DIGESTER 1----
Roger Decker, president of Top Deck Holsteins Inc. along with his three sons Derek, Jason and Justin entered into an agreement with the Iowa DNR in early 2000 to put in a digester and power generating system when they expanded from 300 cows to 700 cows. They typically milk 600 cows and have room for 100 cows in the dry cow and transition section of one barn. The Iowa DNR gave them a grant for $154,000. This design has a precast concrete top unlike some others which have flexible insulated covers.

**Initial Construction**
The final digester dimensions settled on were 8.2 m x 37.8 m inside by 3.6 m deep (see fig. 1 & 2). The walls are 305 mm thick. A 4.0 m x 4.0 m preheat tank and a 4.0 m x 4.0 m separator pump tank were added on the west end of the digester. This gives about a 14 day detention time based on 109 L per cow per day of manure and milking center wastewater production. (The tank was originally designed for 75 L per cow per day and a 20 day detention time). The first item of business for Top Deck Holstein was getting a construction permit from Iowa DNR which required bringing the existing earthen manure storage of 54.9 m x 73.1 m x 3 m deep up to the latest IDNR requirements.

The digester tank construction was started in the fall of 2000. A 102 mm tile line was placed around the perimeter. Underneath the floor they laid 51 mm thick polystyrene foam. On the sides of the tank they put 76 mm of foam and sand backfill. A cold winter set in and no more work was done until the summer of 2001 to put the precast lid on top followed by 100 mm of concrete and 100 mm of foam insulation and 300 mm of soil (see fig 3). The IDNR wanted the digester effluent to enter above the earthen manure storage surface so the digester was elevated 1.8 m above the surrounding grade. This also saved a pump to get it into the earthen storage which was about 9 m further south. This also made the inerrant leakage of the digester gas above ground level instead of into the ground which might move horizontally and come up elsewhere and cause an explosion. A 203 mm wide concrete beam 610 mm deep was placed 0.6 m from the west end to trap the biogas. The manure outlet weir is 1.8 m wide x 1.2 high and made with pressure treated 4 x 4’s are slid down in grooves on both sides of the opening. The building to house the engine and generator set was located 12.2 m north of the digester for safety reasons and based on experience of observing other digester installations.

**Power System Set-up**
On October 10, 2000 Alliant Energy Corporation entered the picture. They wanted the electricity produced by the dairy in exchange for furnishing and maintaining a 150 hp engine, a 100 Kw generator and a 30 Kw Capstone micro turbine. This equipment can be purchased by Top Deck Holsteins at the end of the 10 year contract for a 10% salvage fee. A $500 a month maintenance fee (adjustable with kilowatt hours generated) was
also part of the contract added for monitoring the digester/engine/micro turbine equipment. Another $1000 in labor per month has been added by Alliant Energy for Top Deck Holsteins. Alliant Energy has offered another digester farmer a package deal to allow them to buy out Alliant Energy’s generating equipment early. Top Deck has not received this deal yet but they are thinking favorably about it but would wait six months or so before doing it.

The contract went to Perennial Energy of West Plains, MO. This did not include the initial price of the micro turbine. It did include a drying system for the micro turbine and pressure system to compress the biogas to feed the turbine at 65 psig. The microturbine has a oil bath to separate out much of the water vapor in the biogas. Perennial did procure an used (700 hours) Waukesha engine (Alliant Energy wanted to keep prices low) and a 100 Kw generator. They installed sensors on these three pieces of equipment and other key points and connected everything into a computer control panel. The microturbine and it’s installation went to Unison Solutions in Dubuque. The engine/generator and microturbine arrived in between December 2001 and April 2002. Most of the hot water pipe, exhaust pipe installation and two L-shaped heat exchangers were done in the engine/generator building in early 2002. One exception to this was the 305 m prefabricated heat exchanger grid of 50 mm diameter steel pipe which was delivered from Perennial Energy in the fall of 2001 to place in the preheat tank. The other loop on the heat exchanger is the 88 m of 50 mm diameter pipe that is around the interior perimeter of the main digester tank.

