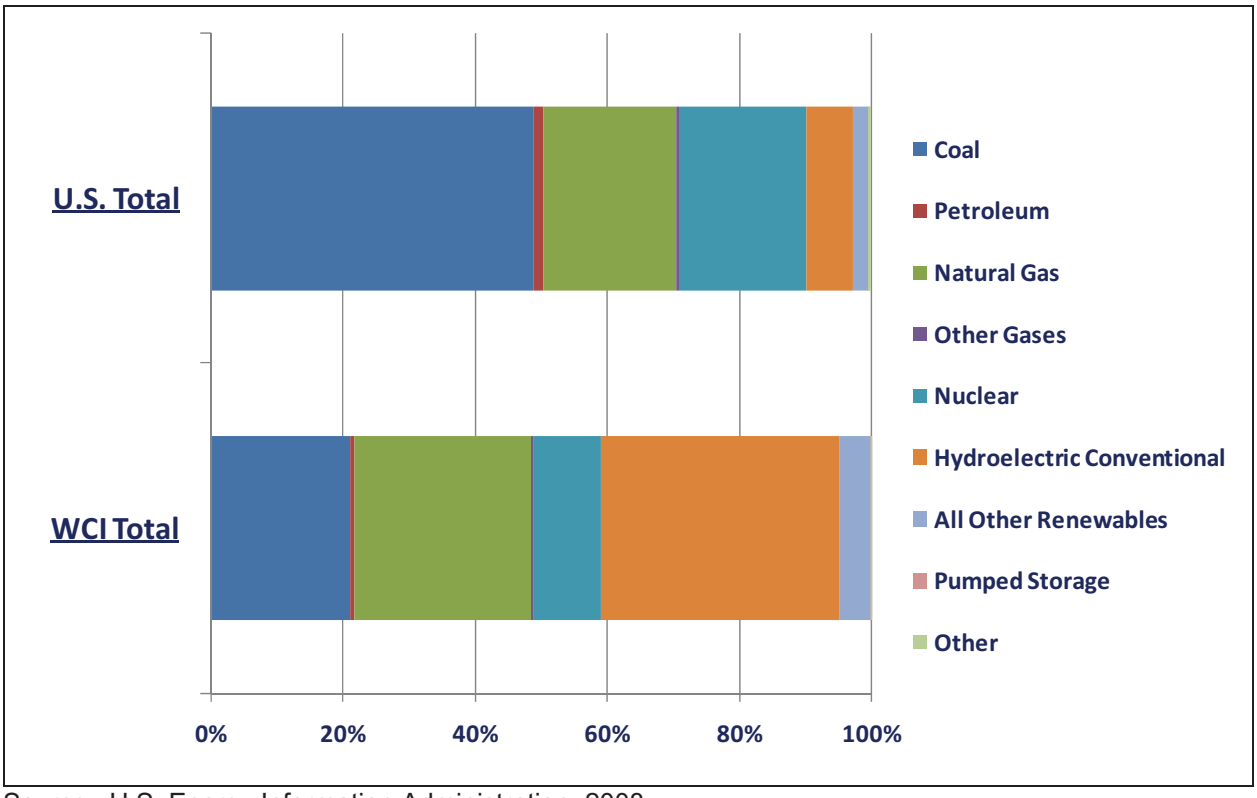
Chapter 9

The Dangers of Reducing Fuel Diversity

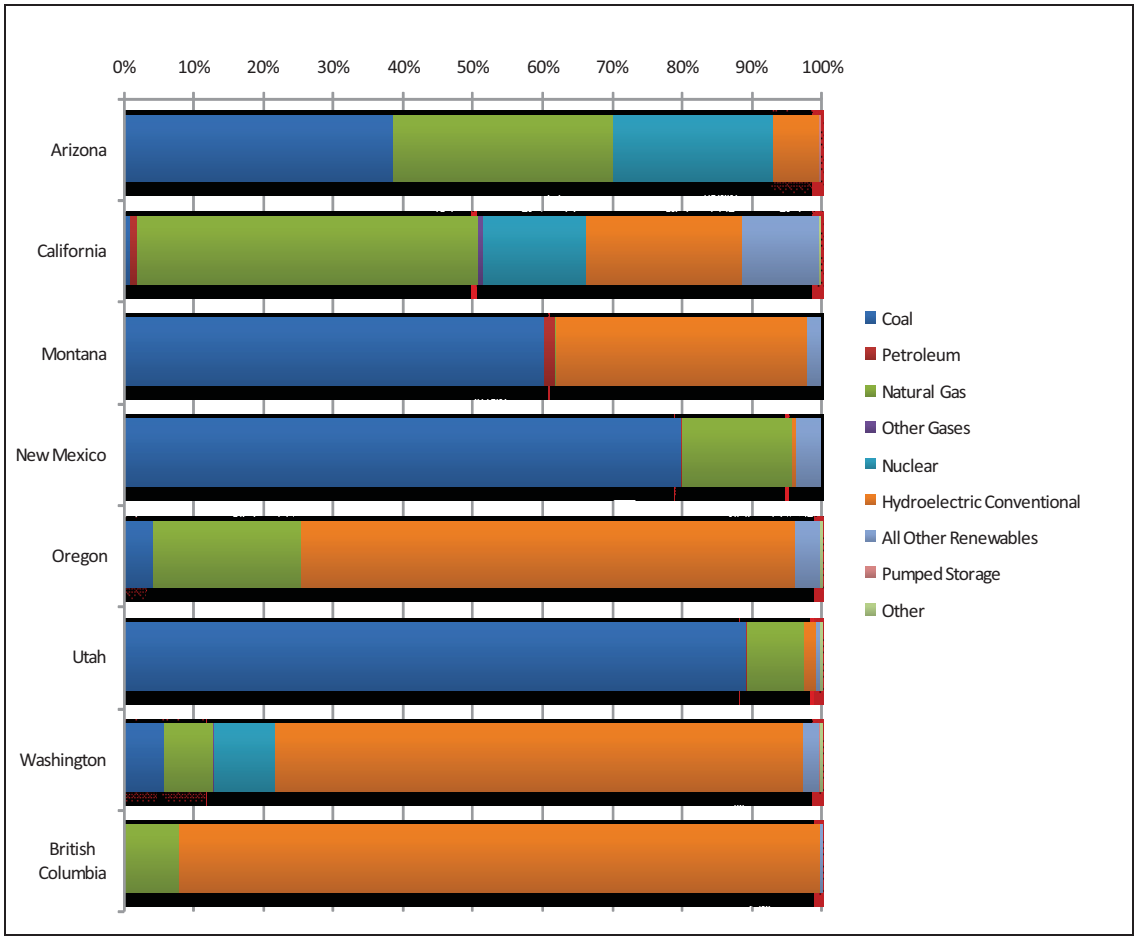
One of the most troubling aspects of the WCI plan is its reliance on an economic model that assumes that the West will see a dramatic reduction in the diversity of electric power production options until the year 2020 and will rely on largely intermittent power generation and demand-side management to meet expected load growth. The current energy resource mix utilized by the West is illustrated in the figures below.

Figure 9-1 Sources of Energy for Generating Electrical Power in 2006



Source: U.S. Energy Information Administration, 2008.

Figure 9-2 Sources of Energy for the WCI Jurisdictions, 2006



Source: U.S. Energy Information Administration, 2008, and Statistics Canada, 2008.

There are three demands that must be met by any large-scale electrical power system: High reliability, low cost, and minimal environmental impact:

1. High reliability means that electricity must be available on-demand as close to 100 percent of the time as possible within reasonable cost constraints. Any power system that is plagued by unreliability and frequent brownouts or blackouts will have very negative impacts on business activities as well as homeowners.

2. Low cost is a significant factor for all consumers. Industries for which electric power cost is important will not move into an area with high electric power costs, and companies already located in a high cost region may leave, if costs are significantly

above other regions. Power costs can thus be a significant factor in regional economic well-being.

