

Strategies for Reducing Energy
Usage for Small Scale Commercial
and Agricultural Business

Denis Donovan
Sustainable Energy Solutions, LLC



Sustainable Energy Solutions, LLC.

USDA

- Farm Types
 - Poultry
 - Dairy
 - Greenhouse/Nursery
 - Cattle Feedlots
 - Oilseed and Grain
 - Fruit and Tree
 - Hogs and Pigs



Sustainable Energy Solutions, LLC.

Savings Opportunities

- Motor Systems – 30-65%
- Water Heating – 20-30%
- Lighting - 40-70%
- HVAC – 10-45%
- Transportation – 5-20%
- Machinery – 5-45%



Sustainable Energy Solutions, LLC.

- Motor Systems
 - Pumps
 - Fans
 - Air compressors
 - Refrigeration compressors
 - Conveyors
 - Other applications that use an electric motor



Sustainable Energy Solutions, LLC.

- Lighting
 - Residential lighting
 - Barn lighting
 - Shop lighting
 - Area lighting
 - Process lighting



Sustainable Energy Solutions, LLC.

- Transport
 - Fork lifts
 - Work trucks
 - Hauling



Sustainable Energy Solutions, LLC.

- Machinery
 - Tractors
 - Combines
 - Harvesters
 - Hay bailers



Sustainable Energy Solutions, LLC.

- Calculations
 - Electrical Power = kW
 - $kW_{input} = (HP \times 0.746) / \text{efficiency}$
 - Electrical Energy = kWh
 - $kWh = kW_{input} \times \text{operating hours}$
 - 1 ton of refrigeration = 12,000 BTU/hr
 - $BTU/hr = GPM(\text{water}) \times 8.34 \times 60 \times dT$
 - 1 Therm = 100,000 BTU
 - 1 Gal. Propane = 92,000 BTU
 - 1 Gal. Diesel = 156,000 BTU



Sustainable Energy Solutions, LLC.

Pump Systems

- Throttle valve-controlled systems
- Recirc(bypass)line normally open
- Multiple parallel pump system with same number of pumps always operating
- Constant pump operation in a batch type process



Sustainable Energy Solutions, LLC.

Important Fundamentals

$$\text{Fluid Power} = \frac{\text{Flow rate} * \text{Head} * \text{S.G.}}{3960}$$

$$\text{Fluid Energy} = \text{Fluid Power} * \text{operating time}$$

Reduce the run time

Reduce the flow rate

Reduce the head





Sustainable Energy Solutions, LLC.

How??

- Reduce Water Flow
 - Low flow emitters
 - Fix leaks
- Reduce Pressure
 - Low pressure emitters
 - Fix Leaks



Sustainable Energy Solutions, LLC.

Friction Losses

- What are some of the sources of friction in the pumping system?

pipe walls	tees
valves	reducers/expanders
elbows	expansion joints

Just about everything including the fluid itself!



Sustainable Energy Solutions, LLC.

Static Head

$$H_S = 2.31 \times (P_{Final} - P_{start}) + \Delta Z$$

Frictional Head

$$H_f = H_{total} - H_S$$

where

$$H_{total} = 2.31 \times (P_{dis} - P_{suc})$$



Sustainable Energy Solutions, LLC.

Darcy-Weisbach

Double the:

Friction factor

Length

Diameter

Velocity

Velocity Head

Pressure drop is:

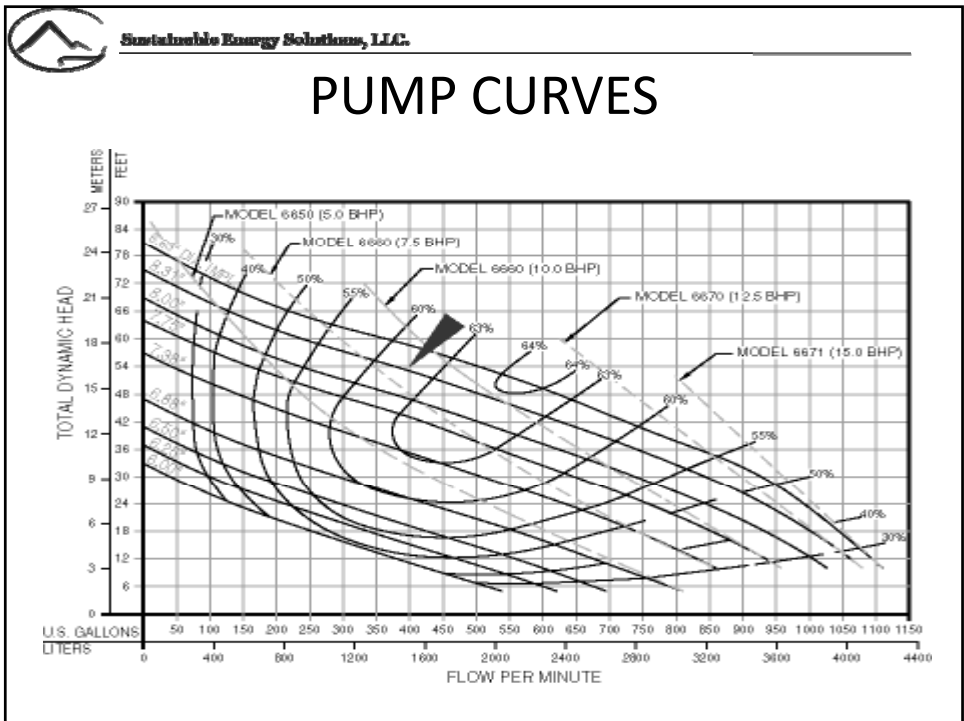
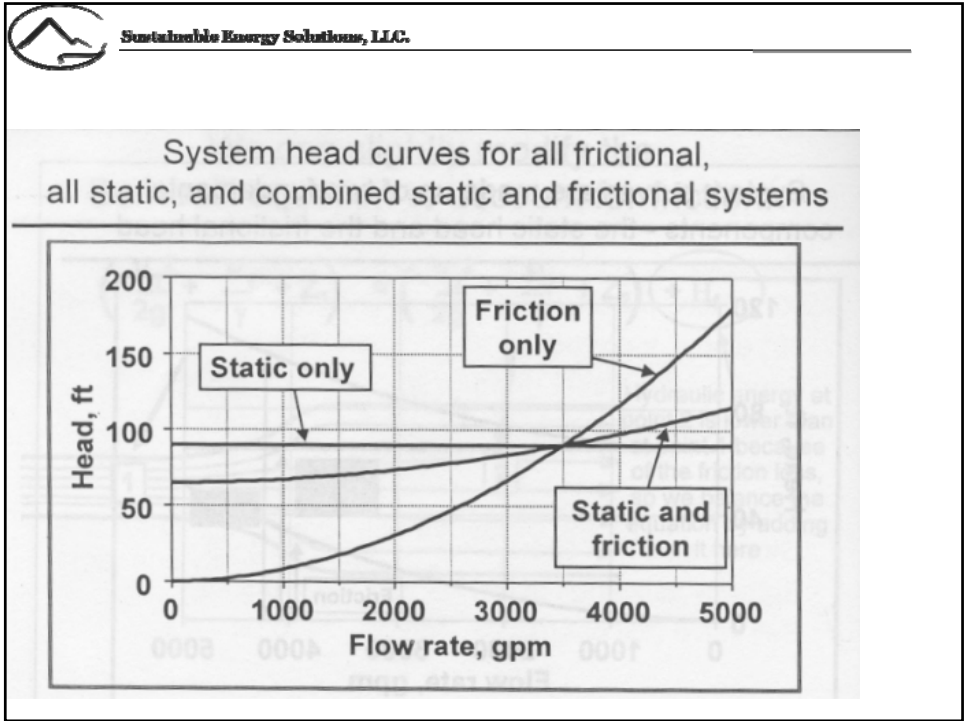
Doubled

