Allocating AB118 Funds to Meet California's 2050 Climate Change Goals

White Paper

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Abstract

This report evaluates and makes recommendations for the allocation of funds to projects which are eligible to receive financial incentives from the Alternative and Renewable Fuel and Vehicle Technology Fund created by AB 118 (Nunez, 2007). Furthermore, this report recommends a straightforward and transparent evaluation process based on legislatively defined criteria. Using a portfolio approach that balances technological and financial risks, the State can maximize the utility of AB 118 funding to help reach its 2050 greenhouse gas (GHG) reduction goals.

Keywords: AB118, alternative fuels and vehicle technologies, climate change, GHG reductions, techno-economic analysis

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Executive Summary

The goal of this work is to develop a strategy to allocate AB 118 funds in order to help the State reach its climate goals, to simplify the evaluation process, to ensure a fair evaluation process, and finally, to maintain technological neutrality. We identified and explored the strengths and weaknesses of five (5) qualitative approaches to distribute AB 118 funding. Based on our review and our stated goal, we identified two (2) of the approaches to explore in greater detail: 1) by technology 'buckets': vehicle efficiency improvements, blended biofuels, nonrenewable alternative fuels, and advanced vehicle technologies, and 2) by area of need; R&D, demonstration, vehicle deployment, and infrastructure. **Ultimately, we recommend that projects be separated and evaluated by technology 'buckets' because it is the best approach to help the State reach its climate goals, it simplifies the evaluation process, it ensures a fair evaluation process, and it maintains technological neutrality**.

We grouped alternative fuels and vehicle technologies into 'buckets' based on overlap in the aforementioned areas of need. The incremental improvements to fuel economy from advances in engine technologies, improved transmissions, reductions in weight, and aerodynamic improvements are grouped into **vehicle efficiency improvements**. In the near-term, R&D funding would be dedicated to OEMs so that they can bundle the array of vehicle efficiency improvements into a single vehicle. This would be followed by gradual increases in deployment funding to decrease the initial costs of rolling out the vehicles.

For **blended biofuels**, we considered ethanol and other advanced bio-hydrocarbons in the light-duty sector with biodiesel and renewable diesel blends in the heavy-duty sector. In the near-term, R&D funding would be dedicated to advancing the next generation of biofuels e.g., cellulosic ethanol from biomass, and would fall off in the mid- to long-term. Because flex-fuel vehicles (FFVs) are already available, the remainder of the funding for biofuels would be dedicated to developing an infrastructure, which includes fuel production and distribution, as well as fueling stations if needed.

We have grouped natural gas (NG) and liquefied petroleum gas (LPG) projects together into the **nonrenewable alternative fuels** bucket. For both fuels, there is a need for R&D funding in the near-term to advance and certify engine technology in the heavy-duty sector. We assume that the heavy-duty sector has more market growth potential than the light-duty sector for the nonrenewable alternative fuels because of the lack of market penetration of CNG and LPG vehicles, despite their widespread availability for many years. We envision a significant amount of money dedicated to heavy-duty vehicle deployment in the near-term, and increasing over the mid- to long-term as technological breakthroughs lead to cleaner and more efficient NG and LPG vehicles.

Finally, we grouped both electric drive vehicles and hydrogen fuel cell technologies into an **advanced vehicle technologies** bucket. We consider both light-duty and heavy-duty applications, as well as on- and off-road applications for both types of technologies. We consider R&D funding a high priority in the near-term, to improve fuel-cell technology, as well as battery technology for electric vehicles. Both types of vehicles (in the light-duty and heavy-duty sectors) will require significant investments for vehicle deployment and infrastructure in the near-, mid- and long-term. Vehicle deployment funding can be used to reduce the upfront capital costs of the vehicles and seed the market, whereas infrastructure funding can go to a variety of applications,

including, but not limited to, re-charging stations, metering, plug-in auxiliary power units (APUs), hydrogen production, hydrogen distribution, and hydrogen fueling stations. In the near- to mid-term, demonstration funding would be used to optimize advanced technologies and help the transition to broad commercialization.

To allocate funds by technology ‘bucket’, we used a quantitative methodology based on greenhouse gas (GHG) reduction potential compared to a baseline technology (e.g., an internal combustion engine, ICE, running on reformulated gasoline, RFG). We assumed a 2050 perspective consistent with the analyses performed in AB 1007, adopted by both the CEC and ARB in 2007, and defined an *Unconstrained* and a *Constrained* GHG reduction potential scenario for various vehicle/fuel types in both the light-duty and heavy-duty sectors. Our constraints accounted for other State policies to ensure that AB 118 funding is dedicated to projects going above and beyond what is legislatively mandated or what is established by current regulations. We also constrained the GHG reduction potential based on our understanding of the market constraints, including market acceptance, market penetration, and supply constraints. We correlated the GHG reduction potential (based on a comparison of current well-to-wheels, WTW, emission factors) of a vehicle/fuel combination to a percent allocation of funding.

We recommend the distribution of AB 118 funds based on the Constrained Scenario for the following reasons: a) it accounts for compliance with other State initiatives in alternative fuels and advanced vehicle technologies, b) it is a more accurate reflection of plausible market acceptance and market penetration, and c) it accounts for likely fuel supply limitations. The results of our analysis are shown in Table ES-1.

Table ES- 1.Recommended percent allocation of AB 118 funds based on a techno-economic analysis of four technology ‘buckets’ based on a) GHG reduction potential and b) market constraints.

Light Duty + Heavy Duty Buckets	**Percent Allocation of AB 118 Funds Constrained**
Improved vehicle efficiency	25%
Blended biofuels	16%
Nonrenewable alternative fuels	5%
Advanced vehicle technologies[1]	54%
Total	**100%**

[1]Note that advanced vehicle technologies include a broad spectrum of light-duty and heavy-duty technologies, as well as on-road and off-road applications. See the text for more detail.

We conclude our report with recommendations for the evaluation process for applicants, including evaluation inputs, the State's analysis, and the scored output. The outline of our recommended approach to the evaluation process is shown in Figure ES-1. The Energy Commission is directed by AB 118 legislation to provide preference to projects based on ten (10) criteria, as appropriate. These criteria provide a useful guide, and along with relevant market data and assumptions, the Energy Commission can perform the evaluation of projects. Based on defined baselines and assumptions, the Energy Commission should score and recommend projects based on: 1) the business case (100 points) and 2) the benefits (100 points). The business case includes information such as the financial solubility of the applicant, the dependency of the technology on other enabling technologies, the costs of the technology relative to competitors, the cost of the integrated system (of which the technology is a part) today and in the future, and the probability of commercialization. The benefits on the other hand, are guided by the legislation and include GHG reductions, petroleum displacement, criteria pollutant reductions, water and toxic pollutant reductions, and economic benefits to the State.

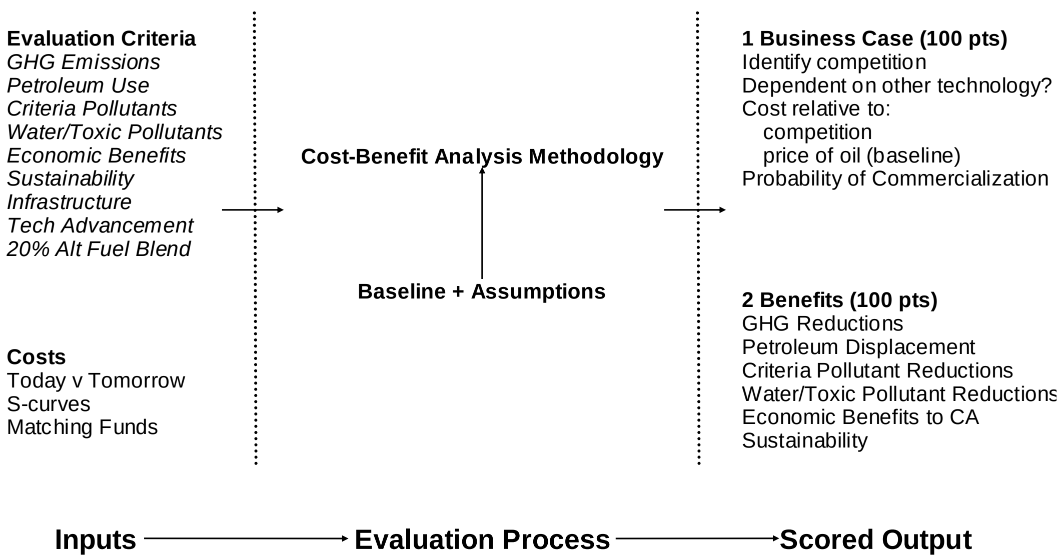

Figure ES-1. The Inputs are based on the criteria defined in AB 118 legislation, as well as additional market information and costing data. In the Evaluation Process, the State defines baselines for comparative purposes and lays out any accompany assumptions to perform a Cost-Benefit Analysis of projects. The Scored Output consists of 100 points for both the 1) Business Case and 2) Benefits. Note that the italicized evaluation criteria are taken directly from the legislation.

