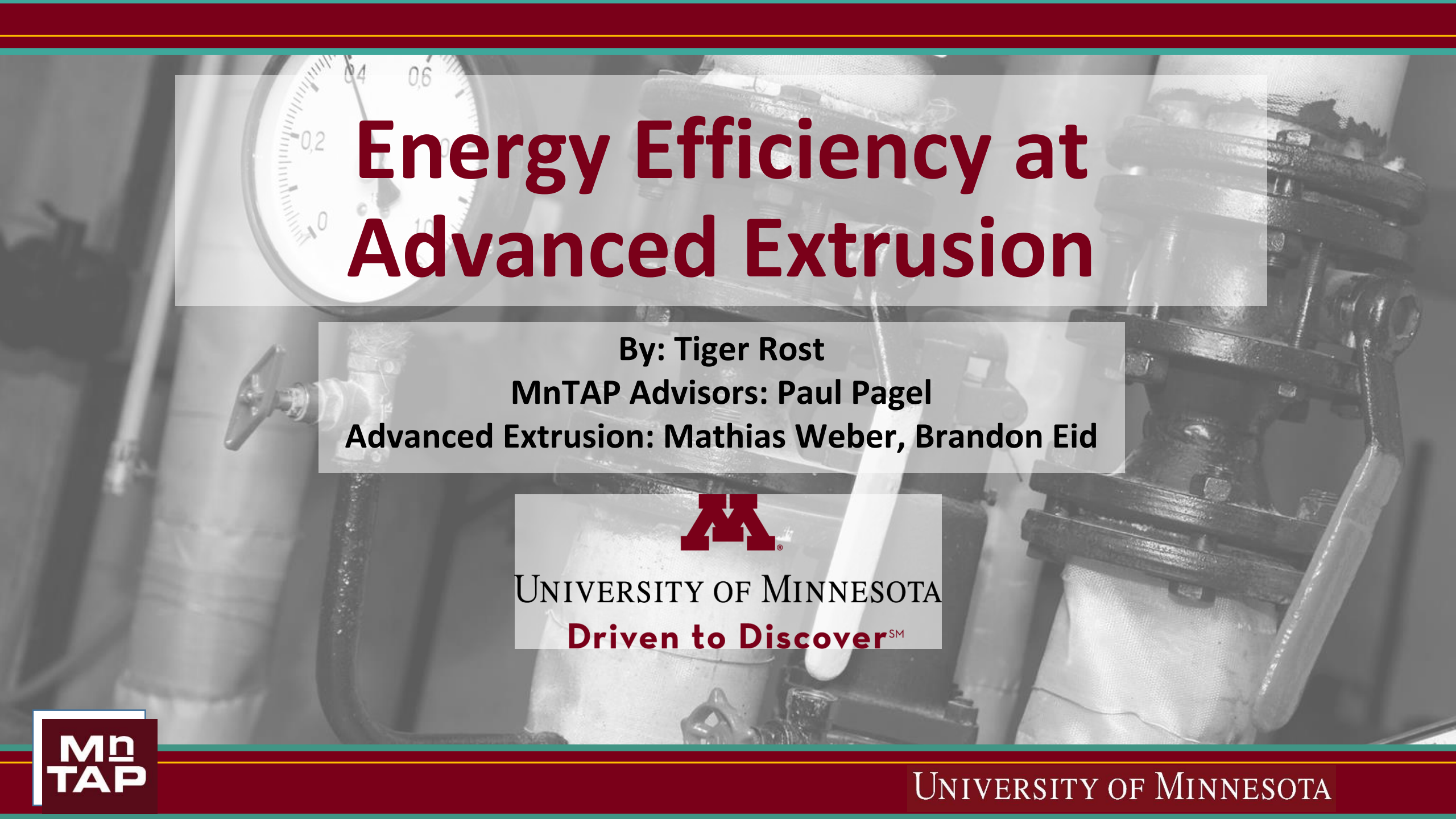
Energy Efficiency at Advanced Extrusion

By: Tiger Rost
MnTAP Advisors: Paul Pagel
Advanced Extrusion: Mathias Weber, Brandon Eid



