Searching for a National Energy Policy:

Is ANWR the right place to look?

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The United States and the world face a daunting array of energy-related challenges. We must work out how to provide, reliably and affordably, the supplies of fuel and electricity needed to sustain and build economic prosperity. We must limit the financial drain, vulnerability to supply-price shocks, and risk of armed conflict from over-dependence on foreign oil. We must reduce the environmental damage done by technologies of energy supply, ranging from local and regional air pollution to the disruption of global climate. We must minimize the accident and proliferation dangers associated with nuclear energy.

The place of these issues on the public agenda depends on whether they appear to be going well or badly. And for most of the past 15 years, energy matters have seemed to most Americans to be going rather well. Real energy prices were falling. Gasoline lines and electricity blackouts were absent. Urban air quality was generally improving. The science of the impact of fossil-fuel use on global climate was widely seen as contentious and inconclusive. There were no major nuclear-reactor accidents after Chernobyl (1986), and concerns about nuclear proliferation and nuclear energy's role in it were on the back burner.

Much of this has now changed. Heating-oil shortages and price spikes in the winter of 1999-2000 were followed by huge increases in natural-gas prices in 2000, with painful impacts on homeowners, industrial users, and electricity generation. The electricity crisis in California focused the attention of the nation on whether reliability and affordability of electricity supply could become a casualty of defects in electricity-sector deregulation elsewhere as well. Oil imports, in the meantime, crept up from their 1985 low of 29 percent of U.S. oil consumption to 57 percent in 2000. Meanwhile, the improving trend in urban air quality has slowed; the scientific consensus about the reality and seriousness of fossil-fuel-related global climate change has solidified; and nuclear proliferation has been propelled back onto the front burner by the 1998 Indian and Pakistani tests and U.S. concerns about Russian sales of nuclear-energy technology to Iran.

As a result of these developments, energy policy is again a matter of public concern. What will the new Bush Administration do about it? What *should* it do?

Drilling our way out of dependency?

Early indications are that the new Administration plans to make drilling in the Arctic National Wildlife Refuge (ANWR) the centerpiece of its energy policy. That would be a mistake. The contribution of ANWR to domestic oil supplies would at best be slow to start, modest at its peak, and strictly temporary, providing limited leverage against the oil-import part of our energy problems and almost no leverage against the other parts. Whether ANWR belongs in the national energy portfolio at all — given the ratio of its possible benefits to its costs and risks — is problematic. It certainly should not be the centerpiece.

Over-dependence on imported oil *is* a real problem. U.S. oil imports are running over 10 million barrels per day, out of total domestic consumption of about 18 million. A quarter of our imports come from the Persian Gulf, half from OPEC overall. The bill for U.S. oil imports last year was well over $100 billion, passing one percent of GNP for the first time since 1985. The economic impact of oil-import dependence is still not as great today as it was twenty years ago, because oil's share in our energy mix has fallen since then and because the amount of energy needed to make a dollar of GDP has also fallen. But the impact is considerable in sectors of the economy that remain heavily dependent on oil, and our oil dependence as a fraction of national energy supply is high enough to make the defense of foreign oil supplies a major mission of U.S. armed forces and, indeed, a potential source of actual armed conflict.

Under "business as usual," moreover, U.S. oil imports are projected to continue to rise. Net U.S. imports of oil in 2020 under the "reference" case in the latest *Energy Outlook* report of the U.S. Energy Information Administration (EIA) reach 16.6 million barrels per day, 64% of projected U.S. consumption. Because both OPEC and the Persian Gulf hold larger shares of world reserves than of current production, moreover, their shares of world production and exports are likely to increase over time. The prospect of increasing dependence on these unpredictable partners — by the United States, its allies, and even some of its potential adversaries — is not reassuring in economic or national-security terms.

Dependence on imported oil can be reduced by increasing domestic oil production or by reducing oil use; and the latter can be achieved either by increasing the efficiency with which oil is converted into goods and services or by substituting other energy sources for oil. All of these approaches have been employed in varying degrees over the past two decades, and all of them have a role to play in the decades ahead. All of them can and should be strengthened with further policy initiatives. But analysis of recent history and future prospects indicates that much larger gains will come from reducing consumption through efficiency increases and substitution than from increasing domestic production.