1. Introduction

The California State Alternative Fuels Plan (the Plan), borne out of Assembly Bill 1007 (2005), presents a combination of strategies and actions that California must take to increase the use of alternative, non-petroleum fuels. In order for the transportation sector to reduce its fair share of greenhouse gas (GHG) emissions in compliance with the State's 2020 and 2050 climate goals, established by Assembly Bill 32 (2006) and Executive Order S-03-05, respectively, a variety of strategies must be pursued in concert, including: improved vehicle efficiency, increased use of biofuels, advancing and deploying next generation vehicle technologies, and reducing vehicle miles traveled (VMT). To facilitate the market transformation needed to reduce the GHG emissions of California's transportation sector, the legislature passed Assembly Bill 118 (2007). This bill created the Alternative and Renewable Fuel and Vehicle Technology Program (Program), to be administered by the California Energy Commission, to provide funding to develop and deploy innovative technologies in California "to help attain the state's climate change policies."

The Program's fund (Fund) is supported by modest increases in vehicle registration fees, vessel registration fees, specified service fees for identification plates, and smog abatement fees. The Fund is estimated to have some $120M[1] available annually, beginning July 1, 2008 until January 1, 2016. The Energy Commission is charged with distributing monies from the Fund to expand alternative and renewable fuel use without any preference. The funds are to be distributed as grants, loans, loan guarantees, revolving loans, or other appropriate measures to "public agencies, businesses and projects, public-private partnerships, vehicle and technology consortia, workforce training partnerships and collaboratives, fleet owners, consumers, recreational boaters, and academic institutions." Clearly, the Energy Commission has been granted significant leeway in the distribution of monies from the Fund.

The distribution of funds requires careful consideration to ensure that the monies are spent in accordance with the State's alternative fuel use and climate goals. Although the legislation describes eligible projects and evaluation criteria, it does not explicitly define an investment plan. The legislation does, however, call for the formation of an advisory body to help develop an investment plan. The legislation also clearly defines evaluation criteria; however, it does not outline a methodology for scoring projects based on these criteria. The goal of this work is to develop an investment plan built on the consideration of the following: eligible and competitive projects, options for categorizing these projects, and an allocation strategy based on the GHG reduction potential of projects. Furthermore, this work considers strategies for evaluating and scoring projects based on the evaluation criteria outlined in the legislation.

2. Overview of Eligible and Competitive Technologies

In Part 5 of Division 26 of the Health and Safe Code, section 44272 subdivision (c) paragraphs (1)-(11), the legislation outlines a broad spectrum of projects eligible for funding. These projects range from low-carbon fuels (1) to efficiency improvements (6) and fueling infrastructure (5) to fuel production (3). For the sake of brevity, we have grouped these projects into four categories: research and development (R&D), demonstration (demo), infrastructure, and vehicle

[1] Note that later in this report we assume an allocation of $100M for the sake of simplicity.

deployment.[2] Note that infrastructure projects in this case are broadly defined to include fuel production, fuel distribution, and fueling stations. In order to develop an allocation strategy for funds, it is important to understand the needs of each alternative transportation fuel relative to each of these four categories. The State Alternative Fuels Plan Storylines (the Storylines)[3] are a useful guide to understand these needs by fuel type. In the Storylines, the State developed three scenarios for each fuel, defined as: business-as-usual, moderate growth, and aggressive growth. In each case, the storyline described the evolution of each market based on a mix of assumptions including, but not limited to technological advancement, government incentives, private investment, and consumer adoption. Each storyline concluded with a series of recommendations based on the needs of each fuel to reach the hypothetical market penetration to achieve the estimated GHG emission reductions. To remain consistent with the Plan, we consider the near-, mid-, and long-term needs of each fuel based on the four categories listed in Table 1. Note that our categorization of funding needs across the various technologies does not consider existing projects that are publicly or privately funded. In order for the State to avoid doubling current funding efforts, it will be necessary to conduct a thorough review of existing efforts. We consider this a “gap” analysis. In other words, the needs in Table 1 then are based on a “pre-gap” analysis.

A circle in the table indicates there is a need for funding in this stage of commercialization. The funding needs are prioritized by the type of circle: the highest priority for funding is indicated by a closed circle (●), medium priority by a half-filled circle (◘) and lower priority by an open circle (○). Note that the projects are separated by fuel type, and further separated based on whether they are related to the alternative *fuel* (top) or the alternative fueled *vehicle* (bottom). Note that the projects under electricity are all related to the vehicle(s) (and the required infrastructure), whereas all the projects listed under biofuels are related to the fuel. There are several funding mechanisms mentioned in AB118 legislation; we have distinguished between two types of funding for *infrastructure* and *vehicle deployment* projects as being likely to receive funding via grants or loans.

[2] Note that the legislation also calls for projects that provide workforce training. Rather than treat this category separately, we make the assumption that the majority of projects will incorporate workforce training into their application for funds. Furthermore, even if there are separate projects for workforce training, we make the assumption that only a small percentage of the Fund will be dedicated to workforce training projects.

[3] State Alternative Fuels Plan: Storylines (Staff Working Paper), California Energy Commission, October 2007.

Table 1. Examples of projects eligible for AB 118 funding, broken down by fuel type, and their needs categorized by research and development (R&D), demonstrations (Demos), infrastructure, and vehicle deployment. The closed circles (●) indicate the highest priority for each type of project, a half-filled circle (◉) indicates medium priority and an open circle (○) indicates a lower priority.

Fuel	Project		R&D	Demos	Infrastructure Grants	Infrastructure Loans	Vehicle Deployment Grants	Vehicle Deployment Loans
	electric vehicles							
		LD PHEVs	●	◉	◉	○	●	○
		HD PHEVs	●	◉	○	○	●	○
		LD BEVs	●	◉	◉	○	●	○
		HD BEVs	●	◉	○	○	●	○
		NEVs					●	○
	truck stop electrification (TSE)							
		on-board HVAC systems			○	●	●	○
		off-board HVAC systems			○	●		
		battery APU			○	●		
	cold-ironing				●	○	●	○
Electricity	electric truck refrigeration units (e-TRUs)							
		electric standby TRUs					●	○
		diesel-electric hybrid TRUs	○	○	◉	●	○	●
	electric forklifts (e-forklifts) and other industrial equipment[a]		○	○		○		●
	lawn and garden		○	○	○	○	●	○
	rail, boats, personal transportation							
		trolley buses	○		◉	○	●	○
		light rail and commuter rail			◉	○	●	○
		maglev rail	●	◉	○	○	○	○
		electric boats	○	○			●	○
		bikes and scooters					●	○
	H_2 fueling stations		◉	●	●	○		
	H_2 home-fueling stations		●	◉	○	○		
	biomass-to-H_2 technologies		●	◉	○	○		
	hydrogen plants		●	◉	○	○		
H2								
	FCV technologies						●	○
	FCV production plants in CA		○				●	○
	H_2 on-board storage technology		◉	●			○	○
	H_2 fuel-cell hybrid technologies		◉	●			○	○

Table 1. continued

Fuel	Project	R&D	Demos	Infrastructure Grants	Infrastructure Loans	Vehicle Deployment Grants	Vehicle Deployment Loans
Biofuels	ethanol production plant						
	out-of-state feedstock	○		○	●		
	in-state feedstock			●	○		
	proof-of-concept cellulosic ethanol plant	◉	●	○	○		
	ethanol fueling stations			○	●		
	biodiesel production technologies	○	●	◉	○		
	biodiesel optimization technologies	●	◉	○	○		
	biodiesel production plant	○	◉	●	○		
	biofuel production technologies	●	◉				
	terminal storage of biofuels	●	○	○	○		
Natural Gas	LNG stations		○	●	○		
	LNG cryogenic processing/production in CA			●	○		
	CNG stations		○	●	○		
	low-pressure tank designs for fueling stations	●	◉	◉	○		
	biogas as feedstock for H_2	●	◉				
	biogas production technologies	◉	●	○	○		
	NG/LG vehicle purchase incentives					●	○
	NG low-pressure on-board storage technology	●	◉	○	○		
	NG hybrid electric vehicles	○	●			●	○
	NG engines/fuel system technologies MD/HD	●	●			●	○
LPG	LPG fueling stations			●	○		
	LPG vehicle technologies	●	◉			○	○
	HD LPG technologies	◉	●			○	○
	off-road LPG technologies		○			○	●

