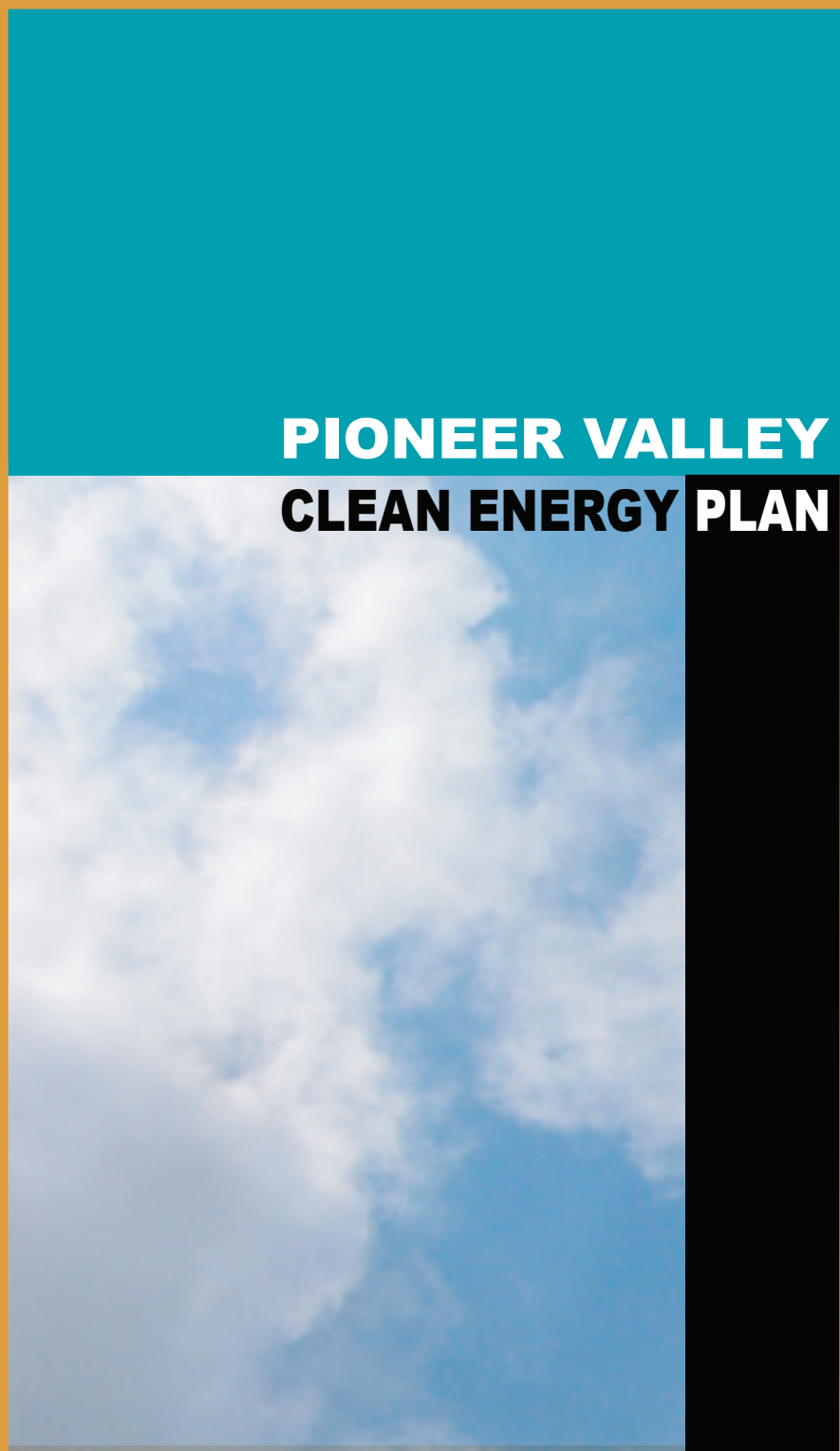
Appendix



January 2008

Prepared by the
Pioneer Valley Renewable Energy Collaborative

The plan and appendices are available at www.pvpc.org and www.frcog.org

Appendices

Appendix I: Webliography

Center for Ecological Technology
www.cetonline.org

Center for energy efficiency and engineering—University of Massachusetts, Amherst
http://www.ceere.org/

Clean Water Action-Massachusetts
www.cleanwateraction.org/ma

CoopPower
www.cooppower.coop

Franklin Regional Council of Governments
www.frcog.org

Greenfield Community College
www.gcc.mass.edu

HAP Inc.
www.masshousinginfo.org/hap

Massachusetts Department of Environmental Protection
www.mass.gov/dep

Massachusetts Division of Energy Resources
www.mass.gov/doer

Massachusetts Executive Office of Energy and Environmental Affairs
www.mass.gov/envir

Massachusetts Technology Collaborative
http://masstech.org/CleanEnergyOrg/index.htm

Mount Wachusett Community College
www.mwcc.mass.edu

Pioneer Valley Planning Commission
www.pvpc.org

SmartPower
www.smartpower.org

Sustainable Step New England
www.ssne.org

Western MA Electric Company
www.wmeco.com

General

Northeast Sustainable Energy Association
www.nesea.org

ICLEI-Cities for climate protection
www.iclei.org

Pew Center for Climate Change—chart of different state's targets.
http://www.pewclimate.org/what_s_being_done/targets/

Alternative Energy Retailer
http://www.aer-online.com/e107_plugins/content/content_lt.php?content.337

Database of state incentives for renewables and efficiency
http://dsireusa.org/

Massachusetts Climate Action Network
http://massclimateaction.org/info.htm

NESEA Building Energy conference presentations 2007
http://buildingenergy.nesea.org/Proceedings-login.php

Smart energy information and ideas for business
http://energypriorities.com/entries/2005/01/2005_energy_pri.html

http://www.25x25.org/

http://www.3phases.com/

American Council on renewable energy
http://www.acore.org/

Alliance to save energy
http://ase.org/section/_audience/consumers

http://www.americanforests.org/resources/ccc/

American Council for an energy efficient economy
http://www.aceee.org/press/0605oildemand.htm

http://news.bbc.co.uk/1/hi/in_depth/sci_tech/2006/energy/default.stm

Biomass research and development initiative
http://www.brdisolutions.com/default.aspx

http://www.environmentaldefense.org/page.cfm?tagID=602&campaign=mts&calcID=1591

Consortium for energy efficiency
http://www.cee1.org/

Conservation Law Foundation
http://www.clf.org/programs/index.asp?id=62

http://www.sustainablecommunities.ca/Capacity_Building/Energy/Municipal_Building_Retrofit_Guide/

http://www.energy.gov/news/3704.htm

http://www.efficiencyvermont.com/pages/

http://www.energyfederation.org/consumer/default.php

http://www.energybulletin.net/16859.html

Energy Information Administration
http://www.eia.doe.gov/

http://epa.gov/cleanenergy/stateandlocal/network.htm

http://www.globalenergymaps.com/renewables-map.html

http://www.gosolarmass.org/

http://www.communities.gov.uk/

http://www.massaudubon.org/advocacy/news.php?id=92&type=news

National Renewable Energy Laboratory
http://www.nrel.gov/

http://www.northeastbiodiesel.com/

http://www.nativeenergy.com/

Communities and government working on our energy future
http://www.newrules.org/de/archives/000068.html

U.S. Dept. of Energy-Policy and International affairs
http://www.pi.energy.gov/enhancingGHGregistry/index.html

http://www.dkosopedia.com/wiki/Peak_Oil

http://www.energybulletin.net/20945.html

Union of Concerned Scientists
http://www.ucsusa.org/clean_energy/renewable_energy_basics/public-benefits-of-renewable-energy-use.html

Wind art exhibit
http://www.reimaginations.com/

Combined heat and power application center
http://www.chpcentermw.org/13-00_links.html

Texas state energy conservation office
http://www.infinitepower.org/

http://www.renewableenergylaw.blogspot.com/

U.S. Climate technology corporation gateway
http://www.usctcgateway.net/tool/

Economics

http://ecosystemmarketplace.com/pages/static/marketwatch.php

http://tqe.quaker.org/2007/TQE155-EN-WorldEnergy-1.html

http://www.realtor.org/libweb.nsf/pages/fg313

http://www.cleanedge.com/

http://www.dti.gov.uk/

http://www.businessweek.com/technology/content/sep2005/tc20050920_4905_tc_217.htm

http://www.entergy.com/our_community/environmental_grants.aspx

http://www.eesi.org/programs/Smartgrowth/smartgrowth.htm

Life cycle Analysis

http://www.earthster.org/index.html

http://www.mrs.org/s_mrs/doc.asp?CID=8005&DID=192322

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V2W-46H216F-1&_user=10&_coverDate=11%2F30%2F2002&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=c250e698857c847f9e25bdab769bbf57
website that includes an article describing life cycle analysis of different electricity generating options.

http://books.google.com/books?hl=en&lr=&id=kwjONMgLlJQC&oi=fnd&pg=PR7&dq=life+cycle+analysis+clean+energy+alternatives&ots=RvJW9eCtPA&sig=NifIZzZWfVev8nAIYq-l7hIGyBQ
website to access a handbook on conducting life cycle analysis of electricity generating options.

Energy/Smart Growth Links

- Energy Solutions for a Livable Community, EESI Congressional Briefing Summary
- Naomi Friedman, The Energy/Smart Growth Connection, *Getting Smart!*, International City County Management Association, Vol. 5, No. 1.
- Jim Schwab, Who's Got the Energy? What Comes to Mind? in American Planning Association, *Planning*, October 2002.
- The Gas Technology Institute, Sustainable Urban Design Competition, San Diego Award Winner.
- The Department of Energy Smart Communities Network: Creating Energy Smart Communities
- A Database of State Incentives for Renewable Energy (DSIRE)
- The National Renewable Energy Laboratory, Case Studies on the Effectiveness of State Financial Incentives for Renewable Energy
- The American Public Transportation Association, Conserving Energy and Preserving the Environment: The Role of Public Transit.
- Place Matters.com, a nonprofit organization that assists communities with integrated, participatory planning
- The Energy Yardstick: Using PLACE3S to Create More Sustainable Communities, US DOE, CA Energy Commission, OR Dept. of Energy, and the WA State Energy Office
- Decision support tools for integrated land-use planning
- The Rocky Mountain Institute, Green Development, report and CD-Rom
- Location Efficient Mortgages
- Solving Sprawl, Natural Resource Defense Council
- U.S. Green Building Council and LEED (Leadership in Energy and Environmental Design) program
- The Local Government Commission, Center for Livable Communities
- Village Homes, Davis, California
- Envision Utah
- Steps To a Sustainable Energy Future for Albuquerque, keynote speech, Dec. 1991
- Ross Baldick, Variation of Distribution Factors with Loading, Center for the Study of Energy Markets, Sept. 2002
- City of Austin, Smart Growth Matrix, tool to assist the City Council in analyzing development proposals.

More General

AGORES, The Official European Commission for Renewable Energy

This site is the European information center for renewable energy. Their web site goal is to allow fast and efficient access to an extensive range of information and connecting all renewable energy players. It features, publications, news, and links with a European focus.

American Bioenergy Association

The ABA web site promotes the economic and environmental benefits of using biomass. Their site contains legislation updates and a fact sheet on biomass-energy benefits.

American Wind Energy Association (AWEA)

The AWEA promotes wind energy as a clean source of electricity for consumers around the world. This web site contains wind energy education, technical information and wind-related power legislation.

Bioenergy Information Network

A sub-section of the Department of Energy, this web site provides information about fast growing trees, grasses, and residues for converting into fuels and chemicals. Also provided is a searchable database of articles, reports, and conference papers related to biomass legislation.

California Energy Commission

The CEC is California's primary energy policy and planning agency. Their web site features press releases and reports on California's energy concerns, as well as a complete list of the CEC funded programs.

Center for Energy and Environmental Education
The CEEE is located on the University of Northern Iowa campus, is an organization that covers a range of energy and environmental education programs including the Iowa Festival Recycling Project and the Iowa Energy Summit.

Center for Global and Regional Environmental Research
The University of Iowa's CGRER promotes research efforts that focus on the multiple aspects of global environmental change. Their web site outlines CGRER goals and offers links to research and reports done by the group on a multitude of environmental issues.

Danish Wind Turbine Manufacturers Association
The Danish Wind Turbine Manufacturers Association publishes information about wind energy, including this web site. Here you will find an animated "guided tour" of wind resources, wind turbine technology, economics and environmental aspects of wind energy. Also featured is a large wind energy reference manual.

Directory of Units of Measurement - University of Exeter
This web site provides a summary of the units of measurement. Also found here are the appropriate conversion factors needed to change those measurements into a "standard" unit of the System International.

Econet Energy Resource - Wind
This web site provides links and summaries of all web sites by members of the American Wind Energy Association. Beyond the AWEA information, there are also links and summaries to global wind energy concerned web sites.

Electric Power Research Institute (EPRI)
EPRI is a non-profit organization committed to providing science and technology-based solutions to global energy customers. The EPRI site shares its wealth of scientific research, technology development, and product implementation to commercial and residential sectors.

EPRI Energysearch Search Engine
A search engine for the Electric Power Research Institute

Energy Center of Wisconsin
A well-organized site that supplies research reports, case studies, fact sheets, videos, software, and other tools. Also on this large site is an updated listing of ECW projects, programs and conferences.

Energy Services Coalition
The Energy Services Coalition (ESC) is a national nonprofit organization composed of a network of organizations working together at the state and local levels to increase energy efficiency and building upgrades through energy savings performance contracting. A lot of this web site focuses on ESC membership information but there is also case studies and contracting tips offered.

Export Council For Energy Efficiency
The Export Council for Energy Efficiency's (ECEE) mission is to promote the global use of energy efficiency products and services, in partnership with US companies and state officials, by increasing the awareness of their economic and environmental benefits. Their web site offers publications and information on regional energy activities.

Energy Ideas Clearinghouse (EIC)
Funded by the Northwest Energy Efficiency Alliance and operated by the Washington State University Cooperative Extension Energy Program, this site contains energy efficiency and renewable energy tools, information and links. A database of technical data offers on line factsheets, publications, Q & A from engineers and software.

Federal Technology Alerts
Sponsored by the Department of Energy, Federal Technology Alerts (FTAs) are designed to provide an overview of U.S.-developed technologies related to energy-efficiency, water-conservation and renewable-energy. The FTAs contain up-to-date information on the emerging technologies, their applications, as well as a list of key contacts and information sources pertaining to the technologies.

Florida Solar Energy Center
A research institute of the University of Central Florida, the FSEC and this web site provide a wide variety of technical articles, research reports, newsletters and public information documents on solar energy. Also presented is a searchable research library that contains one of the nations largest collections of solar energy and renewable energy resource materials.

Geothermal Energy Association
The Geothermal Energy Association is a trade association composed of U.S. companies who support the expanded use of geothermal energy and are developing geothermal resources worldwide for

electrical power generation and direct-heat use. Their web site is mostly comprised of membership information but there are also statistics and articles on geothermal energy.

Great Lakes Renewable Energy Association
The GLRE is a non-profit organization that educates, advocates, promotesand publicly demonstrates renewable energy technologies. Their web site contains a newsletter and a large listing of links.

Greentie Environmental Information
IEA (International Energy Association) GREENTIE is an international information network that distributes details on companies that distribute products that reduce greenhouse gas emissions. The searchable GREENTIE Directory database contains details of almost 8,000 technology suppliers and information organizations. Also provided is an updated news and links section.

Home Energy Magazine on the Web
Home Energy magazine is published by a non-profit organization whose mission is to provide objective and practical information on all aspects of home performance, from residential energy conservation to indoor air quality to building more energy efficient homes. You can find selected articles from the magazine on this site.

International Space Environment Service
ISES provides information to the world community to assist in the planning, coordination and conduct of scientific work affected by the sun-earth environment. Their web site features information and research on many solar aspects including the solar cycle and the geophysical calendar.

Interstate Renewable Energy Council
The IREC offers a range of market-oriented services and products targeted at education, coordination, and accessibility. You will find information on IREC's programs, services and products, as well as resources on issues impacting the expansion of renewable energy use.

Lawrence Berkeley National Laboratory (Energy and Environment Division)
This is an immense web site that contains detailed information on the research at the LBNL. The focus of the research is developing technology that uses, converts and stores energy more efficiently and with less environmental impact. They also study and offer reports on energy use and the environment.

National BioEnergy Board
NBB has developed minimum quality standards and a system to register fuel suppliers assuring a high quality fuel supply and consumer confidence. This site facilitates in the exchange of information for the commercialization effort, which includes all feedstock providers, government agencies, customers, engine manufacturers, fuel providers, and other interested parties.

National BioEnergy Industries Association
This site offers links and information from a variety of national bioenergy sources such as federal agencies, industry associations and commissions. Some facets of the web site are currently under construction.

National Renewable Energy Laboratory (NREL)
NREL works toward a sustainable energy future by developing renewable energy technologies, improving energy efficiency, advancing related science, engineering and facilitating commercialization. Their large web site contains a detailed listing of NREL research that offers a spectrum of global marketing techniques and alternative fueling resources.

National Wind Coordinating Committee
A U.S. consensus-based collaborative, the NWCC identifies issues that affect wind power. Though this site concerns itself mostly with communication between NWCC members, the web site also features reports and publications related to the development of wind power available for downloading.

Oak Ridge National Laboratory (Energy Division)
One of the 15 research divisions out of Oak Ridge, the Energy Division provides solutions to energy and related issues of importance through research, development, and use. Here you will find the site divided into four “centers”: The Center for Transportation Analysis, The Center for Energy and Environmental Analysis, The Building Technology Center and The Emergency Management Center. Each provides its own reports, energy solutions and links.

Pacific Northwest National Laboratory (PNNL)
Regulated by the U.S. Department of Energy, The Pacific Northwest National Laboratory web site delivers environmental science and technology in the form of an extensive list of reports and publications. The Lab reports focus on nuclear technology, health and energy efficiency.

Pollution Prevention Regional Information Center
The Pollution Prevention Regional Information

Center (P2RIC) provides access to pollution prevention resources and articles, in particular those that relate to the states of Iowa, Nebraska, Missouri and Kansas. This web site is very largeand easy to search and navigate due to its well organized search engine.

Renewable Fuels Association
As the national trade association for the U.S. fuel ethanol industry, the Renewable Fuels Association (RFA) has been working on behalf of the industry to secure a strong marketplace for ethanol. Their web site contains ethanol-related statistics as well as legislation and news that affect the ethanol market.

Repowering the Midwest: The Clean Energy Development Plan
Repowering the Midwest: The Clean Energy Development Plan for the Midwest is a blueprint for harnessing clean, affordable energy efficiency and renewable energy in the Midwest. This web site divides its information by state so that they may address best how to shift the region's electricity source mix from a reliance on coal and nuclear power to cleaner fuels.

