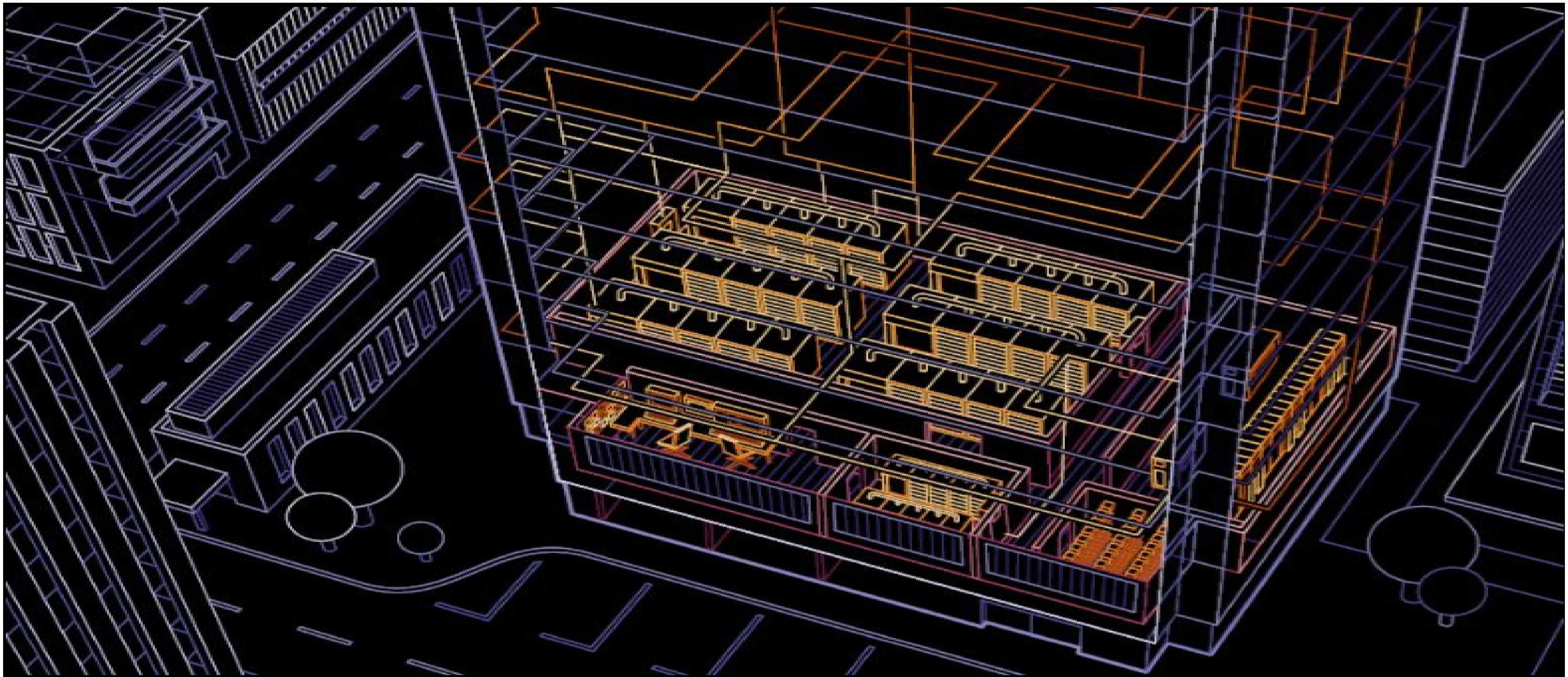
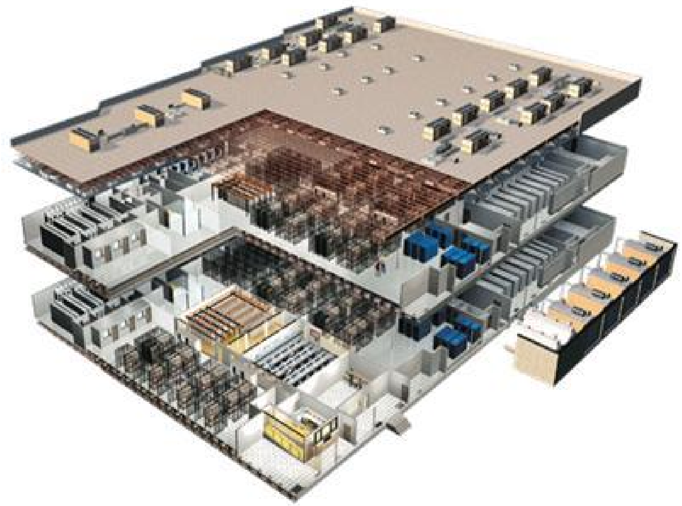


Andreas Ganz, June 2013

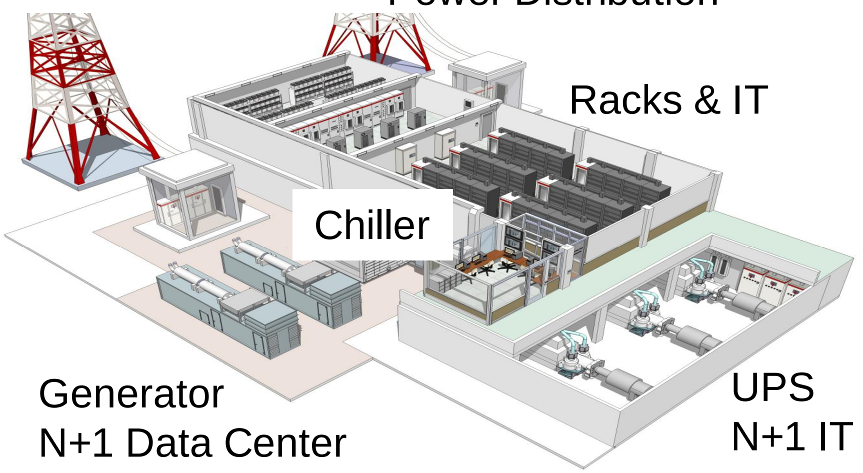
Data Centers Efficiency

A global leader in power and automation technologies
Leading market positions in main businesses



