LUCAS E^3

Keynote Presentation

Educating Business on Energy Efficiency in Ethanol Plants

JC SE

Agricultural Utilization Research Institute
Minnesota Renewable Energy Roundtable
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Presenters

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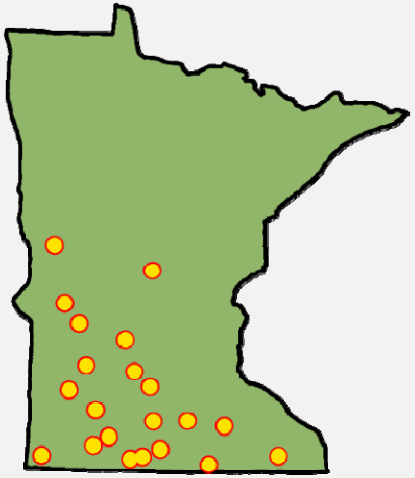
Presentation Outline

- Section 1 - Introduction & Presentation Outline
- Section 2 - Ethanol Production & Plant Issues
- Section 3 - Lucas E^3 Philosophy of Service
- Section 4 - Service Packages
- Section 5 - Example Customer & Project
- Section 6 - Energy Efficient Projects - Looking Forward
- Section 7 - Comments and Questions

Ethanol Production & Economic Impact



- For 2012 U.S. had 211 active ethanol plants producing 13.3 BGY at 90% of current national nameplate capacity of 14.7 BGY
- Minnesota had 21 plants producing 1.0 BGY at 100% nameplate capacity accounting for about 7.7% of U.S. production
- Minnesota plants use about 400 million bushels of corn annually, account for about 4,300 jobs, and have an estimated annual total economic impact of about $2.2 billion
- Due to size and distribution all Minnesota ethanol plants can benefit significantly from specific targeted process improvements

Plight of the Smaller Ethanol Plant

- Few ethanol plants have a process engineer on staff, which some estimates put at about 20%
- Even with a process engineer, duties can prevent the in-house design of simple and readily available projects
- Many opportunities exist for the small, targeted project that can improve energy efficiency at the plant, often with less than a $300,000 capital investment
- This type of project is often revealed after a detailed optimization process using common engineering methods

Plight of the Smaller Ethanol Plant

- Large consulting design firms are often engaged on new plants and large additions or remodels
- These firms focus on larger projects in excess of $1,000,000 and they tend not to approach small plants for proposals with minor upgrades and additions
- When engaged on a smaller plant they may come to the table with a predetermined solution that has more than what the Owner really needs
- Smaller firms can work more closely but may lack the breadth of experience, relying more on past projects

Lucas E3 Philosophy of Service

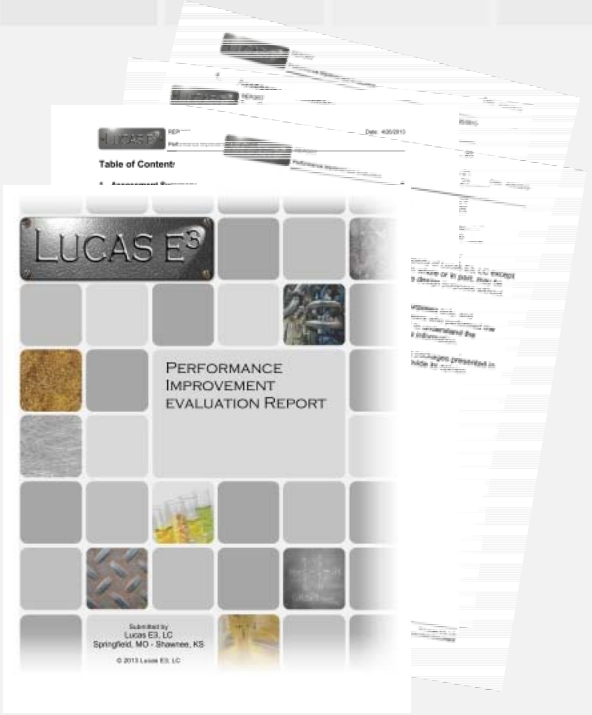
- As Scott Lucas worked for one of the largest ethanol design firms, he came to see this plight of the small to mid-size plant as unacceptable and unnecessary
- In 2010 Scott founded Lucas E^3 and quickly began to associate with other experienced and like-minded designers, contractors, suppliers in order to offer Owners the same types of service – but with a twist
- The twist? We do what our clients need us to do regardless of plant size and project scope

