Silver Bay Eco-Industrial Business Park

September 2010

City of Silver Bay

Silver Bay Economic Development Authority

Minnesota Pollution Control Agency

Iron Range Resources

How it Began

- October 2008 interdisciplinary project team of stakeholders discussed how to transform Silver Bay Business Park into and eco-park.
- In 2008 the City applied for an MPCA Environmental Assistance Grant and was awarded $40,000 in June 2009.
- Focus of the grant project was to assess the potential to use wind, biomass and biodiesel to generate renewable heat and power, and to apply industrial ecology methods to achieve "zero waste - zero emissions"

Silver Bay Eco-Industrial Business Park
Project Team

- **City of Silver Bay Representatives/Stakeholders**
  - Scott Johnson-Mayor
  - Lana Fralich-City Administrator
  - Wade LeBlanc-Silver Bay EDA President
  - Guss Krake-Retired Engineers Technical Assistance Program/Silver Bay Resident
- **Bruce Carman, Cedar Tree Enterprises, Inc., SBEIBP Project Coordinator**
- **Chuck Hartley, LHB Engineering-Director of Energy Management Services**
- **Dr. Mike Mageau, Center for Sustainable Community Development**
- **Bill Mittlefeldt, NE Clean Energy Resource Teams Coordinator**
- **Tim Nolan, MPCA - Sustainable Industrial Development Coordinator**
- **Joe Nicklay, Silver Bay K12 Principal**
- **Gwen Carman, Cook County K12 Principal**
- **Rich Sill, North Shore Trade and Tech Project, Coordinator**
- **Kim Skyelander, Wolf Ridge Environmental Learning Center, Director**
- **Dave Abazs, Round River Farms & Wolf Ridge Environmental Learning Center**
- **Paul Sandstrom, Laurentian R C & D Coordinator, USDA**
- **Don Peterson, Woody Biomass Consultant, USFS**
- **Mike Polzin-Minnesota Power Representative**
- **North Shore Mining/Cliffs Natural Resources, Inc.**
  - Mike Mliner-General Manager
  - Scott Gischia-Manager of Environmental Services

Mission Statement

To network businesses to work with each other and the Silver Bay Community in order to create and diversify living wage employment, by improving resource productivity, eliminating pollution and expanding markets through renewable sustainable energy development.

Benefits to the Community

- Economically
  - Sustainable Job Growth
  - Revenue Source
- Health
  - Reductions in Pollution
  - Healthier and Fresher Food
- Socially
  - Environmental Stewards
  - Build on and expand the existing community pride.

Eco-Industrial Development involves a network of businesses that cooperate with each other and their communities to:

- Improve Resource Productivity
- Eliminates Pollution
- Mechanism for Economic Gain
- Enhancement of human and natural resources.

Industrial Ecology involves designing businesses and groups of businesses as if they were a series of interlocking systems which interface benignly with the environment.

- Pairing businesses together
- The waste from one is the raw material for another
- Zero Waste – Zero Emissions

Cluster Based Economic Development

Cluster based economic development refers to similar manufacturing processes or infrastructure needs, and related feedstocks or resources that are typically positioned in a defined geographical area.

- Reduces waste and pollution
- Provides for resource conservation
- Reduces transportation costs
- Greater efficiency within related manufacturing processes.

Primary Goals

Apply industrial ecology strategies by designing clusters of businesses and industries to network with each other so that one industry's waste becomes another nearby industry's feedstock.

Design the park to be self sustainable, i.e. off the grid and powered by renewable energy production systems that are locally owned. The SBEIP could be an ideal location for integrating three types of renewable energy (wind, biomass, biodiesel).

Competitive Advantage

Businesses will be attracted to locate within the park, as they will benefit from predictable renewable sustainable energy costs. In addition, the need for fossil fuel consumption will be eliminated, which ultimately results in reductions in greenhouse gas emission, reductions in carbon footprint, and reductions in waste.

Renewable Sustainable Energy Generation

Three Forms of Energy Generation

- Biomass Binary Combined Heat and Power
- Wind / Solar
- Biodiesel though Algal Growth

Combined Heat and Power Generation

- Co-generated Combined Heat & Power (CHP) is the sequential generation of electricity & heat.
- Fuel conversion efficiency for CHP is about 75%.
- FCP for CHP is about 4500 Btu's/kW, a little higher for as received biomass.

