

Pulp and Paper Industry Energy Bandwidth Study

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Summary

Identified Distribution of Energy Used in Pulp and Paper Industry

- Six major mill areas: 85% of the 1,606 TBtu used in manufacturing
- Kraft pulping, bleached and unbleached: 57% of the pulp production but 78% of the energy consumed for pulp production

Significant Energy Reduction Possible, Comparing Current Energy Consumption With:

- Best Available Technology (BAT)
- Practical Minimum
- Theoretical Minimum energy consumption

Summary

By Applying BAT – Current Design Practices for the Most Modern Mills:

- 26% reduction in energy consumption (versus current)
- 48% reduction in purchased fossil fuel
- 46% reduction in purchased energy

Potential Energy Savings (Bandwidth) Between BAT and Practical Minimum:

- Paper Drying – 57% (versus BAT)
- Liquor Evaporation – 27%
- Lime Kiln – 35%

Approach

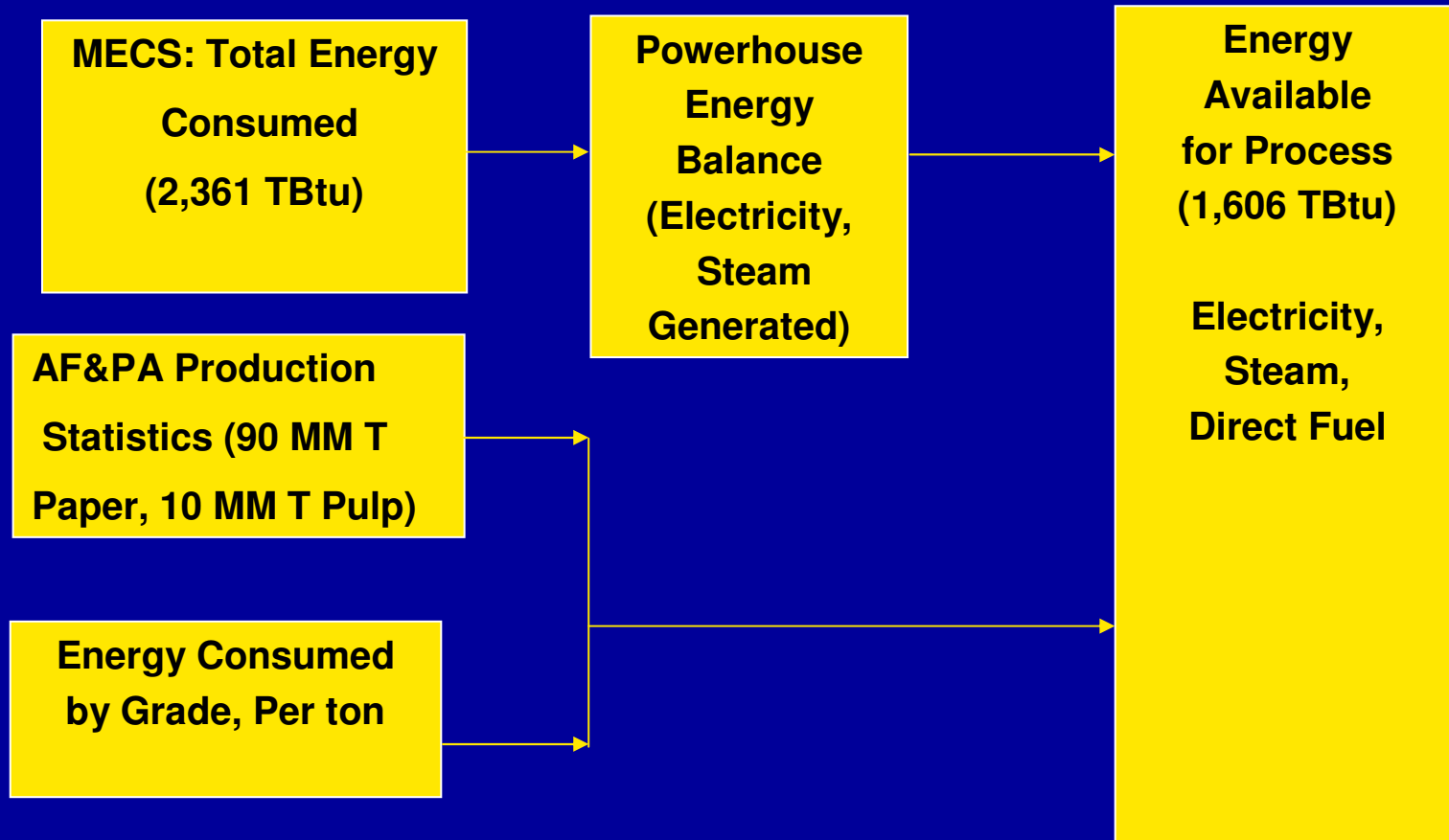
- Current Average Energy Consumption
 - MECS*: domestic energy consumption by energy source
 - AF&PA: tonnage by pulp type and paper grade
 - Published energy use/ton data for specific unit operations

*2002 Manufacturing Energy Consumption Survey (MECS), Energy Information Administration (EIA), Department of Energy (DOE)

