

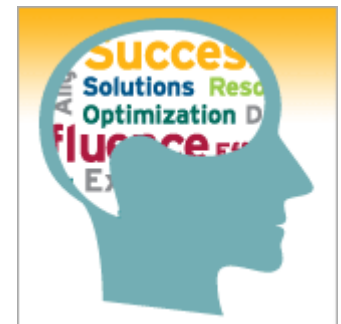
Andreas Bieswanger

STSM, System z Firmware Development & GreenIT



Energy Management for IBM zEnterprise™ 196

Session 8669



February 28th, 2011





agenda



1	zEnterprise Energy Efficiency Improvements
2	zEnterprise Energy Management Controls
3	Unified Resource Manager - Energy Monitoring and Management
4	IBM Energy Management Stack Integration



IBM zEnterprise System – Best in Class Systems and Software Technologies

A system of systems that unifies IT for predictable service delivery



Unified management for a smarter system: **zEnterprise Unified Resource Manager**

- Unifies management of resources, extending IBM System z® qualities of service end-to-end across workloads
- Provides platform, hardware and workload management

The world's fastest and most scalable system: **IBM zEnterprise™ 196 (z196)**

- Ideal for large scale data and transaction serving and mission critical applications
- Most efficient platform for Large-scale Linux® consolidation
- Leveraging a large portfolio of z/OS® and Linux on System z applications
- Capable of massive scale up, over 50 Billion Instructions per Second (BIPS)

Scale out to a trillion instructions per second: **IBM zEnterprise BladeCenter® Extension (zBX)**

- Selected IBM POWER7® blades and IBM System x® Blades¹ for tens of thousands of AIX® and Linux applications
- High performance optimizers and appliances to accelerate time to insight and reduce cost
- Dedicated high performance private network



¹ All statements regarding IBM future direction and intent are subject to change or withdrawal without notice, and represents goals and objectives only.



Goals for Energy Management



Cost Reduction and Avoidance

- Identify opportunities for energy cost reduction (*Operating Expenses*)
- Delay facility expansion due to energy or cooling constraints (*Capital Expenses*)



Remove Operational Barriers

- Manage power and cooling capacity to enable growth and flexibility
- Power Control (Capping, Power Saving)

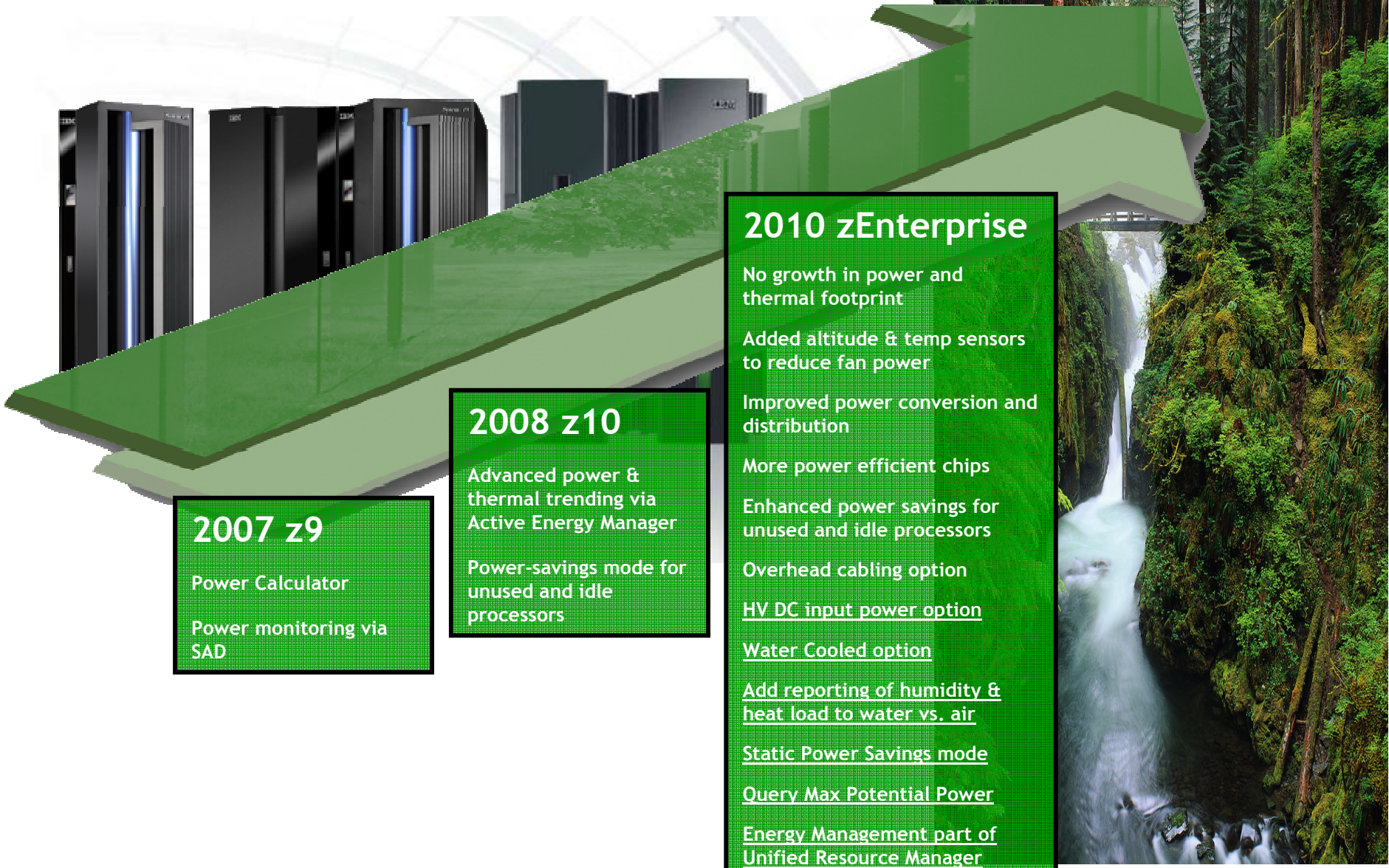


Manage Risk and Streamline Compliance

- Document and validate energy efficiency gains to stakeholders



System z Energy Efficiency Roadmap



2007 z9
Power Calculator
Power monitoring via SAD

2008 z10
Advanced power & thermal trending via Active Energy Manager
Power-savings mode for unused and idle processors

2010 zEnterprise
No growth in power and thermal footprint
Added altitude & temp sensors to reduce fan power
Improved power conversion and distribution
More power efficient chips
Enhanced power savings for unused and idle processors
Overhead cabling option
HV DC input power option
Water Cooled option
Add reporting of humidity & heat load to water vs. air
Static Power Savings mode
Query Max Potential Power
Energy Management part of Unified Resource Manager

