Cornell University
Facilities Services

EPA Clean DG Policy and CHP Webinar Series

The Role of CHP in a District Energy Setting

Sustainable Energy at Cornell

Aiming toward a Climate Neutral Future

W.S.(Lanny) Joyce, PE, CEM
Director, Energy Management
Cornell Energy and Sustainability

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Facilities Services

Agenda

- Cornell energy overview – fast!
- Sustainable supply side energy projects
- CCHPP at Cornell
- Climate Action Planning
- What might be in our future for climate neutrality?

Ithaca Campus Utilities

- 115 kV electric substation
- Central heating with cogeneration of electricity
- Central cooling (chilled water) with LSC
- Water Filter Plant
- Hydroelectric Plant
- Fully metered

Large utility user due to research mission
$~65 million per year total cost

Existing Utility Infrastructure Loads			
Utility	Average	Peak	Units
Electric	28	35	MW
CHP	125	375	klbs/hr
CWP	4,500	20,000	tons

Annual energy purchases nearly flat since 1990 due to conservation

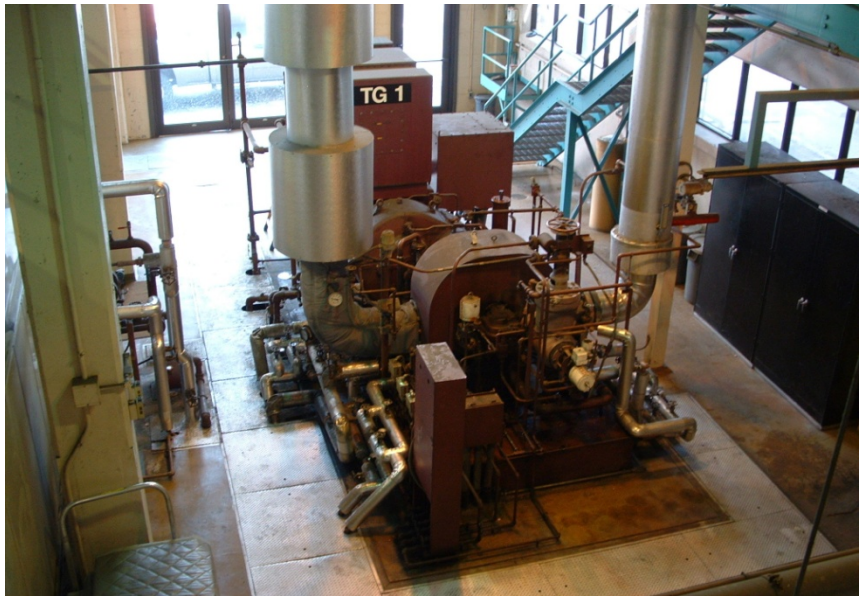
Sustainable Supply Side Energy at Cornell

- Cogeneration
- Hydroelectric plant
- Lake Source Cooling

- Combined Heat and Power

Co-generation

- 30 million kW-hr/year or 12 % of campus
- Built in 1986, 8000 kW total
- Two back pressure steam turbines

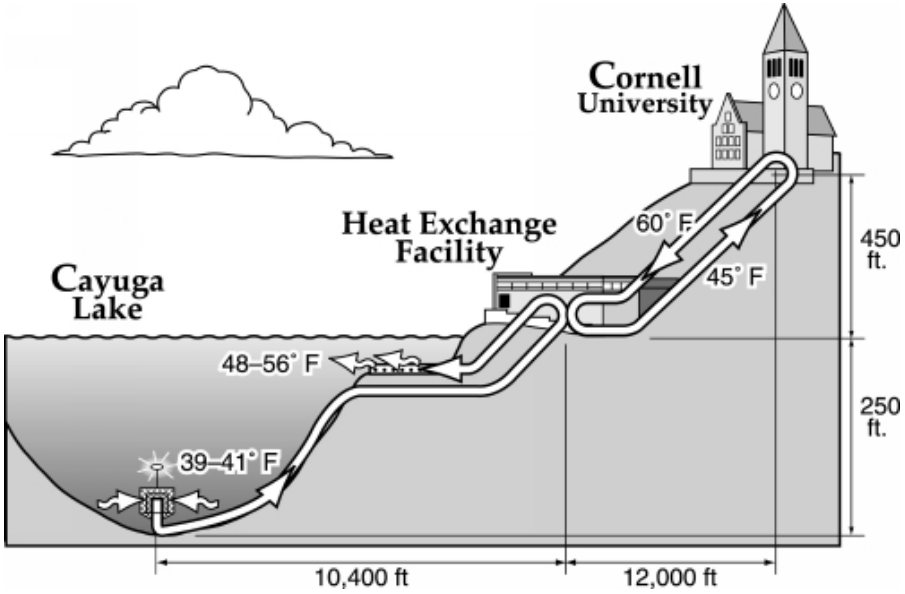


Hydroelectric Plant

- 5 million kW-hr/yr or 2 % of campus
- Rebuilt 1981
- Controls upgrade in 2008 increased annual production by 20%

