

# Investigating Solutions to Voltage Increase on Distributed Generation Power Systems

Dec1613

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# The Problem

- Lightly loaded rural systems are seeing an increase in Distributed Generation
- Low load times correspond to high solar production (Mid-day on sunny days)
- ANSI Voltage Regulation Standards are 114V to 126V
- High solar production and low loads can cause voltages above 126V on the system

# Requirements

## Functional

- Keep all elements with voltage limits under all conditions.
- Accurately model system under differing load/DG conditions
- Solving all instances where model departs from ANSI limits

## Non-Functional

- Learning to use modeling software
- Research into possible solutions to select the most universally applicable
- Compiling our data and research to present to our client: MVEC

# Our Plan

- Investigate/Research 5 solutions to stop voltage rise
  - Solar inverters
  - Storage
  - Capacitor bank
  - Customer side voltage regulation
  - Load Tap Changing Transformers
- Test out solutions on various cases to find the best options

# Schedule

	Week Of														
	Jan 25th	Feb 1st	Feb 8th	Feb 15th	Feb 22nd	Feb 29th	Mar 7th	Mar 14th	Mar 21st	Mar 28th	Apr 4th	Apr 11th	Apr 18th	Apr 25th	May 2nd
Create Project Schedule	Yellow														
NDA Process and gather data form MVEC		Blue	Blue	Blue	Blue										
Obtain WindMil Software			Green	Green	Green	Green	Green	Green	Green	Green					
Learning WindMil and OpenDSS software										Blue	Blue	Blue	Blue	Blue	
Model Systems										Yellow	Yellow	Yellow	Yellow		
Research		Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red

	Week Of																
	Aug 22nd	Aug 29th	Sep 5th	Sep 12th	Sep 19th	Sep 26th	Oct 3rd	Oct 10th	Oct 17th	Oct 24th	Oct 31st	Nov 7th	Nov 14th	Nov 21st	Nov 28th	Dec 5th	Dec 12th
Confirm research and testing	Dark Blue	Dark Blue															
Model and Test method 1			Light Blue	Light Blue	Light Blue	Light Blue	Light Blue										
Model and Test method 2			Green	Green	Green	Green											
Model and Test method 3							Yellow	Yellow	Yellow	Yellow							
Model and Test method 4							Orange	Orange	Orange	Orange							
Finalize Findings											Light Green	Light Green					
Perform Cost Analysis											Blue	Blue	Blue				
Write report													Purple	Purple			
Give presentation															Red		

