

HPC at NCAR

Past, Present and Future

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NCAR - 50th Anniversary - 2010

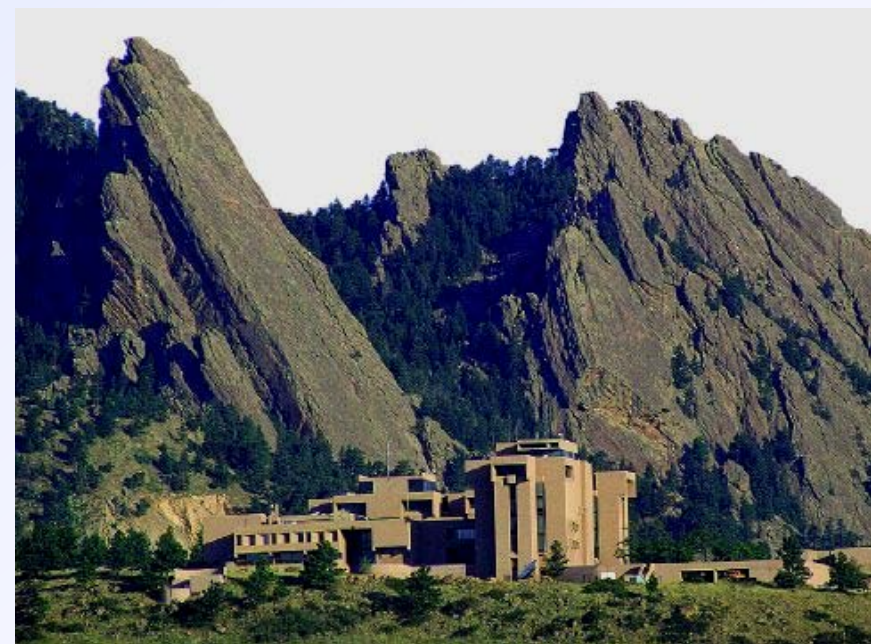
“Blue Book” 1959:

There are four compelling reasons for establishing a National Institute for Atmospheric Research:

1. The need to mount an attack on the fundamental atmospheric problems on a scale commensurate with their global nature and importance.
2. The fact that the extent of such an attack requires facilities and technological assistance beyond those that can properly be made available at individual universities.
3. The fact that the difficulties of the problems are such that they require the best talents from various disciplines to be applied to them in a coordinated fashion, on a scale not feasible in a university department.
4. The fact that such an Institute offers the possibility of preserving the natural alliance of research and education without unbalancing the university programs. The scientific program of the Institute will be focused on the fundamental problems in four principal areas of research: atmospheric motion, energy exchange processes in the atmosphere, water substance in the atmosphere, and physical phenomena in the atmosphere.

Early Years

- Walter Roberts & I.M. Pei conceive a structure commensurate with its surroundings
- Scientists sprinkled around Boulder
 - Armory, CU cyclotron building, former CU women's dormitory
- Mesa Laboratory
 - Groundbreaking June 1964
 - Scientists & first computers begin move-in late 1966
 - Dedication May 1967



CDC (1963-1983)

- CDC 3600 (1963-1966)
 - 1.3 MFLOPs
 - 32 kByte memory
 - CU PSR-2
- CDC 6600 (1966-1977)
 - 10 MFLOPs
 - 655 kByte memory
 - CU PSR-2, Mesa Lab
- CDC 7600 (1971-1983)
 - 36.4 MFLOPs
 - 655 kByte memory
 - Mesa Lab



Cray Research, Inc. / Cray-1A

- 1972 Valentine's Day Memo to William Norris re: "Emotional Problems"
- Cray Research, Inc.
 - Seymour and six engineers
 - Borrowed from CDC developments: 8600 cooling technology, Star-100 vectors
 - First integrated circuits
- LANL / LLNL battle over who gets to buy S/N 1
- NCAR signs contract May 16, 1976 for Cray-1A



NCAR's Cray-1A S/N 3

- Cray-1A S/N 3
 - 11 Jul 1977 to 1 Feb 1989
 - 160 MFLOPs
 - 8 MBytes memory
 - 4.8 GBytes DD-19 disk
 - 110 kW frame (2x including cooling and disk cabinets)



