Biomass Fuel Characteristics and Supply Logistics

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David Dubois, Manager of Business Development

Fink Machine Inc

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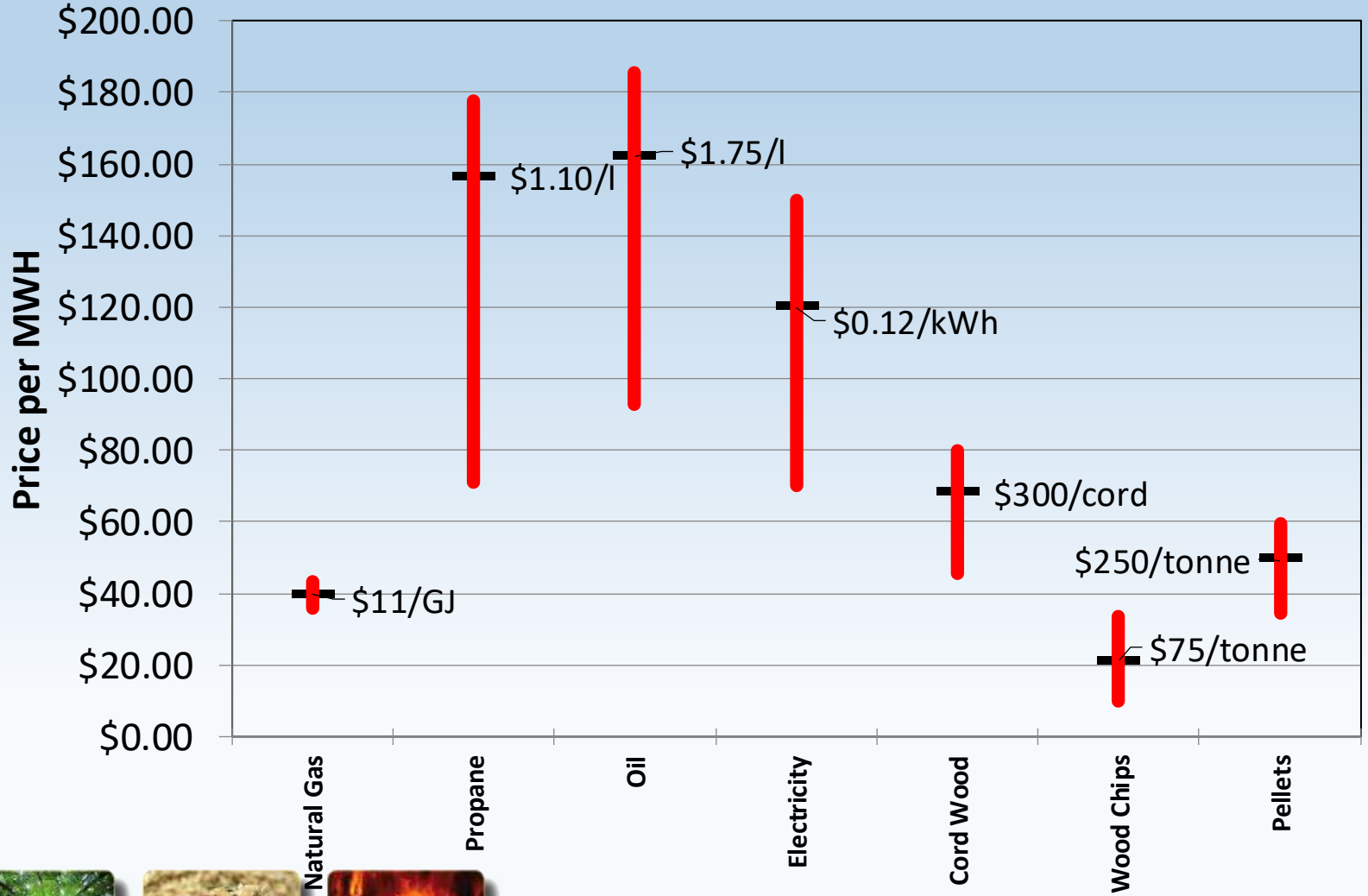
State of the Art Bio Energy Heating Systems
Revolutionary Wood Heating Technology
Highly Economical for Commercial, Industrial Buildings

A Few thoughts on Forestry and Bioenergy

- Wood is one of the best options for low carbon sustainable construction
- Bioenergy is not viable without conventional forestry!!
- Economic demands that fibre goes to high use value
  - Current price of 2”x4” x 8’ = $4 → $1000/tonne
  - Current Price of Pellets 40 lb bag = $7 → $389/tonne
- New value stream for the forest industry - creates jobs.
- Money spent on wood fuel is a direct investment into the local economy.

