Energy and Estimated Treatment Costs Associated with Treating Iowa's Drinking Water and Wastewater

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Funded by:

Iowa Energy Center

IAMU

Welcome to a Brief Glimpse of IAMU

- Thank you for inviting me to share IAMU's involvement in energy efficiency in water and wastewater treatment.
- Our values at IAMU are to provide service to our member utilities and others; to promote innovative thinking and use of technology; this includes stewardship of human and natural resources
- With this in mind you can now understand our interest in energy efficiency in water and wastewater treatment.

A little about IAMU……..

•Nonprofit, 550 municipal utility members, provide services related to electric, water, gas, telecom, wastewater, stormwater

•Assist utilities through training and resources.

•Worked with IEC during the development of our building, energy efficient features include geothermal heating and cooling, light sensitive fixtures, computer monitoring of energy usage, minimal site disturbance, stormwater management, prairie restoration, constructed wetland

IOWA
ASSOCIATION OF MUNICIPAL
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Presentation Outline

- Iowa Survey of Water and Wastewater Treatment Systems; Constructed Wetland Study
- Energy Efficiency E-Mail Survey
- WW-CAT Cost Analysis Tool
- Water and Wastewater Energy Efficiency Assistance

Purpose and Available Information

•Purpose: survey all permitted, municipal water and wastewater systems to collect baseline information on treatment type, operational costs, and energy costs and consumption.

•Usefulness of Data: Develop a database with specific treatment and energy costs data that can be used by water and wastewater utility managers to assess the operation of their system and when considering system upgrades.

Survey Process

•Fall 0f 2000 surveys were sent out to 800 water and 880 wastewater treatment plant managers in Iowa. Lists of permitted municipal facilities from IDNR.

•In early winter 2001 follow-up surveys were sent out to those that didn't respond to the first survey

•2000-01 surveys were reviewed and hundreds of follow-up calls, e-mails, faxes, were made to obtain further accurate information

•During winter-spring 2001 surveys were coded by the ISU Statistical Lab to create a database and the dataset was made available to IAMU in June

What Tools Were Used For This Project?

- Hardcopy of survey, follow-up survey using regular mail
- Phone, faxes, e-mails trying to gather information
- Data entry, Excel spreadsheets
- SAS for statistical analyses
- ARCView for Geographic Information System (GIS) maps

Survey Questions

Wastewater:

1. What are sources of and where is treated wastewater discharged?
2. Storm water-combined if not where does it go?
3. Type of wastewater treatment and age of most recent upgrade?
4. What is design capacity and actual gallons treated per day?

Water:

1. Source of water?
2. What type of treatment is used and year of most recent upgrade?
3. What is design capacity and actual gallons treated per day?

Survey Questions Continued…

Wastewater and Water Treatment Costs:

1. How many customers billed and type?
2. 1999-2000 fiscal year budget for treatment plant and/or collection and/or distribution system?
3. What did you budget for labor, equipment purchases, maintenance, supplies, training, capital replacement, and bonds and debt?

Electricity and Gas Consumption for Wastewater and Water:

1. Where do you get your energy and separate metering?
2. For each treatment system what was the KWhr consumed and costs and gas consumed, units, and costs?

Some Interesting Responses

- "The survey was the biggest pain in the butt and biggest hassle I have had to deal with.."
- "The mayor has thrown the 2 surveys away..too hard to figure out and don't want to mess with it"
- "The treasurer died this summer and some of the answers I don't have yet"
- "We don't treat our wastewater we only have lagoons"

Other Comments

"This information will be very useful to us"

"We're looking forward to the data you obtain"

Data Processing

- **Water systems data sorted by source of water:** surface water; shallow wells; deep wells; shallow and deep wells

- **Wastewater systems data sorted by 2nd treatment:** activated sludge (oxid. Dit. + SBR too); trickling filters (biotowers); activated sludge+trick. filt.; RBC, Nonaerated fac. Lagoons; aerated fac. lagoons

