Indicator 9

Healthy Natural Environment

Resource Use

Energy Supply and Use

What are the Most Important Goals?

- *Informed residents*
- *Visionary leaders*
- *Engaged institutions*
- *Accessible services*
- *Continuous education*
- *Creative economy*
- *Good health*
- *Integrated infrastructure*
- *Valued ecosystems*

What is this Indicator?

This indicator profiles the current state of Cape Cod's energy economy, characterizing the various ways in which energy resources are supplied to, and used by, local residents, property owners, visitors, businesses, organizations, institutions, and municipalities. It describes how much electricity is consumed in the Cape and Islands region and how this electricity is generated, discusses trends influencing the use of home heating and transportation fuels, and reviews the benefits of consumer aggregation and energy efficiency programs.

The economic, environmental, and social implications of the present fossil-fuel-based energy economy are reviewed, and potential pathways toward an efficient, "green" energy economy are introduced. In these optimistic but achievable visions, Cape Cod's energy future enhances environmental quality, restores ecosystem function, and improves public health while fueling economic growth in sustainable directions.

Why is this Indicator Important?

From a sustainability perspective, Cape Cod's energy economy may be important more for its *potential* than for its *current state* in early 2003. At present, the New England, national, and global energy economies largely define the environmental, economic, and social implications of energy use for Cape Cod communities.

The New England grid supplies the electricity used on Cape Cod, while heating and transportation fuels arrive by pipeline, barge and truck. Consumers experience the immediate impacts of energy use mostly through their pocketbooks. Rates for electricity, natural gas, oil, gasoline, and other commodities are generally higher on the Cape than elsewhere in Massachusetts and throughout most of New England.[1] Higher energy costs harm the overall economy of Cape Cod, hindering the competitiveness of local businesses, shrinking the pool of public funds available for other uses, and burdening individual consumers—most notably those with lower or fixed incomes. (See *Employment and Workforce Wages* and *Workforce Housing* indicators.)

Cape Cod, like the rest of the nation and the world, relies on fossil fuel combustion for the majority of its energy. Power plants and home heating systems, automobiles and other transportation modes, motor boats and other recreational vehicles, construction and landscaping equipment, and additional sources generate airborne emissions. Nitrogen and sulfur oxides (NO_x and SO_x), particulate matter, mercury, and other pollutants emitted by local, regional and national sources adversely affect air and

What Can We Do?

■ ***Individuals:***

- *Practice energy conservation and efficiency at home, at work, and on the road:*
  - *use locally available energy audits to identify problems and obtain financial incentives for implementing efficiency measures;*
  - *purchase energy-efficient light bulbs and appliances;*
  - *insulate homes, businesses, and hot water heaters;*
  - *turn thermostats down;*
  - *take shorter showers;*
  - *purchase fuel-efficient vehicles;*
  - *avoid idling;*
  - *carpool; and*
  - *use mass transit.*
- *Advocate for conservation, efficiency, and renewables development.*
- *Purchase green power.*
- *Request sustainable design and building practices in remodels and new construction.*
- *Assess renewable technologies for home and business applications:*
  - *engage local contractors to assess renewable energy options; and*
  - *take advantage of incentive programs.*
- *Practice waste minimization, recycling, and reuse.*

■ ***Communities:***

- *Implement proactive energy management plans that emphasize energy conservation, energy efficiency, and renewables development.*

water quality on Cape Cod. In addition, combustion-related chemicals—including ground-level ozone—pose significant public health risks.[2] (See *Traffic Congestion and Transit Use, Air Quality,* and *Drinking Water Quality and Quantity* indicators.)

Fossil fuel use also produces carbon dioxide (CO_2) and other gases that trap heat in the upper atmosphere. As a remnant of previous glacial advances and retreats, Cape Cod is particularly susceptible to global climate change induced by the rising atmospheric concentrations of greenhouse gases. Extensive research has documented local vulnerabilities spanning economic, environmental, and social dimensions, including coastal properties, tourism, fisheries, aquatic and terrestrial ecosystems, water supplies and public health.[3,4,5]

Climate change represents the most significant energy-related challenge to a sustainable Cape Cod. Its global nature means that the effects experienced by local residents and communities will be influenced by national and worldwide efforts to control greenhouse gas emissions. This is where the potential of the energy economy of the Cape and Islands region becomes clear.