The Solar Guide
The Solar Guide is an independent information site that is written, edited and maintained by industry professionals. Our objective is to provide factual, up-to-date information and advice to consumers about solar and renewable energy.

Technical University of Denmark
This web site offers links to other wind energy related sites, but does offer sites in a variety of languages including Danish, French, English and German.

U.S. Department of Energy
The government agency's site is the most complete and accurate source of renewable energy information on the web. Found here are studies and reports on the full spectrum of renewable energy sources. The federal site is a very good starting point.

U.S. DOE - Energy Efficiency and Renewable Energy Network
Offering even greater detail on renewable energy, EREN provides 600 links and 80,000 documents on bioenergy, hydrogen, ocean, wind, geothermal, hydro and solar power.

EREN alphabetical list of links
See Above

Federal Energy Management Program
The FEMP initiated The You Have the Power Campaign, helps agencies reach their energy-saving goals by raising awareness of energy efficiency activities at Federal agencies. This web site spotlights the energy saving work of agency personnel and provides material for energy awareness campaigns.

United States Energy Association
As a member of the World Energy Council, this group, made up of public and private energy related organizations, corporations and government agencies, focuses on all types of energy including coal, oil, natural gas, nuclear, hydro and renewables. (See World Energy Council).

U.S. Environmental Protection Agency Programs
Though they concern themselves with much more than renewable energy, this federal web site offers a large amount of information on renewable energy and its uses for around your home or business. Since the EPA is a regulatory agency there are also a large amount of information given on standards and laws for energy use.

Windustry
Windustry is a non-profit organization working to increase wind energy opportunities for rural landowners and communities by providing technical support and creating tools for analysis. Windustry's areas of special focus include: economic development from wind energy; landowner rights, risks, and benefits; and community based wind energy.

World Energy Council
The World Energy Council is a global multi-energy organization, covering all types of energy, including coal, oil, natural gas, nuclear, hydro and renewables. (See United States Energy Association).

Appendix II: Bibliography

- Agency Sustainability Planning and Implementation Guide. Commonwealth of Massachusetts State Sustainability Program. State Sustainability Coordinating Council, and State Sustainability Program Staff, 2004.

  This guide is meant to move Massachusetts towards more sustainable and smart development policies and practices. This is promoting more environmentally sustainable practices throughout Massachusetts that the state agencies can implement in their areas. This is great source for that shows the goals for Massachusetts; shows what is currently being done, and what can be done in the future.

- Barbose, Galen, Ryan Wise, and Mark Bolinger. Berkeley Lab and the Clean Energy States Alliance. 2006. http://eetd.lbl.gov/ea/ems/reports/61643.pdf.

  This is a case study for renewable energy. The energy efficiency of photovoltaic systems is looked at in this study. They found that the systems themselves perform well, it's the building operators that lack the information to ensure the system is efficient and effective.

- Beckett, Margaret, and Alan Johnson. Creating a Low Carbon Economy. Sustainable Energy Policy Network. DTI, 2005. http://www.dti.gov.uk.

  There are four main objectives that are discussed in this report for the UK; cutting carbon dioxide emissions, to maintain the reliability of energy supplies, to promote competitive markets in the UK to ensure every home is adequate and affordably heated. In this report the UK recognizes what has been done up, and what needs to be done for the future in reference the Climate Change Program. Most information is not conducive for other areas to use.

- Bierbaum, Rosina, John P. Holdren, Michael Maccraken, Richard H. Moss, and Peter H. Raven.

  Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable. United Nations Foundation. SIGMA XI, the Scientific Research Society, 2007.

  This is an informative report with great quotes about climate change. There is also a map that displays the significant impacts climate change will most likely cause in the future. Great ideas for adaptation and mitigation.

- Breslow, Marc, and Janet McGarry. How Cities & Towns Can Cut Global Warming Emissions: First Steps. Mass. Climate Action Network. 2004. http://www.massclimateaction.org.

  This report breaks down the emissions into municipal operations, and community emissions with ideas of reducing emissions into those areas. There is also a list of ideas for GHG reducing ordinances. It also provides cases studies at the municipal, and community levels for cutting emissions.

- A Call for Action. U.S. Climate Action Partnership. USCAP, 2007. 3-11. 29 Jan. 2007, http://www.us-cap.org/.

  This general source gives design principles and recommendations for implementing renewable energies and technologies across the U.S.

- Clean Energy Future a Must to Combat Global Warming and Protect American Security, Families, Health, and Environment. Clean Energy Platform. 2007. http://www.wilderness.org/Library/Documents/upload/EnergyPlatform2007.pdf.

  This source has general information on clean, renewable, and efficient energy. Details what needs to be done to improve the environment and slow global warming, but does not provide recommendations for doing so at any level.

- Costanti, Mike, and Peggy Beltrone. Wind Energy Guide for County Commissioners. National Renewable Energy Laboratory, Wind Powering America, and National Association of Counties. U.S. Department of Energy.

  This report is intended for and consists of information for planners, county commissioners and other local officials on the implementation and success of commercial wind energy projects for their area. Provides a variety of information on the facts and costs of wind energy, along with case studies of current wind projects.

- Dutzik, Tony, Alexios Monopolis, Timothy Telleen-Lawton, Rob Sargent, and Anna Aurilio. The Road to a New Energy Future. U.S. PIRG, Education Fund. 2006.

This is a great report about energy efficiency technologies, oil saving technologies, renewable energy technologies, and improving on what we have today. There are goals that should be set for the future of these technologies. This would be useful in applying these ideas on a local level, our region.

- Energy Efficiency, Renewable Energy, and Jobs in Massachusetts. Massachusetts Technology Collaborative.

  This is source is specific to Massachusetts area, and discusses the job growth and creation, along with economic growth associated with the "clean energy". This will make the area a leader in renewable energy technology.

- Flavin, Christopher, Janet L. Sawin, Ph.d, and John Podesta. The Renewable Path to Energy Security. Center for American Progress. Washington, DC: Worldwatch Institute, 2006.

  This is a great source for giving examples of the potential economic opportunities that could/would be available by reducing our reliability on foreign oil and move toward renewable/clean energy resources.

- Friedman, Naomi. It's About How and Where We Build; Connecting Energy and Smart Growth. Environmental and Energy Study Institute. ACEEE Summer Study on Energy Efficiency in Buildings, 2006.

  This is a great source that supports the "smart growth" principles and energy efficiency. This source shows how the two ideas are linked to one another. The way that we design, build, and plan influence the amount of energy that is used.

- Kutscher, Charles F. Tackling Climate Change in the U.S. Potential U.S. Carbon Emissions Reductions. American Solar Energy Society. Roger Braithwaite/Peter Arnold, Inc., 2007. 1-173.

  This is a fantastic basic source. Discusses in detail the different studies that have been done, along with renewable resources available for of reducing carbon emissions by the year 2030.

- LEED for Neighborhood Developments Rating System-Preliminary Draft. Congress for New Urbanism, Natural Resource Defense Council, and U.S. Green Building Council. LEED-ND, 2005.

  This is draft of a rating system for, Location Efficiency; Environmental Preservation; Compact, Complete, & Connected Neighborhoods; and Energy Efficiency. This system is divided into "credits" and "prerequisites", a point system for each project. This has a list of requirements that each site should meet according to the different categories.

- Local Energy Efficiency Program Workbook. California Public Utilities Commission. CALeep, 2006.

  This workbook was developed to help California launch energy efficiency initiatives to meet with the state's energy efficiency goals. This workbook has helpful information that can be applied to other areas besides California. Gives useful ideas and examples of what had been done there.

- National Action Plan for Energy Efficiency. U.S. Department of Energy and U.S. Environmental Protection Agency. Eastern Research Group Inc., 2006. http://www.epa.gov/cleanenergy/actionplan/report.htm.

  This report has excellent guidelines for an action plan for energy efficiency. There are recommendations resource planning. This report also contains detailed information on the national benefits of energy efficiency, which can also be applied at the local and/or regional level.

- The Path to Climate Sustainability, a Joint Statement by the Global Roundtable on Climate Change. Columbia University. 2007. http://www.earth.columbia.edu/grocc/.

  This source brings climate change into a global plan. It has specific ideas that can be used for smaller scale plans, local level.

- Planning for Renewable Energy: a Companion Guide to PPS22. Ove Arup and Partners. Office of the Deputy Prime Minister: Creating Sustainable Communities. Queen's Printer, 2004.

  This guide discusses the planning and development of renewable energy schemes across England. This involves strategic/forward planning and development control at the region and local levels. It offers information on the renewable energy technologies and the issues that surround the application of them into communities.

- Productivity of Growing Global Energy Demand: a Microeconomic Perspective. McKinsey Global Institute. McKinsey & Company, 2006.

  There is a global debate about energy. The main focus of this report is on energy productivity, how it is being used and how it can be used more efficiently in order to be able to meet the demand for it. This report looks at the global demands; some of these ideas can be used on the local/ regional levels.

- Stern Review: the Economics of Climate Change. HM Treasury. Cambridge University, 2005. http://www.hm-treasury.gov.uk.

  This report reviews the economic impacts of climate change, along with the global causes and consequences. Climate change will have severe impacts across the globe; general impacts on food production, health, water, and land/environment. This is a good resource, discusses the current condition conditions, future (future if BAU continues), and the obstacles involved in reversing this process.

- Teske, Sven, Arthouros Zervos, and Oliver Schafer. Energy [R] Evolution. European Renewable Energy Council. Greenpeace International, 2007.

  This is a great source with numerous reports, and studies that show the possibility of supplying all the energy we need from clean, and renewable sources. Research shows that we can stop global warming if GHG emissions are reduced by 80% by 2050.

- Vermont Electric Energy Efficiency Potential Study: Executive Summary of the Final Report. Vermont Department of Public Service. GDS Associates, Inc., 2006.

  This is a study the current and potential savings for cost effective electric energy-efficiency and fuel conversion measures for Vermont. This also displays the achievable cost effective potential that was based on a series of tests. This was an okay source, did not provide much information that could be applied.

Appendix III: 2006 Summary of Best Practices from Around the World for Energy Use Reduction, Increased Energy Efficiency, and Clean Energy Generation

Clean Energy Production

1. Municipalities, businesses, and residents develop new renewable energy sources.

   Recover landfill methane gas and capture methane at wastewater treatment plants.

   Use fuel cells to generate electricity from anaerobic digestion gases at waste water treatment plants. If needed, supplement with organic waste digester.

   Install renewable energy systems on municipal facilities and vehicles.

   Support the use of micro-generation systems (such as heat-pumps, fuel cells, micro-CHP, micro-hydro, micro-wind, bio-energy, and solar).

   Support implementation and reduce barriers to Combined Heat and Power (CHP) systems.

   Support the development of geothermal heating/cooling systems.

   Develop projects with schools to install solar energy systems and conduct associated classroom activities.

   Build medium scale (1.5 MW to 30 MW) clean electricity generating facilities where appropriate and supported by host community and neighbors.

   Provide technical assistance to builders and developers for installation of renewable energy.

   Site generating capacity close to demand—minimizing transmission losses.

2. Encourage municipalities, businesses, and residences to buy green power.

   Explore cost-effective opportunities to invest directly in new larger-scale renewable projects like wind, solar, geothermal, and landfill gas systems.

   Encourage residents and businesses to purchase at least 20 percent of their electricity from new renewable sources by promoting green power as a community ethic.

   Promote a green-power purchase by aggregating public-sector entities.

3. Secure financing and funding for renewable energy production, including:

   Low/no interest loans for residential and small business renewable energy systems.

   Redirecting fuel taxes to renewable energy/green planning/and mass transit.

   Loans and financing for energy efficiency and renewable energy projects with terms that enable repayment from the resulting operating cost savings.

   Funding of clean energy installations for municipalities through the Massachusetts Renewable Energy Trust.

   Use of electricity system benefits funding allocated to renewables to leverage the development of new renewable resources.

4. Adopt new regulatory measures for renewable energy production

   Create a local or regional carbon trading market.

   Facilitate local discussions for community-based clean electricity generating facilities.

   Prepare model bylaws to facilitate siting of clean electricity generating facilities.

   Regulate biomass and forestry harvesting operations at sustainable levels.

   Support federal action on lowering power plant emissions of CO2 and conventional air pollutants.

   Support amendments to the State Business Energy Tax Credits and State Energy Loan Programs to encourage green building practices and make the tax credits more accessible to organizations.

   Work toward tax and regulatory policies that reflect the true cost of energy production and manufacturing processes, based on a life-cycle "cradle to grave" analysis.

5. Advocate for renewable energy legislation requiring 20 percent of all power sold to rate-regulated customers be from new renewable resources.

6. Integrate renewable energy into the operations and management of municipal government.

   Integrate renewable energy and energy conservation in all planning and development processes.

   Consider the establishment of an energy management position at the regional level.

   Integrate renewable energy installations into the municipal capital planning process.

   Develop guidelines for the installation of combustion distributed generation systems.

   Include renewable resource incentives or requirements in utility franchise agreements.

   Support the use of small-scale renewable energy systems in mobile applications.

   Support code revisions that facilitate low-cost interconnection of photovoltaic and other renewable electricity systems.

7. Promote and educate citizens and employers about renewable energy.

   Build partnerships with the Center for Energy Efficiency and Renewable Energy at UMASS to help local businesses, developers, etc. apply the Center's research.

Land Use, Buildings, and Trees

1. Promote community planning that reduced transportation needs and preserves farmland and forests in the region.

   Update zoning bylaws to encourage pedestrian-scaled mixed-use development with residential infill.

   Encourage mixed-use development near public transportation.

   During the permitting process for development projects, encourage the incorporation of open space into the project design.

   Create appealing small-scale public gathering spaces with well-adapted vegetation as part of development and redevelopment projects.

   Integrate green building guidelines, renewable energy and energy conservation in all planning and development processes.

   Encourage reuse and renovation of existing buildings rather than demolition and replacement.

   Work with legislators and other public officials to create a regional land use plan.

2. Maintain and protect the urban forest.

   Promote the planting of trees to accrue optimum benefits for carbon offsets, energy conservation, air quality, heat/cooling loads, storm water management, and habitat.

   Maintain existing forests and vegetation on public and private lands.

   Develop a geographic information systems (GIS) inventory of the urban canopy to determine its current health and identify needs and priorities for future urban forest management.

   Provide incentives for planting trees and creating additional green space as part of new development and major renovations.

   Improve development practices to limit destruction of trees and encourage planting of suitable trees.

   Expand the urban forest and improve forest performance by eradicating invasive vegetation.

   Forge partnerships with community groups to organize tree-planting and maintenance events.

   Improve community understanding of the role and value of urban and rural forests.

   Secure increased funding for green infrastructure through partnerships with businesses, residents, and organizations that benefit, either directly or indirectly, from tree planting.

   Seek resolution to conflicting municipal, regional, and state goals that impact urban and rural forestry.

   Develop and carry out policies and programs to maximize the tree canopy cover, with special attention to parking lots and other heat-absorbing locations, and to shading air-conditioning units. This should include attention to soils, water retention, and appropriate species.

   Adopt policies to restrict the purchase and use of non-sustainable harvested timber by municipal and regional agencies.

   Support private, non-profit, and government efforts to reforest timberland.

3. Encourage LEED certification for residential, commercial and municipal buildings

Require all new municipal buildings and major renovations to be certified under LEED.

Provide developers, citizens, and municipal staff with information to help them apply LEED standards.

Provide developers and property owners with information about using green roofs or high reflectance roofs on buildings and other reflectance and shading techniques.

Strengthen zoning incentives to include LEED in project review and Planned Unit Development (PUD) processes.

Reuse materials from existing structures during renovation or redevelopment projects.

Provide incentives for new construction and renovations to meet LEED standards for reflectance and shading.

Incorporate LEED standards for reflectance and shading in all city/town and private parking lots and in new construction and major renovations.

Design and construct durable buildings based on LEED principles with flexible re-use options.

Design and construct durable city/town buildings that use LEED principles and have flexible re-use options.

Develop local standards for green buildings and help local buildings meet national energy-efficiency and green building standards such as LEED, Energy Star, and Earth Advantage.

Provide developers, citizens, and city/town staff with information to help them apply LEED standards.

Develop a pilot program to demonstrate how LEED and green building principles can be applied affordably in existing homes.

Investigate sliding-scale building permit fees with rebates for high-performance green buildings and higher fees for conventional buildings.

Provide tax rate reduction or rebate for LEED certifies, Energy Star, or other verifiable standard home or building.

4. Ramp up food production locally

Sheet-mulch yards & turn them into food production, either annual vegetables or forest gardens producing food, fuel and other useful products

Ditto for parks, Conservation land, vacant lots.

De-pave driveways, sidewalks and parking lots and turn them into food production.

Consider low energy input systems (regarding pesticides and fertilizers) as part of ecologically oriented food production.

Agroecology education, including landscape agroecology planning should be integrated into vocational training and should be included in outreach work by CISA and other groups serving area farmers.

Work with schools to start producing food on site and incorporating food production into the curriculum at elementary, middle & high schools & vocational schools.

Guidance counselors and teachers steer young people towards futures in farming rather than high-tech, etc.

Build root cellars into peoples' basements. Construct community root cellars. Construction department of vocational school teach root cellar construction.

Identify land—even scraps—throughout every community that could be mobilized for ecologically-oriented food production.

Small-scale business: buy small seedlings of fruit trees & shrubs, grow them out in pots or in your yard, then sell or trade them.

Another business: seed production. With more people growing food they'll be the need for more seed.

Reading groups: Edible Forest Gardens, for example.

Education and Outreach

Inform local elected officials, community leaders, and local and regional media about the causes and impacts of global warming and the importance of facilitating clean electricity and energy efficiency in the Pioneer Valley.

Continue to compile and distribute information on greenhouse gas reduction technologies, programs, and policies that will improve the local economy and environment.

Expand the civic, educational, religious, and neighborhood institutions that specifically address global warming/energy supply, generation and use.

Improve community understanding of the nature

of the greenhouse gas effect and possible global, regional, and local impacts of climate change.

Inform residents, businesses, and institutions about how their actions affect greenhouse gas emissions.

Encourage residents, businesses, and institutions to reduce greenhouse gas emissions.

Provide tools to local residents and businesses to estimate their greenhouse gas emissions and emission reductions.

Work with Municipal and County agencies to publicize clean energy/energy efficiency projects and actions through public education efforts.

Encourage and support clean energy/energy efficiency/greenhouse gas-reduction efforts at state, national, and international levels.

Establish a hotline for business and household resource-conservation questions and provide educational information and referrals to resources and clean energy/energy efficiency/global warming-related programs.

Ensure that teachers have access to effective educational materials about clean energy/energy efficiency/global warming.

