



Capturing CHP Opportunities

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ICF International

EPA's Clean DG Policy and CHP Webinar Series

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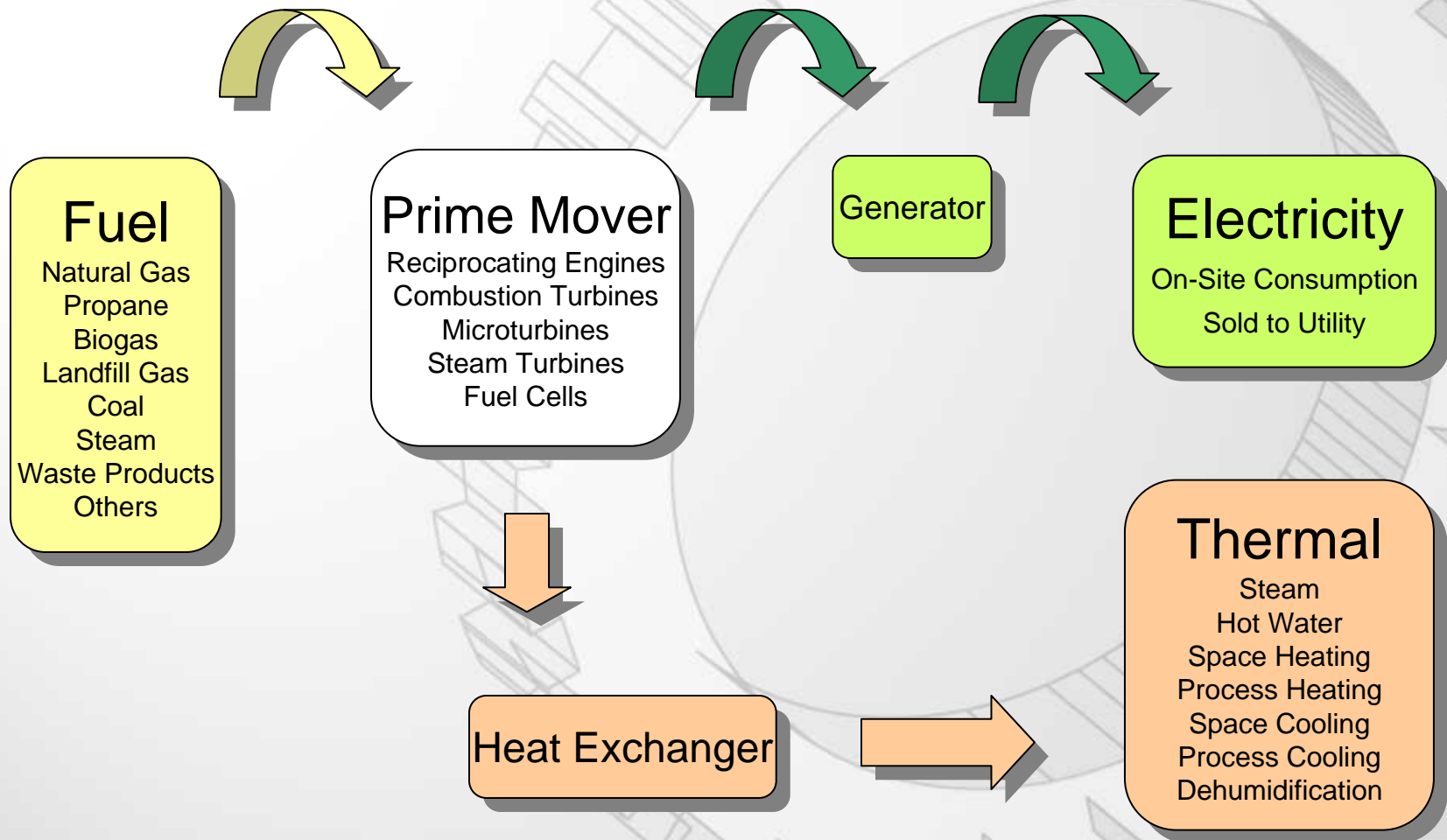
What Is Combined Heat and Power?

CHP is a highly efficient energy system that:

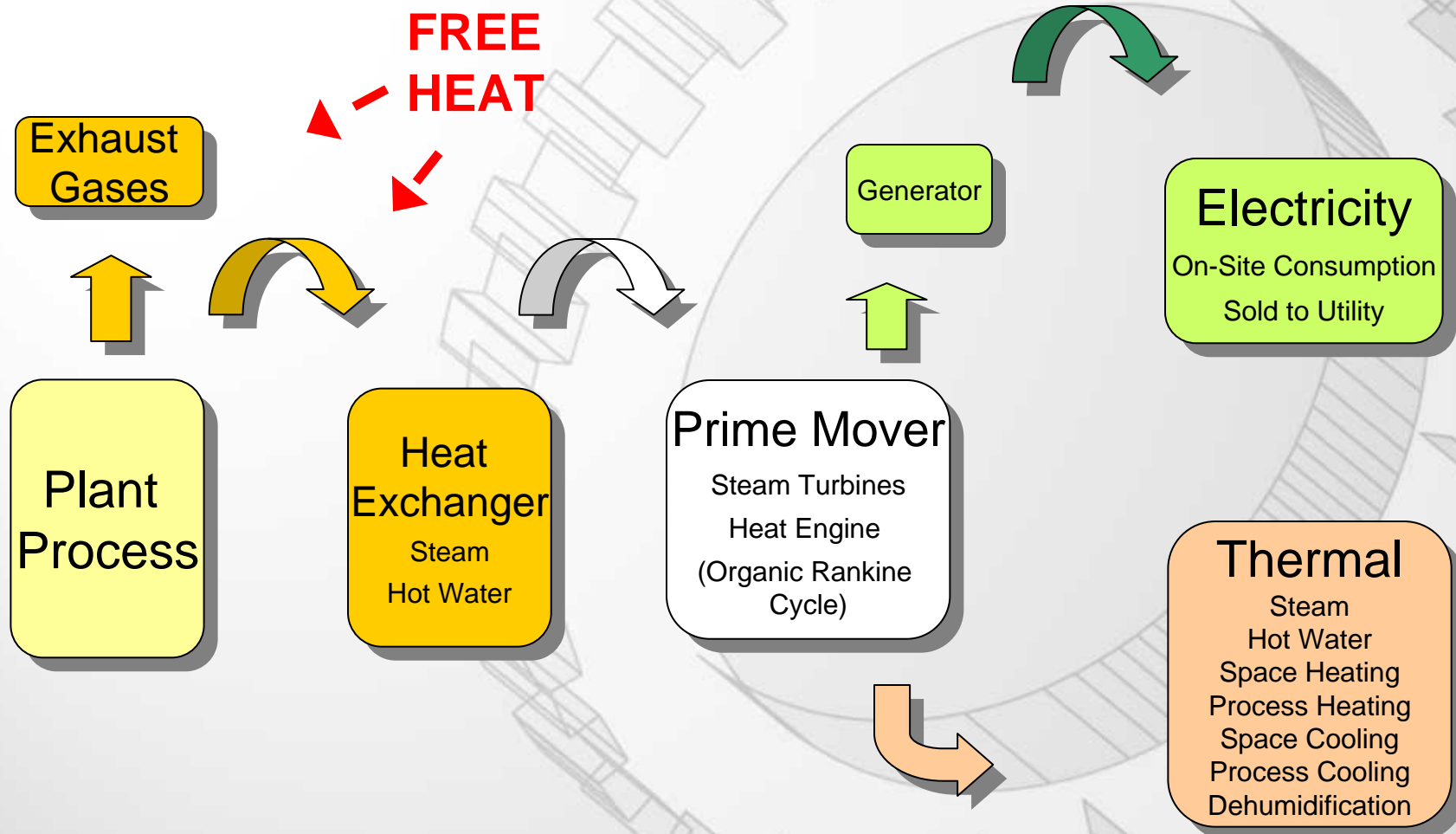
- Is located at or near a building/facility
- Generates electrical and/or mechanical power
- Recovers waste heat for
 - heating
 - cooling
 - dehumidification
- Can utilize a variety of technologies and fuels



What Makes Up a Typical CHP System?



