THIRD WAY

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Interactive Maps Decarb America

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Energy Infrastructure Needs for a Net-Zero Economy. The United States is a world leader in developing the new, low-carbon technologies and innovative infrastructure solutions that will be needed to effectively mitigate and manage the worst effects of climate change. However, Decarb America modeling of net-zero pathways shows that the United States must speed up the deployment of new clean energy production, transmission, and transportation technologies and associated infrastructure to meet deep decarbonization targets in time. This is both an enormous challenge and an opportunity to create jobs, grow the economy, and position American companies to supply the growing global market for climate-friendly energy alternatives. Deploying this technology at the scale required will also require the ability to site a large number of clean energy projects throughout the nation at an unprecedented rate.

Check out the opportunities in your state across 12 infrastructure categories in the interactive maps below. All maps show results from nine scenarios: 1) Reference Case, 2) Sectoral Policies, 3) High

Renewables/High Electrification, 4) Constrained Renewables, 5) Slow Consumer Adoption, 6) Constrained Renewables + Slow Consumer Adoption, 7) High Conservation, 8) Low Biomass, and 9) No Fossil. More details on these cases are available on the Scenarios webpage.

Onshore Wind

- This map shows the buildout of onshore wind compatible with reaching net-zero emissions by 2050 in five-year increments. Interactive features show this deployment broken down into existing facilities as well as techno-resource groups (TRGs) that demonstrate the resource potential and capacity factor for different wind facilities. TRGs 1-3 represent high-quality wind resource areas; TRGs 4-6 represent medium-quality wind resource areas; and 7-10 represent low quality wind resource areas. These resource groups follow NREL Annual Technology Baseline characterization for resource quality.

- Onshore wind grows most significantly in the Mid-Continent where states have high-quality wind resources. Texas remains the largest producer of onshore wind, in most cases generating more than three times the amount of wind as the next closest states, Kansas and Oklahoma. We constrain the potential of onshore wind development by different amounts for various scenarios to acknowledge land use constraints, siting challenges, or other societal factors.

Offshore Wind

- This map shows the buildout of offshore wind compatible with reaching net-zero emissions by 2050 in five-year increments. Interactive features reveal a breakdown of floating and fixed-bottom deployment. Fixed-bottom turbines, most commonly used today, are built into the sea-floor and are therefore limited by the depth of the water. Floating turbines are not as limited by water depth, allowing them to be sited where there is higher-quality wind. Researchers are developing multiple designs for floating turbines to withstand high winds and large waves.

- We see significant growth of offshore wind along the east coast, especially in North Carolina. Opportunity on the east coast is greater than on the west coast because of resource quality as well as the fact that the ocean depth increases rapidly in the Pacific, limiting opportunities for fixed-bottom offshore wind. The Great Lakes region also sees a large increase in offshore wind, assuming developers are able to overcome technical and siting challenges. Without the availability of this offshore wind in the Great Lakes region, states would need to turn to lower quality solar resources or replace the energy from offshore wind with resources like nuclear or gas with carbon capture.

Solar

- This map shows the buildout of solar compatible with reaching net-zero emissions by 2050 in five-year increments. Interactive features show this deployment broken down into rooftop and utility-scale. Utility-scale solar is cheaper and can provide higher capacity factors and economics of scale. While rooftop solar costs more than utility-scale solar, it offers benefits in reliability, customer choice, and location, as well as the potential to avoid some distribution costs (though these benefits were not assessed in our modeling).

- We see a large increase in solar everywhere, with solar playing some role in every region as capital costs continue to decline, overcoming any barriers due to low resource quality.

Nuclear

- This map shows the buildout of nuclear energy compatible with reaching net-zero emissions by 2050 in five-year increments. Interactive features show resources broken down into existing and new. Existing nuclear consists of all our large light water reactors and represents reactors that are relicensed up to an eighty-year useful life. New nuclear comprises all advanced nuclear technologies. We do not project any new large light-water reactors.

- Strong policy support for nuclear ensures existing reactors are not shut down prematurely, which is an essential component for reaching net-zero emissions by 2050. We do see a slight decrease in existing nuclear power as some of the fleet retires naturally. The development of new nuclear power occurs in states that are resource-constrained compared to others, like Florida and New York which have limited onshore and high-quality offshore wind potential. Different technology costs may increase the competitiveness of new nuclear power, which is explored in our Nuclear Innovation Case coming soon.

Energy Storage

- This map shows the buildout of energy storage compatible with reaching net-zero emissions by 2050 in five year increments. Interactive features show both capacity (in gigawatts [GW]) and energy (gigawatt-hours [GWh]) further broken down into utility-scale lithium-ion, long-duration storage, and pumped hydro.

- The growth of energy storage closely follows the growth of solar. We find that areas with high wind energy development tend to deploy more electrolysis to produce hydrogen from any overgeneration of electricity. The energy storage technology we see deployed most often with solar is lithium-ion with durations matching the expected period of solar overgeneration in the middle of the day (~8 hours). Pumped hydro storage represents existing facilities already constructed. There may be opportunities for new cost-effective pumped hydro, but opportunities are site-specific and difficult to represent in this national modeling exercise. Our results find that long duration storage is not deployed economically in significant quantities; instead, gas power plants using zero-carbon fuels provide the bulk of reliability services.

