NORTH COAST RESOURCE PARTNERSHIP

CLIMATE MITIGATION REPORT

for the North Coast Region of California

Authors:
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Woods Biological Services

April 2018

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EXECUTIVE SUMMARY

This Climate Mitigation report to the North Coast Resource Partnership (NCRP) presents a suite of integrated strategies aimed to improve the region's inefficient or failing infrastructure, to increase its resilience and reduce emissions; and reduce GHG emissions from major energy sources, as well as non-energy sectors.

With abundant and diverse renewable resources combined with a wealth of human ingenuity and commitment The North Coast Region has the potential to:

1. Meet regional energy needs with local renewable resources, and also be a net exporter of renewable energy to support state-level energy and climate goals;
2. Managing the region's abundant natural and agricultural landscapes to sequester carbon;
3. Serve as innovation hub and catalyst for the development of new climate mitigation technologies and program that benefit the region as well serving as a model for other communities across the state.

Summarized below are climate mitigation strategy recommendations focused on 1) regional infrastructure improvements that can support greenhouse gas reduction efforts, and 2) energy independence and emissions reduction strategies that enable a regional transition from the use of fossil fuels to a economy powered by local renewable resources.

CLIMATE MITIGATION INFRASTRUCTURE STRATEGIES

Electricity Transmission and Distribution System

Upgrade the regional transmission and distribution electrical grid to enable increased development of both utility-scale renewable energy projects as well as community-scale distributed generation systems.

Advanced Microgrids

Deploy renewable energy microgrids, focusing on critical infrastructure and community facilities, that through onsite generation, energy storage, and advanced control systems provide energy resiliency and emergency-response capabilities as well as ongoing economic and environmental benefits.

Alternative Fueling Infrastructure

Continue to develop electric vehicle charging stations and other alternative fuels infrastructure across the region.

Multi-modal Transportation Infrastructure

Facilitate multi-modal transportation options through regional trail networks, transit infrastructure, and complete streets infrastructure strategies that support walking, biking, and the use of public transportation.

ZNE Building Construction

Zero-net energy building construction through high-efficiency systems and on-site renewable energy generation.

Carbon-neutral Water and Wastewater Systems

Address the water-energy nexus through renewable energy and energy efficiency strategies that eliminate greenhouse gas emissions resulting from the energy used to treat and convey water and wastewater in the region.

Broadband Infrastructure

Deploy broadband infrastructure in rural communities to both facilitate remote access to educational and business opportunities as well as to enable the deployment of advanced, resilient grid management technology and integrated energy efficiency and demand response solutions.

ENERGY INDEPENDENCE & EMISSIONS REDUCTIONS STRATEGIES

Renewable Energy Generation

Solar Energy

As a ubiquitous and abundant resource, solar energy can continue to be deployed across the region at the utility, community, and facility scale.

Offshore Wind

The North Coast's offshore wind resource is the best in the U.S., and the floating-platform technology required to deploy offshore wind in the region's deep waters is now becoming commercially viable. Harbor and grid infrastructure upgrades will be needed to fully capitalize this potential, but increasing State and Federal support have poised the North Coast to possibly develop into a significant west-coast hub for the offshore wind industry in the future.

A Diverse Renewable Energy Portfolio

Building on the region's existing geothermal and biomass generation capabilities, the North Coast region has the potential to continue to develop a diverse and resilient portfolio of renewable generation

technologies including onshore wind, distributed biomass, small-hydro, biogas, and wave energy.

Building Energy Retrofits

Integrated Demand-side Management

Support the adoption of energy efficient technologies and processes, while also integrating demand response and load shifting strategies to support the cost-effective and efficient operation of the grid.

Distributed Generation and Energy Storage

Support on-site solar energy systems and other distributed generation technology as well as facility-scale energy storage systems.

Fuel-Switching

Support fuel switching from combustion-based heating systems to electric heat-pump technologies which significantly reduce GHG emissions and support increased utilization of locally-generated renewable electricity.

Transportation

Electric Vehicles and Other Alternative Fuels

Supporting community-wide adoption of electric vehicles and other alternative fuel technologies for both passenger vehicles as well as commercial and freight application.

Support for Multi-modal Transportation Decisions

Develop programs and incentives that facilitate and support walking, biking, and public transportation use.

Land Use Planning

Encourage infill, transit-oriented development, and walkable and bikeable communities though thoughtful zoning and land-use planning process.

Community Strategies and Financing

Community Choice Aggregation

Capitalize on the potential of Community Choice Aggregation and public power agencies to be central mechanisms to support a broad range of energy independence strategies.

Community Equity

Across all initiatives and strategies ensure that consideration of equity and social justice issues is part of the decision-making process so that the benefits of any actions or programs reach all people in the region, especially disadvantaged communities and populations.

Financing Mechanisms

Facilitate Property Assessed Clean Energy (PACE) and other financing programs that access the needed capital to deploy regional energy independence strategies.

Cap and Trade Auction Proceeds

Work regionally to access Cap and Trade auction proceeds and other State funding mechanisms to ensure effective, efficient, coordinated, and equitable resource allocation in the North Coast Region.

Land Management Strategies

Carbon Sequestration

Develop and deploy mechanisms for retaining carbon in region's abundant natural areas and working lands.

Biomass Fuels Reduction and Utilization

Develop strategies and technologies for improved biomass utilization in ways that effectively support restoration objectives and fire management priories.

Figure 1. Bear River Band of the Rohnerville Rancheria renewable microgrid system, Loleta, California.

1 INTRODUCTION

According to the Public Policy Institute of California, "Global emissions of greenhouse gases (GHGs) are raising air and water temperatures and sea levels, with serious consequences for California. The state has recently experienced record-high temperatures, and warming is expected to continue over the century" (PPIC 2017). Extreme weather events are increasing and costlier than ever: recent droughts and floods have damaged local infrastructure and rural economies, and the region's wildfires are becoming increasingly devastating, with the 2017 Tubbs fire in Sonoma County was California's most destructive and third most deadly wildfire in recorded history.

In response to evident and escalating consequences of GHG emissions, the state has mandated aggressive mitigation. *Mitigation* of climate change (as opposed to *adaptation* to the impacts of climate change) is "intervention to reduce the human impact on the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks [sequestration]" (CNRA 2018). Statewide mitigation policies and programs have put California on track to meet its 2020 target; increasing the pace of GHG reductions will ensure aspirational targets for 2030, 2050, and beyond are achievable if every sector, in every part of the state, and that every community is involved.

Climate change challenges everyone, but impacts "are often disproportionately borne by the state's most vulnerable and disadvantaged populations" (CARB 2017). Relative to the rest of California, the North Coast hydrologic region is rural, politically underrepresented, and economically disadvantaged. It also is incredibly rich in natural resources, including renewables, and natural/ working lands, including forests and farms. There is compelling local incentive and potential for the region to reduce GHG emissions outputs, increase carbon sequestration inputs, and engage and empower communities – all while growing the economy and revitalizing infrastructure.

This report to the North Coast Resource Partnership (NCRP1) presents a suite of integrated strategies aimed to improve the region's inefficient or failing infrastructure, to increase its resilience and reduce emissions; and reduce GHG emissions from major energy sources (e.g. electricity, transportation), as well as non-energy sectors (e.g. water, buildings, agriculture, forestry, wildfire). It is based substantially on existing technical documents2 produced for the NCRP as part of their collaborative effort to improve North Coast communities, economies, and the environment. As such, the strategies presented align closely with climate mitigation and community vitality goals3 stated in the NCRP's North Coast Integrated Regional Water Management Plan (NCIRWMP) and program. The California Air Resources Board is mandated to implement the state Global Warming Solutions Act; their Scoping Plan (CARB 2017), and sector-based recommendations in it, also informs this climate mitigation report for the North Coast region.

1 Boundary of NCRP region is watershed-based. Represented Tribes and counties of the NCRP are: Bear River Band of the Rohnerville Rancheria, Coyote Valley Band of Pomo, Karuk Tribe, Kashia Band of Pomo of Stewarts Point Rancheria, Pit River Tribe, Redwood Valley Little River Band of Pomo, Sherwood Valley Band of Pomo Indians; and all or portions of Del Norte County, Humboldt County, Mendocino County, Modoc County, Siskiyou County, Sonoma County, Trinity County. NCRP documents and programs available at http://www.northcoastresourcepartnership.org.

2 NCRP reports in 2017 quantified local energy production, consumption, and emissions (SERC, RCEA 2017); characterized GHG sink estimates (Nickerson 2017); assembled GHG accounting recommendations (SERC 2017); and highlighted key policy and financing options (ECONorthwest 2017); see http://www.northcoastresourcepartnership.org/resources/.

3 Goals of NCIRWMP with respect to climate mitigation and economic/ community vitality are at http://www.northcoastresourcepartnership.org/partnership/

MAP 1 THE NORTH COAST REGION

2 CLIMATE MITIGATION POLICY LANDSCAPE

California is a leader in climate mitigation policy. The state legislature has set clear policy objectives for mitigating climate change across sectors, including[4]:

- Reduce GHG emissions 40% below 1990 levels by 2030;
- Increase retail sales of renewable electricity to 50% by 2030;
- Achieving a cumulative doubling of statewide energy efficiency savings by 2030;
- Provide support for clean cars;
- Integrate land use, transit, and affordable housing to reduce person- and vehicle-miles traveled;
- Prioritize direct reductions;
- Identify air pollution, health, and social benefits of climate policies;
- Slash "super pollutants";
- Protect and manage natural and working lands;
- Invest in disadvantaged communities; and
- Demonstrate strong support for Cap-and-Trade.

A suite of policies (Senate Bills, Assembly Bills, and Executive Orders) has been established and continually developed to achieve these goals. The major policies5 are outlined chronologically below, beginning with the state's landmark 2006 "Global Warming Solutions Act."

AB 32 *– California Global Warming Solutions Act (2006)*

Assembly Bill 32, the Global Warming Solutions Act of 2006, requires that the California Air Resources Board (CARB) approve a statewide GHG limit, equal to the 1990 level, to be achieved by 2020: a reduction approximately 15 percent below emissions projected under a "business as usual" scenario (SB 32 2016, extends the goal to 40%; see below). Pursuant to AB 32, CARB must adopt regulations to achieve the maximum technologically feasible and cost-effective GHG emission reductions. The full implementation of AB 32 will help mitigate risks associated with climate change, while improving energy efficiency, expanding the use of renewable energy resources, cleaner transportation, and reducing waste. AB 32 required CARB to develop a Scoping Plan that describes the approach California will take to reduce GHGs to achieve the goal of reducing emissions to 1990 levels by 2020. The Scoping Plan was first approved by the Board in 2008 and must be updated every five years. A 2017 update has been drafted (CARB 2017).

AB 1803 *– Greenhouse Gas Inventory (2006)*

Assembly Bill 1803 made CARB responsible to prepare, adopt, and update California's greenhouse gas inventory. The bill transfers responsibility from the California Energy Commission.

SB 107 *– Renewable Energy Portfolio Standard (2006)*

Senate Bill 107 directs California Public Utilities Commission's Renewable Energy Resources Program to increase the amount of renewable electricity (Renewable Portfolio Standard) generated per year, from 17% to an amount that equals at least 20% of the total electricity sold to retail customers in California per year by December 31, 2010.

AB 118 *– Alternative Fuels and Vehicle Technologies (2007)*

Assembly Bill 118 creates the Alternative and Renewable Fuel and Vehicle Technology Program to provide funding to public projects to develop and deploy innovative technologies that transform California's fuel and vehicle types to help attain the state's climate change policies.

SB 375 *– Sustainable Communities and Climate Protection Act (2008)*

Senate Bill 375 requires CARB to develop regional greenhouse gas emission reduction targets for passenger vehicles.

SB 1191 *– Broadband Services (2008)*

This bill would authorize a community services district to construct, own, improve, maintain, and operate broadband facilities and to provide broadband services, under specified circumstances, until a private person or entity is ready, willing, and able to acquire, construct, improve, maintain, and operate broadband facilities and to provide broadband services, and to sell those services at a comparable cost and quality of service to the district and its property owners, residents, and visitors.

AB 1504 *– Forest Resources and Carbon Sequestration (2011)*

Assembly Bill 1504 requires Department of Forestry and Fire Protection and Air Resources Board to assess the

4 CARB 2017 Scoping Plan at https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017_es.pdf

5 CA Legislative Portal at http://focus.senate.ca.gov/climate/full-package and CA Climate Change Portal at http://www.climatechange.ca.gov/state/legislation.html

capacity of its forest and rangeland regulations to meet or exceed the state's greenhouse goals, pursuant to AB 32.

SB 535 *– GHG Reduction Fund and Disadvantaged Communities (2012)*

Senate Bill 535 requires the California Environmental Protection Agency to identify disadvantaged communities; requires that 25% of all funds allocated pursuant to an investment plan for the use of moneys collected through a cap-and-trade program be allocated to projects that benefit disadvantaged communities and 10% of the 25% is to be use within disadvantaged communities; and requires Department of Finance annual reporting.

AB 8 *– Alternative Fuel and Vehicle Technologies: Funding Program (2013)*

Assembly Bill 8 funds AB-programs that support the production, distribution, and sale of alternative fuels and vehicle technologies and air emissions reduction efforts. The bill suspends until 2024 CARB's regulation requiring gasoline refiners to provide hydrogen fueling stations and appropriates up to $220 million in AB 118 funds (above) to create a hydrogen fueling infrastructure in the state.

AB 1092 *– Building Standards: Electric Vehicle Charging Infrastructure (2013)*

Assembly Bill 1092 requires the Building Standards Commission to adopt mandatory building standards for the installation of future electric vehicle charging infrastructure for parking spaces in multifamily dwellings and nonresidential development.

SB 1275 *– Charge Ahead California Initiative (2014)*

Senate Bill 1275 establishes a state goal of one million zero-emission and near-zero-emission vehicles in service by 2020. Establishes the Charge Ahead California Initiative requiring planning and reporting on vehicle incentive programs and increasing access to and benefits from zero-emission vehicles for disadvantaged, low-income, and moderate-income communities and consumers.

SB 64 *– California Transportation Plan (2015)*

Senate Bill 64 reduces greenhouse gas emissions, increases sustainability, and helps prepare the state transportation system to deal with long-term climate change.

SB 367 *– Agriculture Climate Benefits Act (2015)*

Senate Bill 367 ensures that California's agriculture sector maximizes its opportunities to achieve voluntary greenhouse gas emission reductions by developing projects and on-farm practices that also have other environmental and health benefits.

SB 398 *– Green Assistance Program (2015)*

Senate Bill 398 creates the Green Assistance Program to provide technical assistance to small businesses, small non-profits and disadvantaged communities to access funding for energy efficiency upgrades or projects that lessen the negative health impacts of poor air quality.

SB 350 *– Clean Energy and Pollution Reduction Act (2015)*

Senate Bill 350 establishes targets to increase retail sales of renewable electricity to 50 percent by 2030 and double the energy efficiency savings in electricity by setting these goals for 2030: 50% reduction in petroleum use; 50% utility power coming from renewable energy; 50% increase in energy efficiency in existing buildings and natural gas end uses by 2030.

SB 32 *– California Global Warming Solutions Act of 2006: Emissions Limit (2016)*

Senate Bill 32 codifies a 2030 GHG emissions reduction target of 40 percent below 1990 levels. SB 32 (with Executive Order B-30-15) extended the goals of AB 32 and set a 2030 goal of reducing emissions. Set the overarching climate pollution reduction target for 2050 that will provide California businesses with regulatory certainty, improve public health, and strengthen the economy. With SB 32, the Legislature passed companion legislation AB 197, which provides additional direction for developing the Scoping Plan.

AB 197 *– Greenhouse Gas Regulations (2016)*

Assembly Bill 197 increases legislative oversight of CARB and is intended to ensure CARB must report to the Legislature. AB 197 is directly related to SB 32 in that AB 197 contains language stating AB 197 is only operative if SB 32 is enacted and becomes law on or before January 1, 2017. The provisions of AB 197 are intended to provide more legislative oversight of CARB. The bill also requires that CARB "protect the state's most impacted and disadvantaged communities ... [and] consider the social costs of the emissions of greenhouse gases" in preparing plans to meet GHG reduction goals. A Joint Legislative Committee on Climate Change Policies (JLCCCP) will be responsible for addressing and prioritizing the disadvantaged communities in California. AB 197 also requires reports of emissions inventories for GHGs, criteria pollutants, and toxic air contaminants are required to be made public and updated at least once a year.

***AB 617** and **AB 398** – Companion to Cap and Trade; Cap and Trade Extension (2017)*

Assembly Bill 617 establishes a program to measure and reduce air pollution from mobile and stationary sources at the community level. Requires the CARB work closely with local air districts and communities to establish neighborhood air quality monitoring networks and to develop and implement plans to reduce emissions. AB 398 extends cap-and-trade until 2030.

3 REGIONAL ENERGY PROFILE

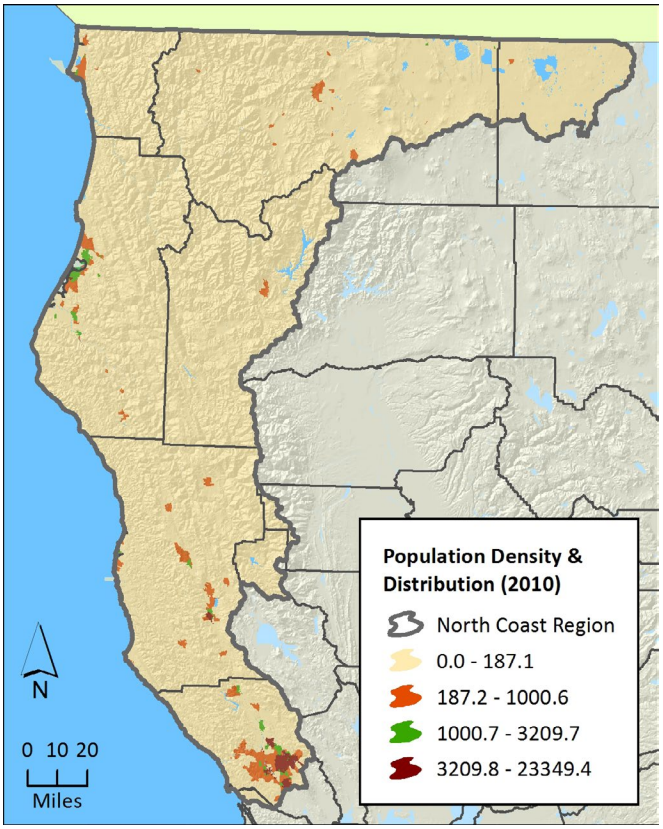
This section presents an energy profile for the North Coast region highlighting energy consumption, generation, and sustainability potential. The GHG emissions associated with the region's energy profile is presented in Section 4. Sectors for the profile include electricity, transportation, and heating. The energy profile is excerpted and adapted from SERC, RCEA 2017 (see http://www.northcoastresourcepartnership.org/resources/). Below is an overview.

- *Consumption:* Sonoma, with its larger population, has the highest energy consumption. However, it also has the lowest electricity consumption per capita. Only three counties (Humboldt, Mendocino and Sonoma) have significant natural gas service. The remaining counties rely on propane, fuel oil, wood and electricity to meet space heating, water heating, and cooking needs.
- *Generation:* The region generates more electricity than it consumes, with Sonoma generating the majority from geothermal power. Other sources throughout the region include hydroelectric, natural gas, biomass, and solar. Almost all natural gas is imported from outside the region, and all gasoline and diesel fuels are imported.
- *Sustainability*: An assessment of the region's potential for generating renewable energy (by county and by sector) indicates significant opportunities throughout the region and across sectors. Development of these opportunities is a key recommendation of this report (see Section 7).
- *Emissions:* The energy related greenhouse emissions in the region appear to be dominated by the transportation sector. However, incomplete data are currently available and further investigation is needed in this area. Heating fuel emissions are significant. Electricity use accounts for a relatively small portion of energy sector emissions. Emissions are quantified for energy, agriculture, wildfire, and other sources in Section 4.

3.1 CLIMATE AND DEMOGRAPHICS

Demographic and climate characteristics tend to impact the energy consumption patterns for observed counties. In general, the NCRP region is rural, sparsely populated, and not very affluent. Of the seven counties in the NCRP region, Sonoma County is by far the most populous, has the greatest population density, and is the most affluent. The six remaining counties rank in the bottom 28% of the 58 California counties in terms of population density. Four counties are on the coast and have rather moderate climates; three counties are inland with more extreme temperature profiles.

MAP 2 POPULATION DENSITY & DISTRIBUTION



3.2 ENERGY GENERATION

This section describes the energy generation for the North Coast Region and individual counties below.

3.2.1 Regional Total

This section presents energy generation data for the region and by county (CEC Energy Almanac 2016). Table 1 shows the region has a diverse set

of power generation sources, with the majority coming from renewable sources. Geothermal is the largest fraction of power generation, followed by hydro, natural gas, biomass, and solar.

