Utility Infrastructure, Energy Generation & Consumption

CAROLINA NORTH

The UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL

Goals in a Global Context

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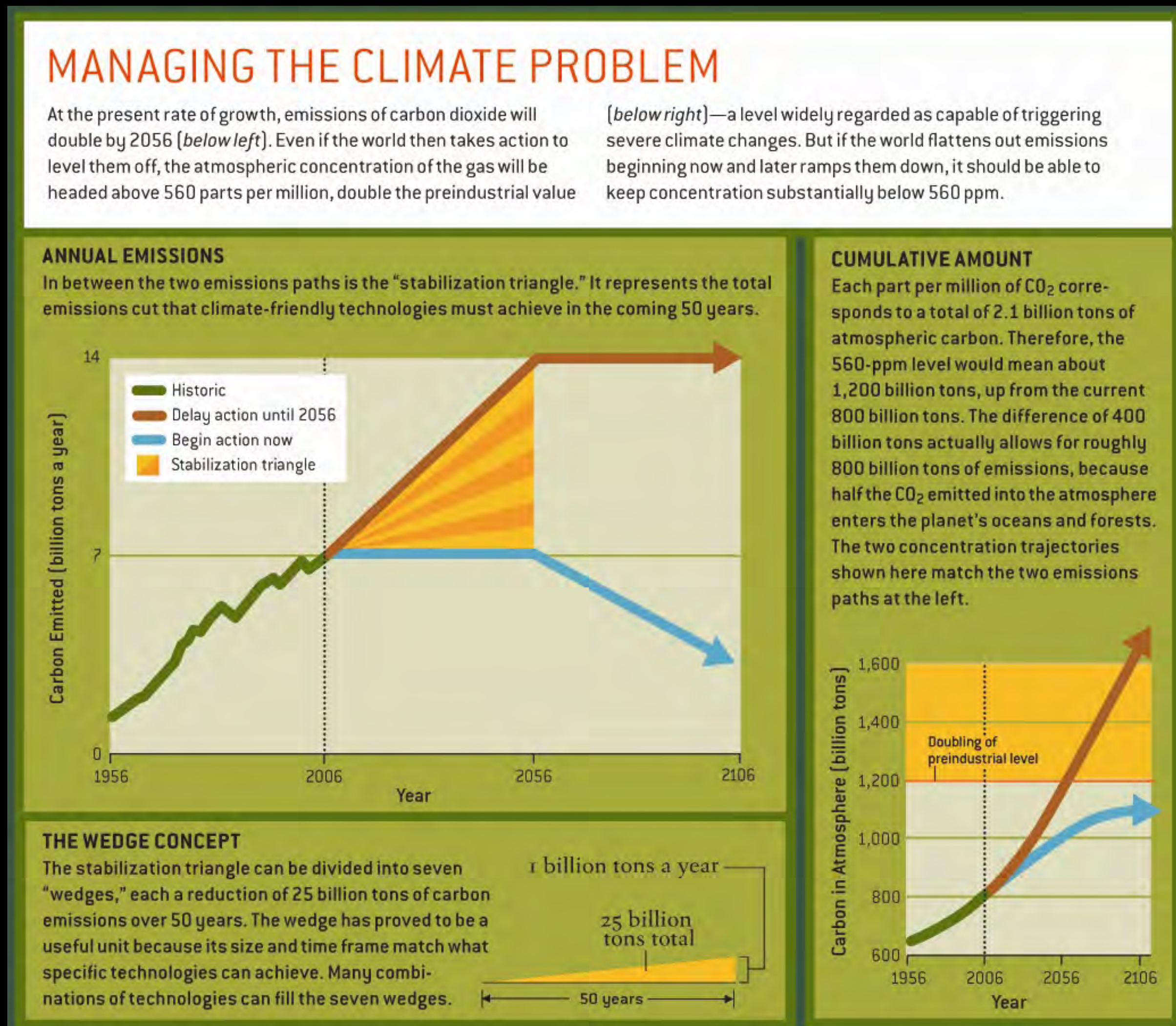
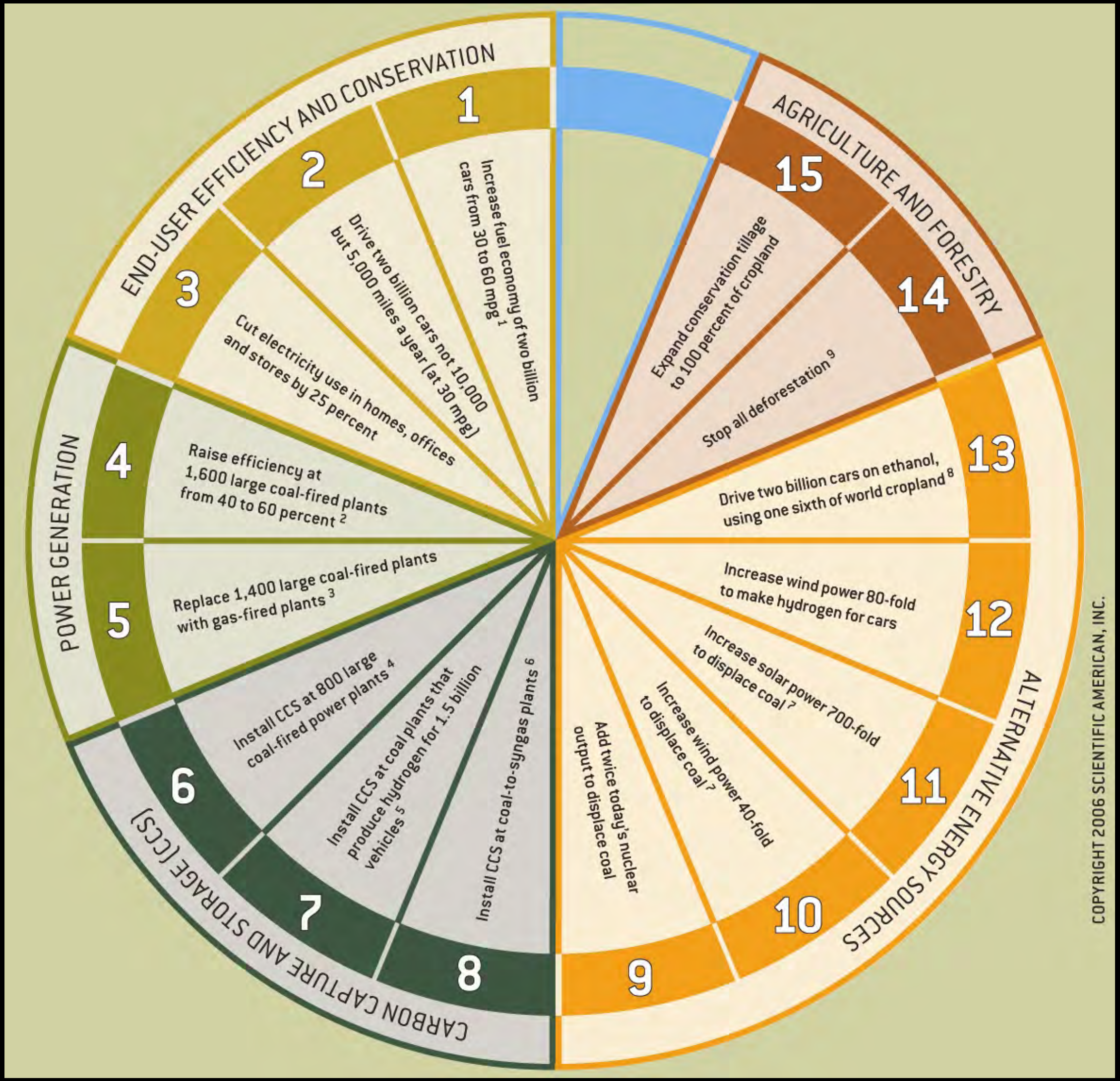
The Wedge Principle



15 Proposed “Wedges”



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Opportunities

- Carbon Reduction – Minimize Greenhouse Gases
- UNC / TCH CRed Pledge – 60% Per Capita Reduction by 2050
- Alternative or Renewable Non-Carbon Based Fuel Sources
- Carolina North to be a Sustainable Campus
- Social Responsibility
- Maintain "Best in Class" Central Systems

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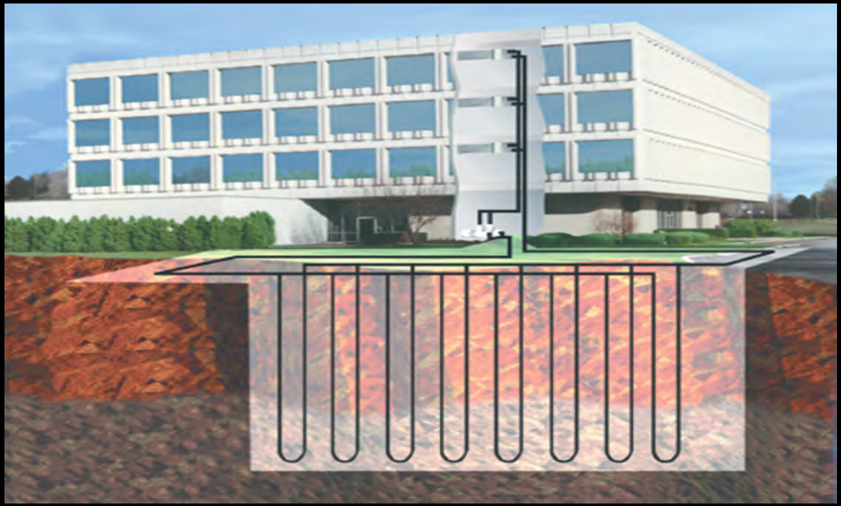
Hierarchal Approach

