Generations of Methane

Jesse Ausubel *is director, Program for the Human Environment, The Rockefeller University, and vice president (programs), Alfred P. Sloan Foundation. He served on EPRI's Advisory Council from 1998 to 2006 and on its Board of Directors from 2006 to 2010.*

Evolution is a series of replacements. Cars replaced horses around 1920, color TV replaced black-and-white about 1960, and digital downloads replaced CDs about 2000. In the energy system, decarbonization, proceeding for more than 200 years, has spanned the successive replacement of wood and hay by coal, then oil, and now natural gas—basically methane. A long, bumpy road sometimes obscures our capacity to see, but happily the USA and the world have crested a hill on the road of decarbonization that permits clear direction for managers, investors, regulators, politicians, and consumers.

This "hill" is the massive quantity of recently established unconventional natural gas deposits, most famously shale gas, and the technologies allowing their economical extraction. Heightening the prospect is experimental evidence that hydrocarbons may also be produced abiogenically in the high temperatures and pressures of the earth's upper mantle and then transported through deep faults to shallower regions in the crust, where they could also contribute to energy reserves. Indeed, abiogenic hydrocarbons are now documented to make significant contributions to commercial gas reservoirs in China's Songliao Basin.

As if anticipating the progress of the geologists and engineers, the capacity to generate electricity from natural gas recently surpassed coal for the first time in the USA. In 2010, natural gas will account for about 24% of USA electricity generation, up from about 9% in 1988. Coal this year will account for about 44%, down from a peak of about 56% in the retrograde year 1988. Many utilities have used natural gas confidently for peak generation but cautiously for baseload, because of worries about volatile and high gas prices. As recognition has spread of methane abundance, both in terrestrial shales and offshore, money worries lessen, and resistance to replacing coal with gas seems folly. Methane spares power generators risks and costs of sulfur, mercury, and mine collapses.

While halving coal's greenhouse gas emissions, methane still contains a worrisome carbon for each of its quartet of hydrogen atoms. Happily, zero-emission power plants, a nightmare with coal as the feedstock, become far less daunting when methane enters the plant. Development of carbon capture needs to shift from coal plants to methane plants. Impressive prototypes exist—for example, at the Kimberlina facility of Clean Energy Systems in Bakersfield, California.

Meanwhile, a deluded crowd believes in wind, as earlier crowds believed in witches and subprime mortgages. The costs of wind to the landscape, system reliability, and wallets will strand its believers and investors—and leave demand for methane to inherit.

Methane also provides the best raw material for pure hydrogen, until nuclear reactors begin to split water thermochemically at a commercial scale in another two to three decades. Steam-reforming the methane to provide the hydrogen for fuel cells creates carbon dioxide for capture and storage, just as a methane-based zero-emission power plant will. Fuel cells operating on hydrogen from methane will operate in favor of climate only when the total system efficiency is higher or the carbon dioxide is safely stored.

In any case, in the long run only hydrogen substitutes well for oil. Battery technology cannot. Basically cars will operate on hydrogen fuel cells with battery assistance to achieve a fulminating start and recover braking energy. The hydrogen tanks will probably initially be fiber-wound pressure bottles.

A further evolutionary advantage for methane is that the gas pipelines accommodating methane can also include up to about 20% hydrogen, carrying the hydrogen piggyback, so to say. Separating the two for final distribution is not difficult with membranes or absorption.

Fuel cells will matter not only for mobility. Fuel cells are also coming to the fore as standby generators because of their capacity for instant intervention, valued for systems managing information, such as phones and computers.

Broadly, researchers and practitioners need to multiply the cleanliness, reliability, and safety of an energy system relying predominantly on natural gas. Total problems must shrink even as the scale of the gas system doubles and triples in the USA and globally during the next couple of generations.

While creationists may favor coal and renewables, evolution favors methane. So should the spectrum of enterprises and stakeholders involved in the generation, transmission, and distribution of electric power.