

Biomass for Combined Heat and Power Applications

ENERGY TRAINING FOR AGRICULTURE PROFESSIONALS
October 1, 2009



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Advancing Renewable Energy for a Sustainable Economy



North Carolina Solar Center

- Solar (photovoltaics, solar hot water, passive solar, daylighting)
- Wind
- Biomass (animal waste, energy crops, landfill gas)
- Biofuels (ethanol, biodiesel)
- Hydrogen & Fuel Cells
- Green Buildings & Sustainable Design
- Energy Efficiency
- CHP & Distributed Generation



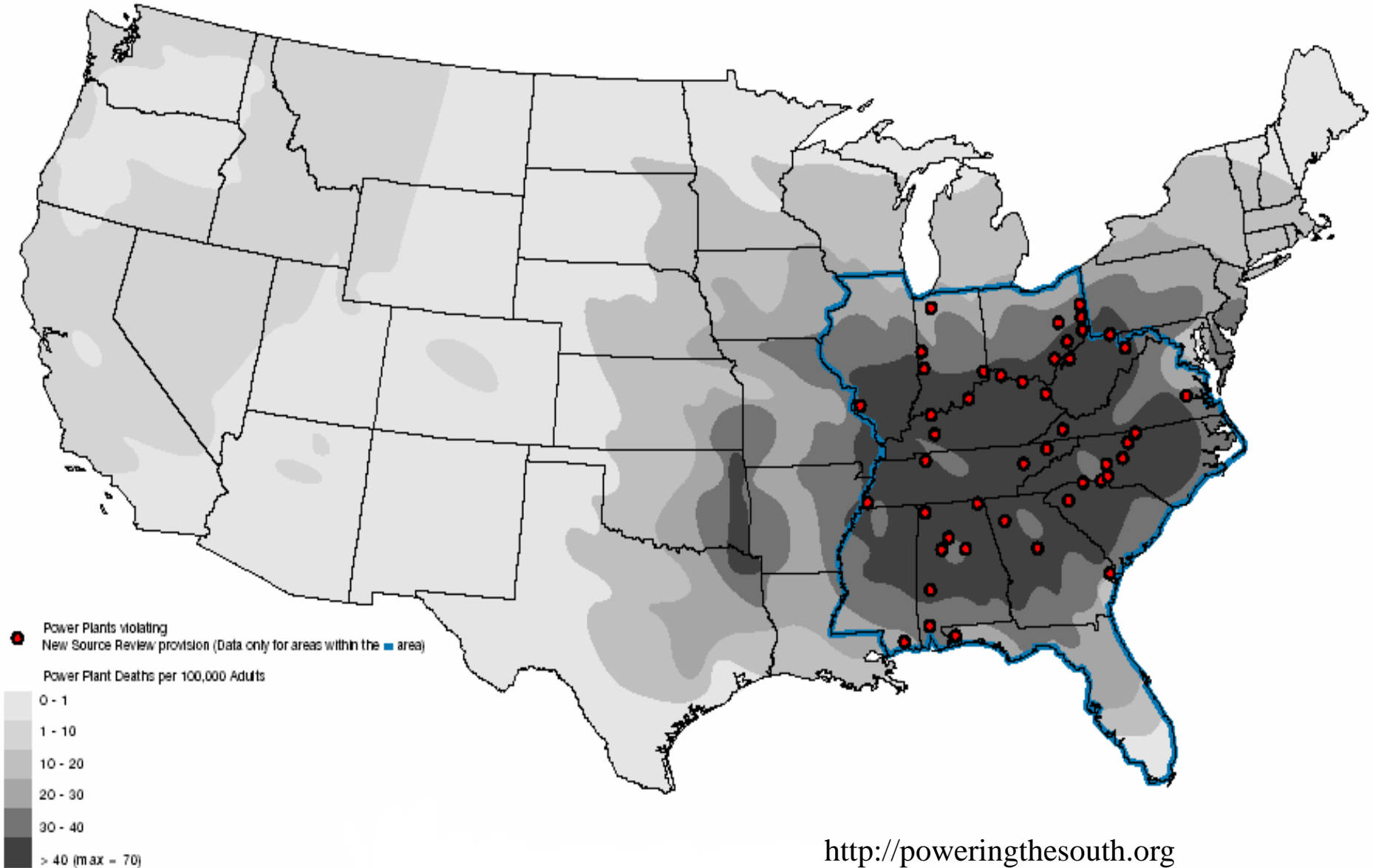
www.ncsc.ncsu.edu

Southeastern energy issues

Do we have “energy issues” in the Southeast that could be improved through reasonable “solutions” provided through policy and technology changes?

Southeast has relatively cheap power

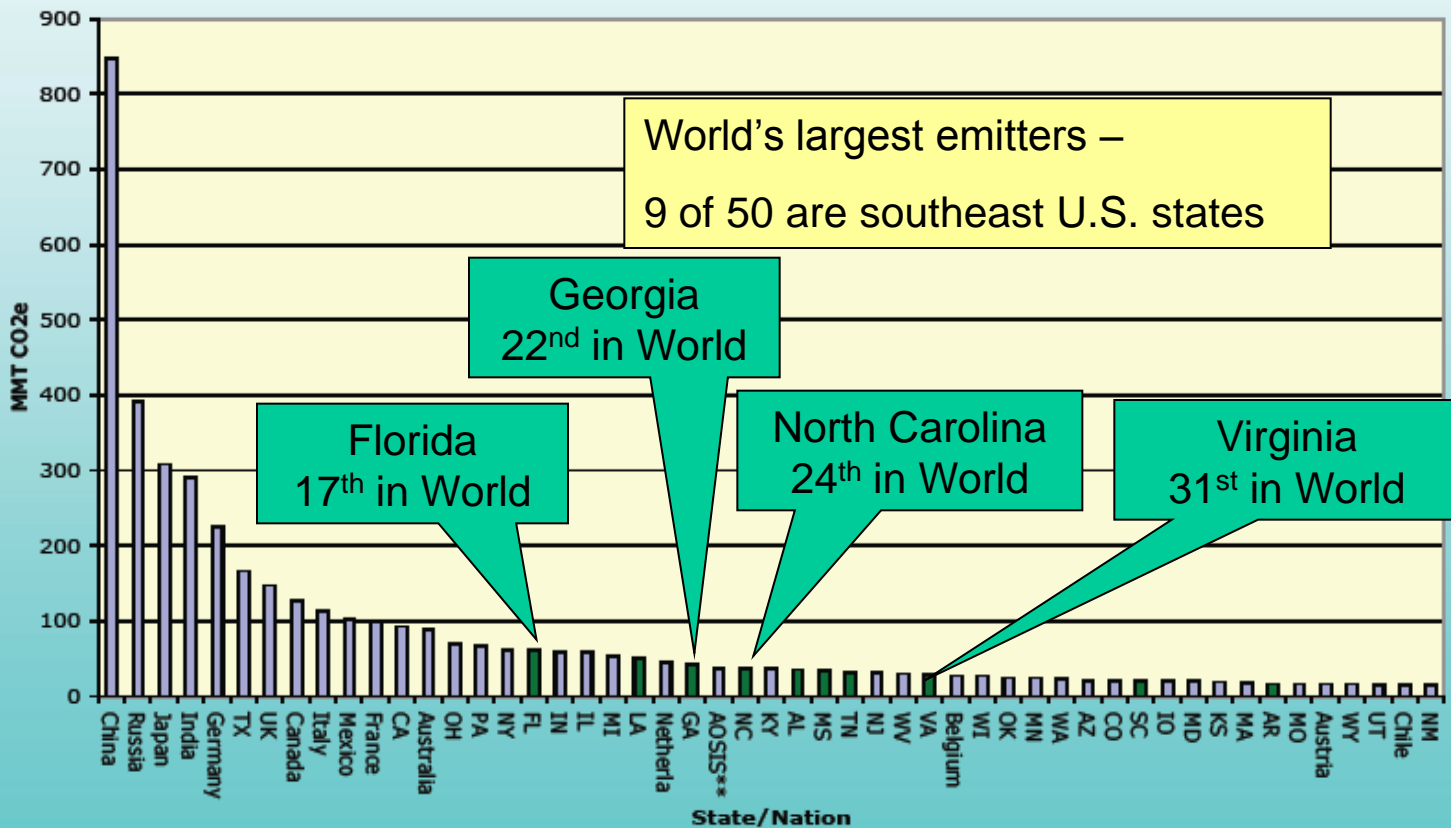
Risk of dying from coal fired power plant caused particulates