Biomass Binary Combined Heat and Power

- Can get up and running relatively quickly.
- Ample feedstock available.
- Immediate Impact on local, sustainable job creation.
- Provides for sustainable forestry management.
- Compatible, viable business / industry can be created simultaneously.

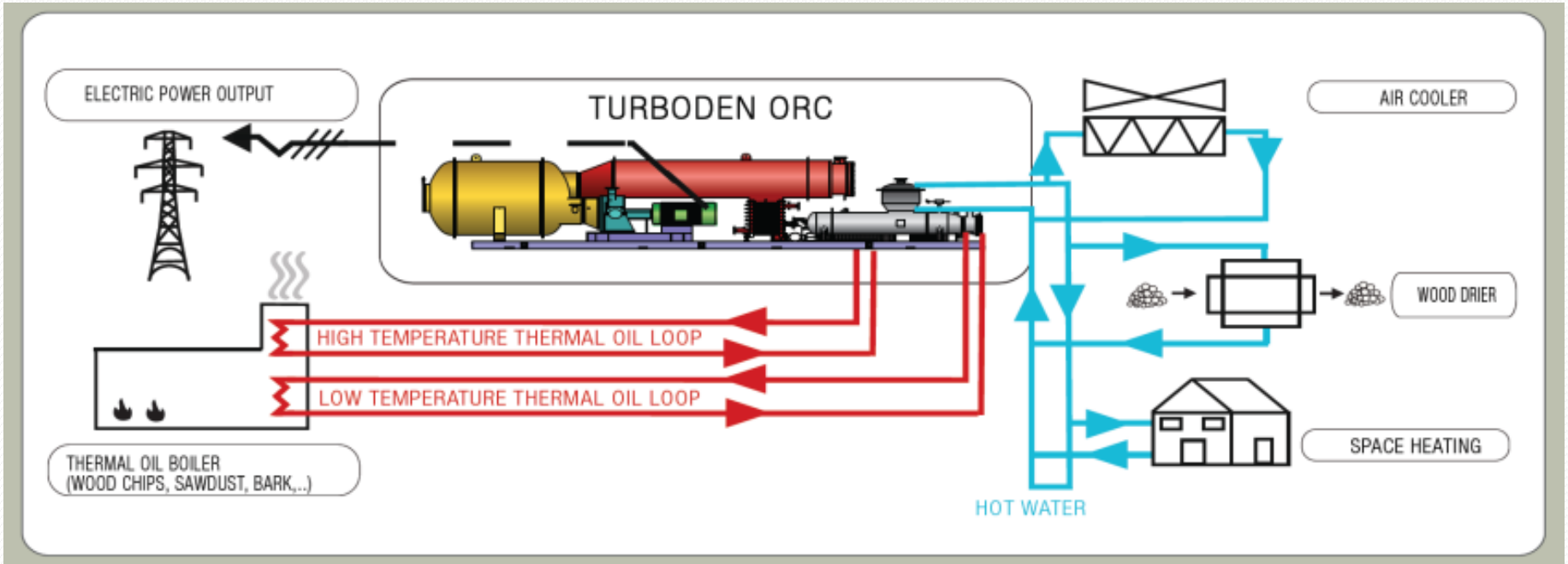
Conventional Condensing Power

Condensing Power is generating electricity without using the waste heat

- Fuel conversion efficiency for fossil fuel condensing power (utilities) is about 37%.
- FCP for fossil fuels condensing power is 10,000 Btu's/kW or more
- Biomass condensing power takes about 16,000 Btu's/kW and is only about 23% efficient.
- Coal based condensing power results in over 1 ton of CO2 per MWh.

Biomass Binary (Organic Rankine Cycle) Power

- Wood combustion heats a thermal oil to 600°F.
- Hot thermal oil vaporizes an organic fluid (silicon oil) which spins a turbine & generates electricity.
- Turbine cooling water is heated to 175°F, suitable for district heat and drying pellet feedstock.



