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Minnesota's Next Generation Energy Initiative

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Introduction by the New Voices in Public Policy Editorial Board

The desirability of ethanol use is a critical issue in the current debate over renewable energy sources. This paper provides an excellent overview of this important public policy topic in the context of Minnesota's Next Generation Energy Initiative. The authors have put together a comprehensive analysis that could serve as a useful tool for any concerned policymaker.



School of Public Policy

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Executive Summary

On February 22, 2007, Minnesota Governor Tim Pawlenty (R) signed into law one of the most ambitious renewable energy requirements in the nation. The initiative builds upon Governor Pawlenty's previous requirement that called for the state to use renewable energy for 25 percent of the state's energy needs by the year 2025. Increasing E85 ethanol pump access across the state, encouraging local ownership of energy production to help rural economies, developing biomass and cellulosic technologies and reducing carbon emissions are several additional initiatives that Clean Consulting targets in this analysis.

In this report, Clean Consulting examines and evaluates the most suitable options and strategies for helping Minnesota to meet its growing demand for ethanol and solve other environmental issues as the state adjusts to the recently-enacted *Next Generation Energy Initiative* ("Initiative"). Clean Consulting believes that these recommendations take a practical and efficient approach and will assist Minnesota in meeting Governor Pawlenty's benchmark goals (See Initiative in Appendix V for the full list).ⁱ Additionally, Clean Consulting's plan will foster an environment that will enable Minnesota to remain as a national leader in the research and development of alternative energies. The following is a summary of the course of action Clean Consulting recommends the State of Minnesota pursue in order to best meet its visionary goals:

1. Utilize available state and federal funding to bolster the research and development of cellulosic ethanol as well as vehicle technologies;
2. Partner with a firm similar to Chippewa Valley Energy Company to launch a cellulosic ethanol pilot project and demonstration facility;
3. Foster partnerships amongst various stakeholders to ensure cooperation and parity; and
4. Research and develop new planting methods to increase corn yields.

I) Introduction and Statement of Problem

Minnesota Governor Tim Pawlenty's (R), *Next Generation Energy Initiative* sets in place benchmarks aimed at weaning the state off of its consumption of foreign sources of oil and reducing its carbon emissions by emphasizing the need for more environmentally-friendly energy technologies. Governor Pawlenty hopes to build on Minnesota's national lead of renewable fuel use by moving the state closer to its target of replacing 25 percent of the state's energy sources with renewable sources by 2025 ("25 x 25 Plan"). The Initiative includes calls for increasing renewable energy sources as well as quintupling the amount of E85 gasoline pumps from the current estimate of 300 to more than 1800 by 2010. To meet these objectives, the state has looked to increasing the development of its ethanol industry.ⁱⁱ

As a leading energy policy advisory team in the nation, Governor Pawlenty has delegated "Clean Consulting" as the principle agents focused on helping the State of Minnesota mature the goals outlined in his energy initiative. More specifically, the group has been tasked with helping the state address its increasing demand for ethanol and position itself to remain at the national forefront in renewable fuel generation. The following analysis will help provide, among other things, long-term solutions to Minnesota's evident ethanol shortage as it moves closer to readily supplying alternative energy sources to more people throughout Minnesota.

II) Ethanol at the State and Federal Level

Ethanol and Minnesota

Since the mid 1980's, Minnesota has helped lead the development of the national ethanol market.ⁱⁱⁱ The goals of the Minnesota Ethanol Program, which has been the state's model for ethanol production, include: building a market for Minnesota corn, developing ethanol facilities in the state, helping the Twin Cities area meet U.S. Environmental Protection Agency ("EPA")

standards for carbon monoxide emissions, and increasing the number of New Generation Farmer Co-ops (“NGCs”).^{iv} Because of this initiative, ethanol consumption has grown from 25 million (“mm”) gallons since 1986 to 260 mm gallons by the end of 2006. Additionally, Minnesota’s ethanol industry has created thousands of jobs; 10,321 jobs were recorded at the end of 2006 and that number is expected to nearly double by 2008.^v

These accomplishments have been achieved through a combination of mandated ethanol blends and producer incentives. Minnesota’s 20 cents per gallon incentive payment provided investors with security to lend money to farmer-owned ethanol facilities.^{vi} In addition to support from the private sector, ethanol production facilities have gained strong financial footing from the Minnesota government, which has provided grants and other tax incentives for ethanol plant construction and start-up costs.

Minnesota has brought relative success to a fledging ethanol industry. Governor Pawlenty built upon Minnesota’s well-established Community-Based Energy Development (“C-BED”) in developing his renewable fuel target for the state. As described by the State of Minnesota’s Smart Renewable Standard, C-BED projects, such as farmer-owned ethanol plants have provided a solid economic foundation for rural farming communities throughout Minnesota.^{vii} Governor Pawlenty aspires to replicate a state government-supported economic framework that invests in research and incentives in order for Minnesota to remain at the forefront of the national biofuels industry. Recognizing the need for Minnesota to diversify its renewable portfolio, Governor Pawlenty has proposed \$100 million for research on making cellulosic ethanol economically possible.^{viii} If enacted, this investment will provide the impetus, resources, and leverage necessary to bring together various industry stakeholders to develop a market for cellulosic ethanol.

Current National Ethanol Situation

Most liquid fuel consumed in the United States today is petroleum-based. Technology has long existed to produce liquid fuels from other forms of fossil energy (i.e., coal, tar sands, shale).^{ix} Biofuel production grew steadily in the U.S. over the past decade. In 2006, grain-based ethanol supplied 4.7 billion gallons to the national fuel supply, serving principally as an environmentally-friendly oxygenate for blended gasoline.^x In response to growing concerns over global warming and volatile fuel sources and prices, Congress provided incentives for increased ethanol use by enacting the Energy Policy Act of 2005 (“EPAAct”). (See Appendix V for a full list of EPAAct funding opportunities for ethanol production).^{xi} Additional loan guarantees and grants were provided in the EPAAct for the construction of ethanol producing facilities. The Department of Agriculture predicts that demand for ethanol will require the use of 50 percent more of the nation’s corn crop this year. The period from August 2006 to January 2007 saw the price of corn grain double due to a surge in production of corn-based ethanol. Due to this high rate of consumption, the federal government’s target of supplying 35 billion gallons of ethanol and other biofuels to the nation’s transportation supply by 2017 will not be met if the current trend of emphasizing corn production continues.^{xii}

III) Evaluation of Options to Meet Minnesota’s Goals

The following section outlines available technologies that Governor Pawlenty can utilize in order to meet his objective. Clean Consulting has also provided a comprehensive review of the current situation in Minnesota and what will happen should Governor Pawlenty choose not to advance any new technologies. Note that Clean Consulting has only reviewed *available* technology in this section. A comprehensive review of potential technologies (including hydrogen fuel cells) is provided in Appendix V.

Status Quo

The recent boom in corn-based ethanol creates a double-edged sword for the farmers in America's Heartland: corn growers may benefit the most in the near-term while other large sectors of the American agriculture sector stand to experience great economic hardship in the long-term.^{xiii} Competition from other corn-based food products may lead to a significant rise in corn prices as the corn used to make ethanol is the same type of corn that is used as feedstock for cattle and other livestock.^{xiv} Despite the widespread popularity of ethanol, it is commonly accepted that corn-based ethanol alone will not significantly reduce the United States' dependence on foreign oil.^{xv} The nation consumes roughly 150 billion gallons of gasoline annually while only consuming about 12 billion gallons of ethanol.^{xvi} Increasing production capacity aside, the nation's corn yields are not large enough to meet the nation's demand for renewable fuel sources.

Minnesota has begun to rely heavily on its abundant corn crop to help meet both its food and fuel needs. On average, 200 billion bushels of Minnesota's annual corn crop, or 15 percent, are converted into ethanol and its 16 ethanol plants are capable of producing 550 million gallons of ethanol annually.^{xvii} An additional eight ethanol production facilities have been approved for construction (see map in Appendix V); economists suggest that such production will likely consume more than 50 percent of Minnesota's corn crop in the next several years.^{xviii} Central to Minnesota's concern with this trend are the competing interests of protecting the environment, keeping consumer food prices low and protecting the interests of its rural communities.^{xix}

If Minnesota continues on this trend of increasing corn-based ethanol production, the state will contribute little in terms of fuel savings at an economic detriment to its citizens. Corn prices have doubled over the past year and are predicted to continue to rise.^{xx} This will ultimately drive

up the cost of the corn feedstock, not only for fuel, but also food for human consumption and livestock feed.

