Demand Response Research Center

Introduction to Commercial Building Control Strategies and Techniques for Demand Response

http://drrc.lbl.gov/pubs/59975.pdf

Sponsored by California Energy Commission
Public Interest Energy Research Program

BERKELEY LAB

Presentation Overview

- **Heating Ventilation and Air Conditioning (HVAC) Strategies**
  - **Global Temperature Adjustment**
  - **Systemic Adjustments to the Air Distribution and/or Cooling Systems.**
- **Lighting Strategies**
- **Lessons Learned**

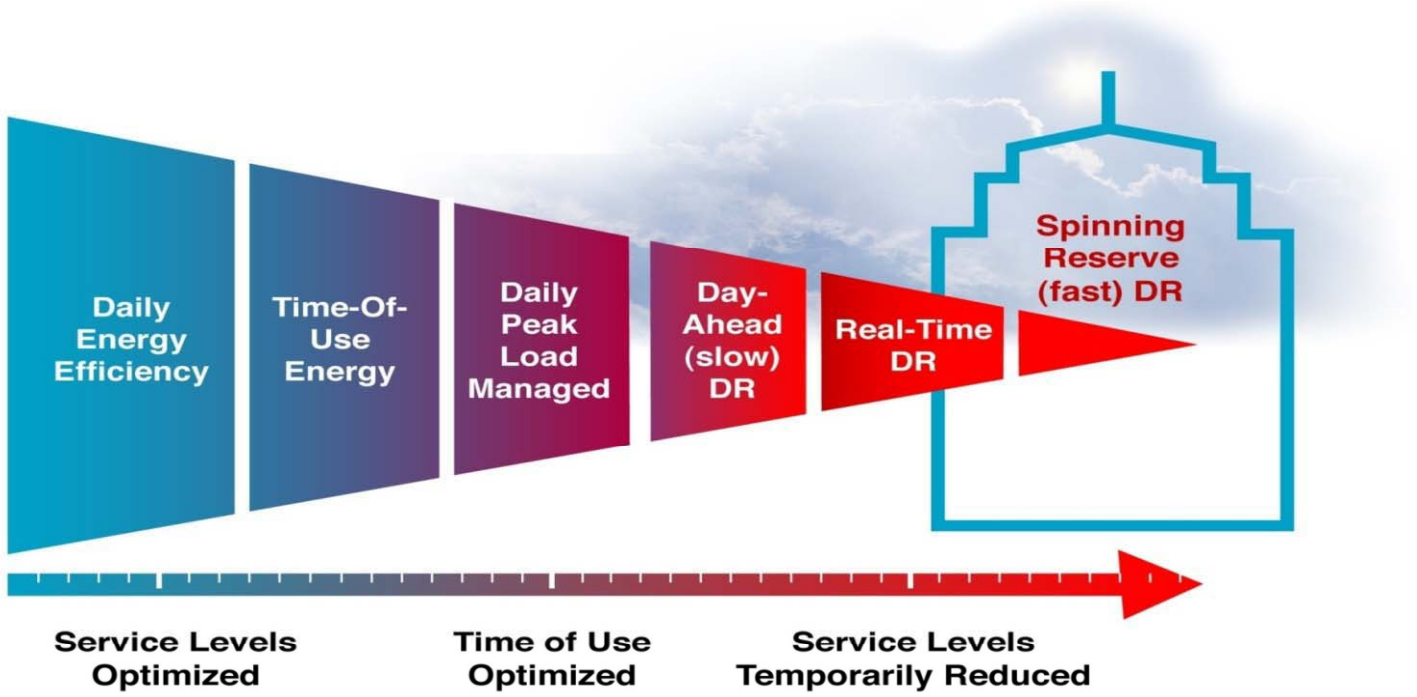
Building HVAC Types

Type	Primary system attribute	Secondary system attribute
Type A	CAV system with central plant (CAV-Central)	Single zone / multi-zone Single duct / dual duct With reheat / without reheat Type of chiller
Type B	VAV system with central plant (VAV-Central)	Single duct / dual duct With reheat / without reheat Type of chiller
Type C	CAV system with package units (CAV-Package)	Single zone / multi-zone Single duct / dual duct With reheat / without reheat
Type D	VAV system with package units (VAV-Package)	Single duct / dual duct With reheat / without reheat