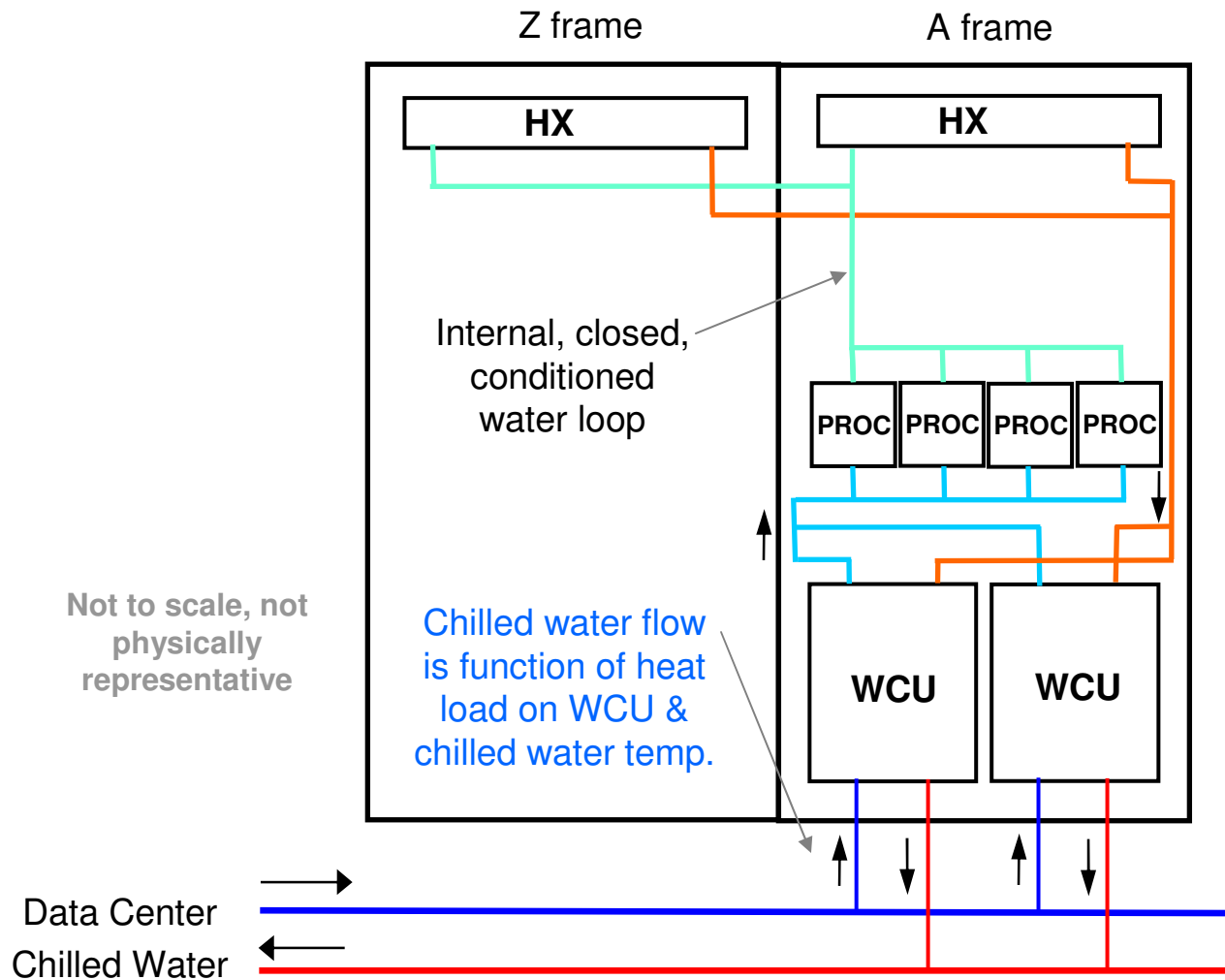


z196 High Voltage DC

- A direct HV DC datacenter power design can improve data center energy efficiency by removing the need for an additional DC to AC inversion step.
- System bulk power for all z196 systems is updated to support HV DC so the only difference in shipped HW to implement the option is the DC line cord:
 - This adds DC line cord feature codes
 - Nominal DC supply voltage supported will be:
 - 380V – 520V (absolute min 330V, absolute max 550V)
 - New technology, multiple proposed “standards”
 - Support both ground referenced and dual polarity HV DC supply
 - As defined will support -380V to -520V, +/-190 to +/-260V, +380V, etc.
- System saves approximately 3% input power when run on HV DC



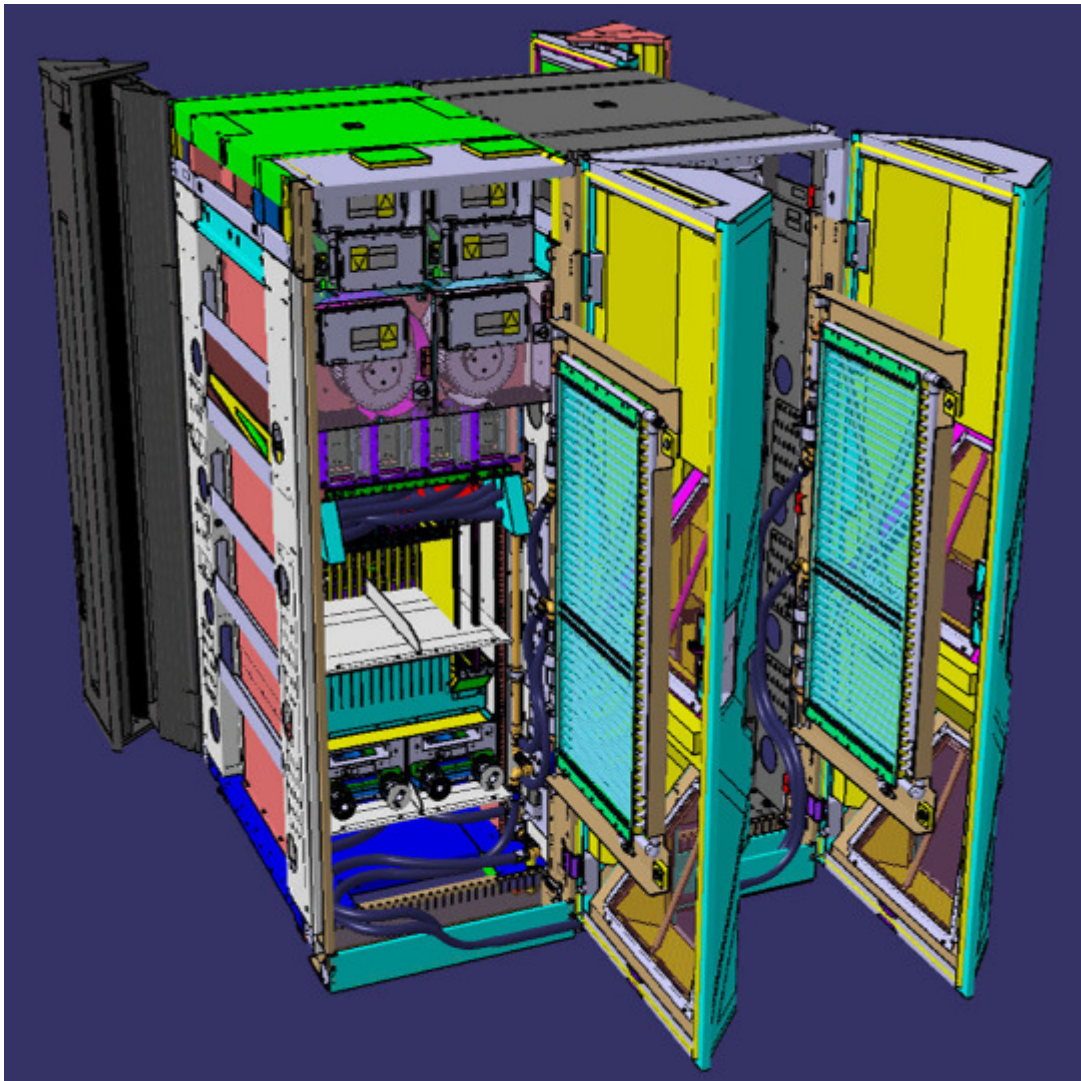
z196 Water Cooling Option



- Water cooled cold plate on processor MCM in each processor book
- 2N Water Conditioning Unit (WCU) with independent chilled water connections
- One WCU can support system
- Heat Exchanger (HX) removes heat from exhaust air at back of both frames
- Typically ~70% of system heat load is removed to water.
- Air cooling back-up mode for maximum robustness (all heat load to air if lose chilled water in to WCU's)

2N building chilled water lines will have better RAS – single facility supply/return shown here.

