Down East Maine
Renewable Energy Working Group:

FINDINGS & RECOMMENDATIONS REPORT

January 2014

This project was undertaken by the Sunrise County Economic Council (SCEC) with generous funding from the U.S. Dept. of Housing and Urban Development. Many Maine property owners, industry leaders, and energy policy experts kindly contributed their time and insights to these findings, and their concern for the subject matter gives grounds for much optimism regarding the expansion of renewable energy opportunities in Maine in the critical years ahead.

The report was prepared by Jon Calame and Asher Woodworth for SCEC.

Sunrise County Economic Council

MOBILIZE MAINE

GROW WASHINGTON AROOSTOOK

Embracing the Future

washington county RENEWABLE ENERGY working group

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1. INTRODUCTION

This document summarizes the findings of a six month exploration of renewable energy issues in Down East Maine, centered on Washington County, Hancock County, and adjacent areas. It looks at investments, challenges, and opportunities – real and anticipated – in relation to renewable power, its sources, networks, mechanical systems, costs, and workforce requirements. It is assumed that expanded investment and deployment of renewable energy, if found to be cleaner and more affordable than existing fuels and systems, would benefit Maine residents, who currently rely on fossil fuels for heat and electricity to a much greater extent than the average American or the average New Englander.

The research team posed a few simple questions to guide its investigation:

> How much does Maine spend now for power and heat?
>
> What are the long-range costs and impacts of that expenditure in terms of money, convenience, efficiency, health, and regional prosperity?
>
> To what degree is rural Maine ready to embrace renewable fuels and systems?
> To what degree is it willing?
>
> If such a shift were made, what kinds of advantages might be expected to follow?
>
> Who else is doing good work on this topic?

Since this study (which included the convening of a working group, a series of community consultations, a baseline economic analysis, and comparative research) is far from comprehensive, it is hoped that the findings and observations recorded here contribute to the larger conversation about renewables in down East Maine, shedding some light on the paybacks and possibilities.

EXECUTIVE SUMMARY

This document summarizes the findings of a six month exploration of renewable energy issues in Down East Maine, centered on Washington County, Hancock County, and adjacent areas. It is assumed that expanded investment and deployment of renewable energy, if found to be cleaner and more affordable than existing fuels and systems, would benefit Maine residents, who currently rely on fossil fuels for heat and electricity to a much greater extent than the average American or the average New Englander. It examined investments, challenges, and opportunities – real and anticipated – in relation to renewable power, its sources, networks, mechanical systems, costs, and workforce requirements.

The centerpiece of this project were the findings of a Renewable Energy Working Group, complemented by community perception consultations, asset inventories, case studies, impacts assessment, best practice indexing, and contextual research regarding policy and legislation (with emphasis on LD 1559 & 1085). The topics arising most consistently, urgently, and persuasively throughout all these investigations concerned the linked challenges of front-end transition costs, market distortion, and fair policy frameworks. In particular, these issues were recurrent in relation to expanded deployment of renewable energy in Down East Maine:

1. status quo is full of liabilities, full of opportunities: existing conditions in Down East Maine's energy sector are problematic due to high reliance on non-renewable fuels (which creates a statewide path dependency), prevalence of fuel poverty, home energy affordability gaps, excess winter morbidity, investment efficiency gaps, and market failures; at the same time, renewable assets are unusually high on a per capita basis, with new employment potential dovetailing with ailing traditional industries.
2. lack of equitable, consistent, and predictable regulation: when there is a perception of imbalance or caprice, investors can lose confidence and startups cannot attract the affordable capital they need.
3. new incentives for new energy markets: feed-in tariffs are viewed as an important tool with which to approach price-parity between incumbents and newcomers in the renewable energy marketplace, providing the funding and stability that support comprehensive development strategies.
4. reliable and affordable access to capital for installation, transition & retrofit: front-end industry investments in alternative energy technologies bring unit prices "multiples above market" in relation to incumbent energy sources, sending a discouraging message about investment in renewables.
5. uniform metrics for impacts & pricing: without apples-to-apples yardsticks for the full cost, success, impact of alternative energy, foggy decision-making precludes long-term policies and investments.
6. prohibitive transaction costs: insufficient information about options coupled with a lack of time and energy to investigate them; absence of trustworthy (neutral) technical guidance
7. low workforce capacity: even if investment were high, Down East Maine currently lacks the technical workforce (and capacity-building potential) to support large-scale energy transition to renewables.

The renewable energy profile for Down East Maine, based on asset inventories of institutional, production, and workforce capacities, shows a widespread need, a high potential, and low deployment. In the region, this study found 46 organizations with, or having significant projects addressing, the development and deployment of renewable energy fuels and systems; of these, 4 addressed finance, 13 addressed industrial production of fuels, power, or mechanicals (4 of which were startups), 11 addressed non-profit research, advocacy, or consulting, 8 addressed public-private partnerships, and 8 addressed grid and utility-scale issues. Meanwhile, just one institution in Washington and Hancock Counties (the Washington County Community College) provides specialized professional training in renewable energy systems and efficiency, with 9 other workforce capacity-building institutions within a 150 mile radius – surely not enough to train a number of new technicians sufficient to support desirable levels of renewable energy deployment. As for renewable energy production, Down East Maine currently generates approximately 384 MW (with an additional 287 MW pending), constituting about 22% of the state's total.

What have these renewable energy investments done to the regional economy, and what impacts could additional investments generate? Though impact assessment methodology remains a contentious realm among researchers, the unusual difficulty and expense of expansion in this sector call for compelling arguments – on social, environmental, and economic grounds at a minimum – to persuade policy makers and investors to take the steps needed to encourage transition from non-renewable to renewable energy systems. Rough estimates indicate that increasing Down East Maine's renewable energy production by 451 MW over five years would call for $1.26b in public and private investments and would leverage about $2.35b in indirect and indirect economic benefits, about 43,000 job-years, and reduce carbon emissions by about 5.1m tons (these are approximate averages of the high and low estimates provided in section 6.2 of this report).

Prospects for renewable energy expansion in Down East Maine can be put into perspective alongside non-affluent regions and small, rural communities – in the northeast and elsewhere – which have made the transition with good results. The keys to their success transferrable to the Down East region include the following: strong local leadership and ambitious, comprehensive local energy transition strategies (Shutesbury, MA & Güssing, Austria); a highly collaborative approach and emphasis on winter heating (Berlin, NH & Cambridge Energy Alliance); linkage of energy concerns with broader strategies for poverty alleviation, sustainable housing, and public health (Haringey's Affordable Heat Strategy, UK); clean energy municipal financing, coordinated on-bill financing, reduction of bureaucratic adoption barriers, and 'class action' transition negotiation (Efficiency Vermont & Berkeley FIRST).

Scanning targeted scholarly research with special relevance to the Down East context, a handful of "best practices" emerged: monetizing hidden costs of non-renewables to level the playing field for competing clean technologies; creating of shared local energy infrastructure to leverage localized purchasing power; private sector performance contracting to provide a market-driven, comprehensive way to distribute and manage risk; decentralizing the power grids by encouraging smaller-scale, local energy producers. In sum, three broad strategies for policy-makers are recommended by this report's findings:

(a) Revoke "most favored nation" status for non-renewable energy incumbents.

If the price of non-renewable energy reflected its comprehensive social costs, market "externalities" would disappear and renewable systems could more readily compete. Relevant tools are carbon taxes, carbon cap and trade regimes, life cycle cost accounting, and strict emission standards.

(b) Lower barriers that stall market entry of renewable energy producers & consumers.

Front-end costs are a high fence keeping individuals, institutions, and firms out of renewable energy's greener pastures. Relevant tools are subsidies, tax credits, renewable energy certificates, feed-in tariffs, specialized loan product interest buy-downs, and on-bill financing.

(c) Prove that the more expensive choice is the less expensive choice.

Access to reliable, non-partisan information and technical guidance will allow many prospective renewable energy producers, consumers, and lenders to take the renewable energy plunge, priming the pump for deployment at scale and amortization of public subsidies for renewable energy.

All of the inventories, observations, and suggestions articulated in this report point to topics that deserve further discussion and study in Down East Maine.

2. WORKING GROUP CONSULTATIONS

The centerpiece of this project was a Renewable Energy Working Group asked to look broadly at the challenges and opportunities tied to the renewable energy sector in Maine – with a focus on Washington, Hancock, and Penobscot Counties. Leading thinkers, advocates, and industry practitioners were brought together to pool insights regarding the expansion and deployment of alternative energy sources (and systems) in the region on the assumption that this would be a good thing for the regional economy along with the upper atmosphere.

Due to the short time frame for exchange and the small number of meetings planned, this group was not expected to conduct original research or hammer out detailed solutions to perceived problems. Rather, the expectation was to articulate major (and often shared) concerns, to think about where opportunities and obstacles to renewable energy deployment are encountered in practice, to describe priorities and sequences in relation to them, and to point the way towards possible routes for expansion or resolution.

This working group has members from many areas of the renewable energy industry in Maine along with advisors conversant with policy, legal, and regulatory domains. The discussion is moderated by working group member Jon Calame. An effort was made to invite a broadly representative range of Working Group participants in order to capture the widest possible spectrum of ideas, insights, and experience.

2.1. **representation**

A relatively small group was invited to participate in a short series of three focused discussions. Not every member of the Working Group attended all three meetings, but the following 17 participants contributed to a least one meeting in the autumn of 2013:

Jon Calame, Coordinator for Thermal Efficiency: Eastport, Working Group moderator

Harold Clossey, Executive Director for Sunrise County Economic Council

Ken Daye, Program Manager for Sunrise County Economic Council

Mike Eisensmith, Regional Planning Director for Northern Maine Development Commission

John Ferland, V.P. of Project Development for the Ocean Renewable Power Co.

Scott Hallowell, CEO for the Eastern Maine Electric Co-op

Wendy Harrington, Program Director for the Maine Sea Coast Mission

Matt Kearns, V.P. of business development for First Wind

Neil Kiely, Director of Development in New England for First Wind

Glen Marquis, Director of Operations and Planning for Ocean Renewable Power Co.

Tim Schneider, Public Advocate for Maine State Government

Mark Seavey, Manufacturing Executive for Fulghum Fibers

Matt Smith, V.P. of sales and marketing for Xpress Natural Gas

Jeff Thaler, Visiting Professor of Energy Policy, Law and Ethics at UMaine Orono

Jeff Tounge, V.P. of Sales and Development for Xpress Natural Gas

Dylan Voorhees, Clean Energy Director for the Natural Resources Council of Maine

Asher Woodworth, research assistant

2.2. process

Three meetings were convened in the autumn of 2013 on the Washington County Community College campus in Calais: the first September 13th, the second September 27th, and the last October 18th. Participants attended in person or via telephone.

Prior to each meeting, a set of topics and related questions were circulated electronically to all working group members. They were asked to join the meetings with information and ideas related to these issues. Following each meeting, the major topics of discussion were noted, those notes were circulated for comment and revision, and a fresh set of topics (based on the prior exchanges) was put forward. At all stages, during and between meetings, working group members were encouraged to share information, suggestions, links, and concerns in order to improve the contents of our 'portfolio' of ideas associated with each topic of common concern. The moderator was responsible for the organization of the meetings, the circulation of related materials, and ongoing correspondence with participants – including recruitment of new and specialized members as requested or indicated by working group deliberations.

2.3. key concerns

The following issues and topics were most frequently and substantially discussed by working group participants across three meetings and intervening exchanges. They are summarized below in no special order.

(a) regulation & permitting

Kearns, Marquis, Tounge and others discussed their experiences with the PUC and other permitting processes. It was noted that some lack of consistency and predictability affects the permitting and review process, such that investors are not always sure that published criteria are applied evenly. When there is a perception of imbalance or caprice, investors can lose confidence, making it difficult for young industries to attract needed capital. Example: Bowers Mountain Decision Appeal. It may be that more familiar, conventional energy sources (like natural gas) move more smoothly through the permitting process than less conventional ones (like wind, solar or tidal). All agreed that the expansion of the renewable energy sector would benefit from a more transparent, predictable, and streamlined permitting process.

related topics: price parity; regulatory practice; clear and reliable ground rules; market distortions; leapfrogging; technical capacity; supply push; demand pull; market entry support; renewable energy portfolio standard; level playing fields; green thumb on the scales

(b) feed-in tariffs

Several discussions of the working group pointed to feed-in tariffs (FITs) as an important tool with which to approach price-parity between incumbents and newcomers in the renewable energy marketplace, potentially a 'game-changer.' Maine does not currently support a FIT[1] , but has offered "long-term above market price opportunities" to select renewable energy producers which have much of the same effect. These price supports provide funding and stability that allowed newcomers to pursue comprehensive development strategies with confidence. FIT payments are typically based on the leveled cost of renewable energy generation plus a targeted return that are guaranteed by a long-term contract.

[1] This may change with new FIT legislation in Maine called LD 1085 "An Act to Establish the Renewable Energy Feed-In Tariff". (link here)

In Maine, this type of public price support was justified by citing "public benefits" like job creation, increased tax revenue, in-state spending, and long-term partnerships with universities and communities. (In other places that utilize FITs, value to society is typically interpreted in terms of the value of the electricity produced plus climate change mitigation, health impacts, energy security, and other externalities.) In the European Union, FITs have been used for about 20 years, and worldwide they are responsible for approximately 75% of photovoltaic and 45% of wind deployment. (It is interesting to note that in the UK new incentives for biomass heating retrofits are planned that borrow from the FIT model for renewable electricity production.)

Ferland pointed out that a virtue of the FIT is its low impact on ratepayers, its solid track record abroad, and the flexibility of introducing ceilings, caps, industry targets, etc. He said it should increasingly be a part of "a suite of public programs for private sector support" of the renewable energy sector. To justify this, he recommended a clear overview of what this sector is in Washington County along with its economic impact; such a document should show that renewable energy production is an increasingly critical part of the regional economy, it is in a growth mode, and it delivers measurable public benefits outside the marketplace.

All this suggests that FITs and related tools can be utilized to the extent that renewable energy production in Maine has been widely recognized as a significant economic driver capable of creating new employment and investment opportunities while assisting with regional wealth retention. Meanwhile, they give producers a better chance to compete with 'legacy players' in the energy sector. For example, John Ferland noted that ORPC is still 5-7 years away from price parity with legacy players in the electricity industry in Maine, so that tools like these help to bridge the gap and keep renewable energy actors in business as their market share grows, research expenditures decrease, and technologies mature.

(c) access to capital for installation & retrofit

Hallowell, Kearns, Tounge and others discussed the capital-intensive nature of the fossil-to-renewable energy transition process (both for energy providers and consumers) and the importance of access to capital. It was noted that front-end industry investments in alternative energy technologies bring unit prices "multiples above market" in relation to incumbent energy sources and these can send the wrong message about renewables; costs spread out through long-term contracts with the PUC are still passed on to consumers, who also have a right to the most affordable energy available. Participants discussed the difficulty of bridging this pricing gap, and achieving parity in the market, when conventional and alternative energy sources are at different stages of development and scale. How to level the playing field without burdening the rate-payers unfairly? Eisensmith noted that commercially disinterested groups like NMDC and SCEC could advocate on behalf of market newcomers in order to attract capital.

related topics: up-front costs; deployment; commercialization; energy incumbents

(d) metrics for success & pricing

Marquis, Hallowell, Tounge, Kearns and others discussed fair, reliable yardsticks for measuring the success and impact of alternative energy industries. Participants discussed whether the following considerations should be part of the success/impact equation: unit price of energy to consumer, life-cycle cost of energy, savings (in dollars and carbon) generated by consumption of alternative energy, size of customer base, jobs created or leveraged, social/community benefits, units of energy delivered to the market, and regional economic multiplier effects. Example: ORPC's Maine PUC contract, with pricing contingent on public benefits. No single criterion is sufficient to allow for apples-to-apples assessment of alternative energy benefits, which generate a wide range of estimated impacts. All agreed that this topic deserves further scrutiny and elaboration by interested parties.

related topics: subsidies; rebates; price parity; regressive & progressive subsidies; internalizing environmental and social externalities; multipliers; rate-based funding; energy security; investment barriers; local energy markets; long-term contracting; long-term benefits v. short-term costs

(e) education, outreach & workforce training

Kearns, Marquis, Eisensmith, Ferland and others articulated the value of educational partnerships as a young industry works towards building a new sector in Maine. In the high school domain, students could be engaged with technical and political questions tied to the alternative energy industry. In the university domain, faculty and advanced student could be engaged with field-based research projects. In the community college and workforce training domains, students could be exposed to new fuels and systems that bring more efficient and affordable energy to communities. In some instances, the alternative energy sector in Maine is hampered by lack of skilled labor and a shortage of consumers who are informed about their options and the long-term implications of assorted energy sources and systems.

Workforce capacity needs differ by renewable energy sector. The tidal power sector in Maine, for example, calls upon traditional maritime work skills to be used in non-traditional ways. For this reason, workforce training was not a primary concern as ORPC project matured and the existence of strong skills in coastal Maine communities was a big reason for positioning their research and develop activities here in the first place, especially given the nearby presence of specialized training institutions like the Maine Maritime Academy ready to offer in-depth support.

