Incremental Expansion yields Incremental Efficiency for UMass Medical School

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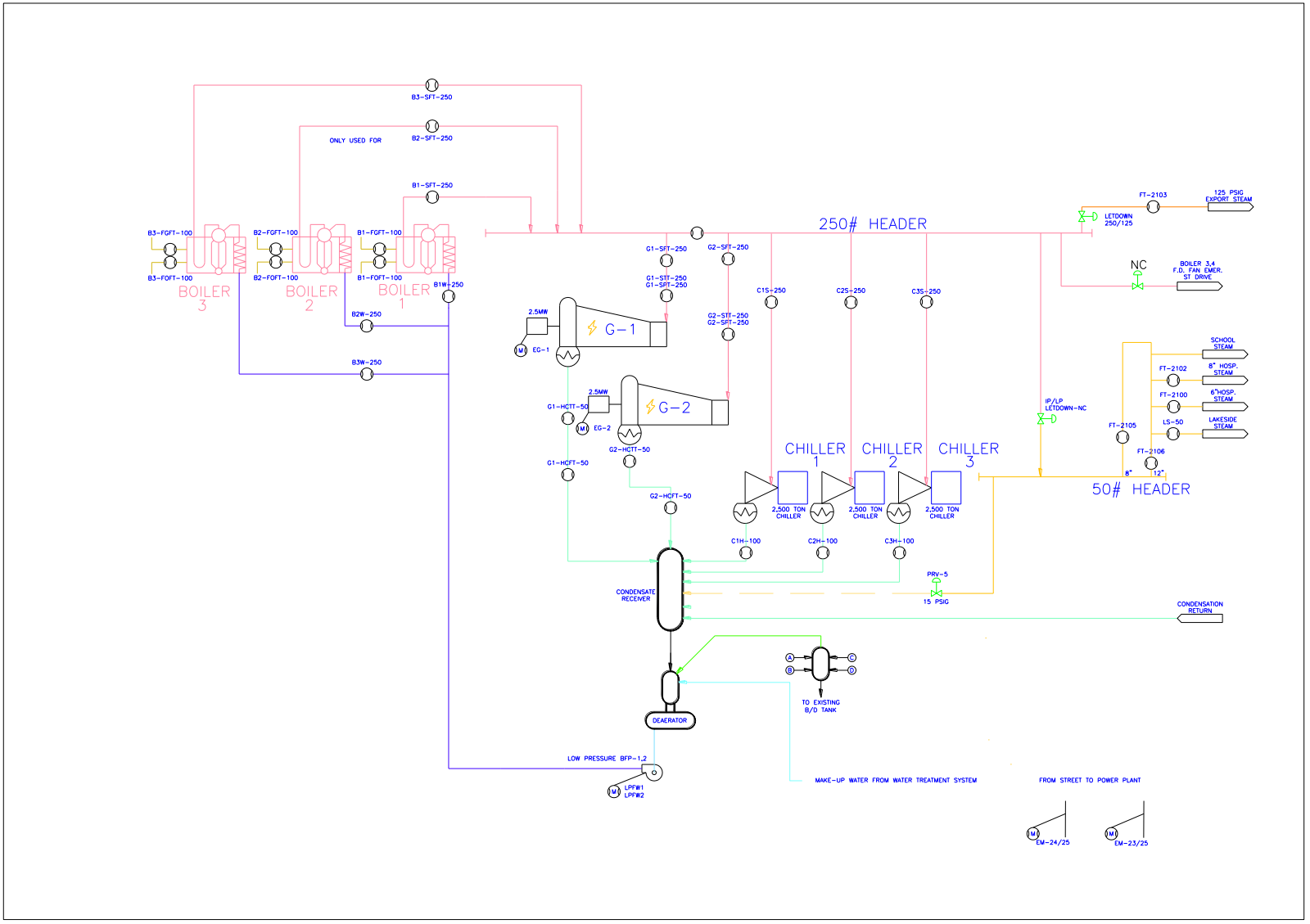
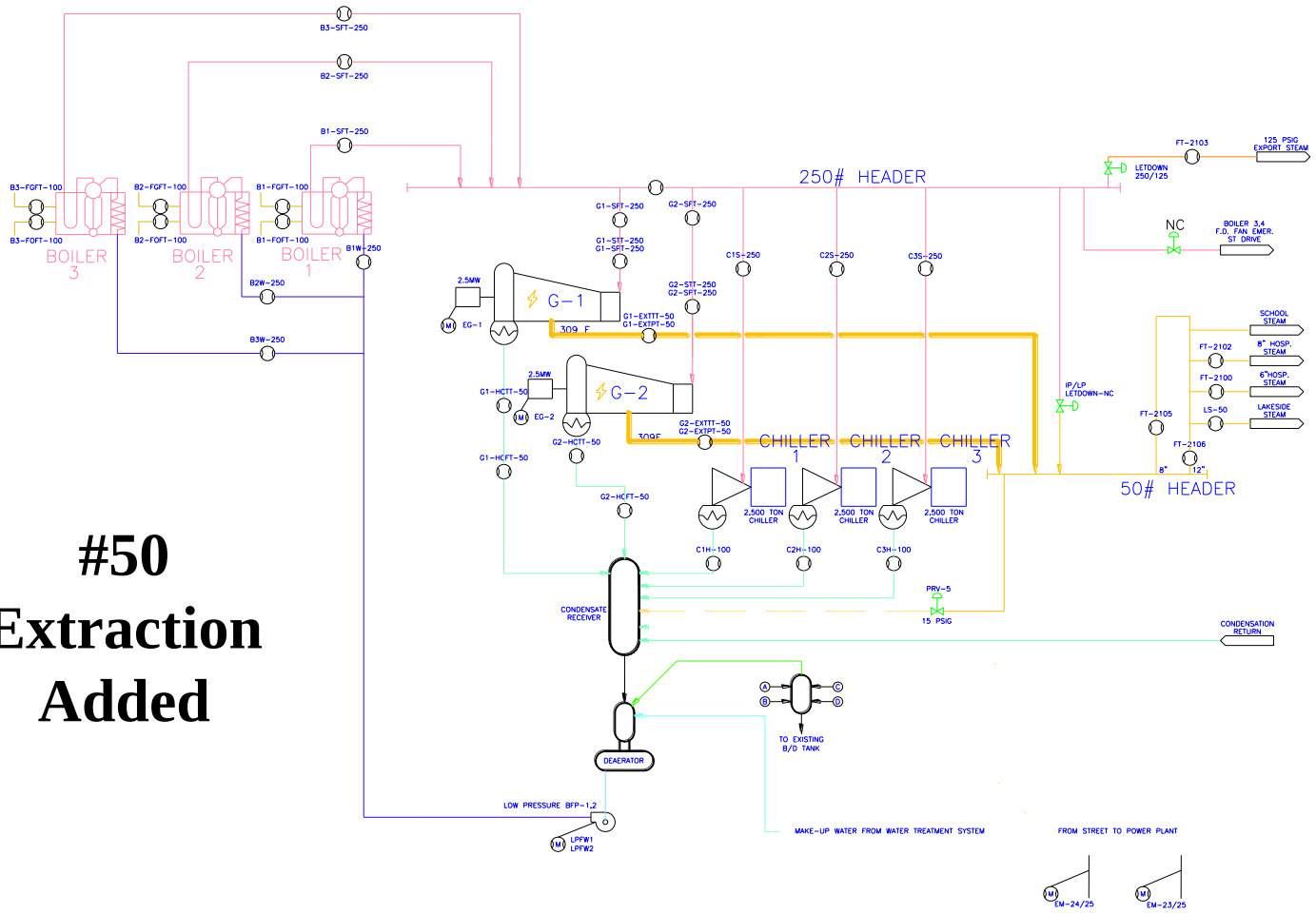
Evolution in the Central Energy Plant UMMS

