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Candor, Climate, and the Energy Transition

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> [W]hile energy transition has become a pervasive theme all around the world, disagreement rages, both within countries and among them, on the nature of the transition: how it unfolds, how long it takes, and who pays. "Energy transition" certainly means something very different to a developing country such as India, where hundreds of millions of impoverished people do not have access to commercial energy, than to Germany or the Netherlands. – *Daniel Yergin*

SUMMARY*

Politicians, academics and think tanks are issuing a variety of aspirational goals for decarbonization of the nation's or world's electricity or energy usage. The goals often have a particular end date—for example, 100% net-zero electricity generation as near as 2035, or as far as 2070.

It is easy to see why decarbonization gets the attention. The vision of renewable assets generating electricity and hydrogen for the world's energy needs is a powerful one. And it is carbon emissions that are the major contributors to the climate change we are experiencing. Decarbonization is the clarion call of the Paris Agreement.

However, decarbonization is only one of the goals of the energy transition. There are multiple goals that are left unstated in the public coverage about plans for solar panels and wind turbines. And the challenges to decarbonization also receive little attention—the costs, the risks, and the foregone benefits that the legacy energy assets will provide until the transition is complete.

This paper fills out the picture of the energy transition, by laying out what our overall goals may be—and how those goals might complement and sometimes compete with one another. I contend that every aspirational decarbonization goal is launched in the *context* of an existing quantity and distribution of energy, and a desired end state. Further, every such goal carries with it an *implicit project*: an enormous initiative in research, development, finance, subsidies, and incentives.

We deserve candor about what that end state is, what the project consists of, and what requirements, challenges and risks are associated with it. Candor is not often observed in this field, but over the long term it is needed for reasoned conversations that will lead to lasting change.

Defining the Energy Transition

The term "energy transition" is used more frequently than it is defined, and publications of the World Economic Forum, consulting firms, and others list different elements. It undoubtedly begins with decarbonization, the change in the primary energy sources from oil, gas, and coal towards renewable and nuclear. That is a mix of adding renewable production,

* A more complete article, with documentation in footnotes, has been submitted for publication. The views are those of the author alone and not his firm or their clients.

retiring fossil production and generation, and accommodating the changeover with storage and grid enhancements. The amazing emergence of low-carbon hydrogen, as an energy source and a storage medium, is also key to this shift.

The transition includes environmental sustainability—not just carbon emissions but also life-cycle costs of other kinds. The production and disposal costs of chemicals and minerals used in making batteries and panels must be managed with reference to the circular economy.

The transition must deliver safe, secure, diversified, and reliable power. The intermittent nature of renewable generation must be fully accommodated as it is introduced, not later (witness the California blackouts). Help is on the way with a wide variety of storage mechanisms, not just pumped hydro and lithium-ion batteries, but also new generation electric storage and thermal storage facilities.

The transition must deliver affordable access to power. It must address how to get energy to all users. The most readily realized projects close to populations have already been developed or applied for. What challenges apply to the *next* group of sites, those that the existing developments rejected in favor of where they wound up putting their assets?

The transition must factor in population growth and equitable economic development. Any decarbonization goal implicitly presumes a level of power or energy usage in the end year (2035, 2040, 2050…). It is estimated that there are 7.8 billon people on earth today, 860 million of whom lack access to electricity and 2.6 billion lack access to clean cooking fuels. We should be able to understand what the goal and the implicit project have in store for the larger population, particularly the vulnerable communities, by the later date.

The public pronouncements focus on building so many solar panels and so many wind turbines. What they should also be talking about is sustainability, security, reliability, access, and inclusive development and growth. If they are not explicit on those features and values, it is up to other voices to be speak on their behalf.

My working definition of the robust energy transition includes the following elements.