Approach

- “Best Available Technology” - Published data for modern/ model mills
- “Practical Minimum” - Use of developing technologies (drying, black liquor evaporation, kiln)
- “Theoretical Minimum” - Theoretical energy requirement

Approach



2002 MECS Energy Consumed

Energy Consumed, Paper Industry

	TBtu	%
Net Electricity	223	9.4
Coal	234	9.9
Residual Fuel Oil	100	4.2
Distillate Fuel Oil	13	0.6
Natural Gas	504	21.3
LPG & NGL	6	0.3
Coke and Other*	1,281	54.3
Total Energy	2,361	100.0

MECS, Selected By-Products

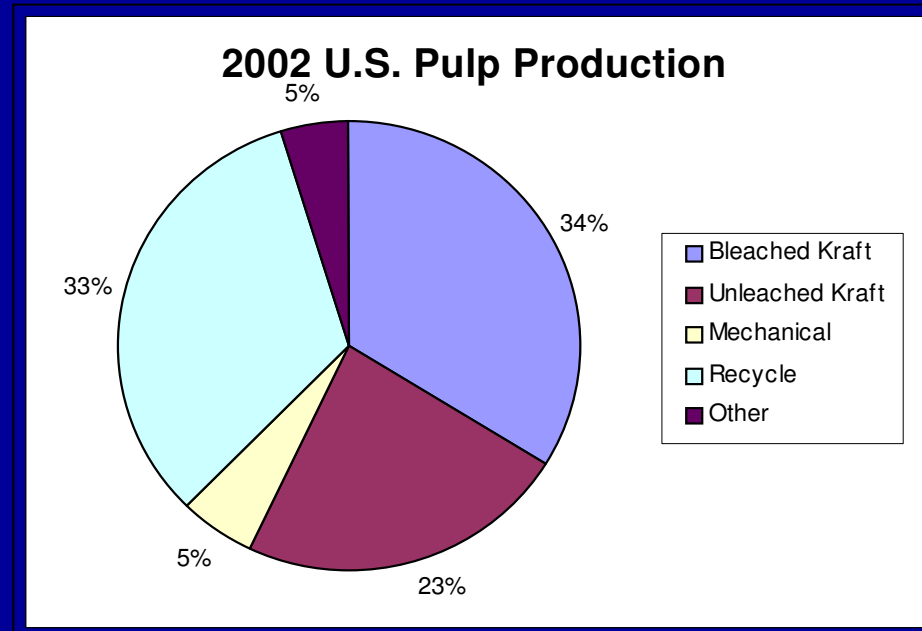
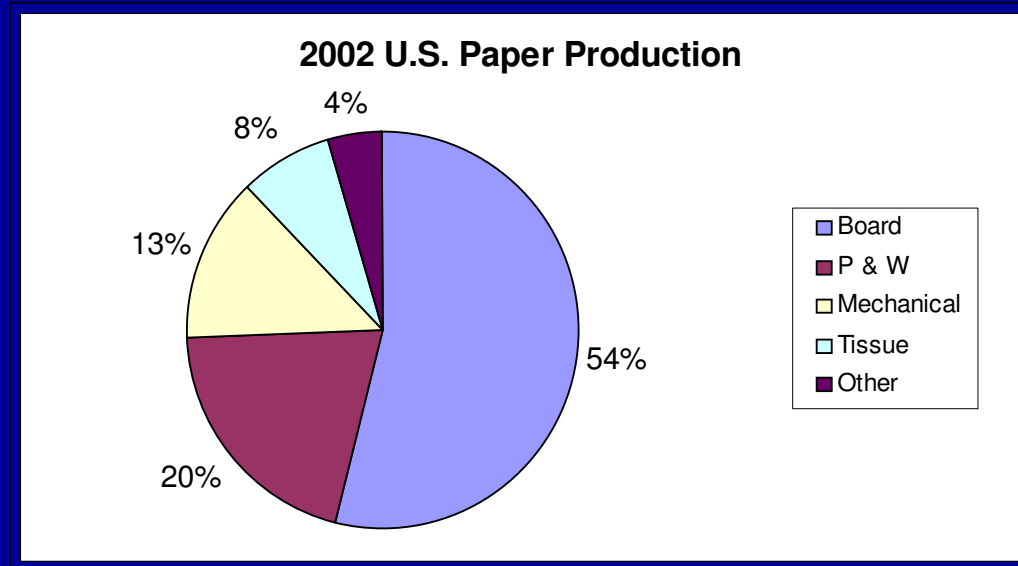
Type	TBtu
Waste Gas	1
Waste Pulp Liquors	820
Wood and Bark	316
Other By Products	21
Total	1,158

* Includes MECS, Selected By-Products plus Pet Coke, TDF, etc.