**Heating the Digester**

Separate pipe heat exchangers were put in the digester and the preheat tank. The pipe in the digester is 91 m long, 450 mm above the floor and 450 mm in from the outer wall. The 395 m pipe grid in the preheat tank is 2.1 m high, 1.8 m wide, 3.4 m long and 0.6 m above the floor. Manure constantly covers this pipe grid to prevent pipe rusting. There are 1 hp recirculating pumps on these two pipe loops. A third loop goes to a hot water heater inside of a hot water heater (in the Dairy’s utility room) so the antifreeze in the lines doesn’t leave the loop. The third loop is 113 m long in each direction. The insulated 38 mm diameter Weirsbo tubing is supposed to handle 93C water. This loop is used to heat water to clean a milk pipeline, heat a hot water floor loop, run through a radiator with a fan behind it to heat the milking center and lastly to be used to heat water for a hot water pressure sprayer to clean the parlor. A fourth loop goes to a radiator next to the engine to be wasted outside. The temperatures are set on the computerized control panel to pump water as the heat is available from the engine water jacket, the engine exhaust heat exchanger and the micro turbine exhaust heat exchanger. A total of 460,000 btu.hr is available from the engine water jacket and it’s engine exhaust pipe heat exchanger and another 270,000 btu/hr from the micro turbine exhaust pipe heat exchanger when they are running at full rpm. The building to house the engine/generator and micro turbine is an insulated 7.3 m x 11 m shed in size and has 4 m high 152 mm thick sidewalls. Drywall was used for an interior liner to minimize noise from the equipment. We did have one drain in the building but had to cut in a second drain to handle the microturbine’s water vapor formed when it is separated out in the oil bath (relatively dry gas has to enter the microturbine).
To warm the manure for the digester requires 400,000 btu/hr in cold weather (based on 4.4 C manure temperature, a 36.7 C digester temperature and 109 L for each of the 700 cows plus about 50,000 btu/hr for the digester tank loss. Perennial Energy told us that the engine would need 370 gallons of LP gas a day to run full throttle. We elected to rent two 200,000 btu/hr boilers that would use about 70 gallons of LP gas together per day. In hindsight the boilers should not have been rented because it took too long to get the digester up and running smoothly. We could have purchased a 400,000 btu/hr boiler for the cost of renting them off and on for 5 months. The boiler would be useful when the engine and/or micro turbine go down for repairs. Normally, only one of the two would go down for repairs at a time so the other one could heat the hot water.

**Items changed after initial start-up to improve digester operation**

Some problems happened during initial start-up that caused headaches. The spray polyurea that was used to seal the inside of the tank and the gas beam (200 mm wide by 600 mm deep and 8.2 m long) and located 0.6 m in front of the pressure-treated 102 mm x 102 mm pressure-treated wood weir to hold the gas in the digester headspace would not allow pressures over 50 mm of water column. The remedy was to bring back the sealer company and seal the outside edge of the tank where the lid set on the wall. The spray polyurea was used initially on the inside at the crack between the wall and top and on both sides of the gas beam. The product was also used to coat the exposed biogas surface (lid area and down 0.9 m from the top on the walls) since hydrogen sulfide gas deteriorates concrete. The product is supposed to resist up to 85% pure sulfuric acid and handle 520 % elongation (it stretches with temperature).

Another thing that happened was foam and liquid came up into the 76 mm biogas line and caused plugging problems in the carbon filter and engine. The remedy installed was about a 113 L heavy steel vessel with an 254 mm diameter window and drain to check what’s coming up the biogas line from the digester. Part of this plugging problem could have been avoided by rising vertically from the digester top instead of coming out of the digester tank at the very top horizontally. This 113 L unit does collect a fair amount of condensation water. A water spray nozzle was also added at the same time to the 76 mm biogas line before it goes to the 113 L vessel to spray down the foam. The 12.2 m long biogas line is sloped 152 mm downward to the digester so the spray nozzle water doesn’t accumulate as much in the 113 L vessel.

