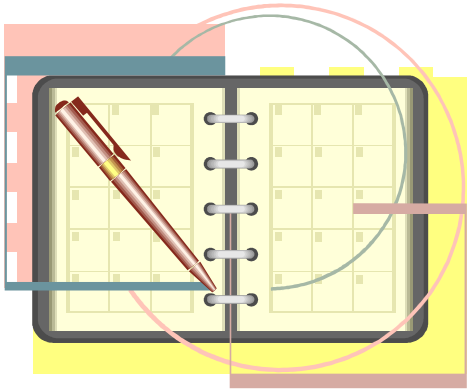
When is it More Efficient to Use Electric Actuators and When Are Pneumatics Better?

Gil Guajardo
Product Marketing Manager – Electric

Agenda

- Criteria to Consider
- Pneumatic
  - Performance
  - Costs
  - Best application scenario
- Electric
  - Performance
  - Costs
  - Best application scenario
- Case Study: Pneumatic Over Electric
- Case Study: Electric Over Pneumatic
- Freebie: Pneumatic versus Electric Cost Calculator
- Power Monitoring:
  - Electronic Power Monitoring Devices
  - DoE Qualified Energy Services Company (ESCO)
- Q&A



Criteria to consider

- Performance advantages and disadvantages
  - Pneumatics Actuators
  - Electric Actuators
- Installation and maintenance costs
- Operating (power) costs
- Productivity gains
  - Reduced Set-up time
  - Increased capacity
  - Labor savings
  - Less Waste

Pneumatic actuator performance characteristics

- High force and speed
- Force and speed are independent and easily adjusted
- Economical to oversize
- Small footprint
- Simple implementation
- Extend and retract only
  - Typically fixed motion processes
- System requirements:
  - Compressor
  - Air lines
  - Fittings
  - Valves
  - Flow Controls
  - Filters
  - Regulators
  - Lubricators
  - Shut-off valve
  - Pressure Gauge
  - Tubing
  - Dryers

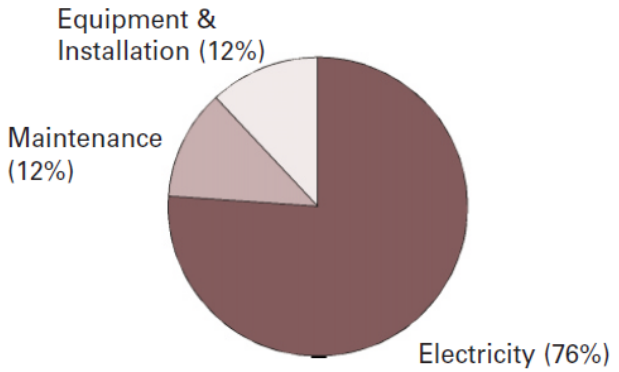
…which limit where it can be deployed

Pneumatic Actuator Costs

- Component costs are low; system costs may vary
  - May be able to take advantage of “sunken costs” (compressor, Air Prep, etc), where electric you have to start from scratch to build system
- Operating costs dominated by compressor power consumption - Electricity (~76%)
  - Efficiency is lower at idle
  - Idling at no load wastes electric power consumption
  - Oversized cylinders and compressors waste money
- Other Equipment and Installation and maintenance costs account for.. (~24%)
- Best scenario for pneumatic:
  - Large scale deployment
  - Efficiently sized compressor
  - Sunken investment costs already exist
  - No labor savings or production downtime

  savings are achievable

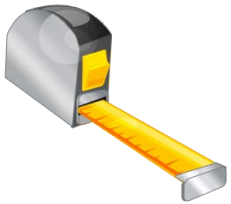
Typical Lifetime Compressed Air Costs in Perspective*