- Individual Building Level (Typology Group)
- Highly Efficient Central Plants
- Opportunities to Reuse Excess Energy from Buildings through Plant



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District Systems

- Takes Advantage of System Diversity and Reliability
- More easily Adaptable for Future Technologies
- Consider Standby Power as a Central Utility
- Hot Water is a Viable Alternative to Steam

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Other Issues

- Demand Side Management
- Net Energy Metering per Building
- Local Display of Building Energy and Systems Operation and Performance
- Education of Building Occupants
- Need to Study Distribution Methods

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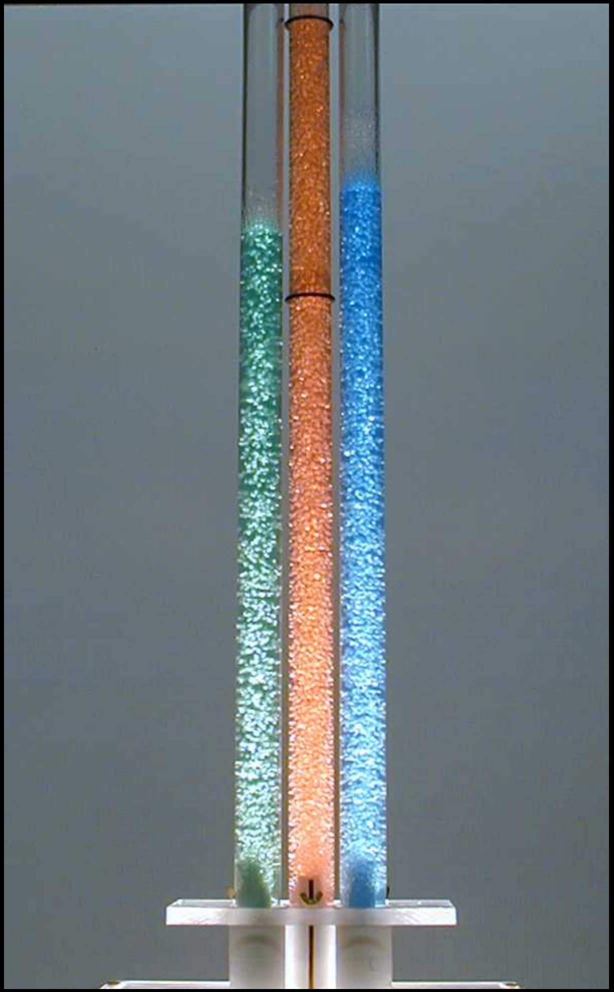
Analog Displays



Provides quick visual of building energy use by type and relative to baseline

Simple display that is cost effective

Provides dynamic visual of building energy production

Easily interpreted by non technical observers

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BREATHING WITH THE WIND

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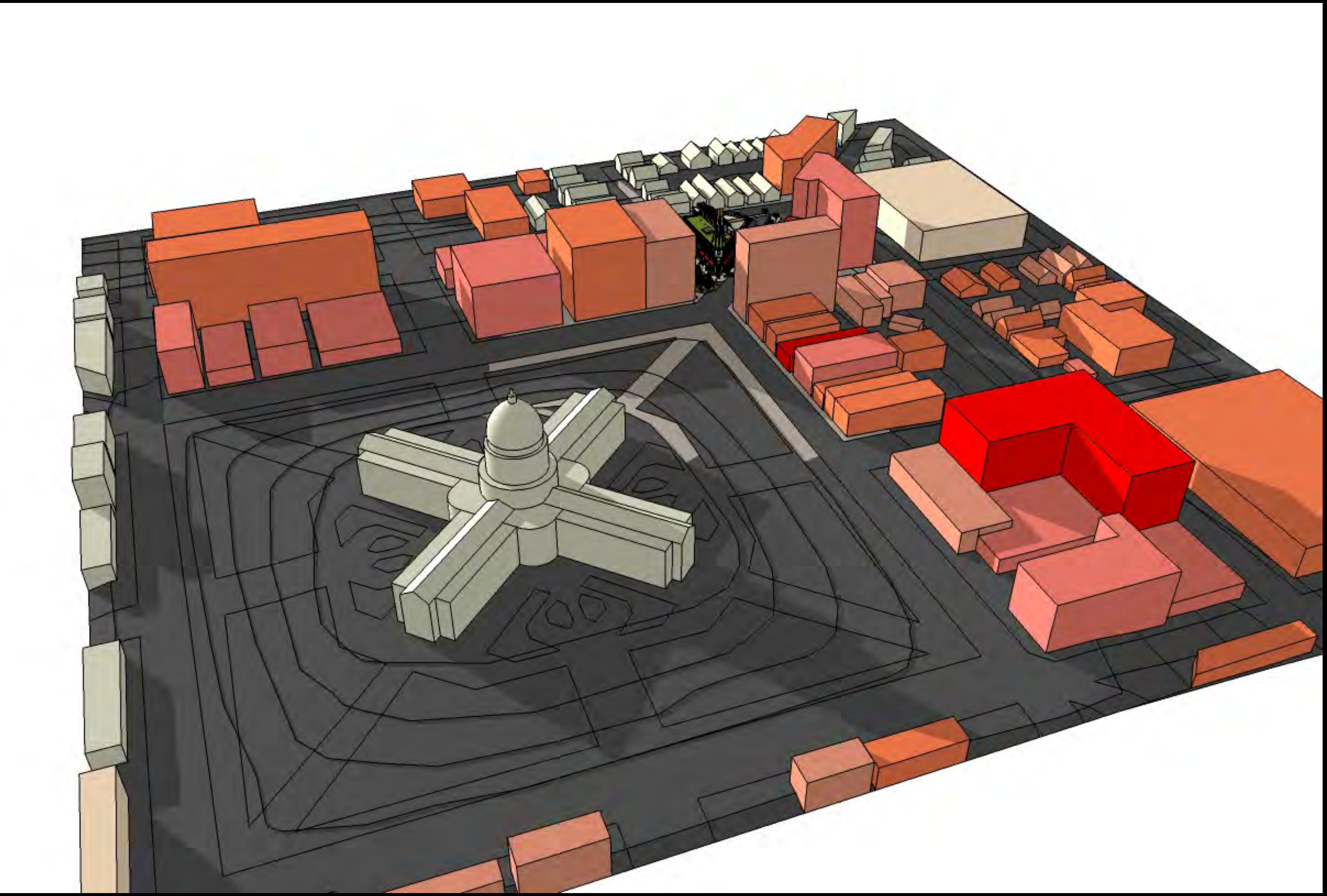
Campus Context



	220+
	180-219
	140-179
	100-139
	60-99
	Not Measured

Scale: KBTUs/GSF/Year

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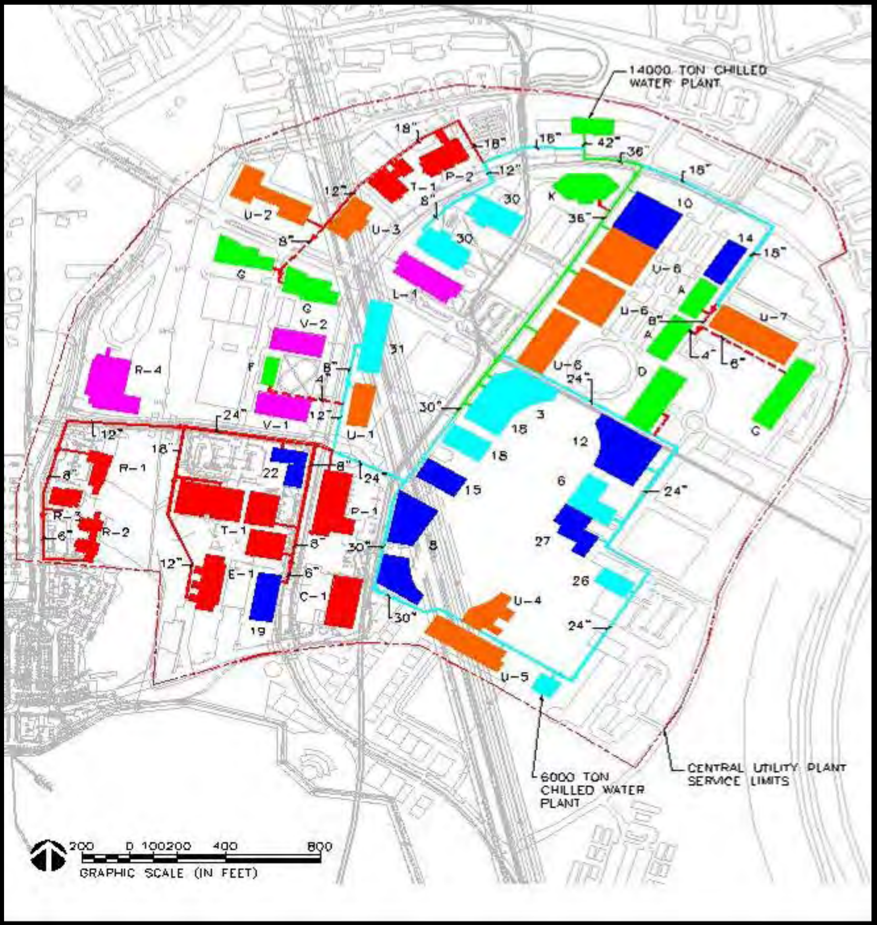
Central vs Regional vs Building

