Advance Planning for Electric Reliability In Princeton University Campus Microgrid

Energy Planning for Resilient Communities – Best Practices

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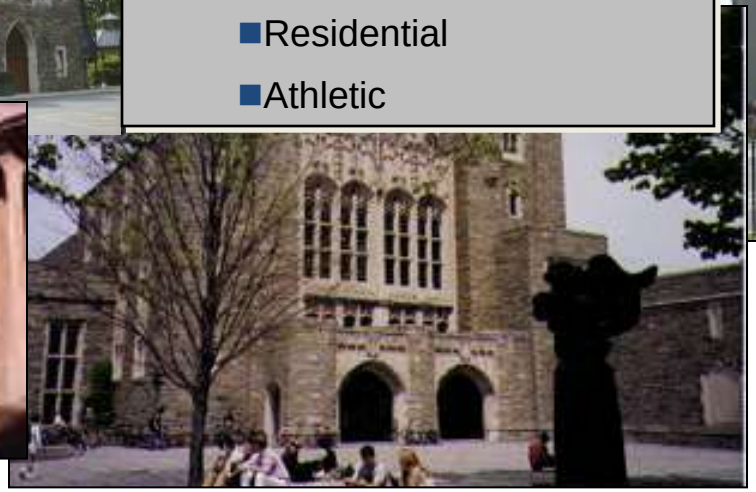
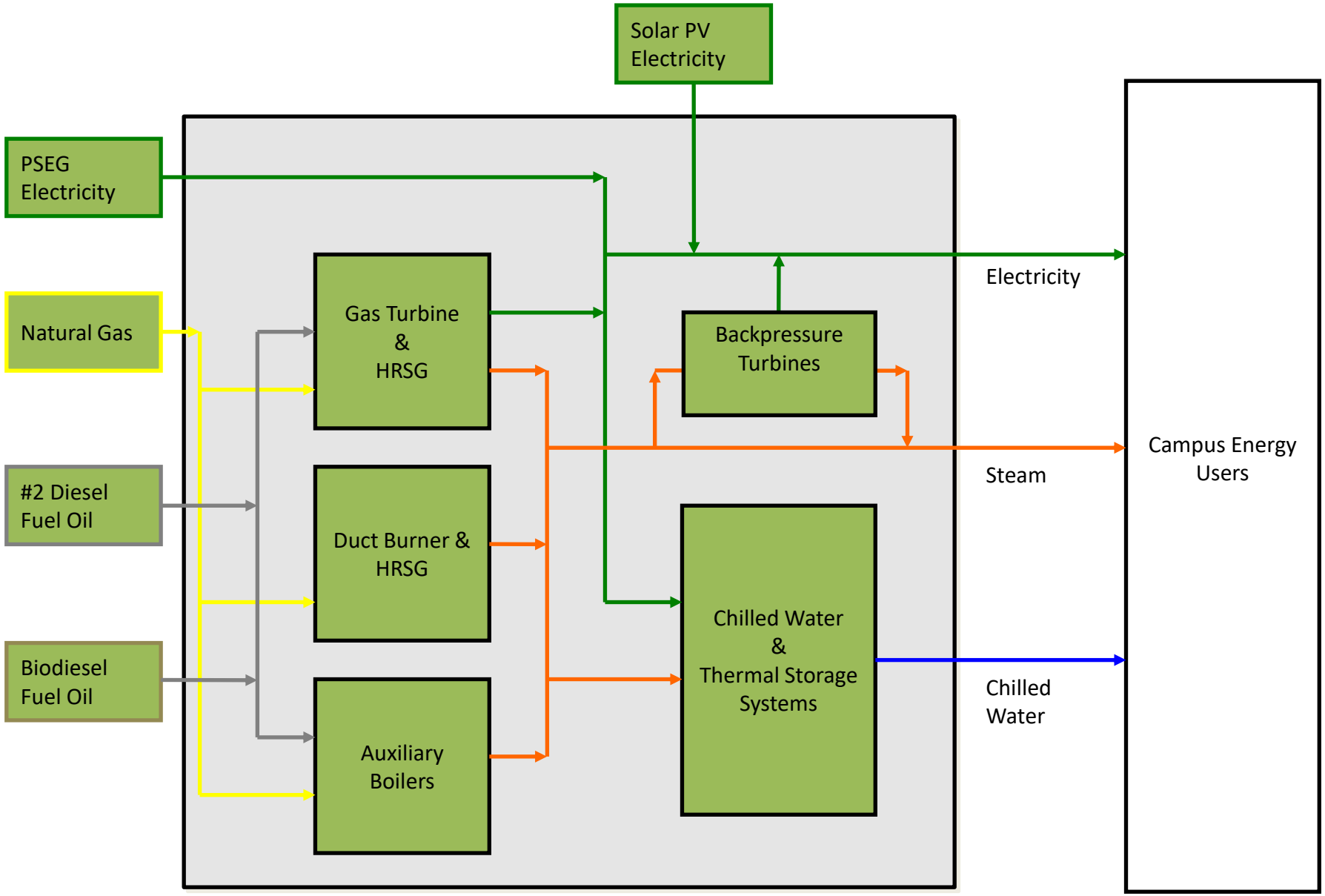
Energy Demands at Princeton

