



Sustainability Innovation Workshop  
Microgrid and Distributed Power

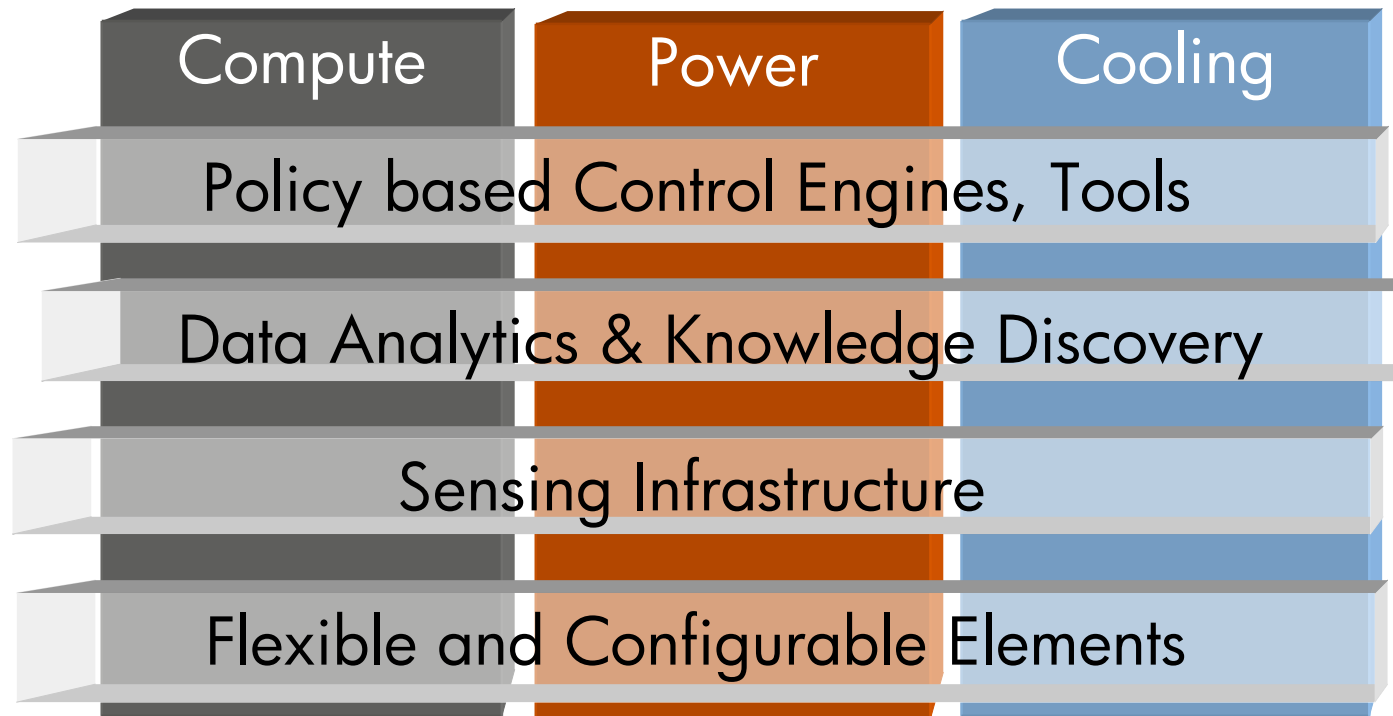
**Ratnesh Sharma, PhD, PE**  
**Sustainable IT Ecosystem Laboratory**



# IT Ecosystem

End to End Management through sensing and control

Compute, power, cooling resources are provisioned based on the need



# Distributed Generation

Intelligent provisioning of Resources for generation of Useful Work

Devise and Manage processes that minimize the destruction of available energy within a micro-grid of generation units

- Manage Generation, Storage and Distribution of Available Energy
- Manage Utilization of Resources (Fuel/Water)
- Improve Availability/Reliability (~5 9s)

## Power Micro-Grid Infrastructure



### Improve

- Generation Efficiency
- Reliability
- Emissions



Combined Heat and Power

Minimize Losses:  
Delivery  
Distribution  
Conversion

IT Infrastructure  
Capacity  
Provisioning



## Cooling Micro-Grid Infrastructure

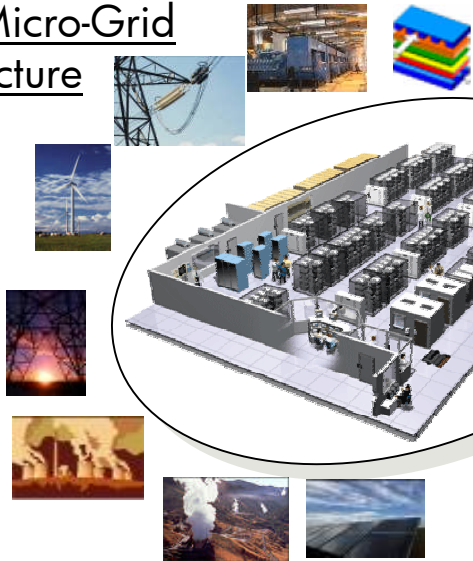


### Improve

- COP
- Reliability
- Emissions

# Supply Side Management

## Power Micro-Grid Infrastructure



## Datacenter

Supply-Side SLOs based on:

1. Least Exergy destruction
2. Least Carbon Emissions
3. Least TCO

Research should address:

- Required Flexible building blocks
- Necessary Monitoring Infrastructure
- Key Metrics for Evaluation
- Control/Management Strategies



