Reduce Your Energy Costs

Reduce your energy costs and their impact by using less energy

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- 38 years of experience in the plastics industry from maintenance technician, energy projects, service engineer, sales, sales manager, equipment representative

The purpose of this talk is action

- MAPP does a great job of supporting its membership with purchasing programs and technical content that they cannot always find on their own.
- My goal is to provide new information and to validate or clarify information that you may have heard.
- I had a person tell me that a training that they had attended was so powerful that they stopped by their plant on the way home on a Friday evening to apply some of the concepts. My goal would be to create that same level of excitement.

3 Ways to Save on Your Energy Bill

- Produce your own energy – This is a full topic in itself – Cogeneration, solar, wind….

3 Ways to Save on Your Energy Bill

- Spend less on the energy that you currently use. Electric rates are NOT going down, so…. Energy bill audits, engineering studies on energy used for production, demand charges, power factor correction. These are items that I can help with or discuss in more details after the talk.
    - Energy bill audits are typically free to conduct and then you will split the savings for a short period.
    - There is a look back period on this, so waiting really does hurt
    - Sales tax audits for energy used in production have similar rules with a better lookback this late in the year
    - Demand charges and power factor will be discussed in this talk

3 Ways to Save on Your Energy Bill

- Consume less energy in a kWh/kg produced metric – This is what this talk is about. The value of this metric will change from plant to plant for multiple reasons, but it is THE metric to measure your improvement.

Teach a manager to fish (or spot issues)

- Later in the presentation, we will get into specifics on certain technologies.
- The real goal of this session is to help managers identify “possible” opportunities to dig into and not to create subject matter experts.
- I will also cover how to identify green washing vs legitimate opportunities.
- We will learn to look for the “white lies” of the industry.

Greenwashing and White Lies

- Green washing
- Carbon washing
- White Lies
- ESG

Why do YOU want to save on energy costs

- It is important for you to determine your purpose for saving energy.
- If, for your company it is a straight money saving ROI investment, then it will need to follow the same rules as any other project.
- If you mix in any environmental concerns, it is easy to make a case for extending the payback some.
- Maybe your plant is nearing its capacity and reducing usage will be less expensive than adding power.
- A lot of times it can be low hanging fruit and it is one of the items in your control.

Definitions and concepts

- Power consumption in kWh
- Demand Charge – as it relates to your bill
- Efficiency vs. cost
- Energy efficiency vs. system efficiency
- kWh per kilogram produced
- There is a certain amount of “work” that has to be done by the electricity to process a kg of material. All else is waste.

Definitions and Concepts

- Bigger is NOT better. Right is better.
- All energy losses show up as heat somewhere.
- Improve the entire process
- Is that part of the process even needed?
- You can’t improve what you don’t measure. Getting a handle on your consumption is key.
- The best time to make an energy consumption improvement is when you already have to buy new equipment. At that point you are only justifying the delta. But you must be prepared.

Definitions and Concepts – Part Loading

- Reduce the amount of “work” that you do and then make sure your system rewards you for it.
- This is probably the single largest parameter that affects energy efficiency in the plastics industry.
- Systems are improving their full load efficiencies, but the gains are much smaller.
- How a system matches its power requirements to a variable demand is truly where the big savings are.

Demand Charges Explained

- Demand charges are a premium that utility companies charge based on your highest demand over some unit of time.
- The reason for this is they must be able to provide everyone their max need (demand) if they need it at the same time.
- Items that will nearly always be part of your demand charges are:
  - Chillers
  - air compressors
  - hot runner controllers
  - single speed motors
  - lighting

Power Factor Correction

- Power factor is a rating of the percentage that the voltage and current are “in-phase”
- Most of the load in a plastics facility is motor related.
- Motors are inductive loads (where the voltage leads the current) making it inefficient and expensive (and penalized).
- Adding capacitors (where the current lead the voltage) will put them more in phase. Typically 95% or better eliminates the premium charge and you don’t want to cross over to capacitive.

MAPP Member Case Study on Power Factor Correction

- Mossberg Industries – Garrett, Indiana
- Power factor issues found during energy bill audit
- Penalty was “hidden” in the bill
- Plant size 30 presses from 100-1000 ton and 3 extruders
- Cost of installation 33,332.00
- First year savings 23,286.34
- Above information provided by the customer

Primary Equipment Opportunities

- In order of significance
  - Intelligent Energy Management
  - Energy Efficient Machine Technologies
  - Suitable Temperature Control
  - Optimum Configuration
  - Rational Production Organization
  - Individual machine Settings

Primary Equipment Opportunities - Injection

- Hydraulic (1X)
- Servo Hydraulic (.5X)
- Hybrids
- All electric (.25X)

- The slower the cycle, the higher the percentage savings.
- The slower the cycle, the lower the overall cost.

