices in the absence of a market beyond 2020, it is relevant to look to the EU experience to extrapolate information on the effect of a long-term cap in California on long-term carbon reduction investments.

Analysis of the EU Emissions Trading System (EU ETS) performed by Piris-Cabezas and Lubowski (2013) suggests that market actors today are heavily discounting the likelihood of a 2020-2030 emissions cap. Despite plans for a future cap, this policy uncertainty has created investment risk, depressing demand to bank emission reductions and contributing to deflated market prices.[9] Although historical price volatility, primarily in the first trial phase of the EU ETS, should be considered in the context of initial program design challenges (namely the over-allocation of allowances in the initial phases of the program and the inability to bank allowances between the pilot and other phases of the program[10]), the current uncertainty over a longer policy horizon in the wake of economic downturn has greatly hindered stabilization, investment by regulated entities, and the early abatement necessary for the EU to meet its emissions targets.

According to Piris-Cabezas and Lubowski, addressing this uncertainty would create a robust demand for banked allowances beyond 2020. By clarifying compliance requirements through 2030, EU prices would likely stabilize at US$ 23 per ton CO_2 in 2013, rising at 5% annually (given current forecasts for permit supply and emission reduction costs).[11,12] This analysis suggests that firms are applying a "risk premium" to carbon market investments and would be investing in greater emissions reductions if they believed the EU would maintain its current

[7] Lucas Brown, *et al., The EU Emissions Trading Scheme: Results and Lessons Learned*, Environmental Defense Fund, at viii (2012), *available at* http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf.
[8] Wråke, *et al.*at 19.
[9] Piris-Cabezas, at 1.
[10] Brown, *et al.,* at 11, 15.
[11] *Id.*
[12] Piris-Cabezas at 2.

policies.[13] In this scenario, prices would be yet higher if there were policy certainty over even more stringent caps or continuing caps beyond 2030 into 2050.

Although maintaining the integrity of a cap that generates real reductions (rather than produces high allowance prices) is the true intention of cap-and-trade programs, policy certainty does more than produce a high price for carbon credits. Long-term, predictable price signals with banking between phases encourages early reductions, technology research and development, and other long-lived investments that help actors optimize the timing of their abatement strategies and prevent carbon-intensive technology lock-ins.[14] As shown by EUETS modeling, this would allow program administrators to achieve increasingly ambitious climate targets at reasonable costs to both regulated entities and the public.

IV. Linkage and Offsets

In addition to establishing a long-term price horizon, CARB should continue to pursue cost-containment and scaled emission reduction opportunities presented by offsets and linkage.

Offsets enable critical emission reductions in unregulated sectors and those sectors beyond California's jurisdiction, such as shipping and aviation, while simultaneously reducing compliance costs for regulated entities and consumers. CARB should continue to actively address the shortage of available offsets under California's cap-and-trade program through the establishment of new, high quality offset protocols that also deliver economic and environmental co-benefits to the state.

Finally, CARB should continue to pursue cautious yet expeditious linkage with jurisdictions that have adopted comparable rules and regulations. Other jurisdictions should include those with carbon regimes of environmental integrity that lead to a larger, more robust carbon market. Essential elements of linkage with foreign jurisdiction, and the benefits of pursuing such programs (in particular, the RGGI program) were recently outlined by Burtraw in August 2013.[15]

The 2013 Scoping Plan Update should reaffirm the original intention of California's program design that the program become linked or integrated with larger programs. Linkage is critical for achieving scaled emission reductions cost-effectively and should continue to be actively pursued by the state.[16]

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[13] *Id*.
[14] *Id.*
[15] Dallas Burtraw, *et al.*, *Linking By Degrees: Incremental Aligning of Cap-and-Trade Markets*, RFF Discussion Paper, at 13-04 (Apr. 2013), *available at* http://www.rff.org/RFF/Documents/RFF-DP-13-04.pdf.
[16] Lee S. Friedman, *Electricity Pricing and Electrification for Efficient Greenhouse Gas Reductions,* Next 10 and the California Council on Science and Technology, at 2 (July 2, 2013), *available at* http://www.next10.org/sites/next10.huang.radicaldesigns.org/files/FINAL%20Electricity%20Pricing%20Report.pdf.

V. Conclusion

The Executive Order of the Governor issued in 2005 currently mandates California's ambitious 2050 emissions reductions goal. However, such a mandate remains highly politically vulnerable, thereby deterring the investment necessary to reduce emissions beyond the state's short-term 2020 target. In order to address this uncertainty, CARB should begin the process of establishing the expectation that AB 32 programs, including cap and trade, will continue in force and effect to reduce GHG emissions beyond 2020.

The expectation of a future carbon price is essential for influencing today's long-term investments required for low-carbon development. The extension of California's cap-and-trade program beyond 2020 will provide this regulatory certainty and spur the deployment of low-carbon technologies, long-term infrastructure investments, and research and development efforts that will contribute to deeper emissions reductions in the future.

As a global leader in environmental policy and clean technology, California depends on a long-term policy horizon to continue to make smart investments in the low-carbon economy. Accordingly, EDF urges CARB to seize the opportunity presented by the 2013 Scoping Plan Update to extend California's cap-and-trade program, reaffirm the state's commitment to tackling climate change, and secure California's position as the epicenter of the global clean economy.

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Air District	Rule	Date Adopted /Modified	Applicability	Boiler Size	Emission Limit
Bay Area	9.6	Adopted April 1992, last amended November 2007	Natural gas fired boilers and water heaters	Less than or equal to 2,000,000 Btu/hour	NOx: Between 20 and 55 ppmv, depending on size of boiler and date of manufacture
Bay Area	9.7	Adopted April 1992, last amended in May 2011	Industrial, institutional, and commercial boilers, steam generators, and process heaters	Greater than or equal to 2,000,000 Btu/hour	NOx: Between 5 and 40 ppmv depending on size of boiler CO: 400 ppmv
Bay Area	9.10	Adopted January 1994, last amended December 2010	Petroleum refinery boilers, steam generators, and process heaters	Greater than or equal to 2,000,000 Btu/hour (if fired with natural gas or liquid petroleum gas); greater than or equal to 1,000,000 Btu/hour if fired with any other fuel	NOx: 30 ppmv (non-CO boilers); 170 ppmv (CO boilers); for small units (less than 10 million Btu), pick one of three compliance options CO: 400 ppmv
Bay Area	9.11	Adopted February 1994, amended May 2000	Electric power generating steam boilers	Greater than or equal to 250 million Btu/hour	NOx: between 10 and 700 ppmv, depending on size and type of fuel used to fire (gaseous or non-gaseous ppmv (non-gaseous)

Air District	Rule	Date Adopted /Modified	Applicability	Boiler Size	Emission Limit
					CO (greater than or equal to 250 mllion Btu/hour): 1000 ppmv during normal operations; 400 ppmv during steady state compliance source tests
					Ammonia (greater than or equal to 250 million Btu/hour): 10 ppmv
Butte County	250	Adopted March 2004	Industrial, Institutional and Commercial Boilers, Steam Generators and Process Heaters	5 million Btu per hour or more (if less, can be in compliance with rule by following one of four options, including following emission limits)	NO_2: 70 ppmv (gaseous only firing); 115 ppmv (liquid or solid fuel); weighted average for gaseous and non-gaseous co-firing
					NH_3: 20 ppmv unless deemed technically or economically infeasible
					CO: 440 ppmv (gaseous or gaseous-liquid combination); for solid, limits expressed in Permit to Operate conditions
Eastern Kern	425.2	Adopted October 1994; last amended July 1997	Boilers, steam generators or process heaters	5 million Btu per hour or more and fired with gaseous and/or liquid fuels	NOx: 70 ppmv (gaseous); 115 ppmv during normal operation or 150 ppmv during natural gas