[a] other industrial electric equipment includes: electric sweepers, scrubbers and burnishers, airport ground support equipment, tow tractors and industrial tugs, and turf trucks

3. Qualitative Approaches to Distributing AB 118 Funds

The legislation does not explicitly state how funds are to be distributed. The distribution of funds can be considered a filter prior to the evaluation of projects based on criteria outlined in the legislation. In other words, how are projects sorted to simplify the evaluation process? It is important that projects are sorted to ensure an even and fair evaluation process. The evaluation process should avoid proverbial apples and orange comparisons. For instance, it is difficult to compare the merits of one project that proposes the installation of an E85 fueling station to another that will advance the stability of a battery for deployment in electric vehicles. We have identified several potentially useful approaches to sort eligible AB 118 projects for further evaluation. Projects may be sorted by:

- stage of impact: near-, mid-, and long-term
- fuel type
- technology buckets: efficiency improvements, blended biofuels,[4] and advanced vehicle technologies
- area of need: R&D, demonstrations, deployment (via vehicle or infrastructure)
- a hybrid of the options listed above

The first approach is implicitly tied to the State's climate goals for 2020 and 2050. While it is important to meet the State's 2020 goals in the near-term, funds should be distributed with more emphasis on the mid- and long-term technologies that will help California reach its more ambitious 2050 goals. In principle, this approach is reflective of the type of thinking that should guide the distribution of funds. Ultimately, however, this approach is too vague and does not sufficiently reduce the complexity of sorting projects for subsequent evaluation. The stage of impact, however, should be absorbed into the allocation strategy and the evaluation criteria (which is discussed in more detail in Section 5).

The second approach to sort projects and distribute funds by fuel type is convenient and consistent with aspects of the State Alternative Fuels Plan. The Plan and accompanying analyses have already mapped out a variety of scenarios for the adoption and penetration of each alternative fuel. This approach, however, falls short for several reasons. Firstly, by isolating the projects by fuel type, the competition for funds is inherently limited. There is considerable overlap amongst the needs and requirements of various fuels and technologies. For instance, the needs of liquefied petroleum gas (LPG) and natural gas (NG) are similar in terms of R&D and vehicle deployment, whereas the same is true for hydrogen fuel cell vehicles (FCVs) and electric vehicles (EVs). On the other hand, there is little or no overlap between the needs of LPG and FCVs or EVs and biofuels, which would make it difficult to determine which technology will have a competitive advantage. Secondly, this approach does not adequately simplify the evaluation process. As mentioned previously, some fuels have overlapping needs for adoption, as shown in Table 1. Although this approach may evaluate projects on a similar basis, similar projects are not necessarily evaluated simultaneously. Thirdly, this approach does not recognize the differences in the potential of each vehicle or fuel type to reduce GHGs. Ultimately, this approach is potentially complicated and may lead to a significant shortfall in GHG reductions by 2050.

[4] Note that we use the term blended biofuels to be consistent with the Plan. The Plan outlines actions needed for biofuels, and in the near- and mid-term, it focuses largely on increasing the use of biofuels by blending it at higher percentages with gasoline and diesel fuels.

The third approach narrows the number of categories by which projects are sorted to three by recognizing the overlapping needs of various fuels and technologies: vehicle efficiency improvements, blended biofuels, and advanced vehicle technologies. This encourages competition amongst fuels and vehicle technologies with similar needs, such as NG and LPG or FCVs and EVs. This approach, like the second one, is convenient in terms of consistency with the Plan. Most notably, these three categories are explicitly defined in the Plan as part of a scenario to reach the State's 2050 goals. As such, it is straightforward to allocate funds in each category or 'bucket' based on the current state of knowledge regarding each technology's GHG reduction potential. It is worth nothing, however, that this approach is only partially technology neutral.

The fourth approach to sort projects by area of need is attractive because it is technology blind and straightforward. This approach, however, does not explicitly differentiate between the GHG reduction potential of technologies. While it is possible to consider the GHG reduction potential in the evaluation criteria, we consider it equally important to remain technology neutral and to quantify the GHG reduction potential of a technology or vehicle/fuel combination.

Based on the advantages and limitations of the approaches to sorting projects listed above, we consider the following two as the most plausible:

1. By technology bucket: efficiency improvements, blended biofuels, and advanced vehicle technologies
2. By area of need: R&D, demo, infrastructure, and vehicle deployment

In the first approach, hydrogen, electricity, NG, and LPG related projects would all compete for funds in the advanced vehicle technology category. Based on the similar needs of NG and LPG, and because they are likely to compete in similar markets, we recommend an approach which separates projects related to these fuels into a separate 'bucket': nonrenewable alternative fuels. Although this adds an additional 'bucket' for evaluation, we consider it an important distinction, and it is consistent with the goal of evaluating projects on an even basis. Therefore, the approaches to sorting projects are:

1. By technology bucket: vehicle efficiency improvements, blended biofuels, nonrenewable alternative fuels, and advanced vehicle technologies.
2. By area of need: R&D, demonstration, infrastructure, and vehicle deployment.

Table 1 is a useful reference for the needs of each fuel type; however, we must complement this with a temporal consideration of these needs. We combined the qualitative strategies 1 and 2 listed above to develop an understanding of the next step in the distribution of AB 118 funds: how should funds be distributed over time? Based on our understanding of the Storylines and the needs of each fuel, we can chart a path for each of the categories in the first approach, broken down by the categories in the second one.[5]

[5] It is important to note that we are describing the total funding needed to advance the technologies in each area. The total funding needed includes private investment and federal investment in addition to any money invested by the State. As such, we acknowledge the need for the CEC to perform a "gap analysis" i.e., to determine the level of funding for existing efforts in each of these areas to ensure that it is not duplicating other efforts.

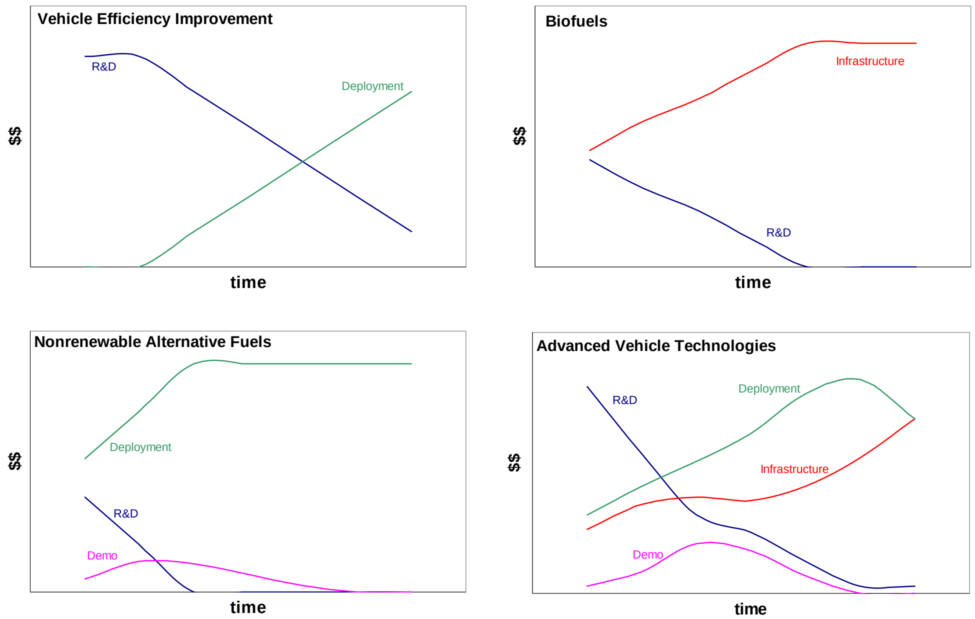

Figure 1. Projected funding scenarios over an arbitrary time period and dollar scale. These graphs demonstrate the evolution of the types of projects in each category over time, broken down by R&D, demonstrations, infrastructure, and deployment. Note that infrastructure is broadly defined and includes fuel production, distribution and fueling stations, as well as metering and other requirements for electricity. The time period and dollar scales are unit-less because the needs may shift slightly in either dimension, depending on the specific technology. These graphs, however, show a valuable overview of the primary needs of each bucket over time.

