# Energy Efficiency and Green Buildings IWG Report to the Climate Action Team

## Summary of Proposed Actions

## EE/GB ACTION 1: ENERGY EFFICIENCY INCENTIVES

This proposed action recommends legislation designed to use incentive-based approaches to motivate and accelerate the design, construction, and annual operation of buildings to levels of superior energy performance (Action 1A), and to encourage the incorporation of combined heat and power, distributed electricity generation, and other distributed and district energy systems, including district heating and cooling (Action 1B). Proposed legislation would reward actual demonstrated energy performance with tax credits.

### EE/GB ACTION 1A: ENERGY EFFICIENCY QUALITY INVESTMENT PROGRAM (EEQUIP)

Near-term high priority legislative concepts for this action include:

1. Public Utility Tax (PUT) credits for non-residential buildings that meet specific levels of energy performance based on actual utility data, with 50 percent of the PUT credit supplied by the utilities serving the building.
2. A modification of statutory language related to Local Improvement Districts (LID) that adds energy efficiency as a qualifying activity.

Other most promising future legislative concepts for this action include:

1. Partial sales tax refunds for new non-residential buildings that achieve energy performance standards equivalent to an ENERGY STAR Target Finder rating of 90.
2. Partial sales tax refunds for new and existing residential buildings that meet a level of energy performance equivalent to an ENERGY STAR Northwest-rated home.

### EE/GB ACTION 1B: EXPANDED IMPLEMENTATION OF DISTRIBUTED ENERGY AND WATER, COMBINED HEAT & POWER (CHP) AND RENEWABLE ENERGY

Distributed energy systems are highly effective tools to maximize the efficient use energy resources, capture waste energy that would otherwise not be used (thus yielding efficiencies that exceed those of larger stand-alone systems), capitalize on the synergies of multiple uses by moving energy between these uses, optimize capital resources, and minimize GHG output. They are effective GHG minimization tools at the neighborhood, campus or district level. Distributed energy systems include combined heat and power (CHP), industrial waste heat, district cooling, and renewable energy systems.

To capture the benefits of distributed energy and related systems, offer incentives to encourage the development and use of CHP and other distributed energy systems using options potentially including B&O (business and operations) Tax credits, Public Utility Tax credits for buildings and industries that use CHP/distributed energy systems, sales tax exemptions on machinery and equipment used in CHP/distributed energy systems, and/or property tax exemptions. In the short term, focus implementation on extending current sales tax exemptions for investments in manufacturing equipment to also cover CHP and distributed energy systems meeting specified performance targets.

## EE/GB ACTION 2: ENERGY EFFICIENCY, ENERGY BENCHMARKING, AND ENERGY PERFORMANCE DISCLOSURE IN EXISTING, NEW AND RENOVATED BUILDINGS

### EE/GB ACTION 2A: ENERGY EFFICIENCY IN EXISTING, NEW AND RENOVATED PUBLIC BUILDINGS

Legislative action is proposed to substantially upgrade the energy efficiency and sustainability of publicly-constructed and -operated buildings, including both new and existing buildings. Key elements of the proposed legislation, which has slightly different provisions for State agencies, colleges, universities and school districts and for cities, counties, and other taxing authorities, would include:

1. Require a process of benchmarking, auditing, and implementation of energy-efficiency measures in existing publicly-constructed and –operated buildings, with energy-efficiency requirements becoming more stringent over time in a tier/phased approach.
2. Require that new and substantially renovated publicly-constructed and –operated buildings meet strict energy performance standards, again with energy-efficiency requirements becoming more stringent over time in a tier/phased approach.
3. Emphasize that education and promotion are critical components to the success of the program.
4. Implementation will emphasize the use of existing programs and funding in state and local governments.
5. Partnering with US EPA’s ENERGY STAR program is a critical element and has been initiated.

### EE/GB ACTION 2B: ENERGY BENCHMARKING AND ENERGY PERFORMANCE DISCLOSURE IN PUBLIC AND PRIVATE BUILDINGS

Develop and implement energy benchmark (e.g. energy use/square foot) public disclosure requirement for private non-residential and residential buildings at the time of sale or, in some circumstances, at the time of lease of a building.

## EE/GB ACTION 3: STATE ENERGY CODE IMPROVEMENTS AND ESTABLISHMENT OF 2030 BUILDING GOALS

This Action includes two major elements:

1. In the 2009 Washington State Building Code adoption cycle, revise the Washington State Energy Code (WSEC) to achieve a 30 percent reduction in new building energy use compared to the 2006 edition of the WSEC. Provide substantial efficiency advances in the code as it applies to remodeling, retrofit and equipment replacement.  Specify a process of periodic review and improvement of building energy codes. Consider the impacts of codes on the availability of incentives through utility demand-side management programs, and provide education and technical assistance in the implementation of updated codes.
2. Legislative action is recommended to provide policy direction in the development and implementation of a long term **State Building Efficiency and Carbon Reduction Strategy**. Legislation would direct CTED to develop a 2010 State Strategy for Building Energy Efficiency and Carbon Reduction, which would include establishing specific targets for building energy use intensity and target for new buildings similar to the Architecture 2030 Challenge schedule. This strategy would examine several implementation methods including: state codes and appliance standards, emerging technologies, user incentives, education and technical assistance, and measurement. It is recommended that the strategy be updated every three years prior to the state building code development and adoption process.

# Full 2009 Action Descriptions

## EE/GB ACTION 1: ENERGY EFFICIENCY INCENTIVES

### EE/GB ACTION 1A: ENERGY EFFICIENCY QUALITY INVESTMENT PROGRAM (EEQUIP)

#### 2009 ACTION DESCRIPTION:

The derived public benefit from investments in superior energy efficiency in Washington is a superior quality-built environment for those using and operating buildings, as well a strategic attraction for additional investments in our economy. To this end, development assistance to provide incentives for quality improvements in building energy efficiency, by definition, must also ensure quality improvements in operations, performance, measurement, and the craftsmanship and training that go into quality buildings. In addition to alignment with the goals of Executive Order 07-02 and subsequent statutes, this rationale works to better ensure the transparency, accountability, and success of the program, from the perspective of the direct beneficiary as well as the public at-large.

This action recommends the following;
Near-term high priority legislative concepts for this action include:

1. Public Utility Tax (PUT) credits for non-residential buildings that meet specific levels of energy performance based on actual utility data, with 50 percent of the PUT credit supplied by the utilities serving the building.
2. A modification of statutory language related to Local Improvement Districts (LID) that adds energy efficiency as a qualifying activity.

Other most promising future legislative concepts for this action include:

1. Partial sales tax refunds for new non-residential buildings that achieve energy performance standards equivalent to an ENERGY STAR Target Finder rating of 90.
2. Partial sales tax refunds for new and existing residential buildings that meet a level of energy performance equivalent to an ENERGY STAR Northwest-rated home.

***PUT Credit and Benchmarking Requirement for Existing Commercial and Multifamily Residential Buildings***

Legislative action is recommended in 2009 to establish a tax incentive for buildings (non-residential occupancies) that meet or exceed a defined level of energy performance as determined by the ENERGY STAR Portfolio Manager program (or a comparable verified third-party or independent system of standardized accounting and benchmarking as determined by the Community, Trade, and Economic Development Department). The Department will develop a program that provides the tax credit that initially (e.g. 2009-2010 biennium) provides incentives for buildings that meet or exceed a Portfolio Manager score of 75 or demonstrate an annual improvement of energy performance of at least 15% (regardless of baseline year Portfolio Manager score). Buildings that continue to meet or exceed the Portfolio Manager threshold score may claim the tax credit annually. Buildings that meet the 15% improvement target may claim the credit only one time. Thereafter, those buildings must meet the Portfolio Manager threshold score to claim the credit in other years

There are three mechanisms for qualification for the PUT credit. All three mechanisms begin with establishing a baseline score using the previous calendar year of energy use data).

1. If the score is 90 or above and that score is maintained or improved in the subsequent calendar year, the PUT credit for year 2 (year after baseline) is available for refund. The PUT refund is available for subsequent years if the score is maintained at 90 or above.
2. For buildings whose baseline year score is between 75 and 89, those buildings must demonstrate 5 points of improvement in year 2 to qualify for a PUT tax refund for year 2 (Note any building that exceeds a score of 90 in the second year will qualify for the process described above). If the 2nd year Portfolio Manager score is maintained or improved in subsequent years, the PUT refund will continue to be available.
3. For buildings whose baseline year score is below 75, those buildings must achieve a minimum score of 75 in any subsequent year to qualify for a PUT refund. If a score of 75 or above is maintained, the PUT refund will continue to be available.

After 3 years, the baseline score in mechanism #2 moves to a range of 80 to 89. All other features remain the same for the subsequent 3 years.

After 3 years, the baseline score for mechanism #3 moves to 80.

After 6 years, the baseline score for all buildings to qualify for a PUT credit will be 90. A score of 90 or above must be maintained in subsequent years to continue to receive the PUT credit.

Verification of Portfolio Manager benchmark scores will in all cases be done through the U.S. EPA ENERGY STAR validation process. Relying on this process reduces administrative cost and burden to the state.

The tax credit described here should be applied to the Public Utility Tax (PUT). The PUT is assessed to electric and natural gas utilities and passed through to energy end use customers. Buildings that meet the level of superior energy performance as described here will receive a full credit of the PUT provided that the serving utility to that building has agreed to participate with the State in this program. Utility participation requires the electricity or natural gas utility agreement to a 50% “cost share” with the State for the value of the tax credit. Buildings that are served by electric and/or natural gas utilities that decline to participate in this agreement will not be eligible for the tax credit. Utilities that do participate in this tax credit program will be allowed to claim a reasonable amount of energy savings from the customer project and use those savings to meet the goals of the Energy Independence Act (I-937). The Department will establish a mechanism in consultation with the state’s public and private utilities and in collaboration with the Department of Revenue to minimize the transactional cost of applying this credit to qualifying buildings.

Revenue effects: It is estimated that up to 28 million square feet of commercial property will qualify for a PUT refund in the second year of the 2009-2010 biennium (given the need for a baseline year, there will be no credits in 2009). The anticipated PUT refund with this level of participation is approximately $750,000.

***Sales Tax Refund for Non-Residential New Construction***

Legislative action is recommended when the state’s revenue situation improves, to establish a sales tax incentive for buildings (non-residential occupancies) that meet or exceed a specific level of superior energy performance. The level of energy performance will be defined as equal to or better than the energy performance of buildings that achieve an ENERGY STAR Target Finder score of 90. The Department will establish through rulemaking procedures any necessary state specific adaptations to the ENERGY STAR Target Finder benchmark as well as all qualifying rating systems that offer energy performance requirements that meet or exceed this level of energy efficiency. All projects that meet this requirement will be eligible for a sales tax refund of 0.75% of the project’s documented cost of construction, up to a maximum refund per square foot of floorspace in the project applying for refund. The Department will establish rules for documenting qualification for this tax credit, for the maximum refund level per unit floor area, and for verification of qualifying cost of construction. Project owners will receive the incentive in the form of a sales tax refund.

Revenue effect: In the 2009-2010 biennium, approximately $80,000,000 of construction costs are estimated to qualify for the refund, rising to nearly $250,000,000 by 2012. This would translate to a tax refund of $400,000 in the 2009-2010 biennium. It is estimated that very few projects would be completed in 2009, so the majority of this tax refund would occur in 2010. By 2012, the estimated tax refund would be about $1.1 million annually.

### *Sales Tax Refund for Existing and New Residential Buildings*

Legislation is recommended when the state's revenue situation improves, to establish a partial sales tax refund for qualifying costs incurred by residential property owners for energy efficient new construction remodels and/or retrofits if as a result of that work the property reaches an established threshold of superior energy performance. The threshold level of energy performance to qualify for this tax credit will be equal to or better than that of an ENERGY STAR Northwest rated home. CTED will, through a rulemaking process, establish specific levels of energy performance pursuant to this benchmark, certify any home rating system that meets or exceeds this threshold level of energy performance, as well as define qualifying expenses for energy efficiency retrofit and renovation projects. The sales tax for these projects would be paid pursuant to RCW 82.08.020.

If the project met the threshold requirement, the property owner would be eligible to claim a partial refund for sales tax paid on the project of no more than 20% of the total tax paid capped at $5,000.

Revenue effect: The revenue effect on the state is estimated to be $3.5 - $7.5 million per year.

### *Amendment to Local Improvement District Statute*

Legislative action is recommended in 2009 to amend the statute [RCW 35.43.040] that governs the general authority of cities and towns to establish Local Improvement Districts (LID) and to levy and collect special assessments on property specially benefited by energy efficiency upgrades in existing buildings and/or qualifying district energy projects. Amendment would allow cities and towns to establish energy efficiency investment districts (EEID) that can access capital via assessment revenue bond sales to enable large energy efficiency investments in existing buildings of the development of district energy projects. Bonds will be repaid over time based on property-specific assessments that capture the special benefits of the upgrades.

This proposal would allow cities and towns to use the LID concept to access capital for city-wide energy efficiency upgrades in existing single family, multifamily and commercial buildings.

Since LIDs are widely used throughout Washington, city and town administrators are familiar with the process and equipped to manage an LID financing.

In practice, this type of financing would likely occur with one or series of LID financings managed by a City. Normally, an LID requires 60% approval of property owners in the district, but because upgrades will be done to specific properties, the approach for an EEID will use a "checkerboard" strategy. The boundaries of the EEID will encompass the entire city and there will be an initial "opt-in" period, where property owners can choose to join the district and access capital for upgrades through the program.

Once property owners have joined, the special district is defined. This special district is allowed to certify assessments to the tax assessor for inclusion on the tax rolls, such that the assessment becomes an increment on the property's tax bill. For LIDs, these incremental property tax payments are tax deductible.

In the proposed EEID, the new assessment is a monthly or annual payment that pays back, over a predetermined term, the full value of the energy remodel elements added during the upgrades, plus interest. This cost is assessed only against individual properties as they participate in the program. If the property owner sells, the buyer can choose to pay off the assessment at the time of purchase, to eliminate any outstanding liens on the property.

An important benefit of this structure is that the proposed EEID financing concept ties repayment of the investment to the property's owners and subsequent owners. This means that the beneficiaries of the investments financed by the program are paying for the benefits. (An alternative financing mechanism may involve municipal utility revenue bonds or city general obligation bonds.) While these mechanisms would access similarly-priced capital, they would also be repaid with revenue streams (rates or taxes, respectively) derived from all ratepayers or citizens in a district.

This LID concept is viewed as one of a series of innovative financing approaches that are necessary to fully realize the energy efficiency potential of existing buildings. Combining this LID approach with other capital generating mechanisms from public, private, and/or utility sources is likely needed to achieve the state's greenhouse gas reduction goals.

Participation of Low Income Property Owners: Since the financing in this program does not result in a new mortgage on the property and qualification does not depend on income, every building owner, including all low-income building owners, should be able to participate.

Recommendation: Add energy conservation/energy efficiency measures and district energy projects as qualifying local improvements in RCW 35.43.040. For example;

(19) Energy efficiency, energy conservation measures, and district energy projects. Assessments may be levied only on property that will be specially benefited by such improvements.

Revenue Effect: This concept has no revenue impact at the state level. It allows cities and towns to establish local improvement districts (LIDs) or utility local improvement districts (ULIDs) as a mechanism to help finance energy efficiency and energy conservation measures in existing buildings.

A number of other possible alternative financing mechanisms have been developed in other jurisdictions, and might be considered (and in some cases, are being considered) for application in Washington. Additional possible alternative financing mechanisms include:

- Creation of a loan program, funded by state bonds but administered on the local level, specifically tailored to finance building energy efficiency improvements. Such a program could include elements of pooled financing programs, bond insurance, state bond banks, and state loan and bond guarantees.
- Creation of an Energy Efficiency Financing Platform Program that brings together as many sources of capital as possible into a system with streamlined and centralized implementation and repayment[1]. Such as platform would bring together capital sources such as, but not limited to state bonds, local government financing sources, utility funds, pension funds, and private investment. The fund would leverage both public and private money at multiple levels. It could be a public entity, perhaps housed within CTED, or elsewhere. It could also be a brokered fund that is privately-managed with public accountability and contributions. Repayment of loans made by the fund could be structured so as to attach the loan to a property and not an individual, either by tying repayment to property taxes, or adding payment to utility bills (on-bill financing). The fund would be managed by a program that is responsible for ensuring oversight, branding, verification, and payment collection (via utilities, municipalities, etc.). The program could be a part of CTED, or exist on its own. The administration costs for the fund would be paid for out of user fees. After an initial expenditure to establish the program, in the long run, the state general fund would not be a source of funding.
- Creation of a state Air Quality Finance Authority that could, for example, offer long-rate, long-term financing to private and other purchasers of buildings and equipment that reduce greenhouse gas emissions, purchase energy-efficient equipment in bulk to achieve large-volume discounts (for resale or lease to consumers)[2],
- The use of U.S. Department of Housing and Urban Development Community Development Block Grant Program loan guarantees for improvements, particularly to low- and median-income housing, that results in greenhouse gas emissions reductions[3].

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[1] A similar initiative, the Joint Energy Financing Fund for energy efficiency, is under consideration in Oregon.

[2] United States Environmental Protection Agency Environmental Finance Advisory Board, Report on Innovative Finance Programs for Air Pollution Reduction. A version of this document dated November, 2007 is available as http://www.epa.gov/efinpage/efab/LetterSJ110107.pdf.

[3] This and other financing options are summarized in United States Environmental Protection Agency (August 2008) Guidebook of Financial Tools: Paying for Sustainable Environmental Systems, available as http://www.epa.gov/efinpage/publications/GFT2008.pdf.

- Creation of public-private partnerships with utilities and other investors to offer financing for energy efficiency improvements that are paid back through payments made on monthly utility bills.

## BASIS FOR SELECTION:

These legislative concepts are designed to use an incentive-based approach to motivate and accelerate the design, construction, and annual operation of buildings to levels of superior energy performance. They are designed to work with familiar and accessible programs of merit (e.g. LEED, ENERGY STAR, Built Green or other verifiable third-party or independent certifications) that have gained acceptance by the commercial and residential buildings market. The reward through tax credits for actual demonstrated energy performance is innovative and critically important to achieving the state's overall greenhouse gas reduction and quality job creation goals, outlined in Executive Order 07-02.

## IMPLEMENTATION APPROACH AND MECHANISMS:

These tax credit proposals have a revenue impact on the state's general fund. However, the ideas can be scaled to both near-term and long-term budget realities. It is recommended that the complexities of tax credit program mechanics be left to a rule making process conducted by the Department.

## SUPPORTING INFORMATION:

### *GHG Reduction Potential*

Analysis of the costs and benefits of this Action have focused on the Public Utility Tax Credit and Sales Tax Rebate elements described above. The table the follows presents the overall results of the analysis.

**Summary Results of Analysis for Action EE/GB-1B**

| EE/GB | Action | GHG Emission Reductions ($MMTCO_2e$) | | | | NPV (2008-2020) ($ Million) | Cost Effectiveness ($/$tCO_2$) |
|---|---|---|---|---|---|---|---|
| | | 2012 | 2020 | Cumulative (2008-2020) | Location | | |
| Action 1A | Energy Efficiency Quality Investment Program (EEQUIP) | 0.1 | 0.8 | 4.8 | In-state / regional | -$180 million | -$38 |

Additional results of and inputs to this option can be found in the Annex to this document.

### *Key Inputs/Assumption for Analysis of Action EE/GB-1B*

PUT Rebate Element

- Levelized Electricity Avoided Cost: $66/MWh
- Levelized Natural Gas Avoided Cost: $7.6/MMBtu
- Levelized Cost of Electricity Savings: $32 $/MWh
- Levelized Cost of Natural Gas Savings: $6.6 $/MMBtu
- 50% of multi-family residential units are candidates for PUT credit element of Action

- The cumulative fraction of commercial and multi-family residential square footage qualifying for PUT rebate by maintaining Energy Star score of 90 or above is 3% by 2012, and 10% by 2020, and provide new savings equal to 1% of 2005 average electricity and gas use per square foot annually.
- The cumulative fraction of commercial and multi-family residential square footage qualifying for PUT rebate by maintaining Energy Star score of 75-89 (80-89 after year 3) is 1.5% by 2012, and 3% by 2016, and provide new savings equal to 3% of 2005 average electricity and gas use per square foot annually.
- The cumulative fraction of commercial and multi-family residential square footage qualifying for PUT rebate by improving to an Energy Star score of 75 (80 after year 3) or making an improvement of 15 points is 5% by 2012, and 8% by 2016, and provide new savings equal to 5% of 2005 average electricity and gas use per square foot annually.

Sales Tax Credit Element

- The cumulative fraction of commercial and multi-family residential square footage qualifying for PUT rebate by maintaining Energy Star score of 90 or above is 3% in 2012 and 10% by 2020.
- Construction costs for non-residential and multi-family residential buildings covered under this element are assumed to average $250/square foot (this value also serves as the maximum basis for tax credits for commercial and multi-family residential buildings). Average construction costs for single-family residences were assumed to be $150 per square foot.
- Only new (not renovated) commercial and multi-family residential floorspace is covered by this element of the Action.
- Both new renovated single-family residential units are covered by this element of the Action, and renovated and new units are assumed to occur in roughly equal numbers.
- Buildings participating in this element of the Action yield average energy savings equal to 20 percent of 2005 average electricity and gas use per square foot of floorspace annually <u>above and beyond</u> the requirements of the more stringent building energy codes included in Action 3.
- In addition to reductions in greenhouse gas emissions, building energy efficiency improvements for which incentives are provided under this action reduce the emissions of non-GHG air pollutants, can result in reduced water use, and can increase the use of in-state renewable fuels while reducing the consumption of imported fossil fuels.

## EE/GB ACTION 1B: EXPANDED IMPLEMENTATION OF DISTRIBUTED ENERGY & WATER, COMBINED HEAT & POWER (CHP) AND RENEWABLE ENERGY

### 2009 ACTION DESCRIPTION:

***Background:***

Distributed energy systems are highly effective tools to maximize the efficient use energy resources, capture waste energy that would otherwise not be used (yielding efficiencies that exceed those of larger stand-alone systems), capitalize on the synergies of multiple uses by moving energy between these uses, optimize capital resources, and minimize GHG output. They are effective GHG minimization tools at the neighborhood, campus or district level. These systems are utilized currently in Washington by public entities such as at the University of Washington and Washington State University as well as by private entities such as Seattle Steam. Distributed energy systems connect multiple heating and cooling energy users through networks of energy sources such as combined heat and power (CHP), industrial waste heat, district cooling, and renewable energy sources such as biomass, geothermal, geoexchange, and other natural sources of heating and cooling. In addition district systems may also include fuel cells, Micro combined heat and power (MicroCHP), microturbines, photovoltaic systems, concentrating solar collectors, reciprocating engines, small wind power systems, Stirling engines and other innovative district-based clean technologies.

District energy systems produce energy, produce and pipe steam, hot water or chilled water underground through a dedicated piping network to heat or cool buildings in a given area, reducing energy costs and greenhouse gas emissions, while freeing up valuable space in individual buildings by centralizing production equipment and, through economies of scale and equipment management, optimizing the use of fuels, power and resources.

By aggregating the thermal requirements of dozens, hundreds, or even thousands of different buildings, the district energy system can employ industrial grade equipment designed to utilize multiple fuels and employ technologies that would otherwise simply not be economically or technically feasible for individual buildings, such as deep lake water cooling; direct geothermal or waste wood combustion[4].

Distributed water systems minimize pump energy and resultant GHG output through the effective utilization of limited water resources at a localized level, minimizing regional pumping issues. Approximately 8 percent of total U.S. energy demand is used to treat, pump, and heat water according to the US EPA. Distributed water systems function through the capturing rainwater, reuse of greywater, and localized treatment of blackwater (for distribution as greywater) involving multiple users at a neighborhood, campus or district level. Integrated with Low Impact Development (LID) strategies, distributed water systems can be effective tools to minimize GHG output as well as protecting Washington water systems, such as Puget Sound.

Combined heat and power systems produce both heat—in the form of hot water, steam, or heated air—and power. The heat can be used for industrial or commercial processes, or to provide water heating and/or space heating in individual buildings or throughout multi-building campuses or districts. Using technologies such as absorption chillers, the heat from CHP systems can also be used for cooling/freezing applications, including applications such as air conditioning, district cooling, and in the food processing industry. Waste heat that often goes up the smoke stack can also be used on the "back end" of industrial processes (following its use in the process) to produce power and recover the waste heat.

The sizing of CHP systems can be based on: 1) following the thermal demand for a facility; 2) following the power demand for a facility; or 3) following both thermal and power demands, when seasonal variations occur; and 4) meeting power needs demanding high reliability. Prime CHP opportunities include forest products/pulp and paper mills, food processing with year-round operations, dairies, feedlots, wastewater treatment facilities, campus settings with district heating of multiple buildings, industrial process facilities with available waste heat, natural gas compressor stations, and facilities with high power reliability, heating and hot water, and cooling requirements such as hospitals and data centers. Cogeneration is an older term for CHP. For additional information see the Northwest CHP Application Center website at http://www.chpcenternw.org/.

Combination heating and district cooling systems provide chilled water that is used for air conditioning of building space and process cooling for data centers and switchgear. In a city, there is generally a diversity of load as different types of buildings (i.e. residential, commercial, retail, convention, etc) will use energy under different operating conditions and set peak demands at different times of day. Serving this variety of loads allows the central plant to operate at optimal output over a longer time period. Additionally, many district cooling systems incorporate thermal storage systems to further expand peak capacity and increase the operational flexibility and efficiency with the ability to operate equipment at optimal output[5].

#### ***Incentives for Development of Combined Heat and Power/Distributed Energy Systems***

It is proposed to offer incentives to encourage the development and use of CHP and other distributed energy and water systems, including district heating and cooling, and district grey & black water systems in the following ways:

- Offer tax incentives potentially including B&O (business and operations) Tax credits, Public Utility Tax credits for buildings and industries that use CHP/distributed energy systems district heating and cooling,

[4] Source: IDEA Report: The District Energy Industry, International District Energy Association.

[5] Source: IDEA Report: The District Energy Industry, International District Energy Association.

and district water systems, sales tax exemptions on machinery and equipment used in these systems, and/or property tax exemptions. In some cases, it may be possible to integrate these incentives with the building energy efficiency incentive programs described in Action 1A, above. Sales tax exemptions on equipment purchases and installation of CHP, district heating and cooling, district water systems will likely be easiest to implement in the short-term, based on the existing manufacturing and retail sales tax and use tax exemptions on equipment used in manufacturing (which include exemptions for CHP systems used in manufacturing).

- Adoption of output-based emissions regulations.
- Requiring CTED and the UTC to assess the regulatory barriers to CHP, district heating and cooling, district water systems, and recommend enabling changes (see "Potential Barriers to Implementation" comments, below)

***Eligibility of CHP/Distributed Energy & Water Systems***

Eligible CHP projects: Combined heat and power systems that meet minimum efficiency standards should be eligible. Combined heat and power systems shall be designed to have a projected overall thermal conversion efficiency (output of electricity plus usable heat divided by fuel input) of at least 70 percent to qualify for a full exemption from the sales and use tax[6].

Eligibility criteria for incentives, and tax credits or exemptions available, for other distributed energy systems such as district cooling, district steam, district hot water, district geothermal, district geoexchange, and other effective technologies will be set by CTED based upon the effectiveness of the system and incentive models established for CHP[7].

Eligible District Water projects: Projects that demonstrate a total potable water demand reduction of a minimum of 55% for the district relative to a baseline code model would be eligible, based upon a tiered approach, for incentives based on efficiency as follows:

- Projects that have a projected total overall potable water reduction between 55-59% would be eligible for 50% of the available tax credits or exemptions.
- Projects that have a projected total overall potable water reduction between 60 and 64% would be eligible for 75% of the available tax credits or exemptions.
- Projects that have a projected total overall potable water reduction above 65% would be eligible for 100% of the available tax credits or exemptions[8].

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[6] A report by the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) characterizes overall system efficiency of gas turbine-based CHP systems as ranging from 65-72%. See table on page 19 of the document at http://www.eea-inc.com/dgchp_reports/TechCharNREL.pdf. The IWG did not reach full agreement on a level of efficiency to receive a tax exemption, with some members favoring a lower threshold in consideration of the substantial efficiency benefits of going from stand-alone energy systems to CHP, and other members emphasizing using incentives to drive implementation of higher-performance CHP systems. The IWG also considered different levels of efficiency that could qualify for a partial tax exemption, but have been advised that a partial exemption from sales and use taxes, at any rate, would be very difficult to administer. The 70 percent threshold shown here reflects a relatively high threshold in consideration of a goal of modest revenue impacts. That is, the 70 percent efficiency threshold takes into account that only limited incentives will likely be practical, at least in the initial years of a program. The efficiency threshold should be more fully evaluated.

[7] There is some disagreement over the definitions of alternative energy/bioenergy with respect to organic byproducts of the pulping process. This definition may affect eligibility for incentives, to the extent that eligibility as ultimately defined by CTED includes an alternative fuels criterion. IWG members have expressed differing points of view as to whether the organic byproducts of the pulping process should be defined as alternative energy/bioenergy.