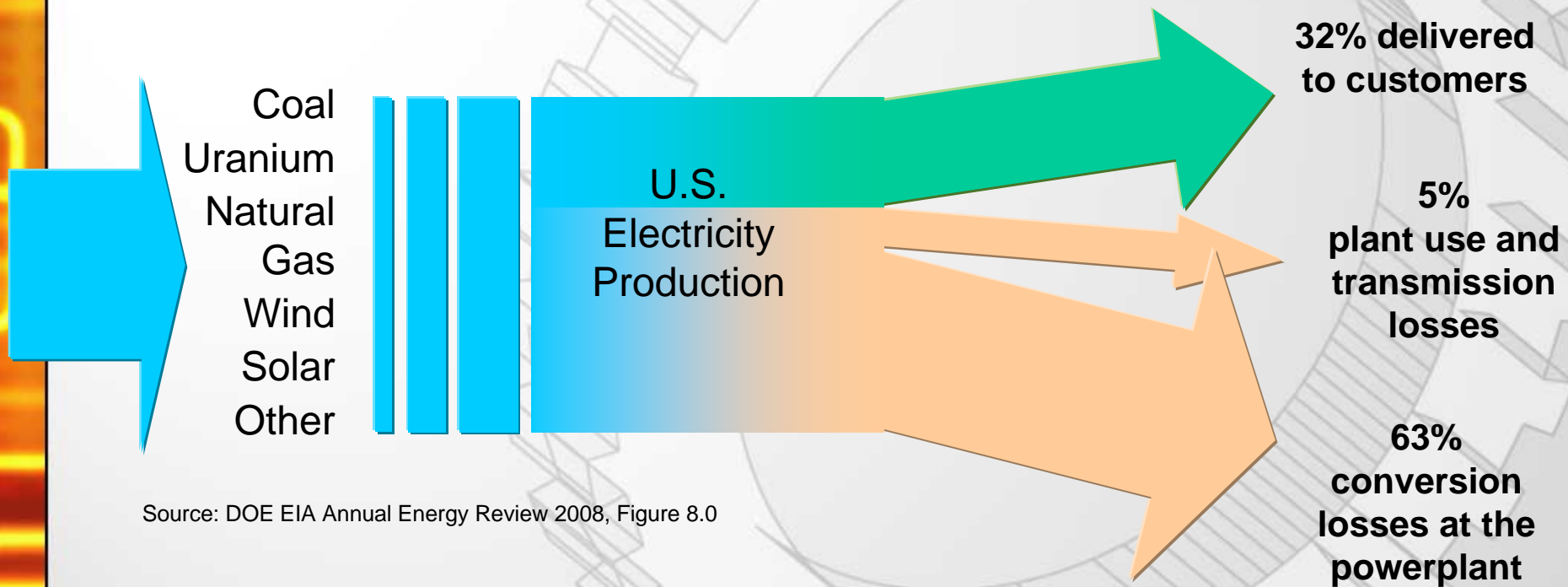
What is Waste Heat Recovery CHP?



What Are the Benefits of CHP?

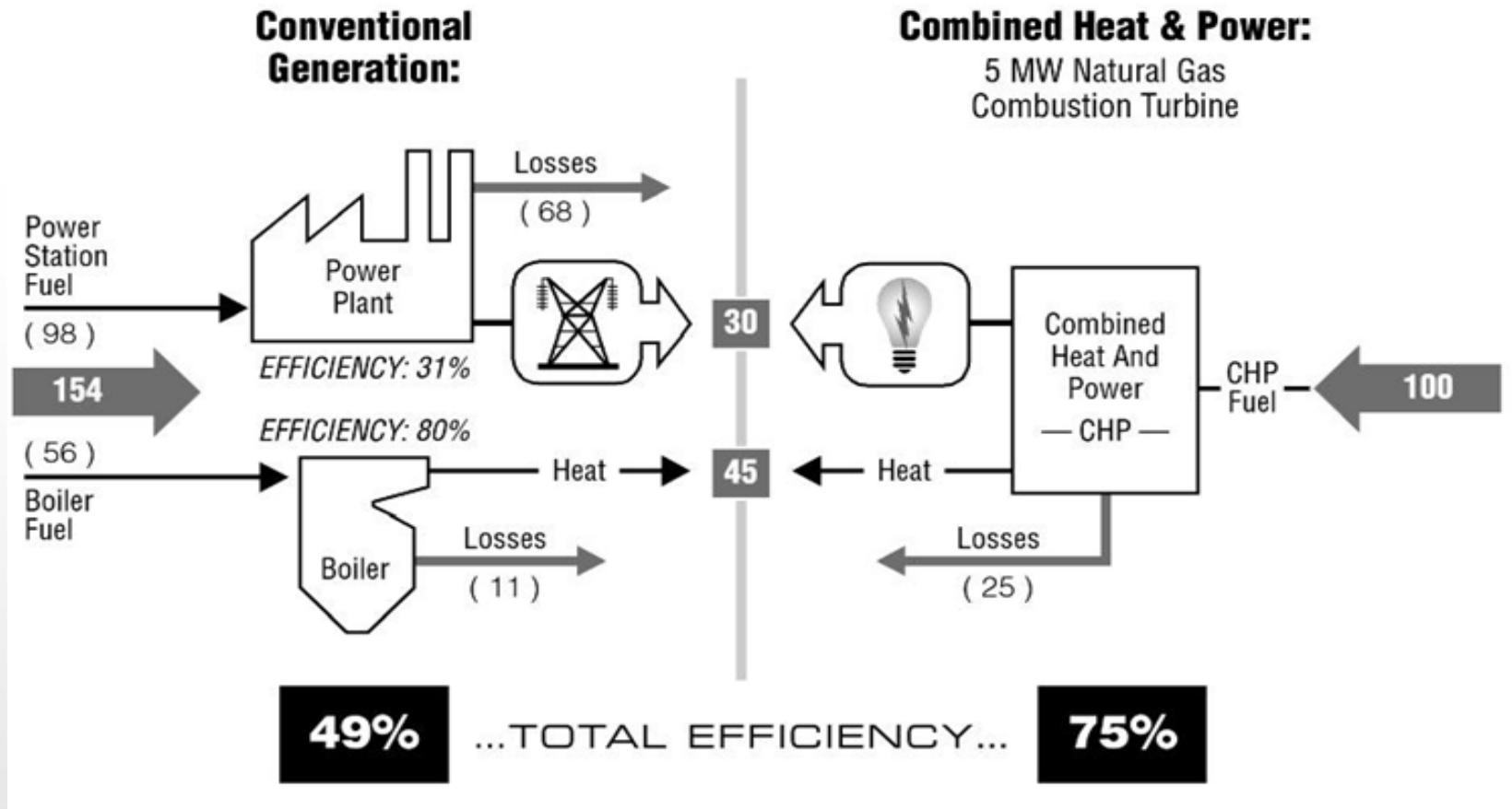
- CHP is more efficient than separate generation of electricity and thermal energy
- Higher efficiency translates to lower operating cost
- Higher efficiency reduces emissions of all pollutants, including CO₂, NO_x and SO₂
- CHP can increase power reliability and enhance power quality
- On-site electric generation reduces grid congestion and avoids distribution costs