- **Data then separated by total number of customers:**

<500, 500-999, 1,000-9,999, >=10,000

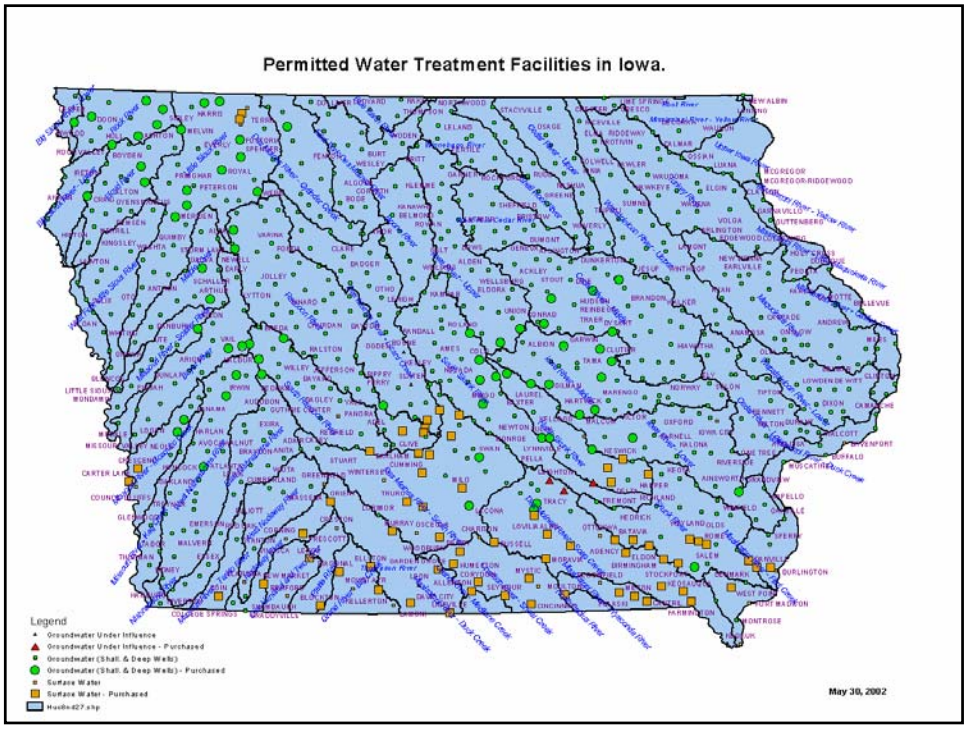
Statistical Analyses:

- Statistical analyses of data performed at ISU STAT Lab using SAS.
- Standardized analyses performed such as mean, standard error, max, min, lower and upper 95% cl, and margin of error.
- Paired t-tests used to compare sample mean difference plant vs distribution or collection at the p=0.05 level.
- Analysis of Variance f-test used to determine if means for different groups such as water sources, are equal at the p=0.05 level.

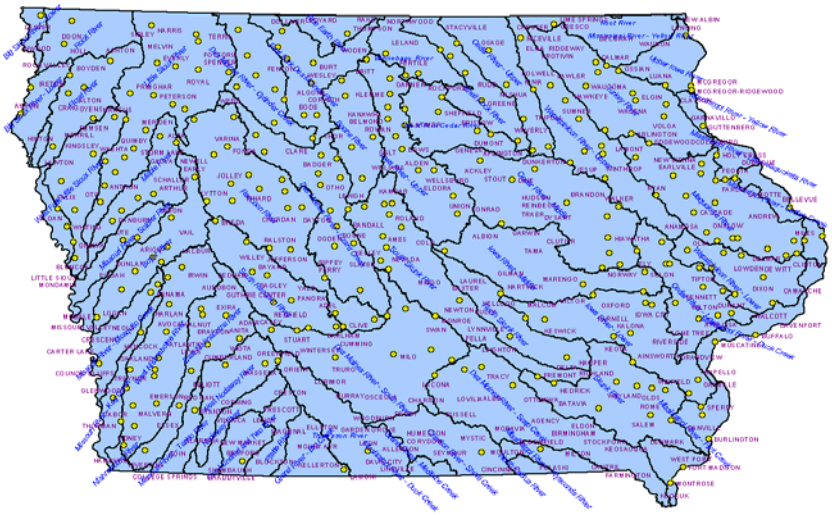
Survey Response Rates

Number of Surveys Sent Fall of 2000	887
Number of Returned Surveys-Useable	403
Response Rate	45%
IAMU Members Sent Surveys	550
IAMU Returned Surveys	297
IAMU Response Rate	54%

Survey Responses: Water Treatment Systems



Survey Responses from Iowa Water Treatment Facilities.



