| **DOCKETED** |
|---------------------|------------------|
| **Docket Number:** | 20-FINANCE-01    |
| **Project Title:**  | Strategies to Attract Private Investment in Zero Emission Vehicle Charging Infrastructure and Other Clean Transportation Projects |
| **TN #:**           | 232704           |
| **Document Title:** | Seedling LLC Comments - Seedling - A Circular Economic Agricultural & Hydrogen Utility |
| **Description:**    | N/A              |
| **Filer:**          | System           |
| **Organization:**   | Seedling LLC     |
| **Submitter Role:** | Public           |
| **Submission Date:**| 4/9/2020 12:54:28 PM |
| **Docketed Date:**  | 4/9/2020         |
Seedling - A Circular Economic Agricultural & Hydrogen Utility

Seedling LLC is happy to share our attached Business Overview that highlights our efforts toward installing regional public-private partnerships that transition organic fractionated municipal solid waste (OFMSW, aka food-waste) into both agricultural and zero emissions transportation assets for use by regional municipalities, universities, and partners. In the attached document viewers will find an overview to the Seedling system of technologies, featuring three scaled installations that produce between ~50kg & 1,270kg of hydrogen fuel per day. These installations rely on industry-available technologies and feature no technological barrier of entry beyond that of tailoring precision fertilizers to regional soils & crops (featured as an appendix to the document, coauthored grant materials for fertilizer development). Each installation aims to provide municipalities with a reliable source of hydrogen fuel for zero emissions fuel cell electric fleets (waste collection, mass-transit, governmental operations). In addition, Seedling’s own distribution channel of hydrogen fuel cell electric mobile food solutions acts as a distributed generation microgrid for municipalities and partners during a crisis; each truck providing in excess of 60kwh in vehicle-to-grid support for the duration of 10-hours between fueling.

To fund these installations, Seedling works with federal, state, county, and municipal funding sources to leverage economic development bonds; paired with investment from university partners and private industry. We are seeking a preliminary investment of $9M for a SEED-150 installation (or $15M for a SEED-270) in partnership with a leading agricultural university in California.

Further inquiry into investment and technology partners can be sent to contact@seedling-PHL.com.

Thank you,
Travis Andren

President | Seedling LLC.
Chairman | D3 Designs Inc.
Adjunct Professor | Thomas Jefferson University
Palo Alto, CA

Additional submitted attachment is included below.
Circulaconomic Agriculture

2019 BUSINESS OVERVIEW
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References to EBITDA in the attached presentation should not be construed as a substitute for income from operations, net income or cash flow from operating activities (as determined in accordance with GAAP) for the purpose of analyzing operating performance, financial position and cash flows.

Investing in Seedling is speculative and involves a substantial degree of risk. Risks include, but are not limited to, the fact that Seedling has or may have: a limited or no operating history; volatile performance; pending customers; limited liquidity with limited secondary market expected and restrictions on transferring interests; high external expenses; and a dependence on D3SIGNS, which will have exclusive authority to select and manage Seedling’s investments. Prospective investors should carefully consider all risks described and determine whether an investment in Seedling is suitable. There can be no assurance that the investment objectives described herein will be achieved. Nothing herein is intended to imply that Seedling’s investment methodology may be considered “conservative”, “safe”, “risk free”, or “risk averse”. Economic, market and other conditions could also cause Seedling to alter its operational objectives, guidelines and restrictions. Investment losses may occur.

Certain information contained herein may be “forward-looking” in nature. Due to various risks and uncertainties, actual events or results or the actual performance of Seedling may differ materially from those reflected or contemplated in such forward-looking information. As such, undue reliance should not be placed on such information. Forward-looking statements may be identified by the use of terminology including, but not limited to, “may”, “will”, “should”, “expect”, “anticipate”, “target”, “project”, “estimate”, “intend”, “continue” or “believe” or the negatives thereof or other variations thereon or comparable terminology.

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Projected performance is not indicative nor a guarantee of future returns.
Target IRR and returns are presented gross and does not reflect the effect of management fees, incentive compensation, certain expenses or taxes. The target IRR and returns presented are not a prediction, projection or guarantee of future performance. The target IRR and returns were calculated based on certain assumptions, which include recent performance data and current market conditions. Seedling gives no assurance that targeted returns will be achieved or that the methodology and assumptions used to estimate such returns are reasonable.

Index performance and yield data are shown for illustrative purposes only and have limitations when used for comparison or for other purposes due to, among other matters, volatility, credit or other factors (such as number and types of securities). Additional information may be available upon request.
| A | AD | Anaerobic Digestion |
| A | Ag | Agriculture |
| A | AgTech | Agricultural Technologies |
| B | Bar | Barometric Pressure |
| B | BEV | Battery Electric Vehicle |
| B | BTU | British Thermal Unit |
| C | CAPEX | Capital Expenditure |
| C | CEA | Controlled Environment Agriculture |
| C | CHP | Cogenerative Heat and Power |
| C | CO₂ | Carbon Dioxide |
| C | CT | Connecticut |
| C | Cu. Ft. | Cubic Foot |
| D | DOE | Department Of Energy (US) |
| D | DOT | Department Of Transportation (US) |
| D | DVO | DVO Digesters |
| E | E | Equity percentage |
| E | e. | electricity |
| E | ea. | each |
| E | EWG | Environmental Working Group |
| F | FCEV | Fuel Cell Electric Vehicle |
| F | FCFT | Fuel Cell Food Truck |
| F | FCB | Fuel Cell Bus |
| F | FTA | Federal Transit Authority (US) |
| F | Fert. | Fertilizer |
| F | FT² | Square Foot |
| F | FT³ | Cubic Foot |
| G | g. | gram |
| G | Ga. | Gallon |
| G | GH | Greenhouse |
| G | GW | GigaWatt |
| G | GWhr | GigaWatts per Hour |
| H | H₂ | Hydrogen |
| H | H35 | California designation for 350Bar |
| H | H70 | California designation for 700Bar |
| H | H₂O | Water |
| I | IoT | Internet of Things |
| I | IBM | Computing Company |
| I | IP | Intellectual Property |
| I | IPP | Independant Power Provider |
| I | IG | Instagram |
| I | Inc. | Incorporated |
| I | IRR | Initial Rate of Return |
| K | kg | kilogram |
| K | kW | KiloWatt |
| L | LLC | Limited Liability Company |
| L | LRG | Large |
| M | M | Million |
| M | MW | MegaWatt |
| M | MWHr. | MegaWatts per Hour |
| M | MCFC | Molten Carbonate Fuel Cell |
| M | Mo. | Month |
| N | Nm³ | Not-Applicable, Not-Available |
| N | N/A | Not-Available |
| N | NIFA | National Institute of Food and Agriculture (US) |
| N | NYC | New York City |
| O | OECD | Organization for Economic Co-operation and Development |
| O | OFMSW | Organic Fractionated Municipal Solid Waste |
| O | OpEx | Operating Expenditure |
| O | OPEX | Operating Expenditure |
| P | PA | Pennsylvania |
| P | PAFC | Phosphoric Acid Fuel Cell |
| P | PGH | Pittsburgh, PA |
| P | PHA | Polyhydroxyalkanoates Bioplastic |
| P | PHL | Philadelphia, PA |
| P | PLA | Poly Lactic Acid, compostably polymer |
| P | PM₁₀ | Particles Per Million |
| P | POS | Point Of Sale |
| P | PSU | The Pennsylvania State University |
| R | R&D | Research and Development |
| S | SEED | An individual Seedling installation |
| S | SAM | Serviceabl Available Market |
| S | SOM | Servicable Obtainable Market |
| S | SSM | Site-specific Crop Management |
| S | SCF | Standard Cubic Foot |
| S | SO₂ | Sulfur Dioxide |
| S | SM | Small |
| T | T | US Ton = 2,000 lbs | 907.2 kg |
| T | TAM | Total Available Market (Global) |
| U | US | United States of America |
| U | USA | United States Department of Agriculture |
| U | USDA | United States Dollar |
| V | VRT | Variable Rate input application Technology |
| V | VF | Vertical Farming |
| W | W | Watt |
| W | WHR | Watts per Hour |
About the Author:  

Travis Andren  
MS. Environmental Policy Mgmt | BS. Industrial Design  
Founder | President: Seedling LLC  
Chairman | CEO: D3 Designs Inc.

Seedling LLC. has been designed by Travis Andren as a continuation of extensive peer-reviewed academic research in circular economic systems relating to renewable energy, agricultural, and environmentally sustainable economics.  

Acquired by D3 Designs Inc. in Q1 of 2017, Seedling LLC has been showcased globally as a representation of innovative approaches to advanced energy technology applications, as well as an example of food-system innovations. Through knowledge-sharing partnerships with suppliers and academic institutions, Seedling is now seeking capital investment for preliminary installation activities.
VISION

Circular Economic Agriculture

ENABLING REGIONAL CIRCULAR ECONOMIES BY BRIDGING RURAL AND URBAN AGRICULTURE IN PUBLIC-PRIVATE PARTNERSHIPS FOR THE PROSPERITY OF PEOPLE AND PLANET.
INTRODUCTION

Circular Economy

An idea for a truly sustainable future that works without waste, in symbiosis with our environment and resources. A future where every product is designed for multiple cycles of use, and different material or manufacturing cycles are carefully aligned, so that the output of one process always feeds the input of another. Rather than seeing emissions, manufacturing byproducts, or damaged and unwanted goods as ‘waste’; in the circular economy they become raw material, nutrients for a new production cycle. Moreover, shifting to the circular economy could unlock an estimated $4.5 trillion in additional economic growth by 2030 and could be the biggest economic revolution in 250 years.¹ Yet the U.S. ranks 18th in recycling among Organization for Economic Co-operation and Development (OECD) countries, with $11.2 billion in recyclables landfilled as waste annually.² Adopting closed loop, circular methods is the best way for companies of all sizes and industries to eliminate waste and recapture its value.

D3 DESIGNS Inc.

Parent corporation to Seedling LLC., D3 Designs was founded in 2007 as an Industrial Design consultancy. A simple philosophy and three-phase practice; Diagnose, Design, Develop; resonates through D3 Designed products and Seedling development. D3 Designs Inc. provides R&D support services to Seedling LLC. through product development, using performance generated data from each Seedling SEED. D3 Designs Inc. technologies within this document are marked with the D3 Designs Inc. logo within the subtitle bar, as shown above.

A Delaware benefit-corporation (S-Corp structure, US Citizen investment only), D3 Designs Inc. has a stated public benefit to directly or indirectly through the use of one or more subsidiary companies, work with a range of stakeholders, including but not limited to, individuals, businesses, foundations, community organizations, and governments to solve economic, transportation, water, energy, environmental, agricultural and other related problems resulting from climate change and urbanization. - In accordance with Delaware law, all stakeholders within the benefit-corporation agree to uphold this public benefit.

D3 Designs Inc. reports sustainable metrics and adherence to the benefit statement for all subsidiary companies using the GRI Global Sustainability Standards in biennial reporting to shareholders, in adherence to Delaware benefit corporation requirements.

D3 Designs Inc.’s board of directors mandates a continued majority ownership of Seedling LLC.

SEEDs

Each Seedling installation is referred to as a SEED. Each SEED is public-private partnership, which is modeled to include: a regional university; municipality (waste management company in lieu of municipal waste management); transit authority; private industry partners; and nonprofit organizations. Within each SEED, Seedling LLC maintains 60% equity ownership. Regional interests share 30% equity ownership. The remaining 10% equity is dedicated to a trust that represents the interest of the staff of the SEED location.

