Jamaica Draft Energy Plan
3-23-2018

Importance of Enhanced Energy Planning
Introduction
Energy planning is important to Jamaica because, as concerned and responsible citizens, we recognize the need to reduce carbon based pollution (CO_2) of the atmosphere through a realistically executable energy plan, one that preserves the nature of our town prized by both our residents and many vacation home owners. The objective of Jamaica's Town Plan revised energy section is to meet the requirements of ACT 174 which embodies the energy saving and sourcing goals of Vermont's 2016 Comprehensive Energy Plan in a manner that is consistent with Jamaica's long-standing Natural Resources, Land Use, and Economic Development policies.

Though Vermont's energy transformation may take years to implement, it will enhance the vitality of the state and local economy by reducing money spent on fuels pumped, mined or generated elsewhere, improve our health through reduced emissions and increased bicycle and pedestrian mobility options, and improve the quality of our local and global environment through reduced greenhouse gas emissions. This robust energy plan is used as a tool to advance the economic and environmental well-being of Jamaica, thereby improving the quality of life for its residents. Furthermore, these energy goals will reduce Jamaica's vulnerability to energy-related economic pressures and, in the long-term, climate change-related natural disasters, and promote long-term community resiliency in a variety of contexts.

The cost of energy in Jamaica, including residential, commercial and governmental use (for heating, electricity, transportation, etc.) is estimated to be $3,897,193 per year (see Energy Costs & Expenditures section below). Because a large majority of this energy is imported from outside of Jamaica and Windham Region, most of the money spent on energy does not directly benefit the local economy. Efforts to reduce the use of energy sources from outside the Town, or shift reliance to locally produced energy, can improve household financial security and strengthen the local economy.

From an environmental perspective, petroleum and other hydrocarbon-dependent energy is a significant cause of localized environmental damage where those fuels are produced and refined, and the emissions from their use is responsible for human-induced climate change, related climate-change disasters, and ecological degradation. Moderate summer weather and snowy winters are major attractions to the tourists and vacation home owners that are both essential to our economy and a major factor in our permanent residents decisions to live here. *Any efforts to reduce the use of non-renewable energy and shift to more environmentally-sound energy sources will benefit the town's environment by contributing, however modestly, to the moderation of greenhouse gas based climate change's effects on our local climate.*

The primary goal of the Energy element of our plan is to meet the Windham Regional Commission's (WRC) allocation of transportation and home heating energy savings and renewable energy sourcing targets in a manner consistent with preserving our town's rural nature and enabling technology and economic developments. Jamaica fully embraces the regional targets for renewable energy generation from solar sources as well as the goals for energy conservation in home heating and transportation. Preserving the town's natural environment is essential to Jamaica's economy and tax base. Many visitors to our state and virtually all of our town's residents value the area's natural beauty, including the state's most popular state park. For these reasons, commercial wind energy sources are not considered appropriate for Jamaica and are opposed. While

Windham Regional's plan does not presently assign a target for commercial wind generated renewable energy, it is Jamaica's policy to meet regional community renewable energy targets with solar generation only and to oppose commercial wind development as inconsistent with long-standing town policies. It is further considered that the regional targets based on current commercially available technology may prove to be very conservative by 2050, thereby diminishing the pressure for supplemental local commercial wind generation.

A second goal is to be a realistically attainable plan. By design, ACT 174 targets are aspirational. Several enabling technologies are necessary to achieve large-scale penetration of renewables into the power grid. These include energy storage, power electronics, smart grid architecture and technology, including grid control. Vermont's current limit on net metering, 15% of base load, is a reflection of the difficulty in accommodating the variable levels of renewable energy source output in the current power grid. Technologies that deal with the variable nature of renewable energy sources and exploit their geographical distribution are necessary to broad utilization of renewable energy sources. These technologies are in various stages of research and commercial development. The cost of renewable energy continues to fall and is predicted to be much less expensive than fossil fuel based sources. The combination of low cost energy and the technology to deliver it to all domestic and industrial energy users will in turn spawn economic models for meeting our goals with minimal capital expense and much reduced usage rates. Our plan will include efforts to keep abreast of these much-anticipated trends so that we may be able to take advantage of them as they develop.

Our third goal is to reduce our citizens' energy expenses. As mentioned above, prices for renewable energy, wind and solar, have continued to decline and are expected to bottom out well below those of fossil fuels. The spread between current fossil fuels and renewable sources will be sufficient to finance the upfront capital costs of installation within usage rates and still offer users considerably less expensive energy usage rates than are currently possible. Since energy is a significant expense for our citizens, anticipated savings from renewable energy will offer them considerable cost savings. We will promote conversion to renewable sources as soon as technology and economics enables.

While Jamaica can do little to shift the broader state or federal policies, we can influence energy use and production on a local level. In this energy plan, we hope to address Jamaica's local actions for increasing our energy efficiency and promoting renewable energy generation, and overall pathways to become more resilient. We will adopt policies to meet our specific goals as technology and economic developments permit.

Long-Term Vision & Petroleum Dependence

There is a trend toward factoring the "societal costs" into the price of energy; society pays for health costs associated with pollution, environmental clean-up, military protection of petroleum sources, and the continued failure of the Federal government to address the disposal of radioactive wastes. In the long-term, communities who depend on fossil fuels are vulnerable to risks associated with their price and production volatility.

These challenges may significantly increase the cost of conventional energy sources within the next ten to twenty years. As a result, Jamaica will seek to establish reliable energy resources for townspeople and municipal operations in order to hedge against the increasing volatility of hydrocarbon prices, and to reduce the environmental impact of our energy use. Should societal costs be added to energy from conventional sources, the spread between fossil fuel and renewable energy will increase providing increased market pull for the technologies enabling large-scale renewable energy grid penetration, i.e. 100% net metering, and business models making it more affordable. *The role of clean, alternative energy sources will be expanded and supported.*

Jamaica's Current Energy Use

The following paragraphs describe Jamaica's current estimated energy demand in detail. These current use

estimations provide a starting point from which the town can develop informed energy policies that directly address its current context and opportunities going forward.

In order to provide a more accurate picture of the energy planning requirements in Jamaica, energy consumption, generation targets, and efficiency targets need to be broken down into three distinct energy sectors. Those sectors are electricity, transportation, and heating.

Current Electricity Demand

*Jamaica's current electric energy supply comes from Green Mountain Power. Electricity consumption data from Efficiency Vermont was produced for each zip code in the state, and is the primary source of this information. This data set combines the energy supplied from all potential electricity providers to that town. It also separates the usage for both the residential and commercial or industrial sectors (*see Figure E2 below*).*

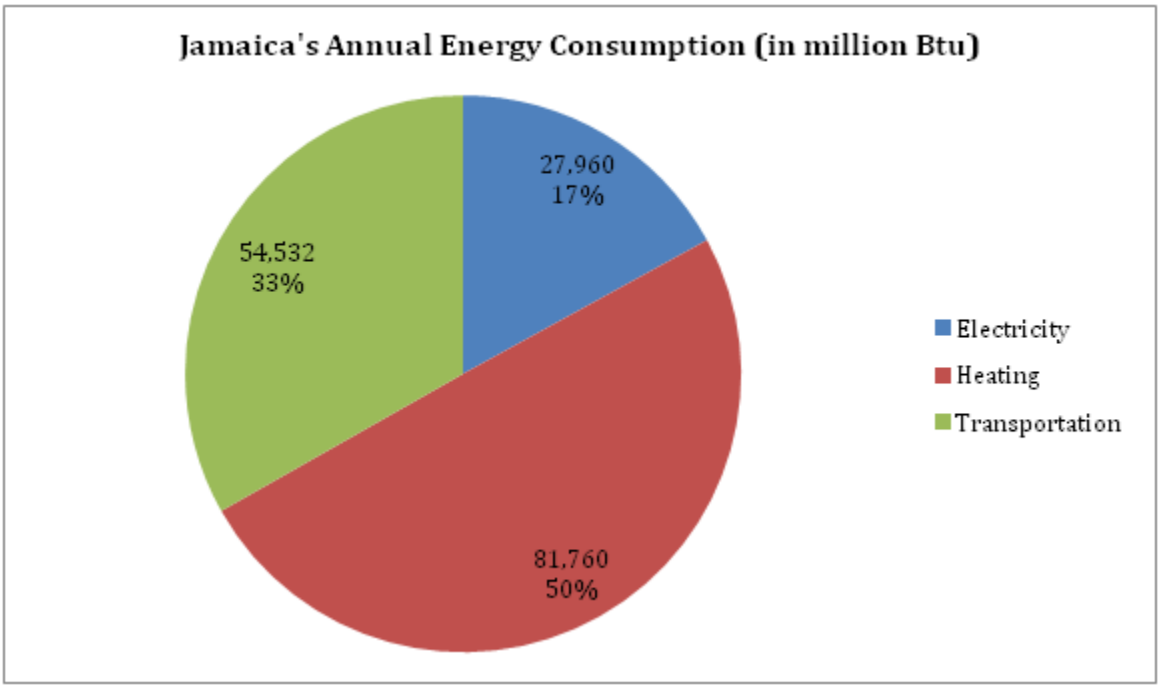

Figure E1

Figure E1 shows how energy consumed in the town is divided between these sectors. The sections below break down the calculations and describe the assumptions made to arrive at these final demand figures.

Because the rural nature of Jamaica is dominated by Jamaica Village residences and geographically dispersed full time and vacation residences, residential electricity far exceeds commercial and industrial use. Because of this, current residential use is the greater factor in our planning. *To translate this energy demand into dollar amounts, we can estimate a cost of $0.1435 per kilowatt-hour (Vermont state average for electricity costs across all sectors in 2015). Based on the above data, residences in Jamaica paid over 1 million dollars in 2014 for 7,103,157 kWh. Commercial and industrial facilities paid just over 156 thousand dollars for their 1,090,991kWh of electricity.*

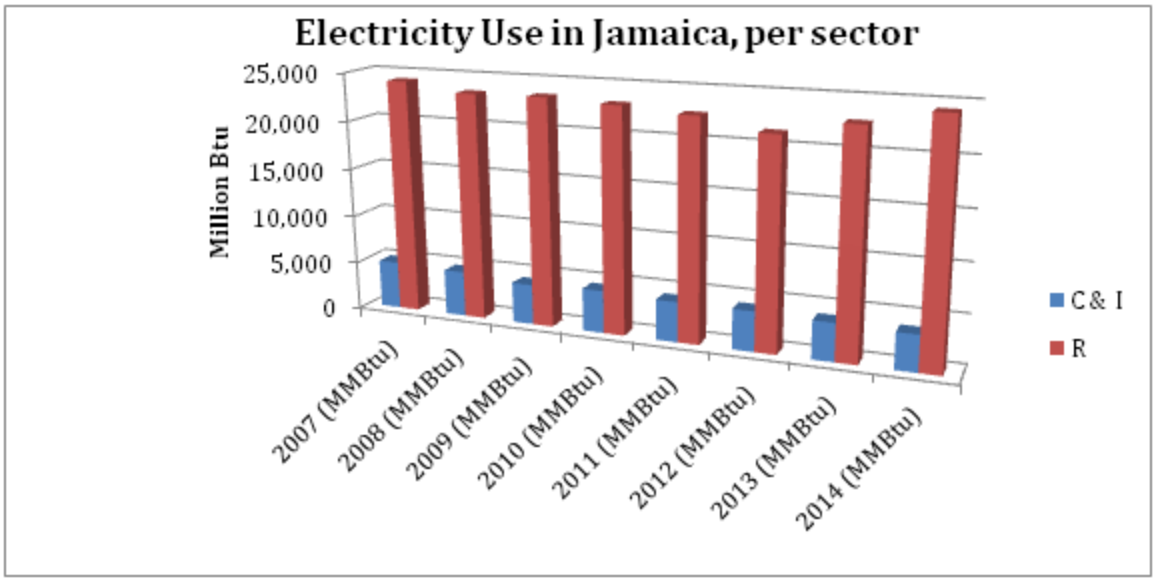

Figure E2

Figure E2 shows the electricity consumption by Jamaica Residential and Commercial and Industrial sectors.

Current Transportation Use

According to 2010 U.S. Census Bureau data, Jamaica has 790 primary housing units, (not vacant or used for seasonal/recreational purposes). Based on that number of households, it can be estimated that there are 1,356 light-duty vehicles on Jamaica's roads, which consume 927,504 gallons of fossil fuel each year. Below is a table summarizing the averages and estimates used to arrive at those figures.