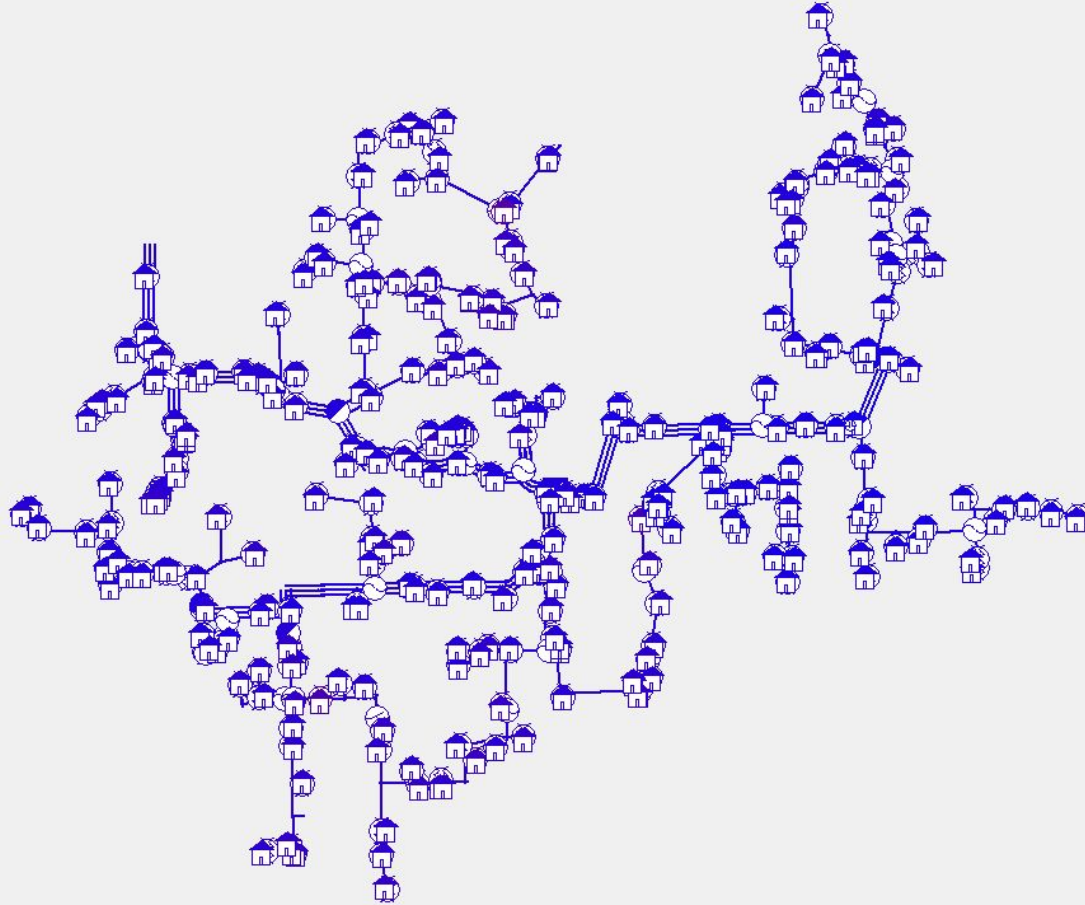
# Software

- Windmil
  - Creates instantaneous snapshot of our system
  - Can easily add and edit components to system and see an immediate effect on the snapshot
  - Graphical user interface adds ease of use when editing solution
  - Exports system and model data to OpenDSS for further analysis
- OpenDSS
  - Creates time lapse data for system
  - Can model DG systems for a range of outputs over course of a day
  - Can model load for range of values as it fluctuates over 24 hours

# System Model

- Feeder for single substation
- Base system has no current DG
- Modeled on worst-case day
  - Highest difference between solar output and load
  - High solar output, low load
- Loads range between 0 and 35 kW