- Start with building level and transition to regional or central?
- Make investment in future and start with central?
- What Are Other Institutions Doing?
  - NCSU – Centennial and Main Campuses
  - Duke Regional Chiller Plants
  - Virginia Tech
  - Oklahoma State
  - University of Illinois
  - University of Wisconsin
  - University of Colorado



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High Efficiency Central Plant

- “Right Sized not Oversized”
- Variable Speed Drives
- Chilled Water ΔT
- Hybrid Chiller Plant
- Free Cooling
- Thermal Storage
- Low Condenser Water Temperatures
- Stack Economizer
- Vent Condenser
- Alternative Heat Sinks
- Combined Heat and Power

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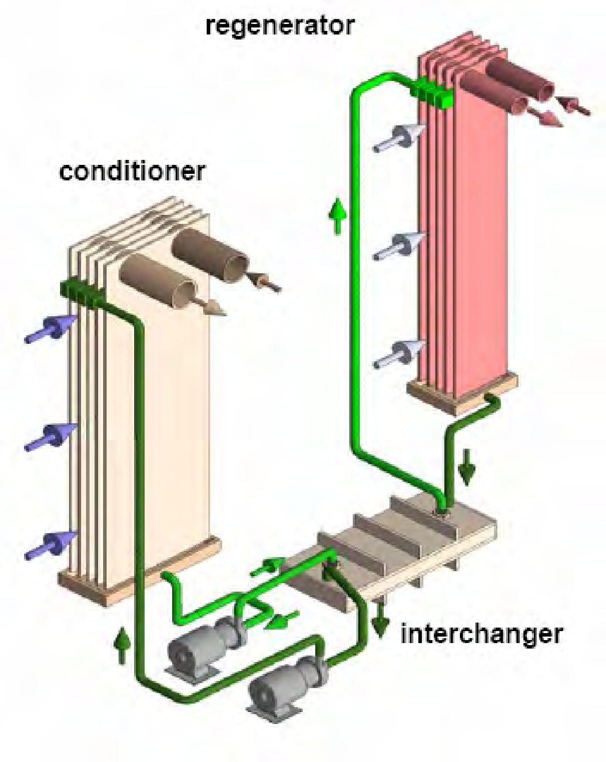
Energy Reuse at Central Plant

- Water Source Heat Pumps
- Building Integration
  - Liquid Desiccant Cooling
  - Solar Collectors
- Reclaim Water Use



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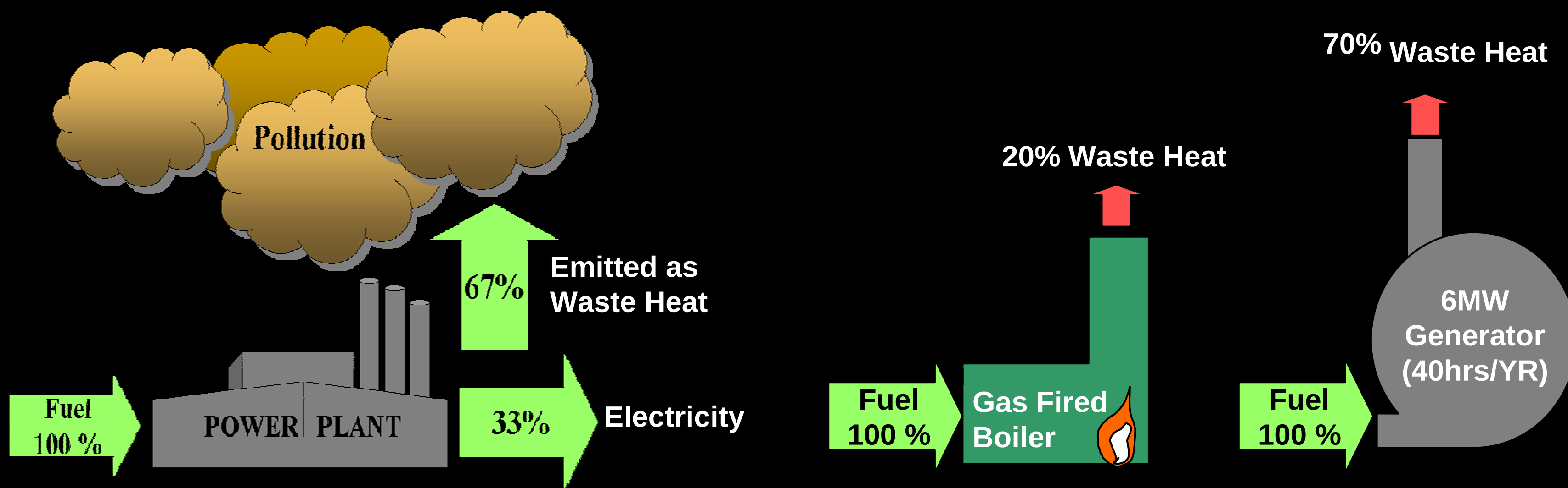
Purchased Utility Arrangement



Remote from Thermal Users

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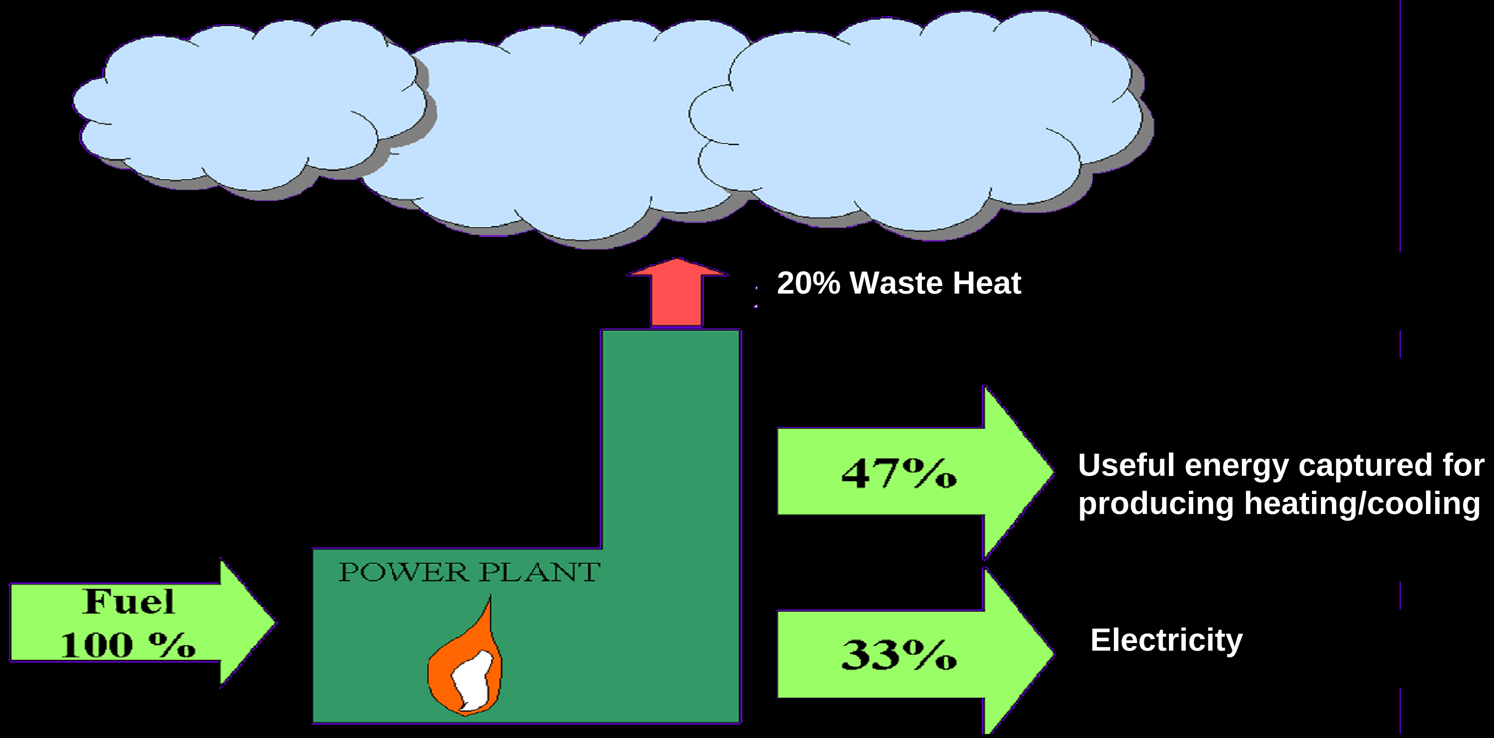
CHP Arrangement



