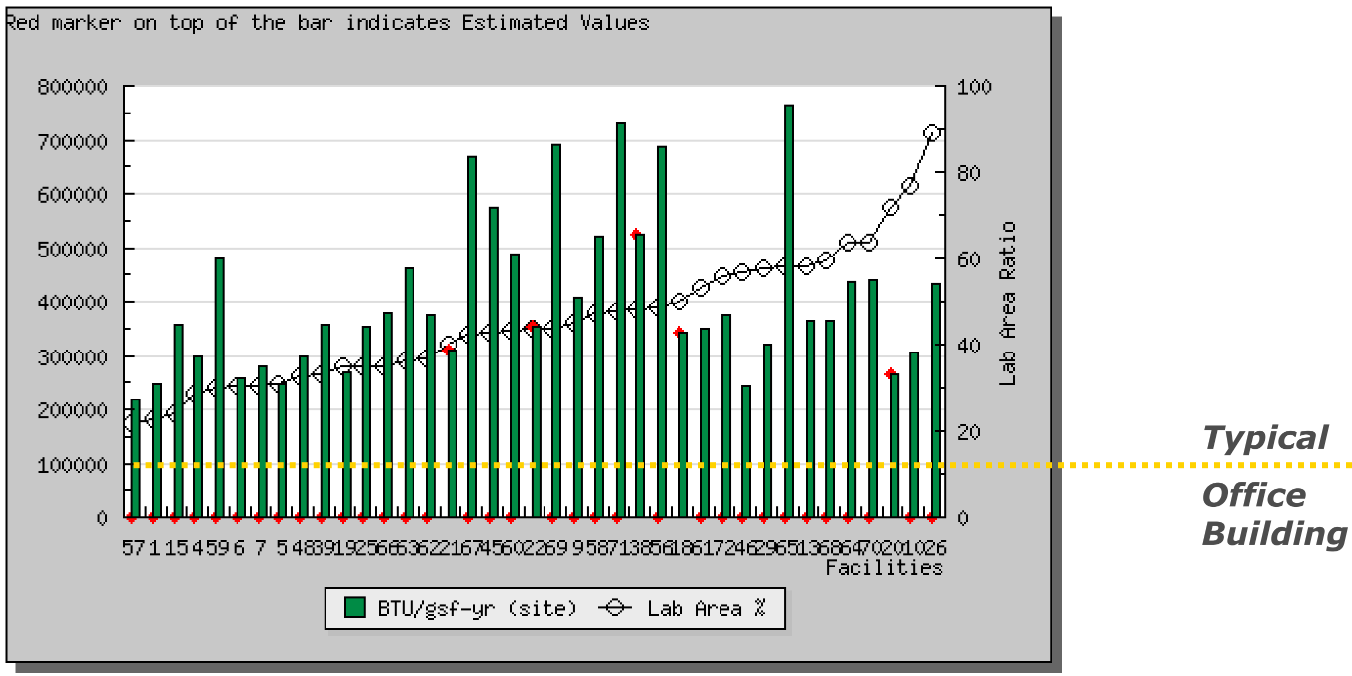
5 Big Hits in Laboratories

Key Concepts for Sustainable Laboratory Design

Dale Sartor, P.E.
Group Leader, Applications Team
Building Technologies Department
Lawrence Berkeley National Laboratory
FIMS Workshop – June 16, 2009

3 to 8 times as energy intensive as office buildings



Total Site Energy Use Intensity BTU/sf-yr
for various laboratories in the Labs21 Benchmarking Database

Why Sustainability for Labs?

- **Laboratories are very energy intensive**
  - 3 to 8 times as energy intensive as office buildings
- **Substantial efficiency opportunities**
  - 30%-50% savings over standard practice

Labs21 Program

- Funded by the DOE Federal Energy Management Program and EPA Facilities Management and Services Division to improve the environmental performance of U.S. laboratories
  - Optimize whole building efficiency on a life-cycle basis
  - Assure occupant safety
  - Minimize overall environmental impacts

