Real Time DG Control and Reliability Improvements

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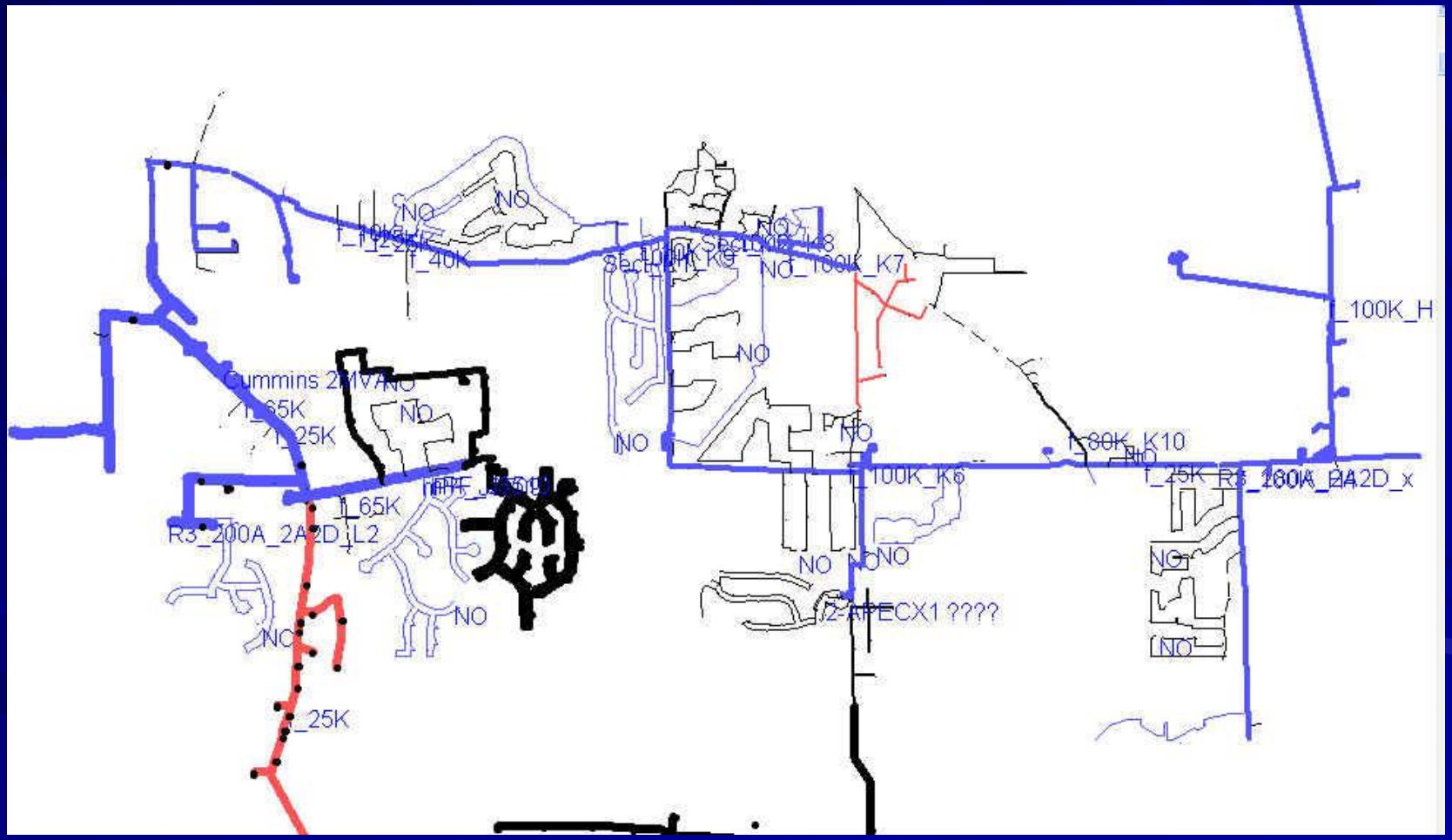
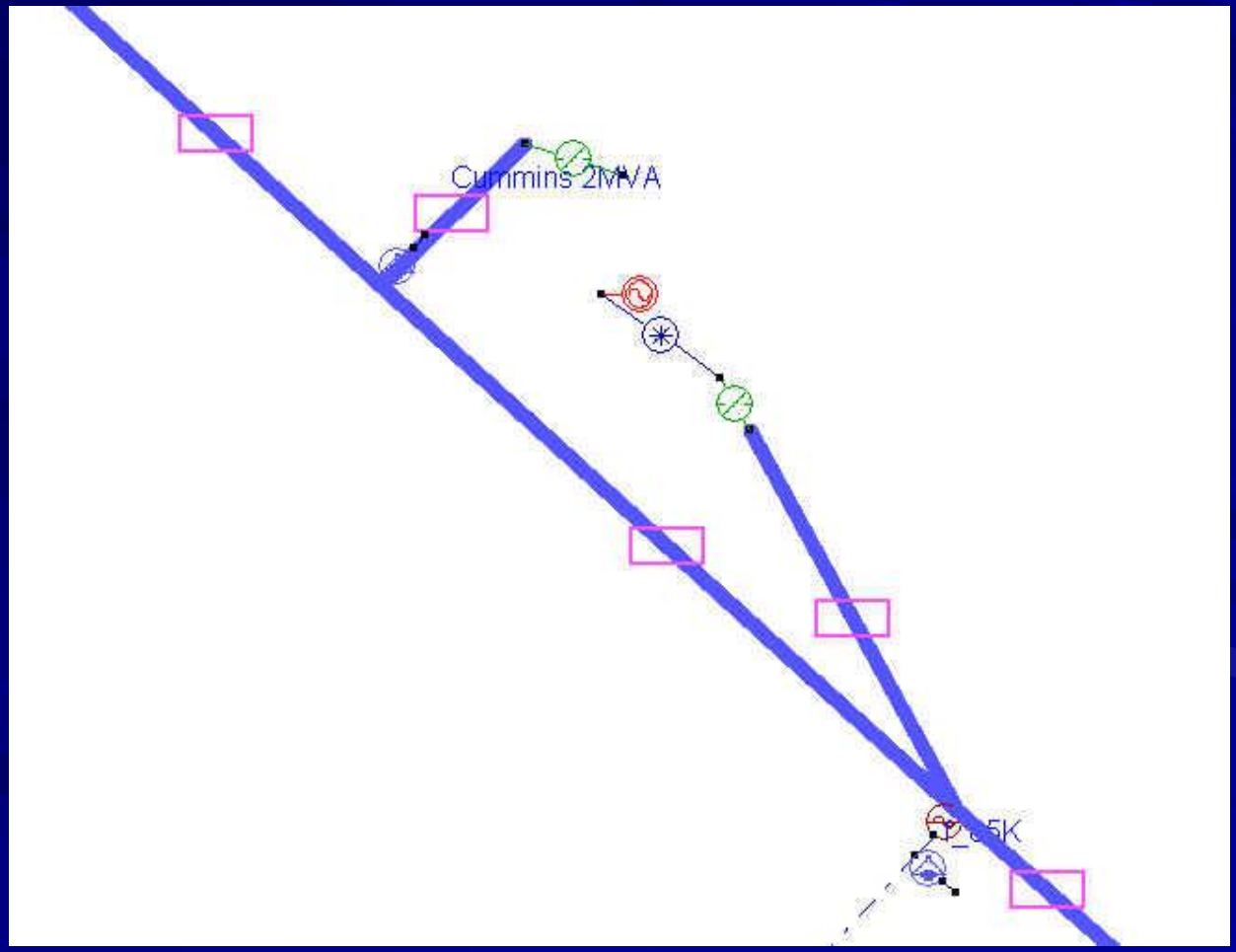
Economics of DG Generation

DGs may sometimes be used to avoid large capital investments, often to solve problems that only exist for a short period