SEED-PSU is a planned partnership between Seedling and Pennsylvania State University. This small-scale installation will provide blockchain-precise formulation of fertilizer nutrient profiles that are responsive to regional soil nutrient profiles and crop selections. This R&D facility acts as the testable scale model for regional SEED installations globally.

Roots LLC.

Roots LLC.* is a mobile food distribution leasing company that connects the SEED’s mobile food vending equipment with regional chefs to provide direct-to-customer channels for food grown by Seedling fertilizer customers and the regional SEED. Roots LLC. is owned by D3 Designs Inc. and partners with each SEED location to provide brokerage services to the SEED.

* Roots LLC business filing pending.
INTRODUCTION

How Does a SEED Work?

HYDROGEN ELECTRIC WASTE COLLECTION

FOOD-WASTE PROVIDED BY: VENDOR / MUNICIPALITY AT FIXED VOLUMES PER DAY:

50
150
270

WASTE STREAMS BACK INTO THE SYSTEM

LOCALLY PRODUCED FOOD, DELIVERED WITH ZERO EMISSIONS

HYDRATE TO CONSISTENCY

BIOPLASTIC (PHA) FERMENTATION

BIOLISTIC (PHA) HARVESTING & PROCESSING

FOOD-GRADE BIOLISTIC PACKAGING

HIGH-TEMPERATURE FUEL CELL

ELECTRICITY
HEAT
HYDROGEN
WATER
PURIFIED CO₂

HYDROGEN ELECTRIC DISTRIBUTION

ANAEROBIC DIGESTION

BIOGAS CONTAINMENT

CENTRIFUGAL DIGESTATE

LIQUID DIGESTATE

SOLID DIGESTATE

FERTILIZER FORMULATION PROCESS

PRESSED FIBERBOARD PACKAGING

CROP-SPECIFIC LIQUID FERTILIZER

CROP-SPECIFIC SOLID FERTILIZER / HYDROPONIC GROW MEDIUM

ONSITE HYDROPONIC FARMING [G.H. & V.F.]

SUBSCRIPTION FERTILIZER SALES TO REGIONAL FARMS

LOCALLY GROWN PRODUCE

LOCALLY GROWN PRODUCE

DUCKWEED FERMENTATION & DEHYDRATION

DUCKWEED FOR FERMENTATION
MARKET TRENDS | PROBLEMS

Food-Waste

Exponential global population growth continues to place increasing pressure on agriculture and waste-management systems. In the United States, food waste is estimated at between 30-40 percent of the food supply. This estimate, based on USDA’s Economic Research Service finding of 31 percent food loss at the retail and consumer levels, corresponded to approximately 133 billion pounds and $161 billion worth of food in 2010.¹

This amount of waste has far-reaching impacts on food security, resource conservation and climate change.
- The land, water, labor, energy and other inputs used in producing, processing, transporting, preparing, storing, and disposing of discarded food are pulled away from uses that may have been more beneficial to society – and generate impacts on the environment that may endanger the long-run health of the planet.
- Wholesome food that could have helped feed families in need is sent to landfills.
- Food waste, which is the single largest component going into municipal landfills, quickly generates methane, helping to make landfills the third largest source of methane in the United States.

Seedling proposes a systematic solution that utilizes organic fractionated municipal solid waste (OFMSW) as a source of organic nutrients and embodied energy, both assets that support an integrated systems that operate carbon-negative, while also providing regional farmers with a cost-effective source of organic fertilizer.

Precision Farming

The USDA’s National Institute of Food and Agriculture (NIFA) identifies site-specific crop management (SSM) using a variety of technologies to manage different parts of a field separately. Natural, inherent variability within fields means that mechanized farming could traditionally apply only crop treatments for “average” soil, nutrient, moisture, weed, and growth conditions.

Necessarily, this has led to over- and under-applications of herbicides, pesticides, irrigation, and fertilizers—except on those rare sites that are truly average. Chemical excesses from blanket applications, then, end up running off or leaching from fields into ground water and surface waters. Most current SSM practices use precise global positioning combined with location-specific measurements—either in-field data collection (such as soil variables or pest occurrence) or remotely sensed data (such as from aircraft or satellites)—to quantify spatially variable field conditions. Within-field operations, then, adjust treatments based on spatially referenced management decisions recorded on maps of management zones.⁴

Variable Rate input application Technology (VRT) allows farmers to customize the application of fertilizer chemicals, and pesticides using GPS data—often from yield and soil maps or guidance systems. Farmers use VRT to plant different types of seeds at different locations with a single pass of the tractor.⁵ The chart above indicates increases in VRT utilization.

Seedling’s precision fertilizer formulation responds to this market demand increase for soil-specific nutrient formulas. D3 Designs efforts toward in-field diagnostic hardware will inform the regional SEED of the customer-farmer’s nutrient demands. Subscription fertilizer services fulfilled by the SEED delivers soil/crop specific organic fertilizers.

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Organic Certification

There are several considerations in the argument for transitioning to organic agriculture. From an environmental standpoint, organic agriculture builds life in the soil while avoiding the use of toxic chemicals that can accumulate in soil, water, food and people. Non-organic farming relies on dwindling fossil fuel resources, while organic farmers build their own fertility into their systems, which improve over time and do not rely on outside inputs.

From an economic point of view, organic farming has been one of the fastest-growing sectors of agriculture for more than two decades—by 20 to 24 percent annually since 1990—and allows farmers to reap up to three times the profit margins of non-organically raised meat and produce. [USDA average price premiums shown below.6]

According to the Economic Research Service of the U.S. Department of Agriculture and farmer interviews, obstacles to adoption by farmers include high managerial costs and risks of shifting to a new way of farming, limited awareness of organic farming systems, lack of marketing and infrastructure and inability to capture marketing economies and the fear of additional paperwork.

A period of three years is required for the transition from conventional to organic production, during which time products may be marketed as transitional or conventional but not as certified organic. During the transition period, growers may also experience reduced yields followed by a return to yields near or equal to conventional production.7

Vertical Farming

As consumer confidence in agrochemical-based farming shifts toward organic certification, controlled environment agriculture (CEA) and urban farming offer regional solutions and yet face a myriad of economic, scientific, and societal challenges.

Advantages of vertical farming are numerous over traditional field/geoponic farming, including:
- Year-round crop production at 3x-30x land use efficiency (species dependent).
- Elimination of pesticides, herbicides, fungicides.
- Elimination of agricultural runoff.
- Significant reduction of fossil fuels associated with distribution miles (1,500 avg).
- No weather related crop failures.
- 70%-95% reduction in water usage.

Problems facing vertical farming are primarily associated with:
- Energy consumption / OpEx for artificial lighting
- Nutrient consumption / cost
- Labor costs

Seedling targets solutions in this space through generation of micro-grid electricity and precision nutrient formulation for automated farming systems. D3 Designs' hydroponic growing solutions featuring Seedling fertilizers and grow mediums offer vertical farming customers access to Seedling assets.

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Zero Emissions Transportation

Even though battery electric mobility is commonly ranked as the most significant trend by automotive executives, the key issues with battery electric vehicles (BEVs) continue to be user-friendly charging infrastructure, operational range, and integration into an aging electrical grid prone to weather-associated outages. Due to these concerns, the majority (62%) of automotive executives believe that BEVs will fail.

In contrast, a significant majority (78%) of automotive executives believe that fuel cell electric vehicles (FCEV) will be the golden bullet of electric mobility while also ranking it as a top 3 key trend. The faith in FCEVs can be explained by the ability of hydrogen infrastructure to solve the recharging problems associated with BEV infrastructure. Since refueling of hydrogen can be done quickly at a traditional gas station, making recharging times of 25-45 minutes for BEVs seem unreasonable.8

Additional benefits to hydrogen FCEVs beyond refueling times look toward hydrogen's offset of battery-associated mass in heavy duty applications. Specifically, operational cost benefit analysis from the DOE indicate operational benefits of FCEV over BEV forklifts. Fleet vehicle and mass transit bus operational performance has been evaluated globally and indicates benefits in these use cases over BEV alternatives. Continued development of municipal applications of hydrogen FCEVs is also yielding opportunities for vehicle-to-grid resiliency programs.

Each SEED's production of hydrogen fuel for zero-emissions distribution of food and fertilizer provides a market responsive supply of hydrogen fuel as electric transportation markets mature. D3 Designs Inc's development of a FCEV food truck provides a market premium user experience and revenue channel for SEED-grown and brokered food.

MARKET SIZE

Collective Market Sizes

- TAM
  - Global Organics: $320 B
  - Global Energy: $1,400 B
  - Global Hydrogen: $150 B
  - Global Aquaculture: $150 B
  - Global Fertilizer: $118 B

- SAM
  - 150 Mi. Radius PHL = 40,226,720 Population

- SOM

SEED-PHL

Market Sample

Organic sales in the U.S. totaled around $49.4 billion in 2017, reflecting new sales of almost $3.5 billion from the previous year. Organic food now accounts for more than five percent of total food sales in the U.S. Organic food sales increased by 6.4 percent from last year, blowing past the 1.1 percent growth rate in the overall food market. Sales of organic non-food products were up 7.4% in 2017.

USA
- Certified Organic Farms (2016): 14,217
- Certified Organic Cropland (acres): 2,714,498

PHILADELPHIA, PA
- Certified Organic Farms (2016): 803
- Certified Organic Cropland (acres): 72,345

Total U.S. Organic Sales and Growth, 2006–2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Organic Non-Food Sales</th>
<th>Organic Food Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
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<td>2015</td>
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</tbody>
</table>

Organic Growth

Percentage of U.S. Households Purchasing Organic Products

MARKET SIZE

United States Food-Waste Market Sizes

40%: The amount of food wasted in total US food production. 33 Million Tons: The amount of food waste thrown away in 2010 — the largest component of MSW reaching landfills and incinerators. 4-10%: The amount of food you purchase that ends up as kitchen waste — 422g., the average amount of food-waste produced by each American daily.

SHOWN BELOW: 173 viable installation markets based on population X 422g of daily kitchen food-waste (4-10% of potential food-waste in each city).

