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Canadian Consulting Engineering Awards 2013

Harvest Energy Garden

The Future of Organic Waste Management







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Association of Consulting Engineers of Canada

CANADIAN CONSULTING ENGINEERING AWARDS
2013
HARVEST ENERGY GARDEN

1 EXECUTIVE SUMMARY

The Harvest Energy Garden, in Richmond, BC, uses an innovative Dry Fermentation High-Solids Anaerobic Digestion (HSAD) technology to process solid organic waste material into biogas and high quality compost. The Harvest Energy Garden is the first facility of this kind in North America.

The Dry Fermentation HSAD technology was developed, tested and commercialized in Germany by Grossmann Ingenieur Consult GmbH (GICON). This technology is new and transformative due to its ability to accept high solids organic material such as mixed food and yard waste, and produce high quality biogas in the range of 70 – 85% methane.

Owned and operated by Harvest Power Canada Ltd., the Harvest Energy Garden is located at the large Fraser Richmond Soil & Fibre composting operation in Richmond, BC. Commissioning started on schedule in November 2012, and full operation commenced in April 2013.

Opus DaytonKnight worked with GICON and Harvest Power since late 2009 to deliver the project through design, construction and commissioning. At design capacity, the facility will process approximately 30,000 tonnes of mixed food and yard waste annually, and will generate over 8 million KWh of renewable, GHG neutral, electrical energy for sale to BC Hydro.

The economic, social and environmental benefits of the Harvest Energy Garden are enormous. The facility will contribute to reduced carbon emissions of approximately 23,000 tonnes of CO_2 equivalent annually, while generating reusable products and renewable energy for local markets. With the opening of this facility, organic waste will no longer be considered “waste”.

View of the Harvest Energy Garden

2 PROJECT DESCRIPTION

2.1 PROJECT OBJECTIVES, SOLUTIONS AND ACHIEVEMENTS

2.1.1 Background

Metro Vancouver is in the process of implementing an organics disposal ban as part of the Regional Organics Strategy to achieve 70% waste diversion from landfills by 2015. Organic material currently makes up about 40% of the waste disposed to landfills. When the organics waste ban is implemented, approximately 265,000 tonnes of organic waste – mostly food waste – will be diverted from landfill disposal on an annual basis.

Yard and green waste has been banned from landfills since 2008. Currently, over 270,000 tonnes of this material is collected through the municipal green bin collection system, and is composted at private facilities in the Metro Vancouver area. Harvest Power is the largest local composter, processing about 200,000 tonnes per year of yard and green waste.

Food waste can be composted with yard waste at a ratio of two parts yard waste to one part food waste. For this reason, composting is not a realistic alternative to process all of the diverted organics. As the largest local composter, Harvest Power needed a new and innovative technology to process food waste, generating renewable energy and compost.

The High Solids Anaerobic Digestion (HSAD) technology, deployed at the Harvest Energy Garden, is described as 'Dry Fermentation', meaning that the organic material remains in a solid state through the digestion process. This technology offers an effective solution to the dilemma of processing food waste and/or mixed food and yard waste. The Harvest Energy Garden is the first full-scale Dry Fermentation HSAD facility in North America dedicated to processing food and yard waste.

2.1.2 Project Objectives

Harvest Power's objectives for the project were:

- Provide an economically viable, environmentally sustainable and market driven solution for the 'disposal' of the organic waste to be diverted from landfills under the Regional Organics Strategy at lower cost than currently available.

- Introduce an advanced anaerobic digestion technology – dry fermentation high solids anaerobic digestion (HSAD) - that can process both food waste, and mixed food and yard waste to produce biogas and high quality compost.
- Produce renewable, greenhouse gas (GHG) neutral energy from mixed food and green waste for sale to local markets where the energy is needed.

2.1.3 Solutions

Food waste is one of the most difficult and odorous constituents of solid waste, and the breakdown of food waste and organic matter in the anaerobic conditions of a landfill is the main cause of the pungent, unpleasant, characteristic odour associated with landfills. As organic matter breaks down anaerobically, it also contributes significantly to greenhouse gases (the best landfill gas extraction systems are estimated to capture about 65% of the actual amount of methane produced) and to ground-water pollution. Capping a landfill helps to contain the odours but does not solve these problems.

