Algona Municipal Utilities Power System Design

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Outline

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Figure 1 Modern Electric Power System

Client & Advisor & Instructor

Client

John Bilsten
Algona Municipal Utilities
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Advisor

Anne Kimber
Executive Director, Electric Power Research Center
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Instructor

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The Description of Project

Upgrade the old and weak distribution system for the Algona Municipal Utilities second largest electric customer, a large industrial company.

Figure 2 Industrial Consumer GIS map

About Algona

Algona is a city of about 5500 people in Northwest Iowa that is served by our client, Algona Municipal Utilities.

Figure 3 The position of Algona

Current Status

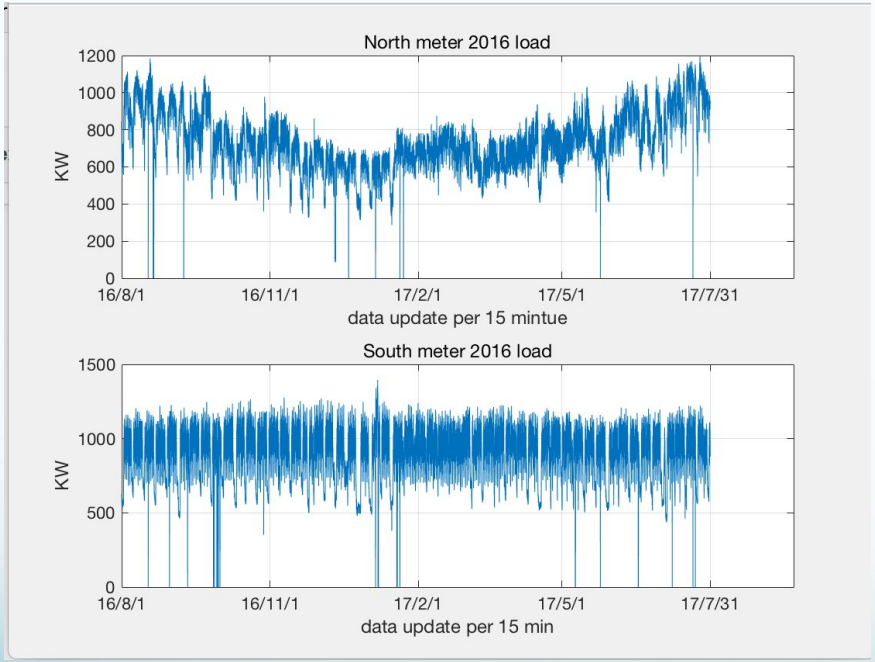

Figure 4 2016-2017 AMI data

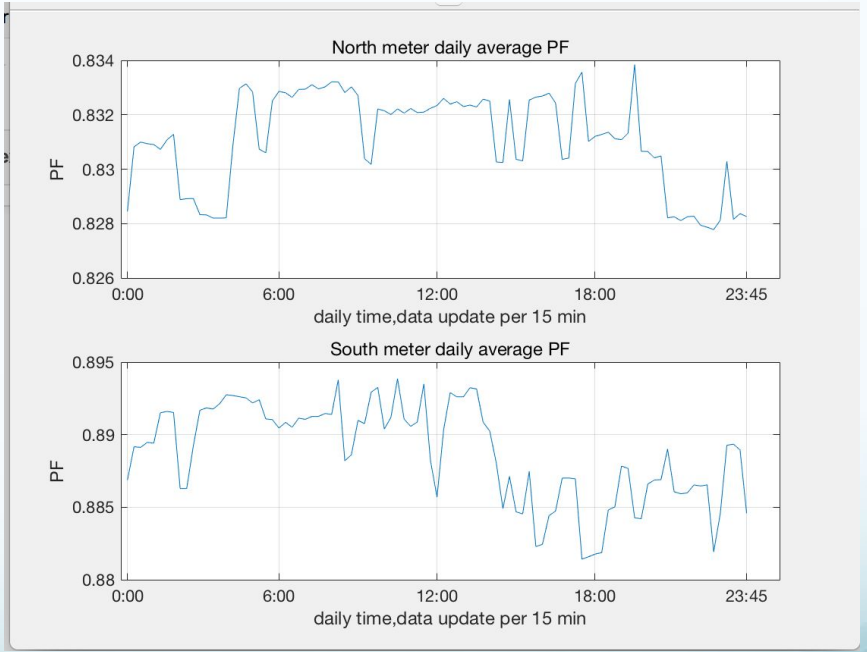