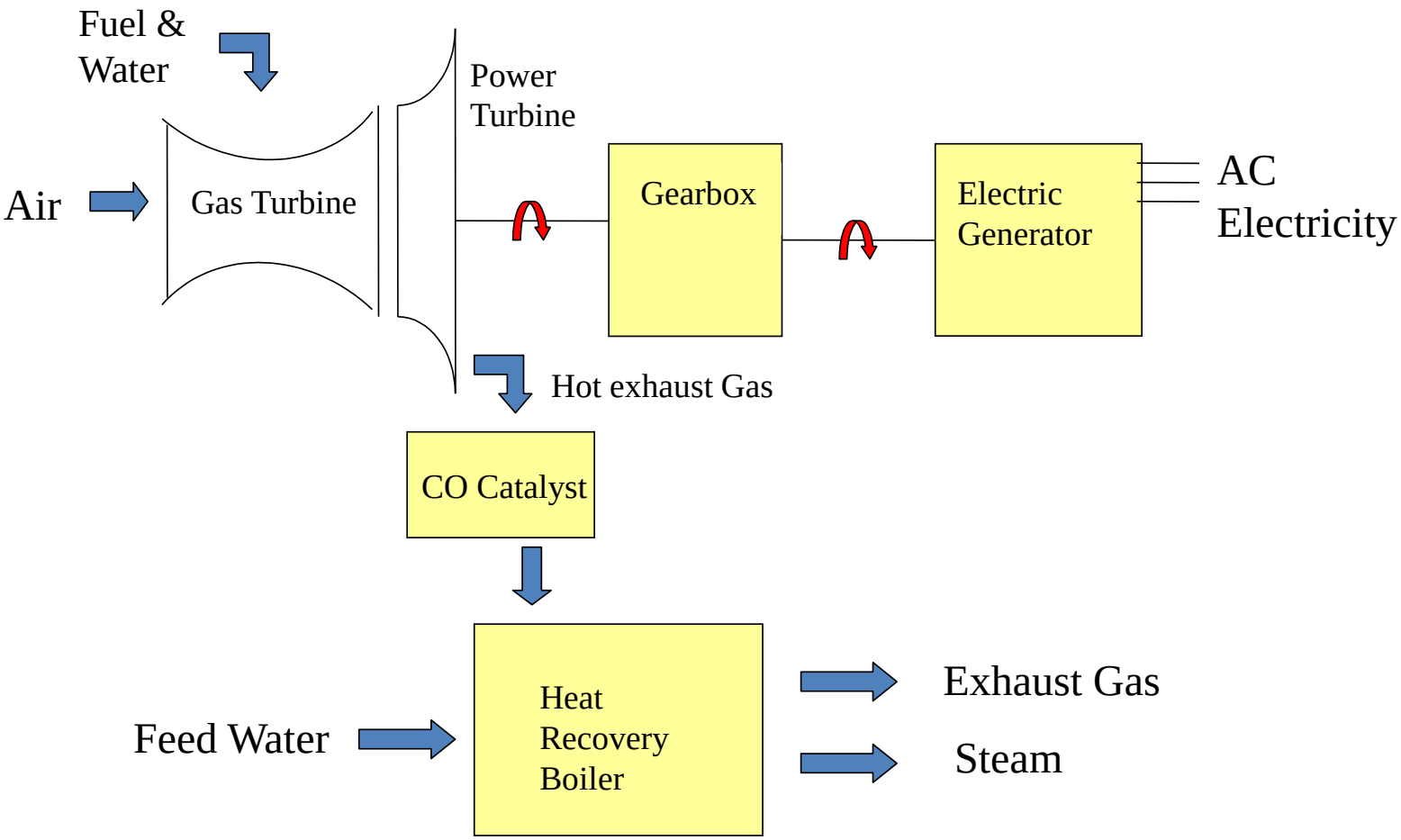
- ~ 180 Buildings
  - Academic
  - Research
  - Administrative
  - Residential
  - Athletic



