



CHP – The Concept

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Presentation Outline

- Overview of DG / CHP
- Biogas CHP Applications
- Market Potential & Indiana Position
- Summary

Distributed Generation

DG is ...

- An Electric Generator
- Located At a Substation or Near a Building / Facility
- Generates at least a portion of the Electric Load

DG Technologies

- Solar Photovoltaic
- Wind Turbines
- Engine Generator Sets
- Turbine Generator Sets
 - Combustion Turbines
 - Micro-Turbines
 - Steam Turbines
- Fuel Cells

Combined Heat & Power (CHP)

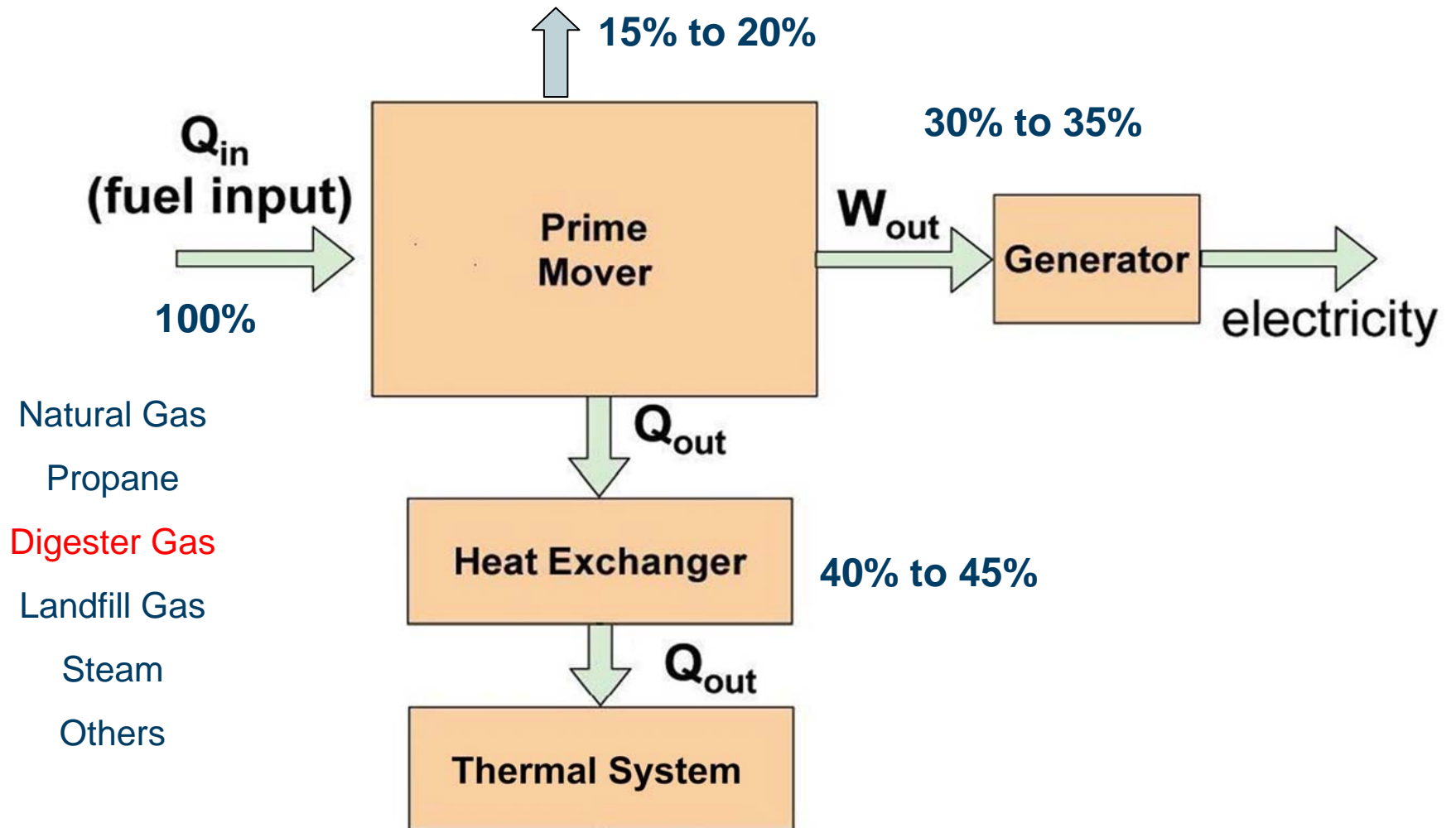
A Form of Distributed Generation



CHP is ...

