REPORT TO STAKEHOLDERS FROM BUILDINGS, FACILITIES & MANUFACTURING WORKING GROUP

Date: June 15, 2004
To: GHG Stakeholder Advisory Group
From: Buildings, Facilities & Manufacturing Working Group
Re: Recommendations regarding Options to reduce GHG emissions from Buildings, Facilities, Manufacturing

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The purpose of this memo is to report to the Stakeholder Group on the work by the Buildings, Facilities & Manufacturing Working Group concerning potential greenhouse gas reduction options related to buildings, facilities and manufacturing in Maine.

The Working Group met four times, on January 23, February 26, March 25 and May 26, 2004. During the first meeting, the Working Group reviewed and commented on information then available for developing an inventory and baseline for residential, commercial, and industrial buildings and facilities. At the first meeting the Working Group also reviewed the GHG Options suggested for analysis by the Stakeholder Group and suggested additional options for analysis. At the second through fourth meetings, the Working Group refined the inventory and baseline by providing Maine specific information, developed and refined policy statements, and provided information to estimate potential GHG emissions savings and costs of options. A number of Working Group members put in many hours outside of meetings to develop this information. During the third and fourth meetings, the Working Group evaluated options. The results of this evaluation are set out below.

The Work Group notes that it has provided a graph of per unit emissions, as well as graphs of projected total emissions from the residential, commercial and industrial sectors. The Work Group urges the Stakeholder Advisory Group and DEP to take into account efforts that have and are being made to reduce emissions on a per unit basis.

All Working Group Members recommend those options set out under the list of consensus recommendations. The Options are described more fully in the accompanying report. Work Group members note that consensus means that members agreed that the Option was sufficiently promising to be considered by DEP for inclusion in the Plan, understanding that the level of detail necessary for a fully implementable policy measure or program will need to be developed in the appropriate forum at a later date. By reaching consensus here, Work Group members are not committing to support specific policy measures or programs not yet developed.

Consensus Recommendation Options - Quantified

	Measure (Sector)	Estimated Savings in 2010 '000 MTCO2 (Electricity)	'000 MTCO2 (Fossil Fuel)	'000 MTCO2 (Total)	Estimated Savings in 2020 '000 MTCO2 (Electricity)	'000 MTCO2 (Fossil Fuel)	'000 MTCO2 (Total)	Cost Effectiveness $/tCO2
1	Appliances							
1.1	Appliance Standards (R/C)	84.3	0.0	**84.3**	128.7	0.0	**128.7**	-134
2	Residential buildings							
2.1	Improve Residential Building Energy Codes	0.6	24.2	**24.7**	1.6	62.5	**64.1**	-35
2.3	Voluntary Green Building Design Standards	0.1	23.4	**23.5**	0.2	27.8	**28.0**	-45
2.6	Efficient Use of Oil and Gas: Home Heating	0.0	29.3	**29.3**	0.0	39.1	**39.1**	-6
3	Commercial and Institutional Buildings							
3.2	Promote energy efficiency buildings	2.9	1.4	**4.3**	7.5	3.7	**11.3**	-19
3.3	Encourage state to fund most cost-effective energy savings in state buildings	4.4	3.5	**7.9**	12.0	9.1	**21.0**	-37
3.6	Green Campus Initiative	3.3	7.7	**11.0**	9.3	20.6	**29.8**	-18
3.7	Enforce Commercial Building Energy Code	9.3	2.6	**12.0**	26.6	7.0	**33.6**	-61
3.8	Improve the electricial efficiency in the commercial and institutional sectors	181.9	0.0	**181.9**	250.8	0.0	**250.8**	-139
3.9	Procurement Preference for Concrete Containing Slag	0.0	18.0	**18.0**	0.0	18.0	**18.0**	0
4	Industry							
4.1	Promote electrical efficiency measures for manufacturing in Maine	156.5	0.0	**156.5**	207.2	0.0	**207.2**	-30
4.8	Accept ASTM specification C150 for portland cement	0.0	9.0	**9.0**	0.0	9.0	**9.0**	0
5	Comprehensive							
5.2	Increase Public Expenditures for Electrical Efficiency Measures	25.0	0.0	**25.0**	71.1	0.0	**71.1**	-55
5.6	PV Buy Down Program	0.1	0.0	**0.1**	0.2	0.0	**0.2**	NE
5.7	Solar Hot Water Heater Program	5.5	6.6	**12.0**	15.6	17.5	**33.1**	16
5.9	Participate in Voluntary Partnerships and Recognition Programs	0.0	34.5	**34.5**	0.0	57.5	**57.5**	NE
5.10	Reduce HFC Leaks from Refrigeration	0.0	1.2	**1.2**	0.0	9.0	**9.0**	1
	Total Savings from BFM ('000 MTCO2E)	**474**	**161**	**635**	**731**	**281**	**1,011**	

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Consensus Recommendation Options—Not Quantified

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5.12	Substitution of High GWP Gases	Data not readily available/Future Technology
5.13	Negotiated Agreements	Data not readily available
5.14	Encourage Combined Heat and Power	Quantified by the Electricity Working Group

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Notes for Table of Consensus Measures:

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Measure 3.8: "Improve Electrical Efficiency in Commercial Buildings:" The Work Group notes that consensus does not reflect agreement on a specific funding mechanism or level.

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Measure 4.5: "Industrial Ecology / Byproduct Synergy:" This Option includes 2 policies. The second includes a recommendation "to evaluate funding for future bioproduct-based research opportunities." NRCM supports this second option only "if the other research opportunities meet health, safety and performance requirements and no additional pollution is generated."

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Measure 5.5: "Increase public expenditures for fuel efficiency measures" All members agreed with this measure with the following exception: The Maine Oil Dealers Association is not in agreement with this option because no definition of "public expenditures" was discussed. MODA has and will continue to support bond proposals such as programs for weatherization improvements.

Measures Combined or Referred to Another Working Group

	Measures Combined with Other Measures or Referred to Another Working Group	
2.2	Training and Enforcement of Residential Building Codes (BFM 2.1)	Included in BFM 2.1
2.4	Energy Efficiency Mortgages (BFM 2.2)	Included in BFM 2.2
2.5	Education to Homeowners (Residential)	Referred to Education WG
3.1	Energy Standards for New Construction/Renovations	Quantified and included in baseline
3.4	Shared Savings Program for Government Agencies (BFM 3.3)	Included in BFM 3.3
5.1	Government Agency Requirement and Goals (BFM 3.3, 3.8)	Included in BFM 3.3, 3.8
5.3	Public Education (Comprehensive)	Referred to Education WG
5.4	Incentives for Green Power Purchases	Referred to Electricity WG

A Work Group member suggested taking a more focused approach to addressing the use of low lumen/watt bulbs, such as incandescent bulbs. The Work Group did not have time to address this, other than through the options listed above.

Notes for Tables:
NE: Not estimated
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*Discount rate of 7% used to estimate cost effectiveness. Time did not allow determination of discount rates for different sectors. Manufacturing representatives wish to have their view of the discount rate included in this report, as follows:

'When reviewing the cost benefit options, representatives from manufacturing state that in their sector, investment paybacks greater than 2 to 3 years are not reasonable when considering private investment or a legal guarantee. The risks of process change, economic conditions and the availability of more attractive options for limited capital investment preclude investments with payback greater than 2 to 3 years.   For many manufacturing projects, a payback of less than 1 year may be required.'

The BFM Work Group does not argue that the previous statement should be used to modify the cost-effectiveness for public investment.

Stakeholders:	Meetings Present	1/23	2/26	3/25	5/26
Anderson, Leslie	Dead River Company	X			
Anderson, Norm	American Lung Association			X	
Barden, Michael	Maine Pulp & Paper Association	X	X	X	X
Baston, Doug	Northeast by Northwest	X	X	X	X
Bergeron, Denis	Public Utilities Commission		X	X	X
Burt, Andy	Maine Council of Churches		X		X
Buxton, Tony	Independent Energy Consumers	X	X	X	X
Cox, Shannon	Interface Fabrics Groups	X	X	X	X
Greeley, Dudley	University of Southern Maine	X	X	X	X
Hall, Dick	National Semiconductor	X	X	X	X
Hubbell, Brian		X	X	X	
Jones, Sue	Natural Resources Council of Me	X		X	X
Karagiannes, Mike	DEP Air Quality	X	X	X	X
Kraske, Chuck	International Paper - Androscoggin	X	X	X	X
Py, Jamie/				X	
Aho, Pattie	Maine Oil Dealers	X	X		X
Stoddard, Michael	Environment Northeast	X	X	X	X
Thayer, Ann	Dragon Products	X	X	X	X
Gosline, Ann	Facilitator	X	X	X	X
Lawson, Karen	CCAP	X	X	X	X

Notes:
Ms. Lawson attended the 3rd and 4th meetings by teleconference
Working Group members who do not attend any meetings are not listed.

Maine Greenhouse Gas Action Plan Development Process

Building, Facilities, and Manufacturing Greenhouse Gas Reduction Options

Center for Clean Air Policy

June 3rd, 2004

Buildings, Facilities, & Manufacturing (BFM) Assumptions Document as of June 3, 2004

Table of Contents

1. Sector Baseline and Cumulative GHG Reduction

The Building, Facilities, and Manufacturing baseline includes the following GHG emissions from the following source categories in the residential, commercial, and industrial sectors:

- *Carbon dioxide emissions from direct combustion of fossil fuels*. Direct combustion of fossil fuels refers to coal, oil and natural gas that is combusted on-site in the residential, commercial, and industrial sector.

- *Methane and nitrous oxide emissions from combustion of fossil fuels at stationary sources (including electricity sector as well as residential, commercial and industrial sectors.* Note: Includes methane and nitrous oxide emissions from wood combustion, but emissions from other biomass is not included.

- *Methane emissions from the transmission and distribution of natural gas within the State of Maine.* Methane is emitted during oil and gas production, storage, transportation, and distribution. Since there is no oil or gas production in Maine, emissions occur solely through gas transmission and distribution. Major CH_4 emission sources from gas transmission pipelines include chronic leaks, fugitive emissions from compressors, compressor exhaust, vents, and pneumatic devices; for gas distribution pipelines, major CH_4 emission sources include chronic leaks, meters, regulators and mishaps.

- *Sulfur hexafluoride (SF_6) emissions from electric power transmission and distribution systems within the State of Maine*.

- *High global warming potential gas (HFC, PFC, and SF_6) emissions from substitutes for ozone-depleting substances*. High GWP gas emissions result from the following applications: refrigeration & A/C, solvents, foams, aerosols, fire extinguishing.

- *Carbon dioxide from cement production process emissions*. CO_2 emissions associated with fossil fuel combustion at cement facilities are not accounted for here. They are captured under "CO_2 emissions from direct combustion of fossil fuels".

- *High GWP gas emissions from semiconductor manufacture*.

GHG emissions not accounted for in this baseline include:

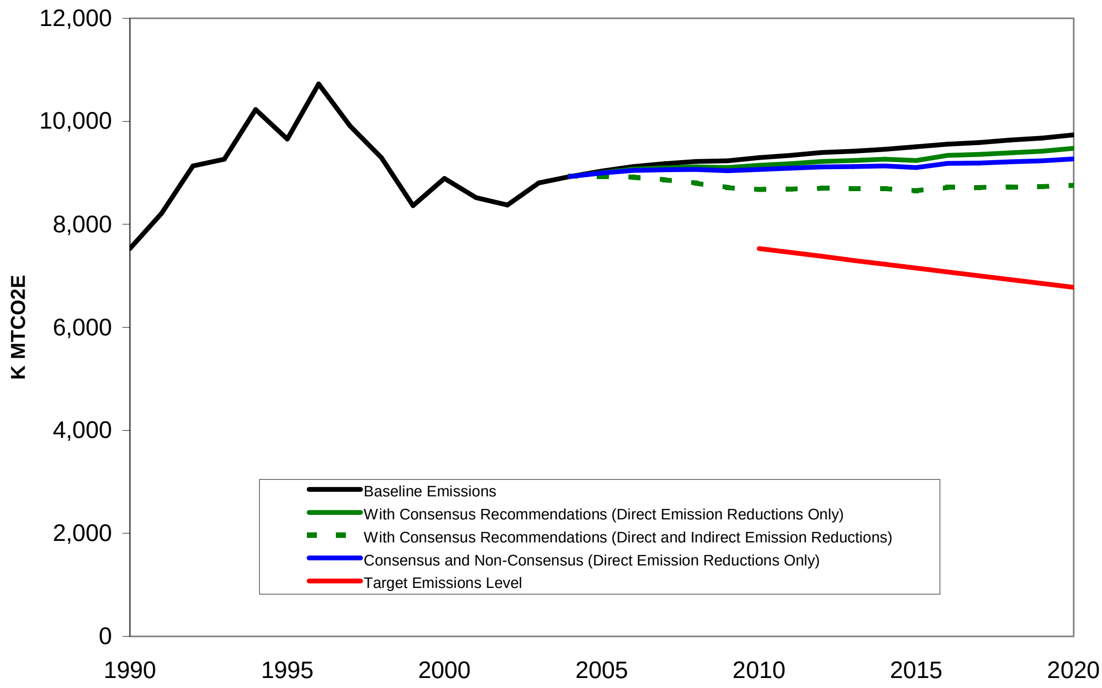
- *CO_2 emissions from wood burning*.
- *Methane emissions from LNG ships cooling gas in ports*.
- *GHG emissions from waste treatment plants*. These emissions are accounted for in the Solid Waste baseline.