Compile and update an inventory of greenhouse gas emissions in the Pioneer Valley and track related air quality, solid waste, energy, and environmental data.

Formally acknowledge the global warming impacts of municipal planning, transportation, and urban redevelopment policies and decisions.

Transportation

1. Educate people to use cars efficiently: The sad truth is that your car emits as much CO2 as your entire house. That's the bad news. The good news is that anything you can do to improve the fuel efficiency of your car will have an enormous impact on climate change. In fact, experts say that paying attention to fuel efficiency in your car may be the single biggest thing you can do to prevent global warming.

   Drive less or not at all. Every year, Americans as a whole drive more miles than they did the year before.

   If you can carpool, walk or ride a bicycle instead of drive, do so.

   Telecommuting and public transportation are also great options – once a week saves a ton of CO2 a year — but even piling multiple errands into one trip helps. If you're contemplating a move, or flexible about where you live, move close to work or school—so you won't feel like you have to drive.

   Park in the first spot you find—that way you won't be driving around looking for a spot and idling while waiting for one.

   Make your vehicle as fuel efficient as you can:

   Keep your car tuned up (If 100,000 of us went out and got a tune up, we'd save 124,000 tons of CO2); Check tire pressure weekly;

   Remove unneeded racks (to reduce resistance); and,

   Clean out any unnecessary items (to make the vehicle as light as possible).

   Drive to conserve fuel. This means:

   Slow down—drive the speed limit or a little below and maintain a consistent speed. Start up slowly and stop steadily—anticipate stops and coast to them;

   Don't idle—in a well-tuned vehicle, you should not have to idle your vehicle to warm it up. Instead, you should start out slowly, not revving your engine, accelerate and slow down gently. Idling increases engine wear and emissions. NEVER idle for more than 10 seconds. If you need to wait in your vehicle for more than 10 seconds—TURN THE ENGINE OFF! It does not damage your car, waste gas, or produce more greenhouse gas emissions to turn your car off and then start it up again.

   Use your AC only when traveling over 50 mph.

   Buy a fuel-efficient car (like a Hybrid) if you can. In fact, replacing your gas-guzzling car with a fuel-efficient one is by far the best thing you can do (if you must drive a car), out of all your choices.

   Support sustainable development principles, compact development and mixed use zoning bylaws/ordinances in your community—these are the regulatory tools that make it possible for planners and developers to build walkable and bicycle-friendly communities.

   Consider flying less, and if you must fly—offset the carbon emissions.

Join the Betterworld club for roadside assistance, insurance and travel services.

Lobby for stricter corporate average fuel economy (cafÈ) standards with Congress and Presidential candidates.

Advocate for a gas tax to make driving more onerous. Article from Business Week

http://www.businessweek.com/bwdaily/dnflash/aug2005/nf20050822_3636_db013.htm

Support Northeast biodiesel and other alternative fuel initiatives.

2. Provide incentives for citizens to reduce personal car use.

Promote transportation alternatives to personal automobiles, such as public transit, bicycles, and pedestrian, and plan and develop infrastructure and development patterns to support this goal.

Build all the proposed bike paths in the Pioneer Valley and assure connections between existing paths.

Plow bike paths in the winter.

Give incentives to employers and municipalities to have bike parking and showers for their employees.

Encourage municipal employees to commute by carpooling and by using public transit.

Subsidize bus or other mass transit fares for employees to encourage commuting using mass or public transportation.

Use bicycles where possible for law enforcement.

Organize and facilitate car and van pools for commuters.

Provide parking incentives for carpoolers.

Reduce per employee vehicle miles by promoting teleconferencing and the availability of pedestrian, bicycle, transit, and rideshare options for employees before, during, and after work.

Promote tele-work, compressed workweeks, and other flexible-schedule work options.

Encourage the establishment and use of home and satellite offices.

Establish a quick-response system to encourage tele-work during winter storms, summer ozone alerts, and major road construction projects.

Enable 25 percent of employees to tele-work or work compressed schedules to avoid commuting at least one day every two weeks

Support the availability and use of tele- and video-conferencing facilities

Promote vehicle sharing to individuals and businesses.

Establish neighborhood-level ride-share cooperatives to encourage neighbors to carpool and reduce both work and non-work trips.

Continue and expand education efforts in schools to promote safe transportation alternatives to single-occupancy vehicles and smart use of cars (e.g. trip chaining, ride sharing, and car sharing).

Work with businesses to encourage all employers who offer subsidized parking to employees also to offer parking "cash out"—an equivalent payment to employees who do not require vehicle parking.

Extend parking pricing to all appropriate commercial areas to reduce single-occupancy vehicle use.

Educate all employees on fuel-efficient driving practices, such as avoiding unnecessary idling.

Publicize and participate in campaigns to promote options to single-occupancy vehicle travel.

Promote MassRIDES and the UMASS ride-sharing program.

Establish storefront "transportation options centers" to help residents and visitors learn and use a variety of travel alternatives.

Support bicycling and walking tours and transportation fairs.

3. Increase mass transit options.

Support expanded transit lines and increased frequency of service on major transit arterials.

Encourage businesses to offer transit tickets to shoppers who request them.

Provide transit passes for all residents funded through a household levy or business tax.

Encourage the Pioneer Valley Transit Authority (PVTA) and the Franklin Regional Transit Authority (FRTA) to consider additional van pools to make connections between existing routes.

Enhance transportation management associations (TMAs) and encourage the development of TMAs in all regional centers to make more efficient use of existing transportation resources.

Work with the PVTA and the FRTA to improve access to transit service.

Encourage shared parking opportunities such as movie theaters with primary parking needs in evenings and churches or other facilities with weekend-only parking needs.

Support park-and-ride lots to encourage car pooling.

Provide additional services such as secure, covered bicycle parking, coffee and newspapers during peak hours, and other amenities.

Continue and expand projects that increase pedestrian accessibility to transit stops, neighborhood shopping areas, schools, churches, and parks.

Help transit riders to show their neighbors, friends, and co-workers how easy it is to take transit.

4. Increase the number of fuel efficient vehicles on the road including municipal and business fleets as well as personal vehicles.

   Operate all diesel vehicles on biodiesel by 2015.

   Replace light duty vehicles with hybrid or other high fuel efficiency vehicles.

   Purchase smaller vehicles.

   Increase the average fuel efficiency of passenger vehicles for individuals and fleets to 35 mpg.

   Purchase hybrid gasoline-electric vehicles with fuel efficiency of at least 45 mpg.

   Implement EPA's "Best Environmental Practices for Fleet Maintenance".

   Strongly advocate raising the federal Corporate Average Fuel Economy standards for new automobiles.

   Encourage the use of low- or no-CO2 technologies in non-road vehicles and equipment, such as electric forklifts and medium-duty construction equipment.

   Work with vehicle maintenance providers to educate consumers about the potential savings and impact on fuel consumption of maintaining vehicles properly and practicing fuel-efficient driving techniques.

   Encourage the use of low- or no-CO2 technologies in non-road vehicles and equipment, such as electric forklifts and medium-duty construction equipment.

   Work with vehicle maintenance providers to educate consumers about the potential savings and impact on fuel consumption of maintaining vehicles properly and practicing fuel-efficient driving techniques.

   Work with vehicle maintenance providers to educate consumers about the potential savings and impact on fuel consumption of maintaining vehicles properly and practicing fuel-efficient driving techniques.

   Promote and support the Pioneer Valley Voluntary Vehicle Recycling program.

5. Encourage citizens to commute to goods and services by bicycle or foot.

   Promote the Pioneer Valley Bicycling map and to the new Franklin County Bikeway Map.

   Provide secure, covered bicycle parking at schools, in commercial districts, and at other destinations.

   Promote growth through redevelopment and infill that maintains or improves the quality of life for existing neighborhoods.

   Promote proximate commuting (i.e., living near a workplace).

   Support continued use of transportation demand management strategies.

6. Provide financing and funding to promote fuel efficiency.

   Support redirecting fuel taxes to renewable energy/green planning/and mass transit.

   Work toward tax and regulatory policies that reflect the true cost to society of energy production and manufacturing processes based on a life-cycle "cradle to grave" analysis.

   Support an excise tax based on miles driven with funds to be used to support green transportation projects.

   Support use of fuel taxes for clean energy and green development projects.

   Support the use of congestion pricing on appropriate regional roadways.

   Work with financial institutions to promote location-efficient mortgages.

   Encourage the state to add a fee to vehicle-inspection charges to fund transportation-option education.

   Investigate a region-wide parking permit and/or

state-wide registration fee based on a vehicle's greenhouse gas emissions. Revenue will be used to reduce use of single-occupancy vehicles.

Work with the state to provide loans and other financial incentives to promote the purchase of vehicles with fuel efficiency by business, government, and individuals.

Waste Management

Increase recycling/Reduce landfill waste (Resource preservation, landfill reduction, green house gas reductions, energy consumption reduction, toxic/pollutant reductions).

Increase/support goods reuse/exchange/take-back programs/remanufacture programs.

Encourage composting and anaerobic digestion of organic material.

Encourage recycling and set required percentages for businesses.

Encourage reuse and renovation of existing buildings rather than demolition and replacement.

Develop organic waste composting or anaerobic digestion facilities and collection programs at the municipal or regional level.

Work toward tax and regulatory policies that reflect the true cost of energy production and manufacturing processes based on a life-cycle "cradle to grave" analysis.

Implement a waste prevention program for municipal government.

Carry out projects to increase participation in existing recycling programs using community-based social marketing techniques, starting with a pilot project.

Facilitate construction and demolition waste recycling. Require a construction and demolition debris recycling plan as a condition of receiving a building permit.

Conduct waste composition studies every two years to develop information about which new portions of the waste stream to target for recycling or reduction and to evaluate the success of the current program. Include all sectors of the community across all seasons of the year.

Expand electronics recycling to include any devices not currently handled.

Promote waste prevention measures in the commercial and residential sectors.

Develop a program to ensure that commercial waste paper is being recycled. The program should be based on a monitoring program.

Facilitate commercial food waste collection.

Conduct a thorough composition study of the residential waste stream to assess the feasibility of a residential food waste collection program. Picking up food waste, yard waste, and cardboard in the same packer trucks should be considered.

Develop a program to pick up used clothing for recycling at the curb.

Re-evaluate the system for tracking recycled and non-recycled paper and plastic purchases to ensure accurate recording of the quantities purchased and set goals for increasing the percentage. Work with the school department to accomplish the same steps.

Work with stores to develop and use point-of-sale reminders to customers to purchase recycled products.

Promote and carry out waste prevention measures.

Track waste disposal and recycling practices and quantities at all regional facilities.

Establish municipal and regional policies to use recycled antifreeze, recycled latex paint, and paper with at least 30 percent post-consumer recycled-content paper. Investigate establishing standards for the purchase of additional recycled-content products.

Evaluate purchasing printers and copiers with duplexing capacity and making duplexing the default setting.

Seek approval to hire a regional pollution-prevention specialist to reduce environmental and human health risks from air-, water-, and land-based pollutants.

Continue to improve internal municipal and regional waste prevention practices.

Achieve a solid waste recovery rate at a set percent at municipal and regional facilities.

Hire a resource-conservation manager to reduce solid waste and the use of energy, water, and other resources at municipal and regional facilities.

Hold municipal and regional agency managers directly responsible for resource-conservation practices in their agencies.

Conduct employee awareness campaigns at municipal and regional governmental agencies and with businesses and organizations.

Require contractors and vendors to document the use of recovered materials in their products and follow environmentally responsible solid waste management.

Expand recycling of asphalt and other street material.

Assist local businesses in developing and implementing improved waste management practices, and continue to expand commercial recycling programs and services.

Promote the continued development of the local building deconstruction and material salvage industries.

Encourage contractors to recycle street and other infrastructure materials.

Implement a commercial food-waste collection program.

Investigate opportunities for waste-recovery technologies.

Promote the reuse and recovery of electronic devices.

Appendix IV: Methodology

Plan History

This plan grew out of the efforts of many people and organizations in the Pioneer Valley region of western Massachusetts working to create a sustainable energy future. It has been developed following a semi-traditional strategic planning process. Our methods included research, education, surveys, stakeholder analysis, participatory planning, and provision of technical assistance to advance specific projects. Work was completed by staff and volunteers at two regional planning agencies and overseen by a multi-disciplinary Advisory Committee members.

This committee played an invaluable role in the success of this plan and bears no responsibility for any of its failings.

Regulatory Barriers Assessment

In 2003, PVPC conducted an assessment of regulatory barriers to renewable electricity projects in the Pioneer Valley. Research on this topic revealed a number of barriers that need to be addressed. Identification of the barriers helped to formulate action recommendations. For example, we identified a possible conflict between height restrictions developed to limit cell tower development and a community's desire to host a wind turbine. Detailed results from this work are available at www.pvsustain.com.

Survey Communities

PVPC surveyed its member communities about their interest in, and knowledge of, renewable energy in 2003. Interestingly, only a handful of survey respondents expressed any interest in, or knowledge of, renewable energy. In 2005, both PVPC and FRCOG surveyed their member communities as well as the general public, and the change in attitude, interest, and knowledge in just two years was astonishing. We posted an electronic survey on our agency website and advertised the survey widely via local media outlets. We had a feature on WFCR, the local National Public Radio station and articles in the major local papers. Over 300 people completed the public survey. We also mailed a separate paper survey to all Planning Boards, Select Boards and DPWs in the 69 communities in the region and called each community to follow up if they did not return a completed survey to us. 2005 survey results showed that almost every one of our 69 communities was interested in learning more about clean energy. Most respondents knew the basics of clean energy and some had projects underway. Full survey results and copies of forms are available upon request.

Clean Energy Inventory

PVPC and FRCOG inventoried all proposed and existing renewable energy facilities in the Pioneer Valley. We also researched all the organizations and institutions involved in renewable energy, including businesses that manufacture clean energy materials, installers, engineers knowledgeable in clean energy siting, educators and advocates. Current research shows that hydropower, solar energy and landfill gas (approximately 12 MW documented) are the primary renewable energy sources currently generating power in the Pioneer Valley. There is a biomass heating facility at the Cooley-Dickinson hospital in Northampton.. Wind, biomass, solar and small-scale hydro electric power plants offer future opportunities for development of renewable energy in the Pioneer Valley.

The Clean Energy Regional Inventory for the Pioneer Valley served as a starting point for collaboration, planning, and action. It is a comprehensive guide to clean energy services, resources and organizations and a listing of clean energy projects and options in our region. This resource was used as a foundation for the development and implementation of this comprehensive clean energy plan for the Pioneer Valley. It is available under separate cover.

Education

One of our early interests was to educate the public as well as key decision makers about clean energy so

that everyone could effectively participate in this regional planning process. Happily, many groups and organizations in the Pioneer Valley have already achieved significant success in this arena. Our region is blessed with a wealth of clean energy organizations—as detailed in the Inventory. Key groups that educate the public in the Pioneer Valley are the Center for Ecological Technology and the five colleges, including the University of Massachusetts-Amherst. Co-op Power, Clean Water Action, and NESEA. In addition, we are fortunate to have the offices of one of the countries pre-eminent clean energy organizations, the Northeast Sustainable Energy Association (NESEA) located in Greenfield.

We ran 12 very successful educational workshops, some stand alone and others integrated in existing conferences or events. Copies of all the PowerPoint presentations prepared for these workshops are available on request.

Stakeholder Analysis/SWOT

Understanding regional perspectives related to clean energy is crucial to the development of a functional clean energy plan for the Pioneer Valley. We identified stakeholders who needed to be involved in this plan development process. Some joined the PVREC, others reviewed drafts, participated in the on-line planning process, or simply spread the word about the planning effort to their colleagues. Project staff

Summary of Stakeholder Analysis

STRENGTH	WEAKNESS	OPPORTUNITIES	THREATS
Educated/knowledgeable/ aware public	Renewable Energy is more expensive to develop than traditional sources	Increased energy prices create higher awareness of renewable energy and possibly enhance acceptance	Renewable Energy is expensive and costly to finance
Existing and potential renewable energy resources for hydro, biomass, and solar	Possible negative environmental impacts	Establish a central, regional clearing house with Circuit Rider to provide technical assistance and feasibility studies	Lack of public education/ awareness on energy consumption behavior
Moderate resources for wind	Lack of expert technical assistance to communities	Fed/State should provide more technical assistance/ funding to communities	People are unwilling to change current energy consumption behaviors
Academic community involvement and knowledge	People are unwilling to invest in untested facilities	Create new state fund for communities to hire consultants	Current Federal/State policies
Existing infrastructure (buildings, dams) for renewable energy	People are uneducated on the process for development of renewable energy	Change zoning, subdivision regulations and building codes to encourage renewable energy	State's REC is “unbankable” Rethink deregulation
Land less expensive to develop than eastern MA	Disparity of where renewable energy is produced to where energy is consumed	Municipalities should become ICLEI members (Local Governments for Sustainability)	Lack of grants /low interest funding
Rising costs of electricity make renewable energy installations more favorable	Local laws / building codes make it difficult to develop renewable energy	Write white papers to assist community leaders in promoting renewable	Lack of proven technical assistance
Active individual organizations	Hydropower not part of renewable porfolio standard	energy	
Technical assistance from MTC and RET	Lack of coordination between like-minded groups	Local utility companies should be allowed to generate renewable energy, not just distribute / transmit.	
Support from Congressman Olver	Region has little policy-making power		
	Renewable Energy is hard to market – not “sexy” enough		

Note: Items in bold were identified by most of the stakeholders interviewed.

interviewed thirteen stakeholders representing varying points of view: State Government (1); Local Government (5); NGOs (3); Business (3); Education (1) asking them to reflect upon the region's strengths, weaknesses, opportunities, and threats (SWOT) with respect to achieving the goals of this plan. Items in bold in the chart were identified by a majority of stakeholders interviewed. As with the other research , results of the SWOT analysis informs the kinds of action recommendations included in this plan.

On-line Participatory Planning Process

In October 2007, project staff facilitated an online citizen deliberation forum to gather public input to assist with the development of the plan . Over 250 people participated in a series of online polls which brainstormed, the prioritized guiding principles, goals, criteria for project selection and implementation strategies. 80 people participated in the online discussion forums. \The experience was a success in terms of 1) giving the plan developers important information to inform plan strategies, and 2) involving more citizens in a planning process than is normally possible in the face-to-face town-meeting format used in the past to inform citizens and gather input. Three traditional face-to-face public forums were also held, timed to occur near the middle of the month-long online forum, so that citizens without easy access or comfort with online technologies could participate in the process. Approximately 90 people participated altogether. A number of publicity venues were used to inform the public of the online and face-to-face forums, including radio, newspaper, "bulk" email outreach, postering, and phone calls.

Brainstorm and Prioritization Polling

The results of these surveys have been incorporated into this document. Here are the surveys that were used to brainstorm and prioritize participant's input on the plan. Results have been reported throughout this document.

