# Clean and Diversified Energy Initiative

WESTERN GOVERNORS' ASSOCIATION

# Combined Heat and Power White Paper

January 2006

# Western Governors' Association
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**At the invitation of the Western Governors' Association's Clean and Diversified Energy Advisory Committee (CDEAC), the individuals below prepared this white paper on Combined Heat and Power. The white paper was presented to the CDEAC on December 8, 2005 and it was accepted for further consideration as the CDEAC develops recommendations for the Governors. At their Annual Meeting in June, 2006, Western Governors will consider and adopt a broad range of recommendations for increasing the development of clean and diverse energy, improving the efficient use of energy and ensuring adequate transmission. The CDEAC commends the individuals listed below for the thorough analysis and thoughtful recommendations.**


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# Contents

# Acronyms and Abbreviations

CHP ..................................... Combined Heat and Power

DG ....................................... Distributed Generation

FERC.................................. Federal Energy Regulatory Commission

GW................................... ... Gigawatt

IEEE 1547 Standards .......... Standards for interconnecting distributed resources with electric power systems

ISO ...................................... Independent System Operator

kW ....................................Kilowatt

kWh .................................Kilowatt-hour

LCOE.............................. ... Levelized Cost of Energy

MW..................................Megawatt

OPUC .................................. Oregon Public Utility Commission

PJM Interconnection ........... A regional transmission organization covering Pennsylvania, New Jersey, and Maryland that plays a vital role in the U.S. electric system

PUC ..................................... Public Utility Commission

PURPA................................ Public Utility Regulatory Policies Act

RGGI ................................... Regional Greenhouse Gas Initiative

RPS...................................... Renewable Portfolio Standard

RTO ..................................... Regional Transmission Organization

T&D .................................... Transmission and Distribution

VARs................................... Volt Amperes Reactive is a component of an electrical system that is often referred to as the “useless part.” Fewer VARs mean more useful energy and better performance.

# Executive Summary

The Western United States is facing explosive growth in electricity consumption and water usage, while at the same time facing escalating fuel costs, "not in my backyard" attitudes towards new transmission lines, continuing air pollution challenges, growing climate change concerns, and new concerns over electric reliability to better cope with major disasters. Given these unprecedented challenges, it will be quite difficult to meet the demands of load growth based on the outdated paradigm of centralized generation with large transmission and distribution investments.

We need to take advantage of electric system advancements in technology and design. There is a better way to move forward.

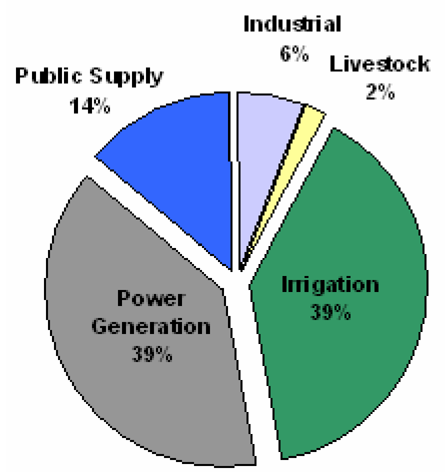



Figure: U.S. Freshwater

## Extensive Benefits from CHP Are Key to a Sound Energy Policy

Combined heat and power (CHP) is an affordable, efficient, clean, and reliable piece of the puzzle for meeting the Western region's energy needs. CHP refers to any system that simultaneously or sequentially generates electric energy and utilizes the thermal energy that is normally wasted. CHP is sometimes called "recycled energy" because the same energy is used twice. The recovered thermal energy can be used for space heating, hot water, steam, air conditioning, water cooling, product drying, or for nearly any other thermal energy need. The end result is significantly more efficient than generating electric and thermal energy separately. In fact, many CHP systems are capable an overall efficiency of over 80 percent – double that of conventional systems.

In addition to tremendous efficiency gain, increased adoption of CHP in the West would save literally billions in new capital investment, reduce power costs, reduce security vulnerabilities, improve reliability and power quality, avoid transmission losses, reduce water used by power plants, cut fossil fuel use, cut greenhouse gas emissions, and cut other pollutants. Combined heat and power, using proven and affordable technologies, significantly improves every key outcome from power generation.

In the private sector, economically motivated investments in CHP by unregulated businesses now generate almost 9 percent of all power consumed in the United States at a total fuel efficiency nearly twice that of the rest of the U.S. power grid. One need only ask what would happen to our electric reliability, fuel prices, or air emissions if these private-sector investments were to be shut down to realize how dependent our electricity infrastructure is on CHP technology.

| State | Existing CHP Capacity (MW) | Add'l Potential Capacity (MW) |
|---|---|---|
| AK | 438 | 277 |
| AZ | 155 | 1,801 |
| CA | 9,043 | 10,945 |
| CO | 791 | 1,578 |
| HI | 565 | 705 |
| ID | 192 | 1,142 |
| KS | 119 | 2,005 |
| MT | 99 | 470 |
| ND | 39 | 1,205 |
| NE | 25 | 834 |
| NM | 226 | 649 |
| NV | 549 | 393 |
| OR | 2510 | 1,862 |
| SD | 2.7 | 307 |
| TX | 17,122 | 13,489 |
| UT | 239 | 1,267 |
| WA | 1132 | 3,189 |
| WY | 59 | 747 |
| **Total** | **33,304** | **42,864** |

**CHP Potential Exists to Meet the 30,000 MW Goal by 2015 and Beyond**

The WGA has set a goal of adding 30,000 MW of new, clean, and efficient capacity by 2015. CHP has the potential to exceed the entire WGA goal of 30,000 MW all by itself. Yet, despite its advantages to end-use customers, utilities, ratepayers, and society as a whole, the potential has not been met. The existing CHP capacity is still far below its technical and economic potential. As of 2005, the WGA states had approximately 33,304 MW of CHP at 1,262 sites. The additional technical potential in the WGA states is estimated to be 42,864 MW.

**Significant CHP Development Opportunities Have Been Lost Over the Past 15 Years due to Major Policy and Regulatory Barriers**

In spite of supportive federal policy directives and guidance, many state utility commissions lack the resources to incorporate CHP policy objectives into the minutiae of utility rate filings, docketed hearings, and other tasks that necessarily shape their day-to-day agenda. Their mandate is typically to interpret and enforce existing law rather than to consider larger issues of energy and environmental policy. Compounding this resource limitation is the fact that electric utilities typically perceive CHP as a competitive threat, to the extent that it reduces their electricity sales and hence, their revenue. Unreasonable interconnection policies[1], standby rates, and demand charges often stem from this conflict. This combination has slowed, and in some cases, prevented deployment of CHP in most Western states, in spite of its beneficial impact on the grid, environment, and economy.

**Long-Term, Stable CHP Policy and Regulatory Changes Are Needed to Meet WGA's Expectations**

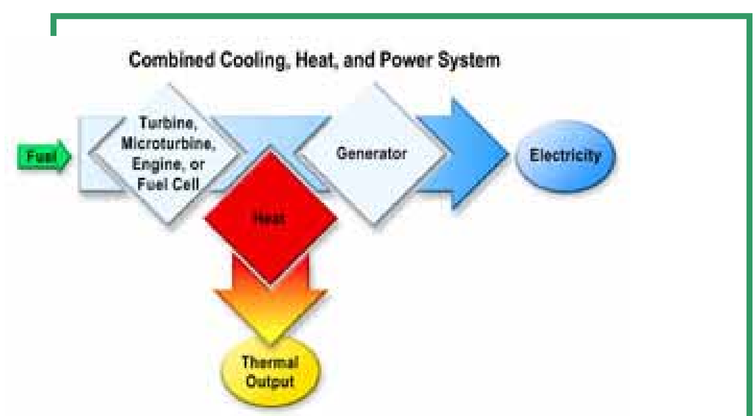
The barriers to increased CHP are deeply rooted in the outdated U.S. electricity framework and deserve a long-sustained effort to address. This will require both intellectual rigor and political courage, but the returns will justify the effort in the long term. In the near term, we recommend first steps that each of the WGA governors should undertake to move toward greater deployment of CHP systems. These are small steps, but they are in the right direction and politically realizable in the short term. The Western states should adopt and implement the following fair and workable CHP policies:

- Have each state undertake a thorough review of policies affecting CHP.
- Adopt recently enacted FERC standards for interconnection agreements.
- Give fair credit for CHP emissions reductions by adopting output-based emission standards and greenhouse gas market trading networks.
- Seek CHP solutions to T&D-constrained areas.
- Undertake a review of electricity rates, including standby rates, to make sure they are not discriminatory toward CHP.
- Incorporate policies that will appropriately promote CHP in state utility Least Cost Planning and Integrated Resources Plans.

- Consider adding CHP to Demand Side Management and other energy efficiency programs.
- Decouple utility revenues from throughput.
- Enact a state equivalent of the Federal Section 45 Production Tax Credit including CHP, wind, geothermal, and biomass technologies.
- Adopt simplified, streamlined, and consistent permitting for CHP systems.
- Offer state-funded training and technical assistance programs for local code officials.
- Ensure that renewable portfolio standards, environmental portfolio standards, advanced energy portfolio standards, and other renewable energy laws include the full range of renewable CHP options, including waste heat recovery and spent pulping liquor.
- Call on CHP Regional Application Centers for help in policy, programs, and analysis.
- Wherever possible, adopt consistent, region-wide policies.

# 1. What is CHP?

Combined Heat and Power or CHP describes any system that simultaneously or sequentially generates electric energy and utilizes the thermal energy that is normally wasted. Most CHP systems are configured to generate electricity, recapture the waste heat, and use that heat for space heating, water heating, industrial steam loads, air conditioning, humidity control, water cooling, product drying, or for nearly any other thermal energy need. (This configuration is also known as cogeneration). Alternately, another CHP configuration may use excess heat from industrial processes and turn it into electricity for the facility.




**Source: Federal Energy Management Program – DER/CHP website**

Figure 1: Combined Heat and Power System

Fundamentally, CHP is a form of recycling, as it converts waste materials into valuable commodities, thus providing both enhanced revenue and reduced environmental impact. For the most part, central station power plants do not recycle their energy waste, as they still throw away, on average, nearly two-thirds of all the fuel they purchase in the form of waste heat released into the environment.

CHP is a subset of Distributed Generation (DG). DG describes those technologies that are sited at the point of electricity consumption for the economic benefit of the electricity user. While not all DG technologies are designed to recover their waste heat, virtually all CHP facilities are sited at or near the point of electricity consumption, due to the economic difficulties associated with the transport and storage of thermal energy.

Following are some "basics" about CHP systems:

- ***Size:*** CHP systems vary in size from several kilowatts to hundreds of megawatts. In the WGA states, they are most feasible in larger commercial buildings, multi-building facilities such as colleges and universities, industrial customer applications, renewable fuel applications, pipeline generation stations, and petroleum refining.

- ***Technologies:*** CHP systems use one or more of the following prime movers: reciprocating engines, gas turbines, steam turbines, microturbines, fuel cells, Stirling engines, or Organic Rankine Cycle system. Generally speaking, any prime mover can configured for CHP applications and, conversely, CHP has no inherent bias toward any specific prime mover technology.[ii] For cooling and air conditioning applications, the waste heat can be used in an absorption chiller, steam chiller, and/or a desiccant dehumidification unit.