1. **Renewable generation:** onshore/offshore wind, solar, geothermal, hydroelectric, biofuels
2. **Storage of electricity and heat:** pumped water storage, lithium-ion and next generation batteries, hydrogen or ammonia fuel cells, thermal storage
3. **Carbon consciousness for fuels in transition:** reducing emissions in production and transmission, enhanced efficiencies, carbon capture and storage (CCS) for power generation and blue hydrogen production, and production for the ongoing non-fuel uses of petroleum
4. **Hydrogen from renewables:** green hydrogen through electrolysis, buildout of hydrogen infrastructure and end uses
5. **Efficiency in infrastructure:** efficiency in building design, construction, operation, and life-cycle costs
6. **Enhancements to grid and distributed resources:** accommodate renewable and storage assets in baseload; behind the meter solutions, demand reduction incentives
7. **Greening of transportation, industrial and public end uses:** overhaul of entire infrastructure and end uses—vehicles on land, sea and air, fueling/charging stations, renewable solutions for hard-to-electrify sectors (steel, cement, petrochemicals)
8. **Enhanced energy technology:** research on generation, storage, use; advanced nuclear, bioenergy, direct air capture, solar radiation management, geothermal, and other applications

   and…

9. **Equity in the transition**—energy that is affordable, available, accessible, sustainable, safe, secure, diverse, and fairly distributed.

Decarbonization goals indicate an implicit project that is part of this broader energy transition. How does the project fit with these other elements? Do they complement one another, or in some cases are they in tension with one another?

What Are the End Zones?

The energy transition goals are expressed in different ways, but one consolation is that they must all begin with the actual circumstances today. Participants in the conversation should have a bundle of facts in the back of their minds as they hear the proposals. To take current U.S. electricity generation as an example:

- Total generation is reported by the EIA, the IEA and BP all at about 4200 trillion watt-hours (terawatt-hours) for 2019. 2020 is slightly down from 2019, but it leaves to be seen whether the early 2020 oil price collapse and the COVID responses are permanent.

- That electricity was generated in the proportion 62:20:17.5. That is, 62% was generated from fossil fuels, with natural gas at 38% and rising and coal at 24% and falling; 20% from nuclear; and 17.5% from renewables of all kinds, including hydroelectric 7%, wind 7% and rising, and solar 1.8% and rising quickly.

- There are about 64,000 wind turbines and over 3000 are installed annually, according to both the AWEA trade association and the U.S. Geologic Survey—3,581 in one recent year.

- There are perhaps 1.5 million solar roofs. Annual installations are expected to top 3 gigawatts in 2020, up from 2.8 GW in 2019.

That basic bundle of facts gives us some idea of our "own end zone," the one from which we receive the kickoff in 2020, if you will. What does the other end zone, the "destination end zone," look like?

A year must be selected—the goals mention 2035, 2040, 2050 and 2070. There will likely be some downward forces on the electricity output—due to greater efficiencies and productivity. And there will likely be some upward forces—due to population growth and the increasing electrification of the transportation and industrial sectors. Whether explicitly or implicitly, the proposals must assume some quantity (terawatt-hours, for U.S. electricity) in the target year.

Remember the 860 million now without electricity, and the almost three billion now without clean cooking fuels. What will be the demands on the energy transition across the globe while any decarbonization project is undertaken?

What Do the Decarbonization Goals Imply?

The full paper discusses many of the decarbonization goals, and this Summary highlights two of them.

Biden-Sanders

A unity plan this past summer from advisers to Vice President Joe Biden and Senator Bernie Sanders calls for 100 percent U.S. net zero electricity by 2035, and 100 percent net zero total energy by 2050. Among all the adjectives and adverbs in the plan come figures that stand out in their simplicity and specificity: 60,000 wind turbines onshore and offshore, all made in the United States, and 500 million solar panels on 8 million roofs and community solar facilities, to be in place during the next five years (2021-2025).

Some of the press coverage either did not report the specific figures at all, or restated them with matter-of-fact exactitude. It was important for the candidate's materials to say the numbers, for the press to report the numbers, and for the targeted audiences to applaud the numbers. An understanding of the numbers appears to have been optional.

Only in the comments of ordinary readers and credentialed academics to some of the press coverage did I see the questions that such numbers in isolation might deserve.