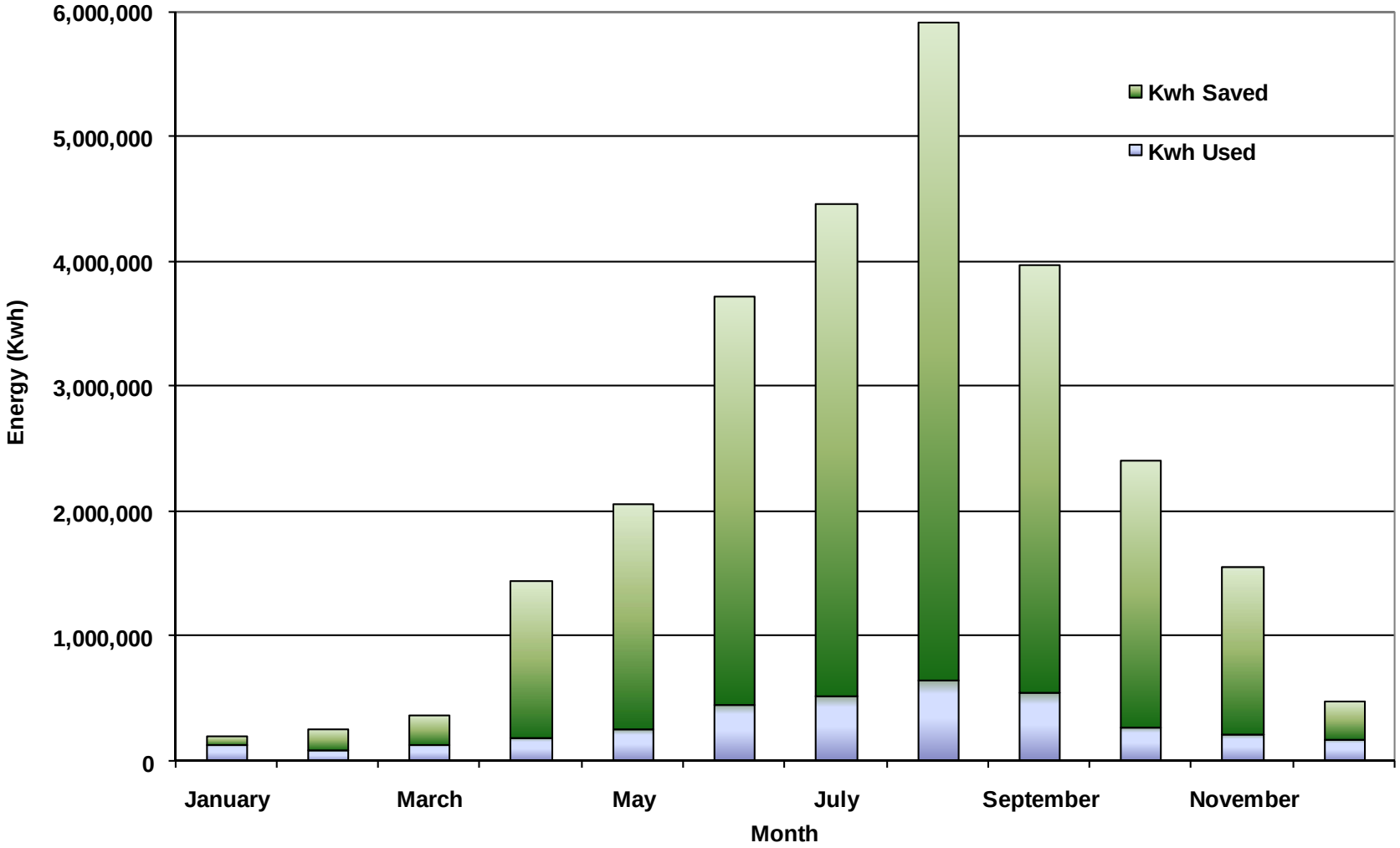
Lake Source Cooling (LSC)

- Started service 2000
- Annual production at 0.1 kw/ton (**86%** savings)
- Truly "renewable" cooling



- Full automation (un-peopled)
- Saves over 25 million kwh/yr
- District cooling system is CFC free

