U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Getting Started: Identifying and Assessing Energy Efficiency Opportunities in Your Data Center

FEMP's Center of Expertise for Energy Efficiency in Data Centers

FEMP
Federal Energy Management Program

Workshop Agenda

I.	Workshop Logistics and Introduction
II.	The need for energy efficiency in data centers
III.	Overview of the CoE
IV.	Demonstration of DC Pro
V.	Questions and Answers on DC Pro
VI.	DC Pro Workshop – audience participation (laptop recommended)
VII.	Final Q&A and Workshop Wrap-up

To Receive IACET-Certified CEUs for a Workshop

To Receive IACET-Certified CEUs, Attendees Must:

- Sign in and out on the official course roster
- Attend the training in full. No exceptions
- Complete an assessment demonstrating knowledge of course learning objectives **within six weeks of the training.** A minimum of 80% correct answers is required.
- Complete an evaluation of the training event within **six weeks of the training**

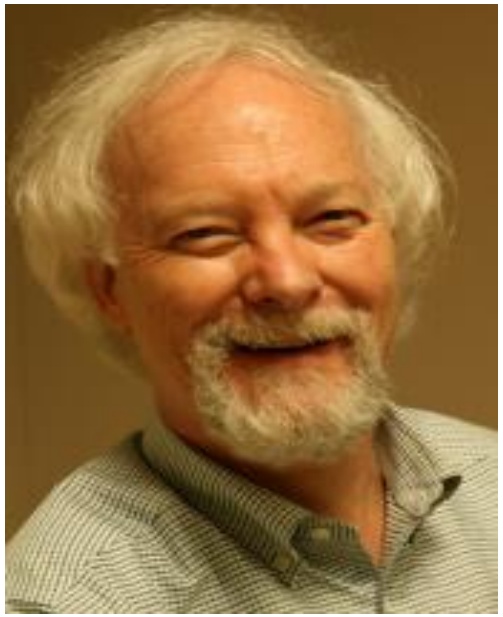
To Access the Workshop Assessment and Evaluation, Visit:

- https://www.wbdg.org/continuing-education/femp-courses/fempws08192019q
- If you do not have a WBDG account created, you will be required to create one.

For logistical questions related to the webinar or evaluation, email Elena Meehan at elena.meehan@ee.doe.gov.

Instructor Introductions and Workshop Logistics

Introductions



Dale Sartor, MBA
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DOE-FEMP

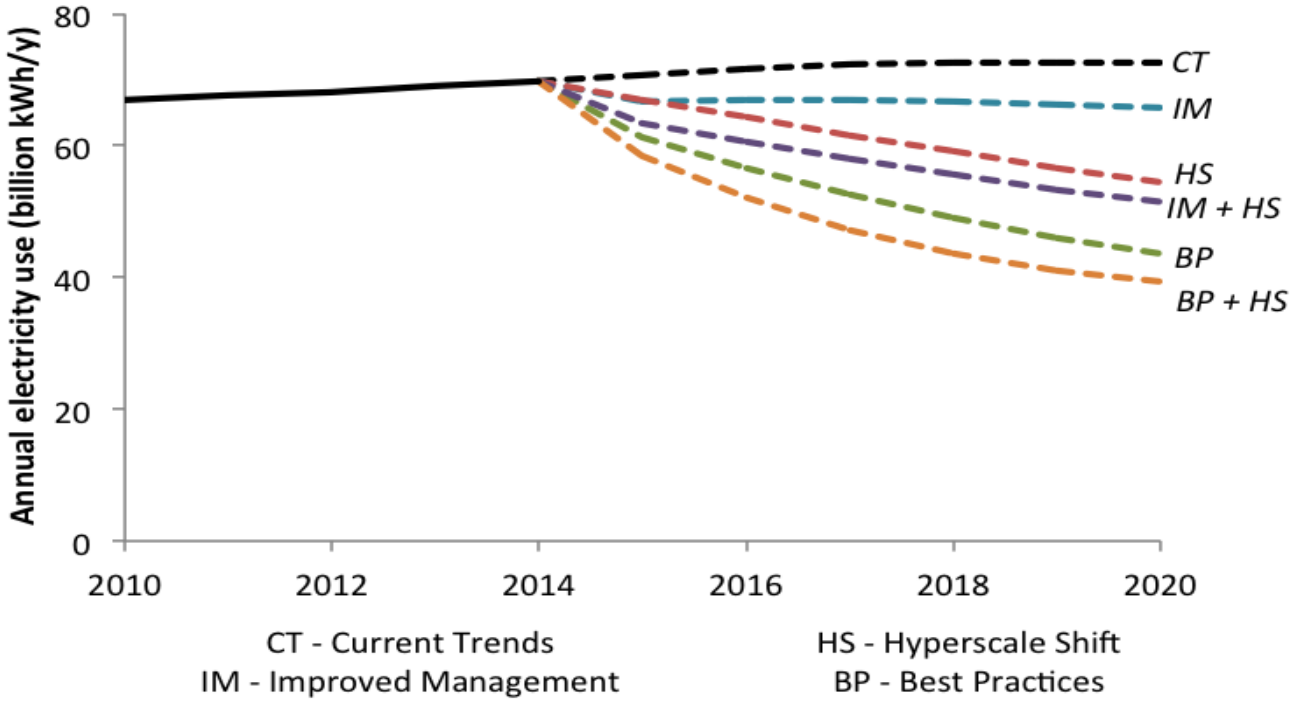
The Need for Energy Efficiency in Data Centers

Why the Need for Data Center Energy Efficiency?

- Data Centers are energy intensive facilities
- Data Centers are **10 to 100+** times more energy intensive than an office, and represent nearly 2% of *all* U.S. electricity consumption.
- No significant slowdown in sight

Potential and Benefits of Energy Efficiency

- 45% Reduction Possible with Best Practices and greater shift to hyper-scale
- 20-40% savings & high ROI typical
- Aggressive strategies can yield 50+% savings
- Extend life and capacity of infrastructures.



About the Center of Expertise for Energy Efficiency in Data Centers

FEMP's Center of Expertise (CoE)

Learn more about the purpose and mission of the CoE.

Use CoE's Energy Efficiency Toolkit

Filter CoE's many resources by type and topic.

Choose from upcoming live webinars, pre-recorded trainings, and in-person Data Center Energy Practitioner (DCEP) trainings.

Search resources by topics of interest.

Explore the diverse activities that CoE is engaged in.

Learn about different energy saving technologies and opportunities.

Follow us on Twitter @DataCenterCoE

Ask us questions!

Visit us at datacenters.lbl.gov

FEMP's Data Center Program

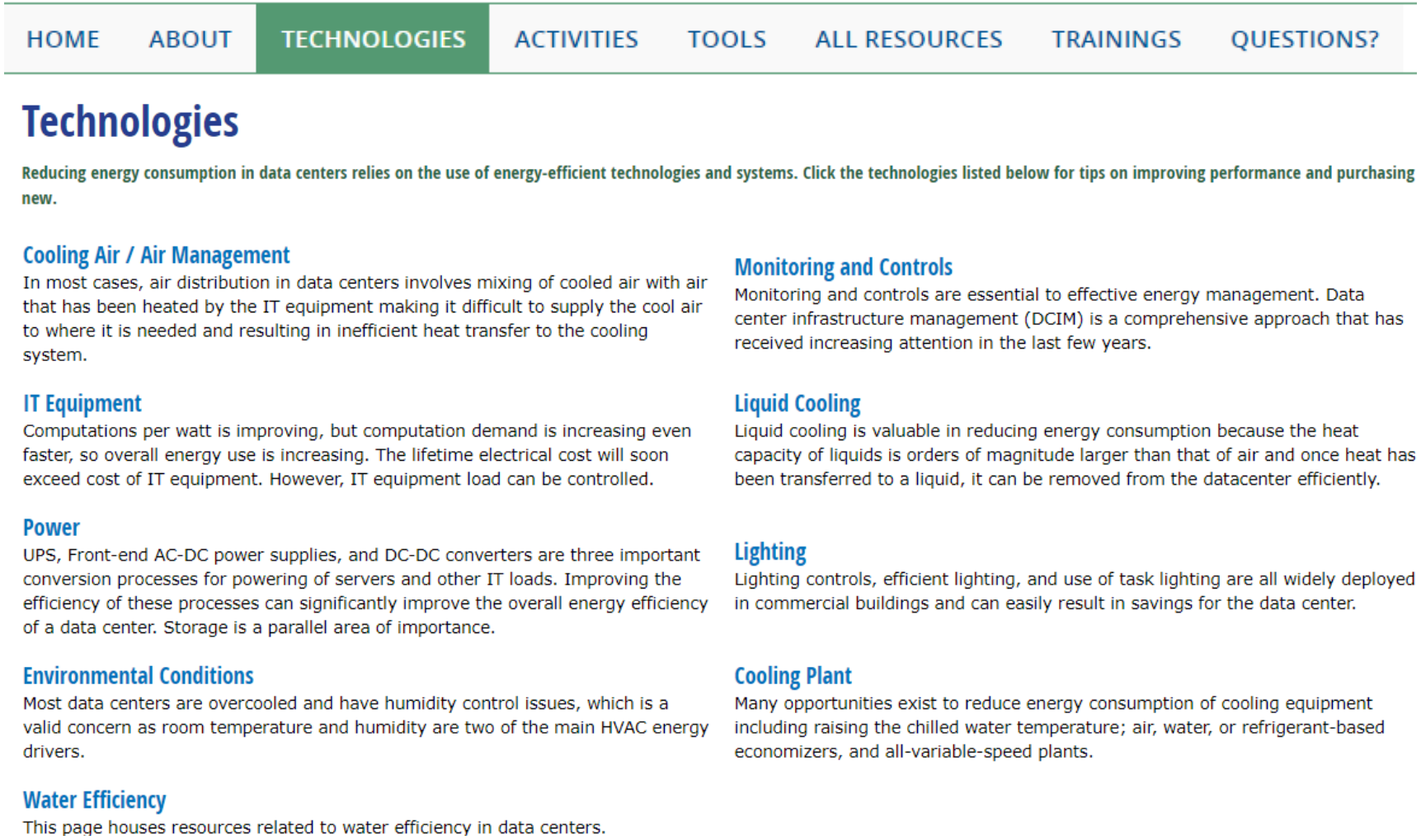
HOME | ABOUT | TECHNOLOGIES | ACTIVITIES | TOOLS | ALL RESOURCES | TRAININGS | QUESTIONS?

- FEMP sponsors the Center of Expertise for Energy Efficiency in Data Centers (CoE) to provide technical assistance, tools, analyses, and resources on best practices and innovative solutions.
- The CoE serves as an information and resource hub for data center owners, operators, and other stakeholders interested in achieving energy reductions and cost savings.



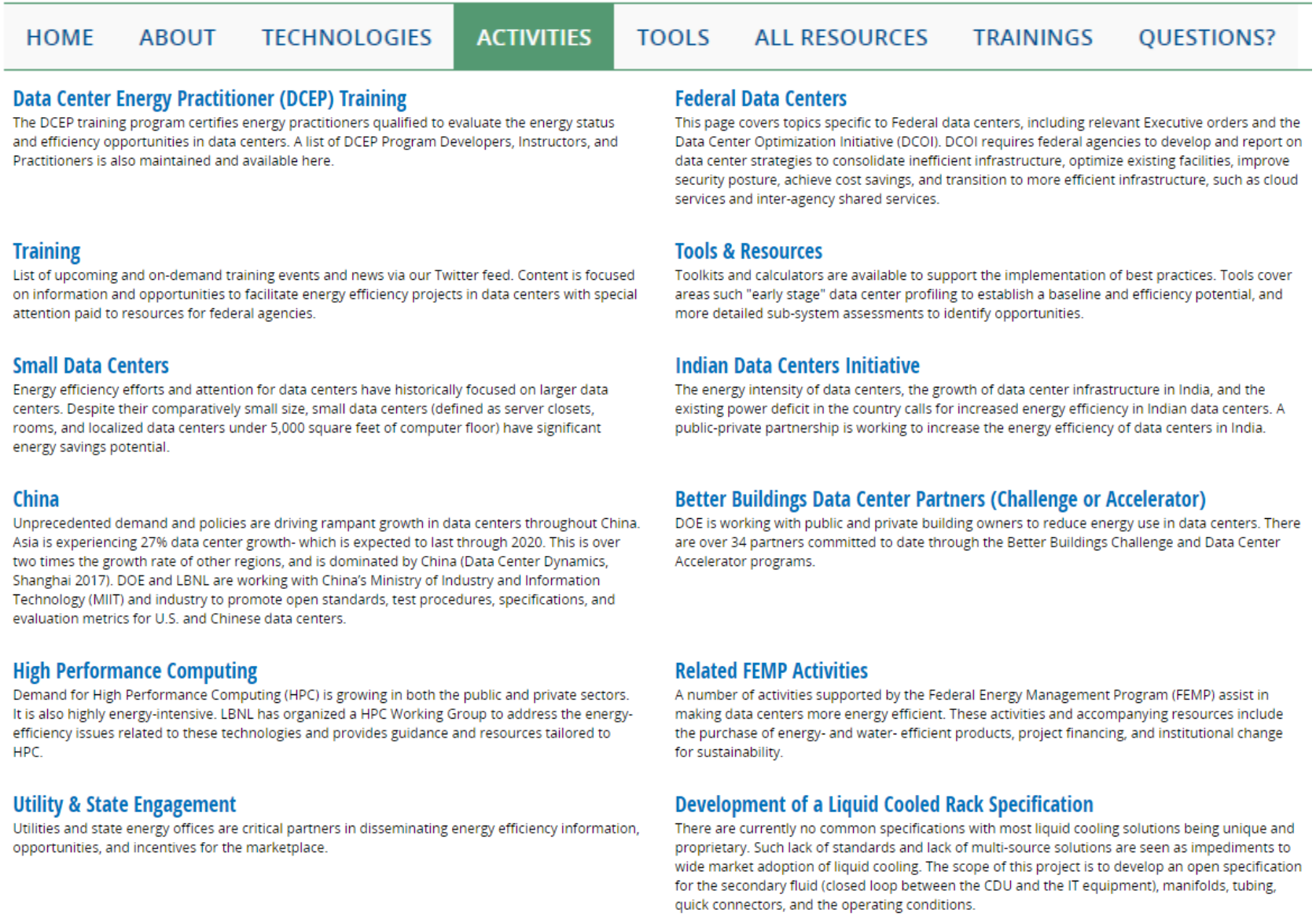

Energy Saving Technologies in Data Centers

The CoE provides information and resources on a wide range of energy-saving technologies and opportunities; from IT Load to Air Management.



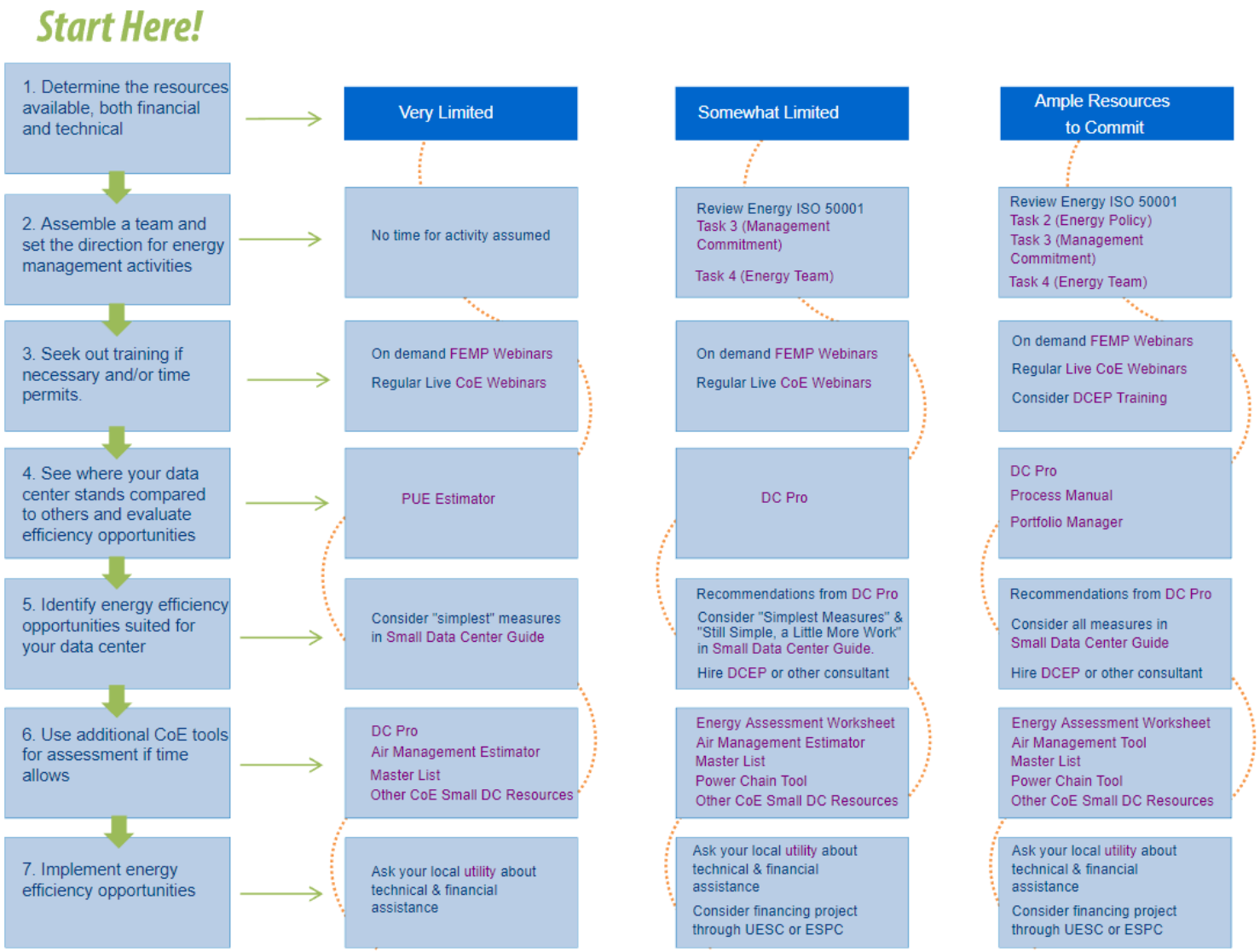
CoE's Activities

CoE engages in a wide variety of activities- such as assisting Federal Agencies in achieving their efficiency goals in data centers, training certifications, and developing specifications for groundbreaking energy saving technologies.