May 22, 2002

Water Treatment Systems

Source	*No. IDNR Permitted Water Systems	**Survey Response
Surface Water	26	9
Groundwater	603	317
Purchased	141	Not Evaluated

*Listed by principal source, no single system counts
**Survey response on single source basis

Frequency of treatment system use for water sources in Iowa.			
Source	Treatment System	Systems Using Treatment	% Using Treatment
Deep Wells		N=157	
	Disinfection	150	96
	Fluoridation	53	34
	Iron Removal	98	62
	Chem. Sed.	64	41
	Cation/Anion Exch	37	24
	Bi-Product Mgmt.	29	18
Shallow and Deep Wells		N=33	
	Disinfection	33	100
	Fluoridation	10	30
	Iron Removal	19	15
	Chem. Sed.	16	48
	Cation/Anion Exch	7	21
	Bi-Product Mgmt.	6	18
Shallow Wells		N=109	
	Disinfection	104	95
	Fluoridation	58	53
	Iron Removal	50	46
	Chem. Sed.	42	39
	Cation/Anion Exch	26	24
	Bi-Product Mgmt.	17	16
Surface Water		N=8	
	Disinfection	8	100
	Fluoridation	7	88
	Iron Removal	6	75
	Chem. Sed.	8	100
	Cation/Anion Exch	3	38
	Bi-Product Mgmt.	7	88

Commonly Used Water Treatment Technologies-Deep Wells

Disinfection 96%	**% Used by all Systems**	**Most Recent Upgrade**
Chlorine Gas	45%	75% 0-15 yr
Sodium Hypochlorite	53%	85% 0-15 yr
Calcium Hypochlorite	3%	40% 0-15 yr
Fluoridation 34%		
Hydrofluorosilicate	94%	62% 0-15 yr
Sodium Fluorosilicate	0%	
Sodium Fluoride	2%	100% 0-15 yr
Iron Removal 62%		
Aeration	85%	57% 0-15 yr
Sequestration using KMnO4	27%	65% 0-15 yr
Chemical Sedimentation 41%		
Filtration Gravity	45%	62% 0-15 yr
Filtration Pressure	52%	55% 0-15 yr
Sedimentation	20%	39% 0-15 yr
Cation and Anion Exchange 24%		
Lime Softening	14%	80% 0-15 yr
Zeolite Softening	59%	68% 0-15 yr
Biosolids Management 18%		
Land Application	14%	50% 16-30 yr

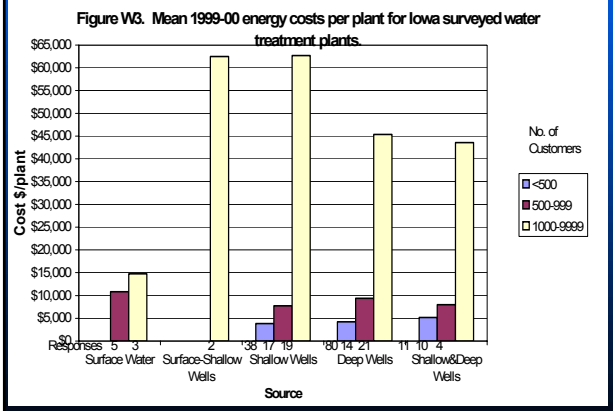
Profile of Survey Responses Based on Customer Class for Major Sources

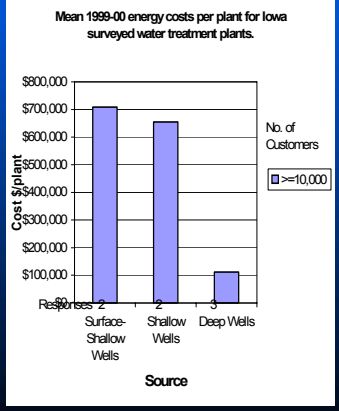
	Number of Customers			
Source	<500	500-999	1,000-9,999	>=10,000
Surface Water	0	5	3	0
Shallow Wells	58	22	24	2
Deep Wells	107	18	25	3
Shallow-Deep Wells	15	10	7	0

