



MANTRA ENERGY ALTERNATIVES LTD



use amount system world
efficiency storage Agency Wind current
Recyclable may MW million Tidal
sources
Renewable
fuel terms

ERC Technology

Our Mission

CCR and ERC

CCR: Carbon capture and recycle strategy is an alternative to the CCS technology

ERC: Electro reduction of carbon dioxide, Mantra Energy's core technology for accomplishing CCR

Mantra Energy Alternatives Ltd. ("ME") will be a world leader in the development of commercially viable, sustainable CCR (carbon capture and recycling) to manage the impact of human activity on the increasing level of carbon dioxide in the atmosphere; this in turn will minimize the impact on our climate, environment and health. Our ERC (electro reduction of carbon dioxide) technology is the core component of our CCR strategy and will make a key contribution to environmental sustainability. ME's aggressive growth strategy has driven a sharp increase in value and will continue to do so.

ME's competitive advantage lies in its ability to flexibly pair together investment and scientific expertise, and to guide promising new technologies thru development into the market and full commercialization. We are based in the Pacific Northwest, a hotbed of innovation in sustainability, an ideal location from which to acquire revolutionary technologies, incubate and commercialize them.

The Need for Carbon Recycling

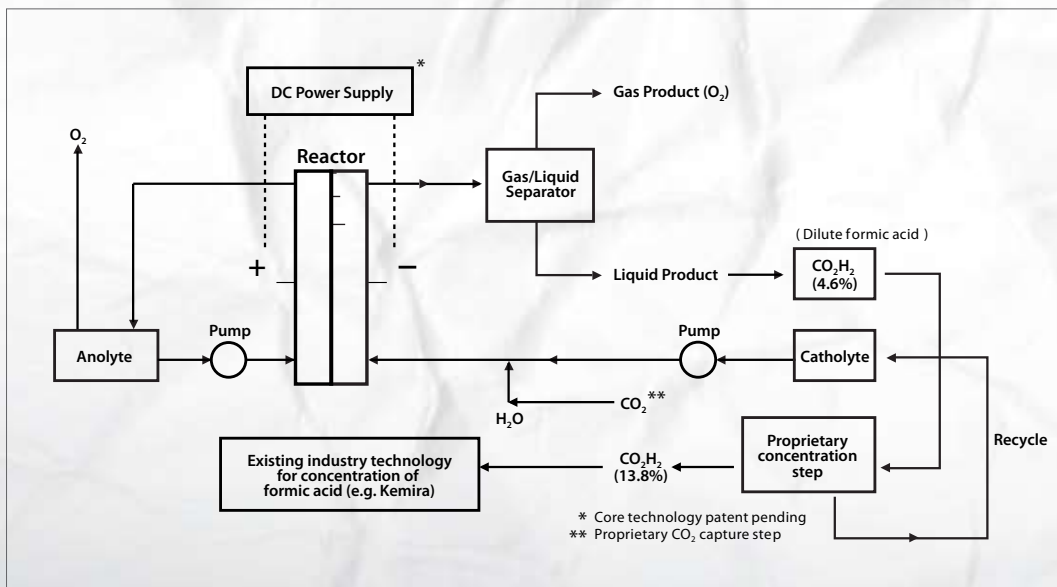
Carbon dioxide is notorious as the cause of climate change, and is an increasing regulatory burden for industrial emitters. The most obvious solution is energy conservation. The next solution, CCS (the deep burial of CO₂), is proving to be problematic as to safety, insurability and economics – the net current cost appears to be approximately \$100 per tonne of CO₂ sequestered. ME's CCR alternative, by comparison, is attractive, practical, safe and profitable.

Anthropogenic CO₂ is now at approximately 29 billion tonnes per year; it adds to the concentration in the atmosphere where it is only slowly reduced by the natural carbon cycle. In 1958 the concentration of CO₂ in the atmosphere was 315 ppm by volume. In December 2010 it was 389.69 ppm.

The international market for carbon management is currently in the hundreds of billions of U.S. dollars annually, and the demand for carbon management is large and increasing. The market for ME's ERC technology is large and robust, driven by firm evidence of climate change, by widespread political will and public concern.

