9. Developing a Biomethane Industry

To be successful a biomethane enterprise must address two main issues, the production of biomethane from organic waste, and the distribution system that will deliver that biomethane to a user. This chapter discusses some of the broad issues related to development of the biomethane industry in the USA. It also reviews the eight steps needed to develop a successful business plan for a biomethane enterprise, and describes five scenarios for potential biomethane projects.

When this study was designed, we believed that the key barrier to producing biomethane from dairy biogas was the lack of economies of scale in a dairy-sized upgrading plant. As our research—including firsthand observation of operations in Sweden—progressed, however, we learned that the small size of dairy operations is only half of the problem. The other half is the need for a distribution system and a market for the fuel.

Thus, to be a viable economic venture, a dairy plant that produces biomethane must be part of an integrated industry that includes all of these activities:

- Gathering the feedstock
- Producing biogas by anaerobic digestion
- Upgrading of biogas to biomethane
- Storing biomethane
- Transporting biomethane
- Using biomethane

Lessons from Sweden

In June 2004, several of the authors of this report joined a small California delegation on an educational tour of the Swedish biogas industry. Sweden is the world leader in the use of biomethane as a transportation fuel. During our week long tour we visited five biomethane facilities and met with many organizations (WestStart-CALSTART, 2004). They have 2,300 vehicles, mostly buses, running on biomethane. Biomethane has proven more reliable than natural gas because it is upgraded to a higher standard (Ichiro Sugioka, personal communication, June 10, 2005).

Swedish experience demonstrates that a viable biomethane industry is possible. The Swedes have about 20 biomethane plants of various sizes. In general, these are centralized plants, run by public agencies, which use a variety of biogas upgrade technologies and use different organic feedstocks, not just manure, in their digesters. This co-digestion of wastes improves production yields.

It is important to note, however, that the economics in Sweden are much more favorable for a biomethane industry than they are in the USA. Sweden has no fossil fuel industry of its own and all natural gas is imported. Automotive fuel is more expensive. Greenhouse gas emissions are highly taxed. Public policy is very committed to energy efficiency, reduced dependence on imported fossil fuel, and reduction of greenhouse gas emissions. Swedes are committed to recycling and to reducing or eliminating the use of landfills. The country also has a very high level of cross-industry cooperation and government support for alternative fuels.

The most important lesson we learned during our trip to Sweden was that no biomethane plant should be built until a market for the biomethane has been established and a distribution system designed that can move the biomethane to the market. Drivers of alternative fuel vehicles are not going to detour long distances for fuel; the biomethane must be transported to a location that is convenient for refueling. The Swedish operations depend largely on dedicated pipelines to move biomethane to fueling stations; trucks are typically used only as an interim measure until production volume is sufficient to support a pipeline.

Why Should the Public Support the Biomethane Industry?

As Chapter 8 revealed, the current economics for development of the biomethane industry in the USA are challenging if there is no public subsidy. We feel, however, that there are a number of valid reasons to support the development of this industry through publicly funded subsidies, regulation, or tax incentives. Such subsidies and incentives are always necessary to develop a new source of renewable energy or an alternative transportation fuel.

A society such as ours that is heavily dependent on fossil fuel energy should be actively developing a wide variety of alternative energy resources. We cannot always predict which technologies will prove the most viable for our future needs. To preserve our ability to respond to changing future conditions, however, we need to invest in research and development and to build pilot plants for a variety of these technologies.

Biomethane production addresses California’s commitment to renewable energy and to reducing dependence on petroleum. Development of a dairy biomethane industry would help to stimulate California’s economy, particularly its rural economy. Biomethane production provides a series of environmental benefits both during the production process and because it can be substituted for fossil fuels. Development of biomethane production technologies and markets today will ensure future preparedness for the growth of this industry should conditions arise that make the production and use of biomethane a more financially viable and/or necessary option.

Energy Independence and Renewable Fuel

The development of a biomethane industry supports state and federal policy by reducing dependence on imported oil and, more generally, on a finite global supply of fossil fuel. Reduced dependence on imported energy increases our national security. Replacing imported energy with domestically produced biomethane develops and supports our economy, especially our rural economy. Even if biomethane costs more than imported oil, the use of locally produced energy keeps our money at home and helps to support our rural communities instead of transferring wealth to Saudi Arabia and other oil producers.