The sources of the inventory (1990-2000) emission estimates and the method and sources used to develop the baseline (2000-2020) emissions forecast for these source categories are provided in the Table 1.

Table 1: Methodology and Sources for BFM Inventory and Baseline		
Source Category	Inventory (1990-2000)	Baseline (2000-2020)
Carbon Dioxide Emissions from Direct Combustion of Fossil Fuels	EIA State Energy Data Report, which is reported by fuel type, by sector and collected from the State of Maine. Default values from the US EPA were used to convert fuel use into CO_2 emissions.	The forecast is based on the New England regional growth forecast for different fuel types by sector from EIA's Annual Energy Outlook 2004. Regional fuel consumption is allocated to Maine as follows: • Residential sector: Fuel consumption is allocated using the ratio of Maine's population growth to that of the NE region. The Charles Colgan, University of Southern Maine, medium range population forecast was used for Maine based on agreement of Stakeholder Advisory Group. • Commercial sector: Fuel consumption is allocated using the ratio of Maine's Gross State Product (GSP) to that of the NE region. The Charles Colgan, University of Southern Maine, medium range GSP forecast was used for Maine based on agreement of Stakeholder Advisory Group. • Industrial Sector: Hold industrial growth at 2000 levels. This was agreed to by the Stakeholder Advisory Group. Default values from the US EPA are used to convert fuel use into CO_2 emissions
Methane and nitrous oxide emissions from combustion of fossil fuels in all sectors	EPA Inventory Tool	Default values from the US EPA are used to convert fuel use into CH_4 and N_2O emissions.
Methane emissions from the transmission and distribution of natural gas within the State of Maine.	EPA Inventory Tool	Forecast assumes construction of one new LNG plant in 2010 as per the BFM WG.
Sulfur hexafluoride (SF_6) emissions from electric power transmission and distribution systems within the State of Maine.	EPA Inventory Tool	Forecast based on historical emission trends.

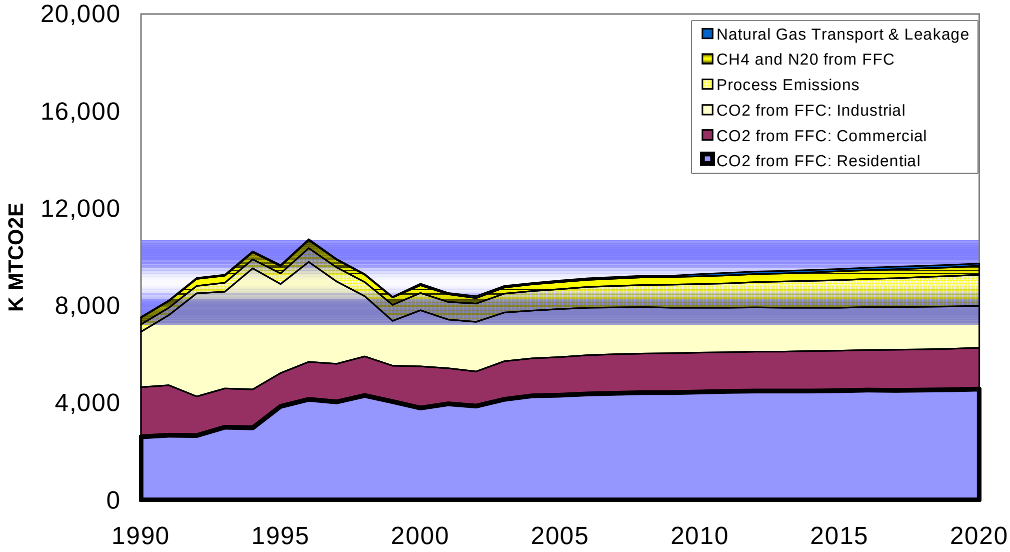
Source Category	Inventory (1990-2000)	Baseline (2000-2020)
High global warming potential gas (HFC, PFC, and SF_6) emissions from substitutes for ozone-depleting substances.	EPA Inventory Tool	Forecast assumes that Maine's share of national ODS replacement emissions remains constant over time (based on ratio in the year 2000). Data on national emissions from ODS substitutes are estimated using a complex vintaging model which accounts for equipment turnover, leak rates, charge size, and initial ODS. These estimates are reported in the following document: USEPA, 2000. Estimates of US Emissions from High GWP Gases and the Cost of Reductions.
Carbon dioxide from cement production process emissions.	Data from Dragon Products	Forecast from Dragon Products
High GWP gas emissions from semiconductor manufacture.	Data from National and Fairchild	Emissions are held constant at 2003 levels from 2003 to 2020. This is a conservative assumption based on the industries overall target to achieve emission reductions under a voluntary agreement with EPA and input from NSC.

BFM GHG Emissions Inventory and Baseline



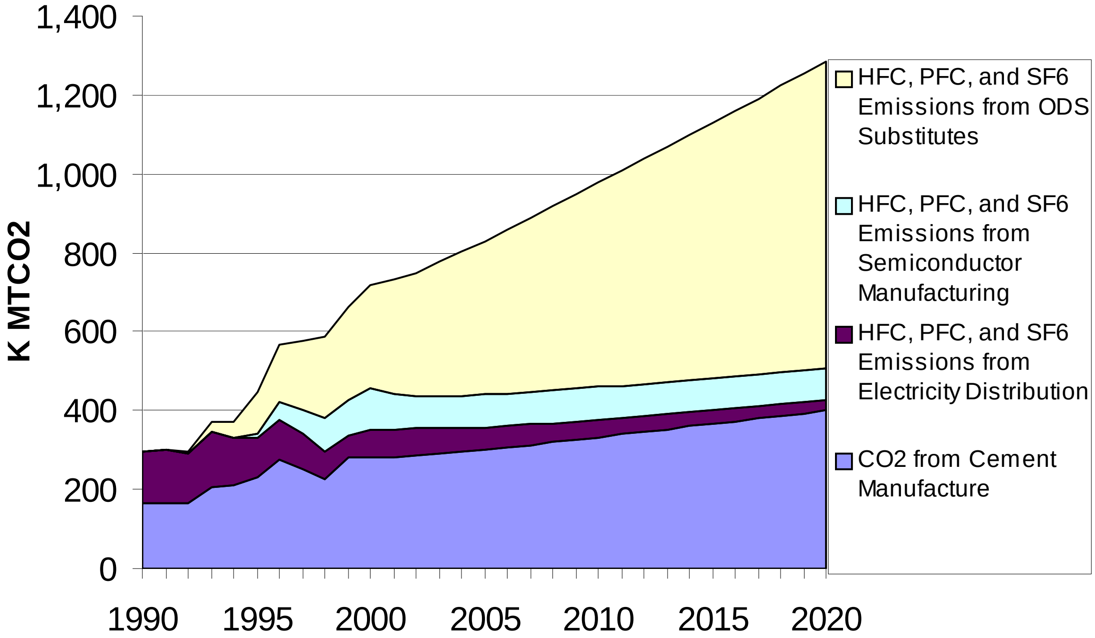
Note: Target level is for illustrative purposes only, and does not represent a mandated target. Target line assumes targets of 1990 sector levels by 2010, 10% below 1990 in 2020.
K MTCO2E= Thousand metric tonnes of carbon dioxide equivalent emissions

BFM GHG Emissions Inventory and Baseline by Sector



Process emissions= See next chart for detail
FFC = Fossil fuel combustion
K MTCO2E= Thousand metric tonnes of carbon dioxide equivalent emissions

Detail of Process Emissions



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2. Summary Table of Sector Priority Options

Consensus Recommendation Options - Quantified

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The BFM Work Group does not argue that the previous statement should be used to modify the cost-effectiveness for public investment.

3. Descriptions and Assumptions For Each Sector Option

Measure:	BFM 1.1 Energy Efficiency Appliance Standards
Sector:	**Residential, Commercial**
Policy Description:	For appliances not covered under federal standards, the state can set minimum levels of efficiency for specific appliances.
BAU Policy/Program:	Legislation proposed, never passed. LED kits for traffic signals have been purchased to address traffic lights in Maine.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Set minimum efficiency standards for the following products:

Product	Savings in 2010 (GWh or BBtu)	Savings in 2020 (GWH or BBtu)	Unit Savings (kWh or therm)	Lifetime (years)	Incremental Cost * ($)
Dry type transformers	6.9	19.3	16.6kWh/kva	30	3/kva
Commercial refrigerators & freezers	1.2	2	430	9	29
Exit signs	3.7	10.3	223	25	20
Traffic signals	1.7	3.1	431	10	85
Torchiere lamps	66.9	121.7	288	10	15
Set-Top boxes	96.7	96.7		5	
Unit heaters (therm savings)	63.8	179.7	268	19	276
Commercial Clothes Washers	1.2	1.8	197	8	200

Source: ENE, Communication with M Stoddard; NEEP, 2003. The estimates in this table are in the NEEP report "Energy Efficiency Standards: A Low Cost, High Leverage Policy for Northeast States. Appendix A of the report cites sources.
* Note: Incremental costs are difficult to calculate because there is almost always a range of products with varying prices.

All of these appliances can be regulated by the state, and do not require a federal waiver.

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions ('000 MTCO2E)	<0.01	<0.01
Indirect Emission Reductions ('000 MTCO2E)*	84.3	128.7
Total Emission Reductions ('000 MTCO2E)	84.3	128.7
Cost Effectiveness ($/MTCO2E)		-82

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
CO2 emission savings estimates will differ from NEEP analysis because the electricity emission factor differs.
'000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 2.1 Improved Residential Building Energy Codes

Sector: **Residential**

Policy Description: Require new buildings or substantial reconstruction to meet the most recent energy code efficiency/performance standards established by the International Code Council and ASHRAE 6.2 ventilation standards, with effective enforcement, as recommended through the PUC process.

BAU Policy/Program: Residential: State-developed code, less stringent than 1992 MEC, mandatory statewide; Voluntary IECC 2000

Maine has held four meetings of the Building Code Working Group starting in March 2003. The purpose of this group is to 1.) Survey stakeholders and determine where they stand on the issues 2.) Determine which code, NFPA or ICC, to adopt 3.) Make recommendations on how the chosen code is going to be implemented and enforced. (Source: www.bcap-energy.org)

DPUC Working Group also.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

- Residential building energy codes are updated every 3 years and adopted by ME 18 months thereafter.
- Each building energy code revision achieves the same percentage of savings.
- Includes BFM 2.2 Training and Enforcement of Building Energy Codes

Data Need	Assumption	Source
Energy Savings		
Fossil Fuel savings per home (IECC 2000 compared to current construction in ME)	10%	David Weitz, Building Code Assistance Project for Maine PUC public hearing on Nov 25th 2003[1]
# of new residential buildings built each year	6,760 single family homes	Maine-specific data from National Association of Home Builders
# of residential buildings that comply with new codes	70%	Estimated
Costs		
Increased cost for enforcement	$150,000	Estimate
Increased cost for training	$200,000	Based on programs in Texas and New Hampshire that provide training on residential codes and produce and distribute video recordings

[1] Estimate appears to be conservative based on 18% reduction cited in Xenergy (2001), "Impact Analysis of the Massachusetts 1998 Energy Code Revisions"

Potential Barriers/Issues: Avoid conflict with building rehab code

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	24.2	65.2
Indirect Emission Reductions (‘000 MTCO2)*	0.6	1.6
Total Emission Reductions (‘000 MTCO2)	24.7	64.1
Cost Effectiveness ($/MTCO2)		-35

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 2.3 Voluntary Green Building Design Standards

Sector: **Residential**

Policy Description: Promote voluntary high efficiency and sustainable building standards that builders can follow (e.g., Energy Star, LEED residential building standard as it becomes available, Built Green^{TM}). In addition to an energy efficiency requirement, require procurement standard for concrete containing up to 20% recovered mineral component.

Also promote energy efficient mortgages, energy improvement mortgages and location efficient mortgages.

Note: Assumes that BFM 2.1 is already implemented.

BAU Policy/Program: None

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Data Needs	Assumption	Source
# of new homes built in ME	6,760 single family homes	Maine-specific data from National Association of Home Builders
# of new homes meeting higher standard	10% per year	Estimated
Savings between Energy Star and standard construction (based on proposed RES code for Maine)	15%	EPA; based on definition of Energy Star Home (ENERGY STAR qualified homes are independently verified to be at least 30% more energy efficient than homes built to the 1993 national Model Energy Code or 15% more efficient than state energy code, whichever is more rigorous.)
Incremental Cost between Energy Star and standard construction	$2100/home	Connecticut Light and Power Note: Price varies depending on house size, prevailing construction practices, availability of equipment, etc. For example, an Energy Star labeled home can actually be less expensive to build than its non-Energy Star counterpart (i.e., good insulation, high performance windows, etc. can lower the heating and cooling loads so much that smaller and less expensive HVAC equipment and more compact duct runs are able to be installed, saving significant first costs.) These costs are offset by the operation and maintenance savings over the lifetime of the home.
Residential Concrete	380,000 to 400,000 cubic	PCA Portland Cement and

Consumption	yards in 2003	Construction Forecast for Maine.
Incremental Cost between concrete and concrete containing slag	0	Dragon Products – For an individual supplier, concrete produced with slag is comparable in cost to concrete made without slag

- Owning (i.e., mortgage amortization) and operating (i.e., utility bills) an Energy Star labeled home costs less than owning and operating a non-Energy Star labeled home. This is because we do not recommend energy-saving measures unless the amortized cost of implementing those measures is less than the utility bill savings resulting from them. Source: EPA Energy Star Homes

- GHG emission savings are estimated assuming BFM 2.1 (Improved Residential Building Codes) is implemented.
- A procurement standard for concrete containing a minimum of 20% slag would result in a CO2 savings of over 20,000 short tons per year of direct and indirect emissions (18,144 metric tons) based on estimated concrete consumption in 2003 for residential applications. .