[8] Please note that the application of tax credits/exemptions to water use reduction projects has not been fully considered by the IWG as a whole.

## BASIS FOR SELECTION:

Greenhouse Gas Reduction Opportunity – CHP efficiencies—the rate of conversion of fuel energy to electricity plus useful heat—ranges from 60% on the low end to 85% on the high end. This is in stark contrast to standalone fossil energy power plants (fueled principally with coal and natural gas) that have efficiencies historically in the range of 30% to 36%. It is the double or triple use of the energy that gives CHP the extra efficiency boost. This makes CHP (even natural gas-based CHP) a greenhouse gas winner. See the ES-7 strategy the chart on page 47 of "Leading the Way on Climate Change: The Challenge of Our Time". ES-7 is CHP http://www.ecy.wa.gov/climatechange/interimreport.htm. In Washington State, most CHP projects are biopower/opportunity fuels-based. This further intensifies the greenhouse gas win, since the initial fuels used for CHP produce low or no GHG emissions when burned.

CHP Potential in Washington – A 2004 report done by Energy and Environmental Analysis titled Combined Heat and Power in the Pacific Northwest: Market Assessment showed the technical market potential for CHP in Washington to be 7,721 MWc. See page 52 of the study http://www.chpcenternw.org/NwChpDocs/Chp_Market-Assessment_In_PNW_EEA_08_2004.pdf. Tapping waste heat sources for power production would provide additional CHP opportunities not specified in this report. This same report also analyzed the major environmental benefits of CHP, including reduced $NO_x$, $SO_x$ and $CO_2$ emissions (see pages 73-75).

District cooling, district steam, district hot water, district geothermal, district geoexchange, and other effective technologies for greenhouse gas emissions reduction in Washington will be evaluated by CTED.

## IMPLEMENTATION APPROACH AND MECHANISMS:

Additional details on the approach for implementation of this option, and integration of incentive approaches for CHP and distributed energy and water systems with incentive approaches for building energy efficiency improvement, are under development.

### *Potential Barriers to Implementation, and Approaches to Address Them*

No significant CHP capacity has been built in Washington during the past 15 years due to a number of important economic and policy barriers that need to be overcome:

- Ability to Dispatch Technology: control of the operation of a CHP plant by the utility that operates the grid that the plant is connected to can be a concern for the plant owner. Mutually agreeable dispatch protocols should be negotiated between the plant owner and the host utility.
- Compliance with Grid Interconnection Standards: Washington State could seek to influence and streamline grid interconnection standards and associated costs, where applicable. Standards are set be FERC and NERC rather than the State.
- High Transaction costs Associated with CHP Projects: CHP and distributed energy projects sometimes face high financing costs because of lender unfamiliarity and perceived risk,
- "Split Incentives": Split incentives between building owners and tenants, and utility-related policies like interconnection requirement, high standby rates, exit fees, etc, act as barriers to CHP/distributed energy system development.
- Lack of Financial Incentives to Pursue CHP/Distributed Energy: Consistent, long-term, clear incentives supporting CHP, waste energy recovery, and other distributed energy systems have been largely lacking to date. The proposals above help to address these needs.
- Potential Regulated Utility Barriers restricting the creation of Mico-Utilities.
- Potential localized regulatory barriers at the county or municipal level.

- Potential regulatory barriers or constraints complicating use of natural deep water cooling.
- Potential water law and health code barriers tied to neighborhood, district, and campus rainwater capture, grey water and black water systems.
- Low electricity rates compared with many other parts of the United States.

## SUPPORTING INFORMATION:

***Interaction of CHP/Distributed Energy Systems with Market-based Regulatory Systems for GHG Emissions***

CHP has been recognized in programs such as those developed by RGGI (Regional Greenhouse Gas Initiative, a collaborative effort by 10 Northeastern and Mid-Atlantic states), and by Alberta, and is now being discussed within the WCI (Western Climate Initiative) cap-and-trade design. There are several potential approaches on CHP and similar technologies might be handled in a market-based system. One approach would be for CHP projects to be awarded allowances or auction proceeds for the projects' avoided emissions. Another option would be simply to exempt existing CHP facilities/projects from emissions limits, and to allow for new CHP facilities/projects to quality for offset credits. Whatever approach is adopted in a market-based system with respect to CHP, the approach should reward/provide incentive for CHP, and seek to avoid inadvertently penalizing CHP systems.

***GHG Reduction Potential***

By recovering waste heat and reusing it through combined heat and power systems (or through using waste heat directly for generation), an equivalent amount of new fossil-based energy can be displaced, resulting in a more energy efficient production of energy services and significantly less GHG production per unit of electricity generated/heat delivered. District heating and/or cooling systems offer the opportunity to provide many users from the same source of thermal energy, including in conjunction with CHP systems. District water systems offer the opportunity to reduce pumping and water treatment energy use as water use efficiency is improved and water is re-used.

To date, analysis of the costs and benefits of this Action have focused on combined heat and power systems. A summary of the results of analysis to-date, and a listing of key inputs, is provided below. The table the follows includes:

- A row listing the benefits and costs of implementing CHP systems in Washington at rates of between 2 and 3 percent annually of estimated "Economic Potential with Accelerated Case Assumptions"[9] [10]; and
- A row showing the benefits and costs of implementing combined heat and power systems that would receive exemptions from the Sales Tax/Use Tax based on the policy outlined above. Key assumptions here are that 50 percent of CHP systems developed (at a 2-3%/year rate of implementation) achieve high enough efficiencies to qualify for tax exemptions, that 100 percent of qualifying commercial CHP systems receive exemptions, and that 10 percent of qualifying industrial systems receive exemptions under this program. Note that investments in most industrial CHP systems **already** qualify for the existing "Manufacturing Machinery and Equipment Sales Tax and Use Tax Exemption", so long as most of the power produced is consumed in the manufacturing facility in which it is located. Based on these

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[9] From Combined Heat and Power in the Pacific Northwest: Market Assessment: Task 1 - Final Report., Submitted to Oak Ridge National Laboratory by Energy and Environmental Analysis, Inc., and dated August, 2004. This report can be found at: http://www.chpcenternw.org/NwChpDocs/Chp_Market-Assessment_In_PNW_EEA_08_2004.pdf. "Accelerated Case" assumptions include 2020 cost and performance specifications (somewhat lower costs in 2020 than in 2004), no stand-by charges, and financial incentives equal to about 15% of capital costs.

[10] Note that this assumption is similar, but not identical to, the level of CHP system implementation that was used in evaluating the cost and savings from development of CHP systems during the Fall 2007 Climate Advisory Team process. Other assumptions used in that analysis have been updated, producing somewhat different results than were found during the earlier analysis.

participation assumptions, the total volume of tax exemptions claimed in 2012 would be just over $1.0 million.

**Summary Results of Analysis for Action EE/GB-1B**

| EE/GB | Action | GHG Emission Reductions ($MMTCO_2e$) | | | | NPV (2008-2020) ($ Million) | Cost Effectiveness ($\$/tCO_2$) |
|---|---|---|---|---|---|---|---|
| | | 2012 | 2020 | Cumulative (2008-2020) | Location | | |
| Action 1B | Expanded Implementation of Distributed Energy & Water, Combined Heat & Power (CHP) and Renewable Energy | 0.3 | 1.4 | 7.5 | In-state / regional | -$72 million | -$10 |
| | Systems Covered by Expanded Sales and Use Tax Exemption | 0.1 | 0.3 | 1.6 | In-state / regional | -$4.6 million | -$3 |

Additional results of and inputs to this option can be found in the Annex to this document.

***Key Inputs/Assumption for Analysis of Action EE/GB-1B***

- Levelized Electricity Avoided Cost: $66/MWh
- Levelized Natural Gas Avoided Cost (used both for gas savings and costs): $7.6/MMBtu
- State Element Sales and Use Tax (% of purchase cost): 6.50%
- 94% of the capacity of systems implemented is fueled with natural gas, with the remainder biomass-fired.
- Usable cogenerated heat is 40 percent of the total energy input to CHP systems.
- Useful heat from CHP systems displaces 90% gas heat/steam, and 10% electric heat/steam.

*Costs/Cost Savings*

The analysis above suggests that the people of the State of Washington will save about $72 million from 2008 through 2020, on a net present value basis, by implementing CHP systems at the levels shown.

*Other Benefits*

In addition to reductions in greenhouse gas emissions, combined heat and power and distributed/district energy systems for which incentives are provided under this Action reduce (in many cases) the emissions of non-GHG air pollutants, can result in reduced water use, and can increase the use of in-state renewable fuels while reducing the consumption of imported fossil fuels. District energy systems can also play a role in promoting compact development to reduce transportation requirements.

***Interaction with Ongoing GHG Emissions Reduction Programs in Washington***

Programs developed in compliance with I-937 get double credit for CHP projects that qualify as distributed generation of under 5 MW of capacity.

# EE/GB ACTION 2: ENERGY EFFICIENCY, ENERGY BENCHMARKING AND ENERGY PERFORMANCE DISCLOSURE IN EXISTING, NEW AND RENOVATED BUILDINGS

## EE/GB ACTION 2A: ENERGY EFFICIENCY IN EXISTING, NEW AND RENOVATED PUBLIC BUILDINGS

### 2009 ACTION DESCRIPTION:

***Background***

The overall effort involves all of the public sector. It includes existing buildings, major renovations and new construction. It would include state agencies, universities, colleges, school districts and local governments. Education and promotion of the program are critical components to the success of the program. Implementation will emphasize the use of existing programs and funding from federal, state and local governments.

Partnering with US EPA's ENERGY STAR program is critical and has been initiated. The ENERGY STAR program is poised to help, for the most part, at no cost. Reporting will be through ENERGY STAR and the US Green Building Council (USGBC).

Affected state agencies will report activity to OFM, but for schools, universities, colleges and local governments will report internally and publicly. Energy performance of all buildings will be posted to a highly publicized web site. It is this program transparency and activating of stakeholders and constituents with information and awareness that will becomes the "carrot and stick" the program needs for success.

The program relies upon the well-established ENERGY STAR and US Green Building Council LEED programs for some level of training, third party verification, and reporting that will be accessible to the public. Additional training will also be coordinated by GA, Dept. of Ecology, and WSU Extension – Energy Programs.

Public entities affected by this proposal are encouraged to make operational refinements to improve the ENERGY STAR score of their buildings prior to the July 2010 target date and thereafter. These operational refinements should include scheduling equipment operation to coincide with occupancy and emphasis on energy efficient occupant behavior.

It is recommended that entities affected by this proposal that manage over 1,000,000 SF of conditioned building space consider the implementation of a Resource Conservation Management (RCM) program using dedicated staff. Energy utility(s) may provide financial support and technical assistance for an RCM program. Technical assistance will also be available through the WSU Extension – Energy Programs.

**PROPOSED LEGISLATION DETAIL**

**<u>Section A: Definitions</u>**

**Architecture 2030.** A non-profit, non-partisan and independent organization, Architecture 2030 was established in response to the global-warming crisis. It refers to an energy performance standard that uses the Energy Star commercial buildings program.

**Benchmark.** The energy used by a building as recorded monthly for at least one year. The building energy use and the building characteristics information are required inputs for ENERGY STAR's Portfolio Manager. Buildings on a campus served by a central plant or centralized metering can develop a prorated benchmark for the buildings served by the central plant.

**Conditioned and Occupied Building.** A building that is occupied more than 30 hours per week, on average, and meeting the definition of a Conditioned Space in the Washington State Energy Code.

**Cost-effective.** Energy conservation measures means energy conservation measures that the investment grade audit concludes will generate savings sufficient to finance project loans of not more than ten years.

**Department.** Refers to the Department of General Administration.

**ENERGY STAR score.** The score provided by the ENERGY STAR program, which indicates the energy efficiency performance of a building compared to similar buildings in the same climate zone. ENERGY STAR is a nationally recognized EPA building energy rating system that is also used by LEED – EB O&M and Architecture 2030 as the energy performance metric. Unrated building types will develop a benchmark using guidance and principles from the ENERGY STAR and LEED EB programs. The department will recommend methods to establish benchmarks for unrated buildings.

**Investment grade energy audit.** A detailed building audit prepared by an Energy Service Company pre-selected by the department in an open public selection process, to provide an energy savings proposal that will guarantee first cost and savings of the energy measures identified. The proposed measures must meet the customer's cost effectiveness criteria or the investment grade audit is free.

**LEED – EB O&M.** Refers to Leadership in Energy and Environmental Design – Existing Buildings Operations & Maintenance as developed by the United States Green Building Council.

**LEED – NC Gold.** Refers to Leadership in Energy and Environmental Design – New Construction. Gold is a level of performance within the LEED Green Building Rating System.

**MACC.** The maximum allowable construction cost.

**Preliminary energy audit.** A quick evaluation by an Energy Service Company or other qualified building auditor of the energy savings potential of a building. This is a free service through the department's Energy Savings Performance Contracting program.

**Resource Conservation Management program.** A program focused on tracking and conserving energy and water to save on expenses.

**Section B: Existing Public Buildings**

***Part 1: State agencies, colleges, universities and school districts***

1. By July 1, 2010 each state agency, college, university and school district shall create an energy benchmark for each conditioned and occupied building over 10,000 square feet using the US EPA's ENERGY STAR Portfolio Manager program.
2. This baseline information will be posted on the ENERGY STAR website or other site as determined by Dept. of Ecology and will be open to public review.
3. For each building with an ENERGY STAR score below 50, state agencies, colleges, universities and school districts shall undertake a preliminary energy audit by July 1, 2011. Department of General Administration's Energy Performance Contracting program can provide the necessary technical assistance to meet this requirement.
4. If potential cost effective energy savings are identified, an investment grade energy audit must be completed by July 1, 2012.
5. Cost-effective energy conservation measures identified in the investment grade energy audit must be implemented by July 1, 2015.
6. All buildings under this section will be required to maintain an ENERGY STAR score of greater than 75 after October 1, 2016. Quarterly inputs are required to keep the Energy Star score current.
7. The ENERGY STAR score will be posted for public review at a site determined by Dept. of

Ecology.

8. (a) By October 1, 2016 all state agency, college, university and school district owned buildings over 50,000 SF under this section will be certified to LEED – EB O&M Silver or equivalent system as determined by the department, and will be re-certified every 5 years.

   (b) All buildings over 50,000 SF covered by this section must achieve the following standards:

   i) ENERGY STAR score of 75 or better.

   ii) LEED-EB–OM: WE credit 2 Indoor Plumbing Fixture and Fitting Efficiency (or an equivalent standard as determined by the Department) – 1 point.

   iii) LEED-EB-OM: WE credit 3 Water Efficient Landscaping (or an equivalent standard as determined by the Department) – 1 point.

   iv) LEED-EB-OM: MR credit 7 Solid Waste Management: Ongoing Consumables (or an equivalent standard as determined by the Department) – 3 points

   (c) These standards will be evaluated for update by guideline by the department in consultation with a committee of affected agencies in 2016 and every 4 years following.

9. Buildings planned for demolition or major renovation by July 1, 2015 are exempt from the requirement to undertake a preliminary energy audit and subsequent energy audits and energy measure implementation.

10. New buildings will be required to comply with the Existing Public Buildings requirements 3 years after occupancy.

11. By July 1, 2011 each conditioned and occupied leased building over 20,000 square feet occupied entirely by a state agency, college, university and school district shall create an energy benchmark using the US EPA's ENERGY STAR Portfolio Manager program.

12. This benchmark information will be posted on the ENERGY STAR website or other site as determined by Dept. of Ecology and will be open to public review.

13. All conditioned and occupied leased buildings over 20,000 SF occupied entirely by a state agency, university or school district must achieve an ENERGY STAR score of 75 or better by October 1, 2016.

14. Buildings that have lease agreements that predate this statute will be exempt, however, any new lease or lease renewal must comply within 15 months of the new lease inception.

***Part 2: Cities, Counties, and other Public Taxing Authorities***

The provisions are the same for buildings owned and leased by cities, counties and other public taxing authorities as in Section B (Part 1), *except* the following timelines are extended:

1. By July 1, 2011 each city, county, and other public taxing authority shall create an energy benchmark for each owned conditioned and occupied building over 10,000 square feet using the US EPA's ENERGY STAR Portfolio Manager program.

2. For each publicly owned building with an ENERGY STAR score below 50, each city, county, and other public taxing authority shall undertake a preliminary energy audit by July 1, 2012. The Department of General Administration's Energy Performance Contracting program can provide the necessary technical assistance to meet this requirement.

3. If potential cost effective energy savings are identified, an investment grade energy audit must be completed by July 1, 2014.

4. Cost-effective energy conservation measures identified in the investment grade energy

audit must be implemented by July 1, 2017.

5. All buildings under this section will be required to maintain an ENERGY STAR score of greater than 75 after October 1, 2018
6. By October 1, 2018 all buildings over 50,000 SF under this section will be certified to LEED – EB O&M Silver or equivalent system as determined by the department, and will be re-certified every 5 years.
7. The initial energy benchmarking efforts will be the responsibility of the local jurisdictions. This is good building operating practices and will help the owners identify buildings with savings opportunities. It would also help to identify no cost and low cost measures. The cost of a preliminary audit and investment grade audit, if working through the Dept. of General Administration's Energy Savings Performance Contracting (ESPC) program, would be zero if no cost effective measures are identified, or would be rolled into the cost of the qualified and contracted energy conservation measures identified. Utility incentives would be utilized to reduce the first cost of measures identified. The balance of the costs for implementation of the energy measures could come from low cost State Treasurer financing. Financing would be paid back from the guaranteed savings. Using this approach requires no capital outlay. The cost of the measures is completely paid off by the savings.
8. As for the cost of the LEED – EB O&M program for buildings over 50,000 SF, these would need to come from the local jurisdictions, however, savings in energy and water, and increase productivity of the workers would provide for a quick payback on costs. An estimate of the cost for documentation and submittal fees is $10,000 to $50,000 per building. Economies will be realized with multiple buildings and through a learning curve, subsequent buildings within an organization will cost less. The cost for LEED-EB O&M re-certification is relatively low.

**<u>Section C: New Construction of Public Buildings</u>**

***Part 1: State agencies, colleges, universities and school districts***

1. All occupied and conditioned buildings over 10,000 SF going into design after July 1, 2011 or after building energy code updates (for example, those proposed under Action 3) are implemented, if applicable, will be required to certify to the LEED NC Gold level or equivalent as determined by the Department. This also applies to major renovation projects where the project construction budget is over 50% of the assessed value of the building. All affected buildings must achieve the following as prerequisites:

   a) Meet "Architecture 2030" goals for energy performance.

   b) LEED-NC Water Use Reduction or an equivalent standard as determined by the Department – 2 points.

   c) LEED-NC Water Efficient Landscaping or an equivalent standard as determined by the Department – 1 point.

   d) LEED-NC Construction Waste Management or an equivalent standard as determined by the Department – 2 points.

   e) A minimum of 0.5% of the MACC must be spent on renewable energy systems as defined under LEED (or under an equivalent standard as determined by the Department).

***Part 2) Cities, Counties, and other Public Taxing Authorities***

1. (a) By July 2011, local governments state-wide shall adopt rules that are at least compliant with this section.

   (b) All occupied and conditioned buildings over 10,000 SF going into design after July 1, 2013 will be required to certify to the LEED NC Gold level or an equivalent standard as determined by the Department.

2. The LEED NC Gold requirement also applies to major renovation projects where the project construction budget is over 50% of the assessed value of the building. All affected buildings must achieve the following as prerequisites:

    a) Meet "Architecture 2030" goals for energy performance.

    b) LEED-NC Water Use Reduction or an equivalent standard as determined by the Department – 2 points.

    c) LEED-NC Water Efficient Landscaping or an equivalent standard as determined by the Department – 1 point.

    d) LEED-NC Construction Waste Mgt or an equivalent standard as determined by the Department. – 2 points.

    e) A minimum of 0.5% of the MACC must be spent on renewable energy systems as defined under LEED (or under an equivalent standard as determined by the Department).

3. As a point of reference for considering the cost impacts of these actions, the added cost to implement LEED NC Gold (or equivalent standards) for jurisdictions that have no such requirements is estimated to be about 2.7% of construction costs[11]. For jurisdictions that already require LEED NC Silver or an equivalent standard, the costs should be 0% to 1% of construction costs[12].

### PROCEDURAL AND ADMINISTRATIVE PROVISIONS AND REQUIREMENTS

It is recommended that this proposal be implemented through legislative action. As currently proposed, it is consistent with the Governor's new Executive Order on Sustainability (expected to be released in fall 2008). An Executive Order alone could achieve a portion of the desired emission reductions; however, the extent of the impacts would be far less since the Order is only binding on the state's executive branch agencies which report to the Governor.

Many existing programs will be utilized to implement this recommendation: the department, Dept. of Ecology, ENERGY STAR, US Green Building Council's LEED program, WSU Extension-Energy Programs, NEEC (Northwest Energy Efficiency Council), and electric and gas utility conservation programs.

The Departments of General Administration (GA) and the Ecology will work closely with the Association of Washington Cities and Washington State Association of Counties to provide information and training designed to assist local jurisdictions in the implementation of this statue.

Currently the Dept. of General Administration is responsible for tracking and administration of new construction/major renovations of state and higher education LEED projects. This would remain in place. For the existing buildings, format for reporting will be established by a stake-holder group facilitated by the department (GA). Annual reporting by state agencies will be submitted to OFM. School districts and local governments will be responsible for administration of their own data through a web site identified by Dept. of Ecology.

Costs of implementation for existing buildings below 50,000 SF would be minimal. Energy savings will pay for improvements. There will be some administration related to energy data collection and interaction with the ENERGY STAR website, and if energy savings potential exists, administration of energy performance contracts with

[11] Davis Langston Adamson, Costing Green: A Comprehensive Cost Database and Budgeting Methodology, 2004.
[12] Ultimately, the net cost of meeting public building energy performance standards will also depend on the efficiency level required in building energy codes such as those proposed in Action 3.

the Department would be needed. Often this expertise exists within public organizations and can be absorbed by current staff.

Cost of implementation for existing buildings 50,000 SF and higher to achieve LEED-EB O&M Silver would range from $10,000 to $50,000 per building. Economies will be realized with multiple buildings and through a learning curve, subsequent buildings within an organization will cost less. Some costs to achieve LEED-EB O&M Silver could come from the energy performance contracting activities. Cost savings from energy, water and recycling efforts will off-set the costs to achieve LEED-EB O&M Silver over time. Support from utilities may be possible though incentives and/or a reimbursement program.

The added cost for new construction to achieve LEED Gold may only be on the order of 0% to 1% of the MACC (Maximum Allowable Construction Cost) for current projects that must currently meet the LEED Silver standard. The added construction cost to entities currently not building to LEED Silver may be 2.7% of the MACC.

## BASIS FOR SELECTION:

***Public Buildings Benchmarking and Efficiency Requirements***

With the 2005 passage of Chapter 39.35D RCW High-performance public buildings, Washington State stepped forward as a national leader in public sector green building projects. As the mandate has seen implementation, areas that can increase the energy-conserving attributes of these buildings have become known. This proposal aims at increasing the strength of the legislation as it currently exists, ensuring that green public buildings are operated and maintained in such as way as to meet the energy goals of the projects, and set the stage to address issues related to embodied energy as focus shifts to building products.

Because this proposal builds on existing legislation that has seen success, it is primarily a revision to a statute with agency and public momentum. This proposal will ensure that public buildings (new/renovated) prioritize energy efficiency credits offered in green building standards and help to build the market for regionally produced green building materials.

## PROJECTED EMISSION REDUCTIONS

Emission reductions in existing buildings when buildings reach the ENERGY STAR level of 75 will result in an average reduction in $CO_2$ of 20% to 25%. This would be further reduced as buildings continue to maintain an ENERGY STAR level of 75, because the overall energy use of the population of buildings included in the ENERGY STAR database will decline, thus “raising the bar” for all buildings. As older buildings are replaced with new efficient buildings, this too will raise the average energy efficiency of the building stock as a whole.

LEED Gold projects for new construction and major renovations require $CO_2$ reductions of 60% by 2010 when replacing an average building. The $CO_2$ reduction target would increase because the Optimize Energy credit within LEED would be tied to Architecture 2030 goals, which call for Net Zero carbon buildings by 2030.

As the Washington economy grows the overall number of buildings will increase and so will overall square footage of buildings. It is for this reason that the Architecture 2030 goals must be met to achieve the reductions we seek.

**Summary Results of Analysis for Action EE/GB-2A**

| EE/GB | Action | GHG Emission Reductions ($MMTCO_2e$) | | | | NPV (2008-2020) ($ Million) | Cost Effectiveness ($/$tCO_2$) |
|---|---|---|---|---|---|---|---|
| | | 2012 | 2020 | Cumulative (2008-2020) | Location | | |
| Action 2 | Energy Efficiency in Existing, New and Renovated Public Buildings | 0.2 | 1.2 | 6.8 | In-state / regional | -$222 million | -$33 |

***Key Inputs/Assumption for Analysis of Action EE/GB-2A***

New and Existing Buildings

- Levelized Cost of Electricity Savings: $32/MWh
- Levelized Cost of Natural Gas Savings: $6.6/MMBtu
- Fraction of statewide commercial space owned or leased by the State, Universities, or Schools: 18%
- Fraction of existing space owned or leased by the State, Universities, or Schools in buildings of greater than 10,000 square feet: 80%
- Fraction of statewide commercial space in other public buildings: 5%
- Fraction of space in other public buildings that are greater than 10,000 square feet: 80%
- Fraction of statewide residential units publicly-owned: 5% (included in action)

<u>Existing Buildings</u>

- Average Electricity and Gas Savings for Buildings Participating in Program (existing commercial and residential buildings): 20% by 2012, 25% by 2020
- Average annual ongoing efficiency improvement in existing public buildings following "ramp-up": 1%/yr

<u>New Buildings</u>

- Fraction of new qualifying public buildings participating in program through target dates: 100%
- Fraction of new public housing units included in program: 80%
- Annual reduction in energy use relative to 2005 existing buildings (for all building types, including public housing), based on Architecture 2030 goals: 64% by 2012, 80% by 2020[13] (note that this is gross target savings, but Action 2 is applied after Action 3—building codes—so savings attributed to Action 2 are less on a net basis)
- Ratio of substantially renovated public building space (also covered under program) to new public building space: 1.00 (implies renovated space is approximately equal to new space)
- Average Fraction of Improvement in Electric Energy Intensities for Public (non-residential) Buildings from different sources are as follows:

| | 2012 | 2020/all |
|---|---|---|
| Energy Efficiency Improvement | 90% | 85% |
| Solar Thermal Energy (hot water/space heat/space cooling) | 3% | 5% |
| On-site Solar PV | 1% | 2% |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 1% | 3% |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | 5% | 5% |

See Annex for additional details of results of and inputs to the analyses of this option.

## IMPLEMENTATION APPROACH AND MECHANISMS:

**Draft legislation** will be prepared for the 2009 Legislative Session by **November 15, 2008**. The legislative text will be completed by a team consisting of: Rachael Jamison (Department of Ecology), Stuart Simpson (Department of General Administration), Ash Awad (McKinstry), David Van Holde (King County), Tony Usibelli (CTED), Becky Kelly (Washington Environmental Council).

[13] For quantification of emission reductions annual reduction in new buildings energy use relative to 2005 existing buildings has been based on goals outlined in EE/GB Action 2A. It is expected that annual reduction in actual implementation may be much less.

***Potential Barriers:***

The primary critique of the state's existing green building mandate is its lack of additional funding to ensure compliance. By revising the mandate to require a higher level of certification with currently optional credits made mandatory, agencies may have difficulty supporting the legislation due to its potential fiscal impacts and need for additional resources (education/staff/etc.). The lack of funding for energy efficiency measures can be overcome, however, by conservation requirements in the Energy Independence Act, I-937 and use of the department's Energy Performance Contracting program.

Quantification of emission reductions for this action is based on goals outlined in EE/GB Action 2A. These goals are very ambitious, will require significant effort and commitment, and may prove difficult for implementation strategies to achieve. They require that a substantial percentage of the existing public buildings in Washington receive significant efficiency upgrades in each year, and that each new building covered by this Action be built to very high standards of energy efficiency. Doing so will require a comprehensive and sustained effort on the part of public entities in Washington (as well as the building industry) to provide the human capacity to carry out these improvements, and, though efficient buildings will ultimately result in significant cost savings, to provide the initial financing to make sure that the improvements can be undertaken. If these conditions are not met the penetration rates, energy savings, and consequently, the emission reductions could fall well short of projected levels.

***Program Costs:***

Existing programs will be utilized as much as possible, however, it is recommended that a professional level staff person be provided to each of the following agencies: Dept. of Ecology (for local governments), Dept. of General Administration (for State agencies, colleges and universities), and Office of the Superintendent of Public Instruction (for K-12 Schools). This is needed to implement these efforts across all public sector entities.