Local to Thermal Users (8760hrs Runtime)

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Carbon Reduction

- Solar
- Wind
- Groundwater
- Landfill Gas
- Hog Waste
- Poultry Waste
- Woody Biomass
- Organic portion of municipal solid waste
- Energy Crops
- Algae Digesters
- Natural Gas / Propane Air




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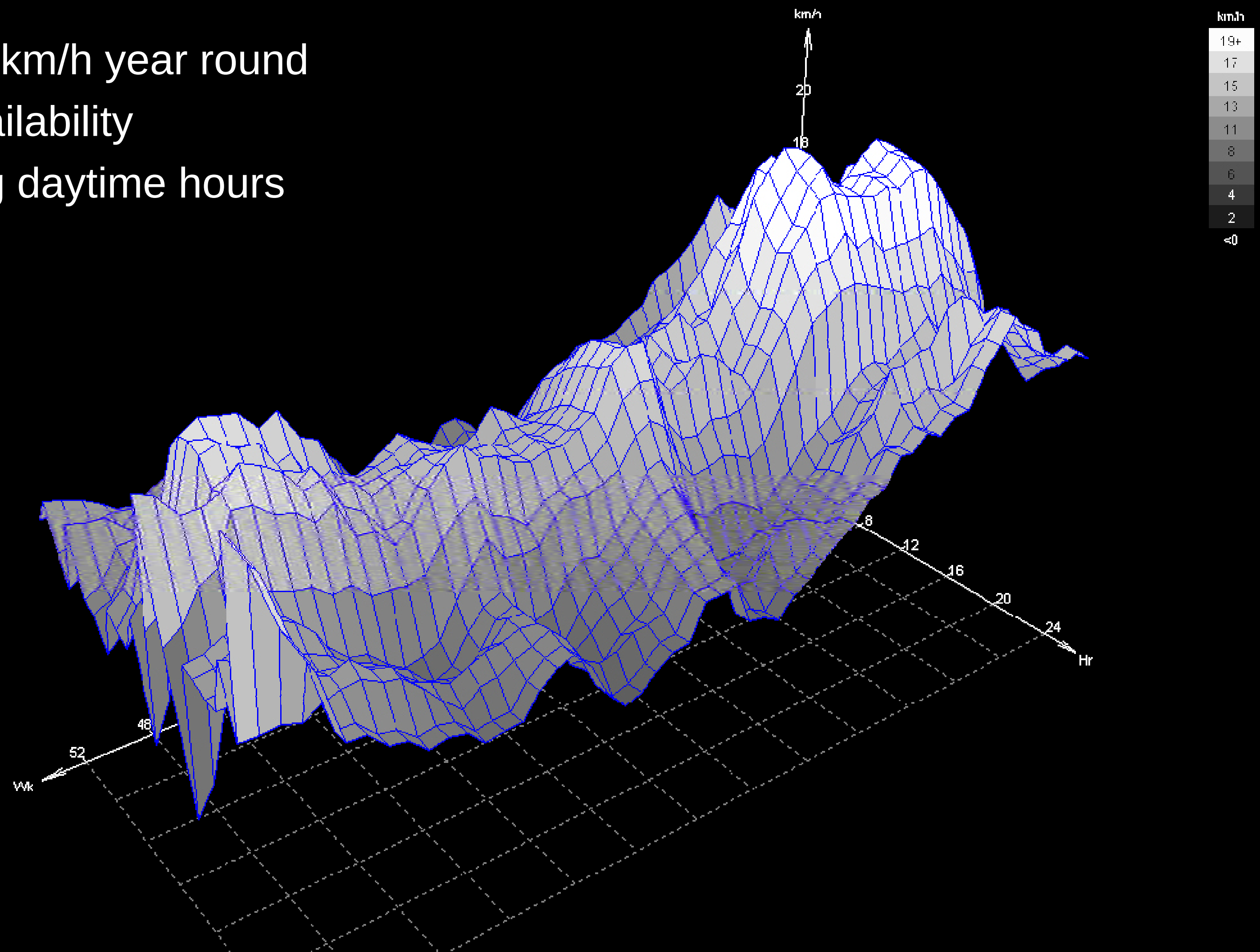
Climactic Realities of Renewable Energy

Wind Speed

- Less than 20km/h year round
- Sporadic availability
- Peaks during daytime hours



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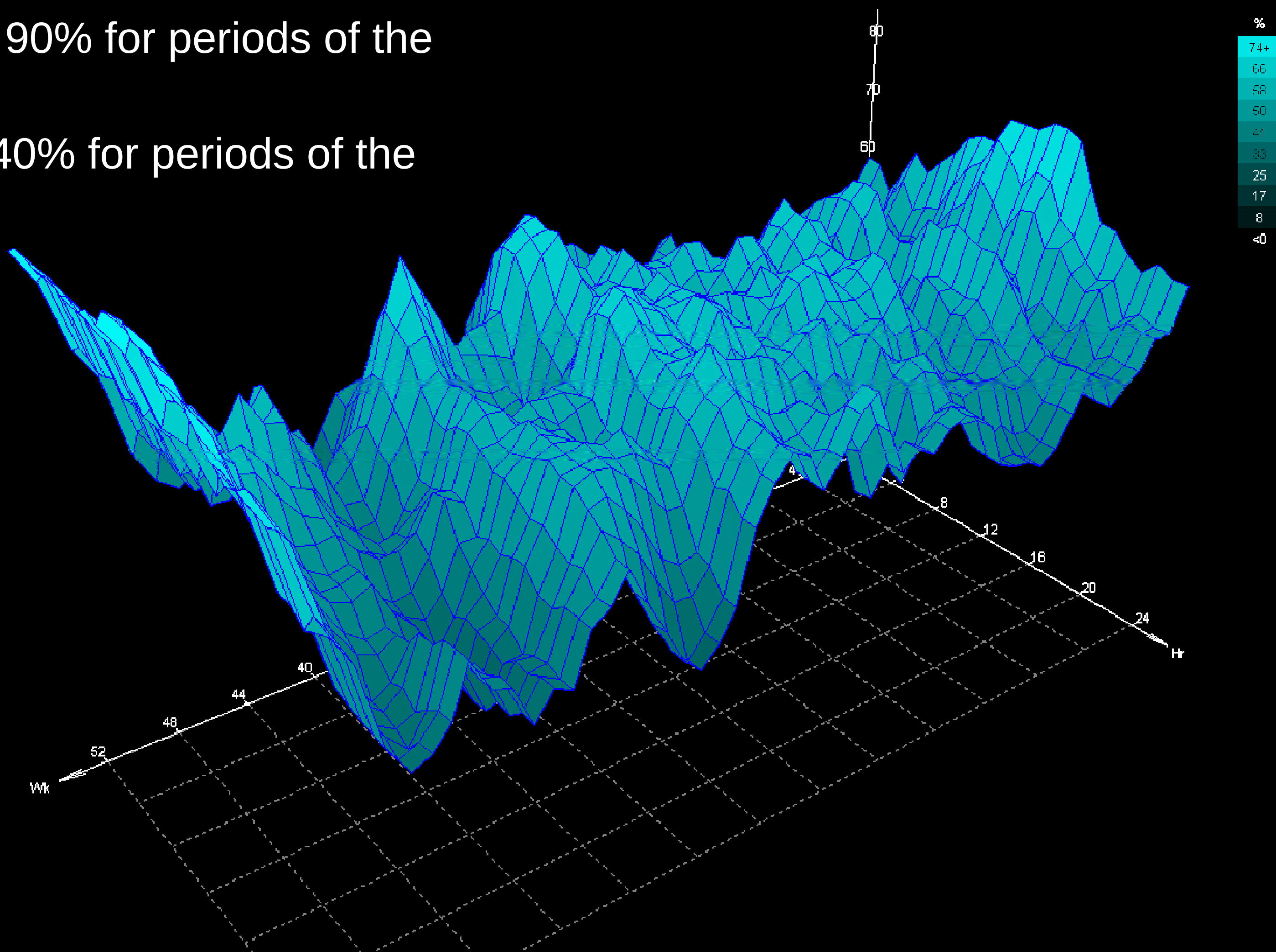
Climactic Realities of Renewable Energy

Cloud Cover

- Varies Widely Annually
- As high as 90% for periods of the year
- As low as 40% for periods of the year



