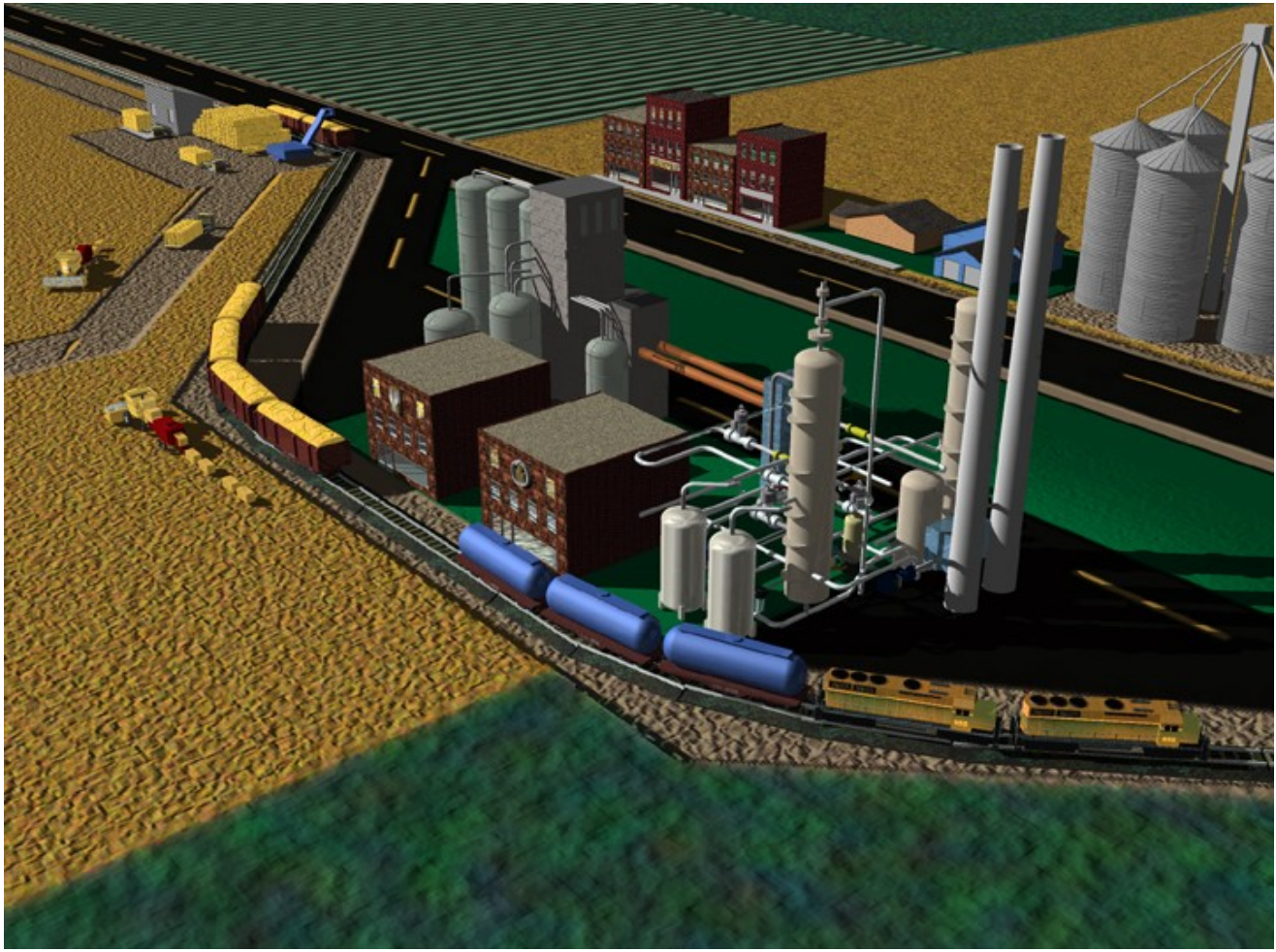
Biomass Logistics

Mike Montross, Jeff Stringer, Scott Shearer
Biosystems and Agricultural Engineering Department
Forestry Department
University of Kentucky

