

Scale+Performance

World-class capability in high throughput, large scale fermentation delivers performance-adding value to everyday products

Who is Central Minnesota Renewables (CMR)?

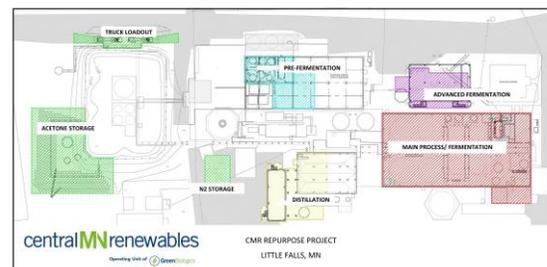
Minnesota has a wide range of raw material resources and leadership that recognizes the balance between sustainable resource management and innovation. The combination of agriculture resources, infrastructure, and an established history of success in ag-based business growth, make Minnesota the ideal location to introduce next generation bio-based products.

CMR is a repurposing of Central Minnesota Ethanol Cooperative (CMEC) in Little Falls, and just as CMEC is a pioneer in renewable fuel, CMR will be a pioneer in bringing renewable acetone and n-butanol to the chemical ingredient marketplace. The repurposing project will have minimal impact on the existing

centralMNrenewables plant and operations and is a relatively straightforward conversion between ethanol fermentation and the

fermentation of Acetone, n-Butanol, and Ethanol (ABE). Existing fermenters will use *Clostridia* to replace yeast as the biocatalyst agent that digests and converts sugar to alcohols and solvents. New distillation equipment will be required, but most everything else at the plant will be re-utilized in the new process

chain. Because changes are small, engineers can carefully design the upgrades around existing ethanol operations so that during construction, the plant can continue to operate in full production mode. The diagram here depicts the limited site impacts, with pads and new equipment shown in red, and new enclosed process additions shown in green.



A brief shutdown is scheduled for 2016 to make the tie-ins and the change-over necessary to deploy the new process. The current skilled work force will be trained in the new process areas and most CMEC vendors, suppliers and service providers will continue to enjoy on-going business with CMR. Once complete, CMR will produce commercial-scale volumes of high value chemicals that serve as raw materials in many popular consumer goods.

Acetone and n-butanol are chemical building blocks essential for the manufacture of a broad range of products. N-butanol is in a variety of moisturizers, emollients, and fragrances used in cosmetics and personal care products. N-butanol derivatives are also used in paints, coatings, adhesives, sealants, and inks. Other n-butanol applications include food and beverage flavoring and in making nontoxic alternatives to synthetic plasticizers. Acetone is a common chemical found in nail polish and paint remover. It can be easily transformed into isopropanol, or rubbing alcohol, and similar to butanol, can be used as an ingredient to make valuable flavor and fragrance compounds.

Nearly 100% of the global market for n-butanol and acetone is supplied through petroleum derived sources. Prior to the growth-leap of the petroleum industry in the 1940's, chemical n-butanol came from fermented molasses. Cheap oil offered a cheaper source, displacing ag-based production. With proprietary advancements in biology and chemical engineering, Green Biologics offers a technology solution that can again compete with the petro-based market. So in essence, CMR represents the next generation of chemical production: renewable chemicals from sustainable raw material sources. In addition to having at least a 45% greater carbon efficiency during production than the petrochemical processes, Green Biologics' ABE fermentations produce higher purity materials. CMR n-butanol will have lower water content and none of the common hydrocarbon impurities intrinsic to the methods used by oil refineries. Similarly, the acetone produced at CMR will be free of toxic impurities common to oil-derived alternatives.

Having been named a CleanTech 100 company, #28 Hottest Company in Biobased Chemicals and Materials, and #6 Hottest Smaller Companies in the Advanced Bioeconomy, Green Biologics is a recognized leader in this technology and is excited about having Minnesota as the location of our commercial launch. CMR will be our flagship facility and join a world-leading cluster of renewable chemical companies including Segetis, Natureworks, and BioAmber. Minnesota companies have attracted nearly \$200 million in venture capital funding in recent years, received more than \$1.6 million in federal SBIR grants, and been issued more than 200 patents and patent applications. The state has clear ambition to attract innovation and with a potential agriculture residue resource of 15 million tons per year, Minnesota stands poised to be a leader in renewable chemicals and products derived from sustainable biomass sources. CMR looks forward to taking its place in the Minnesota renewable chemical community and being a founding member of the movement.



Central MN Renewables – A Pioneer in Renewable Chemicals