APPLICATION CHECKLIST

Use this checklist as a tool to ensure that you have all of the components of the application package. Please note, this checklist is for your use only and does not need to be included in the package.

☐	Application
☐	Transmittal Letter
☐	$100 Application Fee
☐	Tax Liability Statement
☐	Letters of Support (If Applicable)
☐	Other Appendices (If Applicable)

When the package is completed, send an electronic version to Ms. Karlene Fine at kfine@nd.gov, and 2 hard copies by mail to:

Karlene Fine, Executive Director
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Ave Dept 405
Bismarck, ND 58505-0840

For more information on the application process please visit:
http://www.nd.gov/ndic/renew/info/submit-grant-app.pdf

Questions can be addressed to Ms. Fine at 328-3722, or Andrea Holl Pfennig at 328-2687.

Renewable Energy Program

North Dakota Industrial Commission

Application

Project Title:

Pilot Scale Facility for Biocomposites Development for Industrial and Consumer Products

Applicant:

c2renew corporation

Principal Investigator:

Dr. Chad A. Ulven

Date of Application:

05/01/2015

Amount of Request:

$500,000.00

Total Amount of Proposed Project:

$1,250,000.00

Duration of Project:

1.5 years

Point of Contact (POC):

Corey Kratcha

POC Telephone:

701.899.0237

POC Email:

ckratcha@c2renew.com

POC Address:

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ABSTRACT

Objective:

This proposal requests funds from the North Dakota Industrial Commission Renewable Energy Program for a pilot scale operation to measure and validate expansion of c2renew corporations' production and development with existing collaborators; Bobcat Co., John Deere Co., Earth-Kind Inc. and Toshiba Corp., as well as new customers, Fargo 3D Printing, Intelligent Agricultural Solutions, Bogobrush, etc. The pilot facility will include a 75 mm twin screw extruder and ancillary processing equipment. With the previous support of the North Dakota Industrial Commission, c2renew corporation is positioned for growth and implementing a pilot scale operation will provide us the ability to measure production efficiencies, customer growth, job growth, rural development and innovation development in North Dakota.

Expected Results:

The expected results of the pilot facility will be the expansion of production capacity with the acquisition of a larger twin screw extruder, polymer dryer, air compressor, dust collector, and chiller. The facility will provide c2renew the ability to validate customer demand of roughly 2.8 million pounds per year (2015) but also expand production capacity to nearly 6 million pounds of material per year. In addition to the equipment, c2renew will also focus on scaling the team to facilitate the expansion of production. This would result in the addition of 4-6 new team members over the course of two years which would increase the company's headcount to 13-15.

Duration: The duration of this project is estimated at 1.5 years.

Total Project Cost: The total project cost is budgeted at $1,250,000.

Participants: c2renew corporation

PROJECT DESCRIPTION

Objectives:

c2renew's goals and deliverables for our initial NDIC Renewable Energy grant was to create specific formulations for four companies. As we look back at the project we have succeeded in developing:

- Generation 1 of the Earth-Kind holder
- Three new products for Earth-Kind
- A formulation for Toshiba and running molding trials with Falcon Plastics
- Expanded material production from 1 part with Intelligent Agricultural Solutions (IAS) to 6 parts
- A 100% bio-based material for 8 new other products
- PDP (product delivery process) with John Deere

With these milestones we have reached the top of the first mountain in our companies journey and are looking at the next mountain we need to climb; the expansion of production from 520,000 pounds of material to 6 million pounds of material per year. In partnering with the North Dakota Industrial Commission (NDIC) in Phase I we navigated the material development in a scaled approach and positioned c2renew for a jump into larger production with more team members.

To validate the scalability of production, we are proposing the pilot scale facility in this application and will focus on a number of key areas to measure the success: 1) customers, 2) production efficiency, 3) product innovation, 4) equipment, and 5) funding.

Methodology:

Scaling manufacturing processes from laboratory to pilot scale production requires a focused effort on the process and defining the right pieces of equipment and analyzing how those pieces of equipment can achieve the optimized results. The equipment and manufacturing assessments outlined below will help to validate the scalability from a pilot facility to large scale commercial production.

Twin Screw Extruder

The addition of a 75 mm twin screw extruder would allow c2renew to measure and refine the cost of production. c2renew's current per pound processing costs on rented equipment are on the high end of the scale compared to the rest of the industry, at $0.30 per pound, excluding personnel costs. More typically, industry costs are $0.20-$0.25 range, including personnel costs.