- ***Use of the thermal energy:*** Once generated, the resulting thermal energy may be used for a broad array of applications, from heating (e.g., a radiator in a college dormitory) to sophisticated commercial and industrial processes (e.g., sterilization in a hospital, or drying applications in a lumber mill). Since heating loads tend to peak in the winter, while power needs tend to peak during the summer, many CHP facilities also use thermally activated cooling technologies (such as absorption chillers) that can maximize the use the waste heat in the summer months.

- ***Fuel:*** Like prime movers, CHP has no bias toward any particular fuel. Most CHP systems in the WGA states use natural gas as a fuel (see page 9 for a specific discussion of CHP impact on natural gas price and supply). They can also run on other fossil fuels such as propane, diesel, or coal, depending on the fuel availability, prime mover's capabilities, and local air regulations. This fuel flexibility makes CHP systems compatible with any future "hydrogen economy" because hydrogen production is also possible with many different primary fuel sources. In the WGA states in particular, a growing number of CHP systems are being fueled by renewable fuels produced by landfills, wastewater treatment plants, concentrated livestock operations, food and beverage processing waste, wood, spent pulping liquor, and other organic waste products. These fuels tend to be more common for CHP technologies than for central power plants, due to the localized nature of fuel availability and thermal loads. Fuels that are not easily distributed are inappropriate for central power plant fuels but quite adaptable to onsite CHP.

# 2. The Logistical Issues of Deploying CHP Systems

## 2.1 CHP Cost Curves

Note: These cost curves are preliminary, and may be revised in the next round of updates. Assumptions and further information on how these costs curves were derived will be provided as an Appendix on September 19th. The curves in these charts are based on quantitative guidelines provided by the WGA CDEAC Quantitative Guidelines Task Force, equipment performance and cost data from a report written by Energy and Environmental Analysis for the National Renewable Energy Laboratory in 2003 (with adjustments to 2005 dollars), and on a second Energy and Environmental Analysis report on CHP potential.

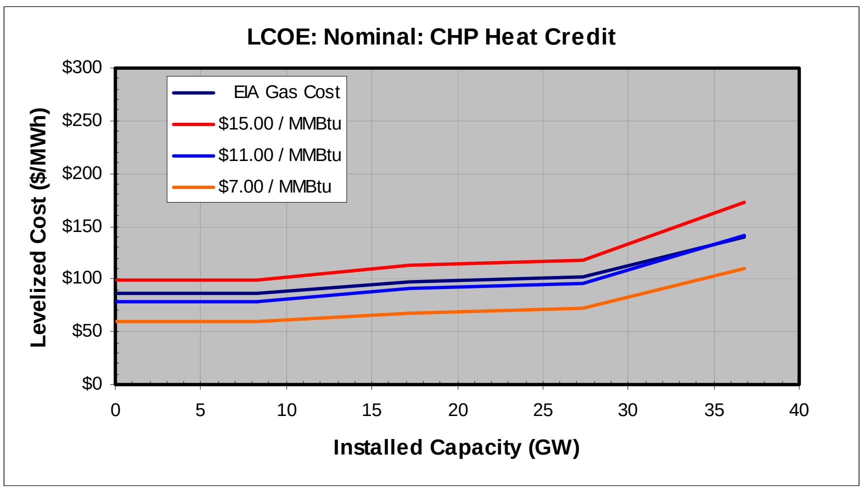



Figure 2: Nominal Levelized Cost of Energy (LCOE) Including a CHP Heat Credit

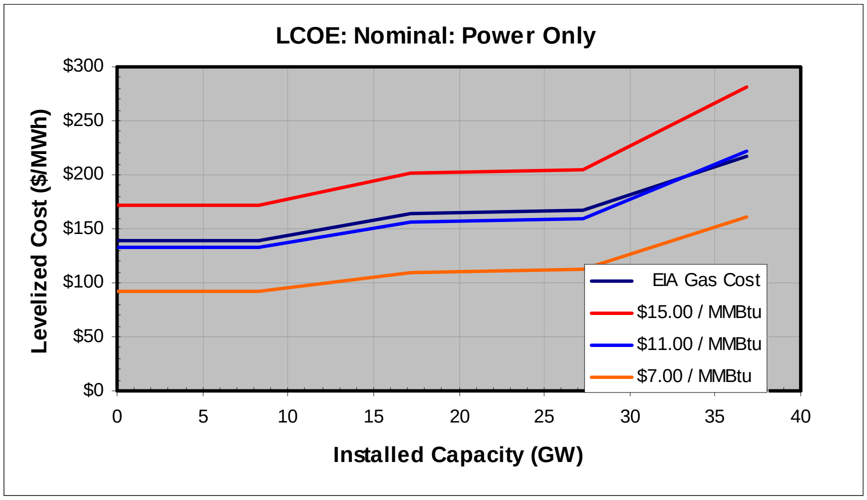



Figure 3: Nominal Levelized Cost of Energy (LCOE), Power Only (Not Including a CHP Heat Credit)

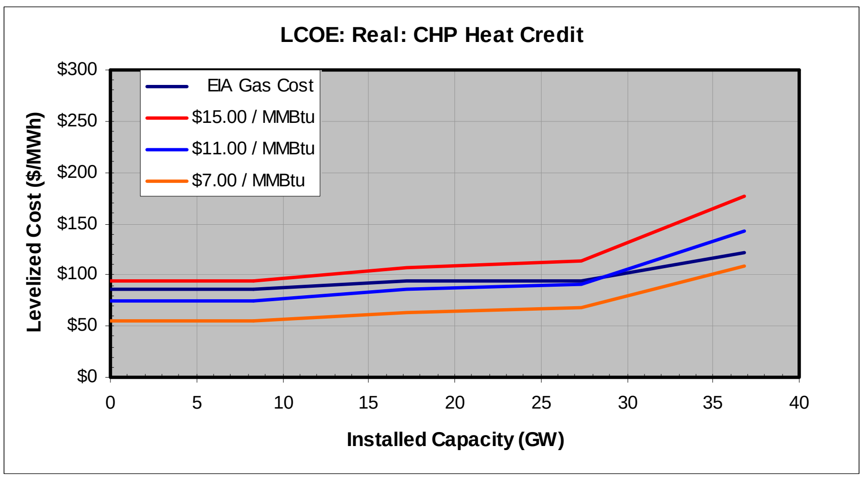



Figure 4: Real Levelized Cost of Energy (LCOE) Including a CHP Heat Credit

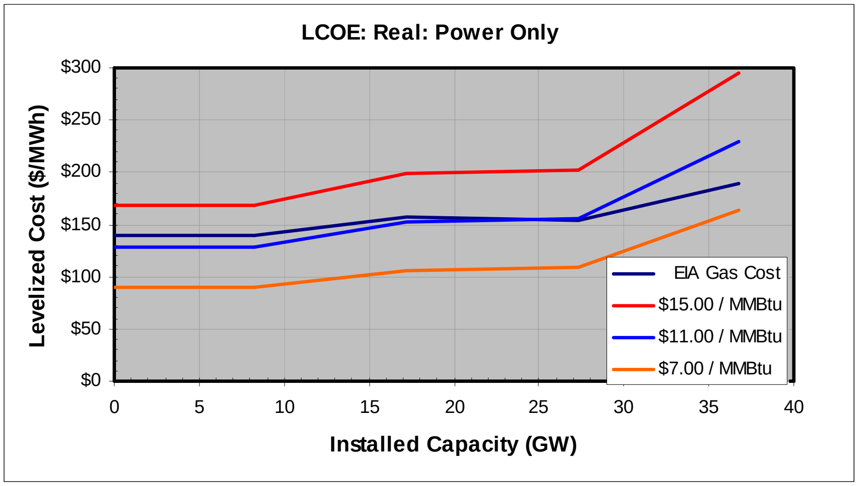


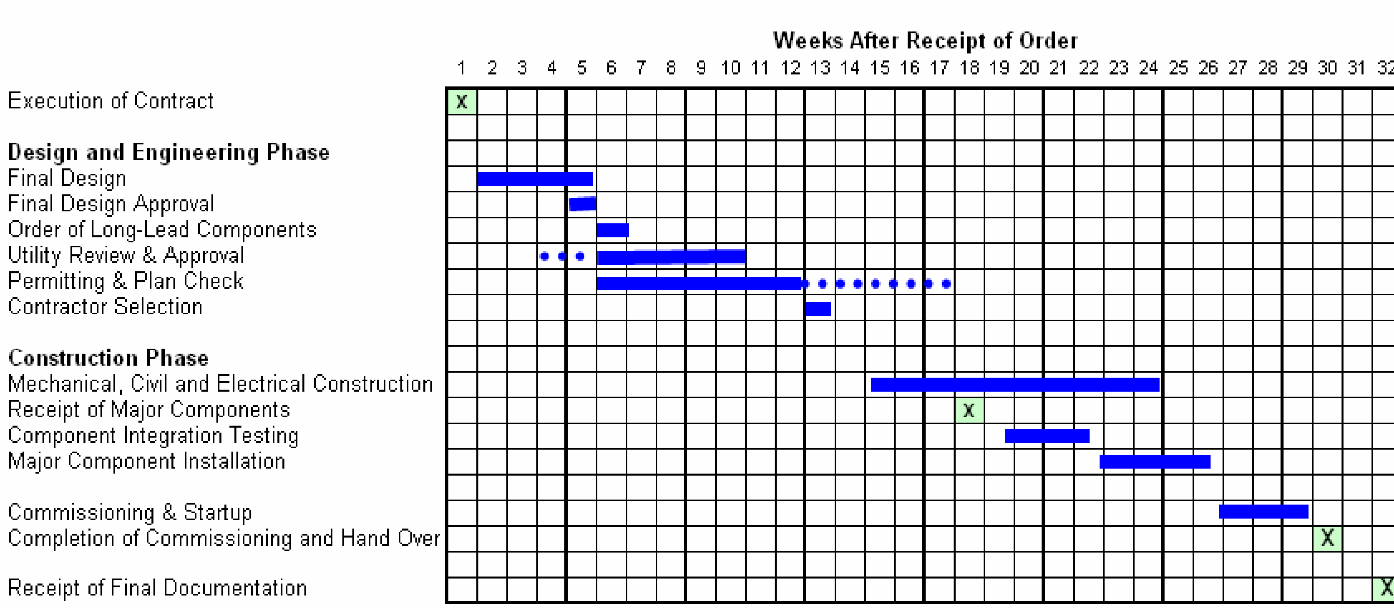

Figure 5: Real Levelized Cost of Energy (LCOE), Power Only (Not Including a CHP Heat Credit)

### 2.2 Timeline for Bringing Generation Online

In traditional electric system planning, capacity can only be added in large increments, resulting in cycles of either not enough capacity or excess capacity sitting idle waiting for the load to grow. Compared to central station resources, CHP can be installed far more quickly and on an as-needed basis, better matching the resource to the load. Furthermore, CHP systems do not have to wait for adequate transmission capacity to be installed, since most CHP owners use all or most of the power they produce for their own facilities.

