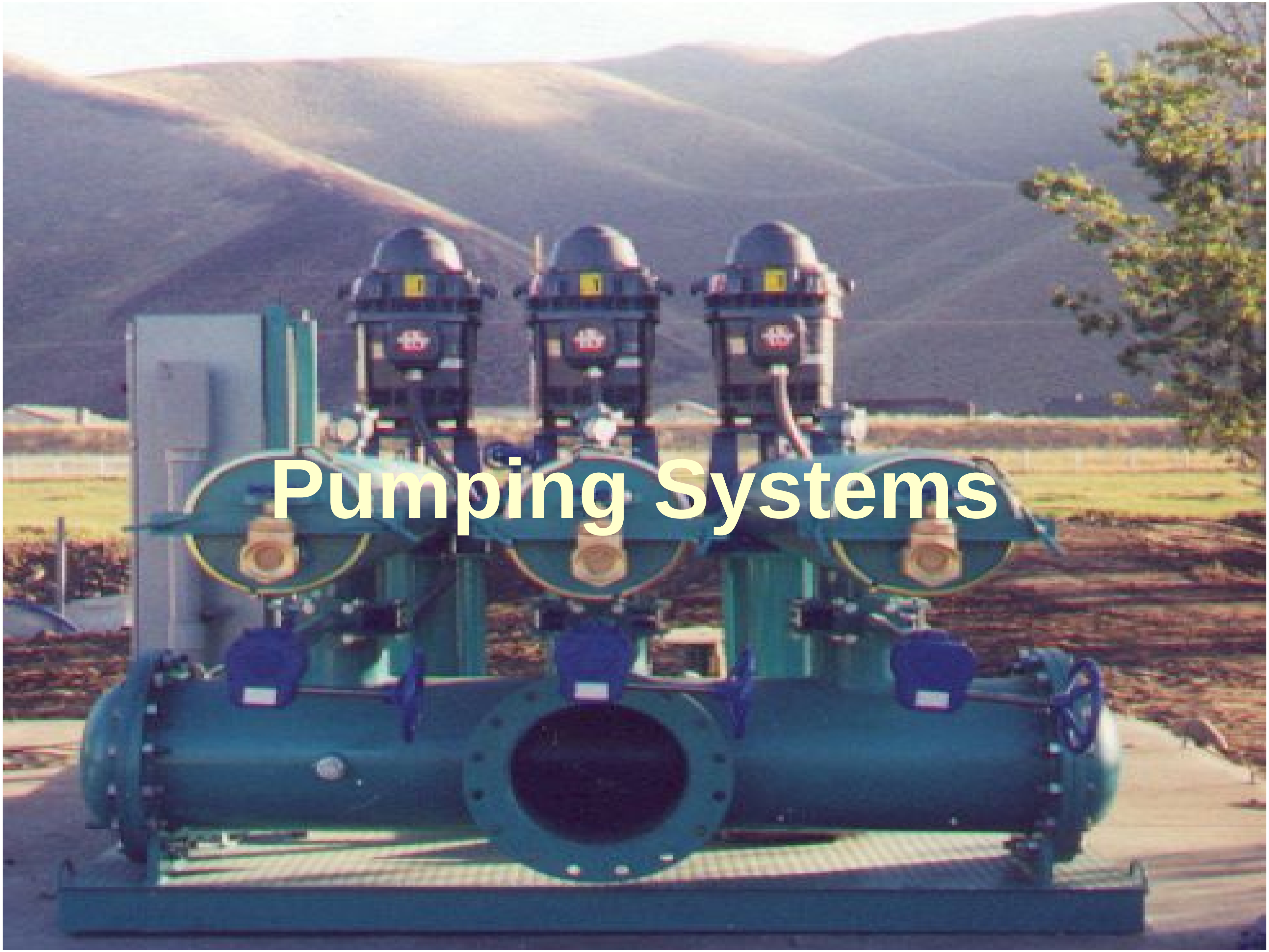
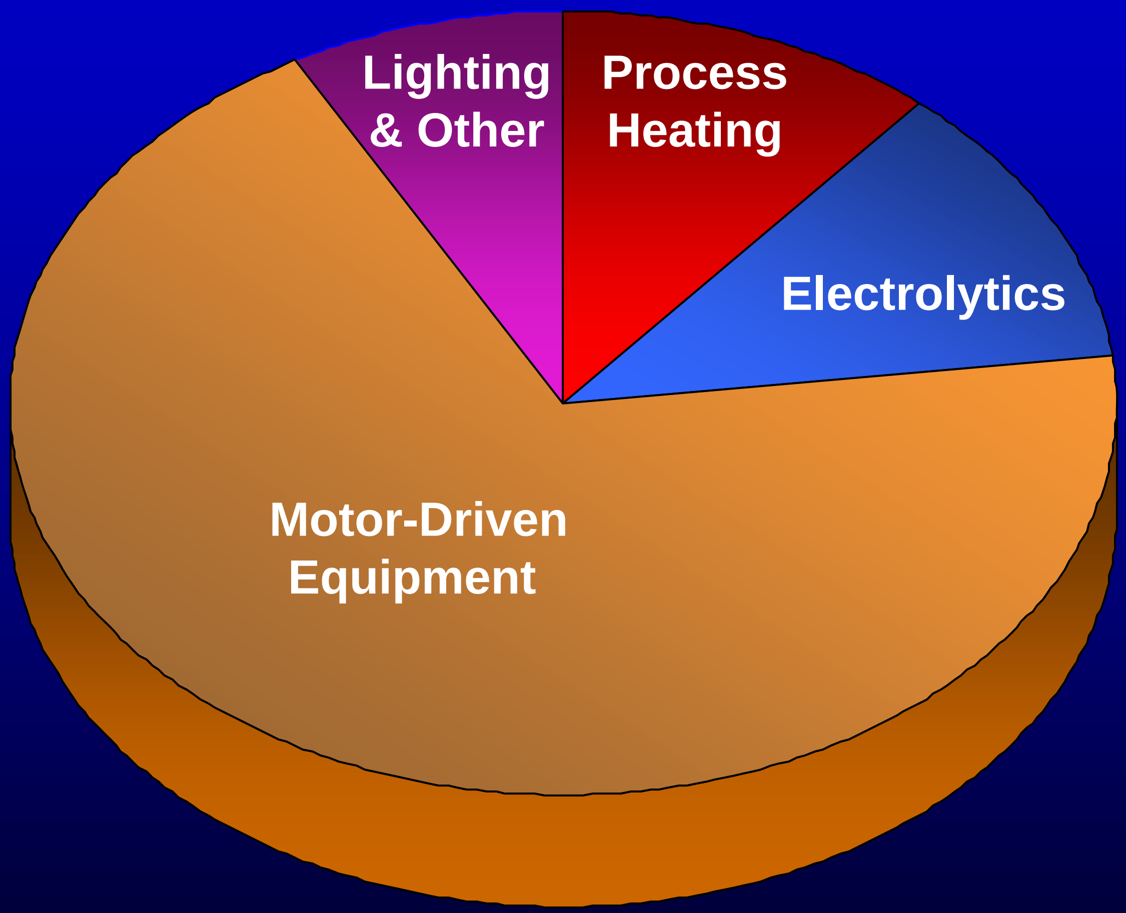

