



Understanding the Economic Development Opportunity & Impact of Climate Change

Presented to the Rhode Island Climate Change Commission
By the Rhode Island Commerce Corporation

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Understanding the Economic Development Opportunity and Impact of Climate Change

A Working Paper – April 2014

Overview:

The following working paper provides an overview and framework for planning and preparing for the economic development opportunities and impacts related to climate change. This information is being supplied to the Rhode Island Climate Change Council for consideration as part of their first report.

Summary of findings

The following table highlights the discussion points contained in the subsequent materials. This information was assembled to begin the development of a framework and advance further conversation around analysis and planning.

| Economic Focus | Considerations | | | Next steps |
|-------------------------|---|---|---|---|
| | Protect the Economy | Advance the Economy | Recover the Economy | |
| Small Business | <ul style="list-style-type: none"> - Business continuity planning services and assistance - Communications and information-sharing among for extreme events - Insurance coverage to cover extreme weather events - Building, equipment, and supply chain retrofits - IT infrastructure and backup storage of critical business information - Specialty financing programs for resiliency preparations | <ul style="list-style-type: none"> - Specialty financing programs for business adaptation and development activities - Building, equipment, and supply chain retrofits to operational flexibility - Communications and information-sharing for businesses interested in climate change-related opportunities | <ul style="list-style-type: none"> - Specialty (short-term) financing programs for recovery efforts and working capital needs - Formation of new businesses providing recovery services or those replacing businesses that cannot recover - Communications and information-sharing among recovering organizations - Identify alternate, back-up work locations and facilities | <ul style="list-style-type: none"> - Identify largest natural and market-based risks and opportunities for RI small businesses - Inventory existing resources and services in RI to support small businesses preparing for and recovering from extreme weather events |
| Ports and Marine Trades | <ul style="list-style-type: none"> - Identify supply chain risks associated with existing imports/exports - Soil erosion threatens marine trades | <ul style="list-style-type: none"> - Identify opportunities for ports to take on capacity from other regions when damage or other impacts are realized - Sea level rise may allow for additional cargo opportunities due to deeper channels - Extended boating/ working season for marine trades | <ul style="list-style-type: none"> - Develop a response preparedness plan to limit port disruptions | <ul style="list-style-type: none"> - Develop a port risk report - RI's Marine Trades Association (RIMTA) should consider the long-term impact of climate change to the industry and make recommendations on how to minimize the impact. |

| Economic Focus | Considerations | | | Next steps |
|-----------------------|---|--|--|--|
| | Protect the Economy | Advance the Economy | Recover the Economy | |
| Tourism | <ul style="list-style-type: none"> - Focus on green/ eco-tourism and shoreline reconstruction - General energy efficiency and sustainability programs and for shoreline areas; incorporate renewable energy - Promote alternative transportation methods to and around shoreline | <ul style="list-style-type: none"> - Explore effects of higher yearly water and air temperature on tourism - Infrastructure to handle heat-related issues on shoreline | | <ul style="list-style-type: none"> - Tourism Industry Taskforce on Climate Change <ul style="list-style-type: none"> + Creation of a Natural Disaster Communication Strategy + Tourism Inventory + Private and public partnership to formulate and implement tourism plan |
| Defense/ Naval | <ul style="list-style-type: none"> - Reduction in energy usage/cost at NUWC will help preserve the base | <ul style="list-style-type: none"> - Technologies being developed at NUWC could have commercial applications for addressing climate change | | <ul style="list-style-type: none"> - The Defense Economy Planning Commission could be engaged to work with NUWC, Commerce, and others to plan for climate change and reduce energy costs for the base |
| Agriculture | <ul style="list-style-type: none"> - Vulnerability and Adaptive Capacity Assessments - Reduce nitrogen emissions - Information delivery/extension systems - Design and planning assistance - Financial assistance - Policy/ regulatory changes | <ul style="list-style-type: none"> - Research and development re: new crops, pests, technologies | | <ul style="list-style-type: none"> - Conduct vulnerability and adaptive capacity assessments |
| Aquaculture | <ul style="list-style-type: none"> - Financial literacy workshops - Zoning opportunities to protect fishing areas - Disaster communications strategy - Asset maps of fishing grounds | <ul style="list-style-type: none"> - Cooperative processing plant - New technology development | <ul style="list-style-type: none"> - Skillshed analysis for alternative jobs - Strong marketing campaign | <ul style="list-style-type: none"> - Partner with Sea Grant program, industry associations, and CRMC to prioritize/ plan for a climate change strategy |

| Economic Focus | Considerations | | | Next steps |
|----------------------------------|--|---|--|---|
| | Protect the Economy | Advance the Economy | Recover the Economy | |
| Manufacturing | <ul style="list-style-type: none"> - Increase adoption of Industrial Energy Efficiency - Reduce use of materials through better design - Increase recycling and life cycle analysis | <ul style="list-style-type: none"> - Explore manufacture of products and technologies that can reduce impact of developing countries - Work with products that produce emissions during use e.g. wood burning equipment and seek to capture carbon - Analyze opportunities to attract companies looking to move from regions with drought, supply chain issues | <ul style="list-style-type: none"> - Develop systems to support manufacturers recovery from severe impacts - Identify locations that are at risk for flooding - Continue to implement Manufacturing Renaissance database project to allow for rapid supply chain response | <ul style="list-style-type: none"> - Identify where RI manufacturers supply chain partners are located to determine vulnerability |
| Energy Production & Distribution | <ul style="list-style-type: none"> - Work closely with utilities to help site infrastructure investments and facilities in low-risk locations - Invest in infrastructure to protect critical sources of energy - Invest in infrastructure to protect and develop innovations within the distribution system - Review existing emergency management plans to determine hierarchy of critical service; invest in energy security systems | <ul style="list-style-type: none"> - Promote and invest in alternative energy technologies (clean tech, etc.) - Educate consumers about access to alternative energy sources - Work with site selection teams and land use officials to address the needs of private traditional and renewable energy producers and distributors - Identify and address workforce needs of local renewable energy companies | | |
| Innovation | <ul style="list-style-type: none"> - Computer simulation for weather forecasting, insurance rate setting, track and trace of objects in water - Communication tools/data narratives to explain climate variability - Autonomous aerial imaging to predict and track algal bloom - Autonomous coastal monitoring devices - Nano products to detect and monitor chemical changes in coastal and marine waters | <ul style="list-style-type: none"> - Biofuels using marine plants - Sculptural forms/new materials for coastal habitat restoration - Culinary products (use of underutilized and emerging species) | <ul style="list-style-type: none"> - Marine disease management (vaccines, natural products) - Fisheries management | <ul style="list-style-type: none"> - Develop proof-of-concept funding to support development of new technologies researched with support of EPSCoR |



Framework Discussion

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Small Business

About

There are generally two components for considering the impact of climate change on small businesses: preparing for extreme weather events and preparing for shifts in the marketplace. The first component requires active planning for a natural disaster while the second involves actively collecting market intelligence and constantly evaluating the organization's business model.

Disaster Planning and Preparedness

Small businesses are particularly vulnerable to extreme weather events due to limited resources and generally operate out of one location and serve the immediately surrounding area.¹ After a disaster, the likelihood of a business reopening declines the longer it is not operating.² Based on a December 2012 survey, small businesses are woefully unprepared for dealing with a disaster (see infographic at right)³

The loss of these businesses can negatively impact a community through the loss of jobs, vital goods and services, and tax revenues, not to mention the cost of re-building, cleaning or demolishing facilities damaged during an event. For example, during Hurricane Sandy, "in New Jersey alone, nearly 19,000 small businesses sustained damage of \$250,000 or more with total business losses estimated at \$8.3 billion ... about 1.0 percent of New Jersey Gross State Product in 2012."⁴

Market Opportunities and Challenges

Climate change can also create opportunities or challenges for small businesses.⁵ Changing weather patterns can generate new or less demand for certain products and services (i.e., more air conditioner sales and service requests due to greater frequency of hot days). Fluctuations in the availability of inventory or inputs (such as agricultural products) can occur due to alterations in regional crops, transportation patterns, or global demand based on climate change factors; these changes in market conditions can negatively impact a business. Examples of impacts and opportunities are outlined in the table to the right.⁶

Businesses must be aware of and capable of responding to changing conditions. To take advantage of market opportunities, businesses need to position themselves to be an early mover when the opportunity arises. To reduce risk, business owners should evaluate their business model and operations to identify and address areas of risk.

¹ <http://www.smallbusinessmajority.org/small-business-research/downloads/072513-Climate-Change-Preparedness-and-the-Small-Business-Sector.pdf>

² <http://restoreyoureconomy.org/case-studies-small-business-finance-following-disaster/>

³ <http://readwrite.com/2013/02/22/the-severe-impact-natural-disasters-can-have-on-small-businesses-infographic#feed=/search?keyword=sever+impact+natural+disasters+can+have+on+small+businesses&awesm=~oBBt2ZblpzhP>

⁴ <http://www.esa.doc.gov/sites/default/files/reports/documents/sandyfinal101713.pdf>

⁵ <http://media.claspinfo.org.ccc.cdn.faelix.net/sites/default/files/Weathering%20the%20Storm%202014.pdf>

⁶ Source: <http://www.giz.de/en/downloads/giz-2012-climate-opportunity-study-en.pdf>



This survey was conducted by Alibaba.com, Vendio and Auctiva. It contained multiple-choice questions and the results are the combined findings from the 600 Vendio and Auctiva customers. Vendio and Auctiva are part of Alibaba.com, a global online marketplace for small businesses.