AF&PA Year 2002 Shipments and Pulp Production

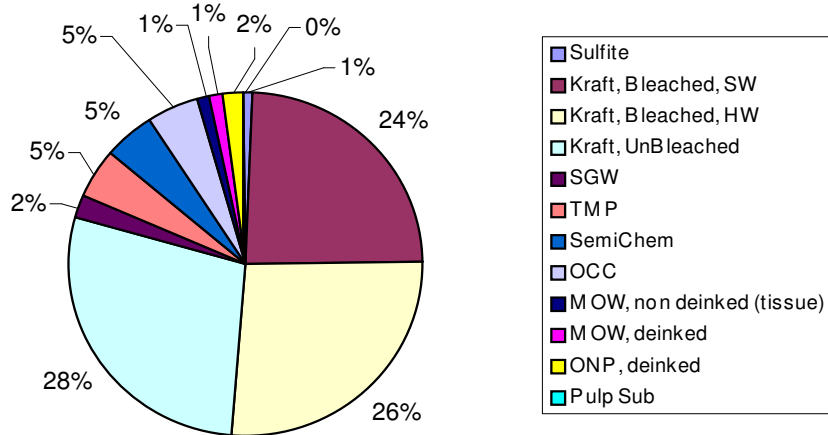
Paper Product	(1,000 tons)	% of Total
Corrugating Medium	9,806	9.9
Linerboard	23,509	23.6
Recycled Board	2,062	2.1
Gypsum Board	1,429	1.4
Folding Boxboard	4,729	4.8
Bleached Folding Boxboard / Milk	6,346	6.4
Other Board, unbleached	247	0.2
Kraft paper	1,545	1.6
Special Industrial	2,323	2.3
Newsprint	5,784	5.8
Groundwood Specialties	1,668	1.7
Coated Groundwood	4,481	4.5
Bleached Packaging	291	0.3
Bleached Bristol	1,350	1.4
Uncoated Freesheet	12,428	12.5
Coated Freesheet	4,481	4.5
Other Specialties	83	0.1
Tissue & Towel	7,127	7.2
Subtotal	89,687	90.1

Paper Product	(1,000 tons)	% of Total
Kraft Pulp, bleached	8,153	8.2
Kraft Pulp, unbleached	na	na
Sulfite Pulp	na	na
Recycled Pulp	na	na
Other Pulp / Dissolving Pulp	1,705	1.7
Subtotal Pulp	9,858	9.9
Subtotal Paper	89,687	90.1
Total	99,545	100.0

