WOODY DEBRIS MANAGEMENT WORKSHOP 2.0

Biomass Quality

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1. Biomass Critical Quality Attributes

Biomass Technology	50 kW CHP	50-250 kW Boiler	250-500 kW Boiler	500kw - 1 MW Boiler	>> 1 MW boiler
Maximum Particle Size	30-40 mm (1 inch minus)	30-40 mm (2 inch minus)	< 75 mm (3 inch minus)	< 100 mm (4 inch minus)	> 100 mm (4 inch minus)
Size Uniformity	Very uniform	Uniform	Uniform	Some variation	More variation
Sensitivity to oversize	High	High	Moderate	Moderate	Low
Sensitivity to fines	High	High	Moderate	Moderate	Low
Maximum Moisture Content	< 10 %	< 20-30%	< 30%	< 30-50%	up to 50-60%
Contamination	Not allowed	Not allowed	Not allowed	Some allowed	More allowed

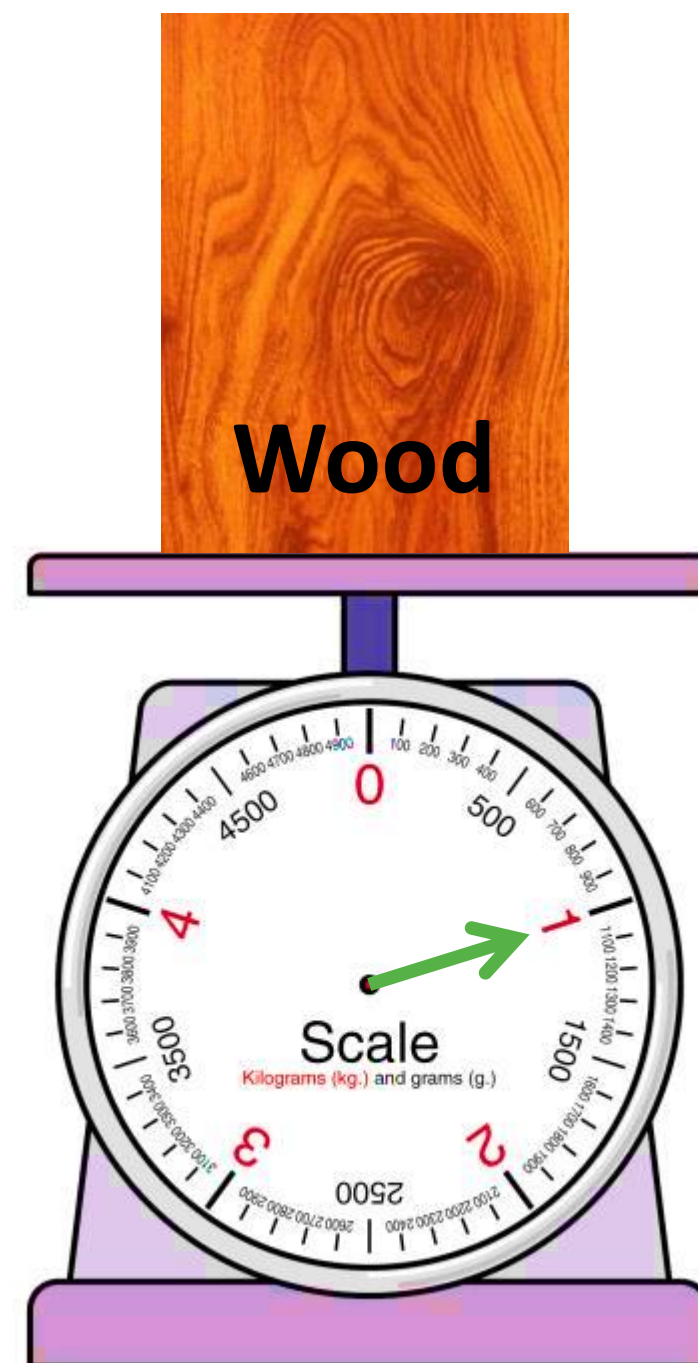**Biomass quality specs are stricter as boiler size decreases**

The rule of thumb of biomass quality

1. Biomass Critical Quality Attributes

MOISTURE CONTENT (MC): % weight of water from total weight

20% Water

50% Water

Wood

Wood

Wood

1,000 grams solid wood (bone dry)

0 g/1,000 g

0% MC

1,000 grams solid wood (bone dry) + 250 grams water
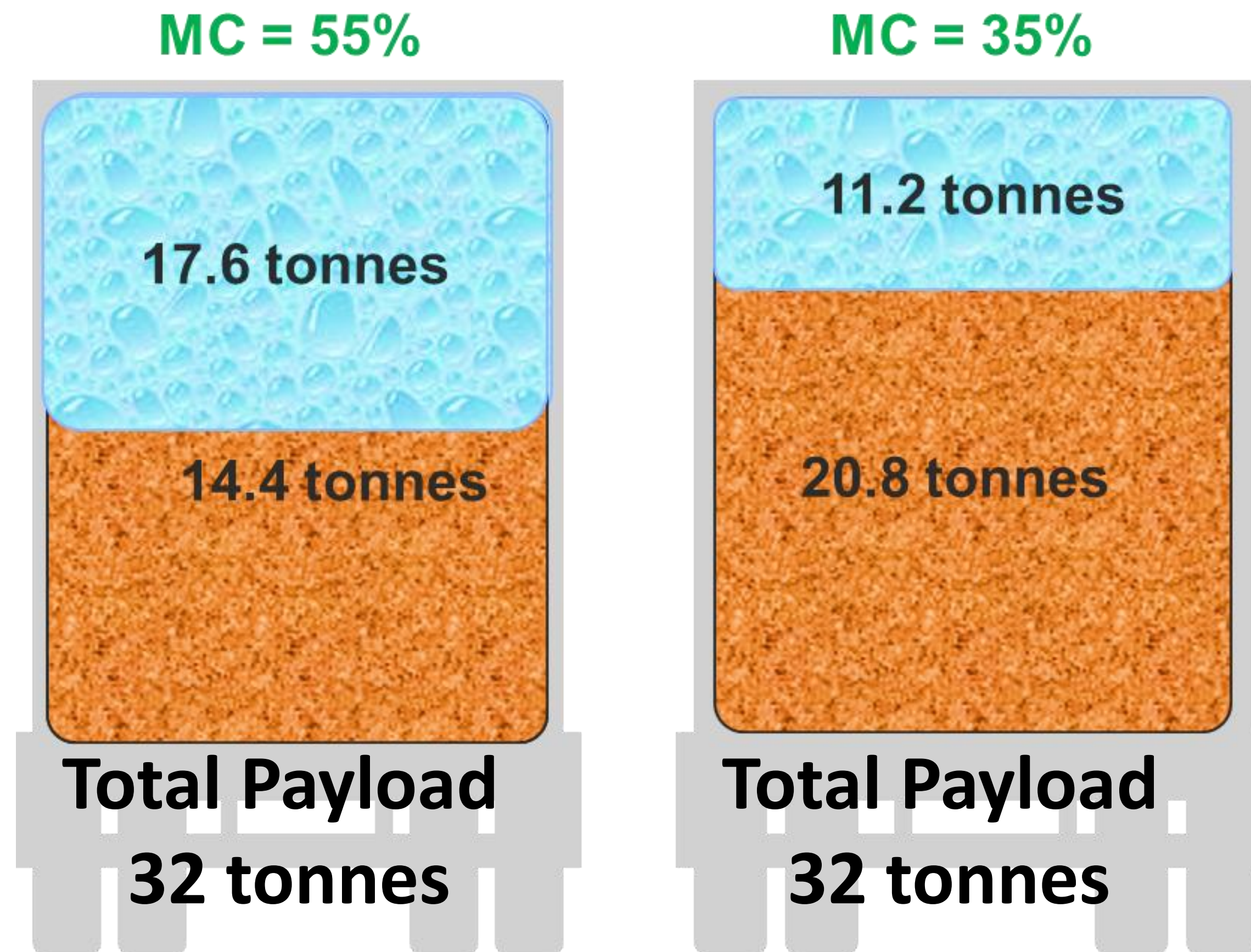
250 g/1,250 g

20% MC
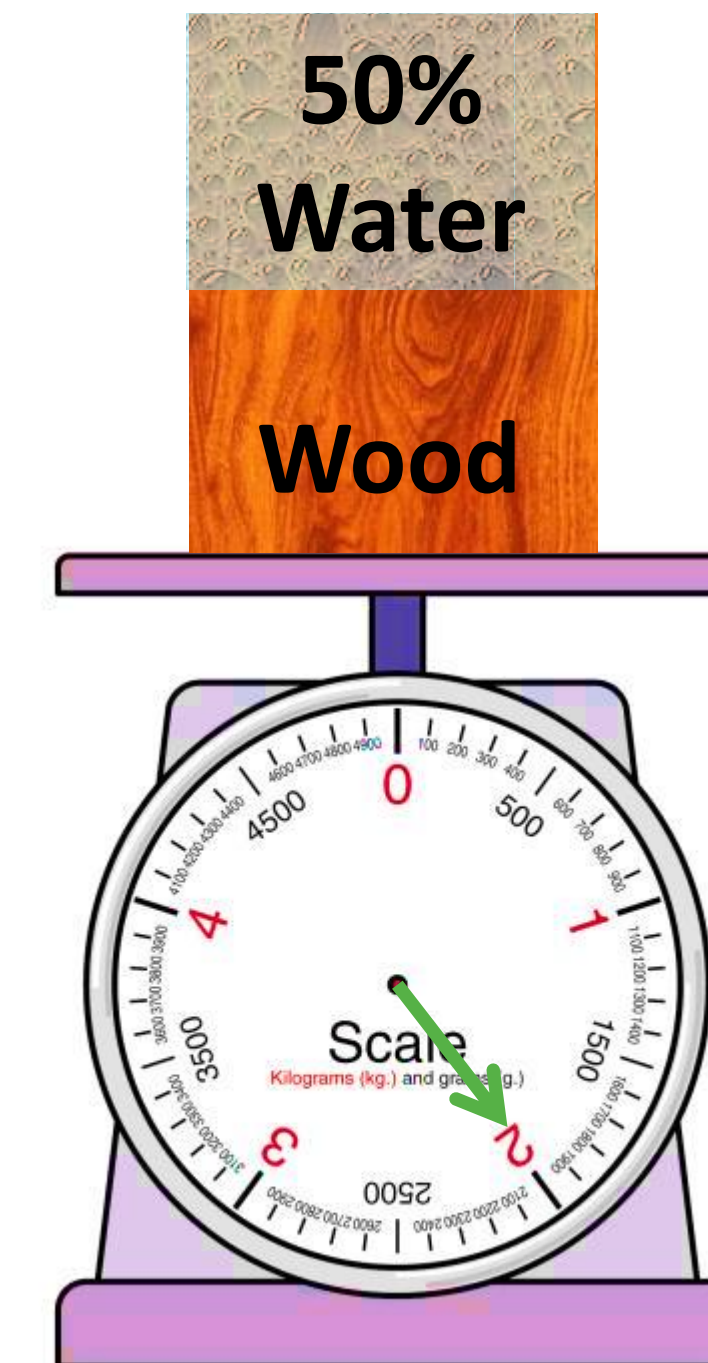
1,000 grams solid wood (bone dry) + 1,000 grams water