California's Renewable Portfolio Standard and similar programs in other states demonstrate a commitment to increasing renewable electrical generation as a proportion of the total electrical mix. Renewable electricity promotes improved air quality, reduces GHG emissions, reduces dependence on imported energy, and preserves finite supplies of fossil fuels.

California's dependence on foreign energy sources for electrical generation (other than Canada) is modest. However, California, as well as the nation, is highly dependent on imported oil from relatively unstable countries for vehicle fuel. California legislators have begun to address this issue. Assembly Bill 2076, which became law in 2000, directed the California Energy Commission and the California Air Resources Board to develop a California Strategy to Reduce Petroleum Dependence. This will include statewide strategies to reduce the growth rate of gasoline and diesel fuel usage, and to increase the use of "nonpetroleum based fuels." Biomethane is one such fuel.

A number of existing federal laws aim to reduce petroleum dependency by supporting the use of ethanol and biodiesel; more laws with this goal are currently being developed. Biomethane serves the same purpose as ethanol and biodiesel and its use should be supported in new legislation. The proposed Energy Policy Act of 2005 would establish a national renewable fuel mandate and includes biomethane (although described in different terms).

Future Fuel Shortages and Increased Prices for Fossil Fuels

The economics of biomethane production will improve in the face of rising fossil fuel prices. Fossil fuels are a limited resource that will only become more expensive over time. Recent predictions by respected petroleum geologists indicate a decline in world peak oil production, which could occur before 2010 (see <http://www.peakoil.net/>). This could have staggering implications for world energy prices. Because of their uneven distribution and use worldwide, there is also an associated risk of supply interruption due to political upheaval (such as happened in 1979 from the overthrow of the Shah of Iran).

When supply is interrupted or threatened, higher prices are a certainty. We can better prepare for shortages if we develop renewable domestic alternatives. As prices rise, domestic sources of renewable automotive fuel will become more valuable and more cost competitive. Biomethane needs to be developed as an additional alternative fuel, alongside ethanol and biodiesel.

Environmental Benefits

There are a number of environmental benefits associated with a biogas upgrading plant that produces biomethane. Methane generated by dairy waste and enteric fermentation makes up about 1% of California's total anthropogenic GHG emissions. On dairies that use flush systems to manage manure, an anaerobic digester collects methane that would otherwise be released to the environment. Whether the methane is used for electricity generation or for biomethane, its combustion reduces GHG emissions (even though CH_4 combustion releases CO_2, another GHG, the harmful effects of methane are 21 times greater than those of CO_2, thus the overall net effect is a 21:1 improvement in GHG emissions).

VOCs are an ozone precursor. Research is underway to determine the quantity of VOCs in the biogas generated from dairy manure. Whatever the quantity, the VOCs in the biogas are largely destroyed when biogas is collected and combusted, or when it is upgraded to biomethane and combusted in engines. Biogas combustion creates NO_x, another ozone precursor, and is expensive to control because of the impurities in biogas. Biomethane, however, can be burned in very low NO_x microturbines, or in internal combustion engines that, if properly equipped with catalytic controls, will generate very low levels of NO_x.

Many dairy digesters are built because neighbors complain about dairy odors; digesters reduce these odors substantially. Because they break down manure and other organic material, they also reduce the number of flies. Plug-flow and complete-mix digesters reduce pathogens and weed seeds in the effluent. The whole system improves manure management and wastewater handling on the dairy.

These benefits have an economic value, even though current market conditions in the USA make it hard to quantify that value. In countries that have approved the Kyoto Treaty, reductions in GHG emissions can be bought and sold or traded at an established market value. In the USA, VOC reductions can be traded as ERCs, although it is currently difficult for dairies to participate in ERC markets. The economic benefit of odor reduction is difficult to value, but is nonetheless real. In some cases, odor reduction allows dairies at the urban rural interface to continue operating when political pressure from unhappy neighbors might otherwise be used to close down the dairy.