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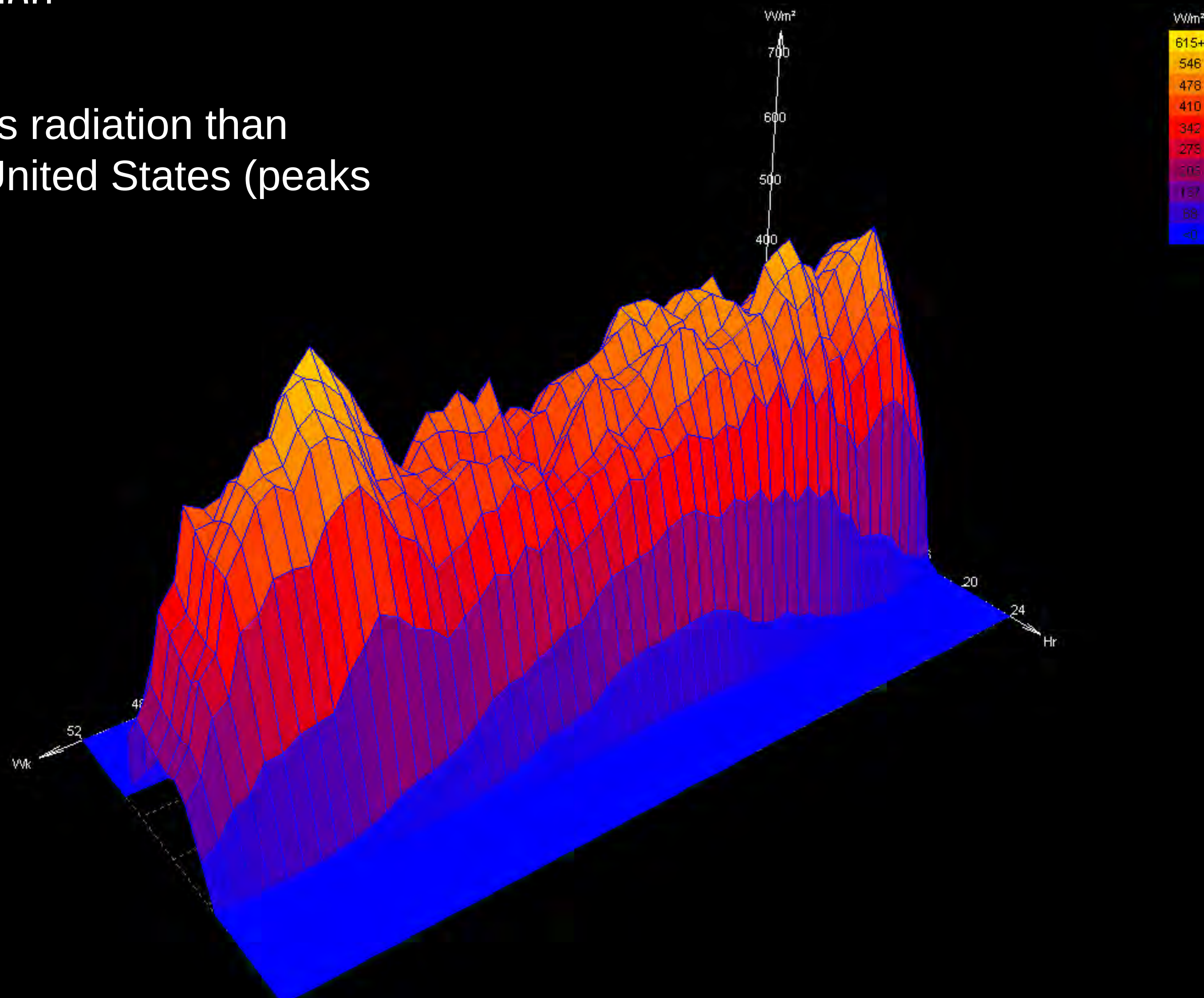
Climactic Realities of Renewable Energy

Direct Solar Radiation

- Peaks at ~ 6(
- Significantly less radiation than Southwestern United States (peaks above 800W/



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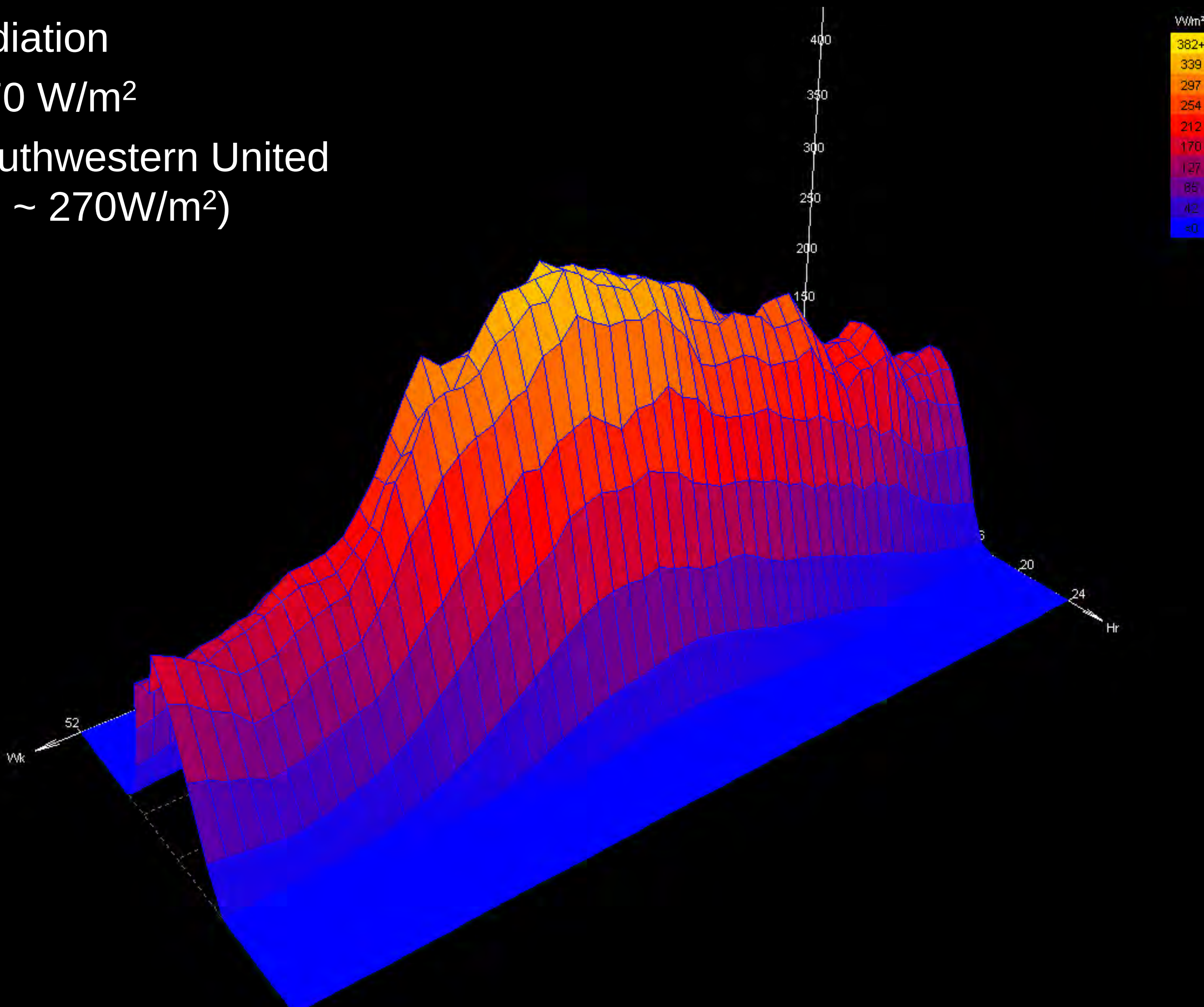
Climactic Realities of Renewable Energy

Diffuse Solar Radiation

- Peaks at ~ 370 W/m^2
- More than Southwestern United States (peaks ~ 270W/m^2)



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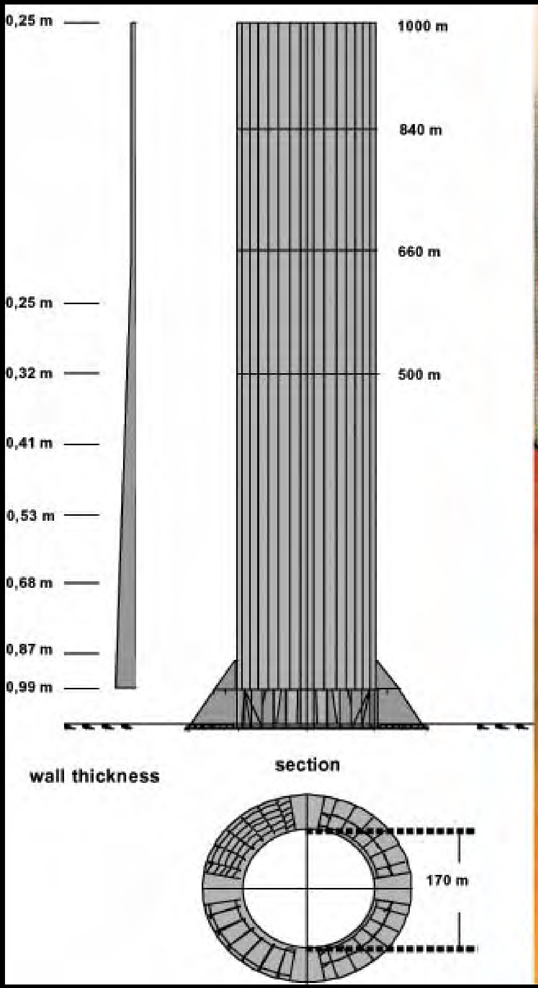
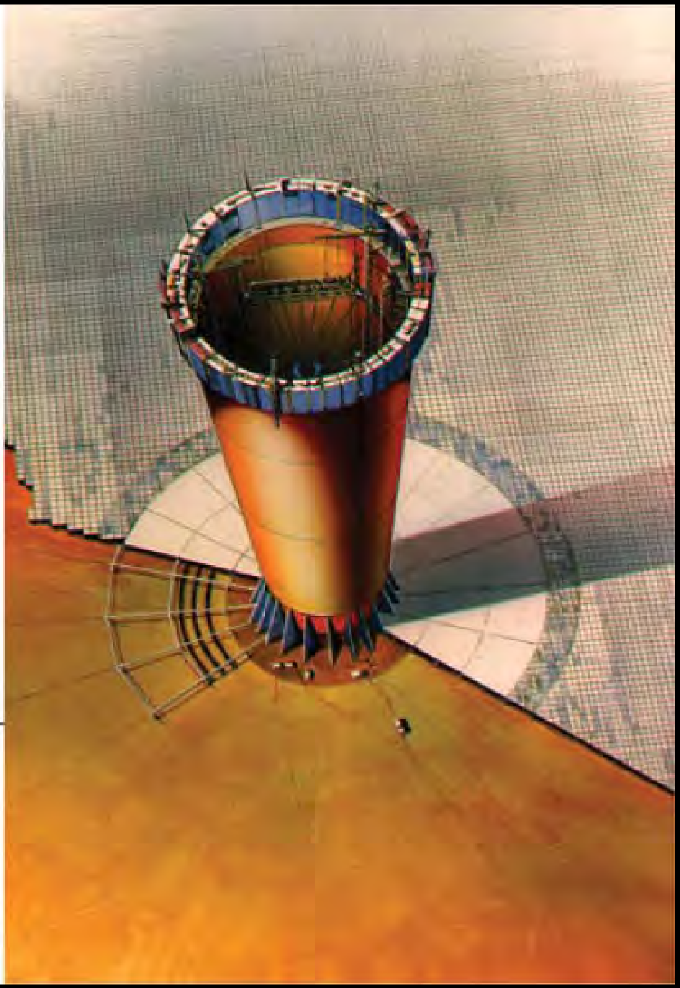
Innovative Energy Generation

