State of California

CALIFORNIA AIR RESOURCES BOARD

Staff White Paper

DRAFT - SB 1383 Pilot Financial Mechanism Concept Paper
May 2018

CALIFORNIA
AIR RESOURCES BOARD

1. EXECUTIVE SUMMARY

To combat climate change, the California Legislature enacted AB 32 (Nunez, 2006), which set a statewide greenhouse gas (GHG) reduction target of 1990 levels by 2020, which the State is on track to achieve ahead of schedule. In 2016, the Legislature enacted SB 32 (Pavley, 2016), which set an ambitious target of at least 40 percent below 1990 levels by 2030. To achieve these targets, the Legislature directed the California Air Resources Board (CARB) to design policies that support efforts to decarbonize the California economy in a cost effective manner.

California now has many successful and robust programs that support the State's ambitious decarbonization efforts. The current Scoping Plan, adopted in Dec. 2017, builds on successful policies adopted to achieve the 2020 target and provides an achievable and cost-effective path towards meeting the 2030 target.[i] These programs achieve these goals by internalizing the cost of GHG emissions, incenting the production and use of alternative fuels and energy sources Statewide, and promoting technological development and deployment in key sectors. Key policies, such as the Cap-and-Trade Program, the Renewable Portfolio Standard, the Zero Emission Vehicle Program, and the Low Carbon Fuel Standard (LCFS), are contributing to significant reductions in GHG emissions and emissions of other air pollutants, increasing the diversity of California's energy matrix, and supporting a growing industry of low-carbon fuel production which is displacing the use of fossil fuels.

Many of the State's climate programs, including the LCFS, allow for some form of credit trading, to provide compliance flexibility. Inherent in any market, including those for LCFS credits, is price uncertainty. As part of the State's efforts to reduce emissions of methane and other potent short-lived climate pollutants (SLCPs), Senate Bill 1383 (Lara, 2016) directs CARB to develop a pilot financial mechanism to increase price certainty for LCFS credits generated by dairies and perhaps other sources of renewable gas. Accordingly, this concept paper describes mechanisms that could reduce credit price uncertainty for these projects to help accelerate their development and methane reductions in the State.

In this white paper, we discuss two potential financial mechanisms—**contracts-for-difference** and **put options**—which can be used to support dairy projects, and potentially other fuel technologies, by leveraging revenues from existing credit trading programs to build these projects. Such financial mechanisms could represent another leading effort by the State to address climate change and promote green/low-carbon finance in California.

Similar concepts have already been demonstrated to be effective in promoting GHG mitigation in other areas of the world: the World Bank Group used a similar mechanism to promote projects that mitigate methane and nitrous oxide emissions, and the United Kingdom government used a similar scheme to promote renewable power generation. One key advantage of these types of financial mechanisms is that they are "pay for performance" programs—projects are only provided money in proportion to their actual production and associated reduction in GHG emissions.

This staff analysis details how the use of a financial mechanism can be a more effective way to use State funds relative to just relying on grant programs. Potentially, financial mechanisms could be expected to support a similar number of dairy projects relative to grants, while either reducing the State's spending or potentially earning the State a positive return.

On the other hand, such a financial mechanism faces two hurdles to implementation that will need to be addressed:

- It would require the establishment of a long term fund that can credibly guarantee the value of environmental credits for an extended period of time (10+ years)
- It would potentially require larger initial appropriation of funds—albeit with a lower probability that the money is spent—relative to continued reliance exclusively on grants.

Staff believes that the use of such a financial mechanism could represent a promising innovation that would further solidify California's role as a leader in the fight against climate change and in the use of cutting-edge carbon financing concepts. The financial mechanism is potentially a useful tool for the State to promote proven GHG mitigating technologies. The financial mechanisms considered here could help alleviate concerns about market risks and leverage private capital and programs already providing strong signals for GHG emissions mitigation. This will allow the State to potentially develop grant programs that target research, development, and deployment of more uncertain—but potentially game-changing—technologies and projects (e.g "valley of death" projects between lab scale demonstration and full commercial deployment).

2. INTRODUCTION

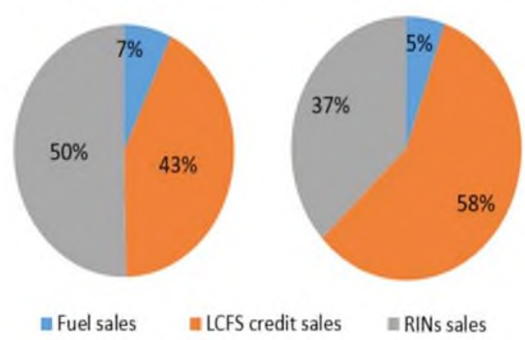
Senate Bill (SB) 1383 (Lara, 2016) requires that CARB develop a pilot financial mechanism to reduce the economic uncertainty associated with the value of environmental credits—including credits pursuant to the Low Carbon Fuel Standard regulation—from dairy related projects producing low-carbon transportation fuels.[ii] Additionally, SB 1383 requires statewide reduction of methane of 40 percent below 2013 levels by 2030, including similar reductions from dairy and livestock operations.

Methane emissions represented 9% of California's greenhouse gas (GHG) emissions inventory in 2015.[iii] On a per-ton basis, methane is a more potent climate forcer than carbon dioxide and California has made reducing methane emissions a high priority.[iv]

The Short Lived Climate Pollutant (SLCP) Reduction Strategy identifies gas from organic waste, particularly from dairy manure management, as an opportunity for California to meet a multitude of environmental goals while providing significant economic benefits to the state.[vii] The report highlights that in-state biogas development can help to significantly reduce methane emissions, while providing valuable clean energy resource, including low carbon transportation fuel. Renewable gas from these sources can substitute for petroleum-derived diesel and contribute to the LCFS goal of decreasing the carbon intensity (CI) of California's transportation fuel pool. The fuel is already being used in California vehicles—renewable natural gas (RNG) displaced about 28 million diesel gallon equivalent (DGE) in the third quarter of 2017, and reduced the transportation's sector GHG emissions by more than 180,000 metric tons of CO_2 equivalent ($MTCO_2e$).

Projects to produce transportation fuel from dairy biogas in California face difficulties in raising capital due to their heavy reliance on revenues from the sale of environmental credits to make the projects economically feasible. Figure 1 shows that a typical dairy biomethane[ix] project would generate more than 95 percent of its revenues from the sale of LCFS credits and credits issued under the federal Renewable Fuels Standard (RINs).[x] The heavy reliance on the sale of volatile environmental credits exposes these projects to atypical risks which may make financial institutions perceive them as too risky to offer capital to.

Figure 1: Sources of revenue from two hypothetical dairy biogas projects: scrape conversion (left) and covered lagoon (right)



The first type of risk of concern to financers of such projects is the volatility of the value of the environmental credits (price volatility risk). As can be seen in Figure 2, the value of LCFS credits has been volatile throughout the years. The values of RINs relevant to dairy RNG projects have also been volatile, ranging between just above $0.40 to more than $3.00 per RIN in the period between 2012 and the present.[xi]

Figure 2: Time series of LCFS credits

The second type of risk is the possibility of early termination of either program and/or the potential for significant changes that may affect the value of these credits (program risk).[xii]

A well-designed SB 1383 financial mechanism may help shift who bears these risks in the case of dairy biomethane projects. As discussed in detail below, such a financial mechanism would involve the government taking some of the project developer's exposure to these risks in exchange for some payment from the developer. By providing funding to finance such a mechanism, the government sends a clear signal of its perception of such risks and demonstrates commitment to these projects.