Further environmental benefits are achieved by the substitution of biomethane in engines for petroleum or natural gas. Biomethane produces no net GHG emissions; the CO_2 released by its combustion represents the product of recent biological processes. In contrast, petroleum and natural gas release GHGs that were captured eons ago, thus introducing an imbalance in the current system.

Greenhouse gases are not currently regulated in the USA, although some states are beginning to address these emissions. California, for example, passed AB 1493, which aims to reduce GHG emissions from vehicle tailpipe emissions. Under federal law, large landfills are required to capture and combust their landfill gas. A state initiative for dairies to reduce GHG emissions by capturing and combusting biogas is under consideration; it would be a very costly proposition for California dairies. Similarly, the San Joaquin and South Coast Air Districts may require dairies to capture and combust biogas to reduce VOC emissions. A viable biomethane industry would allow dairies to recoup some of the costs associated with methane collection and would mitigate their opposition to these requirements.

Eight Steps to a Successful Biomethane Enterprise

A business plan for a successful biomethane enterprise should demonstrate that the following have been researched and, where possible, completed or obtained:

- Buyer for the biomethane
- Supply of organic waste
- Distribution system—pipeline or storage and subsequent over-the-road transport
- Location for biomethane plant
- Technology and operating plan
- Financial plan
- Permitting and regulatory analysis
- Construction plan

Step 1: Find a Buyer for the Biomethane

The Swedish tour made it clear to us that a biomethane developer must have a firm buyer before building a plant. As discussed in Chapter 5 of this report, a dairy cannot use all the biomethane it can produce for on-farm purposes. Converting agricultural pumps, refrigeration, and vehicles to run on biomethane is costly in terms of both time and money. At a typical dairy, even if all of equipment was converted to run on biomethane, facility production would still outstrip demand.

Thus, a dairy upgrading plant needs to find an off-farm market for its biomethane. As part of this project, a special study focused on finding specific locations in the San Joaquin Valley where dairies were concentrated in proximity to CNG fueling stations and other potential biomethane markets. The resulting report is attached as Appendix G; some of the details are summarized below.

Potential Biomethane Markets in the San Joaquin Valley

There are 20 CNG fueling stations in the San Joaquin Valley. Those stations located closest to clusters of dairy farms, however, have a very small demand. For example, the CNG fueling station in Tulare, which is in the midst of what may be the largest concentration of cows in the world, pumps only 84,000 GGE a year of CNG (10 million ft^3/year or about 27,600 ft^3/day). A

1,000-cow dairy could meet this need, but a biomethane plant that small would not be economically feasible.

This demand could be increased if the community committed itself to increasing its CNG fleet. Since the Central Valley has serious air pollution problems, a community might find it worthwhile, and might find public funding, to replace its diesel bus fleet with CNG buses. In this case, it could contract with local dairies to provide the CBM for the buses.

In addition to fueling stations, there are a number of industrial users in the Valley, including cheese plants, which use a significant quantity of natural gas. For example, the CP International plant in Tulare uses 140,000 ft^3/day of natural gas. It would take more than 4,500 cows to produce this much biomethane. Appendix G identifies a number of other such plants in the area.

Other Potential Markets

If a biomethane plant were located on the distribution arm of a public natural gas pipeline, and if it could overcome any regulatory issues and meet utility requirements, it could pay to *wheel* the gas through the pipeline and sell it to an industrial user or perhaps to a local power utility.

Biomethane could be converted to LBM and used as a substitute for LNG. This product can be trucked more competitively than CNG, since it does not compete with gas delivered via a pipeline. (Almost no LNG is produced in California; instead it is trucked into California from out of state.)

Biomethane could be also be used, instead of biogas, to generate electricity. Using biomethane to generate electricity has two advantages over using biogas. First, it can be used in engines that do not produce NO_x: this is important because future regulations to control NO_x emissions in California may make biogas-generated electricity very expensive. Second, it can be stored to provide valuable peaking power, although this opportunity is limited by the high cost of storage.