CCR (Mantra's ERC technology) described

A number of technologies exist that can be described as contributing to CCR, carbon capture and recycling. The specific technology developed by ME is ERC, electro reduction of carbon dioxide.



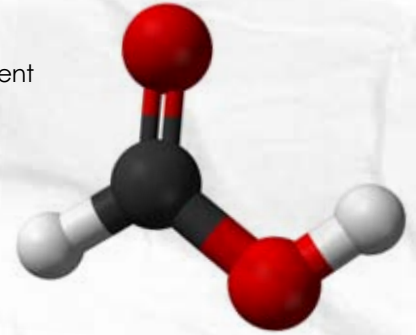
In November 2007, Mantra acquired its flagship technology ERC, an electrochemical process developed at the University of British Columbia's Clean Energy Research Center where it was invented by Professor Colin Oloman. ERC has been successfully proven through small scale prototype trials and will shortly be demonstrated in industry. It offers an innovative solution to reduce the volume of CO₂ released by industrial emitters. The technology uses electricity to combine carbon dioxide with water to manufacture high value chemicals: formate salts, formic acid and fuels.

Formate and formic acid has already created a market in a range of applications: it is used as a precursor in various chemical and pharmaceutical manufacturing processes, for deicing of airplanes and runways, it is used by some in an alternative method of papermaking, and is being used more and more widely as a preservative in animal feeds where it replaces the use of antibiotics; the largest single use is in leather and cloth finishing. The current worldwide market has a value of approximately US\$1 billion. ME has plans to develop a number of innovative uses for formic acid which will result in creation of major additions to the existing market. It is helped in this by its development partners.

CCR Alternatives Analyzed in a University of BC Study

From a report entitled Evaluation of Carbon Recycling Technologies, August 2010; the student report evaluates four carbon recycling technologies:

1. Thermochemical methanol synthesis
2. Electrochemical reduction of carbon dioxide
3. Photosynthetic conversion of carbon dioxide
4. Bio-thermochemical conversion of carbon dioxide.
5. The report can be summarized thus: carbon recycling technologies provide many options. Carbon Sciences' process (bio-thermochemical process) shows potential, although more information was needed)...the photosynthetic process showed a negative economic potential.

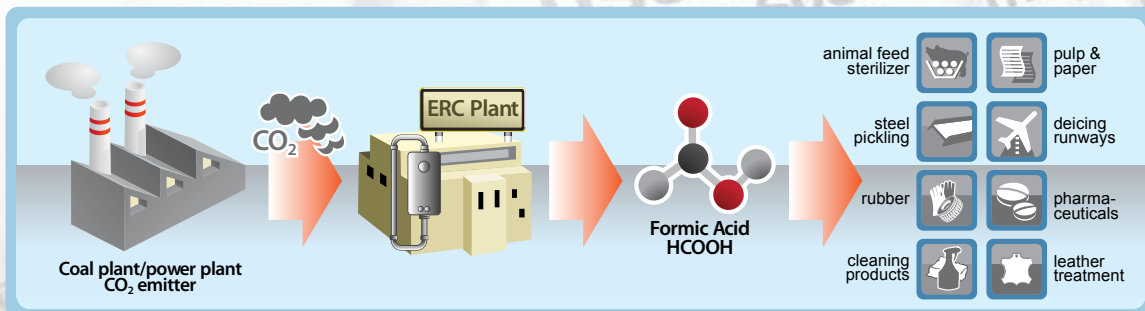


Based on the criteria used, the thermochemical methanol synthesis process appeared to be highly attractive. The electrochemical reduction of carbon dioxide (Mantra energy's ERC technology) had an economic potential of US\$985 and an avoidance of 868 kg of carbon dioxide per tonne of CO₂ processed.

Development of ERC

Following acquisition of the ERC technology in 2007, with 7 years of development behind it, ME embarked on a laboratory development program with funding from the Industrial Research Assistance Program combined with equity capital. That program allowed the rapid improvement of the ERC system and indicated the way forward into commercialization.

ME established an R&D facility in Vancouver for ERC where it was assisted by Kemetco Research Ind., a private sector integrated science, technology and innovation company. Spring of 2011 will see the first industry demonstration unit being built; commercial scale units will be engineered and behind built within 2



to 3 years. They will be capable of processing hundreds of tonnes of CO₂ per day; as the number of plants grow, this will have a significant effect on anthropological CO₂ volumes reaching the atmosphere.