MAP 3 ELECTRIC POWER INFRASTRUCTURE

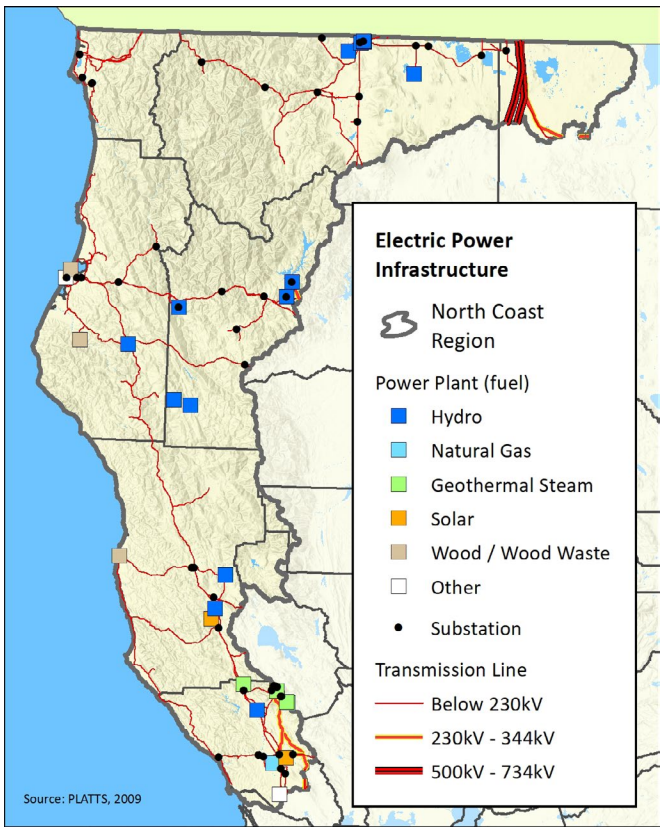
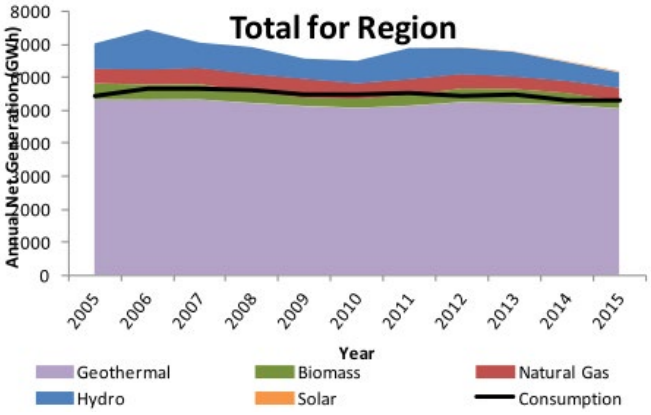


Table 1. Generation capacity and number of energy plants by fuel type for the region.

Fuel	MW	Number of Plants
Biomass	74.7	4
Natural Gas	176.6	4
Geothermal	1368	13
Hydro	233	15
Landfill Gas	16.0	3
Solar	17.2	13
Total	**1886**	**52**

Several counties have hydroelectric generators that have been limited in recent years by the historic drought in the Western United States, starting in 2011 and continuing through 2015. Biomass power has also decreased over recent years. The aggregate electricity consumption for the NCRP region is shown in Figure 2 and shows that the region is a net exporter of electricity. For example, in 2015 the region consumed 5,300 GWh of electricity and generated about 6,200 GWh of electricity, a net export of 900 GWh. Of the 6,200 GWh that were generated, approximately 5,800 GWh was from renewable energy sources, predominantly geothermal (nearly 90%). This 5,800 GWh of renewable electricity slightly exceeds the region's total 2015 electricity consumption of 5,300 GWh.

Figure 2. Energy consumption and generation by resource type for the region.



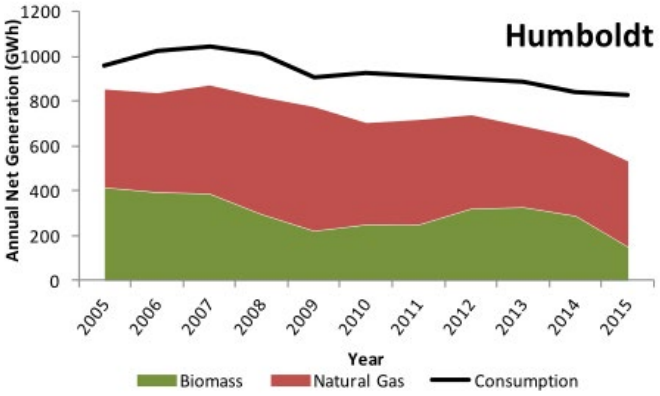
3.2.2 Humboldt County

Table 2 shows installed electrical generation capacity in Humboldt County as of 2016. The county's primary electricity generation is from natural gas and biomass. Recent years have seen a decrease in the amount of biomass generation as the cost of natural gas generation has decreased, making the relatively more expensive biomass energy less economical (Figure 3). While electricity consumption in Humboldt County has dropped slightly over the last ten years, it has not kept pace with the drop in generation. This means that the import of electricity into Humboldt County has grown by about 100–200 GWh/year over the last 10 years.

Table 2. Humboldt County generation capacity and number of plants by fuel type.

Fuel	MW	Number of Plants
Biomass	61.3	3
Natural Gas GasGas	168	1
Total	**229**	**5**

Figure 3. Humboldt County energy consumption and generation by resource type.



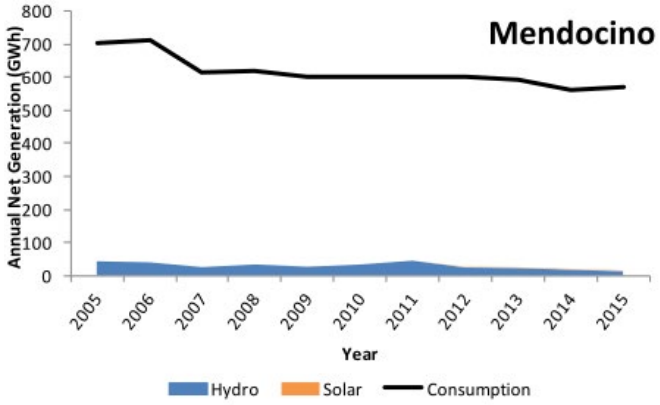
3.2.3 Mendocino County

Table 3 shows installed electrical generation capacity in Mendocino County as of 2016. Hydropower is the dominant electricity generation source in Mendocino County, and recently a large solar electric system was installed at Mendocino Community College. As shown in Figure 4, output from hydro has decreased in recent years due to the historic drought in California. With an average consumption ranging from about 550-700 GWh/year over the last ten years and only about 15-40 GWh/year of generation, Mendocino is a clear importer of electricity.

Table 3. Mendocino County generation capacity and number of plants by fuel type.

Fuel	MW	Number of Plants
Hydro	12.7	2
Solar	7	4
Total	**19.7**	**6**

Figure 4. Mendocino County energy consumption and generation by resource type.



Note peaks and troughs in hydropower generation are in large part dominated by amount of rainfall.

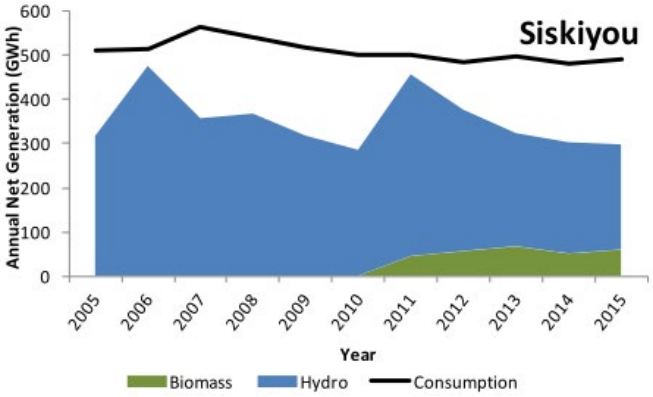
3.2.4 Siskiyou County

Table 4 shows installed electrical generation capacity in Siskiyou County as of 2016. Siskiyou County's generation resource is dominated by hydropower, with smaller amounts of biomass generation in the last five years. Siskiyou's electricity demand has been roughly 500 GWh/year over the last 10 years. As can be seen in Figure 5 in a good year hydro generation can nearly meet the total demand, but most years some import is required.

Table 4. Siskiyou County generation capacity and number of plants by fuel type.

Fuel	MW	Number of Plants
Biomass	13.4	1
Hydro	61.8	6
Total	**75.1**	**7**

Figure 5. Siskiyou County energy consumption and generation by resource type.



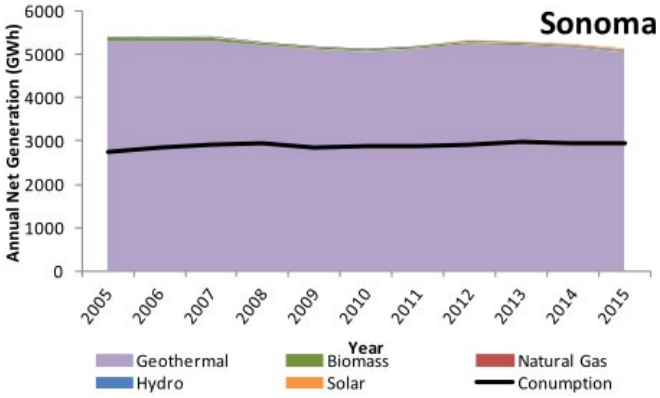
3.2.5 Sonoma County

Sonoma County is the largest power producer in the region with a diverse set of generation facilities. Table 5 shows installed electrical generation capacity in Sonoma County as of 2016. The overwhelming majority of generation comes from geothermal (Figure 6), though the county also delivers more than 90% of the NCRP region's community-scale solar generation capacity. With an annual electricity demand of nearly 3,000 GWh per year and annual generation of over 5,000 GWh/year, Sonoma County is the largest electricity exporter in the NCRP region.

Table 5. Sonoma County generation capacity and number of plants by fuel type.

Fuel	MW	Number of Plants
Natural Gas	8.5	2
Geothermal	1368	13
Hydro	2.8	1
Landfill Gas	16	3
Solar	10.2	9
Total	**1405**	**28**

Figure 6. Sonoma County energy consumption and generation by resource type.



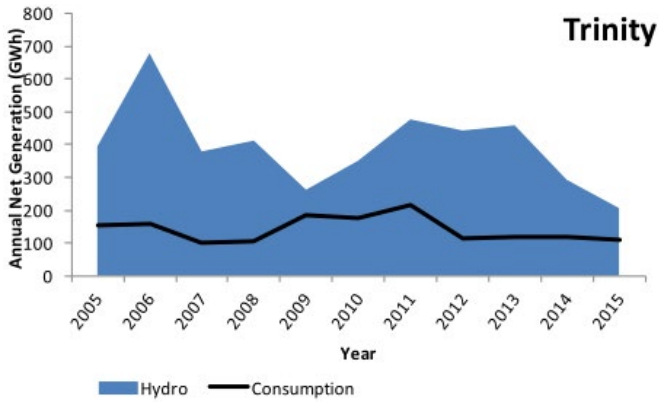
3.2.6 Trinity County

Table 6 shows installed electrical generation capacity in Trinity County as of 2016. As shown in Figure 7, Trinity County's generation is exclusively from hydro sources. As with other counties with large amounts of hydro generation, the output in recent years has been affected by the historic drought in California. Per data available from the California Energy Commission, Trinity County's electric load varied between 100-200 GWh/year from 2005 to 2015. Over that same period hydroelectric generation was 250 GWh/year or more, so Trinity County is historically a consistent exporter of electricity.

Table 6. Trinity County generation capacity and number of plants by fuel type.

Fuel	MW	Number of Plants
Hydro	78.6	6

Figure 7. Trinity County energy consumption and generation by resource type.



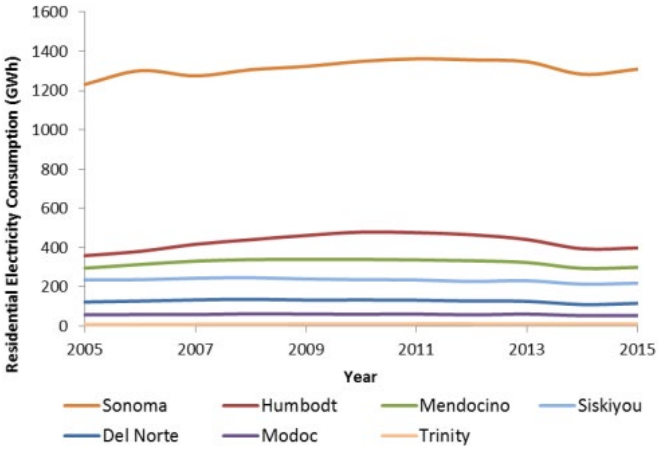
3.3 ENERGY CONSUMPTION

Section 3.3 covers energy consumption for the NCRP region for electricity, heating, and transportation. This includes only electricity, natural gas, gasoline and on-highway diesel fuels.

3.3.1 Electricity

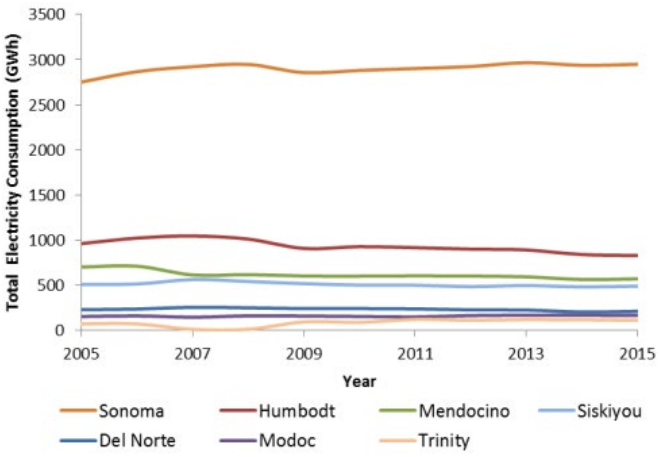
This section presents the electricity consumption for the region by county. Data were obtained from the California Energy Commission (CEC ECDMS 2016). Figure 8 presents the electricity consumption in the residential sector for all counties in the NCRP region for the years 2005-2015. Figure 9 presents the total electricity consumption for each of the counties in the NCRP region. Sonoma County is the largest consumer of energy due its large population size.

Figure 8. Residential electricity consumption for the region.



Note Sonoma County uses more residential electricity than the remaining counties combined.

Figure 9. Total electricity consumption for the region.



Note Sonoma County uses more electricity than the remaining counties combined. Sources of variation for Trinity County have not been identified.

The per capita electricity consumption by county for residential and total energy use is presented in Figure 10 and Figure 11, respectively. In every instance each county's per capita consumption has decreased modestly between 2010 and 2014. Sonoma County has the lowest per capita total energy consumption.

Figure 10. Residential electricity consumption per capita by county.

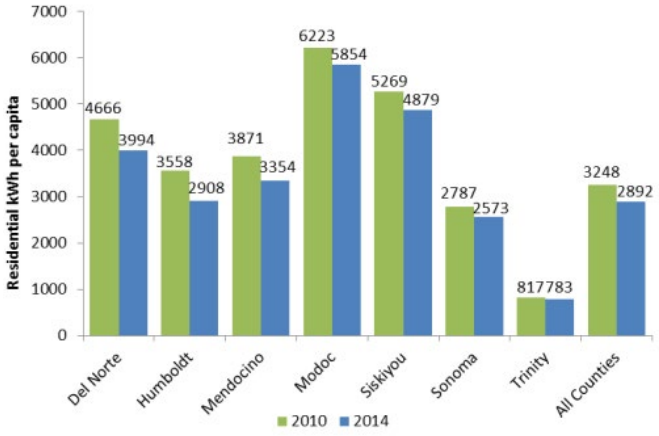
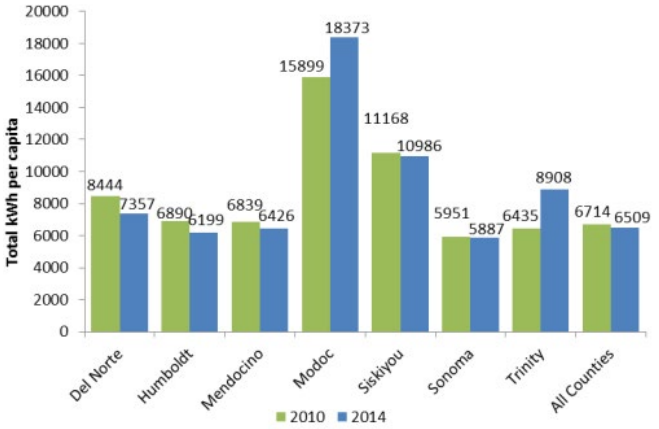


Figure 11. Total electricity consumption per capita by county.



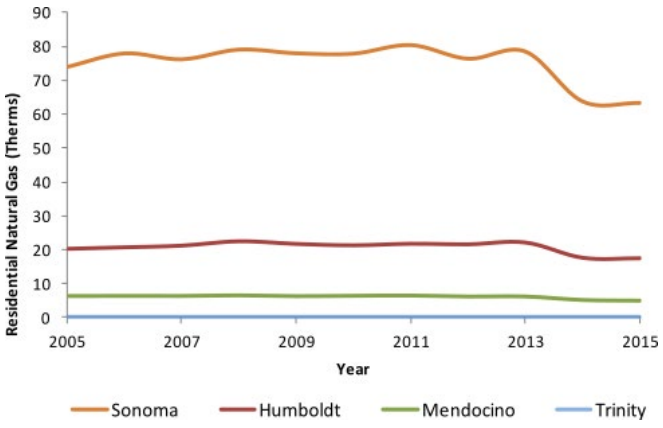
3.3.2 Natural Gas

Natural gas service is available in most areas of Sonoma, Mendocino and Humboldt Counties. All natural gas consumed in the NCRP region is imported from outside the region except for Humboldt County, where about 10% of gas consumed comes from gas wells located within the county. Del Norte, Modoc, Siskiyou, and almost all of Trinity County are not served by a natural gas utility. These areas often use other fuels for heating, such as propane, fuel oil, and wood. However, data to quantify the consumption of these other fuel sources is not readily available. This represents a significant gap in the energy consumption data for the region.

Figure 12 presents annual natural gas consumption in the residential sector for counties with available natural gas service; Figure 13 presents total natural gas consumption for these same counties (CEC ECDMS 2016). These data include natural gas use in residential, commercial and industrial end use sectors; they do not account for natural gas used to generate electrical power at utility-scale power plants such as the Humboldt Bay Generating Station in Eureka. Note there is a drop in the natural gas consumption in later years in all counties, both in the residential sector and overall. There is not an obvious reason for this drop; it may be due to warmer winter weather conditions, efficiency programs, and/or changes in the reporting protocols for the data.

Per capita natural gas consumption for residential use is presented in Figure 14. Note this plot includes only the population living in households with natural gas as a primary heating fuel. In all counties with natural gas service, the per capita residential consumption went down between 2010 and 2014. This is tied to the unexplained drop in gas use noted above.

Figure 12. Residential natural gas consumption by county.



Note there is no natural gas service in Del Norte, Modoc, or Siskiyou Counties.

Figure 13. Total natural gas consumption by county.

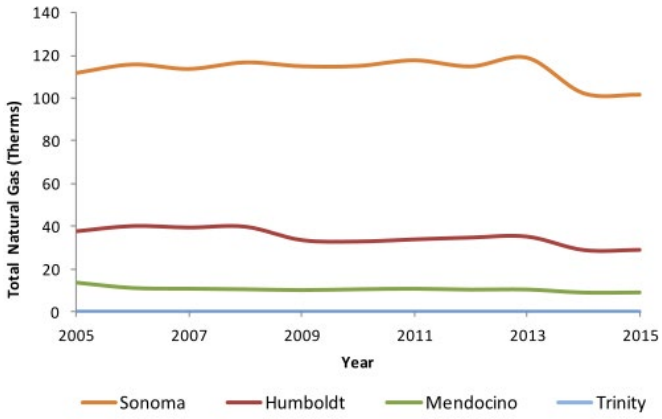


Figure 14. Residential natural gas consumption per capita by county.

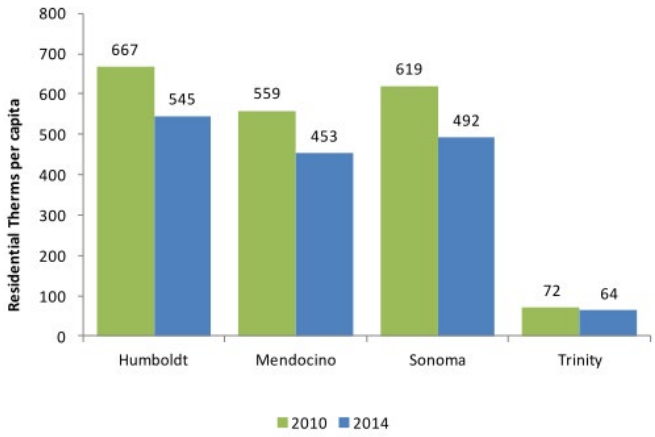


Figure 15. Estimated annual gasoline sales for counties.

