



The Role of Biomass in MN's Energy Future

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“ By 2030, Minnesota will be a premier center of energy technology research and deployment and a net exporter of energy”

Energy Alley Workgroup

“to be the Saudi Arabia of renewable energy”

Gov. Tim Pawlenty



- Where are we now?
- Is this possible?
- How do we analyze the problem?
- Where does biomass fit?



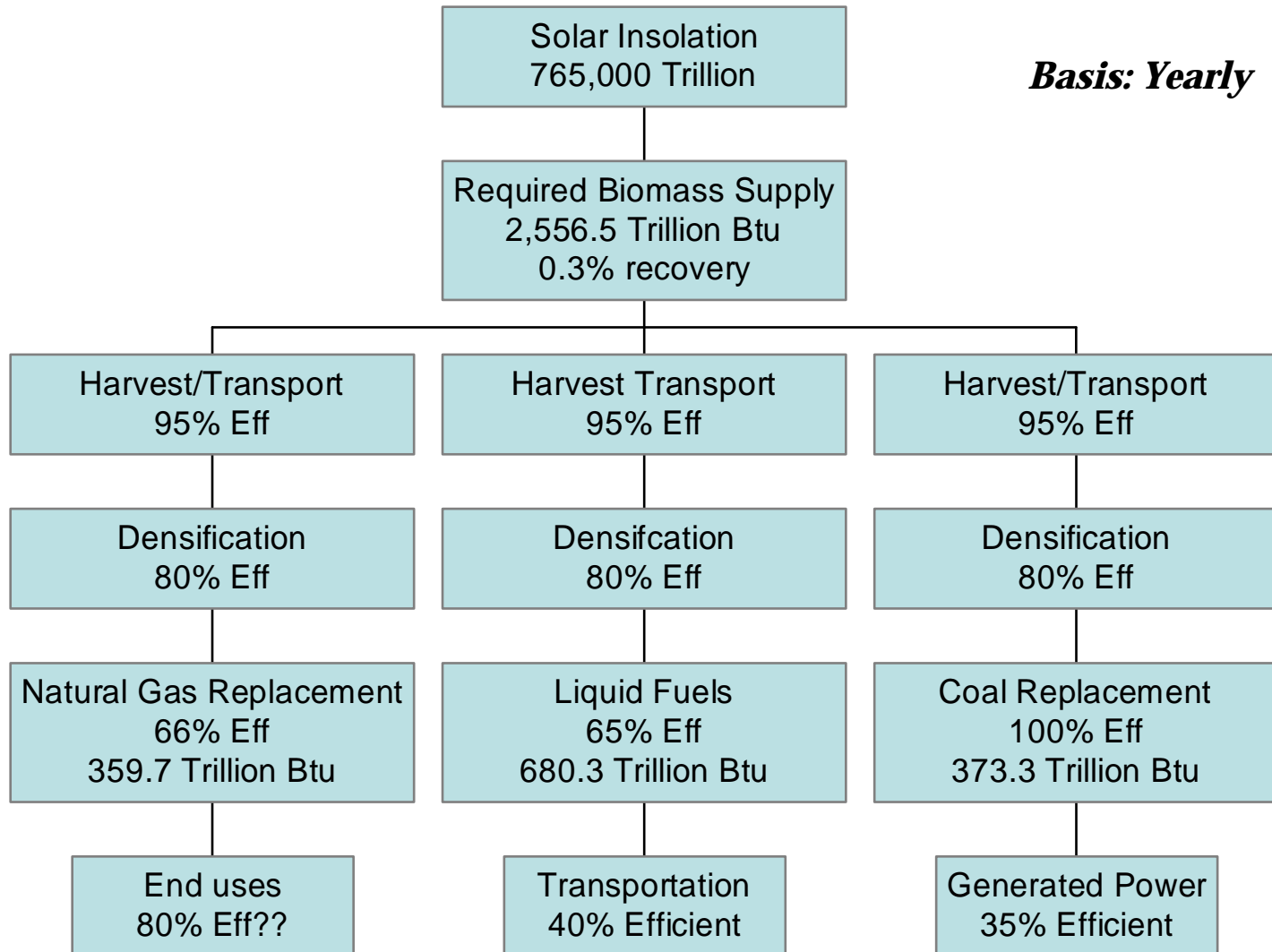
- All renewable energy sources are really different forms of solar energy
 - Wind - kinetic
 - Hydro – kinetic/potential
 - Biomass - chemical
 - Photovoltaic – direct
 - Solar thermal - thermal



- Annual solar insolation 765,000 trillion Btu
 - Solar insolation rate = 15 Billion Btu per year per acre
 - Total state area is 51 million acres
- State demand is 1,668 trillion Btu annually
- 0.3% of solar insolation would meet our needs
- Efficiency not sufficiency



Basis: Yearly





Available crop residue could supply 225 trillion Btu or about 10% of the estimated need while creating a billion dollar industry for the state.