## EE/GB ACTION 2B: ENERGY BENCHMARKING AND ENERGY PERFORMANCE DISCLOSURE IN PRIVATE BUILDINGS

To inform potential building buyers and users, a system of Energy Performance Certificates (EPCs) should be developed and implemented in Washington. The EPCs would include a rating system that reflects the energy use, greenhouse gas emissions (and potentially water use) performance of a building compared against Washington State Energy Code-compliant buildings, and provide a defensible and clear measurement of the environmental footprint of new and existing buildings in the State.

EPCs disclose energy and other environmental performance information for buildings, providing consumers with a "right to know" mechanism to raise awareness of the importance of energy performance to the total cost of ownership or occupation of a building at the time of sale or lease.

### PART 1: DISCLOSURE REQUIREMENT FOR ENERGY PERFORMANCE OF PRIVATE NON-RESIDENTIAL AND LARGE MULTI-FAMILY RESIDENTIAL BUILDINGS

Legislation is recommended in 2009 that requires non-residential and large multi-family residential building owners to develop an energy benchmark score using the ENERGY STAR Portfolio Manager tool or an alternative equivalent benchmark process as determined by CTED. The benchmark score will be included as part of the Energy Performance Certificate for the building. Building owners would be required to disclose this benchmark information at point of sale to prospective buyers. This benchmark score would also be disclosed to potential lessees when an entire building is being offered for lease to that prospective tenant.

To facilitate the transition to this disclosure requirement, it is further recommended that the benchmark requirement be phased in over time. Buildings 100,000 square feet or more would comply by January 2010. All buildings over 50,000 square feet would comply after January 2011. Buildings that are 20,000 square feet and larger would comply after January 2012. Buildings under 20,000 square feet would be exempt from this requirement.

In addition, electric and natural gas utilities in the state with 100,000 customers or more would be required to provide their billing data in a form compatible with automatic download to Portfolio Manager. ENERGY STAR already offers this automatic download feature to utilities in its tool and qualifying Washington utilities would provide this feature to customers by January 2010. Specific requirements should be patterned after California's AB 1103 legislation. Additionally, data formats should also be compatible with existing benchmarking efforts by institutions and commercial businesses.

Revenue effects: No substantial state revenue effects are anticipated by this action.

### PART 2: DISCLOSURE REQUIREMENT FOR ENERGY PERFORMANCE OF PRIVATE SINGLE-FAMILY AND SMALL MULTI-FAMILY RESIDENTIAL BUILDINGS

For residential buildings, a new EPC specification needs to be developed. A pilot program funded by the Energy Trust of Oregon (ETO), and supported by the Northwest Energy Efficiency Alliance and the City of Portland is currently underway to develop and test the EPC for residential dwellings in Oregon. This pilot program may serve as a model for development of a residential EPC program in Washington.

It is recommended that an entity (for example, CTED, the Department of Ecology, or another appropriate entity) be designated to develop an EPC specification for residential units (single-family residential and small multi-family buildings) by Dec 31, 2009. Specifically, the entity will:

- Review the findings of the 2008 ETO EPC pilot as part of the EPC specification development.
- Analyze the cost and implementation impacts of the 2008 ETO EPC pilot.
- Recommend a structure to support a voluntary, incentive-based program. The entity to recommend what thresholds of adoption need to be realized in the voluntary period before the initiative moves into 2011.
- Recommend public outreach and education initiatives to ensure smooth deployment of the EPC program.
- Implement a pilot program using the recommendations to refine a voluntary implementation incentive program to test the implementation of an EPC program starting Jan 1, 2010.

Provided that the performance criteria in the voluntary period have been met:

- All new dwellings will carry an EPC beginning Jan. 2011.
- All existing dwellings will carry an EPC at time of sale or lease beginning Jan 2012.
- The designated entity directed to develop minimum EPC performance levels that align with state building codes, and energy efficiency and Greenhouse Gas reduction goals, beginning Jan 2015.

Revenue effects: No substantial state revenue effects are anticipated by this action, but fiscal impacts to the state would occur in three areas: covering the EPC audit cost, administrative costs of archiving EPC data in a registry, and providing training to boost the EPC delivery infrastructure.[14]

### BASIS FOR SELECTION:

***Implementation of Disclosure Requirements***

Introduction of the residential EPC will do the following:

[14] By way of comparison, information from the Energy Trust of Oregon EPC pilot project indicates that the cost of having an EPC audit assessment available for Oregon homes that participate will be in the range of $600 to $900 per home using current methodologies. The intent of the pilot is to explore ways to reduce time spent conducting the audit and the cost of the EPC audit. The ideal EPC audit target price is in the $150 - $225 range.

- Allow measurement of the carbon impact of new and existing housing stock.
- Provide a valuable guide to consumers, including an easy means of comparison of energy use and carbon impacts between homes under consideration for purchase or lease.
- Provide a concise performance ranking tool for a homeowner/buyer who is unfamiliar with the multitude of green building brands in the current market.
- Stimulate improvement of EPC scores for homeowners seeking higher resale values.
- Reflect the improved performance of homes receiving energy efficiency remodels.
- Stimulate mortgages; refinance packages, and homeowner insurance that are favorable to purchase of those homes with higher performing EPCs.
- Link public-purpose incentives to higher performing EPC scores.
- Allow the EPC rating to be listed on the Multiple Listing Service databases alongside a property listing.
- Allow high performance home builders to showcase their products and inventory with high scoring EPCs.
- Stimulate technology investment in smart technologies and materials that improve EPC scores.
- Promote green collar job development in the building trades.
- Enable prospective rental tenants to know ahead of time the likely size of their utility bills based on the availability of the EPC.
- Provide a tool that can guide minimum performance scores over time, in concert with Washington's climate goals (for example, those described in EE/GB Action 3) and/or the Architecture 2030 Challenge. This will effectively link new and existing housing stocks to defined carbon reduction goals.
- Addresses carbon reduction in a sector not covered by the current proposed WCI (Western Climate Initiative) Cap and Trade structure.
- Assuming that a massive infusion of funds was procured for the state (through the proceeds of a Cap and Trade allowances auction, for example, or another source) investments made in upgrading the existing housing stock (which could be up $50,000 per home) would be reflected by the issuance of EPCs.
- The universally understood 'MPG' for automobiles will be replicated for a homes' 'EPC' performance.

Many of these attributes are also shared by non-residential EPCs.

## PROJECTED EMISSION REDUCTIONS:

EE/GB IWG Action 2B is not designed to specifically produce emission reductions and has therefore not been quantified. Prior experience, however, indicates that additional information for building owners and managers regarding energy usage can improve management and lead to lower energy consumption.

## IMPLEMENTATION APPROACH AND MECHANISMS:

***Potential Barriers:***

Considerations related to how requirements for private building point-of-sale or point-of-lease EPC requirements are structured, including (but not limited to) how energy efficiency performance of a building (and thus qualification for EPC) may be affected by tenant behavior, suggest that Action 2B will need to be carefully designed and implemented with input from appropriate stakeholders. Concern has been raised that there may be opposition to establishing point of sale energy disclosure requirements. Comments received by the CAT via its public website noted opposition to point–of-sale disclosure requirements that would broaden the seller disclosure law beyond current requirements that is be based on the seller's existing knowledge.

**Program Costs:** No substantial state revenue effects are anticipated for EPCs for private non-residential and large multi-family residential buildings or for single-family and small multi-family residential buildings. However, some fiscal impacts to the state would occur in three areas for single-family and small multi-family residential buildings: covering the EPC audit cost, administrative costs of archiving EPC data in a registry, and providing training to boost the EPC delivery infrastructure.

***Training and Infrastructure Needs for EPC Element of Action:***

Training of Home Performance with Energy Star contractors, Home Energy Rating System (HERS) raters, and other performance contractors will need to be delivered across the state. Training techniques used during the EPC pilot program in Oregon can be used as a resource in developing Washington's EPC program.

### SUPPORTING INFORMATION:

***Implementation Goals and Experience in Using Residential Energy Performance Certificates***

According to the Pew Center's "Agenda for Climate Action," emissions can be addressed through labeling and expanded, tightened standards for products and buildings, focusing on those that would result in significant GHG reductions through reduced energy use. By requiring a minimal level of efficiency and providing consumers with information on homes that do better than the minimum, standards and labeling can overcome obstacles to building energy efficiency—insufficient and imperfect information; market distortions; and split incentives—and thus advance building efficiency.

In this regard, much work has been done in the area of bringing a labeling performance metric to the residential market in the United Kingdom. The new label released for implementation in August of 2007 is called an Energy Performance Certificate (EPC). Energy Performance Certificates, which rate the energy efficiency and carbon ($CO_2$) emissions impact of buildings (including residential), are part of the Home Information Packs (HIP) that the U.K. Government is promoting.

Energy Performance Certificates describe how energy-efficient a home is on a scale, and informs on the impact the home has on the environment. The most efficient homes have the lowest utility bills, and better-rated homes should have less carbon dioxide ($CO_2$) emission impact. The EPC is also accompanied by a list of recommended measures that will improve the EPC score, thereby saving energy and cutting carbon emissions from the home.

***Relationship of Energy Performance Certificates Concept to Western Climate Initiative Mechanisms***

The current design of the Western Climate Initiative, with its associated carbon emission reduction goals, frames the policy context in the following way: The WCI will address all capped sectors and drive emission targets. Since the residential housing sector accounts for 20% of GHG emissions, it is a worthy area of focus. Having a tool—the EPC—to track the baseline, the increased levels of energy performance, and carbon mitigation efforts will allow Washington to account for this uncapped sector and advance it in line with the state's target.

## EE/GB ACTION 3: STATE ENERGY CODE IMPROVEMENTS AND ESTABLISHMENT OF 2030 BUILDING GOALS

### 2009 ACTION DESCRIPTION:

### PART 1

In the 2009 Washington State Building Code adoption cycle, revise the Washington State Energy Code (WSEC) to achieve a 30 percent reduction in new building energy use compared to the 2006 edition of the WSEC.

***Background:***

In 2030, new buildings constructed in the preceding two decades will account for 20 to 25 percent of the commercial building floor area and will account for more than 20 percent of the housing units. Over the same 20 year period, it is expected that most existing buildings will undergo some level of renovation, install new equipment, and will add or replace many energy using devices. As a result, the effectiveness of the State Energy Code as well as federal and state equipment and appliance standards will play a large role in the future energy use intensity of all buildings. It is important to note, that it is much less expensive to implement energy efficiency in buildings during initial construction and major renovations than as stand alone measures. There will also be incentives for improvement of existing buildings as the state's large electric utilities implement conservation activities in compliance with the state Energy Independence Act.

Building codes for the State of Washington are reviewed and adopted through an administrative process conducted by the Washington State Building Code Council (SBCC). National and state-developed codes are reviewed, revised and adopted on a three-year cycle. The next review cycle begins early in 2009. Codes adopted by the council during the 2009 cycle will be implemented July 1, 2010. Under the current schedule this process will be repeated in 2012, 2015, 2018, 2021, and so on.

***Specific Actions:***

*Code Development*

Through the established administrative process, revise the Washington State Energy Code (WSEC) to achieve a 30 percent reduction in new building energy use compared to the 2006 edition of the WSEC. The administrative process will take place in 2009, with the revised code being implemented in July 2010.

The Office of the Governor is responsible for articulating the objective to SBCC, and will provide policy and administrative support consistent with obtaining the objective. Technical support shall be provided by the Department of Community, Trade, and Economic Development (CTED) Energy Policy Division.

To limit negative impacts of new building code provisions on existing structures, code development activities will make recommendations for alternative energy code provisions that may be applied to renovations and system replacement in existing buildings. Modifications to the code shall take place in the existing rulemaking process conducted by the State Building Code Council.

*Code Implementation Support to Local Government*

Technical support for local building departments and the building industry shall be provided. Through federal and utility grant programs, Washington State University Extension Energy Program (WSU) and the Northwest Energy Efficiency Council (NEEC) have historically provided training and technical support for the energy code. These activities provide training to local building department staff and professionals in the building industry. The IWG recognizes that training and technical support are important supporting activities for this implementation strategy. Initial training is needed for code changes and ongoing training is needed to maintain appropriate levels of compliance over the long term.

## PART 2

***Building Efficiency and Carbon Reduction Strategy***

Legislative action is recommended to provide policy direction in the development and implementation of a long term building energy efficiency and carbon reduction strategy. This includes setting targets for building energy efficiency and carbon reduction through 2030, providing direction to CTED to develop a state strategy for building efficiency and carbon reduction, and establishing a schedule of periodic review and revisions of the state strategy for activities involved in building efficiency research, demonstration and education programs designed to support the achievement of the Targets.

*Targets for Energy Efficiency and Carbon Reductions in the Building Sector:*

The Washington State Building Efficiency and Carbon Reduction Strategy will include specific targets for median building energy use, by building occupancy class and climate zone. For new buildings, target development will follow a schedule similar to the schedule developed the Architecture 2030 Challenge[15], but using current code levels as the starting point. By or before 2015, the target for new buildings will be 50 percent of the energy use of base code buildings built to the 2006 Washington State Energy Code (WSEC), with an incremental improvement in new building efficiency reaching net zero by 2030. Existing buildings will be improved over time to achieve a 50 percent reduction in energy use intensity (EUI) for the sector. CTED will be charged with determining the best methodology for establishing the 2009 baseline and monitoring future improvements. Sector improvements may include energy efficiency improvements, implementing innovative sustainable design strategies, generating with on-site renewable power and/or purchasing (20% maximum) renewable energy and/or certified renewable energy credits. The table, **Target Building Sector Median Energy Use Intensity (EUI),** details the targets.

**Target Building Sector Median Energy Use Intensity (EUI)**

Percent of Median 2009 EUI Building Occupancy Class and Climate Zone

| Target Year | 2009 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Existing Building Sector (2009) | 100% | 96% | 85% | 74% | 63% | 50% |
| New Building Sector (2009) | 100% | 70% | 50% | 40% | 20% | 0% |

Legislative action is recommended that directs the Washington State Building Code Council through their established public process to achieve the energy savings targets.

***What is a "net zero" energy or carbon emission building?***

A "net zero" energy building will produce as much energy as they use on an annual basis. This design criterion combines a high efficiency building with renewable on site generation, typically photovoltaic (PV) panels. On an annual basis the generation system produces enough energy to offset the annual building energy use. To cope with fluctuations in energy demand, zero energy buildings are typically envisioned as connected to the grid, exporting electricity to the grid when there is a surplus, and drawing electricity when not enough electricity is being produced. Under most cases, net zero energy will result in net zero carbon emissions.

It should be noted that the recommendation for the use of renewable resources to meet this target includes up to 20% off site power generation. Thermal and electric generation systems using bio-fuels in combined heat and power systems could also be used to meet net zero carbon emissions standards. Other technologies are expected to enter the marketplace.

***What is the Net Zero New Building Sector?***

It is recognized that given current state of the shelf technology, it will be difficult for some buildings to install the generating capacity required to power the building on an annual basis. There are also opportunities for some buildings to generate more energy than they require. For example, meeting the power needs of a one-story warehouse using rooftop PV will be easier than meeting the needs of a high rise office structure with limited roof area.[16] Providing policy direction targeting net zero energy for the new building sector allows technical development of standards that account for different building requirements and power systems, while still meeting the target for the sector as a whole.

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[15] "Architecture 2030, a non-profit, non-partisan and independent organization, was established in response to the global-warming crisis by architect Edward Mazria in 2002. 2030's mission is to rapidly transform the US and global Building Sector from the major contributor of greenhouse gas emissions to a central part of the solution to the global-warming crisis". http://www.architecture2030.org/home.html

[16] B. Griffith, N. Long, P. Torcellini, and R. Judkoff, Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector, National Renewable Energy Laboratory, 2007

*Develop a State Strategy for Building Efficiency and Carbon Reduction.*

It is recommended that the state legislature direct CTED to develop a 2010 State Strategy for Building Energy Efficiency and Carbon Reduction. CTED will develop the strategy with input from the public. The strategy will adopt the Long Term Targets for Energy Efficiency and Carbon Reductions and develop a plan to meet the targets. The state strategy will develop recommendations for a short term and a long term action plan. This plan builds on the actions already recommended by the EE/GB workgroup.

The strategic plan will examine the implementation methods for advancing building efficiency and reducing carbon emissions. In recognition that reducing energy use in buildings will include a number of administrative and legislative actions, the strategy should include examination of the interaction between the different activities to assure that actions are complementary. The scope of the strategy shall include:

**Codes and Standards**: Minimum efficiency thresholds for buildings, appliances and equipment. This includes state codes and standards as well as an examination of the state role in the development and implementation of national standards.

**Reach Codes and Standards:** A strategy for Reach Codes and Standards shall be developed to lead the base codes and standards by one or more code adoption cycles. Early adopter programs for building efficiency are an important component of a progressive energy strategy. These include voluntary standards for building efficiency, equipment, appliances and lighting. The most prevalent example is the Energy Star program. Early adopter programs assure that voluntary programs complement progress in the base codes. It also provides the building industry a context for planning future projects.

**Emerging Technologies**: Research, development, demonstration and deployment to move new energy-efficient products into the buildings marketplace. It is recognized that to meet the targets specified new technology and building designs will need to be implemented. This includes both building efficiency and building integrated power systems.

**User Incentives**: These include tax incentives, rebates, innovative or discounted financing and non-financial support to energy consumers. This includes the role of government programs as well as utility sponsored programs.

**Education and Technical Assistance**: This includes school curricula, technical training, peer-to-peer exchanges for professional and trade audiences. This may also include education and information programs for energy consumers.

**Measurement**: This includes an examination of expanding building benchmarking actions as well as program evaluation. To the extent possible the Strategy will take advantage of program evaluation conducted by utilities.

*Update the State Strategy for Building Efficiency and Carbon Reduction Every Three Years*

To assure a continued commitment to the Targets for Energy Efficiency and Carbon Reductions it is recommended that the strategic planning process be repeated at a minimum every three years. It is recommended that the revised strategy precede the state building code development and adoption process that occurs every three years. On this schedule, the first updated strategy would be available prior to May, 2012.

The Update shall include review of program activities covered in the first plan, and also include evaluation of the progress toward the targets. The update shall include recommendations for revisions in each of the above program areas. Recommendation for further action required to achieve the established targets shall be included.

## BASIS FOR SELECTION:

***Part 1.*** *In the 2009 Washington State Building Code adoption cycle, revise the Washington State Energy Code (WSEC) to achieve a 30 percent reduction in new building energy use compared to the 2006 edition of the WSEC.*

There is already recognition both in the state and at the federal level that a 30 percent is the appropriate target for improvement in both the residential and commercial building sectors. This level of efficiency is achievable and is necessary to meet the carbon reduction targets established by the Climate Action Team.

A thirty percent reduction in energy use through code has been adopted by numerous organizations as an appropriate target.

- The US Department of Energy has committed to the development and adoption of national energy codes that provide a 30 percent reduction in energy use in all building sectors. This activity is being conducted in the two primary energy code adoption processes, the International Code Conference and through the American Society of Heating, Refrigerating and Air-Conditioning Engineers, standard 90.1 code development process.
- Federal Building Code: Since 2007, federal commercial building must be designed to achieve an energy consumption level that is at least 30 percent below the level achieved under 90.1-2004, if life-cycle cost-effective.
- The ASHRAE *Advanced Energy Design Guide* series for commercial buildings provides a sensible approach to easily achieve levels of energy savings without having to resort to detailed calculations or analysis. These guides were developed to provide prescriptive standards for achieving a 30% reduction in energy use compared to the current national standard.
- Energy codes in California already implement a strategy that reduces energy use in buildings by 30 percent when compared to national standards. Oregon recently passed new residential standards that provide a 15-20 percent reduction in energy consumption for homes, and will be providing new standards that achieve 25 percent reductions in commercial energy use in 2009.
- The 2005 Federal Energy Policy Act provides $2000 tax incentives for buildings that achieve a reduction in home energy use by 50 percent compared to the national standards. Washington State's largest home builder has developed and implemented designs that achieve this level of performance.

Improvements to the state energy code are being proposed as an existing administrative process. The code will be updated through the regularly scheduled process conducted by the Washington State Building Code Council. This process will occur during 2009. Implementation of the revised code will occur on July 1, 2010.

***Part 2.*** Legislative action is recommended for the development of a State **Building Efficiency and Carbon Reduction Strategy**.

To achieve the proposed targets, it is essential to start early with substantial proposals. It is also important that the strategy be comprehensive and includes new and existing building construction, equipment, appliances as well as community heat and power systems.

In 2030, new buildings constructed in the preceding two decades will account for more than 20 percent of the commercial building floor area, and more than 20 percent to the number of housing units. Over the same 20 year period, it is expected that most buildings will undergo some level of renovation, install new equipment and will add or replace many energy using devices. The effectiveness of the State Energy Code as well as federal and state equipment and appliance standards will play a large role in the future energy use intensity of all buildings. The injection of state and utility incentives will move the existing building sector, as well as promote further innovation in new construction.

The change in the built environment occurs over time. Opportunities to capture the large efficiency improvements at a minimal cost occur only once or twice in the life of a structure. This opportunity occurs during the original design and construction of a building as well as during major renovations. Major building equipment replacements occur in a 15 to 25 year time frame. The development of community scale heat and power system occurs over long planning and implementation periods.

The implementation targets listed suggest a gradual improvement of all buildings over time. But for any specific project, it is important to achieve maximum technical potential when the prime opportunities occur.

Much of the progress in building efficiency in Washington has resulted from following a technology maturity progression that begins with research and development, moves through market entry and diffusion support efforts and culminates, where appropriate, in the adoption of common practices as minimum code requirements. Washington has been a leader in each of the elements of this progression and can take advantage of the economic development and job creation opportunity presented by additional work in these areas. Supporting university level research, participating in federal research and analysis projects, working with utilities and private sector partners within the state on market diffusion strategies and supporting effective technology transfer efforts should all be part of a comprehensive plan to continue bringing new technologies and efficiency strategies into the marketplace, into common use, and, where appropriate, into code.

## PROJECTED EMISSION REDUCTIONS:

**Summary Results of Analysis for Action EE/GB-3**

| EE/GB | Action/Element | GHG Emission Reductions (MMTCO$_2$e) | | | | NPV (2008-2020) ($ Million) | Cost Effectiveness ($/tCO$_2$) |
|---|---|---|---|---|---|---|---|
| | | 2012 | 2020 | Cumulative (2008-2020) | Location | | |
| Action 3 | State Energy Code Improvements and Establishment of 2030 Building Goals (Action Total) | 0.4 | 6.4 | 26.6 | In-state / regional | -$841 million | -$32 |
| | Part 1 of Action (WSEC Revision) | 0.35 | 2.7 | 13.8 | In-state / regional | -$487 million | -$35 |
| | Part 2 of Action (Existing Buildings Element) | 0.02 | 2.1 | 7.1 | In-state / regional | -$242 million | -$34 |
| | Part 2 of Action (New Buildings Element) | 0.02 | 1.6 | 5.6 | In-state / regional | -$112 million | -$20 |

***Key Inputs/Assumption for Analysis of Action EE/GB-3***

New and Existing Buildings

- Levelized cost of electricity savings: $32/MWh
- Levelized cost of natural gas and oil products savings: $6.6/MMBtu
- In both Parts 1 and 2, "substantially renovated" buildings are assumed to be equal in space/number to new buildings
- The elements of Action 3 in Part 2 exclude existing and new public-sector buildings and public housing covered in Action 2A.

<u>Existing Buildings—Part 2 "Building Efficiency and Carbon Reduction Strategy" Element</u>

- Average electricity and gas savings for buildings participating in program (existing commercial and residential buildings): 8.4% by 2012, 26.0% by 2020
- Fraction of existing (as of 2006) commercial and residential buildings participating in program through 2030: 75%
- "Ramp-up" period for existing building element begins in 2012, completed in 2017 (by which time ~4.5% of buildings participate annually)

New Buildings—Part 1 "Revised Building Energy Codes" Element

- Average electricity and gas savings for new residential and commercial buildings covered by revised codes, relative to 2006 WSEC: 30%

New Buildings—Part 2 "Building Efficiency and Carbon Reduction Strategy" Element

- Fraction of new residential and commercial buildings participating in program through target dates: 50% (after ramp-up which begins in 2012, and is completed by 2017).
- Annual reduction in energy use relative to revised energy code in Part 1 for new and renovated residential and commercial buildings: 8% in 2012, 30% in 2020
- Average fractions of improvement in electric energy intensities for residential and commercial buildings from different sources are as follows:

Average Fraction of Improvement in Electric Energy Intensities for commercial buildings from:

| | | |
|---|---|---|
| Energy Efficiency Improvement | 90% | 80% |
| Solar Thermal Energy (hot water/space heat/space cooling) | 3% | 7% |
| On-site Solar PV | 1% | 3% |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 1% | 5% |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | 5% | 5% |

See Annex for additional details of results of and inputs to the analyses of this option.

## IMPLEMENTATION APPROACH AND MECHANISMS:

In the 2009 Washington State Building Code revision cycle, revise the Washington State Energy Code (WSEC) to achieve a 30 percent reduction in new building energy use of compared to the 2006 edition of the WSEC. Provide substantial efficiency advances in the code as it applies to remodeling, retrofit and equipment replacement.

Through the 2009 administrative procedures of the Washington State Building Code Council (SBCC), develop and adopt advances to the Washington State Energy Code (WSEC) to achieve a 30 percent improvement in building efficiency compared to the 2006 WSEC. The Office of the Governor is responsible for articulating the objective to SBCC, and will provide political and administrative support consistent with obtaining the objective. Technical support for local building departments and the building industry shall be provided by CTED Energy Policy Division and the WSU Extension Energy Program.

## POTENTIAL BARRIERS:

A potential barrier to implementation is the lack of knowledge at the local government building departments and in the building industry. This proposed action includes a recommendation for funding to provide training and technical support for those implementing the revised code requirements. This assistance may include training workshops, supportive materials, and direct assistance through available phone technical advice. This approach has proven successful with past energy code changes. It will also be necessary to consider the impacts of new codes on the availability of incentives through utility demand-side management programs, so as to assure that implementation of the codes do not cause unintended consequences that could reduce the level of energy efficiency improvement. The targets of this Action, both in terms of the fraction of buildings included in the Action and the energy savings targets per building unit, are, as in Action 2, achievable but quite aggressive. Meeting these targets will require commitments and significant, sustained, and well-coordinated efforts on many fronts from both government and the private sector.

## SUPPORTING INFORMATION:

The following report outlines a strategy developed by the US Department of Energy for achieving Net Zero Energy Buildings in the Commercial Sector. It is important to note that not all individual buildings will meet this standard. But in the population of buildings, some will exceed net zero and offset the buildings that do not. This is in part the basis for establishing building sector median targets in the **State Building Efficiency and Carbon Reduction Strategy**.

B. Griffith, N. Long, P. Torcellini, and R. Judkoff, *Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector National Renewable Energy Laboratory*, 2007

- In this Action, expenditures by building owners and developers are expected to be more than made up for by savings in energy costs by building owners and tenants, thus reducing the overall costs of building operations for years to come, and increasing the value of the new and existing buildings covered by the Action. In addition, this Action will result in better-built and –operated buildings that require less maintenance over time. Through its impacts on energy use, the Action will reduce emissions of local and regional environmental air pollutants (in addition to greenhouse gases), reduce water use, and promote the use of in-state sources of renewable energy.