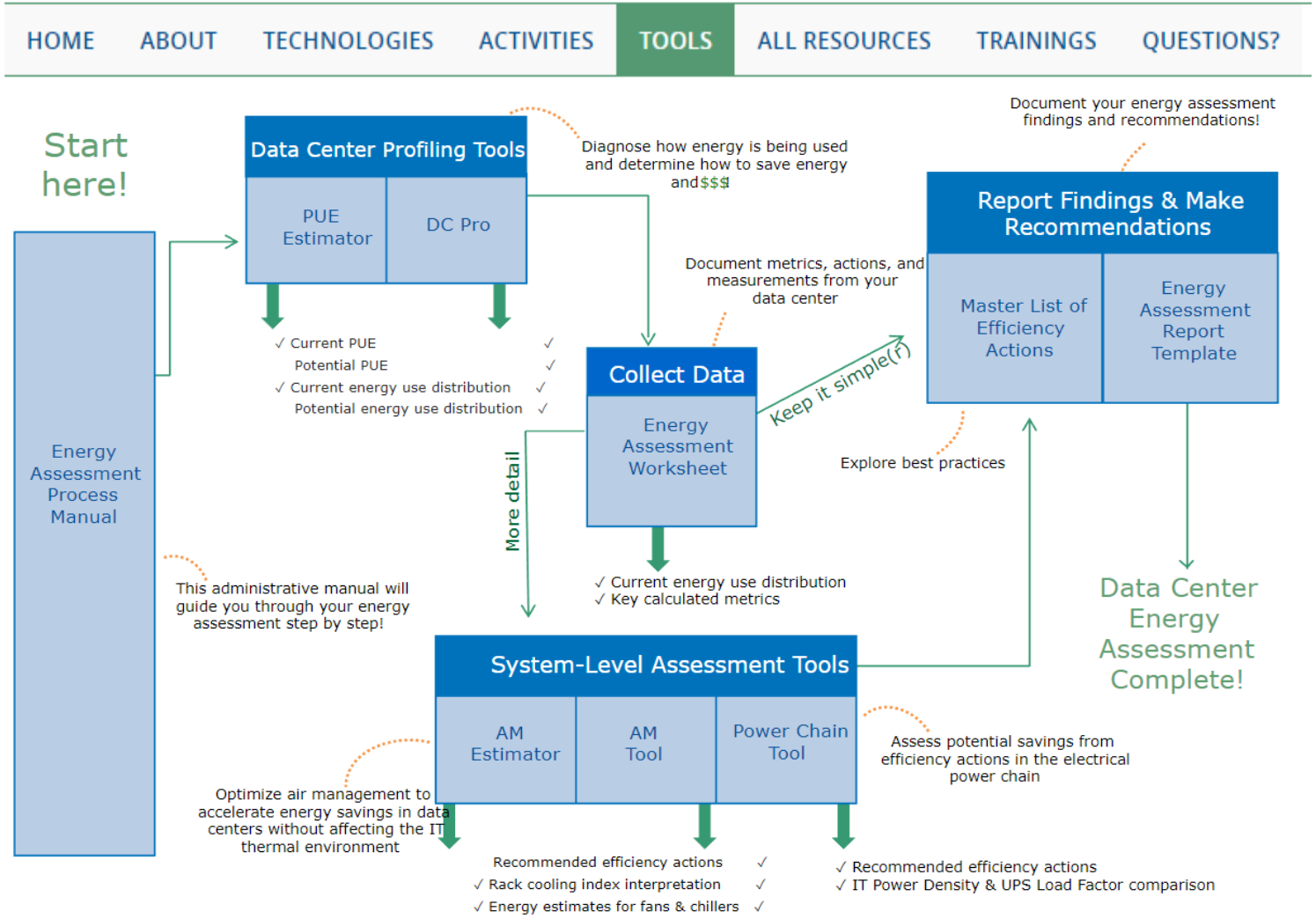
Small Data Center Page

Process-oriented page guides users through various CoE (and third party) resources based on the levels of financial and technical resources available.



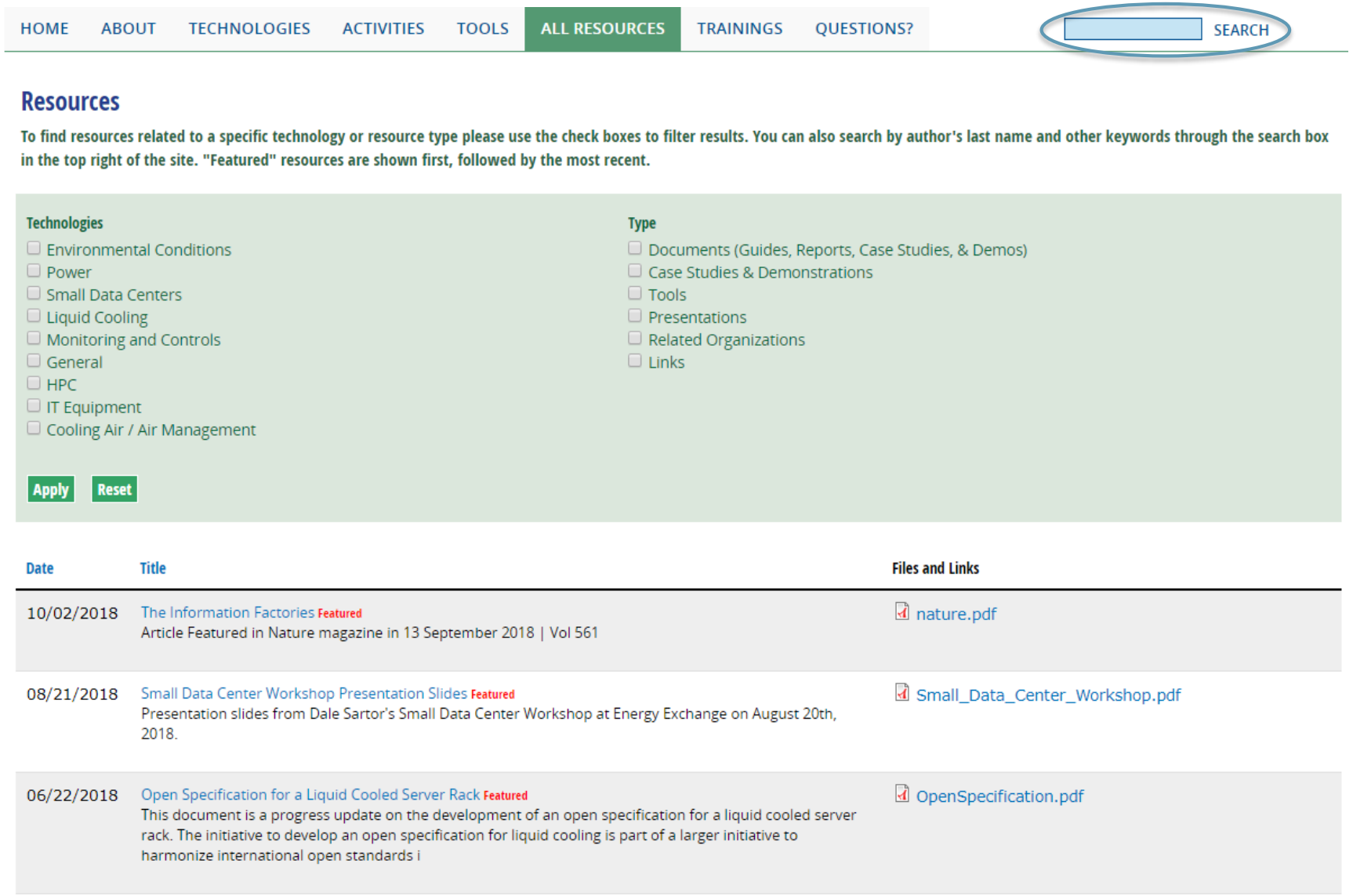
Energy Efficiency Toolkit

- The CoE toolkit provides a recommended order for using CoE tools and resources, from diagnosis of current energy consumption and opportunities to actionable next steps.
- Today we'll be focusing on the first step- profiling tools, specifically the DC Pro tool.



All CoE Resources

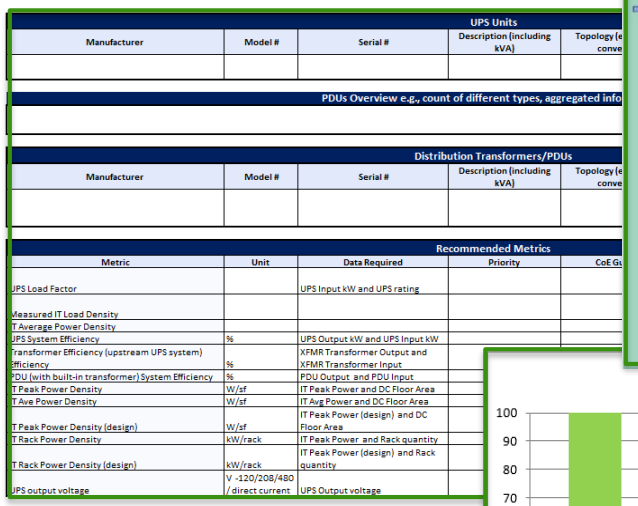
- Filter all CoE resources by technology or resource type
- Use the “search” bar to find resources on a particular topic.

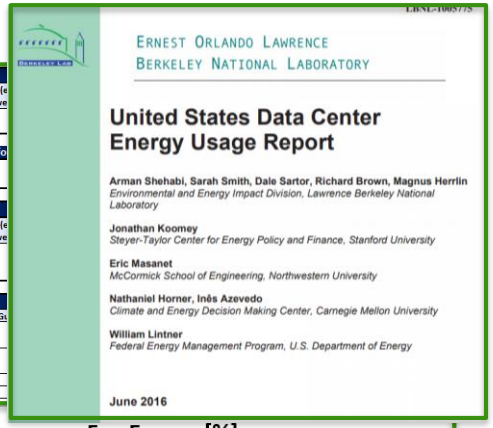


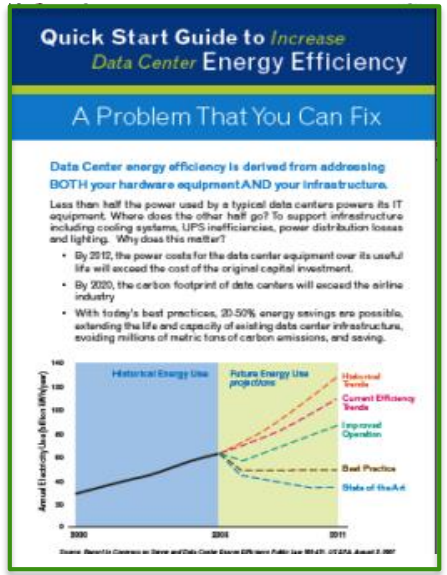
Examples of CoE Resources

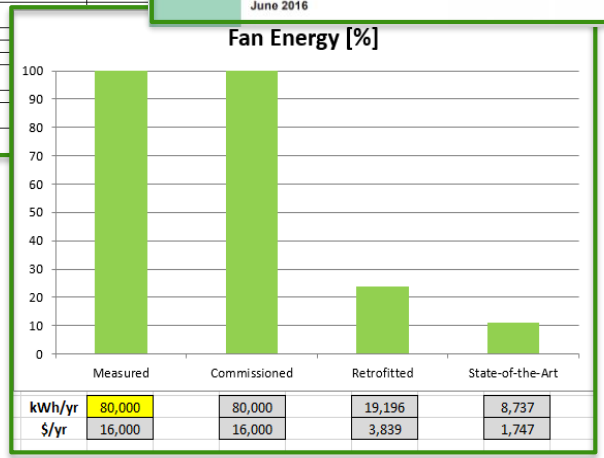
Data Center Resources

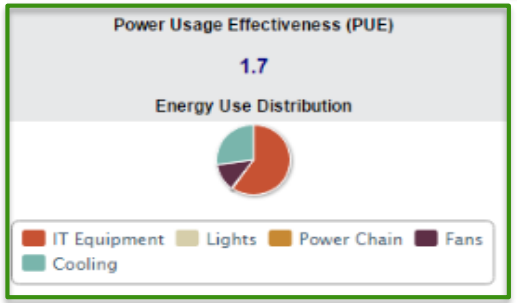
- High-level profiling tools
- Best Practices Guide
- Data Center Programming Guide
- Benchmarking Guide
- Technology Case Study Bulletins
- Process manuals
- Report templates
- High-level profiling tools
- System-level assessment tools(air management, electrical systems)
- End-use breakout





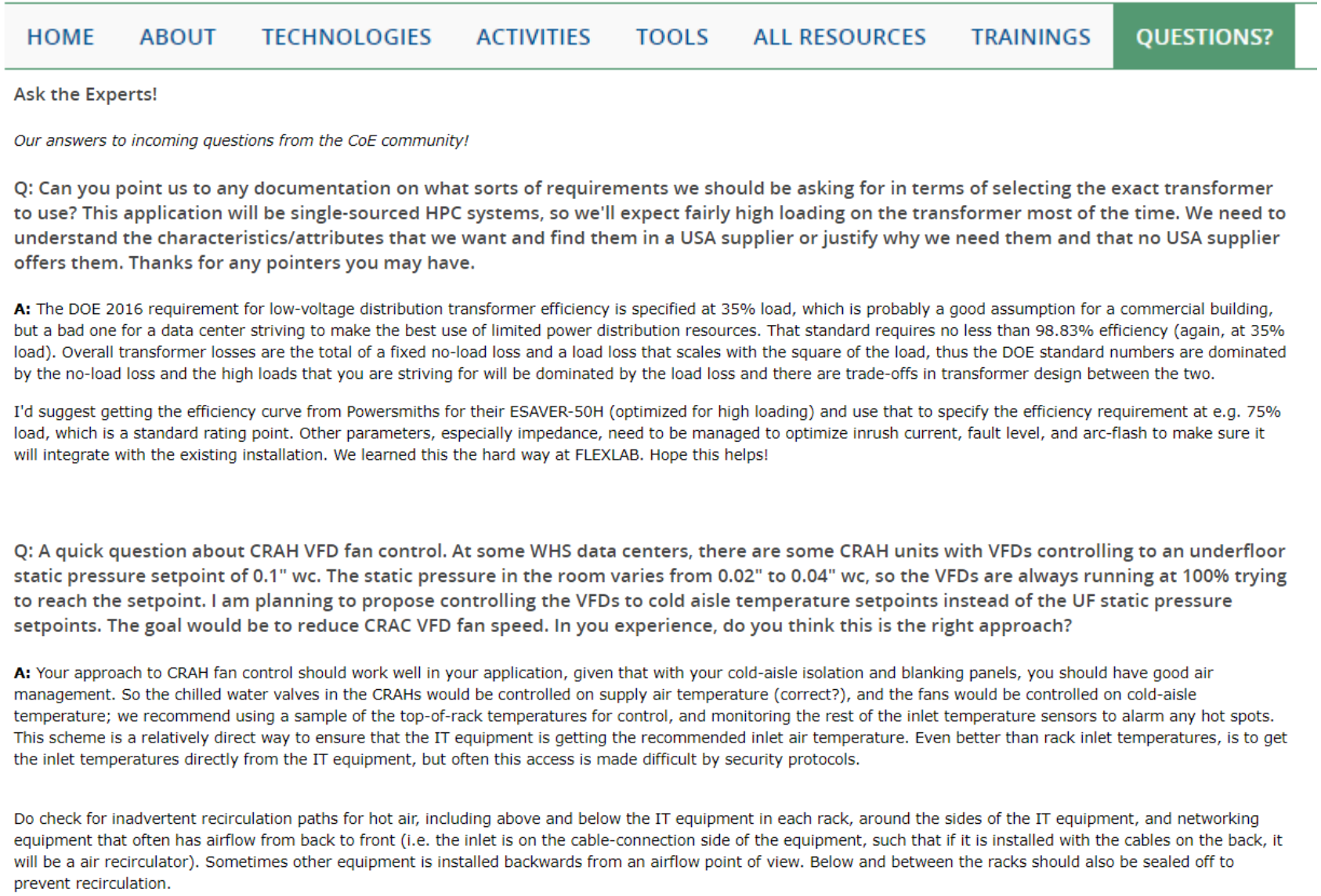






We're here to answer your questions!

- Send us your questions related to data center energy efficiency questions by contacting us at CoE@lbl.gov
- Browse our "Ask the Experts" section to see whether your questions have already been addressed!



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Ask the Experts!

Our answers to incoming questions from the CoE community!

Q: Can you point us to any documentation on what sorts of requirements we should be asking for in terms of selecting the exact transformer to use? This application will be single-sourced HPC systems, so we'll expect fairly high loading on the transformer most of the time. We need to understand the characteristics/attributes that we want and find them in a USA supplier or justify why we need them and that no USA supplier offers them. Thanks for any pointers you may have.

A: The DOE 2016 requirement for low-voltage distribution transformer efficiency is specified at 35% load, which is probably a good assumption for a commercial building, but a bad one for a data center striving to make the best use of limited power distribution resources. That standard requires no less than 98.83% efficiency (again, at 35% load). Overall transformer losses are the total of a fixed no-load loss and a load loss that scales with the square of the load, thus the DOE standard numbers are dominated by the no-load loss and the high loads that you are striving for will be dominated by the load loss and there are trade-offs in transformer design between the two.

I'd suggest getting the efficiency curve from Powersmiths for their ESAVER-50H (optimized for high loading) and use that to specify the efficiency requirement at e.g. 75% load, which is a standard rating point. Other parameters, especially impedance, need to be managed to optimize inrush current, fault level, and arc-flash to make sure it will integrate with the existing installation. We learned this the hard way at FLEXLAB. Hope this helps!