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Company Background

- Business in Rogers, MN
- Specializes in polyethylene terephthalate (PET) extrusion
- PET sheets for food package manufacturing
- 14,500,000 kWh, 68 employees

ADVANCED EXTRUSION

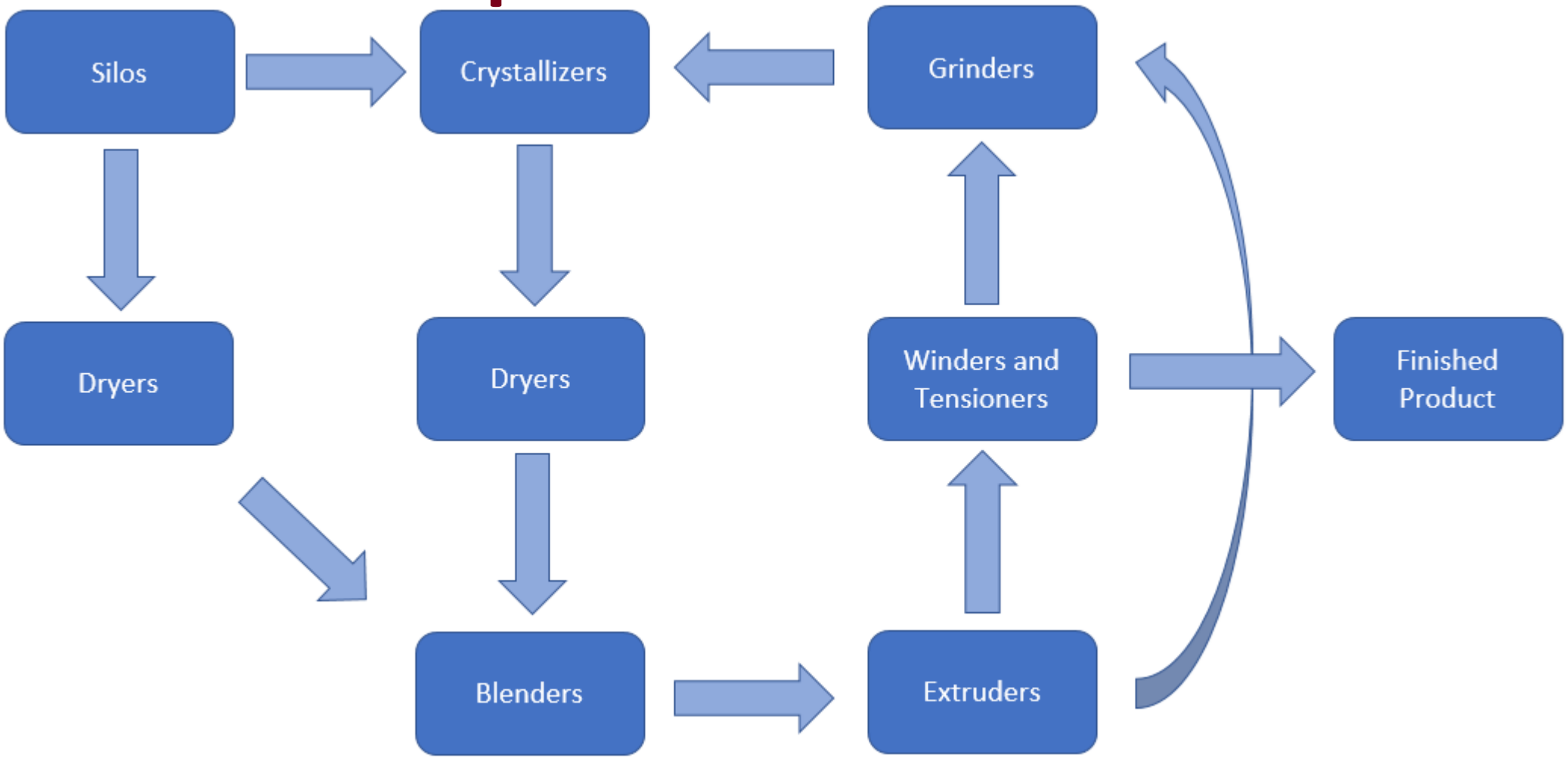
Process Description

Source: Noon-intl.com

Source: Alibaba.com