U.S. domestic oil production declined from 1970 to 2000, despite the urgency that the oil embargoes and price shocks of the 1970s placed on increasing exploration. The all-time peak of U.S. domestic production of crude petroleum plus natural-gas plant liquids (together characterized as "total petroleum") was 11.3 million barrels per day in 1970. By 2000, it was only 8.0 million barrels per day. It is hard to estimate the amount by which prices, policies, and technological improvements slowed the decline in U.S. domestic oil production over this period from what it otherwise would have been. Certainly, advances in seismic exploration, horizontal drilling, and secondary oil recovery all helped add to U.S. production. Nonetheless, Alaska's contribution (which peaked at about 2 million barrels per day) had fallen by 2000 to about 1 million barrels per day; and U.S. offshore production was contributing about the same 1.5 million barrels per day to domestic supply at the end of the 1990s as it had contributed 30 years earlier.

Stemming the expected continuing decline in domestic petroleum production in the decades ahead will not be easy, with or without ANWR. According to the EIA "reference" scenario — which does not consider production from ANWR — U.S. domestic petroleum production will be only 7.5 million barrels per day in 2010 and 7.9 million in 2020. These levels are marginally *lower* than the 2000 figure, despite assumed continuing technological innovation in exploration and extraction and a 30-percent increase in production offshore. Even in EIA's "high world oil price" scenario, under which some additional fields become profitable, domestic production in 2020 would only be 0.7 million barrels per day higher than in the reference scenario.

What might be added to this by drilling in the coastal shelf of ANWR? First of all, it is not certain that oil would be found there at all. The U.S. Geological Survey's 1998 estimate of how much might be recoverable ranged from 4 to 12 billion barrels. Since U.S. oil consumption is the equivalent of about 6.6 billion barrels of crude per year, this means that ANWR could ultimately provide the equivalent of 0.6- 2 years' current U.S. oil supply, or 1 to 4 years' current imports.

At the upper end of the range of estimates, ANWR would be comparable to the Prudhoe Bay field. If that were so, a production trajectory similar to Prudhoe Bay's would presumably ensue — production ramping up over a decade or so to 1.5 to 2 million barrels per day, remaining at that level for a decade or two, and then tailing off. The question for the U.S. public and the policy makers who represent us is whether the *possibility* that ANWR could displace perhaps 10 percent of projected U.S. oil imports in the period 2010-2020, with declining contributions thereafter, justifies the certain environmental damage of exploring for oil in this unique and fragile habitat and the risk of even larger impacts from oil production and transport if oil is found.

The answer ought to depend, at least in part, on the prospects for achieving comparable or larger (and longer-lived) reductions in U.S. oil-import dependence at lower costs and risks and with larger ancillary benefits. Let me turn, then, to the possibilities for reducing oil imports — and for simultaneously addressing other dimensions of the energy challenges we face — through increased energy efficiency and through expanded use energy sources other than oil.

Efficiency first

The historical record reveals the potential of the energy "resource" that is available in efficiency improvements. From 1955 to 1970, the energy intensity of the U.S. economy stayed essentially constant, at about 19 quadrillion Btu per trillion 1996 dollars of GDP. But from 1970 to 2000, driven in the first part of this period by the oil-price shocks of the 1970s and later by continuing technological innovation and structural changes in the economy, energy intensity fell at an average rate of 2.0% per year. In the year 2000, it was 10.5 quadrillion Btu per trillion 1996 dollars. As a result, total U.S. energy use in that year was 79 quadrillion Btu lower than it would have been if energy intensity had remained at the 1970 value.

For most of the last 30 years, oil's share of U.S. energy supply slowly declined as well, falling from 43.5% in 1970 to 38.8% in 2000. As a result of these trends in energy intensity and oil share, in the year 2000 the United States was using 18 million barrels of crude per day *less* than what it would have been using at the 1970 levels for energy intensity and oil's share of total energy supply. Had the 1970 ratios still prevailed, U.S. oil consumption in 2000 would have been twice as large as it actually was.

As for the future, it remains clear that by far the greatest immediate as well as longer-term leverage for reducing dependence on imported oil lies in increasing the efficiency of oil use in particular and of energy use overall. (Improvements in overall energy efficiency free-up non-oil sources of supply that can then, in principle, substitute for oil.) Notwithstanding the impressive efficiency gains over the past 30 years, every serious study of the matter indicates that the technical potential for further improvements remains large. Most studies also indicate that further efficiency increases are the most economical option available for reducing oil dependence.