INSTALLATION SCALE MAY EXCEED MODELED INSTALLATION SIZES, BASED UPON POPULATION AND FOOD-WASTE COLLECTION OF OPERATIONAL RADIUS.
# SEEDS: 5TH YR. OPERATION PROJECTIONS

## Seed Market Size Requirements:

<table>
<thead>
<tr>
<th>OFMSW Food-Waste Input: Philadelphia</th>
<th>Estimated CAPEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 T/Day</td>
<td>150 T/Day</td>
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<tr>
<td>270 T/Day</td>
<td></td>
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</tbody>
</table>

## CAPEX

- **Site:** Industrial Zoning
  - (YR 0): $4,000,000
- **Fuel Cell | Electrolyzer**
  - (YR 0): $4,000,000
  - Doosan - 400kW | Nel-A-150
- **AD | Fermentation | Build**
  - (YR 0): $5,500,000
- **VF Growing Footprint @ 5 Layer Height**
  - (YR 0): $3,250,000 | 4,500 ft²
- **GH Growing Footprint**
  - (YR 0): $2,250,000 | 11,250 ft²
- **Produce Processing | Packaging**
  - (YR 0): $1,250,000
- **Hydrological Processing**
  - (YR 0): $1,500,000
- **Roots LLC. Fuel Cell Food-Truck**
  - (YR 0): $850,000
- **H₂ Containment | Station**
  - (YR 0): $2,500,000
- **Distribution Vehicles**
  - (YR 0): $480,000

## PRODUCTION | REVENUE: Year 5

- **Electricity Produced /Yr**
  - 3.110 GW
- **Carbon Produced (CO₂)/Yr**
  - 1,480 T
- **Carbon Reduction (CO₂)/Yr**
  - -36,861 T
- **Fertilizer: FERTILIZER REVENUE:**
  - $2,107,000
- **Produce: PRODUCE REVENUE:**
  - $1,122,000
- **Brokerage: 4%-FERTILIZER REVENUE:**
  - $84,000
- **Roots LLC FOOD-TRUCK LEASE: # FCFIT | $**
  - 1 | $48,000
  - 3 | $144,000
  - 6 | $288,000
- **Hydrogen: Production/Day**
  - 48 kg
  - 192 kg
- **HYDROGEN REVENUE @ $3 GGE:**
  - $66,000
  - $276,000

## SEED BALANCE @ Year 5

- **REVENUE:**
  - $3,427,000
  - $11,528,000
  - $22,411,000
- **OPEX:**
  - $3,090,000
  - $6,749,000
  - $13,132,000
- **EBITA:**
  - $337,000
  - $4,779,000
  - $9,340,000

## FUNDING SOURCES

- **Grant Applicable (50 - 100%) +1-3 Years**
  - (YR 0-2; 100%) $25,580,000
  - (YR 0-2; 50%) $21,985,000
  - (YR 0-2, 50%) $37,365,000
- **[County] Economic Development Bond**
  - N/A Non-Profit
  - (YR 0) $21,985,000 - $43,970,000
  - (YR 0) $37,365,000 - $75,730,000
- **Economic Development Bond Payment/Year**
  - N/A Non-Profit
  - $975,000 - $1,950,000
  - $1,657,000 - $3,315,000

## INVESTMENT

- **Investment Round**
  - Seed: $6,395,000
  - Series A - Local: $10,000,000
  - Series B - Local: $15,000,000

- **ROI [Grant v. Full Bond]**
  - N/A Non-Profit: $(219,800)
  - (30% Equity) Return at 6.25Yrs. investment
    - N/A Non-Profit: (3.7%)
      - 33.4% - 48.6%
      - 43.5% - 60%

- **Subsequent Seed-investor IRR**
  - $2,881,000 @ 48% @ 6.25 Yr.
  - $5,407,920 @ 90% @ 6.25 Yr.
SEED-50

Min. STAFF | Job Creation: 20
Exec. | Dir. | PhD.: 3 [$132K]
Mid-Level: 5 [$66K - $96K]
Entry-Level: 12 [$50K]

CITY POPULATIONS: 150K-350K

HYDROGEN PRODUCED: 48KG/DAY | 15.7T/YR.
POWER PRODUCED: 400KW/HR | 3.15GW/YR.

Food-Waste: 50 T/DAY | 16425 T/YR.
CO2 Diverted: ≥ 35,000 T/YR.
Organic Fertilizer
  Solid: ≥ 5,000 T/YR
  Liquid: ≥ 700,000 Ga./YR
PHA Bioplastic Option: ≥ 800,000 Lb./YR

TOTAL CROP GROWTH AREA: ≤ 45,000 FT²
TOTAL VF GROWTH AREA: 35,000 FT²
TOTAL GREENHOUSE AREA: 10,000 FT²

HYDROLOGY SYSTEM: ≤ 450,000 GA.
AQUACULTURE OPTION: + 250,000 GA.

Shown: 20,000 ga. PHA Fermentation
Shown: 40,000 ga. Duckweed Fermentation
Shown: ~48,000 ga. Hydrology

Processing/ Office Scalable to Installation

Up to 16 Containerized Farms*

400kW Fuel Cell
50T/Day Anaerobic Digester
48kg/day Hydrogen Fueling
1 Food-Truck
  -or-
  3-5 FCEV Van Fleet

* Containerized Farming Modules modeled as example only. Brick & mortar designed installations showcase greater hydroponic efficiencies.
### OFMSW Food-Waste Input

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAPEX</strong></td>
<td>Site: Industrial Zoning</td>
<td>$4,000,000</td>
<td>$4,000,000</td>
<td>$4,000,000</td>
<td>$4,000,000</td>
<td>$4,000,000</td>
</tr>
<tr>
<td></td>
<td>Doosan - 400kW</td>
<td>$4,000,000</td>
<td>$4,000,000</td>
<td>$4,000,000</td>
<td>$4,000,000</td>
<td>$4,000,000</td>
</tr>
<tr>
<td></td>
<td>AD</td>
<td>$5,500,000</td>
<td>$5,500,000</td>
<td>$5,500,000</td>
<td>$5,500,000</td>
<td>$5,500,000</td>
</tr>
<tr>
<td></td>
<td>VF Growing Footprint @ 5 Layer Height</td>
<td>$3,250,000</td>
<td>$4,500 ft²</td>
<td>$4,500 ft²</td>
<td>$4,500 ft²</td>
<td>$4,500 ft²</td>
</tr>
<tr>
<td></td>
<td>GH Growing Footprint</td>
<td>$2,250,000</td>
<td>$11,250 ft²</td>
<td>$11,250 ft²</td>
<td>$11,250 ft²</td>
<td>$11,250 ft²</td>
</tr>
<tr>
<td></td>
<td>Processing</td>
<td>$1,250,000</td>
<td>$1,250,000</td>
<td>$1,250,000</td>
<td>$1,250,000</td>
<td>$1,250,000</td>
</tr>
<tr>
<td></td>
<td>Hydrological Processing</td>
<td>$1,500,000</td>
<td>$1,500,000</td>
<td>$1,500,000</td>
<td>$1,500,000</td>
<td>$1,500,000</td>
</tr>
<tr>
<td></td>
<td>Fuel Cell Food-Truck (# FCFT)</td>
<td>$850,000</td>
<td>(1 FCFT)</td>
<td>(1 FCFT)</td>
<td>(1 FCFT)</td>
<td>(1 FCFT)</td>
</tr>
<tr>
<td></td>
<td>Distribution Vehicles</td>
<td>$480,000</td>
<td>$480,000</td>
<td>$480,000</td>
<td>$480,000</td>
<td>$480,000</td>
</tr>
</tbody>
</table>

### Production | Revenue:

<table>
<thead>
<tr>
<th>Category</th>
<th>Production/Day</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Produced /Yr</td>
<td>0 GW</td>
<td>3.153 GW</td>
<td>3.153 GW</td>
<td>3.153 GW</td>
<td>3.153 GW</td>
<td></td>
</tr>
<tr>
<td>Carbon Produced (CO₂) Yr</td>
<td>(N/A)</td>
<td>1,480 T</td>
<td>1,480 T</td>
<td>1,480 T</td>
<td>1,480 T</td>
<td>1,480 T</td>
</tr>
<tr>
<td>Carbon Reduction (CO₂) Yr²</td>
<td>(N/A)</td>
<td>-36,861 T</td>
<td>-36,861 T</td>
<td>-36,861 T</td>
<td>-36,861 T</td>
<td>-36,861 T</td>
</tr>
<tr>
<td>Fertilizer: FERTILIZER REVENUE:</td>
<td>(N/A)</td>
<td>$932,000</td>
<td>$1,459,000</td>
<td>$1,675,000</td>
<td>$1,891,000</td>
<td>$2,107,000</td>
</tr>
<tr>
<td>Produce: PRODUCE REVENUE:</td>
<td>(N/A)</td>
<td>$694,000</td>
<td>$925,000</td>
<td>$1,003,000</td>
<td>$1,063,000</td>
<td>$1,122,000</td>
</tr>
<tr>
<td>Brokerage: 4% FERTILIZER REVENUE:</td>
<td>(N/A)</td>
<td>$37,000</td>
<td>$58,000</td>
<td>$67,000</td>
<td>$76,000</td>
<td>$84,000</td>
</tr>
<tr>
<td>FOOD-TRUCK LEASE:</td>
<td>(N/A)</td>
<td>$48,000</td>
<td>$48,000</td>
<td>$48,000</td>
<td>$48,000</td>
<td>$48,000</td>
</tr>
<tr>
<td>Hydrogen: Production/Day</td>
<td>&lt;48 kg</td>
<td>48 kg</td>
<td>48 kg</td>
<td>48 kg</td>
<td>48 kg</td>
<td>48 kg</td>
</tr>
<tr>
<td>HYDROGEN REVENUE @ $3 GGE:</td>
<td>(N/A)</td>
<td>$66,000</td>
<td>$66,000</td>
<td>$66,000</td>
<td>$66,000</td>
<td>$66,000</td>
</tr>
</tbody>
</table>

### SEED-50 Balance

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>REVENUE:</strong></td>
<td>$0</td>
<td>$1,777,000</td>
<td>$2,556,000</td>
<td>$2,859,000</td>
<td>$3,144,000</td>
<td>$3,427,000</td>
</tr>
<tr>
<td><strong>OPEX:</strong></td>
<td>$4,904,000</td>
<td>$2,594,000</td>
<td>$2,550,000</td>
<td>$2,717,000</td>
<td>$2,896,000</td>
<td>$3,090,000</td>
</tr>
<tr>
<td>Salaries</td>
<td>$1,549,000</td>
<td>$2,107,000</td>
<td>$2,079,000</td>
<td>$2,245,000</td>
<td>$2,425,000</td>
<td>$2,619,000</td>
</tr>
<tr>
<td>Auto</td>
<td>$360,000</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>General Office</td>
<td>$372,000</td>
<td>$42,000</td>
<td>$42,000</td>
<td>$42,000</td>
<td>$42,000</td>
<td>$42,000</td>
</tr>
<tr>
<td>Accounting &amp; Legal</td>
<td>$160,000</td>
<td>$18,000</td>
<td>$18,000</td>
<td>$18,000</td>
<td>$18,000</td>
<td>$18,000</td>
</tr>
<tr>
<td>Advertising</td>
<td>$145,000</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Outside Services</td>
<td>$1,575,000</td>
<td>$24,000</td>
<td>$24,000</td>
<td>$24,000</td>
<td>$24,000</td>
<td>$24,000</td>
</tr>
<tr>
<td>Power System Lease</td>
<td>(N/A)</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Anaerobic Feedstock</td>
<td>$64,000</td>
<td>$180,000</td>
<td>$180,000</td>
<td>$180,000</td>
<td>$180,000</td>
<td>$180,000</td>
</tr>
<tr>
<td>Misc. [IT, Fees, Packaging, Insurance]</td>
<td>$680,000</td>
<td>$96,000</td>
<td>$87,000</td>
<td>$87,000</td>
<td>$87,000</td>
<td>$87,000</td>
</tr>
<tr>
<td><strong>EBITA:</strong></td>
<td>$4,904,000</td>
<td>$817,000</td>
<td>$6,000</td>
<td>$142,000</td>
<td>$248,000</td>
<td>$337,000</td>
</tr>
</tbody>
</table>

**Investment | Return | Grant Funded | $6,395,000 | N/A | ($245,100) | ($1,800) | ($42,600) | ($74,400) | ($101,000) | N/A (3.7%)**

SEED-150

STAFF | Job Creation: 34
Exec. | Dir. | PhD.: 3 ($132K)
Mid-Level: 12 ($66K - $87K)
Entry-Level: 19 ($50K)

CITY POPULATIONS: 350K-650K

HYDROGEN PRODUCED: 192KG/DAY | 63.1T/YR.
POWER PRODUCED: 1,400KW/HR | 11.04GW/YR.