790	Number of primary housing units.
1356	Number of fossil-fuel burning light-duty vehicles (LDV).
11,356	Estimate of the average annual number of miles travelled by an LDV in the area (for Vermont as a whole, total vehicle miles traveled per registered vehicle was around 12,500. The vast majority of LDV in Vermont can safely be assumed to drive between 9,000 and 15,000 miles annually).
22	Estimate of the average fuel economy of fossil-fuel burning LDV fleet in the area, in miles per gallon (statewide average fuel economy).
408,373	**Estimated number of gallons of fossil fuel consumed annually, calculated from the values above.**

121,259	Number of Btu in a gallon of fossil fuel, computed as a weighted average of the individual heat contents of gasoline (95%) and diesel (5%).
62,591	**This is the estimated total annual energy consumption of internal combustion vehicles in the area, in millions of Btu.**

Table E1

Table E1 Summary of Jamaica's Transportation Energy Use

To estimate the cost of this consumed energy, we assumed a cost of $2.34 per gallon (Vermont state average in 2015). In Jamaica, consumers spent over $955,692 on transportation related fuel costs alone.

Current Heating Demand

To account for the different building types and their respective uses, the following estimates divide thermal energy demand by either residential or commercial use (industrial building thermal demand is not included).

For residential buildings, it was assumed that average annual heating load of area residences is 110 million Btu, for both space and water heating (Vermont state average). With 460 residential housing units, 23 commercial buildings, and 585 vacation homes in Jamaica, the state average usage yields an estimated 81,760 MMBtu annual total heat consumption.

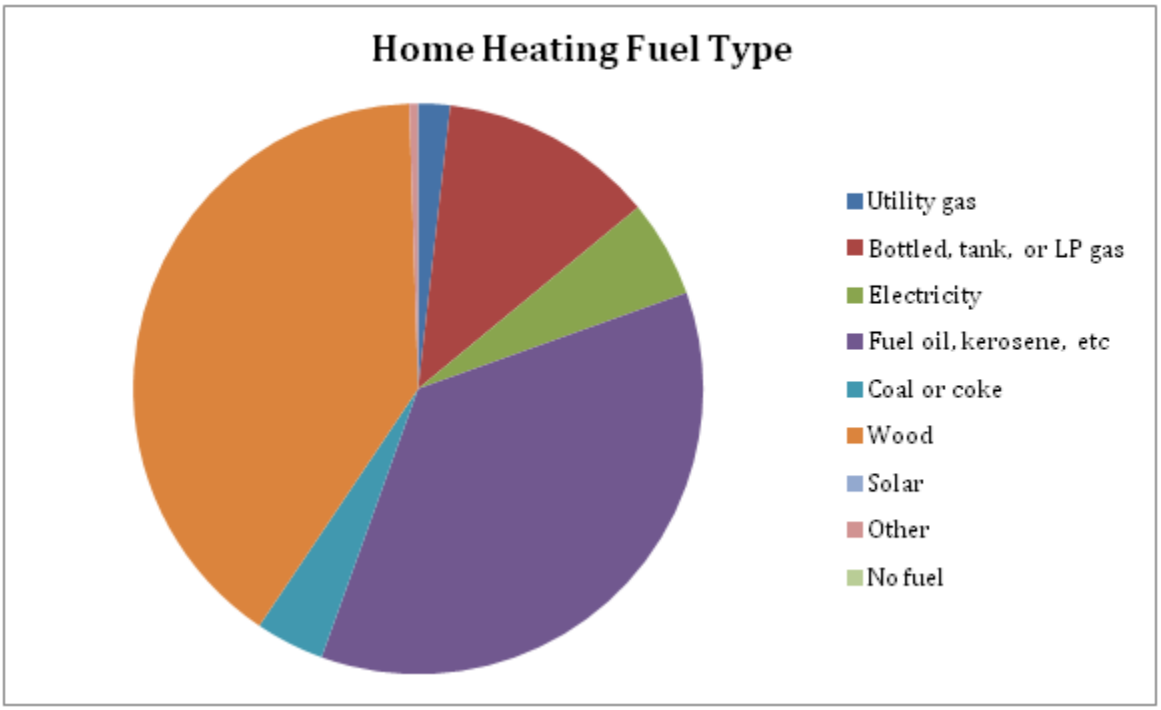

Figure E3

Figure E3: Use of home heating fuel in Jamaica by type

Furthermore, census data also provides information on the home heating fuels used for both owner-occupied and renter-occupied housing units (both are considered "occupied"). Figure E3 above shows the percentage of fuel use by fuel type.

For residential and commercial buildings, an estimated total of just over $1.8 million was spent in home heating (roughly $1.67 million from home owners and $330,000 from renters).

In Jamaica, there is also a high percentage of seasonal homes (44% of housing units are primary/"occupied" homes, while 56% are seasonal/"vacant" homes). Based on the energy model projections from the state (created by the LEAP, or Long-Range Energy Alternatives Planning model), it can be assumed that seasonal homes only use about 15% of the energy of a primary home, due to more occasional use and a presumed higher energy efficiency. As such, seasonal homes in town are estimated to consume about 7,590 MMBtu annually (compared to the 50,600 MMBtu for primary residences).

For commercial establishments, it is estimated that the total heating load is 650 MMBtu each year. For the state, the average is in the range of 700 MMBtu to 750 MMBtu per year, but the average for any given area is very likely to be significantly higher or lower, as the mix of businesses from region to region is highly variable. Based on the types of commercial buildings in Jamaica, the heating load was calculated to be less than state average. With 23 commercial establishments, there is an estimated thermal energy demand of 21,500 MMBtu. These businesses pay about $770,000 each year in heating expenses.

Total Energy Costs

In sum, Jamaica pays a staggering amount in energy across the three use sectors. The total estimated cost to the town for electricity, heating, and transportation is roughly $3.9 million dollars each year. There are real financial incentives for the town to move toward energy efficiency, on behalf of both the residents and its business owners (see section "4. Jamaica's Energy Targets and Conservation Challenges" of this plan for more detail about energy efficiency and conversion targets).

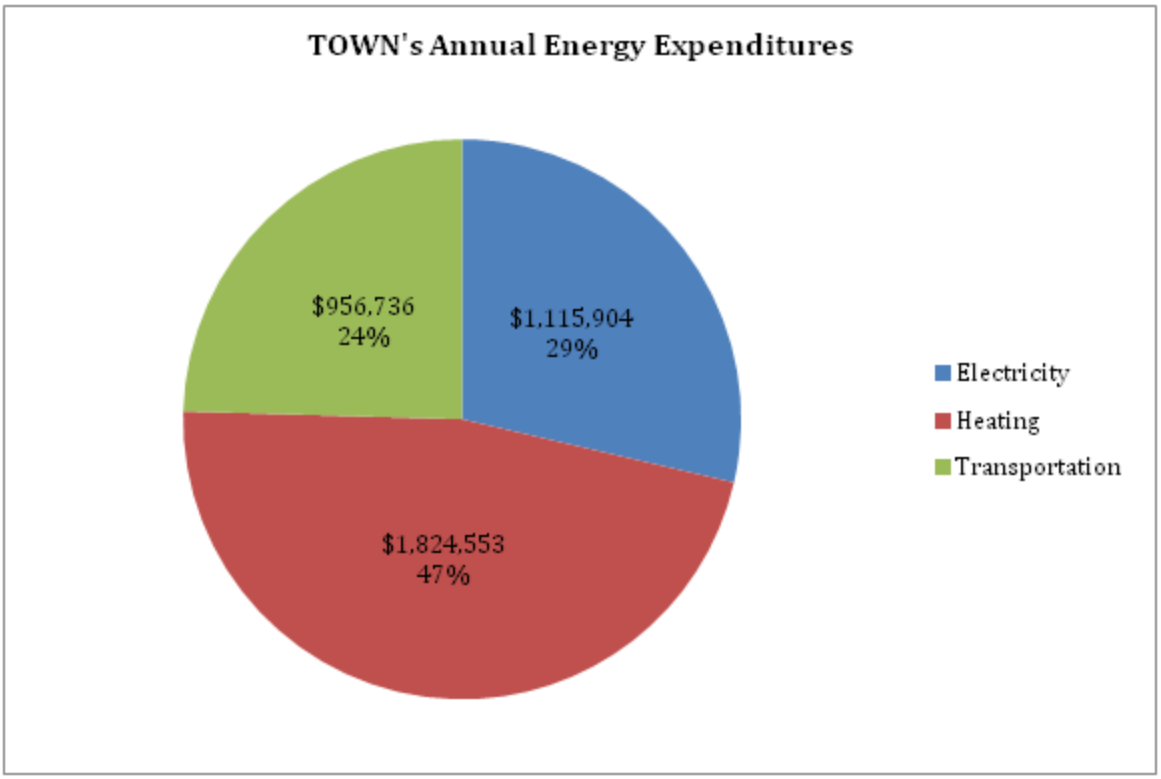

Figure E4

Figure E4 Jamaica's energy costs by energy category

Jamaica's Resources, Constraints, & Potential for Energy Generation

Energy resources within Jamaica are all renewable resources: wood, solar, hydro, and residential wind. In order to reduce dependence on conventional energy sources, of which the costs and availability are outside residents' control (see the section above), the use and generation of appropriately sited *alternative energy sources is encouraged.* Additionally, Jamaica may share a unique resource with neighboring Townshend in the Ball Mountain and Townshend Dams that may be suitable for a hydroelectric pumped energy storage system.

Photovoltaic (PV) Solar Potential

PV Solar renewable energy trends support high potential for meeting Jamaica's overall renewable energy generation targets with a PV solar only strategy. While State and regional plans are aspirational, it is considered that conversion to renewable energy sources will be driven by economic considerations. Jamaica residents most likely will act in what they perceive to be their economic self-interest. We anticipate that the falling price of renewable energy, particularly PV Solar, will align our residents' economic interests with meeting our targets for PV solar conversion. Figure E6 below shows the declining prices of PV solar and wind renewable energy in comparison to that from coal and natural gas. Cross-over of renewable sources with fossil fuel sources is anticipated to occur in 2022 according to this Bloomberg data.

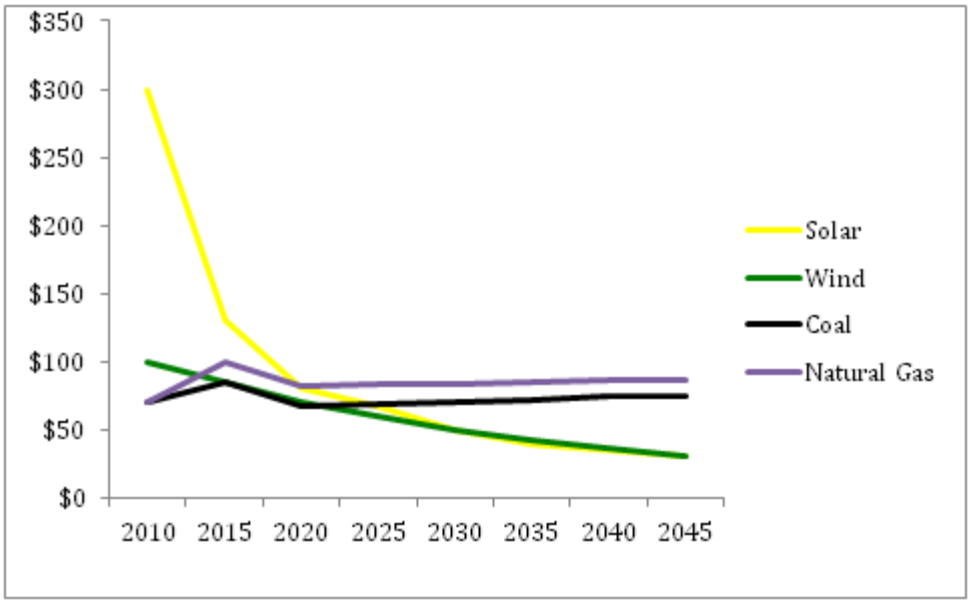

Figure E5

Figure E5 Cost per MWHr by fuel type; source: Bloomberg New Energy Finance as reprinted in April 2017 National Geographic

Large PV Solar generator projects scheduled for completion beyond this date are anticipating usage rates well below the $0.14 current average. The spread between current and anticipated future usage rates from PV solar sources will finance innovative business models. Homeowners will be offered a variety of energy loans or lease-based financial products with little or no capital requirements for installation of PV solar systems that will include usage rates well below current averages. Venture capital most likely will be readily available for financing consortium-based community PV solar generators.