3. Minimal environmental impact is a very important societal desire, but it is critical to recognize that environmental impact can never be zero, because every electric supply option has environmental negatives. Many of the drawbacks of electrical energy options can be decreased with various mitigation technologies, but all mitigation options come at a cost, and some can impact reliability.

Consider the most significant of the pluses and minuses of the major electric power options:

1. Coal is a high energy density fuel with a very large domestic resource base, and electric power from coal plants is reliable and low cost. Coal power plants emit a number of pollutants, however. Ultra-clean coal technologies exist but are more expensive than most existing coal plants. All coal plants emit significant quantities of CO_2, but CO_2 can be sequestered so as to not enter the atmosphere. Integrated Gasification Combined Cycle (IGCC) power plants emit essentially zero criteria pollutants and produce CO_2 in a highly concentrated form that is ready for sequestration. CO_2 production from early IGCC plants has value for enhanced oil recovery, but IGCC power is more expensive than existing coal plants.

2. Natural gas is clean burning with modest pollutant and CO_2 emissions, and electric power from natural gas is very reliable. Natural gas combustion emits CO_2 but less than coal. Conventional natural gas production in North America has been in decline for many years, but unconventional natural gas has risen to take up much of the slack. Liquefied Natural Gas (LNG) is available for import but at a substantial cost. In a very restrictive CO_2 regulatory environment, CO_2 from natural gas combustion can be used for EOR or sequestered. Natural gas electric power generation is low-cost as long as plants are operated a significant fraction of the time, however, as standby generators they are expensive.