Air District	Rule	Date Adopted /Modified	Applicability	Boiler Size	Emission Limit
					curtailment (liquid); if mixed input, use heat input-weighted average (has to have annual heat input rate of 90,000 therms or more)
					CO: 400 ppmv (annual heat input rate of 90,000 therms or more)
Mojave	1157	Adopted October 1994; last amended May 1997	Industrial, institutional, and commercial boilers, steam generators, and process heaters	5 million Btu per hour or more	RACT standards apply unless units are permitted to emit more than 5 tons per day or more than 250 tons per year (then BARCT is applicable)
					NOx (50 million Btu or more): 70 ppmv for RACT, 30 ppmv for BARCT (gaseous); 115 ppmv for RACT, 40 ppmv for BARCT (liquid/solid) NOx (less than 50 million Btu): choose from one of four compliance options
					CO (50 million Btu or more): 400 ppmv (RACT and BARCT) CO (less than 50

Air District	Rule	Date Adopted /Modified	Applicability	Boiler Size	Emission Limit
					million Btu): choose from one of four compliance options
Placer	231	Adopted October 1994, last amended October 1997	Industrial, institutional and commercial boilers, steam generators and process heaters	5 million Btu per hour or more	NOx (annual heat inputs greater than or equal to 90,000 therms): 30 ppmv (gaseous); 40 ppmv (nongaseous fuel); weighted average when mixed; if annual heat inputs are less than 90,000 therms, choose from one of four compliance pathways
Sacramento	411	Adopted February 2005, last amended August 2007 (full compliance required by 2009)	Boilers, steam generators, and process heaters	1 million Btu per hour or greater	NOx: Between 9 and 30 ppmv depending on size and type of boiler (gaseous); 40 ppmv for nongaseous fuel firing; 70 ppmv (biomass firing)
					CO: 400 ppmv
Sacramento	414	Adopted August 1996, amended August 2010	New sales, manufacture or installations of water heaters or process heaters	Less than 1 million Btu	NOx: 15, 20, or 55 ppmv depending on the heat input range and type of heater
					CO: 400 ppmv (only applicable for heat input range of 400,000 to less than 1 million

Air District	Rule	Date Adopted /Modified	Applicability	Boiler Size	Emission Limit
					Btu)
San Diego	69.2	Adopted September 1994	Boilers, process heaters, and steam generators	5 million Btu per hour or greater	NOx for heat input 50 million Btu/hour and annual heat input of 220,000 therms/annual capacity factor 10% or greater: 30 ppmv (gaseous); 40 ppmv (liquid); for heat input less than 50 million Btu/hour and annual heat input 220,000 therms/annual capacity factor less than 10%, choose from one of 4 compliance paths
					CO: 400 ppmv for heat input less than or equal to 50 million Btu/hour and annual heat input of 220,000 therms/greater than 50 million Btu/hour and annual capacity factor 10% or greater
San Diego	69.2.1	Adopted March 25, 2009, Effective March 2010	New boilers, process heaters or steam generators	600,000 Btu per hour to 2 million Btu per hour	NOx: 30 ppmv (gaseous fuel); 40 ppmv (liquid fuel)
					CO: 400 ppmv
San Diego	69.5	Adopted June, 1998; Effective January 1999	Natural gas-fired water heaters	All water heaters that are manufactured, distributed, sold,	NOx: 55 ppmv (home water heater); 70 ppmv (mobile home water

Air District	Rule	Date Adopted /Modified	Applicability	Boiler Size	Emission Limit
				offered for sale, or newly installed	heaters)
San Joaquin	4305	Adopted December 1993; Last amended August 2003	Gaseous or liquid fired boilers, steam generators, and process heaters	Greater than 5 million Btu per hour	NOx: 147 ppmv for box or cabin type units, and vertical cylindrical process heaters, 30 ppmv for all other units (gaseous); 155 ppmv for box or cabin type units and vertical cylindrical process heaters, 40 ppmv for all other units (liquid fuel); weighted average if combination
					CO: 400 ppmv
					For units with annual heat input less than 30 billion Btu or replacement standby units with annual heat input less than 90 billion Btu picks one of three compliance pathways
San Joaquin	4306	Adopted September 2003; Last amended October 2008	Gaseous or liquid fuel fired boilers, steam generators, or process heaters	Greater than 5 million Btu/hour	NOx: 6 ppmv and 30 ppmv depending on heat input, standard or enhanced option, and type of boiler (gaseous); 40 ppmv

Air District	Rule	Date Adopted /Modified	Applicability	Boiler Size	Emission Limit
					(liquid) type of unit (gaseous fuel); 40 ppmv (liquid fuel); weighted average for fuel mix
					CO: 400 ppmv
San Joaquin	4307	Adopted December 2005; Last amended May 2011	Gaseous or liquid fuel fired boiler, steam generator, or process heater	2 million Btu/hour up to and including 5 million Btu/hour	NOx: 30 ppmv (gaseous); 40 ppmv (liquid)
					CO: 400 ppmv
San Joaquin	4308	Adopted October 2005; Last amended December 2009	Boilers, steam generators, process heaters, and water heaters	75,000 Btu/hour to less than 2 million Btu/hour	NOx: 20 or 55 ppmv depending on the type of unit (PUC gas); 30 or 77 ppmv depending on the type of unit (non-PUC gas or liquid)
					CO: 400 ppmv
San Joaquin	4320	Adopted October 2008	Advanced emission reduction options for boilers, steam generators, and process heaters	Greater than 5 million Btu/hour	NOx: Between 5 and 12 ppmv, depending on the facility category and schedule of compliance
					CO: 400 ppmv
San Luis Obispo	428	Adopted July 1995	Sale or installation of natural gas-fired residential water heat or fan-type central furnace	Rated heat input capacity of less than 175,000 Btu/hour or rated cooling capacity of less than 65,000 Btu/hour	NOx: 55 ppmv

Air District	Rule	Date Adopted /Modified	Applicability	Boiler Size	Emission Limit
San Luis Obispo	429	Adopted November 1993; Last amended November 1997	Electric power generation boilers	All boilers	NOx: 2.50 tons per day from all boilers combined
					CO: 1000 ppmv (boilers above 1500 mmBtu/hour)
					Ammonia: 10 ppmv
San Luis Obispo	430	Adopted July 1995	Industrial, institutional, and commercial boilers, steam generators, and process heaters	Greater than or equal to 5 million Btu/hour	NOx if annual heat input is greater than or equal to 90,000 therms: 30 ppmv (gaseous fuel); 40 ppmv (nongaseous fuel) If annual heat input is less than 90,000 therms, follow one of four compliance pathways
Santa Barbara	360	Adopted October 2002	New water heaters, boilers, steam generators or process heaters	75,000 Btu up to and including 2,000,000 Btu	NOx: 55 ppmv (if less than or equal to 400,000 Btu/hour); 30 ppmv (if less than or equal to 2,000,000 Btu/hour)
Santa Barbara	361	Adopted January 2008	Small boilers, steam generators, and process heaters	Greater than 2,000,000 Btu and less than 5,000,000 Btu	NOx: 30 ppmv
					CO: 400 ppmv