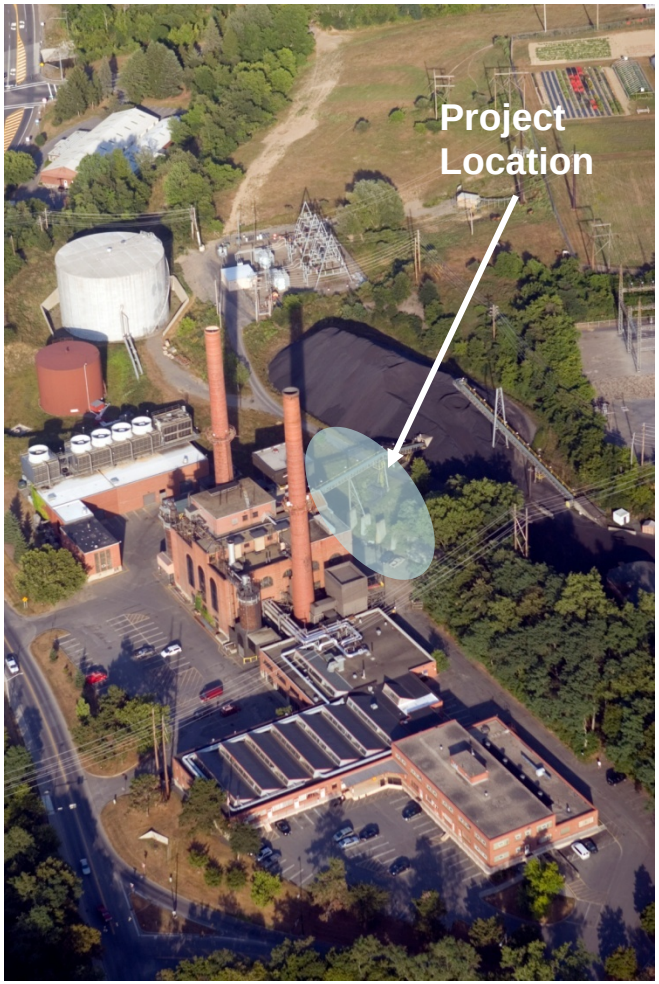
Lake Source Cooling Energy Savings



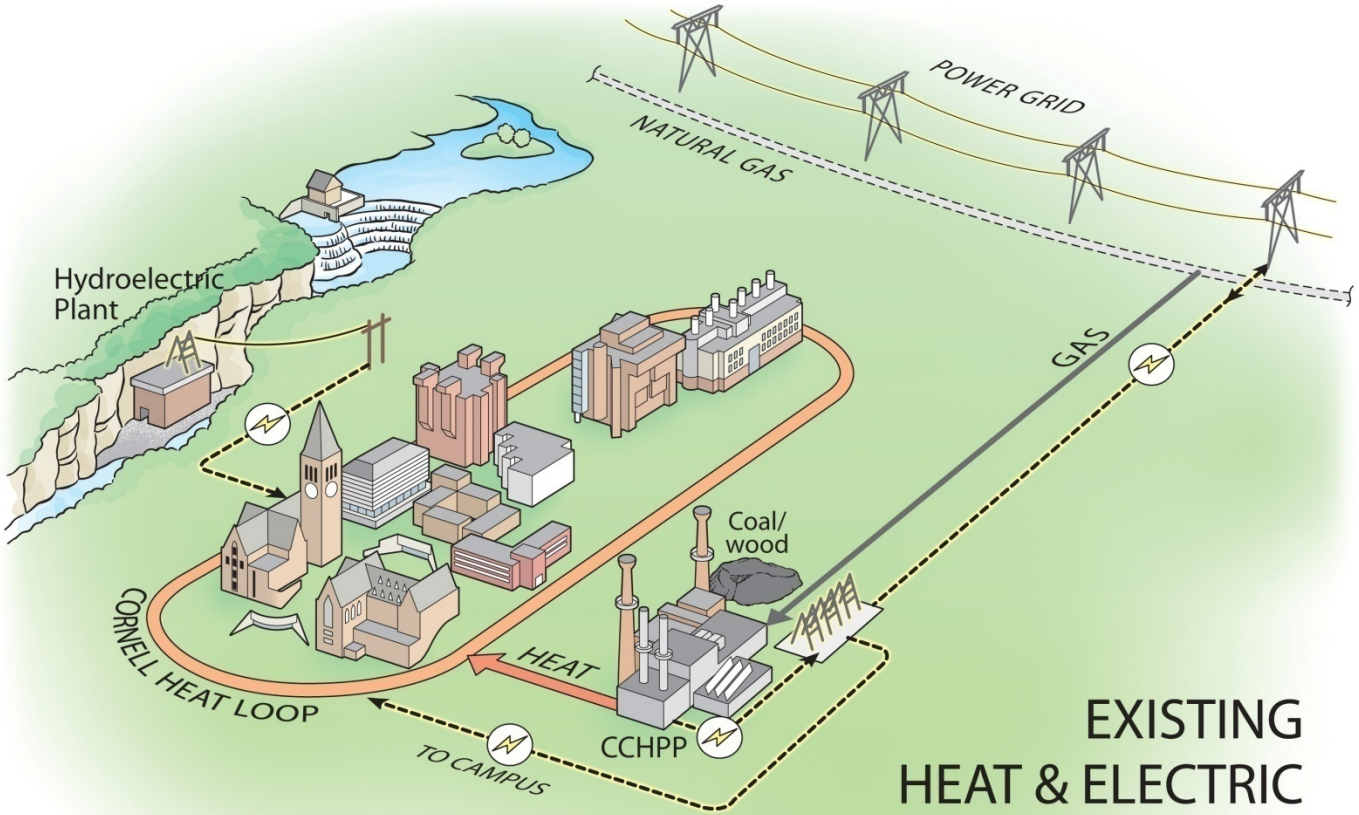
Positioning the 63″ OD Intake

Heat Exchangers and Chilled Water Pumps

Combined Heat & Power Project



- Project Scope
  - Two (2) combustion turbines (15,000 kW x 2)
    - Produce ~ 70% of kWh
  - Heat Recovery Steam Generators (HRSG)
    - Produce ~ 50% of steam unfired, up to 90% fired
  - Substation renewal
- Project cost ~ $82 Million
  - Bldg addition at heating plant

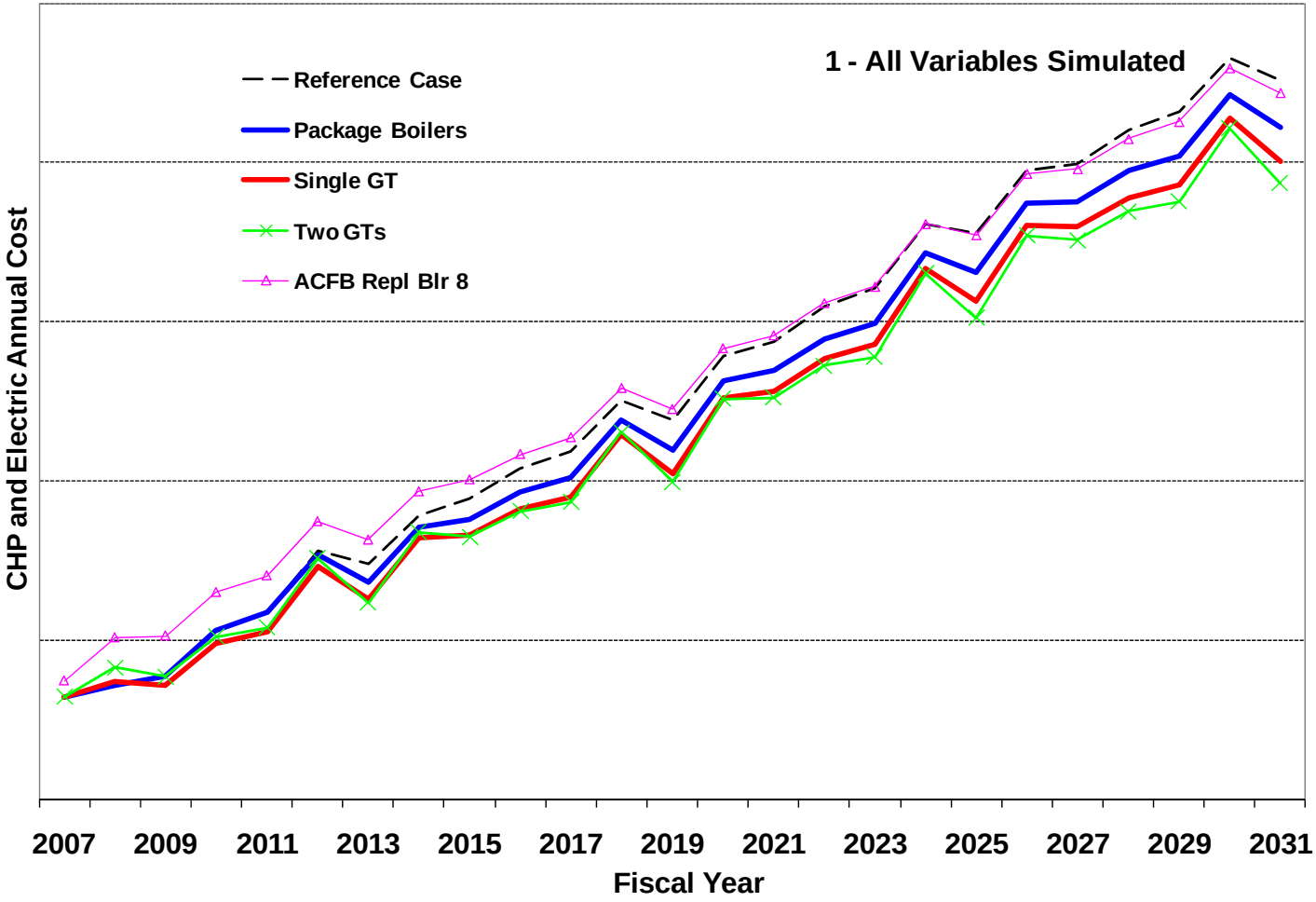


EXISTING HEAT & ELECTRIC GENERATION SYSTEMS

Analysis and decision on CCHPP

- Energy and economic analysis over 25 years
- Options studied included peaking boilers (base case), ACFB coal, biofuel, combustion turbine/HRSG
- CT/HRSG won due to lowest life cycle cost, fuel flexibility, reliability, emission reduction
- Next to highest capital cost
- Combined with substation upgrade

