CHP Is Flexibility:
CHP Offers a Flexible Compliance Option for Power Plants under 111(d)

Jennifer Kefer – Alliance for Industrial Efficiency
Melissa Mullarkey – Recycled Energy Development
Bruce Hedman – Institute for Industrial Productivity
Vignesh Gowrishankar – NRDC
Stacey Davis – Center for Clean Air Policy
Rodney Sobin – Alliance to Save Energy

The Alliance for Industrial Efficiency

Anatomy of the Clean Air Act

- Section 110 – Regulates 6 common air pollutants (NAAQS)
- Section 112 – Hazardous Air Pollutants (HAPs)
- Section 111 – Gap pollutants
  - 111(b) - new, modified and reconstructed sources
  - 111(d) - existing sources

The Alliance for Industrial Efficiency

Federal-State Collaboration

1. EPA establishes emission guidelines
2. States design programs that meet those guidelines

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Standard of Performance

"degree of … limitation achievable through the … best system of emission reduction … taking into account the cost … and any nonair quality health and environmental impact … the Administrator determines has been adequately demonstrated."

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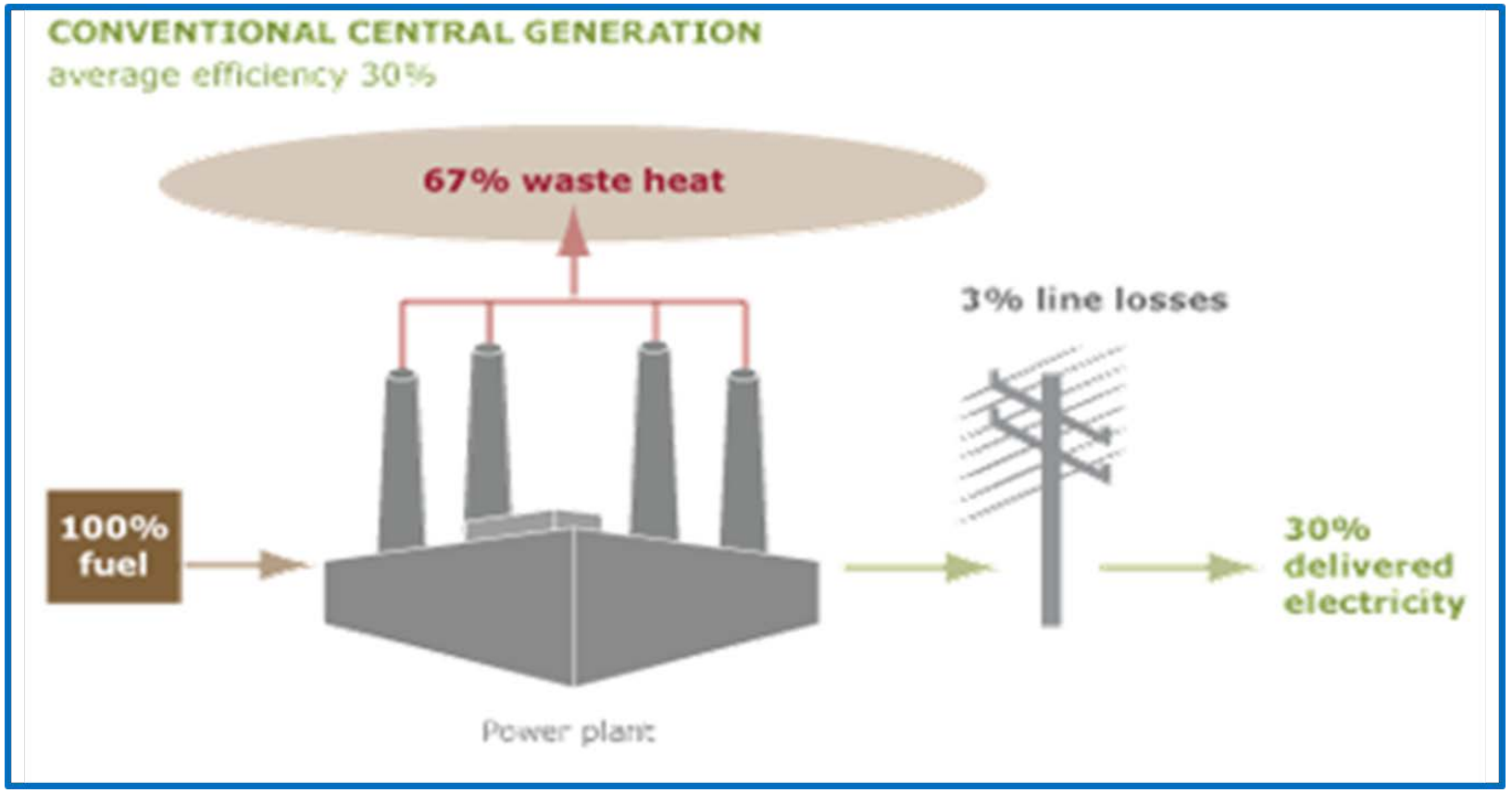
Conventional Power Generation Is Inefficient



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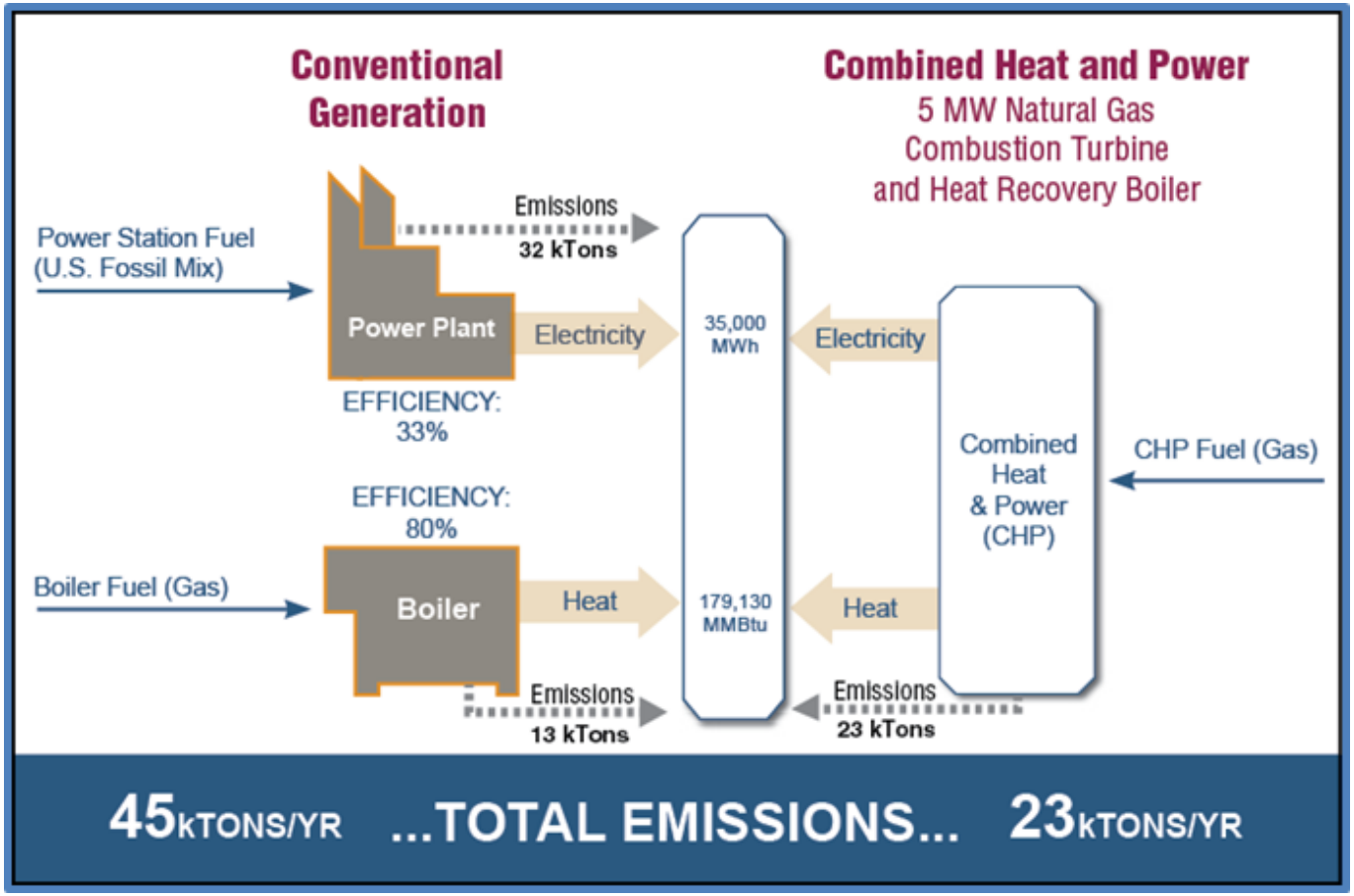
CHP Reduces GHGs