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions ('000 MTCO2)	23.4	27.8
Indirect Emission Reductions ('000 MTCO2)*	0.1	0.2
Total Emission Reductions ('000 MTCO2)	23.45	28.0
Cost Effectiveness ($/MTCO2)		-45

Direct Emissions: On-site emission reductions
Indirect Emissions: Emission reductions at the site of electricity generation
Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
Note: Emission reductions from a procurement standard for concrete are included in the table under direct emissions reductions eventhough reductions will have both direct and indirect impact.
'000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 2.6 Efficient Use of Oil and Gas: Home Heating

Sector: **Residential**

Policy Description: Develop energy efficiency programs for oil and gas-fired heating and hot water systems.

BAU Policy/Program: LIHEAP, WAP, REACH Central Heating Improvement (CHIP) Programs for low-income residents. (Energy Advisors, LLC, 2003)

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

<u>Contribution of oil and natural gas combustion to GHG emissions in Maine.</u>

- Maine residential heating and hot water systems annually consume:
    - 272 million gallons of #2 fuel oil (EIA, Fuel Oil and Kerosene Sales, 2002, Table 19 – Adjusted Sales for Residential Use)
    - 1196.75 MMCF natural gas (EIA, Annual Natural Gas Deliveries to Residential, by State, 2003)

- Greenhouse gas emissions associated with residential heating in Maine were approximately 3,790 thousand metric tonnes of CO2e in 2000, or 43% of GHG emissions from the BFM sectors

<u>Programs in other States</u>

- 22 states have natural gas conservation programs. In the Northeast, NH, VT, MA, NY, NJ, PA, MD and WV have natural gas conservation programs. ME, RI, CT and DE do not.
    - Vermont's natural gas conservation program has saved 1,000 cubic feet/year (typically lasting 20 years) for every $29 spent. (Grevatt, 2003).
    - Programs include:
        - promoting ENERGY STAR heating equipment;
        - promoting ENERGY STAR-rated water heaters;
        - promoting ENERGY STAR-rated programmable thermostats;
        - increasing the efficiency of residential new construction;

<u>Proposed recommendation for Maine</u>

- Maine should review market and regulatory barriers to identify best opportunities for increasing installation of cost-effective efficiency measures, and review potential mechanisms for incentivizing and implementing these measures. For example,

Recommended Improvement	**Estimated Savings**
Heating System Tune	2 to 10%
Reduced firing rate or nozzle reduction	6 to 10%
Reduced temperature of circulating water/furnace air	5 to 12 %
Pipe and duct insulation	5 to 10%
Flame retention head burner	15 to 20%
New high-efficiency hot water boiler	20 to 40%

New high-efficiency warm air furnace	20 to 40%

Source: Maine Oil Dealers web site- www.meoil.com

- Pilot program – As part of a more comprehensive residential heating efficiency program, promote and incentivize the early retirement of inefficient furnaces/boilers to be replaced with ENERGY STAR furnaces/boilers, integrated hot water heaters, and the installation of set-back thermostats.

Data Needs	**Assumption**	**Sources**
Oil Furnaces/Boilers		
# operating at or below 60% AFUE	15%	Expert judgment
Energy savings associated with replacing 60% AFUE furnace with Energy Star oil Furnace (90% AFUE)	24.25 MMBTU/furnace	Calculated based on 20% efficiency increase and avg 80.8 MMBTU/household for space heating
Estimated cost of conventional oil furnace	$2000	EPA
Estimated cost of Energy Star oil furnace	$2700	Consumer Energy Council of America (2001)
Market penetration	2%	Estimated
Natural Gas Furnaces		
# operating at or below 60% AFUE	15%	Expert Judgment
Energy savings associated with replacing 60% AFUE furnace with Energy Star natural gas furnace (90% AFUE)	25.25 MMBTU/furnace	Calculated based on 20% efficiency increase and avg 80.8 MMBTU/household for space heating
Estimated cost of conventional natural gas furnace	$2000	EPA Energy Star
Estimated cost of Energy Star natural gas furnace	$2500	EPA Energy Star
Market Penetration	2%	Estimated
Integrated hot water heater		
Average energy factor of stand alone water heater more than 10 years old	50%	USDOE Building Technologies Program
Energy factor of new integrated hot water heater	88%	USDOE Building Technologies Program
Cost of installation	900	USDOE Building Technologies Program
Market Penetration	2% of oil heated homes; 2% natural gas heated homes	Assume install with furnace replacement
Set-back Thermostat		
Energy Savings per year	5%	EPA (Ranges from 5 to 30%)- Energy Star requires 2 programs with 4 settings each
Cost	$195	EPA (product cost ranges from 40-120; installation charge of 25-75)
Market Penetration	2% of oil heated homes; 2% natural gas heated homes	Assume install Energy Star Programmable Thermostat with boiler replacement

Percentage of Homes by Heating Fuel Type		
Oil	80%	US Census, 2000
Natural Gas	8%	US Census, 2000
Electricity	4%	US Census, 2000
Number of homes in ME	518,200	US Census, 2000

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	29.3	39.1
Indirect Emission Reductions (‘000 MTCO2)*	0.0	0.0
Total Emission Reductions (‘000 MTCO2)	29.3	39.1
Cost Effectiveness ($/MTCO2)		-6

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 2.7 Fuel Switching

Sector: **Residential**

Policy Description: Study opportunities in Maine to switch from electric heat and/or electric hot water systems to lower greenhouse gas alternatives using high efficiency oil or natural gas fired systems.

BAU Policy/Program: None

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Estimates of Electric Heating and Hot Water Systems in Maine

- The 2000 US census data says 4.4%of the Maine homes use electricity as House Heating Fuel Total electric sales for heating were 2,838 million kWh (about 22% of CMP sales) in 1994.[2].

- CMP estimates 46% of hot water systems are electric and used 398 million kWh in 1994.

A. Switching from Electric to Oil

- Oil industry studies indicate that converting electrically heated homes to oil heated homes can lower greenhouse gas emissions by more than 15.5 tons of CO2 per house per year, or a reduction of at least 50%. (Batey, 10/2003).
- If only the electrric hot water heater is converted to oil, reductions may be 2 tons per unit per year.
- New oil equipment, on average, pays for itself in about 2.6 years using average energy prices. Assuming energy prices found in Conn. in 2002, converting from electric to oil heat and hot water would save more than $60,000 over 20 years for the average Conn. homeowner.
- This assumes that:
  - electricity generation is assigned the national average for CO2 emissions per MWh;
  - electric heating incurs in-house losses of 5%;
  - home oil burner emissions have an emission factor of 22,300 pounds per thousand gallons (USEPA, AP-42), or 161 pounds per million Btu of fuel consumed;
  - homes convert from combination electric heat and hot water systems to oil heat and hot water systems.

B. Switching from Electric to Natural Gas (NG) or Propane

- The Work Group did not review potential greenhouse gas benefits of switching from Electric to NG heating and hot water systems.
- Assuming for the sake of argument that the global warming emissions from a natural gas system were equal to an oil system, and also using the same assumptions as in the

[2] Data from CMP in 1994: 16.6% of homes had electric heating systems installed, using 227 million kWh. John Duvalis observed this was considerably higher than he would have expected, and suggested that the number of those systems actually in use was likely much lower. He also notes that they've lost more systems than they've gained to competing fuels in the intervening decade, so this number has certainly gone down.

previous section, we can estimate that the total CO_2 (equivalent) reductions would also be 15.5 tons of CO_2 per house per year by switching from electric to NG heating systems.

- If assumptions change to illustrate lower lifecycle leakage rates for NG, the CO_2e reductions will be higher.
- If assumptions change to illustrate lower CO_2 emissions/MWh than the national average, then reductions will be lower.

C. Switching between Oil and Natural Gas (NG)

- There are four main variables that impact the calculation of benefits of switching from one fuel to the other: (1) the assumed lifecycle emissions rates for combustion of a Btu of oil v. a Btu of NG; (2) the capital costs of installing/modifying or replacing oil burning systems in the home v. installing/modifying or replacing NG burning systems in the home; (3) the assumed maintenance costs for each system; and (4) the assumed cost of each fuel.
- It is the sense of the Work Group that further study would help to clarify the most appropriate assumptions for these variables, and that the range of possible assumptions is so wide as to make a comparison inappropriate at this time.
- Emission rates:
  - Natural Gas at the burner tip: USEPA ap-42 = 120,000 lb /1000 scf /1020 MMBTU per 1000 scf = 117.6 lb/MMBTU
  - #2 Heating oil at the burner tip: USEPA AP-42 = 22,300 lb/1000 gal /140 MMBTU per 1000 gal = 159 lb/MMBTU

  - NG energy system emission estimates:
    - 140 lb CO_2e /MMBtu if you factor in 2.6% of methane leakage upstream in the processing and transportation and assume (per EPA) methane has GWP 21x CO_2
    - 151 lb CO_2e /MMBtu if you factor in 2.6% of methane leakage upstream in the processing and transportation and assume (per Batey) methane has GWP 30x CO_2
    - Various analyses estimate methane leakage rates from the transportation of NG in the U.S. at between 1.4% and 3.5%. (Batey, citing US DOE and Gas Research
  - #2 Heating oil system estimates:
    - More work needs to be done. Significant discrepencies and intense detail remain.
    - See, Batey, "The Role Of Home Heating Oil in Lowering Greenhouse Gases and Other Air Emissions in Maine", May, 2004, Appendix ____.
    - See also, Consumer Energy Council of America, "Conservation makes more sense than switching form oil to natural gas." See www.cecarf.org.

- Capital cost -- switching from Oil to NG systems:
  - ranges from $500 - $5,000 or more per home. (Batey, citing Consumer Energy Council of America)
  - Includes:
    - gas piping to the house
    - exhaust vent changes
    - chimney modification/lining
    - new hot water heater
    - fuel tank removal
    - condensate pump
    - draft inducer
    - sound and vibration dampers
    - sound insulation
- Fuel cost –

- The average price of residential fuel oil in Maine over 5 years from 1994-1999 was $0.860/gallon. (Batey, citing Petroleum Marketing Monthly, DOE/EIA – 0380(00/03).
- Fuel oil delvers 138,690 Btu/gallon (*Id.*)

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)		
Indirect Emission Reductions (‘000 MTCO2)*		
Total Emission Reductions (‘000 MTCO2)		
Cost Effectiveness ($/MTCO2)		

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 3.2 Promote Energy Efficient Buildings

Sector: **Commercial and Institutional***

Policy Description: Encourage privately financed new construction and renovation to be high performance buildings by certifying to 20% above existing code.

BAU Policy/Program: None

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Data Need	Assumption	Source
Number of nonresidential buildings built each year	2,184	CT data scaled to ME. CMP does not have better data. Texas A&M University estimate of 3,650 nonresidential building permits issued in Maine in 1995. No better data available at this time.
Market penetration	2%	Estimate based on penetration rate of similar programs implemented elsewhere (CT)
Energy Savings compared with then current code	20%	As per recommendation
Average energy intensity for non-governmental buildings		
Electricity	13.4 kWh/sq ft	EIA CBECS (1999)
Natural Gas	43.1 cu ft/sq ft	EIA CBECS (1999)
Oil	0.18 gallons/sq ft	EIA CBECS (1999)
Incremental Cost	$3/sq ft	Katz et al. (2003)[3] estimates 3-5 $/sq ft.

*Does not include state or state-funded buildings

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions ('000 MTCO2)	1.4	3.7
Indirect Emission Reductions ('000 MTCO2)*	2.9	7.5
Total Emission Reductions ('000 MTCO2)	4.3	11.3
Cost Effectiveness ($/MTCO2)		-19

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
'000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

[3] "Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force" (October 2003). Costs based on 33 green buildings compared to conventional designs for those buildings. The average premium was slightly less than 2% or $3-5/sq ft.

Measure:	BFM 3.3 Implement the most cost-effective energy savings in State Buildings

Sector: **Government Agency Buildings**

Policy Description:

Implement cost-effective savings in state buildings at a level of 1% per year above the existing legislative mandate. Specifically, implement the most cost-effective Harriman study recommendations such as appropriately adjusting building temperatures and turning off unneeded lights. Further evaluate emerging technology, such as the pilot program for biodiesel.

BAU Policy/Program:

25% energy reduction goal by 2010 (relative to 1998 baseline) added to Energy Conservation Building Act for Public Buildings. This legislation established a pilot program to seek to achieve that level of energy savings in ten facilities of over 40,000 square feet. Under the pilot program, energy savings are to be achieved through performance contracts with energy service companies.

The BFM Work Group notes that the legislatively mandated reduction is not being fully implemented. Because it is a mandate, however, the reduction is included in the baseline. The figures for CO2 reduction associated with this measure reflect the incremental savings of 1% over the mandated level.