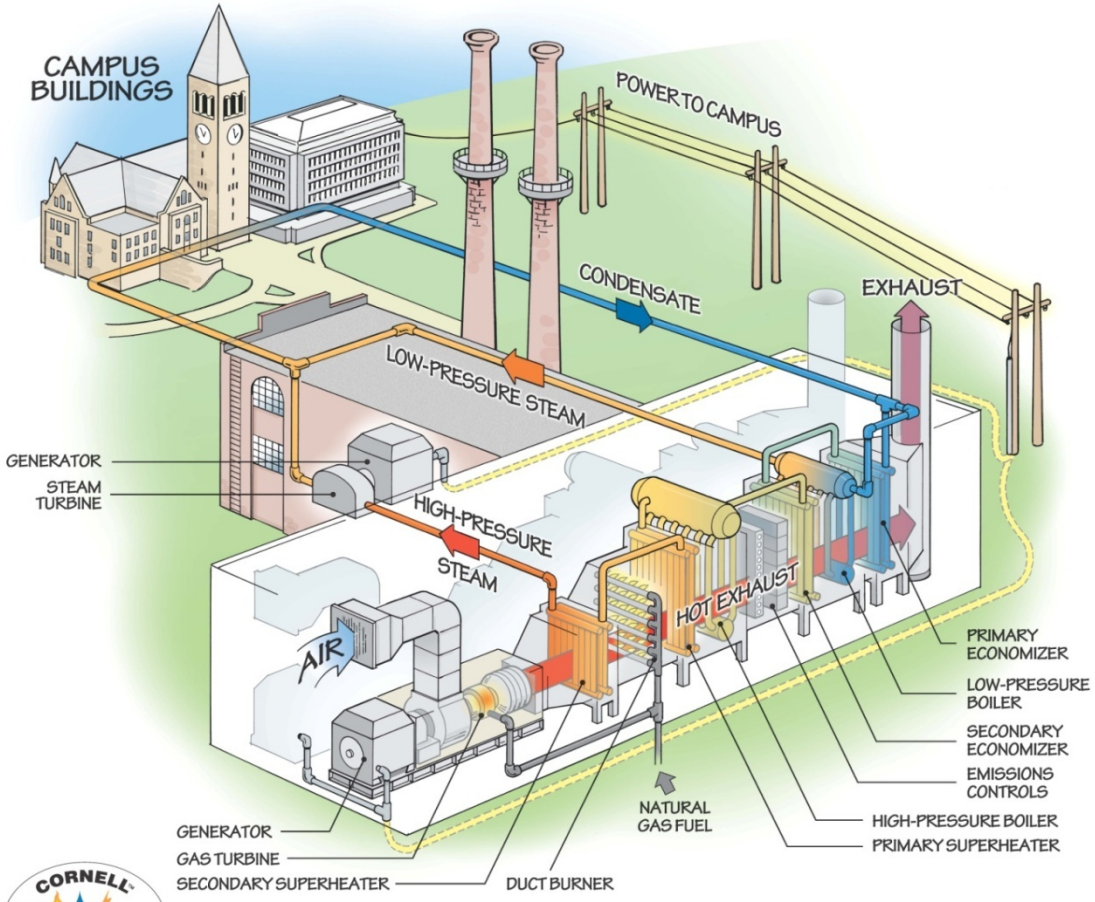
Annual Cost Comparison



Project Development and Delivery

- Owner financed, local IDA bonding
- Owner developed and managed construction
- CT/HRSG and all major equipment pre purchased and assigned to contractor
- Four major construction contracts
- One engineer, one permitting consultant
- Owner commissioning, training, operation

Combined Heat & Power Project



Combustion Turbine with Heat Recovery Steam Generator

Project benefits:

- Highly efficient (70%+)
- Electrical reliability
  - "Islanded" operation
- Emissions reductions
  - CO2 70,000 tons/yr (25+% of "total")
  - NOx 250 tons/yr
  - SO2 800 tons/yr
- Fuel flexibility and lowest life cycle cost