It was noted that other renewable energy industries rely less on traditional workforce skills and knowledge. These may require increasing cooperation with regional training institutions, which are considered in detail elsewhere in this document. If the existing workforce and vocational training programs cannot absorb these new curricula and supply-side demands in a timely way, it is possible that new programs will need to be created.

related topics: job creation; educational infrastructure; regional wealth retention

(f) current Maine legislation & relevant policy frameworks

Several participants noted that opportunities for heating retrofit may be hampered by limitations on state and federal funds. One limitation is a restriction on "fuel switching" which may confine some property owners to weatherization projects even when the larger savings would be generated by alternate fuels – biomass or solar instead of oil, for example. It was generally agreed that further investigation of this condition is needed, since an obvious long-term goal in relation to environmental impacts is the shift away from carbon-intensive heating fuels towards cleaner, renewable ones. If access to useful information is one barrier to affordable heat (as above), then contradictory or compromised public policies are another. Further exploration will include review of Maine's new Omnibus Energy Bill (LD 1559), addressed elsewhere in this report.

related topics: tax increment financing for renewable development; Regional Greenhouse Gas Initiative (ReGGIe); feed-in tariffs; net metering, carbon regime; cap and trade; energy & utilities committee of the State legislature

(g) housing stock & home heating

Participants specialized in housing issues in Maine emphasized the close linkage between energy consumption (especially winter season residential space heating) and affordable housing crisis. It was noted that the need for efficiency upgrades and system/fuel switching in housing used by non-affluent Maine residents, especially in rural areas, extends far beyond available funds. Meanwhile, there is little awareness of options among residents experiencing 'fuel poverty,' that circumstance in which more than 15% of disposable income is required to maintain adequate indoor temperatures at home. Another related issue is the "home energy affordability gap" that looks at how much energy is consumed by household in relation to income. If we look at dollars spent by Maine families below 200% of the federal poverty level for energy using census data, we can see the "shortfall" (amount spent by household in excess of what is considered affordable, which is 6% of income) and the "burden" (portion of income needed for actual energy bills) by county and income group.

For Maine households below 100% of the poverty line, which is about 71k households in Maine, these numbers are quite large: towards 36% of income is used for energy bills on average. It is also revealing that, in an approximate way, Mainers in households below 200% of the federal poverty line (about 177,567 houses total in 2010) spend around $508m more than they can afford each winter on energy. If we assume that home heating is around 40% of this toll, it is easy to approximate the amount spent on heat above what "should" be spent. This "home energy burden" contributes – it might be assumed – mightily to housing concerns in Maine, and the ability of non-affluent residents to achieve household stability.

related topics: fuel poverty; distributed cost and risk; front-end energy system retrofit costs; median household income; rate-based funding

(h) summary for working group

Discussion turned early to the tethered problems of front-end costs, reliable access to capital, and stable policy frameworks. It appears to us that it does not matter much how promising, or efficient, a given technology or energy source may be – if there is not a clear and viable way for people to adopt it. Looking forward to future efforts towards expanded renewable energy deployment in Maine, it was agreed that these concerns, key questions, and findings could be used to forge and solidify partnerships with likeminded affiliates (in Maine and beyond) and to persuade policy makers that renewable energy constitutes an important economic opportunity in Maine. It was recommended that results are shared first with existing consortia (like MREA) and key legislative bodies like the Maine legislature's Joint Standing Committee on Energy, Utilities and Technology and the PUC. It was also noted that, given how important the natural resources of Washington County are to many renewable energy industries, increased regional representation on the energy committee in Augusta would be optimal.

3. COMMUNITY PERCEPTIONS INVENTORY

Complementing the industry-led working group findings was a a community perceptions inventory. In this initiative, we selected four end-users in the Down East region whose energy consumption needs are representative of a larger group. We had in-depth consultations with:

owners of a mid-size rural farm (Tide Mill Farm),

a public university campus facilities manager (Bob Farris at UMM),

three small-scale solar power generation developers (RBJ group in Jonesport), &

residents and business owners in a small rural community (Eastport).

In each case, we posed a prescribed set of related questions so that, after findings were gathered, we might pull out key concerns, findings & patterns of general relevance to the region.

These standard questions, at least three of which were posed to each group, were:

(1) When you think about the costs of electricity, transportation, heating, and so forth, do you think in terms of your budget, impact on the environment, public health, or all of the above?

(2) If money were no object, what changes to the way you consume energy would you make first?

(3) What barriers currently prevent you from making these changes?

(4) Have you sought support from Maine's existing energy programs? If so, how was the process?

(5) How are people in your community coping with the escalating costs of conventional energy?

(6) Do you perceive any resistance to the adoption of renewable energy alternatives in your community?

We learned much from these exchanges, the key findings from which are summarized below.

3.1. rural mid-size farm / Tide Mill Farm (Edmunds, ME) consultation

(Jon and Asher met with Carly DelSignore and Aaron Bell of Tide Mill Farms in Edmunds on 10/16/2013, following email correspondence to isolate key concerns.)

Carly and Aaron are part of the the ninth generation of the Bell family to manage the Tide Mill Farm, and they have their hands full. We spoke with them on a chilly evening after dark while Aaron milked the cows and Carly made sure a bunch of different things were seen to.

It was easy to see why the challenge of re-thinking energy consumption would take a back seat to the endless list of pressing concerns on a small family farm in Maine. Regardless, they provided many useful insights to our study and affirmed a readiness to try new energy strategies if the options are clear, accessible, and persuasive.

If money were no object, what changes to the way you consume energy would you make first?

Carly and Aaron understand the many advantages of renewable energy consumption, and are fully informed about the long-term benefits of fossil fuel reduction. An ideal solution, from their point of view, would be not only a decisive shift away from fossil fuels (upon which the running of the farm now largely depends in the form of diesel and #2 oil) but also a centralized co-generation biomass plant that utilized locally-harvested wood scrap to provide heat and power to the farm's numerous and dispersed buildings.

Several existing conditions mitigate in favor of such an alternative:

- ☑ Much of the basic infrastructure needed to install such a 'Tide Mill Farm heating district' – much like those recently adopted on college campuses throughout the northeast US and in Europe – is already available;
- ☑ heating and other energy needs are currently substantial enough to justify such a comprehensive improvement;
- ☑ the local work crews have much of the technical skill needed to create and maintain such a system;
- ☑ the possibility for savings from such an improvement is great;
- ☑ Tide Mill Enterprises, a forest management and wood harvesting operation that is tied to Tide Mill Farms, currently harvests and delivers biomass to be used as a fuel source to various locations including the biomass electrical facility in Jonesport.

What barriers currently prevent you from making these changes?

The constraints on this best-case-scenario were predictable: lack of front-end capital, lack of information about technical options and specifications, lack of local examples, lack of time to investigate and sort out the above. A recurring theme in our conversation was the difficulty that Carly and Aaron perceived in accessing reliable, usable information on various fuel sources (diesel, oil, biomass pellets, etc), and efficiency and energy improvements that are available to them and their business.

This lack of information extended to questions of the costs and benefits associated with switching from one fuel/system to another, and a lack of guidance about the pathways required to make such changes; Carly and Aaron spoke about the challenge inherent in upgrading a multifarious operation like theirs from the current system(s), which though inefficient and more costly perhaps, were working for the time being. Carly, in particular, remarked that the demands of running a multifaceted dairy, vegetable and animal farm make it near impossible to even think about finding the time it would take to sit down and think through all of the variables that go into transitioning to a comprehensive, cheaper, and more sustainable system; Carly and Aaron spoke about the piecemeal approach to improvements and renovations that they arbitrarily found themselves using.

Since the largest energy cost/consumption at the Tide Mill Farm is attached to hot water used for sanitation chores in the dairy and animal processing facilities, as well as heating for the greenhouses, it would make sense to streamline a system around hot water (so that a single system heated sanitation water, domestic hot water, and warm water for radiant heating installations.

Still, it was clear that without the time, energy and resources to take a look at the entire operation as a whole, with detailed consideration of needs, loads, and efficiencies, individual upgrades would continue to be dealt with as they arose, and more often than not that will mean going with the cheapest option that can be implemented immediately, leading back to fossil fuels and related systems. Carly and Aaron underscored the need for upfront capital to undertake retrofits and improvements that come with a hefty initial price tag, and expressed the need for time to think comprehensively and plan wisely.

Have you sought support from Maine's existing energy programs? If so, how was the process?

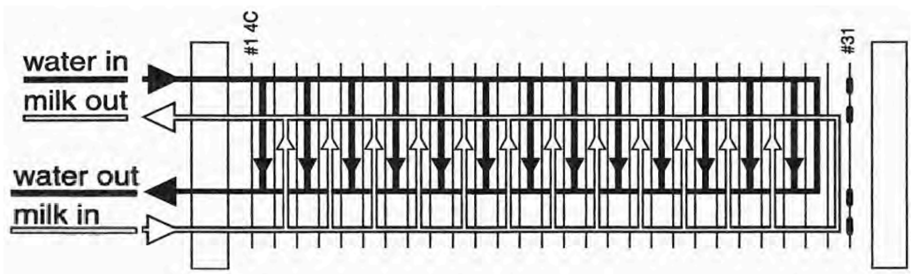
Aaron and Carly have explored several grant, subsidy, and loan programs, but the time needed to identify, apply, and comply with programs often exceeds time available outside of farm demands...a steep hill to climb even when significant support lies on the other side. They expressed continuing interest in these options and their need for technical guidance in order to navigate the applications and understand the long-term paybacks.

When you think about the costs of electricity, transportation, heating, and so forth, do you think in terms of your budget, impact on the environment, public health, or all of the above?

It was clear that the full range of potential benefits to be associated with a transition from non-renewable to renewable energy sources is familiar to Aaron and Carly. The Tide Mill Farm as a whole embraces the ethic of local, sustainable food production grounded in organic production, so its commitment to environmentally-conscious and community-supported approaches is evident. How to translate this ethic and commitment to their energy consumption is, for the moment, neither clear nor apparently affordable. Yet the prospect of renewable energy use on a family farm named for a traditional source of renewable energy – hydro-electricity provided by tidal turbines installed in local stream beds – is appealing.

How are people in your community coping with the escalating costs of conventional energy?

Our discussion centered on traditional and contemporary energy uses at Tide Mill Farm – a sort of small community unto itself. One energy efficiency measure that had long been employed there was especially ingenious: a dedicated liquid-to-liquid heat exchanger that pulls heat from milk just taken from cows (which anyway needs to be cooled) and uses it to preheat the water used to rinse and sanitize the milking equipment. This preheating process saves a lot of energy bringing the water up to temperature while taking advantage of the heat already bought and paid for in the form of hay metabolized by the dairy cows. The employment of these bovine batteries is a good example of sustainable problem solving in context.



A diagram of a simple plate heat exchanger designed for the dairy industry, which cools milks and warms water for cleaning.

3.2. university physical plant / Univ. of Maine, Machias campus (Machias, ME) consultation

(Jon spoke with Bob Farris, Physical Plant Manager for the University of Maine at Machias, by telephone on 11/20/13, following email correspondence to isolate key concerns.)

If money were no object, what changes to the way you consume energy would you make first?

Mr. Farris expressed strong interest in renewable energy systems, with special emphasis on solar and geothermal applications. One goal would be to make the Fitness Center, which includes a large indoor pool used intensively throughout the year, self-sustaining with a water heating system fueled by solar panel installed on the roof. [The Fitness Center used to require 32,000 gallons of fuel oil each year to supply a boiler installed in 1968, and now it consumes 16,000 gallons annually with 4 new oil boilers and a propane heater for the pool.]

What barriers prevent you from making these changes?

Farris observed that "a great system will sell itself" because an alternative fuel or system will pay for itself. In his exploration of the relative benefits of solar, pellet, and geothermal systems, he has been frustrated. Many renewable systems "sound great" in terms of fuel unit costs and payback periods associated with capital outlays, but he emphasized that institutional savings must be considered primarily in relation to technical costs for repairs and maintenance over the life of a system. Mr. Farris calls this the "true cost" of the system. His point raises the problem of technical support for alternative, renewable-energy systems in Maine; this technical support can be hard to secure, and remote, bringing special costs. Mr. Farris noted that "windshield time" for specialized or far-flung technicians can become a problem for late-night emergencies; UMM can spend $700 just to get a technician to appear from Bangor.

These marginal costs can push otherwise attractive renewable energy options out of range of many institutional budgets, and for the moment this seems to be the case at UMM. And so a circular dilemma emerged from the conversation: despite his desire to move away from non-renewable systems, Mr. Farris notes that dependency (on remote technicians) is expensive, such that it is essential to "use local help", but qualified local tradesmen are generally not available to support the installation of renewable energy systems at the campus scale. ("Location, location, location..." Mr. Farris said.) This leads back to continued investment in conventional systems, which tend to be less expensive in terms of acquisition, installation, and maintenance, but more expensive in terms of long-term efficiency (power and heat per BTU) and carbon emissons.

One way around these concerns is the adoption of a 'performance contract' with an energy service company (or ESCO), but Mr. Farris said that the ESCOs he approached about energy transition were not interested in a contract with UMM due to low consumption (in relation to their minimum investment thresholds) and lack of central heating plant (a dispersed, and therefore inefficient, campus network). Meanwhile, Mr. Farris is asked by the University to keep his labor and maintenance costs low, creating something of a Catch-22 with respect to adoption of alternative, renewable energy systems with low market saturation – which account for most renewable options in Maine as of late 2013.

Have you sought support from Maine's existing energy programs? If so, how was the process?

UMM used a low-interest loan from Efficiency Maine to switch campus lights to LEDs. They pursued a grant to support geothermal and solar applications through the "Put Maine Back to Work" program, but they were not successful. It seems that solar installations did not put people back to work, Mr. Farris said.

When you think about the costs of electricity, transportation, heating, and so forth, do you mainly think in terms of your budget, impact on the environment, public health, or all of the above?

Mr. Farris places emphasis on the long-term, "true costs" of a new system, which he also linked to an understanding of the "real cost per BTU". He offered the example of wind turbines that might be wrecked in a severe winter storm: with a primary power system down, it may be that a specialized technician is unavailable, out sick or on vacation, putting classes and life support systems on campus at risk...such that the cost of such an outtage is nearly incalculable. So Mr. Farris made it clear that in his role he must consider a number of 'worse case scenarios' when weighing the relative merits of a renewable energy system which might be, in a good day, obviously superior to convential non-renewable fuel systems.

On the brighter side, Mr. Farris noted the very high public relations value of energy efficiency and green energy in the campus setting. He suggested that when you can show the administration that your campus is out-performing peer institutions in relation to BTUs per square foot and overall environmental sustainability[2], you gain support. When you can show parents that the campus is safe, comfortable, and frugal, impresses them, and enrollment goes up – since the parents are paying the bills. There is a lot of room, Mr. Farris suggested, to document and refine these performance-based statistics in order to strengthen the case for increased investment in renewable energy systems. According to Mr. Farris' observations, the adoption of green energy systems could become an important selling point for UMM in the increasingly competitive marketplace of undergraduate campuses. Meanwhile, up-front investment and high labor costs push in the opposite direction.

How are people in your community coping with the escalating costs of conventional energy?

The UMM campus consists of eleven buildings used in all seasons. Since 2006, carbon emissions are down 44%[3], thanks to control systems (more sensitive, linked to outdoor temperature schedules), temperature-averaging thermostats (placed on 4 levels in each large building, with 4 sensors each to balance hot and cold spots[4]), conservation measures, LED lighting, and new windows. Much of this progress was coordinated and planned by a campus energy team, of which Mr. Farris is a leading member. Since such significant reductions in energy consumption are possible through conservation and efficiency measures, it is interesting to consider how much more thrifty the UMM energy consumption profile could be – both in terms of dollars spent and carbon emissions generated – if a transition to renewable energy systems were made.

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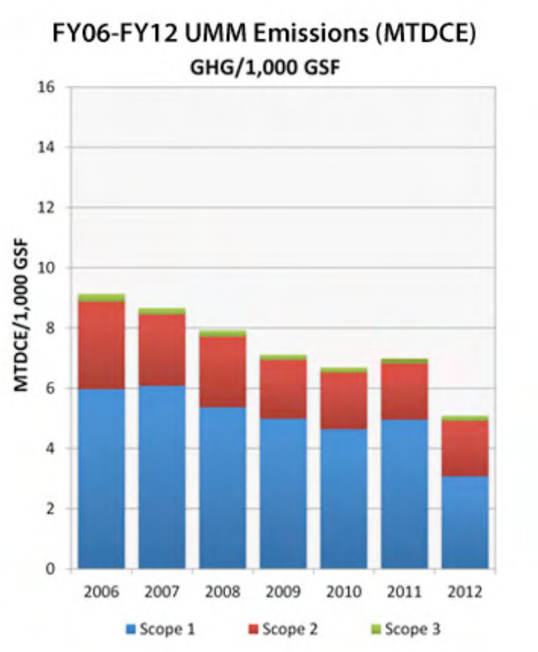
2 UMM tracks its performance with contracted assistance from Sightlines LLC, which issues regular reports of facilities benchmarking and analysis in relation to campus sustainability within a national cohort.

3 Here is a link to recent UMM heat initiatives, which have reduced campus-wide energy consumption dramatically, but none of which indicate a substantial investment in or strategic pivot towards renewable fuels.

4 It is interesting to note that Mr. Farris chose to leave the old thermostats (no longer functioning) in place when the new, more efficient thermostats were installed. This allows occupants to manipulate 'placebo devices' room by room while the digital sensor made real measurements and adjustments.



UMM annual energy consumption, down 44% 2006-2012.

Do you perceive any resistance to the adoption of renewable energy alternatives in your community?

Mr. Farris emphasized the need to adopt systems that "support the local community", which seemed to imply fuels, systems, and labor contracts that could be fulfilled locally without dependence on far-flung specialists or unfamiliar technologies. As above, he made the case for why systems (like many renewable energy options) with strong efficiency profiles and weak maintenance profiles would not be favored at UMM. He also noted that when systems benefit the local community's vendors and service professionals, then the community is more likely to vote for a bond issue that allows for initial capital investment in expensive equipment. This seems to suggest that an alternative system must meet the local community where it is, rather than recommend that the local community adapt to take advantage of an alternative system.

3.3. private solar generation at community scale / RBJ Enterprises' Jonesport Solar Project (Jonesport, ME) consultation

(Jon and Asher met with John Beale, Ruth Fenton, Jane McMichen of the Jonesport Solar Project in Jonesport on 11/18/13)

If money were no object, what changes to the way you consume energy would you make first?