Labs21 Program Components

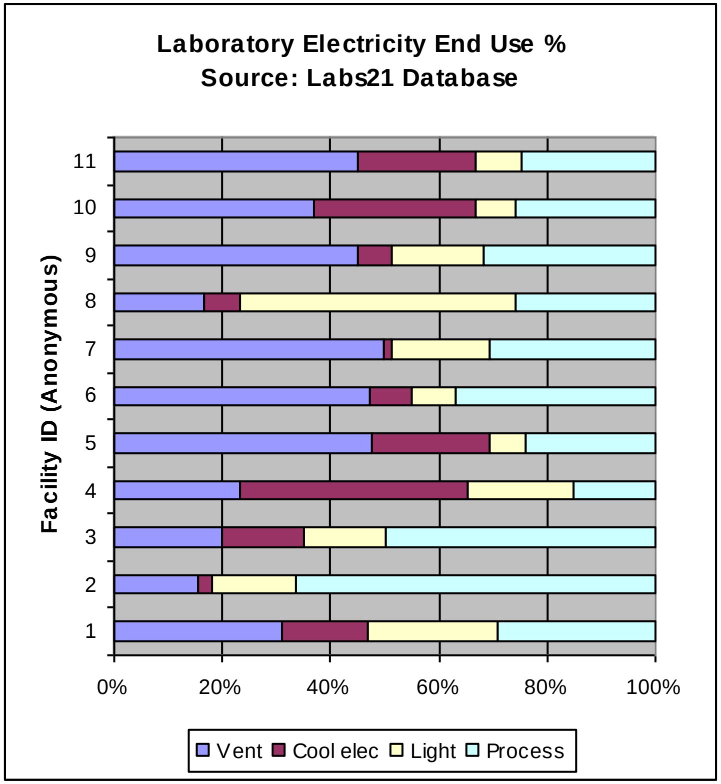
- Partnership Program
  - Draws together lab owners and designers committed to implementing high performance lab design.
- Training Program
  - Includes annual technical conference, training workshops, and other peer-to-peer opportunities.
- Tool Kit for Sustainable Design
  - Resources for owners, designers, and operators

Labs21 Toolkit

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- *Core information resources*
  - Design Guide
  - Case Studies
  - Energy Benchmarking
  - Best Practice Guides
  - Technical Bulletins
- *Design process tools*
  - Env. Performance Criteria
  - Design Intent Tool
  - Labs21 Process Manual

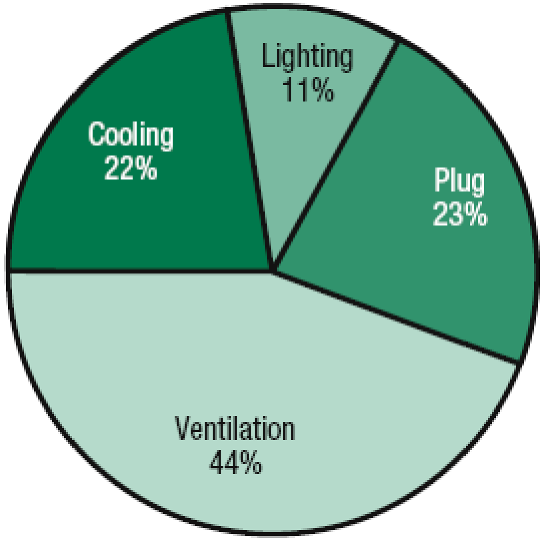
Lab Energy Use is Dominated by HVAC



- Ventilation is the largest component of energy consumption in most labs
  - % varies by lab type and location
- In some labs, 10-20% savings in ventilation is equivalent to total lighting energy use

Five BIG HITS

1. Scrutinize the air changes:
   Optimize ventilation rates
2. Tame the hoods:
   Compare options
3. Drop the pressure drop:
   Use lower pressure-drop HVAC designs
4. Get real with plug loads:
   Right-size HVAC systems
5. Just say no to re-heat:
   Minimize simultaneous heating and cooling



Annual electricity use in Louis Stokes Laboratory, National Institutes of Health , Bethesda, MD