Air District	Rule	Date Adopted /Modified	Applicability	Boiler Size	Emission Limit
Santa Barbara	342	Adopted March 1992; Last amended April 1997	Industrial, institutional, and commercial boilers, steam generators, and process heaters	Greater than or equal to 5,000,000 Btu/hour	NOx: 30 ppmv (gaseous fuel); 40 ppmv (nongaseous) or weighted average for combination If permitted annual heat inputs of less than 9 billion Btus and greater than or equal to 5 million Btus, can follow one of four compliance pathways
					CO: 400 ppmv
Shasta	3-26	Adopted June 1995; Last amended December 1995	Industrial, institutional, and commercial boilers, steam generators, and process heaters	All boilers	NOx: 70 ppmv (gaseous); 115 ppmv (liquid or solid fuel); weighted average if combination; if less than 5 million Btus, follow one of four compliance pathways
South Coast	1146	Adopted September 1988; Last amended September 2008	Industrial, institutional, and commercial boilers, steam generators, and process heaters	5 million Btu or greater	NOx: Between 12 and 40 ppmv, depending on type of boiler
					CO: 400 ppmv
South Coast	1146.1	Adopted October 1990; Last amended September 2008	Small industrial, institutional, and commercial boilers, steam generators, and process heaters	Greater than 2 million Btu/hour and less than 5 million Btu/hour	NOx: Between 9 and 25 ppmv (depending on type of unit)

Air District	Rule	Date Adopted /Modified	Applicability	Boiler Size	Emission Limit
South Coast	1146.2	Adopted January 1998; Amended May 2006	Natural gas fired later water heaters and small boilers and process heaters	Less than or equal to 2,000,000 Btu/hour	NOx: 20 ppmv
Tehama	4:31	Adopted March 1995; Amended January 2002	Industrial, institutional, and commercial boilers, steam generators, and process heaters	Greater than or equal to 5,000,000 Btu/hour (if less, choose one of four compliance options)	NOx: 70 ppmv (gaseous); 115 ppmv (liquid or solid fuel); weighted average for combination
					CO: 400 ppmv (gaseous or combination of gaseous and liquid fuels); limits expressed in permit to operate conditions for solid fuel-fired units
Ventura	74.11.1	Adopted September 1999	Sale or installation of new water heater, boilers, steam generators, or process heaters	Greater than or equal to 75,000 Btu/hour and less than 2,000,000 Btu/hour	NOx: 55 ppmv (rated heat input capacity less than or equal to 400,000 Btu/hour); 30 ppmv (rated heat capacity greater than 400,000 Btu/hour and less than 2,000,000 Btu/hour)
					CO: 400 ppmv
Ventura	74.15.1	Adopted May 1993; Last amended September 2012	Boilers, steam generators and process heaters	Greater than or equal to 1 million Btu/hour and less than 5 million	NOx: 30 ppmv

Air District	Rule	Date Adopted /Modified	Applicability	Boiler Size	Emission Limit
				Btu/hour	CO: 400 ppmv
Ventura	74.15	Adopted March 1989; Last amended November 1994	Industrial, institutional and commercial operation boilers, steam generators, and process heaters	Greater than or equal to 5 million Btu/hour and annual heat input rate equal to or greater than 9 x 10^9 BTU/year (if lower heat input, choose from four compliance pathways)	NOx: 40 ppmv
					CO: 400 ppmv

ENVIRONMENTAL DEFENSE FUND: 2013 SCOPING PLAN UPDATE
Appendix B: Smart Moves, Creative Supply Chain Strategies Are Cutting Transport Costs and Emissions

August 2013

See attached beginning at next page

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Smart Moves

Creative Supply Chain Strategies Are Cutting Transport Costs and Emissions

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Creative Supply Chain Strategies Are Cutting Transport Costs and Emissions

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Environmental Defense Fund
Environmental Defense Fund is dedicated to protecting the environmental rights of all people, including the right to clean air, clean water, healthy food and flourishing ecosystems. Guided by science, we work to create practical solutions that win lasting political, economic and social support because they are nonpartisan, cost-effective and fair.

Photos: iStock

The complete report is available online at edf.org/smartmoves.

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Introduction

Thanks to persistently high diesel costs, along with corporate commitments to improve supply chain sustainability and curtail heat-trapping carbon emissions, commercial shippers across the United States are devising innovative and increasingly creative new strategies to move goods more efficiently, at lower cost, and with smaller environmental footprints.

These solutions go beyond asking carriers to make improvements such as reducing vehicle speeds or improving aerodynamics. They involve actions directly under the control of the shippers. These solutions are being unlocked with unconventional thinking, and by breaking down traditional silos both between and within companies. Those that are willing and able to look beyond the usual tools are racking up big savings as a result.

The global flow of goods provides society with a greater selection of products at lower prices than ever before. But they represent significant cost centers for shippers faced with high oil prices and lean margins. Moving freight also carries a significant environmental footprint, one that increasingly runs counter to shippers' public environmental and sustainability goals.

All told, the global freight transportation and distribution system accounts for nearly three billion metric tons of heat-trapping carbon emissions each year.[1] That's equal to over 700 coal plants[2] or the combined total global warming pollution from Japan, Germany, Canada and Mexico.[3] Transportation accounts for 89 percent of the environmental footprint of supply chain logistics; warehousing and distribution take up the remaining 11 percent.[4]

Global freight emissions are growing rapidly as a result of increased demands for goods and services. In the United States alone, emissions from freight are projected to increase 74 percent from 2005 to 2035.[5] China is expected to increase its use of freight transportation fuels by more than 320 percent from 2008 to 2035.[6]

The surge in the movement of goods presents major challenges for efforts to avert climate destabilization and threatens widespread harm to public health from tailpipe emissions.[7] Growing volumes will also require further capital investment and increase demand for the world's limited supply of fossil fuels. Thus, costs could continue to rise.

By following the examples of leading shippers, we can create a future where freight transport remains affordable, results in less carbon pollution and minimizes the threat to public health. Shippers—companies that utilize logistics services to move products but are not primarily in the freight business—have the most to gain from an increasingly carbon- and cost-efficient freight system for three reasons:

- **Profitability:** Shippers can reap the greatest financial rewards from increasing the efficiency of their logistics operations
- **Reputation management:** Since these companies interface directly with consumers, they stand to gain the most from being viewed as good environmental stewards
- **Market leverage:** Shippers dictate business trends in the goods movement marketplace; if they demand greater efficiency and better environmental performance, carriers and other logistics service providers will respond

Creative thinking means lower costs, less pollution

Initiatives are already being implemented by leading shippers today to reduce costs and improve carbon efficiency. Our goal in sharing these case studies is to help companies everywhere benefit from these solutions pioneered by industry leaders and their transport providers.

By showcasing these stories together, we demonstrate the range of opportunities available for shippers to improve freight carbon efficiency and reduce costs. Collectively, these steps can enable shippers to pursue a bold freight strategy that will produce tangible economic and environmental results.

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First, we look at companies that have been able to shift cargo to more carbon-efficient modes of transportation. We also look at changing inventory management practices, which will enable shippers to further transition to more carbon- and cost-efficient alternatives.

Next, we highlight shippers optimizing their distribution networks to cut carbon and costs. For example, several companies have made specific changes to reduce overall miles traveled. Others have leveraged partnerships—sometimes even with direct competitors – to increase efficiencies through collaborative distribution projects.

From there, we examine companies that are rethinking the goods and packaging that make up each shipment, or changing the mix of products to optimize for space and weight in order to eliminate capacity that often goes to waste.