The JSP partners have translated their optimal renewable energy vision into a business plan, with primary emphasis on greening the power grid "bit by bit" for better regional sustainability (not higher profit margins). They would like to build a successful model for small-scale renewable power generation in rural Maine and would like to see that model propagate.

They project targets small-to-mid-sized business customers currently consuming 50 MW/year or more: hospitals, universities, industry, grocery stores, etc. They believe that a decentralized, sustainable power grid is the best option for this region.

What barriers currently prevent you from making these changes?

The startup costs for a small-scale solar generation facility are sobering, according to the Jonesport group. The system of financing, permitting, and testing seem to be tailored for developers with deep pockets; it seems that more than $100,000 is required just to complete the studies required for consideration by the permitting authorities. Additional funds are needed to pay lawyers, specialized consultants, grant-writers, and project managers during the feasibility and fundraising phases of the project – all aside from the actual costs of project development and activation once approvals are secured. Despite the high price tags, this is no guarantee of permissions or regulatory approval.

The Jonesport group lamented the many financial and technical obstacles which seem to standing in the way of their sustainable, community-centered project. They noted that you need large amounts of money to secure large amounts of money to implement a project of this kind. Without it, the path is very difficult. Many loan products are geared to projects with development costs pegged at $20m and up, leaving JSP in a grey area with respect to startup capital.

Over and over, the JSP team observed, "How much cash do you have right now?" is the critical question in the eyes of lenders and equity investors. Stuck in a chicken-and-egg situation – to get a loan, you have to complete feasibility studies, to complete the studies you need money – it is easy to become overwhelmed or discouraged. The process appears "not smart, not transparent, not fair and not equitable" to these renewable energy entrepreneurs, who are "pushed into the hands of private equity investors" and left to choose from the most expensive and conservative sources of investment capital.

Have you sought support from Maine's existing energy programs? If so, how was the process?

The Jonesport group explored participation in the new markets tax credit, but learned that upwards of $1m in legal fees would be required to determine eligibility alone. What would be a minor inconvenience for a large utility company or national corporation becomes an insurmountable barrier for community-centered, small-scale investors like JSP. A litany of fees and hoops encountered during the evaluation phase, they observed, tends to negate efficiencies and outlying incentives.

On a more positive note, JSP will offer its investors the dividends from sale of Renewable Energy Certificates (RECs), which allow a participating business to legally advertise that it is "offsetting carbon emissions" and "lowering [its] carbon footprint" while supporting renewably-based businesses. Tradable solar RECs in Maine are mandated by the renewable energy portfolio standard and are currently worth around $22 for each MW produced. Their value is a major reason why JSP can offer a competitive price for its electricity in relation to the standard offer benchmark.

When you think about the costs of electricity, transportation, heating, and so forth, do you think in terms of your budget, impact on the environment, public health, or all of the above?

The JSP business plan identifies a primary motivation "to do lasting and measurable good works for our community." In addition to offering more affordable electricity to local businesses, it is contributing to the "greening" of the power grid while allowing customers to advertise that they use green energy. The owners of the JSP belong to the Jonesport community and wish to strengthen it and "are driven by a strong desire to identify ways to better the world in which they live". They emphasize that providing an efficient, long-term, and ecologically sound business platform is a higher priority than realizing short-term high profits with a less stable model. They would like to insure that a large portion of project expenditures will benefit local companies and consumers.

How are people in your community coping with the escalating costs of conventional energy?

The JSP observe that Jonesport is "a pristine area ecologically and a struggling village economically." Their project attempts to take advantage of these local strengths and address local weaknesses. At the moment, the proposed solar generation facility would create the only source of renewable energy available on the grid for Jonesport and the surrounding communities. It would be sold at one cent below the standard offer price, making it both affordable and superior in terms of environmental impacts and the multiplier effects of regional wealth retention.

Do you perceive any resistance to the adoption of renewable energy alternatives in your community?

Preliminary conversations with potential customers like local hospitals, universities, supermarkets, municipalities and private sector industries revealed a strong interest in "green" power options and the cost efficiencies it can offer, the JSP team observed. While economic conditions mean that few potential clients can pay more than the standard rate for alternative power sources, the appreciation for renewable energy's benefit is evident, according to the JSP team. They noted that resistance is not felt locally, but rather in the form of institutional, bureaucratic, and regulatory obstacles.

3.4. small community / Eastport Energy Committee (Eastport, ME) consultation

(Jon and Asher met with members from the Eastport Energy Committee in Eastport on 10/07/13)

When you think about the costs of electricity, transportation, heating, and so forth, do you think in terms of your budget, impact on the environment, public health, or all of the above?

The perception was that residents of Eastport and the surrounding area were mixed in their priorities, many concerned with all of the above issues, but that by and large the most important single issue across the board had to do with cost: up-front costs of acquisition and installation of renewable energy systems in particular. While the environmental and public health components of the energy question were acknowledged, it was generally felt by EEC members that operating budgets for both local businesses and households were such that affordability becomes a forced priority.

The problem of winter heating costs was foregrounded among all energy concerns, since it seems to constitute – for many Eastport residents – a major budgetary burden, and may even be linked to local real estate foreclosures. This question of winter heating "fallout" – along with related concerns like fuel poverty and excess winter morbidity – seem to deserve further exploration and study, according to EEC members.

How are people in your community coping with the escalating costs of conventional energy?

It seems that many people in the Eastport area are coping with the escalating costs of conventional heat by using cord wood to supplement their fuel bills, which are almost exclusively tied to the consumption of heating oil and propane for heating purposes. (It was observed that demand for cord wood had risen so much recently that it was becoming increasingly difficult to buy raw uncut, un-split logs on short notice.)

Some residents are sectioning off parts of their houses for the colder months, and putting on extra layers of clothing. Some migrate south in the winter, noting that it can be less expensive to acquire or rent property in warmer places for a few months than to pay for heat in Eastport. (Some Eastport residents speculate that some foreclosures in the town and beyond are prompted by unaffordable heating bills which, under certain hardship conditions not altogether rare, set a domino effect in motion.)

Meanwhile, only a small handful of properties in Eastport rely on renewable heating fuel systems (most notably the South Street Greenhouse owned by Sally Erickson and Tim Bennett, and the Tides Institute StudioWorks building on Water Street).

Several initiatives to look at energy and heating challenges are now underway in Eastport. The Energy Committee itself is a new body created by the City Council to make studied recommendations about efficiency and consumption. The non-profit "Thermal Efficiency: Eastport" project seeks to inform ongoing conversations about heating systems in particular, and both of these efforts are participants in the "Affordable Heat Consortium" which is a year-long effort to articulate and implement strategies that put efficient, sustainable heating systems within reach of non-affluent residents of Washington County and beyond. While all of these activities are in early stages of development, they indicate a growing interest in the question of energy use and optimal expenditure of regional resources.

Do you perceive any resistance to the adoption of renewable energy alternatives in your community?

There does not seem to be resistance to a transition to renewable energy systems, but few have considered it. The greatest challenges to the adoption of more renewable sources of energy and heat come from access to capital. The perception was that people in Eastport and the surrounding area are open to alternatives to costly oil, but:

1. They lack access to good information about what else is out there;

2. They lack access to the upfront capital that is required for improvements; and

3. Even if they did miraculously acquire a system that was more efficient, used a renewable fuel, and was less costly, sufficient technical workforce is not present in the area to properly maintain and service such systems.

Perceptions were unanimous that people in Eastport and the surrounding area were especially adverse to debt of any kind. The feeling was that people are so tight on their finances as it is, that it is impossible for the average resident to imagine going any (further) into debt. This lead to a conversation about the relationship of heating systems with household income (a relationship addressed by the concepts of "fuel poverty" and "home energy affordability gaps" addressed elsewhere in this report), the age of housing stock in a community, and health (a subject contained by the notion of "excess winter morbidity" and the patterned relation of energy costs with compromised public health, addressed further in section 5.2.2 of this report).

3.5. key concerns, findings & patterns

Across all these consultations with typical stakeholders in the region, a few shared or recurrent concerns are summarized below.

... regarding what is desirable:

> realization of long-term savings while recognizing the need to decrease environmental impacts of fossil fuel consumption; employment of centralized, rationalized, locally sustainable, efficient and consolidated power and heat; utilization of affordable renewable energy sources; capture of low-hanging fruit (e.g. water-to-water heat exchange for dairy sterilization, or direct solar water heating for swimming pool); implementation of model approaches which can be adjusted and repeated regionally; reclaiming lost sheep – the small to mid-sized institutions, rural residences, and isolated rural communities which often miss the benefits and efficiencies of energy transition.

... regarding major constraints in relation to renewable energy deployment:

> lack of front-end capital for system retrofit, fuel switching, and efficiency upgrades; resistance to incurring debt; insufficient information about options coupled with a lack of time and energy to investigate them; absence of trustworthy (neutral) technical guidance; the cheapest option immediately at hand is generally an upgraded version of the status quo; lack of local technicians to support new/unfamiliar systems; early adoption of alternative fuels and systems is generally expensive and uncertain; many prefer the Devil they know; local technicians and suppliers would like to share in benefits of investment in renewable fuel systems, but lack acquaintance.

... regarding existing programs in support of renewables:

> eligibility is uncertain and applications are complex, time-consuming, and expensive; special subsidies, credits, rebates and tax incentives can be difficult to assess and navigate; specialized monitoring of progress (e.g. “Sightlines” in Machias); Efficiency Maine strong but of limited purview; regulatory requirements designed for larger developers and investor; feed-in tariffs and RECs help to level the playing field.

... regarding costs and benefits of transition from fossil to renewable energy sources:

> short-term budgeting is primary, esp. regarding the barricade of winter heating expenses; traditional thrift and ingenuity mitigates both for and against energy transition; self-help preferred for sustainability and local resource reliance.

... regarding coping strategies:

> belt-tightening; specialized local inquiry; improved systems monitoring; estimating the cost of the status quo; inefficient renewables (e.g. cord wood).

4. DOWN EAST MAINE ASSETS & INVESTMENTS INVENTORY

4.1. The following organizations are primarily concerned with, or have significant projects addressing, the development and deployment of renewable energy fuels and systems in Down East Maine.

ORGANIZATION	TYPE	PRIMARY ACTIVITY	LOCATION
Bangor Savings Bank	Finance	Bank	Bangor, ME
Downeast Credit Union	Finance	Credit Union	Bangor, ME
Machias Savings Bank	Finance	Bank	Machias, ME
The First	Finance	Bank	Damariscotta, ME
CES Inc.	Industry	Contracting, Engineering	Machias, ME
Eastport Port Authority	Industry	Shipping, biomass fuel, pellets	Eastport, ME
Fulgham Fibers, Inc	Industry	Biomass	Woodland, ME
Great Northern Paper	Industry	Paper	East Millinocket, ME
Old Town Fuel & Fiber	Industry	Pulp, Biomass, Biofuel	Old Town, ME
Pelletco	Industry	Pellet, Biomass, Systems	Orono, ME
Thermogen Industries	Industry	Biomass	Millinocket, ME
Woodland Pulp LLC	Industry	Pulp, Paper	Woodland, ME
Sunrise County Solar	Industry	Audit, Manufacture, Education	Trescott, ME
Thermal Efficiency Eastport	Non-profit	Research, Consulting	Eastport, ME
Affordable Heat Consortium	Non-profit	Research, Demonstration	Eastport, ME
Maine Sea Coast Mission	Non-Profit	Community Development	Cherryfield, ME
Downeast Alternative Design Solar	Non-Profit	Education	Jonesport, ME
Downeast Resource Conservation & Devel.	Non-Profit	Community	Cherryfield, ME
GroWashingtonAroostook	Non-Profit	Development	Machias, ME
Maine Solar Energy Association	Non-Profit	Education	Harrington, ME
Northern Forest Center	Non-Profit	Research	Concord, NH
Sky Heat Associates	Non-Profit	Education, Solar	Harrington, ME
Washington County Energy Initiative	Non-Profit	Research, Planning	Machias, ME
Washington Hancock Community Agency	Non-Profit	Community	Ellsworth, ME
East-West Corridor	Private	Transportation, Utilities	Pittsfield, ME
Maine Tidal Power Initiative (UMaine)	Public	Research	Orono, ME
University Maine Machias	Public	Education	Machias, ME
Washington County Community College	Public	Education	Calais, ME
Washington County Council of Governments	Public	Planning	Calais, ME
Aroostook Partnership for Progress	Public/Private	Development	Caribou, ME
Mobilize Down East Maine	Public/Private	Economic Development	Calais, ME
Mobilize Northern Maine	Public/Private	Economic Development	Caribou, ME
Northern Maine Development Commission	Public/Private	Regional Planning & Development	Caribou, ME
Coastal Solar	Service Provider	Distributed Generation	Southwest Harbor, ME
Dead River Company	Service Provider	Heating	Machias
Bealenergy LLC	Start-Up	Wind	Machias, ME
Maine Tidal Power/Tidewalker Associates	Start-Up	Tidal	Trescott, ME
Mason Bay Wind LLC	Start-Up	Wind	Jonesport, ME
Sipayik Energy LLC	Start-Up	Research, Development, Planning	Perry, ME
Bangor Hydro	Utility	Transmission, Distribution	Bangor, ME
Exergy Development Group	Utility	Wind	Boise, ID
KEAN Energy LLC	Utility	Wind	Jonesboro, ME
Lubec Wind Power	Utility	Wind	Lubec, ME
Native Power	Utility	Wind	Brunswick, ME
Ocean Renewable Power Company	Utility	Tidal	Eastport, ME
Xpress Natural Gas	Utility	Natural Gas	Boston, MA
Eastern Maine Electricity Cooperative	Utility, Non-Profit	Transmission, Distribution	Calais, ME

4.2. The following organizations serving Down East Maine are primarily concerned with, or offer major programs in support of, workforce development and capacity-building in relation to renewable energy fuels and systems.

INSTITUTION	PROGRAM	CERTIFICATION	LOCATION
1. Build Green Maine	BPI Building Analyst Certification	BPI, energy auditing	Brooks
2. Eastern Maine Com. College	Energy Audit & Weatherization Training Lab	BPI	Bangor
3. Kennebec Valley Com. College	Energy Services Center	Solar (PV & Heating), Biomass Solid Fuel, Geothermal, Small Wind, EPA Refrigerant, Heat Pumps, Propane/Natural Gas	Fairfield
4. Maine Energy Marketers Assoc.	Technical Education Center	BPI, Conservation Tech, HVAC	Brunswick
5. Maine Energy Systems	AutoPellet System contractor training	AutoPellet installer certification	Bethel
6. Northern Maine Com. College	Wind Power Associate Degree, Weatherization	Associate Degree	Presque Isle
7. Southern Maine Com. College	Sustainability Center	ANSI, BPI, BPI/NREL, GPRO, LEED, Maine Auditor, Maine Weatherization	South Portland
8. University of Maine	Renewable Energy Minor	B.A. and B.S. in Economics	Orono
9. U.S. Green Building Council / Maine	LEED Workshops	LEED	Portland
10. Washington County Com. College	Weatherization Training Center	NCCER	Calais

For a mapping and discussion of these facilities and the need for expanded workforce training capacity in Down East Maine, please refer to section 7.2 of this report.

4.3. The following facilities located in or serving Down East Maine generate power from renewable energy sources.

NAME	TYPE	CAPACITY	LOCATION	PARENT COMPANY	STATUS
Boralex Sherman	Biomass	18 MW	Stacyville, ME	Boralex Sherman LLC	online
Covanta Power Station	Biomass	24.5 MW	Jonesboro, ME	Covanta	offline
Covanta West Enfield	Biomass	25 MW	Enfield, ME	Covanta	online
Old Town Fuel & Fiber	Biomass	28.5 MW	Old Town, Maine	Patriarch Partners	online
Penobscot Energy Recovery	Biomass	25 MW	Orrington, ME	SET PERC Investment LLC	online
ReEnergy Ashland	Biomass	40 MW	Ashland, ME	ReEnergy Holdings LLC	online
Worchester Energy	Biomass	4.33 MW	Deblois, ME	DownEast Power Company	online
TideGen	Tidal	1 MW	Eastport, ME	ORPC	2nd prototype
Bowers Mountain Wind Project	Wind	69.1 MW	Penobscot County, ME	First Wind	in appeal
Bull Hill Wind	Wind	34 MW	Hancock County, ME	First Wind	online
Mars Hill	Wind	42 MW	Mars Hill, ME	First Wind	online
Oakfield Wind	Wind	150 MW	Oakfield, ME	First Wind	permit review
Passadumkeag Mountain	Wind	42 MW	Grand Falls Twnshp, ME	Quantum Utility Generation	permit review
Rollins Wind	Wind	60 MW	Penobscot County, ME	First Wind	online
Stetson Wind	Wind	83 MW	Danforth, ME	First Wind	online

	TYPE	POWER (MW)	RPS GOAL (40% R/E)	RPS GOAL (75% R/E)	% TOTAL STATE CAPACITY	MW PENDING
Maine	wind	431			100%	
	solar PV	2.8			100%	
	solar therm	0			100%	
	geo therm	0			100%	
	hydro	733			100%	
	marine	0.24			100%	
	biomass	609			100%	
	total:	1,776	98.8%	52.7%	100%	
Down East	wind	219			50.8%	261.9
	solar PV	0			0.0%	
	solar therm	0			0.0%	
	geo therm	0			0.0%	
	hydro	0			0.0%	
	marine	0.1			41.7%	0.9
	biomass	165.3			27.1%	24.5
	total:	384.4	21.4%	11.4%	21.6%	287.3

5. CONTEXTUAL RESEARCH

5.1. cohorts & case studies

A small sample of renewable energy projects are summarized below. They were chosen to demonstrate a range of challenges and solutions that correspond well to the issues of primary concern raised during the fact-finding and consultation phases of this project. For each case, an overview of the project goals and accomplishments is followed by a description of what might be borrowed and adapted for implementation in Down East Maine.