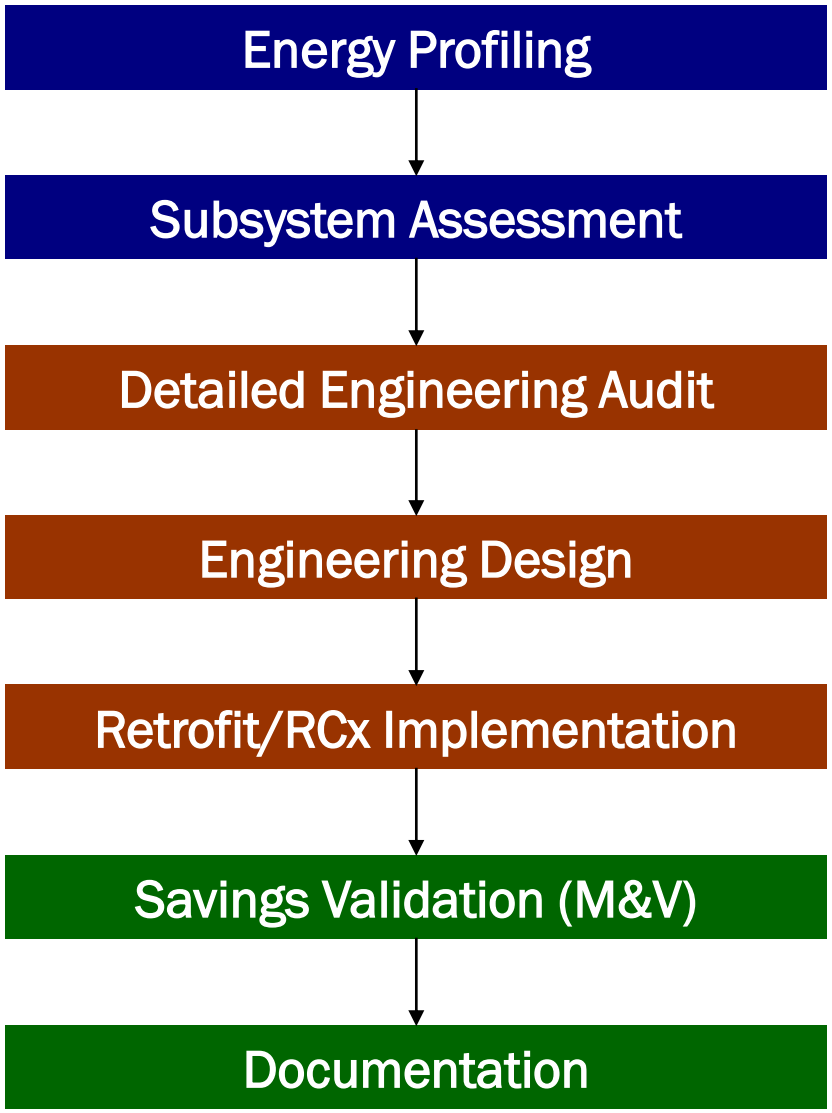
Q: A quick question about CRAH VFD fan control. At some WHS data centers, there are some CRAH units with VFDs controlling to an underfloor static pressure setpoint of 0.1" wc. The static pressure in the room varies from 0.02" to 0.04" wc, so the VFDs are always running at 100% trying to reach the setpoint. I am planning to propose controlling the VFDs to cold aisle temperature setpoints instead of the UF static pressure setpoints. The goal would be to reduce CRAC VFD fan speed. In you experience, do you think this is the right approach?

A: Your approach to CRAH fan control should work well in your application, given that with your cold-aisle isolation and blanking panels, you should have good air management. So the chilled water valves in the CRAHs would be controlled on supply air temperature (correct?), and the fans would be controlled on cold-aisle temperature; we recommend using a sample of the top-of-rack temperatures for control, and monitoring the rest of the inlet temperature sensors to alarm any hot spots. This scheme is a relatively direct way to ensure that the IT equipment is getting the recommended inlet air temperature. Even better than rack inlet temperatures, is to get the inlet temperatures directly from the IT equipment, but often this access is made difficult by security protocols.

Do check for inadvertent recirculation paths for hot air, including above and below the IT equipment in each rack, around the sides of the IT equipment, and networking equipment that often has airflow from back to front (i.e. the inlet is on the cable-connection side of the equipment, such that if it is installed with the cables on the back, it will be a air recirculator). Sometimes other equipment is installed backwards from an airflow point of view. Below and between the racks should also be sealed off to prevent recirculation.

DC Pro: Demonstration

Energy Management



Data center profiling provides an initial assessment of how energy is used in your data center and sub-system assessments provide more detailed insight. Both activities are conducted by agency staff or consultants.

Audits, design, and the implementation of energy efficiency measures are facilitated by engineering firms and contractors.

Measurement and Verification (M&V) is conducted by site personnel and engineering firms to confirm and track performance. M&V is key for continuous improvement.

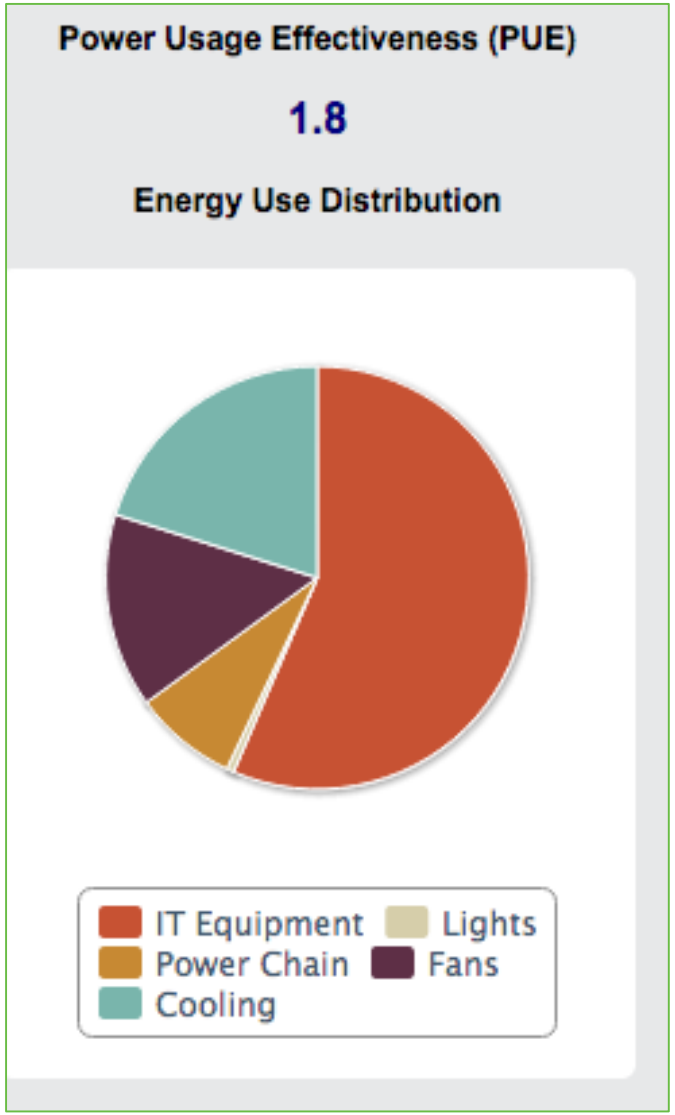
DC Pro Tools - Background

- DC Pro is an “early stage” assessment tool designed for data center owners and operators to diagnose how energy use is distributed in their data center and determine ways to save energy and money.
- Sponsored by the U.S. Department of Energy (DOE)
- Hosted by Lawrence Berkeley National Lab (LBNL)

- Core development team
  - LBNL
  - ANCIS Incorporated
  - Integral Group
  - Hewlett Packard
  - Taylor Engineering
  - Kemtah (software)
- Wide array of reviewers
  - Data center owners
  - Design professionals
  - Product manufacturers

DC Pro Tools – DC Pro & PUE Estimator

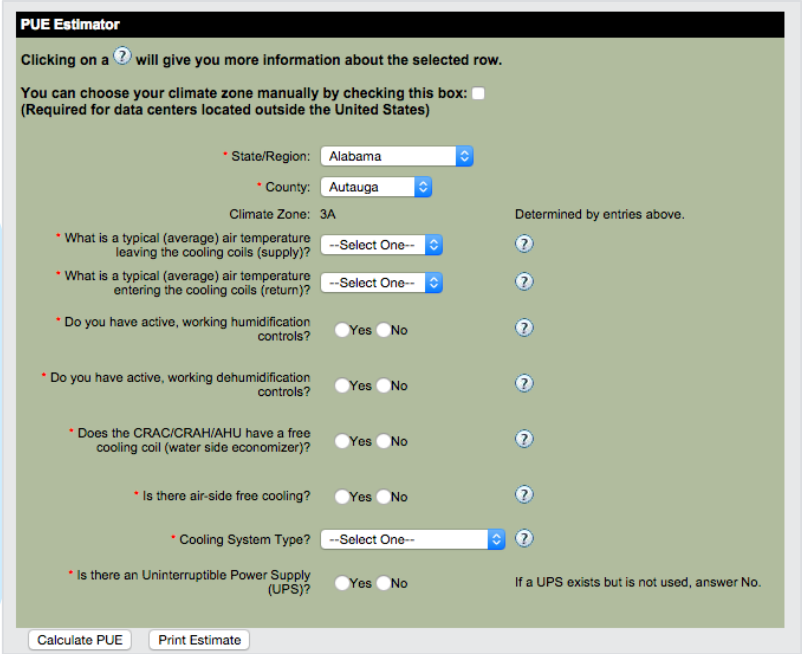
- **DC Pro (V4, 2016)**
  - Estimates current and potential PUE and energy use distribution
  - Tailored recommended actions to start an improvement process
  - Requires a login, saves data
- **PUE Estimator (V1, 2016)**
  - Quick, simplified version of DC Pro
  - Only asks questions that affect PUE
  - Does not provide potential PUE or recommended actions
  - No login, doesn't save data
- datacenters.lbl.gov/dcpro



DC Pro Tools - PUE Estimator Input / Output

INPUTS

- One input screen
- Only questions needed to estimate PUE



OUTPUTS

- Current PUE
- Current Energy Use Distribution

DC Pro Tools – PUE Estimator Export

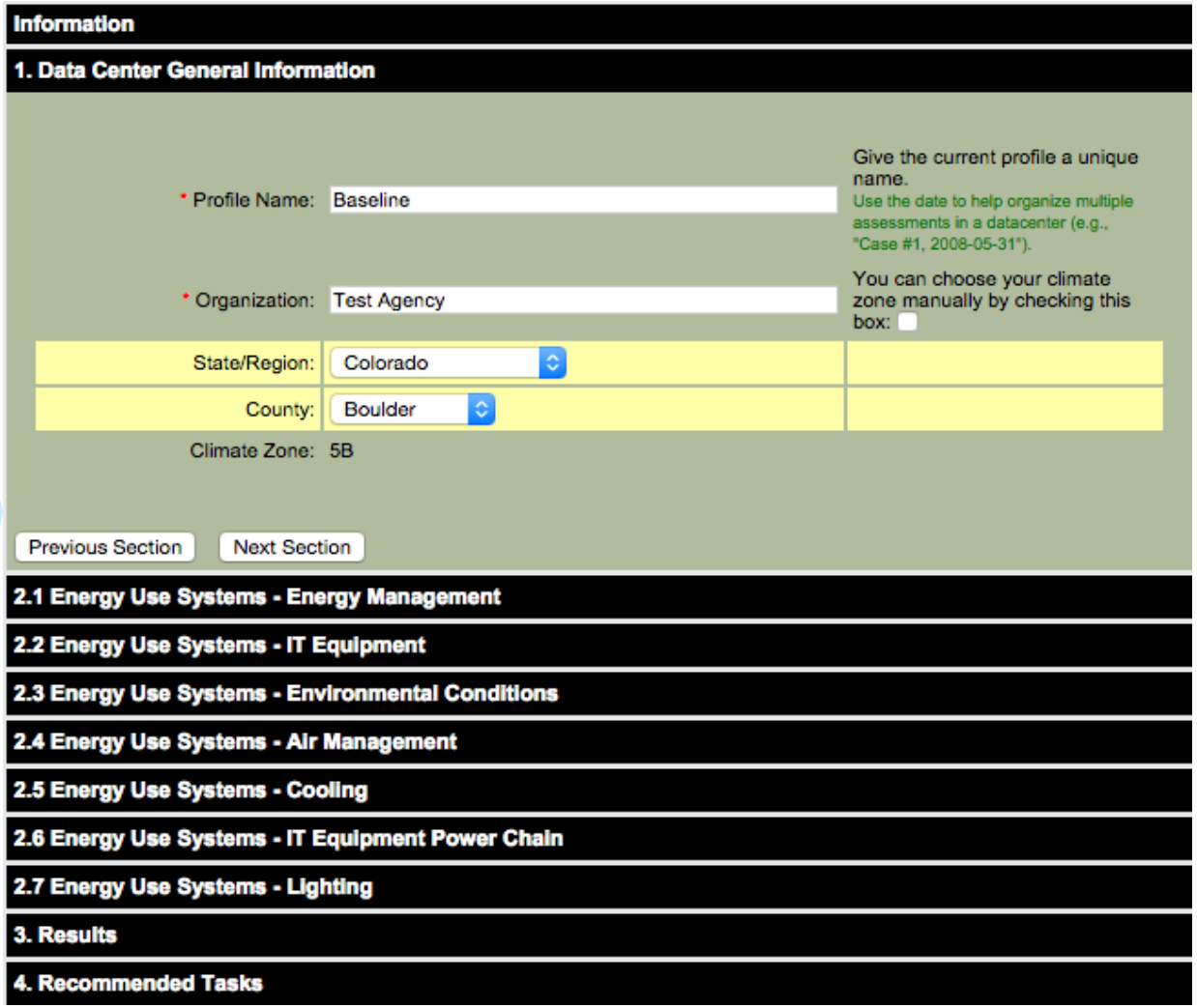
	A	B
1	**PUE: 1.4**	
2		
3	**Energy Use Distribution**	**%**
4		
5	**IT Equipment**	**69**
6	**Lights**	**0.7**
7	**Power Chain**	**1.4**
8	**Fans**	**20.3**
9	**Cooling**	**8.6**
10		
11		

Excel and PDF

DC Pro Tools – DC Pro Input/Output

INPUTS

- General Facility Description
- Environmental Conditions
- System information
  - IT
  - Air Management
  - Cooling
  - Power
  - Lighting



OUTPUTS

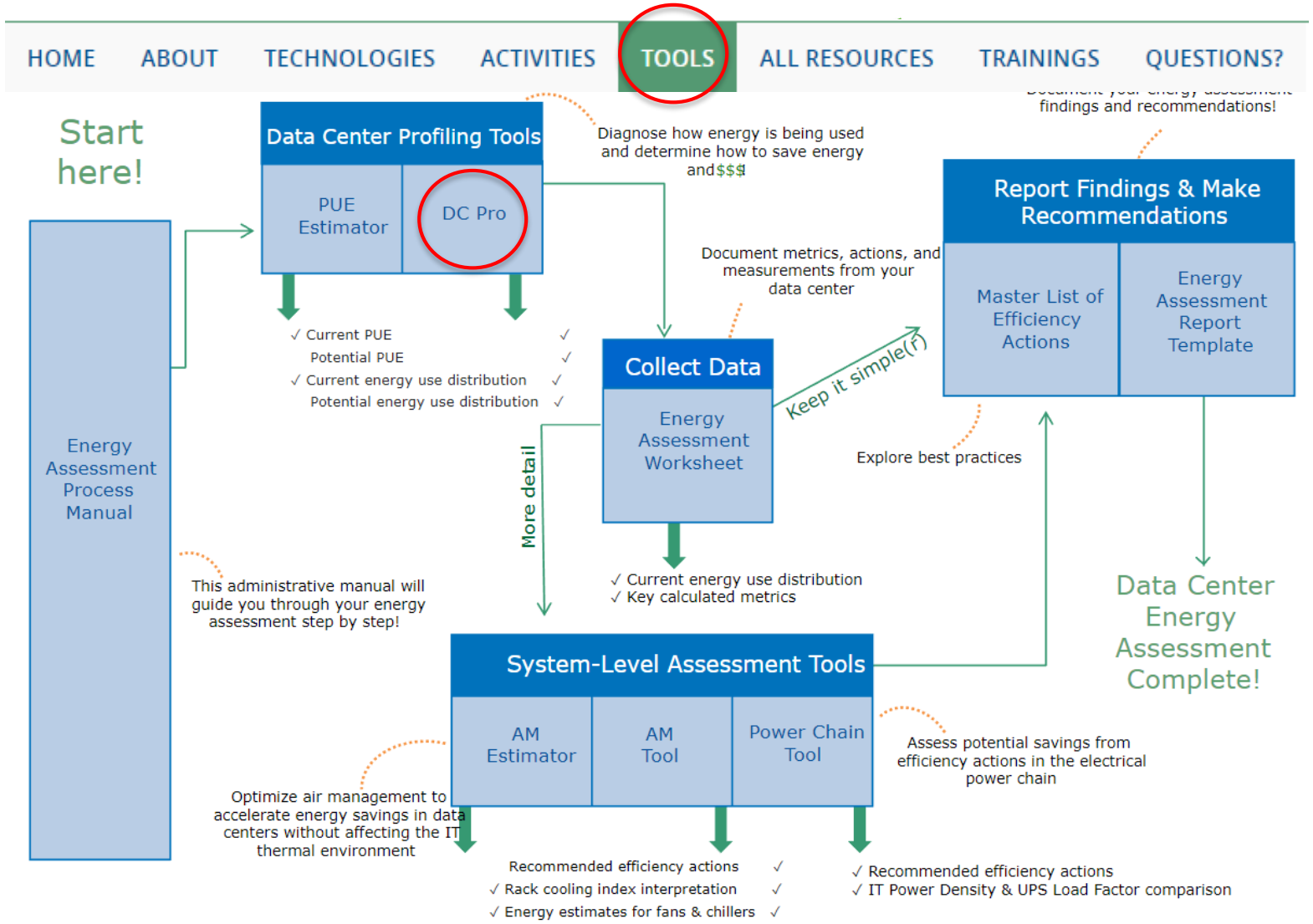
- Current PUE
- Potential PUE
- Current Energy Use Distribution
- Potential Energy Use Distribution
- Recommended tasks for improvement

DC Pro Tools – DC Pro Export

	A	B	C
1	**Current PUE: 1.8**		
2			
3	**Potential PUE: 1.2**		
4			
5	**Energy Use Distribution**	**Current Energy Use**	**Potential Energy Use**
6		**%**	**%**
7	IT Equipment	56.3	83.5
8	Lights	0.6	0.1
9	Power Chain	10.3	1.7
10	Fans	13.8	6.4
11	Cooling	19.1	8.3
12	**Task**	**Description**	
13	Configure equipment in straight lineups (rows) for hot/cold aisles and cable management	Since straight equipment lineups are generally a prerequisite to alternating hot and cold aisles, it should have a very high priority. Straight lineups also allow structured cable management.	
14	Use appropriate overhead diffusers	The generally high pressure drops across the end devices (diffusers) and low pressure losses in the distribution system (ductwork) promote high air stability. Stability means that the system can be balanced successfully and that external disturbances have limited impact on that balance. In addition, the diffusers should have characteristics promoting penetration of the supply air into the cold aisles.	
15	Use adequate ratio system flow to rack flow (target 1.0 or RTI=100%)	Ideally, the total flow rate of air delivered by the cooling equipment fans is equal to the total flow rate of the IT equipment fans, and no air bypasses the racks or recirculates in the racks. When balancing the data center air flow, aim for this ideal.	