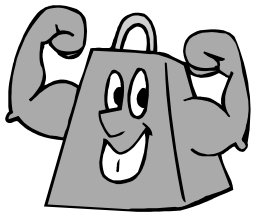


*- Source: DOE/GO-102000-0986 December 2000 Compressed Air Tip Sheet #1

Electric actuator performance characteristics

- **Advantages to Electric:**
- Precise control and positioning
- Adapt machines to flexible processes
  - Flexible
  - Scalable
  - Adaptability
  - Repeatable
- "Portable" – install anywhere electric power is available
- Quiet, smooth and repeatable
- Networking and Communication available
  - Predictive Maintenance
  - Preventive Maintenance
  - Diagnostics
  - Management Visibility
- **Points to Consider:**
- More complex to implement
  - More flexibility and control leads to more complex implementation
- Accurate sizing is critical
  - Over sizing is expensive
  - Under sized actuators will not perform
  - Force and speed limits are locked in by design
- Trade speed for thrust and thrust for speed





Electric Actuator Costs

- High unit cost ~ $300 - $2000 or more depending on design and electronics
  - Stepper motor and/or Drive
  - Stepper motor with encoder
  - Servo motor & Drive
- High replacement cost
  - Modular designs help minimize replacement costs
  - Mechanical wear parts – 3 year life
  - Electrical components – 5 to 10 year life
- Low power consumption
- Flexibility can yield cost savings
  - Reduce costly set-up time & change over time
  - Not automatic – needs to be designed in
- Best scenario
  - Smaller scale deployment
  - Effects process improvements or cost savings through automation

Efficiency Example – Electric/Manual/Pneumatic Guide rail

- ✓This example moved customer from manual to electric solution
- ✓Customer considered 3-position Position Pneumatic but preferred multiple position solution
- ✓Customer considered PFC but price approached electric costs and requires need for PLC

Conveyor Guide Rail Adjust System

- OEM is providing new 100 ft. conveyor system to F&B customer
  - Customer spent 30 minutes each morning adjusting rail system
  - Two technicians at a cost of $65/hr. make necessary adjustments
  - Manual rail adjustments are difficult to precisely align
  - Often two or more variations of product are processed each day
- Customer cost under current system include…
  - Min. $130/day labor
  - 260 work days/yr. →$33.8K labor cost
  - 25% of days 2 products are processed → Additional $8.5K cost
  - $8.5K additional cost for multiple part runs
  - Cost of downtime while adjustments are made → $1K/day
  - Annual downtime cost →$260K annually
- Solution Savings
  - 70 pcs. Actuator (w/ motor/drive) @ $900 →$63K
  - ROI = 3 months!

Pneumatic or electric actuators? Electricity Costs

Cost Calculator will use Kilo-watt-hour (kWh) in its calculations.

What is a Kilo-watt-hour (kWh)? Electric Utility charges by the kWh. Wattage x hours Used / 1000 x price per kWH = Cost of Electricity

For example, let's say you leave a 100-watt bulb running continuously (730 hours a month), and you're paying 15¢/kWh. Your cost to run the bulb all month is 100 x 730 ÷ 1000 x 15¢ = $10.95.

- Average retail price: 12 cents per kilowatt-hour (kWh)*
  - Residential: 12¢ per kWh
  - Transportation: 10.7¢ per kWh
  - Commercial: 10.4¢ per kWh
  - Industrial: 6.8¢ per kWh
- Highest average price of electricity:
  - Hawaii (36¢ per kWh)
  - Connecticut (16.95¢ per kWh)
  - New York (16.74¢ per kWh)
- Lowest average price:
  - West Virginia (5.59¢ per kWh)
  - Wyoming (5.68¢ per kWh)
  - Idaho (5.70¢ per kWh)

- *- Source: http://www.eia.gov/totalenergy/data/annual/index.cfm

Average Retail Price of Electricity

Table 5.3. Average Retail Price of Electricity to Ultimate Customers:

Total by End-Use Sector, 2002-August 2012 (Cents per Kilowatthour)

Graph

Period	Residential	Commercial	Industrial	Transportation	All Sectors
Annual Totals					
2002	8.43	7.87	4.88	--	7.18
2003	8.72	8.01	5.11	7.54	7.42
2004	8.94	8.15	5.25	7.18	7.60
2005	9.43	8.64	5.72	8.57	8.11
2006	10.37	9.42	6.15	9.54	8.86
2007	10.64	9.62	6.39	9.70	9.10
2008	11.25	10.32	6.82	10.75	9.71
2009	11.51	10.15	6.81	10.65	9.80
2010	11.55	10.16	6.76	10.57	9.80
2011	11.72	10.21	6.81	10.46	9.86