The current capacity rating of the lab scale extruder is 175 lb/hr, but often must be run at rates below this. The new extruder would have a throughput of 1,500-2,000 lb/hr, depending on formulation. By increasing the throughput by a factor of 10, the annual capacity is obviously increased, but the operating cost, particularly the personnel cost, is significantly decreased. The lab scale extruder also lacks the capability of blending more than three ingredients into a formulation. The new extruder would blend up to five, providing increased flexibility for more complex formulations. In summary, the purchase of a new extruder would lower the cost of processing, increase capacity, and add additional capability to

create more complex formulations, including the use of additives specifically to improve plastics with biomass content (Appendix 1 – Pro Forma Extruder Economics).

Polymer Dryer

A large polymer dryer is needed for ramping up production due to increased throughput. The purpose of a polymer dryer is to remove adsorbed moisture prior to any melting of a moisture sensitive polymer. When moisture sensitive polymers are melted in the presence of moisture, a hydrolysis reaction occurs resulting in decreased properties and poor surface appearance of the polymers. Some moisture sensitive polymers that c2renew is already working with include nylon, PLA, and PHA.

Air Compressor, Dust Collector, and Chiller

These pieces of equipment are common to many different manufacturers. The purpose of these are to provide compressed air, remove harmful dusts from the airspace to improve worker safety, and provide chilled water for dehumidification and process control.

In addition to defining the appropriate pieces of equipment for the pilot facility, it is also critical to evaluate how the equipment will impact the business operations. c2renew will implement certain manufacturing assessments and benchmarks to gauge the impacts of the equipment in the pilot facility. A few critical areas we will measure will be:

- Throughput Rate – measure percent change from current production to production in pilot facility and how additional extruder lines impact the rate.
- Unit Economics – analyze the difference in the cost of goods, personnel cost and shipping with an expansion of production (i.e. IAS and Toshiba)
- Cost of Production – measure the change in scrap rate, equipment up-time and extruder profile change over.
- Production Scheduling – refine production schedule and define a manufacturing ERP system for scaled growth.

Each of the assessments will have a broader impact in providing critical insight into when the best time to add additional extruder lines and how each of those pieces of equipment will fit into our process.

To finance the equipment c2renew has developed a strategic plan that pulls funds from a number of sources: 1) c2renew equity, 2) debt financing with CoBank, 3) NDIC Renewable Energy Council, and 4) loan guarantee from USDA (Appendix 1 – Equipment Debt Financing Plan). We feel it is important to have a defined financing strategy to provide confidence to those that invest in us to see our growth plans.

Anticipated Results:

c2renew has been committed to expanding our production capacity in North Dakota by building and strengthening our relationships with the molders and original equipment manufacturers (OEMs) that we work with. Developing the pilot facility will provide c2renew the ability to assess the following criteria:

- Processing costs
- Personnel
- Scalability of additional extruder lines
- Unit economics for formulations
    - Toshiba
    - Intelligent Agricultural Solutions
    - Fargo 3D Printing

The anticipated results will be expanding c2renew production to 6 million pounds per year and give us the ability to provide customers larger volumes as well as new materials which leads to increased value-add agriculture processing (530,000 lbs source annually) and job creation (both direct and indirect).

Facilities:

With the expansion of production, c2renew will need to expand into additional manufacturing space of 8,000 square feet. The 8,000 square feet will be located in a transitional space in north Fargo as c2renew plans to move production to Colfax, ND at the tail end of this grant period (2017). The facility in Colfax will be roughly 20,000 square feet and will include additional extruder production lines. In addition to the production facility, c2renew will continue to lease office space at the NDSU Technology Incubator where engineering services, marketing and admin support takes place.

Resources:

With the work we have accomplished in the NDIC Phase I grant and the extensive biocomposite formulation expertise we have developed at c2renew, we have positioned ourselves well for expansion. In addition to the great team we have internally, we have also built a great advisor network that has hundreds of years of combined experience in commodities, manufacturing, product development and finance and has provided valuable insight on our business during the scale up process. The combination of our team and advisors has helped to establish the criteria necessary for scaling up our production and ensures successful implementation of the new extruder and scale up.