This region harbors significant opportunities for renewable energy development, particularly offshore and on-shore wind energy resources.[6,7] Tapping local renewable sources, shifting to non-carbon fuels, and increasing overall resource productivity promise to reduce reliance on off-Cape sources and decrease on-Cape pollution. These actions are expected to improve environmental and social well-being, diversify the regional economy, and promote energy independence. They will also help "defossilize" the local energy economy, ensuring that residents and communities have done what they can to mitigate the potential adverse impacts of climate change on Cape Cod's prospects for a sustainable future.

Analysis of Data

Summarized below are findings and implications from a preliminary analysis of the current state of selected aspects of Cape Cod's energy economy.

Electricity Demand and Supply

The entire New England region is served by a complex, interconnected network of electricity generation and delivery facilities. In the Cape and Islands region, the power grid is relatively simple—the transmission lines crossing the Cape Cod Canal connect local communities, as well as those in Nantucket and Martha's Vineyard, to the New England grid, and the electrons generated by the 1120-megawatt (MW) Canal Station in Sandwich feed into the grid at a substation in Bourne. The Canal Station is fueled primarily by residual (No. 6) oil; to date, cleaner but more expensive natural gas has been used only sparingly.[8]

In 2002, the average load on the regional transmission system was about 230 MW; this corresponds to the average aggregate demand by electricity consumers in Cape Cod, Nantucket, and Martha's Vineyard.[9] Regional demand is characterized by a summer peak, driven by the influx of tourists and nonresident homeowners as well as total air conditioning loads, and a somewhat lower winter peak, driven by electric heating loads. The maximum annual peak increased from 342 MW in 1997 to 446 MW in 2002[10]; consumers in Cape Cod communities accounted for more than 90% of these totals.[11]

- *Implement policies and codes for promoting the development of local renewables and energy-efficient transportation alternatives.*
- *Initiate education programs to improve understanding of the implications of energy use among residents, visitors, and municipal employees.*
- *Integrate planning for water, wastewater, energy, transportation, waste management, and other infrastructure.*
- *Consider energy efficiency when voting on municipal expenditures and build on existing efficiency programs.*
- *Purchase fuel-efficient vehicles for municipal use.*
- *Identify and implement renewable energy technologies.*
- *Join the Cities for Climate Protection program, conduct a greenhouse gas emissions audit, and create a climate action plan for residents and municipalities.*
- *Develop aggressive waste minimization, recycling, and reuse programs.*

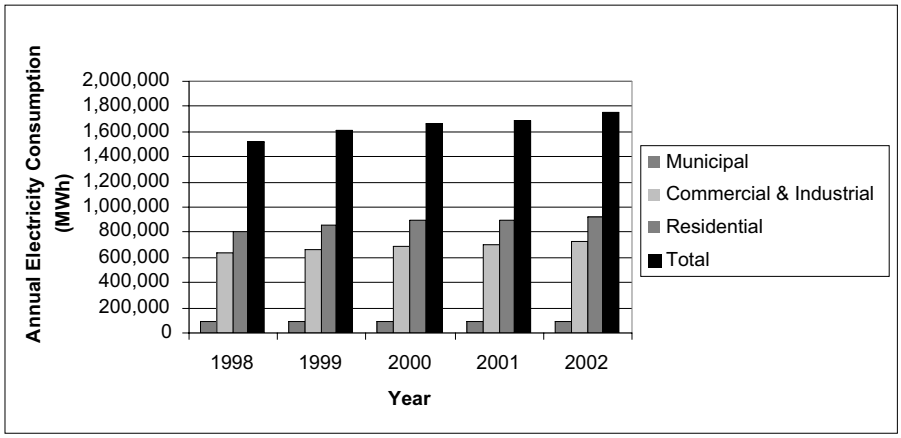
■ ***Decision-makers:***

- *Factor the externalized impacts of energy usage and the value of local ecosystems into all environmental and economic decisions.*
- *Integrate planning for water, wastewater, energy, transportation, waste management, and other infrastructure.*
- *Implement aggressive local measures for reducing energy use and associated emissions.*

Figure 1 shows annual electricity usage by Cape Cod's residential, municipal, and commercial and industrial consumers from 1998-2002, displaying load growth of more than 10% over the 5-year period for all customer classes.[12] Because electricity flows according to the laws of physics, the electrons consumed within a specific area are those generated by the most proximate sources. Accordingly, nearly 100% of the electrons consumed in Cape Cod communities (and on Martha's Vineyard and Nantucket) are produced by the Canal Station.[13] Small, dispersed, customer-owned generating systems—including diesel- and gas-fired engines, solar photovoltaic (PV) arrays, wind turbines, microturbines, and fuel cells—supply electricity to some Cape Cod residents, businesses, and institutions; the amount they deliver to the grid is negligible when considered in light of overall Cape demand.

