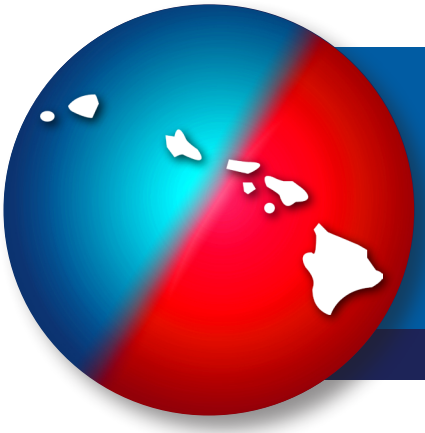


FACTS

HAWAII

AMERICAN SECURITY PROJECT

Pay Now, Pay Later: Hawaii

Rising temperatures and sea levels could threaten Hawaii's beautiful beaches and unique ecosystems, jeopardizing its $10.7 billion tourist industry.[1]

Sand replenishment to protect Hawaii's coasts from a 20-inch rise in sea level could cost $340 million to $6 billion.[2]

Hawaiian clean jobs grew 43.6% between 1998 and 2007, far outpacing overall job growth of 7.3% in the state;[3] Hawaii is committed to generating 40% of its energy from renewable sources by 2030,[4] offering many local opportunities for new jobs.

Admittedly, the effects of climate change, a complex and intricate phenomenon, are difficult to predict with precision. Informed scientific and economic projections, as we have used in our research, however, allow us to see that Hawaii faces significant losses in industries crucial to its economy if no action is taken.

Moreover, data shows that Hawaii is poised to benefit from the research, development, and distribution of renewable energy technologies. Although Hawaii is the most oil-dependent state in the nation—importing 51 million barrels annually—it has abundant renewable resources and has projects underway to tap the renewable energy potential of the sun, wind, sea, and land.[5] **For example, Hawaii leads the nation in solar water heating[6] with an estimated 80,000 facilities currently using solar power to heat water.**[7] Should we fail to take action against climate change, Hawaiians have much to lose.

Pay Later: The Cost of Inaction

Visitors from all over the world come to Hawaii for its beautiful beaches and oceans and the unique plant and wildlife ecosystems found nowhere else in the world. Because of their isolation, native species on islands are highly vulnerable to extinction due to predators, diseases, and competition from other species introduced by humans.[8]

Even a slight change in the climate could cause major local changes for Hawaiian ecosystems.[9] **Average temperatures in Hawaii could rise by an estimated 4.1°F by the end of the century;[10] the number of very warm nights (defined as the top 10% of annual daily lows) increased by 10 or more per year between 1950 and 2004.**[11] Rising sea levels and temperatures threaten Hawaii's natural beauty, along with the state's vital tourism industry, and the agricultural and associated food-product manufacturing sectors.

Beach Bummer

Changes in sea level vary widely from island to island and are affected by factors such as the El Niño Southern Oscillation (ENSO) cycles and the resulting storm surges. **If the sea level rises over the long term, however, consequences include saltwater intrusion into freshwater and agricultural areas, erosion, and damage to transportation and other facilities.[12] The sea level at Honolulu, Nawiliwili, and Hilo is currently rising at a rate of 6-14 inches per century and could rise by 17-25 inches by the close of this century.**[13]

Rising sea levels and temperatures threaten Hawaii's natural beauty, along with the state's vital tourism industry and the agricultural and associated food-product manufacturing sectors.

Beach erosion rates can be 150 times the amount of sea level rise.[14] As beach erosion worsens, the cost of protecting the coasts rises. Sand replenishment to protect the coast from a 20-inch rise could cost between $340 million and $6 billion.[15]

Rising sea levels and beach erosion are not a far-off threat in Hawaii.