Pumping Systems

Big Picture Perspectives: Industrial Motor Systems

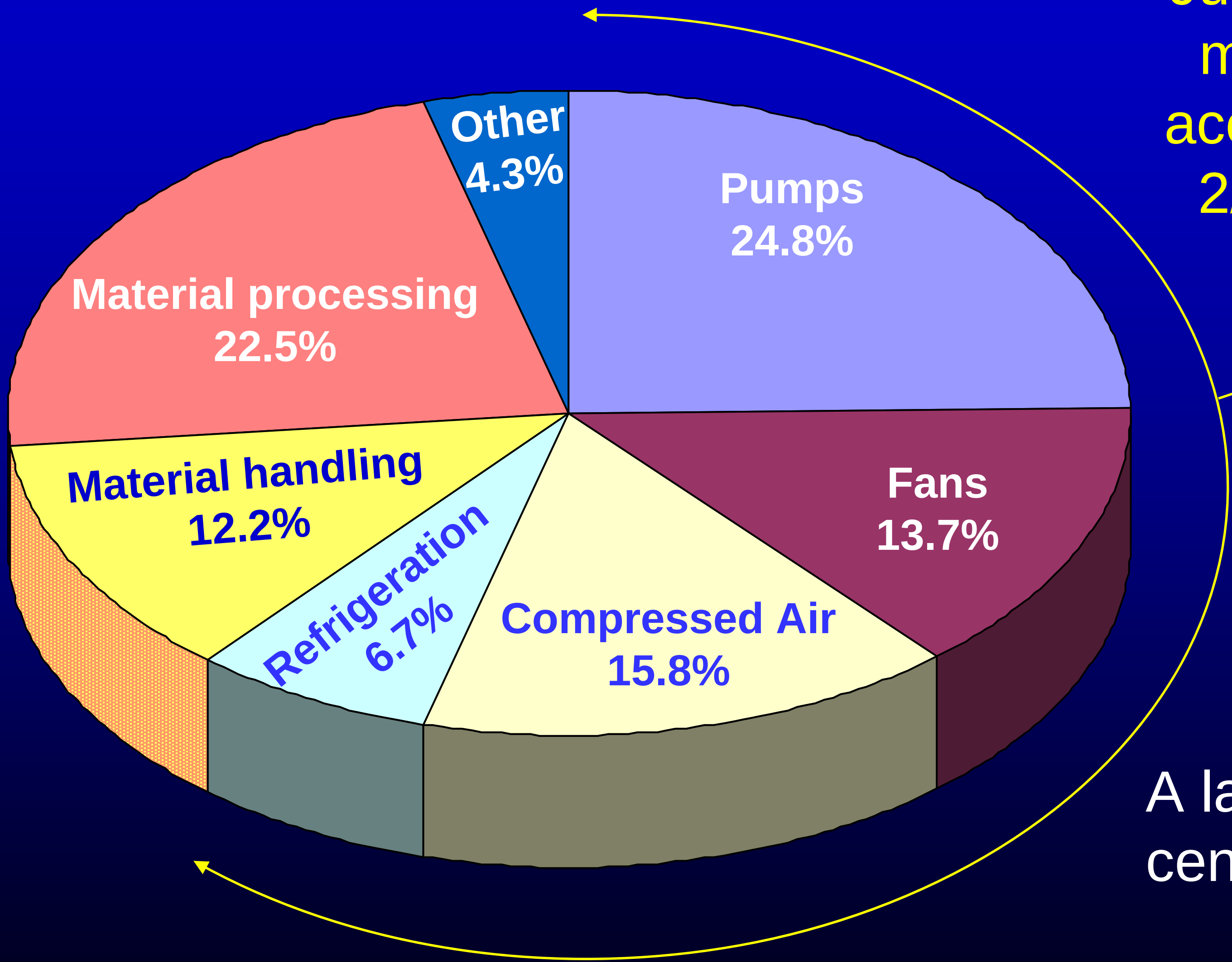
Industrial motor systems:

- are the *single largest electrical end use* category in the American economy
- account for 25% of U.S. electrical sales

Motor loads dominate industrial electrical energy consumption



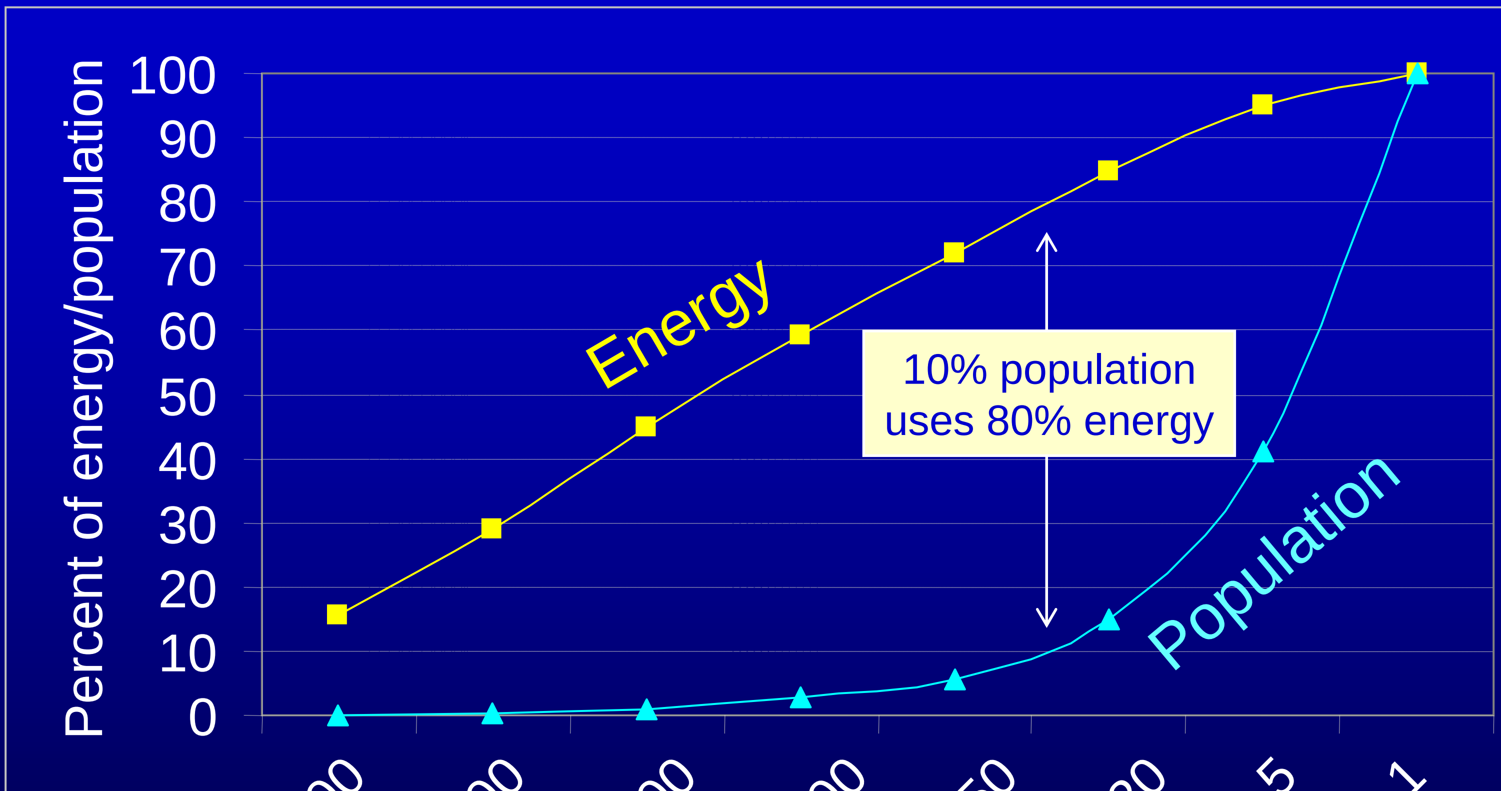
Over 60% of industrial motor-system energy consumption involves fluid handling