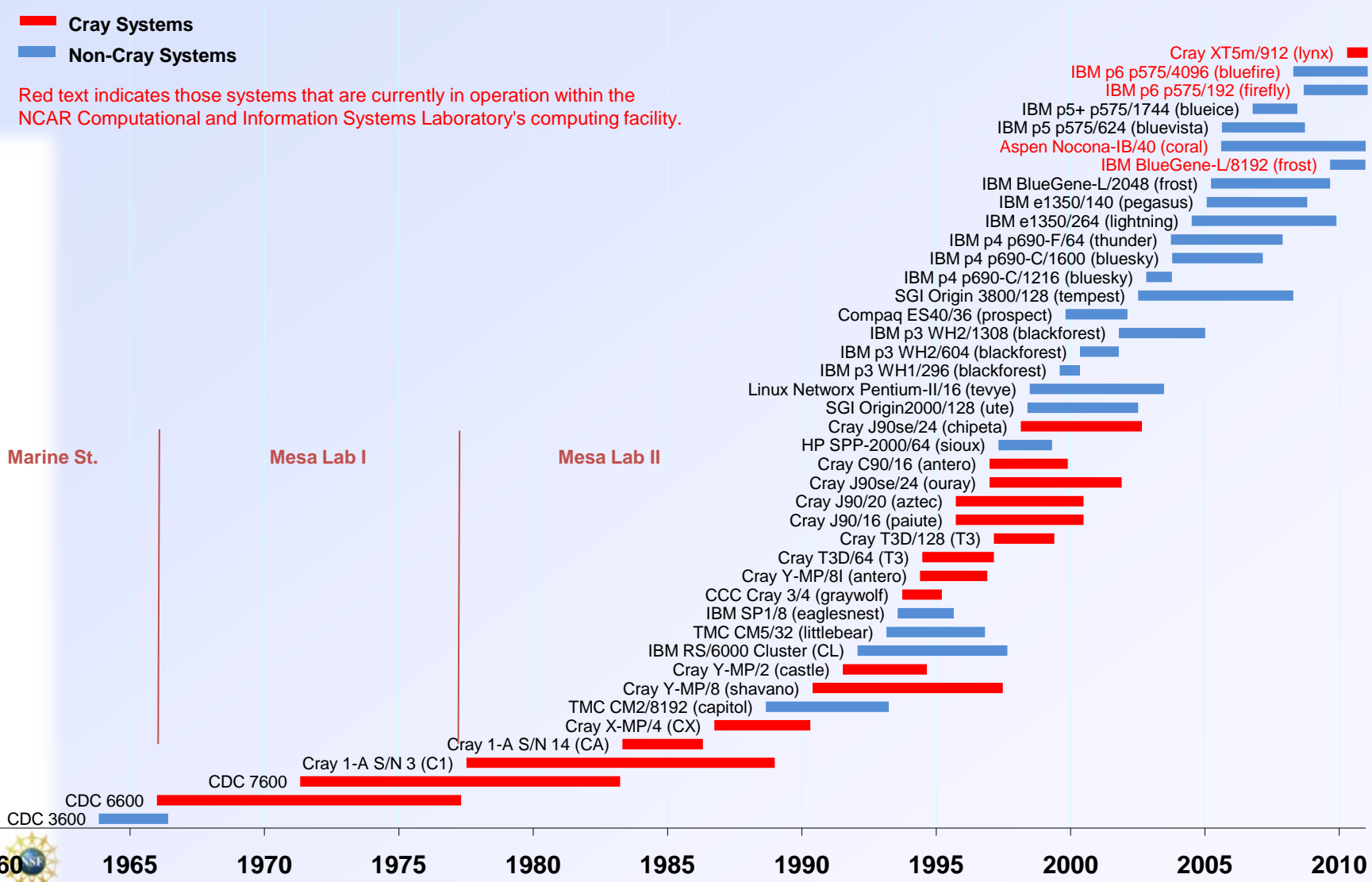
Technology	Year	
Cray-1A S/N 3	1977	
Processor Speed	80 MHz	
Random Access Memory	8 MBytes	
Disk Storage	4.8 GBytes	
Power	110 kWatt	(~2x for cooling and disk)
iPhone 3GS	2009	
Processor Speed	600 MHz	7.5 x Cray-1A
Random Access Memory	256 Mbytes	32 x Cray-1A
Flash Storage	16 GBytes	3.33 x Cray-1A
Power	3 Watt (max)	0.000027 x Cray-1A

HPC History at NCAR

■ Cray Systems
■ Non-Cray Systems

Red text indicates those systems that are currently in operation within the NCAR Computational and Information Systems Laboratory's computing facility.