5.1.1. Model Neighborhood Program, Berlin, NH

Launched in the autumn of 2011, the Model Neighborhood Project is a collaboration among the Northern Forest Center, Berlin BetterBuildings, the City of Berlin (pop. 10,051) and Maine Energy Systems to subsidize the installation and use of state-of-the-art, high efficiency wood pellet boiler systems as direct replacements for traditional boilers fueled by imported #2 heating oil. The 40 participating Berlin households are expected to save an average of 40% on home heating costs while injecting their remaining energy dollars into the regional economy.

To help meet the costs involved in the transition from fossil fuels to advanced wood pellet boilers, Berlin homeowners received direct financial assistance of up to 60% from two funding sources: the Northern Forest Center's direct cash Subsidy of $11,000, and 1% loans through the Berlin BetterBuildings Program and assorted local lending institutions. These funds were earmarked for the purchase and installation of biomass heating systems, as well as any additional expenses related to repairs or upgrades to the chimney, circulation system or other elements of the existing home heating system.

One reason the Northern Forest Center wanted to contribute to the Berlin program was to showcase the diversity of buildings in which you could install the pellet boilers. Aware of the obstacles, the collaborative team designed a process to encourage owner-occupied buildings in Berlin to participate, with an aim to make it as affordable enough to allow people at all economic levels to benefit. An overall goal was to help communities benefit from "forest-based initiatives" through subsidized deployment of regionally-produced renewable fuels. Berlin advocates note that this approach brings parallel benefits: 1.) it helps a Northern Forest community to save money on heating, 2.) it supports the regional market for low-grade wood, a consideration important to local landowners who must sell wood to keep their forested properties viable, 3.) it supports wood-based manufacturing since pellet manufacturing in Northern Forest communities is a value-added industrial process, and 4.) it keeps heating dollars circulating in the regional economy since 100% of every dollar spent on locally produced pellets is retained to foster jobs in local communities.

Project representatives predict that 14 fewer tons of greenhouse gas emissions are released for every home that replaces 1,000 gallons of heating oil with wood pellets, and that the four existing Maine pellet producers in the area could support 500 additional direct and indirect jobs if operating at full capacity. Based on its initial successes in Berlin, NH, the Model Neighborhood project was expanded in 2013 to communities of Farmington and Wilton, Maine in partnership with Western Maine Community Action.

5.1.2. Shutesbury, MA

Located in the western part of the state, Shutesbury, Massachusetts is a small town of just 1,834 encompassed in 26.6 square miles. In 2002, Shutesbury took a proactive stance on energy and environmental sustainability by joining International Council for Local Environmental Initiatives (ICLEI) "Local Governments for Sustainability" network and forming an Energy Committee to study and recommend energy conservation policies and projects.

Shutesbury had a record of investment in energy efficiency on which to pursue more ambitious goals. In 2008 the town completed installation of a small 2 kw solar array on the elementary school to provide clean electricity. In 2011 Shutesbury was awarded the designation of a Green Community and was awarded a grant of $142,275 for energy efficiency projects. The grant funded a 15 kW pole-mounted solar PV system at the Fire Station, an energy audit of the Fire Station to determine appropriate energy conservation measures for the heating and hot water system, implementation of approved measures from the completed audit, an HVAC upgrade at the Town Hall, air sealing at the Elementary School, and an interior lighting upgrade at the Fire Station.

The Energy Committee set a course to pursue four goals: 1) study and recommend energy efficiency and conservation policies and projects in town buildings, 2) install a solar photovoltaic array at the elementary school, 3) install a small-scale wind generator and 4) boost energy education and assistance initiatives in the community. With only 2% of the town budget allotted to energy projects, the Town realized they would need to take an innovative approach in order to successfully enhance energy efficiency in their community and achieve their clean energy goals. In spite of a small town budget, through persistence and creative funding, Shutesbury was successful in undertaking multiple renewable energy projects that will pay back dividends in money, energy security, environmental education and greenhouse gas reduction for years to come.

Forming an Energy Committee was an essential first step in reaching Shutesbury's energy goals. The Energy Committee, comprised of local citizen volunteers, provides assistance and education to residents and empowers families and individuals to implement renewable energy and conservation efficiency measures in their homes and daily lives. The Committee took the next step by identifying state grants and rebate money to help offset the costs of renewable energy projects. Funding was available from the Massachusetts Renewable Energy Trust, a Center for Ecological Technology grant, the Community Energy Challenge Green-Up program and a Massachusetts DEP Climate Protection grant.

Shutesbury encourages citizens to discuss and ask questions about the town's clean energy projects in public meetings and online discussions. The Energy Committee works closely with school staff to integrate educational components of the solar and wind projects into the curriculum. Community members can even track the town's energy usage online, providing concrete evidence of the energy savings Shutesbury sees over time. Community engagement of this caliber translates into greater energy awareness for the entire community and fosters support for continued expansion of energy saving projects that can save taxpayer dollars while saving the environment. In fiscal year 2010, the Select board asked all departments to reduce their budgets by 0.25%, which resulted in approximately $13,600 used to finance energy efficiency projects throughout the Town.

5.1.3. Efficiency Vermont

In 1999, the Vermont Legislature passed a law enabling the creation of Efficiency Vermont. In 2000, Efficiency Vermont was founded as the nation's first Energy Efficiency Utility and is operated by a private nonprofit organization, the Vermont Energy Investment Corporation, under an appointment issued by theVermont Public Service Board. It provides technical assistance and financial incentives to help Vermont households and businesses reduce their energy use and costs with energy-efficient buildings, equipment, and lighting. Efficiency Vermont also provides energy-efficient approaches to construction and renovation.

Efficiency Vermont's heating and process fuels services are funded by two revenue streams: 1.) Vermont revenues from the Regional Greenhouse Gas Initiative, a marketplace for nine northeastern and mid-Atlantic states to sell emission allowances, 2.) revenues received from selling energy efficiency savings to the region's Forward Capacity Market, where electrical energy and capacity is bought and sold to meet New England's electricity needs. Electricity efficiency services are funded through a surcharge that appears on all residents' electricity bills. (The levelized net resource cost of fossil fuel saved through efficiency in 2012 was 1.4 cents per MMBtu, whereas the avoided cost for that fuel was 2.9 cents per MMBtu along with 800,000 tons of CO_2 emissions avoided; meanwhile, the levelized net resource cost of saved electric energy in 2012 was less than 0.1 cents per kWh, while the cost of comparable electric supply in 2012 was 8.6 cents per kWh, according to the 2012 Efficiency Vermont annual report.)

It works with several lenders to offer the Home Performance with ENERGY STAR program, in which customers choose lenders. The customer works with a contractor to get a quote and scope of work, and then seeks approval from both the lender and Efficiency Vermont. Once the work is complete, the funds are disbursed to the directly to contractor. The lender provides all of the underwriting, origination, and servicing. Efficiency Vermont approves the efficiency measures, and then pays a lump sum equal to the net present value of buying down the loan by 3.5% (an average of $670 per loan); the interest rate charged to the customer varies according to the loan type and the creditworthiness of the customer, but tends to be in the 2.0% to 6.5% range after the buy down. Efficiency Vermont's overhead costs are relatively low, an estimated $250 per loan for the average staff time spent of 4-5 hours per loan.

Another Efficiency Vermont program is the Community Energy & Efficiency Development Fund to support investment in customer efficiency measures, community-based renewable energy, weatherization and other improvements. Efficiency Vermont also supports the Vermont Town Energy Data project to gather and assess electricity usage and savings data for the Renewable Energy Atlas of Vermont, a project undertaken by the Vermont Sustainable Jobs Fund. This annual snapshot provides municipalities, energy committees, and individuals with information about a town's historical energy usage, and can help to increase awareness about energy consumption. As part of its effort to help Vermonter's reduce their electricity use, Efficiency Vermont receives customer electric usage results from the state's utilities.

5.1.4. Cambridge Energy Alliance

In May 1999, the Cambridge City Council voted to join Cities for Climate Protection (CCP), an international consortium of communities working to reduce the impacts of climate change by reducing greenhouse gas emissions from fossil fuels. As a member of CCP, the City created a city-specific greenhouse gas emissions inventory and subsequently set targets and strategies to reduce these emissions through a comprehensive and well-defined plan. To help achieve these goals, the City created the Cambridge Energy Alliance (CEA) in 2007 as a non-profit organization.

In 2007, the State of Massachusetts announced the creation of a $2 million loan fund for local governments to supplement start-up costs for energy efficient programs modeled after CEA. In 2008, CEA became a National Council for Public-Private Partnerships Innovation Service Award Winner. In 2011, CEA became part of City government, continuing its mission of helping Cambridge residents and businesses identify and arrange financing for all cost-effective energy efficiency improvements for their homes and businesses.

The CEA in partnership with the City of Cambridge addressed a voluntary goal of retrofitting 50% of Cambridge buildings and reducing the city's emissions by 10% over five years. The program targeted all building types, and was designed to make energy improvements through a number of selected energy service companies (ESCOs). For the residential market, homeowners could take advantage of a free audit, paid for by state public benefit charge funds. All the work is specified and implemented by an ESCO that CEA has selected for the residential market.

CEA directs customers who need help with financing to two loan options: 1.) They have negotiated a rate of 9.75% for an unsecured personal loan with East Cambridge Savings Bank, with a maximum loan amount is $25,000 for a term of up to 10 years for energy efficiency, solar thermal, or solar PV. The approval rate for these loans is projected to be approximately 80%.; 2.) customers with less than 80% of the area median income could apply for a loan from Citizens Bank at a program-subsidized interest rate of 1-3%.

Project objectives included reduction in energy usage, development of more sustainable energy sources and the mobilization and education of the community. Another important objective of CEA was to develop a program that can be a model of community collaboration for other cities and towns as they embark on their own energy efficiency programs.

5.1.5. Berkeley FIRST

In November 2007, the Berkeley City Council approved a proposal by Mayor Bates to make Berkeley the the first city in the nation to allow property owners to pay for energy efficiency improvements and solar system installation as a voluntary long-term assessment on their individual property tax bill. The Berkeley "Financing Initiative for Renewable and Sustainable Technology" (FIRST) allows residential and commercial property owners to install energy efficiency measures, solar thermal, and solar PV, and pay for the cost over a 20 year period.

An early renewable energy retrofit experiment in Clean Energy Municipal Financing instrumentalized with on-bill financing (OBF), only FIRST participants who have had work done on their property are responsible for paying the special tax. If the property is sold prior to the end of the repayment period, the new owner takes over the remaining special tax payments as part of the property's annual tax bill. The long repayment period and transferability of the payments allow property owners to invest in comprehensive energy savings and renewable projects that pay back over a longer period than many existing financing options allow.

This strategy does not anticipate considering general applicant credit-worthiness as a qualification, but rather uses the record of paying property taxes as a proxy for credit. The City funds the program through the issuance of a municipal bond. The interest for participants is in the range of 5% to 7%, and the interest portion of the payments is tax deductible. To initiate the financing, the City records a Notice of Special Tax Lien against the participating FIRST property to secure the obligation to pay special taxes and takes priority over a property's first mortgage. In the event of delinquent special taxes, the City has the ability to foreclose on the delinquent property, or it may choose to wait for the county to initiate foreclosure. Berkeley FIRST is a component of Berkeley's voluntary emissions target, which calls for an 80% greenhouse gas reduction target by 2050.

The Berkeley FIRST Pilot Program was designed to solve many of the financial hurdles of incorporating solar on their homes. The advantages of the Berkeley FIRST program are:

1.) it is administered citywide through a voluntary Sustainable Energy Financing District;
2.) it presents low up-front costs to the property owner, since the solar system is paid for through a special property tax spread over 20 years;
3.) financing costs comparable to a traditional equity line or mortgage;
4.) a tax obligation that stays with the property, so that when a participating property is transferred or sold, the new owners will pay the remaining tax obligation.

5.1.6. Haringey Affordable Heat Strategy (United Kingdom)

In 2001 the Government published its "U.K. Fuel Poverty Strategy," with the primary aim to tackle the growing numbers of households who could not afford to heat their homes (for whatever reason) to an acceptable level. Through this strategy, the Government is under a statutory duty to ensure the eradication of fuel poverty in vulnerable households by 2010 and in all other households by 2016. The Home Energy Conservation Act 1995 (HECA) required every local authority with housing responsibilities to produce an energy conservation report identifying practical and cost effective measures to improve the energy efficiency of all residential accommodation in their area.

The multi-partnership Affordable Warmth Strategy for Haringey (pop. 230,000) was launched in November 2009 by David Kidney MP, Parliamentary Under Secretary of State for Energy and Climate Change, and it identifies how to tackle fuel poverty and promote energy efficiency. Its mission was to make sure that no family in Haringey lives in a cold, unheated home and that people know how to use energy in their homes efficiently in order to save money and reducing CO_2 emissions.

According to the U.K. Government, a household is said to be in fuel poverty if it needs to spend more than 10 percent of its income on fuel to maintain a satisfactory heating regime (usually 21 degrees for the main living area, and 18 degrees for other occupied rooms). Haringey Council defined any household where the occupants are unable to heat their property to a sufficient degree, so as to ensure their personal comfort, as a household that is suffering from fuel poverty.

In practice, several factors contribute to Haringey fuel poverty, including; low income, rising fuel prices, inadequate insulation, household composition relating to property size, inefficient heating systems, and lack of information and awareness about how fuel poverty can be tackled. Vulnerable groups on low incomes, especially older people, are typically most affected by fuel poverty. In some cases, they are faced with a choice that would be unimaginable to most: to heat or eat[5]. There is a greater prevalence of fuel poverty among people aged over 60 years of age, single people under 60, and households with children. The consequences of fuel poverty can be severe; fuel poor householders are more susceptible in particular to respiratory illness such as bronchitis and asthma, and are at increased risk of strokes and heart attacks.

The associated stress and anxiety that often goes hand in hand with fuel poverty can also lead to feelings of helplessness and depression. There are an estimated 25,000 excess winter deaths between December and March every year in the U.K., a figure is far in excess of those in much colder countries such as Russia and Finland. Since these figures are not related to low external temperatures only, it is widely recognized that fuel poverty is a likely factor. If fuel poverty were eradicated, the savings to the National Health Services in the U.K. would run into millions of pounds each winter.

Haringey Council and its partners worked hard over many years to alleviate the impact of fuel poverty in the Borough, but historically lacked a co-ordinated approach. With its affordable warmth strategy, Haringey seeks to effectively reflect existing good practice and to

5 The 2002 "Heat or Eat? Cold Weather Shocks" study by the National Bureau of Economic Research (link here) found that non-affluent American adults consume 147 fewer calories during then winter than in the summer (a 7.9% decline), adults with children consume 241 fewer calories (an 11.6% decline), and poor children consume 197 fewer calories (a 10.9% decline).

support existing frameworks for the delivery of affordable warmth measures. This strategy was developed by the Integrated Housing Board (a thematic partnership of Haringey Strategic Partnership) and is a sub-strategy of the overarching Housing Strategy 2009-2019.

In order to deliver this vision, four aims were adopted:

1. Engage with people to improve awareness and understanding of fuel poverty and energy efficiency such that all agencies play a part in reducing the number of people in fuel poverty and residents know what help may be available to them, and how to get it.
2. Increase the energy efficiency of housing across Haringey to reduce long term levels of fuel poverty within the Borough regardless of whether the housing is social rented, privately rented or owner occupied.
3. Maximize resources and opportunities for tackling fuel poverty, since many funding opportunities are available, old and new.
4. Link to other strategies, since affordable warmth should not be seen in isolation.

5.1.7. Güssing, Austria

Güssing is a small rural town in the Burgenland district with about 3,800 inhabitants, located about 200 km south of Vienna near to the Hungarian border. Throughout the Cold War, proximity to this border discouraged industrial investments, which led to a lack of jobs for the residents of Güssing, many of whom migrated to other regions for work. In the late 1980s, Burgenland was the poorest and least developed region of Austria, and the Güssing region was one of the poorest within Burgenland. But because 40% of the region surrounding Güssing is forested, sufficient raw material was available to meet the energy needs of the whole city; in the early 1990s, the mayor of Güssing and other visionary residents worked out a concept to take advantage of it.

In 1998, the largest biomass-based district heating system in Austria was commissioned, providing heat for 95% of the residents of Güssing, with a total pipe network length of more than 20 km. The consumers are mainly private houses (300), public offices, schools, and hospitals (50). There is a growing demand for industrial heat throughout the year.

Beginning in January 2002, a steam biomass gasification process runs a combined heat and power (CHP) plant able to supply all of Güssing's electricity needs, so that now Güssing is supplied by 100 % renewable energy which is fully based on locally-harvested biomass and the plant produces more biodiesel than the local community consumes. Excess electricity is sold to the electrical grid at competitive rates. The biomass supply is secured by long term contracts. The fuel for the heat and power production are wood chips delivered by local wood farmers who have established a wood farmers association.

The acceptance of the CHP-plant by the people of Güssing as well as the local authorities has been high thanks to five key factors:

1.) A CHP-plant was the missing link for complete local energy supply by biomass;
2.) The production of heat and electricity only from local raw material;
3.) Sufficient, renewable stocks of local biomass are available;
4.) Energy supply is now independent from oil prices, and
5.) Local jobs were created not only by the demands of the CHP power plant but also by the stabilization and invigoration of the local wood-working industry.