Almost Two Thirds of the Fuel Used to Generate Power Is Lost as Heat



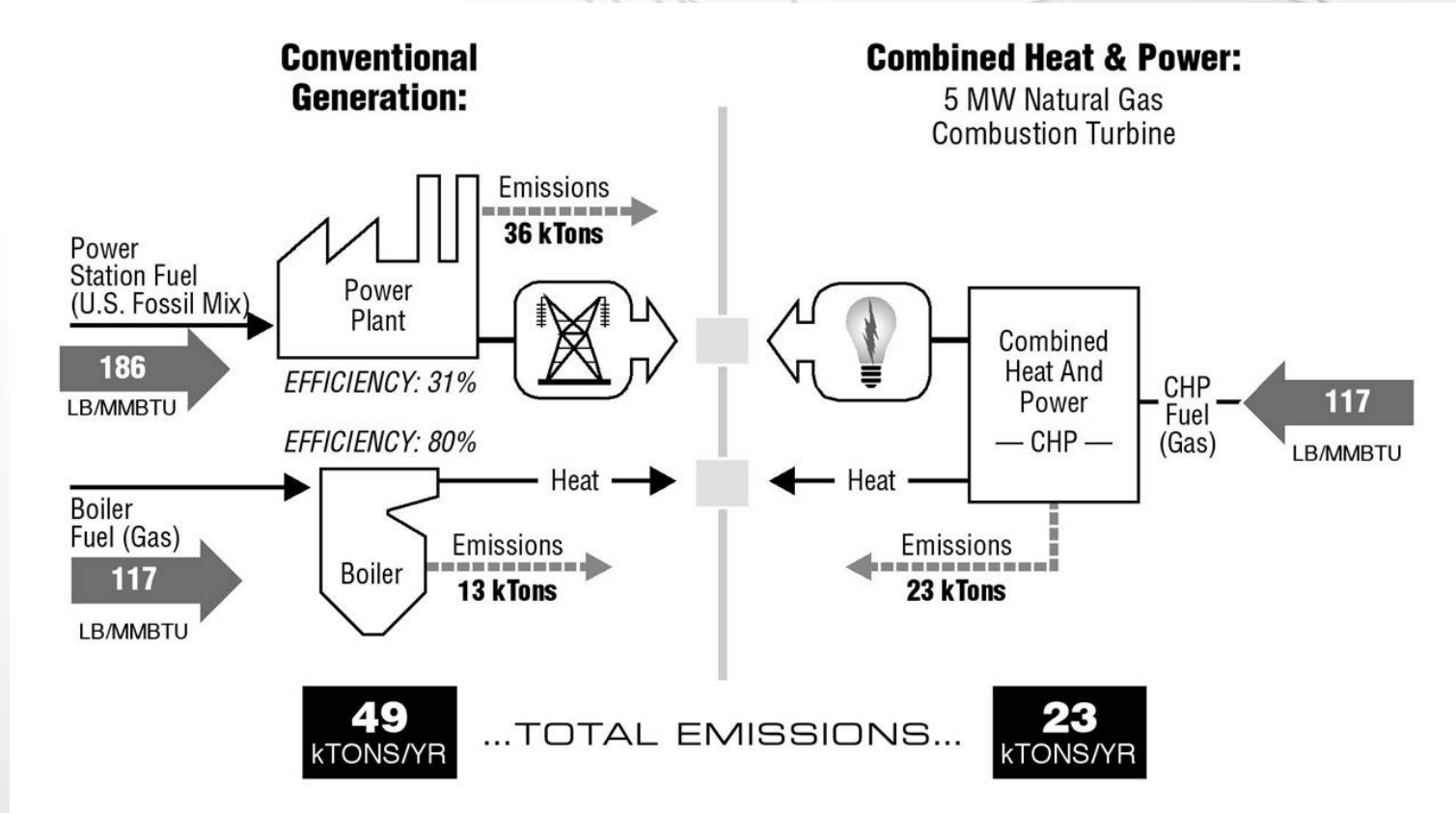
Source: DOE EIA Annual Energy Review 2008, Figure 8.0

CHP Recaptures Much of that Heat



Source: ICF

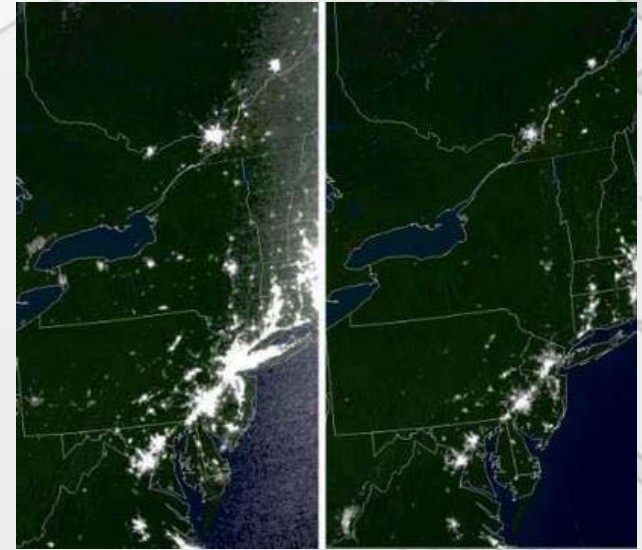
Increased Efficiency Results in Reduced Carbon Emissions



Source: EEA

Power Reliability Benefits of CHP

- Blackout of 2003:
Affected portions of the Midwest, Northeast, and Ontario, Canada
- Power out for up to four days in some locations
- Over 50 million people affected
- Total losses estimated at \$10 billion
- Traditional emergency generators had problems



CHP Kept Facilities Operating in New York during the Blackout

- Montefiore Medical Center; New York City
 - Site down for 5 minutes, then fully operational throughout the duration of the outage
- Spring Creek Towers, New York City
 - Independent of grid, never lost power and was able to provide for some needs of the community
- South Oaks Hospital, Amityville, NY
 - Seamless transfer to CHP system only; staff unaware of blackout until police call

CHP Kept Power on During Katrina

- Baptist Hospital, Jackson, MS
- 624 bed urban hospital, 3000 employees
- 3.2 MW gas turbine CHP system – installed 1994
- Steam used for hot water, sterilization and absorption chillers
- Grid down for 52 hours starting August 29, 2005 due to Katrina
- CHP system ran islanded and provided power, hot water and air conditioning



CHP Is Low Technical Risk

- Uses Proven Technologies
- Based on Standard Design Practices
- Relies on Good Maintenance Practices
- **CHP Is More A Financial and Regulatory Risk**

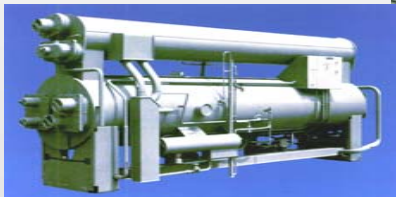
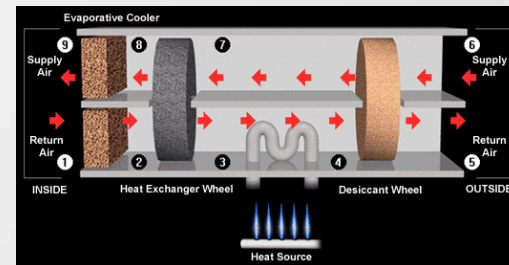
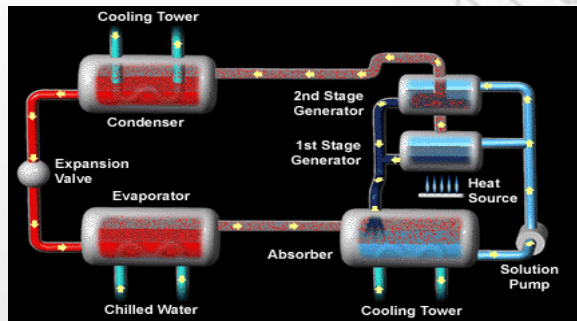
CHP Is Proven Technology

- Generation Equipment
 - Reciprocating Engines
 - Gas Turbines
 - Microturbines/Fuel Cells
 - Steam Turbines



CHP Is Proven Technology

- Heat Recovery Equipment
 - Steam and Hot Water
 - Absorption Cooling
 - Desiccant Dehumidification
 - Direct Process Heat



What Affects Technology Choice?

- Energy costs and fuel availability
- Electrical load size/factor/shape
- Load criticality
- Thermal load size/shape
- Special load considerations
- Regulatory requirements

CHP Economics

CHP System:

- 250 kW
- 75 Tons
- 1,300 MBH

Utilities:

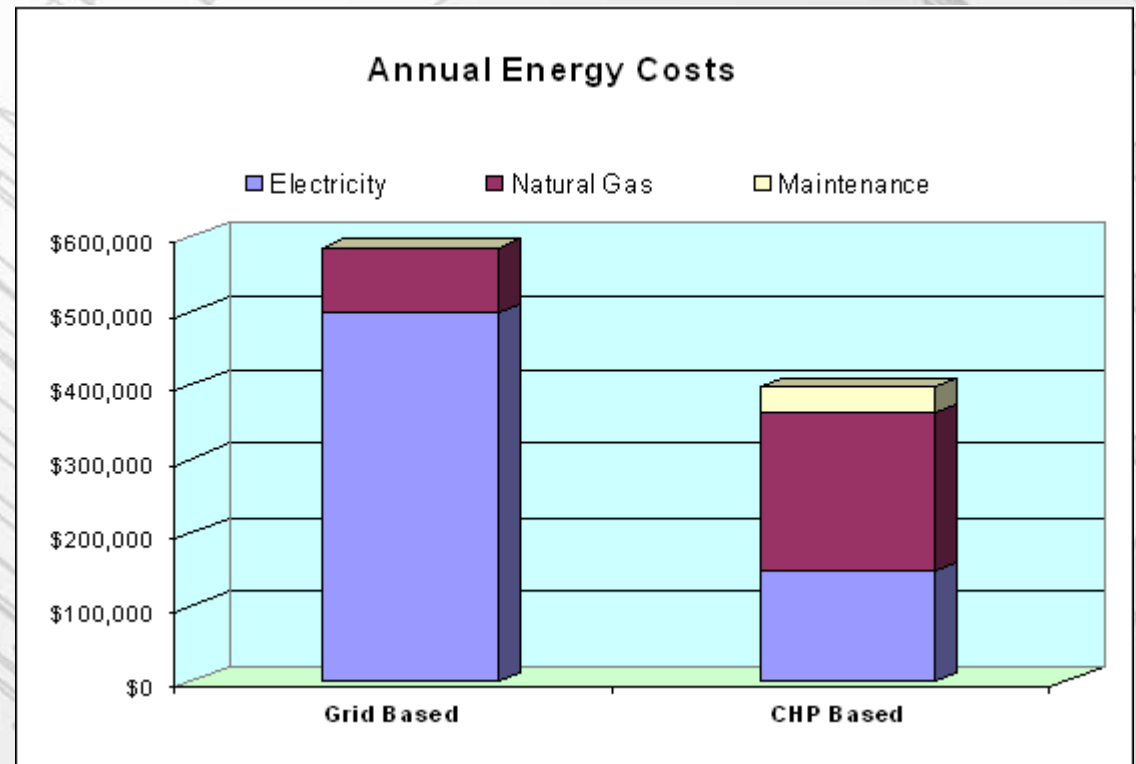
- \$0.12/kWh
- \$8.59/MMBtu

Maintenance:

- \$0.0175/kWh

Savings:

- **\$188,000/Yr**



What Makes a Good CHP Application?

