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The Path from Petroleum Shortages to Electricity Shortages

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It seems to me that there is likely to be a very short path from petroleum shortages to electricity shortages. There are a lot of issues involved, from the fact that the fuels used in electricity production are themselves dependent on petroleum for their extraction and transportation, to the current state of the US electricity infrastructure, to the impact of peak oil on debt financing. I have written about most of these issues before, but since the petroleum/electricity link is such an important one, I thought I would devote an article to putting the pieces together.

Fuels used for electricity generation

In the United States, the primary fuel used for electricity generation is coal, at 49% of electricity production. Natural gas follows at 22%; nuclear at 19%; hydroelectric at 6%, and petroleum at 1.6%. The newer renewables are all quite small: wood at 0.93%; wind at .77%; waste at .41%; and solar (for electricity generation) at 0.01%.

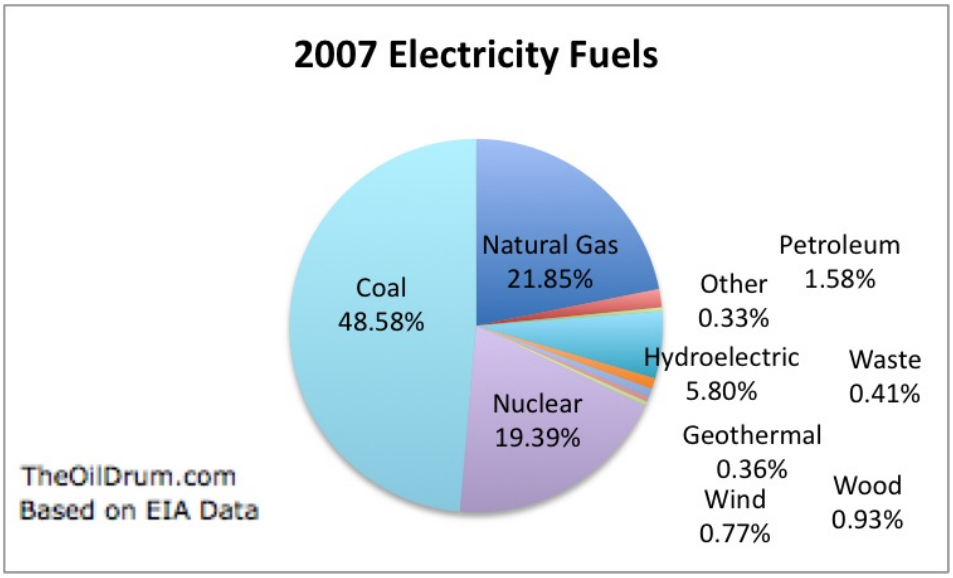

Figure 1. Distribution of fuel supplies used in US electricity generation, based on EIA data.

I see a number of reasons why there is likely to be a very short path from petroleum shortages to electricity shortages:

1. All of the fuels used today for electricity generation are dependent to some

extent on petroleum for their production and transport.

Unless there is an amazingly good allocation system, once there is a shortage of oil, of say, 20%, it is going to start affecting electricity production, because the oil deficit will start affecting fuels used for electricity production.

Electrical fuel dependence on petroleum

Coal. Surface mining uses large diesel powered machinery. Below ground mining almost certainly uses some diesel powered equipment, since diesel is so portable. Workers in mines use gasoline or diesel fuel to get to work. Transportation of coal is primarily by rail and barge, and these are petroleum powered in the US.

Natural gas. Drilling rigs are often powered by diesel fuel. Workers who visit wells to make adjustments drive trucks that use diesel or gasoline. Roads to the wells are maintained using diesel operated equipment. In arid places like Wyoming, the food that workers eat needs to be shipped long distances.

Uranium. Uranium mining is very volume-intensive, because it is only available in low concentrations. Earth-movers used to mine uranium use diesel fuel; the process for separating out the ore from the waste most likely uses petroleum as well. Once the ore is mined and suitably processed, it must be transported to the ultimate location, again using some form of petroleum as fuel.