Sources: US Energy Information Administration (eia) Electric Power Monthly with Data for August 2012, October 2012

Compressor Sizing Calculations

Inputs:

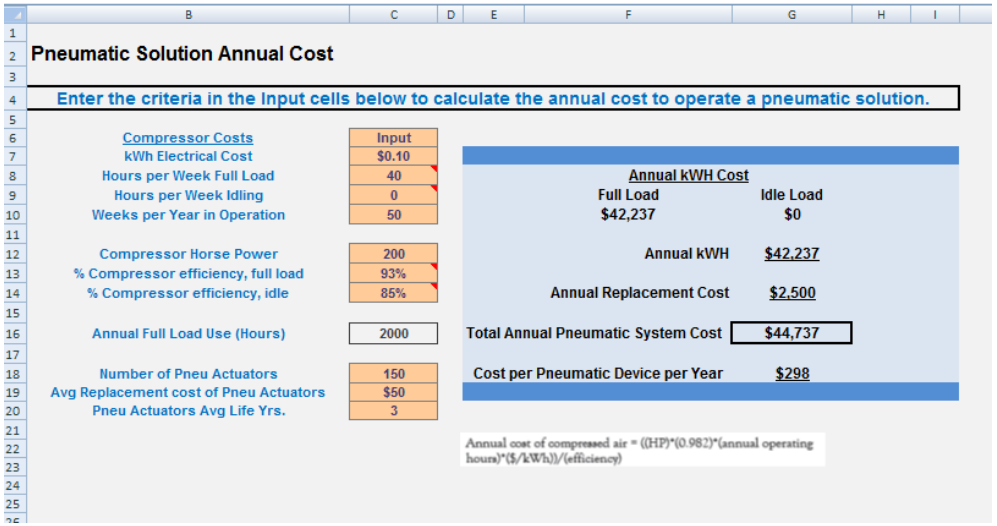
- Average bore size
- Average stroke length
- Average time for stroke
- Number of cylinders
- % of cylinders that actuate simultaneously

Output:

- CFM required
- Find compressor HP using the CFM number and the manufacturer's specifications

Cost Evaluation Calculator

- Bimba now features a Pneumatic versus Electric Actuator cost evaluation spreadsheet, which is available for download from bimba.com
- This spreadsheet allows a person to estimate pneumatic and electric costs, facilitating a comparison and selecting the correct actuator depending upon the application
- Let's have a look at the calculator and conduct some calculations to demonstrate the value of reviewing costs in advance of making a decision.
- And then let's manipulate some of the numbers



Pneumatic Solution Annual Cost

Enter the criteria in the Input cells below to calculate the annual cost to operate a pneumatic solution.

Compressor Costs	Input
kWh Electrical Cost	$0.10
Hours per Week Full Load	40
Hours per Week Idling	0
Weeks per Year in Operation	50
Compressor Horse Power	200
% Compressor efficiency, full load	93%
% Compressor efficiency, idle	85%
Annual Full Load Use (Hours)	2000
Number of Pneu Actuators	150
Avg Replacement cost of Pneu Actuators	$50
Pneu Actuators Avg Life Yrs.	3

Annual kWH Cost	Full Load	Idle Load
	$42,237	$0
Annual kWH	$42,237	
Annual Replacement Cost	$2,500	
Total Annual Pneumatic System Cost	$44,737	
Cost per Pneumatic Device per Year	$298	

Annual cost of compressed air = ((HP)*(0.982)*(annual operating hours)*($/kWh))/(efficiency)