Scale of servo hydraulic opportunity – Retrofit existing machines or realize with new purchases

- Servo hydraulic Retrofit
- 10 machine average of 300 and 400 ton machines, .10 per kWh,
- Standard hydraulic - 29.6 kwh/hr
- After Servo upgrade - 13.9 kwh/hr
- Savings - 15.7 kwh/hr
- Percent saving 53% (20%- 64%)
- $36.21 average per day per machine
- $1086.30 per month
- $13035.6 per year (again per machine average)
- Plus 3,800 on tower savings (would be much higher for air cooled chiller on heat exchanger)
- 600 on maintenance and oil savings

- An all electric machine would cut this in half again.

Injection machine – Other opportunities

- Blankets for barrel heaters
- Screw design
- Set up - Barrel temps, cooling temp, hold times…

Extruders – Extrusion Systems

- DC – AC conversion
- More efficient heater bands
- Barrel heater insulation
- Inline processes such as inline thermoforming

Scale of DC – AC Conversion

- 250 hp extruder
- 24/7 50
- 92% load and 62% speed
- .10 per kwh
- DC operating 105,000
- DC demand 27,000

- AC Operating 92,000
- AC demand 22,800

- Savings 17,200 or 13% savings
- 4.56 year payback if you change out a good motor. Much shorter if you need to make the change.

Other Primary Processes

- Injection Blow Molding
- Extrusion Blow Molding
- Rotational Molding
- Thermoforming

Opportunities in Water Products (Chilled/Cold)

- Different chiller technologies have different kWh/ton ratings. EER
- Anything with a compressor in it is going to be expensive to run.
- Anytime that you can experience free cooling without jeopardizing the process, it is a huge win. Towers/Adiabatic
- Every factory that I walk into will have chillers driven to a temperature well below where it needs to be. This makes them less efficient and actually reduces their efficiency.
- Matching each machine to the correct temperature as opposed to driving down the entire plant temperature

Scale of opportunity for chilled water

- 100 tons
- 8,000 hours
- $0.10 per kWh
- Base line technology $76,000 per year
- Highest efficiency $47,000 (38% savings)
- Free cooling (95% savings when it is available)

Opportunities in Water Products (Warm)

- Hot water is a better “cooling” medium than oil.
- Water has a very high specific heat capacity (nearly 10 times that of steel). Reducing the amount of water in the circuit will greatly reduce the time and by default, the energy needed to get a mold up to temp.
- Energy loss is a function of surface area - Reducing the surface area reduces the losses
- Bundling and insulating hoses reduce heat loss
- Insulating the mold can greatly reduce the energy that spills to the platen

Opportunites in Water Products (Warm) cont.

- Effects of a bad PID loop/control system
- Maintenance is critical due to where hardness precipitates.
- Once you reach turbulent flow, the cooling affect of increased flow does NOT follow the increase in cost.

Opportunities in Water (Cleanliness)

- Contaminated or fouled water lines greatly reduce heat transfer. Nearly all fouling materials are great insulators.
- Required pumping pressure can be lowered if cooling channels are clean.
- Cycle times can be lowered, which will typically lower your kWh/kg.
- Scrap will be reduced which is a major contributor to a ballooning kWh/kg metric

Effects of Scale on Chiller Cost

The following table shows the potential economic impact of scale deposits on a 500 ton chiller running at full load, 24 hours per day. Actual increased energy use depends on compressor type, actual operating head pressure, and percent operating load.

For the same thickness, the increased cost associated with a biofilm deposit can be significantly greater than with scale, depending on the actual scale composition. It becomes clear that good microbiological control is vital for efficient chiller operation.

Deposit Thickness, inches	Fouling Factor	% Efficiency Loss	Increased Annual Electrical Cost Scale Deposit
0	0.0000	0	$ 0
0.01	0.0008	9	$ 19,790
0.02	0.0017	18	$ 39,580
0.03	0.0025	27	$ 59,365
0.04	0.0033	36	$ 79,155
0.05	0.0042	45	$ 98,945

Condenser Deposit Thickness vs. Increased Electricity Cost

Based on electricity cost of $0.07 per KWH, a chiller efficiency of 0.65 KW/Ton, a power factor of 0.91.