A flare was added to burn the gas produced during problem times and when the engine and micro turbine weren’t using it up. Other items added were a gas meter after the 113 L vessel and a 100% shut-off valve outside the building. The gas valve was removed after the 113 L vessel later because it was found to restrict gas flow. The pressure instead of being controlled by the 1.8 m wide pressure-treated wood manure outlet weir was changed to be controlled by a more sensitive pressure relief valve set at 305 mm of water pressure.

The L-shaped heat exchanger above the micro turbine has lots of 16 mm stainless steel pipes in it to get it’s 90 % efficiency. Thirty of the 220 pipes had to be plugged because
the exhaust temperature exiting was below 88 C and causing a sulfur build-up in the pipes. The exit temperature is now running 104 C.

Some of the copper wiring starting turning black because several times the biogas was released in the building. A design error was made by placing the digester weir outlet, pumping station to fill the digester from the preheat tank, 305 mm diameter digester exit pipe to the earthen storage and earthen storage south of the air inlets on the engine/generator/micro turbine building. The small releases of hydrogen sulfide gas also tarnish the copper wiring.

The biggest headache has been the used engine. The money saved was more than spent in the repair of the engine, the down-time of not being able to generate electricity and the cost to run LP gas to keep the digester partially functioning while repairs were being made.

One item that has made a significant difference in the gas production is removing of the carbon in the filter (about 400 mm diameter by 1.2 m tall). This has added about 40 percent to the gas flow (48 cfm compared to the 34 cfm earlier). The future plan is to add industrial “socks” in the filter to take out some particulate matter and mercaptans.

**Back-up provisions**

We may have a problem down the road on the bedding being used in the digester. It may not be 100% biodegradable. Currently rice hulls are being used. They have been running about 10 months on rice hulls and now 2 months on oat hulls. We do have five 254 mm diameter pipes in the north wall of the 37.8 m long digester that were placed at a 60 degree angle in case the digester would need to be pumped empty. Also the 254 mm PVC pipes can be used to place a 3200 rpm fan in in case people need to enter the digester for clean-out. There is also a 305 mm valve that can be opened to drain the digester into the 4 m x 4 m preheat tank where there is a 20 hp manure pump that pumps the approximate 3760 L of manure every 71 minutes into the digester on the average (see fig. 4).

A future separator is a good possibility to reduce potential solids’ build-up in the digester and to reduce the annual rice hull or oat hull bedding bill. The separator was not added initially because they figured they would have enough problems just getting the digester working. The 4 m x 4 m separator pit is already in place and the mechanical separator could be located just west of it so the separator effluent could drain the 9 m distance into the earthen storage.

In case the preheat tank is overloaded with liquid manure, there is a 356 mm x 356 mm opening below the lid in the south wall for gravity discharge. This hole leads to the separator pit which also gravity overflows. The digested manure overflows the wood weir and enters the separator pit and flows out by gravity through the same 305 mm diameter pipe. In case manure is not wanted in the preheat tank two valves can be closed to transfer the manure from the two barns to the earthen manure storage directly.
**Manure sample analysis**

Manure is pumped independently from the North and the South barns which both have about 350 cows in them. The North barn’s manure has the milking center wastewater added to it. This is because they flush the maternity pen cow manure alley. Both barns are pumped to the preheat pit at the west end of the digester. There a 20 hp Houle pump with a propeller on it agitates (a nozzle on the pump discharge was changed to the propeller because solids were building up) and pumps into the east end of the digester (Note this wastes less biogas since the digester’s gas production is more uniform for the engine and microturbine.) The sonar control on the two barn pumps and preheat tank pump allows flexibility in the manure volumes pumped.

