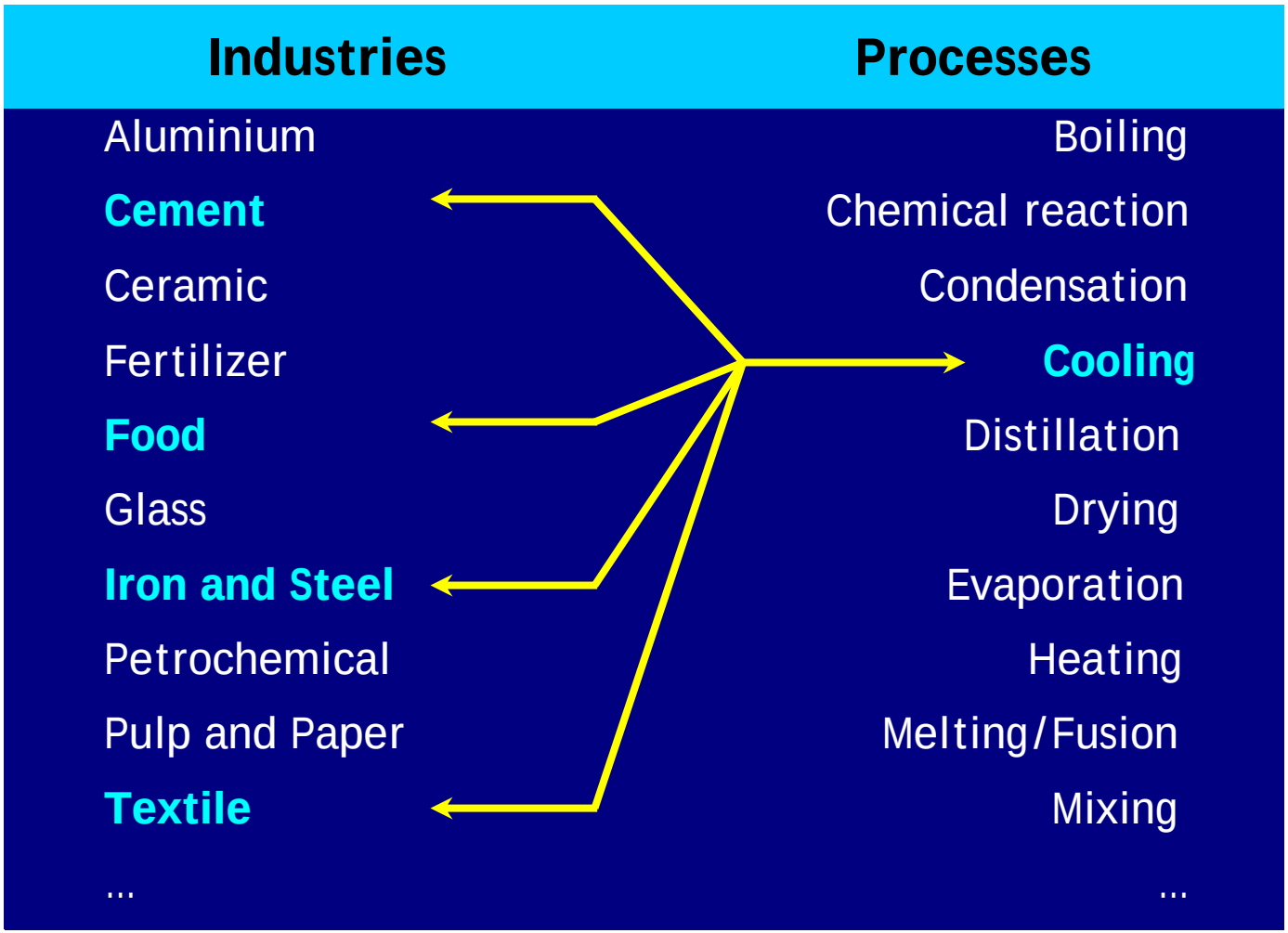
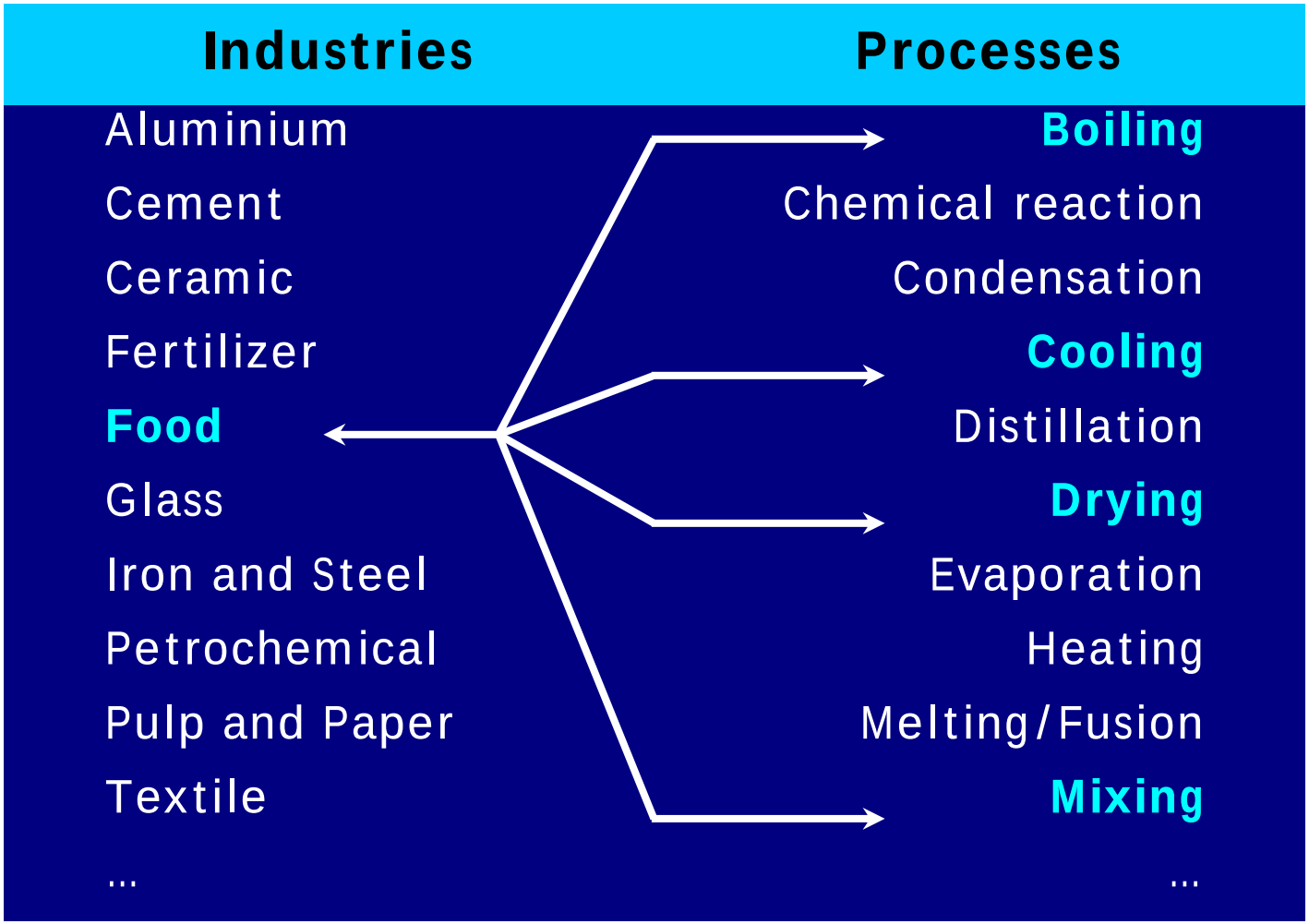
Overview of process energy efficiency

- **Review:**
  - Concept of process optimization
  - Start at the end use and go backwards
  - Map energy use and match supply with process energy needs
  - Importance of systematic maintenance
  - Energy efficiency is central to “clean technology”, “cleaner production” and “resource efficiency”
  - Cyclic process of energy efficiency promotion