Source: Millikenchemical.com

Process Description

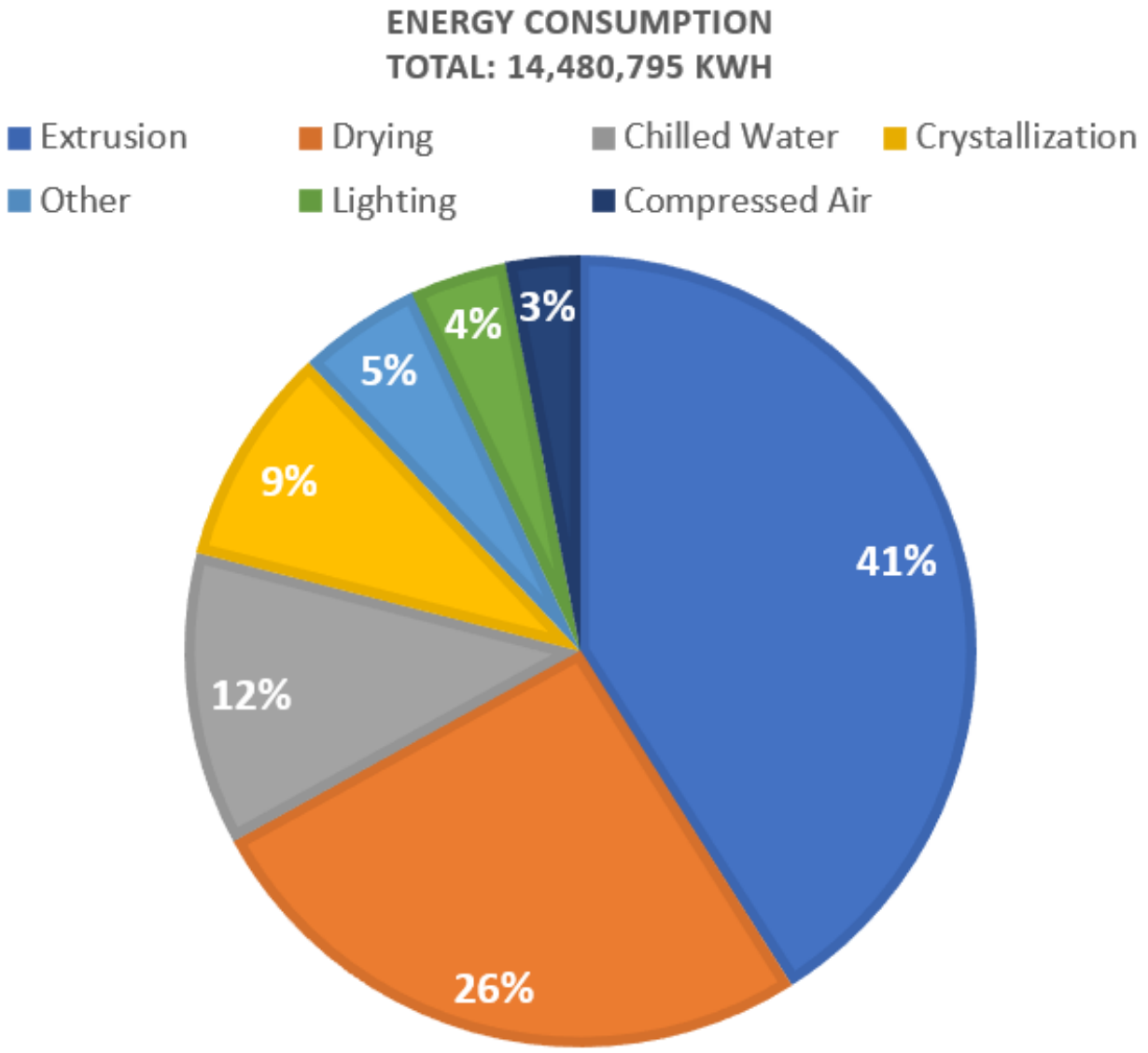


Project Overview

- Recommendations help reduce energy and keep company competitive
- Lower energy consumption reduces state generation needs, utility payer costs
- Xcel, Graphet already providing data
- MnTAP opportunities help utilize information