Excel and PDF

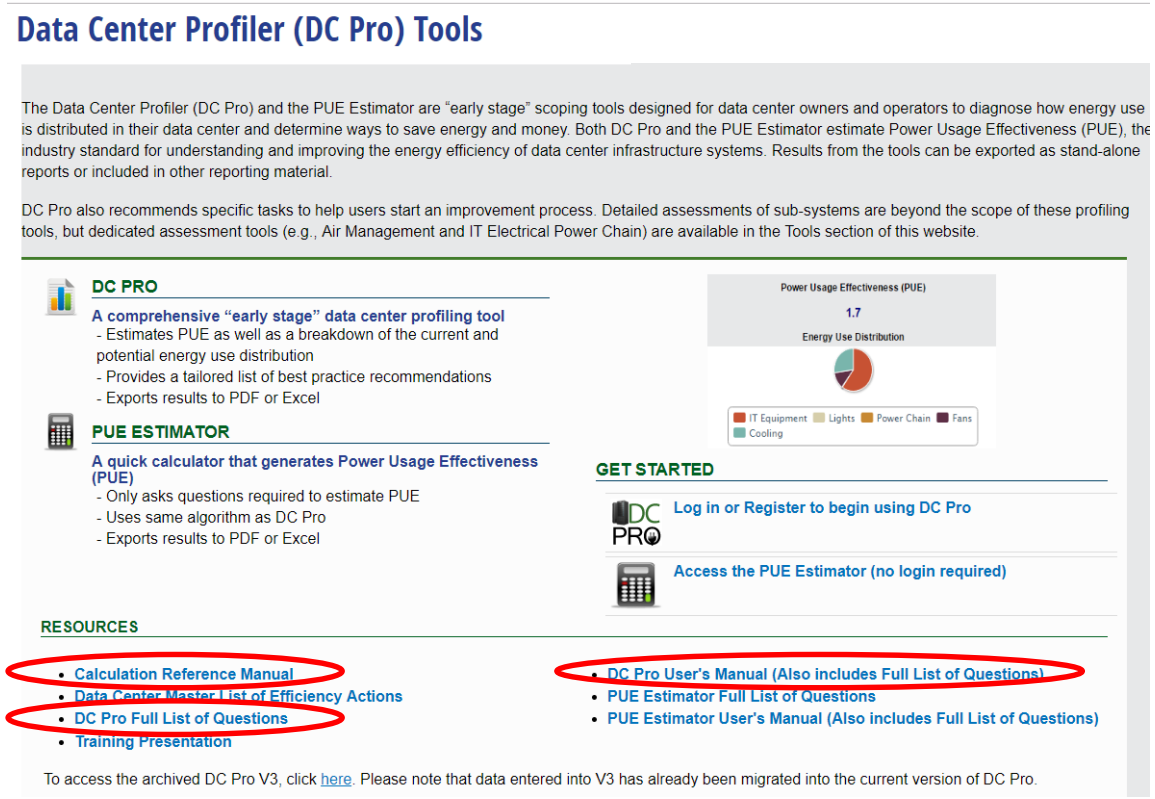
Demonstration: DC Pro Tools Access Overview



Demonstration: DC Pro Tools – Access to DC Pro

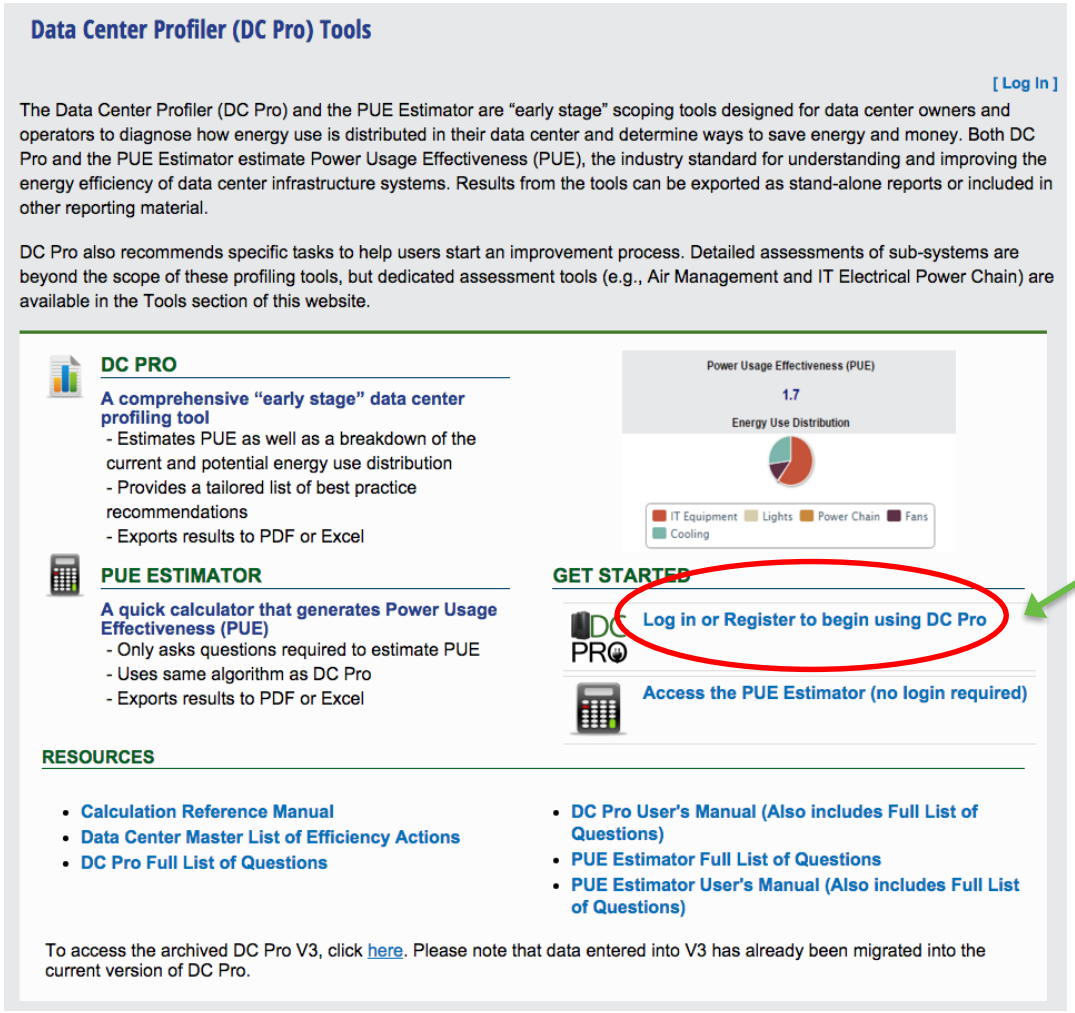
DC Pro has a number of introductory resources to help users get started with the tool:

- Calculation Reference Manual – Details how results are generated.
- DC Pro Full List of Questions – Full list of questions in DC Pro (can be printed for offsite information gathering).
- User's Manual – This manual is a step-by-step guide for using DC Pro V4 (DC Pro) including how to get started, provide the required inputs, and view results.



DC Pro Tools Homepage: datacenters.lbl.gov/dcpro

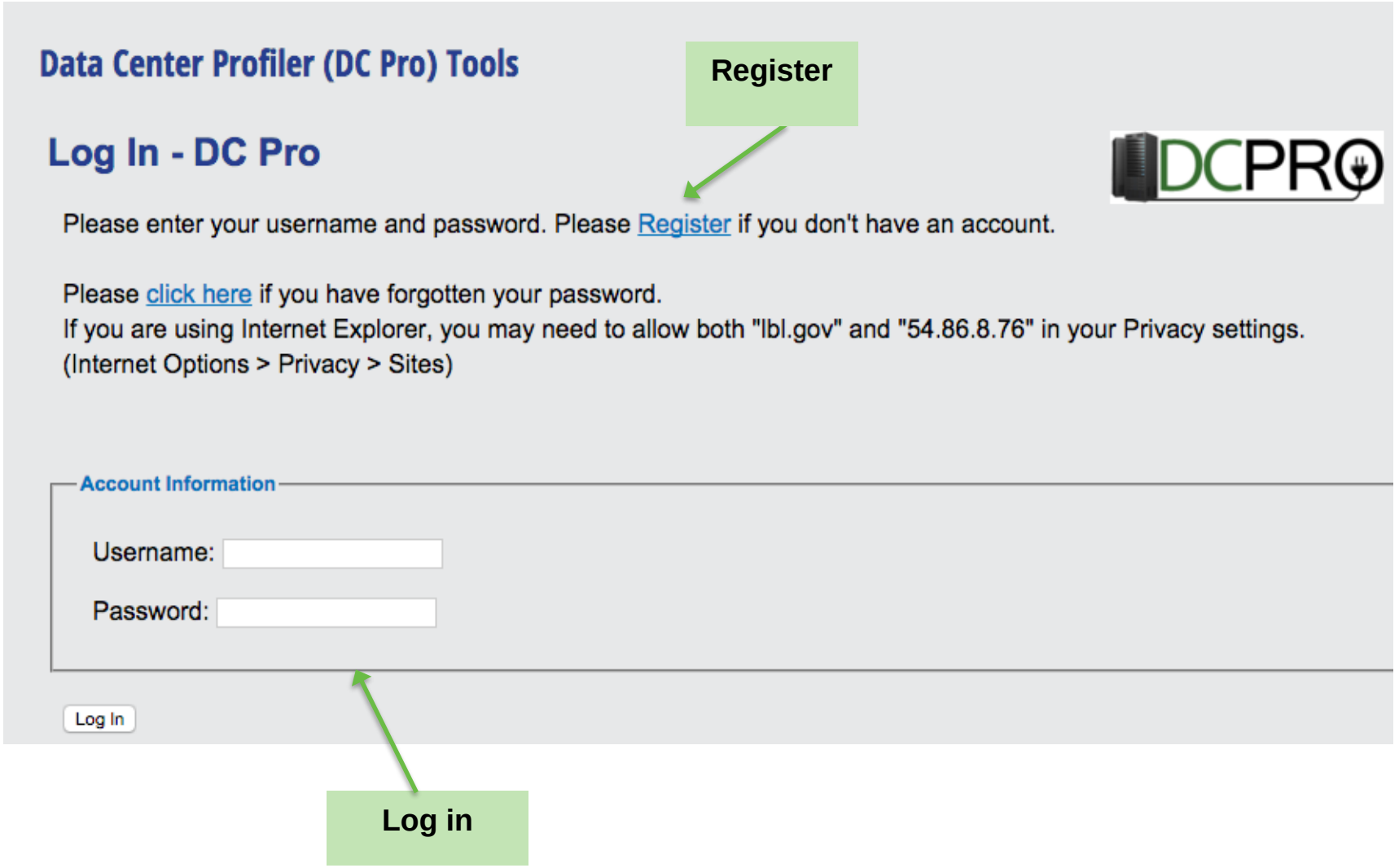
Demonstration: DC Pro Tools – Access to DC Pro



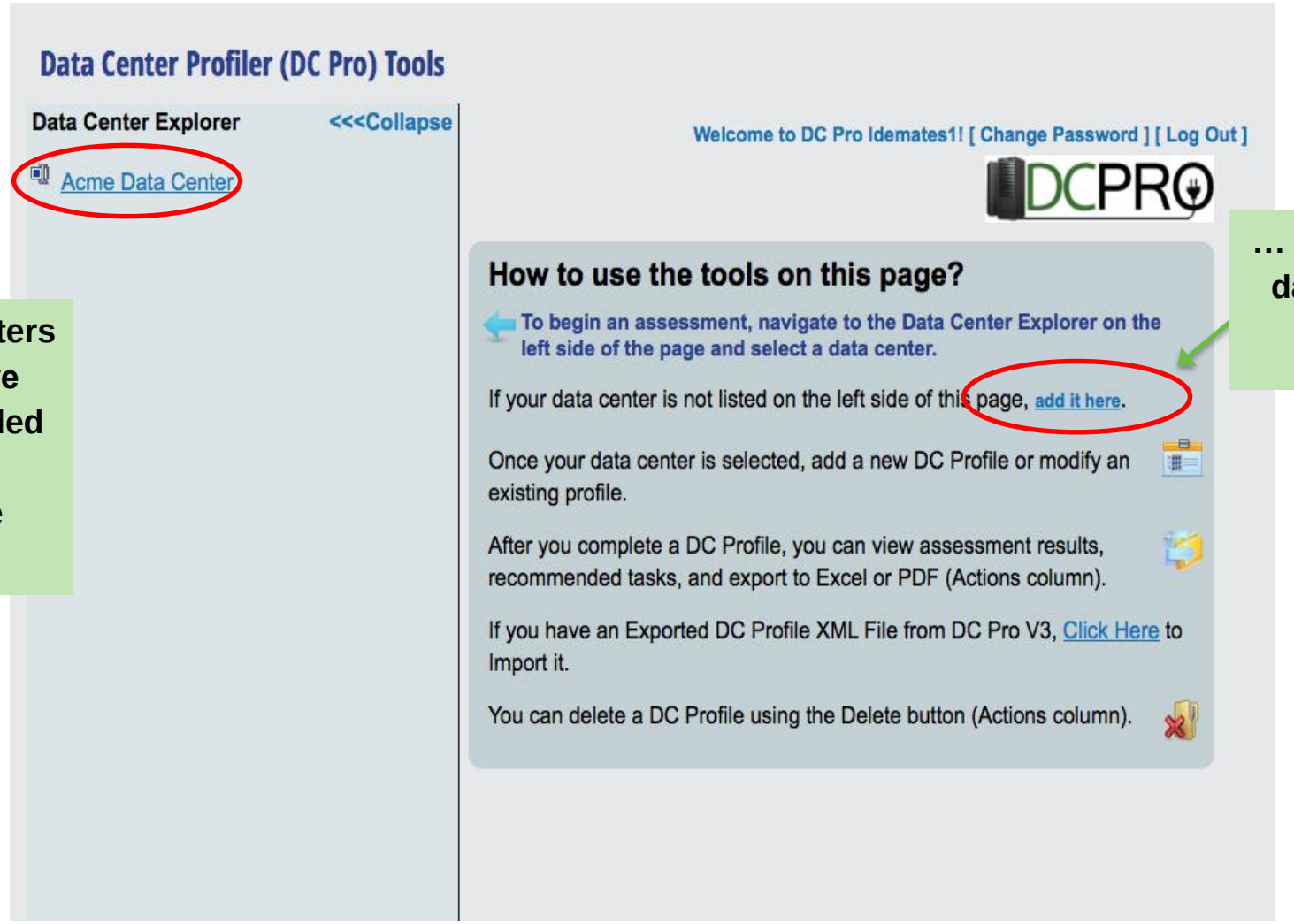
Log in or Register for DC Pro

DC Pro Tools Homepage: datacenters.lbl.gov/dcpro

Demonstration: DC Pro – Log in/Register



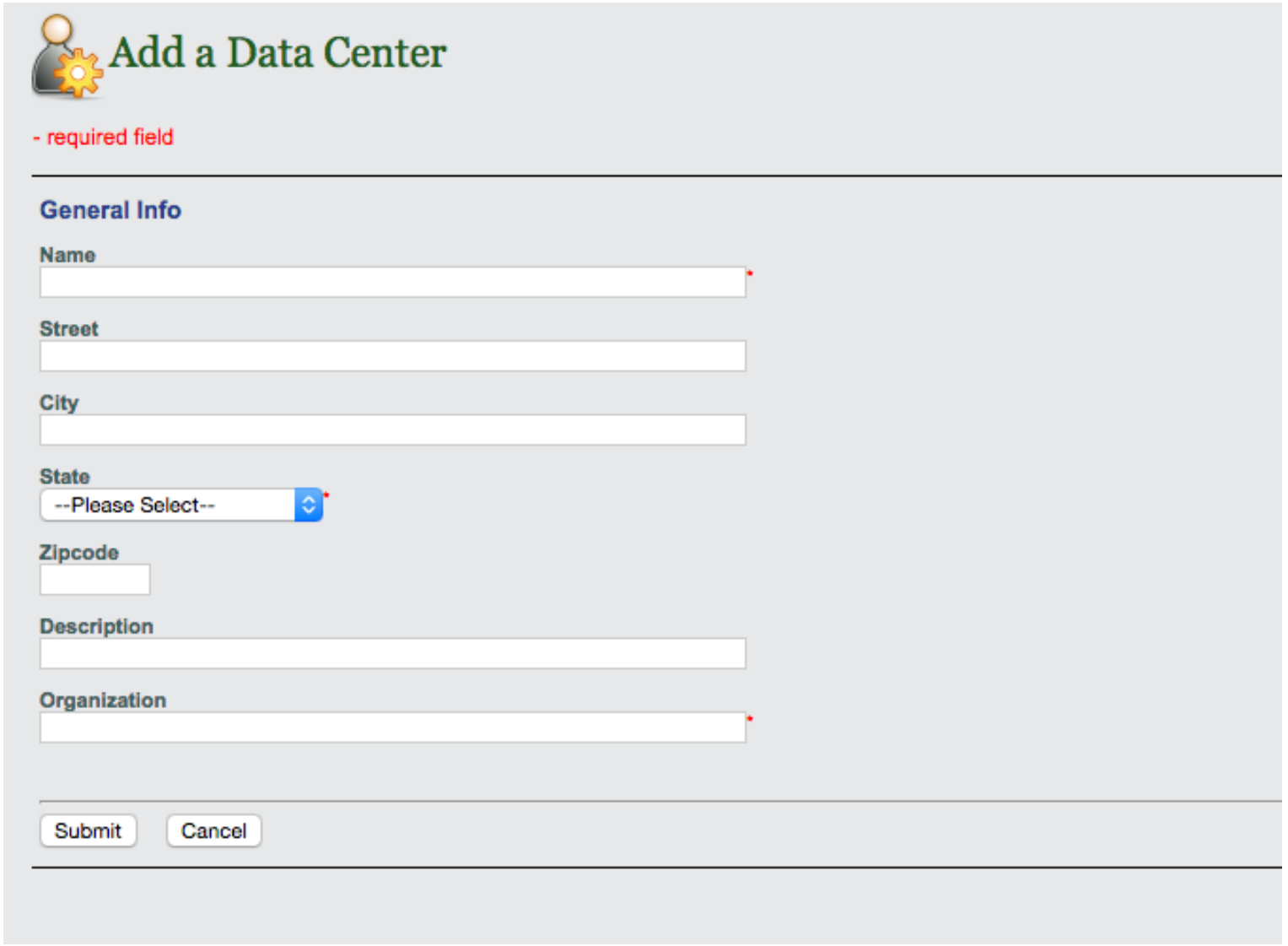
Demonstration: DC Pro – Data Center Records