A summary of three available sets of manure sample analysis were averaged. The North Barn, South Barn and the Digester Effluent were the sources of the three samples. The two sets averaged for the North barn: 27.3 pounds per 1000 gallons of total N, 9.4 for ammonia N, 13.7 for phosphate (P2O5), 22.0 for potash (K2O), 9.6% solids, 6.9 pH and 66,200 mg/Kg for COD. The South Barn averaged 46.7 pounds per 1000 gallons for total N, 16.1 for ammonia N, 21.3 for phosphate, 31.0 for potash, 15.4% solids, 7.2 pH and 125,300 mg/Kg for COD. The digester effluent averaged 31.1 pounds per 1000 gallons for total N, 16.7 for ammonia N, 13.8 for phosphate, 21.3 for potash, 7.6% for solids, 7.7 pH and 61,200 mg/Kg for COD. The manure will continue to be analyzed monthly for the next year. The biogas tested at 65 to 72% methane.

**Current operating parameters**

The current gas production (April 9, 2003) was 48 cfm plus whatever the flare is wasting. This gas is enabling the micro turbine to run at 28.5 Kw and the generator to run at 87 Kw. The total gross Kw is 115.5 Kw. Dead-load Kw includes 3 Kw to compress the biogas into the micro turbine at 65 psig, 5 Kw to run the radiator fan, and 4 hp to run the four hot water circulating motors. Note the latter motors do not run continuously. The electrical generation rate increased from about 95 Kw to the 115 when an integrated throttle and actuator were installed the week of March 31 and the carbon was taken out of the large carbon filter. The integrated throttle and actuator were added to decrease the response time to a change in gas production. The latter items now limit the 100 Kw generator to about 90 Kw (they could not get a bigger unit for the Waukesha engine).
### Digester system costs*

150 hp used engine + generator + computerized control panel + sensors  
+ special oil bath on micro turbine + installation +  
trouble shooting problems  $170,000  
30 Kw Capstone Micro turbine + installation  $80,000  
Labor for plumbers, electricians, engine repair and maintenance  
and materials (includes 150 kva transformer)  $76,400  
7.3m x 11m insulated building for engine/generator/micro turbine  $33,600  
8.5m x 42.6m x 3.6m’ deep total tank  $113,500  
Pre-fabricated 305 m pipe exchanger in preheat tank + plumbing  $22,500  
Wiring, piping for electric and excess hot water to dairy center  $45,300  
Spray polyurea plastic paint to seal digester cracks  $17,500  
Manure pump (20 hp, propeller for preheat tank to load digester)  $8200  
Boiler rent & LP gas to heat digester to get engine/micro turbine  
installed and during trouble-shooting procedure  $15,000  
Backfilling digester & rock for around building and on road  $4,500  
**Total**  $586,500  

*Digester partners cost breakdown  
   Alliant Energy  =  $335,000  
   Iowa DNR  =  $154,000  
   Top Deck Holstein Inc.  =  $97,500**  
**  Note extra money was spent in utilizing the excess heat  

### Digester Economics:

There are several ways to look at return on the dairy manure digester. They can be 1) improved odor control on the manure storage, 2) generation of electricity, 3) excess heated water from the engine/micro turbine set and 4) future cost savings on utilizing separated digested composted manure solids for free stall barn bedding. It is hard to put a cost on improved odor control because the farm is not in a high traffic area. The digested solids are not being separated out yet so it is not known if this possibility will work here.  

Top Deck Holstein’s average monthly electric usage varies from 28,880 KWH in winter (cost was $1813) to summer when it peaked at 45,400 KWH (cost was $3197). So the average dollars saved for a month would be $2505 if they only generated electricity for their farm. This translates to a savings of $30,000 per year. At the time of the digester installation the electrical payback for electricity generated was 2 cents per Kwh. This is the main reason Top Deck decided to allow Alliant Energy to furnish the electrical equipment. In April of 2003 I found out that through Alliant Energy that farmers in Alliant Energy’s territory in Iowa generating less than 800 Kw will now be paid 6 cents per Kwh plus the federal subsidy of 1.5 cents per Kwh. At an average 115 KW (current Top Deck Holstein generating production) this translates to 2760 Kwh per day or 82,800 Kwh per month or 993,600 Kwh per year. They would be using an average of 37,100
Kwh per month. The excess would be 45,700 Kwh per month. At 6 cents per Kwh, this would amount to an income of $2742 per month or $32,900 per year. The total income would then be: $30,000 (electricity used on farm) + $32,900 (surplus electricity sold to power company) + $4000 (saved on utility bills in the dairy center) for a total of $66,900 per year. Based on the $586,500 this would represent a return of 11.4%. This could be improved if a $80,000 manure separator and shed were added to save on bedding. With the additional savings of $25,000 per year on bedding, the new annual return would be $91,900 on an investment total of $586,500 + $80000 or $666,500. The annual return would then be 13.8%. Most of this would go to depreciation, interest, repairs, taxes, and insurance. The federal tax break would be 1.5 cents per Kwh or $14,904 per year.