Figure 5 2016-2017 daily average Power Factor

Distribution System

Distribution System is the final stage in the delivery of electric power and carriers electricity from transmission system to individual

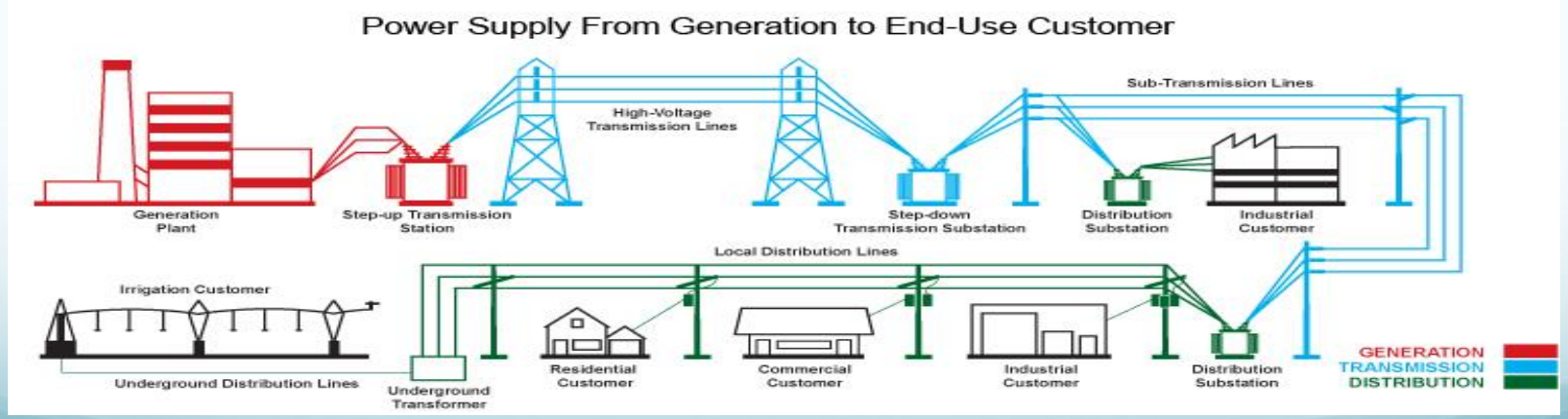

Figure 6 The brief power system

Timeline

MONTH/2017	
JAN.	Pick the project
FEB.	Visit Algona and check some data
MAR.	Design some route draft
APR.	Learn how to use Milsoft and fix login problem about this software
MAY.	Report first semester working
SEP.	Check DGR model
OCT.	Discuss with our client and pick one route, design two models
NOV.	Figure out equipment specification and finish our total cost
DEC.	Report our project

Figure 7 Timeline of project

Software & Database

Milsoft

- Voltage Drop
- Basic PV Analysis
- Effects of voltage profiles for various times
- Harmonics
- Effects of EV charging

Figure 8 Milsoft Utility Solutions

DGR Engineering

- DeWild Grant Reckert Engineering
- Professional Engineering company
- Work for civil engineering, water systems, electrical distribution