Source: EPA CHP Partnership - 2012

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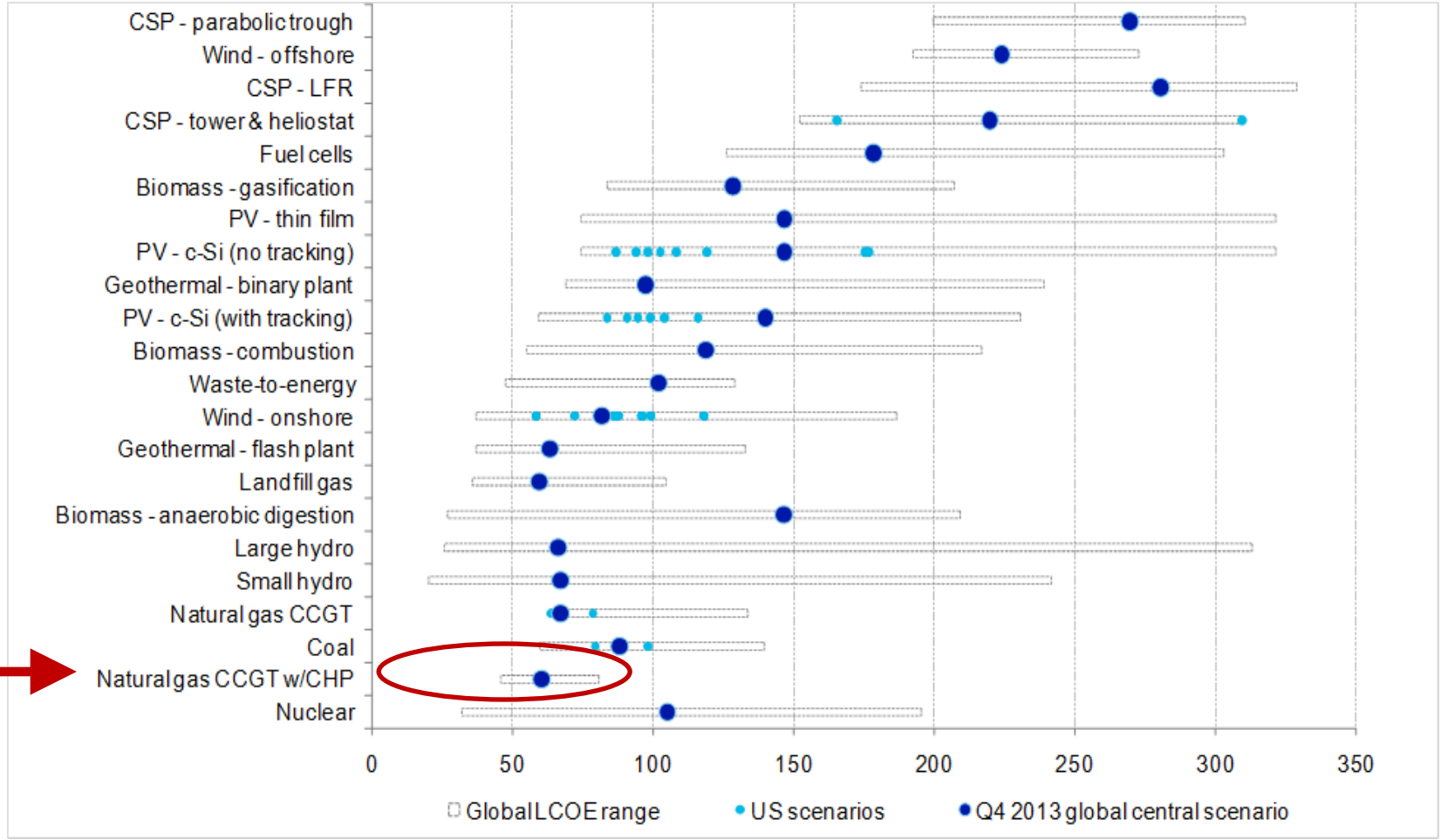
CHP Is Cost-Effective



Levelized Costs of Energy across Power Generation Technologies, Q4 2013 ($/MWh)