Considerations

Small businesses need to be aware of the risks and opportunities associated with climate change. This can be accomplished by engaging them in roundtables, providing training, or distributing information. These businesses then need to actively engage in disaster planning and market analysis to determine

- how their organization is at risk should an extreme weather event occur
- expected changes in their businesses' supply chain due to changing environmental conditions
- expected changes in their businesses' market due to changing environmental conditions

Small businesses will need resources such as knowledge, capital, and infrastructure in order to make the appropriate proactive changes to their operations and business model. During times of crisis, however, small businesses will need expedited access to services, capital, and equipment in order to increase their chances of recovery and survival.

Work being done

Disaster Planning and Preparedness

Local organizations are offering or have offered business continuity planning and assistance within Rhode Island. These include:

- The Business Continuity and Resilience Project funded by the Providence Urban Area Security Initiative (P-UASI) (<http://www.risbj.com/business-continuity-resilience-project-2/>)
- The Greater Providence Chamber of Commerce recommends business continuity planning resources on their website (<http://providencechamber.com/business-resources/business-continuity-planning>)
- Rhode Island SCORE & the Association of Contingency Planners (ACP) sponsored a Business Continuity & Disaster Recovery Planning 101 event in Warwick, RI in September 2013 (<http://www.srichamber.com/cwt/External/WCPages/WCEvents/EventDetail.aspx?EventID=1533>)

Communities and organizations around the country are learning from and preparing for the worst. New York City has been developing recovery and resiliency strategies, programs, and services in the wake of Superstorm Sandy. The NYCEDC and other partners within New York City are developing and implementing programs to help local businesses recover and to help communities invest in long-term growth and resiliency strategies. These programs include:⁷

- RISE : NYC, Resiliency Innovations for a Stronger Economy: A competition to identify and deploy innovative, cost-effective technologies and solutions to improve the resiliency of infrastructure and buildings.

| Table 1 | Examples Climate Risks requiring Business Action |
|--|---|
| Impacts of Climate Change | Knock on Impacts on Business |
| Temperature change | Requirement for cooling equipment for employees and to maintain stable temperatures for climate sensitive industrial processes. |
| Precipitation change impacting agricultural yields | Change in availability and quality of climate-sensitive natural resources as input materials for production, increased competition and cost for resources. |
| Sea Level rise and extreme weather events including flooding | Risk of damage of assets (buildings and equipment), business interruption to water and energy supplies, supply chain & logistics, increased costs to weather proof buildings & storage facilities and higher costs of insurance policies. |
| Water stress | Increased competition and cost for water resources. |
| Biodiversity loss | Change in availability of natural resources as input materials. |
| Human health and increase in incidence of disease | Health of employees and workers in supply chain compromised, and rising costs of healthcare. |
| Regulation to encourage mitigation | Increased cost for energy resources and cost for compliance. |
| Changing socio-cultural preferences | Changes in consumer behaviour and demand for specific products and services. |

⁷ <http://www.nycedc.com/service/programs-business-recovery-resiliency>

- Business Recovery Loan and Grant Program: Low-interest loans and expedited grants to storm-impacted businesses for working capital and moveable equipment.
- Neighborhood Game-changer Investment Competition: A competition to fund transformational investment opportunities to spur long-term economic growth in areas impacted by Sandy.
- Business Resiliency Investment Program: Incentives to businesses to make investments to improve resiliency to severe weather. NYCEDC is currently working to complete a detailed design of this program and expects to launch in the first half of 2014.⁸

Economic development practitioners in other parts of the country - including Midwestern communities impacted by tornadoes and floods; coastal communities destroyed by hurricanes; and western regions damaged by earthquakes, fire, and drought - all have a wealth of knowledge, experience, and best practices to share. RestoreYourEconomy.org is an online repository of webinars, reports, and publications that provide information about financing programs, case studies, and lessons learned from recent natural disasters around the U.S.

Market Opportunities and Challenges

Conversations about business opportunities, green infrastructure investment financing, and other business responses to climate change are occurring on a global scale. Examples include:

- Climate Finance and the Private Sector: Investing in New Opportunities Conference, December 2013, South Korea
- Climate Change Challenges and Business Opportunities Conference, November 2013, Spain

Other organizations are developing responses and guidance aimed at the local entrepreneur. For example, the UK Climate Impacts Programme published a factsheet outlining general market opportunities, production opportunities, and adaptation guidelines for small businesses: http://www.ukcip.org.uk/wordpress/wp-content/CLARA/Opportunities_171110.pdf

Work to do

Rhode Island needs to help its small businesses prepare for potential natural disasters, business opportunities, and challenges associated with climate change. This should be a coordinated agency and community resource approach that takes on the following work.

- The first step is to start the conversation among small business owners about preparing for climate change in order to increase awareness and to identify the greatest risks and opportunities.
- Next, further study is needed to define these risks and opportunities for prominent industry sectors representing RI's small businesses.
- Once these risks and opportunities have been identified, business and government leaders need to work together to make sure the necessary resources, including capital (model after the program being developed in NY), equipment, and knowledge, are available to support businesses seeking to adapt. Ultimately these efforts will require training, writing and technical assistance resources all of which can spur job creation to serve this proactive need.

Commerce RI should continue to support improvement in overall business cost climate in Rhode Island. Any new regulations and rules that are adopted in relation to climate change planning should be done at a neutral cost to business.

Additional Resources:

Restore Your Economy Webinar Series: <http://restoreyoureconomy.org/resources/learn/webinar-archives/>

⁸ Per the NYCEDC website: NYC Business Recovery & Resiliency programs are funded by the Community Development Block Grant-Disaster Recovery program. Funds are contingent on NYCEDC receiving funding from the U.S. Department of Housing and Urban Development as a subrecipient.

Ports and Marine Trades

About

Both the ports and trade sectors have the ability to assist in the overall effort of climate change abatement, though their major focus is on mitigating the effects of climate change and the natural disasters associated with it. Climate change effects demand, trade levels and patterns in shipping systems, navigation and berthing, goods handling and storage, vehicle movements, building and equipment damage, insurance availability and costs, workforce health and community relations.

By virtue of their long lifetimes and locations on coasts, rivers or lakes, ports will face a considerable battle in regards to climate change symptoms, including rising sea level, storm surges and extreme wind and waves. It should also be noted that climate change could result in drought conditions that would impact shipping routes through the lakes that are part of canal and river systems. Such examples would necessitate the lighthering of In-land barges allowing them to transit vice keeping them in port. Additionally, severe cold temperatures could extend ice conditions beyond existing seasonal cycles that would limit their shipping seasons. This would require short-term alternate shipping solutions and routes.

Systems are quick to respond to devastating climate change effects, but slow to recover because of the amount of devastation, which illustrates the physical and economic vulnerability of coastal infrastructure to storm surges and sea level rise. Planning for adaptation, accompanied by an analysis of alternative strategies, is required to guide policy decisions about protecting and locating extensive vulnerable port and transportation assets, particularly in coastal areas.

Marine Trades, a vital part of Rhode Island's economy is also at risk. According to the Rhode Island Marine Trades Association's (RIMTA) analysis of Rhode Island Department of Labor and Training data, the marine trades and recreational boating alone generate \$1.3 billion in direct spending, 7,100 direct jobs, and \$327 million in direct wages. The marine trades include boatbuilding marine services, which include yacht design, rigging, engine repair, and sail-making. The breadth and depth of the cluster of marine trades related companies that exist in Rhode Island only exists in a couple of other places in the country. This coupled with the sales tax exemption on boats gives the state a true competitive advantage for further growth. However rising oceans and increased storm events from climate change will necessitate that the marine trades industry take action in order to mitigate the possible effects of climate change and capture that further growth. William Ramos of Schulz Boat Company, Inc. observed, "less predictability to weather patterns affects day-to-day operations" and expressed concern about the potential impacts of high-speed winds on "boat yard operations, boat moving, and commissioning." Matt Calouro, Assistant Harbormaster for Bristol and Harbormaster of Warren, believes coastal erosion could be a serious consequence of sea level rise.

However, alternatively, climate change could provide an increased demand for their products by extending the boating season. Although concerned about climate change, Blount Boats recognizes some benefits from the adaptation process. Julie Blount, Executive Vice President of Blount Boats, acknowledged, "If climate change creates deeper water we would benefit because [Blount Boats'] shallow draft river location limits the types of vessels we can build." In addition, shorter winters would allow the company to extend its working season.

Considerations

- Partner with businesses that can study sea rise – i.e. develop models and system – and consult with them on how to solve issues.
- Form stronger partnerships between Quonset and Providence Metro Terminals with marine-based industry. Quonset can help import/export components of boat building, has cold storage facilities for seafood while the Providence metro terminals could focus on new liquid and break bulk commodity customers.
- Federal maritime agencies, such as the U.S. Coast Guard, the Maritime Administration, and the U.S. Army Corps of Engineers have increased their coordination and communication with ports to strengthen ports' ability to recover from future natural disasters and to build stakeholders' knowledge about federal resources for port recovery efforts.