# ANNEX: Additional Details of Analyses

## Estimate of Mitigation Option Costs and Benefits for Washington EE/GB IWG GHG Analysis

## Common Assumptions for Washington EE/GB IWG GHG Analysis

*Date Last Modified:* *10/2/2008 D. Von Hippel/C. Lee*

**Common Assumptions**

| | | |
|---|---|---|
| **Real Discount Rate** | **5%** | |
| | | |
| **Levelized, Avoided Costs (2008-2020, 2006$)** | | |
| **Electricity** | **$ 66.13** | $/MWh |
| *Estimate based on Energy Supply (ES) Technical Working Group (TWG) decision (at its Nov 7, 2007 meeting), as part of the 2007 WA CAT process, based on Avista avoided cost analysis as described in ES-1 option.* | | |
| **Electricity - Residential** | **$66** | $/MWh |
| **Electricity - Commercial** | **$66** | $/MWh |
| **Electricity - Industrial** | **$66** | $/MWh |
| *Levelized Costs not differentiated by sector for this analysis.* | | |
| **Natural Gas** | **$7.6** | $/MMBtu |
| *Levelized costs, 2008 to 2020. 2005-2007 cost from EIA data for "City Gate" prices in WA (from http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_SMT_a.htm), escalated based on AEO2008 natural gas price projections (see "Fuel prices aeo2008" worksheet in this workbook).* | | |
| | | |
| **Prices** | | |
| **Electricity Price - Sales-Weighted, Levelized** | **$59** | $/MWh |
| *Prices are based on DOE data for prices in 2005 http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html. Changes from 2008 to 2020 are based on the relative changes in "Region 9" prices in US DOE Annual Energy Outlook 2008. AEO 2008 projects prices to declining to below 2006 levels from 2008 onward.* | | |
| **Electricity - Residential Prices (Levelized, 2008-2020)** | **$67** | $/MWh |
| **Electricity - Commercial Prices (Levelized, 2008-2020)** | **$62** | $/MWh |
| **Electricity - Industrial Prices (Levelized, 2008-2020)** | **$42** | $/MWh |
| **Natural Gas (Delivered, RCI sales-weighted average)** | **$11.5** | $/MMBtu |
| *Natural gas prices are estimated as described for electricity above.* | | |
| **Natural Gas - Residential Prices (Levelized, 2008-2020)** | **$13.3** | $/MMBtu |
| **Natural Gas - Commercial Prices (Levelized, 2008-2020)** | **$13.1** | $/MMBtu |
| **Natural Gas - IndustrialPrices (Levelized, 2008-2020)** | **$8.8** | $/MMBtu |
| **Biomass - All Users** | **$3.4** | $/MMBtu |
| | **$54.5** | $/dry ton |
| *Based on mix of resources (forest biomass and mill residues) as reported in the F TWG (options F-6, and F-7)* | | |
| **Coal - Industrial Users** | **$2.5** | $/MMBtu |
| *average coal heat content of 23.18 MMBTU/ton, based on USDOE/EIA data (http://www.eia.doe.gov/emeu/states/sep_use/notes/use_b.pdf). USDOE/EIA coal consumption figures for 2006 "other industrial users" are withheld for WA. A "Pacific" (West Coast) average coal price of $58.12 per ton is given for "Other Industrial Users" in http://www.eia.doe.gov/cneaf/coal/page/acr/table34.html. By contrast, the "Other Industrial Users" value for Idaho is given as $40.57 for 2006.* | | |
| **Oil - Distillate/Diesel** | **$15.4** | $/MMBtu |
| *Levelized costs, 2008 to 2020. USDOE/EIA data for wholeale distillate fuel show a cost of $1.92 per gallon in 2006/07 heating season. This cost does not include fuel taxes. An appendix to the 2006 Annual Energy Outlook by USDOE/EIA (see http://www.eia.doe.gov/oiaf/aeo/pdf/appendixes.pdf) lists an energy content for distillate oil of 5.799 MMBtu/bbl, or 0.138 MMBtu/gallon. Cost computed used for 2006 price, which is escalated using the trends from AEO2008 all-user distillate oil prices for the Pacific region (see "Fuel prices AEO2008" worksheet in this workbook).* | | |
| **LPG/Propane** | **$13.8** | $/MMBtu |
| *Levelized costs, 2008 to 2020. USDOE/EIA data are not available for WA. The US West Coast (PADD V) average wholesale price given by USDOE/EIA for propane is $1.22 per gallon in the 2006/07 heating season. This cost does not include fuel taxes. Prices expressed on $/MMBtu basis a conversion factor of 0.09133 MMBtu/gallon (see "Fuel Data" woksheet). Cost computed based on 2006 price, which is escalated using the trends from AEO2008 distillate oil prices for the Pacific region (see "AEO2008 Fuel Prices" worksheet in this workbook).* | | |
| **Landfill Gas - All Users** | **$5.0** | $/MMBtu |
| *Placeholder Estimate* | | |
| **Biogas Gas - All Users** | **$5.0** | $/MMBtu |
| *Placeholder Estimate* | | |

| Emission Rates, etc. | 2010 | 2020 | Units |
|---|---|---|---|
| **Electricity T&D losses (fraction of total generation)** | 7.4% | 7.0% | |
| *Estimated based on US DOE Annual Energy Outlook figures for 2005 - 2025 for "total sales" and "total net energy for load" as reported in "Table 72. Electric Power Projections for EMM Region, Western Electricity Coordinating Council / Northwest Power Pool Area - 11", from http://www.eia.doe.gov/oiaf/aeo/supplement/sup_elec.xls. Could be revised to reflect WA-specific data if available.* | | | |
| **Avoided electricity emissions rate** | 0.50 | 0.50 | $tCO_2$/MWh |
| *As used in Energy Supply analysis as of 9/20/07 for "small reductions" Can be considered an initial estimate.* | | | |

| Notes | 2010 | 2020 | Units |
|---|---|---|---|
| **Multi-Gas Emission Factors** | | | |
| *Except as noted, the following emission factors are calculated from values in the Washington Inventory and Forecast prepared for the CAT, and reflect the average emissions over 2000 to 2020 per BTU and physical amount of fuel. They include combustion $CH_4$ and $N_20$ as well as $CO_2$ emissions for consistency with the inventory.* | | | |
| | *$tCO_2e$/billion BTU* | | |
| **LPG - RCI** | 61.978 | | |
| **Coal - RCI** | 93.483 | | |
| **Natural Gas - RCI** | 52.910 | | |
| **Biomass - RCI** | 2.500 | *Rough estimate at present* | |
| **Oil - RCI** | 67.968 | *Weighted Average over all RCI Petroleum Use, including LPG* | |
| **Oil - Residential and Commercial Only** | 68.741 | *Weighted Average over all RC Petroleum Use, including LPG* | |
| **Landfill Gas - RCI** | 0.260 | *Placeholder Value, from Steve Roe. Does not count benefit of capture of landfill gas.* | |
| **Biogas - RCI** | 5.000 | *Placeholder Value--May in fact be negative* | |

**Inflation index (to 2006$)**

Calculated using http://data.bls.gov/cgi-bin/cpicalc.pl

| | Cost Year | Index |
|---|---|---|
| | 1997 | 1.26 |
| | 1998 | 1.24 |
| | 1999 | 1.21 |
| | 2000 | 1.17 |
| | 2001 | 1.14 |
| | 2002 | 1.12 |
| | 2003 | 1.10 |
| | 2004 | 1.07 |
| | 2005 | 1.03 |
| | 2006 | 1.00 |
| | 2007 | 0.97 |
| As of 9/08 | 2008 | 0.92 |

| | | |
|---|---|---|
| Natural Gas Conversion | 1.03 | million Btu/ thousand cf |
| Electricity Conversion | 3413 | MMBTU/ GWh |

## Estimate of Mitigation Option Costs and Benefits for Washington EE/GB IWG GHG Analysis

# GHG Emissions Totals for Washington EE/GB IWG GHG Analysis

| Date Last Modified: | 10/31/2008 | D. Von Hippel/C. Lee |
|---|---|---|

**Summary Interim Results and Totals for EE/GB Mitigation Actions**

| | Option Name | GHG Reductions ($MMtCO_2e$) 2012 | GHG Reductions ($MMtCO_2e$) 2020 | Cost-Eff ($/t$CO_2$e) | NPV 2008-2020 ($million) | Cumulative Emissions Reductions (MMt $CO_2$e, 2008-2020) |
|---|---|---|---|---|---|---|
| EE/GB-1A | Energy Efficiency Quality Investment Program (EEQUIP) | 0.12 | 0.78 | -$38 | -$179 | 4.8 |
| EE/GB-1B | Expanded Implementation of Distributed Energy and Water, Combined Heat and Power (CHP) and Renewable Energy | 0.06 | 0.31 | -$3 | -$5 | 1.6 |
| EE/GB-2 | Energy Efficiency in Existing, New and Renovated Public Buildings, and Energy Benchmarking and Energy Performance Disclosure in Public and Private Buildings | 0.16 | 1.21 | -$33 | -$222 | 6.8 |
| EE/GB-3 | State Energy Code Improvements and Establishment of 2030 Building Goals | 0.38 | 6.37 | -$32 | -$841 | 26.6 |
| | **Total Gross Savings** | 0.7 | 8.7 | -$31 | -$1,247 | 39.8 |

| Adjustment for Estimated Overlap Between EE/GB Options and with Recent Actions | | | | | | |
|---|---|---|---|---|---|---|
| **Overlap between EE/GB Options** | | | | | | |
| EE/GB-1A, Overlap with other Actions | 0.12 | 0.78 | | -$179 | 4.8 | ***See Note 1*** |
| EE/GB-1B, Overlap with other Actions | 0.00 | 0.02 | | -$4 | 0.1 | ***See Note 2*** |
| EE/GB-2, Overlap with other EE/GB and Recent Actions | 0.13 | 0.70 | | -$115 | 3.8 | ***See Note 3*** |
| EE/GB-3, Overlap with Recent Actions | 0.02 | 1.68 | | -$196 | 5.7 | ***See Note 4*** |
| Total Estimated Overlap Among EE/GB and Recent Actions | 0.27 | 3.17 | | -$494 | 14.4 | |
| **Total Savings Net of Overlaps** | 0.45 | 5.50 | -$30 | -$753 | 25.4 | |

**Additional Emissions Savings from Recent Actions (not included in forecast or in policy options above)**

| | Option Name | GHG Reductions ($MMtCO_2e$) 2012 | GHG Reductions ($MMtCO_2e$) 2020 | | Cumulative Emissions Reductions (MMt $CO_2$e, 2008-2020) | |
|---|---|---|---|---|---|---|
| | Existing Gas Utility DSM Spending | 0.10 | 0.25 | | 1.8 | |
| | State green buildings--electricity savings | 0.03 | 0.11 | | 0.7 | |
| | State green buildings--gas savings | 0.03 | 0.09 | | 0.6 | |
| | Building Codes--electricity savings | 0.14 | 0.28 | | 2.3 | |
| | Building Codes--gas savings | 0.12 | 0.25 | | 2.0 | |
| | Appliance Efficiency Standards--electricity savings | 0.41 | 1.13 | | 7.9 | |
| | Appliance Efficiency Standards--gas savings | 0.07 | 0.14 | | 1.1 | |
| | I-937 Load Goals--electricity savings* | 0.66 | 2.41 | | 14.5 | |
| | **Total** | 1.57 | 4.66 | | 30.91 | Total Recent Action |

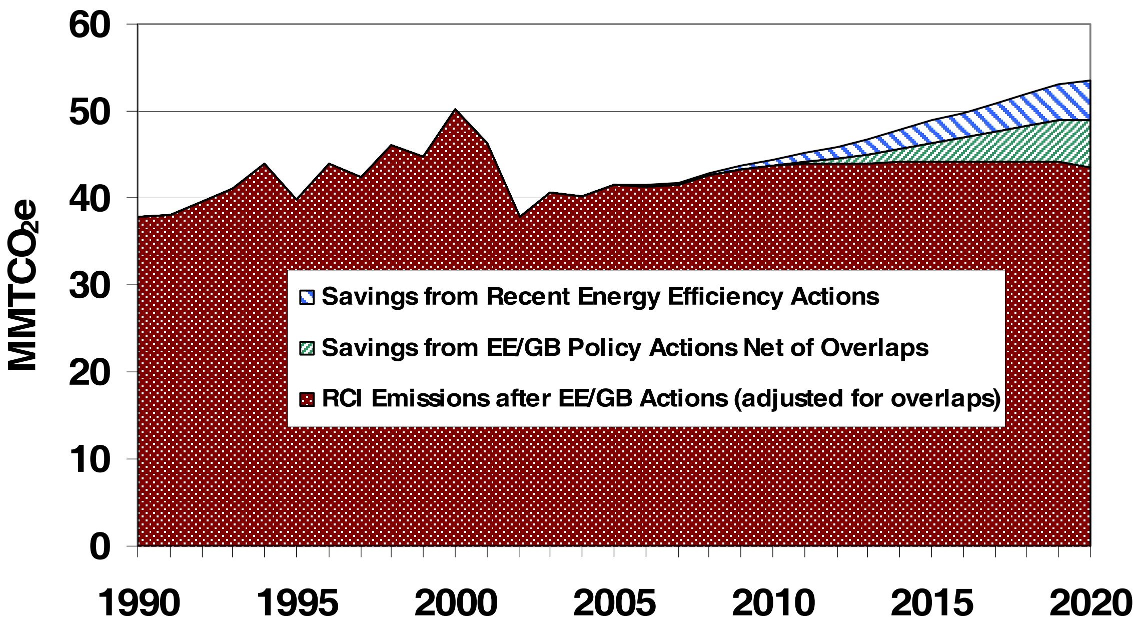
***Estimate revised as of 10/30/08**

| | 2012 | 2020 | | Cumulative |
|---|---|---|---|---|
| **Total Emissions Reductions Net of Overlaps (including recent actions)** | 2.02 | 10.16 | | 56.3 |

**TABLE BELOW SHOWS NET ADJUSTED SAVINGS BY OPTION**

**Summary Results and Totals for EE/GB Actions**

| | Option Name | GHG Reductions 2012 | GHG Reductions 2020 | Cost-Eff ($/t$CO_2$e) | NPV 2008-2020 ($million) | Cumulative Emissions Reductions (MMt $CO_2$e, 2008-2020) |
|---|---|---|---|---|---|---|
| EE/GB-1A | Energy Efficiency Quality Investment Program (EEQUIP) | 0.00 | 0.00 | N/A | $0 | 0.0 |
| EE/GB-1B | Expanded Implementation of Distributed Energy and Water, Combined Heat and Power (CHP) and Renewable Energy | 0.06 | 0.29 | -$1 | -$1 | 1.6 |
| EE/GB-2 | Energy Efficiency in Existing, New and Renovated Public Buildings, and Energy Benchmarking and Energy Performance Disclosure in Public and Private Buildings | 0.03 | 0.52 | -$36 | -$107 | 3.0 |
| EE/GB-3 | State Energy Code Improvements and Establishment of 2030 Building Goals | 0.36 | 4.69 | -$31 | -$645 | 20.8 |
| | **Total Savings** | 0.5 | 5.5 | -$30 | -$753 | 25.4 |




***NOTES ON ESTIMATES OF OVERLAP BETWEEN POLICIES***

***Note 1:***

EE/GB-1A provides incentives to carry out building improvements included in the goals for EE/GB Action 3 (and possibly Action 2), and thus overlaps 100% with savings from EE/GB-3 and other actions.

***Note 2:***

EE/GB-1B may overlap very slightly with energy efficiency and on-site energy measures carried out in EE/GB Action 3 (and possibly Action 2), and thus is assumed to overlap 5% with savings from EE/GB-3 and other actions.

***Note 3:***

The electricity savings from EE/GB-2 may overlap with the savings from I-937 goals, to the extent that utility programs are used to help support changes in government buildings. We assume that 25% of electricity savings from Action 2 overlap with I-937 goals. In addition, EE/GB-2 will overlap with existing programs for electricity and gas savings in state buildings. We assume that this overlap is 100% of post-2011 savings from the existing state building programs. Public buildings are also assumed to be candidates for programs mandated under I-937, and thus I-937 savings will overlap with savings in Action 2, as described in Note 4, below. The estimate of overlap in NPV cost for this action should be considered a rough approximation.

***Note 4:***

The electricity savings from EE/GB-3 will likely overlap significantly with the savings from I-937 goals, to the extent that utility programs support energy efficiency measures in homes and businesses, and, conversely, the building energy codes aspects of Action 3 will reduce the pool of cost-effective electricity efficiency measures available for utilities to tap under I-937.
Based on analysis done by the Northwest Power Planning Council for its 5th Plan, about 10% of overall conservation potential comes from measures applicable to the the non-direct-service-industry sector (see http://www.nwcouncil.org/energy/powerplan/5/(03)%20Conservation%20Resources.pdf, figure 3-2).
We thus assume that I-937 overlaps only with EE/GB results for existing buildings, with 90% of estimated I-937 savings overlapping with the existing-building portions of EE/GB Actions 2A and 3. This overlap is apportioned to EE/GB Actions 2 and 3 in proportion to the fraction of total electricity use (as of 2006) by the existing residential and commercial buildings covered by the two Actions, which is estimated as 12% for Action 2 and 78% for Action 3.
The estimate of overlap in NPV cost for this action should be considered a rough approximation.

## Estimate of Mitigation Option Costs and Benefits for Washington EE/GB IWG GHG Analysis

**EE/GB-1A** **Action 1A: Energy Efficiency Quality Investment Program (EEQUIP)**

*Date Last Modified:* *10/30/2008 D. Von Hippel*

| Key Data and Assumptions | 2012 | 2020/all | Units |
|---|---|---|---|
| **First Year Results Accrue**<br>*Placeholder assumption pending TWG input* | | 2010 | |
| **Electricity** | **2012** | **2020/all** | **Units** |
| **Levelized Cost of Electricity Savings**<br>*Preliminary estimate based on 7-year payback as estimated in WGA CDEAC EE Report. See Note 1.* | | $32 | $/MWh |
| **Levelized Cost of Natural Gas Savings**<br>*Preliminary estimate based on 7-year payback as estimated in WGA CDEAC EE Report. See Note 1.* | | $6.6 | $/MMBtu |
| **Avoided Electricity Cost**<br>*See "Common Factors" worksheet in this workbook.* | | $66 | $/MWh |
| **Avoided Natural Gas Cost**<br>*See "NG prices aeo2006" and "Common Factors" worksheets in this workbook.* | | $7.6 | $/MMBtu |

| Other Data, Assumptions, Calculations | 2012 | 2020/all | Units |
|---|---|---|---|
| **Inputs to/Intermediate Results of Calculation of Electricity and Gas Savings** | | | |
| Total Commercial Floorspace in Washington (million square feet)<br>*Draft estimates from Northwest Power Planning Councl for "6th Power Plan" (see "WA_Activities_Est" worksheet in this workbook). An estimate in the same worksheet, based on USDOE EIA CBECS (commercial survey) data for the Pacific region, extrapolated using projected Washington population as a driver, yields quite similar results.* | 1,817 | 2,072 | |
| Est. area of new commercial space per year in WA (million square feet)<br>*Calculated based on annual floorspace estimates above.* | 31.5 | 23.6 | |
| Total Residential Housing Units in Washington<br>*Draft estimates from Northwest Power Planning Councl for "6th Power Plan" (see "WA_Activities_Est" worksheet in this workbook). An estimate in the same worksheet, which assumes 2005 ratio of new homes to increase in population holds through 2020, based on 2005 WA housing units as provided in U.S Census Bureau annual data, http://www.census.gov/popest/housing/HU-EST2005.html, produces similar results.* | 2,965,669 | 3,383,726 | |
| Implied persons per housing units in Washington (for reference only) | 2.24 | 2.22 | |
| Estimated number of new residential units per year<br>*Calculated based on estimates above.* | 44,695 | 39,648 | |
| Total Multi-family Residential Housing Units in Washington<br>*Draft estimates from Northwest Power Planning Councl for "6th Power Plan" (see "WA_Activities_Est" worksheet in this workbook).* | 610,955 | 715,883 | |
| Estimated average floorspace per multi-family unit.<br>*Estimate, but consistent with data in BASELINE CHARACTERISTICS OF THE MULTI-FAMILY SECTOR: OREGON AND WASHINGTON, prepared for the Northwest Energy Efficiency Alliance by Ecotope (David Baylon, Alison Roberts, Shelly Borrell, and Michael Kennedy), October, 2001.* | 1,000 | 1,000 | |
| Implied Floorspace in Multi-family Residential Housing Units in Washington (million square feet) | 611 | 716 | |
| Implied New Floorspace Annually in Multi-family Residential Housing Units in Washington (million square feet) | 10.11 | 10.49 | |
| Estimated fraction of multi-family floorspace in buildings qualifying for Action<br>*[Placeholder estimates for now, pending further definition of eligibility. Data on fraction of units in buildings by number of units per building may be available from Northwest Power Planning Councl for 5th or 6th Power Plan materials.] 1999/2001 survey data from PSE and PacificCorp suggest that about 80 and 55 percent, respectively, of the multi-family units in their service territories were in buildings of 4 units or more (as reported in NPPC workbook "PNWResCharacteristicsData.XLS").* | 50% | 50% | |

| | | |
|---|---|---|
| Implied Average Electricity Consumption per Square Foot Commercial Space in Washington as of 2005 (see Note 2) | 17.04 | kWh/yr |
| Implied Average Natural Gas Consumption per Square Foot Commercial Space in Washington as of 2005 (see Note 2) | 27.58 | kBtu/yr |
| Implied Average Electricity Consumption per Housing Unit in Washington as of 2005 (see Note 2) | **12.08** | MWh/yr |
| Implied Average Natural Gas Consumption per Housing Unit in Washington as of 2005 (see Note 2) | **27.58** | MMBtu/yr |
| Estimated Average Electricity Consumption per Multi-Family Housing Unit in Washington as of 2005 (as assumed in Action 3 analysis) | **11.00** | MWh/yr |
| Estimated Average Natural Gas Consumption per Multi-Family Housing Unit in Washington as of 2005 (as assumed in Action 3 analysis) | **5.35** | MMBtu/yr |

**ADDITIONAL PROGRAM ASSUMPTIONS FOR EEGB-1A**

**PUT Credit and Benchmarking Requirement for Existing Commercial and Multifamily Residential Buildings**

| | 2012 | 2020/all | Units |
|---|---|---|---|
| CUMULATIVE fraction of commercial and multi-family residential square footage qualifying for PUT rebate by maintaining Energy Star score of 90 or above.<br>*Placeholder assumption, assuming that progressively more buildings will be shifted to this category over time. Adjusted to yield total 2010 PUT credit revenue impact noted in Action Document.* | **3%** | **10%** | |
| Fractional additional annual savings relative to 2005 energy use (electricity and gas) for commercial and multi-family residential buildings qualifying for PUT rebate by maintaining Energy Star score of 90 or above.<br>*Placeholder assumption--buildings already at Energy Star rating of 90 wouldn't be required to improve to meet targets (though presumably qualifying for the rebate could help to drive the market).* | **1%** | **1%** | |
| Electricity and gas use relative to 2005 energy use (electricity and gas) for commercial and multi-family residential buildings qualifying for PUT rebate by maintaining Energy Star score of 90 or above.<br>*Placeholder assumption--used to estimate total electricity and gas use in the buildings for the purposes of estimating the PUT credit.* | **65%** | **55%** | |
| CUMULATIVE Fraction of commercial and multi-family residential square footage qualifying for PUT rebate by maintaining Energy Star score of Energy Star score of 75 to 89 (80 to 89 after 3 years of the program) <u>and</u> posting an improvement in their score in the second year of at least 5 points.<br>*Placeholder assumptions. Adjusted to yield total 2010 PUT credit revenue impact noted in Action Document.* | **1.5%** | **0.0%** | |
| Average annual fractional savings relative to 2005 energy use (electricity and gas) for commercial and multi-family residential buildings qualifying for PUT rebate by maintaining Energy Star score of 75 to 89 (80 to 89 after 3 years of the program) <u>and</u> posting an improvement in their score in the second year of at least 5 points.<br>*Placeholder assumption.* | **3%** | **3%** | |
| Electricity and gas use relative to 2005 energy use (electricity and gas) for commercial and multi-family residential buildings qualifying for PUT rebate by maintaining Energy Star score of Energy Star score of 75 to 89 (80 to 89 after 3 years of the program) and posting an improvement in their score in the second year of at least 5 points.<br>*Placeholder assumption--used to estimate total electricity and gas use in the buildings for the purposes of estimating the PUT credit.* | **75%** | **65%** | |
| CUMULATIVE Fraction of commercial and multi-family residential square footage starting with an Energy Star score of less than 75 but qualifying for PUT rebate by posting an improvement in their score to least 75 points (80 points after three years of the program).<br>*Placeholder assumption. Adjusted to yield total 2010 PUT credit revenue impact noted in Action Document.* | **5.0%** | **0.0%** | |
| Average annual fractional savings relative to 2005 energy use (electricity and gas) for commercial and multi-family residential square footage starting with an Enegy Star score of less than 75 but qualifying for PUT rebate by posting an improvement in their score to least 75 points (80 points after three years of the program). | **5%** | **5%** | |

| | | |
|---|---|---|
| Electricity and gas use relative to 2005 energy use (electricity and gas) for commercial and multi-family residential buildings starting with an Energy Star score of less than 75 but qualifying for PUT rebate by posting an improvement in their score to least 75 points (80 points after three years of the program). | **85%** | **75%** |

*Placeholder assumption--used to estimate total electricity and gas use in the buildings for the purposes of estimating the PUT credit.*

Public Utility Tax (PUT) Rate — **3.873%**

*As provided by Gary Grossman of the Department of Revenue.*

Fraction of Public Utility Tax credit to be provided by electric and gas utilities — **50%**

*As specified in Action Document.*

## Sales Tax Refund for Non-Residential New Construction

| | | |
|---|---|---|
| CUMULATIVE fraction of commercial and multi-family residential square footage qualifying for PUT rebate by maintaining Energy Star score of 90 or above. | **3%** | **10%** |

*Placeholder assumption, assuming that progressively more buildings meet goals over time.*

Average (and maximum for rebate) cost of non-residential construction — $ 250.00 /square foot

*Rough assumption, but considered a reasonable average by Implementation Working Group members in and familiar with the building industry in Washington. Value is in year 2007 dollars per square foot.*

Fraction of cost of non-residential construction (up to maximum above) to be provided as a sales tax rebate — **0.75%**

*As specified in Action Document.*

Ratio of the area of commercial or multi-family residential floorspace substantially rennovated to that of new commercial floorspace covered by this element of Action — **0.00**

*Placeholde assumption--set at zero because the Action Document makes no mention of the inclusion of rennovated space, though rennovated space might be included in the future.*

| | | |
|---|---|---|
| Fractional annual savings relative to 2005 energy use (electricity and gas) for commercial buildings qualifying for sales tax rebate. Savings fractions shown are over and above energy efficiency improvements required by revised building codes included in Action 3. | **20%** | **20%** |

*Placeholder assumption.*

## Sales Tax Refund for Existing and New Residential Buildings

| | | |
|---|---|---|
| Fraction of new and rennovated residential space qualifying for Sales Tax Refund | **4%** | **10%** |

*Placeholder assumption, assuming that progressively more buildings meet goals over time.*

Average cost of non-residential construction — $ 150.00 /square foot

*Rough assumption, but considered a reasonable average by Implementation Working Group members in and familiar with the building industry in Washington. Value is in year 2007 dollars per square foot.*

Ratio of number of homes substantially rennovated to new residential homes covered by this element of Action — **1.00**

*Placeholder assumption--implies approximately the same number of rennovated as new homes.*

| | | | |
|---|---|---|---|
| Average floorspace of new residential homes and rennovated space covered by this element of Action | 1,850 | 1,800 | square feet |

*Placeholder assumption. Values are roughly consistent with data from Puget Sound Energy and PacificCorp (Washington customers) appliance saturation surveys in 1999 and 2001, respectively, as reported in NPPC workbook "PNWResCharacteristicsData.XLS".*

Sales Tax Rate (State portion) — **6.500%**

*As provided by Gary Grossman of the Department of Revenue.*

| | | |
|---|---|---|
| Fraction of applicable sales tax to be provided as a sales tax rebate: The lower of | **20.00%** | of tax paid or |
| | **$5,000** | per unit |

*As specified in Action Document.*

| | | |
|---|---|---|
| Fractional annual savings relative to 2005 energy use (electricity and gas) for commercial buildings qualifying for sales tax rebate. Savings fractions shown are over and above energy efficiency improvements required by revised building codes included in Action 3. | **20%** | **20%** |

**PROGRAM PARTICIPATION AND SAVINGS CALCULATIONS FOR EEGB-1A**

**PUT Credit and Benchmarking Requirement for Existing Commercial and Multifamily Residential Buildings**

| | 2012 | 2020/all | Units |
|---|---|---|---|
| Square feet of existing commercial buildings qualifying for PUT Tax Credit (score of 90 or greater) | 56.4 | 207.2 | million square feet |
| Square feet of existing commercial buildings qualifying for PUT Tax Credit (score of 75 to 89 in first three years, 80 to 89 years 4 through 6) | 28.2 | - | million square feet |
| Square feet of existing commercial buildings qualifying for PUT Tax Credit by improving to score of 75 in first three years, 80 years 4 through 6 | 94.1 | - | million square feet |
| Square feet of existing multi-family residential buildings qualifying for PUT Tax Credit (score of 90 or greater) | 9.5 | 35.8 | million square feet |
| Square feet of existing multi-family residential buildings qualifying for PUT Tax Credit (score of 75 to 89 in first three years, 80 to 89 years 4 through 6) | 4.7 | - | million square feet |
| Square feet of existing multi-family residential buildings qualifying for PUT Tax Credit by improving to score of 75 in first three years, 80 years 4 through 6 | 15.8 | - | million square feet |
| Annual (not cumulative) electricity savings in existing commercial buildings qualifying for PUT Tax Credit (score of 90 or greater) | 9.6 | 35.3 | GWh |
| Annual (not cumulative) gas savings in existing commercial buildings qualifying for PUT Tax Credit (score of 90 or greater) | 15.6 | 57.1 | billion Btu |
| Annual (not cumulative) electricity savings in existing commercial buildings qualifying for PUT Tax Credit (score of 75 to 89 in first three years, 80 to 89 years 4 through 6) | 14.4 | - | GWh |
| Annual (not cumulative) gas savings in existing commercial buildings qualifying for PUT Tax Credit (score of 75 to 89 in first three years, 80 to 89 years 4 through 6) | 38.9 | - | billion Btu |
| Annual (not cumulative) electricity savings in existing commercial buildings qualifying for PUT Tax Credit by improving to score of 75 in first three years, 80 years 4 through 6 | 80.1 | - | GWh |
| Annual (not cumulative) gas savings in existing commercial buildings qualifying for PUT Tax Credit by improving to score of 75 in first three years, 80 years 4 through 6 | 129.7 | - | billion Btu |
| Annual (not cumulative) electricity savings in existing multi-family residential buildings qualifying for PUT Tax Credit (score of 90 or greater) | 1.0 | 3.9 | GWh |
| Annual (not cumulative) gas savings in existing multi-family residential buildings qualifying for PUT Tax Credit (score of 90 or greater) | 0.5 | 1.9 | billion Btu |
| Annual (not cumulative) electricity savings in existing multi-family residential buildings qualifying for PUT Tax Credit (score of 75 to 89 in first three years, 80 to 89 years 4 through 6) | 1.6 | - | GWh |
| Annual (not cumulative) gas savings in existing multi-family residential buildings qualifying for PUT Tax Credit (score of 75 to 89 in first three years, 80 to 89 years 4 through 6) | 0.8 | - | billion Btu |
| Annual (not cumulative) electricity savings in existing multi-family residential buildings qualifying for PUT Tax Credit by improving to score of 75 in first three years, 80 years 4 through 6 | 8.7 | - | GWh |
| Annual (not cumulative) gas savings in existing multi-family residential buildings qualifying for PUT Tax Credit by improving to score of 75 in first three years, 80 years 4 through 6 | 4.2 | - | billion Btu |

