

GOLDBUG ISLAND LIVING SHORELINE

SINCE 2016 | MOUNT PLEASANT, SC | THE NATURE CONSERVANCY



CHARLESTON, SOUTH CAROLINA has experienced an increase in flooding due to rising sea levels and extreme precipitation events. Annual days of tidal flooding, which cause storm-water drainage stress and street flooding, increased by 12 days to a total of 50 between 2015 and 2016 and is forecasted to reach 180 days by 2045.¹ Nature-based solutions, such as living shorelines and oyster reefs, provide a cost-effective way to address these threats.

The Goldbug Island Living Shoreline was completed in 2016 near Sullivan's Island as an illustration of one way to address tidal flooding. The Nature Conservancy worked with local groups to develop this installation, using oyster habitat restoration to increase vegetation and assist in shoreline protection. Over a hundred volunteers assisted to create the 240 feet long living shoreline, built from wooden pallets, castle building blocks, and oyster shells.²

Oysters have attached to the reef at Goldbug, helping wildlife and fish populations thrive while also protecting the eroding shoreline from increasingly high tides. The visible high tide vegetation line moved out 30 to 70 feet from the shore between 2016 and 2018 (photo on reverse), indicating increased stability and protection against higher tides.³

Living shoreline installations utilize structures and reinforcements created from natural materials, such as oyster shells and vegetation, to protect shorelines from erosion and flooding caused by storms and sea level rise. These protected coastal zones are a valuable alternative to grey infrastructure, which can cost up to three times more for materials and installation and often causes accelerated erosion on adjacent properties or damage to habitats when wave energy bounces off rigid seawalls.^{4,5} Living shorelines also enhance the natural habitats of marine life, increasing water quality and fish populations, bringing a benefit to those who make a living fishing.

In addition to these shorter-term benefits, living shorelines play an important role in climate change mitigation through carbon uptake and storage. In a year, one square mile of marsh stores the carbon equivalent of 76,000 gallons of gasoline.⁶

PROJECT GOALS

- Display co-benefits of oyster restoration
- Alleviate flooding
- Prevent erosion
- Restore marine life habitats

OYSTER REEF BENEFITS



One oyster can filter 180 liters of water per day⁷



They boost populations of over 130 fish and invertebrate species, improving sustenance fishing for communities⁸



SC commercial fishing value of oysters was \$2.6 million in 2017⁹



Oyster reefs save \$750/meter on coastline protection⁷



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GOLDBUG LIVING SHORELINE RESULTS³

- 2019 New vegetation clusters
- 2019 Vegetation above high water
- 2018 Vegetation above high water
- 2017 Vegetation above high water
- 2016 Living shoreline reef
- - - 2016 Vegetation above high water



LEADERSHIP AND COLLABORATION

The Goldbug project was initiated by The Nature Conservancy (TNC) and funded with a 2-year Climate Adaptation Fund grant from the Wildlife Conservation Society. CH2M worked with TNC to develop the design of the structure, and over 200 volunteers have participated in installation and monitoring of the project, including groups from the Citadel and Boeing. TNC and the South Carolina Department of Natural Resources (SCDNR) continue to monitor water quality, oyster and vegetation growth, and sediment accretion from the installation.²

BUSINESS

CH2M (D)
East Cooper Outboard Motor Club (I)
H&E Equipment Services (F)

SOCIAL MISSION

The Nature Conservancy (A, C, D, E, I)
Wildlife Conservation Society (F)
Lowcountry Land Trust (E, I)

GOVERNMENT

SC Department of Natural Resources (E)

A: Advocacy, C: Champion, D: Design, E: Evaluation, F: Funding, I: Implementation

REPLICATION

The Nature Conservancy has installed living shorelines across the United States, including 8 in South Carolina since 2009. The Living Shorelines Academy provides a collection of databases listing these and other installations across the US, online training modules, and a practitioner directory.