Large Wind

Finland Air Base

- Highest elevation in MN.
- Very good use of the existing facility and the surrounding land.
- Infrastructure is already in place.

Small Wind

Silver Bay Eco-Park

- Makes beneficial use of coastal wind source.
- Wind source is readily available.
- Can be harvested using low elevation turbines (less than 35 feet high).
- Environmentally and aesthetically friendly.

Biodiesel through Algal Growth

Emerging form of Renewable Energy

- Needed for back up power supply for the park.
- Production can ramp up with the increase need for back up / emergency power within the park.
- Compatible with future economic opportunities within the park.

Silver Bay Eco-Park Geographic Cluster Design

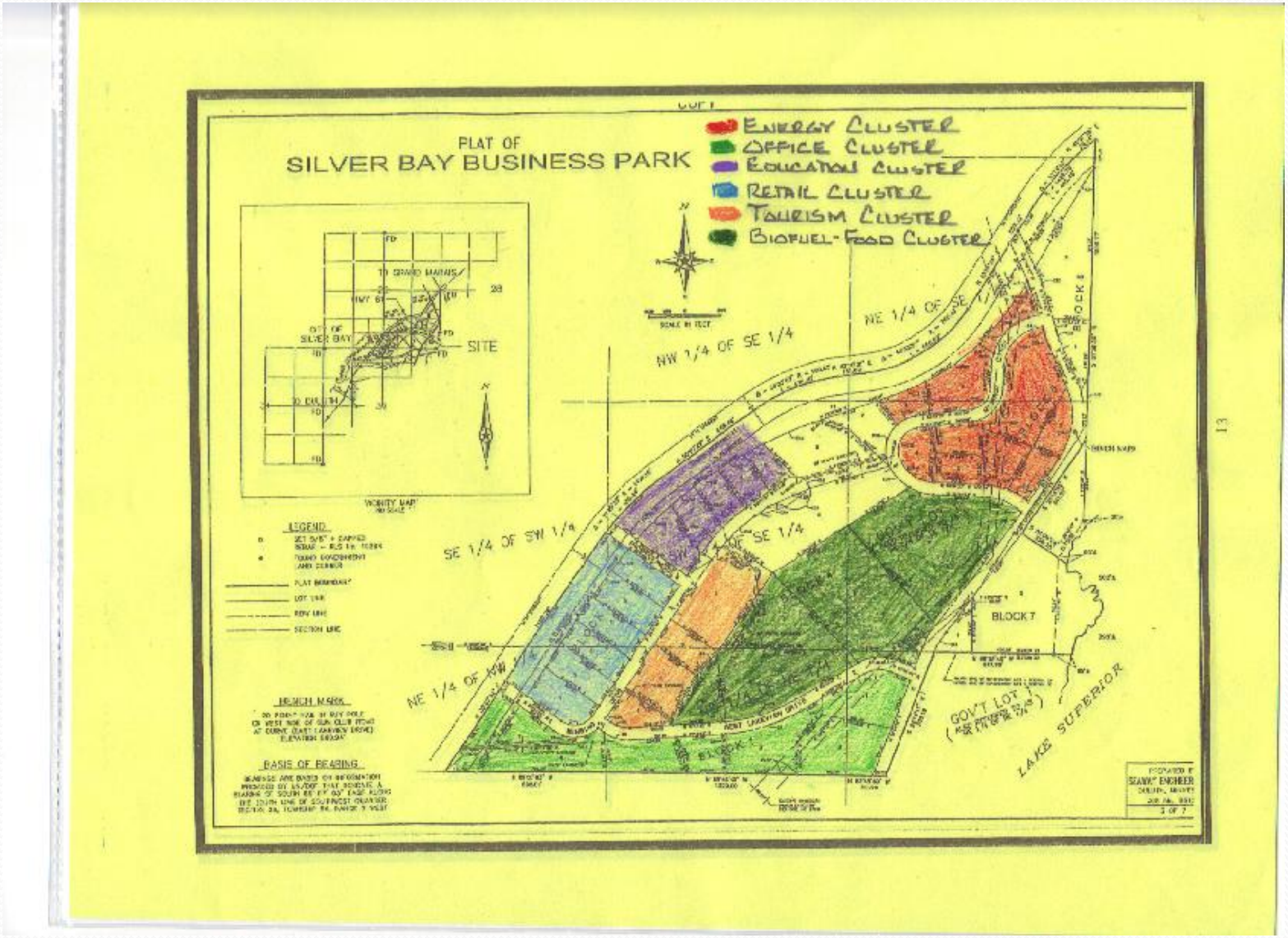
Identification of the individual clusters.