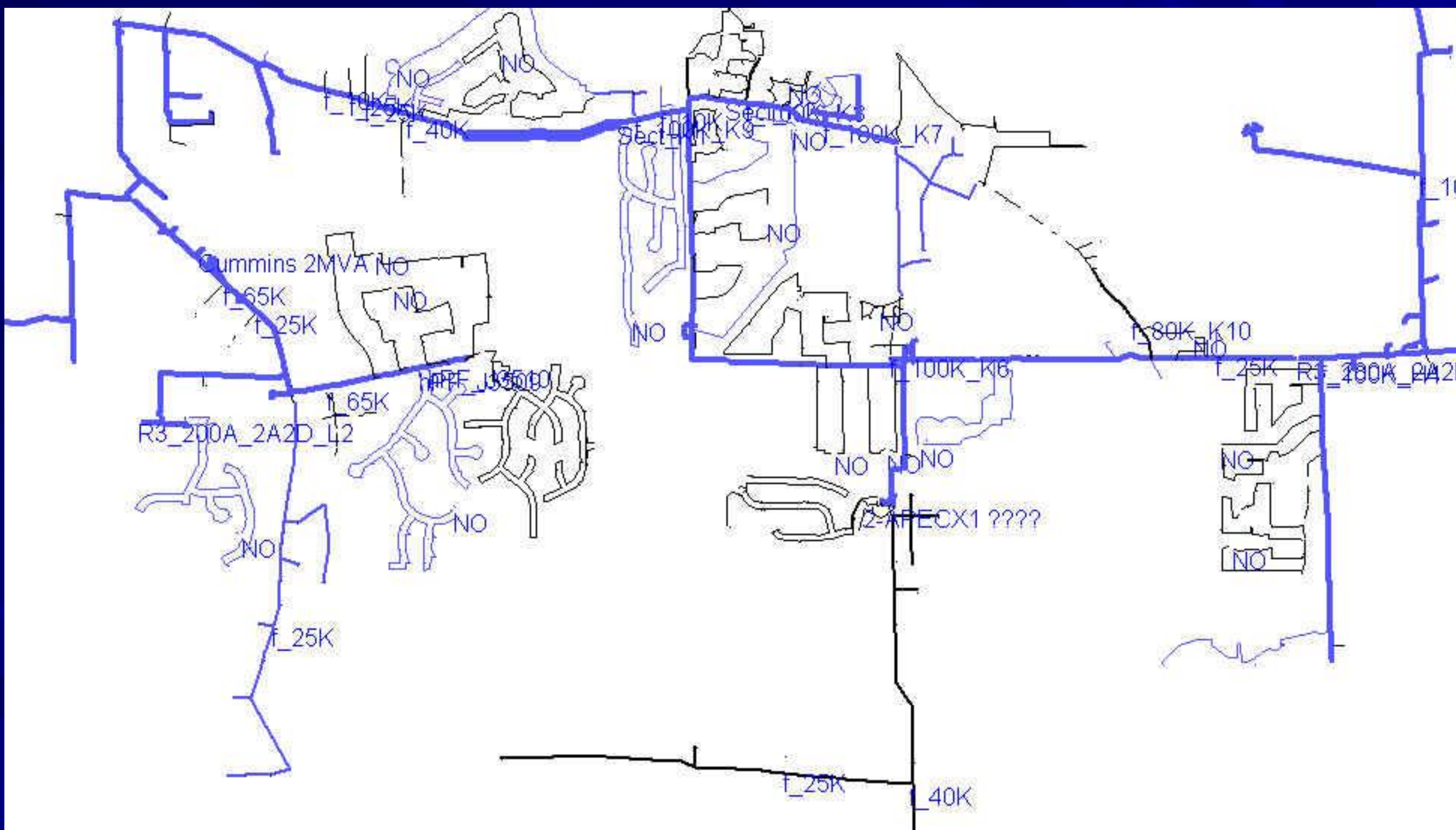
Using DG to Correct Low Voltage



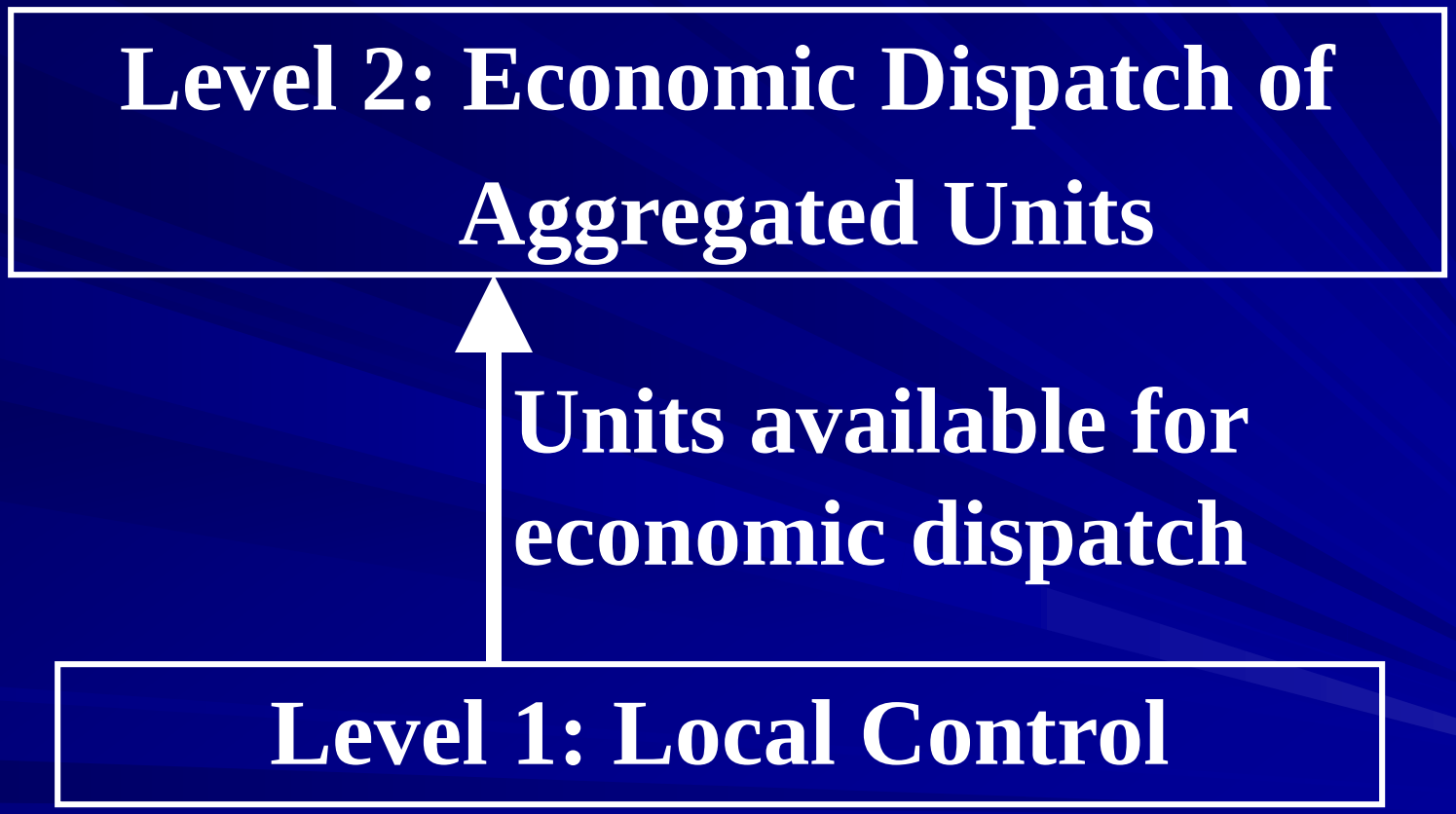
Zoom In to DG Site



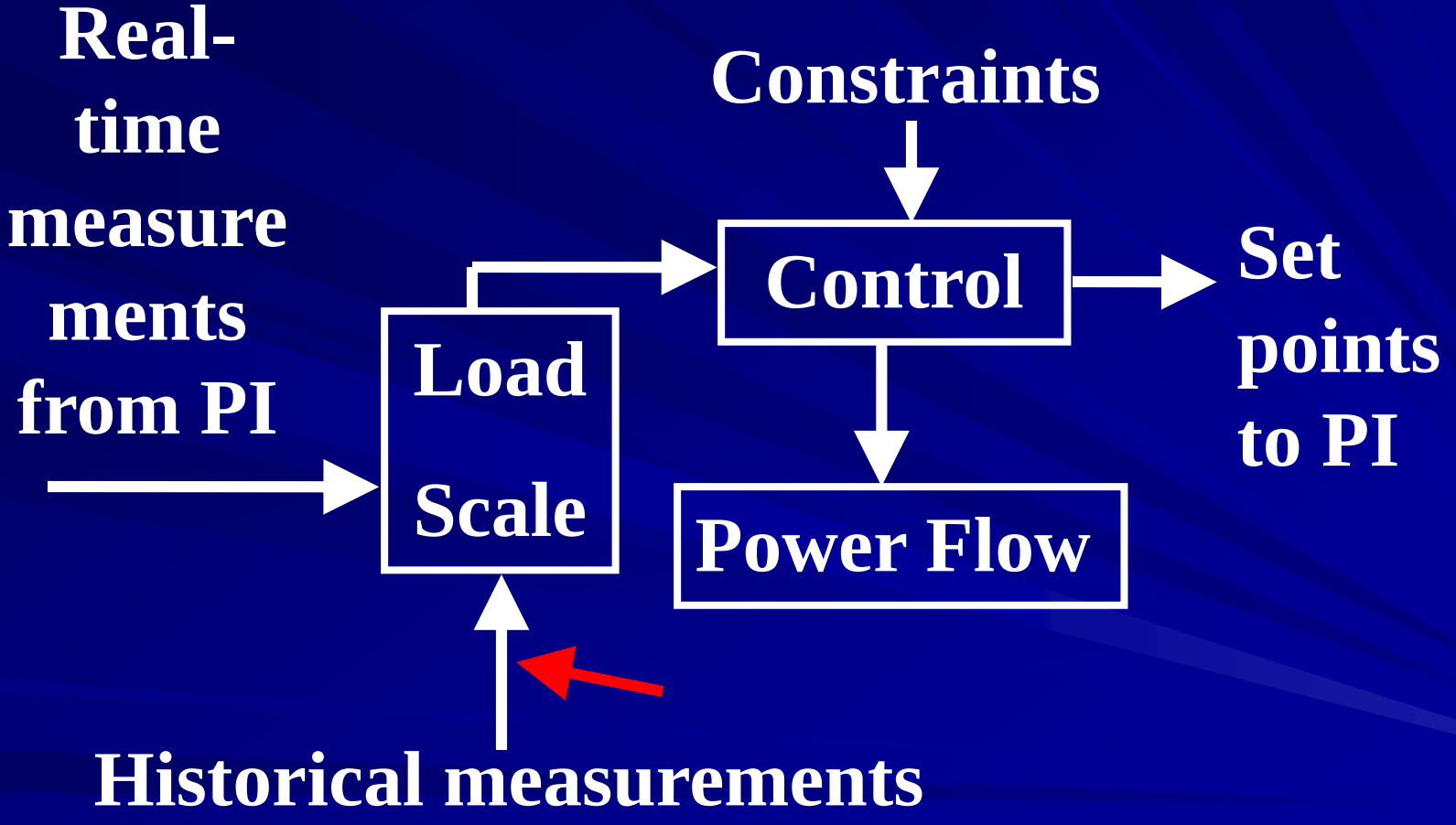
DG Corrects Problem



Hierarchical Control



Control System