CHP project developers estimate that a typical CHP project in most Western states takes 2-3 years. This includes 1-2 years for the sales process, site surveys, and engineering and design studies, and another 8 months to a year for construction, installation, interconnection procedures, and commissioning of the CHP system (see Figure 2).

While there will always be customer indecision slowing the sales process, CHP developers and CHP customers say the two factors slowing the rest of the process are lengthy, unreasonable, delayed, or stalled interconnection procedures with the utility, and/or getting approval from local code officials unfamiliar with CHP systems. These two areas represent an opportunity for Western governors and policymakers to remove the hurdles and speed up the process, as noted in our recommendations (Section 7, page 25).




**Source: Northern Power Systems, 2005**

Figure 6: Estimated Timeline for Installation of a CHP System (from contract to commissioning)

### 2.3 Transmission and Distribution Issues

Only the largest CHP projects that export significant amounts of power will require any extra transmission capacity. Most CHP systems will not require any transmission capacity. In fact, rather than causing transmission issues, CHP can actually help solve them.

When sited in the right place, specific CHP and other customer-sited solutions can be used to defer or avoid upgrades or expansions to transmission and distribution (T&D) systems. (In aggregate, all CHP systems lead to system capital deferrals by slowing the overall load growth.) Whether owned by the utility or by the customer, CHP systems help utilities improve the use of existing assets and minimize capital investment in new assets. In addition to being cost effective in such situations, using CHP to avoid new T&D lines is politically beneficial in that it avoids NIMBY battles and years of legal wrangling by communities whose views and property values would be negatively affected by new T&D lines.

However, there are several reasons why CHP is not used more often to solve T&D issues. Generally, utility distribution planners don't have the time or resources to evaluate every single alternative nor do they have the motivation. By and large, utility distribution engineers prefer to use the tried-and-true solutions, even when CHP solutions would potentially yield greater cost savings and greater reliability.

On the other side of the equation, the high cost of strained T&D systems is not seen by end users or CHP project developers; the end users or CHP project developers who do locate CHP plants in T&D-constrained areas are not given a share of the savings that the utility sees. Those savings could potentially make the difference between a CHP project going forward and the option being rejected. The average distribution rates are about 2.5¢ per kWh. Marginal distribution costs, though, vary substantially from one place to another and from one time to another, ranging from zero to substantially more than 20¢ per kWh.[iii] The marginal costs of transformers, substations, lines, and feeders are also high and variable. The average marginal costs for transformers, substations, lines, and feeders exceeds $700 per kW for the entire group of 124 major U.S. utilities analyzed in a study by the Regulatory Assistance Project.[iv] These are the costs that would be saved or deferred by adopting a CHP solution. These savings should be shared with the CHP owner, operator, or developer.

Clearly, increased adoption of CHP in high-cost, T&D-constrained areas would be a win-win situation for utilities and CHP users alike. The challenge is to develop policies and market-based incentives to encourage the use of CHP in these constrained, high-cost areas.

To the extent CHP yields savings on T&D costs, these savings can and should be shared by the utility, end user, and the CHP developer. De-averaged T&D credits and distributed resource development zones are two practical policy actions.[v] De-averaged T&D credits, for example, offer financial incentives to CHP based on the T&D cost savings generated by the CHP, taking into account the duration and magnitude of the deferral. As another option, distributed resource development zones would designate geographic areas and set a standard credit for all qualifying distributed resources that locate in the area.

It is important to re-emphasize that the value CHP provides to the T&D system is not limited to deferring or avoiding expansions. Additional value stems from voltage support, voltage regulation, reactive power support, network stability, system blackstart, equipment life extension, reduced facility maintenance, and reduced line losses.[vi]

### 2.4 Fuel Issues

Most CHP systems in the 18 WGA states are fueled by natural gas. Biomass, wood, and waste fuel sources are the next largest, followed by coal.

Specific fuel impacts depend on what fuel the CHP system uses and what fuel it replaces. Gas CHP systems generally replace gas boilers, so new CHP systems do not represent entirely new demand for natural gas. In fact, many new CHP facilities will be replacing older boilers that may be less efficient than contemporary designs or are now significantly oversized for current loads. The average industrial and institutional boiler is now over 50

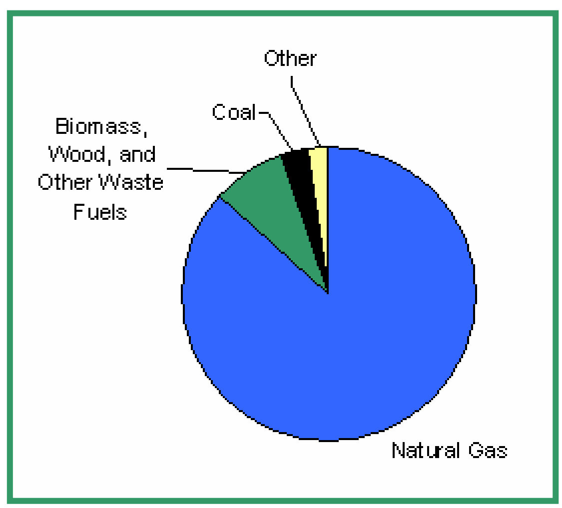



Figure 7: Fuels Used by Existing CHP Capacity in the 18 WGA States

years old.[vii] On some occasions, the total fuel for the CHP system may be less than the fuel required for the existing boiler. In all cases, the total fuel use is less than what would be required for separate heat and power once the offsite fuel displacement is taken into account.

The Western region is seeking responses to the current tight natural gas supply/demand balance. The relationship between CHP and natural gas prices is complex and has important but different ramifications for policymakers and the end users. A sort of "chicken and egg" dilemma is at play:

- Relevant to the interest of policymakers, studies show that an increase in CHP penetration will reduce gas consumption (because of the high efficiency of CHP and zero electric transmission losses with the onsite electricity generation), and a subsequent reduction in gas prices.

- However, the end users are concerned with the high natural gas prices, and are, therefore, less likely to invest in and install natural gas-fueled CHP, or even run the CHP systems they already have in place.

This leads to a market externality that strategic regulation ought to tackle. Rather than wait for private individuals to risk their own financial gains for the good of society at large, a robust energy policy ought to provide some incentives to CHP adopters to accelerate the realization of CHP benefits for the natural gas market. Further, reducing barriers to grid-interconnection, crafting more equitable electricity rates, and other policy measures recommended herein would – while driven by different arguments – also provide synergistic support for these same benefits.

**Policymaker's Perspective: Lowered Fuel Prices from Increased CHP Usage**

Efficiency responses will be a critical component of short- and long-term solutions to the tight natural gas supplies. CHP is an immediately available, widely applicable natural gas efficiency measure.

A study by Energy and Environmental Analysis in 2003 looked at natural gas impacts of increased CHP in three regions: Texas, California, and the Northeast.[viii] The conclusions of this report are that a 50 percent increase in CHP penetration would <u>reduce gas consumption by 6.4 percent</u> (in the regions studied), which would lead to a <u>reduction in gas prices of nearly $1/MMBtu</u>, or a little less than 20 percent. Other analyses have shown that national gas demand reduction in this range can result in a much greater percentage reduction in gas price. (These price impacts were for 2003 market conditions. Markets have tightened since then, so even greater price response would be anticipated.)

The study looked at Texas, California, and the Northeast because these three regions have historically been high CHP users, and have a high concentration of gas-using industries and a gas-intensive electricity sector. These three regions account for approximately 40 percent of the U.S. gas consumption. These factors made them good candidates for an initial analysis of the gas impacts of increased CHP. As the study noted, “If the impacts are small in these regions, they would likely be even smaller in other regions. On the other hand, if the impacts are significant here, it would be worth analyzing other regions.”

The study also notes, “The results could be different in other regions of the country due to different potential market sizes for CHP and particularly due to different fuel mix characteristics of the power-generating system. While some regions are more reliant on coal generation and would be likely to show less gas displacement in the power generation sector, others are more similar to the regions already analyzed and will likely show similar gas reduction results. The overall effect is expected to be a net national reduction in gas consumption.”

**End User’s Perspective: High Gas Prices, a Deterrent for Installing CHP**

From an end-user perspective, there is a thermal demand at their facility that will have be to satisfied with either a dedicated device (e.g., boiler) or a CHP system. Nevertheless, the price of natural gas and the spark spread[ix] strongly influence the decision of whether or not to install CHP. The rising cost of natural gas (for many users, tripling over the past 2.5 years to the current level of $8-9 per MMBtu) and the resulting poor spark spread has not only canceled prospective projects but have caused a number of existing projects to shut down. This is a hard reality for CHP end users and CHP project developers.

Spark spread alone, of course, is not the only concern in the entire decision-making process for CHP. Some users still highly value CHP’s ability to help manage energy price volatility and act as a hedge between electricity and fuel prices. A properly designed and sized CHP system can afford greater flexibility to a facility to manage its energy demand by switching fuels, shifting loads, and shaving peaks depending upon economic conditions.

If the facility has access to a reliable renewable or waste energy source, this can further shield the facility from price volatility and uncertainty. Economic access to these alternative fuel sources are, for the most part, isolated from volatile energy market fluctuations. For example, some chemical plants can burn excess hydrogen and some pulp and paper plants can burn biomass spent pulping liquor instead of natural gas. Anaerobic digester gas (such as from wastewater treatment plants, food or beverage processing, or concentrated animal feeding operations), landfill gas, or certain industrial processes (e.g., refiners or blast furnace gas) can be other options for some facilities. Relative fuel prices, price escalation options, contract length, and fuel availability will determine whether one fuel is preferred over another.

# 3. Benefits of CHP

Combined heat and power comprises many technologies with many distinct attributes and applications, yielding varying benefits and costs to different stakeholder groups. CHP benefits can accrue to individual CHP users, utilities, ratepayers in general, and/or to society as a whole. Some benefits are tangible and relatively easy to quantify (e.g., customer energy cost reductions), but others are less tangible and more difficult to assess (e.g., homeland security and supply diversity).

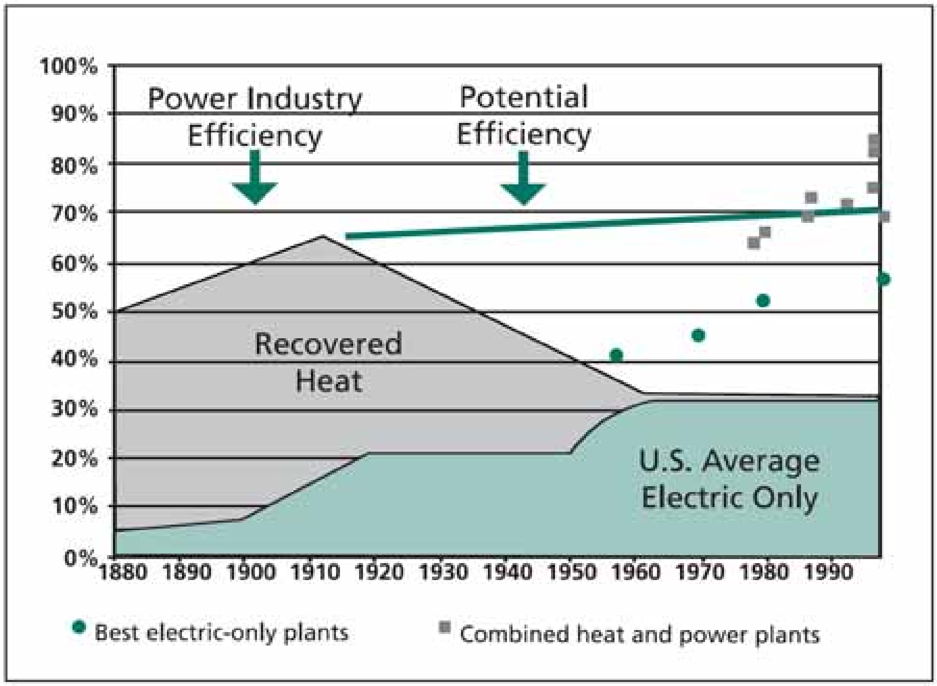
Most of the benefits of CHP are public benefits rather than private benefits. These public benefits justify public policy support for CHP. Three of the most important benefits of CHP – higher efficiency, homeland security, and environmental impact – deserve particular attention from the WGA Clean and Diversified Energy Initiative. Each of these is discussed in turn, followed by a brief mention of other important benefits as well.