World's 50 largest GHG producers

States = 34 of top 50 Global Emitters

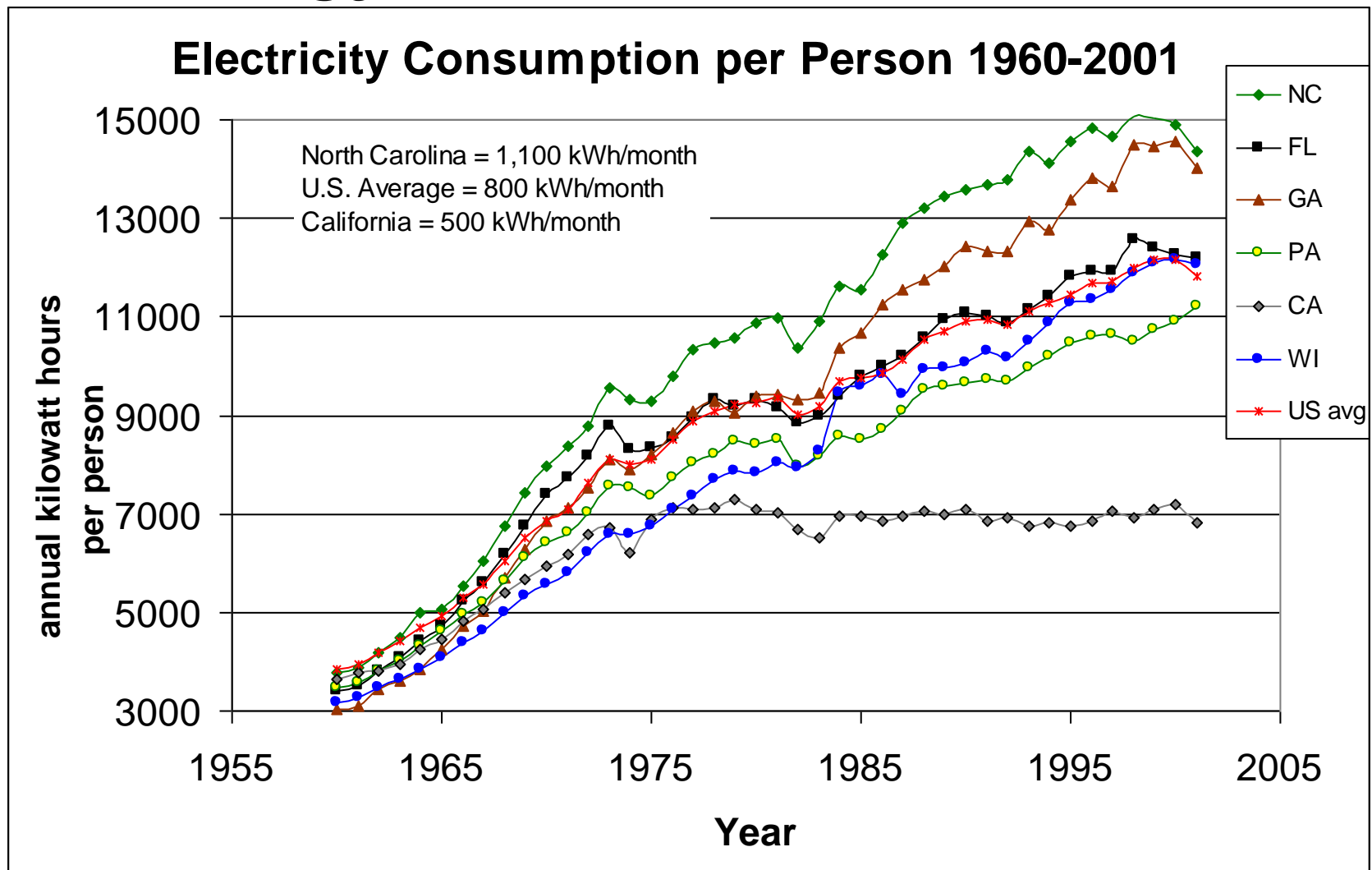
Global GHG Emissions



Source: Pew Climate Center presentation to NC Climate Change Commission, 2006

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NC and GA – two of most inefficient energy economies in the U.S.



Source: U.S. Department of Energy, Energy Information Administration. 2006

Our Energy Future Will Cost More, with or without Renewable Energy

- Fuel price increases
 - Coal: \$28/ton 2002 is \$64/ton in 2005
 - Natural Gas: \$2/MMBtu in 1998, \$7.39 in 2005
 - Uranium: \$7.10 in 2000, \$23 in 2005
- Utilities: 10,000 MW new capacity proposed by 2013
 - Both new nuke and coal plants proposed
 - Recent coal plant costing at \$3000/kw
- Future uncertainty (and higher costs)
 - Bad for policymakers, shareholders, consumers
 - Capital flows to lower risk and shared risk projects
 - Global Warming cost is unknown

Are these “issues” pushing for a “solution” in the Southeast?

- Agricultural community is politically strong and owns renewable energy feedstock
- Economic development opportunities for depressed regions that need jobs
- Air quality and climate change issues makes strange bedfellows
- Energy security and independence perceived as critical need
- Price Volatility and Escalation – How much will fuel cost next year?
- Business community has turned a corner – green for marketing & social responsibility
- Distributed Generation Technologies are coming to market at higher efficiencies and lower emissions

Consider CHP for efficiently using biomass for power production

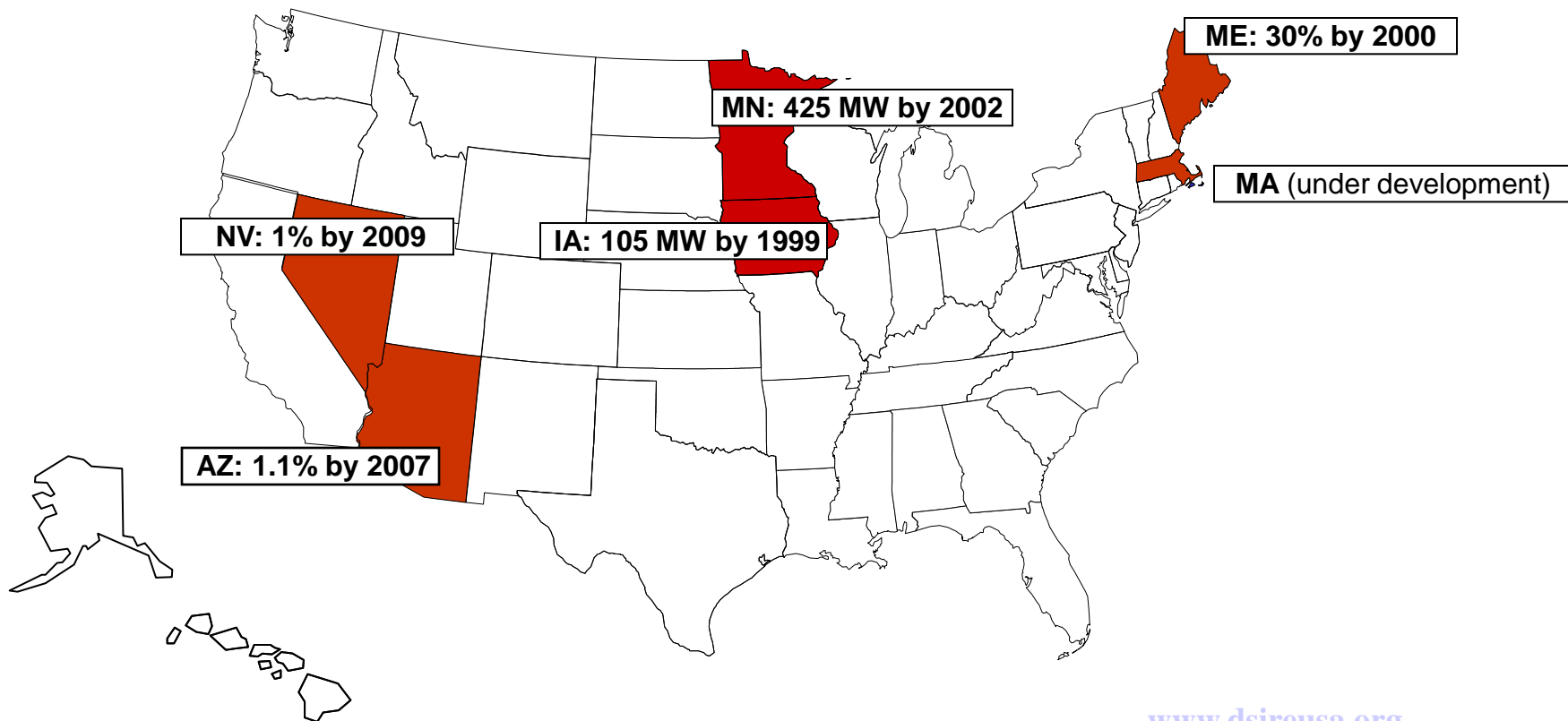
- Promote distributed generation using **available “opportunity” fuels**
- Utilize waste heat from the natural inefficiency of power generation
- Strive to reduce carbon emissions to the atmosphere
- Support the process to establish policies that allow change to occur

Policy Requirements

Policy Requirements

- Renewable Energy and Efficiency Portfolio Standards
 - RPS (REC's Green Tags)
 - EPS (REC's White Tags)
- Interconnection Standards
 - Conform to IREC recommendations
- Net Metering Standards
 - Conform to IREC recommendations

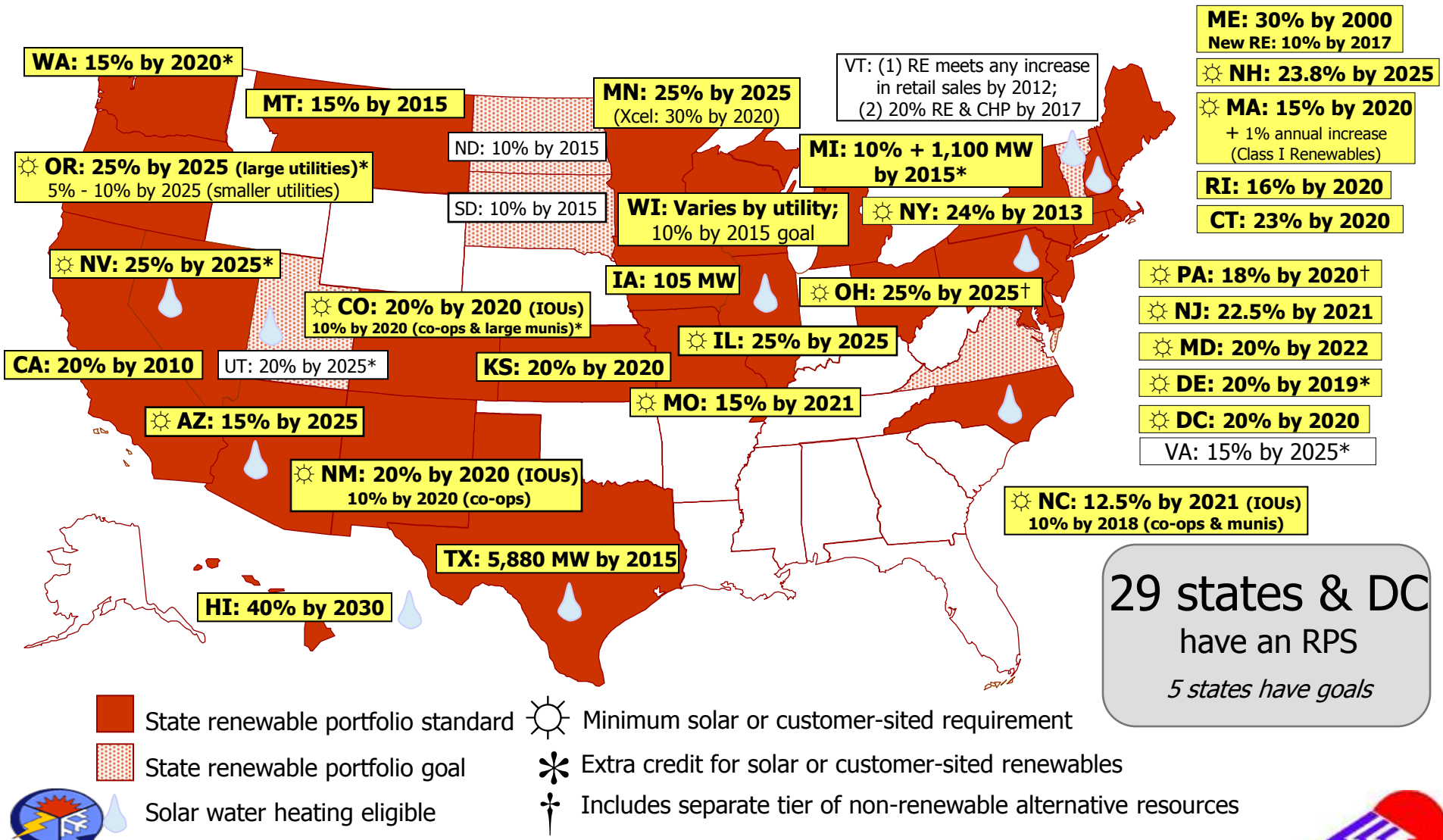
Renewable Portfolio Standards, 1997



www.dsireusa.org

Renewable Portfolio Standards

www.dsireusa.org / August 2009



29 states & DC
have an RPS
5 states have goals

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Key Elements of NC REPS

- Exempts RE systems under 2 MW from obtaining a Certificate of Public Convenience and Necessity from NCUC but require Notice of Intent
- Directs NCUC to increase size of Interconnection Standard to 10 MW
- Suggests that NCUC consider increasing Net Metering Rule to 2 MW