In the case of vehicle efficiency improvements (Figure 1, upper left), money is invested in research and development by automobile manufacturers, for both light-duty and heavy-duty vehicles. In reality, OEMs will spend money to incorporate a variety of efficiency improvements as research, development, and demonstration (RD&D). There are a variety of technologies and improvements that will incrementally improve vehicle efficiency, many of which already exist. However, in order to achieve higher efficiency, a composite of these technologies needs to be incorporated into the vehicle design. OEMs will need to incorporate these technologies into their vehicles as R&D, and when necessary, as internal demonstrations as part of their standard manufacturing processes. Deployment funding will be used to defray the initially higher costs of vehicles that have incorporated an array of efficiency improvements. There are no infrastructure requirements because the improvements are on the vehicle side and will not require significant changes in the existing fueling infrastructure.

For blended biofuels (Figure 1, upper right), the money is originally equally split between R&D and infrastructure. The R&D money is to accelerate technological breakthroughs in the production of biofuels, such as cellulosic ethanol, from stable feedstocks and waste streams. The infrastructure money is intended to fund an expansion of the existing infrastructure, for instance to produce more ethanol via existing methods, while providing a transition to the next generation of biofuel production. In the light-duty sector, flex-fuel vehicles are currently manufactured by OEMs, so we do not incorporate any vehicle deployment or demonstration funds. Similarly, in the heavy-duty sector, we assume that biofuels will be used as low-level blends without significant modifications to the vehicles. It is important to note that there is significant potential for considerable cost savings by blending higher percentages of biofuels for use in conventional vehicles because this would eliminate a parallel fueling infrastructure.

For nonrenewable alternative fuels (Figure 1, lower left), we assumed that the majority of the funding will go towards heavy-duty vehicles. The funds are equally split between R&D and deployment at first, but over time, the R&D money is intended to translate into increased vehicle deployment. There are some requirements for infrastructure in this category, however, we assume that fuel producers will provide the fueling stations if there is significant penetration in the vehicle market. Although there are existing vehicle technologies for both NG and LPG transportation fuels, we anticipate a fraction of funding to go to demonstration of new heavy-duty vehicles.

In the case of advanced vehicle technologies (Figure 1, lower right), both light-duty and heavy-duty vehicle technologies are included. The light-duty vehicles include plug-in hybrid electric vehicles (PHEVs) or battery electric vehicles (BEVs) and FCVs, whereas heavy-duty vehicles include off-road technology applications such as truck stop electrification (TSE), electric truck refrigeration units (TRUs), lawn and garden equipment (e.g., electric lawnmowers), electric forklifts, and cold-ironing. At the onset, funding is provided to R&D, deployment, and infrastructure. Since the off-road applications of electric drive technologies are close to or are commercialized, funding for deployment and infrastructure would emphasize these applications. Later, funding would switch to on-road vehicle applications. R&D funding is for on-road vehicles to accelerate the commercialization of both PHEVs/BEVs and FCVs. In the case of PHEVs and BEVs, for instance, money would be spent to advance battery technology. In the case of FCVs, R&D funding would be used to reduce the costs of hydrogen fuel cells and increase the capacity of on-board hydrogen storage. The funding dedicated to the deployment and infrastructure for off-road technologies tapers off in the mid-term, but the overall funding in the category only decreases slightly because there is a transition towards spending money on infrastructure and deployment for on-road vehicles. The funds dedicated to vehicle deployment eventually plateau as the vehicles are adopted into the market. Meanwhile, the infrastructure for either type of vehicle is developed consistently over time. There is a small, but significant amount of money dedicated in the interim to vehicle demonstration. This money decreases as deployment is accelerated.

As mentioned previously, these graphs are meant to provide an overview of the funding needs (as dollars) over time for each technology bucket. Each project will have specific needs that vary in both the magnitude of investment required and the timing. The graphs in Figure 1, however, present a valuable overview of how funding may be distributed over time for R&D, demonstrations, infrastructure and vehicle deployment in each of the technology buckets: vehicle efficiency improvements, blended biofuels, nonrenewable alternative fuels and advance vehicle technologies. Furthermore, it is not surprising that both the magnitude of the funding needs and the distribution of funding over time vary for each technology bucket.

4. Allocating Funds using GHG Reduction Potential

The stated goal of the Program is "to provide funds to develop and deploy innovative technologies that transform California's fuel and vehicle types *to help attain the state's climate change policies*." As such, the distribution of funds should reflect the capacity of a vehicle or fuel technology to reduce greenhouse gas (GHG) emissions in accordance with the State's 2020 and 2050 goals. For our analysis, we assumed a perspective that would lead California to reach its 2050 goal.

In Section 4.1, we develop an allocation strategy based on the GHG reduction potential of each vehicle/fuel type. Furthermore, the allocation of funds is recommended for two scenarios: an Unconstrained Scenario and a Constrained Scenario – constrained by market conditions and technological barriers. To develop the allocation strategy, vehicle/fuel types are first grouped by technology buckets. In Section 4.2, we combine the needs of each bucket described in Section 3 and the percent allocation by bucket in Section 4.1 to develop an allocation strategy based on area of need.

4.1. Allocating Funds Based on Technology Buckets

In the following subsections, we explore two scenarios.
Unconstrained GHG Reduction Potential Scenario: We use existing well-to-wheels (WTW) emissions data to develop optimistic 2050 scenarios by vehicle type, separated by light-duty and heavy-duty vehicles. We review the assumptions for each technology and vehicle type. Ultimately, we include an allocation of AB 118 funds based on the normalized GHG reduction potential of each optimistic scenario.
Constrained GHG Reduction Potential Scenario: We apply a series of practical constraints to each technology based on data from the Plan, the Storylines, and other sources. Based on these constraints we make a final recommendation for the distribution of AB 118 funds in each of the categories discussed previously: improved vehicle efficiency, blended biofuels, nonrenewable alternative fuels, and advanced vehicle technologies.

4.1.a – Unconstrained GHG Reduction Potential Scenario
Our initial assumption for each technology and vehicle type is optimistic. We assume by 2050 that each type of vehicle will reach 100% adoption. This means that each vehicle scenario is mutually exclusive of the others. To develop the allocation strategy, we first separated potential GHG reduction strategies by light-duty and heavy-duty sectors. Secondly, we distinguished strategies by efficiency and fuel type, including biofuels, natural gas (NG), liquefied petroleum gas (LPG), electric drive, and hydrogen fuel cell vehicles (H2 FCV). For each fuel/engine combination, we determined a percent improvement on a well-to-wheels (WTW) GHG emissions basis for each technology relative to a baseline internal combustion engine (ICE). We subsequently normalized the percent improvement of each fuel/engine combination to determine a percent allocation based on GHG reduction potential. For each fuel type, we weighted the GHG reduction potential of the light-duty and the heavy-duty sector based on the estimated GHG emissions for each sector. To determine the weighting of potential GHG reductions, we used the emissions from gasoline and diesel as proxies for each sector, respectively. We used the demand for gasoline and diesel (in gallons)[6], heating values (in BTU per gallon of fuel),[7] and well-to-tank emissions (in grams per unit energy, g/MJ) of the California average mix of reformulated gasoline and average mix of California diesel[8] to project the split of GHG emissions. We used

[6] Transportation Energy Forecasts for the 2007 Integrated Energy Policy Report (Draft Staff Report), July 2007, California Energy Commission, CEC-600-2007-009SD, p.16-17.
[7] Full Fuel Cycle Assessment: Well-to-Tank Energy Inputs, Emissions, and Water Impacts (Consultant Report), TIAX LLC, June 2007, CEC-600-2007-003, p.**2**-12.
[8] *Ibid*, Appendix A, p.1

these factors to adjust for percent improvements in the light- and heavy-duty sectors. Based on the GHG emissions of gasoline and diesel, the GHG emissions reduction potential of light-duty and heavy-duty fuel/engine types were weighted as 82% and 18%, respectively.