9/29/06 Clean Energy Plan Guiding Principles and Goals Survey with 31 participants – brainstormed guiding principles and goals for the region.

10/3/06 Clean Energy Plan Guiding Principles and Goals – Second Round to Test for Agreement with 297 participants – to organize and begin to prioritize principles and goals

10/7/06 Clean Energy Plan Guiding Principles and Goals – Final Round to Test for Agreement with 86 participants – prioritized the principles and goals

10/9/06 Clean Energy Plan Strategies with 152 participants – to brainstorm strategies to implement the plan

10/16/06 Clean Energy Plan Strategies – Final Round with 42 participants – to prioritize additional strategies contributed in 10/9/06 survey

4/24/07 Comments on the Pioneer Valley Clean Energy Plan with 889 participants – reviewed first draft of the plan

Online Forums

From October 2006 to July 2007 several online forums were open on our Pioneer Valley Clean Energy Planning Website: http://forums.e-democracy.org/pioneer-valley. The two most popular discussion groups were the forum on the Russell Biomass Plant with 38 members posting 200 messages and the general forum with 165 members posting 167 messages. The majority of the discussion online focused on the Russell Biomass Plant. Here are some of the things we learned.

Opponents to the plant voiced the following concerns:

- Air quality concerns from stack emissions and diesel truck emissions in their river valley with frequent air inversions that trap hazardous air pollution at ground level
- Biomass should not be included in a "clean" energy plan because it produces air pollution and greenhouse gasses when it's burned
- Impact of water cooling process on the river – the plant's wet cooling towers would use 885,000 gallons of Westfield River water each day harming fish and the river's ecosystem
- Disruption of a residential neighborhood, near an elementary school and homes, with 840 tractor-trailer trucks a week bringing in wood to the plant
- Concern about the violations documented in similar plants where they were found to be burning contaminated wood and demolition debris even thought they weren't permitted to do so – How can they know this plant will burn only

"clean" wood now? And will permitting become more lax in the future allowing these polluting fuels to be burned?

- Concerns about technology – What emissions controls and cooling tower will the plant use?
- Concerns about the decision making process. How do you get reliable information? Who has access to it? Who has input into the siting and permitting decisions? Who is getting money for helping this plant get sited? Are the elected officials in Russell acting in the town's best interest? Did residents get adequate notice before the Select Board signed on to support the biomass plant? Some residents believe they did not get adequate notice before the Select Board signed onto this project.
- There are two families who live on the road to the site of the proposed biomass plant involved in complicated legal issues related to the access road, causing tremendous stress for both families.
- The Town of Russell has not had any industry for many years. People who have moved there in the last decade moved to a tranquil, beautiful small town. Their sense of their town's identity is being threatened with this very large industrial development right in their back yard.

Supporters of the plant say:

- Cooley Dickinson and Mt. Wachusett both have very successful biomass plants. The developers have agreed to limit burning to wood chips from forest gleanings and non-toxic pallets. Why can't we believe them?
- Are the down sides of the Russell plant greater than the status quo of foreign oil and nuclear power?
- Biomass is one of the few sources of energy we have in plentiful supply in Western Mass and it's one of the most affordable energy sources to build and operate. It also is an engine for economic development - supporting a large number of forestry and trucking jobs in the region.
- If the people in Russell have decided not to elect the Select Board representative that the biomass plan opponents ran in the last election, and if the elected officials on the Select Board representing the town have voted to support the plant, why would people outside of Russell oppose a plant the majority of the people in Russell are supporting?
- The amount of water required by the plant (885,000 gallons/day) is comparable to the 1.2 million gallons/day of water that evaporates every day from the Westfield River. Studies have shown it's not a problem. The daily August flow is 161 million gallons/day.
- If the plant satisfied the state of Mass. air quality permitting process, it will not compromise the health and safety of the residents in the town. The efforts of the developers to replace old wood burning stoves in town are a good faith effort to improve air quality and alleviate the negative impact on air quality from their plant with a stack 135 feet high dispersing the emissions over a broad range.
- The town of Russell has been an industrial town. With this plant, it's just going back to being what it once was. People who have lived in town for decades want jobs and industry to return to their town. Their sense of their town's identity is being restored.

Overall we are pleased with both the substantive outcomes and the lessons we learned in the online citizen deliberation project. We were treading new ground in trying to bridge two worlds: the world of online discussion forums and social networking sites that support large numbers in free expression and divergent discussions, and the world of online "decision support" tools and content management tools that help well-defined groups coordinate their efforts to support concrete accomplishments. A goal-oriented online community is a world unto itself, and its success and internal culture depends on a complex combination of who participates, what the expectations are, and the tools that are provided. We developed structures that supported both the welcoming and motivating "host of the party" role needed to bring new people together, and the facilitating and orienting role needed to move toward convergent outcomes. And it was through the on-line process that we developed the plan's guiding principles, goals, project selection criteria, and implementation strategies—two key elements of the plan and of the region's clean energy future.

Appendix V: Detail on On-line Planning Process

100 people gave the following comments on these goals. Here are some of the comments they gave:

- 25 people wrote in to oppose biomass plants saying they should not be included as a clean energy option, because safeguards are not in place to protect residents, because forests are more valuable standing than cut down. because they increase pollution/smog and ozone problems; there were concerns about the impact of the Russell Biomass plant on a small town
- 9 people wrote in to supports biomass plants because they make reliable clean energy; they are dispatchable – able to generate energy even if the wind isn't blowing and the sun isn't shining; because wood burning sources of heat must be accommodated due to the economics of rural areas; plants are best when they use the heat produced too; support for the Russell proposed biomass plant, assuming the permits are granted; a logger wanted a market for the low-value wood he has to leave in the forest before he goes out of business because he can't sell the low-value logs.
- 7 wrote in to support solar electric for vehicles and transportation
- 5 wrote in to support wind power
- 2 wrote in with concerns about critical natural areas being compromised in the siting of clean energy production facilities
- 2 wrote in to support small hydro and heat pumps, especially in solar heat pump homes
- 3 wrote in to support nuclear power – technology could render that source both safe and efficient, it's a clean energy source, nuclear is required for us too meet our energy needs – we should find a site we can support now and have it ready; these goals cannot be met without nuclear power.
- 3 wrote in to oppose nuclear power
- 2 wrote in to support decentralized power plants to reduce transmission/transportation requirements
- 2 wrote in to support locally-owned clean energy plants
- 3 felt more discussion is needed about the lifestyle changes that are required to reduce energy use
- 11 believed the targets were set too low
- 5 believed the goals set a good baseline.
- 1 person though the target for new renewable energy generation was too high.
- 4 were appreciative of the effort given to put the plan together.

QUESTIONS raised by respondents:

- How will energy reductions proposed be achieved?
- What is meant by "clean (bio) fuels"?
- Have we addressed the tie-line route issue?
- How will these goals be achieved? What will the outcomes be?
- We are in love with our cars and lifestyle. How will we make this happen?
- How will we create the jobs?

Here are some comments on the development of the Guiding Principles:

- 24 oppose biomass. Example: "Biomass emissions are not as clean as what is being sold to the public and will release tons of pollution into our air per minute. Very scary when we have 1000s of people with respiratory illnesses in the Pioneer Valley. Pollution is a silent killer. There is such a strong push to protect our food, we should be doing the same for the air we breath. Biomass Plants would also require us to rely on Fossil fuels in order for it to run. Co-Fired Boilers, Daily Diesel Trucks that bring in the fuel, or train engines if the wood chips are brought in by rail, etc."
- 5 support clean biomass plants. Example: "As a member of the Mass. Farm Bureau and Mass. Forestry Association and someone who makes a living in agriculture, I think it is vital that non-C&D derived biomass become a component of our region's energy plan because 1.) this renewable resource holds great promise and is widely available in our region and 2.) the development of biomass electrical generation plants will improve the market for low-grade wood and offer rural landowners another incentive for keeping their

land in forest, thereby contributing to carbon sequestration and enhanced air quality. By consuming wood products locally, we help ensure that forests will continue to thrive throughout our region."

- 5 want public transportation including rail. Example: "maximize ridership on current public transportation"
- 5 people supported policies that helped farmers. Example: "Another idea to help large landowners keep their land in forest or farm land would be further reduction in taxes and/or possible payments for the carbon sequestration and wildlife habitat they provide. This is all done for the benefit of the public now at no cost to them. If the public wants the above then the landowners should be rewarded or compensated for such items."
- 3 support the commitment to low-income people in the proposed principles.
- 3 support the use of nuclear energy.
- 2 wanted to reduce or eliminate our use of nuclear energy.
- 2 people questioned the focus on small, locally owned businesses. Example: "I agree that sustainable small businesses are important but these should not be prioritized over possibly more efficient, large-scale, non-local businesses who want to invest in the region. The same is true for statement about generating 'living wage opportunities.' These practices must be encouraged, but I would support business practices that allow economic viability and competitiveness first rather than imposing conditions on the market first." And, "Doesn't matter who owns the resources; if someone makes money off of it, then good for them."
- 1 person wrote in to support this local ownership: "I'm very excited about the ideals of community control & community ownership expressed here! I believe that long term sustainability in the Pioneer Valley will require us to allocate more of our land to the "commons" & will require us to better steward critical community resources such as farmland, food, energy production, forests, and affordable housing."

Appendix VI: Comprehensive Energy Primer

Until recently, Americans have felt free to use the nation's energy resources as though they were unlimited. However, this is changing. Global warming has become a reality; the cost of fossil fuels is on the rise pinching peoples' pocketbooks, increasing business expenses, and threatening the US economy; and regional conflicts and the "war against terrorism" is destabilizing supplies. As a result, people are finally trying to reduce their consumption of energy resources and to find alternatives to fossil fuels.

Making decisions about energy use is complicated, so the Franklin Regional Council of Governments and Pioneer Valley Planning Commission have produced this *Understanding Energy Primer* to provide consumers in the Pioneer Valley with basic information about energy. The two Regional Planning Agencies define terminology, provide facts about energy resources and distribution, and explain the differences among the fuels, so you can the best decision about energy for you home, business or community.

Our hope is that people will use the *Primer* and the Pioneer Valley Clean Energy Plan to make the changes in energy consumption in their vehicles, homes, businesses, communities and that are needed to save energy and sustain the quality of life in the Connecticut River Valley.

What is Energy?

Source: www.eia.doe.gov

Energy comes in different forms – heat (thermal), light (radiant), mechanical, electrical, chemical, and nuclear energy. Energy is in everything. All forms of energy are stored in different ways, in the energy sources that we use every day. These sources are divided into two groups – *renewable* (an energy source that can be replenished in a short period of time) and *nonrenewable* (an energy source that we are using up and cannot recreate in a short period of time).

Renewable energy sources include solar energy, which comes from the sun and can be turned into electricity and heat. Wind, geothermal energy from inside the earth, biomass from plants, and hydropower and ocean energy from water are also renewable energy sources.

However, we get most of our energy from nonrenewable energy sources, which include the fossil fuels – oil, natural gas, and coal. They're called fossil fuels because they were formed millions of years ago by the action of heat from the Earth's core and pressure from rock and soil on the remains (or "fossils") of dead plants and animals. Another nonrenewable energy source is the element uranium, which atoms we split (through a process called nuclear fission) to create heat and ultimately electricity.

We use all these energy sources to generate the electricity we need for our homes, businesses, schools, and factories. Electricity "energizes" our computers, lights, refrigerators, washing machines, and air conditioners, to name only a few uses. Gasoline and diesel fuel made from oil power our cars and trucks. Propane made from oil and natural gas fuels our outdoor grills and makes hot air balloons soar.

Energy Efficiency

Energy efficiency is the amount of useful energy you get from a system. A perfect, energy-efficient machine would change all the energy put in it into useful work – an impossible dream. Converting one form of energy into another form always involves a loss of usable energy. In fact, most energy transformations are not very efficient. The human body is a good example.

Your body is like a machine, and the fuel for your machine is food. Food gives you the energy to move, breathe, and think. But your body isn't very efficient at converting food into useful work. Your body is less than five percent efficient most of the time. The rest of the energy is lost as heat. You can really feel that heat when you exercise!

Energy Conservation

Energy is the art of using less energy.

You look for ways you can reduce the energy you use by shutting off lights, replacing light bulbs with compact fluorescents, replacing your appliances with energy efficient appliances, installing an automatic thermostat, using less hot water, insulating your home, getting tighter windows and doors, etc.

What Is Climate Change?

http://www.n-ergise.net/page/climate.cfm

The term Climate Change refers to changes in the Earth's climate, i.e. its weather systems, rainfall and temperatures. These changes can be caused naturally either, as a result of changes in the way oceans and the atmosphere interact, or from changes in the amount of energy received from the sun.

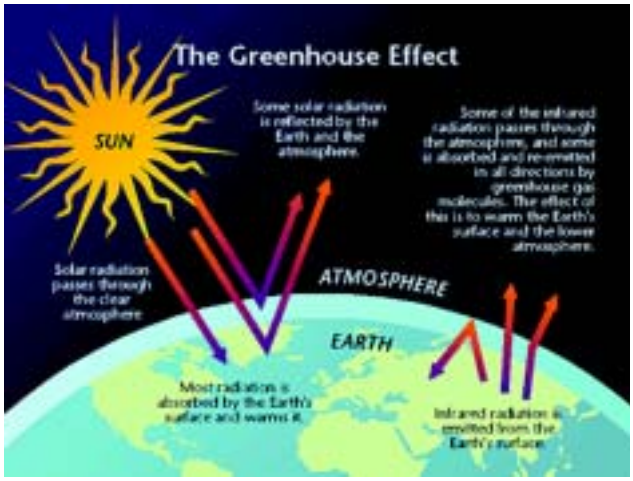
However, human activities that are increasing the emissions of greenhouse gases such as carbon dioxide and methane may also be speeding up Climate Change. The way humans generate energy is contributing to Climate Change. Understanding the 'Greenhouse Effect' is key to understanding the term Climate Change.

The Greenhouse Effect

[Illustration showing how gas molecules trap solar radiation in the Earth's atmosphere provided by Manitoba Energy, Science and Technology, Climate Change Branch]

The Earth's surface is warmed by solar radiation that beats down on the Earth from the Sun. Most solar radiation is reflected from the Earth's surface back into space, but a number of gases in the atmosphere absorb and trap some of the outgoing reflected solar heat. This process naturally keeps the Earth at a steady temperature by trapping some heat but allowing the majority of the reflected solar radiation to pass back out into space. Without this trapping effect the planet would be too cold for life as we know it. It is important for life on Earth that this fine balance remains relatively constant. Any increase in the concentration of particular gases in the atmosphere can prevent heat from being radiated out into space, thus upsetting the balance and raising the world's temperature.

This trapping and reflection of radiation is known as the Greenhouse Effect; it is essentially the same



process that warms the air in the greenhouse in your garden. One of the results of the global Greenhouse Effect is the heating up the Earth's surface, oceans and atmosphere.

Scientists believe that the Greenhouse Effect is already occurring as historical records show that global temperatures are increasing, polar snow caps are retreating, and sea levels are rising. A rise in temperature of just one or two degrees will result in changing weather patterns and lead to increased flooding, desertification, crop failures, freshwater shortages and storms.

Carbon dioxide is the main gas that accounts for the Greenhouse Effect. Approximately 6.5 billion tons of carbon dioxide are emitted globally each year, mostly through the burning of coal, oil and gas. At present there is no technology that will prevent the release of carbon dioxide, although some reduce the amount of gas being released. Other greenhouse gases also have an effect, such as methane, nitrous oxide and aerosol gases like hydrofluorocarbons.

How are greenhouse gases being released?

Fuels such as oil and coal were formed 300-350 million years ago from the remains of plants and animals. Deposits of silt covered this organic material. As the organic material began to decompose and compress, huge deposits of fossil fuels were formed. The silt deposits covering the organic material prevented natural gases such as sulfur dioxide, nitrogen oxide and carbon dioxide from being released into the atmosphere. Instead it was trapped in a solid (coal), liquid (oil) and gas (natural gas) form.

By burning these fuels now to produce power, the gases which were trapped are released adding to the carbon dioxide in the atmosphere. Modern life demands power. Ultimately, it is this power demand driven by fossil fuel burning that threatens to change Earth's climate.

What is being done about it?

The Kyoto Protocol is an international agreement that commits the world's industrialized countries to specific targets for reducing their greenhouse gas emissions. The Protocol came into force in 2005 when Russia became the 128th nation to ratify agreement. This bound nations whose combined emissions accounted for 55 percent of the world's total greenhouse gas emissions to emission reductions.

However, the Protocol suffered a huge blow when the USA – responsible for a quarter of global emissions – pulled out in 2001. The USA, China, Australia, India, Japan and South Korea have declared their intention not to ratify the Protocol. Instead they have signed a separate agreement, the Asia-Pacific Partnership on Clean Development. This pact focuses on technology transfer to reduce emissions and does not set targets for individual countries.

Both international agreements are steps in the right direction in dealing with global warming. It's a global problem, so nations must set and agree on targets. However, real change has to happen at the local level. Only individuals, communities, and companies can affect the continued increase of the Greenhouse Effect by transforming their energy use and consumption. The Pioneer Valley Clean Energy Plan is a regional effort to reduce local energy use and replace energy sources with clean energy.

Renewable Energy

From www.eia.doe.gov

Renewable energy sources can be replenished in a short period of time. The five renewable sources used include: hydropower (water), solar, wind, geothermal, and biomass. In most cases renewables are clean energy sources because they do not require burning (biomass is the exception).

Renewable energy's impact on the world's energy picture is significant, but the overall consumption from renewable energy sources has declined by about 15 percent from their 1996 peak to about 6 Quadrillion Btu (Quads) in 2005.

The use of renewable energy is not new. Five generations (125 years) ago, wood supplied up to 90 percent of our energy needs. However, due to the convenience and low prices of fossil fuels, wood (one form of biomass) use has fallen. Now, the biomass, which would normally present a disposal problem for industry and agriculture, can be converted into electricity (e.g., manufacturing wastes, rice hulls, and black liquor from paper production).

Historically, low fossil fuel prices, especially for natural gas, have made growth difficult for renewable fuels. Yet, increased awareness/education about global warming and renewable energy alternatives could significantly improve their marketability. Also, the deregulation and restructuring of the electric power industry could have a major impact on renewable energy consumption and breathe new life into this industry.

Use of renewables in the United States is not currently expected to approach that of the major fuels, and due to their limitations (e.g., their intermittent nature – cloudy days have no solar gain, quiet days mean no wind blows to drive wind turbines, dams are primarily for flood control, so hydroelectricity production varies as dams' water levels change), renewables may never provide "the" answer to all energy problems in the United States. However, around the world, renewable energy is proving to be of great value, so the U.S. should pursue new technologies for using renewable energy sources.