- An Integrated System
- Located At or Near a Building/Facility
- Provides at Least a Portion of the Electrical Load and
- Recycles the Thermal Energy for
 - Space Heating / Cooling
 - Process Heating / Cooling
 - Dehumidification
 - Domestic Hot Water

Combined Heat and Power



Normal CHP Configuration

- CHP Systems are Normally Installed in Parallel with the Electric Grid (CHP does not replace the grid)
- Both the CHP and Grid Supply Electricity to the Customer
- Recycled Heat From the Prime Mover Used for:
 - Space Heating (Steam or Hot Water Loop)
 - Space Cooling (Absorption Chiller)
 - Process Heating and/or Cooling
 - Dehumidification (Desiccant Regeneration)

Generators and Inverters

Two Types of Generators

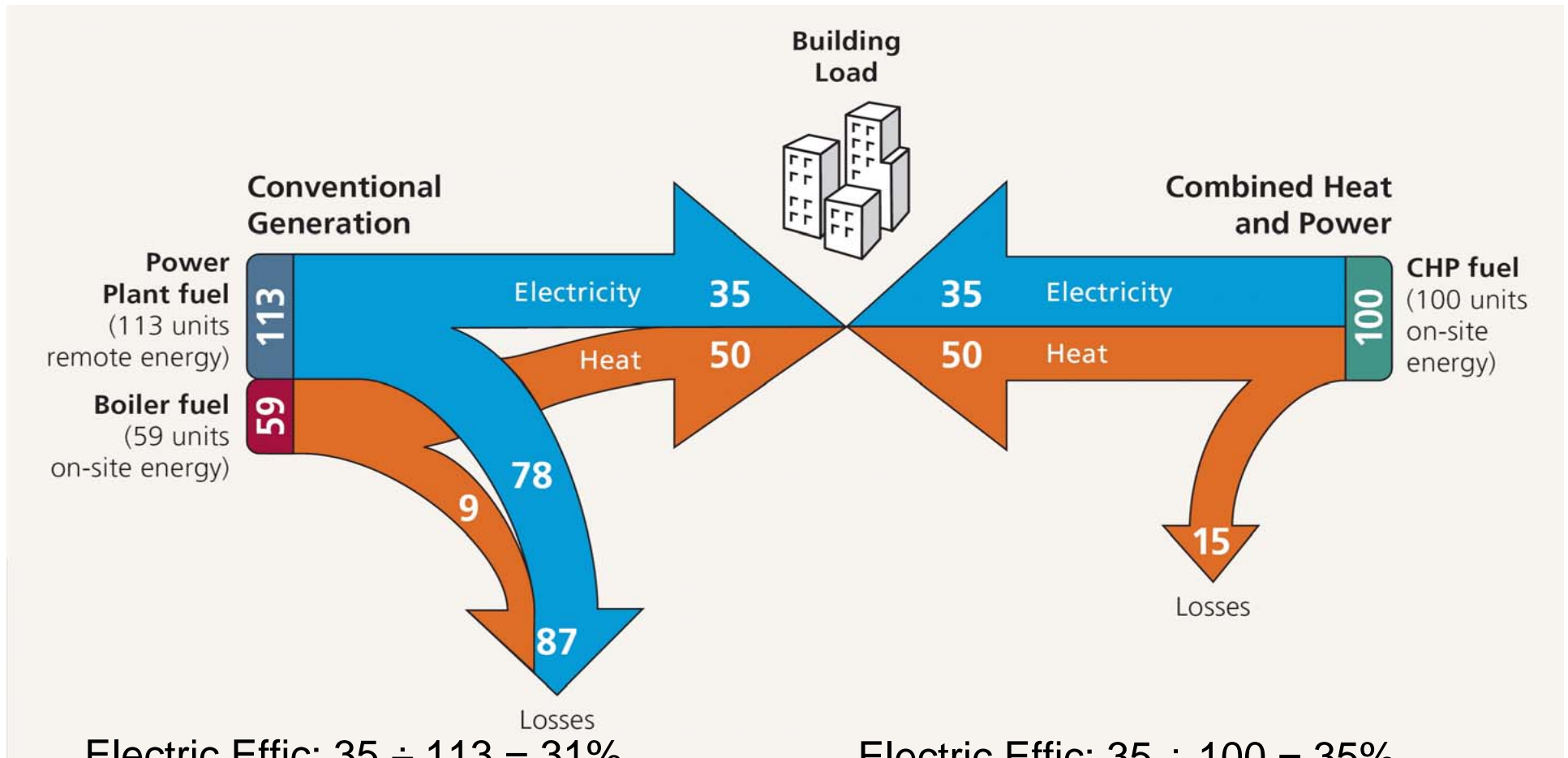
Induction

- Requires External Power Source to Operate (Grid)
- When Grid Goes Down, CHP System Goes Down
- Less Complicated & Less Costly to Interconnect
- Preferred by Utilities

Synchronous

- Self Excited (Does Not Need Grid to Operate)
- CHP System can Continue to Operate thru Grid Outages
- More Complicated & Costly to Interconnect (Safety)
- Preferred by CHP Customers

Conventional Energy System vs. CHP



Electric Effic: $35 \div 113 = 31\%$

Heating Effic: $50 \div 59 = 85\%$

Combined Effic: $85 \div 172 = 49.4\%$

Electric Effic: $35 \div 100 = 35\%$

No Additional Fuel for Recycled Heat

Combined Effic: $85 \div 100 = 85\%$

Candidate Applications for CHP

- Hospitals
- Colleges / Universities
- High Schools
- Residential Confinement
- High Rise Hotels
- Fitness Centers
- Food Processing Waste
- Farm Livestock Waste
- Waste Water Treatment
- Landfill Sites
- Pulp & Paper Mills
- Chemicals Manufacturing
- Metal Fabrication
- Ethanol / Biodiesel Plants

What are the Customer Benefits of CHP?



CHP does not make sense in all applications, but where it does make technical and economic sense, it will provide

- Lower Energy Costs
- Reduced Energy Consumption
- Increased Electric Reliability
- Standby Power
- Improved Environmental Quality

Installed CHP

- 82,400 MW at approx. 3000 sites (Nationally)
- Represents approx. 9% of total US generating capacity
- Saves an estimated 3 Quads of fuel per year
- Eliminates over 400 million tons of CO₂ emissions annually

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- 1,870 MW at approx. 32 sites (Indiana)