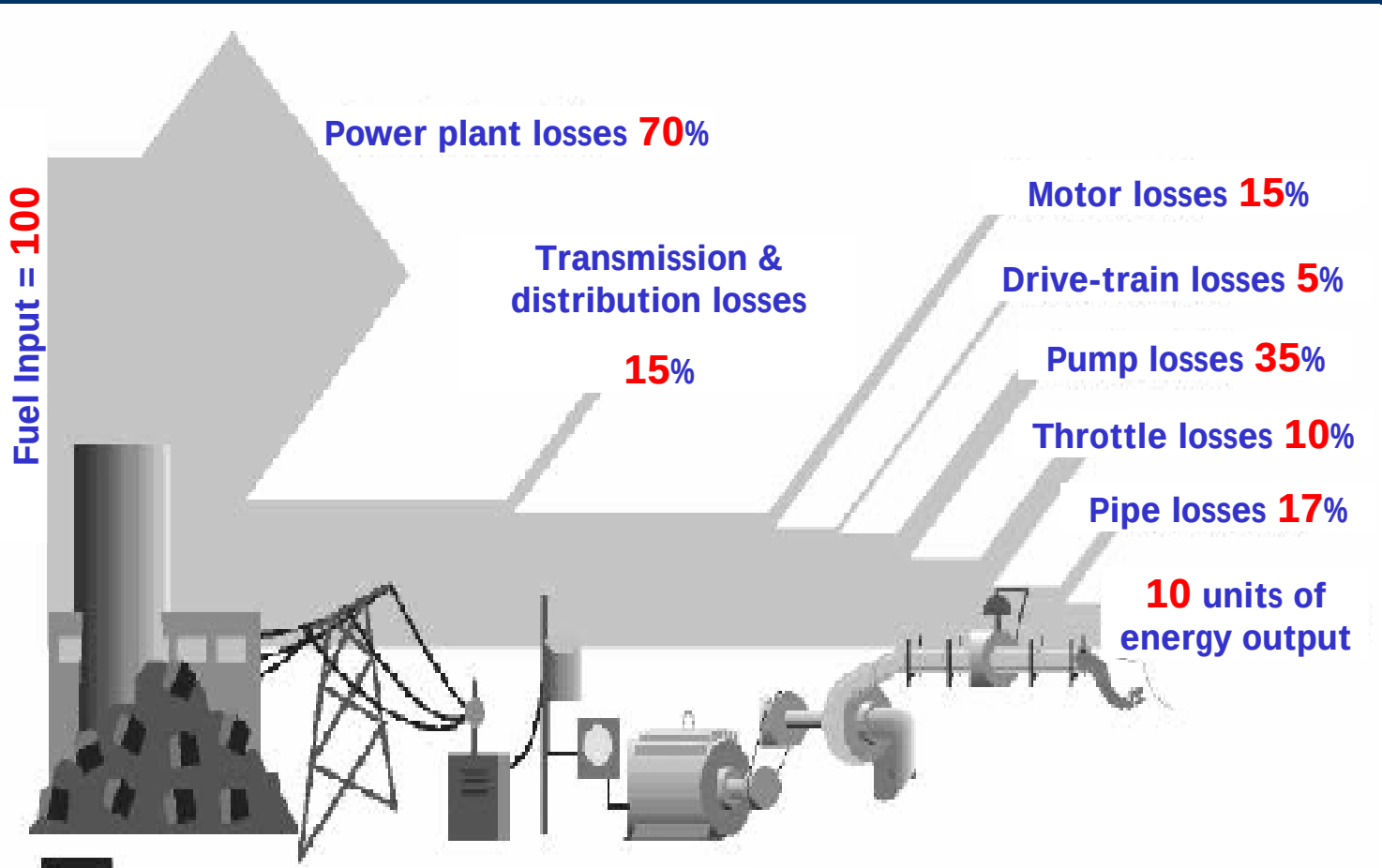
Basics of industries and processes



Processes used in an industry



Losses multiply



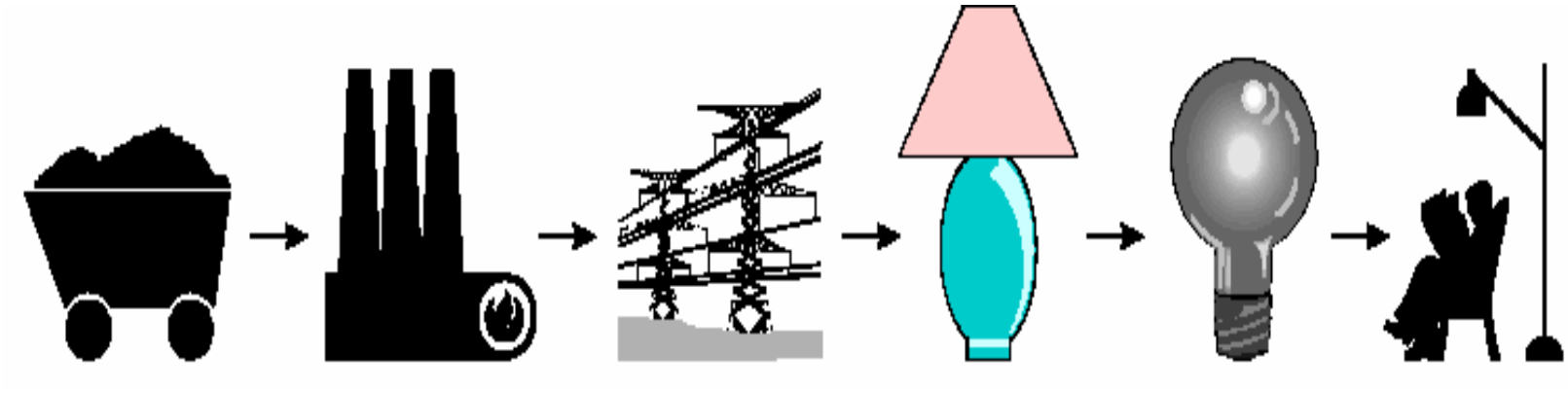
Adapted from the Drivepower Technology Atlas

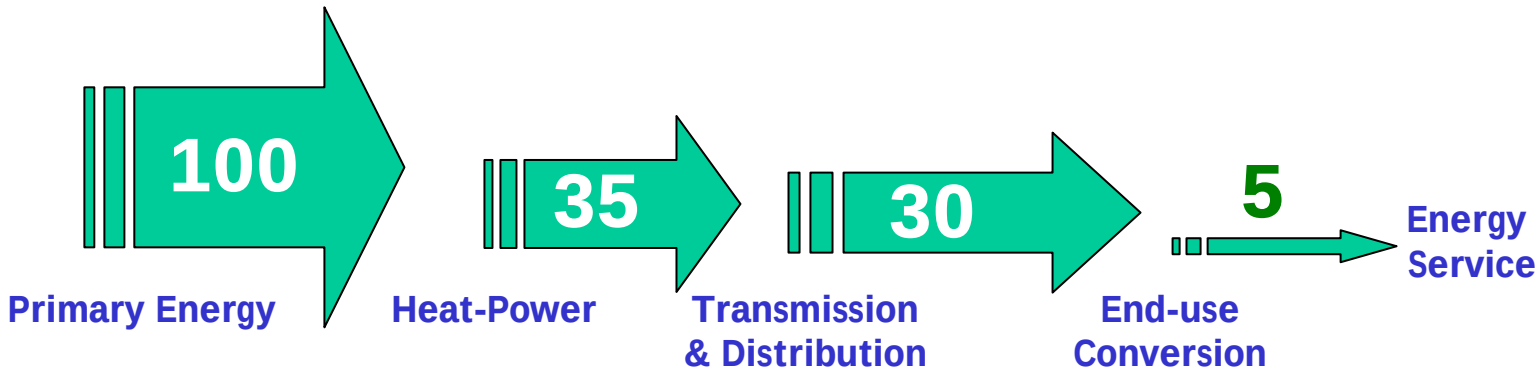
Courtesy of E SOURCE www.esource.com

Start at the end use & go backwards

- **Start at the process to get compounded savings:**
  - Compounding losses require 10 units of fuel in power plant to deliver 1 unit of flow in the pipe
  - Turn those compound losses around backwards into compounded savings
  - Savings 1 unit of flow or friction in the pipe can then save about 10 units of fuel, cost, and pollution at the power plant
  - Downsize in-plant equipment: 1 unit of saved flow or friction saves about 2.4 units of motor sizing