Light-Duty Sector Assumptions

For the light-duty sector, the WTW emissions for GHGs (weighted, in grams per mile, g/mi) were compared to a standard internal combustion engine (ICE) using reformulated gasoline (RFG). For each vehicle type, we used WTW emissions as reported for Scenario Year 2012 with a model year start in 2010.[9] The type of fuel selected, vehicle type, corresponding WTW emissions, and percent improvements as compared to an ICE using RFG are shown in Table 2.

Table 2. Recommended percent allocation of AB118 funds for LD vehicles based on WTW emissions.

Light-Duty Vehicle Technologies	Powertrain	WTW Emissions (g/mi)	% Improvement (over ICE/RFG)	% Allocation
RFG, marginal (baseline)	ICE	431	—	—
Efficiency improvement	ICE	144	67%	22%
E30, cellulosic	FFV	322	—	—
E85, cellulosic	FFV	120	72%	24%
NG, North America	ICE	302	30%	10%
LPG, natural gas	ICE	354	18%	6%
Electricity, natural gas/RPS	PHEV	224	—	—
	BEV	124	—	—
Electricity, 80% PHEV : 20% EV	PHEV/BEV	204	53%	17%
H2, biomass	FCV	40	—	—
H2, NG SR, renewable power	FCV	170	—	—
H2, 20% biomass: 80% NG SR	FCV	144	67%	22%
			Total	**100%**

Source Full Fuel Cycle Assessment: Well-to-Wheels Energy Inputs, Emissions, and Water Impacts (Consultant Report), TIAX LLC, August 2007, CEC-600-2007-004-REV

In the case of improved vehicle efficiency, we derived the WTW emissions factor assuming a three-fold increase in the current on-road fuel economy of light-duty vehicles by 2050 e.g., 20 miles per gallon increasing to 60 mpg.[10] Efficiency improvements via plug-in or battery electric vehicles, fuel cells, and other alternative fuels are excluded. We assume that this efficiency improvement is reached solely through changes such as hybrid electric drives, advances in engine technologies, improved transmissions, weight reduction, and aerodynamic improvements.

In the case of biofuels for light-duty vehicles, we assumed an E85 infrastructure and 100% use of cellulosic ethanol. It is worth noting that there is considerable uncertainty in the WTW GHG emissions for ethanol because of GHG emissions resulting from indirect land-use changes. Because the research in this field is ongoing and considerable uncertainty remains in the

[9] Full Fuel Cycle Assessment: Well-to-Wheels Energy Inputs, Emissions, and Water Impacts (Consultant Report), TIAX LLC, August 2007, CEC-600-2007-004-REV.
[10] State Alternative Fuels Plan, California Energy Commission, CEC-600-2007-011-CMD, p. 76

determination of GHG emissions resulting from indirect land-use change, we have opted to use the WTW GHG emissions from the CA-GREET model. As such, the WTW emission factors for ethanol should be considered a lower limit, which in turn means that the percent allocation of funds is an upper limit.

For NG, we used the WTW GHG emissions factor for North American derived natural gas. For LPG, we assumed that LPG is derived from natural gas wells (instead of petroleum refining). For electricity, we assumed that the vehicle mix would be 80% plug-in hybrid electric vehicles (PHEVs) and 20% battery electric vehicles (BEVs). For the WTW emissions, we used the California marginal mix for electricity production assuming 20% renewable generation (to fulfill the renewable portfolio standard, RPS) and that the remainder is natural gas combined cycle power plants. For hydrogen production, we assumed that production would meet the goal of 20% production from renewable resources in the California Hydrogen Blueprint Plan and that the remainder of production would be through steam reformation of natural gas.[11]

In Table 2, it is important to understand that we assume 100% penetration of a given vehicle or technology. That means that each row is mutually exclusive of the other rows and that the estimated GHG reduction is the maximum possible for each of the fuel/vehicle combinations. We recognize these are overstatements of what is plausible; however, to establish our baseline for potential GHG reductions, we assume that we have infinite resources and that each vehicle will reach 100% market penetration and that there are no restrictions on fuel production or supply.

We normalized each fuel/vehicle technology scenario based on the percent improvement compared to the ICE using RFG (ICE/RFG). In other words, a 50% improvement over the ICE using RFG is considered to have a GHG reduction potential of 50 units. We then sum the units of GHG reduction potential and determine a percent allocation based on the GHG reduction potential of each vehicle type relative to the cumulative GHG reduction potential.

Note that we have included other technologies for reference, but not scored them. For instance, we have included the WTW emissions for a mid-level blend of ethanol at 30% (E30). As noted previously, a mid-level blend strategy may have significant cost savings as compared to the E85 scenario because it would not require the development of a parallel fueling infrastructure. A mid-level blend strategy, however, would still require the use of FFVs. In this case, however, the GHG reduction potential for E30 is lower than the E85 strategy because the E85 fuel supply is unconstrained. In the next section, Section 4.1.b, we consider supply constraints and discuss the high-level and mid-level blend strategies further.

We also included the WTW emissions for PHEVs and BEVs to show how we determined the mixed PHEV/BEV WTW emissions factor. The emission factor for BEVs highlights the significant GHG reduction potential for this technology if these vehicles are adopted at a rate higher than the estimated 20%. Similarly, we have shown the contrast in the GHG reduction potential of hydrogen FCVs, depending on the source of the hydrogen. If the hydrogen is generated from biomass, the GHG reduction potential is nearly four times higher than if the hydrogen is generated from steam reforming natural gas.

[11] California Hydrogen Blueprint Plan, Volume 2, May 2005, CalEPA, p.6

Heavy-Duty Vehicle Assumptions

For the heavy-duty sector, the well-to-wheels (WTW) emissions for GHGs (weighted, in grams per mile, g/mi) were compared to a standard internal combustion engine (ICE) using California marginal ultra low-sulfur diesel (CA ULSD). The percent improvement in GHG emissions for each fuel/engine combination, as compared to the ICE using diesel was used as proxy for the maximum potential GHG reductions possible – assuming in each case that there is 100% vehicle adoption. In each case, we used urban buses as a proxy for HD vehicles. We used WTW emissions as reported for Scenario Year 2012 with a model year start in 2010.[12] Our assumptions for each vehicle are listed in Table 3.

Table 3. Recommended percent allocation of AB118 funds for heavy-duty vehicles based on WTW emissions.

Heavy-Duty Vehicle Technology	Powertrain	WTW Emissions (g/mi)	% Improvement (over ICE/diesel)	% Allocation
Diesel, CA (baseline)	ICE	3255	—	—
Efficiency Improvement	ICE,HEV	2607	20%	15%
Renewable Diesel, FTD 30	ICE	2578	—	
Bio-Diesel, BD 20	ICE	2865	—	
Bio-/Renewable Diesel Mix: 20% Bio, 80% Renewable	ICE	2635	19%	14%
LPG, North America	ICE	2872	12%	9%
NG, North America	ICE	2515	23%	17%
Electricity, NG/RPS	PHEV	2207	—	—
	EV	1463	—	—
Electricity, 90% PHEV : 10% EV	PHEV/EV	2058	34%	26%
H2, on-site NG SR	FCV	2468	24%	18%
			Total	**100%**

Source: Full Fuel Cycle Assessment: Well-to-Wheels Energy Inputs, Emissions, and Water Impacts (Consultant Report), TIAX LLC, August 2007, CEC-600-2007-004-REV

In the case of vehicle efficiency improvements, we assumed that the HEV ICE is the best-case scenario for reduced WTW GHG emissions, amounting to a 20% increase over the baseline diesel case. For bio-diesel, we assumed that 20% of the fuel supply would be bio-diesel and 80% would be renewable bio-diesel. In the case of electric drive technologies, we assumed a split of 90% PHEVs and 10% EVs for the heavy-duty sector. We determined the PHEV miles for a heavy-duty engine by combining the WTW GHG emissions of an EV and an HEV (run on diesel), assuming that the vehicle was in all-electric mode 35% of the time. We made no adjustments to the hydrogen WTW emissions factor, and assumed that the hydrogen would be exclusively produced via steam reforming natural gas.