#1 Scrutinize the Air Changes

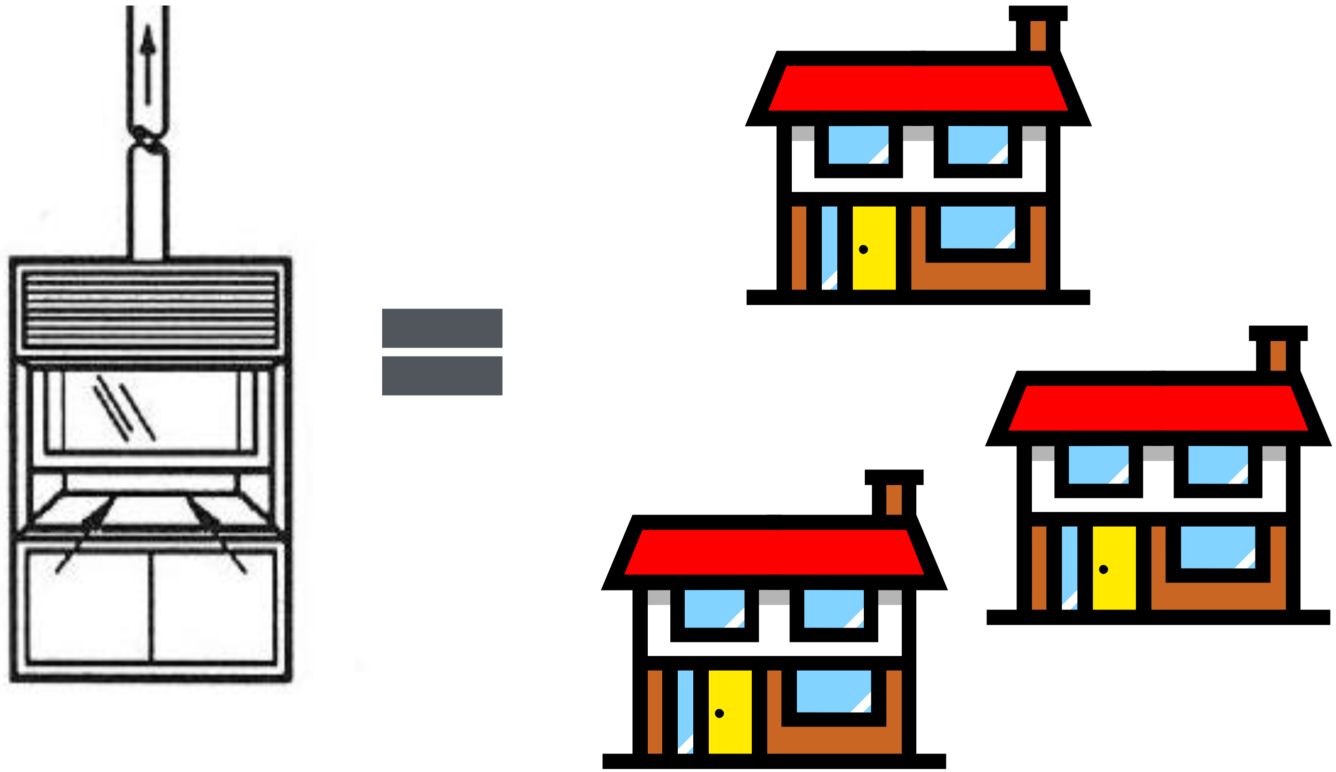
Air change rates have large peak and total cost impact

- Don’t assume air changes are driven by thermal loads
- What do you use as minimum air change rate (ACR)?
  - Why? Why? Why?
- When is ten or more air changes safe and six air changes (or less) not?

Scrutinize the Air Changes

- Options to consider
  - cfm/sqft rather than ACR
  - Panic switch concept
  - Cascading air from clean to dirty
  - Setback ACR when lab is unoccupied
  - Demand controlled ventilation (based on monitoring of hazards and odors)
  - Control Banding (one rate doesn't fit all)
  - Modeling and simulation for optimization
- Ventilation effectiveness is more dependent on lab and HVAC design than air change rates (ACR)
- High ACR can have a negative impact on containment devices

Fume hood Energy Consumption



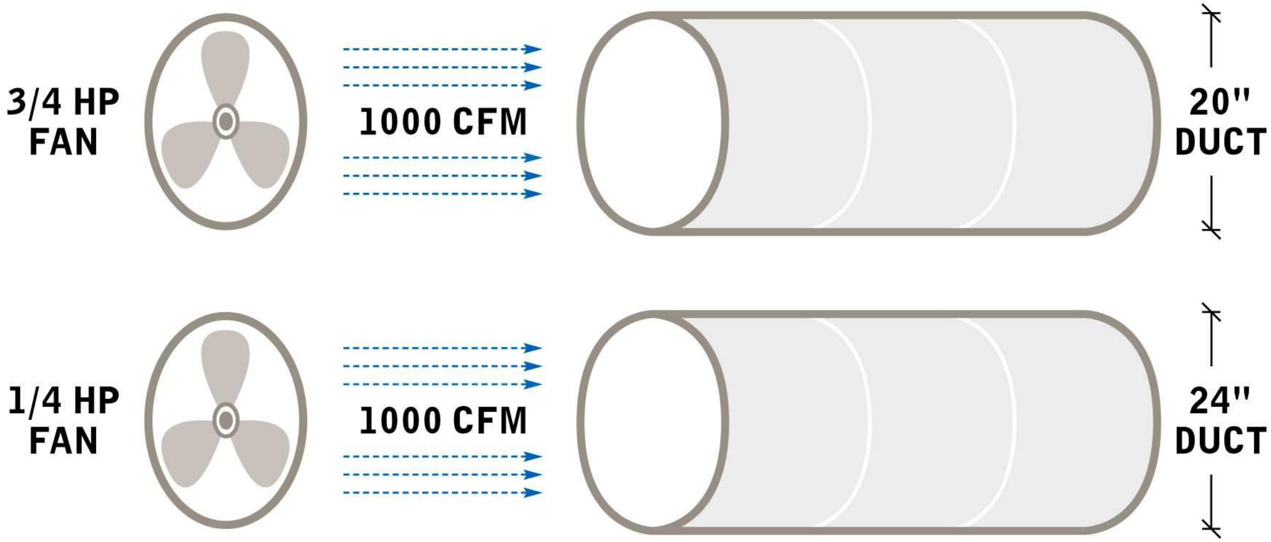
Tame the Hoods

1. Reduce the number and size of hoods
2. Restrict the sash opening
3. Use Two “speeds” occupied and un-occupied
4. Use variable air volume (VAV)
5. Auto sash closures
6. Consider high performance hoods
7. Say no to Auxiliary Air hoods