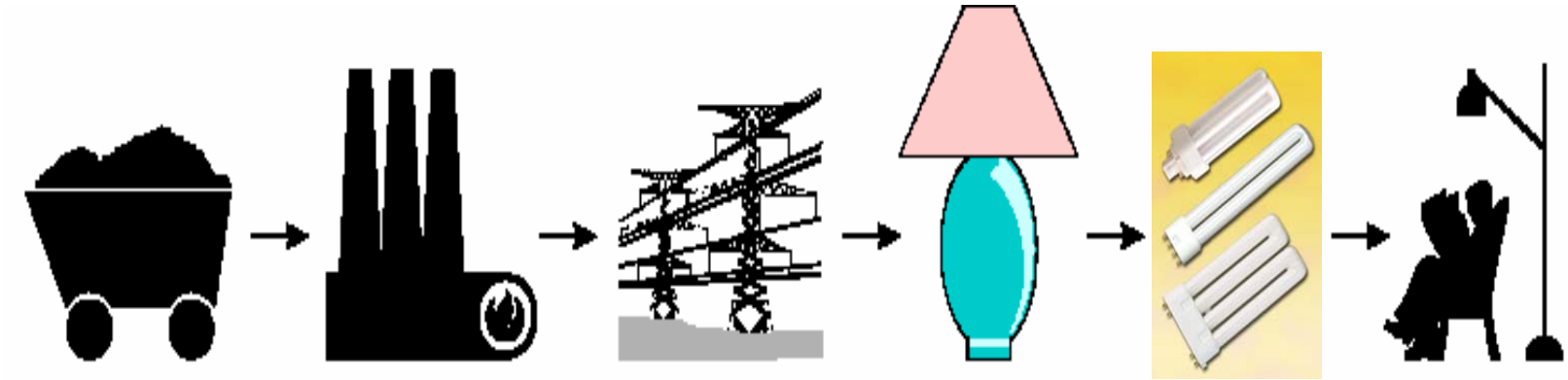
Energy flow in a lighting system

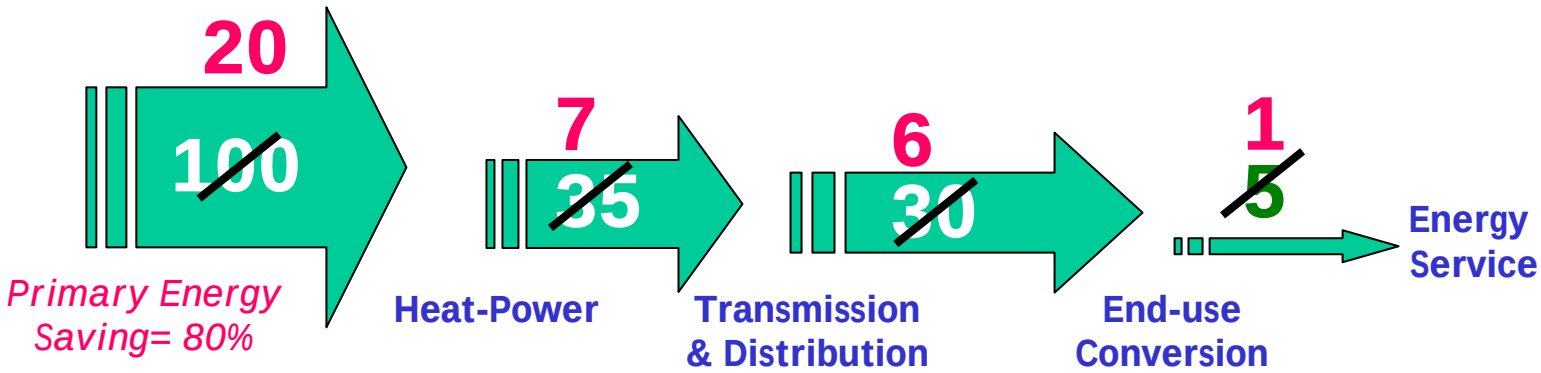




Energy flow in a lighting system

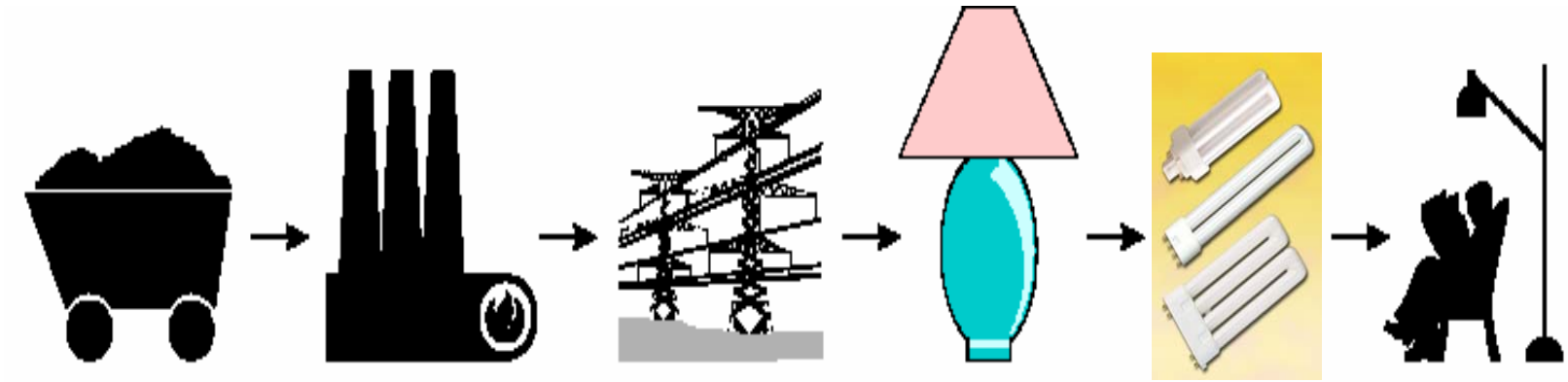
Energy efficiency: use of more efficient technologies



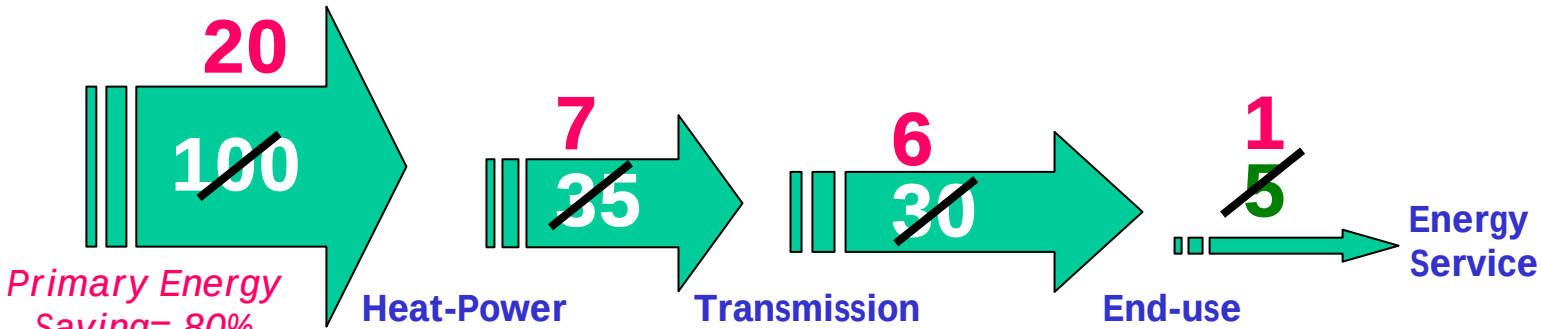


Energy flow in a lighting system

Does energy efficiency need more investment?