## 3.1 Higher Efficiency

The average electrical efficiency of existing central station power plants in the United States has remained virtually stagnant at approximately 33 percent for the last 40 years.[x] No other industry wastes two-thirds of its raw material; no other industry has such stagnant efficiency; no other industry gets less productivity per unit output in 2005 than it did in 1905. All power plants used to recycle their heat to provide steam for nearby buildings, until power plants started to be sited far away from the end-use customers they serve. While electricity can be delivered across many miles (with losses of about 10 percent), it is not practical to transmit waste heat over long distances. Conventional central generation plants dump two-thirds of their energy into lakes, rivers, and cooling towers, while factories and commercial facilities burn more fuel to produce the heat just thrown away.[xi]

Separate heat and power systems, with 33 percent efficient remote power plant, 10 percent transmission and distribution losses, and a typical 80 percent efficient onsite boiler, yield a total electric and thermal efficiency of only about 39 percent.

In contrast, CHP systems have a combined electric and thermal efficiency of 70-80 percent efficient or higher – double that of conventional systems – because they can make use of both the electrical and the thermal energy. Making better use of our limited fossil fuel resources by increasing production and delivery efficiency helps circumvent arguments in Western states over issues of drilling on public lands, importing fossil fuels, and land use.




**Source: Primary Energy**

Figure 8: Stagnant Efficiency of U.S. Electric System

### 3.2 Homeland Security

Keeping vulnerability issues in sight, CHP systems should be considered key components to economic and homeland security strategies throughout the Western states. CHP is virtually an ideal form of energy from an energy security point of view:

- CHP facilities are relatively small and distributed widely.
- They do not offer a high-profile target to potential terrorists.
- Their locations in industrial, commercial, residential, and district energy facilities of many sorts mean they are not physically isolated and vulnerable, but instead share the security implicit in their host facilities.
- Their locations at the point of need eliminate their vulnerability to a disruption of the transmission system, and indeed create the ability to provide emergency power downstream of such a disruption.
- They are independently fueled and operated.
- While they can be centrally dispatched, they can also be operated independently in the event of a disruption to central systems.

- Most CHP systems utilize natural gas from secure sources (and thus share a common vulnerability), but they can also be operated on wood wastes, coal, or other fuels. Each system can also be designed to run on multiple fuel sources.

- The efficiency of CHP has an added security benefit, since vulnerability to fuel interruptions is proportionate to fuel consumption.

- During times of crisis, CHP systems can sustain hospitals, first responders, security command or operation centers, and key manufacturing facilities indefinitely. Since onsite CHP systems are regularly used and exercised, they are more reliable during grid outages than onsite back-up generators.

- Renewable CHP systems have an additional security component. Dairy operations, feedlots, poultry farms, food processors, and wastewater treatment plants provide vital services to states and regions where they are located. Utilizing packaged digester-CHP solutions creates a self-sustainable power system for food production and water treatment facilities.

### 3.3 Environmental Impacts

CHP has fewer negative environmental impacts than separate heat and power systems. The U.S. Environmental Protection Agency supports CHP because increasing efficient energy supply is known to yield significant cost-effective emissions reductions of criteria air pollutants and carbon dioxide, the leading greenhouse gas associated with climate change as well as reducing energy consumption. The use of renewable energy sources to fuel CHP, such as opportunity fuels including biomass and biogas, reduces fossil fuel consumption even further. In addition, renewable-fuel-fired CHP systems can actually be a solution to unrelated environmental problems. CHP's specific environmental effects are described below:

- ***Criteria Pollutants.*** By increasing energy efficiency, CHP reduces annual emissions of criteria pollutants, such as nitrogen oxides ($NO_x$), sulfur dioxide ($SO_2$), and particulate matter, compared to separate heat and power systems. The level of reduction depends on the CHP system (i.e., the prime mover and fuel used) and what it electrical and thermal sources it is displacing.

- ***Localized Emissions and the Urban Heat Island Effect***. Even though CHP reduces total emissions when it displaces remote central-station electric generation and separate thermal generation, local emissions at the load center will increase, which could contribute slightly to the "urban heat island effect." While no studies have looked at the effects of CHP on the heat island effect, we suspect that any additions are minimal when accounting for two things: first, many CHP systems will be displacing existing boilers that themselves had their own emissions; and second, the effects of CHP are greatly dwarfed by such sources as cars and asphalt.

- ***Mercury:*** 96 percent of CHP systems in the Western states are fueled with natural gas or opportunity fuels. Since these fuels do not contain mercury, such CHP systems do not emit mercury. As such, they emit much less mercury than coal-fired central station power plants. The seven interior Western states (CO, MT, WY, UT, NV, NM, and AZ) have an electric system based predominately on coal and export power to other Western states, including California.

- ***Carbon Dioxide:*** Since CHP reduces the amount of fuel required to produce a given output when compared to central station power generation, the corresponding emissions are reduced. One generalized estimate is that CO2 emissions are 49 percent lower than centralized power generation.

- ***Land Use and Wildlife Impacts:*** CHP is located at or very near the energy end user. Most CHP is installed in the end user's existing building or in an adjacent building. As such, CHP does not require developing "green space" or "open space," as new central station power plants do. Thus, the impact on undeveloped land and on wildlife is negligible. It is important to note that the size of CHP systems is very small compared to a central station.

- ***Water Usage:*** Thirty-nine percent of our water goes to fossil fuel central station power plants, which require large amounts of water for their cooling process. In the seven interior Western states (CO, MT, WY, UT, NV, NM, and AZ), coal and gas steam-generating electric plants currently withdraw over 650 million gallons of water every day, totaling over 728,0100 acre-feet each year.[xii] Over half the water withdrawn is evaporated in the cooling process, and the remainder is discharged into nearby waterways, often at a higher temperature or in a degraded state.[xiii] CHP systems do not require water for cooling and thus save water and do not disturb the fragile stream, river, and lake ecosystems.

- ***Optimization of Resources:*** CHP efficiently uses natural resources. Since CHP requires less fuel for a given energy output, it reduces the demand for our finite natural resources, such as natural gas. Also, through the use of renewable fuels, such as urban woody waste and forest waste, landfills, wastewater treatment plants, livestock operations, pulp and paper waste, food and beverage processing, industrial waste heat, and some solar technologies, CHP utilizes materials which would otherwise be disposed of, to produce beneficial electricity and thermal energy.

- ***Co-products:*** Essentially, thermal energy is produced as a beneficial co-product of electricity generation, or conversely, electrical energy is produced as a co-product of thermal generation. There can be other co-products as well, depending on the configuration and fuel source:

  - $CO_2$ is a co-product that is captured and used in some instances for purposes such as boosting plant growth in greenhouses (in some cases, boosting plant growth by as much as 30 percent).

The excess $CO_2$ from a clean onsite CHP system can be used to boost plant growth in greenhouses, in some cases boosting growth by as much as 30%.

**Source: Mariah Energy**

Figure 9: Co-product Benefits: Use of $CO_2$

- Additional co-products are formed if the CHP system is fueled by certain renewable fuels (anaerobic digester gas from sources such as hog farms, dairy farms, and cattle feedlots). Some agricultural producers with anaerobic digesters and renewable CHP systems find that these co-products are equal or more beneficial economically than the energy benefits. After waste has been fully broken down by an anaerobic digester and the methane has been piped off to run a CHP system, the remaining odor-free substance is divided into a liquid and a solid, i.e., nutrient water and fiber, respectively. The nutrient water is land-applied as a fertilizer because the ammonia in the water is readily available for plant uptake. The fiber is used as an organic soil amendment, animal bedding, or as a peat moss replacement in greenhouses and horticulture nurseries.


**Odorless fiber left over from anaerobic digestion is used as an organic soil amendment, animal bedding, or peat moss replacement in greenhouses or horticulture nurseries.**

**Source: Resource Development Associates**

Figure 10: Co-product Benefits: Use of Fiber from Anaerobic Digestion

**Anaerobic digesters at concentrated animal feeding operations convert manure nitrate into ammonia, which is quickly taken up by plants.**

**Source: Danish Energy Agency**

Figure 11: Co-product Benefits: Nutrient Water from Anaerobic Digestion

- ***Solving Unrelated Environmental Problems:*** Anaerobic digester CHP systems at concentrated animal-feeding operations eliminate odors, pathogens, and methane emissions (a powerful greenhouse gas 21 times more potent than $CO_2$). Anaerobic digester CHP systems at food processing industries reduce or eliminate the organic waste released into the municipal treatment system. This organic waste otherwise stresses municipal treatment systems and damages watersheds, fisheries, and industries that rely on them. Anaerobic digesters at wastewater treatment provide plant operators with another option for improving water quality. In some states and localities, environmental regulations mandate these treatment options at the expense of the industry. Adding CHP to an anaerobic digester maximizes the payback for these applications and makes meeting the regulations more feasible financially. In fact, they turn a cost into a revenue source. However, such beneficial solutions are subjected to the same hurdles as all CHP installations. These hurdles act as roadblocks to applications that benefit multiple stakeholders in the Western states.

### 3.4 Societal Benefits

- ***Retention of the local economic base:*** Local industries that are able to lower their energy costs can be more competitive in the global marketplace and have a greater chance of survival, thus preserving the state's jobs, tax revenues, and its economic base.

- ***Market liberalization:*** CHP supports competition and a free market structure by offering commercial and industrial end users an alternative for the source of their power and by mitigating market power of generation suppliers. The proliferation of CHP systems has the potential to bring new and vigorous competition into the electric power sector and the thermal energy sector alike.

- ***Supports the domestic economy:*** Much CHP equipment and expertise is of domestic U.S. origin, promising to bring economic benefits home.

### 3.5 Grid Benefits

- ***Reduced vulnerability to brownouts and blackouts:*** Having a wide range of supply options can mitigate widespread outages like the ones that hit the northeast and California in recent years. Loss of a single plant or a few plants would have a far smaller effect on the whole system. Each facility that has CHP could keep their operation running throughout the outage. Also, depending on how the CHP units are configured, they can help utilities bring up the rest of the grid after an outage.

