Timing: Can Emissions Reductions be Frontloaded?

Becoming carbon neutral over the course of thirty years is a vital goal; but reducing emission by only 33% during the first ten years may not be fast enough. Fortunately, because much of the infrastructure being replaced lasts much less than thirty years, the bulk of emissions reduction will occur towards the beginning. Renewable sources may be phased in a bit faster as well. And a few inexpensive additional steps may frontload the process further.

The First Ten Years

How much can we cut in the first ten years? (For the sake of the calculation, we assume a period from 2010 to the beginning of 2020.)

Transportation accounts for 27% of energy used. One third of the way into the transition we could cut a surprisingly large amount. Electric and Hypercars can be prototyped very rapidly once a decision is made to build commercial models; Electric and Hypercar factories are also faster to build than normal automobile plants. So you might actually have cars rolling off the factory floor within five years of deciding to start. Certainly regulators could insist that all new hybrids be plug-in hybrids. Possibly they would insist that plug-in hybrid efficiency was the minimum standard that would be accepted for any new car made or sold. Ideally that standard would increase to Plugin Electric Hypercars levels as quickly as possible.

CyberTran, and various Personal Rapid Transit (PRT) schemes have been alpha tested. You need to do competitive beta testing by setting up small commercial lines of each, to see which works best in day-to-day operations. During beta testing, you could simultaneously plan sign track locations in each major urban and suburban area, even obtaining easements and buying property, waiting until a system passed all real world tests to create final designs for each location. Still it would be four to six years before laying of track for major ultra-light rail systems could begin; once begun ultra-light rail can be constructed much faster than normal light rail. But most likely CyberTran (or some PRT if that proved better in practice) would be just beginning operation in year eight or nine of the transition. We would also have done a buyback of the worst fuel-hog junkers on the road, providing efficient automobiles to people who currently get 17 mpg or worse in things that barely run.

Autos have a twenty year life cycle; but they are usually down to traveling a few thousand miles a year or less by the end of thirteen years. So we would have replaced about 40% of the ones traveling the longest distances by the end of ten years. Many of those replacements would be electric cars that get eight times the mileage equivalent of conventional cars; some would be plugin hyper cars that get seven times the mileage. But even before this we would have begun phasing in plug-in hybrids which produce half conventional emissions.

When it comes to heavy trucks we can do even better. Freight trains need no Beta testing. And there is no reason to take 30 years to encourage a switch from truck to rail. Lay the tracks; put in the switchyards; build freight yards. Containers that can travel equally well by rail or truck are pretty routine, so if rail can get it most of the way, trucks can handle the first and last fifty miles. Put some of the 150 billion a year we have proposed allocating into this, and there is no reason we can't come close to eliminating long distance heavy trucking by the end of ten years. The same applies to savings in water transport as well; the potential is modest, but given that ships are one of great unregulated sources of air pollutants, there is no reason the modest savings there can't be phased in pretty quickly - paid for by air pollution reductions.

We can incorporate a modest portion of airline improvements too. We won't have CyberTran operating to replace short flights yet. But, there is no reason we can't put into place the operational efficiencies or the more advanced telecommuting.

Reductions in material intensity and energy use through the tenth year should lower the volume of freight shipped, and of fossil fuels pumped through pipelines by one third in the first ten years. In addition there is no reason the full 14% savings via operational efficiencies in pipelines should not be implemented within the first decade.

So we should end up with about a 39% per capita reduction in transportation emissions just from efficiency improvements. After allowing for population growth, that means total consumption would be down to 20 quads. Not bad for the first ten years of a thirty year program in a sector where a slow ramp up is unavoidable.

What about residential buildings, which account for about 21% of energy use? There is no reason adequate insulation and weather sealing should not be complete for every home in the U.S. in ten years. Windows and appliances will be replaced as they wear out; but lifespans imply that in ten years we will have replaced two thirds or more of these. New buildings will have to meet standards from day one. On average we should be over 70% through the efficiency cycle in residential buildings – which means per capita consumption in residences should be down 48%+. Allowing for population growth this means at the end of ten years, in 2020, residential consumption will be a bit over 13 quads.