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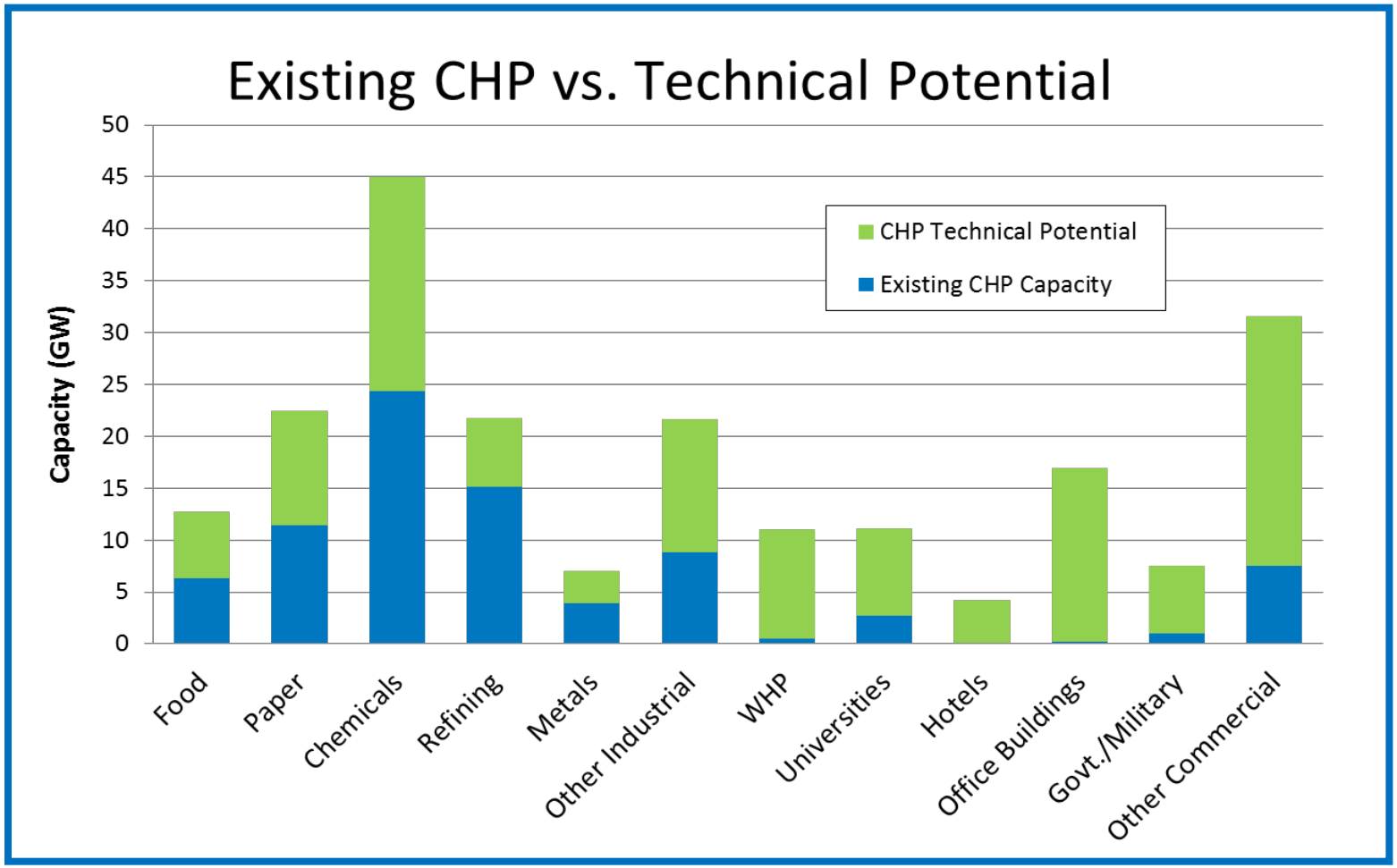
Remaining Potential for CHP (National)



Source: ICF Internal Estimates
***Technical potential is 130 GW**
(assuming systems are sized for on-site use)

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CHP as a Compliance Option

- Recognizing CHP benefits developers and manufacturers
- CHP needs to be treated in the same manner as other clean-energy sources
- EPA must embrace system-wide approach to emission reductions
- Thermal output cannot be overlooked
- Convert energy savings to emissions benefits
- Consideration needed for on-site emissions
- State policies can create opportunities

The Alliance for Industrial Efficiency

About RED

- **Mission is to profitably reduce greenhouse gas (GHG) emissions by recycling waste energy.**

- RED partners with industrial facilities to recover otherwise wasted energy, dramatically reducing GHG emissions and energy costs. RED operates CHP plants in California, Massachusetts, New Jersey and New York.

- Over the past 35 year RED principals have developed more than 300 CHP projects that have avoided over 5 million tons of CO_2 emissions per year.

Regulatory carrot for CHP?

- There is currently no mechanism in the CAA that allows CHP projects to monetize emission reduction benefits.
- While these emission reductions can be significant and verifiable as a developer we receive no benefits.
- If EPA includes language explicitly noting that CHP reduces GHGs in this rule, it can help create a path for states to craft programs so that we may start to monetize these benefits.

RED-Rochester GHG reduction

- REDs utility operations in Rochester is impacted by MACT and we, along with other affected sites, have evaluated several compliance options.
- Simply replacing coal with gas would reduce CO_2 by 40%.
- Installing an ultra efficient CHP project (GTs with heavily duct fired HRSGs) cuts emission per unit of output by nearly 80%.

Absence of a stick

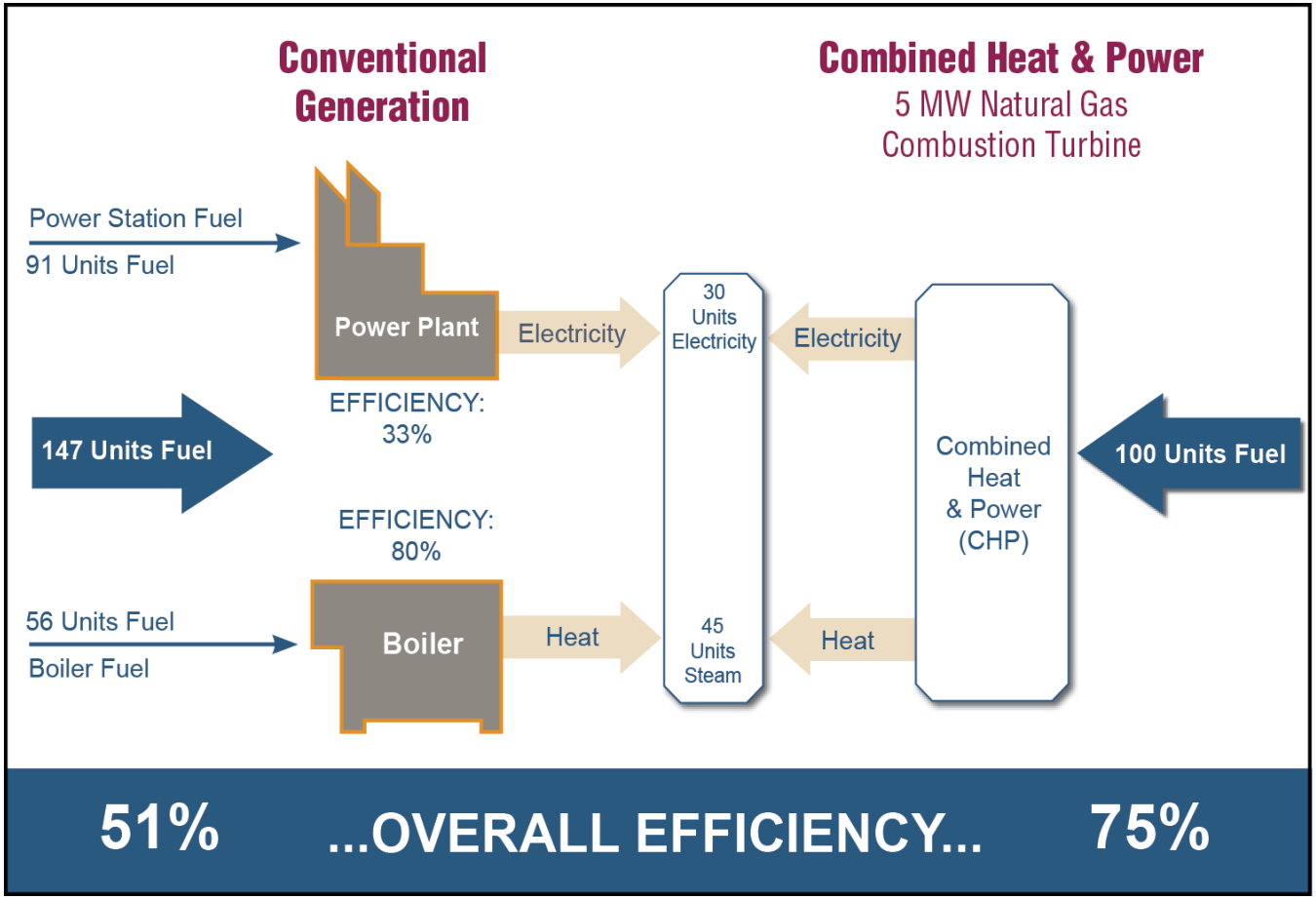
- Under current governance, RED will receive zero financial credit for reducing CO_2 or other emissions, in spite of active NY programs to reduce CO_2 emissions from electric utilities.