Results and Conclusions of the digester set-up
The digester ran at about 95 Kw initially and then in April 2003 increased to 115 Kw (see fig. 5) when the carbon filter was emptied. Note 50 of their cows are dry cows and part of their manure falls on a bedded pack (about 50%). The 30 Kw micro turbine runs about 28.5 Kwh. It does decrease in hot weather to 25-26 Kw. Two 36” fans help cool the building.

There have been very few mechanical problems with the micro turbine. The engine has lots of problems and down time during the first year. Hopefully most of the bugs are out of the system. The beauty of the micro turbines is they can be added in stages as the dairy would grow. They come in 30 and now 60 Kw models. So when designing for cow expansion it would be good to design for extra space in the generator room too. The main reason why the microturbines would not always be used is their efficiency is not as high as the engine with an exhaust heat exchanger.

The preheat tank has been a good change from the original plans. It is much easier to access the heat changer with a precast lid in case it leaks or needs replacement. The dairy barn also may have grit that settles out which we can get access to easier than inside the sealed digester tank. Hopefully this will prolong the digester’s life before cleanout.

Down time costs money two ways. First it costs in LP gas to keep the digester and preheat tank warm when the engine and/or micro turbine aren’t providing the heat. Second, it costs money in electricity production when they aren’t generating power. It is good to have both systems because the micro turbine can almost heat the digester and preheat tanks if the engine/generator system is down. This should be a consideration for sizing the microturbine.
Figure 1. Top Deck Digester and Pipe Grid for Preheat Tank
Fig 2  Top Deck Holstein Digester Layout
Figure 3. Digester tank with top insulation and 254 mm side pipes

Figure 4. Pump in preheat tank and earthen storage
The Iowa DNR was also instrumental in getting a dairy digester constructed at a small community college in Calmar, Iowa (NICC). A group called the Dairy Foundation composed of dairy farmers and dairy businesses was started to have first hand experience in dairy production for the NICC college’s students, have a demonstration dairy farm which did research and an outreach with Iowa State University as a partner. The farm consisted of a 150 cow free stall barn which had a slotted floor for 50 cows and the remainder on automatically scraped alleys. Another 25 dry cows and transition cows were housed in a scraped alley barn. The total manure for the digester came from 125 cows. An open house for the dairy farm was held on October 14, 2000. At that time the digester was nearly done except for the biogas receiving unit which was to be a hot water heater. The concept was the digester would be utilized to help heat the concrete floor (576 sq. meters) of the dairy center (no classrooms involved). Currently one 300,000 btu/hr boiler is utilized to do this.

**Initial Construction**

The digester installed was a similar plug model to Top Deck Holstein in Westgate Iowa. In dimensions it was 4.0 m wide x 20.7 m long and 3.0 m deep (see fig 1 & 2). It had an overflow pit of 4.0 m wide x 1.5 m long x 3.0 m deep (see fig 3). The walls were 254 mm thick and the lid 178 mm thick above precast sections 102 mm thick. The overflow pit was built for a transfer pump. The digester has a 152 mm wide concrete beam 610 mm deep 0.6 m from the end of the digester under the digester top to hold back the
The tank had 51 mm of closed cell foam under it, 76 mm on the sides of it and 102 mm on the top of it followed by 0.3 m of soil. Manure was pumped into the south end of the digester through an 203 mm diameter PVC pipe. It flows out of the digester through a 610 mm wide PT wood weir into the small end pit. The PT wood extends to within 1.2 m of the bottom to allow human access into the tank. The tank also has four 254 mm PVC pipes extending at a 60 degree angle out the one long side for back-up reasons. The small pit has a gravity discharge through a 305 mm diameter dual drainage tube that runs 21.3 m to a 44 m diameter 3.6 m deep concrete storage. A large vertical shaft chopper pump in a 3.6 m x 4.9 m x 3.0 m deep pit at the free stall barn is utilized to pump manure to the digester or to the large concrete storage tank. The underside of the digester lid and 0.9 m down the walls was sand blasted and coated with a coal tar epoxy. An insulated 3.0 m x 3.6 m shed 5.5 m from the digester is used to house the hot water heater and controls. An insulated Weirsbo high temperature (93°C) tubing was used to transfer the heated water from the water heater to the dairy center (total round trip was 225 m).