Note that we included the WTW emissions factors for other fuel/vehicle combinations in Table 3 without including the associated GHG reduction potential. For the Bio- and Renewable Diesel fuels, we included the individual WTW emissions factors to show how we determined the WTW emissions factor for the 80/20 mix of the two fuels. In the case of electric drive technologies, we

[12] Full Fuel Cycle Assessment: Well-to-Wheels Energy Inputs, Emissions, and Water Impacts (Consultant Report), TIAX LLC, August 2007, CEC-600-2007-004-REV

included the WTW emissions factor for both a PHEV and EV, as we did the light-duty sector as shown in Table 2. We predict a mix of these electric drive technologies making their way into the fleet by 2050, so we combine their WTW emissions factors to generate a single factor and subsequently determine the GHG reduction potential.

Developing the Allocation Strategy

To build an allocation strategy we grouped the fuels according to the technology 'buckets' listed in the State Alternative Fuels Plan and discussed previously in Section 3: improved vehicle efficiency, blended biofuels, new vehicle strategies using alternative fuels, and advanced technologies.[13] The **vehicle efficiency improvements** bucket is straightforward. The allocation for the **blended biofuels** bucket is the sum of the percent GHG reduction potential for E85 and renewable diesel. There may be a number of strategies within the blended biofuels bucket, including low- and mid-level blends (e.g., E30, as shown in Table 2), in addition to E85 and renewable diesel. Our recommended allocation, however, is based on an aggressive production and consumption of ethanol as E85, which captures the maximum reduction potential of ethanol. We combined NG and LPG in a **non-renewable alternative fuels** bucket; whereas electric drive and H2 FCV technologies were combined as an **advanced vehicle technologies** bucket. We combined the LD and HD sector results in Tables 2 and 3, weighted by the demand for gasoline and diesel, respectively to arrive at our recommended percent allocation for the Unconstrained GHG Reduction Potential scenario (Table 4).

Table 4. Recommended percent allocation of AB 118 funds determined by optimistic GHG reduction potentials, as distinguished by buckets.

Light-duty + Heavy-duty **Buckets**	**Percent Allocation Unconstrained Scenario**
Improved vehicle efficiency	21%
Blended biofuels	22%
Nonrenewable alternative fuels	17%
Advanced vehicle technologies	40%
Total	100%

4.1.b – Constrained GHG Reduction Potential Scenario

We modified the Unconstrained Scenario in Section 4.1 to reflect more plausible circumstances in the light-duty sector. Note that we did not apply any constraints in the heavy-duty sector. We modified the scenario in 4 ways:

1. For efficiency projects and biofuels projects, only GHG reductions going above and beyond Pavley and the Low Carbon Fuel Standard (LCFS), respectively, are credited.
2. There is a supply constraint for ethanol based on available biomass.
3. For both NG and LPG vehicles, market penetration is constrained.
4. For both FCVs and PHEVs/BEVs, market penetration is constrained.

In the first constraint, we consider current legislation and policies. We make two assumptions here: 1) the ARB's GHG emissions standards (Pavley) for light-duty vehicles are eventually

[13] The State Alternative Fuels Plan also included the reduction of vehicle miles traveled (VMT) as a strategy; however, projects based on this strategy are not eligible for AB118 funding.

implemented in California[14] and 2) we can only credit efficiency improvements and biofuel projects for going above and beyond Pavley and the low-carbon fuel standard (LCFS), respectively. Note that we assume that fuel providers are generally going to meet the LCFS by increasing the percent blend of biofuels (e.g., ethanol or biodiesel) in the gasoline or diesel fuel supply. It is possible, however, that fuel providers could meet the LCFS by using an advanced bio-hydrocarbon fuel or by increased use of other alternative fuels, including NG, LPG, electricity, and hydrogen. If we apply these constraints to our calculations, the percent allocation in Table 2 for efficiency improvements and blended biofuels is reduced.

In the second constraint, we account for the supply constraints of ethanol in California. In an optimistic scenario, in-state production of ethanol has the potential to reach 3.2 billion gallons per year (Bg/yr) in 2050.[15] In addition to the 3.2 Bg/yr produced in-state, we assume that California will continue to consume about 17% of the ethanol supply in the United States.[16] Furthermore, we assume that annual ethanol production in the United States will peak around the 36 Bg of production (in addition to California production) mandated by federal legislation; this amounts to another 6.1 Bg/yr of ethanol for California from out-of-state resources. Accounting for the energy content of gasoline as compared to E85 (1.39)[17] and the energy efficiency ratio (EER) of E85 compared to gasoline in a FFV (1.03),[18] and the 85% blend, leads to a total supply of ethanol equivalent to 5.9 billion gallons of gasoline equivalent per year (Bgge/yr). We compare this to the roughly 15 Bg of gasoline demand predicted for 2050,[19] meaning that in an optimistic scenario, the ethanol (as E85) supply can displace nearly 40% of the gasoline demand in California. This supply constraint reduces the allocation of funds to blended biofuels further. Note that we did not apply this constraint to the heavy-duty sector because there is likely to be sufficient supply of biodiesel to reach the 20% blend we assume in our determination of GHG reduction potential.

In the third constraint, we assume that both NG and LPG vehicles, despite their full fuel cycle improvements as compared to the standard ICE fueled with RFG, are unlikely to achieve significant penetration in the light-duty sector. According to the storylines developed for the State Alternative Fuels Plan, even in the most aggressive scenarios NG and LPG achieved less than 3% of vehicle penetration by 2050.[20] Here, we constrain both vehicle types to 5% market penetration by 2050 in the light-duty sector, resulting in a dramatic reduction of the GHG

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[14] http://www.arb.ca.gov/msprog/levprog/cleandoc/cleancomplete_lev-ghg_regs_12-07.pdf
The California Low-Emission Vehicle Regulations for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, including all or portsion of Sections 1900, 1956.8, 1960.1, 1960.5, 1961, 1961.1, 1962, 1962.1, 1965, 1976, 1978, 2062, and 2101, title 13, California Code of Regulations, as of January 4 , 2008 (last amended October 17, 2007).

[15] Williams, RB; Jenkins, BM; and Gildart MC. California Biofuel Goals and Production Potential, May 2007. 15th European Biomass Conference & Exhibition, Berlin, Germany.

[16] *Ibid*.

[17] Full Fuel Cycle Assessment: Tank-to-Wheels Emissions and Energy Consumption (Consultant Report), TIAX LLC, June 2007, CEC-600-2007-003, p.**3**-10.

[18] *Ibid*.

[19] Transportation Energy Forecasts for the 2007 Integrated Energy Policy Report (Draft Staff Report), July 2007, California Energy Commission, CEC-600-2007-009SD, p.16. This report predicts demand out to 2030; based on declining on-road gasoline demand in the high-fuel price scenario without GHG standards, and declining demand in all the fuel price scenarios with GHG standards, we assume a demand of 15 Bg.

[20] State Alternative Fuels Plan: Storylines (Staff Working Paper), California Energy Commission, October 2007, p. 131 and 133.

reduction potential for these fuels. We do not apply any constraints to the heavy-duty sector for NG or LPG vehicles.

Finally, in the fourth constraint, we limit the market penetration of FCVs and/or PHEVs/BEVs. Although there is no supply constraint for either electricity or hydrogen as a fuel akin to that of ethanol as described above, the market penetration of vehicles is highly unlikely to reach 100% by 2050. In the CEC's 2050 Vision Forecast[21] there are 28 million FCVs or EVs out of a total 39 million vehicles, or roughly 70% market penetration.

Based on these four (4) constraints, we recommend the percent allocation of funds for the Constrained Scenario as shown in Table 5. For comparison, we also have included the percent allocation based on the Unconstrained Scenario defined in Section 4.1. Note that the constraint on biofuel supply (constraint 2) and the constraint on gaseous vehicle market acceptance (constraint 3) have the largest impact on the recommended allocation of funds.

Table 5. Recommended allocation of AB118 funding separated by the four (4) technology buckets described in the text, determined as the percentage of *potential* GHG emission reductions on a per vehicle basis.

Light-duty + Heavy-duty	**Percent Allocation of AB 118 Funds**	
Buckets	**Unconstrained**	**Constrained**
Improved vehicle efficiency	21%	25%
Blended biofuels	22%	16%
Nonrenewable alternative fuels	17%	5%
Advanced vehicle technologies	40%	54%
Total	100%	100%

4.2. Allocating Funds by Area of Need

We can combine the percent allocation of AB 118 funds (Table 5) with the hypothetical projected funding scenarios (Figure 1) to assign dollar values to each bucket in the first sorting strategy, characterized by: vehicle efficiency improvements, blended biofuels, nonrenewable alternative fuels, and advanced technologies. For the sake of simplicity, we assume that the Fund will have $100M annually and that the program will begin and end funding in 2009 and 2015, respectively. By combining these strategies, we end up with a projected funding scenario as shown in Figure 2. The results shown are for the Constrained Scenario.