1,000 g/2,000 g

50% MC

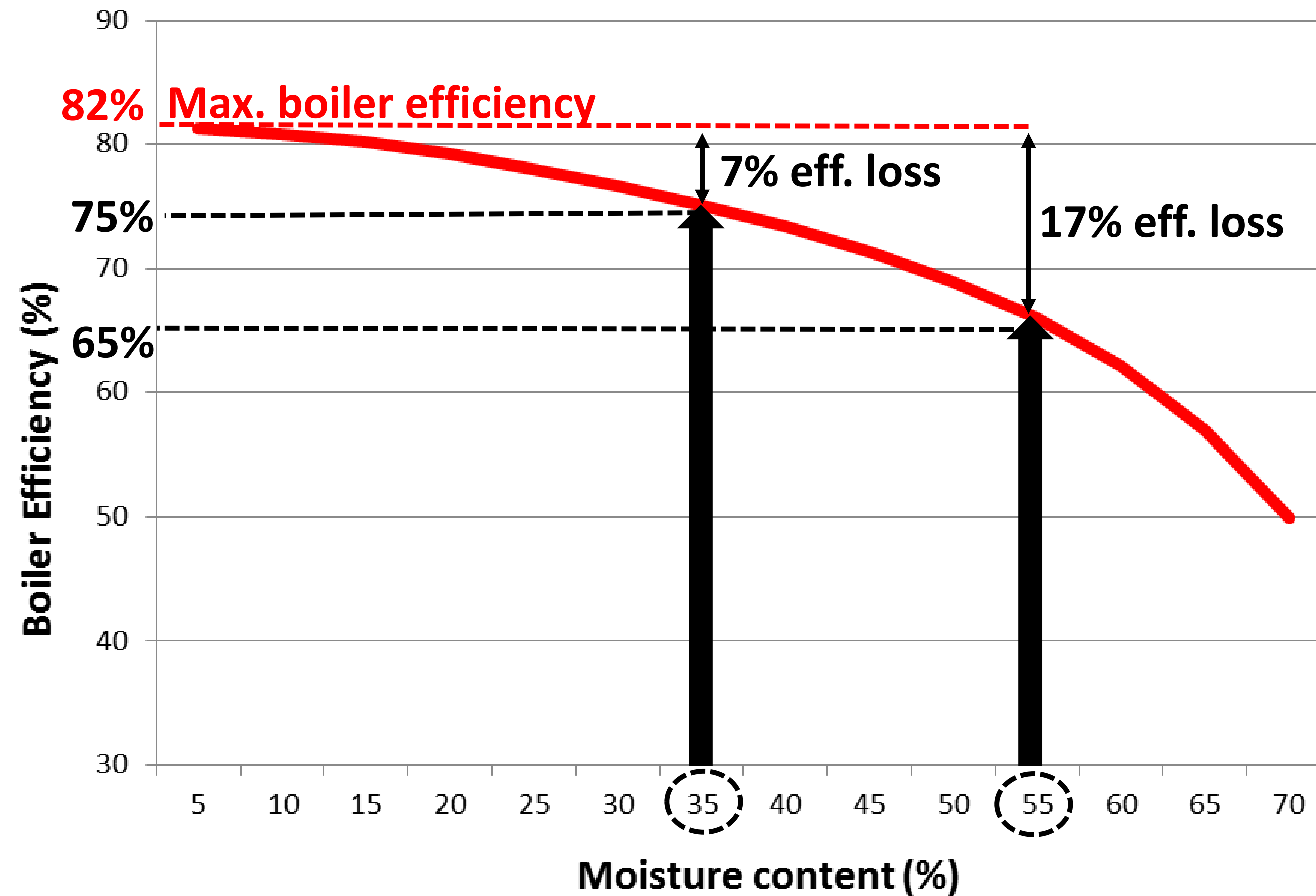# 1. Biomass Critical Quality Attributes

WHY IS MOISTURE CONTENT IMPORTANT?

MC = 55%

MC = 35%

17.6 tonnes

11.2 tonnes

14.4 tonnes

20.8 tonnes

**Total Payload
32 tonnes**

**Total Payload
32 tonnes**

Deliver more wood (energy!) less water!

1. Biomass Critical Quality Attributes
WHY IS MOISTURE CONTENT IMPORTANT?

82% Max. boiler efficiency

7% eff. loss

17% eff. loss

75%

65%

Boiler Efficiency (%)

Moisture content (%)

Combust more wood, evaporate less water!
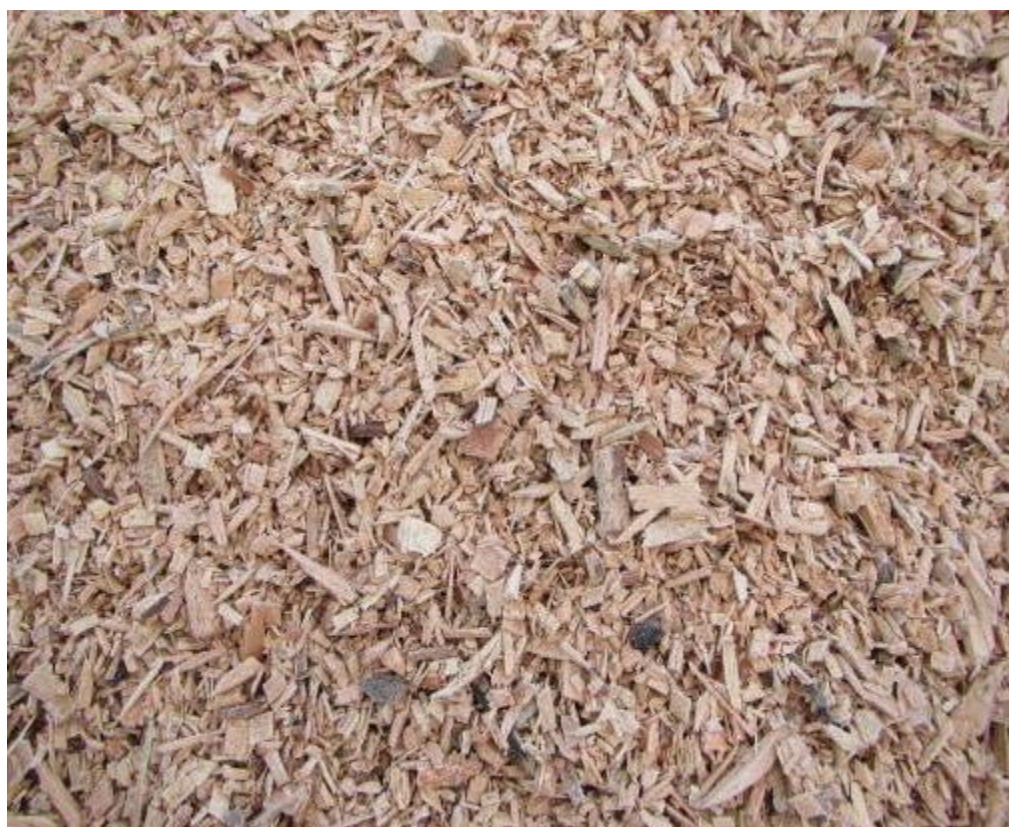
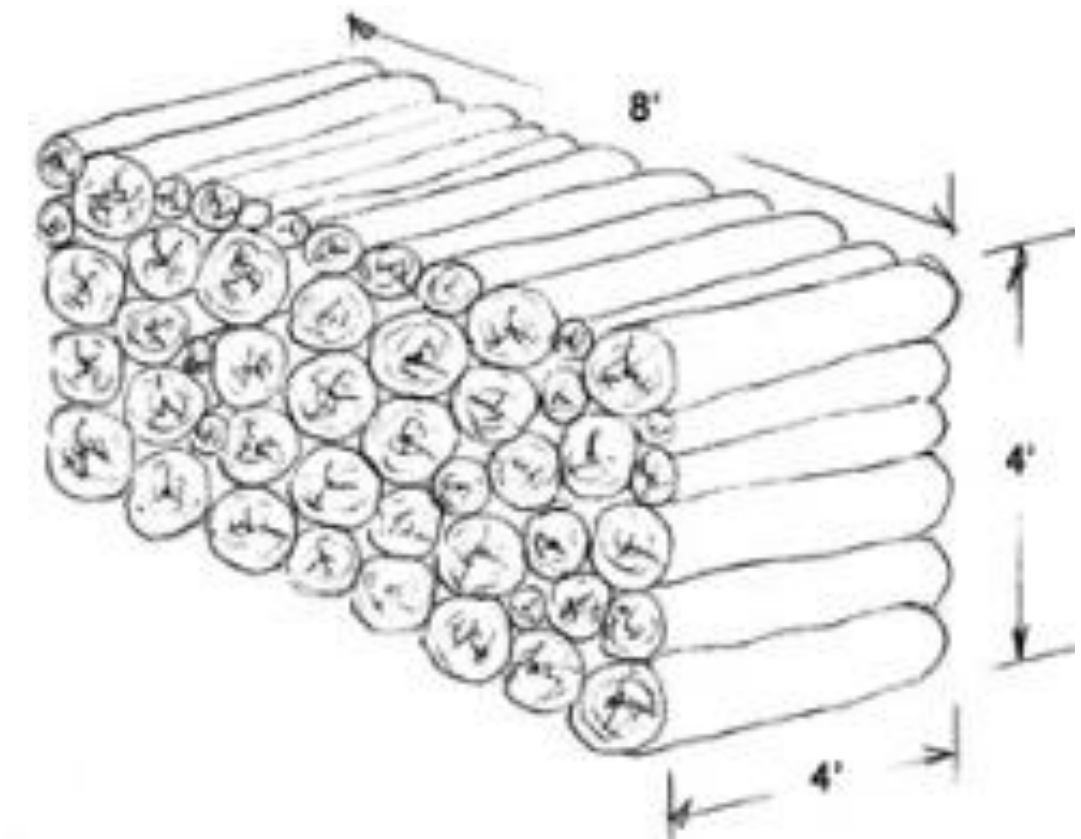# 1. Biomass Critical Quality Attributes