Plant Energy Flows

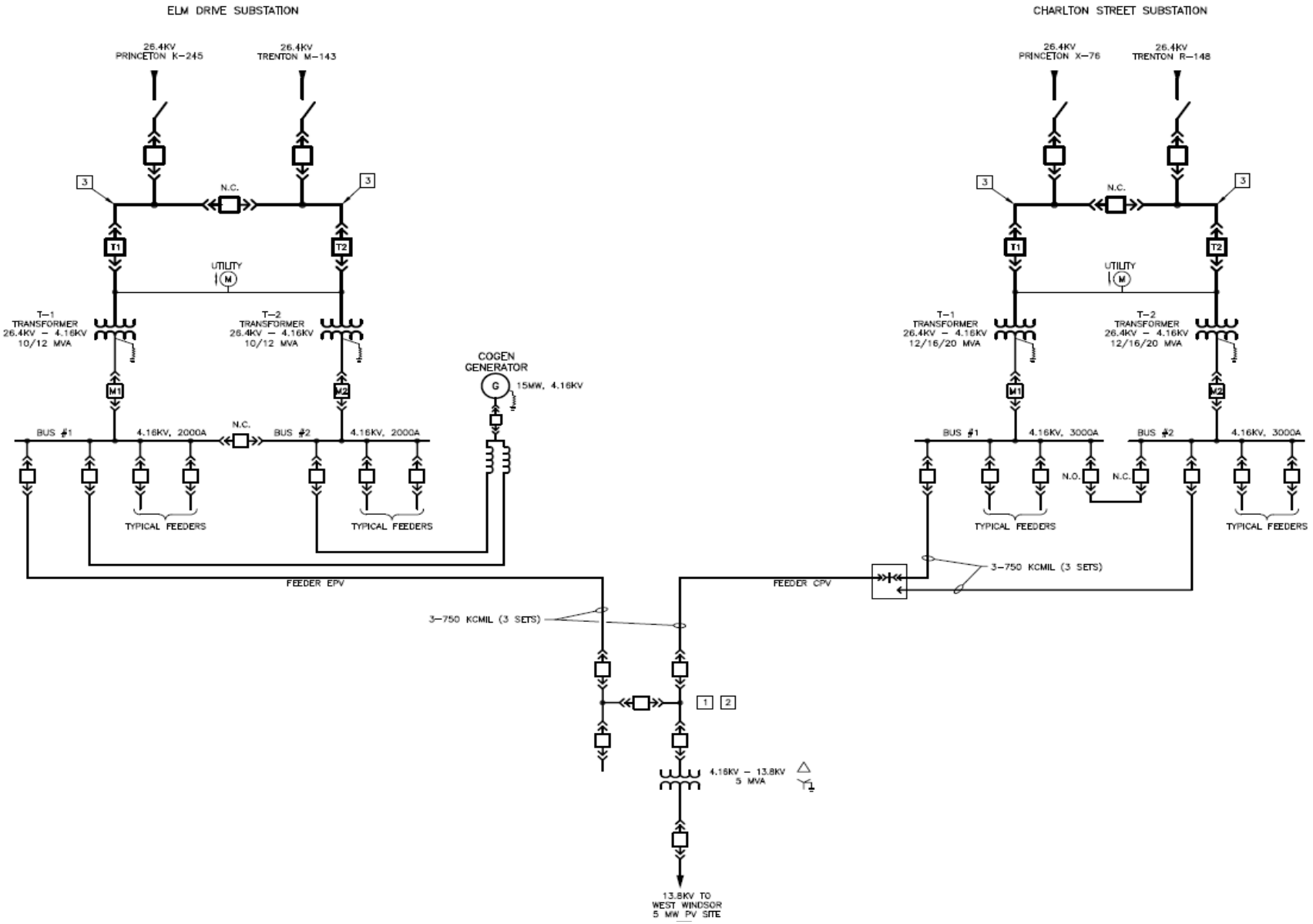


Combined Cycle “Cogeneration”