Hydrogen Production

- This map shows the production of hydrogen compatible with reaching net-zero emissions by 2050 in five-year increments. Interactive features show hydrogen production further broken down into production from electrolysis (green hydrogen), bioenergy with carbon capture and storage (also green hydrogen), and gas reformation with carbon capture (blue hydrogen).

- Today, the U.S. only produces hydrogen through gas reformation (grey hydrogen), mainly in Texas and Louisiana, to provide feedstocks for the chemical and petroleum refinery industries. As we approach 2050, almost all hydrogen produced from gas reformation includes the use of carbon capture. We also see significant new green hydrogen production either using wind capacity in the Midwest to produce hydrogen through electrolysis or from the use of biomass in the South and Midwest.

Hydrogen End-Use

- This map shows the end-use of hydrogen compatible with reaching net-zero emissions by 2050 in five year increments. Interactive features show hydrogen end-use further broken down into end-use of bulk chemicals, domestic shipping, freight rail, heavy duty trucks, international shipping, medium duty trucks, and other industries.

- As the innovation and production of hydrogen increases, so does the opportunity to use hydrogen across sectors, especially hard-to-decarbonize subsectors. We currently use hydrogen exclusively for bulk chemicals and that end-use will continue in the clean energy economy. The other significant end-use of hydrogen as we reach net-zero emissions is heavy duty trucks. Hydrogen is also used in other modes of transportation and parts of industry, all across the country. One implication of this will be the need for alternative fueling stations along major highways as well as the deployment of additional transport and storage facilities for hydrogen.

Biomass

- This map shows the buildout of biomass compatible with reaching net-zero emissions by 2050 in five year increments. Interactive features show biomass further broken down into corn, herbaceous, waste, and woody biomass. Total biomass use declines in the early years with decreasing gasoline consumption (and reduced use of corn for ethanol production) before increasing in the later years with the increased demand for zero-carbon fuels.

Zero-Carbon Fuels & Biofuels

- This map shows the buildout of zero-carbon fuels and biofuels potentially compatible with reaching net-zero emissions by 2050 in five year increments. Interactive features show zero-carbon fuels and biofuels further broken down into ammonia, biogas with carbon capture, corn ethanol, corn ethanol with carbon capture, Fischer–Tropsch diesel, Fischer–Tropsch diesel with carbon capture, and synthetic hydrocarbon.

- Corn ethanol is the main biofuel used today. As we approach 2050, we see new zero-carbon fuel and biofuels industries emerging with ammonia, biogas and F-T diesel with carbon capture, and synthetic hydrocarbons. Electric fuels (i.e., with a feedstock of electrolyzed hydrogen) are located in areas with an abundance of wind like the Midwest. Fuels using blue hydrogen (natural gas with carbon capture) are located in areas with cheaper natural gas and the availability of geologic sequestration. Fuels that use biomass as a feedstock are primarily located in the Midwest and Southeast.

Carbon Dioxide Pipelines

- This map shows the buildout of carbon dioxide pipelines in tonnes per year (TPY) compatible with reaching net-zero emissions by 2050 in five year increments. Initial pipeline deployment expands off the intrastate-network of CO2 pipelines used for enhanced oil recovery in Texas and the Southwest. By 2045, a network of large trunk-lines enables smaller feeder lines to connect areas with large-scale ethanol production (i.e., the Midwest) to areas with enhanced oil recovery opportunities and potential for geologic storage or utilization in industrial products like cement or chemicals. In the longer term, inter-state pipelines tend to move CO2 from areas with high amounts of biomass or areas with significant amounts of wind (to power direct air capture facilities).

Carbon Capture

- This map shows the buildout of carbon capture facilities compatible with reaching net-zero emissions by 2050 in five-year increments. Interactive features show the deployment of carbon capture across the economy in biofuels, hydrogen production, power, industry, and direct air capture facilities.

- For carbon capture on existing heavy industry, deployment is found in states with these industries today. When the source of carbon is natural gas, capture facilities are found at the confluence of natural gas production and geologic sequestration sites, with a heavy concentration in the Gulf Coast. Capture on biofuels is found primarily in the Midwest and Southeast. Capture in the power sector is generally found in areas with more limited access to renewable resources, specifically wind (California and Florida as primary examples). Direct air capture facilities are located where there are significant wind resources that can be used to power them at low costs.

Electric Vehicles

- This map shows the buildout of electric vehicles compatible with reaching net-zero emissions by 2050 in five-year increments. Interactive features reveal the share of vehicles of each type (light-duty autos, light-duty trucks, heavy-duty vehicles, medium-duty vehicles, transit buses) that are electrified in terms of vehicle sales (i.e., vehicles purchased in a year) as well vehicle stocks (i.e., vehicles on the road in that year).