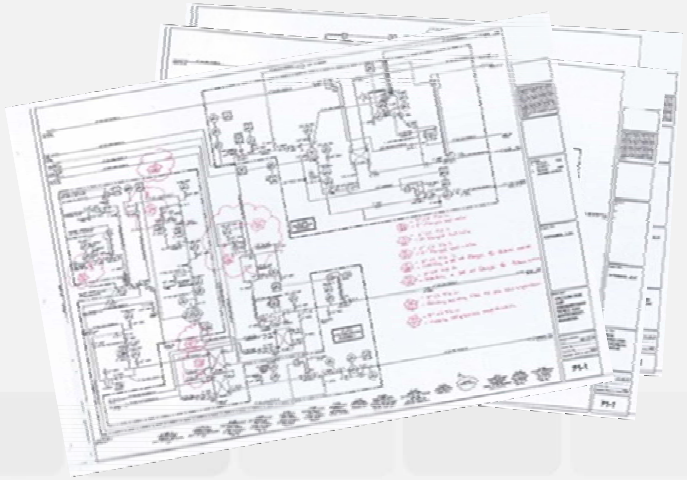
Lucas E3 Philosophy of Service

- We start by focusing our efforts to determine what the Owner needs and develop solutions from there
- We spend time with the Owner, usually in face-to-face meetings, to foster a close working relationship
- We educate the Owner on readily-available methods and projects that increase energy and operational efficiency
- We develop solutions with significant Owner input

Service Packages

- Plant Evaluation & Report
- Engineering Design
- Owner Representation & Coordination





Service Packages

- Plant Evaluation & Report
  1. Plant Walk-Through
  2. Baseline Model
  3. Improved Model
  4. Model Comparison
  5. Issue Report with Recommendations

Service Packages

- Plant Evaluation & Report

1. Plant Walk-Through
    a. Physically walk the plant to develop a more complete understanding of operations and begin to identify bottlenecks
    b. Collect operational information, data, drawings, etc.
    c. Interview operational staff to discuss specific issues to be addressed
2. Baseline Model
3. Improved Model
4. Model Comparison
5. Issue Report with Recommendations

Service Packages

- Plant Evaluation & Report
  1. Plant Walk-Through
  2. Baseline Model
     a. Material & Energy Balance to establish current process flows
     b. Define process flow into and out of each piece of equipment
     c. Model will more accurately represent current plant operations
  3. Improved Model
  4. Model Comparison
  5. Issue Report with Recommendations

Service Packages

- Plant Evaluation & Report
  1. Plant Walk-Through
  2. Baseline Model
  3. Improved Model
     a. Use baseline model to introduce process modifications
     b. Create modified P&IDs and M&EBs to quantify impact
  4. Model Comparison
  5. Issue Report with Recommendations

Service Packages

- Plant Evaluation & Report
  1. Plant Walk-Through
  2. Baseline Model
  3. Improved Model
  4. Model Comparison
     a. Evaluate changes between Baseline Model and Improved Model
     b. Summarize comparisons for inclusion in Report
  5. Issue Report with Recommendations

Service Packages

- Plant Evaluation & Report
  1. Plant Walk-Through
  2. Baseline Model
  3. Improved Model
  4. Model Comparison
  5. Issue Report with Recommendations
     a. Summarize operations at current plant rate
     b. Discuss bottlenecks, areas of concerns, and potential energy savings
     c. Identify 10 to 15 recommended process modifications (projects)
     d. Develop cost estimate and quantify economic benefit of each project
     e. Develop cost estimate for delivery of Engineering Design

Service Packages

- Engineering Design

1. Lucas E^3 works with the Owner to develop an appropriate plan for implementing the projects identified by the Plant Evaluation & Report considering the Owner's specific needs and conditions
2. Project development made openly to encourage communication and coordination that permits Owner input on project direction
3. Engineering Design package for selected projects are developed to facilitate the Owner's ability to work directly with local contractors and vendors of choice

Service Packages

- Engineering Design package includes process engineering information such as:
  1. Material and Energy Balance
  2. P+IDs
     - Existing P+IDs marked up for updating and New P+IDs as needed
  3. Equipment Specifications
     - Include the information necessary for Owner's coordination with vendors and contractors
  4. Operating Procedures
  5. Control Narratives
     - Used for coordinating with programmers

Service Packages

- Owner Representation & Coordination

1. Where the Engineering Design package is developed for the Owner to work directly with contractors and vendors, Lucas E^3 can provide coordination assistance at the Owner's direction
2. Or we can act as the Owner's Representative in using the Engineering Design package to work directly with vendors and contractors on the Owner's behalf
3. Lucas E^3 can also act as an on-call consultant to evaluate new technologies and projects being offered by other design firms, vendors, and contractors

Example Customer & Project

- Lucas E³ completed a Plant Evaluation & Report package in early 2012 for the 45 MM GPY Chippewa Valley Ethanol Co. (CVEC) plant located in Benson, Minnesota
- That report identified twelve specific projects that could directly address plant efficiency and create significant cost savings with coordinated installation
- Considerable time was spent with the Owner to review those recommendations and discuss outcomes resulting from possible adjustments to scope and schedule

Example Customer & Project

- Lucas E^3 is currently developing the engineering package for two of the twelve identified projects which involves a previously installed project designed by another firm
- Our ongoing relationship with CVEC staff has resulted in the development of several new project ideas not initially included in the Plant Evaluation & Report
- Value of long term relationship in that we have the opportunity to continue to educate plant staff, which in turn makes it easier for the plant staff to educate us about their plant operations