Water Energy Results

Energy Costs

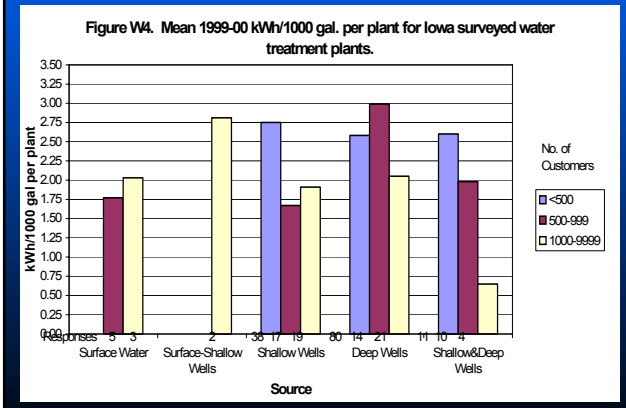
- Electric costs major component of energy costs
- Costs increase as number of customers increases
- Differences between sources but not significant

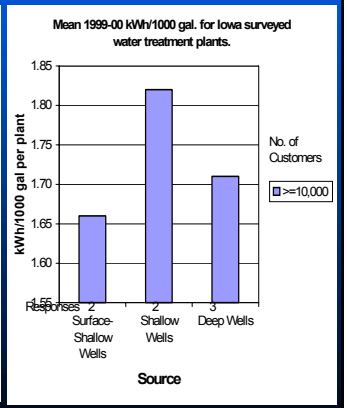




Energy Consumption

- kWh/1000 gal. are variable, for shallow-deep wells they decrease as number of customers increases
- Max. deep wells 500-999 customers; Min. shallow-deep wells 1,000-9,999 customers





What Influences Water Treatment and Distribution Costs?

Residential vs Industrial Customers

Table W6. Flow per customer consumption comparison of residential-commercial customers versus residential-commercial-industrial customers for all sources and customer classes.

Source	Number of Customers or Meters							
Customer Class	<500		500-999		1,000-9,999		>=10,000	
	Resp.	1000Gal/m	Resp.	1000Gal/m	Resp.	1000Gal/m	Resp.	1000Gal/m
Surface Water								
Res. Com			1	54	1	77		
Res.Com. Ind.			2	**122**				
Shallow Wells	37	87	10	105	7	104		
Res. Com.	5	74	7	**117**	13	**190**	2	243
Res. Com. Ind.								
Deep Wells	68	80	6	89	5	104		
Res. Com	11	**89**	12	85	14	**124**	3	132
Res.Com. Ind.								
Shallow-Deep Wells								
Res. Com	11	80	5	120	4	163		
Res.Com. Ind.	2	**310**	2	82	2	163	1	113

Note: Res.=residential; Com=commercial; Ind.=industrial + others

1000 Gal/m= 1000 Gallons/meter

Age of System vs Consumption/Meter

Table W7. Age of system versus gallons/meter for deep wells with <500 Residential-commercial customers, the most common source and customer class.

	Year of Most Recent Upgrade		
	0-15 years	16-30 years	>30 years
Mean Gallons/meter	81	84	86
Responses	39	12	3