Just over 1/3 of the motor population accounts for almost 2/3 of the energy

A large portion are centrifugal devices

A small fraction of the motor population is responsible for most of the energy consumption



Assuming:

1. **Avg. potential energy reduction in smaller systems is 20%**
2. **Avg. potential energy reduction in larger systems is 10%**

Then, if fully implemented, energy savings would be:

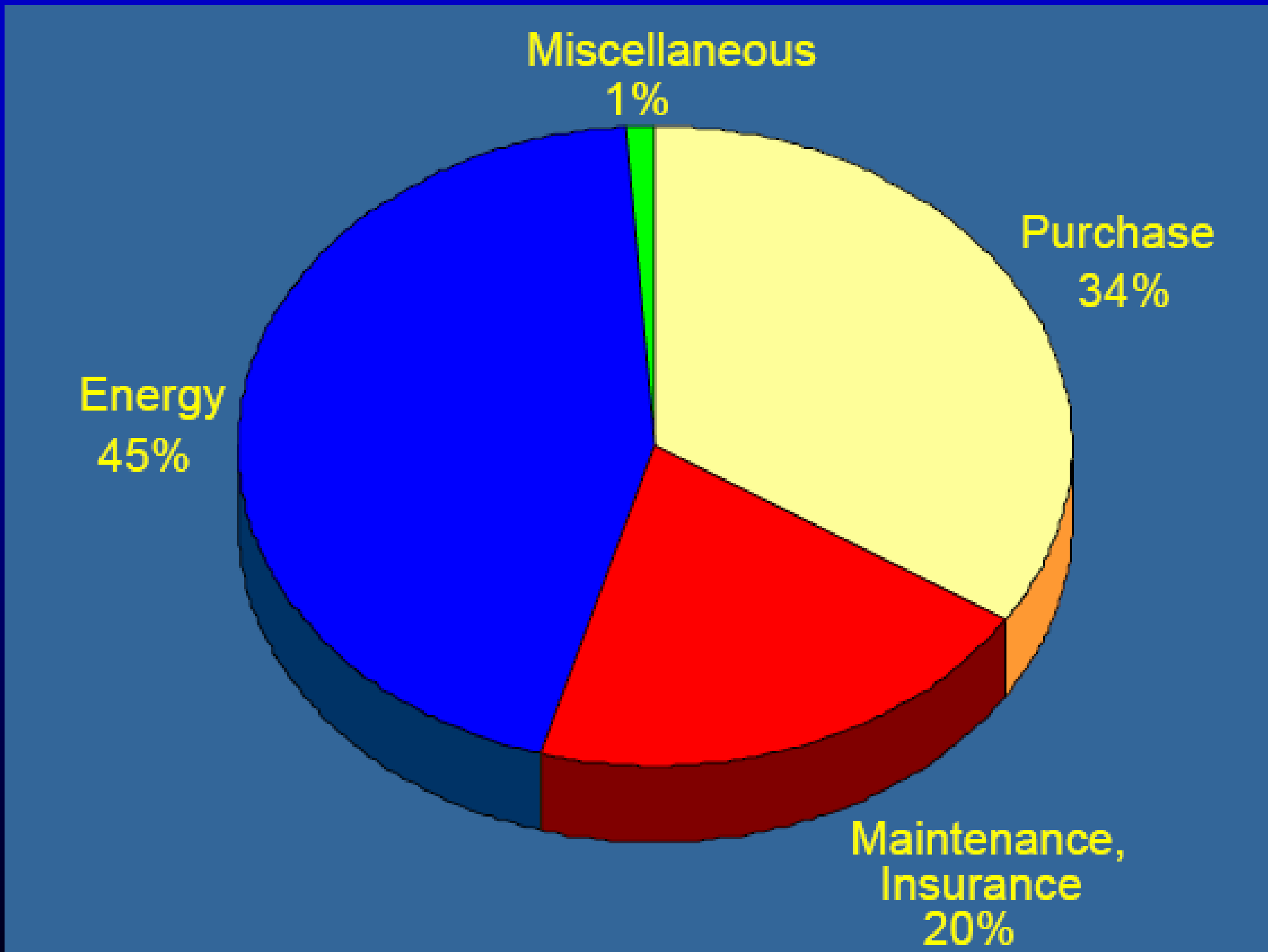
1. **An 8% reduction for changing 10% of the population**
2. **A 4% reduction for changing 90% of the population**