Energy Prices Comparison



Fuel Type	Unit Sale size	Retail Price
Natural Gas	GJ	$10-12/GJ
Propane	Litre	$0.5-1.25/l
Fuel Oil	Litre	$1.00-2.00/l
Electricity	kWh	¢7.0-15.0/kWh
Ponderosa Pine	Cord	$200-350/cord
Wood Chips	Green Tonne	$35-120/Tonne
Pellets (Retail)	Tonne	$175-300/tonne

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Wood Pellets

- Raw material is usually dry wood waste from sawmills, wood manufacturing plants etc.
- Produced without any additives such as binders and glues.
- Untreated wood waste is compressed under high pressure and temperature.

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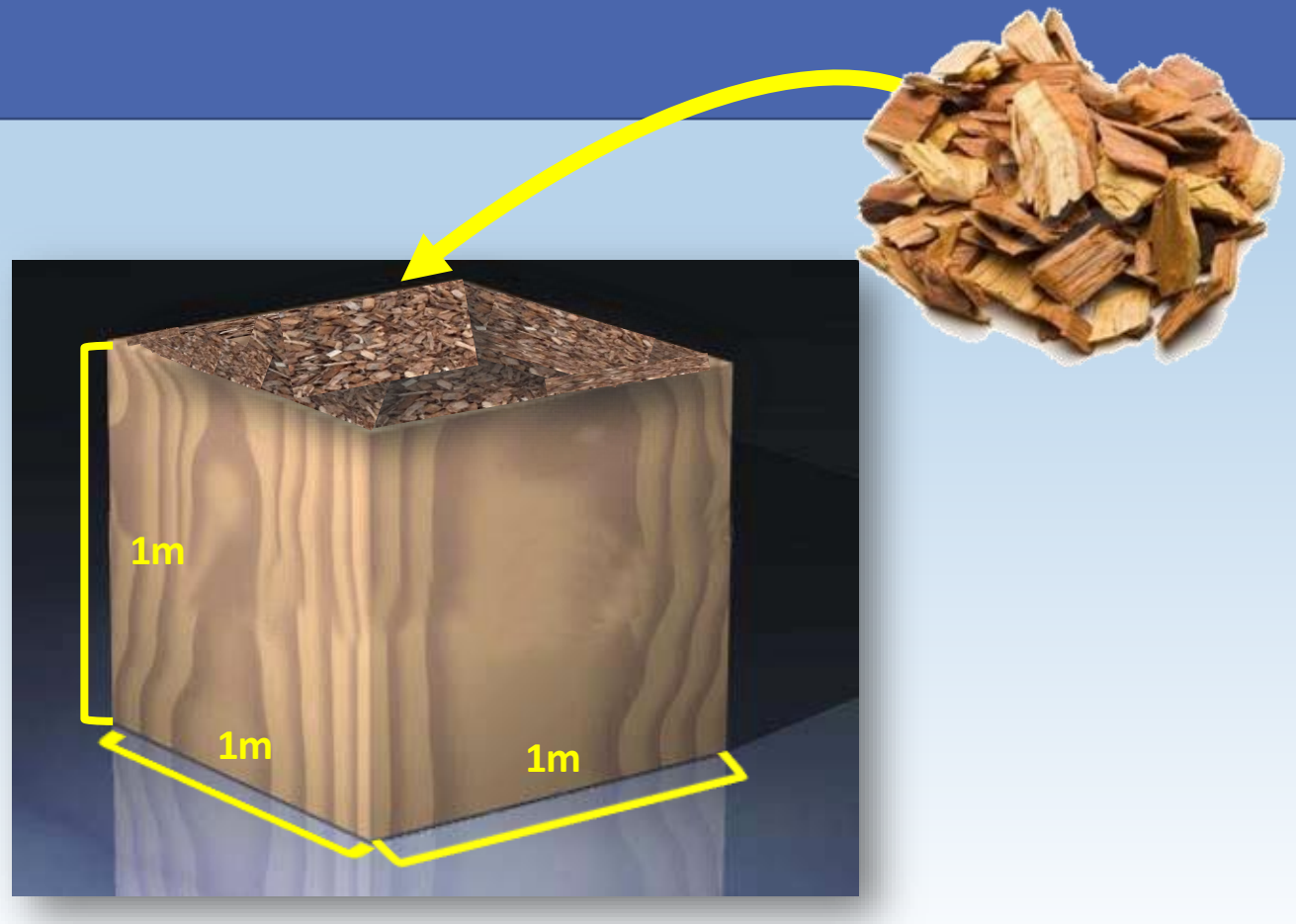
Wood Chips