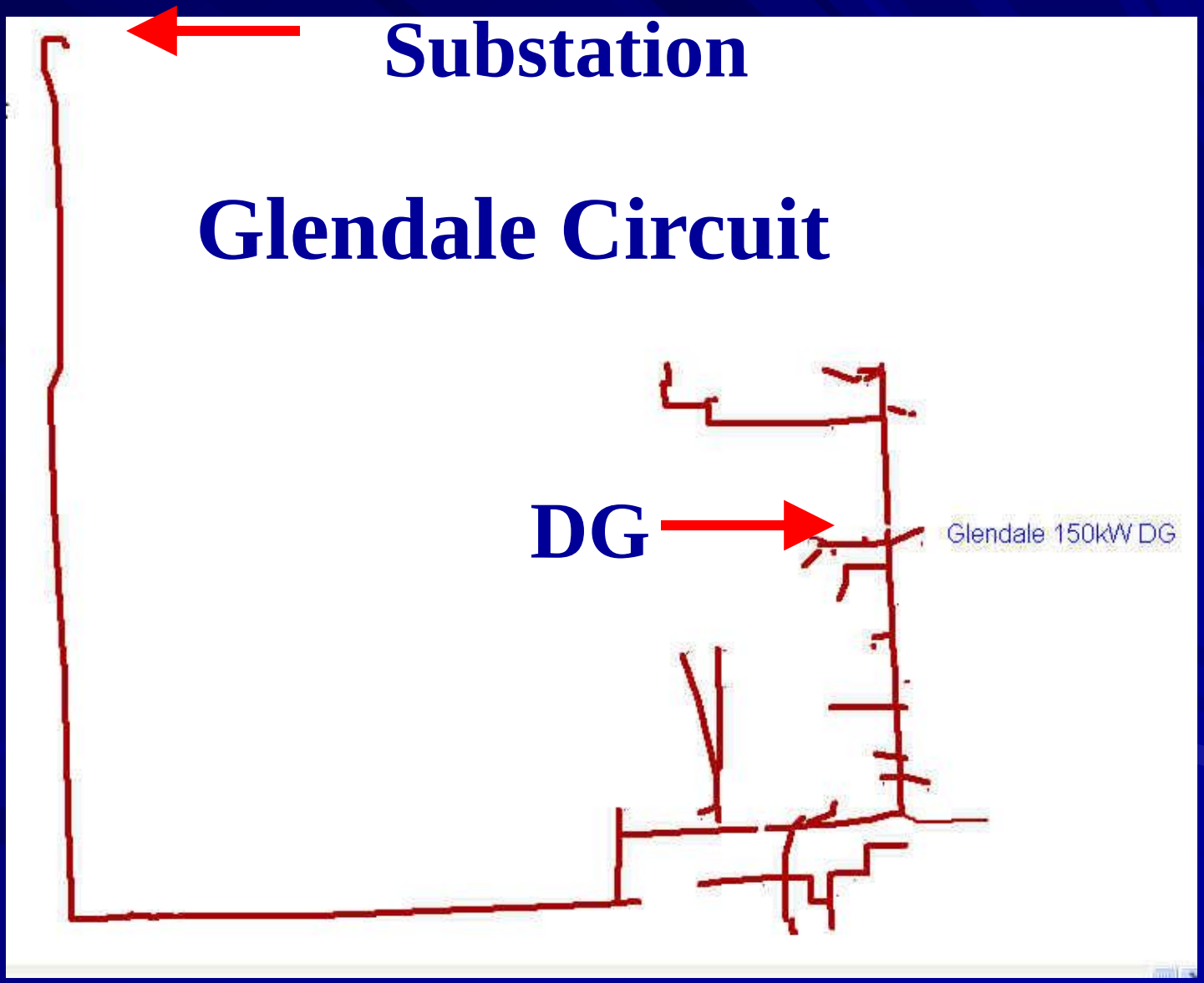


Historical Measurements

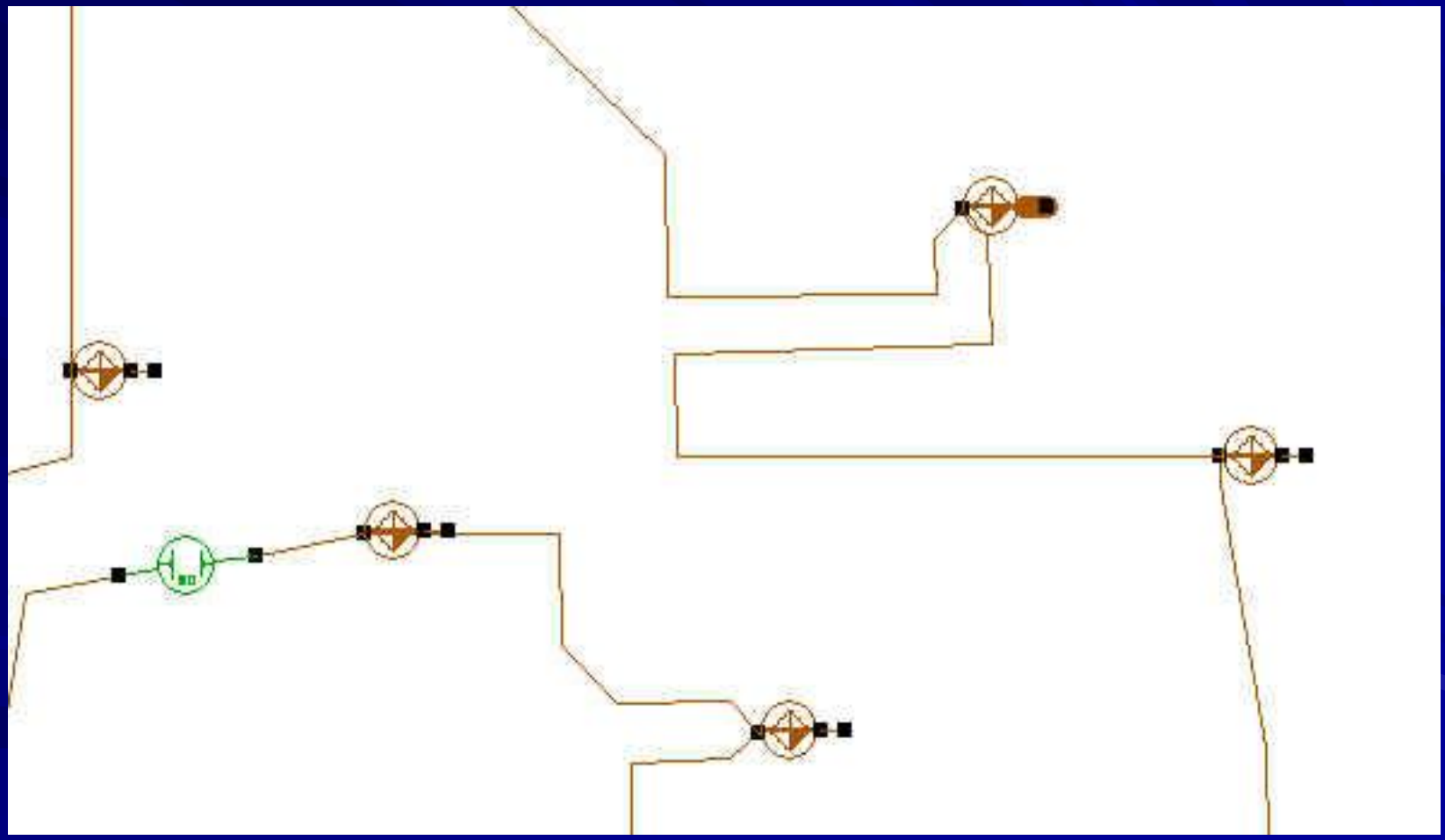
- 8760 hourly kW, kVar measurements for some large customers
- 12 kWHr measurements for other loads
  - Load research statistics are used to estimate kW, kVar loads