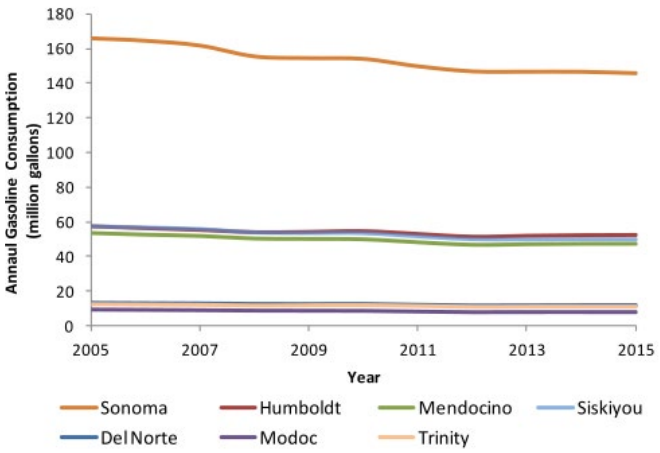
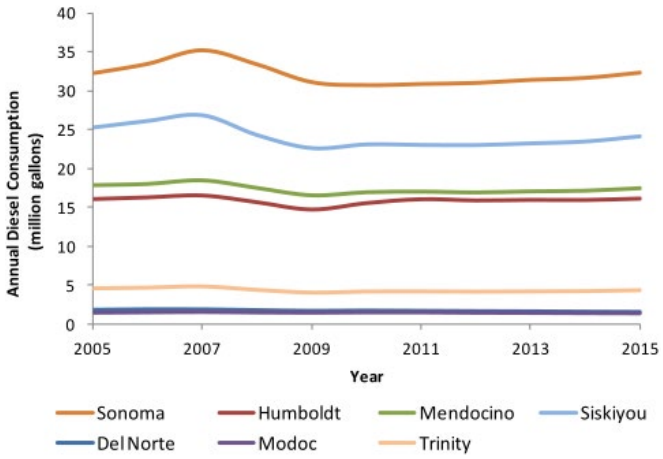


Figure 16. Estimated annual diesel sales for counties.



Note: data are from CARB-EMFAC model to estimate transportation fuel consumption/ emissions.

3.3.3 Gasoline and Diesel

- Figure 15 presents estimates of regional gasoline sales for the years 2005 through 2015. Estimates are from the EMFAC database (CARB 2014), which estimates consumption and GHG emissions for vehicles in California. It is important to note that disaggregating them by county may lead to errors. Nonetheless, these estimates are likely the best available for gasoline and diesel consumption (and emissions) and therefore are included in this analysis.
- All petroleum fuels consumed in the NCRP region are imported. Sonoma County has the largest gasoline consumption by a substantial margin, followed by Humboldt, Siskiyou and Mendocino, which are tightly clustered, followed by Del Norte, Trinity and Modoc Counties. Like electricity consumption, these differences are largely driven by differences in the population for each county.

3.3.4 Heating Fuel

Data from the U.S. Census estimating the number of households using various primary heating fuels (U.S. Census Bureau 2015) were used to estimate penetration of various primary heating fuels throughout the region as shown in Table 7. As expected, the leading heating fuel in Humboldt, Mendocino and Sonoma Counties is natural gas, though many other fuels are used. Mendocino has the highest penetration of propane gas service. The leading heating fuel is electricity in Del Norte; fuel oil/ kerosene in Siskiyou; and firewood in Modoc, Siskiyou and Trinity Counties. Data are not readily available for propane, heating oil, or wood used for heating, but these fuels account for a substantial portion of heating fuel use as much of the region (i.e. Del Norte, Modoc, Siskiyou and Trinity Counties) lack natural gas service. It is recommended to conduct

research to explore opportunities to obtain data and estimate regional consumption of these fuels.

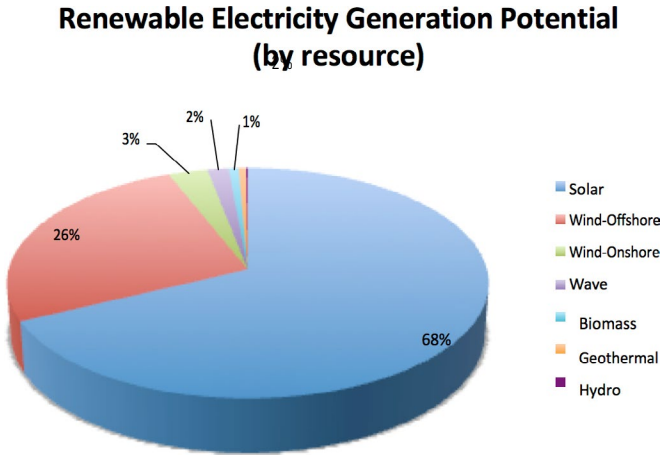
Table 7. Primary heating fuel penetration in the residential sector.

	Del Norte	Humboldt	Mendo	Modoc	Siskiyou	Sonoma	Trinity	Region
Utility gas	7.1%	58.2%	33.1%	5.0%	4.2%	67.0%	5.2%	54.4%
Bottled, tank, LP gas	4.8%	6.1%	20.1%	6.8%	5.1%	6.3%	13.4%	7.8%
Electricity	58.4%	14.2%	17.5%	18.8%	27.4%	20.8%	29.2%	21.0%
Fuel oil, kerosene	12.8%	1.3%	5.7%	18.6%	26.4%	0.2%	8.2%	3.3%
Wood	13.7%	17.9%	21.4%	48.0%	35.9%	4.2%	42.0%	11.8%
Other	3.2%	2.3%	2.2%	2.8%	1.0%	1.5%	2.0%	1.7%

3.4 RENEWABLE ENERGY POTENTIAL

This section examines the renewable energy development potential for the NCRP region. The NCRP region is rich in renewable energy resources (e.g. biomass, geothermal, hydroelectric, solar, wave, and wind power). Figure 17 shows estimated technical potential for renewable electricity generation in the NCRP region broken out by resource. Solar and off-shore wind dominate the region with over 94% of the total technical potential. Onshore wind, wave, biomass and geothermal resources make up most of the remainder.

Figure 17. Relative renewable electricity generation potential, by resource.



While there are a tremendous number of renewable energy development opportunities in the North Coast, these resources are not uniformly distributed throughout the region. For example, coastal counties in the region tend to be rich in wave and wind energy, while inland counties have greater solar resource. Other resources, like geothermal and biomass power, are distributed based on unique geological and ecological characteristics. Figure 18 shows the breakdown of total technical potential by county. Modoc has the greatest potential at 28%, Humboldt, Mendocino, Siskiyou and Sonoma range from 13% to 18% of the total, and Del Norte and Trinity Counties each represent less than 10% of the total technical potential (total = 765 TWh/year).

Figure 18. Relative renewable electricity generation potential by county.

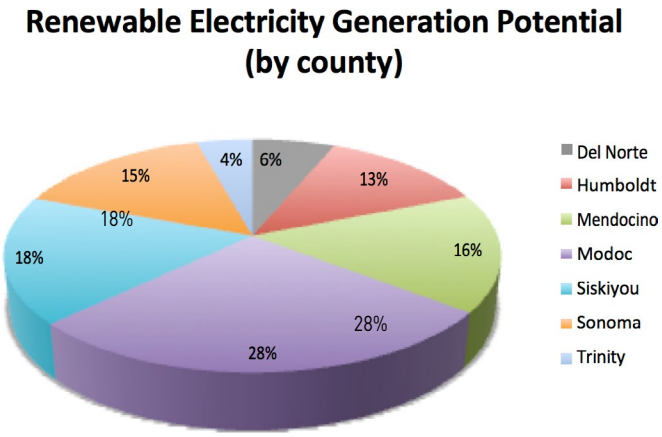


Table 8 compares resource potential and total electricity consumption in 2014 for each of the counties in the NCRP region. Note the total technical potential for the region is about 140 times as great as total consumption. However, as already noted, the economic potential is likely to be only a small fraction of total technical potential. If the percent of technical potential that is economically viable is similar to the percentage predicted by NREL for the State of California (approximately 3%), then the total economic potential closely matches electricity consumption for the region.

Table 8. Renewable electricity generation potential by county and resource, and regional 2014 consumption.

	Del Norte	Humboldt	Mendocino	Modoc	Siskiyou	Sonoma	Trinity	Total	Resource % of Total
2014 Electricity Consumption (GWh)	203	839	563	168	482	2,943	118	5,314	
Renewable Electricty Generation Technical Potential (GWh/yr)									
Biomass	168	1,369	1,291	443	1,137	556	748	5,711	0.7%
Geothermal	-	-	430	860	1,505	1,505	-	4,300	0.6%
Hydro (Total)	100	184	50	42	339	48	223	986	0.1%
Hydro - Unpowered Dams	-	13.1	13.1	13.1	45.85	45.85	-	131	
Hydro - New run-of-river (>1MW)	100	171	37	14	289	-	223	835	
Hydro - In-Conduit	-	-	-	14.3	3.7	2.0	-	20	
Solar	8,452	36,580	61,196	205,753	123,752	53,006	30,461	519,200	68%
Wave	1,916	3,455	3,303	-	-	3,560	-	12,233	1.6%
Wind - Onshore	2,212	4,222	2,132	3,176	8,575	958	1,428	22,703	3.0%
Wind - Offshore	35,683	51,101	57,269	-	-	55,947	-	200,000	26%
Total	48,532	96,911	125,669	210,274	135,308	115,579	32,860	765,133	
County % of Total	6%	13%	16%	27%	18%	15%	4%		

See sources in SERC, RCEA 2017 (http://www.northcoastresourcepartnership.org/resources/)

Based on a review of renewable energy potential in each county and a few other key criteria (e.g., Humboldt County's deep-water port makes it best suited for wave or offshore wind energy development), a renewable energy opportunity matrix was developed and is shown in Table 9. This matrix is intended to provide general guidance regarding where the best renewable energy development opportunities are likely to be found in the NCRP region.

Table 9. Matrix of renewable energy potential by county and resource for the region.

	Del Norte	Humboldt	Mendocino	Modoc	Siskiyou	Sonoma	Trinity
Biomass	Low	**High**	**High**	Medium	**High**	Medium	**High**
Geothermal	—	—	Medium	**High**	**High**	**High**	—
Hydro (Total)	Medium	Medium	Low	Low	Medium	Low	Medium
Solar	**High**	**High**	**High**	**High**	**High**	**High**	**High**
Wave	**High**	**High**	Medium	—	—	Medium	—
Wind-Onshore	**High**	**High**	Medium	Medium	**High**	Low	Medium
Wind-Offshore	**High**	**High**	Medium	—	—	Medium	—

3.5 POTENTIAL BENEFITS AND IMPACTS OF ENERGY OPPORTUNITIES

There are potential benefits and/or impacts associated with the energy strategies outlined in this report. Broadly, categories of expected positive benefits and negative impacts can include economic, environmental, social, and political.

Economic

The promotion of energy efficiency, local renewable energy development, and fuel switching strategies along with community-based energy programs such as Community Choice Aggregation will lead to more energy dollars circulating in the local economy and more local jobs. Numerous studies have examined the economic effects of local renewable energy development. One tool available from the National Renewable Energy Laboratory for assessing the jobs and economic development impacts of local renewable energy projects is the Jobs and Economic

Development Impact6 (JEDI) models). These models can be customized with local economic data to estimate the impacts of renewable energy projects to local economies. One such study that utilized the JEDI models and estimated local economic impacts was the RePower Humboldt Strategic Planning study. The economic analysis report associated with the RePower study included a JEDI-based economic analysis.

Environmental

Renewable energy projects can have many associated environmental benefits. Foremost among these is they offer an alternative to conventional fossil fuel energy sources and the serious environmental impacts they pose. However, all energy technologies, even "green" renewable energy technologies, pose some level of impact on the environment. Impacts might include wind energy impacts to bird and bat populations, hydroelectric system impacts to aquatic ecosystems, wave and offshore wind energy impacts to commercial fishing, or biomass energy impacts to air quality and/or forest ecosystems. These impacts must be considered when choosing which energy projects to pursue and which to abandon. Each project must be evaluated on its own merits with ample opportunity for input from local stakeholders. When feasible, impacts should be avoided or mitigated.

It is important to understand that the "do nothing" alternative also has impacts. If we continue our current energy path, we are likely to severely overheat our planet. Therefore, local impacts and concerns associated with a new project must be considered in concert with the larger impacts associated with global climate change. A balance must be struck where the majority of the community, and especially those most seriously impacted, can agree on a path forward.

Political

One of the key political outcomes associated with the energy strategies presented in this report is the ability to increase local participation in energy decision-making. Distributed generation projects by their very nature engage local stakeholders. Community-based ownership models like Community Choice Aggregation directly engage local stakeholders in energy decision-making. This increases awareness of where our energy comes from and with this greater knowledge, hopefully people can make better decisions for their communities and their planet. The promotion of decentralized, local, community-scale energy systems engages and empowers local stakeholders to be responsible and accountable for their energy use—rather than simply flipping a switch with no thought of where the energy comes from, instead they will be more apt to think about energy sources and their impacts, especially if the energy is generated next door in their own community.

Social

Energy-related issues in the social realm typically refer to social equity and social justice. The National Academy of Public Administration (NAPA) defines social equity as:7 The fair, just and equitable management of all institutions serving the public directly or by contract, and the fair, just and equitable distribution of public services, and implementation of public policy, and the commitment to promote fairness, justice, and equity in the formation of public policy." Energy solutions that are founded on community choice and community equity will ensure that climate mitigation solutions benefit everyone. Specific strategies recommended to bolster social equity and justice while implementing GHG reductions are listed in Section 7.1.

3.6 ENERGY ORGANIZATIONS AND PROGRAMS

Regional Organizations

The list below identifies some of the region's energy related organizations. It provides a brief description of services and includes Internet links for more information.

- *Redwood Coast Energy Authority* (RCEA) is a joint powers authority in Humboldt County whose purpose is to develop and implement sustainable energy initiatives that reduce energy demand, increase energy efficiency, and advance the use of clean, efficient and renewable resources available in the region. In May 2017 RCEA launched a community choice energy program to the vast majority of customers in Humboldt County. (http://www.redwoodenergy.org/)
- *Sonoma Clean Power* (SCP) is a Community Choice Energy program in Sonoma County. In October 2016 the Board of Directors voted to include Mendocino County in the service region, excluding the city of Ukiah, which currently has a municipal electric utility. (https://sonomacleanpower.org/)
- *Trinity County Public Utility District* is a municipal utility of Trinity County, which supplies residents with 100 percent hydroelectric

6 See (http://www.nrel.gov/analysis/jedi/

The study can be accessed from the California Energy Commissions publications page: http://www.energy.ca.gov/publications/displayOneReport.php?pubNum=CEC-500-2013-020

7 https://www.napawash.org/working-groups/standing-panels/social-equity-in-governance

power through the Western Area Power Administration. (http://trinitypud.com/)

- *The Northern California Center for Alternative Transportation Fuels and Advanced Vehicle Technologies* (NorthCAT) creates a physical and virtual network of training and showcase centers and informational resources for alternative fuels and vehicle technologies. (http://northcat.org/)
- *The Watershed Research and Training Center* (WRTC) mission is to promote a healthy forest and a healthy community through research, training, and education. The WRTC was formed in order to rebuild the economy of Hayfork California based on an ethic of land stewardship and restoration. (http://www.thewatershedcenter.com/)
- *Redwood Community Action Agency* is a Humboldt County based, private non-profit organization that provides a wide range of services to low and moderate-income residents of Humboldt County. The long-term goal is to develop programs through which people can become self-sufficient and empowered to improve their own lives. Their weatherization services also cover Del Norte and Modoc Counties. (http://rcaa.org/)
- *Community Development Commission of Mendocino County* is a public agency whose mission is to provide opportunities for decent, safe, affordable housing and a suitable living environment to low-and moderate-income, special needs households, and communities in an effective, efficient, and respectful manner.
- *Training Employment and Community Health, Inc.* (TEACH) is a broad based, multi-purpose non-profit community organization that serves the population of Modoc County. They offer a wide range of programs including heating assistance for low income households. (http://teachinc.org/)
- *Klamath Alliance for Resource and Environment* (KARE) is a grassroots, non-profit located in Siskiyou County dedicated to educating the public about the environmental benefits of responsible management of our natural resources on public and private lands with the purpose to inform and educate the public by providing science-based information on forest ecosystems, environmental issues, and the economic benefits of forest resources in our communities. (http://www.klamathalliance.org/)
- *Great Northern Services* (GNS) is a community organization serving Siskiyou County that seeks to invigorate community by initiating positive social change to improve economic conditions. They offer a variety of services including energy assistance and home weatherization services. (http://www.gnservices.org/)
- *Northern California Indian Development Council* is a private nonprofit corporation established to research, develop, and administer social and economic development programs designed to meet the needs of Indian and Native American Communities to provide support and technical assistance for the development of such programs, and the conservation and preservation of historic and archeological sites and resources. They are the LIHEAP providers for 48 California Tribes, including many in the NCRP Region. (http://www.ncidc.org/)
- *Del Norte Senior Center* is a provider of LIHEAP and weatherization service to qualifying low income households in Del Norte County in addition to senior services. (http://www.delnorteseniorcenter.org/home.html)
- *North Coast Energy Services* is a not-for-profit organization that provides energy conservation, consumer education and advocacy, home improvement, utility assistance, job training, and other services to people in need in Lake, Mendocino, Solano, Sonoma, and Yolo Counties. (http://www.northcoastenergyservices.com/index.html)
- *The Regional Climate Protection Authority* (RCPA) is a Sonoma County agency that coordinates community-wide climate solutions for a better future. The RCPA is focused on securing grant funding for GHG reduction programs and projects, as well as leading countywide climate planning efforts. (http://rcpa.ca.gov/)

Regional Programs

The section presents some of the regional programs that promote energy efficiency and renewable energy throughout the region.

- *Energy Watch* is a program administered by PG&E. In the NCRP region the following organizations provide services under Energy Watch:
  - » Mendocino-Lake Energy Watch (http://mendoenergy.org/)
  - » RCEA administers the Redwood Coast Energy Watch (http://www.redwoodenergy.org/)
  - » Sonoma County (http://www.sonoma-county.org/gs/energy/scew/index.htm). Sonoma County is also served by energy efficiency programs offered by the Bay Area Regional Energy Network (www.bayren.org).

- *Wattsmart* energy efficiency incentive programs are offered by Pacific Power in Del Norte, Siskiyou, and Modoc Counties (https://www.pacificpower.net/res/sem/california.html)
- *Public Utility District efficiency programs* are administered by the Trinity County Public Utility District and the Ukiah and Healdsburg municipal utilities.
- *The Rural Energy for America Program* (REAP) provides guaranteed loan financing and grant funding to agricultural producers and rural small businesses for renewable energy systems or to make energy efficiency improvements. (https://www.rd.usda.gov/programs-services/rural-energy-america-program-renewable-energy-systems-energy-efficiency)
- *Property Assessed Clean Energy Financing* is a program allowing for energy efficiency, water efficiency, and renewable energy projects to be financed through a voluntary property assessment that is attached to the property, not the owner, and is paid back through the property tax system. These programs are administered by a variety of lenders and public agencies. Information on PACE financing and other programs is available through the Sonoma County Energy Independence Program (http://sonomacountyenergy.org/) or the Redwood Coast Energy Authority's PACE webpage (http://www.redwoodenergy.org/energy-efficiency/pac).
- *Community choice aggregation* is a program that allows California cities, counties, and or joint powers agencies to purchase electricity on behalf of the customers in their territories. Transmission and distribution lines and their maintenance remain the responsibility of the incumbent utility, as does billing, but CCAs are able to determine their own energy supply mixes and rate structures. Currently Sonoma Clean Power operates in Sonoma County and Mendocino County and the Redwood Coast Energy Authority serves Humboldt County – accordingly most of the population in the NCRP region is served by a CCA.

In California investor owned utilities are required to collect and spend funds from ratepayers for efficiency programs. Table 10 presents data from the first quarter of 2013 through the third quarter of 2015 (CPUC 2017). The data represent the amount of gross demand reduction (MW), energy savings (GWh), and natural gas reduction (therms) for each county, and the amount of program funding spent per county. These data are only for counties in PG&E's service territory as comparable data from Pacific Power was not readily available.

Table 10. Energy efficiency program energy, demand, savings, and program funding for 2013-2015 in PG&E service territory.

	Demand Reduction (kW)	Energy Savings (MWh)	Natural Gas Savings (MMTh)	Total Program Cost (thousand $)
Humboldt	1,100	6,100	0.3	5,600
Mendocino	500	3,600	0.1	2,600
Sonoma	7,800	39,100	0.9	21,200
Total	**9,500**	**48,800**	**1.3**	**29,300**

The region's public utilities also fund efficiency programs. The programs are naturally smaller in overall scale due to the smaller customers bases of North Coast public utilities.

Table 11. Public utility energy efficiency program energy, demand, savings, and program funding for Public Utility in FY15-16.