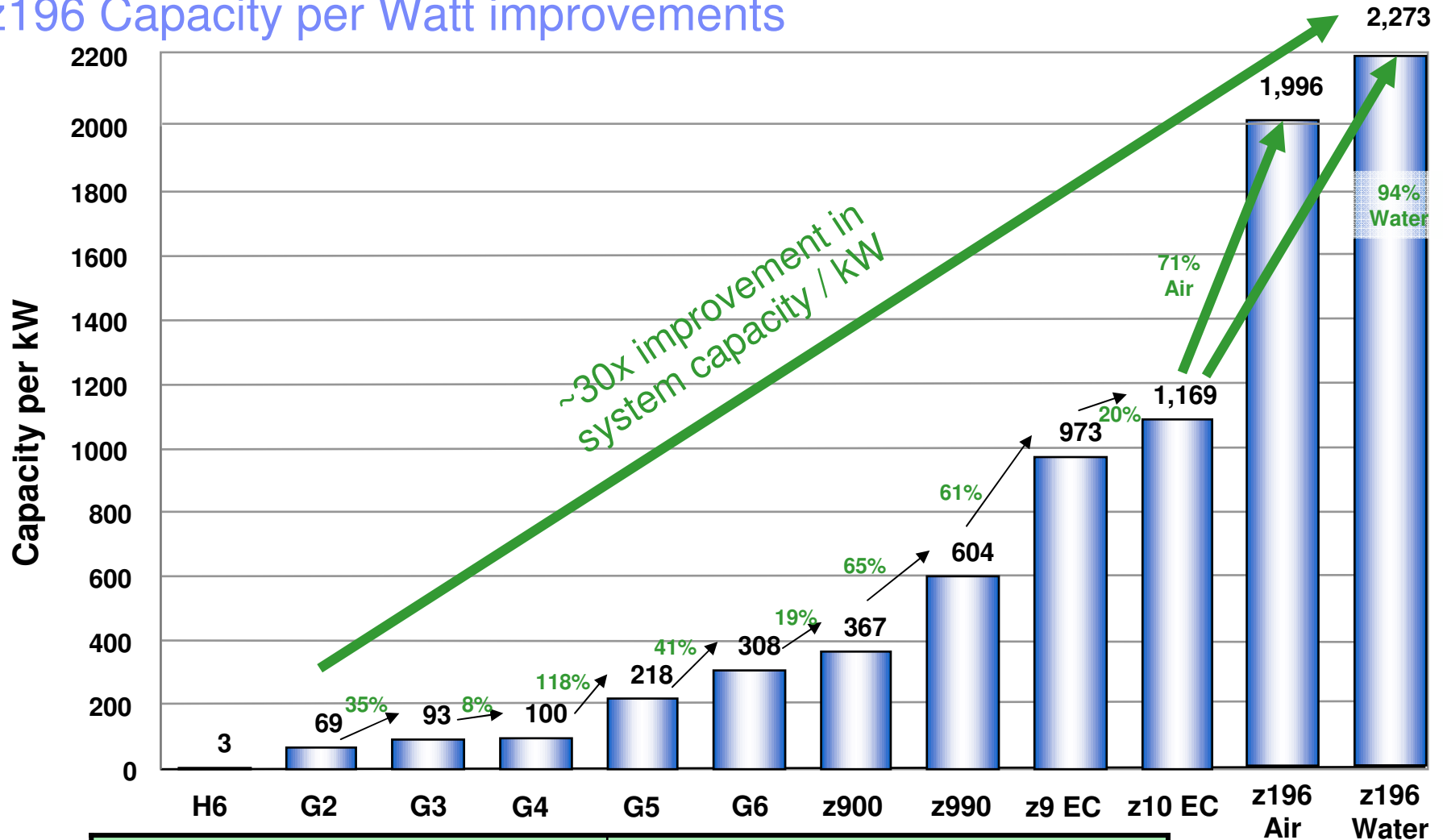
Z196 Water Cooling Option



- Reduce max air heat load to less than 10 kW (about 5 kW typical)
- Input energy saving 2 kW
- Additional power saving in data center typically about 3 kW (water cooling efficiency higher than air cooling efficiency)



z196 Capacity per Watt improvements



15 years of CMOS: G2 to z196 *		Net Effect: G2 to z196 *	
Power Increase:	17% per year	Performance increased by:	~300x
Performance increase:	46% per year	Performance / kWatt increased by:	~30x
Power density increase:	13% per year	Performance / sq ft increased by:	~190x

Note: Capacity/kWatt assumes hot room, max plugged I/O power, max memory power and all engines turned on. Real world max capacity system is about 3/4 of this.



Three fundamentals of energy management



Measure/Trend Power Consumption

- Determine the power being consumed now
- Trending energy and thermals over extended periods of time



Allocate Power Correctly

- Rightsizing of power and cooling allocations
- Enables deployment of more servers within the physical limits of a data center



Reduce power consumed

- Reduce power in periods of low utilization to reduce energy cost



Power Estimation Tool for z196

Configuration

Model: M32

Voltage group: 208 to 240V group

Line voltage: 208

Water cooled (FC 0159): Yes

Room temp: <28C (82F)

Installed altitude (in feet): 0

Workload: Normal power save

Flexible memory: No

Balanced power (FC 3003): No

Cargo cages (FC see help): 1

Cayuga drawers (FC 4000 or 4004): 1

CEC data

Card Name	FC	Quantity	Max
Customer configured processors		9	32
Base SAPs		6	
Ordered memory		32	1520
IBT-2 Fan-out Card for Copper	0162	0	16
IBT+K42-2 Fan-out Card for Optics	0163	0	16

Cargo Cages

Card Name	FC	Quantity	Max
ISC-daughter card	0218	0	24
IB-MP Daughter Card	0326	0	24
Crypto Express3	0864	0	8
16 port ESCON (old QZ26)	2323	0	36
16 port ESCON (new QZ25)	2323	10	36
FICON Express4 10KM LX	3321	4	36
FICON Express4 SX	3322	0	36
FICON Express4 4KM LX	3324	0	36
FICON Express8 10KM LX	3325	0	36
FICON Express8 SX	3326	0	36
OSA-Express3 GbE LX	3362	0	24
OSA-Express3 GbE SX	3363	0	24
OSA-Express2 GbE LX	3364	0	24
OSA-Express2 GbE SX	3365	0	24
OSA Express2 1000base-T	3366	0	24
OSA-Express3 1000base-T	3367	10	24
OSA-Express3 10 GbE LR	3370	0	24
OSA-Express3 10 GbE SR	3371	0	24
Power Sequence Controller	6501	0	2

Results

System total heat load: 20677 BTU/hr

Utility input power: 6064 W

<https://www-304.ibm.com/servers/resourcelink/hom03010.nsf/pages/pet2817v2110?opendocument>

