Evaluation of Distributed Generation Within **A MUNICIPAL ELECTRICAL INFRASTRUCTURE**

Team: J. Dugan, A. Gigstad, D. Kinganga, M. Koehn, C. Maluwelmeng, S. Taha
Advisers: A. Kimber and Z. Wang
Client: Bloomfield, Iowa (via Chris Ball)

PROJECT PLAN

6 October 2015

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1 Problem Statement

The City of Bloomfield has a goal to be energy independent by 2030. To achieve this, the city desires to increase its installed capacity of distributed generation (DG): solar, wind, etc. Our senior design team was tasked with the responsibility of determining feasible solutions that the city can execute to reach their goal of energy independence.

2 Deliverables

Bloomfield requested energy independence by 2030. Our team will provide the city with the following items to assist them in their journey to energy independence:

1. An evaluation of the system as is with pinpointed ideal locations for DG placement
2. Solution(s) to integrate DG into the system
3. Cost analyses of all options considered

First, the team must analyze the system and use Bloomfield's current equipment to optimize distribution generation. The City of Bloomfield contains three proponents which consumes power: residential, commercial and losses. Below are the forecasts of power consumption over the next 15 years.

a) Residential – steady 12100 MWh consumption

b) Commercial – forecasted to increase by 3200 MWh from 15800 MWh

c) Losses (which are unaccounted energy) – steady 2500 MWh

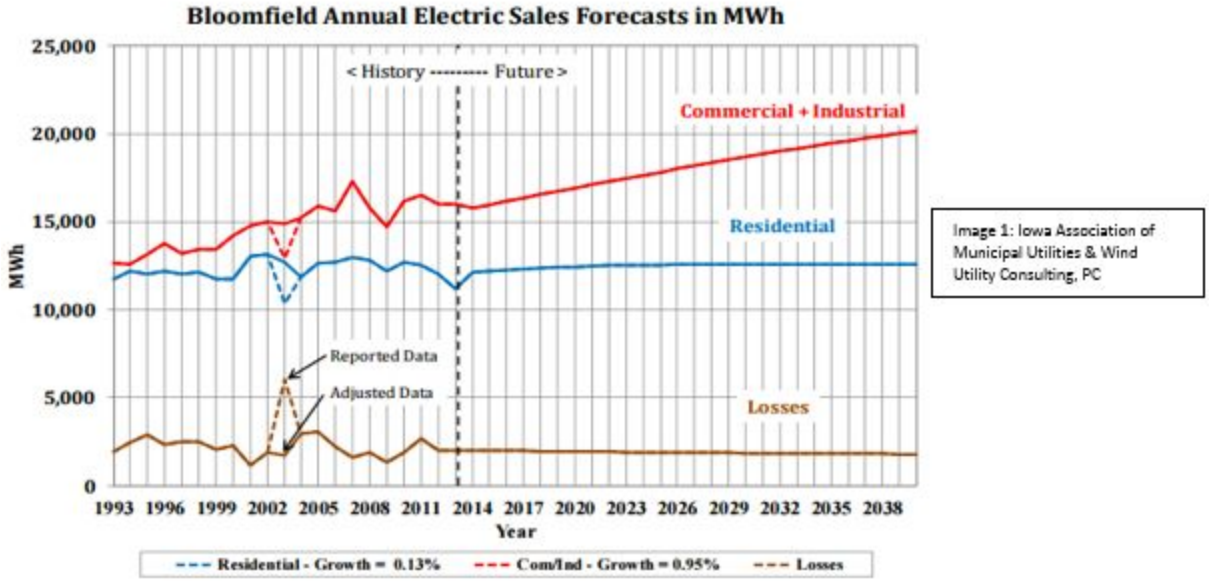


Image 1: Iowa Association of Municipal Utilities & Wind Utility Consulting, PC

Wholesale power will increase by 3% per year. Bloomfield currently can implement three options which will reduce the city's power consumption and lower the bill without hiring outside contractors. Below are three different strategies that were compared with Business As Usual (BAU). A description of these strategies are in the Table ES-1.