Benefits of an REPS for NC

- Economic (net gain) Benefits
 - Rate impact estimated lower than new coal or nuclear
 - 2,000+ net jobs per year /\$1.5 billion more in wages through 2017
 - \$2.7 billion increase in Gross State Product
 - **Keeps more \$'s circulating in NC economy**
- Social Benefits
 - Creates local wealth statewide; close to the land
 - Strengthens rural counties
- Environmental Benefits
 - Helps resolve hog and poultry waste/pollution issues
 - Improves air and water quality
 - **Reduces NC's CO₂** emissions by 13+ million metric tons per year

This slide from Legislative presentation on REPS, 2005 by Urlaub - sources ASU Energy Center, La Capra/NCUC.



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Renewable Energy and Energy Efficiency Portfolio Standard

Incentive Type: Renewables Portfolio Standard

Eligible Efficiency Technologies: CHP/Cogeneration;
specific technologies not identified

Eligible Renewable/Other Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Hydrogen, Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy

Applicable Sectors: Municipal Utility, Investor-Owned Utility, Rural Electric Cooperative

Standard: 12.5% of 2020 retail sales by 2021 for investor-owned utilities; 10% of 2017 retail sales by 2018 for electric cooperatives and municipal utilities

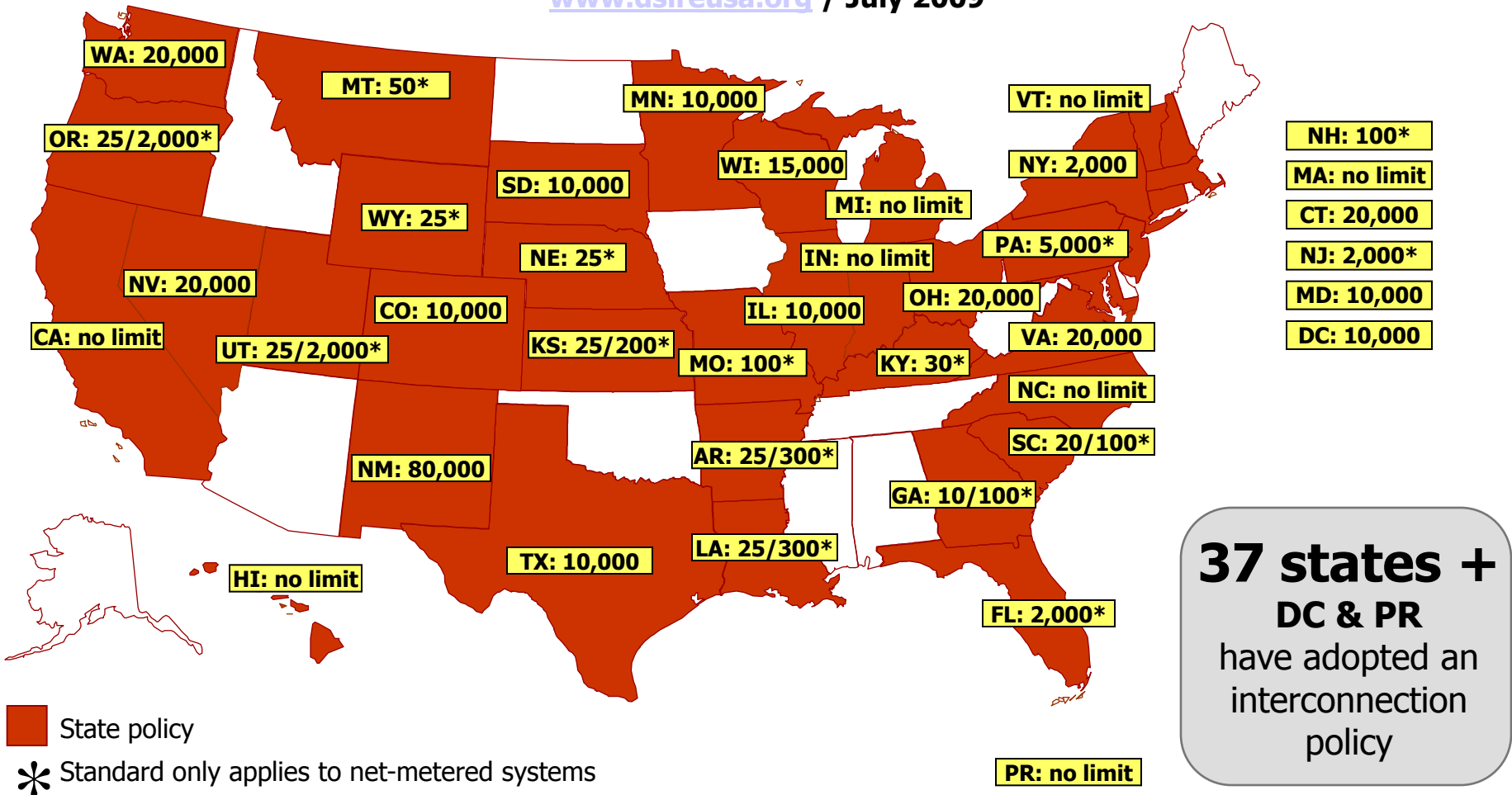
Technology Minimum: 0.2% solar electricity and thermal energy by 2018; 0.2% swine waste by 2018; 900,000 MWh of poultry waste by 2014

Renewable Energy Resource

- **“Renewable energy resource”** means a solar electric, solar thermal, wind, hydropower, geothermal, or ocean current or wave energy resource; a biomass resource, including agricultural waste, animal waste, wood waste, spent pulping liquors, combustible residues, combustible liquids, combustible gases, energy crops, or landfill methane; waste heat derived from a renewable energy resource and used to produce electricity or useful, measurable thermal energy at a retail electric customer's facility; or hydrogen derived from a renewable energy resource.
- **“Renewable energy resource”** does not include peat, a fossil fuel, or nuclear energy resource.

Interconnection

www.dsireusa.org / July 2009



37 states + DC & PR
 have adopted an interconnection policy

Interconnection Best Practices

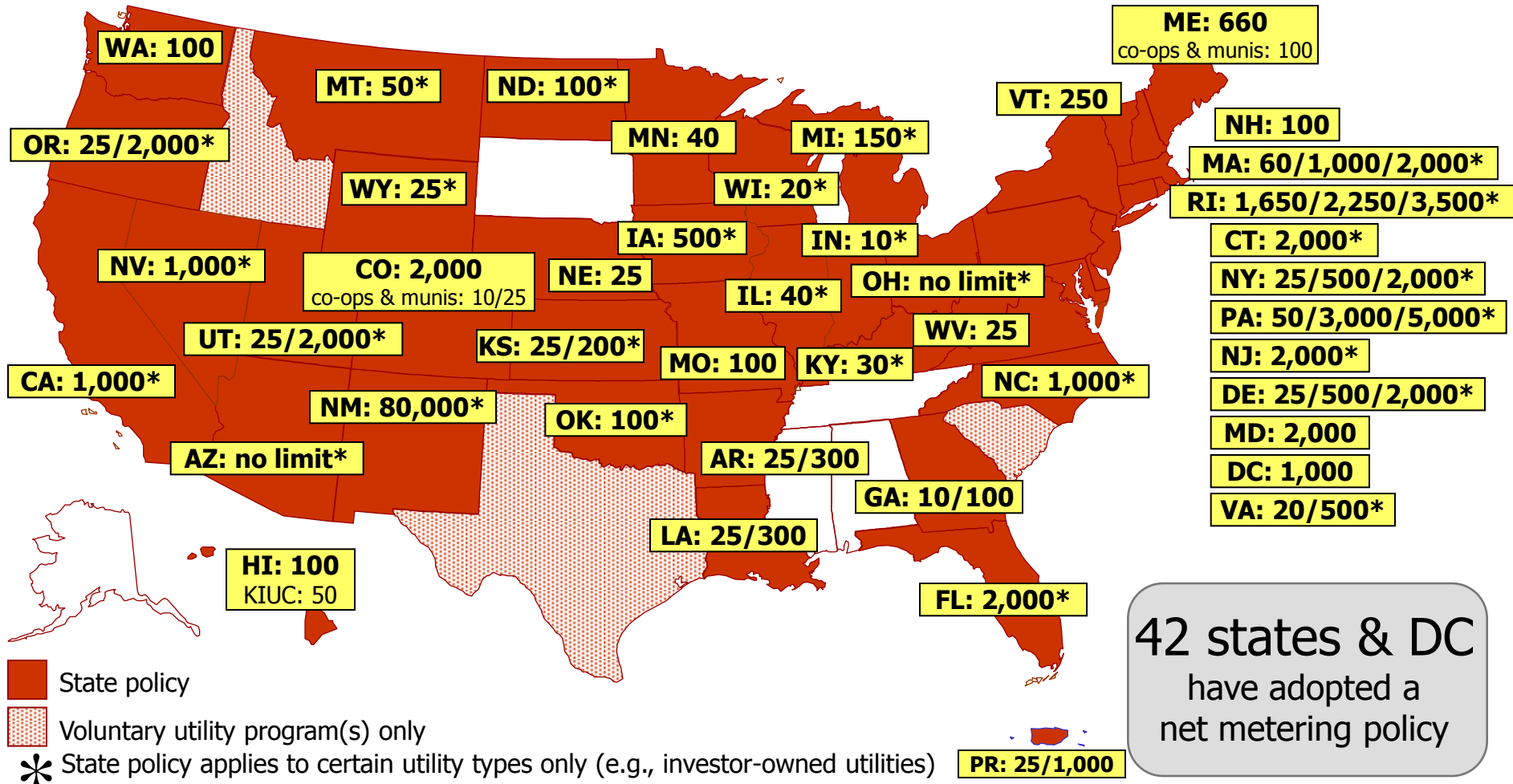
- **Explicitly allows third party ownership** (as with net metering)
- Four levels of review criteria for different sizes and types of systems: Fast track for 1) 25 kW and under, 2) 2 MW and under, 3) Non-exporting Systems 10 MW and under and 4) all others systems
- Quick, low-cost dispute resolution procedures
- Includes a footnote on the prohibition of utility external disconnect switch requirement, highlighting the consensuses regarding small facilities
- Extends applicability beyond 10 MW to cover all state jurisdictional facilities

Interconnection Grades for the Southeast

State	Total	2009	2008
Virginia	16	A	F
North Carolina	9	B	B
Florida	6.5	C	D
Arkansas	-3	F	F
Georgia	-1	F	F
Kentucky	-0.5	F	N/A
Louisiana	-4	F	F
South Carolina	-1	F	F
Alabama	N/A	N/A	N/A
Mississippi	N/A	N/A	N/A
Tennessee	N/A	N/A	N/A

Net Metering

www.dsireusa.org / September 2009



42 states & DC
have adopted a
net metering policy

Note: Numbers indicate system capacity limit in kW. Some state limits vary by customer type, technology and/or system application. Other limits might also apply.