Techniques to Be Used, Their Availability and Capability:

In pilot scale development, c2renew will continue to build upon its foundation, which is based on the principles of organic chemistry combined with composite micromechanics theory. The research that has been conducted by Dr. Ulven and expanded within c2renew has allowed us to develop a unique strategy of robust techniques for combining a multitude of agricultural byproducts (flax fiber, flax shive, sunflower hull, dried distillers grains with solubles, soybean hull, corn cob, sugar beet pulp) into a wide variety of plastics (PP, PE, ABS, ABS-PC, PS, PVC, PA, PLA, PHA) such that no single formulation is

dependent on one particular agricultural biomass. In this way, c2renew can purchase agricultural byproducts at the lowest price, regardless of their source, while repeatedly producing consistent biocomposite materials.

Environmental and Economic Impacts while Project is Underway:

No negative environmental impacts are foreseeable during the project. The use of benign polymers and agricultural biomass significantly reduce the environmental and safety concern. Green chemistry principles such as the use of bio-based raw materials, non-toxic surface treatments and compatibilizers will be implemented wherever possible in the production of all c2renew's biocomposites. Any chemical waste produced will be disposed according to established protocols.

Ultimate Technological and Economic Impacts:

The proposed project will provide an impact in the key areas of job creation, market growth for North Dakota agriculture producers, community growth – building location in Colfax, ND (2017) and will have a significant impact on innovation development.

The stimulating effect of game-changing innovation like this in North Dakota cannot be minimized as it creates the ideal eco-system for a clustering of like-minded innovators, and symbiotic spin-offs. A few examples of this has been the work we have done both internally with our coffee cup that is made from coffee residuals and a spin-off company based on our work in bio-based materials (Appendix 2 – Technology Licensed to c2sensor) as well as the collaborative work with Fargo 3D Printing in creating the first 100% bio-based spool for 3D printer filament (Appendix 3– Letter of Support) and Earth-Kind in developing new products and finding new uses for North Dakota biomass.

Why the Project is Needed:

The proposed pilot facility will provide c2renew the ability to validate production expansion which will have a broader impact in the following areas:

- Expansion of value-added agriculture for producers
- Rural development growth in south eastern North Dakota
- Job creation (both direct and indirect)
- Development hub for bio-based product and material development

c2renew is committed to growing our business in North Dakota and are excited to grow our production footprint with the support of the North Dakota Industrial Commission.

STANDARDS OF SUCCESS

The expected deliverables by the end of this project include:

1. Production Growth – Toshiba
   Over the course of our two year Phase I project, c2renew has been able to expand production into new markets (i.e. home goods, consumer and commercial) as well as new materials (ex. bio-based filaments). With each of these new products and materials we have pushed the capacity of our current extruder at 520,000 pounds per year. A pilot facility with potential capacity of 6 million pounds per will allow us to supply our customers at the volumes they are requesting and expand production at a more efficient rate.

   In the pilot facility, c2renew will gauge the impact of scaled production with Falcon Plastics, Toshiba's injection molder, to an estimated 350,000-650,000 lbs per year. The scaled production will provide us with some valuable information on scalability in material supply; both in biomass and resin, quality control and assurance parameters and production scheduling.

2. Production Efficiency
   With production growth an important metric to evaluate are efficiencies gained in the pilot production process. When expanding into new materials it requires a new set of processing setups which results in material waste during extruder prep, lost personnel time and redundancy in production scheduling (highlighted in Appendix 1 – Extruder Pro Forma). The pilot facility will allow us to specifically measure the substantial decreases in the inefficiencies. With these reductions, it will allow c2renew to achieve better economies of scale and tackle projects that were originally out of our production capabilities (automotive components – 1.1 million tons of plastic used in US automobiles in 2013) but could easily be addressed with the new equipment.

3. Customer Acquisition – Intelligent Agricultural Solutions
   Customer growth is the byproduct of the production capacity growth and production efficiency and with each of these more defined it will allow c2renew to expand our customer growth at a more rapid rate by not being constrained by our equipment. Intelligent Agricultural Solutions (IAS), will be a case study in customer expansion for the pilot facility, c2renew will work to expand the number of product lines we produce material for from one to six. This expansion will lead to an estimated production of 60,000 – 80,000 lb of production per year.

   In addition, to focusing on our biocomposite production, c2renew will also focus on traditional compounding services for Midwest molders, given that we are currently the only material compounder in North Dakota and more than 100 injection molders in the upper Midwest.