Food-Waste: 150 T/DAY | 49,275 T/YR.
CO2 Diverted: ≥ 110,000 T/YR.
Organic Fertilizer
Solid: ≥ 16,000 T/YR
Liquid: ≥ 2,170,000 Ga./YR
PHA Bioplastic Option: ≥ 2,463,750 Lb./YR

TOTAL CROP GROWTH AREA: ≤ 125,000 FT²
TOTAL VF GROWTH AREA: 85,000 FT²
TOTAL GREENHOUSE AREA: 40,000 FT²
HYDROLOGY SYSTEM: ≤ 1,250,000 GA.
AQUACULTURE OPTION: + 625,000 GA.

* Containerized Farming Modules modeled as example only. Brick & mortar designed installations showcase greater hydroponic efficiencies.
Most flexible configuration. Post SEED-50 R&D Installation.

### OFMSW Food-Waste Input

<table>
<thead>
<tr>
<th>Input Type</th>
<th>Quantity</th>
<th>Unit</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philadelphia</td>
<td>Estimated CAPEX</td>
<td></td>
<td>$43,970,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAPEX Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site: Industrial Zoning</td>
<td>$10,500,000</td>
</tr>
<tr>
<td>FCEL: 1.4 MW (Leased)</td>
<td>$1,750,000</td>
</tr>
<tr>
<td>AD</td>
<td>Fermentation</td>
</tr>
<tr>
<td>VF Growing Footprint @ 5 Layer Height</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>GH Growing Footprint</td>
<td>$4,000,000</td>
</tr>
<tr>
<td>Processing</td>
<td>Packaging</td>
</tr>
<tr>
<td>Hydrological Processing</td>
<td>$2,250,000</td>
</tr>
<tr>
<td>Fuel Cell Food-Truck (# FCFT)</td>
<td>$2,550,000</td>
</tr>
<tr>
<td>H₂ Containment</td>
<td>Station</td>
</tr>
<tr>
<td>Distribution Vehicles</td>
<td>$920,000</td>
</tr>
</tbody>
</table>

### PRODUCTION | REVENUE:

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>$8,353,000</th>
<th>$10,128,000</th>
<th>$10,736,000</th>
<th>$11,306,000</th>
<th>$11,528,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Produced /Yr</td>
<td>0 GW</td>
<td>11.037 GW</td>
<td>11.037 GW</td>
<td>11.037 GW</td>
<td>11.037 GW</td>
<td>11.037 GW</td>
</tr>
<tr>
<td>Carbon Produced (CO₂)/Yr</td>
<td>[Captured]</td>
<td>-4,840 T</td>
<td>-4,840 T</td>
<td>-4,840 T</td>
<td>-4,840 T</td>
<td>-4,840 T</td>
</tr>
<tr>
<td>Carbon Reduction (CO₂)/Yr</td>
<td>(N/A)</td>
<td>-112,770 T</td>
<td>-112,770 T</td>
<td>-112,770 T</td>
<td>-112,770 T</td>
<td>-112,770 T</td>
</tr>
<tr>
<td>Fertilizer: FERTILIZER REVENUE</td>
<td>(N/A)</td>
<td>$5,674,000</td>
<td>$5,998,000</td>
<td>$6,063,000</td>
<td>$6,127,000</td>
<td>$6,192,000</td>
</tr>
<tr>
<td>Produce: PRODUCE REVENUE</td>
<td>(N/A)</td>
<td>$2,032,000</td>
<td>$3,470,000</td>
<td>$4,010,000</td>
<td>$4,514,000</td>
<td>$4,965,000</td>
</tr>
<tr>
<td>Brokerage: 4%ECONOMY REVENUE</td>
<td>(N/A)</td>
<td>$227,000</td>
<td>$240,000</td>
<td>$243,000</td>
<td>$245,000</td>
<td>$227,000</td>
</tr>
<tr>
<td>FOOD-TRUCK LEASE</td>
<td>(N/A)</td>
<td>$144,000</td>
<td>$144,000</td>
<td>$144,000</td>
<td>$144,000</td>
<td>$144,000</td>
</tr>
<tr>
<td>Hydrogen: Production/Day</td>
<td>&lt; 192 kg</td>
<td>192 kg</td>
<td>192 kg</td>
<td>192 kg</td>
<td>192 kg</td>
<td>192 kg</td>
</tr>
<tr>
<td>HYDROGEN REVENUE @ $3 GGE</td>
<td>(N/A)</td>
<td>$276,000</td>
<td>$276,000</td>
<td>$276,000</td>
<td>$276,000</td>
<td>$276,000</td>
</tr>
</tbody>
</table>

### SEED-150 BALANCE

| REVENUE: | $0 | $8,353,000 | $10,128,000 | $10,736,000 | $11,306,000 | $11,528,000 |
| OPEX: | $5,086,000 | $5,837,000 | $6,036,000 | $6,124,000 | $6,424,000 | $6,749,000 |
| Salaries | Benefits | Discounts | | | | |
| Auto | Delivery | Travel | | | | |
| General Office | Admin | | | | | |
| Accounting & Legal | Advertising | Tradeshow | | | | |
| Outside Services | Consultants | | | | | |
| Power System Lease | | | | | | |
| Anaerobic Feedstock | | | | | | |
| Misc. [IT, Fees, Packaging, Insurance] | | | | | | |
| Grant Applicable (50% CAPEX) | +1-3 Yrs | $21,985,000 | | | | |
| Economic Development Bond (50% CAPEX) | | $21,985,000 | $975,000 | $975,000 | $975,000 | $975,000 |

| EBITA: | $4,214,000 | $2,516,000 | $4,092,000 | $4,612,000 | $4,882,000 | $4,779,000 |

| Investment | Return [Grant Funded] | $10,000,000 | $462,300 | $997,500 | $1,091,100 | $1,172,100 | $1,141,200 |

(30% SEED Equity) Return @ 6.25% Yr. Investment 48.6%


---

SEED-270

STAFF | Job Creation: 53
Exec. | Dir. | PhD.: 3 ($132K)
Mid-Level : 17 ($66K - $87K)
Enter-Level : 33 ($50K)

CITY POPULATIONS: 650K+

HYDROGEN PRODUCED: 1.27T/DAY | 417.2T/YR.

POWER PRODUCED: 2,350KW/HR | 18.53GW/YR.

Food-Waste: 270 T/DAY | 88,695 T/YR.
CO2 Diverted: ≥ 210,000 T/YR.
Organic Fertilizer
Solid: ≥ 29,000 T/YR
Liquid: ≥ 3,900,000 Ga./YR
PHA Bioplastic Option: ≥ 4,434,750 Lb./YR

TOTAL CROP GROWTH AREA: ≤ 240,000 FT²
TOTAL VF GROWTH AREA: 160,000 FT²
TOTAL GREENHOUSE AREA: 80,000 FT²

HYDROLOGY SYSTEM: ≤ 2,400,000 GA.
AQUACULTURE OPTION: + 1,200,000 GA.
# OFMSW Food-Waste Input

<table>
<thead>
<tr>
<th>Site: Industrial Zoning</th>
<th>$16,500,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCEL: 2.35 MW Tri-Gen (Leased)</td>
<td>$0</td>
</tr>
<tr>
<td>AD</td>
<td>$12,100,000</td>
</tr>
<tr>
<td>VF Growing Footprint @ 5 Layer Height</td>
<td>$20,000,000</td>
</tr>
<tr>
<td>GH Growing Footprint</td>
<td>$9,000,000</td>
</tr>
<tr>
<td>Processing</td>
<td>$3,000,000</td>
</tr>
<tr>
<td>Hydrological Processing</td>
<td>$5,500,000</td>
</tr>
<tr>
<td>Fuel Cell Food-Truck (# FCFT)</td>
<td>$5,100,000</td>
</tr>
<tr>
<td>H2 Containment</td>
<td>$2,500,000</td>
</tr>
<tr>
<td>Distribution Vehicles</td>
<td>$1,030,000</td>
</tr>
</tbody>
</table>

## Production Revenue

<table>
<thead>
<tr>
<th>Electricity Produced /Yr</th>
<th>18,527 GW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Produced (CO2)/Yr</td>
<td>8,123 T</td>
</tr>
<tr>
<td>Carbon Reduction (CO2)/Yr</td>
<td>-216,166 T</td>
</tr>
<tr>
<td>Fertilizer: FERTILIZER REVENUE</td>
<td>$8,606,000</td>
</tr>
<tr>
<td>Produce: PRODUCE REVENUE</td>
<td>$4,066,000</td>
</tr>
<tr>
<td>Brokerage: 4% FERTILIZER REVENUE</td>
<td>$344,000</td>
</tr>
<tr>
<td>FOOD-TRUCK LEASE</td>
<td>$288,000</td>
</tr>
<tr>
<td>Hydrogen: Production/Day</td>
<td>$2,333,000</td>
</tr>
</tbody>
</table>

## SEED-270 Balance

<table>
<thead>
<tr>
<th>REVENUE:</th>
<th>$5,720,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPEX:</td>
<td>$11,163,000</td>
</tr>
<tr>
<td>Salaries</td>
<td>$2,103,000</td>
</tr>
<tr>
<td>Auto</td>
<td>$350,000</td>
</tr>
<tr>
<td>General Office</td>
<td>$374,000</td>
</tr>
<tr>
<td>Accounting &amp; Legal</td>
<td>$160,000</td>
</tr>
<tr>
<td>Advertising</td>
<td>$155,000</td>
</tr>
<tr>
<td>Outside Services</td>
<td>$1,600,000</td>
</tr>
<tr>
<td>Power System Lease</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Anaerobic Feedstock</td>
<td>$81,000</td>
</tr>
<tr>
<td>Misc. [IT, Fees, Packaging, Insurance]</td>
<td>$700,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EBITA:</th>
<th>$37,365,000</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Investment Return</th>
<th>$15,000,000</th>
<th>$845,100</th>
</tr>
</thead>
</table>

*30% SEED Equity Return @ 6.25Yr. Investment 60%* 

Value Proposition: Food-Waste

**Key Partners**
Our supply of OFMSW Food-waste is delivered daily on a per ton contractual cost agreement. Initial supplies of food-waste is pre-consumer, collected from grocers by Organix, who diverts 7M Tons of food-waste from 6,000 supermarkets in 34 states and Puerto Rico.  

**Partnership | Customer Segment**
As each SEED comes on-line as a private waste utility service, our produce customers (municipalities, grocers, restaurants, universities, food-service), fertilizer customers, and contractual partnerships with food-processors may yield new feed-stock streams.

Feed-stocks will first be evaluated for nutrient extraction, feedstock purity/sorting, and volume prior to contractual intake.

---

Value Proposition: Organic Fertilizer

**Subscription Model**
Each SEED provides a subscription fertilizer (solid & liquid) service to transitional organic farms for the duration of their transition (3-year target).

The subscription service formulates crop and soil responsive nutrient profiles specific to customer growing conditions. Soil samples utilizing in-field diagnostic sampling technologies will provide precise soil composition. This data is cloud-computed and paired with blockchain-driven formulations for next shipment to the farmer.

**Hydroponics**
Internal to each SEED will be the formulation of nutrient fertilizers specific to the crop species that are grown within the SEED’s hydroponic farming operations.

