Overview of 350 ppm Pathways research completed by Evolved Energy Research and the Deep Decarbonization Pathways Project

Introduction:
This summary describes the key lessons learned from decarbonization research recently completed by Ben Haley, Jim Williams, and Ryan Jones, a team of energy experts at Evolved Energy Research. This is the first research completed in the United States that provides multiple highly detailed scenarios to place the U.S. economy on an emissions reductions path consistent with returning global atmospheric CO_2 to 350 ppm by 2100. A more extensive Executive Summary and a full length report are available online at: www.ourchildrenstrust.org/350-ppm-pathways

Research Question:
Are there viable scenarios to transition the U.S. off of fossil fuels at a pace consistent with returning global atmospheric CO_2 to 350 ppm? A 350 ppm pathway calls for reducing U.S. fossil fuel CO_2 emissions by 12% per year starting in 2020 accompanied by 100 GT of carbon sequestration globally[1]. An alternative 350 ppm scenario involves 6% annual reductions beginning in 2020 and 153 GT of carbon sequestration globally[2].

Findings:

- It is entirely possible to transition the U.S. off of fossil fuels at a pace consistent with returning global atmospheric CO_2 to 350 ppm by 2100.
- Placing the US energy system on a pathway to 350 ppm is affordable – temporarily increasing the total cost of the energy system in the United States by 2% or 3% of GDP. This level of cost increase is small in comparison to recent (2005-2012) spikes in energy prices (See figure 1). Eliminating fossil fuel dependence will also eliminate the potential for economic disruption caused by volatile oil prices.
- Any further delay in beginning the transition will result in dramatically increasing costs.
- Rapidly falling prices for renewable energy technologies and conservative assumptions used in this research mean the transition off of fossil fuels may well cost *less* than the estimates found in this study.

[1] This 11% annual reduction pathway is described in the EER/DDPP research as the "Low Land Nets" scenario.
[2] This 6% annual reduction and 150 GT carbon sequestration is the basis for the other five 350 ppm pathway scenarios described by the research team. Recent research (Griscom et al. 2017) suggests 150 GT of carbon sequestration is possible globally using natural methods such as changes in forest management and soil management practices.

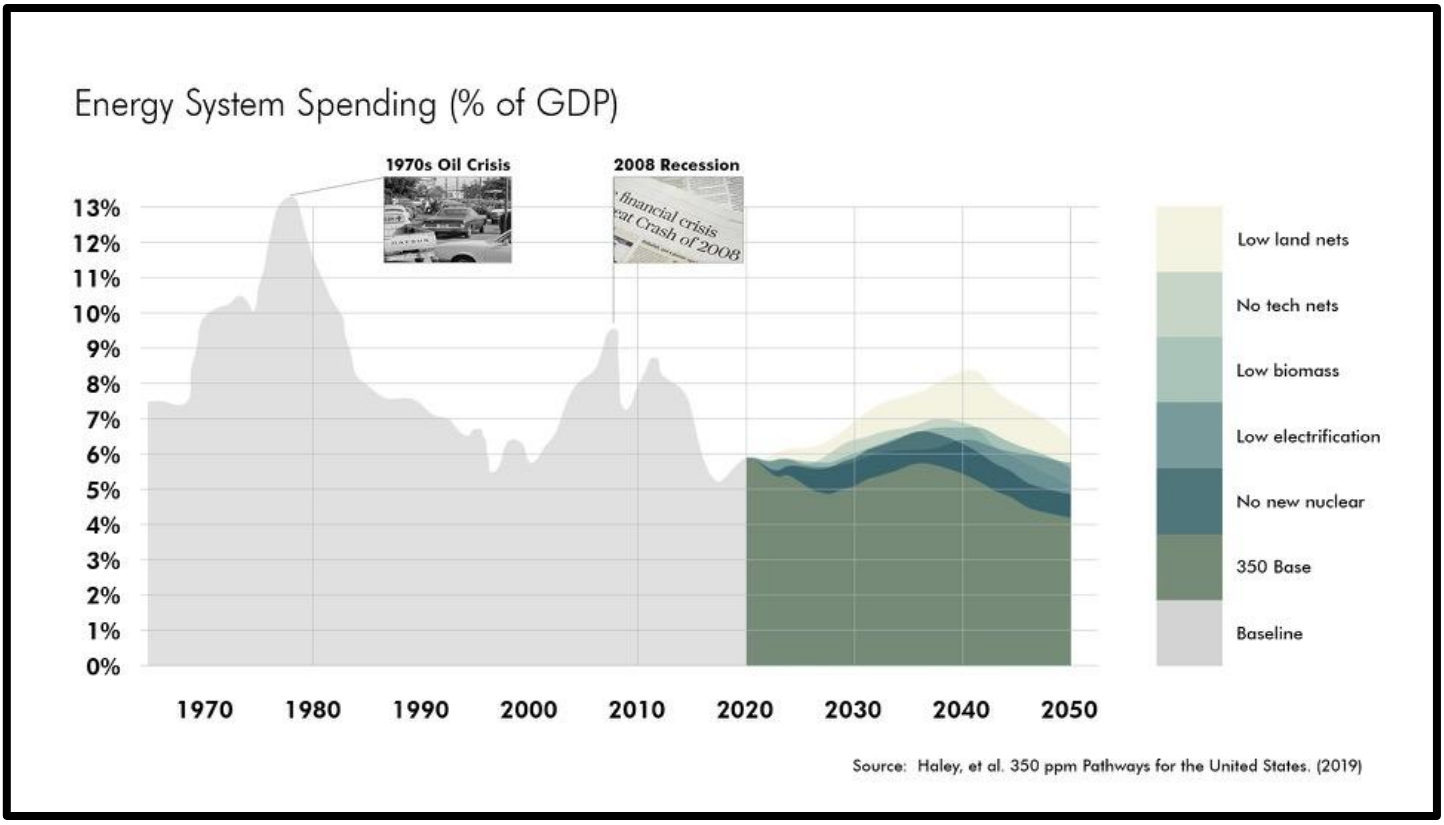

Figure 1: U.S. Energy System Cost as % of U.S. GDP for multiple fossil fuel reduction scenarios

- There are multiple scenarios that achieve this scale and pace of reductions. Even if one of the strategies is not pursued, for example expanding nuclear power or increasing biomass use, the necessary emissions reductions can still be achieved.

- Final research results provide detailed timelines for uptake of electric vehicle technology, electrification of buildings, build out of solar, wind, and other renewable energy generation, and much more.

- Achieving this level of decarbonization creates an increase in demand for electricity. Deep decarbonization relies on investments in energy efficient technologies, electrification of everything that is practical to electrify, generating electricity from renewable sources, and some measure of carbon capture for utilization and/or storage. Electrifying and integrating energy systems across all sectors is essential and requires systemic planning at the national level.

- These research results will be submitted for peer review in 2019.

The following actions illustrate some of the steps required to make the transition:

In the 2020s: Begin large-scale electrification in transportation and buildings; Switch coal to fuel of last resort for electricity generation; Ramp up construction of renewable generation; Pilot new technologies that will need to be deployed at scale after 2030; Stop developing new infrastructure to transport fossil fuels.

In the 2030s: Maximum build-out of renewable generation; Nearly 100% of auto sales are electric vehicles; Begin large-scale production of bio-diesel and bio-jetfuel; Build out of electrical energy storage for short-duration balancing.

In the 2040s: Complete electrification of building heating equipment and vehicles; Deploy Direct Air Capture facilities and electrolytic hydrogen facilities to produce synthetic fuels; Use synthetic fuel production to balance and expand renewable generation.