- Mechanically processed wood in various sizes from 1mm (1/32”) to 100mm (4”)
- Wood chips are usually measured in “poured” m^3
- Nomenclature varies with supplier
  - Chips
  - Hog fuel
  - Sawdust
  - Shavings
  - Etc.



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Wood Chip Sources

Depending on scale and scope of project sources include

- Sawmilling residuals
- Harvesting residuals
- Urban development
- Wildfire mitigation
- Landfill waste diversion

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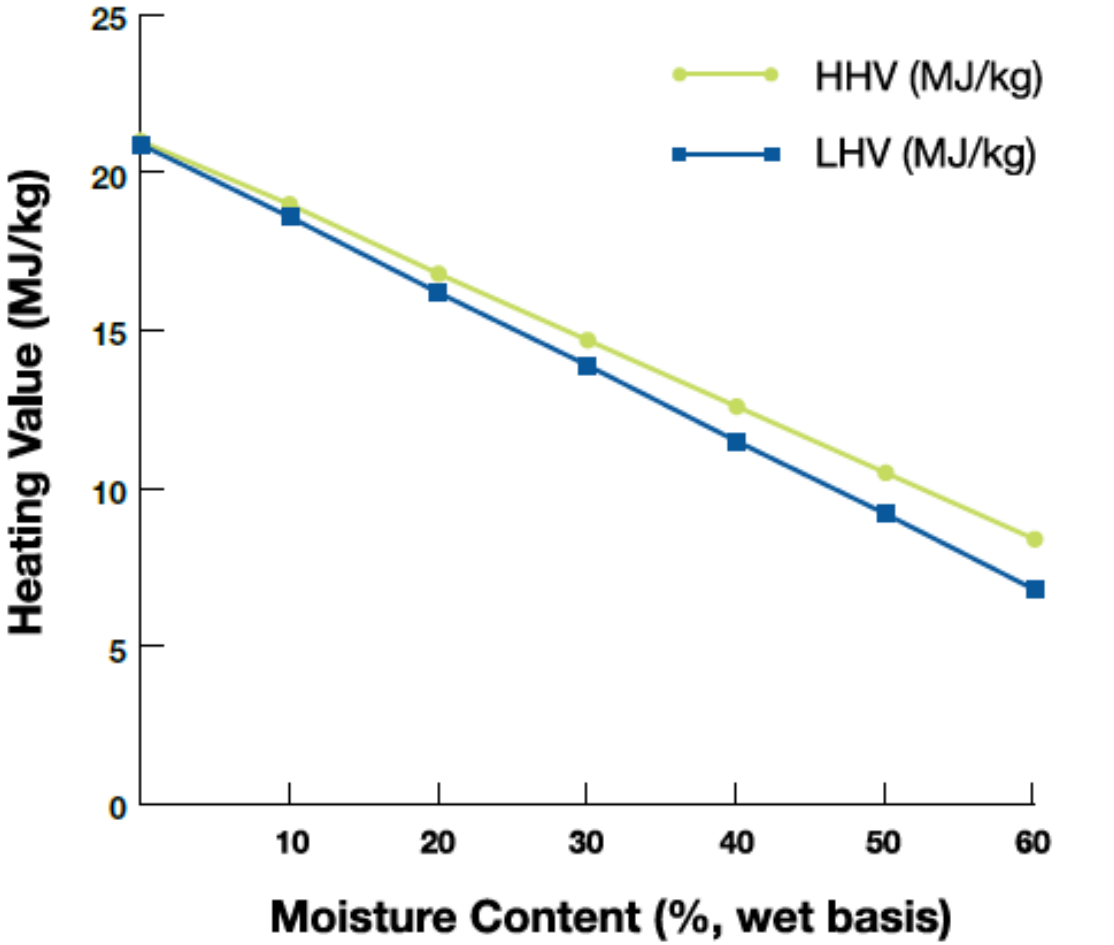
Fuel Type – Chips vs Pellets