Computational & Information Systems Laboratory



Cray-3 S/N 5 (graywolf)

- Cray-3 development moves to Colorado Springs (Aug '88)
- CRI spins off CCC (May '89)
- CCC acquires fab assets from Gigabit Logic, builds GaAs fab, manufacturing facility in 'old INMOS building'
- Seymour gives Cray-3 S/N 5 to NCAR (May 1993):
 - “If it runs at NCAR,
it will run anywhere.”
 - 1 GFLOPs per CPU
 - 1 GByte memory
 - 20 GBytes disk
 - 90 kWatts



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ACE & the Dumping Case

- Accelerated Computing Environment RFP (3/23/95)
 - To 16 vendors / 4 respondents / 3 competitive
- CCC files Chapter 11 (3/24/95)
- SGI acquires CRI (Feb '96)
- Benchmarks lead NCAR to ACE negotiations with FCC (had bid four NEC SX-4/32 systems over 5 years)
- SGI/Cray files dumping complaint with Commerce Department (7/29/96)
 - ... Commerce, ITC, up to 454% anti-dumping duties imposed, ITC Court, U.S. Supreme Court ...
 - While the case was litigated, NCAR acquired a C90, two J90se/24s, and upgraded its T3D via sole-source to meet growing capacity demands
- U.S. Supreme Court sustains dumping decision (2/22/99)

21st Century

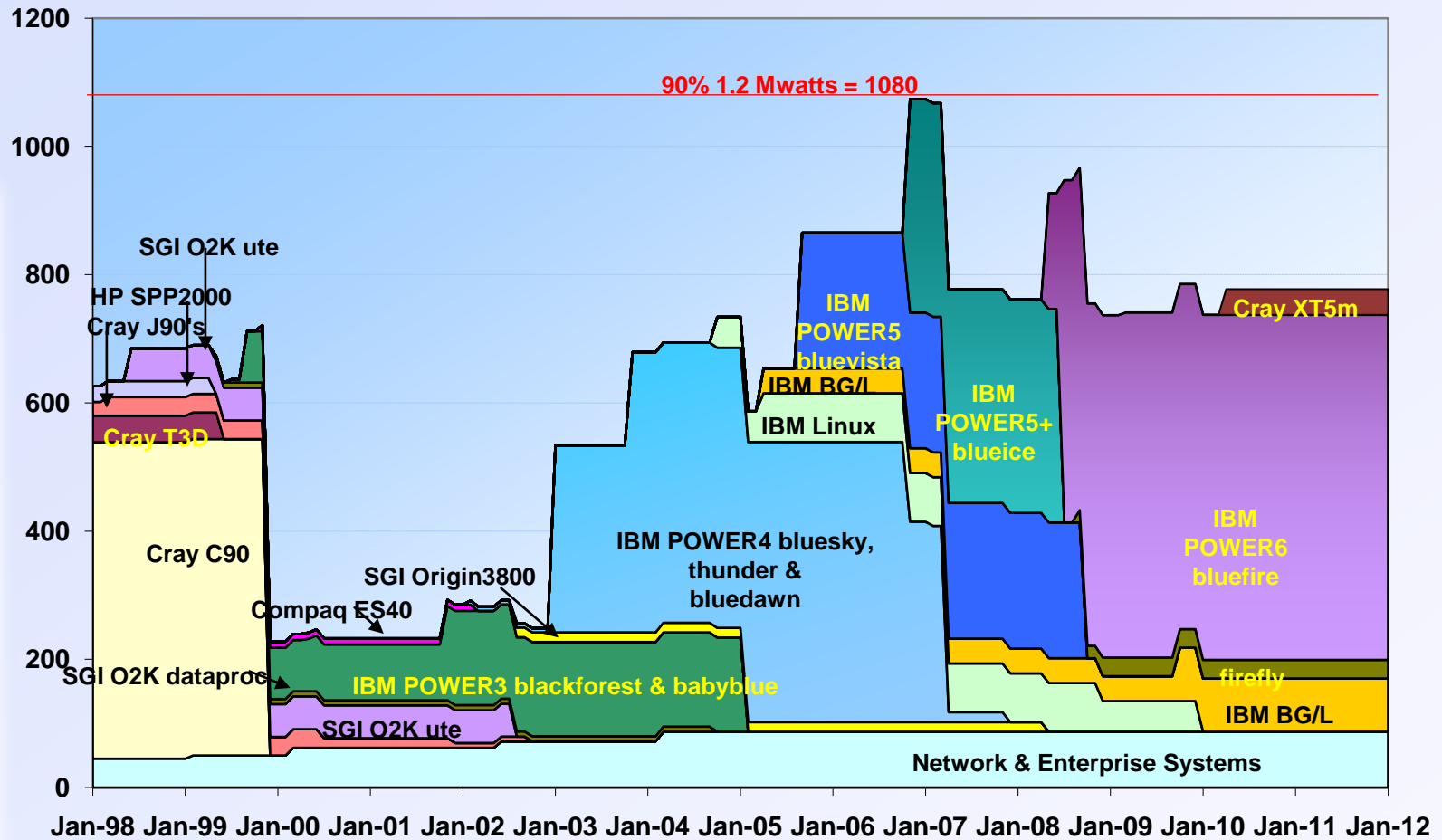
- “Buy American”
- Turmoil in the American supercomputer industry & Japan’s Earth Simulator
- Tera acquires Cray (Mar 2000) for <\$100M, becomes Cray, Inc.
- Accelerated Research Computing System RFP (ARCS 2000)
 - Compaq, IBM, SGI proposals
 - \$24M 3-year agreement with IBM; extended to five years, four phases
 - blackforest (P3), bluesky (P4) & expansion, bluevista (P5)
- Integrated Computing Environment for Scientific Simulation RFP (ICESS 2006)
 - Cray, IBM, SGI proposals (squeaker between Cray & IBM)
 - \$15M 3.5-year agreement with IBM – two phases
 - blueice (P5+), bluefire (P6)
 - 2-stage P6 acceptance, bumping head on ‘power ceiling’

