

I PRO 349: Solid Fuel from Biomass for Cogeneration

Step 1: Harvesting



Windrower
John Deere WR30
\$6,677

2 Pass Harvest (Dry)

Combine Windrow

- Easy
- Long dry time

Raker Windrow

- Even coverage
- A third step



Baler

John Deere 458 Silage Special
\$28,359



Rotary Drum Dryer

- Reduce moisture content from ~35% to ~10-15%
- Increase durability

0.5MW case study

- Electricity usage: 80kW
- Cost: \$80,000

2MW case study

- Electricity usage: 130kW
- Cost: \$102,960

Pellet Mill

- Compress stover into denser pellets
- Often used in tandem with a conditioner and cooler

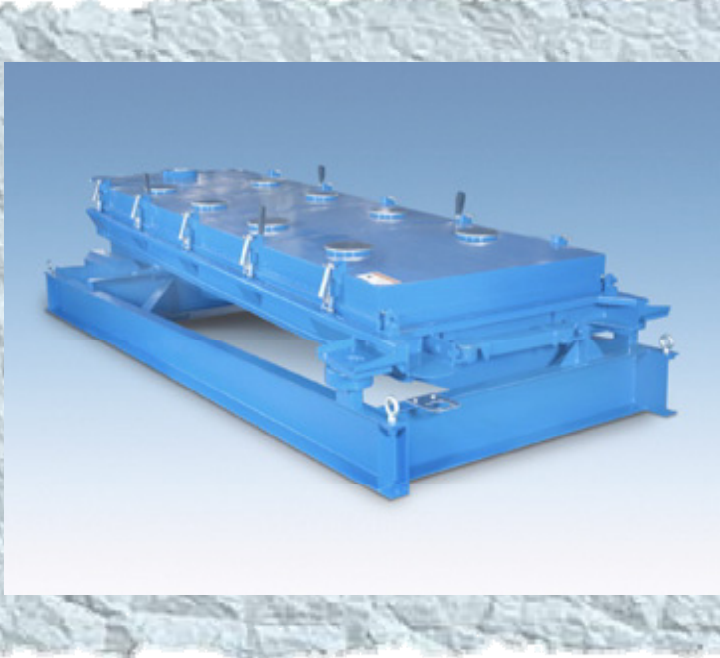


0.5MW case study

- CPM 1116-4
- 37kW
- Cost: \$112,000

2MW case study

- CPM 7722-6
- 186kW
- Cost: \$240,000



Screener

- Rotex Pellet & Crumble
- Energy usage: 0.4kW
- Cost: \$13,000

0.5MW case study

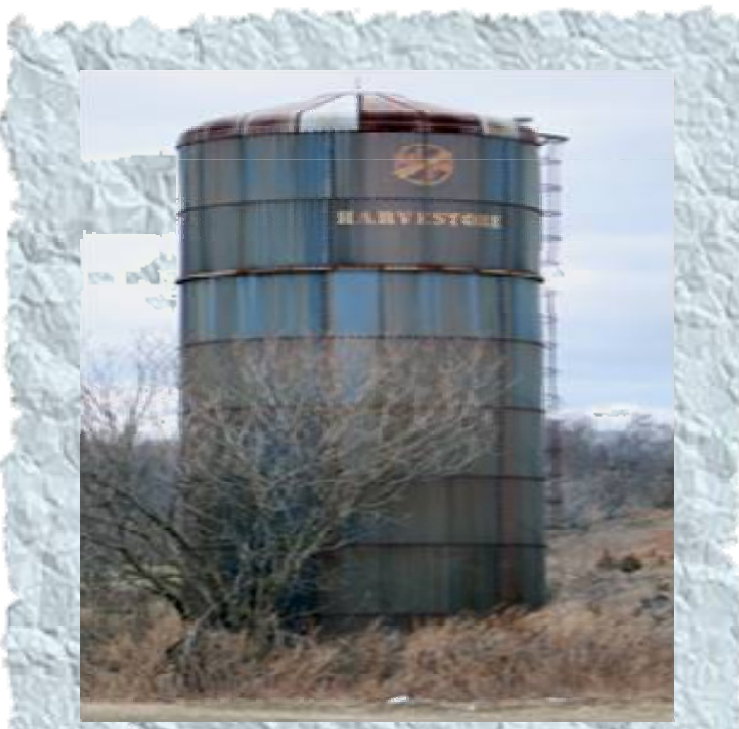
- 1 ton/hour in;
- 0.97 ton/hour out

