IHTC
SINCE 1951

A Critical Societal Need

To obtain sustainable and safe energy supply with least environmental impact

Yogesh Jaluria
Rutgers University, USA

Energy: Generation/Conversion, Distribution, storage, Utilization

Environment: Heat Dissipation, Nuclear Waste, Greenhouse Gases

Safety and Security: Accidents, Disruption, Uncertainties, breakdown

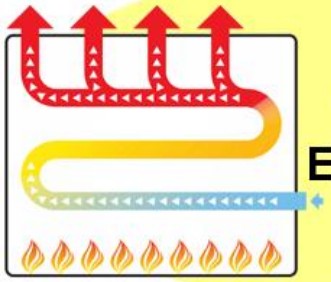
IHTC
Since 1951

Thermal Systems

Manufacturing and Materials Processing Systems

Energy Systems

Cooling Systems

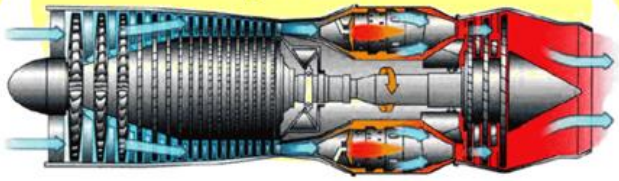


Heat Transfer Equipment

Environmental and Safety Systems

Air conditioning, Refrigeration, and Heating Systems

Transportation Systems



Aerospace Systems

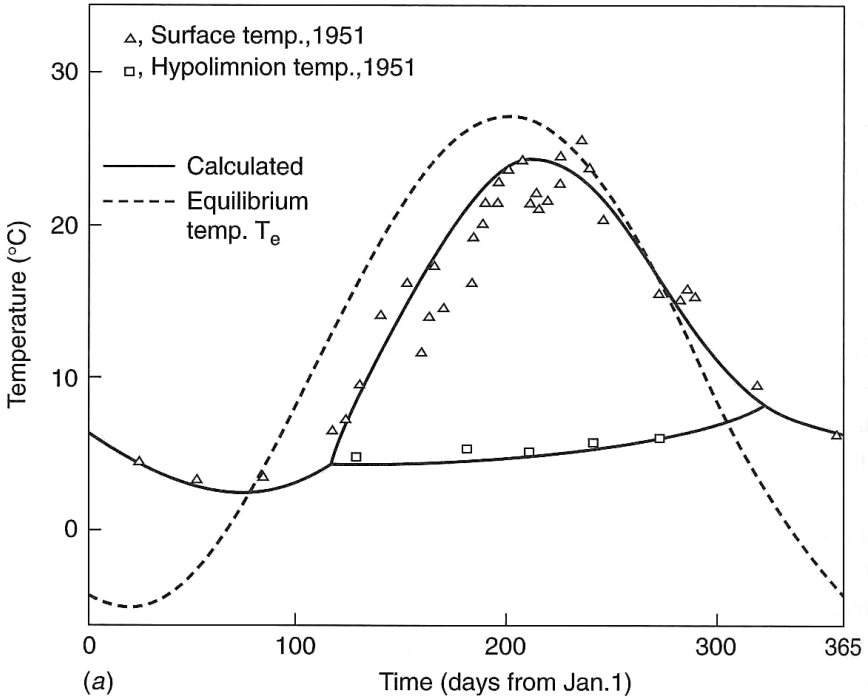
Challenges for Thermal Sciences

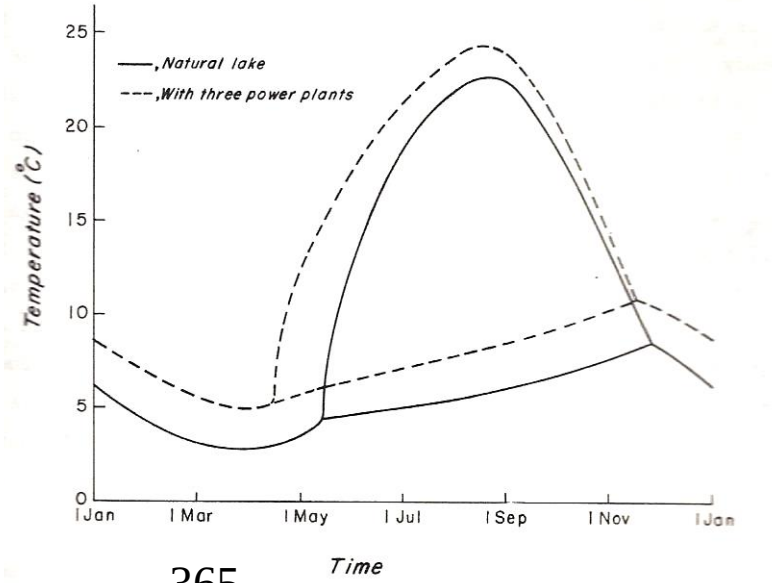
- **Renewable sources:** Materials processing (PV), stand-alone systems, system design
- **Energy storage:** Thermal, batteries, chemical reactions
- **Recovery of waste heat:** Regeneration, energy utilization