Energy consumption

- 30 million pounds produced per year
- $1,100,000 spent on electricity annually
- Extrusion and drying dominate electrical costs


ENERGY CONSUMPTION
TOTAL: 14,480,795 KWH
Extrusion
Drying
Chilled Water
Crystallization
Other
Lighting
Compressed Air
41%
26%
12%
9%
5%
4%
3%

Recommendation categories

- Lighting
- Heat losses and leaks
- Motors and drives
- Production setting optimization
- Equipment line upgrades
- Miscellaneous upgrades

Lighting

Recommended changes:

- Replace 32W fluorescents with 15W LED lamps
- Motion sensors (part of lighting retrofit)
- Emergency lighting (batteries)
- Exterior lighting

Lighting savings

Recommendations	Waste/energy reduced	Implementation cost (w/ rebates)	Annual savings	Payback period	Status
Lighting retrofit	374,000 kWh	$ 27,700	$ 29,900	11 months	Implementing
Exterior lighting	57,700 kWh	$ 15,900	$ 4,620	3.5 yrs	Recommended
Emergency lighting	N/A	$ 18,600	N/A	N/A	Implementing

Heat losses and leaks

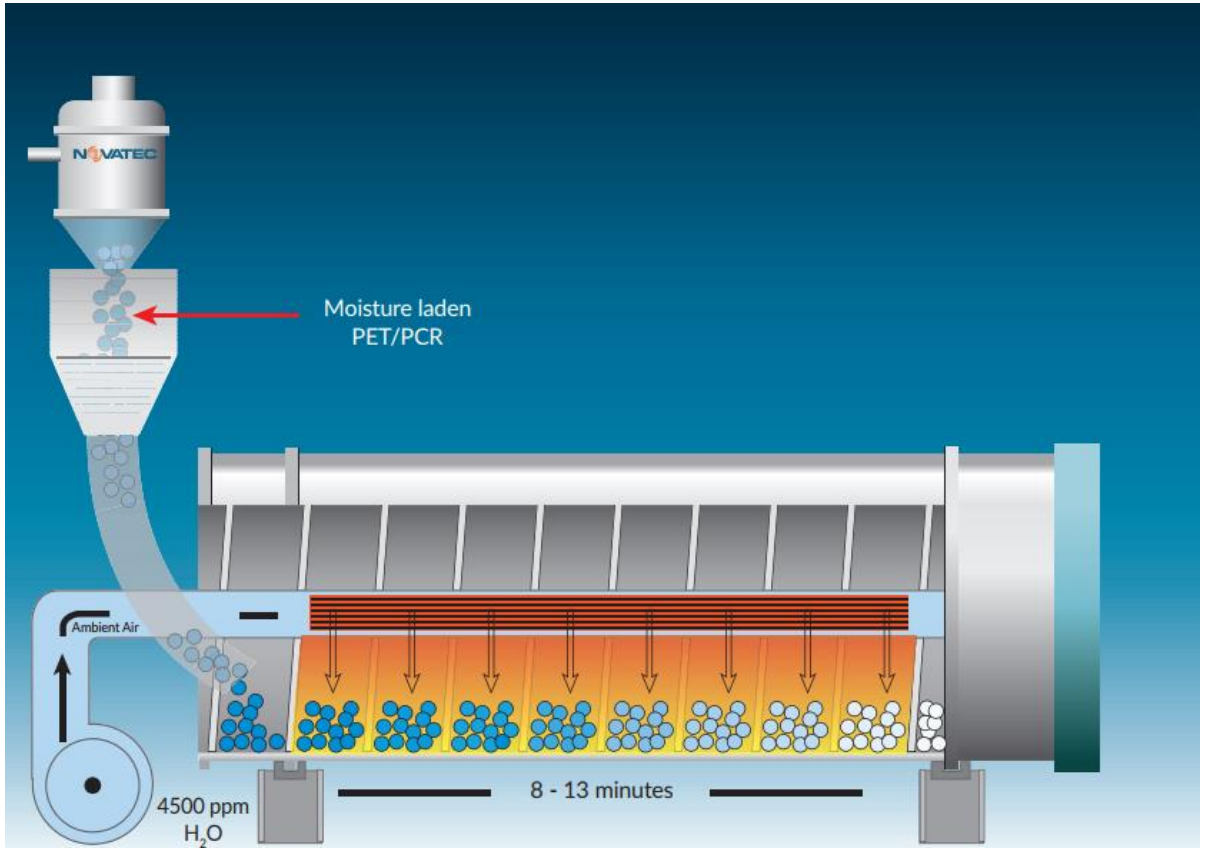
Recommended changes:

- Fixing heat losses and leaks
- Fixing compressed air and vacuum system leaks
- Reducing heat loss and dust from infrared dryer

Heat losses and leaks continued

Two parts:

- Insulation losses
  - Losing heat from conduction
- Mass transfer
  - Heating entirely new air from low temp. to process temp.
- Dryers cause most heat loss



Source: Novatec

Heat losses and leaks savings

Payback periods:

- Averages to half a year in payback
- Process air leaks the most costly

Recommendations	Waste/energy reduced	Implementation cost (w/ rebates)	Annual savings	Payback period	Status
Heat losses, leaks	622,000 kWh	$ 20,000	$ 49,800	9 months	Implementing
Compressed air, vacuum leaks	337,000 kWh	$ 4,000	$ 27,000	2 months	Implementing
Infrared dryer heat loss, leaks	178,000 kWh	$ 2,000	$ 14,300	2 months	Implementing

More efficient motors and drives

Motors

- Replace extruder DC motors with AC
- Attach VFDs to crystallizers
- Exchange motors for more efficient models
- Address grinding
- Change Line 6 DC to AC

Source: Baldor

Adding more efficient motors and drives

Motors

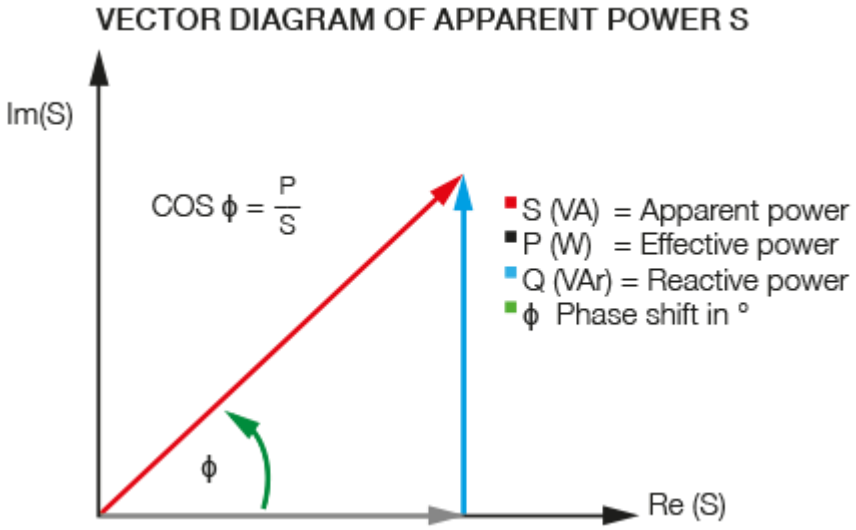
- At the right size:
  - Savings through efficiency upgrades
- Oversized:
  - Savings through re-sizing motor or drives
- Variable Frequency Drives (VFD)
  - Putting VFD will de facto “re-size”
- Larger motors have lower power factor at lower loads