**Heating the Digester**

A 150,000 btu/hr hot water heater and control panel was constructed by Perennial Energy to utilize the biogas from the digester (see fig 4). A total of 152 m of 19 mm diameter black steel pipe (a prefabricated unit from Perennial) was placed on the south end of the 20.7 m long tank to heat the manure. A 25 mm diameter stainless steel pipe at the north end of the pit in the digester lid is used to transfer the biogas to the hot water heater. Hot water was to be utilized in two loops –to heat the digester first and second to transfer heated water to the dairy center floor heat system. Two exhaust stacks on the hot water heater were used. The first was to burn the biogas needed in the hot water heater and second to act as a flare for any extra biogas not needed by the water heater. A computer control panel ran the whole system.

**Items changed after initial start-up**

The digester manure and wastewater quantity was under-estimated at 75 L per day per cow. It was closer to 225 L per cow per day. The manure line to the 3.6 m x 4.9 m barn pit fortunately has a valve which can divert the milking center wastewater to the slotted floor pit under the 50 cow portion of the barn. This is not perfect because they need some extra water in cold weather to agitate the 3.6 m x 4.9 m pit and the liberal wood shaving bedding usage requires some extra water to get it agitated or it will plug the 203 mm PVC pipes leading to the digester and to the large pit.

A June 2001 grant from the Iowa DNR of $28,500 allowed a manure separator purchase, a 6.1 m x 7.3 m solid’s storage shed to be constructed and a 76 mm vertical shaft chopper pump purchase for the 4.0 m x 1.5 m pit to be installed next to the hot water heater shed. The 152 mm diameter Vincent separator model KP-6 gave us problems. It has overflowed several times down a nearby grass waterway. There is a 1300 L/min pump in the 4.0 m x 1.5 m pit at the end of the digester which pumps to the 75 L/min separator. The separator does have a 102 mm PVC pipe overflow back to the 4.0 m x 1.5 m pit. In August of 2002 a 15,000 L steel tank was buried to act as a secondary containment.
believe most of the problem is still with the large flow rate being sent to the manure separator. Currently the manure separator is not being used.

The biggest problem has been with the settling out of the wood shavings in the digester. Manure was pumped for about 3 months before it started coming out of one of the 254 mm pipes. We also noticed at the same time our pressure would rise to 178 mm of water column but then drop off quickly to 51 mm after pumping. Perennial Energy wanted 300 mm of water column pressure feeding the water heater burner. The digester loading was shut down to check out the problem. We tried to utilize a large vertical shaft chopper pump to clean out the digester but it didn’t work. The material was so layered in we couldn’t break it loose. We even sent the manure down the southern most 254 mm PVC pipe. A 254 mm diameter drain hole in the divider wall between the digester and 4 m x 1.5 m pit was opened but, the contents would not drain out. After looking at various options Dan Meyer elected to put an 203 mm diameter grain auger with a 5 hp motor at the top end down the 0.6 m x 1.8 m wood weir hole and start augering into a box spreader. We filled 28 large box spreaders. A 3200 rpm 254 mm fan fan was placed in the southern most 254 mm PVC pipe to pull air through the tank so we could feed the auger since it only slid into the tank about 9 ft. The pit atmosphere was analyzed with portable ammonia and hydrogen sulfide meters to be safe. We ended up using silage forks to feed the mixture of manure and wood shavings to the end of the auger. It costs about $1500 in student labor plus my 44 donated hours of labor to empty the digester. It was filled to about 2.4 m of depth in the whole digester. About half way through the unloading we had a chance to sandblast the ceiling cracks and the gas beam cracks and put on a spray polyurea about 100 mill thick to seal the tank to handle a higher pressure.

