Session No. 703

Designing and Permitting SH&E into an Alternative Energy Facility—Part III

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Prevention through Design in Real Time

This presentation is the third in a series reporting on the process for an alternative energy project development. Do not be concerned if you have not participated in previous presentations since we are reporting on developments as they occur in "real time".

The project, Calumet Green Energy Park (Calumet Park), is being developed as an eco-industrial park, anchored by a 250 TPD thermophilic anaerobic digester. The digester will take organic waste and hold it in an oxygen-free environment for <30 days; capture the methane and carbon dioxide, which are released from living organisms as they decompose in an anaerobic environment; create compost; and release only clean water and oxygen.

Methane and carbon dioxide can be thus created in a carbon-negative system, reducing atmospheric carbon. Methane can be converted to a transportation fuel, compressed natural gas (CNG), which exhibits a very good environmental profile. My first PDC presentation in this series focused primarily on the fuel created from the gas.

The following data utilized Argonne National Labs' Greenhouse Gases in Transportation (GREET) model and has previously been reported at this conference.[1]

	Btu/mile or grams/mile				
Item	Low Sulfur Diesel	Biodiesel BD20	Ethanol diesel ED10	CNG	Renewable CNG
GHGs	1,536	1,363	1,499	1,601	-763
VOC: Urban	0.156	0.151	0.166	0.146	0.145
CO: Urban	0.239	0.231	0.236	2.408	2.405

[1] Argonne National Laboratory, "GREET Model," http://www.transportation.anl.gov/modeling_simulation/GREET/index.html.
The GREET model is free software and is used to calculate reporting requirements of the Renewable Fuel Standard.

NOx: Urban	5.242	5.222	5.236	0.314	0.307
	Btu/mile or grams/mile (cont.)				
Item	**Low Sulfur Diesel**	**Biodiesel BD20**	**Ethanol diesel ED10**	**CNG**	
PM10: Urban	0.055	0.05	0.053	0.024	0.025
PM2.5: Urban	0.025	0.023	0.024	0.015	0.014
Sox: Urban	0.122	0.109	0.119	0.068	0.065

Table 1. Envoronmental Impact of Light-Duty Truck/School Bus Fuels on Well-to-Wheel Buses
(*Source:* Argonne National Laboratory, GREET model)

Carbon dioxide from the digester will be pumped into a large commercial greenhouse. On a sunny day, naturally-occurring CO_2 in commercial greenhouses is dissipated by 11am.[2] Most CO_2 is derived from fossil-fuel sources. Where greenhouse operators can afford it, it does improve production; however, it is generally considered cost-prohibitive. Further, greenhouse profits are limited by the high cost of natural gas to heat the greenhouse in the winter. The digester anchor at Calumet Park will produce hot by-product CO_2 which will be readily used in the greenhouse.

The compost at the end of the process has wide application as a fertilizer and, of course, also has applications in greenhouse operations.

Initial investigation in this series examined the environmental profiles of five transportation fuels for their environmental/public health impact. Utilizing Argonne's GREET model, we determined that the renewable compressed natural gas (CNG) to be manufactured offers significant environmental and public health benefits.

Indeed, comparing the data garnered from the modeling exercise against current air quality data in the Chicago area, we were able to determine that widespread adoption of CNG as a transportation fuel would have a positive impact on air quality in Chicago, which is non-attainment under the Clean Air Act for ozone, small particulates, and the newly proposed nitrous oxide (NOX) designation.

Early Project: 2007

These findings buoyed us and encouraged our project. Early in 2007, Green SEED Energy was incorporated to promote building anaerobic digesters in southeast Chicago and elsewhere. Later that year, the City of Chicago offered a Request for Proposals (RFPs) for an engineering study to convert an existing double bank of 264 silos in Chicago's southeast side to anaerobic digesters.

Based on engineering difficulties with the silos, Green SEED Energy responded only in order to encourage their larger vision. A number of environmental professionals, lawyers, architects and others from the community came together to provide considerable talent, imagination, tenacity, and hope to propose that such a facility can and should be built. The idea of building an eco-industrial park anchored by waste-driven energy is not new to this group. In fact, many of the same individuals working on the

[2] T.J Blom; W.A. Straver; F.J. Ingratta; Shalin Khosla - OMAF; Wayne Brown – OMAF, Ontario Ministry of Agriculture, Food & Rural Affairs, *Carbon Dioxide in Greenhouses, Factsheet.*

project first worked together on recycling, waste-to-energy incinerators, composting operations and the development of anaerobic digester technology from its earliest iterations in the United States and have worked together since the mid-1980s. Indeed, as a component of the Resource Recovery Industrial Park project, Calumet Park team members worked with one of the first engineers to perfect thermophilic systems, which capture methane for reuse.