Comparing life cycle costs: automobile and pump/motor combination

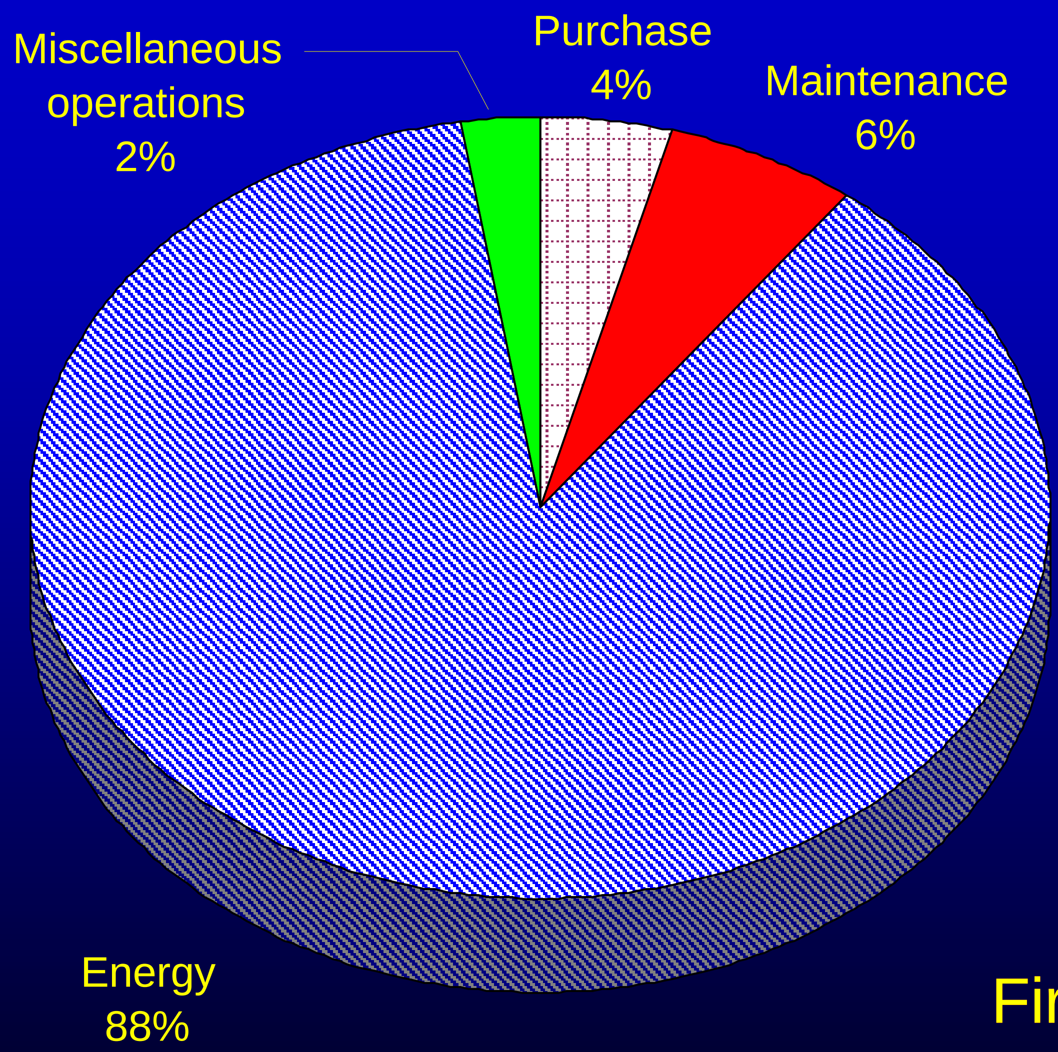
Common assumptions
Discount rate = 8%
Non-energy inflation rate = 4%
Lifetime = 10 years

Item	Automobile	Pump & motor
Initial energy cost rate	$4.00/gal	5 cents/kWhr
Energy inflation rate	10%/yr	5%/yr
Operating extent	20,000 miles/yr	7000 hr/yr (80%)
Maintenance/Insurance	$2,000/yr	$5,000/yr

Life cycle cost - example automobile
$28,000 purchase, 24 mpg, $4.00/gal, 20,000 miles/yr