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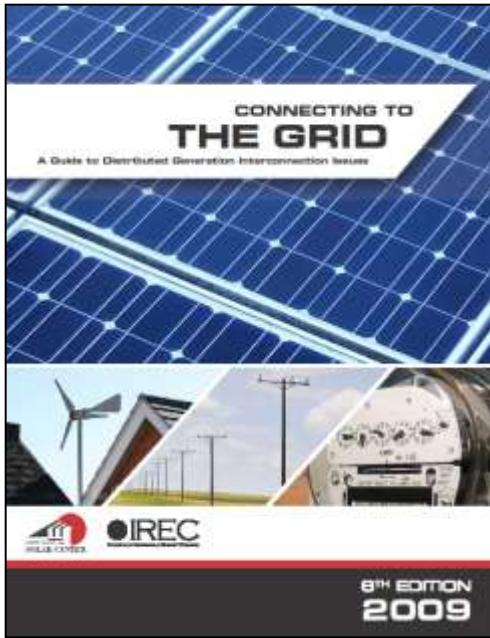


Net-Metering Best Practices

- **Maximum system size ≥ 2 MW**
- All renewables eligible (+CHP)
- All utilities must participate
- All customer classes eligible
- **Limit on aggregate capacity $\geq 5\%$**
- Interconnection standards
- No application fee
- No special charges or monthly fees
- **Customer retains REC's**

Net Metering Grades for the Southeast

State	Total	2009	2008
Florida	16.5	A	A
Virginia	15	A	C
Kentucky	10.5	B	B
Louisiana	9	B	C
Arkansas	8	C	B
North Carolina	5.5	D	F
Georgia	0.5	F	F
South Carolina	N/A	N/A	F
Alabama	N/A	N/A	N/A
Mississippi	N/A	N/A	N/A
Tennessee	N/A	N/A	N/A

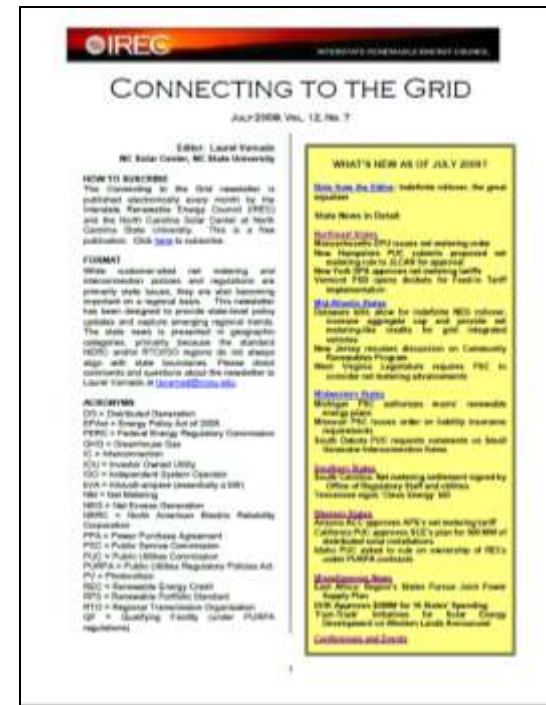


Connecting to the Grid: A Guide to Distributed Generation Interconnection Issues

Coming soon to
<http://www.irecusa.org>

Available at
<http://www.irecusa.org/>

This monthly newsletter
provides state-level policy
updates and captures emerging
regional trends in net metering



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CHP Applications



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CHP in the SE

- Simplify interconnection standards
- Revise rate structure to reward energy efficiency, reduced emissions and grid support
- Adopt output based emission standards
- Apply appropriate tax treatment
- Allow third party suppliers to operate on site facilities

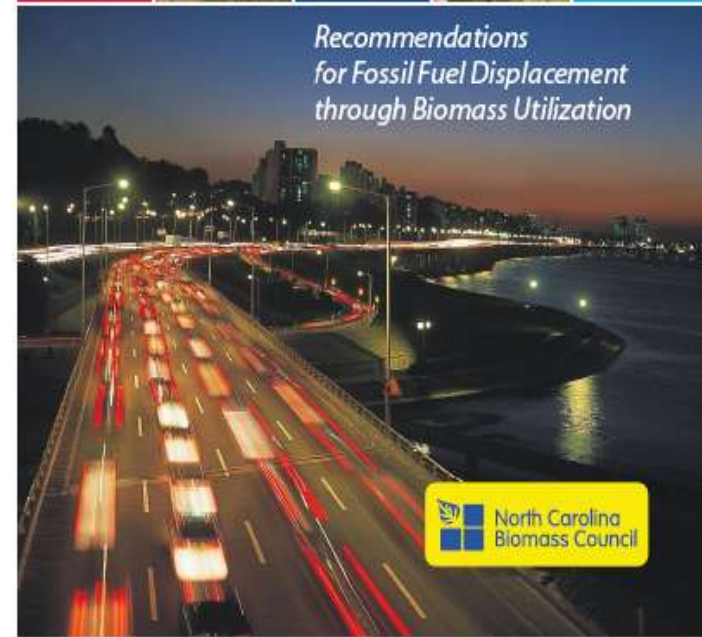
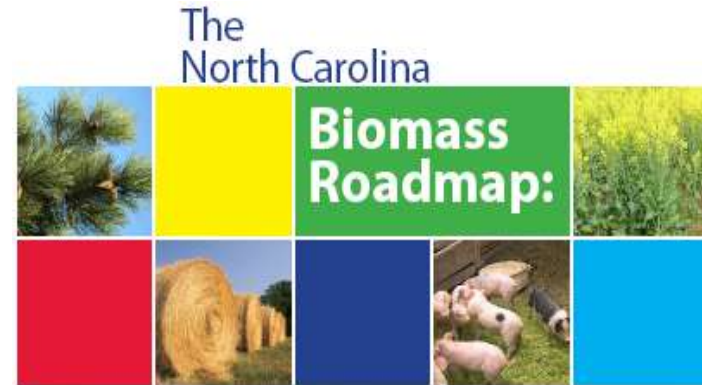
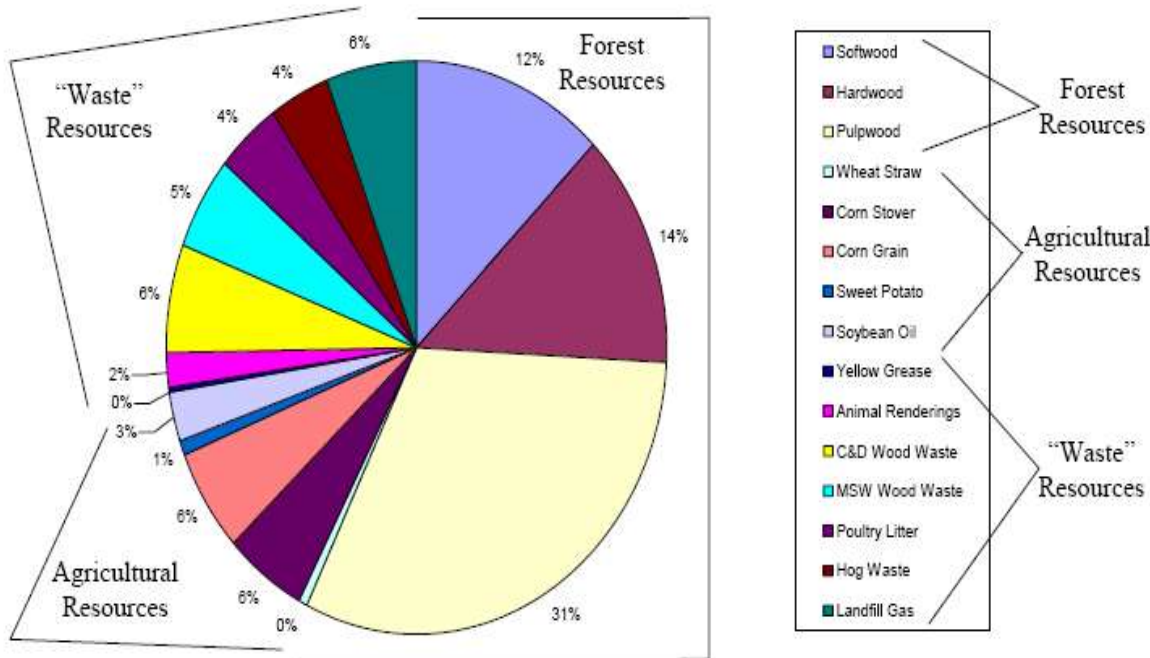
Combined Heat and Power (CHP) can be powered by “Opportunity Fuels”

- Improved efficiency
 - Putting the waste heat produced during power generation to good use is CHP
 - Using waste heat available from other activities to produce electric power is CHP
- Lower environmental impact
 - Use of biomass and other sustainable or otherwise wasted fuel resources for power generation