Ecosystem of Clients 

# Talks

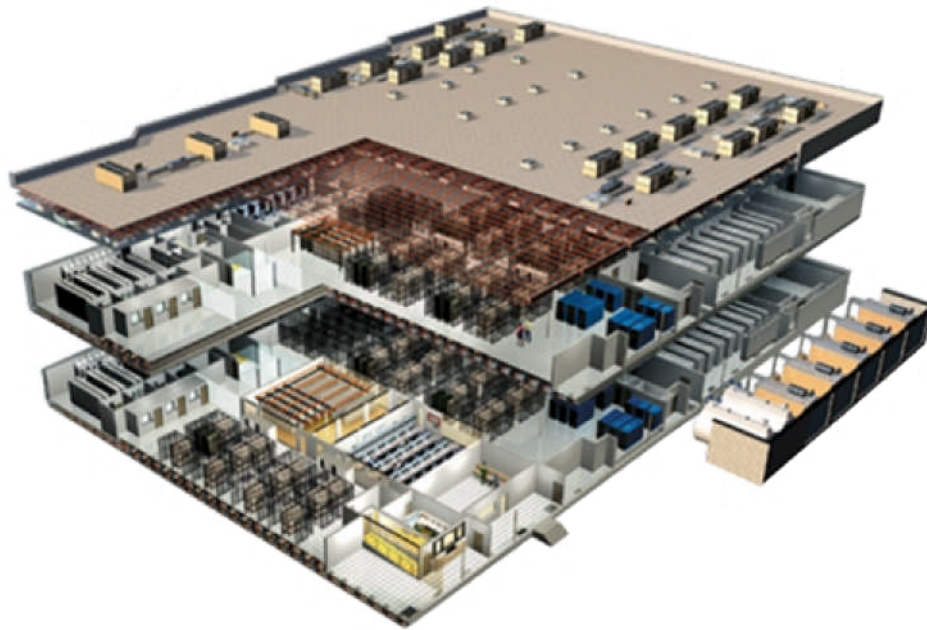
- Microgrids and Distributed Energy Resources
  - Robert H. Lasseter, University of Wisconsin
- Optimizing Microgrid Selection and Operation for Data Center Sustainability
  - Chris Marnay, LBNL
- EPRI Smart Grid R&D Overview
  - Angela Chuang, EPRI
- Energy Efficiency in Digital Networks
  - Rich Brown, LBNL

**LABS<sup>hp</sup>**

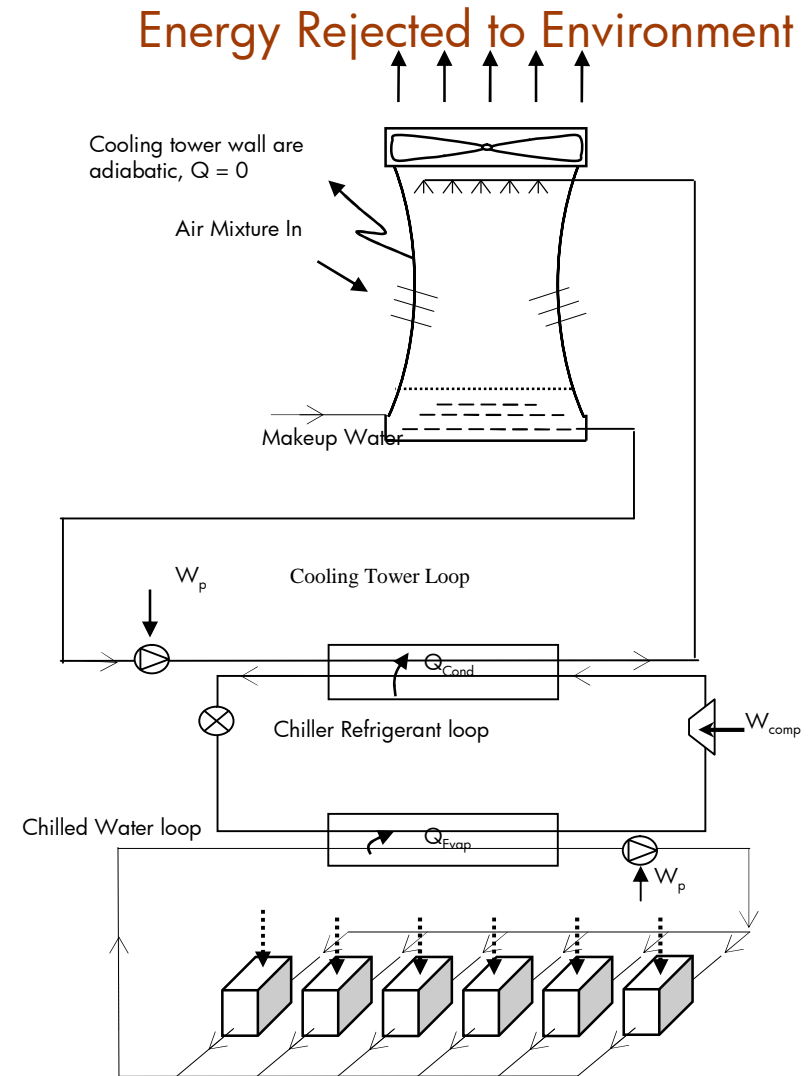




# Data Centers



- Power – Generation/Storage/Dist.
- Cooling – Gen./Storage/Dist.
- Compute – Servers/Storage/Network



# Sustainability Metric: Currency of the Flat World

Ecosystem: billions of handhelds and printers, thousands of data centres and print factories

Cradle to Cradle Design: Least Material based on the 2<sup>nd</sup> Law of Thermodynamics  
Least Energy based on Need based provisioning of resources