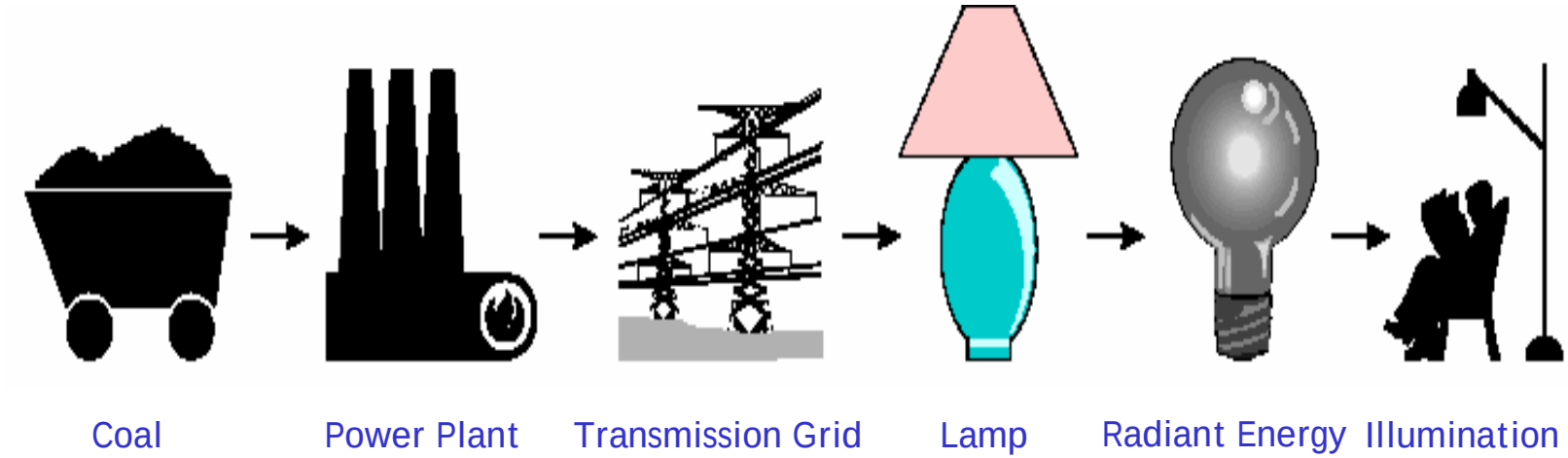


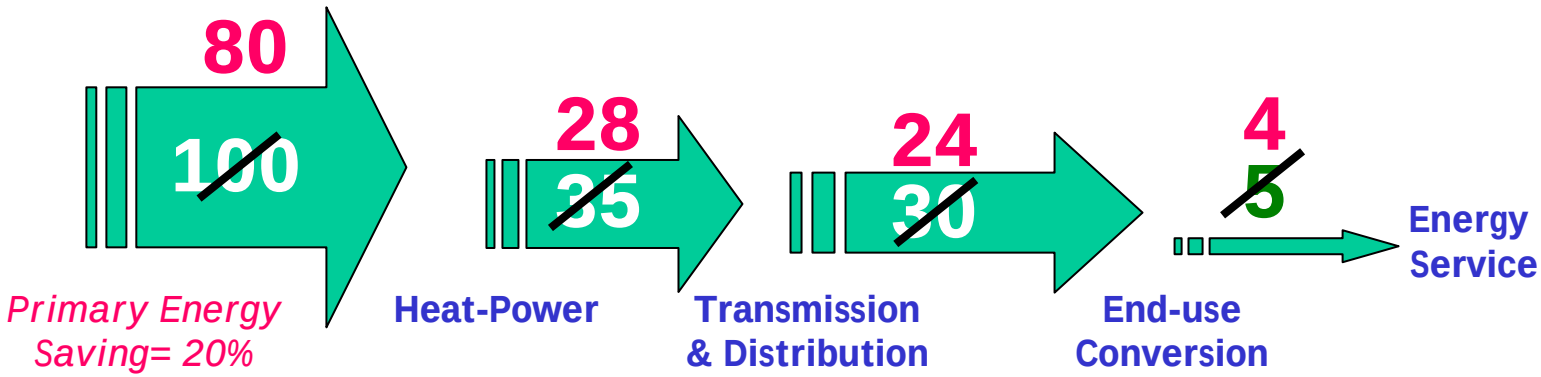
Coal → More Efficient **but Much Smaller** Power Plant → More efficient T&D System → Lamp → **More expensive** lamp → Illumination



Energy flow in a lighting system

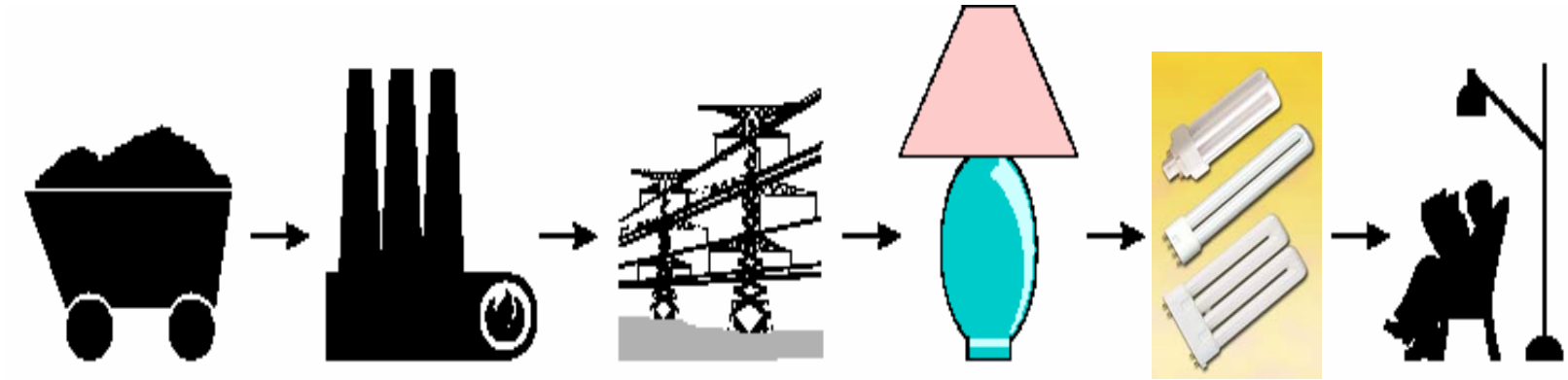
Energy conservation: switching off light when not required