- Good Coincidence Between Electric and Thermal Loads
- Central Heating/Cooling System
- Large Cost Differential Between Purchased Electricity (Grid) and CHP Fuel --- “Spark Spread”
- Long Operating Hours
- Economic Value of Power Reliability is High
- Renovation and/or expansion of existing facilities
- New facilities

Candidate Applications for CHP

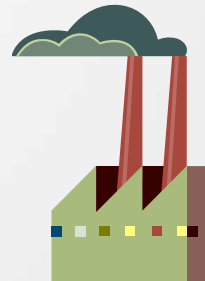
Commercial/Institutional

- Hospitals
- Universities/Schools
- Office Buildings
- Data Centers



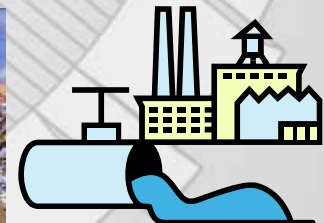
Industrial

- Manufacturing
- Food Processing
- Ethanol



Municipalities

- Landfills (fuel source)
- Wastewater Treatment Facilities



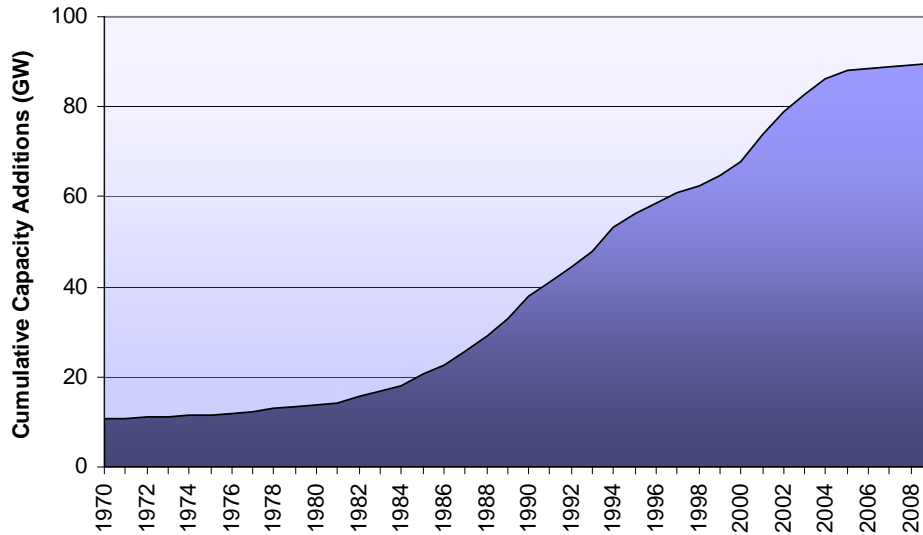
Agriculture

- Livestock Waste
- Crop Waste



CHP Is already a Significant Resource for the US

CHP Growth 1970 to Present



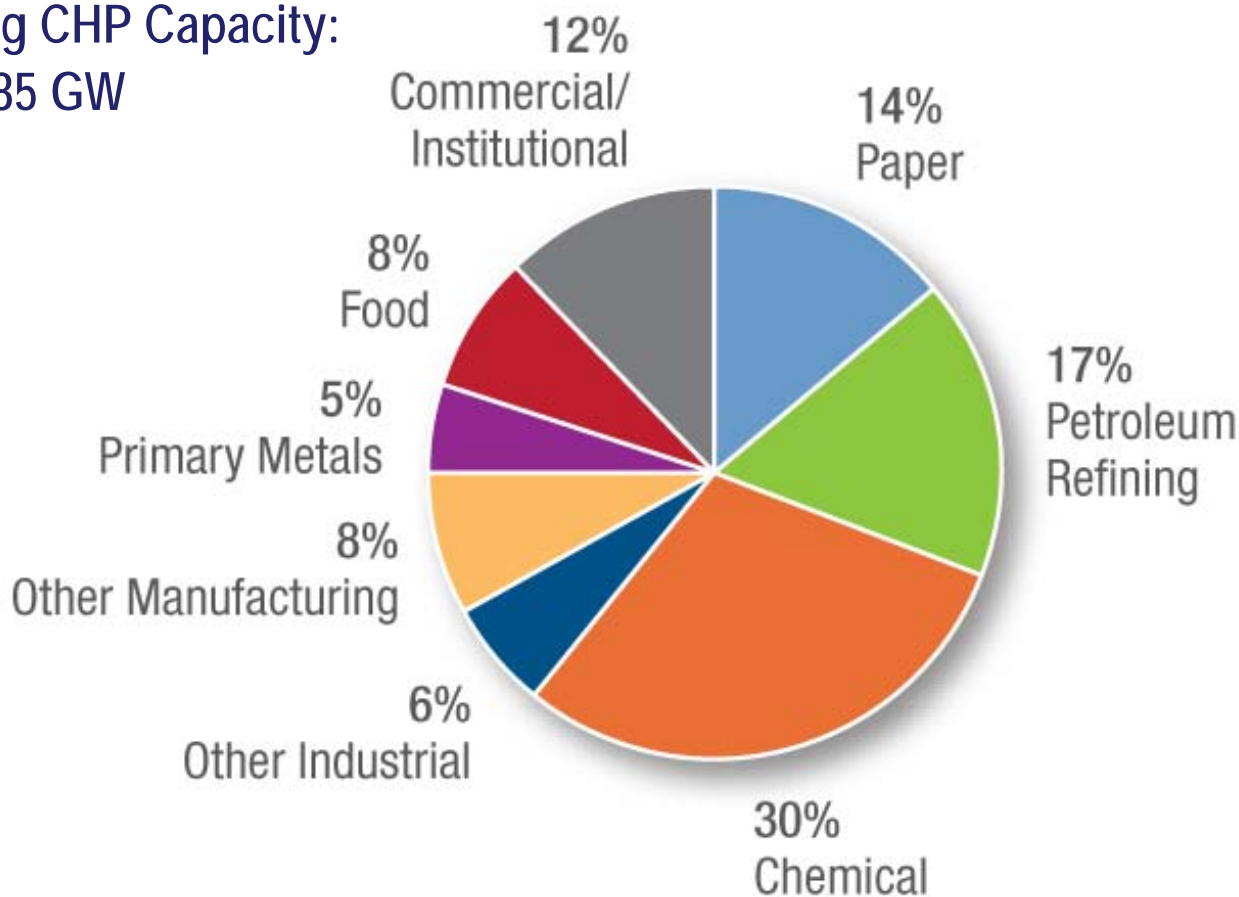
- 82% Manufacturing
- 5% Other Industrial
- 13% Commercial/Institutional

- 9% U.S. Generating Capacity (MW)
- 12% Generation (MWh)

2008 Existing CHP - 9% of U.S. Capacity	85 GW
Reduced Annual Energy Consumption With CHP	1.9 Quads
Total Annual CO ₂ Reduction	248 MMT
Carbon Saved	68 MMT
Number of Car Equivalents Taken Off Road	45 million