Finally, as nearly all goods flow through warehouses and distribution centers, we look at companies that have significantly cut energy consumption by making changes to their lighting and heating systems.

Ultimately, shippers are a critical link in determining the success of collective efforts to reduce harmful freight emissions. With the steps outlined in this report, shippers can get started on this vital opportunity today.

Modes and management: picking the right tools for the job

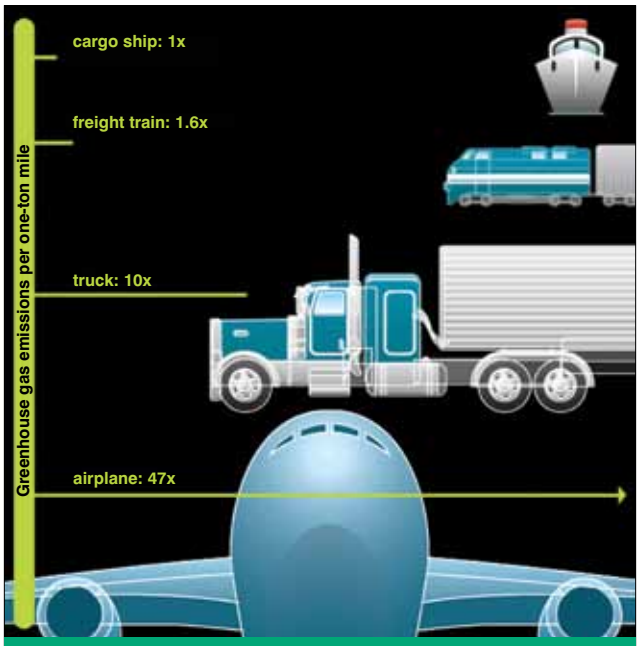
Rising fuel prices have pushed shippers to re-examine long standing practices and assumptions about transportation mode choices. The process, while difficult, has led to impressive results. Shippers are more discerning about expediting freight. They have invented solutions for more efficient modes to fit within the constraints of the "just-in-time" inventory model. Many shippers and their service providers also have adopted new inventory management models that increase flexibility. These developments are good news from a cost and carbon perspective.

For transportation mode options, air and ocean freight are the predominant choices for intercontinental transport. Freight trucks, rail and barges are the most common choices for domestic transport. Planes emit 47 times more carbon per ton mile than container ships; trucks emit six times more carbon per ton mile than trains.[8] The more carbon intensive modes typically cost more as well.

Nike led the way in differentiating cargo that needed to be expedited from cargo that could travel on the water. Prior to 2003, Nike often sent its goods via air freight from Asia, where most of its products are manufactured, to North America, where many are sold. As a result, inbound logistics—the movement of product from manufacturing facilities to distribution centers—were the second leading source of emissions, behind only manufacturing. Since 2003, Nike has taken action to reduce its inbound footprint. The company has been using air freight more sparingly and sending an increasing amount of its cargo by ocean freight.

Nike saved over $8 million in 2009 alone while also reducing its emissions per product moved by four percent with these changes.[9] On an absolute basis, it was able to limit growth in its carbon emissions from inbound logistics to 14 percent while increasing revenues by 70 percent. Encouraged by its initial success, Nike set an ambitious goal to reduce carbon emissions from inbound logistics by 30 percent from 2003 to 2020.

Computer giant **HP** also found savings in switching from air



The choice of transportation mode matters. Air freight is 47 times more carbon-intensive than ocean cargo. Trucking is more than 6 times more carbon intensive than rail.

Christine Daniloff/MIT News

Each ocean container can hold a large amount of goods – up to 70,000 T-shirts. Some of the newest cargo ships can hold up to 18,000 containers.

freight to ocean freight while still meeting time and inventory carrying cost pressures. The company changed most shipments of its Visual Collaboration studio—a TelePresence conferencing system—to ocean freight. This resulted in a savings of $7,000 and nearly 900 tons of carbon per shipment.[10]

Moving from air freight to ocean freight has even been possible in the world of high-fashion, among the most time sensitive industries on the planet. **Michael Kors**, a leading designer for high-end handbags, utilized an innovative ocean freight service through OceanGuaranteed, a joint service provided by **APL Logistics** and **Con-Way Freight**.

Ocean containers can hold a large amount of goods – up to 70,000 T-shirts[11] or 28,000 Barbie dolls.[12] Since the volume of handbags was significantly less than the size of a typical container, Michael Kors needed a service that matched loads into full containers. This "less than container load" (LCL) approach historically added transit time. Unlike a full container, which can be transported directly from the destination port to a distribution center, goods traveling via LCL traditionally need to be re-sorted upon arrival before they could be transported to their final destination via "less than truckload" (LTL) freight. Through their partnership, APL Logistics and Con-Way offered the designer a single-source option for LCL and LTL needs. The strategy helped the designer reduce the transit time by 30 percent compared to standard LCL shipments. This change also reduced carbon emissions and freight costs by $20 per bag.[13]

"The savings and sustainability benefits of inter-modal were too big to pass up. Once we had converted long-haul inbound movements, we knew we needed to try outbound moves, as well."

Tom Sangalli, Logistics and Transportation Director for The Container Store.

Intermodal transportation

Many shippers also are utilizing rail to reduce freight costs and emissions. Intermodal ground transportation—where a container is moved a long distance by rail and then delivered to its final destination by truck—allows shippers to maximize the efficiency of rail while still leveraging the flexibility of trucks. The result can be large carbon and cost savings.[14] Two of the leaders adopting intermodal are Baxter and Levi's.

Baxter, a global medical products and services company, believes intermodal transport represents a significant opportunity to cut carbon and costs. The company increased the share of U.S. shipments using intermodal transport by more than 30 percent from 2005 to 2010. By taking this action, Baxter reduced greenhouse gas (GHG) emissions by 14,000 metric tons in 2010 compared to 2005.[15]

Intermodal is a solution that is here today and has great potential for cost and carbon savings. If just 10 percent of truck shipments shifted to utilizing an intermodal strategy, one billion gallons of fuel can be saved in the United States, reducing carbon pollution by more than 13 million metric tons every year.

Levi's switched to intermodal transportation and cut carbon emissions by 60 percent in some shipping lanes. The company is currently exploring opportunities to increase intermodal transport elsewhere.[16]

Many companies have been using intermodal to deliver some of their inbound freight. **The Container Store** led the way in demonstrating that intermodal can be used for outbound transport, from distribution center to retail facility, as well.

The company had already been using intermodal freight though inbound logistics. In 2009, it partnered with **Burlington Northern Santa Fe Railway** and **J.B. Hunt Transport Services** to move inbound cargo from the west coast of the United States to Texas. A year later, the three companies decided to incorporate outbound moves.[17]

There were some initial challenges that needed to be addressed. One of the top priorities was to transport deliveries to stores within the 15-minute window required by The Container Store. To help solve this issue, J.B. Hunt gave cargo heading to the stores a priority status recognized by the drayage drivers.[18]

The endeavor was such a success that The Container Store now services nearly a third of its stores via intermodal, with stores averaging three deliveries a week. It has resulted in expected cost savings of $300,000[19] while also reducing carbon impact of transporting goods to these stores by 41 percent.[20]

"The savings and sustainability benefits of intermodal were too big to pass up," said Tom Sangalli, Logistics and Transportation Director for The Container Store. "Once we had converted long-haul inbound movements, we knew we needed to try outbound moves, as well."[21]

Intermodal is a solution that is here today and has great potential for cost and carbon savings. If just 10 percent of truck shipments shifted to utilizing an intermodal strategy, one billion gallons of fuel could be saved in the United States, reducing carbon pollution by more than 13 million metric tons every year.[22]

Inventory management

Pressure to keep inventory levels low is one of the greatest barriers to increased utilization of more carbon-efficient modes. The cost of financing inventory is a major expense. It also requires

Intermodal ground transportation allows shippers to maximize the efficiency of rail, while still leveraging the flexibility of trucks.

resources to store and manage inventory. Inventory can quickly become obsolete because of changing consumer tastes or the introduction of a new product by a competitor.