- Sixty thousand, eight million, five hundred million—for any of these specific figures, ***is that a lot?*** How does that compare to how many turbines and panels we install today?

- Are these figures inclusive of business as usual, installations already planned and permitted under the Obama and Trump Administrations, or are they incremental?

- How would the United States cause those projects to appear? We know how wind and solar projects are sited, developed, financed, and connected to customers in a locality, and the multitude of federal, state and local laws, regulations and causes of action that apply to them. How will government make this expansion happen?

- And if we were to install that many resources on this timetable, how far would that go, by 2026, in reaching the end zone goal—that of 100% green power by 2035?

My end zone data give us some context for these figures. If 3581 turbines were installed in a recent year, then 60,000 turbines would suggest a need to quadruple that rate up to perhaps 20,000 in the final year of a five-year plan. The solar calculation is trickier but similar. To achieve the Biden-Sanders plan, the installations might have to rise to 500,000 in 2021, and then well into the millions annually in 2022-2025.

These rates of growth may not appear out of the question from a financing perspective—similar growth in European offshore wind has happened. That growth took place in the context of a global supply chain, however. More interesting are two bookends: how such an increase in U.S. manufacturing and installation capacity would be accomplished, and how the site permitting process could be so expanded, given that in some locales the best and easiest to permit installations may have already been launched.

The fact that we must perform all this work on our own is more to my point. The proponent and the press did not unpack the implications of the goal—the implicit renewables project. And they shed little light on the rest of the implicit energy transition—the need for storage, grid enhancements, and overall equity.

Goldman School

The Biden-Sanders plan can be contrasted with the *2035 Report* of the Goldman School of Public Policy at UC Berkeley. It calls for 90% U.S. net zero electricity by 2035. It reflects a judgment that getting rid of the last 10% of fossil fuel sources would be uneconomic or impractical. Notably, the report is accompanied by a series of technical appendices, the first of which is a literature survey—explaining why the authors differ from facts or conclusions of other studies.

The task ahead is not minimized. One positive outcome of the Goldman report is that its authors project per unit costs of electricity generated in the end state would be lower, not higher, than a business-as-usual approach, especially when taking into account environmental and health benefits. And there are specific recommendations for federal and state regulators regarding generation, transmission, and usage, and for streamlining the entitlements process. Regardless of what one may make of the decarbonization goals and the present state of the technology needed to achieve them, I credit the Goldman report for its candor.

Candor in the Energy Transition

Candor is not always forthcoming from the proponents. But attempts to supply candor by opponents can also be unreliable. And self-proclaimed objective fact-checkers often need to have their own facts checked, or to be called on occasions where they are not checking facts of what was actually said, but expressing opinions or supplying other facts that could have been mentioned.

Some may object that by asking for candor, I am trying to chill the vibe, to throw cold water on audacious actions needed for an unprecedented problem. I do not believe that candor implies timidity. Time and again, we have accomplished audacious things for which we probably would not have received budget and schedule approvals before the fact—the full paper cites the data on the Manhattan Project, the Apollo Project, and other great initiatives.

Nonetheless, there should be good faith inquiries into the pathways by which any audacious goal could be achieved. Sometimes, aspirational goals are harmless. But other times, acting in reliance on ambitious timetables may untimely divert funds from other vital needs.

It may be too much to expect advocates, particularly those in the public sphere, to accompany their own goals with full downside disclosures of costs and risks—in the manner of an environmental impact statement or a securities prospectus. If their proposals depend on a study, though, it would be civil and courteous for them to cite that study, so anyone interested could see how that study fits with other studies in the marketplace of ideas.

Public policy is too important to be left entirely to proponents. Leaders can express proposals, experts can speak to their prospects from the standpoint of their respective fields, but the public is at least entitled to understand what the proposal *is*.

Candor can enrich debate in a democracy and harden our resolve to accomplish bold initiatives. That frankness may be supplied by opponents, akin to the Anglo-American system of legal advocacy, or by neutral parties, like the investigating judge in civil law regimes. But it needs to be supplied by *someone*, so that all of us may come to informed opinions on our energy future.

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