So when the city issued its RFP, this team had already mobilized and created a strategy that made it possible to credibly respond even as a new company.

While many of the details of its project have changed over the past four years, the commitment to create this eco-industrial park has only strengthened as pieces of the development continue to come together and its benefits to the environment, sustainable development and energy independence are crystallized.

In 2007 the Supreme Court ruled that the EPA could regulate carbon as a pollutant, opening the door for regulations that we knew would increase the viability of the entity we proposed.

The project was initially proposed as the movement began to encourage corporate social responsibility and sustainability. Companies all over the country have begun to adopt aggressive policies, and these policies are being carried out worldwide. ASSE has initiated a task force under COPA for examining our role in this movement and seeking to include worker safety standards as part of the definition of sustainable.

When Green SEED Energy incorporated, EPA had already begun racheting up renewable fuels and air quality requirements in fuels and implementation of the Renewable Fuels Standard was imminent. Today, its challenges are being recognized in the industry.[3]

The political shift in the executive and congressional branches made it more likely that the "American Clean Energy and Security Act" would be passed. As of this date, the bill has passed the House, but not the Senate. Senator Ben Nelson of Nebraska has proposed the "Biogas Production Incentives Act of 2007," which would also be helpful.

<u>Adoption of CNG Fuel by Municipalities and Bus Fleets</u>

Also on the political side, we have been encouraged by Chicago's Mayor Daley, who is a strong advocate for greening the urban environment. The city has encouraged the development of anaerobic digestion projects by Green SEED Energy and others. It has also encouraged increased adoption of CNG fuel and has helped to build six CNG fueling stations around Chicago. Again, this project has many layers of complexity. One of them is that, in order to sell compressed natural gas, the infrastructure for distributing CNG must be in place.

Since our modeling work was completed almost four years ago, many cities around the U.S. have followed their colleagues in Europe, Asia, and South America and converted their bus fleets to CNG. In addition to the environmental benefits, this transition saves those cities money, since CNG sells for less than diesel or gasoline on a gas-gallon-equivalent (GGE) basis.

> By the end of 2010, about 6 million tons/year of processing capacity divided over 200 plants in 17 countries is expected.[4]

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[3] Renewable Fuel Standard, http://www.epa.gov/otaq/fuels/renewablefuels/index.htm.
[4] *BioCycle,* Cover, February, 2010.

We have benefitted from the work done by our colleagues in these cities as they have documented the knowledge they have gained in building, installing, and maintaining CNG engines in municipal fleets and siting, constructing, and operating CNG distribution systems.

We have learned from our colleagues in the oil and gas distribution industries who have much relevant knowledge to share and who now recognize that energy is and must increasing become a more multi-layered industry.

Despite a decline in industrial activity, the air quality in Chicago has not significantly improved. In fact, a newly proposed standard for nitrous oxides (NOX) would make Chicago the only city in the country to be designated non-attainment for NOX. It may also be significant that the two highest levels of NOX found in Chicago were near two city transit bus barns.[5] Asthma rates continue to be among the highest in the country.[6]

Design for Safety[7] guidelines have proven a useful tool for examining potential risks from a facility from the conceptual stage. Such a complex project brings together many EHS practice specialties. Multiple hazards at multiple levels, distinct by development period and expertise required, must be managed.

Setbacks, Delays and Lessons Learned

Since this project has not yet started construction, these progress reports over the past four years have shown both the growth of our knowledge of a complex development process, the folly of optimism and the reality of the impact of economic conditions, market forces, and political winds. Yet, always, know and recognize that development is a process; even development that starts with a sound strategic initiative and pathway has a high risk at this stage for collapse. Innovation is considered a risky investment in the best of circumstances; it is even more difficult when the stock market is plunging. The Calumet Park team has recognized all of these risks and given their souls to this project anyway. The project now being sited has withstood scrutiny from both friends and professionals, not to mention three years of questions from ASSE's PDCs attendees.

Because site acquisition from a public agency has proven more complicated than had been anticipated, alternative sites had to be developed. This delayed construction permits, which must be site specific, although some sections may be template.

It may be noted by any who have been to this session before that the throughput capacity of this facility has decreased over the years. As our knowledge has grown, so has our understanding of the point at which the project will be profitable. The object here is to find the optimal balance between the smallest possible capital investment that will be profitable. Such opportunity for review has increased our confidence in our financial projections.