NC Biomass Council

Estimated 277 trillion Btu's
or 81 billion kW_thr of biomass
resource in NC

Figure 5: Distribution of the Potential Biomass Energy in North Carolina¹²



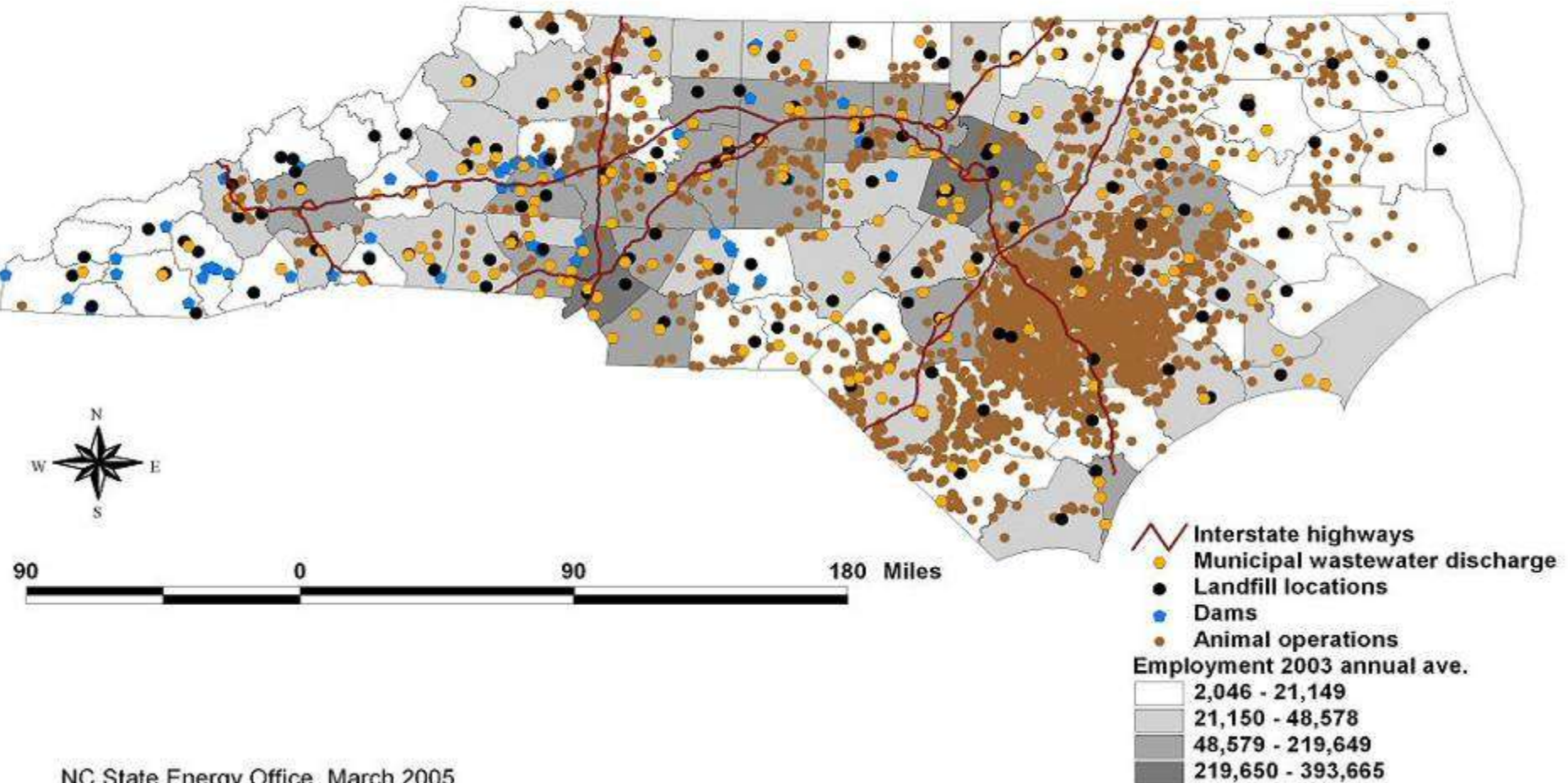
http://www.engr.ncsu.edu/ncsc/bioenergy/docs/NC_Biomass_Roadmap.pdf

Opportunity Fuels

- Anaerobic Digester Gas (ADG)
- Land Fill Gas (LFG)
- Fuel Gas
- Biomass
- Construction and Demolition (C&D)
- Municipal Waste
- Shredded Tires

Opportunity fuels

Locations of Landfills, Hydroelectric, Waste Treatment and Animal Operations



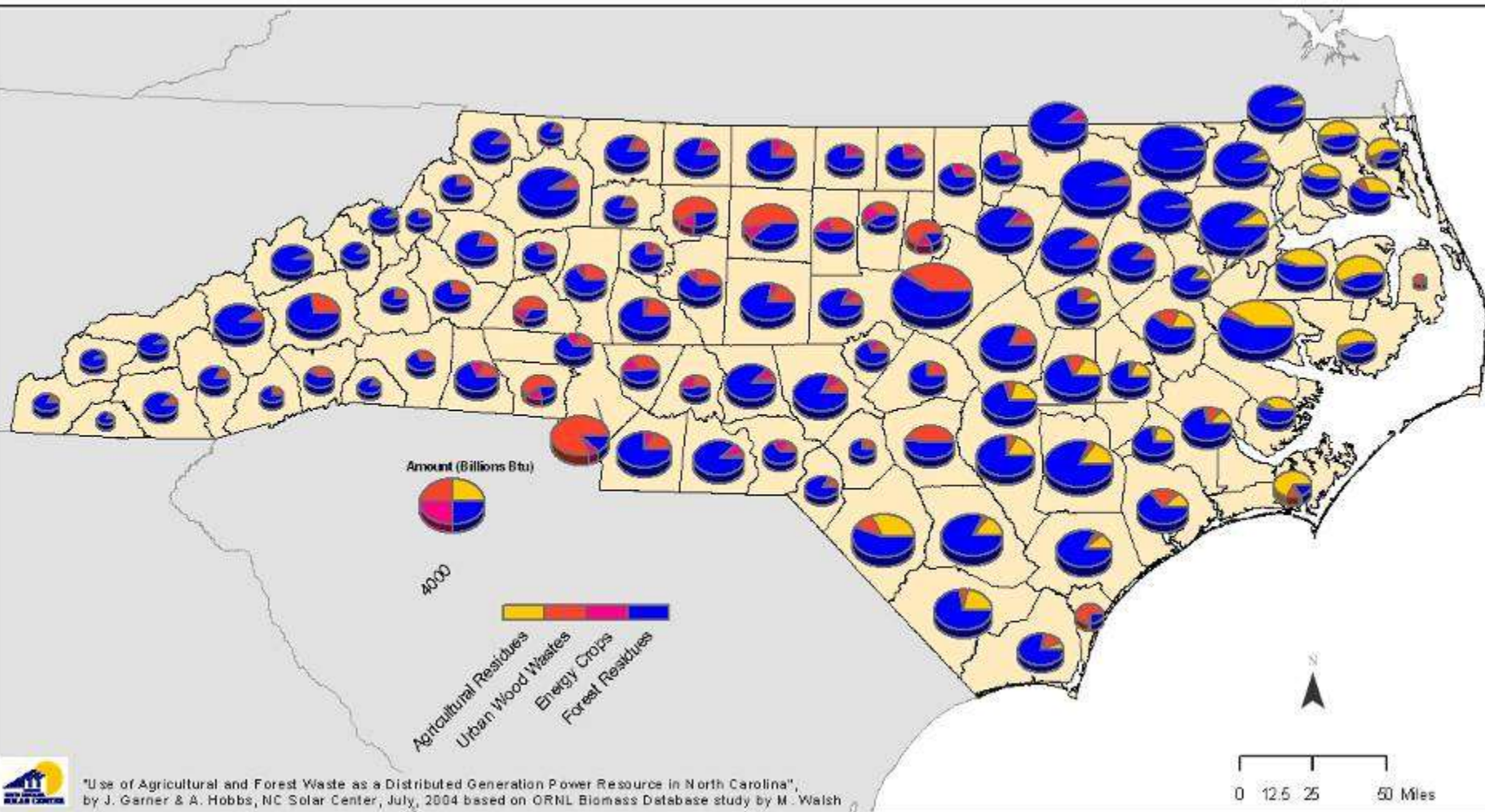
NC State Energy Office, March 2005
With assistance from NC Solar Energy Center and
NC Center for Geographic Information and Analysis

Total Biomass *Thermal Fuel Value*

199×10^{12} Btu/yr

6650 Mw_t

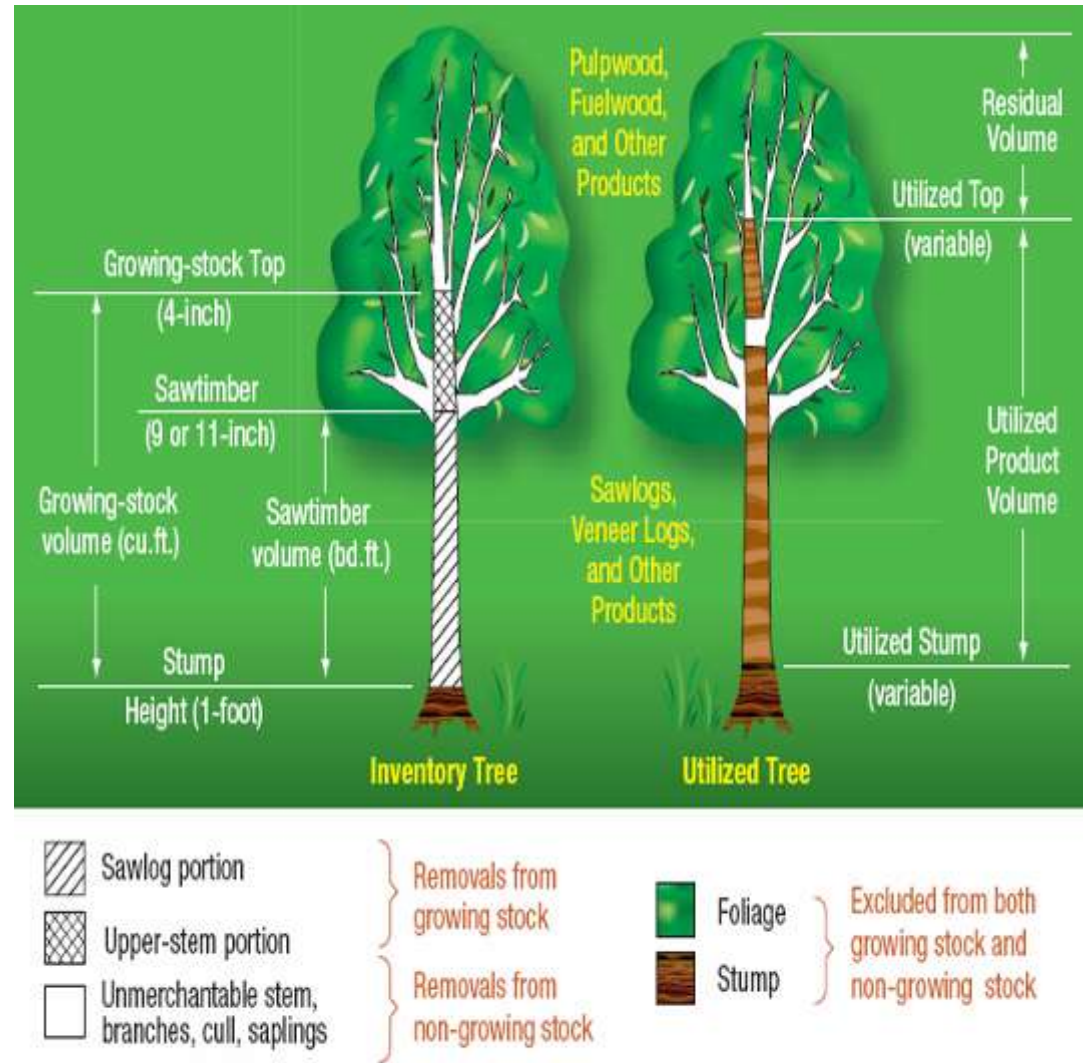
1662 Mwe



Wood residues

The conversion of woody biomass to energy in the NC poses a unique opportunity to address three issues:

- The need to restore forest health
- The need to find renewable energy alternatives
- The need to provide economic development in rural communities



- Logging residue includes the unmerchantable tops and small branches.

There is a significant proportion of the 10% NC REPS available from gleaning logging residues.



Biomass harvests can reduce site preparation costs.



Advantages of Biomass

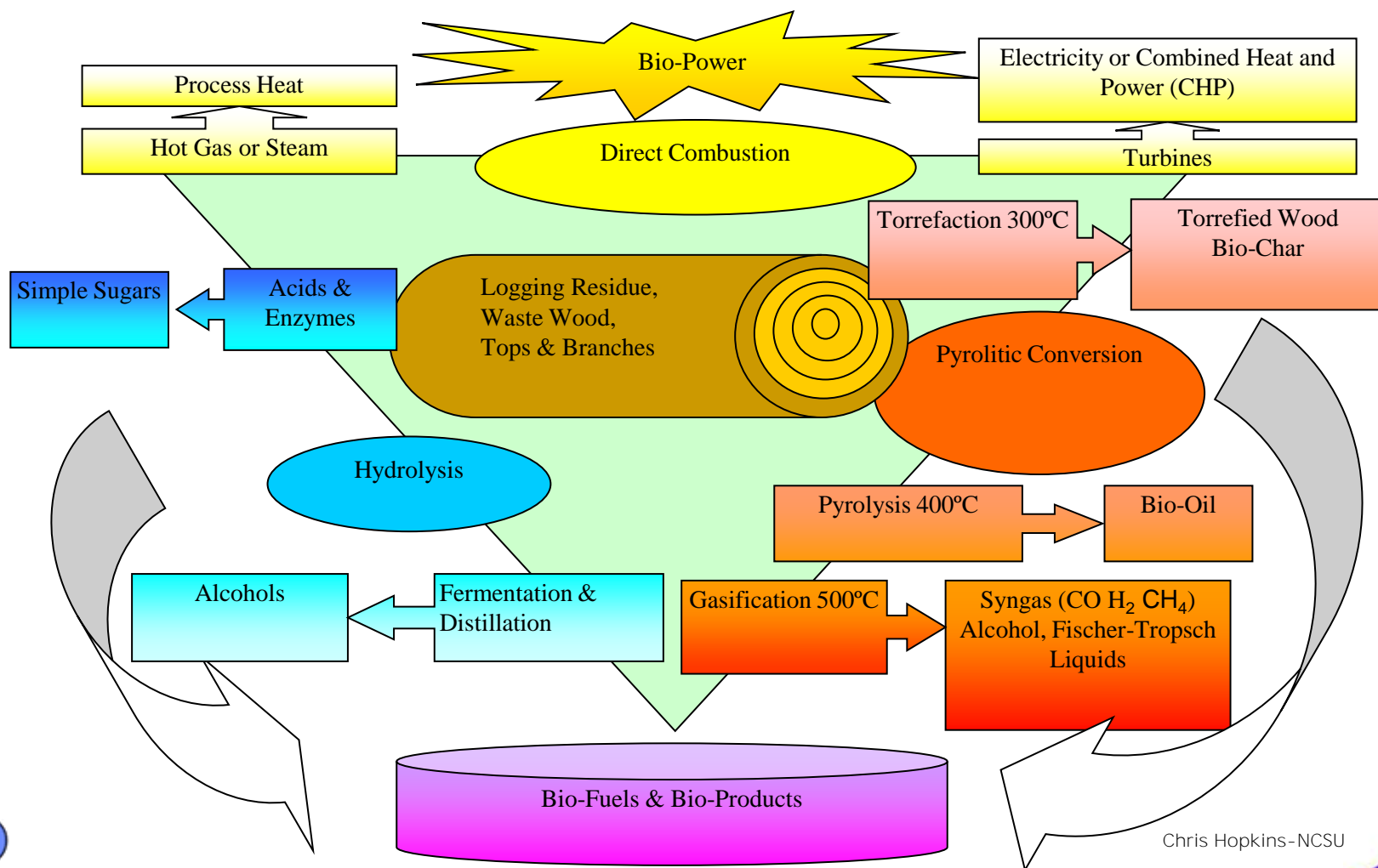
- Crude Oil => \$60 / barrel
- Natural Gas => \$10 / 1000 cf

Three times the price of

- Woody Biomass => \$50 / dry ton
- On a BTU basis at these prices, biomass resources are available for approximately on third the cost of oil and gas and equivalent to coal

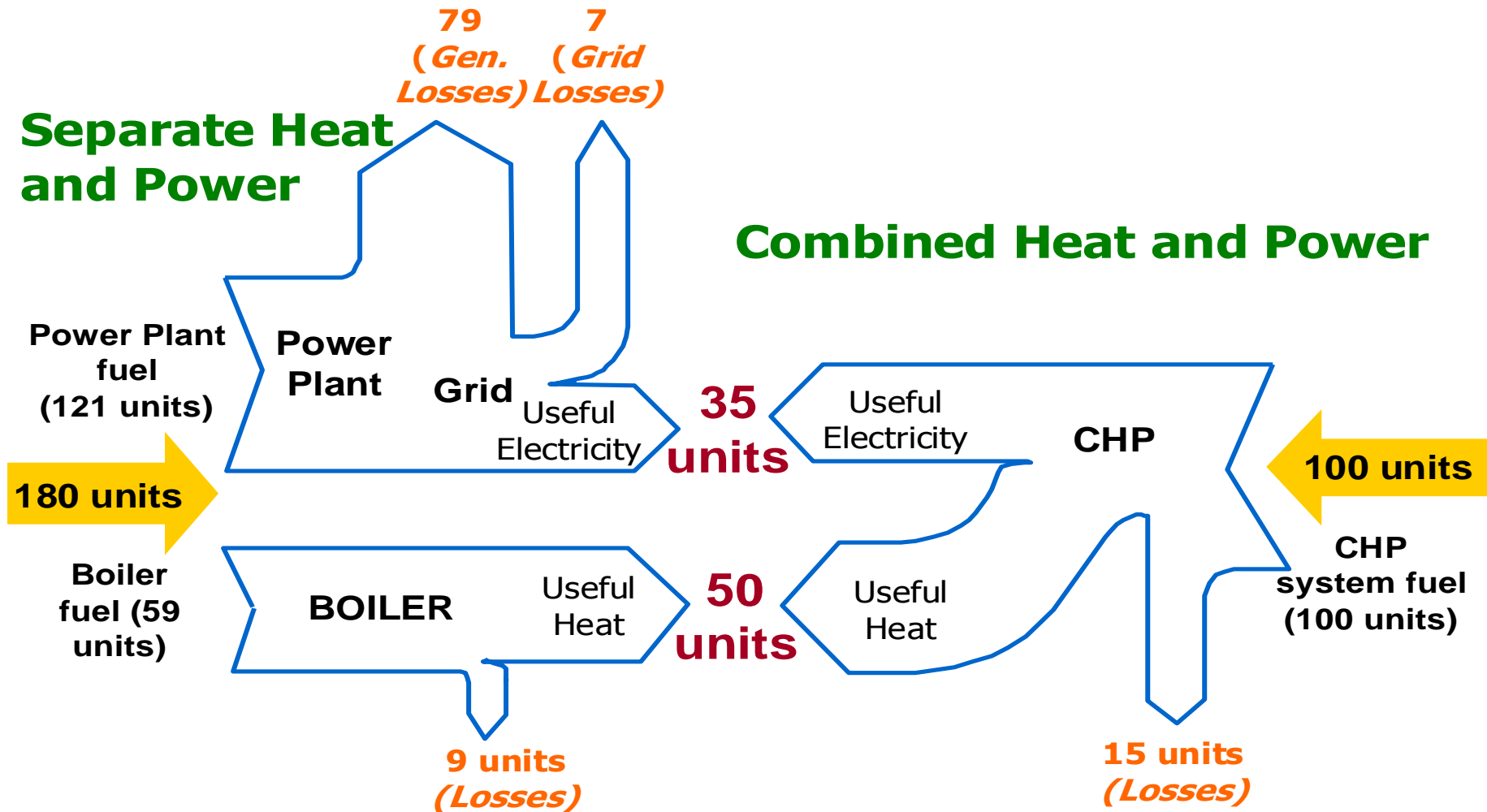
Competition Among Energy Conversion Technologies

Energy Products and Processes for Woody Biomass



Chris Hopkins-NCSU

Combined Heat & Power



Centralized Generation vs Combined Heat and Power Systems (Source: Elliott and Hedman 2001)