Solar Panel efficiencies currently available are in the 17% to 18% range, somewhat better than the 15% assumed in the 2016 CEP. However, there are a number of research efforts to improve solar cell efficiency. As of 2016, various solar cell efficiencies ranging from 20% to 46% have been demonstrated in laboratories[1]. The time and effort required to transition laboratory results to production solar panels cannot be predicted with certainty and expectation of near term availability is not reasonable. Nevertheless, in the 32 years until 2050, it is entirely reasonable to expect that these research efforts will result in major improvements in PV solar source efficiency. Efficiency improvements will in increase power outputs, make marginal sites viable, and reduce required footprints for given output levels -- all of which will lower costs. It is likely that in retrospect, targets assigned in 2018 will seem very conservative by 2050.

A vigorous national research and development effort is underway to enable large scale penetration of renewable energy sources into the nation's power grid. These include a revolution in the grid itself, reorganizing it into a "smart grid", a network of "micro-grids" which include local generators, users, and energy storage. Micro-grids will be the building blocks of the larger smart grid and be capable of being controlled as if they were a single net metered user transferring energy in and out of the larger smart-grid. They will also be capable of "island mode" or stand alone operation independent of the larger network. Consuming and storing energy where it is generated will provide significant energy savings, as much as 30% s relative to current grid operations.

[1] M. Malinowski, J.I. Leon, H. Abu-Rub, Solar-Photovoltaic and Thermal energy Systems: Current Technology and Future Trends, Proceedings of the IEEE, Vol.105,no 11, November 2017, pp 2136

Enabling Technologies

Large scale penetration of the power grid by renewable energy sources is dependent on several enabling technologies.[2] The fluctuating nature of renewable power sources makes maintaining grid power quality difficult. Vermont's current limitations on net metering result from the difficulty in accommodating fluctuating and intermittent power generation from solar and wind sources. In the absence of devices and controls that support efficient grid-based energy from renewable sources, homeowners converting to PV solar energy generation will be forced to operate in a virtual off-the-grid mode in which power in excess of that needed onsite is wasted, i.e. shunt to ground rather than sold; occasionally they may draw power from the grid if not physically off the grid. Community generators will be forced to sell power to the wholesale market on an opportunity basis. Returns from capital investment will be reduced below the level that full utilization of the generators can produce. While ideal for some remote locations, large scale realization of off-grid operation of renewable energy sources will be inefficient and create major difficulties for those homeowners that have not converted to renewable energy sources.[3] Those remaining customers will have to bear the cost of GMP's distribution system resulting in much higher rates.

For these reasons, technologies necessary to effectively integrate renewable energy generation on a scale envisioned by this plan must be broadly available. These technologies are in various stages of research and development. Their commercial availability will pace the rate of conversion to PV solar energy and supporting business models. These technologies are energy storage, solid state power electronics, smart grid architecture, and smart grid control, including control algorithms and their distributed high performance computing based implementation.

Energy Storage

Energy storage is considered fundamental to integrating PV solar energy generation into the power grid. There are a number of technologies that provide energy storage; mechanical, electrical, electrochemical, chemical and thermal.[4] Energy storage technology will provide a number of essential services to future smart grid components. Those of relevance to a possible West River Valley based microgrid element of a regional or state smart grid are: (1) electrical storage devices for maintaining power levels and quality over short periods of time (seconds to minutes) and (2) electrochemical (battery) storage systems that provide peak shaving and longer term (hours to days) load leveling. Additionally, battery storage at the microgrid level will allow separation of the times of energy generation and delivery to users. The ability of battery-based energy storage to absorb peaks of fluctuating power from renewable generators and deliver needed additional power during valleys of generation to maintain a constant power output is absolutely essential to lifting the stringent limits on net metering. PV Solar generators with adequate energy storage with the right controls may be treated similarly to hydro sources in that power may be put on the grid at predictable times and levels. In its absence, PV solar generators would have to operate in a virtual off-the-grid mode as described above.

Pumped hydroelectric storage systems are responsible for the bulk of the world's energy storage.[5] These normally are massive systems consisting of two reservoirs separated in elevation and a pump/generator at the

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[2] M. G. Molina, Energy Storage and Power Electronics Technologies: A Strong Combination to Empower the Transformation to the Smart Grid, Proceedings of the IEEE, Vol. 105, NO 11, November 2017, pp 2191

[3] Vermont Department of Public Service, 2016 Comprehensive Energy Plan (2016 CEP), Chapt. ___, pp___

[4] M. G. Molina, Energy Storage and Power Electronics Technologies: A Strong Combination to Empower the Transformation to the Smart Grid, Proceedings of the IEEE, Vol. 105, NO 11, November 2017, pp 2191

[5] M. G. Molina, Energy Storage and Power Electronics Technologies: A Strong Combination to Empower the Transformation to the Smart Grid, Proceedings of the IEEE, Vol. 105, NO 11, November 2017, pp 2210

lower reservoir. Water is pumped up to the upper reservoir with electrical energy to be saved as kinetic energy and released to flow to the generator at the lower reservoir to be recovered as electrical energy. Costing hundreds of millions of dollars to build, they are used to store GWH of energy for large energy providers. While not feasible now because of dam limitations and shoreline erosion concerns, Jamaica is investigating the possibility of a more modest pumped hydro energy storage system utilizing the Ball Mountain and Townshend dams if dam and environment concerns are addressed.[6] Since the dams are already in place, the major cost of building a pumped energy system can be avoided. If the dams are strengthened and shoreline soil erosion is mitigated, such a system could provide bulk energy storage for a potential future West River Valley based micro grid.

Smart Grid

By 2050, the 2016 CEP envisions a radical reorganization of the power grid into what as become known as the smart grid. In concept, the smart grid is a inter-connected network of micro grids. Micro-grids are smaller connections of power generators, energy storage, and power users. Generators may be both residential and community-based PV solar generators and energy storage may be both "behind the meter" and at the community generator level. Micro grids will be controlled as a single entity, a single unified producer and consumer of electrical power, and capable of operating as a externally controlled element of the larger smart grid or in a stand alone, "island" mode.

The smart grid will network micro grids, providing exchange of power among them and providing power to them on those occasions when local sources are inadequate, e.g. during prolonged periods of overcast skies when PV solar generation is inadequate. A certain amount of conventional power generation will be at the smart grid's disposal for this purpose, but its use will be limited and more importantly predictable well in advance of need. Consuming power locally where generated and better controlled transfer of power directly from centralized generators to micro-grids will avoid transmission losses the grid currently experiences saving 5% of current electrical energy generated.[6]

Power Electronics

Power electronics are those devices found in inverters and transformers needed to transform the output of renewable energy generators to 60 cycle AC power homeowners and business users consume. Other power electronics are used in the grid to transform power between AC and DC currents and between different voltage levels for long haul transmission. An emerging form of power electronics is the Flexible AC Transmission system components to be used in the smart grid to support active control of power. Local consumption of power in micro grids where generated and flow in and out of micro grids when needed will require external control of these devices by the smart grid control system.

Smart Grid Control

Control of the smart grid is envisioned to be implemented on a distributed computing network of high performance computers, e.g., distributed cloud computing. Control algorithms for control of the smart grid and the hardware and software computing architecture are in the conceptual stage of research and development efforts.

Solar Constraints

The above discussion of enabling PV Solar technology is to make the point that the pace at which the technology necessary to integrate renewable energy generation into the power grid will constrain the rate at which Jamaica, and the rest of the state, can adopt it. Jamaica fully accepts the WRC targets for PV solar energy generation and their scheduled implementation as the best estimate of what can be achieved based on

[6] U.S. energy Information Administration (EIA), https://www.eia.gov/tools/faqs/faq.php?id=105

the 2016 CEP. However, we expect that near-term targets will be subject to change as the pace of enabling technology reaching market availability becomes clearer. We expect that as the technology is realized as products, business models that make it attractive to consumers will quickly follow. As Jamaica residents and vacation home owners become aware of PV solar systems available to them at energy cost savings, we expect them to act in their economic self interest and expeditious conversion to renewable PV solar energy will follow. Accordingly, it follows that a major part of Jamaica's path forward will be to maintain awareness of the state of PV solar enabling technologies and supporting business models so that our residents and vacation homeowners may be made aware of their availability at the earliest opportunity.

Wind Potential and Constraints

Jamaica does not consider industrial scale wind to be an acceptable source of renewable energy as its introduction in potential wind energy regions of the town is inconsistent with other elements of our Town Plan and detrimental to the town's economic interests. While the WRC plan assigns 0 acres as the target for wind generation, this energy plan establishes the town's opposition to industrial wind independent of regional targets. This plan does not oppose residential-scale wind generators when consistent with other elements of the town plan. The WRC targets assign 0 acres for residential wind generation and identifies 1060 acres available for residential wind energy generation. It is considered that residential wind installations would be beneficial supplements to PV solar generators, and particularly useful in areas where PV solar may be impractical. The above discussion of enabling technologies applies to residential wind sources as well.

Ridge Line Protection

It is a long standing policy of Jamaica to protect the ridge lines of surrounding mountains from commercial and residential development.[7] The town's natural beauty, particularly its forested ridgelines, are the main attraction for our full time residents, vacation home owners, and the many visitors we enjoy. Jamaica is home to the State's most popular State Park. The views of surrounding ridgelines are one of the major attractions of this enjoyed by visitors to this park.

Specific ridge lines that are to be protected from development include the Pinnacles, Sage Hill, and Mundal Hill. Ridge lines associated with these mountains are viewsheds shared both by Jamaica and neighboring Stratton resort area. Ridgelines of Cottage Hill, Ball Mountain, South Hill and the peak overlooking Adam Pond surrounding Jamaica State Park are viewsheds included in Jamaica's protected ridgelines as viewsheds enjoyed by the many visitors to Jamaica State Park. Shatterack Mountain ridgeline lies within Public land with a conservation easement and is a protected ridgeline. Turkey Mountain ridgeline lies within a special interest area and is protected. East hill ridgeline lies within a town conservation area and is protected. Turkey Mountain and South Hill ridgelines are important viewsheds for travelers along route 30 during fall foliage season and are protected ridgelines on that basis as well.

Environmental Concerns

Areas identified as secondary wind energy resources either lie within or adjacent to conservation areas.[8] Per the WRC Possible Constraints for Energy Generation Map, all the named peaks and associated ridgelines, except South Hill, lie in Vermont Conservation Design Highest Priority Forest Blocks. Deer wintering areas are located on the sides of Turkey Mountain and South Hill ridgelines. Location of commercial wind towers in these areas will cause severe environmental damage to these areas, interrupt wild life habits, and is some cases cause run off damage to local brooks and streams and the West River.

[7] Town Plan, Town of Jamaica, Vermont, November 13, 2017. Appendix

[8] Town Plan, Town of Jamaica, Vermont, November 13, 2017, Town Plan Maps, Proposed Land Use Map

The entire town of Jamaica lies within the West River Watershed and is included in the Vermont Department of Environmental Conservation (VDEC) Basin 11 Strategic Plan. The ridgelines listed above all overlook tributaries or smaller brooks that empty into the West River and are governed by the VDEC Basin 11 strategic Plan. Run-off from industrial wind turbine sites if located on protected ridgelines would cause unacceptable levels of contamination the West River, Ponds and Wetlands included in the Jamaica Watershed.

Economic Concerns

A large part of Jamaica's economy is centered on tourism or providing goods and services to vacation homeowners. The natural beauty of the town's forests and mountains are a major draw for both. Vacation home owners are both summer residents and winter residents taking advantage of the nearby ski resorts. Vacation homes constitute the major portion of the town's grand list. Any industrial wind installations degrading the natural beauty of the area will adversely affect property values an increase in the tax burden of full time residents and reducing the considerable contribution of Jamaica tax revenue to the State's Education Fund. Additionally, commercial wind installations located on the town's western ridgelines of the Pinnacles, Sage Hill, or Mundal Hill will effect on neighboring Stratton as well.

Jamaica is undertaking economic development efforts, infrastructure improvements, and outreach efforts to attract new businesses and residents. The area's natural beauty is one of the advantages we are offering to potential new residents.