Work being done:

- The Port Authority of New York and New Jersey, the Ports of Seattle and Corpus Christi and the Georgia Ports Authority have all taken first steps in planning for climate change adaptation, either by commissioning studies on the impacts of climate change or considering sea level rise scenarios in planning for new projects. For instance, the Georgia Port Authority's Environmental Impact Statement considered two sea level rise scenarios to assess the impacts of dredging on wetland habitats (USEPA, 2008).
- The Port of Miami, which is located on an island, participated in a study on the 'Miami-Dade Climate Change Advisory Task Force' which recommended the creation of a detailed elevation map of the county using survey technologies to assess flood risk (USEPA, 2008). The Port of Miami is planning adaptation investments, including raising some of its property during near-term redevelopment works to meet a minimum elevation of 10ft (3m), though the planned elevation is based on old plan datum which does not consider increased sea levels. The plans for a new tunnel which connects the Port to the mainland implemented the 10 feet minimum elevation requirement, designed its storm water system for a 1-in-100 year storm and planned flood gates (USEPA, 2008).
- The Port of Los Angeles has partnered with the RAND Corporation and is currently holding workshops to analyze a range of potential vulnerabilities that the port might face from climate change. The final report generated through these workshops will facilitate the development of a Climate Adaptation Plan (Wunder, 2010).
- In 2009, the RI Marine Trades Association hosted "Our Changing Coastline", an opportunity for the marina industry to fully engage in the conversation happening right now between the scientific community and the professionals influencing policy. It is not clear what work has been done since then to engage the marine trades in preparing for climate change.
- Rhode Island Sea Grant is working with Newport's waterfront businesses to understand risks, develop strategies and identify adaptation actions to improve their resilience, so they can bounce back quickly when extreme weather strikes. Rhode Island Sea Grant also worked in collaboration with the city and the University of Rhode Island to develop maps that illustrate areas vulnerable to sea-level rise. A recent panel at the Newport Yacht Club featured state and local officials speaking about the impacts and lessons learned from the most recent major weather events and how to prepare for a future that includes a predicted sea-level rise of 5 feet.

Work to do

- Conduct a Risk Report. It is clear that, to understand how climate change could affect a given port, the risks need to be assessed based on a solid analysis of the port's particular climatic vulnerabilities. Differences in how severely ports will be affected by climate change will be driven mostly by location, the climatic resilience of their designs and the activities that they undertake. Appraisal of adaptation measures, in terms of costs and benefits, also needs to take account of local conditions, including risks and costs. In developing its own report, Rhode Island should take into account existing risk analysis done by other ports with a similar profile, as well as the risk analysis and/or disaster plans developed by larger port-based companies.
- Improve stormwater management so as to reduce the huge cost of infrastructure upgrades to protect water quality.
- RI's Marine Trades Association (RIMTA) should consider the long-term impact of climate change to the industry and make recommendations on how to minimize the impact.

Tourism

About

The tourism industry in general does not have a strong direct impact on climate change (transportation is discussed as its own segment), but climate change does have immediate and important impacts on tourism. As RI's 4th largest private sector employer, tourism is an important aspect regarding RI's economic path from present to future. Considering the 400 miles of coastline that RI boasts, a significant portion of this tourism comes from shoreline activities. 1 out of 10 Rhode Islanders' job is attributed to tourism and approximately \$1.63 billion in wages and salaries are generated by travel and tourism. With this in mind, climate change and the natural disasters that accompany it can have a very direct impact on the sector and its potential for future growth. The EPA sees the main focus from climate change on coastal areas as sea level rise, changes in storm surge and precipitation, coastal water temperature and ocean acidification. Recent levels of beach closings, 119 days in 2013, due to stormwater runoff are raising concerns and costing the tourism industry.

The most vulnerable areas of the state are those that rely primarily on outdoor recreation activities, such as Block Island, Aquidneck Island and ocean-fronting South County. Changing weather conditions could potentially disrupt or discourage visits to these areas. Block Island, a longtime tourist destination, advertises its "long public beaches and 365 freshwater ponds" as the premier attractions of the small island 10 miles off the Rhode Island mainland. But sea level rise and more extreme storms could pose a threat to harbor infrastructure and that of its Great Salt Pond — with some models even predicting a "splitting of the land mass of the island — where thousands of boats moor each summer."⁹

Considerations

- RI's focus on Eco-tourism has a positive impact on economic resiliency both pre and post-climate event. Not only does this focused tourism attract more varied tourists, but the infrastructure that accompanies expansive and natural shorelines is some of the best mitigation against shoreline degradation due to storm surges and flooding. Expansive and natural beaches, with built infrastructure adhering to proper codes and set-backs, can significantly reduce the harmful effects of catastrophic storms.
- By looking at the impact from Hurricane Sandy on New Jersey and New York, we are able to predict how a similar system could impact the tourism industry and its economic implications. It was concluded that New Jersey's tourism industry would likely see losses for a few years after Sandy.
- RI's tourist communities are being impacted by increasing flood insurance rates. Recently legislation that drastically raised premiums on at-risk properties was repealed by the Homeowners Insurance Affordability Act of 2014. It is clear though that a new model for financing homeowner insurance will be needed as the current system is running at a deficit.
- One of the longer-term affects of climate change is the increase in yearly temperatures. The impact of longer, hotter summers on the tourism industry in RI is actually a positive in the summer months – as an increase in the beach-going season can lead to more visitors in the warmer months, for longer periods of time. However, tourists who venture to RI for colder weather tourism, like leaf-peeping, will find drastically shorter seasons. Also, it is possible that there would be other adverse affects for beachgoers if infrastructure is not in place for tourists to escape the escalating temperature – these beachgoers may migrate to more northern beaches.¹⁰
- Another unexpected benefit to the economic security of tourism from damaging storms are the varying types of tourism as visitors and volunteers come to help and see first hand the impacts. Nearly 10 years after Hurricane Katrina left parts of New Orleans devastated and destroyed, buses of tourists continue to tour the neighborhoods most affected by the winds and high water. This type of travel behavior may have unintended policy issues, but economically continues to bring in tourists immediately after and during the rebuilding phase of both Katrina and Sandy,

Work being done

- Because a large portion of tourist activity in RI is related to beach conditions and shore use, there can be significant assistance to the amount of time taken to bounce back from climate change storms by taking necessary steps to restore the shoreline before a natural disaster hits. These include restoring natural storm surge buffers,

⁹ [http://www.riclimatchange.org/reports/Tourism Hospitality.pdf](http://www.riclimatchange.org/reports/Tourism%20Hospitality.pdf)

¹⁰ [http://www.riclimatchange.org/reports/Tourism Hospitality.pdf](http://www.riclimatchange.org/reports/Tourism%20Hospitality.pdf)

building or repairing dikes and seawalls, modifying building codes to enable structures to withstand higher water levels, expanding setbacks, upgrading and redesigning coastal infrastructure, evaluating drinking water supply, mapping coastal hazards. Eco-tourism goes hand-in-hand with many of these efforts and can lead to increased numbers of tourism.

- There are a number of management and planning programs through the EPA that offer significant help and efforts in the planning for catastrophic events in regards to climate change. They include:
 - **Climate Ready Estuaries Program:** EPA works with the National Estuaries Program and coastal managers under the Climate Ready Estuaries (CRE) program to prepare for the impacts of climate change. Estuaries, the transition zones where rivers meet the ocean, are particularly sensitive to climate change. CRE partners have successfully completed assessments, engaged stakeholders, identified climate change indicators, and initiated adaptation planning efforts. Narragansett Bay is part of this program.
 - **Coastal Zone Management Programs:** Some states with Coastal Zone Management Programs are taking steps to protect their coastal resources, minimize erosion, and lower risks of damage from strong storms and sea level rise. Although several of these states may not be considering future climate changes or sea level rise explicitly, many of their actions are likely to bolster resilience to expected impacts.
 - **StormSmart Coasts:** The network provides an online forum for coastal communities to find and share information about protecting coastal communities from extreme weather, sea level rise, and other climate-related hazards. Through the website, participating states have access to instructions on how to map hazards, create an emergency response plan, and recover from floods. Communities involved in the network can post webinars, studies, and funding opportunities related to coastal impacts for use by other communities in the region. ¹¹

Work to do

Before brick and mortar changes can be made to the infrastructure of RI's coastline regarding natural disaster preparedness, a number of planning efforts focused on the tourism industry are recommended:

- Creation of a Tourism Industry Taskforce that is large enough to represent broad interests but small enough to accomplish work that needs to be undertaken. Needs to be addressed may include creating an industry recovery strategy and response plan, policy recommendations, financing and fundraising strategies, collaboration with transportation linkages, communications issues. ¹²
 - a. Creation of a Natural Disaster Communication Strategy for direct and immediate communication after the disaster regarding both residents and for tourists.
 - b. Conduct a Tourism Inventory, which should be considered before a disaster occurs. A tourism inventory allows the community to understand what assets it has, the quality of the assets and how to best market itself as a tourism destination.
 - c. Private and public partnership to formulate and implement tourism plan that takes climate change into consideration
- Continue to push green/ eco-tourism on RI's shorelines, which in turn promotes mitigation programs that can assist in the direct preparedness of a beach community when storms hit.¹³
 - a. A need exists for sustainable tourism development that incorporates climate change mitigation strategies
- Proactively incorporate renewable energy into the tourism industry
- Future promotions should be based primarily on increasing effect of climate change

¹¹ <http://www.epa.gov/climatechange/impacts-adaptation/coasts.html>

¹² <http://restoreyoureconomy.org/wp-content/uploads/2013/09/Tourism-White-Paper.pdf>

¹³ http://www.riclimatchange.org/reports/Tourism_Hospitality.pdf

Defense/ Naval

About

The Department of Defense and the Navy recognize the serious impacts of climate change, though their main focus is on its impact on national security. According to Defense Secretary Leon Panetta, “In the 21st century, we recognize that climate change can impact national security — ranging from rising sea levels, to severe droughts, to the melting of the polar caps, to more frequent and devastating natural disasters that raise demand for humanitarian assistance and disaster relief.” The administration projects that the change wrought by a warming planet will lead to new conflicts over refugees and resources and catastrophic natural disasters, all of which would require increased U.S. military support and resources.