Already, Whale Skate Island in the Northwest Hawaiian Islands has completely disappeared, in the process washing away habitats for birds, seals, and turtles.[16]

Hawaii's coasts are currently protected by underwater coral reefs that serve as storm barriers for the mainland and home to many fish species. **Coral reefs are very sensitive to water temperature changes,**[17] **and the particularly strong 1997-1998 ENSO cycle—combined with the associated increase in ocean temperature—resulted in widespread coral bleaching worldwide.**[18] As the colorful tissue of the coral is stripped away through bleaching (resulting from water temperature increases of as little as 1.8ºF),[19] the bone-white skeleton is left behind, possibly leading to the death of the coral organism.[20]

Cloud Forests Especially Vulnerable to Climate Change

Hawaiian ecosystems—especially those in the high-elevation areas—face an uncertain future. Scientists highlight two scenarios. If climate change causes increases in the Trade Wind Inversion (TWI), Hawaii will likely see an upward shift of areas suitable for plant growth, but the state will not see a major increase in drought occurrence. However, drought frequency would rise if, simultaneously, ENSO events become increasingly intense and the TWI falls. With lower hanging clouds and less moisture, the tree line would likely retreat.[21]

Biological invasion and habitat destruction have already caused the extinction of some species, and any climate shift will most likely exacerbate such losses, as scientists predict such disruption would favor non-indigenous species. The U.S Geological Survey's Hawaiian Ecosystems at Risk project asserts that millions of dollars worth of crop losses, loss of native species and forests, as well as spread of disease is already attributable to such invasions.[22]

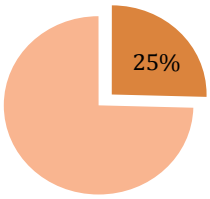
The rate of species extinction on the Hawaiian Islands is the highest in the nation.[23] **Moreover, the islands together currently house 317 threatened and endangered species.**[24] High-elevation cloud forest areas such as Haleakala and Hawaii Volcanoes National Park are especially at risk from climate change, since even small shifts could cause major local variations in rainfall, cloud cover, and humidity.[25] Scientists expect that any such change would favor invasive non-native species, allowing them to survive in areas where native species previously lived with competition. For example, any warming that allows mosquitoes carrying avian malaria to survive at higher elevations threatens the birds that currently thrive at those elevations.[26]

Impact of Climate Change on Tourism and Agriculture Industries

Tourism is the most important industry in Hawaii.[27] **In 2008, the direct and indirect impact of the statewide visitor industry equaled nearly 17% of the gross state product and provided 151,331 civilian jobs and over 21% of state taxes.**[28] If potential tourists decide not to go to Hawaii because it is too hot, or the beaches or native plants and animals have disappeared, consequences for the state will be dire.

The tourism industry relies heavily on transportation availability. Transportation accounts for more than 60% of

Hawaiian Labor Force Projected to be Directly Affected



Source: Hawaii Department of Business, Economic Development and Tourism[29]

Tourism is the most important industry in Hawaii. In 2008, the direct and indirect impact of the statewide visitor industry equaled nearly 17% of the gross state product and provided 151,331 civilian jobs and over 21% of state taxes.

Hawaii's total energy consumption, approximately half of which is used to fuel both military and commercial planes.[30] Moreover, most of the infrastructure—roads, bridges, docks, water supply systems, and hotels—is concentrated near the coasts, and is therefore particularly vulnerable to rising sea levels and increasing storm frequency and intensity. Hawaii's ports are also crucial to petroleum distribution to the islands.[31]

In 1992, Hurricane Iniki—the most powerful hurricane to strike Hawaii in the recent past—caused $2.3 billion in property damage on Kauai.[32] If the frequency and severity of storms increases as many scientists predict, a comparable hurricane today would cause many more billions of

dollars in damage and major disruption.