PARTICLE SIZE DISTRIBUTION/PARTICLE UNIFORMITY:

Pellets
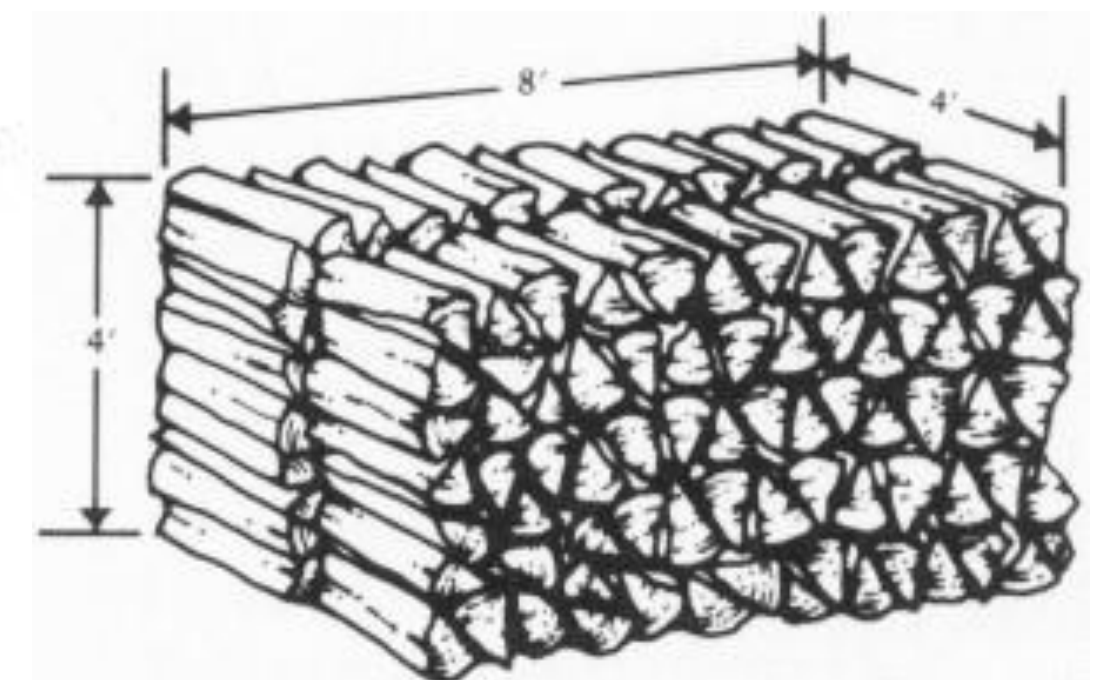**Diameter: 6 or 8 mm**
Length: 3.15 – 40 mm

Wood chips
1" minus
2" minus
3" minus
4" minus
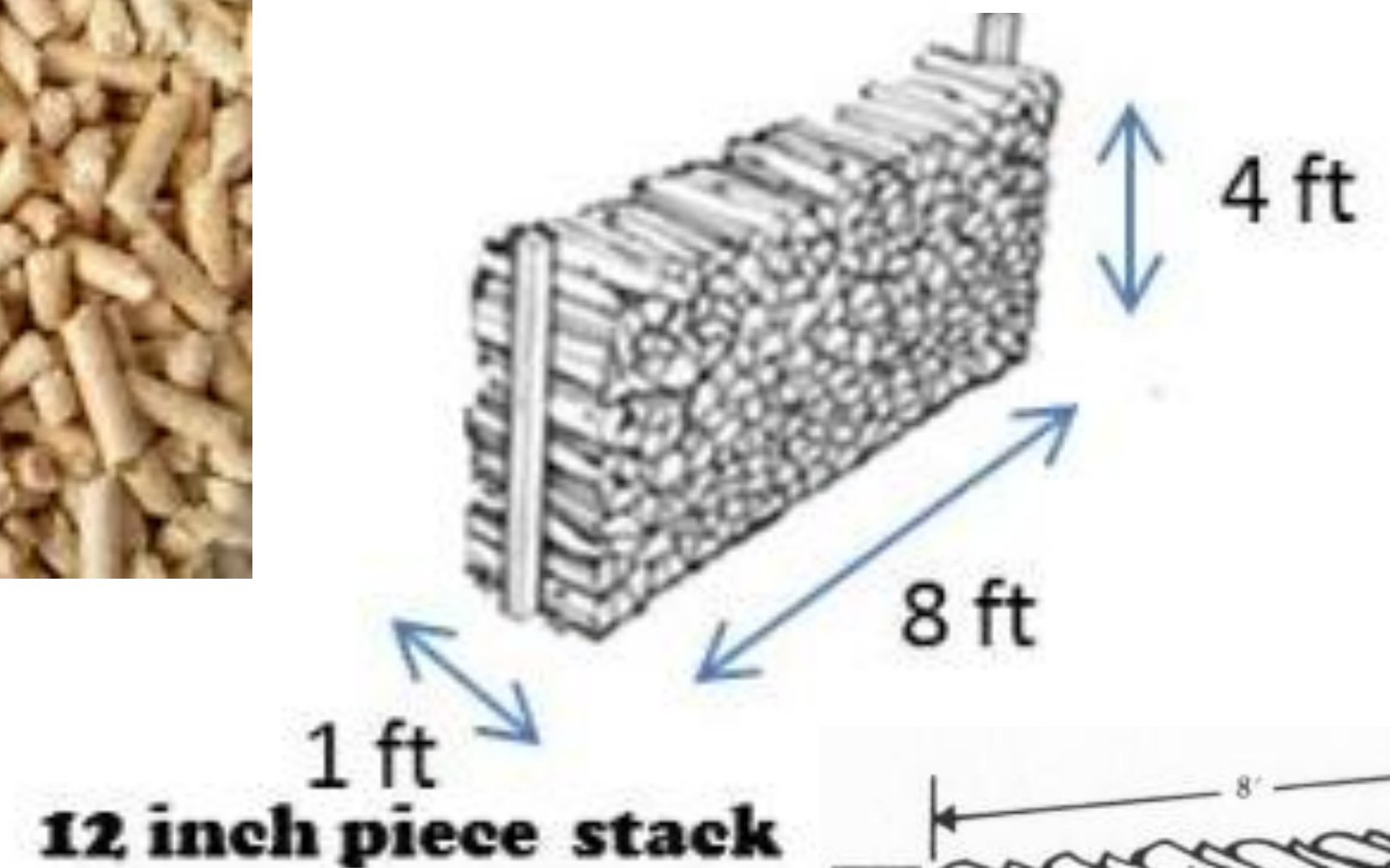
CSA/ISO wood chip standards have been developed