- Priorities and Goals of the EDA.
- Renewable and Sustainable Energy Policies of the Eco-Park.
- Eco-Industrial Development Goals “zero waste – zero emissions”.
- Sustainable Economic Viability and Job Creation.
- Public Revenue Stream for the City of Silver Bay.
- Positively Networking with the Community.

Environmental and Economic Benefits from CHO System

- The renewable combined heat and power system will result in a minimal amount of waste and displace approximately 150,000 tpy CO2 emissions.
- It will increase fuel efficiency from about 37%, in utility sized coal fired electric power plants, to about 75%.
- Complete system emissions at maximum potential to emit will be less than 235 tpy.
- Utilization of 100,000 tpy of wood pellets, displacing a 50/50 mix of propane and fuel oil, yields a total of 127,500 tpy of CO2 displaced.
- Approximately forty (40) construction jobs, fifteen (15) permanent pellet plant operating and 6 logging jobs could be created.

Silver Bay Eco-Park Geographic Clusters



Energy Cluster – First Priority

Biomass Binary Combined Heat and Power

- Feedstock readily available.
- Immediate impact on local sustainable job creation.
- Technology available and accepted.
- Quickest energy source to get up and running.
- Compatible and synergistic industry available.

Combined Heat and Power Generation

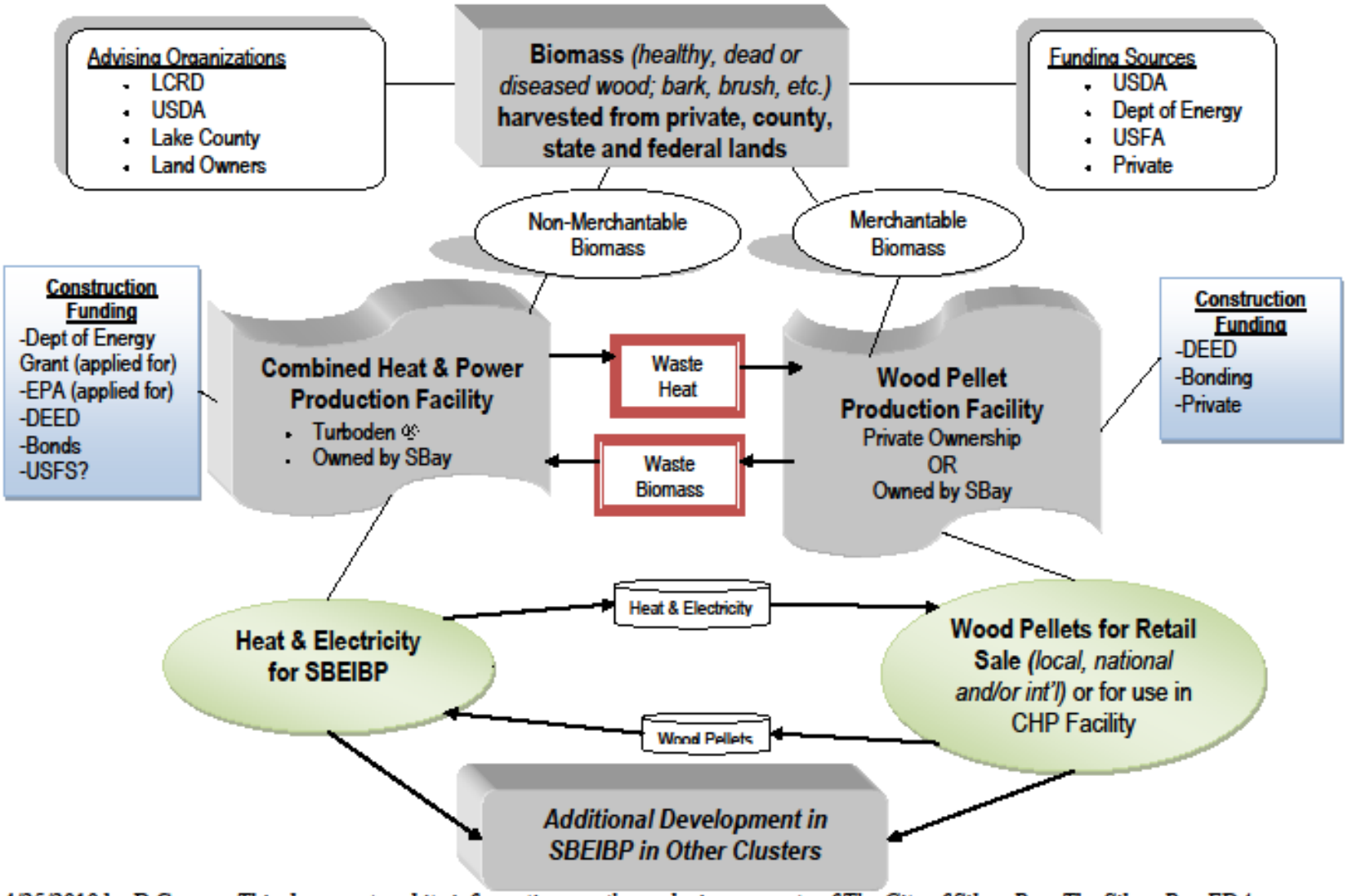
- Co-generated Combined Heat & Power (CHP) is the sequential generation of electricity & heat.
- Fuel conversion efficiency for CHP is about 75%.
- FCP for CHP is about 4500 Btu's/kW, a little higher for as received biomass.