Substation

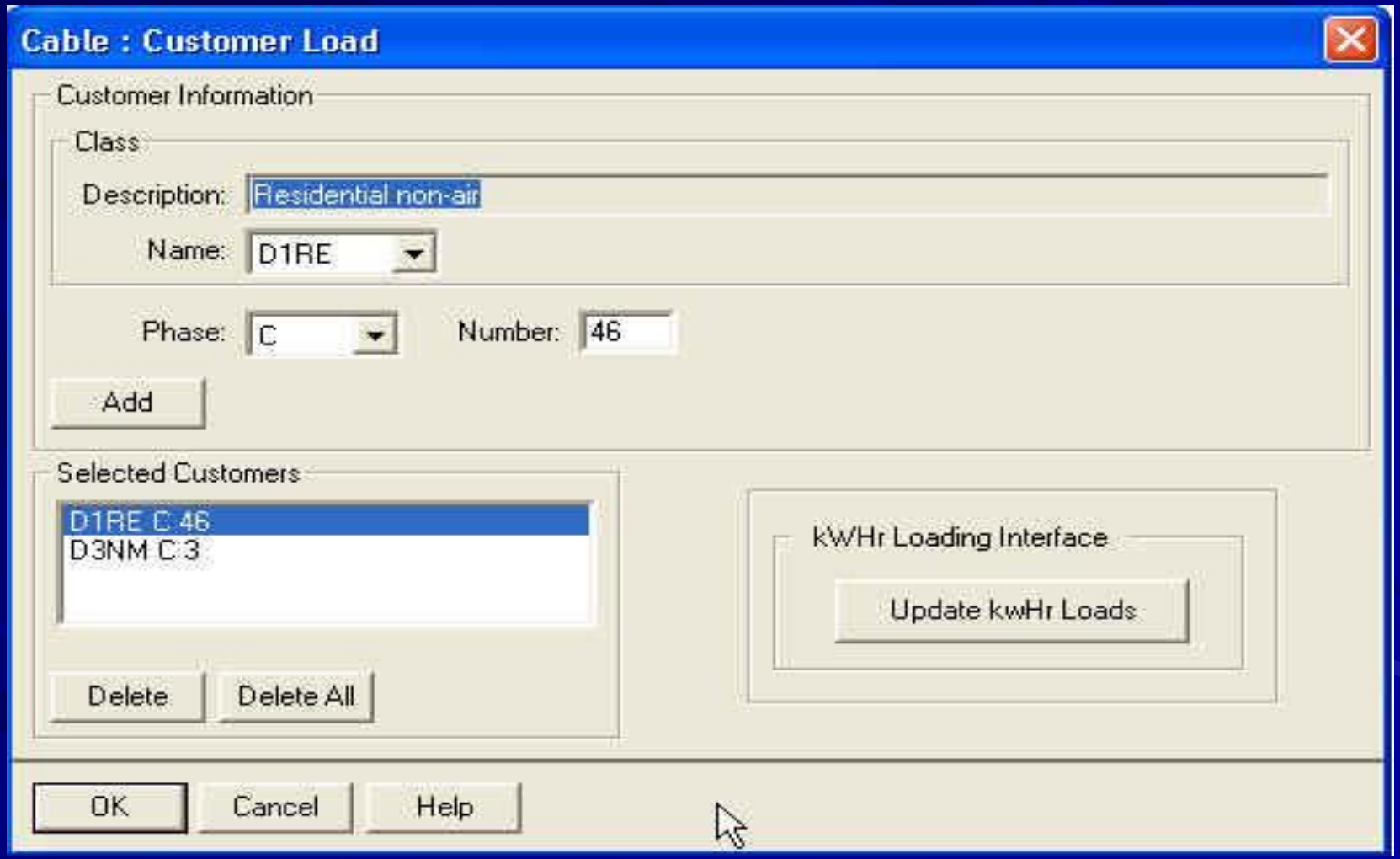
Glendale Circuit



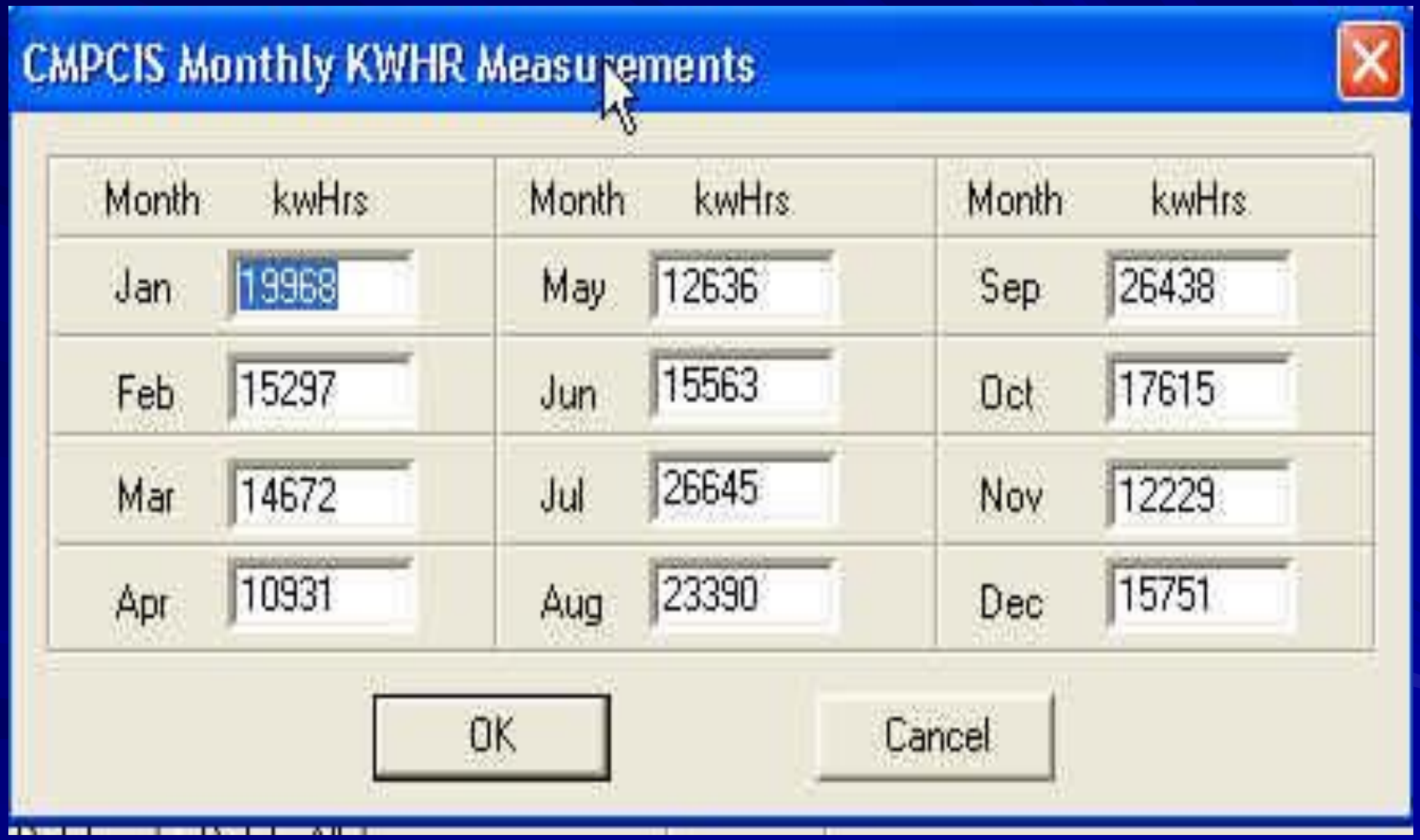
Distribution Transformer Models



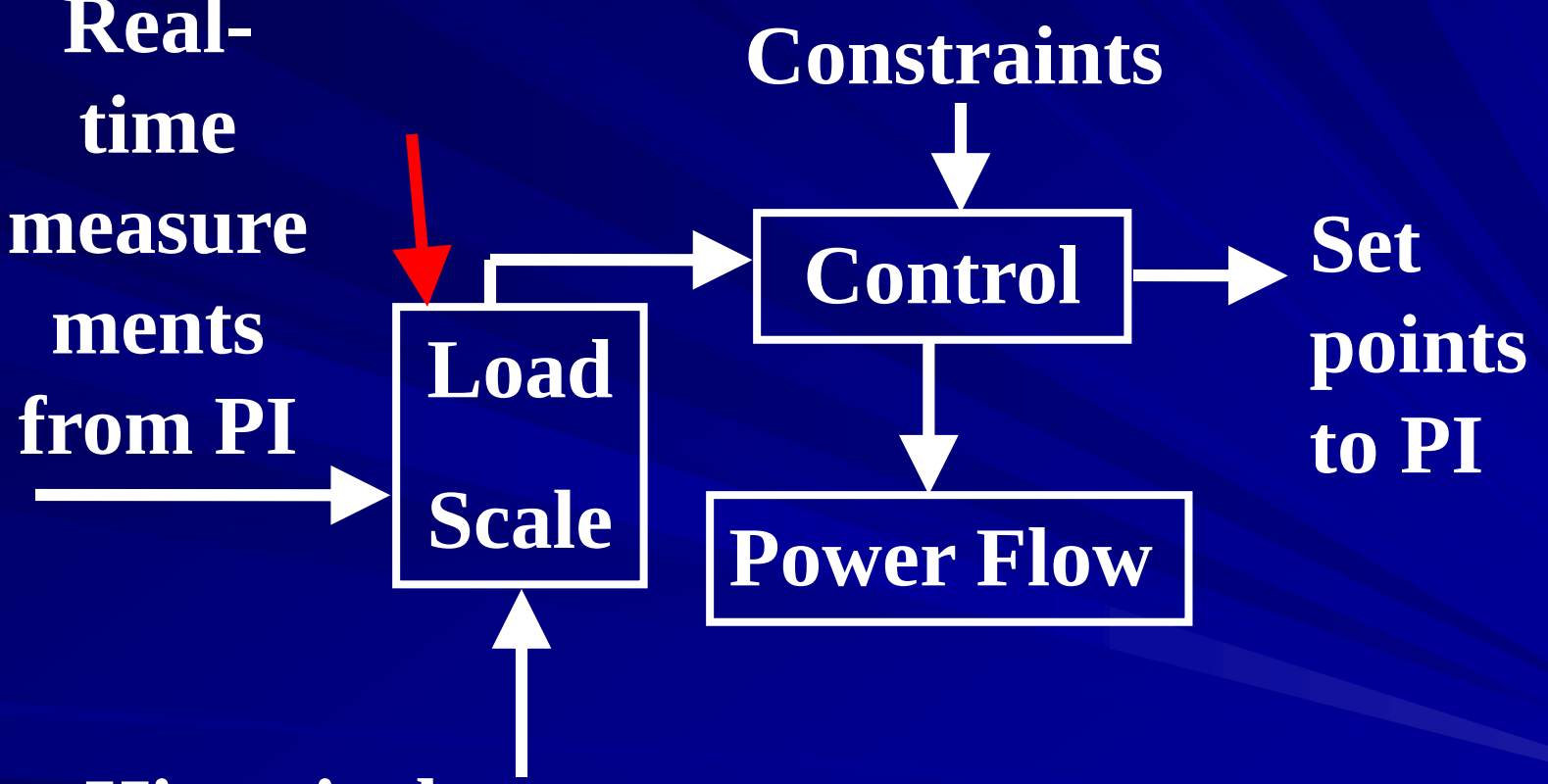
Customer Types



Monthly kWHr Measurements



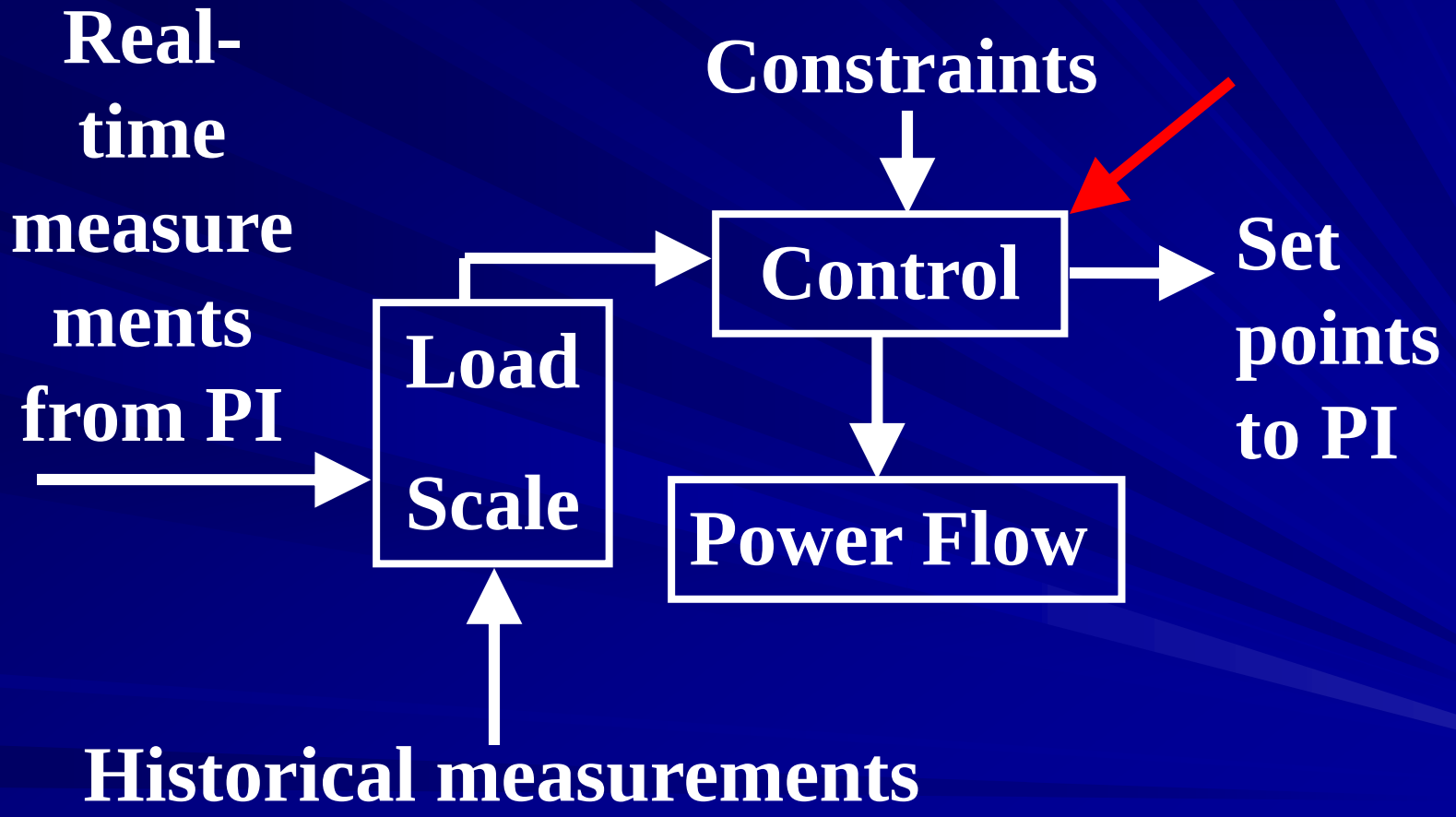
Control System



Scaling of Model Loads

