

White Paper:

**Alternative Interim Energy Strategy for Transportation**

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We believe that there is a national consensus that the US has to become independent of oil as the primary energy source. This is particularly true for transportation, where no good alternatives exist. The oil reserves in the US are declining and oil now has to be imported from abroad, quite often from countries that are not friendly to the USA. Of course, worldwide, new oil deposits are discovered, but in most cases the costs of extracting oil are increasing, so that there will be a long-term trend for oil prices to increase. With raising oil prices the price of liquid fuels (e.g. gasoline) will increase as well. Long term, the US is more and more counting on alternative energies such as wind, solar, water (ocean waves and tides), geothermal and others to take over. However, these alternative energies are currently not cost effective or they have to be highly subsidized by the US government. An alternative energy that could provide a majority of the US energy needs at costs equivalent or lower than the cost of fossil fuels is nuclear energy. However, the long term disposal problem of spent fuels is not solved and the political will to go that route is not there. Also, the problems at Japan's Fukushima nuclear power plant do not help. Other potential alternative energy forms such as bio-fuels present a host of other problems. For example, commercializing bio-fuel derived from corn drives up the price of corn (used by many as food), contributing to inflation.

Everybody seems to agree that the USA should become independent of oil as the primary energy source, but what alternative energy forms should be pushed is not clear. In other words, there is a **critical need** to move the USA toward energy independence, i.e. to not depend on imported oil, but it may take a very long time to commercialize any alternative energy source (even if we knew which one to push). There will be a time when we run out of oil or when oil will be very expensive or when we will have political problems due to our oil imports from unfriendly nations. In other words, we believe that an interim energy strategy is needed. This is not being addressed, but it could be addressed through high-risk, high-reward research sponsored by the government.

Becoming energy independent is also a **societal challenge**. If the problem of an interim alternative energy strategy is not being addressed, it could negatively affect the overall function and quality of life in the USA. Oil prices will increase and with them the price of liquid fuels. It will take too long for solar, wind, geothermal or ocean wave technology to mature enough to replace oil as the primary energy source. There will be a time period (perhaps 10 to 20 years) where we still depend on liquid fuels (e.g. gasoline) for transportation. During that interim period, gasoline will be very expensive and this will impact the life of every person in the USA. As an example, much effort is currently expended to develop a hydrogen based automobile or an automobile driven by electrical energy. However, there are major obstacles to be overcome for these two innovations to take hold. For example a new infrastructure for hydrogen cars has to be built and technical problems with storage of hydrogen have to be solved. Safety issues have to be addressed. No good solution for batteries in electrical cars exists yet. And electricity

has to be generated in power plants that are currently operated by burning fossil fuels contributing to global warming through CO<sub>2</sub> emissions. Nuclear power stations could be used for providing electricity to power electrical cars, but, as mentioned above, we believe that there is no political will to build enough nuclear power stations to make a difference and safety issues and disposal problems are not solved yet..

An effective interim alternative energy strategy, if implemented in time, will have **transformational results**. People will adapt to this new energy form provided it is cost effective, available when needed and user friendly.

Although DOC and TIP should be open to any new ideas on an interim alternative energy strategy, we will propose an example.

Example: Coal to liquids technology. The US has plenty of coal. Its coal reserves are estimated to be 275 billion tons which will cover the energy needs of the US for more than 100 years even if energy demand increases. Coal is currently mostly used to operate coal fired power plants that produce electricity. It is well known that coal fired power plants are the major source of CO<sub>2</sub> emitted into the atmosphere that contributes to global warming. A recent study has shown that, since 2006 and as a country, China is the number one emitter of CO<sub>2</sub>, but the US is number 2. On a per-capita basis the US is by far number one with about 20 tons of CO<sub>2</sub> per person per year discharged into the atmosphere.<sup>1</sup> The world average is 5.3 tons, while China is at 5.8 tons per-capita per year. Technology exists to capture CO<sub>2</sub> and store it underground. However, this technology is expensive and not used to the extent required. Proposals to tax companies that emit CO<sub>2</sub> or to allow cap and trade are only postponing the problem and do not offer a real solution. Also, the electricity produced by coal fired power plants cannot currently be used for transportation. Electrical cars are way off in the future and no solution exists to power airplanes with electricity.

A real interim solution for transportation would be to turn coal into liquid fuels. A process to do this was developed by Franz Fischer and Hans Tropsch in Germany in 1923 and used by Germany and Japan in World War II to produce alternative fuels. Germany and Japan have coal reserves but no oil. This Fisher-Tropsch (FT) process was further developed by South Africa in the 1960's when South Africa was cut off from world oil supplies. South Africa, again, has coal reserves but little oil. There are various ways to liquefy coal. It can be done in a single step or in two steps. In most cases catalysts have to be used. The FT process turns coal into a gas that is then liquefied.

An interesting interim alternative energy strategy would be to develop a process to liquefy coal, i.e. to turn coal into liquid fuels that can then be used for transportation. This process should not use catalysts because we do not want to just shift the problem to become a supply

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<sup>1</sup> The Associated Press, 11/18/2009

problem of scarce or expensive catalysts. Catalysts can in principle be recycled, thus reducing cost, but they wear out and need to be replaced periodically. There is a good chance that a catalyst-free FT process can be developed since some of the intermediate steps in the chemical reaction are exothermal and the FT process could be run at high temperatures. The FT process also has to be scalable in order to be a true alternative to liquid fuels such as gasoline.

An effective Coal to Liquid (CTL) fuel strategy has the following advantages: A CTL plant can be built in remote areas where there is plenty of wind power (e.g. Wyoming) or solar energy (e.g. the Southwest). As is well known, both wind and solar energy sources have the problem that they are intermittent (the wind does not always blow and the sun does not shine at night) and electrical energy cannot easily be stored. However, liquefied coal such as gasoline can be stored in storage tanks. A second advantage of the proposed interim strategy is that no new electrical transmission lines have to be built. High voltage transmission lines are expensive (a 765kV transmission line costs \$2.6million per mile<sup>2</sup>) and ugly. The proposed technology can use the existing infrastructure to transport gasoline, e.g. pipelines, tankers, railway cars, etc. Also, gasoline has a very high energy density.

We believe that an interim alternative energy strategy is needed for the US. The proposed technology has major hurdles that have to be overcome, that means, it is high-risk and high-rewards. Catalysts in a Fisher-Tropsch type process have to be avoided and the process has to be scaled up to make it worthwhile. We also believe that major new elements have to be introduced into a process that is about 70 years old.

We realize that the proposed technology is not a long term solution. Coal, also more abundant than oil, is still a limited commodity. Using liquefied coal as a transportation fuel still contributes to air pollution and global warming. However, as an interim solution it may work.

We propose that TIP solicits proposals for an interim alternative energy strategy to cover the gap expected between the current use of gasoline powered cars and airplanes and a true long-term solution probably based on hydrogen or electrically powered cars and airplanes. We consider the current push to bio-fuels not an attractive intermediate solution.

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<sup>2</sup> Matthew L. Wald, "The power of Renewables", Scientific American, March 2009, pp.56-61 (2009).