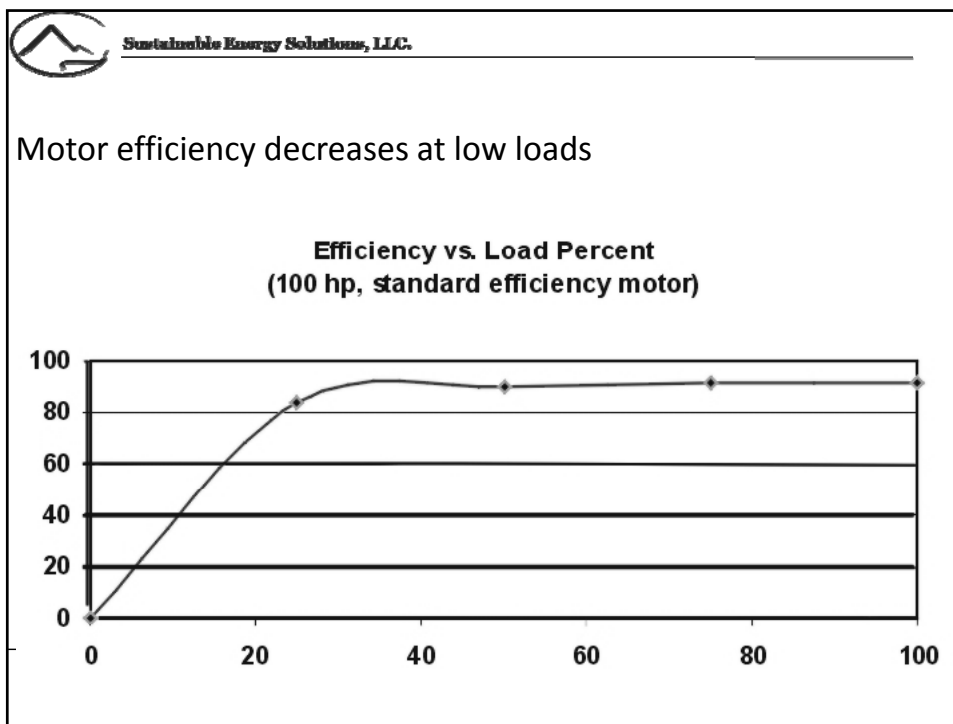
Doubled

Halved

Quadrupled


Doubled





Replace current motors with high efficiency motors

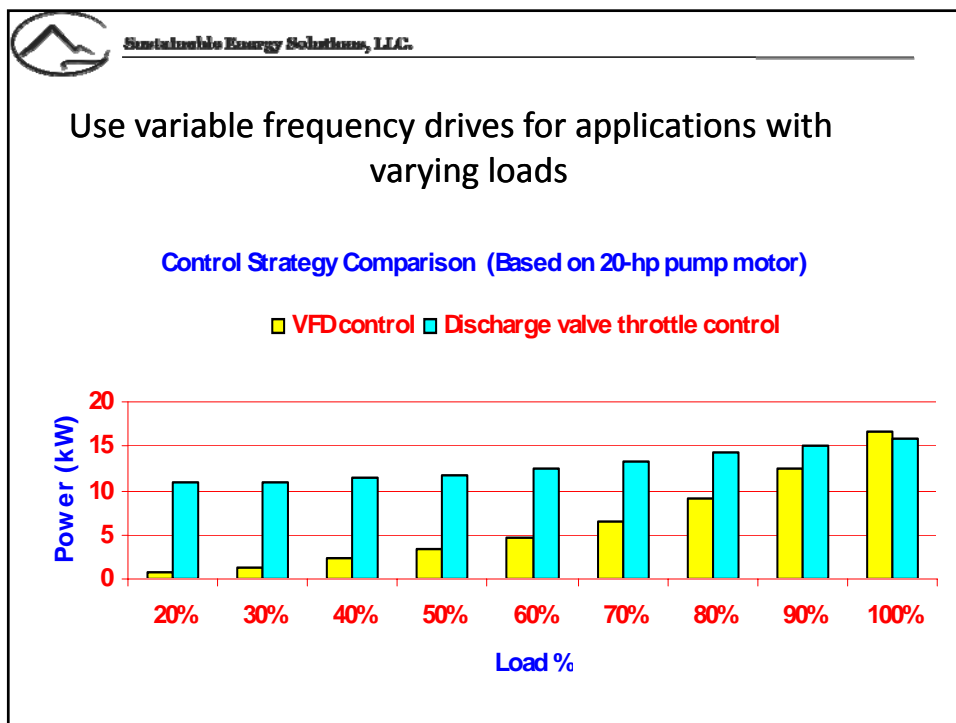
Motor Size (hp)	Standard Eff.	High Eff.	Energy Savings (kWh/yr)	Potential Savings (\$/yr)	Cost Premium (\$/motor)
5	0.824	0.883	2,650	\$265	\$125
10	0.85	0.903	4,512	\$451	\$134
20	0.866	0.911	7,455	\$746	\$123
50	0.89	0.932	16,545	\$1,654	\$420
100	0.909	0.944	26,655	\$2,665	\$1,044
200	0.927	0.954	39,903	\$3,990	\$1,801