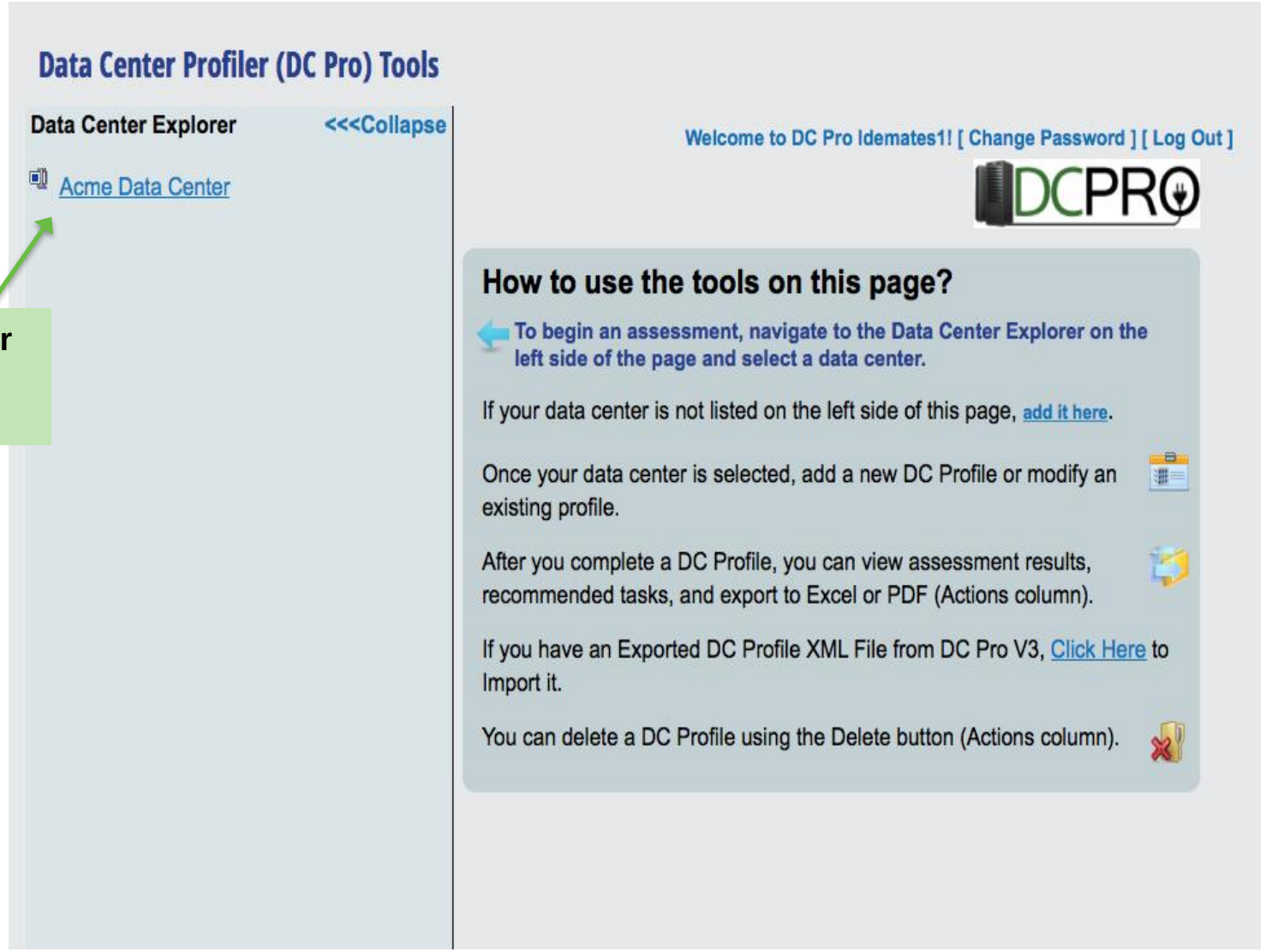
All data centers that you've already added will be available here…

… create new data center

Demonstration: DC Pro – Create (Add) New Data Center

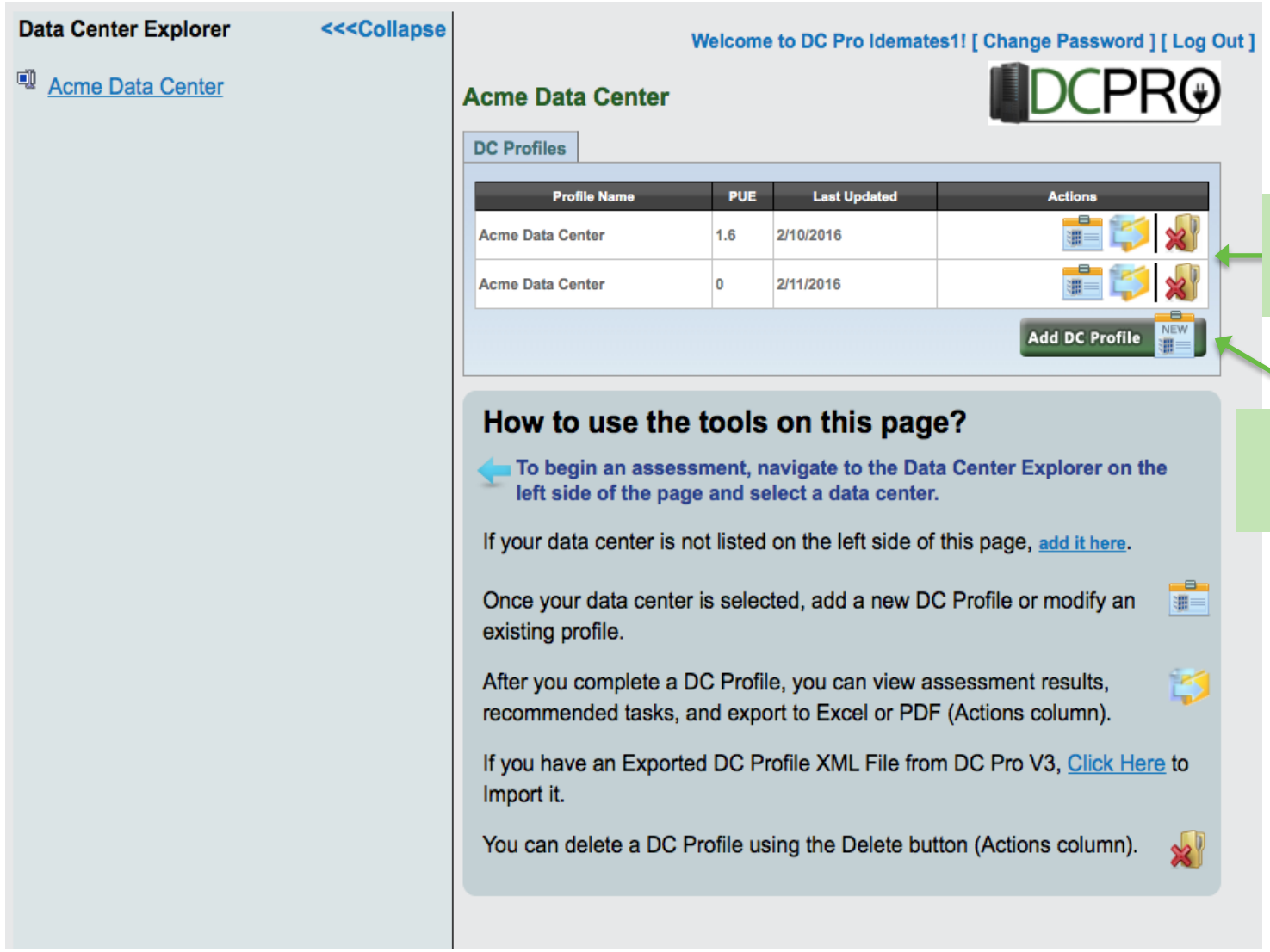


Demonstration: DC Pro – Existing Data Center(s)



Data Center Explorer

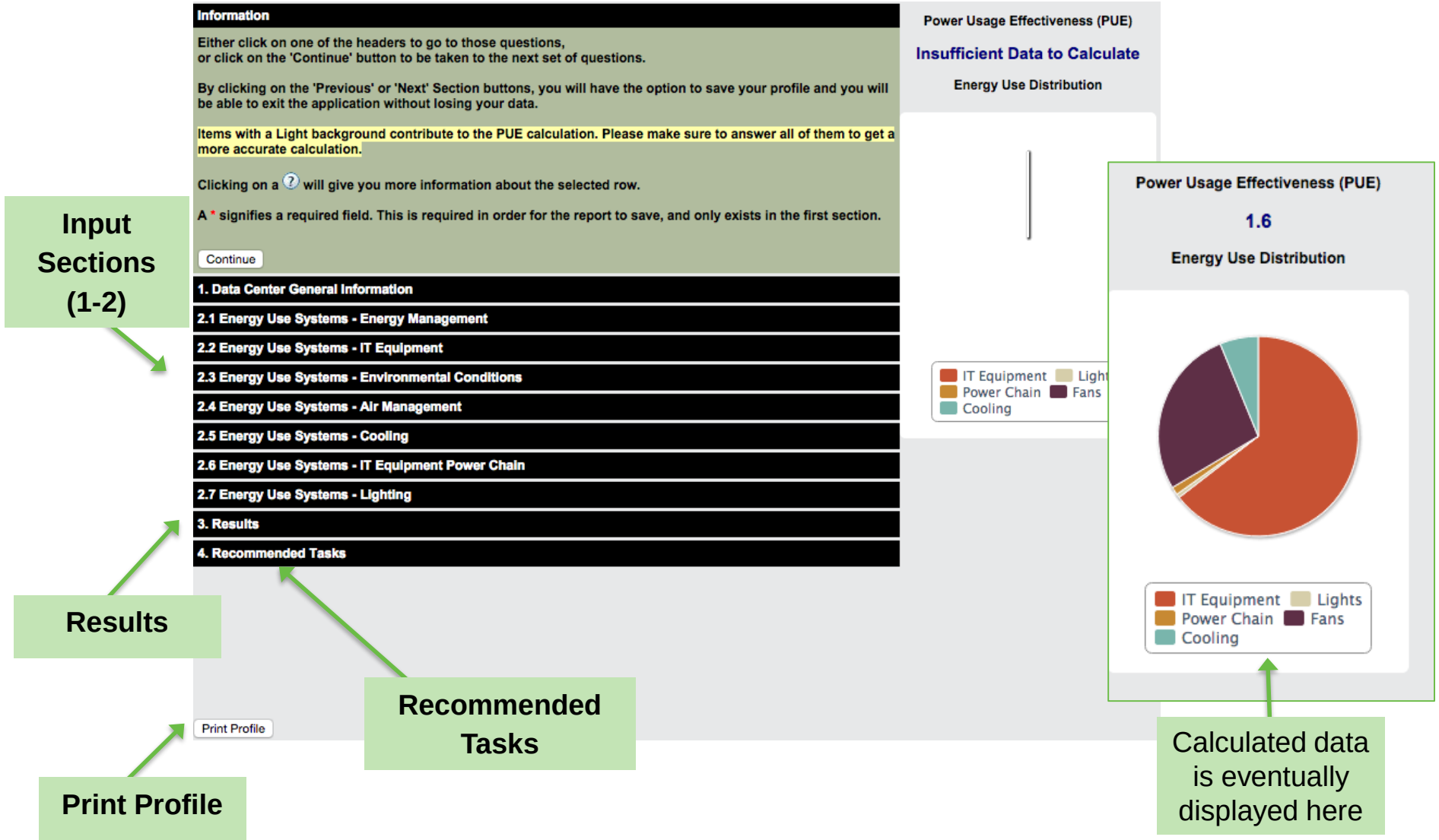
Demonstration: DC Pro – Edit or Create New DC Profile



Edit existing profiles

Create new profile

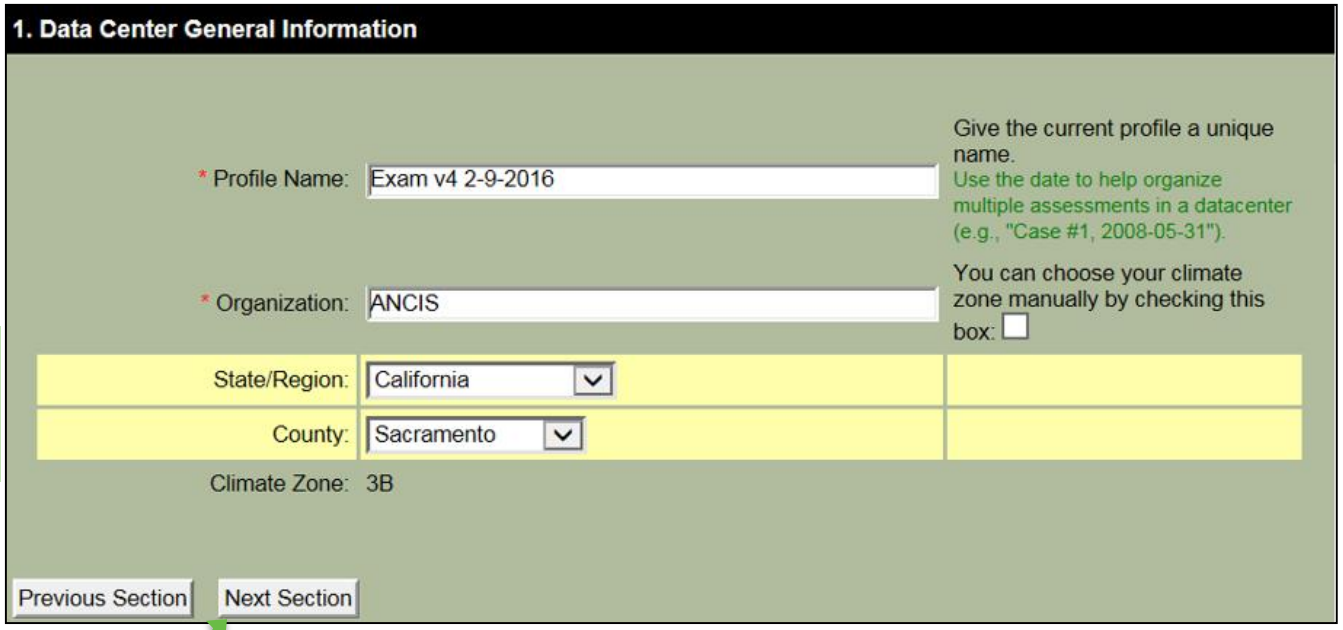
Demonstration: DC Pro – New DC Profile



Input 1: Data Center General Information

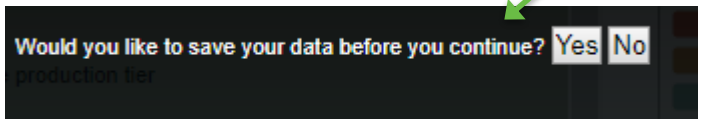
Red "*" is a required field

Only highlighted items contribute to PUE calculation



Click "Next Section" to proceed to the following screen

Be sure to save your data as you move through the screens



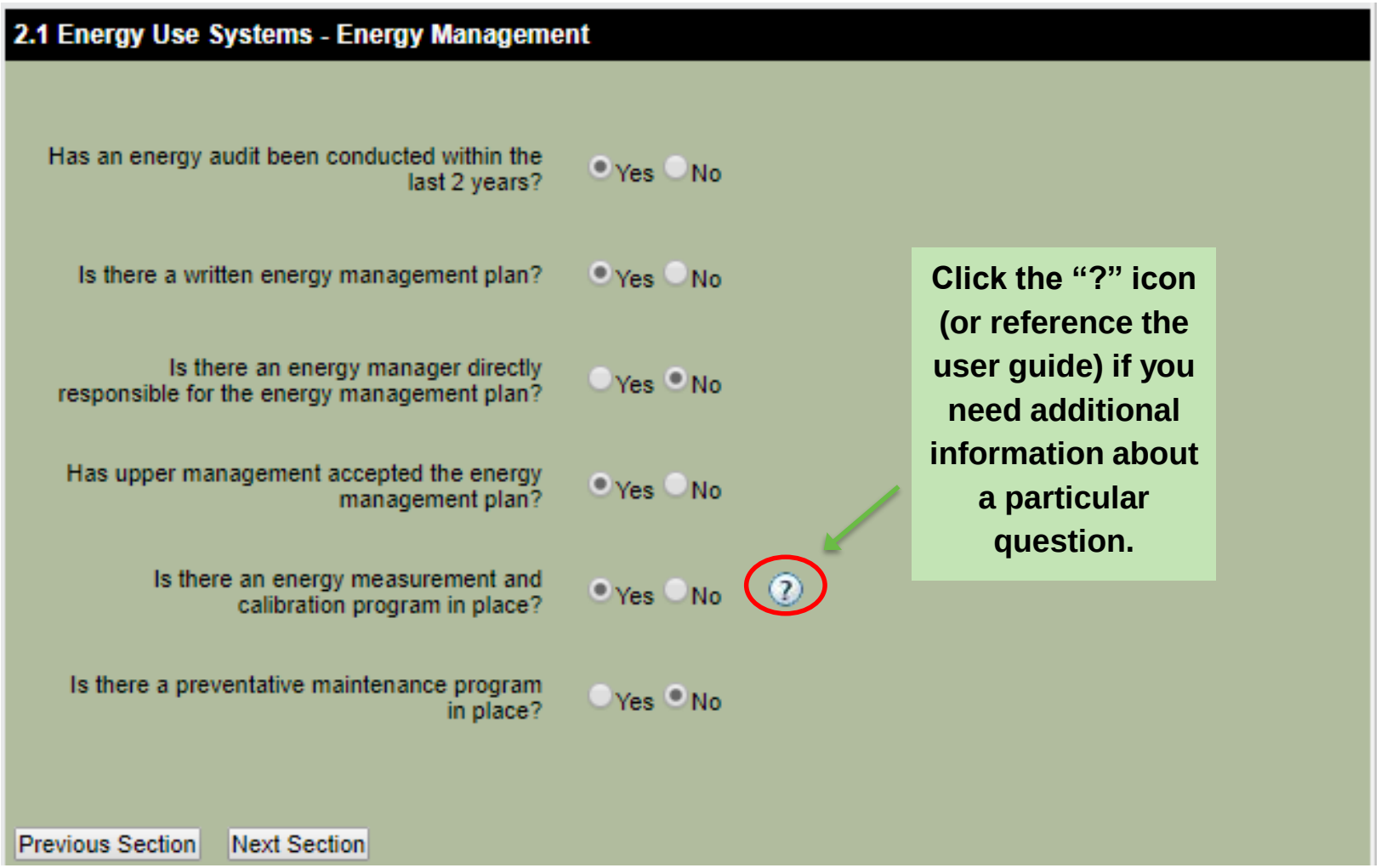
Input 2: Energy Use Systems

- Inputs 2.1 through 2.7 allow the DC Pro tool to:
  - Determine whether an action is recommended or not recommended, in the "Suggested Next Steps."
  - Influence the output values that the Profiler calculates. Not every question influences the calculated values.
- Answers to Energy Use Systems also estimates how the data center's energy use is distributed among five end-use categories (default energy end-use breakouts).