Increasing Corn Yields

The National Corn Growers Association, the nation's largest agriculture trade association, advocates that the easiest way to meet the demands of the booming corn ethanol industry without upsetting agricultural markets is to simply increase corn yields. One method used to increase corn yields includes utilizing improved plant breeding practices and biotechnology.^{xxi} The process involves intercrossing similar plants to create stronger plants that have higher tolerance for viruses, bacteria and other environmental elements. Another popular proposal to increase corn yields includes opening the land that is currently under contract within the Conservation Reserve Program ("CRP") for farming. CRP is land that has been set aside to assist in the reduction of erosion and sedimentation in rivers and lakes.^{xxii} Opponents to opening CRP land to corn farmers argue that such action will increase carbon emissions and will reduce the ability to protect against food shortages. Approximately 35 million acres of national farmland are currently designated CRP.^{xxiii}

Alternative Fuels

Natural Gas

Natural gas is a clean-burning, efficient and domestically-available fuel source and emits between 30-40 percent fewer greenhouse gases than traditional fuel. Only two types of vehicles are able to run on natural gas: those that are dedicated natural gas vehicles ("NGVs") and those that have two distinct fueling systems (one for natural gas and one for traditional gas). Currently there are 150,000 NGVs on the road in the U.S. and over 5 million vehicles worldwide.^{xxiv} The most common NGVs in the U.S. are mass-transit vehicles; the DOE's Energy Efficiency and

Renewable Energy Office estimates that one in every five new transit busses in the U.S. runs on natural gas. In addition to its widespread domestic availability, natural gas is much less expensive than traditional gasoline.^{xxv}

There are several significant roadblocks to the mainstream commercialization of NGVs. Cars that run on natural gas are not produced in large numbers. To date, Honda is the only commercial automobile manufacturer to produce a dedicated NGV – the Honda GX CNG. Natural gas vehicles also have poor gas mileage, requiring more frequent trips to fill up the tank on a fuel that is not widely supplied at traditional commercial filling stations.^{xxvi}

Ethanol

Ethanol is a high-octane, clean-burning fuel that can be produced domestically in large quantities. It can be created from biological feedstocks that contain large amounts of sugar (or materials that can be converted into sugar). Corn, the most commonly-used grain for ethanol production, contains starches that easily break down into sugar.^{xxvii}

The production of ethanol increased sharply in 1990 when the Clean Air Act was amended to require the sale of oxygenated fuels in areas with unhealthy carbon dioxide emissions levels. Approximately 10 billion gallons of ethanol are blended with gasoline every year. Traditional cars can only run on ethanol blends of up to 10 percent (E10), thus most ethanol in the country is produced as an oxygenate. Blends of 85 percent (E85) ethanol and 15 percent gasoline can only be used in vehicles that are designated “flex-fuel.” Due to federal subsidies, the pump price for E85 is traditionally less than that of conventional gasoline.^{xxviii}

In spite of popular acceptance of ethanol, the fuel faces several significant roadblocks to widespread commercialization, including:

- **Infrastructure:** Because corn-based ethanol absorbs water, it cannot be shipped through the same pipelines that transport petroleum. Corn-based ethanol must be trucked or

shipped, which is far more expensive than pipeline transport. Currently, most E85 filling stations are only in the Midwest.^{xxix}

- **Energy Efficiency:** Corn-based ethanol is not completely energy efficient. Corn takes more energy to grow, harvest, transport and refine than ethanol derived from other sources such as sugar cane or biomass. As additional land is used to plant corn, more carbon will be emitted into the atmosphere.^{xxx}
- **Sustainability:** The demand for corn-based ethanol will drive up the cost of corn prices, as well as other agricultural food sources that rely on corn, and will require more land.^{xxxi} In 2006, corn prices averaged \$1.90/bushel. The current Chicago Board of Trade price of corn is \$4.21/bushel.^{xxxii}

Cellulosic Ethanol

Cellulosic biofuels are clean-burning and can be derived from widely-available domestic resources such as grasses, wood and agricultural waste. Cellulosic ethanol has the potential over the next decade to provide a nearly unlimited supply of transportation fuels.^{xxxiii} Ethanol derived from cellulosic material requires additional enzymes to break down the sugars that are locked up in the plant structure. Once the requisite sugar is derived from the plant, those sugars can be readily fermented into ethanol and used as a fuel. While corn is currently less expensive than cellulose to process into ethanol, cellulose is easier to produce due to the abundant supply of natural resources.

Cellulosic ethanol faces several hurdles as it moves into commercialization, including:

- **Production Costs:** Currently, there are no cellulosic ethanol plants operating on a commercial scale in the U.S. A commercial size bio-refinery costs between \$200 and \$250 million to build. It is estimated that to build a commercial biomass ethanol plant with a 40-million-gallon annual production capacity, a capital investment of over \$350 million is needed.^{xxxiv}
- **Conversion Technology:** The genetic make up of cellulose is more complicated and harder to break down. Biomass to ethanol is a very complex process and requires pretreatment and costly enzymes to convert the 5 and 6 carbon sugars to ethanol. The cost of enzymes per gallon of biomass ethanol is estimated to cost 30 to 50 cents per gallon of ethanol.^{xxxv}

Advanced Vehicle Technology

Reducing carbon emissions, as called for in Governor Pawlenty's Next Generation Initiative will require revolutionizing vehicle technology such that Minnesota is able to utilize advanced energy technologies. The most pertinent options include the following:

Hybrid-Electric Vehicles

Commercial hybrid-electric vehicles are powered simultaneously by electronic batteries and an internal combustion engine that runs on traditional gasoline. Running on an electric battery allows for improved fuel efficiency. Vehicle popularity has spiked in the past few years due to government incentives for the purchase of hybrid-electric vehicles. Though most commercial automakers have at least one hybrid model on the road, many do not produce enough to meet consumer demand.^{xxxvi}

Flex Fuel Vehicles

Produced since the mid-1990's, flex-fuel vehicles (FFVs) are capable of running on ethanol blends of up to 85 percent (E85). FFVs have the same power, acceleration and payload as traditional vehicles and are similar to traditional gasoline-only vehicle models, except for minor adjustments to the fuel cylinder. FFVs typically get between 20-40 percent fewer miles per gallon than gas-only vehicles, partially due to the fact that a gallon of ethanol contains less energy than traditional gas. FFVs contain a small computer chip that detects what fuel blend is being utilized and automatically adjusts the engine's ignition to best maximize fuel efficiency, thus reducing the car's carbon emissions. There are currently more than 6 million FFVs on the road today and there are 700 fueling stations for FFVs to fill up on E85, most of which are located in the upper Midwest. Additionally, FFVs are available for the about the same purchase price as cars that run on traditional fuel.

Plug-in Electric Hybrids

Plug-In Electric Hybrid Vehicles (“PHEVs”) are similar to traditional hybrids in the sense that they rely on battery power in addition to an internal combustion engine. Rather than depending on gasoline to recharge their batteries, PHEVs recharge through the electrical grid. Once PHEVs are commercially-available, owners will be encouraged to charge their PHEV batteries overnight, thus using low-cost, off-peak electricity.^{xxxvii}

Although PHEV technology exists, there are several roadblocks to its widespread commercialization:

- **Technology**: PHEVs are in the developmental phase. They require lithium-ion batteries, which are incredibly expensive and inefficient. Batteries cost nearly \$10,000 and perform differently based on outdoor temperatures.^{xxxviii}
- **Availability**: Toyota Motor Corp., the leading PHEV manufacturer, has invested millions into developing battery technology and plans to refurbish half of its Prius fleet with lithium-ion batteries to be sold in American markets by the second half of 2008. American automakers, on the other hand, invested significantly less into battery technology and are looking to roll out PHEV fleets by the end of the decade.
- **Congressional Support**: Congress has provided little incentive for research and development of the technology. In 2006, the DOE awarded a single contract for \$15 million to a company called A123 to research advanced battery technology; DOE has requested \$41 million for advanced battery research in fiscal year 2008.^{xxxix}

IV) Stakeholder Tradeoffs

Minnesota’s farmers, researchers, energy producers and rural economies have all benefited from both federal and state government financial support and initiatives. For those most directly involved with Governor Pawlenty’s initiative, it is necessary to evaluate all tradeoffs associated with potential policy solutions. Before a proper analysis of those tradeoffs can occur, however, a thorough evaluation of each stakeholder’s interest in the Next Generation Energy Initiative should be conducted.

Agricultural Farmers and Co-ops

Governor Pawlenty's initiative specifically targets the development of advanced biomass technologies, including cellulosic ethanol, with a recognizable focus on economic development that links farmer-owned agribusinesses with the rural economies they support.^{xi} However, many market and policy analysts see the "corn crunch" as becoming dominated by large agri-business firms that are anxious to profit from the expanding renewable energy market.^{xii} The market, once dominated by independent farmers, has attracted large firms to join the rush for a part of the market share, weakening the ability of family-owned farms to fully participate in the market, forcing them into a distinct minority. Through copious tax incentives and grant programs, the federal government has unwittingly created a large negative externality for the small-scale ethanol producers, which are now struggling to compete with the industry giants for market share. In 1999, all ethanol plants were owned and operated by independent farmers; whereas, by 2006, only 19 percent of the ethanol produced in Minnesota was produced by independent farmers.^{xiii} Governor Pawlenty's initiative redirects the next generation of renewable fuels back into the hands of independent farmers. His locally-driven, environmentally-sustainable model offers an alternative to large-scale corn reproduction, known as "monocropping," that is associated with current ethanol production.^{xiiii}

Agricultural cooperatives bring together farmers and other related businesses with collective interests. The co-op helps its members stay abreast of new market and legislative information and can easily organize them in a way to best take advantage of the growing biofuels industry.^{xliv} Central to Mancur Olson's discussion of small groups, cooperation will help small ethanol producers achieve their common interests.^{xlv} On the other hand, independent farmers that are not in cooperatives behave as free riders by benefiting from the advancements made by

coalitions without adding to the collective.^{xlvi} Cornerstone Co-op, based in Luverne, Minnesota, is an example of a financially-strong ethanol producer. Its stated goals include the production of biofuels in a sustainable way that financially benefits farmers and rural communities. To compete against large agri-businesses, small and independent farmers will be best served by joining together to form co-ops such as Cornerstone.