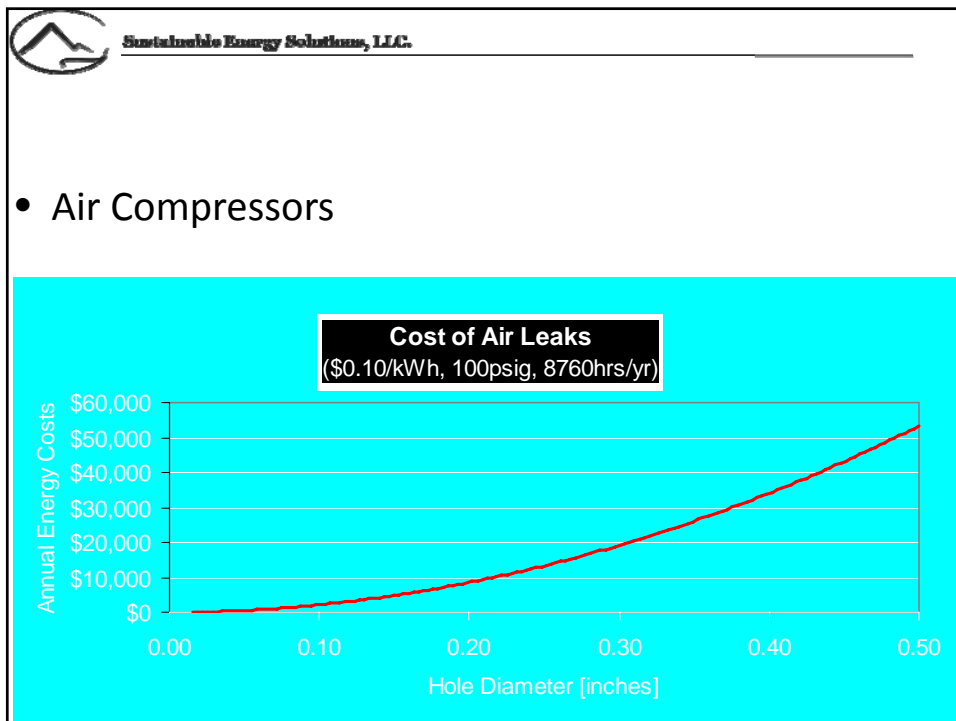
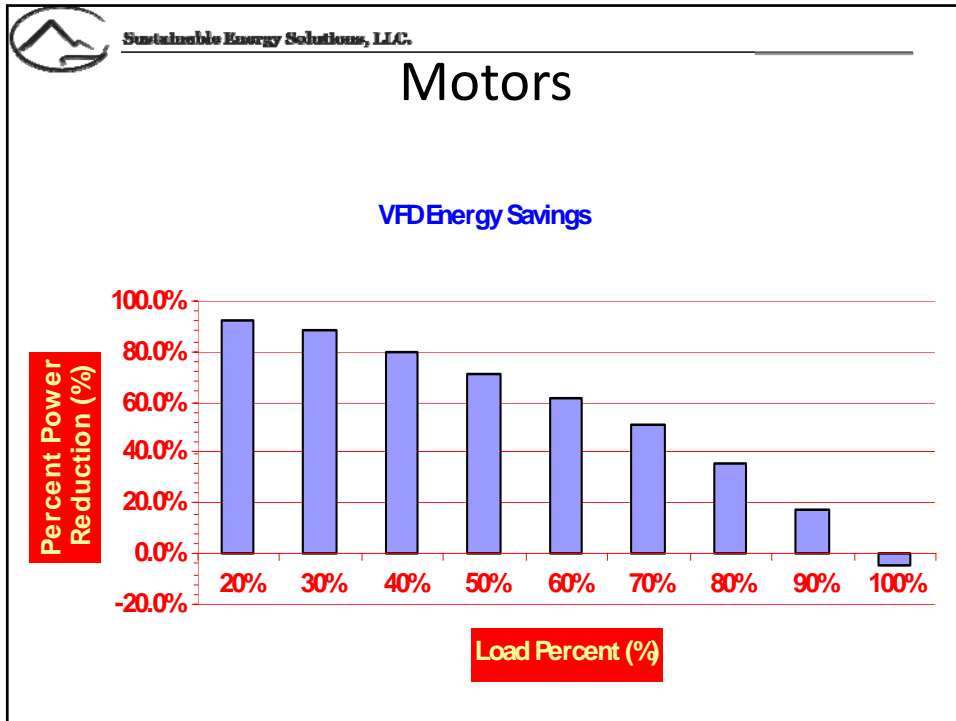
 Sustainable Energy Solutions, LLC.

Motors

- Variable Speed Drives
 - Systems with a bypass
 - Systems with changing loads
 - Systems with throttling valves

NOT FOR SYSTEMS WITH LARGE STATIC





- Air Compressors



Sustainable Energy Solutions, LLC.