TABLE ES-1 – Summary of Strategies Developed and Evaluated to Become More Energy Independent

#	Name	Description	Goal	Local Generation Added
1	BAU	Business as usual	Status Quo	None
2	EE	Implement a comprehensive set of Energy Efficiency (EE) programs to reduce electricity usage as much as economically practical	Reduce electricity usage gradually over a ten-year implementation period by 23%	None
3	DLC	Install Direct Load Control (DLC) equipment that intermittently interrupts central air conditioning compressors and electric water heaters during peak load periods	Reduce summer peak loads and wholesale power demand charges	None
4	PS	Use the City's dual-fueled diesel generators during high load periods to reduce the monthly or annual peak usage	Reduce peak loads and demand charges by Peak Shaving (PS) with the existing diesel generators	None

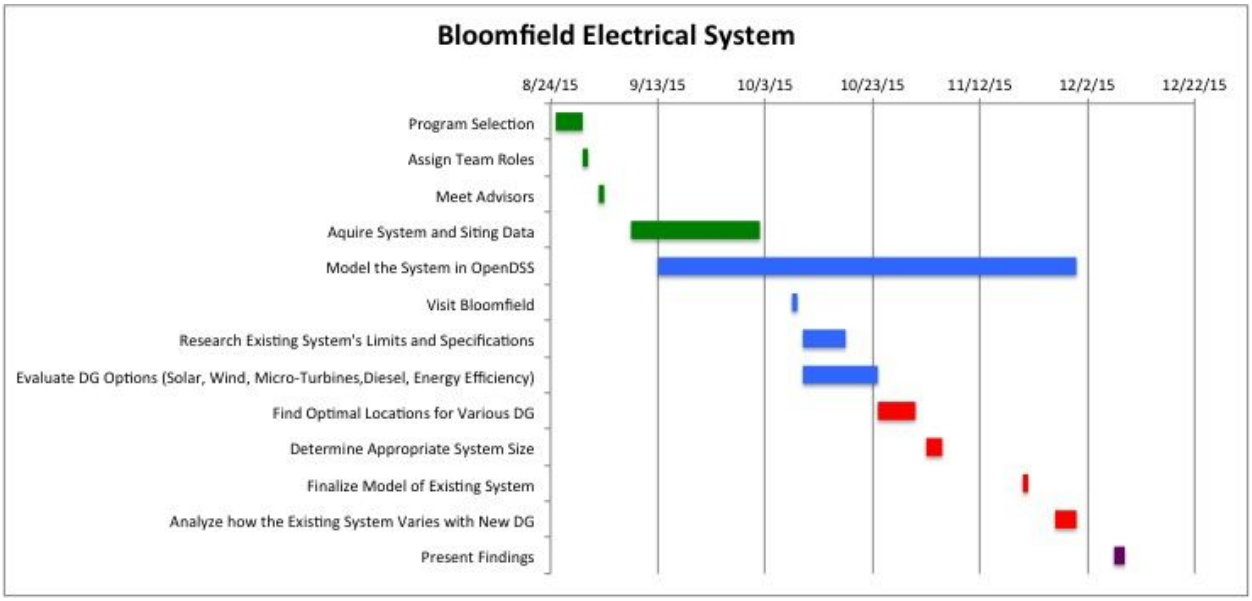
Image 2: Iowa Association of Municipal Utilities & Wind Utility Consulting, PC

By re-evaluating Bloomfield's system, the city can achieve a reduction in net wholesale purchase by 25.2% (depicted in chart below). This will allow Bloomfield to head towards the direction of complete independence by 2030. Allowing for optimization of the distribution generation first, will guarantee future Renewable energy is being fully utilized.