In 2005, about 6.1 Quads of U.S. energy came from renewable fuels. Each of the energy sources we use is measured, purchased, and sold in a different form. Many units of measurement are used to measure the energy we use each day

Sources: Energy Information Administration, Annual Energy Review, August 2006.

What are the Main Renewable Energy Technologies?

http://www.n-ergise.net/page/renewable.cfm

Photovoltaics (PV)

Solar radiation is converted directly into electricity by photovoltaic cells. PV cells are arranged into

modules that can be attached to existing buildings, installed as integral parts of new buildings, or used as stand alone systems.

Solar Hot Water (SHW)
Solar radiation is absorbed in collectors to provide space and water heating. In the UK solar water heating systems can provide about 50 percent of a household's annual hot water requirements. They need minimal maintenance and have a life span of 20 years.

Passive Solar Design (PSD)
PSD harnesses the sun's energy to provide space heating and reduce the need for artificial light in buildings. PSD buildings use orientation, materials and layout to capture, store and distribute solar radiation.

Wind Energy
Wind is the result of different pressures around the world caused by extremes of temperature created by the sun. Wind energy can be harnessed by small, medium and large turbines that generate mechanical power and produce electricity.

Biomass
The energy stored in living material such as trees or straw can be converted into heat and electricity through burning, pyrolysis (chemical change brought about by the action of heat), or gasification. Because the overall amount of carbon dioxide absorbed while the plant is growing is the same as that is released when it is burned, biomass is seen as being "carbon neutral." Systems harnessing the heat from biomass can be as small as log fires or pellet and chip boilers or can be larger such as district heating schemes and power generation stations.

Hydroelectricity
The power of falling and flowing water can be converted into electricity by the means of hydro-turbines. Hydroelectric power stations are highly efficient, reliable and have a long life span. Hydro power is controllable and offers an element of storage in the electricity supply systems.

Geothermal energy
The earth's interior heat can be utilized for both space heating and electricity production. Geothermal steam can be used to produce electricity or heat can be transferred to water to provide hot water or heat.

Biofuels and biogas
These are transport fuels derived from biological sources such as recycled oil and sustainable crops, which are digested to produce gas or liquids such as methane.

Tidal power
Tides can be harnessed to provide electricity. There are many sites around the US coastline where geographical features help increase the tidal resource. Although the output from a tidal power station is variable it is highly predictable. However, it does not necessarily coincide with variations in electricity demand. Currently tidal projects are prohibitively expensive and more research is needed to progress this technology.

Wave energy
The motion and force of waves can be harnessed for conversion to electricity, although this technology is still at the experimental stage and is not yet commercial the US has significant potential for using wave energy.

What is the difference between power and energy?

Power = Size of the pipe
Energy (with regards to electricity) = Quantity that moves through the pipe.

Electrical power is usually measured in watt (W), kilowatt (kW), and megawatt (MW), etc. Power is energy transfer per unit of time. Power may be measured at any point in time, whereas energy has to be measured during a certain period, e.g. a second, an hour, or a year. When we use the word power we are talking about the size of the pipe from which the energy will flow. The capacity of that source is its power rating, not the actual amount of electricity it generates.

Electricity is the flow of electrons from a source (out of the "pipe"). It is measured with reference to time and is impacted by the efficiency of the energy facility.

For example, if a biomass plant with a rated power of 20 MW, might generate 140, 160 MWh in a given year or 140, 16 GWh/year. The capacity factor is calculated by taking the actual energy produced (140,

160 MWh/yr) and dividing it by the hypothetical energy it would produce if it constantly produced at its rated power for 365 days per year and 24 hours/day (20MW x 365 x 24 = 175,200 MWh/yr). In this example, the capacity factor is 140, 160 / 175,200 = 80 percent.

How did the New England Power Grid come to be?

New England's electric power industry, like that of the entire nation, has changed dramatically during the past few decades. Until the 1970s, the industry was comprised of utilities that handled every aspect of providing electricity: generating it, transmitting it, and distributing it to homes and businesses. These utilities were regulated local monopolies that operated independently of each other.

The Great Northeast Blackout of 1965 marked a turning point for the region's electric power industry. Concerned about the system's reliability, the Northeast's power companies formed three "power pools" to ensure a dependable supply of electricity. The New England Power Pool (NEPOOL), formed in 1971 by the region's private and municipal utilities, was intended to foster cooperation and coordination among utilities in the six-state region.

During the next three decades, NEPOOL created a regional power grid that now includes more than 350 separate generating plants and more than 8,000 miles of interconnected transmission lines.

While the electric power industry's regulated monopolies worked well for generations, by the 1990s there was a perceived lack of competition. In New England, electricity rates were among the nation's highest, and the region had an antiquated electric power infrastructure.

In the early 1990s, Congress and the Federal Energy Regulatory Commission (FERC), which oversees the electricity industry nationally, began the restructuring of wholesale electric power. They believed competition would provide needed renewal, much as it had in transportation, telecommunications and financial services. FERC created a level playing field for competitive markets to equal access to transmission grids, encourage states to require utilities to sell off power plants, and gradually eliminate regulator-set rates in favor of prices determined by the markets.

What are Independent System Operators (ISOs)?

FERC also created independent system operators, or ISOs, to oversee restructuring on a regional basis. These ISOs were given responsibility for ensuring reliability and establishing and overseeing competitive wholesale electricity markets. Created by FERC in 1997, ISO New England has helped this effort at restructuring. To date, five of the six states have required utilities to sell off their power plants, and 88 percent of the region's generation is unregulated, the most in the nation.

The New England Power Pool-Current Status (June 2006)

The New England Power Pool has:

- 6.5 million customer meters
- 350+ generators
- 8,000+ miles of high voltage transmission lines
- 5 local control centers
- 12 interconnections to neighboring systems
- 32,000 MW of installed generating capacity
- Peak load power capacity:
  - Summer: 26,885 MW (7/05)
  - Winter: 22,818 MW (1/04)

Between 2006 and 2015, ISO NE estimates that consumer electricity use in New England will grow by about 1.3 percent per year. During "Peak Demand" (when consumer demand energy use is at it highest and thus the determinate for the size of our electricity generating infrastructure) the need for electricity is estimated to grow 1.9 percent annually. To maintain a reliable supply of electricity to accommodate this expected growth, New England would need to add the equivalent of one new 500-megawatt (MW) power plant each year.

Peak electricity use is growing much faster than overall use, about a third of the power grid's total generating capacity (10,000 MW of roughly 30,000 MW) is required just to meet consumer demand during the summer season. Increased efficiency and conservation can slow this growth – deferring the need to build new power plants and infrastructure, ultimately reducing overall consumer costs, and making progress toward reducing greenhouse gas emissions at the same time.

Challenges of NE Power Pool System

Achieving diversity of fuels for generating electricity: The system relies very heavily on natural gas for generation. This lack of diversity has reliability and price implications. Natural gas supplies can be tight, especially during extreme weather events. In addition, the fuel delivery infrastructure can be impacted by natural disasters and global market forces.

Price: High cost fuels like natural gas set the price for electricity most hours of the day. Rates were projected to increase 26 percent during the winter of 2006/2007.

Siting new energy developments and infrastructure: Building energy generation facilities is considered to be difficult especially for sources other than natural gas.

Our Energy Mix in the New England Power Pool

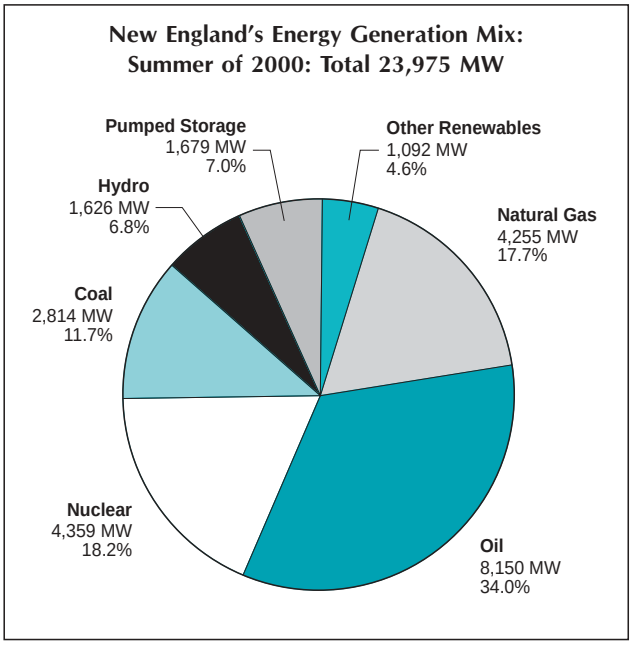
Over the past six years, we have become increasingly dependent on fossil fuels to meet peak summer demand. The share of fossil fuels for our electricity increased 13 percent between 2000 and 2006. Natural gas was the fuel source used most (38 percent) in 2006, replacing oil's previous dominance. Coal and nuclear energy sources also increased slightly while the "other renewables" category (wind and biomass) actually declined (see pie charts below).

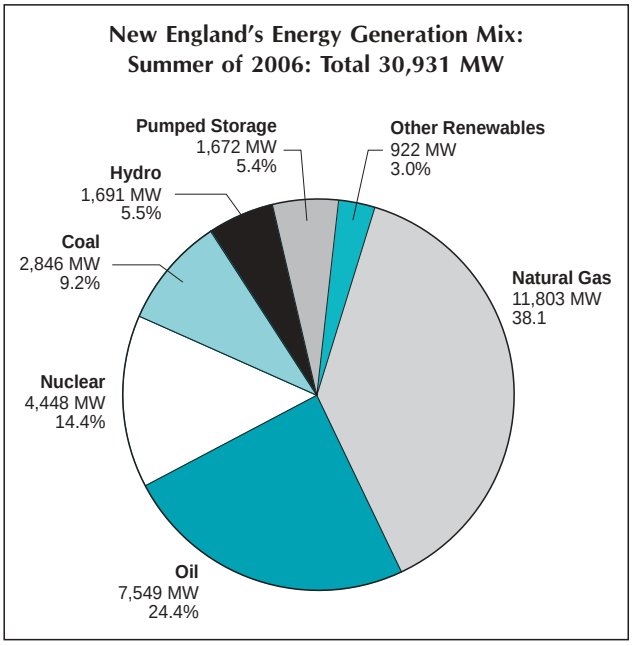
In 2006, fossil fuels represented 71.7 percent of total power capacity during the summer peak load in New England. Of that amount coal and oil, the most polluting of fossil fuels, represented 33.6 percent of total capacity.

In the Pioneer Valley, electric generators use a mix of power sources with a breakdown dominated by hydropower (51.7 percent of summer peak capacity). However, fossil fuels still comprise 47.7 percent of the total capacity in the region, with coal and oil and other petroleum liquid fuels comprising more than half.

Which mix of renewable technologies is best to reduce peak demand?

Electricity generators for the most part can be broken down into combustion and non-combustion types. Combustion sources like fossil fuels, and to a much lesser extent biomass fuels, produce emissions that contribute to global warming through generation of carbon dioxide. Non-combustion sources like wind, solar, geothermal and hydro do not emit greenhouse gasses but they are intermittent in nature. Intermittent power generation technologies will produce electricity, but the time at which they are available will affect their ability to impact peak power capacity. Solar-derived electricity will typically provide some electrical demand offset, because the peak power production contributes significantly during the peak





summer air conditioning load, which is often the peak for the utility.

Wind generated electricity does not reliably occur at the peak requirement time. So without a storage strategy, it cannot be counted on to offset peak load. However if pumped storage capacity, such as that of the Northfield Mountain facility, was used to store up off-peak (night or weekend) wind-generated potential energy, the wind systems could also contribute to demand offset.

Biomass-fueled generation can be more useful to offset peak demand and as a means for replacing capacity now provided by fossil fuels.

Using British Thermal Units (Btu) To Compare Energy

From www.eia.doe.gov
Physical units reflect measures of distances, areas, volumes, heights, weights, mass, force, impulse and energy. Different types of energy are measured by different physical units: barrels or gallons for petroleum; cubic feet for natural gas; tons for coal; kilowatt-hours for electricity. To compare different fuels, we need to convert the measurements to the same units. Some popular units for comparing energy include: British Thermal Units (Btu), barrels of oil equivalents, metric tons of oil equivalents, metric tons of coal equivalents, and terajoules (a unit of work or energy equal to the work done by a force of one newton acting through a distance of one meter – a huge number). In the United States, the British Thermal Unit (Btu), a measure of heat energy, is the most commonly used unit for comparing energy. Because energy used in different countries comes from different places, the Btu content of fuels varies slightly from country to country. The Btu content provided below and used in the energy calculator reflects the average energy contents for fuels consumed in the United States.

BTU Content of Common Energy Units

1 barrel (42 gallons) of crude oil = 5,800,000 Btu
1 gallon of gasoline = 124,000 Btu
1 gallon of diesel fuel = 139,000 Btu
1 gallon of heating oil = 139,000 Btu
1 barrel of residual fuel oil = 6,287,000 Btu
1 cubic foot of natural gas = 1,031 Btu
1 gallon of propane = 91,000 Btu
1 short ton of coal = 20,754,000 Btu
1 kilowatt-hour of electricity = 3,412 Btu

Energy Use For Transportation

America is a nation on the move.
About 28 percent of the energy we use goes to transporting people and goods from one place to another. Cars, vans, and buses are commonly used to carry people. Trucks, airplanes, and railroads are used to carry people and freight. Barges and pipelines only carry freight. In 2002, there were over 222 million vehicles (cars, buses, and trucks) in the United States. That's more than three motor vehicles for every four people!

Automobiles, motorcycles, trucks, and buses drove over 2.8 trillion miles in 2002. That's almost one-twelfth the distance to the nearest star beyond the solar system. It's like driving to the sun and back 13,440 times.

Types of Energy Used for Transportation

Gasoline is used mainly by cars, motorcycles, and light trucks; diesel is used mainly by heavier trucks, buses, and trains. Together, gasoline and diesel make up 86 percent of all the energy used in transportation.

There is currently a push to develop vehicles that run on fuels other than petroleum products, or on blended fuels. Today, there are some vehicles that run on electricity, natural gas, propane, and ethanol. Hybrid-electric vehicles combine the benefits of gasoline engines and electric motors, reducing the amount of fuel required for moving a vehicle. This is why hybrid-electric vehicles can get more miles per gallon of gasoline compared to vehicles that run on gasoline alone.

Fuels Used for Transportation

Note: Due to rounding, data may not sum to exactly 100 percent.

Energy Use by Type of Vehicle

In the United States personal vehicles (like cars and light trucks) consume almost 60 percent of the total energy used for transportation, while commercial vehicles (like large trucks and construction vehicles), mass transit (like airplanes, trains, and buses), and

pipelines account for the rest.

Last Revised: July 2006
Source: U.S. Department of Energy, Transportation Energy Data Book: Edition 24-2004.

Sustainable Transport

(wikipedia.com)

Sustainable Transport is a phrase which was coined in the late 20th century to describe all forms of transport that minimize emissions of carbon dioxide and pollutants. Sustainable transport can mean public transport, car sharing, walking and cycling as well as technology such as electric and hybrid cars and biodiesel vehicles. The term is based on the phrase sustainable development and encompasses a wide array of economical, social and environmental effects that should be taken into account when developing new transport policy and/or projects.

In the future, it will not be possible communities to continue to rely on personal transportation vehicles. We will need to design communities so that people can more easily walk or bike where they need to go. We will need to re-build and expand the region's rail and public transportation systems.

Alternative Fuels

www.wikipedia.com

Alternative fuel (alternate fuel), also known as non-conventional fuels, is any material or substance that can be used as a fuel, other than fossil fuels, or conventional fuels of petroleum (oil), coal, propane, and natural gas. The term "alternative fuels" usually refers to a renewable energy source.

The main purpose of fuel is to store energy in a form that is stable and can be easily transported from the place of production to the end user. Almost all fuels are chemical fuels that store potential energy. The end user is able to consume the fuel at will, and release energy, usually in the form of heat for a variety of applications, such as powering an engine, or heating a building.

Some well known alternative fuels include biodiesel, ethanol, butanol, chemically stored electricity (batteries and fuel cells), hydrogen, methane, natural gas, wood, vegetable oil, biomass, and peanut oil.

Biodiesel is a domestically produced, renewable fuel that can be manufactured from vegetable oils, animal fats, or recycled restaurant greases. Biodiesel is safe, biodegradable, and reduces serious air pollutants such as particulates, carbon monoxide, hydrocarbons, and air toxics. Blends of 20 percent biodiesel with 80 percent petroleum diesel (B20) can generally be used in unmodified diesel engines and oil heat systems. Ethanol is an alcohol-based alternative fuel produced by fermenting and distilling starch crops that have been converted into simple sugars. Feedstocks for this fuel include corn, barley, and wheat. Ethanol can also be produced from "cellulosic biomass" such as trees and grasses and is called bioethanol. Ethanol is most commonly used to increase octane and improve the emissions quality of gasoline. It can be blended with gasoline to create E85, a blend of 85 percent ethanol and 15 percent gasoline. In some areas of the United States, lower concentrations of ethanol are blended with gasoline. The most common low concentration blend is E10 (10 percent ethanol and 90 percent gasoline).

In the year 2000, there were about eight million vehicles around the world that ran on alternative fuels, indicating the increasing popularity of alternative fuels. There is growing social interest and an economic and political need for the development of alternative fuel sources. This is due to general concerns of sustainability – environmental protection and restoration, economic development, and geopolitical relations. A primary concern is that the use of conventional fuels directly contributes to the global warming crisis. Another concern is the problem of peak oil, which predicts a rising cost of oil derived fuels caused by severe shortages of oil during an era of growing energy consumption. A more recent concern is regional conflicts and terrorism, which disrupts the distribution of oil and increases the cost.

Eventually, the demand for oil will exceed supply and this gap will continue to grow, which could cause an energy crisis by the year 2010 or 2020. Lastly, the majority of the known petroleum reserves are located in the middle east. There is general concern that worldwide fuel shortages could intensify the unrest that exists in the region, leading to further conflict and war.

Residential Energy Usage

From AnnArborHomeInspection.com

Have you ever wondered how you use energy in your home? More basically, have you ever wondered about energy itself? The following is a review of the

basics of energy and how we use it to heat and cool our homes. We will also look at some guidelines for saving energy. This is a brief summary of an extensive, complex subject. It is intended to offer a practical perspective, not a detailed analysis. These terms are often misused, so it's a good idea to start with the basics:

BTU
BTU is a measure of thermal energy.
It stands for British Thermal Unit.
One BTU is the amount of heat needed to raise one pound (one pint) of water 1 degree Fahrenheit.

BTUH
BTU per Hour represents the thermal energy requirement per hour to heat or cool a specific volume of air.