Finally, biomethane could be a feedstock for other liquid fuel products such as methanol or fuels produced through the Fischer Tropsch process. Potentially, dairy biomethane could substitute for natural gas as a feedstock for hydrogen, although the technical problems associated with this use are greater than for most of the other uses. With the current administration’s focus on the hydrogen highway, this source of renewable hydrogen may attract a lot of interest. Highway 99, which runs down the San Joaquin Valley, could become California’s Hydrogen Highway.

Step 2: Obtain Feedstock for the Anaerobic Digester

This report focuses on dairy manure as a feedstock for on-farm or centralized anaerobic digesters. The biomethane plants we visited in Sweden use a variety of feedstocks, based on what is available in the area. As Chapter 1 demonstrates, there are other feedstocks available in California, such as poultry and swine manure, field and seed residue, vegetable residue, slaughterhouse waste, food processing waste, and slaughterhouse waste. Multiple feedstocks can increase biogas volume and yield, but may require careful monitoring to keep the process healthy. Also, the transport of off-farm wastes to an on-farm anaerobic digester may be subject to additional regulations.

Step 3: Determine Means of Transport

Conceivably, there are several steps in the biomethane production process that may require the transport of feedstocks, wastes, or products to or from the facility. The need for transport depends on a number of factors including location of the facility (on-farm vs. centralized), the use of off-farm feedstock, and the final market.

Organic wastes from dairies, food plants, or similar industries make up the feedstock for the anaerobic digester. On California dairies that use flush systems to manage manure, the feedstock will normally be used on-site since it is mostly water, and therefore is too expensive to move. However, most dairies in the Chino basin in Southern California manage their manure wastes with a scrape system. Because of its lower moisture content, this manure is less expensive to transport than liquid wastes and is trucked to a centralized anaerobic digester at the Inland Empire Utility Agency in Chino. Trucking is only economically feasible for wastes generated a short distance from the processing site, typically less than 5 miles. The facilities in Sweden were all centralized and all trucked in the organic waste product that fed the anaerobic digester.

After biogas is produced from a digester, it must be conveyed to the upgrading plant for biomethane production. In Sweden, the upgrading plants were located next to the anaerobic digester. However, it would be possible to transport the biogas to a centralized location using private pipelines. A centralized upgrading plant that accepted biogas from multiple digesters would allow for greater economies of scale in the biomethane production process. As an example, the Inland Empire Utility Agency in Chino pipes biogas from the digester to the electrical generator (less than 2 miles), and one large dairy in California pipes biogas across its farm almost 1 mile to its electrical generator.

Finally, the biomethane must be transported to market. If the biomethane plant is located on the natural gas grid, using the existing public natural gas pipeline would be the most efficient and cost-effective way to move the biomethane. Distribution via the natural gas grid would eliminate the need to have the biomethane plant in proximity to end users and would also eliminate any need to store the biomethane. In Seattle, the King County wastewater treatment plant transports biomethane produced from digester gas in the local gas utility’s pipeline. Since biomethane is chemically equivalent to natural gas this does not cause any problems. However, in California regulation and resistance from the utilities will make this access more difficult and expensive.

A second alternative is to build a private pipeline to transport the biomethane. Pipelines cost $100,000 to $250,000 per mile, and are less expensive when they do not cross public rights-of-way. Private pipelines eliminate the need for storage at the point of production, although storage would probably be required at the delivery site, especially if it is a fueling station.

The third alternative is to truck the biomethane. This requires compressing or liquefying the biomethane and storing it at the point of production. Stand-alone storage can be avoided if there is enough trucking capacity to always have a truck available for filling. Trucking is more cost competitive if the product is liquefied (i.e., LBM).

Step 4: Locate the Upgrading Plant

The first three steps all revolve around location issues: Where is the buyer? Where is the feedstock? How will the end product be transported to the buyer? The answers to these questions will determine where the upgrading (biomethane) plant should be located. If access to a public gas pipeline is not available, cost considerations require the feedstock, the buyer, the digester, and the biomethane plant to be within a few miles of each other. However, in the case of liquefied biomethane the buyer and the plant can be at a considerable distance.