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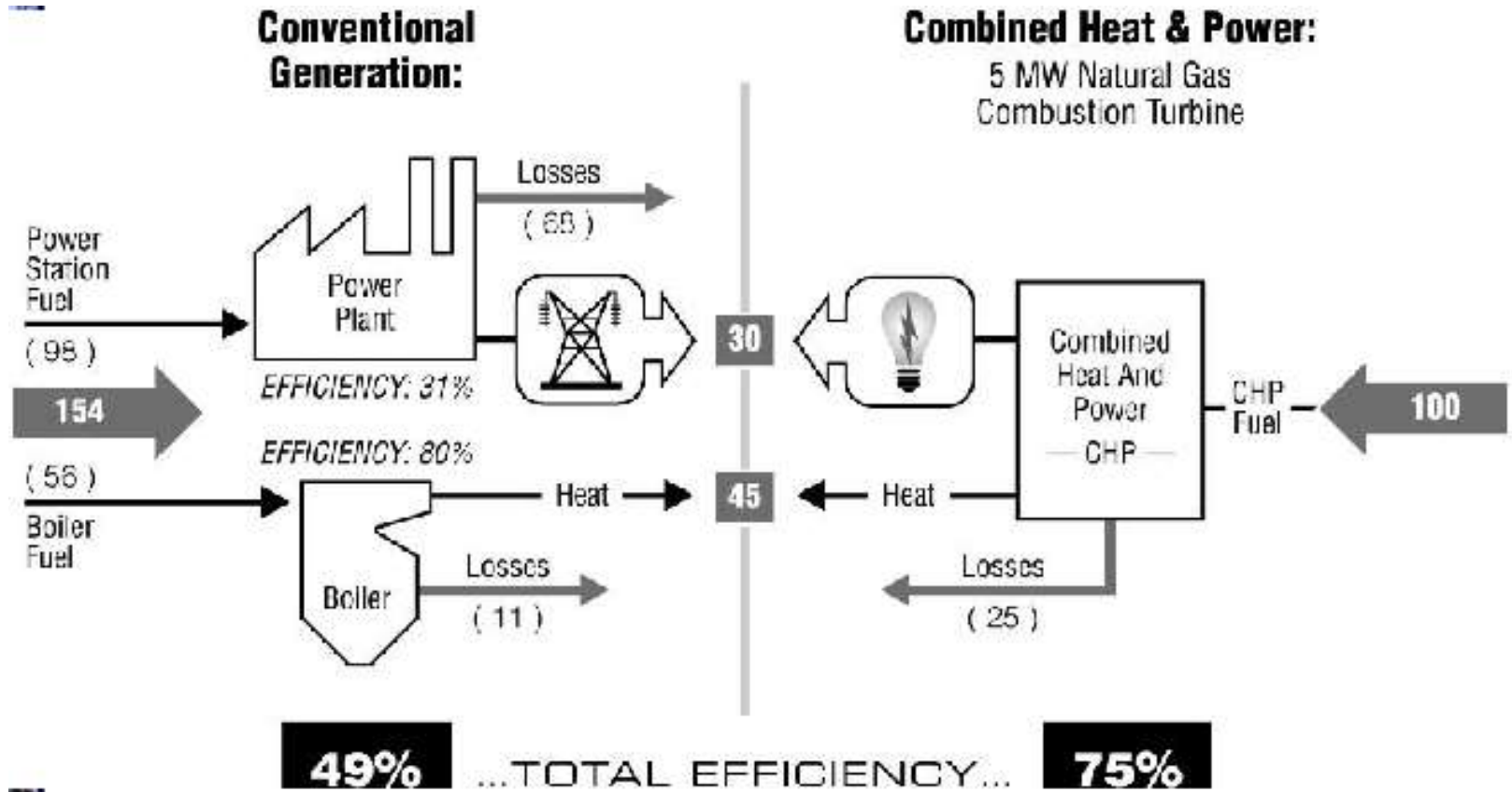
Where Does CHP Fit With DER?

- High Thermal Loads High Thermal Loads
 - Cooling, Heating, or Dehumidification Cooling, Heating, or Dehumidification
 - Steam, Hot Water, or Direct Heat Steam, Hot Water, or Direct Heat
- High Electric Loads
- Coincident Thermal and Electric Loads
- Extended Operating Hours
- Where the Rates and Regulatory Climate are Favorable
- Central HVAC System
- Access to Fuels (Natural Gas or Byproducts)

CHP Technologies

- Cooling Equipment
 - Mechanical Chillers
 - Absorption Chillers
 - Thermal Storage
 - Desiccant Dehumidification
- Heat Recovery Systems
 - Hot Water
 - Steam
- Electric Generation Equipment
 - Reciprocating Engines
 - Turbines/Microturbines
 - Fuel Cells

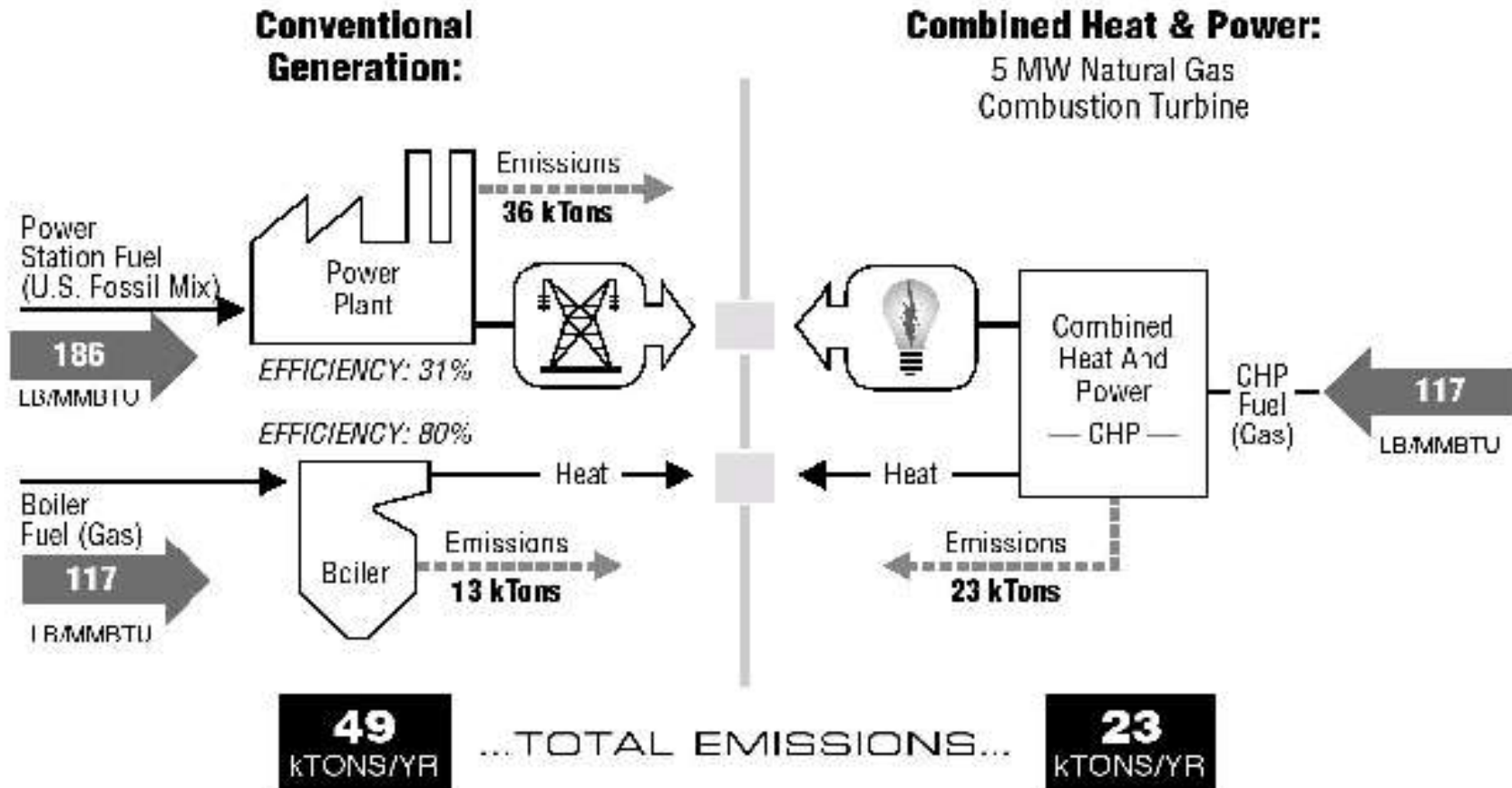
Efficiency Advantages of CHP



Courtesy of Merrill Smith, US DOE

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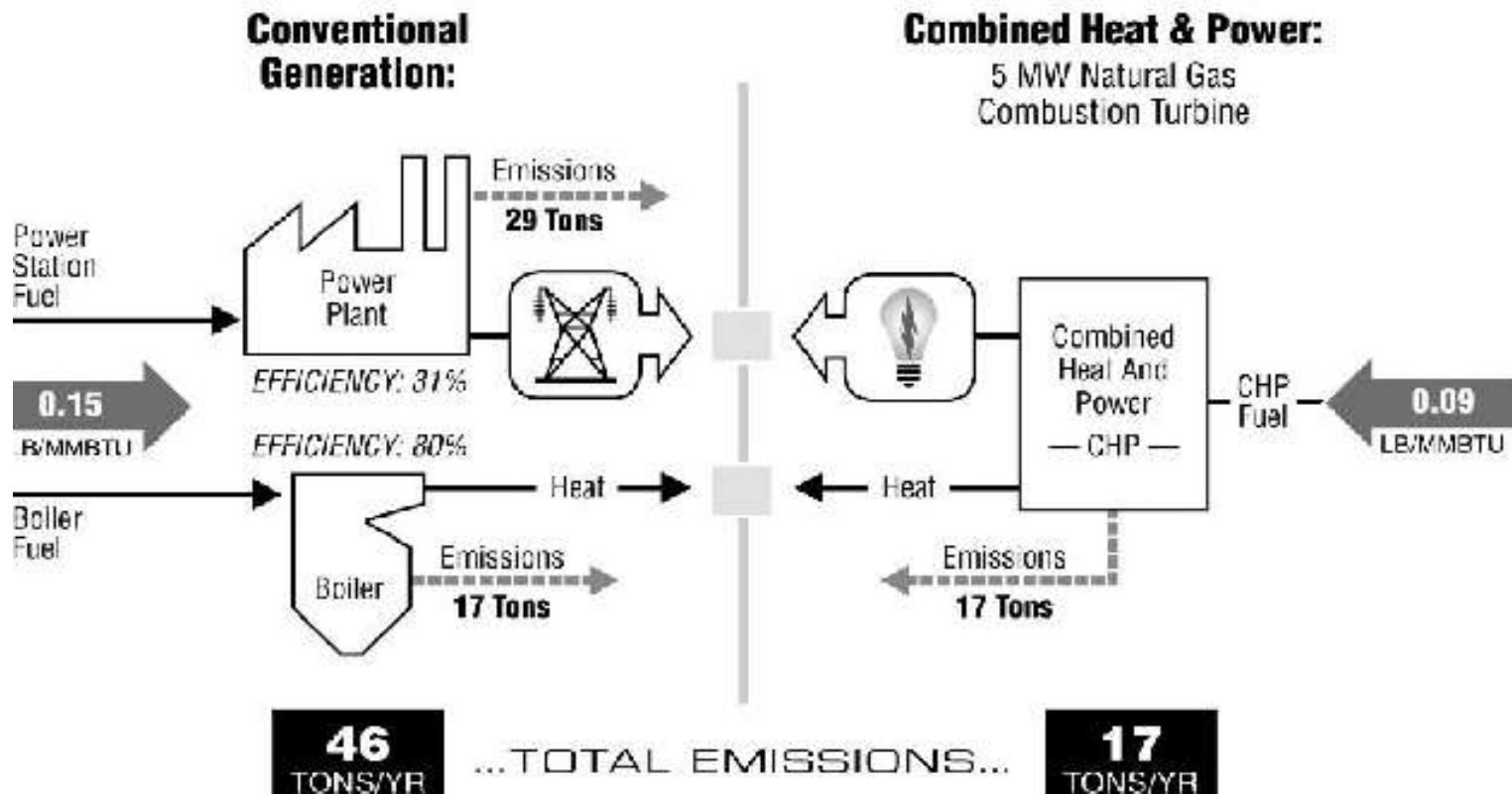
Environmental Benefits of CHP- CO₂ Example