- **1972 - Initial Cogeneration plant**
  - Campus - 1.6 million ft² (School + Hospital)
  - Steam 70kpph, CW 5k tons, Electric 5MW
  - Plant Efficiency (no extraction) – 32%
  - Plant Efficiency (with extraction) – 38%
- **2000 - Plant / Campus Expansion**
  - Campus - 2.5 million ft²
  - Steam 95kpph, CW 7k tons, Electric 7.5MW
  - First Environmental Reduction
  - Plant Efficiency 51%
- **2010 - Plant / Campus Expansion**
  - Campus – 3.3 million ft²
  - Steam 170kpph, CW 12.7k tons, Electric 12MW
  - Accelerated Environmental Reduction
  - Maximize Financial Incentives
  - Plant Efficiency ~ 66%

1972 - Central Energy Plant UMMS

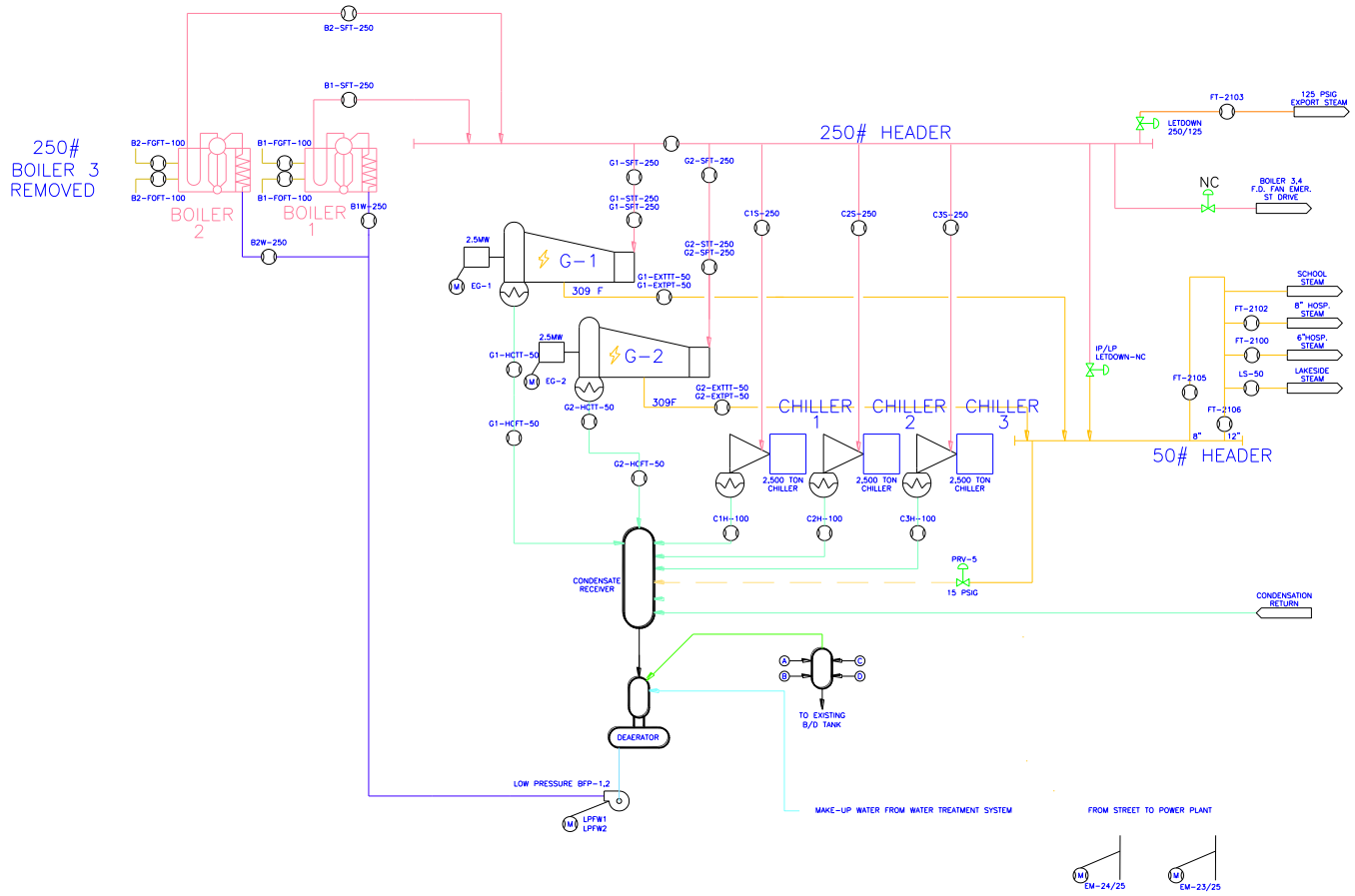


1972 - Central Energy Plant UMMS

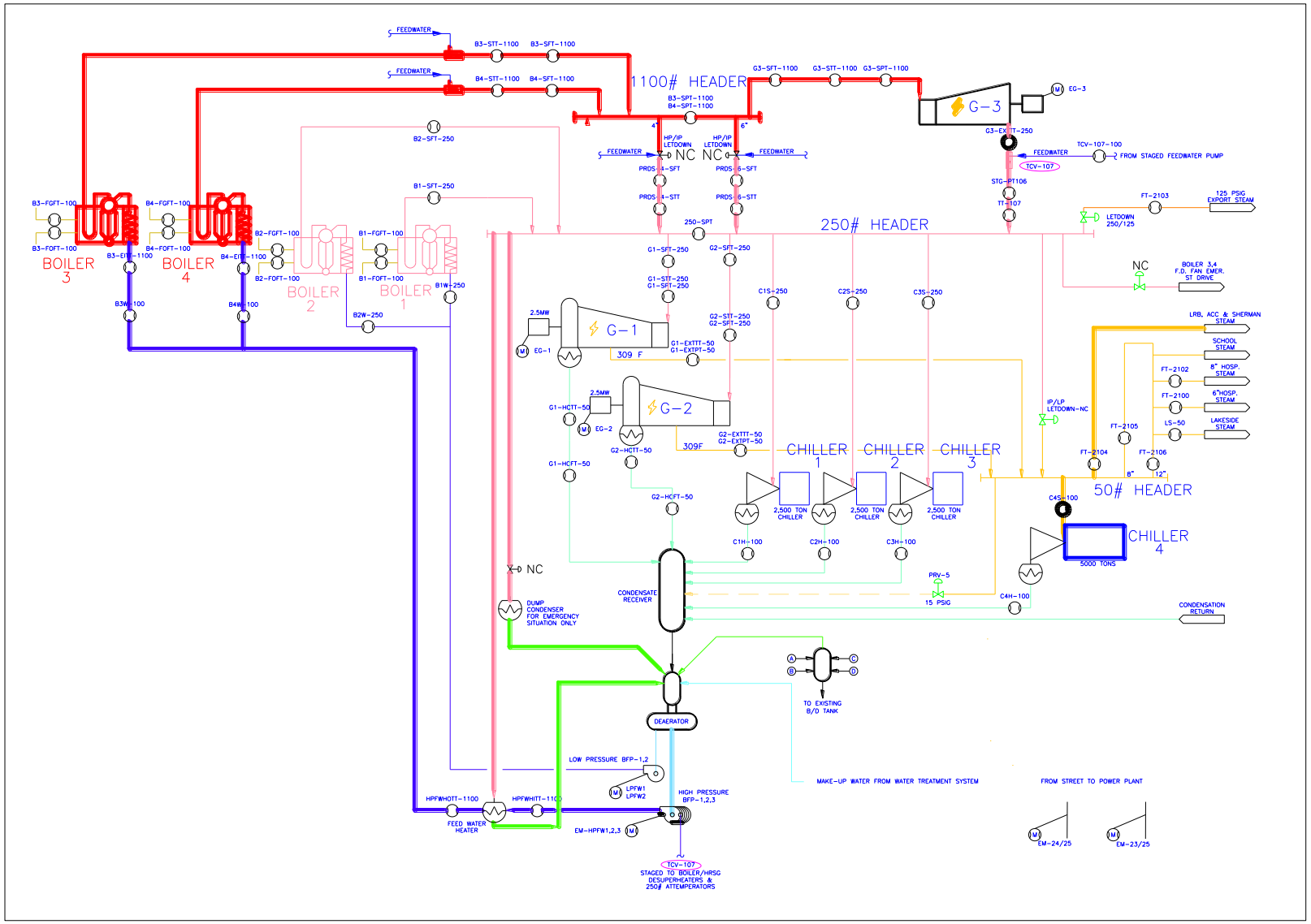


#50 Extraction Added

1999 - Central Energy Plant UMMS



2000 - Central Energy Plant UMMS



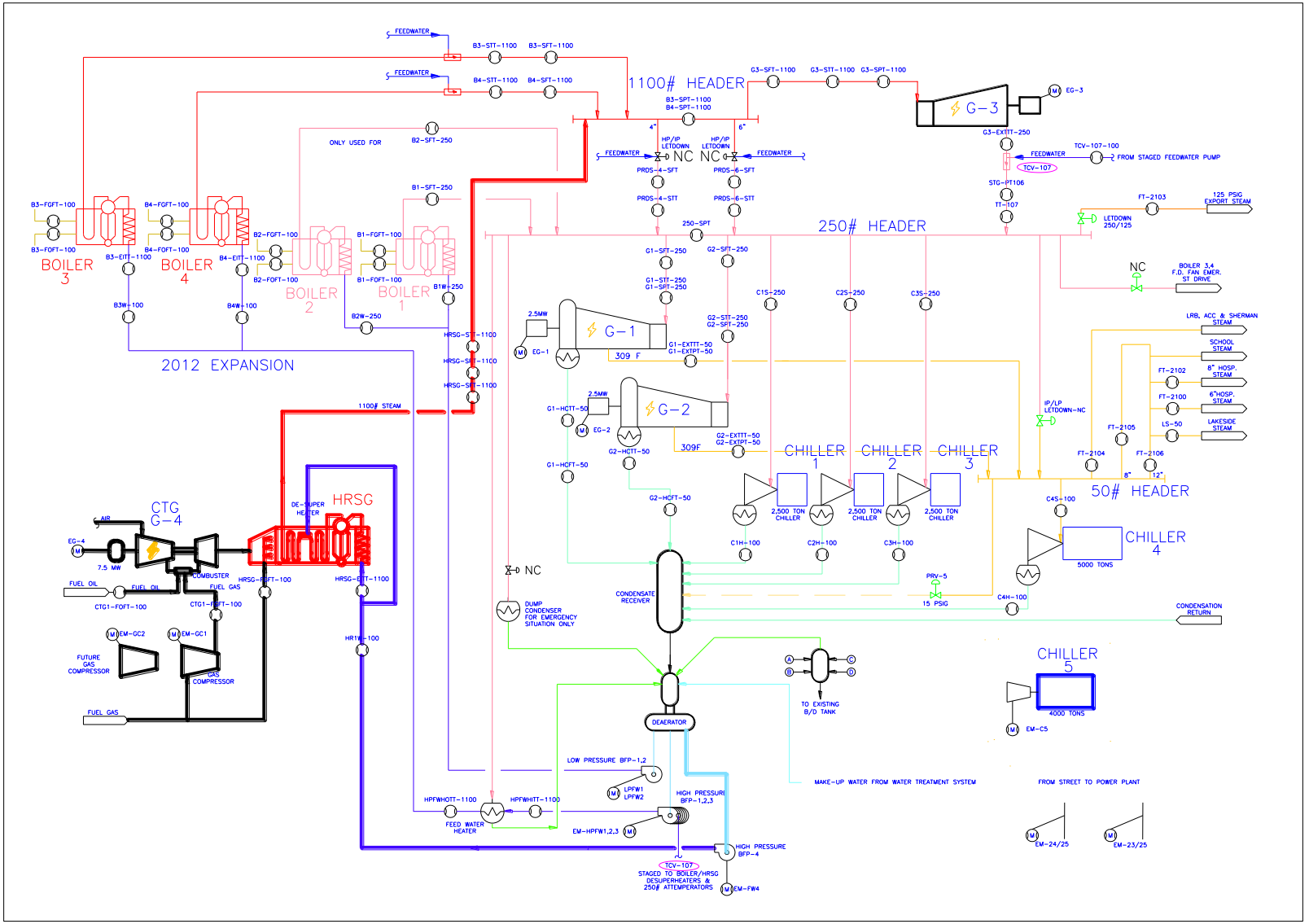
UMMS Goals - 2010 Expansion – Central Plant