LD845 Climate Change: This bill requires new sources of greenhouse gases to be reported to the Department of Environmental Protection. It also requires the department to create an inventory of greenhouse gas emissions associated with state-owned facilities and state-funded programs and to create a plan for reducing those emissions.

The Maine Public Utilities Commission and the Maine Department of Administrative and Financial Services (DAFS) developed a Memorandum of Understanding (MOU) to improve the energy efficiency of State buildings. The program will fund renovations that enhance electrical efficiency. It will also fund an energy survey of all state buildings to identify opportunities for energy efficiency. Under the MOU, DAFS identifies potential projects and Efficiency Maine reviews the proposed projects for cost effectiveness. If the projects are cost effective, they are developed and managed by DAFS and financed through mechanism through Maine PUC to DAS.

Existing mechanisms that are not fully implemented include:

1. Third party financing of energy efficiency improvements in existing state buildings/facilities PL 1985, ch. 128 5M.R.S.A. § 1767

- Any department or agency of the State, subject to approval of the Bureau of Public Improvements, may enter into an agreement with a private party such as an energy service or 3rd-party financing company for the design, installation, operation, maintenance and financing of energy conservation improvements at state facilities. [1985, c. 128 (new).]

- Any department or agency of the State, subject to approval by the Bureau of Public Improvements, at the termination of the agreement with the private party pursuant to this section, may acquire, operate and maintain the improvement, may renew the agreement with the private party or may make an agreement with another private party to operate and maintain the improvement. [1985, c. 128 (new).]

- All agreements made with private parties as contemplated in this section shall be subject to review by a subcommittee of the joint standing committee of the Legislature having jurisdiction over appropriations and financial affairs. [1985, c. 128 (new).]

2. Third party financing of energy efficiency improvements PL 1999, ch. 35, 5 M.R.S.A. § 1770
1. Goal. The Legislature finds it is in the best interests of the State to significantly reduce its energy consumption to the extent possible without interfering with other goals, plans and policies of the State. The energy reduction goal, referred to in this section as the "goal," for facilities owned by the State is, by 2010, a 25% reduction in energy consumption relative to baseline consumption in 1998, as long as the achievement of the goal is accomplished in a manner that:

A. Is consistent with all applicable laws; and [1999, c. 735, §1 (new).]
B. Does not interfere with other goals, plans or policies of the State. [1999, c. 735, §1 (new).]

For purposes of this subsection, "facilities owned by the State" includes all facilities that consume energy and that are owned by the legislative, judicial or executive branches of government, any state department, agency or authority, the University of Maine System or the Maine Community College System.

3. Improvements in efficiency to new buildings - Consider life cycle energy costs in state owned buildings 5 M.R.S.A. § 1762 Consider life cycle energy costs in state leased builidings 5 M.R.S.A. § 1763.
No public improvement, as defined in this chapter, public school facility or other building or addition constructed or substantially renovated in whole or in part with public funds or using public loan guarantees, with an area in excess of 5,000 square feet, may be constructed without having secured from the designer a proper evaluation of life-cycle costs, as computed by a qualified architect or engineer. The requirements of this section with respect to substantial renovation shall pertain only to that portion of the building being renovated. Construction shall proceed only upon disclosing, for the design chosen, the life-cycle costs as determined in section 1764 and the capitalization of the initial construction costs of the facility or building. The life-cycle costs shall be a primary consideration in the selection of the design. As a minimum, the design shall meet the energy efficiency building performance standards promulgated by the Department of Economic and Community Development.

4. Improvements in efficiency to new buildings - Include an energy-use target that esceeds by at least 20% the energy efficiency standards in effect for commercial and institutional buildings 5 M.R.S.A. § 1764-A
The Bureau of General Services, in consultation with the Energy Resources Council and the Public Utilities Commission, shall by rule require that all planning and design for the construction of new or substantially renovated state-owned or state-leased buildings and buildings built with state funds, including buildings funded though state bonds or the Maine Municipal Bond Bank:

A. Involve consideration of architectural designs and energy systems that show the greatest net benefit over the life of the building by minimizing long-term energy and operating costs; [2003, c. 497, §1 (new); §5 (aff).]

B. Include an energy-use target that exceeds by at least 20% the energy efficiency standards in effect for commercial and institutional buildings pursuant to Title 10, section 1415-D; and [2003, c. 497, §1 (new); §5 (aff).]

C. Include a life-cycle cost analysis that explicitly considers cost and benefits over a minimum of 30 years and that explicitly includes the public health and environmental benefits associated with energy-efficient building design and construction, to the extent they can be reasonably quantified. [2003, c. 497, §1 (new); §5 (aff).]

Rules adopted pursuant to this section apply to all new or substantially renovated state-owned or state-leased buildings and buildings built with state funds, including buildings funded through state bonds or the Maine Municipal Bond Bank, regardless of whether the planning and design for construction is subject to approval by the department.

Rules adopted pursuant to this section may provide for exemptions, waivers or other appropriate consideration for buildings with little or no energy usage, such as unheated sheds or warehouses.

The Bureau of General Services shall adopt rules pursuant to this section by July 1, 2004. Rules adopted pursuant to this section are routine technical rules as defined in Title 5, chapter 375, subchapter 2-A

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Data Needs	**Assumption**	**Source**
State Agency Fuel Consumption		
Electricity	127,384 MWh	Energy Advisors, LLC
Natural Gas	90,025 MMBTU	Estimated using government to commercial sector electricity share
Oil	643,062 MMBTU	Estimated using government to commercial sector electricity share
Government building share of commercial sector electricity consumption	3%	Energy Advisors, LLC
Reduction in state energy use by 2010	7%	1% per year above current regulation; Savings associated with regulation accounted for in baseline
Reduction in state energy use by 2020	17%	1% per year above current regulation; Savings associated with regulation accounted for in baseline
Costs	\$0.3/kWh	Based on Maine Efficiency results from State Building Program; Consistent with cost estimates in Optimal Study

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions ('000 MTCO2)	3.5	9.1
Indirect Emission Reductions ('000 MTCO2)*	4.4	12.0
Total Emission Reductions ('000 MTCO2)	7.9	21
Cost Effectiveness (\$/MTCO2)		-37

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation

Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
'000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 3.5 Load Management

Sector: **Commercial**

Policy Description: Maine should fully examine the usefulness of TOU electric meters, rates, and related technologies to allow consumers to respond to price signals and to shift consumption.

BAU Policy/Program: None

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	0.0	0.0
Indirect Emission Reductions (‘000 MTCO2)*		
Total Emission Reductions (‘000 MTCO2)		
Cost Effectiveness ($/MTCO2)		

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 3.6 Green Campus Initiatives

Sector: **Commercial**

Policy Description: Promote a "Green Campus" Initiative with all Maine Colleges, Universities, Private/Secondary Schools with Campus to minimize environmental impact.

BAU Policy/Program: Currently underway (USM, Others)

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Data Needs	Assumption	Source
Duration of Proposed Program	5 years	Estimated
Market Size	27 colleges and universities with 52,441 student enrollment	Department of Education
Average $/student for energy	$265/Student	Based on University of Southern Maine
% of Market enrolled in program each year	5%	Estimated
Average electricity savings	15%	Communication with Clean Air-Cool Planet
Average fossil fuel reductions	20%	Communication with Clean Air-Cool Planet
Cost	$0.3/kWh	Based on Maine Efficiency results from State Building Program; Consistent with cost estimates in Optimal Study

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions ('000 MTCO2)	7.7	20.6
Indirect Emission Reductions ('000 MTCO2)*	3.3	9.3
Total Emission Reductions ('000 MTCO2)	11.0	29.8
Cost Effectiveness ($/MTCO2)		-18

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
'000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 3.7 Improve Enforcement of Commercial Energy Codes

Sector: **Commercial**

Policy Description: Improve enforcement of the requirement that new construction and substantial renovations of commercial buildings meet the most recent energy code efficiency/performance standards established by the International Code Council.

BAU Policy/Program: Commercial: ASHRAE/IESNA 90.1-2001, mandatory statewide (includes all institutional buildings such as schools and hospitals); Legislature must pass "housekeeping legislation" whenever the State wants to update to the most recent building energy codes. (Located in MRSA Title 10, Part 3, Chapt. 214, Section 1415-D: Mandatory standards for commercial and institutional construction.)

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

- Upgrades to commercial building code included in baseline.

Data Need	Assumption	Source
Annual Commercial Savings		
Oil savings	5%	EERE
Natural gas savings	5%	EERE
Electricity savings	5%	EERE
New commercial buildings built each year	2,184	CT data scaled to ME. CMP does not have better data. Texas A&M University estimate of 3,650 nonresidential building permits issued in Maine in 1995. No better data available
Number of commercial buildings that comply with new codes if enforced	15%	Expert judgment
Costs		
Cost for enforcement	$150,000	Based on Residential Code Estimates
Cost for training	$200,000	Based on Residential Code Estimates

Potential Barriers/Issues: Avoid conflict with Rehab code

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	2.6	7.0
Indirect Emission Reductions (‘000 MTCO2)*	9.3	26.6

Total Emission Reductions (‘000 MTCO2)	12.0	33.6
Cost Effectiveness ($/MTCO2)		-61

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 3.8 Improve Electrical Efficiency in Commercial Buildings

Sector: **Commercial**

Policy Description: Improve electrical efficiency in commercial buildings

BAU Policy/Program: Efficiency Maine C&I Program, available to businesses with > 50 FTEs, includes three components (1) business practices training, (2) information and end-use training opportunities, and (3) financial grants to assist in the purchase of EE equipment.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Optimal Energy Study for Public Advocate looks at electrical energy savings potential and cost for the following commercial and institutional sector measures:

Efficient Lighting
Efficient Air Conditioning
Building System Controls
Enhanced Envelope Measures
Efficient Appliances
High Efficiency Motors
Variable Frequency Drives
High Efficiency Refrigerators

Estimates for MWh of savings by year and measure are shown in the table below. Savings represents economically achievable savings over currently planned expenditures. In other words, these estimates exclude the MWh savings estimated from these measures under the current Efficiency Maine funding (which are assumed to be in the baseline).

Commercial and Public Authority	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*201*
Efficient Lighting	0	25,377	54,218	86,990	121,142	156,803	193,550	231,169	269,552	308,757	348,2
Efficient Air Conditioniing	0	2,904	6,205	9,956	13,864	17,946	22,151	26,457	30,850	35,337	39,8
Building Systems Controls	0	9,261	19,786	31,746	44,209	57,223	70,633	84,361	98,369	112,676	127,0
Enhanced Envelope Measures	0	1,678	3,585	5,752	8,011	10,369	12,799	15,286	17,824	20,417	23,0
Efficient Appliances	0	1,339	2,861	4,591	6,393	8,275	10,215	12,200	14,225	16,295	18,3
High Efficiency Motors	0	2,520	5,384	8,638	12,029	15,570	19,219	22,954	26,765	30,658	34,5
Variable Frequency Drives	0	970	2,073	3,326	4,632	5,995	7,400	8,839	10,306	11,805	13,3
High Efficiency Refrigeration	0	192	410	657	915	1,184	1,462	1,746	2,036	2,332	2,6
Total savings	0	36,218	77,380	124,150	172,892	223,788	276,233	329,922	384,703	440,658	497,0

Source: Optimal Energy Study

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions ('000 MTCO2)	0.0	0.0
Indirect Emission Reductions ('000 MTCO2)*	181.9	250.8
Total Emission Reductions ('000 MTCO2)	181.9	250.8
Cost Effectiveness ($/MTCO2)		-139

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation

* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
'000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 3.9 Procurement Preference for Concrete Containing Slag

Sector: **Buildings Facilities and Manufacturing**

Policy Description: Specify procurement preference for concrete and concrete products that contain a minimum of 20% of ground granulated blast furnace slag for publicly funded projects, as long as this is cost-effective.

BAU Policy/Program: ASTM specifies standards for the inclusion of slag to concrete. MDOT specifications allow for the inclusion of slag in concrete.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Slag is derived from a by-product of the steel industry. It is processed and grounds to meet strict specifications and sold as a cementitious (cement-like) product. Slag has cementitious properties and can be used to offset a portion of the cement used in concrete mixtures. How much can be offset is dependent on season (winter/summer), set requirements and other factors. Assumptions used here include:

- 550 lbs cement is used per yard of concrete (average)
- Approximately, 880,000 cubic yards of concrete for all applications in Maine in 2003. (based on data from USGS for Cement consumption)
- Approximately 315,000 to 350,000 cubic yards of concrete used for public buildings, structures, and transportation.
- Use of 20% slag as a replacement for cement yields savings of approximately 18,000 to 20,000 tons of CO2 per year.
- This is a conservative estimate based on slag. Use of other recycled mineral components such as fly ash or silica fume may be different. Slag usage may be higher (30 to 40%) and result in higher CO2 savings.

Concrete consumption includes commercial, residential, industrial and government consumption. Transportation accounts for approximately 215,650 cubic yards (PCA Construction Forecast, February 2004). Approximately 22,000 tons of slag was used in concrete in 2003 for all uses. Slag is comparable in cost to cement. . For an individual supplier, concrete produced with slag is comparable in cost for concrete produced without slag. Availability may be limited. May require a capital investment of additional silo storage for some suppliers.