A financial mechanism will not, however, eliminate all risks involved with these projects. Projects will be exposed to typical risks such as operational and macroeconomic risks. These risks will continue to be borne by the private parties involved in the project. Therefore, the mechanisms discussed in this paper are "pay for performance" programs where the government does not protect against project nonperformance (projects that fail to produce biomethane in a given year will not receive any revenue). This is appropriate as the performance of the project is primarily a function of the ability of the private actors involved, including the project developer and their counterparties, to build and operate a successful project.

This paper describes two financial mechanisms that could be developed to reduce the risk for dairy project developers. Chapter 3 provides a brief summary of other state programs that aim to reduce methane emissions from California dairies. Chapter 4 provides a historical background on how similar financial mechanisms have been implemented by other entities. Chapter 5 describes the two financial mechanisms and provides simple illustrative examples. Chapter 6 discusses the parameters that would determine how the financial mechanisms will work. Chapter 7 discusses the criteria of the projects that are eligible for the financial mechanism. Chapter 8 discusses the amount of funding for establishing the financial mechanism, and potential agencies or groups that may run such a program.

3. SUMMARY OF EXISTING DAIRY METHANE MITIGATION PROGRAMS IN CALIFORNIA

I. Dairy Digester Research and Development Program (DDRDP)

The California Department of Food and Agriculture (CDFA) administers the DDRDP, which provides grants to dairy digester projects in California.[xiii] To receive awards from the DDRDP, projects must utilize the produced biogas for power generation or transportation fuel production, demonstrate GHG emission reductions, and meet water and air protection goals. The grant awards cover up to 50 percent of a project's cost up to a maximum of $3 million per project.

The Budget Act of 2014 provided CDFA with $12 million from the Greenhouse Gas Reduction Fund (GGRF) to fund dairy methane mitigation projects. In 2015, The CDFA, through a competitive grant process awarded six projects with a total of $11.1 million, and the rest was used to fund dairy digester research and to cover administrative costs. The Budget Act of 2016 awarded CDFA an additional $50 million from the GGRF to reduce methane from dairies, of which $35.3 million was awarded to 18 dairy projects, and the rest of the funding going to the Alternative Manure Management Program (AAMP – discussed below) and administrative costs. Of the 24 projects that were awarded funding in the two solicitations, four are electrical power generating projects, ten are renewable compressed natural gas (RCNG) projects, six will deliver process energy for the Calgren plant for ethanol production with a potential future expansion to deliver RCNG, one is a combined electrical power and RCNG project, and one is a project that will generate electrical power and heat.

The Budget Act of 2017 awarded CDFA an additional $99 million from the GGRF for dairy methane mitigation, of which $61-$75 million are expected to be awarded through the competitive DDRDP grant process, and the rest will be awarded through the AAMP. Seventy-four projects have applied for the third DDRDP round. Award results will be published in July 2018.

II. Alternative Manure Management Program (AMMP)

The AMMP, also administered by the CDFA, awards grants to projects that mitigate methane through non-digester manure management practices.[xiv] Similar to the DDRDP, the grant awards are based on a competitive process. The AMMP covers 100 percent of the cost up to a maximum of $750,000 per project. In 2017, the CDFA awarded 18 projects for a total of $9.6 million through the AMMP. In 2018, the CDFA plans to award an additional $24-$38 million to projects through the AMMP.

III. BioMAT

SB 1122 (Rubio, 2012) directed the California Public Utilities Commission (CPUC) to require the Investor Owned Utilities (IOUs) to purchase 250 MW of electricity capacity from projects that generate electricity from biological sources.[xv] Ninety MW of electrical generation capacity is allotted exclusively to dairy and other agricultural waste. In response, the CPUC established the Bioenergy Market Adjusting Tariff (BioMAT) program, a feed-in-tariff program that offers bioenergy electricity projects the opportunity to be compensated for electricity they procure at fixed rates.

IV. CPUC Interconnection Pilot Program

SB 1383 (Lara, 2016) directed the CPUC to require gas utilities to implement at least five dairy biomethane pilot projects to demonstrate interconnection to the natural gas pipeline system. In Dec. 2017, the CPUC adopted *Decision 17-12-004: Establishing and Selection Framework to Implement the Dairy Biomethane Pilots as Required by Senate Bill 1383*, and solicitations for projects are expected to be received in the spring of 2018.[xvi]

V. Compliance Offset Program – Livestock Projects

CARB allows a portion of Cap-and-Trade compliance to be met through offset credits generated by projects that demonstrate GHG reductions by following CARB-approved Compliance Offset Protocols. The Livestock Compliance Offset Protocol provides the required methods to measure, report, and verify GHG emission reductions from projects that control methane from manure produced from cattle and swine operations.[xvii]

VI. Low Carbon Fuel Standard (LCFS):

The LCFS is a performance based standard the incents the production of low carbon transportation fuels by providing producers of low carbon fuels with credits depending on the carbon intensity score of the fuel. Dairies and other facilities which produce RNG from organic waste are eligible to participate in the LCFS program and have generated about 7% of LCFS credits in 2017.

4. IMPLEMENTATIONS OF FINANCIAL MECHANISMS IN OTHER PROGRAMS

Staff and stakeholders have identified two potential designs for the financial mechanism required to be developed by SB 1383. The first design, referred to as a **contract for difference** (CfD), ensures that the generator of the credit will obtain a certain predetermined value for environmental credits regardless of the market price. The second design, referred to as a **put option**, ensures that the credit value will not fall below a minimum predetermined floor price. Both of these mechanisms would greatly reduce the risk to credit generators created by fluctuations in the value of environmental credits.