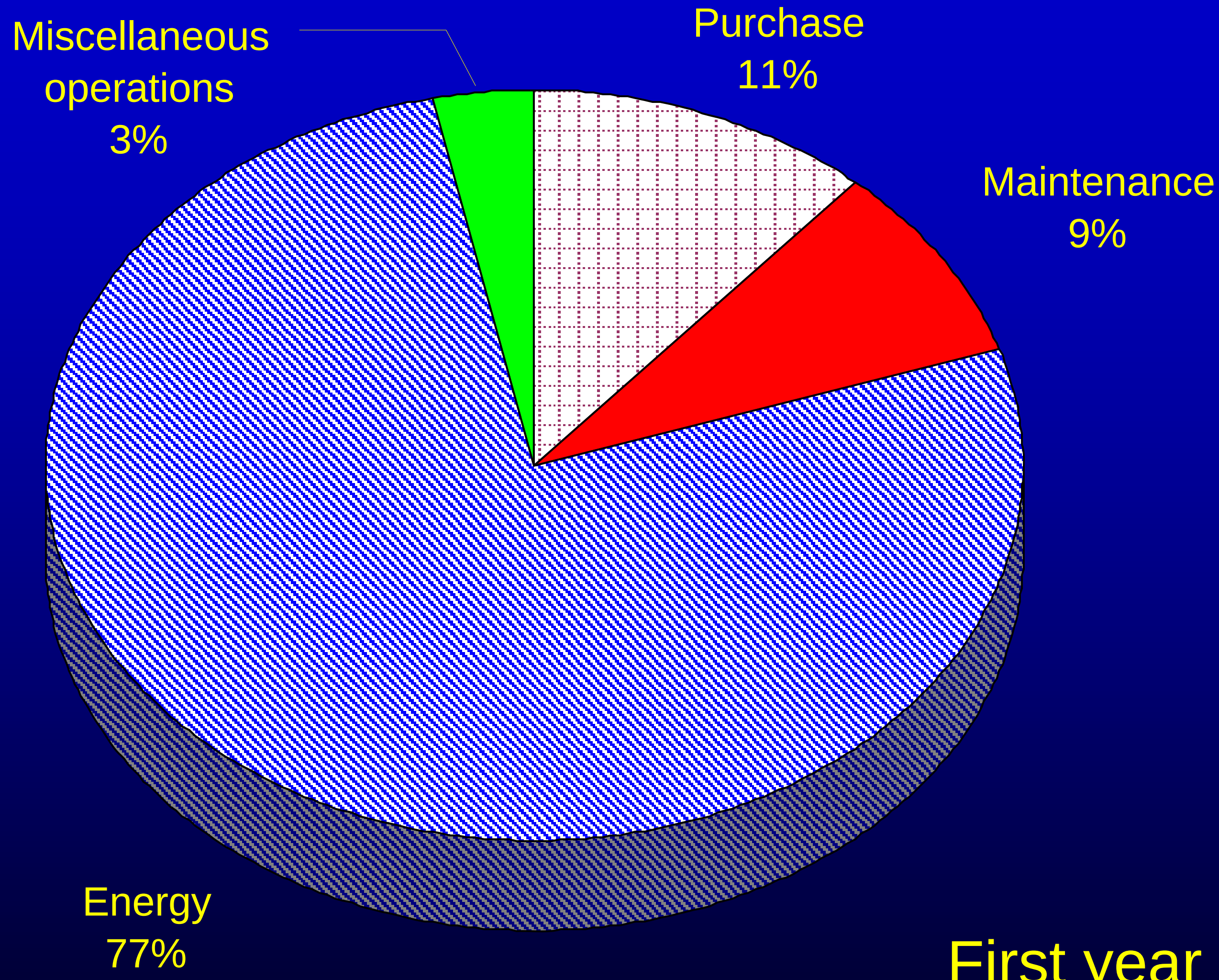


Life cycle cost - 250-hp pump and motor
$28,000 initial cost, $5,000/yr maintenance



First year energy cost = $69,000

Higher first cost pump and motor ($56K), low service time (4,380 hrs/year)



First year energy cost = $43,000

Pump and motor *component* efficiencies: Seventy+ years of progress

Year	Pump efficiency (%)	Motor efficiency(%)
1928	80	87.5
1955	85	90.5
2002	88	95.4

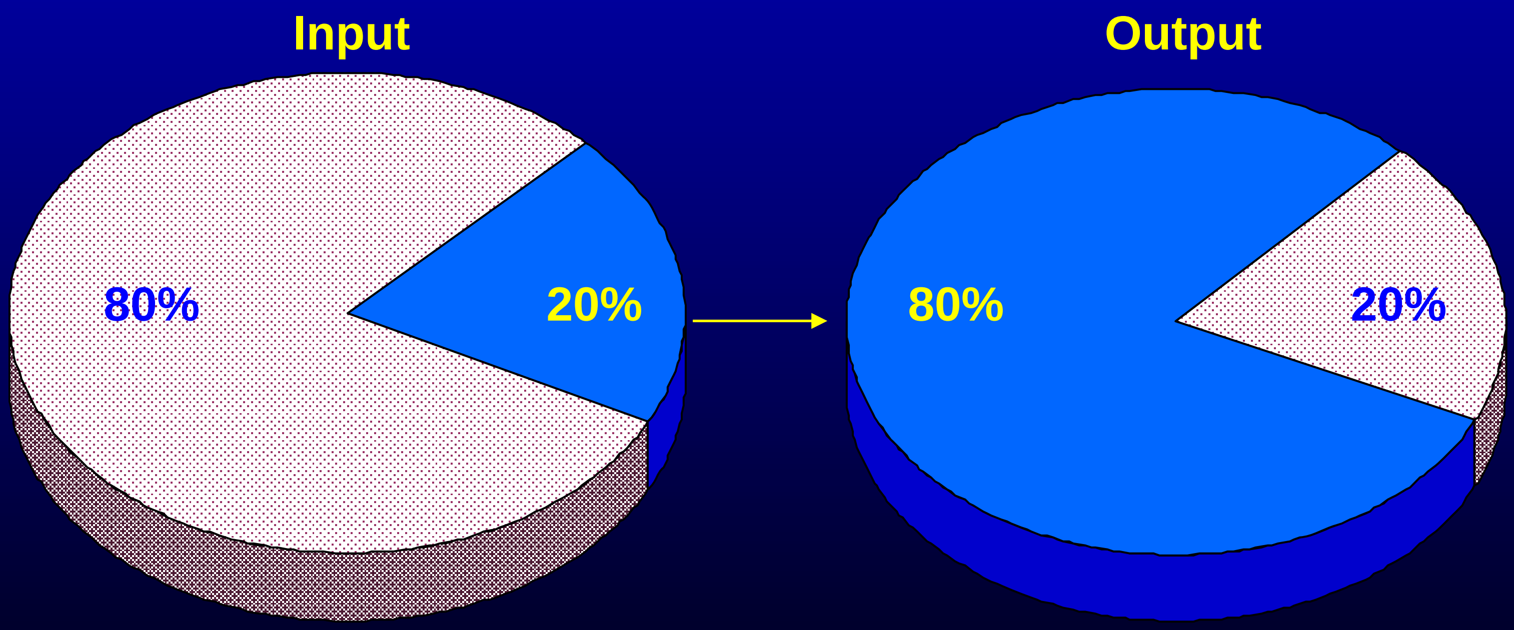
Achievable efficiency estimates for commercially available 75-hp pump and motor