- We cannot entice investors to CHP projects with the absence of sticks.

The Importance of Recognizing the Multiple Outputs of CHP

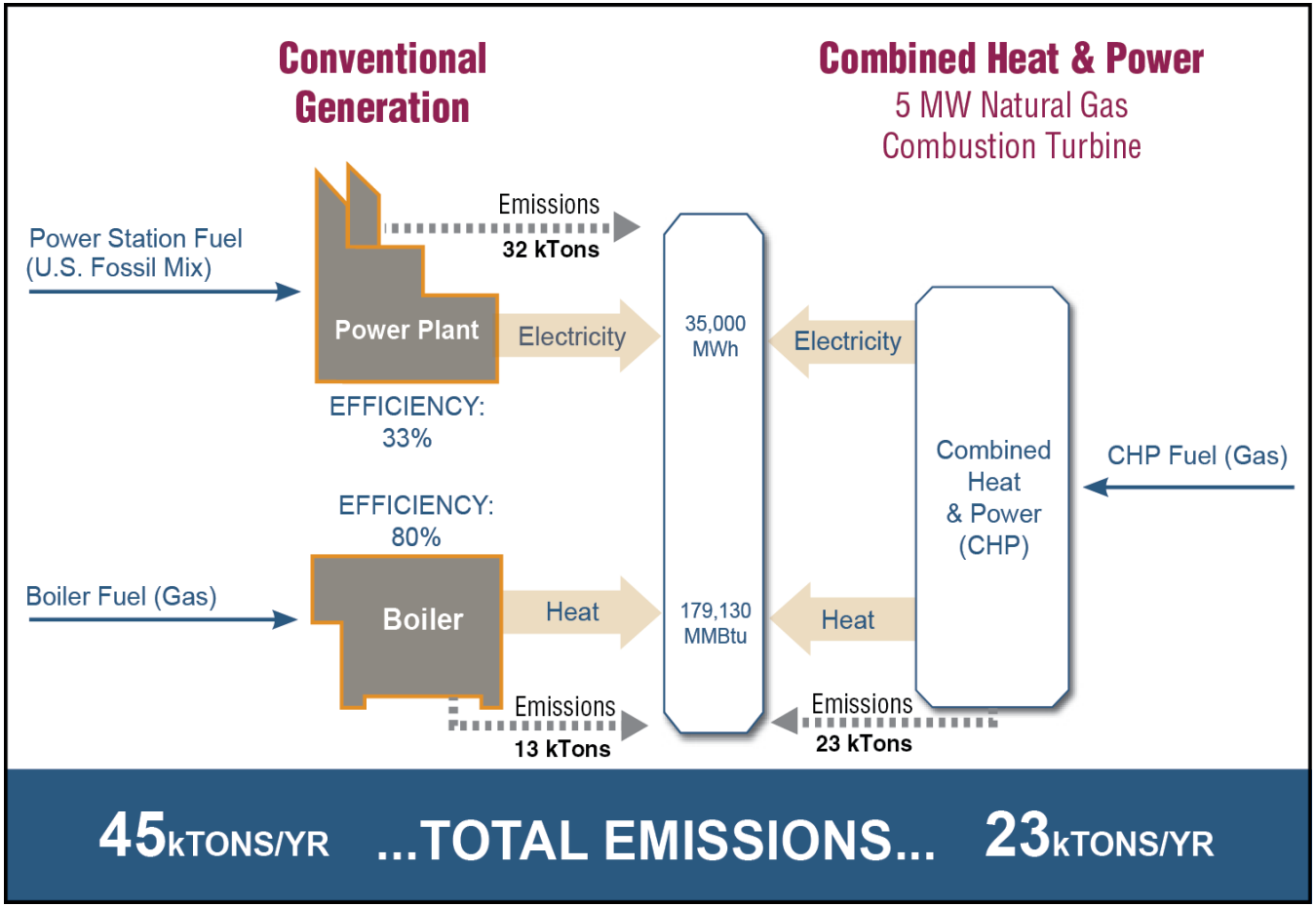
Bruce Hedman
Institute for Industrial Productivity

CHP is a Clean, Efficient Method of Providing Energy Services



Source: EPA CHP Partnership - 2012

That Efficiency Generally Results in Lower Emissions



Source: EPA CHP Partnership - 2012

Recognizing CHP Savings

- CHP systems produce both power and thermal outputs using a single fuel input
- Fuel and CO_2 savings come from displacing on-site boilers/furnaces and central station generation (including T&D losses)
- CHP may result in increased fuel use and/or emissions at the site
- Critical to recognize multiple outputs of CHP, and impacts beyond site, in order to properly credit efficiency and emissions benefits

Overall Fuel Savings from CHP

Fuel Savings = Fuel SHP – Fuel CHP

+ Fuel use from avoided on-site thermal energy production
+ Fuel use from avoided purchased grid electricity
- Fuel use by the CHP system

Total Fuel Savings

(56 + 91) – 100 = 47 units

Overall CO_2 Savings from CHP

CO_2 Savings = CO_2 SHP – CO_2 CHP

+ CO_2 emissions from avoided on-site thermal energy production

+ CO_2 emissions from avoided purchased grid electricity

- CO_2 emissions from the CHP system

Total CO_2 Savings

(13k + 32k) – 23k = 22k tons CO_2

Approaches to Crediting CHP

- Two common approaches to credit both CHP outputs
  - Equivalence approach
  - Avoided emissions approach
- The two approaches can result in different levels of emissions rates based on CHP system characteristics and emissions rates of avoided separate heat and power
- Which approach to use would be influenced by the overall regulatory structure and objectives

Equivalence Approach

- Directly adds the thermal output to the electric output of the CHP system in consistent or equivalent units
  - Example: Total output = (30 units + 45 units) = 75 units
- The value of the conversion factor depends on the underlying regulatory objectives
  - Can be based on straight unit conversion (i.e., 3412 Btu equals 1 kWh – credit 100% of thermal output)
  - Can incorporate a factor for the relative value of the outputs (credit 75% of thermal output)
  - Example: Total output = (30 units + 0.75*45 units) = 63.75 units
- Results can vary substantially based on the ratio of power and heat output of the CHP system