CAV: Constant air volume VAV: Variable air volume

Purpose of DR Strategies Guide

- Help decision makers understand types of DR strategies
- Present typical savings (kW, %, and W/sqft)
- Understand efficiency versus demand response

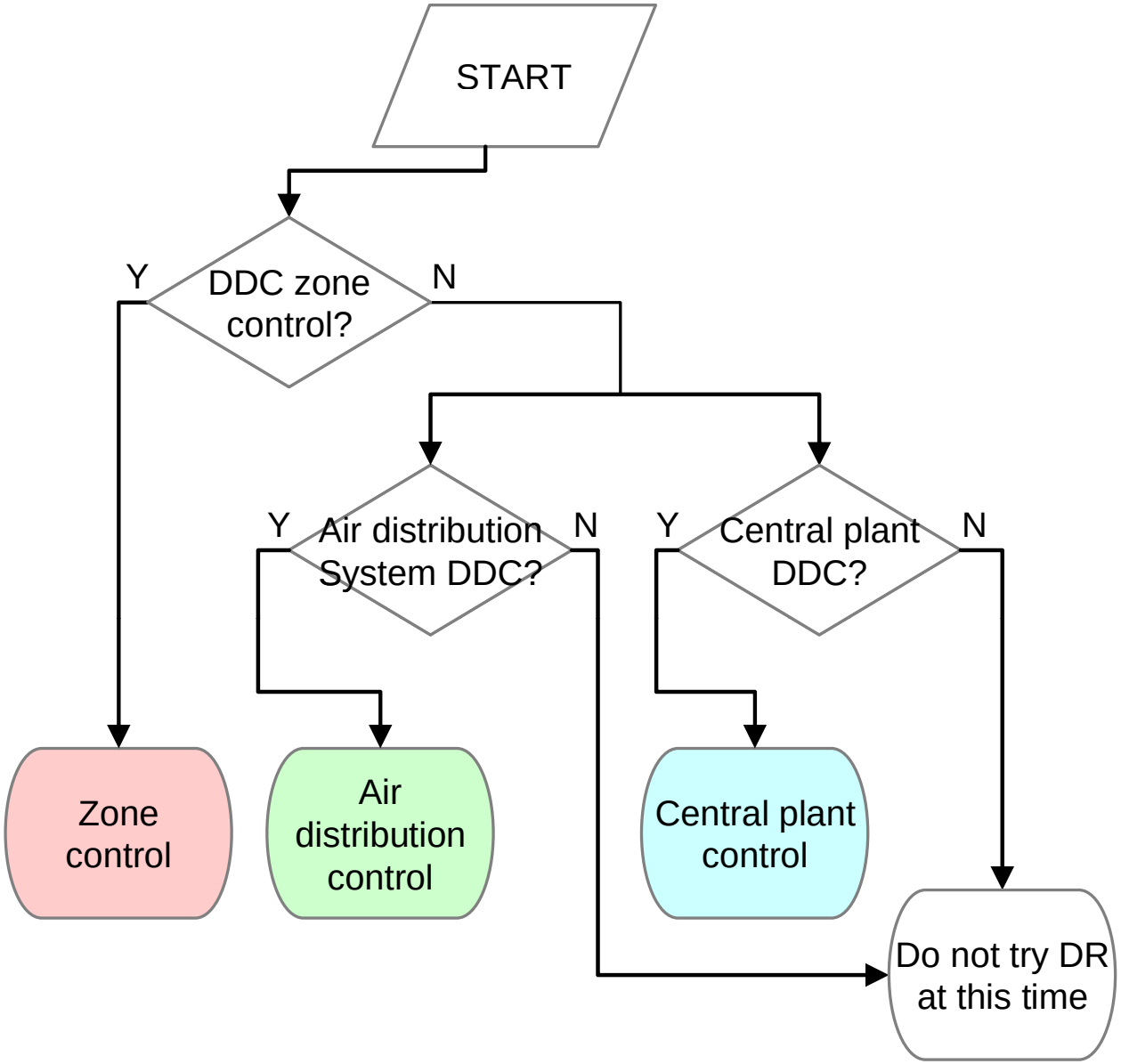


HVAC strategies by building type

Category	DR Strategy	Definition	A	B	C	D
Zone control	Global temperature adjustment	Increase zone temperature setpoints for an entire facility	X	X	X	X
	Passive thermal mass storage	Decrease zone temperature setpoints prior to DR operation to store cooling energy in the building mass, and increase zone setpoints to unload fan and cooling system during DR.	X	X	X	X
Air distribution	Duct static pressure decrease	Decrease duct static pressure setpoints to reduce fan power.		X		X
	Fan variable frequency drive limit	Limit or decrease fan variable frequency drive speeds or inlet guide vane positions to reduce fan power.		X		X
	Supply air temperature increase	Increase SAT setpoints to reduce cooling load.	X	X	X	X
	Fan quantity reduction	Shut off some of multiple fans or package units to reduce fan and cooling loads.	X	X	X	X
	Cooling valve limit	Limit or reduce cooling valve positions to reduce cooling loads.	X	X		
Central plant	Chilled water temperature increase	Increase chilled water temperature to improve chiller efficiency and reduce cooling load.	X	X		
	Chiller demand limit	Limit or reduce chiller demand or capacity.	X	X		
	Chiller quantity Reduction	Shut off some of multiple chiller units.	X	X	*	*
Rebound avoidance	Slow recovery	Slowly restore HVAC control parameters modified by DR strategies.	**	**	**	**
	Sequential equipment recovery	Restore HVAC control to equipment sequentially within a certain time interval.	**	**	**	**
	Extended DR control Period	Extend DR control period until after the occupancy period.	**	**	**	**

* The strategy can be applied to package systems by reducing shutting off some of the compressors.
** Applicability of rebound avoidance strategies is determined by the DR strategies selected.