There is not enough biomass to meet the demand



- Reduce demand/increase efficiency at use
- Increase biomass supply
- Improve process efficiency



- Set priority by the value of the energy replaced
 - Oil @\$50/bbl - \$8.60 per million Btu
 - Natural gas - \$7 per million Btu
 - Coal - \$1 per million Btu



- In the near term replacement fuels must be functionally and if possible chemically identical to existing fuel supplies
- Dispersed renewable resources favors small-scale integrated design
- Nutrient recycle is part of the process



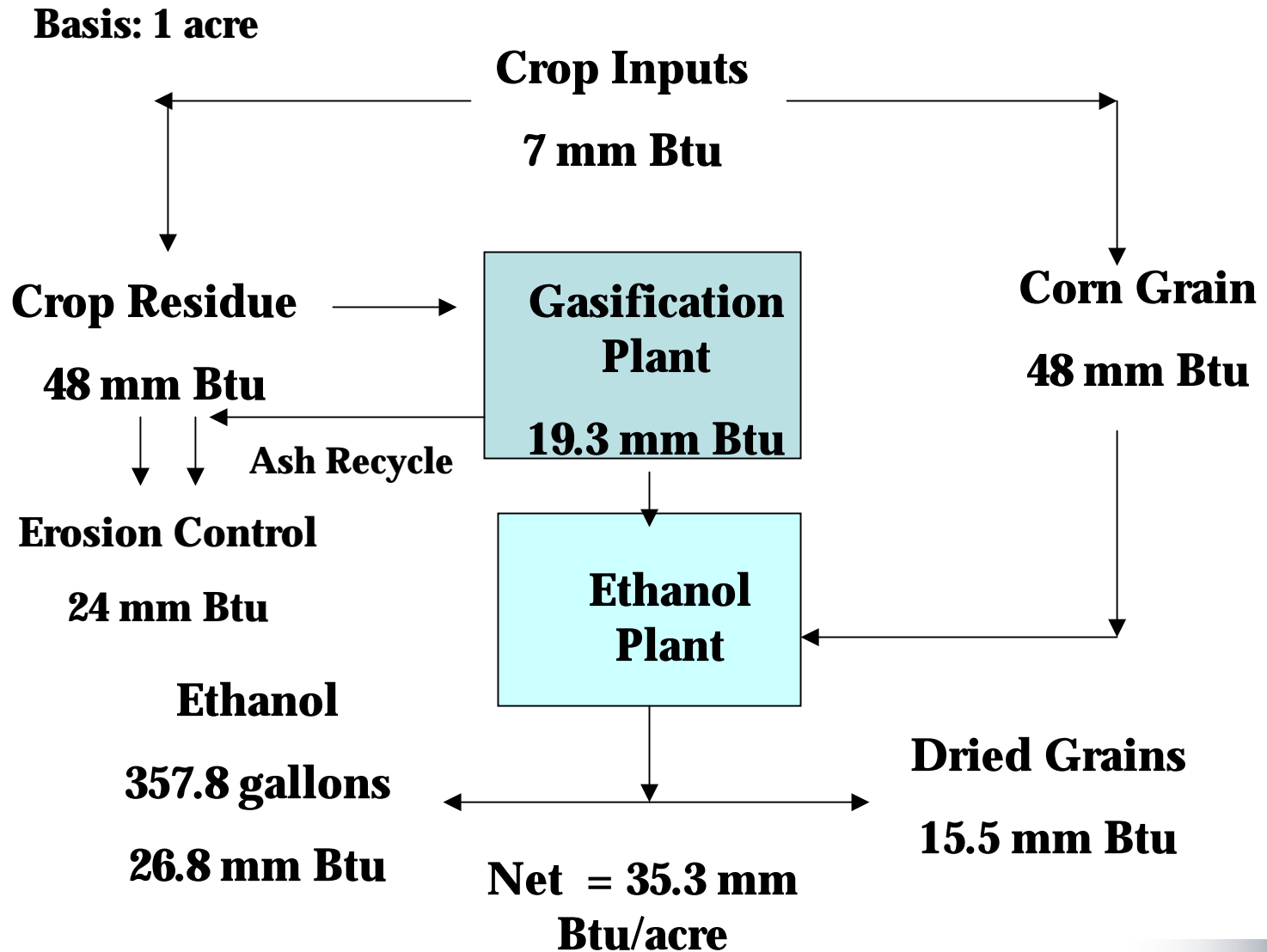
- Future crop mix will maximize biomass production not grain
- New species and crops
 - GMO species of corn or other crops
 - High biomass perennials
 - Hybrid poplar
- Modified tillage practices
 - Whole stalk harvest
 - No-till farming w partial crop residue removal
 - Different crop rotations