- Some model loads are scaled to cause power flow results to match real-time measurements
- Non-scalable loads
- Load scaling restrictions

Control System



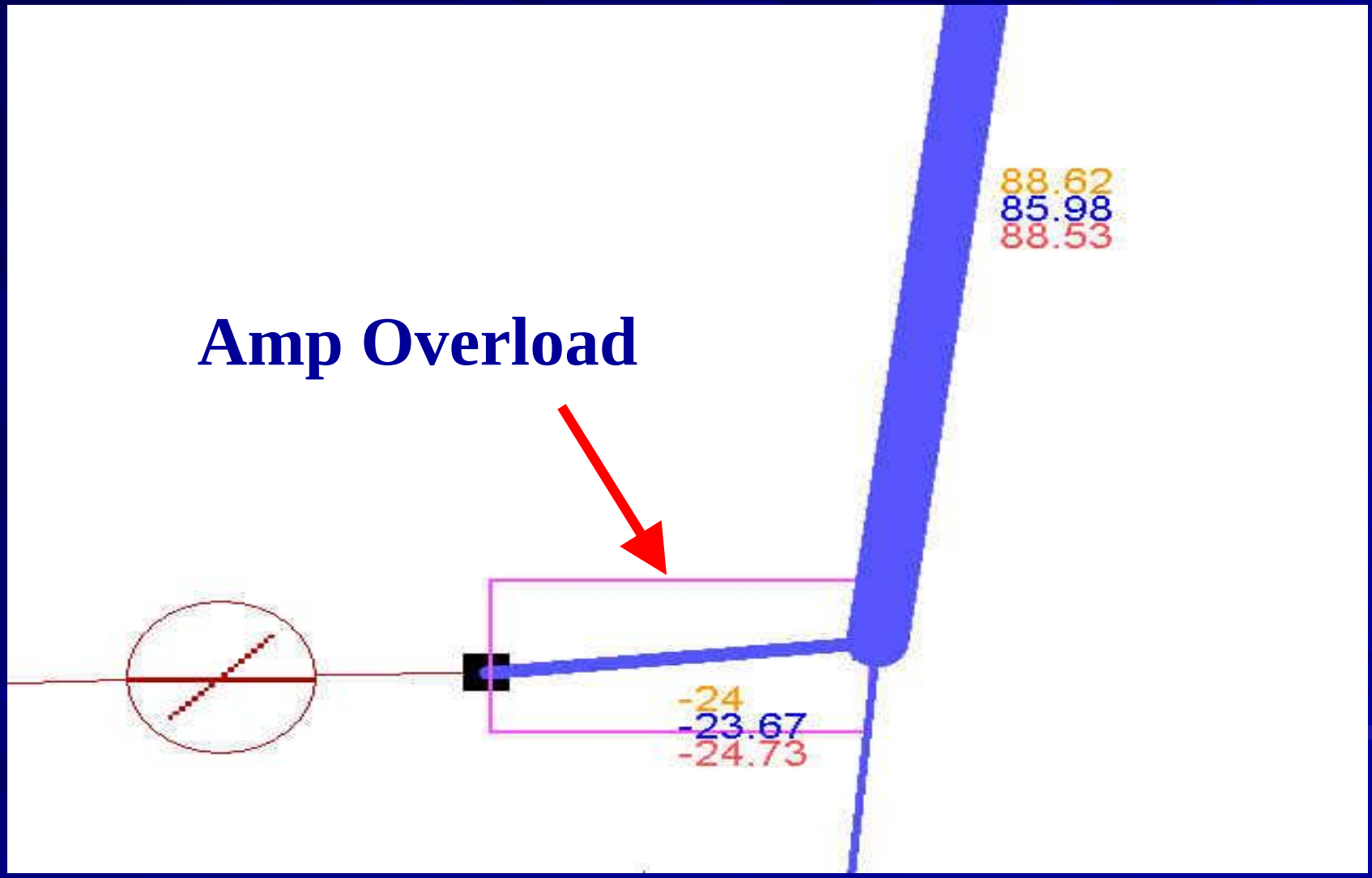
Control of Voltages and Currents

- No direct measurement of problems
- Use model to predict problems
- Use model to calculate generation levels needed to eliminate problems