However, the Navy is also concerned about the operational effects of climate change. The Navy Task Force Climate Change report (2010 – 2014) outlines action items and objectives intended to ensure that:

- The Navy is fully mission-capable through changing climatic conditions while actively contributing to national requirements for addressing climate change
- Naval force structure and infrastructure are capable of meeting combatant commander requirements in all probable climatic conditions over the next 30 years
- The Navy understands the timing, severity, and impact of current and projected changes in the global environment
- The media, public, government, Joint, interagency, and international community understand how and why the Navy is effectively addressing climate change
- The Navy is recognized as a valuable joint, interagency, and international partner in responding to climate change

In addition, energy availability costs and security are at the forefront of the challenges faced by the, Department of Defense and Navy, as energy availability is essential for developing and employing combat capabilities. The cost of energy needed to complete Navy missions is becoming more volatile and less secure. Both price volatility and supply predictability are strategic concerns since Navy operational flexibility and sustainability are linked directly to access to energy.

Table 1 Recent and Planned Naval Energy Initiatives

| Focus Area | | Near Term | Long Term |
|------------|-----------------------------|---|---|
| Tactical | Conservation and Efficiency | <ul style="list-style-type: none"> ▶ Modify platforms with proven technology ▶ Expand i-ENCON for aircraft ▶ Institute measurement and verification systems and protocol ▶ Adopt operating practices that reduce energy usage ▶ Increased simulator usage ▶ Conduct shipboard energy audits | <ul style="list-style-type: none"> ▶ Adopt alternative prime mover technologies and hull designs ▶ Codify operating practices and train operators continuously |
| | Alternatives | <ul style="list-style-type: none"> ▶ Certify aircraft and ship systems to operate on a 50/50 alternative fuel blend ▶ Adopt commercial power solutions where feasible ▶ Demonstrate emerging technologies at USMC Experimental Forward Operating Base ▶ Expand the usage of Ground Renewable Expeditionary Energy Systems (GREENS) in the battlefield | <ul style="list-style-type: none"> ▶ Integrate alternative fuels and concepts into new systems designs ▶ Pursue Science & Technology (S&T) investments for cutting-edge technologies |
| Shore | Conservation and Efficiency | <ul style="list-style-type: none"> ▶ Conduct facility energy audits ▶ Adopt advanced metering and integrate with energy management systems ▶ Pursue building recommissioning ▶ Require at least LEED Silver certification for new construction and major renovations ▶ Integrate Smart Grid enhancements | <ul style="list-style-type: none"> ▶ Pursue Research, Development, Test and Evaluation (RDTE) on innovative energy technologies ▶ Demonstrate and adopt innovative facility technologies ▶ Work with industry to develop cutting-edge technologies |
| | Alternatives | <ul style="list-style-type: none"> ▶ Develop necessary alternative fuel infrastructure ▶ Aggressively adopt commercial solutions ▶ Install wind, solar, biomass and explore geothermal ▶ Rapidly deploy alternative-fueled vehicles | <ul style="list-style-type: none"> ▶ Conduct RDTE on renewable power generating technologies ▶ Conduct RDTE on next generation biofuels |

The Navy Energy Coordination Office (NECO) was established to support Task Force Energy and to coordinate the overall Navy Energy strategy. The Navy's Energy Strategic Roadmap outlines five energy goals to reduce Department of the Navy's overall consumption of energy, decrease its reliance on petroleum, and significantly increase its use of alternative energy. The two priorities for Naval energy reform outline in the Roadmap are Energy Security and Energy Independence.

- Energy Security is achieved by utilizing sustainable sources that meet tactical, expeditionary, and shore operational requirements and force sustainment functions, and having the ability to protect and deliver sufficient energy to meet operational needs.
- Energy Independence is achieved when Naval forces rely only on energy resources that are not subject to intentional or accidental supply disruptions. As a priority, energy independence increases operational effectiveness by making Naval forces more energy self-sufficient and less dependent on vulnerable energy production and supply lines.

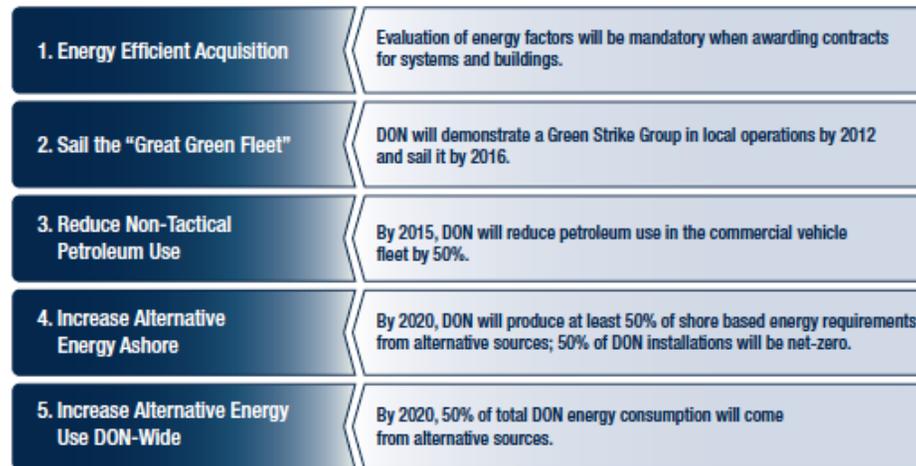
Considerations

According to SENEDIA's "Advancing RI's Defense Industry" report, installation energy, the energy used on military bases, is a major energy consumption category for the DoD, approximately 25%. Naval Station Newport and Quonset Point maintain large infrastructure presences and are large energy consumers. For example, in 2012, Naval Station Newport used about 103,500 MWH of electricity, costing the facility \$9.8 million. The DOD's reliance on utility consumption makes it vulnerable to both long-term price increases (particularly relating to fuel) and short-term price volatility.

Work being done

In fiscal year 2010, the Naval Undersea Warfare (NUWC) Commander Rear Adm. Tom Wears directed the two NUWC divisions to take energy saving actions to achieve aggressive goals set by the Secretary of the Navy for conserving energy. The challenge of those goals was increased in mid-2012 to achieving a 50% reduction in shore energy consumption per square foot by the year 2020.

Figure 1 The Secretary of the Navy's Energy Goals





Work to do

A key recommendation from SENEDIA's "Advancing RI's Defense Industry" report is that: Leadership at Rhode Island's defense facilities should work with local public and private sector stakeholders to advance the DOD's agenda in moving towards a more efficient, stabilized energy portfolio. Options for collaboration between stakeholders include locking in long-term power purchasing agreements and exploring the environment needed to pursue smart grid technology in Rhode Island.

The RI Economic Development Corporation (RI Commerce Corporation) and the Newport County Chamber of Commerce funded a portion of the environmental assessments (EAs) for Naval Station Newport's proposed wind energy project, in assisting the Base meet its DON alternative energy goals – 50% shore based electricity generation by alternative sources by 2020.

The Defense Economy Planning Commission was created in 2010. The 25-member panel includes state legislators, as well as representatives of private businesses, the National Guard, chambers of commerce, and branches of state government. It is unclear whether this group has addressed the issue of climate change as they relate to the defense industry, however, they could be a platform for advancing those discussions/actions.

Manufacturing

About

There are primarily three ways of thinking about the relationship between climate change and the manufacturing sector :

- The impact that the process of manufacturing has on the environment and e.g. greenhouse gas emissions and product waste
- The potential of manufactured products to reduce the impact of climate change e.g. clean technology
- The opportunity for manufactured products to solve some of the impacts of climate change e.g. protective devices and enhanced building products.