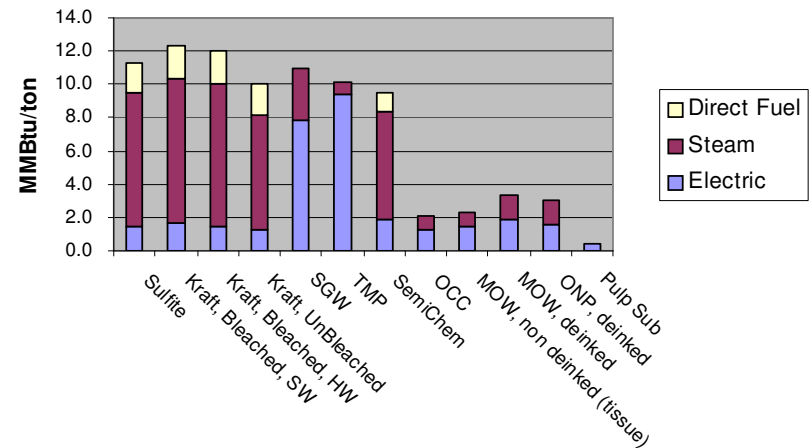


Energy Use by Pulping Process and Energy Type

U.S. P&P Energy Use by Pulping Process



Pulp Mill Energy Use by Type

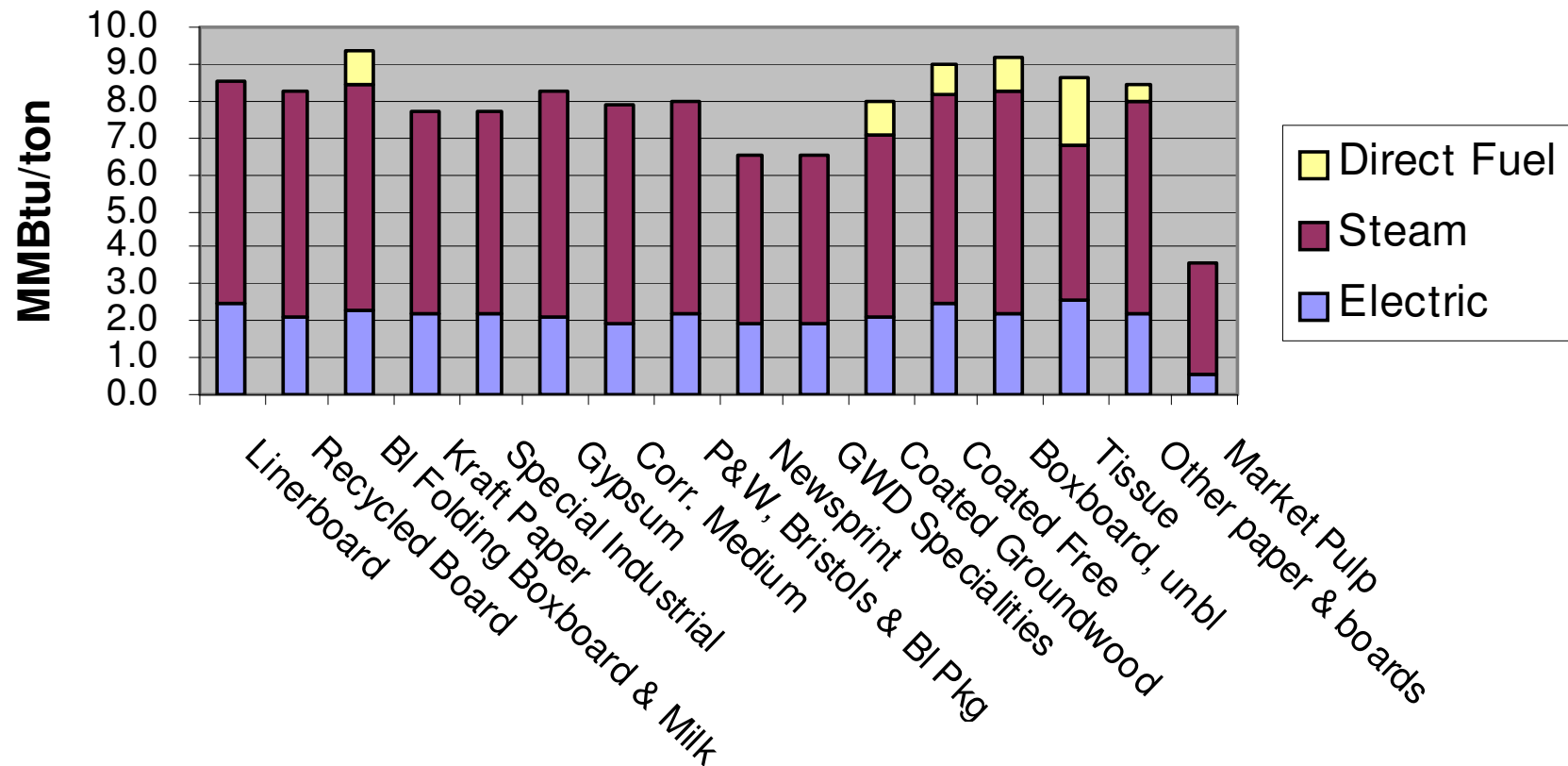


Kraft Pulping, Bleached and Unbleached:

- 57% of the pulp production
- 78% of the energy consumed for pulp production

Energy Use by Grade and Energy Type

Papermaking Energy Use by Grade



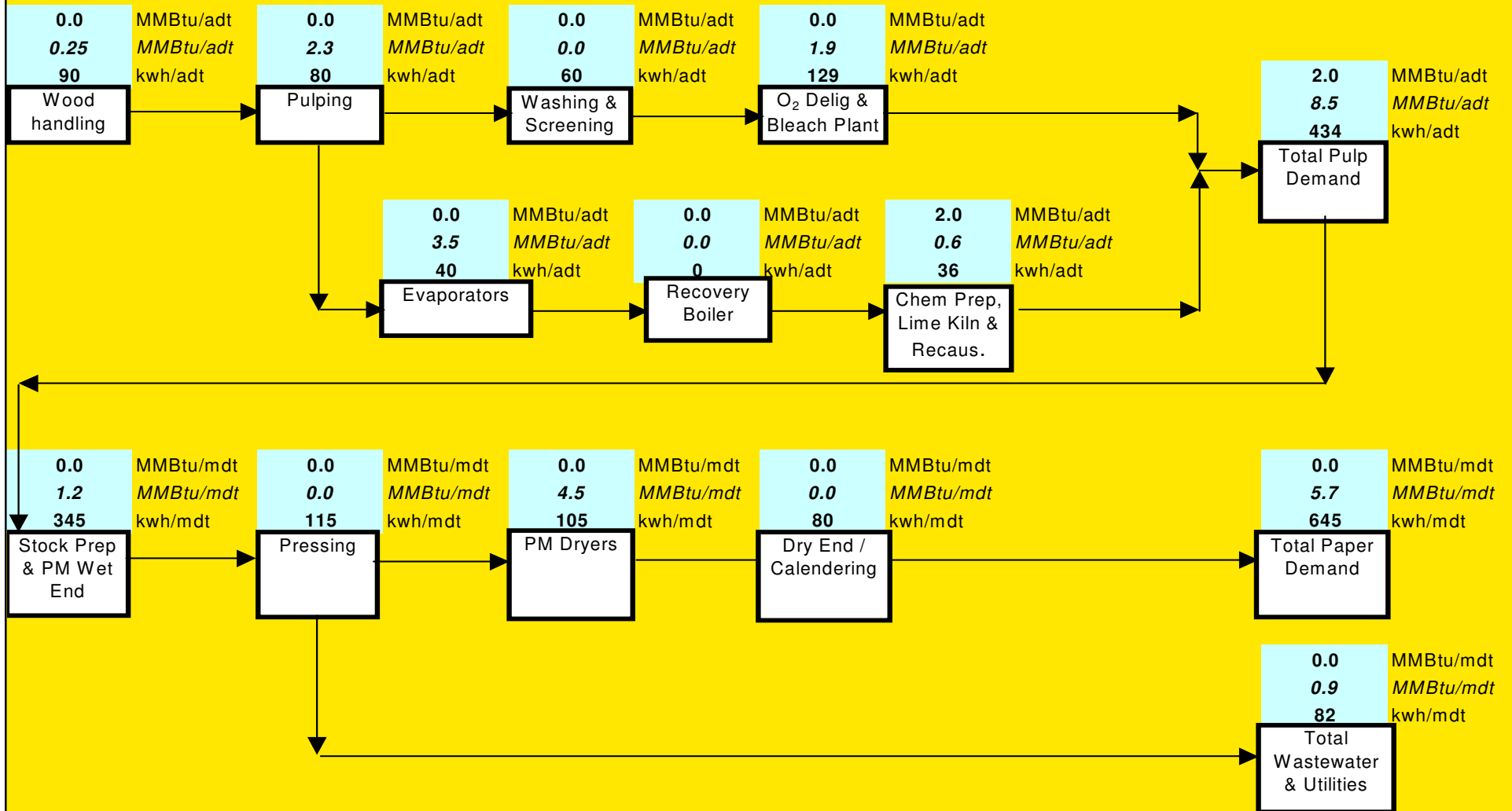
Energy Distribution – Average Case

	Elec kWh/t	Elec MMBtu/t	Steam MMBtu/t	Direct Fuel MMBtu/t	Production 1000 t/yr	Production %	Elec Million kWh	Electric TBtu	Steam TBtu	Direct Fuel TBtu	Total TBtu
Sulfite	434.3	1.5	8.00	1.78	532	0.6%	231	0.8	4.3	0.9	6.0
Kraft, Bleached, SW	484.0	1.7	8.74	1.97	13,848	16.0%	6,702	22.9	121.0	27.3	171.2
Kraft, Bleached, HW	434.3	1.5	8.53	1.97	15,404	17.8%	6,690	22.8	131.4	30.4	184.6
Kraft, UnBleached	372.3	1.3	6.84	1.87	19,917	23.0%	7,415	25.3	136.3	37.3	198.9
SGW	2,283.3	7.8	3.16		1,416	1.6%	3,233	11.0	4.5	0.0	15.5
TMP	2,761.1	9.4	0.74		3,264	3.8%	9,012	30.7	2.4	0.0	33.2
SemiChem	564.6	1.9	6.42	1.17	3,547	4.1%	2,003	6.8	22.8	4.2	33.8
OCC	372.3	1.3	0.84		16,683	19.3%	6,211	21.2	14.1	0.0	35.2
MOW, non deinked (tissue)	434.3	1.5	0.84		3,658	4.2%	1,589	5.4	3.1	0.0	8.5
MOW, deinked	558.4	1.9	1.47		2,021	2.3%	1,129	3.9	3.0	0.0	6.8
ONP, deinked	465.3	1.6	1.47		4,442	5.1%	2,067	7.1	6.5	0.0	13.6
Pulp Sub	111.7	0.4			1,705	2.0%	190	0.6	0.0	0.0	0.6
Sub Total					86,437	100.0%	46,472	158.6	449.3	100.2	708.0
Linerboard	713.5	2.4	6.11		23,509	23.6%	16,774	57.2	143.6	0.0	200.8
Recycled Board	620.5	2.1	6.11		2,061	2.1%	1,279	4.4	12.6	0.0	17.0
BI Folding Boxboard & Milk	682.5	2.3	6.11	0.89	6,346	6.4%	4,331	14.8	38.7	5.6	59.2
Kraft Paper	651.5	2.2	5.47		1,545	1.6%	1,006	3.4	8.5	0.0	11.9
Special Industrial	651.5	2.2	5.47		2,323	2.3%	1,514	5.2	12.7	0.0	17.9
Gypsum	620.5	2.1	6.11		1,429	1.4%	886	3.0	8.7	0.0	11.7
Corr. Medium	558.4	1.9	6.00		9,806	9.9%	5,476	18.7	58.8	0.0	77.5
P&W, Bristols & BI Pkg	645.3	2.2	5.75		14,069	14.1%	9,078	31.0	80.9	0.0	111.9
Newsprint	558.4	1.9	4.63		5,784	5.8%	3,230	11.0	26.8	0.0	37.8
GWD Specialities	558.4	1.9	4.63		1,668	1.7%	931	3.2	7.7	0.0	10.9
Coated Groundwood	620.5	2.1	4.95	0.89	4,481	4.5%	2,780	9.5	22.2	4.0	35.6
Coated Free	719.7	2.5	5.69	0.89	4,481	4.5%	3,225	11.0	25.5	4.0	40.5
Boxboard, unbl	639.1	2.2	6.11	0.89	4,729	4.8%	3,022	10.3	28.9	4.2	43.4
Tissue	744.6	2.5	4.21	1.87	7,127	7.2%	5,307	18.1	30.0	13.4	61.5
Other paper & boards	651.5	2.2	5.79	0.39	330	0.3%	215	0.7	1.9	0.1	2.8
Market Pulp	160.3	0.5	3.07		9,858	9.9%	1,581	5.4	30.3	0.0	35.7
Sub Total					99,545	100.0%	60,636	206.9	537.8	31.3	776.0
Wastewater & Utilities	81.9	0.3	0.95		99,545		8,153	27.8	94.3	0.0	122.1
Grand Total							115,260	393.3	1,081.4	131.4	1,606.1