3. Nuclear power has an excellent safety record over recent decades, electric power from nuclear plants is very reliable, and power costs from older plants are low. There are no CO_2 emissions in normal operation and minimal amounts associated with component manufacturing, fuel preparation, and plant construction. New nuclear plants will be expensive

compared to coal and natural gas generation, and the radioactive waste problem is not yet resolved.

4. Photovoltaics (PVs) emit no CO_2 during operation and minimal amounts during component manufacturing and plant construction. PV output is directly proportional to incident sunlight, so there is no power production at night and significantly reduced output during periods of cloudiness. PV power is thus intermittent, and to provide reliable power from PVs, either large-scale electrical storage or a companion power plant is needed to accommodate wide PV power swings. Large-scale electric storage is not economic except for pumped hydro, which is available in relatively few parts of the U.S. Using existing hydro facilities for electric energy storage would require them to be removed from the existing power generation pool. The costs of PV have been declining in recent years but are still quite high. PV economics are often not properly calculated, because backup power is usually assumed to be available at zero cost. Standalone PV power plants are made of relatively frail structures to minimize costs, so PV power systems can be damaged in violent weather. It is not clear that solar would continue to be developed at its current rate without generous tax incentives and other subsidies.

5. Wind power systems emit no CO_2 or other emissions, except during manufacturing and installation. Wind power output is proportional to the cube of wind velocity, so output can fluctuate dramatically and will drop to zero during periods of low-zero wind velocity. Wind power's intermittency and unreliability requires either large-scale electrical storage or a companion power plant to accommodate wide power swings. Wind economics are often not properly calculated because backup power is assumed to be available at zero cost. Wind power facilities are more mechanically robust that PV installations, but are still subject to damage in major storms. It is not clear that wind would continue to be developed without government mandates and tax and regulatory subsidies.

6. Solar thermal power systems produce electric power in direct proportion to the solar flux, but do not produce electric power during hazy or cloudy periods or at night. Solar thermal systems can utilize thermal storage, which is relatively inexpensive and which can provide electric power during short periods of cloudiness. Solar thermal systems emit no CO_2 or criteria pollutants during normal operation. Parts of solar

thermal power plants are made of relatively frail structures to minimize costs, so they can be damaged and rendered inoperative in violent weather.

7. Hydroelectric power systems operate with essentially zero emissions and are among the lowest cost electric power sources. They are considered very clean by many but are opposed by some environmentalists. Nevertheless, there are very few hydro sites available for new installations. Hydro can be used for pumped electric power storage, but to the degree hydro is so utilized, it is not available for electric power generation. Hydropower is dependent on precipitation, and there have been periods when hydro power in the west was inadequate to meet demands during periods of drought.

8. Biomass electric power is produced on a modest scale using wood and other wastes in situations where feedstock collection is paid for other purposes, e.g., lumber production and waste collection. Biomass is not used on a significant scale for electricity production on a standalone basis because of high costs and significant criteria pollutant emissions.

9. Electric power storage is currently only available on a large scale via pumped hydro, which is possible in few places. Efforts have been ongoing for decades to develop affordable large-scale electric storage systems such as compressed air and superconducting magnetic energy storage (SMES), but none have proven to be economically viable. If large scale, widely usable electric power storage were to become available, it would dramatically alter how electric power systems are configured, because it would allow all electric power plants to operate at full power at all times.

The current U.S. electric power system is comprised of a number of different electric power generators. Coal and nuclear generators operate in a reliable, base load mode because of their inherent reliability and low costs. Natural gas generators often operate in peak and intermediate modes because of their ability to follow time-varying loads. Because of the high reliability and low cost of these generators, the power grid can accommodate small amounts of intermittent power from wind and PVs. However, intermittent power contributions above about 15-20 percent of capacity cannot be accommodated without major upgrades in the grid system (e.g., the so-called "smart grid" concept). Even then, combined intermittent contributions above 20 percent are unlikely, and a contribution of 50-100 percent is impossible from a practical

standpoint. Power generation diversity is thus fundamental to the operation of the U.S. power grid.

The WCI plan to minimize the use of reliable, base load electric power generators (coal and nuclear) not only goes against worldwide experience in large power systems, but at high levels of intermittency, the approach is not viable operationally. Wind, PVs, and solar thermal are intermittent and inherently unreliable and cannot provide a viable grid backbone, which means inherently unreliable power delivery. Furthermore, if the Western states were to utilize existing hydro capacity for electric energy storage for intermittent power sources, related hydroelectric generators would be taken out of the reliable generation mix and would have to be compensated for by new power generators. In periods of drought when hydro capacity is reduced, such a system could become inoperable.

If the West builds little to no new natural gas-fired power plants, as the WCI's economic model assumes, the plan's renewables-only strategy for meeting demand growth in the West makes little sense.

Diversity of electric power sources is important and a significant backbone of base load generators is essential, not only for reliability but also to ensure reasonable costs to industrial and other consumers.