Although food waste can be composted with green waste, it requires twice the volume of green waste to compost effectively, uses large amounts of energy and gives rise to a significant odour risk. For the volumes of organic waste to be diverted from the landfill, composting alone is not a viable option.

The Harvest Energy Garden provides a solution to these problems.

At the Harvest Energy Garden, food waste is tipped into a receiving hall for processing prior to being fed into the anaerobic digestion process. Odours are controlled within the receiving hall. Large air extraction fans continuously change the air in the receiving hall to remove odours and noxious gasses, and create a safe and acceptable working environment for the facility operators. The receiving hall is under negative pressure so that air does not escape when the receiving doors are open. The extracted air is passed through a dedicated biofilter to remove more than 90% of the odours, vapours and VOCs.

Within the receiving hall, the food waste is shredded to break open bags, boxes and other containers. Plastic bags, boxes and large contaminants are removed and the remaining material is blended and stockpiled for placing into large percolators to start the anaerobic digestion process. There are ten percolation tunnels each 30 meters long, 4.5 meters wide and 5 meters high. The processed organics are moved into and out of the percolators by large, front end loaders. When a percolator is full, the doors are closed and sealed, and the digestion process takes place in a completed sealed, carbon dioxide rich and oxygen deprived environment.

There are two main process steps: percolation and digestion. During percolation, warm water (called hydrolysate) is percolated through the organic matter and recycled over several days. Gradually the biodegradable organic components (the sugars, proteins, carbohydrates, fats, etc.) are ‘leached’ from the organics and become concentrated in the hydrolysate. A side stream of concentrated liquid is diverted to the methane digesters for conversion of the biodegradable constituents to methane (biogas).

When the percolation process is complete, the percolators are vented to the biofilters, air is re-introduced and the doors are opened so that the material can be removed. At this stage, the spent solid waste is low in odour, but rich in nutrients and breaks down rapidly in the compost operation.

The process is very energy efficient: after a percolator is filled, the only process step is the pumping of liquids, which allows a high level of process control and optimization. Process liquids are recycled continuously, retaining heat energy in the system. Biogas is scrubbed and combusted in a 1.0 MW combined heat and power generator (CHP) unit to generate green electricity for sale to BC Hydro.

2.1.4 Achievements

The project has met or exceeded all objectives. The key achievements are:

- The project entered commissioning in November 2012 on schedule and at budget.
- Food waste from commercial sources, and mixed yard and food waste from residential curb-side pick-up, is being received at the facility. Local municipalities and commercial waste haulers are benefitting from lower costs and greatly reduced haul distances.
- Design expectations for odour control and containment, organic material processing and biogas production are being met or exceeded. The biogas is low in contaminants resulting in lower cleaning costs and higher quality biogas.
- Demand for the service exceeds capacity, and expansion of the facility is under consideration.
- The carbon footprint of the process is significantly lower than the landfill alternative, and the facility will contribute an estimated GHG reduction of 23,000 tonnes of CO_2 equivalent per year.
- 1 MW of renewable, GHG neutral electrical energy is being supplied to local markets.
- The project won an Award of Merit at the ACEC-BC 2013 Awards for Engineering Excellence.
- The Harvest Energy Garden was the recipient of the 2012 KPMG 100 Most Innovative Urban Infrastructure Projects Globally in the Recycling and Waste Management Category.

2.2 TECHNICAL EXCELLENCE AND INNOVATION

Organic Waste Management – Food waste is a difficult material to process, but is high in energy. The Harvest Energy Garden is a new innovative technology that extracts the energy from solid organic waste. The process requires very little energy to operate and the project will establish new standards and options for processing organic waste material, turning a difficult and odorous waste into highly beneficial resources: GHG neutral energy and high value compost.

Odour Control – The facility has been designed with complete containment for the handling of raw food waste. Once the material enters the percolators, the process is entirely sealed and all anaerobic processes take place in carbon-dioxide rich, anaerobic environments.

Optimization of Biogas Production – The two main process steps in the conversion of organic material to biogas are hydroloysis and methanization. In all anaerobic digestion facilities, these processes take place in parallel in completely mixed tanks. In the GICON HSAD process utilized at the Harvest Energy Garden, these process steps are separated, and optimal conditions for each process are created. This is a major advance in the anaerobic digestion of organic waste, and is the key to the effectiveness of the high solids digestion process.

