Case Studies in West Coast Community Energy:

Stanford University, UCDSC and the University of Washington

IDEA JUNE 2014: MOVING COMMUNITY ENERGY FORWARD

ANNUAL CONFERENCE & TRADE SHOW

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Affiliated Engineers

Agenda

- Drivers for Community Energy Review
- Case Studies
- Conclusions

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Drivers for Review

- Aging Infrastructure
- Climate Change
- Policy Change
- Campus/Community Growth
- Resiliency

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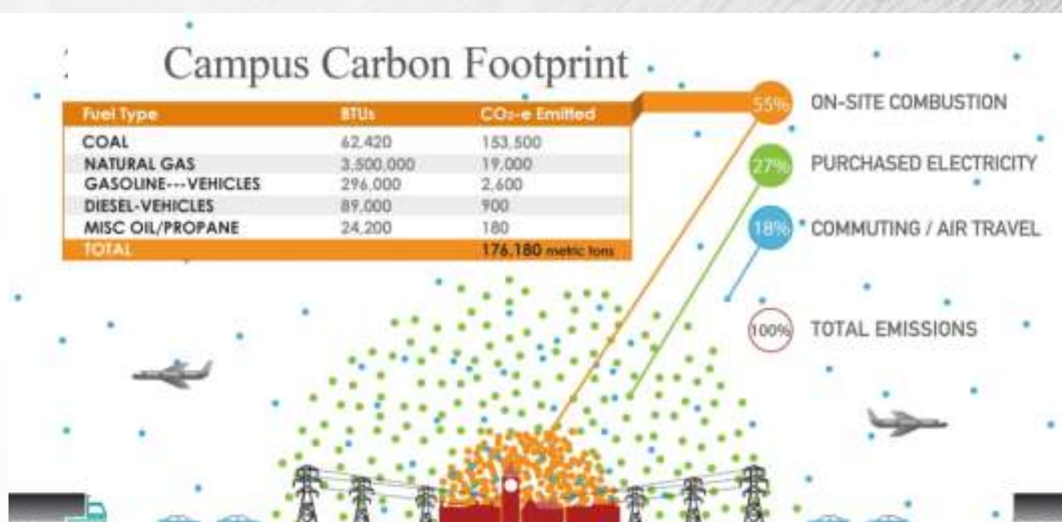

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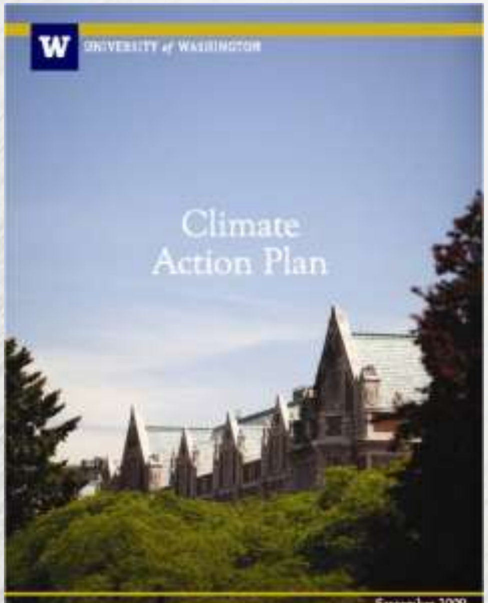

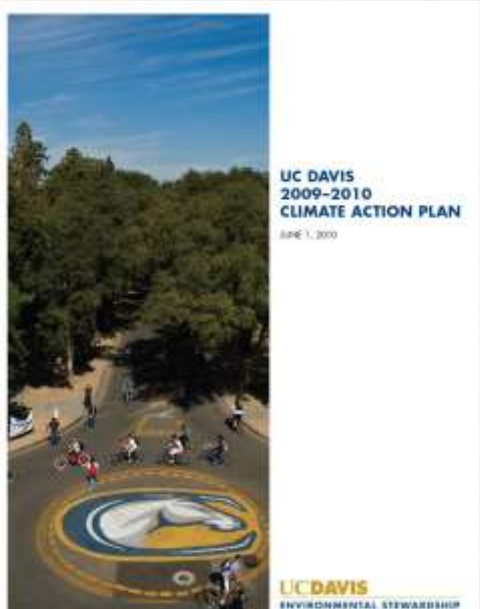

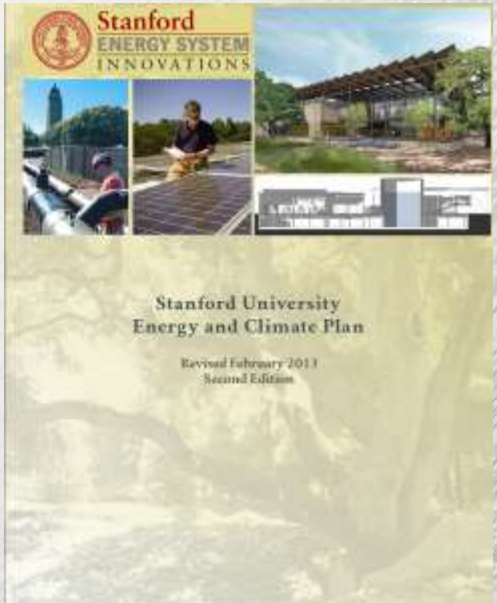

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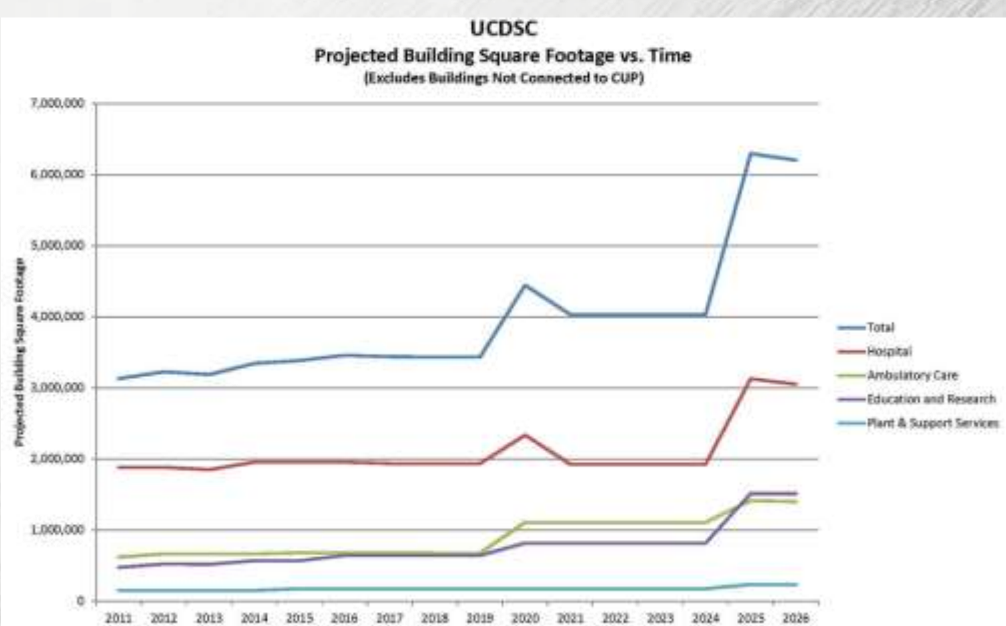