The Pareto Principle or "the vital few and trivial many"

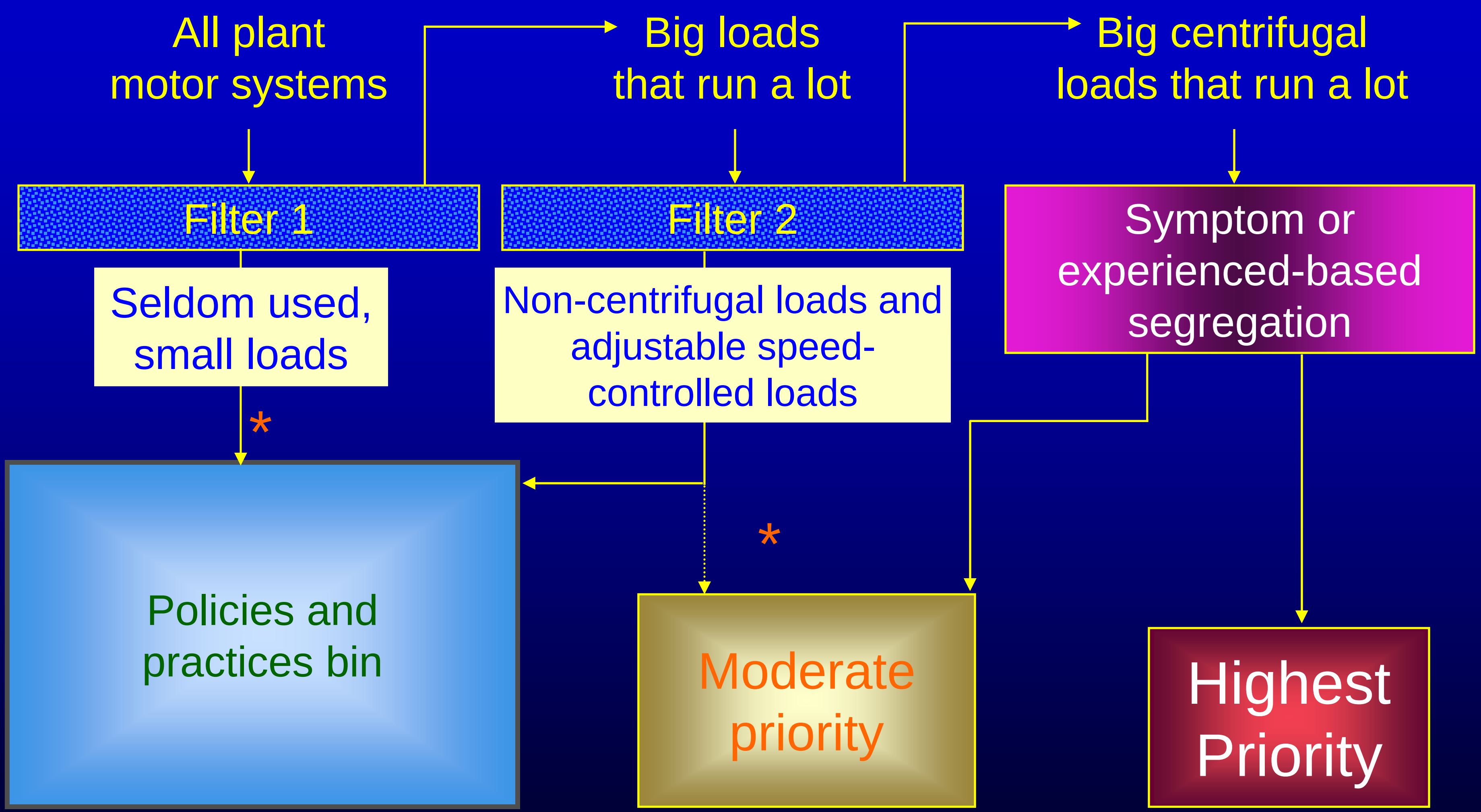
J. M. Juran, who first used the term "Pareto Principle" also coined a more descriptive phrase:

"The VITAL FEW and the trivial many"

(Relatively few are responsible for relatively much)



Prescreening to narrow the field of focus - i.e., to select the VITAL FEW for further review



