Impact of High Photovoltaic Penetration on Distribution Systems

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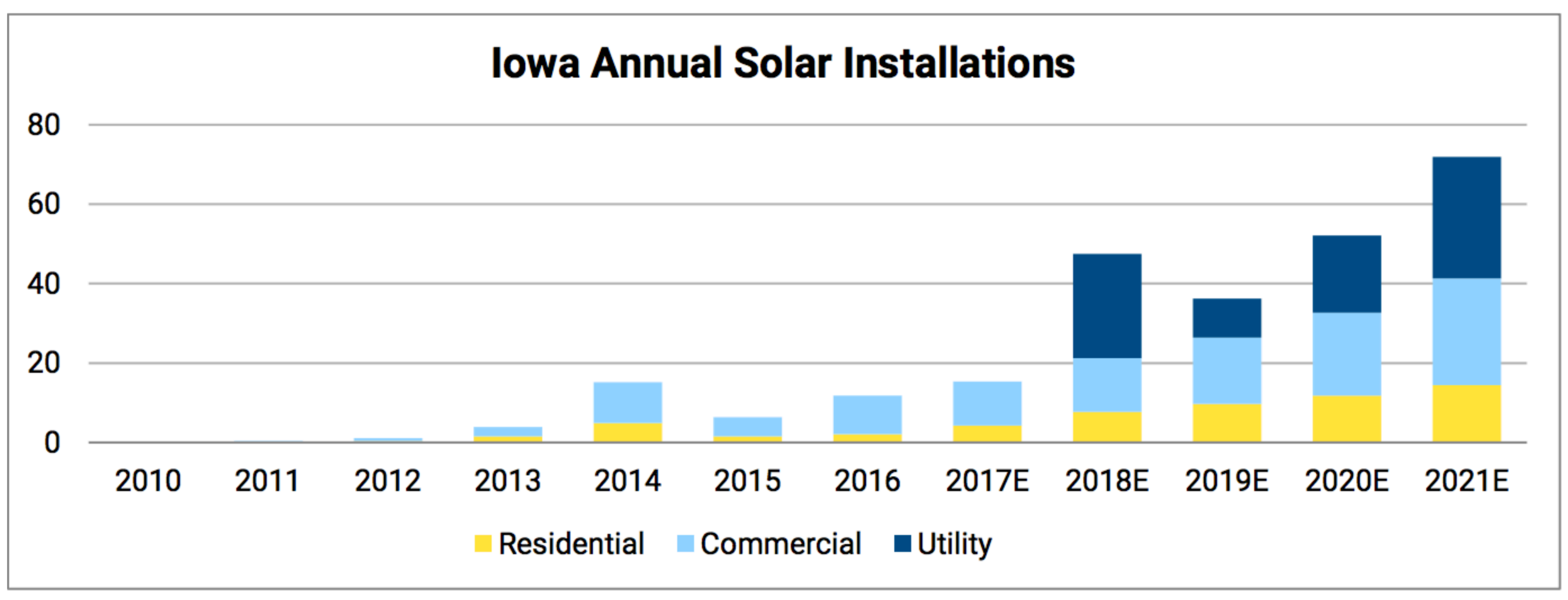
Project Advisors: *Dr. Ajjarapu, Ankit Singhal*

Team Members: *Nathaniel Summitt, Wyatt Lauer, Samuel Searls, Mark Szkodyn, Abdul Waasay Mirza*

1. Introduction

- Solar is an ever increasing type of power generation in Iowa, therefore, utilities need to learn how the increased levels of penetration will affect their distribution systems