Güssing the first community in the European Union to produce its whole energy demand – electricity, heating/cooling, fuels – out of renewable resources, all resources from within the region. In addition, Güssing was the first community in the European Union to cut carbon emissions by more than 90%, helping it attract a steady stream of scientists, politicians, and eco-tourists.[6] In 2008, Güssing built a research institute focusing on thermal and biological gasification and production of second-generation fuels. That same year a solar manufacturer started producing PV modules in Güssing, producing 850 megawatts of modules a year and employing 140 people.

[6] Tirone, J. "'Dead-end' Austrian town blossoms with green energy" in *The New York Times*, August 28, 2007.

5.1.8. strategies directly transferrable to Down East Maine

Two of the case studies above (Shutesbury, MA and Güssing, Austria) show the **positive impact of energy transition** in small, non-affluent communities very similar in size and demographic profile to most towns and cities in Down East Maine. Shutesbury's example shows the value of **local leadership**, participation in **larger networks** (ICLEI), modest budget allocations well-spent, **energy use monitoring** at a community scale, **dedicated budget reductions** earmarked for energy efficiency investments, and an active local energy committee. In Güssing, strong local leadership was also essential, along with an ambitious and **comprehensive local energy transition strategy** that placed emphasis on the **creation of new jobs** and revenues for local business.

The most nearby example cited here is Berlin, NH, which also has a community profile similar to many in Hancock and Washington counties. Berlin is a non-affluent city with a flagging economy historically reliant on forest-based industries whose future prospects are uncertain. By taking a highly **collaborative approach** to local concerns, new vitality was injected into these industries. Berlin focused on one renewable fuel, wood pellets, and emphasized **winter heating** as a central component of energy consumption. Partnerships, smart planning, and **efficiencies of scale** allowed the Model Neighborhood Project to negotiate strong subsidies and loan products on behalf of participating residents.

Collaboration was key to success for Cambridge Energy Alliance (a **public-private partnership** with the City and local **energy service companies**), Haringey's Affordable Heat Strategy (**inter-agency coordination** at the borough level, along with strong national support), and Berkeley FIRST (part of a clean energy **municipal financing district**, and able to coordinate **on-bill financing** with all 20 local utilities on behalf of participating residents). In each of these cases, program design allowed for the study, adaptation, and **transfer of successes** to other communities with matching goals.

Efficiency Vermont, a relatively freestanding government-mandated program, demonstrates the benefits of a statewide organization: **red tape and complex arrangements** with lenders and contractors can be taken care of on behalf of participants; **favorable lending rates** can be negotiated as a sort of 'class action' for energy transition; **coordination with public utilities** agencies allows for steady, long-term funding streams, which in turn support **interest rate buy-downs** that put retrofit capital within reach of non-affluent property owners. The eagle's eye view of a statewide organization also allows for **comprehensive monitoring and data collection**, providing insights about leverage and program scope adjustments that would otherwise be too expensive or difficult to gather.

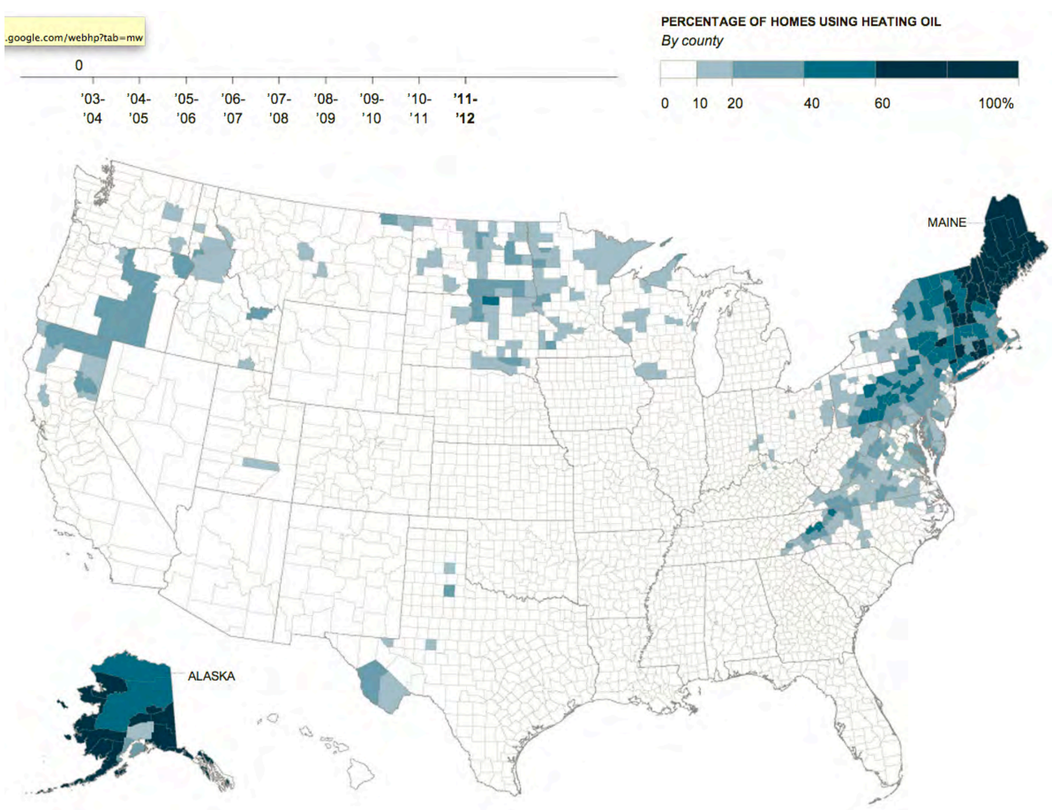
If just a handful of these proven strategies were adopted by a Maine community, the savings could be substantial. These are just a small sampling of thousands of energy transition programs in the world that provide insight and encouragement for ambitious renewable energy development and deployment in Down East Maine.

5.2. Maine's renewable energy deployment context

5.2.1. energy consumption profile

The line between Maine's assets and liabilities in relation to energy can be blurry. Its low population density, rural character, and traditional self-reliance means that Mainers are generally frugal and resilient; on the other hand, energy distribution networks are more costly to create and maintain under these demographic conditions, so unit prices for fuel are high. Mainers have historically harvested renewable biomass locally for heating, but they generally have burned it in inefficient ways. Maine burns large amounts of fossil fuels per capita, but also has the best renewable source profile for electricity generation along with the highest wood and wood waste power generation capacity in the United States – mostly untapped.

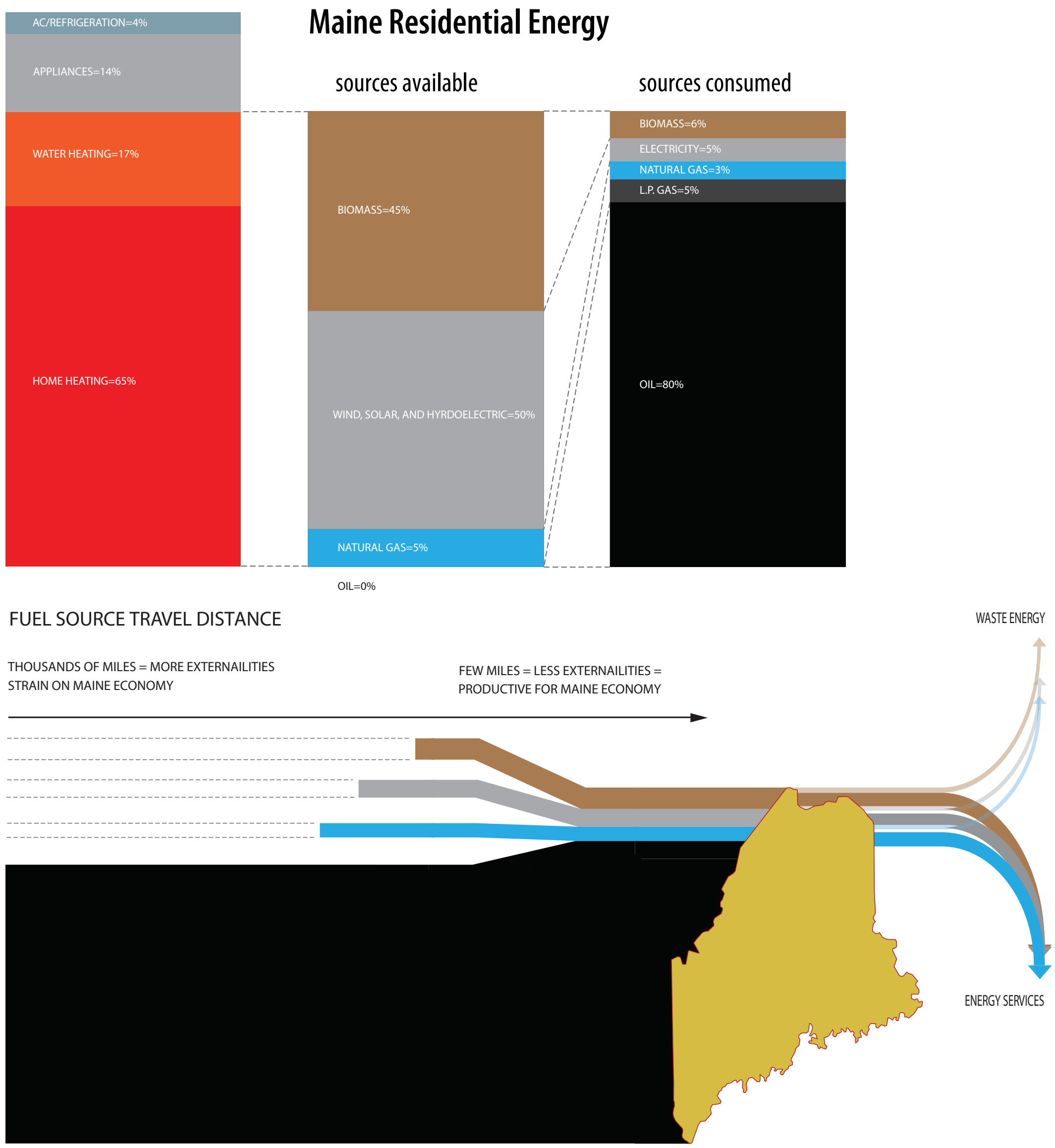
As of 2011, Maine's overall energy consumption was 26th in the country (at approximately 311m BTU per capita annually), but the cost of that energy ranked much higher – at 10th in country (approximately $5,508 per capita annually, amounting to 14% of Mainers' personal income on average and a statewide expenditure of $7.32b for the year).[7] Since Maine residents have household incomes generally well below the national average, these figures spell out a painful picture: those with less to spend spend more per unit of energy. The map below, published in 2013 by the *New York Times*, shows the special dependency on fossil fuel for structural heating in Maine, reflecting recent data from the US census showing that 75.6% of Maine's homes use #2 heating oil,[8] is by far the highest proportion of heating oil dependency of any state in the continental U.S.



[7] US EIA Maine state profile based on 2011 data, link here.

[8] From the Energy Information Agency website.

Another way to look at Maine's energy consumption profile is to compare regionally available energy sources with the fuels actually burned, as below:



Here the discrepancy between regionally available energy sources (mostly renewables in the form of biomass, wind, solar, and tidal sources) and current dependencies is evident. Environmental concerns aside, Maine's reliance on heating oil is problematic because it contributes to energy insecurity, exposes consumers to price volatility, wastes resources on long-distance fuel transport, and constitutes a large annual net export of wealth out of the state and, in large part, out of the country.

5.2.2. cost & burden of non-renewables

Many observers have noted that American dependence on non-renewable energy sources is both expensive and dangerous. What is true for the country is urgently true for Down East Maine. In a perfect world, the price of energy in this region would include the cost of health care, lost productivity, and foreclosures as residents are forced to choose between essentials in the winter season.

One study finds that "the use of fossil fuels for energy creates external effects in the future through its emissions of atmospheric greenhouse gases (GHGs) that cause climate change, subsequently resulting in damages to ecosystems and society."[9] Many studies agree that the earth will emit the trillionth ton of harmful carbon into the upper atmosphere in June 2043 (we are about half way to that threshold currently), while the International Energy Agency warns that we will reach the 6°C mark by 2050 at current rates of fossil fuel usage – both tons of carbon and warming degrees are benchmarks for irreversible, widespread harm.

One scholar of energy issues in Maine (also a contributor to the renewable energy working group component of this project) goes on to observe: "The human and environmental costs from failing to promptly reduce dependence on carbon-dioxide emitting sources for electricity, heating, and transportation are dire and indisputable." Thaler illustrates links between climate change and poverty, water scarcity, disease, political instability, and public health, such that it poses "an urgent and potentially irreversible threat" to all communities. These assertions place a large burden on the current generation of policy makers, who are "uniquely placed in human history: the choices we make now—in the next 10–20 years—will alter the destiny of our species (let alone every other species) unalterably, and forever...."[10]

These are broad concerns, and important ones, but for many they seem intangible and difficult to believe. One yardstick that is easier to grasp is the cost of residential heat in the winter – a significant source of anxiety for many people in Maine. While heat is just one feature of Maine's overall energy consumption profile, it is useful as a barometer for the challenge of efficient and affordable energy use overall. For those who live and work in Down East Maine, the high cost of energy given existing consumption patterns can become tangible through a home energy affordability gap analysis. Since it is commonly assumed that a household should not spend more than 6% of its disposable income on home heating, it is easy to measure the "gap" between what is considered affordable (no more than 6% of the income available within a particular segment of the Maine population) and is actually spent to stay warm. As the table on the following pages indicates, the situation in Down East Maine (figures for Washington County were used in relation to statewide averages) is worthy of concern.

This "Home Energy Affordability Gap" (HEAG) shows that for Maine residents with incomes at or below the federal poverty level (constituting about 71,708 households, 13% of all households in the state), the amount spent for winter heating above and beyond the portion of disposable income considered affordable (heating budget "shortfall") was about $3,264 per household and $144m in aggregate. For Down East Maine, it was worse: shortfalls of about $3,654 per household representing spending at least 30% beyond the affordable threshold. Put differently, if non-affluent residents in Down East Maine could heat their homes affordably, they would have about $3,654 more to spend on other things each year.

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9 National Research Council. *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use*. Washington, DC: The National Academies Press, 2010. (link here)

10 Thaler, Jeffrey. "Fiddling as the World Floods and Burns: How Climate Change Urgently Requires a Paradigm Shift in the Permitting of Renewable Energy Projects", in *Environmental Law*, Fall 2012, Vol. 42 Issue 4: 1101-1156. (link here)

To quantify the gap between "affordable" home energy bills and "actual" home energy bills, Fisher, Sheehan & Colton (FSC) developed a model that estimates the "home energy affordability gap" on a county-by-county basis for the entire country.

Maine 2012 Home Energy Affordability Gap: Washington County

Average amount by which actual home energy bills exceeded affordable bills (amount exceeding 6% of gross household income).

Energy costs as a percentage of income. Housing analysts consider an energy burden of more than 6% to be unaffordable.

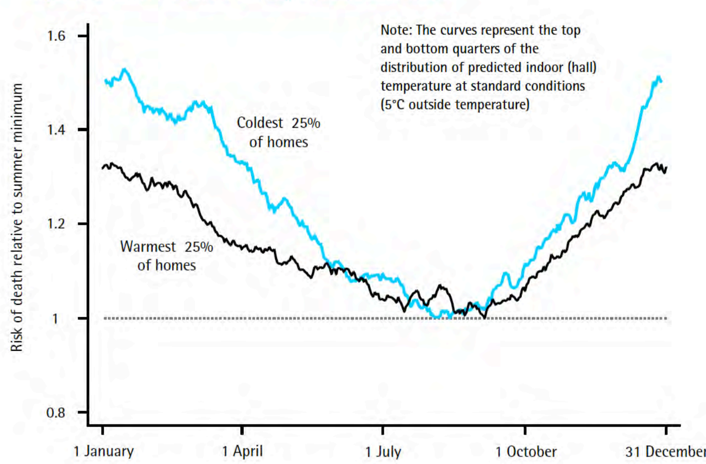
13% of Maine residents (about 71,708 households, with 2.34 persons per household) earn below 100% of the FPL

average household income in relation to federal poverty level		household avg shortfall	households	aggregate shortfall	home energy burden
< 50%	Washington County	$3,992	963	$3,844,296	67.9%
	Maine	$3,600	26,469	$95,288,400	60.7%
50-99%	Washington County	$3,654	1,927	$7,041,258	36.2%
	Maine	$3,264	44,134	$144,053,376	32.4%
100-124%	Washington County	$3,291	953	$3,136,323	24.1%
	Maine	$2,904	25,127	$72,968,808	21.7%
125-149%	Washington County	$3,049	1,082	$3,299,018	19.8%
	Maine	$2,651	26,673	$70,710,123	17.7%
150-184%	Washington County	$2,759	1,144	$3,156,296	16.2%
	Maine	$2,349	38,207	$89,748,243	14.5%
185-199%	Washington County	$2,517	515	$1,296,255	14.1%
	Maine	$2,093	16,957	$35,491,001	12.6%
<200%	Washington County		6,584	$21,773,446	
	Maine	$2,862	177,567	$508,259,951	
		LIHEAP allocation for 2012:		$38,500,000	
	Maine households < 200% FPL without energy help:			164,117	

For those who have an income and food but struggle to bridge this winter heating affordability gap, researchers in the U.K. coined the term "fuel poverty". One study finds that "It is now well documented that fuel poverty has a number of adverse health impacts, especially on the elderly. Chronic exposure to low ambient temperatures in the home resulting from fuel poverty often leads to a physiological condition in humans known as 'cold strain'. While short episodes of cold stress are unlikely to cause serious adverse health impacts among the young and healthy, such physiological effects are damaging to the cardiovascular and respiratory systems of the elderly, and may exacerbate current ill health or diminish resistance to infections in healthy persons."[11]

This figure from the Irish study shows a seasonal pattern of cardiovascular deaths using data for the years 1986-96 collapsed into one artificial year of 365 days. Two patterns stand out: indoor temperature is linked to excess mortality, and indoor temperature is also linked to fuel poverty, which in turn is tied to income.