Drivers for Review

- Aging Infrastructure
- Climate Change
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- Campus/Community Growth
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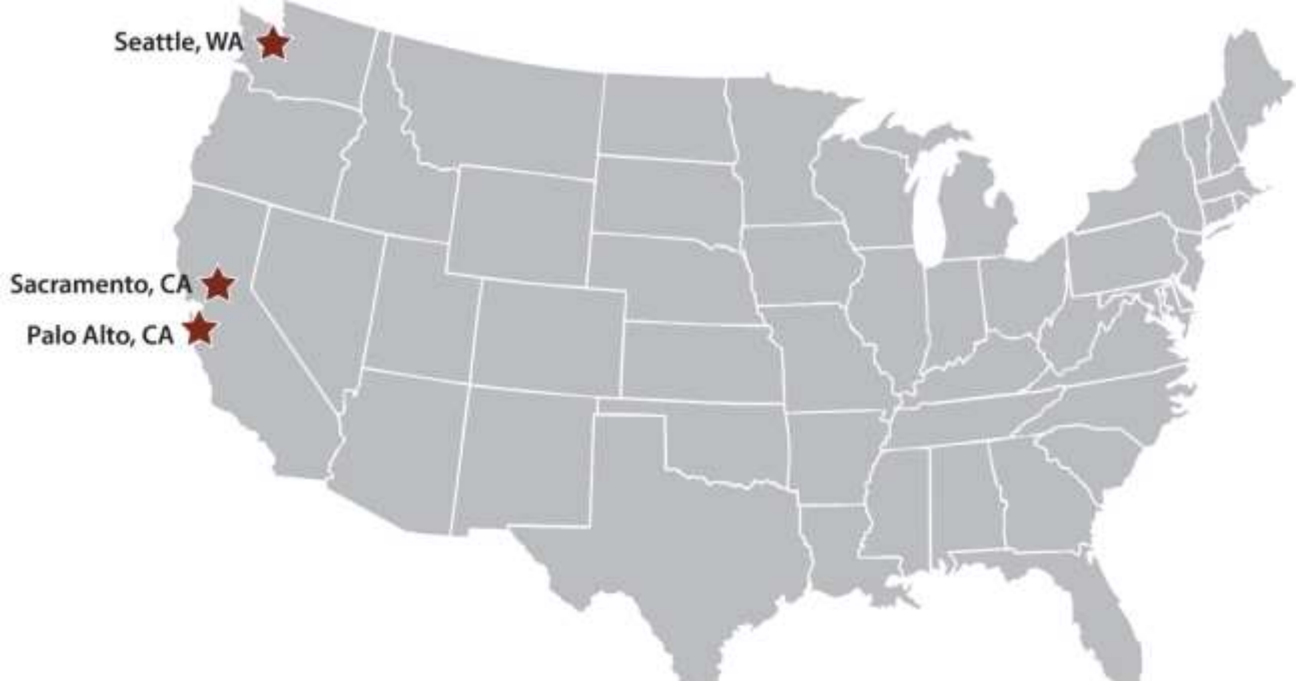
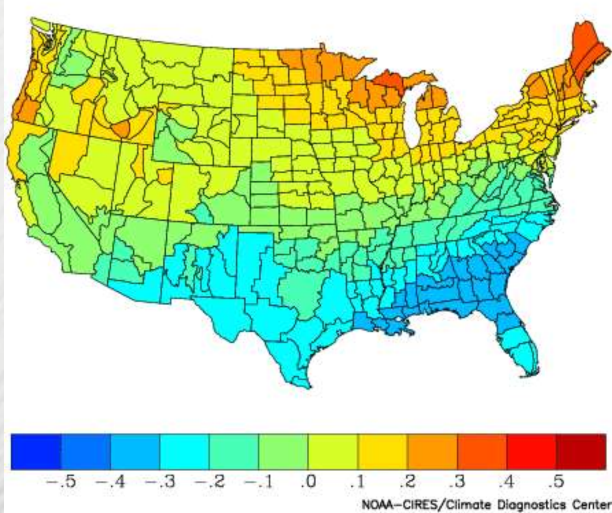
Case Studies

- University of Washington, Seattle, WA
  - South of Pacific Master Infrastructure Review
- UC Davis Sacramento Campus, Sacramento, CA
  - Utilities Master Plan
- Stanford University, Palo Alto, CA
  - Stanford Energy Systems Innovations (SESI)



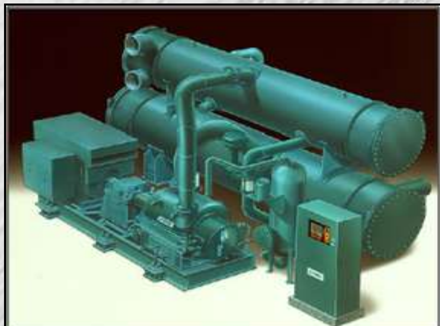
Climate

- Seattle
  - 85/65 F Cooling
  - 24 F Heating
- Sacramento, CA
  - 100/70 F Cooling
  - 31 F Heating
- Palo Alto, CA
  - 93/67 F Cooling
  - 36 F Heating



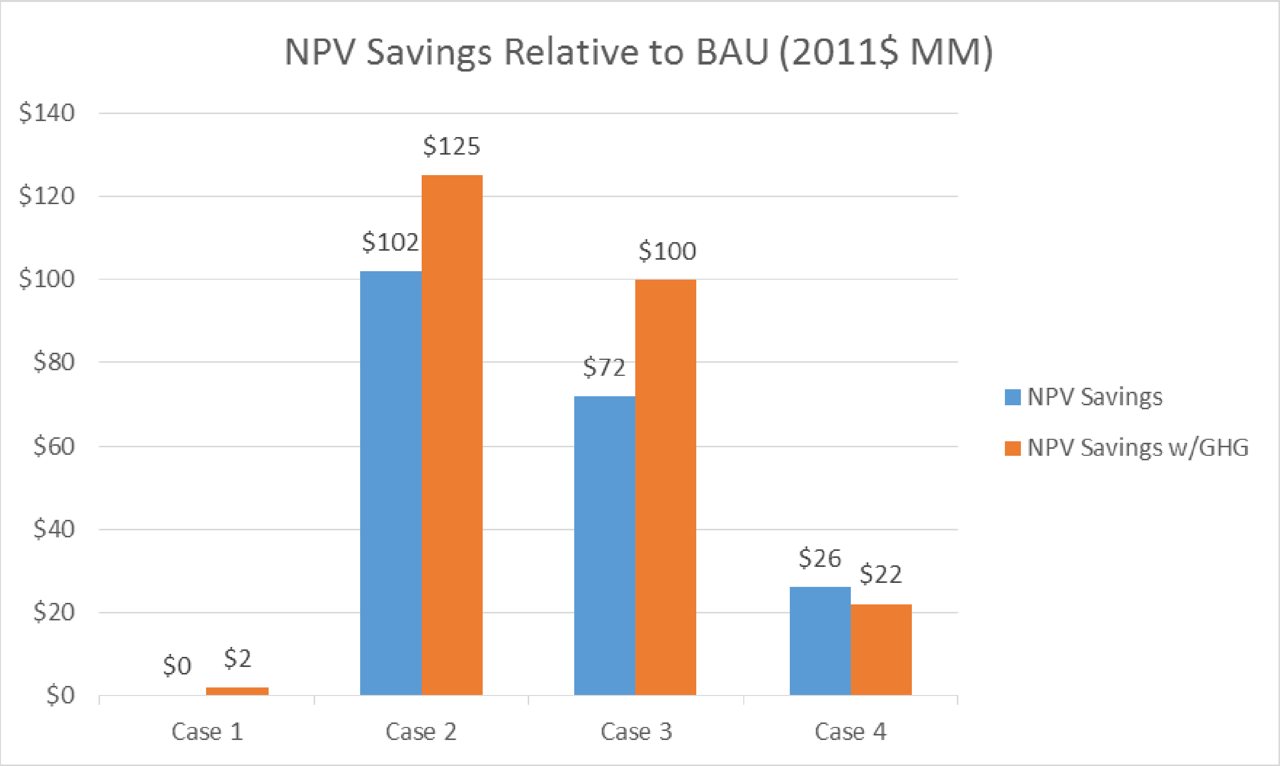
U of Washington South Campus

- Options Studied
  - Business as Usual
    - Distributed Chilled Water Generation
    - Campus Steam Heating
  - Case 1
    - Conventional Central Chiller Plant
    - Maintain Campus Steam Use
  - Case 2
    - Heat Recovery Chiller for Base Heating and Cooling Loads
    - Conventional Chiller Plant for Chilled Water Peaks
    - Maintain Campus Steam for Heating peaks
  - Case 3
    - High-pressure steam biomass boilers backpressure steam turbine cogeneration
  - Case 4
    - Same as Case 3 with NG boilers



U of Washington South Campus

- Case 2 – Heat Recovery Chiller Option yields greatest savings relative to BAU
- Case 3 – Cogeneration with biomass also yields high savings