Shippers actively work to keep inventory levels lean. For goods with a short lifecycle, such as fashion apparel and consumer electronics, many companies are unwilling to commit to the eight weeks of additional inventory that is needed to utilize ocean freight.[23]

Another challenge is that expensive or capital-intensive goods are also often expedited in efforts to minimize the amount of costly inventory that needs to be carried on the books.

Warehousing, of course, involves carbon considerations too. Holding inventory requires warehouses, which consume energy. Unsold products may be shipped back to their origin or to a third party and consume more fuel in the process. Outdated or perishable products may be simply destroyed, negating any benefit from the resources invested or the carbon emitted.

Many companies are using new approaches to meet inventory benchmarks while still capturing the carbon and cost benefits of more efficient modes.

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D.W. Morgan, a transportation and logistics provider, partnered with a client to change how a key product was transported. The client company imported a large, capital-intensive product to the United States from Asia, while also trying to minimize inventory. Using air freight to transport goods from Asia to the United States was the answer. However, this resulted in high transportation costs and emissions.

D. W. Morgan offered a solution. It would act as a value-added reseller.[24] Upon picking up product at the manufacturing facility in Asia, D.W. Morgan took title to the shipment, arranging for transportation to its U.S. facilities using ocean container shipping instead of air. The client arranged for delivery, only as needed, from D. W. Morgan's U.S. fulfillment center. By doing so, the client did not take ownership of the product until it was delivered to its door. This way it was able to keep the cost of inventory off its books, while the carbon and cost impacts of transporting goods were significantly reduced.

Another tool for inventory management is to postpone the final assembly of products until they are closer to the end consumer, as opposed to being done by the manufacturer. This practice improves efficiency by delaying the assembly of bulky products, thereby optimizing container use. Inventory levels are also reduced by enabling mass customization at the distribution center.

Kenco, a logistics service provider, serves as a useful case study. The company worked with a manufacturer in the kitchen and bath industry to develop and implement a process where semi-finished goods were kitted—customized to meet customers' requirements—at the regional distribution facility. Previously, assembly occurred at the manufacturing facility. The change allowed the manufacturer "to ship the product's components individually, maximizing trailer cube capacity, and thus saving on freight costs." In total, Kenco states its client was able to cut its inbound freight costs nearly in half.[25]

Similarly, **Bang & Olufsen**, the Danish luxury video and audio maker, follows a postponement strategy. This customized approach allows the company to "configure products to customers' specific demands for features, color and size without having to build large stocks of configurations that may not be used," thus transport less overall inventory.[26]

Optimizing the transportation network

An industry report recently found that collaborative supply chain logistics have the potential to slash costs by more than 30 percent and increase carbon efficiency by 25 percent.

Working in partnership with other companies—even competitors—to increase the efficiency of distribution systems can improve the bottom line and reduce carbon emissions. Collaboration enables greater use of assets, from trucks to warehouses, resulting in economies of scale that lower costs.[27]

Cooperating with other shippers in warehouse and distribution operations can produce significant savings. An industry report recently found that collaborative supply chain logistics have the potential to slash costs by more than 30 percent and increase carbon efficiency by 25 percent.[28]

Under a collaborative distribution arrangement, companies in the same or similar industries share warehouse and distribution assets. Because the products from the participating companies are going to the same destinations, this arrangement enables more efficient loading of trucks and more frequent deliveries. A third party logistics firm is typically involved in these arrangements and ensures security of proprietary data and fair treatment of the products for all participating companies.

Companies participating in collaborative distribution arrangements today include **Best Buy**, **Sun-Maid Growers**, **Just Born** and **The Topps Company, Inc.**[29]

In the fall of 2011, competing candy makers **Hershey's** and **Ferrero**, the maker of Tic Tac and Nutella, announced plans to collaborate on warehousing, transportation and distribution in

By coordinating with other shippers, companies sometimes can send more goods per truck trip.

North America. When announcing the collaboration, the companies highlighted the cost- and emissions-reduction benefits of the deal.[30,31]

Back-haul matching

Macy's and trucking company **Schneider National** demonstrated the value of reducing empty backhauls through Empty Miles Service, an online service provided by the Voluntary Inter-industry Commerce Solutions Association (VICS). This program helps participating companies expand their network of others wanting to identify matches for their empty backhauls.[32] In the pilot project, Macy's and Schneider found an average annual savings of $25,000 per lane and were able to reduce per-lane carbon emissions by 150 tons.[33] Given that Macy's operates over eight hundred stores[34] and likely even more lanes—a regular route on which a company moves goods—the potential savings of this program are enormous.

Direct shipment

Walmart and **Minute Maid** worked together to cut the number of trips and product miles traveled to transport Minute Maid's Simply Orange Juice to Walmart distribution centers. Previously, the product was sent from a production facility in Florida to Minute Maid warehouses in Texas, Michigan, Florida or California, then to Walmart distribution centers. The companies estimate that this change will reduce 1,500 metric tons of CO_2 emissions annually and, even more critically, add six days to the shelf life for the product.[35]

Record high oil prices and volatility over the past several years have led several companies to modify their distribution networks in order to cut fuel costs.

Co-loading freight

Dal-Tile Corporation, the largest U.S. manufacturer of ceramic tile, recently increased container utilization rates by finding freight from other companies that could be loaded atop their floor tiles. Because floor tiles are heavy, Dal-Tile previously was unable to use the full cubic space of the trailers they were shipping from Mexico to distribution centers in the U.S. Lighter freight from other companies enabled Dal-Tile and its partners to cut transportation costs up to 15 percent per load.[36]

Finding the right partner, of course, does take work. The Director of Transportation for Dal-Tile offered the following advice: Look for companies that have "similar lanes and have similar service requirements" and try to match products of similar value.

Network design

The design of a company's distribution network is influenced by many factors, including proximity to consumers, access to transportation modes, and inventory requirements. Distribution networks strive to deliver goods accurately and on time while minimizing costs. Record high oil prices and volatility over the past several years have led several companies to modify their distribution networks in order to cut fuel costs. These changes also reduce pollution and increase carbon efficiency.

Researchers at the University of Nevada, Reno modeled the optimal distribution network of a U.S.-based furniture manufacturer at different price points for diesel fuel. They found that the optimal number of facilities increased from seven to 10 when the price of diesel jumped from $2.50 to $3.50 per gallon. The change was a function of the increasing cost of long-distance transportation overtaking the cost of adding new facilities to the network.[37]

Another U.S.-based company was the focus of a separate study by David Simchi-Levi of the Massachusetts Institute of Technology (MIT).[38] Simichi-Levi found that when oil went from $75 to $200 per barrel, the optimal number of distribution centers for the company increased

from five to seven. While the distribution centers on the eastern half of the United States were largely unaffected, Simichi-Levi recommended replacing a center in Las Vegas with three separate facilities in Los Angeles, Albuquerque and Portland.