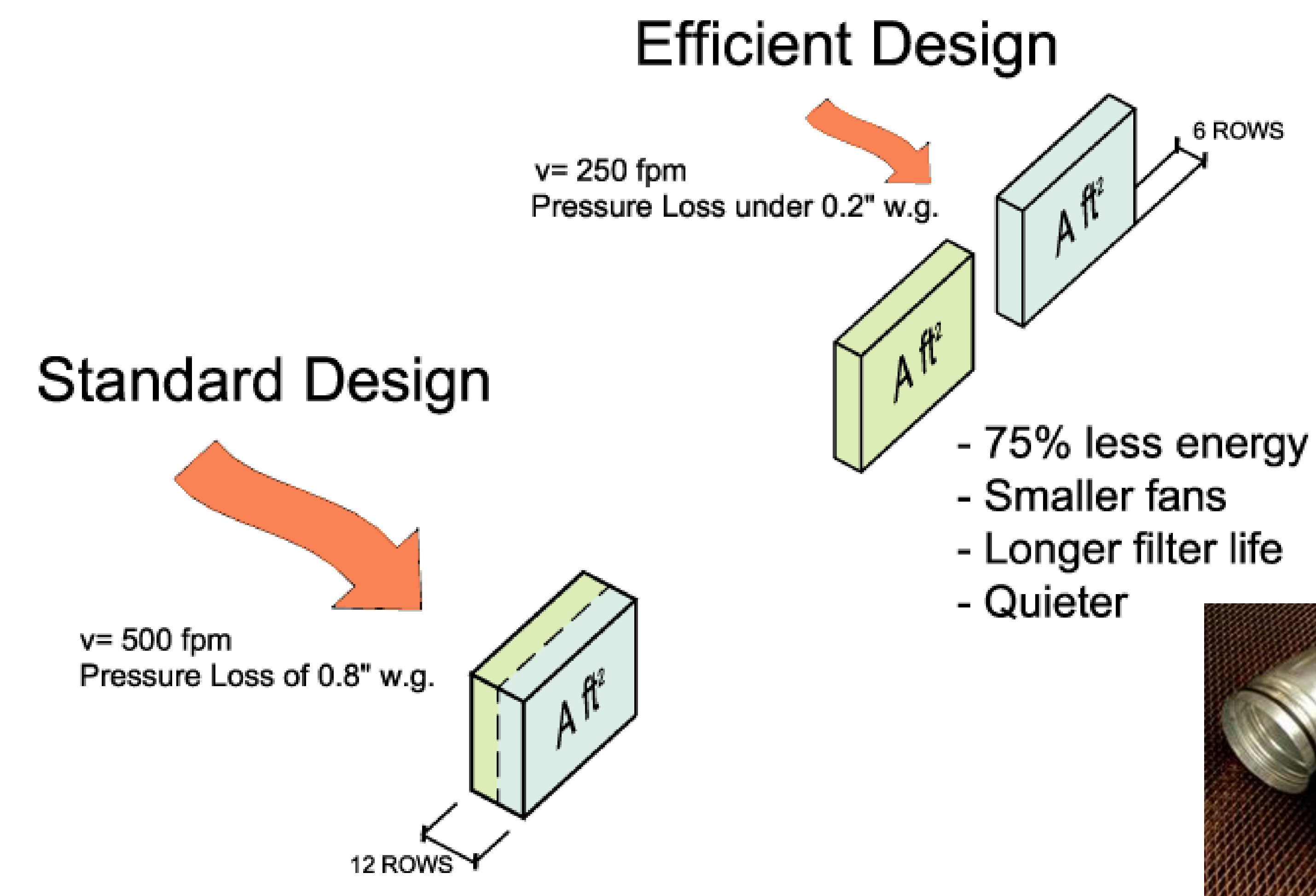
#3 Drop the Pressure Drop

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- Up to one half HVAC energy goes to fans
- How low can you go?