Scenario Number >	1	2	3	4
Abbreviated Title >	BAU	EE Only	EE + DLC	EE+DLC+PS
Scenario Title	Business As Usual	Energy Efficiency Programs Only	EE + Direct Load Control Programs Only	EE + DLC + Peak Shaving by Diesels
MWh Needed				
Total MWh Sales to Ultimate Customers	445,657	375,708	375,708	375,708
System Losses	28,781	25,031	25,009	25,009
Total MWh Sales for Resale	0	0	0	0
Total MWh Needed	474,438	400,739	400,717	400,717
Sources of MWh				
Wholesale Purchases, MWh	474,438	400,739	400,325	391,408
Diesel Plant Generation, MWh	0	0	0	8,917
Microturbine Generation, MWh	0	0	0	0
Wind Generation, MWh	0	0	0	0
Solar PV Generation, MWh	0	0	0	0
Other (DLC, Storage), MWh	0	0	392	392
Total Sources of Energy	474,438	400,739	400,717	400,717
Measures of Energy Independence				
% Reduction in Retail Sales in 2029	0	22.5%	22.5%	22.5%
% Reduction in Net Wholesale Purch., in 2029	0	22.5%	22.6%	25.2%
% of Energy Locally Produced	0	0.0%	0.0%	3.4%

Image 3: Iowa Association of Municipal Utilities & Wind Utility Consulting, PC

3 Timeline



4 Design Possibilities and Solutions

First we are going to evaluate the overall health of the system by taking a closer look at the existing infrastructure and answering a few questions:

- How old are the poles, conductors, transformers, capacitors and how much load can they handle at the present situation?
- Tree trimming - is the distribution network well maintained to reduce costs associated with bad weather?
- Can the current substation accommodate DG (Distributed Generation/generation on-site)?

Answering these questions will help us to create a better model of the city's distribution system which will allow for more concise analyses and evaluations.

We are using OpenDSS (a modeling software) to model the City of Bloomfield's distribution system. Once we have done this, we will be able to see the capacity for DG that the system will have. Determining how much DG each feeder can handle will allow us to look more at locations to place various forms of DG.

The ideal way to create a good model of the distribution system would require us to have as much load and consumption data as possible. This data will enable us to make very few assumptions and could possibly make a very exact model. This would allow us to produce accurate response of the system when adding DG onto the system. One downside of this approach would be that, the modeling process would take much longer than making some assumptions. From what we have found out so far from the city is that we will most likely not get all the data we are looking for.

The situation that may be most likely that we get some load data and some information about the feeders but not down to individual transformers. This is where we will have to make some assumptions about the system based on the total load of the feeder or substation. Our group would have to make some assumptions about the voltages and currents on the feeder. This will slightly impact our evaluation of the DG but our group will still be able to make a good evaluation of the system. The workload for this will be slightly less because we will have to make some assumptions.

The worst case scenario would be we get minimal data and we have make assumptions about almost every aspect of the system. This will make the accuracy of the evaluation of the DG not as accurate. The possible locations to place DG may be accurate but the power that is produced could be very unrealistic and we would be very unsure how the system would respond.

Once the modelling is done we will decide what types of DG that the city of Bloomfield can incorporate to the existing distribution network without overloading the existing feeders.

5 Costs

The only cost we foresee having is that of travel: gas expenses to and from Bloomfield. As this is a design project, no physical work will be done by the team. Simulation and designs will all be done on OpenDSS, a free software.

6 Risks

The completion and the success of evaluating and designing this system is contingent upon a few factors:

- Scarcity of relevant data
- Appropriate assumptions
- City budget/funds

We are currently still waiting to receive data from the city. As mentioned, limited data runs the risk of evaluating a system that does not quite match that of Bloomfield. Assumptions will be

made to the best of our abilities, but we might not be able to gauge how close our assumptions are to the true values. Thus, calculations made and modeling done may not be as realistic as desired.

Another aspect that we would need to take into consideration is the cost limits of the city. Since municipals are nonprofit, the budget for the utility will most likely consist of the minimum needed to maintain the system. In this respect, we will attempt to create multiple solutions that might fit varied levels of funding.

7 Conclusion

The team has created a plan to assist in Bloomfield's goal to not only become energy independent but also to have a more energy efficient system. By the end of the year, we hope to have multiple solutions in which the city's citizens can choose from. Each option will consist of evaluations of the system, cost analyses for associated costs, and how that option will propel the city to achieve their goal of energy independence by 2030.