	Demand Reduction (kW)	Energy Savings (MWh)	Total Program Cost (thousand $)
Trinity	1	57	65
Ukiah	34	149	93
Healdsburg	55	987	345
Total	**90**	**1,193**	**503**

3.7 INFORMATION GAPS

To refine this energy profile, it is recommended that further analysis of existing information as well as new research be conducted to fill most or all the information gaps listed below.

- There is no data readily available for the quantity of propane or fuel oil consumed in the NCRP region by county. Consumption of these fuels could be tracked based on sales. These heating fuels are especially important in geographic areas not served by a natural gas utility (i.e., the counties of Trinity, Del Norte, Siskiyou, and Modoc). To make a proper assessment of the GHG emissions of the region, this information is necessary.

  Additionally, it would be useful to have data throughout the region on the number, type and utilization frequency of wood burning stoves, which are numerous in the region. These data are needed to inform program design in the region and characterize the impacts of such programs. The benefits of switching to other sources of heat, for example heat pumps, cannot be measured unless there is a reliable baseline for comparison.
- Data on the number of fleet vehicles, number of organizations with fleet vehicles and the miles traveled by fleet vehicles would be useful

to help determine the best opportunities for introducing alternative fuel vehicles into fleets.

- There is a multitude of energy related data that would be useful to have compiled and put into a geographic information system format. This includes: energy infrastructure, energy use, fuel availability, energy generation by source, energy resource potential, sensitive environmental areas, land use characteristics, land ownership, zoning, electric utility service territories, etc.
- Gasoline and diesel fuel data at the county level. Specifically, request and aggregate available data from each regulating agency.
- Collect available data on electric utilities and CCAs in the region, including areas they serve, programs offered, etc.
- Data on electricity distribution and transmission networks, including infrastructure capacities (total and available). An example of this is PG&E's PVRAM map.
- Compile energy-related GHG emission and criteria pollutant emission data associated with the energy consumed in the NCRP region. Only CO2 emissions estimates are presented in this report, and they are incomplete.
- A survey of boilers in the region to identify potential biomass heating and combined heat and power project opportunities.
- A survey of water conveyance systems in the region and an assessment of those that could offer conduit hydropower opportunities.
- Tracking of distributed generation, energy storage, microgrid, and combined heat and power projects (size, type, ownership, characteristics, output, etc.) in the region.
- Estimation and tracking of jobs and economic stimulus associated with sustainable energy projects and programs in the region.
- Research regarding forest-derived woody biomass as a fuel for electricity generation and its effect on human and forest health.
- Identification and assessment of energy assurance planning needs for the region. Identification of key project opportunities for resilient energy systems for critical services.
- Identification and assessment of infrastructure needs for the region. Identification of deteriorating infrastructure most at risk to climate change impacts.
- Identification and tracking of key renewable energy and distributed energy generation projects in the region and development of case studies that can encourage replication of successful projects.

4 GHG EMISSIONS SOURCES & SINKS

The previous section detailed energy production and consumption for the region. The corresponding part of presenting an energy profile is examining carbon sources and sinks: both where emissions come from, and where they can be sequestered or retained. The focus of this section is on estimating GHG emissions from the energy/ transportation sector, [i.e. electricity (conventional, renewable), heating fuel (e.g. natural gas), and transportation fuel (e.g. gas, diesel). It is important to note there are numerous GHG emission sources and potential sinks in addition to "energy/ transportation" (e.g. water sector; agriculture; natural lands conversion; wildfire; waste). However, there is value in presenting these data on emissions from the energy/transportation sector as that is the source of most of the region's emissions (and represent numerous opportunities for emissions reductions).

4.1 ENERGY SECTOR GHG EMISSIONS

This section provides high-level estimates of GHG emissions from the energy sector (i.e. from electricity, natural gas, and gas/diesel). Where possible, information is presented per capita, annually, and/or by county. This is only a partial "high level" emissions assessment since some heating fuel use is not accounted for. Section 4.1 "Energy Sector GHG Emissions" and figures/ tables therein is excerpted and adapted from SERC, RCEA 2017 (see report for methodology at http://www.northcoastresourcepartnership.org/resources/).

4.1.1 Overview

The energy-related greenhouse emissions in the region appear to be dominated by the transportation sector. However, incomplete data are currently available and further work is needed in this area. Heating fuel emissions are significant and electricity use accounts for a relatively small portion of energy sector emissions.

4.1.2 Per Capita Emissions

Figure 19 presents per capita annual CO2 emissions for four of the NCRP counties. Interestingly, Trinity County has the highest per capita annual emissions even though there are zero emissions from electricity consumption in the county (all hydroelectric) and essentially zero

emissions from natural gas (nearly zero natural gas customers). As already noted, no data for propane use are provided in this report. That means that the transportation sector accounts for nearly all of Trinity County's CO2 emissions. It appears that a relatively high level of diesel fuel consumption and a low population are the key reason Trinity County's per capita CO2 emissions are higher than other counties shown.

4.1.3 Annual Emissions

Figure 20 and Figure 21 show the annual CO2 emissions associated with electricity and natural gas consumption, respectively. Due to its larger population, Sonoma has the highest level of CO2 emissions in the electricity and natural gas sectors. In contrast, The Trinity County PUD, which provides electricity to the majority of Trinity County, gets all its electricity from hydropower, so the CO2 emissions associated with electricity consumption in Trinity County are close to zero. The spike in emissions in 2007 (Figure 22) is due to an increase of the emissions factors for PG&E electricity in those years; this increase could be due to an increased proportion of fossil fuels in the power mix. An important consideration for the GHG emissions estimates is that GHG emissions from fuel sources such as propane, fuel oil/kerosene and wood that are commonly used for heating in the areas that don't have natural gas service (i.e., outside of PG&E service territory). Figure 22 and Figure 23 show the annual CO2 emissions associated with gasoline and diesel consumption, respectively.

4.1.4 County Emissions

Figure 24 and Figure 25 present the total CO2 emissions from electricity, natural gas and transportation fuels for Humboldt and Sonoma Counties. These two counties were chosen because natural gas and electricity account for most of the residential heating fuel for these two counties (see Table 7). Therefore, we would expect most of energy related CO2 emissions for these counties are accounted for in Table 7. Transportation accounts for over half the emissions in all cases. This is not atypical, especially for rural areas where emissions from industry are relatively low and per-capita vehicle miles traveled is relatively high. For comparison, the transportation sector accounted for 37% of total CO2e emission for the State of California in 2014 (CARB 2016).

Figure 19. Total annual CO2 emissions per capita for counties not in Pacific Power territory.

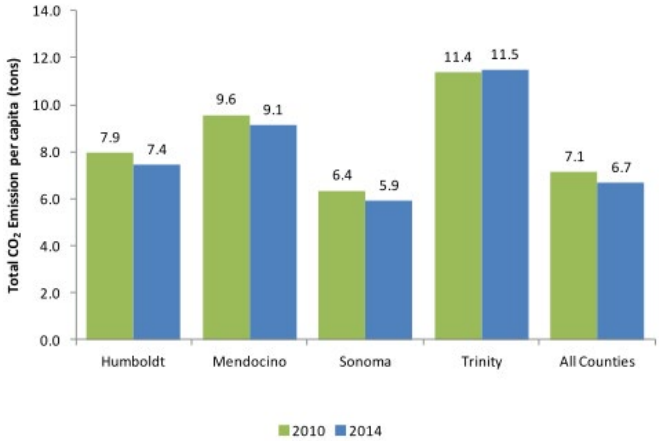
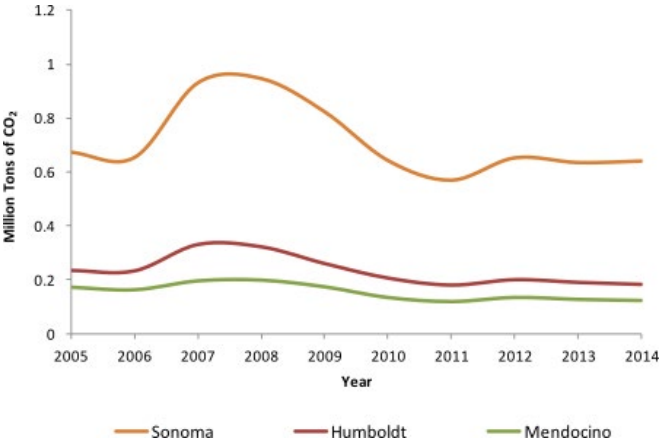
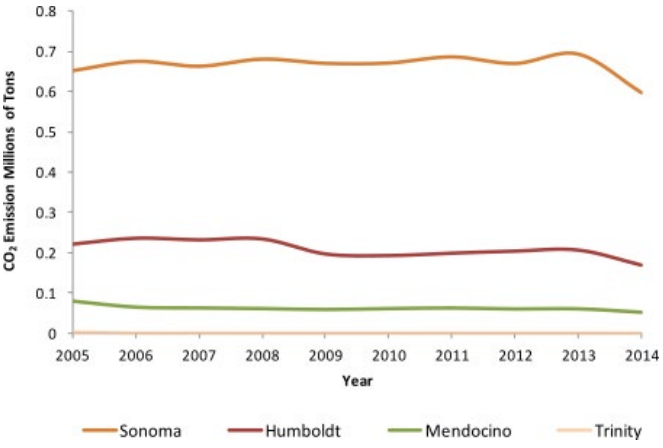


Figure 20. Annual CO2 emissions from electricity consumption for counties in PG&E territory.



Note that data do not account for the transition to community choice aggregation in these Counties, beginning with Sonoma Clean Power's launch in 2014.

Figure 21. Annual CO2 emissions from natural gas consumption.



Note that Del Norte, Modoc, and Siskiyou Counties are unserved by natural gas utility.

Figure 22. Estimated annual CO2 emissions from gasoline consumption.

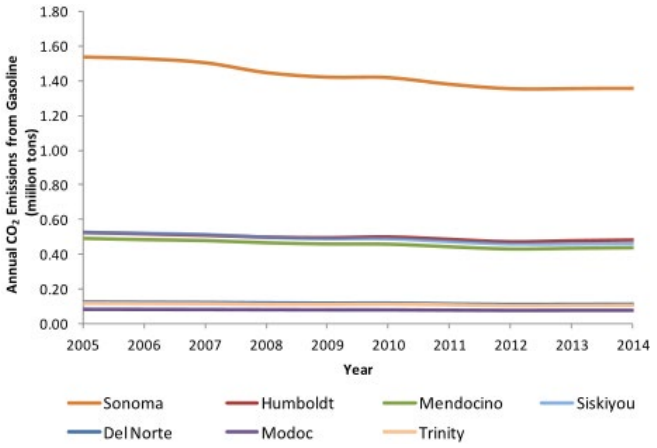


Figure 23. Estimated annual CO2 emissions from diesel sales.

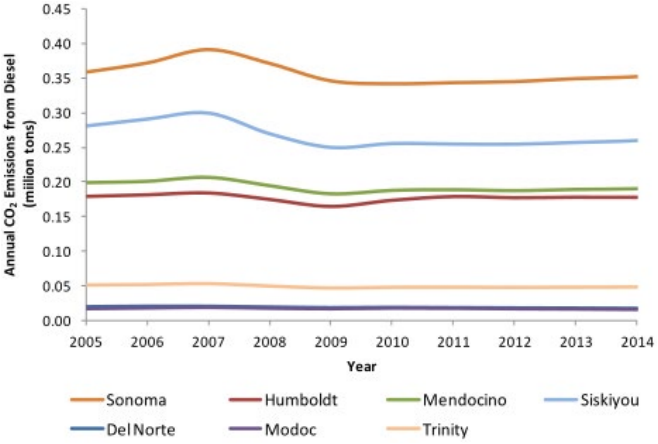


Figure 24. Humboldt County total emissions by fuel source.

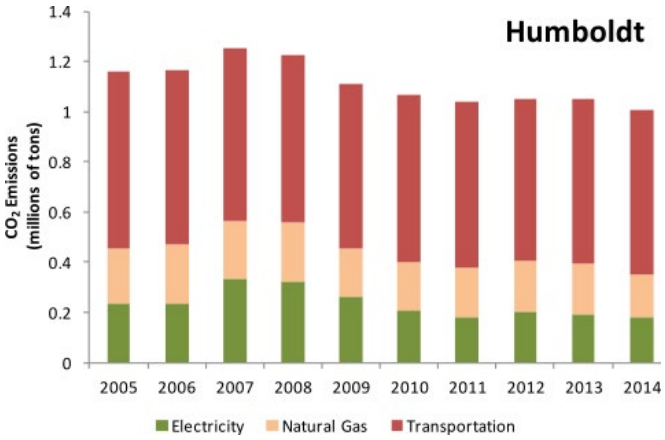
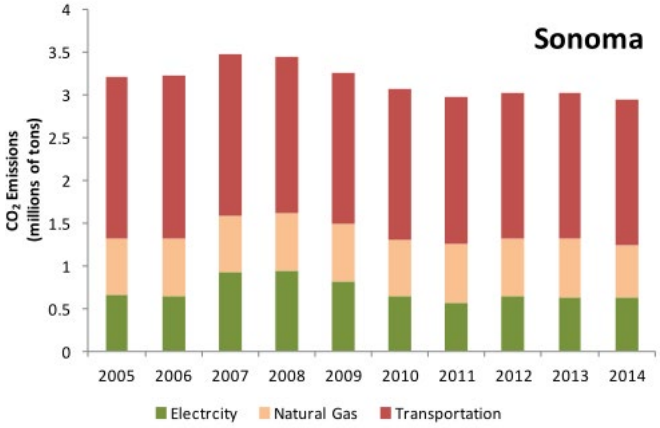


Figure 25. Sonoma County total emissions by fuel source.



4.2 TRANSPORTATION EMISSIONS

Transportation (gas, diesel) emissions are subsumed in 4.1.

4.3 BUILDINGS EMISSIONS

As stated by the California Legislature in AB 32, "building-related emissions are the second largest category of emissions of greenhouse gases in California, accounting for 25 percent of all emissions of greenhouse gases. Direct emissions from combustion of fossil fuels in buildings, primarily for space and water heating, accounts for 10 percent of all emissions of greenhouse gases in California. Decarbonizing California's buildings is essential to achieve the state's greenhouse gas emission reduction goals at the lowest possible cost" (California Legislative Information 2018).

In 2014 Redwood Coast Energy Authority conducted a 2005 greenhouse gas inventory for Humboldt County revealing 20 percent of the county's emissions were

related to residential and commercial energy use (Humboldt County General Plan 2017). Reinforcing the trend, Sonoma County's 2010 GHG inventory data shows building emissions accounting for 36 percent of countywide greenhouse gas emissions (Sonoma County Regional Climate Action Plan 2016).

4.4 WATER RELATED EMISSIONS

Due to pumping, treating, and heating, water systems are energy intensive. California's water system accounts for nearly 10 percent of the state's greenhouse gas emissions. Most energy consumed by California's water sector goes to residential use (42%), however water supply, conveyance, and treatment accounts for 12% of energy consumed by the water sector (PPIC 2016). Significant differences in energy used to convey water in Northern and Southern California call for a closer look at local data. According to the California Energy Commission, "on average, water conveyance requires more than 50 times the energy for Southern California than it does for Northern California" since the water must travel hundreds of miles and, in some cases, pumped over mountain ranges before reaching the destination (California Energy Commission 2005).

Compiling and analyzing detailed regional data would provide a better understanding of County and community-level water-related GHG emissions due to the variability of local conditions as well as local emissions-reduction efforts. For example, the Sonoma County Water Agency is one of the largest energy users in the county, but has undertaken aggressive renewable energy and emissions-reduction strategies, including sourcing 100% of its electricity from renewable and carbon free sources, which have resulted in the Sonoma Regional Climate Protection Authority reporting a 96% decrease from in county-wide emissions from water conveyance between 2010 and 2015 (SCWA and RCPA 2018).

The intricate link between energy use and water supply, distribution, and conservation is commonly referred to as the water-energy nexus. This nexus requires an integrated cross-discipline approach to water-climate-energy security. Given the tight relationship between water and energy, the relationship between local energy generation and local economic development, and the nexus between GHG emissions and watershed management, the North Coast must logically integrate energy considerations into its programmatic regional approach to water resources planning and management (NCRP 2014).

4.5 AGRICULTURAL AND NATURAL LANDS

Cultivated lands (e.g. orchard, row crop, vineyard, some timber, and soils) and natural lands (e.g. forest, shrubland, grassland) can sequester significant amounts of carbon out of the atmosphere. Different land cover types exhibit different potential for sequestering carbon. Below is an overview of the estimated carbon stored in these agricultural and natural areas. Section 4.5 is excerpted and adapted from Nickerson 2017.

4.5.1 Overview

Figure 26 displays the area and CO2e associated with each landcover class within the study area. The second graph zooms in on results excluding forests, which alone accounts for 90% of carbon.

Figure 26. Area and carbon stocks of landcover classes in study area.

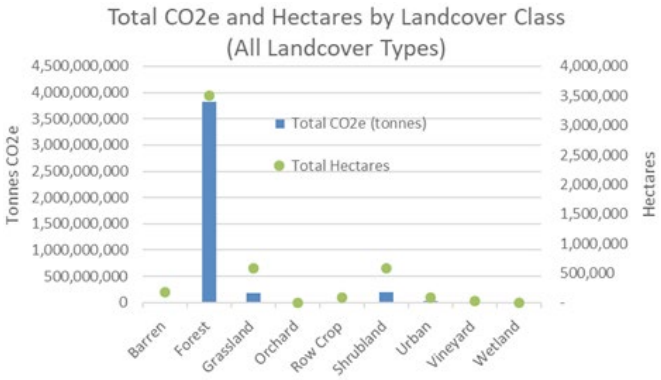
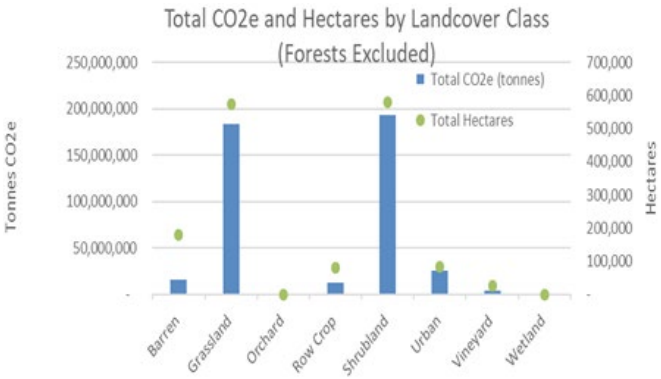


Figure 27. Relative soil and non-soil carbon by landcover class.



4.5.2 Soil

Figure 27 displays the estimates of CO2e per hectare by soil and non-soil reservoirs by landcover class. Landcover classes that contain woody material have a greater proportion of their carbon in non-soil

reservoirs. In landcover classes that don't have as much woody material (e.g. agriculture, grassland), the bulk of the carbon is stored in soils.

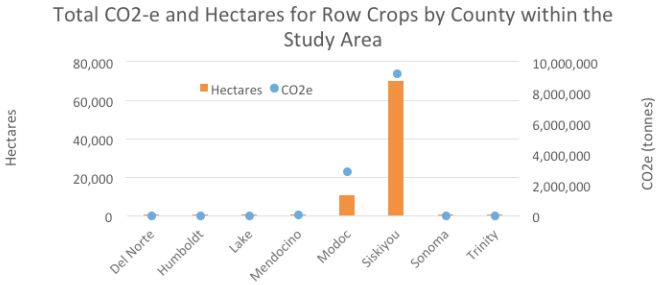
4.5.3 Orchard

Orchards constitute approximately 36 hectares or less than 1% of the study area and contain less than 1% of the carbon in the natural and working landscapes within the study area. The majority (64%) of carbon within the orchard landcover class is estimated to be in the soil carbon pool. Approximately 70% of the landcover classified as orchard by LANDFIRE within the study area is found in Mendocino County. Siskiyou County has the next highest proportion at 16% of the region.

4.5.4 Row Crop

The row crops in general constitute approximately 1.6% of the land classes within the study area and contain less than 1% of the carbon in the study area. The carbon in the row crop landcover class is mostly (>99%) within the soil pool. The majority of row crops within the study area are found in Modoc and Siskiyou Counties, as shown in Figure 28.

Figure 28. Area and carbon stocks of row crops by county.



4.5.5 Vineyards

There are 26,648 hectares of vineyards within the study area with an average of 160 tonnes CO2e per hectare. Vineyards contain less than 1% of the surface area and contain less than 0.1% of the carbon stocks within the study area. Approximately 89% of the carbon in vineyard landscapes is estimated to be in the soil carbon pool. Most of the vineyard area within the study area is found in Sonoma and Mendocino Counties.

4.5.6 Harvested Woods Products

Timber harvest continues to be an important economic activity in the region. When trees are harvested, CO2-e may remain sequestered for long periods of time in harvested wood products (and in landfills) before they decompose and release the carbon stored in them to the atmosphere. The average timber harvest in the study area has averaged 850,637 thousand board feet a year over the timeframe from 2012 to 2016. This harvest amount represents 1,211,067 tonnes of sequestered CO2e on an annual basis. This value is expected to increase as harvest volumes slowly increase in the future.