**Sales Tax Refund for Non-Residential New Construction**

| | 2012 | 2020/all | Units |
|---|---|---|---|
| Square feet of new and rennovated commercial space qualifying for Sales Tax Refund by achieving an Energy Star Target Finder score of 90 or more | 1.0 | 2.4 | million square feet |
| Annual (not cumulative) electricity savings in new and rennovated commercial buildings qualifying for Sales Tax Refund | 3.4 | 8.0 | GWh |
| Annual (not cumulative) natural gas savings in new and rennovated commercial buildings qualifying for Sales Tax Refund | 5.5 | 13.0 | billion Btu |

**Sales Tax Refund for Existing and New Residential Buildings**

| | 2012 | 2020/all | Units |
|---|---|---|---|
| Number of new and rennovated homes qualifying for Sales Tax Refund | 3,517 | 7,930 | units |
| Annual (not cumulative) electricity savings in new and rennovated commercial buildings qualifying for Sales Tax Refund | 8.5 | 19.2 | GWh |
| Annual (not cumulative) natural gas savings in new and rennovated commercial buildings qualifying for Sales Tax Refund | 19.4 | 43.7 | billion Btu |

**TAX INCENTIVES CALCULATIONS FOR EEGB-1A**

**PUT Credit and Benchmarking Requirement for Existing Commercial and Multifamily Residential Buildings**

| | 2012 | 2020/all | Units |
|---|---|---|---|
| Estimated electricity use in commercial buildings participating in program | 2,348 | 1,942 | GWh |
| Estimated natural gas use in commercial buildings participating in program | 3,801 | 3,143 | billion Btu |
| Estimated electricity use in multi-family buildings participating in program | 255 | 217 | GWh |
| Estimated natural gas use in multi-family buildings participating in program | 124 | 105 | billion Btu |
| Estimated electric revenues from commercial buildings participating in program | $ 136 | $ 107 | million |
| Estimated natural gas revenues from commercial buildings participating in program | $ 44 | $ 36 | million |
| Estimated electric revenues from residential buildings participating in program | $ 16 | $ 14 | million |
| Estimated natural gas revenues from residential buildings participating in program | $ 2 | $ 1 | million |
| Estimated PUT tax paid by commercial buildings participating in program | $ 7.0 | $ 5.6 | million |
| Estimated PUT tax paid by residential buildings participating in program | $ 0.7 | $ 0.6 | million |
| Total PUT Tax Credit | $ 7.7 | $ 6.1 | million |
| Total Impact of PUT Tax Credits to State Budget<br>*Based on assumption regarding utility contribution to credit as noted above.* | $ 3.8 | $ 3.1 | million |

**Sales Tax Refund for Non-Residential New Construction**

| | | | |
|---|---|---|---|
| Estimated value of commercial new construction and renonvations qualifying for Sales Tax Refund under program. | $ 249 | $ 590 | million |
| Estimated value of Sales Tax Refund for commercial new construction and renovations qualifying under program. | $ 1.9 | $ 4.4 | million |

**Sales Tax Refund for Existing and New Residential Buildings**

| | | | |
|---|---|---|---|
| Estimated value of residential new construction and renonvations qualifying for Sales Tax Refund under program. | $ 976 | $ 2,141 | million |
| Estimated value of Sales Tax Refund for residential new construction and renovations qualifying under program. | $ 3.5 | $ 7.5 | million |

| Results by Program Element | 2012 | 2020/all | Units |
|---|---|---|---|
| **PUT Credit and Benchmarking Requirement for Existing Commercial and Multifamily Residential Buildings** | | | |
| **Electricity** | | | |
| Reduction in Electricity Sales: Residential | 16 | 104 | GWh (sales) |
| Reduction in Electricity Sales: Commercial | 146 | 955 | GWh (sales) |
| TOTAL Reduction in Electricity Sales | 162 | 1,059 | GWh (sales) |
| Reduction in Generation Requirements | 175 | 1,139 | GWh (generat |
| GHG Emission Savings | **0.09** | **0.57** | $MMtCO_2e$ |
| **Economic Analysis** | | | |
| Net Present Value (2008-2020) | | **-$151.6** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 3.6 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$41.99** | $/tCO_2e$ |
| **Natural Gas** | | | |
| Reduction in Gas Use, Residential Sector | 8 | 51 | Billion BTU |
| Reduction in Gas Use, Commercial Sector | 261 | 1,682 | Billion BTU |
| TOTAL Reduction in Gas Sales | 268 | 1,733 | Billion BTU |
| GHG Emission Savings | **0.01** | **0.09** | $MMtCO_2e$ |
| **Economic Analysis** | | | |
| Net Present Value (2008-2020) | | **-$7.1** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 0.59 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$12.18** | $/tCO_2e$ |
| **Sales Tax Refund for Non-Residential New Construction, Existing and New Residential Buildings** | | | |
| **Electricity** | | | |
| Reduction in Electricity Sales: Residential | 17 | 134 | GWh (sales) |
| Reduction in Electricity Sales: Commercial | 7 | 51 | GWh (sales) |
| TOTAL Reduction in Electricity Sales | 24 | 185 | GWh (sales) |
| Reduction in Generation Requirements | 26 | 199 | GWh (generat |
| GHG Emission Savings | **0.01** | **0.10** | $MMtCO_2e$ |
| **Economic Analysis** | | | |
| Net Present Value (2008-2020) | | **-$19.4** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 0.5 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$41.40** | $/tCO_2e$ |
| **Natural Gas** | | | |
| Reduction in Gas Use, Residential Sector | 39 | 305 | Billion BTU |
| Reduction in Gas Use, Commercial Sector | 11 | 83 | Billion BTU |
| TOTAL Reduction in Gas Sales | 50 | 388 | Billion BTU |
| GHG Emission Savings | **0.00** | **0.02** | $MMtCO_2e$ |
| **Economic Analysis** | | | |
| Net Present Value (2008-2020) | | **-$1.2** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 0.10 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$12.00** | $/tCO_2e$ |

| Summary Results | 2012 | 2020 | Units |
|---|---|---|---|
| **Electricity (Conventional)** | | | |
| Reduction in Electricity Sales: Residential | 33 | 238 | GWh (sales) |
| Reduction in Electricity Sales: Commercial | 153 | 1,006 | GWh (sales) |
| TOTAL Reduction in Electricity Sales | 186 | 1,244 | GWh (sales) |
| Reduction in Generation Requirements | 200 | 1,338 | GWh (generat |
| GHG Emission Savings | **0.10** | **0.67** | $MMtCO_2e$ |
| **Economic Analysis** | | | |
| Net Present Value (2008-2020) | | **-$171.0** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 4.1 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$41.92** | $\$/tCO_2e$ |
| **Natural Gas** | | | |
| Reduction in Gas Use, Residential Sector | 47 | 356 | Billion BTU |
| Reduction in Gas Use, Commercial Sector | 271 | 1,765 | Billion BTU |
| TOTAL Reduction in Gas Sales | 318 | 2,121 | Billion BTU |
| GHG Emission Savings | **0.02** | **0.11** | $MMtCO_2e$ |
| **Economic Analysis** | | | |
| Net Present Value (2008-2020) | | **-$8.3** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 0.68 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$12.16** | $\$/tCO_2e$ |

| Summary Results for EE/GB-1A | 2012 | 2020 | Units |
|---|---|---|---|
| **Total for Option (Natural gas and Electricity)** | | | |
| GHG Emission Savings | **0.12** | **0.78** | $MMtCO_2e$ |
| Net Present Value (2008-2020) | | **-$179.3** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 4.8 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$37.66** | $\$/tCO_2e$ |

***NOTES AND DATA FROM SOURCES***

***Note 1:***

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at: http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.
The CDEAC report provides a cost of saved energy (electricity) based on an average 7-year payback for code improvements (page 42). This is likely to be a lower bound for the cost of green building practices that yield a 50 percent improvement over existing buildings, but is used as a starting point for this analysis.

For Washington, the equivalent cost is estimated as follows for electricity and natural gas

| | | |
|---|---|---|
| payback | 7 | years, from CDEAC report |
| lifespan | 25 | years, conservative assumption |
| **elec price** | **$65** | $/MWh (weighted average levelized cost of residential and commercial electricity prices in WA--See Common Factors worksheet). |
| **NG price** | **$13.25** | $/MMBtu (weighted average levelized cost of residential and commercial natural gas prices in WA--See Common Factors worksheet). |

| | | |
|---|---|---|
| Electricity levelized cost | $32.176 | $/MWh |
| Natural Gas levelized cost | $6.583 | $/MMBTU |

***Note 2:***

Based on results from Table B.5 of the 2003 Commercial Buildings Energy Consumption Survey, Detailed Tables dated October 2006 and published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/alltables.pdf, as described in "WA_Activities_Est" worksheet in this workbook.

Following data on electricity sales in Washington as of 2005 as described in "Utility_Sales" worksheet in this workbook.
Downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html (file sales_revenue.xls)

| | MWh | Fraction of Total |
|---|---|---|
| Residential | 33,212,197 | 40% |
| Commercial | 28,099,583 | 34% |
| Industrial | 22,111,773 | 27% |
| Total | 83,423,553 | 100% |

For natural gas use in Washington, consumption data are from the USDOE EIA downloaded from http://www.eia.doe.gov/oil_gas/natural_gas/applications/eia176query.html are are follows:
(See "EIA_NG_Data" worksheet in this workbook for raw EIA data)

| | Sales (Million Cubic Feet of Natural Gas) | | | |
|---|---|---|---|---|
| | Residential | Commercial | Industrial | Total |
| 2005 | 73,626 | 44,155 | 10,565 | 128,347 |
| Fraction of 2005 Total | 57% | 34% | 8% | 100% |

**Estimate of Mitigation Option Costs and Benefits for Washington EE/GB IWG GHG Analysis**

**EE/GB-1B** **ACTION 1B: Expanded Implementation of Distributed Energy and Water, Combined Heat and Power (CHP) and Renewable Energy**

*Date Last Modified:* *10/13/2008* *D. Von Hippel*

| Key Data and Assumptions | 2012 | 2020/all | Units |
|---|---|---|---|

**Total Remaining Estimated CHP Potential in WA as of 2004**

**2,847** MW (See ***Note 1***)

*From the Combined Heat and Power in the Pacific Northwest: Market Assessment, dated August 2004, to the Oak Ridge National Laboratory (http://www.chpcenternw.org/NwChpDocs/Chp_Market-Assessment_In_PNW_EEA_08_2004.pdf). From "Economic Potential, Accelerated Case" results.*

| | 2012 | 2020/all | Units |
|---|---|---|---|
| **First Year Results Accrue** | | **2010** | |
| **Fuel Costs** | **2012** | **2020/all** | **Units** |
| **Natural Gas Avoided Cost** | | **$7.6** | $/MMBtu |
| *Based on projections of "city gate" gas price.* | | | |
| **Biomass** | | **$3.4** | $/MMBtu |
| *Estimate based on national study of state-by-state biomass resource resource assessments (Biomass Feedstock Availability in the United States: 1999 State Level Analysis, M Walsh et al 1999, with 2000update). Price equivalent of $51/dry ton at 16 MMBtu/dry* | | | |
| **Oil** | | **$9.5** | $/MMBtu |
| *From Seattle Steam comments during Fall 2007 CAT process.* | | | |
| **Coal** | | **$2.5** | $/MMBtu |
| *Average coal heat content of 26.75 MMBTU/ton, based on 2001 USDOE/EIA data. USDOE/EIA figures for 2005 "other industrial users" are withheld for WA. www.eia.doe.gov/cneaf/coal/page/acr/table34.html. See "Common Factors" worksheet in this workbook.* | | | |
| **Avoided Electricity Cost** | | **$66** | $/MWh |
| *Estimate derived from NWPCC data from RTF analysis, same source as marginal CO2 emission rate for electricity reductions, this is the simple average (not levelized value) of the marginal dispatch costs for 2010, 2015, and 2020* | | | |
| **Avoided electricity emissions rate** | **0.50** | **0.50** | $tCO_2$/MWh |
| *As used in CAT Fall 2007 analyses* | | | |
| **State Element Sales and Use Tax (% of purchase cost)** | | **6.50%** | |
| *Used to reflect implied revenue impacts/incentive value of Sales Tax and Use Tax exemption on commercial CHP systems (industrial CHP systems are already expected to be largely covered by the existing "Manufacturing Machinery" exemption.* | | | |
| **Fraction of CHP systems implemented meeting qualifying efficiency level** | | **50%** | |
| *Assumption* | | | |
| **Fraction of commercial CHP systems implemented (with qualifying efficiency) receiving exemption** | | **100%** | |
| *Assumption* | | | |
| **Fraction of industrial CHP systems implemented (with qualifying efficiency) receiving exemption** | | **10%** | |
| *Assumption. This value is set low because most industrial CHP systems meeting efficiency criterion already qualify for existing Manufacturing Machinery and Equipment Sales/Use Tax Exemption. This fraction would, for example, include industrial CHP plants that produce substantially more power than can be used on-site.* | | | |

| Summary Results | 2012 | 2020 | Units |
|---|---|---|---|
| **Total for Policy (All Fuels, All Systems)** | | | |
| Total Net GHG Emission Savings | **0.28** | **1.4** | $MMtCO_2e$ |
| Net Present Value (2008-2020) | | **-$71.7** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 7.5 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$9.6** | $\$/tCO_2e$ |
| Total net in-state expenditures | **-$2.2** | **-$29.3** | $million |
| **Total for Policy (All Fuels, Systems Receiving Tax Exermptions)** | | | |
| Total Net GHG Emission Savings | **0.06** | **0.3** | $MMtCO_2e$ |
| Net Present Value (2008-2020) | | **-$4.6** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 1.6 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$2.8** | $\$/tCO_2e$ |
| Total net in-state expenditures | **$0.3** | **-$3.6** | $million |
| Total Tax Exemption | **$1.04** | **$1.50** | $million |

*Note that cost results for systems receiving tax exemptions should be considered approximzate at this time, as they do not fully reflect the added capital and O&M cost sof the small fraction of systems that are assumed to be fueled with biomass.*

| Other Data, Assumptions, Calculations | 2012 | 2020/all | Units |
|---|---|---|---|
| Fraction of Washington's Remaining Existing CHP Potential Tapped per Year | 2.0% | 3.0% | |
| *Rough estimate to be refined in consultation with TWG. Fractions of remaining potential tapped in each year are assumed to be beyond "baseline plus existing policies" levels, and thus due to CAT policies.* | | | |
| Annual Growth in CHP Potential | 1.6% | 1.6% | |
| *Rough estimate based on consideration of growth in electricity use in the commercial and industrial sectors.* | | | |
| Estimated CHP Potential by Year (MW) | 3,182 | 3,612 | *MW* |
| *Potential shown above grows at the rate shown above.* | | | |
| Estimated CHP Installed Under Policy by Year (MW) | 64 | 108 | *MW* |
| Average full-capacity-equivalent hours of operation for New CHP units: | 4,000 | 4,000 | |
| *assumption* | | | |
| Fraction of New CHP Capacity/Energy Fueled With: | | | |
| Natural Gas | 94% | 94% | |
| Biomass | 6% | 6% | |
| Oil | 0% | 0% | |
| Coal | 0% | 0% | |
| *Assumptions - see Note 3* | | | |
| Implied Annual New CHP Capacity by Fuel (MW) | | | |
| Natural Gas | 60 | 102 | |
| Biomass | 4 | 6 | |
| Oil | - | - | |
| Coal | - | - | |
| Implied Cumulative New CHP Capacity by Fuel (MW) | | | |
| Natural Gas | 177 | 860 | |
| Biomass | 11 | 55 | |
| Oil | - | - | |
| Coal | - | - | |
| Implied Cumulative New CHP Electricity Output by Fuel (GWh) | | | |
| Natural Gas | 707 | 3,441 | |
| Biomass | 45 | 220 | |
| Oil | - | - | |
| Coal | - | - | |
| Average Net Heat Rate by Fuel (Btu Fuel Input/kWh Electricity Output) | | | |
| Natural Gas (weighted average by system size) | 9,341 | 8,520 | |
| Biomass | 13,000 | 13,000 | |
| Oil | 12,000 | 12,000 | |
| Coal | 12,000 | 12,000 | |
| *Assumptions* | | | |
| Implied Fuel Input by Fuel (Billion Btu) | | | |
| Natural Gas | 6,600 | 29,315 | |
| Biomass | 586 | 2,854 | |
| Oil | - | - | |
| Coal | - | - | |
| Usable Cogenerated Heat Output as a Fraction of Fuel Energy Input | | | |
| Natural Gas | 40% | 40% | |
| Biomass | 40% | 40% | |
| Oil | 40% | 40% | |
| Coal | 40% | 40% | |
| Implied Usable Heat Output by Fuel (Billion Btu) | | | |
| Natural Gas | 2,640 | 11,726 | |
| Biomass | 234 | 1,141 | |
| Oil | - | - | |
| Coal | - | - | |

| | | |
|---|---|---|
| **Fraction of New CHP Capacity/Energy by Size:** | | |
| <1 MW | 14% | 14% |
| 1-4.9 MW | 24% | 24% |
| 5-24.9 MW | 19% | 19% |
| 25-39.9 MW | 13% | 13% |
| 40-259.9 MW | 15% | 15% |
| >259.9 MW | 16% | 16% |
| **Implied Annual New CHP Capacity by Size (MW)** | | |
| <1 MW | 9 | 15 |
| 1-4.9 MW | 15 | 26 |
| 5-24.9 MW | 12 | 21 |
| 25-39.9 MW | 8 | 14 |
| 40-259.9 MW | 10 | 16 |
| >259.9 MW | 10 | 17 |
| **Implied Cumulative New CHP Capacity by Size (MW)** | | |
| <1 MW | 26 | 128 |
| 1-4.9 MW | 45 | 218 |
| 5-24.9 MW | 36 | 173 |
| 25-39.9 MW | 24 | 115 |
| 40-259.9 MW | 28 | 138 |
| >259.9 MW | 29 | 143 |
| **Implied Cumulative New CHP Electricity Output by Size (GWh)** | | |
| <1 MW | 105 | 513 |
| 1-4.9 MW | 179 | 872 |
| 5-24.9 MW | 142 | 693 |
| 25-39.9 MW | 95 | 460 |
| 40-259.9 MW | 113 | 552 |
| >259.9 MW | 117 | 571 |
| **Average Net Heat Rate by Size (Btu Fuel Input/kWh Electricity Output)** | | |
| <1 MW | 11,234 | 10,343 |
| 1-4.9 MW | 9,868 | 8,480 |
| 5-24.9 MW | 9,213 | 7,935 |
| 25-39.9 MW | 9,945 | 8,865 |
| 40-259.9 MW | 9,220 | 8,595 |
| >259.9 MW | 7,937 | 7,300 |
| **Implied Fuel Input by Size (Billion Btu)** | | |
| <1 MW | 1,165 | 5,306 |
| 1-4.9 MW | 1,717 | 7,392 |
| 5-24.9 MW | 1,275 | 5,499 |
| 25-39.9 MW | 920 | 4,080 |
| 40-259.9 MW | 1,030 | 4,741 |
| >259.9 MW | 915 | 4,167 |
| **Usable Cogenerated Heat Output as a Fraction of Fuel Energy Input** | | |
| <1 MW | 40% | 40% |
| 1-4.9 MW | 40% | 40% |
| 5-24.9 MW | 40% | 40% |
| 25-39.9 MW | 40% | 40% |
| 40-259.9 MW | 40% | 40% |
| >259.9 MW | 40% | 40% |
| **Implied Usable Heat Output by Fuel (Billion Btu)** | | |
| <1 MW | 466 | 2,122 |
| 1-4.9 MW | 687 | 2,957 |
| 5-24.9 MW | 510 | 2,200 |
| 25-39.9 MW | 368 | 1,632 |
| 40-259.9 MW | 412 | 1,896 |
| >259.9 MW | 366 | 1,667 |

| Other Data, Assumptions, Calculations | 2012 | 2020/all | Units |
|---|---|---|---|
| Fraction of Usable Heat Output Replacing Space/Water/Process Heat Use | 94% | 94% | |
| *(Assumption from Seattle Steam provided during 2007 CAT process)* | | | |
| Fraction of CHP Heat Output Displacing Thermal Energy Produced Using | | | |
| Natural Gas | 90% | 90% | |
| Biomass | 0% | 0% | |
| Coal | 0% | 0% | |
| Electricity | 10% | 10% | |
| Oil | 0% | 0% | |
| *Based on input from TWG* | | | |
| Net Efficiency of Displaced Boiler/Heater Thermal Energy Produced Using | | | |
| Natural Gas | 75% | 75% | |
| Biomass | 75% | 75% | |
| Coal | 75% | 75% | |
| Electricity | 85% | 85% | |
| Oil | 75% | 75% | |
| *Assumptions* | | | |
| Net Displaced Fuel Use (Billion Btu) | | | |
| Natural Gas | **3,242** | **14,514** | |
| Biomass | - | - | |
| Coal | - | - | |
| Electricity | **318** | **1,423** | |
| Oil | - | - | |
| **Inputs to Cost Estimates for CHP Systems** | | | |
| Factors for Annualizing Capital Costs (all plant types) | | | |
| Interest Rate (real) | | 8% | /yr |
| Economic Life of System | | 20 | years |
| Implied Annualization Factor | | 10.19% | %/yr |
| Estimated Average Installed Capital Costs by System Type ($2006/kW) | | | |
| Natural Gas | $ 1,005 | $ 875 | |
| Biomass | $ 1,300 | $ 1,250 | |
| Oil | $ 1,050 | $ 1,000 | |
| Coal | $ 1,200 | $ 1,150 | |
| *Source: Combined Heat and Power in the Pacific Northwest: Market Assessment, based on average of range of sizes of turbine systems; Biomass system assumed $250 higher than gas turbine; Coal system assumed equal to gas turbine* | | | |
| Estimated Average Non-fuel Operating and Maintenance Costs by System Type ($/MWh) | | | |
| Natural Gas | $ 8.45 | $ 7.36 | |
| Biomass | $ 12.00 | $ 12.00 | |
| Coal | $ 12.00 | $ 12.00 | |
| *Source: Combined Heat and Power in the Pacific Northwest: Market Assessment. Natural gas values based on weighted average of values shown below by range of size class. Biomass and coal system values are rough assumptions at present.* | | | |
| Estimated Average Installed Capital Costs by Size ($2006/kW) | | | |
| <1 MW | $ 1,456 | $ 1,119 | |
| 1-4.9 MW | $ 1,090 | $ 969 | |
| 5-24.9 MW | $ 1,032 | $ 916 | |
| 25-39.9 MW | $ 928 | $ 818 | |
| 40-259.9 MW | $ 814 | $ 766 | |
| >259.9 MW | $ 684 | $ 615 | |
| Estimated Average Non-fuel Operating and Maintenance Costs by Size ($2006/MWh) | | | |
| <1 MW | $ 17.05 | $ 12.10 | |
| 1-4.9 MW | $ 9.90 | $ 8.80 | |
| 5-24.9 MW | $ 8.80 | $ 8.80 | |
| 25-39.9 MW | $ 5.50 | $ 4.40 | |
| 40-259.9 MW | $ 4.40 | $ 4.40 | |
| >259.9 MW | $ 4.40 | $ 4.40 | |

**Intermediate Results for Cost Estimates**

Total Capital Costs for New Systems by Fuel (thousand 2006 dollars)

| | | |
|---|---|---|
| Natural Gas | $ 60,137 | $ 89,159 |
| Biomass | $ 4,960 | $ 8,123 |
| Oil | $ - | $ - |
| Coal | $ - | $ - |

Annualized Capital Costs for All Systems by Fuel (thousand 2006 dollars)

| | | |
|---|---|---|
| Natural Gas | $ 18,088 | $ 82,671 |
| Biomass | $ 1,492 | $ 7,133 |
| Oil | $ - | $ - |
| Coal | $ - | $ - |

Annual Non-Fuel Operating and Maintenance Costs for All Systems (thousand 2006 dollars)

| | | |
|---|---|---|
| Natural Gas | $ 5,973 | $ 25,325 |
| Biomass | $ 541 | $ 2,634 |
| Oil | $ - | $ - |
| Coal | $ - | $ - |

Total Non-Fuel Costs for All Systems (thousand 2006 dollars)

| | | |
|---|---|---|
| Natural Gas | $ 24,061 | $ 107,996 |
| Biomass | $ 2,033 | $ 9,767 |
| Oil | $ - | $ - |
| Coal | $ - | $ - |

Total Gross Fuel Costs for All Systems (thousand 2006 dollars)

| | | |
|---|---|---|
| Natural Gas | $ 50,322 | $ 223,523 |
| Biomass | $ 1,995 | $ 9,717 |
| Oil | $ - | $ - |
| Coal | $ - | $ - |

Total Fuel Cost Savings from Displaced Heating Fuels for All Systems (thousand 2006 dollars)

| | | |
|---|---|---|
| Natural Gas | $ 24,721 | $ 110,671 |
| Biomass | $ - | $ - |
| Coal | $ - | $ - |
| Electricity | $ 6,160 | $ 27,578 |
| Oil | $ - | $ - |

Total Capital Costs for New Systems by Size (thousand 2006 dollars)

| | | |
|---|---|---|
| <1 MW | $ 12,984 | $ 17,003 |
| 1-4.9 MW | $ 16,525 | $ 25,000 |
| 5-24.9 MW | $ 12,438 | $ 18,803 |
| 25-39.9 MW | $ 7,426 | $ 11,145 |
| 40-259.9 MW | $ 7,809 | $ 12,503 |
| >259.9 MW | $ 6,792 | $ 10,392 |

Annualized Capital Costs for All Systems by Size (thousand 2006 dollars)

| | | |
|---|---|---|
| <1 MW | $ 3,905 | $ 16,931 |
| 1-4.9 MW | $ 4,970 | $ 22,921 |
| 5-24.9 MW | $ 3,741 | $ 17,247 |
| 25-39.9 MW | $ 2,234 | $ 10,264 |
| 40-259.9 MW | $ 2,349 | $ 11,113 |
| >259.9 MW | $ 2,043 | $ 9,469 |

Annual Non-Fuel Operating and Maintenance Costs for All Systems (thousand 2006 dollars)

| | | |
|---|---|---|
| <1 MW | $ 1,796 | $ 6,207 |
| 1-4.9 MW | $ 1,772 | $ 7,671 |
| 5-24.9 MW | $ 1,252 | $ 6,098 |
| 25-39.9 MW | $ 520 | $ 2,025 |
| 40-259.9 MW | $ 498 | $ 2,427 |
| >259.9 MW | $ 516 | $ 2,512 |

| | 2012 | 2020/all |
|---|---|---|
| **Total Non-Fuel Costs for All Systems (thousand 2006 dollars)** | | |
| <1 MW | $ 5,701 | $ 23,138 |
| 1-4.9 MW | $ 6,742 | $ 30,592 |
| 5-24.9 MW | $ 4,993 | $ 23,345 |
| 25-39.9 MW | $ 2,753 | $ 12,289 |
| 40-259.9 MW | $ 2,847 | $ 13,540 |
| >259.9 MW | $ 2,559 | $ 11,980 |
| | $ 25,596 | $ 114,885 |
| **Total Gross Fuel Costs for All Systems (thousand 2006 dollars)** | | |
| <1 MW | $ 7,332 | $ 32,688 |
| 1-4.9 MW | $ 12,459 | $ 55,545 |
| 5-24.9 MW | $ 9,905 | $ 44,158 |
| 25-39.9 MW | $ 6,579 | $ 29,329 |
| 40-259.9 MW | $ 7,883 | $ 35,146 |
| >259.9 MW | $ 8,159 | $ 36,375 |
| | | *$ 233,240* |
| **Total Fuel Cost Savings from Displaced Heating Fuels for All Systems (thousand 2006 dollars)** | | |
| <1 MW | $ 4,328 | $ 19,375 |
| 1-4.9 MW | $ 7,354 | $ 32,923 |
| 5-24.9 MW | $ 5,847 | $ 26,174 |
| 25-39.9 MW | $ 3,883 | $ 17,384 |
| 40-259.9 MW | $ 4,653 | $ 20,832 |
| >259.9 MW | $ 4,816 | $ 21,560 |
| | | *$ 138,249* |

| Calculation and Results of Tax Exemption Implications | 2012 | 2020/all | Units |
|---|---|---|---|