The EIA "reference" forecast projects an average rate of decline of 1.6% per year for the energy intensity of the U.S. economy over the next 20 years. This already reduces total U.S. energy use in 2020 by about 50 quadrillion Btus (equivalent to about 23 million barrels of oil per day) compared to what energy use would be if the energy intensity of the economy remained at its 2000 value and economic growth averaged, as EIA assumes, 3% per year. If the rate of decline in U.S. energy intensity from 2000 to 2020 were as high as was achieved from 1995 to 2000 — 2.8% per year — the further savings in U.S. energy use in 2020, beyond those in the EIA "reference" forecast, would be equivalent to another 11 million barrels per day of oil.

The potential for efficiency improvements is nowhere more apparent than in the oil sector itself. In 2000 more than 12 million barrels per day of petroleum products were being used for transportation fuel, 8 million barrels per day of that in gasoline and 2 million barrels per day in diesel fuel. U.S. automotive fuel economy has been essentially constant since 1991, at about 21 miles per gallon, thanks to the false reassurance of low gasoline prices, the absence in recent year's of increases in the Corporate Average Fuel Economy (CAFE) standards, and the growing proportion of sport utility vehicles and pick-up trucks purchased by consumers, for which the current CAFE standards are lower than for ordinary cars.

Perfectly comfortable and affordable hybrid cars already on the market get 60 to 70 miles per gallon. With the help of the government-industry Partnership for a New Generation of Vehicles, more advanced hybrid and possibly also fuel-cell powered cars could be on the market before 2010 that would get 80 to 100 miles per gallon. Straightforward arithmetic shows that doubling the average fuel economy in a U.S. fleet of gasoline-burning vehicles the size of today's would save 4 million barrels of oil per day. Comparable efforts to improve the fuel economy of trucks, as recommended in the 1997 study of U.S. energy R&D strategy that I chaired for the President's Committee of Advisors on Science and Technology (PCAST) in 1997, could save a further 1.5 million barrels per day by 2020. A government initiative to help bring this about was launched last year.

Specific opportunities for major efficiency increases are easily identifiable in industry and in residential and commercial buildings, as well. In industry, these opportunities include: increased use of advanced combined-heat-and-power systems; improved electric motors and drive systems; and reductions in process energy requirements in the chemical, petroleum refining, forest products, steel, aluminum, metal-casting, and glass industries (which together account for about 20 percent of total U.S. energy use). The EIA projects overall industrial energy intensity to fall 25 percent between 2000 and 2020 in the "reference" case and nearly 30 percent in a "high technology" case. The 1997 PCAST study and studies by the DOE national laboratories have argued that bigger gains are possible.

In residential and commercial buildings, advances in the energy performance of the building shells and of the energy-using devices inside ¯ especially in air conditioning, refrigeration, heating, and lighting — offer big potential gains. The EIA "high technology" case knocks 1.5 quadillion Btu off the 5 quadrillion Btu growth projected for the residential sector in the period 2000-2020 in the "reference" case, for example, and a "best available technology" case reduces the 2020 figure by another 4 quadrillion Btu (giving a total lower than in 2000). The Partnership for Advancing Technology in Housing, launched in 1998, aims to achieve a 50% improvement in efficiency in new homes by 2010.

Expanding non-oil energy supplies
While the largest and cheapest leverage in the decades immediately ahead resides in increasing energy efficiency, there is also considerable potential in expanding energy supplies from sources other than oil. The sources with the largest short-term and medium-term potential to directly displace oil in the U.S. energy mix are natural gas and biofuels.

Natural gas could displace oil in a number of industrial applications, in home heating, and in motor vehicles. In the EIA "reference" case, petroleum use in the industrial sector increases between 2000 and 2020 by the equivalent of 1.2 million barrels of crude oil per day and natural gas use by about the same amount; in principle, higher growth of natural-gas use could displace some or all of that growth in use of petroleum. Residential use of oil, amounting in total to the equivalent of about 600,000 barrels of crude oil per day in 2000, falls by about 100,000 barrels per day by 2020 in the EIA "reference" scenario, while natural-gas use in the residential sector increases by the equivalent of 600,000 barrels per day. Again, gas use could increase faster, at the expense of oil.