The most promising locations will have a number of large dairies located in proximity to a CNG fueling station and/or to industrial users of natural gas. Proximity to landfills or to wastewater treatment plants can also be useful, because these facilities can produce large volumes of biogas and could be a good location for a centralized biomethane plant. Also, if the upgrading facility is in a non-attainment area for ozone and particulate matter, public subsidies might be available if it can be shown that the facility will help reduce these emissions.

Appendix G focuses on possible locations in the San Joaquin Valley, a non-attainment area for ozone and particulate matter. Seven counties in the Valley produce 72% of the state's milk. Various items were considered in the preparation of this appendix: databases on dairies, and the locations of CNG fueling stations, industrial gas users, landfills and wastewater treatment plants, were examined to determine optimal locations for upgrading facilities.

Four promising locations were identified in the San Joaquin Valley, the cities of Tulare, Visalia, Modesto, and Hanford (Appendix G). These four areas all have a high concentration of dairies and markets. Potential biomethane developers should review this document for its conclusions as well as for the methodology used. For example, if a developer wishes to locate a facility outside the San Joaquin Valley, he/she could use a similar methodology to review other regions of the State such as the Inland Empire or the Sacramento Valley.

Step 5: Select a Technology and Prepare an Operating Plan

Chapters 2 and 3 of this report (and Appendices A and B) review the various technology alternatives for anaerobic digesting and biogas upgrading. There are three main technologies for dairy anaerobic digestion, several technologies for removing the hydrogen sulfide, and a number of technologies for removing the carbon dioxide. A business plan for a biomethane facility needs to review these technologies in more detail to determine which are most suitable for the planned application. In this process the developer should consider European experiences, especially that of Sweden, which has the largest number of upgrading plants in the world. A review of products and package plants is also needed; for example, several firms are marketing small-scale, skid-mounted biogas upgrading plants.

A technology plan should consider operational requirements as well as performance and capital costs. Some very efficient technologies may require more sophisticated operational management; others may be less efficient but more robust. A large on-farm or a centralized plant may be a better venue for more sophisticated solutions, while smaller farm-based plants should probably choose robustness and ease of maintenance/operation over yields. Whatever technology the developer selects, the technology and operating plan should consider staffing needs.

Step 6: Develop a Financial Model and Locate Potential Financing

As discussed, the first dairy upgrading plants, like other pioneering renewable energy technologies, are not likely to be cost effective without public subsidies. A pro forma financial model needs to be developed that considers account revenues and expenses including operating, maintenance, transportation, and storage costs. Current natural gas prices are at an historical high, but natural gas and electricity prices are highly volatile. Without a long-term fixed price contract, discount rates must consider future price volatility. A capital plan should include permitting and other transaction costs involved in building the plant. To gain public support, the developer should try to quantify and value environmental and other societal benefits. The financial model will help determine the size of the needed public subsidy, while establishing the value of the societal benefits will demonstrate the contribution that the plant can make to the community and help convince decision-makers that a subsidy is warranted.

The developer also needs to identify potential funding sources. Unfortunately, as discussed in Chapter 6, most subsidies and tax benefits are designed either for renewable electricity or for two specific alternate fuels, ethanol and biodiesel. Nevertheless, some potential funding sources for biomethane projects do exist. Also, if community support can be developed, other funding sources, such as local economic development funds, may be tapped.

Step 7: Identify Permitting Requirements and Develop a Permitting Plan

A biomethane plant will require permits, as discussed in Chapter 7. Since the first such plants in California will be pioneering enterprises, the developers will face a great deal of regulatory scrutiny. A CEQA review is likely to be required. Some counties will be more cooperative than others. The developer will need to communicate the societal benefits from the plant. Acquiring the necessary permits will be a substantial effort, and money and time must be designated for this task. If the process proves to be especially difficult, it will add direct costs and cause expensive delays, which would increase the cost estimates provided in Chapter 8.

Step 8: Select a Designer and Contractor and Build the Facility

A competent plant designer and contractor are critical to a successful facility. The anaerobic digester and the biomethane plant may be built by different designers and contractors, but it needs to be a coordinated effort. Many designers claim that they can build good anaerobic digesters because they have built digesters at publicly owned treatment works, however, in the USA few of these have dairy digester experience. Because the feedstock is a critical component of system design, it is best to find a designer who has experience with the proposed feedstock(s). References for both designers and contractors should be obtained and checked. Experience designing small-scale biomethane plants will be very rare in the USA, so it might be useful to consider European designers as well.