CHP & Pellet Production Synergy

- Related Industries and Feedstocks
- Sustainable Job Creation
- Local Economic and Environmental Benefits
- Pellet Production uses 1.6MW of the 2.5MW.Zero Waste – Zero Emissions

Combined Heat and Power (CHP) & Wood Pellet Production Facilities

Mutually Dependent and Mutually Beneficial: Renewable Energy and Industrial Production
The Energy Cluster of the Silver Bay Eco-Industrial Business Park



Wood Pellet Production in Silver Bay

- Ample, renewable, sustainable feedstock.
- Growing usage providing marketability.
- Economically and Environmentally Beneficial.
- Closed Loop Energy Source when combined with Energy Crop Production.
- Sustainable Forest Management.
- Premium, Industrial and Animal Bedding Pellets.
- Production Starting at 50tpy and increase to 100tpy.

CHP / Pellet Production Sustainable Projected Job Creation.

- CHP Facility 5
- Pellet Facility 20-30
- Logging 75-100
- Distribution _____?

- Total 95-135

Biofuel – Food Cluster

WARF Greenhouse (Wind – Algae – Rain – Food)

- Wind Funneling
- Algae Growth – Biodiesel
- Rain Capture
- Food Production

Wind Funneling

- Gathering Low Level Wind.
- Site and Building Design
- Typical Elevation 35 Feet
- Aesthetically and Environmentally Appropriate
- Intensifies Wind Speed and Power

Algal-based Biodiesel Fuel Production

- Back-up and Emergency Power.
- Ability to Ramp up Production.
- Greater Production than Anticipated.
- Works Synergistically with other Systems in the Greenhouse and with CHP.

On Site Rain Water Capture

- Fresh Water Resource
- Reduces Storm Water Run-Off
- No Need to Remove Purification Chemicals
- Works Synergistically with other Systems in the Greenhouse.

Fish and Produce Production

- Locally Grown Food Initiative: “Food to Cafeteria” (Schools, Hospitals & Assist. Living)
- Sustainable Job Creation
- Better Quality & Lower Cost Production
- Food Security and Safety
- Eliminates Transportation
  - Reduces Cost
  - Reduces Pollution
  - Resource Conservation
- Works Synergistically with other System in the Greenhouse.