Digestion of Mixed Food and Yard Waste – All single family residential food waste is collected as mixed food and yard waste. Mixed food and yard waste cannot be processed in standard anaerobic digestion facilities. Commercial and institutional food waste can only be processed in standard anaerobic processes if it is liquefied and heavily pre-processed. The Harvest Energy Garden is capable of digesting solid organic waste, including commercial food waste and mixed food and yard waste, as solid material with minimal pre-processing.

2.3 ENVIRONMENTAL, ECONOMIC AND SOCIAL SUSTAINABILTY AND AESTHETIC ASPECTS

Environmental Sustainability –The following specific features of the project enhance long term environmental sustainability and protection:

- Food waste from commercial and residential sources is being diverted from landfill leading to long term environmental benefits and reduced GHG emissions of 23,000 tonnes of CO_2 equivalent/yr.
- Approximately 30,000 tonnes of food and yard waste will be processed annually at the facility to produce biogas and high quality compost to satisfy demand in local markets.
- Haul distances for food and organic waste are significantly reduced; local waste disposal problems have a local solution with local and global environmental benefits.
- In excess of 8,000 MWh of GHG neutral electrical energy is being produced and sold to local energy markets annually.

Economic Sustainability – Financial benefits from the project are reduced tipping fees and haul distances for the haulers resulting in lower costs for businesses and local government utilities. Reduced costs throughout the economy result in a more competitive and sustainable local economy. Production of GHG neutral energy has benefit for the local economy and the project investors. Production of high quality compost benefits a range of local businesses such as turf growing, vegetable and grass production, market gardening and horticultural businesses who depend on readily available and competitively priced soil amendments and natural fertilizers year round.

Social Sustainability – The project makes a major contribution to social sustainability by providing local solutions to local problems, by creating new sustainable business practices and enabling the abandonment of unsustainable practices (landfilling organic waste). The facility also creates long term employment and facilitates an economically competitive local business environment.

Aesthetic Aspects – Although function often takes precedence over aesthetics in engineering, the physical appearance of a project usually garners the most attention. The Harvest Energy Garden has been designed to be an aesthetic and functional facility. An office building adjacent to the receiving hall enables the Operators to monitor the plant via the control screens, and also visually observe the handling of wastes and the changing of percolators from the control room. Visitors can also observe the waste handling in the receiving hall, and view the complete process operation from this same location. The facility is visually striking and a functionally effective and satisfactory environment for Operators and visitors.