A working group comprised of the South Carolina Department of Health and Environmental Control and SCDNR is in the process of a 5-year study to define living shorelines permitting separately from grey infrastructure, setting standards and evaluation criteria to make these projects accessible to more people in the state.¹⁰

CLIMATE AND RESILIENCE BENEFITS

CLIMATE BENEFITS



RESILIENCE BENEFITS



OTHER BENEFITS



FOOD & WATER
JOB & ASSETS
HEALTH, WELLBEING, & SAFETY
CONNECTION
RESILIENCE

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The Nature Conservancy



Protecting nature. Preserving life.®



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Case study images provided by project contact Joy Brown.

BORREGO SPRINGS MICROGRID

SINCE 2009 | BORREGO SPRINGS, CA | SAN DIEGO GAS & ELECTRIC



BORREGO SPRINGS, CALIFORNIA is a remote desert town whose electricity was generated dozens of miles away and transmitted over a single line. Power outages caused by thunderstorms, flash floods, wind, wildfires, and planned maintenance used to occur several times per year.¹

Daily temperatures exceed 110 degrees Fahrenheit throughout the summer months.² Additionally, roads going into and out of Borrego Springs can close during powerful storms, trapping residents. With extreme temperatures, a fragile connection to the main grid, and a high elderly population, frequent power outages pose a significant public health risk to the residents of Borrego Springs.

A crisis in 2007 left Borrego Springs without power when a wildfire took down the town's only transmission line. Spurred by the crisis, the local utility, San Diego Gas & Electric (SDG&E), won a grant to build a demonstration microgrid, which was completed in 2012. The microgrid brings power to the most critical sites in Borrego Springs whenever the connection to the main grid fails.

In 2013, the microgrid proved successful when a thunderstorm knocked down the same transmission line impacted by the 2007 wildfire. SDG&E disconnected the microgrid from the main grid and used it to direct power to the critical zones: a gas station, a library that was a designated cool zone, and a community of elderly people. These areas had power until the connection to the main grid was completely restored. Since then, the microgrid has kept electricity flowing to these and other critical zones during several power outages and planned maintenance periods.^{3,4}

In 2015, SDG&E won a grant to expand the microgrid and connect it with a nearby solar farm. The expansion and connection project enabled the microgrid to bring power to all of Borrego Springs.⁵ The microgrid has also added technology such as automated switching, which allows it to operate independently and automatically in case of emergency.

Overall the microgrid has reduced extended power outages, so residents of Borrego Springs enjoy more reliable service.⁶

PROJECT GOALS

- Prevent power outages
- Protect the health of the city's elderly residents
- Reduce reliance on diesel generators
- Establish a replicable microgrid model
- Demonstrate possibility of 100% renewables-powered microgrid

POWER OUTAGE COSTS⁷

Power outages in the US cost over \$18 billion per year and up to \$75 billion in years with major storms:



Public health threats



Food spoilage



Lost productivity



Missed school days



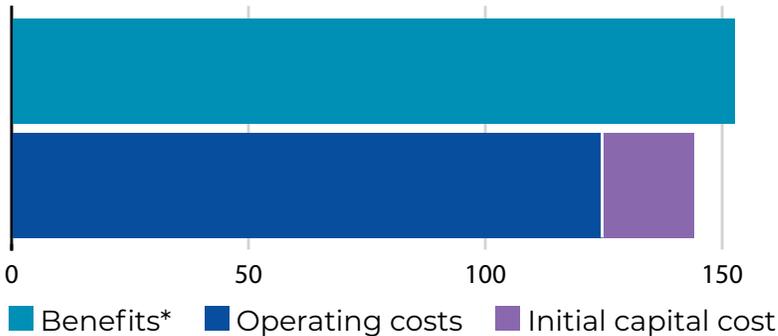
Slow emergency response



Infrastructure damage

MICROGRID COSTS AND BENEFITS⁸

20-Year Net Present Value, in Millions USD



*Includes consumer, system, and societal benefits



LEADERSHIP AND COLLABORATION

SDG&E designed, implemented, and funded the project with the help and advocacy of public and private sector partners, universities, and nonprofits. Several energy, engineering, and technology companies aided implementation, and the US Department of Energy, the California Energy Commission, and the Pacific Northwest National Laboratory provided technical expertise. The Anza-Borrego Desert Natural History Association partnered with SDG&E to create a community outreach program that educates consumers on the connection between energy and nature.^{9,10}