The first step is to begin to recognize the opportunity to use biomass energy in existing processes

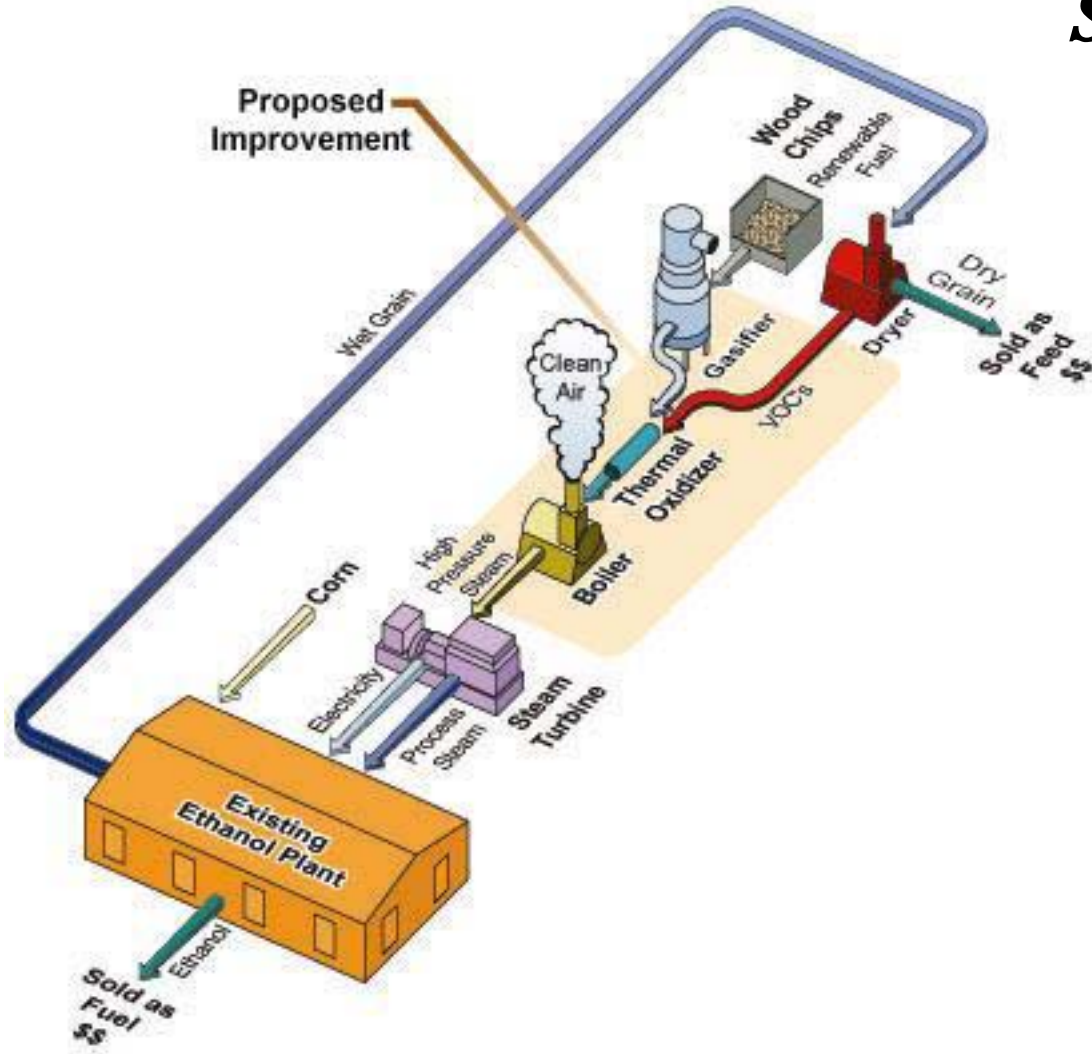
For example:

Corn stalks can be readily used to fuel ethanol plants reducing the use of fossil fuels and adding value to the corn crop





Gasification as NG Substitute





- Biomass will play key role in liquid fuels because of compatibility with current infrastructure
- Liquid transportation fuels will predominate for the foreseeable future
- Ethanol is the likely transitional fuel from internal combustion to fuel cell engines



- Fermentation to ethanol and other fuels
 - Ethanol
 - Butanol
 - Ethyl/methyl Butyrate
- Mixed Technologies
 - Fermentation with hard chemistry
Butyric acid to butanol
- Catalytic conversions
 - To ethanol or methanol
 - To alkanes