The impact that the process of manufacturing has on climate change is the most widely discussed theme and one that has historically placed manufacturing in a negative position during these discussions. The United Nations Environmental Program cites that “Responsible for some 35 percent of global electricity use, 20 percent of CO2 emissions, and a quarter of primary resource extraction, manufacturing has a major impact on the environment and must be factored into the climate change equation. At the same time, the sector’s economic importance cannot be ignored: including extraction and construction, manufacturing currently accounts for 23 percent of worldwide employment.”¹⁴

An article in Industry Today authored by researchers at the Pew Center on Climate Change notes, “furthermore, for powered manufactured goods such as appliances, electronics and autos, up to 90+ percent of emissions are created from product use, not their manufacture. Considering this greenhouse gas footprint, it is clear that manufacturing will be significantly impacted by any future climate change regulatory regime, and must now, as a sector, begin to confront the risks and opportunities that climate change presents. This includes awareness of and engagement in the national policy debate, as well as examining how climate can be factored into core business strategies.”¹⁵

Considerations

There are a number of manufacturing related concepts that lend themselves to protecting and advancing the economy as well as economic recovery from disasters. These are areas that the Council needs to consider the opportunities and impacts that Rhode Island will experience:

- Experience and research demonstrates that introducing enhanced design into manufacturing can reduce a significant amount of materials and waste in the manufacturing process.¹⁶ Rhode Island is already in the process of forming a Center for Industrial Design and Manufacturing.
- EPA regulations on carbon emissions are driving costs for electricity production that will be passed on to consumers with manufacturers being significantly impacted because of their reliance on electricity. Electricity costs are predicted to drastically increase according to the State’s energy plan that is currently being developed.
- Manufacturers that produce products that will be targets of carbon emissions reductions e.g. wood burning stove manufacturers; oil heating equipment and determine if companies domiciled in the state are manufacturing these products.
- The developing world is recognized as having some of the largest climate impacts – this provides an export opportunity for implementation of products manufactured in RI¹⁷
- Supply chain disruptions are not being analyzed to determine where critical issues may present – while this is seen as a global issue, Rhode Island can take a lead in analyzing potential impacts in it’s state.¹⁸

¹⁴ <http://www.unep.org/climatechange/mitigation/Manufacturing/tabid/104340/Default.aspx>

¹⁵ http://industrytoday.com/article_view.asp?ArticleID=F272

¹⁶ [http://www.sustainablebusiness.com/index.cfm/go/news.display/id/25610?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+SBGeneralNews+\(SustainableBusiness.com+General+News\)](http://www.sustainablebusiness.com/index.cfm/go/news.display/id/25610?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+SBGeneralNews+(SustainableBusiness.com+General+News))

¹⁷ <http://www.global-economic-symposium.org/knowledgebase/the-global-environment/climate-change-and-economic-development>

¹⁸ <http://www.nature.com/news/climate-economics-make-supply-chains-climate-smart-1.14636>

**Work being done**

- National Grid is implementing the industrial energy efficiency pilot with National Grid this effort can be expanded and additional capital sources sought to allow manufacturers to reduce their energy consumption.
- The Rhode Island Manufacturing Extension Service provides Lean Enterprise consulting that can help companies increase operational efficiencies, enhance shop floor layout and other services that can reduce environmental impacts.
- The Manufacturing Renaissance project led by RIMA, RIMES and Commerce RI is creating of database of Rhode Island based manufacturers to support B2B connections. This effort can include supply chain connectivity tools and information to help in advancing and during recovery from any disruptions both with Rhode Island and elsewhere.

Work to do

- Conduct analysis on existing supply chains to determine regional and global risks that can be caused by natural and disruptions.
- Identify Rhode Island manufacturing companies that are producing GHG reduction technologies
- Explore climate related port vulnerability compared with other U.S. ports to determine opportunities to promote or prepare for additional import/ export opportunities.

Aquaculture

About

Climate variability has always had a large impact on fisheries. The main climate change drivers impacting fish populations include changes in **temperature, circulation, salinity, disease, invasive species, ocean acidification and food availability**, all of which could affect the spawning and distribution of fish and shellfish causing changes in fishing.

With warming ocean temperatures, local species that are at or near the southern extent of their range are likely to move north, decreasing in abundance and/or the extent of time in which they can be caught by commercial fishers (Perry et al. 2005, Nye et al. 2009, Hare et al. 2010). Commercially valuable species most likely to be impacted in this way include American lobster, Atlantic cod, silver hake and winter flounder (Frumhoff et al. 2007). Conversely, species such as Atlantic croaker, black sea bass, blue crab, butterfish, scup and summer flounder that are at or near the northern extent of their range are likely to increase in abundance and/or extent of time in which they can be caught locally (Hare et al. 2010, Nye et al. 2009). Warming sea temperatures are likely to bring more southern fish species that are primarily, but not solely, targeted by recreational fishers. With increasing populations of these species, some of them may become targeted by commercial fisheries more often.

As species move and targeted fish stocks change, there could be significant impacts on Rhode Island commercial fisheries. Potential impacts include (1) increased time and cost to travel to fishing grounds, (2) reduced catch per unit effort, (3) reduced market value of more abundant southern species compared with less abundant northern species, and (4) costs of altering gear.

Fishers who target Rhode Island waters often use a variety of gear types and are accustomed to modifying gear to target different stocks as they change seasonally. Therefore, if fish communities change, fishers may be able to adapt their fishing practices accordingly. An exception is the lobster fishery, in which lobstermen typically fish almost exclusively for lobster. With the prediction of northern movement of the species with increased water temperatures, and increased incidence of shell disease associated with increased water temperature, lobster fishing is likely to decline.

Diseases that are regional to southern waters could extend northward and negatively impact local communities of marine plants and animals. For example, the American oyster, which had repopulated Narragansett Bay and the south shore salt ponds in the 1990s after being absent from commercial fisheries for nearly four decades, was severely afflicted by a southern oyster parasite causing the Dermo disease, which is attributed to warming waters by having extended the northern limit of the parasite's geographical range.

A disease caused by bacteria in lobsters, often referred to as "shell disease" or "shell rot," has become highly prevalent in Rhode Island's lobster populations. Lobster catch in Rhode Island has declined sharply in the last decade beginning with a 1997 die-off in Rhode Island and Buzzards Bay, Mass., likely associated with the onset of the temperature-sensitive bacterial shell disease. Though the cause of the spread of this disease is unknown, it has been speculated that anthropogenic forces are responsible, including warmer water temperatures. Currently, the southern extent of the commercial lobster harvest appears to be limited by this temperature-sensitive disease, and these effects are expected to increase as near-shore water temperatures rise.

Considerations

- High cost of entry, high insurance rates, and the costs and restrictions of permitting may prohibit fishermen from rebuilding their business or changing the species they harvest.
- Lack of records and the cash based nature of some businesses
- Fishermen are independent by nature and tend to be unresponsive to surveys, town halls and roundtables, which makes communicating recovery strategies more difficult.
- Limited understanding of the industry itself and its supply chain on the part of other economic development and recovery entities.

- Decrease in ability of fishermen to harvest their crop can lead to a decrease in the domestic crop and an increase in price for domestic product. However, in today's global market many buyers will choose to purchase imported seafood at lower prices. An influx in imports can cause a drop in the prices of domestic seafood, which may indirectly lead to a decrease in the number of fisheries.
- Following a disaster, the fishing industry struggles to retain and attract workers. Rebuilding post-disaster can require an upgrade in technology or harvesting skills to which the older workforce may no longer have the ability to adapt. Or, they may no longer have the passion to return to the water.

Work being done

- RI Seafood Marketing Collaborative was established by the Rhode Island General Assembly in 2011. The objective of the Collaborative is to support local fishermen and small businesses and to increase awareness and consumption by the public of locally fished species. The Collaborative is administered by Farm Fresh Rhode Island with the support of the van Beuren Charitable Foundation on behalf of the RI Department of Environmental Management, which has been charged with implementing the legislative initiative.
- Rhode Island Sea Grant/Coastal Resources Center is facilitating for the state the creation of the Rhode Island Shellfish Management Plan (SMP). This document will provide comprehensive policy guidance regarding management and protection measures for shellfish, such as quahogs and oysters, located in state marine waters. Human and natural risks will be addressed a part of this Plan.
- DEM and CRMC will continue to develop and work to implement the SMP Science Research Agenda, in coordination with the researchers, federal, state, and local government and other parties, to improve management policies and practices. The SMP Science Research Agenda will allow DEM and CRMC to: 1) Continue to learn about Rhode Island's shellfish resources and human activities; 2) Better understand the potential effects of future development and other human impacts on this resource; and 3) Increase Rhode Island's understanding of the projected impacts of global climate change.
- Known as the Reed Aquaculture Initiative, the CRMC has asked the University of Rhode Island (URI), Roger Williams University (RWU) and the RI Sea Grant College Program (RISG) to serve as major partners in administering funds and coordinating the programs to be conducted under the Rhode Island Aquaculture Initiative. The Initiative has released a development and economic feasibility report that outlines the rationale and potential for the development of a Marine Technology and Aquaculture Center (MTAC) to attract and support start-up marine biotechnology and aquaculture companies in Rhode Island.