4 ft

8 ft

1 ft
12 inch piece stack

1. Biomass Critical Quality Attributes

PARTICLE SIZE DISTRIBUTION/PARTICLE UNIFORMITY:
 % weight of each particle size class (mm) from total weight
Size distributions are highly dependent on **biomass source**
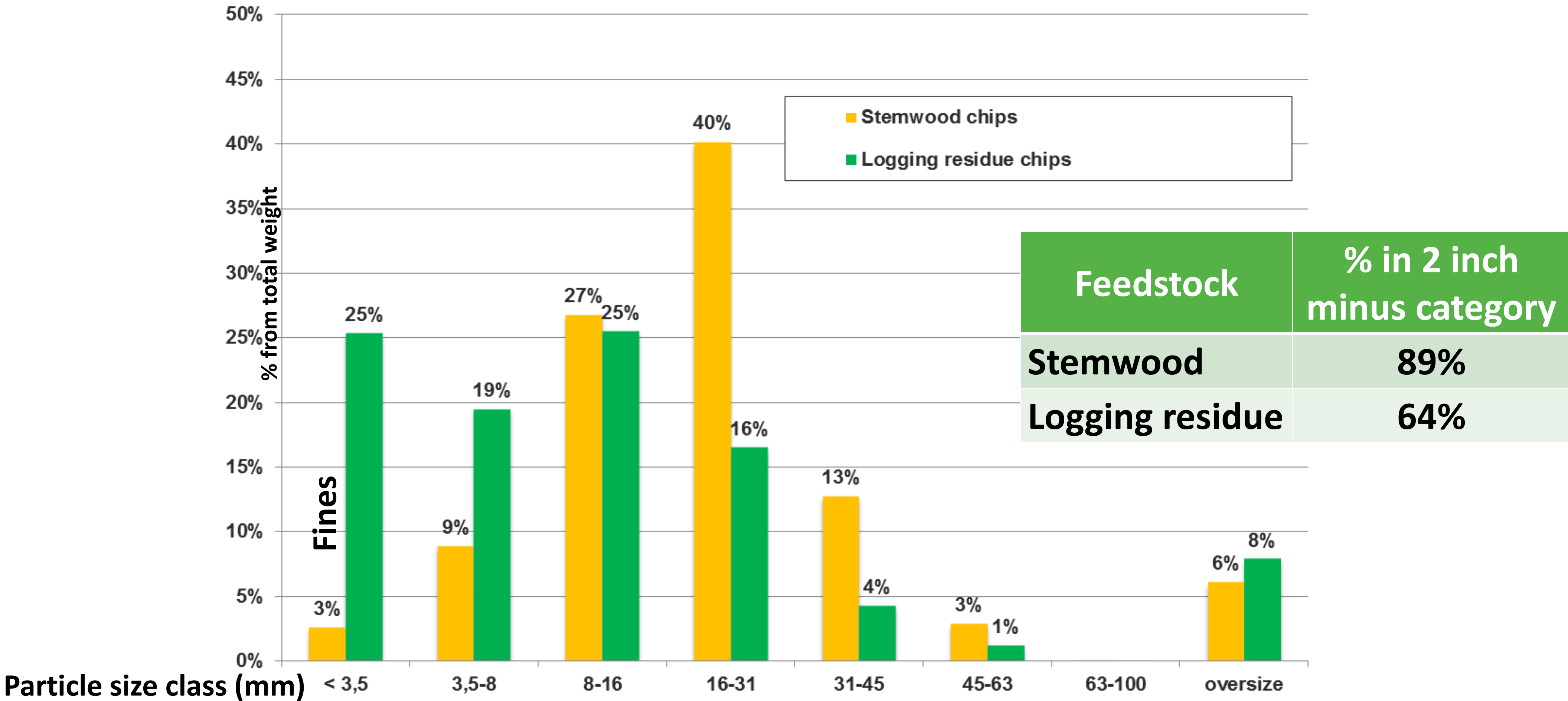
Feedstock	% in 2 inch minus category
Stemwood	**89%**
Logging residue	**64%**

Particle size class (mm)

1. Biomass Critical Quality Attributes

PARTICLE SIZE DISTRIBUTION/PARTICLE UNIFORMITY:

Size distributions are highly dependent also on **chipping/grinding equipment:**

Burnt Softwood Stem Tops

- ■ Large Drum Chipper
- ■ Small Disk Chipper

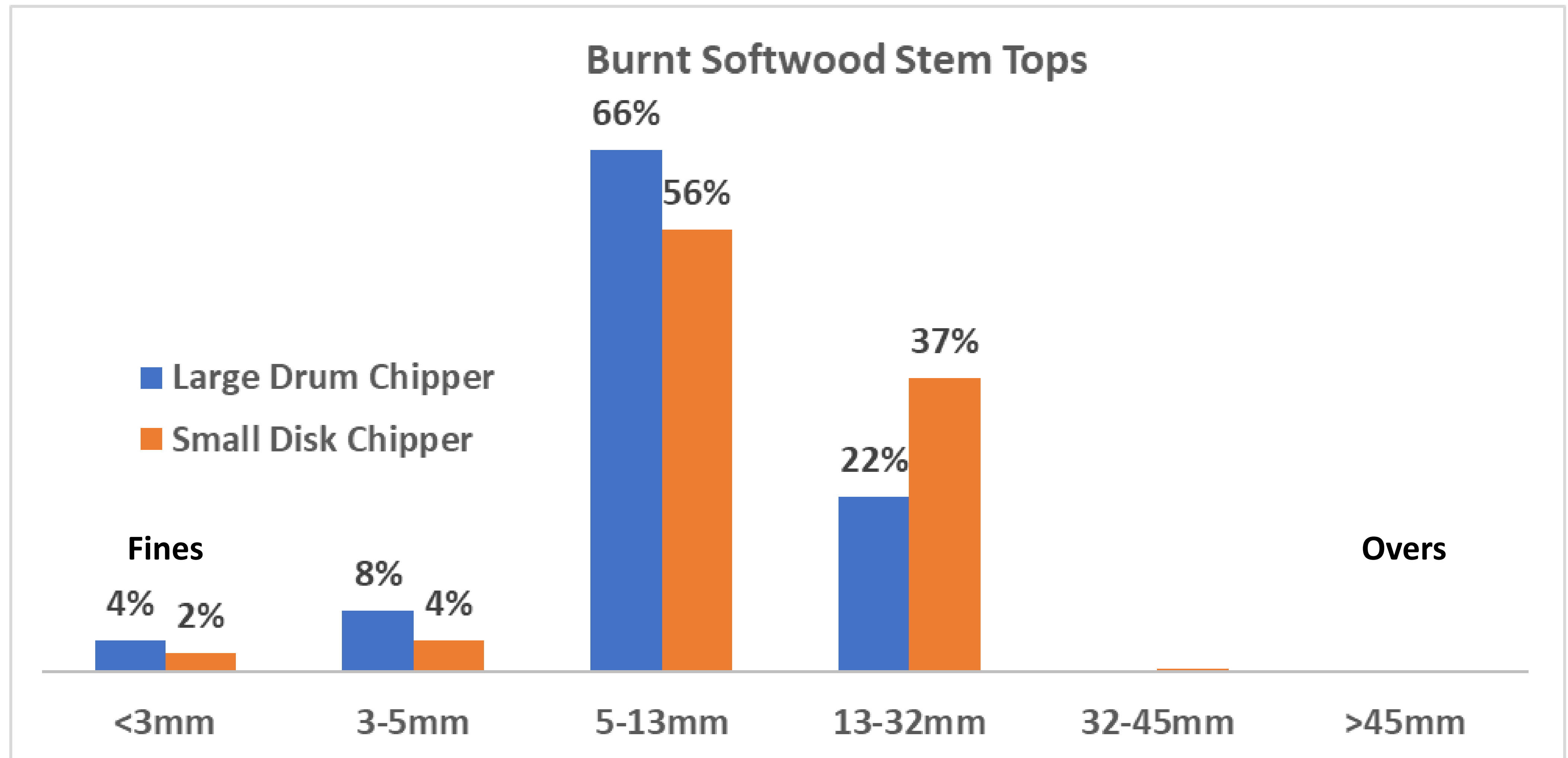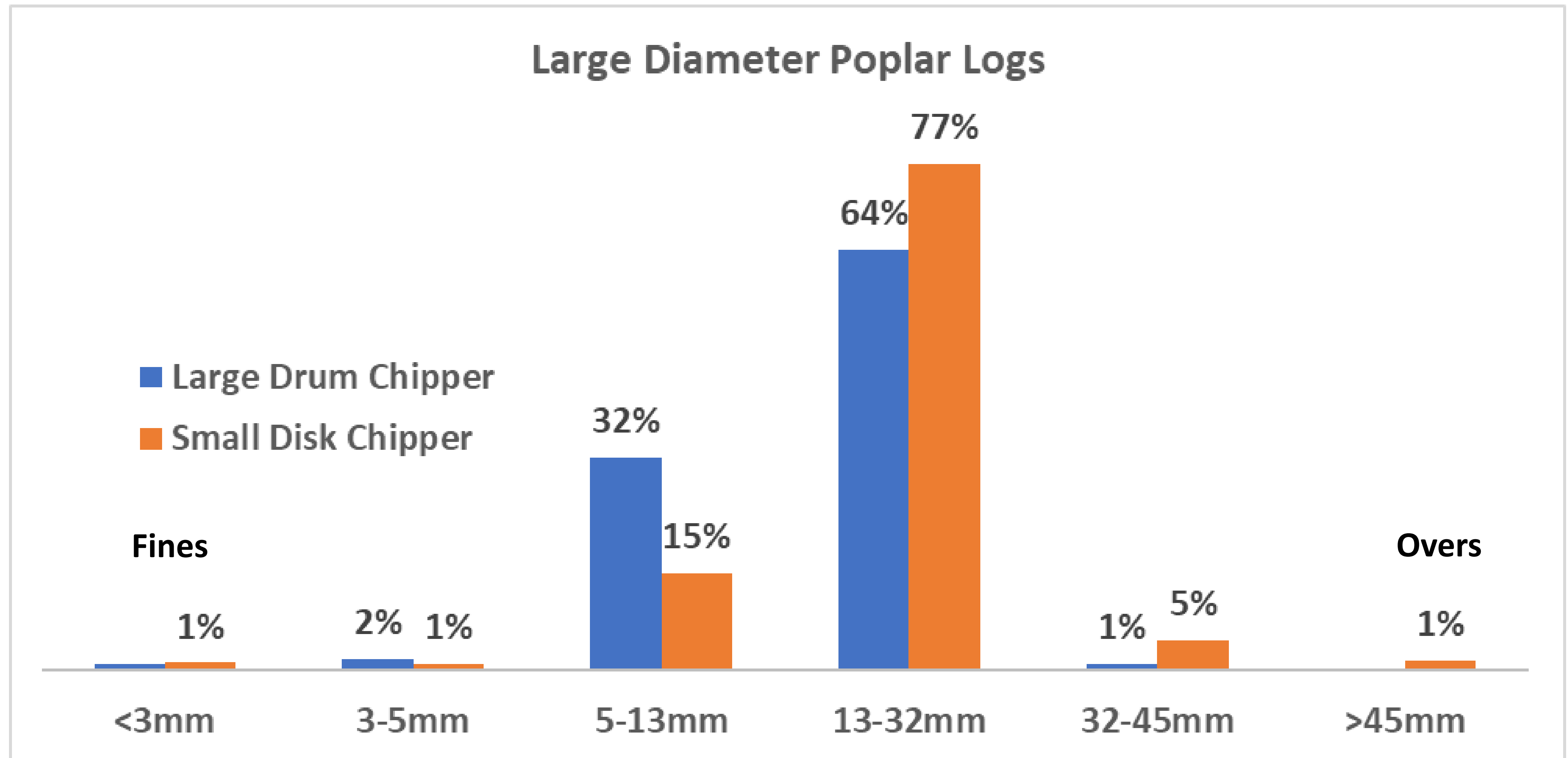|	<3mm	3-5mm	5-13mm	13-32mm	32-45mm	>45mm
Large Drum Chipper	4%	8%	66%	22%		
Small Disk Chipper	2%	4%	56%	37%		