- ***Flexibility and modularity:*** CHP is a better way to plan for new capacity additions. CHP units are smaller than central power plants and come in a variety of sizes, so they can be added as they are needed, and when and where they are needed. CHP units' smaller size means they have a shorter lead-time to install. This reduces the risk of over- or under-building (each of which has its own financial consequences), and avoids the problem of excess capacity being idle while waiting for the demand to "grow into it."

- ***Helps aging or congested T&D pockets:*** CHP helps avoid or defer upgrades to T&D lines by reducing the load on these lines. Being sited at the load, CHP is downstream from constraints on T&D lines, easing the constraints and freeing T&D capacity.

- ***Reduced line losses:*** An average of 9.5 percent of electricity generated at a power plant never gets to its destination.[xiv] Such "line losses" increase with both the distance the electricity has to travel and the congestion on a power line. During peak periods, line losses can and have exceeded 20 percent. Since CHP is located at or near the point of electricity consumption, it avoids these line losses. As a result, the net impact of CHP on *delivered efficiency,* above and beyond that associated with the actual generation efficiencies, is 10-20 percent higher than that of a central power plant.

- ***Double benefits for summer peak reduction:*** During high summer demand periods, CHP systems reduce demand on the grid by the amount of electricity they are generating, and by the accompanying line loss reduction, as described above. Additionally, CHP systems with absorption chillers or other thermally driven cooling systems reduce the strain on the grid even further by cutting or reducing their electrically driven cooling load that would otherwise require additional grid capacity.

- ***Reduced NIMBY effect of transmission lines:*** Many communities believe that a new transmission line running though their neighborhood will ruin scenic views and decrease property values. These communities fight new transmission lines, in some cases stalling the process for years through legal wrangling. By siting the generation resource near the load, CHP reduces the need for new T&D lines.

- ***Grid ancillary benefits:*** CHP can offer ancillary benefits to the grid and can improve the performance of a given network in terms of voltage support, voltage and current frequency regulation, reactive power support, reduced central station generating reserve requirements, equipment life extension, reduced facility maintenance, and reduced network stress.

- ***No ratepayer investment required:*** Assets that are purchased, deployed, and operated by regulated utilities necessarily add to the rate base, while those (like CHP) that are purchased, deployed, and operated by unregulated entities do not factor into the rate base. Thus, grid benefits created by CHP deployment are realized at little or no cost[xv] to the ratepayer.

### 3.6 Commercial and Industrial Benefits

- ***Lower energy bills:*** Many businesses can see significant cost savings on their energy bills by self-generating all or some of their electric load.

- ***Fewer outages and reduced downtime:*** The costs of outages for businesses include lost computer data, employee downtime, ruined production processes, and frustration from customers. Companies such as credit card and brokerage operations, cellular communications, and airline reservations face costs ranging from tens of thousands to millions of dollars per hour of a power outage. CHP helps protect businesses against electric system outages.

- ***Improved power quality:*** Synchronous generation sited close to the load can provide reactive power support to boost local power quality. Indeed, many such generators already provide power quality support as a means to reduce the "$/kVAR" charges on electric bills, even without central control by utility regulators. Since these generators provide such benefits while simultaneously creating a revenue-producing product (kWh), they form a much more cost-effective approach to achieving power quality than the capacitor banks used by the conventional utilities.

- ***Improved environmental quality:*** Customers and investors are increasingly putting pressure on businesses to improve their environmental profile. Unlike many other measures to meet this pressure, increasing the efficiency of energy use and production are revenue-producing means to meet these environmental goals.

- ***PR and marketing benefits:*** Businesses that install CHP often receive favorable publicity for being innovative, technologically advanced, and environmentally friendly.

# 4. Existing Capacity and Achievable Potential of CHP in Western States

### 4.1 Summary Table

| State | Number of CHP Systems | Existing Capacity (MW) | Additional Potential Capacity (MW) |
|---|---|---|---|
| AK | 86 | 438 | 277 |
| AZ | 18 | 155 | 1,801 |
| CA | 791 | 9,043 | 10,945 |
| CO | 21 | 791 | 1,578 |
| HI | 28 | 565 | 705 |
| ID | 15 | 192 | 1,142 |
| KS | 13 | 119 | 2,005 |
| MT | 10 | 99 | 470 |
| ND | 6 | 39 | 1,205 |
| NE | 12 | 25 | 834 |
| NM | 17 | 226 | 649 |
| NV | 8 | 549 | 393 |
| OR | 49 | 2510 | 1,862 |
| SD | 1 | 2.7 | 307 |
| TX | 137 | 17,122 | 13,489 |
| UT | 16 | 239 | 1,267 |
| WA | 25 | 1132 | 3,189 |
| WY | 9 | 59 | 747 |
| **Total** | **1,262** | **33,304** | **42,864** |

Table 2: The Gap between the Existing and the Potential CHP Capacity

### 4.2 Analysis of the Region's Existing CHP Capacity

As of 2005, the 18 WGA states had a combined total of 33,304 MW of CHP capacity at 1,262 sites. The profile of CHP systems in the region is different from the rest of the nation, in a few ways:

- They are less heavily concentrated in industrial applications. (81% compared to 90%)

- A higher percentage are fueled by natural gas (89% compared to 68%) and a lower percentage are fueled by coal (3% compared to 15%)

- Two states alone, Texas and California, have 78 percent of the existing installed capacity.

### 4.3 Analysis of the Region's Technical CHP Potential

The existing capacity is far below the potential. With the right policies and conditions in place to encourage development of this potential, the 18 WGA states could add a combined total of up to 42,864 MW or more from CHP alone, far exceeding the WGA's goal of 30,00 MW from all sources by 2015.

Our first-cut estimate of the potential for additional CHP in the region is for the technical potential only, and does not include further economic screening. Detailed information on how are estimates were derived is provided in the Appendix.

Compared to the existing installed CHP base, about half of the additional potential capacity is in applications that are 5 MW or smaller. Commercial and institutional sectors such as hotels, hospitals, colleges, schools, office buildings, prisons, and nursing homes all have strong market potential for adoption of clean and efficient CHP in Western states. Yet, the commercial and institutional buildings sector is the most harmed by ineffective policies that intentionally or unintentionally make CHP projects difficult or impossible. The buildings sector, unlike the industrial sector, is far less likely to put forth significant effort, time, and resources to either change or navigate around difficult policies, preferring instead to drop an otherwise successful CHP project.

| | WGA Cogeneration Technical Potential, MW | | | |
|---|---|---|---|---|
| | < 1MW | 1-5 MW | 5-20 MW | >20 MW |
| Commercial | 6,823 | 3,935 | 3,122 | 531 |
| Industrial | 2,717 | 6,230 | 5,778 | 7,736 |
| Total | 9,540 | 10,165 | 8,900 | 8,267 |

Table 3: Much of the Additional CHP Technical Potential is in Applications of 5 MW or Less[xvi]

## 5. Barriers to Increased CHP Deployment in Western States[xvii]

Barriers to CHP market penetration fall into five distinct categories, which are discussed below. CHP developers perceive that the true barriers to CHP are very deeply rooted, stemming from a long history and evolution of electric utility regulation in the U.S. These barriers, in turn, produce the more tangible barriers that CHP developers face every day, including unreasonable interconnection policies and standby rates. It is important to note that utilities, in general, do not see their interconnection requirements, rates, and other policies to be obstructionist towards CHP. This is a difference in perception, since CHP developers clearly do perceive these policies to be obstructionist.

### 5.1 Financial Bias of Electric Utilities

*Electric utilities have a disincentive to allow their customers to invest in CHP due to their volume-based revenue structure and, therefore, misuse their monopoly power to block customers who choose to make such investments.*

In a normal functioning market, it is to be expected that companies earn profits at the expense of their competitors. Thus, the fact that utilities lose revenue from CHP deployment is not *per se* an obstacle to CHP penetration.

However, the electricity market is anything but a normal functioning market, especially at the retail level. Retail customers typically have a single electric utility, and that utility has full monopoly powers to prevent those customers from self-generating a portion of their electric load. Thus, actual (and in some cases, simply threatened) abuse of utility monopoly position can block competitively inspired innovation from occurring, to the benefit of the monopoly, but to the detriment of the public interest. These abuses include – but are not limited to – over-complex grid interconnection requirements and discriminatory pricing structures that overcharge CHP owners for surplus power purchases.

These actions have served to block the deployment of technologies that have lower capital and operating costs than the grid that would conventionally serve a local load – precisely those technologies that would be deployed in a competitive, profit-maximizing marketplace. Such profit-seeking ploys that block the deployment of CHP are directly responsible for increasing the overall cost of electricity and increasing the emissions associated with fuel combustion for power generation.

### 5.2 False Conflict between Environmental and Economic Policies

*Environmental regulation often fails to encourage economic and environmental "win-win" investments, thereby ignoring – and in some cases, penalizing – investments in energy efficiency applications like CHP.*

Much of our environmental policy is predicated on the belief that investments that reduce pollution *and* save money must already have been made, and therefore, resources and regulations must focus exclusively on economically painful environmental measures.

This philosophy is not only shortsighted, but also creates unnecessary political tension between environmental advocates who "know" that profit-seeking businesses are anti-environment and business advocates who "know" that environmentalists must be kept at bay lest they destroy the economy. Both perspectives are flawed, as demonstrated best by the vast untapped potential of CHP.

Input-based ("ppm") emissions standards are one such example, as they implicitly penalize investments in energy efficiency. Many renewable energy statutes erect similar barriers by preferentially directing clean energy funds only to the most expensive clean-generation technologies.

These regulations are directly responsible for the under-deployment of CHP (and other energy efficiency technologies) which are, for the most part, ignored or under-appreciated by environmental legislation at the expense of more economically painful pollution abatement measures. The net result of these rules is thus to drive scarce capital dollars away from technologies that ought to form the basis of any economically responsible environmental legislation.

### 5.3 Failure of Retail-Level Grid Management to Acknowledge Unregulated Market Participants

*Retail-level electricity regulation is fundamentally distrustful of market economics.*

In an unfettered market, businesses might invest in CHP for the same reason that they invest in more efficient machinery – as a tool to lower their cost of production and increase their profits. Most CHP technologies deliver lower operating and capital costs than the central power alternative by burning less fuel to make a kWh than the central power alternative, and by avoiding the need for costly T&D capital.[xviii]

However, retail-level electricity markets are anything but unfettered. Competition has been slowly and incompletely introduced into wholesale power markets, with positive impacts on the efficiency of central power generation.[xix] Nonetheless, there remains virtually no competition at the retail level where distribution utilities still maintain a monopoly over the "last mile." Moreover, these distribution utilities cannot use efficient investments like CHP to boost their profits, since cost-plus ratemaking protocols give them a <u>disincentive</u> to engage in least-cost system planning. Finally, the central planners at the utility, PUC – and to some degree, even the ISOs – generally do not understand or appreciate generation that they cannot control and/or dispatch.

This failure to appreciate the actions of many independent players may at first sound reasonable; after all, how can the central planners count on CHP being online during a stage III power emergency unless they control it? If they cannot be sure of CHP back up, they must ensure substitute supply from another generator.

