ACEEE
American Council for an Energy-Efficient Economy

Suggested Treatment of CHP in an EERS & Climate Context

R. Neal Elliott, Ph.D., P.E., Associate Director for Research

Co-Authors: Anna Chittum, Research Associate
Dan Trombley, Engineering Associate
Suzanne Watson, Policy Director

ACEEEE, Washington, DC

CHP Treatment in Context

- Measuring savings from CHP different from incenting efficiency investment
- Need reliable way to credit savings for system of varying efficiency in different regions
- Development of Federal EERS prompted effort
- Transitioned into element of climate legislation
- Other approaches exist but must address principle of measuring actual savings

What is an EERS and why do we care?

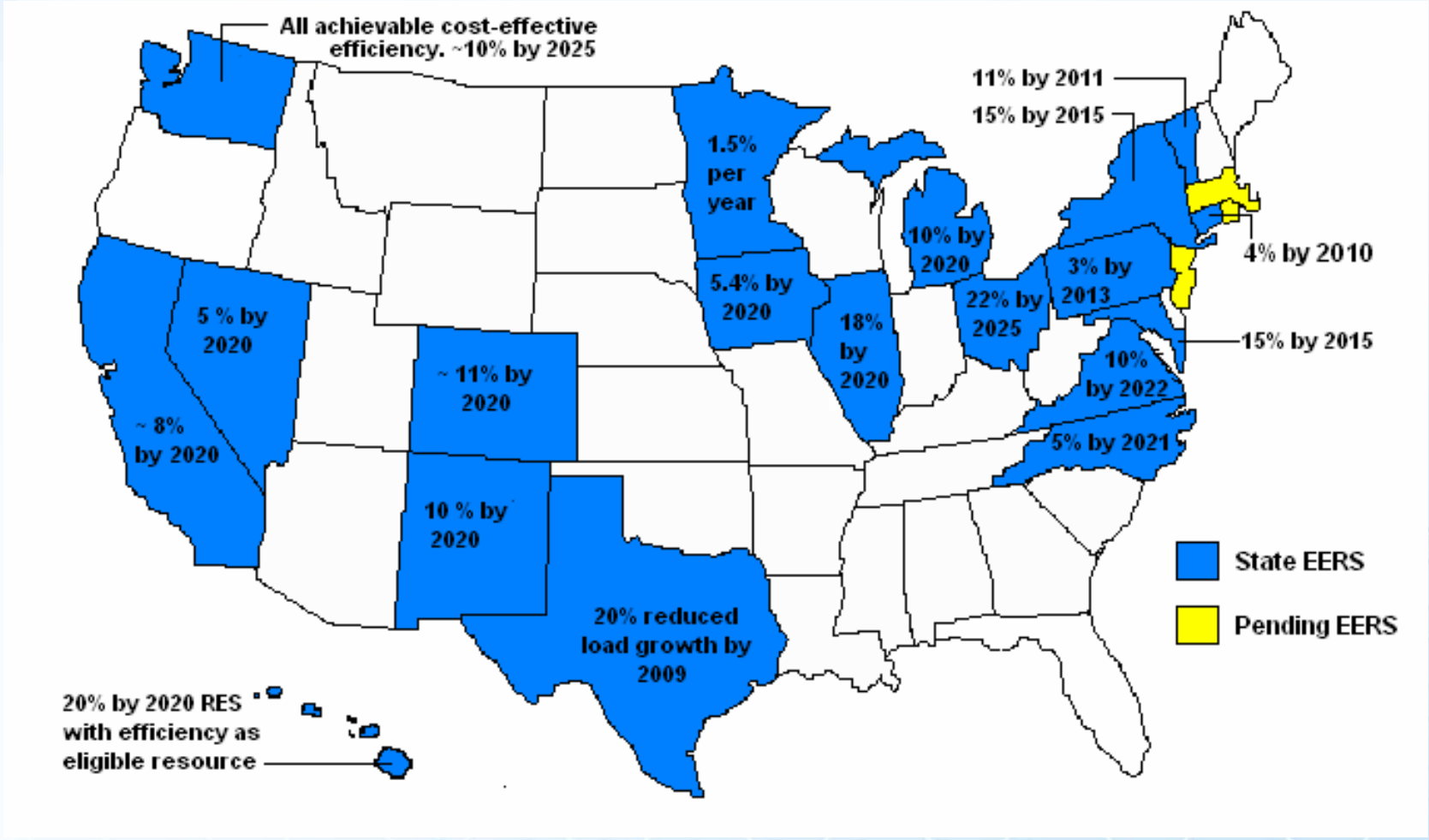
Energy Efficiency Resource Standard (EERS):