Figure 9 DGR Engineering

Original Model

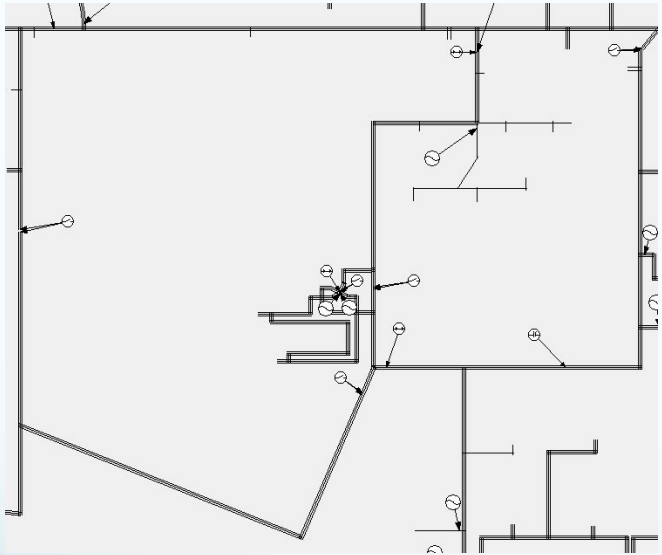

Figure 10 The DGR Milsoft model for the industrial consumer

Original Model

- Milsoft software
- Primary feeder EB5
- Secondary feeder 1
- Two Pad Mounted Transformers
- Two switches