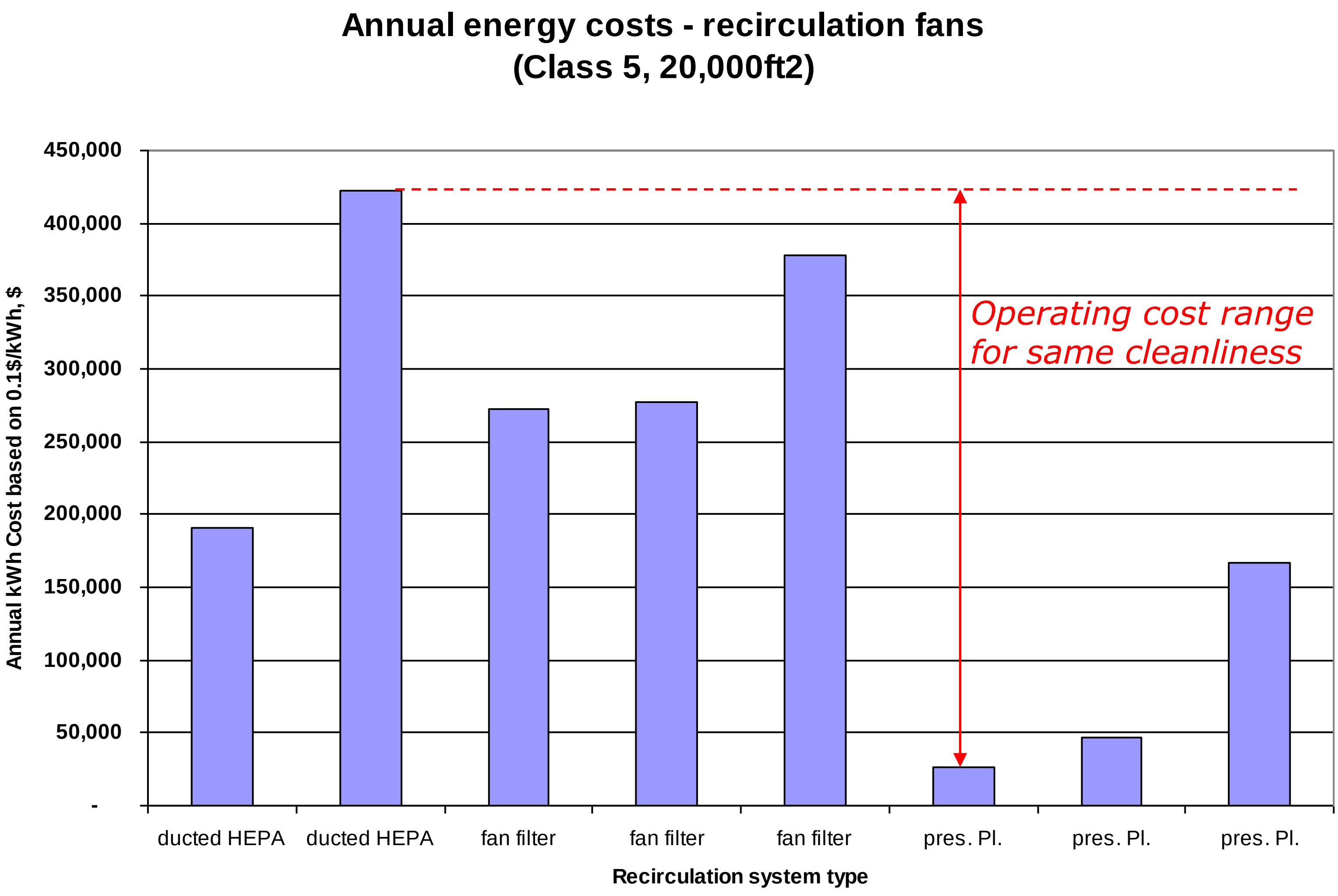


Low Pressure Drop Design



Annual Energy Cost for Cleanroom Recirculation Fans

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

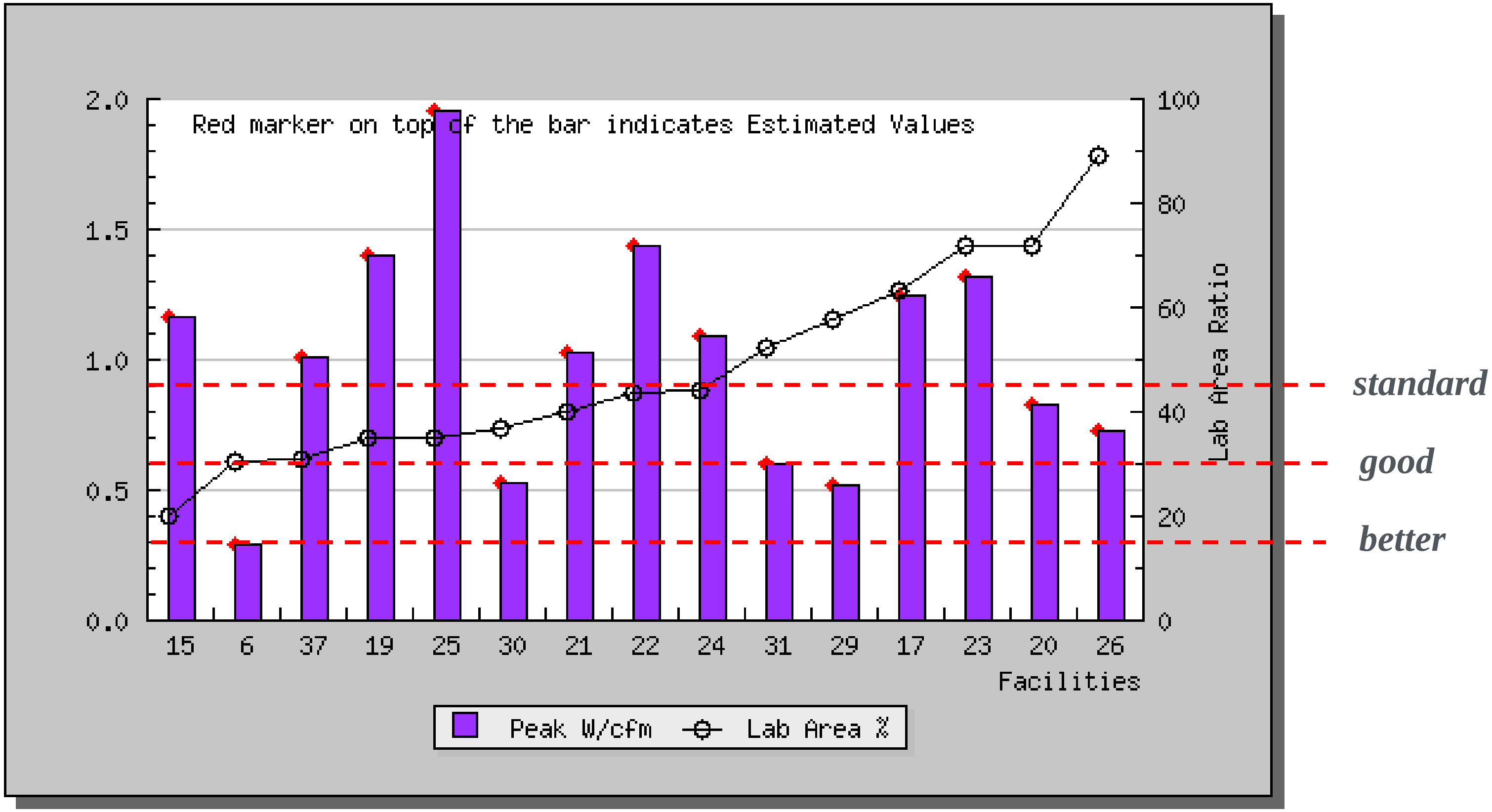


Low Pressure-Drop Design Guidelines

Component	Standard	Good	Better
Air handler face velocity	500	400	300
Air Handler	2.5 in. w.g.	1.5 in. w.g.	0.75 in.w.g.
Heat Recovery Device	1.00 in. w.g.	0.60 in. w.g.	0.35 in. w.g.
VAV Control Devices	Constant Volume, N/A	Flow Measurement Devices, 0.60 - 0.30 in. w.g.	Pressure Differential Measurement and Control, 0.10 in. w.g.
Zone Temperature Control Coils	0.5 in. w.g.	0.30 in. w.g.	0.05 in. w.g.
Total Supply and Return Ductwork	4.0 in. w.g.	2.25 in. w.g.	1.2 in. w.g.
Exhaust Stack	0.7" w.g. full design flow through entire exhaust system, Constant Volume	0.7" w.g. full design flow through fan and stack only, VAV System with bypass	0.75" w.g. averaging half the design flow, VAV System with multiple stacks
Noise Control (Silencers)	1.0" w.g.	0.25" w.g.	0.0" w.g.
Total	9.7" w.g.	6.2" w.g.	3.2" w.g.
Approximate W / CFM	1.8	1.2	0.6

Source: J. Weale, P. Rumsey, D. Sartor, L. E. Lock, "Laboratory Low-Pressure Drop Design," ASHRAE Journal, August 2002.

Labs21 Benchmarking Tool – Vent. W/cfm



Standard, good, better benchmarks as defined in
"How-low Can You go: Low-Pressure Drop Laboratory Design" by Dale Sartor and John Weale