Independent Purchasing Cooperative, a purchasing cooperative for **Subway** franchises, recently modified its network. One of the company's salad packaging suppliers was moved from a facility in West Virginia to Texas—closer to the redistribution center. This move cut the supplier's annual transportation by more than one million miles, eliminated 2,000 metric tons of GHG emissions and reduced supply chain costs.[39]

Another component of a network redesign strategy is to locate manufacturing facilities closer to end customers, a practice sometimes known as near-shore manufacturing.

Alcatel-Lucent, a leader in communications technologies, established a goal to reduce its carbon footprint 50 percent by 2020. The company recognized the need to improve the carbon efficiency of its logistics operations as a key strategy to meet its carbon goal. The company decided that one way to do so was by "making products closer to customers."[40] In the past, Alcatel-Lucent's optical networking terminals destined for the North American market were manufactured in Asia. Now, these products are produced in Mexico, eliminating the need for air shipment and allowing faster order fulfillment."[41]

Getting the most out of each move

No matter what the mode of transport, companies can move goods most efficiently by maximizing the cargo capacity on each trailer, railcar or shipping container. While this simple proposition seems self-evident, competing demands of "just-in-time" inventory, smaller order sizes and rush deliveries mean it's easier said than done. More than a quarter of tractor trailers on U.S. highways are running empty.[42]

To date, Stonyfield Farm has cut costs by $7.5 million and reduced its net emissions 46 percent while still growing its business.

Stonyfield Farm undertook an extensive effort starting in 2006 to improve the environmental performance of its transportation and distribution network. To date, the company has cut costs by $7.5 million and reduced its net emissions 46 percent while still growing its business.[43] Network changes,[44] mode shifts[45] and asset utilization are all part of the comprehensive strategy.

As a first step, Stonyfield created new polices for lead times and minimum order size, and improved its ordering process to ensure its shipping containers were as full as possible.[46] It also began specifying that carriers use 53-foot trailers. The longer trailers allowed for pallets to be side loaded or "pinwheeled"—rotated 90 degrees from the standard—to create room for a minimum of 26 pallets.[47] The company also worked with its clients to redesign their pallets to lessen the need for dunnage – a form of protective packaging – to further maximize available space per trailer.

Similarly, **Kraft Foods** realized that trailer weight and space capacity were being underutilized in its Vendor Managed Inventory (VMI) system. For instance, due to the variety of products either cubing-out (reaching the trailer volume limit) or weighing-out (reaching

More than a quarter of tractor trailers on U.S. highways are running empty. Maximizing the cargo capacity is an easy way to move goods more efficiently.

Cisco Systems, which outsources most of its manufacturing and relies heavily on air freight, says it has saved more than $24 million a year from packaging improvements.

the truck weight limit) trailers, Kraft's refrigerated outbound shipments were averaging only 82 percent of the weight capacity. To address the problem, Kraft teamed up with **Transportation/ Warehouse Optimization**, a purveyor of software designed to enhance efficiency.

The AutoVLB software, also known as "Super Truck," converts demand into optimized orders to maximize truck usage without damaging products. As a result of this partnership, Kraft cut 6.2 million truck miles and reduced truckload costs by four percent.[48]

SC Johnson, a leading manufacturer of household cleaning products, launched its "Truckload Utilization Project" in 2007. The company says the project has reduced annual fuel consumption of its fleet by more than 160,000 gallons[49]—more than $500,000 at current diesel prices. This was accomplished by combining orders, reducing the use of heavier sleeper cabs and restructuring incentives for its customers.

SC Johnson also found it could improve truck utilization by combining different weights and sizes of various products. For example, the company combined its Ziploc brand products, which are light but require a significant among of truck space, with its heavier Windex glass cleaner to better utilize all the space in the trailer.

Packaging design significantly impacts container utilization rates. There are three levels of product packaging,[50] each offering opportunities to enable better container utilization:

- **Individual packaging:** Many products, such as light-bulbs, are individually packaged until consumption by the end-user
- **Group packaging:** Groups of products, such as canned goods, are also packaged for handling or in-store stocking
- **Storage and distribution packaging:** Cases of product are packaged together for storage and distribution too, such as a pallet of copy paper cases

Many factors go into product design, including optimization for transport. Take, for example, liquid laundry detergents. By removing water and creating a more concentrated product, manufacturers such as **Method**, are able to ship an equivalent amount of detergent in reduced sizes. This means more products per truck and less material for packaging.

Smart packaging methods can also result in fewer damaged products. This provides a secondary cost reduction with the lessening of damaged inventory. As damaged inventory

leads to returned products, it's important that packaging modifications consider this impact. Returns are a major logistical challenge that also has emissions implications. In 2009, $186 billion worth of merchandise was returned, accounting for eight percent of all sales.[51]

IKEA, the global home products company, implemented a broad campaign to redesign its product packaging. One early project that demonstrates the opportunity for design improvements involved the GLIMMA tealight candle, a high-volume item whose packaging contained large amounts of air and unused space.[52]

The new packaging, which required new sorting and packing machinery, increased the number of 100-pack tealights that fit in a standard European pallet by more than 40 percent. This meant fewer truck trips, which yielded carbon reductions of 21 percent.[53] The new packaging also increased efficiency by allowing for faster unpacking in stores.

Cisco Systems, which outsources most of its manufacturing and relies heavily on air freight, says it has saved more than $24 million a year from packaging improvements.[54] The company eliminated paper documentation and user guides, and placed the information on a compact disc or summary card with a link to web-based guidance. This change allowed three IP phones to fit in the same shipping space previously occupied by two phones.[55]

Cisco also identified opportunities to save materials and labor by reconfiguring product packaging for its TelePresence videoconferencing systems. With these packaging changes, nine TelePresence units now fit in each truck instead of two under the previous system. Each unit is now placed in stackable cartons, reducing the number of cartons needed per unit from 83 to nine.[56] The change has resulted in significantly lower emissions.

Minimizing transportation-related emissions is just one facet of the overall environmental impact of packaging. While transportation impact is the focus of this discussion, companies undertaking packaging changes should consider other factors too, including toxicity and use of recycled materials.[57]

Increasing energy efficiency: warehouses and distribution centers

In the journey from their point of origin to final destination, nearly all goods move through a distribution center. These vital links account for 11 percent of the carbon footprint of total goods movement.[58] Heating and lighting alone consume more than 70 percent of the energy used in warehouse operations.[59] Thus, these facilities are natural targets for efficiency gains.

Heating and lighting alone consume more than 70 percent of the energy used in warehouse operations.

Each year, dozens of companies participate in EDF Climate Corps, which places specially trained MBA and MPA students in companies, cities and universities to build the business case for energy efficiency. Several EDF Climate Corps fellows have found significant energy and cost reductions at distribution centers.

An EDF Climate Corps fellow at a leading athletic apparel company found that the biggest opportunity was a surprisingly easy fix: optimize the "sleep settings" on the conveyor motor controls. By programming the 1,200 conveyor motors to turn off in periods of inactivity, the company could avoid over 1,400 metric tons of carbon emissions a year, reduce noise levels, and cut its electricity bill by over $140,000. Best of all, outside in-house programming time, there would be no upfront cost to achieve these savings.

An EDF Climate Corps fellow that looked into a distribution center for another company suggested three lighting changes. These changes targeted the facility's parking lot, a temporary

Warehouses and Distribution Centers account for 11 percent of the carbon footprint of total global goods movement.

storage area and an annex for bulky goods. One recommendation was to switch the 400-watt metal halide lighting to more efficient fluorescent lamps. Motion sensors were suggested for the seldom-used temporal storage areas. And 250-watt high pressure sodium fixtures were replaced with 170-watt bulbs in parking lots.