- 145,000 employees in about 100 countries and 130 years of history
- $38 billion in revenue (2011)
- $5 billion in service revenue (2011)
- Publicly owned company with head office in Switzerland
- Leading provider of the electrical infrastructure solutions in Data Centers
- Completion of the offered portfolio for innovative DataCenter-solutions through several M&As: PowerAssure, Newave, Validus DC, Thomas&Betts, Ventyx

Data Center Facts



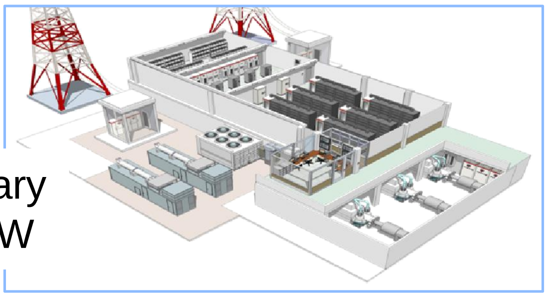
- Invest of a 9 M$ (1.000 sqm) in a Tier 3 Data Center with expected reliability of the infrastructure 99.9820% (downtime of 1.6 h p.a.)
- Or invest of 14 M$ (1.000 sqm) in a Tier 4 Data Center with expected reliability of the infrastructure 99.995% (downtime of 0.4 h p.a.)
- With measured Application Reliability (fact) of 99.65% (downtime of 31 h)
- But the SLA defined IT Application Reliability – measured by % uptime is 99.999% (downtime of 0.1 h)

➔ Main Concern: (1) Supply Application Reliability then
(2) Cost Efficiency

Data Center Risk Factors and Mitigation Strategies

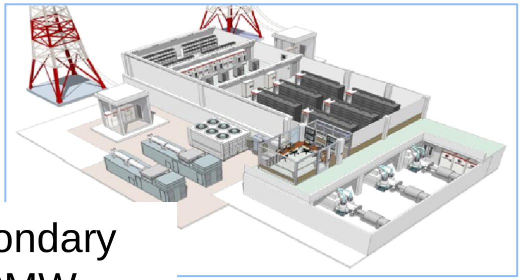
$$\textbf{Reliability of IT-Services defined in a SLA} = \frac{\text{MTBF}}{\text{MTTR} + \text{MTBF}} \times 100\%$$

R (IT-Services) = R (Power) * R (Cooling) * R (Connectivity) * R (Servers / Storage / Network / Security)



Primary
10MW

2x Capacity



Secondary
10MW

IT Hardware → Virtualization:
Software Defined Data Center

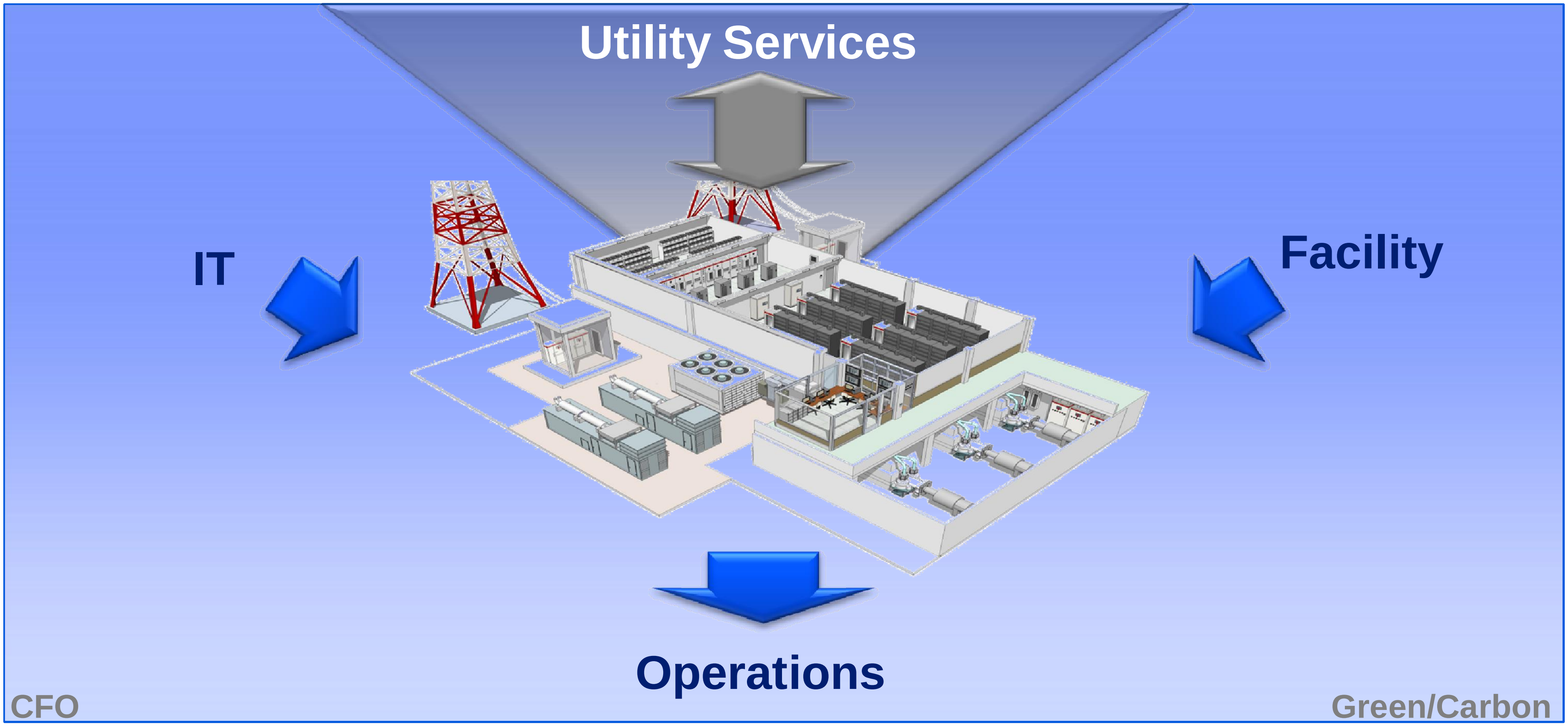
Overheating → Run with low temperature:
Software Defined Cooling