Note that we did not consider existing or planned funding of alternative fuel and advanced vehicle technology projects when assigning quantitative values to these curves. The State will need to conduct what we call "gap analysis" to ensure that AB 118 funding is not used to duplicate existing efforts. Ultimately, then, the curves in Figure 2 are likely to shift based on an improved understanding of existing public and private research efforts. Furthermore, we fully recognize that $100M per year on its own is not sufficient to achieve the 2050 GHG reduction goals of the State, but is intended to seed the market for alternative fuels that will get the State on a path to reaching its 2050 goals.

[21] State Alternative Fuels Plan, California Energy Commission, CEC-600-2007-011-CMD, p. 77.

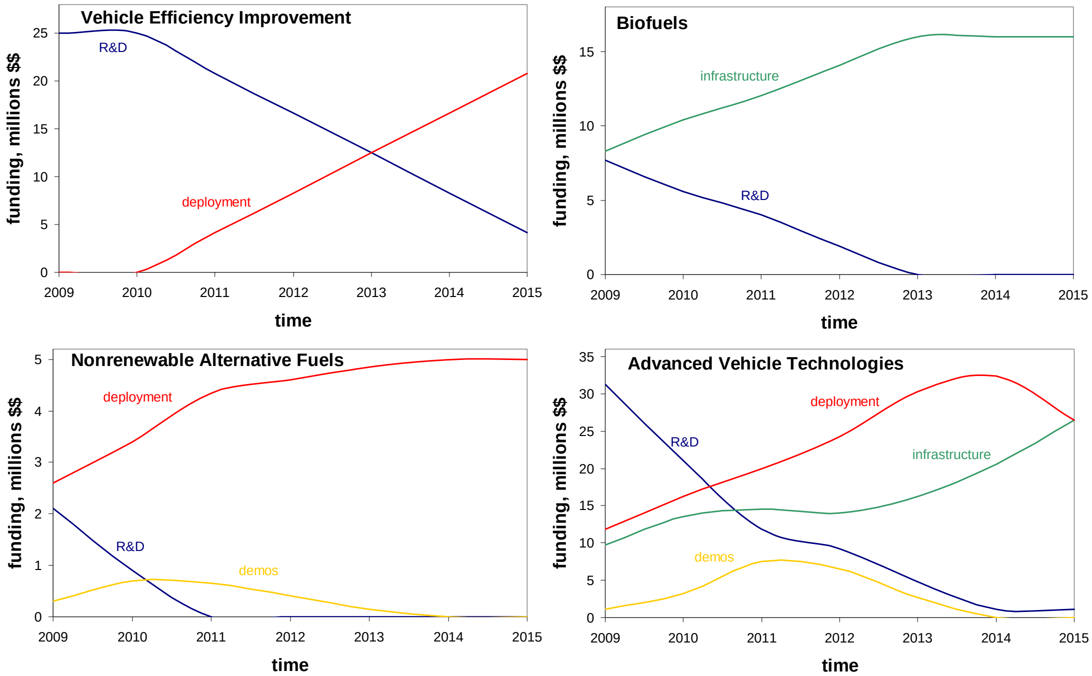

Figure 2. Projected funding scenario for each of the technology buckets, as separated by needs of each technology. The results shown are for the Constrained Scenario (see text). Note the varying scales on the y-axis, as shown in millions of dollars.

We can also develop projected funding scenarios for the strategy that sorts projects by the area of need, described previously in Section 3. Using this strategy, projects seeking AB 118 funds are first separated by: research and development (R&D), demonstration, infrastructure, and vehicle deployment. We breakdown each technology bucket shown in Figure 1 by each of the areas of need and subsequently aggregate the allocated funds into these four categories. In other words, the funds dedicated to R&D for vehicle efficiency improvements, blended biofuels, nonrenewable alternative fuels, and advanced technologies are summed over each year from 2009-2015 to build a time-dependent investment portfolio (as shown in Figure 3). We applied this methodology to the Unconstrained and Constrained Scenarios described previously in Section 4. The average over the years 2009-2015 for each of these scenarios is shown in Table 6.

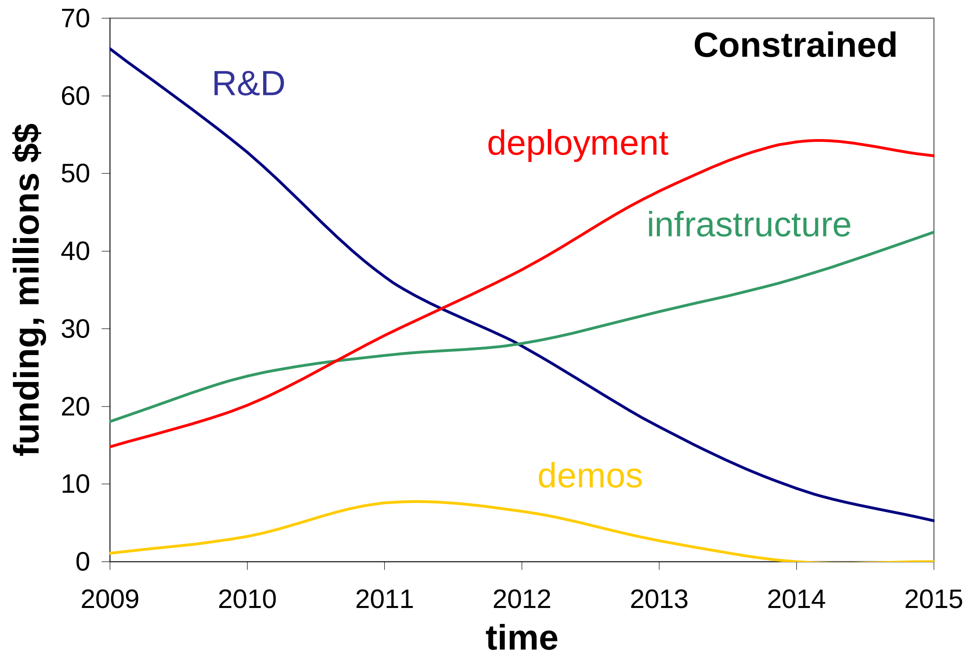

Figure 3. Recommended AB 118 funding for R&D (blue), demos (gold), infrastructure (green), and deployment (red) in millions of dollars for the years 2009-2015. This methodology is technology blind and is based on the breakdown of the needs for each of the four GHG reduction strategies, vehicle efficiency improvement, blended biofuels, nonrenewable alternative fuels, and advanced vehicle technologies. After breaking down the needs of each area, we aggregate the funds allocated in each of the four categories shown to generate the graph. In this case, we show the results for the recommended Constrained Scenario (see text).

Table 6. Average percent allocation of AB 118 funds based on the years 2009-2015 for the four areas of need, as described in Section 3.

Light-duty + Heavy-duty **Area of Need**	**Percent Allocation of AB 118 Funds** **Constrained**
Research & Development	31%
Demonstrations	3%
Infrastructure	30%
Vehicle Deployment	36%
Total	100%

This methodology is an indirect way of developing an allocation strategy. It is important to note that this approach limits the State by relying exclusively on the evaluation criteria (see Section 5) as a means to differentiate between projects. That, however, would not necessarily lead to a simplified evaluation process. Furthermore, perhaps the methodology is technology blind to the point of being detrimental to the State reaching its 2050 climate goals.

Ultimately, we recommend the percent allocation of funds based on the Constrained Scenario for projects sorted by technology buckets because it is most likely to produce the mix of alternative fuels and vehicles in the transportation sector to help the State reach its 2050 climate goals.