Solar Chimney

- Uses ΔT of air in vertical shaft to induce air flow through the chimney to spin a turbine





Innovative Energy Generation

Solar Chimney

- 50KW Prototype in Manzaneres, Spain
- 200 meters tall!
- Current project in Australia to construct 1000 meter tall solar chimney to produce 200 MW
- Does it scale?
- Can it be optimized with solar concentrating technology or evacuated tubes?

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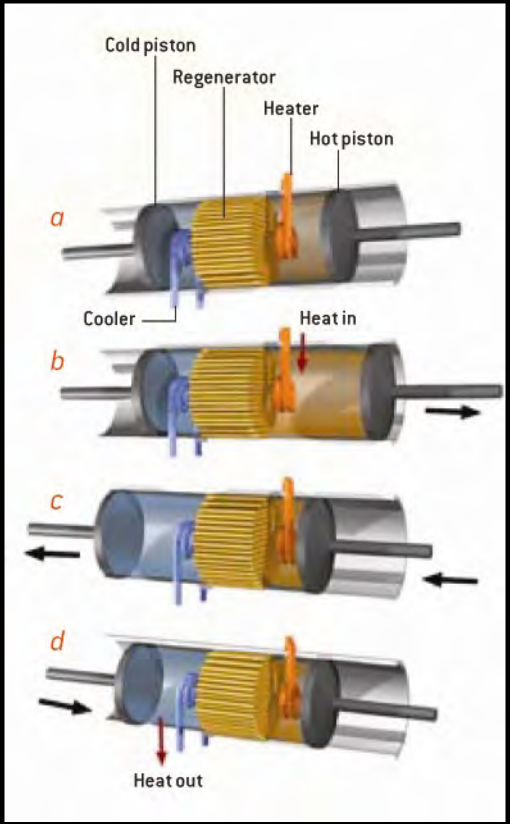
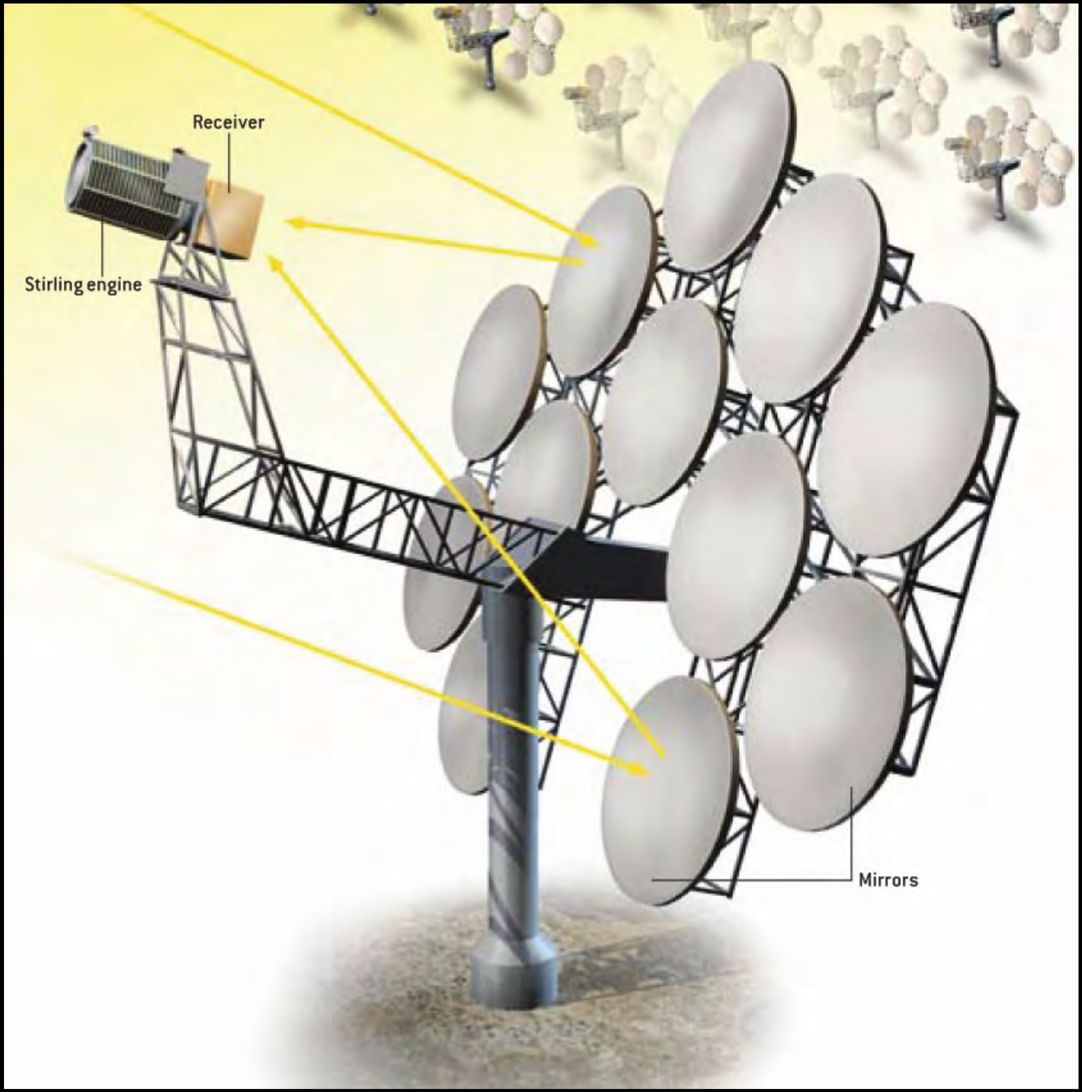
Concentrated Solar Power





Concentrated Solar Power

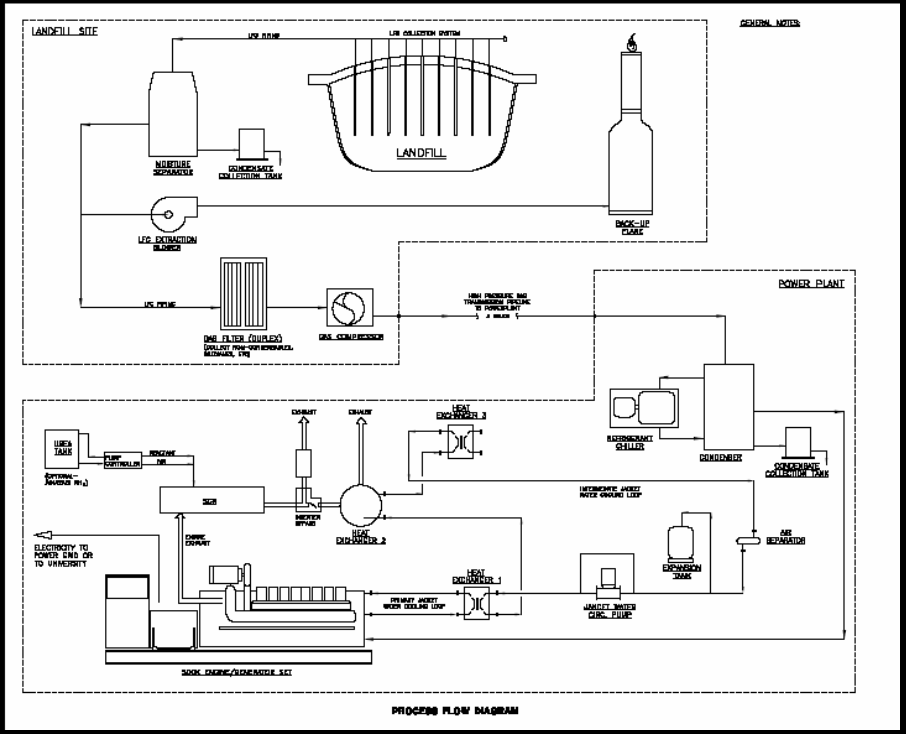
- ~25KW per dish
- ~$0.13 / kWh
- Due to two large scale plants currently being commissioned price per kWh is expected to drop to $0.04 to $0.06
- Major push by the federal government and national laboratory community to advance this technology
- Can incentives be secured for a demonstration/research project?