Figure 1.

Cape Cod Electricity Consumption by Customer Class, 1998-2002



Using output-based emission rates for the Canal Station,[14] emissions associated with local electron consumption are estimated in Table 1. For each hour of every day in 2002, average demand by Cape and Islands consumers accounted for the release of more than 3000 lbs of SO_2 and NO_x emissions, as well as more than 200 tons of CO_2 emissions. During peak periods, local electricity usage accounted for the release of

Table 1.

Relations Between Local Electricity Demand and Canal Station Emissions

2002 Cape & Islands Electricity Consumption	Output-Based Emissions Rates for Canal Station		
	Sulfur Dioxide (SO_2)	Nitrogen Oxides (NO_x)	Carbon Dioxide (CO_2)
	10.53 lb/MWh	2.89 lb/MWh	1,882 lb/MWh
Average Demand (230 MW)	2400 lb/h	670 lb/h	430,000 lb/h
Peak Summer Demand (446 MW)	4700 lb/h	1290 lb/h	840,000 lb/h

- *Support accelerated development of local renewable energy sources and develop applicable siting criteria and guidelines.*
- *Support energy efficiency and renewables development at the regional, state, and national levels.*

even more emissions. (In these calculations, demand and output are assumed to be equivalent; in practice, the emissions accounted for by local demand are greater because additional generation is required to offset transmission and distribution losses.)

The potential exists for a substantial near-term increase in central-station and distributed generation from "green" energy sources and in distributed generation from cleaner fossil-fired systems.[15] The regional wind energy resource alone is estimated to be at least an order of magnitude greater than current and projected electricity demand. Other renewable options—including solar PV, wave, tidal, and ocean thermal power—may also play a role in meeting future electricity needs. For example, the number of rooftop PV systems in local communities is expected to double within the next couple years under a program administered by Cape & Islands Self-Reliance Corporation.[16]

Offshore and on-shore renewable energy development could position the Cape and Islands region as a net exporter of green electrons to the New England grid. Local production and consumption of green electrons will not translate directly to reduced emissions from the Canal Station, but each megawatt of local renewable generation will decrease the amount of electricity required from fossil-fired facilities in order to meet demand within New England.[17] This will correspond to a net reduction in the energy-related emissions that may impact Cape Cod ecosystems and communities.

Electricity Rates and Service Options

In the restructured electricity marketplace in Massachusetts, Cape Cod consumers may elect to purchase power from a competitive supplier. Because electricity markets remain immature, the opportunities to reduce costs and procure "green power" promised by industry deregulation have remained largely elusive.

In Cape Cod communities, two main service options are available: "Standard Offer" and "Default Service." Until a fully competitive marketplace develops, default consumers remain particularly vulnerable to high electricity prices. Standard offer consumers are not immune, however; local residential customers are subject to higher rates than those served by large utilities in other Eastern Massachusetts communities.[18] By March 2005, consumers who have not chosen a competitive supplier will receive default service.

As the consumer aggregator for communities on Cape Cod (and Martha's Vineyard), the Cape Light Compact leverages the buying power of local ratepayers to reduce electricity costs. Table 2 presents data illustrating the economic benefits of two programs administered by the Compact.[19] As shown in Column 1, Cape-wide municipal savings attributable to streetlight purchase and maintenance total almost $300,000 annually over a 3-year period. Column 2 summarizes early benefits resulting from an agreement between the Compact and Mirant Corporation, a retail electricity supplier, which saved default consumers more than $1.8 million over a six-month period.

Table 2.

Cost Savings and Efficiency Gains Attributable to Phase I Cape Light Compact Programs