  - Low voltages
  - Equipment overloads

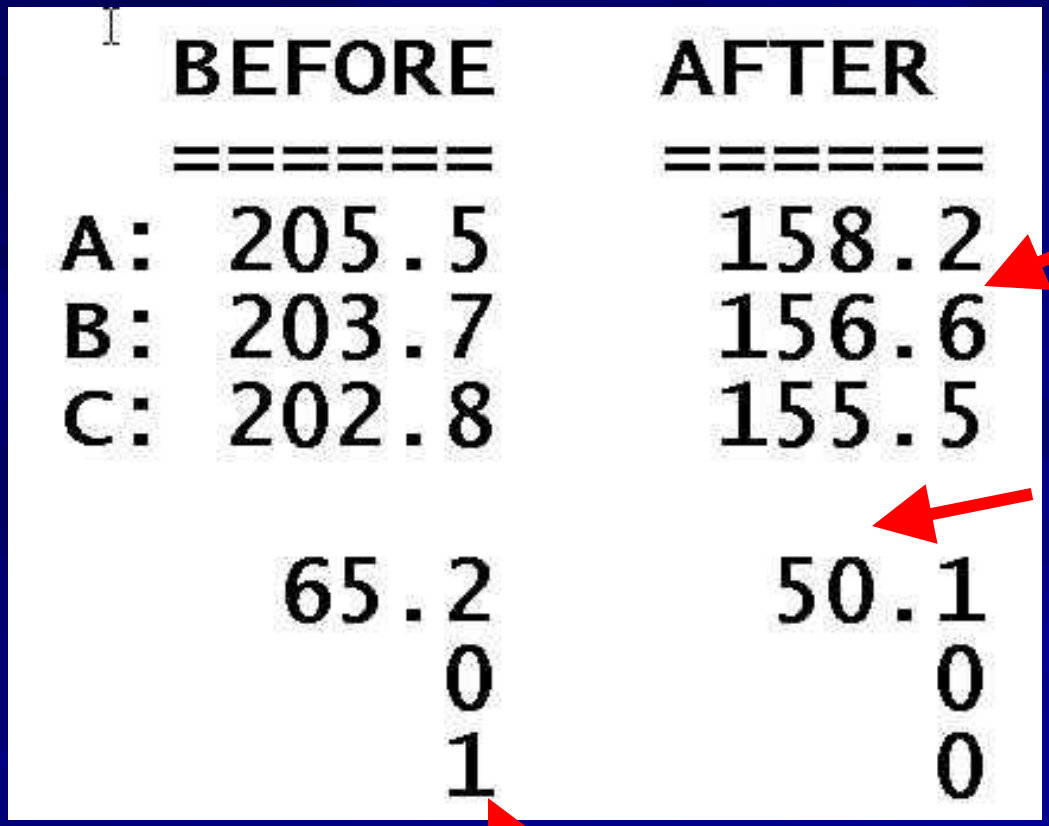
DG Control Features

- Control performed 24 X 7
- Complete control calculation, including power flow, requires 1-2 seconds per circuit
- Calculates “just right” level of generation
- Takes into account constraints