2.1 Energy Management
2.2 IT Equipment
2.3 Environmental Conditions
2.4 Air Management
2.5 Cooling Systems
2.6 IT Equipment Power Chain
2.7 Lighting

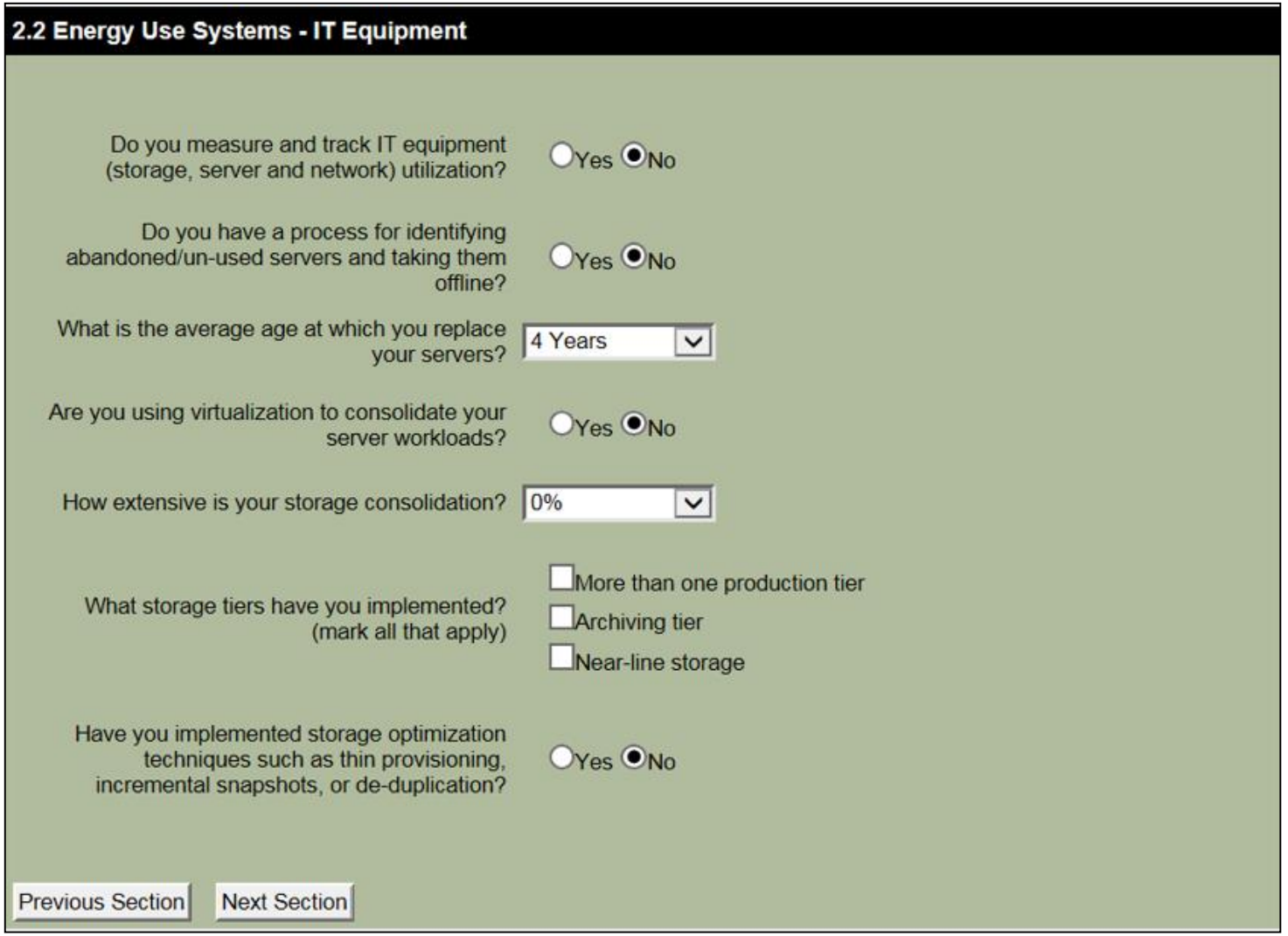
Input 2.1: Energy Use Systems- Energy Management

- Energy audit conducted in the last 2 years
- Written energy management plan
- No energy manager
- Plan accepted by upper management



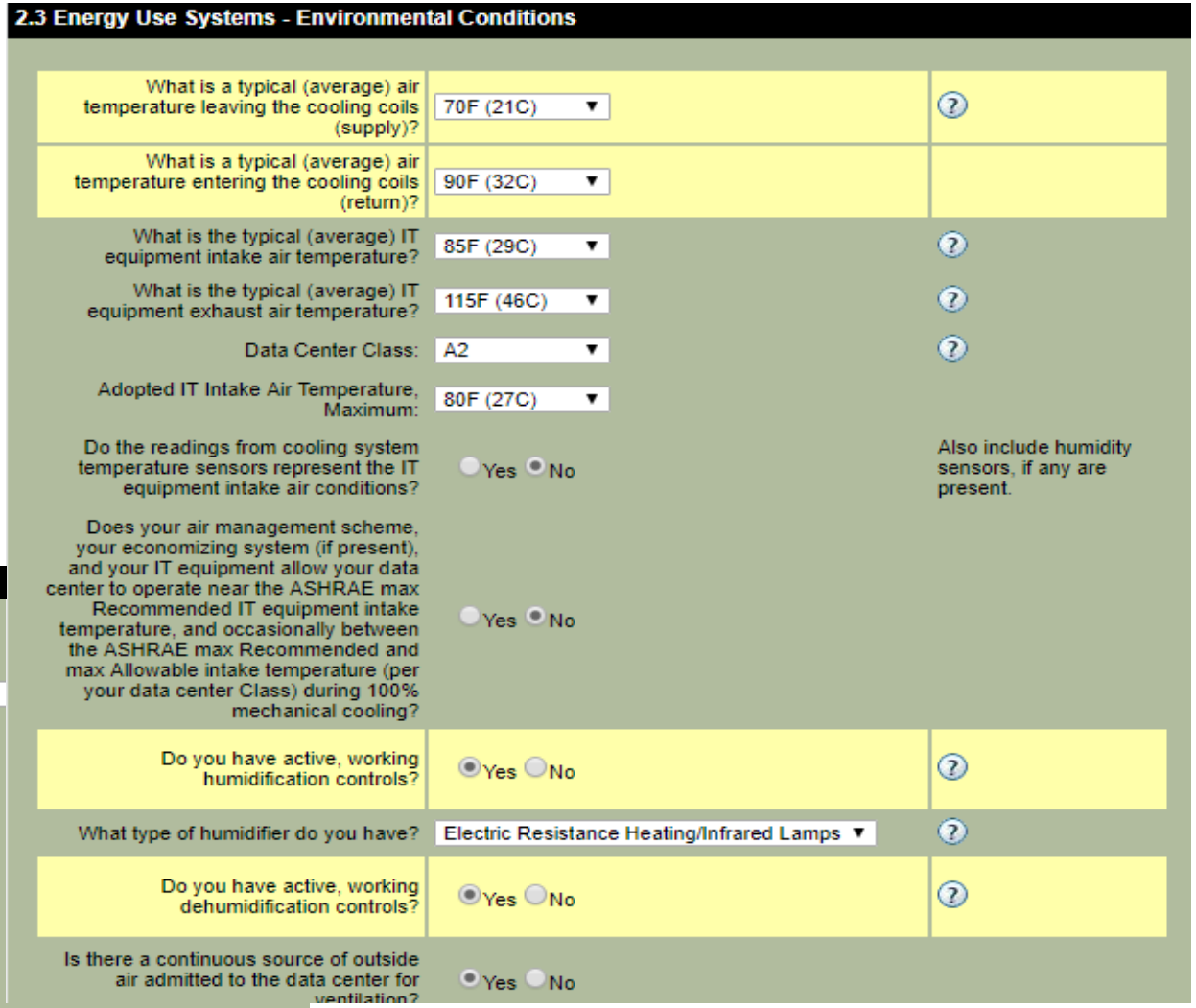
Input 2.2: IT Equipment

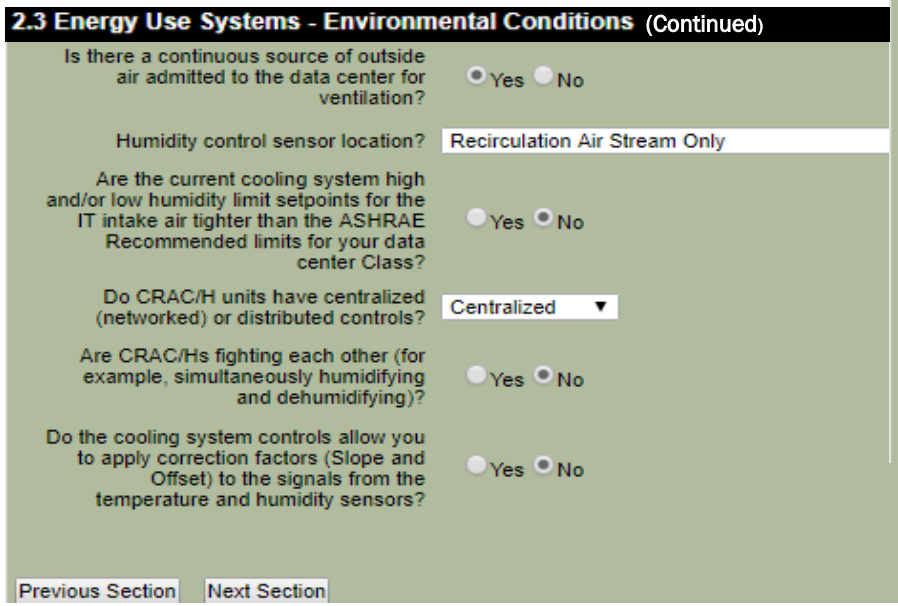
- No IT-equipment utilization tracking
- Servers replaced every 4 years
- No server virtualization
- No storage consolidation
- No storage tiers
- No storage optimization.



Input 2.3: Environmental Conditions

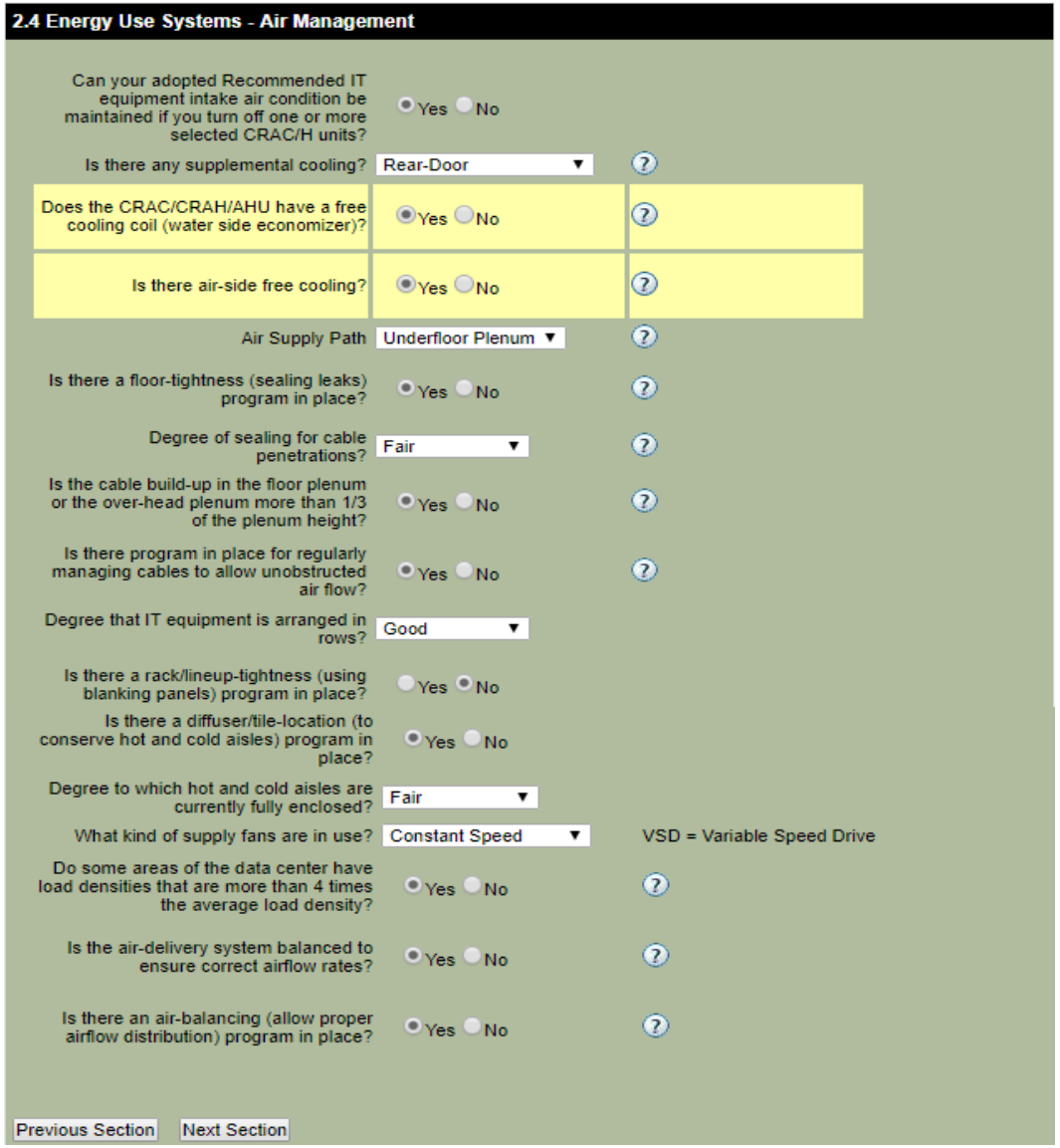
- Yellow shaded cells are inputs for DC Pro calculations.
- Typical supply air temperature of 70F (21 C)
- Typical return air temperature of 90F (32 C)
- Active/working humidification controls.
- Active/working dehumidification controls





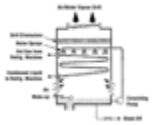
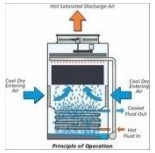
Input 2.4: Air Management

- Rear-door supplemental cooling
- CRAC/CRAH/AHU has a free cooling coil (water side economizer)
- Free air-side cooling
- Floor-tightness program in place
- IT equipment row arrangement is “good”
- Rack tightness (blanking panels) in place
- Diffuser/tile-location program in place to conserve hot and cold aisle
- Hot and cold aisle enclosures are “fair”
- Constant speed supply fans in use
- Air delivery system is balanced to ensure correct airflow rates.
- Air balancing program in place



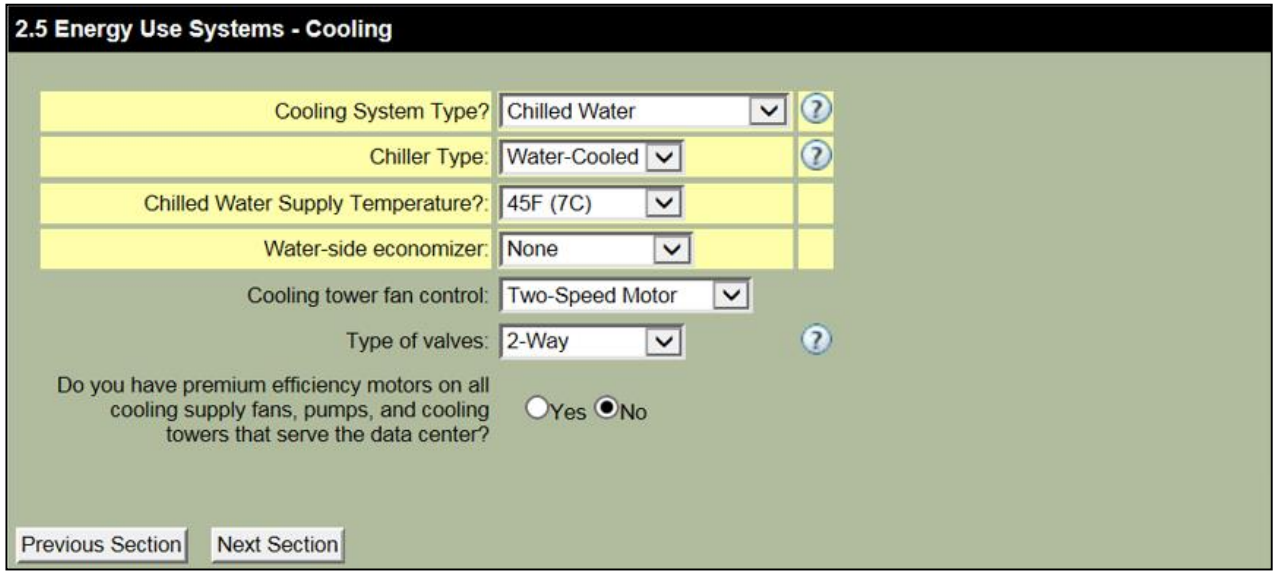
Overview of Available Cooling System Types in DC Pro