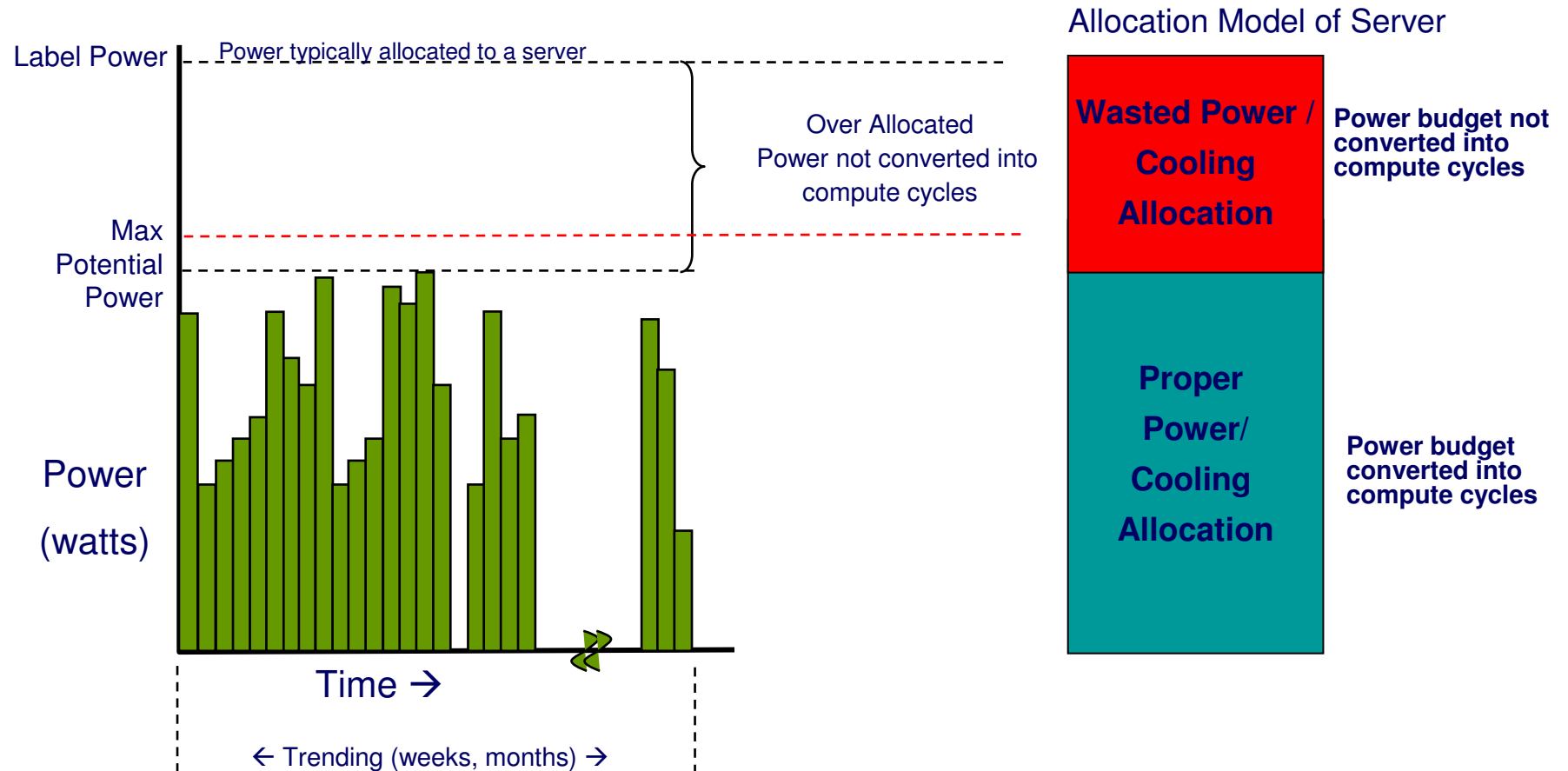


Max Potential Power

- **Main use cases**
 - Allows reducing power allocation for system since you know the maximum power system can draw even with faults and hot room
 - Allows facility and system people without knowledge of z system configuration and use details to query max possible power of system
 - Looks like power capping to higher level management tools
- **Base mechanism: Calculation of max potential power based on**
 - System configuration
 - Altitude (absolute pressure sensors in bulk power subsystem)
 - Hot room environment
 - Highest single fault service scenario power condition for this configuration
 - Reasonable tolerances
- **Max Potential Power should be used in conjunction with the System z Power Estimation Tool which allows pre-planning for power and cooling needs**



Optimize Power/Cooling Allocation with Max Potential Power





Static Power Saving Mode

- **Main use cases**

- Periods of low utilization
- CBU Systems: Systems used for disaster recovery

- **Base mechanism**

- Build upon existing RAS functions (frequency/voltage variation) implemented originally for MRU failures (since z900)
- Use frequency and voltage reduction to reduce energy consumption of CEC
- Only explicitly triggered by customer. No autonomic changes done “under the cover”

- **Power Savings Mode expectations**

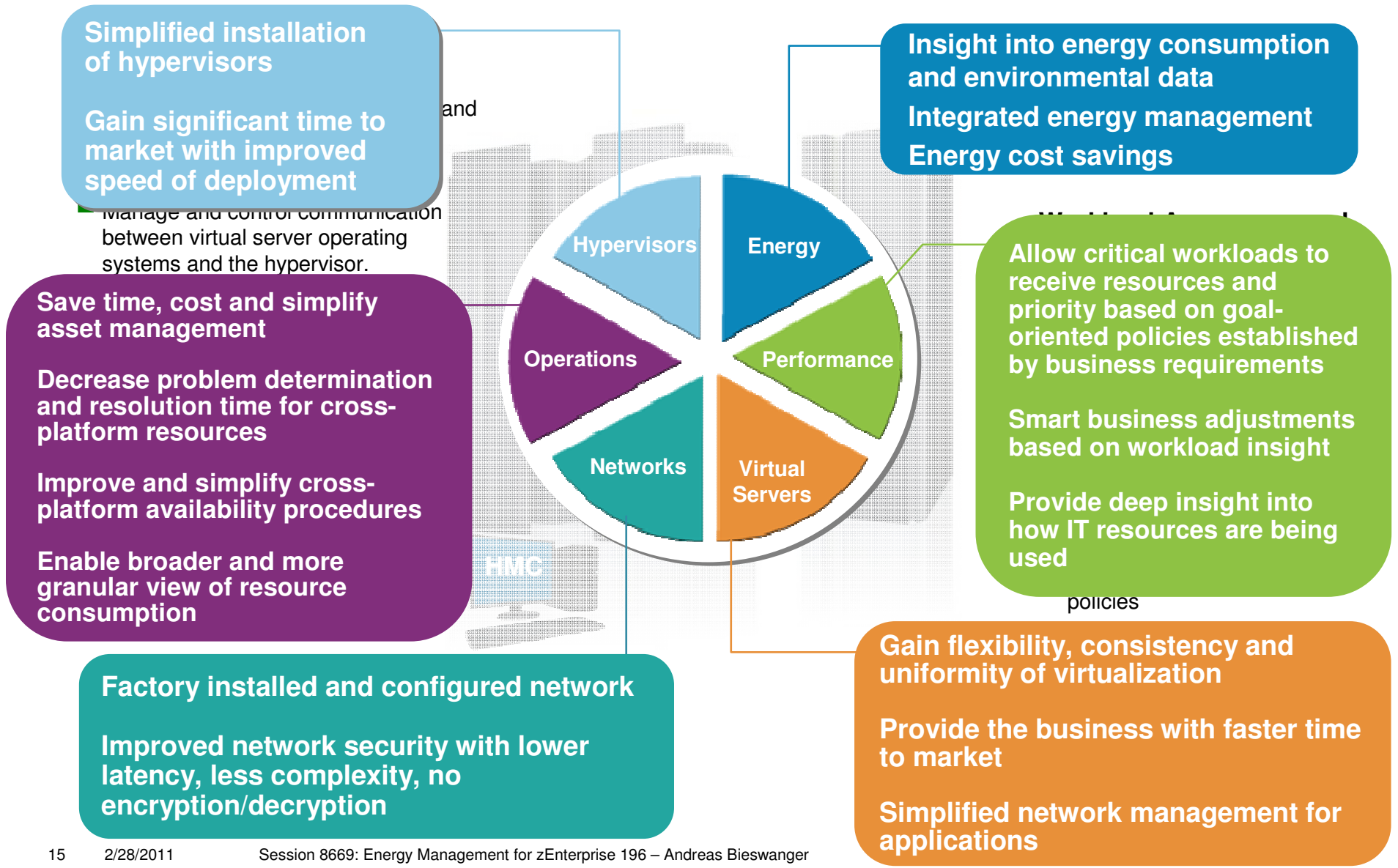
- Frequency reduction: 17%
- Processor voltage reduction: 9%
- Expected system power savings: 15%-20% (configuration dependent)

- For air-cooled systems entering power save is limited to once a day.