### Fraction of Systems by Size Class Qualifying for Sales Tax and Use Tax Exemption

*Commercial systems meeting qualifying efficiency standards. Based on estimates of Technical Potential from document in Note 1. See Note 4 for derivation of fractions of potential systems by size class that are estimated to be in commercial/institutional applications.*

| | 2012 | 2020/all |
|---|---|---|
| <1 MW | | 43% |
| 1-4.9 MW | | 27% |
| 5-24.9 MW | | 30% |
| 25-39.9 MW | | 18% |
| 40-259.9 MW | | 5% |
| >259.9 MW | | 5% |

### Implied Capital Costs for Qualifying Systems (thousand 2006 dollars)

| | 2012 | 2020/all |
|---|---|---|
| <1 MW | $ 5,596 | $ 7,328 |
| 1-4.9 MW | $ 4,530 | $ 6,853 |
| 5-24.9 MW | $ 3,775 | $ 5,706 |
| 25-39.9 MW | $ 1,325 | $ 1,988 |
| 40-259.9 MW | $ 390 | $ 625 |
| >259.9 MW | $ 340 | $ 520 |
| **TOTAL, ALL SYSTEMS** | $ 15,955 | $ 23,020 |

### Implied State Portion of Sales Tax and Use Tax Exemptions for Qualifying Systems (thousand 2006 dollars)

| | 2012 | 2020/all |
|---|---|---|
| <1 MW | $ 364 | $ 476 |
| 1-4.9 MW | $ 294 | $ 445 |
| 5-24.9 MW | $ 245 | $ 371 |
| 25-39.9 MW | $ 86 | $ 129 |
| 40-259.9 MW | $ 25 | $ 41 |
| >259.9 MW | $ 22 | $ 34 |
| **TOTAL, ALL SYSTEMS** | $ 1,037 | $ 1,496 |

### Implied Total Annual Costs for Systems Qualifying for Tax Exemption, Net of Displaced Heating Fuel Savings (thousand 2006 dollars)

| | 2012 | 2020/all |
|---|---|---|
| <1 MW | $ 3,752 | $ 15,710 |
| 1-4.9 MW | $ 3,247 | $ 14,587 |
| 5-24.9 MW | $ 2,747 | $ 12,542 |
| 25-39.9 MW | $ 972 | $ 4,324 |
| 40-259.9 MW | $ 304 | $ 1,393 |
| >259.9 MW | $ 295 | $ 1,340 |
| **TOTAL, ALL SYSTEMS** | $ 11,317 | $ 49,895 |

**Implied Total Annual Fuel Input to Systems Qualifying for Tax Exemption (billion Btu)**

| | | |
|---|---|---|
| <1 MW | **502** | **2,287** |
| 1-4.9 MW | **471** | **2,026** |
| 5-24.9 MW | **387** | **1,669** |
| 25-39.9 MW | **164** | **728** |
| 40-259.9 MW | **52** | **237** |
| >259.9 MW | **46** | **208** |
| **TOTAL, ALL SYSTEMS** | **1,621** | **7,155** |

**Fraction of Fuel Input to from All Systems Modeled** | **22.6%** | **22.2%**

*Here "all systems modeled" Includes commercial systems meeting qualifying efficiency standards, systems not meeting efficiency standards, and industrial systems, including those that already qualify for existing (2008) tax exemption. This fraction is used to estimate the net emissions benefit of the systems receiving tax exemptions.*

**Implied Total Electricity Output by Systems Qualifying for Tax Exemption (GWh)**

| | | |
|---|---|---|
| <1 MW | **45** | **221** |
| 1-4.9 MW | **49** | **239** |
| 5-24.9 MW | **43** | **210** |
| 25-39.9 MW | **17** | **82** |
| 40-259.9 MW | **6** | **28** |
| >259.9 MW | **6** | **29** |
| **TOTAL, ALL SYSTEMS** | **166** | **809** |

**Fraction of Electricity Output from All Systems Modeled** | **22.1%** | **22.1%**

*Here "all systems modeled" Includes commercial systems meeting qualifying efficiency standards, systems not meeting efficiency standards, and industrial systems, including those that already qualify for existing (2008) tax exemption. This fraction is used to estimate emissions benefit from electricity generation by the systems receiving tax exemptions.*

| **Results** | **2012** | **2020** | **Units** |
|---|---|---|---|
| **Electricity** | | | |
| TOTAL Reduction in Electricity Sales (electricity output from CHP plus avoided electricity use in boilers/space heaters/water heaters) | 845 | 4,077 | GWh (sales) |
| Reduction in Generation Requirements | 911 | 4,386 | GWh (generation) |
| Gross GHG Emission Savings | **0.46** | **2.19** | $MMtCO_2e$ |
| **Natural Gas** | | | |
| Net Change in Gas Use (negative values denote increased use) | -3,358 | -14,801 | Billion BTU |
| Net GHG Emissions (negative values denote increased emissions) | **-0.18** | **-0.78** | $MMtCO_2e$ |
| **Biomass** | | | |
| Net Change in Biomass Use (negative values denote increased use) | -586 | -2,854 | Billion BTU |
| Net GHG Emissions (negative values denote increased emissions) | **0.00** | **-0.01** | $MMtCO_2e$ |
| | | -178344 | dry tons |
| **Coal** | | | |
| Net Change in Coal Use (negative values denote increased use) | 0 | 0 | Billion BTU |
| Net GHG Emissions (negative values denote increased emissions) | **0.00** | **0.00** | $MMtCO_2e$ |
| **Oil** | | | |
| Net Change in Oil Use (negative values denote increased use) | 0 | 0 | Billion BTU |
| Net GHG Emissions (negative values denote increased emissions) | **0.00** | **0.00** | $MMtCO_2e$ |

***NOTES AND DATA FROM SOURCES***

***Note 1:***

From *Combined Heat and Power in the Pacific Northwest: Market Assessment*
Task 1 - Final Report. Submitted to Oak Ridge National Laboratory
This report can be found at:
http://www.chpcenternw.org/NwChpDocs/Chp_Market-Assessment_In_PNW_EEA_08_2004.pdf
Accelerated Case assumptions – 2020 cost and performance specs, no stand-by charges, financial incentives equal to about 15% of capital costs

***Note 2:***

Natural gas - cell AJ53 of SEDS workbook
Coal - cell AQ53 of SEDS workbook
Electricity - to be confirmed
Oil - pet. coke, pentanes plus, residential fuel, still gas, napthas, unfinished oils - cells AK53 to AP53 of SEDS workbook

***Note 3:***
From *Combined Heat and Power in the Pacific Northwest: Market Assessment*

**Large industrial**

| From Table 4-1 (Washington only) On-site CHP Technical Potential | | From Table 4-1 (Washington only) CHP Export Potential | |
|---|---|---|---|
| Food | 27 | Food | 24 |
| Lumber and Wood | 33 | Lumber and Wood | 28 |
| Paper | 122 | Paper | 229 |
| Chemicals | 25 | Chemicals | 11 |
| Petroleum Refining | 81 | Petroleum Refining | 568 |
| Primary Metals | 28 | Primary Metals | 9 |
| Electronic Equipment | 0 | Electronic Equipment | 0 |
| Transportation Equipment | 45 | Transportation Equipment | 0 |
| Instrumentation | 0 | Instrumentation | 0 |
| | 361 | | 869 |

| | | |
|---|---|---|
| Total Large Industrial CHP Technical Potential | 1,230 | MW |

| **Techical Potential** | |
|---|---|
| Existing facilities | MW |
| Large Industrial - On-site | 360 |
| Large Industrial - Export | 870 |
| Resource Recovery | 27 |
| Small Industrial | 745 |
| Commercial | 2,885 |
| New facilities | |
| Large Industrial - On-site | 57 |
| Small Industrial | 304 |
| Commercial | 2,473 |
| TOTAL | 7,721 |

| Technical Potential for Industries Assumed to use Biomass | | |
|---|---|---|
| Food | 51 | MW |
| Lumber and Wood | 61 | MW |
| Paper | 351 | MW |
| Total | 463 | MW |

| | | |
|---|---|---|
| Biomass as percentage of total technical potential | 6.0% | |
| Amount of CHP economic potential from biomass | 171 | MW |

*Source: NW Council's Fifth Power Plan*

| | | | Capacity | |
|---|---|---|---|---|
| Landfill gas | 100-200 | aMW | 176 | MW |
| Washington % of population | | | 51.20% | |
| Landfill gas in Washington | | | 90 | MW |

*Assume landfill gas in included in "Technical Potential" in CHP in the Pacific Northwest: Market Assessment*

| | | |
|---|---|---|
| Landfill gas as percentage of total technical potential | 1.2% | |
| Amount of CHP economic potential from landfill gas | 33 | MW |

***Note 4:***

| Economic Potential - Accelerated Case | | | |
|---|---|---|---|
| Upper limit of system size range | | Potential (MW) | |
| 500 | kW | 399 | 14.0% |
| 1,000 | kW | 678 | 23.8% |
| 5,000 | kW | 539 | 18.9% |
| 20,000 | kW | 358 | 12.6% |
| 50,000 | kW | 429 | 15.1% |
| 260,000 | kW | 444 | 15.6% |
| | | 2,847 | |

| From Table 5-1 | Reciprocating Engine | | | | | Gas Turbine | | |
|---|---|---|---|---|---|---|---|---|
| Size of System (kW - Electricity Capacity) | 100 | 300 | 1,000 | 3,000 | 5,000 | 25,000 | 40,000 | 260,000 |
| CHP Potential (MW) | 79.8 | 319.2 | 678 | 323 | 216 | 358 | 429 | 444 |
| Current Technology Specifications (2000) | | | | | | | | |
| Electric_Heat_Rate_(Btu/kWh_HHV) | 11,500 | 10,967 | 10,035 | 9,700 | 9,213 | 9,945 | 9,220 | 7,937 |
| Electrical_Efficiency_(%) | 29.70% | 31.10% | 34.00% | 35.20% | 37.00% | 34.30% | 37.00% | 43.00% |
| Installed_Cost_--_CHP_(2003_$/kW) | $1,350 | $1,160 | $945 | $935 | $890 | $800 | $702 | $590 |
| Installed_Cost_--_CHP_(2003_$/kW) | $1,424 | $1,223 | $997 | $986 | $939 | $844 | $740 | $622 |
| O&M_Costs | $0.02 | $0.01 | $0.01 | $0.01 | $0.01 | $0.01 | $0.00 | $0.00 |
| Fuel_Input | 1.15 | 3.29 | 10.04 | 29.1 | 46.07 | 248.63 | 368.8 | 2063.67 |
| Total_Recoverable_Heat_(MMBtu/hr) | 0.56 | 1.52 | 3.7 | 9.84 | 16.66 | 89.9 | 127.3 | 443.56 |
| Economic_Life_Years | 10 | 10 | 15 | 15 | 15 | 15 | 15 | 15 |
| Net_Power_Costs | $0.08 | $0.07 | $0.06 | $0.06 | $0.05 | $0.05 | $0.05 | $0.05 |
| Advanced Technology Specifications (2020) | | | | | | | | |
| Electric_Heat_Rate_(Btu/kWh_HHV) | 10,500 | 10,185 | 8,638 | 8,322 | 7,935 | 8,865 | 8,595 | 7,300 |
| Electrical_Efficiency_(%) | 32.50% | 33.50% | 39.50% | 41.00% | 43.00% | 38.50% | 39.70% | 46.80% |
| Installed_Cost_--_CHP_(2003_$/kW) | $1,000 | $930 | $840 | $830 | $790 | $705 | $660 | $530 |
| Installed_Cost_--_CHP_(2005_$/kW) | $1,055 | $981 | $886 | $875 | $833 | $744 | $696 | $559 |
| O&M_Costs | $0.01 | $0.01 | $0.01 | $0.01 | $0.01 | $0.00 | $0.00 | $0.00 |
| Fuel_Input | 1.05 | 3.06 | 8.64 | 24.97 | 39.68 | 221.63 | 343.8 | 1898 |
| Total_Recoverable_Heat_(MMBtu/hr) | 0.49 | 1.35 | 2.9 | 8 | 13 | 77.3 | 115.5 | 409.24 |
| Economic_Life_Years | 10 | 10 | 15 | 15 | 15 | 15 | 15 | 15 |
| Net_Power_Costs | $0.06 | $0.06 | $0.05 | $0.05 | $0.05 | $0.05 | $0.04 | $0.04 |

Technical Potential By Type of System, Existing Facilities (Data from report in Note 1, Appendix E, and Tables 4-1 and 4-2). Breakdown for Large Industrial category is estimated based on Northwest Data

| Upper limit of system size range | | Large Industrial | Small Industrial | Commercial | TOTAL | Commercial as % of Total |
|---|---|---|---|---|---|---|
| 500 | kW | | 131.00 | 643.40 | 774 | 83% |
| 1,000 | kW | | 137.00 | 836.30 | 973 | 86% |
| 5,000 | kW | 283.0 | 478.00 | 755.00 | 1,516 | 50% |
| 20,000 | kW | 329.5 | | 425.00 | 755 | 56% |
| >20,000 | kW | 563.5 | | 225.00 | 789 | 29% |
| TOTAL | | 1176 | 746.00 | 2,884.70 | 4,807 | 60% |

| Allocation of Commercial System Potential into Size Ranges Used in Calculations | Commercial as % of Total |
|---|---|
| <1 MW | 85% |
| 1-4.9 MW | 50% |
| 5-24.9 MW | 56% |
| 25-39.9 MW | 29% |
| 40-259.9 MW | 0% |
| >259.9 MW | 0% |

# Estimate of Mitigation Option Costs and Benefits for Washington EE/GB IWG GHG Analysis

## EE/GB-2 EE/GB Action 2: Energy Efficiency in Existing, New and Renovated Public Buildings

*Date Last Modified: 10/31/2008 D. Von Hippel*

| Key Data and Assumptions | 2012 | 2020/all | Units |
|---|---|---|---|
| **First Year Results Accrue for Existing Public Buildings Elements**<br>*Assumed to be start of phase-in, based on Action Description.* | | 2012 | |
| **First Year Results Accrue for New Public Buildings Elements**<br>*Based on Action Description.* | | 2012 | |
| **Levelized Cost of Electricity Savings**<br>*Preliminary estimate based on 7-year payback as estimated in WGA CDEAC EE Report. See Note 1. This figure may need to be revisited in consideration of existing requirements, at least for new buildings, in WA.* | | $32 | $/MWh |
| **Levelized Cost of Natural Gas Savings**<br>*Preliminary estimate based on 7-year payback as estimated in WGA CDEAC EE Report. See Note 1. This figure may need to be revisited in consideration of existing requirements, at least for new buildings, in WA.* | | $6.6 | $/MMBtu |
| **Avoided Electricity Cost**<br>*See "Common Factors" worksheet in this workbook.* | | $66 | $/MWh |
| **Avoided Natural Gas Cost**<br>*See "Fuel prices aeo2008" and "Common Factors" worksheets in this workbook.* | | $7.6 | $/MMBtu |

| Other Data, Assumptions, Calculations | 2012 | 2020/all | Units |
|---|---|---|---|
| **Inputs to/Intermediate Results of Calculation of Electricity and Gas Savings** | | | |
| Total Commercial Floorspace in Washington (million square feet)<br>*Draft estimates from Northwest Power Planning Councl for "6th Power Plan" (see "WA_Activities_Est" worksheet in this workbook). An estimate in the same worksheet, based on USDOE EIA CBECS (commercial survey) data for the Pacific region, extrapolated using projected Washington population as a driver, yields quite similar results.* | 1,881 | 2,072 | |
| Est. area of new commercial space per year in WA (million square feet)<br>*Calculated based on annual floorspace estimates above.* | 33.1 | 23.6 | |
| Fraction of statewide commercial space owned or leased by the State, Universities, or Schools<br>*Placeholder estimate. US DOE Commercial Building Energy Consumption Survey (CBECS) data for the Pacific States suggests that about 20 percent of commercial building space is government owned, of which about 1% is federal, over 7 percent is state-owned, and the rest is locally-owned. It is assumed that a significant fraction of the local government floorspace recorded in CBECS is in public schools. Draft estimates from the Northwest Power Planning Council (see above) for floorspace by building type in Washington suggests that nearly 14 percent of total commercial/institutional building floorspace was in the categories "K-12" and "University" alone.* | | 18% | |
| Fraction of existing space owned or leased by the State, Universities, or Schools in buildings of greater than 10,000 square feet.<br>*Placeholder estimate--see above. CBECS national and regional data (Energy Information Administration, 2003 Commercial Buildings Energy Consumption Survey: Building Characteristics Tables, Tables B6, B7, B4, B5 of file b1-b46.pdf, downloaded from http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/b1-b46.pdf) suggest that this fraction is likely to be between 80 and 90 percent.* | | 80% | |
| Fraction of statewide commercial space in other public buildings<br>*Placeholder estimate--see discussion of CBECS data above.* | | 5% | |

| | | | |
|---|---|---|---|
| Fraction of space in other public buildings that are greater than 10,000 square feet.<br>*Placeholder estimate--see above. CBECS data suggest that this fraction is likely to be between 80 and 90 percent.* | | 80% | |
| Total Residential Housing Units in Washington<br>*Draft estimates from Northwest Power Planning Councl for "6th Power Plan" (see "WA_Activities_Est" worksheet in this workbook). An estimate in the same worksheet, which assumes 2005 ratio of new homes to increase in population holds through 2020, based on 2005 WA housing units as provided in U.S Census Bureau annual data, http://www.census.gov/popest/housing/HU-EST2005.html, produces similar results.* | **3,054,060** | **3,383,726** | |
| Implied persons per housing units in Washington (for reference only) | **2.23** | **2.22** | |
| Actual number of new housing units in Washington in 2007 | | 44,944 | |
| Estimated number of new residential units per year<br>*Calculated based on estimates above.* | **44,994** | **40,584** | |
| Fraction of statewide residential units publicly-owned<br>*Placeholder estimate.* | | 5% | |
| Implied Average Electricity Consumption per Square Foot Commercial Space in Washington as of 2005 (see ***Note 2***) | | 17.04 | kWh/yr |
| Implied Average Natural Gas Consumption per Square Foot Commercial Space in Washington as of 2005 (see ***Note 2***) | | 27.58 | kBtu/yr |
| Electricity consumption per square foot in publicly-owned or leased commercial space relative to average in WA<br>*Placeholder estimate--to be set at a value different than 100% if needed.* | | 100% | |
| Gas consumption per square foot in publicly-owned or leased commercial space<br>*Placeholder estimate--to be set at a value different than 100% if needed.* | | 100% | |
| Implied Average Electricity Consumption per Square Foot Publicly-owned or -leased Space in Washington as of 2005 | | 17.04 | kWh/yr |
| Implied Average Gas Consumption per Square Foot Publicly-owned or -leased Space in Washington as of 2005 | | 27.58 | kBtu/yr |
| Implied Average Electricity Consumption per Housing Unit in Washington as of 2005 (see ***Note 2***) | | **12.08** | MWh/yr |
| Implied Average Natural Gas Consumption per Housing Unit in Washington as of 2005 (see ***Note 2***) | | **27.58** | MMBtu/yr |
| Electricity consumption per square foot in publicly-owned or leased housing relative<br>*Placeholder estimate--to be set at a value different than 100% if needed.* | | 100% | |
| Gas consumption per square foot in publicly-owned or leased housing relative to<br>*Placeholder estimate--to be set at a value different than 100% if needed.* | | 100% | |
| Implied average electricity consumption per publicly-owned or leased housing unit in Washington as of 2005 | | 12.08 | MWh/yr |
| Implied average gas consumption per publicly-owned or leased housing unit in Washington as of 2005 | | 27.58 | MMBtu/yr |

| **PROGRAM ASSUMPTIONS FOR EE/GB-2** | **2012** | **2020/all** | **Units** |
|---|---|---|---|
| **Energy Efficiency Improvements in Existing Public Buildings** | | | |
| Average Electricity and Gas Savings for Buildings Participating in Program (existing commercial and residential buildings)<br>*The description for this option currently includes the following: "Emission reductions in existing buildings when buildings reach the ENERGY STAR level of 75 will result in an average reduction in $CO_2$ of 20% to 25%. This would be further reduced as buildings recertify with ENERGY STAR level of 75, because the overall building energy use will go down thus raising the bar for all buildings."* | **20.0%** | **25.0%** | |
| Date program of improvement of existing state, university, and school buildings fully "ramped up"<br>*Specified as October 1, 2016 in the Action Description* | | 2017 | |
| Date program of improvement of other existing public buildings fully "ramped up"<br>*Specified as October 1, 2018 in the Action Description* | | 2019 | |
| Fraction of existing (as of 2005) of public buildings participating in program through target dates<br>*Program Goal.* | | 100% | /yr |
| Average annual ongoing efficiency improvement in existing public buildings following "ramp-up"<br>*Program Goal (placeholder value). Intended to reflect ongoing efforts to improve energy efficiency once initial target of Energy Star rating of 75 (or equivalent) has been met.* | | 1% | /yr |
| Fraction of existing (as of 2005) public housing units participating in program through target date (uses target date for "other existing public buildings").<br>*Assumes that public housing included in program (currently placeholder value).* | | 80% | |
| Fraction of existing (as of 2005) state, university, and school buildings participating in program annually.<br>*Calculated from above.* | **16.7%** | **0.0%** | /yr |
| Implied existing state, university, and school buildings floorspace included in program annually (million square feet) | **39.574** | **-** | /yr |
| Fraction of existing (as of 2005) other public buildings participating in program annually.<br>*Calculated from above.* | **12.5%** | **0.0%** | /yr |
| Implied other public buildings floorspace included in program annually (million square feet) | **8.245** | **-** | /yr |
| Fraction of existing (as of 2005) public housing units participating in program annually.<br>*Calculated from above.* | **10.0%** | **0.0%** | /yr |
| Implied number of public housing units included in program annually | **13,750** | **-** | /yr |

**Energy Efficiency Improvements in New Public Buildings**

| | | | |
|---|---|---|---|
| Fraction of new qualifying public buildings participating in program through target dates<br>*Program Goal.* | | 100% | /yr |
| Fraction of new space owned or leased by the State, Universities, or Schools in buildings of greater than 10,000 square feet.<br>*Placeholder estimate.* | | 80% | |
| Fraction of new space owned or leased in other public buildings of greater than 10,000 square feet.<br>*Placeholder estimate.* | | 80% | |
| Fraction of new public housing units included in program.<br>*Placeholder estimate.* | | 80% | |
| Annual **reduction** in energy use relative to 2005 existing buildings (for all building types, including public housing), based on Architecture 2030 goals.<br>*From http://www.architecture2030.org/pdfs/2030Blueprint.pdf, The 2030 Blueprint: Solving Climate Change Saves Billions, Architecture 2030, page 6. Action document specifies that Architecture 2030 goals should be met for new and rennovated public buildings.* | **64.0%** | **80.0%** | |
| Ratio of substantially rennovated public building space (also covered under program) to new public building space.<br>*Placeholder estimate, but consistent with that applied in the Achitecture 2030 document referenced above for the United States as a whole.* | | 1.00 | |
| Ratio of substantially rennovated public housing (also covered under program) to new public housing space.<br>*Placeholder estimate, but consistent with that applied in the Achitecture 2030 document referenced above for the United States as a whole.* | | 1.00 | |
| Implied new state, university, and school buildings floorspace included in program annually (million square feet) | **9.543** | **6.796** | /yr |
| Implied new other public buildings floorspace included in program annually (million square feet) | **2.651** | **1.888** | /yr |
| Implied number of new residential public housing units included in program<br>*Calculated from above.* | **1,800** | **1,623** | /yr |

## CALCULATION OF SAVINGS

### Energy Efficiency Improvements in Existing Public Buildings

| | 2012 | 2020/all | Units |
|---|---|---|---|
| Implied total electricity savings in existing existing state, university, and school buildings participating in program annually.<br>*First-year savings--not cumulative.* | 134.9 | 50.8 | GWh/yr |
| Implied total electricity savings in existing other public buildings participating in program annually.<br>*First-year savings--not cumulative.* | 28.1 | 14.1 | GWh/yr |
| Implied total gas savings in existing existing state, university, and school buildings participating in program annually.<br>*First-year savings--not cumulative.* | 218.3 | 82.3 | GBtu/yr |
| Implied total gas savings in existing other public buildings participating in program annually.<br>*First-year savings--not cumulative.* | 45.5 | 22.9 | GBtu/yr |
| Implied total electricity savings in existing public housing<br>*First-year savings--not cumulative.* | 33.2 | 20.4 | GWh/yr |
| Implied total gas savings in existing public housing | 75.8 | 46.7 | GBtu/yr |
| Implied cumulative electricity savings in existing existing state, university, and school buildings | 134.9 | 1,044.4 | GWh/yr |
| Implied cumulative electricity savings in existing other public buildings | 28.1 | 268.4 | GWh/yr |
| Implied cumulative gas savings in existing existing state, university, and school buildings | 218.3 | 1,690.3 | GBtu/yr |
| Implied cumulative gas savings in existing other public buildings | 45.5 | 434.5 | GBtu/yr |
| Implied cumulative electricity savings in existing public housing | 33.2 | 321.0 | GWh/yr |
| Implied cumulative gas savings in existing public housing | 75.8 | 733.0 | GBtu/yr |

| | 2012 | 2020/all | Units |
|---|---|---|---|
| **Energy Efficiency Improvements in New Public Buildings** | | | |
| Average 2009 Energy Use Index for new commercial space relative to 2005 average energy use (electric and gas) per unit floor area in existing commercial space. | | 1.00 | |
| *Placeholder value. Value of 1.0 indicates that 2009 average for new buildings will be similar to 2005 average for all existing buildings* | | | |
| Annual **reduction** in energy use relative to 2005 existing buildings (for all building types, including public housing), based on improvements in building energy codes through Action EE/GB-3. | **38.0%** | **70.0%** | |
| *Based on EE/GB-3 goals for new buildings.* | | | |
| Implied additional reduction relative to 2005 energy intensity to meet Architecture 2030 goals | **26.0%** | **10.0%** | |
| Implied required intensity improvement to meet Architecture 2030 goals, public sector (non-residential) buildings, electricity use per square foot | **4.43** | **1.70** | kWh/yr |
| Implied required intensity improvement to meet Architecture 2030 goals, public sector (non-residential) buildings, gas use per square foot | **7.17** | **2.76** | kBtu/yr |
| Average Fraction of Improvement in Electric Energy Intensities for Public (non-residential) Buildings from: | | | |
| Energy Efficiency Improvement | 90% | 85% | |
| Solar Thermal Energy (hot water/space heat/space cooling) | 3% | 5% | |
| On-site Solar PV | 1% | 2% | |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 1% | 3% | |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | 5% | 5% | |
| *All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.* | | | |
| Average Fraction of Improvement in Gas Energy Intensities for Public (non-residential) Buildings from: | | | |
| Energy Efficiency Improvement | 96% | 92% | |
| Solar Thermal Energy (hot water/space heat/space cooling) | 3% | 5% | |
| On-site Solar PV | 0% | 0% | |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 1% | 3% | |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | 0% | 0% | |
| *All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.* | | | |
| Implied Cumulative Impacts of Action, New (non-residential) Public Building Space (Electricity savings) | | | |
| Energy Efficiency Improvement | **48.08** | **227.48** | GWh |
| Solar Thermal Energy (hot water/space heat/space cooling) | **1.84** | **10.38** | GWh |
| On-site Solar PV | **0.65** | **3.89** | GWh |
| On-site Biomass/Biogas/Landfill Gas Energy Use | **0.76** | **5.18** | GWh |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | **2.70** | **13.00** | GWh |
| Implied Cumulative Impacts of Action, New (non-residential) Public Building Space (Natural Gas savings) | | | |
| Energy Efficiency Improvement | **83.25** | **395.52** | GBtu/yr |
| Solar Thermal Energy (hot water/space heat/space cooling) | **2.97** | **16.81** | GBtu/yr |
| On-site Solar PV | **-** | **-** | GBtu/yr |
| On-site Biomass/Biogas/Landfill Gas Energy Use | **1.22** | **8.39** | GBtu/yr |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | **-** | **-** | GBtu/yr |
| Implied required intensity improvement to meet Architecture 2030 goals, public housing, electricity use per unit | **3.14** | **1.21** | MWh/yr |
| Implied required intensity improvement to meet Architecture 2030 goals, public housing, gas use per unit | **7.17** | **2.76** | kBtu/yr |

Average Fraction of Improvement in Electric Energy Intensities for Public Housing from:

| | | |
|---|---|---|
| Energy Efficiency Improvement | 90% | 85% |
| Solar Thermal Energy (hot water/space heat/space cooling) | 3% | 5% |
| On-site Solar PV | 1% | 2% |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 1% | 3% |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | 5% | 5% |