Scale assumed to have thermal conductivity of 1.0 BTU/(hr)(SqFt)(F^{o})

Opportunities in Water (pumping)

- Larger water lines where possible
- VFD pumps based on system pressure
- Reduce quick couplers
- High efficiency pumps and motors

Difference between load side and supply side capacity control

Application Guide Cooling

http://www.leonardo-energy.org

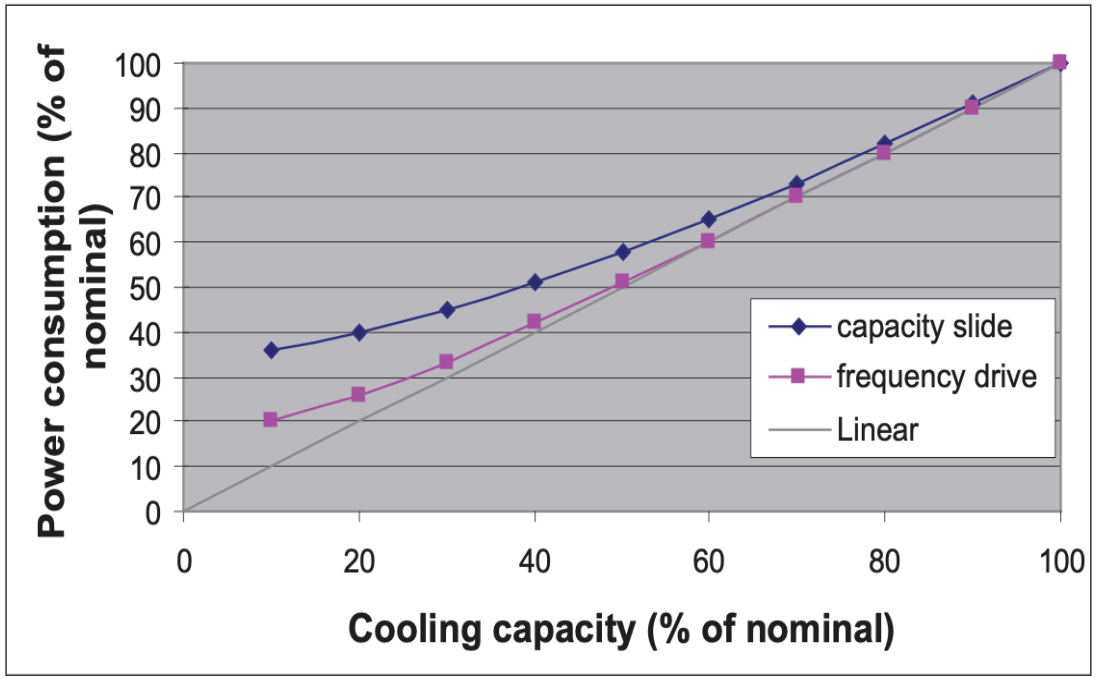


Figure 7: Effect on porwer consumption for differing cooling capacity

Dryer Technology

- Old twin tower
- Carousel
- Wheel (Gas vs. Electric as well)
- Compressed air
- Membrane
- Vacuum
- IR

Energy Consumption by Technology Based on 100 pounds per hour of PC and $.10 per kwh

Energy Consumption Chart

Technology	Cost
Vacuum Dryer	$0.40
Typical Wheel Dryer	$0.41
Membrane Dryer	$0.54
Dual Bed Desiccant Dryer	$0.64
Compressed Air Dryer	$0.83
Compressed Air w/Membrane	$1.30

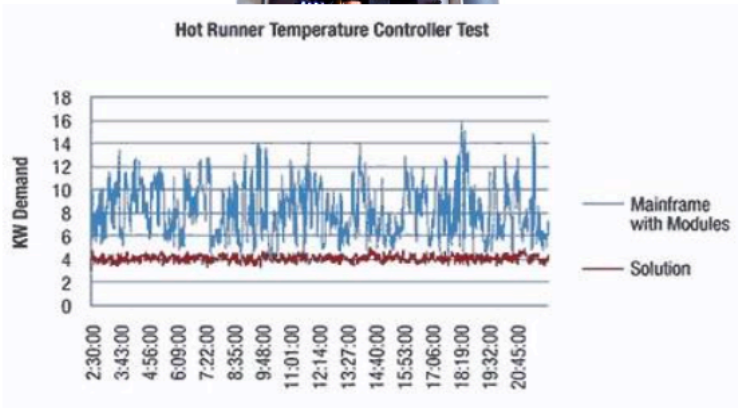
Drying considerations

- Technology
- Sizing (right is right).
- Measuring incoming moisture
- Regeneration heat is a major consumer
- Overdrying
- Gas vs. Electric
- Central vs. Beside the Press (up to 70% savings)

Hot Runner Controllers

Waterfall Technology™ – Minimizes Peak Amp Draw and Better Control

- Reduces peak Amp draw by up to 67% during production.
- Groups tool into 3 – one group for each phase.
- Only fires one phase at a time unless more than 33% power is called for on zones in another group.
- Works in harmony with Auto-Tuning PID to limit temp fluctuations



Hot Runners

- Design
- Insulation
- Cooling water source

Grinders

- Grinders are engineered systems and should be bought and applied that way.
- Chamber design, knife design, screen size all affect the operating costs.
- Pre-shredding the material will not only reduce the load of the grinder, it will reduce the overall system demand.
- Nearly every grinder that I see is either being over fed or under fed. Both of these waste energy. Proper feeding methods are available.