Ton
Ton is a measure of cooling; 1 ton is 12,000 BTUH. A ton is the amount of heat removed by an air conditioning system that would melt 1 ton of ice in 24 hours.

KWH
Kilowatt Hour is a measure of electrical energy. One KWH is equivalent to using 1 kilowatt of power for 1 hour or roughly equivalent to keeping your toaster on for 1 hour.

Conditioned space
Conditioned space is typically the living space in a home that is heated and/or cooled (i.e. conditioned). This is usually measured as a volume (cubic feet) rather than an area (square feet). It is about AIR not AREA. A room with a cathedral ceiling has more conditioned space than one with a flat, standard height ceiling.

Building envelope
The building envelope, or shell (walls, roof, floor, windows and doors), separates the conditioned space from the unconditioned space.

Now that we are beginning to understand the vocabulary of energy, let's consider how we use it. To do that, it is useful to distinguish the source from the distribution system. The source of heat is, in most cases, gas, oil, electricity or wood. Heat is produced at the source in a furnace (hot air) or a boiler (hot water) by the combustion (burning) of gas, oil or wood. Heat is also produced directly by electricity in various types of electrical devices, including baseboard units and hot air furnaces. This is often referred to as "resistance" heat because the flow of electricity is resisted by the device through which it is flowing to produce heat. A heat pump is another way to produce heat with electricity; it will be discussed later.

The heat output of each fuel (energy source) is different. Some average values are shown below.

Average heat output

Propane	92,500 BTU/gallon
Natural gas*	92,500 BTU/gallon
Natural gas	100,000 BTU/therm
No. 2 heating oil	136,700 BTU/gallon
Hardwood	16,300,000 BTU/cord
Softwood	9,300,000 BTU/cord
Electricity	3,413 BTU/kilowatt hour

* Natural gas in public utility systems is often measured in hundreds of cubic feet (Ccf) or therms. A therm is typically determined by the utility and depends on the quality of the gas.

The source of air conditioning, typically electric, is actually a heat "mover" rather than a heat producer. Essentially, a heat pump or air conditioner (AC) moves heat from the conditioned space to the unconditioned space. A compressor is common to both a heat pump and an AC unit. Using a refrigerant and a coil, the compressor "squeezes" heat out of the conditioned air, thus moving the heat from where it is not wanted to someplace more acceptable, typically outside. In the heating mode, a heat pump still moves heat, but now it is taking it from the unconditioned space (outside) and delivering it to the conditioned space (inside).

There is a limit to how cold the outside temperature can be for a heat pump to function. This is why heat pumps need backup (electrical resistance heat or natural gas) in cold temperatures, typically below 30 degrees F.

Now that we have examined the source – how we use energy to create heating or cooling – let's consider the distribution (how we get energy from the source to the conditioned space).

Heat is distributed by water (steam or liquid) or air. Cooling is typically distributed by air. Water distribution uses a system of pipes to move heat energy around the house. Air distribution uses a system of

duct work to move conditioned air around the house. Air distribution for heat is typical in areas that are heavily dependent on cooling because that allows dual-purpose duct work. Water distribution for heat requires a separate air system for air conditioning.

We use energy to produce heat or cooling, and then we distribute energy via water or air. How can we minimize our use of energy? In other words, how can we maximize energy efficiency?

The first stage of efficiency is combustion efficiency (burning gas or oil to produce heat). Combustion efficiency does not apply to electric because there is no combustion. How efficiently does your heating equipment convert energy to flame (flame energy is the heat source)? The combustion efficiency of oil-fired equipment ranges from 70 percent to 85 percent, with most new equipment running close to 85 percent. The combustion efficiency of gas-fired equipment ranges from 75 percent to 90 percent, depending on the age and type of equipment.

The second stage of efficiency is thermal conversion efficiency. How well does your heating equipment convert the energy from the flame to heat ready to be distributed throughout your house? In other words, how well does your furnace use the flame energy to produce warm air? Or, how well does your boiler use the flame energy to produce hot water?

Older cast-iron, steam and hot water units score low on thermal conversion efficiency, often as low as 50 percent. Most modern boilers (water) will reach about 80 percent. Some multi-pass boilers will reach 90 percent. Most hot air furnaces operate at about 80 percent thermal conversion efficiency. Electricity is the most thermally efficient, at about 95 percent, and there is no combustion efficiency to consider. However, electricity is among the most expensive energy sources available.

So, to calculate efficiency, first convert the fuel to flame energy then convert that to heat. In the worst case (70 percent combustion, 50 percent thermal conversion), only 35 percent of the energy from fuel consumed will reach the conditioned space to heat your home.

For comparison, electrical devices such as heat pumps and AC units have a similar measure of efficiency, the coefficient of performance (COP), which is essentially the ratio of electricity used to heat moved. An efficient device will typically have a COP in the range of 5 to 6. Higher is more efficient. Also, you may encounter a seasonal energy efficiency rating (SEER) on heat pumps and AC units. A low-end SEER, typical for window air conditioners, is 10, but new, larger central air systems can go up to 17 or 18. Higher is better. A unit with a SEER of 18 costs half as much to run as one with a SEER of 9. Typically, for new equipment, you should expect a SEER of at least 12. Now we have discussed the first step in an energy-efficient home, optimizing the efficiency with which you are using your energy to produce heating or cooling. By the way, all of the ratings noted above will deteriorate with time. As equipment gets older, it becomes less efficient. Good annual maintenance will help slow the deterioration. The second step in achieving an energy-efficient home is the building envelope. How well does the building envelope separate the conditioned air from the unconditioned air? Fundamentally, there are three criteria: conduction, infiltration and radiation. Conduction is the direct loss of energy through the components of the building envelope. Infiltration is the loss of energy by air leaks (around doors and windows, in duct work, etc.). Radiation is the flow of heat into or out of the building based on exposure to the sun. The use of radiant energy shields and low-e windows reflect heat either into or out of the house, depending on the orientation, and reduces energy use.

At this point, balance must also be considered. The most efficient home will be the tightest home. However, that home will also be the most uncomfortable because very little fresh air reaches the inside. Indoor air quality (IAQ) must be considered when optimizing efficiency. The ideal condition is a completely sealed house with an independent fresh air source on the HVAC system.

The amount of insulation needed to minimize conduction losses varies by region. Most states have established standards for energy-efficient construction. Also, the federal Department of Energy has many good guidelines. Visit www.eren.doe.gov/consumerinfo. Also, the EPA has quite a bit of information in their "Energy Star" program at http://www.energystar.gov/default.shtml.

Evaluating the energy efficiency of an existing home is often done by "rules of thumb."

Rules of Thumb for the Northeast are shown below:

Heating	
Average Home	40 BTU/hr/SF
Efficient Home	30 BTU/hr/SF
Cooling	
Average Home	1 Ton/400 SF
Efficient Home	1 Ton/500 SF

Every house is different. Local conditions vary. Altitude makes a difference. By converting the actual energy used with the information provided here, however, at least you will have a sense of the efficiency of the home you are considering. For example, you know a 2000 square foot house in the Northeast uses 1500 gallons of oil each year to heat it: 1500 gallons times 136,700 BTU/gallon divided by 2000 SF, equals 102,525 BTU/SF per heating season. If a heating season runs for 210 days (5040 hours), then dividing 102,525 by 5040, we get an average BTU/hr/SF of just over 20. Energy costs will continue to rise. Having a good understanding of how your home uses energy will help you minimize those costs.

Commercial and Industrial Energy Savings

www1.eere.energy.gov

To ease the effects of variable energy prices and supplies, U.S. commercial and industrial businesses are identifying ways to reduce energy and operating costs, lower utility bills, and ensure future savings. In the last year, industrial plants working in partnership with the U.S. Department of Energy (DOE) uncovered more than $300 million in total potential annual savings through Energy Savings Assessments (ESAs) of industrial process heating and steam systems. Implementing measures could help these plants save 7 percent or more per year on energy bills.

For more information, visit the Save Energy Now Web site, www.eere.energy.gov/industry/saveenergynow, and contact the Energy Efficiency and Renewable Energy (EERE) Information Center (1-877-337-3463).

Leadership in Energy and Environmental Design

www.usgbc.org/

What is LEED®?
The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

A large amount of energy goes into maintaining the buildings we build. Green Buildings can be energy producers rather than energy users as they take advantage of passive solar gains, use energy efficient lighting, appliances, pumps and motors, and install renewables.

Sustainable Waste Management

http://www.logan.qld.gov.au/LCC/residents/wastecollection/education/community/sustainable_waste_management.htm

Waste management will be the greatest challenge for the global economy in the 21st Century. In the US, we rely, and have relied, on using the landfill method for our waste disposal, mainly because of the availability of land to bury our waste has not been a pressing issue. Many other countries around the world have been forced to look at other waste management options, because they have run out of suitable land in which to bury their waste. The US is the highest producer of waste in the world. As a result, our landfills are filling at an unprecedented rate and pressure for suitable land is growing. The landfilling method of waste disposal is easy and convenient; however, it is not sustainable and raises many environmental issues.

With a continuing global debate about unsustainable waste generation levels and depleting natural resources, sustainable waste management has been something that all governments have now been forced to consider, protecting the future of their local environments and the health of their local populations. Actions to minimize and avoid waste, through encouraging waste reduction, waste reuse, and waste

recycling and waste recovery are critical to sustainable waste management for our future. We need to develop a 'zero waste' policy; where we move away from waste disposal through land filling, towards an integrated waste management approach that recovers resources and encourages materials efficiency.

The Future of Waste

Our priorities are turning towards a 'zero waste' focus for sustainable waste management. The true solution to our waste issues lies in slowing down the rate at which we churn through resources, or just by using resources in cleaner ways. This means producing more goods and services with less energy and fewer natural resources, which results in less waste and less pollution. In a 'materials efficient world' or 'closed loop economy', the amount of waste created would be minimized by clever product and package design and delivery and through production processes that exclude wastes. Materials that are discarded would be recovered for their inherent value and reused, recycled and reprocessed in a way that exploits their highest value.

http://www.ecocycle.org/ZeroWaste/
(Find out all about 'zero waste' here)

http://www.ecocycle.org/newsletters/index.cfm
(Find out about what other countries around the world are doing through the EcoCycle newsletter)

Smart Growth and Sustainable Land Use

Wikipedia.com

Smart growth refers to a set of policies governing transportation and planning that benefit communities and preserve the natural environment. Smart growth advocates land use patterns that are compact, transit-oriented, walkable, bicycle-friendly, and include mixed-use development with a range of housing choices. This philosophy keeps density concentrated in the center of a town or city, combating urban sprawl.

Proponents of smart growth advocate comprehensive planning to guide, design, develop, revitalize and build communities that: have a unique sense of community and place; preserve and enhance natural and cultural resources; equitably distribute the costs and benefits of development; expand the range of transportation, employment and housing choices; value long-range, regional considerations of sustainability over a short term focus; and promote public health and healthy communities.

Sustainable Development Principles

The Office for Commonwealth Development is dedicated to careful stewardship of our natural resources, wise investment in public infrastructure, and the expansion of opportunity for all our residents. Future growth is inevitable and desirable – but we need to plan for it in a responsible manner. Our choices today must create value and opportunity for all our residents now and in the future. Careful, sustainable development decisions will foster continued economic growth in Massachusetts, while mitigating the environmental impacts of our past and minimizing those of the future.

To this end, the Office for Commonwealth Development has adopted the following Sustainable Development Principles. A more detailed description of these principles can be found on the web at www.mass.gov/ocd.

1. Redevelop first.
2. Concentrate development.
3. Be fair.
4. Restore and enhance the environment.
5. Conserve natural resources.
6. Expand housing opportunities.
7. Provide transportation choice.
8. Increase job opportunities.
9. Foster sustainable businesses.

Conclusion

We have an opportunity in the Pioneer Valley to take the lead in energy conservation. We simply need to take charge of our future by working on our own and with others in the Valley to institute new energy standards and business and community practices that collectively will reshape our energy consumption. By doing so, we will preserve our quality of life and develop a progressive economy that will sustain our future.

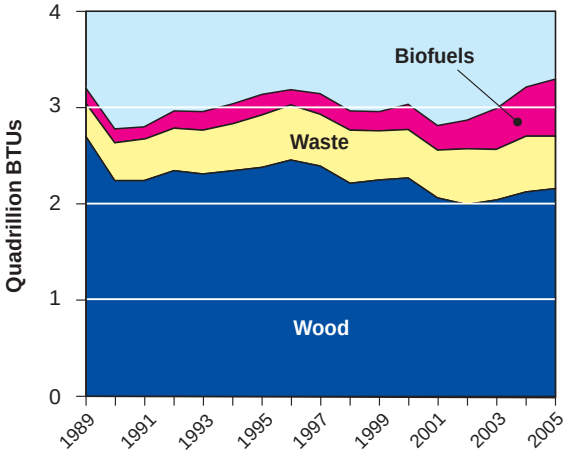
Appendix VII: Detail on Biomass

Biomass-Based Energy in Massachusetts

Introduction

The purpose of this paper is to explore the issues surrounding the application of biomass-based energy in Massachusetts. Biomass-based energy will likely play an important role in our energy future both in the short- and long-term but it will not be the silver bullet, due in part to feedstock supply issues. The source of the biomass, the way in which the material is processed prior to its combustion, and the design of the energy facility all have important implications to consider. As part of a comprehensive mixture of renewable energy, biofuels could provide viable alternatives to energy derived from coal, oil, natural gas, and nuclear sources.

Figure 1: **U.S. Historical Consumption of Biomass by Type (1989 - 2005)**



Biomass Defined

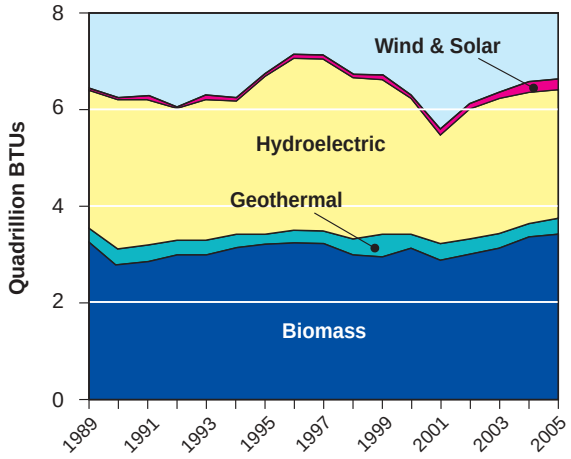
Biomass commonly refers to plant matter grown or harvested for use as fuel but it can also be used to describe animal and plant matter used for production of fibers, chemicals or heat. In other words, biomass is energy captured by photosynthesis. In the context of renewable energy, biomass can include wood, plant crops like soybeans and corn, liquid biofuels, and process wastes used in the production of electricity, power, and heat. Sources of biomass can be processed to create solid fuels like wood chips, liquid fuels like biodiesel and ethanol, and gases like methane from landfills. The term biofuels is also sometimes used to define a solid, gaseous, or liquid fuel produced from biomass. As a stored form of solar energy, biomass can be used to generate power and heat continuously, without the intermittency limitations of wind and solar energy systems.

National Trends in Biomass-Based Energy Consumption

According to the U.S. Energy Information Agency (EIA), biomass energy consumption increased to 3.3 quadrillion Btu in 2005, which is half of total renewable energy consumption and the largest domestic source of renewable energy. Biomass currently supplies over 3 percent of the U.S. total energy consumption — mostly through industrial heat and steam production by the pulp and paper industry and electrical generation with forest industry residues and municipal solid waste (MSW). Nearly 65 percent of biomass energy consumption was wood consumption and another 17 percent was energy generated from waste. Despite being a relatively small component of biomass, biofuels experienced the most rapid growth within that fuel category. Ethanol consumption in the transportation sector was four billion gallons in 2005, well on the way to allowing the ethanol industry to meet the Renewable Fuel Standard of 7.5 billion gallons in 2012. Biodiesel consumption in the transportation sector represented a much smaller volume of biofuels than ethanol, but it increased almost fourfold to 11 trillion Btu between 2004 and 2005, up from just 1 trillion Btu in 2001. Total biofuel consumption was 594 quadrillion Btu in 2005.

While some industries co-generate electricity and steam, most biomass energy consumption in the industrial sector was used for useful thermal output or process heat during 2005. The Paper and Allied Products industry consumed nearly two-thirds of all biomass for energy in 2005. Seventy percent of biomass energy consumed by the Paper and Allied Products industry was “black liquor”, a residue of the chemical wood-pulping process used in making paper.

Figure 2: **U.S. Historical Consumption of Renewable Energy by Energy Source (1989 - 2005)**



Overall, 109 electricity generating plants burned both biomass and coal in 2005. Plants for which biomass is only a small fraction of total energy consumption compared to coal are generally "co-fired" plants attempting to reduce emissions without making major retrofit investments. The remaining plants are dual- or multi-fired plants consuming fuels based on availability, demand and price. The average fuel mix for plants that use both coal and biomass was about 36 percent biomass and 55 percent coal in 2005, with the remainder being other fuels.

The National Capacity for Increased Biomass Energy Consumption

The U.S. Department of Energy (DOE) and the U.S. Department of Agriculture (USDA) put out a publication in 2005, Biomass as a Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply. The two federal agencies are supporting biomass fuels and products as a way to reduce dependence on imported oil and gas; to support the growth of agriculture, forestry, and rural economies; and to foster major new domestic industries making a variety of fuels, chemicals, and other products.

The conclusion of the report was that there are adequate land resources in the United States capable of producing a sustainable supply of biomass sufficient to meet this goal. It would require approximately 1 billion dry tons of biomass feedstock per year. This could amount to a 30 percent replacement of the current U.S. petroleum consumption with biofuels by 2030.

The two largest potential biomass sources in the United States are forestland and agricultural land, , which according to the study would be enough to produce over 1.3 billion dry tons per year which would meet more than one-third of the current demand for transportation fuels. The full resource potential could be available within fifty years when large-scale bioenergy and biorefinery industries are likely to exist. This annual potential is based on a more than seven-fold increase in production from the amount of biomass currently consumed for bioenergy and biobased products.

Specifically, this study estimated that forestlands in the contiguous United States can produce 368 million dry tons annually: 14 percent from fuelwood; 39 percent as residues from wood processing mills and pulp and paper mills; 13 percent from urban wood residues including construction and demolition debris; 17 percent from site clearing operations; and, 17 percent from fuel treatment operations to reduce fire hazards. For estimating the residual tonnage from logging and site clearing operations and fuel treatment thinnings, a number of important assumptions were made:

- All forestland areas not currently accessible by roads were excluded;
- All environmentally sensitive areas were excluded;
- Equipment recovery limitations were considered; and
- Recoverable biomass was separated into two utilization groups – conventional forest products and biomass for bioenergy and biobased products.