HVAC strategy development - Decision tree

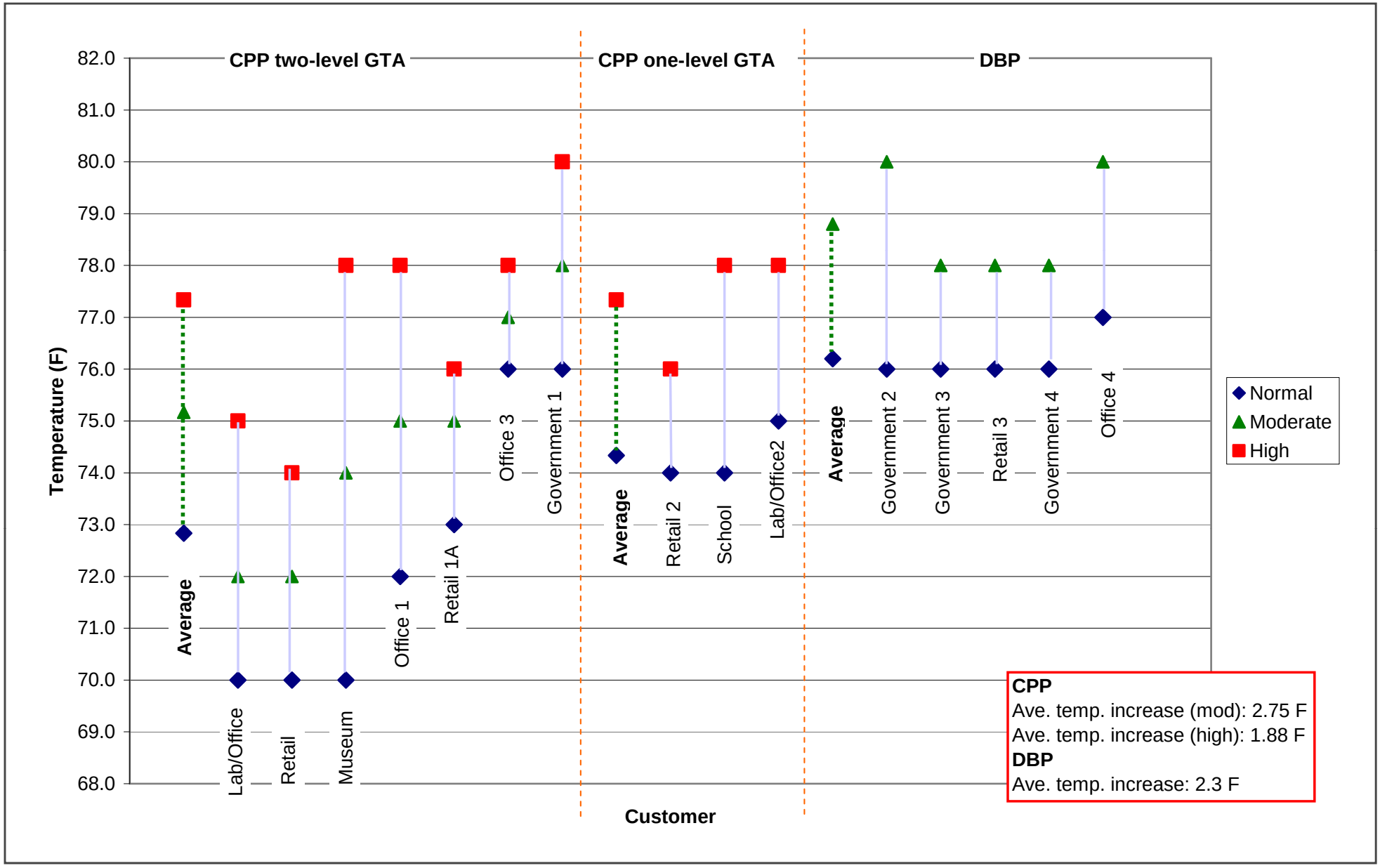


Comparison of End-Use Strategies