In the transport sector, by far the largest user of oil, the EIA projects contributions from natural gas as motor-vehicle fuel equivalent in 2020 to 600,000 barrels per day, about twice the 2000 value. Here, too, the potential for natural gas is clearly larger than envisioned by EIA, if we really want to minimize reliance on foreign oil. (Concerns that recent increases in natural-gas prices mean we are running out of gas are misplaced. Gas futures prices have recently been declining, and the EIA projects increasing additions to domestic reserves, as well as increasing production from onshore, offshore, and unconventional sources, through 2020.)

As for liquid fuels from biomass, the 1997 PCAST study estimated that an aggressive program to produce ethanol from cellulosic biomass could be displacing 1.5 million barrels per day of oil by 2020 (and over 3 million barrels per day in 2035). The EIA estimate of the contribution of biomass fuels for the transport sector in 2020 was far smaller, but EIA's assumptions did not include incentives for biomass use of the sort that would be contemplated if our country actually got serious about reducing oil imports and greenhouse-gas emissions.

Production of liquid hydrocarbon fuels from coal is technically feasible using a variety of approaches, but it is not yet economically competitive with oil or with production of liquid fuels from natural gas. In addition, production of liquids from coal using existing technology results in carbon dioxide emissions about twice as large, per barrel, as for petroleum — a major drawback in light of climate-change risks. As oil and natural gas become more expensive over time, advanced coal-to-liquids technologies that can capture and sequester carbon dioxide rather than releasing it to the atmosphere may eventually become attractive. The 1997 PCAST study recommended increasing R&D on these carbon-sequestering coal technologies.

The potential for reducing U.S. oil consumption by replacing oil-fired electricity generation with other fuels is quite limited. In 2000, oil generated only 2.7 percent of U.S. electricity, using 500,000 barrels per day. In the EIA "reference" scenario, oil use for electricity falls by 2020 to less than 100,000 barrels per day. A larger source of leverage of the electricity sector against oil consumption is indirect, through the potential of alternative electricity options to displace natural gas from electricity generation, which could in turn displace oil in the industrial, residential, and transport sectors.

From an environmental standpoint and quite possibly also from an economic one, the most attractive candidates to displace some of the growth of gas-fired generation envisioned in the EIA scenario (and thereby make gas available to displace oil in other sectors) are the non-hydro renewables. A very conservative estimate of their potential for doing so out to 2020 is provided by the EIA "high renewables" scenario, which in 2020 obtains 107 billion kWh from biomass, about 65 billion kWh each from wind and geothermal, and 5 billion kWh from solar. The additional non-hydro renewable generation in this scenario, compared to the 2000 figure, totals 145 billion kWh — equivalent to about 700,000 barrels per day of oil.

The EIA estimate of renewable-electric potential is conservative, because the EIA study did not consider the possibility of substantial increases in the prices of fossil fuels, or the possibility of major policy changes that would sharply increase the incentives for expanding the use of non-fossil fuels. The 1997 PCAST study made some estimates of what might be achievable from renewable-electric options under prices or policies that encouraged these options very strongly, and the resulting figures were far higher than those in the EIA scenario. They included as much as 1100 billion kWh by 2025 from wind systems with storage technologies and similar quantities by 2035 to 2050 from solar-electric systems with storage, from biopower, and from hot-dry-rock geothermal. These are possibilities, not predictions, but the figures do indicate very large potential: 1000 billion kWh per year is the equivalent of about 5 million barrels of oil per day.

As for nuclear energy, there are no new nuclear power plants on order in the United States and there are not likely to be as long as gas-fired electricity generation remains as cheap as EIA expects. The range of nuclear contributions in 2020 in the EIA scenarios thus depends only on the rate of nuclear-plant retirements versus license extensions for additional years of operation. The difference between the EIA's "high nuclear" and "low nuclear" variations in these respects amounts to 240 billion kWh in 2020, equivalent to 1.2 million barrels of oil per day.