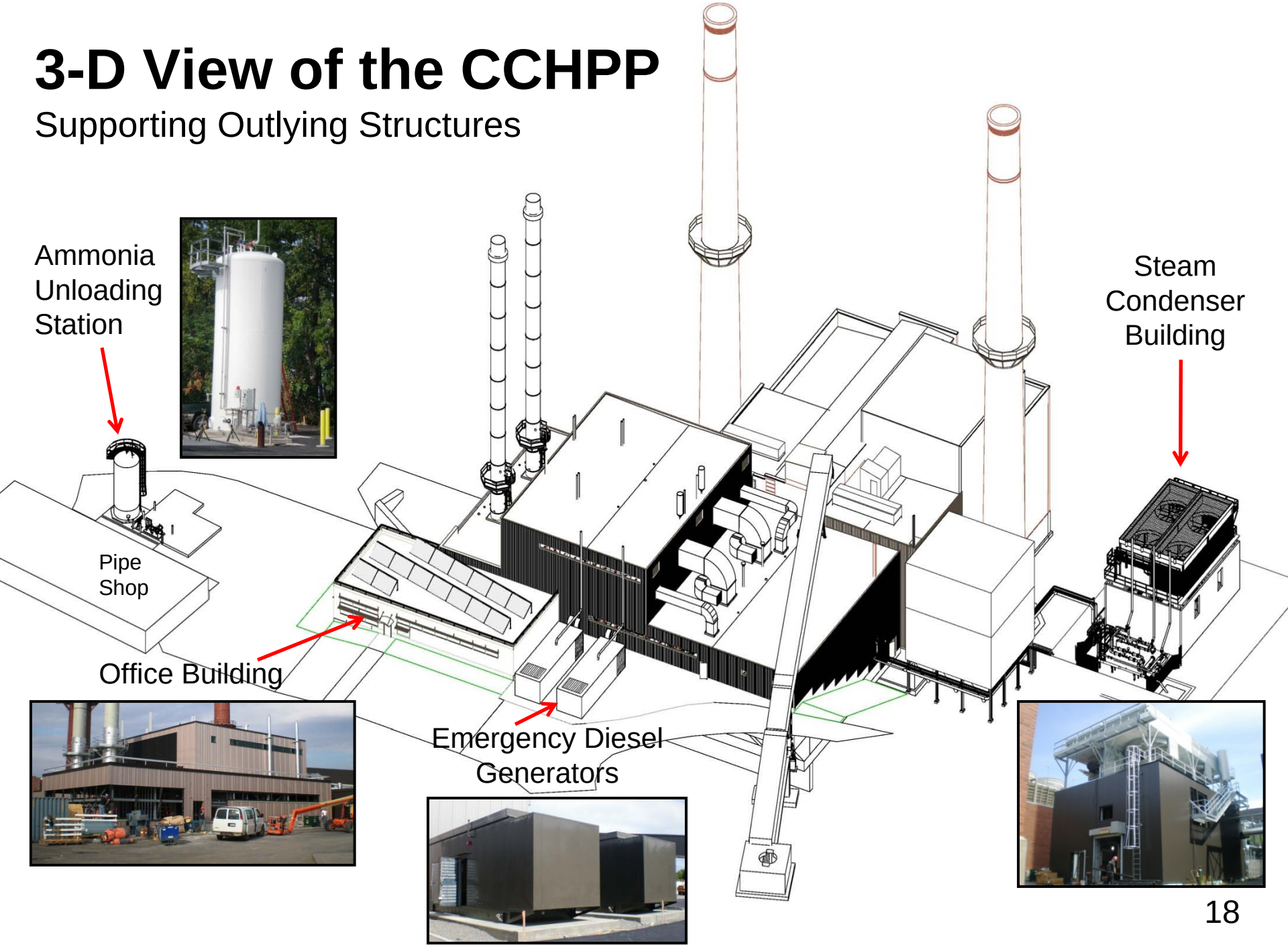
In service Dec 2009

Dedicated gas line

- 3.2 miles, 8" diameter, 600 lbs, Class 4 designation
- Interconnection with Dominion Transmission Inc.
- Certificate of Environmental Compatibility & Public Need
  - NYS Public Service Law, Title 16 (Article VII)
- 15,000 Dtherms/day firm (15 year special rate)
- 24,000 Dtherms/day capacity