No Power → Shifting application to other site:
Software Defined Power

ABB's focus

➔ **Multi site, virtualized and load balanced – Location independent**

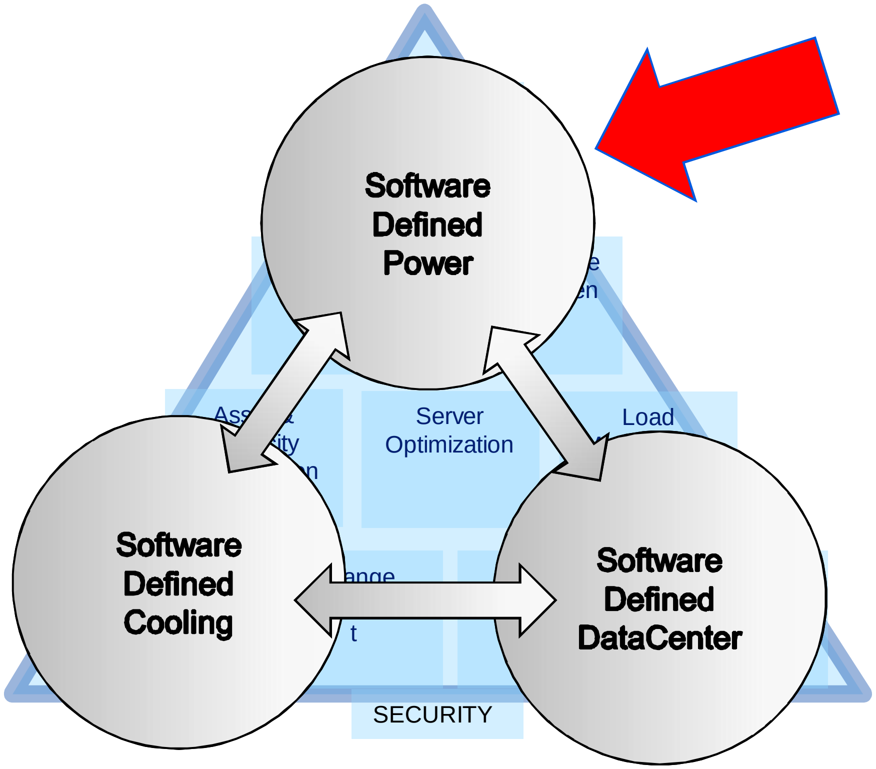
Data Center "Participants"

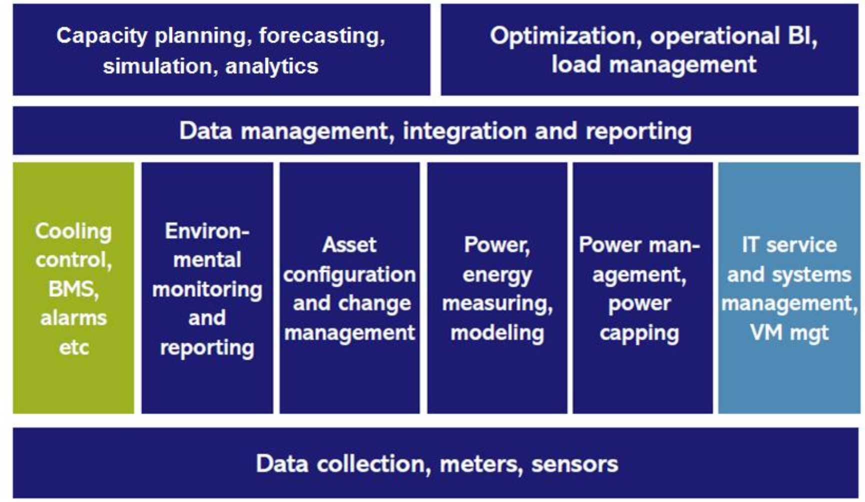


Key Measure: Application Service Levels

Secondary: Efficient Use of Assets

Convergence
DCIM Maturity Model





Source: The 451 Group

Level 5: Self optimizing, autonomic	Integrated software adjusts datacenter behavior and resource use according to rules and data and service requirements.
Level 4: Optimizing	Multiple IT and infrastructure subsystems integrated, data models used for prediction, service management, multiple views, optimizing in near real time.
Level 3: Proactive	Datacenter equipment characteristics, location and operational status tracked. Energy and environmental data used to reduce risks, waste.
Level 2: Reactive	Software installed to monitor environment and equipment power use. Ability to adjust cooling to demand.
Level 1: Basic	No integration; basic monitoring supplied with equipment. Health and safety.