Town	Column 1	Column 2	Column 3 Efficiency Programs, July 1, 2001 - June 30, 2002		
	Annual Savings, 2002-2004, from Streetlight Purchase and Maintenance	Savings for Default Customers, May - Dec., 2002	Number of Participating Residents and Businesses	Cost of Efficiency Services and Incentives	Savings, kWh
Barnstable	$44,935*	$447,307	1,534	$280,227	836,637
Bourne	$39,701	$127,285	830	$ 94,005	369,955
Brewster	$ 3,541	$ 68,060	427	$ 80,512	269,198
Chatham	$18,807	$ 60,169	325	$ 35,663	142,876
Dennis	$73,855	$125,733	1,215	$142,762	649,090
Eastham	—	$ 44,632	224	$ 33,652	142,620
Falmouth	$26,374	$219,607	1,166	$145,928	496,723
Harwich	$38,686	$ 89,136	709	$ 59,532	284,965
Mashpee	$12,414	$142,240	98	$ 27,754	125,832
Orleans	$ 9,866	$ 80,759	246	$ 63,998	188,262
Provincetown	$14,501	$ 55,532	178	$ 32,914	120,156
Sandwich	$ 8,698	$114,227	722	$112,248	351,841
Truro	$ 1,217	$ 16,682	105	$ 15,323	60,681
Wellfleet	—	$ 24,430	139	$ 41,321	109,040
Yarmouth	$ 5,186	$162,910	1,023	$181,168	592,578
Totals	$297,781	$1,808,709	8,941	$1,346,998	4,740,463

*Includes savings for Hyannis Fire District only.

Energy economies based on nonrenewable resources are, by definition, unsustainable.

Although many Cape Cod consumers have indicated a willingness to pay premium prices for electricity from renewable sources, green electrons remain a scarce commodity. Purchasing green power sends important signals to the electricity marketplace, but it is the signals sent by government policies, notably the Commonwealth's Renewable Portfolio Standard, that are expected to significantly expand the role of renewables in meeting local demand. The baseline standard is for at least 1% of the total electricity supplied to Massachusetts consumers in 2003 to be generated by post-1997 renewable facilities; the standard rises to a minimum of 4.5% by 2009.

The Compact continues to pursue green power purchase options. Of particular note is the recent decision by Barnstable County to work with the Compact to create a "retail interface" to the wholesale electricity market. This innovative arrangement could reduce local rates by eliminating the role played by for-profit retail suppliers (such as that of Mirant Corp. under the aforementioned default service agreement).[20] It would also position local consumers to take advantage of long-term power purchase opportunities with renewable energy producers in the Cape and Islands region or elsewhere on the New England grid.

Providing Cape Cod consumers with alternatives for reducing energy costs and encouraging renewables development improves local prospects for sustainability.

We can no longer afford to ignore the dependence of the economy and social progress on the environmental resource base. —*Edward O. Wilson, The Future of Life*

Transportation Fuels

Cape Cod is not completely reliant on petroleum-based fuels. For example, Keyspan Energy Services, the local natural gas supplier, powers its service fleet with compressed natural gas (CNG), and a handful of local vehicles are running on biodiesel, a renewable and domestically produced alternative to conventional diesel fuel.

Although CNG and biodiesel are cleaner fuel options, conventional gasoline-powered vehicles represent the overwhelming majority of rolling stock. In recent years, Cape Cod communities, like others throughout the United States, have experienced a rapid increase in the number of low-efficiency sport utility vehicles (SUVs) plying local roadways. A trend with the potential to offset this unsustainable direction is the recent up-tick in the sales of hybrid gas-electric vehicles.

Hybrid vehicles require much less petroleum-based fuel than equivalently sized conventional ones, and they produce significantly lower total fuel-cycle emissions.[21] In 2001, 36 hybrids were sold by local Honda and Toyota dealers. In 2002, the number more than doubled to 87 vehicles, and sales during early 2003 suggest continued growth in local market share.[22] As the number of hybrid vehicle platforms expands to include mid- and full-size SUVs, consumers are likely to satisfy transportation needs and wants in a more sustainable way.

Gas-electric hybrids are a transitional solution, however. Vehicles powered by fuel cells running on hydrogen represent the ultimate approach for reducing emissions of pollutants and greenhouse gases, as well as reliance on foreign oil supplies. By-products from this renewable, carbon-free fuel source include only water and heat. Technical and economic obstacles must be overcome to evolve an electricity- and hydrogen-based energy economy. A primary one is the energy intensity of electrolysis, a hydrogen production method: significant amounts of electricity are required to split water molecules and isolate hydrogen in fuel form. Combusting fossil fuels to electrolyze water defeats the purpose of switching to hydrogen in the first place.

Abundant renewable resources in the Cape and Islands region offer opportunities to produce hydrogen fuel for transportation and other applications with essentially zero fuel-cycle emissions. Through a pilot-scale project proposed for Cape Cod, demonstration of a clean, integrated energy system is planned for powering vehicles and for serving electricity and heating loads in built environments. This system would blend renewable electricity generation, hydrogen production, and fuel cell technology, helping establish the feasibility of a truly sustainable local energy economy while informing economic development and infrastructure planning strategies.