The 1997 PCAST study recommended a modest increase in Federal nuclear-energy R&D in order to clarify safety issues associated with license extension, and it recommended a somewhat larger and longer-term Nuclear Energy Research Initiative focused on clarifying the prospects for improvements in the cost, safety, waste-management, and proliferation-resistance characteristics that will determine whether deploying a new generation of nuclear reactors in the United States in the longer term becomes a real option. PCAST also recommended an increase in the funding for R&D on fusion energy, which although it remains far from commercialization today could conceivably make a large contribution to electricity generation in the second half of the 21st century.

The recent history of relevant Federal policy

The potential to reduce U.S. oil dependence using currently available as well as still to be fully developed energy-efficiency and non-oil energy supply options is clearly very large. The question is how much of this technical potential will be realized in practice, by when. The key to expanded use of the currently available options is incentives. The keys to achieving the potential of the emerging options are, first, research, development, and demonstration; and, second, incentives to promote the early commercialization and widespread deployment of the results.

Energy R&D is valuable for many reasons beyond reducing costly and dangerous over-dependence on foreign oil. It can reduce consumer costs for energy supplies and services, increase the productivity of U.S. manufacturing, and improve U.S. competitiveness in the multi-hundred-billion-dollar world market for energy technologies. It also can lead to improvements in air and water quality, help position this country and the world to cost-effectively reduce greenhouse-gas emissions, improve the safety and proliferation resistance of nuclear energy operations around the world, and enhance the prospects for environmentally sustainable and politically stabilizing economic development around the world.

Many of these benefits fall under the heading of "public goods," meaning that the private sector is not likely to invest as much to attain them as the public's interest warrants. That is one of the main reasons the government needs to support energy R&D, even though the private sector will continue to do a considerable amount on its own. The 1997 PCAST study concluded, however, that the Federal government's applied energy-technology R&D programs (then totaling $1.3 billion per year for fossil, fission, fusion, renewable, and end-use efficiency technologies combined) were "not commensurate in scope and scale with the energy challenges and opportunities that the 21st century will present, [taking into account] the contributions to energy R&D that can reasonably be expected to be made by the private sector under market conditions similar to today's."

Accordingly, the PCAST study recommended increasing DOE's budget for these programs to $1.8 billion in FY 1999 and $2.4 billion in FY 2003 (figures in as-spent dollars). The R&D portfolio proposed by PCAST addressed the full range of economic, environmental, and national-security challenges related to energy, in the short-term and long-term. Also recommended were a number of improvements in DOE's management of its R&D efforts.

In its FY1999 budget request, the Clinton Administration included a total increment about two-thirds of what PCAST recommended for that year, and Congress appropriated about 60 percent of the request. The net result was an increment about 40 percent as large as PCAST recommended for FY1999. Appropriations continued to increase in FY2000 and FY2001, but the gap between the PCAST recommendations and the amounts appropriated widened: in FY2001, the total applied energy-technology R&D appropriation was $1.7 billion, $0.5 billion below the PCAST recommendation for that year.

The details of the Bush Administration's request for FY2002 are not available as this is written, but indications are that there will be cuts in most of the energy R&D categories, rather than increases that would begin to narrow the gap between appropriations and the very responsible and balanced PCAST recommendations. (It is worth noting, first, that the $0.5 billion gap for FY2001 could be paid for with half a cent per gallon from the Federal gasoline tax and, second, that fully funding the PCAST recommendations for FY2002 would barely return real spending for these purposes to where it was in FY1991 and FY1992, under the senior President Bush.)

A follow-up PCAST study in 1999, which I also chaired, focused on the rationales for and ingredients of the Federal role in strengthening international cooperation on energy innovation. The resulting 1999 report, "Powerful Partnerships," noted that many characteristics of the global energy situation that affect U.S. interests will not be adequately addressed if responses are confined to the United States, or even to the industrialized nations as a group.

The oil-import problem is one compelling example, insofar as the pressures on the world oil market (and on oil from the politically fragile Persian Gulf) depend on the sum of all countries' imports. The solution therefore depends on the pace at which options that displace oil imports are deployed in other countries, not just in the United States. Another problem whose solution depends on deployment of advanced technologies everywhere is the contribution of anthropogenic greenhouse gases to global climate change. In addition, the use of public-private partnerships to promote energy-technology innovation abroad, as proposed by the 1999 PCAST panel, would help U.S. companies increase their share of the trillions of dollars in energy-technology purchases that developing countries will be making over the next few decades.