*All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.*

Average Fraction of Improvement in Gas Energy Intensities for Public Housing from:

| | | |
|---|---|---|
| Energy Efficiency Improvement | 96% | 92% |
| Solar Thermal Energy (hot water/space heat/space cooling) | 3% | 5% |
| On-site Solar PV | 0% | 0% |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 1% | 3% |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | 0% | 0% |

*All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.*

Implied Cumulative Impacts of Option, New Public Housing (Electricity savings)

| | | | |
|---|---|---|---|
| Energy Efficiency Improvement | **5.03** | **29.35** | GWh |
| Solar Thermal Energy (hot water/space heat/space cooling) | **0.19** | **1.35** | GWh |
| On-site Solar PV | **0.07** | **0.51** | GWh |
| On-site Biomass/Biogas/Landfill Gas Energy Use | **0.08** | **0.68** | GWh |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | **0.28** | **1.68** | GWh |

Implied Cumulative Impacts of Option, New Public Housing (Natural Gas savings)

| | | | |
|---|---|---|---|
| Energy Efficiency Improvement | **12.28** | **72.00** | GBtu/yr |
| Solar Thermal Energy (hot water/space heat/space cooling) | **0.44** | **3.09** | GBtu/yr |
| On-site Solar PV | **-** | **-** | GBtu/yr |
| On-site Biomass/Biogas/Landfill Gas Energy Use | **0.18** | **1.56** | GBtu/yr |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | **-** | **-** | GBtu/yr |

### Additional Inputs to/Intermediate Results of Costs Analyses

| | 2012 | 2020/all | Units |
|---|---|---|---|
| Estimated annual levelized cost of residential solar hot water per unit output | **41.19** | **30.60** | $/MMBtu |
| *Based on inputs to/results of solar hot water heating analysis included in EE/GB-Solar_Data* | | | |
| Estimated annual levelized cost of commercial solar hot water per unit output | **38.89** | **28.89** | $/MMBtu |
| *Based on inputs to/results of solar hot water heating analysis included in EE/GB-Solar_Data* | | | |
| Adjustment to solar thermal costs for inclusion of space heat/cooling measures | 1.00 | 1.00 | |
| *Placeholder assumption--Value of 1.0 implies that solar space heat and cooling will cost the same per unit output as solar water heating.* | | | |
| Implied Per Unit Cost Electricity Avoided by residential Solar WH/SH/Cooling | **130.70** | **97.09** | $/MWh |
| Implied Per Unit Cost Natural Gas Avoided by residential Solar WH/SH/Cooling | **28.83** | **21.42** | $/MMBtu |
| *Assumes delivered solar WH/SH/Cooling replaces electric with EF of 0.93, gas with EF of 0.70 (and therefore one MMBtu of delivered solar heat is the equivalent of more than one MMBtu of each fuel).* | | | |
| Implied Per Unit Cost Electricity Avoided by Solar WH/SH/Cooling (Commercial) | **123.40** | **91.67** | $/MWh |
| Implied Per Unit Cost Natural Gas Avoided by Solar WH/SH/Cooling (Commecial) | **27.22** | **20.22** | $/MMBtu |
| *Assumes delivered solar WH/SH/Cooling replaces electric with EF of 0.93, gas with EF of 0.70 (and therefore one MMBtu of delivered solar heat is the equivalent of more than one MMBtu of each fuel).* | | | |

| | 2012 | 2020/all | Units |
|---|---|---|---|
| Estimated annual levelized cost of on-site Solar PV, Commercial<br>*Based on inputs to/results of solar PV analysis included in EE/GB-Solar_Data.* | **546** | **353** | $/MWh |
| Estimated annual levelized cost of on-site residential Solar PV<br>*Based on inputs to/results of solar PV analysis included in EE/GB-Solar_Data.* | **506** | **327** | $/MWh |
| Fuel Cost for On-site Biomass/Biogas/Landfill Gas Energy Use<br>*Based on costs for Biomass fuel, which will likely dominate this category of fuel inputs. See "Common Assumptions" worksheet in this workbook. If significantly processed biomass fuels (such as pelletized fuels) are required, this cost may need to be increased.* | | 3.41 | $/MMBtu |
| Relative Efficiency of On-site Biomass/Biogas/Landfill Gas displacing electricity<br>*Placeholder assumption.* | | 0.75 | |
| Factor to reflect probable higher costs of on-site Biomass/Biogas/Landfill Gas Equipment Relative to Electric Equipment<br>*Placeholder assumption--In most cases, heating/water heating equipment designed to use biomass-derived fuels will be more expensive than equipment designed to use electricity. This factor loads these incremental capital costs into estimated fuel costs.* | | 1.50 | |
| Implied Per Unit Cost Electricity Avoided by Biomass/Biogas/Landfill Gas | **23.16** | **23.16** | $/MWh |
| Incremental Cost for Green Power Purchase (from off-site, beyond supply RPS)<br>*Placeholder assumption.* | 25.00 | 20.00 | $/MWh |

| | 2012 | 2020/all | Units |
|---|---|---|---|
| Implied Annual Net Costs of Action, New Public (non-residential) Buildings (Electricity savings) | | | |
| Energy Efficiency Improvement | **$ (1,632)** | **$ (7,723)** | $ thousand |
| Solar Thermal Energy (hot water/space heat/space cooling) | **$ 105** | **$ 433** | $ thousand |
| On-site Solar PV | **$ 311** | **$ 1,523** | $ thousand |
| On-site Biomass/Biogas/Landfill Gas Energy Use | **$ (33)** | **$ (223)** | $ thousand |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | **$ 68** | **$ 301** | $ thousand |
| Implied Annual Net Costs of Action, New Public (non-residential) Buildings (Gas savings) | | | |
| Energy Efficiency Improvement | **$ (87)** | **$ (412)** | $ thousand |
| Solar Thermal Energy (hot water/space heat/space cooling) | **$ 58** | **$ 271** | $ thousand |
| On-site Solar PV | **$ -** | **$ -** | $ thousand |
| On-site Biomass/Biogas/Landfill Gas Energy Use | **$ (5)** | **$ (35)** | $ thousand |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | **$ -** | **$ -** | $ thousand |
| Implied Annual Net Costs of Action, New Public Housing (Electricity savings) | | | |
| Energy Efficiency Improvement | **$ (171)** | **$ (996)** | $ thousand |
| Solar Thermal Energy (hot water/space heat/space cooling) | **$ 11** | **$ 55** | $ thousand |
| On-site Solar PV | **$ 33** | **$ 197** | $ thousand |
| On-site Biomass/Biogas/Landfill Gas Energy Use | **$ (3)** | **$ (29)** | $ thousand |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | **$ 7** | **$ 39** | $ thousand |
| Implied Annual Net Costs of Action, New Public Housing (Gas savings) | | | |
| Energy Efficiency Improvement | **$ (13)** | **$ (75)** | $ thousand |
| Solar Thermal Energy (hot water/space heat/space cooling) | **$ 9** | **$ 49** | $ thousand |
| On-site Solar PV | **$ -** | **$ -** | $ thousand |
| On-site Biomass/Biogas/Landfill Gas Energy Use | **$ (1)** | **$ (7)** | $ thousand |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | **$ -** | **$ -** | $ thousand |
| Implied Annual Net Costs of Option, Existing Public (non-residential) Buildings (Electricity savings) | **$ (5,533)** | **$ (44,569)** | $ thousand |
| Implied Annual Net Costs of Option, Existing Public (non-residential) Buildings (Gas savings) | **$ (275)** | **$ (2,214)** | $ thousand |
| Implied Annual Net Costs of Option, Existing Public Housing (Electricity savings) | **$ (1,128)** | **$ (10,898)** | $ thousand |
| Implied Annual Net Costs of Option, Existing Public Housing (Gas savings) | **$ (79)** | **$ (764)** | $ thousand |

| Results | 2012 | 2020 | Units |
|---|---|---|---|
| **Electricity (Conventional)** | | | |
| Reduction in Electricity Sales: Public Housing | 39 | 355 | GWh (sales) |
| Reduction in Electricity Sales: Public Sector Buildings (non-residential) | 217 | 1,573 | GWh (sales) |
| TOTAL Reduction in Electricity Sales | 256 | 1,927 | GWh (sales) |
| Reduction in Generation Requirements | 276 | 2,073 | GWh (generation) |
| GHG Emission Savings | **0.14** | **1.04** | $MMtCO_2e$ |
| **Economic Analysis** | | | |
| Net Present Value (2008-2020) | | **-$211** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 5.8 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$36.34** | $\$/tCO_2e$ |
| **Natural Gas** | | | |
| Reduction in Gas Use, Public Housing | 89 | 810 | Billion BTU |
| Reduction in Gas Use, Public Sector Buildings (non-residential) | 351 | 2,546 | Billion BTU |
| TOTAL Reduction in Gas Sales | 440 | 3,355 | Billion BTU |
| GHG Emission Savings | **0.02** | **0.18** | $MMtCO_2e$ |
| **Economic Analysis** | | | |
| Net Present Value (2008-2020) | | **-$11** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 1.0 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$10.86** | $\$/tCO_2e$ |
| **Biomass/Biogas/Landfill Gas Fuel Use** | | | |
| Added GHG Emissions from Biomass Fuels Use | **0.00001** | **0.00009** | $MMtCO_2e$ |
| Cumulative added Emissions from Biomass Fuels (2007-2020) | | 0.0005 | $MMtCO_2e$ |

| Summary Results for EE/GB-2 | 2012 | 2020 | Units |
|---|---|---|---|
| **Total for Option (Natural gas and Electricity less Biomass)** | | | |
| GHG Emission Savings | **0.16** | **1.21** | $MMtCO_2e$ |
| Net Present Value (2008-2020) | | **-$221.9** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 6.8 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$32.63** | $\$/tCO_2e$ |

| Additional Summary Results for EE/GB-2 for Reporting | 2012 | 2020 | Units |
|---|---|---|---|
| Total Green Power Purchased Under EE/GB-2 | 3 | 15 | GWh (sales) |
| Total Green Power Generation to Serve EE/GB-2 | 3 | 16 | GWh (generation) |
| GHG Emission Savings from Green Power Component | **0.0016** | **0.0079** | $MMtCO_2e$ |
| Net Present Value (2008-2020) of Green Power component of EE/GB-2 | | **$1** | $million |
| Total Renewable Electricity Under EE/GB-2 | 1 | 4 | GWh (at consumer site |
| Total Reduction in Conventional Generation due to Renewable Electricity Under EE/GB-2 (displacement from Solar PV) | 1 | 5 | GWh (equivalent at central generator) |
| GHG Emission Savings from Renewable Power Component | **0.0004** | **0.0023** | $MMtCO_2e$ |
| Net Present Value (2008-2020) of renewable electricity component of EE/GB-2 | | **$6** | $million |

***NOTES AND DATA FROM SOURCES***

***Note 1:***

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at:
http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.
The CDEAC report provides a cost of saved energy (electricity) based on an average 7-year payback for code improvements (page 42). This is likely to be a lower bound for the cost of green building practices that yield a 50 percent improvement over existing buildings, but is used as a starting point for this analysis.

For Washington, the equivalent cost is estimated as follows for electricity and natural gas

| | | |
|---|---|---|
| payback | 7 | years, from CDEAC report |
| lifespan | 25 | years, conservative assumption |
| **elec price** | **$65** | $/MWh (weighted average levelized cost of residential and commercial electricity prices in WA--See Common Factors worksheet). |
| **NG price** | **$13.25** | $/MMBtu (weighted average levelized cost of residential and commercial natural gas prices in WA--See Common Factors worksheet). |

| | | |
|---|---|---|
| Electricity levelized cost | $32.176 | $/MWh |
| Natural Gas levelized cost | $6.583 | $/MMBTU |

***Note 2:***

Based on results from Table B.5 of the 2003 Commercial Buildings Energy Consumption Survey, Detailed Tables dated October 2006 and published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/alltables.pdf, as described in "WA_Activities_Est" worksheet in this workbook.

Following data on electricity sales in Washington as of 2005 as described in "Utility_Sales" worksheet in this workbook.
Downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html (file sales_revenue.xls)

| | MWh | Fraction of Total |
|---|---|---|
| Residential | 33,212,197 | 40% |
| Commercial | 28,099,583 | 34% |
| Industrial | 22,111,773 | 27% |
| Total | 83,423,553 | 100% |

For natural gas use in Washington, consumption data are from the USDOE EIA downloaded from http://www.eia.doe.gov/oil_gas/natural_gas/applications/eia176query.html are are follows:
(See "EIA_NG_Data" worksheet in this workbook for raw EIA data)

| | Sales (Million Cubic Feet of Natural Gas) | | | |
|---|---|---|---|---|
| | Residential | Commercial | Industrial | Total |
| 2005 | 73,626 | 44,155 | 10,565 | 128,347 |
| Fraction of 2005 Total | 57% | 34% | 8% | 100% |

# Estimate of Mitigation Option Costs and Benefits for Washington EE/GB IWG GHG Analysis

**EE/GB-3** — **EE/GB Action 3: State Energy Code Improvements and Establishment of 2030 Building Goals**

*Date Last Modified: 10/31/2008 D. Von Hippel*

| Key Data and Assumptions | 2012 | 2020/all | Units |
|---|---|---|---|
| **First Year Results Accrue for Building Energy Code Elements**<br>*Based on Action Description.* | | 2012 | |
| **First Year Results Accrue for Existing Buildings and New Building "Beyond Code" Elements**<br>*Based on Action Description.* | | 2012 | |
| **Levelized Cost of Electricity Savings**<br>*Preliminary estimate based on 7-year payback as estimated in WGA CDEAC EE Report. See Note 1. This figure may need to be revisited in consideration of existing requirements, at least for new buildings, in WA.* | | $32 | $/MWh |
| **Levelized Cost of Natural Gas and Oil Products Savings**<br>*Preliminary estimate based on 7-year payback as estimated in WGA CDEAC EE Report. See Note 1. This figure may need to be revisited in consideration of existing requirements, at least for new buildings, in WA.* | | $6.6 | $/MMBtu |
| **Avoided Electricity Cost**<br>*See "Common Factors" worksheet in this workbook.* | | $66 | $/MWh |
| **Avoided Natural Gas Cost**<br>*See "Fuel prices aeo2008" and "Common Factors" worksheets in this workbook.* | | $7.6 | $/MMBtu |
| **Avoided Oil Products Cost**<br>*See "Common Factors" worksheet in this workbook. Rough weighted average of costs for distillate oil and LPG in the combined residential and commercial sectors.* | | $14.8 | $/MMBtu |

| Other Data, Assumptions, Calculations | 2012 | 2020/all | Units |
|---|---|---|---|
| **Inputs to/Intermediate Results of Calculation of Electricity and Gas Savings** | | | |
| Total Commercial Floorspace in Washington (million square feet)<br>*Draft estimates from Northwest Power Planning Councl for "6th Power Plan" (see "WA_Activities_Est" worksheet in this workbook). An estimate in the same worksheet, based on USDOE EIA CBECS (commercial survey) data for the Pacific region, extrapolated using projected Washington population as a driver, yields quite similar results.* | 1,881 | 2,072 | |
| Est. area of new commercial space per year in WA (million square feet)<br>*Calculated based on annual floorspace estimates above.* | 33.1 | 23.6 | |
| Total Residential Housing Units in Washington<br>*Draft estimates from Northwest Power Planning Councl for "6th Power Plan" (see "WA_Activities_Est" worksheet in this workbook). An estimate in the same worksheet, which assumes 2005 ratio of new homes to increase in population holds through 2020, based on 2005 WA housing units as provided in U.S Census Bureau annual data, http://www.census.gov/popest/housing/HU-EST2005.html, produces similar results.* | 3,054,060 | 3,383,726 | |
| Implied persons per housing units in Washington (for reference only) | 2.23 | 2.22 | |
| Actual number of new housing units in Washington in 2007 | | 44,944 | |
| Estimated number of new residential units per year<br>*Calculated based on estimates above.* | 44,994 | 40,584 | |
| Residential Housing Units by type in Washington | | | |
| Single Family | 70.8% | 70.5% | |
| Multi-Family | 20.7% | 21.2% | |
| Manufactured Housing<br>*Derived from draft estimates from Northwest Power Planning Councl for "6th Power Plan" (see "WA_Activities_Est" worksheet in this workbook).* | 8.5% | 8.3% | |
| Implied Average Electricity Consumption per Square Foot Commercial Space in Washington as of 2005 (see ***Note 2***) | | 17.04 | kWh/yr |
| Implied Average Natural Gas Consumption per Square Foot Commercial Space in Washington as of 2005 (see ***Note 2***) | | 27.58 | kBtu/yr |
| Implied Average Oil Products Consumption per Square Foot Commercial Space in Washington as of 2005 (see ***Note 2***) | | 3.68 | kBtu/yr |

| | | |
|---|---|---|
| Electricity consumption per square foot in commercial space meeting 2006 WSEC relative to 2005 average in WA<br>*Placeholder estimate--to be set at a value different than 100% if needed.* | 100% | |
| Gas and oil products consumption per square foot in commercial space meeting 2006 WSEC relative to average in WA in 2005<br>*Placeholder estimate--to be set at a value different than 100% if needed.* | 100% | |
| Implied average electricity consumption per square foot commercial space meeting 2006 WSEC | 17.04 | kWh/yr |
| Implied average gas consumption per square foot commercial space meeting 2006 WSEC | 27.58 | kBtu/yr |
| Implied Average Electricity Consumption per Housing Unit in Washington as of 2005 (see ***Note 2***) | **12.08** | MWh/yr |
| Implied Average Natural Gas Consumption per Housing Unit in Washington as of 2005 (see ***Note 2***) | **27.58** | MMBtu/yr |
| Implied Average Oil Products (Distillate/LPG) Consumption per Housing Unit in Washington as of 2005 | **5.43** | MMBtu/yr |

*Based on data in WA GHG inventory--see "Inventory Data" worksheet in this workbook. Residential oil consumption in 2005 was roughly half distillate oil, somewhat less than half LPG, and a few percent kerosene. See, for example, http://www.eia.doe.gov/emeu/states/_seds_updates.html.*

Average 2005 Energy Consumption Per Housing Unit, by Housing Type

| Fuel | Single-family Homes | Mult-Familty Homes | Manufactured Homes | Weighted Average | Units |
|---|---|---|---|---|---|
| Electricity | 12.16 | 11.00 | 14.00 | 12.08 | MWh/vr |
| Natural Gas | 36.00 | 5.35 | 10.00 | 27.58 | MMBtu/yr |
| Oil Products | 6.75 | 1.00 | 5.00 | 5.43 | MMBtu/yr |

*Placeholder estimates at present (except averages, which are set to match utility sales per household), pending receipt of historical data or alternative estimates. Estimates are intended to roughly reflect dominance of electricity as a heating fuel in multi-family and manufactured housing in Washington (See, for example, NPPC workbook "PNWPop&HousingData.xls", "Housing Completion Summary" worksheet.*

| | | |
|---|---|---|
| Electricity consumption per unit in new homes (all types) meeting 2006 WSEC relative to average in WA in 2005<br>*Placeholder estimate--to be set at a value different than 100% if needed.* | 100% | |
| Gas and oil consumption per unit in new homes (all types) meeting 2006 WSEC relative to average in WA in 2005<br>*Placeholder estimate--to be set at a value different than 100% if needed.* | 100% | |
| Implied average electricity consumption per new home in Washington meeting 2006 WSEC | 12.08 | MWh/yr |
| Implied average gas consumption per new home in Washington meeting 2006 WSEC | 27.58 | MMBtu/yr |

| PROGRAM ASSUMPTIONS FOR EE/GB-3 | 2012 | 2020/all | Units |
|---|---|---|---|
| **Action Part 1: Washington State Building Energy Code Revision** | | | |
| Average Electricity, Gas, and Oil Products Savings for New Residential Single-Family Buildings Covered by Revised Codes, Relative to 2006 WSEC | 30.0% | 30.0% | |
| Average Electricity, Gas, and Oil Products Savings for New Multi-Family Buildings Covered by Revised Codes, Relative to 2006 WSEC | 15.0% | 15.0% | |
| Average Electricity, Gas, and Oil Products Savings for New Manufactured Homes Covered by Revised Codes, Relative to 2006 WSEC | 20.0% | 20.0% | |
| Average Electricity, Gas, and Oil Products Savings for New Commercial Space Covered by Revised Codes, Relative to 2006 WSEC | 20.0% | 20.0% | |
| *Estimates provided by Chuck Murray of CTED (except for manufactured housing, which is a placeholder estimate), roughly consistent with Action goals.* | | | |
| Ratio of substantially rennovated commercial building space (also covered under codes) to new commercial building space. *Placeholder estimate, but consistent with that applied in the Achitecture 2030 document referenced above for the United States as a whole.* | | 1.00 | |
| Ratio of substantially rennovated homes (also covered under codes) to new homes. *Placeholder estimate, but consistent with that applied in the Achitecture 2030 document referenced above for the United States as a whole.* | | 1.00 | |
| **Action Part 2: Building Efficiency and Carbon Reduction Strategy** | | | |
| **Energy Efficiency Improvements in Existing Buildings** | | | |
| Average Electricity and Gas Savings Targets for Buildings Participating in Program (existing commercial and residential buildings). *As described in goals for Action EE/GB-3* | 8.4% | 26.0% | |
| Date program of improvement of existing buildings "ramped up". *Placeholder Estimate* | | 2017 | |
| Fraction of existing (as of 2006) commercial (non-public) and residential buildings (excluding public housing) participating in program through 2030. *Program Goal (placeholder)* | | 75% | |
| Fraction of existing commercial and residential buildings participating annually after ramp-in. *Adjusted iteratively to meet final target above. Currently MATCHES targets.* | | 4.55% | /yr |
| Implied non-public commercial building floorspace included in program annually (million square feet). *Calculated from above and from parameters in EE/GB-2. Excludes public sector floorspace.* | 9.844 | 59.065 | /yr |
| Implied number of existing homes included in program annually. *Calculated from above and from parameters in EE/GB-2. Excludes public housing, which is covered in Action 2.* | 20,149 | 120,894 | /yr |
| **Energy Efficiency Improvements in New Buildings** | | | |
| Fraction of new residential and commercial buildings participating in program through target dates. *Program Goal, assuming that higher targets for energy efficiency will eventually be incorporated into the building energy code* | | 100% | /yr |
| Date program of improvement of new buildings "ramped up". *Placeholder Estimate* | | 2017 | |
| Annual **reduction** in energy use relative to revised energy code in Part 1 for new and renovated residential and commercial buildings. *From EE/GB-3 goals, based on http://www.architecture2030.org/pdfs/2030Blueprint.pdf, The 2030 Blueprint: Solving Climate Change Saves Billions, Architecture 2030, page 6.* | 8.0% | 30.0% | |
| Ratio of substantially rennovated commercial space (also covered under program) to new commercial space. *Placeholder estimate, but consistent with that applied in the Achitecture 2030 document referenced above for the United States as a whole.* | | 1.00 | |
| Ratio of substantially housing (also covered under program) to new housing. | | 1.00 | |

| | 2012 | 2020/all | Units |
|---|---|---|---|
| Implied new commercial floorspace meeting EE-3 beyond-code targets annually (million square feet)<br>*Calculated from above. Excludes public-sector buildings covered under Action 2.* | 8.505 | 36.338 | /yr |
| Implied new residential units meeting EE-3 beyond-code targets annually<br>*Calculated from above. Excludes public housing covered under Action 2.* | 14,248 | 77,110 | /yr |

**CALCULATION OF SAVINGS**

**Action Part 1: Washington State Building Energy Code Revision**

| | 2012 | 2020/all | Units |
|---|---|---|---|
| Implied total electricity savings in new and renovated commercial buildings covered by codes in each year<br>*First-year savings--not cumulative.* | 225.9 | 160.8 | GWh/yr |
| Implied total gas savings in new and renovated commercial buildings covered by codes in each year<br>*First-year savings--not cumulative.* | 365.6 | 260.3 | GBtu/yr |
| Implied total oil products savings in new and renovated commercial buildings covered by codes in each year<br>*First-year savings--not cumulative.* | 48.8 | 34.8 | GBtu/yr |
| Implied total electricity savings in new and renovated single-family housing covered by codes in each year<br>*First-year savings--not cumulative.* | 232.4 | 208.8 | GWh/yr |
| Implied total gas savings in new and renovated single-family housing covered by codes in each year<br>*First-year savings--not cumulative.* | 688.0 | 618.0 | GBtu/yr |
| Implied total oil savings in new and renovated single-family housing covered by codes in each year<br>*First-year savings--not cumulative.* | 129.0 | 115.9 | GBtu/yr |
| Implied total electricity savings in new and renovated multi-family housing covered by codes in each year<br>*First-year savings--not cumulative.* | 30.7 | 28.3 | GWh/yr |
| Implied total gas savings in new and renovated multi-family housing covered by codes in each year<br>*First-year savings--not cumulative.* | 14.9 | 13.8 | GBtu/yr |
| Implied total oil savings in new and renovated multi-family housing covered by codes in each year<br>*First-year savings--not cumulative.* | 2.8 | 2.6 | GBtu/yr |
| Implied total electricity savings in new and renovated manufactured housing covered by codes in each year<br>*First-year savings--not cumulative.* | 21.5 | 19.0 | GWh/yr |
| Implied total gas savings in new and renovated manufactured housing covered by codes in each year<br>*First-year savings--not cumulative.* | 15.3 | 13.5 | GBtu/yr |
| Implied total oil savings in new and renovated manufactured housing covered by codes in each year<br>*First-year savings--not cumulative.* | 7.7 | 6.8 | GBtu/yr |

| | | | |
|---|---|---|---|
| Implied cumulative electricity savings in new and renovated commercial buildings covered by codes | 225.9 | 1,526.0 | GWh/yr |
| Implied cumulative gas savings in new and renovated commercial buildings covered by codes | 365.6 | 2,469.9 | GBtu/yr |
| Implied cumulative oil savings in new and renovated commercial buildings covered by codes | 48.8 | 329.8 | GBtu/yr |
| Implied cumulative electricity savings in new and renovated single-family homes covered by codes | 232.4 | 1,971.2 | GWh/yr |
| Implied cumulative gas savings in new and renovated single-family homes covered by codes | 688.0 | 5,835.9 | GBtu/yr |
| Implied cumulative oil savings in new and renovated single-family homes covered by codes | 129.0 | 1,094.2 | GBtu/yr |
| Implied cumulative electricity savings in new and renovated multi-family homes covered by codes | 30.7 | 263.9 | GWh/yr |
| Implied cumulative gas savings in new and renovated multi-family homes covered by codes | 14.9 | 128.3 | GBtu/yr |
| Implied cumulative oil savings in new and renovated multi-family homes covered by codes | 2.8 | 24.0 | GBtu/yr |
| Implied cumulative electricity savings in new and renovated manufactured homes covered by codes | 21.5 | 180.9 | GWh/yr |
| Implied cumulative gas savings in new and renovated manufactured homes covered by codes | 15.3 | 129.2 | GBtu/yr |
| Implied cumulative oil savings in new and renovated manufactured homes covered by codes | 7.7 | 64.6 | GBtu/yr |

## Action Part 2: Building Efficiency and Carbon Reduction Strategy

### Energy Efficiency Improvements in Existing Buildings

| | | | |
|---|---|---|---|
| Implied total electricity savings in existing existing commercial buildings participating in program annually. *First-year savings--not cumulative.* | 14.1 | 261.7 | GWh/yr |
| Implied total gas savings in existing existing commercial buildings participating in program annually. *First-year savings--not cumulative.* | 22.8 | 423.6 | GBtu/yr |
| Implied total oil savings in existing existing commercial buildings participating in program annually. *First-year savings--not cumulative.* | 3.0 | 56.6 | GBtu/yr |
| Implied total electricity savings in existing housing participating in program. *First-year savings--not cumulative.* | 20.4 | 379.6 | GWh/yr |
| Implied total gas savings in existing housing participating in program. *First-year savings--not cumulative.* | 46.7 | 866.8 | GBtu/yr |
| Implied total oil savings in existing housing participating in program. *First-year savings--not cumulative.* | 9.2 | 170.8 | GBtu/yr |

| | | | |
|---|---|---|---|
| Implied cumulative electricity savings in existing commercial buildings participating in program | 14.1 | 1,272.9 | GWh/yr |
| Implied cumulative gas savings in existing commercial buildings participating in program | 22.8 | 2,060.3 | GBtu/yr |
| Implied cumulative oil savings in existing commercial buildings participating in program | 3.0 | 275.1 | GBtu/yr |
| Implied cumulative electricity savings in existing housing | 20.4 | 1,846.4 | GWh/yr |
| Implied cumulative gas savings in existing housing | 46.7 | 4,216.1 | GBtu/yr |
| Implied cumulative oil savings in existing housing | 9.2 | 830.7 | GBtu/yr |

| **Energy Efficiency Improvements in New Buildings** | 2012 | 2020/all | Units |
|---|---|---|---|
| Implied required intensity improvement beyond revised code to EE/GB-3 targets, commercial buildings, electricity use per square foot | 1.36 | 5.11 | kWh/yr |
| Implied required intensity improvement beyond revised code to EE/GB-3 targets, commercial buildings, gas use per square foot | 2.21 | 8.27 | kBtu/yr |
| Implied required intensity improvement beyond revised code to EE/GB-3 targets, commercial buildings, gas use per square foot | 0.29 | 1.10 | kBtu/yr |