Amp Overload



Output Report



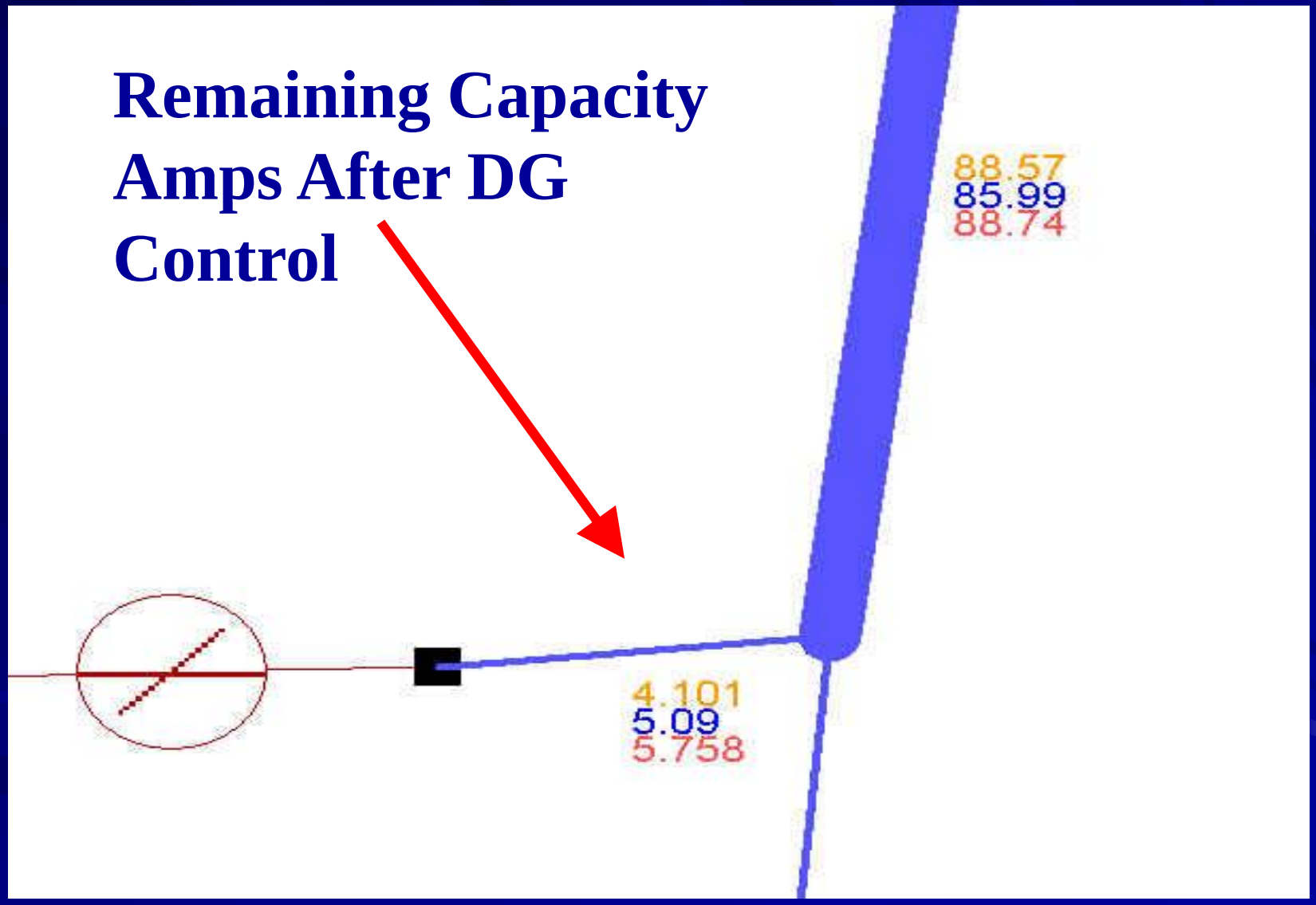
	BEFORE	AFTER
	======	======
A:	205.5	158.2
B:	203.7	156.6
C:	202.8	155.5
	65.2	50.1
	0	0
	1	0