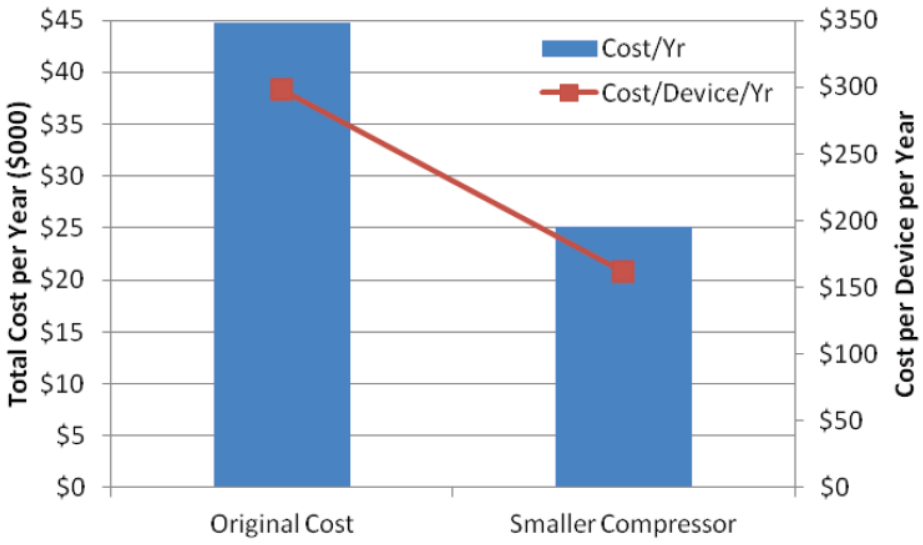
Case study

- Pneumatic solution
  - 200 HP compressor
    - 2000 hours per year at full load, 93% efficiency ($0.10/kWh)
    - When not in use it is off
  - 150 pneumatic actuators deployed
    - Average unit cost: $50
    - Life expectancy: 3 years
- Electric solution
  - 150 electric actuators deployed
    - All-in-one design: includes drive and controller but not DC power supply
    - Average unit cost: $1200
    - Life expectancy: 3 years
  - Actuator draws 6A fully loaded at 48 VDC; fully loaded 30% of the time
  - Actuator draws 3A at 48 VDC 70% of the time
  - Power supplies draw 6A at 120 VAC fully loaded, producing 9A at 48 VDC

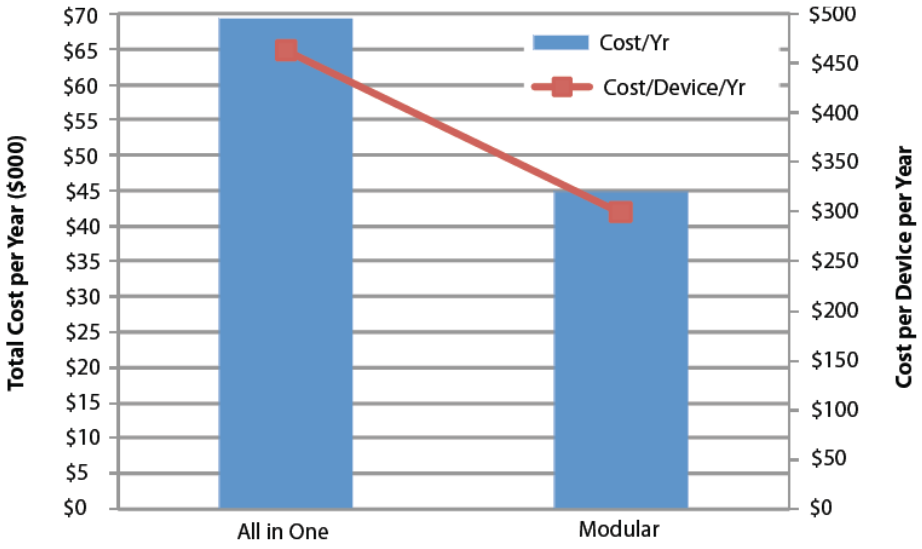
Case study Pneumatics over Electrics

- Pneumatic solution
  - Annual cost of compressed air: $42,237
  - Replacement cost of actuators: $2,500 per year
  - Total annual cost: $44,737
  - Total annual cost per actuator: $298
- Electric solution
  - Annual cost at full load: $4,320
  - Annual cost at idle: $5,040
  - Annual operating cost: $9,360
  - Replacement cost of actuators: $60,000 per year
  - Total annual cost: $69,360
  - Total annual cost per actuator: $462