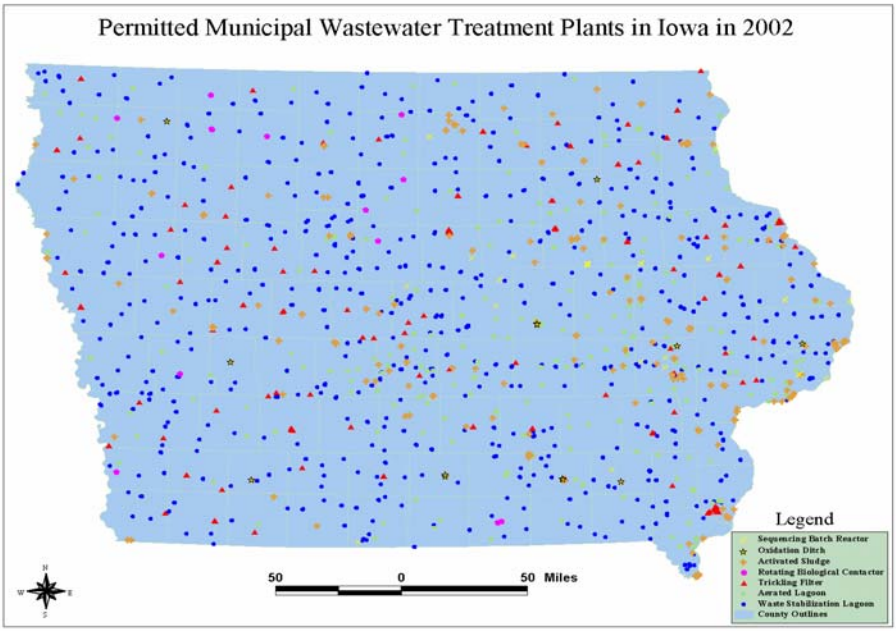
Size of Utility vs Consumption/Meter

Figure W8. Size of utility versus water consumption in gallons/meter for deep wells With <500 residential-commercial customers.

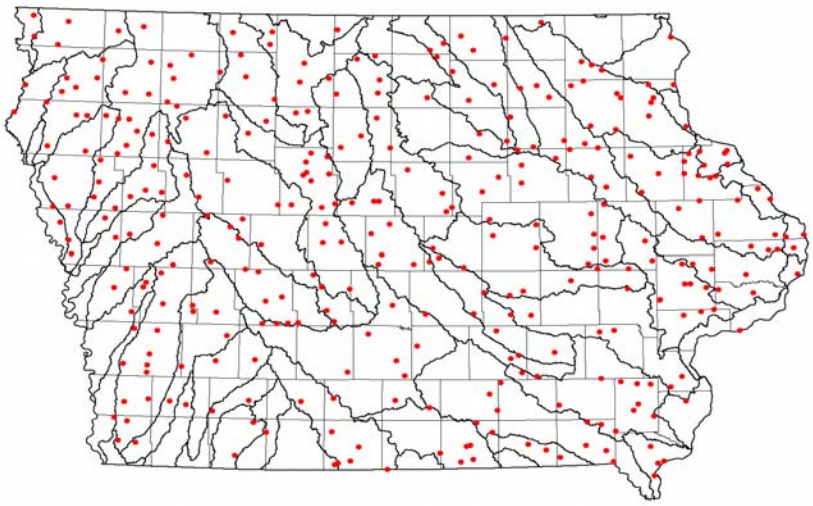
	Number of Customers/Meters			
Mean	**<500**	**500-999**	**1,000-9,999**	**>=10,000**
	Gallon/meter	**Gallon/meter**	**Gallon/meter**	**Gallon/meter**
Consumption	83	93	105	
Responses	40	4	4	No Response

Survey Responses:

Wastewater Treatment Systems



Iowa wastewater treatment system survey responses.



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IAMU 1999-2000 survey response for Iowa municipal wastewater treatment systems.

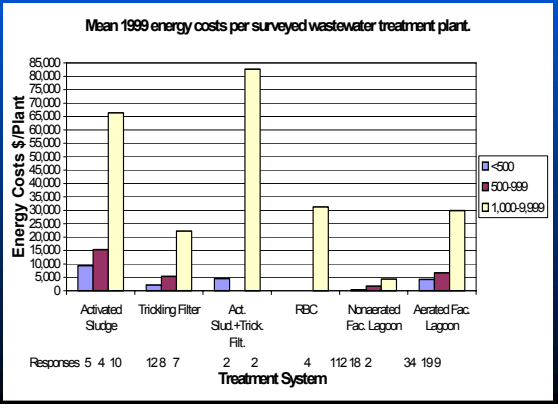
Treatment Type	*No. Permitted Water Systems	Survey Response
Lagoons	537	260
Activated Sludge	74	34
Oxidation Ditches	5	4
Sequencing Batch Reactors	16	3
Trickling Filters	94	54
Rotating Biological Contactors	13	10

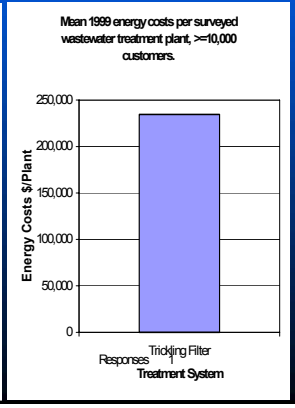
*These are listed by principal source by IDNR. Single source system counts are not available.