Large Agricultural Businesses

An important component of the growing ethanol industry are large agricultural businesses. Clean Consulting understands that there is not an industry-wide accepted definition of what constitutes “large agricultural businesses” beyond that they are typically publicly-traded companies that currently utilize the majority of available farmland. Although these businesses are in direct competition with the small and independent agricultural businesses discussed above, they play a vital role in strengthening the fledgling ethanol industry. Archer Daniel Midland (“ADM”) is the largest ethanol fuel producer in the United States and has a clear financial interest in remaining at the top of the industry.^{xlvii} ADM is debatably a monopolistic entity, which Charles Lindblom includes in his discussion of market inefficiencies. As previously discussed, ADM operates in a market that is largely comprised of small agricultural farmers and cooperatives. According to Lindblom, markets do not alleviate monopolies naturally.^{xlviii} ADM will continue to behave as a monopoly as long as it benefits from doing so. Thus, government intervention is necessary to correct ADM’s current behavior.

Additionally, ADM has been strengthened through its association with the National Corn Growers Association. Working (“NGCA”) together, these two bodies have successfully lobbied Congress to impose a \$.54/gallon tariff on ethanol imports from Brazil.^{xlix} This tariff benefits

both ADM and the NGCA significantly by limiting the domestic ethanol supply, thereby increasing demand for their product. In this way, ADM and NCGA operate as rent-seekers.¹

With its resources, capital and industry knowledge, ADM could serve Minnesota well as it looks to expand its renewable energy portfolio. For example, ADM can use its capital and presence in the market to serve as an industry leader in developing other feedstocks presently available in Minnesota. Minnesota can also utilize ADM's industry influence as well as their extensive logistical management experience to secure federal and state funding.

Ethanol Production Facilities

As one of Minnesota's first farmer-owned ethanol production facilities, Chippewa Valley Ethanol Company ("CVEC") serves as a model for farmers looking to participate in the biofuels market. Located in Benson, Minnesota, CVEC produces over 45 million gallons of corn ethanol a year. The firm's stated goals include: aggressively developing new product markets; seeking innovative sources for material input; and continuing its reputation for efficient operation and innovative process development.ⁱⁱ

The increase in federal initiatives has created a new competitive climate within the energy sector, which could encourage numerous firms to develop new or more renewable fuel programs. CVEC would strengthen its competitive edge and market share by taking advantage of Minnesota's resources other than corn. Investing in cellulosic research and development, for example, while expensive in the near-term, may lead the company to long-term financial success as the cellulosic market expands and the corn-based market stabilizes.

Independently-Owned Gas Stations

Currently, less than 1 percent of the nation's gas stations stock E85-graded gasoline.ⁱⁱⁱ Despite the booming ethanol production market, independently-owned gas stations are not able

to participate in that market due to two significant hurdles: the limited number of FFVs on the road as well as policies set forth by major oil companies. Many major oil companies stipulate that franchises can only purchase E85 fuel if available from the parent company. ExxonMobil, for example, maintains that limiting customer access to E85 is a simple means to mitigate customer confusion regarding vehicle compatibility.^{liii} Other firms have policies that prohibit E85 pumps from being included along with the other pumps at the front of the station. Several companies allow stations to install E85 pumps, but strongly recommend they install new pumps and tanks, which the station owner must pay for out-of-pocket at a cost of about \$200,000.

Any future successes of the ethanol industry will arguably be hampered by large oil companies. Additionally, oil companies will continue to rationally suppress the ethanol industry unless there is a market or government driver to force them to change. Legislative initiatives, such as the *Next Generation Energy Initiative*, are necessary to allow the ethanol infrastructure to expand.

Oil Companies

Oil companies have long been interested in the ethanol industry, as many of them currently blend up to 10 percent of their gasoline supply with the fuel and are anxious to develop and deploy cleaner-burning fuels to appeal to the national interest in “green” environmentalism. Shell has already been involved in the production, storage and distribution of ethanol and is now developing more efficient ways of producing it.^{liv} ExxonMobil has additionally announced their plan to spend \$20 billion annually through 2011 on developing 25 new oil and gas technology projects.^{lv} Oil companies do not view ethanol as a major threat to their industry, but at the same time, work to ensure that it stays that way. As mentioned above, oil companies have worked hard to ensure that the sellers of their product have little incentive to offer their customer an

alternative to gasoline whereas numerous reports indicate that grain-based corn only comprises two percent of the nation's energy supply.

Automobile Industry

The automotive industry is an important component to the ethanol industry. To date, there are twelve different models of hybrid vehicles ranging from sedans to trucks on the market. Four additional models will be introduced in 2007 and an additional 18 models will be introduced in subsequent years.^{lvi} Currently, the number one selling hybrid vehicle is the Toyota Prius, which highlights the issue that the U.S. auto industry is lagging behind its foreign counterparts in producing alternative fuel vehicles. Domestic automakers General Motors Corporation, Ford Motor Company, and DaimlerChrysler, have expressed to Congress and the Administration that they are ready and willing to continue increasing production and technological advances for hybrids and flex fuel vehicles.^{lvii} However, those automakers will need to rely on incentives from the government in order to compete with their foreign competitors.

Lawmakers

Historically, lawmakers have been entrusted as delegates of their constituencies. Following Blackburn's description of the Categorical Imperative, lawmakers are typically required to take actions that will lead to the common good of the states they are elected to represent.^{lviii} Clean Consulting recommends that lawmakers involved with the Governor's Initiative employ the Categorical Imperative, which requires taking the action that will provide maximum benefits with minimum harm. *The Next Generation Energy Initiative* was supported by a Republican governor and a Democratic Party-controlled legislature. Clearly, the issue of renewable energy has bipartisan support. As both Minnesota and the nation begin to place a

higher political value on environmentalism, many politicians stand to gain from carrying out successful programs such as Governor Pawlenty's initiative. Come election time, lawmakers who supported the policy will use its success as a political advantage over those who did not. Furthermore, other stakeholders such as farmers, ethanol plant owners, research firms and Minnesota citizens are positioned to feel the effects of the initiative first-hand. Thus the support and the political future of involved lawmakers remains directly tied to their constituents' responses to the initiative.

Academia and Research Facilities

Governor Pawlenty's administration has placed great emphasis on the importance of diversifying the state's renewable fuel portfolio to include cellulosic ethanol. As stated before, corn based ethanol alone will not be able to support the growing demand for ethanol either at the national or state level. Support in the form of funding and grants will be necessary to perform research to explore other sources of renewable fuel.

Under the supervision of Professor Tilman, who has acknowledged the limitations of corn-based ethanol, the University of Minnesota is heavily involved with the research of cellulosic ethanol. For the past dozen years the professor and his students have grown a variety of plants that could potentially be used as the biomass feedstock to replace corn. His team has grown plots mixing 16 different types of prairie grasses, discovering that the plots with the greatest variety produce the most potential energy. Prairie grass is able to grow on land that does not typically support corn growth. Through the professor's research, farmers can learn how to maximize the output from their land. The University has the potential to research and analyze the production of other sources of renewable energy as well.

Environmentalists

Defined as non-activists, environmentalists are generally concerned about global climate change and take steps in their individual lives to contribute, in their view, to a “greener” way of living. Because ethanol is touted as a clean-burning fuel, many environmentalists support it as an alternative to traditional petroleum. Ethanol has benefited greatly from federal and state incentives to keep the price of ethanol level to that of traditional gasoline.^{lix}

Additionally, many are beginning to realize that ethanol is not as clean as once believed. There is growing concern in the agricultural community about the degradation of farm land due to corn’s rapid pace of production and the use of pesticides, fertilizer, and machinery that burn fossil fuels during this process.^{lx} Externalities of this sort are to be expected with most market processes. Accounting for the spillovers associated with increased ethanol production, however, will become the focus of any environmentally-based argument for the development of the cellulosic ethanol industry.^{lxi}

Minnesota Citizens

The latest market trend pushing for the production of ethanol fuel has both positive and negative tradeoffs for the citizens of Minnesota. A study of the ethanol economic impact in Minnesota, performed by the Minnesota Department of Agriculture, showed that since 2005 there has been a 1.5 billion gallon output of ethanol and a creation of over 5,800 jobs.^{lxii} These jobs help to build upon and strengthen Minnesota’s rural economies.

However, there has been an increasing concern among various economists and agricultural scientists regarding the over-production of corn. Specifically, corn for human consumption is now facing competition by a new, large competing market.

V) Plan of Action

After thoroughly analyzing various renewable energy technologies as well the multitude of stakeholders involved, Clean Consulting has determined that a hybrid approach will be necessary in order to achieve Governor Pawlenty's goals outlined in the *Next Generation Energy Initiative*. Based on the results of the data collected, Clean Consulting advocates bringing together seemingly- disparate entities in order to achieve mutually-beneficial outcomes for most stakeholders involved. The following plan of action explains this approach:

1. Presentation of Data:

Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis:

The traditional method for using the SWOT analysis is to identify the internal strengths and weaknesses of a company measured against its external opportunities and threats. Clean Consulting has applied this business-oriented method of analysis to the policy realm by identifying the costs and benefits of the available policy options and their impacts on the identified stakeholders (See (Appendix IV).