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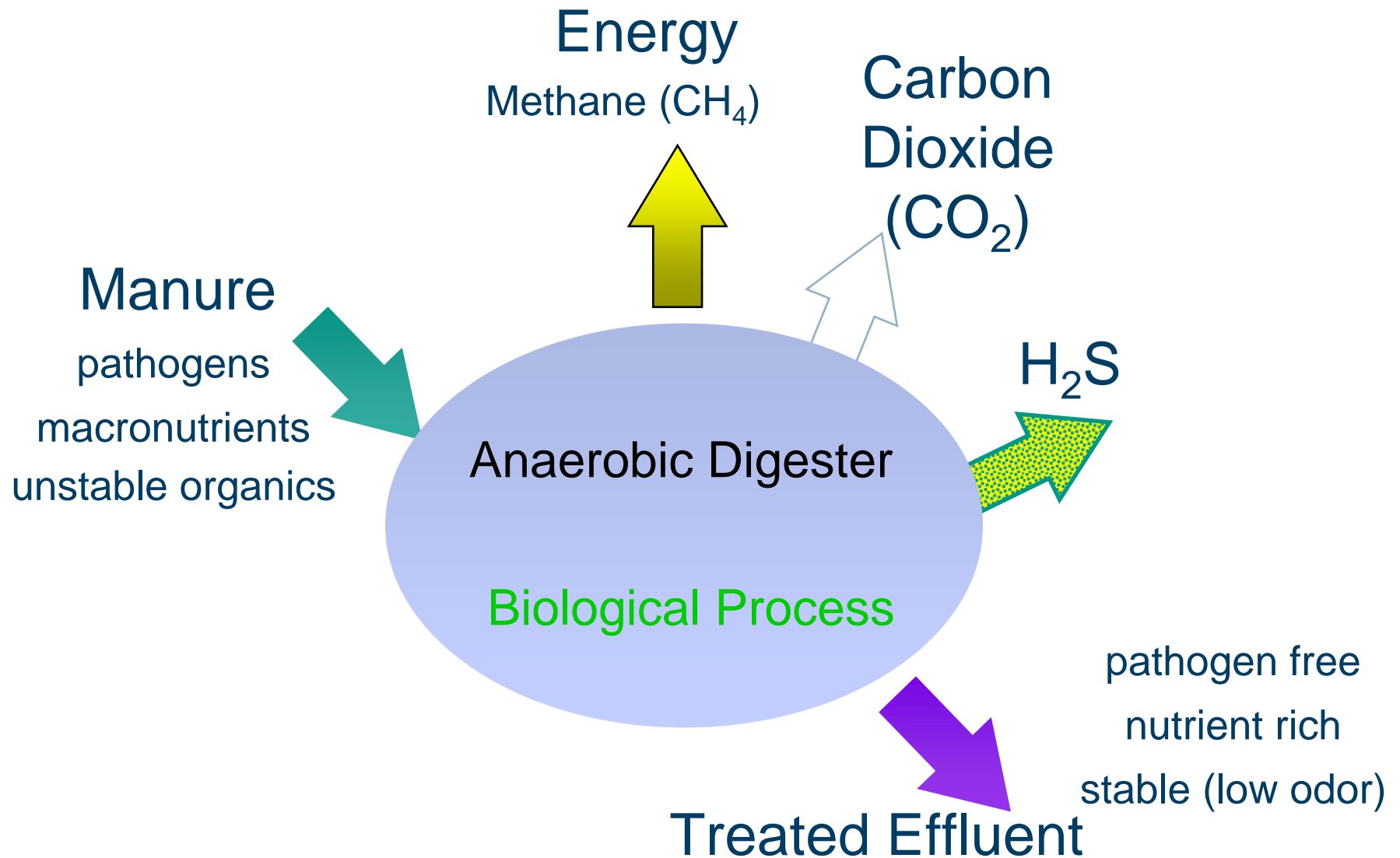
Biogas CHP Applications (Digester Gas)

- Animal Waste / Manure Management
- Food Processing Waste
- Waste Water Treatment Facilities

Anaerobic Digesters

- Natural Biological (bacterial) Process That Occurs When Organic Material Decomposes Biologically in the Absence of Oxygen
- When Properly Applied, Digester Technology Can Effectively Assist in:
 - Sustainable
 - Economical
 - Environmentally Balanced
 - & Neighbor Friendly Agricultural Practices