**Blockchain** [See additional information in BLOCKCHAIN]
Providing farmers with unprecedented nutrient-content transparency, Seedling fertilizer is tailored through Blockchain data driven formulations. The data within this process provides regional data on food-waste content (Agri-chem), soil composition mapping, crop growth statistics (CEA), and process mapping of chemical composition outcomes.

---

Value Proposition: Packaging

Pressed fiber packaging is a common anaerobic digestion byproduct. This nutrient-stripped material can be formulated for food-grade packaging. Combined with poly lactic acid (PLA), an anaerobically digestible bioplastic, Seedling will provide the packaging and carton materials for SEED Produce distribution.

D3 Designs packaging solutions for Seedling produce will provide uniform, modular delivery & collection cartons for use by SEED Produce customers. Packaging is in D3 Diagnosis phase.

---

**Fermentation**
The potential for improving bioenergy yields from OFMSW Food-waste is through the inclusion of *duckweed*, a fast-growing, simple, floating aquatic plant. This was evaluated by Penn State University’s Eco-Machine™ by subjecting the dried biomass directly to anaerobic digestion, or sequentially to ethanol fermentation and then anaerobic digestion, after evaporating ethanol from the fermentation broth. The combined bioethanol-biomethane process yielded 70.4% more bioenergy from duckweed, than if anaerobic digestion had been run alone.11

**Anaerobic Digestion (AD)**
Starting with a market-available example, Magic-Dirt™ is an anaerobically-digested dairy-farm waste, organic-certified, national brand sold at Wal-Mart. Their digestion and nutrient extraction is supplied by DVO Digesters of Chilton, WI. DVO is currently the preferred vendor for Seedling. Their experience in designing digesters for urban organics and food-waste processing has been represented in the largest installations in the United States and globally sought after.

**Nutrient Recovery**
Using a baseline of DVO nutrient recovery processes, tailored for organic certification, crop/soil-specific formulations for both liquid and solid nutrient recovery are to be developed in partnership with Penn State University within SEED-PSU. The sensorized formulation processes combined with blockchain-managed data processing, will enable automation of subscription formulations as they are uploaded from the field.

**Post Processing**
Subscription shipments to regional farmers will be delivered in reusable market available containment systems and shipped through FCEV distribution to customers.

Manufacturing processes for organic hydro/geoponic grow mediums will coincide with D3 Designs’ hydroponic systems using Seedling grow mediums and liquid nutrients. Analogous to injection molded bricks, these grow mediums will be packaged and sold to hydroponic farmers seeking organic certification.

Regional supply to Magic-Dirt™ may be viable pending formulation testing and organic certification.

**OFMSW Food-Waste**
The selection of food-waste compared to other categories of substrates is directly related to volumetric biogas production per ton, societal health improvement12,13, and environmental improvement of diversion from landfill.

**SEED-CITIES**
Operational partnerships supported through regional bond programs target evolutionary opportunities to transition urban centers into more responsible OFMSW Food-Waste collection practices. Opening new markets for silent FCEV refuse trucks that purchase hydrogen upon delivery to each SEED.

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Value Proposition: Microgrid Independence

**Independent Power Provider**
Filing as an Independent Power Provider (IPP) enables each SEED to provide contractual rates for excess electricity sales. **America loses $150 billion per year due to power outages** that occur 285% more frequently than in 1985

The U.S. power grid, which could be considered the largest machine on earth, was built after World War II from designs dating back to Thomas Edison, using technology that primarily dates back to the ‘60s and ‘70s. Its 7,000 power plants are connected by power lines that combined total more than 5 million miles, all managed by 3,300 utilities serving 150 million customers, according to industry group Edison Electric Institute. The whole system is valued at $876 billion.

A smarter grid could reduce costs of outages by about $49 billion per year and reduce carbon emissions by 12 to 18 percent by 2030. 14

**Redundant Reliability**
Each SEED has designed in redundancies including utility natural gas to back up biogas production. Hydrogen to back up natural gas. Utility power to back up microgrid energy production for critical systems.

Value Proposition: Multi-generation Technology

**Cogenerative Heat & Power (CHP)**
An energy production methodology that utilizes thermal energy in addition to electrical energy created by an energy system. CHP efficiencies in power generation have exceeded 85% efficiency, compared to a national electrical grid average of 26% efficiency. High-temperature fuel cell technologies (SOFC/MCFC/etc.) are commonly formatted to utilize heat production in the onboard reformation of fuel (thermochemical electrolysis/steam methane reforming, SMR) to extract hydrogen for power generation.

**Carbon Capture**
FuelCell Energy (Danbury, CT) feature-optional configurations for Carbon Capture that captures up to 90% CO₂ (in addition to 70% NOX destruction, and clean water production).15 This purified CO₂ stream is an asset that is currently used in vertical farming systems to manipulate yield rates on crops. Seedling will both utilize and sell this asset to controlled environment agriculture (CEA) markets.

**Hydrogen Production | SMR | Electrolysis**
Production of a higher-value assets, hydrogen & food-crops, is prioritized over bulk energy sales to local utilities. IPP utility status acts as a production/demand buffer and emergency response capability. FuelCell Energy’s Tri-Gen technology has been implemented in modeling of full-scale SEEDs (PHL & PGH). This technological configuration produces 1,270kg H₂/day in a configuration that cannot be turned off outside of service schedules. Alternatively, energy produced by a CHP fuel cell will be used in smaller scale SEEDs integrating SMR/Electrolysis for hydrogen production.

### Key Activities | Key Resources

**High-Temperature Fuel Cell**

Commercially tested and operated for decades, high temperature fuel cells provide precision performance with greater reliability, greater efficiency, and more capabilities than alternative combustion-based power generation means. Commonly paired with biogas/methane fuel processing, these technologies classify for renewable energy credits, grants, and incentives.

Seedling has selected two primary suppliers for these technologies, Doosan and FuelCell Energy:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Technology</th>
<th>Power Output</th>
<th>Gas Input: NG</th>
<th>Gas Input: Biogas</th>
<th>Digester Size</th>
<th>Additional Output</th>
<th>Carbon Capture</th>
<th>Buy / Lease</th>
<th>Available</th>
<th>Pending Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doosan</td>
<td>PureCell 400</td>
<td>PAFC</td>
<td>400/440 KW</td>
<td>66 SCFM @ 1025 Btu/SCF</td>
<td>124 SCFM @ 545 Btu/SCF</td>
<td>50T/Day</td>
<td>0.64 MMBtu/h @ 250° F</td>
<td>Not Featured</td>
<td>Buy</td>
<td>Available</td>
<td>Buy / Lease [Leases starting at $ 0.078/kWhr &amp; $ 7.00.kg H₂]</td>
</tr>
<tr>
<td>FuelCell Energy</td>
<td>Sure Source 1500</td>
<td>MCFC</td>
<td>1,400 KW</td>
<td>181 SCFM @ 930 Btu/SCF</td>
<td>308 SCFM @ 545 Btu/SCF</td>
<td>150T/Day</td>
<td>2.216 MMBtu/h @ 250° F</td>
<td>NOx: 0.01 lbs/MWh</td>
<td>CO: TBD lbs/MWh</td>
<td>NOx: 0.01 lbs/MWh</td>
<td>CO: TBD lbs/MWh</td>
</tr>
<tr>
<td>FuelCell Energy</td>
<td>Sure Source Hydrogen</td>
<td>MCFC</td>
<td>2,350 KW</td>
<td>372 SCFM @ 930 Btu/SCF</td>
<td>634 SCFM @ 545 Btu/SCF</td>
<td>270T/Day</td>
<td>0.415 MMBtu/h @ 180° F</td>
<td>NOx: 0.01 lbs/MWh</td>
<td>CO: TBD lbs/MWh</td>
<td>NOx: 0.01 lbs/MWh</td>
<td>CO: TBD lbs/MWh</td>
</tr>
</tbody>
</table>

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Value Proposition: Controlled Environment Agriculture (CEA)

**Vertical Farming (VF)**
Defined as the stacked configuration of hydroponic crop systems illuminated by electrified light sources, Vertical Farming has shown a dynamic relationship between benefits and problems, resulting in industry caution of business model success and market concern with energy consumption and nutrient composition and sourcing. VF configurations have been modeled at scales ranging from micro in-home systems for microgreens, to shipping-container systems that cite production rates of over 500 heads of lettuce per week.\(^{19}\) These configurations are convenient for modularity and small scale production (SEED-PSU), but suffer from performance limitations and economic restrictions associated with containment of growth systems within a small, containerized footprint.

**Strengths:**
- 90% yield
- 90% water reduction/recycling
- 3x-30x land-use efficiency
- Peak-harvest schedules | nutrient/terroir densities
- Food-mile reduction | GHG reduction
- Zero Pesticides | Zero Herbicides | Zero Fungicides
- Climate change resistant | Non-seasonal growth cycle

**Weaknesses:**
- High energy costs/consumption
- Limited crop-growth portfolio (photon availability)
- Nutrient demand/composition typically non-Organic
- Terroir reflective of practices (Opportunity)
- Conflicts with traditional farming

**Greenhouse Hydroponics**
This sun-fed, hydroponic configuration of CEA allows for reductions in energy costs associated with VF and provides a greater portfolio of large fruit-bearing crop species due to increased photon output associated with sunlight. The benefits associated with the sun-fed configuration are weighed against the benefits of land-use efficiency within VF configurations. Seedling seeks brick-and-mortar structures that allow for roof-top greenhouses, to maximize the breadth of our portfolio of in-house grown crop species. Advancements in combined electrified-lighting and greenhouse configurations are an area that Seedling intends to explore through our operations. The goal of this exploration is to advance the crop yield rates beyond sunlight cycles to provide increased production rates.

**Aquaponics**
In an effort to reduce external nutrient input, aquaculture systems are combined with hydroponic systems to utilize nutrient-enriched water (ammonia & others) from the aquaculture to supply hydroponic crops with nutrients. This increase in complexity of systematic relationships, including aquaculture feed-stocks, health, water quality, species selection, and organic certification requirements has shown extreme market difficulties.

Seedling’s inclusion of aquaculture within our model serves as an exploratory path toward regional waterway rejuvenation through native species growth programs. Additional research associated with the growth of crustaceans for nutrient amendment\(^{20}\), hydrological processing, and marketability will be subsequent phases of R&D for SEED-PSU.

Value Proposition: Brokerage Services

**Key Partners | Customer Segment**
Providing subscription fertilizer customers a channel to market at a rate between standard & organic, reduces the barrier of entry throughout their transitional period to organic certification. As an added service to fertilizer subscription, Seedling will include regional produce within a brokerage portfolio that is provided to the regional SEED’s produce customers. Using Seedling’s direct-to-customer channels and network of food-industry customers enables each SEED to provide support for customer farms during their fertilizer contract periods.