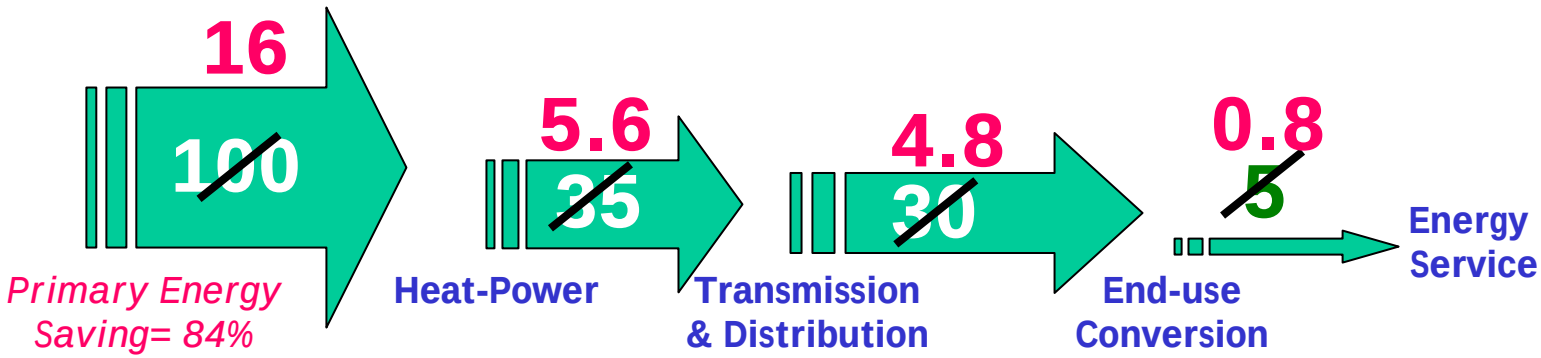




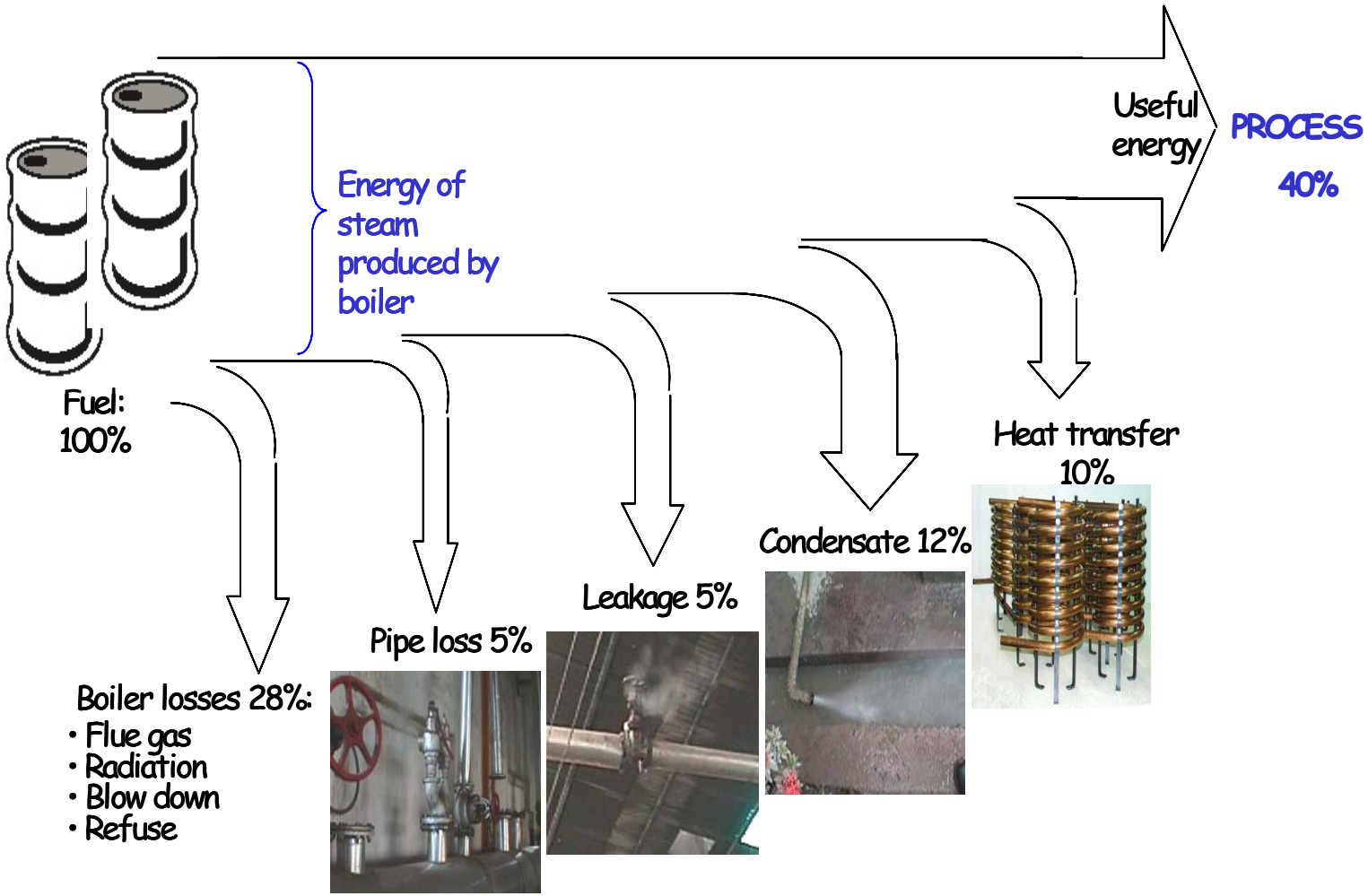
Energy flow in a lighting system

Combine energy efficient system with energy conservation practices

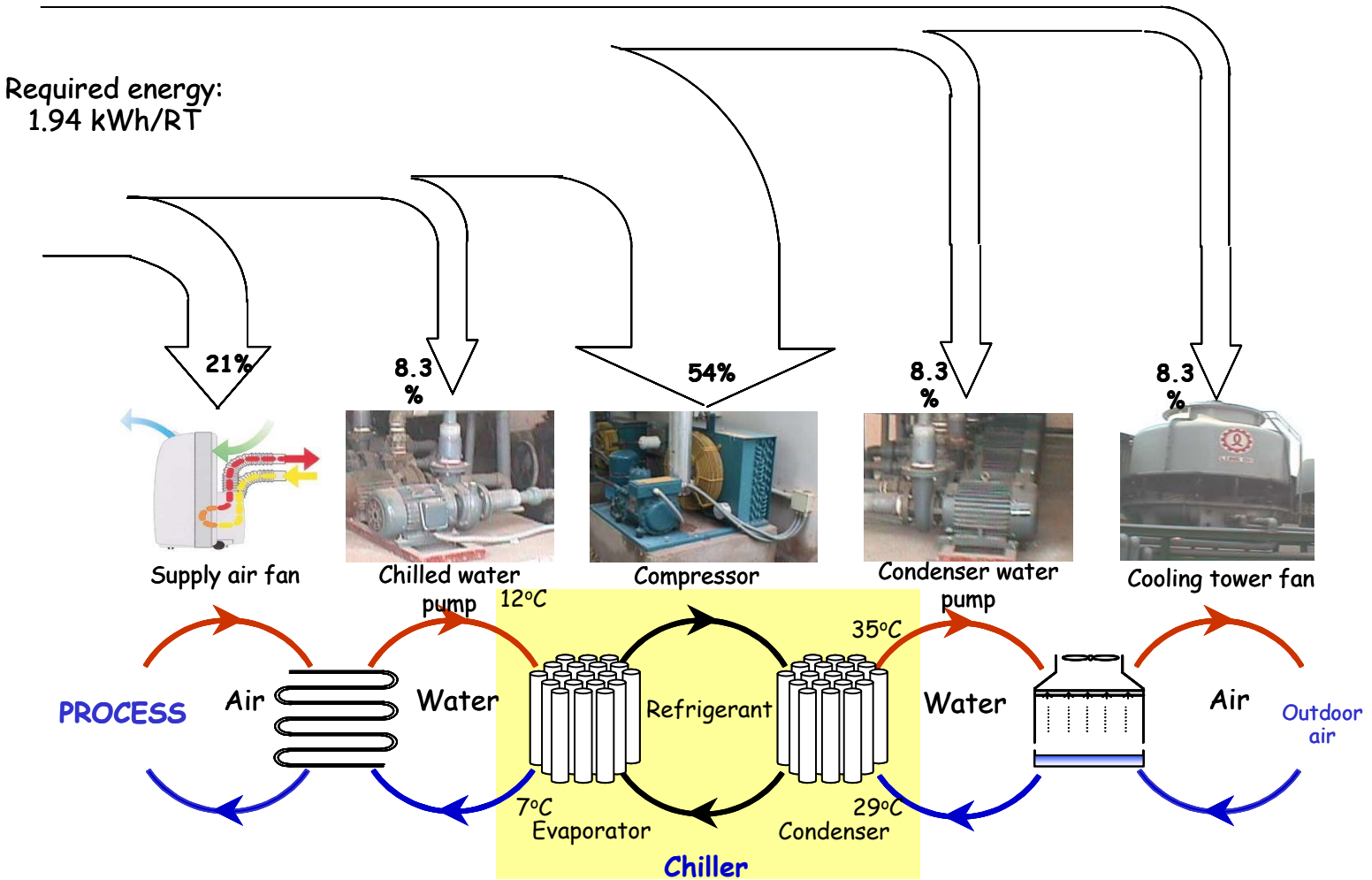




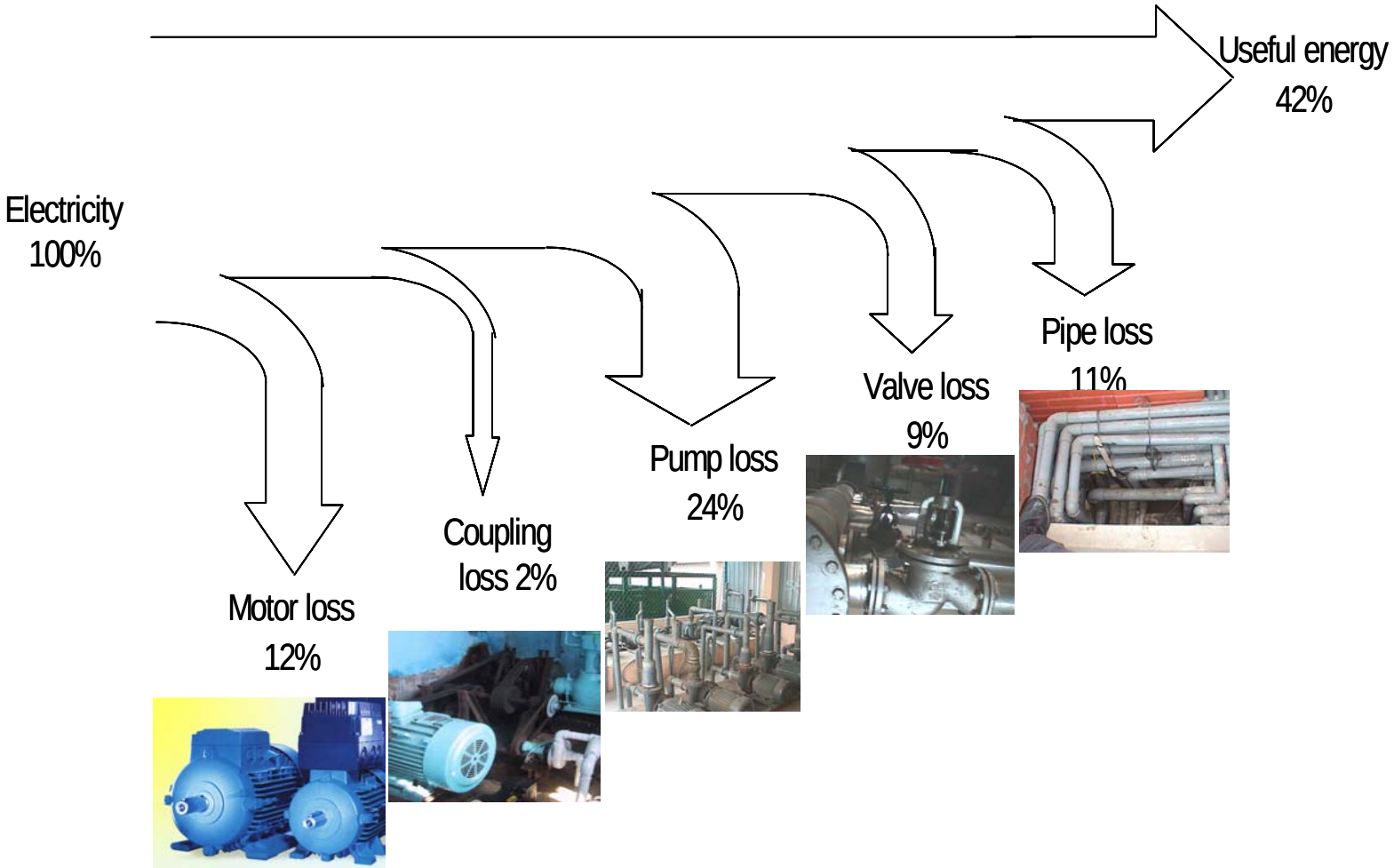
Energy flow in steam system



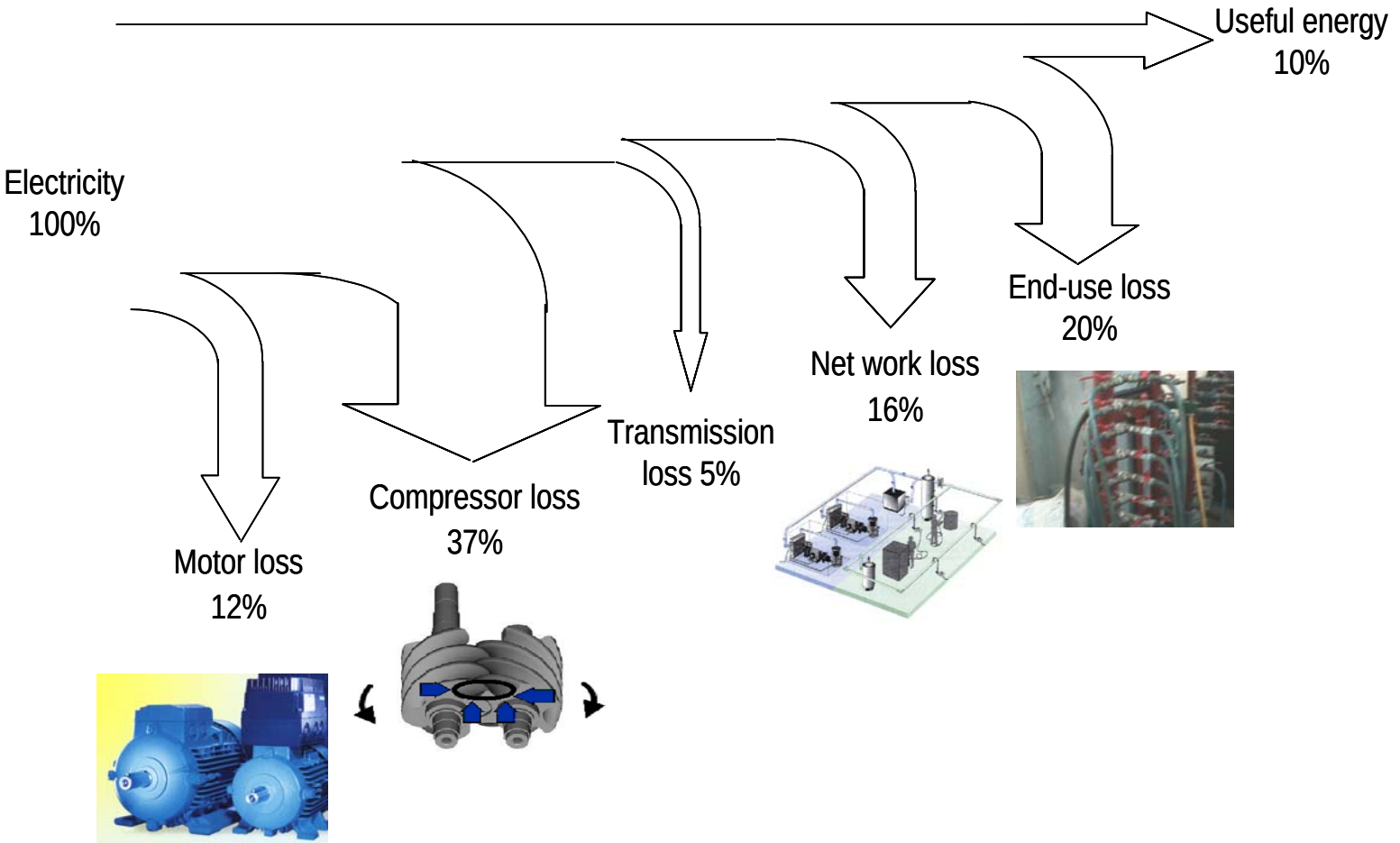
Energy flow in air conditioning system



Energy flow in pumping system



Energy flow in compressed air system



Match supply with process energy need

- **Assess the Exact Energy Needs of the Process:**
  - Understand well the main process function
  - Monitor the exact nature of energy services needed (temperature, pressure, flow rate, power, variations, part load performance…)
  - Identify all possible wastages or losses and look for ways to eliminate or reduce them (e.g. machines idling)
  - Check if the energy source matches well with the process energy service requirements
  - If not, identify least-cost and reliable utility alternative

Match supply with process energy need

- **Examples:**
  - Process needs heating at 100°C but steam is provided at 9 Bar
  - Compressed air is used for cooling a heated surface
  - Refrigerant evaporated at 8°C for maintaining the spinning section at 30°C
  - High-capacity pump installed for a process requiring low fluid flow rate

Assessing losses & ways to improve

- **Need to conduct an audit for:**
  - Making inventory of wastes generated in all areas of the factory and quantifying them
    - Include production, materials handling and storage, utilities…
    - Include raw materials, energy, water, chemicals, solid waste, waste water, air emissions, etc.
  - Evaluating the causes of the wastes being generated
    - Identify wasteful process steps and obvious lapses in working procedures and process control, spills and leakages
  - Finding solutions for eliminating such wastes or for reusing/recycling them

Importance of systematic maintenance

- **Negligence in operation and maintenance lead to:**
  - Lower energy performance
    - Fouling of cooling water circuit resulting in higher chiller power consumption
  - Reduced productivity or product quality
    - Inefficient cooling of products
  - Unscheduled system breakdown and loss of revenue
    - Breakdown of cooling tower fan