- Update to “**STSI: SYSIB 1.2.1 (Basic-Machine CPU) Performance-Reduction Indicator**” to reflect entering and leaving power save mode

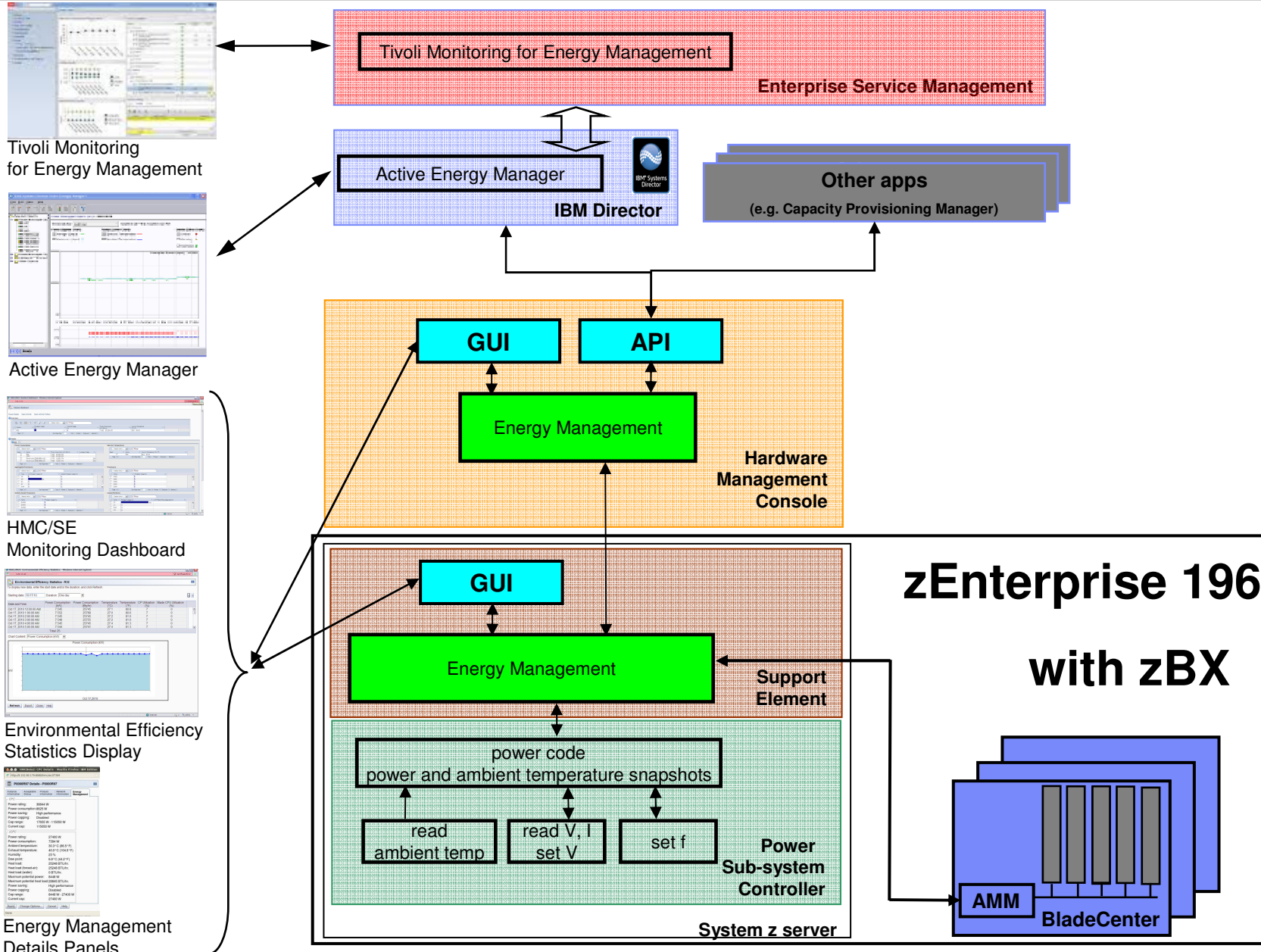


... value made possible by the Unified Resource Manager





zEnterprise Energy Management Structure

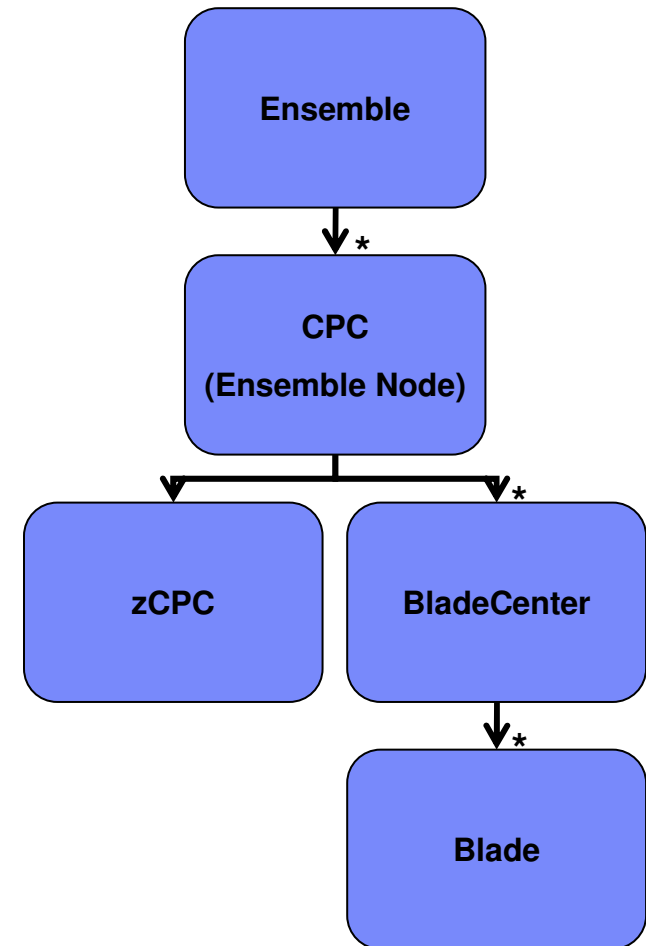




Unified Resource Manager - Energy Monitoring Overview

Monitoring data available at

- Monitors Dashboard
- Environmental Efficiency Statistics
- Additional detailed data provided for
 - **Blade**,
 - Energy and environmental data
 - **BladeCenter**
 - Aggregated energy and environmental data
 - **zCPC**
 - Energy and environmental data
 - Max potential power
 - **CPC**
 - Aggregated energy and environmental data
 - **Ensemble**
 - Aggregated energy data





zEnterprise Monitors Dashboard



The screenshot shows a web browser window titled "HMCBeta2: Monitors Dashboard - Mozilla Firefox" with the URL <http://9.152.90.179:8080/hmc/content?taskId=48&refresh=75>. The dashboard is divided into several sections:

- Monitors Dashboard:** The main header area.
- Overview:** Contains a "Pause Display" button and a "System" dropdown menu. A "Select" button is also visible.
- Details:** Shows the selected monitor "P0000R97". Under "Power Consumption", there is a table with the following data:

Name
P0000R97
zCPC
BladeCenter
zBX Blade C
zRV Blade C

Below the table, there are "Aggregated Power" options with "Type" set to "All Pr" and "GP" and "CP" checkboxes.
- Dashboard Histogram Display - P0000R97:** A sub-window showing a "Power Consumption display for P0000R97". It includes a "Display Type" dropdown set to "Power Consumption (kW)" and a "Frequency and Duration" dropdown set to "15 seconds for 1 hour". The main chart is titled "Power Consumption (kW)" and shows a line graph of power consumption over time. The y-axis is labeled "Power (kW)" and ranges from 0 to 11. The x-axis shows time from 20:30:00 to 21:20:00 on Nov 7, 2010. The data points are clustered around 9 kW. A legend indicates the blue line represents "Power".
- System Assis:** A partially visible section at the bottom left.