Petroleum. If petroleum itself is used as a fuel, there is clearly a direct link between petroleum shortages and electricity shortages. In the US, petroleum is primarily used in Hawaii (since it is a group of islands) and for backup generation. Outside the US, there are many countries that use oil for power generation because oil is easy to transport and plants powered by petroleum are easy to build.

Wood or switchgrass. If biomass is used as a fuel, it must be harvested and transported to the place where it will be used. Diesel operated trucks and other equipment are currently used for this purpose.

Wind turbines. Wind turbines are very large. Roads must be maintained to transport the equipment to the site where it is used. Trucks are needed when maintenance is performed. If the turbines are located offshore, boats are needed for maintenance. Wind turbines must be serviced regularly because of wear and tear on the gearbox.

Hydroelectric. Needs less petroleum inputs than most. Petroleum is used for maintaining the transmission lines to the electrical power plant; for replacing parts of the hydroelectric dam when they wear out, and for dredging out the area behind the dam when it gets filled with silt.

Solar power generation. Today, solar generates only 0.01% of grid electric power. If solar power stations are situated in the desert to produce electrical power for the grid, oil is needed to transport the equipment to the desert location, and to bring food for the workers. Oil is needed in the initial manufacture of the equipments, and for building and maintaining transmission lines.

Geothermal. Less oil dependent than most. Oil is needed in building the initial station,

for making and transporting replacement parts, and for maintaining electrical transmission lines from the plant.

2. If there is a shortage of oil, people will tend to substitute other fuels for petroleum. This substitution is likely to lead to other shortages.

We have already seen how a plan to use biofuels as a substitute for gasoline can result in higher food prices. There has been considerable discussion of using cellulosic ethanol as a liquid fuel. If wood and other biomass are used to produce cellulosic ethanol, there are likely to be shortages of these fuels for powering electric generation.

Petroleum, coal, natural gas and nuclear are used for electricity generation around the world. Once petroleum is high priced or unavailable, power companies are likely to switch to other forms of electricity generation, at least for their new power plants. Because of this, it is likely to become increasingly difficult to buy uranium, coal, and natural gas for use in power plants.

T. Boone Pickens and others have talked about using natural gas as a transportation fuel. This is also likely to put pressure on available natural gas supply for electricity.

Even apart from the substitution issue, many forecasts say that other fossil fuels will peak not many years after petroleum supply peaks.