- Depends on fuel type
  - Chip systems can use pellets
  - Pellets system cannot typically use chips
- Chips require 2.5-3 times as much volume for same amount energy as pellets
- Pellets flow with enough angle
- Chips require mechanical extraction from storage

Physical Properties Moisture

- Most critical property for biomass fuels
- Water does not burn
- Beware of higher vs lower heating values
- Wet basis vs dry basis
- It is very difficult to dry wood fuel once it is chipped
- Pellets approx. 8% moisture



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Physical Properties – Density (Bulk/Energy)

- Bulk density
  - Wood chips - 250kg/m3
  - Pellets – 650 kg/m3
  - 2.5 times more volume for chips vs pellets
- Energy Density
  - Chips depends on moisture
    - 5.49 kWh/kg bone dry
    - 3.84 kWh/kg @ 30%
    - 3.02 kWh/kg @ 45%
  - Pellets – 8% moisture- 5.05 kWh/kg
- Impacts auger sizes

1 litre of oil has the same energy as:
1) Just over 2 kg of pellets
2) Just over 3 litres of pellets
3) Almost 4 kg of chips



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CSA Fuel Standard

- Based on Source and Origin
- Grade A typical for smaller systems < 500 kW
- Grade B for larger > 500 kW

Table 1. Hierarchical classification and grading of Woody Biomass (Classification 1) by origin and sources*

1.1 Forest, plantation and other virgin wood	Grade A	Grade B
1.1.1 Whole tree without roots	yes	yes
1.1.2 Whole trees with roots	no	yes
1.1.3 Stem wood	yes	yes
1.1.4 Logging residues**	no	yes
1.1.6 Bark (from forestry operations)	no	yes
1.1.7 Segregated wood from gardens, parks, roadside maintenance, vineyards, fruit orchards, driftwood from fresh water	no	yes

1.2 By-products / residues from wood processing industries	Grade A	Grade B
1.2.1 Chemically untreated wood by-products, residues, wood constituents**	yes	yes
1.2.2 Chemically treated wood by-products, residues, wood constituents***	no	yes

1.3 Used wood****	Grade A	Grade B
1.3.1 Chemically untreated used wood	no	yes

* The focus of this bulletin is solid biofuels for residential, commercial and institutional heating applications, i.e. Grades A and B; industrial grade solid biofuels, Grade (I), are excluded. Furthermore, the blends and mixtures as raw materials are excluded.
** Woody biomass sourced from Classifications 1.1.4 and 1.2.1 is the main source for solid biofuel production in Canada
*** To qualify, chemically treated wood by-products and residues shall not contain heavy metals or halogenated organic compounds as a result of treatment with wood preservatives or coatings
**** To qualify, used wood shall not contain heavy metals or halogenated organic compounds as a result of its usage and treatment with wood preservatives or coatings.

Physical Properties – Ash content

Table 1. Key specifications of properties for graded wood chips based on CAN/CSA-ISO 17225 Part 4

Property Class	Unit	Grade A1	Grade A2	Grade B1	Grade B2
Moisture (M)	weight %	M10 ≤10 M25 ≤25	M35 ≤35	Maximum value to be stated	Maximum value to be stated
Ash (A)	weight %, dry	A1.0 ≤1.0	A1.5 ≤1.5	A3.0 ≤3.0	A3.0 ≤3.0

- Higher ash means higher maintenance costs
- Grate cooling and flue gas recirculation to reduce clinkers etc.