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FOOD PRODUCTION

Revenue Stream: Hydroponic Produce

Energy Input | Hydroponic Area
The single greatest limiting factor to vertical farming is energy input.
Within hydroponic growing markets, technologies range from containers to warehouses. Containers (200ft² growing) are indicated, the power input rating ranges from 4.17KW to 8.34KW based on growing configuration for all contained technology. Containers often achieve a 3 layer growth efficiency. That factors at 0.0139 kW/ft²/Hr @ 1 layer @ 50% power demand (lighting: 12hr on / 12hr off)

Warehouses are indicated, the power input rating is estimated at 0.0228KW/ft²/Hr Fluorescent & 0.0174KW/ft²/LED (21), we factor this to:

WE USE 50% +0.017kW: 0.0122kWh/ft²/Hr @ 1 layer @ 50% power demand (lighting: 12hr on / 12hr off)

Based upon a 50% power demand, at 5 layers in height, the ratio between fuel cell power system and farm is:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Floor Area Minimum:</td>
<td>300 kW</td>
<td>1,000 kW</td>
<td>2,000 kW</td>
</tr>
<tr>
<td>VF Hydroponic Growing:</td>
<td>15,000 ft²</td>
<td>48,000 ft²</td>
<td>100,000 ft²</td>
</tr>
<tr>
<td>Total VF Growing Area:</td>
<td>4,500 ft²</td>
<td>16,000 ft²</td>
<td>32,000 ft²</td>
</tr>
<tr>
<td>(5 layers, species dependant)</td>
<td>35,000 ft²</td>
<td>87,710 ft²</td>
<td>160,000 ft²</td>
</tr>
<tr>
<td>Rooftop CEA Greenhouse:</td>
<td>11,250 ft²</td>
<td>40,000 ft²</td>
<td>80,000 ft²</td>
</tr>
</tbody>
</table>

Produce Yields
Seedling will target early-stage fertilizer formulations for crop species identified by the Environmental Working Group's (EWG) annual "Dirty Dozen" list of crops with the most intensive Ag-chem usage.22

The following modeled produce yields and market values are calculated based on available USDA and academic research. Growth-rates are averaged per species of plant based on traditional soil-based farming practices over a single month.

<table>
<thead>
<tr>
<th>Vertical Farm</th>
<th>PRODUCE YIELDS</th>
<th>UNIT SIZE</th>
<th>LOW</th>
<th>HIGH</th>
<th>WHOLESALE RATE PER UNIT23</th>
<th>STACKED LAYERS [X*LAND-USE]24</th>
<th>GROWTH RATE/MONTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>LETTUCE (SM)</td>
<td>HEAD</td>
<td>$0.80</td>
<td>$1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LETTUCE (LG)</td>
<td>HEAD</td>
<td>$0.85</td>
<td>$1.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPINACH</td>
<td>1#</td>
<td>$1.25</td>
<td>$1.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BASIL</td>
<td>1#</td>
<td>$3.00</td>
<td>$5.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rooftop CEA Greenhouse</td>
<td>PEPPERS (BELL)</td>
<td>1#</td>
<td>$1.25</td>
<td>$1.65</td>
<td>2</td>
<td>1</td>
<td>0.7</td>
</tr>
</tbody>
</table>

**HYDROPONIC PRODUCE REVENUE ANNUAL**

**Food-Truck**
The US Food-Truck market in 2017 had revenue of 960M which is a 7.3% growth rate over 5 years. The industry employs more than 14,000 workers within a fleet of over 4,000 trucks nationwide. In surveys of more than 200 truck purveyors, over 85% of full-time food trucks generate over $100,000 in annual gross revenue. Over half of the vendors that responded sold $150,000 or more from their mobile food units last year. However, food-trucks still remain a gamble with high upfront costs.

**Traditional Food Truck Start-up Costs**

<table>
<thead>
<tr>
<th>Item</th>
<th>Estimated Start-up Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Truck + Wrap &amp; Equipment</td>
<td>$25,000 – $100,000</td>
</tr>
<tr>
<td>Initial Product Inventory</td>
<td>$1,000 – $2,000</td>
</tr>
<tr>
<td>Permits and Licenses</td>
<td>$100 – $500</td>
</tr>
<tr>
<td>Website</td>
<td>Free – $5,000</td>
</tr>
<tr>
<td>Facebook / Twitter / IG</td>
<td>Free</td>
</tr>
<tr>
<td>Register / POS</td>
<td>$200 – $1,000</td>
</tr>
<tr>
<td>Uniforms / T-Shirts</td>
<td>$0 – $1,000</td>
</tr>
<tr>
<td>Paper Products (Plates / Napkins, etc.)</td>
<td>$200 – $300</td>
</tr>
<tr>
<td>Misc. Expenses (Decor)</td>
<td>$500 – $2000</td>
</tr>
<tr>
<td>Small-wares: Pots, Pans, etc.</td>
<td>$1000 – $2000</td>
</tr>
<tr>
<td>Fire Extinguisher</td>
<td>$100 – $300</td>
</tr>
<tr>
<td>Total Chef Cost Low End</td>
<td>$28,100</td>
</tr>
<tr>
<td>Total Chef Cost High End</td>
<td>$114,100</td>
</tr>
</tbody>
</table>

**Food Truck On-Going Costs**

<table>
<thead>
<tr>
<th>Item</th>
<th>Monthly Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissary</td>
<td>$400 – $1,200</td>
</tr>
<tr>
<td>Phone / Internet</td>
<td>$100 – $200</td>
</tr>
<tr>
<td>Fuel</td>
<td>$500</td>
</tr>
<tr>
<td>Labor</td>
<td>???</td>
</tr>
<tr>
<td>Repairs</td>
<td>$1000</td>
</tr>
<tr>
<td>Food / Beverage Restock</td>
<td>???</td>
</tr>
<tr>
<td>Paper Product Restock</td>
<td>???</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>???</td>
</tr>
</tbody>
</table>

**Roots LLC by D3 Designs**

**Food-Truck Producer:** Lightning Systems & Cruising Kitchens for D3 Designs Inc.

**Managed by:** Roots LLC, a subsidiary of D3 Designs Inc. Roots LLC leases the fuel cell food-trucks to regional chefs, provides contractual purveyorship services for the regional SEED and its fertilizer subscription customers.

Roots’ transforms regional oil/lube facilities into leased food-truck centers, complete with commissary, hydrogen fueling station, and purveyorship of regionally grown produce and bioplastics & pressed fiber consumable goods.

Roots’ truck-leasing chefs/restaurants may also be provided options to lease hydroponic farming plots within the regional SEED installation. Providing a reliable and consistent source of baseline produce at constant pricing.

Hosting between 3-5 food-trucks per Roots facility, this distribution channel allows for networked placement of SEED assets over an urban area. Lease models allow for Roots reallocation of food-trucks between markets.

The food-truck market today is highly variable and holds a low barrier to entry for ill-suited first-time business owners. Roots and Seedling ease this process through fixed rates of hydrogen fuel pricing (target $3GGE), fresh & local organic produce, hosting services that provide training, cleaning, and purveyorship services. By transitioning these mobile food services to compostable/bioplastics packaging, the waste-stream can be returned to the regional SEED.

**Today, Chefs are left with questions. Roots & Seedling fixes this through a nimble & premium user experience. Targeting food-deserts through improved food-mobility.**

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26 FoodTruckEmpire. Survey Results: What is the Average Income for a Food Truck Vendor? 2017. [https://foodtruckempire.com/aew/survey-results/](https://foodtruckempire.com/aew/survey-results/)

Direct-To-Customer Brokerage | Roots LLC.

All-Electric Fuel Cell Food-Truck [R.E.C.E.S.S.]
Originally designed as a Regional Education Campaign for Environmentally Sustainable Solutions (R.E.C.E.S.S.), this all-electric drivetrain and electric cooking solution enables zero-emissions, silent delivery of produce to urban centers. The truck has a 50kg H₂ capacity & can operate at peak power (60-80kw) for 8hrs + drive 100 miles. V2G potential enables a fleet of food-trucks to provide emergency power backup to key urban infrastructure (FEMA, Homeland Security, Red-Cross).

Cooking equipment is interchangeable thanks to the lack of plumbed propane/Ng lines within the truck. As a zero-emissions solution it can operate closer to events, indoors, and without disturbance.

All 5 Channel Phases
The food-truck is a “perfect-channel”:
1. Awareness - greater visibility at populated events.
2. Evaluation - Samples. Crowd conversation.
3. Purchase - Direct payment.
4. Delivery - Hand-off delivery
5. Follow-Up - Immediate end-customer feedback.

On-board Standard All-Electric Catering Equipment
1. Carter-Hoffman HL-18 Stand Up Holding Cabinet
2. Steam Table - two well steam table
3. Pitco Fryer: 58,000 BTU - two well electric fryer
4. Wells 36" Electric Griddle - 400°F operation
5. Vulcan 36" Electric Oven w/ 3-section flat-top griddle
6. True 28+ cubic foot 0°F freezer
7. True 28+ cubic foot 33-38°F Fridge
8. True Refrigerated Sandwich/Salad station 33°-41°F
9. Arctic Air 60" glass door beverage fridge 33°-41°F

* Additional electric-only cooking equipment may be added by Caterers. Examples include induction cookers, sous vide, heat lamps/saladwells, etc. All equipment add-ons must be permitted by the local health department prior to Caterer event.
** The addition of electric cooking equipment may require the temporary removal of items shown below.

SAFETY FIRST:
HYDROGEN GAS IS A HIGHLY FLAMMABLE, ODORLESS GAS.
NO OPEN FLAME IS ALLOWED WITHIN 50 FEET FROM THE TRUCK.
NO GAS COOKING EQUIPMENT.
NO CHARCOAL OR WOOD-FIRED OVENS, TORCHES.
NO SMOKING.
Key Activity: Hydrogen Gas Production

Energy Input | Electrification
For SEEDs that are sized to the Doosan PureCell 400 or the FuelCell Energy Sure Source 1500, pairing with secondary electrolysis systems for the production of hydrogen fuel is standard. For this we are citing Nel A-Range Alkaline Electrolysers. Performance may vary with alternative suppliers.
For SEEDs sized to the FuelCell Energy Sure Source Hydrogen, the production of 1,270kg/day \( H_2 \) is factored prior to the power rating of 2,350kW.

Nel A-Range Specifications 28
- Capacity range per unit (Nm\(^3\) H\(_2\)/hr)
  - Nel A-150: 50-150
  - Nel A-300: 150-300
  - Nel A-485: 300-485
- Production capacity dynamic range
  - 15 – 100% flow range
- DC power consumption
  - 3.8 – 4.4 kWh/Nm\(^3\)

1kg \( H_2 \) = 11.126 Nm\(^3\)
Avg. 1kg \( H_2 \) = 50kW Input

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen/Year Production:</td>
<td>100 kW</td>
<td>400 kW</td>
<td>N/A kW</td>
</tr>
<tr>
<td>Asset Value/Year @ $3 GGE</td>
<td>15,550 kg</td>
<td>62,200 kg</td>
<td>1,270 kg</td>
</tr>
<tr>
<td>Estimated SEED Use/Day Material Handling</td>
<td>$93,000</td>
<td>$373,200</td>
<td>$2,468,880</td>
</tr>
<tr>
<td></td>
<td>20 kg</td>
<td>50 kg</td>
<td>70 kg</td>
</tr>
</tbody>
</table>

Customer Segment: Hydrogen FCEVs

Contractual Fleet Customers | Mass Transit
The Department of Transportation (DOT) and Federal Transit Authority (FTA) have continued focus on the decarbonization of buss systems within the United States 29 offering millions in funding for No-Low Emissions bus programs (both buses and supporting infrastructure).

Ports | Heavy Duty
American ports are among the highest concentrations of diesel emissions pollution of all commercial operations. In Essex County, NJ alone the projected costs to regional health of citizens exceeds $500M/Yr. 30 Hydrogen fuel cell applications for heavy duty use are specifically favorable due to power/weight ratios compared to battery solutions. These heavy duty applications are market available today. [Images 31]

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Key Resource: Electrolyzer

For smaller scale or remote SEED installations, containerized electrolyzers may be selected for ease of installation.