- Sets targets for utilities to achieve more electric and natural gas efficiency
- Can be found in 19 states / 3 pending
- Part of House climate and Senate energy legislations
- Brings benefits of energy efficiency (cost and emissions reductions) to all states

ACEEE
American Council for an Energy-Efficient Economy

Energy Efficiency Resource Standards

19 States have EERS in Place



15 states have requirements of 5% or higher

ACEEE
American Council for an Energy-Efficient Economy

CHP in an EERS Context

- CHP offers considerable cost-effective savings

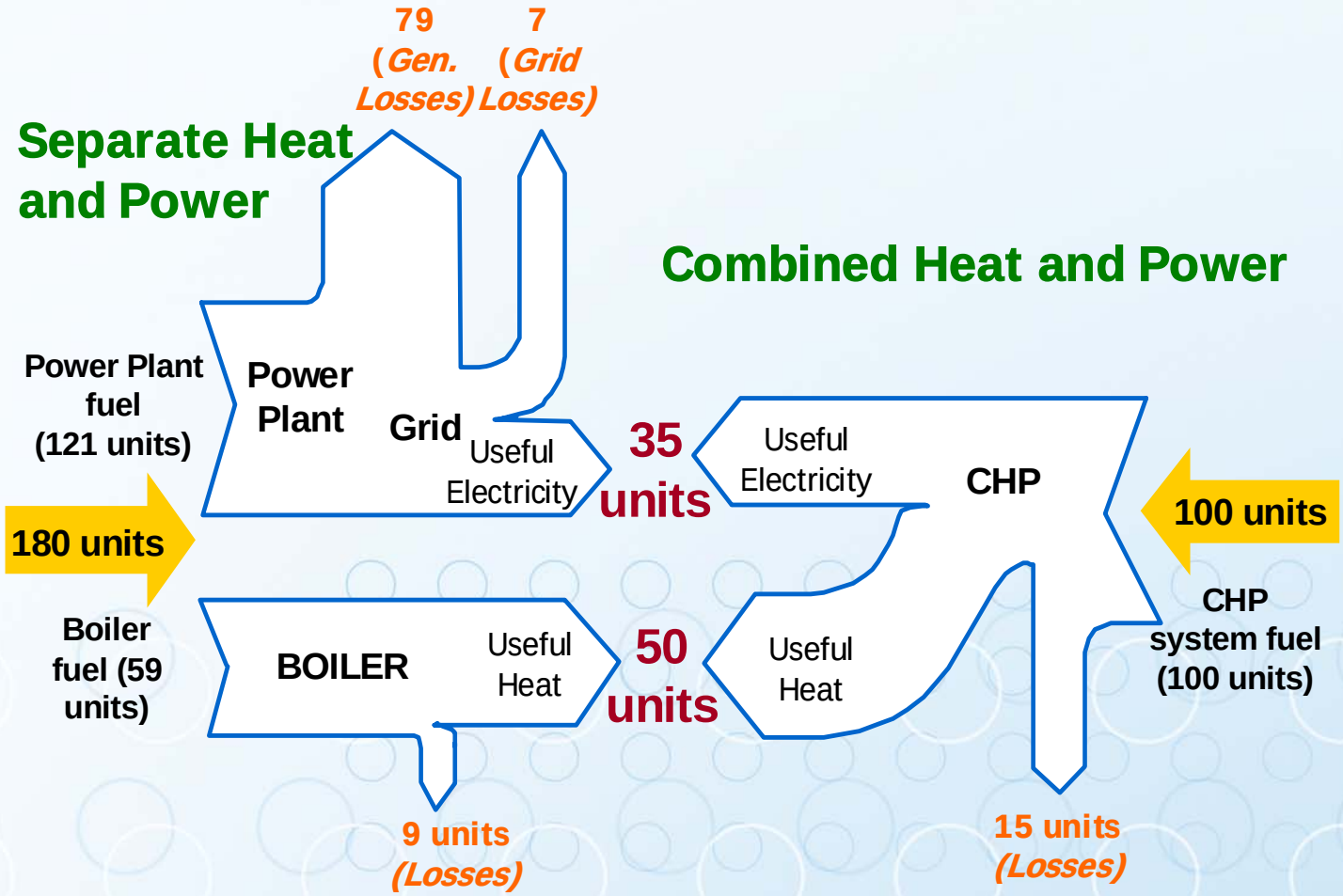
However:

- EERS savings primarily end-use not supply
- Savings must be quantifiable—what is impact?
  - Utilities and policymakers consider future savings in system and environmental plans
  - Valuation mechanism depends on accurate estimates
  - Most energy savings estimates straight-forward
- CHP savings nuanced and complex

What makes CHP different?