The study estimated that from agricultural lands, the United States could produce nearly 1 billion dry tons of biomass annually and still continue to meet food, feed, and export demands. This projection includes 43 percent from annual crop residues, 38 percent as perennial crops, 9 percent in grains used for biofuels, and 11 percent as animal manures, process residues, and other miscellaneous feedstocks. Important assumptions, which appear to assume no limitation on petroleum inputs to agriculture, include the following:

- Yields of corn, wheat, and other small grains were increased by 50 percent
- The residue-to-grain ratio for soybeans was increased to 2:1;

- Harvest technology was capable of recovering 75 percent of annual crop residues (when removal is sustainable);
- All cropland was managed with no-till methods;
- Overall, 55 million acres of cropland, idle cropland, and cropland pasture were dedicated to the production of perennial bioenergy crops;
- All manure in excess of that which can be applied on-farm for soil improvement under anticipated EPA restrictions was used for biofuel; and
- All other available residues were utilized.

According to the federal agencies, the biomass resource potential identified in the report could be produced with relatively modest changes in land use, and agricultural and forestry practices.

It is important to note that a 2007 review the Billion-ton study, found important flaws only one of which is that it relies on significant increased energy inputs especially in the case of agricultural-based biomass, which call for a 50 percent increase in harvests. Shifts in the supply or price of liquid fuels over the next 50 years would likely challenge the realization of these yield targets. Specifically, the Hirsch Report (see pages 18-20) describes consensus among researchers that a significant decrease in the availability of liquid fuels will come to pass over the next twenty years. Rising costs for transportation, fertilizer, electricity, etc. would likely result in lower yields than estimated by the supply study.

Biomass: A Renewable Source of Energy

All energy other than nuclear is ultimately derived from the sun. Biomass fuels are considered renewable because the trees and plants that store solar energy were recently growing and new biomass will be regenerated in their place in the immediate future. Fossil fuels on the other hand take millions of years to form and when burned, quickly release "new" greenhouse gases into the atmosphere disrupting the contemporaneous balance of the earth's atmosphere. Some other types of biofuels generated from municipal waste and construction and demolition debris streams for example, are also considered renewable (though not necessarily eligible under the State's RPS program) by Massachusetts state agencies because they are produced on a continual basis (like landfill gas).

Biomass-derived fuels, power, chemicals, materials, or other products essentially generate no net increase in greenhouse gas outside of any fossil-fuel use to grow, collect, and convert the biomass in a full life-cycle analysis. The carbon dioxide released when biomass is burned is balanced by the carbon dioxide captured when the biomass is grown. Its production and use will also generally be local and not entail global transport, so it has other important environmental, economic, and security benefits.

Woody Biomass Fuel in Massachusetts

In Massachusetts, the most prevalent form of biomass fuel is wood and woody debris. Although Massachusetts is one of the most densely populated states in the union, three-fifths of the land base is covered in forest and this forest cover has expanded significantly since the agricultural economy of the 1800's. According to a 2002 study produced by Breger and Fallon for the Division of Energy Resources, The Woody Biomass Supply in Massachusetts: A Literature-Based Estimate, there are seven main categories of woody biomass supply in the state (see the table below for estimated volumes):

1. Woody residue from the Municipal Solid Waste Stream (12%);
2. Woody residue from the Construction and Demolition (C &D) waste stream (9%);
3. Woody residue from primary wood manufacturers (6%);
4. Woody residue from secondary wood manufacturers (5%);
5. Urban wood residue (*branches, tree tops, etc.*) (24%);
6. Unutilized annual net growth in Massachusetts forests—Growing-Stock Trees (34%); and,
7. Unutilized annual net growth in Massachusetts forests—Branches, Top Wood (10%).

Municipal solid waste-based woody residues are defined as pallets and shipping containers. According to the study, nearly half of these pallets were disposed of in landfills in 1995, which as of July 2006, is no longer an option due to the Massachusetts wood ban (for disposal in in-state landfills). The study suggests that although woody debris from this waste stream could be recovered, contaminants associated with pallets and the complexity of stream-

Table 1:
Estimated Annual Volumes of Woody Biomass in Massachusetts

Woody Biomass Source	Amount (tons/year)
Residue Sources	
Municipal Solid Waste	523,500
Construction and Demolition Debris	404,000
Primary Wood Manufacturers - Residues	279,608
Secondary Wood Manufacturers - Residues	225,000
Urban Wood Residues	1,049,200
Subtotal	2,481,308
Unutilized Annual Net Growth in Massachusetts Forests	
Growing-Stock Trees	1,484,000
Branches, Top Wood	446,000
Subtotal	1,930,000
TOTAL	4,411,308

separation; make this a less desirable fuel choice for New England's current and future biomass plants.

Construction and demolition (C&D) woody debris estimates showed that 30 percent of the C&D materials entering state processing facilities were wood (21% clean wood, 9% dirty wood). The report estimated that 30 percent of the C&D materials currently unrecovered (exported and disposed of) could be recovered and used as biomass fuels. The study also noted that including these "dirty" woody debris would require different "conversion technologies or emission controls."

Primary and secondary wood manufacturers in Massachusetts include the fifty remaining sawmills that generate sawdust, wood chips and bark. Secondary manufacturers work with wood to create consumer goods including furniture and casket makers.

Urban sources of woody debris include chips, logs, tops, brush, mixed wood and whole stumps generated by commercial firms, municipal tree care, nurseries and other types of companies.

Woody biomass derived from forest harvests includes the net growth of larger trees within the forest as well as the tops of trees harvested already. Harvesting net growth is similar to taking the interest and leaving the principal. Much debris would continue to fall naturally and replenish the soil. And roots and below-ground biomass are not considered as a source of fuel in the United States.

Why depend on a combustible?

Each renewable energy technology requires consideration of technical research and development issues, cradle to grave environmental impacts, scenic impacts, expense, relative efficiency, and availability of the resource to the demand. Increasing energy efficiency and conservation are very attractive strategies for reducing use of fossil fuels as compared to siting any single type of renewable energy facility. Still, while wind, solar power, and tidal energy are relatively emission-free technologies in their operation, biomass fuels emit pollutants when combusted.

When biomass and biofuels are burned (either directly or after gasification), the resulting emissions often contain carbon monoxide, nitrous oxides, sulfur dioxide, and small particulates. Emissions vary depending on the type of fuel, the method, size, and efficiency of the combustion system. Other environmental impacts can include increased traffic, noise, dust, water withdrawals, and others. Although these emissions and impacts are regulated by environmental protection agencies like the Massachusetts Department of Environmental Protection one must ask the question, with all the choices why consider anything but a *very* clean energy source?

The answer is efficiency and availability. Efficiency is the relative ability of an energy facility whether powered by biomass, the sun, or wind to generate electricity or heat or both over a set period of time based on a known capacity. For example, wind turbines have a particular blade and generator size and solar arrays have their associated square footage of panel space. How much electricity they produce is dependent not only on the size of the blade or panel but also on how much wind passes over the turbine's blades or how much of the sun's rays reach the panels' surface over time. Availability relates to the degree to which energy is produced in proximity, in both space and time, to the demand. Wind and solar energy facilities are generally unable to contribute to peak capacity. A biomass facility can generate electricity and steam heat twenty-four hours a day.

In this way, biomass is one of the few fuel sources that can replace the generation capacity currently held by coal, oil, and nuclear fuels.

When considering renewable energy choices, one must also consider costs. Compared to biomass, solar PV is substantially more expensive in terms of the lifecycle $/kwh of electricity generated, and only the best of the Massachusetts wind sites would provide electricity as inexpensive as biomass.

A Look at Our Energy Choices: Mt. Tom Coal Plant and a Biomass Plant

The Pioneer Valley Clean Energy Plan demonstrates that if people are intent on reducing carbon dioxide, then finding ways to reduce our use of carbon-intensive fuels has to be a major part of the picture. Reducing our use, and being much more efficient with our energy is critical. Our Plan states that a 30 percent reduction in carbon dioxide by 2020 is possible if half of that amount comes from better efficiency and reducing our use. The other half would need to come from replacing fossil fuel power plants like the Mt. Tom coal plant with renewable energy facilities.

Research by the Clean Air Task Force (CATF), the U.S. Public Interest Research Group Education Fund and the National Environmental Trust, shows that no other single industry comes close to matching the negative impacts generated by electric fossil fuel power plants. They are the single largest industrial source of sulfur dioxide, nitrogen dioxides, carbon dioxide, and mercury.

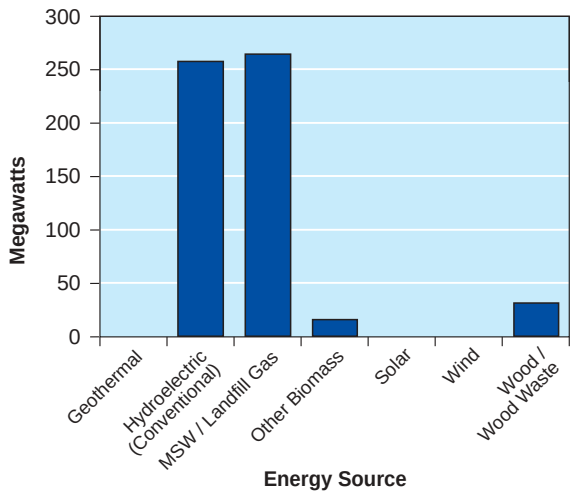
According to First Light and Power's website, the Mt. Tom coal-burning power plant in Holyoke, Massachusetts has a generating capacity of 146 MW, which is enough to meet the electrical demand of a city more than twice the size of Holyoke. In 2002, the Mt. Tom plant emitted 5,282 tons of sulfur dioxide, 1,991 tons of nitrous oxides, over one million tons of carbon dioxide, and 32 lbs. of mercury per year (CATF).

There are nine fossil fuel-based generating power plants in Massachusetts. Outside of Mt. Tom the plants include: MassPower 1&2 (natural gas), Salem Harbor (coal), New Boston (natural gas), Mystic (oil), Bellingham B1 & 2 (natural gas), Somerset (coal), Brayton Point (coal), and Canal (oil). Together they generate over 90,000 tons of sulfur dioxide, 28,000 tons of nitrous oxides, 21 million tons of carbon dioxide and 324 lbs of mercury.

What can Western Massachusetts use to replace the need for a Mt. Tom-sized coal-burning plant? Under our plan's premise, we would need to come up with half of the plant's capacity or, 73 MW. That is a lot of power capacity, which we would be challenged to satisfy using just wind turbines and photo-voltaic arrays.

As shown in Figure 3 of all the different renewable energy technologies in Massachusetts in 2005, solar, wind, and geothermal sources were not contributing a significant amount of the summer peak power capacity. Hydroelectric, municipal solid waste, landfill gas, and biomass did contribute summer capacity. One could argue that society needs to reduce summer peak demand through demand response, conservation and efficiency. However, if peak demand is currently satisfied by fossil fuels, hydro, and combustibles and, Massachusetts residents want to replace fossil fuels with renewable energy sources, which are the best sources able to take their place?

Figure 3: **Total Renewable Net Summer Capacity by Energy Source in Massachusetts (2005)**



If Cape Wind is constructed with 130, 3.6 MW wind turbines, it will be an example of the siting of a renewable energy technology close to both the demand (it will satisfy 75% of electricity needs of the Cape and Islands) and the source. At an average capacity of 170 MW, it represents a significant source of electric capacity for that region.

The environmental advocacy organization Healthlink posted a letter to Governor Patrick dated July 11, 2007 with signatories including representatives across the state including Clean Water Action, Environmental League of Mass., Conservation Law Foundation, American Lung Association, Clean Air Cool Planet, Toxics Action Center, etc. The letter urges the Governor to invest in renewable energy and not in clean-coal technology unless it results in zero-net gain in carbon dioxide emissions. The letter asks Governor Patrick to consider that, "there is substantial untapped energy efficiency available at a cost far cheaper than buying electricity. Further, low- and zero-carbon renewable energy technologies are poised for major growth in the coming decade." While wind power must be seen as a one of the low or zero-carbon technologies, could biomass be considered one as well?

The proposed Russell Biomass Plant is included here to illustrate the emissions of a clean wood-based biomass plant in comparison to a coal plant. The potential maximum emissions of the major ("criteria") pollutants are the following, assuming 365 days per year of operation (Russell Biomass Expanded Environmental Notification Form):

nitrogen oxides (NOx)	245 tons/year;
carbon monoxide (CO)	425 tons/year;
volatile organic compds. (VOC)	32 tons/year,
sulfur dioxide (SO2)	117 tons/year
particulate matter (PM)	40 tons/year
carbon dioxide (C02)	632,180 tons/year

In the table on the following page, the estimated emission figures per MW of power capacity for the Russell biomass plant are described. The proposed biomass plant would emit 36 percent of the nitrogen oxide emitted by Mt. Tom and 6 percent of its sulfur dioxide. Finally, while the carbon dioxide released by the biomass plant would be nearly double that of the coal plant on a per MW basis, biomass energy is net zero in carbon emissions as discussed earlier. The coal plant's carbon dioxide emissions on the other hand represent the addition of substantial new carbon to the atmosphere.

This added "new" carbon is what is causing climate change. Carbon that is released by combusting wood is not the problem for as long as we protect forests from development and encourage sustainable forest management

Table 2:
A Comparison of Pollutants per MW of Capacity for Russell Biomass and Mt. Tom Power Plant

Pollutant	Russell Biomass (50 MW) (est. tons/year/MW)	Mt. Tom Coal (146 MW) (tons/year/MW)
nitrogen oxides	4.9	13.6
carbon dioxide*	0 (net)*	6,850
sulfur dioxide	2.3	36

Note*: CO2 released from trees is roughly equal to C02 sequestered in trees; gross emissions are 12,644 tons/yr/MW.

Three Key Factors Affecting Impacts from Biomass Plants: Design, Size, and Fuel Type

Any manufacturing facility allowed through a special permit process in a Massachusetts municipality must show how the activities and processes at the site will impact the community. Special permit language in local zoning bylaws describe impacts that the city or town will investigate to determine if the project complies with zoning and is appropriate to the city. These can include traffic, fiscal and environmental impacts.

Impacts to air and water quality also need to be determined and often the city or town will defer to the regulatory powers of the Massachusetts Department of Environmental Protection and other permitting agencies.

Let's assume that these and other impacts (e.g. noise, dust, and scenic impacts) would be typical of many other types of manufacturing uses whether they were a cement factory or a paper company. What are the attributes of a biomass facility that are wholly unique to an energy facility and in this case, a combustion-based facility?

Design of the Biomass Plant

The first question relates to whether the biomass plant generates electricity only or does it also utilize the extra heat generated by the process? A Co-Gen biomass plant typically generates electricity for a host industry or the grid and heat for an on-site industrial use or a local use including a village district. In addition, biomass plants might also utilize the ashes left over from combustion to fertilize the forests or fields from which the biomass material was harvested. In essence, biomass plants would seek to

utilize as much of the energy and by-products of electric generation as possible.

The more efficient a biomass plant is the more the biomass facility can use the heat and waste products generated by the combustion process, the more efficient the plant is. Greater efficiency could also mean fewer negative impacts on the environment. Increasing the use of heat produced through combustion of the biomass could increase overall efficiency and result in less impact on the environment. For example, a plant could use that extra energy to heat homes and businesses within a village during the heating months and to another industrial property nearby in the summer months. Using process heat for winter season space heating could result in a reduction in the need for burning firewood, oil, or coal in a dense village area benefiting residents with cleaner relatively particulate-free air.

Size of Biomass Plants

There are three main reasons why size matters with regards to siting biomass facilities.

Pollution Control: The cost of a bag house to catch fine particulates is enough to ensure that below a certain size, the best pollution controls can be cost prohibitive. On the other hand, the larger the plant is, the more pollution per unit time will be expelled from the plant.

Efficiency: Generally, larger facilities can afford the most advanced technologies to most efficiently convert biomass fuel to electricity. Small powerplants, however, may be more conducive to siting closer to loads that can utilize the units thermal output creating significant overall efficiency benefits,

Supply Considerations: The larger the plant, the more materials it would need to keep on hand to ensure a continued supply. These materials would need to be transported by truck or rail to the site where both transport and storage of materials could involve dust, fumes, and smoke. However, given higher efficiency of larger plants, less fuel overall would be required compared to the same energy generated by a large number of smaller plants.

Type of Fuel

There are a number of issues which could affect local acceptance of a biomass power plant. The guiding principles listed in the Pioneer Valley Clean Energy Plan provide a glimpse as to how a project might be designed so that it would receive public support by communities. Like the design and size of the project, the type of fuel can affect the impacts, both positive and negative, people associate with the technology and with a proposed plant.

For example, consider the ramifications to the host community and the region if the fuel source is mostly wood from sustainably managed forests. The plant would be buying wood chips sourced from forest landowners all over the region and beyond. By expanding markets for low-grade forest products, new jobs would be created and foresters would have a wider choice of management options.

Now imagine that the fuel mix was to include "clean" wood sorted from construction and demolition materials at facilities designed for that purpose (two C&D sorting facilities are currently located in Ware and Taunton). Woody debris could be coming in from around Massachusetts or from other nearby states. As of July 2006, Massachusetts banned wood from in-state landfills. This created the market for sorting, recycling, and reuse operations. One benefit of using C&D wood for generating electricity is that it would reduce fossil fuels used to transport the materials to out-of-state landfills. A serious concern however is that DEP cannot guarantee facilities permitted to burn C&D woody debris would not also combust contaminated wood. DEP would regulate the emissions based on the air permit held by the power plant. How these emissions would be regulated over time is another concern.

Outstanding Issues for Biomass Fuels

There are several issues that have been at the center of discussion concerning biomass energy in Massachusetts. These areas of concern are described by the following questions:

- Which bio-fuels should be considered clean burning?
- What do Massachusetts communities need to understand about construction and demolition (C&D) woody debris with regards to the Renewable Portfolio Standard and the State's Solid Waste Master Plan?
- What is the role of the Massachusetts Department

of Public Utilities in our biomass-based energy future in Massachusetts?

- Can woody debris biomass be harvested from forests in a sustainable manner?
- What is the connection between biomass and biofuels and the global supply of oil?

Which bio-fuels should be considered clean burning?

The American Lung Association in their State of the Air (2007) report gives Hampden and Hampshire Counties an "F" air quality rating for particle pollution and an "F" for Hampden County for high ozone days. As a point of comparison, Worcester County received a "C" rating for ozone and a "D" for particulates. Biomass energy production is seen by many as a less desirable source of renewable energy because in many of its applications the resulting emissions, though regulated by the DEP, add to an atmosphere already plagued with low air quality.