I. Contracts for Difference

CfDs have been used by the UK Department for Business, Energy and Industrial Strategy (BEIS) to incentivize low carbon electricity generation.[xviii] For each technology category (e.g. offshore wind, onshore wind, energy from waste) a different CfD strike price is determined by a reverse auction. The reverse auction mechanism induces competition between different energy providers within each technology category without limiting the number of projects, as all committed funds will be spent. Each firm competitively bids down the strike price of the CfD until the available funding is fully committed.[xix] The winning firms receive a CfD with a strike price that is fixed for 15 years. If market electricity prices are below the CfDs strike price, the generator will receive the difference from the program administrator (BEIS). By contrast, if market prices are higher than the strike price, the generator will pay the administrator the difference. The first auction was conducted on Feb 26, 2015, funding 27 projects with a total capacity of 2.1 GW, at an estimated total cost of £56 million.[xx] The second auction was held on Sep 11, 2017, funding eleven projects with a total capacity of 3.3 GW, at an estimated total cost of £149 million.[xxi]

Another example of a program similar to CfDs was the California Ethanol Producer Incentive Program (CEPIP). The California Energy Commission (CEC) designed CEPIP to compensate ethanol producers under specific unfavorable economic conditions, and require that producers reimburse the program in specific favorable market conditions.[xxii] This arrangement, while not perfectly mirroring a CfD, presents an interesting modification that may be considered. The CEPIP payments and receipts depended on the ethanol crush spread (ECS) which was defined by the following formula:[xxiii]

$$ECS = \text{Ethanol price} - \frac{\text{Corn price}}{\text{Ethanol Yield}}$$

If the ECS was below 55 cents per gallon (cpg), the program compensated the producer for the difference between 55 cpg and the monthly ECS, up to a maximum of 25 cpg. If the ECS was higher than $1 per gallon, then the producer would reimburse the program the difference up to a maximum of 20 cpg. The producer would only have to pay the program the deficit it incurred from previous payments made by the program to the producer. The program was funded through the Alternative and Renewable Fuel and Vehicle Technology Program and was run by the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA). AB 523 (Valadao, 2012) precluded the funding of ethanol produced from corn through CEPIP.

An International Council on Clean Transportation working paper compared alternative schemes to finance ultralow-carbon fuel projects and found that a CfD scheme would be able to support the same amount of projects at a substantially lower cost in contrast to other more "traditional" financing schemes such as capital grants and production subsidies.[xxiv]

II.Put Options

Put options have been used by the World Bank's Pilot Auction Facility (PAF) to set a floor price for carbon reduction credits generated by Clean Development Mechanism (CDM) projects. Government donors capitalized a fund, and then an auction was held where competitive bids were submitted by bidders seeking to purchase the put option. The first two auctions held were forward auctions. Under the forward auction, the auction strike price was fixed and bidders competed to purchase the options, with the option premium increasing until the market was cleared. The last auction, held on January 10, 2017, was a reverse auction, where the option premium was fixed, while bidders competitively bid down the strike price until the market cleared. The three auctions insured a total of 11.9 million tons of CO_2e of credits.[xxv]

5. PROPOSED MECHANISMS

This section discusses these two possible mechanisms in the context of dairy biomethane projects in California. Both of the proposed mechanisms involve establishing a contract between two parties—namely the project developer that has produced the biomethane and taken ownership of the environmental credits (referred to as the Producer) and the pilot financial mechanism program administrator who administers payments and receipts to the pilot financial mechanism (referred to as the Administrator).

I. Contracts for Difference

Under this design mechanism, the Producer and the Administrator enter a contract where the two parties agree on a predetermined price (referred to as the strike price) for a specified quantity of environmental credits. When the market price of the environmental credit is below the strike price the Administrator pays the Producer the difference. Conversely, when the market price of the credit is above the strike price the Producer pays the Administrator the difference. The CfD guarantees the Producer a certain annual revenue, and eliminates the Producer's exposure to the price volatility and program risk.[xxvi]

The following example illustrates how a CfD would work. First, assume a Producer is expecting to generate 100 environmental credits in one year.[xxvii] Next, assume that in a year the environmental credit price will either be \$100 or \$150.[xxviii] The Producer's earning from the sale of environmental credits can be expressed as:

$$\text{Env. Credit Sale Earnings} = \text{Market Price} * \text{Quantity}$$

$$\text{Env. Credit Sale Earnings} = \begin{cases} \$10{,}000, \text{ if Env. credit price is } \$100 \\ \$15{,}000, \text{ if Env. credit price is } \$150 \end{cases}$$

Now, suppose the Producer has access to a CfD with a strike price of \$125 a year from today. The Producer elects to enter a contract with the Administrator for 100 CfDs. In a year, the Producer's revenue will be a combination of earnings from the sale of credits, and earnings or losses from the CfDs. The earnings from the sale of credits is identical to the calculations above, while the earnings or losses from the CfDs are:

$$\text{CfD Payoffs} = (\text{Strike Price- Market Price}) * \text{Quantity}_{cfd}$$

$$\text{CfD Payoffs} = \begin{cases} \$2{,}500, \text{ if Env.credit price is } \$100 \\ -\ \$2{,}500, \text{ if Env.credit price is } \$150 \end{cases}$$

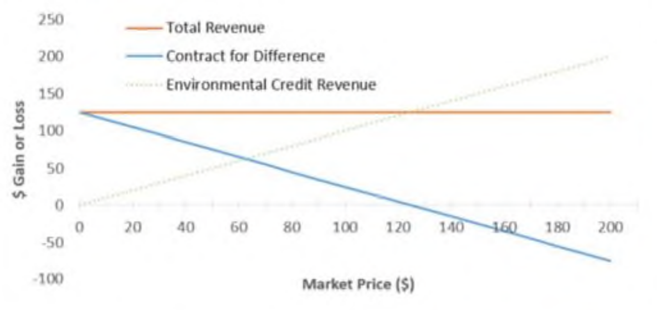
Thus the total revenue for the digester in a year from sale of credits and CfD payoffs are:

$$\text{Total Earnings} = \text{Env. Credit Sale} + \text{CfD Payoffs}$$

$$\text{Total Earnings} = \begin{cases} \$12{,}500, \text{ if Env.credit price is } \$100 \\ \$12{,}500, \text{ if Env.credit price is } \$150 \end{cases}$$

Figure 3 summarizes the gains and losses (in blue), from the perspective of the Producer, from obtaining a CfD with a strike price of \$125. At market prices below the strike price, the CfD pays to the Producer the difference between the strike price and the market price and results in a gain for the Producer. At a higher market prices, the CfD will require the Producer to pay the Administrator the difference between the market price and the strike price, resulting in a loss for the Producer. However, as the orange line shows, the total revenue (the sum of the revenue from the sale of the environmental credits and the gains or losses from the CfD) stays constant regardless of fluctuations in market price.

Figure 3: Gains and Losses and Total Revenue from a Contract of Difference with a Strike Price of $125.



From this example, it's clear that the price risk has been completely eliminated for the Producer. Regardless of the market price of the environmental credit, the CfD ensures that the Producer's revenues are completely unaffected by price volatility of the environmental credit; the Producer will certainly earn $12,500 in revenues in a year from the combination of the sale of its credits and CfD payments.

II. Put Options

Under a put option, the Producer and the Administrator enter an agreement whereby the Producer is guaranteed a minimum price for the environmental credits (which is referred to as the strike price). If the market price is lower than the strike price, then the Producer will receive the difference between the market price and the strike price from the Administrator. If the market price is higher than the strike price, then no payments are made. Unlike CfDs, the put options mechanism design requires Producers to pay an initial premium for the right to obtain the put option. Put options are always valuable which means that all Producers will attempt to obtain options if they are offered without a premium; a free put option is similar to a free insurance product which is valuable to all participants. A premium thus acts as both a way to screen for serious applicants who can complete projects at the lowest possible economic cost, and as a potential source of revenue to the Administrator to expand the program over time.

Just as in the previous example, assume a Producer expects to generate 100 environmental credits in one year. Also assume that environmental credit prices will either be $100 or $150 in a year. The revenue if prices are $100 is $10,000, and if prices are $150 it is $15,000.