The Bulk of Existing CHP Capacity Is in Industry

Existing CHP Capacity:
85 GW



Source: ICF CHP Installation Database

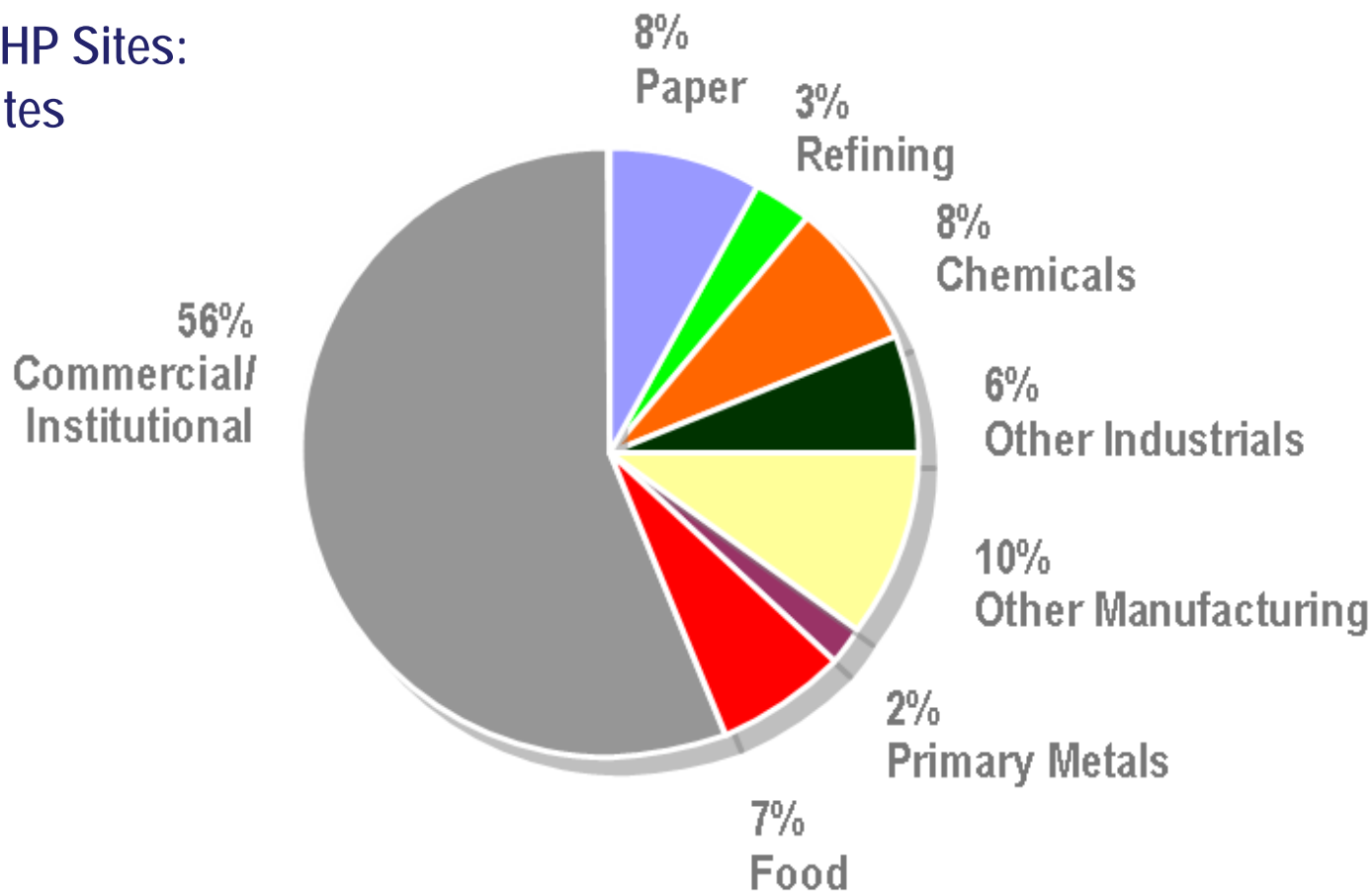
Frito-Lay CHP System

- Killingly, Connecticut Facility
 - 400 employees
 - Processes 250,000 lb/day of corn and potatoes
- CHP System
 - 4.6 MW Gas Turbine with SCR for NOx Control
 - Provides 100% electricity needs and 80% of site steam needs
- Start-up March 2009



But CHP Is Employed by a Variety of Users

Existing CHP Sites:
3,600 sites



Source: ICF CHP Installation Database

Arrow Linen Supply CHP System

- Laundry service for restaurants in New York
- Two 150 kW reciprocating engine packages
 - Peak demand of 370 kW
- Hot water thermal recovery for washers and processing
- Electric Load Following
 - CHP system provides 70% of facility's power



Arrow Linen Supply

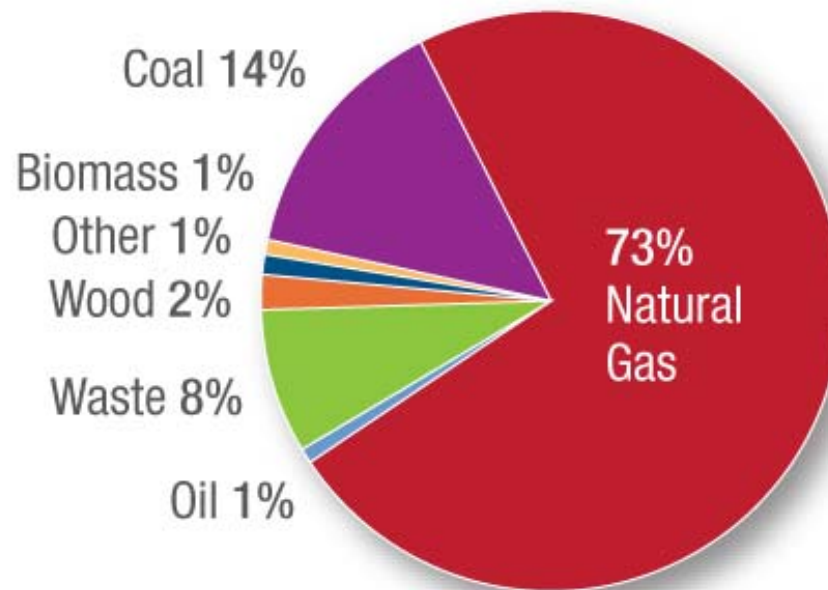
Project Economics

- Annual energy costs of \$900,000 before CHP
- CHP installed cost \$700,000
- CHP savings of \$115,000 per year
- 6.25 year payback based on typical costs
- 3.7 year payback for project with incentives



CHP Uses a Variety of Fuels

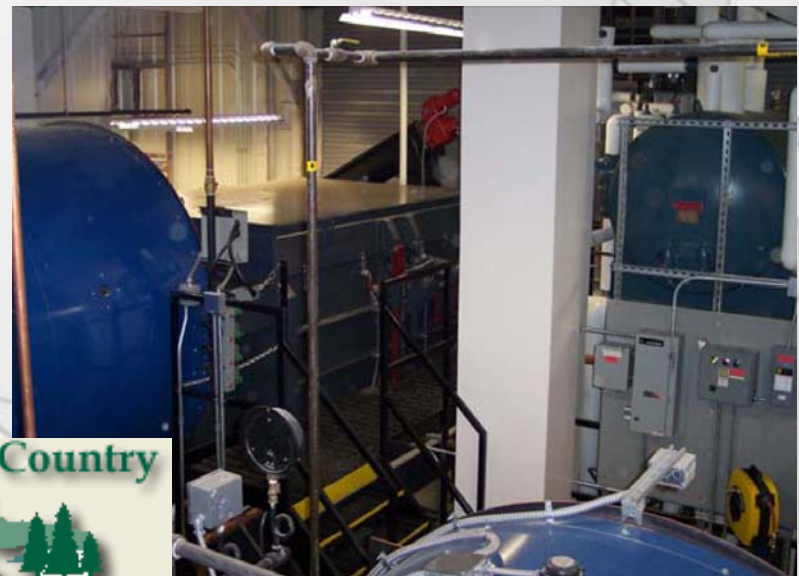
Existing CHP Capacity:
85 GW



Source: ICF CHP Installation Database

North Country Hospital

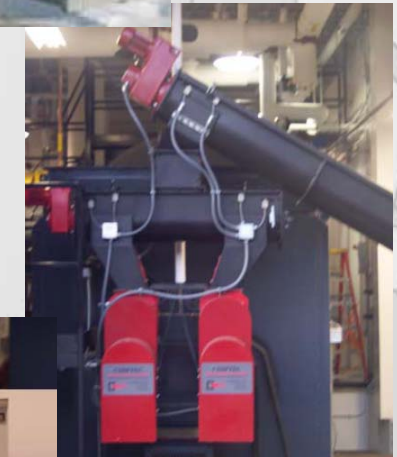
- 279 kW boiler/steam turbine CHP system, in Newport, VT
- Fuel - gasified wood chips
 - Wood chip moisture content of 35%
- All electricity and thermal energy is used on-site
- Steam flow rate 11,000 lb/hr
- Steam provides heating in the winter and powers an absorption chiller in the summer