variablefrequencydrive.org

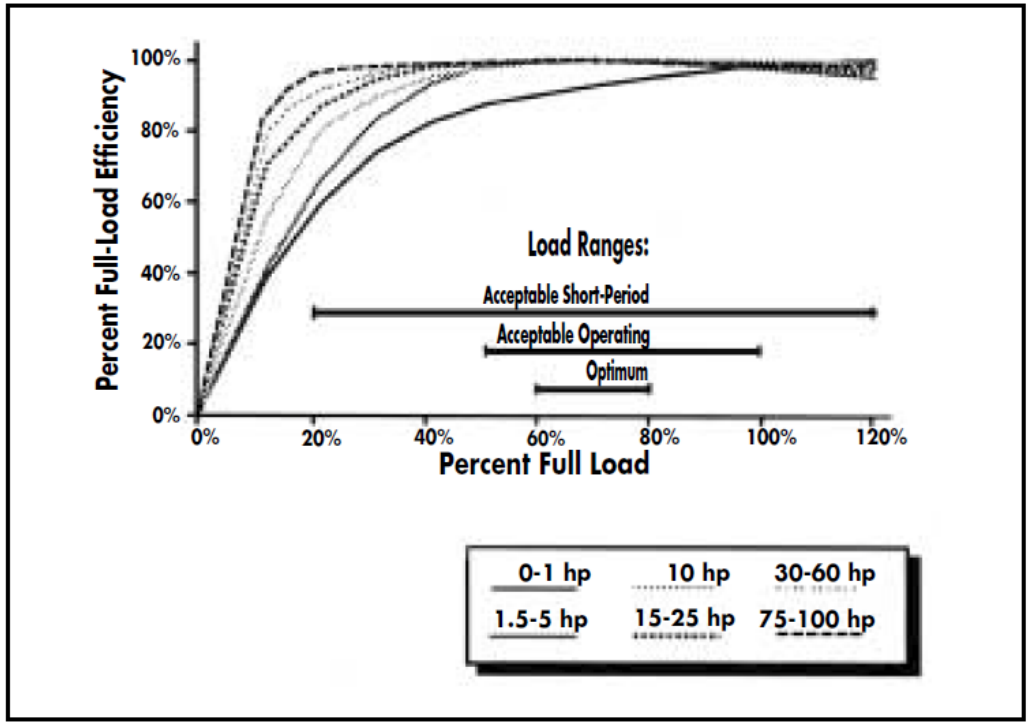
More efficient motors and drives

Motors

- Ideal motor load around 75-80%



Source: Toshiba Lighting Systems



Source: Physics Stack Exchange

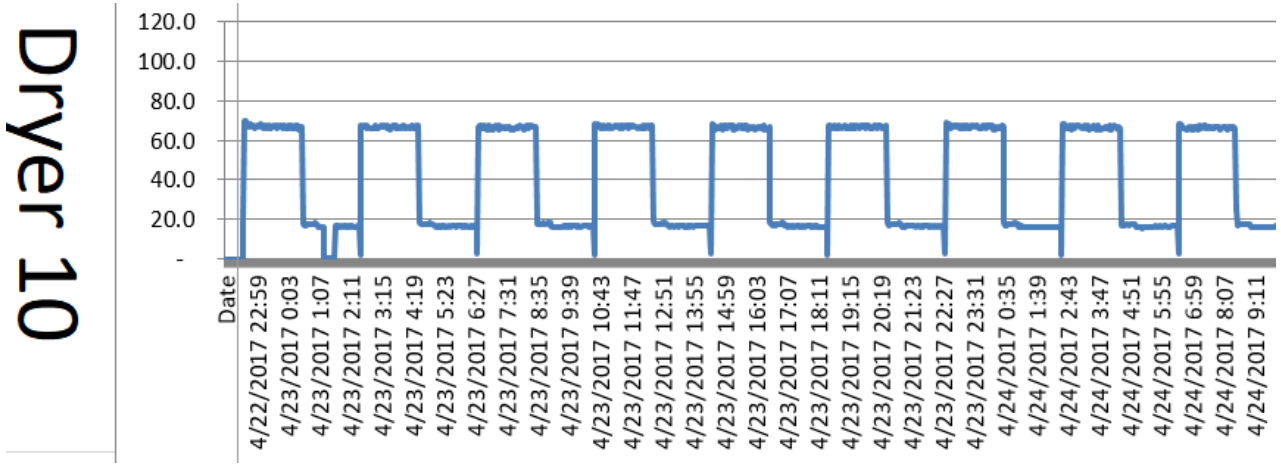
Motor and drive savings

Recommendations	Waste/energy reduced	Implementation cost (w/ rebates)	Annual savings	Payback period	Status
Replace extruder DC motors with AC	763,000 kWh	$ 21,300	$ 61,000	4 months	Recommended
Attach VFDs to crystallizers	898,000 kWh	$ 18,700	$ 71,800	3 months	Implementing
Convert motors to higher efficiency	181,000 kWh	$ 48,600	$ 14,500	3.4 yrs	Recommended
Address grinding	71,200 kWh	$ 2,070	$ 17,100	2 months	Recommended
Convert line 6 DC to AC motors	173,000 kWh	$ 4,200	$ 13,800	4 months	Recommended

Production setting optimization

Recommended changes:

- Lengthening regeneration cycle of dryer beds
- Changing crystallization process



Production savings

Paybacks:

- Instantaneous paybacks
- Requires making process changes to produced material
- Process changes risk altering material properties

Recommendations	Waste/energy reduced	Implementation cost (w/ rebates)	Annual savings	Payback period	Status
Lengthen dryer regen cycles	219,000 kWh	$ -	$ 17,600	Instant	Recommended
Changing crystallizing process	262,000 kWh	$ -	$ 21,600	Instant	Recommended

Equipment line upgrades

Recommended changes:

- Using compounders to create pellets from raw materials
  - Alternatively, combine PET with additives
- High vacuum twin screw extrusion (HVTSE)

Source: PTi Extruders

Equipment line savings

Compounding:

- Waiting on specific quotes for compounding costs