At the bottom of the histogram window, there are buttons for "Clear", "Pause", "Export", "Close", and "Help".



Environmental Efficiency Statistics

NEXTGEN: Environmental Efficiency Statistics - Mozilla Firefox: IBM Edition

9.60.92.193 https://9.60.92.193/hmc/content?taskId=28&refresh=36

Environmental Efficiency Statistics - PZBONZAI

To display new data, enter the start date and/or the duration, and click Refresh.

Starting date: 7/13/10 Duration: One day

Date and Time	Power Consumption (kW)	Power Consumption (Btu/hr)	Temperature (°C)	Temperature (°F)	CP Utilization (%)	Blade CPU Utilization (%)
Jul 13, 2010 12:00:00 AM	13.967	47657	26.0	78.8	0	0
Jul 13, 2010 1:00:00 AM	14.133	48224	26.0	78.8	0	0
Jul 13, 2010 2:00:00 AM	14.025	47855	26.0	78.8	0	0
Jul 13, 2010 3:00:00 AM	14.036	47893	26.0	78.8	0	0
Jul 13, 2010 4:00:00 AM	13.985	47719	26.0	78.8	0	0
Jul 13, 2010 5:00:00 AM	13.989	47732	26.0	78.8	0	0

Total: 25

Chart Content: Power Consumption (kW)

Refresh Export Close Help

Transferring data from 9.60.92.193...



Energy Management Information - CPC and zCPC

The screenshot shows a web browser window titled "HMCBeta2: CPC Details - Mozilla Firefox: IBM Edition" with the URL "http://9.152.90.179:8080/hmc/wcl/T24a3". The page displays "P0000R97 Details - P0000R97" with tabs for Instance Information, Acceptable Status, Product Information, Network Information, and Energy Management. The Energy Management tab is active, showing details for CPC and zCPC.

CPC	
Power rating:	36844 W
Power consumption:	8355 W
Power saving:	Not entitled
Power capping:	Not entitled

zCPC	
Power rating:	27400 W
Power consumption:	7266 W
Ambient temperature:	29.6°C (85.3°F)
Exhaust temperature:	39.0°C (102.2°F)
Humidity:	24 %
Dew point:	7.0°C (44.6°F)
Heat load:	24810 BTU/hr.
Heat load (forced-air):	24810 BTU/hr.
Heat load (water):	0 BTU/hr.
Maximum potential power:	8448 W
Maximum potential heat load:	28845 BTU/hr.
Power saving:	Not entitled
Power capping:	Not entitled

Buttons: Apply, Change Options..., Cancel, Help

Done



Energy Management Information - CPC and zCPC

The screenshot shows a web browser window titled "HMC Beta2: CPC Details - Mozilla Firefox: IBM Edition" with the URL "http://9.152.90.179:8080/hmc/wcl/T394". The page displays "P0000R97 Details - P0000R97" with several tabs: Instance Information, Acceptable Status, Product Information, Network Information, and Energy Management. The Energy Management tab is active, showing two sections: CPC and zCPC.

CPC	
Power rating:	36844 W
Power consumption:	8625 W
Power saving:	High performance
Power capping:	Disabled
Cap range:	17655 W - 115050 W
Current cap:	115050 W

zCPC	
Power rating:	27400 W
Power consumption:	7394 W
Ambient temperature:	30.3°C (86.5°F)
Exhaust temperature:	40.0°C (104.0°F)
Humidity:	23 %
Dew point:	6.8°C (44.2°F)
Heat load:	25248 BTU/hr.
Heat load (forced-air):	25248 BTU/hr.
Heat load (water):	0 BTU/hr.
Maximum potential power:	8448 W
Maximum potential heat load:	28845 BTU/hr.
Power saving:	High performance
Power capping:	Disabled
Cap range:	8448 W - 27400 W
Current cap:	27400 W

Buttons: Apply, Change Options..., Cancel, Help

Done



Energy Management Information - BladeCenter and Blade

HMCBeta2: zBX BladeCenter Details - Mozilla Firefox: II
http://9.152.90.179:8080/hmc/wcl/T80f

C.2 Details - C.2

Instance Information	Acceptable Status	Product Information	Energy Management Information
Power rating:	9444 W		
Power consumption:	1233 W		
Ambient temperature:	21.0°C (69.8°F)		
Exhaust temperature:	27.5°C (81.5°F)		
Power saving:	Custom		
Power capping:	Disabled		
Cap range:	3127 W - 9444 W		
Current cap:	9444 W		

Apply Cancel Help

Done

HMCBeta2: zBX Blade Details - Mozilla Firefox: IBM Edi
http://9.152.90.179:8080/hmc/wcl/T9ff

C.2.06 Details - C.2.06

Instance Information	Acceptable Status	Product Information	Energy Management Information	Hypervisor Information
Power rating:	382 W			
Power consumption:	131 W			
Power saving:	Low power			
Power capping:	Disabled			
Cap range:	277 W - 382 W			
Current cap:	382 W			

Apply Cancel Help

Done



Energy Management Information - Ensemble

The screenshot shows a Mozilla Firefox browser window titled "HMCAlpha: Ensemble Details - Mozilla Firefox". The address bar displays "9.152.90.116 https://9.152.90.116/hmc/wcd/T24fc". The main content area is titled "Ensemble Details - Alpha Ensemble" and features three tabs: "Instance Information", "Performance Management", and "Energy Management". The "Energy Management" tab is active, displaying "Energy Management Information" with the following data:

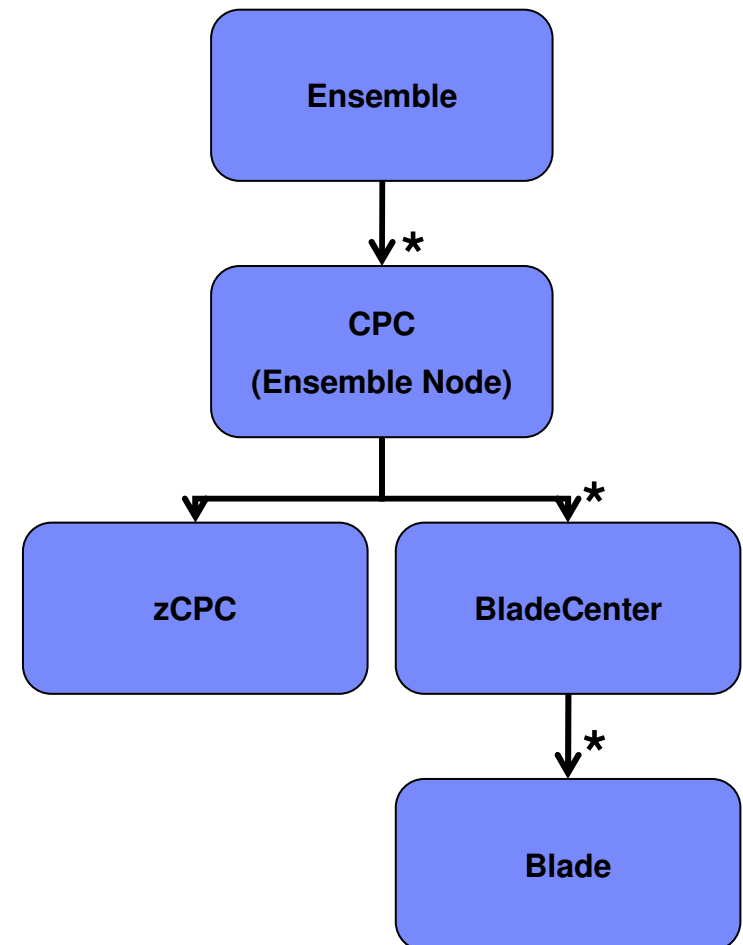
Power rating:	85768 W
Power consumption:	5158 W

At the bottom of the window, there are four buttons: "OK", "Apply", "Cancel", and "Help".