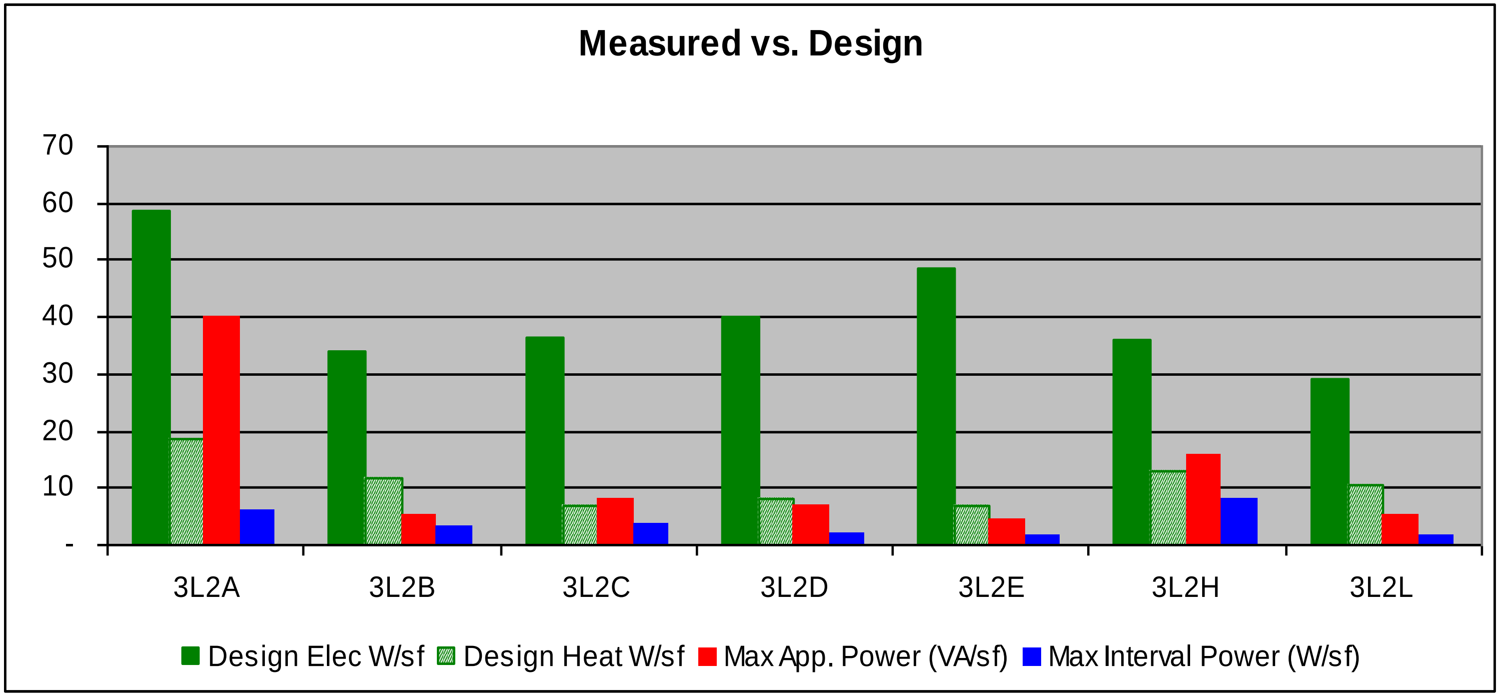
#4 Get Real with Plug Loads

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- Save capital cost and operating cost
- Measure actual loads in similar labs
- Design for high part- load efficiency
  - Modular design approaches
- Plug load diversity in labs increases reheat

Measured vs. Design – UC Davis Case Study

- Significant over-sizing not unusual



Measured Plug loads in Labs

- Sandia PETL Lab
  - Designed for 6 W/nsf;
  - Metered data: 1.8 W/nsf (avg.), 2.7 W/nsf (peak)
- Fred Hutch Cancer Research Center
  - Phase 1 designed for 15-30 W/nsf
  - Phase 2 reduced design to 8 W/nsf based on Phase 1 experience
- Pharmacia
  - Designed for 12 W/nsf
  - Metered data: 2.7 W/nsf

Benefits of Right-sizing at LBNL-MFL

- $2.5 million first cost savings for right-sizing HVAC systems
  - Based on measured data from comparable labs

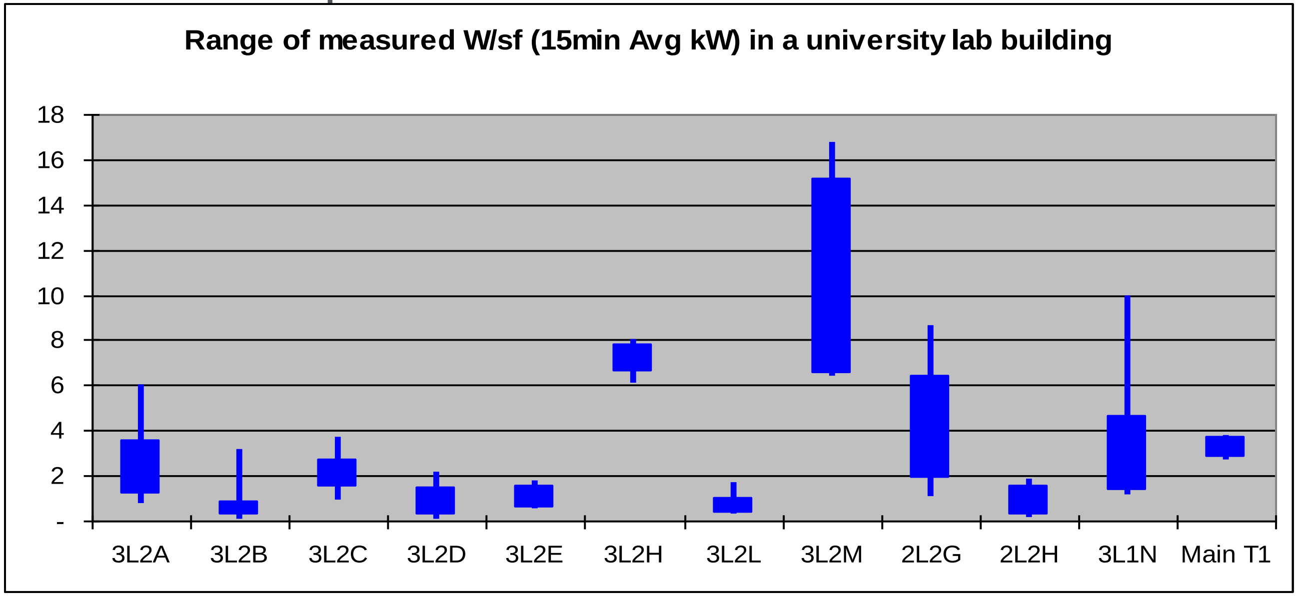
- LEED Silver (expected)
  - Rightsizing savings allowed additional green features with 4% cost savings over baseline.