Suppose the same Producer has access to a put option with a strike price of $125 and a premium price of $10/option, and it chooses to purchase 100 put options, completely eliminating its downside risk. In a year the options will have the following payoff:

$$\text{Put options Payoffs} = \text{Max}(\text{StrikePrice - Market Price}, 0)*\text{Quantity}_{\text{options}}$$

$$\text{Put options Payoffs} = \begin{cases} \$2{,}500, \text{ if Env.credit price is } \$100 \\ \$0, \text{ if Env.credit price is } \$150 \end{cases}$$

Where the $Max\ (a, 0)$ function returns a if $a > 0$ and returns 0 otherwise. Thus the Producer's total earnings are:

$$\text{Total Earnings} = \text{Env. Credit Sale} + \text{Option Payoffs}$$

$$\text{Total Earnings} = \begin{cases} \$12{,}500, \text{ if Env.credit price is } \$100 \\ \$15{,}000, \text{ if Env.credit price is } \$150 \end{cases}$$

Figure 4 summarizes the gains (in blue), from the perspective of the Producer, from obtaining a put option with a strike price of $125. At market prices below the strike price, the put option pays to the Producer the difference between the market price and the strike price and results in a gain for the Producer. At a higher market prices, no payments are exchanged between the Producer and the Administrator. The orange line shows that the total revenue under this mechanism provides a floor for the Producer, while maintaining the potential for a significant upside.[xxix]

Figure 4: Gains and Losses and Total Revenue from a Put Option with a Strike Price of $125.

Two main points differentiate put options from CfDs. First, put options require an initial outlay from the Producer to purchase the put options, while CfDs do not require any exchange of cash at the onset of the contract. In the put option example, the Producer needed to purchase the options for $1,000. Second, put options eliminate negative variations only and maintain the potential for an upside with the Producer, while CfDs eliminate both positive and negative variations for the Producer.

III. Variations on Basic Designs

a. Payout Limits

Both the CfD and put option design can be modified by adding a limit on the amount of payouts to the Producer. Limiting payouts to Producers will have the effect of decreasing the amount of risk transferred from the Producers to the Administrator. This modification will also allow the Administrator to cover a larger number of projects for the same amount of funding. Limiting payouts, however, reduces the certainty provided to the Producer by the contract with the Administrator.[xxx]

Payouts can be limited by specifying certain annual or lifetime limits on payments. To illustrate, suppose a CfD contract is signed by an Administrator and a Producer covering the LCFS price value with a Strike Price of $100 per environmental credit and an annual payout limit of $40 per environmental credit. If the market price of the environmental credit for that year falls below $100, the CfD will compensate the Producer the difference up to $40 maximum.

b. CfD with a Ceiling and a Floor

This modification to the financial mechanism is only applicable to CfDs. Instead of specifying one strike price, a CfD can specify two prices: a floor price and a ceiling price. If the market price falls below the floor price, the Administrator will pay the Producer the difference between the market price and the floor price. If the market price is higher than the ceiling price, the Producer will have to pay the difference between the market price and the ceiling price. If the market price falls between the floor and ceiling prices, then no money is exchanged between the Producer and the Administrator.

This modification allows the Producer to capture some of the upside in the value of environmental credits, while still covering a significant proportion of the price volatility and program risk discussed above.

Figure 5 summarizes the gains or losses (in blue), from the perspective of the Producer, from obtaining a CfD with a floor price of $125 and a ceiling price of $150. At market prices below the floor price, the CfD pays to the Producer the difference between the floor price and the market price and results in a gain for the Producer. At market prices between the ceiling and floor prices, no payments are exchanged. At market prices higher than the ceiling price, the Producer will have to pay the Administrator the difference between the market price and the ceiling price, resulting in a loss for the Producer. The orange line shows that the total revenue with a CfD with a ceiling and floor price, illustrating how this mechanism guarantees the Producer that the value of the environmental credits falls in a range between the floor and the ceiling price.

Figure 5: Contract of Difference with a Floor ($125) and Ceiling ($150) Price

Table 1 provides a summary of the different proposed mechanisms. A CfD will guarantee projects a specific price for their environmental credits and will require no upfront cost. A CfD with a ceiling and floor price will guarantee projects a specific price range for the environmental credits and also will not require any upfront cost. Put options provide projects with a minimum guaranteed value for their environmental credits, and no limit for their upside potential. However, put options require Producers to pay an upfront cost to obtain them.

Table 1: Summary of Different Proposed Financial Mechanisms.

	CfD (one Strike Price)	CfD (Ceiling and Floor Prices)	Put Options
What is guaranteed?	A specific price	A specific price range	A minimum price
Upside potential to Producer?	None	Within the specified range	Unlimited
Upfront cost to Producer?	No	No	Yes

5. FINANCIAL MECHANISM PARAMETERS

As discussed above, both CfDs and put options are contracts between a Producer and Administrator that are defined by several parameters: strike price (or a floor and a ceiling price in the case of a CfD with a floor and ceiling price), a premium price (for put options), market price and contract length. In this section, we discuss options for how each of these parameters could be determined by the program Administrator.

I. Strike Price

The strike price is one of the most important parameters that will determine the success of the financial mechanism. If the strike price is set too low, the financial mechanism will not be attractive to Producers. Conversely, if the strike price is too high, the financial mechanism may overpay Producers for GHG reductions from dairy projects.

To address this issue, both the World Bank Pilot and the United Kingdom determined the strike price by using an auction format. Both the World Bank Group and the United Kingdom cited that the auction format ensured only the lowest cost projects received financing, thereby ensuring the cost efficiency of the program and maximizing the GHG reduction impact of the programs.[xxxi,xxxii] ICCT's working paper on CfDs also recommends the use of an auction to determine the strike price of the CfD. Holding a reverse auction process is possible for both CfDs and put options.