Necessity

Commercial wind renewable energy is not necessary to meet the WRC targets for renewable energy generation. PV Solar alone will be sufficient. If as expected the next 32 years sees substantial improvement in PV solar efficiency, the goals established by the WRC plan will prove to be conservative and easily exceeded with PV solar energy alone.

Potential Heating Energy Conservation and Constraints

Wood Heating

The fact that Jamaica's forests are able to supply significant quantities of cordwood for local cordwood businesses plus the ready availability of wood pellets heightens the potential for increasing the number of homeowners who heat with wood. The lower cost of heating BTUs from wood relative to fuel oil is an added incentive for wood heating. To the extent that Jamaica residents cut their own firewood, the cost of wood heating is further reduced. Further, Jamaica's extensive forest lands act as in important CO_2 sink.

However, there is an important caveat to encouraging a further increase in the use of wood for home heating. Burning wood is half of a CO_2 cycle. To be a recyclable source of energy, growing new trees must reabsorb the CO2 released from burning wood. Burning wood releases nearly as much CO_2 per BTU as heating oil. Growing a tree to replace a tree consumed will reabsorb the CO_2 released, but it will take the tree's lifetime. The CO_2 load in the atmosphere will build up until sufficient replacement trees establish equilibrium.[9] Figure E6 illustrates the effect for three scenarios.

[9] Vermont 2016 Consolidated energy Plan Chapter_____ pp._____

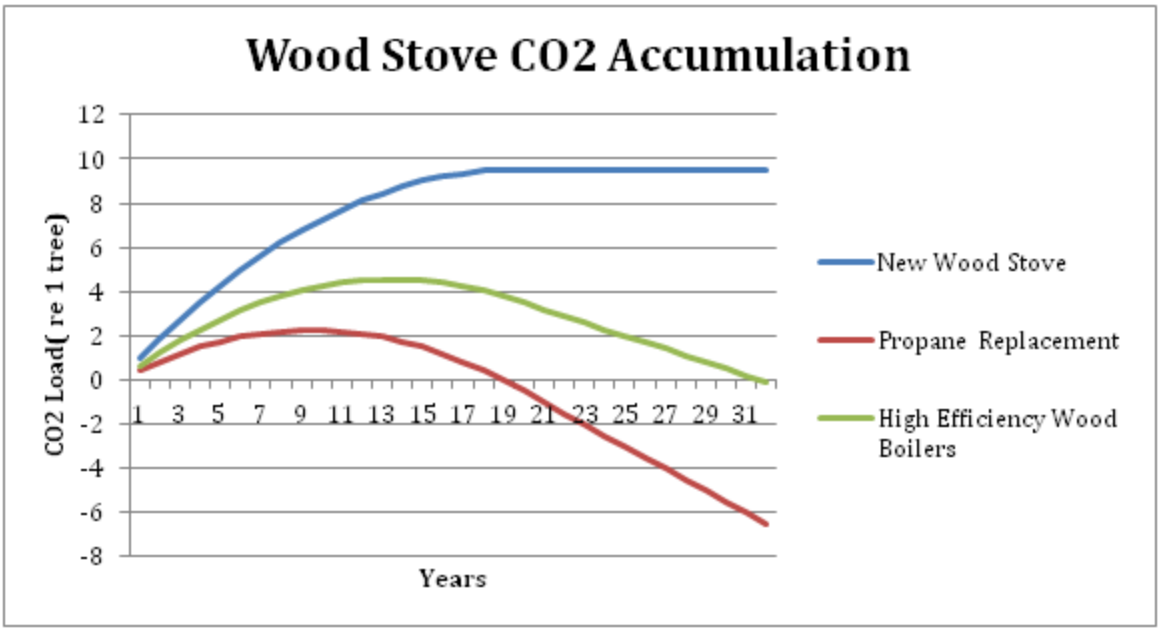

Figure E6

Figure E6 CO_2 atmospheric load buildup and dissipation for three wood heating conversion scenarios

Introducing a new conventional wood stove (blue curve) and tree-for-tree replacement of trees burned will cause build up of $_{CO2}$ until sufficient replacement trees have been planted to absorb the CO_2 released by each tree consumed. In this example, a 20-year life cycle is assumed, i.e. each replacement tree absorbs 5% of the CO_2 released per year. Replacement trees therefore absorb the CO_2 released by a single tree in 20 years and are then harvested to repeat the cycle. Equilibrium, CO_2 released by each tree consumed is equal to CO_2 absorbed after 20 years by a constant number of 20 replacement trees. Replacing an existing fuel heating oil system with wood heating would cause the same build up and equilibrium except instead of starting at zero CO_2 load, it would start from a load already established by burning fuel oil.

Heating with propane or natural gas releases approximately half the CO_2 per BTU as Fuel Oil. Therefore, replacing propane heating with wood introduces a net of half the CO_2 load per BTU as a new or fuel oil based system. This is the equivalent of two-for-one tree replacement. The red curve illustrates the initial $_{CO2}$ load build up from an initial level followed by a decline in CO_2 load as the number of replacement trees growing during their life cycle exceeds the number of trees required to absorb the CO_2 released by consuming each tree consumed.

Heating with a high efficiency wood pellet or high efficiency cord wood gasification boiler will have much the same effect. Increasing efficiency from 60% to 90% will have the effect of replacing each tree consumed with one and a half replacement trees (green curve). CO_2 load will build up to a higher level and decrease at a lower rate than two for one tree replacement.

To be effective in addressing the fundamental objective of the State's 2016 CEP, i.e., reducing the greenhouse gas loads from energy generation, use of wood for heating energy must be accompanied by responsible forest management. Firewood must be harvested at a sustainable rate and in a manner that assures replacement trees grow at a rate not less than one-for-one replacement. Greater would be better. Jamaica is largely covered in forests and Jamaica has had a long standing policy of encouraging responsible forest management practices.[10] While this policy has been motivated by esthetic and economic reasons in the past, promoting

[10] Town Plan, Town of Jamaica, Vermont, November 13, 2017, Natural Resources, p14

increases in the use of wood for heating energy must be accompanied by re-emphasis of good forest management to ensure Jamaica remains a CO_2 sink for itself and perhaps other less wooded towns.

A major constraint to conversion of current residential heating systems to high-efficiency wood heating is cost. High efficiency wood stoves and wood gasification wood boilers are expensive. Initial costs may be offset through the Department of Public Services Small Scale Renewable Energy Incentive program (SSREI) rebate offers for advanced wood pellet, and chip boilers and solar heating systems. The department also offers low interest loans through the Heat Saver Loan program to offset up front costs for energy upgrades that may be used to finance conversion to wood heating. Cost savings of wood pellets and cordwood relative to fuel oil, propane, and electricity heat will allow homeowners to recover conversion costs. Jamaica will ensure that citizens are informed of available financial assistance for conversion to high efficiency wood heating.

Heat Pumps

Heat pumps offer an efficient alternative to electric, propane and oil heating. This is because heat pumps move heat (calories) rather than create them through burning or passing electric current through electrical resistance.[11] In a manner analogous to electrical transformers, heat pumps extract calories from a large volume from outdoor air at a low temperatures and release it as a lower volume of air at a higher temperature indoors. Given their efficiency relative to fossil fuel heating, they offer homeowners significant cost savings. They lose their effectiveness at sub-zero temperatures, so on Vermont's coldest days they must be supplemented with a second heating source. Ground-based heat pumps that extract calories from the ground to heat indoor air and can deliver 100% of a building heat even on the coldest days. Because of excavation costs, they are costlier than air source heat pumps.

Depending on the source of electricity to operate them, the $_{CO2}$ load on the atmosphere varies. Because of their improved efficiency, $_{CO2}$ loads are reduced even if powered by electricity distributed from fossil fueled generators. With the conversion to renewable power, their use will create no $_{CO2}$ impact.

Financing conversion to heat pumps may be eased through rebates and income based low interest loans available through Efficiency Vermont. Businesses may finance conversion to heat pumps through business energy loans also available through Efficiency Vermont.

Other Alternative Heating

Geothermal heating, and solar hot water heating systems are alternative heating sources to replace or augment non-renewable heating. They may require augmentation from a second source. While the energy element of the Windham Regional Plan plan does not assign a target for savings from these alternative heating systems, they may offer an attractive alternative renewable heating option. The SSREI and Heat Saver Loan programs may help finance conversion to these alternative heating options.

Potential Transportation Energy Saving and Constraints

Based on 2016 five-year estimates of commuting times from 2010 census date, the average daily round trip commute for Jamaica residents is 43 miles. Energy use for all transportation from regional data is 3075 MBTUs. Meeting these needs with electric vehicles, provided they are charged with electricity from renewable sources, or with renewable fuel has the potential of significantly reducing greenhouse gas loads of the atmosphere. While Jamaica adopts the WRC targets as Jamaica's goals for transportation energy saving, the pace at which these goals can be met is dependent on factors beyond the town's control. These include the pace at which enabling technology is brought to market, the availability of suitable vehicles at affordable prices, and the development of infrastructure needed to support vehicles using alternative fuel or power. Because of

[11] Residential standards available at http://publicservice.vermont.gov/energy_efficiency/rbes

the multi-use automotive needs of Jamaica residents, winter driving conditions and the preponderance of class 2 and 3 dirt roads with difficult driving conditions in mud season, residents require all-wheel drive or four-wheel drive vehicles or light trucks. Additionally, many local businesses require vans and trucks. It is not known when electric or alternative fuel version of these vehicles will be available for purchase. An additional lag will occur until they are available as more affordable used vehicles.

Battery Technology

The current state of battery technology limits the range of electric vehicles to approximately 200 miles, the mean weekly commuting distance of Jamaica workers. This range is for a relatively light car. A much lower range would be possible for the larger all-wheel or four-wheel drive cars and light duty trucks appropriate for Jamaica's roads. A number of research and development efforts are underway to increase the charge-carrying capacity of batteries that will increase electric car range and make their use in heavier car models practical.

Current battery charging times are lengthy and battery charging infrastructure is limited for the most part to home recharging. Limited public electric vehicle recharging is available in Brattleboro, bur for the most part, electric vehicles will have to be recharged at home over a period of hours. This is satisfactory for commuting purposes, but not for longer trips. A "chicken and egg" relationship between infrastructure development and electric car use is anticipated. More electric cars will stimulate more infrastructure development which will support more electric car buying.

Renewable Energy

Electric vehicles, because of their energy recovery systems, are slightly more efficient than internal combustion vehicles. Their real impact on reducing CO_2 will come when they are recharged from renewable energy sources. Drawing transportation energy from significantly cheaper renewable energy will offer a major reduction in operating costs and provide an incentive to buy electric vehicles. The rate at which the grid converts to renewable sources will therefore pace transition to electric vehicles.

Alternative Automotive Technologies

While electric vehicles are the most advanced of renewable or recyclable energy automotive technologies now, other approaches are in various stages of research and development. The automotive technologies of 2050 are far from settled. These include alternative fuels such as biodiesel, hydrogen, and even ammonia, hydrogen fuel cells, and hybrid electric, alternative fuel cell vehicles. The latter would address the long haul problem of all electric vehicles. These technologies are not mature and their commercial availability is uncertain.

Resource Mapping Process and Policy Tool

Jamaica will utilize the Town of Jamaica Solar Energy Potential and Town of Jamaica Wind Energy maps generated by the Windham Regional Commission as the maps supporting the town's energy policies. We have augmented these maps by superimposing the Jamaica parcel maps on them so that solar and wind energy potentials may be identified by parcel and owner. Both the town and individual parcel owners will then be better able to use these maps in future renewable energy conversion determinations.

Solar Resource Maps

Jamaica's solar map *includes raw resource potential, known and possible constraints, grid infrastructure, transmission and distribution resources and constraints.* There are a few solar projects in existence and one larger net-metered project in the permitting process. Parcel boundaries have been superimposed over the solar energy map. Comparison of the parcel boundaries with the indexed parcel map in the town office will allow identification of parcel owners and facilitate promoting solar energy conversion to and by individual parcel owners. It will also support forming consortiums or other business partnerships for community solar generator.

Wind Resource Maps

Jamaica's wind map *includes raw resource potential, known and possible constraints, grid infrastructure, transmission and distribution resources and constraints.* There are no existing wind installations. As with the solar map, parcel boundaries have been superimposed to facilitate location of possible residential wind installations. Comparison with the town's indexed parcel map will facilitate both planners and parcel owners to determine the wind energy potential of their property.