Fines ... **Overs**

1. Biomass Critical Quality Attributes

PARTICLE SIZE DISTRIBUTION/PARTICLE UNIFORMITY:

Size distributions are highly dependent also on **chipping/grinding equipment:**

Large Diameter Poplar Logs

- Large Drum Chipper
- Small Disk Chipper

| Fines | | | | | Overs |
| <3mm | 3-5mm | 5-13mm | 13-32mm | 32-45mm | >45mm |

1. Biomass Critical Quality Attributes

CONTAMINATION: % weight of contaminants from total weight

At the source:
- Rocks, soil, chain, wire rope, track pads, grinder teeth

At storage site:
- Rocks, soil, and equipment parts

SALT IS ALSO A MAJOR CONTAMINANT!

Contaminants end up in the ash!

1. Biomass Critical Quality Attributes

ASH CONTENT: % weight of ash (after complete combustion) from total weight before combustion

Fly ash
- Represents about 5% of total ash generated
- Escapes with the combustion gases, but are captured by Emission Control Systems (expensive)
- Presence of heavy metals (Pb, Zn, Ni)

Bottom ash
- Represents about 95% of total ash generated
- Especially the alkali metals (Ca, K, Mg, Mn, P)
- May be used as soil amendment

% Ash
- Bark, needles, soil, contamination

Disposal of contaminated biomass ash may be very expensive!

1. Biomass Critical Quality Attributes

BULK DENSITY (BD) = $\dfrac{\text{Mass of biomass}}{\text{Volume of biomass}}$ [kg/m^3]

Wood pellets: 600 kg/m^3

Wood chips: 250 - 450 kg/m^3
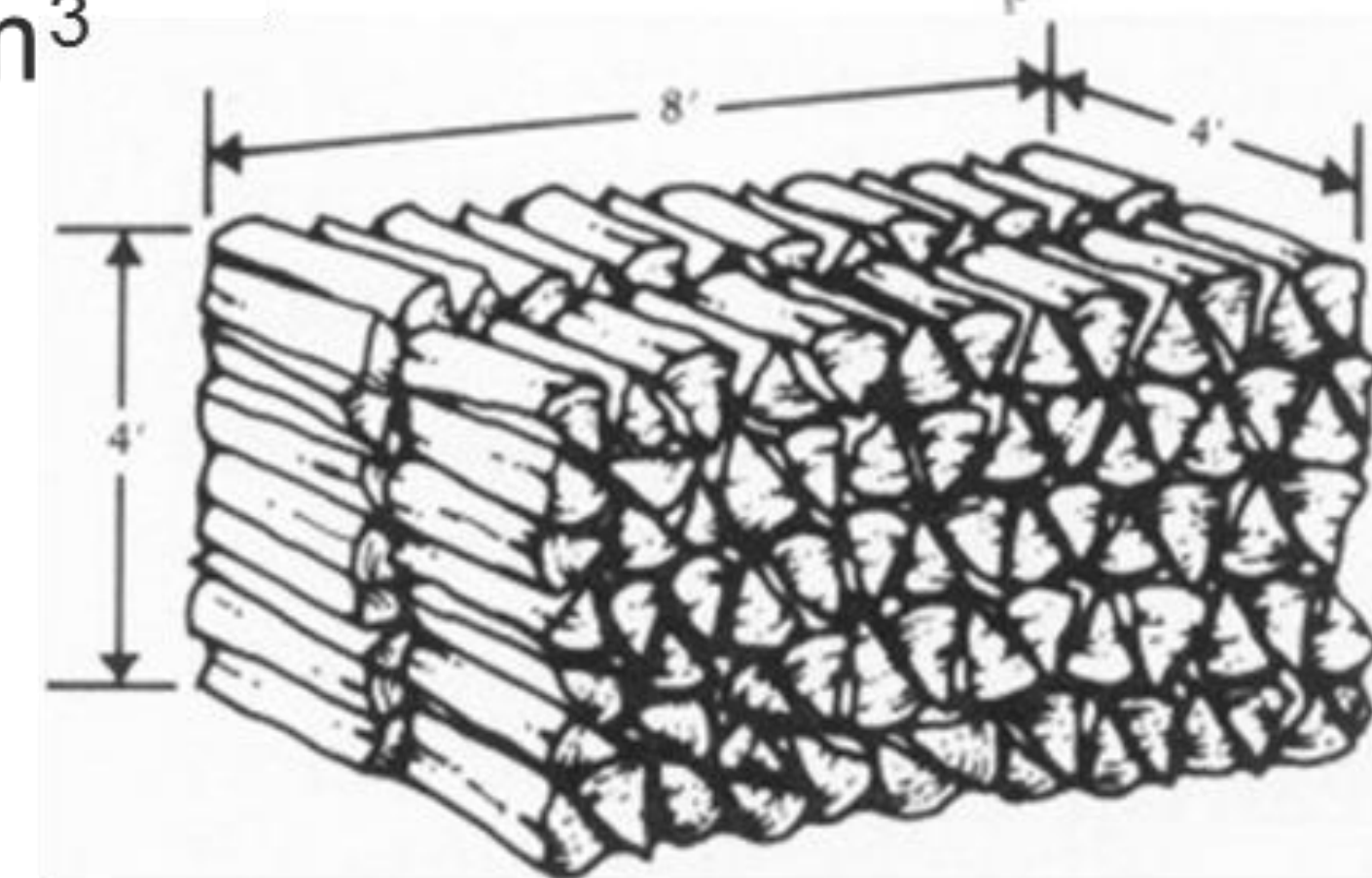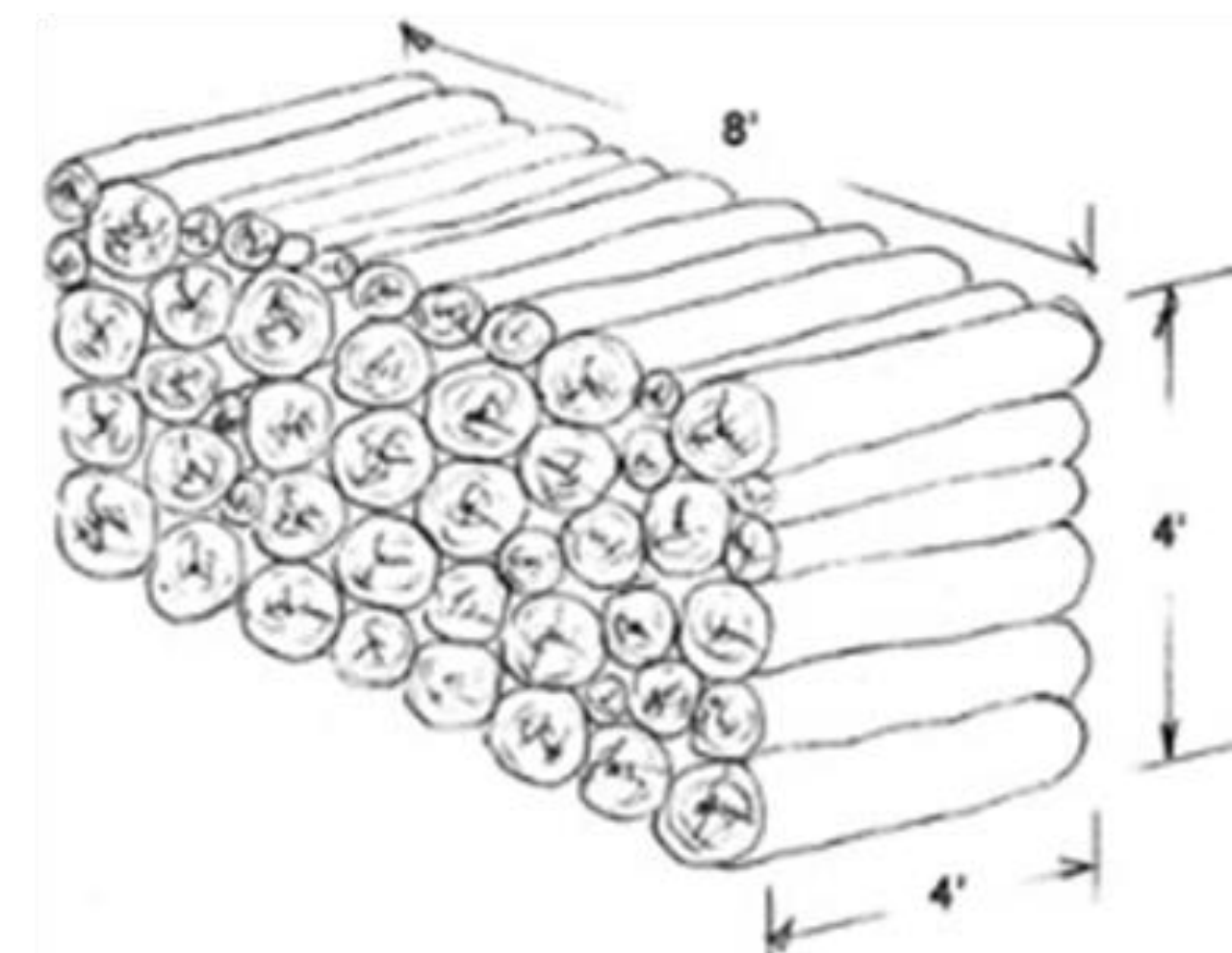
Logs stacked (20% mc): 350 - 500 kg/m^3

1. Biomass Critical Quality Attributes

WHY IS BULK DENSITY IMPORTANT?