Work to do

- Protect the Economy
 - Fishermen tend to earn all of their annual income during their crop season and often have little to no savings. As a largely cash-based industry, the fishermen may not have accounts or relationships at banks. Natural disasters or decreased production due to climate change may have a strong negative financial impact on fishermen. However, their independent nature may lead the fishermen not to request assistance. When presenting available recovery resources for the fishery industry, social assistance opportunities should be included. Additionally, **hosting workshops on financial literacy** are helpful to fishermen in learning how to address the need for keeping accurate records and creating savings, which can help them respond to a disaster and subsequently return to operations.
 - As communities navigate the post-disaster redevelopment process, it is possible that they will want to consider their waterfront for development and associated tourism opportunities. However, as more waterfront real estate is sold, suitable fishing areas become minimized and can be further damaged by runoff from nearby developments. Communities with working waterfronts should **explore zoning opportunities** to protect and expand their fishing industry.
 - Create a **communication strategy for disasters**, including identifying a potential spokesperson for the industry, will be helpful in advance of a disaster. The more fishermen know, the better organized they are for a disaster.
 - **Asset maps of the fishing grounds** and shore side in preparation for disasters will aid responders in recovery efforts and document what existed prior to the disaster. Additionally, the asset maps can be used to identify opportunities to diversify the economy and creation jobs, as they will highlight opportunities in the tourism, coastal restoration and food processing industries.

- Advance the Economy
 - The fishing industry is highly dependent on its infrastructure. When a disaster strikes, the ice plants used to store the fish for processing and wholesale can be lost... Privately owned processors can face challenges in reopening after a disaster due to a range of reasons including a lack of insurance and access to funding to rebuild. In some communities a **cooperative processing plant** is developed with public funding from federal, state and local grants and loans as well as private financing...<http://restoreyoureconomy.org/establishing-seafood-cooperative/>.
 - New technologies are continuously created for the fishing industry that will help fishermen be better prepared for future disasters such as advance warning systems through mobile phones. To **train fishermen to adopt new technology**, fishermen must be allowed to test the technology and discover how it can improve their abilities. An incentive may be needed to encourage fishermen to incorporate new technologies into their harvesting routines and to encourage fishermen to participate in a series of trainings.
- Restore the Economy
 - Conduct a **skilled analysis** to determine potential industries and occupations that could use the skills of the fishermen and the region to grow emerging industries. When a disaster strikes and impacts the fishing season, fishermen need to find other sources of income to survive until the next fishing season. Using skills from their part-time and offseason jobs, along with the transferrable skills learned in the fishing industry, fishermen may be able to find work in alternative jobs and industries such as carpentry, mechanical, electrical and plumbing.
 - A **strong marketing campaign** will help to restore customers' demand for local seafood. After a manmade or natural disaster, all possibly affected seafood should be tested to ensure safety for consumption. If it is safe, the testing results should be used to highlight the availability of quality local seafood and to encourage customers to purchase domestically.
- **Partner with the Sea Grant program**, whose responsibilities include, but are not limited to, independently assessing what occurred during a disaster, providing expert testimony, aiding in rebuilding efforts, working with businesses to identify risks, creating materials and delivering trainings to aid communities and businesses to prepare for disasters and bringing together stakeholders.

Agriculture

About

Climate Change will present both opportunities and challenges to Rhode Island's growers and producers. Average temperatures in the Northeast are projected to increase and precipitation patterns are projected to continue to change. **These changes are likely to affect the types of crops cultivated in the Northeast.** For example, increases in the frequency of short-term drought could necessitate increased irrigation and operational costs, while a longer growing season could benefit those farmers invested in warmer-weather crops. Rhode Island fruit growers produce an abundance of high-value fruit crops, many of which require a certain number of hours each winter of adequately cold temperatures for optimal flowering and fruit development. By midcentury under the higher-emissions scenario, the winter chilling requirements of blueberries, raspberries, cranberries, and certain varieties of apples would not be met across most of the state. Under the lower emissions scenario the southern half of the state would, by late-century, become too warm to support these crops. **Livestock will also be affected.** Increases in temperature will likely reduce milk yields and slow weight gain in dairy cows. The projected increases in temperature would negatively affect operations, since production costs would increase with reductions in milk and meat production. In addition, without cooler nighttime temperatures, many cows would experience continued heat stress that could ultimately result in loss of cattle.

Across the United States from 1980 through 2011 there has been an increase in the number of events with significant economic impact. An increased occurrence of extreme events associated with climate change across the United States will likely lead to an increased incidence of weather events with significant economic impact. Patterns already evident in crop insurance payments, workable field days, and soil erosion provide a glimpse into the implications for agriculture of an increased incidence of extreme events.

Considerations

Several regional and national studies have predicted that U.S. cropland agriculture will be fairly resilient to climate change in the short term, with expansion of irrigated acreage, regional shifts of crop acreage, and other adjustments to inputs and outputs partially compensating for yield effects caused by changing climate pattern. **Capacity for adaptation is therefore a critical determinant of the net economic effects of climate change** and of the regional distribution of those effects. Adaptive behavior can significantly mitigate the potential effects of climate change on food production, farm income, and food security by moving agricultural production out of regions with newly reduced comparative advantage in specific production sectors and into areas with improved relative productivity. Reilly et al. (2007) estimate that with adaptation, the production effects of climate change are reduced to one-fifth to one-sixth of the initial yield effects.

The recognition of the inherent uncertainties associated with adaptation cost-benefit analysis coupled with the desire to move ahead with adaptation planning despite these uncertainties have driven research to develop robust adaptation-decision strategies. Such strategies support robust adaptation planning through use of adaptive management practices, case studies, hedging mechanisms, methods that prioritize and sequence adaptation investments, and methods that support a consideration of the social, institutional, and cultural factors that influence adaptation. Adaptation planning should be driven by both vulnerability assessments and adaptive capacity assessments.

- **Vulnerability assessment** aims to estimate the exposure, sensitivity, and adaptive capacity of the agricultural system of interest in order to quantify vulnerability to climate change effects for a specific geographic location. Vulnerability assessment is typically integrated across multiple scales; national or regional climate projections are integrated with individual, community, or regional estimates of adaptive capacity.
- **A better understanding of the key determinants of adaptive capacity** in agricultural systems would aid efforts to sustain agricultural production and productivity in the face of projected increases in the frequency and intensity of climatic events. Research and development is underway to understand the determinants of agricultural adaptive capacity in all its dimensions and to develop assessment methods useful to decision-makers operating within an agricultural system. Key to the utility of adaptive capacity concepts in decision-making is to be able to identify critical determinants and their links to potential adaptive responses in the system of interest. This emerging body of work suggests that the adaptive capacity of agricultural systems is dynamic and determined by a complex mix of economic, ecological, and social factors that interact with climatic effects across multiple dimensions of space and time.

Work being done

- To be determined.

Work to do

- In an analysis of climate change adaptation policymaking by U.S. municipalities, States, and the Federal Government, Smith et al. (2009) identified an “adaptation architecture” fundamental to facilitating successful governance of adaptive action. Components of the architecture include **governance processes that provide clear leadership, enable coordination between agencies and departments, incorporate mainstream climate considerations into daily decision making, integrate new funding for adaptation into baseline support for climate-sensitive sectors, address institutional and policy barriers to adaptation efforts, and involve stakeholders in policy development and implementation.** In addition, government decision-makers employ decision tools that are robust under uncertainty and informed by accurate, timely, and scale-appropriate climate change information. Finally, government programs invest in adaptation research to understand conditions that promote or impede adaptation decisions and in technology development and diffusion to expand adaptation options.
- Agriculture is the source of 10% of all GHG emissions. Methane is one gas that can result from large livestock operations. But perhaps more critical in Rhode Island is the emission of nitrous oxide from the use of nitrogen fertilizers on our farms and on lawns. Nitrous oxide emissions are over 300 times more harmful to the climate than carbon dioxide. Moreover, they last in the atmosphere for about 120 years, so stopping such emissions entirely goes a long way in cutting risk. The easiest way to do this is to **enforce a set of best management practices that will limit fertilizer overuse by farms** and homeowners. Save the Bay has begun to advocate for this as a part of their efforts, but current activity is being undertaken in a voluntary and individual manner.
- Adaptation Strategies suggested by the New York Response to Climate Change report, which will require societal investment or private industry response include:
 - Technological/applied research developments, e.g. new varieties or new cooling and irrigation technologies;
 - Information delivery/extension systems, e.g. real-time local weather data for integration into farm-management decision tools;
 - Locally available design and planning assistance, e.g. to help design new heat-resistant barns;
 - Disaster risk management insurance;
 - Financial assistance, e.g. low-cost loans for adaptation investments;
 - Major capital investments, e.g. for new flood-control and drainage systems;
 - Policy and regulatory decisions, e.g. amendments to the Federal Insecticide, Fungicide, and Rodenticide Act; and
 - Research on new crops and pests.