Jamaica's Preferred Locations

Jamaica will determine specific areas suitable for community solar generators by comparison of solar potential maps with our Existing Land Use and Proposed Land Use District maps. State defined preferred locations other than residential (previously developed sites, brownfields, gravel pits, etc.) and existing open spaces where solar fields may be unobtrusively located will be identified. Community generators, co-ops, or other ventures will be encouraged to develop these sites. Residential sites for rooftop solar panels or small stand-alone solar arrays must be handled individually in that house orientation and available direct sunlight vary from property to property. Similarly, Jamaica will encourage homeowners to determine the suitability of their property for residential solar or wind generation using the solar and wind potential maps with parcel overlays. Our energy committee will request suitability information from our residents. A planned town survey may be used for this purpose. This data will be used to keep homeowners appraised as anticipated technology and business developments enable economic conversion to renewable energy generation.

Areas Unsuitable for Energy Siting

Jamaica has overlaid the conservation, and special siting areas from our town plan Proposed Land Use District map and the public land and conservation easement areas from our Existing Land Use map with the wind and solar potential maps from the WRC. The high degree of correlation between the wind potential and the existing and proposed and current conservation areas and special sites leaves little acreage with commercial wind potential that would not have unacceptable environmental consequences and would not be in conflict with the Town's land-use policies. Existing and proposed conservation areas generally correspond with ridgelines our town plan seeks to protect for economic as well as environmental reasons. This is further reason to exclude commercial wind from our approach to meeting regional targets.

Jamaica's Energy Targets and Conservation Challenges

The Windham region was given an overall renewable energy generation target, as determined by the Department of Public Service, based on its percentage of the state's population (which directly affects its share of statewide consumption). The Windham Regional Commission (WRC) then determined energy generation targets for each of their member-towns, based on both the resource availability in town and its population. The resulting Jamaica *generation targets are an average between those two characteristics.*

Energy Generation Targets

In Jamaica*, it is estimated that* 2056 megawatt *hours of renewable energy should be generated each year. This figure is an average of 4,382 MWh (based on the town's share of the regional population), and 1,144 MWh (based on the percent of regional resource availability). This estimated generation target serves as a starting point from which the town can develop policy to address its energy needs.*

To translate this figure into what kinds of installations would be required, 2056 megawatt hours *of renewable energy each year would require a total of* 1581 kilowatts of solar photovoltaic installations *(using the assumption that only solar energy would contribute to the overall energy generation target, not any other generation source). On the landscape, this could mean that the town identifies* 108 acres of solar-capable *land. This is a very conservative figure; assuming that each megawatt of energy requires 60 acres (on average,*

solar installations produce a single megawatt over 8 acres). Using the 60 acres/megawatt energy production rate is for contingency; meaning that it reserves space for landowner, grid, or spatial constraints that may limit development. This ensures enough space would be delineated.

While not included in the target, residential wind generation that may be installed will increase renewable energy generation beyond Jamaica's target. Also, though not included in any targets, it should be noted that a 2.2 megawatt hydro generator recently commenced operation at the Ball Mountain dam.

Although renewable energy generation can occur in the town and supply its residents with reliable, affordable, and clean power, the town is challenged by the current amount of energy being consumed. In order to minimize the amount of energy generation required, the town must first develop strategies to reduce the amount of energy consumed.

Projected Energy Use: LEAP Model Results

To help inform Jamaica's *policies on energy conservation measures,* Jamaica *used guidance from the LEAP (Long-Range Energy Alternatives Planning system) model, conducted by the Vermont Energy Investment Corporation as part of the state's comprehensive energy planning initiative.*

The LEAP model is used to guide the state's regions towards reducing the amount of greenhouse gas emissions and consuming 90% renewable energy by 2050 (referred to as the "90x50" goal). To accomplish the state's energy goals, there are several interim benchmarks built into the LEAP model which ensure a progressive pace in attaining that "90 x 50" goal. The state energy goals are:

- *Greenhouse gas reduction goals of 50% from 1990 levels by 2028 and 75% by 2050.*
- *25% of energy supplied by renewable resources by 2025 (25 x 25).*
- *Building efficiency of 25% of homes (80,000 units) by 2020.*

Incorporating those goals into the model produced energy generation, conservation, and fuel conversion targets for benchmark dates for all regions in the state, and is informed by the region's current energy profile. The WRC received the results from this model and was tasked with making those results relevant to its member-towns. The WRC therefore divided its region-wide benchmark targets among its towns based on their population (which is assumed to most directly impact the amount of energy the towns consume).

The following paragraphs and figures show Jamaica's *LEAP model results, and how much energy could be conserved in order to reduce the burden of energy generation facilities in the region.*

Residential Heating Conservation & Fuel Conversion

In order to determine how much energy would have to be conserved or how much fuel conversion to renewable energy achieved, the LEAP model produced both a "Reference" and "90x50" scenarios. The Reference scenario is meant to depict energy use over decades if no major changes were made in our energy profile. It is the "business as usual" scenario. The "90x50" scenario shows one pathway that communities can adopt in order to reduce greenhouse gas emissions, conserve energy, and generate renewable energy so as to meet the state's goals. This pathway is translated to Jamaica's use, and is shown below. It is another data estimate that serves to help inform the town to develop its own policies for energy conservation and fuel conversion.

Figure E8 below shows the LEAP results for Jamaica's *residential heating sector. In both the Reference and*

90x50 scenarios, energy consumption is modeled to decrease (on account of technological improvements, building innovation, and home efficiency improvements).

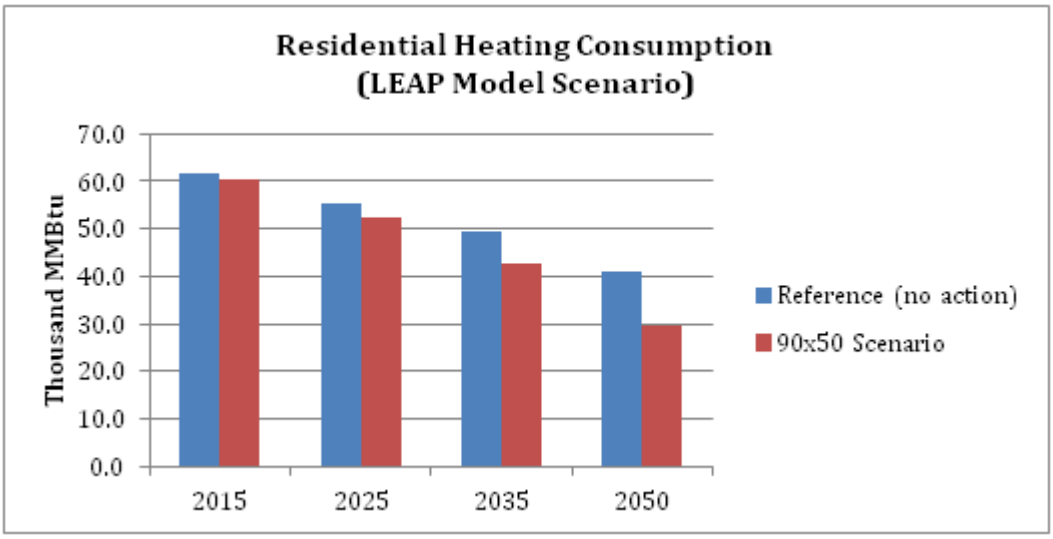

Figure E7 Jamaica Residential Heating Sector LEAP Results

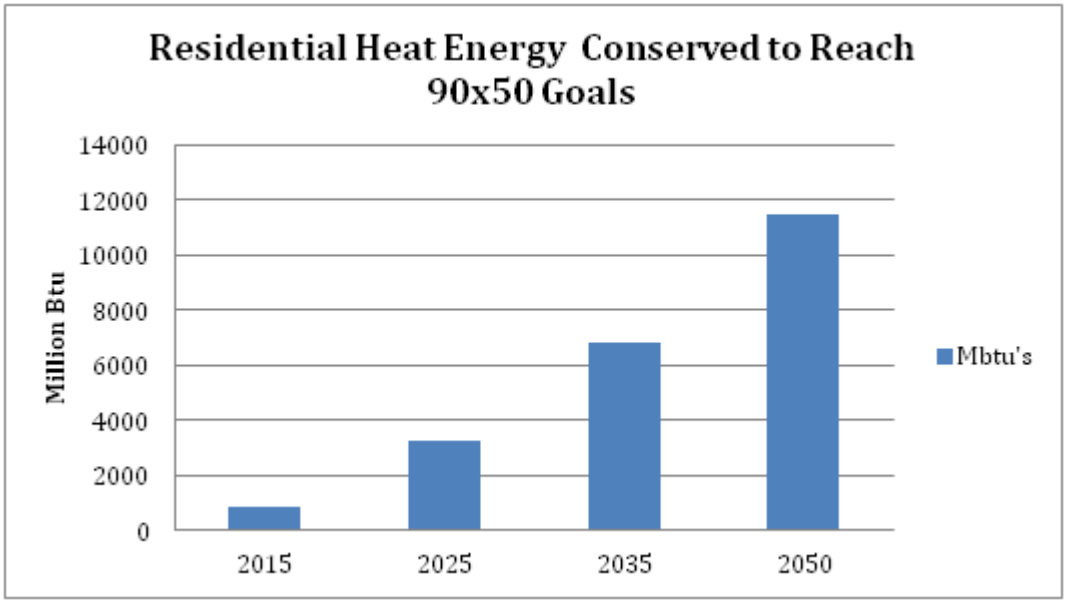

Figure E8 Jamaica Residential Heat Energy Conserved to Reach 90X50 Goals

However, the 90x50 scenario shows a sharper increase in the amount of energy conserved in residential heating. Figure E9 shows how much energy should be conserved, through 2025, 2035, and 2050, to help the town arrive at these energy goals. Not only would energy need to be conserved solely by building efficiency measures, but fuel conversion to more efficient energy sources would be promoted. (Include any other information relevant to your town).

In order to attain the renewable energy goals, the following cumulative targets have been established for Jamaica for years 2025, 2035, and 2050.

Thermal (Heat) Efficiency Targets at Benchmark Years

Use/Sector	*2025*	*2035*	*2050*
Residential thermal *(increased efficiency and conservation): Percent of municipal households to be weatherized over benchmark years to meet efficiency targets.*	*9%*	*17%*	*36%*
Residential thermal *(increased efficiency and conservation): Estimated number of municipal households to be weatherized.*	*94*	*184*	*377*
Commercial thermal *(increased efficiency and conservation): Percent of commercial establishments to be weatherized over benchmark years to meet efficiency targets.*	*9%*	*16%*	*30%*
Commercial thermal *(increased efficiency and conservation): Estimated number of commercial establishments to be weatherized.*	*3*	*6*	*10*

Table E2 Jamaica Thermal (Heat) Efficiency Targets at Benchmark Years

Additionally, the following fuel conversion targets are set for heating fuel types used, with an emphasis towards shifting to more renewable heat sources and using more efficient sources (such as heat pumps).

Heating Fuel Switching Targets			
Use/Sector	***2025***	***2035***	***2050***
Residential and Commercial Thermal Fuel: *Estimated **new efficient wood heat systems overall** (in units) in the LEAP 90x50 scenario (this includes both wood stoves and wood pellet burners for homes and businesses).* *This number may decline over the target years, which indicates an overall trend toward energy conservation and building weatherizing, which reduces the demand on heating systems.*	*280*	*266*	*266*
*Residential and Commercial Thermal Fuel: Estimated **new wood pellet systems only** (in units) in the LEAP 90x50 scenario.*	*49*	*54*	*67*
Residential and Thermal Fuel: *Estimated **new heat pumps** (in units).*	*87*	*172*	*243*

Table E3 Jamaica Heating Fuel Switching Targets

Transportation System Changes

The LEAP model created benchmark targets for both light and heavy duty vehicles, assuming a difference in residential and industrial energy needs and changes over time. Below are the two interpretations of these sector's efficiencies over time.