Energy Use, Kraft P&W

Direct Fuel - MMBtu/t
 Steam - MMBtu/t
 Electricity - kwh/t

Pulp tons = adt
 Paper tons = mdt



Overall Distribution of Energy Used

	Electric		Steam		Direct Fuel	
	TBtu	%	TBtu	%	TBtu	%
Pulp Manufacture	158.6	40.3	449.3	41.5	100.2	76.2
Paper Manufacture	206.9	52.6	537.8	49.7	31.3	23.8
Utilities, excluding Powerhouse	27.8	7.1	94.3	8.7	0.0	0
Total Manufacturing	393.3 (24.5%)	100.0	1,081.4 (67.3%)	100.0	131.4 (8.2%)	100.0
Grand Total	1,606.1 (100.0%)					

- Pulping, papermaking, utilities
- Electricity, steam, direct fuel

Most Significant Energy Users – Current Average

Area	MECS Energy Consumption TBTtu	MECS Percent of Total %
Paper Drying	481	32.4
Paper Machine Wet End	211	14.2
Liquor Evaporation	195	13.1
Pulping Chemical Prep	140	9.5
Wood Cooking	149	10.0
Bleaching	80	5.4
Other Processes	228	15.4
Total Process	1,484 (100.0)	

**Six major mill areas: 85% of the 1,606 TBtu
used in manufacturing**

Best Available Technology

Total Energy Use – Average vs. BAT

Area	Total Energy Use 2002 MECS TBtu (% of total)	Total Energy Use BAT TBtu (% of total)	BAT Percent Change vs. MECS (%)
Paper Manufacturing	776 (32.9)	527 (30.1)	-32.1
Pulping	708 (30.0)	508 (29.0)	-28.2
Powerhouse Losses	755 (32.0)	592 (33.9)	-21.5
Misc. & Environmental	122 (5.1)	122 (7.0)	0.0
Total Industry Energy Consumption (Purchased and By-product Fuels)	2,361 (100.0)	1,749 (100.0)	-25.9

By applying BAT – current design practices for the most modern mills: energy consumption can be decreased by 26% versus current practice

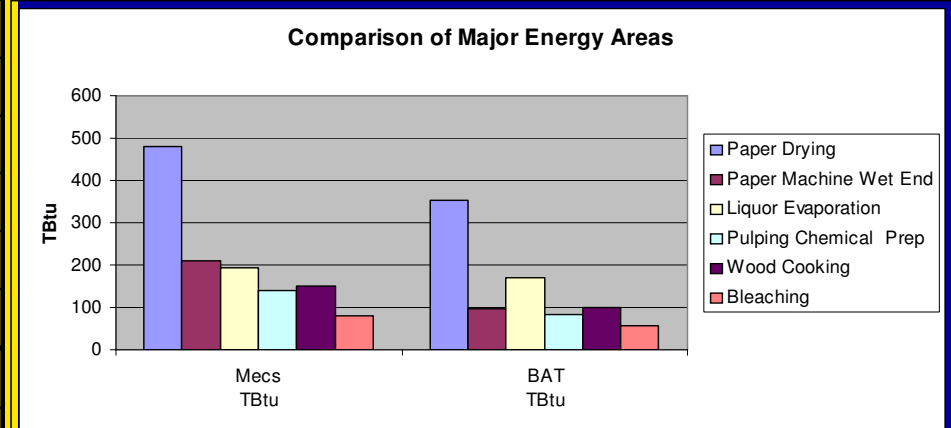
Total Energy Use – Average vs. BAT

Type	Total Energy Use by Type 2002 MECS TBtu (% of Total)	Total Energy Use by Type BAT TBtu (% of Total)	BAT Percent Change vs. MECS (%)
Direct Fuel	132 (8.2%)	104 (9.0%)	-21.1%
Electricity	393 (24.5%)	297 (25.7%)	-24.4%
Steam	1,081 (67.3%)	756 (65.3%)	-30.1%
Total Manufacturing	1,606 (100%)	1,157 (100%)	-28.0%
Powerhouse Losses	755	592	-21.5%
Total Industry	2,361	1,749	-25.9%

By applying BAT (current design practices for the most modern mills) : energy consumption can be decreased by 26%

Major Energy Users – Average vs. BAT

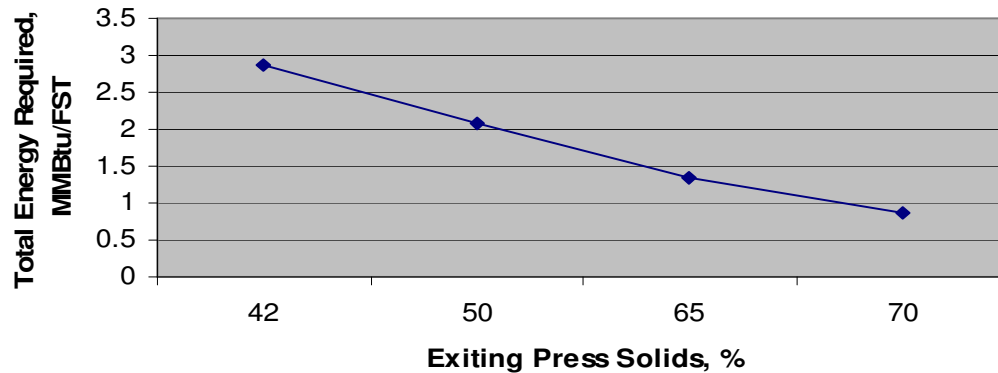
Area	Total Energy Use by Area 2002 MECS TBtu (% of Total)	Total Energy Use by Area BAT TBtu (% of Total)	BAT Percent Change vs. MECS (%)
Paper Drying	481 (32.4%)	354 (34.2%)	-26.4%
Paper Machine Wet End	211 (14.2%)	95 (9.2%)	-54.9%
Liquor Evaporation	195 (13.1%)	171 (16.5%)	-12.1%
Pulping Chemical Prep	140 (9.5%)	84 (8.1%)	-40.1%
Wood Cooking	149 (10.0%)	101 (9.8%)	-32.1%
Bleaching	80 (5.4%)	55 (5.3%)	-31.3%
Process Sub Total	1,256 (84.6%)	860 (83.1%)	-31.5%
Other Processes	228 (15.4%)	175 (16.9%)	-23.4%
Total Process	1,484 (100%)	1,035 (100%)	-30.3%
Environmental & Utilities	122	122	0
Total Manufacturing	1,606	1,157	-28.0%