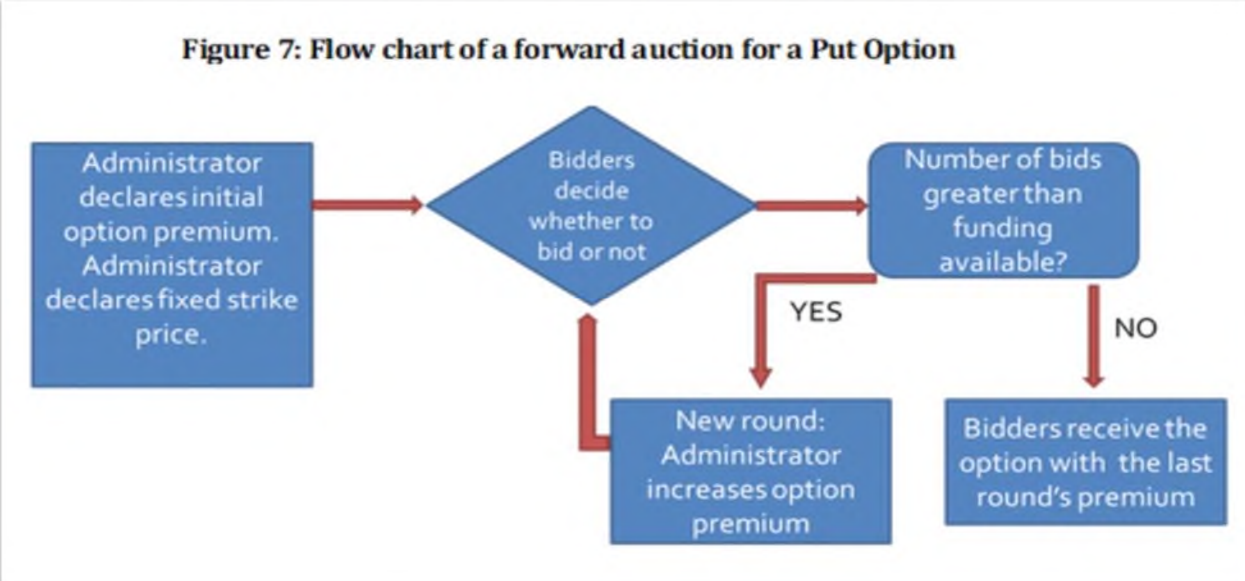
Figure 6 summarizes the process of a reverse auction for a CfD with one strike price. In the first round, the Administrator will announce an initial strike price. Bidders then determine whether to bid for the CfD or not. If the number of bids is greater than the funding available, then another round is held, with a lower strike price. When the number of bids falls below the amount of funding available, the auction concludes and the bidders of the last round will obtain a CfD with a strike price of the last round.

Figure 6: Flow chart of a reverse auction for a CfD (One Price)

CfDs with floor and ceiling prices and put options can be auctioned by the same reverse auction process but with an additional requirement. For a CfD with a floor and a ceiling, a fixed interval between the floor and ceiling will be determined by the Administrator. In other words, the ceiling price will be equal to the floor price plus a fixed interval that will be announced before the beginning of the auction. For put options the Administrator will have to announce a fixed premium price as well as an initial strike price. While the strike price decreases from one round to the next, the premium remains fixed for the duration of the auction.

In all cases the winners of the final bid will enter a contract with the Administrator. In the case of put options, Producers will have to pay the Administrator the put option premium multiplied by the number of option contracts won.

As in all auctions, the success of an auction in setting the appropriate strike price will be determined, in part, by the number of bidders and their bidding strategies. We note that the number of firms active as project developers currently involved in developing digester projects in California is small. We request stakeholder comments on whether a reverse auction to determine strike price would be competitive with the number of firms currently expected to be interested in such contracts.



II. Put Option Premium
As discussed before, the put option shifts the downside risk of the environmental credit price to the Administrator, while allowing the Producer to retain all of the upside benefit. Producers must pay a premium to the program Administrator to acquire this option.

In the previous subsection, staff discussed that the put option premium can be fixed by the Administrator, and a reverse auction can be held to determine the strike price of the option. The winners of the bids are the Producers who accept the lowest strike price and will proceed to pay the Administrator a premium price of the option selected by the Administrator.[xxxiii]

Alternatively, if the Administrator selects the strike price and the price of the premium is instead subject to auction, it may ensure that only the Producers who value the option the highest will succeed in securing the option. The premium also provides a partial source of program funding, so maximizing this value has some advantages from the Administrator's perspective.

An auction procedure that can be used to effectively award put options with a variable premium is a forward auction. This is the auction procedure that was used in the World Bank's PAF second auction. Figure 7 summarizes the process of a forward auction for a put option. In the first round, the Administrator will announce an initial option premium and declares the fixed strike price. Bidders then determine whether to bid for the put option or not. If the number of bids is greater than the funding available, then another round is held, with a higher put option premium. When the number of bids fall below the amount of funding available, the auction concludes, and the final bidders will obtain the put option at the option premium of the last round. The winners of the bid will then have to pay the Administrator the put option premium multiplied by the number of options won.

The choice between a forward and a reverse auction is not clear. According the World Bank PAF report, theoretically the two approaches are similar, but in practice there are some differences. Forward auctions favor well-capitalized firms that can afford to finance the initial high outlay. Forward auctions might also lead to higher amounts of funds raised by the Administrator in the auction, which can be used to provide additional funding for subsequent contracts.

III. Market Price
The payout for the financial mechanism, whether it is a CfD or a put option, depends on the difference between the strike price and the market price. In the above subsection, staff discussed how the strike price can be determined.
To determine the market price for the financial mechanism requires specifying the following three factors:

- What environmental credits are included in the market price calculation?
- What data should be used to determine the value of these credits?

- What period to use as a basis for the calculation.

Several choices can be made regarding which credit(s) to include as basis for calculating the market price for the PFM. One choice is to just include the LCFS credits. Another is to include the value of LCFS credits as well as the value of RIN credits. Another is to include the value of LCFS credits, RIN credits and any additional environmental credits or subsidies awarded to the project in the future. Additionally, the commodity price of the natural gas produced may be included in the definition for the market price.

Current staff thinking is to include the widest definition of project revenue for the mechanism.

There are several advantages to including a wider variety of credits for calculating the market price. First, the more types of credits that are included, the bigger the sum of the value of these credits, which means that the Administrator is less likely to payout, for the same strike price.

Second, the value of different credits historically have not been highly correlated to each other. In other words, a rise in D3 RIN price is not necessarily accompanied by an increase in the price of LCFS credits. In fact, all else considered equal, LCFS credit prices are more likely inversely correlated with RIN values, with LCFS credit values increasing as RIN values decrease and vice versa. This translates to a lower total variability of the credit values, and thus decreases the variability of payouts from and to the financial mechanism.

Third, including a broad definition of credits will allow the program flexibility to include credits that might come up in the future or to modify the definition of credits if the LCFS program or the RFS program change substantially in the future. Finally, including a broad definition of credits will allow Producers to shift from receiving LCFS credits to receiving Cap and Trade program offsets if future changes to market prices justify the shift.

If multiple environmental credits are used to determine the market price, it must be made clear what the strike price unit is. For example, if LCFS credits and RINs are both used to calculate the market price, then it is not immediately clear what the strike price will represent, is it $/ton GHG mitigated, $/MMBTU, or some other unit?

Current staff thinking is that the strike price be represented on the basis of $/ ton GHG mitigated, since the goal of the financial mechanism is primarily to achieve maximum GHG mitigation given the available funding. The GHG mitigated calculation should follow the calculation developed under the LCFS program.

For price data, current staff thinking is to use average market prices of credits rather than the actual amount received by the Producer. This minimizes the potential for large credit buyers to exercise market power over small fuel producers, knowing that they are ultimately covered under the mechanism. The average of LCFS prices is calculated and published weekly, monthly, and quarterly by CARB.[xxxiv] For RINs current staff thinking is to use the average prices provided by multiple subscription services such as OPIS and Argus Media. We seek stakeholder feedback in this area.

Determining the reference date and data to use as a basis for calculation is the next step. Since the sale of the fuel and the credit(s) may not be on the same date, several ways can be used to determine the reference date.