US Foods also found significant savings by increasing energy efficiency in its distribution centers. As part of the Green Portfolio Program between EDF and **Kohlberg Kravis Roberts & Co.**, US Foods improved efficiency by 13 percent against a 2008 baseline. These improvements in efficiency helped US Foods to avoid approximately $9.3 million in electricity costs and approximately 73,000 metric tons of carbon emissions since 2008.[60]

US Foods also invested in cascade refrigeration systems, which use carbon dioxide as a refrigeration fluid in place of ammonia, and reduces environmental impact while increasing energy efficiency. The company also utilized high efficiency heating, ventilation and air conditioning (HVAC) systems, and replaced traditional high intensity lighting with energy efficient, and often sensor based, lighting in distribution facilities.

A warehouse owned by **Kaiser Compressors, Inc.** qualified for the EPA Energy Star labeling program as a result of several efficiency improvements. In addition to significant lighting improvements, the company improved its HVAC system. Kaiser reconfigured the control system for its HVAC systems to limit system operations on nights and weekends. The company has reduced the cooling demand from the building by installing a white Thermoplastic Olefin (TPO) roof. TPO roofs reflect sunlight as opposed to standard black roofs, which absorb heat.

Another innovation used by Kaiser to cut HVAC costs was installing an underfloor air distribution system. This system supplies warmer air than a traditional system, which reduces heating costs. It is also 30 percent more efficient than a traditional overhead variable air volume (VAV) system.[61]

Conclusions

This report shows how shippers exercise significant control over the environmental footprint of logistics operations. Their decisions on where products are made and stored, how they are designed and packaged, and how much time is allotted for transit have a tremendous impact on carbon efficiency. By leveraging the available strategies, including mode matching, container utilization, collaborative distribution, and network redesign, shippers can put us on a more sustainable path where we aren't forced trade off human health for the expeditious flow of goods. As these strategies lead to reduced costs, companies can do well by going good.

There are, of course, challenges to improve freight carbon efficiency. Orders sometimes must be rushed to facilitate promotions or changes in demand. The cost of capital and rapid rate of obsolescence prohibit some goods from using more carbon-efficient, but in some cases slower, modes of transportation. Working in collaboration requires dedicated staff and software. Companies have reasonable concerns about protecting proprietary data. Still, leaders are finding solutions to these challenges.

Given the magnitude of the changes required, the urgent need to cut fuel consumption and carbon pollution, and the complexity of the freight industry, all parties need to work together to increase efficiency and share information on sustainability advancements.

At Environmental Defense Fund, we believe these successes can be shared by all shippers and encourage companies to adopt the practices discussed in this report. We also want to hear from shippers about challenges they face in implementing these solutions. This list of actions is by no means comprehensive, and we look forward to hearing about other innovative approaches that are enabling cost and carbon reductions.

The stakes are high. The freight system is one of the world's largest sources of harmful pollution, including emissions of heat-trapping gases. To fully transform the system, other stakeholders such as carriers and governments will need to act as well. But shippers can lead the way to a more sustainable freight system and reap significant cost savings. In the process, they will make a profound and lasting difference in the effort to deliver a stable climate to our children and grandchildren.

Notes

[1] Doherty et al, "Supply Chain Decarbonization—The Role of Logistics and Transport in Reducing Supply Chain Carbon Emissions," World Economic Forum, 2009 https://members.weforum.org/pdf/ip/SupplyChainDecarbonization.pdf

[2] U.S. Environmental Protection Agency, Greenhouse Gas Equivalencies Calculator, May 2011. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results (accessed February 2, 2012)

[3] Mark McCormick and Paul Scruton, "Country emissions data from Carbon Emissions World Map in 2009," *The Guardian*, February 2011. http://image.guardian.co.uk/sys-files/Guardian/documents/2011/02/10/CarbonWeb.pdf

[4] David Simchi-Levi, Operations Rule. The MIT Press, 2011. http://www.operationsrules.com/

[5] Cristiano Façanha and Jeff Ang-Olson, "Policies to Reduce Greenhouse Gas Emissions Associated with Freight Movements," ICF International. http://www.fhwa.dot.gov/policy/otps/innovation/issue1/policies.htm (accessed 10/19/2011)

[6] "International Energy Outlook 2011," Energy Information Administration, DOE/EIA-0484, September 19, 2011. http://205.254.135.24/oiaf/ieo/transportation.html

[7] Matsuoka et al, Global Trade Impacts: Addressing the Health, Social, and Environmental Consequences of Moving International Freight Through Our Communities, Occidental College and University of Southern California, February 2011. http://hydra.usc.edu/scehsc/web/Resources/Reports%20and%20Publications/Resources-%20Reports%20and%20Publications.html

[8] Peter Dizikes, "The Six-percent Solution," *MIT News* November 8, 2010. http://web.mit.edu/newsoffice/2010/corporate-greenhouse-gas-1108.html

[9] "Corporate Responsibility Report FY 07 08 09," NIKE, INC http://www.nikebiz.com/crreport/content/pdf/documents/en-US/full-report.pdf (accessed September 1, 2011)

[10] HP, Global Citizenship Report, Environmental, Energy and Climate, Product Transport. http://www.hp.com/hpinfo/globalcitizenship/environment/transport.html (accessed November 30, 2011)

[11] The Economist, *Economies of scale made steel: The economics of very big ships*, Nov 12th 2011. http://www.economist.com/node/21538156 (accessed February 2, 2012)

[12] Kindberg, Lee, *Carbon Footprint of Supply Chain Transportation & Shipping*, Maersk Inc, April 2008. http://www.gsb.stanford.edu/ser/documents/SER08-Maersk.pdf (accessed February 2012)

[13] Kevin Jones, National Sales Manager, APL Logistics, Personal correspondence with EDF, January 2012.

[14] Perry A. Trunick, "Green on The Ground," Inbound Logistics, June 2011. http://www.inboundlogistics.com/cms/article/green-on-the-ground/#sidebar1

[15] Baxter, Product Transport, 2010 Sustainability Report, June 30, 2011. http://sustainability.baxter.com/product-responsibility/product-transport.html#intermodal-transport

[16] Levi, Sustainability Report. http://www.levistrauss.com/sustainability/product/distribution (accessed November 30, 2011)

[17] Solomon, Mark B. Rails try new route to intermodal growth, *DC Velocity*, July 4, 2011. http://www.dcvelocity.com/articles/20110704rails_new_route_for_intermodal_growth/

[18] Solomon, Mark B. Rails try new route to intermodal growth, *DC Velocity*, July 4, 2011. http://www.dcvelocity.com/articles/20110704rails_new_route_for_intermodal_growth/

[19] Solomon, Mark B. Rails try new route to intermodal growth, *DC Velocity*, July 4, 2011. http://www.dcvelocity.com/articles/20110704rails_new_route_for_intermodal_growth/

[20] BNSF Railroad, The Container Store brings benefits of intermodal service to store deliveries. http://www.bnsf.com/customers/campaign/pdf/case-study-container.pdf (accessed January 25, 2012)

[21] BNSF Railroad, The Container Store brings benefits of intermodal service to store deliveries. http://www.bnsf.com/customers/campaign/pdf/case-study-container.pdf (accessed January 25, 2012)

[22] Perry A. Trunick, "Green on The Ground," *Inbound Logistics*, June 2011. http://www.inboundlogistics.com/cms/article/green-on-the-ground/#sidebar1