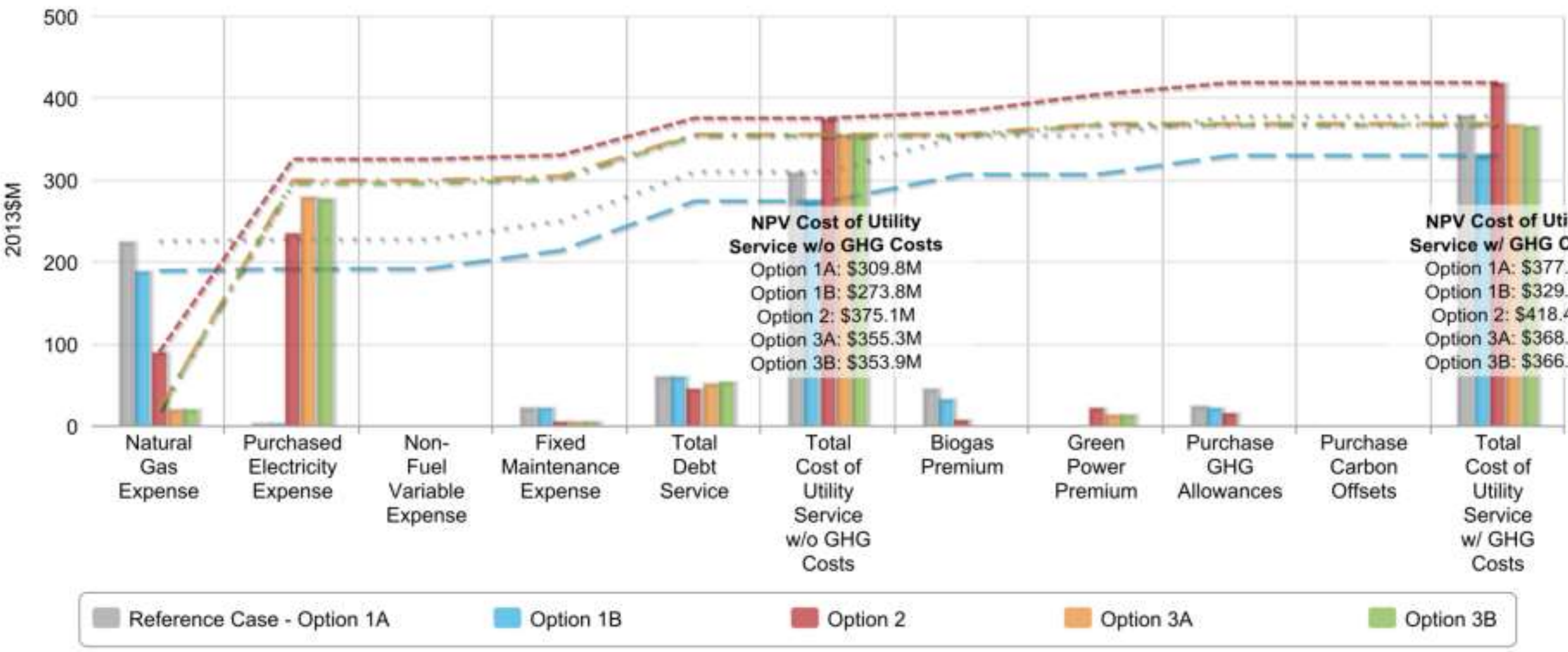


UCDSC - Utility Master Plan

- Options
  - Business as Usual
    - NG Turbine Cogeneration (25 MW)
    - Absorption chillers use excess steam, electric ch topping
    - All campus power generation by turbine
  - Option 1A
    - Optimize Existing Cogen System
  - Option 2
    - Decommission NG turbine
    - Conventional boiler chiller plant w/ utility power
  - Option 3A
    - Decommission turbine
    - Heat recovery chiller system for base heating and cooling
    - Conventional boilers and chillers for peak loads
    - Utility power
  - Option 3B

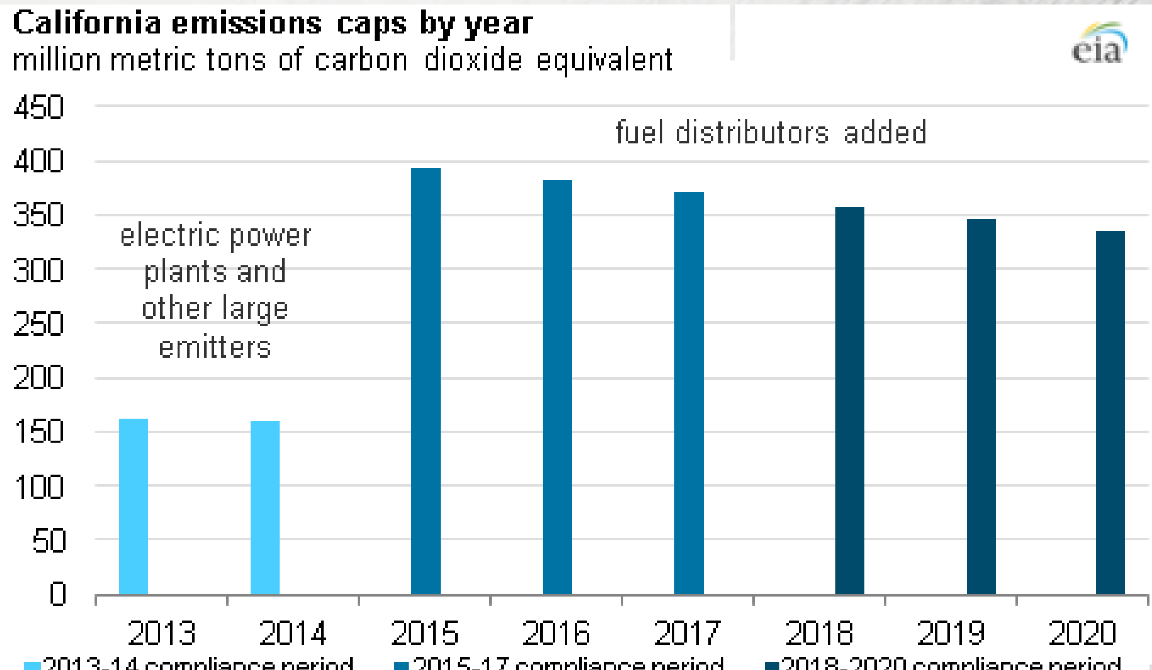
UCDSC -Utility Master Plan

- Option 1B (Optimize existing cogeneration) has lowest NPV cost
- Heat recovery chiller options better than existing cogen operating scenario (w/GHG cost included)