Source: 451 Research

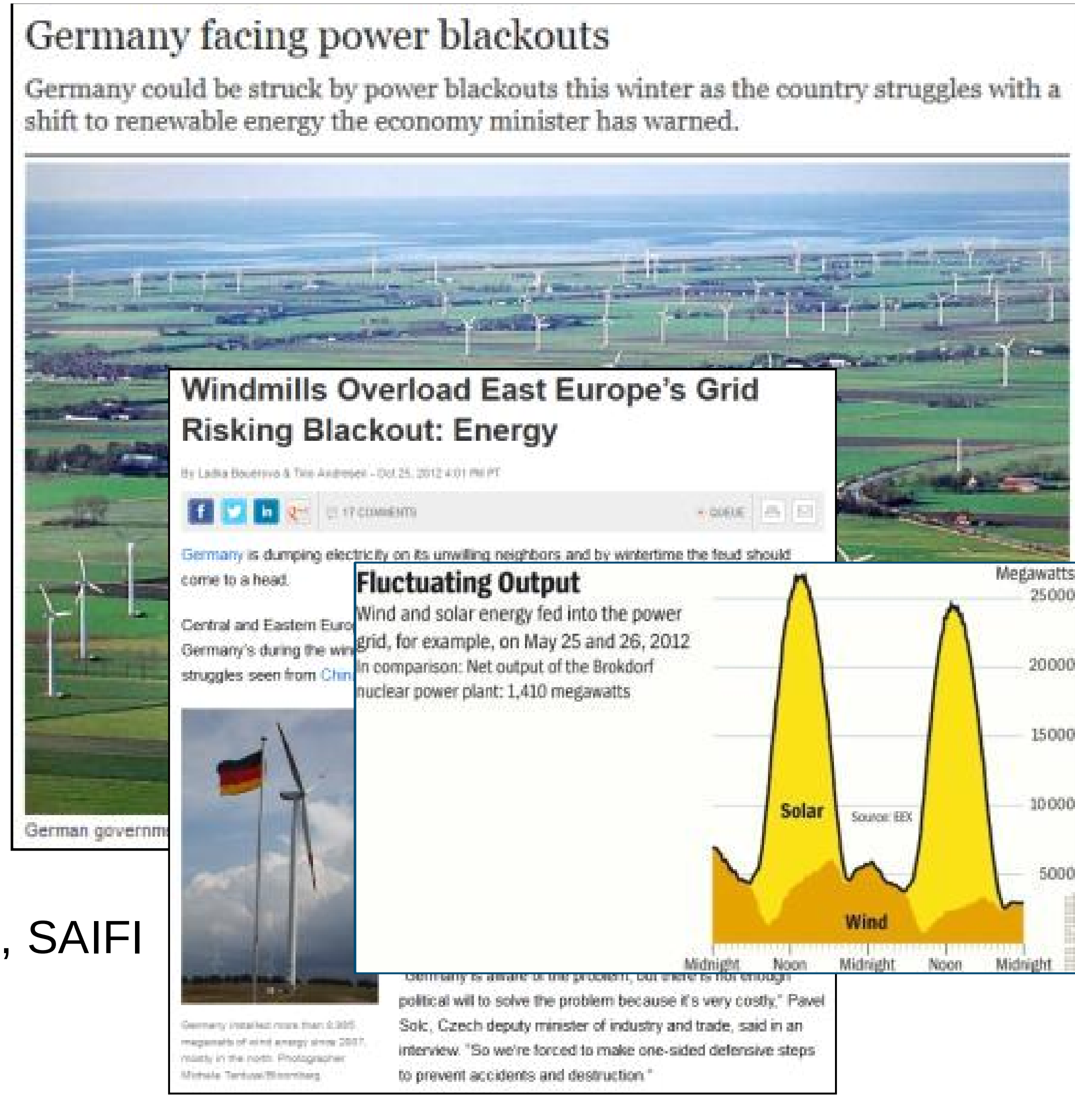
The Limit of a Software Defined Data Center Today
50% of downtime is caused by power problems

A few pertinent recent, notable examples

- **Equinix Syd2:** A utility power incident was detected at 8:02AM site local time and customer loads were transferred to generator power. Multiple AHUs tripped and had caused high temperature. Navitaire went down which stopped multiple airlines in Sydney.
- **Internap:** Reportedly out of fuel and offline, but it is trying to get more fuel to the building. As of 12:55pm ET, the Internap network operations center hotline was playing a recorded message that says the facility is "currently without power due to flooding" and that co-location and IP customers can expect "widespread outages" due to Hurricane Sandy.
- **Amazon:** A slew of sites, including Netflix, Instagram and Pinterest, have gone down this evening, thanks to "power issues" at Amazon's Elastic Compute Cloud data center in North Virginia.

Utilities Facts

- Unexpected Outages
- Generation Problems
- Transmission Issues
- Intermittent Renewables
- Bad Forecast
- Over Production
- Over Utilization