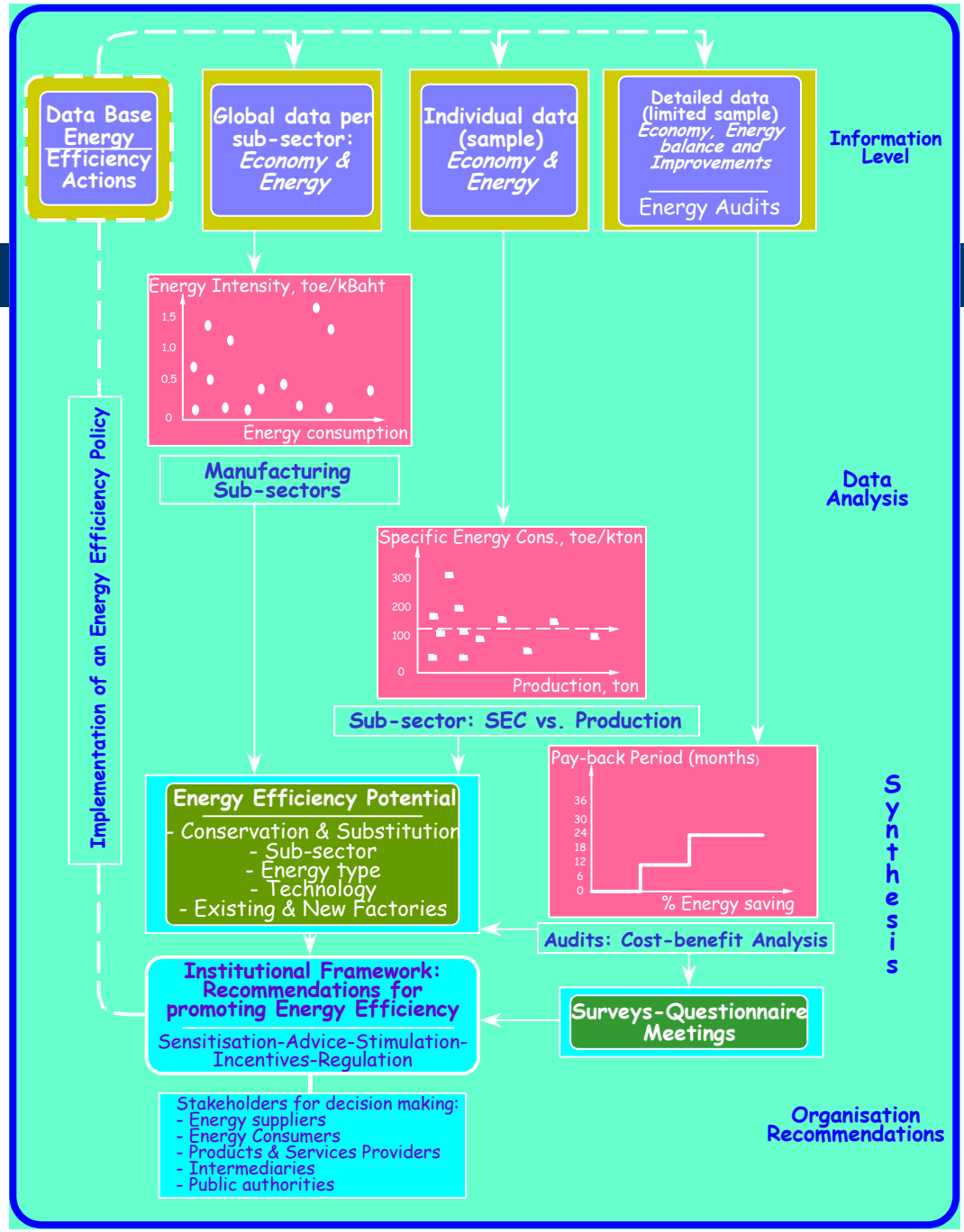
Central role of energy efficiency

- **Benefits of "Clean Technology" (CT), "Cleaner Production" (CP) or Resource Efficiency" concepts:**
  - Reduced environmental impacts
  - Reduced production costs
  - Improved product quality and/or higher productivity
  - Savings in raw materials, intermediate products, water…
  - Better working environment
  - Better corporate image, etc

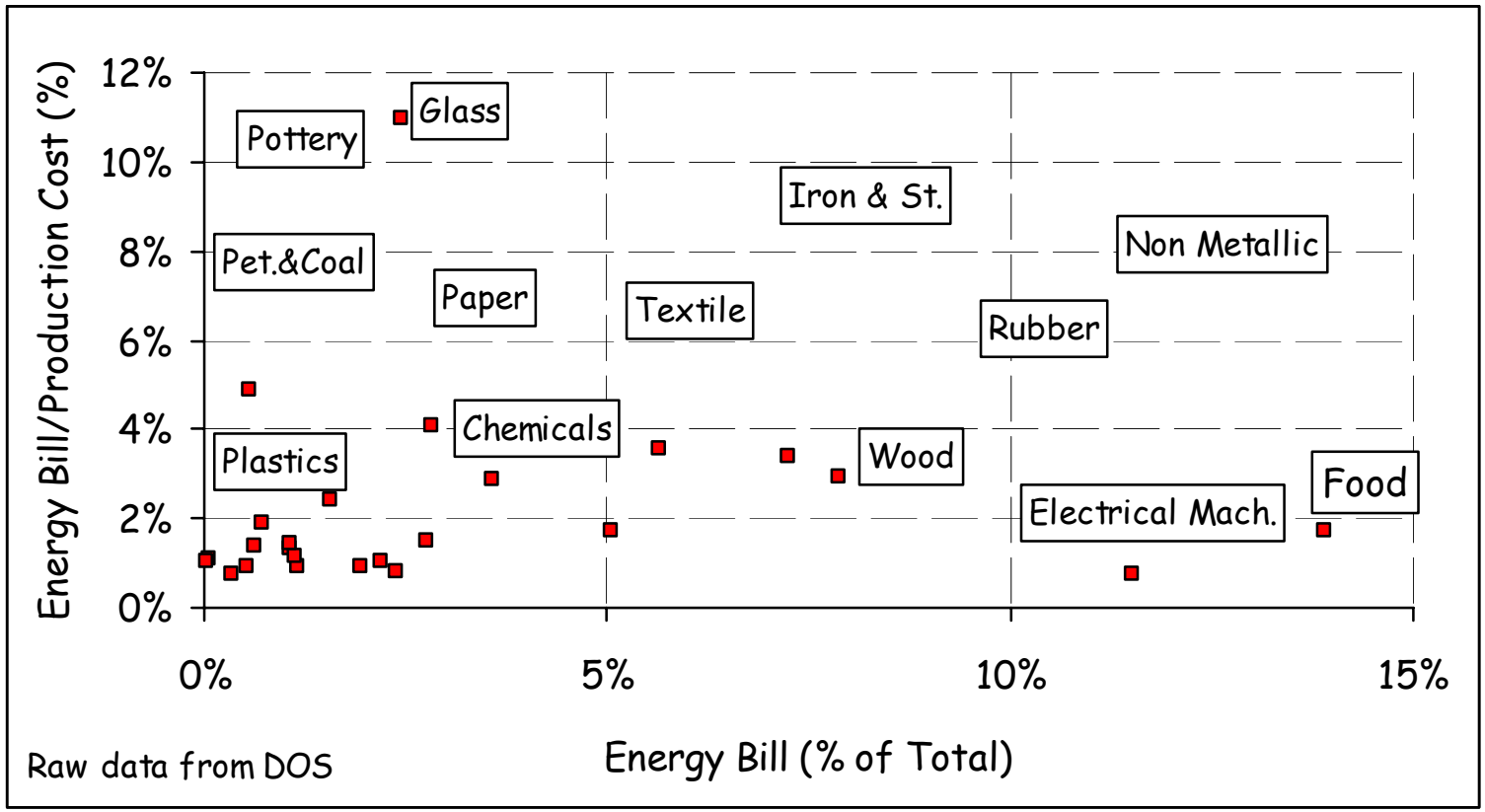
Multiple benefits of energy efficiency

- **Multiple benefits of energy efficiency:**
  - Adoption of innovative technology that allows immediate reduction of energy costs
  - Less adverse impact on the environment and human health due to low energy use (less direct or indirect NO_x, SO_x, particulate or CO_2 emissions)
  - Technical and managerial causes of resource wastage eliminated (better housekeeping and O&M, better motivation and training of personnel)