EPA procurement guidelines for recovered materials:
http://www.access.gpo.gov/nara/cfr/waisidx_03/40cfr247_03.html

GHG Emission and Cost Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	18	18
Indirect Emission Reductions (‘000 MTCO2)*	0	0
Total Emission Reductions (‘000 MTCO2)	18	18
Cost Effectiveness ($/MTCO2)		0

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation

* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
'000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 4.1 Promote Electrical Efficiency Measures for Manufacturing in Maine

Sector: **Industrial**

Policy Description:

Offer financial incentive/rebates for EE improvements for manufacturing in Maine. Can include:

- Tax incentives, such as Investment Tax Credit or shortened depreciation periods for installation of energy efficient systems and equipment
- Creative financing mechanisms
- Rebates
- Grants
- Technical assistance
- Training
- Interruptible power programs
- Real time pricing

BAU Policy/Program:

Efficiency Maine has established a new Commercial and Industrial Program for Maine businesses that provides a combination of services, including energy efficiency information and training, business practice assistance, and direct financial incentives in the form of grants. The components of the program are designed to encourage businesses to adopt energy efficient business practices, to include consideration of energy costs and energy efficiency in their business decisions, and to purchase and install energy efficient products.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Optimal Energy Study for Public Advocate looks at electrical energy savings potential and cost for the following industrial sector measures:

- Efficient Lighting
- Efficient Ventilation and Cooling
- Efficient Process Controls
- Building System Controls
- Variable Frequency Drives
- High Efficiency Air Compressors

Estimates for MWh of savings by year and measure are shown in the table below. Savings represents economically achievable savings over currently planned expenditures. In other words, these estimates exclude the MWh savings estimated from these measures under the current Efficiency Maine funding (which are assumed to be in the baseline).

Industrial	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Efficient Lighting	0	5,814	12,160	19,085	26,016	32,969	39,852	46,621	53,258	59,773	66,083
Efficient Ventilation & Cooling	0	2,078	4,346	6,821	9,299	11,784	14,244	16,663	19,036	21,364	23,619
Efficient Process Cooling	0	1,273	2,661	4,177	5,694	7,216	8,723	10,204	11,657	13,083	14,464
Building Systems Controls	0	2,828	5,914	9,283	12,654	16,036	19,383	22,676	25,904	29,073	32,142
High Efficiency Motors	0	3,998	8,362	13,123	17,890	22,671	27,404	32,059	36,622	41,102	45,441
Variable Frequency Drives	0	18,380	38,441	60,332	82,245	104,224	125,983	147,383	168,364	188,959	208,905
High Efficiency Air Compressors	0	1,763	3,686	5,786	7,887	9,995	12,082	14,134	16,146	18,121	20,034
Industry-Specific Measure #1	0	0	0	0	0	0	0	0	0	0	0
Industry-Specific Measure #2	0	0	0	0	0	0	0	0	0	0	0
Industry-Specific Measure #3	0	0	0	0	0	0	0	0	0	0	0
Total savings	0	36,134	75,571	118,607	161,685	204,895	247,670	289,741	330,987	371,474	410,687

Source: Optimal Energy Study

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions ('000 MTCO2)	0	0
Indirect Emission Reductions ('000 MTCO2)*	156.5	207.1
Total Emission Reductions ('000 MTCO2)	156.5	207.1
Cost Effectiveness ($/MTCO2)		-30

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
'000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 4.5 Industrial ecology/by-product synergy

Sector: **Industrial**

Policy Description: Two recommendations are as follows:

(1) Amend Liability Clause as per recommendation of Beneficial Use Stakeholder Group: Although beneficial use and recycling of solid waste rank at the top of Maine's waste management hierarchy, these activities have languished in recent years. This slackening in beneficial use activity can be attributed, in part, to the mere stigma assigned to the term "solid waste" and the fear of potential end users and handlers of the liability that might be imposed, even years later, despite their lawful reuse of the waste. The proposed bill developed by the Maine Beneficial Use Stakeholder Group was intended to promote and encourage beneficial use and recycling of solid waste by providing liability protection under relevant State laws to persons who engage in such activities in accordance with a permit or exemption:

An Act to Promote Beneficial Reuse of Solid Waste
Be it enacted by the People of the State of Maine as follows:
Sec. 1. 38 M.R.S.A. § 1304, Sub-§ 18 is enacted to read:

> Liability protection for beneficial use. Any person who is engaged in a beneficial use activity or generates, handles or uses a solid waste that has been licensed or exempted from licensing under the Department's beneficial use or recycling regulations may not be deemed a responsible party and is not subject to Department orders or other enforcement proceedings or otherwise responsible under Sections 568; 570; 1304, subsection 12; 1318-A; 1319-J; 1361 to 1367 or 1371 for the use of the solid waste, provided such person has used the waste or conducted the activity in accordance with a Department license or exemption and relevant Department laws, as applicable.

(2) Fund pilot project with the University of Maine to establish a Recycled Resource Center and evaluate funding for future bioproduct-based research opportunities.

BAU Policy/Program: Beneficial Use is Maine's Industrial Ecology program and is regulated under Chapter 418. Agronomic Use of waste materials is a similar program and is not discussed here. DEP convened a multi-year stakeholder process with the task of reviewing issues related to beneficial use with the overall goal of increasing beneficial use in Maine. The stakeholders' group funded a pilot project through the University of Maine to compile data related to beneficial use of certain materials. This site resides at http://useit.umeciv.maine.edu. The group also developed educational and presentational materials for trade shows and other presentations. Finally, the group proposed legislation that was based on the successful brownfields program (VRAP) that called for limiting the liability of the material suppliers, the material processor and the ultimate beneficial user of the material.

CURRENT PROJECTS

Waste Derived Fuels

- *Tire Derived Fuel (TDF)* – Tires from Maine's tire dumps were shredded using bond money and then distributed for beneficial use. About half of Maine's waste pile tires went to TDF the other half went to geotechnical applications. One passenger tire is the equivalent of 280,000 to 300,000 BTUs. Tire chips are 10-12,000 BTUs/lbs. Approximately 1.2 million new waste tires are generated in Maine every year. Three facilities in Maine are burning TDF. These are chipped tires or tire shreds. Whole tires are advantageous in that they do not require additional energy to process the tire to chips.

- *Construction and Demo Debris as Fuel (demo chips)* – Demo chips consist of ground wood wastes including pallet wood, painted wood, etc. It excludes pressure treated. BTU values are approximately 7,500 BTUs/lbs. This is higher than biomass as the wood waste typically has lower moisture content. Several plants in Maine are burning demo chips in biomass boilers.
- *Gates Formed Fiber Waste* – This is felted non-woven polyester fiber. The material has a BTU value of approximately 15,000 BTUs/lbs. One plant in Maine is burning a small amount of this waste.
- *Pioneer Plastics* – Pioneer produces laminate trimmings as well as a fine dust. The trimmings have a BTU value of 8,200 BTU/Lbs. These have been burned for fuel at one facility, but the project has been discontinued.
- *Biodiesel from used fryolater oil* - Current operated on a small scale at the Chewonki Foundation, there is an effort to evaluate the potential for a commercial scale operation in Maine.
- *Methane Gas from Landfills* – One potential pilot project.
- *Pulp & paper sludge* - Large quantities of primary and secondary sludge are generated by pulp & paper facilities. Most ends up landfilled or burned as a low heat value fuel. Methane collection from landfills is cost-prohibitive due to the low permeability. Technologies to ferment the sludge and collect the resulting ethanol are being developed. The ethanol can be marketed as biomass-derived fuel and the amount of sludge being landfilled would be significantly reduced. Other processes are being developed to take residual biomass streams from the pulp & paper industry to create high heat value fuels or other useful products.

Raw Material Substitution

- *Dragon Cement* – Dragon takes a variety of materials for use in the cement manufacturing process. Lime mud is a by-product of the paper making process and is an alternative calcium source to limestone. (Use of lime mud reduces direct process GHG emissions from Dragon's cement manufacture.) Fly ash from coal-fired power plants supplies aluminum and silica as well as BTU value. Spent foundry sand is from Enterprise Foundry in Lewiston and supplies silica. Oil Contaminated Soil from leaking tanks and spills provides a silica replacement.
- Fly Ash, Ground Granulated Blast Furnace Slag and Silica Fume as a cement replacement in concrete.
- Masonite in Lisbon Falls used wood chips soaked in black liquor as part of their process although this may have been discontinued.

Waste Utilization

- Stabilized Dredge Spoils as structural fill – dredge spoils may be stabilized with cement or cement kiln dust (a waste product) to reduce the moisture content and to increase the workability of the material. Use on site replaces use of virgin fill material.
- Scrap Tires for geotechnical applications - Tires are also used in many geotechnical applications and replace virgin materials in use as lightweight fill. Tires projects completed in Maine include the new Portland Jetport interchange and the Brunswick-Topsham bypass.
- Commercial Paving and Recycling - Commercial produces a variety of products using recycled waste material. Crushed concrete is used as a recycled aggregate, Asphalt shingles as bituminous asphalt mix, contaminated soils are treated and used as recycled soil products
- International Paper has produced a flowable fill (low strength concrete mixture) from ash, paper mill waste and lime wastes.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Estimates of potential not available at this time.

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	NE	NE
Indirect Emission Reductions (‘000 MTCO2)*	NE	NE
Total Emission Reductions (‘000 MTCO2)	NE	NE
Cost Effectiveness ($/MTCO2)	NE	NE

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 4.8 Accept ASTM specification C150 for portland cement

Sector: Manufacturing

Policy Description: Specify ASTM (American Society for Testing and Materials) specification C150 for Portland cement rather than AASHTO (American Association of State Highway Officials).

BAU Policy or Program: MEDOT currently specifies AASHTO specifications.

ASTM is the American Society for Testing and Materials, the largest voluntary standard development system in the world. The manufacturing of portland cement is outlined in ASTM standard C150. ASTM C 150 was recently amended to allow for the inter-grinding of up to 5% limestone in Portland cement while maintaining all performance specifications. The amended specification lowers the overall carbon intensity of the portland cement. This standard is consistent with standards already in place in Mexico and Canada. EPA supports this revised standard due to the potential for CO2 reductions. The ASTM standards Board is currently working to harmonize the revised standard with existing AASHTO (American Association of State Highway Officials) standards, which do not recognize this amended standard.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates

- Approximately 450,000 tonnes of cement were produced in Maine in 2003.
- If Maine and the surrounding states adopt the ASTM standard C 150, up to 5% limestone can be introduced in the final grind of cement as long as all other performance standards are met.
- Based on experiences from Canada and European cement manufacturers, a conservative figure that 2.5% limestone addition is possible.
- This results in a reduction of approximately 10,000 tonnes of CO2.(reported in metric tonnes) Reduction in emissions is directly related to cement production. Revise estimates based on cement production in 2010 and 2020.
- There are no cost implications for adopting the revised standard.

The Working Group reviewed a two-page letter from the U.S. EPA to the ASTM Committee C01 on Cement. The letter supports the modification of ASTM standard C 150 allowing up to 5% limestone intergrading in portland cement.

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	10	10
Indirect Emission Reductions (‘000 MTCO2)*		
Total Emission Reductions (‘000 MTCO2)	10	10
Cost Effectiveness ($/MTCO2)		<0

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 5.2 Increase Public Expenditures for Electrical Efficiency Measures

Sector: Residential, Commercial, Industrial

Policy Description: Develop mechanism(s) to raise public funding for electrical EE measures.

BAU Policy/Program: Efficiency Maine is funded by electricity consumers and administered by the Maine Public Utilities Commission (current funding level ~$16 million per year); no sunset date

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

- Estimates reflect the savings associated with putting $15 million into this effort beyond business-as-usual. It does not specify a funding mechanism.

Data Need	Assumption	Source
Electricity		
Funding for EE measures per year 2005-2020	$ 15 Million	Estimated
2003 Efficiency Maine Program Costs	$2,921,000	Efficiency Maine Annual Report 2003
2003 Annual Participant Benefits	$370,150	Efficiency Maine Annual Report 2003
Savings (1^{st} year)	4,837 t CO_2	Efficiency Maine Annual Report 2003
Lifetime of savings	15 years	CT C&LM Fund

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions ('000 MTCO2)	0.0	0.0
Indirect Emission Reductions ('000 MTCO2)*	25	71
Total Emission Reductions ('000 MTCO2)	25	71
Cost Effectiveness ($/MTCO2)		-55

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
'000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 5.5 Increase Public Expenditures for Fossil Fuel Efficiency Measures

Sector: Residential, Commercial, Industrial

Policy Description: Develop mechanisms to raise public funding for fossil fuel efficiency measures.

BAU Policy/Program: None

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Data Need	Assumption	Source
Natural Gas		
Funds collected beyond BAU 2005-2020	$0.6 Million	Assumes 7 cents per MCF
Average Savings per $ for first year	1MCF/ $29	VT gas program
Lifetime of savings	15 years	CT C&LM Fund
Oil		
Funds collected beyond BAU 2005-2020	$4.5 Million	Assumes 1cent per gallon charge
Savings per $	164 barrels/$	VT gas program
Lifetime of Savings	15 years	CT C&LM Fund

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	76.6	204.4
Indirect Emission Reductions (‘000 MTCO2)*	0	0
Total Emission Reductions (‘000 MTCO2)	76.6	204.4
Cost Effectiveness ($/MTCO2)		-34

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

Measure:	BFM 5.6 Photovoltaic Buy Down Program

Sector: **Residential, Commercial, and Industrial**

Policy Description: To promote and encourage the use of renewable energy through the installation of photovoltaic (PV) systems by offering a rebate, or “buying down,” the high upfront cost of PV systems.