The Molecular Foundry
Lawrence Berkeley National Laboratory

#5 Just Say No to Reheat

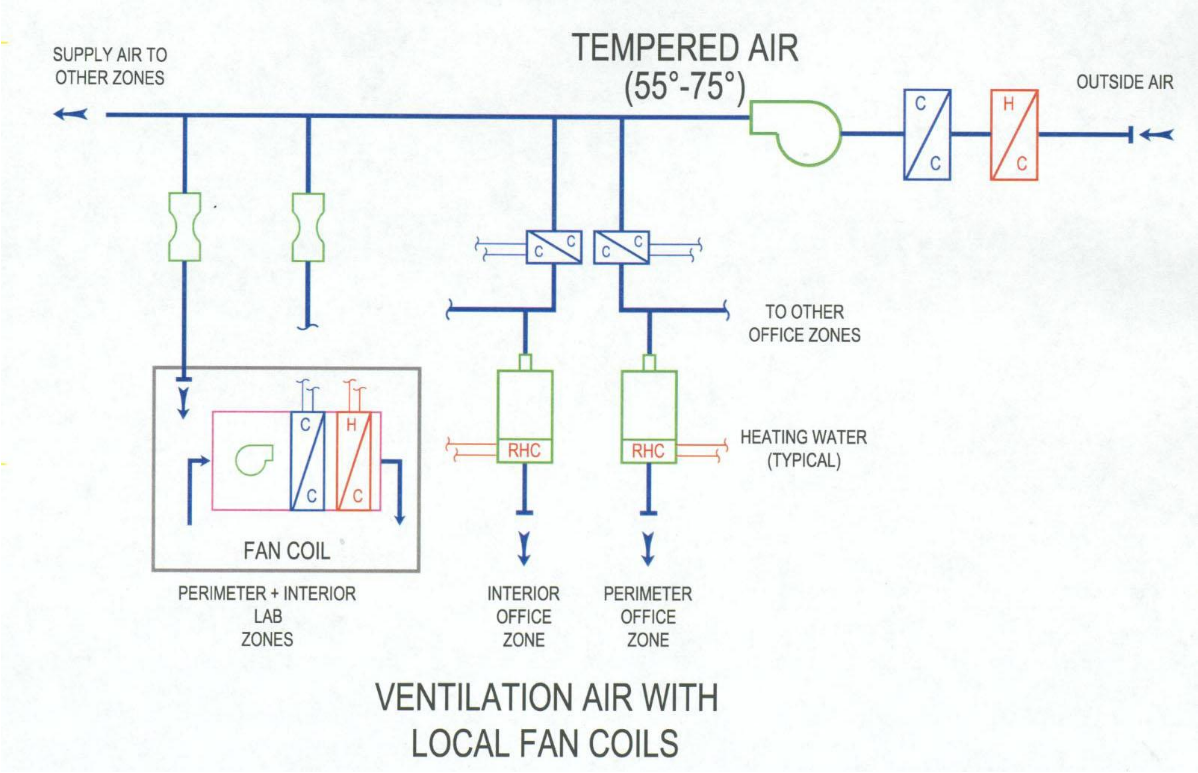
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- Reheat (simultaneous heating and cooling) causes major energy use in labs
  - High-load areas require lower supply air temperature, so reheat occurs in other spaces



System Alternatives to Minimize Reheat

- Dual-duct systems
- Ventilation air with zone coils
- Ventilation air with fan coils
- Ventilation air with radiant cooling
- Ventilation air with inductive cooling coils (Cool Beams)
- Possible free cooling with water side economizer



For More Information

Main Labs21 web site:

http://www.labs21century.gov

Contacts:

Dale Sartor, PE
Lawrence Berkeley National Laboratory
Phone: 510 486-5988
E-mail: dasartor@lbl.gov