Definition of Logistics

- Harvest of biomass crop, storage, preprocessing,& transportation to end-user



Idaho National Laboratory

Biomass Issues

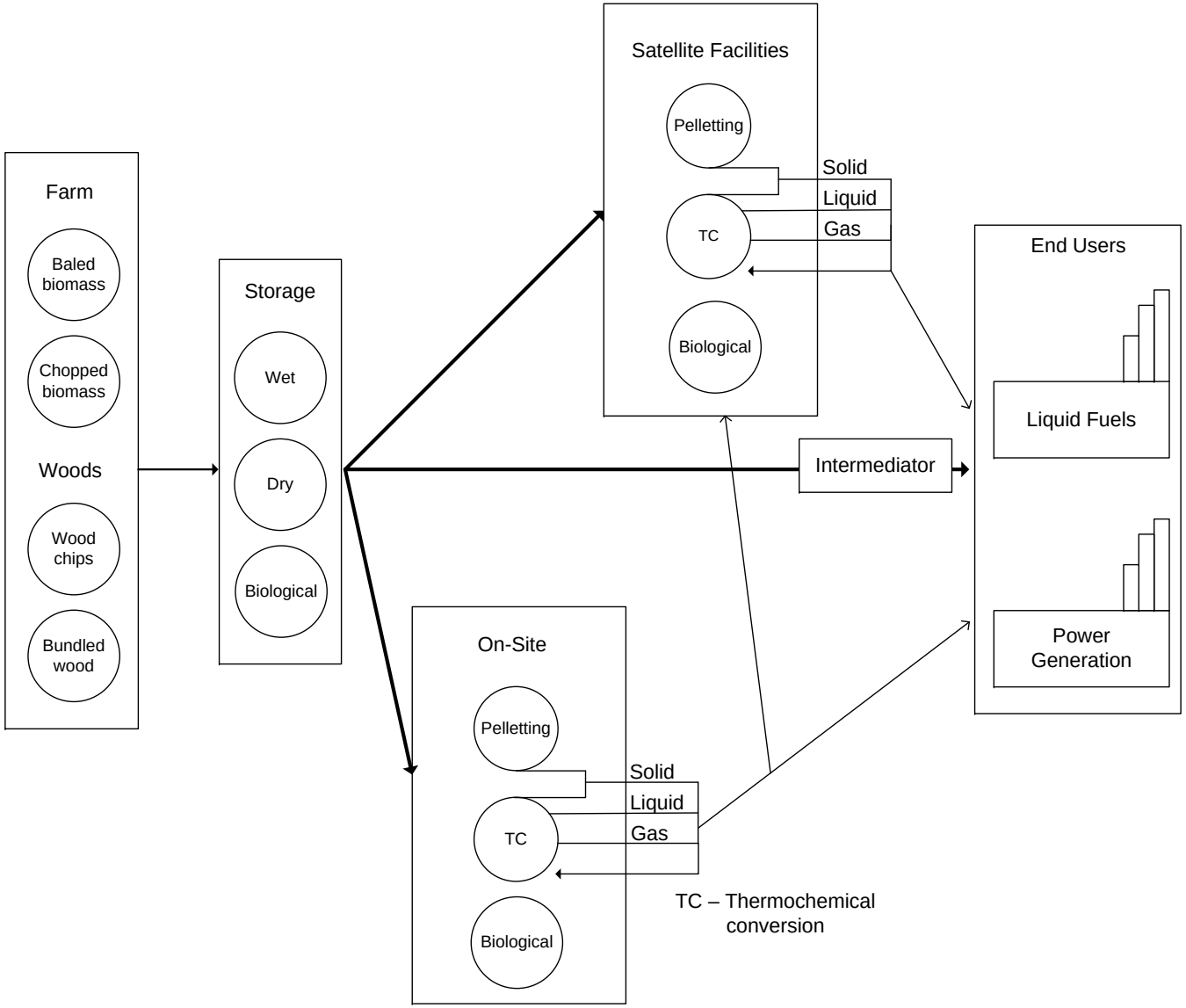
- Some truck transportation will be required
- Technology for woody and herbaceous biomass available
- Slope issues with biomass crop production (<35% for woody and <20% for herbaceous)
- Moisture content
- Energy/bulk density