Wastewater Energy Results

Energy Costs

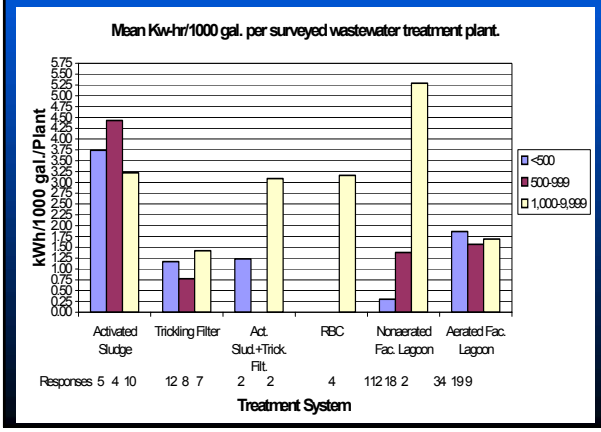
- Plant costs are greater than collection costs.
- Costs increase as the number of customers increases.
- Most notable differences between activated sludge and activated sludge-trick. filter and lagoons.

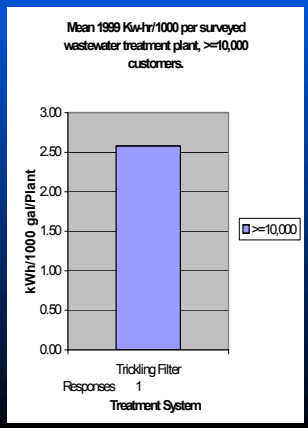




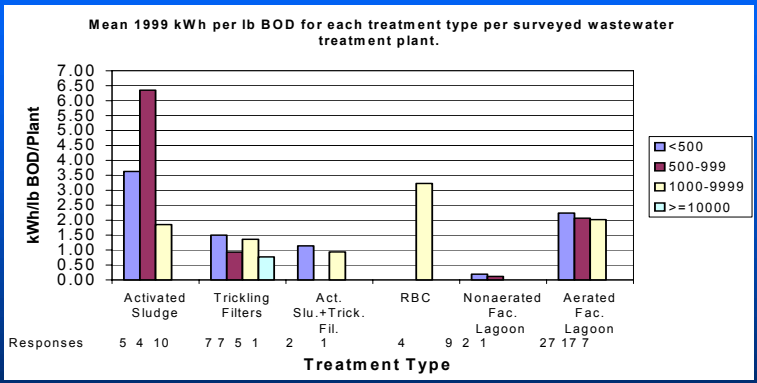
Energy Consumption

- kWh/1000 gal. results are variable between treatment types.
- Higher kWh/1,000 gal. for activated sludge.





BOD



Kw-hr/lb BOD decrease with numbers of customers, except at 500-999 for act. sludge and nonaer lag.

Summary

- Iowa now has baseline information available on water and wastewater treatment energy and treatment costs.
- This information can be used to compare to individual system operations.
- This treatment costs and energy consumption information can be used when considering system upgrades.
- Information is available in hardcopy and on our website; individual reports also sent out to survey participants.

Energy Efficiency E-Mail Survey (IAMU)

- Survey sent out 10/02 to several hundred water and wastewater treatment system managers.
- Nearly 50% indicated that some type of energy efficiency methods used.
- 50% wanted to find out more about options for energy efficiency.
- Nearly 80% do not take advantage of off-peak energy use, load management, methane generation.
- 50% not concerned with compliance with nutrient limits; 40% concerned and want more information.

WW-CAT Water and Wastewater Cost Analysis Tool (IEC)

Website demonstration: www.iamu.org

Water and Wastewater Treatment System Energy Efficiency Assistance (DEED, APPA)

Case Studies:

- Water reuse-Clear Lake Sanitary District wastewater effluent used for cooling water at major power plant.
- Cedar Rapids: Wastewater from local industries-anaerobic reactor, biogas used in place of natural gas for fueling sludge incinerator.
- Cedar Rapids: Water Treatment Energy Management Program-energy monitoring, VSD, Dr. DAS software, backup generation, peak management, city-wide energy management
- Denver: City water used for geothermal heating and cooling of city building, plus other activities-site visit scheduled for next week.

Water and Wastewater Treatment System Energy Efficiency Assistance (DEED, APPA)

- Fact Sheets, Manual with Case Studies
- Workshop to present all of these efforts and look at other innovations in energy efficient water and wastewater treatment technologies

What Should the Next Step Be for Iowa Efforts?