

## CELLULOSIC ETHANOL RANGE FUELS

**“Cellulosic ethanol will typically have twice the ethanol yield of corn-based ethanol, at lower capital cost, with far better net energy yield.” Could you elaborate on “lower capital cost” and “a better net energy yield”?**

Numerous studies have shown that ethanol has a positive energy balance, particularly when compared with gasoline. According to the US Department of Energy, it takes 1.23 units of fossil energy to make one unit of gasoline – an energy cost of 23 percent. In contrast, corn ethanol delivers 20 – 50% more energy than it takes to produce, and cellulosic up to 600 % more..

Our focus on efficiency goes beyond how we produce ethanol - it also extends to where we produce it. Our distributive design lets us bring systems to sources where biomass is most plentiful, instead of having to transport biomass to a central processing site. This reduces transportation costs and related transportation fuel consumption. Our modularity also allows the system to grow as more biomass becomes available. Simply adding another module - which is easy to ship and install – immediately doubles the output. We put our systems where they are needed, in just the size that is needed.

**In fuel terms - what can it substitute and how “implementable” is this technology - ie need to re-design cars, manufacturing processes?**

It has potential to substitute fossil fuels, not just in cars, but also in industrial and manufacturing processes where gasoline is used. However, transportation-led gasoline consumption is amongst the highest and to that end, without any amendments, cars can already substitute 10% of their gasoline consumption with cellulosic ethanol. With a USD100 manufacturing change, it can run on 85%ethnol and 15%gasoline. I have such a Flexfuel car and tank up on ethanol wherever I can.

**What are the risks... resistance?**

This is a new, technology - just beginning to develop its potential. Infact, ours will be the first cellulosic ethanol plant anywhere in the world. It has entailed a lot of R&D, innovation and costs several 100ml Dollars to build.

Until economies of scale are realised, currently it will cost about the same as corn about USD1.50 - 1.60 per gallon. However, the cost to produce cellulosic ethanol will go down as the industry implements new technologies and efficiencies.

**What has been your assessment of the availability of renewable and sustainable cellulosic feedstock?**

The US Department of Energy, in their joint report with the USDA, has identified over 1 bn tons of biomass

annually that could be converted to biofuels, like ethanol. Our technology can transform all of this biomass, including wood chips, agricultural wastes, grasses, and cornstalks as well as hog manure, municipal garbage, sawdust and paper pulp into ethanol. The company has already successfully tested close to 30 types of biomass for producing ethanol.

Our technology completely eliminates enzymes which have been an expensive component of cellulosic ethanol production. We use a thermo-chemical conversion process - the K2 system, which uses a two step process to convert the biomass to synthesis gas, and then converts the gas to ethanol. In addition to the ability to process a broad range of potential biomass feedstock, the K2 system benefits from a modular design. Depending upon the quantity and availability of feedstock, the K2 system can scale from entry level systems to large configurations. This range of system size allows placement of the K2 near the biomass source reducing transportation costs, and will allow the most appropriate size system to be deployed.

**Do you believe cellulosic ethanol will eventually be traded as fossil fuels do today (futures contracts, etc.)?**

Without a doubt – and as soon as the supply for cellulosic ethanol comes on line. But it will take time, as our first plant will only be completed in 2008. So perhaps 2010, might be more realistic?

**How can investors allocate capital? Is private equity the only route? What other vehicles are available?**

Currently we are privately financed (Vinod Khosla founded Range Fuels through his firm, Khosla Ventures) and it has been via the private equity route. However, as we progress from our start -up phase we intend to enter the public market.

Ground breaking will take place this summer in Treutlen County, Georgia for a 100-mn-gallon-per-year cellulosic ethanol plant that will use wood waste from Georgia's forests as its feedstock. Phase 1 of the plant is scheduled to complete construction in 2008 with a production capacity of 20 mn gallons a year.

**Comments / thoughts...**

This technology will scale, ethanol will be competitively priced and be a significant option compared to gasoline. We also put up these plants in rural economies, so they help create jobs. Even more encouraging, waste products – material left to decay and be buried in our land today – can be recycled into fuel tomorrow. Our new fuel is innovative, eco-friendly and sustainable.



**Mitch Mandich**