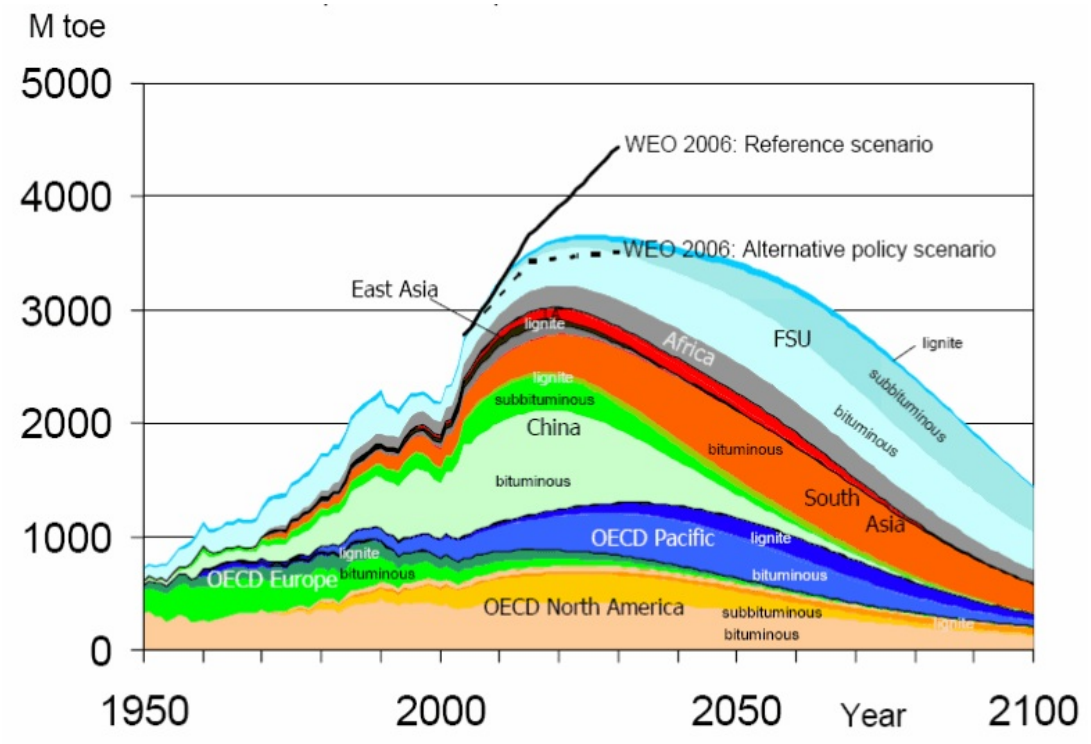

Figure 2. Worldwide possible coal production, according to Energy Watch Group

3. Our electrical infrastructure is very dependent on petroleum inputs.

Our electrical infrastructure includes transmission lines and transformers, among other things. Many components of the transmission systems are reaching the ends of their normal life spans, and will need replacement in the next few years. Outages are also expected because of storms.

In order to service these transmission lines and generators, replacement transmission lines and generators much be built and transported to the location where they are needed. Workers need trucks and roads to do the servicing. All of this requires considerable petroleum use. If transmission lines are to be expanded because of addition of new wind or solar or nuclear plants, this also requires petroleum.

4. There is a substantial chance that petroleum products available will suddenly decline by a large percentage (more than 20%), rather than just the small annual increment one might expect that results from the world decline in oil production.

There are really two issues with oil availability--the worldwide decline, expected to begin in the next few years, and a decline in the US ability to import petroleum products. Of the two, the decline in the US ability to import petroleum products is probably the bigger issue.

We have lived in a world where the United States uses 24% of the world's petroleum products for such a long that it seems like this is the natural order of things. The problem is that we are no longer exporting very many goods to pay for this oil, and our balance of payments situation is getting worse and worse. Our financial situation is worsening. There is a substantial chance that the value of the dollar will drop sufficiently that we will not be able to afford to continue our big share of world oil supply.

There are other ways that the amount of oil we are able to buy might decline, also. Geopolitical forces may eliminate some production, or may change the amount we are able to purchase in the open market.

5. Shortages of petroleum products are likely to occur in unexpectedly, in places where it hurts the economy.

In an ideal situation, shortages of petroleum products will only affect consumption in places that it will have no negative impacts elsewhere in the economy--for example, will not reduce natural gas production, or will not affect our ability to produce food and water, and transport it to those who need it.

In practice, it would be very difficult to design such a system. Diesel is likely to be in especially short supply, because it is used for so many commercial and industrial purposes. If its use is allocated based on who is able to pay the most, there is no reason to believe that those who will make the best use of the oil will receive it. For example, many small truckers who are involved with food delivery are likely to be priced out of the system.

If oil use is allocated by a governmental organization, they may do a bit better, but it still will be very difficult to get the oil to the those who will make the best use of it. Supply chains are so long and complicated that it is difficult to foresee what impact a shortage for one particular user will have, as it works its way through the system. Even with the best intentions, allocation schemes designed by government agencies are likely to undersupply users who are critical to the system.

As a practical matter, I think that what we will see is a lot of local outages, based on logistical issues. People at the end of the pipeline will find that there is not enough oil left by the time it gets to them. A particular refinery will not be able to get enough oil, and the people in the area of the refinery will discover themselves without enough gasoline and diesel, because the refinery was not able to purchase adequate fuel, or was not able to make repairs after an accident, because of missing parts. A pipeline operator (or refinery) will go bankrupt, and there will be no substitute available. We have already seen unplanned outages in North Dakota and Winnipeg.

There were also problems with oil shortages after Hurricane Katrina hit. The problem in this situation was electrical outages along the Colonial Pipeline. In order to get the pipeline moving again, it was necessary to bring generators to the pipeline and use oil from the pipeline to generate electricity to operate the pumps.

6. With increased petroleum shortages, we should expect more and more gaps in petroleum supply. If these gaps become widespread, they are likely to trigger further loss in electrical fuels.