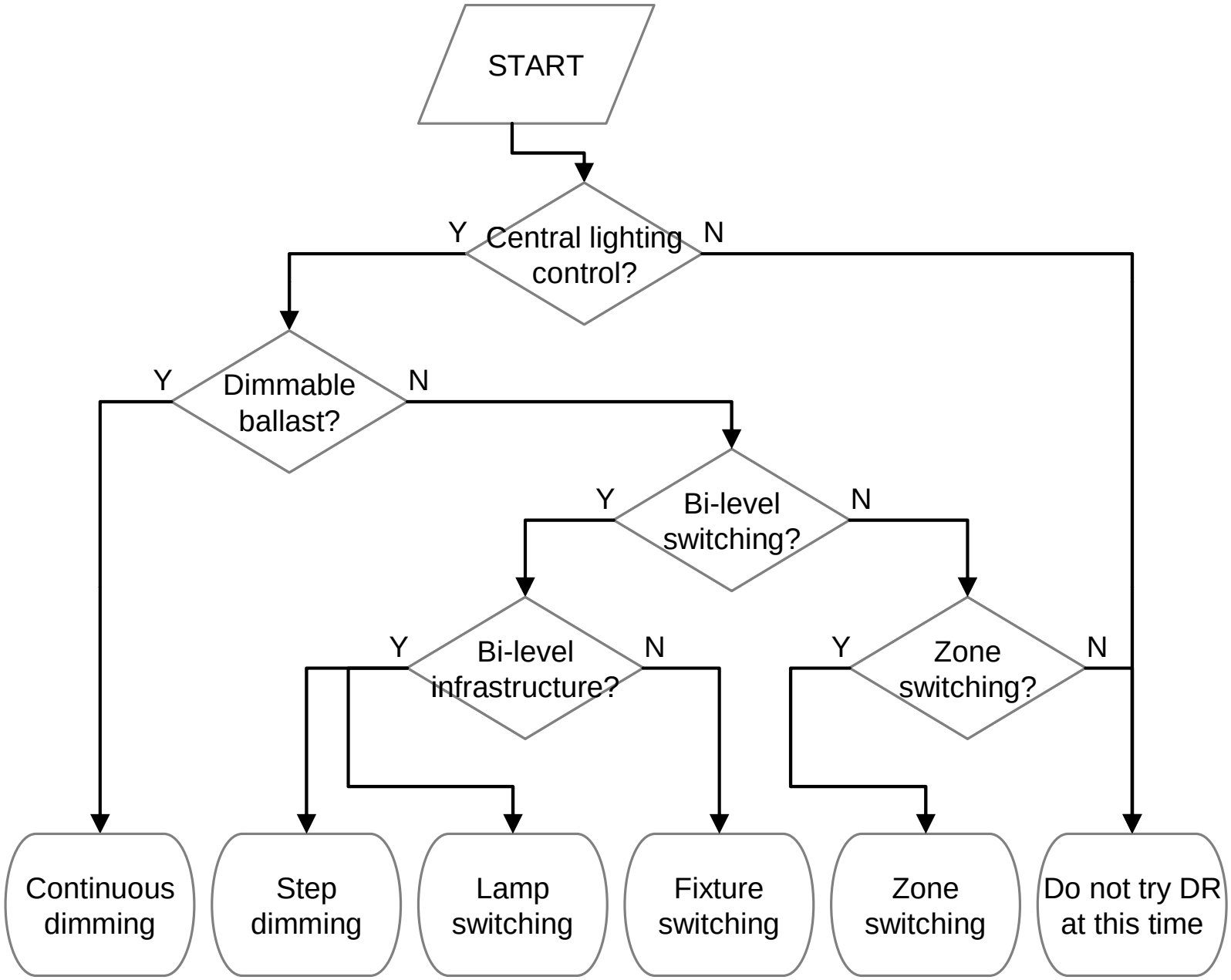
Global temperature reset migrating to State Energy Code