Current staff thinking is to use the calendar quarter of the sale of the fuel as the reference date. The use of a quarterly reference date ensures that the market prices are reflective of average prices, rather than daily or weekly trades which may be non-representative of the value actually received by the Producer for their credit sales. A quarterly price evaluation is also consistent with the issuance of LCFS credits, which occurs quarterly.

IV. Contract Length

Current staff thinking is to use a contract period of 10 years, with an additional 2 years grace period to allow for construction.

There are several advantages to a longer contract period (10+ years). A longer contract period will provide investors with a longer period of increased security for the revenue from their investment. Producers will thus be more likely to accept lower strike prices from the financial mechanism, allowing for more projects to be built with the funding available.

Additionally, a 10 year contract period comports with the 10 year crediting window for methane destruction under CARB's Offset Protocol Livestock Projects and the Draft LCFS Dairy Crediting Guidance.[xxxv,xxxvi]

6. PROJECTS CRITERIA, LIMITATIONS AND EXCLUSIONS

In this section, staff proposes the inclusion of several criteria to determine whether projects are eligible to participate in the financial mechanism bidding process. The criteria will ensure that participating projects will demonstrate protection of air and water quality, financial soundness, and "shovel readiness." Staff also discuss criteria for the exclusion of certain projects.

I. Air and Water Quality Protection

Staff proposes that projects must meet or exceed the water and air protection criteria set by the 2018 Dairy Digester Research and Development Program (DDRDP).[xxxvii]

II. Financial Soundness and "shovel readiness"

Staff proposes that projects must demonstrate their financial and technical expertise in managing similar projects. Projects should also demonstrate their readiness to undertake the project by including supporting evidence, including but not limited to, the obtaining of required permits. A more complete list of required evidence should be developed by the Administrator. We seek stakeholder input in this area.

III. Exclusions and Limitations

Staff propose the following projects should be excluded from participating in the financial mechanism project.

- Projects that do not use a commercially available technology for manure management.
- Projects that propose to switch from existing manure management practice to other practices that could increase baseline GHG emissions (for example, switching from a dry scrape to flushed lagoon system).

IV. DDRDP and CPUC Interconnection Pilot Project

SB 1383 (Lara) directed the "California Public Utilities Commission (CPUC) to direct gas corporations to implement no less than five dairy biomethane pilot projects to demonstrate interconnection to the common carrier pipeline system."[xxxviii] Interconnections represent a substantial portion of the cost of building a dairy digester project, and thus a gas corporation funded interconnection may potentially unfairly advantage the dairy biomethane projects covered under this pilot project.[xxxix]

The DDRDP provided grant funding for seventeen projects that will produce RCNG and will potentially earn LCFS credits. The DDRDP grants will also cover a substantial portion of the capital cost of these projects.

Staff proposes that projects which are included in the CPUC pilot project or the DDRDP should still be eligible to apply for the pilot financial mechanism but suggest the "market price" used for these projects should include the amortized value of the interconnection or the DDRDP funding, in addition to the value of the environmental credits included as discussed in section 5.III. This calculation will allow these projects to participate in the financial mechanism, without putting other projects at a competitive disadvantage.

7. FUNDING NEEDED AND IMPLEMENTATION

I. Funding Needed

The funding needed for this mechanism depends largely on the number of dairies that will be covered under the program and the degree of protection offered by the financial mechanism.

To achieve SB 1383 goals, the SLCP Reduction Strategy report estimates that low carbon transportation fuel projects at over 500 dairies, housing one million milking cows, can be cost effectively developed at recent LCFS and RIN credit prices. A financial mechanism, such as the one described here, could help develop those projects before they might otherwise, and before regulation may require it, which could deliver significant additional methane reductions.

The SLCP Reduction Strategy report also included an economic analysis of the net present value of different methane mitigation projects for a hypothetical 2,000 cow dairy. Using similar assumptions[xl], staff calculated the funding needed per a dairy participating in a CfD financial mechanism. Table 2 provides an estimate of the guaranteed revenue per $MTCO_2e$ mitigated that would be required by different project types to ensure they break-even. These values assume that the market price is calculated to include both the LCFS and RIN credits.

Table 2: Required Guaranteed Revenue per Metric Ton CO_2e Mitigated to Make SLCP Dairy Projects Break-even if RINs are included

	$/MTCO_2e$ needed for project breakeven	Annual revenue needed for a 2000 cow dairy (million $)
Pathway 1b: Scrape conversion + onsite digestion and clean up	$156	$1.25
Pathway 2b: Scrape conversion + centralized digestion and clean up	$120	$0.96
Pathway 3b: Covered lagoon + onsite gas cleanup	$147	$1.18
Pathway 4b: Covered lagoon + centralized gas cleanup	$132	$1.06

For the same number of dairy projects covered under the financial mechanism, the funding required to implement a put option financial mechanism should be lower than using CfDs for two reasons. First, the Administrator will earn a premium that will be used to defray some of the initial needed funding. Second, put options offer the Producers unlimited upside profit, and thus Producers will likely accept a lower strike price than the CfD. A lower strike price will mean less funding needed to establish the financial mechanism. However, put options are more complicated to value than CfDs, as valuing them requires making assumptions about the volatility of the LCFS credit prices (and potentially the volatility of RIN prices, and the covariance between the prices of LCFS and RINs, if RINs are included in the market price calculation).

Staff also conducted an analysis of the funding needed based on the cost data provided to the CDFA for the DDRDP grants awarding process. The DDRDP funded a total of 24 projects in two rounds. Twelve of these projects plan to produce renewable CNG (RCNG) exclusively, six of the projects plan to provide process energy for the production of ethanol at the Calgren ethanol biorefinery with plans to eventually use the dairy gas for the production of RCNG for transportation fuel, and one project plans to produce both electricity and RCNG. The remaining projects plan to use the dairy biogas for power or power and heat generation.

How does this policy design compare with grant awards? To illustrate, suppose the State plans to spend $100 million to fund dairy digester projects annually. Through grant awards, and assuming the grant funds 30% of the capital costs, the State can fund 452 dairies in eight years. On the other hand, if the funding is used to establish a financial mechanism that awards contracts to projects for eight years and expires in 20 years[xli], and assuming that unused funds can be used to fund new projects in subsequent years, then the number of dairies that can be supported depends on the design choices of the financial mechanism and the prices of LCFS and RIN credits. Table 3 summarizes the potential number of digester projects that can be supported with a CfD that covers both the values from the LCFS and RFS credits, under three different environmental credit prices scenarios: optimistic, medium and pessimistic. To cover the target of 543 dairies, staff calculates that the financial mechanism fund should receive $250 million annually for 8 years in the optimistic scenario, $325 million annually for eight years in the medium scenario, and $475 million annually for eight years in the pessimistic scenario.