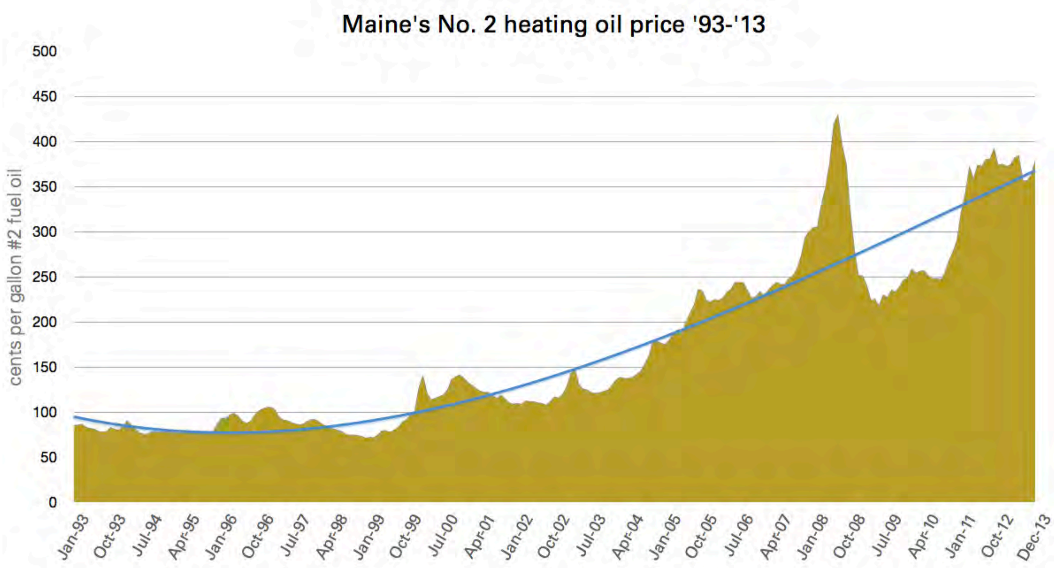
Figure 6: Seasonal fluctuation in mortality in cold and warm homes



[11] Healy, John D. & J. Peter Clinch. "Fuel poverty, thermal comfort and occupancy: results of a national household-survey in Ireland," in *Applied Energy*, 2002, vol. 73, issue 3-4, pages 329-343. (link here)

Over and over, these correlations appear in medical studies, affirming that low indoor temperature can be an important predictor of excess winter mortality.[12] Unfortunately, prominent economic and demographic trends in Down East Maine bring together many of the baseline conditions that give rise to fuel poverty: long winters, old housing stock, low household income, high energy prices for heating, and wide affordability gaps.

As for unit prices, with ups and down the long-term trend is made clear in the chart below, showing the evolution of retail heating oil prices over a decade in Maine:



In 2013, Maine "exported" about $720m after it consumed about 305,797,000 gallons of heating oil. Of those millions, about 78% left the region, according to the EIA's "Home Heating Oil Report 2010"– more specifically, for each dollar spent, 62% pays for the crude and 16% pays for refining, mostly in the Gulf Coast states.

Such a heavy reliance on non-renewable fuels for heating is not just regrettable in light of regional economics, social justice, and the raft of public health risks that comes with it. In the case of Maine, this large net export of precious wealth is also taking place in the most forested state in the United States, with sustainable biomass harvests of more than 16 million tons per year.[13] In 2008 the Governor's Task Force on Wood to Energy concluded that Maine has a sustainable wood supply sufficient to convert 45,000 homes (about 10% of Maine residences) from oil to wood heat. The forest products sector historically has been – and could remain – the mainstay of Maine's manufacturing sector if value added refined fuel gradually replaces some or perhaps eventually all of the pulp production while displacing the use of heating oil.

Jobs and income tied to wood pellet fuel production, for example, are generated directly through the production of pellets and indirectly through retention of disposable income. This may be especially relevant to the economic prospects for Down East Maine.

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[12] Wilkinson, P. & Ben Armstrong. *Cold Comfort: The Social and Environmental Determinants of Excess Winter Death in England, 1986-96*, Policy Press, Dec 1, 2001. (link here)

[13] Maine Forest Service Assessment of Sustainable Biomass Availability, July, 2008. (link here)

5.2.3. energy policy & legislation

To appreciate the policy context for renewable energy deployment in Maine, it is useful to review four major pieces of constructive legislation supporting renewable energy development statewide:

1. In September 1999, as part of electricity market restructuring, Maine's Public Utilities Commission (PUC) adopted a Renewable Portfolio Standard (RPS) which placed an obligation on electricity supply companies to produce a specified fraction of their electricity from renewable energy sources, such as wind, solar, biomass, and geothermal.[14] In June 2009, new policies allowed certified renewable energy generators to earn renewable energy certificates (RECs) for every unit of electricity they produce, and to sell these along with their electricity to supply companies. Supply companies may then pass their acquired RECs back to the Maine PUC to demonstrate compliance with the RPS. RECs provide a mechanism by which to track the amount of renewable power being sold and to financially reward eligible power producers. For each unit of power that an eligible producer generates, a certificate or credit is issued.

   Maine's RPS requires that at least 30% of retail electricity sales come from renewable sources, although state electricity distributors had already surpassed that goal. In June 2006, Maine adopted another renewable portfolio goal to increase all renewable energy to 40% of total capacity and class I new renewable energy capacity (renewables came on-line after September 1, 2005) by 10 percent between 2007 and 2017 (with a 1% increase in required renewable capacity imposed each year). In February 2010, new policy provided for Community Based Renewable Energy Production Incentive through the RPS also to offer a 1.5 credit multiplier for larger qualifying community-based renewable energy projects up to 10 MW (or $0.10 per kWh for solar, wind, hydro projects under 1 MW) with long-term project contracts up to 20 years. To date, 16 applications for these multipliers have been approved.[15]

2. In December 2005, Maine signed on to the Regional Greenhouse Gas Initiative (ReGGI) and was eventually joined by eight other states (Connecticut, Delaware, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont) ReGGI is a market-based, mandatory cap-and-trade consortium intended to reduce power plant greenhouse gas emissions in the Northeastern United States and Eastern Canada. Power sector CO_2 emissions are capped at 188 million short tons per year through 2014. The cap will then be reduced by 2.5 percent in each of the four years 2015 through 2018, for a total reduction of 10 percent. Under RGGI, electric generators with over 25 megawatts (MW) of fossil fuel-based capacity must purchase emissions allowances for every ton of greenhouse gas emitted. Generators that reduce emissions can purchase fewer allowances, and may sell surplus allowances to generators less able to meet emission reduction targets.

3. In June 2009 the Efficiency Maine Trust Act (Public Utilities 35-A chapter 97) was passed to establish an Efficiency Maine Trust (EMT) and direct its Trustees to invest RGGI auction proceeds in electric and fossil fuel energy efficiency programs. Proceeds from the sale of Maine's RGGI CO_2 allowances are allocated by the EMT. So far, the Trust has invested: 1.) $7.1 million in its Large Projects Grant Program, a program to

[14] More details are available on the DSIRE web site, here.

[15] Please see the Maine PUC web site for the incentives program, here.

provide grants between $100,000 and $1 million for large-scale energy efficiency projects, including combined heat and power (CHP) systems; 2.) $5.8 million in the Efficiency Maine Business Program, a program to provide prescriptive and custom incentives for businesses to replace out of date equipment and upgrade to energy-efficient alternatives; 3.) $2.9 million in the Efficiency Maine Residential Lighting Program and Efficiency Maine Appliance Rebate Program, designed to reduce energy demand and provide sustained energy cost savings for Maine consumers; 4.) $650,000 in low-income weatherization programs. Efficiency Maine is funded in part by a 1.45 mill rate per kWh on all electricity bills in the state, and the Maine PUC reported that these energy-efficiency investments will save Maine residents more than $100 million with a benefit to cost ratio of 3.8 to 1.

4. In June 2013, the Maine State Legislature passed the Omnibus Energy Bill LD 1559 in order to: 1.) provide support for reducing the cost of energy to residents of the State; 2.) maximize the use of cost-effective weatherization and energy efficiency measures, including measures that improve the energy efficiency of energy-using systems, such as heating and cooling systems and system upgrades to energy efficient systems that rely on affordable energy resources; 3.) reduce economic insecurity from the inefficient use of fossil fuels; 4.) increase new jobs and business development to deliver affordable energy and energy efficiency products and services; 5.) enhance heating improvements for households of all income levels through implementation of cost-effective efficiency programs, including weatherization programs and affordable heating systems; 6.) simplify and enhance consumer access to technical assistance and financial incentives by coordinating dispersed programs under a single administrative unit; and 7.) utilize cost-effective energy and energy efficiency investments to reduce greenhouse gas emissions.

   The goals of the bill include: 1.) Reducing energy costs, including residential heating costs; 2.) weatherizing substantially all homes whose owners or occupants are willing to participate in and share the costs of cost-effective home weatherization to a minimum standard of weatherization, as defined by the trust, by 2030; 3.) reducing peak-load demand for electricity through trust programs by 300 megawatts by 2020; 4.) by 2020, achieving electricity and natural gas program savings of at least 20% and heating fuel savings of at least 20%, as defined in and determined pursuant to the measures of performance approved by the commission under section 10120; 5.) creating stable private sector jobs providing alternative energy and energy efficiency products and services in the State by 2020; and 6.) reducing greenhouse gas emissions from the heating and cooling of buildings in the State by amounts consistent with the State's goals.

Other energy-related policies in Maine seems demonstrate ambivalence or even present obstacles – though apparently not by design – to the expansion of renewable energy infrastructure in the state. Two examples are summarized below.

5. Functioning as a statewide stop-gap measure, the Low Income Home Energy Assistance Program (LIHEAP) is a federal social services program established in 1981 funded annually through Congressional appropriations and distributed to each of the fifty states, U.S. territories and tribal governments through the United States Department of Health and Human Services (HHS), while administration of the program is left up to state. In Maine, LIHEAP generally means that struggling residents receive cash disbursements earmarked for heating fuel. In light of the HEAG analysis above, it is clear that existing sources of energy assistance do not adequately address the predictable shortfalls in Maine. In 2012, the gross LIHEAP allocation to Maine was $38.5m to assist with

approximately 16,865 low-income heating bills, down from $51.5m for 25,129 Maine households in 2011. Meanwhile, the 2012 shortfall for home heating totaled $508.3m incurred by 177,567 households. More simply, LIHEAP met only 7.6% of the winter need and left about 155,000 household in the cold. The scale of LIHEAP is a problem, and questions also arise regarding its scope. Since LIHEAP funds – by definition – allow struggling property owners to buy emergency heating fuel when they need it most, it becomes an annual lump-sum investment in existing fuels and systems. As noted above, Maine is disproportionately dependent on fossil fuels for heating, making the LIHEAP program – by default – a subsidy for the fossil fuel industry. The long-term expediency of LIHEAP is poor to the extent that the state's heavy reliance on fossil fuels is a concern.

6. Thaler points out that local, state and federal regulations governing renewable energy development projects have become "so unduly burdensome, slow, and expensive" that they will chill investment in renewable carbon-free energy sources and projects in Maine. The flaws in current licensing permitting regimes are demonstrated with the example of offshore wind installations, which offer a good prospect for Down East Maine's future renewable energy deployment strategy. He notes that the maze of federal and state regulatory requirements facing renewable energy projects in general and offshore wind in particular requires a year or more to complete and be approved, with large front-end consultant and legal expenditures before any permits have been approved. These hoops inevitable create substantial delays, costs, risks, and deterrents to project implementation.

   Because clean energy sources promote the conservation of species and ecosystems, and because they contribute to the mitigation of negative environmental impacts, Thaler argues, they deserve prioritization. This prioritization can take the form of subsidies, or policy makers can require that the "hidden" costs of fossil-fueled energy be taken into account, along with the comparative life cycle impacts of competing energy sources, as part of NEPA's no-action alternative analysis and other regulatory review processes. Thaler and others underscore the need to "significantly revamp" the legal process in order to greatly accelerate the development of renewable energy projects and remove the many obstacles in the path of achieving an 80% reduction in GHG emissions by 2050.

5.3. best practices

Gleaned from the above and related examples, a few tools and strategies stand out as especially relevant to the context for renewable energy deployment in Down East Maine. Some are summarized very briefly below in no special order.

☑ monetizing hidden costs of non-renewables

To level the playing field for renewable energy developers in Maine, policy makers can tip the scales in their favor with tax credits, subsidies, loan guarantees, etc. A complementary approach is to curtail subsidies to the non-renewable energy sector by internalizing its historically "unpriced" or "social" or "negative externalized" costs – measured in terms of pollution, public health impacts, compromised security, 'lives and treasure,' etc. – so that 'market failures,' barriers, and distortions are partially corrected.[16] The simplest way is to reverse-subsidize conventional energy is with aggressive carbon taxes, though the current political climate does not support that approach. Another way to address "hidden" costs of non-renewable fuels is to utilize attributive life cycle cost accounting when comparing the efficiency of different fuels and systems. In 2009, the estimated externalized costs of fossil fuel use in the U.S. were $240b,[17] so if these costs were put back into the unit price of fossil fuels, the effort to bring renewable fuels and systems to scale would intensify, converting a market failure into a market triumph.

Several researchers have observed that while hidden costs remain subsidized for incumbent technologies, superior technologies swim against the current of "path dependency" that can "lock in societies into energy or infrastructure options that may be inferior in terms of cost efficiency or accumulated social costs in the long term...."[18] One study notes that "[t]here is a constant need for mechanisms for sustainable development that internalize environmental or social externalities...when external costs are included, the relative advantage of renewable energies is highlighted...."[19] Another states the case more bluntly when it concludes that "the removal of both direct and indirect subsidies to power-generation technologies and the appropriate pricing of fossil (and nuclear) fuels to reflect the environmental damage (local, regional and global) created by their combustion are essential policy strategies for stimulating the development of renewable energy technologies."[20]

☑ heat districts & shared energy infrastructure

In Helsinki, Finland fuel was expensive after WW2, so the city established its district heating system in 1952 and hot water is now distributed to almost the entire city. The case of Güssing shows some of the virtues of small-scale, shared heating infrastructure (along with the benefits of biomass co-generation). Instead of installing and maintaining a boiler in every house, a central plant could provide hot water to an entire district of 300 houses with all the attendant efficiencies of scale. The numbers speak in favor of heat districts, but the social

[16] Market failures can be caused by (1) misplaced incentives; (2) distortionary fiscal and regulatory policies; (3) unpriced costs such as air pollution; (4) unpriced goods such as education, training, and technological advances; and (5) insufficient and incorrect information; meanwhile the unpriced costs of conventional fuels insure that "more fossil energy is consumed than is socially optimal" according to M. Brown's "Market failures and barriers as a basis for clean energy policies" in *Energy Policy* 29 (2001): 1197ff. (link here)

[17] Greenstone, Michael & Adam Looney. "Paying Too Much for Energy? The True Costs of Our Energy Choices", MIT Department of Economics Working Paper No. 12-05: Feb. 2012. (link here)

[18] Unruh, G. "Understanding carbon lock-in." in *Energy Policy*, v. 28, n. 12, Oct. 2000: 817-830. (link here)

[19] Sathaye, Jayant & Atiq Rahman. "Renewable Energy in the Context of Sustainable Development" in the *Special Report Renewable Energy Sources and Climate Change Mitigation*, for the Intergovernmental Panel on Climate Change, 2009, chapter 9: 761ff. (link here)

[20] Owen, Anthony D. "Renewable energy: Externality Costs as Market Barriers," in *Energy Policy* 34 (2006) 632–642. (link here)

habits of American communities do not. This is probably why heat districts are mainly seen on college campuses or highly organized corporate parks. It need not be this way, though. Small communities – especially those with woody biomass stocks within 50 miles – are well-poised to pool ideas, resources, and political will in order to share expensive infrastructure.

☑ power purchase & performance contracting

High front costs are a recurrent obstacle to renewable energy transition, retrofit, and startup production, calling for a market-driven, comprehensive way to distribute and manage risk. One study notes that the high upfront costs of renewable energy technologies may inhibit uptake by low-income consumers who lack access to cash or credit and may "prefer to keep the initial cost low rather than minimizing the operating costs which run over a longer period of time...." [21] Access to capital for renewable energy deployment and efficiency measures may be addressed by outsourcing investment risks in return for shared savings. This approach asks end-users pay to enter a long-term contract for power, or heat, at guaranteed rates (termed 'performance contracting') while investors – often organized as an 'energy service company' (ESCO) – pay for capital costs, fuel, and maintenance. In this arrangement, prohibitive initial investments are avoided by consumers while investors benefit from highly predictable returns.

National ESCOs increasingly involved with renewable energy include Siemens, Johnson Controls, and Honeywell International; at present, Down East Maine is served by only one ESCO specializing in biomass installations, PelletCo.

☑ feed-in tariffs

When governments subsidize renewable energy development, that is good for the developer, but often – if the subsidies are funded from general sources – the taxpayers are paying on one end for a discount on the other. This arrangement is considered regressive and non-optimal. The feed-in tariff (FIT) is an alternative to taxpayer-subsidized incentives for renewable energy programs. It creates a financial incentive to produce clean electricity from renewable sources and feed it into the public grid. With a FIT, the government mandates electric utilities to pay a prescribed above-market rate for electricity generated by net-producers preferential, technology-specific renewable energy. It is market-driven, so it takes a burden off of strapped state and federal budgets, and it permits renewable growth to scale with a predictable return on investment.