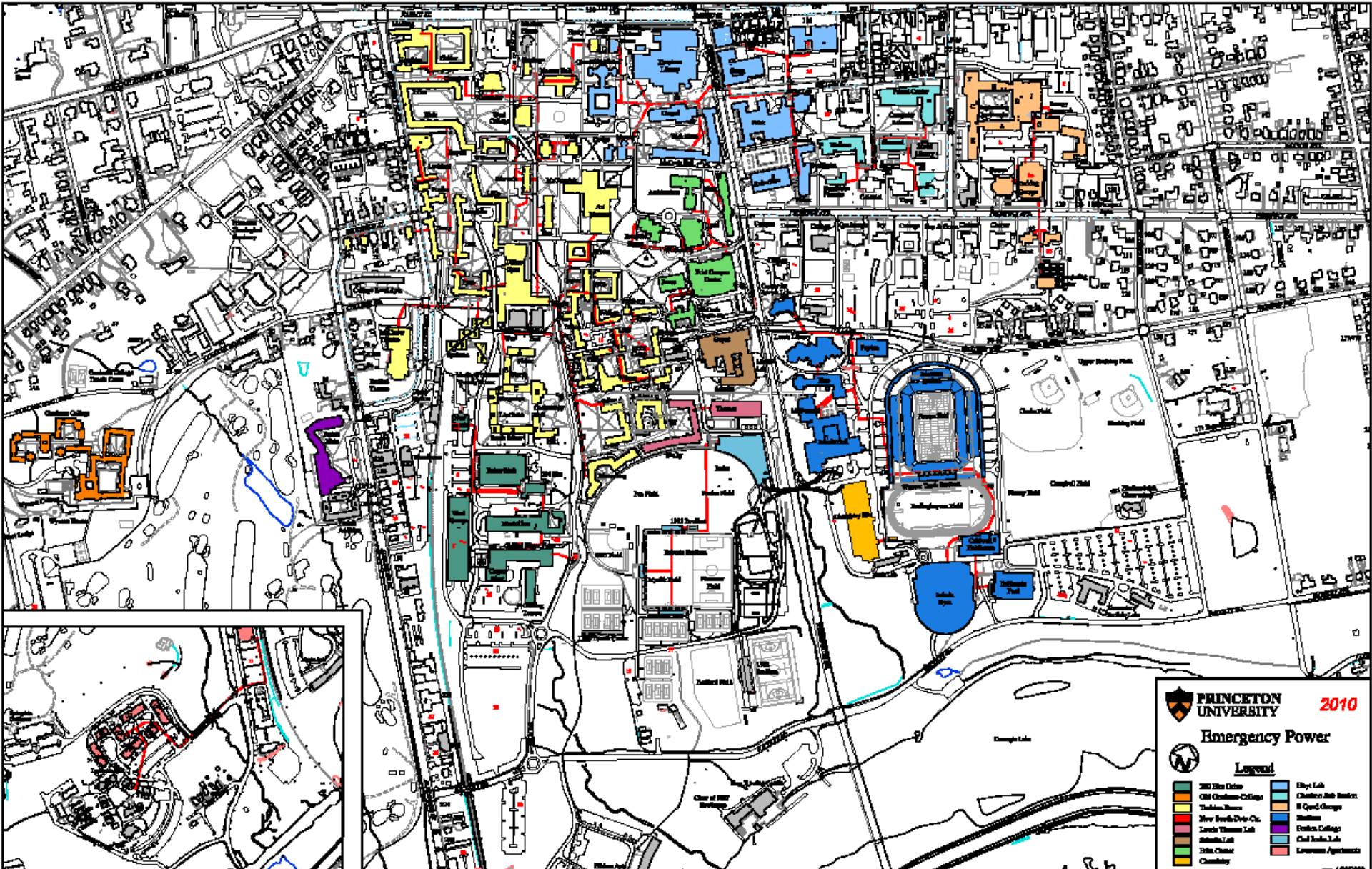


Campus District Energy Systems

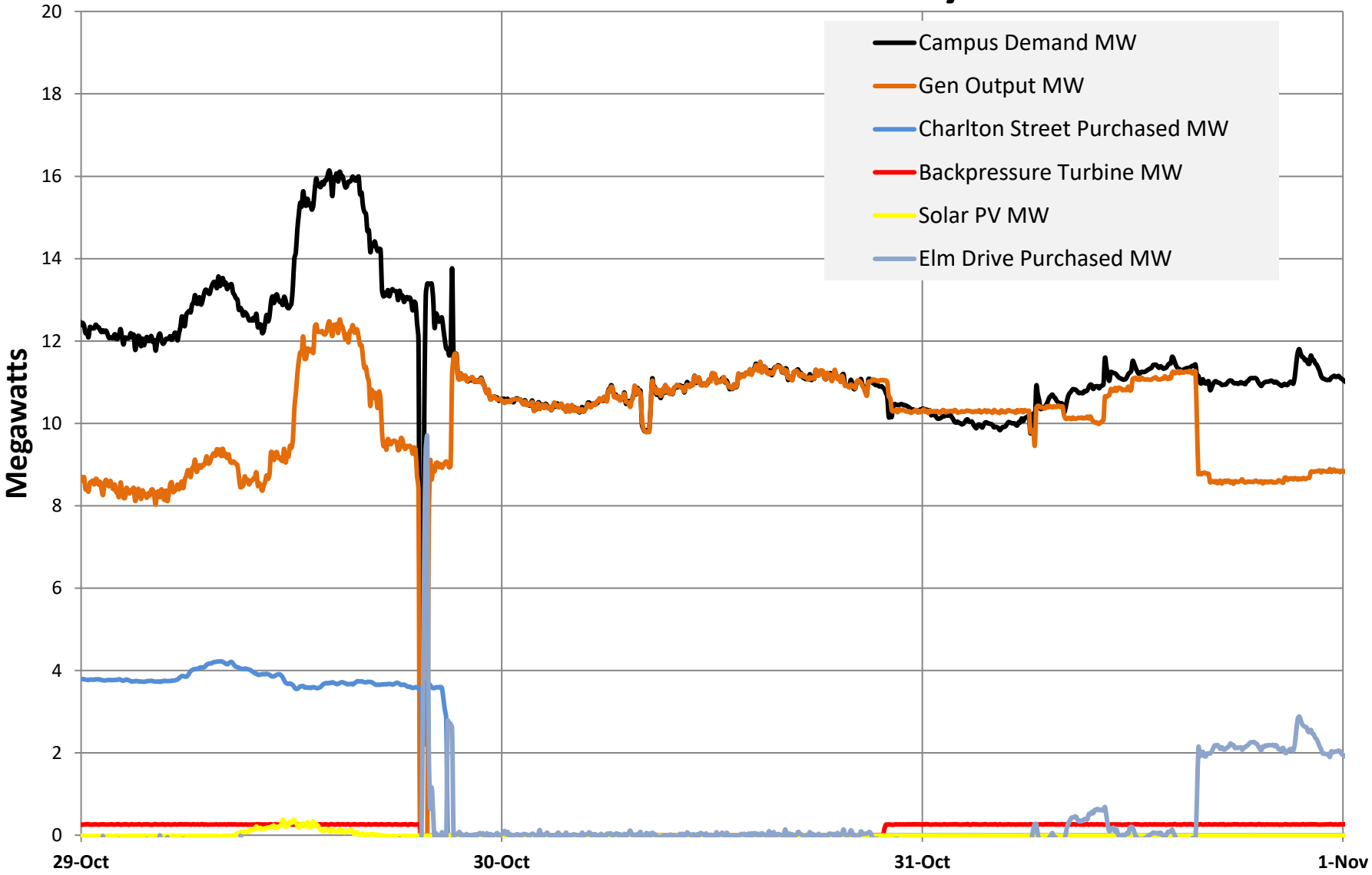
Campus One-Line



Emergency/Life Safety Generators



Campus Power During Hurricane Sandy



Should Do
For Microgrid Reliability

- Fully commission complete systems
- Re-test periodically
- Test using realistic conditions
- Building-level load-shed capability
- Multiple fuel options
- Use emergency response teams periodically
- Plan for human needs

Make Life Better Every Day

- CHP or combined cycle
  - not necessary in emergency response
  - make the equipment more cost-effective
  - Run more often, thus more reliable
  - Most problems happen in non-emergency situations

- Permitting for non-emergency use
  - not necessary for emergency response
  - more cost-effective by increasing capacity factor
  - run more often, thus more reliable
  - usually adds emissions controls

- Energy storage