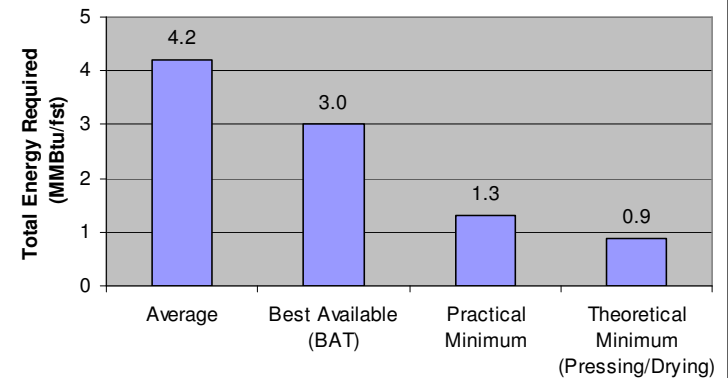
Practical Minimum

Paper Drying

Minimum Theoretical Drying Energy

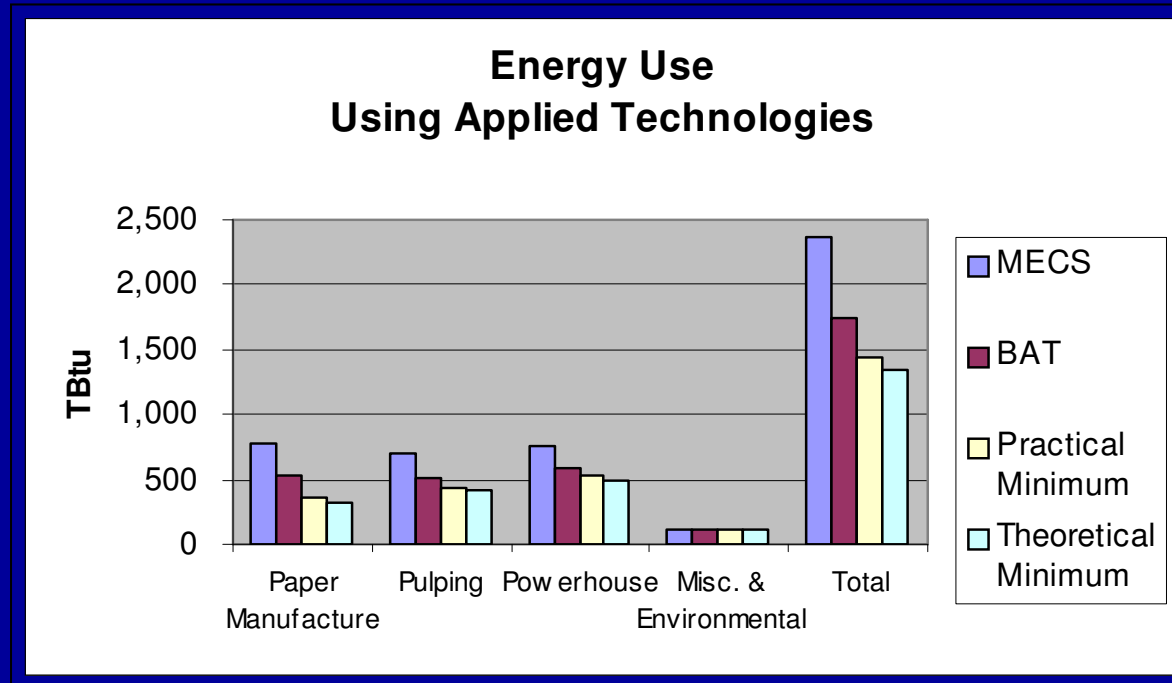


Bandwidth - Paper Drying



- BAT: press dewatering up to near 50% depending on BW, grade
- Practical Minimum: press dewatering to 65% solids followed by drying
- Theoretical Minimum: press dewatering to 70% solids
- 57% Potential energy savings (bandwidth) between BAT and Practical Minimum