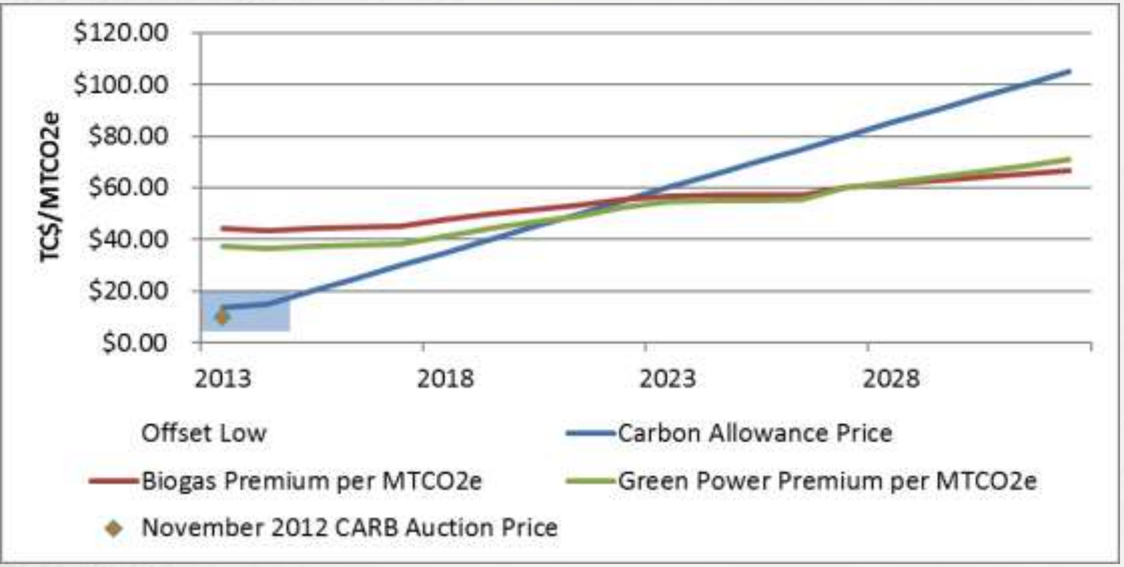


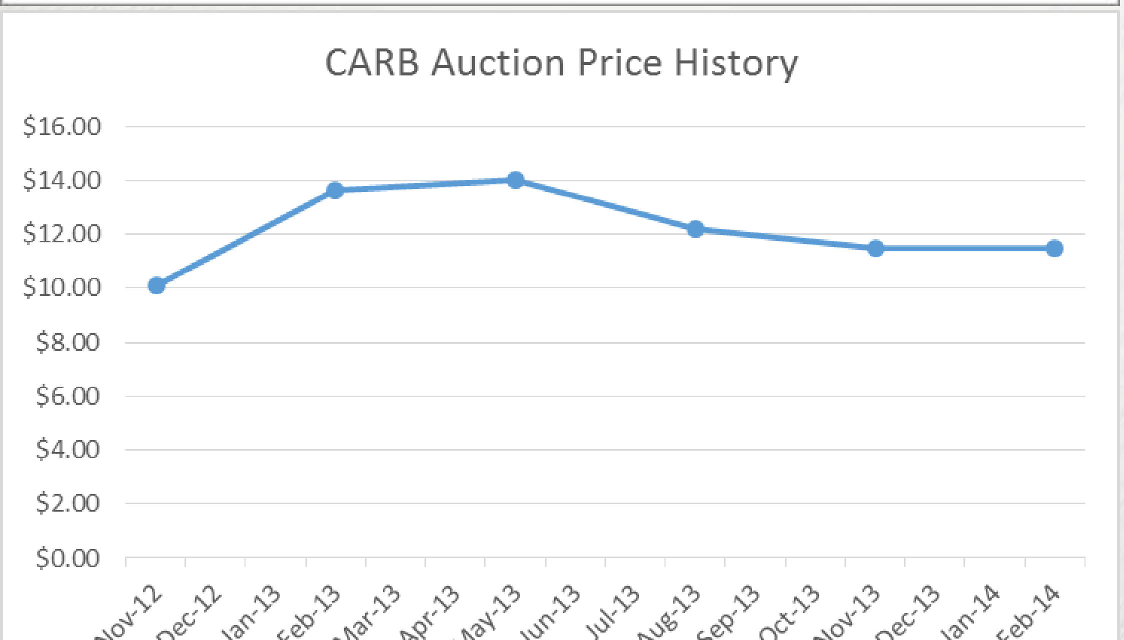
Cal EPA ARB Cap & Trade

- Applies to users over 25,000 MT CO2e/yr
- Allowances are made available at auction
- Allowance quantity is slowly reduced over time (3% per year)

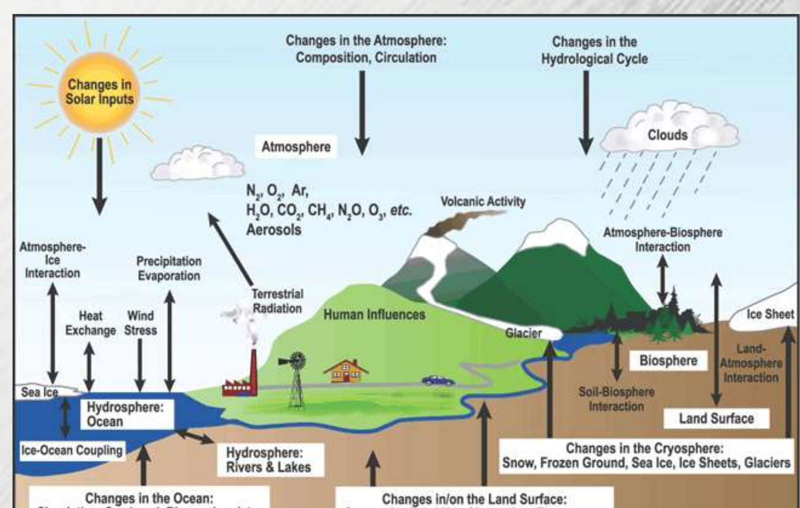


CARB Cap & Trade





- UCDSC analysis assumed a steep upward trend after the initial startup period
- Initial trend in GHG allowance costs is relatively flat – no obvious trend



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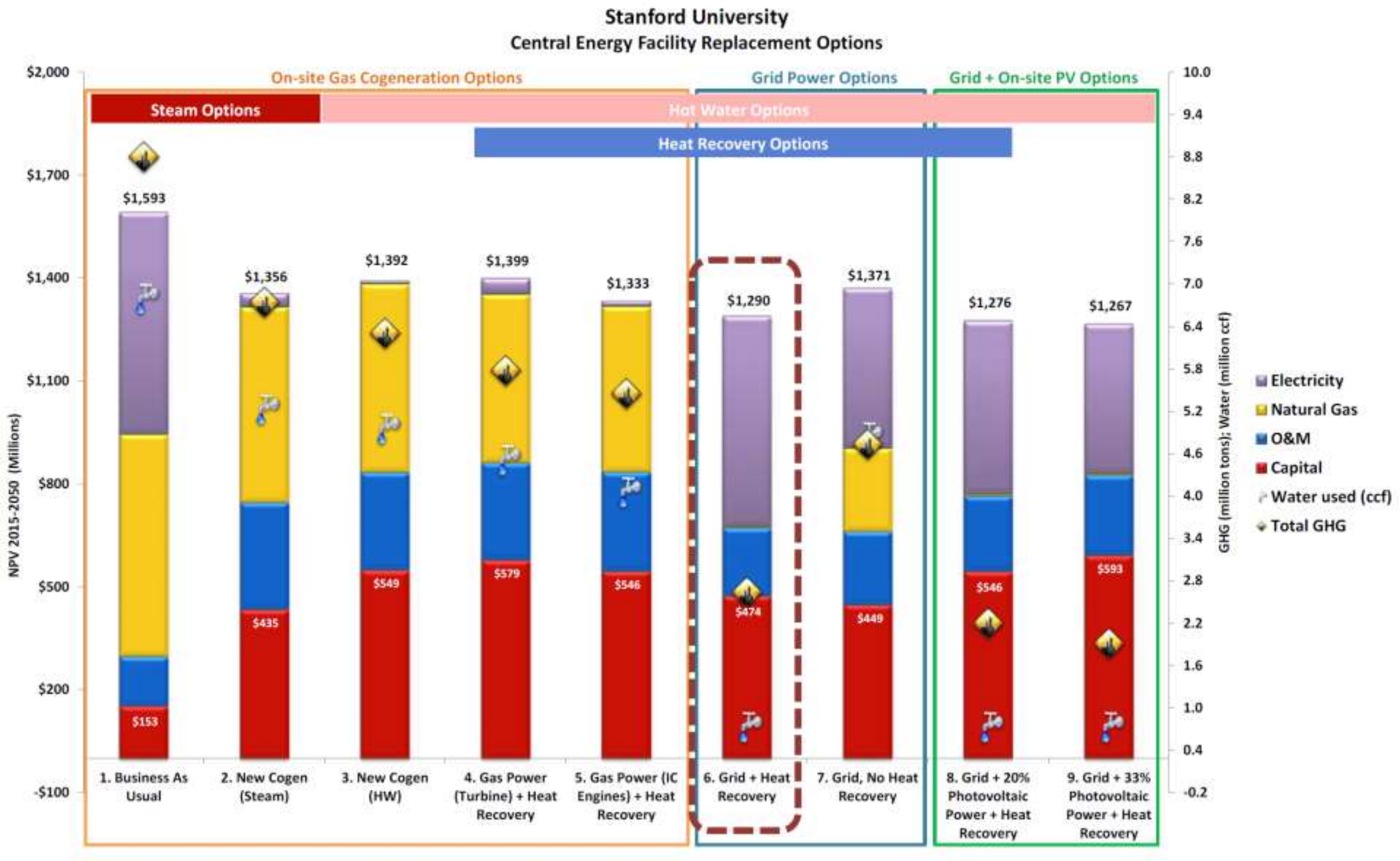
Stanford ENERGY SYSTEM INNOVATIONS

Stanford: Options Evaluated

- Cogen Options w/ Steam
  - Business as Usual
  - New CT
- Cogen Options w/ Hot Water
  - New CT
  - New CT + Heat Recovery
  - New IC Engine + Heat Recovery
- Grid Power Options w/ Hot Water
  - Grid + Heat Recovery
  - Grid + No Heat Recovery
- Grid Power + On-Site Solar w/ Hot Water
  - 20% Solar
  - 33% Solar