Five Possible Biomethane Plant Projects

Below are short descriptions of five biomethane projects that we consider to have the greatest chance for success from a business perspective.

Project 1: Support Community Vehicle Fleet that Uses Compressed Biomethane

The San Joaquin Valley is a non-attainment area for ozone and particulate matter. A community in the Valley could make a significant environmental contribution by developing an integrated project involving CNG vehicles and a biomethane plant. The community could reduce emissions from diesel buses by substituting CNG buses, and could fuel those buses with CBM produced from manure on a nearby dairy or group of dairies.

At least four San Joaquin communities—Tulare, Visalia, Hanford, and Modesto— have both CNG fueling stations and a nearby dense population of dairies. However, the current CNG fleets in these communities are not large enough to support a biomethane plant. To make such a plant viable, demand for CBM needs to be increased beyond the current level. An integrated project that increased the number of CNG vehicles on the road and used locally produced CBM would capture a number of environmental and energy security benefits. The first community to do this would be a national showcase.

With a fueling station already in place, part of the CBM distribution problem would be solved; however, the existing station(s) would need to be substantially expanded, at a significant cost. Increased demand would come from a new fleet of CNG-fueled municipal vehicles.

A single large dairy could generate the biogas and biomethane on-site and then pump it through a dedicated pipeline or truck it to the fueling station. Trucking (of CBM) is expensive and it should probably be considered only as an interim solution until the volume is sufficient to support a pipeline. Alternatively, several dairies could pool their partially cleaned (i.e., H_2S removal would be done on-farm) biogas and pump it through a dedicated pipeline to a centralized biomethane plant. If the dairies were near a landfill, the biomethane plant could be built at the landfill and could use biogas from the dairies as well as from the landfill gas to produce biomethane. Ideally, the biogas upgrading plant would be very close to the filling station.

If such a facility processed waste from around 8,000 cows, it would cost $3,000,000 to $5,000,000 for anaerobic digestion, the upgrade plant, storage, and piping. Additional costs would be incurred for the purchase of the fleet and for the fueling station at the bus barn. The financing of the biomethane plant would be facilitated if the community committed to purchasing CBM on a long-term contract. Finding an appropriate subsidy for the biomethane plant would take some ingenuity, but could be done.

The societal benefits would include cleaner air from cleaner vehicles, energy security and GHG emission reductions by substituting domestically produced renewable fuel for imported oil, reduced GHG and VOC emissions by capturing and eventually combusting dairy biomethane, odor and fly reduction at the dairy, and pathogen and weed seed reduction from the anaerobic digester.

Project 2: Sell Biomethane Directly to Large Industrial Customer

A number of areas in the San Joaquin Valley have dairies concentrated near sizable industrial users of natural gas. One or more of these industrial users could provide a substantial demand for locally produced biomethane.

As with the previous example, a single large dairy could generate biogas and upgrade it to biomethane on-site and then pump it through a dedicated pipeline or truck it to the industrial user (again, trucking should be considered an interim solution). Several dairies could pool partially cleaned biogas and pump it through a dedicated pipeline to a centralized biomethane plant. Ideally that plant would be very close to the industrial buyer.

This project would be especially useful for industrial users that are located off of the natural gas transmission grid. Because industrial users need a reliable supply of gas, the biomethane plant needs to be robust and storage would be needed at the industrial site to ensure fuel supply when the biomethane plant is not operating.

For many industrial users of natural gas, their main need is for heat. In some applications, heat could be supplied by raw or partially cleaned biogas, without the need to upgrade to biomethane. Even if heat is the only application, concerns about transportation, storage, corrosion, fuel blending, or air emissions may make the biogas unsuitable for an industrial user.

Project costs and benefits would be similar to the first proposed project, except there would be no costs for a vehicle fleet or upgraded fueling station. The financing of the biomethane plant would be facilitated if the industrial user committed to purchasing its output on a long term contract. As with any other pioneering renewable energy project, public subsidies would be needed to make this project feasible.