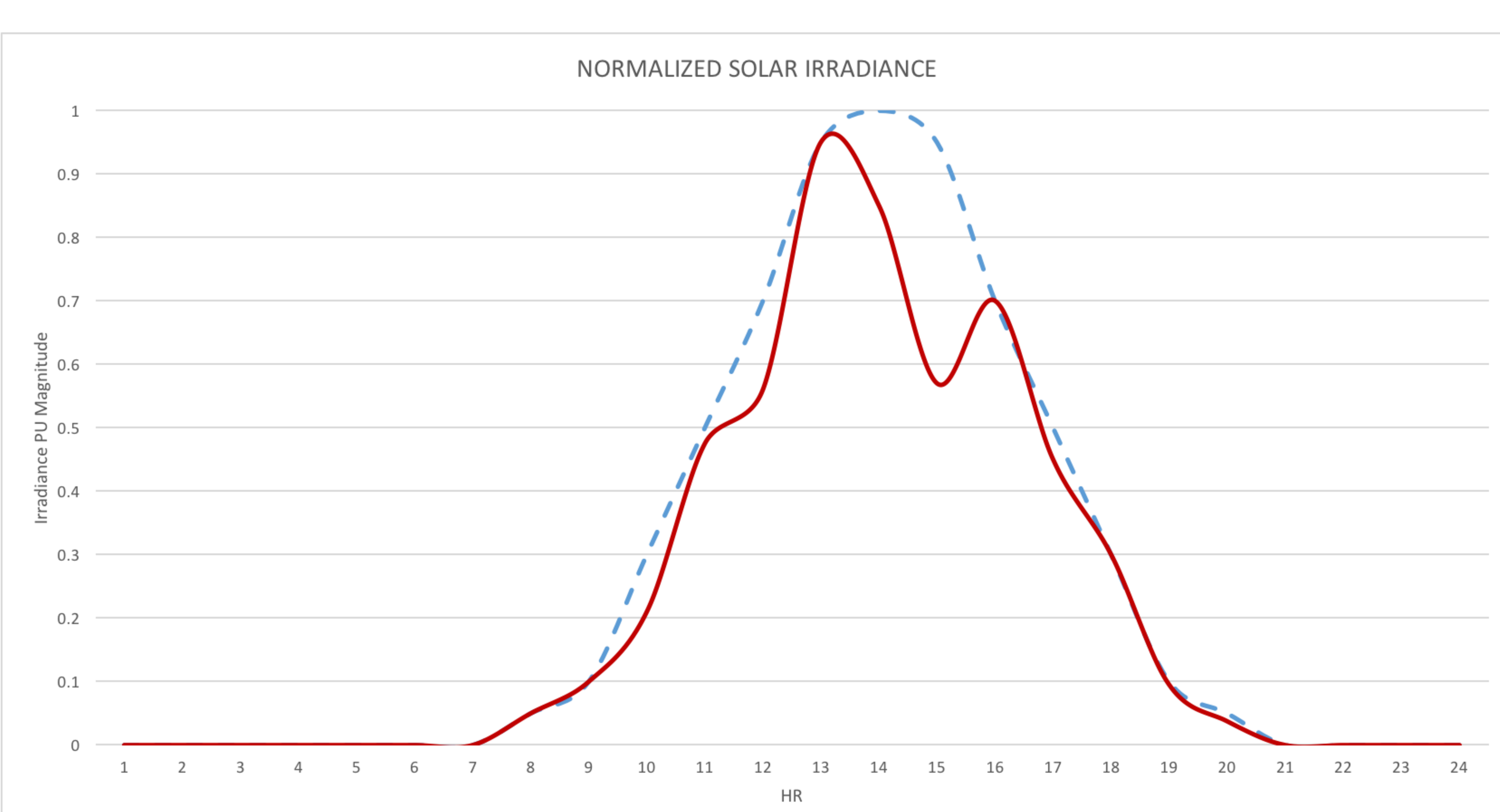


http://www.seia.org/state-solar-policy/iowa

3. Design Approach

- Implemented knowledge from IEEE 34 bus system to understand how we can add solar PV into the Alliant System
- Ran simulations without cloud intermittency in Alliant System to locate the best areas to add solar generation
- Compared effects of single solar site vs distributed solar on system with cloud intermittency
- Integrated smart inverters and capacitor banks in system for the most cost effective solution

5. Testing



- Created a waveform that simulated the worst cloud cover possibilities, quick oscillations between sun and clouds, on a minute to minute and hour to hour basis
- Found that the North, South and Residential could handle 60%, 50%, and 110% PV penetration, respectively, as compared to the load
- Chose the south as our test area as it would create the worst case scenarios
- Implemented capacitors and smart inverters through out South region, to determine the most cost effective solution