**Nel C-Range Specifications**
- Capacity range per unit (Nm³ H₂/hr): 150 - 300
- Production capacity dynamic range: 15 – 100% flow range
- DC power consumption: 3.8 – 4.4 kWh/Nm³
- Feed water consumption: 0.9 litre / Nm³ H₂

**Nel A-Range Specifications**
- Capacity range per unit (Nm³ H₂/hr): 50-150
- Production capacity dynamic range: 15 – 100% flow range
- DC power consumption: 3.8 – 4.4 kWh/Nm³
- Electrolyte: 25% KOH aqueous solution
- Feed water consumption: 0.9 litre / Nm³ H₂

1 kg H₂ = 11.126 Nm³
Avg. 1 kg H₂ = 50kW Input

Key Resource | Channel: Hydrogen Fueling Station | Self Serve & Contract

350 Bar | 700 Bar
Hydrogen fuel for transportation is commonly dispensed at two pressure ratings, 350 Bar (H35) and 700 Bar (H70). Often H35 is dedicated to commercial applications like material handling, while H70 is dedicated to consumer vehicles, although this is changing with the launch of the Nikola hydrogen semi-truck (H70 only). This pressure difference is determined by storage and compression equipment at the fueling station. Seedling may choose to store this inventory through cryogenic means for ease of distribution.

**H35**

**H70**

Self Serve & Contractual Sales
Partnering with fleet managers, each SEED provides contractual hydrogen sales to municipal garbage-collection fleets, municipal fleets, regional transit fleets, and Roots LLC food-truck fleets. Translating self-serve fueling stations from SEED to Roots locations provides for reduced traffic congestion at the SEED facility, and allows for greater market service.

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Key Activities: Bioremediation | Duckweed

Duckweeds have evolved the ability to rapidly remove minerals necessary for their growth from the water on which they float. When present, duckweeds also can remove many organic nutrients. These mineral and organic nutrients are converted into the substance of the plants, that is, their biomass. Research has shown that duckweeds are especially adept at removal of phosphates and nitrogen, particularly ammonia. The treatment of wastewater from agricultural operations requires the removal of great amounts of nitrogen and phosphate. These wastes are a growing problem around the world because of population growth and the trend of modern farming operations.\textsuperscript{32} Seedling utilizes the growth of duckweed with our hydroponic waste water as a bioremediation process that produces duckweed biomass to aide in the anaerobic digestion process, while also pre-filtering our post-hydroponic water.

Value Proposition: Water Use Reduction

Traditional farming requires 20 times the water use of a recirculating system. Agricultural flood irrigation in large fields loses water to simple evaporation, run-off, and dispersion beyond the reach of plant roots. The agricultural industry is changing its practices to be more water-wise, but even the best drip irrigation only cuts flood irrigation losses by about one-fourth, nothing close to hydroponics which commonly achieves a \textbf{90\% reduction in water consumption} compared to traditional farming.

In most hydroponic farming systems, water is recirculated. Run-off water that is not taken up by the plants is recaptured. Nutrients are constantly added by fish waste or fertilizer, and water returns to the plants. Every bit of water is reused over and over again, an impossibility in traditional, soil-based agriculture.

Since it is recirculated and recycled, water is never discharged in hydroponics or aquaponics. Water loss occurs in two main ways:

1) \textbf{Evapo-transpiration}

Evapo-transpiration is the use and evaporation of water through the plants. There is no way to eliminate evapo-transpiration; it is a necessary function of living plants! You can, however, keep it as efficient as biologically possible by making sure that your temperature range is suitable for the crops you are growing.

2) \textbf{Leaks}

Leaks sometimes form in the greenhouse irrigation system. This might be a broken pipe or split tubing, but it's most likely that a dripper has been displaced or a leaf is redirecting the water flow. Careful and frequent monitoring of the system is the best way to identify leaks.\textsuperscript{33}

Value Proposition: Water Production

\textbf{Stationary Water Production:}

SEED installations at the scale of 270T/2.4MW will be producing a quoted 700,000 gallons per year of water from the stationary fuel cell system (Sure Source Hydrogen\textsuperscript{™}). Although this water production is not scaled to match the hydroponic output of biomass, it will aide in reducing the volume of water that is consumed from local utilities.

\textbf{Mobile Water Production:}

FCEVs produce on average between 1-4 gallons per hour of operation. Design features within the Fuel Cell Food-Truck are currently exploring the recapture of this water for use within the cooking/cleaning operations of the food-truck.


Aquaponics, a term coined in the 1970s, has ancient roots in agriculture. The relationship between aquaculture and hydroponics, this symbiotic relationship encourages the waste matter that the fish produce to act as a nutrient source for the hydroponic plants. This process was deemed to be organically-certifiable by the USDA, providing that there is no direct contact between plant root systems and the aquaculture tanks. This requirement encourages filtration of solid materials, leaving the nutrient enriched water to flow through hydroponics. Seedling’s approach to this practice intends to utilize the aquaculture-enriched water sources, adding to it crop-specific nutrient profiles from our anaerobic fertilizer production processes. Nutrient enrichment as a primary value proposition focuses efforts within aquaculture on the health of the species being grown, as well as the water quality both entering and exiting the aquaculture system. Species selection targets higher value choices of freshwater fish, starting with native species to the SEED’s region. Customer Relationships with regional Fish & Wildlife departments, universities, and non-profit aquatic conservation companies prioritizes waterway restocking of native species as a Phase 1 approach to new species integration into the SEED. Upon successful growth of native species, the species will be considered for market testing for human consumption.

<table>
<thead>
<tr>
<th>Net Income</th>
<th>$</th>
<th>as % of revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Aquaponics</td>
</tr>
<tr>
<td>Revenue</td>
<td>10,483,200</td>
<td>10,240,000</td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquaculture labor</td>
<td>55,000</td>
<td>0</td>
</tr>
<tr>
<td>Fish feed or nutrient cost</td>
<td>175,088</td>
<td>33,279</td>
</tr>
<tr>
<td>Overhead costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent</td>
<td>704,791</td>
<td>694,590</td>
</tr>
<tr>
<td>Total variable costs</td>
<td>934,879</td>
<td>727,869</td>
</tr>
<tr>
<td>Non-variable costs</td>
<td>8,000,000</td>
<td>8,000,000</td>
</tr>
<tr>
<td>Total operating costs</td>
<td>8,934,879</td>
<td>8,727,869</td>
</tr>
<tr>
<td>EBITDA Margin</td>
<td>1,548,321</td>
<td>1,512,131</td>
</tr>
</tbody>
</table>

Example From Edenworks NYC Demonstrating The Economic Viability Of Aquaponics Compared To Only Hydroponics.

Value Proposition: Crustaceans | Shellfish | Soil Amendment

Chitin a naturally occurring compound specifically from fresh water crabs, is observed to have outstanding effect specifically on cucurbitaceae in controlling plant diseases, growth enhancement increasing size, color, vigour of the plant & it’s fruits, leaves, etc. Main commercial sources of chitin are shells of crustaceans such as shrimps, crabs, lobsters and krill that are supplied in large quantities by the shellfish processing industries. Extraction of chitin involves two steps, demineralisation and deproteinisation, which can be conducted by two methods, chemical or biological. Crayfish (Procambarus clarkii) by-products have also been used to recover chitin.

If a SEED determines viability in farming crustaceans/shellfish for soil amendment additives to fertilizer, all species are intended to be grown in freshwater configurations. No saltwater species are currently being evaluated.

34 Kumar, Surya et al. Effect of Freshwater Crab Shell Fog as Organic Fertilizers. International Journal of Agriculture and Food Science Technology. 2014
Commonly grown stocking fish species within Pennsylvania include Yellow Perch and various types of Trout (Brown, Brook, Rainbow, etc.).

**Stocking Prices In Pennsylvania:**

- **Yellow Perch**
  - Avg. growth 6”/gallon/90days
  - Avg. price 6” @ $4.00/ea.

- **Trout** (varietal independent)
  - Avg. growth 7”/gallon/160days
  - Avg. price 7” @ $2.75/ea.

Common aquaculture tank sizes are in 12,000 gallon increments. Revenues shown (right) do not include tanks for hatch/spawning processes.

**Revenue Stream: Red Claw Crayfish**

Red Claw crayfish (Cherax quadricarinatus) are commercially grown in Australia, Mexico, and Argentina. This species is rarely tank-grown at commercial volumes. All estimates are based on earthen ponds. If a SEED pursued this species, ponds & tanks would be evaluated per SEED location.

The value to cost ratio is estimate to reflect within the enhanced value of the fertilizer from the biomass of the crayfish.

**Growth Rates:**

- Market size = 65g
- Market rate = $12.50/kg
- Growth rate = 9 months (YR 2)
- Volume rate = 394kg/1,000m² **

**Footnotes:**

**POLYHYDROXYALKANOATES (PHA) BIOPLASTICS**

**PHA Bioplastics**

PHAs are biodegradable, readily compostable thermoplastics, produced by microbial fermentation of carbon-based feedstocks. The properties of PHA polymers are customizable to the application, depending on the specific combinations of different monomers incorporated into the polymer chain.

To demonstrate the potential of PHA bioplastics in the food service industry, which can be conveniently disposed at the point of use. All items are designed to decompose in industrial composting facilities, meaning they can be disposed of alongside food waste—eliminating the need for sorting, washing and separate bins.37

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**Current**

- Refuse sacks, compost bin liners, carrier bags, gift bags, shrink wrap
- Disposable gloves, disposable aprons, liners for coffee cups, foam packaging
- Mulching film, plant pots
- Absorbable sutures, absorbable mesh, absorbable surgical film, composite mesh
- Phone case, furniture
- Plastic additives

**Future**

- Packaging
  - Bottles, laminated foils
- Food service
  - Food containers and utensils
- Agriculture
  - Slow release of fertilizers etc into soil
- Medical
  - Microencapsulation, slow release drug formulations, cartilage engineering, stents, wound dressings, bone plates, high performance filters, syringes, gowns, gloves
- Consumer Products
  - Sanitary goods, wipes, textiles, toys, cosmetics (microbeads), interior design
- Chemicals
  - Adhesives, paints, coatings, fine chemicals

**Full Cycle Bioplastics**

Business Model: Full Cycle co-locates with licensees who own the facilities, and receives an upfront license fee, an equity carry, a recurring PHA volume-based fee, with potential for additional revenue from (optional) O&M service contracts. Full Cycle is responsible for continuous optimization of the PHA production process and, where necessary, supports brokering PHA into the plastics supply chain. Each facility **footprint is small (1/2 to 3 acres)** and generates **incremental revenue of $75 to $500 per ton of waste processed** (assuming a PHA price of $1.50/bl.) CAPEX estimates are $15M to $50M, depending on scale, with a payback period of ~2 to 7 years.38

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**Value Proposition: IoT | Precision Automation**

Internet of Things (IoT) technologies revolutionize the supply chain with both operational efficiencies and revenue opportunities, enhanced further with data transparency. SEED-installed sensor-driven analytics on an IBM Hyperledger blockchain network, provides:

- IoT Automation For Anaerobic Optimization
- OFMSW Food-Waste Ag-Chem Toxicity Data
- Precision Fertilizer Nutrient Formulation & Automation
- Fertilizer Customer Soil Composition Data
- Energy System Optimization And Compliance
- CEA Atmospheric Control For Growth Optimization
- Food-safety Regulation Compliance
- Produce Nutrient Composition
- Organic-Certification Compliance
- Food-System Supply Chain Management | Asset Tracking
- Fleet Performance & Future Automation
- Aquaculture Atmospheric Control (when applicable)

**IBM Hyperledger Food-Trust™**

Integrating in the pioneering food-system work already conducted for the largest retailer of organic produce in the world, Wal-Mart, Hyperledger integration will allow regional SEEDs to integrate with regional farmers that sell through Wal-Mart channels. Additional retail opportunities showcasing Wal-Mart quality through packaged fertilizer offerings.