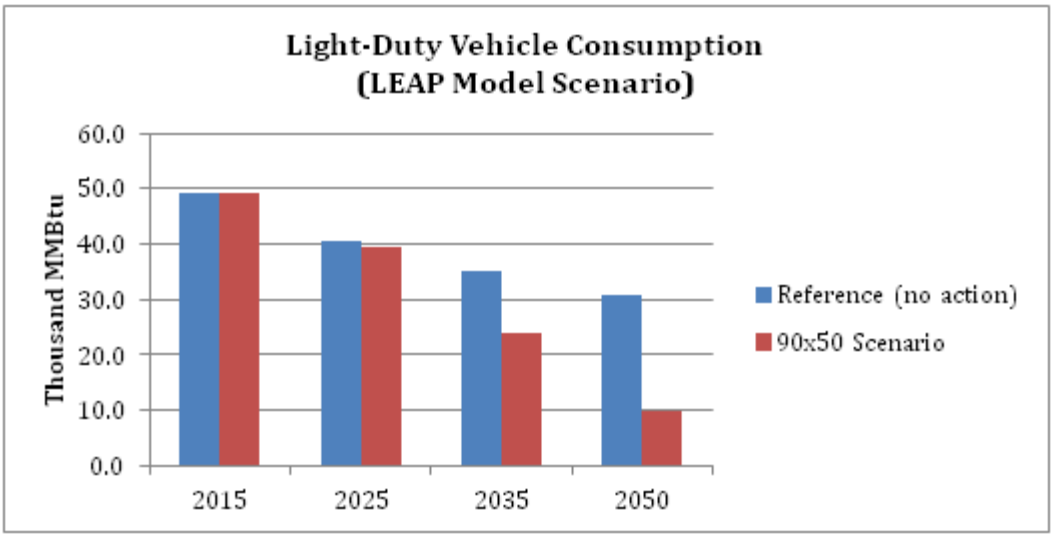

Figure E9 Jamaica Light-Duty Vehicle Consumption (LEAP Model Scenario)

Light-duty vehicle consumption represents a larger portion of the total amount of energy consumed by the transportation sector, and there is a large amount of energy conservation required. The LEAP model projects much of this conservation of energy comes from the electrification of the vehicle fleet, especially as market demand changes and technology improves. This reduction in gasoline consumption and electrification of the car motor comes in addition to increased cluster developments and other land use changes that improve the efficiency of our community's transportation network. Jamaica's economic development policies encourage business development in Jamaica Village and Rawsonville. Improved local availability of goods and services will decrease vehicle use. *The following targets for the years 2025, 2035, 2050 are set for the town's transportation fuel conversion:*

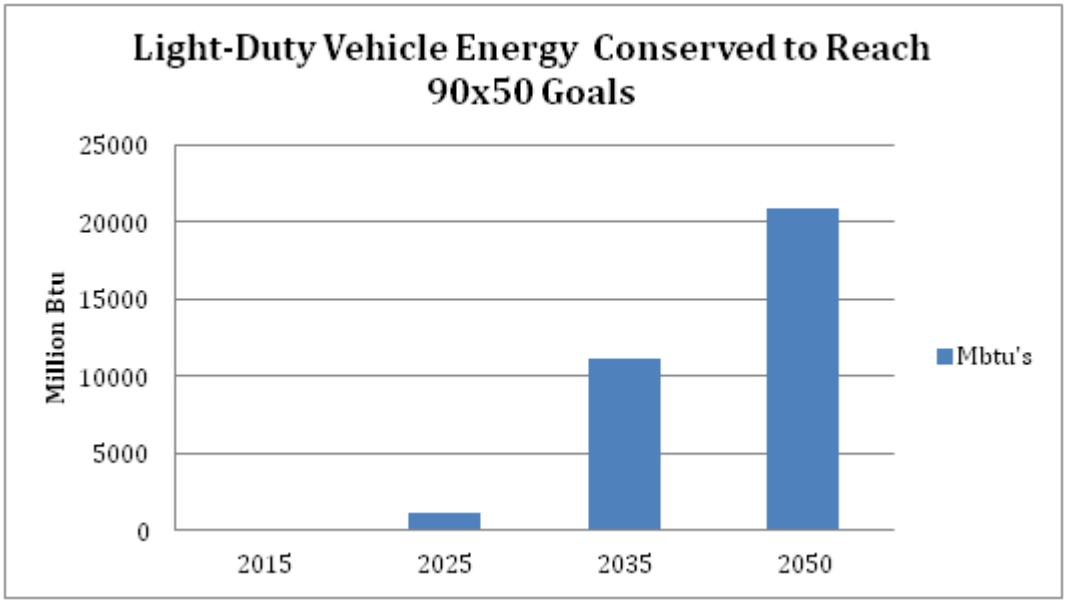

Figure E10 Jamaica Light-Duty Vehicle Energy Conserved to Reach 90x50 Goals

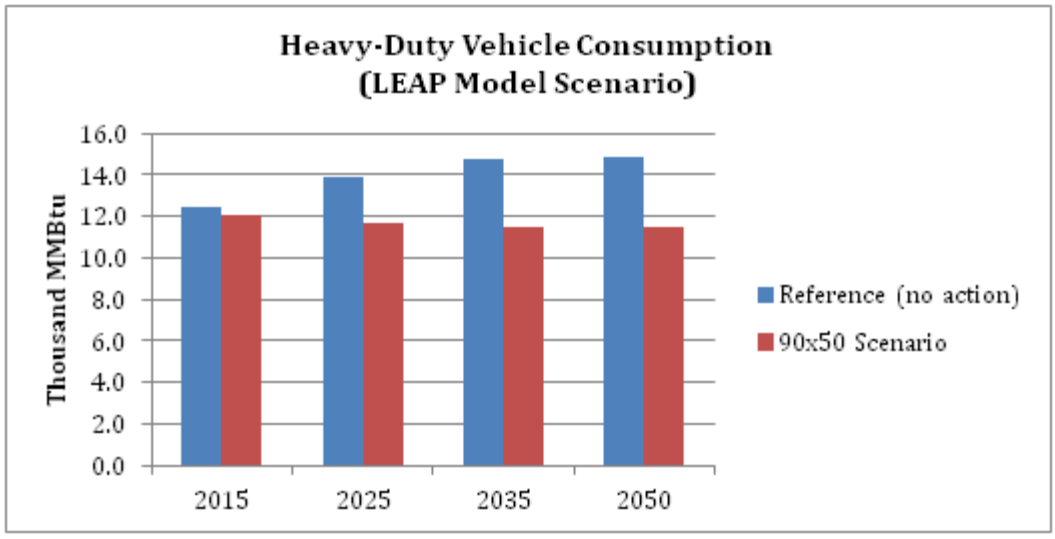

Figure E11 Jamaica Heavy-Duty Vehicle Consumption (LEAP Model Scenario)

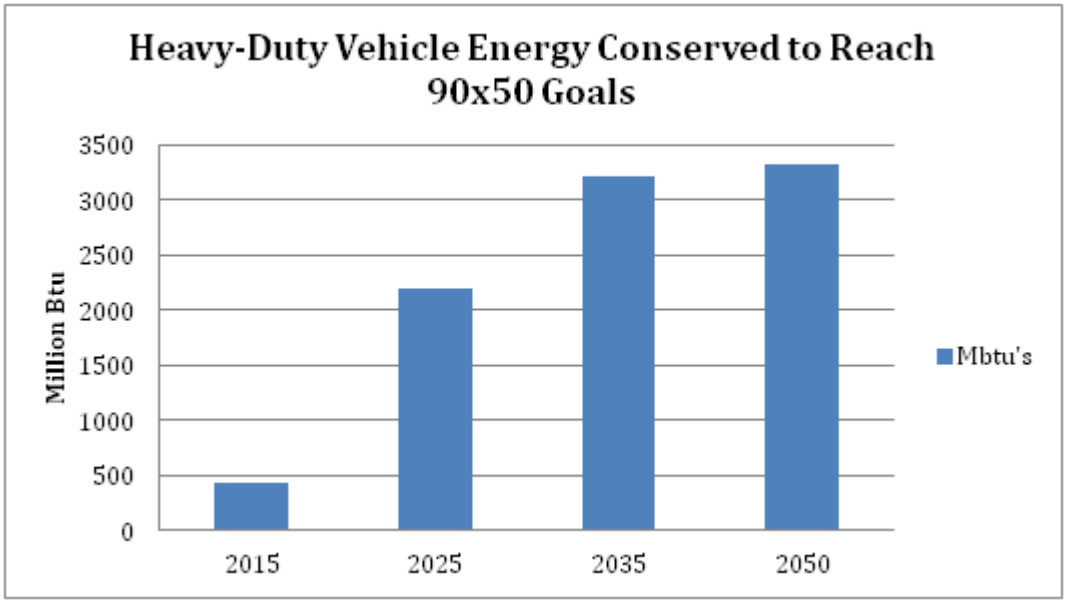

Figure E12 Jamaica Heavy-Duty Vehicle Energy Conserved to Reach 90x50 Goals

Transportation Fuel Switching Targets *[MM1]*			
Use/Sector	***2025***	***2035***	***2050***
Transportation Fuel: Estimated number of ***new electric vehicles, in town.***	*60*	*424*	*896*
Transportation Fuel: Estimated number of ***biodiesel-powered vehicles, in town.***	*92*	*176*	*304*

Table E4: Fuel switching targets for the transportation sector, across the benchmark years.

Heavy-duty vehicle consumption doesn't show the same curves as per light-duty vehicles, since commercial and industrial applications for this vehicle fleet isn't anticipated to change as much. However, efficiency in this sector is achieved by changing the fuel type for these vehicles from diesel to bio-diesel. (May be some discussion about this fuel conversion viability in your town…)

Electricity Conservation

Over the benchmark years, electricity rates are anticipated to increase in the Reference scenario, due to a combination of more amenities, appliances, and motors being supplied by electric power, and an increase in the number of people using those products. The 90x50 scenario promotes electricity conservation in the form of energy-efficient appliances, lighting, and heating/cooling.

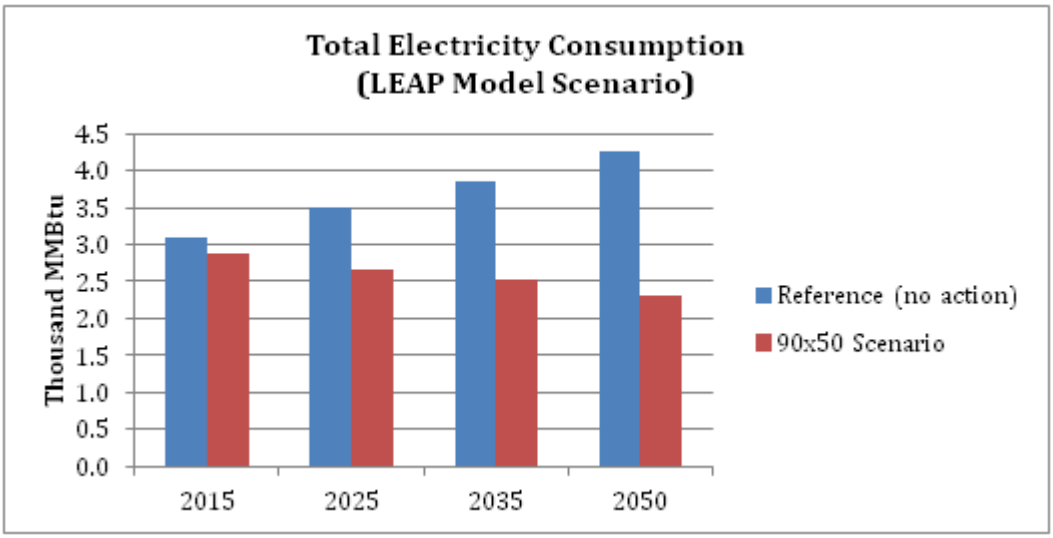

Figure E13 Jamaica Total Energy Consumption (LEAP Model Scenario)