- **System optimization and efficiency:** Thermal systems, components, processes, simulation, design
- **Global climate change:** Melting polar caps, storms, drought, large fires, modeling, experimental data
- **Important time scales:** Daily, seasonal, annual, long-term
- **Greenhouse effect:** Carbon sequestration, emission reduction
- **Sustainability:** Ecology, economics, politics, resources
- **Security and Safety**: Modeling of different scenarios, experimental data, back-up systems

Further Work Needed

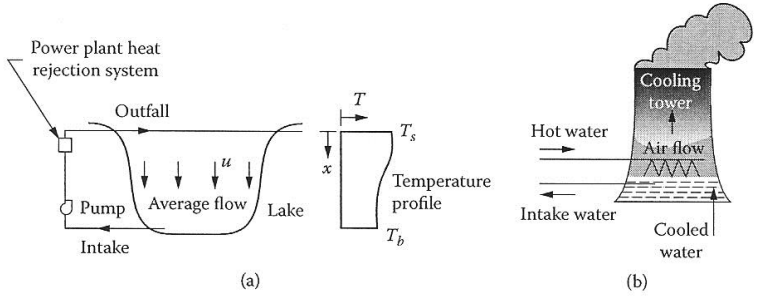
- Energy storage
- Efficiency of small independent systems
- Reduction in consumption
- Optimization, efficiency
- Waste heat utilization
- Cost reduction in materials processing
- Climate change and its effects
- Local environmental effects
- Modeling and experimental data for global warming
- Sustainability
- Safety and security of systems and supply
- Bring these aspects into educational programs

Environmental Effect of Thermal Discharge to a Water Body





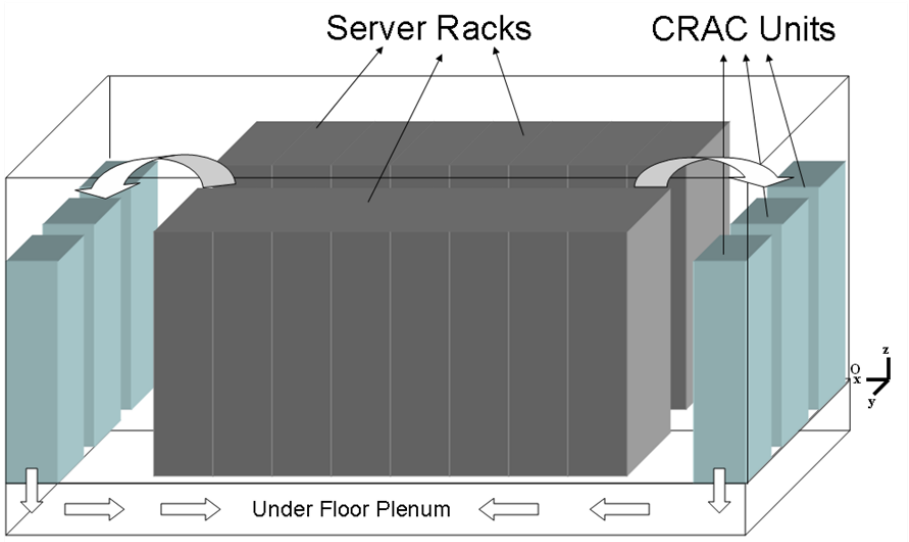
$$\int_0^{365} q''_{surface}\,dt = Q_{rejected}$$