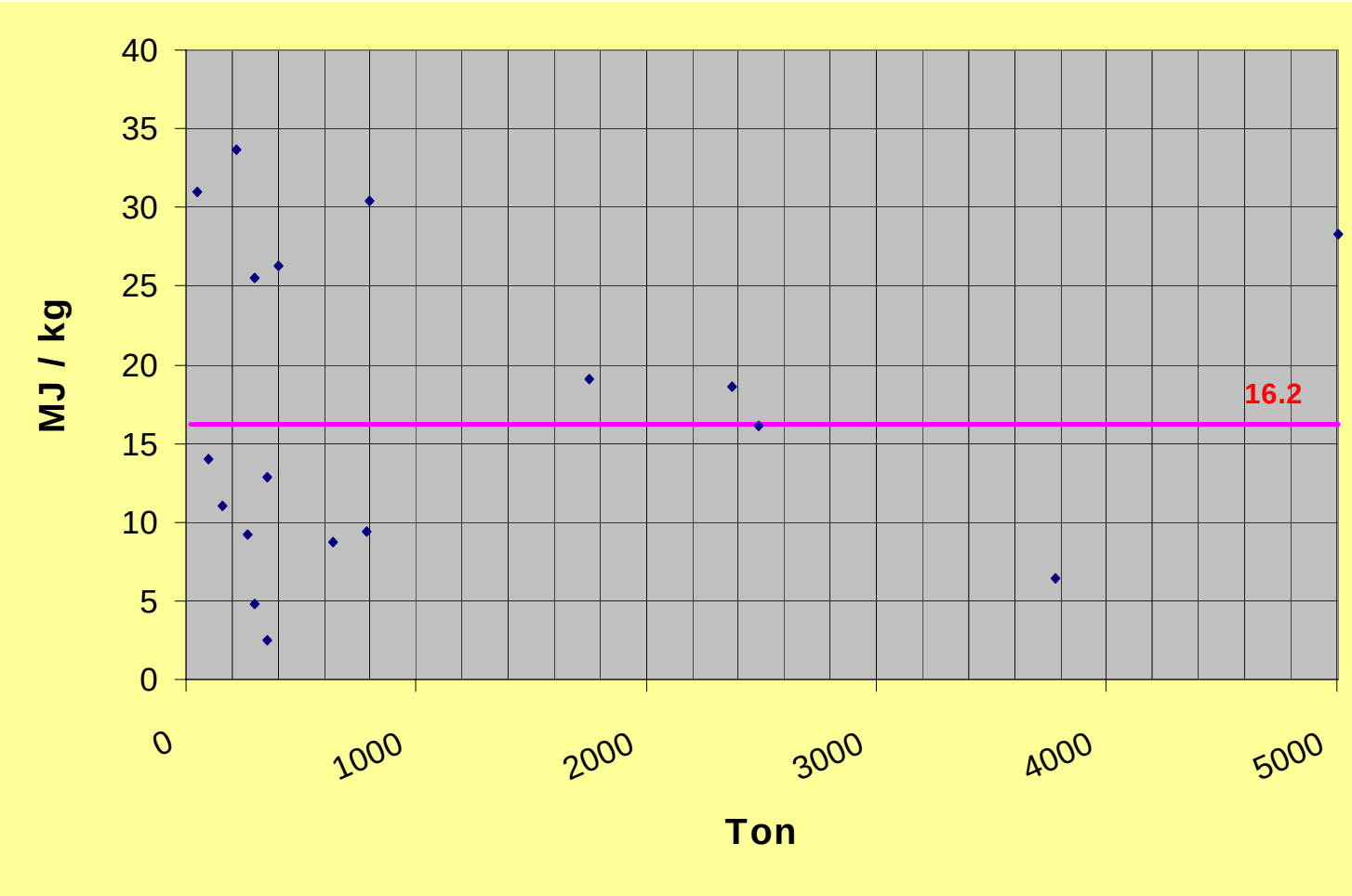
Cyclic process of energy efficiency promotion



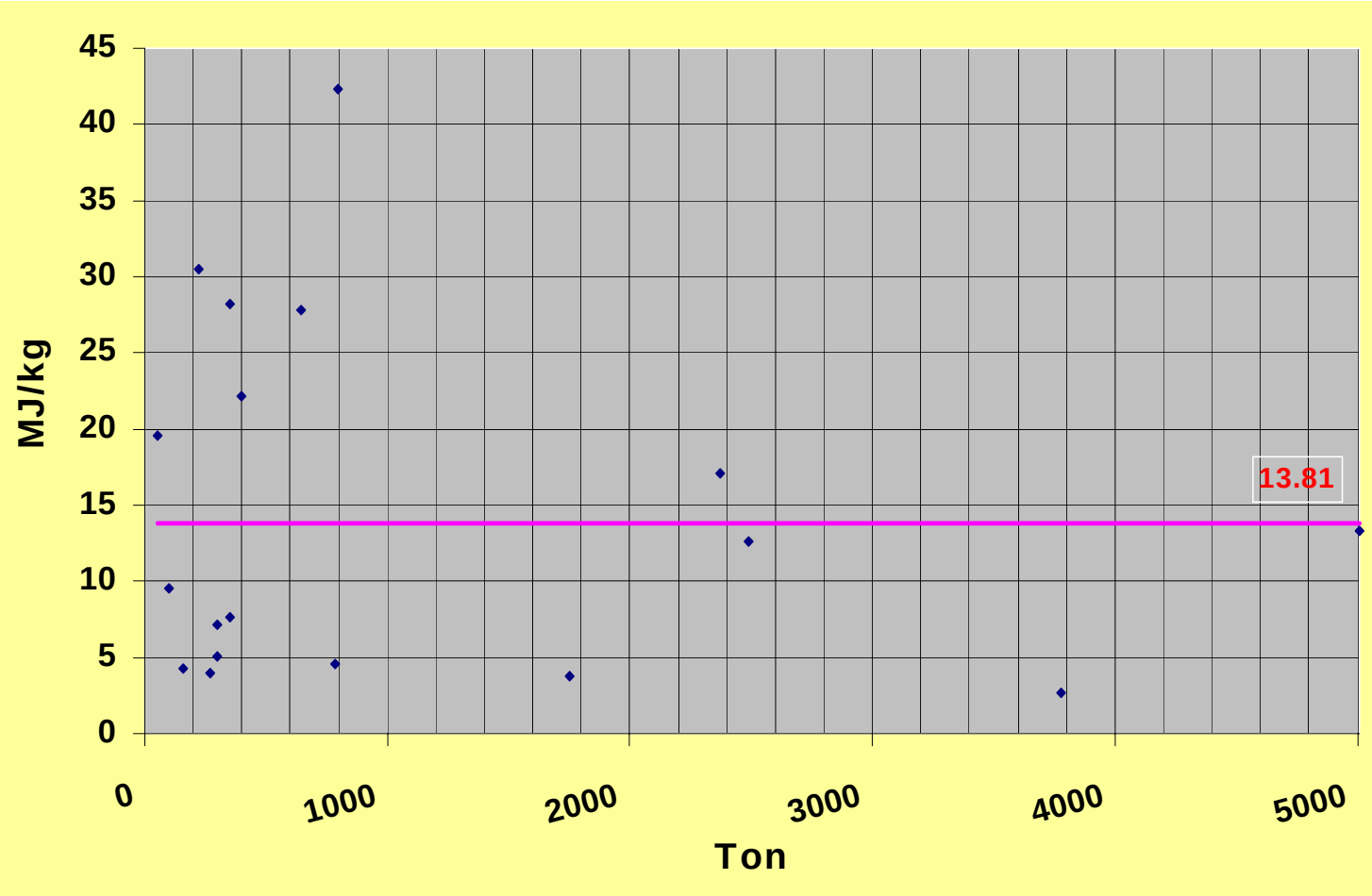
Energy intensity vs. energy cost share



Specific thermal energy (steel industry)



Specific electricity use (steel industry)



Cost-benefit analysis of EE measures