BAU Policy/Program: None

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Through the creation of a Maine PV Buy-Down Program, customers with qualifying PV systems that are a minimum 300 watts in size and maximum of 1,000 kW, are eligible for the rebate. Rebates may be awarded on a $/Watt basis depending on the size of the system.

Data Need	Assumption	Sources
Number of kWh generated per year from PV buy down program	30 kW; 11% availability	RI Program
Duration of program	2005-2020	Estimate
Incremental cost of PV system	NA	

GHG Emission and Cost Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	0	0
Indirect Emission Reductions (‘000 MTCO2)*	0.1	0.2
Total Emission Reductions (‘000 MTCO2)	0.1	0.2
Cost Effectiveness ($/MTCO2)		NE

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the average NEPOOL emission factor.

Comparative Data:

Buy Down Level	Installed/Reserved Wattage	Program Sponsor	Estimated Cost
$4.50/W up to 50%	21 MW	CA	$47,250,000
$6/W up to 60%	700 kW	IL	$2,520,000
$4/W up to 60%	1.9 MW	NJ	$4,560,000
$5/W for >=10kW system	208 kW	NY	$1,040,000
$3/W up to 50%	30 kW	RI	$45,000
$1.75/W	15 kW	WI	$26,250
$2/W	400 kW	MN	$800,000
$4.50/W w/ caps	4.6 MW	LADWP	$20,700,000 w/o caps
$3/W w/ caps	248 kW (78 systems)	City of Palo Alto	$744,000 w/o caps

Innovative Buy-Down Program Features Commonly Found in Related Programs:

- Average incentive, by system size: for small systems (< 10 kW) is $5/Watt, medium systems (11-100kW) is $4/Watt, and large systems (>100 and <1,000 kW) is $3/Watt.
- Incentive to reward output performance: A one year "anniversary payment" of $1/kWh, which is approximately $1.75/Watt, for owners (up to $2,000) and $0.10/kWh for the system installer (up to $250)
- Promotion of locally manufactured products incentive: In order to help stimulate local manufacturing, customers purchasing solar products made in-state receive an additional $1/Watt rebate.
- Systems must carry a full 5-year warranty against component failure, malfunction, and premature output degradation, and modules and inverters must be UL-certified.
- PV customers are required to use a participating contractor from a pre-certified list.
- Program administrators will inspect 100% of the eligible installations in the first year prior to issuing the rebate incentive
- Program administrators provide a project checklist on their website which explains how to move a PV project through the State's approval and incentive process.
- Program administrators offer two "Solar Energy Basics" workshops per year for customers.
- The Program provides a list of eligible system components that are UL-listed
- New construction projects that provide the most visibility and demonstrated value will receive preferential funding

References:

- **Customer-Sited PV: A Survey of Clean Energy Fund Support.** Clean Energy Funds Network, Ernest Orlando Lawrence Berkeley National Laboratory, May 2002: Table 1. PV Buy-Down Program.
- **Redding Electric – Vantage Renewable Energy Rebate Program**
  Contact:
  Pam Brady-Koss
  Redding Electric Utility
  Vantage Rebate Program
  (530) 339-7389
  http://reddingelectricutility.com
  pbradykoss@reddingelectricutility.com
- **LADWP – Solar Incentive Program**
  Contact:
  Thomas Honles
  Los Angeles Power and Water
  Solar Program Information
  (800) 473-3652
  http://www.ladwp.com/whatnew/solaroof/solaroof.htm
  Thomas.honles@ladwp.com
- **City of Palo Alto – PV Partners**
  Contact:

City of Palo Alto Utilities
Utility Marketing Services
(650) 329-2241
http://www.cpau.com
pvpartners@cityofpaloalto.org

- **Anaheim Public Utilities – PV Buydown Program**
  Contact:
  Dina Predisik
  Anaheim Public Utilities
  Anaheim Advantage
  (714) 765-4152
  http://www.anaheim.net/utilities/
  dpredisik@anaheim.net

Measure:	BFM 5.7 Solar Water Heat Rebate

Sector: **Residential, Nonprofit, Schools, and Local and State Government**

Policy Description: To promote the use of renewable energy through the installation of solar water heating systems.

BAU Policy/Program: None

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

The State will promote through education, rebates, tax credits, etc. the procurement and installation of solar water heating systems for residential applications. To qualify, the system owner must have an inspector confirm the conservation measure is an efficiency upgrade.

Data Need	Assumption	Sources
Number of homes in Maine	518,200	US Census
Percent of homes with electric hot water heat	46%	CMP, 1994 data
Percent of homes with stand alone oil and/or gas-fired hot water heat	30%	
Market penetration in homes with electric water heaters	0.5%	Estimate
Market penetration in homes with oil/gas-fired water heaters	0.5%	Estimate
Annual energy used for DHW per home	19.2 MMBTU/yr	
Estimate lifetime	15 years	
Costs of solar hot water heater	$5000	Based on cost of a typical residential unit consisting of 2 panels. Note: The cost per btu for solar hot water heating varies quite a bit depending on the configuration of the system.
Cost of typical hot water heater	$450	Flordia Solar Energy Center (Natural gas DHW ranges from $350 to $450; electric from $150-$350)

GHG Emission and Cost Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	6.6	17.5
Indirect Emission Reductions (‘000 MTCO2)*	5.5	15.6
Total Emission Reductions (‘000 MTCO2)	12.0	33.1
Cost Effectiveness ($/MTCO2)		16

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the average NEPOOL emission factor.

Innovative Buy-Down Program Features Commonly Found in Related Programs:

- All solar water-heating units must meet standards set by a pre-approved solar contractor must and pass inspection.
- To be eligible, participating contractors must provide a full 3-year warranty on systems they install.
- The solar collector is covered for 5 years with a prorated warranty from the 6th through the 10th year.
- Free maintenance inspections are provided at five-year and ten-year intervals.

References:

- **SMUD – Solar Water Heater Program Rebate**
  Contact:
  Mike Zannakis
  Sacramento Municipal Utility District
  (916) 732-6994
  http://www.smud.org
  mzannak@smud.org
- **Redding Electric – Vantage Renewable Energy Rebate Program**
  Contact:
  Pam Brady-Koss
  Redding Electric Utility
  Vantage Rebate Program
  (530) 339-7389
  http://reddingelectricutility.com
  pbradykoss@reddingelectricutility.com
- **Franklin PUD – Solar Water Heating Loan**
  Contact:
  Darroll Clark
  Franklin PUD
  (800) 638-7701
  http://www.franklinpud.com
  dclark@franklinpud.com
- **Grays Harbor PUD - Solar Water Heating Loan**
  Contact:
  Doug Smith
  Grays Harbor PUD
  (360) 538-6508
  http://www.ghpud.com
  dsmith@ghpud.org

Measure:	BFM 5.8 REC Purchase Program

Sector: **Commercial and Residential**

Policy Description: To help reduce the cost of renewable energy by brokering the renewable energy credits (RECs) purchased from commercial and residential owners of renewable energy systems.

BAU Policy/Program: The State will offer owners of renewable energy systems the opportunity to sell their renewable energy credits (RECs) to the State, which can then broker these RECs on the open market. The amount of the payments depends on the current market demand for the type of renewable energy technology, the amount of electricity produced by the system, and the length of the contract period.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Data Need	Assumption	Sources
Average price per kWh for solar PV RECs	Solar PV: $0.02-0.05/kWh $50-250/year residential $300-3,000/year commercial	Mainstay Energy
Average price per kWh for Wind RECs	Wind: $0.002-0.15/kWh	Mainstay Energy
Average price per kWh for Biomass RECs	Biomass: $0.01-0.01/kWh	Mainstay Energy
Anticipated number of program participants (solar PV)	13	Bonneville Environmental Foundation
Anticipated number of program participants (various technologies)	200 (commercial and residential)	Mainstay Energy

GHG Emission and Cost Estimates :

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	NE	NE
Indirect Emission Reductions (‘000 MTCO2)*	NE	NE
Total Emission Reductions (‘000 MTCO2)	NE	NE
Cost Effectiveness ($/MTCO2)		NE

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the average NEPOOL emission factor.

References:

- **BEF – Photovoltaic Electricity Production Incentive**
  Contact:
  http://www.b-e-f.org/news/releases/061802.shtm
- **Mainstay Energy Rewards Program – Green Tag Purchase Program**
  Contact:

www.mainstayenergy.com/

Measure:	BFM 5.9* Participate in Voluntary Partnerships and Recognition Programs

Sector: **Comprehensive**

Policy Description: Recognize voluntary programs and reward actions in the appropriate sectors. While some programs already exist at the national level, there may also be an opportunity to develop additional programs in Maine.

BAU Policy/Program: Several programs already exist at the national level: EPA Climate Leaders, DOE Industries of the Future (Maine Industries of the Future currently includes pulp and paper, secondary wood, and metals industry), EPA Energy Star Benchmarking Program, Climate Vision, DOE Rebuild America; Maine STEP-UP program, Carbon Challenge

Clean Air-Cool Planet program highlights include MOU's with Star supermarket, Timberland company, Tom's of Maine, Oakhurst Dairy, Poland Spring, York hospital

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

- DOEs suggestions for expanding Maine participation in IOF:
  - Include agriculture and plastics and potentially welding
  - Additional publicity
  - The Maine legislature might consider creating a mini state grant program that could provide funds to Maine businesses for feasibility studies to determine whether to adopt new energy-efficient technologies.
  - Discuss energy and EE technologies as part of technology cluster project

- The Maine Smart Tracks for Exceptional Performers and Upward Performers, or STEP-UP, Program offers recognition and other incentives to businesses interested in implementing sustainable practices.
  - Alan Auto (Portland), Bath Iron Works (Bath), Fairchild Semiconductor (South Portland), Interface Fabrics Group (Guilford), Moss, Inc. (Belfast), NorDx (Scarborough) and Poland Springs Bottling Company (Hollis). College of the Atlantic (Bar Harbor), CYRO Industries (Sanford), National Semiconductor of Maine (South Portland) and Naturally Potatoes (Mars Hill).

  - Quantification assumes subset of companies in Maine representing 10% of GHG emissions reduce GHG emissions by 15% in 2010 and 25% in 2020 compared to 2000 levels. (Based on commitments under EPA Climate Leaders Program; e.g., Interface and International Paper have pledged similar reductions as those assumed for 2010)
  - Industrial sector direct emissions from fossil fuel combustion in 2000 = 2,300,000 Metric Tonnes

GHG Emission and Cost per Tonne Estimates:

	2010	2020

Direct Emission Reductions (‘000 MTCO2)	34.5	57.5
Indirect Emission Reductions (‘000 MTCO2)*	0	0
Total Emission Reductions (‘000 MTCO2)	34.5	57.5
Cost Effectiveness ($/MTCO2)		NE

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

* Formerly BFM 4.2

Measure:	BFM 5.10* Reduce HFC Leaks from Refrigeration.

Sector: **Commercial and Industrial**

Policy Description: Reduce HFC leaks from refrigeration

BAU Policy/Program: None

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Data Needs	Assumption	Source
ODS substitute emissions from refrigeration and A/C	67%	US EPA based on national statistics*
HFC emissions from stationary refrigeration	40%	USEPA based on national statistics*
Market penetration	5% per year	Estimated
HFC leak reduction potential for stationary refrigerants	5%	US EPA*

* EPA(Environmental Protection Agency). (2001). U.S. High GWP Gas Emissions 1990–2010: Inventories, Projections, and Opportunities for Reductions, Washington, D.C: Office of Air and Radiation. EPA 000-F-97-000.

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	1.2	9.0
Indirect Emission Reductions (‘000 MTCO2)*	N/A	N/A
Total Emission Reductions (‘000 MTCO2)	1.2	9.0
Cost Effectiveness ($/MTCO2)		1.2

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

*Formerly BFM 4.3

Measure:	BFM 5.11* Study the Potential for the Reduction from Leaks from LNG Systems.

Sector: **Comprehensive**

Policy Description: Study the potential for the reduction from leaks from LNG systems.

BAU Policy/Program: Existing federal program – EPA Natural Gas Star Program - aims to reduce methane leaks from natural gas pipelines

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Data Needs	Assumption	Source
Increased participation in EPA Natural Gas Star	NA	

NA: Data not available at this time

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)		
Indirect Emission Reductions (‘000 MTCO2)*		
Total Emission Reductions (‘000 MTCO2)		
Cost Effectiveness ($/MTCO2)		

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

*Formerly part of BFM 4.3

Measure:	BFM 5.12* Substitution of High GWP Gases

Sector: **Comprehensive**

Policy Description: Examine mechanisms to encourage substitution of other gases for high GWP gases if viable, cost-effective, and meets environmental, safety and performance requirements.