Typically, solids produce more particulates and more pollution when combusted than a bio-gas or a bio-liquid. In gasification systems, biomass is heated to high temperatures in a gasifier. The solid biomass is converted to a gas primarily composed of hydrogen, carbon monoxide, carbon dioxide, water vapor, and methane. The gas is then used in a variety of applications, including gas electricity-generating turbines and boilers.

Gasifiers have several advantages over systems that burn biomass solids. Most notably, they emit less air pollution. They are significantly more efficient than biomass combustion facilities, so they require fewer raw materials and can potentially generate electricity more cheaply. The technology is still being perfected and refined for use in large power plants.

Liquid pyrolysis technology is similar in concept. Solid biomass is heated rapidly in a high-temperature, oxygen-free environment, converting it into a liquid fuel (bio-oil) as well as other products. The bio-oil can then be converted into useful energy in conventional combustion systems.

Since gasifier and liquefier technologies are still in the research and design phases we are likely to see improvements in the application of biomass fuels in the coming decades. Until these exciting technologies are available, it would seem the cleanest biofuels will be solids generated from forest harvests and from other woody debris sources, but not include "dirty" (painted or treated wood) construction and demolition woody debris.

What do Massachusetts communities need to understand about construction and demolition (C&D) woody debris with regards to the Renewable Portfolio Standard and the State's Solid Waste Master Plan?

This question perhaps needs to be answered by looking at how the state through its agencies plans for C&D materials. Overall, state agencies see C&D woody debris as both a potential source of energy and as a waste management issue.

In the regulations of the Massachusetts Renewable Energy Portfolio Standard, the term *organic refuse-derived fuel* is included in a list of eligible biomass fuels, and has been interpreted by the Division of Energy Resources (DOER) as being inclusive of wood derived from construction and demolition (C&D) debris. In several Advisory Rulings and two Statements of Qualification for proposed biomass projects, DOER provided contingent approval of the use of C&D wood along with clear direction as to the stringent emission limits and monitoring of toxics that would need to be met.

In 2005, and continuing through 2007, DOER opened a Notice of Inquiry to consider revisions to the RPS regulations pertaining primarily to biomass and including the inclusion of C&D wood as an eligible biomass fuel. During this process, much information and public comment was heard with regard to current and advanced sorting practices for C&D, emissions from C&D combustion, gasification and other technologies that might reduce toxics in the exhaust air stream, and public concerns and perceptions of C&D burning.

While C&D is a fuel which can be burned in Massachusetts, subject to MassDEP permit regulations, the issue of whether such material is an eligible biomass fuel for the purpose of generating renewable energy credits under the RPS program remains under discussion by the DOER and the EOEEA. DOER anticipates that a decision on this issue will be made in the middle of 2008.

A change in policy excluding C&D from consideration as a RPS fuel would support the efforts of the Massachusetts Department of Conservation and Recreation, which supports the development of markets for forest-derived biomass. Biomass harvested as part of timber and fuelwood sales on private and public forests will likely be the tops and small-diameter wood. Yet the estimated volume of waste-based to forest-based wood would be 2:1 based on findings reported in Woody Biomass Supply in Massachusetts: A Literature-Based Estimate. Unlike forest-based biomass, the expense of C&D to the plant would be low, nil, or might generate additional revenue as the wood ban on Massachusetts landfills could result in a demand for other disposal options. C&D woody debris as a biomass feedstock may be an attractive option for those seeking to dispose of these materials.

In 2006, the Northeast States for Coordinated Air Use Management (NESCAUM), whose members represent states' environmental protection departments, including MassDEP, prepared a report, Emissions from Burning Wood Fuels Derived from Construction and Demolition Debris to "gain a better understanding of emissions and related environmental issues from the use of construction and demolition (C&D) wood for power generation." NESCAUM estimated that economic and regulatory shifts were increasing interest in using C&D as a biomass feedstock. As costs to dispose of C&D materials increased, companies were investigating ways of reducing disposal costs and generating power at the same time. C&D woody debris were estimated to cost ten to twenty dollars less per ton to process as fuel than to send to a landfill. Two other factors supporting the use of C&D wood were increasing costs of oil and natural gas and increased regulatory incentives to use renewable energy sources. Coal emission control costs were rising while renewable energy credits (RECs) for biomass generated electricity using virgin biomass and C&D wood were becoming available.

As of May 2006, three states in the NESCAUM region received permit applications proposing new wood-fired power plants that could be fired with wood derived from C&D waste. The proposed facilities are in Athens, Maine, Russell, Massachusetts, and Hinsdale, New Hampshire. In addition, some existing plants are assessing the addition of C&D wood to their fuel mix.

While public opposition to the use of C&D woody debris for power generation has been strong, NESCAUM's review of the data suggested that if C&D wood could be appropriately processed, its emissions would be similar to that of virgin wood. However, they determined that control requirements for C&D-derived wood would be similar to or more stringent than that required for plants burning clean wood. For example, air pollution controls proposed for the plant in Athens, Maine would include control equipment similar to that found on municipal waste combustors.

Only New Hampshire, via a temporary moratorium likely to continue until December 31, 2007, has restricted the use of C&D wood for fuel. Other states do not have official restrictions, but do place operational limitations on these sources through their regulatory process. The report finds that a critical element for use of C&D wood as a fuel source is the development of "strict" fuel standards.

According to NESCAUM, adequate fuel standards would include the following:

- The limitation of treated wood such as chromated copper arsenate (CCA) wood and penta-treated wood to reduce arsenic emissions;
- Minimizing contamination from other C&D materials and removal of C&D fine material (known as "fines") from the fuel chips to increase fuel quality substantially, and result in lower metal and other air toxic emissions; and,
- Requiring comprehensive testing and sampling of the fuel at both the processing facility and at the power plant to assure that the fuel quality is maintained.

According to the Massachusetts Department of Environmental Protection's (DEP) solid waste master plan, the *Beyond 2000 Plan*, wood and asphalt shingles represent the largest un-diverted portion of C&D waste, as asphalt, brick, and concrete (ABC) are recycled at a very high rate. Excluding ABC, remaining C&D materials are only recycled at a 10 percent rate. Therefore, DEP plans on focusing on these other materials, particularly wood, gypsum wallboard, and asphalt shingles.

Over the past five years, seven new construction and demolition (C&D) processing facilities have been

built, equal to approximately 800,000 tons of annual processing capacity in Massachusetts. Most of the material produced by these facilities is used at active and inactive landfills as daily cover and shaping and grading material.

In the long term, DEP plans to stimulate additional markets and uses for C&D materials that are not dependent on landfills. Because most C&D is generated by a relatively small group of companies, the report states that DEP should be able to target waste reduction initiatives. DEP's strategy for increasing the diversion of wood from disposal is centered on the disposal ban on wood, combined with technical assistance. The ban has, according to DEP, already stimulated C&D processing investments in Massachusetts. DEP's efforts will be to work with solid waste facilities to implement the ban and with the construction and demolition industry and other stakeholders to develop additional markets for C&D wood, particularly clean wood that can be separated at construction sites.

A concern expressed in clean energy planning forums between 2005 and 2007 as part of the development of the Pioneer Valley Clean Energy Plan, is that by permitting C&D woody debris as a biomass feedstock, a back door is created for the incineration industry to be able to increase the burning of municipal solid waste (MSW) and other wastes in the generation of electricity. The concern is that a plant owner, years after the operation has commenced, could successfully argue before the Massachusetts Department of Public Utilities' Siting Board to revise their fuel from forest-based biomass to C&D woody debris, or perhaps to municipal solid waste, despite these fuels being explicitly prohibited by the local special permit. Such a change would also require the power plant owner to apply for a change in its DEP Air Permit, which would be difficult but not impossible.

On the other hand, DEP has maintained a moratorium on new municipal waste combustion capacity due to concerns about mercury emissions. Despite significant reductions in mercury emissions over the past several years, municipal waste combustion facilities continue to represent the largest in-state source of mercury emissions. DEP believes that further expanding municipal waste combustion capacity, which already represents nearly 50 percent of Massachusetts total disposal capacity and 65 percent of in-state disposal capacity, is inconsistent with EOEEA's Zero Mercury Strategy and the New England Governors/Eastern Canadian Premiers Mercury Strategy.

The biomass field is clearly in a state of flux and uncertainty. Other states in New England may include C&D wood and MSW as an RPS eligible fuel. It also remains to be seen how DEP will regulate C&D sorting. If DEP cannot demonstrate that they can effectively regulate the sorting of C&D, should there not be a DEP regulation prohibiting the burning of C&D woody debris in any new biomass facility?

Can society afford to ban all C&D wood from use as biomass feedstock? To answer that question may require consideration of a larger context to energy use based on the relative capacities of alternates to coal, oil, natural gas, and nuclear energy. Based on the Independent System Operator (ISO) New England 2005 peak summer capacity figures, Massachusetts' demand share of the total New England load was approximately 13,690 MW. Less than 10 percent of that capacity was provided via hydro and other renewable energy sources. Therefore, to replace fossil and nuclear fuels with renewables would require alternatives with considerable capacity in terms of the technology, plant design and fuel supply.

What is one of the roles of the Massachusetts Department of Public Utilities in our collective biomass-based energy future in Massachusetts?

According to Governor Patrick's Reorganization Plan, House Bill 2034, the Department of Telecommunications & Energy ceased to exist as of April 11, 2007. In its place, the Plan established two new agencies: The Department of Telecommunications & Cable (DTC) that would handle telecommunications and cable issues and The Department of Public Utilities (DPU), which would handle electric and gas siting of new facilities, and pipeline, water and transportation issues.

The DTC is overseen by the Office of Consumer Affairs and Business Regulation and is within the Executive Office of Housing & Economic Development. The DPU is overseen by the Undersecretary of Energy and is within the Executive Office of Energy and Environmental Affairs.

The DPU's Siting Board is responsible for providing the most reliable supply of electricity, with the least environmental impact for the lowest price to the Massachusetts consumer. As part of carrying out its responsibilities, the Siting Board provides a process within which a power plant developer can appeal the conditions set by an existing local permit. This appeal process can result in negating local control of a plant's permit conditions. This is obviously a concern of residents and town officials who have a desire to control the siting of projects and the fuels under which an electric generating plant would be permitted. As long as C&D and MSW materials are, or could be in the future, permitted sources of biomass feedstock, communities considering hosting cleaner fuel biomass facilities may be at risk of surreptitious fuel replacement.

Can woody debris biomass be harvested from forests in a sustainable manner?

As increasing investment in the production of energy and from biomass occurs, there is concern that withdrawals of woody debris from forests will negatively impact wildlife habitat, forest health, and soil nutrients.

In response to these concerns, the Minnesota State Legislature, as part of legislation on energy production from woody biomass, required the Minnesota Forest Resources Council (MFRC) and the Minnesota Department of Natural Resources (DNR) to develop guidelines or best management practices for "sustainably managed woody biomass" (MN Statute 216B.2424). Draft Biomass Harvesting on Forest Management Sites in Minnesota, was prepared by the Minnesota Forest Resources Council Biomass Harvesting Guideline Development Committee.

Typically biomass harvesting is usually conducted in conjunction with timber and firewood (roundwood) harvesting. Biomass harvests might include the utilization of tops and limbs, small diameter trees, or stems which have historically been "non-merchantable" dead trees, down and dead woody material, and brush. Biomass harvests typically remove more woody material from a site than would be removed under traditional harvest.

Woody debris retention in forests is essential for sustaining biodiversity and wildlife populations. Natural disturbances create and retain considerably more woody debris than commercial timber harvests and that this difference is increased by a woody biomass harvest. This study determined that the development of a market for woody biomass would remove much of the coarse woody debris and slash (or fine woody debris) that normally would remain on site.

However, in the development of their guidelines, the MFRC determined that in most cases biomass harvesting would not adversely impact soil productivity if certain guidelines are followed. Where biomass harvesting may create an increased impact compared to conventional forest harvesting, is with respect to nutrient removals. . However, new long term research on nutrient budgets indicate that for most mineral soils (in Minnesota) the nutrient capital on-site in soil and plant matter is sufficient to tolerate a large number of such harvest rotations without deleterious effects. On the other hand, deep organic soils would require fertilization and steep shallow soils would be most at risk for nutrient loss.

The MFRC has developed a set of guidelines for sustainably removing woody debris for biomass feedstock. Their findings included that on mineral soils, as long as the leaves and small stems are left to develop a rich leaf litter, the removal of other biomass in conjunction with a conventional harvest would not have significant negative impacts on soil nutrients or forest floor biodiversity, within a forest with a 50-year rotation (from seedling to final harvest).

The results of an older study in 1986 indicate that forest biomass should not be harvested using the whole-tree method. This study of average potential whole-tree (above-ground) harvest removals of biomass in conifer and hardwood stands in central Nova Scotia, described average increases over sawlog (main stem of the tree)-only harvesting of 50 percent for biomass, 170 percent for nitrogen, 200 percent for phosphorus, 160 percent for potassium, 100 percent for calcium, and 120 percent for magnesium. In other words, much larger increases in removals of major nutrients occurred with whole-tree harvests as compared to harvests of the main stem only.

What is the connection between biomass, biofuels and the global supply of oil?

The main connection between biomass, biofuels and

global oil supplies is the future promise of cellulosic ethanol, which based on existing research, could provide a much greater return on energy investment than what is currently possible with corn-based ethanol. Wood-based ethanol could become an important liquid fuel product for use in existing transportation support infrastructure. This potential alternative to oil may become commercialized at a critical point in the history of the world: the peaking of global oil production.

Some energy experts estimate that sometime between 2007 and 2025, the earth's total supply of oil will peak in production (*see table on the following page*). This is not to say that we will run out of oil during this time, only that supplies of oil will neither be cheap nor plentiful. The peak-oil theorists continue that from that point forward there will never be more oil in production. New discoveries and changes in technology will only help to accelerate the withdrawal of oil to keep up with an ever growing demand. Beyond this, different views of what a post-peak production world will be like are widely offered. A common theme among many is a widespread and growing shortage of liquid fuels for space heating, transportation, food production, etc. following a period of dynamic fuel prices.

In 2002, the U.S. Department of Energy commissioned a study on the future outlook of oil. The "Peaking of World Oil Production: Impacts, Mitigation, and Risk Management" authored by Robert L. Hirsch, Roger Bezdek, and Robert Wendling, frames our energy future within the context of how quickly we can switch to alternate liquid fuels. Hirsch used three scenarios to describe our options and estimated the impacts of each. Each scenario was based on how many years ahead of the peak do we aggressively implement mitigation efforts to wean ourselves from oil. The conclusions of the "Hirsch Report" include the following:

- When world oil peaking will occur is not known with certainty. A fundamental problem in predicting oil peaking is the poor quality of and possible political biases in world oil reserves data. Some experts believe peaking may occur soon. This study indicates that "soon" is within twenty years.
- The problems associated with world oil production peaking will not be temporary, and past "energy crisis" experience will provide relatively little guidance. The challenge of oil peaking deserves immediate, serious attention, if risks are to be fully understood and mitigation begun on a timely basis.
- Oil peaking will create a severe liquid fuels problem for the transportation sector, not an "energy crisis" in the usual sense that term has been used.
- Peaking will result in dramatically higher oil prices, which will cause protracted economic hardship in the United States and the world. However, the problems are not insoluble. Timely, aggressive mitigation initiatives addressing both the supply and the demand sides of the issue will be required.
- Mitigation will require a minimum of a decade of intense, expensive effort, because the scale of liquid fuels mitigation is extremely large.
- While greater end-use efficiency is essential, increased efficiency alone will be neither sufficient nor timely enough to solve the problem. Production of large amounts of substitute liquid fuels will be required. A number of commercial or near-commercial substitute fuel production technologies are currently available for deployment, so the production of vast amounts of substitute liquid fuels is feasible with existing technology.
- Intervention by governments will be required, because the economic and social implications of oil peaking would otherwise be chaotic. The experiences of the 1970s and 1980s offer important guides as to government actions that are desirable and those that are undesirable, but the process will not be easy.

What source of liquid fuels might be available in modest supplies over the next five to twenty years? The answer will likely include biofuels, especially cellulosic ethanol, which interestingly enough will likely require harvests of woody debris from many sources, just like biomass-fueled power plants require today. It will also require machines to harvest and chip these woody materials and transport them to bio-refineries. Developing the markets and support infrastructure for biomass today may give society a head start on establishing a sustainable supply of cellulosic ethanol for tomorrow.

Table 2:
Projections of the Peaking of World Oil Production

Projected Date	Source of Projection	Background & Reference
2006-2007	Bakhitan, A.M.S.	Oil Executive (Iran)[1]
2007-2009	Simmons, M.R.	Investment banker (U.S.)[2]
After 2007	Skrebowski, C.	Petroleum journal editor (U.K.)[3]
Before 2009	Deffeyes, K.S.	Oil company geologist (ret., U.S.)[4]
Before 2010	Goodstein, D.	Vice Provost, Cal Tech (U.S.)[5]
Around 2010	Campbell, C.J.	Oil geologist (ret,. Ireland)[6]
After 2010	World Energy Council	World Non-Government Org.[7]
2012	Pang Xiongqi	Petroleum Executive (China)[8]
2010-2020	Laherrere, J.	Oil geologist (ret., France)[9]
2016	EIA nominal case	DOE analysis / information (U.S.)[10]
After 2020	CERA	Energy consultants (U.S.)[11]
2025 or later	Shell	Major oil company (U.K.)[12]

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Conclusion

If Massachusetts communities and state government are serious about developing a sustainable energy future, then biomass energy and biofuels need to be seriously considered. Forest-based feedstocks are by far the better biomass fuel choice for today compared to C&D woody debris. Additionally, cellulosic ethanol and biogas will be much cleaner fuels for the future and are well deserving of intense research and development efforts.

In light of both global warming and the likely future shortages in liquid fuels, society needs to reduce its dependence on fossil fuels and come up with viable replacements that do not include nuclear energy, an unsafe and non-renewable fuel. Whatever the fuel choice, navigating to a clean, safe, and viable energy future will require communities, businesses, and government agencies at all levels working together to solve these challenges.

If state agencies cannot guarantee that C&D woody debris biomass feedstock will not contain contaminated wood and that the DPU Siting Board is authorized to override local control over the types of fuels used in locally-sited plants, should Massachusetts communities not support a change in DEP policies and regulations that in effect ban, in perpetuity, new C&D and MSW-fueled power plants? How will biomass energy change over the coming decades as markets develop for carbon sequestration and demand grows for the replacement of fossil derived energy? When will our society recognize the economic, social and ecological benefits of proper forest management and support businesses that utilize wood as a local, carbon-neutral energy source and commercial product? Given the potential supply issues with regards to woody biomass, how will we as a state develop renewable energy facilities to replace fossil and nuclear fuels more effectively? We all need to work together to find answers to our energy questions. Our answers will reflect what we as a society value, the limitations of resources and time, and our ability to strive and overcome these challenges.

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