Policy Levers Influencing the Adoption of Methane Digesters in California Dairies

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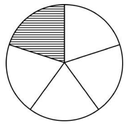
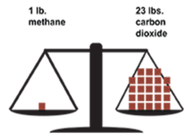
Problem and Purpose

1 Dairy Cow produces 250lbs of methane annually

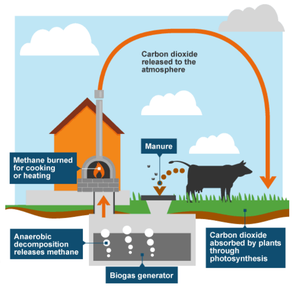


California has $^1/_5{}^{th}$ of all US dairies



1lb methane has the same heat trapping ability of 23lbs of CO_2

In an attempt to limit greenhouse gas production, California recently passed a Bill that requires dairies to cut methane emissions by 40% in the by 2030. They have set aside $50M in subsidies for methane digesters that capture methane from manure that can be used for energy. Creating a model of the adoption of digesters in California dairies can help determine what the best policies to achieve maximum methane emission reduction while keeping digesters financially viable for dairies.

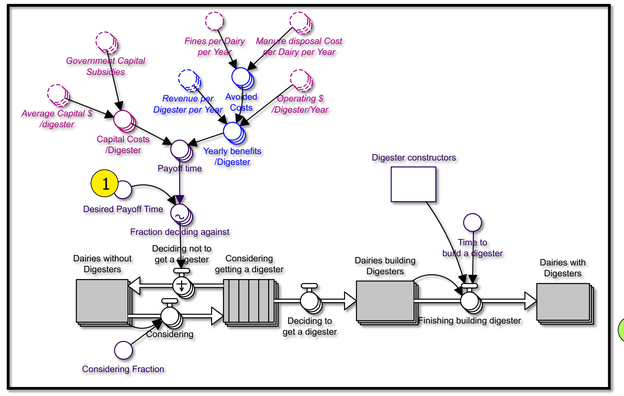


Approach

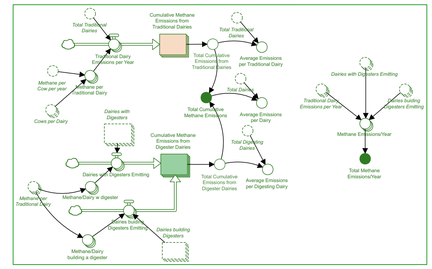
I developed a system dynamics model of digester adoption dynamics. Key aspects of the model include:

- Movement of "Traditional Dairies" to "Dairies with Digesters" (4 sizes: Small, Medium, Large, Mega)
- Payback period accounting influences adoption of digesters
- Methane emission accounting
- Manure related revenue and cost accounting

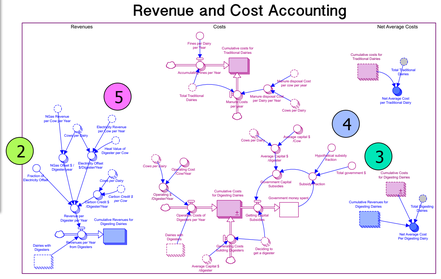
Movement of Dairies from Traditional Manure Management to Digester Ownership for Manure Management



Methane Accounting

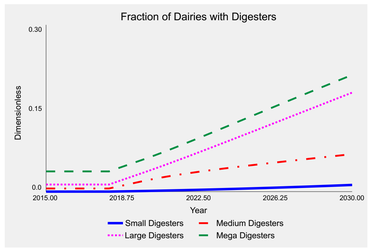


Revenue and Cost Accounting



Progression of Tests

Base test Conditions:
-50% Capital Subsidy
-50M in subsidies
-50% Electricity Offset
-$0.05/kWh wholesale rate
-5 year desired payoff period