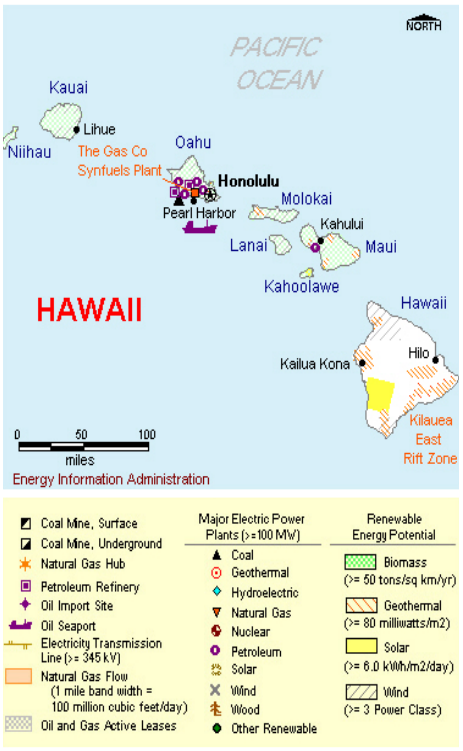
Because of their unique geography, island communities frequently encounter problems with freshwater availability, whether due to frequent droughts, lack of adequate storage, or a "mismatch" between the source and the need. As an example, **the Hilo side of Hawaii receives plenty of rainfall, but the Kona side—where most tourists visit—experiences significant droughts. Tourism is "extremely water-intensive"**[33] and any climatic changes that result in more frequent droughts, floods, or changes in sea level could adversely affect water supplies.[34]

Agriculture and associated nondurable goods manufacturing (such as food processing) provided nearly 13,000 Hawaiian jobs in 2008.[35] Higher temperatures and increased regional droughts could lower the yield from important livestock and crops, including ornamental flowers, sugar cane, and coffee.[36]

Since 1995, the most severe droughts have been associated with the ENSO cycles.[37] **In 1996, losses from drought emergencies for Hawaii, Maui, and Molokai totaled at least $9.4 million.**[38] Most recently, the October 2009 through April 2010 wet season was ranked as the driest in the past 30 years, leading the state to declare all four Hawaii counties agriculture disaster areas as of July 19, 2010.[39]

Pay Now: The Benefits of Taking Action

Despite a per capita energy consumption among the lowest in the nation, Hawaii relies on imported oil for roughly 90% of its energy, arriving from Alaska and foriegn countries.[40] Recognizing that this dependence threatens its precious natural resources and its long-term economic outlook, Hawaii introduced the Clean Energy Initiative in 2008. A collaborative effort between the state and the U.S. Department of Energy, the Initiative has set a goal "to achieve 70% clean energy by 2030," receiving "30% from efficiency measures, and 40% coming from locally generated renewable sources."[41] The state is on its way to meeting those goals, with projects planned or implemented to tap the plentiful resources available locally: sun, wind, sea, and land.



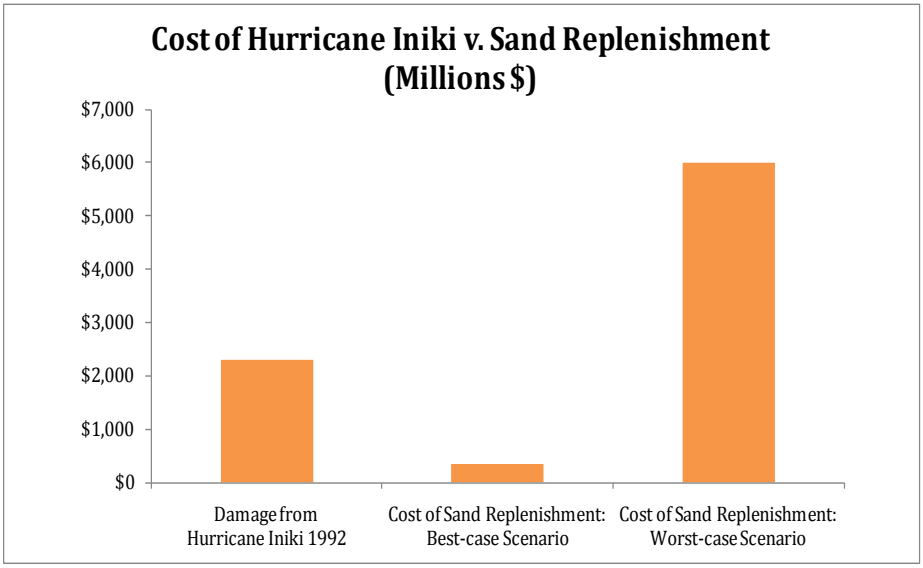
The Big Island of Hawaii has the greatest potential for renewable energy generation of any of the Hawaiian Islands. Impressively, nearly 30% of its energy already is derived from renewable sources, including wind, geothermal and hydroelectricity.[42]