4.5.7 Forests and Other Natural Lands

The majority of landcover areas within the study area remain in natural (i.e. non-developed) landcover classes. Forests store the most amount of carbon with almost 4 gigatonnes of CO2e or 90% of the carbon within the study area. The carbon densities in forests within the study area are among the highest in the United States8. Forest cover dominates landcover within the study area, covering approximately 3.5 million hectares, or almost 70% of the surface area within the study area. Forests are irregularly distributed across the region. Humboldt, Mendocino, Siskiyou, and Trinity Counties contribute the most forest area and forest carbon for both coniferous (Figure 29) and woodland (Figure 30) types.

Figure 29. Area and carbon stocks within coniferous forests by county.

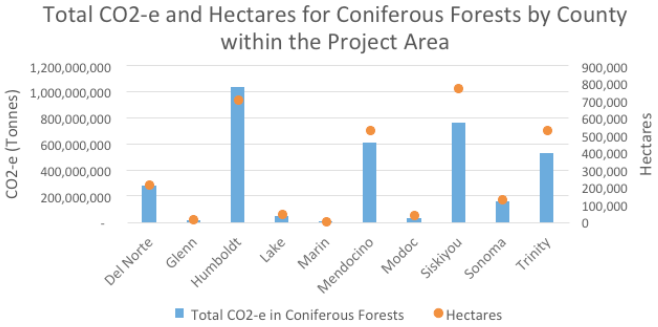
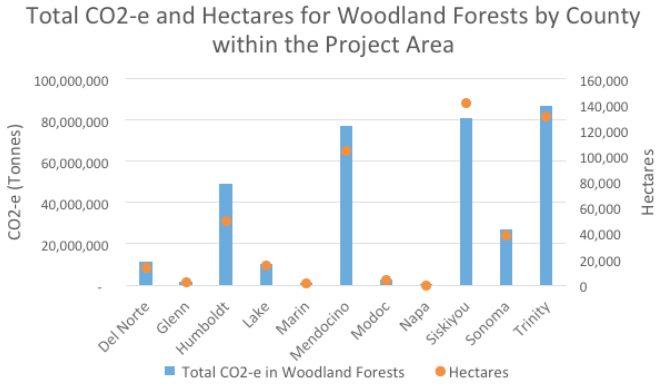


Figure 30. Area and carbon stocks within woodland forests by county.

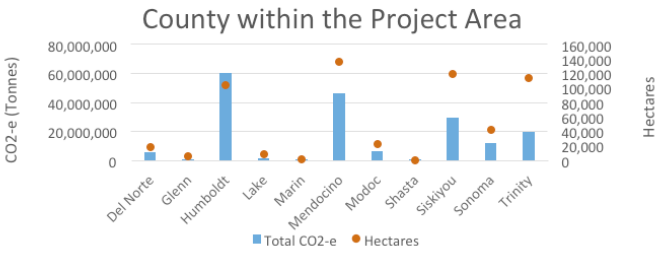


8 Air Resources Board Assessment Area Data File (https://www.arb.ca.gov/cc/capandtrade/protocols/usforest/usforestprojects_2015.htm)

4.5.8 Grassland and Shrubland

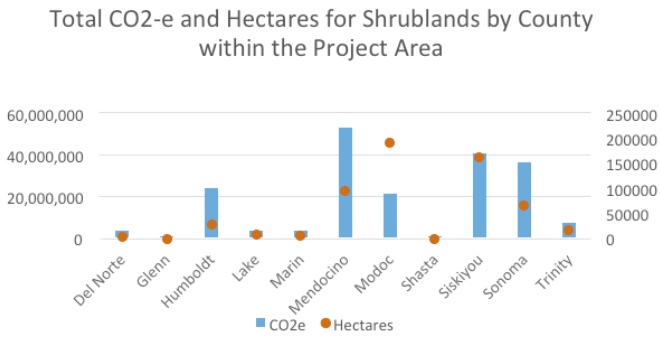
Grasslands constitute approximately 12% of the study area and contain approximately 4% of the carbon in the natural and working landscapes. Most of the grassland areas are found in Humboldt and Mendocino Counties within the study area, as shown in Figure 31.

Figure 31. Area and carbon stocks within grasslands by county.



Shrublands constitute approximately 580,000 hectares or 12% of the study area and contain approximately 5% of the carbon in the natural and working landscapes. Figure 32 display the carbon stock densities and area of shrublands, by county, within the study area.

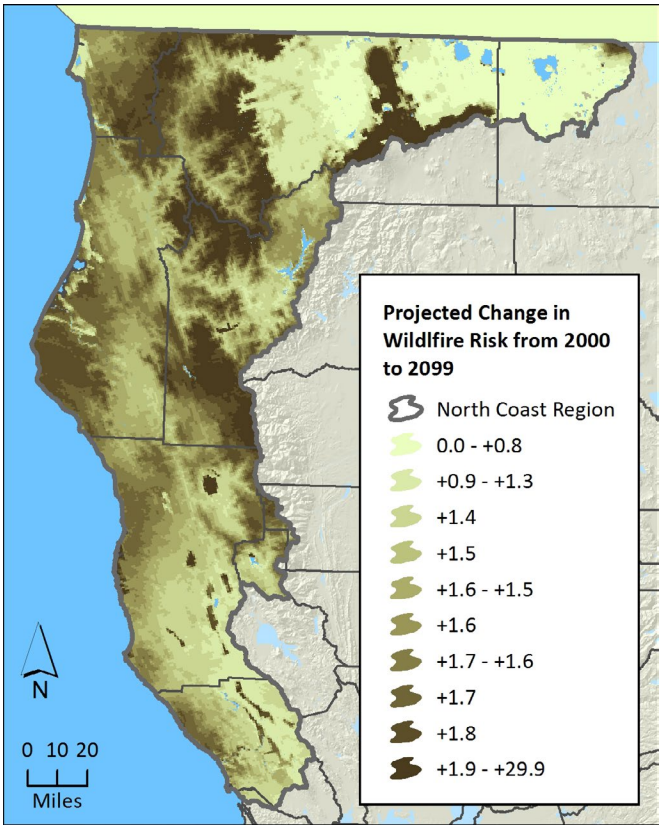
Figure 32. Area and carbon stocks within shrublands by county.



4.6 WILDFIRE

With the region's forests serving as important carbon storage sinks, wildfires can conversely cause significant releases of CO2 back into the atmosphere along with other GHGs and particulate matter. Fire is a natural and important element in the ecosystems of the region, but the intensity, size and characteristics of fires influences both their GHG emissions impacts as well the human and natural impacts.

MAP 4 PROJECTED CHANGE IN WILDFIRE RISK (2000-2099)



There has been significant effort to identify the ability for forest treatments to influence the severity of wildfire through various treatment methods. A good brief overview of efforts to date regarding fuel treatment-wildfire-carbon dynamics can be found in the introduction of (Chiono et al., 2015). In general, it is possible to protect live carbon stocks using fuel treatments that produce lower density stand structures that are dominated by large fire-resistant species (Hurteau and North, 2009). Emissions from wildfires can be reduced because of forest treatments, but it is not guaranteed that this will sufficiently offset the emissions associated with treatment activities. For example, according to one study the severity of very large wildfires (~10,000 hectares) must be reduced to offset the emissions from treatments employing prescribed burning (Chiono et al., 2015). Some of the additional important variables that impact wildfire emissions estimates include existing stand structure, forest type, treatment type, stand management type, spatial distribution of treatments relative to each other (Ganz, 2007), fire weather conditions, and landscape-scale variables such as long-term wildfire probability and impacts from diseases and pests.

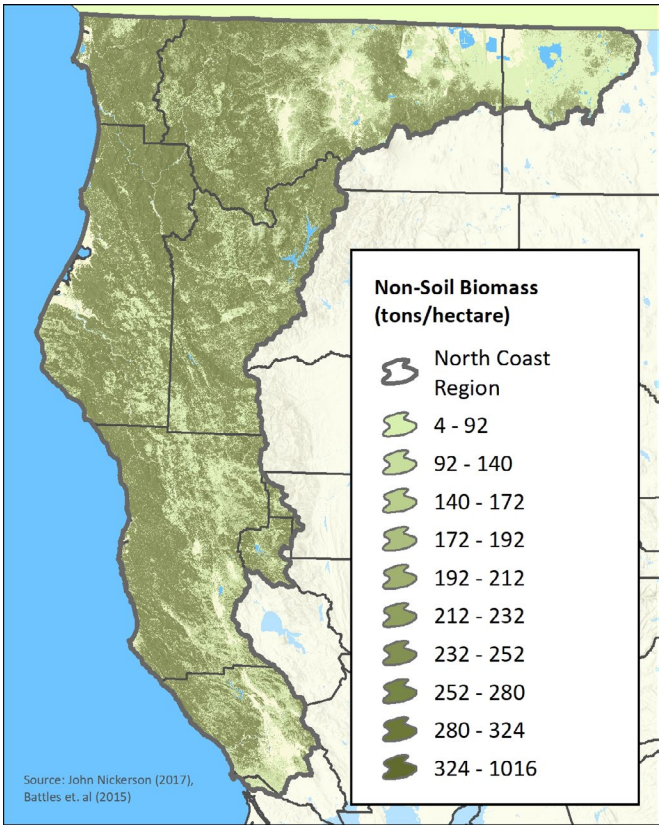
Because of the complexity of fuel treatment-wildfire-carbon dynamics it is difficult to generate a blanket

number that represents potential emissions impacts. However, a study conducted in Trinity River Watershed Management Area estimated that if it could be assumed that thinning practices reduced wildfire severity from "high" to "low", then 15 tonnes of stored CO2 per acre (12,500 tonnes total for the Trinity study) could potentially be retained through avoided fire-caused mortality (NCRC&DC, 5C 2017). Many forested communities, including those in the North Coast Region, are already removing significant biomass from forested areas on both public and privately-owned lands. Some of this removal is part of current timber harvest activity, and a large part is for fuels reduction to assist in limiting the occurrence of regional large-scale catastrophic wildfires.

Biomass energy project designed to support forest restoration and management priorities have the potential to support overall net reductions in GHG emission. In a study conducted by the USFS Rocky Mountain Research Station, a comparison of CO2 emissions of pile burning, natural gas, and bioenergy concluded that biomass energy projects, with defined implementation, can result in over-all reduced emissions (TWC 2017). However transporting forest biomass material to traditional centralized plants can be difficult and costly. There are ongoing efforts to explore strategies to process forest fuels to make transport more feasible as well as to develop smaller, community scale technologies that can utilize the material closer to the source to reduce the need for long-distance transportation.

Further research is needed to draw conclusions specific to forest-derived woody biomass as a fuel for electricity generation. More information will be available when Humboldt State University's Schatz Energy Research Center completes its California Biopower Impact Project, supported by a grant from the California Energy Commission.

MAP 5 FOREST BIOMASS STORAGE POTENTIAL



4.7 OTHER SOURCES & SINKS

Landfills can emit significant amounts of methane into the atmosphere. The landfilling of organic materials leads to the anaerobic breakdown of these materials into landfill gas. Landfill gas is primarily composed of methane, which is 72-84 times more potent than carbon dioxide (CARB 2018). A 2010 GHG inventory for the City of Ukiah in Mendocino County revealed that 21% of greenhouse gas emissions in the city were from the city landfill (City of Ukiah Climate Action Plan 2014).

The North Coast Region has undertaken multiple strategies to decrease emissions from landfills. In Sonoma County, the Landfill Gas Power Plant produces up to 5MW electricity using gas collected from 150 collection wells in its landfill. The landfill gas is transported through four miles of pipeline to the landfill gas-to-electricity facility and to the landfill gas-to-vehicle fuel pilot project. The compressed natural gas produced is used to fuel select vehicles in the Sonoma County fleet (County of Sonoma). Humboldt Waste Management Authority collects green waste and 85% is composted at Mad River Compost Facility in Arcata, while the remainder is used as fuel to produce energy at local biomass facilities (HWMA).

Livestock is another significant source of GHG emissions. For example, even as the most-populous county in the region, Sonoma County's 2015 GHG Inventory found that 10% of County's emission were from Livestock and fertilizer – more than the emission from solid waste, off-road transportation, and water and wastewater sectors combined (RCPA). Animal waste digesters are strategy to capture the release of methane. Biogas is created when animal waste decomposes, and as stated by the Environmental Protection Agency, "capturing biogas from cattle, hog, and poultry farms can reduce greenhouse gas emissions and recovering the methane from the biogas can provide a cost-effective source of renewable energy" (EPA).

The North Coast Region should continue exploring innovative ways to capture the release of greenhouse gases from landfills and agriculture.

5 GHG ACCOUNTING FRAMEWORKS

A robust GHG accounting framework is a central element of accurately tracking GHG emission sources and sinks. GHG accounting is an important tool for developing well-targeted GHG action strategies as well as for evaluating the effectiveness of those strategies over time. This section 5 on GHG Accounting Frameworks is excerpted from SERC 2017; tables from the report are not included for brevity but are recommended for consultation to support decision-making.

5.1 EXISTING GHG INVENTORIES & ASSESSMENTS IN THE REGION

Summarized below are GHG assessment methodologies used by various local government entities in the NCRP region. (see Table 5 Appendix A in SERC 2017, http://www.northcoastresourcepartnership.org/resources/). Local government stakeholders are a key group interested in assessing GHG emissions. Over the last two decades regulatory drivers involving greenhouse gas emissions assessments have come into play. For local governments the key areas driving this are California Environmental Quality Act (CEQA) compliance, SB 375 compliance, and the development of local legislation that considers and/or addresses GHG emissions. Mitigation targets motivate GHG emission benchmarking and tracking. Adaptation targets are generally less concerned with quantifying GHG emissions.

In CEQA, §15064.4, §15064.7, and Appendix G are key sections containing language related to determining the significant impacts from GHG emissions. Furthermore, SB 375 has driven direct action by local transportation planning agencies regarding mitigating GHG emissions. Legislative development has been another key driver motivated by state, federal and international momentum. Local governments are increasingly looking to understand GHG emissions in the context of policy development. Furthermore, CEQA also serves a motivating role through §15183.5 which provides guidelines for local jurisdictions on adopting GHG mitigating plans in a way that legally facilitates streamlining the CEQA compliance process.

Overall, while there has been significant early activity in the NCRP region regarding GHG accounting, the substantial outreach and training provided by the Green Communities project in 2012, a partnership between PG&E and ICELI, catalyzed a recent widespread effort by jurisdictions in the region to quantify GHG emissions.

Counties

Sonoma, Mendocino, and Humboldt counties have seen the most local government action in this space, with Sonoma County and the City of Arcata being recognized early leaders. Furthermore, the BAAQMD is the only entity in the NCRP region to issue guidance on GHG emissions significance thresholds for CEQA compliance. The Mendocino AQMD explicitly recommends the use of the BAAQMD significance thresholds, while all other AQMDs in the region do not address significance thresholds. All AQMDs in the region provide some level of guidance regarding models and data sources on their websites.

Humboldt County

Except for the City of Arcata, Humboldt County and jurisdictions recently began actively inventorying GHG emissions due in large part to the proactive and effective Green Communities program implemented by PG&E and ICLEI.

The City of Arcata is an internationally recognized leader in sustainable community planning. Along with the County of Sonoma, the City joined the Cities for Climate Protection Campaign developed by ICLEI. The City completed their first GHG inventory in 2001, followed by an inventory update and a Greenhouse Gas Reduction Plan in 2006, inclusion of GHG reduction goals in their General Plan in 2008, and another inventory update for 2015. The City now works to align their GHG accounting efforts with those pursued by other county jurisdictions through efforts by the Redwood Coast Energy Authority (RCEA).

In 2005 RCEA partnered with the Schatz Energy Research Center in the development of a technical analysis for the Energy Element of the Humboldt County General Plan Update. This report noted greenhouse gas reductions as a motivation for pursuing alternative and renewable energy sources.

More recently jurisdictions in the County have begun pursuing climate action plans. The City of Trinidad developed a draft climate action plan in 2010, and in the same year the City of Fortuna included GHG reduction goals in their General Plan. In 2011 RCEA conducted a GHG Inventory for the Humboldt County Planning Department's draft Climate Action Plan which was released in 2012. In 2012 RCEA partnered with PG&E and ICLEI in the Green Communities program and began conducting GHG Inventories for all jurisdictions in the County. RCEA continues to update GHG inventories for jurisdictions on a regular basis. Recently other jurisdictions in the County have begun pursuing climate action plans.

Mendocino County

Mendocino County has been very proactive regarding the inclusion of GHG reduction in local government planning. The Mendocino Council of Governments has been including GHG reduction as a motivation in transportation planning since 2000. The 2004 City of Ukiah General Plan directly includes reductions in GHGs, two years before the passage of AB 32.

More recently, the 2009 County General Plan specifically discusses GHG reduction goals. In the same year the Ukiah Department of Planning and Building completed a city- wide GHG inventory. The development of climate action plans followed for both the City of Ukiah and City of Fort Bragg in 2012. The Community Development Commission of Mendocino County has been conducting GHG inventories for jurisdictions in the County through a Green Communities partnership with PG&E and ICLEI since 2012.

Sonoma County

The Center for Climate Protection (CCP) in Sonoma County has been conducting GHG Inventories for the County since 2003 after the county joined the Cities for Climate Protection Campaign developed by ICLEI. This campaign included guidance on the development of a GHG Inventory. The CCP continues to use this guidance facilitating consistent tracking and comparison with past inventories even though the methodology is now outdated.

Partly in recognition of the fact that the GHG Inventory methodology space is dynamic, the Sonoma County Water Agency contracted with the CCP in 2010 to assess the current status of GHG tracking and make recommendations for future action. Notably, they partnered with ICLEI Local Governments for Sustainability (ICLEI USA) who developed a GHG Inventory framework specifically for Sonoma County. Shortly thereafter ICLEI released the U.S. Community Protocol based in part on the county-specific framework developed for Sonoma County. Currently the U.S. Community Protocol is used widely for local-scale accounting of emissions.

In 2016 the Regional Climate Protection Authority (RCPA) developed a climate action plan for the county. For this effort RCPA conducted a community-level inventory of the county, the methodology of which differs from that used by CCP, following primarily the ICLEI U.S. Community Protocol.

Private Sector

There has been a global proactive effort within the private sector to quantify GHG emissions and environmental impacts associated with business operations and product supply chains. This has largely been driven by consumer interest via local government and community pressures in recent years. With the release of International Organization for Standardization (ISO) 14000 series standards focused on corporate and product sectors, the success of the Greenhouse Gas Protocol® suite of guidelines and tools, and the development of widely adopted modeling software, private sector accounting of GHG emissions is becoming increasingly common. As important as this background is, a review of activity in this sector within the NCRP region is left for future work.

Non-Government Sector

There has been significant activity around proactively assessing GHG impacts in the non- government sector for decades, likely highly correlated with the significant degree of environmental activism in the NCRP region. A review of this sector is left for future work.

5.2 EXISTING PROTOCOLS, FRAMEWORKS, AND TOOLS

(See Table 3 in SERC 2017, *http://www.northcoastresourcepartnership.org/resources/*)

This section presents a preliminary set of recommendations to can assist an entity in navigating through the myriad options for accounting GHG emissions. Recommendations focus on local government stakeholders but are also relevant to other stakeholder groups.

Community

- Humboldt County Greenhouse Gas Emissions Inventory Tool 31
  - » Developed by the Redwood Coast Energy Authority specifically for assessing community inventories for jurisdictions in Humboldt County.
  - » Based upon the ICLEI U.S. Community Protocol.

  - » Output facilitates reporting to the Statewide Energy Efficiency Collaborative (SEEC) ClearPath California tool.
- ICLEI U.S. Community Protocol: http://icleiusa.org/ghg-protocols/
  - » Offered at no cost to cities and counties.
  - » Development was a collaborative between ICLEI, ILG, LGC, and the California Investor-Owned Utilities. The Climate Registry also contributed to its development.
  - » Integrates with the Statewide Energy Efficiency Collaborative (SEEC) ClearPath California tool that is freely available to, and developed specifically for, local government jurisdictions to facilitate tracking emissions and estimating the mitigation potential of actions that can feed into a climate action plan.
- SEEC ClearPath: http://californiaseec.org/seec-clearpath/
  - » Freely available online tool targeted to local government and Community GHG Inventories.
  - » Facilitates tracking Inventory updates, forecasting future emissions, and visualizing mitigation impact associated with proposed actions.