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PROJECT PHOTOS AND SKETCHES

Figure 1 Aerial View of the Harvest Energy Garden near Completion

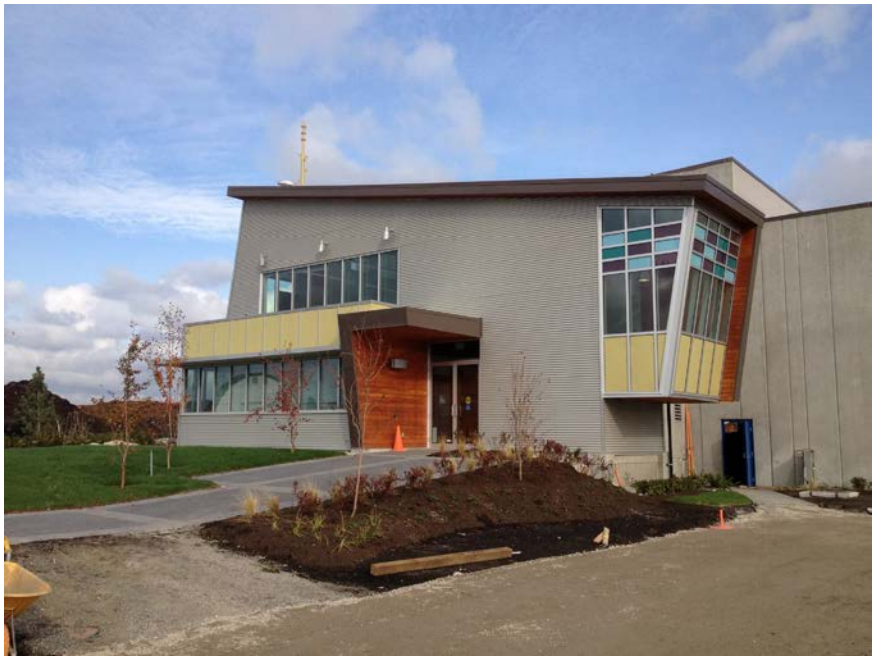

Figure 2 The Green Energy Center and Visitors' Gallery near Completion

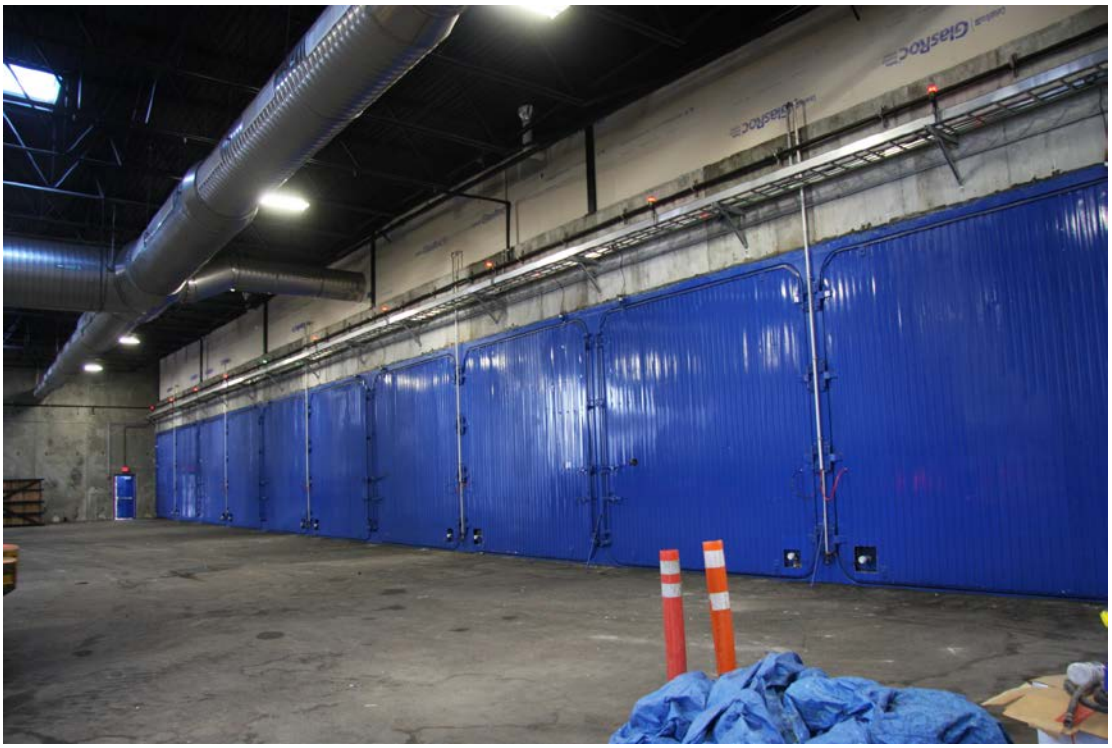

Figure 3 Interior of the Receiving Hall showing the Percolator Tunnels

Figure 4 First Filling of Organic Waste into a Percolator

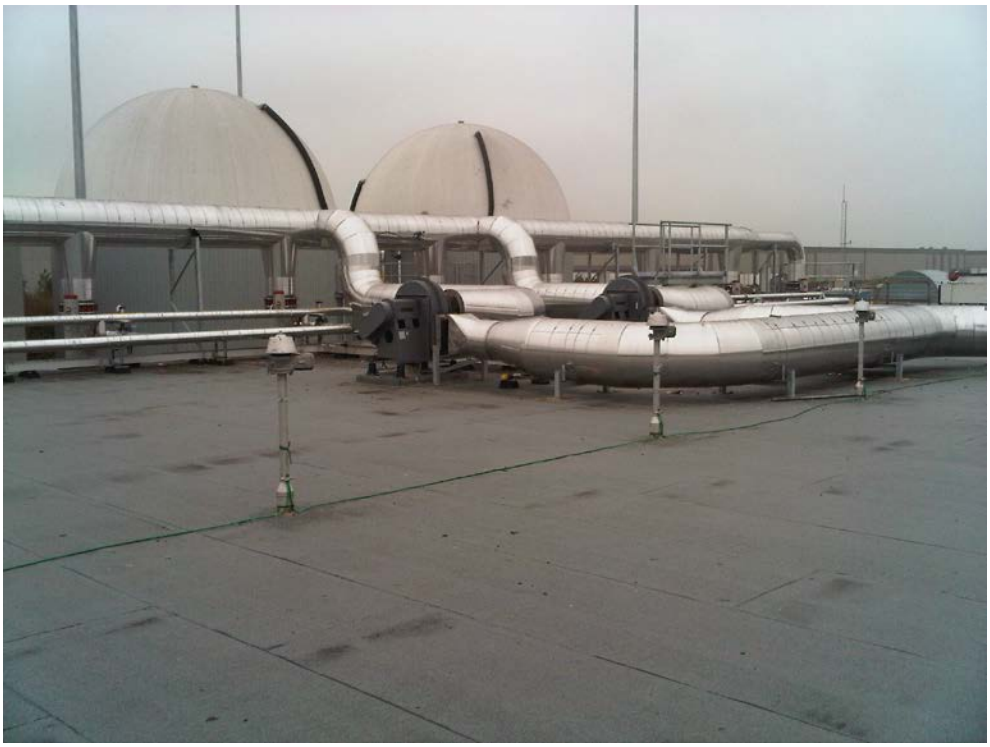

Figure 5 Top of the Percolators showing the Percolator Extraction Fans and Safety Vents (Methane Digesters in background)

Figure 6 & 7 Views of Mechanical Room 2 showing the hot water recirculation pumps and heat exchangers (left) and the percolator recirculation pumps (right)

Harvest Energy Garden

The Future of Organic Waste Management

- The Harvest Energy Garden in Richmond, British Columbia is the first high solids, food waste, anaerobic digestion plant in North America
- The facility will divert nearly 30,000 tonnes per year of food and yard waste from landfills and convert it into biogas
- Biogas will be combusted to produce about 8 million KWH per year of renewable electricity
- The residuals from the digestion step will be further processed to yield over 17,000 tonnes per year of high quality marketable compost
- The Harvest Energy Garden will contribute an estimated reduction in GHG emissions of 23,000 MT CO_2 equivalent per year
- The facility entered commissioning on schedule in Nov 2012 and will enter full service in Apr 2013