Why Heat Recovery is Possible



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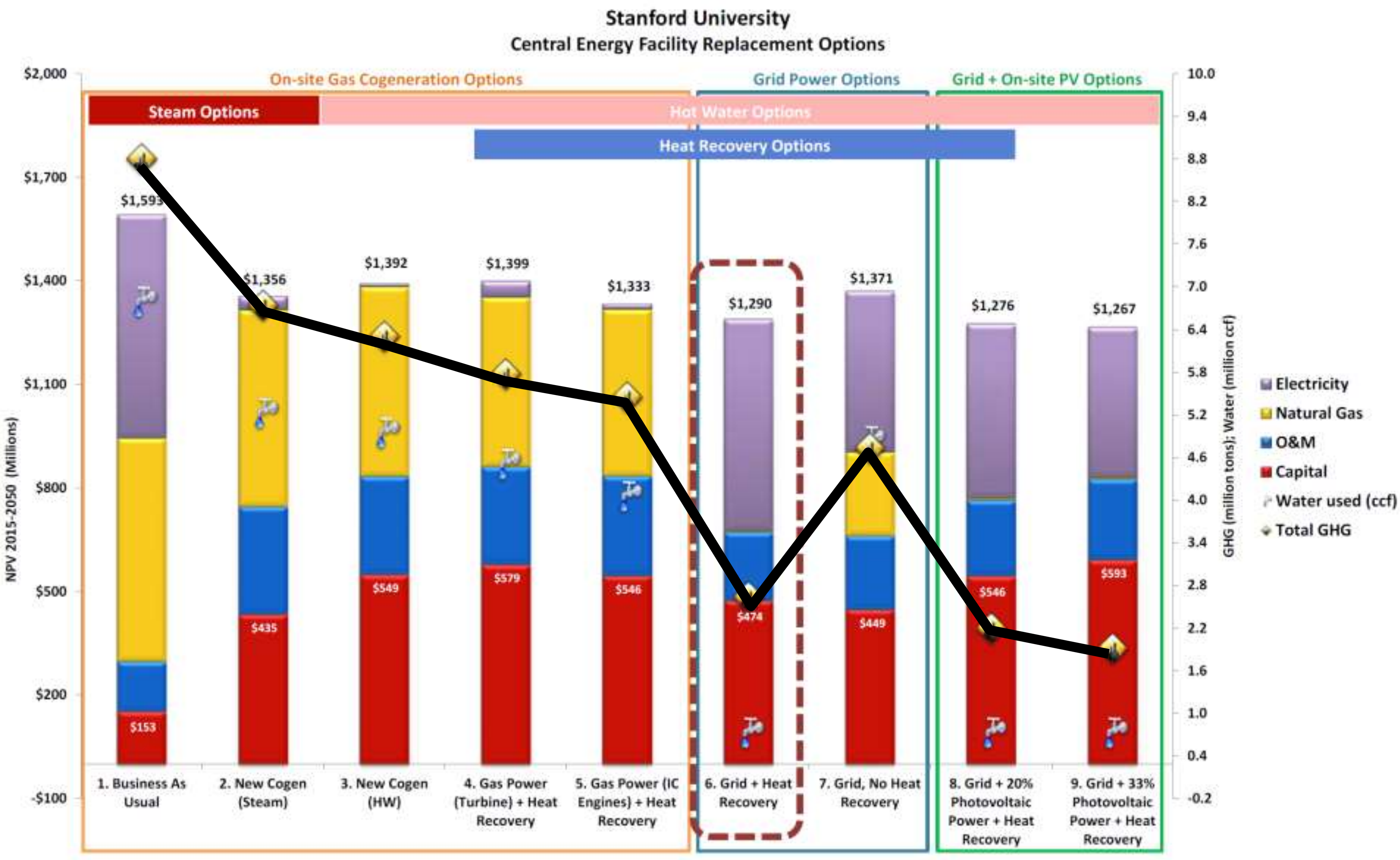

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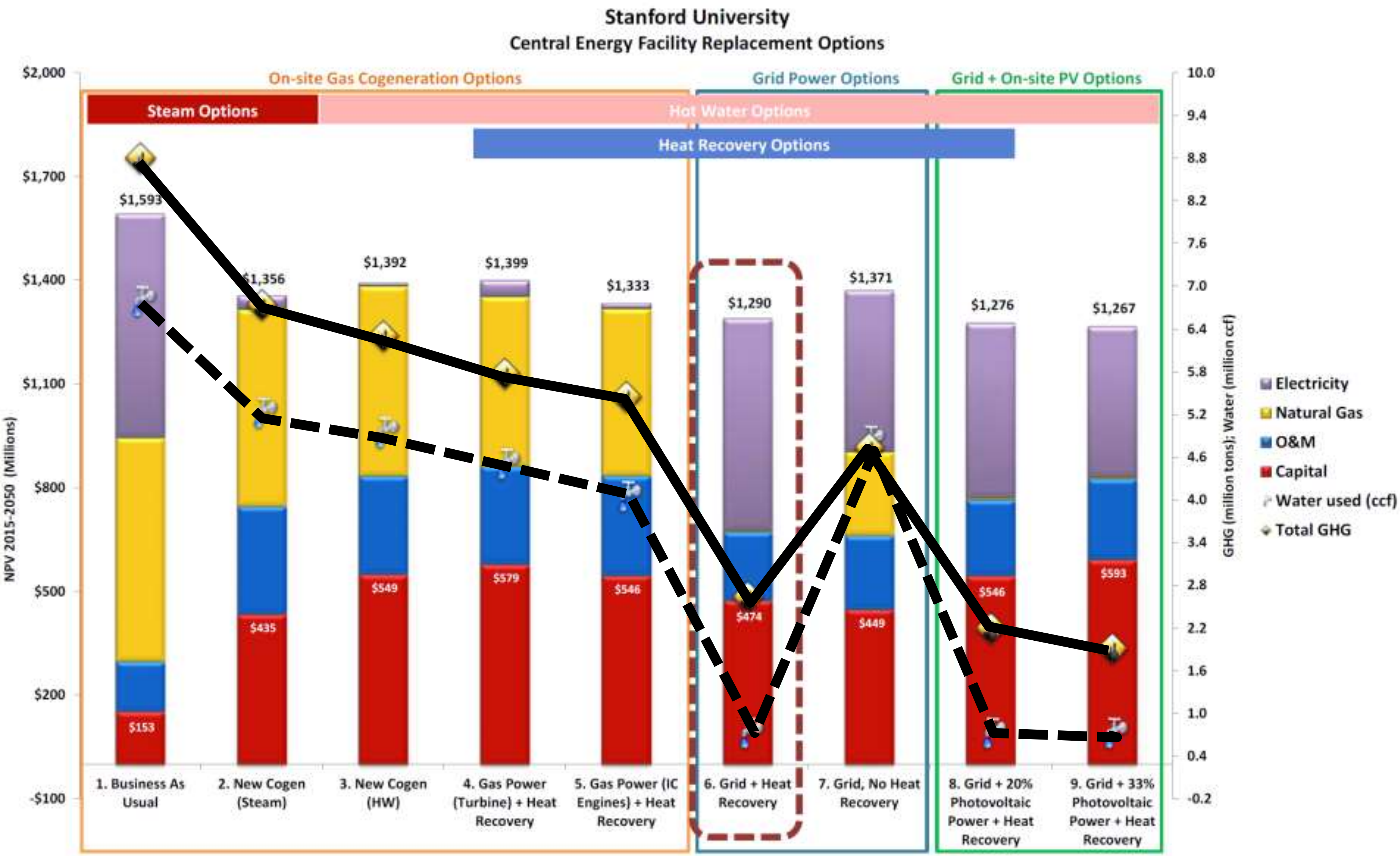