However, such seemingly sound reasoning falls apart when one realizes that by the same logic, our entire market economy should not work, since, for almost all other commodities, it manages to set supply, demand, and price (and ensure "resource adequacy") even without the oversight of central planners. This distrust of market forces has severe stunting impacts on economic efficiency and, yet, there is little effort underway to introduce true retail-level competition into electric markets.

### 5.4 Conflict between Electric Utility Shareholders and the Public Interest

*The interests of regulated utility shareholders are often in direct opposition to the public interest.*

Our electric power grid is fundamental to our national health and welfare, and no less important than our water supplies, police force, or highway system. However, while these latter public goods are (for the most part) regulated as a branch of government, our electricity system remains a 100-year old amalgam: mostly shareholder owned, but with a guaranteed monopoly and extensive governmental oversight.

It is worth questioning whether or not this structure serves the public interest as well as the other public services. Economic theory teaches that competitive markets – not businesses per se – engender the public good. But this does not come close to defining the situation faced by investor-owned utilities. These entities have guaranteed monopoly franchises, face no threat of bankruptcy, and have no incentive to pursue cost-reduction as a route to greater profits due to the fixed return-on-equity-based rates. Furthermore, they face no risks encountered by competitive businesses, thus making their earnings questionable (especially, when that profitability comes at the expense of the utility customers.)

In other words, utilities face none of the discipline of competitive markets. They still have incentives to maximize shareholder return, but without competitors, many paths to this incentive come at the expense of the public interest. The only way to boost dividends is to boost cash flow, which means either raising rates to customers, preventing competitors from succeeding in their market, or skimping on infrastructure investment.

It is not suggested that there is no place for markets in our electricity system. On the contrary, generation should rightly be treated as a competitive enterprise; certain elements of the transmission grid are also amenable to competitive pressures, as shown by ISOs and RTOs throughout the country. In situations where such potential exists for a functioning market, it should be encouraged, since a truly competitive market will always do a better job of capital allocation than the public sector. However, there is also always going to be a need for grid oversight and there will always be a natural monopoly associated with certain elements of the distribution system. Where such natural monopolies exist, the public interest is best served by regulating the utilities as the civil servants they are rather than the businesses they claim to be.

### 5.5 Private Sector Capital Allocation Processes

*The private sector demands an exceptionally high return on non-core investment dollars.*

Finally, it is worth noting that some of the barriers to CHP deployment are not failures of policy, but rather of private sector capital allocation processes. Regulators cannot and should not try to remove these barriers, but should be cognizant of them in order to fully understand how changing electricity regulations will impact private sector capital allocation.

The overwhelming majority of our nation's CHP is built and owned by entities whose core business is **not** electricity generation, distribution, or sale. When considering projects for capital investment, these entities will preferentially direct financial resources toward projects that relate to their core business, only investing in non-core activities like CHP if it delivers exceptionally high returns. Thus, a paper mill will spend $1 million on a new paper machine with an 18 percent rate of return before it spends that same $1 million on a new CHP plant with a 40 percent rate of return. Amongst CHP project developers, it is widely understood that projects need to have a simple payback of at most 3 years if they are to receive serious consideration, 2 years being the more common (but still not guaranteed) threshold for non-core capital investments.

By contrast, regulated utilities typically have rates of return (as fixed by utility commissioners) in the range of 10-15 percent (7-10 year simple payback). Thus, the fact that a CHP plant can be used to save money on energy costs is – on its own – not sufficient to justify private sector capital investment. Rather, the savings must be substantial relative to the total project capital costs. As such, it is critical that regulators not allow utilities to artificially inflate the costs of interconnection or impose rates that are designed to reduce the savings generated by CHP facilities, *even if those projects are still theoretically capable of realizing high returns*, as doing so can lead to dramatic reductions in CHP deployment.

Finally, these private sector barriers have an interesting ramification for utility regulators. When the private sector deploys capital for CHP projects, they face much higher risks than their utility counterparts, and thus demand much greater returns. However, when they find such opportunities and choose to deploy their own capital, they are necessarily spending less capital to derive greater return than utility investments to serve the same marginal load.[xx] This creates an opportunity for farsighted utility commissioners who can essentially use the private sector to "backstop" their own decisions, providing necessary – and otherwise unavailable – competitive discipline to the utilities they regulate.

## 6. Recommended Policies for Western Governors

On first read, the barriers presented above can seem quite daunting. (Indeed, their presence has driven many investors away from CHP investments.) Resolving them requires not only a tremendous amount of intellectual rigor to “unpack” a century of legislative and judicial history, but also the political courage to confront many deep-pocketed beneficiaries of the current status quo. Given these political realities, it is understandable that it is not feasible for Western governors to immediately embark on a plan to remove the five barriers described above. However, an acknowledgement of these larger barriers is critical for any progress to be made.

Understanding “how hard to push” these issues is a question of politics that varies from state to state. Nonetheless, in the following section, a list of first steps toward the removal of these barriers has been presented; these actions have been shown in some jurisdictions to demonstrably enhance the deployment of CHP technologies, while not requiring as large an expenditure of political capital. As a cautionary note, these are only first steps, though important steps that ought to be considered as part of a larger strategy to remove the barriers described above, rather than being considered as the final measures in regulatory modernization.

Since politics is “the art of the possible,” the following near-term policy actions are recommended for Western governors seeking to encourage the deployment of clean and efficient CHP in their states.

***1. Have each state undertake a thorough review of the policies affecting CHP.***

Determine whether there are currently unnecessary barriers to implementation of these resources, or if not, whether there are further reasonable steps state policymakers could take to promote the deployment of these resources.

***2. Adopt recently enacted FERC standards for interconnection agreements and apply to all interconnections in the state (even if they fall outside FERC jurisdiction).***

Interconnection standards are widely divergent from utility to utility. Effectively, every single utility in the Western region has its own interconnection standards, policies, and procedures. This disparity greatly increases the costs for equipment developers, CHP project developers, and end users who are trying to deploy CHP systems. We recommend that all states adopt fair interconnection standards and procedures based on the FERC interconnection standards, including the IEEE 1547 technical standards.[xxi] If rural cooperatives, municipal utilities, and their generation and transmission suppliers are not subject to state interconnection standards for the regulated utilities, encourage these entities to adopt simplified, clear, and streamlined interconnection standards that are consistent with the state standards.

The importance of this recommendation is echoed in the Energy Policy Act of 2005 (signed by the President on August 8, 2005), which encourages all states to upgrade their interconnection standards for small generators.[xxii]

It is true that introducing new energy sources on electrical distribution systems designed for one-way energy flow requires technical management to prevent harm to customers and support workers. However, the FERC and IEEE 1547 standards underwent an extensive review process that included many utilities, and the final standards completely and adequately address these safety concerns.

***3. Give fair credit for CHP emissions reductions by adopting output-based emission standards and greenhouse gas market trading networks.***

Regulations of emission standards vary across the Western states. California and Texas have adopted output-based emission standards that allow CHP systems that are at least 60 percent efficient to take a credit based on the amount of heat recovered, which, in case of a conventional power plant, would have been emitted. In other states, the current emissions standards do not capture this value, since they are based on how much fuel is put into the generating equipment, rather than how much energy is produced. We recommend states adopt the model output-based emission rule developed by the Regulatory Assistance Project in a collaborative process involving utilities, industry, government, and other stakeholders.[xxiii]

***4. Seek CHP solutions to T&D-constrained areas.***

CHP and DG should be given credit for how they can help defer or avoid transmission or distribution upgrades in constrained or congested areas, or how they can help defer or avoid transmission or distribution expansions into new areas. Instead of the default question, "Where can we put the next line?," states and utilities should investigate if a CHP solution would be feasible. We recommend that states adopt the "Distributed Resource Distribution Credit Pilot Program" designed by the Regulatory Assistance Project, which provides a fair, realistic, and workable plan for giving incentives to CHP owners/developers to locate in distribution-constrained areas in a way that is beneficial to them and to the distribution utilities.[xxiv]

***5. Undertake a review of rates, including standby rates, to make sure they are not discriminatory toward CHP.***

Implementing rates that are both fair and rational is critical to the long-term success of this innovative energy option, as well as for realization of all the benefits that CHP can offer. Standby or backup rates are one area that needs particular attention by Western states. States should direct Utility Commissions to adopt standby tariffs only if there is hard analytical evidence to support the claim that CHP imposes costs on utilities (net of benefits) that are distinct from those of other load-reduction measures and distinguishable from the normal load variability within a given rate class. Historically, this has not been the approach taken by the utility regulators. Most standby rates are not based on actual in-field data, have not quantitatively compared CHP load variation to normal load variation, and do not the system benefits CHP creates for utilities. Furthermore, standby tariffs are often set as if all CHP systems on a given utility system will fail at the same time, during a peak period – clearly a very unlikely scenario. For all of these reasons, standby rates have tended to be unnecessarily high, imposing undue discriminatory economic barriers on potential CHP customers and making it unfairly difficult for utility competitors to gain market share.

***6. Incorporate policies that will promote CHP in state utility Least Cost Planning and Integrated Resource Plans.***

Customer-sited CHP investments ought to form a critical component of least-cost planning activities that seek to minimize ratepayer-funded investments in system load growth. Assets that are purchased, deployed, and operated by regulated utilities necessarily add to the rate base, while those like CHP that are purchased, deployed, and operated by unregulated entities do not factor into the rate base. Thus, grid benefits that are created by CHP deployment are realized at little to no cost to the ratepayer. CHP investors assume 100 percent of the capital risk when they install their power plant, as compared to utility investments, which spread their risk across all electric consumers. Thus, ratepayers realize all the benefits of good private sector investment decisions while bearing none of the risk for bad private sector investment decisions. This is precisely inverted for regulated utilities, where shareholders are consistently insulated from poor investment decisions, since these costs are invariably passed along to ratepayers (as many a nuclear plant cost-overrun will attest). Seen from the perspective of resource planning, this means that a grid that utilizes CHP maximum will also realize the maximum social benefit per dollar of rate base capital investment. Note that this is true no matter what the economics of the CHP system are, since in virtually all cases, those investments are made with unregulated dollars.

***7. Consider adding CHP to Demand Side Management and other energy efficiency programs.***

CHP is inherently an energy efficiency measure and should be regarded as such. It should be eligible for energy efficiency incentives and rebates.

***8. Decouple utility revenues from throughput.***

Under the current regulatory structure in most WGA states, utility revenues are tied to sales volume (in kW and kWh). In other words, the more they sell, the higher their profits, and the less they sell, the lower their profits. This often leads utilities to discourage energy efficiency measures, including CHP, that reduce electricity sales. Decoupling revenue from throughput would fix this incentive problem. Decoupling could be combined with a sliding
scale or range of earnings potential that rewards increasing efficiency.

***9. Enact a state equivalent of the Federal Section 45 Production Tax Credit that includes CHP, wind, geothermal, and biomass technologies.***

This would provide the most effective incentive to increase the production of clean, efficient, and renewable electricity in the West. We recognize this is inconsistent with our desire for more market-oriented price signals, but recommend this only because we feel that until the utilities are fully exposed to market forces, CHP must be given incentives like this one to level the playing field. In addition, tax incentives for CHP would be justified since so many of the benefits of CHP accrue to society at large rather than to just the individual CHP owner.