- **Prepare future campus energy needs**
- **Maintain N+1 Redundancy for each energy loads**
- **Create controls using BAT with ease of use**
- **Diversified steam mix / chilled water production**
- **Reduce Environmental impact (Nox, CO2, etc.)**
- **Reduce unit cost of energy input**

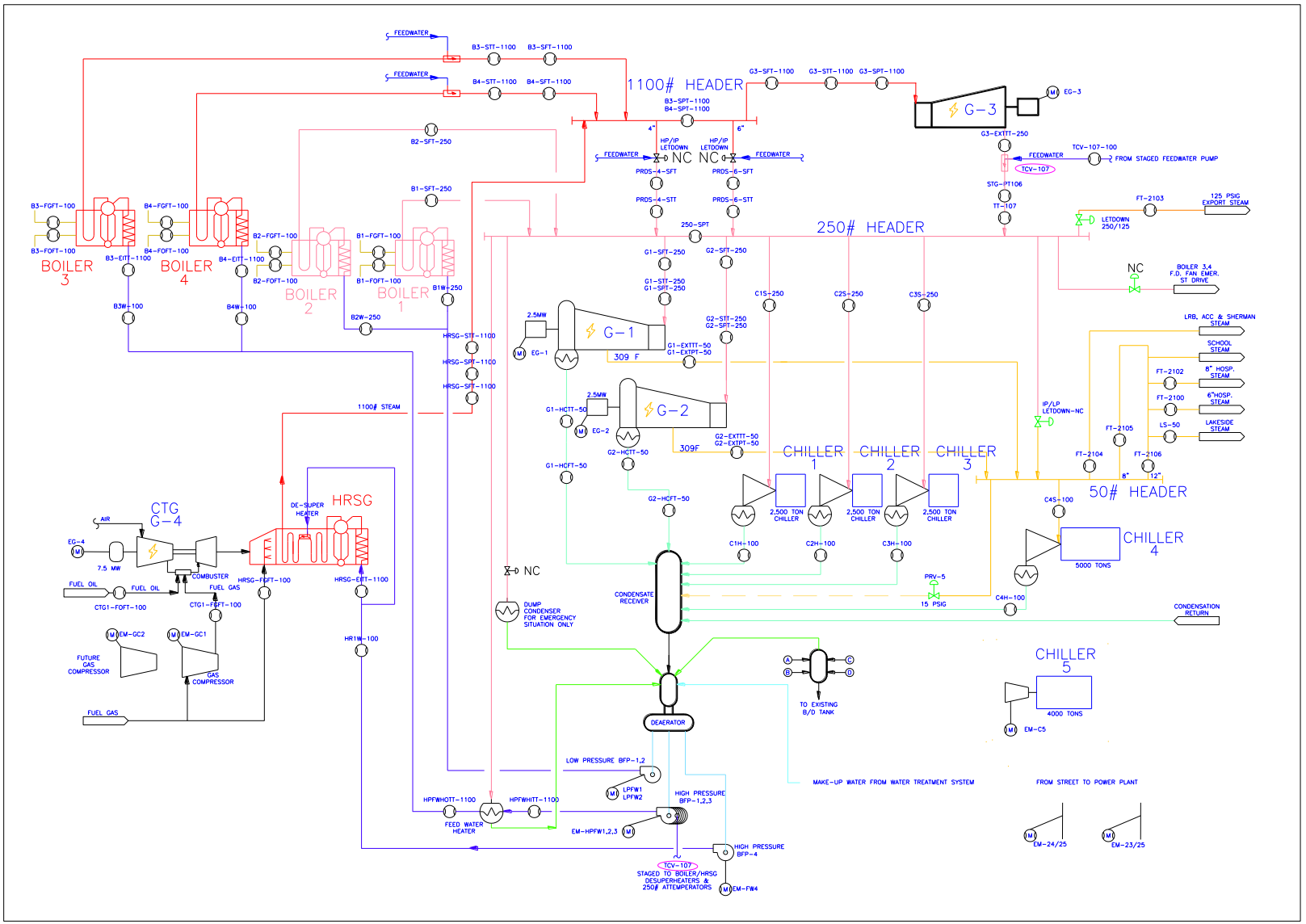
2010 Equipment Selection

- **7.5 MW Combustion Turbine**
  - Natural Gas + #2 Oil back up
- **60 KPPH / 1100 psig HRSG**
  - Duct-Fired on natural gas
  - SCR Emissions Control
- **4K Ton VFD Industrial Electric Chiller**