Anaerobic Digestion Process Overview



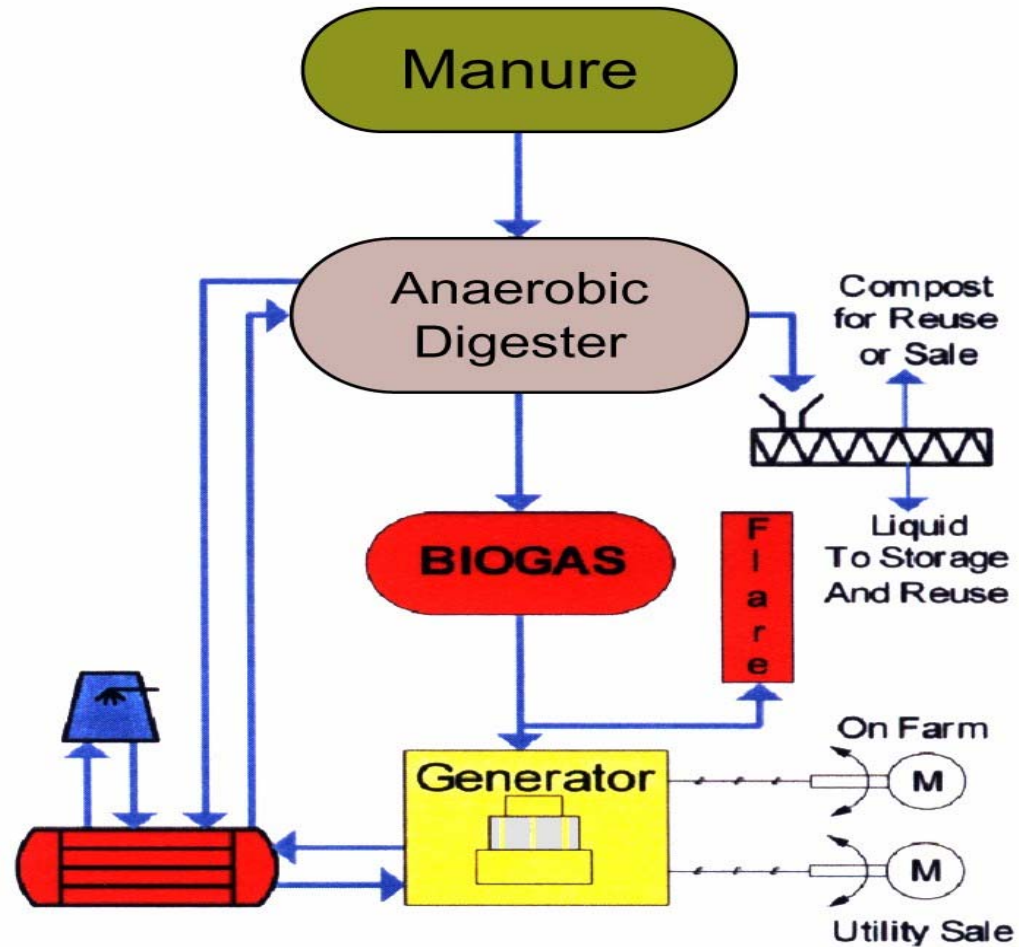
Energy Recovery – Biogas

(60% to 65% Methane)

- Flare It
- Use It for Heating
 - Displace Natural Gas / Propane
- Use It for CHP
 - Displace Purchased Electricity
 - Displace Natural Gas / Propane
- Clean It Up for Pipeline Use

Anaerobic Digester / CHP System

Manure Digestion



Electric & Thermal Coincidence

- Steady Use of Recovered Thermal Energy
 - Heat the Digester
 - Heat the Livestock Operation
 - Heat Potable Water
- Steady Use for the Electricity
 - Displace Electricity Utilized on the Farm
 - Possibly Sell Excess Electricity to Utility

CHP Technologies (Biogas Applications)

- Prime Movers:
 - Reciprocating Engines
 - Micro-turbines
- Gas Clean up (H_2S)
- Gas Compression (micro-turbines)
- Generator / Heat Recovery
- Grid Interconnect Hardware

Advantages & Disadvantages CHP and Anaerobic Digesters

Advantages

- Odor & Insect Mitigation
- Nutrient Management
- Pathogen Reduction
- Energy Savings
- Heating Fuel Savings
- Reduced Electric Bills
- Qualified for Net Metering
- Potential Farm Bill Funding

Disadvantages

- Adding Complexity to Farming
- Commitment to Digester System Management (labor & maintenance)
- Commitment to CHP System Maintenance
- Capital Costs
- Electric Utility Interconnect can be Tedious

Expanded Applications

- Adding Food Processing Waste to a Manure System Can Increase Biogas Production with Higher Methane Content
- Community Digesters Provide Economic Development
- Tipping Fees Normal for Handling Food Wastes
- Bedding Material / Compost (potential revenues)

Potential U.S. Market Anaerobic Digester Gas

- Over 3 GW of Potential Capacity
 - 7,000 Dairy Farms
 - 11,000 Hog Farms
 - 6,800 WWTPs

**Source: Resource Dynamics Corp.
“Opportunity Fuels for CHP” www.rdcnet.com**

Biogas Production – Indiana

- Three Farm Systems Installed:
 - Boss Dairy 700 kW
 - Fair Oaks Dairy 700 kW
 - Herrema Dairy 700 kW
- Leader In Midwest – Wisconsin
 - 16 farm digesters operating 5,975 kW
 - 5 under construction / start up 1,850 kW
 - 15 in planning stages

Summary CHP / Digester Applications

- Appropriate when digester being installed for odor mitigation or other reasons
- Good match for thermal energy (digester)
- Significant market (manure, food processing, waste water treatment, community digesters)
- Turn an operational cost (waste product) into a revenue resource
- Farm Bill and Net Metering add incentives
- Reasonable paybacks (6 years possible w/o grants)

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Questions / Discussion