3-D View of the CCHPP

Supporting Outlying Structures



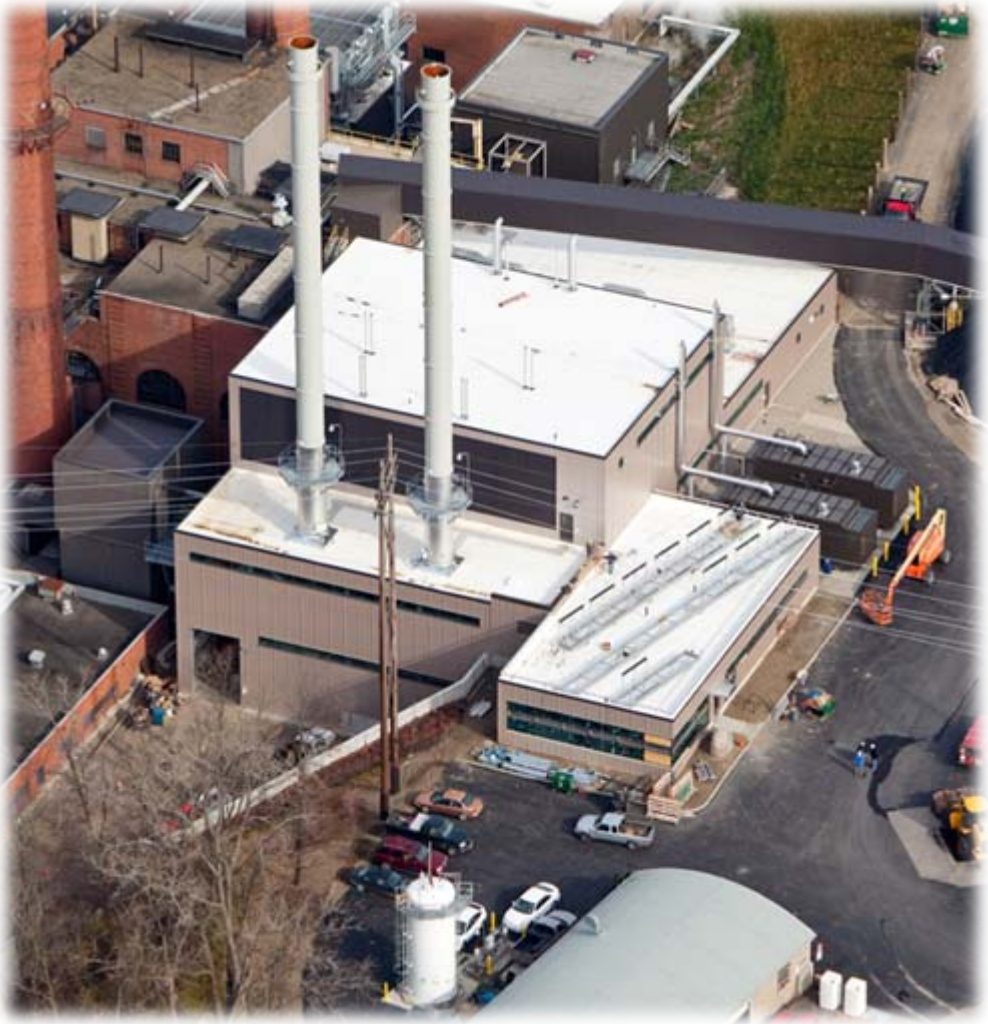
Equipment Setting

10/08

Inside the New Plant

12/09

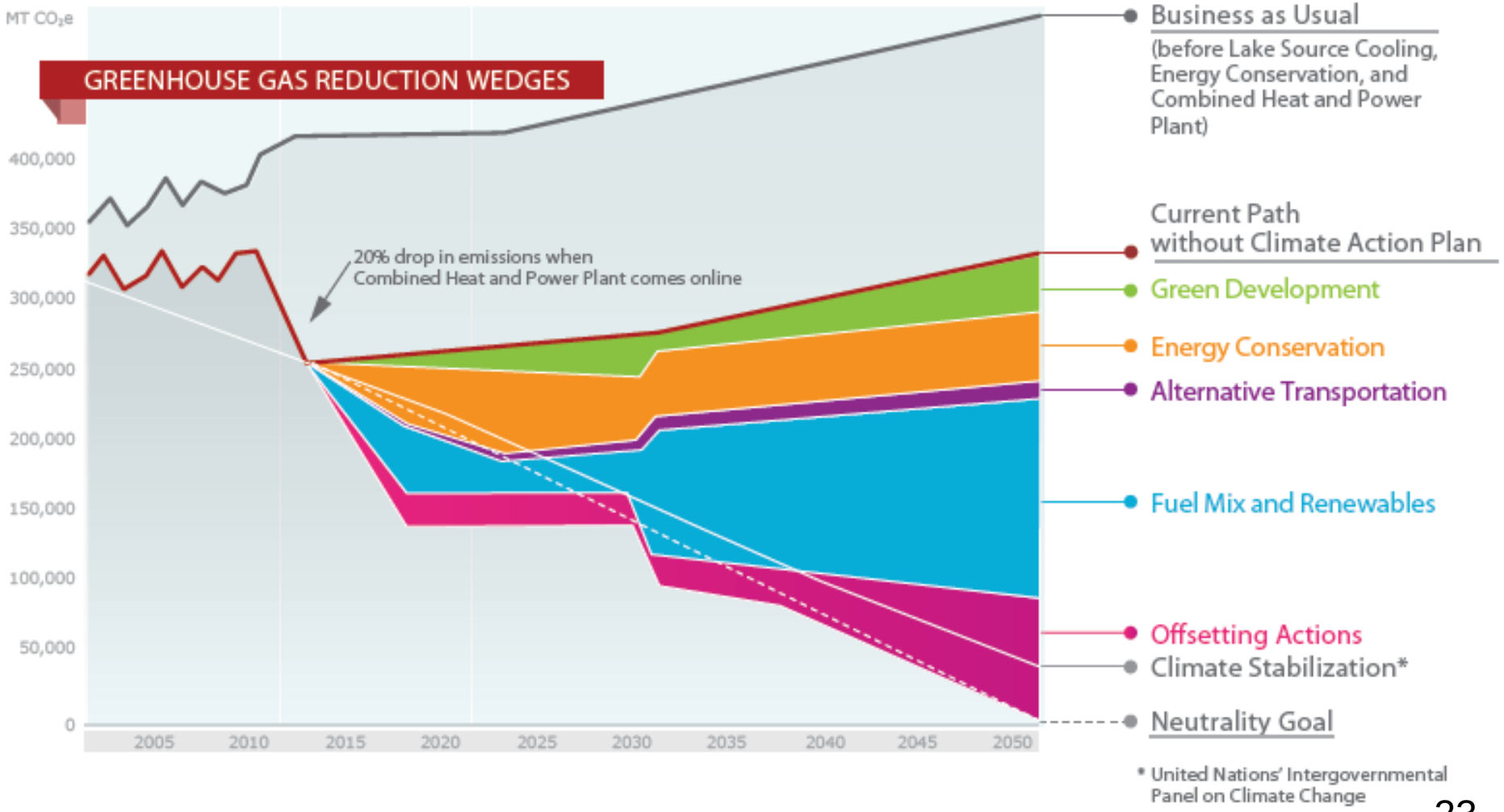
Outside New Plant



Permitting and Approval Challenges

- University, including debt financing
- Dedicated gas line from interstate pipeline
  - Connection and transportation (FERC)
  - Pipeline (NYS PSC)
- NYS/EPA air permits and approvals
- Local municipality approvals (town and city)
- Electric interconnection
- Local utility power purchase agreement

Attaining Carbon Neutrality – The CAP



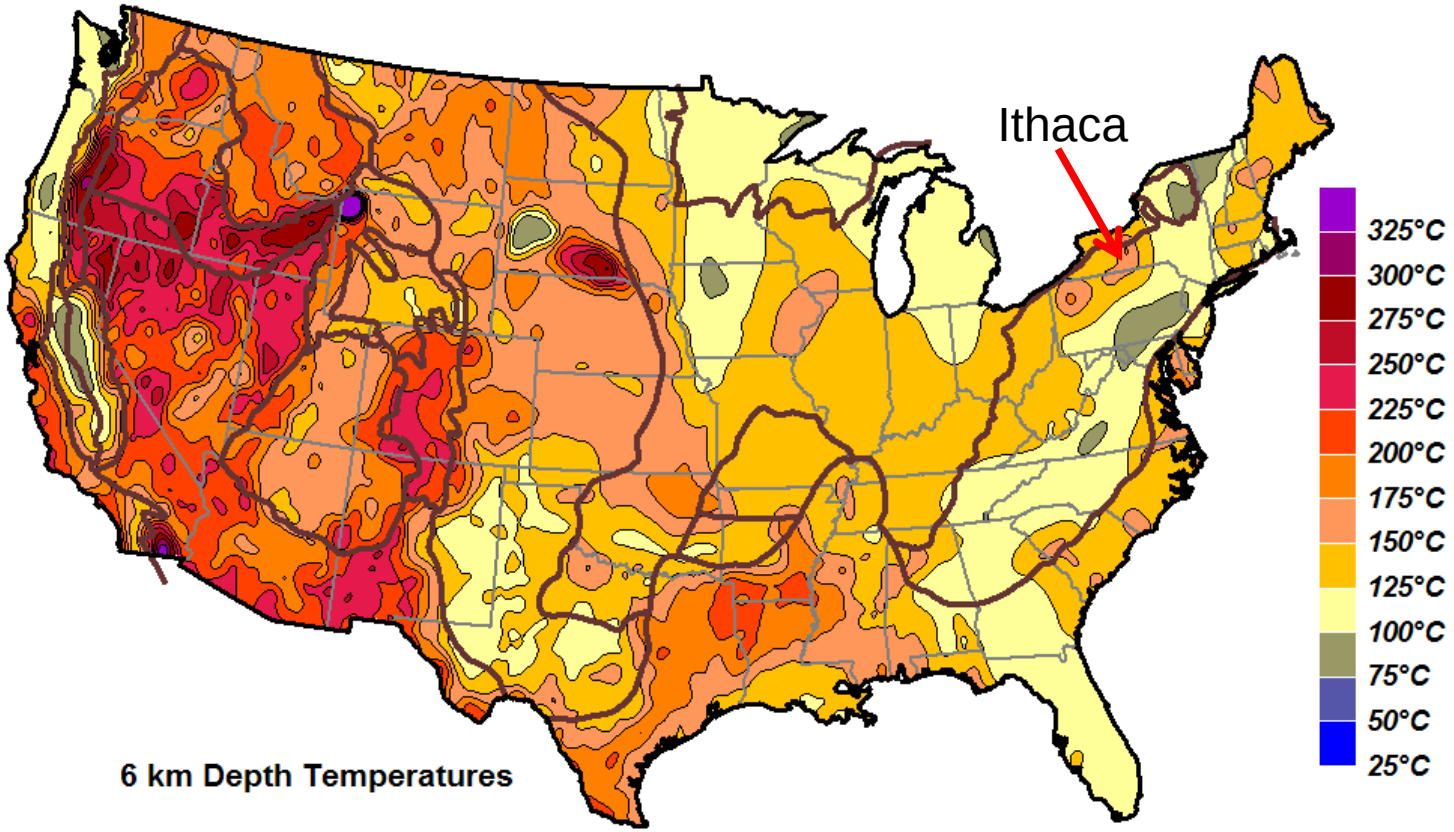
What might be in our future?