Geographical Route Design

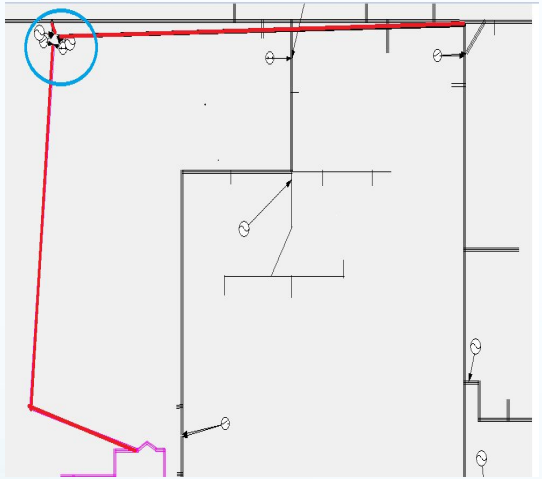

Figure 11 Geographical route Design I

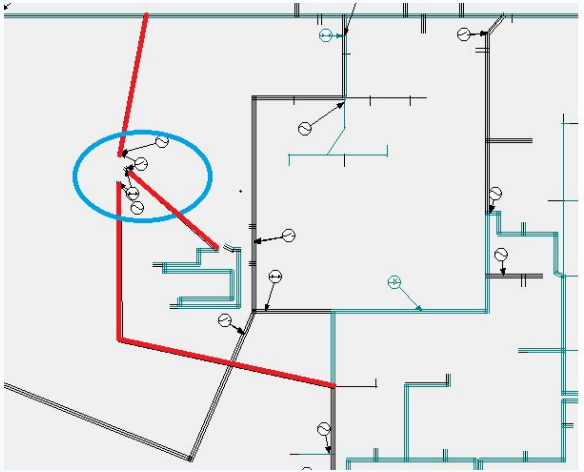

Figure 12 Geographical route Design II

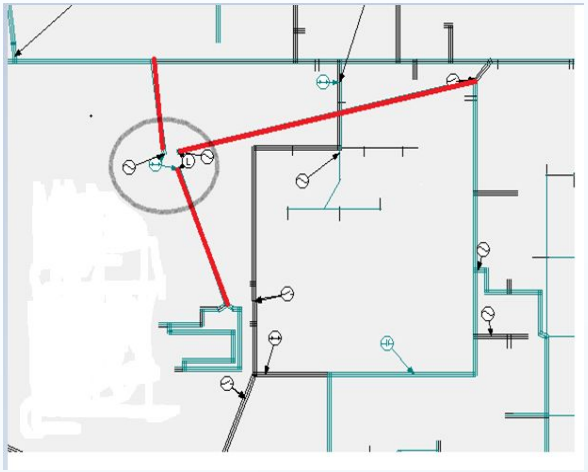

Figure 13 Geographical route Design III

Simulation Model

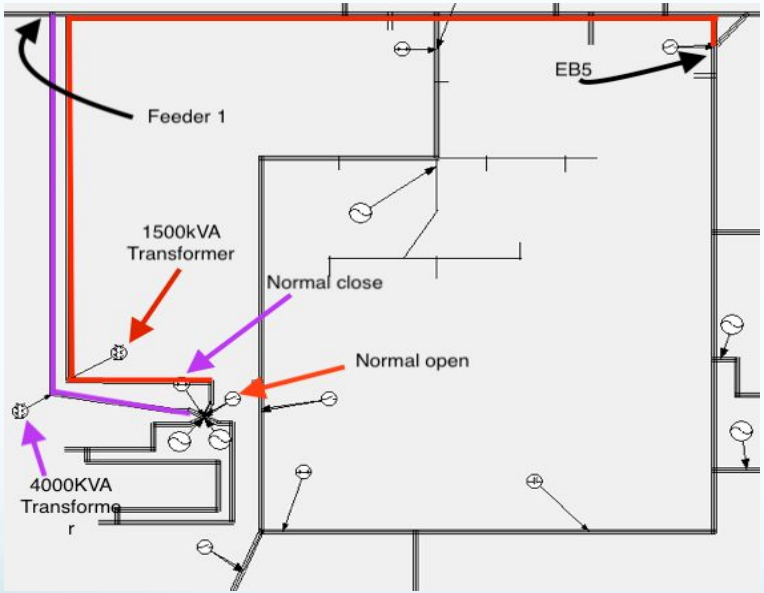

Figure 14 Model I (Based on DGR model Load)

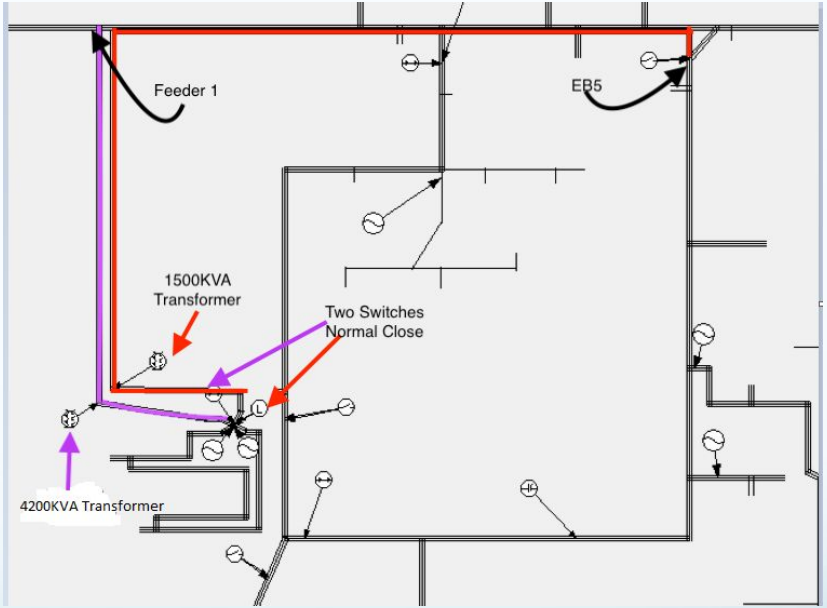

Figure 15 Model II (Based on the AMI data)