ME has undertaken the worldwide patenting of PCT Patent Application WO 2007/041872 A1: that work is proceeding. A number of related concepts have been found in the process which will result in future related patent applications.

Intellectual Property:

ME owns the core ERC technology, applied for under the Patent Cooperation Treaty entitled: Continuous Co-current Electrochemical Reduction of Carbon Dioxide, identifier WO 2007/041872 A1. Inventors are Colin Oloman and Hui Li of the Chemistry and Biological Engineering Department, University of BC. Those interested in more information can review the additional material attached or go to the Mantra web site (www.mantraenergy.com).

ME has planned an aggressive program of exploration of new concepts which will result in at least 3 new patent applications in the next 2 years with more to follow.

Recent Achievements

-  The Lafarge Cement demonstration project is slated to start in the very near future (see Mantra's webpage for more on ME's development partner Lafarge). This will be the first industry demonstration of our CCR technology and is an important step toward full commercialization. Lafarge is the largest single cement company in the world with 120 cement plants and representation in 78 countries.

-  ME has partnered with a significant co-developer, Kemira Oyj of Finland, who will work with us to improving the formic acid concentration technology within the ERC. This will result in product that is market-ready. The ERC of the future will be a package technology between Mantra and our co-development partner.

-  Powertech (a subsidiary of BC Hydro) is committed to being part of the science team on the Lafarge project along with Kemetco, our existing science and technology development group.

Powertech has an excellent reputation for engineering, problem solving,

-  Kemetco is Mantra's development laboratory. They will work with Powertech in the future projects.

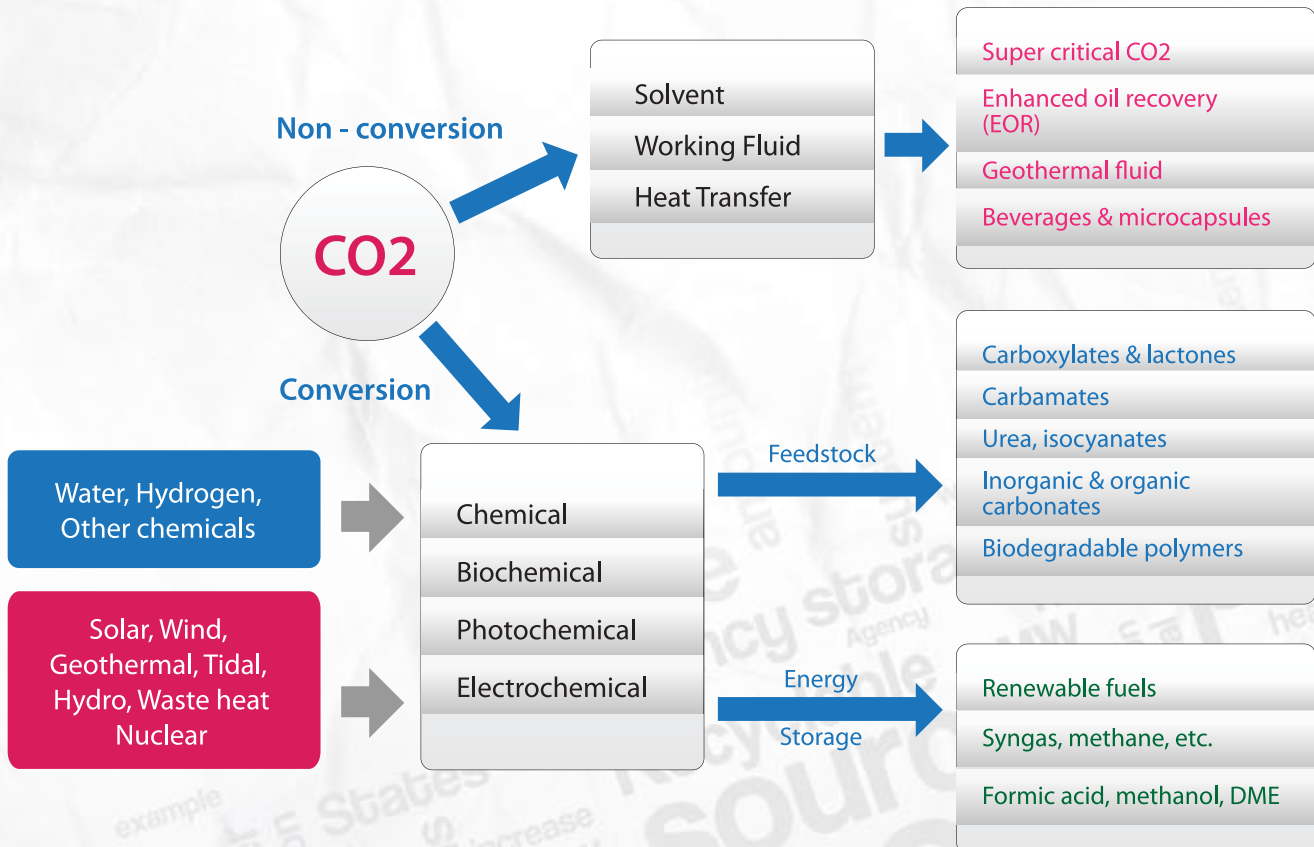
The Practicality and Economic Potential of Mantra Energy's ERC Technology