4. Job Growth
   As customer growth expands the need for additional team members is important. During our NDIC Phase I grant, c2renew expanded from the 2 founders and one employee to 7 FTE employees and

will be bringing on a 8th team member in the next couple months. With this Phase II grant we anticipate the need for 4-6 additional employees to work in our production teams, sales, administration and engineering services.

5. Rural Development
   Each element described above results in c2renew needing to find a place and space to accommodate the growth. As a company that uses agricultural waste products in our process we feel it is important to locate in a rural location and found that in Colfax, ND. When selecting Colfax, all the necessary boxes were checked: 1) logistical center of our biomass inputs, 2) transportation routes, 3) availability of land, 4) infrastructure, and 5) proximity to talent – production (NDSCS) and engineering (NDSU). By expanding our operational footprint in Colfax it creates great rural economic development by adding new residents to the community which leads to homes sales, school enrollments and sales tax growth.

6. New Technology Development – Fargo 3D Printing
   The last deliverable is focused on looking even further past the two year duration of the grant and innovating on new ideas and bringing them to market. By building larger production, hiring more team members, establishing a manufacturing hub, it is c2renew's responsibility to innovate and create and we are committed to doing all of this in North Dakota.

   c2renew will push the technology development in the pilot facility with the expansion into a new product category, 3D printer filament, in partnership with Fargo 3D Printing. This collaborative work will lead to the development of the first bicomposite 3D printer filament in the US. Through the pilot facility it will allow c2renew to scale the manufacturing and prepare us to be on the forefront of a $13 billion industry by 2019.

BACKGROUND/QUALIFICIATIONS

Dr. Chad A. Ulven, CTO/Co-Founder of c2renew corporation, Associate Professor of Mechanical Engineering at NDSU

Biocomposite materials based on petroleum or biobased plastics reinforced with natural fibers have been the focus of Dr. Chad Ulven and his research group in the Mechanical Engineering (ME) Department at NDSU over the past ten years. Some of their discoveries lead to the development of a small spin-off company, c2renew corporation (2011), in which he acts as the chief technology officer. Dr. Ulven received his B.S. degree in Mechanical Engineering from NDSU (2001) and M.S. and Ph.D. degrees in Materials Engineering from the University of Alabama at Birmingham (2003 & 2005).

Michael Ehresmann, Operations Manager/Lead Engineer of c2renew corporation

Michael Ehresmann oversees the day-to-day operations and engineering of c2renew corporation. He is currently located in the NDSU Technology Incubator, Fargo, ND. Following graduation with a B.S. in Mechanical Engineering from NDSU in 2003, Michael went on to work as a Systems Engineer for Delta-Energy, LLC, a startup working on the commercialization of tire pyrolysis technology. This process is capable of processing shredded rubber into oil, carbon black, and natural gas. Here he served as the company's only engineer supporting a pilot plant by both troubleshooting operations as well as designing and implementing process improvements. Michael then completed an M.S. in Mechanical Engineering from NDSU in May of 2012, studying under Dr. Ulven with a research focus of biocomposite materials.

Corey Kratcha, co-founder and ceo of c2renew corporation

Corey Kratcha (Co-founder and CEO c2renew and c2sensor) has been focused on business development and creation centered on manufacturing. He partnered with a US and international manufacturer to create infrastructure and business structure for component manufacturing of agriculture equipment. From there the need for light-weight equipment led to Corey and Chad co-founding c2renew to create innovative materials for a broad range of industries. As part of c2renew, Corey is responsible for the managing the backend of the business; sales, marketing, capital raising, etc.

Rachel Tharalson, project engineer at c2renew corporation

Rachel Tharalson has a B.S. in mechanical engineering from North Dakota State University. As a project engineer at c2renew, Rachel has a wide range of responsibilities from sourcing materials for new product development and designing equipment layouts for future growth to manufacturing and testing product. She also aids in testing and product design for engineering services customers.

MANAGEMENT

The project will be managed by Dr. Ulven, Michael Ehresmann and Corey Kratcha across the following areas:

- Equipment acquisition – Dr. Ulven, Michael Ehresmann and Corey Kratcha
- Equipment install – Michael Ehresmann and c2renew personnel
- Customer Growth – Dr. Ulven and Corey Kratcha
- Production Process – Dr. Ulven and Corey Kratcha

To ensure that each team member meets their goals, c2renew has developed a roadmap that lays out each phase of growth. In addition c2renew's management teams has defined specific key performance indicators (KPIs) that we can easily measure and track.