System Types

- Air-Cooled DX 
- Evaporatively-Cooled DX 
- Water-Cooled DX
  - Dry Cooler Condensing System, or 
  - Cooling Tower Condensing System
    - Tower Fan Motor Control: Fixed Speed, 2-Speed, or Variable Speed 
  - Type of valves: 2-way or 3-way
- Chilled Water
  - Air-Cooled Chiller 
  - Water-Cooled Chiller 
    - Water-Side Economizer: None, Integrated, or Non-Integrated 
    - Tower Fan Motor Control: Fixed Speed, 2-Speed or Variable Speed 
  - Type of valves: 2-way or 3-way

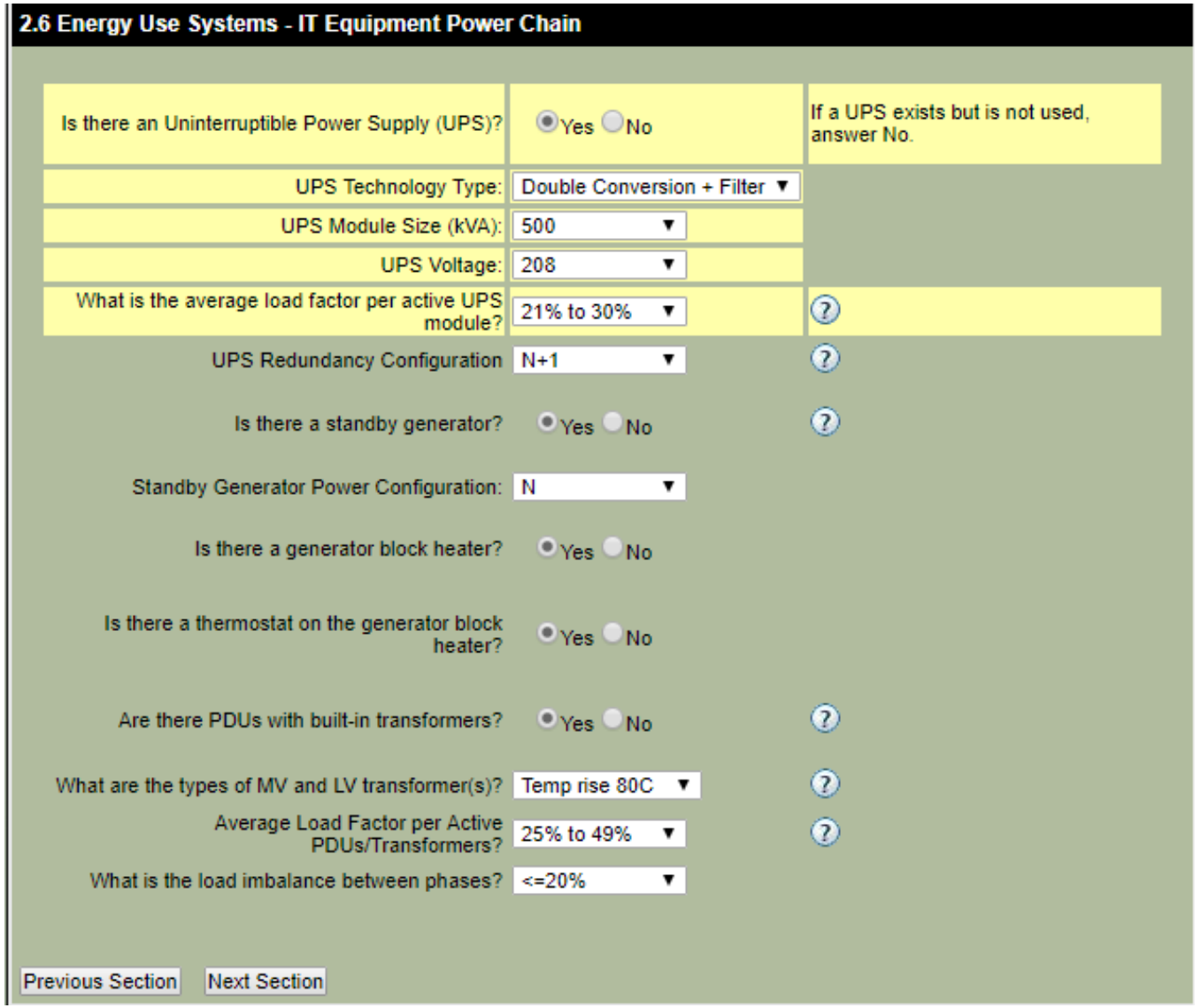
Input 2.5: Cooling System

- 25 chilled-water CRAH units
- 4 water-cooled chillers
- Chilled water supply temperature is 45°F (7°C)
- No water-side economizers
- Two-speed cooling tower fans
- 2-way chilled-water valves
- Standard efficiency motors



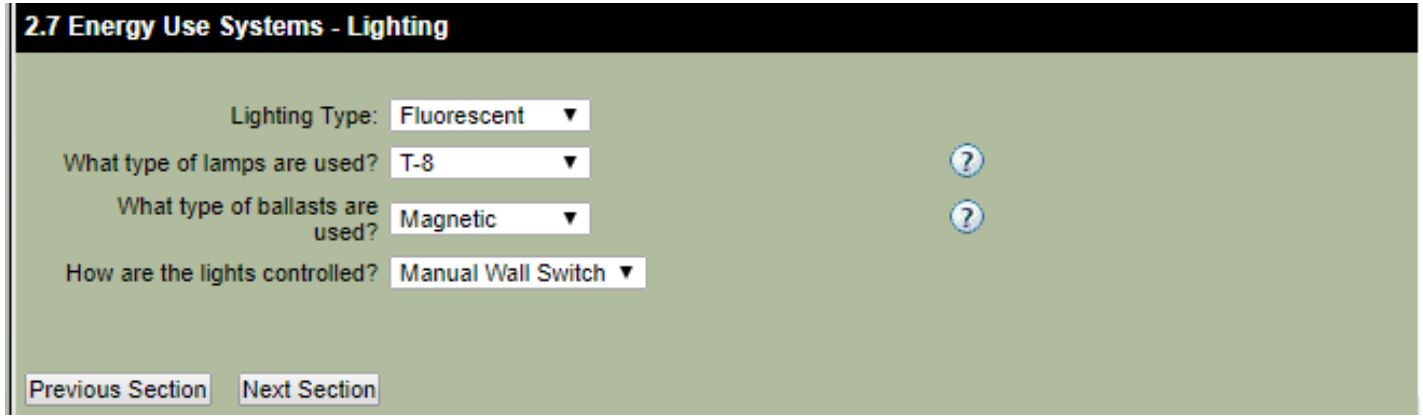
Input 2.6: IT Equipment Power Chain

- 500 kVA, double conversion UPS in place.
- UPS voltage of 208
- Average load factor per active UPS module approximately 21-30%.
- UPS redundancy configuration of N+1
- Standby generator present
- Generator block heater (with thermostat)
- PDUS with built-in transformers

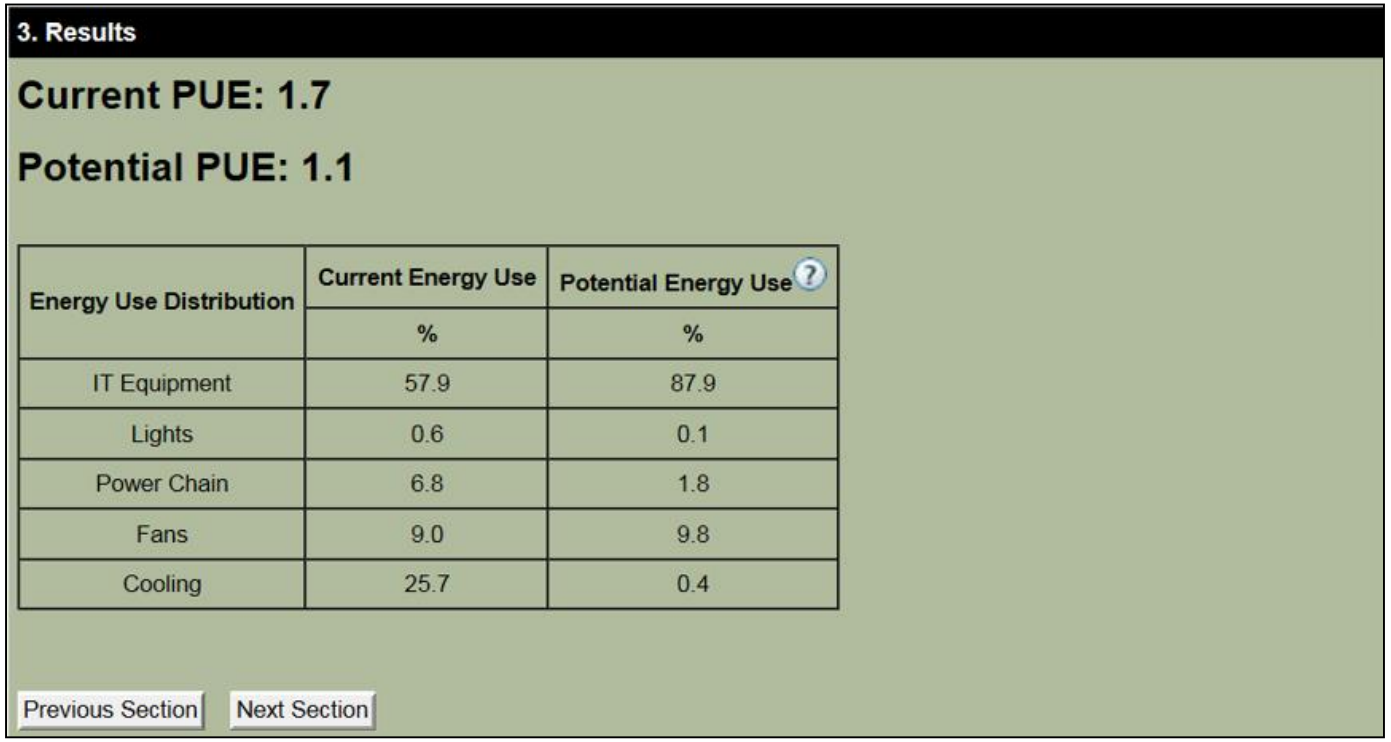


Input 2.7: Lighting

- Fluorescent lighting
- T-8 lamps
- Magnetic ballasts
- Lighting controlled via manual wall switch



Step 3: Results – PUE and Energy Use Distribution



3. Results

Current PUE: 1.7

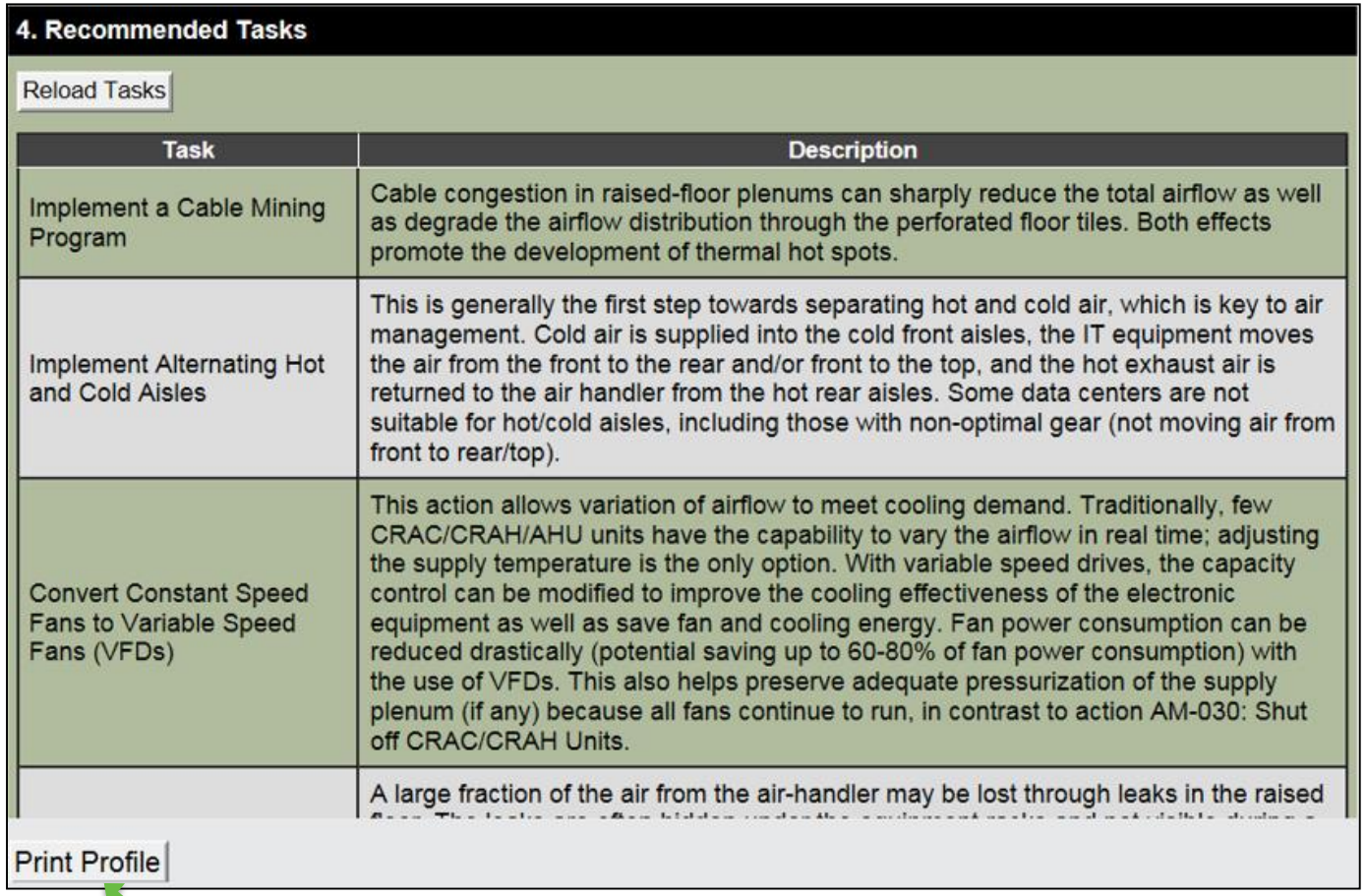
Potential PUE: 1.1

Energy Use Distribution	Current Energy Use	Potential Energy Use
	%	%
IT Equipment	57.9	87.9
Lights	0.6	0.1
Power Chain	6.8	1.8
Fans	9.0	9.8
Cooling	25.7	0.4

Previous Section | Next Section

The values for "Potential PUE" and "Potential Energy Use" are ideal values based on implementing all recommended energy efficiency tasks outlined in Section 4.

Step 4: Recommended Tasks



4. Recommended Tasks

Reload Tasks

Task	Description
Implement a Cable Mining Program	Cable congestion in raised-floor plenums can sharply reduce the total airflow as well as degrade the airflow distribution through the perforated floor tiles. Both effects promote the development of thermal hot spots.
Implement Alternating Hot and Cold Aisles	This is generally the first step towards separating hot and cold air, which is key to air management. Cold air is supplied into the cold front aisles, the IT equipment moves the air from the front to the rear and/or front to the top, and the hot exhaust air is returned to the air handler from the hot rear aisles. Some data centers are not suitable for hot/cold aisles, including those with non-optimal gear (not moving air from front to rear/top).
Convert Constant Speed Fans to Variable Speed Fans (VFDs)	This action allows variation of airflow to meet cooling demand. Traditionally, few CRAC/CRAH/AHU units have the capability to vary the airflow in real time; adjusting the supply temperature is the only option. With variable speed drives, the capacity control can be modified to improve the cooling effectiveness of the electronic equipment as well as save fan and cooling energy. Fan power consumption can be reduced drastically (potential saving up to 60-80% of fan power consumption) with the use of VFDs. This also helps preserve adequate pressurization of the supply plenum (if any) because all fans continue to run, in contrast to action AM-030: Shut off CRAC/CRAH Units.
	A large fraction of the air from the air-handler may be lost through leaks in the raised

Print Profile

Export Results (Excel and PDF)

DC Pro - Export

PDF

Excel

Report generated through the DC Pro Tool (datacenters.lbl.gov/dcpro): 2/5/2016

Back | Save to PDF | Export Results to Excel

Current PUE: 1.5

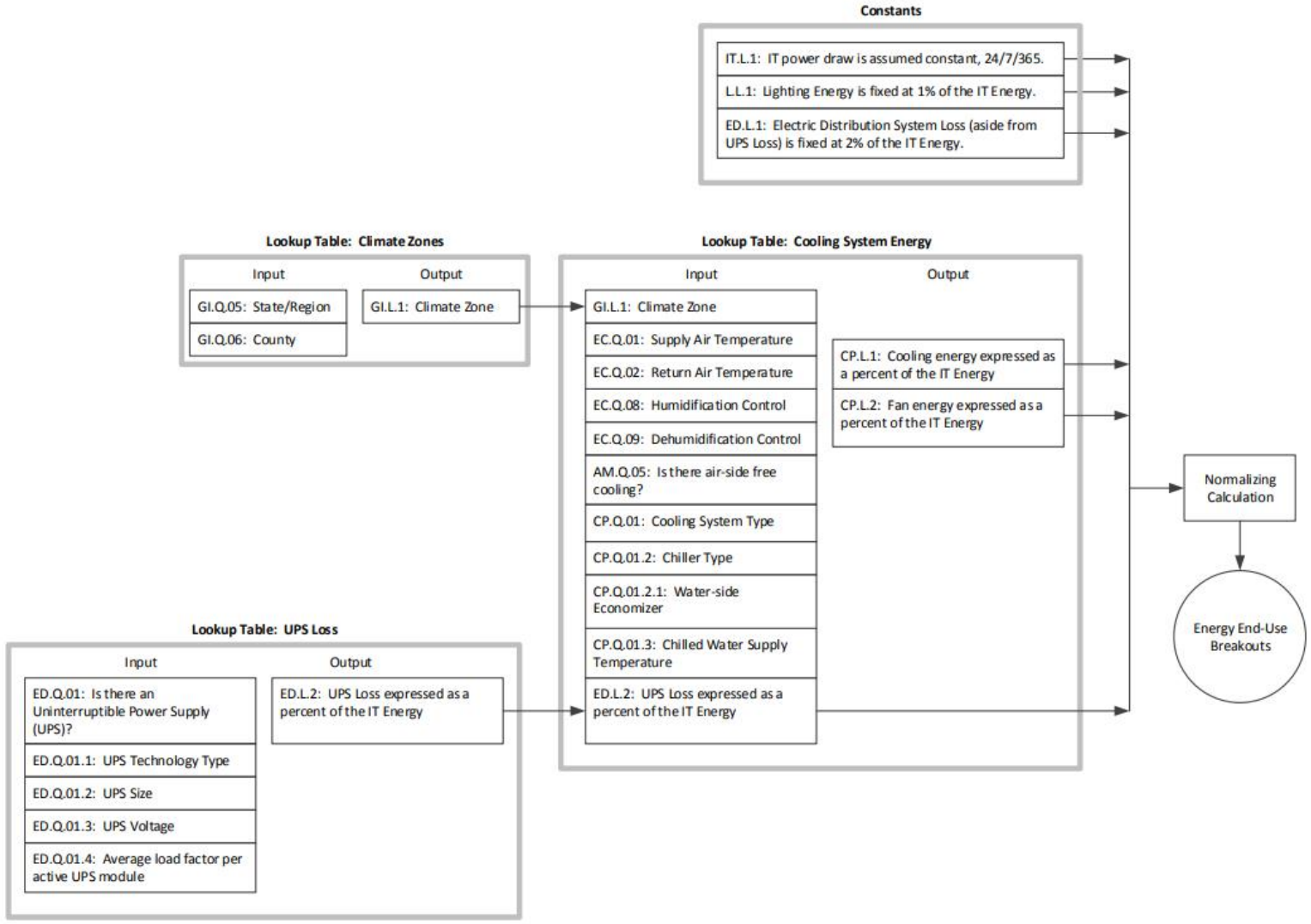
Potential PUE: 1.1

Energy Use Distribution	Current Energy Use	Potential Energy Use
	%	%
IT Equipment	67	88.5
Lights	0.7	0.1
Power Chain	1.3	1.8
Fans	14.1	9.5
Cooling	16.9	0.1

Task	Description
Place supply devices in cold aisles only	If the IT racks are arranged in alternating hot and cold aisles, it is important to prevent warm air from diluting the cold air in the cold aisles. This reduces the ability of the cold air to do useful cooling. Likewise, it is important to prevent cold air from diluting the warm air in the hot aisles. Again, this takes away the ability of the diluting cold air to do useful cooling. Additionally, cooling equipment capacity depends on the temperature of the warm air it receives. In most cases, the warmer the return air, the greater the cooling capacity. Diluting the warm return air impairs cooling capacity. There should be no reason to place supply air tiles or diffusers in the hot aisles.
Use appropriate overhead diffusers	The generally high pressure drops across the end devices (diffusers) and low pressure losses in the distribution system (ductwork) promote high air stability. Stability means that the system can be balanced successfully and that external disturbances have limited impact on that balance. In addition, the diffusers should have characteristics promoting penetration of the supply air into the cold aisles.