Table 7.2. A Typology of Climate Change Adaptation Strategies for Agriculture. This table presents examples of climate change adaptation strategies to key biophysical and social drivers of adaptation (Iglesias, et al. 2007, Smit and Skinner, 2002). The adaptation strategies are grouped according to the actors involved and the form the adaptation takes. The first three categories mainly involve enterprise-scale decision-making by producers. The last two are typically the responsibility of public agencies and agribusiness. Adaptations included in these categories could be thought of as system-wide.

| Key Adaptation Drivers | Adaptation Strategies | | | | |
|--|---|---|--|--|--|
| | Farm Production Practices | Farm Financial Management | Farm Infrastructure | Technological Developments | Government Programs and Insurance |
| Increased variability in growing conditions (changes in seasonal temperature and precipitation patterns) | Change crop variety and breed, change timing of farm operations, use season extension and irrigation, Build soil health | Purchase crop insurance, invest in crop shares/future, participate in income stabilization programs, diversify household income | Install water management (eg, catchment, swales), irrigation systems, weather protection systems, data collection/analysis systems | Drought/cold/heat tolerant crop varieties, Efficient irrigation, Weather and climate information systems and decision-support tools, Farm-level resource mgt practices to improve resilience | Modify gov. insurance, subsidy, support and incentive programs to influence farm-level risk management strategies, provide technical support for risk mgt. Modify land and water resource management policies and programs to improve resilience to climate change |
| Increased soil degradation (increased erosion reduces soil quality) | Soil conservation practices (eg, no-till, mulch), Build soil health | Participate in soil conservation cost share and easement programs | Install soil conservation structures (eg, terraces, grassed waterways, riparian areas) | Farm-level soil conservation practices, Soil building amendments (eg. biochar, stabilizing agents) | Modify land and water resource management policies and programs to promote soil conservation and soil health mgt. |
| Increased pest pressure, novel pests | IPM practices, Resistant crop varieties and breeds, Farmscaping | Participate in insurance programs | Purchase improved application technologies, Pest protection structures | Pest resistant crop varieties, IPM options and early warning information systems, Decision-support tools, Pest suppression technologies | Insurance programs, Risk analysis, IPM and weather-based decision-making, Technical advice |
| Increased number, length and/or intensity of drought events | Resistant varieties/breeds, adjust crop/livestock development, build soil health | Participate in insurance programs | Install water management systems (eg, catchment, swales), Install irrigation systems | Drought resistant crop varieties and breeds, Alternative crops/livestock, Efficient irrigation, Farm-level water management decision-support tools | Insurance programs, Weather-based decision-making, Farm-level and regional contingency planning and water use priority planning, Technical advice |
| Increased number and/or intensity of flood events | Avoid high risk locations/time periods | Participate in insurance programs | Increase drainage capacity, Build defense structures, Restore/create wetlands, Floodplain mgt. plan | Flood tolerant varieties, Excess water management technologies | Insurance programs, Weather-based decision-making, Farm-level and regional contingency planning, Technical advice |
| Shift in optimum zones for current production systems | Change in crop/livestock systems | Participate in insurance programs | Adapt existing infrastructure to new crop/livestock systems | New climate control technologies, Adapt existing equipment to new crop/livestock systems | Create transition insurance and cost-share programs, Develop technical advice for transitioning to alternative resilient farming systems |
| Government climate change policy | Use GHG emissions reduction practices | Participate in financial incentives programs | Install GHG reduction measures | GHG Monitoring/reduction and decision-tools | Agricultural GHG management policies and programs |
| Economic (eg. carbon markets) | Adjust crop/livestock mix appropriate to new market | Participate in new market | Alter tillage and water management regimes and storage and use of livestock waste, invest in necessary equipment, re-train staff. | Develop capabilities to manage GHG emissions. | Develop and provide advice and guidance on BMP |
| Consumer behavior (eg, diet change) | Adjust crop/livestock mix to meet demand | Participate in new market | Develop flexibility to respond to changes in consumer behavior. | Utilisation of web resources to stay informed and make informed decisions. | Provision of information and advice on trends, preferences and market conditions. |
| Perception of climate risk | Short-term vs. long-term adjustments | Participate in insurance programs | Develop flexibility to enable rapid responses. | Utilisation of most appropriate sources of information for decision making. | Seasonal and decadal forecasts with associated probabilities of error. |

Energy Production and Distribution (Energy Security)

About

Access to energy is a critical component of any modern society; climate change creates critical challenges and business opportunities within the energy sector.

Critical Challenges

Major weather events and environmental conditions caused by climate change will significantly impact the energy sector's operations in terms of both emergency conditions and day-to-day conditions.

The U.S. and Rhode Island have faced their fair share of costly weather-related energy outages in recent years. These type of weather-related outages pose significant financial, operational, and security risks for public and private organizations due to lost sales, stolen or damaged property, limited communications, and lost wages. Per the RISEP March 18, 2014 Draft: "A 2013 report prepared by the Obama administration found that 670 widespread weather-related power outages occurred nationwide over the past decade, with an average annual cost to the U.S. economy of \$18 billion to \$33 billion. Rhode Island has witnessed numerous severe weather-related events over the last four years, including floods, blizzards, extended heat waves, extreme cold snaps and hurricanes. These events pose significant energy security risks to the State. For example, during Blizzard NEMO in February 2013, all of the fuel terminals in the State lost electrical power for two days and were unable to provide fuel (i.e. gasoline, diesel, heating oil, jet fuel) to gas stations, homes and the airports. During Superstorm Sandy, approximately 120,000 electric customers and 1,200 natural gas customers lost service, and five days passed until National Grid was able to restore electric power to 100% of the state."

Rising sea temperatures caused by climate change will impact the efficiency and viability of today's energy technologies. "Use of warmer water reduces the efficiency of thermal power plant cooling technologies. And, warmer water discharged from power plants can alter species composition in aquatic ecosystems. Large coal and nuclear plants have been limited in their operations by reduced river levels caused by higher temperatures and thermal limits on water discharge."¹⁹

Business Opportunities

New technologies and the diversification of energy production and distribution supports energy security measures and provide new business opportunities. The development of alternative energy resources and businesses (i.e., clean technologies) can spur new businesses and attract capital to the region. Advances in energy storage and distribution technologies can also stimulate the economy as companies invest in and deploy these technologies.

"Once considered a fringe target for economic development, renewable energy is now taking a larger role as it grows and becomes more relevant to the U.S. economy. In 2009, the U.S. ranked third in the world with \$15 billion in investment in research and development targeted at renewable energy (government and private sector combined), while Germany and China led the pack with \$25-30 billion each.

The growth of domestic renewable energy has been so significant that policy makers are not only working to continue to grow these sectors, but are increasingly concerned about how to retain renewable energy companies and jobs in the U.S. and not to lose them to offshoring opportunities. Yet at the same time (but less publicized), a significant amount of foreign direct investment (FDI) has been coming into the U.S. in the alternative and renewable energy sectors. Prior to 2006, renewable/alternative energy had never attracted more than five FDI deals per year, but between 2008 and 2010, the sector recorded more than 35 deals a year, and that was during the height of the economic recession. In fact, the 2007-2010 period averaged nearly 400 percent more alternative/renewable energy deals than the 2003-2006 period. No other sector surpassed 140 percent growth."²⁰

¹⁹ http://nca2009.globalchange.gov/energy-supply-and-use#Energy_and_Water_Connections

²⁰ http://www.iedconline.org/clientuploads/Downloads/edrp/IEDC_Powering_Up.pdf

Considerations

Critical Challenges

Major stakeholders must be engaged in conversations to increase awareness of climate change impacts, identify risks, and develop plans and solutions for addressing these risks. While general awareness has increased due to recent weather-related events, detailed analysis, modeling, planning, and investments are needed to address critical infrastructure and operational risks.

Business Opportunities

An IEDC recent survey of economic development leaders around the U.S. exploring the opportunities and challenges state-level economic development professionals face in developing renewable energy projects produced the following results:²¹

- Renewable energy has grown in its importance to economic development over the past 5 years.
- Most states are very active in strategic planning activities that target renewable energy development.
- Political Leadership is seen as the leading asset in growing renewable energy.
- Investment in R&D is seen as a critical area of attention for state economic development leaders who are looking to stimulate renewable energy sectors.
- Some regions focus on one or two key renewable energy sectors, while others diversify.
- Renewable Portfolio Standards and financial incentives were the highest-ranking policy tools in stimulating renewable energy growth.
- Lack of investment capital and financing is the leading challenge to renewable energy business growth.
- The American Recovery and Reinvestment Act was a significant player in supporting renewable energy growth.
- Most states don't view local level policy (city, county, regional) as influential to renewable energy growth.

Work being done

Critical Challenges

On the public side, per the RISEP March 18, 2014, Draft: "Rhode Island has already taken initial steps to gather high-level information on energy emergency considerations through the development of an Energy Assurance Plan (EAP)³, which was funded through an American Recovery and Reinvestment Act (ARRA) State Energy Program (SEP) grant in 2012.

On the private side, major regional utility National Grid "conducted a year-long assessment of potential future flood risks to all of its electricity substations in Rhode Island following damage from major river floods in March 2010 that reached 2 to 6.5 feet and inundated eight out of 67 substations.⁹ Inland and coastal flood zone maps from the Federal Emergency Management Agency (FEMA) were overlaid on the boundaries of the company's substations, with special consideration given to those that had been affected in the past. Elevation and other data discrepancies were resolved through on-the-ground field surveys. Based on the findings, National Grid plans to rebuild parts of its substations, or elevate specific equipment within substations, in areas susceptible to flood conditions, investing nearly \$23 million over the next five years. Similar assessments are underway for electric substations located within National Grid's service territory in Massachusetts and upstate New York."²²

Business Opportunities

Rhode Island recognizes the need for and opportunities associated with renewable energy and renewable energy technology development.