Fish Production - Aquaculture

- Greenhouse Temp 80 to 90 degrees

- Tilapia (50k to 60k lbs annually)
  - Neutral Taste
  - Grows Fast
  - Hearty Species
  - Growing Demand
  - Security

Processing, Marketing & Distribution

- Locally, Regionally and On-line Sales

Produce - Agriculture

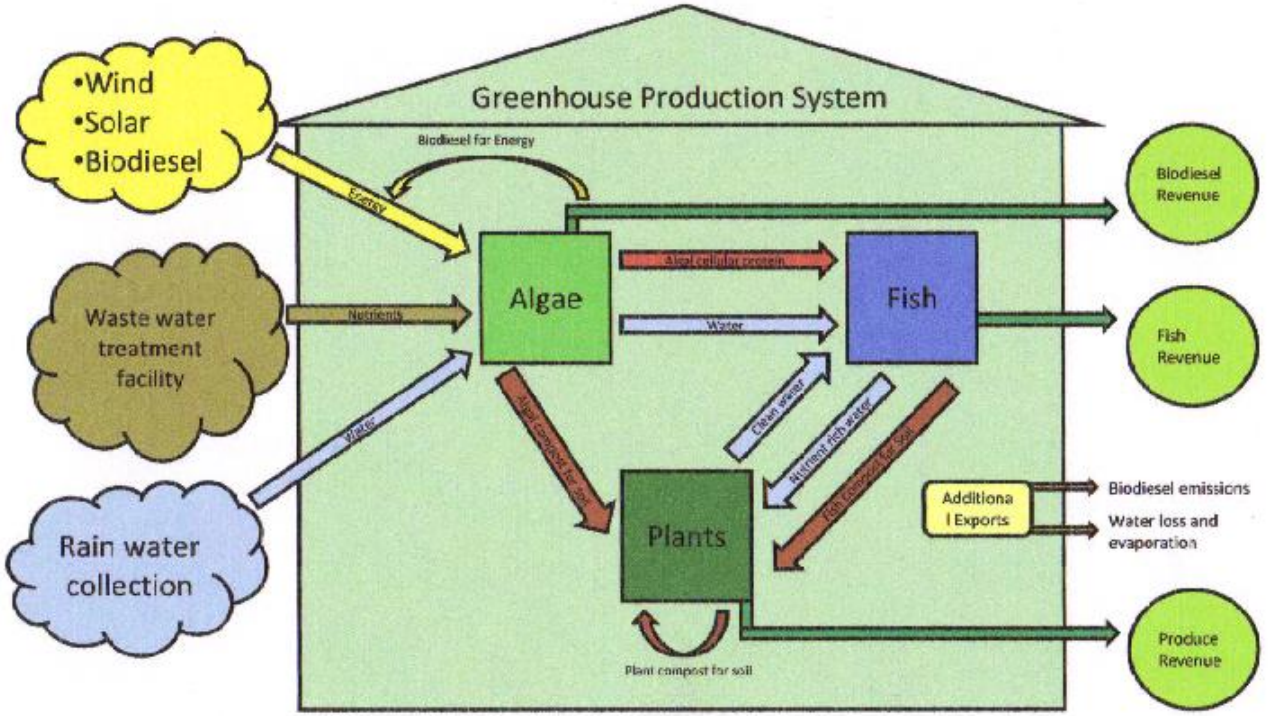
- Greenhouse Temp 80 to 90 degrees

- Produce in This Greenhouse.
  - Tomatoes (3000lbs)
  - Bibb Lettuce (5600 heads)
  - Herbs (Basil, Cilantro, Parsley)

Processing, Marketing & Distribution

- Locally and Regionally

WARF (Wind-Algae-Rain-Food) Synergistic Systems



Additional WARF Benefits

Job Creation

- Initially – One Greenhouse 5 employees
- Full Build Out 300 to 500* hundred employees.
  - Processing – Marketing – Distribution
- Summertime High Hoop Greenhouses.

Other Clusters

- Education
- Office
- Retail
- Tourism

Need Design Standards

- Space usage
- Materials
- Shared Facilities

Eco-Park as a Revenue Source

Renewable & Sustainable Energy – All Forms

- Locally Owned
- Silver Bay EDA owns 51%
- Business, Land Owners and Stakeholders 49%
- “Silver Bay Eco-Park Renewable Energy, LLC”
- PPA with local Utility
- Revenue source to maintain the Eco-Park or other civic improvements