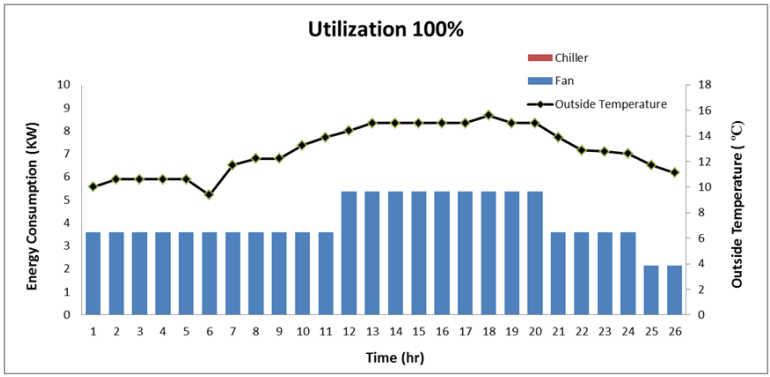
Relatively small temperature changes
Effect on natural cycle
Effect on transport processes
Effect on bio-organisms

Must work with environmental scientists to determine biological effects

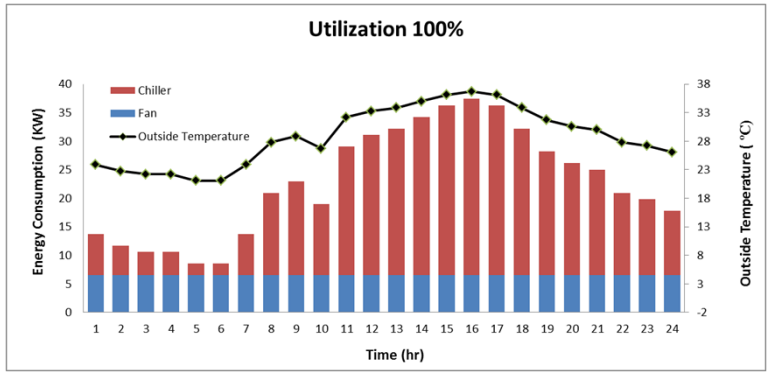
Energy Consumption in Data Center Cooling