***10. Adopt simplified, streamlined, and consistent permitting for CHP systems and offer state-funded training and technical assistance programs for local code officials.***

Local code officials are often not familiar with CHP systems and, therefore, unnecessarily delay deployment of CHP projects. Simplification and streamlining local codes and permitting for air quality, noise, fuel supply, public safety, building codes, and fire codes would help potential projects overcome these hurdles, especially if done in conjunction with state-funded training workshops for local code officials.

***11. Ensure that renewable portfolio standards, environmental portfolio standards, advanced energy portfolio standards, and other renewable energy laws include the full range of renewable CHP options, including waste heat recovery and spent pulping liquor.***

State renewable energy laws and regulations should be made to ensure that renewable/opportunity-fueled CHP is not inappropriately culled from enabling laws. Waste heat recovery and spent pulping liquor (from pulp and paper mills) are two scenarios that have been overlooked for renewable portfolio standards, yet provide a viable alternative to traditional renewable energy resources; these should, therefore, get more consideration. Nevada is the only Western state to amend its RPS statutes to include waste heat recovery, while Oregon is the only Western state to include spent pulping liquor.

***12. Call on CHP Regional Application Centers for help in policy, programs, and analysis.***

The U.S. Department of Energy has established eight CHP Regional Application Centers to assist with policy analysis and implementation, market assessments, coalition building, education and outreach, and direct technical assistance to end users. These centers are willing and interested in working with Western governors and other Western policymakers to design programs and policies incorporating the recommendations contained here, or other activities that fall within their mission.

***Contact information for CHP Regional Application Centers for Western states:***

- Gulf Coast CHP Center: TX
  www.gulfcoastchp.org/
  Contact: Karl Rabago, Houston Advanced Research Center, 832-723-7443, krabago@harc.edu

- Intermountain CHP Center: AZ, CO, NM, UT, WY
  www.intermountainCHP.org
  Contact: Patti Case, etc Group, 801-278-1927, plcase@etcgrp.com

- Midwest CHP Center: KS, ND, NE, SD
  www.chpcentermw.org/
  Contact: John Cuttica, UIC Energy Resources Center, 312-996-4382, cuttica@uic.edu

- Northwest CHP Center: AK, ID, MT, OR, WA
  www.chpcenternw.org/
  Contact: Dave Sjoding, Washington State University, 360-956-2004, sjodingd@energy.wsu.edu

- Pacific CHP Center: CA, HI, NV
  www.chpcenterpr.org/
  Contact: Tim Lipman, University of California, Berkeley, 510-642-4501, telipman@berkeley.edu

***12. Wherever possible, adopt consistent, region-wide policies.***

All of the recommendations in this document will have a much higher chance of success in the Western region if member states undertake these efforts in a coordinated fashion, including adopting policies that are similar from one state to another and policies that are based on national models. Many of the model standards developed throughout the country have been specifically designed for states, with the collaboration of industry, government, end users, environmental organizations, and other stakeholders.

# 7. Positive Examples of Regional and State Activities Encouraging CHP

Some Western states have recognized the value in adopting policies that ensure investment in the development of clean distributed generation and CHP. The level of effort across the Western region, however, appears to be uneven.

## 7.1 Mid-Atlantic Distributed Resources Initiative (MADRI)

The PUCs of Delaware, District of Columbia, Maryland, New Jersey, and Pennsylvania, along with the U.S. Department of Energy and PJM Interconnection, have established the Mid-Atlantic Distributed Resources Initiative (MADRI). The main objective of this effort is to develop regional policies and market-enabling activities to support use of CHP and other forms of DG, and demand response in the Mid-Atlantic region. MADRI is managed by a steering committee comprised of utility commissioners from the five Mid-Atlantic States and representatives from DOE and PJM.

The MADRI has the potential to play a key role in the Mid-Atlantic region's electricity future, but adoption of DG is being hampered by several issues. The initiative has formed five working groups to address the key issues affecting the use of distributed generation:

- Interconnection Standards
- Environmental Impacts
- Pricing and Regulatory Framework
- Advanced Metering
- DG Business Development

The desired outcome of this effort is consensus agreements on how these issues should be treated from the state regulatory standpoint, along with a series of draft model rules.

## 7.2 Northwest Power and Conservation Council (NWPCC)

The NWPCC is considered the Northwest's lead energy planning body. *The Fifth Northwest Electric Power and Conservation Plan* has now been adopted and published by the NWPCC. For the first time, CHP is included and supported in the plan. The federal enabling legislation for the NWPCC is an interstate compact that provides a priority order of electrical resource acquisition as follows: 1) Conservation; 2) Renewable resources; 3) Cogeneration; and 4) Central power plants. The policy direction laid out by the NWPPC is implemented in individual Integrated Resource Plans and operating policies.[xxv]

## 7.3 State Activities

Individual states in the WGA region have initiated terrific programs to help move CHP forward. Efforts in Oregon, California, Texas, and Nevada need to be duplicated in other WGA states. Part of this process should include examining and adopting progressive policies and actions adopted by other states such as Connecticut, New York, Pennsylvania, and New Jersey.

- ***Oregon:*** Oregon has a very active six-prong effort to enable CHP. The different prongs are very well coordinated. This strategy stemmed from an initial CHP workshop held in November 2004, led by a joint effort of the Oregon Department of Energy, the Oregon Public Utility Commission (OPUC), and the Energy Trust of Oregon. The combination of Governor-led action plans and strategies, revised OPUC ground rules for CHP, and financial incentives from three Oregon energy and climate change state agencies/state-established non-profits has proven to be very potent; the measures have resulted in significant advancement of CHP.[xxvi]

- The Governor of Oregon has released the Oregon Renewable Energy Action Plan, part of which focuses on the biomass opportunity fuel for power and CHP.[xxvii]
- The Governor's Advisory Group on Global Warming has published the Oregon Strategy for Greenhouse Gas Reductions, which also supports renewable CHP.[xxviii]
- The OPUC has completed an initial information study entitled Removing Regulatory Barriers to Distributed Generation.[xxix] Following this study, the OPUC has worked to eliminate the barriers as they appeared before the commission in regulatory proceedings. One order set forth a pathway to resolve new generation issues.[xxx] Another order updated Qualifying Facilities rules under PURPA by increasing the size from 1 to 10 MW and changing the contract duration from 5 to 20 years; a staff report was also issued on tariffs and standard filings.[xxxi, xxxii] In August 2005, a staff report was issued on integrated resource planning for PacifiCorp and included the matter of standby rate charges.
- The Oregon Department of Energy provides Business Energy Tax Credits to help finance CHP projects.[xxxiii]
- The Energy Trust of Oregon (ETO) has a biopower program that is renewable CHP-focused, with up to $4.7 million available in financial incentives.[xxxiv]
- The Climate Trust established under Oregon law provides funding for greenhouse gas offsets including CHP.[xxxv] An example of CHP deployment is a Collins Pine lumber mill in Lakeview, Oregon.[xxxvi]

- ***California:*** The California Energy Commission (CEC) administers the Public Interest Energy Research (PIER) Program which annually awards up to $62 million to move environmentally safe, affordable and reliable energy services and products, including CHP, into the marketplace.

  The Self Generation Incentive Program provides an annual $112 million ratepayer-funded program that pays for the deployment of clean and efficient generation systems installed on customers' premises. This program originated in response to the California energy crisis in 2001 is administered by several investor owned utilities and the San Diego Regional Energy Office under the auspices of the California Public Utilities Commission (CPUC). CHP systems that generate 5 MWs or less utilizing microturbines, internal combustion engines and small gas turbines utilizing sufficient waste heat recovery and meeting emissions and reliability criteria are eligible for $1/watt payment, capped at 1 MW.

  In terms of reducing the regulatory barriers for CHP installation, California has instituted comprehensive interconnection standards, and exempted customers deploying CHP from standby charges and exit fees.

- ***Texas:*** Texas was one of the first states to adopt substantive interconnection rules, and its rules still represent a decent model for other states to follow. Adopted in 1999, the rules apply to the interconnection of generation facilities of 10 MW or less to radial and secondary network distribution systems. These rules are intended to streamline the interconnection process and reduce interconnection costs for applicants, particularly those with smaller devices and for those that are likely to have minimal impact on the electric utility grid.[xxxvii] In addition, in 2001, Texas promulgated a standard permit with output-based emission limits for small electric generators.

- ***Nevada:*** In 2003, the Nevada Renewable Portfolio Standard statute was amended to grant renewable energy status to qualified heat recovery processes. This statue gives Nevada utilities the opportunity and financial incentives to capture waste heat from industrial, manufacturing and gas pipeline compression processes.
- ***Connecticut:*** On July 21, 2005, Governor Rell signed the Connecticut House Bill 7501, *An Act Concerning Energy Independence*.[xxxviii] This law includes numerous provisions which are positive developments for CHP, including:
  - New Efficiency and CHP Portfolio Standard. The bill requires standard offer and competitive electric suppliers to obtain a percentage of their output from energy conservation services and CHP generation at commercial and industrial sites, ramping up to 1 percent by January 1, 2007 and to 4 percent by January 1, 2010.[xxxix]
  - Back-up Power Rates. If a customer develops a customer-sited DG project, as defined in the law, after January 1, 2006, and the capacity is less than the customer's maximum metered peak load, the customer will not have to pay back-up power rates, provided the resource is available during system peak periods.
  - Natural Gas Distribution Cost Rebate. Customer-sited distributed resources[xl] that use natural gas will be eligible for a rebate of gas delivery charges from the electric distribution company. The rebate will be recovered through electric rates.
  - Connecticut Clean Energy Fund. The Fund will now be able to provide support to CHP and thermal storage technologies.

- ***New York:*** Enacted December 1999, New York was one of the first states to issue standard interconnection requirements for DG systems. The initial requirements were limited to DG systems rated up to 300 kW connected to radial distribution systems. In November 2004, New York modified these interconnection requirements to include interconnection to radial and secondary network distribution systems for DG with capacities up to 2 MW.[xli] In July 2003, the New York State Public Service Commission (NYPSC) voted to approve new standby rates for utilities' standby electric delivery service to DG customers. A key consideration was for the rates to result in running onsite generation when it is less expensive than purchasing power from the grid.

  The NYPSC directed electric utilities to consider DG as an alternative to traditional electric distribution system improvement projects. The Commission also recognized that increased gas use for DG could create positive rate effects for gas consumers by providing increased coverage of fixed costs. They, therefore, ordered natural gas companies to create a rate class specifically for DG users.[xlii]

New York also runs the nationally known New York State Energy Research and Development Authority (NYSERDA) Distributed Generation and Combined Heat and Power Program. The program is funded at a level of $15 million per year and supports the development and demonstration of DG systems, components and related power systems technologies, and CHP applications in industrial, municipal, commercial, and residential sectors. The program offers each project a maximum of $100,000 for feasibility studies, $500,000 for product development, and/or $1,000,000 for demonstrations. All proposals must be cost-shared, preferably at or above 50 percent (cash and in-kind), with preference given to proposals with higher contribution levels and a higher cash portion of the contribution.