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Physical Properties – Particle Size and Distribution

Size of Wood Chips as per CAN/CSA-B366.1-M91, Grade C7

			G 30 Fine	G 50 Medium
Total mass 100%				
Coarse percentage max. 20%	Max. cross-section	in.^{2} (cm^2)	½ (3)	¾ (5)
	Max. length	in. (cm)	3⅓ (8.5)	4¾ (12)
	Coarse sieve nominal mesh width	in. (mm)	⅝ (16)	1¼ (31.5)
Main percentage 60 to 100%	Medium sieve nominal mesh width	in. (mm)	⅛ (2.8)	¼ (5.6)
Percentage of fines (incl. ultrafine content) max. 20%	Fine sieve nominal mesh width	in. (mm)	1/25 (1)	1/25 (1)

- Pellets uniform size is benefit – flexible augers
- Chips more variable
- Impact fuel handling systems not typically the boiler
- Increases capital cost

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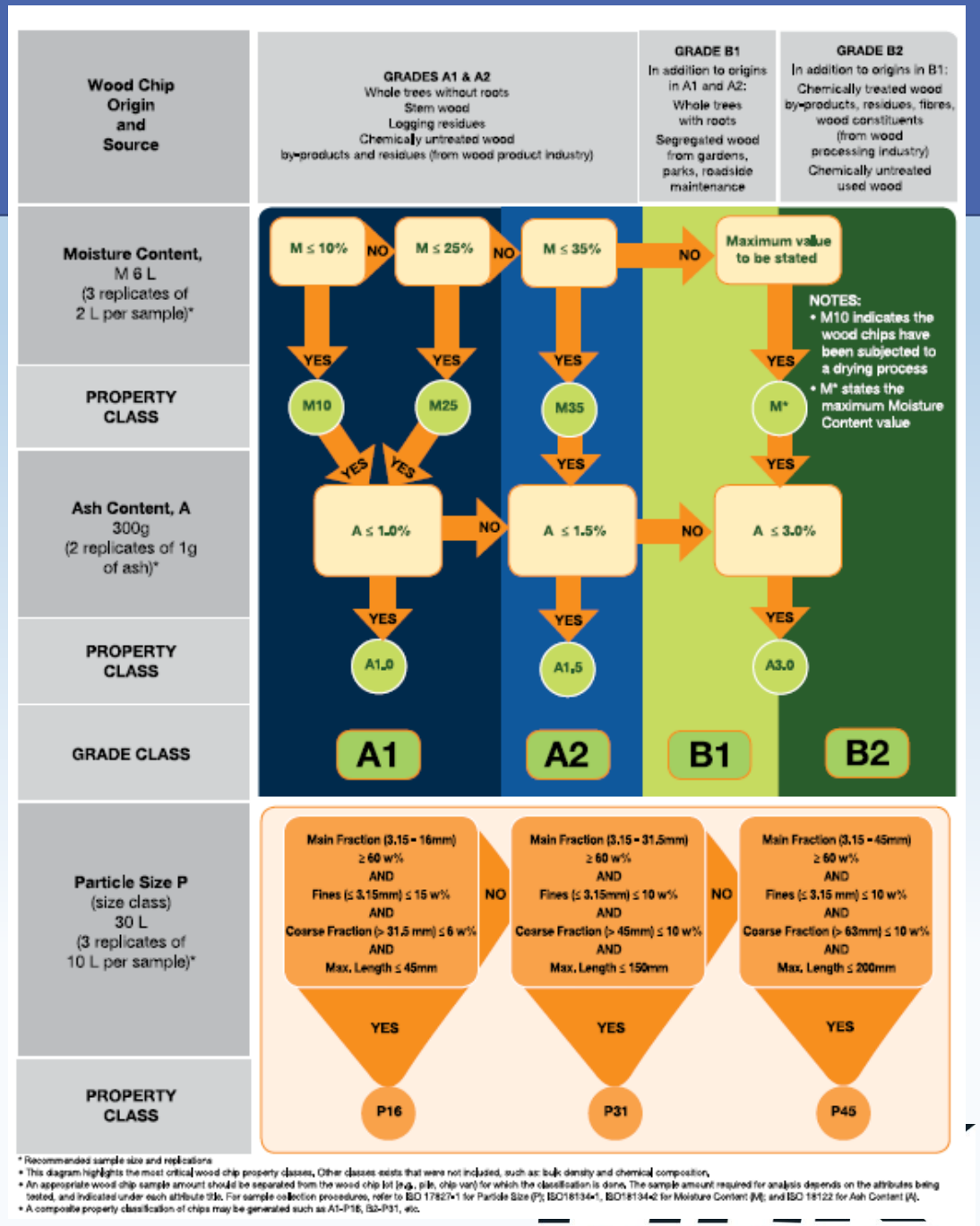
Wood Fuel Procurement