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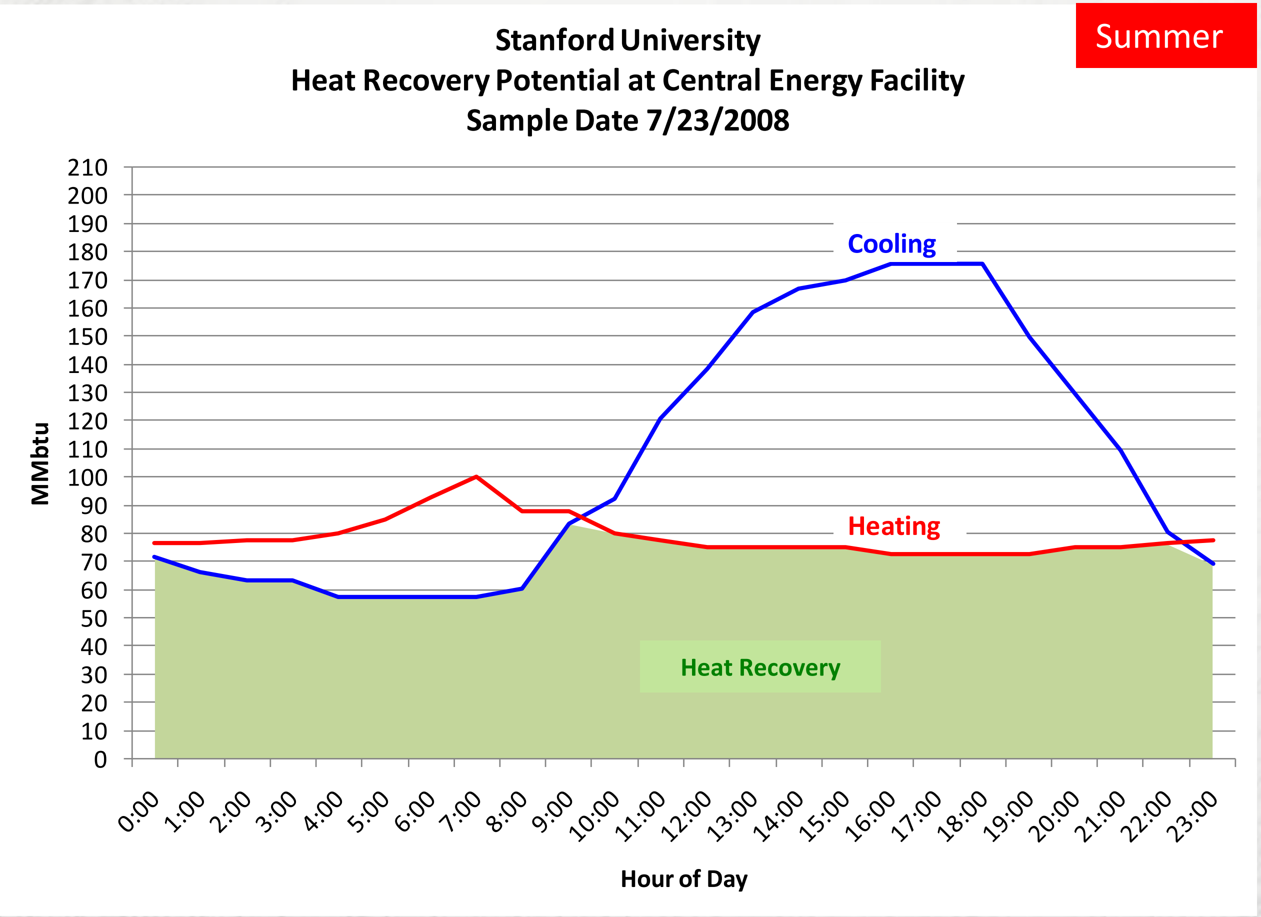
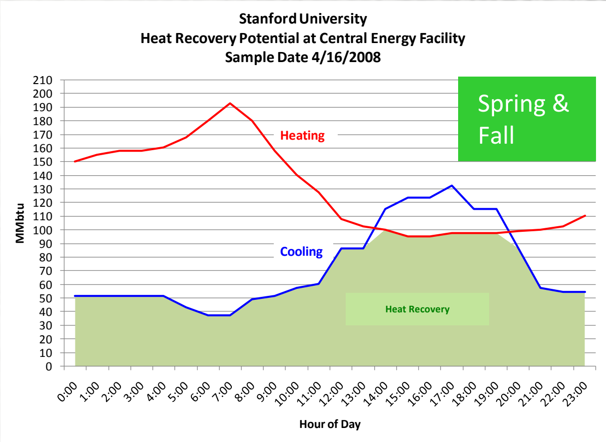
Why Heat Recovery is Possible

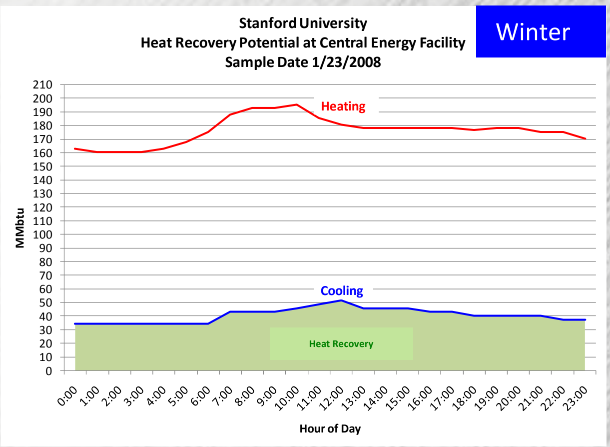
- We heat & cool buildings at the same time
- Cooling is just the collection of unwanted heat

Stanford can recover 65% of the heat now discharged from the cooling system to meet 80% of campus heating demands.

Source: Stanford University Draft Energy & Climate Plan (April 2009)







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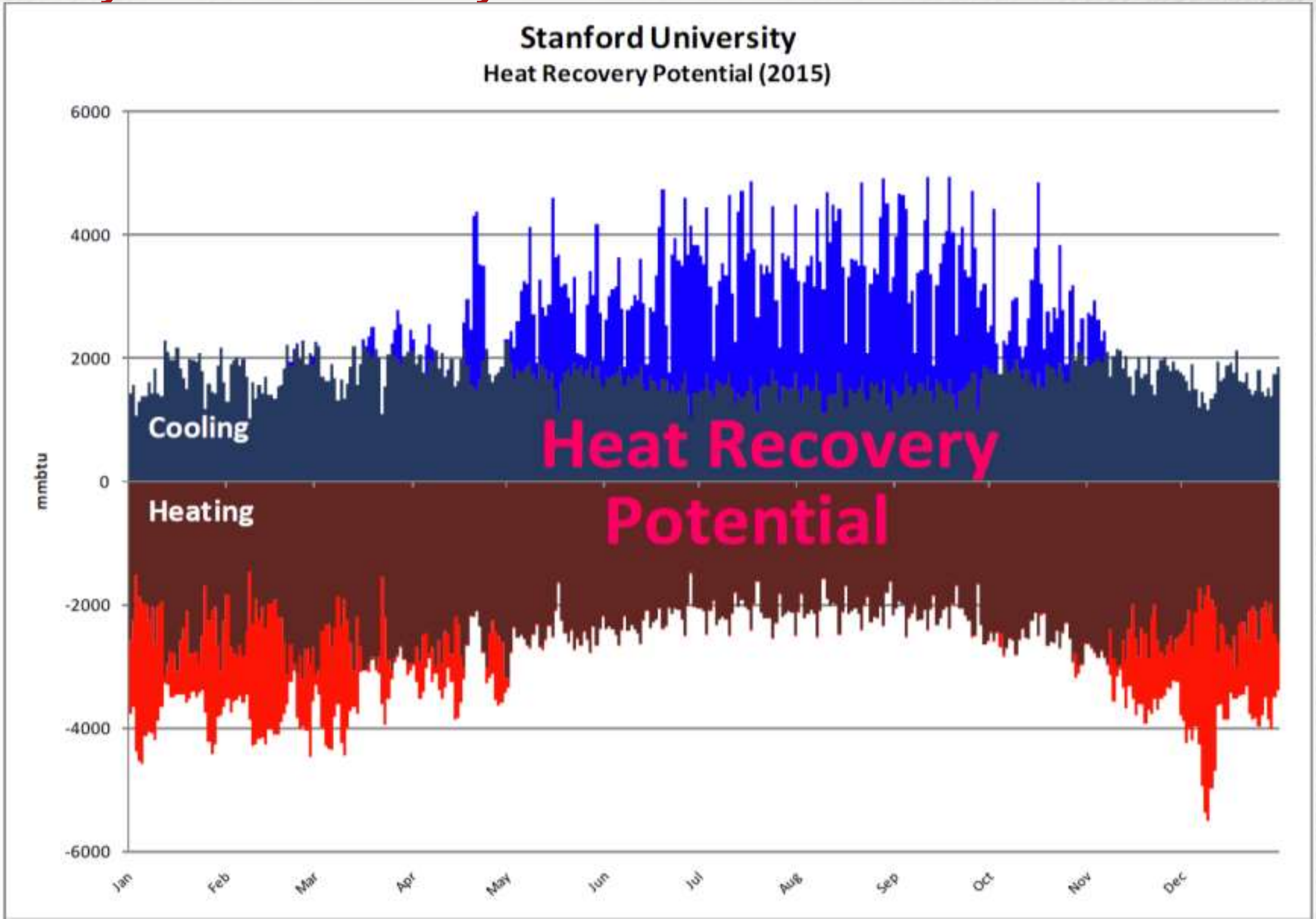