Evaluation of Stakeholder Affects (Table I), Option Analysis and Criteria (Table II):

After a thorough analysis of how the policy options will affect the stakeholders, Clean Consulting developed two charts to merge market and polis factors to determine the most feasible options in achieving Minnesota's renewable energy objective. For Tables I and II, Clean Consulting used an interpretive approach ranking each policy option with a positive (+), neutral (0), or negative (-) mark to determine its affect on each stakeholder. A positive mark was given one point, a negative mark subtracted a point, and a neutral mark did not affect the totals. The points were then added up and illustrated with a numerical value to depict the strength of the policy option in relation to all stakeholders we evaluated (See Appendix IV). The rankings of

the policy options for each stakeholder in Table I were totaled and applied to Table II under the term “Stakeholder Affects.” In addition to the stakeholder affects, Table II specifically factors in each option’s readiness, cost, and potential:

Readiness: Availability of technology, infrastructure and public/private support for large-scale implementation. How soon can the option be implemented or enhanced to the scale necessary for Minnesota to meet its goals?

Cost: Financial feasibility of implementation based on technology, research and infrastructure costs.

Stakeholder: Positive and negative impacts and externalities on specified stakeholders.

Potential: Defines a policy option's likelihood of meeting the energy changes that Minnesota is seeking. This entails the practicality of success, both business and technical, coupled with the potential magnitude of change. Preferably, Clean Consulting desires a solution that is feasibly large enough to be applied on a macro scale throughout Minnesota and possibly the rest of the United States.

The rankings of the policy options, weighted against readiness, cost, stakeholder affects, and potential were added together for the “total.” The policy options with the highest totals were then considered favorable options for our final recommendation and are included in the following plan of action:

2. Research and development for cellulosic ethanol and corn yields:

Clean Consulting recognizes the importance of the corn ethanol industry as well as its permanence and therefore advocates for the continued financial support of small corn growing operations. At the same time, Minnesota’s fledgling cellulosic industry must be bolstered in order to meet the state’s growing demand for ethanol. We recommend that Minnesota provide equal financial support for both industries. This equal support will help get the cellulosic industry off the ground and it will provide fewer incentives for the corn-ethanol industry to suppress its competition. Additionally, by uniting these two groups, Keck and Sikkink would

argue that they would have the means and industry knowledge through which to frame their agenda and become recognizable to a larger audience.^{lxiii}

3. Cellulosic Pilot Plant and Demonstration Facilities:

Currently, there are no full-scale demonstration facilities in the United States. Clean Consulting has determined that without the presence of a full-scale demonstration facility, attaining future private investment for cellulosic ethanol will remain a challenge for the industry. Therefore, Clean Consulting recommends that Governor Pawlenty, by utilizing available federal and state funding and by awarding loan guarantees to private investors, construct a small cellulosic ethanol production facility where further research and development can be conducted to bring down future costs.

Chippewa Valley Ethanol Company (“CVEC”) has been identified by Clean Consulting as a small ethanol production facility in Minnesota that is dedicated to advancing new technologies. CVEC, as a rational actor, may be anxious to participate in this emerging market as it recognizes huge potential payoffs, however, CVEC will not abandon its current production of corn-based ethanol.^{lxiv} Rather, by providing state and federal subsidies, Governor Pawlenty will link CVEC together with the University of Minnesota. As a rational actor, however, CVEC will need to be guided, through financial incentives, into a market that it probably sees as not being fruitful. Clean Consulting will need to convince CVEC that by agreeing to participate in the demonstration program, they will perform an action that will produce the best overall outcome for them. The University of Minnesota, on the other hand, as a research institution, is simply looking for an arena through which to practice its research. CVEC is as attractive to the University of Minnesota as any other small-scale ethanol production facility.

4. **Funding:**

Clean Consulting has identified numerous funding options for a variety of the projects called for in Governor Pawlenty's Initiative. Specifically, the Energy Policy Act of 2005 provides numerous tax incentives for the owners of hybrid-electric vehicles as well as loan guarantees for ethanol producers. For a full list of funding for renewable energy projects in the EPAct, see Appendix V. Additionally, the state of Minnesota has provided tax incentives and several other funding opportunities for renewable energy on a smaller scale. See Appendix V a full list of current Minnesota funding opportunities for renewable energy.

Clean Consulting advocates that Governor Pawlenty continue to take advantage of federal funding opportunities currently available and that he develop a sound lobbying initiative to gain home-stake provisions and funding in the upcoming Farm Bill Re-authorization. Additionally, Clean Consulting urges Governor Pawlenty to extend state financial incentives (i.e., loan guarantees) for a minimum of a seven year period in order to attract private investment for the cellulosic ethanol industry. This is necessary to avoid the two-year "sunset" of incentives common within the renewable fuel industry.

Clean Consulting further advocates that Governor Pawlenty provide state funding initiatives at an equal or greater rate than those enacted by EPAct. Further, Clean Consulting urges that Governor Pawlenty focus those initiatives towards bolstering the cellulosic ethanol industry, while at the same time maintaining the current level of incentives for the corn ethanol industry. Tax incentives aimed at persuading more Minnesotans to purchase hybrid and flex-fuel vehicles should also be a priority for Governor Pawlenty. If Minnesota plans to increase access to E85 pumps, Governor Pawlenty needs to ensure that there will be a consumer market for that

fuel. Basic tax deductions remain the most suitable means for the promotion of advanced vehicle technologies.

5. Opposition:

The cellulosic ethanol industry faces two significant forces of opposition: large oil companies and the corn-ethanol industry (as represented by the National Corn Growers Association, the industry's lobbying arm). Recognizing the strengths and value of these entities, Clean Consulting advocates that an alliance be formed with the corn lobby, the oil industry and the cellulosic industry. Such an alliance would be formidable as each entity would be able to draw upon the others' strengths, without the sacrifice of profits. In order to entice these otherwise disengaged entities, Governor Pawlenty will need to provide some form of incentive. It should be noted that not all stakeholders who voice their concerns over the stated plan of action need to be satisfied. Companies such as ExxonMobil and other firms who may operate their headquarters outside of Minnesota should carry less weight in trying to appease these concerns. Minnesota citizens and job growth should be the most important factor when weighing all stakeholder concerns.

6. Evaluation:

The solutions presented should be evaluated on one distinct criterion: time. The *Next Generation Energy Initiative* stresses the need for timed benchmarks and the plan of action should be no different. Because this policy analysis is aimed at helping Minnesota meet its goals outlined in the Initiative, the policy solutions must be evaluated on how effectively they contribute to meeting the benchmarks. Granted, this plan is not a silver bullet to solve the problems defined in the initiative. Clean Consulting believes that this plan will spur innovation and action while pushing forth Minnesota's long term energy goals.

In addition to time, another crucial criterion that should gauge the effectiveness of the plan of action is Minnesota's corn prices. Increasing corn yields coupled with the development of cellulosic ethanol should help stabilize rising corn prices due to economic laws of supply and demand.

7. Conclusion

The implementation of a hybrid policy approach that incorporates research and development of corn yields and cellulosic ethanol in conjunction with developing a pilot cellulosic plant will increase the supply of ethanol in Minnesota and will aid in reducing carbon emissions. Targeting relevant funding options and addressing needs of stakeholders will help promote cellulosic technologies and ensure strong rural economies while helping Minnesota maintain its strong reputation as a leader in renewable energies. Implementing the plan proposed above should support Minnesota as it strives to increase the supply of ethanol as gas stations look to increase access to ethanol pumps. If properly administered, these solutions should help achieve many of Minnesota's stated energy and environmental goals.

Appendix I

Group and Individual Contributions

Our full group met on several occasions at the George Mason Library and after class.

February 18: 1:00 – 3:30

February 25: 1:00 – 4:30

March 4: 1:00 – 2:30

March 11: 1:00 – 3:30

March 18: 1:00 – 3:00

March 25: 1:00 – 3:30

April 11: 10:00 – 11:00

April 15: 1:00 – 3:30

April 21: 10:00 – 4:30

The research assignments listed under each team member's name is not an exclusive list of assignments. Beyond the considerable amount of meetings held, each team member spent immeasurable individual time completing various components of the paper not listed below.

Caroline Roach

Lead Editor

Appendix III Organization

Plan of Action Development

Research Assignments

- National Ethanol Issues
- Traditional Corn-based and Cellulosic Ethanol
- Hydrogen and Natural Gas
- Vehicle Technology

Eric Zulkosky

Introduction and Development of Statement of Problem

Editor

Criteria Development

Data Development

Executive Summary

Plan of Action Development

Chart Development (Tables 1 and 2)

Stakeholder Research Assignments:

- Academia/Research Facilities
- Minnesota Citizens
- Lawmakers

Cami Dodge

Title Page Development

Appendices I and II Development

Editor

Plan of Action Development

SWOT Chart Development

Meeting Scheduler

Research Assignments:

- Ethanol Initiatives in Minnesota
- Status Quo in Minnesota
- Stakeholders: Automobile Industry and Environmentalists

David Sprenger

Researcher of Relevant Class Material

Creation of Citation Database and Works Cited

Initial Stakeholder Research

Kerry Mulholland

Initial SWOT Chart Development

Research Assignments

- Increasing Corn Yields

Stakeholder Research Assignments:

- Agri-Farmers, Small Ethanol Production Facilities and Independently-Owned Gas Stations and Co-Ops

Appendix II

The Client: Governor Pawlenty

Republican Minnesota Governor Tim Pawlenty has had a well-established career in state politics. Before he was elected governor in 2002, the fiscal conservative served in the Minnesota House of Representatives for ten years, including four years as Majority Leader. The state of Minnesota has traditionally been represented by a mix of both Republican and Democratic constituents. Governor Pawlenty also served as former Chairman of the Governors' Ethanol Coalition in 2005. This coalition, made up of mostly Midwestern Governors, works to promote the use of ethanol.