These delays allowed time for additional research projects that have ultimately strengthened the project. We have added digestion of invasive species, algae as biomass, and synergistic relationships with constructed wetlands into our project development thinking. Further, the delay has allowed investigation into areas of safety sustainability most in need of address in this development.

Indeed, development of this project has given us the opportunity to reflect on how best to contribute to the development of what may become a "Prevention through Design" (PtD) standard. In its recent

[5] U.S .EPA, "Nitrogen Dioxide," http://www.epa.gov/air/nitrogenoxides.
[6] Respiratory Health Association of Metropolitan Chicago, *Fact sheet*, http://www.lungchicago.org/site/epage/23938_487.htm.
[7] "Design for Safety," http://www.cdc.gov/niosh/blog/nsb010410_green.html.

"Making Green Jobs Safe" workshop, NIOSH presented six ideas for incorporating worker health and safety concepts into green and sustainability developments.[8] These are:

- Define, categorize, and track green jobs
- Evaluate all green jobs, practices, processes, and products for hazards to worker safety and health
- Integrate worker safety and health, energy conservation and environmental protection efforts
- Plan early for prevention
- Make safety and health part of green jobs training
- Add safety and health to green benchmarks

Define, Categorize, and Track Green Jobs

The alternative energy industry and its many component parts offer us a ready-made case study for implementing an effective safety program literally from conception. Since we are one of the lesser-known alternative energy technologies, there is the risk that we might not be included in this work.

Evaluate All Green Jobs, Practices, Processes, and Products for Hazards to Worker Safety and Health

We know that the way to approach such complex risks is first to look at all of the smaller and more distinct risks.

For example, as previously mentioned, our anaerobic digester will create methane. We have always known, of course, that methane is a dangerous chemical. We are very aware that we are creating methane in a way that is not thoroughly familiar in the U.S. We become all the more aware and all the more committed to getting it right when one of our own loses their life in a natural gas explosion. Chris Walter's death reminds us that our jobs are hazardous and that we must remain vigilant.

The digesters we are building take advantage of a European innovation, which allows minute amounts of oxygen in the otherwise anaerobic chamber in order to neutralize H2S. European success with this innovation is reported to be good. Given the severity of outcomes possible from getting this particular element of the facility wrong, we believe that it, too, must have redundant protections and alarms and that the engineering of these systems must be reviewed and found effective.

Integration, Early Prevention and Training for Safety and Health

Successful operation of Calumet Park will show this integration. We believe that our planning activities now will impact safety rates in our operations. These lessons will then be incorporated into training programs.

Add Safety and Health to Green Benchmarks

There has been resistance on the part of the U.S. Green Building Council and those re-writing the LEED certification program standard[9] to incorporate worker health and safety into that standard. This project has the opportunity to be a showcase for how this can occur.

We started this process at the beginning and know that it will continue throughout the life of the facility. Indeed, we have a responsibility to think about a facility's entire life cycle even in the design, construction, and operation phases in order not to repeat mistakes of the early industrial period with regard to abandonment of brownfield properties or by contaminating people, property, and the environment.

[8] CDC, "Going Green: Safe and Healthy Jobs" http://www.cdc.gov/niosh/blog/nsb010410_green.html.

[9] U.S. Green Building Council, http://www.usgbc.org/DisplayPage.aspx?CategoryID=19.

Life-cycle risk assessment and risk management must occur not only at the facility, but also in related risks in agriculture, CNG design, vehicle maintenance and repair, fueling stations distribution systems, and others.

As the instigator and the project manager of such a complex project, it has fallen to me to become conversant in technologies with which I had little prior experience. My own experience is in the environmental health and safety field where I have worked for over 30 years, concentrating primarily on waste projects and brownfield redevelopment. In the last 12, years my project experience has been with wastewater clients, focusing heavily on food processors. It is here I became familiar with anaerobic digester technologies in their application for wastewater.

What I was not was a transportation fuels expert, a methane gas expert, a hydrogen sulfide expert, or even a chemist. Does that mean I should not be managing this project? No, it does not. In such a complex project, no one person can be expert in all the small and distinct specializations present.

Conclusion

It means, as Design for Safety guidelines would inform us, that we must know what we do not know; that we must learn much as we can and as quickly as possible; that we continue to learn until we know what we do not know; and that we then continue to learn after that.

It means we must hire competent experts in these fields, such as those who will spend their busy work time and even their vacation time to hone their skills at an ASSE PDC in a range of jobs. Experts will be required to help to conceptualize, design, refine, and construct the safest possible work place; to examine processes to identify, assess, document, engineer and re-engineer systems; to train and re-train ourselves and our work force. Only then can we affect the safest possible work place with the greatest opportunity for successfully managing the risks associated with it.