- ***Pennsylvania:*** In 2004, Pennsylvania passed a law that requires electric distribution companies and electric generation suppliers to increase use of selected alternative generation sources. One of the approved sources is CHP. Pennsylvania also has implemented a series of grant programs that have provided direct financial support for CHP projects. These programs have included three rounds of Energy Harvest grant solicitations, along with grants of $10 million to 17 projects issued by the Pennsylvania Energy Development Authority (PEDA). A third area of support is an interconnection rulemaking starting in August 2005. Further, the Commonwealth of Pennsylvania is a strong supporter of the MADRI process. The MADRI Interconnection working group is moving rapidly so that they can provide input to the Pennsylvania Public Utility Commission prior to the hearings.

- ***New Jersey:*** The state of New Jersey has implemented a multi-faceted program to promote energy efficiency and reduce existing and new demands on the electric power grid. One of the main elements of this program is “promoting on-site power generation with recovery and productive use of waste heat” or CHP. The state is providing financial incentives for CHP installations to help accomplish this objective. A total of $5 million of CHP incentives were approved in 2004 and $8 million in 2005. In addition, New Jersey is a strong supporter of the MADRI process and is actively involved in that effort.

## 8. Conclusion

Highly centralized generation of electrical power is a paradigm that has outlived its usefulness. The industry's average efficiency has not improved in forty-three years. No other industry wastes two-thirds of its raw material; no other industry has such stagnant efficiency; no other industry gets less productivity per unit output in 2005 than it did in 1905. Conventional central generation plants dump two-thirds of their energy into lakes, rivers, and cooling towers, while factories and commercial facilities burn more fuel to produce the heat just thrown away.

It will be quite difficult to continue to meet the demands of Western load growth based on the paradigm of centralized generation with large investments in T&D. Decentralized generation, using combined heat and power, could save literally billions in new capital investment, reduce power costs, reduce security vulnerabilities, cut fossil fuel use in half, cut greenhouse gas emissions in half, and cut other pollutants in half. Combined heat and power, using the same technologies used by remote central generation, significantly improves every key outcome from power generation.

## Endnotes

[1] Introducing new energy sources on electrical distribution systems designed for one-way energy flow requires technical management to prevent harm to customers and support workers. However, the FERC model standards and IEEE 1547 standards completely and adequately address all safety concerns, and we recommend state adoption of these standards. Otherwise, current utility interconnection standards will continue to prevent CHP in two ways. First, they are often, by design, very costly and time-consuming to the potential CHP user. Second, they differ from utility-to-utility, and this disparity further increases the costs and time to comply. Interconnection standards are addressed further in Section 6, "Recommended Policies for Western Governors."

[ii] The term "prime mover" describes any device that converts fuel into mechanical and/or electrical power.

[iii] Regulatory Assistance Project, *Distributed Resource Distribution Credit Pilot Programs: Revealing The Value To Consumers And Vendors*, September 2001, http://www.raponline.org/Pubs/DRSeries/DRCredit.pdf

[iv] Ibid.

[v] These approaches are outlined more completely and clearly in the study *Distributed Resource Distribution Credit Pilot Programs: Revealing The Value To Consumers And Vendors* by the Regulatory Assistance Project, 2001, http://www.raponline.org/Pubs/DRSeries/DRCredit.pdf

[vi] A good explanation and methodology for quantifying these benefits is available in the following study: Evans, Peter, *Optimal Portfolio Methodology for Assessing Distributed Energy Resources Benefits for the Energynet*, California Energy Commission, PIER Energy-Related Environmental Research, 2005, http://www.energy.ca.gov/2005publications/CEC-500-2005-061/CEC-500-2005-061-D.PDF

[vii] R. Neal Elliott and Mark Spurr, *Combined Heat and Power: Capturing Wasted Energy,* Report #IE983, American Council for an Energy-Efficient Economy, 1999.

[viii] Energy and Environmental Analysis, *Natural Gas Impacts of Increased CHP*, October 2003, http://www.eea-inc.com/dgchp_reports/CHPA-Gas.pdf

[ix] Spark spread is defined as the difference between the cost of purchased electricity and the cost to generate electricity from a purchased fuel onsite.

[x] While newer combined cycle plants have a much better efficiency (45-60 percent), the average efficiency of existing plants in the U.S. still remains at 33 percent.

[xi] Some make the argument that new central station natural gas combined cycle plants and/or integrated coal gasification combined cycle plants could be used to improve average power plant efficiency instead of CHP solutions. However, compared to CHP, these central station plants would still yield transmission and distribution losses when delivering the electricity, and would forego most of the other benefits of CHP as detailed in this section.

[xii] Western Resource Advocates, Synapse Energy Economics and Tellus Institute, *A Balanced Energy Plan for the Interior West,* 2004, www.westernresourceadvocates.org

[xiii] Ibid.

[xiv] U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability, *GridWorks: Overview of the Electric Grid*, data as of 2001, http://www.energetics.com/gridworks/grid.html

[xv] "Little" refers to those CHP plants that are deployed in part with the incentives created by system benefits charges. However, even in these cases, the public sector contribution to total project capital costs rarely exceeds 30 percent of total system capital investment. Thus, even in these exceptional cases, CHP would have to be more than three times as expensive as the fuel purchase, generation, transmission and distribution it displaces before it imposes greater costs on ratepayers than rate-based investments in central power-only generation.

[xvi] This chart does not include industrial waste energy recovery (waste heat-to-power configurations). That is why the total of this chart, 36,872 MW, is lower than the total technical potential noted earlier, 42,864 MW.

[xvii] This section is extracted from a larger and more detailed document describing barriers to CHP deployment prepared by the U.S. Combined Heat and Power Association as a part of their "CHP Regulator Toolbox." We would be happy to provide this document for readers interested in learning more about the issues described herein.

[xviii] Comparing CHP only to central power technologies without including transmission and distribution costs, a common mistake, greatly understates the actual financial benefits of CHP deployment.

[xix] U.S. Department of Energy data shows that unregulated power producers began deploying more efficient combined cycle gas turbine technology a decade sooner than their regulated counterparts.

[xx] The point is mathematical: With utility investments earning 10-15 percent returns via the revenue from a given rate and deployed CHP investments earning returns in excess of 30 percent by displacing the same rate, the latter investment is necessarily a more capital-efficient way to serve the same load. The math is even more compelling if one considers the return on ratepayer-funded capital investment for the two options.

[xxi] Federal Energy Regulatory Commission, *Standard Interconnection Agreement for Large Generators and Small Generators*, 2005, http://www.ferc.gov/industries/electric/indus-act/gi.asp

[xxii] *Energy Policy Act of 2005*, Sections 1251, 1252, and 1254.

[xxiii] Regulatory Assistance Project, Model Regulations for the Output of Specified Air Emissions from Smaller-Scale Electric Generation Resources, October 2002, http://www.raponline.org/ProjDocs/DREmsRul/Collfile/ModelEmissionsRule.pdf

[xxiv] Regulatory Assistance Project, *Distributed Resource Distribution Credit Pilot Programs: Revealing The Value To Consumers And Vendors*, September 2001, http://www.raponline.org/Pubs/DRSeries/DRCredit.pdf

[xxv] Northwest Power and Conservation Council, *Fifth Northwest Electric Power and Conservation Plan*, May 2005, http://www.nwcouncil.org/energy/powerplan/default.htm. See Volume One, page 58 and Volume Two (the generating resources chapter), pages 5-5 to 5-7.

[xxvi] Energy Trust, Oregon Department of Energy, Oregon Public Utilities Commission, *Combined Heat and Power (CHP) Workshop*, November 2004, http://www.puc.state.or.us/agenda/113004.htm

[xxvii] Oregon Department of Energy, *Oregon Renewable Energy Action Plan*, April, 2005, http://egov.oregon.gov/ENERGY/RENEW/docs/FinalREAP.pdf. Pages 7 and 17-22 focus on the biomass opportunity fuel for power and CHP.

[xxviii] Oregon Governor's Advisory Group on Global Warming, *Oregon Strategy for Greenhouse Gas Reductions,* December 2004, http://egov.oregon.gov/ENERGY/GBLWRM/docs/GWReport-FInal.pdf. See pages 66-74.

[xxix] Oregon Public Utility Commission, *Distributed Generation in Oregon: Overview, Regulatory Barriers and Recommendations*, February, 2005, http://www.puc.state.or.us/elecnat/dg%5Freport.pdf

[xxx] Oregon Public Utility Commission, Order No. 05-133 (UM 1066), March 2005, http://www.puc.state.or.us/orders/2005ords/05%2D133.pdf

[xxxi] Oregon Public Utility Commission, Order No. 05-584 (UM 1129), May 2005, http://www.puc.state.or.us/orders/2005ords/05%2D584.pdf

[xxxii] Oregon Public Utility Commission, Staff Report, July 2005, http://www.puc.state.or.us/agenda/pmemos/2005/080205/reg2%2C3%2C4.pdf

[xxxiii] Oregon Department of Energy, *Business Energy Tax Credits*, http://egov.oregon.gov/ENERGY/CONS/BUS/BETC.shtml

[xxxiv] Energy Trust of Oregon, Inc., *Biomass Energy Program Launched* and *Biomass Project Selected*, 2005, http://www.energytrust.org/RR/bio/index.html. See also Energy Trust of Oregon, Inc., *Briefing Paper: Combined Heat and Power (Co-generation) Policy Status Report,* September 2004, http://www.energytrust.org/Pages/about/activities/board/2004/040908/2_1_CHP_status.pdf and

Energy Trust of Oregon, Inc., *CHP Policy*, August 2005, http://www.energytrust.org/Pages/about/activities/rac/2005/050817/CHP.pdf

[xxxv] The Climate Trust, *About the Climate Trust,* http://www.climatetrust.org/about_us.php

[xxxvi] The Climate Trust, *Lumber Mill Cogeneration*, http://www.climatetrust.org/offset_mill.php

[xxxvii] Public Utility Commission of Texas, Distributed Generation Interconnection Manual, May 2002, http://www.puc.state.tx.us/electric/business/dg/dgmanual.pdf

[xxxviii] State of Connecticut General Assembly, *An Act Concerning energy Independence,* June 2005, http://www.cga.ct.gov/2005/TOB/h/pdf/2005HB-07501-R00-HB.pdf

[xxxix] Class III: CHP must have an operating efficiency no less than 50 percent, be sited at a commercial or industrial end user's facility, and be developed on or after January 1, 2006.

[xl] Customer-sited distribution resource is defined as per law: A) generation of electricity from a unit with a rating of not more than 65 MW on the premise of a retail end user within the transmission and distribution system, including, but not limited to, fuel cells, PV systems, or small wind turbines, or B) a reduction in the demand for electricity on the premises of a retail end user in the distribution system through methods of conservation and load management, including, but not limited to, peak reduction systems and demand response systems.

[xli] New York State Public Service Commission, *New York State Standardized Interconnection Requirements and Application Process for New Distributed Generators 2 MW or Less Connected in Parallel with Utility Distribution Systems*, November 2004, http://www.dps.state.ny.us/SIR_Require_11_04.pdf

[xlii] New York State Public Service Commission, *Distributed Generation Information: Gas Service for Distributed Generation*, April 2003, http://www.dps.state.ny.us/distgen.htm