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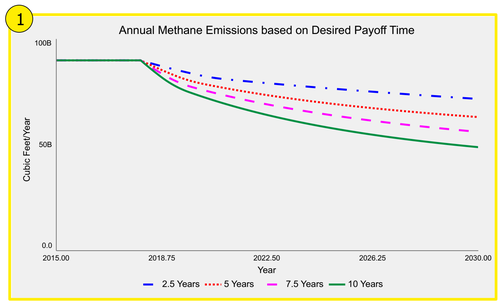

The biggest sensitivity in the whole system was the Desired Payoff Time. The decision to invest is based on how the payback period accounting (Capital costs/yearly benefits) compares to the dairy farmers' average desired payback time, essentially their risk aversion. If the desired payback period were 10 years instead of 5, that alone would lower emissions 40% by 2030

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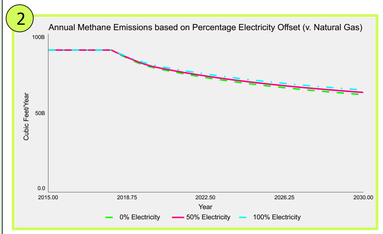

Dairies can burn methane to generate electricity or sell it as natural gas. Utilities often require the dairy farmer to first buy all of their electricity $0.15/kWh and then sell off their generated electricity at a wholesale price of $0.05/kWh. Because of this, dairies get a higher price by selling the methane as natural gas. 100% electricity leads to a 28% drop in methane emissions by 2030 while 100% natural gas leads to a 31% drop

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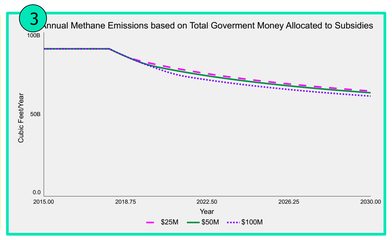

California has decided to allocate $50M to subsidies. In the model, $50M in subsidies runs out in 2.5 years with a 50% capital subsidy rate. The amount of money allocated to subsidies is so small that doubling the amount of money allocated to subsidies only leads to a 2 percent decrease in emissions, from 30% to 32% decrease, by 2030.

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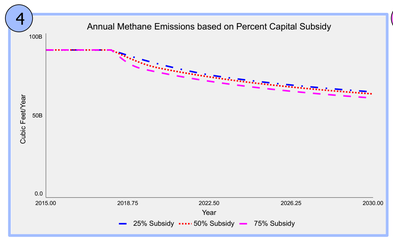

Changing the % subsidy from 25% to 75% lowers methane emissions 3% more, from 29% to 32%, despite that the government is still spending $50M total. This phenomenon occurs because of the non-linear effect of payback period on decision-making.

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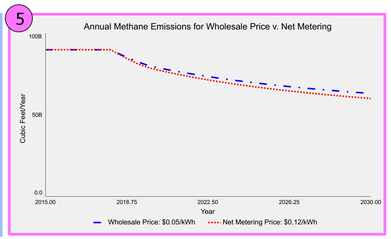

States can force utilities to allow net-metering for renewable electricity generation so that dairies only pay for their net electricity use instead of having to buy all of their electricity at $0.15/kWh and sell at a wholesale rate of $0.05/kWh. A wholesale electricity price leads to a 30% drop in methane emissions by 2030 while net metering leads to a 34% drop.

Conclusions and Implications

- Mega Dairies are the most likely to get digesters because economies of scale lead to smaller payback periods
- Desired payoff time significantly affects speed of adoption. This implies that it would be more effective to hold seminars for dairy farmers to explain the benefits of digesters rather than spending more on capital subsidies
- A higher subsidy offered for a short amount of time is more effective even when the cumulative amount spent is equal
- Requiring utilities to allow net metering for digester-generated electricity would be more effective than investing in infrastructure so dairies can sell methane as natural gas
- The implementation of multiple policies to decrease payback time is more effective than the sum of separate implementation of both policies

Next Steps

- Extend model to represent variety of Anaerobic Digesters Extend methane accounting to total greenhouse gas accounting to account for CO_2 released in building the digesters and in using the methane as fuel
- Expand model to include financing and creation of natural gas pipelines to pipe methane from farms to use areas
- Experiment with how fines could affect outcomes

References and Acknowledgements

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