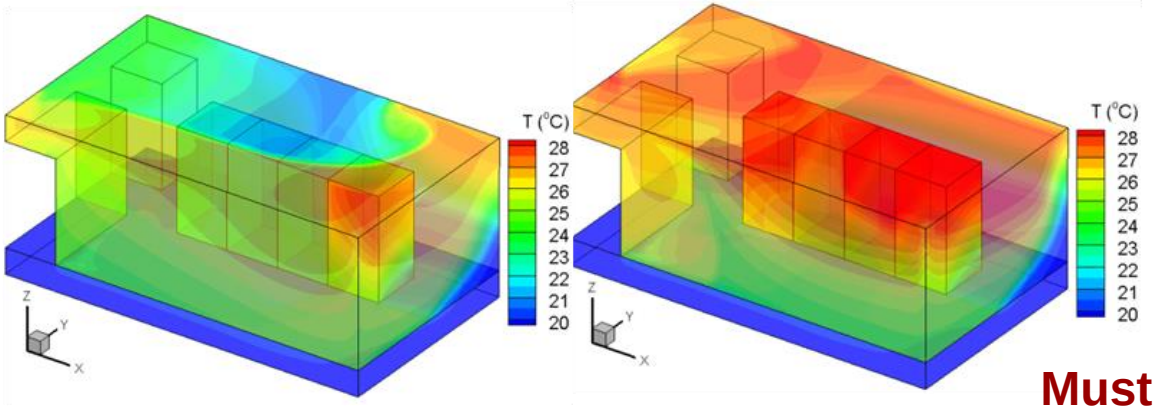
Sketch of a Data Center



Seattle, 100% Utilization, January



Princeton, 100% Utilization, August



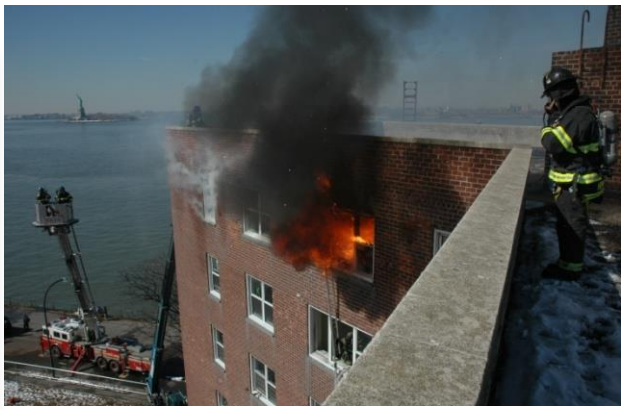
25 % Utilization

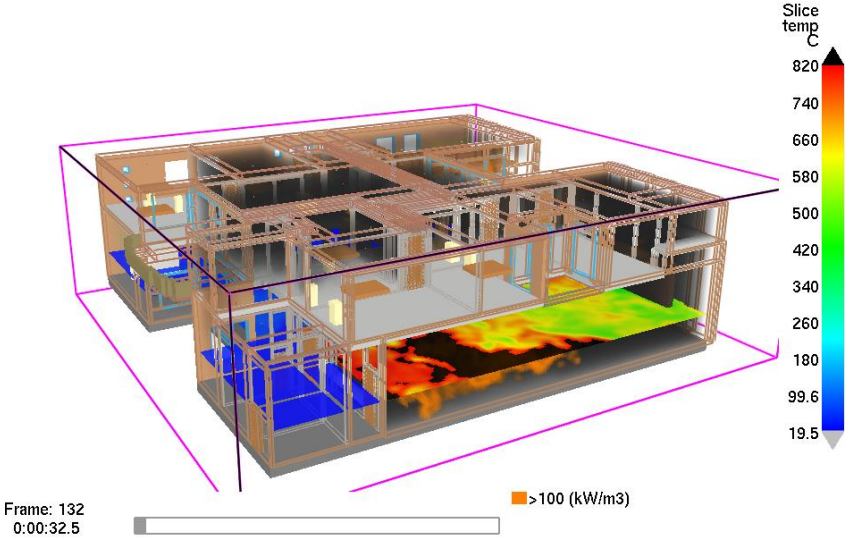
50% Utilization

Temperature Distributions

Must work on load distribution for substantial reduction in consumption

Safety Issues with Fires, Explosions and Other Accidents





Important to consider different scenarios to prepare for safety and security

Funding and Control

- **Federal Government:** Renewable sources, climate change, grid safety, nuclear safety, accidents, sustainability. Thermal science researchers should strive to influence policies and regulations.
- **Local and State:** Environmental issues, energy needs, clean energy, education, local policies.
- **Industry:** Material processing, efficiency, waste heat recovery, power plan safety, improvement of existing systems, delivery. Thermal scientists must work with industry for impact.
- **Academia:** Research, long-term issues, education and training.
- **Research Direction:** Must justify research in terms of societal needs, explain long range goals and benefits to society. Promotion procedures must consider impact on society.

Role of Thermal Science Research

- Use existing and future research to guide use of fossil fuels
- Advise on basic and practical changes needed for greater use of renewable sources
- Advise on funding to improve efficiency, thus reducing consumption and costs
- Play a leading role in looking at global energy needs and climate change
- Modify existing education programs to bring these issues to the forefront, linking research to important applications
- Articulate research areas of greatest need, such as energy storage, PV fabrication and carbon sequestration
- Collaborate with industry and government for safety and security issues, playing a crucial or leading role
- Help in formulating policy for safety and security of energy systems
- Enhance standing of thermal science researchers in the world to impact on policy, funding, and research direction
- Align basic research interests with issue-based, top-down, research direction and influence funding direction for greater impact