The panel recommended an increment of $250 million per year, in the FY2001 budget, for Federal support for international cooperation on energy research, development, demonstration, and deployment. These recommendations have not fared as well so far as the 1997 recommendations on U.S. domestic energy R&D. The Clinton Administration did form the interagency task force that the panel had recommended for coordinating the government's efforts in this domain, and the FY2001 budget request contained an International Clean Energy Initiative of $100 million, along the lines recommended by PCAST. But only $8.5 million of this was actually appropriated by Congress.

Ingredients of a new national energy policy

The first step the Bush Administration and the Congress ought to take in reshaping U.S. energy policy is to boost Federal spending for energy R&D — and for international cooperation on energy-technology innovation — to the levels recommended in the 1997 and 1999 PCAST reports. The investments involved are modest; the PCAST studies and many others have shown that the returns to such investments in the past have been high; and the leverage that advanced energy technologies offer now against looming energy-linked challenges in the economic, environmental, and national-security dimensions of the public's well-being is immense.

That should be the easy part. More difficult, but nonetheless essential, is to put in place an array of price and non-price incentives and other policies that will encourage deployment of energy-efficiency and advanced energy-supply technologies in proportion to their public benefits. Elements of such an array should include tighter Corporate Average Fuel Economy standards; expanded use of renewable-energy portfolio standards and production tax credits; energy-efficiency standards and labeling programs for energy-using equipment in residential and commercial buildings; and more.

Perhaps most importantly, the price signals affecting our energy choices will not be "right" until they better reflect the high costs and risks to our society from the climate-imperiling emissions of carbon dioxide by fossil-fuel combustion and from over-dependence on imported oil. The sensible thing, which could easily be made consistent with the desire of the Bush Administration to cut taxes overall, would be to increase taxes on things that society has an interest in constraining (in this case, oil use and emissions of carbon dioxide to the atmosphere) while decreasing taxes on things we want to encourage (such as income and capital gains).

The natural antipathy of consumers to higher energy taxes could be alleviated not only with offsetting reductions in other taxes but also with education about the economics of the matter. Failing to reflect the dangers of climate-disrupting emissions and over-dependence on oil imports in the price of energy from fossil fuels is a prescription for under-investing in technological alternatives that would reduce these dangers. And under-investing now is a prescription for higher costs later, in the form of bigger damages from climate change and higher oil-import bills.

It should also be remembered that the revenues from energy taxes — unlike those from OPEC price hikes — stay in the United States, where the money can be used not only to reduce other taxes but also to reduce the disproportionate impacts of energy price increases on the poor and to support research, development, demonstration, and accelerated deployment of advanced energy options.

What should be the role, finally, of ANWR in a new national energy policy? As already indicated, the contribution from ANWR would be modest at most — very limited even in its temporary leverage against oil imports, and relatively short in duration — but bought at a high environmental (and political) cost. Whatever ANWR might bring in the way of a modest and temporary reduction in oil-import requirements, moreover, it would buy nothing against the parallel problem of climate-change risks and little if anything against the electricity-supply problems plaguing California.

Still, if there were few or no alternatives to ANWR for reducing oil-import dependence, one might imagine the public's swallowing the sacrifice of energy development in this unique wilderness. But there are abundant alternatives. Expanded use of natural gas is more promising in the short term, expanded reliance on biomass and other renewables more promising in the middle- and long-terms. And the potential of improvements in energy efficiency dwarfs that of ANWR in the short-, middle-, and long-terms alike. Renewables and efficiency, moreover, are energy sources that address climate risks and electricity supply as well as oil dependence, and they are sources that keep on giving, in contrast to the temporary contributions of a new oil field.

If the Bush Administration and the Congress adopt the more comprehensive, more technology-centered, more forward-looking approach outlined here for addressing the energy challenges facing this country and the world, ANWR will not be needed — we will be able to have the energy we need and our wilderness, too. If, against all odds, the contributions of alternatives to ANWR prove, 10 or 20 years down the road, to be insufficient, then whatever oil lies beneath that particular piece of Arctic tundra will still be there to be found. In the meantime, it may be hoped that President Bush and his advisors will not allow a divisive struggle over developing ANWR now to distract us from fashioning the larger strategy that our energy challenges and opportunities require.

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Further reading

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