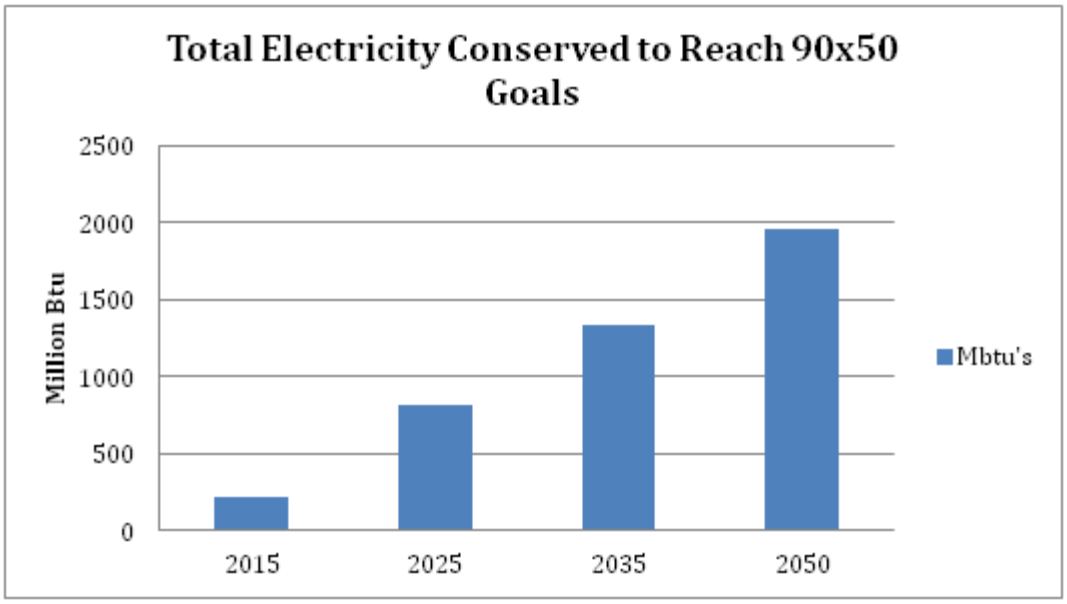

Figure E14 Jamaica Total Electricity Conserved to Reach 90x50 Goals

Pursuing these upgrades, the town is targeted to save the following in electrical conservation measures for target years 2025, 2035, 2050:

Efficiency Targets at Benchmark Years

Efficiency Targets at Benchmark Years*[MM1]*			
Use/Sector	***2025***	***2035***	***2050***
Electricity*:* *Number of kilowatt hours to be conserved, annually, over the target years.*	*561,700*	*917,900*	*1,342,600*
Electricity*:* *Percentage of number of homes and buildings that will have been upgraded with electric efficiency improvements.*	*42%*	*68%*	*100%*

Table E5: Electric-sector efficiency targets across the benchmark years.

Conservation and Efficiency Strategies

With total energy expenditures in the Town in excess of 164,252 MBTUs*, there is considerable opportunity for savings from various energy conservation and improved efficiency measures. Because most of the energy use in* Jamaica *is for private uses (home heating, commuting, etc), savings would accrue primarily to residents. Public education is one of the most effective strategies to bring about savings through energy conservation and improved efficiency, though there are some specific policies that can also move the community in that direction.*

Most new construction in Jamaica *is required* by the State *to meet or exceed the Vermont Building Energy Standards (for both residential and commercial buildings) through the use of insulation, heating systems, and weatherproof windows and doors. Current building codes provide basic energy efficiency requirements for buildings; however, technology advancements have generated higher standards such as net-zero energy construction standards in which buildings generate as much energy as they consume. Green construction and LEED Construction (Leadership in Energy and Environmental Design) standards promote the use of natural, recycled and durable building materials, as well as energy efficiency. These efficiency standards are also applied to landscaping, advocating for native plantings that are low-maintenance.*

The siting, design, and construction of buildings strongly influences the amount of energy needed for heating as well as the amount of electricity needed for lighting. Proper subdivision design, building orientation, construction and landscaping provide opportunities for energy conservation such as less vehicular travel, and by designs incorporating passive solar space and domestic hot water heating, natural lighting and photovoltaic electricity production.

Energy savings can be realized by retrofitting existing buildings with insulation, installing high-performance windows and doors to reduce heat loss, weather-stripping, replacing incandescent lights with LED bulbs, and using energy efficient appliances. The following programs are available to residents of Jamaica:

- *Southeastern Vermont Community Action (SEVCA): SEVCA is the service provider in Windham County that runs the Weatherization Assistance Program. Weatherization services, which include an energy audit, diagnostic tests, analysis and installation measures, are available at no cost to income-eligible homeowners and renters. SEVCA is also available to help in the event of a heating emergency. They can help purchase oil, kerosene, propane or wood. In addition, they also work with electric companies in order to prevent disconnection and help negotiate payment plans.*
- *Efficiency Vermont: Efficiency Vermont is the State's provider of energy efficiency services. They provide technical and financial assistance to electrical consumers for the purpose of improving the efficiency of existing and new facilities.*
- *ENERGY STAR Home Rebates: Energy Star Homes meet strict energy efficiency guidelines set by the U.S. Environmental Protection Agency and U.S. Department of Energy. Efficiency Vermont provides free financial, design, and technical to help build an ENERGY STAR qualified home. Benefits of being an ENERGY STAR home include financial incentives such as product rebates; utility savings; higher resale value; increased comfort and air quality; and other environmental benefits.*
- *Vermont Housing Finance Authority's Energy Saver Loan Program: Administered by Windham Housing Trust, this program offers low interest loan funding for homeowners for an energy audit and improvements specified in the audit.*

Transportation-related efficiency strategies are a very significant part of Jamaica's efforts, since it represents a

significant portion of the energy demand. Simple changes, such as ride-sharing, combining trips and using alternative transportation, will conserve fuel and reduce wear and tear and maintenance costs on individual vehicles. Fuel efficient and electric cars will use less gasoline and emit less pollution.

Effective land use planning can promote energy conservation. Targeting new development toward areas located close to the community's major roads and existing settlements will minimize the energy consumed by residents commuting, and will reduce the energy required to deliver essential services to residents and businesses.

Energy Goals, Policies, and Action Steps

Goal 1: Jamaica will reduce the total energy use by our town through education and promotion of economic opportunities to implement energy conservation and efficiency measures and convert to renewable and recyclable energy sources.

Jamaica will use the communications tools available to inform our citizenry and promote energy savings and conversion opportunities. We will enable residents to exploit the nexus of advances in energy savings technology and the innovative financing methods that will follow with economic self-interest. We will combine the interests of good citizenship in reducing the $_{CO2}$ burden on the atmosphere with energy cost savings products and practices. Most importantly, we will bring low up front cost financing programs to our citizen's attention to make it financially feasible for everyone to participate in energy saving efforts.

Policy 1.1: Jamaica will promote individual energy conservation through use of the town website and informational town energy presentations and workshops.

Action Steps:

1. Jamaica Planning Commission will maintain an energy committee responsible for overseeing implementation of this plan (see policy 1.5). It will promote state Energy Efficiency Utility (EEU) and the Weatherization programs by using the town website to inform our citizens. We will provide links to available electric, natural gas, and deliverable fuel EEU program resources and Efficiency Excellence Network (EEN) contractors. We will co-sponsor weatherization information presentation to town meetings, recording them for later viewing on our website for those unable to attend the original presentation. We will promote energy efficiency opportunities in new construction and remodeling to businesses we hope to attract to Jamaica (see economic development). Jamaica will focus energy conservation measures on the buildings that are municipally owned with particular emphasis on measures to reduce operating costs. Jamaica is encouraging the development of affordable rental units. We will encourage energy audits as these properties are developed.

Policy 1.2: Jamaica will promote the efficient use of heating energy in commercial and residential buildings by encouraging citizens to follow energy saving standards and building codes emphasizing lifecycle costs savings of heating energy conservation.

Action Steps:

1. Jamaica will promote the use of Vermont's residential building energy score/label through use of the town's website. We will encourage local realtors to feature energy labels in real estate offers. We will make commercial building energy standards available to all commercial and residential building permit applicants. We will encourage the use of the EPA's Portfolio Manager tool with EEU assistance for commercial building construction and renovation. The residential stretch energy codes will be promoted for all residential Act 250 projects and required for all commercial Act 250 projects. Jamaica will review and consider making the stretch energy code the standard recommended for all building additions , alterations, and repairs. Jamaica will join the Vermont Climate Action Coalition and its popular tool, the Vermont Energy Dashboard, to encourage

citizens to take energy-actions, no matter how small. The Planning Commission will take the lead on publicizing and implementing. See https://www.vtenergydashboard.org/stories/vermont-climate-action-communities

Policy 1.3: Statement of policy that promotes the decreased use of fossil fuels for heating. Jamaica will promote the decreased use of fossil fuel for heating by encouraging the use of efficient heat technology to reduce heating costs.

Action Steps:
1. Heating costs are a major element of all Jamaica residents budgets and a significant municipal operating cost. Conversion to advanced heating technology can save sufficient energy costs to more than pay for conversion. Financing programs that reduce initial capital outlay can make energy savings possible for everyone. Jamaica will encourage the conversion to cold climate heat pumps and use of ground-source heat pumps as primary heat sources for new construction and major remodeling projects. We will assess the cost effectiveness of converting municipal building heating systems to cold weather heat pumps. Jamaica will encourage the use of efficient wood heating systems in both commercial and residential buildings including the upgrade of the significant number of wood heating already in use to EPA approved cord and pellet stoves by making heating cost reduction information available through the town website and town energy information meetings. We will encourage the installation district heating systems in Jamaica Village and Rawsonville. We will identify local businesses selling wood heating products including cord, pellet and wood chip fuel and high efficiency wood heating systems. As discussed above, responsible forest management is required to make wood heating effective in reducing $_{CO2}$ from wood heating systems. With it's preponderance for forest lands, Jamaica is in an excellent position to do this and will continue to emphasize responsible forestry for $_{CO2}$ reduction as well as environmental and economic concerns. Harvesting wood for heating purposes as well as timber sales in a manner that promotes forest regrowth will be encouraged.

Policy 1.4: Jamaica will lead by example by assessing and where cost effective upgrading the heating of municipally owned buildings.

Action Steps:
1. Jamaica will conduct a baseline energy study including energy audits to determine energy use and identify opportunities for energy cost savings. Opportunities may include improvements in conservation such as improved insulation and weatherization as well as heating source conversion. Initial costs and lifecycle cost reduction will be assessed to determine cost effectiveness of improvements considered. The number of years required for heating cost reduction to offset capital outlay will be determined and used as the major decision criteria. Energy certifications will be sought. Capital costs of projects to be undertaken will be included in proposed town budgets.

Policy 1.5: The Jamaica Planning Commission's energy committee will educate itself on the current state of energy conservation technology and energy conservation financial assistance programs. This policy is considered key to meeting all of our Energy Plan goals.

Action Steps:
1. As recognized in the 2016 CEP, compliance with all the energy savings goals is dependent on voluntary actions of an informed citizenry. Informing Jamaica's residents of available opportunities is therefore key to meeting all policy objectives. It is the commission's approach to meeting all goals to facilitate aligning our residents economic interests with available energy saving programs, products, and most importantly low cost , low up-front capital financing opportunities. A number of opportunities currently exist while others will emerge as the enabling energy savings and conversion technologies mature. For example, the lifecycle cost of cold

weather heating systems will decrease as conversion to PV solar electricity generation proceeds. The spread in operating costs will in turn enable attractive financing options for conversion. A primary responsibility of the commission's energy committee will be to maintain awareness of the state of energy conservation technology and financing opportunities in order to inform our citizens and encourage adoption of the various conservation measures. Therefore the energy committee will review available material on energy conservation technology and financial assistance programs from both state and commercial sources on an ongoing basis to maintain a current awareness of available conservation measures suitable for Jamaica's residents. Participation in the Vermont Energy Dashboard will facilitate this.

Goal 2: Jamaica will address reduction of transportation energy with steps to immediately facilitate ride sharing. We will encourage use of electric vehicles and or alternative fuel vehicles as alternative automotive technology and renewable or recyclable fuel becomes available and economically feasible.

As noted above, the dispersed commuting and shopping needs of our rural community are not yet well met public transportation or alternative vehicles and fuels. In the near term, Jamaica will implement measures to facilitate ride sharing to common destinations. Anticipated advancement in automotive technology that will increase the range of electric vehicles and the variety of models appropriate to rural community needs will make it practical to promote their purchase for family and municipal use. As conversion to renewable electricity proceeds, savings in fuel costs will provide economic incentives for their use. As they become available, Jamaica will implement measures to promote the use of alternative vehicles and fuels and the economic benefits they offer.

Policy 2.1: Jamaica will encourage the increased use of public transit.

Action Steps:
1. Identify public transit options available to Jamaica residents, including those offered by local service organizations, such as Neighborhood Connections, Senior Solutions, Southeast Vermont Transit (operates The Current and Dial-A-Ride).
2. Develop an information-dissemination strategy, including print, online, and in-person methods in order to keep Jamaica residents aware of options and choices.
3. Examine strategies to increase effective communications and exchange of knowledge.