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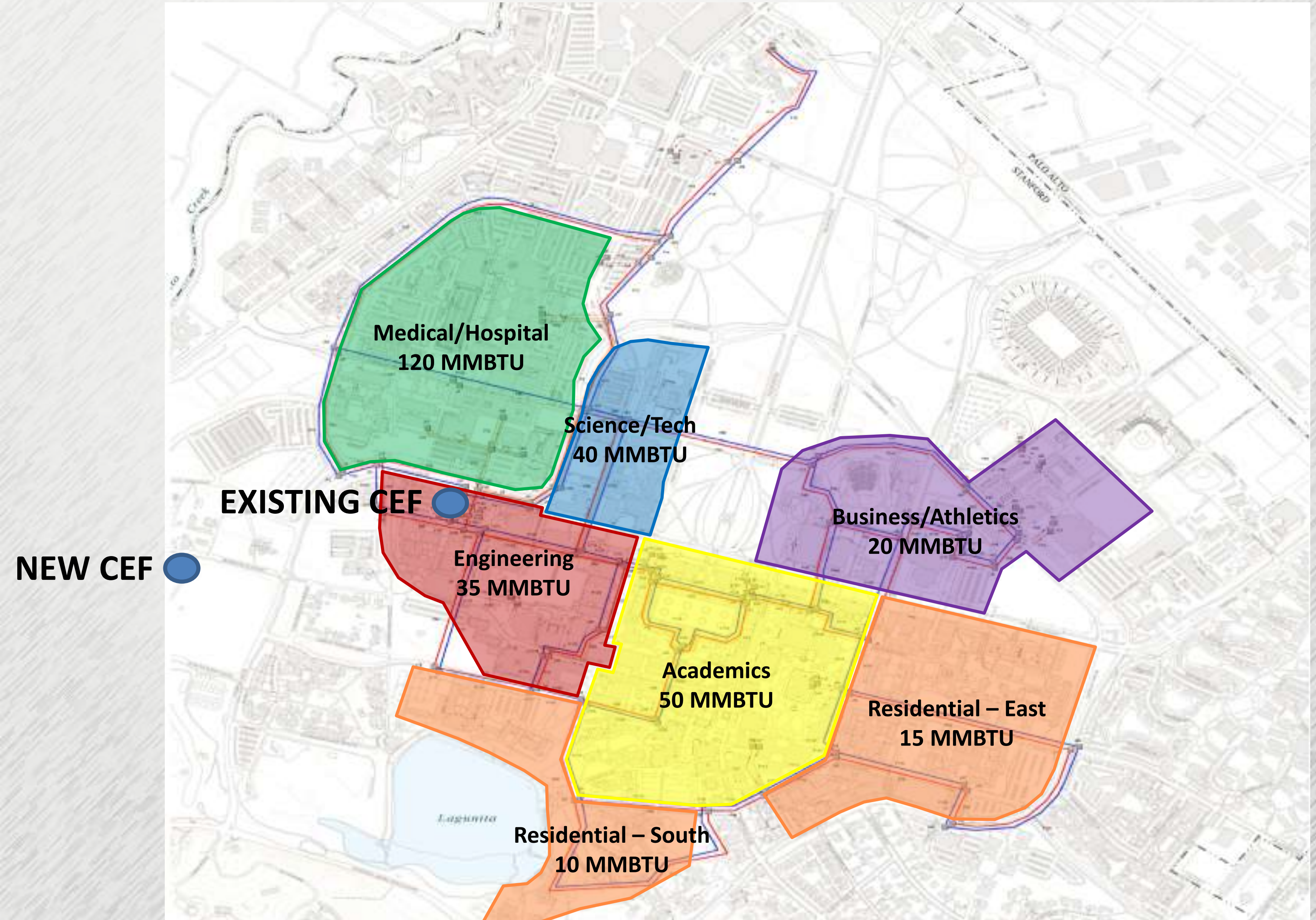
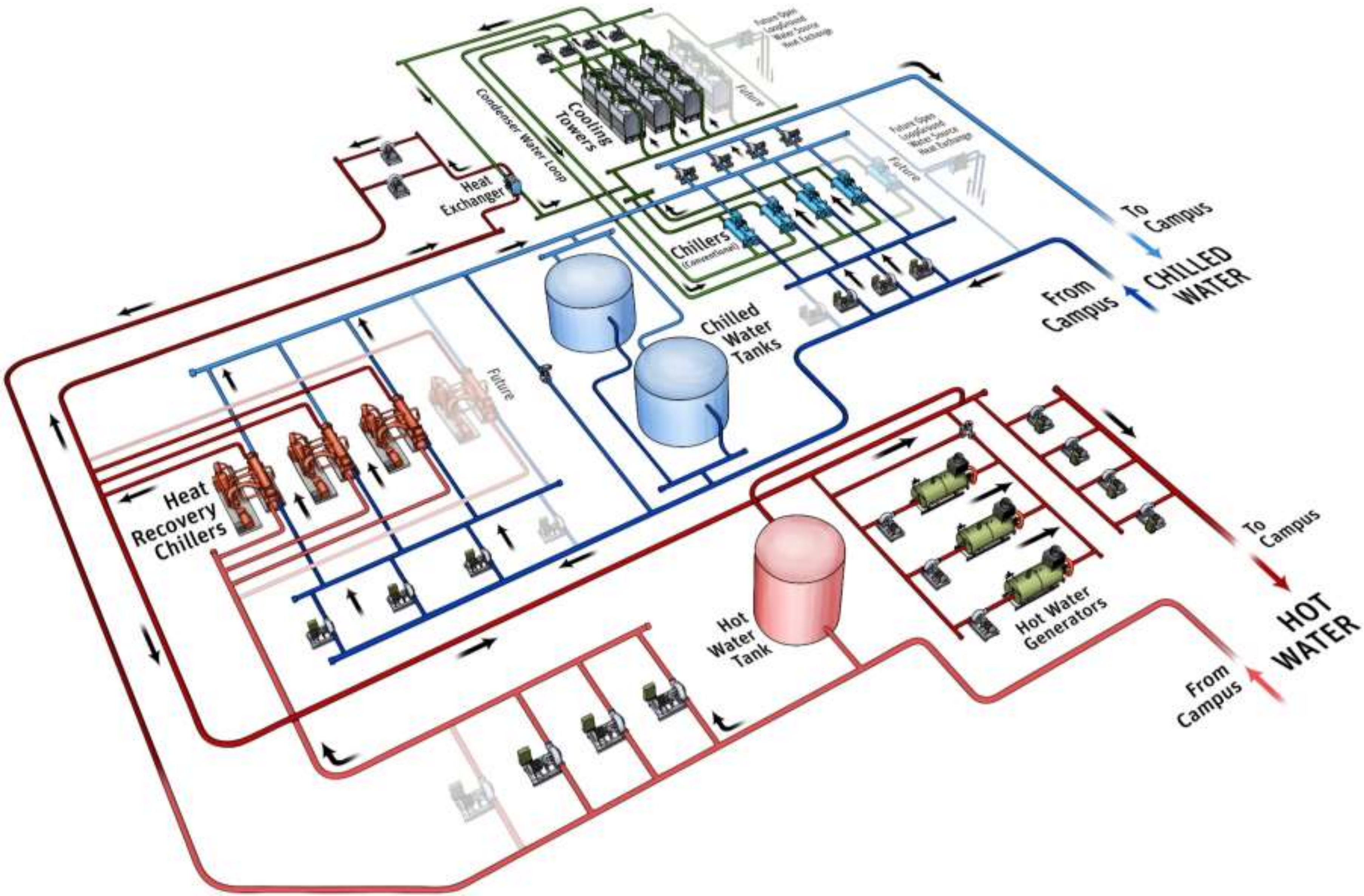