➔ Main Concern: **Supply Reliability**

Measured by CAIDI, SAIDI, SAIFI

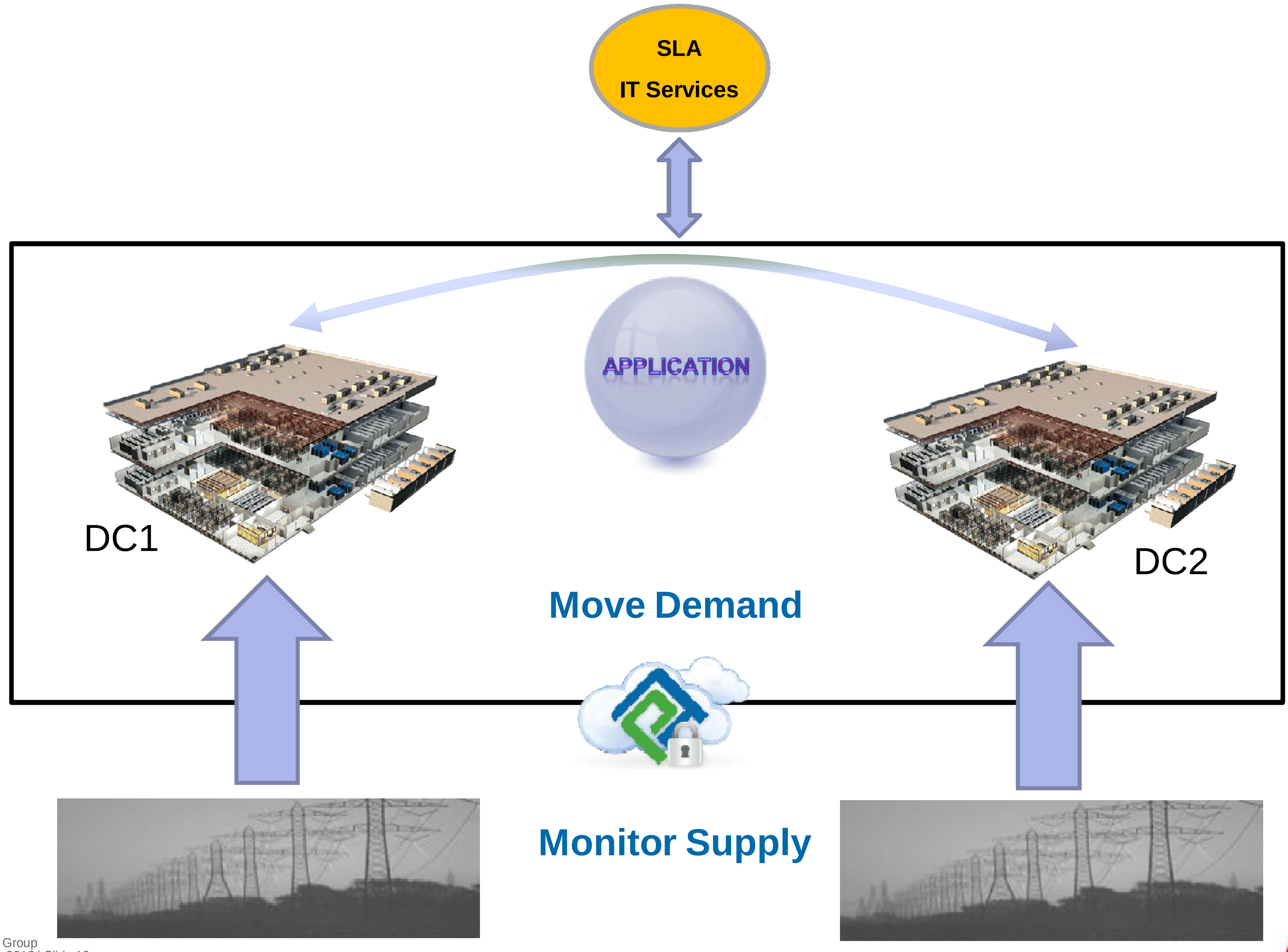
Risk Factors and Mitigation Strategies:

▪ Adequate Generation	➔	Overbuild, use low LF Peaking Plants (v. costly)
▪ Transmission	➔	Multi-path, Congestion Management
▪ Distribution	➔	Redundancy, fast restoration
▪ Supply / Demand Balance	➔	Adequate reserves or demand response