BAU Policy/Program: None.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Alternative Refrigerants

- Ammonia. Ammonia, primarily used in water cooled chillers, has excellent thermodynamic properties and can be used in many types of systems. However, it must be used carefully, because it is toxic and slightly flammable. Building and fire codes restrict the use of ammonia in the urban areas of the United States and many other countries. (EPA, 2001)

- *Hydrocarbons.* Hydrocarbons have thermodynamic properties that make them good refrigerants; however, their high flammability causes concern for safety. Hydrocarbon refrigerant use is generally restricted by U.S. safety codes, with the exception of industrial refrigeration(EPA, 2001).

- *Carbon Dioxide.* Carbon dioxide has been investigated for use primarily in mobile air-conditioning systems and refrigerated transport. (EPA, 2001)

Alternative Solvent Fluids

- In electronics, metal, and some precision cleaning end uses, alternative organic solvents with lower GWPs are being manufactured and integrated into the industry. Some of these solvents, such as HFCs, HFEs, hydrocarbons, alcohols, volatile methyl siloxanes, brominated solvents, and non-ODS chlorinated solvents, can be used as alternatives to PFC/PFPEs, CFCs, and HCFCs.

Non-HFC Blowing Agents

- Hydrocarbons (HC) Hydrocarbons such as propane and butane are alternatives to HFCs. HCs are inexpensive and have lower GWP impacts relative to HFCs. However, key technical issues associated with hydrocarbons are: flammability, VOCx, and performance.

- Liquid Carbon Dioxide (LCD). Foams blown with CO2 might suffer from lower thermal conductivity, lower dimensional stability, and higher density versus HCFC blown foams. To overcome these limitations, CO2 can be blended with hydrocarbons or HFCs.

- Water-Blown (in situ) Carbon Dioxide (CO2/water). During manufacturing, no ODP or high GWP gases are emitted, and there are limited health and safety risks during processing. However, foams produced using CO2/water are subject to the same performance limitations discussed for LCD-blown foams

- Lower-GWP HFC Substitution. Manufactures can reduce their emissions on a carbon basis by switching from a blowing agent with a high GWP to one with a lower GWP, but any associated energy penalties must also be considered.

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	NE	NE
Indirect Emission Reductions (‘000 MTCO2)*	NE	NE
Total Emission Reductions (‘000 MTCO2)	NE	NE
Cost Effectiveness ($/MTCO2)	NE	NE

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent emissions

*Formerly BFM 4.4

Measure:	BFM 5.13* Negotiated Agreements

Sector: **Comprehensive**

Policy Description: Include GHG reduction projects as acceptable Supplemental Environmental Project (SEP). A SEP is an environmentally beneficial project that a company performs in exchange for a reduction in penalty associated with violation of an environmental regulation or statute, but it is in addition to the actions necessary to bring the company into compliance.

BAU Policy/Program:

LD845 Climate Change: This bill requires new sources of greenhouse gases to be reported to the Department of Environmental Protection. The bill also requires the department to enter into carbon emission reduction agreements with nonprofit organizations and businesses.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

EPA has set out eight categories of projects that can be acceptable SEPs. To qualify, a SEP must fit into at least one of the categories. The following six seem to be the categories where reducing GHGs can be worked in. (Original numbering from the EPA webpage has been preserved.):

2. Pollution Prevention: These SEPs involve changes so that the company no longer generates some form of pollution. For example, a company may make its operation more efficient so that it avoids making a hazardous waste along with its product.
3. Pollution Reduction: These SEPs reduce the amount and/or danger presented by some form of pollution, often by providing better treatment and disposal of the pollutant.
4. Environmental Restoration and Protection: These SEPs improve the condition of the land, air or water in the area damaged by the violation. For example, by purchasing land or developing conservation programs for the land, a company could protect a source of drinking water.
6. Assessments and Audits: A violating company may agree to examine its operations to determine if it is causing any other pollution problems or can run its operations better to avoid violations in the future. These audits go well beyond standard business practice. [Detailed energy audits would fit this and reduce GHGs.]
7. Environmental Compliance Promotion: These are SEPs in which an alleged violator provides training or technical support to other members of the regulated community to achieve, or go beyond, compliance with applicable environmental requirements. For example, the violator may train other companies on how to comply with the law. [Violators could train other companies on ways to reduce GHGs. Could include training similar companies on ways to reduce high GWP process gases.]
8. Other Types of Projects: Other acceptable SEPs would be those that have environment merit but do not fit within the categories listed above. These types of projects must be fully consistent with all other provisions of the SEP Policy and be approved by EPA.

GHG Emission and Cost per Tonne Estimates:

	2010	2020
Direct Emission Reductions (‘000 MTCO2)	NE	NE
Indirect Emission Reductions (‘000 MTCO2)*	NE	NE
Total Emission Reductions (‘000 MTCO2)	NE	NE
Cost Effectiveness ($/MTCO2)	NE	NE

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on a projection of the marginal NEPOOL emission factor.
‘000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

*Formerly BFM 4.6

Measure:	BFM 5.14* Encourage Combined Heat and Power/ EW 1.8

Sector: **Comprehensive**

Policy Description: Reduce barriers and implement programs to increase CHP in the state.

BAU Policy/Program: CHP is a high efficiency method of DG that utilizes both the steam (or heat) and electricity produced by the electricity generating process, rather than just the electricity. Efficiency can be 2-3 times that of systems not utilizing the heat produced. (For example, an older stand-alone fossil fuel utility powerplant will have a thermal efficiency of about 30%. A new gas turbine,also a stand-alone, will have a thermal efficiency of 50%. CHP, regardless of fuel, will enjoy a thermal eficiency of 85 to 90%.)
(CHP units of at least 70% efficiency)are included as eligible efficient sources under the state Renewable Resource Portfolio Requirement (for a description of this state program see Renewable Portfolio Standards [RPS] measure above).

Data Needs, Sources & Assumptions for GHG Savings and Cost Estimates:

The promotion of CHP is a fundamental issue for our society. CHP is not a tool or a technology; CHP results only from the watershed determination that the foundation of an efficient electric grid is the most complete use of the energy potential of all thermal generation. Development of our full CHP potential will produce a grid with more distributed and less centralized generation, generation less dependent on economies of scale, more shared or district heating in communities and industrial parks, less transmission investment and greater grid stability and reliability . Several policies can promote CHP in Maine:

1) Protection of the Consumer Right to Self-Generate Behind the Meter: Maine law recognizes self-generation, but the right is threatened in several ways. First, some have attempted to require consumers that self-generate to pay transmission charges to utilities even though the electricity generated never uses the utility grid. This proposal was defeated in New England but approved in the West and Midwest. The risk of such a policy is a disincentive to CHP, as such utility charges would penalize CHP and make it uneconomic. Maine's PUC, Public Advocate and other public officials must be required to oppose such policies in Maine, New England and at the federal level. Second, others have proposed that those who self-generate pay excessively for backup power from the grid used during scheduled and unscheduled maintenance. Backup power rates should be based on the probability of the need for backup service, and should not be designed to discourage CHP and require greater grid use, as has often been the case. The PUC should be required to ensure backup rates do not discourage CHP. Third, Maine's PUC and other public officials should be required to oppose exit fees in any form. Exit fees were proposed during electric restructuring to discourage the use of CHP and to provide guaranteed payments to utilities for service not taken by larger customers. Customers should pay only those costs they agree to assume, or which are for service actually taken. Other devices, such as exit fees, are inconsistent with our regulatory model for utilities and strongly discourage the movement to more efficient consumption or conservation, such as CHP.

2) The NEPOOL Minimum Grid Interconnection Standard Must be Maintained.

After a long and expensive legal battle waged by Champion International, a Maine CHP located in Bucksport (now International Paper), the Federal Regulatory Energy Commission ("FERC"), adopted a simple and easy policy for allowing the interconnection of powerplants to the electric grid. The policy is now used in most regions of the nation, but is opposed by some large electric utilities, including some in New England. The policy allows interconnection without expanding the grid beyond what is necessary to ensure its reliabillity and stability for consumers and generators. Repeal of the policy essentially would require owners of CHP (and other generators) which export to the grid at all to build additions to the grid that are unnescessary. The policy not only helps CHP, but also lowers electricity costs.

3) Permitting Must Recognize the Benefits of CHP.

Present federal and state air permitting policies do not contain recognition of the societal benefits of CHP. For example, most air analyses focus on the amount and kind of pollutants emitted by a source, rather than also considering the efficiency of the use of fuel . Clearly the efficiency of CHP lowers total societal pollution. But, since CHP meets both electricity and heat needs at a given location, CHP requires more emissions at the site than if only heat or electricity were produced. This increment of emissions stresses the permitting system when, if both heat and power were considered, it would not. The effect of current permitting policies is to encourage the centralized generation of electricity, usually at far lower efficiencies than when CHP is used, because the incremental electricity production requires no permitting, unless an entirely new plant is required. The granting of emissions credits may also be useful.

A more positive step, however, is to incorporate the efficiency of energy use (and the benefits of CHP) into all state and local permitting, so as to provide an incentive to new building construction and air system renovation to consider CHP. This can only occur by use of a broader societal perspective on total energy use. The current disaggregation of land , air and water use from energy use is unrealistic and harmful to the environment.)

4) Financial Incentives--- could be any of many available for other purposes.

Policy Options for CHP Development: This analysis does not identify which option would be used to obtain the required level of CHP penetration. There are several methods that can be employed. Interconnection standards are technical guidelines governing the linking of the CHP unit to the grid. In some cases they may be difficult to meet, and may thus serve as barriers to new CHP. Developing uniform and consistent interconnection standards can allow units to be connected to the electricity grid faster and reduce the cost of interconnection. Stand-by fees are charged by utility companies to provide back-up or stand-by electricity in the event of power loss or to supplement generation. The cost of ensuring the availability of stand-by power can be as high as the cost of buying the electricity directly from the grid. Lowering standby fees can therefore promote CHP development.

Other methods include the awarding of emission reduction credits to CHP units for emission reductions realized as a result of their high efficiency; consumer choice, which allows electricity customers to purchase CHP-generated electricity; and direct subsidies, provided to CHP units on a per unit, efficiency or energy production basis, which can improve the depreciation allowance for CHP equipment.

Several efforts to increase generation from CHP are already under way. The RAP model rule, developed in 2002, seeks to establish uniform and appropriate emission standards for new distributed generation (DG) and to streamline the permitting process (see http://www.eea-inc.com/rrdb/DGRegProject/modelrule.html). The Distributed Generation Interconnection Collaborative issued a report titled "Proposed Uniform Standards for Interconnecting Distributed Generation in Massachusetts" which describes a starting point for DG interconnection of various sized units located on both radial and secondary network systems within Massachusetts (see http://dg.raabassociates.org/Articles/DG%20Report.Final.doc). Massachusetts has also issued D.T.E. 02-38. requesting comments on four issues: (1) whether current distribution company interconnection standards and procedures in Massachusetts act as a barrier to the installation of distributed generation; (2) whether current distribution company standby service tariffs act as a barrier to the installation of distributed generation; (3) what the role of distributed generation is with respect to the provision of service by Massachusetts distribution companies; (4) what other issues are appropriate for the Department to consider (see http://www.state.ma.us/dpu/electric/02-38/103order.pdf and http://www.state.ma.us/dpu/electric/02-38/81necacom.pdf).

For modeling analysis, following assumptions were made:

- Total potential capacity (MW) provided by Energy and Environmental Analysis (EEA). This potential represents the technical potential only, and does not evaluate economic potential. EEA has emphasized that this is an extremely rough estimate. However, a study by Onsite Sycom (*The Market and Technical Potential for Combined Heat and Power in the Commercial/ Institutional Sector*) estimates the total commercial CHP technical potential in Maine to be 300 MW. The EEA estimate of 411 MW is reasonably close to this value, so the total potential estimated by EEA has been used.
- Only a portion of the technical potential will be economically viable. It has therefore been assumed that only 20% of the total technical potential could be developed, and a level of 130 MW of additional CHP penetration was modeled with NEMS. 82 MW would be in the commercial sector, 46 MW in the industrial sector.
- Policy begins in 2008, with the full 130 MW online in that year and continuing through 2020.
- All CHP units assumed to be fired by natural gas
- Fuel input of stand-alone boilers replaced assumed to be 1/2 gas, 1/2 oil (Btu basis). Oil is assumed to be distillate in commercial sector and residual in industrial.
- Efficiency of stand-alone boilers assumed to be 80%
- CHP units assumed to have following characteristics:

Economic Sector	Parameter	Commercial	Industrial
System assumption		200 kW micro-turbine	5MW combustion turbine
Electrical efficiency		36%	28%
Heat efficiency	Fraction of fuel energy input	27%	45%
Capital cost	$/kW	$1,415	$966

Source : Assumptions to NEMS model, *Annual Energy Outlook 2004*

GHG Emission and Cost per Tonne Estimates: See Electricity Work Group Memo for Emission Reductions

	2010	2020
Direct Emission Reductions ('000 MTCO2)		
Indirect Emission Reductions ('000 MTCO2)*		
Total Emission Reductions ('000 MTCO2)		
Cost Effectiveness ($/MTCO2)		

Direct Emissions: On-site emission reductions
Indirect Emissions: Emissions at the site of electricity generation
* Indirect Emissions are based on NEMs Model Results
'000 MTCO2 = Thousand metric tonnes of carbon dioxide equivalent
MTCO2= Metric tonnes of carbon dioxide equivalent

*****Formerly BFM 4.7

Appendix 1:

Potential Building, Facilities, and Manufacturing GHG Reduction Opportunities – *Edited 12-17-03*

The following notation was used in the table below:

- *Options that were popular choices in other states, potentially high Maine GHG reduction options, or both (originally denoted by CCAP, reviewed by Stakeholders
- *? For *'d options to which at least one member of the Stakeholder Advisory Group expressed uncertainty about it being important in Maine
- *! For options not previously marked with a *, which at least one member of the Stakeholder Advisory Group thought should be a priority
- Some additional comments from stakeholders are highlighted in the list

Status Legend:

NI: **Not Identified** for pursuit by Working Group or Stakeholder Advisory Group, but included in CCAP's original list of GHG mitigation options

D: **Dropped**. Originally selected for evaluation and consideration by Stakeholder Group or Working Group, but dropped by the Working Group.