Case study
Pneumatics over Electrics



Pneumatic Costs



Electric Costs

Electrics over Pneumatics

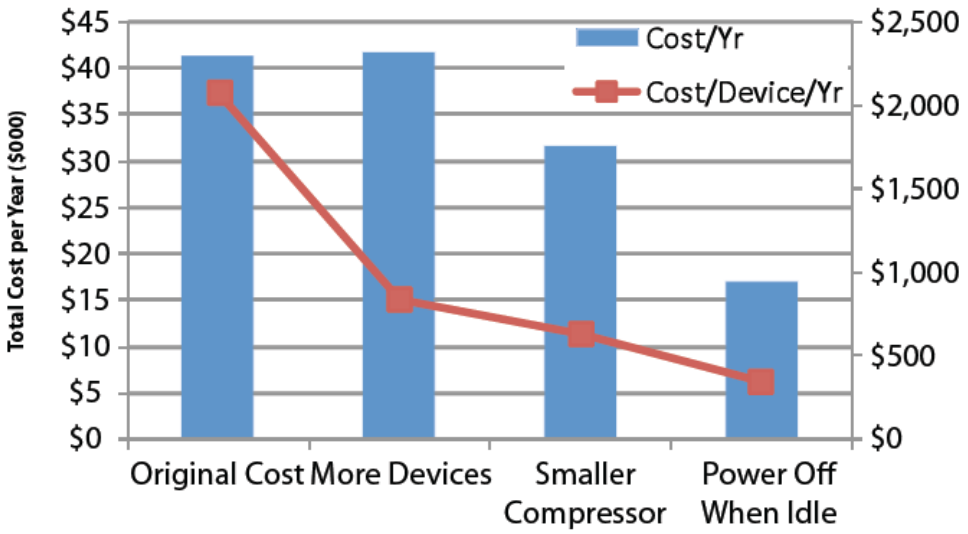
- Pneumatic solution
  - 100 HP compressor
    - 2000 hours per year at full load, 90% efficiency ($0.10/kWh)
    - When not in use it is idling at 25% power and 85% efficiency
  - 20 pneumatic actuators deployed
    - Average unit cost: $50
    - Life expectancy: 3 years
- Electric solution
  - 20 electric actuators deployed
    - Modular: Motor/actuator and separate controllers
    - Average unit cost: $900 for actuator and $1200 for electronics
    - Life expectancy: 3 years for actuators, 10 years for electronics
  - Actuator draws 6A fully loaded at 48 VDC; fully loaded 30% of the time
  - Actuator draws 3A at 48 VDC 70% of the time
  - Power supplies draws 6A at 120 VAC fully loaded, producing 9A at 48 VDC
  - Process improvement: Automates a line change
    - Saves 2 hours every week for 2 employees at $30/hr each
    - Saves 2 hours of lost production: 100 products/hr, $1 per product

Electrics over Pneumatics

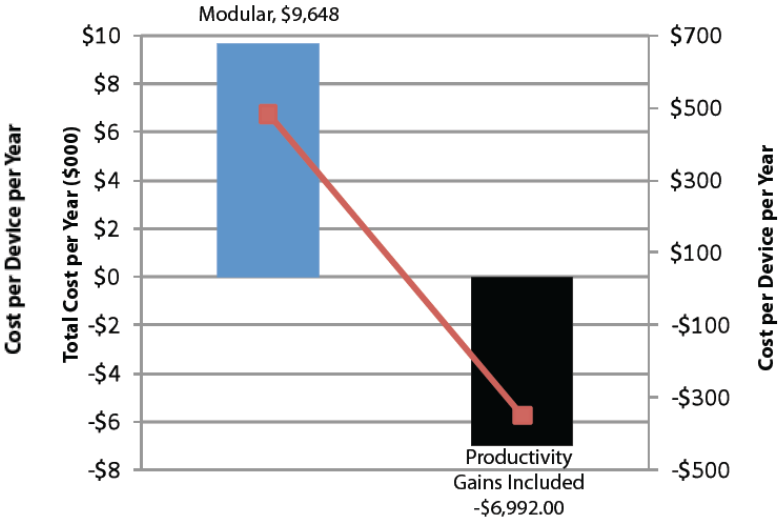
- Pneumatic solution
  - Annual cost of compressed air: $21,882 full load
  - Annual cost of compressed air: $19,351 at 25% power
  - Replacement cost of actuators: $333 per year
  - Total annual cost: $41,506
  - Total annual cost per actuator: $2,075
- Electric solution
  - Annual cost at full load: $576
  - Annual cost at idle: $672
  - Annual operating cost: $1,248
  - Replacement cost of electronics: $2,400 per year
  - Replacement cost of actuators: $6,000 per year
  - Total annual cost: $9,648