What It Takes

- A proactive time view of the horizon, not your feet
  - years
  - iterative projects
- Money, not necessarily yours
  - Loans, grants, tax credits, PPAs…
- Sweating the details
- Some smart people
  - Use outside experts as needed
- Passion and tenacity
- Permitting process has many challenges
  - Fed, State, local, making this streamlined, coordinated, predictable would be a big help
- For CHP
  - Size based on thermal load
  - Spark spread can be a strong motivator/anti-motivator

Benefits of Microgrids

- Lower life-cycle costs
- Options to generate or buy power based on economics and/or carbon footprint
- Reduce both energy ***use*** and peak ***demand***
- Work well with CHP to greatly increase energy efficiency
- Provide self-sufficiency in emergencies
- Support places of refuge in an emergency

- Real-time power costs are set by the most expensive plant that is required to run. Microgrids lower energy cost for all customers.
- Microgrids distribute risk into smaller pieces so overall grid reliability is improved.

When it goes right…

The Christian Science Monitor

Lessons from Sandy: how one community in storm's path kept lights on

President Obama toured Sandy-hit areas Thursday, even as some communities still wait for power. Princeton University avoided power outages by using a 'microgrid' – and the idea is spreading.

rk Clayton, *Staff writer* / November 15, 2012

President Obama, accompanied by New York City Mayor Michael Bloomberg, New York Gov. Andrew Cuomo, and Sen. Charles Schumer (D) of New York, hugs Debbie Ingenito Thursday on Staten Island's Cedar Grove Avenue, a street significantly impacted by hurricane Sandy.

Carolyn Kaster/AP

Hurricane Sandy fan letter - Message (H

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You replied to this message on 11/2/2012 9:16 AM.