With the KPIs our team meets weekly to assess the performance of each of projects and we are implementing project management technology (Asana) to more efficiently manage all the details of each of our projects.

TIMETABLE

Please provide a project schedule setting forth the starting and completion dates, dates for completing major project activities, and proposed dates upon which the interim reports will be submitted.

Utilizing the tasks identified above, an associated timeline was generated in order to keep the workflow on track and set realistic deadlines with realistic deliverables. The following table provides the major milestones needed to be completed in the timeframe identified for the success of the project and in order to meet the objectives stated above for a 1.5 year project.

Milestone	**Date**
Start of the Project	JUL 2015
Equipment bids and sourcing, contractor bids and loan closing (Ehresmann, Ulven, Kratcha)	JUL 2015
Extruder build, polymer dryer acquisition, air compressor acquisition, chiller acquisition (Ulven, Ehresmann and Tharalson)	OCT 2015
Building upgrades and retrofit for equipment (Ehresmann)	MAR 2016
Equipment Install (Ehresmann and Tharalson)	MAR 2016
Equipment Testing and Trials (Ehresmann, Ulven and Tharalson)	MAY 2016
Production and Process Evaluation (Ehresmann, Ulven and Kratcha)	DEC 2016
Final Report (Ulven , Ehresmann and Kratcha)	JAN 2017

Milestone	Jul-Sept	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec	Jan
Start of the Project							
Equipment Bids and Sourcing							
Equipment Build and Acquisition							
Building Upgrades and Retrofit							
Equipment Install							
Equipment Testing and Trials							
Production and Process Evaluation							
Final Report							

BUDGET

Project Associated Expense	NDIC's Share	Applicant's Share (Cash)	Applicant's Share (In-Kind)	Other Project Sponsor's Share
Equipment	$350,000	$750,000		
Project Management and Engineering Services	$150,000			

Please use the space below to justify project associated expenses, and discuss if less funding is available than that requested, whether the project's objectives will be unattainable or delayed.

$500,000 from the NDIC-REP

- $350,000 will be allocated to equipment purchase
- $150,000 will be allocated for operating expenses

c2renew provides $750,000 match

Total Project - $1,250,000

Budget Justification

Equipment – The budget for the equipment will include the purchase of a twin screw extruder, polymer dryer, chiller, feeder system and equipment installation (Appendix 5 – Line Item Budget).

Project Management and Engineering Services – Funds will be used for project management to manage the equipment acquisition and installation. In addition to project management, it will also be used to scale up new equipment and prepare for increase in customer production.

Michael Ehresmann will spend three quarters of his time sourcing equipment, managing equipment install, scaling up equipment and evaluating the production process. Mike will also assist in providing reports for NDIC interim reports - $65,125.

Rachel Tharalson will spend half of her time assisting Mike scaling production and providing project management for customer expansion - $30,000

c2renew production member will spend three quarters of their time producing material and work with Mike to refine the process - $44,875.

Corey Kratcha and Dr. Ulven will provide oversight on the project and will develop reports - $10,000.

CONFIDENTIAL INFORMATION

This proposal does not contain any confidential information.

PATENTS/RIGHTS TO TECHNICAL DATA

c2renew corporation reserve the right to all intellectual property developed as part of this project.

Equipment Description	Supplier	Cost
72 mm Twin Screw Extruder and Underwater Pelletizer	Crown Machine UWP, Inc.	$ 943,000
W-800 Carousel Polymer Dryer	Conair	$ 53,000
Dust Collection	Donalson Torit	$ 30,000
80 Ton Chiller	Federal Equipment	$ 14,000
Screw Type Air Compressor	Federal Equipment	$ 12,000
Biomass Vacuum Loader	CAMCORP	$ 21,000
Biomass Hopper	Standard Industries	$ 6,000
High Temperature Burnoff Oven	Lucifer Furnaces	$ 10,000
Compressed Air Dryer	Federal Equipment	$ 2,500
Dehumidifier	Dehumidifier Corp. of America	$ 10,000
Racking	Adams, Inc.	$ 12,000
Tools, Workbench, Etc.	Various	$ 5,000
Thermo Gravimetric Analyzer	American Laboratory Trading	$ 15,000
Mass Flow Indexer	Tinius Olson	$ 12,000
Moisture Analyzer	Arizona Instruments, Inc.	$ 14,000
Shipping and Installation	Various	$ 100,000
Total		$ 1,259,500