**Value Proposition: Soil Mapping | Precision Nutrients**

Seedling fertilizer subscription services will start with existing in-field and in-lab diagnostics of customer soil composition. Data collected on the following attributes will be logged within the blockchain:

- Soil Temperature
- Soil pH
- Soil Lime Requirement
- Soil Conductivity
- Soil Nitrogen (N)
- Soil Phosphorus (P)
- Soil Potassium (K)
- Soil Magnesium
- Soil Calcium
- Soil Aluminum
- Soil Ammonia
- Soil Chloride
- Soil Copper
- Soil Iron
- Soil Manganese
- Soil Sulphur

Development of a wearable in-field soil diagnostic system is currently in the Diagnose phase within D3 Designs Inc. This system intends to meld in-field soil sample data with augmented reality evaluation of in-field conditions relating to pests and plant pathogens, as well as inputs from site-surveying drones capturing 3D/4K data of farm fields. The data from this diagnostic system will be blockchained and computed by the regional SEED for responsive automation of nutrient profiles within the next delivery of fertilizer.

**Value Proposition: Tokenized IP Exchange**

Development of an internal Utility Token is currently in Diagnose phase within D3 Designs Inc. The utility reflected in this token would represent IP exchange between SEED locations for utilization of patents in fertilizer formulation, technological equipment, software, and further technological developments at each SEED location.
Fertilizer & Biogas Blockchain Data Collection Flow Chart

**ANAEROBIC DIGESTION PROCESS**

1. **FERMENTATION**
   - Food waste sensors: mass:volume, temperature, humidity, inorganics, metallics, etc.

2. **SENSORS**
   - Water sensors: full water profile. Precise data to be defined at later date.

3. **SENSORS**
   - Fermentation sensor systems will be determined at first SEED installation (SEED-PSU), reflective of bioplastics & duckweed fermentation activities.

4. **SENSORS**
   - Sensors for each substance contained in USDA-NOP UREC of Title 7: 205.601, 205.602, 205.603, 205.604, 205.605b [USDA National Organic Program Unavoidable Residual Environmental Contaminants]

5. **SENSORS**
   - SENSORS 3 + Biogas/Methane production & quality

6. **SENSORS**
   - SENSORS 3 + SENSORS 10 (as applicable to solid sampling)

7. **SENSORS**
   - SENSORS 3 + SENSORS 10 (as applicable to liquid sampling)

8. **SENSORS**
   - SENSORS 3 + SENSORS 10

9. **SENSORS**
   - SENSORS 3 + SENSORS 10 X Time (Degradation Factoring)

10. **SENSORS**
    - In-Field Soil Tests for: Volume, Temperature, Humidity, pH, Lime Requirement, Conductivity, Nitrogen, Phosphorus, Potassium, Magnesium, Calcium, Aluminum, Ammonia, Chloride, Copper, Iron, Manganese, Sulfur. [Informs VI. FORMULATION PROCESS]

**V. LIQUID DIGESTATE**

**VI. FORMULATION PROCESS**

**VII. FERTILIZER COMPOSITION**

**VIII. SOIL / CROP COMPOSITION**
INTELLECTUAL PROPERTY | EXIT

SEEDs

Data derived by a SEED installation remains property of that SEED-Location LLC and will be licensed for use by other SEED locations. Seedling LLC retains all rights to license data for use in any SEED location for as long as Seedling LLC retains an ownership share of SEEDs that produce and/or license the data. Examples of data are, but are not limited to:

- OFMSW Food-Waste Ag-Chem Toxicity Data
- Precision Fertilizer Nutrient Formulations
- Fertilizer Customer Soil Composition Data
- Energy System Optimization And Compliance
- CEA Atmospheric Control For Growth Optimization
- Food-safety Regulation Compliance Methodologies
- Produce Nutrient Composition
- Food-System Supply Chain Management | Asset Tracking
- Fleet Performance
- Aquaculture Atmospheric Control

SEEDs may not license data or intellectual property to any other company that is not parent or subsidiary to Seedling LLC. without written consent of the President of Seedling LLC, AND board approval from D3 Designs Inc.

Seedling LLC.

Seedling LLC will maintain all financial, operational performance, permitting, installation development, and all record keeping of all SEED locations, and subsidiary companies. All SEED location performance data will be compiled and reported through D3 Designs Inc. annual sustainable metric reporting.

D3 DESIGNS Inc.

D3 Designs Inc. retains all rights of ownership of all products designed and developed as a result of Seedling LLC and SEED installation operations.

D3 Designs Inc. retains all rights to performance data of D3 Designs' products for the duration of which they are owned or operated by a D3 Designs Inc. subsidiary.

D3 Designs Inc. will retain all rights to access all data derived by Seedling LLC or any SEED installation at any time for the purpose of research and development of product or business concept and product development.

INVESTMENT EXIT STRATEGIES

D3 Designs Inc. US Citizen investors must adhere to company by-laws and shareholder’s agreements for the entire duration of ownership of shares within D3 Designs Inc. Terms of investment are on a per-case basis in accordance with D3 Designs Inc. by-laws and the agreement of the board members at time of investment.

Seedling LLC. investment exit strategies are determined by performance of subsidiary SEED locations and associated capital. Seedling retains the right to buy-back shares are fair and determinate market price from any investor within Seedling LLC. business structure at any time.

SEED-[Location] LLC. investment exit strategies are determined by the performance of the SEED installation. In the event of economic failure, as determined by Seedling LLC, all capital equipment assets will be sold at auction and/or to the minority share investor within the SEED location. In this event, all intellectual property associated with SEED operations is retained property of Seedling LLC. and D3 Designs Inc.
USDA AFRI Sustainable Agricultural Systems
Coordinated Agricultural Projects (CAP)
Letter of Intent

Lead Project Director: Rachel A. Brennan, Ph.D., P.E.
Associate Professor of Environmental Engineering
Courtesy Assoc. Prof. of Agricultural and Biological Engr.
The Pennsylvania State University
rbrennan@engr.psu.edu

Lead Collaborating Investigator: Travis Andren
President
Seedling LLC.
travis.andren@seedling-phl.com

Program Area Priority:
Improve water and nitrogen and phosphorus nutrient use efficiency by 50 percent.
Rationale

Exponential global population growth continues to place increasing pressure on agriculture and waste-management systems, with USDA figures identifying annual food waste from retail and consumers at an estimated 133 billion pounds. As consumer confidence in agrochemical-based farming shifts toward organic certification, controlled environment agriculture (CEA) and urban farming offer regional solutions and yet face a myriad of economic, scientific, and societal challenges.

We propose a systematic solution that utilizes organic fractionated municipal solid waste (OFMSW) as a source of organic nutrients and embodied energy, both assets that support an integrated CEA system that operates carbon-negative, while also providing regional farmers transitioning to organic certification with a cost-effective source of organic fertilizer that is formulated specifically to their growing conditions.

Hypothesis

The proposed work supports the installation of a scaled demonstration facility at a land-grant institution in collaboration with industrial partners and local farmers. Through blockchain decision modeling, food waste will be systematically converted into organic fertilizers, crops, and biogas. Through sensor-driven analytics, the nutrient composition of fertilizers will be formulated and tracked to support both hydroponic growing systems as well as soil-responsive liquid and solid organic fertilizers. The use of blockchain will enable the collection of unprecedented data on fertilizer composition and efficacy for both hydroponics and geoponics. The biogas derived from food waste processing will be processed into heat, carbon dioxide, and hydrogen gas by an on-site energy system to support the formulation of fertilizers, the growth of CEA crops, and the distribution of these to regional customers through zero-emissions vehicles. By integrating with regional agricultural systems, this process will support both rural farmers and urban agricultural centers, thereby producing organic food at a greater economic advantage than existing vertical farms and greenhouses.

Objectives

Short-term goals to achieve operational stability and efficiency within the proposed integrated systems begins with: (1) the intake and processing of reoccurring volumes of OFMSW food waste into an onsite anaerobic digestion (AD) system to produce biogas; (2) utilization of AD biogas within stationary fuel cell technology to produce electricity for powering facility operations; and (3) the production of hydrogen gas for fuel cell electric vehicle delivery of products to customers.

Mid-term goals for the advancement of performance agriculture begins with (4) formulation of AD digestate into organic-certified fertilizers and grow mediums for geoponic and hydroponic agriculture. Aiding in this process will be the (5) documentation of sensor-driven analytics within a blockchain data encryption format, forming a database of fertilizer nutrient content, AD composition, and system performance metrics. This database of fertilizer formulations will enable (6) precision growth of an expansive portfolio of organic-certified hydroponic vegetation within an onsite CEA vertical farming system.
Long-term goals for the evaluation of installation performance and assessment of environmental impacts and scalability include: (7) quantifying environmental carbon reductions, improved nitrogen and water use efficiencies, and food system distribution reductions resulting from the installation’s operations and diversion of OFMSW from landfills; (8) providing educational opportunities for community, K-12, and collegiate students through operation of the facility as a living lab at the campus Sustainability Experience Center and Student Farm; and (9) integration of lessons learned into regional large-format commercial installations.

Approach

Research collaborators in Agricultural and Biological Engineering will evaluate how seasonal fluctuations in OFMSW affect biogas production and energy system performance. Plant scientists will evaluate how macronutrient and micronutrient compositions of AD digestate materials can be strategically blended to promote hydroponic growth efficiencies within CEA systems. Together with Computer Scientists, participants from Ecosystem Science and Management will develop geoponic fertilizer formulations from AD digestate materials that are responsive to the soil microbiology and geochemistry at the Student Farm and regional farms through extension services. Operational performance of AD, CEA, energy production, and fertilizer formulation will be quantified by integrated sensors on a blockchain encryption network, providing precision data-tracking for responsive adjustments within the systems. By demonstrating this integrated systems approach to sustainable agriculture within a campus facility, variations in inputs (food waste) and outputs (energy, fertilizers, and food) can be thoroughly quantified to better understand the operational mechanisms which are critical to future full-scale implementation.

Outcomes

Diversion of food-waste from landfills into the agricultural value-chains provided by this approach will not only improve environmental sustainability, but also provide rural farmers with precision formulations of organic fertilizers to enable them to transition to organic certification. Fertilizer production volumes will scale in response to the food-waste processing capacity of the installation as well as the on-site utilization of nutrient streams for CEA production. Ultimately, food grown through CEA in this approach will replicate multi-acreage production rates at the commercial scale, without the use of pesticides, herbicides, and fungicides. It is envisioned that large-scale installations will offer organic hydroponic produce to urban consumers, increasing food-security and reducing food-desertification within densely populated urban centers. Through comprehensive precision analytics of CEA performance, opportunities to automate growth processes will provide lower cost food production.

Subsequent installations will further improve energy independence through onsite microgrid power generation. Production of renewable hydrogen for integration into regional transportation markets further reduces greenhouse gas emissions otherwise associated with global distribution. This comprehensive approach to regional improvements in agricultural throughput strengthens the nation’s ability to fight hunger and ensure global food security while also reducing environmental impacts currently associated with food-waste.