- If CHP didn't exist, onsite thermal generation would likely have existed regardless
- Savings accrue at point of centralized generation *not* at point of use
- Multiple entities involved—who gets savings?
- Not all CHP systems are created equal—efficiencies vary
- Not all centralized generation is created equal

Considerations with CHP



Source: Elliott and Hedman 2001

Considerations with CHP

- Net decrease in total fuel input compared to separate generation
- Reduced transmission/distribution losses
- Wholesale power generators excluded—EERS end-use focused
- Cannot simply credit absolute output of CHP system – distorts & misrepresents “true” CHP savings

ACEEE
American Council for an Energy-Efficient Economy

Necessity for a new methodology

- Previous CHP incentives and policies: looked to set a single efficiency threshold
  - Adequate for just encouraging CHP deployment
  - But by producing 1kWh, is a CHP system directly displacing 1kWh from being created by the centralized grid?
  - In a word: No – must scale credits accordingly
- Because an EERS confers calculable benefits to measures that save energy, measures must be comparable and tradable (if applicable)

Underlying assumptions of ACEEE methodology

- Not all CHP systems created equal
- Not all centralized generation equally efficient/clean
- Natural gas-fired CHP systems will participate in *one* EERS market, and it will be the electric market *not* gas
- Other fueled CHP systems will generally only participate in one EERS market as well
  - Onsite systems would exist regardless of CHP
  - Trying to capture benefit to electric market in particular
- EERS methodology should be directly applicable to future greenhouse gas crediting/trading systems

ACEEE
American Council for an Energy-Efficient Economy

Proposed calculation

Credited savings = energy no longer consumed due to the presence of CHP

- For ease of discussion, we use fuel (expressed as BTUs) as basic unit
- Will convert back to creditable kWh later

$$S_{FUEL} = F_{GRID,POWER} - F_{CHP,\ POWER}$$

Proposed calculation

$$S_{FUEL} = F_{GRID,POWER} - F_{CHP,\ POWER}$$

S_{FUEL}= Total (creditable) net fuel savings from CHP system

$F_{GRID,POWER}$= Fuel that *would have been used* by the power pool to create onsite electricity

$F_{CHP,\ POWER}$= Fuel that is used by the CHP system to produce onsite electricity

Proposed calculation – input fuel

$$S_{FUEL} = F_{GRID,POWER} - F_{CHP,\ POWER}$$

Working on the last term of the equation…

$F_{CHP,\ POWER}$= Fuel that is used by the CHP system to produce onsite electricity

- Net out: fuel that would have otherwise satisfied onsite thermal load (reference quant.)
- Justification: what is benefit to *this* market? We only credit fuel attributable to the electricity

Proposed calculation – input fuel

$$S_{FUEL} = F_{GRID,POWER} - F_{CHP,\ POWER}$$

Working on the last term of the equation…

$$F_{CHP,\ POWER} = F_{CHP,\ TOTAL} - F_{CHP,THERMAL}$$

Where

$F_{CHP,\ TOTAL}$ =Absolute fuel input of CHP system

$F_{CHP,THERMAL}$ =CHP fuel input that would have been required to produce the same thermal energy as an onsite thermal system

ACEEE
American Council for an Energy-Efficient Economy

Proposed calculation – grid fuel

$$S_{FUEL} = F_{GRID,POWER} - F_{CHP,\ POWER}$$

Working on the second term of the equation…

$F_{GRID,\ POWER}$= Fuel that would have been used by the power pool to generate the now-onsite electricity

- Consider: rate at which power pool coverts fuel to electricity on average + T&D losses
  - AKA: Average heat rate of power pool (BTU/kWh, would include T&D rate)
- Justification: What does saving 1 kWh mean *here*? Need to know fuel reductions, emissions reductions

Proposed calculation – grid fuel

$$S_{FUEL} = F_{GRID,POWER} - F_{CHP,\ POWER}$$

Working on the second term of the equation…

$$F_{GRID,\ POWER} = E_{CHP} * H_{GRID}$$

Where

E_{CHP}= Avg. annual output of CHP system in kWh

H_{GRID}= Average heat rate of the corresponding power pool expressed as BTU/kWh

Proposed calculation – saved fuel

$$S_{FUEL} = F_{GRID,POWER} - F_{CHP,\ POWER}$$

S_{FUEL} = Creditable fuel savings that occur *at the point of generation*, in BTUs.