Unified Resource Manager - Energy Controls Overview

- **zCPC**
 - **Power Save**
- **Blade**
 - **Blade power save**
for all blades supporting power savings mode
 - **Blade power cap**
- **BladeCenter**
 - **BladeCenter group power save**
Ensure that all elements in a group (that support it) are in power save or high performance state.
 - **BladeCenter group power cap**
Ensures that the group power consumption stays at or below the maximum value specified in the group cap using automatic power budget distribution.
- **CPC**
 - **CPC group power save**
 - **CPC group power cap**
 - Uses max potential power as Pcap-min for zCPC





Set Power Saving Task

Name ^	Type ^	Power Saving ^
P0000R97	CPC	Custom
zCPC	zCPC	High Performance
C.2	BladeCenter	Custom
C.2.05	POWER Blade	High Performance
C.2.06	POWER Blade	Low Power
C.2.07	POWER Blade	High Performance

Total: 6 Filtered: 6

OK Apply Cancel Help

Done



Energy Management Automation

P0000R97: Customize Scheduled Operations - Mozilla Firefox

9.152.90.179 https://9.152.90.179:9950/hmc/wd/T8ca

Set up a Scheduled Operation - P0000R97

Date and Time Repeat Set Power Saving

The following scheduled operation will be created :

Set power saving

Select the date and time of the initial execution, then select a time window.

Date and Time: Date: * 11/8/10 Time: * 4:39 PM

Time Window: 10 minutes 20 minutes 30 minutes 40 minutes 50 minutes 60 minutes

Save Cancel Help

https://9.152.90.179:9950/hmc/wd/T8ca#

P0000R97: Customize Scheduled Operations - Mozilla Firefox

9.152.90.179 https://9.152.90.179:9950/hmc/content?windowName=P0000R97

Set up a Scheduled Operation - P0000R97

Date and Time Repeat Set Power Saving

--- Select Action ---

Name	Type	Power Saving
P0000R97	CPC	Custom
zCPC	zCPC	High Performance
C.2	BladeCenter	Custom
C.2.05	POWER Blade	High Performance
C.2.06	POWER Blade	Low Power
C.2.07	POWER Blade	High Performance

Total: 6 Filtered: 6

Save Cancel Help

Done



Set Power Cap

P0000R97: Set Power Cap - Mozilla Firefox

9.152.90.179 https://9.152.90.179:9950/hmc/wd/T7de

Set Power Cap - P0000R97

Select a resource from the table below to configure power capping.

--- Select Action ---

Name	Type	Power Capping	Cap Value (Watts)	Cap Value Range (Watts)
P0000R97	CPC	Custom	115050	17655-115050
zCPC	zCPC	Disabled	27400	8448-27400
C.2	BladeCenter	Enabled	3200	3127-9444
C.2.05	POWER Blade	Enabled	298	277-382
C.2.06	POWER Blade	Enabled	298	277-382
C.2.07	POWER Blade	Enabled	298	277-382

Total: 6 Filtered: 6

OK Apply Cancel Help

https://9.152.90.179:9950/hmc/wd/T7ee?wh=action_2acc2acc&action_2acc2acc=toggleSort(0)×tamp=12c2c22e41e#tableTop_2...



Set zCPC Power Saving Policy in the Activation Profile

The screenshot shows a web browser window titled "HMCBeta2: Customize/Delete Activation Profiles - Mozilla Firefox: IBM Edition". The address bar shows the URL "http://9.152.90.179:8080/hmc/wcl/Te6d#We43_treeSel(6)". The main content area is titled "Customize Activation Profiles: P0000R97 : DEFAULT : Options".

On the left, a tree view shows the profile structure:

- P0000R97
 - DEFAULT
 - General
 - Storage
 - Dynamic
 - Options (selected)
 - CP/SAP
 - Partitions
 - CF01
 - CSTSAK
 - LP1
 - LP2
 - LP3
 - LP4
 - CF02
 - CSTSAK1
 - LP5
 - LP6
 - LP7
 - LP8
 - HYBBIG
 - HYB1
 - HYB2
 - HYB3
 - HYB4

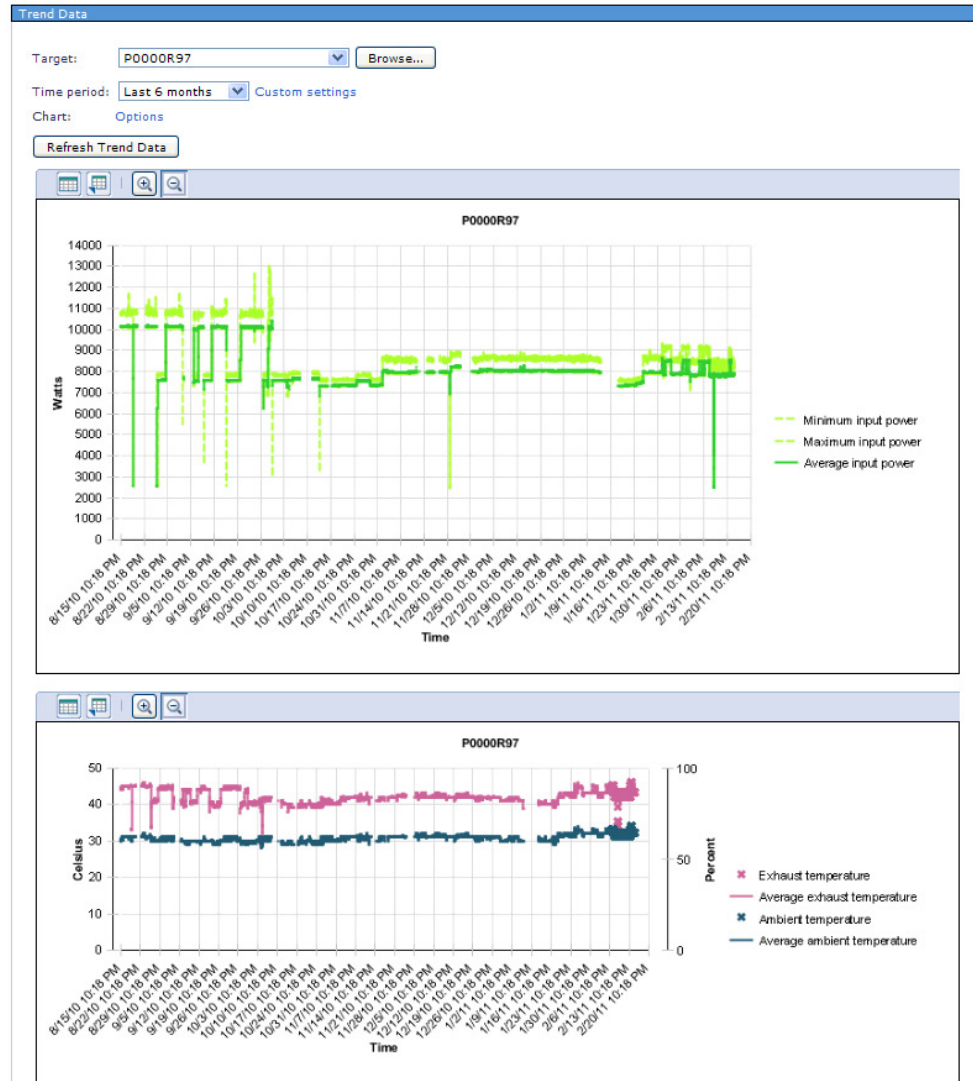


Active Energy Manager Integration



zEnterprise

- IBM System Director Active Energy Manager is an advanced energy manager provided through IBM Systems Director
- AEM monitors, measures and controls energy usage at the data center level
- Support across a large spectrum of IBM and non-IBM systems. System z support available since z10 GA1.
- AEM monitoring functions can be used free of charge.
- Enables to monitor System z in context of a heterogeneous data center.
- AEM 4.3.1 added Power Savings support for both zCEC and zBX