C: **Combined** with another option (list which option)

R: **Referred** to another working group (name working group)

F: **Future** technology. Technology not commercially viable at present, but flagged for monitoring and possible future pursuit.

WG: Working Group proposing this option

	Residential Sector GHG Reduction Opportunities	
1	**Improve Energy Efficiency (EE) of Appliances**	**Status**
1.1	*Energy Efficiency Appliance Standards - For appliances not covered under federal standards, the state can set minimum levels of efficiency for specific appliances.	WG
1.2	Tax Incentives for EE Appliances	NI
1.3	Discounts/Rebates on Energy Star Products	NI
1.4	Contractor Education: Proper sizing of HVAC – Proper sizing of air ducts and other components of heating, ventilation and air conditioning systems can significantly reduce the size and energy requirements of furnaces and air conditioning units.	NI
1.5	Consumer Education: Selection, Alternate appliance choices – Educate consumers about the lifetime savings achieved over appliance lifetime by appliances that consume less energy.	NI
1.6	Bulk Purchasing Program - Bulk procurement can reduce the cost of energy efficient appliances or renewable technologies.	NI
1.7	Promote Appliance Recycling	NI
1.7.a	Appliance recycling pick-up program – Program to collect and recycle old	NI

	residential appliances, rather than send them to junkyards/landfills.	
1.7.b	Reduce secondary market for used appliances – Create incentives for residential customers to discard old appliances when new ones are purchased, rather than selling the old appliance or running both the new and old appliance (e.g. air conditioners or refrigerators). Other states have offered a "bounty" rebate to residents who buy a new window AC unit and turn in the old unit to the state for disposal.	NI
2	Incentives to Technology Providers	
2.1	R&D	NI
2.2	Incentives to manufacturers (regional) –Cross cutting for all GHG sectors	NI
3	EEE Design of Building	
3.1	*Improved Building Codes (revisit every 3 years) - Require buildings to meet the most recent Energy Code efficiency/performance standards established by the International Code Council. (Avoid conflict with Rehab code)	WG
3.2	*!Training (builders, code officials, architects etc.) and Enforcement of Building Codes	C with 3.1
3.3	EPA Energy Star Homes - This program provides rebates for the purchase of newly constructed homes meeting higher efficiency standards established by the U.S. EPA and DOE Energy Star Program.	C with 3.4
3.4	*!Voluntary Green Building Design Standards – Create voluntary high efficiency and sustainable building standards (recycled material, low VOC content, low embodied energy construction materials, etc.) that builders can follow. Buildings meeting the standards can have a "seal of approval" or other type of recognition (e.g., LEED).	WG
3.5	Mandatory "Green" Standards for New Construction/ Renovations	NI
3.6	*Energy Efficiency Mortgages - Energy Efficient Mortgages allow purchasers to borrow a larger mortgage when purchasing an Energy Star home. Energy Improvement Mortgages allow owners to borrow money for energy efficiency improvements on their homes, or to upgrade the energy efficiency of a home before purchasing.	C with 3.4
3.7	Financial incentives for contractors, builders, homeowners	NI
3.8	Increased marketing of existing programs	NI
3.9	White Roofs and Rooftop Gardens – Reflect sunlight and shade roofs to reduce air conditioning energy requirements.	NI
3.10	Landscaping – Well-planned landscaping with trees for shade and evergreens/hedges to block wind reduce a building's heating and cooling requirements.	NI
3.11	*Education to homeowners – Educate homeowners energy efficiency and sustainable design retrofits, renovations and new construction options.	R: Education WG
4	Improve Energy Management	
4.1	Energy Audits – Assess a home's energy use, and areas where energy is being wasted.	NI
4.1.a	Weatherization	NI
4.1.b	Blower door testing	NI
4.2	Training of Building Operators	NI
4.3	Efficient Use of Oil and Gas	WG
4.3.a	Improve building envelope – windows, insulation, etc.	NI
4.3.b	*Heating	WG
4.3.c	DHW	WG
4.3.d	Cooking	NI
4.3.e	Pumping well water	NI
4.3.f	Fuel Switching to less carbon-intensive fuels	WG
4.4	Efficient Use of Electricity	NI

4.5	*Educate residents/ public/ children	R Education WG
4.5.a	Marketing Programs	NI
4.5.b	Introduce in School Curriculum	NI
4.6	Advanced metering – Provides real or near real-time electricity consumption data. Combined with time-of-use rates, creates incentive for residential electricity load management and conservation.	NI
4.7	Load Management – With advanced meters and time-of-use rates in place, residential electricity customers can manage their energy use to reduce consumption during peak daytime rates, thereby saving money.	WG
4.8	Time-of-Use (TOU) Rates – Time-of-use rates for electricity, a market mechanism charging customers more during daytime peak periods and less during off-peak periods. Provides incentive for residential customers to save money by shifting some energy consuming tasks (such as laundry) to off-peak periods.	NI
	See also "Comprehensive Programs"	
	Commercial Sector GHG Reduction Opportunities	
1	Improve Energy Efficiency (EE) of Equipment and Appliances	
1.1	*EE Equipment and Appliance Standards - For appliances not covered under federal standards, the state can set minimum levels of efficiency for specific appliances.	WG
1.2	Tax Incentives for EE Equipment and Appliances	NI
1.3	Discounts on Energy Star Products	NI
1.4	Bulk Purchasing Program - Bulk procurement can reduce the cost of energy efficient appliances or renewable technologies.	NI
2	Energy Efficient Buildings	
2.1	*Improved Building Codes - Require buildings to meet the most recent Energy Code efficiency/performance standards established by the International Code Council.	WG
2.2	Training (Builders, Code Officials, Architects etc.) and Enforcement of Building Codes	C: 2.1
2.3	Voluntary Green Building Design Standards	WG
2.4	*"Green" Standards for New Construction/ Renovations	WG
2.4.a	Mandatory standards for state buildings – Construction and renovations receiving any state funding should meet higher energy efficiency/performance standards.	WG
2.4.b	Mandatory standards for schools - Construction and renovations receiving any state funding should meet higher energy efficiency/performance standards.	NI
2.5	*Incentive payment for green buildings – Provide incentives for privately financed new construction and renovation to meet higher energy efficiency performance standards than standard construction.	C: 2.3
2.6	White Roofs and Rooftop Gardens – Designed to reduce solar heat gain and thereby reduce air conditioning electricity needs.	NI
2.7	*State-wide EE Goals and Reporting for Government Buildings - A program to encourage measurement and tracking of energy consumption, strategic planning and benchmarking against other buildings.	WG
3	Improve Energy Management	
3.1	Energy Audits	NI
3.2	Building Recommisioning	NI
3.3	Training of Building Operators - Training building operators in how to maximize the efficiency of their buildings will decrease energy use if operators apply what they learned.	NI
3.4	Efficient Use of Oil and Gas	NI

3.4.a	Building Shell – Windows, insulation, etc.	NI
3.4.b	Heating	NI
3.4.c	DHW	NI
3.5	Efficient Use of Electricity	WG
3.5.a	Lighting	WG
3.5.b	A/C	WG
3.5.c	Ventilation	WG
3.5.d	Pumps/motors	WG
3.6	*Shared Savings Program for Government Agencies - Allows a state agency to keep a portion of the energy savings realized when the agency makes energy efficiency improvements to a building.	C:2.7
3.7	Fuel Switching to less carbon-intensive fuels – such as natural gas, biodiesel, etc.	WG
3.8	*Load Management	WG
3.9	*!Green campus initiative –already begun.	WG
4	Promote Recycling	NI
	See also "Comprehensive Programs"	
	Industrial Sector GHG Reduction Opportunities	
1	Industrial Energy Efficiency (EE), Management, and Conservation	
1.1	Efficient Use of Oil and Gas	NI
1.1.a	Boilers	NI
1.1.b	Upgrade to steam system	NI
1.1.c	Process-specific equipment	NI
1.1.d	Building Envelope – Windows, insulation, etc.	C:2.1
1.2	Efficient Use of Electricity	WG
1.2.a	Pumps	WG
1.2.b	Motors	WG
1.2.c	Lighting	WG
1.2.d	Cooling	WG
1.3	Optimization of Compressed air systems	C: 1.2
1.4	EE process improvements	C: 1.2
1.5	Shut-it off program (curtailment) – Financial incentive for industrial electricity customers to cut demand during peak/emergency demand periods for the local utility.	NI
1.6	Energy Management Training	NI
1.7	R&D of new technologies	NI
1.8	*Financial incentives - Offer incentive rebates for energy efficiency improvements.	C: 1.2
1.9	Education	R: Education WG
2	Reduction in Process Gases	
2.1	*Participate in Voluntary Industry-Government Partnerships	WG
2.2	*Leak Reduction Programs	WG
2.3	Process Changes/ Optimization	NI
2.4	Capture, Recovery and Recycling of Process Gases	C: 2.2
2.5	New Equipment	NI
2.6	*!Substitution of High GWP Gases – Substitute high global warming potential (GWP) gases with appropriate substitutes depending on application (e.g., CO_2, ammonia).	WG
3	Supply Side Measures	
3.1	*Encourage Combined Heat and Power – Combined heat and power is a high efficiency method of distributed generation that utilizes both the steam and electricity produced from the electricity generating process, rather than	WG (R: ESW WG)

	just the electricity. Efficiency can be 2-3 times that of systems not utilizing the heat produced.	
4	Other programs	
4.1	*!Industrial ecology/ by-product synergy – Programs to link the by-products from one industry with use as the feedstock for other industries.	WG
4.2	*!Negotiated Agreements - To promote GHG reductions in particular sectors, a state government may enter into direct voluntary or negotiated agreements with industries or industrial sectors. Legislation requires (need to develop metrics)	WG
4.3	Cap and Trade	NI
	See also "Comprehensive Programs"	
Comprehensive Programs for Residential, Commercial and Industrial Sectors GHG Reduction		
1.1	Mandatory Reporting of Fuel Use, GHG Emissions	NI
1.2	State-wide Energy Efficiency/GHG Emission Reduction Goals	C:2.7
1.3	*Government Agency Requirements and Goals	C: 2.7
1.4	*Public Benefit Funds – Funds created by a surcharge on electricity, natural gas or oil sales that are used to fund demand side energy efficiency and conservation programs.	WG
1.5	Negotiated Agreements	WG
1.6	Environmentally Friendly Procurement	WG
1.7	Small-source aggregation	NI
1.8	Supply-Side Measures	
1.8.a	Net-metering - Allows the electric meters of customers with generating facilities to turn backwards when the generators are producing energy in excess of the customers' demand, enables customers to use their own generation to offset their consumption over a billing period.	NI
1.8.b	Encourage Green Power Purchases	R: EW
1.8.c	Incentives for Renewable Energy Applications	WG

Appendix 2:
Proposed Criteria for Assessing and Prioritizing GHG Measures

PRIMARY CRITERIA	**Indicators that would be assessed by CCAP to the extent possible using the best available data for each option.**
GHG Impact	Total annual GHG's reduced in relevant target years in carbon equivalents. This is typically expressed as an average annual level of projected MMTCE reduction in a given year beyond baseline emissions. GHG impacts must be quantified in order to aggregate measures toward a numerical target.
Cost-Effectiveness	Direct net cost divided by the GHG impact (expressed in dollars per metric ton of carbon equivalent) and is typically expressed in a given year as an average annual value over the life of the action. Costs may be expressed as a range.
SECONDARY CRITERIA	**Indicators that would be assessed by CCAP, the Working Groups, or both when relevant for a particular option using best available data. These impacts may not be readily quantifiable**.
Ancillary Environmental Impacts	Environmental impacts other than GHG emissions reductions, including public health and ecosystem impacts from changes in air quality or other environmental indicators. These impacts may not be readily quantifiable.
Ancillary Economic Impacts	Economic impacts other than direct costs or benefits of GHG reduction actions (e.g. economic development, cost savings for other actions). These impacts may not be readily quantifiable.
Equity Effects	Measure disproportionately affects a population, sector or a region of the state or affects the state's competitive position relative to other states. These impacts may not be readily quantifiable.
Public and Political Support/Concern	Expected support and or concern from the general public and from policymakers. These impacts may not be readily quantifiable.
Feasibility	Ease of implementation and administration by implementing parties. These impacts may not be readily quantifiable.
Compatibility	Measure reinforces or enhances the effectiveness of other policy programs, or is required for other measures to work. These impacts may not be readily quantifiable.
Transferability to Other States/Nationally	Ease of duplication of measure in other states and or national and international policies. These impacts may not be readily quantifiable.

Appendix 3:

Emissions per Unit of Production for Select Maine Industries

[Information to be provided]