Average Fraction of Improvement in Electric Energy Intensities for commercial buildings from:

| | | |
|---|---|---|
| Energy Efficiency Improvement | 90% | 80% |
| Solar Thermal Energy (hot water/space heat/space cooling) | 3% | 7% |
| On-site Solar PV | 1% | 3% |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 1% | 5% |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | 5% | 5% |

*All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.*

Average Fraction of Improvement in Gas and Oil Energy Intensities for commercial buildings from:

| | | |
|---|---|---|
| Energy Efficiency Improvement | 96% | 92% |
| Solar Thermal Energy (hot water/space heat/space cooling) | 3% | 5% |
| On-site Solar PV | 0% | 0% |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 1% | 3% |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | 0% | 0% |

*All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.*

Implied Cumulative Impacts of Action, New Commercial Building Space (Electricity savings)

| | | | |
|---|---|---|---|
| Energy Efficiency Improvement | 10.20 | 772.08 | GWh |
| Solar Thermal Energy (hot water/space heat/space cooling) | 0.44 | 56.09 | GWh |
| On-site Solar PV | 0.16 | 23.37 | GWh |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 0.21 | 37.38 | GWh |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | 0.58 | 46.79 | GWh |

Implied Cumulative Impacts of Action, New Commercial Building Space (Natural Gas savings)

| | | | |
|---|---|---|---|
| Energy Efficiency Improvement | 17.87 | 1,408.53 | GBtu/yr |
| Solar Thermal Energy (hot water/space heat/space cooling) | 0.64 | 68.11 | GBtu/yr |
| On-site Solar PV | - | - | GBtu/yr |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 0.26 | 37.82 | GBtu/yr |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | - | - | GBtu/yr |

Implied Cumulative Impacts of Action, New Commercial Building Space (Oil Products savings)

| | | | |
|---|---|---|---|
| Energy Efficiency Improvement | 2.39 | 188.07 | GBtu/yr |
| Solar Thermal Energy (hot water/space heat/space cooling) | 0.09 | 9.09 | GBtu/yr |
| On-site Solar PV | - | - | GBtu/yr |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 0.04 | 5.05 | GBtu/yr |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | - | - | GBtu/yr |

| | | | |
|---|---|---|---|
| Implied required intensity improvement to meet Architecture 2030 goals, housing, electricity use per unit | **0.97** | **3.62** | MWh/yr |
| Implied required intensity improvement to meet Architecture 2030 goals, housing, gas use per unit | **2.21** | **8.27** | MBtu/yr |
| Implied required intensity improvement to meet Architecture 2030 goals, housing, oil use per unit | **0.43** | **1.63** | MBtu/yr |

Average Fraction of Improvement in Electric Energy Intensities for Housing from:

| | | |
|---|---|---|
| Energy Efficiency Improvement | 90% | 80% |
| Solar Thermal Energy (hot water/space heat/space cooling) | 3% | 7% |
| On-site Solar PV | 1% | 3% |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 1% | 5% |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | 5% | 5% |

*All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.*

Average Fraction of Improvement in Gas and Oil Energy Intensities for Housing from:

| | | |
|---|---|---|
| Energy Efficiency Improvement | 96% | 92% |
| Solar Thermal Energy (hot water/space heat/space cooling) | 3% | 5% |
| On-site Solar PV | 0% | 0% |
| On-site Biomass/Biogas/Landfill Gas Energy Use | 1% | 3% |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | 0% | 0% |

*All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.*

Implied Cumulative Impacts of Option, New Housing (Electricity savings)

| | | | |
|---|---|---|---|
| Energy Efficiency Improvement | **12.11** | **1,206.58** | GWh |
| Solar Thermal Energy (hot water/space heat/space cooling) | **0.52** | **87.60** | GWh |
| On-site Solar PV | **0.19** | **36.49** | GWh |
| On-site Biomass/Biogas/Landfill Gas Energy Use | **0.25** | **58.36** | GWh |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | **0.69** | **73.11** | GWh |

Implied Cumulative Impacts of Option, New Housing (Natural Gas savings)

| | | | |
|---|---|---|---|
| Energy Efficiency Improvement | **29.92** | **3,105.18** | GBtu/yr |
| Solar Thermal Energy (hot water/space heat/space cooling) | **1.07** | **150.09** | GBtu/yr |
| On-site Solar PV | **-** | **-** | GBtu/yr |
| On-site Biomass/Biogas/Landfill Gas Energy Use | **0.44** | **83.32** | GBtu/yr |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | **-** | **-** | GBtu/yr |

Implied Cumulative Impacts of Option, New Housing (Oil Products savings)

| | | | |
|---|---|---|---|
| Energy Efficiency Improvement | **5.89** | **610.89** | GBtu/yr |
| Solar Thermal Energy (hot water/space heat/space cooling) | **0.21** | **29.53** | GBtu/yr |
| On-site Solar PV | **-** | **-** | GBtu/yr |
| On-site Biomass/Biogas/Landfill Gas Energy Use | **0.09** | **16.39** | GBtu/yr |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | **-** | **-** | GBtu/yr |

**Additional Inputs to/Intermediate Results of Costs Analyses, Part 2 Beyond Code Elements**

| | 2012 | 2020/all | Units |
|---|---|---|---|
| Estimated annual levelized cost of residential solar hot water per unit output<br>*Based on inputs to/results of solar hot water heating analysis included in EE/GB-Solar_Data.* | **41.19** | **30.60** | $/MMBtu |
| Estimated annual levelized cost of commercial solar hot water per unit output<br>*Based on inputs to/results of solar hot water heating analysis included in EE/GB-Solar_Data.* | **38.89** | **28.89** | $/MMBtu |
| Adjustment to solar thermal costs for inclusion of space heat/cooling measures<br>*Placeholder assumption--Value of 1.0 implies that solar space heat and cooling will cost the same per unit output as solar water heating.* | 1.00 | 1.00 | |
| Implied Per Unit Cost Electricity Avoided by residential Solar WH/SH/Cooling | **130.70** | **97.09** | $/MWh |
| Implied Per Unit Cost Natural Gas Avoided by residential Solar WH/SH/Cooling<br>*Assumes delivered solar WH/SH/Cooling replaces electric with EF of 0.93, gas with EF of 0.70 (and therefore one MMBtu of delivered solar heat is the equivalent of more than one MMBtu of each fuel).* | **28.83** | **21.42** | $/MMBtu |
| Implied Per Unit Cost Electricity Avoided by Solar WH/SH/Cooling (Commercial) | **123.40** | **91.67** | $/MWh |
| Implied Per Unit Cost Natural Gas Avoided by Solar WH/SH/Cooling (Commecial)<br>*Assumes delivered solar WH/SH/Cooling replaces electric with EF of 0.93, gas with EF of 0.70 (and therefore one MMBtu of delivered solar heat is the equivalent of more than one MMBtu of each fuel).* | **27.22** | **20.22** | $/MMBtu |
| Estimated annual levelized cost of on-site Solar PV, Commercial<br>*Based on inputs to/results of solar PV analysis included in EE/GB-Solar_Data.* | **546** | **353** | $/MWh |
| Estimated annual levelized cost of on-site residential Solar PV<br>*Based on inputs to/results of solar PV analysis included in EE/GB-Solar_Data.* | **506** | **327** | $/MWh |
| Fuel Cost for On-site Biomass/Biogas/Landfill Gas Energy Use<br>*Based on costs for Biomass fuel, which will likely dominate this category of fuel inputs. See "Common Assumptions" worksheet in this workbook. If significantly processed biomass fuels (such as pelletized fuels) are required, this cost may need to be increased.* | | 3.41 | $/MMBtu |
| Relative Efficiency of On-site Biomass/Biogas/Landfill Gas displacing electricity<br>*Placeholder assumption.* | | 0.75 | |
| Factor to reflect probable higher costs of on-site Biomass/Biogas/Landfill Gas Equipment Relative to Electric Equipment<br>*Placeholder assumption--In most cases, heating/water heating equipment designed to use biomass-derived fuels will be more expensive than equipment designed to use electricity. This factor loads these incremental capital costs into estimated fuel costs.* | | 1.50 | |
| Implied Per Unit Cost Electricity Avoided by Biomass/Biogas/Landfill Gas | **23.16** | **23.16** | $/MWh |
| Incremental Cost for Green Power Purchase (from off-site, beyond supply RPS)<br>*Placeholder assumption.* | 25.00 | 20.00 | $/MWh |

| | 2012 | 2020/all | Units |
|---|---|---|---|
| **Results of Costs Analyses, Part 1 Code Revision Elements** | | | |
| Implied Annual Net Costs of Option, Code Revision Element, New and Renovated Commercial Buildings (Electricity savings) | $ (7,668) | $ (51,807) | $ thousand |
| Implied Annual Net Costs of Option, Code Revision Element, New and Renovated Commercial Buildings (Gas savings) | $ (381) | $ (2,573) | $ thousand |
| Implied Annual Net Costs of Option, Code Revision Element, New and Renovated Commercial Buildings (Oil savings) | $ (400) | $ (2,700) | $ thousand |
| Implied Annual Net Costs of Option, Code Revision Element, New and Renovated Residential Buildings (Electricity savings) | $ (9,661) | $ (82,021) | $ thousand |
| Implied Annual Net Costs of Option, Code Revision Element, New and Renovated Residential Buildings (Gas savings) | $ (748) | $ (6,348) | $ thousand |
| Implied Annual Net Costs of Option, Code Revision Element, New and Renovated Residential Buildings (Oil savings) | $ (1,142) | $ (9,683) | $ thousand |
| **Results of Costs Analyses, Part 2 Beyond Code Elements** | | | |
| Implied Annual Net Costs of Option, Beyond Code Elements, Existing Commercial Buildings (Electricity savings) | $ (478) | $ (43,216) | $ thousand |
| Implied Annual Net Costs of Option, Beyond Code Elements, Existing Commercial Buildings (Gas savings) | $ (24) | $ (2,146) | $ thousand |
| Implied Annual Net Costs of Option, Beyond Code Elements, Existing Commercial Buildings (Oil savings) | $ (25) | $ (2,252) | $ thousand |
| Implied Annual Net Costs of Option, Existing Housing (Electricity savings) | $ (694) | $ (62,686) | $ thousand |
| Implied Annual Net Costs of Option, Existing Housing (Gas savings) | $ (49) | $ (4,392) | $ thousand |
| Implied Annual Net Costs of Option, Existing Housing (Oil savings) | $ (75) | $ (6,801) | $ thousand |
| Implied Annual Net Costs of Action, New Commercial Buildings (Electricity savings) | | | |
| Energy Efficiency Improvement | $ (346) | $ (26,212) | $ thousand |
| Solar Thermal Energy (hot water/space heat/space cooling) | $ 25 | $ 1,785 | $ thousand |
| On-site Solar PV | $ 78 | $ 7,777 | $ thousand |
| On-site Biomass/Biogas/Landfill Gas Energy Use | $ (9) | $ (1,606) | $ thousand |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | $ 14 | $ 1,009 | $ thousand |
| Implied Annual Net Costs of Action, New Commercial Buildings (Gas savings) | | | |
| Energy Efficiency Improvement | $ (19) | $ (1,467) | $ thousand |
| Solar Thermal Energy (hot water/space heat/space cooling) | $ 13 | $ 957 | $ thousand |
| On-site Solar PV | $ - | $ - | $ thousand |
| On-site Biomass/Biogas/Landfill Gas Energy Use | $ (1) | $ (160) | $ thousand |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | $ - | $ - | $ thousand |
| Implied Annual Net Costs of Action, New Commercial Buildings (Oil savings) | | | |
| Energy Efficiency Improvement | $ (20) | $ (1,540) | $ thousand |
| Solar Thermal Energy (hot water/space heat/space cooling) | $ (1) | $ (134) | $ thousand |
| On-site Solar PV | $ - | $ - | $ thousand |
| On-site Biomass/Biogas/Landfill Gas Energy Use | $ (1) | $ (75) | $ thousand |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | $ - | $ - | $ thousand |
| Implied Annual Net Costs of Action, New Housing (Electricity savings) | | | |
| Energy Efficiency Improvement | $ (411) | $ (40,963) | $ thousand |
| Solar Thermal Energy (hot water/space heat/space cooling) | $ 30 | $ 2,792 | $ thousand |
| On-site Solar PV | $ 92 | $ 12,161 | $ thousand |
| On-site Biomass/Biogas/Landfill Gas Energy Use | $ (11) | $ (2,508) | $ thousand |
| Green Power Purchase (from off-site, beyond electricity supply RPS) | $ 17 | $ 1,577 | $ thousand |
| Implied Annual Net Costs of Action, New Housing (Gas savings) | | | |
| Energy Efficiency Improvement | $ (31) | $ (3,235) | $ thousand |
| Solar Thermal Energy (hot water/space heat/space cooling) | $ 21 | $ 2,111 | $ thousand |
| On-site Solar PV | $ - | $ - | $ thousand |
| On-site Biomass/Biogas/Landfill Gas Energy Use | $ (2) | $ (352) | $ thousand |

| Results | 2012 | 2020 | Units |
|---|---|---|---|
| **Electricity (Conventional)** | | | |
| Reduction in Electricity Sales: Residential Sector | 319 | 5,725 | GWh (sales) |
| Reduction in Electricity Sales: Commercial Sector | 252 | 3,735 | GWh (sales) |
| TOTAL Reduction in Electricity Sales | 570 | 9,459 | GWh (sales) |
| Reduction in Generation Requirements | 615 | 10,174 | GWh (generation) |
| GHG Emission Savings | **0.31** | **5.09** | $MMtCO_2e$ |
| **Economic Analysis** | | | |
| Net Present Value (2008-2020) | | **-$724** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 21.2 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$34.12** | $/tCO_2e$ |
| **Natural Gas** | | | |
| Reduction in Gas Use: Residential Sector | 796 | 13,648 | Billion BTU |
| Reduction in Gas Use: Commercial Sector | 430 | 6,468 | Billion BTU |
| TOTAL Reduction in Gas Use | 1,226 | 20,116 | Billion BTU |
| GHG Emission Savings | **0.06** | **1.06** | $MMtCO_2e$ |
| **Economic Analysis** | | | |
| Net Present Value (2008-2020) | | **-$45** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 4.5 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$10.10** | $/tCO_2e$ |
| **Oil Products** | | | |
| Reduction in Oil Use: Residential Sector | 155 | 2,670 | Billion BTU |
| Reduction in Oil Use: Commercial Sector | 9 | 534 | Billion BTU |
| TOTAL Reduction in Oil Use | 163 | 3,204 | Billion BTU |
| GHG Emission Savings | **0.01** | **0.22** | $MMtCO_2e$ |
| **Economic Analysis** | | | |
| Net Present Value (2008-2020) | | **-$72** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 0.9 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$79.77** | $/tCO_2e$ |
| **Biomass/Biogas/Landfill Gas Fuel Use** | | | |
| Added GHG Emissions from Biomass Fuels Use | **0.00001** | **0.00139** | $MMtCO_2e$ |
| Cumulative added Emissions from Biomass Fuels (2007-2020) | | 0.0043 | $MMtCO_2e$ |

| Summary Results for EE/GB-3 | 2012 | 2020 | Units |
|---|---|---|---|
| **Total for Part 1 of Action (WSEC Revision) (natural gas, electricity, and oil)** | | | |
| GHG Emission Savings | **0.35** | **2.68** | $MMtCO_2e$ |
| Net Present Value (2008-2020) | | **-$487** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 13.8 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$35.34** | $/tCO_2e$ |
| **Total for Existing Buildings Improvement portion of Part 2 of Action (natural gas, electricity, and oil)** | | | |
| GHG Emission Savings | **0.02** | **2.09** | $MMtCO_2e$ |
| Net Present Value (2008-2020) | | **-$242** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 7.1 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$33.86** | $/tCO_2e$ |
| **Total for New Buildings Efficiency Targets portion of Part 2 of Action (natural gas, electricity, and oil less biomass)** | | | |
| GHG Emission Savings | **0.02** | **1.60** | $MMtCO_2e$ |
| Net Present Value (2008-2020) | | **-$112** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 5.6 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$19.76** | $/tCO_2e$ |
| **Total for All Parts of Option (natural gas, electricity and oil less biomass)** | | | |
| GHG Emission Savings | **0.38** | **6.37** | $MMtCO_2e$ |
| Net Present Value (2008-2020) | | **-$840.9** | $million |
| Cumulative Emissions Reductions (2008-2020) | | 26.6 | $MMtCO_2e$ |
| Cost-Effectiveness | | **-$31.63** | $/tCO_2e$ |

| Additional Summary Results for EE/GB-3 for Reporting | 2012 | 2020 | Units |
|---|---|---|---|
| Total Green Power Purchased Under EE/GB-3 | 1 | 120 | GWh (sales) |
| Total Green Power Generation to Serve EE/GB-3 | 1 | 129 | GWh (generation) |
| GHG Emission Savings from Green Power Component | **0.0007** | **0.0647** | $MMtCO_2e$ |
| Net Present Value (2008-2020) of Green Power component of EE/GB-3 | | **$5.2** | $million |
| | | | |
| Total Renewable Electricity Under EE/GB-3 | 0 | 60 | GWh (at consumer site |
| Total Reduction in Conventional Generation due to Renewable Electricity Under EE/GB-3 (displacement from Solar PV) | 0 | 65 | GWh (equivalent at central generator) |
| GHG Emission Savings from renewable electricity component | **0.0002** | **0.0309** | $MMtCO_2e$ |
| Net Present Value (2008-2020) of renewable electricity component of EE/GB-3 | | **$39.8** | $million |
| | | | |
| **Reduction in Electricity Sales and Emissions from Existing Buildings Component of EE/GB-3** | | | |
| Reduction in Electricity Sales: Residential Sector | 20 | 1,846 | GWh (sales) |
| Reduction in Electricity Sales: Commercial Sector | 14 | 1,273 | GWh (sales) |
| TOTAL Reduction in Electricity Sales | 35 | 3,119 | GWh (sales) |
| Reduction in Generation Requirements | 37 | 3,355 | GWh (generation) |
| GHG Emission Savings | **0.02** | **1.68** | $MMtCO_2e$ |

Estimated savings in 2030 (Existing Buildings Component only) as a fraction of 2030 Forecast Demand by sector (for comparison with, for example, utility I-937 Targets--see "GHG Totals" Worksheet).

| | |
|---|---|
| Residential Sector | 15.0% |
| Commercial Sector | 13.0% |

***NOTES AND DATA FROM SOURCES***

***Note 1:***

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at:
http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.
The CDEAC report provides a cost of saved energy (electricity) based on an average 7-year payback for code improvements (page 42). This is likely to be a lower bound for the cost of green building practices that yield a 50 percent improvement over existing buildings, but is used as a starting point for this analysis.

For Washington, the equivalent cost is estimated as follows for electricity and natural gas

| | | |
|---|---|---|
| payback | 7 | years, from CDEAC report |
| lifespan | 25 | years, conservative assumption |
| **elec price** | **$65** | $/MWh (weighted average levelized cost of residential and commercial electricity prices in WA--See Common Factors worksheet). |
| **NG price** | **$13.25** | $/MMBtu (weighted average levelized cost of residential and commercial natural gas prices in WA--See Common Factors worksheet). |

| | | |
|---|---|---|
| Electricity levelized cost | $32.176 | $/MWh |
| Natural Gas levelized cost | $6.583 | $/MMBTU |

***Note 2:***

Based on results from Table B.5 of the 2003 Commercial Buildings Energy Consumption Survey, Detailed Tables dated October 2006 and published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/alltables.pdf, as described in "WA_Activities_Est" worksheet in this workbook.

Following data on electricity sales in Washington as of 2005 as described in "Utility_Sales" worksheet in this workbook.
Downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html (file sales_revenue.xls)

| | MWh | Fraction of Total |
|---|---|---|
| Residential | 33,212,197 | 40% |
| Commercial | 28,099,583 | 34% |
| Industrial | 22,111,773 | 27% |
| Total | 83,423,553 | 100% |

For natural gas use in Washington, consumption data are from the USDOE EIA downloaded from
http://www.eia.doe.gov/oil_gas/natural_gas/applications/eia176query.html are are follows:
(See "EIA_NG_Data" worksheet in this workbook for raw EIA data)

| | Sales (Million Cubic Feet of Natural Gas) | | | |
|---|---|---|---|---|
| | Residential | Commercial | Industrial | Total |
| 2005 | 73,626 | 44,155 | 10,565 | 128,347 |
| Fraction of 2005 Total | 57% | 34% | 8% | 100% |

## Estimate of Mitigation Option Costs and Benefits for Washington EE/GB IWG GHG Analysis

**EE/GB-Solar Data** **Supplemental to Actions 2 and 3: Assumptions and Intermediate Results for Cost and Performance of Solar Water/Space Heating, Solar PV, and Biomass Measures**

*Date Last Modified: 10/17/2008 D. Von Hippel*

| Data, Assumptions, Calculations | 2012 | 2020/all | Units |
|---|---|---|---|
| **Additional Inputs to/Intermediate Results of Costs Analyses** | | | |
| | **2012** | **2020/all** | **Units** |
| Incremental Capital Cost of Solar Water Heater (relative to electric or gas unit) | **$5,000** | **$4,000** | |
| *Assumption for residential unit, and assumes costs will decrease over time. Due to high prices for metals, current retail costs of solar hot water systems are higher than 2012 value shown.* | | | |
| Fraction of household hot water needs provided by solar HW units | **65.0%** | **70.0%** | |
| *Rough Estimate, but consistent with rule of thumb from Puget Sound Solar Inc (http://www.pugetsoundsolar.com/starthere.html) for Seattle area installation.* | | | |
| Average annual water heating energy used per household (hot water output) | | 12.69 | MMBtu |
| *Based on assumption of household with electric water heater using 4000 kWh/yr at average efficiency (EF) of 93% heat in hot water/electrical energy input.* | | | |
| ***Inputs to Cost Estimates for Residential Solar PV Systems (Data from Source in Note 4)*** | | | |
| Average Capacity of Solar PV System Installed on New Homes (kW) | **2.00** | **2.00** | |
| *Assumption, consistent with capacity assumption used in Source in* ***Note 1*** *.* | | | |
| Capital Costs for PV Systems for New Homes | | | |
| Module | **$ 3,019** | **$ 2,003** | |
| BOS (Balance of System) | **$ 1,115** | **$ 739** | |
| Installation | **$ 331** | **$ 143** | |
| Total System - $/kW | **$ 4,465** | **$ 2,885** | |
| Total System - $ | **$ 8,929** | **$ 5,769** | |
| Average full-capacity-equivalent hours of operation for Solar PV Systems: | **1,200** | **1,200** | |
| *Rough estimate, but consistent, for example, with rule-of-thumb from Puget Sound Solar, Inc. (http://www.pugetsoundsolar.com/starthere.html) for Seattle area installation.* | | | |
| Factors for Annualizing Capital Costs (Residential PV and Solar Hot Water Systems) | | | |
| Interest Rate (real) | | 7% | /yr |
| Economic Life of System | | 20 | years |
| Implied Annualization Factor | | 9.44% | %/yr |
| Marginal Federal Tax Rate, Residential | | 28% | |
| Federal Solar Tax Credits: Residential Sector--See ***Note 2.*** | 0% | 0% | |
| Capital Cost per Unit Capacity (and output) of Commercial Versus Residential Solar HW Heaters | | **70%** | |
| *Placeholder Assumption. Assumes economies of scale for materials and installation for commercial units relative to (significantly smaller, on average) residential units.* | | | |
| Commercial System Capital costs/kW Relative to New Residential | 80% | 80% | |
| *Rough assumption, but similar to values in literature--See* ***Note 3*** *.* | | | |
| Federal Solar Tax Credits: Commercial Sector--See ***Note 2.*** | 10% | 10% | |
| Other Factors for Annualizing Capital Costs (Commercial PV and Solar Hot Water Systems) | | | |
| Interest Rate (real) | | 8% | /yr |
| Economic Life of System | | 20 | years |
| Implied Annualization Factor | | 10.19% | %/yr |

| | | | |
|---|---|---|---|
| Estimated annual levelized cost of residential solar hot water per unit output<br>*Calculated based on inputs above.* | **41.19** | **30.60** | $/MMBtu |
| Estimated annual levelized cost of commercial solar hot water per unit output<br>*Calculated based on inputs above.* | **38.89** | **28.89** | $/MMBtu |
| Adjustment to solar thermal costs for inclusion of space heat/cooling measures<br>*Placeholder assumption--Value of 1.0 implies that solar space heat and cooling will cost the same per unit output as solar water heating.* | 1.00 | 1.00 | |
| Implied Per Unit Cost Electricity Avoided by Solar WH/SH/Cooling (Residential) | **130.70** | **97.09** | $/MWh |
| Implied Per Unit Cost Natural Gas Avoided by Solar WH/SH/Cooling (Residential)<br>*Assumes delivered solar WH/SH/Cooling replaces electric with EF of 0.93, gas with EF of 0.70 (and therefore one MMBtu of delivered solar heat is the equivalent of more than one MMBtu of each fuel).* | **28.83** | **21.42** | $/MMBtu |
| Implied Per Unit Cost Electricity Avoided by Solar WH/SH/Cooling (Commercial) | **123.40** | **91.67** | $/MWh |
| Implied Per Unit Cost Natural Gas Avoided by Solar WH/SH/Cooling (Commercial)<br>*Assumes delivered solar WH/SH/Cooling replaces electric with EF of 0.93, gas with EF of 0.70 (and therefore one MMBtu of delivered solar heat is the equivalent of more than one MMBtu of each fuel).* | **27.22** | **20.22** | $/MMBtu |
| Estimated annual levelized cost of on-site Solar PV, Residential<br>*Calculated based on inputs above.* | **565** | **327** | $/MWh |
| Estimated annual levelized cost of on-site Solar PV, Commercial<br>*Calculated based on inputs above.* | **610** | **353** | $/MWh |
| Fuel Cost for On-site Biomass/Biogas/Landfill Gas Energy Use<br>*Based on costs for Biomass fuel, which will likely dominate this category of fuel inputs. See "Common Factors" worksheet in this workbook. If significantly processed biomass fuels (such as pelletized fuels) are required, this cost may need to be increased.* | | 3.41 | $/MMBtu |
| Relative Efficiency of On-site Biomass/Biogas/Landfill Gas displacing electricity<br>*Placeholder assumption.* | | 0.75 | |
| Factor to reflect probable higher costs of on-site Biomass/Biogas/Landfill Gas Equipment Relative to Electric Equipment<br>*Placeholder assumption--In most cases, heating/water heating equipment designed to use biomass-derived fuels will be more expensive than equipment designed to use electricity. This factor loads these incremental capital costs into estimated fuel costs.* | | 1.50 | |
| Implied Per Unit Cost Electricity Avoided by Biomass/Biogas/Landfill Gas | **23.16** | **23.16** | $/MWh |
| Incremental Cost for Green Power Purchase (from off-site, beyond supply RPS)<br>*Placeholder assumption, but should be linked to assumptions for relevant EEGB options, as necessary.* | 25.00 | 20.00 | $/MWh |

***NOTES AND DATA FROM SOURCES***

***Note 1:***

Source: Worksheet "Solar Homes Summary table.xls", with calculations in support of the California Million Solar Homes Initiative, authored by XENERGY, Inc., and provided by M. Lazarus. Selected annual data provided.

***Note 2:***

A description of the new Federal Solar Tax Credits for businesses and residences as contained in the Energy Policy Act of 2005 (EPAct 2005) (see, for example, http://www.seia.org/getpdf.php?iid=21) provides for 30% (of system cost) tax credits for solar PV investments by businesses in 2006 and 2007, reverting to 10% thereafter. For residences, the credit in 2006 and 2007 is 30% with a "cap" of $2000, reverting to zero after 2007. For the purpose of this analysis, we are modeling the federal tax credit at its long-term (10% business, 0% residential) level, as no systems are added in 2006 and 2007.

See also, for Example,
http://www.sdenergy.org/uploads/PV-Federal%20Tax%20Credits%20Summary%206-01-04%20FINAL.pdf.

***Note 3:***

Source: International Energy Agency (IEA), T<u>RENDS IN PHOTOVOLTAIC APPLICATIONS</u>
<u>Survey report of selected IEA countries between 1992 and 2004</u>. Report #IEA-PVPS T1-14:2005.
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"Indicative costs" in 2004 in USD per kWp (assumedly DC output) for on-grid PV systems in the US:

| | |
|---|---|
| <10 kW | 7000 to 10,000 |
| >10 kW | 6300 to 8500 |

In EIA Projections of Renewable Energy Costs, presented in "Forum on the Economic Impact Analysis of NJ's Proposed 20% RPS" by Chris Namovicz of the USDOE EIA (Energy Information Administration), dated February 22, 2005, and available as http://www.eia.doe.gov/oiaf/pdf/rec.pdf, a wind power average cost of

| | |
|---|---|
| 6000 | dollars/kW is provided for a 25 kW Commercial system, or |
| 8200 | dollars/kW for a 2 kW Residential system, with |

"Large potential for cost reduction".