2012 - Central Energy Plant UMMS

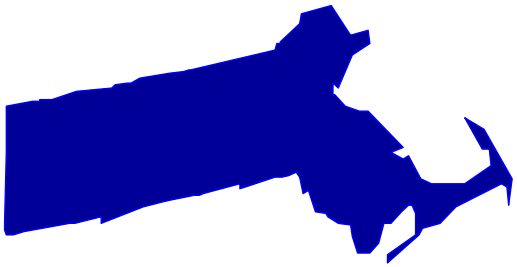


2014 - Central Energy Plant UMMS



Incentive Opportunity – Massachusetts

- **Electric Utility Install Rebates**
  - Minimal load data = to $750 /kW
  - ASHRAE Level 1 audit = to $950 /kW
  - ASHRAE Level 2 audit = to $1100 /kW



- **Mass DOER Efficiency Certificates ~ 21$/credit**
  - AEC Formula is Efficiency-based
  - 2013 Under Supplied Market
  - Increasing Requirements (Utility Purchases)
  - Inflation-adjusted ACP 2014 = $21.72 / Credit (MWh)

Incentives "Capitalized" by UMMS Project

- **Electric Utility**
  - Installation Incentive $750 / kW
- **Massachusetts Alternative Portfolio Standard**
  - Credits based on net fuel savings Vs. SHP
  - Credits create cash flow from measured performance
  - Typical CHP with net electric efficiency of 30% + overall efficiency of 75% will generate ~ 3¢ / net kWhe.
  - UMMS will need qualify under "Incremental" definition
  - Program has no end date – "Annual Cash Flow"

Nexant - Clean Energy Markets

- **2010 UMass Medical selects Nexant "Authorized Representative" for Mass APS program**
- **UMMS first true "Incremental CHP plant" in APS**
  - Credit production from fuel savings above previous baseline operating efficiency, Vs. separate heat and power. **Computed fuel savings = Mass AECs.**
- **Nexant establishes monthly baseline from CY 2009 metered data**
  - (Total Fuel, Net Electric & Useful Thermal)
- **2012 UMMS awarded APS approval by MA DOER**

CY 2013 Performance Vs. 2009 Baseline

- **Net Electric Generation – 81,859 MWh**
  - 114.5% increase (baseline 38,162 MWh)
  - 80% increase in electric generating efficiency
- **Useful Thermal (steam) to Campus – 235,311 MWh**
  - 803,113 MMBtuh
  - 2.5% less thermal load to campus
- **Fuel Consumption (Gas + Oil) – 462,907 MWh**
  - 18.4% increase total fuel input
  - 88% reduction oil consumption