2MW case study

- 5 ton/hour in;
- 4.85 ton/hour out

Harvestore Structure Silo

- Model 3189
- Volume capacity: 1750m³
- Cost: \$192,650/each



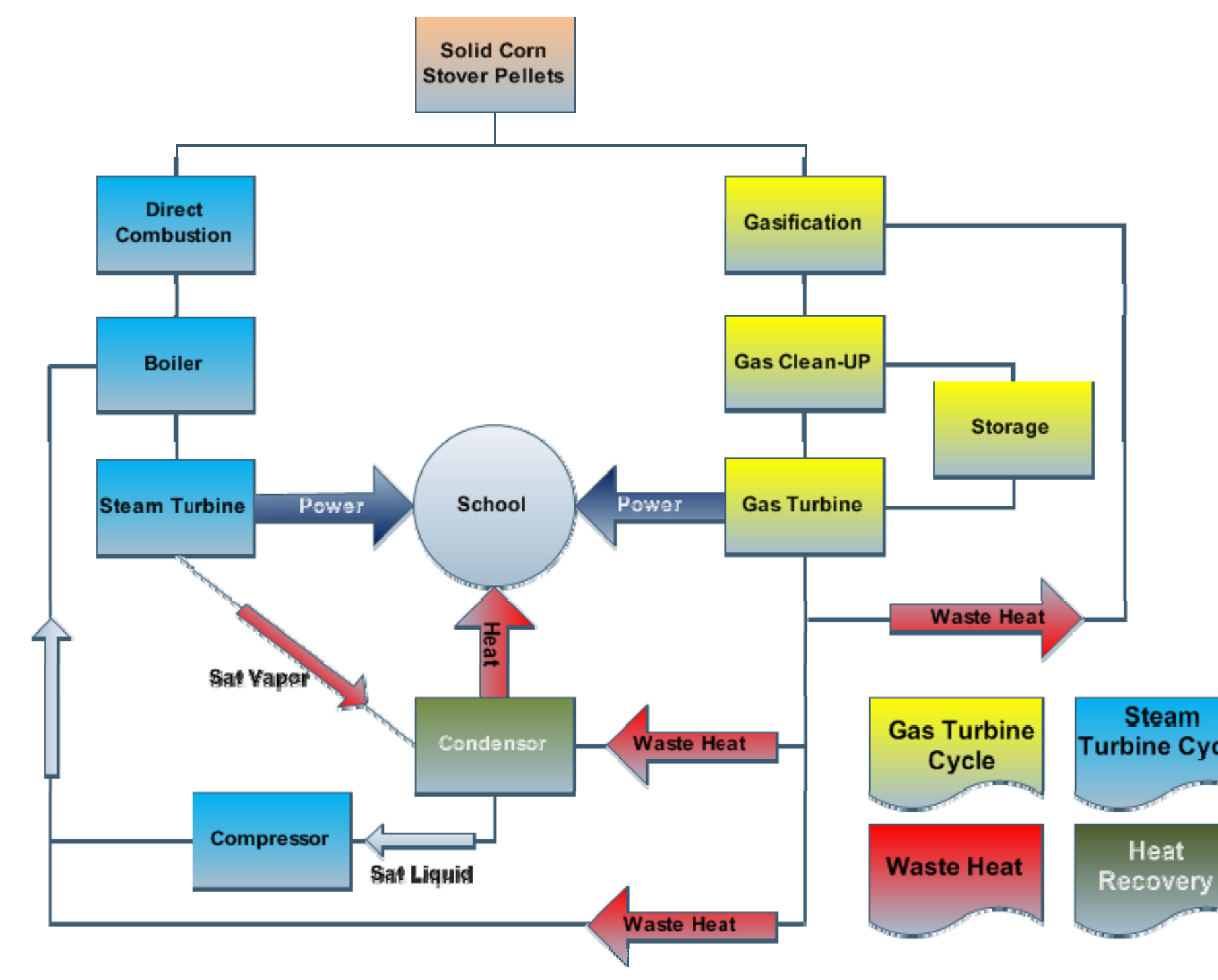
0.5MW case study

- 5 silos

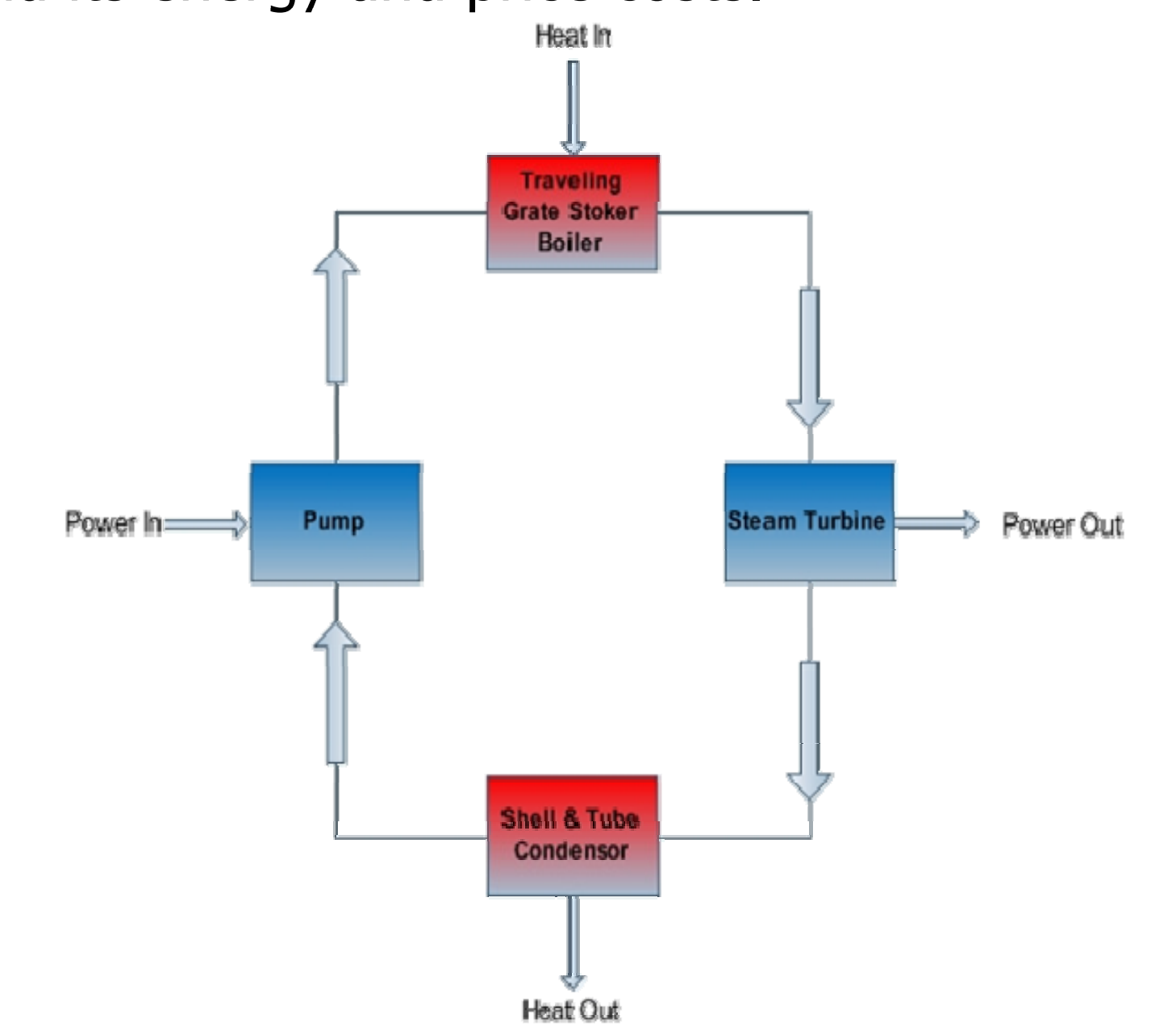
2MW case study

- 22 silos

Conversion of Pellets Into Power



To the left: A picture of the possible flow of energy of a CHP system.
At the bottom: the steam turbine cycle, and its energy and price costs.