Solar Energy

Thanks to the abundant sunshine, solar energy has the potential to offset a significant portion of the state's current fossil fuel use. **Hawaii ranks in the top 10 of solar-producing states,**[43] **and 80,000 homes and businesses statewide have installed solar water heaters—a number that will continue to increase as a result of legislation passed in 2008 that requires most new homes to be fitted with solar panels.**[44]

Wind Power

Just as ancient Hawaiians depended on the trade winds to power their canoes,



Sources: National Wildlife Federation; Center for Integrative Environmental Research

wind power offers huge potential today as a clean, renewable energy source. Wind farms already supply electricity on Maui and the Big Island.[45] Construction began in July 2010 on a 30 MW wind project that will supply enough energy for up to 7,700 homes—and create about 200 construction jobs, not to mention design and engineering jobs—on Oahu.[46] Once completed, the project has the potential to help reduce Hawaii's "oil consumption by about 139,500 barrels a year and to reduce carbon dioxide emissions by about 96 million pounds per year."[47]

Hydropower

Hawaii has begun experimenting, using cold ocean water to provide unconventional air-conditioning. **By using such a system to cool three of its buildings, the Natural Energy Laboratory of Hawaii saves up to $4,000 a month.**[48]

Hawaii has also been using hydropower to generate electricity for nearly two decades at the Wailuku River plant on the Big Island, the most expansive hydropower facility in the state. Smaller plants on that island, as well as on Kauai and Maui, also have great responsibility, generating electricity for sugar mills and the three island utility companies. Expansions to the hydroelectricity program are currently being considered.[49]

Thanks to Hawaii's powerful waves, wave-to-energy projects are being planned and implemented. **One project in the planning stages could generate up to 2.7 MW of electricity by the end of 2011.**[50]

Geothermal Energy and Biofuel

Hawaii has tapped into its geothermal sources of energy, too. For example, **geothermal sources supply 20% of the Big Island's energy**.[51] The state has also developed a wide variety of techniques using different materials to produce energy from plants and plant-derived materials. This has the potential to reduce dependence on foreign oil, reduce greenhouse gas emissions and boost Hawaii's agricultural industry. For example, H-POWER (Honolulu Project of Waste Energy Recovery) burns refuse-derived fuel to produce electricity, which it sells to the Hawaiian Electric Company. Since becoming operational in 1990, H-POWER has processed about 600,000 tons of waste into electricity each year, and currently provides about 8% of Oahu's electricity.[52]

Sugar factories on Kauai and Maui burn their own waste, bagasse, saving on energy costs and providing steam for sugar processing and **generating a total of 46 MW of electricity; excess power is sold to local utility companies.**[53]

Plants on Maui and Oahu convert used cooking oil into biodiesel fuel, which is then blended with regular diesel and used in trucks, buses, boats, and stationary distributed generator systems. **The plants can produce a combined total of 550,000 gallons of biodiesel a year.**[54]

Conclusion

Hawaii must consider action on climate change not just in terms of cost, but also in terms of opportunities. If we give Hawaii's population, businesses, and investors clear and consistent signals by properly offering initiatives and cultivating demand, investment and innovation in renewable technologies will follow.

Hawaii residents will have to pay for the effects of climate change. The only remaining question is whether they will pay now, or pay later and run the risk of paying significantly more.

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