- Compounding can save $9,000,000 potentially for PET
- Self-compounding eliminates mark-up
  - Material costs dominate, not energy

Equipment line savings

High vacuum twin screw extrusion (HVTSE):

- HVTSE can reduce energy costs by 30-40% by eliminating need for drying and crystallization
- HVTSE saves $405,000 annually (5,000,000 kWh), but costs $2,500,000 per line installation ($10,000,00 total)
  - Improved throughput, material variety

Miscellaneous

Recommended changes:

- Curtailment
- Improving dust collection and ventilation

Miscellaneous

Paybacks:

- Other opportunities are instantaneous
- Many do not save energy, but address finances

Recommendations	Waste/energy reduced	Implementation cost (w/ rebates)	Annual savings	Payback period	Status
Curtailment	N/A	$ -	$ 62,600	Instant	Recommended
Improving dust collection	N/A	$ -	N/A	N/A	Implementing

Conclusions

Recommendations	Waste/energy reduced	Implementation cost (w/ rebates)	Annual savings	Payback period	Status
Lighting	432,000 kWh	$ 62,200	$ 34,500	1.8 yrs	Implementing
Heat losses and leaks	1,140,000 kWh	$ 26,000	$ 91,000	4 months	Implementing
Efficient motors and drives	2,090,000 kWh	$ 94,000	$178,000	7 months	Implementing
Changing production settings	481,000 kWh	$ -	$ 39,200	Instant	Recommended
Miscellaneous upgrades	N/A	$ -	$ 62,600	Instant	Implementing
Totals	4,143,000 kWh	$ 182,200	$405,300		

Personal Benefits

- Learned how to quantify opportunities into tangible paybacks
- Developed skills to pull information together from different sources
- Discovered the general processes in the background that drive energy consumption
- Practiced time management

Questions?