²¹ http://www.iedconline.org/clientuploads/Downloads/edrp/IEDC_Powering_Up.pdf

²² <http://www.c2es.org/docUploads/cs-national-grid.pdf>

In June 2014, Rhode Island adopted a Renewable Energy Standard requiring “the state's retail electricity providers -- including non-regulated power producers and distribution companies -- to supply 16% of their retail electricity sales from renewable resources by the end of 2019. The requirement began at 3% by the end of 2007, and then increases an additional 0.5% per year through 2010, an additional 1% per year from 2011 through 2014, and an additional 1.5% per year from 2015 through 2019. In 2020, and in each subsequent year, the minimum RES established in 2019 must be maintained unless the Rhode Island Public Utilities Commission (PUC) determines that the standard is no longer necessary.”²³

Given the early-stage nature of such technologies and businesses, the State has established the Renewable Energy Fund to support the development and commercialization of renewable energy technologies. The Fund “provides grants and loan opportunities for eligible renewable energy technologies for preliminary feasibility studies as well as direct residential, commercial, and municipal installations. Funding is also offered for new renewable energy business ventures and innovative development. The fund is supported by a surcharge on electric customers' bills. The REF program is currently administered by the Rhode Island Economic Development Corporation with the Office of Energy Resources providing assistance in development of the rules and regulations and evaluation of submitted REF applications.”²⁴

A few other states are allowing and even supporting the development of micro grids ²⁵which provide low power storage and generation in the event of system outages. These micro grids can utilize renewable energy sources thus making them more environmentally sustainable. This approach allows communities to ensure remote and vulnerable locations and critical assets such as hospitals remain powered in the event of a natural disaster.

Work to do

Critical Challenges

Per the RISEP March 18, 2014, Draft: “The State, however, has not yet drawn on the recommendations of the EAP to design and implement a comprehensive, targeted strategy addressing energy security vulnerabilities at the municipal or facility level, specifically at discrete critical infrastructure assets— hospitals; police and fire stations; water and sewage treatment plants; senior centers and nursing homes; shelters; correctional facilities; fueling stations; and grocery stores. Smart energy security investments at these locations including, but not limited to backup generation, fuel reserves, distributed generation, combined heat and power, energy storage, microgrids, or other energy resiliency solutions could help alleviate the impact of power outages or fuel supply disruptions during energy emergency situations.

Public and private organizations must work together going forward to share information and develop solutions to energy security issues. The RISEP (March 18, 2014, Draft) “recommends the formation of a working group charged with the task of developing a short- and long-term strategy for mitigating critical infrastructure energy security risks and investing in power resiliency solutions. The working group should convene the appropriate set of stakeholders to review the state of current critical infrastructure; better characterize the need for resiliency investments; assess existing information and options; evaluate costs and benefits; and most importantly, devise a sustained and institutionalized funding mechanism to help ensure that the recommended energy security improvements can be made in critical infrastructure locations throughout the State.” From the private utility perspective, “National Grid in the United States has worked with other utilities in industry groups and with state regulators to develop local responses to local threats. The company emphasizes the importance of working and sharing information with state environmental departments and utility commissions, to ensure that its investment in hardening systems is commensurate with the expected level of risk. Given the critical role of state utility commissions in approving rates and expenditures, these efforts will become increasingly important over time.”²⁶

²³ <http://energy.gov/savings/renewable-energy-standard-2>

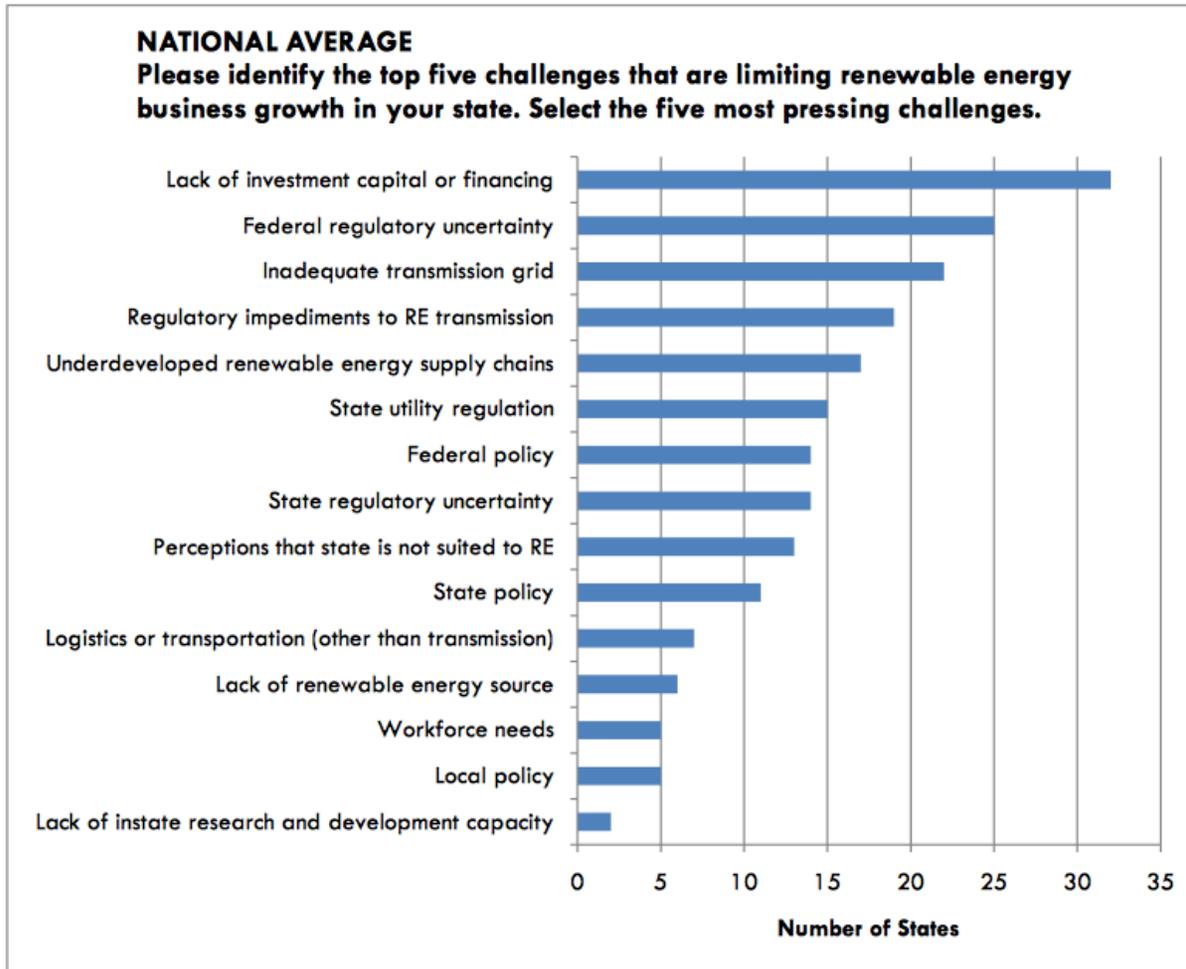
²⁴ <http://www.energy.ri.gov/renewable/ref/>

²⁵ <http://www.greenbiz.com/blog/2013/10/14/microgrid-solution-macro-challenge-climate-change>

²⁶ <http://www.c2es.org/docUploads/cs-national-grid.pdf>

Business Opportunities

Rhode Island should continue to invest in energy technology R&D and commercialization. State leadership and energy stakeholders should review and address impediments to renewable energy business growth. Examples of impediments could include those identified by economic development leaders from around the U.S. as illustrated in the chart below:²⁷



²⁷ http://www.iedconline.org/clientuploads/Downloads/edrp/IEDC_Powering_Up.pdf

Innovation

Rhode Island's ability to harness the vast amount of climate change research being conducted by Rhode Island colleges and universities, and develop that research into new products to help our economy mitigate and/or adapt to climate change, is something that goes beyond just one type of business or industry. Under the NSF EPSCoR grant, nearly \$40K million dollars of combined state and federal funds will have been invested by 2015 with an additional \$20K million requested for 2016-2021 around climate variability in Narragansett Bay (NB). NB is a watershed of national significance and uniquely positioned at the convergence of two climatic zones making it one of the best places in the world to demonstrate how the effects of climate change are intense and detectable.

Building on our "Ocean State" assets that include deep expertise in the natural sciences, engineering and art/design, we enjoy a broad range of possibilities for development of new products and services for both private and public sector use. Examples include:

- Computer simulation for weather forecasting, insurance rate setting, track and trace of objects in water (chemical spills, disasters)
- Communication tools/data narratives to explain climate variability
Autonomous aerial imaging (drones) to predict and track algal bloom
- Autonomous coastal monitoring devices
- Biofuels using marine plants
- Sculptural forms/new materials for coastal habitat restoration
- Marine disease management (vaccines, natural products)
- Nano products to detect and monitor chemical changes in coastal and marine waters
- Fisheries management
- Culinary products (use of underutilized and emerging species)

A new proof-of-concept fund should be administered by STAC to support the commercialization of research around climate change.

Notes:

Major impacts on crops and livestock: <http://deltafarmpress.com/government/climate-change-reports-warn-major-agriculture-forestry-impacts>

Work from Brown University provides a significant amount of information - <http://envstudies.brown.edu/Summary-RIClimateChangeAdaptation.pdf>

New York State has performed an exhaustive study of the impacts of climate change by key sectors and estimated costs (<http://www.nyseda.ny.gov/climaid>)

This working paper was developed by Fourth Economy Consulting under contract with Commerce, RI. They may be contacted with any questions or to note omissions.
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