[23] Leach, Peter T., Closer to Near-Sourcing, *Journal of Commerce*, January 16, 2012. http://www.joc.com/logistics-economy/closer-near-sourcing

[24] "Value-added resale," D.W. Morgan. http://www.dwmorgan.com/wp-content/uploads/2010/11/DWM-0001-ValueAdded.pdf (accessed 10/24/2011)

[25] " Freight Costs Reduced by 49% with Postponement Packaging," Kenco. http://www.kencogroup.com/case-study/freight-costs-reduced-by-49-with-postponement-packaging (accessed August 2011)

[26] Oracle, The Shape of Tomorrow's Supply Chain: The Science of Sustainability. http://www.oracle.com/us/products/applications/green/051300.pdf (accessed November 30, 2011)

[27] Jean-Paul Rodrigue, Claude Comtois and Brian Slack (2009), The Geography of Transport Systems, New York: Routledge, 352 pages. ISBN 978-0-415-48324-7. http://people.hofstra.edu/geotrans/index.html

[28] Capgemini and the Global Commerce Initiative, 2016: Future Supply Chain, 2009. http://www.futuresupplychain.com/

[29] Fuetsch, Michele, Cooperate Alters Operations Among Warehouse Users, Transportation Topics, July 26, 2010. www.ohl.com/pdfs/w13094.pdf

[30] Cassidy, William B., "Hershey, Ferrero Sign Supply Chain Pac," *Journal of Commerce*, October 5, 2011 http://www.joc.com/warehousingdistribution/shippers-hershey-ferraro-sign-supply-chain-pact

[31] Cassidy, William B., "Seeking Space, Creating Capacity," *Journal of Commerce*, V.12 N. 39. October 24, 2011

[32] " Empty Miles Service enables shippers and carriers to fill empty trailers for supply-chain and environmental benefits," VICs, October 2009 http://www.vics.org/docs/home/pdf/Macys_Schneider_National_Empty_Miles_Service_101209_FINAL_med.pdf

[33] Steve Matheys, "An overview of the Macy's / Schneider Case Study," http://www.vics.org/docs/home/Empty_Miles_FHWA_v3.pdf (accessed August 2011)

[34] Macy's, 2011 Fact Book. http://www.macysinc.com/Investors/vote/2011_fact_book.pdf

[35] "Wal-Mart Promotes Sustainable Agriculture," Walmart, May 2008, http://walmartstores.com/media/factsheets/fs_2307.pdf

[36] Cassidy, William B., Seeking Space, Creating Capacity, *The Journal of Commerce*, October 24, 2011. http://www.joc.com/logistics-economy/seeking-space-creating-capacity (subscription required)

[37] Dale S. Rogers and Craig R. Carter "Optimizing a distribution network with increasing fuel costs," University of Nevada, Reno, College of Business , The Sustainable Supply Chain Management Project. http://www.sustainable-supplychain.com/networkanalysis.html (accessed August 2011)

[38] David Simchi-Levi, Operations Rule. *The MIT Press*, 2011.

[39] Katherine Doher, "Green Progress." *Food Logistics*, June 11, 2010. http://www.foodlogistics.com/article/10255639/green-progress

[40] Stephanie Gruner, "Carbon Execution Officer: The CEO of Alcatel-Lucent has put cutting emissions at the heart of strategy," *The Wall Street Journal*, May 16, 2011. http://online.wsj.com/article/SB10001424052748703789104576272532218665822.html?KEYWORDS=Alcatel-Lucent

[41] Stephanie Gruner, "Carbon Execution Officer: The CEO of Alcatel-Lucent has put cutting emissions at the heart of strategy," *The Wall Street Journal*, May 16, 2011

[42] Art Smith, "Innovative Empty Miles Service Enables Efficient Truck Transport," *Logistics Quarterly Magazine*, Volume 16, Issue 1, 2010. http://www.logisticsquarterly.com/issues/16-1/gs1.html

[43] Stonyfield Farms, Transportation and Distribution, MAP Team. http://www.stonyfield.com/healthy-planet/our-roadmap-green-business/mission-action-program-map/map-teams/transportation-distri (accessed December 1, 2011)

[44] Ryder, Stonyfield Farm: Greener Supply Chain Accelerates Profits and Carbon Footprint Reduction, Edge, 2008. http://www.ryder.com/supplychain_case-studies_stonyfield.shtml

[45] Stonyfield, Truckin': What Goes Out. http://www.stonyfield.com/healthy-planet/our-practices-farm-table/transportation/truckin-what-goes-out (Accessed December 1, 2011)

[46] Cooke, James A., On the road to a smaller carbon footprint, CSCMP Supply Chain Quarterly, 2009. http://www.supplychainquarterly.com/topics/Logistics/scq200904stonyfield/

[47] Mary Fischer, Carbon Master, Stonyfield Farm, Personal correspondence with EDF, June 2011

[48] Tom Moore, Scott Neufarth and Pamela Haining, "Order and Truck Optimization: Increasing Sustainability and Profitability," Supply Chain Conference, February 1, 2011. http://maxx.gmaonline.org/uploadFiles/176452000007DA.filename.Order_Optimization_and_Load_Size_Updated_Moore,_Haining.pdf

[49] Johnson, Fisk, Improvements by the Truckload, A letter to global thought leaders from Fisk Johnson, SC Johnson Chairman and CEO. http://www.scjohnson.com/en/commitment/dialogue-on-sustainability/Improvements-by-the-Truckload.aspx (accessed November 30, 2011)

[50] Gunilla Jönson et al., "Packaging Logistics and Retailer Profitability: An IKEA case study," Lund University, 2005. http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=541306&fileOId=626088

[51] April Terreri, "How Green Is Your Returnables Process?" *Food Logistics*, August 19, 2011 http://www.foodlogistics.com/article/10278455/how-green-is-your-returnables-process

[52] Gunilla Jönson et al., "Packaging Logistics and Retailer Profitability: An IKEA case study," Lund University, 2005.

[53] Gunilla Jönson et al., "Packaging Logistics and Retailer Profitability: An IKEA case study," Lund University, 2005.

[54] Claudia Girrbach, "Cisco Trims Packaging & Saves $24M," Green Grows Green, March 3, 2010.

[55] Claudia Girrbach, "Cisco Trims Packaging & Saves $24M," Green Grows Green, March 3, 2010.

[56] "Sustainable Packaging Update," Cisco, February 2010. www.greenbiz.com/sites/default/files/Cisco_SustainablePackagingUpdate_Feb2010%5B1%5D.pdf

[57] " Definition of Sustainable Packaging," Sustainable Packaging Coalition. http://www.sustainablepackaging.org/content/default.aspx?type=5&id=definition-of-sustainable-packaging (accessed August 2011)

[58] David Simchi-Levi, Operations Rule. *The MIT Press*, 2011. http://www.operationsrules.com/

[59] " Major Fuel Consumption (Btu) by End Use for Non-Mall Buildings, 2003," DOE EIA Commercial Buildings Energy Consumption Survey (CBECS), Table E1. September 2008. http://www.eia.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set19/2003pdf/e01.pdf

[60] Kohlberg Kravis Roberts & Co., US Foods: Results, KKR Green Protfolio. http://green.kkr.com/results/us-foodservice (accessed January 31, 2012)

[61] U. S. Environmental Protection Agency, Buildings & Plants, Energy Star program http://www.energystar.gov/index.cfm?c=business.bus_index (accessed January 31, 2012)

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