Lighting

- Tubular Fluorescent
 - T-12
 - T-8
 - T-5



Sustainable Energy Solutions, LLC.

Lighting

- High Intensity Discharge (HID)
 - Mercury Vapor
 - Metal Halide
 - High Pressure Sodium
 - Low Pressure Sodium



Sustainable Energy Solutions, LLC.

Lighting

- Light Emitting Diode (LED)
 - Exit signs
 - Sign Boards
 - Spot Lighting



Sustainable Energy Solutions, LLC.

Lighting

- Ballast
 - Magnetic
 - Electronic
 - Rapid Start
 - Dimmable



Sustainable Energy Solutions, LLC.

Energy Assessments

- An Energy Assessment provides the facility management a road map to achieving improvements in operating efficiency.
- The effectiveness of the Assessment is dependent on the Assessment teams experience and systems knowledge.



Sustainable Energy Solutions, LLC.

SYSTEMS

- Component optimization involves separating the component and treating it as stand alone.
- System optimization looks at how the sum of the components function together and how changing one can affect the other.



Sustainable Energy Solutions, LLC.

Identifying the Target

- In order to identify the energy abusers an understanding of how that component functions within the system must be determined.
- By analyzing and understanding systems, maximum savings can be achieved.



Sustainable Energy Solutions, LLC.

Assessment Process: Level 1

- “No Brainers”
 - Lighting
 - Premium Efficiency Motors
 - Throttled Valves
 - Air Leaks



Sustainable Energy Solutions, LLC.

Assessment Process: Level 2


- Working together with the facility management and staff, the Assessment team will identify the targets.
- The targets will be determined based on energy consumption, maintenance issues, and comfort complaints.
- The payback criteria will be determined by management.



Sustainable Energy Solutions, LLC.

Assessment Process: Level 2

- An estimated annual savings for the proposed changes is calculated.
- The estimated cost to implement the change will be determined.
- The estimated simple payback can be found and is then compared to the criteria determined by the facility management.




Sustainable Energy Solutions, LLC.

Case Studies

- Pump Sizing

Three pumps rated at 2,400 gallons per minute and 180 feet of head supply the chilled water at the facility. Balancing valves located downstream from the main supply pumps control the flow rate in the chilled water system. The valves induce a 53 psi pressure drop. This is the single largest pressure drop in the chilled water system; causing the pump motors to supply an estimated additional 50 horsepower each. Fully opening the balance valves and resizing the chilled water pumps to better match system demands can save a considerable amount of energy.




Sustainable Energy Solutions, LLC.

Case Studies

- Pump Sizing


Type of Resource Saved	= Electricity
Estimated Resource Saved	= 122.13 kW
	= 357,075 kWh/yr
Estimated Cost Savings	= \$35,120/yr
Implementation Cost	= \$62,742
Simple Payback Period	= 1.79 years (21 months)



Sustainable Energy Solutions, LLC.

Case Studies

- Lighting
 - Impressive economic, energy, and maintenance savings can be achieved when retrofitting metal halide with high-bay fluorescent fixtures.
 - 51% less energy consumption.
 - Crisp white lighting with consistent color over entire life span.
 - Instant-on and instant-restrike.
 - Flexibility of energy consumption and lighting when utilizing accessories.
 - (i.e. motion sensors, light level detectors).
 - Multiple fluorescent lamps in each high-bay fixture adds to lighting reliability.
 - Reduction of cooling load by a minimum of 764 Btu/hr per fixture.



Sustainable Energy Solutions, LLC.

Case Studies

- Lighting

Type of Resource Saved	= Electricity
Estimated Resource Saved	= 153,858 kWh/yr
	= 24.87 kW
Estimated Cost Savings	= \$15,078/yr
Estimated Cost	= \$21,460
Simple Payback Period	= 1.42 years (18 months)



Sustainable Energy Solutions, LLC.

Lessons Learned

- An Energy Assessment yields significant potential energy savings!
- The savings are real!!
- Sometimes you can't see the forest through the trees!!!



Sustainable Energy Solutions, LLC.

Renewable Energy

- Solar
- Hydroelectric
- Wind
- Geothermal



Sustainable Energy Solutions, LLC.

Renewable Energy

- Solar Electric
 - Photovoltaic
- Solar Thermal
 - Water Heating
 - Air Heating



Sustainable Energy Solutions, LLC.

Renewable Energy

- Hydroelectric
 - Topography
 - Rivers
 - Reservoirs
 - Elevated Tanks