In 2006, Governor Pawlenty and a Democrat-controlled legislature worked together to pass bipartisan legislation aimed at ultimately replacing 25 percent of Minnesota's traditional energy sources (i.e. fossil fuels) with renewable sources of energy by the year 2025 ("25 x 25 Plan"). Strong support from both political parties is necessary to assure that cellulosic ethanol is able to become a viable player in the renewable fuels market.

A highlight of the Governor's 25 x 25 Plan is its call for increasing the number of E85 pumps in the state from 300 to 1,800. This mandate will bring about a huge demand for ethanol. Governor Pawlenty called upon Clean Consulting to provide him with a thorough analysis of how he can best achieve the goals outlined in his Initiative. Clean Consulting, with over 20 years of experience, will provide Governor Pawlenty with industry insight as well as a carefully-planned analysis for how best to implement his initiative.

Appendix III

Strengths, Weaknesses, Opportunities and Threats (S.W.O.T.) Analysis

This S.W.O.T. Analysis provides a traditional, business-like approach for identifying the internal strengths and weaknesses of an entity measured against its external opportunities and threats. Clean Consulting has applied this basic interpretive model to the policy realm in order to better implement a cost-benefit analysis of various proposals to achieve Governor Pawlenty's Initiative.

❖ S.W.O.T. Analysis of Farmers

Status Quo

- **Strengths**
 - Increasing demand for product
 - Strengths in cooperative programs (ethanol plants)
 - 16 ethanol plants; 8 additional plants under construction
 - MN consumes 260 million gallons of ethanol annually
 - 550 million gallons of total ethanol capacity
 - Average of 200 billion bushels of corn or 15percent of the state's annual corn crop
- **Weaknesses**
 - Can not control the demand
 - Can not control the supply due to:
 - Weather, disease, drought, etc.
- **Opportunities**
 - Growing market; domestic and global
 - Renewable fuel (corn ethanol)
 - Stable demands for live stock feed
 - Funding and grants for research and development
 - Federal and state
 - Research on improving plant breeding practices and biotechnology
- **Threats**
 - Ever-changing market economy
 - Change in the supply and demand of product (unpredictable market)
 - Large agri-businesses
 - Controlling the market
 - Putting rural farmers out of business
 - Tariffs being lifted or created
 - Example: lifting the tariffs on Brazilian ethanol

Alternative Fuels

Natural Gas

- **Strengths**
 - None (farmers do not produce it)
- **Weaknesses**
 - Farmers do not produce natural gas
- **Opportunities**
 - Clean burning fuel to be used for their equipment
- **Threats**
 - Natural gas could take away market share from farmers that produce crops for fuel

Hydrogen Fuel Cells

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Increasing demand for cleaner burning, renewable fuel sources
- **Threats**
 - Fuels cells increasing their market share

Corn-Based Ethanol

- **Strengths**
 - Already in production at commercial scale
 - Rural farmers in Minnesota, have been harvesting corn for generations (experts in the field)
- **Weaknesses**
 - Balancing production between live stock feed and renewable fuels
 - Small voice in a rapid growing market
- **Opportunities**
 - Increasing market for alternative and renewable fuels
 - Funding and grants for research and development
 - Federal and state
 - Creation of coalitions and cooperatives between production plants and farmers
- **Threats**
 - Other forms of renewable fuels: cellulosic ethanol, natural gas, hydrogen fuel cells, PHEVs, etc.

- Large agri-business firms such as ADM
 - Strong hold on the market
 - Large capital to invest
 - new ethanol plants (infrastructure)
 - research and development

Cellulosic Ethanol

- **Strengths**
 - Can utilize the full potential of range of MN natural resources
 - Sources used to produce cellulose can be planted in areas where the corn cannot grow
- **Weaknesses**
 - Technology is not yet advanced:
 - Need a steady purchaser of the product
 No incentive place different crops
- **Opportunities**
 - Emerging market
 - Heavy research and development going into this field
- **Threats**
 - Large agri-business with the capital to invest and build an infrastructure for this new biotechnology

Vehicle Technology

Flex-Fuel Vehicles

- **Strengths**
 - Environmental benefits
 - Create a market for the increased use of E85 pumps
 - Many flex-fuel cars have been in mass production for 7 years
 - Large capital to influence market
 - Push to create cleaner burning fuels
 - Obtain tax credits from government
- **Weaknesses**
 - Flex-fuel cars not widely marketed to consumers
 - Consumer understanding of what a flex-fuel does or what it can do
- **Opportunities**
 - Growing demand for cleaner running vehicles
 - Federal influence and push for ethanol production
 - Market influence
 - Lobbying groups and associations pushing for the use of ethanol
- **Threats**
 - Traditional hybrids
 - Plug-in hybrids

Traditional Hybrids

- **Strengths**

Will continue to use gasoline with a 10percent ethanol blend

- **Weaknesses**

- Can not control hybrid automobile market

- **Opportunities**

- Market demands an environmentally-friendly fuel

- **Threats**

- Technology not currently geared towards using ethanol fuel

Plug-in Electric Hybrids

- **Strengths**

- Will continue to use gasoline with a 10percent ethanol blend

- **Weaknesses**

- Can not control hybrid automobile market

- **Opportunities**

- Market demands an environmentally-friendly fuel

- **Threats**

- Technology not currently geared towards using ethanol fuel

Increase Corn Yields

- **Strengths**

- Already produce/ harvest corn
- Increased market demand

- **Weaknesses**

- Chance of over using the land
- Limited control of the market demand – will have to find more land

- **Opportunities**

- Growing market demand
- Research on improving plant breeding practices and biotechnology

- **Threats**

- Environment
 - Poor weather; drought, hail, etc
- Large agri-businesses
 - Taking control of ethanol market
 - Taking market share away from farmers

❖ S.W.O.T. Analysis of Small Ethanol Plants

Status Quo

- **Strengths**

- Increasing demands for product
- Strengths in cooperative programs (ethanol plants)
 - 16 ethanol plants; 8 additional plants under construction

- MN consumes 260 million gallons of ethanol annually
- 550 million gallons of total ethanol capacity
- Average of 200 billion bushels of corn or 15percent of annual corn crop
- **Weaknesses**
 - Not investing in new forms of renewable fuel energy
- **Opportunities**
 - Increasing demand of ethanol fuel
- **Threats**
 - Ever changing market economy
 - Large argi-businesses
 - Controlling the market
 - Putting rural farmers out of business
 - Tariffs being lifted or created
 - Example: lifting the tariffs on Brazilian ethanol

Alternative Fuels

Natural Gas

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Does not produce this form of alternative fuel
- **Opportunities**
- Not applicable**Threats**
 - Can gain renewable fuels market share

Hydrogen Fuel Cells

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Does not produce this form of alternative fuel
- **Opportunities**
- **Threats**
 - Can gain renewable fuels market share

Corn-Based Ethanol

- **Strengths**
 - Increasing demands for product
 - Strengths in cooperative programs (ethanol plants)
 - 16 ethanol plants; 8 additional plants under construction
 - MN consumes 260 million gallons of ethanol annually
 - 550 million gallons of total ethanol capacity
 - Average of 200 billion bushels of corn or 15percent of annual corn crop
- **Weaknesses**

- Have not invested in any other infrastructure to produce ethanol from other sources
- **Opportunities**
 - Growing market demand
 - Federal and State Government influences
 - Strong push for renewable fuels
 - Grants and funding
- **Threats**
 - Other forms of renewable fuel (cellulosic ethanol, natural gas, etc)
 - Can not control the corn supply provided by the farmers

Cellulosic Ethanol

- **Strengths**
 - Large enough capital to invest in technology
- **Weaknesses**
 - Does not produce this form of ethanol
- **Opportunities**
 - Growing market demand for a more efficient renewable fuel
 - Federal and state grants
- **Threats**
 - Heavy capital intensive agri-businesses investing in cellulosic ethanol technology
 - Using market influence to obtain federal and state grants

Vehicle Technology

Flex-Fuel Vehicles

- **Strengths**
- Can utilize the ethanol produced at the plants **Weakness**
 - Not applicable
- **Opportunities**
 - Create a partnership with the auto industry to promote the purchase of ethanol based fuel
- **Threats**
 - An emerging cellulosic ethanol industry
 - E85 pumps are not readily available to consumers

Traditional Hybrids

- **Strengths**
 - Will continue to use gasoline with a 10percent ethanol blend
- **Weaknesses**
 - Cannot control hybrid automobile market
- **Opportunities**
 - Market demands a car that will run on environmentally-friendly fuel
- **Threats**

- Technology not geared towards using ethanol fuel

Plug-in Electric Hybrids

- **Strengths**
 - Will continue to use gasoline with a 10percent ethanol blend
- **Weaknesses**
 - Cannot control hybrid automobile market
- **Opportunities**
 - Market demands a car that will run on environmentally-friendly fuel
- **Threats**
 - Technology not geared towards using ethanol fuel