Avoided Emissions Approach

- Credits the CHP system with the avoided emissions that a conventional separate heat and power system would otherwise emit to provide the same energy services
- The approach relates the value of the thermal output to the emissions actually avoided by the displacement of the on-site boiler/furnace
- Results can vary based on thermal unit displaced (e.g., replacing new gas on-site boiler or old coal boiler)
  - CHP electric emissions = (23K – 13K) = 10K tons CO_2

Regulatory Experience

Entity	Equivalence Approach	Avoided Emissions Approach
California	DG and conventional emissions limits (100% thermal credit)	
Connecticut		Small DG Rule
Delaware		Conventional emissions limits
Massachusetts		Small DG Rule and performance standards
Rhode Island		Conventional emissions limits
Texas	DG Permit by Rule and Standard Permit (100% thermal credit)	
US EPA	Electric Utility Steam Generating Unit NSPS, Subpart Da (75% thermal credit)	
	Gas Turbine NSPS, Subpart KKKK (100% thermal credit)	
	Proposed rule for GHG emissions from New Electric Generating Units 111(b) (75% thermal credit)	

Resources

- Crediting CHP
  - *Fuel and CO_2 Savings Calculation Methodology for CHP Systems* - http://www.epa.gov/chp/documents/fuel_and_co2_savings.pdf
  - Accounting for CHP in Output-Based Regulations - http://www.epa.gov/chp/documents/accounting.pdf
  - *CHP Emissions Calculator* - http://www.epa.gov/chp/basic/calculator.html
- Calculating Avoided Emissions
  - *EPA Roadmap for EE/RE in SIPs* - http://epa.gov/airquality/eere/
  - *Emissions & Generation Resource Integrated Database (eGRID)* - http://www.epa.gov/cleanenergy/energy-resources/egrid/
  - *AVERT emissions quantification tool* - http://epa.gov/statelocalclimate/resources/avert/index.html

Emissions reductions from CHP would translate to "credits"…

Emissions reductions

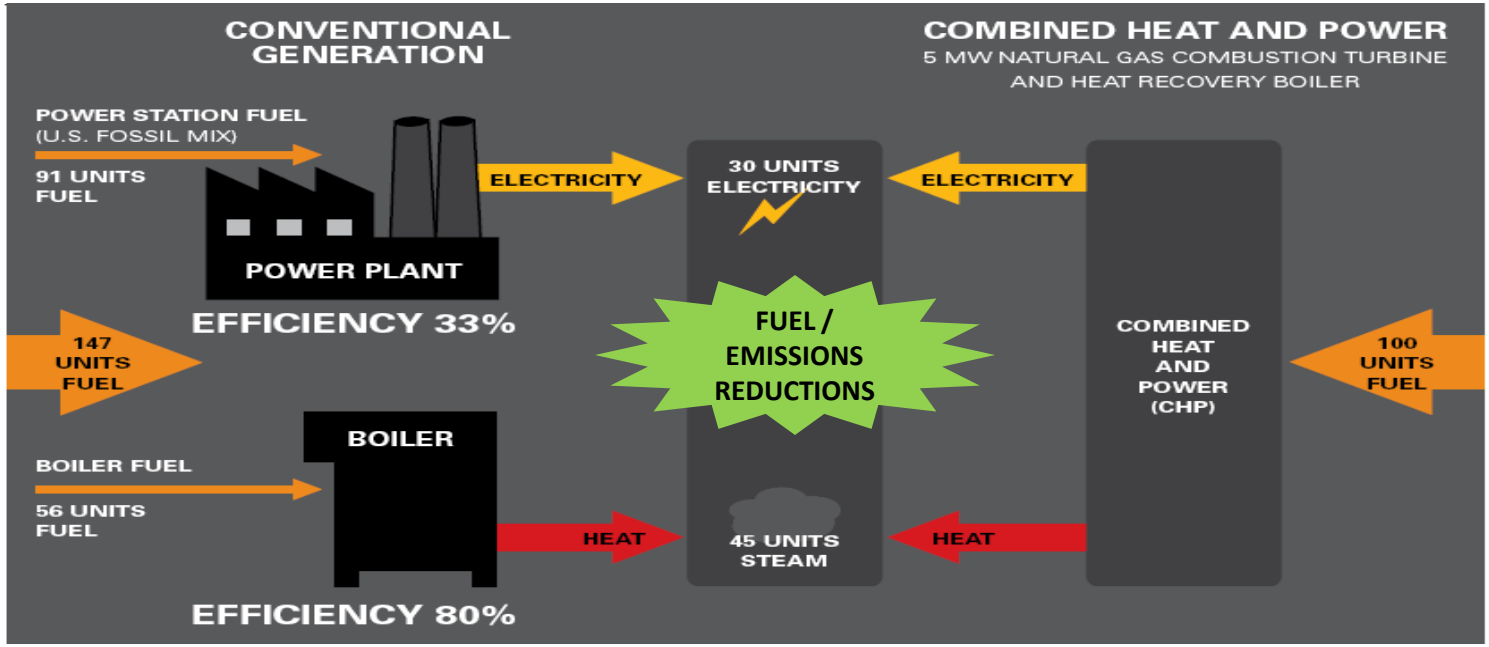
- Accounting for thermal and electric output
- Either via equivalence or avoided emissions approach

Lower emission rate

or

Fewer total emissions

"Credits"

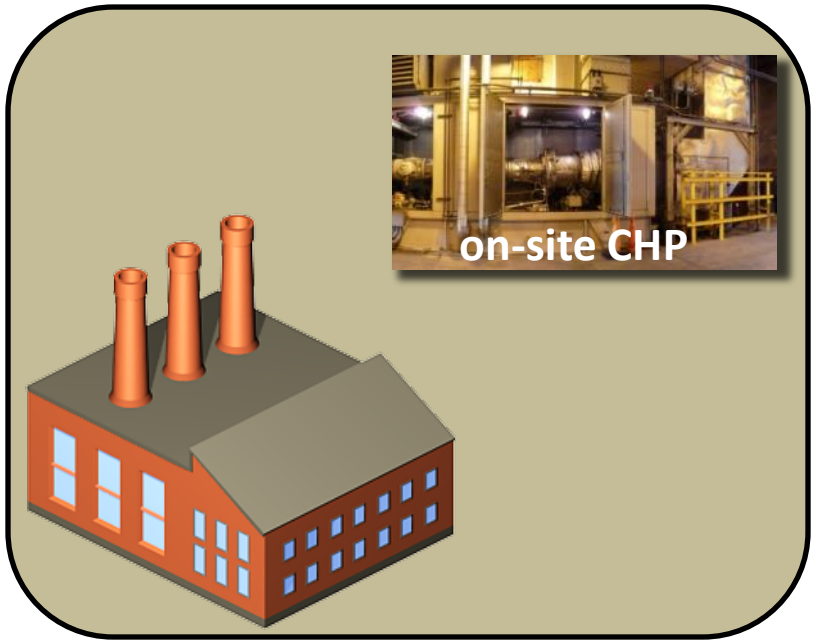


…provided there is a system-based approach to the emissions standards that account for these emissions reductions and accordingly benefit CHP

CHP systems

A. Can be built within a power plant site
B. But much more likely built elsewhere e.g., at industrial facility, commercial building

A system-based approach is essential to capture the benefits of CHP, no matter where installed