Example Customer & Project

- Three related energy-saving projects delivered as a single package were revealed from our work with CVEC
- This package of projects can be applied at most ethanol plants, which makes it a larger benefit to the ethanol industry as a whole
- The package consists of the following projects
  1. Energy Recovery from Stack Gases
  2. Alternative Front-End Heating
  3. Heavy Syrup Evaporation

Example Customer & Project

1. Energy Recovery from Stack Gases
   a. Capture waste heat to displace use of steam
   b. Project value is dependent on efficient end use of recovered heat
   c. Most plants have several areas to utilize this waste heat
   d. For CVEC the Energy Recovery portion was already in place but not being fully utilized
2. Alternative Front-End Heating
3. Heavy Syrup Evaporation

Example Customer & Project

1. Energy Recovery from Stack Gases
2. Alternative Front-End Heating
   a. Uses waste heat in lieu of steam to heat up incoming corn
   b. Improves flour-water mixing
3. Heavy Syrup Evaporation

Example Customer & Project

1. Energy Recovery from Stack Gases
2. Alternative Front-End Heating
3. Heavy Syrup Evaporation
   a. Use waste heat in lieu of steam to drive evaporation
   b. Reduces moisture of evaporated syrup sent to dryers
   c. Reduces load and gas usage at DDG Dryer

Example Customer & Project

- For a 50 MM GPY plant including the installation of the energy recovery, alternative heating, and syrup evaporation projects, we estimate:
  - $2.0 million capital investment
  - Potential energy savings of 25 million btu/hr
  - Energy cost savings of $1.0 million per year

Energy Efficient Projects - Looking Forward

- High-Protein Low-Fiber Feed from DDG
- Water Saving Opportunities
- Lucas E^3 Solvent Fractionation

Energy Efficient Projects - Looking Forward

- High-Protein Low-Fiber Feed from DDG
  1. New process designed for existing ethanol plants to diversify production, add revenue stream, and reduce operating costs
  2. Co-product is extracted from Thin Stillage and can be sold locally to poultry and swine producers as a feed additive
  3. Removal of co-product can reduce: evaporator fouling, load on DDG Dryer, and operational issues when using Ring Dryers on evaporated syrup
- Water Saving Opportunities
- Lucas E^3 Solvent Fractionation

Energy Efficient Projects - Looking Forward

- High-Protein Low-Fiber Feed from DDG
- Water Saving Opportunities
  1. Most plants are already zero process-water discharge, state regulation changes will require Owners to continually look at water usage issues
  2. Water usage in ethanol plants commonly related to:
     A. Cooling tower evaporation and blow-down
     B. Direct steam usage
     C. CO2 scrubber operation
  3. Several projects currently being marketed to the ethanol industry to reduce water usage in these areas
- Lucas E^3 Solvent Fractionation

Energy Efficient Projects - Looking Forward

A. Cooling Tower Blow-Down Treatment
   1. Blow-down from cooling tower treated to remove salt solids before water is returned to tower
   2. Process reduces the required volume of make-up water
   3. Estimated potential savings of 0.75 gallons water for each gallon of ethanol produced

B. Direct Steam Usage Reduction/Elimination

C. CO2 Scrubber Upgrade

Energy Efficient Projects - Looking Forward

A. Cooling Tower Blow-Down Treatment

B. Direct Steam Usage Reduction/Elimination

1. Alternate methods of heating can significantly reduce or eliminate need for direct steam
2. Energy Recovery from Stack Gases to transfer waste heat to available areas is one economical solution
3. Estimated potential savings for displacing direct steam usage of 0.25 gallons water for each gallon of ethanol produced

C. CO2 Scrubber Upgrade

Energy Efficient Projects - Looking Forward

A. Cooling Tower Blow-Down Treatment

B. Direct Steam Usage Reduction/Elimination

C. CO2 Scrubber Upgrade

1. Clean fresh water is needed to produce the required specification of CO2 released to the atmosphere
2. Modifications to existing scrubber packing for more efficient operation reduces need for fresh water
3. Estimated potential savings of 0.15 gallons water for each gallon of ethanol produced

Energy Efficient Projects - Looking Forward

- High-Protein Low-Fiber Feed from DDG
- Water Saving Opportunities
- Lucas E^3 Solvent Fractionation

Energy Efficient Projects - Looking Forward

- High-Protein Low-Fiber Feed from DDG
- Water Saving Opportunities
- Lucas E^3 Solvent Fractionation
  1. Patent-pending process developed by Scott Lucas
  2. Provides method to process grain before use in the ethanol plant
  3. Clean starches (sugars) are removed from grains to be sent to plant for more efficient processing into ethanol
  4. Residual protein, oil and fiber are separated and sold as high value food grade products

Comments and Questions

- Scott Lucas will be happy to take your questions or to discuss comments you may have about the issues we have presented today
- You should also feel free to speak with him during the rest of today's event

Thank You for Attending this AURI Event

Stay Focused!