Heating Fuels

Historically, wood, coal, and oil were the primary heating fuels on Cape Cod. In the late 1960s and the 1970s, electric heating systems were installed in many buildings in response to promises of electricity "too cheap to meter," as well as to oil price shocks. By 2000, more than 16,000 residential electric space-heating accounts remained active in Cape Cod communities.[23] Many multifamily dwellings rely on these inefficient systems because installations are cheaper and tenants absorb heating costs. Split incentives also contribute to the reliance on higher-cost electric heat in rental homes.

The fact is that ceiling insulation and double-glazed windows can produce more oil than the Arctic National Wildlife Refuge at its most optimistic projections, at about one-twentieth the cost, with four times the employment per unit of energy conserved versus the energy consumed by burning oil. —*Paul Hawken*
The Ecology of Commerce

Both oil-fired burners and furnaces and boilers fueled by natural gas have become very efficient. Oil serves a substantial percentage of local heating loads, while natural gas has made significant inroads across all sectors even though the pipeline owned by Keyspan is not accessible in many locations. Cogeneration, in which exhaust from distributed electricity generation systems is used for space and/or water heating purposes, is expected to see increasing application on Cape Cod[24]; gas-fired cogeneration systems include microturbines installed at a Yarmouth retirement community and a fuel cell installed at the U.S. Coast Guard Air Station Cape Cod in Bourne.

Solar thermal systems, which transform solar radiation into heat energy, are already being used for water heating and, to a lesser extent, space heating, in a number of Cape Cod buildings. Because they offer a short payback period, these systems can represent a cost-effective retrofit solution in residential and certain commercial applications—particularly hotels and other facilities with high water-heating loads during the summer months.

"Green" design and building practices are the most effective approach for reducing—or even eliminating—reliance on fossil fuels for heating and other uses. Just as energy and materials efficiencies led to the "quintessential Cape" design, the Woods Hole Research Center's Ordway Campus illustrates the promise of today's architecture and construction.[25] The Ordway Campus integrates passive solar, conservation, and high-efficiency design and construction features to decrease overall energy requirements by more than 75%, in comparison to similar buildings of standard construction. Solar PV, solar thermal, and geothermal systems are used to meet a significant percentage of the building's actual needs. Near-term installation of a wind turbine is planned to make the facility completely energy independent.

By demonstrating the efficacy of green design and building practices, institutions, residents, organizations, property owners, businesses, and municipalities can encourage others to create built environments that leverage Cape Cod's natural energy flows and use all resources more efficiently.

Energy Efficiency

Well-managed energy efficiency programs yield important economic, environmental, and social benefits by reducing electricity and fuel consumption and, thus, the associated costs and emissions. The Cape Light Compact currently manages efficiency programs funded through fees paid by electricity consumers on Cape Cod (and Martha's Vineyard). The Compact's Energy Efficiency Plan includes two phases.[26] Phase I began in July 2001, while Phase II began on January 1, 2003, and runs through 2007.

Column 3 in Table 2 provides town-by-town data on the Compact's programs during the initial 12 months of Phase I.[27] These transitional programs reduced average aggregate demand in the Cape and Islands region by about 0.5 MW during the one-year implementation period and will yield lifetime savings of at least 10 times that amount. Phase II programs have more ambitious goals: measures installed during 2003 are projected to reduce average aggregate demand by a minimum of about 1.5 MW by the end of this year; at the conclusion of Phase II, cumulative effects are expected to be decreasing regional demand by a minimum of 6.4 MW while generating major reductions in costs, fuel consumption, and emissions.[28]

When buying a gallon of gasoline, customers in effect pay to get the oil out of the ground, refine it into gasoline, and deliver it to the local service station. But they do not pay the health costs of treating respiratory illness from air pollution or the costs of climate disruption.

—Lester R. Brown, Eco-Economy

Keyspan offers local incentive programs geared toward increasing the efficient use of natural gas in both retrofit and new construction for all building types. Efficiency measures and end-use technologies adopted in Cape Cod communities during a recent 1-year period will reduce annual gas consumption by almost 500,000 therms for 15 years.[29]

Energy Policy

Reducing consumption, increasing the productivity of consumed resources, and tapping local renewables are complementary components in an integrated strategy for Cape Cod communities to transition away from fossil fuels toward a sustainable energy future. The failure of the present economy to reflect the true costs and impacts of energy supply alternatives presents significant obstacles.