  - Savings, changeover labor: $6,240
  - Savings, lost production: $10,400
  - Net results of deployment: $6992 COST REDUCTION!

Case study
Electrics over Pneumatics



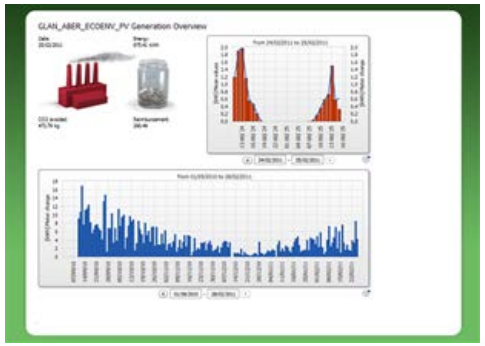
Pneumatic Costs



Electric Costs

Power Monitoring

- If you can measure it, you can manage it
- Electronic Tool to help monitor, reduce and save energy and cost.
  - Measures actual operating parameters; V, I, Power Factor, real power, Active Power, reactive power, energy consumption (kWh), freq. (Hz.)
  - Facilitates awarenesss via cumulative readings with graphing, trending, etc
  - Can be used to help identify air leaks
- Offers visual about how much a compressor contributes to overall utility costs
  - Motivates you to decrease consumption → use less energy
  - Motivates you to use energy at “lower-cost” times of day
  - Can help avoid peak cost charges
  - Allows one to compare energy costs to baseline or projected costs
- Supports energy audits and leads to energy cost savings $ improvements
- Reduces carbon footprint → Supports Green initiatives.

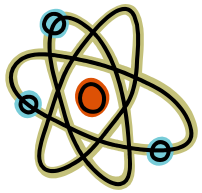


Qualified Energy Services Company (ESCO)

NAESCO National Association of Energy Service Companies

- What is an ESCO? Energy Service Company, develops, installs, and arranges projects designed to improve the energy efficiency and maintenance costs for facilities over a time period.
  - develop, design, implement energy efficiency projects;
  - install and maintain the energy efficient equipment involved;
  - measure, monitor, and verify the project's energy savings; and
  - assume the risk that the project will save the amount of energy guaranteed
- What does an ESCO offer?
  - Energy saving measures…Education, HE Lighting, HF HVAC, eff. Motors, VSD
  - Measure and verify rather then estimate
  - Economic Benefits via energy cost savings
  - Often costly retrofits cost savings are tied to debt payments
- Organizations offering ESCO?
  - Siemens
  - Eaton
  - Honeywell

Conclusions



- Many costs must be considered when selecting actuators
  - Initial Electric Cost can be misleading
  - Hidden energy costs of pneumatics can quite high
- Adequate Pneumatic sizing can help control energy costs
  - Shut down during non operating time can help
  - Smaller Compressor
- Electric Actuator costs can help be minimized by performing an appropriate sizing evaluation

- Performance advantages should be included to quantify savings
- A thorough upfront estimated assessment can produce considerable energy savings → Energy Calculator
- Power monitoring can offer a live real energy use assessment
- ESCO companies can offer services to help an organization complete detailed assessments, and suggested improvements including retrofitting existing equipment

Questions

Thank you for attending!

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