Voltage Drop Report

	Element Name	Parent Name	Cnf	Type/ Conductor	Pri kV	Base Volt	Element Drop	Accum Drop	Thru Amps	% Cap	Thru KW	KVAR	% PF	kW Loss	% Loss	From Src	Length (mi)	KW	KVAR	Cons On	Cons Thru	
	UG2180	UG2179	A	4/0AL 220E	7.80Y	117.4	0.01	2.56	156.42	48	1093	542	90	0.31	0.0	1.682	0.007	0	0	0	0	
			B		7.79Y	117.4	0.01	2.61	156.49	48	1093	542	90					0	0	0	0	
			C		7.79Y	117.4	0.01	2.63	156.51	48	1093	542	90					0	0	0	0	
	UG2181	UG2180	A	4/0AL 220E	7.80Y	117.4	0.01	2.57	156.42	48	1092	542	90	0.30	0.0	1.689	0.007	0	0	0	0	
			B		7.79Y	117.4	0.01	2.62	156.49	48	1092	542	90					0	0	0	0	
			C		7.79Y	117.4	0.01	2.64	156.51	48	1092	542	90					0	0	0	0	
	SW2182	UG2181	A	Closed	7.80Y	117.4	0.00	2.57	156.42	0	1092	542	90	0.00	0.0	1.689	0.000	0	0	0	0	
			B		7.79Y	117.4	0.00	2.62	156.49	0	1092	542	90					0	0	0	0	
			C		7.79Y	117.4	0.00	2.64	156.52	0	1092	542	90					0	0	0	0	
	SW2182-B	SW2182	A	Closed	7.80Y	117.4	0.00	2.57	156.42	0	1092	542	90	0.00	0.0	1.689	0.000	0	0	0	0	
			B		7.79Y	117.4	0.00	2.62	156.49	0	1092	542	90					0	0	0	0	
			C		7.79Y	117.4	0.00	2.64	156.52	0	1092	542	90					0	0	0	0	
	EB5-UG2	SW2182-B	A	80E S&C S1	7.80Y	117.4	0.00	2.57	78.23	0	546	272	90	0.00	0.0	1.689	0.000	0	0	0	0	
			B		7.79Y	117.4	0.00	2.62	78.26	0	546	272	90					0	0	0	0	
			C		7.79Y	117.4	0.00	2.64	78.28	0	546	272	90					0	0	0	0	
	UG2186	EB5-UG2	A	4/0AL 220E	7.80Y	117.4	0.01	2.58	78.23	24	546	272	90	0.08	0.0	1.696	0.007	0	0	0	0	
			B		7.79Y	117.4	0.01	2.63	78.26	24	546	272	90					0	0	0	0	
			C		7.79Y	117.4	0.01	2.65	78.28	24	546	272	90					0	0	0	0	
	UG2187	UG2186	A	4/0AL 220E	7.80Y	117.4	0.01	2.59	78.23	24	546	272	90	0.16	0.0	1.711	0.015	0	0	0	0	
			B		7.79Y	117.4	0.01	2.64	78.27	24	546	272	90					0	0	0	0	
			C		7.79Y	117.3	0.01	2.66	78.28	24	546	272	90					0	0	0	0	
	UG2188	UG2187	A	4/0AL 220E	7.79Y	117.4	0.01	2.60	78.24	24	546	272	90	0.13	0.0	1.722	0.012	0	0	0	0	
			B		7.79Y	117.4	0.01	2.65	78.27	24	546	272	90					0	0	0	0	
			C		7.79Y	117.3	0.01	2.67	78.28	24	546	272	90					0	0	0	0	
	UG2189	UG2188	A	4/0AL 220E	7.79Y	117.4	0.02	2.62	78.24	24	546	272	90	0.30	0.0	1.750	0.027	0	0	0	0	
			B		7.79Y	117.3	0.02	2.67	78.28	24	546	272	90					0	0	0	0	
			C		7.79Y	117.3	0.02	2.69	78.29	24	546	272	90					0	0	0	0	
	UG2190	UG2189	A	4/0AL 220E	7.79Y	117.4	0.00	2.63	78.26	24	546	272	90	0.03	0.0	1.759	0.009	546	272	0	0	
			B		7.79Y	117.3	0.00	2.68	78.29	24	546	272	90					546	272	0	0	
			C		7.79Y	117.3	0.00	2.69	78.30	24	546	272	90					546	272	0	0	
P	UG2191	UG2189	A	4/0AL 220E	7.79Y	117.4	0.00	2.62	-0.00	0	0	0	100	0.00	0.0	1.755	0.005	0	0	0	0	P
P			B		7.79Y	117.3	0.00	2.67	-0.00	0	0	0	0					0	0	0	0	P
			C		7.79Y	117.3	0.00	2.69	-0.00	0	0	0	0					0	0	0	0	
	EB5-UG1	SW2182-B	A	80E S&C S1	7.80Y	117.4	0.00	2.57	78.19	0	546	271	90	0.00	0.0	1.689	0.000	0	0	0	0	
			B		7.79Y	117.4	0.00	2.62	78.23	0	546	271	90					0	0	0	0	
			C		7.79Y	117.4	0.00	2.64	78.24	0	546	271	90					0	0	0	0	