Increase Corn Yields

- **Strengths**
 - Will create more jobs if supply increases
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Chance to create stronger economic anchors in MN rural communities
 - Increase supply of ethanol
 - MN state government to increase the E85 pump infrastructure
- **Threats**
 - Large agri-businesses
 - competitive advantage issues
 - controlling a large market share

❖ S.W.O.T. Analysis of Small, Independently Owned Gas Stations

Status Quo

- **Strengths**
 - Not applicable
- **Weaknesses**
 - No control over the supply or production of ethanol
- **Opportunities**
 - Growing domestic and global market
 - Renewable fuel
 - Funding, grants, and tax incentives
 - Federal and state
- **Threats**
 - Ever changing market economy
 - Change in the supply and demand of products
 - Large oil companies controlling what is sold at pumps

Alternative Fuels

Natural Gas

- **Strengths**
 - Not applicable
- **Weaknesses**
 - No existing infrastructure
- **Opportunities**
 - Not applicable
- **Threats**
 - Cut into alternative fuels market

Hydrogen Fuel Cells

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Do not produce hydrogen fuel cells
- **Opportunities**
 - Increasing demand for cleaner-burning, renewable fuels
 - Build new structures on existing gas stations
- **Threats**
 - Fuels cells increasing their market share, taking away the need for oil fuel

Corn-Based Ethanol

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Most do not have updated fuel tanks for ethanol
- **Opportunities**
 - Increasing market for alternative and renewable fuels
 - Consumers will always need fuel for their cars
- **Threats**
 - Other forms of renewable fuels; cellulose ethanol, natural gas
 - Competition from other gas stations and franchised owned oil companies

Cellulosic Ethanol

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Emerging market
 - Chance to sell a cleaner burning fuel

- **Threats**
 - Depends if the oil company wants to sell primarily corn-based ethanol

Vehicle Technology

Flex-Fuel Vehicles

- **Strengths**
 - These vehicles will still need a source of fuel
- **Weaknesses**
 - No real marketing programs at local gas stations
- **Opportunities**
 - If E85 pumps are installed the flex-fuel vehicles will become a great target market
- **Threats**
 - New technology that cuts down the use of oil or even ethanol fuel

Traditional Hybrids

- **Strengths**
 - Still will use gasoline
- **Weaknesses**
 - Cannot control hybrid automobile market
- **Opportunities**
 - Not applicable
- **Threats**
 - Technology not geared towards consuming more fuel

Plug-in Electric Hybrids

- **Strengths**
 - Still will use gasoline
- **Weaknesses**
 - Cannot control hybrid automobile market
- **Opportunities**
 - The creation of pug in outlets at the existing gas stations
- **Threats**
 - Technology not geared towards consuming fuel

Increase Corn Yields

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Growing market demand
 - Depends on if oil companies invest in it
- **Threats**

- Not applicable

❖ S.W.O.T. Analysis on Large Agri-business

Status Quo

- **Strengths**
 - Producing large amounts of ethanol
 - Influential in the emerging ethanol market
- **Weaknesses**
 - Viewed as a corporate entity that will take ruin the rural agriculture businesses in Minnesota
- **Opportunities**
 - Growing domestic and global market
 - Renewable fuel
 - Minnesota Consumes 260 million gallons of ethanol annually
 - Funding, grants, and tax incentives
 - Federal and state
- **Threats**
 - Ever changing market economy
 - The change in the supply and demand of products
 - Large oil companies controlling what is at the pumps
 - Environmental threats that could hurt the harvest of corn
 - 16 ethanol plants (currently in Minnesota)
 - 8 more plants currently under construction

Alternative Fuels

Natural Gas

- **Strengths**
 - Not applicable
- **Weaknesses**
 - No existing infrastructure
- **Opportunities**
 - Not applicable
- **Threats**
 - Cut into alternative fuels market specifically ethanol

Hydrogen Fuel Cells

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Do not produce hydrogen fuel cells
- **Opportunities**
 - Increasing demand for cleaner burning, renewable fuels

- Growing market for alternative fuels such as ethanol
- **Threats**
 - Fuels cells increasing their market share, taking away the need for ethanol fuel

Corn-Based Ethanol

- **Strengths**
 - Already produces and supplies large amounts of ethanol
 - Large market influence
 - Great amounts of capital to invest in more production plants
 - Chance to buy out small struggling farmers
- **Weaknesses**
 - Not enough investment in other alternative fuels
- **Opportunities**
 - Increasing market for alternative and renewable fuels
 - Consumers will always need fuel for their cars
- **Threats**
 - Other forms of renewable fuels: cellulosic ethanol, natural gas, etc.
 - The strengthening of rural farmers
 - Cooperatives between farmers and ethanol plants

Cellulosic Ethanol

- **Strengths**
 - Capital to invest in the new area of renewable fuels
- **Weaknesses**
 - Cellulosic ethanol can be produced from many different sources
- **Opportunities**
 - Emerging market
 - Chance to sell a cleaner burning fuel
- **Threats**
 - Not applicable

Vehicle Technology

Flex-Fuel Vehicles

- **Strengths**
 - These vehicles will still need a source of fuel
- **Weaknesses**
 - No real marketing programs at local gas stations
- **Opportunities**
 - If E85 pumps are installed the flex-fuel vehicles will become a great target market
- **Threats**
 - New technology that cuts down the use of oil or even ethanol fuel

Traditional Hybrids

- **Strengths**
 - Still will use gasoline with a mix of ethanol
- **Weaknesses**
 - Cannot control hybrid automobile market
- **Opportunities**
 - Not applicable
- **Threats**
 - Technology not geared towards consuming more fuel

Plug-in Electric Hybrids

- **Strengths**
 - Still will use gasoline
- **Weaknesses**
 - Cannot control hybrid automobile market
- **Opportunities**
 - The creation of pug in outlets at the existing gas stations
- **Threats**
 - Technology not geared towards consuming fuel

Increase Corn Yields

- **Strengths**
 - Has the available infrastructure to produce more ethanol
- **Weaknesses**
 - Output depends on the supply from the farms
- **Opportunities**
 - Growing market demand
 - The demand for renewable fuels
 - Plant breeding and biotechnology
- **Threats**
 - Environmental conditions

❖ S.W.O.T. Analysis of Oil Companies

Status Quo

- **Strengths**
 - Influence in the fuels market
 - Large capital to invest in new technologies
- **Weaknesses**
 - Product is harmful to the environment
- **Opportunities**
 - Growing domestic and global market
 - Renewable fuel
 - Funding, grants, and tax incentives

- Federal and state
- **Threats**
 - Increasing demands for product
 - Strengths in cooperative programs (ethanol plants)
 - 16 ethanol plants; 8 additional plants under construction
 - MN consumes 260 million gallons of ethanol annually
 - 550 million gallons of total ethanol capacity
 - Average of 200 billion bushels of corn or 15percent of annual corn crop

Alternative Fuels

Natural Gas

- **Strengths**
 - Not applicable
- **Weaknesses**
 - No existing infrastructure
- **Opportunities**
 - Invest in producing natural gases
- **Threats**
 - The natural gas could take away market share from oil companies

Hydrogen Fuel Cells

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Increasing demand for clean burning, renewable fuels
 - Growing market for alternative fuels such as ethanol
- **Threats**
 - Fuels cells increasing their market share, taking away the need for oil

Corn-Based Ethanol

- **Strengths**
 - Large market influence
 - Greats amounts of capital to invest in more production and research
- **Weaknesses**
 - Not apart of current core business
- **Opportunities**
 - Increasing market for alternative and renewable fuels
 - Consumers will always need fuel for their cars
 - Combine the oil with the ethanol
- **Threats**
 - Other forms of renewable fuels: cellulosic ethanol, natural gas, etc.

- Domestic and foreign oil companies
- Rural farmers and cooperatives producing ethanol

Cellulosic Ethanol

- **Strengths**
 - Capital to invest in the new area of renewable fuels
- **Weaknesses**
 - Heavily invested in oil production
- **Opportunities**
 - Emerging market
 - Chance to sell a cleaner burning fuel
- **Threats**
 - Could severely hurt oil companies competitive advantage by completely changing the fuel markets

Vehicle Technology

Flex-Fuel Vehicles

- **Strengths**
 - These vehicles will still need a source of fuel
 - Control what fuel is sold to franchises gas stations
- **Weaknesses**
 - Not heavily invested in ethanol
- **Opportunities**
 - If E85 pumps are installed the flex-fuel vehicles will become a great target market
 - Investments in a diversified fuel market
- **Threats**
 - New technology that cuts down the use of oil

Traditional Hybrids

- **Strengths**
 - Still will use gasoline
- **Weaknesses**
 - Cannot control hybrid automobile market
- **Opportunities**
 - Not applicable
- **Threats**
 - Technology not geared towards consuming more fuel
 - Will significantly reduce the use of oil

Plug-in Electric Hybrids

- **Strengths**
 - Still will use gasoline
- **Weaknesses**

- Cannot control hybrid automobile market
- **Opportunities**
 - Raise the price of oil
- **Threats**
 - Technology not geared towards consuming fuel