Bandwidth, Overall Energy Reduction



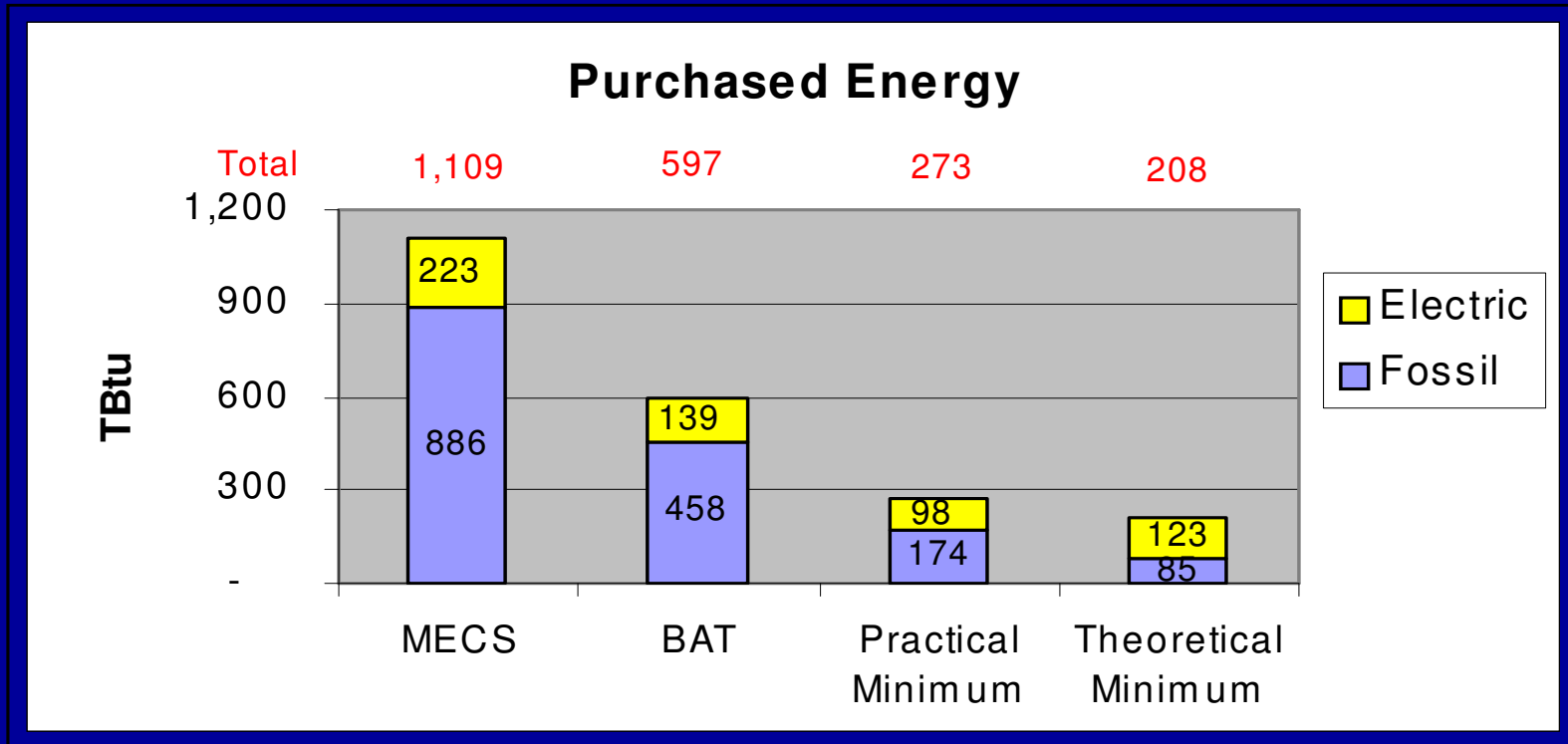
Significant energy reduction possible, comparing current energy consumption with:

- Best Available Technology (BAT) , Practical Minimum, Theoretical Minimum

Potential energy savings (bandwidth) between BAT and Practical Minimum:

- Paper Drying – 57% ; Liquor Evaporation – 27%;
Lime Kiln – 35%

Bandwidth, Reduction in Purchased Energy



By applying BAT—current design practices for the most modern mills:

- 48% reduction in purchased fossil fuel (versus MECS)
- 46% reduction in purchased energy

Practical Minimum: 80% reduction versus MECS

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Agenda 2020 Breakthrough Manufacturing

Pulping Process	Next Generation Technologies for Pulping and Bleaching	Reduce process energy consumption by at least 33% and/or produce same or better quality fiber at 5-10% higher yield
	Reduced Energy for Black Liquor Concentration	Reduce energy consumed in the process of increasing black liquor solids by at least 50%
	Reduced Energy for Causticizing	Develop lower-cost technology to replace the current (energy- and capital-intensive) causticizing process
Papermaking Process	Reduced Energy in Paper Dewatering/Drying	Reduce the energy consumed for paper dewatering, pressing and drying by at least 50%
	Increased Filler/Sustainable, Cost-Effective Pigments	Produce same or better quality paper products with three times the non-fiber filler content and using coating pigments derived from lower-cost, renewable raw materials
	Sheet Property Development Using Less Energy and Materials	Reduce energy consumed in the paper machine wet end by at least 33% and/or lower sheet basis weight by 15-20% while producing same or better performing products

Thank You

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