Concentrated Solar Power

- Distributed hot water production
- Can be integrated architecturally to perform multiple functions
- Used to supplement centralized system?

Land Fill Gas

- Orange County has two fields 2-3 miles from site
- Capacity to produce 0.75 MW of power or 100k to 200k GSF of building space
- Source will diminish over time with peak output by 2010
- Break even in 20 years due to pipeline expense
- Carbon emissions reduction credit since methane is currently vented to atmosphere



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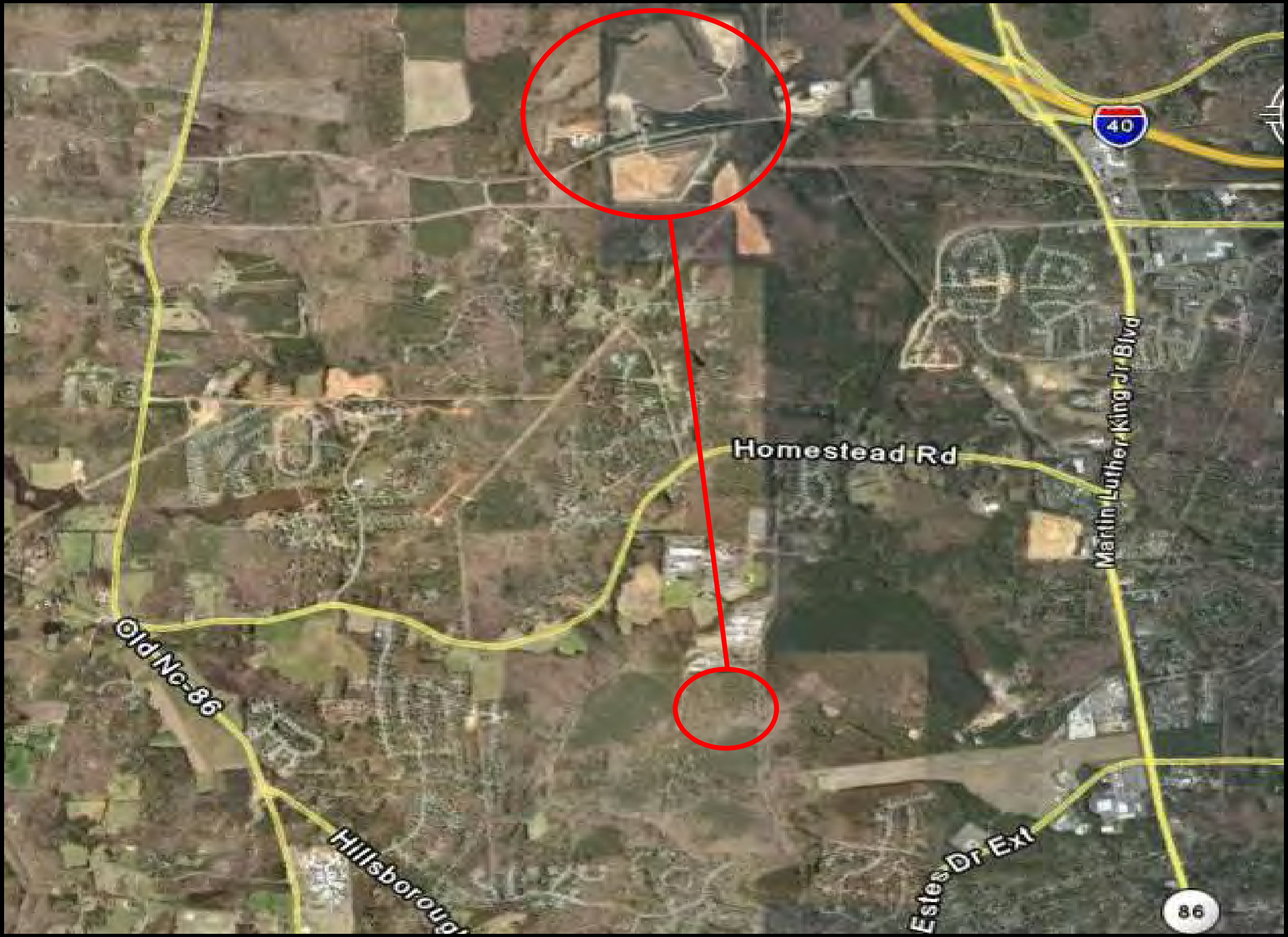
Land Fill Gas



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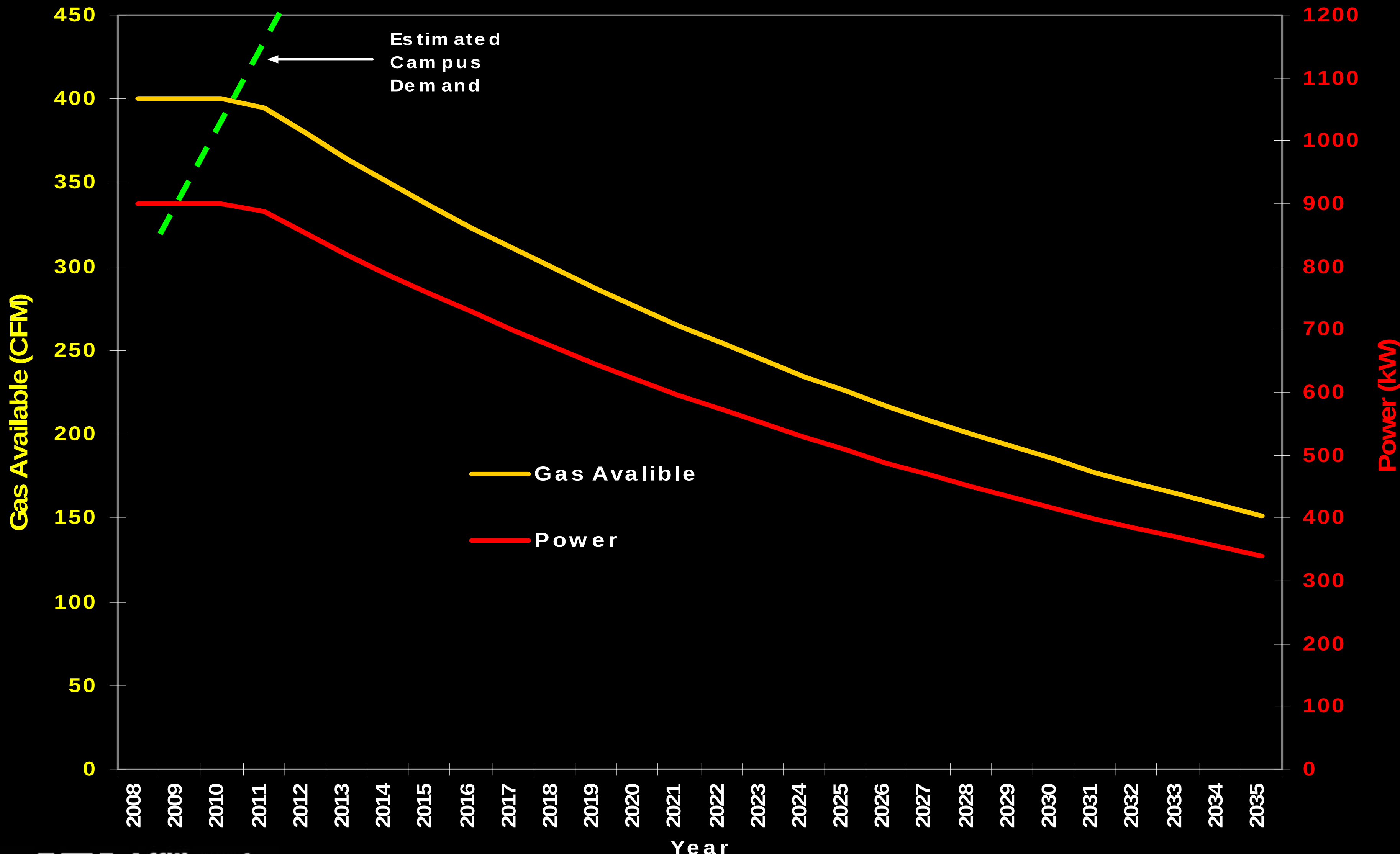
Land Fill Gas