Figure 16 Voltage Drop Report with Model I

Overhead & Underground

Advantage of Underground cable:

- Low Transmission loss
- Absorb Emergency power loads
- Less Susceptible to the impacts of severe weather
- Less Maintenance Cost

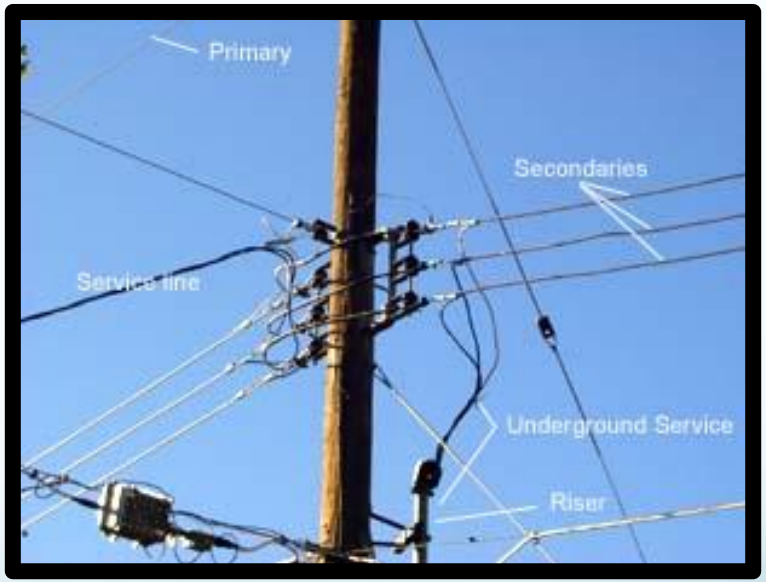

Figure 17 UG & OH Riser

Cable Type

- 15KV Underground Distribution Cable
- All made with Aluminum
- For Two Models:

	Conductor	Thickness(mils)	Rubber Type	Neutral
Type 1	4/0	220	EPR	1/3
Type 2	4/0	220	EPR	Full
Type 3	350	220	EPR	1/3