A 2008 European Commission report noted that "well-adapted feed in tariff regimes are generally the most efficient and effective support schemes for promoting renewable electricity," especially when coupled with subsidies, soft loans, and quota obligations.[22]

[21] Reddy, S., & J.P. Painuly. "Diffusion of renewable energy technologies – barriers and stakeholders' perspectives." in *Renewable Energy*, v. 29 n. 9, 2004:1436. (link here)

[22] In April 2013, the Joint Standing Committee on Energy, Utilities and Technology of the Maine Legislature held a hearing on a bill that proposes to enact a comprehensive feed-in-tariff program to be administered by the Commission for renewable technologies of up to 500 kW. The prices for long-term contracts under this process can be expected to be significantly above wholesale market prices and thus the program essentially represents a renewable resource incentive subsidy that is ultimately paid for by the general body of ratepayers. Legislative action on LD 1085 has been postponed for further study until 2014. (link to pending legislation here)

☑ Clean Energy Municipal Financing (CEMF) & on-bill financing (OBF)

CEMF uses a special municipal tax to finance energy improvements. A municipality provides funding for the program through the issuance of a bond that is repaid through a line item on the property tax bills of participating property owners and guaranteed by a lien. If the property is sold prior to the end of the repayment term of 20 years, the new owner takes over the remaining special tax payments as part of their property's annual tax bill – this kind of repayment obligation that is tethered to a property, not a person, is called on-bill financing. In this arrangement, there is no up-front cost to the property owner[23] and interest payments on the project are sometimes tax deductible, similar to a home mortgage. The long repayment period and transferability of the payments allows property owners to invest in comprehensive energy savings and renewable projects that pay back over a longer time frame than many existing financing options allow. An example of how CEMF-OBF can work successfully is the Berkeley FIRST project described elsewhere in this report.

☑ local energy producers & markets

The serious challenge to community-scale energy projects is demonstrating a consistent return on investment to attract the right mix of public and private financing. A smaller scales – towns and rural communities, for example – the risks are fewer and the decision-making pathways less complex, making these places strong candidate sites for renewable energy deployment experimentation and demonstration. "The local government has a critical role to play in climate leadership, galvanizing stakeholders, bringing focus to zones, and leveraging public financing," says Rhys Roth, director of strategic innovations for Climate Solutions.[24] This approach is affirmed by Efficiency Maine's Community-Based Renewable Energy Pilot Program and the proposed feed-in tariff legislation, which offers special financial incentives for projects created within a "renewable energy opportunity county" defined by its lower-income demographic profile. This incentive pushes investment opportunities towards smaller, rural communities in Maine, where innovation can have the shortest turnover cycle and largest impacts per capita.

Meanwhile some studies indicate that the political atmosphere at national and state echelons is so inimical to energy transition and that its inertia is intractable. A regional approach, though less efficient in relation to scale, is more likely to succeed. Since "the political forces needed for major changes in U.S. energy policy are not in place," as one observer notes, progress with renewable energy deployment is more likely when "action can be taken at the margin."[25] Community-owned energy production models can transform the wider energy economy if self-supporting trust networks are enabled both within and between communities and other partners.[26] One study from the UK notes that such potentials are vastly overlooked in current policy debate.[27]

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[23] This addresses the capital market barriers that can inhibit efficiency purchases. According to Brown's 2001 study, different energy producers and consumers have varying access to financial capital, and at different rates of interest. In general, energy suppliers can obtain capital at lower interest rates than can energy consumers, resulting in an "interest rate gap."

[24] Tucker, Libby. "Cities Use Creative, Targeted Lending to Speed Energy Projects" in the *New York Times*, January 6, 2009. (link here)

[25] Keohane, R. & D. Victor. "The Transnational Politics of Energy," in *Daedelus* Winter 2013, Vol. 142, No. 1: 97-109. (link here)

[26] Rifkin in *The Third Industrial Revolution: How Lateral Power Is Transforming Energy, The Economy, And The World*. New York: Palgrave Macmillan: 2011 (link here) argues, "localised energy production creates the potential for a 'third industrial revolution' that could generate thousands of jobs and business opportunities through the creation of a distributed 'energy internet' – a system in which individuals can produce, deliver and receive renewable energy generated nearby."

[27] "The focus on drawing new suppliers into the existing energy market and providing consumers with greater choice or purchasing power may bring bills down or limit their increase, but continues to treat the public as passive consumers rather than potential producers and 'market-makers' – those who are able to build and develop sustainable models for wider public good." in "Re-energising Our Communities: Transforming the Energy Market through Local Energy Production" by C. Julian and J. Dobson, a ResPublica green paper, 2012. (link here)

☑ lower transaction costs

Numerous studies demonstrate that consumers invest in upgrades of their buildings, appliances, cars, and other equipment for safety, health, comfort, aesthetics, reliability, convenience, and status reasons. Though it promises undisputed benefits and substantial cash savings, energy efficiency rarely is a high priority issue relative to these other factors.[28] What stands in the way may be a lack of trustworthy information about and intuitive access to the competing options, such that the "transaction costs" of obtaining information and access are higher than the perceived returns. Measurable ways to lower barriers include:

1.) reduced interest rates (interest buy-downs or earmarked loans),

2.) deductibility of interest payments;

3.) stretching underwriting criteria to include anticipated energy savings in the calculation of debt-to income ratio;

4.) loan guarantees and reserves to enable lenders to offer below-market rates to a wider pool of borrowers;

5.) rebates offering a direct payment for implementing certain efficiency measures;

6.) subsidized transaction costs like free legal advice or energy audits before and after the installation of new systems or efficiency upgrades; and

7.) revision of building codes and permitting regulations to make the startup process for renewable energy developers quicker, easier, less costly, and less complicated.

[28] T'Serclaes, Philippine de, & Nils Devernois. "Promoting Energy Efficiency Investments: Case Studies in the Residential Sector" Paris: OECD/IEA and AFD, 2008. (link here)

6. DEPLOYMENT COST & IMPACTS

6.1. impact yardsticks

The spirit and intent of this report affirms, in a general way, the idea that development and consumption of renewable energy is superior to its non-renewable counterparts in relation to collective health, wealth, and sustainability. This assumed superiority has less to do with current pricing and markets than with anticipated aggregate outcomes in the following areas of concern:

a.) productivity & income growth

b.) wealth retention & expanded employment opportunities

c.) health & environmental safety

d.) macroeconomic stability & governance

e.) equity & energy access

f.) energy security & supply volatility

This said, it is well known that off-the-shelf prices of renewable energy development and consumption are often higher than existing sources. It is also notoriously difficult to estimate apple-to-apples costs and benefits among currently competing energy sources and systems, let alone the extrapolation of future pricing and commercialization rates. Most elusive of all are predictions regarding a broader impacts – the 'multiplier effects' – of particular source of energy, especially when it involves newer technologies that are largely untested, like offshore wind for example. Problems inherent to these kinds of predictions include:

1.) reliance on static input-output models that ignore dynamic price and competitiveness impacts of energy policies over time;

2.) lack of reliable program cost and impact data, cited apples-to-oranges;

3.) use of misleading hypothetical potential scenarios based on maximum achievable savings and minimum achievable costs;

4.) lack of reliable information on program spending patterns and outflows;

5.) the tendency of end-users to increase their consumption as energy becomes less expensive on a per unit basis;

6.) excessive focus on job creation benefits without sufficient attention to related job losses and economic impacts as energy systems become less labor-intensive.

Despite all this, there is utility in making estimates of renewable energy development impacts, in part because the difficulty and expense of expansion in this sector call for compelling arguments – on social, environmental, and economic grounds at a minimum – to persuade policy makers and investors to take the steps needed to encourage transition from non-renewable to renewable energy systems at a scale that is positively consequential.

As a result, many researchers have attempted to quantify these future impacts of expanded renewable energy deployment (or the penalties of low expansion), resulting in 'rules of thumb' like the following:

* On average, for every billion dollars invested in green recovery scenarios by the study reduce annual CO_2 emissions by 592,600 tons, create 30,100 jobs and save the economy $450 million per year in energy costs, which can serve as a sort of "efficiency pay-go" for government outlays, while national investment in renewables will bring $50b in tax credits to finance building retrofits, $46b in direct government spending to support new investments in renewable energy, and $4b in federal loan guarantees for retrofits.[29]
* According to the U.S. Department of Energy, every dollar invested in building its weatherization program returns $1.67 in energy-related benefits, $1.07 in non energy-related benefits, and leverages $1.54 from other sources,[30] while each $1m invested creates 52 "direct jobs" in the installation of weatherization measures and another 10-20 jobs in the production of energy-efficient building materials.[31]
* The renewable energy projects construction- and installation-related expenditures funded by the §1603 Treasury Grant Program are estimated to have supported an average of 52,000-75,000 direct and indirect jobs per year over the program's operational period (2009-2011), a total of 150,000–220,000 job-years. These expenditures are also estimated to have supported $9-$14 billion in total earnings and $26-$44 billion in economic output over the same period.[32]
* A green stimulus of USD_{2005} 90.7 billion could create roughly 2 million jobs nationally, while in Maine it was anticipated that $160m spent on energy-efficiency retrofits would create more than 3,000 additional jobs in the state.[33]
* If Maine adopted optimized energy efficiency measures, the non-manufacturing commercial sector could save about $230m each year.[34]
* Assuming half of the proposed new wind projects in Maine are built in the future, bringing an additional 625 MW online with a total investment cost of $2,563/kW, they would bring approximately $560 million of investment to Maine, resulting in a cumulative 2% increase over current GSP and the creation of roughly 11,700 jobs during construction, leading to a stronger industry knowledge base, improved air quality, fuel cost savings and diversification benefits.[35]

Because impact assessment methodology remains a contentious realm among researchers, many voices question sunny estimates like the ones cited here.[36] The data above certainly raise important questions regarding the compatibility of units, time frames, and contingencies for comparison. In the impacts assessment that follows, we use conservative figures, assumptions, and methods in order to approximate costs and benefits of expanded renewable energy deployment in Down East Maine.

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[29] T. Houser, S. Mohan & R. Heilmayr. "A Green Global Recovery? Assessing US Economic Stimulus and the Prospects for International Coordination," for the Petersen Institute for International Economics, World Resources Institute Policy Brief: Feb. 2009. (link here)

[30] U.S Dept. of Energy Office of Renewable Energy and Energy Efficiency report, May 2009. (link here)

[31] Millhone, John P. "The 'Longest Running and Perhaps Most Successful' U.S. Energy Efficiency Program," Fed. of Am. Sci. 2008. (link here)

[32] Steinberg, D.; Porro, G.; Goldberg, M. "Preliminary Analysis of the Jobs and Economic Impacts of Renewable Energy Projects Supported by the §1603 Treasury Grant Program." NREL Report No. TP-6A20-52739: April 2012. (link here)

[33] Pollin, R. et al. *Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy*. Washington D.C.: Center for American Progress, Sept. 2008. (link here)

[34] Jacobson, G.L., I.J. Fernandez, P.A. Mayewski, & C.V. Schmitt (eds). *Maine's Climate Future: An Initial Assessment*. Orono, ME: University of Maine, 2009. (link here)

[35] "MPUC RPS Report 2011 - Review of RPS Requirements and Compliance in Maine" prepared by London Economics International LLC for the Maine Public Utilities Commission January 2012. (link here)

[36] R. Michaels & R. P. Murphy. "Green Jobs: Fact or Fiction? An Assessment of the Literature" for the Institute for Energy Research: January 2009. (link here)

6.2. investment scenarios

It is understood that the development and deployment of any new energy production capacity is complex and expensive; even more so when – as is often the case with renewable energy systems – the associated technologies are new, unfamiliar, or both. In relation to renewable energy deployment in Down East Maine, it is safe to say that startup costs for expanded production are high for two elementary reasons: new technology transition is always capital-intensive, and the perceived risks of regionally unproven fuels and systems makes startup capital expensive. The cost of development coupled with the cost of money might be called a 'double jeopardy' for renewable energy projects in Down East Maine, as elsewhere. They are a daunting prospect and a gamble.

If this is so, why make the investments? Why not wait until the cost of renewable energy systems deployment is competitive in the open market, or wait for the non-renewable systems to evolve towards more sustainable forms? As noted above, some reasons not to wait are:

1. time is short to achieve great energy security and avoid hazardous climate benchmarks
2. non-renewable fuels are extracted and refined outside the State, so that related energy expenditures leave the regional (and often the national) economy
3. the low price of non-renewable energy depends on the externalization of hidden costs

If this is so, why not make the investments? Many of the reasons have been explored in previous sections of this report, especially in relation to the working group deliberations and findings from the community consultations. Prominent among them are:

1. insufficient access to reliable information, advice, and technical support, along with a lack of compelling demonstrations of renewable energy systems and savings
2. inadequate access to affordable investment capital for energy transition
3. market distortions favoring non-renewable energy fuels and systems

Because these barriers have to do with faulty perceptions (i.e., renewable energy is risk and unaffordable) and market failures (i.e. social cost of fossil fuel consumption), it may be argued that expanded renewable energy capacity is an expensive thing worth buying. In Maine, its return on investment is significant when investments reach an appropriate scale, renewable energy sources would keep expenditures on extraction, refinement, and distribution within the regional economy, and legislative measures (like LD 1559 and 1085) create serious incentives.

To explore the return on investment (R) for renewable energy deployment in Down East Maine, three scenarios are explored, where levelized costs [37] are projected for 2014-2019 in $\$^{2013}$:

S_1 = business as usual, continued renewable energy development at 2013 rates based on current Renewable Portfolio Standard and Efficiency Maine targets.

S_2 = expanded renewable energy development based on sstrengthened RPS targets and budgets allowing EMT to meet short and long-term targets.

S_3 = expanded renewable energy development based on S_2 plus additional investment from MPUC through Feed-In Tariff Legislation and strengthened RGGI to include a cap on carbon emissions from residential and transportation fuel.

[37] Please see the U.S. EIA's "2018 Levelized Costs AEO, 2013" report, tables 1 and 2. (link here)

In each future investment scenario, the "multiplier effect" is recognized for both existing and anticipated conditions, with the understanding that each scenario brings positive and negative impacts which be weighed and compared. These anticipated investment multipliers, as discussed above, must be approximate and borrowed from quantitative studies, since the scope of this project did not allow for the collection of statistically significant data of this kind.

As a baseline we can recall that, at of 2013, Maine has an installed renewable energy capacity of approximately 1.78 GW representing a total investment of approximately $8.48b, from which the Down East portions may be broken down roughly this way:

AREA	TYPE	INSTALLED (MW)	STATE TOTAL (%)	PENDING (MW)	INVESTMENTS (millions of $)	note
Down East	wind	219	50.8%	261.9	762	on- and off-shore
	solar PV	0	0.0%	-	-	
	solar therm	0	0.0%	-	-	
	geo therm	0	0.0%	-	-	
	conv. hydro	0	0.0%	-	-	
	marine	0.1	41.7%	0.9	21	including tidal
	biomass	165.3	27.1%	24.5	976	sustainable harvests
	efficiencies	-	-	-	13	voluntary, private sector
	public programs	-	-	-	19	Efficiency Maine Trust '02-'12
	total:	384.4	21.6%	287.3	1,790	figures for baseline R/E below

		BASELINE R/E 1995-2012	S_1 above baseline	S_2 above baseline	S_3 above baseline	NOTE
renewable power (installed MW)		384.4	451.4	1,001.8	1,151.9	S_2 is identical to S_3 with the added assumption that Maine adopts a FIT to generate a 15% increase[1] in renewable production over 5 years.
costs (billion $)	HIGH	1.90	1.26	4.21	4.97	emphasis here is on new renewable power deployment, so the figures rely on 'overnight capital costs'[2] per MW generation capacity (not counting operation & maintenance) with 10% increases for efficiency and subsidy programs.
	LOW	1.79	1.04	3.56	4.43	
benefits (billion $)	HIGH	5.20	3.45	11.54	13.61	using rough-estimate economic multipliers[3] and allowing for direct and induced impacts, savings, and avoided costs. High leverage estimates reflect optimistic U.S.-DoE efficiency program returns with a multiplier of $2.74 for each R/E $1 invested, while the low estimates reflect a leverage multiplier of $1.25 for each R/E $1 invested, lower than the lowest reported impact ratio to reflect market distortions, losses, etc.
	LOW	2.24	1.30	4.46	5.54	
CO_2 saved (million tons)	HIGH	1.12	0.75	2.50	3.69	assuming 592,600 tons of CO_2 reduction in GHG emissions per $1b spent on energy efficiency and renewables at the high end, and a full 60% less (355,560 tons per $1b invested) at the low end to account for inefficiencies.
	LOW	0.64	0.37	1.27	2.32	
green jobs (net job-yrs)	HIGH	16,951	59,029	157,950	139,725	using the Iowa model of 25,000 job-years per $1b for R/E, with green jobs as those "…essential to providing products or services that improve energy efficiency, expand the use of renewable energy, or support environmental sustainability."
	LOW	11,018	26,957	92,664	115,128	

1 This is a conservative estimate derived from the "Ontario Ratepayer Impact of Sustainable FIT Program" (link here)

2 These costs based on anticipated MW of renewable production capacity based on the U.S. Energy Information Agency's capital costs estimates report (link here) and the Efficiency Maine Trust's 2014-2016 Triennial Plan (link here)

3 The higher multiplier based on U.S Dept. of Energy Office of "Renewable Energy and Energy Efficiency" report, May 2009. (link here), and lower multiplier based on a conservative reading of the 1995 Iowan "Long-Term Economic Impact" study (link here)

7. SUMMARY FINDINGS & RECOMMENDATIONS FOR DOWN EAST MAINE

7.1. policies & incentives

In the annals of renewable energy study, an "efficiency gap" is the difference between actual investments in energy efficiency and higher levels of investment that would be cost-beneficial from an individual's or firm's point of view. There is, in this regard, an old tale of two refrigerators, in which a study tracked consumers given a choice in stores between two refrigerators identical in all respects except two: energy efficiency and price.[38] The energy-efficient model consumed 25% less electricity over its lifetime–providing an annual return on investment of about 50%–and cost $60 more than the standard, less efficient model. Despite these favorable economics easily grasped by the purchasers, more than half still chose the inefficient model. The higher purchase price of the efficient model was presumably the principal barrier. Remarkable behavior!

