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OPTIONALITY, FLEXIBILITY, & INNOVATION: PATHWAYS FOR DEEP DECARBONIZATION IN CALIFORNIA

The Energy Futures Initiative report “Optionality, Flexibility & Innovation: Pathways for Deep Decarbonization in California,” analyzes ways the state can meet its aggressive 2030 low-carbon energy goals and outlines the innovation agenda needed for mid-century deep decarbonization.

The report team, led by EFI founder and CEO Ernest J. Moniz, conducted a modeling-informed analysis that included a top-down assessment of California’s deep decarbonization, as well as multiple bottom-up models that approximated how various technologies can contribute to the reduction of emissions.



Professor Moniz, who served as the 13th U.S. Secretary of Energy, is also an Emerson Collective Distinguished Fellow.

California has committed to reduce its greenhouse gas emissions to 80% or more below 1990 levels by 2050, with an ambitious interim target of 40% below 1990 levels by 2030.

- Meeting California’s carbon reduction goals by 2030 will require a range of clean energy pathways across all economic sectors—Electricity, Transportation, Industry, Buildings and Agriculture.
- California needs a major effort to achieve deep decarbonization by midcentury, in line with the 2018 SB 100 legislation, which mandates net zero emissions electricity by 2045. Energy efficiency, defined broadly, is likely to be the most cost-effective approach to decarbonization in the energy end-use sectors in California.
- California’s decarbonization policy focus on the Electricity sector is important because it is both a source of emissions (16% of statewide emissions in 2016) and can play a critical role in supporting the decarbonization of all end-use sectors.
- Transportation accounted for 39% of the state’s emission in 2016, making it the single largest emitting sector in California. There needs to be transformational change to achieve aggressive decarbonization by 2030.

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- More than 950,000 Californians are employed in energy jobs, making the sector a key part of the state's economy. The state's energy transformation must take place with as little disruption to essential services (light, heat, mobility, electricity, etc.) and operate reliably at all times.
- Clean fuels (e.g., renewable natural gas (RNG), hydrogen, biofuels) are critical clean energy pathways due to the enormous value of fuels to flexible operations of energy systems.
- California can meet its 60% RPS target by 2030 with continued expansion of wind (both onshore and offshore) and solar resources; some geothermal and increased imports of clean electricity (mostly hydro) will play a role, as well.
- Natural gas generation will continue to play the key role in providing California's electric grid with operational flexibility and enabling the growth and integration of intermittent renewables. Natural gas-fired generation provides key load following services.
- There are several cross-cutting technologies or classes of technologies that can help meet the large-scale decarbonization needs for several economic sectors. These include technologies for: large-scale carbon management (LSCM); hydrogen applications; leveraging carbon infrastructure and expertise, and smart systems and platforms.
- Energy system "boundary conditions," including considerable system inertia that works against rapid change, complex supply chains, long-duration of technology development, and commodity business models must be taken into consideration when developing decarbonization strategies.
- Existing carbon infrastructure and expertise must be aligned with deep decarbonization goals.
- Transportation, Industry/Manufacturing and Agriculture -- some of the hardest sectors to decarbonize -- account for 70% of the state's emissions.
- Advances in energy storage are key to increasing the role of intermittent energy sources. Seasonal storage technologies will be critical as California moves toward its deep decarbonization goals midcentury.
- There is no "silver bullet" technology for deep decarbonization. Technology optionality and flexibility are critical to any decarbonization strategy, especially for the difficult-to-decarbonize sectors.
- This analysis identified a portfolio of 31 clean energy pathways that cover all economic sectors in California.

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- The study identified key technology innovation areas that need to be pursued aggressively, including:
 - ▶ Renewable generation technologies
 - ▶ Energy Efficiency
 - ▶ Hydrogen
 - ▶ Carbon Management (Direct Air Capture & CCUS)
 - ▶ Seasonal Storage
 - ▶ Renewable Natural Gas/Biogas
 - ▶ Electrification & Fuel Switching
 - ▶ Smart Systems & Other Platform Technologies

- A successful transition of California's energy economy will include many "exportable" policy elements that can be adopted by other states, regions and countries to reduce carbon emissions.

About the Report:

The Summary for Policy Makers of Optionality, Flexibility & Innovation: Pathways for Deep Decarbonization in California is available for download at www.energyfuturesinitiative.org. The full report will follow later this month.

About the Energy Futures Initiative:

The Energy Futures Initiative (EFI), established in 2017 by former Secretary of Energy Ernest J. Moniz, is dedicated to addressing the imperatives of climate change by driving innovation in energy technology, policy, and business models to accelerate the creation of clean energy jobs, grow local, regional, and national economies, and enhance energy security. We are fact-based analysts who provide our funders with practical real-world energy solutions. Read more at www.energyfuturesinitiative.org.