The prices paid for electricity and fuels do not reflect "externalized costs" resulting from resource depletion, air and water quality degradation, public health impacts, national security concerns and other factors; instead, these costs are imposed on society. Climate change, for example, may be considered a physical manifestation of an economic anomaly: because no meter runs as smokestacks, tailpipes, and additional sources emit CO_2 and other greenhouse gases (GHGs), there is no incentive to control these emissions so long as fuel prices do not reflect externalized costs and thus remain artificially low.[30] Externalities tilt markets in favor of existing energy supply alternatives while discouraging investment in efficiency and renewables. These economic incongruities justify government intervention to promote efficiency and conservation, which temper electricity and fuel demand, and to encourage renewables development, which displaces fossil fuel consumption directly.

A study recently completed by the Cape Light Compact estimated the potential local benefits associated with expanding ratepayer-funded efficiency programs through 2015. Results indicate that greater investment in the Compact's programs could help reduce long-term growth in both local electricity demand and in associated CO_2 emissions.[31] Policies that "internalize" externalized impacts, level the playing field for renewables, and promote local renewables development could have synergistic effects, helping establish Cape Cod communities as net exporters of green electrons and, thus, CO_2-free electricity consumers. The U.S. federal government has renounced the Kyoto Protocol, but other policy frameworks are emerging on scales relevant to Cape Cod.

Examples include the Climate Change Action Plan,[32] which will cap emissions within New England states and Eastern Canadian provinces at 1990 levels by 2010; and pending Massachusetts air quality standards, which will cap CO_2 emissions from the Canal Plant and other facilities by 2006. The Commonwealth's Renewable Portfolio Standard complements these market-based carbon management frameworks by creating renewable energy credits that assign financial value to the environmentally beneficial attributes of green power, distinct from the commodity value of the electricity itself. The state's ratepayer-funded Renewable Energy Trust also provides important incentives for renewables development.

Meaningful policy action is occurring at the local level. For example, many municipalities are exploring small on-shore wind energy projects, and approaches are being evaluated for maximizing local benefits and minimizing adverse impacts associated with large-scale renewables development. Falmouth and Barnstable are

participating in the Cities for Climate Protection program, and future regional and local energy-related decision-making is expected to reflect sustainability issues such as economic development, ecosystem integrity, public health, and climate change.

Plans, policies, and initiatives that promote conservation, increase resource productivity, and encourage appropriate renewables development can make a difference by reducing the ecological footprint of Cape Cod's energy economy and by catalyzing larger-scale change. In the long run, visionary leadership at the national and international levels is required to create market-based frameworks that account for energy-related externalities and protect the public's interest in livable communities, sustainable economies, and healthy ecosystems.

What Connections Does this Indicator Have?

This indicator is inextricably linked to the other environment indicators, and it has important links with the full set of economic and social indicators. Connections and synergies are broadly summarized below.

Cape Cod harbors significant opportunities for renewable energy development, particularly off-shore and on-shore wind energy resources. Tapping local renewable sources, shifting to non-carbon fuels, and increasing overall resource productivity promise to reduce reliance on off-shore Cape sources and decrease on-Cape pollution.

Almost every aspect of modern existence is influenced by energy consumption and the sources from which this energy is derived. The ability of populations to extract and use fossil fuels, particularly for electrification, has largely defined their economic and social progress—but at a cost borne largely by the natural environments that sustain them.

As a tightly bounded, increasingly crowded ecosystem, Cape Cod is extremely vulnerable to externalized impacts associated with energy supply and consumption. Energy economies based on nonrenewable resources are, by definition, unsustainable; at present, they are the driving force behind global climate change and other significant national, regional, and local challenges. Future generations will be affected by present society's ability to meet its energy needs in a sustainable manner.

Cape Cod, like the rest of the world, will continue to depend on fossil fuels for the foreseeable future. By practicing conservation and efficiency, individuals, organizations and communities can reduce the use of nonrenewable sources while increasing the productivity of those that are consumed. Tapping renewable resources to meet a growing portion of local needs represents the most critical step for accelerating the transition toward a sustainable energy future. Potential benefits include controlling costs, improving service reliability, enhancing air and water quality, reducing health risks, mitigating local contributions to climate change, promoting economic diversification, and stimulating public and private investment in sustainable directions.

By leveraging the natural energy flows that shape and define this singular region, local communities can help foster environmental, economic, and social conditions conducive to a sustainable Cape Cod.