Lynx (a small Jaguar)

- Test platform (batch & resource management, filesystems, WAN filesystems)
- Local development platform for NCAR-DoE collaboration
- Cray XT5m (lynx)
 - 8.03 TFLOPs
 - 1.3 TByte memory
 - 32 TByte disk
 - 35 kWatt
- Accepted 29 Apr 2010



Facility Constraints ... Finding New Digs



2003: began assessment of options (facilities, partnerships ...)

January 2007: announced partnership with U.WY, State of WY, Cheyenne LEADS, WY Business Council, and Cheyenne Light, Fuel & Power Co.

NWSC

NCAR-Wyoming Supercomputing Center project



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NWSC

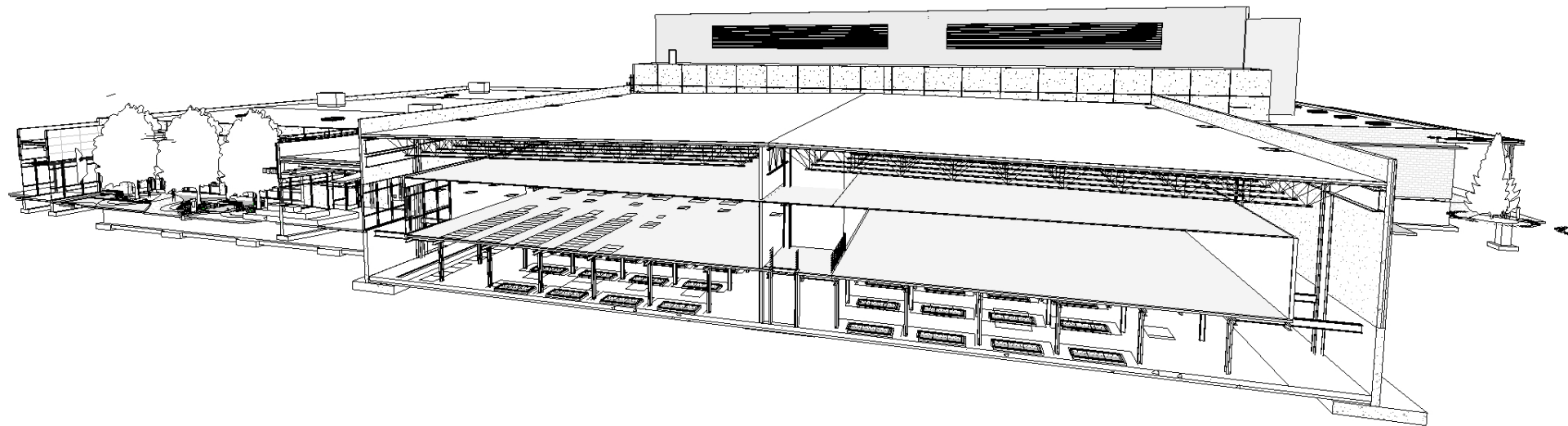
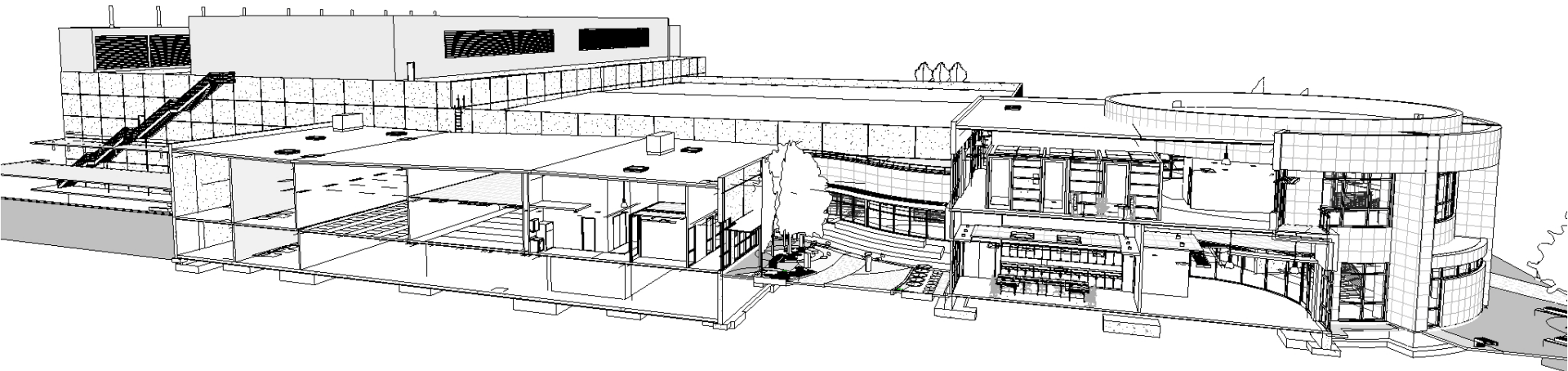
NCAR-Wyoming Supercomputing Center project



Image courtesy of H+L Architecture

NWSC

NCAR-Wyoming Supercomputing Center project

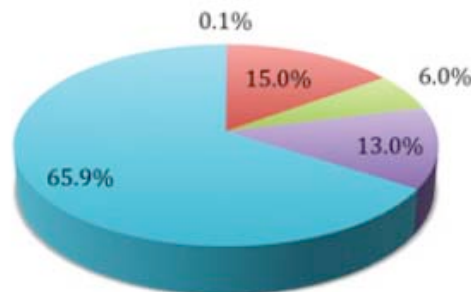


A Focus on Sustainability

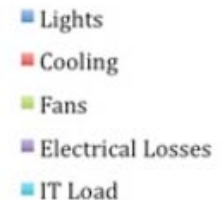
- **Energy efficiency**

- Natural cooling to be used 96% of the year
- Designed to achieve a Power Usage Effectiveness (PUE) value (ratio of the total power consumed by the data center to the power consumed by facility IT equipment) of < 1.1
- Minimum of 10% of locally generated renewable energy
- Office spaces 60% more efficient than typical office spaces

Typical Modern Data Center



NWSC Design



A Focus on Sustainability (2)

- **Resource Conservation**

- *Specialized cooling tower equipment* to save up to four million gallons of water each year
- *Locally sourced building materials* to be used whenever practicable
- *Recycled content and materials* to be used in the construction, including steel and concrete
- *Waste heat recycling* to pre-heat components in the power plant, provide heat for office spaces, and to melt snow and ice on outdoor walkways and rooftops
- *Rainwater recycling* for toilets reducing the use of potable water by over 50%; *low-flow plumbing fixtures* will further reduce water consumption by 40%

A Focus on Sustainability (3)

- **LEED Certification**

- NWSC team intently pursuing USGBC LEED certification
- At present, facility design is solidly positioned to achieve *LEED Gold* certification

For more information on the NWSC sustainability planning and objectives, please see www.cisl.ucar.edu/nwsc/sustainability



Questions