If, on the other hand, the financial mechanism limits the annual payment to a portion of the potential losses, then more projects can be covered with the same amount of funding. However, project developers and their creditors will either have to accept a larger risk, or obtain private insurance or other instruments to decrease their risk exposure.[xlii] Table 4 summarizes the number of projects that can be funded with a put option design financial mechanism that is funded by $100 million annually for eight years under different credit price scenarios. For this analysis, staff assumed a higher strike price will be needed to cover the cost of the insurance product but limited the payouts to an annual maximum of $40/MTCO$_2$e.[xliii]

This analysis shows that grants and partial coverage financial mechanisms are more likely to bring more projects in operation and at a faster pace than a financial mechanism that provides a full coverage of risk. Grants will bring in a more certain number of projects than the financial mechanism, since the number of projects that can be funded with the financial mechanism will depend on uncertain future credit prices. However partial

Table 3: Number of Dairy Digester Projects that Can Be Supported by the Financial Mechanism with $100 million Annually for Eight Years, Assuming Full Coverage.

Year	Optimistic (LCFS Price = $150, RIN Price = $2.50)	Medium (LCFS Price = $100, RIN Price = $1.85)	Pessimistic (LCFS Price = $50, RIN Price = $0.00)
1	12	12	12
2	27	27	25
3	46	43	39
4	69	62	53
5	97	85	68
6	132	111	83
7	175	141	100
8	229	176	117

Table 4 Number of Dairy Digester Projects that Can Be Supported by the Financial Mechanism with $100 million Annually for Eight Years, Assuming Coverage of $40/MTCO$_2$e Annual Loss.

Year	Optimistic (LCFS Price = $150, RIN Price = $2.50)	Medium (LCFS Price = $100, RIN Price = $1.85)	Pessimistic (LCFS Price = $50, RIN Price = $0.00)
1	40	40	40
2	86	86	81
3	138	138	121
4	196	196	162
5	262	262	202
6	336	336	243
7	420	420	283
8	515	515	324

coverage financial mechanisms provide similar certainty on the number of projects, unless environmental credits experience a large negative shock.[xliv]

With that said, either of the financial mechanisms discussed above are a much cheaper method to get these projects online. Staff calculates that after the 20 year period (when the financial mechanism expires), the fund will hold between $486 million (pessimistic case) to $4,983 million (optimistic case) in the case of a financial mechanism that covers the whole risk of the projects. In the case of a partial coverage financial mechanism, the fund will hold between $0 (pessimistic case) and $1,800 million (medium and optimistic case). The balance at the end of the mechanism can be returned to the State's citizens or used for other purposes. (Under the grants, the whole amount of public dollars are transferred to the project developers and cannot be recovered.) In other words, the financial mechanism can be designed to get similar results to grants, while providing the potential for smaller payouts to projects, making it the more efficient option for the use of the State's funds.

II. Funding Sources

A source of funding will have to be identified prior to implementing the mechanism, as SB 1383 did not specify a source. The Legislature could provide funding for the financial mechanism through the general fund, through an existing special fund (such as the Greenhouse Gas Reduction Fund) or through a fund established through new legislation. Alternatively, if a non-governmental entity was to act as a program Administrator, funds could be made available from other sources, such as private capital.

Various funding sources present some challenges to implementation. If the funding is obtained from the Legislature, the financial mechanism will require a much longer than average period for distribution of funds. California Government Code Sec. 16034.1 limits the spending window for State government funds to 2 years after encumbrance. Current staff thinking is to extend the period to to at least 10 years to accommodate the appropriate contract length under the mechanism. For the financial mechanism to succeed, it is critical to assure investors that the funding is committed for a long period of time to assuage their risk concerns. Additionally, if the money is obtained from the Legislature, a clear description of how residual funds will be liquidated upon program completion should be specified, as the program may not spend all the funding provided.

III. Administering Body

The administering body for the financial mechanism must ideally have the infrastructure and the managerial experience in staff who have run similar programs. Additionally, running the program will potentially require the Administrator to securely handle sensitive and business confidential information.

Staff has identified at least four potential categories of groups that could theoretically run the financial mechanism:

1) The California State Treasurer: Specifically the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) or the California Pollution Control Financing Authority (CPFTA). CAEATFA has expertise in running innovative financing solutions and has previously ran the CEPIP program, which has a similar structure to the proposed financial mechanism. CPCFA specializes in providing innovative financial solutions that mitigate risk for pollution reducing California projects. Additionally, as part of the Treasury, the CAEATFA and the CPCFA have experience in managing State's funding and knowledge of the State's budget process and in prudently managing government assets and cash flows. Additionally, both groups are fully independent of the LCFS and are not involved in any decisions that might affect the LCFS or any other environmental credit prices, thereby reducing the potential conflicts of interests.

2) Grant awarding agencies: The CEC and CDFA both have experience in evaluating projects and conducting competitive award processes. If this mechanism is viewed by stakeholders as primarily a transition from existing grant processes, these agencies may be the appropriate administrators.
3) Independent non-profit organizations: Some non-profits who operate within the green financing/carbon financing space have expertise in running similar programs and can be used to administer this program. An example of such a non-profit organization is the Climate Trust, a non-profit that specializes in carbon instruments financing.[xlv]

4) CARB: While CARB could technically administer this program, staff do not recommend making CARB the Administrator of this program. As the regulator of LCFS markets, CARB has influence on the price of LCFS credits. Since the payout from the financial mechanism is dependent on the price of the LCFS credits, the administering of the financial mechanism by CARB will introduce a perception of conflicts of interest, reducing the efficacy of and trust in both the LCFS program and the financial mechanism.

Staff seeks stakeholder comment on the most appropriate program administrator.

8. CONCLUSION

In this white paper, staff discussed in detail the development of a financial mechanism to support the production of RNG from dairy digester projects in California. Staff believes that the financial mechanism is an innovative way to use the State's funds for the development of this emerging industry. The financial mechanism will potentially save the State a sizeable amount of money, as it leverages revenues from existing programs (such as the LCFS and the RFS) in lieu of increases in State funding of grant awards. Implementing this financial mechanism will require overcoming some important hurdles. It requires the encumbrance of State funds for an extended period, which represent a major shift in how State funding is most often used. Despite these challenges, such a financial mechanism could potentially be a powerful addition to the suite of tools used in California's fight against climate change and examples of leadership.