- The CU Climate Action Plan proposes a mix of "engineered geothermal" or EGS, and peaking gasified biofuel for heating with grid purchased electricity by 2030-2040
- Grid purchased electricity in NYS is 60% less than coal now and is headed much lower due to RPS, RGGI, fuel prices, and pending national carbon legislation

What is EGS?

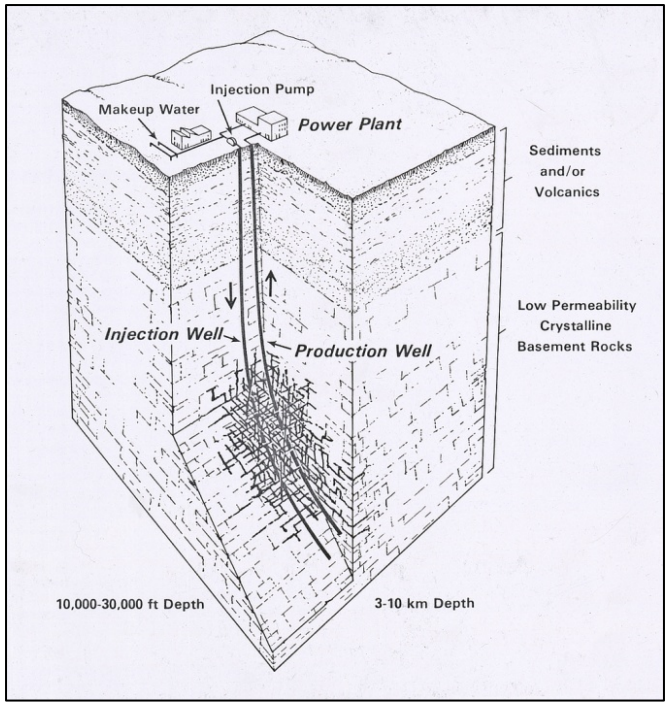
- Utilization of “low” grade real geothermal heat
- Drill well into the “basement” rock
- “Stimulate” the rock
- Drill a second well into the fractured zone
- Circulate water from the surface, through the rock, and back to a surface HX/Power facility

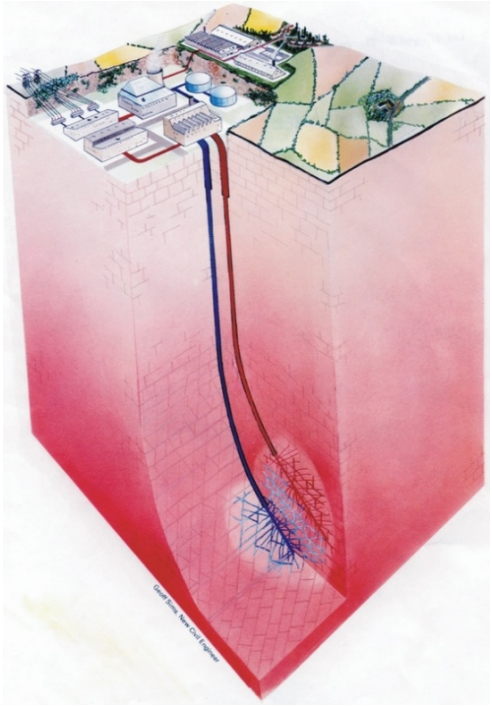
With EGS working at depths to 6 km all of the US becomes a viable geothermal resource



From Blackwell and Richards (June, 2007)