To transport and store 1,000 ODt of biomass requires:

	Slash	Wood and woodparts	Chips	Bundles	Round wood
Number of 32 t trucks	63	46	34	31	31
Storage Area (m²)	2,100	1,500	1,100	990	700

Order of magnitude: ice rink = 1,600 m²

1. Biomass Critical Quality Attributes

ENERGY CONTENT: energy value per unit of <u>weight</u> [GJ/ODt]; [kWh/ODt]
ENERGY DENSITY: energy value per unit of <u>volume</u> [GJ/m^3]; [kWh/m^3]

ENERGY CONTENT <u>DOES NOT DIFFER</u> BETWEEN SPECIES

Tree components	Calorific value (GJ/ODt)	
	Balsam fir	White birch
White wood	20.0	19.8
Bark	21.1	22.9
Needles/Leaves	21.6	21.5
GJ/m^3 solid	7	11

ENERGY DENSITY <u>DIFFERS</u> BETWEEN SPECIES
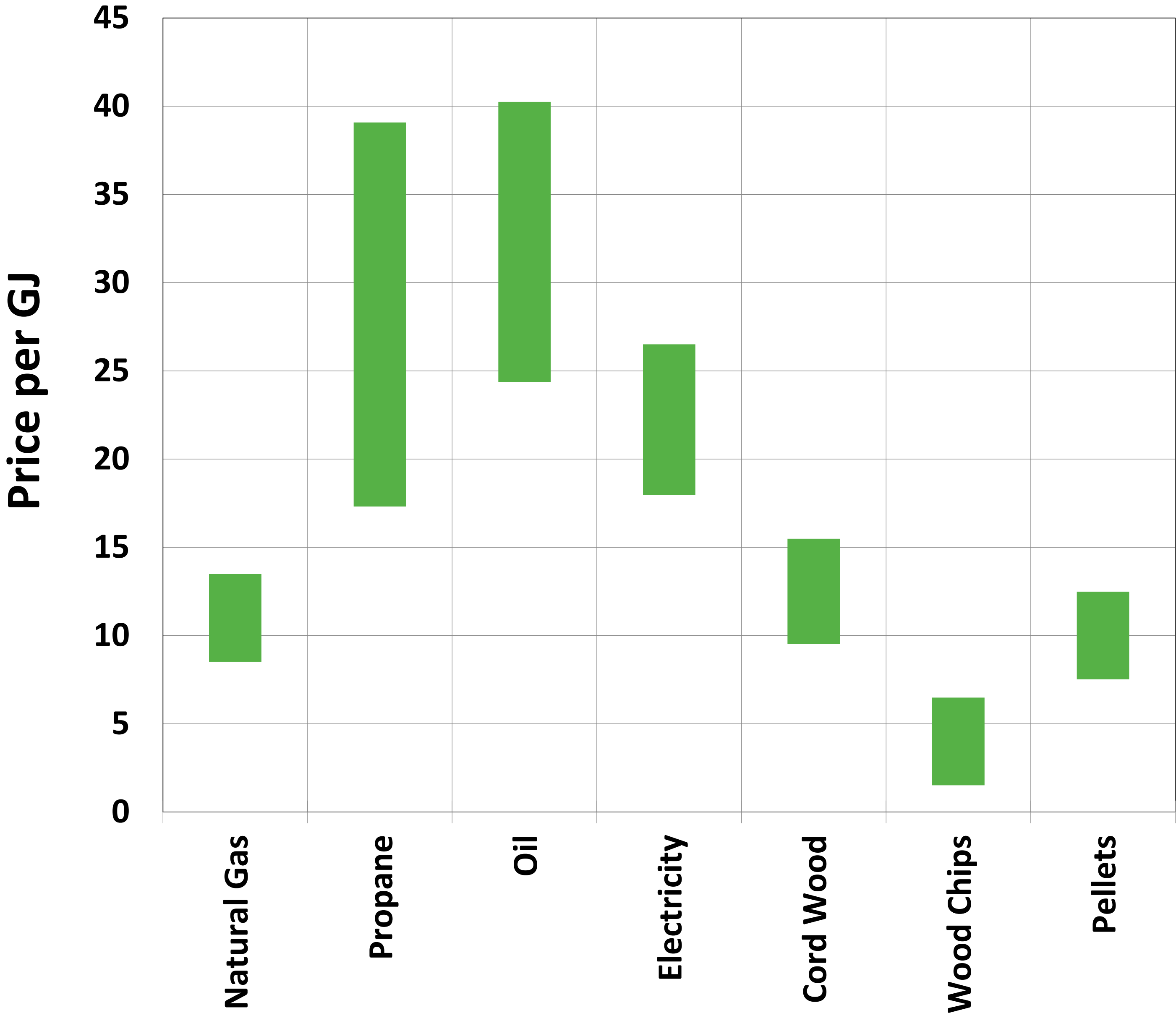
2. Biomass is not "JUST BIOMASS"!

Residue Pile

Chipping & Transportation

Storage

Boiler

ENERGY USER

2. Biomass is not "JUST BIOMASS"!

3. The right biomass product to the right utilization/market

Biomass Classifier

Class

4A-54

→ Moisture content

Particle size indicator
- A: < 10 mm
- B: < 50 mm
- C: < 100 mm
- D: > 100 mm

Quality number. Rating of 1 is the best, 4 is the worst.
- Contaminants (sand, clay, metal, rocks, paint)
  1: No contaminants
  2: Light contamination
  3: Medium contamination
  4: Heavy contamination
- White wood (% of white wood in supply)
  1: > 75%
  2: > 50%
  3: > 25%
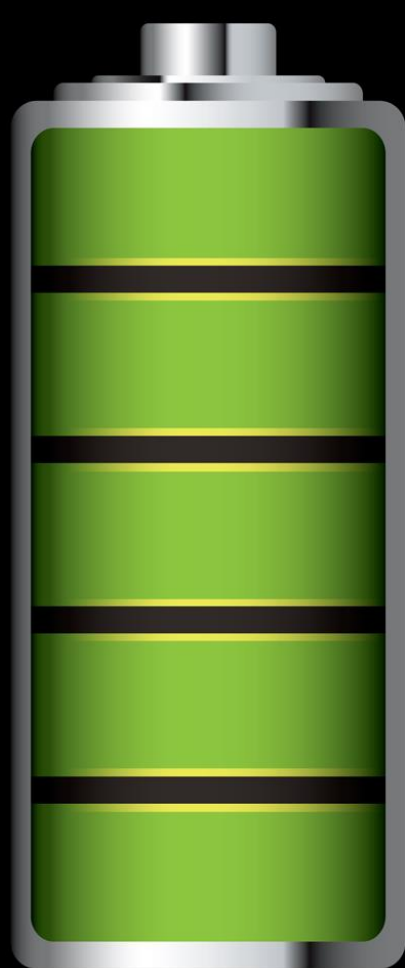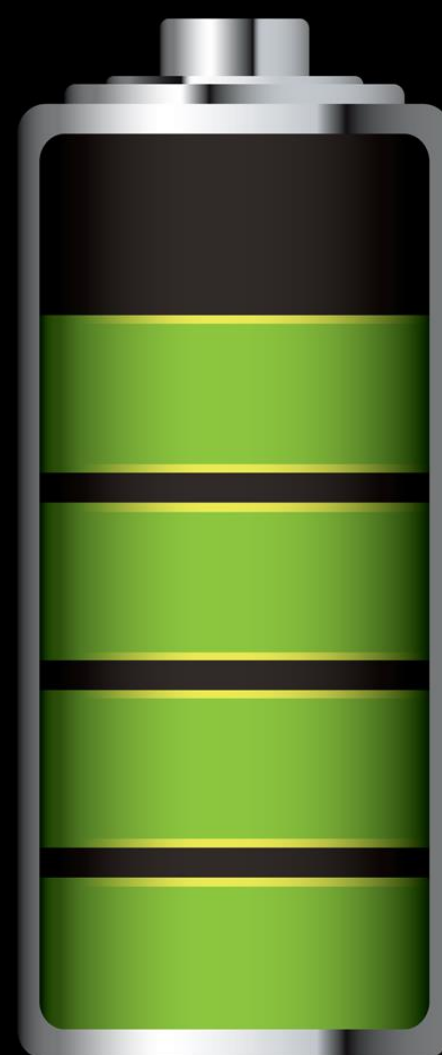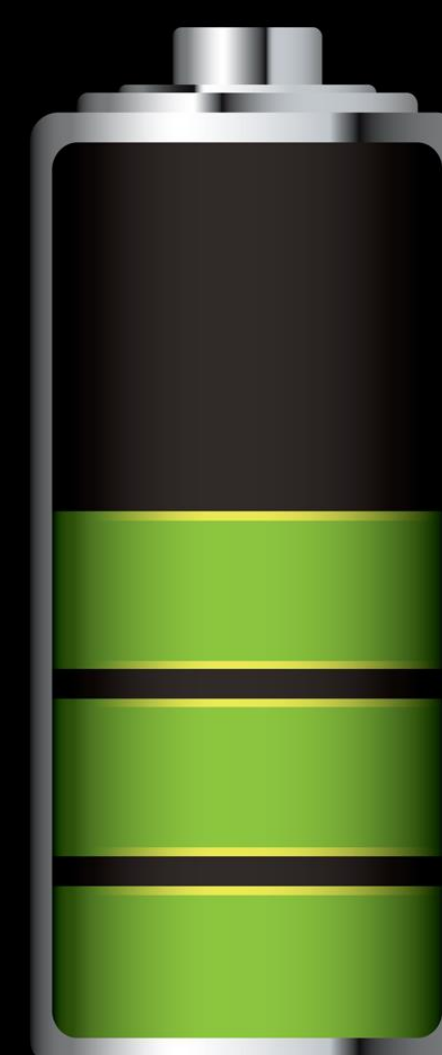 4: < 25%
- Species (basic density kg/m³)
  1: > 550
  2: > 450
  3: > 350
  4: < 350