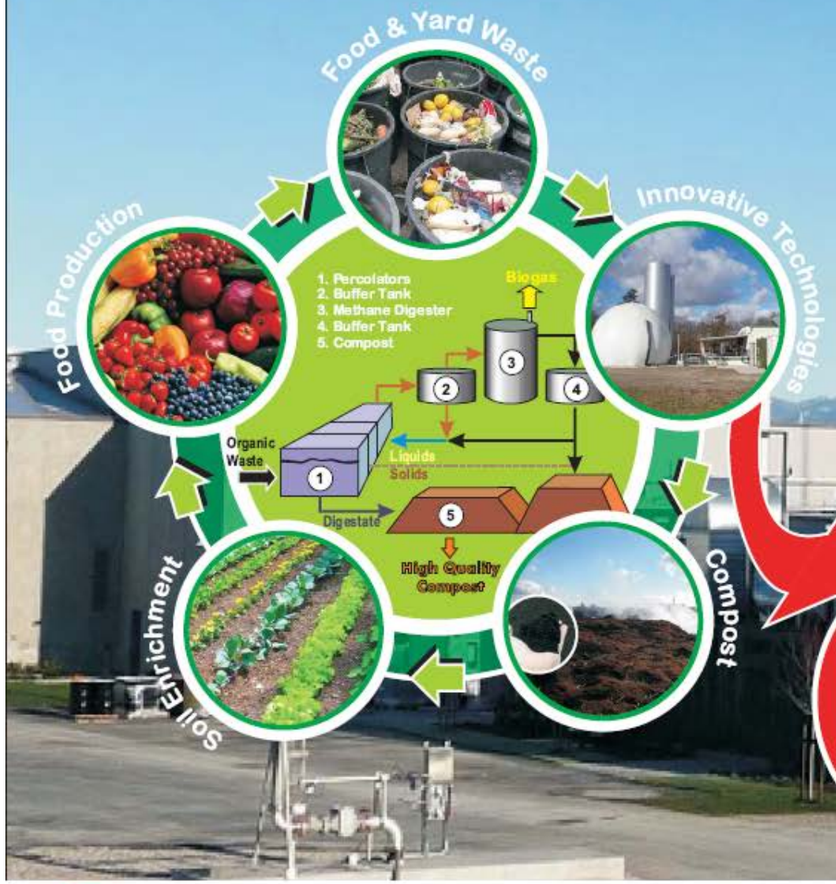

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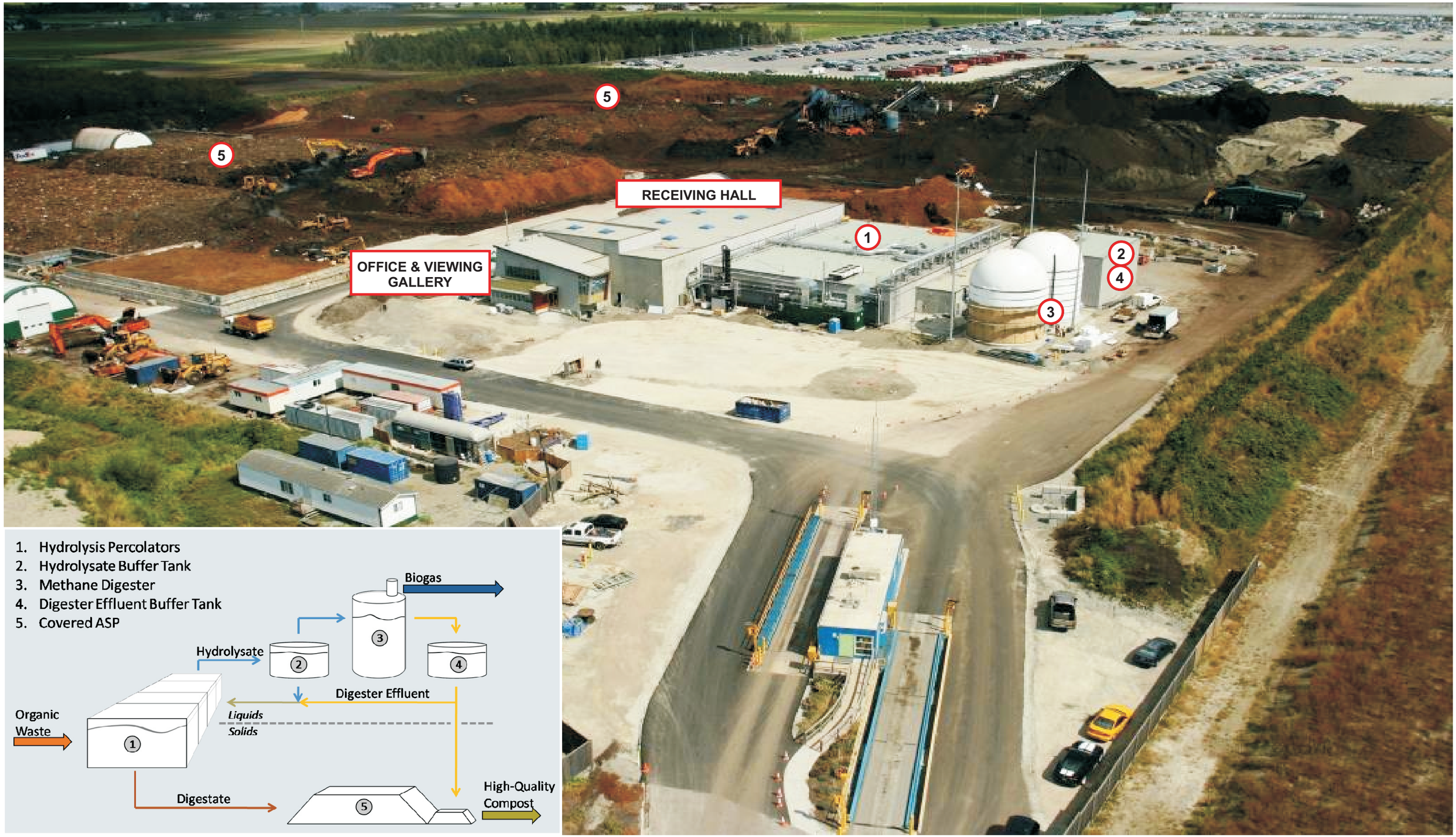
Figure 8 Harvest Poster Presentation



1. Hydrolysis Percolators
2. Hydrolysate Buffer Tank
3. Methane Digester
4. Digester Effluent Buffer Tank
5. Covered ASP

Aerial View Showing Energy Garden Under Construction with Compost Operation in Background

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