A pathway to sustainable energy from geothermal

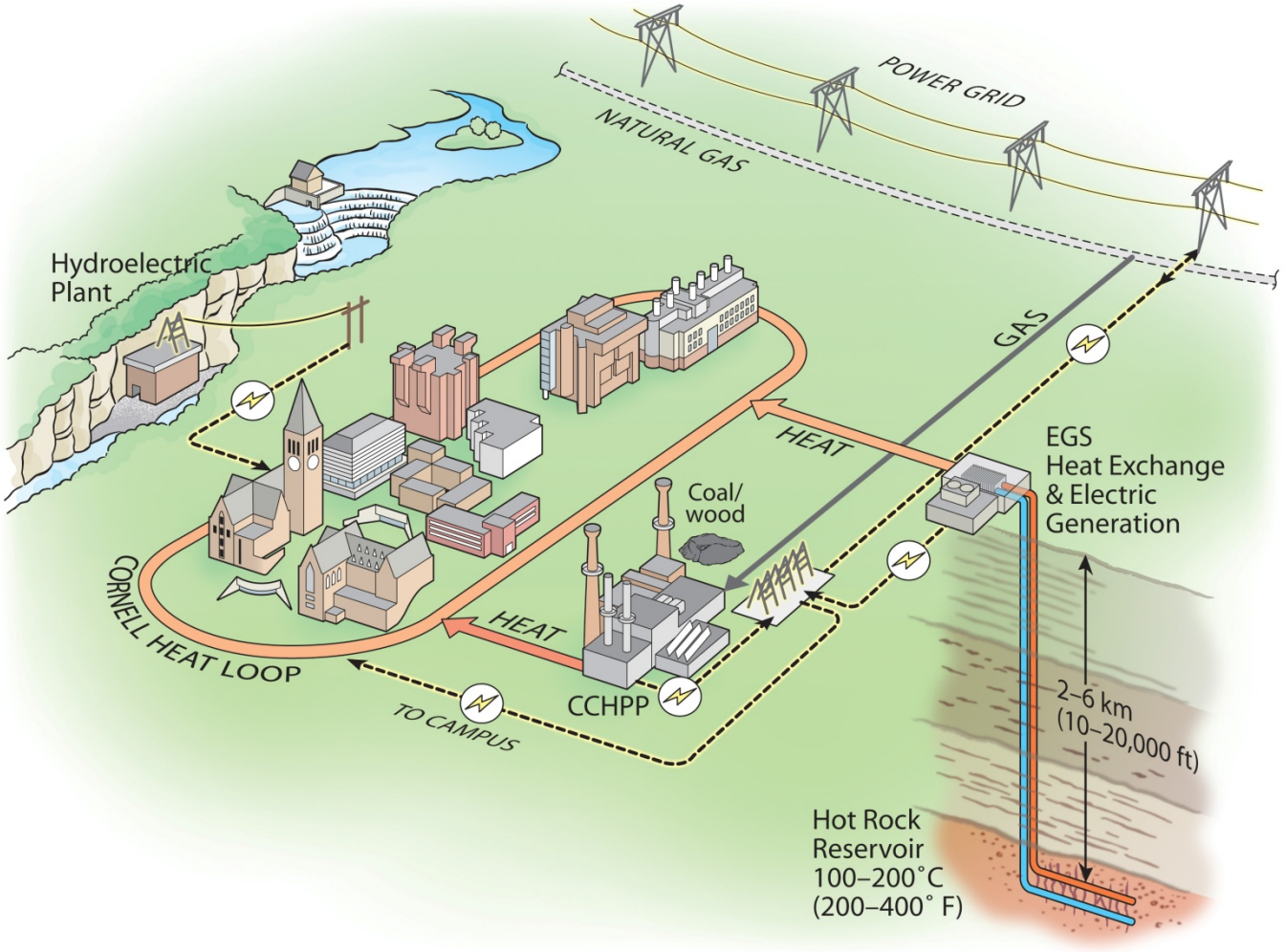




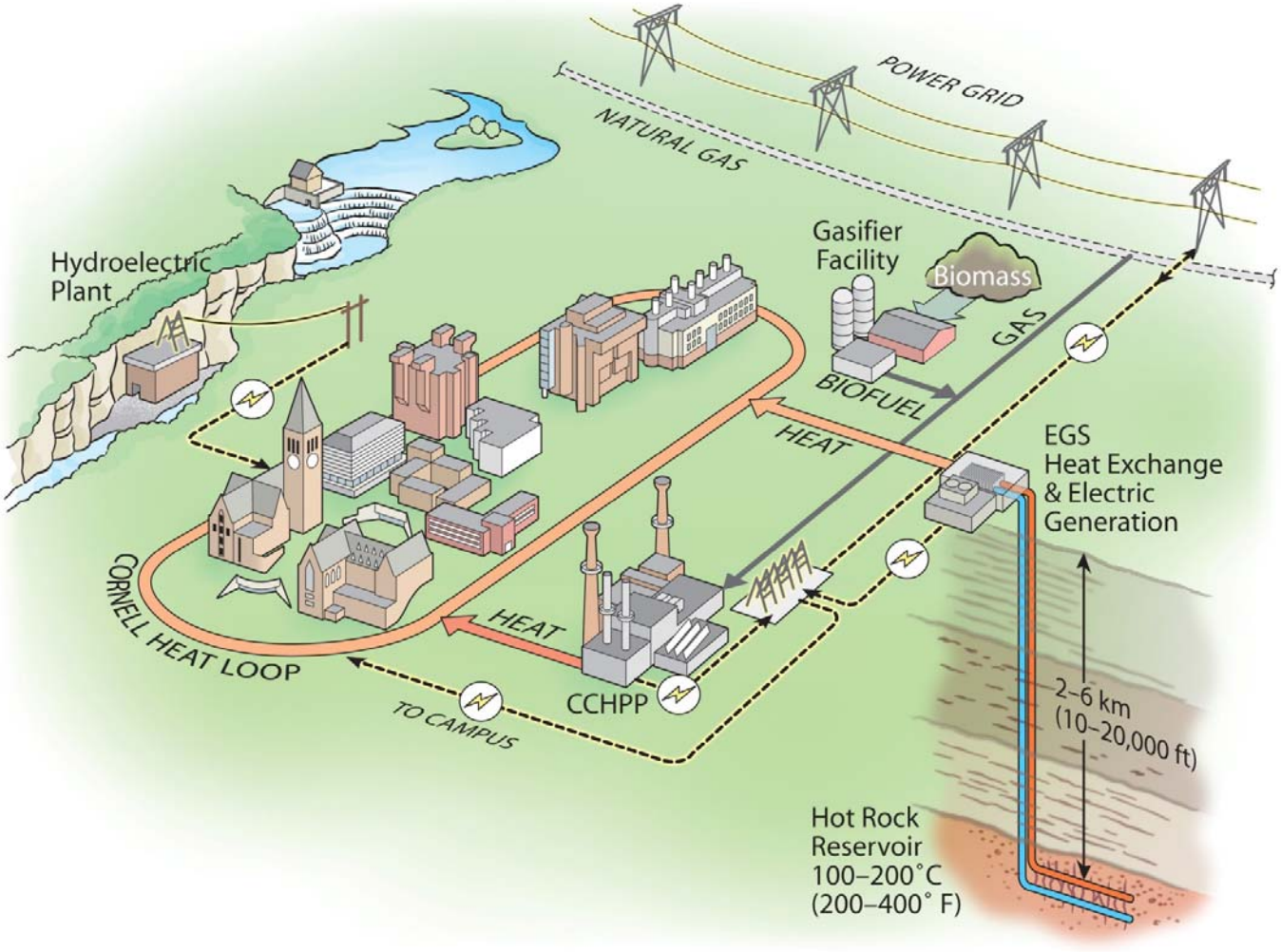
Enhanced/Engineered Geothermal Systems (EGS)

EGS defined broadly as engineered reservoirs that have been stimulated to emulate the production properties of high grade commercial hydrothermal resources.

Cornell Energy with EGS



Cornell Energy with EGS and Peaking Biofuel



Questions ?

Cornell Contacts:

W.S. (Lanny) Joyce, PE
Director, Energy Management
LSC Project Manager
wsj1@cornell.edu
607-255-6631

Tim Peer, PE
Energy Plant Manager
CCHPP Project Manager
tsp1@cornell.edu
607-255-9968

Jim Adams
Director, Utilities
jra4@cornell.edu
607-255-6648

Day Hall Solar PV
15 kW peak output
December 2006