North Country Hospital

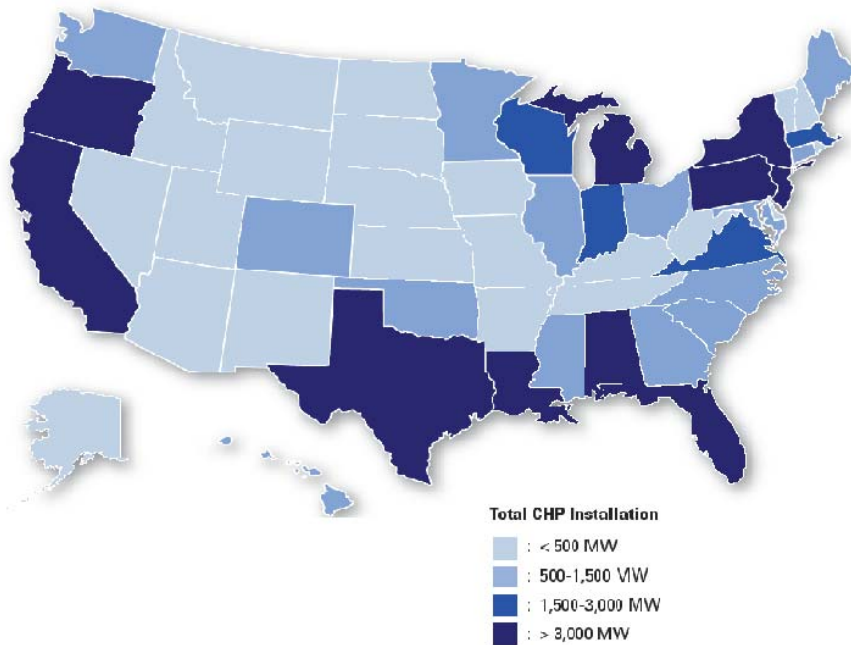
Project Economics

- Installed cost \$1.5 million
- Annual Savings
 - \$115,000 in electricity costs
 - \$70,000 in demand reduction
 - \$210,000 in heating fuel costs
- 3.8 year payback
- 26% return on investment

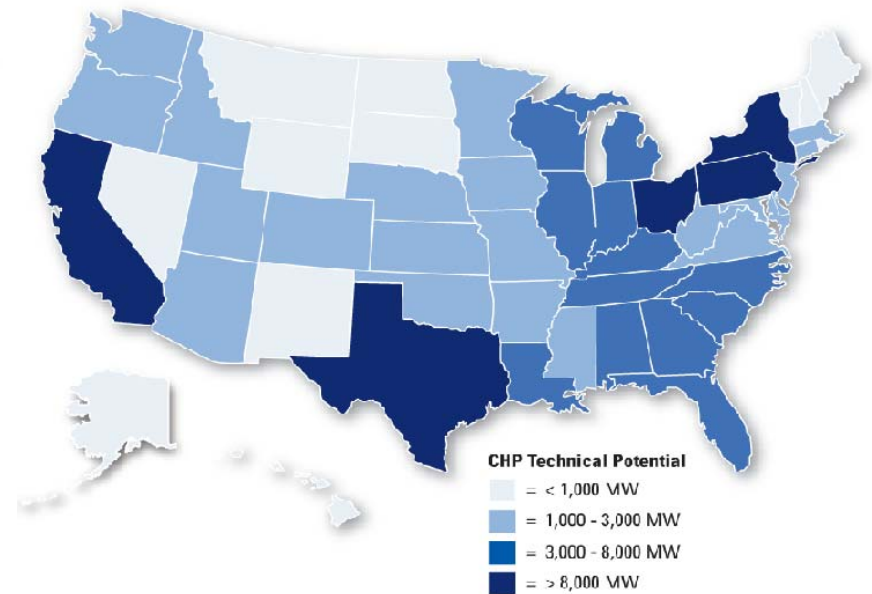


CHP Is Applicable Nationwide

Existing CHP Systems



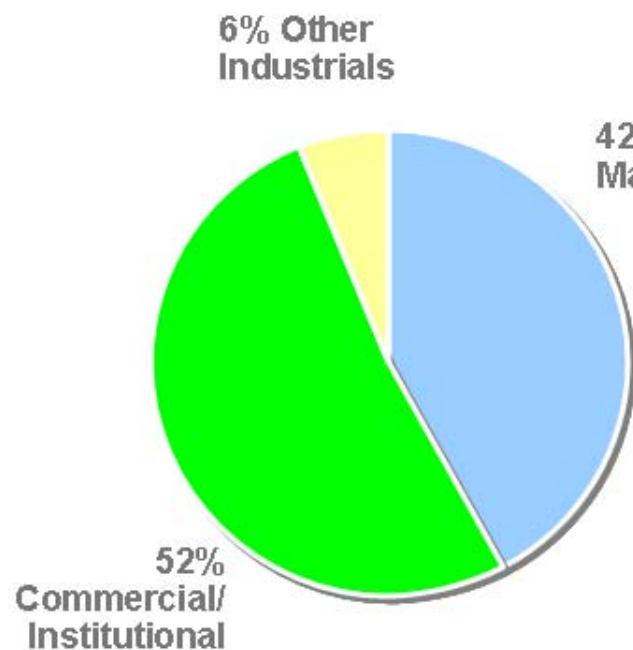
Potential for Additional CHP



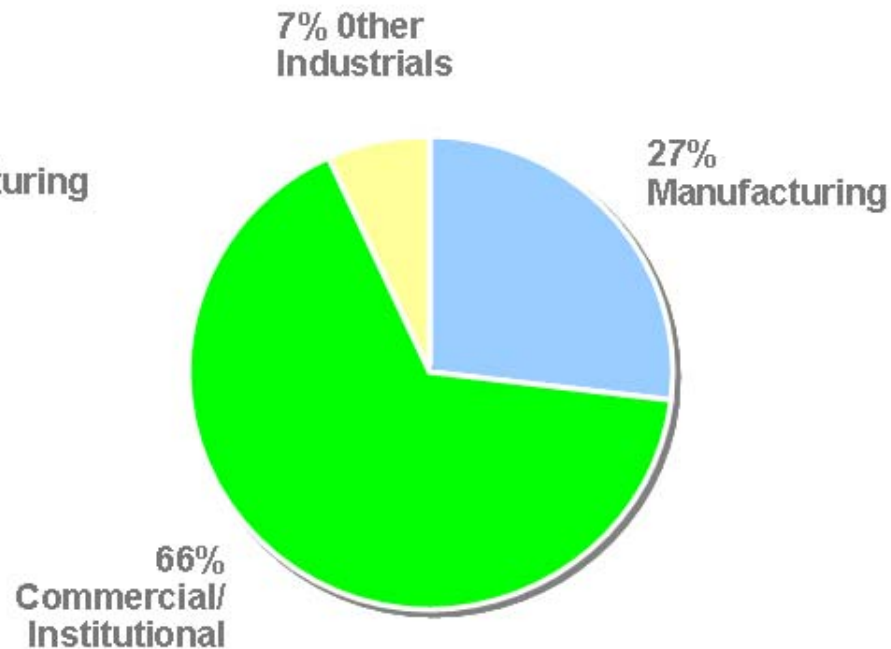
The Future Is Smaller, Thermally-Based CHP

- Thermally-sized systems providing heat and power primarily for on-site use
- Almost one-half of the potential is in commercial / institutional applications
- Much the potential is in systems below 20 MW in size
- Much of the potential is in applications with limited experience with CHP
 - Industrial – food processing, fabrication and assembly
 - Commercial – lodging, office buildings, multifamily
 - Institutional – hospitals, schools, government facilities

CHP Is Already Being Adopted by Non-Traditional Users



Up to 1999: 2,585 sites



2000-2009: 1,374 sites

Source: ICF CHP Installation Database

Qualcomm CHP System for Mixed Office and Data Center Use

- Wireless technology innovator with strong sense of environmental stewardship
- Two CHP systems at San Diego campus
- One system dedicated to LEED Gold certified facility with 12,000 sq ft data center
- Recent CHP expansion had a payback of 4 years
- CHP systems save 6,172 tons per year in CO₂ emissions and 44 tons per year of NO_x,