Organization

- Local Government Operations (LGO) Protocol: http://icleiusa.org/ghg-protocols/
  - » Freely available, and endorsed and used by The Climate Registry, CARB, CAPCOA, and many others.
  - » Widely used in the NCRP region
- EPA Center for Corporate Climate Leadership: https://www.epa.gov/climateleadership
  - » Targeted to the private sector.
  - » Freely available suite of Protocols and Methodologies with a couple high- level tools.
- Greenhouse Gas Protocol® Corporate Accounting Standard: http://ghgprotocol.org/
  - » The Climate Registry assisted in the development of the Greenhouse Gas Protocol Scope 2 Guidance and Corporate Value Chain (Scope 3) Accounting and Reporting Standard.
  - » Freely available and widely used globally
- Energy Star Portfolio Manager: https://portfoliomanager.energystar.gov/
  - » Widely used online tool to benchmark and track energy consumption and GHG emissions of buildings.
  - » Built by the EPA Energy Star program
  - » Freely available

Policy

- California Air Pollution Control Officers Association (CAPCOA) Quantifying Greenhouse Gas Mitigation Measures: http://www.capcoa.org/documents/
  - » Freely available and widely used in California
  - » Highly detailed Protocol and Methodology for quantifying the potential impact of both GHG mitigation policies and actions.
  - » Widely utilized in California and recommended by all air quality districts
  - » The CalEEMod tool fully includes the Methodology from this document
- ICLEI Recycling and Composting Protocol: http://icleiusa.org/ghg-protocols/
  - » Compliments the U.S. Community Protocol, and allows for assessing the net GHG impact associated with recycling and composting efforts in a community.
- Greenhouse Gas Protocol® Policy and Action Standard: http://ghgprotocol.org/
  - » Collaboratively developed internationally, and as such is not focused on any particular geographic region
  - » Applicable to all scales of focus entities or actions from a local policy or project to one of international breadth.

Project

- California Emissions Estimator Model (CalEEMod): http://www.capcoa.org/caleemod/
  - » Developed for CAPCOA and recommended by all air quality districts in the NCRP region
  - » Replaces URBEMIS which many local government entities are familiar with
  - » Designed for assessing compliance with CEQA, NEPA, and local air quality standards
  - » CAPCOA Quantifying Greenhouse Gas Mitigation Measures: http://www.capcoa.org/documents/
  - » See description above

- Bay Area Air Quality Management District (BAAQMD) CEQA Information: http://www.baaqmd.gov/plans-and-climate/california-environmental-quality-act- ceqa
  - The BAAQMD provides extensive and useful information regarding assessing GHG emissions for projects and CEQA compliance.
- CalTrans Standard Environmental Reference (SER): http://www.dot.ca.gov/ser/
  - Provides handbooks of environmental guidance regarding transportation- related projects
  - GHGs are addressed in Volume 1, Chapter 13
  - CARB Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies (SCS) Pursuant to SB 375 [38] and CARB Summary of Off-Model Strategies
- The CARB Description of Methodology provides additional Protocol- level information for MPOs and RTPAs regarding quantifying GHG emissions for Projects related to SB 375 goals and requirements.
  - Significant discretion is left to the practitioner regarding what Methodology to use.
  - The CARB Summary of Off-Model Strategies discusses approaches that other MPOs and RTPAs have taken to quantify the GHG emissions reduction impacts from projects that traditional transportation models are currently not able to quantify, such as ride sharing or intelligent transportation systems.
- CARB Guidance for Projects Funded with Greenhouse Gas Reduction Funds (GGRF): https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/quantification.htm
  - Methodologies developed specifically for projects funded with Greenhouse Gas Reduction Funds which are raised through Cap-and-Trade auction proceeds.
  - Although developed specifically for GGRF-funded projects, can be useful for assessing emissions associated with similar projects. Methods are typically reliant on CalEEMod and CAPCOA Quantifying Greenhouse Gas Mitigation Measures (see above).
- CARB Compliance Offset Protocols: https://www.arb.ca.gov/cc/capandtrade/offsets/offsets.htm
  - Developed by CARB for assessing mitigated emissions for projects to be submitted for compliance under cap-and-trade
  - Can be useful for assessing emissions associated with related projects even if those projects are not pursuing cap-and-trade compliance or credits
- Greenhouse Gas Credit Exchange (GHGRx): http://www.ghgrx.org/
  - Developed by CAPCOA, specific to California
  - Can be useful for assessing emissions associated with related projects even if those projects are not pursuing GHGRx emissions reduction credits
- Protocols from CARB-approved registries: https://www.arb.ca.gov/cc/capandtrade/offsets/registries/registries.htm
  - There are currently three approved registries which are listed on CARB's website, each with their own set of Protocols
  - Can be useful for assessing emissions associated with related projects even if those projects are not pursuing voluntary emissions reduction credits
  - Local AHJ guidance
  - As accounting for GHG impacts for CEQA compliance becomes more common local jurisdictions will be able to offer insight regarding Protocols, Methodologies, and Tools for projects within their local area

5.3 RECOMMENDED INFORMATION SOURCES & EMISSION FACTORS

(See Table 4 in SERC 2017, *http://www.northcoastresourcepartnership.org/resources/*)

Information sources (i.e. data and emissions factors) are ranked using the following ratings:

Best: Emissions factors that are as specific as possible to the focus entity or action are the most ideal. Examples include direct measurements, significant modification based on local data of inputs to a model that generates emissions factors, or emissions factors compiled from data directly applicable to the source or activity. Use this approach only if all of the following apply:

- Emissions factors come from a reputable source,
- It is reasonably expected that the source of the emissions factor is dependable for years to come, and
- The method used to create the emissions factor can, and is expected to, be repeated in the future.

Good: Emission factors that are as specific to the geographic region, entity, or activity being considered in the assessment as possible. For example, an emissions intensity factor of CO2e/sq. ft. of commercial space created from a county-level survey is preferable to one created from a national-level survey.

Fair: Sources to be used if there are no appropriate options rated as Good or Best. Typically these will be generic default or national-level averages. Note that the rating of "Fair" does not refer to the reputability of recommended sources but on how appropriate or ideal they are.

Recommendations are organized into specific categories, where each category is defined by Sector (i.e. direct; e.g. multiple sectors, built environment, transportation, water/wastewater, etc.), or indirect.

Multiple Sectors

There are many data sources that contain information across multiple emissions sectors. Although useful, often multi-sector data sets are not as preferred as sector-specific data sets.

Best:

- CEQA §15364.5
  - » Provides guidance regarding which greenhouse gases to consider

Good:

- CA-specific data in the ICLEI U.S. Community Protocol [15]
  - » Contains detailed data with sources cited that is specific to California energy and mass flows and emissions factors

Fair:

- National-level data in the ICLEI U.S. Community Protocol
- EPA Center for Corporate Climate Leadership GHG Emission Factors Hub: https://www.epa.gov/climateleadership/center-corporate-climate- leadership-ghg-emission-factors-hub
  - » Contains national average emissions factors across a broad range of sectors
- Climate Analysis Indicators Tool (CAIT): http://cait.wri.org/
  - » Contains global emissions data at the national scale
- EPA Clearinghouse for Inventories and Emissions Factors (CHIEF): https://www.epa.gov/chief
  - » Contains detailed criteria and hazardous air pollutant data, including federal compliance and emissions reporting data.

Built Environment

Built environment refers to energy consumption and mass flows associated with the construction and/or operation of stationary infrastructure such as buildings and roads.

Best:

- Local utility or Climate Registry Information System (CRIS): https://cris4.org
  - » Utilize these resources for obtaining emissions factors for utilities that provide electricity. Reporting to CRIS is voluntary so only a handful of utilities can be found in this database.
- CARB Facility GHG Emissions Visualization and Analysis Tool: https://www.arb.ca.gov/ei/tools/ghg_visualization/
  - » Provides geospatial access to GHG emissions reported by all mandated large polluters in California

Good:

- CAPCOA Quantifying Greenhouse Gas Mitigation Measures: http://www.capcoa.org/documents/
  - » Contains detailed emissions factors and cited sources specific to California

Fair

- Emissions & Generation Resource Integrated Database (eGRID): https://www.epa.gov/energy/egrid
  - » Contains sub region grid-scale emissions factors for the electricity sector.
  - » If the Protocol or Methodology being used by the practitioner does not contain guidance on the use of eGRID data, guidance can be found at https://www.epa.gov/sites/production/files/2015- 01/documents/adiem.pdf

Transportation

Best:

- Data and Tools developed by regional AQMD
  - » These include regional transportation models, model data informed by regional data, direct local measurement data, etc. Check with the applicable AQMDs for more information.

- CARB Emissions Factors (EMFAC) Model coupled with custom data input from regional transportation model
  - » The EMFAC model is a tool developed by CARB that estimates emissions from the transportation sector. Advanced use of this tool allows customized data inputs in order to create emissions estimates specific to a particular fleet of any size. Use of EMFAC with default input data is recommended as Good and use with customized inputs is recommended as Best.

Good:

- EMFAC or CT-EMFAC
  - » The use of EMFAC with default data inputs reflects state-wide average on-road vehicle fleet data from the eight municipal planning organizations in the state. CT-EMFAC was developed by CalTrans and UC Davis and provides a simplified interface version of EMFAC targeted specifically at transportation emissions analysis for CEQA conformity.
- CAPCOA Quantifying Greenhouse Gas Mitigation Measures: http://www.capcoa.org/documents/
  - » Contains detailed emissions factors and cited sources specific to California

Fair:

- Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model (GREET): https://greet.es.anl.gov/
  - » This model estimates national average life cycle emissions associated with the transportation sector. It differentiates between direct and indirect emissions. Because the direct emissions reflect national averages it is preferable to use other sources recommended above. However, this is a highly recommended and industry leading resource for estimating indirect emissions for the transportation sector, and as such is rated as Best for the Indirect category.

Water and Wastewater

Best:

- Local data coupled with Methodology-specific guidance
  - » Many Methodologies specify exactly how to calculate emissions from the water and wastewater sectors based on locally collected information. If a Methodology does not provide this guidance, and allows freedom to choose the Methodology, it is recommended that the specified calculations in the U.S. Community Protocol be used to convert local data into emissions estimates.

Good:

- CA-specific data in ICLEI U.S. Community Protocol
  - » This is the same approach as above but using the default data specific to California that is provided in the U.S. Community Protocol. If a Methodology does not provide calculation guidance, and allows freedom to choose the Methodology, it is recommended that the specified calculations in the U.S. Community Protocol be used to convert the CA-specific data into emissions estimates.

Agriculture, Forestry, Other Land Use

An assessment of recommendations for this sector is left for future work.

Indirect

Best:

- Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model (GREET): https://greet.es.anl.gov/
  - » This model estimates national average life cycle emissions associated with the transportation sector. It differentiates between direct and indirect emissions. This is a highly recommended and industry leading resource for estimating indirect emissions for the transportation sector but is recommended as Fair for direct emissions.

5.4 BEST PRACTICES

To be developed under future work. For example, best practices on the following would be valuable:

- How to choose a data source, elaborating on the Best, Good, Fair approach used above.
- Discuss required vs. recommended GHGs as well as near-term climate forcers.
- Discuss challenges with temporal consistency for carbon foot printing, particularly for biogenic emissions, and for Consequential protocols and methodologies.

6 REGIONAL BUILT INFRASTRUCTURE IMPACTS

The 2009 California Statewide Adaptation Strategy report outlines future climate change impacts to infrastructure. The report asserts "the most significant climate impacts

to California's infrastructure are predicted to be from higher temperatures and extreme weather events across the state, reduced and shifting precipitation patterns in Northern California, and sea-level rise. Heavy precipitation and increased runoff during winter months are likely to increase the incidence of floods damaging housing, transportation, wastewater, and energy infrastructure. The largest projected damages will come from sea-level rise threatening large portions of California's coastal transportation, housing, and energy-related infrastructure" (CNRA 2009).

As of today, regional infrastructure already faces challenges. As of 2014, the American Society of Civil Engineers gave Humboldt County a grade of D+ for roads and a grade of C- for bridges (ASCE 2014). Other counties in the region have their share of aging infrastructure. While evaluating projected climate change impacts, an opportunity exists to prioritize projects based on infrastructure already showing signs of deterioration and deficiencies in condition and functionality.

6.1 BROADBAND ACCESS AND INFRASTRUCTURE

Telecommunications infrastructure and services are increasingly important for commercial competitiveness and regional economic growth. Additionally, residents increasingly rely on telecommunication for quality of life, education, research, and access to health care and government services. Improved telecommunications infrastructure also supports public safety and emergency services by improving communications and information availability. Additionally, broadband enables online education and work telecommuting opportunities, reducing the need for vehicle trips. The North Coast region, with its rural nature and dispersed population, lags in providing access to reliable telecommunications services when compared with urban centers such as the San Francisco Bay area.

North Coast communities are so widespread that satellite internet (as opposed to phone line or cable connections) is often the most practical mode for those in outlying areas. However, the landscape can interfere with continuous access. Mountainous terrain, proximity to the Pacific Ocean, deep canyons, and weather events can result in sub-standard connection speed and reliability. For mobile internet users, similar connectivity challenges and sparse infrastructure also results in limited or unreliable service for residents and visitors when traveling through or visiting certain parts of the region.

In urban centers, residents and businesses have more options, including stand-alone and bundled services, and multiple delivery channels such as cable, satellite, microwave, fiber optic, and traditional copper telephone service. Dense populations also result in a healthy competitive marketplace, encouraging affordable pricing models. Additionally, all county libraries offer internet access through use of public computers. Use is timed to ensure equitable access and is only available during hours of operation. In some county libraries and municipalities, free Wi-Fi is available to the public 24-7. However, accessing these internet services requires proximity, which is not always readily available to residents of disadvantaged rural communities who may live and work miles away from public facilities.

Lack of adequate access is a recognized issue in the region: The Broadband Alliance of Mendocino County and the North Bay/ North Coast Broadband Consortium are two organizations working towards equitable broadband access.

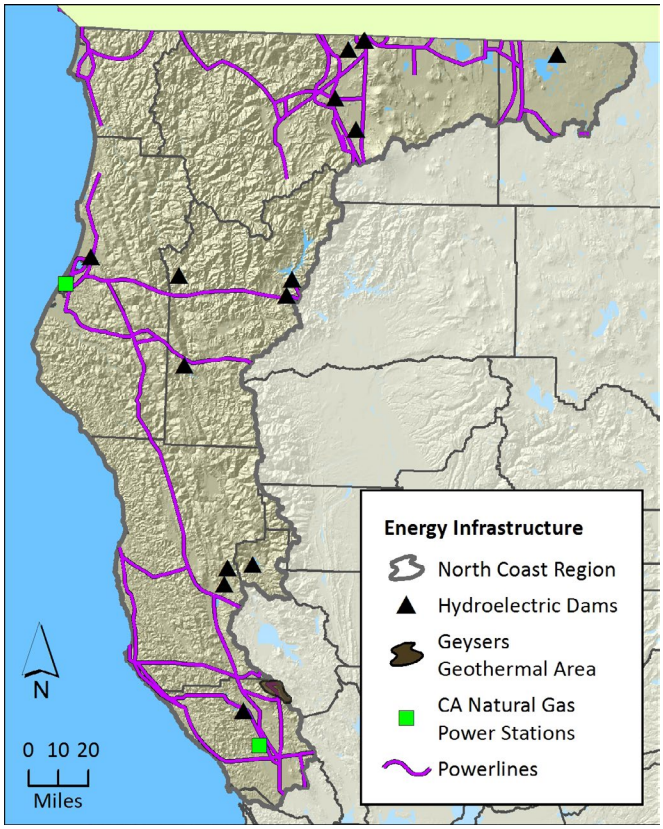
Not only are there issues with the widespread population and challenging topographic conditions, but there are also issues regarding equitable access to broadband service. In both Mendocino and Sonoma County, a digital divide is identified, where areas with a high population density have broadband access, but other portions of the County, its population, visitors, anchor institutions, government services, and transportation corridors are underserved.

In 2014, a $138 million initiative to extend high-speed Internet capacity to about 150,000 rural Northern California households collapsed after nearly three years of negotiations. This new fiber-optic based network would have connected 16 northern counties and provided the anchor for expansion of fast, affordable service. Also, in 2014 a major outage in August interrupted Internet access for three days for a large part of Mendocino County. This type of outage basically puts health care professionals out of business until service is restored, affecting social health and safety. Additionally, loss of Internet capacity slows business for those using the Internet for sales, file storage, and general communication, potentially affecting the local economy.

6.2 ELECTRICITY GENERATION AND TRANSMISSION INFRASTRUCTURE

California Energy Commission believes that California's energy policies will "require substantial increases in the generation of electricity from renewable energy resources. Implementation of these policies will require extensive improvements to California's electric transmission infrastructure" to accommodate for a flexible and responsive network (CEC).

MAP 6 ENERGY INFRASTRUCTURE



Extreme weather events can affect energy demand, impact energy production, and cause potential disruptions to transmission and distribution infrastructure. As outlined by a report from the California Climate Change Center, "potential for disruption of energy supply is particularly high during periods of extreme heat, when energy demand increases (for air conditioning, but also to meet needs such as pumping water for agricultural uses) and energy transmission infrastructure (e.g., transformers) can also be compromised" (California Climate Change Center 2009). When temperatures increase, fossil fuel-burning power plants and transmission lines lose efficiency, which calls for attention to either increase production or improve efficiency (CEC). Temperature increases also adversely affect the efficiency of solar panels.

The North Coast region's renewable energy generation potential can support both local energy security and self-sufficiency as well as providing an important contribution to the large state-level effort to transition off of fossil fuels. However a critical barrier to realizing the potential is in many cases limitation and constraints on the region's electricity transmission and distribution grid. Many sites that could serve as small or medium-size "community-scale" solar projects are limited by the local distribution grid's ability to accept the power, and significant offshore wind energy potential of Humboldt, Del Norte, and Mendocino Counties.

6.3 TRANSPORTATION INFRASTRUCTURE

Throughout the North Coast, communities contend with challenges associated with transportation. The rural nature and widespread geography of North Coast communities facilitated development of roads and highways over non-motorized infrastructure; thus, vehicle transportation is most commonly used for both individual transit and freight transport. However, as concern about GHG emissions and interest in healthy lifestyles and walkable neighborhoods increases, many North Coast communities are planning for and implementing projects that improve public transit and bicycle and pedestrian pathways.

Obtaining sufficient funding for maintenance, repairs, and improvements is a challenge for many North Coast communities. Throughout the region, the condition of some roadways is compromised due to this funding deficit. Additionally, private roads, which have historically been lacking sufficient maintenance, are in various states of repair.

All counties in the North Coast have developed Transportation Plans and many communities have developed Bicycle and Pedestrian Plans. Some also possess airport, rail, and harbor plans. The challenge facing the region is to operate and develop these systems into the future so that they coalesce into a safe, efficient, integrated intermodal system that serves the mobility needs of people and freight while fostering economic growth and development.

The impacts of climate change pose increasing risks to the region's transportation infrastructure. Sea level rise threatens costal roadways in the region along with the associated increases in erosion, as well as the potential impacts from more extreme weather events such as increased risks of flooding. The Humboldt Bay Area Plan Sea Level Rise Vulnerability Assessment identified approximately 38 miles of surface roads vulnerable to tidal inundation by 1.5 meters of sea level rise because of diked shoreline breaching or overtopping, and backwater flooding effects from stormwater runoff (Trinity Associates 2018).

6.4 BUILDINGS

Coastal areas in northern California experience the coolest climate in California with the most heating degree days according to PG&E's guide to California climate zones. Cool, wet winters and cool summers with frequent fog and strong winds make it a climate requiring a lot of heat for comfort with peak demand

in the winter, especially in Humboldt and Mendocino coastal areas. Farther inland, as well as in Siskiyou County, many microclimates exist in the varied geography affected by proximity to the ocean and elevations. Due to this climate, heating days dominate building needs, but some cooling is needed in the summer (PG&E 2006).

With an expected increase in the number and intensity of heating degree and cooling degree days (Cal-Adapt.org), a need exists for buildings to focus on energy management and building maintenance, especially given the region's dependency on heat for comfort.

Increase risk of wildfire is a critical threat to the region's building stock, as evidenced by the devastating 2017 Sonoma County Tubbs fire, which was the most destructive wildfire in California ever recorded, destroying 5,643 structures.

6.5 WATER AND WASTEWATER STORAGE AND CONVEYANCE INFRASTRUCTURE

In almost all instances across the North Coast Region, wastewater collection and treatment systems are owned and operated by local agencies (either cities or special districts). There are some instances where wastewater systems were installed to serve a "company town" containing a lumber or paper mill and the wastewater system is owned and operated by the company. Over time, ownership of the utilities serving company towns has transitioned from private to public ownership as property has changed hands. Many rural residents rely on wells and or Onsite Wastewater Treatment Systems (OWTS) such as septic systems for household wastewater disposal. Many public wastewater treatment plants in the North Coast suffer from aging infrastructure and lack of capacity, which will only be further exasperated by climate change.

One of the central threats to water systems resulting from climate change is sea level rise. Water systems in coastal areas face notable risks as sea levels increase the potential for salt water intrusion and for storm surges and high tides to cause inundation of low-lying areas. There are approximately 52 miles of shoreline on Humboldt Bay that form a barrier protecting nearly 10,000 acres of low-lying areas from tidal inundation, an area that contains amounts of water and wastewater systems and lines along with other critical infrastructure.

Humboldt Community Services District's Truesdale municipal water pump station and inter- tie to the City of Eureka water system, with the potential tidal inundation area by 2070 of 3.3 feet (1.0 M) of sea level rise (Trinity Associates 2018).

Water systems will also continue to be threatened by the drought and extreme weather conditions California. High elevation watersheds, such as ones found throughout Trinity County, tend to store more water in the form of snow with percolation into soils. This natural storage is vital to help maintain consistent stream flows in the drier months. In recent years, the region has experienced several very dry years and very low, sometimes negligible, snowpack (NCR&DC, 5C 2017). Wildfires and the associate erosion impacts also pose an increasing risk to water infrastructure.