Increase Corn Yields

- **Strengths**
 - Has capital to invest in ethanol plants
- **Weaknesses**
 - Corn ethanol is not part of the oil companies competitive advantage
- **Opportunities**
 - Growing market demand for renewables
 - Plants breeding and biotechnology
 - Opportunity to invest in an emerging market
- **Threats**
 - Losing competitive advantage
 - Local farmers and cooperatives gaining a market voice and influence
 - Ethanol has become an environmentally-friendly fuel

❖ **S.W.O.T. Analysis of the Automobile Industry**

Status Quo

- **Strengths**
 - Influential in the fuels market
 - Large capital to invest in new technologies
- **Weaknesses**
 - Bi-product is harmful to the environment
- **Opportunities**
 - Growing domestic and global market
 - Environmentally-friendly cars
 - Funding, grants, and tax incentives
 - Federal and state
- **Threats**
 - Ever changing market economy
 - The change in the supply and demand of products
 - Oil reserves are being depleted around the world
 - Keeping up with the market demands
 - Competition from other automobile manufactures

Alternative Fuels

Natural Gas

- **Strengths**

- Not applicable
- **Weaknesses**
 - No existing cars to use this type of fuel
- **Opportunities**
 - Invest in producing automobiles to use natural gases
- **Threats**
 - None

Hydrogen Fuel Cells

- **Strengths**
 - Capital available to invest in new technology
- **Weaknesses**
 - Do not currently mass produce hydrogen fuel cells
- **Opportunities**
 - Increasing demand for cleaner burning, renewable fuels
 - Federal Funding for R&D
- **Threats**
 - Stricter legislation on fuel standards

Corn-Based Ethanol

- **Strengths**
 - Large market influence
 - Greats amounts of capital to invest in more production and research
 - Already produce a large portion of cars able to use ethanol-mixed fuel
- **Weaknesses**
 - Little marketing and advertising towards the use of ethanol related fuels
- **Opportunities**
 - Increasing consumer confidence in an environmentally-friendly car
 - Consumers will always need fuel for their cars
 - Automobile industry will be less of a target for environmentalists
- **Threats**
 - Competitors creating a car that is more fuel efficient

Cellulosic Ethanol

- **Strengths**
 - Already produce ethanol-ready vehicles
- **Weaknesses**
 - Poor advertising for ethanol ready vehicles
- **Opportunities**
 - Emerging market
 - Chance to sell cleaner cars
- **Threats**
 - Competition

- Force automakers to manufacture a car that can efficiently run on ethanol

Vehicle Technology

Flex-Fuel Vehicles

- **Strengths**
 - Automakers have been making these cars since 2000
 - Been a leader in the auto industry to bring vehicles to a more environmentally-friendly state
- **Weaknesses**
 - Not widely marketed
- **Opportunities**
 - If E85 pumps are installed the flex-fuel vehicles will become a great target market
 - Provides a chance for the automobile industry to lead the way to create environmentally-friendly cars
- **Threats**
 - Competition
 - Mass production of flex fuel vehicles and hybrids

Traditional Hybrids

- **Strengths**
 - Still will use gasoline, but at a reduced rate
 - Large capital to invest in this new technology
 - Have already began making these types of cars
- **Weaknesses**
 - Do not produce enough to meet consumer demand
- **Opportunities**
 - High demand from consumers for a more environmentally-friendly car
- **Threats**
 - Competition
 - Changing markets, too many choices
 - Ethanol
 - Hydrogen fuel cells

Plug-in Electric Hybrids

- **Strengths**
 - Capital to spend on R&D
- **Weaknesses**
 - Currently not widely supplying these cars to consumers
- **Opportunities**
 - High demand for environmentally-friendly cars
- **Threats**
 - No developed infrastructure for plug-in cars
 - Competition

Increase Corn Yields

- **Strengths**
 - Some auto manufacturers already produce cars that can run on ethanol fuel
- **Weaknesses**
 - Not commercially available
- **Opportunities**
 - Growing market demand
 - The demand for renewable fuels
 - Opportunity to invest in an emerging auto market
 - Meet Federal fuel emission standards
- **Threats**
 - Competition

❖ S.W.O.T. Analysis of Lawmakers

Status Quo

- **Strengths**
 - Assist in the better use of the newly constructed 1500 E85 pumps (Goal)
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Increasing demands for product
 - Strengths in cooperative programs (ethanol plants)
 - 16 ethanol plants; 8 additional plants under construction
 - MN consumes 260 million gallons of ethanol annually
 - 550 million gallons of total ethanol capacity
 - Average of 200 billion bushels of corn or 15percent of annual corn crop
- **Threats**
 - Environmental factors could ruin the corn crops in MN

Alternative Fuels

Natural Gas

- Not applicable

Hydrogen Fuel Cells

- Not applicable

Corn-Based Ethanol

- **Strengths**
 - Federal Government's target of supplying 35 billion gallons of ethanol by 2017
- **Weaknesses**
 - Completely rely on the farmers to harvest the necessary amounts
- **Opportunities**
 - Potential to assist the state in replacing 25percent of the state's energy sources by 2025
- **Threats**
 - Potential of future MN lawmakers to not share the vision of Governor Pawlenty

Cellulosic Ethanol

- **Strengths**
 - Proposed \$100 million for research
 - Federal government's target of supplying 35 billion gallons of ethanol by 2017
- **Weaknesses**
 - Not applicable
- **Opportunities**

- Potential to assist the state in replacing 25percent of the state’s energy sources by 2025
- **Threats**
 - Not applicable

Vehicle Technology

Flex-Fuel Vehicles

- **Strengths**
 - Not applicable
- **Weaknesses**
- Not applicable
- **Opportunities**
 - Can use renewable energy
- **Threats**
 - Not applicable

Traditional Hybrids

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Can use renewable energy
- **Threats**
 - Not applicable

Plug-in Electric Hybrids

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Can use renewable fuel
- **Threats**
 - Not applicable

Increase Corn Yields

- **Strengths**
 - Federal Government’s target of supplying 35 billion gallons of ethanol by 2017
- **Weaknesses**
 - Not applicable
- **Opportunities**

- Potential to assist the state in replacing 25percent of the state’s energy sources by 2025
- **Threats**
 - Not applicable

❖ **S.W.O.T. Analysis of Academia/Research Facilities**

Status Quo

- **Strengths**
 - Pre-existing Research Facilities and Faculty
- **Weaknesses**
 - Corn based ethanol is not going to have long term sustainability
- **Opportunities**
 - New credentials and breakthroughs in an emerging field
 - New field of research
- **Threats**
 - Funding cut offs

Alternative Fuels

Natural Gas

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Not applicable
- **Threats**
 - Take away grant money for researching in other forms of renewable fuels

Hydrogen Fuel Cells

- Not applicable

Corn-Based Ethanol

- **Strengths**
 - Strong background in research and development
- **Weaknesses**
 - No long term sustainability
- **Opportunities**
 - Not applicable
- **Threats**
 - Not applicable

Cellulosic Ethanol

- **Strengths**
 - \$100 million towards research in Minnesota
 - Years of experience research cellulose biotechnology at the University of Minnesota
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Variety of plants grown that could replace corn ethanol
- **Threats**
 - The elimination of funding

Vehicle Technology

Flex-Fuel Vehicles

- **Strengths**
 - Vehicle could utilize the research and development of cellulose
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Not applicable
- **Threats**
 - Not applicable

Traditional Hybrids

- Not applicable

Plug-in Electric Hybrids

- Not applicable

Increase Corn Yields

- **Strengths**
 - Not applicable
- **Weaknesses**
 - University of Minnesota researchers do not focus on corn ethanol as a solution for a renewable fuel
- **Opportunities**
 - Not applicable
- **Threats**
 - Increasing the focus on a corn based renewable fuel will hinder the acceptance of other renewable fuels from other feedstocks

❖ S.W.O.T. Analysis of Environmentalists

Status Quo

- **Strengths**

- Not applicable
- **Weaknesses**
 - Staying on the same course of action would mean fewer advances in creating a more environmentally-friendly fuel
- **Opportunities**
 - Not applicable
- **Threats**
 - Not applicable

Alternative Fuels

Natural Gas

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Emits 30-40percent less green house gases
- **Threats**
 - not widely available
 - 150,000 on the road in the U.S. as oppose to 5 million cars on the road world wide

Hydrogen Fuel Cells

- **Strengths**
 - Environmentally-friendly: zero emissions
- **Weaknesses**
 - Fuel capacity for trips under 200 miles
 - Costly to produce
 - Not widely available
- **Opportunities**
 - Emits no greenhouse gases or other air pollutants
- **Threats**
 - Too expensive for the average consumer

Corn-Based Ethanol

- **Strengths**
 - More environmentally-friendly than traditional oil
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Not applicable
- **Threats**
 - Takes more energy to grow, harvest and ship

- Ethanol has to be shipped or trucked everywhere; no existing pipeline infrastructure
- Over-production can be harmful to land

Cellulosic Ethanol

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Better for the land
 - Utilizes many forms for fuel
 - Switch grass, commercial waste, willow trees etc
- **Threats**
 - More expensive to produce (\$4.30-\$5.44 per gallon)

Vehicle Technology

Flex-Fuel Vehicles

- **Strengths**
 - In production since 2000
 - Might already own one
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Use cleaner burning fuels
- **Threats**
 - New pumps at stations