Worst rating of three quality indicators is put on the product description label

Hog Fuel Class Description Product Sheet

| Description Date: | | Company Name: | |
| Assessor Name: | | Location: | |

Class
4A-54

Label	
Contaminants	4
White wood	3
Species	1
Sizing	A
MC	54

Contaminants:	Cobbles - Heavy	
		%

			User Type	Suitability
White wood	Stemwood	59		
Other tree parts	Branches	41	Co-gen (Large)	Poor
Species present:	Douglas-fir	100	Co-gen (Medium)	Poor
			Co-gen (Small)	Poor
			Pellets (Industrial)	Poor
Particle sizes	1mm to 10mm	70	Pellets (Residential)	Poor
	1mm to 10mm	20	Compost	Medium
			Animal Bedding	Poor
Moisture content	54		Surfacing	Medium
Origin:	Sawmill	100		

3. The right biomass product to the right utilization/market

Biomass Classifier

Class
3B-30

→ Moisture content

Particle size indicator
- A: < 10 mm
- B: < 50 mm
- C: < 100 mm
- D: > 100 mm

Quality number. Rating of 1 is the best, 4 is the worst.
- Contaminants (sand, clay, metal, rocks, paint)
  - 1: No contaminants
  - 2: Light contamination
  - 3: Medium contamination
  - 4: Heavy contamination
- White wood (% of white wood in supply)
  - 1: > 75%
  - 2: > 50%
  - 3: > 25%
  - 4: < 25%
- Species (basic density kg/m³)
  - 1: > 550
  - 2: > 450
  - 3: > 350
  - 4: < 350

Worst rating of three quality indicators is put on the product description label

Hog Fuel Class Description Product Sheet

Description Date:		Company Name:	
Assessor Name:		Location:	

Class
3B-30

Label	
Contaminants	1
White wood	3
Species	2
Sizing	B
MC	30

		%		
Contaminants:	None			
White wood	Stemwood	60	User Type	Suitability
Other tree parts	Branches	40	Co-gen (Large)	Good
Species present:	Lodgepole pine -	100	Co-gen (Medium)	Good
			Co-gen (Small)	Medium
			Pellets (Industrial)	Medium
Particle sizes	25mm to 50mm	70	Pellets (Residential)	Poor
	25mm to 50mm	20	Compost	Good
			Animal Bedding	Good
Moisture content	30		Surfacing	Good
Origin:	DDC Chipper	100		

3. The right biomass product to the right utilization/market

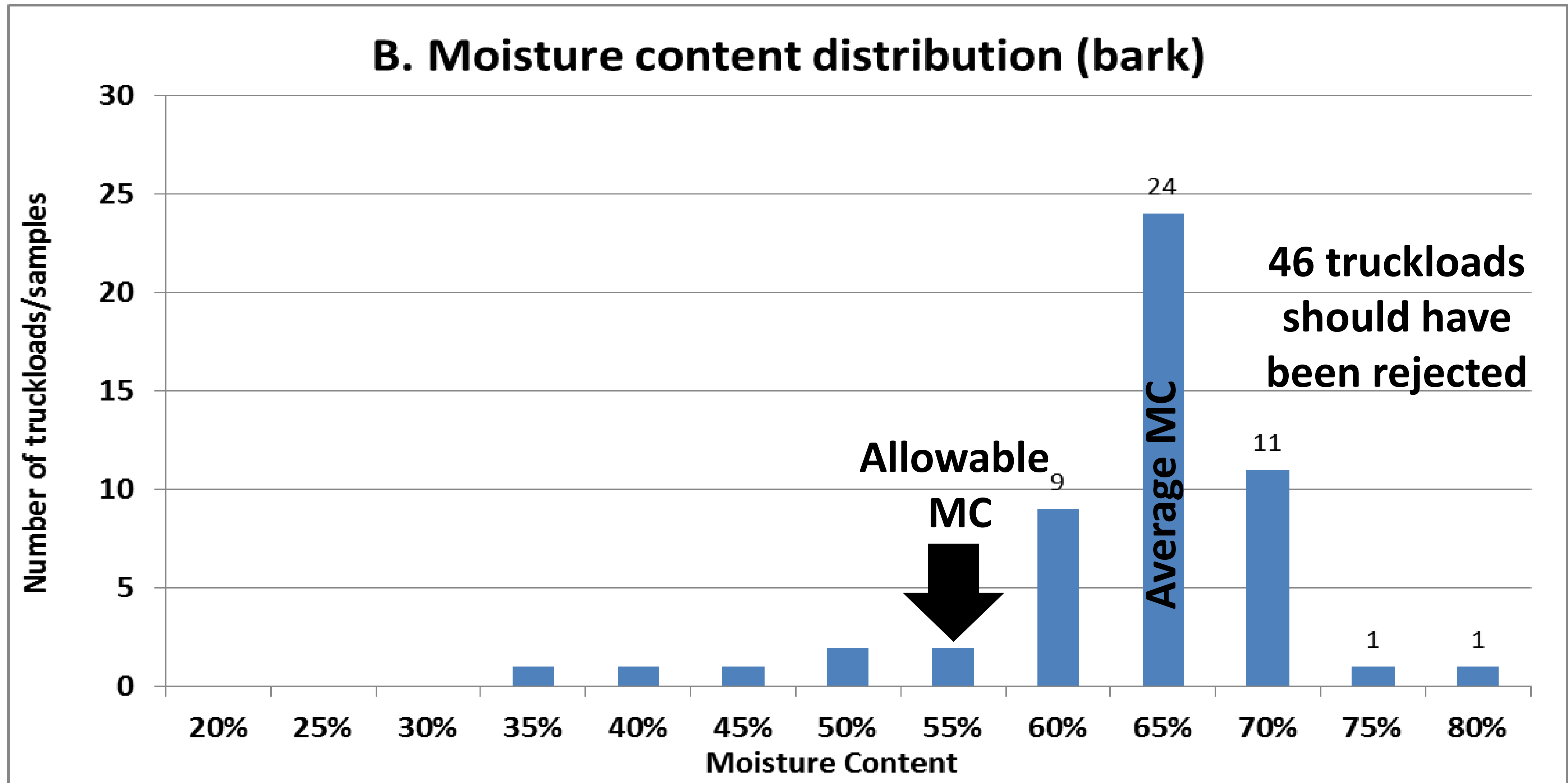## BIOMASS QUALITY CONTROL – WHAT GETS MEASURED GETS DONE!

A. Moisture content distribution (chips)

3. The right biomass product to the right utilization/market
BIOMASS QUALITY CONTROL – WHAT GETS MEASURED GETS DONE!

B. Moisture content distribution (bark)

46 truckloads should have been rejected

Allowable MC

Average MC

3. The right biomass product to the right utilization/market

BIOMASS QUALITY CONTROL – WHAT GETS MEASURED GETS DONE!