More About the DC Pro Calculations

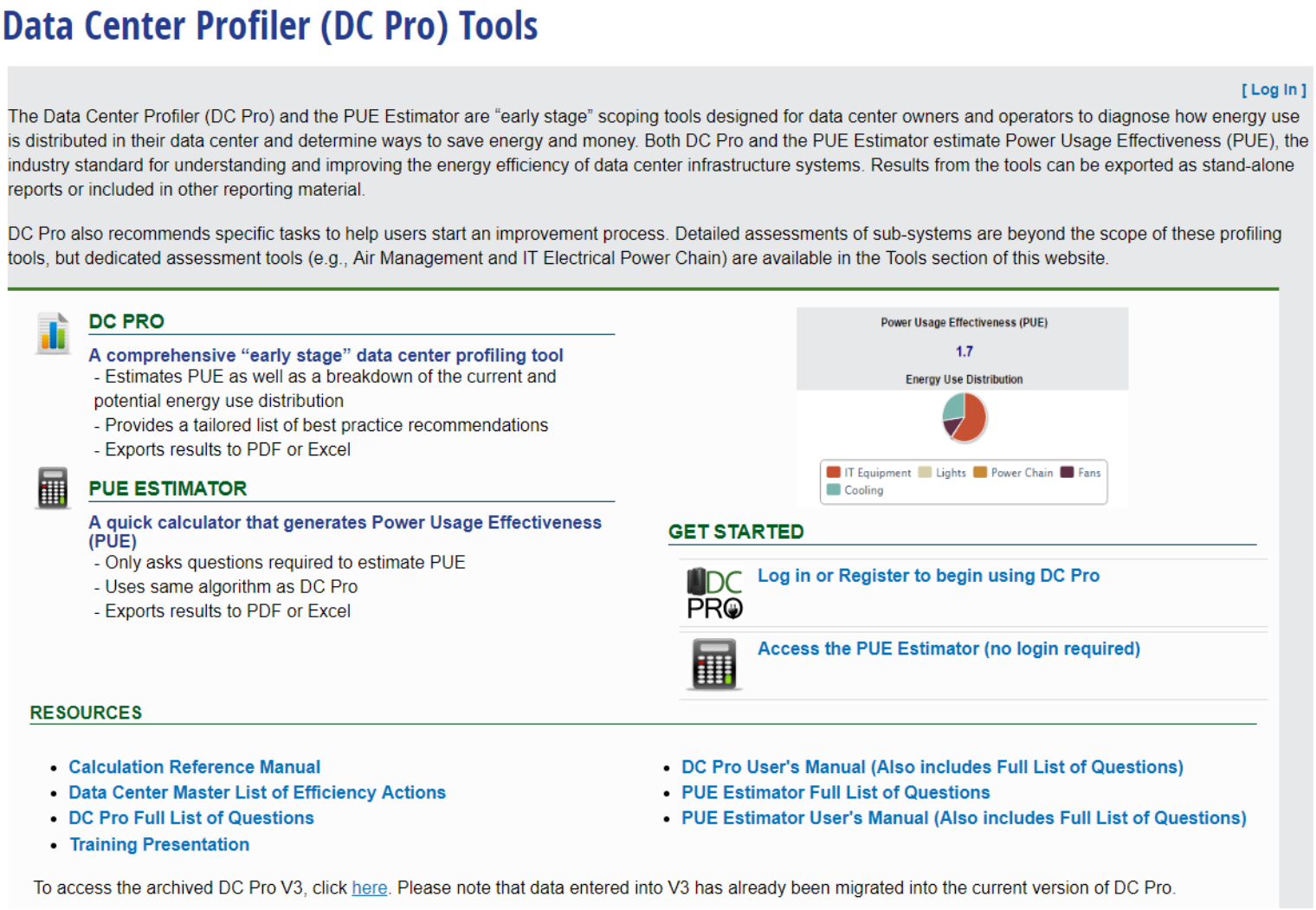
The Profiler takes some of the user's inputs from the General Data Center information and Energy Systems information and refers to look-up tables to determine the default, estimated data center energy end-use breakouts.



DC Pro: Interactive Workshop

Registering with DC Pro

- Get out your laptops
- Connect to the Wi-Fi
- Make the information relevant to your data center (if you brought it) accessible
- To register and get started, go to: datacenters.lbl.gov/dcpro
- We'll be circulating to answer questions!



Data Center Profiler (DC Pro) Tools

[Log In]

The Data Center Profiler (DC Pro) and the PUE Estimator are "early stage" scoping tools designed for data center owners and operators to diagnose how energy use is distributed in their data center and determine ways to save energy and money. Both DC Pro and the PUE Estimator estimate Power Usage Effectiveness (PUE), the industry standard for understanding and improving the energy efficiency of data center infrastructure systems. Results from the tools can be exported as stand-alone reports or included in other reporting material.

DC Pro also recommends specific tasks to help users start an improvement process. Detailed assessments of sub-systems are beyond the scope of these profiling tools, but dedicated assessment tools (e.g., Air Management and IT Electrical Power Chain) are available in the Tools section of this website.

DC PRO

A comprehensive "early stage" data center profiling tool

- Estimates PUE as well as a breakdown of the current and potential energy use distribution
- Provides a tailored list of best practice recommendations
- Exports results to PDF or Excel

PUE ESTIMATOR

A quick calculator that generates Power Usage Effectiveness (PUE)

- Only asks questions required to estimate PUE
- Uses same algorithm as DC Pro
- Exports results to PDF or Excel

GET STARTED

Log in or Register to begin using DC Pro

Access the PUE Estimator (no login required)

RESOURCES

- Calculation Reference Manual
- Data Center Master List of Efficiency Actions
- DC Pro Full List of Questions
- Training Presentation
- DC Pro User's Manual (Also includes Full List of Questions)
- PUE Estimator Full List of Questions
- PUE Estimator User's Manual (Also includes Full List of Questions)

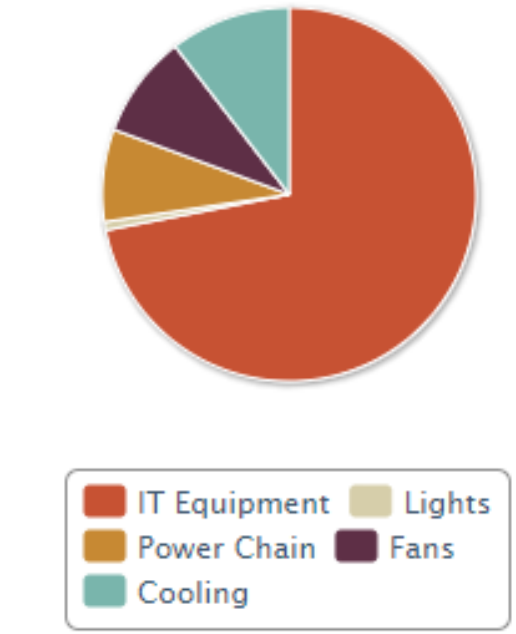
To access the archived DC Pro V3, click here. Please note that data entered into V3 has already been migrated into the current version of DC Pro.

Data Center X Case – DC Pro Results

Power Usage Effectiveness (PUE)

1.4

Energy Use Distribution



Current PUE: 1.4

Potential PUE: 1.1

Energy Use Distribution	Current Energy Use	Potential Energy Use
	%	%
IT Equipment	71.9	88.6
Lights	0.7	0.1
Power Chain	8.0	1.8
Fans	8.9	9.5
Cooling	10.4	0.1

Data Center X Case – Recommended Task Examples

Task	Description
Remove Abandoned Cable and Other Obstructions	Under-floor and over-head obstructions often interfere with the distribution of cooling air. Such interferences can significantly reduce the air handlers' airflow as well as negatively affect the air distribution. The cooling capacity of a raised floor depends on its effective height, which can be increased by removing obstructions that are not in use.
Place Supply Air Devices in Cold Aisles Only	Perforated floor tiles or over-head supply diffusers should only be placed in the cold aisles to match the "consumption" of air by the electronic equipment. Too little or too much supply air results in poor overall thermal and/or energy conditions. Note: the hot aisles are supposed to be hot and supplies should not be placed in those areas.
Seal Raised Floor Leaks	A large fraction of the air from the air-handler may be lost through leaks in the raised floor. The leaks are often hidden under the equipment racks and not visible during a casual walk-through audit. Such leakage often causes by-pass air that does not contribute to cooling the electronic equipment. There are a number of commercial products that can be used to seal the raised floor.
Maintain Tight Racks and Rows	Blanking panels should be used to seal openings under and between equipment racks, between equipment shelves in partially filled racks, or completely empty racks. Managing blanking panels is especially important in hot and cold aisle environments. Blanking panels come in various heights and widths to fit almost any application, and they come in snap-on or screw-in types.
Implement a Rack and Row Tightness Program	Any opening between the cold aisle and the hot aisle will degrade the separation of hot and cold air. A program should be in place to minimize leakage by maintaining blanking panels and unbroken rows.
Shut off CRAC/CRAH Units	If it is determined that a lower airflow volume is desired and the CRAC/CRAH/AHU units do not have variable speed fans, adjustment is limited to shutting off individual units. This is not a precise way of controlling the air volume, but it can still yield acceptable results. Some experimentation may be required to determine which units can be shut off without compromising adequate cooling of the IT equipment.
Control All Supply Fans in Parallel	If all the supply fans serving a given space are identical and equipped with variable speed drives, fan energy is minimized by running all the fans (including redundant units) at the same reduced speed.
Retrocommission the Airside Economizers	While airside economizers can offer large energy savings (particularly in milder climates), they need regular service to operate properly. Outside air temperature sensors that control when the economizer opens and closes must be kept calibrated. The actuators and linkages that control the economizer louvers must be kept lubricated and in adjustment. The entire economizer system should be tested at least once a year to ensure it operates as intended.
Evaluate Chillers for Replacement	Chillers are typically the greatest energy-using components in the cooling system. Recent advances in chiller technology, especially variable-speed compressors, offer more efficient operation. For these reasons, it is often worthwhile to examine the cost-effectiveness of replacing existing chillers if they are more than 5 years old or are in poor condition.

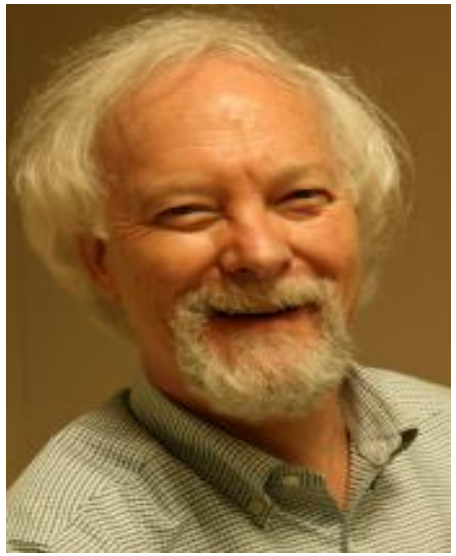
Data Center X Case – Recommended Task Examples

Task	Description
Disable or Eliminate Humidification Controls or Decrease the Humidification Setpoint	Tightly controlled humidity can be very costly in data centers since humidification and dehumidification are involved. A wider humidity range allows significant utilization of free cooling in most climate zones by utilizing effective airside economizers. In addition, open-water systems are high-maintenance items.
Disable or Eliminate Dehumidification Controls or Increase the Dehumidification Setpoint	Most modern IT equipment is designed to operate reliably when the intake air humidity is between 20% and 80% RH. However, 55% RH is a typical upper humidity level in many existing data centers. Maintaining this relatively low upper limit comes at an energy cost. Raising the limit can save energy, particularly if the cooling system has an airside economizer. In some climates it is possible to maintain an acceptable upper limit without ever needed to actively dehumidify. In this case, consider disabling or removing the dehumidification controls entirely.
Change the Type of Humidifier	Most humidifiers are heat based, ie., they supply steam to the air stream by boiling water. Electricity or natural gas are common fuel sources. The heat of the steam becomes an added load on the cooling system. An evaporative humidifier uses much less energy. Instead of boiling water, it introduces a very fine mist of water droplets to the air stream. When set up properly the droplets quickly evaporate, leaving no moisture on nearby surfaces. This has an added cooling benefit, as the droplets absorb heat from the air as they evaporate. A wetted media can also be used.
Change Cooling Unit Air Temperature Setpoints Based on IT Equipment Thermal Demand	IT equipment is designed to operate most reliably within a certain range of intake air temperatures, and a certain temperature rise of the air is expected before it is exhausted. Programming the cooling system to match these temperatures avoids cooling system energy waste due to overcooling the supply air, and ensures reliable IT equipment operation.
Use an Enthalpy Sensor to Control the Airside Economizer	An economizer can be either a temperature or enthalpy economizer. A temperature economizer is controlled by temperature only. An enthalpy economizer on the other hand is controlled by temperature and humidity (that is, energy content). Using an enthalpy economizer generally saves more energy than using a temperature economizer. However, it is also more complex.
Anticipate that Servers will Occasionally Operate in a Higher, but Allowable, Range (89.6F)	Data centers can often go beyond the Recommended range for additional energy savings by following the process outlined in the ASHRAE Thermal Guidelines for Data Processing Environments.
Reconfigure the UPS Topology for More Efficient Operation	UPS technology continues to evolve. If the existing UPS is scheduled for replacement, be sure to specify a high-efficiency UPS topology. If the existing UPS more than 10 years old, it may be cost-effective to replace it with a new system.
Shut Down UPS Modules and PDUs when Redundancy Level is High Enough	In some facilities, the array of UPS modules and/or PDUs has more than enough capacity to serve the load. It may be possible to shut down some modules and still retain the required level of redundancy. This will allow the remaining units to operate at a higher load factor, which usually translates to higher efficiency.
Use High Efficiency MV and LV Transformers	Medium Voltage (MV) and Low Voltage (LV) transformers are available in a range of efficiencies. Specify high efficiency transformers when any existing units are scheduled for replacement. If inspection reveals that any existing transformers are operating with particularly poor efficiency, analyze the cost-effectiveness of replacing them with high efficiency, appropriately-sized units immediately.

Data Center X Case – Recommended Task Examples

Task	Description
Change UPS DC Capacitors	The DC capacitors in typical UPS systems tend to lose effectiveness over time. This can result in the inverter failing to operate under load, and increased ripple current in the batteries. Not only does this result in less efficient operation, it becomes a safety issue as well. The DC capacitors usually have the same design lifetime as the batteries; approximately 5 years. The capacitors should be checked regularly.
Assign an Energy Manager	If your facility does not already have an Energy Manager, consider assigning one. Efforts to improve energy efficiency often falter when there is no clearly identified "champion" to lead and coordinate.
Sub-Meter End-Use Loads and Track Over Time	Many data centers have only a few main energy meters (electric, gas, etc.). These typically report the total energy use of the facility accurately, but they cannot indicate how the energy use is distributed among the IT equipment and support systems. Installing sub-meters at key locations provides a powerful tool for measuring the energy performance of individual systems. Providing these sub-meters with recording capability allows you to monitor system performance over time, providing evidence of degradations and improvements.
Review Full System Operation and Efficiency on a Regular Basis	You may already be monitoring some of your data center support systems and are satisfied that they are operating efficiently, but it is important to monitor the energy efficiency of the data center as a whole. The common "big picture" metric is PUE (Power Usage Effectiveness). This measurement indicates how much energy the support systems use in comparison to the IT equipment itself. The less energy the support systems use for a given IT load, the more efficiently the facility operates. Continuously monitoring this ratio is the best way to keep track of the performance of the whole data center.
Install Occupancy Sensors to Control Lights	Many data centers are unoccupied for long periods. Controlling the data center lights with occupancy sensors, timers, or manually operated switches directly saves lighting energy. This also reduces the heat load, saving cooling system energy.
Install Peak Shaving Devices on Lighting Systems	If the electric power utility serving the data center offers a power demand response program, installing controls to reduce lighting levels is one strategy for reducing electric demand when requested. The main benefit of complying with a demand response program is electric cost savings (particularly if the facility is on a time-of-use rate schedule), but it saves energy too, increasing data center efficiency.

Contact Information and Q&A



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