Building W Campus CHP System

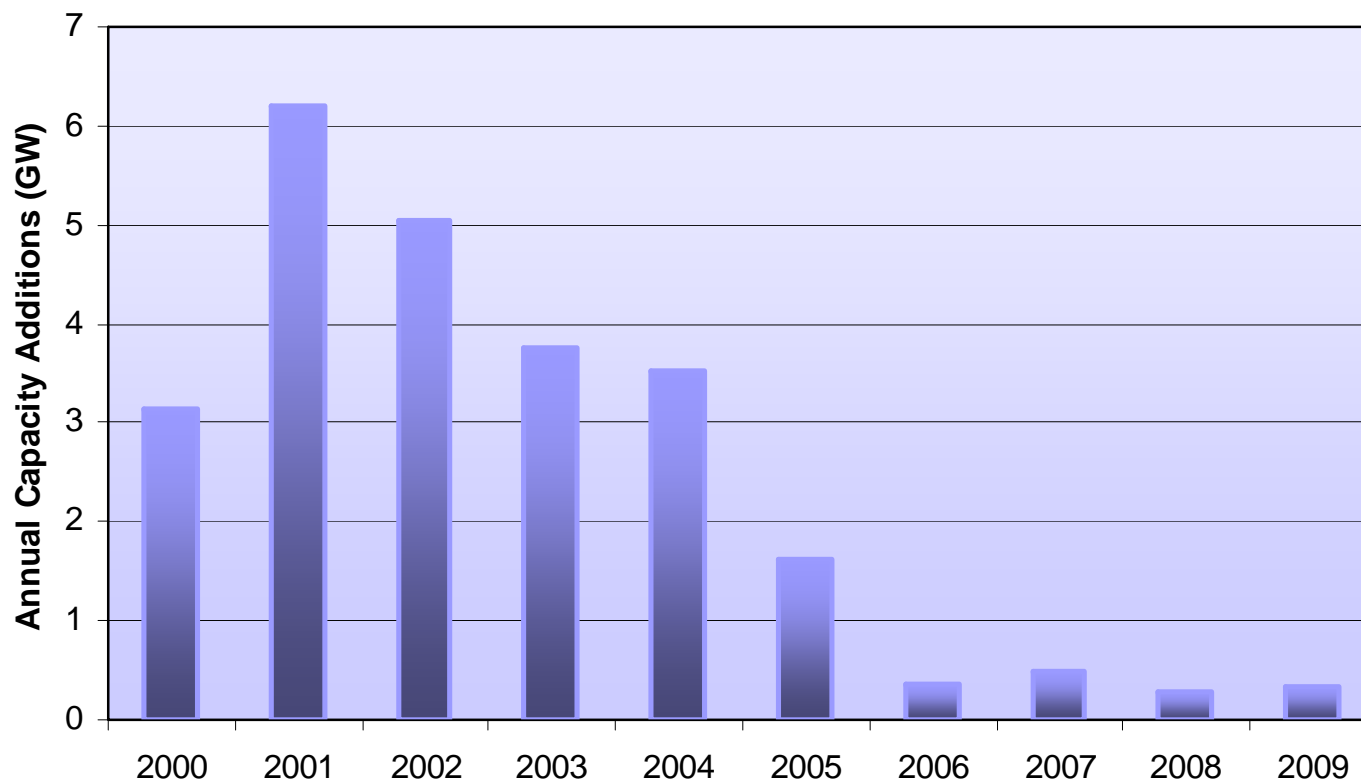
- 4.5 MW Gas Turbine CHP system
- 1200 Ton Absorption Chiller
- 1 million square foot LEED Gold Certified facility
 - Engineering labs
 - Chip testing floor
 - Data center
 - Cafeteria
- Supplies 85% of building's power and cooling load



Current Market Conditions

New CHP Capacity Additions Have Been Below 1,000 MW/Year Since 2006

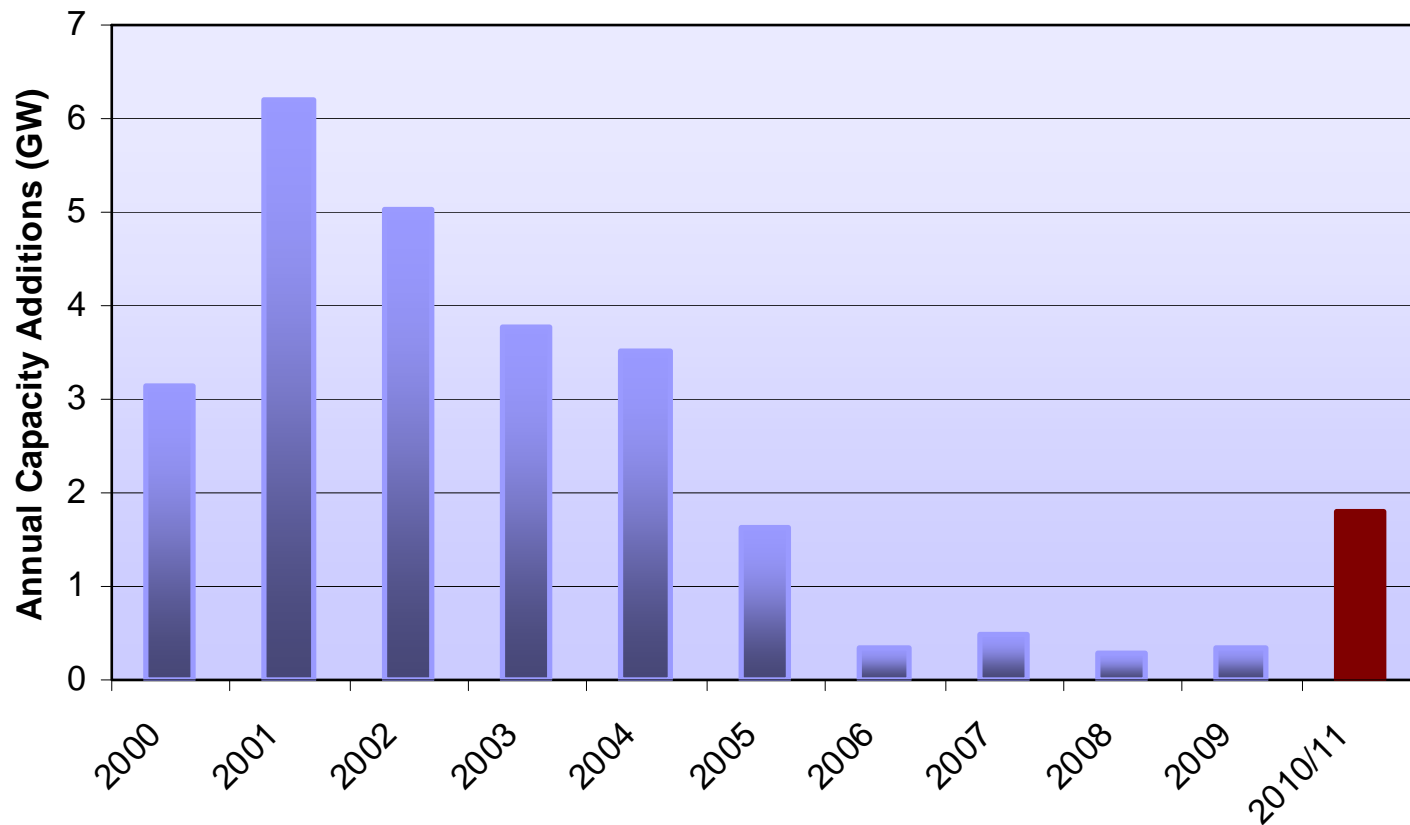
Annual Capacity Additions, 2000 to Present



Source: ICF CHP Installation Database

Over 1,800 MW of New CHP Capacity Is Currently in Construction or Engineering

Annual Capacity Additions, 2000 to 2010/2011



Source: ICF CHP Installation Database

Market Status

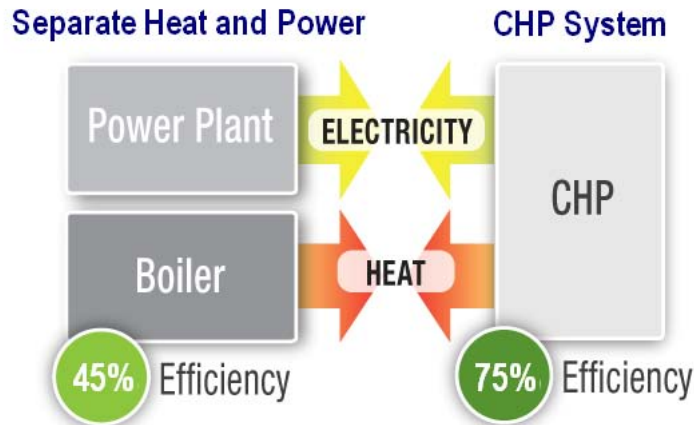
- Most activity in states with favorable regulatory treatment and/or specific incentives
- Natural gas CHP in areas with supportable spark spread (Northeast, Texas, California)
- Biomass and opportunity fuels in Southeast, Midwest and Mountain
- “Hot” applications: universities, hospitals, waste water treatment, food processing
- Growing interest in waste heat to power applications
- Increasing interest in carbon reduction and in power reliability benefits of CHP