		HVAC											Lighting					Other
	Building use	Global temp. adjustment	Duct static pres. Increase	SAT Increase	Fan VFD limit	CHW temp. Increase	Fan qty. reduction	Pre-cooling	Cooling valve limit	Boiler lockout	Slow recovery	Extended shed period	Common area light dim	Office area light dim	Turn off light	Dimmable ballast	Bi-level switching	Non-critical process shed
ACWD	Office, lab	X	X	X		X			X	X		X						
B of A	Office, data center		X	X	X	X			X									
Chabot	Museum	X						X										
2530 Arnold	Office	X									X							
50 Douglas	Office	X									X							
MDF	Detention facility	X																
Echelon	Hi-tech office	X	X	X			X						X	X	X	X		
Centerville	Junior Highschool	X						X										
Irvington	Highschool	X						X										
Gilead 300	Office			X														
Gilead 342	Office, Lab	X		X														
Gilead 357	Office, Lab	X		X														
IKEA EPaloAlto	Furniture retail	X																
IKEA Emeryville	Furniture retail	X																
IKEA WSacto	Furniture retail																	
Oracle Rocklin	Office	X	X															
Safeway Stockton	Supermarket																X	
Solectron	Office, Manufacture	X													X			
Svenhard's	Bakery																	X
Sybase	Hi-tech office														X			
Target Antioch	Retail	X					X											
Target Bakersfield	Retail	X					X											
Target Hayward	Retail	X					X						X				X	
Walmart Fresno	Retail	X															X	