Commercial buildings undergo full rehabs at least every 25 years. So a bit less than half of existing commercial buildings will have undergone full efficiency upgrades; 100% of new buildings will have to meet the new standards; so commercial buildings can be about 50% of the way through their possible savings in 10 years. Since total savings for commercial buildings is 70%, that means a reduction of 35% per capita; allowing for population growth, consumption will be 13.4~ quads.

However we could also develop about 50% of low temperature active solar potential by then, giving us another 3.3 quads – reducing combined consumption in commercial buildings to around 10.1 quads. (If some of the low temperature solar thermal proves impractical, we could put in additional wind without storage, and let the buildings use this "off-peak" wind energy to produce heat they would store in PCM, natural zeolites, or plain old thermal mass.)

Industrial equipment has an average lifespan of 20 years. In spite of the exceptions that are longer, the weighted average is much lower than that, because of the huge number with shorter lifespans. So when it comes to direct energy savings, there is no reason at least half should not be instituted within ten years. Changes in material intensity should be able to take place as fast or faster. So per capita industrial consumption should be reduced by 37.5 % over a ten year period; net industrial consumption should be less than 27 quads.

Total emissions in the three sectors combined will be about 70% of what was released in 2000. Energy consumption will be a bit higher than that of course, due to active solar.

But we can lower this a bit further. Around 35% of carbon equivalent emissions are generated from electricity production. (These, of course, are already included in sectorial reductions; we can't count them again.). But we could speed up decarbonization of our electrical grid -- massively deploying wind and solar and long distance transmission and storage, so that we phase out anther 25% or 30% of 2000 consumption. That would cut fossil fuel use for electricity production by more than half, and (if we phased out coal before phasing out other fossil fuels) about 60% of total electrical emissions. That would represent another ~10 quads over the savings from efficiency alone. That would bring total emissions reduction to around 40% - during the first ten years.

In addition we might get some reduction from carbon sequestration in the soil from "energy prairies", cultivation of glomalin in no-till agriculture, and the use of charcoal soil amendment. I'm very suspicious of counting soil sequestration in the long run; we don't know how long carbon in the soil stays in the soil. But if this works the way a lot of very smart people think it will, we could get another 2%

The Second Decade

How about the second ten years? CyberTran (or some electrified light or ultra-light rail system) will be complete; pre-efficiency standard autos will be 15 or older; most will be driven fewer than 1,200 miles a year. So transportation efficiency improvements will be 99%+ complete. The same will be true in residential buildings. 80% of existing commercial buildings will have finished their rehab cycle, and the remaining ones will have five years left at most; a short enough time to economically justify a premature rehab on grounds of energy savings and efficiency improvements, given higher energy prices at the time. Industry will similarly be through its 20 year equipment replacement cycle. Since this is an average, significant equipment will remain. But it is unlikely that this will represent a great deal of energy. Material intensity improvements should be complete – at least to the factor-four level we projected, though there are good reasons to support further ones. There is no reason 95% of efficiency improvements can't be in place.

What about supply? With only a few efficiency improvements remaining, all the supply improvements should be phased in as well. The saving from efficiency improvements will be more than enough to justify developing 100% of the renewable potential outlined. So we will have reduced fossil fuel consumption to about five quads or fewer at the end of 20 years. This is around a 94% reduction in absolute total. Since consumption will be small enough to consist entirely of natural gas, that should be better than 95% reduction in net emissions - especially since glomalin cultivation combined with low input farming should convert agriculture to a small carbon sink. Since population will be greater, the per capita reduction will be better than this.

The final five quads of fossil fuel consumption, or as much of it as necessary, could be eliminated over the remaining ten years, as additional efficiency savings and increased renewables reduce the need for natural gas.

Somewhere in this thirty year process we will get some sort of breakthrough. That is not speculation. It is certainly. While it is speculation to guess what that improvement will be, will either find cheaper renewable methods to generate some of this energy, cheaper methods to store this energy, or cheaper methods to save even more energy. Probably we will find all three. But note that even ignoring this we have the means to get off fossil fuel.