This is to say: 'market failures' and 'inefficient' energy consumption decisions are abundant. Some might conclude that a consumer unable to favor substantial ongoing savings over insubstantial one-time bargains (as above) is a hopeless case, no matter how sound his options may be. While these conditions are sobering, this report still finds a handful of ideas worth exploring further by those in Down East Maine who would like to expand energy efficiency. The sense of possibility is echoed by many credible studies, and there is reason to agree that "[m]omentum is building...but businesses, investors, activists, and scientists alone cannot change the way we produce and use energy...[they] can anticipate change, facilitate it, and profit from it, but they cannot drive it." [39] What are the tools and strategies, then that might drive it?

Based on best practices gleaned from the literature and findings drawn from this report, three strategic policy positions might be strongly suggested:

1.) Revoke "most favored nation" status for non-renewable energy incumbents.

The simplest way to enable the deployment and commercialization of renewable energy in Down East Maine, as elsewhere, is to insist that the price of non-renewable energy reflects its comprehensive social cost – to recognize and eliminate market "externalities" that make non-renewables seem more cost-effective than they actually are. This is a simple matter of removing costly distortions to the energy pricing framework, but implementation is anything but simple: "Since [1920]...economists have understood that pricing externalities is likely to be the best way to move behavior towards efficiency... in the context of electricity, this means taxes on emissions or a tradable permit system, but such market-based policies have garnered limited political support in the U.S. and elsewhere."[40] Progress towards the optimal solution appears generally constrained by political considerations in the American context.

Relevant tools are carbon taxes, carbon cap and trade regimes, life cycle cost accounting, the National Environmental Policy Act's "no action alternative" analysis, and strict emission standards.

☞ Detailed discussion is found in sections 2.3 • 3.3 • 5.2.2 • 5.3 of this report.

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[38] Meier, A. & Whittier, J. "Consumer Discount Rates Implied by Purchases of Energy-Efficient Refrigerators," *Energy* v.8, n.12,1983: 957–962.

[39] El-Ashry, Mohamed T. "National Policies to Promote Renewable Energy," in *Daedalus* Spring 2012, v.141, n.2: 105-110. (link here)

[40] Borenstein, Severin. "The Private and Public Economics of Renewable Electricity Generation," in University of California Energy Institute at Haas Working Paper #221R, 2010: 2. (link here)

2.) Lower barriers that stall market entry of renewable energy producers & consumers.

Throughout this report, would-be renewable energy producers and end-users have pointed to front-costs as serious obstacles to their forward motion. The picture that emerges is a high fence keeping individuals, institutions, and firms out of renewable energy's greener pastures.[41] A non-optimal alternative to removing market distortions associated with non-renewable energy production and consumption is the creation of new distortions that tip market scales in favor of renewable energy systems.

Relevant tools are subsidies, tax credits, renewable energy certificates, feed-in tariffs, loan product interest buy-downs, on-bill financing, and renewable portfolio standards.

☞ Details in sections 2.3 • 3.2 • 3.3 • 3.5 • 5.1.4 • 5.1.8 • 5.2.3 • 5.3 of this report.

3.) Prove that the more expensive choice is the less expensive choice.

It seems likely that access to information and technical guidance will allow many prospective renewable energy producers and consumers to take the plunge and buy the more expensive refrigerator – or its equivalent – in order to see it turn into the less expensive refrigerator. For many, this transformation needs to be understood with numbers and convincing demonstration in order to overcome or compensate for the high transaction costs associated with alternative energy adoption. Our associations with the more pricey, less costly, refrigerator should change, and the change would apply just as well to a new wind farm, solar array, heat district, or biomass plant.[42] Risk is distributed and participation stabilized when renewable energy consumers can collaborate with trusted local actors, act jointly, pooling investments, increasing buying power, and achieving efficiencies of scale not available to individuals.

Relevant tools are communication campaigns, heat districts, energy service providers, rigorous statewide monitoring projects, pilot and demonstration sites, 'early adopter' incentives, performance contracting, and free access to impartial information brokers.

☞ Details in sections 3.1 • 3.2 • 3.3 • 3.4 • 5.1.2 • 5.1.8 • 5.3 of this report.

The findings of this report indicate that policy support for these suggestions would enable deployment of renewable energy fuels and systems in Down East Maine at a scale likely to approach mandated energy mix targets. A few reasons why these kinds of policies have historically been difficult to enact are summarized on the next page.

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41 One study notes that these conditions fail to offer "a nimble platform for end-to-end innovation...rather, they suggest a business with high barriers to displacement of incumbents." Ernest J. Moniz, "Stimulating Energy Technology Innovation," in *Daedalus* Spring 2012, v.141, n.2: 83. (link here)

42 Another study observes that "...this shift in perspective converts the high costs and uncertain benefits of mitigating climate change into the manageable costs of mitigating climate change risks and the palpable benefits of avoiding foreseeable economic, social, and environmental damage." from M. Dworkin, R. Sidortsov, B. Sovacool, "Rethinking the Scale, Structure & Scope of U.S. Energy Institutions" in *Daedalus* Winter 2013, v.142, n.1: 129-145. (link here)

7.2. challenges to policy implementation

Though few contest their environmental benefits and long-term economic returns, entry of "more benign energy technologies" into the main stream of the power sector has been constrained by a range of obstacles nicely summarized in a 2006 study.[43] These chronic challenges include several that have already been addressed, like market entry burdens, price distortions, time-of-investment information from reliable and independent sources, insufficient access to affordable investment capital, and high transaction costs. Three others deserve special emphasis here:

a.) Foggy decision-making

It is difficult to choose the right systems, incentives, and penalties without convenient, consistent and transparent ways to determine savings. This job is complicated by price fluctuations (of fuels, transport, and labor) which can make today's projections invalid tomorrow. Decision-makers would benefit from a reliable, dynamic, apples-to-apples approach to relative costs and benefits over time with which to compare options and scrutinize the efficiency of decisions rendered.

b.) Inefficient market organization

Many renewable energy developers are hampered by what they perceive to be excessive or inefficient regulation based on codes that are not calibrated to newer technologies and the urgency of energy transition, a situation further complicated by tax rules geared for older technologies that require long depreciation periods. Adding drag to this process are conservative underwriting standards imposed by lenders unfamiliar renewable energy systems.

c.) Technology-specific barriers

Even under perfect market conditions, deployment of renewable energy systems depends on affordable access to the specialized skills required for installation maintenance. This raises the question of regional workforce capacity, training opportunities, and specialized labor distribution. Section 3.2 of this report provides a clear example of how potential investment in renewable energy is hampered by workforce constraints. In general, technical support for renewable energy systems – at both the industrial and residential scales – is insufficient to enable desirable levels of renewable energy deployment in Down East Maine. As the map of workforce development sites on the following page shows[44] (based on asset inventory data presented in section 4.2), the only training program in the region with a focus on energy efficiency is offered by the Washington County Community College. Because it is a prerequisite for many other investments, this may be the single most important challenge to be addressed by decision-makers in Down East Maine seeking to expand renewable energy deployment and adoption.

The Renewable Energy Working group and related research which furnished the substance of this report provide, at most, a starting point for more detailed exploration. Future efforts towards expansion of renewable energy deployment in Down East Maine might address the issues, potential, and challenges noted in this section.

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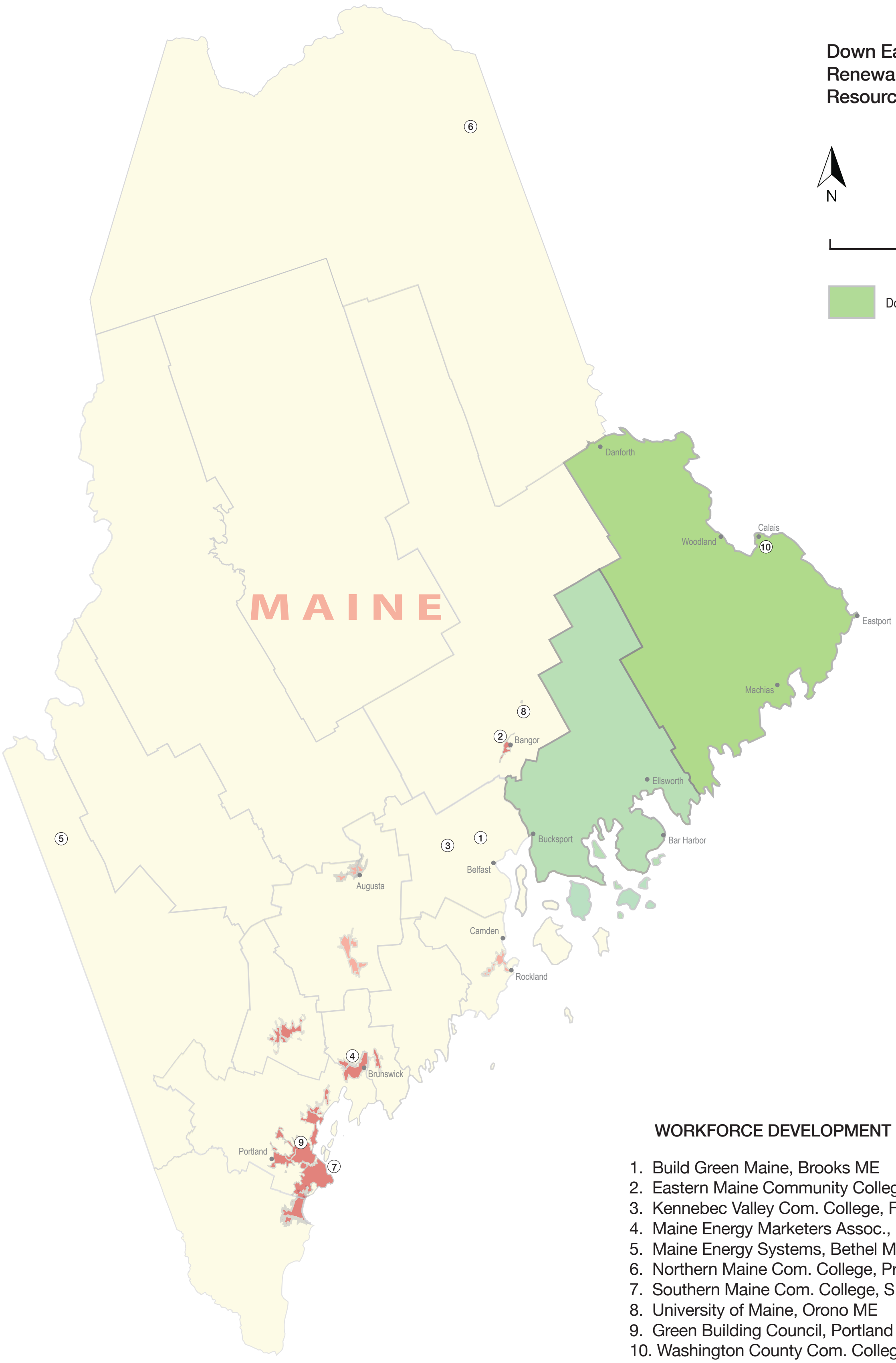
[43] Owen, Anthony D. "Renewable energy: Externality Costs as Market Barriers" in *Energy Policy* 34, 2006: 632–642. (link here)

[44] Beyond WCCC, commuting distances to specialized and comprehensive programs for technical training in renewable energy systems average 300 miles round trip – surely too far for most qualified recruits. Addressing this training gap may be among the most vital steps towards expanded renewable energy production and deployment in the region.

Down East Maine Renewable Energy Resources Inventory



WORKFORCE DEVELOPMENT SITES

1. Build Green Maine, Brooks ME
2. Eastern Maine Community College, Bangor ME
3. Kennebec Valley Com. College, Fairfield ME
4. Maine Energy Marketers Assoc., Brunswick ME
5. Maine Energy Systems, Bethel ME
6. Northern Maine Com. College, Presque Isle ME
7. Southern Maine Com. College, S. Portland ME
8. University of Maine, Orono ME
9. Green Building Council, Portland ME
10. Washington County Com. College, Calais ME

8. REFERENCES

The following citations appeared in the footnotes of this report and are repeated for easy reference.

Bhattacharya, J., T. DeLeire, S. Haider & J. Currie. “Heat or Eat? Cold Weather Shocks,” National Bureau of Economic Research Working Paper 9004, June 2002. (link here)

Borenstein, Severin. “The Private and Public Economics of Renewable Electricity Generation,” in University of California Energy Institute at Haas Working Paper #221R, 2010: 2. (link here)

Brown, M. “Market Failures and Barriers as a Basis for Clean Energy Policies” in *Energy Policy* 29 (2001): 1197ff. (link here)

Dworkin, M., R. Sidortsov & B. Sovacool. “Rethinking the Scale, Structure & Scope of U.S. Energy Institutions” in *Daedalus* Winter 2013, v.142, n.1: 129-145. (link here)

El-Ashry, Mohamed T. “National Policies to Promote Renewable Energy,” in *Daedalus* Spring 2012, v.141, n.2: 105-110. (link here)

Greenstone, Michael & Adam Looney. “Paying Too Much for Energy? The True Costs of Our Energy Choices”, MIT Department of Economics Working Paper No. 12-05: 2012. (link here)

Healy, J. D. & J. P. Clinch. “Fuel poverty, thermal comfort and occupancy: results of a national household-survey in Ireland,” in *Applied Energy*, 2002, vol. 73, issue 3-4: 329-343. (link here)

Houser, T., S. Mohan & R. Heilmayr. “A Green Global Recovery? Assessing US Economic Stimulus and the Prospects for International Coordination,” for the Petersen Institute for International Economics, World Resources Institute Policy Brief: Feb. 2009. (link here)

Jacobson, G.L., I.J. Fernandez, P.A. Mayewski, & C.V. Schmitt (eds). *Maine's Climate Future: An Initial Assessment*. Orono, ME: University of Maine, 2009. (link here)

Julian, C. & J. Dobson. “Re-energising Our Communities: Transforming the Energy Market through Local Energy Production” a ResPublica green paper, 2012. (link here)

Keohane, R. & D. Victor. “The Transnational Politics of Energy,” in *Daedelus* Winter 2013, Vol. 142, No. 1: 97-109. (link here)

London Economics International LLC. “MPUC RPS Report 2011 - Review of RPS Requirements and Compliance in Maine” for the Maine Public Utilities Commission, January 2012. (link here)

Maine Forest Service Assessment of Sustainable Biomass Availability, July, 2008. (link here)

Meier, A. & Whittier, J. “Consumer Discount Rates Implied by Purchases of Energy-Efficient Refrigerators,” *Energy* v.8, n.12,1983: 957–962. (link here)

Michaels, R. & R. P. Murphy. “Green Jobs: Fact or Fiction? An Assessment of the Literature” for the Institute for Energy Research: January 2009. (link here)

Millhone, John P. “The ‘Longest Running and Perhaps Most Successful’ U.S. Energy Efficiency Program,” Fed. of Am. Sci. 2008. (link here)

Moniz, Ernest J. "Stimulating Energy Technology Innovation," in *Daedalus* Spring 2012, v. 141, n. 2: 83. (link here)

National Research Council. *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use*. Washington, DC: The National Academies Press, 2010. (link here)

Owen, Anthony D. "Renewable energy: Externality Costs as Market Barriers," in *Energy Policy* 34 (2006): 632–642. (link here)

Pollin, R. et al. *Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy*. Washington D.C.: Center for American Progress, Sept. 2008. (link here)

Reddy, S., & J.P. Painuly. "Diffusion of renewable energy technologies – barriers and stakeholders' perspectives." in *Renewable Energy*, v. 29 n. 9, 2004: 1436. (link here)

Rifkin, J. *The Third Industrial Revolution: How Lateral Power Is Transforming Energy, The Economy, And The World*. New York: Palgrave Macmillan, 2011. (link here)

Sathaye, Jayant & Atiq Rahman. "Renewable Energy in the Context of Sustainable Development" in the Special Report Renewable Energy Sources and Climate Change Mitigation, for the Intergovernmental Panel on Climate Change, 2009, chapter 9: 761ff. (link here)

Steinberg, D.; Porro, G.; Goldberg, M. "Preliminary Analysis of the Jobs and Economic Impacts of Renewable Energy Projects Supported by the §1603 Treasury Grant Program." NREL Report No. TP-6A20-52739: April 2012. (link here)

Thaler, Jeffrey. "Fiddling as the World Floods and Burns: How Climate Change Urgently Requires a Paradigm Shift in the Permitting of Renewable Energy Projects", in E*nvironmental Law*, Fall 2012, v.42, n.4: 1101-1156. (link here)

Tirone, J. "'Dead-end' Austrian town blossoms with green energy" in *The New York Times*, August 28, 2007. (link here)

T'Serclaes, Philippine de, & Nils Devernois. "Promoting Energy Efficiency Investments: Case Studies in the Residential Sector" Paris: OECD/IEA and AFD, 2008. (link here)

Tucker, Libby. "Cities Use Creative, Targeted Lending to Speed Energy Projects" in the *New York Times*, January 6, 2009. (link here)

Unruh, G. "Understanding carbon lock-in." in *Energy Policy*, v. 28, n. 12, 2000: 817-830. (link here)

U.S. Dept. of Energy *Office of Renewable Energy and Efficiency Report*, May 2009. (link here)

U.S. EIA's "2018 Levelized Costs, 2013" online report. (link here)

Wilkinson, P. & Ben Armstrong. *Cold Comfort: The Social and Environmental Determinants of Excess Winter Death in England, 1986-96*. Policy Press, Dec 1, 2001. (link here)