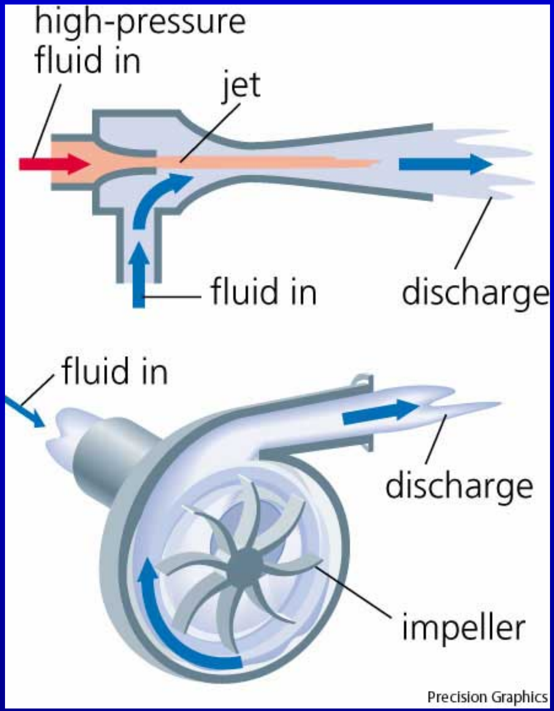
* Productivity/reliability-critical systems sent to higher priority levels

Contingency planning - making the change when a failure occurs

- The alternatives evaluation picture changes dramatically when failures occur
- Changes that couldn't be justified when the system was functional may very well be after failure
- The alternative may actually be less costly than simple repair/replace of the existing component

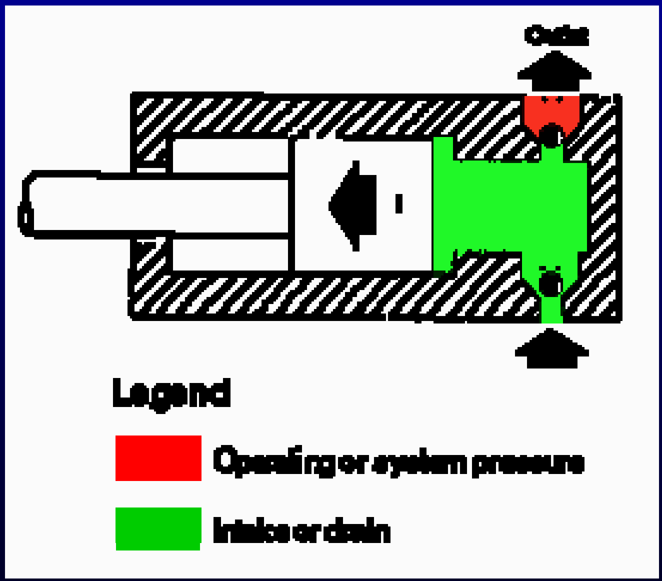
PUMP OPERATION

- Conservatively size pumps to ensure that the needs of the system will be met under all conditions.
  - Pump failure can result in
    - Equipment overheating & catastrophic damage.
    - Substantial loss in productivity.
- Engineers often overlook the costs of oversizing pumps & error on the side of safety by adding more capacity, resulting in
  - Higher-than-necessary system operating & maintenance costs.
  - More frequent maintenance.
  - Excess flow energy increasing the wear and tear on system components, resulting in valve damage, piping stress & noisy system operation.



PUMP TYPES

- Classified by the way they add energy to a fluid:
  - **Centrifugal pumps (most common):** speed up the fluid and convert this kinetic energy to pressure.
    - Axial (propeller), mixed flow, & radial pumps
    - Safe operation, low maintenance requirements, long operating lives, operate over a broad range of conditions, low risk of catastrophic damage.
  - **Positive displacement pumps:** squeeze the fluid directly, fixed displacement volume.
    - Piston, screw, sliding vane, & rotary lobe pumps
    - Highly viscous working fluid, high system pressure, flow must be metered or controlled.
    - Require more system safeguards such as relief valves.



SYSTEMS APPROACH

- Analyzes both supply & demand sides of the system and how they interact
- Broader perspective of how the system parameters are affecting this equipment instead of focusing on individual components.
  - Example: frequent replacement of pump seals & bearings can keep a maintenance crew so busy that they overlook the system operating conditions causing the problems

SYSTEMS APPROACH

Systems approach involves the following types of interrelated actions:

1. Establishing current conditions and operating parameters
2. Determining present and estimating future process production needs
3. Gathering and analyzing operating data and developing load duty cycles
4. Assessing alternative system designs and improvements
5. Determining the most technically and economically sound options, taking into consideration all of the subsystems
6. Implementing the best option
7. Assessing energy consumption with respect to performance
8. Continuing to monitor and optimize the system
9. Continuing to operate and maintain the system for peak performance

DOE PUMP PERFORMANCE TOOLS

- Sourcebook available (2nd Edition released May 31) to help designers & operators improve pump system performance through better pump selection and improved operating & maintenance practices.

- PSAT 2004 available on Save Energy Now CD