- The replacement for natural gas will be methane produced from biomass by anaerobic digestion

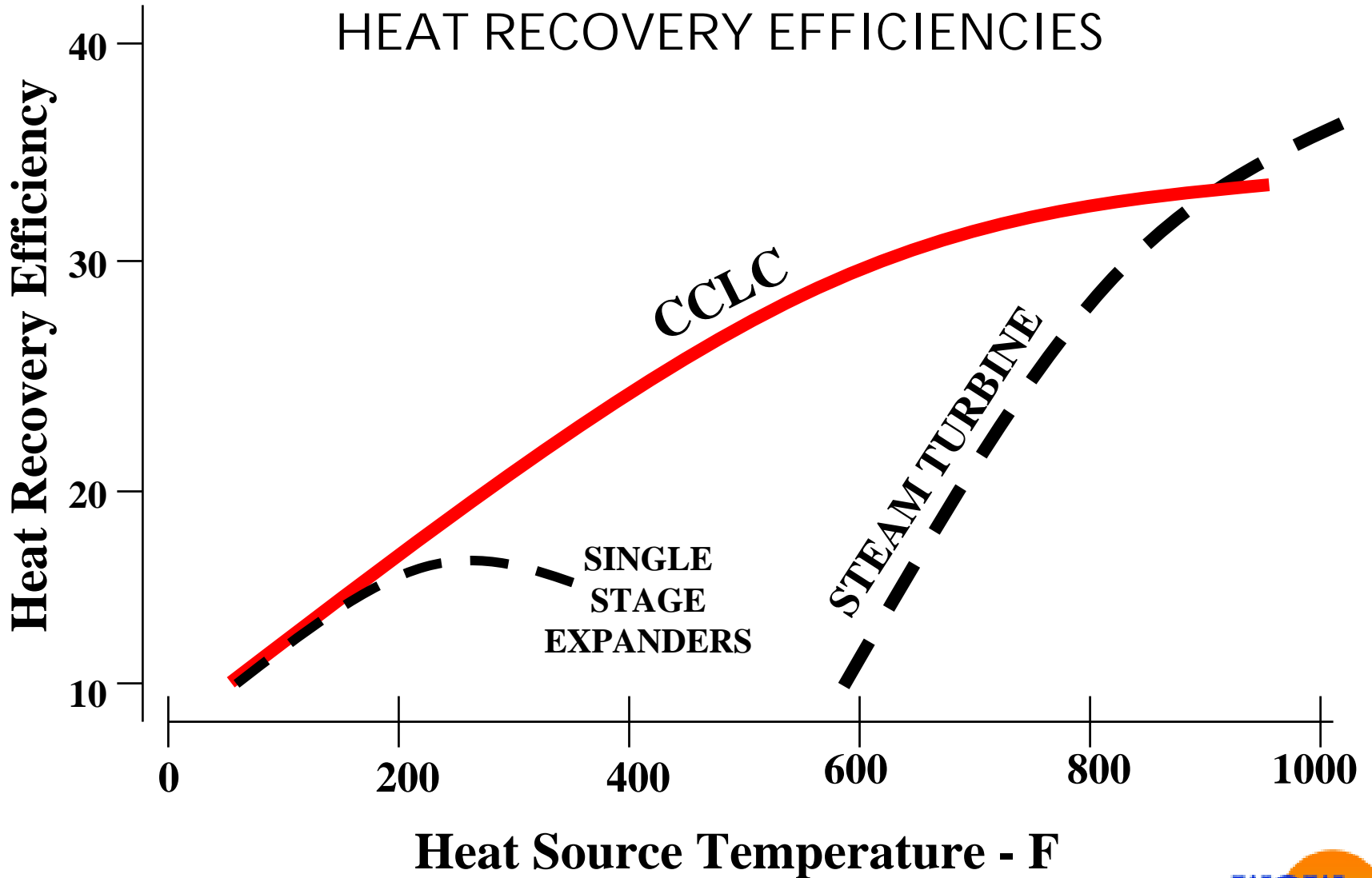
Emerald Dairy
Baldwin, Wisconsin





- Biomass for power production should be a low priority due to low efficiency
- Improving generation efficiency from current 35% should be top goal.
 - Waste heat from power plants is the largest single use of energy in the economy
- Emerging technologies use different working fluids and waste heat from process industry stacks

HEAT RECOVERY EFFICIENCIES



Patented Technology

Figure 2





- Converting Minnesota energy supplies to biomass/renewable will produce a major rearrangement of our ag sector
- Even with best technologies it will be difficult to achieve energy independence
- The opportunity is diverse both technically and geographically



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