One example of a system-based approach: NRDC proposal, state-specific standards for emissions rates

State-specific fossil-fleet average CO_2 emission rates (lbs/MWh) for 2020 and 2025

Calculated by applying benchmark coal and gas rates to each state's baseline (2008-2010) fossil generation mix

Averaging allowed among all fossil units in state (including new units subject to the 111(b) standard)

Credit for incremental renewables and energy efficiency (equivalent to adding MWhs to denominator in calculating emission rate for compliance purposes)

States may opt in to **interstate averaging** or credit trading

States may adopt **alternative plans**, including **mass-based** standards, provided they achieve equivalent emission reductions

The NRDC proposal looks at a number of scenarios, and in all cases energy efficiency plays an important role

Some of that energy efficiency could be CHP

Reference Case

Moderate Case, Full Efficiency

Moderate Case, Constrained Efficiency

Ambitious Case, Full Efficiency

Ambitious Case, Constrained Efficiency

Ambitious Case, Constrained Efficiency, PTC

CHP could benefit under a rate-based or mass-based approach

Rate-based approach
(e.g., NRDC proposal)

- Sets emissions-rate targets (e.g., lbs / kWh)
- CHP systems generate electricity at a lower effective emissions rate
- Incentive derived from lower emissions rate

Mass-based approach

- Sets emissions targets (e.g., tons of CO_2)
- When properly accounted for, CHP systems should yield fewer total emissions
- Incentive derived from fewer total emissions

This benefit may be monetized via different mechanisms (e.g., depending on different state approaches)

Nature of incentive	Examples of possible implementation
Credits for emissions reductions	*Potentially compatible with rate-based approach* • Utility required to achieve an (effective) emissions rate • Utility meets requirements by counting low-emissions generation from third-party sources – wind, solar, EE, CHP • Utility provides monetary/other benefit to third-party sources
Credits for cleaner electricity	*Potentially compatible with rate-based approach* • State requires a number of kWh to come from renewables, energy efficiency, based on nationally set standards • Customer-funded programs provide funding for cleaner sources • CHP becomes eligible as energy efficiency (for part of its power) (NRDC supportive of this only if certain conditions are met)
Fewer emissions allowances consumed	*Potentially compatible with mass-based approach* *…discussed in next section…*

MASS-BASED STANDARD

EPA COULD ALLOW/ENCOURAGE A MASS-BASED EQUIVALENT TO A RATE STANDARD

- **Mass-based standard –** Standard is set as a tonnage limit; compliance is through cap-and-trade among covered sources.
  - Could be implemented at the state or regional level.

- EPA is expected to allow states to meet a mass-based equivalent to a rate standard.
  - Supports RGGI as a means of compliance.
  - Could be desirable for states forecasting declining load.
  - Simpler than a rate-based approach.

- EPA could specify the equivalent mass-based standard for each state, or offer a methodology.

CLEAN ENERGY HELPS COVERED SOURCES MEET EMISSIONS CAPS

- Clean energy measures help covered sources meet their mass standard, resulting in:
  - Need for fewer emissions reductions from among covered sources; and
  - Lower compliance costs.

- Clean energy displacing covered sources does not ordinarily receive emissions credit for this contribution.
  - This would result in double counting (unless there is a set-aside).

A MASS-BASED STANDARD AUTOMATICALLY ENCOURAGES LOW CARBON INVESTMENTS

- For covered sources, allowance costs factor into the variable cost of generation.
- High emitting electricity sources will need more allowances than less carbon intensive generation.
  - Covered CHP units, if thermal emissions are addressed fairly, will need fewer allowances than other covered sources.
- Uncovered sources—including existing and new energy efficiency, CHP below the threshold, renewable energy, nuclear—do not see higher operating costs.
  - These sources become more competitive relative to covered sources.
  - They may also benefit from higher electricity prices.

IS THE MASS-BASED PROGRAM GOOD ENOUGH "AS IS" IN ENCOURAGING CLEAN ENERGY?

Yes

- By changing relative electricity costs, the mass-based standard already "recognizes" the benefits of clean energy.

No

- A more direct incentive could be warranted, particularly if free allocations are offered to covered sources.
  - One remedy is a **set-aside program**--a pool of allowances from within the mass standard—that is used to support clean energy technologies.

TREATMENT OF CHP UNDER A SET-ASIDE

- Unlike other forms of clean energy, CHP emits GHGs.
- If CHP is awarded and sells set aside credits based on power sector emissions reduced, the resulting emissions would exceed the cap.
  - GHG allowances earned from set-aside are sold back to covered sources (these are from within the cap)
  - There are additional GHG emissions from the CHP facility (associated with electric production)
- Possible solution:
  - CHP facility earns set-aside allowances based on emissions reduced, but must deduct CHP facility electricity emissions from the allowances that can be sold to the market.

VARIANT: MASS-BASED REGIONAL STANDARD

Great River Energy and Brattle Group have proposed use of a regional standard—it could be mass-based—with a novel approach to implementation.

- Under the proposal, implementation is through a carbon price path, not allowance trading.
- Covered sources pay this price and clean energy sources don't.
- Current proposal is to return revenues to ratepayers based on energy used.
- As there are no allowances to create a set-aside, one way to reward clean energy sources (if desired) would be through reserving a share of the revenues.

ALLIANCE TO SAVE ENERGY

Using less. Doing more.

CHP, State Policies, and 111(d)

Rodney Sobin
Alliance to Save Energy

CHP Webinar

April 8, 2014

CHP Policies and State 111(d) Plans

- States responsible for implementation plans
- EE, RE, CHP policies may be recognized
  - Portfolio standards
    - Energy Efficiency Resource Standards (EERS)
    - Renewable/Alternative Energy Portfolio Standards (RPS/AEPS)
  - Other EE/Demand Side Management Policies
  - Capped emissions (RGGI, AB32)
  - Other
- Supporting policies
  - Financial incentives
  - Environmental, siting, energy reliability/resilience
  - Interconnection, standby rates