Tigercat

Issues Associated With Biomass

Biomass Format	Shape and Size	Bulk Density (lb/ft^3)	Energy Density (Btu/ft^3)
SG Chopped	3/4-1 1/2 in loose fill	3.7-5.0	30,000-40,000
SG Round Bales	Full length	7.5-8.7	60,000-70,000
SG Rectangular Bales	Full length	8.7-11.0	70,000-87,000
Wood Chips Dry	2x2x3 in	12.0-28.0	96,000-224,000
SG Briquettes and Pellets	1.25 in diameter by 1 in	22.0-44.0	175,000-350,000
Coal		50.0-60.0	550,000-660,000
Pyrolysis oil		75.0	750,000
Crude oil		55.0	990,000

Potential Scenarios – Combination of Scenarios



Progression of Logistics System

- Bales (round) and wood chips direct to end user
- Rectangular bales and wood chips to satellite locations
  - Custom operators
- Satellite locations to densify material (solid, liquid, gas, or biological treatments)
- Distributed production of energy or other value-added activities

Pelleting

- Use pelleting generic for briquette or cubes
- Dry (10-15% moisture) and grind to small size
- Potentially from 10,000 to 200,000 ton/yr plant size
- Satellite or on-site application
- Produce free flowing material

Midwestern Biofuels

Thermochemical Conversion

- Satellite locations to produce bio-oil, syngas, or torrefied biomass
- Off products used for energy within the plant
- Old technology based on coal
- Could potentially produce material on-farm (cooperatives)

Collection Strategies

- Unused residues from traditional timber harvest
  - Thinning
- Short rotation woody crops
- Urban residues
- Herbaceous energy crops
- Agricultural residues

Unused Residues from Traditional Timber Harvests

- Whole-tree skidding to landing, chipped into van - moisture problems
- Whole-tree skidding to landing, residual placed in windrows or bundled, chipped at a later date – reduced moisture

Short Rotation Woody Crops

- Equipment readily available for establishment and maintenance
- Most likely chipped in field – difficult managing moisture
- Specific equipment to harvest coppice biomass

SUNY

Urban Residues

- Urban woody and other yard wastes
- Construction and demolition waste

Herbaceous Energy Crops

- Equipment readily available for establishment and maintenance
- Round balers initially used
- Mid-size rectangular bales probably preferred
  - Potentially forage harvester
- Custom operators
- Other crops (forage sorghum, sweet sorghum, triticale, barley, corn)

Agricultural Residues

- Corn stover and wheat straw also potential feedstocks
- Single-pass (harvest corn and stover) would be lowest cost, probably highest moisture
- Multi-pass would allow moisture management at a higher cost

Potential Cellulosic Ethanol Plant

- 50 million gallon/yr
- 625,000 ton/yr biomass
  - 70 truck loads per day
- Storage facility covers 130 ac (not including any drives, scales, etc.)
- Multiple feedstocks

Closing Remarks

- Collection equipment available, expensive
- Improvement in energy density and transportation
- Need to consider interaction of feedstock, logistics, and end-user
  - Moisture content
  - Feedstock effect on process (ash or cellulose recalcitrance)
  - Value-added on-farm and coproducts

Transportation Costs

Mode	Cost (¢/ton-mile)
Truck	26.6
Rail	2.24
Barge	1.47
Pipeline	0.72

US Bureau of Transportation Statistics

One tractor-trailer
of coal = 600 million btu
of pelleted biomass = 400 million btu
of baled biomass = 275 million btu

Most studies indicate a maximum of 50 mile trucking distance

Generalized Logistics Systems

- Biomass (bales or chips) delivered directly to the plant;
- Biomass delivered to satellite locations for storage, blending, and densification (pelleting, pyrolysis, gasification, or torrefaction) prior to delivery to end-user;
- Distributed energy production at satellite locations or performed on-farm.