Figure 18 Figure Type

	Model I	Model II
Primary Feeder	Type 2	Type 3
Secondary Feeder	Type 1	Type 1

Figure 19 Model feeder type

*EPR: Ethylene Propylene Rubber

Cable Length

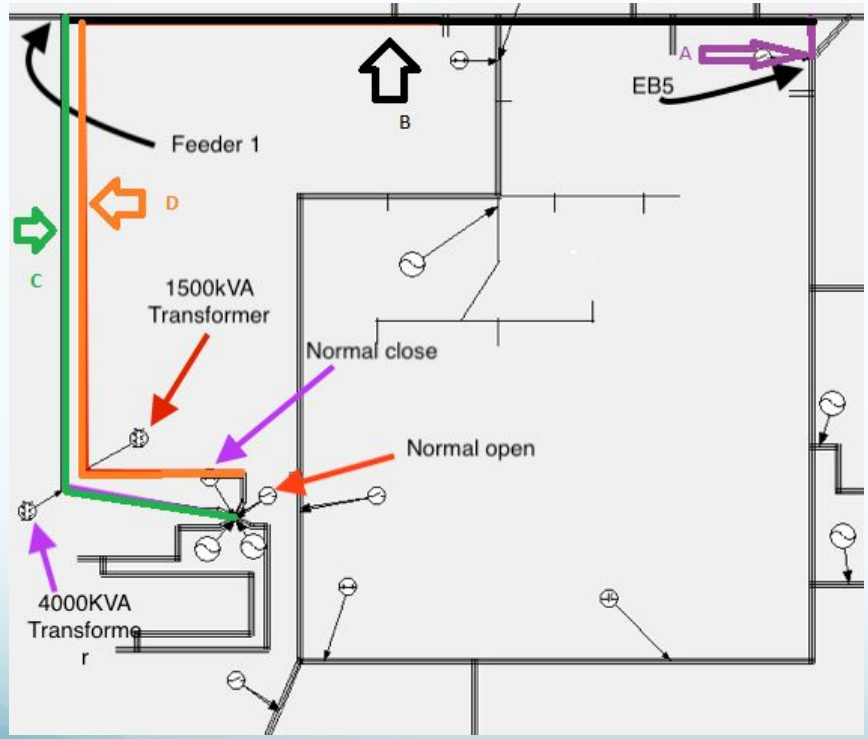

Figure 20 Cable length

- Line A : 69 ft (4/0 220 EPR 1/3)
- Line B: 1841 ft (4/0 220 EPR 1/3)
- Line C: 991.52 ft (4/0 220 EPR FULL or 350 220 EPR 1/3)
- Line D: 981.71ft (4/0 220 EPR 1/3)

Cost of Cable

We recommend Okonite Company productions:

- 4/0 220 EPR 1/3 : 160-23-3081 ---$4.63/ ft, total around:$40167 (Line A, B, D Together)
- 4/0 220 EPR FULL: Need Special Order, total: Unknown（Model I, Line C)
- 350 220 EPR 1/3: 162-23-3090 ---$6.04/ ft, total around: $17967（Model II, Line C)

* Price was provided by Wesco Distribution of Des Moines

Material of Conduit

Different material of conduit pipe such as EMT, IMC, GRC, Sch80 PVC and Sch40 PVC. After we talked to the client, they prefered Sch40 PVC. We list some satisfy productions below:

- United States Plastic Corp (http://www.usplastic.com)
- Grainger (https://www.grainger.com)
- PVC Pipe Supplies (http://pvcpipesupplies.com)

PVC Cable Price

	Price ($/ft)	Weight (lbs/ft)	Max Pressure(PSI)	Temperature(F)
US Plastic Company	1.89	0.682	/	33-140
Grainger Company	1.84	/	280	/-140
PVC Pipe Supplies Company	1.15	0.72	280	32-140

Figure 21 PVC Cable Price

** “/” means unknown

Transformer

- Three phase
- Voltage rating: 13.8KV/480V
- KVA rating: (Load Volts*Load AMP*1.732)/1000= “X” KVA .
- Impedance : 5%-7%
- Frequency: 60Hz
- Cooling Type: OA/FA

Figure 22 Pad Mounted Transformer

Cost of Transformer

We calculate the transformer cost from ABB Inc that it provides a roughly average price for us: usually price is $17/KVA.

	Model I ($)	Model II ($)
Transformer Price	93,500	96,900

Figure 23 Cost of Transformer

Total Cost

	Model I ($)	Model II ($)
Transformer	93,500	96,900
Cable	40,305+Y	58,389
Conduit Pipe	5,824.89	5,824.89
Total Cost	139,629.89+Y	161,113.89

Figure 24 Total Cost

*Y means total cost of the second type distribution cable

Conclusion

- Project Website: http://dec1702.sd.ece.iastate.edu/
- In this project, we designed three different geographic designs and we picked one.
- Designed two models, one is from DGR model data and one is from 2016-2017 customer AMI data.
- For cable, we provide 3 type cable.
- For transformer, we provide 3 capacity with 4000 KVA, 4200 KVA, 1500 KVA.
- For conduit pipe, we provide Sch 40 PVC.

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Question?

Thanks for Listening
Have a good day!