5. Evaluation Process

The Energy Commission is directed by AB 118 legislation to provide preference to projects based on ten (10) criteria, as appropriate. The evaluation process, however, is not defined by the legislation. The evaluation criteria nonetheless provide valuable insight into how projects can be evaluated, scored, and subsequently prioritized. The goal of the evaluation process is to ensure that the State maximizes the utility of AB 118 funding while reaching its GHG reduction goals. The State is most likely to fulfill this goal by developing a portfolio approach that hedges against technological and financial risks. In this section, we outline a hypothetical evaluation process to score eligible AB 118 projects, as diagrammed in Figure 4. We envision the applicants providing data to the State as inputs to a cost-benefit analysis, guided by the evaluation criteria and market data (e.g., cost of commercialization and market penetration). The State in turn uses pre-defined baseline technologies and assumptions to generate a two-fold scored output. The scored output consists of two equally weighted elements: 1) a business case and 2) estimated project benefits. Each of these stages is described in more detail below.

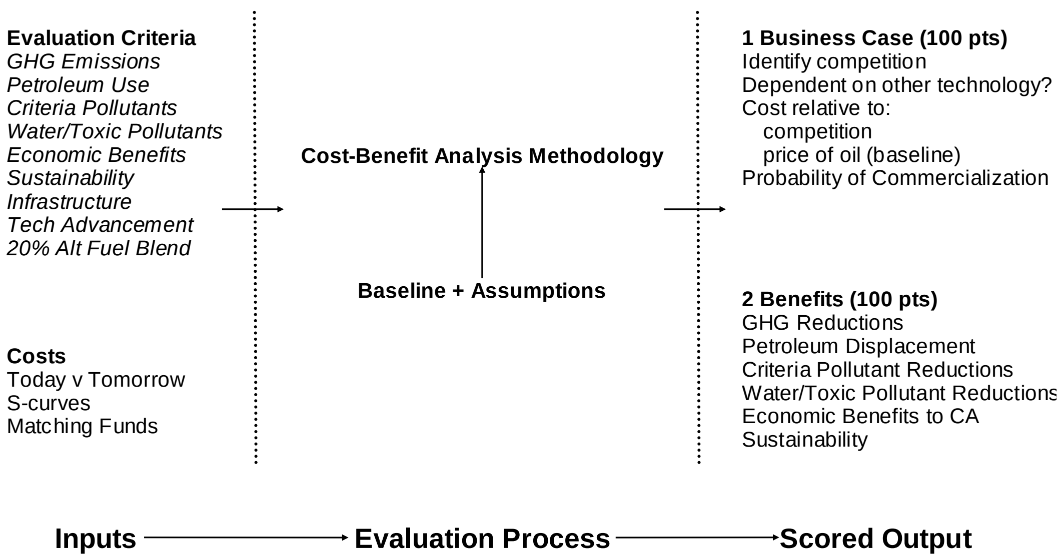

Figure 4. The Inputs are based on the criteria defined in AB 118 legislation, as well as additional market information and costing data. In the Evaluation Process, the State defines baselines for comparative purposes and lays out any accompany assumptions to perform a Cost-Benefit Analysis of projects. The Scored Output consists of 100 points for both the 1) Business Case and 2) Benefits. Note that the italicized evaluation criteria are taken directly from the legislation.

We use the evaluation criteria from the legislation as a guide for the inputs into the evaluation process. Using these criteria, we recommend that applicants provide information on the benefits of an integrated system rather than a specific technology. For instance, in the case of battery technology, the applicant would calculate GHG emissions based on the attributes of the vehicle and predicted market penetration. In addition to the inputs that are linked to the evaluation criteria, the applicant should provide cost data. These data include the current costs of the technology and predicted commercial costs, as well as information on competitive technologies. Note that competitive technologies include similar enabling technologies as opposed to similar integrated systems. The applicants should provide information including S-curves, which include data such as market penetration, projected cost reductions, and performance improvements.

The evaluation process is an opportunity for the State to check and/or verify applicant assumptions regarding performance, market penetration, and other variables. We are not recommending a specific methodology at this point, and refer to this generally as a cost-benefit analysis. In addition to the analysis, the State must define baseline technologies and assumptions to ensure that the evaluation of projects is as uniform and fair as possible. This will require the State to define baseline technologies in a variety of areas, including the light- and heavy-duty sectors, as well as the on-road and off-road sectors. In addition to defining baselines and assumptions, the State should perform what we have termed a gap analysis i.e., investigate existing funding efforts for alternative fuels and advanced vehicle technologies to ensure that the State is not providing unnecessary overlapping funds. The State is also responsible for determining the probability of success for each technology. This will require a more detailed analysis of factors such as other competitive technologies and a review of cost assumptions provided by applicants. The areas of need for each technology bucket serve as a useful guide when considering the probability of success. R&D projects are furthest from commercialization and generally carry more risk, whereas demonstration projects are generally characterized by projects that have shown sufficient promise to warrant further consideration. Vehicle deployment and infrastructure projects are intertwined: Deployment projects will include technologies that are ready to enter the market immediately, whereas infrastructure projects are dedicated to the production and distribution of fuels. In either case, the risk factors are likely to be co-dependent, depending on the fuel type and vehicle technology.

The output of the evaluation process is the score of a particular project. The score is equally weighted based on two parts: 1) the business case and 2) the benefits. The business case for a project is a combination of financial and technological risk, using the cost data, S-curves, and market assumptions. In its evaluation, the State will identify the strengths, weaknesses, and opportunities of a project relative to its competition. Similarly, the State will need to consider the financial stability of the applicant. The State will also consider how the technology may be dependent on other enabling technologies. Although AB 118 legislation is meant to promote inter-comparison and competition amongst alternative fuels and advanced vehicle technologies, it will also be important to understand how any project compares to a reference case e.g., gasoline or an ICE. Also in the business case, the State will quantify the probability of commercialization by considering the positive and negative attributes in the application e.g., vehicle range, acceleration, and storage. These attributes will help the State determine the likelihood of factors such as consumer acceptance or achieving cost reductions. Ultimately, the State will quantify the probability of achieving the anticipated environmental performance.

In the second part of the scoring, the State will award up to 100 points to projects based on the benefits of each technology. This part of the scoring is more in line with meeting the specific evaluation criteria laid out in the legislation. The reductions of emissions (on a WTW basis) are calculated based on the difference between the projected emissions of a new technology as part of an integrated system, as compared to the aforementioned baseline technology, defined during the State's evaluation process. Similar to the business case, the assumptions used to quantify the benefits of a given project will be verified and checked for accuracy by the State. We recommend a distribution of the 100 points across the criteria as shown in Table 7.

Table 7. Evaluation criteria for AB 118 projects.

Evaluation Criteria	Point Allocation
GHG Reductions (WTW)	30
Petroleum Displacement (WTW)	15
Criteria Pollutant Reductions (WTW)	15
Water/Toxic Pollutant Reductions (WTW) Economic Benefits to California Sustainability Matching Funds Existing/Proposed Fueling Infrastructure 20% Alternative Fuel Blend* Technology Advancement	40
Total	100

* We assume the 20% alternative fuel blend criterion is unique to the blended biofuels bucket

Based on our reading of the legislation and other State policies, we have given the highest priority to WTW GHG reductions, followed by equal consideration to WTW petroleum displacement and criteria pollutant reductions. Together, these three (3) criteria account for 60 of the total 100 points possible in our scoring table. The remaining 40 points should be more-or-less equally distributed (5-7 points) amongst the remaining criteria: water/toxic pollutant reductions, economic benefits to California, sustainability, matching funds, the use of existing or proposed fueling infrastructure, or technology advancement. It is important to note that the language of the legislation regarding the sustainability criterion is narrow: “the project does not adversely impact the sustainability of the state’s natural resources, especially state and federal lands.” In a broader definition, sustainability can include all of the criteria listed above it in Table 7 (and additional factors). At this point, it is unclear how the State will enforce the sustainability criterion; although, it is possible that the Commission may broaden the scope of sustainability to align more closely with the LCFS rules being developed by ARB.[22]

Although we have developed an approach to allocating AB 118 funding that simplifies the evaluation process, it is important to note that scoring projects across areas of need is complicated. For instance, it is difficult to quantify the benefits of R&D and demonstration projects considering that benefits will only be realized if the project and subsequent scale up and commercialization are successful. These early-stage projects are important steps to ensure the commercialization of a fuel or vehicle technology, however, there is always a risk that the benefits will not be realized. This is further reason to rely on a portfolio approach that will enable the State to hedge against both technological and financial risks of eligible fuel and vehicle technologies.

[22] K. Douglas, Commissioner, California Energy Commission, in remarks at the Joint Forum on Bioenergy Sustainability and Lifecycle Analysis on May 30, 2008.