# Basic System With Low Load

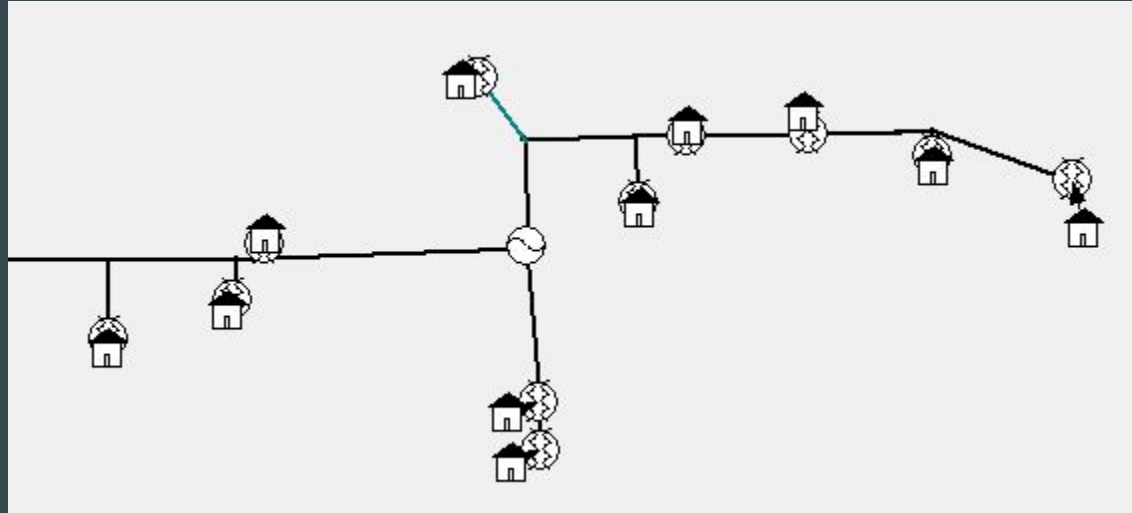




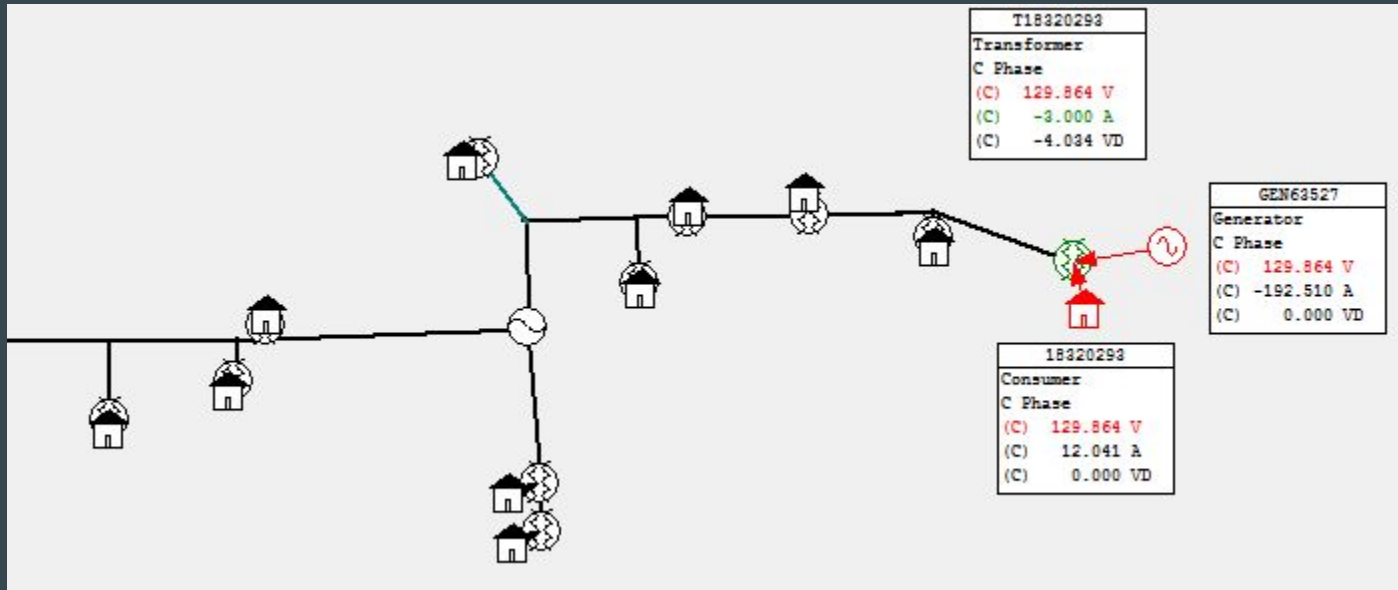
# Problem Conditions

- A branch far from substation
- Initial installation of 15 kW solar generator
  - 15 KW is average installation size
  - Customers oversize solar generator for tax benefit (approx. 50% cost recouped)
- Installation of 4 additional 15 kW Generators
- Extensive voltage rise on immediate branches beyond installation site

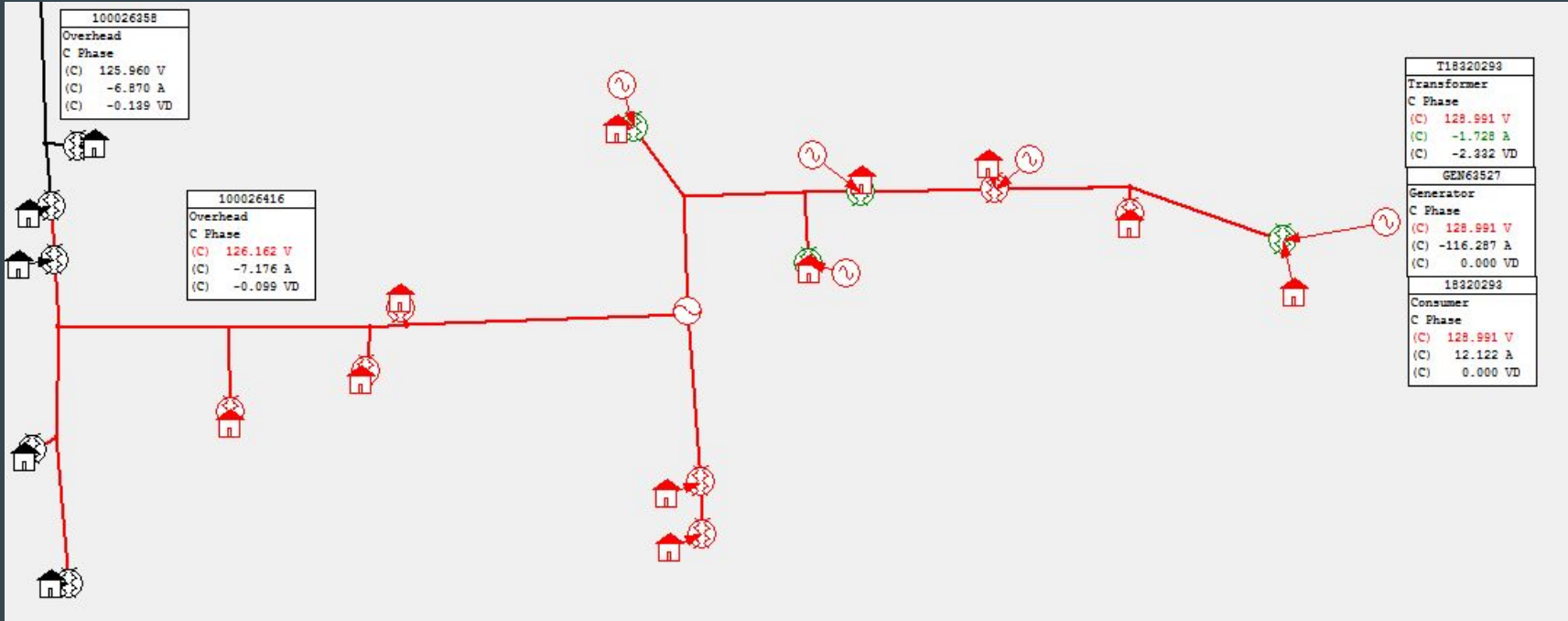
# Existing Branch with No DG



# 1- 15 kw DG



# 5 - 15 kw DG



# Where Are We Now

- Analyzing data
  - Over 100000 individual data points on three systems
  - Distilling data down to a few point indicative of broader system statuses
- Understanding software
  - Two completely new softwares to our team
  - Relatively little documentation / tutorials
  - Very complex and intricate systems to accurately model

# Questions?

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