6.6 RELATIONSHIPS AMONG BUILT INFRASTRUCTURE SECTORS

According to the California Air Resources Board, in the face of rising temperatures, six economic sectors -- water, energy, transportation, tourism and recreation, agriculture, and public health-- would together incur tens of billions per year in direct costs, even higher indirect costs, and expose trillions of dollars of assets to collateral risk (CARB 2010).

To reduce greenhouse gas emissions, there is a clear push for reducing dependency on oil and natural gas by electrifying transportation and heating in homes. Energy efficiency of systems and appliances becomes increasingly important as electrification increases demand. With transportation being a key source of regional GHG emission it is particularly important to address the electrification of transpiration and the need to develop regional electric vehicle charging infrastructure. The electrification of heating and transportation also increases dependence on transmissions and

distribution systems, furthering the need for systems that can cope with grid power interruptions.

There is a strong connection between water supply and conveyance with energy use. At its core, the water-energy nexus stems from the fact that there is both limited supply and high demand for energy and water. Climate change has forced the water-energy nexus into the forefront (NCRP 2014).

6.7 ECONOMIC AND COMMUNITY IMPACTS OF INFRASTRUCTURE CONDITION

Infrastructure for electricity, transportation, and communication is critical for everyday life and especially for those in rural and hard-to-reach areas. Mitigation funds remain scarce and often directly compete with funds to tackle decaying national infrastructure and increased disaster response costs stemming from climate change (RCEA 2017). Not only is infrastructure already aging, the rugged terrain and dispersed populations in the North Coast Region add an extra challenge to communities who are trying to mitigate their contributions towards climate change. Logistical and technical feasibility of mitigation projects remain challenges, however funding remains the largest hurdle.

Impacts from climate change, specifically wildfires and sea level rise, are not only broad environmental issues but also pose direct, major threats to the safety, quality of life, and economy of the people of the NCRP region. Counties should continue mitigating their contributions to greenhouse gas emissions, while also planning to adapt to the consequences of climate change that the region is already starting to experience.

7 STRATEGIES FOR IMPROVED BUILT INFRASTRUCTURE

To achieve greenhouse gas reductions targets, a diverse mix of strategies must be deployed. California's approach to climate change channels innovation at local and regional levels. The North Coast region can learn from other regions while also creating novel programs.

The North Coast is large and diverse, relative to other portions of the state. Therefore, the approaches and priorities of local counties, Tribal areas, municipalities, and watersheds also vary. There will be no single "one-size-fits-all" solution to climate change and energy capacity; solutions will need to be tailored to local conditions (climatic, financial, ideological, and otherwise). Different strategies are applicable, feasible, warranted, or otherwise appropriate for different jurisdictions. It is up to local entities to evaluate with stakeholders which strategies to implement locally, to satisfy local priorities and in the context of local conditions (NCRP 2014).

7.1 BROADBAND ACCESS AND INFRASTRUCTURE STRATEGIES

Continued collaboration by the Broadband Alliance of Mendocino County, Sonoma County, Redwood Coast Connect, Tribes, and entities such as Community Service Districts (CSDs) will be necessary to develop suitable infrastructure for reliable, complete broadband coverage on the North Coast. SB 1191 expanded CSDs' powers to include broadband service. CSDs can offer an option for broadband service for those communities too small or too remote to interest commercial providers. CSDs are trusted community organizations with billing systems and the administrative support in place to outsource broadband operations. Additionally, CSDs are government agencies that are eligible to apply for many grant funds.

In 2010, the Yurok Tribe used grant funding from the USDA Rural Utilities Service and the California Consumer Protection Agency to bring broadband internet to its communty. The Tribe's Information Services Department developed *A Rural Broadband Model: A Simplified Guide to Rural Broadband Deployment* to assist others through the process. The document provides an example model for replication, equipment needs list, and technology recommendations based on site characteristics. Since its initial foray into broadband provision, the Yurok Tribe has teamed up with the Karuk Tribe to extend high-speed broadband service in Tribal lands.

Transportation contributes significantly to greenhouse gas emissions, especially in rural counties in the North Coast Region, and the ability to access information and

conduct business and educational activities remotely via broadband infrastructure can reduce transportation-related emissions. Developing programs and supporting infrastructure to enable the business and educational use of broadband capabilities can be an effective way of enabling economic development opportunities in rural communities while minimizing GHG emission impacts.

A strategy to reduce transportation-induced emissions is through telecommunications, where broadband-driven applications substitute high-carbon travel for meetings. Caltrans offers teleconference options for its meetings using regional call-in centers to minimize travel. Broadband can also assist commuters with carpool, vanpool, and ride-matching services to reduce vehicle miles traveled and effectively reduce greenhouse gas emissions (CETF). When focusing on transportation applications, broadband is also key to monitoring and operating payment in electric vehicle charging stations.

Another significant opportunity is the increasingly important role of broadband in enabling smart-grid technology, advanced demand-response and energy management strategies, and microgrids and other advanced electricity grid management capabilities. Broadband is vital to maintaining grid communications. Microgrids rely on distributed networks to perform their islanding capability. With the Internet of Things (IoT), consumers are also becoming increasingly dependent on broadband. Advanced sensors and technology, such as smart thermostats, can communicate two-way enabling utility-to-customer energy management. Engaging consumers through these devices is crucial to motivating better energy choices.

The potential to increase energy reliability, efficiency, and resiliency through distributed generation and micrgrids are particularly important strategies for the region's remote areas, but limitations in broadband infrastructure could significantly constrain the opportunity to deploy advance grid management and renewable energy integration solution in rural communities.

7.2 ENERGY GENERATION AND CONVEYANCE INFRASTRUCTURE STRATEGIES

There is a significant opportunity to develop the North Coast Region's energy infrastructure to support climate mitigation at the local, regional, and State level.

Renewable energy generation infrastructure is addressed in Section 8 below; improvements to the electricity distribution and transmission infrastructure systems of the region can play a critical role in the feasibility of fully developing local renewable energy generation. For example, the North Coast has a world-class offshore wind energy resource, however the transmission system serving to coast areas of Del Norte, Humboldt, and Mendocino Counties does not have the capacity to support the full development of that resource. Investment in the transmission system upgrades that are needed should be evaluated and, if feasible, pursued to unlock the significant potential of offshore wind energy on the North Coast.

The development of renewable energy microgrids throughout the region offers the potential to both reduce GHG emissions while also increasing the reliability and resiliency of the electricity grid, particularly for critical infrastructure and other important community facilities. Microgrids integrate on-site generation, storage, and controls systems that increase the resiliency of the grid by allowing sections to remain operational in the event of a larger grid outage. Planning for microgrids should be done as part of a local energy assurance planning effort. Critical facilities should be identified and assessed for microgrid suitability. In addition to providing resiliency, microgrids can also encourage the use of distributed renewable resources, delay expensive transmission upgrades, and provide other ancillary benefits to the grid. During "blue sky" operation microgrids can offer energy cost savings as well as demand response and energy arbitrage opportunities.

The region is already a national leader in microgrid development and deployment. In Humboldt County Schatz Energy Research Center developed an innovative microgrid with Blue Lake Rancheria in 2017 and will work with Redwood Coast Energy Authority and PG&E to develop an upcoming solar microgrid at the Humboldt County's Airport and Coast Guard Air Station.

Figure 33 Blue Lake Rancheria's solar array as part of a microgrid developed with the Schatz Energy Research Center (Blue Lake Rancheria).

7.3 TRANSPORTATION INFRASTRUCTURE STRATEGIES

7.3.1 Alternative Fuels Infrastructure

A comprehensive approach to sustainable transportation includes regulation, incentives, and investment. According to the Governor's 2016 ZEV (zero-emission-vehicle) Action Plan, "The consumer confidence needed to adopt light-duty ZEVs relies in large part on adequate charging and fueling infrastructure." (Governor's Interagency Working Group on Zero-Emission Vehicles 2016). To address this gap in consumer confidence, it is critical for the NCRP region to accelerate the deployment of alternative fueling infrastructure.

Electric vehicle charging infrastructure planning and deployment is ongoing across the region. State and local charging infrastructure planning efforts have identified the need for several thousand public and private charging stations across the North Coast Region to be able to support the region's contribution of State's ambitious goals for electric vehicle adoption. The installation of charging stations across the region is accelerating, though these efforts have been primarily focused in Sonoma, Humboldt, and Mendocino County. The California Energy Commission in 2017 awarded several grants that will support DC fast charging infrastructure along I-5 in Siskiyou County as well as the 101 corridor from Oregon south to Santa Rosa, which will greatly enhance the viability of long-range electric vehicle travel in the region.

In addition to reducing transportation-related fossil fuel consumption, advanced electric vehicle charging infrastructure can support cost-effectively integrating increasing amounts of renewable electricity generation on to the grid. Sonoma Clean Power (SCP) is leading efforts to deploy this kind of advance charging infrastructure with their "Grid Savvy" Program, which provides free wi-fi enable smart charging stations and with financial incentives to customers, who intern allow SCP to adaptively manage charging remotely. SCP can use this capability to help balance the electricity grid and reduce costs by shifting charging to times with there is excess energy on the grid or delaying charging when there is too much demand and the grid is stressed.

While electric vehicles are now a well-established, viable transportation option for consumers, regional stakeholders are also currently working to identify critical anchor sites for hydrogen infrastructure through the North Coast & Upstate Fuel Cell Vehicle Readiness Plan. Leveraging state funds to build hydrogen fueling stations at the sites identified in this plan will enable both local FCEV adoption and travel from areas with currently available hydrogen infrastructure, such as the SF Bay Area.

7.3.2 Multi-modal Transportation Infrastructure

With passenger vehicles being a major source of GHG emissions, a critical mitigation strategy is developing transportation infrastructure to support other modes of travel such as walking, biking, and pubic transit. This can include regional bike path networks, improved transit systems, and walkable and bikable neighborhoods and business districts. Supporting more transportation options also improves equity for the many community members for whom a personal vehicle is not an option (including low-income populations, children, seniors, and those with disabilities).

This strategy is often referred to as a "complete streets" approach, which the National Complete Streets Coalition describes as follows:

> "Streets are a vital part of livable, attractive communities. Everyone, regardless of age, ability, income, race, or ethnicity, ought to have safe, comfortable, and convenient access to community destinations and public places–whether walking, driving, bicycling, or taking public transportation. But too many of our streets are designed only for speeding cars or creeping traffic jams.
>
> "A Complete Streets approach integrates people and place in the planning, design, construction, operation, and maintenance of our transportation networks. This helps to ensure streets are safe for people of all ages and abilities, balance the needs of different modes, and support local land uses, economies, cultures, and natural environments."

While complete streets strategies are most commonly deployed in urban areas, the principles of providing transportation options and making our streetscapes more focused on people rather than cars can be applied successfully in any community. Indeed, the historic character of many of the region's small communities already have many of the targeted design elements, thanks to a foundation of initial planning and building prior to the rise of the automobile.

7.4 BUILDINGS STRATEGIES

Improving energy efficiency in buildings is a key step in reducing emissions while also saving building owners and residents money on bills and reducing the need to build new energy infrastructure. California Energy Commission releases new building energy efficiency standards approximately every three years. The new 2019 Title 24 California Green Building Standards Code (CALGreen) will go into effect January 1, 2020. The standards apply to construction of buildings

resulting in increased energy efficiency and overall less dependence on fossil fuels. Mandatory requirements cover techniques, such as temperature controls for water heaters, limiting air leakage in building envelopes, and high efficiency lighting systems (California Building Standards Commission 2016).

In the North Coast Region, the County of Sonoma has developed a robust Green Building program, which adopted California Green Building Standards Code (CALGreen) establishing requirements for residential and non-residential construction. CALGreen is composed of certain mandatory measures and two tiers of voluntary measures. Local agencies, such as the County Board of Supervisors, have the option of adopting these state-suggested voluntary measures as mandatory requirements at the local level (County of Sonoma).

Ultimately these efforts are pushing toward zero net energy (ZNE) buildings, which through high-efficiency systems and onsite renewable energy generation are able to produce as much energy onsite as they use over the course of the year. California's Long-Term Energy Efficiency Strategic Plan establishes a State-level goal to have all new residential buildings be Zero Net Energy by 2020, and all new commercial buildings be Zero Net Energy beginning in 2030. A range of tools and resource on this topic are available through the California Zero Net Energy Action Plan web portal at www.capath2zne.org .

Although green building is important in reducing the carbon footprint of new construction, the potential for updates to existing construction is of equal or greater importance, especially as building stock ages in the North Coast Region. Other regional programs listed in Section 8 of this report are key to administering and promoting energy retrofits in the North Coast Region.

7.5 WATER AND WASTEWATER STORAGE AND CONVEYANCE INFRASTRUCTURE STRATEGIES

Because of the strong demonstrated link between water and energy, reducing water use results in complimentary reduction energy use and the associated GHG emissions. Water conservation efforts that reduce the use and waste of water, more water-efficient appliances and technologies, and water recycling reclamation efforts that allow for the reuse of wastewater can all also be effective GHG reduction strategies. All of these strategies are being pursued in various ways across the North Coast Region.

In Trinity County, the Raw and Recovered Water for Irrigating Public Agencies program recycles water used to backwash the filtering system at the water treatment plant. The project recovers approximately 150,000 gallons of backwash water per day, which is now used by large irrigation users who previously purchased potable water for irrigation. The new system reduces power consumption and chemical costs for treatment of water (NCRP).

The Covelo Wastewater Facilities Improvement project in Mendocino County made many modifications and improvements to ponds, electrical and control systems, as well as sand filter rehabilitation bringing the facility into compliance with the Regional Water Board Waste Discharge Requirements. Equipment was modernized and failing sections replaced to minimize excess infiltration and protect surface water quality (NCRP).

The Sonoma County Water Agency has received recognition from numerous distinguished organizations for its Carbon Free Water program. The Water Agency contracts to procure 100% of its electricity needs through renewable and carbon free resources, thus achieving a carbon neutral electricity supply to power its system. 93 percent of renewable energy sources are from within Sonoma County. The Water Agency has a dedicated staff member whose main focus is finding grants for not only energy and sustainability projects but for all of the Water Agency's projects and operations (SCWA).

Figure 34 Sonoma County Water Agency achieving Carbon Free Water with solar-powered energy.

Water-saving management practices and technology for the home, agriculture, and industry can enhance the beneficial use of water and should continue to be explored in the region.

8 STRATEGIES FOR ENERGY INDEPENDENCE AND EMISSIONS REDUCTION

Strategies for climate mitigation in the North Coast region are presented in this section. They are organized around energy independence and sustainable energy (8.1), carbon sequestration (8.2).

8.1 ENERGY INDEPENDENCE STRATEGIES

Energy Independence strategies broadly focus on 1) increasing energy efficiency, 2) developing renewable energy resources, and 3) reducing the consumption of carbon-intensive fossil fuels via fuel switching.

8.1.1 Renewable Energy

Key alternative energy sources that reduce GHG emissions in the transportation, heating, and electricity energy sectors are briefly described below, including potential viability in the North Coast region. Also see Section 3.4 Renewable Energy Potential.

Biomass Energy

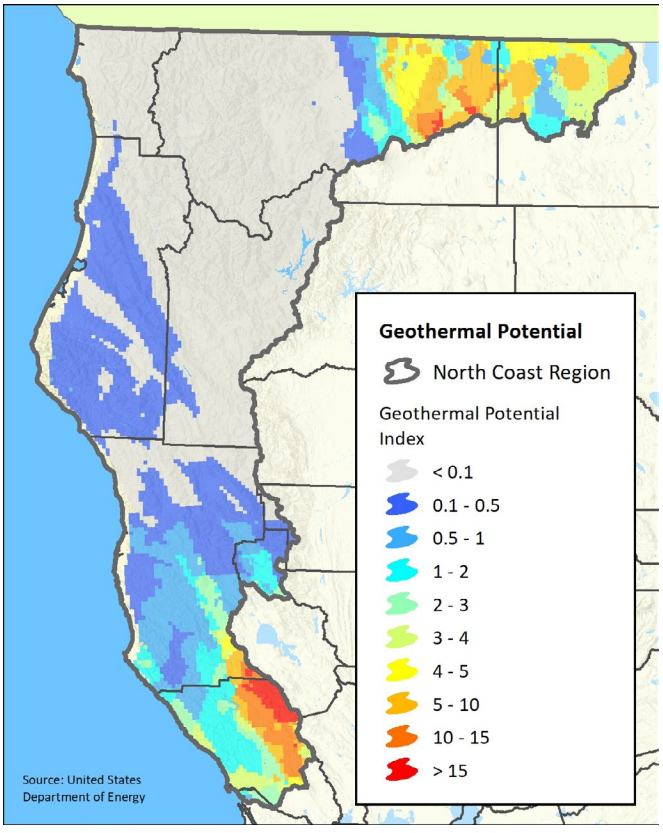
Biomass plants process raw plant and waste materials into useable biofuels like wood or paper pellets. Biomass-sourced fuels are, in theory, more sustainable than fossil fuels because the carbon burned (e.g. wood) is newly removed from the carbon cycle, versus coal or oil that had been sequestered more or less indefinitely. Transporting waste or crop biomass over long distances to large, widely distributed biomass processing plants can overcome its actual value as fuel. It is therefore preferable to collect biomass and process it locally, distributing energy via a network of small biomass plants located strategically throughout the region.

Forest biomass utilization offers many benefits far beyond the energy related benefits: it plays a critical role supporting the responsible disposal of residues from the logging and forest products industries. It is also a pathway to help support forest management practices like thinning and fuel reduction efforts. Because of the many faceted benefits associated with biomass energy, it is recommended that key opportunities in the biomass sector be pursued, particularly in Humboldt, Mendocino, Siskiyou and Trinity Counties. Potential biomass energy projects should include both heating and combined heat and power applications, as well as other higher valued products (densified biomass, biochar, torpified material, etc.). Where viable, other biomass projects should be considered as well, such as biogas for WWTP digesters, animal farm manure digesters, landfill gas, and woody biomass crop residues.

Geothermal Energy

Geothermal energy is power extracted from heat stored deep underground, used to generate electricity and heat to run a variety of industrial, desalination and agricultural applications. The North Coast is home to a portion of the largest geothermal energy plant in world: The Geysers field (in Sonoma and Lake Counties), which claims to produce one-fourth of the "green" energy in the state. Though it appears unlikely that a large-scale power plant such as Geysers could be developed elsewhere, geothermal opportunities exist in the NCRP region, as the practice of using underground heat for energy can be applied at scale of the individual home or business. It may be possible to develop a smaller scale electrical generation or district heating system in Siskiyou or Modoc counties. Feasibility depends on finding adequate resources located in close proximity to a population center where the heat or power could be utilized.

MAP 7 GEOTHERMAL POTENTIAL



Hydroelectric Energy

Hydroelectric energy generation produces no GHG emissions locally and aggressive implementation

could significantly reduce local and global GHG emissions. Traditionally, hydroelectric power generation was dam-and-reservoir and reserved for large-scale applications. The endangered and threatened status of local salmonids; future drought scenarios; and the huge physical infrastructure (and capital) required for building a dam and its hydro facility have dissuaded large infrastructure investment.

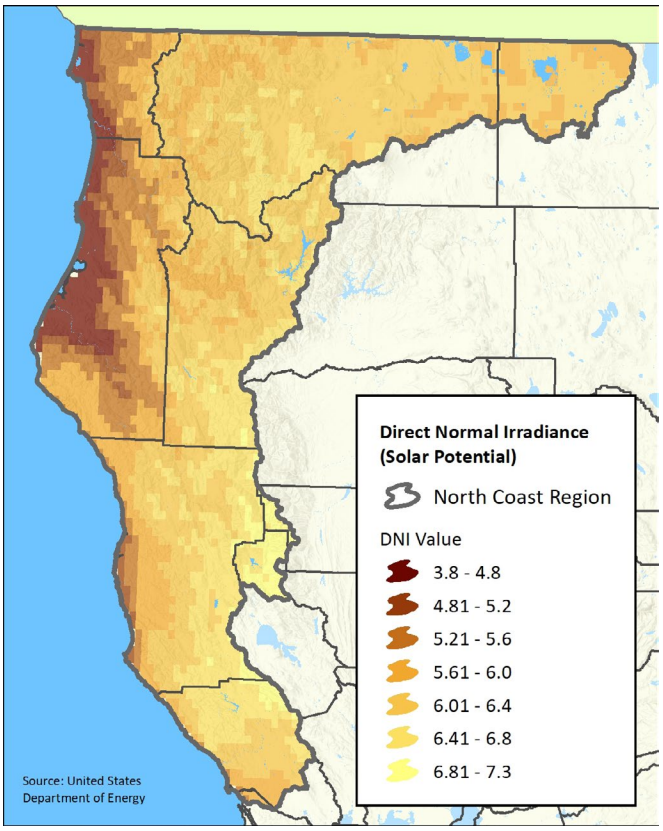
Small-scale hydroelectric power ("micro-hydro"), which generates at a capacity of 30 megawatts or less, has good potential for the North Coast's rural, widely distributed, off-the-grid locations, particularly where other energy sources are not available. Opportunities, while not insubstantial in the region, are likely to face significant challenges regarding feasibility. In some locations, the possibility of drought and endangered or threatened status of local salmonids may make even micro-hydro unattractive, despite its potential to help lower GHG emissions and provide rural electricity. Conduit hydropower opportunities are another possibility, though substantial opportunities are not apparent in the region; nonetheless, these opportunities should be investigated further and potentially pursued if favorable opportunities are identified.