From: Peter Maag <maag.peter@gmail.com> Sent: Thu 11/1/2012 7:01 PM
To: Edward T. Borer Jr.
Cc:
Subject: Hurricane Sandy fan letter

Hi Ted,

This is Peter Maag of the cross country team. I was in contact last year to organize a power plant tour for the team over one of our breaks. I graduated this spring, but I happened to be on campus this past week throughout the storm. Just wanted to make sure you got at least one well-deserved fan letter for keeping the lights on.

When I saw the news that a 100 year storm was about to slam Princeton while I visited, I was immediately grateful that I would be on campus. I was pretty confident that it would be one of the most reliable places for power in the whole region. I had to work remotely for a couple days, so power was essential. Thanks for keeping the juice flowing throughout my stay!

By this point, you've probably realized that I have r
the Princeton cogeneration plant. I'm assuming this
common. That being said, I'd love to hear a war sto
storm. Did anything out of the ordinary happen (or

Upendra J. Chivukula @UChivukulaNJ 14 Jan

Did you know that @Princeton University ran on almost full power post-Sandy because of their combined heat and power system? #NJAssembly

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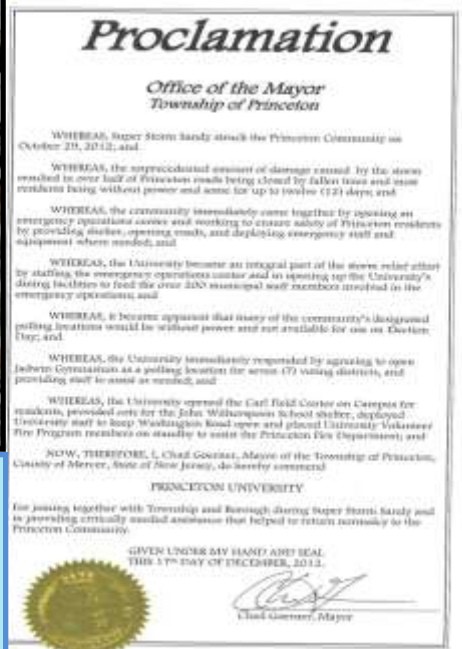

Proclamation

Office of the Mayor
Township of Princeton

WHEREAS, Super Storm Sandy struck the Princeton Community on October 29th, 2012; and

WHEREAS, the unprecedented amount of damage caused by the storm resulted in over half of Princeton roads being closed by fallen trees and some residents being without power and some for up to twelve (12) days; and

WHEREAS, the community immediately came together by opening an emergency operations center and working to ensure safety of Princeton residents by providing shelter, opening roads, and deploying emergency staff and equipment where needed; and

WHEREAS, the University became an integral part of the storm relief effort by staffing the emergency operations center and in opening up the University's dining facilities to feed the over 300 municipal staff members involved in the emergency operations; and

WHEREAS, it became apparent that many of the community's designated polling locations would be without power and not available for use on Election Day; and

WHEREAS, the University immediately responded by agreeing to open Jadwin Gymnasium as a polling location for seven (7) voting districts, and providing staff to assist as needed; and

WHEREAS, the University opened the Carl Field Center on Campus for residents, provided cots for the John Witherspoon School shelter, deployed University staff to keep Washington Road open and placed University Volunteer Fire Program members on standby to assist the Princeton Fire Department; and

NOW, THEREFORE, I, Chad Goerner, Mayor of the Township of Princeton, County of Mercer, State of New Jersey, do hereby commend

PRINCETON UNIVERSITY

for joining together with Township and Borough during Super Storm Sandy and in providing critically needed assistance that helped to return normalcy to the Princeton Community.

GIVEN UNDER MY HAND AND SEAL THIS 17TH DAY OF DECEMBER, 2012.

Chad Goerner, Mayor

Hurricane Sandy Student Video

- http://youtu.be/WtjIj91imSQ