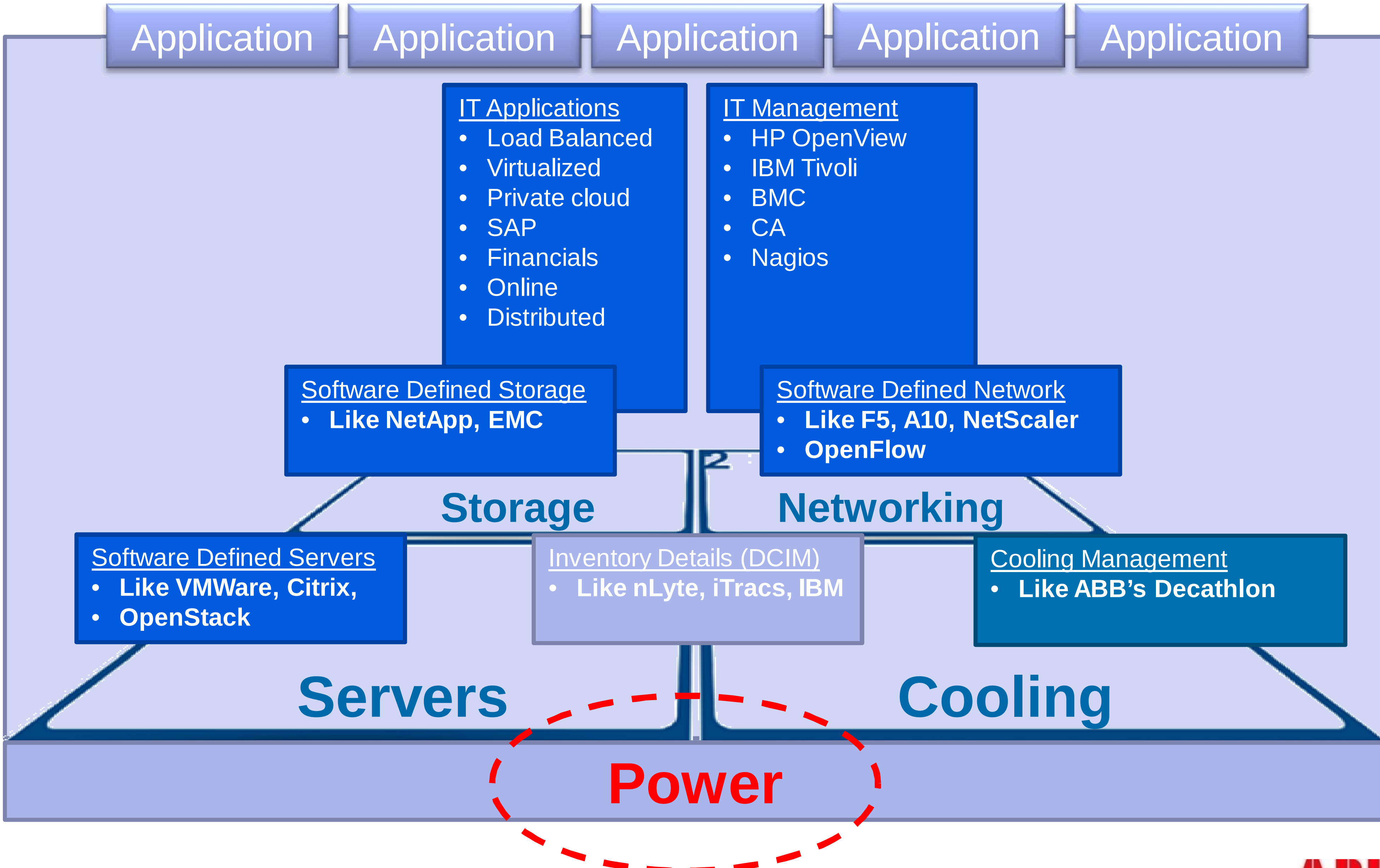
Data Center – multiple sites strategy

Option	DtC 1					DtC 2					DtC 3					Summary			
	TIER	Reliability (Facility)	sqm	Invest / sqm (Facility)	IT Capacity	TIER	Reliability (Facility)	sqm	Invest / sqm (Facility)	IT Capacity	TIER	Reliability (Facility)	sqm	Invest / sqm (Facility)	IT Capacity	R (Facility)	delta to TIER 4	downtime (min)	Invest (Facility)
1	4	99,9950%	240	14.000	100%											99,9950%	0,0000%	26	3.360.000
2	3	99,9820%	240	9.000	100%											99,9820%	-0,0130%	95	2.160.000
3	2	99,7410%	240	6.000	100%	2	99,7410%	240	6.000	100%						99,9993%	0,0043%	4	2.880.000
4	2	99,7410%	120	6.000	50%	2	99,7410%	120	6.000	50%	2	99,7410%	120	6.000	50%	99,9980%	0,0030%	11	2.160.000
5	1	99,6710%	120	4.500	50%	1	99,6710%	120	4.500	50%	1	99,6710%	120	4.500	50%	99,9967%	0,0017%	17	1.620.000

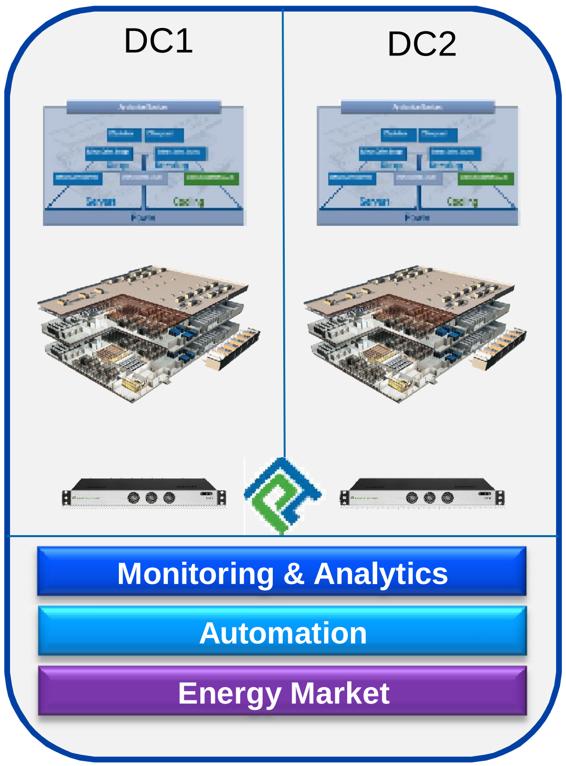
Mitigate against Power Risk using



Software-Defined Product Portfolio



Software Defined Power



Software-Defined Power

POWER ASSURE

Monitoring & Analytics

- Appliance based integration with existing IT and Facility equipment and monitoring systems
- On-premise or hosted data repository
- IT Inventory integration
- IT Equipment reference data

Automation

- Out-of-band integration with facility and IT components
- Appliance based for easy security integration with in house security framework
- Based on runbooks (standard operating procedures) as defined for operations center
- Event driven, ongoing or schedule based

Energy Market

- Real time and day ahead power pricing details
- Demand response requests using OpenADR
- Alerts and energy forecast information
- Creation of IT forecast and data center operating schedule
- Capacity placement and energy trading integration