Solar Energy

Solar energy can be captured and used to heat water or produce electricity. Solar power implementation should be pursued throughout the region. Solar power generation is now cost competitive with conventional generation sources. Unused power can be stored in batteries or transmitted via the grid to other electricity customers elsewhere. Solar is the quietest way to generate energy, involves no moving parts, and releases no GHGs at the source (production of PVs and other components utilize energy and emits GHGs, however). While some parts of Siskiyou or Modoc Counties might have adequate solar resources to warrant a large, utility-scale solar power plant, these resources are not near population centers where the power is needed. While power generated could be fed into the electrical transmission system, it seems unlikely that utility-scale solar projects in the region would be competitive with those in other parts of the state.

However, distributed scale solar proves competitive, especially if it is valued at the retail electricity rate via a net metering arrangement. Distributed scale solar opportunities could include larger, community-scale systems that serve groups of customers, or facility level systems that serve one facility (residence, commercial facility, etc.). Distributed solar should be pursued in the NCRP region. Note that both Sonoma Clean Power and Redwood Coast Energy Authority Community Choice Energy Programs are pursuing new solar projects, and smaller distributed scale solar projects are common throughout the region.

MAP 8 DIRECT NORMAL IRRADIANCE (SOLAR POTENTIAL)



Wave Energy

Wave energy is the transport of energy by ocean surface waves, and the capture of the energy for electricity generation, water desalination, water pumping and other work. Theoretically, wave energy releases no GHGs locally and could be a vast source of local, renewable energy. However, currently it is an immature technology. There are concerns about pursuing wave energy facilities (e.g. inevitable saltwater corrosion of infrastructure; the possibility of entangling marine life in mooring lines; underwater noise pollution; and potential interference with local fisheries and fisheries-based economies).

The wave energy resource off the northern California coast is substantial, with Humboldt Bay a particularly well-suited deep-water port that could provide the needed supporting infrastructure for a wave energy project. Wave generation technology is still very much in the research and development stage, but the region should position itself as a prime location for early wave energy demonstration projects in California.

MAP 9 WAVE POWER POTENTIAL

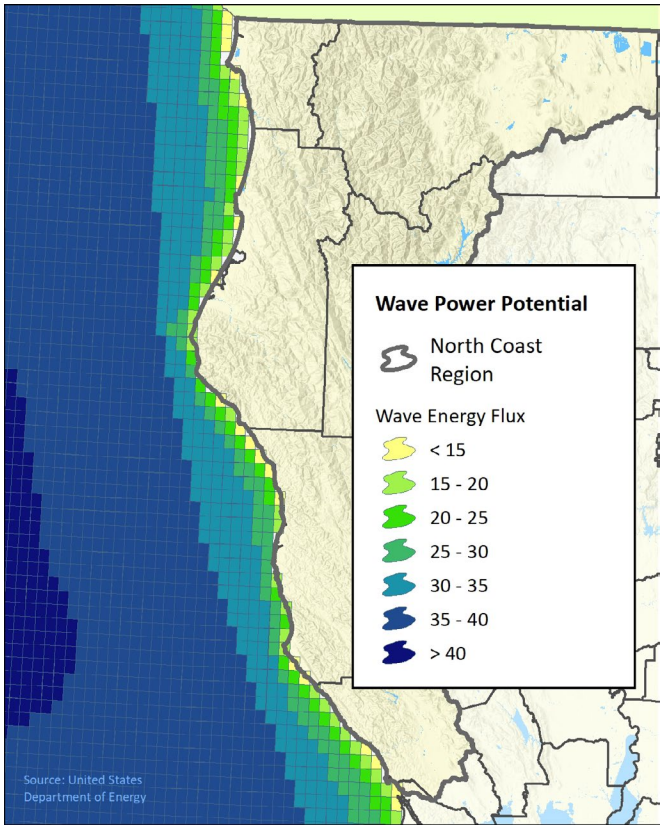


Figure 35 National Renewable Energy Laboratory's illustration of various floating wind turbine structures.

Wind Energy

Wind energy generation is a well-established technology with significant regional potential with numerous opportunities throughout the NCRP region, as several locations exist where commercial scale wind farms could be built. Probably the best known is the Cape Mendocino area in Humboldt County. A project on Bear River Ridge was proposed a few years ago and developer are currently evaluating a new project in the same general area. Other potential onshore wind farm sites include locations in Siskiyou and Modoc Counties, however it is uncertain if these locations would prove feasible. Smaller community-scale wind projects or facility-scale wind projects might prove feasible in the right locations throughout the NCRP region.

Perhaps the best wind resource opportunity in the region is offshore. The floating foundation technology needed to deploy offshore wind turbines in deep waters (like those off the Pacific Coast of California) is just now reaching commercialization. This presents another opportunity (see Wave Energy) for Humboldt County to market the Humboldt Bay deep-water port to support the first deployment of this technology in California.

The Redwood Coast Energy Authority is currently working toward the development of an offshore wind project off the Humboldt Coast in coordination with State and Federal agencies who see the north coast a likely location for the first offshore wind project on the west coast and likely the first floating wind project in North America. While this initial proposed project is being design to fit within the region's transmission grid constraints, to fully develop the regions offshore wind potential will require significant transmissions system upgrades as noted in section 7.

8.1.2 Energy Independence of Buildings

California Assembly Bill 3232 established the goal stating new residential and nonresidential buildings built on or after January 1, 2030, should be zero-greenhouse-gas emission buildings. Zero-emission buildings are buildings with operational parameters that result in zero or negative emissions of greenhouse gases, as measured on an annual basis, when considering the hourly marginal emissions factors from both thermal fuels and electricity at the time when energy is used in the building (California Legislative Information 2018).

The 2019 update to Title 24 building energy efficiency standards will provide tools for local governments to adopt ordinances to achieve zero net energy through reach codes.

A key strategy to achieving energy independence is Net Energy Metering (NEM). Customers who install small solar, wind, biogas, and fuel cell generation facilities to serve all or a portion of onsite electricity needs are eligible for the state's net metering program (CPUC). Pacific Gas and Electric serves most of the North Coast Region and offers NEM programs to reduce customers' monthly electric bills with the energy generated by

their own renewable system. All Community Choice Aggregation programs in the North Coast Region, Sonoma Clean Power and Redwood Coast Energy Authority, offer NEM programs to customers.

8.1.3 Energy Efficiency

Energy efficiency is key to reducing GHG emissions in the NCRP region. California has been at the leading edge of energy efficiency efforts resulting in a long history of efficiency programs throughout California and the NCRP region. State policies (SB 350 and others; see Section 2) require a 50% increase in the savings generated by energy efficiency measures. This will require deep energy efficiency retrofits that go beyond simple equipment replacement (e.g., replacing inefficient incandescent light bulbs with more efficient LEDs).

Deep energy efficiency retrofit programs should look holistically at building energy use and should be based on actual measured energy savings. There are currently many energy efficiency programs that operate in the NCRP region; however there is still untapped potential to enhance and expand these programs. This can include a focus on "integrated demand-side management" which goes beyond technology retrofits and includes demand response and load shifting strategies to support the cost-effective and efficient operation both at the facility level as well as for the management of the overall utility grid.

Geo-Exchange

A geo-exchange system is a central heating and/or air-cooling system that actively pumps heat to or from the shallow ground several meters deep, where temperatures remain moderate all year. One barrier to employing geo-exchange is high up-front cost, but the difference can be made up in energy cost savings in three to ten years. In Sonoma County, the Sonoma County Water Agency is studying the feasibility of using recycled water to heat and cool buildings using geo-exchange principles in a project called the Regional Geo-Exchange Energy Efficiency Project9.

Micro-Cogeneration

Cogeneration is the principle of capturing and using the waste heat emitted by heat engines powering other energy applications. Micro-cogeneration, also called micro combined heat and power (microCHP), is an extension of cogeneration to the scale of the home or small building and is used to heat water or spaces and produce electricity. Micro-cogeneration systems use conventional (natural gas) or alternative (biomass or fuel cells) fuels to power engines and turbines so a system's operation is only as "green" as its power supply.

8.1.4 Fuel Switching in the Heating Sector

Under the right circumstances, fuel switching in the heating sector can save money and reduce greenhouse gas emissions. The most economically viable opportunity is to convert propane or fuel oil users over to electric heat pumps. Data should be collected to help determine the potential size of this market and to assess the opportunity in more detail. If the market is of sufficient size and the economic and GHG reduction opportunity is compelling enough, serious consideration should be given to creating a promotional program. However, the key obstacle is identifying the owner and implementer of such program. While an electric utility provider would typically handle such a program, it may be difficult to get PG&E or PP&L to develop such a program. However, a municipal utility could easily take it on, or if a CCA were serving the entire NCRP region they could offer such a program.

8.1.5 Distributed Generation

California Energy Commission defines distributed generation projects as "20 megawatts or smaller-including both self-generation and projects that do not directly serve a home or business and are interconnected 'in front of the meter' to generate energy to be sold to load-serving entities or on the wholesale market. Self-generation is defined as distributed generation systems installed at a utility customer's facility, business, or home. These systems serve primarily on-site load or export excess power back to the grid through net-energy metering" (CEC).

Parts of the North Coast Region are divided by numerous mountainous regions and extensive river systems. This rugged terrain requires distributed assets, especially distributed generation, which would allow autonomous operation in more isolated communities in case of damaged central generation or transmission lines. In many North Coast Region areas there are very limited transmission line connections to the larger statewide electric grid. Focusing on smaller, distributed sources of renewable energy generation, coupled with other microgrid technology components as described in section 7, allows for adaptation in emergency situations while also decreasing everyday dependence on fossil fuels that provide electricity to the central grid.

8.1.6 Low-carbon Transportation

Alternative fuels refers to vehicles that run on a fuel other than conventional petroleum fuels like gasoline and diesel. Replacement of conventional vehicles with low-

9 Regional Geo-exchange Energy Efficiency Project at http://scwa2.computer-grafixco.com/eNews/index.asp?issue=1/1/2009&campaign=Enews&article=2029

or zero-emission vehicles would have the potential to significantly reduce GHG emissions locally and globally.

Plug-in electric vehicle (PEV) drivers have the ability to easily charge vehicles at home during the night, taking advantage of off-peak electricity rates. To encourage modes of non-fossil fuel transportation, Sonoma Clean Power's Drive EverGreen program pays for the cost of home charging equipment for PEVs. Once customers have charging equipment installed, they are also encouraged to buy Sonoma Clean Power's 100% local, renewable electricity option to lower personal GHG emissions (SCP 2018).

Another emerging technology is hydrogen fuel cell electric vehicles, which create electricity from a chemical reaction, not combustion. Currently, there are no commercial hydrogen fueling stations in the North Coast Region.

In addition to building alternative fuel infrastructure, continued implementation of supporting activities called for in regional readiness plans is critical to accelerating adoption. For example, the North Coast Plug-in Electric Vehicle Readiness Plan identifies the follow supporting activities as necessary to facilitate EV adoption (RCEA 2014):

- Engage with regional permitting entities to encourage the adoption of standardized and streamlined permitting and inspection processes and fee structures.
- Produce a streamlined set of EVCS criteria to assist potential EVCS owners/operators in choosing what equipment to install and to assist contractors with adopting best practices and understanding regional permitting requirements.
- Engage with potential site hosts for EVCS in the North Coast Region and produce preliminary engineering designs and cost estimates for 30-40 sites.
- Install directional signage guiding drivers to at least 10 regional EVCS.
- Promote PEV adoption through public and fleet operator outreach and education campaigns.
- Educate and support regional municipalities on the potential to adopt local building codes that promote PEV adoption.

In addition to the technological solutions provided by alternative fuel vehicles, developing programs and incentives that facilitate and support walking, biking, and public transportation use can be key local, community-scale GHG-reduction strategies.

8.1.7 Land Use and Zoning

The Environmental Protection Agency's Smart Growth development principals helps communities develop while benefitting the economy, environment, and public health. Development principles in urban and rural areas have similarities, such as mixing land use, taking advantage of compact design, encouraging stakeholder collaboration, and preserving farmland, natural beauty, and critical environmental areas.

The EPA's *Essential Smart Growth Fixes for Rural Planning, Zoning, and Development Codes* outlines the importance of determining areas for growth and for preservation, using cluster development, and encouraging right-size rural roads to protect pedestrian and bike traffic. Counties have the opportunity to reduce greenhouse gas emissions with zoning by reusing existing structures for mixed use development and offering transportation choices other than driving, such as walking and bicycling (EPA).

While infill projects and transit-oriented development are often considered urban planning strategies, adapting these principles in rural areas can help reduce GHG emissions, maintain the rural and historic character of regional small cities and towns, and created more livable and accessible communities (which is often of most important to disadvantaged populations and well as the increasing percentage of senior citizens).

Zoning for the development of renewable energy is also important to energy independence and reduction of greenhouse gas emissions- "The County of Sonoma has adopted changes to its zoning code that enable the construction and use of renewable energy facilities throughout the county, while protecting sensitive resources and ensuring neighborhood compatibility" (Sonoma County Permit and Resource Management Department).

8.1.8 Community Choice Aggregation and Public Power

Assembly Bill 117 codified Community Choice Aggregation (CCA; also often referred to as community choice energy) in California, which grant local governments and communities a more direct role in energy resource planning, determining the types of power generation technologies used to meet their electricity requirements, setting rates for generation services, and implementing local programs for energy efficiency, distributed generation, and other energy-related programs. The incumbent investor-owned utility continues to own and operated the grid and provide customer service and billing.

CCA programs and other public power providers can directly benefit local communities by empowering them

to decide where their energy comes from and by allowing them to develop local programs that increase energy efficiency and local renewable energy procurement.

Through the spread of Community Choice Aggregation, combined with the existing service territories of the region's pubic utility districts, the majority of the population in the NCRP region is now served but local, not-for-profit public power agencies that provide local control over the sources and prices of the electricity customers purchase. Sonoma Clean Power's CCA program now serves both Sonoma and Mendocino County and the Redwood Coast Energy Authority's CCA serves all of Humboldt County These agencies join the region's existing public power providers of Trinity County PUD, the City of Ukiah and the City of Healdburg.

Del Norte, Siskiyou, and Modoc counties are served by Pacific Power (an investor-owned utility) and do not currently have CCA program, but are eligible to establish a CCA or join an existing program. The Counties and the cities within them may want to evaluate CCA as option to increase local control over electricity supply and costs.

8.1.9 Community Equity

Strategies that can be employed to promote community equity (i.e. social equity and social justice) in energy policy include:

- Ensure that energy programs serve all populations irrespective of income, race, color, ethnicity, or any other discerning demographic characteristic. Ensure access to clean and sustainable energy options to all demographic populations, including low-income populations, renters and those who use public transportation.
- Make sure all communities, irrespective of any discerning demographic characteristics, have equal input into energy decisions, including where energy generation projects are sited, and which types of technologies are chosen.
- Promote decentralized, community-based renewable energy generation and demand reduction.
- Create community-based energy programs and ownership structures, such as Community Choice Aggregation, community renewable energy projects, cooperatives, and nonprofit financing and revenue-sharing models where local stakeholders and community members can have a greater opportunity to participate in energy projects and affect energy related decisions.
- Promote equal distribution of social costs and benefits of energy programs and projects.
- Promote clean and environmentally friendly energy projects that do not degrade the communities they are located in.
- Offer energy job skills trainings so that workers within the local communities where energy projects are located can benefit from the jobs created.

GRID Alternatives offers an example of climate action strategies that also address community equity concerns. An internationally-active non-profit with a North Coast Regional office in Willits, GRID Alternatives is brings together community partners, volunteers and job trainees to implement solar power and energy efficiency for low-income families, providing energy cost savings, valuable hands-on experience, and a source of clean, local energy that benefits the broader community and environment (https://gridalternatives.org).

8.1.10 Policy and Financing

In July 2008, Assembly Bill 811 was approved, which allows property owners to enter contractual assessments to finance the installation of distributed generation renewable energy sources or energy efficiency improvements that are permanently fixed to existing homes and businesses. Property Assessed Clean Energy is an innovative mechanism for financing energy efficiency and renewable energy improvements, where property owners finance the up-front cost of energy improvements on a property and then pay the costs back over time through a voluntary assessment. The County of Sonoma developed the Sonoma County Energy Independence Program, which guides commercial and residential buildings through funding mechanisms, such as Property Assessed Clean Energy, rebates, and other incentives (Sonoma County Energy Independence Program).

Sonoma County was an early pioneer of PACE financing with the highly-successful Sonoma Energy Independence Program. Building off of Sonoma's model, numerous state-wide PACE programs have now been established and are available for local governments to join to be able to offer PACE financing in their jurisdictions, with all counties in the region except Trinity now making one or more PACE programs available to their communities.

8.1.11 Next Steps

To drive continued development of energy independence in the North Coast region, it is recommended that following strategies be integrated into future NCRP planning/ implementation.

- Develop a vision statement with broad goals and objectives and a corresponding strategic energy plan for the NCRP region. Allow for flexibility across the region,

acknowledging that different jurisdictions may have different goals and objectives.

- Identify the highest-value and most feasible renewable energy opportunities. These research efforts should then feed into the development of a regional strategic energy plan.
- Consider using NCRP to provide coordinated energy services to the entire region. Most important is to find a way to meet the needs of those communities that are not currently adequately served. Look for ways to replicate existing programs that have already proved successful in the region.
- Pursue regional funding for energy planning and program and project development.
- Pursue development of demonstration projects that can be replicated.
- Pursue research and development opportunities where special assets in the region distinguish and even favor local project development. For example, the tremendous offshore wind energy potential and the asset of a deep-water port in Humboldt Bay make Humboldt County rather well suited to wind energy research and/or demonstration. A similar argument can be made for wave power.

8.2 CARBON SEQUESTRATION & EMISSIONS AVOIDANCE STRATEGIES

The following section outlines strategies to increase sequestered carbon and greenhouse gas emissions.

8.2.1 Mechanisms for Retaining Carbon in Natural Areas and Working Lands

Carbon sequestration is a collection of techniques for the capture and long-term storage of carbon dioxide, charcoal, or other forms of carbon using combinations of biological, physical, or chemical processes. Natural biological processes that sequester carbon include ocean mixing, photosynthesis and soil sequestration. Since plants and soils naturally absorb carbon dioxide, preventing outright deforestation and managing forests and agricultural lands as carbon sinks can remove significant amounts of GHGs. If large-scale algae farms become viable, they would also act as biological carbon sinks.

It is well-established that forest conservation and management of forests as carbon sinks and to prevent catastrophic wildfires can be a viable strategy to reduce GHGs and the impacts of future climate change. The Forest Investment Zones program is funded by the non-profit US Endowment for Forestry and Communities and is California's first county-wide energy efficiency financing district, authorized by AB 811.

Enhancing resiliency of forests to wildfire and pests is generally achieved by removing biomass that historically and naturally was removed by more frequent wildfire. Investments in fuel reduction help to ward off large scale losses of biomass from wildfire. The material removed can be used to produce energy while displacing energy production from fossil fuels and can be used as feedstock for innovative wood products, such as cross laminated timber, which will increase the proportion of carbon in long-lived wood products.

8.2.2 Auction Proceeds as a Mechanism for Funding

To accomplish the goals of Assembly Bill 32, a cap-and-trade program was established, which mandates an upper limit on the amount of carbon that can be released into the atmosphere in each year. AB 32 provides two potential revenue streams through the carbon permitting process: the first is an investment program, which uses revenue generated through carbon credit auctions to fund projects that reduce GHG emissions. In 2016, approximately 51 percent of permits were sold and generated revenue for the state to invest in GHG reduction projects. The other revenue stream arises from regulated entities that can meet up to 8 percent of their compliance obligations through offsets around the United States (ECONorthwest 2017).

Agencies in the North Coast Region can apply for program grants through AB 32 auction revenues. Programs funded by cap-and-trade range include dairy digesters, organics and recycling programs, forestry health, and sustainable communities. The specific amount of funding available for priorities varies over time, and total program funding in the future is somewhat uncertain, though it is unlikely to disappear in the foreseeable future (ECONorthwest 2017).

Regional entities can work together to access Cap and Trade auction proceeds and other State funding mechanisms to ensure effective, efficient, coordinated, and equitable resource allocation in the North Coast Region.

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- Estimate of carbon released from wildfire
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- Energy production requires water; water production requires energy

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- Regional energy profile (production, consumption, infrastructure, renewable potential)
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- Recommended data, tools, frameworks, and protocols for doing a local-specific GHG inventory/assessment

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- Recommends biomass energy for reducing GHG emissions
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