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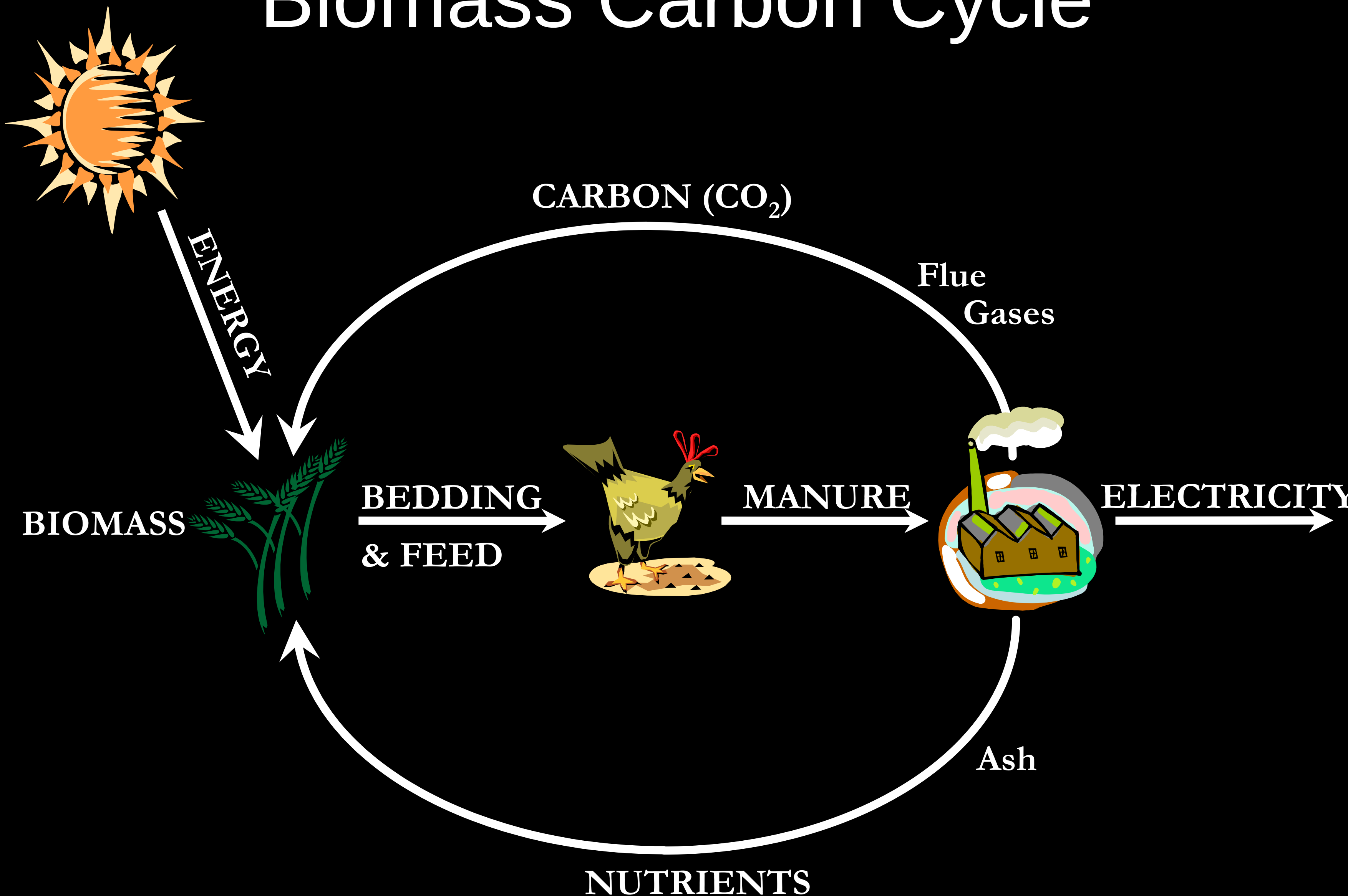
Biomass Carbon Cycle



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Distribution Methods

- Direct Buried
- Accessible Tunnels
- Walkable Tunnels
- Shared Utility / Service Tunnels
- Materials of Construction

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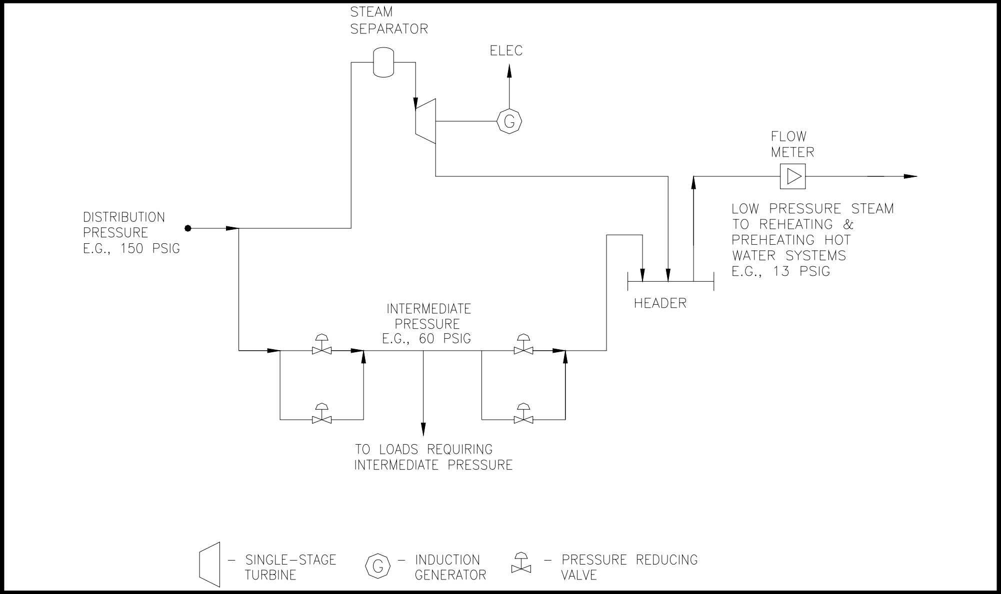
Distribution Medium

- Chilled Water
- Steam
- Hot Water
- High Temperature Hot Water



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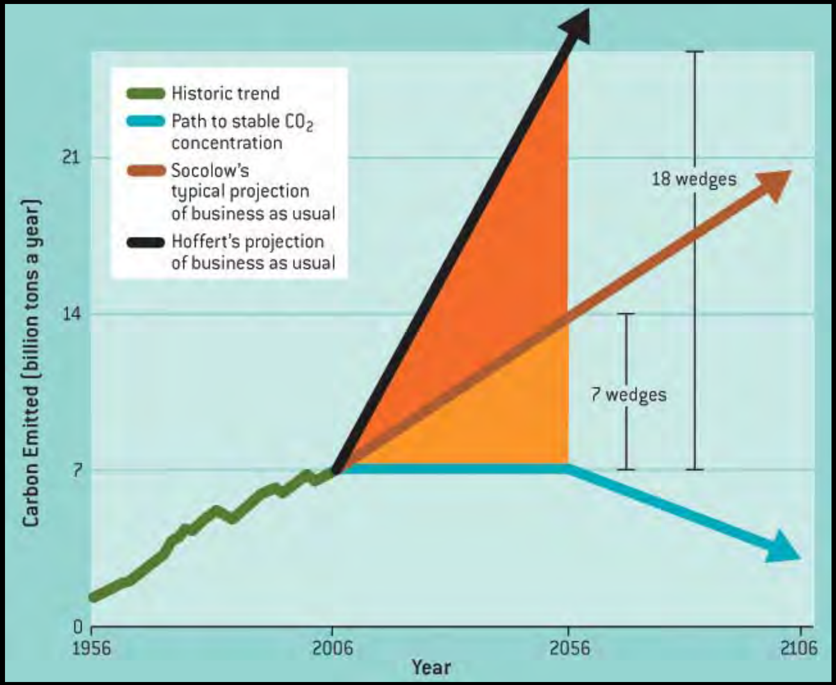
Electrical Power

- Duke Energy
  - "Green" Power Purchase
- Off-Site Generation
- Co-generation On-Site
- Renewable On-Site
- Standby Capacity as Primary Source w/ Grid Backup
- Distribution
  - Central Substation
  - Multiple Substations
  - Voltage
- Carbon Profile



Challenges / Barriers

GENERAL

- New Ideas and Technologies
  - Acceptance
  - Reliability
  - Operation and Maintenance
- Utility Ownership and Maintenance
- Reliability Expectations
- Funding of Production and Distribution Systems
- Single Source for Procurement of New Technologies
- Shared Utility Corridors – Separation / Easements / Access
- Metering and Billing of Shared Utilities

BIOMASS RELATED

- Supply issues
  - Dispersed sources
  - Long-term contracts challenging
  - "Waste" today, "valuable resource" tomorrow
  - Fuel processing & fuel quality
  - Reliability
- Fuel handling and transportation
- Space for fuel processing & storage

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Potential Goals

- CRED / Emissions
- Solar
- Other Renewable or Carbon Offset
- Central vs. Local
- Synergistic Energy Distribution
- Combined Heat and Power
- Reliability / Redundancy
- Flexibility and Adaptability
- Net Energy Metering with Local Display
- Utility Distribution – Shared, Accessible Corridors
- Education