Barriers to Further Development

- **Grid Interconnection and Regulatory Issues** – Expensive and time-consuming interconnection process, high standby rates, unattractive rates for exported power
- **Capital Costs** – Fully installed costs of CHP systems are high in some applications
- **Fuel Availability and Prices** – Fuel price volatility creates uncertainty and risk; fuel related costs remain a large part of life cycle/operating costs
- **Permitting** – State by state regulations impact decisions; CHP not credited for system-wide emissions reductions and benefits of heat recovery
- **Greenhouse Gas Legislation** – Unclear how pending climate legislation or regulation will affect CHP

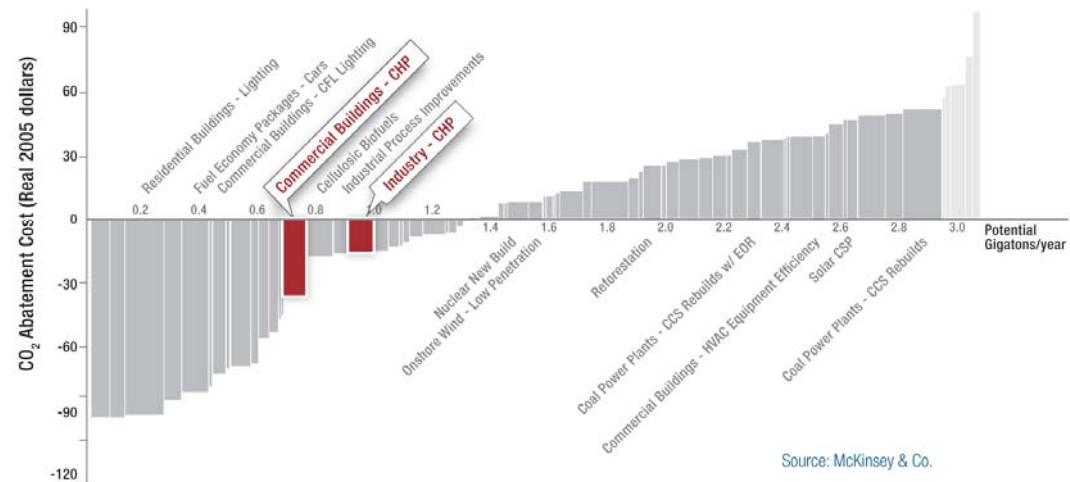
Policymakers Are Getting the Message about CHP

Benefits of CHP



- CHP is a critical energy efficiency resource
- CHP can quickly and cost-effectively reduce CO₂ emissions
- CHP can enhance economic competitiveness

Cost of CO₂ Reduction Technologies



Energy Independence and Security Act of 2007

- Title IV, Section D, contained provisions designed to improve energy efficiency by promoting CHP, waste energy recovery and district energy.
- Called for EPA to establish a Waste Energy Recovery Registry to identify the quantity and quality of recovery potential
- Authorized funding of regional Clean Energy Application Centers
- Authorized a Waste Energy Recovery Incentive Program (not appropriated)
 - Production incentive of \$10/MWh during first three years of operation

Energy Improvement and Extension Act of 2008

- Provided a 10% investment tax credit (ITC) for the first 15 MW of CHP property
 - Systems <50 MW
 - Produce at least 20% useful thermal and 20% electricity
 - Be 60% efficient
 - Be placed in service before January 1, 2017
- CHP qualifies for 5 year depreciation under Modified Accelerated Cost Recovery System (MACRS)

American Recovery and Reinvestment Act of 2009

- Provides refundability to investment and production tax credits through a grant program within the Department of Treasury
- Allows “bonus depreciation” for CHP:
 - 50% of depreciation value can be taken in the first year
 - Remainder over the following four years
- Allows CHP tax credits even if projects are financed with local development bonds
- Allows biomass projects to claim a 30% investment tax credit
- Provides some \$100 billion of additional government-backed loan guarantees for clean energy projects
- Funding for “shovel ready” projects
 - \$156 million of cost-share grants for CHP, waste energy recovery, district energy, and industrial-efficiency projects (DOE ITP FOA44)

Waste Energy Recovery Registry

- Purpose
 - Provide a list of the economically feasible waste energy recovery opportunities in the U.S. based on a survey of major and large commercial sources
 - Provide state and national totals of the existing waste energy recovery opportunities, as well as potential criteria pollutant and GHG emissions reductions
 - Serve as the basis for potential waste energy recovery projects to qualify for financial and regulatory incentives
- Status
 - Final rule under review within EPA

Federal Outlook

- Proposed Tax Enhancements
 - Clarify ITC for waste heat to power CHP
 - Increase ITC eligibility from 15 to 25 MW for projects of unlimited size CHP
 - Increased ITC of 30% for highly efficient CHP
- Jobs Bills – additional funding for “shovel ready” projects
- Loan Guarantees
- Climate Legislation
 - Include CHP in Combined Efficiency and Renewable Energy Standard
 - How to recognize GHG benefits of CHP?

State Initiatives

- Thirteen states include CHP or waste energy recovery in portfolio standards
 - Nevada, Oregon, South Dakota, North Dakota (*B.C. and Saskatchewan*) - waste heat recovery projects equivalent to other renewable electric generation resources
- State/Regional Climate Plans
- Specific incentives for CHP
 - New York
 - Connecticut
 - New Jersey
 - Massachusetts
 - California
 - Texas
 - Midwest Governors Association

New Jersey

- Clean Energy Program supports increased energy efficiency and installation of clean energy technologies
 - Calls for 1,500 MW of CHP as part of state energy plan
 - Provides \$450/kW incentive (first \$70 million offering closed at the end of 2009)
- Utility-based Energy Efficiency Incentive programs
 - PSE&G announced \$190 million program
 - \$450/kW rebates for CHP in hospitals
 - 50% of design costs

Massachusetts

- MA Alternative Energy Portfolio Standard – CHP is eligible technology
 - 250 MW by 2020
 - \$20/MWh equivalent
 - CHP credit includes electricity and thermal
 - Metered power output and useful thermal reported quarterly with independent verification
- Gas and Electric Rebates for CHP
 - Green Communities Act directs utilities to purchase all cost-effective efficiency and makes CHP eligible
- MicroCHP eligible for Renewable Trust

Questions

Appendix

New York

- CHP technology demonstration and fleet program
 - Energy Efficient Power Systems
- Existing Facilities Program – pay for performance
- Multi-family Facilities Program – pay for performance
- Renewable Portfolio Standard
 - Anaerobic Digesters under customer-sited tier
 - Fuel cells

Connecticut

- “An Act Concerning Energy Independence”, June 2005
- Customer CHP and DG Incentives
 - \$450/kW, additional \$50/kW in congestion area
 - Utilities receive \$200/kW (down to \$50 in 2011)
 - Low interest financing
 - Natural gas distribution cost rebate
 - No back-up power for new systems
- More than 80 applications representing 300 MW between 2006 and 2008

California

- CARB set a target of 4,000 MW of new CHP by 2020 in response to AB 32
- AB1613 calls for feed in tariffs for excess power from CHP systems $< 20\text{MW}$
- CPUC considering must-take contracts for excess power from large CHP ($>20\text{ MW}$)
- Bill to reinstate Self Generation Incentive Program for fossil-fueled CHP signed
 - \$600/kW for first 1 MW, systems up to 5 MW
- Waste heat recovery projects not regulated as GHG sources

Texas

- Active Texas CHP Initiative
- State emergency preparedness bills include CHP provisions
 - State and local government buildings that must operate before, during and after major events and >500 kW
 - Mandated to evaluate CHP before construction and major renovation
 - Consider implementing if payback is less than 20 years

Midwest

- Midwest Governors Association released carbon reduction plan
- Doubling amount of CHP by 2030
 - Increase current 10.4 GW to 21 GW
 - Increase CHP's share of generating capacity from 4.3% to 7.1%
- City of Chicago considering its own target
 - Increasing current 117 MW to 317 by 2019