ERC (electro reduction of CO₂) is technology that falls into the broad category of carbon capture and recycling (CCR). It is a practical and economic alternative to other technologies that are being put forward today, such as CCS. These point notes are a summary of wide-ranging work undertaken by ME in exploring the practical potential of ERC and determining its competitive economics.

1. There are essentially three pathways for utilizing CO₂:
 - a. conversion of CO₂ into fuel,
 - b. utilization of CO₂ by conversion into a feedstock for chemicals (ME's chosen route)
 - c. and non-conversion use of CO₂ (CCS or carbon capture and sequestration).
2. Various utilization technologies together have the potential to reduce CO₂ emissions by at least 3.7 gigatons/year (Gt/y) (approximately 10 % of total current annual CO₂ emissions), both directly and by reducing use of fossil fuels.
3. Chemical and electrochemical conversion of CO₂ into value-added chemical feedstocks and intermediates is attractive in terms of fossil fuel avoidance. It is estimated that the total CO₂ emissions avoidance potential of this pathway is about 0.3 Gt/y (billion tonnes per year).

This is ME's business model: production of green feedstock chemicals. The figure above defines a reasonable initial target market for ME, the use 0.3 Gt/y of CO₂ to make a similar volume of high value chemicals. An additional assumption is that these chemicals will have an average market value of \$1,000 per tonne: giving a market value of \$300 billion. This is in reasonable conformity with the ME projections (\$350bn) arrived at by a totally different route.

4. Pathways for utilization of CO₂:



5. Formic acid may be a useful storage medium for hydrogen that could be used in fuel cells. This is a potential added value to formic acid, but unquantified at this time.
6. An alternative pathway is to convert CO₂ into chemical feedstock. The entire portfolio of commodity chemicals are currently manufactured from a few primary building blocks or platform chemicals in the fossil-based chemical industry. CO₂ can be used as a source material and, utilizing renewable energy sources and water, can be converted into a similar suite of building block chemicals. Insertion of CO₂ into epoxides to manufacture various polymeric materials is an exciting technology as it not only utilizes CO₂, but also avoids using fossil feedstock and creating CO₂ emissions. It has been estimated that the various chemical conversion pathways can consume approximately 0.3 to 0.7 Gt/y of CO₂.

Using the same assumptions as above, this market is worth approximately \$300 to \$700 Billion per year.

7. Electrochemical CO₂ conversion: The recoverable energy density that would be available via the combustion of methanol, ethylene, or methane, or the use of formic acid in fuel cells, is higher than conventional energy storage technologies. Products created from electrochemical CO₂ conversion processes have significantly more energy density than other energy storage technologies.