- Understand fuel then pick equipment that best suits
- Fuel supplier produce to the standard but do not certify to it
- Fuel supplier speak wood not energy
- Pellets most similar to fossil fuels
- Chips need to be aware of market
  - Typical spot pricing or short term contracts
- Best out come based on communication with supplier





Wood Chip Production

- Wood fuel production is expensive
  - $100-200/tonne
- Leverage multiple goals
  - Wildfire mitigation
  - Waste/residue diversion
  - Economic Development
  - Fuel Security
- Capital investment in equipment vs procurement from ready sources
  - Partnerships with others

Designing Fuel Storage – Delivery Vehicle Configuration

- Types of Delivery Vehicles
  - B-Train Belly dump
  - Auger Truck and Trailer
  - Dump Truck or Trailer
  - Walking/Shuffle Floor Truck or Trailer
  - Pneumatic

Storage Volume

- 1.25-1.5 times larger than delivery vehicle if possible
- Runtime on storage
  - Smaller systems (150 – 400 kW)
    - 2 or 3 weeks to allow for holidays
    - on demand delivery
  - Medium system (400 – 720 kW)
    - depending on fuel supply chain
    - Scheduled or on demand delivery
  - Larger system (720 kW +)
    - 3-4 days (over the weekend)
    - Scheduled delivery

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Examples of Storage Bins

- Cone bottom
- Flat bottom
- Site built below grade
- Combination above or below grade
- Containerized

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Spring/Disk Extraction Systems

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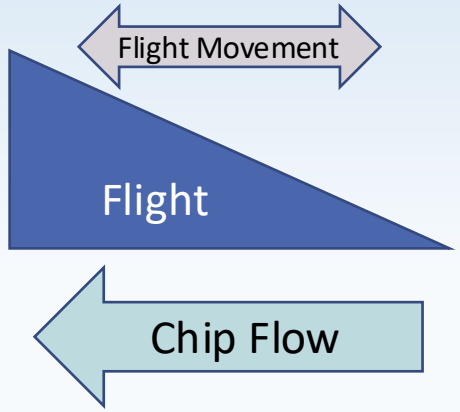
Walking Floor

- Most versatile
- Any fuel type
- Higher capital cost
- Flexible design



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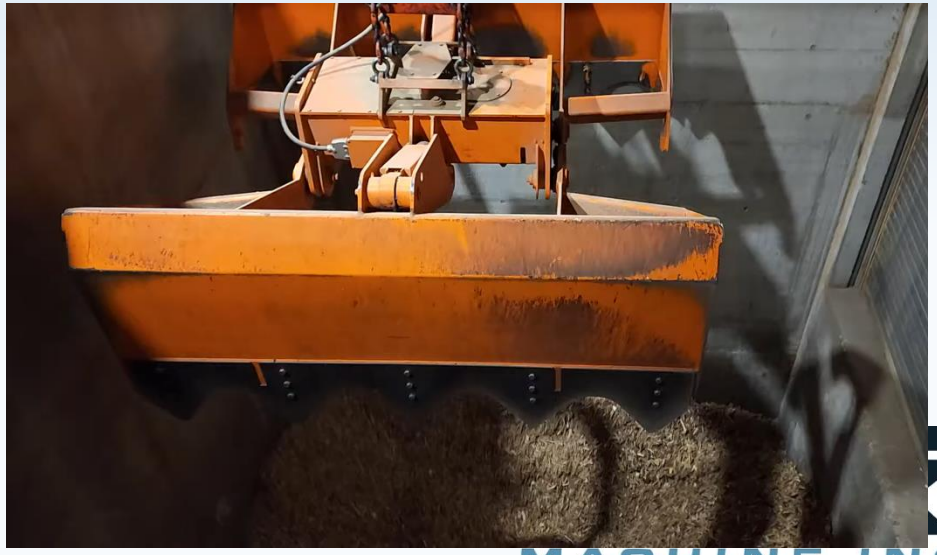
Other Less Common Extraction Systems

- Auger extraction (Pellets)
- Funnel Extraction Systems
- Vacuum Systems (Smaller boilers)
- Cranes



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Final Thoughts

- Operator buy in is more critical than fuel quality
- Good operators can get good results with poor fuel with diligence and commitment
- For smaller systems it is more cost effective for more expensive better-quality fuels than doing increased maintenance (chips/pellets)

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Questions?