CY 2013 Performance Results Vs. Baseline

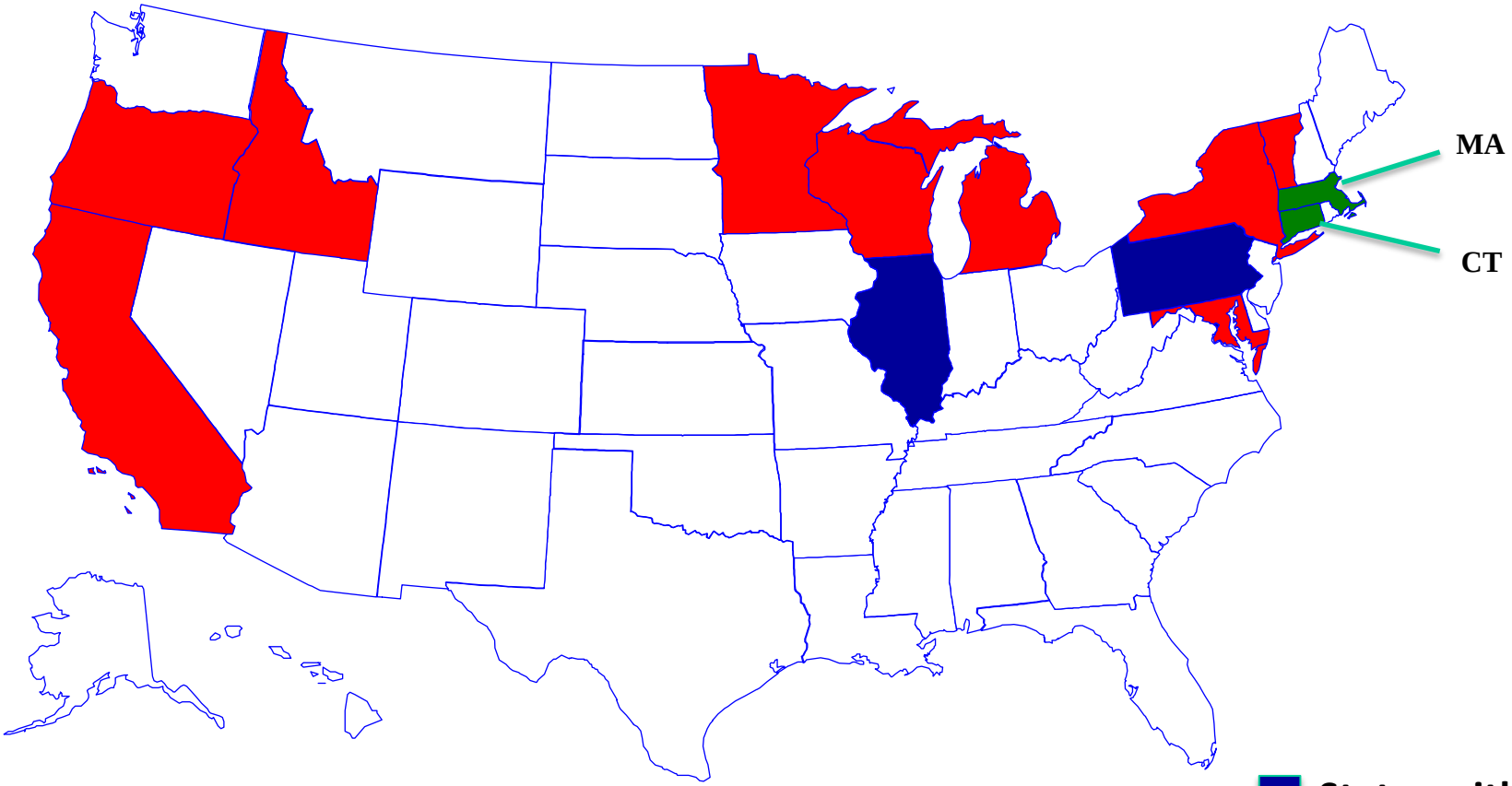
- **Stack Emissions Reduction**
  - Positive Impact from CGT generation
  - Reduction in fuel oil consumption
- **Overall Fuel Efficiency – Year 1**
  - 68.5%
  - 52,103 MWh fuel savings from Cogen mode Vs. Separate Heat & Power generation

  (What are these MWh savings called in Massachusetts?)

Alternative Energy Credits!!!

- **1 AEC = 1 MWh of net source Fuel Savings**
  - AECs = (MWh elec/0.33 + MWh useful thermal/0.8) – MWh Fuel
- **UMMS 2013 Incremental Vs. Baseline**
  - 2.5% less useful thermal load to campus
  - Generated 115% more electric
  - Consumed 18% more fuel
  - Created 52,103 MWh of Energy Efficiency = “AEC’s”
  - **$1 million income ~ 1.3¢/kWh total or 2.5¢/kWh incremental**
- **UMMS Looking Forward**
  - No sunset for Mass APS program
  - Improved operating efficiency will increase AEC production
  - As campus load increases AEC production increases
  - Annual cash flow available for ROI or O&M

States with EECs & Electric Decoupling



States with EECs
States w/ Decoupling
States w/ Both

Conclusion for UMass Medical

- **First Year operating efficiency ahead of projections**
- **Combustion Turbine/HRSG now primary boiler**
- **Stack emissions below 2009 levels**
- **Thermal Plant owner's who purchase majority of electricity from a utility will benefit from incremental addition of a CTG/HRSG and a steam turbine generator.**

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