Global Temperature Adjustment



Lighting strategy development - Decision tree



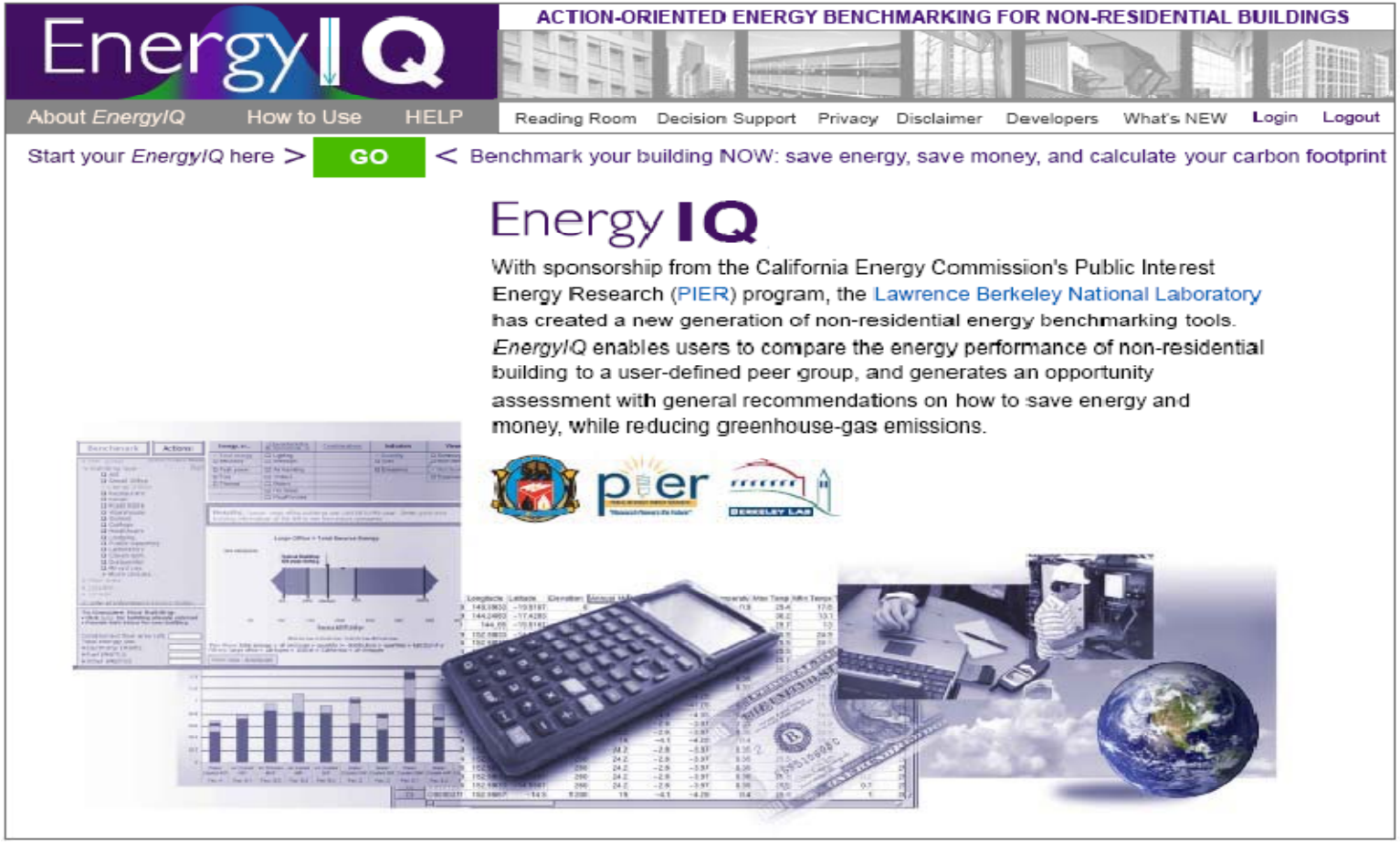
Lessons Learned

- Shed strategies should be designed to minimize discomfort, inconvenience, and loss of revenue
- High granularity closed loop control are less likely to negatively impact building occupants for a given demand shed
- In addition to HVAC control strategies, lighting and misc. loads should be considered for sheds
- Beware of rebounds that can occur after a DR event and include DR recovery strategies during planning

Another opportunity for customers to understand building energy performance:

Action-oriented Benchmarking

http://energyiq.lbl.gov/



Action-oriented Benchmarking: Concepts and Tools, Mills, Mathew, Piette, Bourassa & Brook, Energy Engineering, Vol. 105, No. 4