2. Design Requirements

- System must withstand PV penetration to a limit where it does not incur violations in all sorts of weather conditions
- Analyze how distributed solar and single solar site PV generation will affect the current distribution system
- Design possible solutions for voltage violations using smart inverters and capacitors

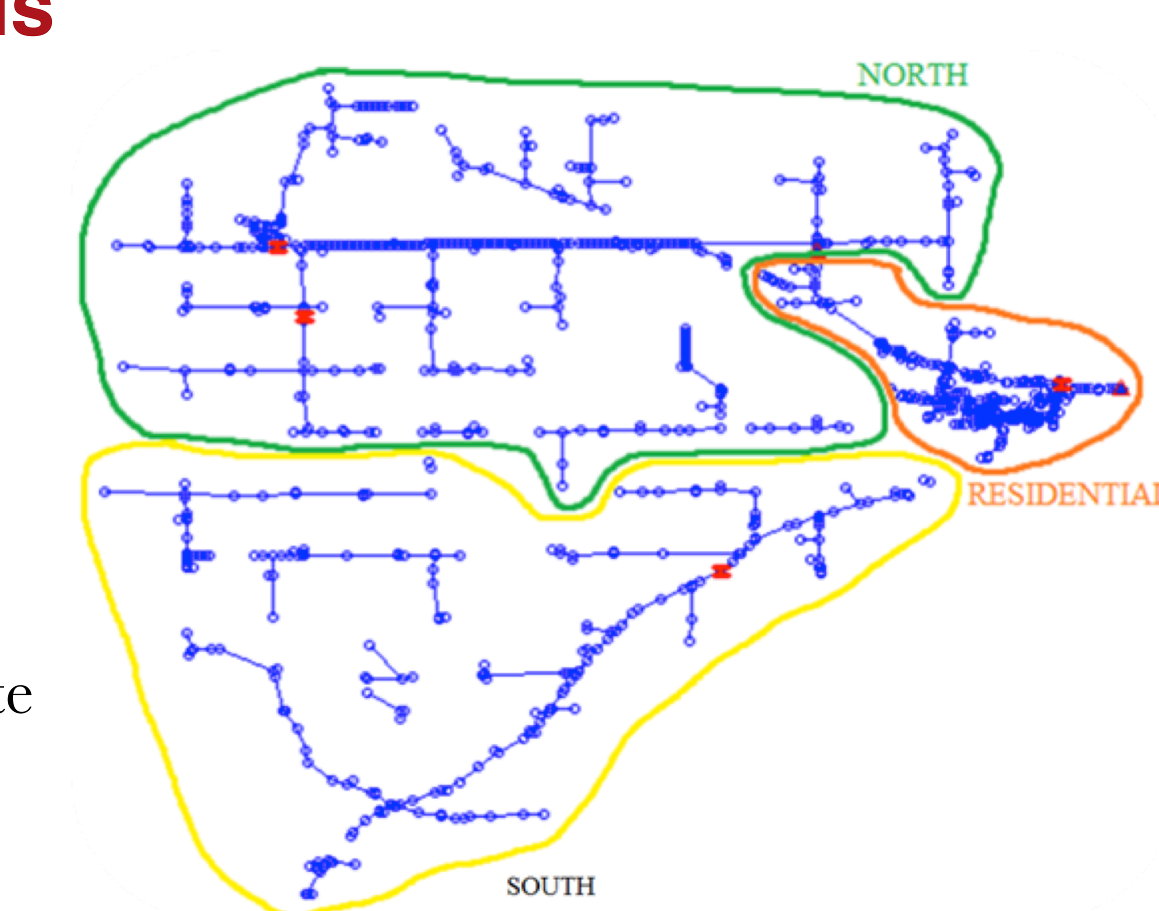
4. Technical Details

System Information:

- 5.5 MW
- 1304 Nodes
- 481 loads

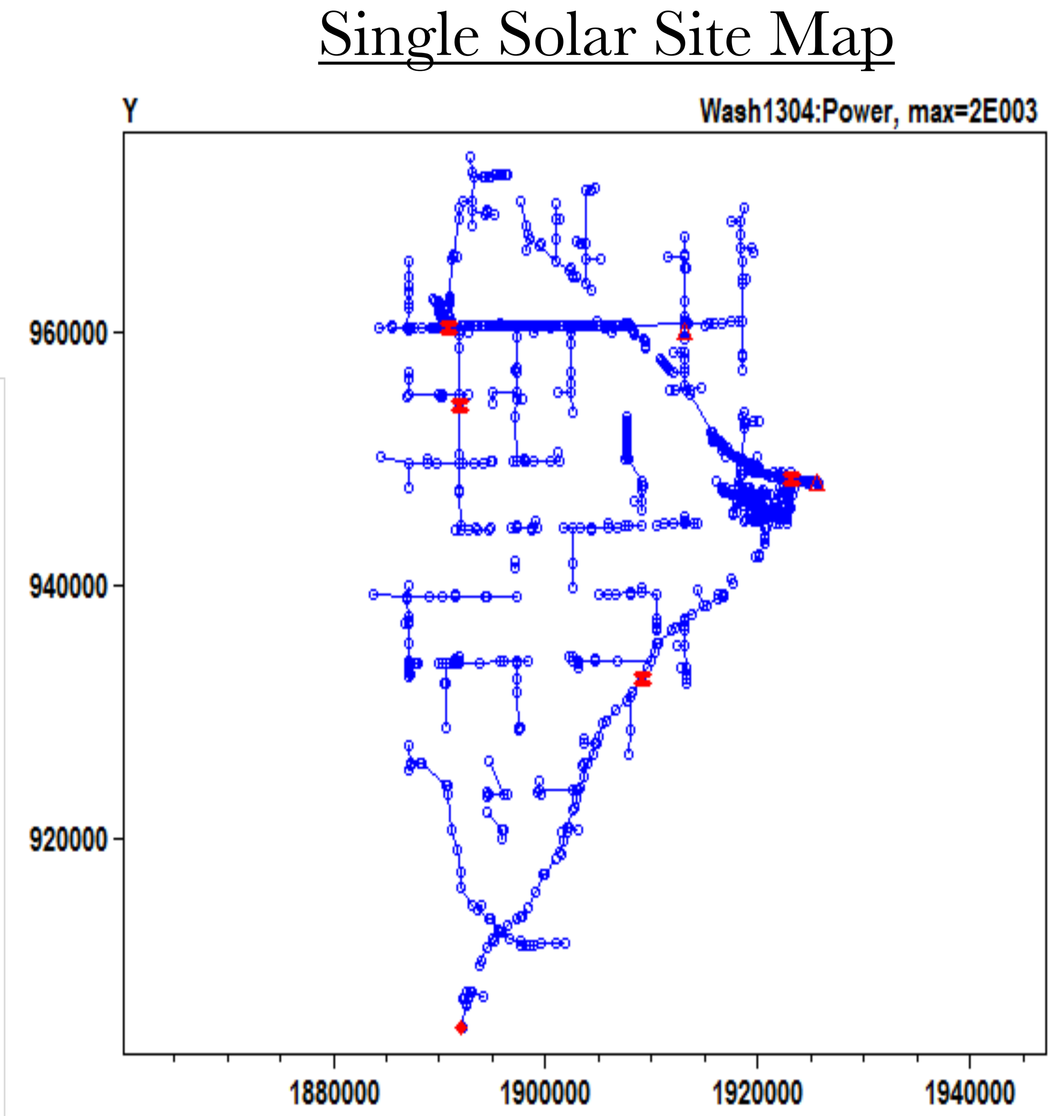
PV Generation:

- 50 kVA – 300kVA per site

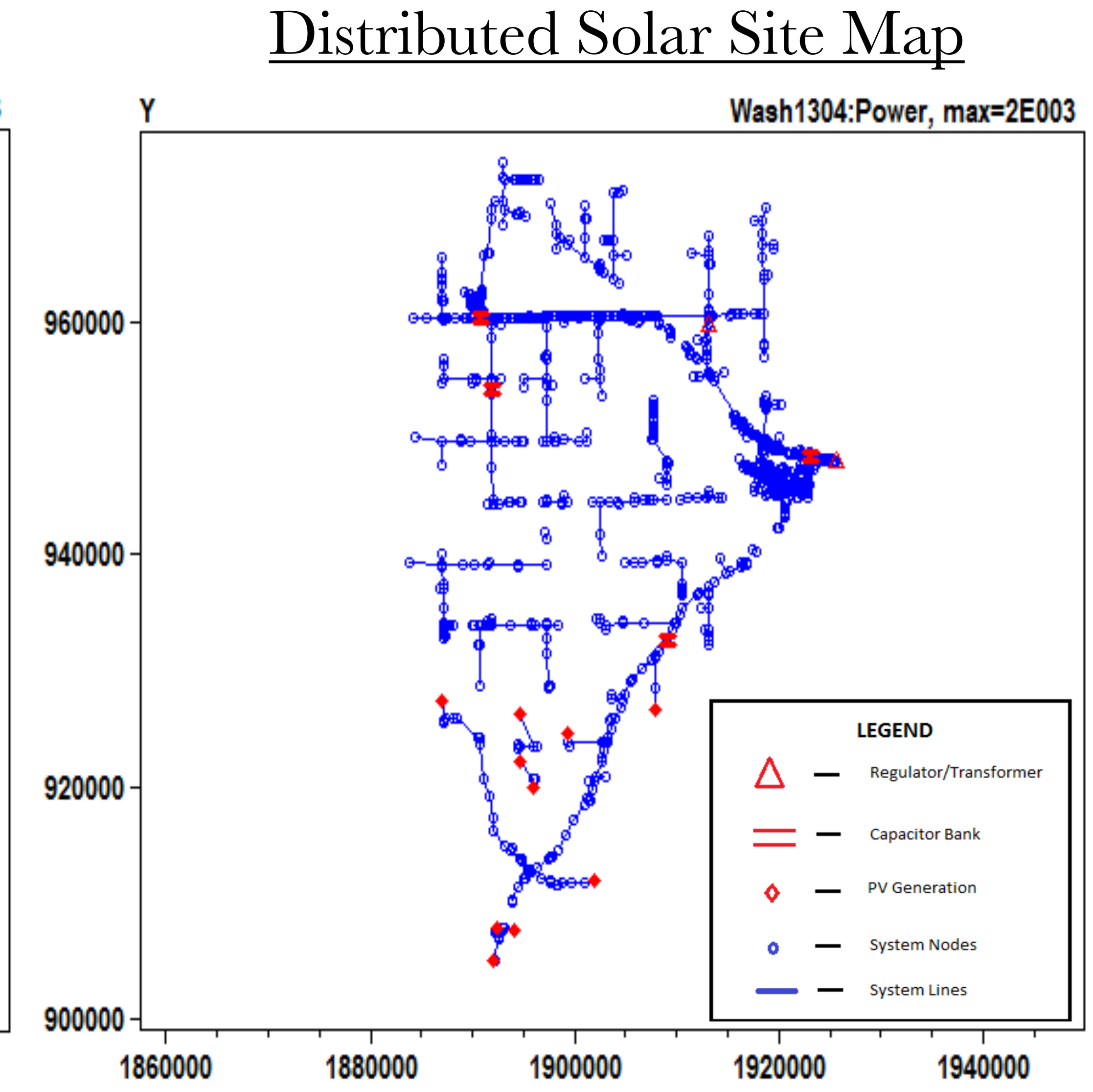


6. Results

<u>Single Solar Site Map</u>



<u>Distributed Solar Site Map</u>



- For the single solar site, we saw violations first occur at 50% PV penetration. For this case, with cloud cover, addition of a smart inverter is not able to correct violations
- For distributed solar, at 50% PV penetration with cloud cover, no violations were seen. However, with addition of smart inverters voltage quality improved
- The most effective way for Alliant to proceed is by encouraging distributed solar generation to their customers, and adding smart inverters as protection from possible extreme condition and to improve power quality.

IOWA STATE UNIVERSITY

Email: may1728@iastate.edu
Website: http://may1728.sd.ece.iastate.edu

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