ACADEMIA

University of California, San Diego (I)

SOCIAL MISSION

Anza Borrego Desert Natural History Association, Borrego Springs Chamber of Commerce (A, I)

GOVERNMENT

US Department of Energy, California Energy Commission (F, I), Pacific Northwest National Laboratory (I)

BUSINESS

Energy, engineering, & technology companies (I), SDG&E (C, D, E, F, I)

A: Advocacy, C: Champion, D: Design, E: Evaluation, F: Funding, I: Implementation

REPLICATION

As a result of its success, cities in California started a program to help other areas develop microgrids. Microgrids continue to grow in popularity as a way to increase resilience against extreme weather events in a cost-effective manner.¹¹ Projects vary widely in size and scope.

NYC built its first microgrid in 2017 at the Brooklyn Marcus Garvey Apartments, a complex of 625 affordable housing units.¹² Princeton University has an on-campus microgrid that provided energy after Hurricane Sandy caused widespread power outages in 2012.¹³ Philadelphia Navy Yard began operating a microgrid in 2016 and will complete the project by 2022.¹⁴ Today, there are over 160 microgrids across the country.

CLIMATE AND RESILIENCE BENEFITS

CLIMATE BENEFITS



RESILIENCE BENEFITS



OTHER BENEFITS



FOOD & WATER
JOBS & ASSETS
HEALTH, WELL-BEING, & SAFETY

CONNECTION
ENERGY & MOBILITY
RESILIENCE





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Case study images provided by project contact Helen Gao.

NASHVILLE HOME UPLIFT

SINCE 2018 | DAVIDSON COUNTY, TN

NASHVILLE ELECTRIC SERVICE & TENNESSEE VALLEY AUTHORITY



DAVIDSON COUNTY, TENNESSEE residents have a higher energy burden than the national average.¹ Energy burden is calculated as the percent of earnings going toward utility bills. Low-income households often occupy older, less efficient housing stock, and have an energy burden three times greater than higher-income groups (see reverse).² Devoting a larger share of earnings to energy costs means less disposable income for healthcare, as well as transportation, food, and childcare. In addition to physical health impacts from poor indoor air quality, high energy burdens can negatively impact mental health outcomes due to an inability to pay electric bills.

In Nashville, the Office of Mayor David Briley partnered with Nashville Electric Service (NES) and the Tennessee Valley Authority (TVA) in the spring of 2018 to launch Home Uplift in Davidson County.⁴ Home Uplift helps ease low-income homeowners' energy burden through retrofits at no cost to residents. Only single-family, owner-occupied structures are eligible; qualifying households are subject to certain income restrictions.⁵ Standard upgrades, valued at about \$8,000 per home, comprise a mixture of: weatherization, HVAC repair and replacement, ENERGY STAR windows and appliances, lighting, and insulation.⁶ Recipients of the upgrades save an average of 25% on their utility bills after completion.⁷

Home Uplift was implemented in specific locations within the Nashville Promise Zones, high poverty communities that receive government support to improve socio-economic outcomes. The coordinating organizations mapped the energy burdens of the Promise Zones to pinpoint zip codes with the greatest need and number of potential participants.⁸

Unlike temporary relief programs such as price adjustments, Home Uplift is designed to make permanent changes that impact overall quality of life. The goal is to create a sustainable program that leverages multiple partnerships and sources of funding to help these Valley residents lower their utility expenditures through upgrades they would never otherwise be able to afford. Home Uplift's mission is not just about weatherization - the upgrades allow families to "have their home back," as many of them were confined to living in one room of the house because that is all they could afford to heat or cool.⁸

While still in its infancy, Home Uplift is growing rapidly; by August 2019, contractors upgraded two hundred homes.⁷