Policy 2.2: Jamaica will promote a shift away from single-occupancy vehicle trips through strategies appropriate to Jamaica.

Action Steps:
1. Identify established local ride-sharing and public transit options (as outlined above).
2. Develop a local database or clearinghouse to identify Jamaica residents who make regular trips to popular destinations (Brattleboro, Grace Cottage, etc).
3. Investigate liability and insurance impacts for those taking part in ride-sharing opportunities, either as drivers or riders.
4. Examine strategies for publicizing the above -- utilizing varied online and offline messaging formats.
5. Investigate the possibility of locating CSA share drops in local establishments to save driving transport time.

Policy 2.3: Jamaica will promote a shift away from gas/diesel vehicles to electric or other non-fossil fuel transportation options through strategies appropriate to Jamaica.

Action Steps:
1. Identify costs and funding opportunities for installing EV charging stations in the Village Center.
2. Develop marketing and publicity for the above (if installed) to alert visitors to Jamaica State Park of the availability of EV charging opportunities. In the meantime, alert potential visitors to Jamaica of other charging stations in the area
3. Examine strategies for funding and maintenance for EV charging stations. Investigate technology for solar charging of EV stations.

Policy 2.4: Jamaica will facilitate the development of walking and biking infrastructure through strategies appropriate to Jamaica.

Action Steps:
1. Identify locations in Jamaica Village and elsewhere in town where bicycle racks would be most used.
2. Develop marketing and publicity to inform residents and visitors of safe places to keep their bikes in town.
3. Examine strategies to secure funding for the above.

Goal 3:Jamaica will continue its standing policy of encouraging development in Jamaica Village and Rawsonville. We will continue our policies that encourage low density development in areas distant from route 30 and the village centers. Recent and planned infrastructure improvements in Jamaica village and along route 30 will be promoted to encourage development in our villages and along this corridor. Policies promoting low density land use and preservation of forests that are central to the Town's economic development goals will be followed.

Responsible forest management practices that are essential to absorb the increase in CO_2 that increased use of wood heating will produce will continue to be emphasized.

Policy 3.1: Jamaica's land use policies and descriptions of current and future land use per our 2017 Town Plan will encourage low-density development outside Jamaica Village and Rawsonville except for certain subdivided areas.

Land Use Policies:
1. Jamaica Village shall continue as the center of the Town. Future expansion of publicly owned community facilities buildings shall be in the Village.

2. Further development within and adjacent to the Village districts must be carefully planned to minimize adverse impacts on the character of the village, existing water supply and wastewater disposal, and traffic within the villages.

3. The character of Jamaica Village is an important asset to the community. The character of the Village shall be maintained by limiting uses within the Village to those that are compatible with the existing commercial and residential uses.

4. Encourage the restoration and preservation of buildings that contribute to the architectural and historical character of the Town. When such buildings become obsolete, new uses shall be found for them that will preserve the architectural and historic character of the buildings.

5. Lands adjacent to or including areas of historical, educational, cultural, scientific or architectural value shall be used in a manner that will not reduce or destroy the value of the site or area.

6. Lands adjacent to existing public land and existing or planned public facilities shall be used in a manner that will not diminish the value of such investments or interfere with their intended uses.

7. Require appropriate site planning and landscape design by siting structures to fit into the natural characteristics of the land and maintaining vegetative buffers along roads and parcel boundaries.

8. Require the use of low impact development strategies (e.g., cluster development, conservation easements) that minimize the fragmentation and loss of agricultural land, forest land, unique or ecologically sensitive areas and special sites and areas.

9. Encourage the town to purchase or accept donations of rights to properties that have high public value.

10. Scenic hills and ridgelines shall be left in their natural condition, free from all development, including roads, building structures, utilities, and wireless broadcast and telecommunications facilities.

11. Require developers to incorporate the following in the site planning of commercial facilities: shared access, landscaping, and provisions for pedestrians.

12. Reduce light pollution by using fixtures that direct light below the horizontal plane, utilizing energy efficient lamps, and using light levels appropriate for the use of the property.

13. Light shall not trespass onto adjacent properties or create dangerous conditions due to glare on adjacent roadways.

14. Lighting design shall include the installation of timers, photo sensors, and other energy saving devices to reduce the overall energy required and to eliminate unnecessary lighting.

15. Require that housing developments not have undue adverse impact on natural resources, open space, and important agricultural and forest lands.

Action Steps:
1. Identify practical ways to identify potential threats to the policies outlined in the 2017 Town Plan.
2. Develop bylaws to strengthen the Land Use policies in the 2017 Town Plan
3. Examine strategies to achieve broad support for the goals outlined in the 2017 Town Plan

Policy 3.2: Jamaica will prioritizes development in compact, mixed-use centers when physically feasible and appropriate to the use of the development, or identify steps to make such compact development more feasible.

Action Steps:
1. Identify barriers to development in compact, mixed-use centers (septic, water issues etc)
2. Develop consensus of citizens to address the above
3. Examine strategies to remove barriers, including exploring funding opportunities

Goal 4: Jamaica will use the WRC generated solar and wind potential maps with parcel overlays to identify parcels with suitable potential for residential PV solar and or wind generators and community PV solar generators.

To enhance the utility of the WRC solar and wind energy potential maps, we have overlayed the town's parcel map on the energy potential maps. This allows determination of renewable energy generation suitability by parcel and owner. Jamaica will institute policies to promote installation of renewable energy generators to specific parcel owners with suitable potential and the development of community solar generators to those parcel owner(s) where potential is greatest. Additionally, Jamaica will investigate the feasibility of developing a hydro-electric pumped energy storage system at the Ball Mountain and Townshend dams to store PV solar energy from residential and community generators.

Policy 4.1 Jamaica will utilize the april 2017 WRC Solar Resource and Wind Resource maps as baseline maps for preferred and potential suitable areas for residential and community solar and residential wind location.

Action Steps:
1**.** Jamaica municipal parcel maps on resource maps to identify parcels and owners of land solar and/of residential wind generation.

2.Overlay Jamaica Town Plan Existing Land Use and Proposed Land Use Maps on resource maps to determine constraints on community solar locations.

3.Overlay Jamaica Town Plan soil resource map on resource maps to determine potential agricultural restrictions of community solar installations.

4. Overlay Jamaica Town Plan Special Sites and Areas map on resource map to determine special area constraints on community solar location.

5. Overlay Town Transportation and Community Resource Map on WRC wind and solar resource maps. Since the majority of Jamaica homesteads have access to either state or town roads, the potential for residential renewable energy development is along state and town roads in areas of solar or wind resource potential. Parcels meeting this criterion will be identified.

6.Review overlaid solar and wind resource maps to determine areas suitable for community solar installations, i.e. areas that are unconstrained or areas that are acceptable subject to requirements to minimize conservation, agricultural, or viewshed impacts.

Policy 4.2: Jamaica will utilize the solar and wind resource maps with overlays to identify areas suitable for renewable energy development consistent with Town Plan Land use policies and exploitation of renewable energy resources.

Jamaica will ensure that town residents and vacation home owners are aware of the residential solar and wind resource potential of their lands. Jamaica will identify lands that are not constrained by town Plan land use restrictions to specific land owners and commercial solar generator developers.

Action Steps:
1.Publish parcel overlayed Solar and Wind Resource maps in amended Town Plan, on energy website, and in community energy information briefs to ensure land owner awareness of the residential renewable energy potential of their land.

2. Develop criteria for approval of community solar installations that minimize impacts on land use and viewsheds for use in siting decisions.

3. Publish both commercial site potential and approval criteria to commercial solar generator developers.

Policy 4.3: In the absence of zoning laws, Jamaica has no constraints or prohibitions on individual land owner's development of residential solar or wind installations. While Town Plan land use prohibition of ridgeline development limits commercial wind development, regional targets can be met with solar alone. Town policies encouraging development of commercial solar projects on preferred land will be sufficient to meet regional goals.

Other than ridgeline protection, Jamaica has no outright prohibitions on individual property owners land use, but rather policies encouraging land use consistent with the town's goals for natural resource protection, cultural heritage, and economic development objectives. The town's policies will encourage individual land owners to develop renewable energy projects in a manner consistent with these goals. Commercial solar development will be encouraged in area determined suitable from overlaid solar resource maps and town plan land use maps.

Action Steps:
1. Encourage residential renewable energy development on parcels identified as having solar or residential potential per policy goal 4.1 consistent with development criteria in policy goal 4.2.

2. Encourage commercial solar development on parcels identified as suitable in policy goal 4.2.

3. Ensure that any criteria developed for residential wind or solar or commercial solar installations to meet Town Plan natural resource preservation do not prevent meeting regional targets for 2050 renewable energy goals.

Policy 4.4: Land suitable for PV solar generators not owned by the state or federal government with solar generation potential per the WRC solar resource map will be reviewed for siting potential. Jamaica will encourage siting of small community PV solar generators (10 - 150 KW requiring less than 1.5 acre footprints) on private lands with due consideration of environmental and economic goals of the town plan. Jamaica will encourage the siting of large PV Solar generators (150 KW - 1MW requiring 8 acres or less footprint) with substantial deference to the town plan's environmental and economic goals. Ridgelines identified in section 3 above, *Jamaica's Resources, Constraints, & Potential for Energy Generation,* are considered unsuitable for commercial wind generation.

Of the 2056 MWH of PV solar energy generation per year goal, 51% is to be generated from community generators. This equates to approximately 800 KW of capacity requiring nearly 6.5 acres of actual solar array footprint. This capacity can best be met by a combination of a large array situated in a area with little or no visual impact on surrounding viewsheds and a few small arrays with limited visual impact. All will be located on private lands.

Action Steps:
1. Jamaica will work with commercial solar installation developers and interested land owners to identify sites with sufficient solar potential per WRC solar resource maps and acceptable impact on town plan land use policies.

2. Jamaica will develop specific siting criteria for minimizing visual impact on viewsheds for both large and small solar field installations.

3. Jamaica will develop specific siting criteria for minimizing impact on town plan economic goals.

4. Where agricultural lands are involved, specific criteria will be developed to ensure that array siting will have minimal impact of agricultural land use.

Policy 4.5: Jamaica will use the WRC Town of Jamaica Solar Energy Potential and Town of Jamaica Wind Energy Potential maps with parcel overlays to identify parcels with potential for residential solar or wind installations and siting of community based solar generators. Parcel-based renewable energy potential maps will be published to the community to facilitate landowner energy conversion initiatives.

Realizing Jamaica's renewable energy conversion goals will be on the basis of individual landowners' decisions in that there are no sites that would qualify for preferred status that show potential for solar energy generation per the WRC Solar and Wind Energy Maps. It is considered that the potential for significant reduction of energy costs will motivate homestead owners with high potential for residential solar or wind energy generation to undertake conversion projects.

Action Steps:
1. Solar and Wind Potential Energy maps will be published as an appendix to this plan for citizen use in determining solar potential for their homestead.

2. Solar and Wind Potential Energy maps will be included in energy information briefings to the community.

3. Solar and Wind Potential Energy maps will be included on the energy section of the energy website or energy section of the town website.

4. Solar and Wind Potential Energy maps will be made available to commercial renewable energy developers upon request to facilitate renewable energy development.

Policy 4.6: A major theme to this energy plan is that advances in renewable energy technology and innovative financing plans that will accompany technology development will motivate conversion to renewable energy on the basis of economic self interest. Jamaica will take the lead in demonstrating that conversion to renewable energy for town owned buildings and surrounding property would reduce annual operating costs. Budget savings will be readily translated to homeowner savings is subsequent energy information briefings and web based material.

Jamaica will monitor commercial offerings of renewable energy conversion projects to determine the availability of renewable energy technology that offers either low or no capital investment and reduced energy costs. Falling renewable energy costs coupled with renewable energy technology advancements should support this by mid 2020. As it becomes possible, Jamaica will initiate projects to save taxpayer money and demonstrate financial advantages to town residents.

Action Steps:
1. Jamaica will maintain awareness of the state of renewable energy technology and financing option available from solar enterprises.

2. As anticipated advances occur, Jamaica will conduct a feasibility study of conversion of town-owned buildings, town office, town garage, and firehouse, to renewable energy utilizing rooftops and surrounding land for solar arrays.

3. When feasibility studies show a combination of both electrical rate reductions and financing the is less that existing energy costs, tow approval will be sought for executing a conversion project as both a demonstration and budget reduction effort.