The societal benefits would include GHG emission reductions by substituting domestically produced renewable fuel for fossil fuel, reduced GHG and VOC emissions by capturing and eventually combusting dairy biomethane, odor and fly reduction at the dairy, and pathogen and weed seed reduction from the anaerobic digester.

Project 3: Distribute Biomethane through Natural Gas Pipeline Grid

If barriers to the use of the natural gas transmission system could be overcome, an on-farm or centralized biomethane plant could sell directly to the local gas utility, or pay to wheel the biomethane to an industrial or municipal customer on the natural gas grid. Of course, the biomethane plant would need to be located along or very close to the distribution line. Since the Central Valley is not well served by natural gas distribution, this option is not practical in some areas, despite the presence of abundant dairies.

The environmental and societal benefits would be similar to the direct sale of biomethane to an industrial customer.

Project 4: Build Liquefied Biomethane Plant

Liquefied biomethane can be used as a direct substitute for LNG. Except for a small PG&E pilot project, all LNG vehicle fuel is trucked into California from out-of-state LNG plants.

A California biomethane plant built to serve the CNG vehicle market has a competitive disadvantage. It has to transport its biomethane, or CBM, to a fueling station and still compete in price with the natural gas delivered via pipeline that already serves the fueling station. A California LBM plant does not have this handicap. In fact, it may have a competitive advantage because it will likely be closer than the out-of-state LNG plants that currently serve the customer.

A dairy LBM plant could be built anywhere in the state where there is a sufficient supply of dairy waste. It could be built at a single large dairy, or it could be operated at a central location by transporting partially cleaned biogas from several nearby dairies through dedicated pipelines to a biomethane plant. If a group of dairies were near a landfill, the LBM plant could be built at the landfill and could use biogas from the dairies as well as landfill gas to produce LBM.

While transportation costs limit a CBM plant to nearby markets, an LBM plant can cost-effectively transport LBM to fueling stations much further away. LBM could also be delivered to liquefied-to-compressed natural gas (LCNG) fueling stations or to customers off the natural gas grid that already receive gas deliveries in the form of LNG.

Most LNG is used in heavy-duty vehicles; California currently has fewer than 1,500 such vehicles. Before an LBM plant is built, the developers must ensure a sufficient demand for its product by contracting with any of a number of fleet fueling stations in the state that could consume the LBM.

The societal benefits from such a plant would be the same as those from the community CBM vehicle fleet project described above.

Project 5: Use Compressed Biomethane to Generate Peak-Load Electricity

Because CBM can be stored (unlike biogas, which cannot be stored at high pressures due to associated corrosion problems and high cost) a biomethane plant could use its fuel to generate peaking electrical power.

The Renewable Portfolio Standard commits California to a substantial increase in renewable electricity. Bids for program funds are evaluated based on “least cost, best fit.” There is a Market Referent Price for electricity, and a higher price for peaking power. Renewable energy that can be dispatched to serve peak demand can earn a substantial premium over non-dispatchable renewable energy resources like wind and solar. If this premium were sufficient, storing compressed biomethane to generate peaking power could be cost effective. While the IOUs have not been eager to buy dairy electricity other than through the upcoming RPS process, the municipal utilities, particularly the Sacramento Municipal Utility District, may be more responsive.

To take advantage of the RPS program, the plant would have to be able to dispatch at least 1,000 kW, which would require biogas from about 10,000 cows. A very large single dairy or group of dairies could produce the needed biomethane on-farm or at a location central to several farms. The biomethane could be used to fuel a microturbine, but substantial storage capacity would be needed to ensure fuel availability for peak times.

True peak-load plants can make a profit running as little as 10 percent of the time. The high cost of biomethane storage, however, will require the biomethane plant to operate on a more regular basis, and will thus reduce the proportion of output that can capture the highest wholesale prices (during highest peak loads). The balance between the opportunity to capture peak-load prices and the cost of storing biomethane would need to be carefully evaluated, but it is unlikely that storage capacity of more than one or two weeks would be feasible.

The environmental and societal benefits would be similar to the direct sale to an industrial customer.