Final Solution – New Plant



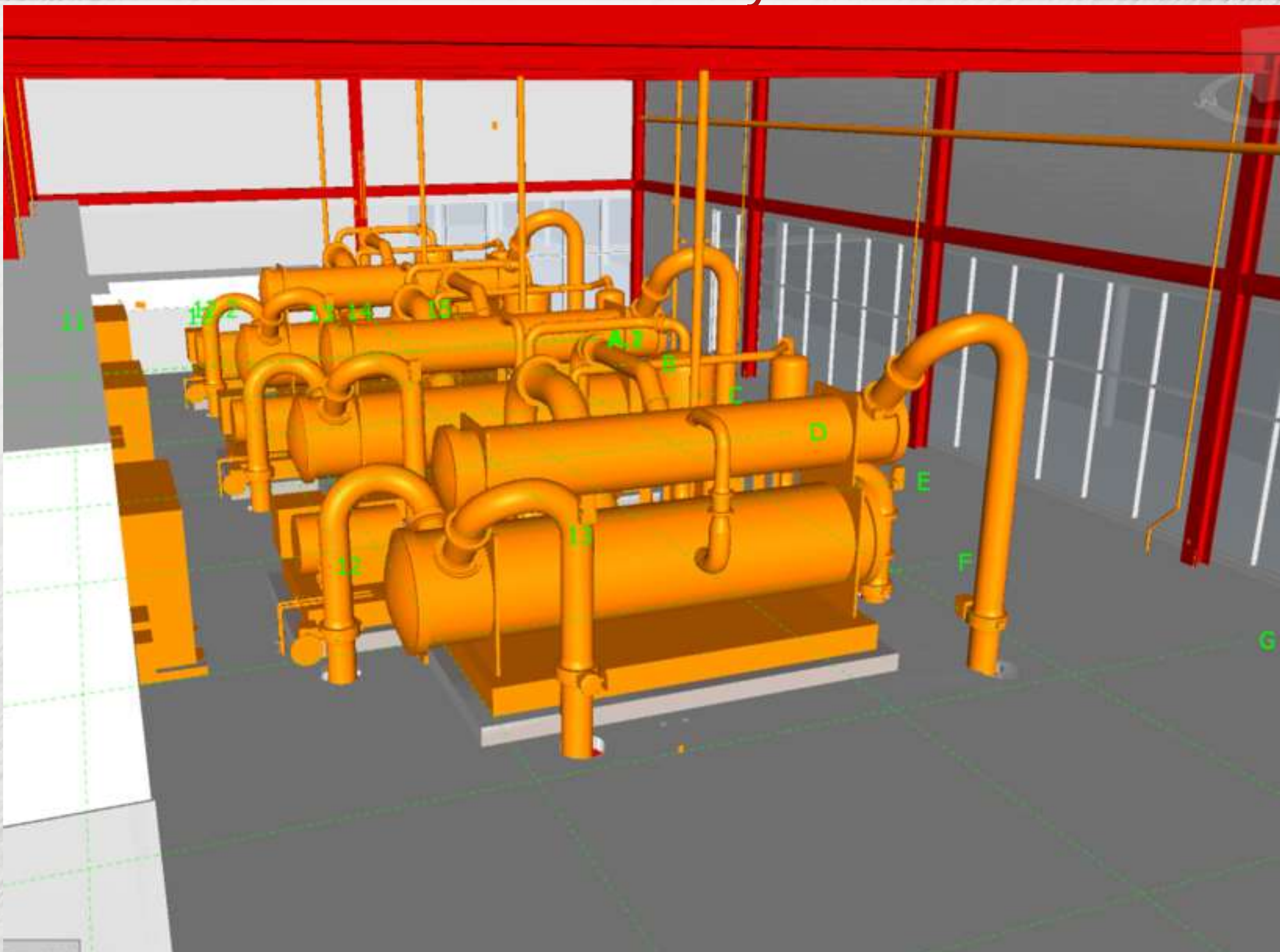
Final Solution – New Plant

- ❑ Distribution – 80%
- ❑ Building Conversions – 70%
- ❑ CEF
  - ▪ Heat Recovery – 80%
  - ▪ OSHPD – 50%
- ❑ Substation – 100%

Project Completion

Spring 2015

Final Solution – Heat Recovery Chillers



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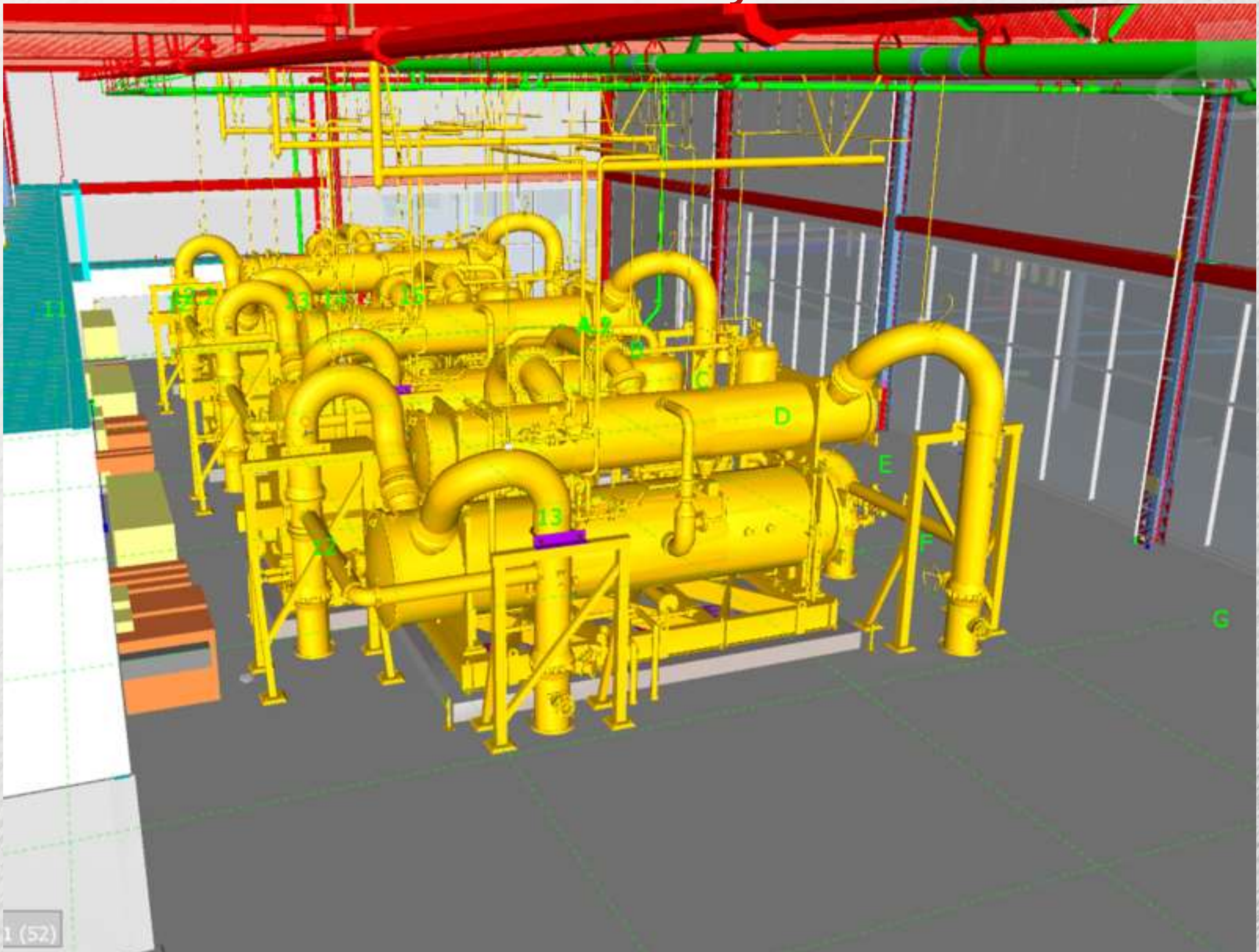

Final Solution – Heat Recovery Chillers

Conclusions

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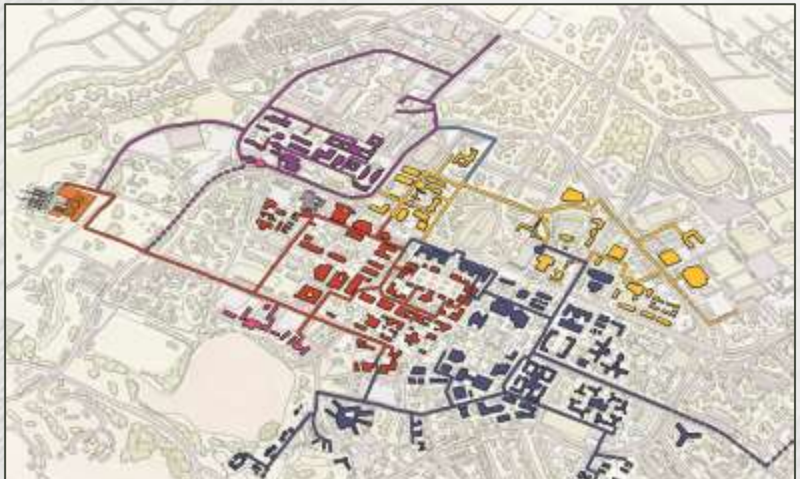
  - State of existing infrastructure can affect outcome
  - GHG costs shift balances between options but not yet to an extreme extent
  - Climate and energy costs are significant drivers in system selection, but are overshadowed by overall system efficiency



Questions?