0.5 MW			
T1	287.8 C	P1	3549 kPa
T2	52.4 C	P2	13.79 kPa
T3	52.4 C	P3	13.79 kPa
T4	52.77 C	P4	3549 kPa

2 MW			
T1	315.6 C	P1	4066 kPa
T2	72.4 C	P2	34.47 kPa
T3	72.39 C	P3	34.47 kPa
T4	72.85 C	P4	4066 kPa

Heat into system (0.5 MW)	9.68E+06	kJ/hr
Steam Flow Rate	2800	kg/hr
Corn Stover Feed Rate	1179.7	lb/hr
Power out (Turbine)	524.2	kW
Power in (Power pump)	3.717	kW
Power in (Cooling Pump estimate)	11.4	kw
Net Power	509.083	kW

Heat into sytem (2 MW)	41290000	kJ/hr
Steam Flow Rate	12100	kg/hr
Corn Stover Feed Rate	5195.2	lb/hr
Power out (Turbine)	2082	kW
Power in (Power pump)	18.62	kW
Power in (Cooling Pump estimate)	47.25	kw
Net Power	2016.13	kW

0.5 MW			
Steam Turbine	13	6.5	500000
Condenser	16	4	250000
Pump	6.5	3.5	
Boiler	30	11	340000
	Radius	Height	
Water Tank(Max)	70	33	Total
			1090000

2 MW			
Steam Turbine	13	6.5	500000
Condenser	16	8	250000
Pump	6.5	3.5	
Boiler	30	11	340000
	Radius	Height	
Water Tank(Max)	70	33	Total
			1090000

Step 2 & 3: Baling & Transport

Round Bales

- Good water management
- Slightly cheaper
- Removal of mesh wrapping adds more labor work