References and photo credits available at climateinteractive.org/resilience

PROJECT GOALS

- Reduce energy bills for low-income customers
- Increase energy efficiency of older buildings
- Improve health of residents
- Calculate non-energy benefits
- Enhance overall quality of life

TENNESSEE HOME ENERGY EFFICIENCY POTENTIAL⁹



8.8 million kWh electricity reduction per year



26% energy conserved per household



\$1.1 billion annual utility bill savings

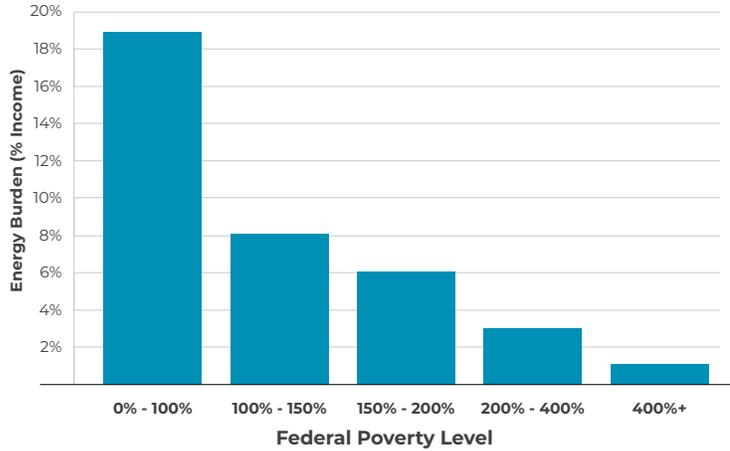


1.5 million cars worth of reduction in air pollution



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ANNUAL ENERGY BURDEN FOR TENNESSEE HOUSEHOLDS¹⁰



*Includes single-family, owner occupied structures. Federal poverty level is determined by household size; family of 4 is \$25,750

LEADERSHIP AND COLLABORATION

The Home Uplift pilot in Davidson County received an initial funding amount of \$1.125 million from TVA.⁸ The Metropolitan Development and Housing Agency offered \$500,000 in additional funding by way of a Federal Home Loan Bank of Cincinnati grant.⁶ TVA and NES collaborated with CLEAResult and AmeriCorps VISTA to determine target areas for the pilot program using statistical analysis and door-to-door canvassing.⁹ In one of the first comprehensive evaluations in the Southeastern US, TVA is working with Knoxville-based firm Three³ to investigate how weatherization and energy savings can reduce chronic respiratory problems and improve livelihoods using Davidson County household data.⁶

SOCIAL MISSION

AmeriCorps VISTA (D, I)

BUSINESS

CLEAResult (E, I)
Three³ (E)
Home Depot (I)
American Home Shield (I)
Pinnacle Bank (F)

GOVERNMENT

Nashville Electric Service (A, C, D, F, I)
Tennessee Valley Authority (A, C, E, F)
Office of Mayor David Briley (A, C, F)
Federal Home Loan Bank of Cincinnati (F)
Metropolitan Development and Housing Agency (F)

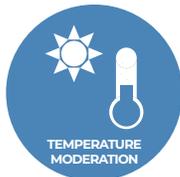
A: Advocacy, C: Champion, D: Design, E: Evaluation, F: Funding, I: Implementation

CLIMATE AND RESILIENCE BENEFITS

CLIMATE BENEFITS



RESILIENCE BENEFITS



REPLICATION

The Davidson County Home Uplift partnership is just one of five pilot programs implemented by TVA within the Tennessee Valley region since the spring of 2018. In addition to Davidson County, one Home Uplift initiative currently operates in Huntsville, Alabama, and three others exist in the Tennessee cities of Memphis, Knoxville, and Chattanooga.¹¹ Additional pilot locations included rural Western Kentucky and East Central Mississippi.⁶ TVA worked with the respective local power companies to design a pilot that leveraged partnerships as well as matched existing policies and sources of funding. All five have been highly successful.¹²

Starting in October 2019, TVA will begin rolling out Home Uplift to all 154 local power companies that receive their electricity from TVA.⁸ The final program design takes features from several of the pilots.