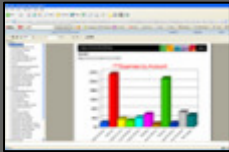




IBM Integrated Energy Management

Tivoli energy management solution

Financial Accounting for Energy



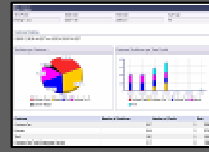
Storage & Data Optimization



Energy-Aware Provisioning and Scheduling



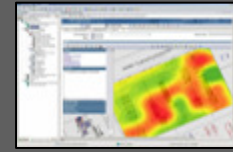
Energy Dashboard for Business Service Management



Optimize Energy Efficiency of Assets

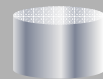


Data Center Mapping and Thermal Maps



Tivoli Monitoring for Energy Management

Tivoli

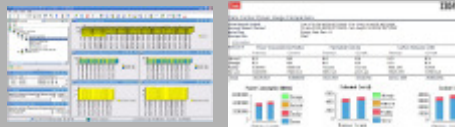


Enterprise Data Repository

Enterprise Assets



Enterprise Energy Optimization & Reporting



Enterprise Alerting for IT and Facilities



IT Assets

Discover and Manage Non-IBM Systems



Facility Infrastructure Assets

Security

Lighting

Fire

HVAC

For data center mgmt

IBM Systems Director Active Energy Manager



Active Energy Management

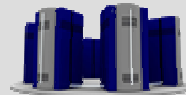


Views, Alerting, & Reporting for IBM Systems



IT Assets

Discover and Manage IBM Systems



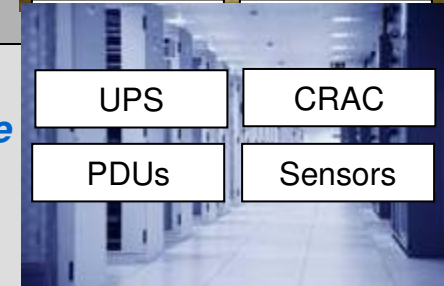
Data Center Infrastructure Assets

UPS

CRAC

PDUs

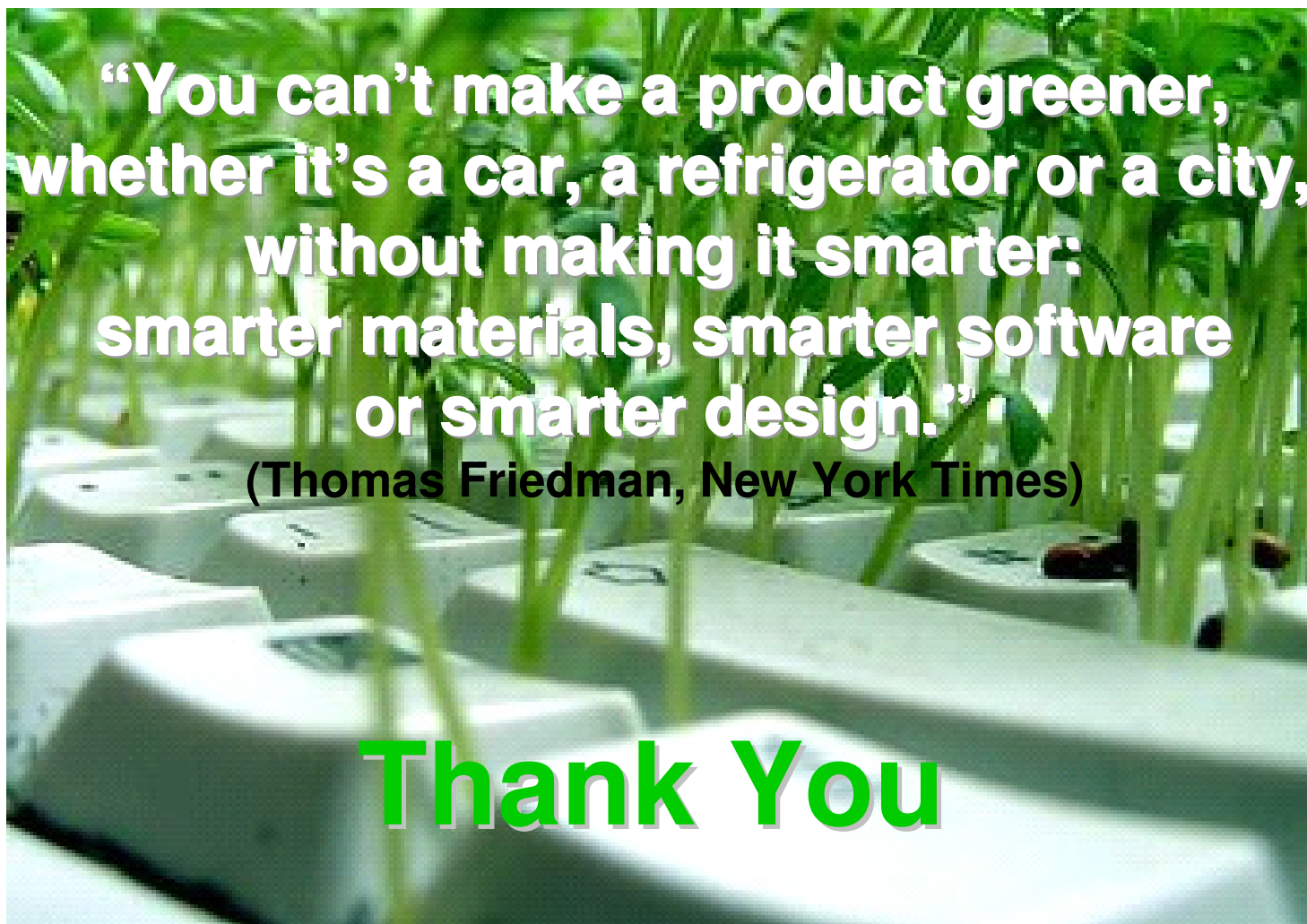
Sensors



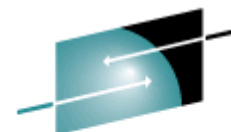


zEnterprise 196 – Energy Efficiency and Management Summary

- Significant improvements in energy efficiency
 - Tremendous performance improvement with same energy footprint
- Enables additional efficiency gains
 - Water cooling option
 - Overhead cabling option
 - HV DC power input option
- Energy Monitoring and Management delivered as part of Unified Resource Manager
 - Extensive monitoring of energy consumption and key environmental parameters
 - Integrated Energy Management Controls
- Integration into IBM Energy Management stack through Active Energy Manager



Session 8669



SHARE
Technology • Connections • Results