Decathlon and Global Energy Intelligence

History
Pricing
Alerts
Forecast

Global Energy Intelligence®

POWER ASSURE

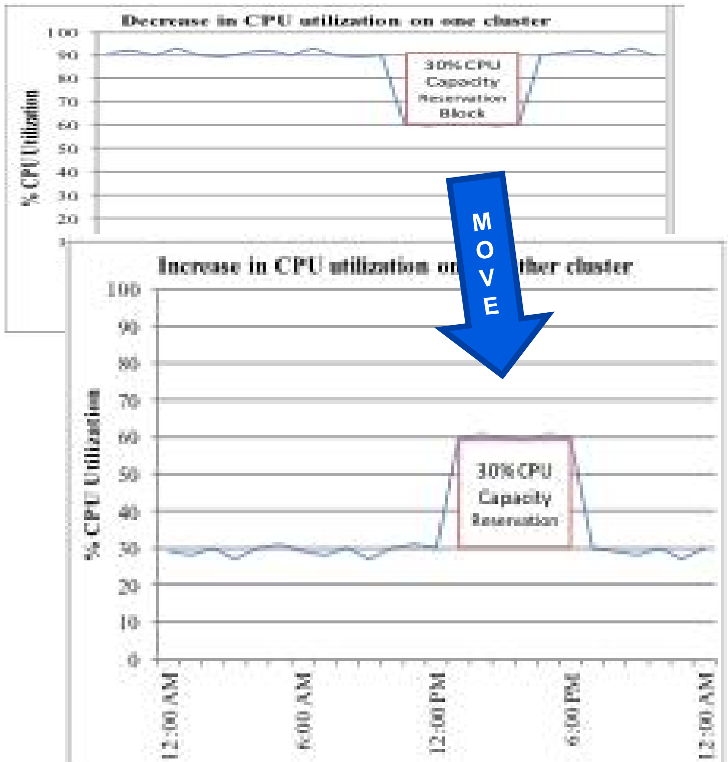
Market
Participation
Trading
Aggregation

Actual Utilization
Data Center Load
Energy Demand

Adjustments
Curtailment
Monetization

Result of Software-Defined Power

- **Study by LBNL, SVLG & Power Assure completed in August 2012**
- Shows how to use automation and analytics to participate in regional demand response markets
- Results:
  - Increased availability and reliability by shifting and shedding load automatically across regional data centers
  - Usable for energy cost arbitrage using a “Follow the Moon” strategy



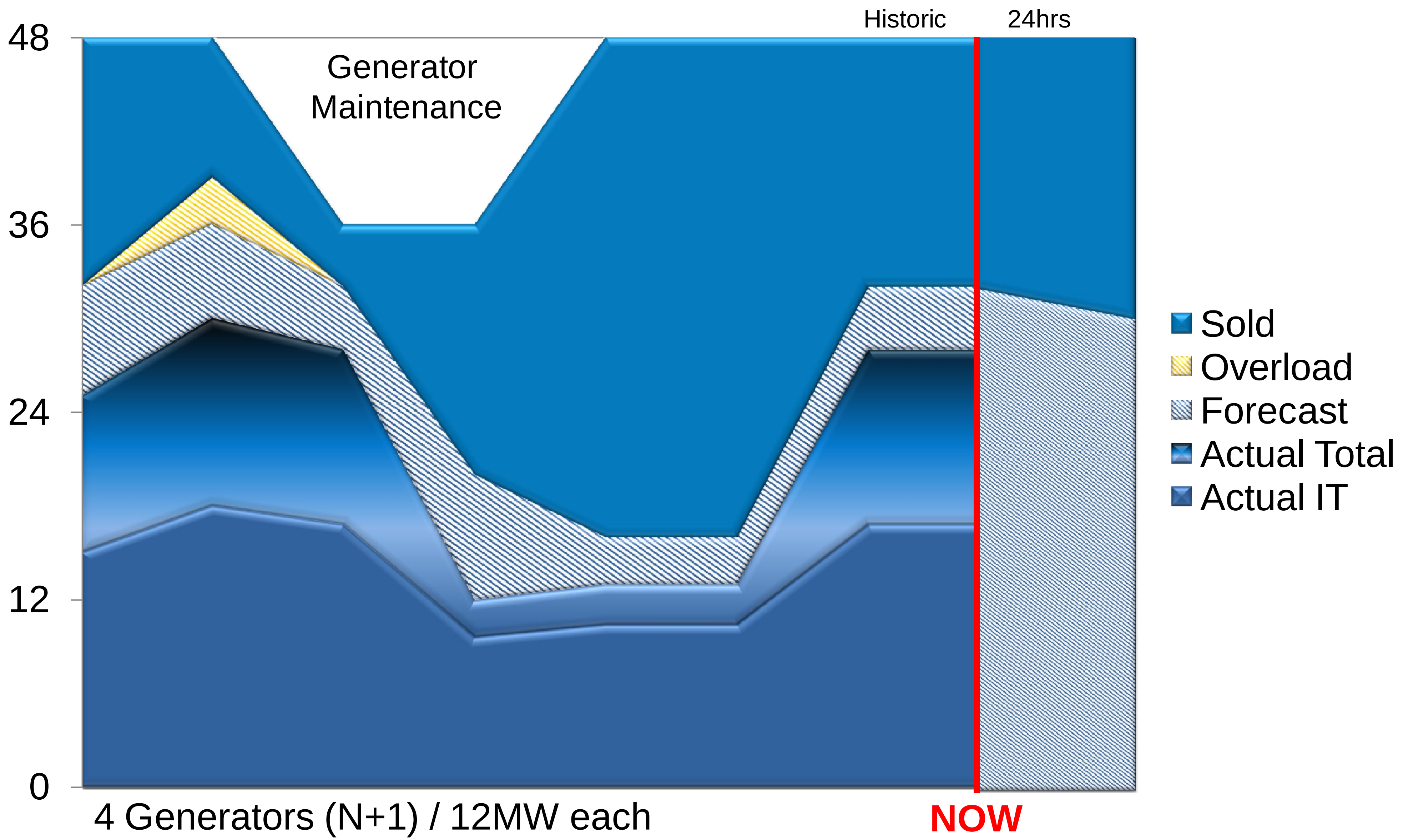
From: Demand Response Opportunities and Enabling Technologies for Data Centers: Findings from Field Studies – LBNL August 2012