---

[i] CARB, 2017. *California's 2017 Climate Change Scoping Plan.* https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf. Accessed May 17th 2018.
[ii] Senate Bill 1383 (Lara). https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB1383. Accessed March 6, 2018.
[iii] CARB, 2017. *California Greenhouse Gas Emissions Inventory.* This calculations is based on 100-year Global Warming Potential values. https://www.arb.ca.gov/cc/inventory/data/data.htm. Accessed April 18, 2018.
[iv] CARB 2018. *Reducing Short-Lived Climate Pollutants.* https://www.arb.ca.gov/cc/shortlived/shortlived.htm. Accessed April 18, 2018.
[vii] CARB, 2017. *Short-Lived Climate Pollutant Reduction Strategy.* https://www.arb.ca.gov/cc/shortlived/meetings/03142017/final_slcp_report.pdf. Accessed March 2, 2018.
[ix] The unprocessed gas produced from the digestion process at a digester is referred to as biogas. Biomethane is the gas produced after the biogas is upgraded to pipeline quality.
[x] RINs are credits used by fuel producers and importers to comply with the federal Renewable Fuel Standard (RFS), a federal program administered by the EPA that mandates the use of various biofuels in the United States.
[xi] There are several types of RIN credits that can be generated in the RFS. Each type of RIN has a different market price. Dairy RNG projects produce cellulosic RINs under the RFS.
[xii] Although CARB staff believes the risk is minimal for the LCFS, the program risk for the RFS may be greater, as evidenced by recent political discussions.
[xiii] CDFA. *Dairy Digester Research and Development Program.* https://www.cdfa.ca.gov/oefi/ddrdp/. Accessed April 18, 2018.
[xiv] CDFA, 2018. *Alternative Manure Management Program*. https://www.cdfa.ca.gov/oefi/AMMP/. Accessed April 18, 2018.
[xv] CPUC, 2018. *Bionenergy Feed-in-Tarrif Program (SB1122*). http://cpuc.ca.gov/SB_1122/. Accessed April 18, 2018.
[xvi] CPUC, 2018*. Dairy Biomethane Pilot Project.* http://www.cpuc.ca.gov/renewable_natural_gas/. Accessed April 18, 2018.
[xvii] CARB, 2018. *Compliance Offset Programs.* https://www.arb.ca.gov/cc/capandtrade/offsets/offsets.htm. Accessed April 18, 2018.
[xviii] United Kingdom Department for Business, Energy & Industrial Strategy. *Contract for difference*. https://www.gov.uk/government/publications/contracts-for-difference/contract-for-difference. Accessed March 6th 2018.
[xix] Under a CfD, a producer is paid the difference between the strike price and the market price of the product (in the case of the UK government CfD, the product is electricity generation). Strike prices are discussed in greater details in Chapter 4.
[xx] United Kingdom Department for Business, Energy & Industrial Strategy. *Contracts for Difference First Allocation Round.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407059/Contracts_for_Difference_-_Auction_Results_-_Official_Statistics.pdf. Accessed March 6th 2018.
[xxi] United Kingdom Department for Business, Energy & Industrial Strategy. *Contracts for Difference Second Allocation Round.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/643560/CFD_allocation_round_2_outcome_FINAL.pdf. Accessed March 6th 2018.
[xxii] Staff Workshop on Implementation of the California Ethanol Producer Incentive Program. April, 29th, 2010.

[xxiii] Ethanol price to be used was the OPIS's monthly average of daily spot prices at Los Angeles. CBOT price was the monthly average of daily prices of Chicago Board of Trade (CBOT) corn future for the next period ahead. The yield is calculated as the gallons of denatured ethanol produced per bushel of corn used, which was updated yearly.
[xxiv] ICCT, 2017. *A comparison of contracts for difference versus traditional financing schemes to support ultralow-carbon fuel production in California.* https://www.theicct.org/sites/default/files/publications/CfD-Cost-Benefit-Report_ICCT_Working-Paper_vF_23012017.pdf. Accessed March 22, 2018.
[xxv] World Bank Group. (2017, January 10). Auctions. Retrieved February 3, 2017, from Pilot Auction facility, http://www.pilotauctionfacility.org/content/auctions-0
[xxvi] The flip side of this statement is that the risk is completely transferred to the Administrator, who will be fully exposed to the price volatility and the program risk. Note that, in this simple example, the Administrator also captures the upside if credit prices move higher than the strike price. This value could be used to expand the program over time.
[xxvii] For this discussion, an environmental credit is the equivalent of one metric ton CO_{2e} emission reduction.
[xxviii] The prices for this example and all subsequent examples are for illustration purposes only and not at all indicative of the opinion of staff on where the pilot financial mechanism resultant strike prices should or could be.
[xxix] The figure does not include the cost of the premium.
[xxx] Presumably, if the Administrator sets the payout limits in a way that absorbs the first tranche of risk and makes the project attractive to private sources of underwriting, these private sources would be willing to take the remaining risk at a reasonable cost to the Producer (should the Producer wish to fully cover its downside risk).
[xxxi] World Bank Group. http://www.pilotauctionfacility.org/sites/paf/files/PAF%20REPORT_FINAL.pdf. Accessed March 22, 2018.
[xxxii] United Kingdom Department of Business, Energy & Industrial Strategy. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/575667/Slides_for_1_Dec_presentation_BEIS_FINAL_for_publication_v3.pdf. Accessed March 22, 2018.

[xxxiii] This is the procedure that was used by the World Bank's PAF first and third auction.
[xxxiv] CARB. *Weekly LCFS Credit Transfer Activity Reports.* https://www.arb.ca.gov/fuels/lcfs/credit/lrtweeklycreditreports.htm. Accessed March 22, 2018.
[xxxv] CARB, 2014. *Compliance Offset Protocol Livestock Projects.* https://www.arb.ca.gov/regact/2014/capandtrade14/ctlivestockprotocol.pdf. Accessed April 4, 2018.
[xxxvi] CARB, 2018. *Draft Dairy Crediting Guidance.* https://arb.ca.gov/cc/dairy/documents/12-13-17/dsg2_draft_dairy_crediting_guidance_121317.pdf. Accessed April 4, 2018.
[xxxvii] California Department of Agriculture, 2017. *2018 Dairy Digester Research and Development Program.* https://www.cdfa.ca.gov/oefi/ddrdp/docs/2017-18DDRDP_RequestforGrantApplications.pdf. Accessed March 22, 2018.
[xxxviii] Senate Bill 1383 (Lara). https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB1383. Accessed March 6, 2018.
[xxxix] Sustainable Conservation, 2015. *Greenhouse Gas Mitigation Strategies for California Diaries.* http://suscon.org/pdfs/news/pdfs/GHG_Mitigation_for_Dairies_Final_July2015.pdf. Accessed March 22, 2018.
[xl] Staff used the same cost information as the SLCP economic analysis but made few changes. First, this analysis assumes that projects rely on 50% debt to asset ratio rather than a 100% debt to asset ratio assumed in the SLCP economic analysis. Second, this analysis assumes capital depreciates using a MACRS – 10 year schedule. Third, this analysis assumes that net income is taxed at a marginal tax rate of 30%. Fourth, this analysis assumes that projects of all pathways will earn the same number of LCFS credits, calculated at 8,000 credits annually (actual number of LCFS credits generated will vary annually depending on the annual diesel LCFS standard, and will vary for each dairy due depending on the calculated CI for each particular project).
[xli] For this analysis, staff assumes eight separate annual solicitations for contracts starting in year 2020. Assuming two years construction time and a contract lasting for ten years, this timing guarantees that all projects will be operational by 2030 and all mechanism contracts will expire by 2040.
[xlii] Stakeholders have informed staff that some private insurers are potentially interested in providing revenue insurance products to dairy projects conditional on the projects' participation in a government sponsored financial mechanism.

[xliii] Staff did not include the revenues from the option premiums in this calculation, thus the number of projects is conservatively estimated.

[xliv] This analysis assumes that all projects funded by grants will materialize. This was not the case with dairy digester projects funded by the California Energy Commission (CEC) Digester Power Production Program (DPPP). The first round of funding in 2002 funded the construction of ten projects, which were completed. However, in the second round of funding in 2006, nine projects were funded, but only one project was actually constructed.

[xlv] Climate Trust. *About Us.* https://climatetrust.org/about/. Accessed April 18, 2018.