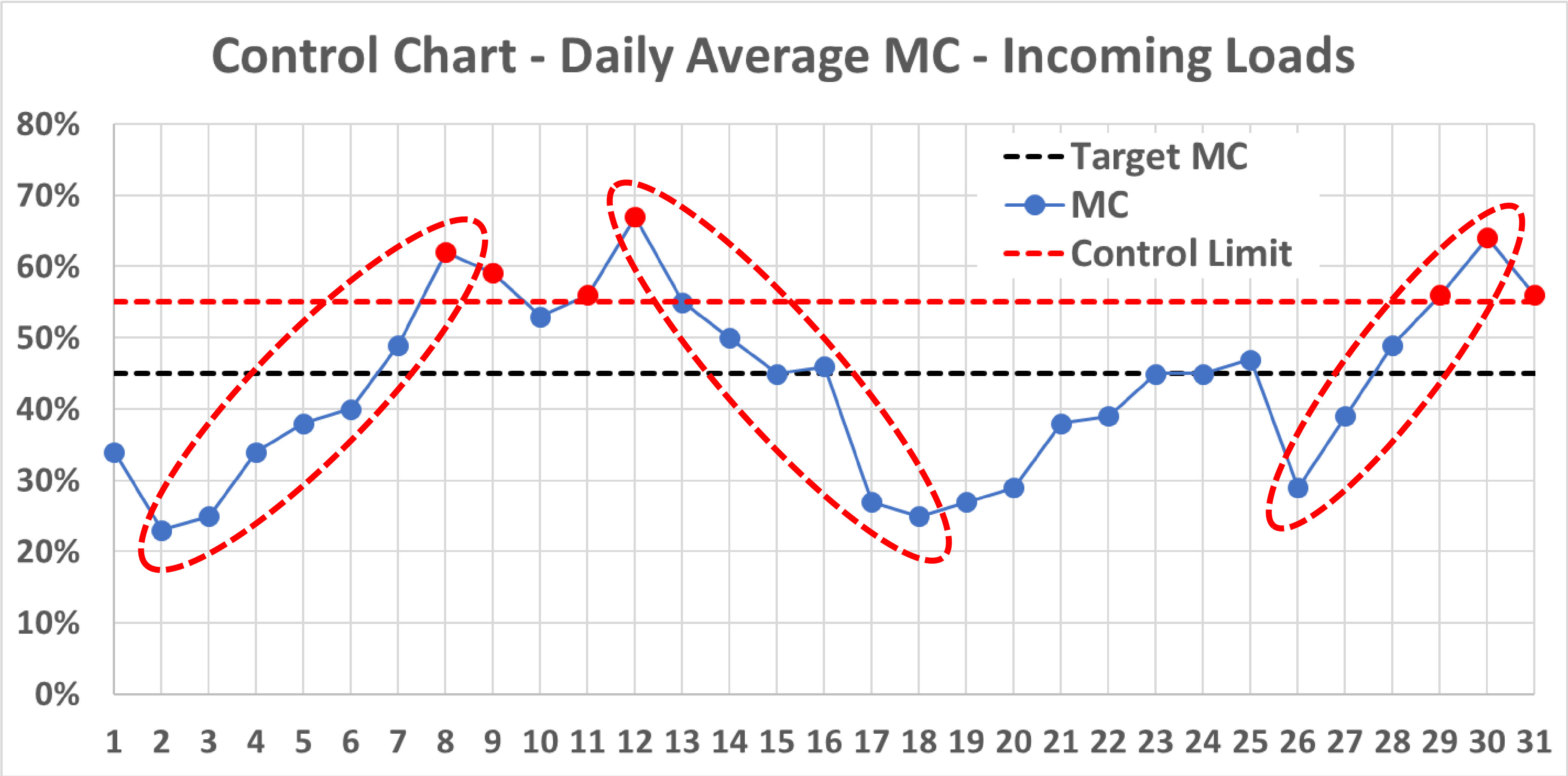Control Chart - Daily Average MC - Incoming Loads
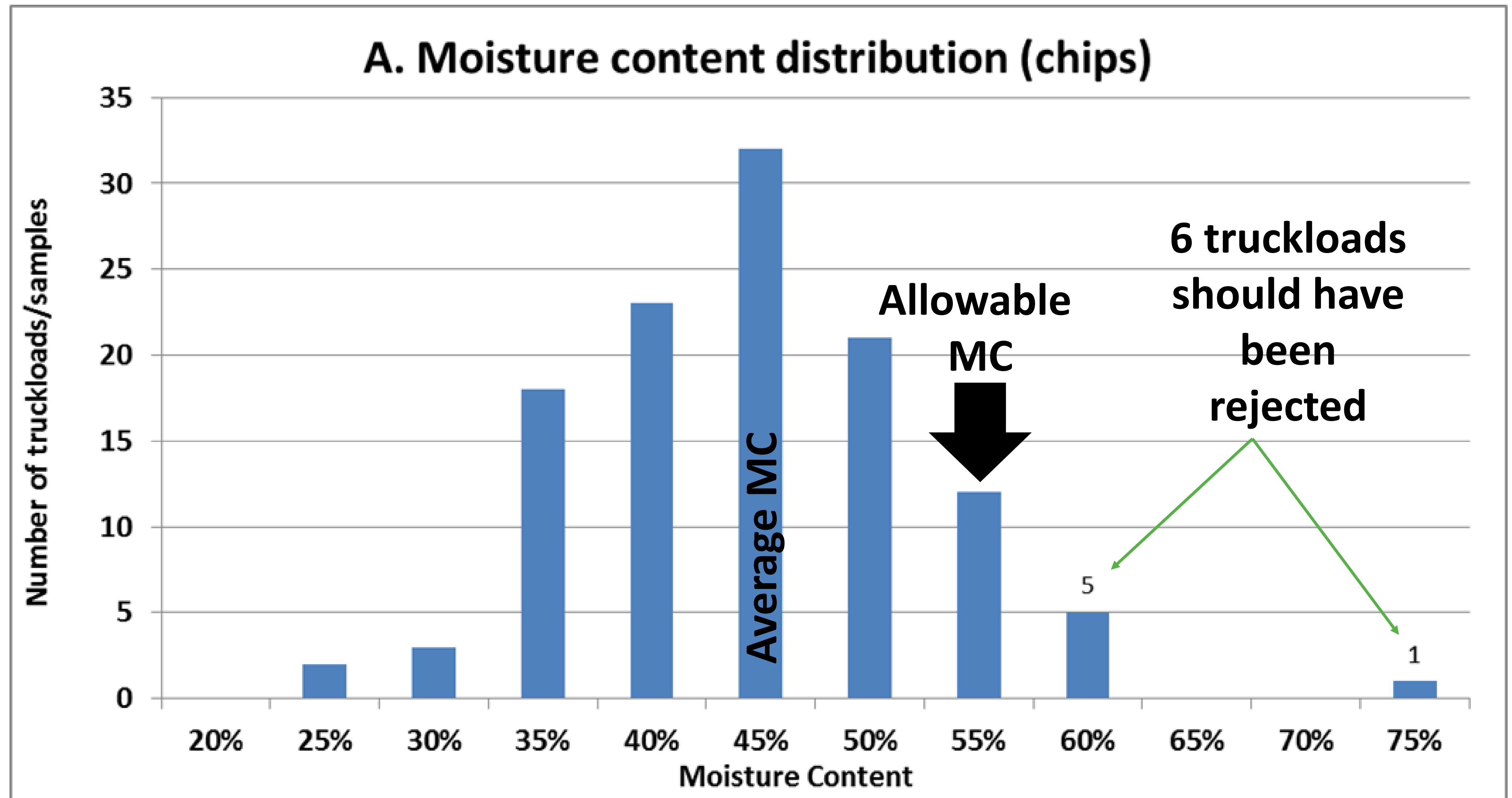
4. Examples of biomass energy systems: Biomass Power

**60 MW Power Plant
Williams Lake, BC**

4. Examples of biomass energy systems: Biomass Heat

Biomass District Heating
System, Revelstoke, BC
1.5 MW, 2.3 km pipe
network

Photo credits: fvbenergy.com

4. Examples of biomass energy systems: Biomass Heat

Alkali Lake, BC
- **Firewood Operation**
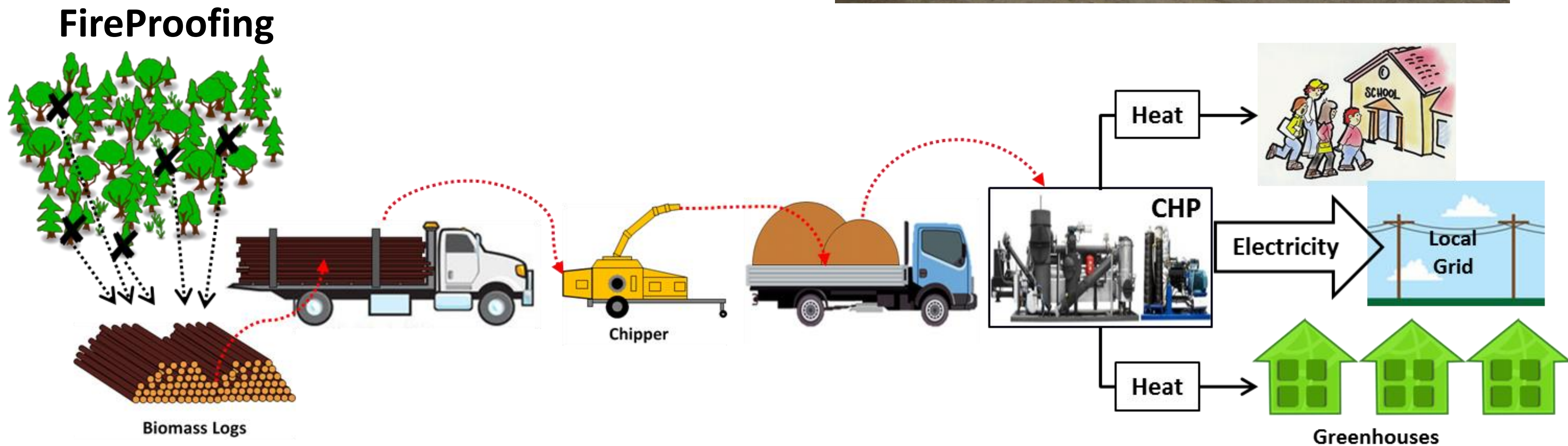- **Chipping Operation**
- **Biomass District Heating**

4. Examples of biomass energy systems: CHP

Fort Ware, BC
- **Biomass from FireProofing the community**
- **Chipping operation**
- **3 units x 45kWel Combined Heat and Power**

FireProofing

4. Examples of biomass energy systems: CHP

January 16th, 2020 - Commissioning of the 45 kWel FPInnovations/NRC Biomass CHP Demo Unit, Vancouver

4. Examples of biomass energy systems: CHP

Q1 2021 – Planned commissioning in off-grid community of Kluskus, BC

Main line 235m

Side arm 25m

Cultural center

CHP location

Google

Other off-grid communities are interested in project

5. CONCLUSIONS

- **Biomass is a product not a waste → Treat with respect!**
- **Biomass quality is important, especially for smaller energy systems**
- **Bio-energy systems exist but before purchasing them:**
  - **Ask manufacturers about biomass specs**
  - **Feasibility study**
  - **Biomass supply study**
- **Biomass quality can make or break a biomass project → a <u>biomass quality control system</u> should be put in place for both suppliers and users of biomass**

FPInnovations

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