Scrap

- Any scrap produced will be at the cost of your kwh/kg. It will just not have any value. If you are lucky, you can add more energy cost to it, grind it and reuse it.

Variable Frequency Drives

Variable Frequency Drive Energy Savings Calculator

The most common applications of using variable frequency drives are pumps and fans, suppose a 24/7 operate constant pressure water supply system's pump controlled by VFD may save as high as 30% electricity cost bills.

% Speed	% Hour
100%	0
90%	0
80%	0
70%	0
60%	0
50%	100
40%	0
30%	0
20%	0
10%	0
	100 %

Hours / Day 24
Days / Week 7
Hours / Week 168
Hours / Year 8,760

Motor size (HP):	30	Efficiency (%):	85
Input voltage (V):	380	Frequency (Hz):	50
Full load current (A):	36	Speed (RPM):	1500

Full load input power (kW): 20.1 kW

VFD Cost ($): 5000
Electricity rate ($/kWh): 0.09

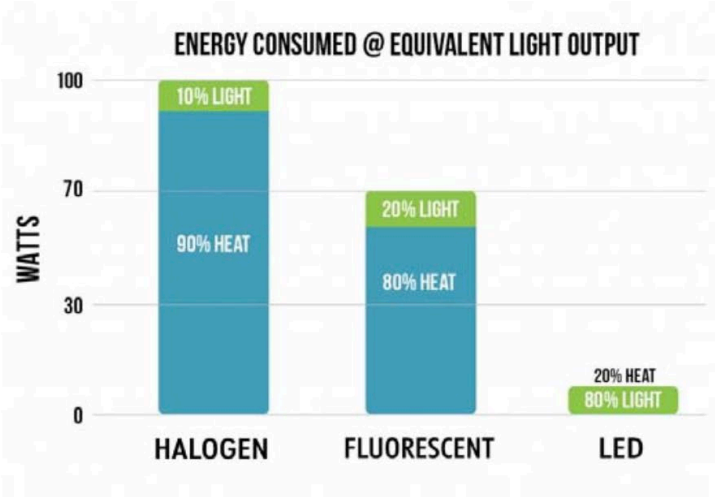
Estimate annual operation cost without VFD: 15,860 $
Estimate annual operation cost with VFD: 2,135 $

Your Annual savings: 13,725 $
Payback time: 4.37 Months.

Calculate

Lighting

the numbers don't LIE



Significantly **REDUCE**
Energy Usage, Utility Costs
and Carbon Footprint

Dramatically **INCREASE**
Productivity, Business, Profit
and Employee Morale

Lighting (benefits)

- Really high energy saving that are by far the easiest to calculate. The savings will normally be higher, since the ballast has some waste.
- Nearly always a brighter work area for quality and safety
- Several standard tax deductions (it is a process that the gov’t understands)
- Utility company grants
- Greatly reduced maintenance
- Greatly reduced heat.

Lighting – Scale of Opportunity

- **Noblesville, IN facility (300,000 ft building), plastics group, 3 shift operation, 7 days a week**
- **Project cost:** $265,963
- **Simple payback ROI:** 3.3 years (30.53% annual ROI)
- **Lifetime Savings:** $464,756
- **Annual Savings:** $81,202
- **Percentage of energy saved:** 53%
- **Happiness of maintenance technician who no longer has to install endless T8 bulbs:** priceless

Lighting – Scale of Opportunity

- **Walkerton, IN facility (100,000 ft building), plastics group, 3 shift operation 5 days a week**
- **Project cost:** $174,090
- **Simple payback ROI:** 2.6 years (37.87% annual ROI)
- **Lifetime Savings:** $507,121
- **Annual Savings:** $65,926
- **Percentage of energy saved:** 72%
- **Happiness of maintenance technician who no longer has to install endless T5 bulbs:** priceless

Air Compressors

- Anything with a compressor is expensive to run.
- Capacity control is critical. VFD design is simple for new compressors.
- Piping and air storage are very important to system efficiency.
- Small leaks cost big dollars. Note, air blow offs appear as leaks.
- The higher the system pressure the bigger the effect on all items.
- Air compressors waste 85-90% of their energy (Compressed Air - Best Practices)
- Part loading is important, but actual consumption reduction is key

Questions

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