Renewable/Alternative Energy Portfolio Stds

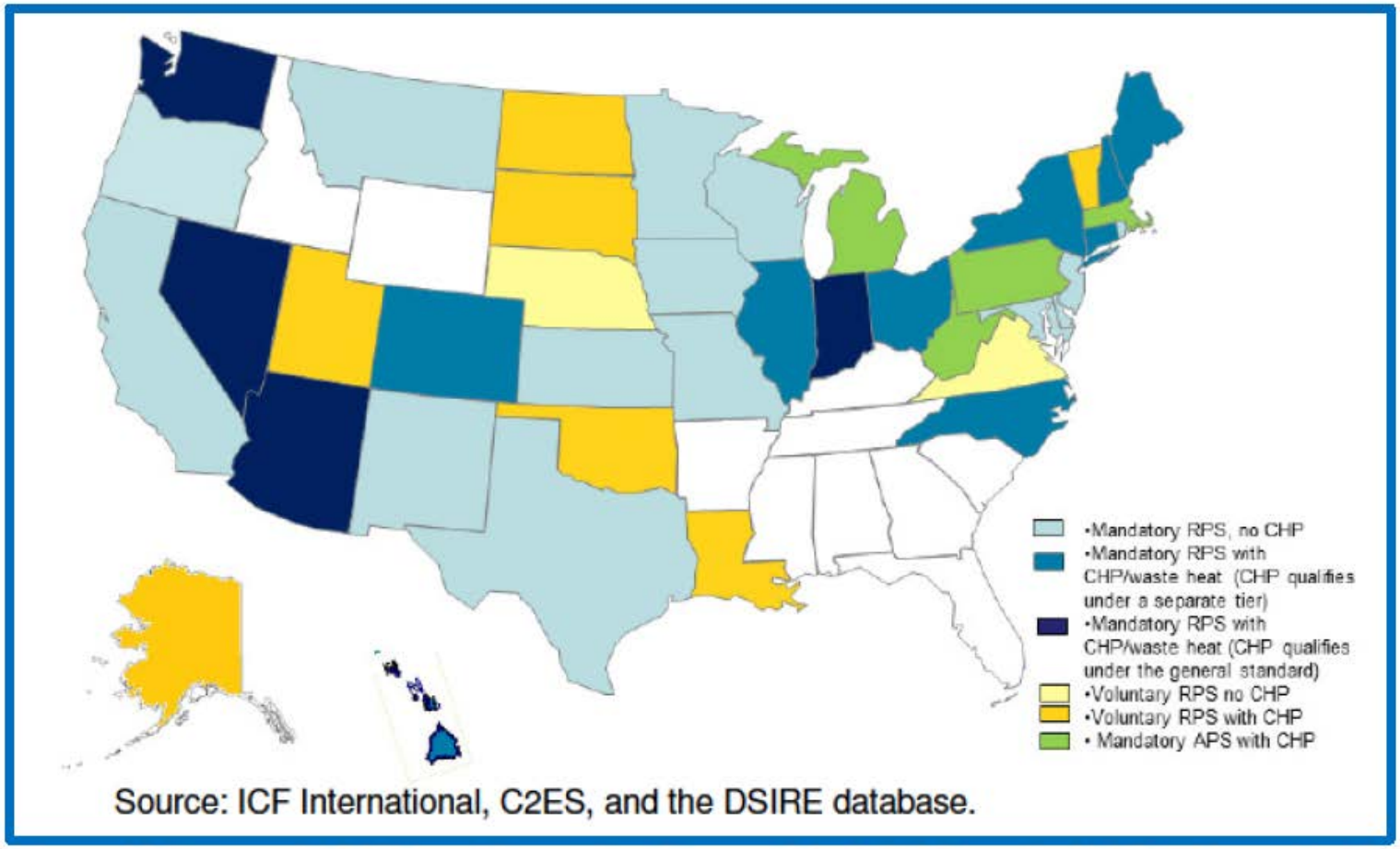


Figure 6: States with RPS or Alternative Energy Portfolio Standard (APS) Reqs. for CHP/ WHP[30]

ALLIANCE TO SAVE ENERGY
Using less. Doing more.

Energy Efficiency Resource Standards

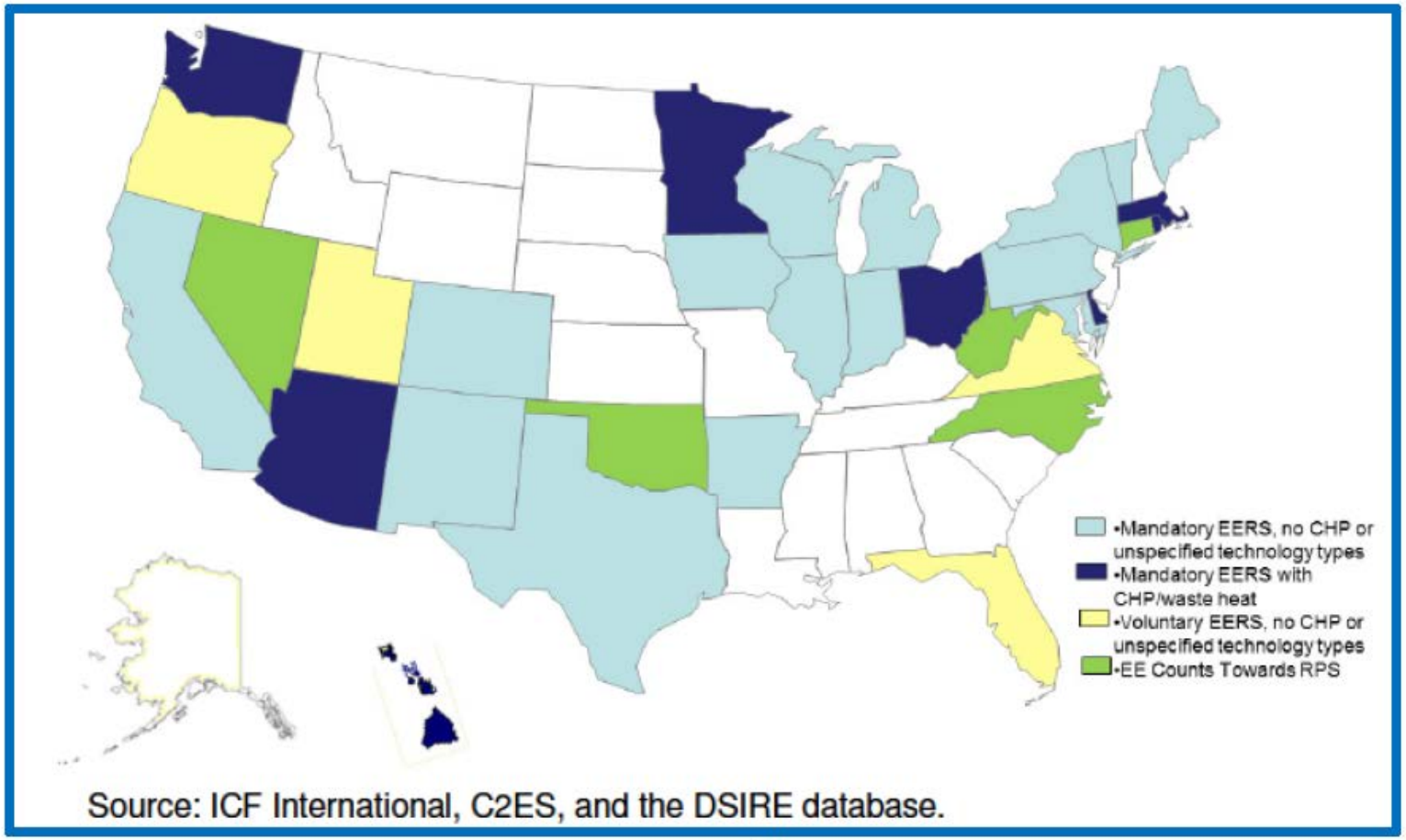


Figure 7: States with EERS Programs for CHP[31]

ALLIANCE TO SAVE ENERGY
Using less. Doing more.

CHP Policy and Program Examples

- Massachusetts
  - AEPS (5% by 2020) separate from RPS
  - Includes renewable and natural gas CHP; thermal credit
  - Small units can be aggregated for qualification
  - Since 2008 74 new CHP units v. 45 in previous 10 yrs.
- EmPower Maryland
  - BG&E CHP program; up to $2M/project, ~$700/kW
  - Incentives for design, construction + 7¢/kWh for 18 mo.
  - 16 proposals → 11 passed reviews, proceeding.