Recoverable Energy Density (kWh/ton)

NiMH battery	100
Flywheel	170
NaS battery	120
Li-ion battery	300
HCOOH	1000
CO	1100
Methanol	7000
Ethylene	9000
Methane	10000

8. A comparison of the market price per metric tonne and the cost of energy invested into the product indicates that:
 - a. the following are highly economically desirable HCOOH and CO
 - b. these are economic methanol and ethylene
 - c. and the following is not economic methane

Carbon monoxide is difficult to store and transport, therefore formic acid is the more practical of the highly desirable product.

9. Profitability will be maximized where the following conditions can be met for ERC:
- a. CO₂ is delivered in pure or near-pure form
 - b. "responsible energy" can be generated from readily available process heat
 - c. The plant is set up for large volumes and continuous production
 - d. Consumables are minimized
 - e. Opportunities for other energy management scenarios are available.

Profitability is always a net of the set of local costs and the recoverable income.

10. Summary points:

- a. CO₂ recycling is becoming widely recognized as a way to manage CO₂ emissions in an economic manner.
- b. Electro reduction of CO₂ (ERC) promises to be deployable and practical: it has a low carbon footprint, is scalable and is economic in its use of electric energy. It has the ability to make a number of high value chemical products.
- c. There are a number of available strategies that promise to support the economics of the ERC technology: use of off-peak energy at lower cost; use of "waste heat" to generate low cost electric energy, etc.



sources
nt
heating high
clean
Agency
MW
million
Recyclable
sources
Renewable
States
emissions
increase
SUPPLY
example
source: future
Environment
production gas
demand
carbon
generation
Local
emissions
heating

Mantra's Key People

Larry Kristof President and CEO

Prior to founding Mantra Venture Group Ltd., Mr. Kristof served as President and Chief Executive Officer of Lexington Energy Services Inc., a Calgary, Alberta company he co-founded. Under his direction, Lexington designed and commercialized innovative mobile drilling rigs and nitrogen generation technologies. He successfully raised capital for the company on public markets. Before establishing Lexington, he founded Westec Venture Group Inc., a company that provided business development and venture capital services.

Jonathan Michael Boughen Director

From May of 2000 to January of 2006, Mr. Boughen was a sales manager at Ropak Corporation, a company that specializes in plastic packaging, container and film technologies worldwide. His responsibilities and duties included managing the sales team and key distributors and sharing the profit and loss responsibility with the Regional Plant Manager.

Since June of 2006, Mr. Boughen has been a general manager at Scientek Technology Corporation, a company that specializes in building hospital and laboratory products such as washers and dryers for the processing of surgical instruments and utensils, O. R. carts, and laboratory glassware. His responsibilities and duties includes leading the company with full profit and loss responsibility and managing the sales and growth profit through major changes in technology and currency value in a highly competitive market. Mr. Boughen was appointed as a member to our board of directors due to his success with business enterprises.

Elden Schorn Director

Elden has extensive experience in business-government relations and had executive positions with trade organizations representing Canadian manufacturers and the Canadian government. Elden previously served as vice president, B.C. Region, Canadian Manufacturers and Exporters Association, Canada's leading business network. He also served as consul and senior investment advisor to the Canadian consulate in New York.

Professor Emeritus Colin Oloman, P.Eng, Scientific Advisory Board Member and Consulting Scientist

Professor Oloman has acted as a consultant in the research and development of various electrochemical processes and has authored three books on the subject. The books address Material and Energy Balances, Electrochemical Processing for the Pulp and Paper Industry, and Fuel Cell Modeling. He has authored over 45 reports and publications in technical journals; he holds twenty US and international patents.

Norman Chow, P.Eng President, Director, Industrial Process, Kemetco Research Inc.

Norman Chow has a B.A.Sc. in Metals and Materials Engineering and a Masters of Applied Science degree. He has 10 years of technology development and contract research experience. Norman's background includes technology development, business management, international sales, project management and manufacturing. Mr. Chow has taken two companies from concept to commercialization and has built over 20 demonstration and commercial projects around the globe.

Joey Jung, P.Eng Research Engineer, Kemetco Research Inc.

Joey Jung earned his Masters of Applied Science Degree from the University of British Columbia in Chemical Engineering and is now a Registered Professional Engineer (P. Eng.). He has had a successful career in electrochemical engineering and battery research, formerly serving as Vice President and Chief Technology Officer of a publicly traded battery development company.



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