JCB Tractor with Trailer



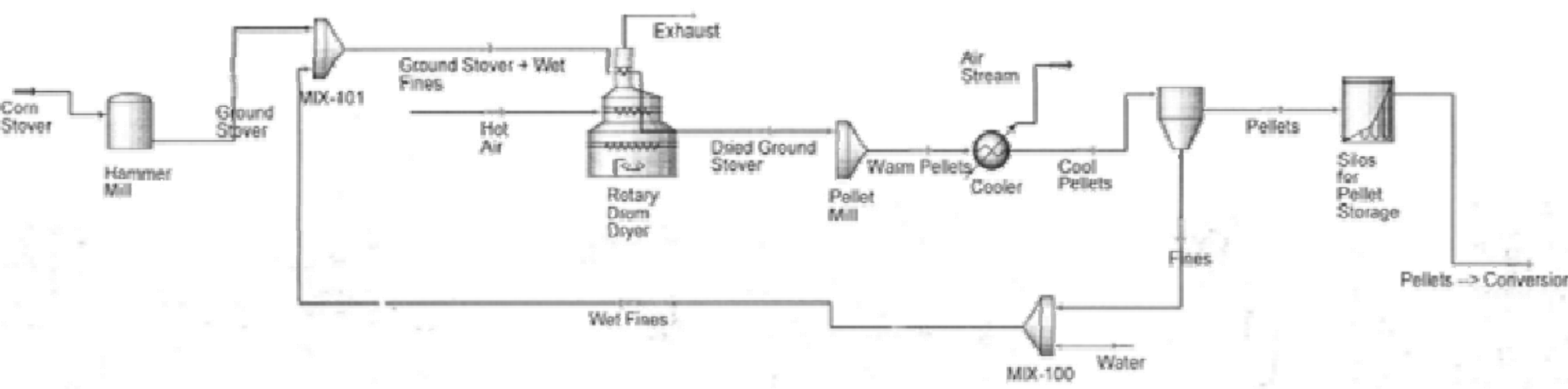
0.5MW Case Study

- 1,100 loads/yr
- 36,000 average miles traveled/yr
- 221,000 kWh/yr

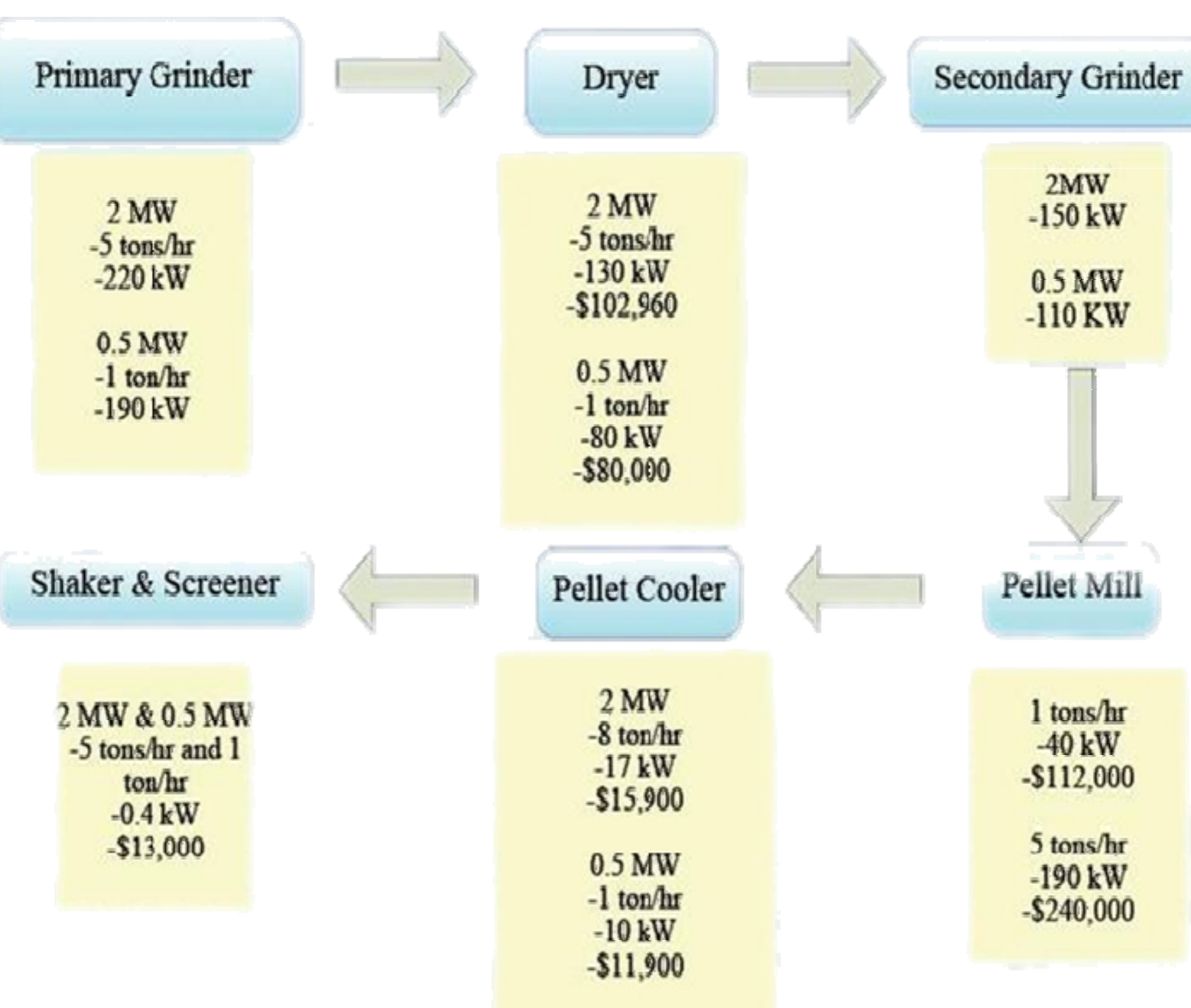
2MW Case Study

- 4,900 loads/yr
- 158,000 average miles traveled/yr
- 971,000 kWh/yr

Distance between farm and school:
Average = **16 miles**
Shortest = **5 miles**



Step 4: Pelletizing



Grinder

CPM Hammer Mill
125HP
\$58,200/each

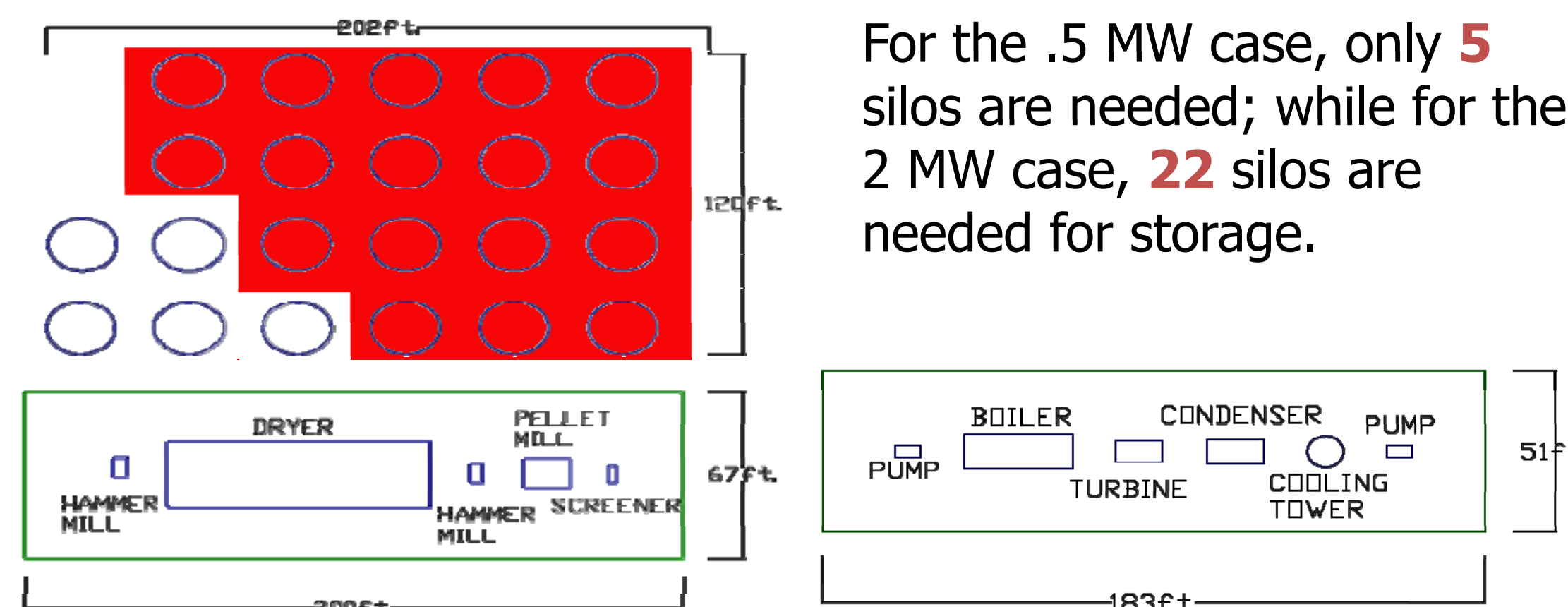
Primary

- Reduce bales to smaller chunks of stover

Secondary

- Reduce stover down to size of pellets

Spatial Layout



For the .5 MW case, only **5** silos are needed; while for the 2 MW case, **22** silos are needed for storage.

The Corn Stalkers

Instructor – Don Tijunelis
Team members - Tyler Rhodes, Richard Byrne, Michael Clark, Ross Brazzale, James Cheever, Elena Dorr, Jeremy Gibbs, Katherine Lazicki, Abhishek Prabha Kumar, Bertha Vandegrift, Robert Williams, Terrika Worthon, Xin Yi Yeap



All Equipment Pictured Is Owned By Their Respectively Labeled Companies.

Total estimate for:
• 0.5MW = 430kW
• 2.0MW = 690kW