CHP Policy and Program Examples

- New York
  - NYSERDA $100M since 2006: 70 projects, 150MW
  - CHP Performance Program, up to $2.6M/project
- California
  - Self-Generation Incentive Program to reduce peak loads
  - Includes RE, CHP/WHP, “emerging technologies”
  - 48¢/W non-renewable CHP, $1.19/W WHP
  - Most SGIP projects are heat recovery projects
  - CPUC also offers a feed-in tariff for <20MW CHP

CHP Policy and Program Examples

- Texas, Louisiana Critical Infrastructure Rules
  - CHP feasibility study required for new/renovated critical public facility
- Environmental rules
  - Permit-by-Rule (TX, CT), general permits
  - Thermal credits, “otherwise flared” gas credit (DE)
  - Output-based standards
- Utility regulation
  - Portland General Electric demand charge structure
  - Minnesota standby rates
  - Interconnection standards

Guidance, Tools and Technical Assistance Needed

- Varying state experience with EE, RE, CHP programs, policies
- States need guidance for including EE, RE, CHP in 111(d) plans
- Guidance on acceptable EM&V, quantification
- Existing resources
  - EPA Roadmap for EE/RE in SIPs http://epa.gov/airquality/eere/
  - AVERT emissions quantification tool http://epa.gov/statelocalclimate/resources/avert/index.html
  - EPA CHP Partnership—calculator, tech catalog, spark spread estimator, project handbook… http://www.epa.gov/chp/
  - CHP Technical Assistance Partnerships https://www1.eere.energy.gov/manufacturing/distributedenergy/chptaps.html
  - SEE Action Network http://www1.eere.energy.gov/seeaction/combined_heat_power.html
  - EM&V resources http://www1.eere.energy.gov/seeaction/emv_resource_portal.html
  - ACEEE http://aceee.org/123-solutions
    - SIP template for EERS http://aceee.org/files/pdf/sip-template-0314.pdf
    - (pending) state-by-state 111(d) potential for CHP, EERS, other policies

Questions?

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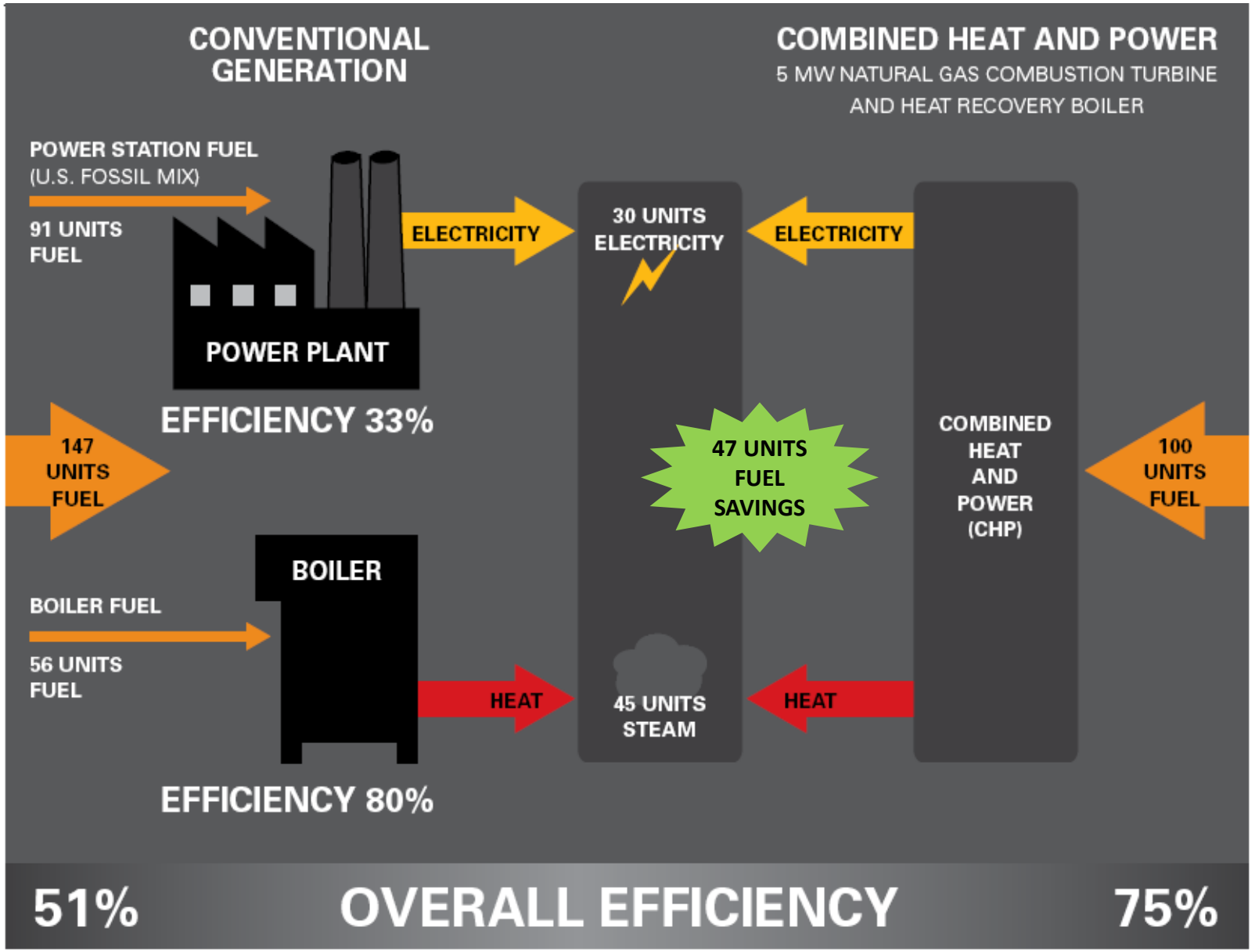
The Alliance for Industrial Efficiency

APPENDIX

CHP systems are efficient



How CHP's emissions savings are counted is important

		Electricity	Heat	Total	Emissions rate per useful output (emission-units / energy-units)
Useful output	**Separate or combined heat and power** (e.g., industrial site)	30 energy-units	45 energy-units	75 energy-units	
Emissions	**Separate heat and power**	91 emission-units (at power plant, 33% efficiency)	56 emission-units (on-site boiler)	147 emission-units	Overall: 147 / (30+45) ~ 2 Electricity only: 91 / 30 ~ 3
	Combined heat and power	?	?	100 emission-units	?
	Overall approach (EPA: "Equivalence approach")	Split does not matter	Split does not matter	100 emission-units **[CHP benefit = 47 emission-units]**	100 / (30+45) ~ 1.33 [Note: inherent conversion assumptions] [Note: harder to incorporate into an emissions standard for power plants]
	Boiler baseline approach (EPA: "Avoided emissions with secondary electrical output")	44 emission-units (= 100 – 56) **[47 less than for power plant]**	56 emission-units (like on-site boiler)	100 emission units **[CHP benefit = 47 emission-units]**	44 / 30 ~ 1.45 [Note: emissions for electricity are those incremental emissions over and above a counterfactual boiler]