Robert, and Edward Phillips expressed some of the very concerns that I have about transition pathways. EFI (headed by Ernst Moniz, previous Secretary of Energy) and Stanford Precourt did a study using natural gas with carbon capture and sequestration (CCS) vs solar/wind systems for California. They concluded that natural gas with CCS was the superior cost option to wind and solar due in part to the uncertainty in the daily availability but also to the times that these resources aren't available (sometimes for up to 10 days for wind). Also I want to point out that the State is in a critical water shortage situation and to produce hydrogen from water would probably not be permitted from solar/wind electrolysis.

They (EFI/Stanford Precourt) did not in their report take into account Mitsubishi's effort to have a 3100 F hydrogen turbine by 2030 which will be deployed for LADWP in Utah and will improve the economic viability of the option Also one can get higher efficiencies from Solid Oxide Fuel Cells (SOFC) in this period. Another advantage of SOFCs is that they co-produce water which is in short supply in the State. One of the commenters (Robert) spoke to the utilization of biomass. His option was to consider State grown biomass options. Oak Ridge National Labs who produced "The Billion Ton Biomass" report is studying the option to produce 400 Million Tons from Poplar trees along with 150 million tons utilization of waste products. The plan is to convert this biomass to Renewable Natural Gas (RNG) which can then be shipped in the natural gas pipeline system to California from the Midwest and Southeast as well as other national marketplaces. So both State grown and imported RNG can be utilized. Only 10% of the RNG/NG will be RNG because it is expensive to produce but CCS will still remove carbon dioxide from the air especially with waste and Poplar trees which grow for 6 to 7 years. The RNG/NG can be delivered to city-gate electric generation plants with 3100 F hydrogen turbines or SOFCs with hydrogen storage underground within 100 to 150 miles of cities. The hydrogen then would only need to be delivered that distance with 14,000 psi hydrogen tankers (no need to liquify) to provide hydrogen fuel for hydrogen fuel cell vehicles at costs of $1 to 3/kg. This was a concept I worked on with California over two decades ago when I was in the Department of Energy.

I want to echo Robert's, and Ed Phillips' concerns about transition strategies and the role that eventual reduction of natural gas with RNG over decades can produce to achieve an economically viable transition option.

Please respond.

Sigmund Gronich