OTHER BENEFITS



JOBS & ASSETS
HEALTH, WELLBEING, & SAFETY
CONNECTION
ENERGY & MOBILITY
RESILIENCE

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Case study images provided by project contact Julia T Settles.

BALTIMORE EDIBLE ORCHARDS

SINCE 2012 | BALTIMORE, MD | THE BALTIMORE ORCHARD PROJECT



MARYLAND



CITY



FOOD

BALTIMORE, MARYLAND faces a food crisis, with a quarter of residents living in a “healthy food priority area,” lacking fresh, nutritious, and affordable food.¹ These healthy food priority areas are most prevalent in low-income neighborhoods and disproportionately affect people of color.² Having limited access to healthy food causes many negative health outcomes, including higher risk of diabetes, obesity, and shorter life expectancy.³

Rabbi Nina Beth Cardin founded the Baltimore Orchard Project in 2012 to harness the power of fruit trees to improve the lives of city residents.⁴ Since then, the Baltimore Orchard Project has planted over a thousand fruit and nut trees in nearly 100 orchards across the city (see map on reverse).⁵ These trees provide communities with a variety of social, economic, and environmental benefits. They reduce air pollution, store carbon dioxide, cool homes and nearby areas, mitigate storm water runoff, boost mental health, improve aesthetics, reduce crime rates, and more.⁶

Edible orchards also create a supply of fresh produce. To date, the Baltimore Orchard Project has harvested nearly 25 thousand pounds of produce.⁷ Much of the bounty is donated to food pantries and the Real Food Farm’s Mobile Market, allowing food insecure residents to enjoy fresh fruits and nuts. The “Funky Fruit Initiative” and “Mulberry Madness” programs reduce food waste by increasing community acceptance of unusual or misshapen fruit that would otherwise be overlooked and go uneaten.⁸

In addition to planting and harvesting, the Baltimore Orchard Project hosts regular adult education workshops; the annual “Orchard Stewards Program” trains individuals on how to properly tend orchards.⁹ In 2014, an orchard staff member and public school teacher coordinated to form the first public school Orchard Club, and an on-going partnership with the Baltimore City Public School System provides youth education programs.⁸

Through its various partnerships and programming, the Baltimore Orchard Project instills a shared sense of community and creates life-long environmental stewards.

PROJECT GOALS

- Improve food security
- Build intercommunity and intracommunity ties
- Increase urban forestry canopy
- Display co-benefits of trees
- Reduce flooding and runoff

VALUE OF BALTIMORE’S TREES

Baltimore’s 2.8 million trees contribute \$159.6 billion in co-benefits, as one tree can provide \$57,000 in benefits over its lifetime.¹⁰