A second idea tried to still handle the wood shaving bedding was to run all the manure through the manure separator to filter out as much bedding before it went into the digester. We ended up with a 4.2 % solids in the separator effluent which we didn’t think would give us much biogas. The total N content was 0.26%, and the COD was 54,500 mg/Kg. This compared to the main barn manure of 11.3 % solids, 0.39 % total N, and COD of 77,500 mg/Kg. Also the manure separator was also overflowing liquid out the solid’s end which wasn’t acceptable.

A third idea was to make the manure thicker by bypassing as much as possible the milking center wastewater. The ISU experts said we needed 8 % solids minimum for plug flow digesters to work. We tried again with the thicker manure only but covered the 152 m of heat exchanger pipe in about three weeks. The digester ran for about two weeks and produced biogas with pressures up to 13 inches of water column and held it. The digester based on probing with a 51 mm diameter pipe through the 254 mm pipes is one fourth full of solids (at loading end). It was decided to shut down the digester again and drain it down to 1.2 m and drop in a vertical shaft chopper pump to clean it out. This has not been done yet. The Dairy Center has several committees which make decisions and things do not progress nearly as fast as when one person is in charge. We are presently at a stalemate. The Dairy Center herdsman does not want to use another bedding product. He has tried oat hulls but, didn’t think they absorbed enough liquid. I did a demonstration using his wood shavings and Top Deck Holsteins’s rice hulls and found I
could absorb 100% more water with the rice hulls than the wood shavings on a similar volume of bedding. He still didn’t buy the idea of using rice hulls.

**Costs on the Calmar digester project:**

- Concrete digester tank------------$35,600
- Consultant expense ----------- $29,175
- H. w. heater + pipe grid + controls $46,100
- Plumbing & Heating $16,000
- Sandblast + epoxy coal tar --- $6500
- Electric work $6950
- Excavating + rock $6500
- Chopper Pump + piping labor $5000
- Hot water shed + concrete ---- $4400
- Spray polyurea sealing $2800
- 4000 gallon tank buried--------- $2800
- Tank clean-out labor + auger rent $2200
- Miscellaneous $6000

**Total** $170,000

- Separator + shed + concrete --- $30,000
- TOTAL $200,000

**Partners in Project:**

- Iowa DNR- digester $57,000
- Iowa DNR – separator project $28,000
- NE Iowa RC & D $50,000
- Dairy Foundation $65,000
- TOTAL $200,000

**Conclusions and Future Plans**

The immediate plans are to try to get the digester running. Other funds that have been received from Iowa DNR are $13,000 to monitor both the Top Deck Holstein and the Calmar digesters for one year. The Northeast Iowa RC & D has pledged another $40,000 toward a micro turbine at Calmar. This won’t happen if the digester doesn’t start working soon. We would still need another $65,000 to put in a 30 Kw micro turbine and the shed to house it.

A college along a major highway is an excellent place to showcase technology. The pitfalls are you work under committees and under other people sometimes that don’t make getting a project down easy or fast. We did learn things at the Calmar digester that were applicable to Top Deck Holstein digester and definitely saved them money. The concept was to get at least dairy two digesters in for demonstration farms in Iowa. Yes, there are hassles with doing it on a college farm but, I’d rather have done it with government money there than working out on a local farm which couldn’t afford the problems and time to get it working. The idea was to demonstrate technology which we did on both.
Figure 1. Dairy Center Digester Schematic
Figure 2. South end of Dairy Center digester

Figure 3. North end of digester showing small pump pit and weir
Figure 4. Skid mounted hot water heater going into shed & biogas line