Suppose that petroleum products become unavailable in Appalachia, because of a pipeline problem. This could affect the production of coal. If there is an outage in Wyoming, it could affect the production of both coal and natural gas. A gap in petroleum supply in the New York City area could bring all kinds of businesses to a sudden stop, and this could lead to all kinds of indirect impacts, which ripple from one sector of the economy through to other sectors of the economy.

7. If we start having electric supply disruptions, these disruptions are likely to start chain reactions of disruptions of other types.

I mentioned earlier the problem with the Colonial Pipeline after Katrina, because of electrical outages. Most oil pipelines and many natural gas pipelines use electricity to pump the product. Gas stations also use electricity to pump gasoline. Because of these connections, an area without electric power is likely to find itself without petroleum products as well, in a fairly short a time period.

If oil is not available in an area, industrial agriculture in the area is likely to cease. Truckers may not be willing to make deliveries, if their trucks cannot get refueled.

8. While it is theoretically possible to get around a lot of oil shortage problems by building new infrastructure, as a practical matter this is not likely to work, because of timing, the enormity of the project, and our current financial problems.

Theoretically, there are a lot of things one could do to circumvent oil shortages. One could build electric cars for transportation. One could build electric powered machines to mine uranium. One could replace our current truck transportation with much expanded railroad transportation.

Even in the best of times, it would be a monumental undertaking to make a transformation from one type of infrastructure to another. It would likely take a very long time--certainly more than 20 years, based on the Hirsch Report. With our current financial situation, it seems like such a transformation is pretty much out of the question. We have been reading recently about the fact that lenders are becoming less and less willing to make loans. This will make financing new infrastructure more difficult.

In the future, the US governments and state governments are likely to be in poorer and poorer financial condition, based on my analysis of the US current financial situation. Local governments will find their revenues dropping as house prices drop. The federal government will find itself increasingly asked to cover debt shortfalls of a lot of different organizations (Fannie and Freddie, banks, insurance companies, pension funds, airlines, auto manufacturers). This will leave little left over for building new infrastructure.

Because of all of the foregoing issues, I expect that we will encounter electrical difficulties within twenty years. The timeperiod may even be much shorter than this..

Any kind of change we want to make to the country's infrastructure to better prepare us for the future will take a very long time--most likely 30 to 50 years. Perhaps, with great effort, we could make a transformation in 20 years.

The issue I see is that if we know we are very likely to have electrical difficulties within twenty years, it does not make sense to start a transformation to a more electrical society. For example, if we start building a lot of electric trains, we are likely to discover that that we don't have the electricity to operate them when they get built. It seems like we would better off figuring out what resource base is likely to be available thirty to fifty years from now, and gearing our efforts accordingly.

It seems to me that the model we should be envisioning for future electric supply is *local* electric supply.

People talk about making food production more local. I think that in the long run, whatever electricity production we have will be primarily local. It seems to me that much hydroelectric power can continue for many years, if we make plans to maintain it. We may also be able to maintain geothermal power and power from photovoltaic cells, if the PV cells have a sufficiently long lifespan. There are likely to be many parts of the country without electricity.

I doubt that coal-fired power stations will still be available, except possibly in areas where coal is produced. (If there is a shortage, those closest to where it is produced are likely to get the output.) Electricity from natural gas may be available near natural gas supplies. Nuclear will probably not be available, because of all of the issues of mining and importing. Back-up batteries are not likely to be available for PV or other use. All of these have very long supply chains, and these are likely to be broken as electric outages become more common.

We need to be looking closely at what is really feasible, and aiming for that level.

With the limited amount of electricity available from local production, our ability to manufacture things will be much reduced. We will need to prioritize what we do manufacture carefully, so as to have the basics covered--food, clothing, heating, and basic transportation. I doubt we will be able to count on imports for very much of our basic needs.

It seems to me that we should be analyzing the situation closely, and developing plans that will work, based on what has worked in the past. We should be thinking about raising more draft animals and building small windmills to pump water. We should be thinking about building bicycles, if we can get all of the necessary components locally sourced. We should be thinking about what infrastructure is really essential (fresh water, hydroelectric dams, geothermal electricity, basic roads), and taking steps to maintain it.

I think the danger is aiming too high, and ending up with virtually nothing that works.