Blocks wind and shades buildings, reducing energy costs \$3.3 million a year



Stores 527 tons of carbon dioxide, valued at \$10.7 million a year



Removes 700 metric tons of air pollution, saving \$3.8 a year

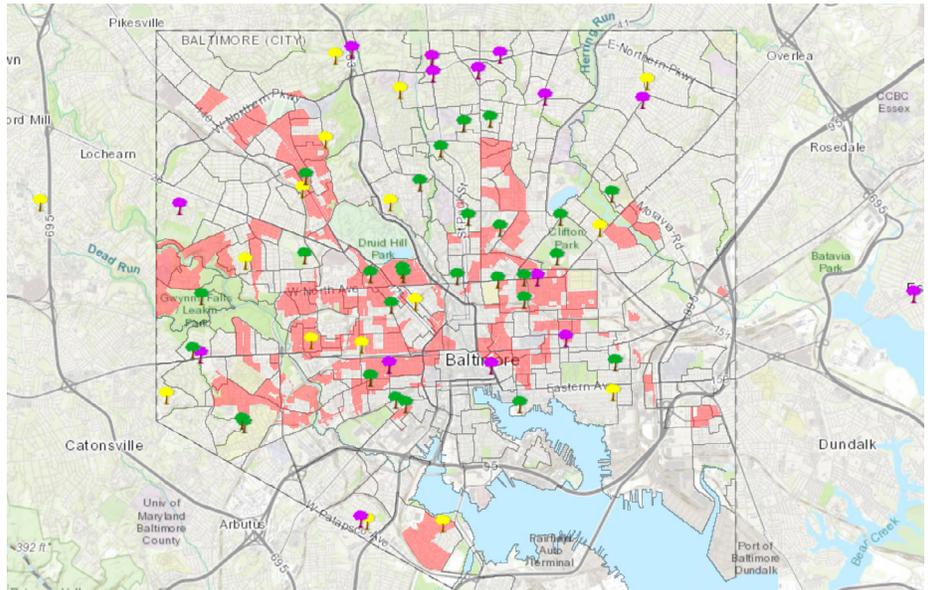
Civic Works



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BALTIMORE ORCHARD PROJECT TREE PLANTING LOCATIONS⁸

-  Community
-  Congregation
-  School
-  Food desert



LEADERSHIP AND COLLABORATION

The Baltimore Orchard Project began as a stand-alone organization from 2012-2015 and transitioned to become a Civic Works program in 2015. It receives funding from multiple government agencies and non-profits.⁷ With the help of local non-profits such as Blue Water Baltimore and Baltimore Green Space, the Baltimore Orchard Project works with schools, congregations, and community groups to design small-scale orchards that fit the groups' needs as well as the space available. Volunteers and AmeriCorps members plant and maintain the fruit trees, all of which are supplied by TreeBaltimore.¹¹

BUSINESS

City Scapes (D, I)
Local Restaurants (I)

GOVERNMENT

TreeBaltimore (C, F, I)
Baltimore Gas & Electric (F)
Office of Sustainability (C)
Department of Public Works (C)

SOCIAL MISSION

Civic Works (A, C, D, E, I)
Baltimore Green Space (I)
Abell Foundation (F)
Parks & People (I)
Blue Water Baltimore (I)

ACADEMIA

Johns Hopkins Center for a Livable Future (I)

A: Advocacy, C: Champion, D: Design, E: Evaluation, F: Funding, I: Implementation

REPLICATION

In 2006, the USDA Forest Service conducted a first-of-its-kind mapping analysis of Baltimore's tree canopy, allowing researchers to examine the health of individual trees as well as how coverage is correlated to social indicators.¹² The novel approach was replicated in i-Tree, a suite of tools used globally.¹³ i-Tree can provide insight into the linkages between tree location and crime rates, health outcomes, neighborhood income, and racial demographics. Non-profit organizations and governments can utilize i-Tree to identify the places of highest need and best suitability for starting their own edible orchards.

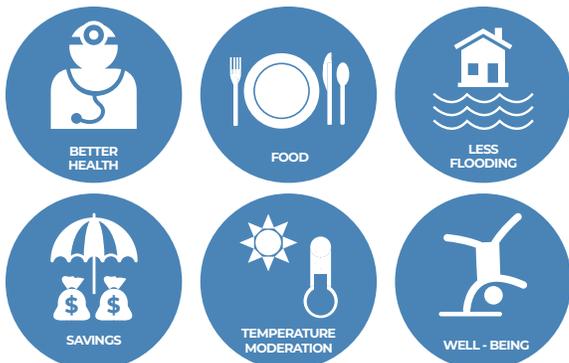
More than fifty edible orchard programs exist in both rural and urban communities.¹⁴ Notable cities include: Atlanta, Georgia; Seattle, Washington; and Philadelphia, Pennsylvania.¹⁵

CLIMATE AND RESILIENCE BENEFITS

CLIMATE BENEFITS



RESILIENCE BENEFITS



OTHER BENEFITS



FOOD & WATER
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CONNECTION
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RESILIENCE

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Civic Works



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Baltimore Edible Orchards

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Case study images provided by project contact Kevin Antoszewski.