Traditional Hybrids

- **Strengths**
 - Better for the environment
- **Weaknesses**
 - Have to purchase a car with the technology
- **Opportunities**
 - Allows consumers to reduce their vehicle's emissions
- **Threats**
 - These vehicles are not widely produced: many customers are on waiting lists

Plug-in Electric Hybrids

- **Strengths**
 - Environmentally and economically friendly
- **Weaknesses**

- Have to plug the car in to re-fuel
- **Opportunities**
 - Not applicable
- **Threats**
 - Congress has provided little funding for the technology
 - Technology still in the development phase

Increase Corn Yields

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Increase ethanol production
- **Threats**
 - Over use of the land
 - Ethanol will remain costly

❖ **S.W.O.T. Analysis of Minnesota Citizens**

Status Quo

- Not applicable

Alternative Fuels

Natural Gas

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Not applicable
- **Threats**
 - not widely available to Minnesota citizens

Hydrogen Fuel Cells

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Not applicable
- **Threats**
 - Not widely available to Minnesota citizens

Corn-Based Ethanol

- **Strengths**
 - Support local community
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Strengthen local economies
 - Job creation
- **Threats**
 - Not applicable

Cellulosic Ethanol

- **Strengths**
 - Support local community
- **Weaknesses**
 - Still in developmental phase
- **Opportunities**
 - Strengthen local economies
 - Job creation
- **Threats**
 - Could negatively affect the corn industry

Vehicle Technology

Flex-Fuel Vehicles

- **Strengths**
 - Minnesota citizens could already own this type of vehicle
- **Weaknesses**
 - Purchase a new vehicle
- **Opportunities**
 - Not applicable
- **Threats**
 - Not applicable

Traditional Hybrids

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Not applicable
- **Threats**
 - Costs of purchasing a new car

Plug-in Electric Hybrids

- **Strengths**
 - Not applicable
- **Weaknesses**
 - Not applicable
- **Opportunities**
 - Not applicable
- **Threats**
 - Not widely available
 - No current infrastructure

Increase Corn Yields

- **Strengths**
 - Support fellow Minnesotans
- **Weaknesses**
- **Opportunities**
 - Creation of jobs
 - Strengthen state economy
- **Threats**
 - Not applicable

Appendix IV

After conducting a thorough analysis of each policy option relative to various stakeholders, Clean Consulting designed the following charts. Merging market and policy factors, these charts determine, in a quantitative fashion, feasible options for achieving Governor Pawlenty's objective. Clean Consulting used an interpretive approach, valuing each policy option with a positive (+), neutral (0), or negative (–) mark relative to its impact on each stakeholder.

Table 1: Evaluation of Stakeholder Affects

	Farmers	PlantsEthanolSmall	OwnersBusinessSmall	Agri-Business	CompaniesOil	ManufacturesAuto	Politicians	AcademiaFacilities/Research	mentalistsEnviro-	Minnesota Citizens
Status Quo	+	+	0	+	+	0	0	-	-	-
Natural Gas	0	0	0	0	-	0	0	-	-	0
Hydrogen Cells	0	0	0	0	-	0	0	0	+	0
Corn-Based Ethanol	+	+	-	+	-	+	+	-	-	+
Cellulosic Ethanol	+	+	-	+	-	+	+	+	+	+
Flex Fuel Vehicles	+	+	+	+	0	+	+	+	+	+
Hybrid Vehicles	0	+	-	+	0	+	+	0	+	+
Plug-In Hybrids	0	+	-	+	0	+	+	0	+	+
Increase Corn Yields	+	+	-	+	-	+	+	-	-	+

	Readiness	Cost	Stakeholder Affect	Potential	Total
Status Quo	+	+	2	0	4
Natural Gas	-	-	-3	0	-4
Hydrogen Cells	-	-	0	+	1
Corn-Based Ethanol	+	+	2	+	3
Cellulosic Ethanol	0	0	6	+	7
Flex Fuel Vehicles	+	+	9	+	10
Hybrid Vehicles	+	+	5	+	8
Plug-In Hybrids	0	0	5	0	5
Increase Corn Yields	+	+	2	+	5

**Table 2:
Option
Analysis
and**

Criteria

Readiness: Availability of technology, infrastructure and public/private support for large-scale implementation. How soon can the option be implemented or enhanced to the scale necessary for Minnesota to meet its goals?

Cost: Financial feasibility of implementation based on technology, research and infrastructure costs.

Stakeholder: Positive and negative impacts and externalities on specified stakeholders.

Potential: Defines a policy option's likelihood of meeting the energy changes that Minnesota is seeking. This entails the practicality of success, both business and technical, couple with the potential magnitude of change. Preferably, Clean Consulting desires a solution that is feasibly large enough to be applied on a macro scale throughout Minnesota and possibly the rest of the United States.

Total: The policy options with the highest totals were considered favorable options for the final recommendation.

Appendix V

The Energy Policy Act of 2005 (H.R. 6) provided many incentives for the production of renewable energy from various feedstocks. The following provides a summary of those provisions as well as the current status of federal programs.^{lxv}

Current Federal Policies that Promote Renewable Fuels: Tax Incentives

Volumetric Ethanol Excise Tax Credit: Gasoline suppliers who blend ethanol with gasoline are eligible for a tax credit of 51 cents per gallon of ethanol. (Expires 12/31/2010).

Small Ethanol Producer Credit: Small ethanol producers are eligible to receive a 10 per gallon credit for the first 15 million gallons of ethanol produced in a year. Small producers have a production capacity below 60 million gallons per year. (Expires 12/31/2007).

Biodiesel Tax Credit: Biodiesel producers are eligible to receive a \$1.00 per gallon credit for biodiesel produced from virgin agricultural products (“agri-biodiesel”), or a \$.50 gallon credit for biodiesel produced from previously used agricultural products. (Expires 12/31/2008).

Small Agri-Biodiesel Tax Credit: Producers of agribiodiesel with an annual production capacity of less than 60 million gallons are eligible to receive an additional 10 cent per gallon on the first 15 million gallons produced each year.

Alternative Fueling Station Tax Credit: Provides tax credit of up to 30 percent of the cost of installing a qualified alternative fuel vehicle refueling pump. The credit is capped at \$30,000 for retail pumps or \$1,000 for residential pumps. (Expires December 31, 2009).

Alternative Fuel Motor Vehicle Credit: Qualifying alternative fuel vehicles (AFVs) purchased or placed into service between January 1, 2005 and December 31, 2010 may be eligible for a federal income tax credit of up to \$4,000.

Current Federal Policies that Promote Renewable Fuels: Program Funding

Bioenergy Program: \$60 million appropriated in FY 2006 to reimburse ethanol and biodiesel producers for expanding their production capacity. Eligible commodities include grain and oilseed crops, cellulosic crops, animal fats, agricultural byproducts and oils. The DOE did not request any funding for this program for FY 2007.

Renewable Energy System Grants: Provides direct loans, loan guarantees and grants to farmers, ranchers and small rural businesses for the purchase of renewable energy systems.

Value-Added Producer Grants: Provides grants to independent producers for value-added agricultural activities, including biofuel production.

Business and Industry Guaranteed Loans: Provides loan guarantees for up to 90 percent of the loan made by a commercial lender. Loan proceeds can be used for working capital, equipment, buildings and real estate.

Rural Business Enterprise Grants: Grants to public bodies, nonprofit corporations and Indian tribes to facilitate the development of small and emerging rural business enterprises.

Current Federal Policies that Promote Renewable Fuels: Other Policies

Conservation Reserve Program: The 2002 Farm Bill modified the conservation reserve program to allow the use of CRP lands for wind energy generation and biomass harvesting for energy production, with reduced payments.

Import Duty for Fuel Ethanol: The Tax Reform Act of 1986 imposes a 2.5percent ad valorem tariff and a most-favored-nation duty of 54 cents per gallon on ethanol imported into the U.S. from other countries. Ethanol produced from Caribbean Basin Initiative countries may be imported duty-free. This tax expires on December 31, 2007.

Appendix VI

The following is a brief summary of funding currently available in the State of Minnesota for renewable energy production and use.^{lxvi}

Biomass

Production Incentive: Payment of 1.5 cents/kWh for 10 years for generation from an on-farm anaerobic manure digester system (Statute 216C.41)

Ethanol

Production Credit: Payment of 20 cents/gallon for ethanol produced in Minnesota and produced at plants that began production by June 30, 2000; annual payments limited to \$3 million for any single producer and \$34 million total (Statute 41A.09)

E85 Station Funding: The Minnesota Dept. of Agriculture received \$500,000 in funding in 2005 legislation for E85 fueling stations up to 50percent of costs up to \$15,000. Rules are currently being developed.

Hydrogen^{lxvii}

Hydrogen is another environmentally-friendly fuel that is being explored as an option for meeting growing energy demands. Hydrogen can be used in a fuel cell to drive electric engines or it can be burned in an internal combustion engine. Hydrogen is produced domestically and can be derived from several different sources, and is also environmentally-friendly. When used in a fuel cell, hydrogen emits no greenhouse gasses or other air pollutants. Currently, hydrogen-fuelled cars exist only in demonstration fleets.

Widespread commercialization faces several challenges including costs and availability of both hydrogen and vehicles. Hydrogen is costly to produce and is only available in a few locations – mostly in California. Fuel cell vehicles are cost-prohibitive to the average consumer. Additionally, hydrogen's weak onboard fuel storage capacity makes it an undesirable fuel option for trips over 200 miles.

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