Courtesy of Merrill Smith, US DOE

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Environmental Benefits of CHP- NOx Example



Courtesy of Merrill Smith, US DOE

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SE Clean Energy Regional Application Center

- Hosted by Mississippi State University and North Carolina State University
- Serving Arkansas, Mississippi, Alabama, Georgia, Florida, South Carolina, North Carolina, Kentucky, Tennessee
- Supported by DOE
- <http://www.chpcenterse.org/>



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EPA CHP Partnership

- Promote education and outreach efforts
- Provide direct project assistance by coordinating efforts among partners
- Public recognition program
- Provide tools and information resources for project development



<http://www.epa.gov/chp/partnership/benefits.html>



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CHP Opportunities

- Municipal WWMP
- Municipal Land Fill Gas
- Animal Waste Stream
 - Hogs, Cattle and Chickens
- Pulp and Paper Kraft Process
- Dry Cement Industry
- Metals Industry
- Petro Chemical Refineries

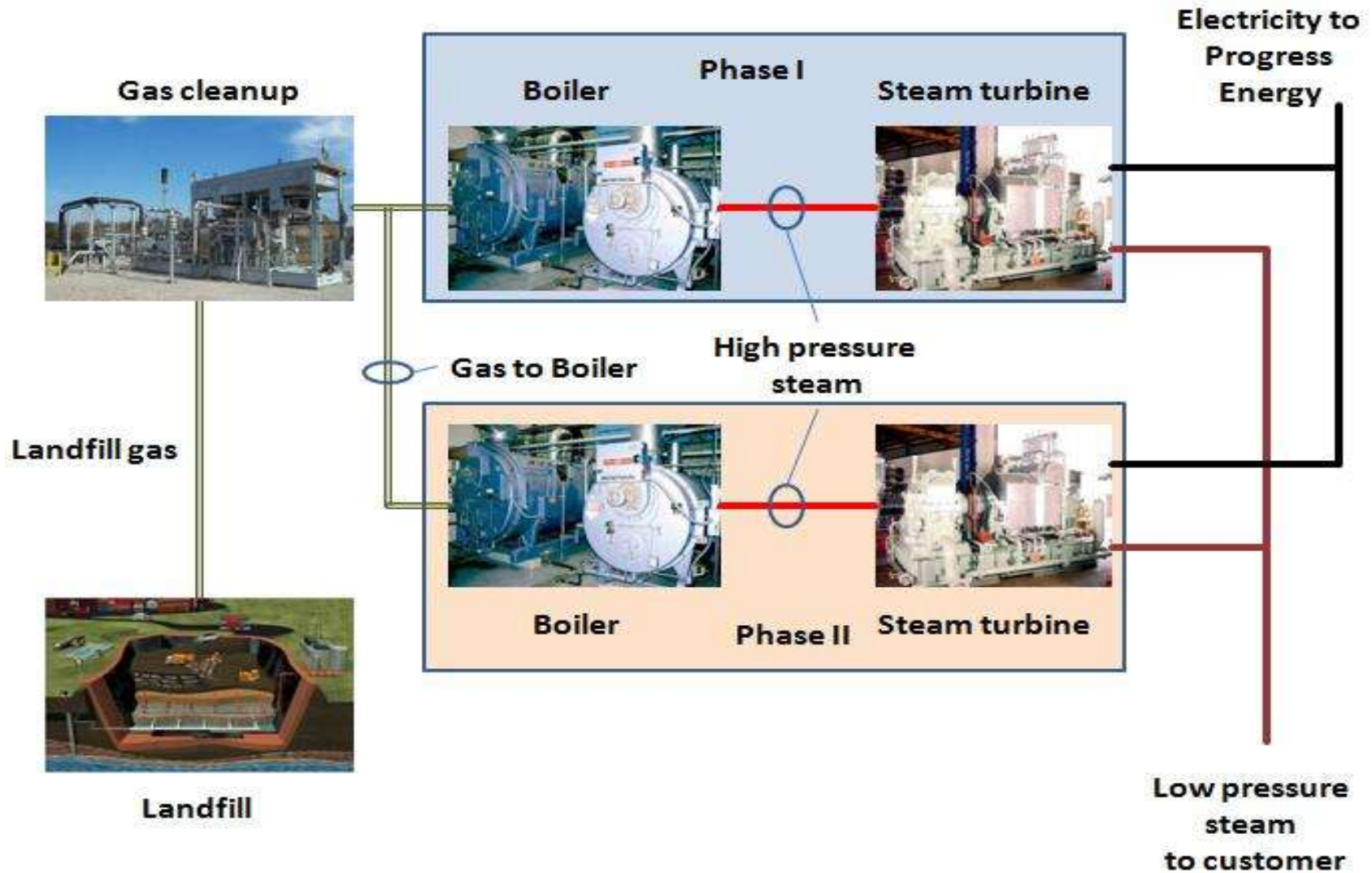
Engine-Generator Set



- EPA AgStar Program
- 120 kW generator & 10,000 gallons hot water

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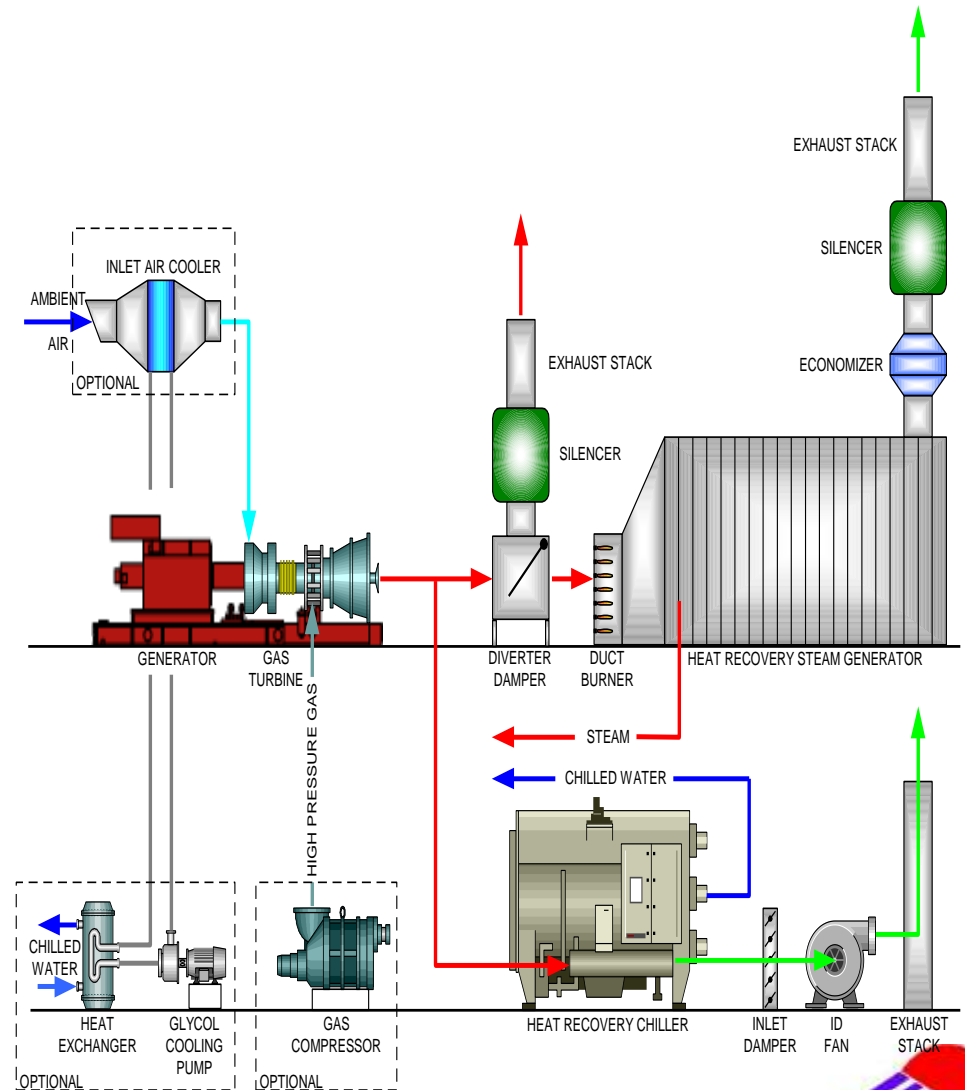
Typical Landfill CHP



Ft. Bragg District Heating and Cooling



82nd Airborne Compound
Natural gas fired
5 MW Solar gas turbine
1000 Ton absorptive cooler
28,000 PPH HRSG



CHP installed in NC

Prime Mover Code	Sites	Capacity (kW)
Total	46	1,483,924
Boiler Steam Turbine	32	1,188,379
Combined Cycle	3	188,300
Combustion Turbine	5	69,100
Fuel Cell	0	0
Microturbine	0	0
Other	1	2,900
Recip engines	5	35,245

<http://www.eea-inc.com/chpdata/States/NC.html>
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For more information

- www.chpcenterse.org
- www.uschpa.org
- www.dsireusa.org

- Keith McAllister
keith_mcallister@ncsu.edu
919-515-3933

Do we have some
questions?

Alex Hobbs

NC Solar Center

www.ncsc.ncsu.edu



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