IT Forecast Leads to Data Center Forecast

Models by

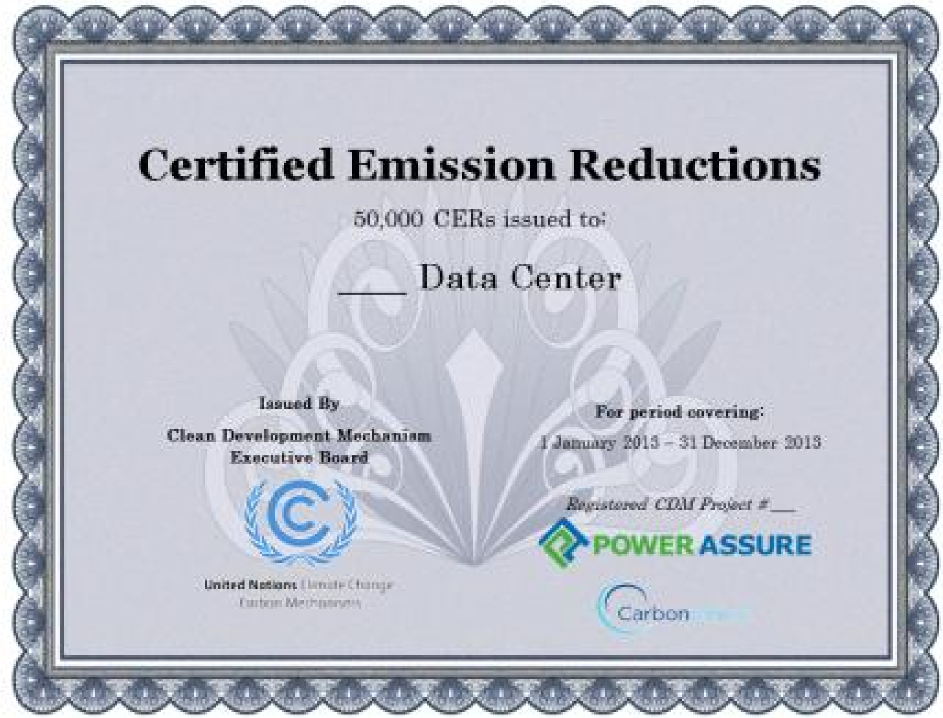
A Xerox Company

Energy Management



Certified Emission Reductions - CERs Countries
E. g. China

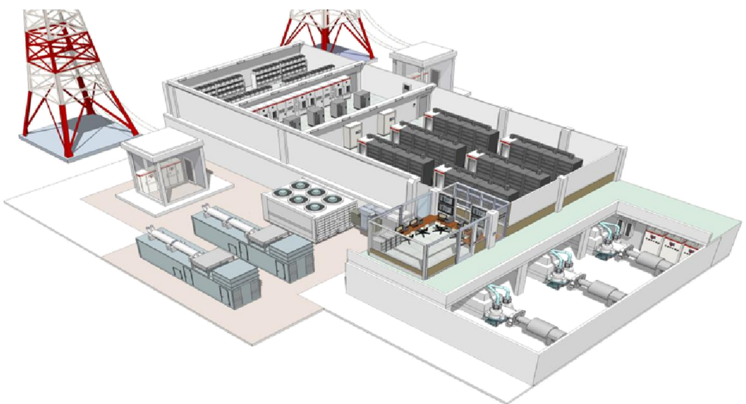
- Carbon Credits available for Dynamic Power Management
- United Nations **CDM AM0105** currently translated
- Requires baseline measurements
- Requires dynamic power management as implemented in Software-Defined Power by Power Assure
- 10 year CO_2 credit creation for all dynamic reductions

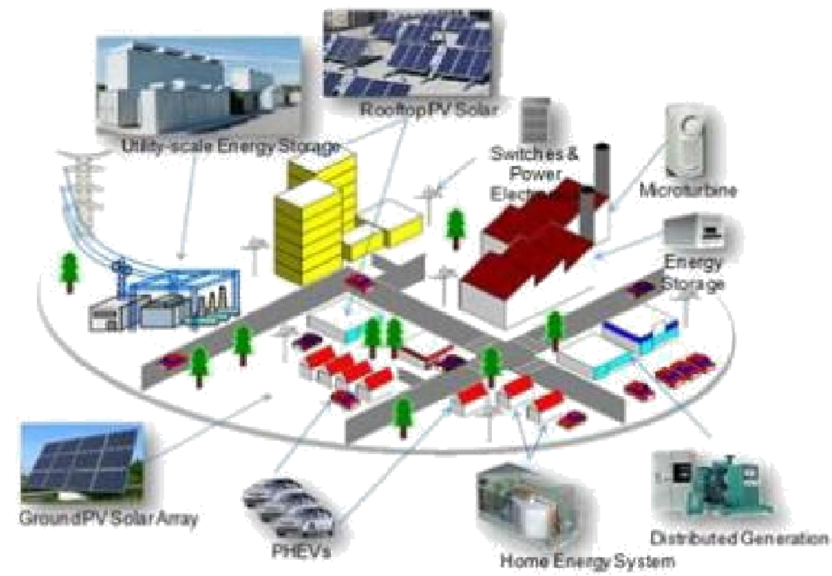


United Nations Climate Change
Carbon Mechanisms

ABB

Data Centers as Distributed Energy Resources





- Data Center can increase reliability by knowing the status of the grid and being able to react, for instance by moving application load, turn on generation, pre-cooling, etc.
- Data Center will help stabilize the grid with these actions even though it is not a primary concern of the data center
- This cooperation between data center and utility can be monetized for both parties

Pre-Requisites for Participation

Data Center must have:

- Onsite storage (thermal, batteries, UPS, fly wheels, etc.)
- Own & operate multiple sites across geographies
- Software-defined power by ABB (Power Assure)
- Bi-directional power capability without transfer switch (for additional benefits)

Regulatory environment must support some of these:

- Demand response programs
- Flexible power purchase agreements
- Smart metering – for time of use pricing etc.
- Direct access to the wholesale power market
- Adequate retail rates for onsite generation – no net zero environment

Power and productivity
for a better world™