- Problem: we need to know what that means in terms of saved, comparable, creditable kWh for purposes of the EERS!
  - Solution: Revisit the grid's average heat rate

Proposed calculation - New term!

$S_{CHP,ELEC}$ = CHP savings (in kWh) creditable to an EERS

$$S_{CHP,\ ELECTRIC} = S_{FUEL} / H_{GRID}$$

Where

S_{FUEL} = Saved fuel (in BTUs) from previous calculation

H_{GRID} = Average heat rate for power pool (same rate used in previous calculation)

Proposed calculation

$$S_{CHP,\ ELECTRIC} = [(E_{CHP} * H_{GRID}) - (F_{CHP,\ TOTAL} - F_{CHP,THERMAL})] / H_{GRID}$$

$$S_{CHP,\ ELECTRIC} = S_{FUEL} / H_{GRID}$$

$$S_{FUEL} = F_{GRID,POWER} - F_{CHP,\ POWER}$$

$$F_{GRID,\ POWER} = E_{CHP} * H_{GRID}$$

$$F_{CHP,\ POWER} = F_{CHP,\ TOTAL} - F_{CHP,THERMAL}$$

ACEEE
American Council for an Energy-Efficient Economy

Proposed calculation

$$S_{CHP,\ ELECTRIC} = [(E_{CHP} * H_{GRID}) - (F_{CHP,\ TOTAL} - F_{CHP,THERMAL})] / H_{GRID}$$

Expressing the above in general form yields:

$$S_{CHP,\ ELECTRIC} = E_{CHP}\left[1 - \frac{F_{CHP,\ TOTAL} - F_{CHP,\ THERMAL}}{E_{CHP} * H_{GRID}}\right]$$

ACEEE
American Council for an Energy-Efficient Economy

Proposed calculation

$$S_{CHP,\ ELECTRIC} = E_{CHP}\left[1 - \frac{F_{CHP,\ TOTAL} - F_{CHP,\ THERMAL}}{E_{CHP} * H_{GRID}}\right]$$

$S_{CHP,\ ELECTRIC}$	CHP savings (in kWh) creditable to an EERS
E_{CHP}	Annual electric output (in kWh) of CHP system, in kWh
$F_{CHP,TOTAL}$	Total fuel input (in BTUs) of the CHP system
$F_{CHP,THERMAL}$	Fuel (in BTUs) that would have been required to produce same amount of thermal energy as CHP system in onsite thermal-only system
H_{GRID}	Average heat rate (in BTU/kWh) at which the corresponding power pool generates and delivers electricity

$$S_{EMISSIONS} = e_{GRID,POWER} * F_{GRID,POWER} - e_{CHP,POWER} * F_{CHP,POWER}$$

Extending Approach to Carbon

$$S_{emissions} = e_{GRID,POWER} * F_{GRID,POWER} - e_{CHP,POWER} * F_{CHP,\ POWER}$$

Where $e_{x,power}$ represents CO2 emissions rates in kg_{CO2}/Btu, which allows accounting of differences in fuel mix between Grid & CHP. The emissions rates can account for various fuels as follows:

$$e_{GRID,POWER} = \frac{\sum_{i=1}^{n} e_{GRID,POWER_i} * F_{GRID,POWER_i}}{F_{GRID,POWER,total}}$$

ACEEE
American Council for an Energy-Efficient Economy

Next Steps Moving Forward

- Concept embodied in federal legislation —will need rulemaking when/if legislation passes
- Growing acceptance of approach in CHP community, but need continued engagement
- Potential for incorporation into state legislation/regulation

ACEEE
American Council for an Energy-Efficient Economy

Summary & Conclusions

- Need different approach to CHP for EERS and climate context than for incentives
- Proposal address these principles—alternative approaches exist, but must adhere to principle of measuring actual savings
- Getting treatment right will allow CHP to participate in EE & climate markets
- We hope this paper can advance the discussion

ACEEE
American Council for an Energy-Efficient Economy

Contact Information:

R. Neal Elliott, Ph.D., P.E.
Associate Director for Research
202-507-4009
rnelliott@aceee.org

529 14th Street, NW, Suite 600
Washington, DC 20045
http://www.aceee.org