Sub Amps

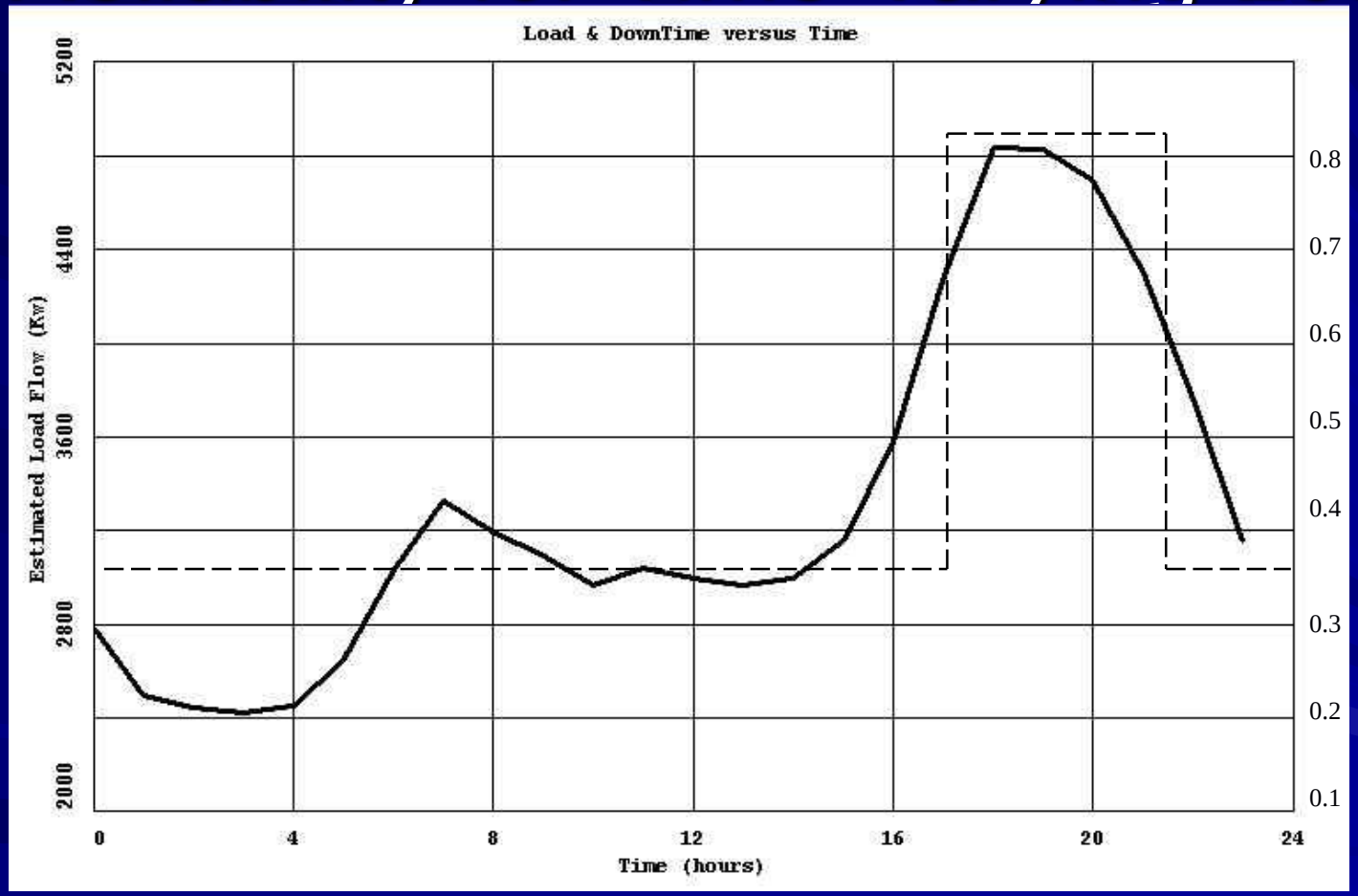
% Sub Loading

Overloaded Components

Remaining Capacity Amps After DG Control

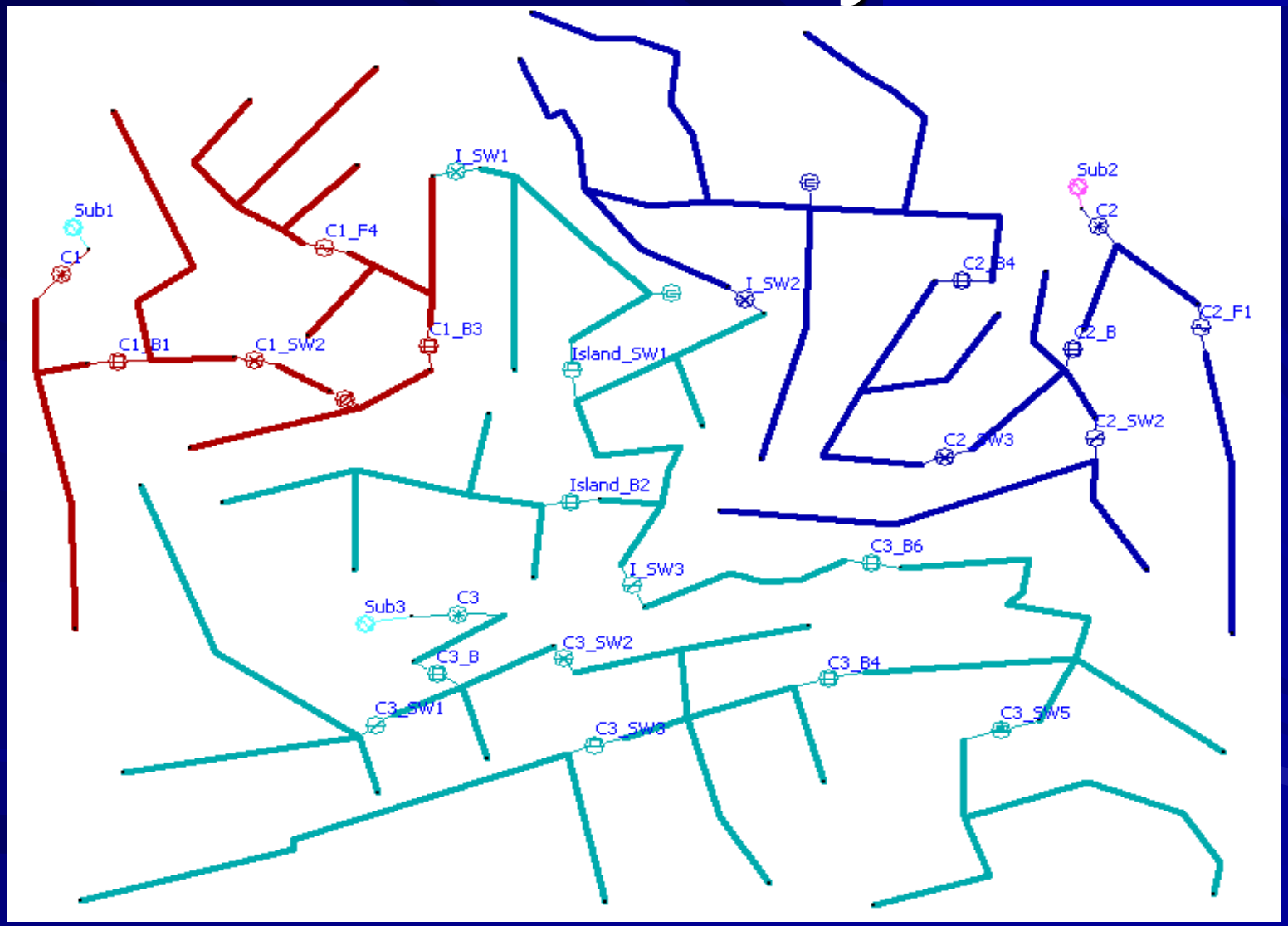


Reliability for Time Varying Load

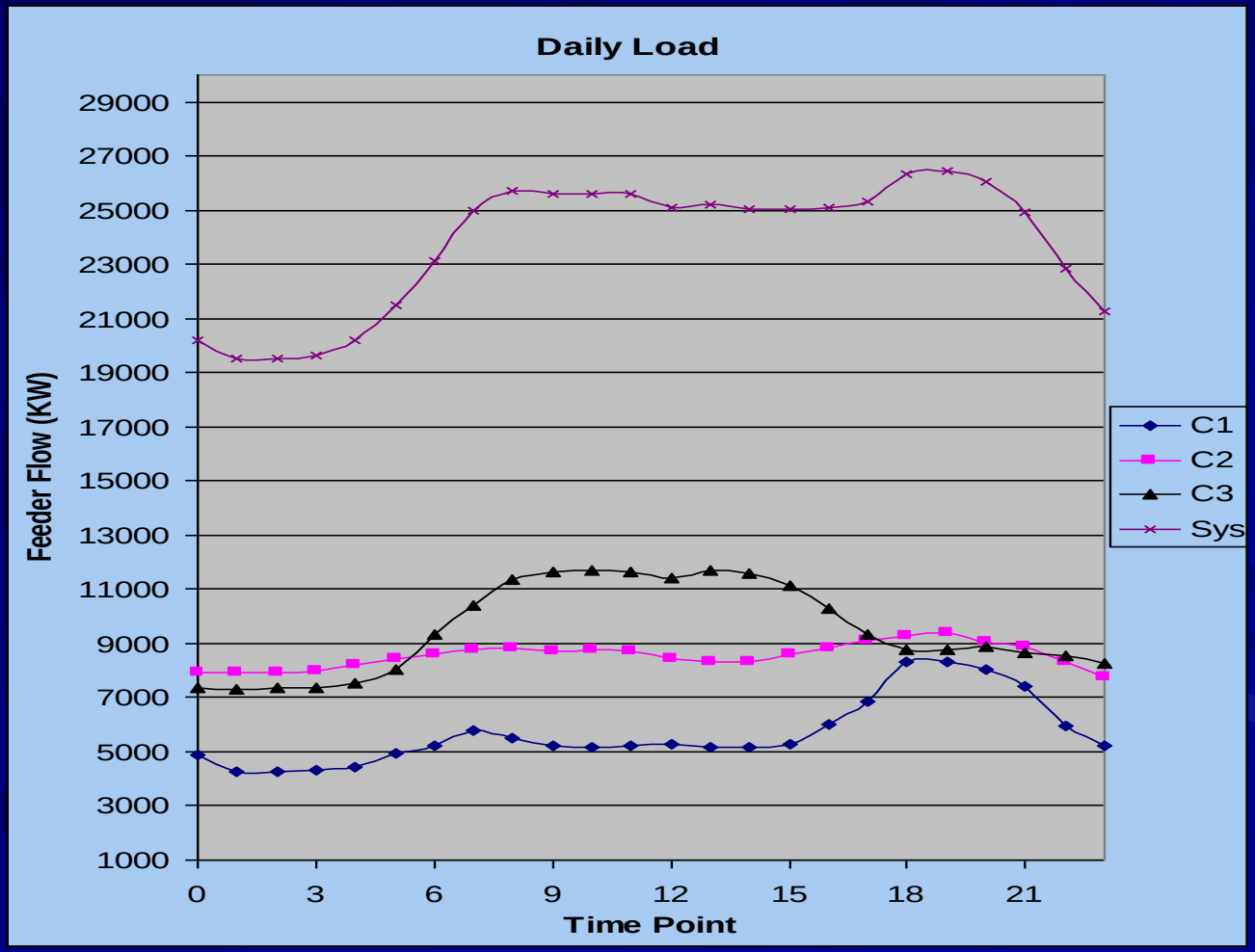


Estimated Load Down Time

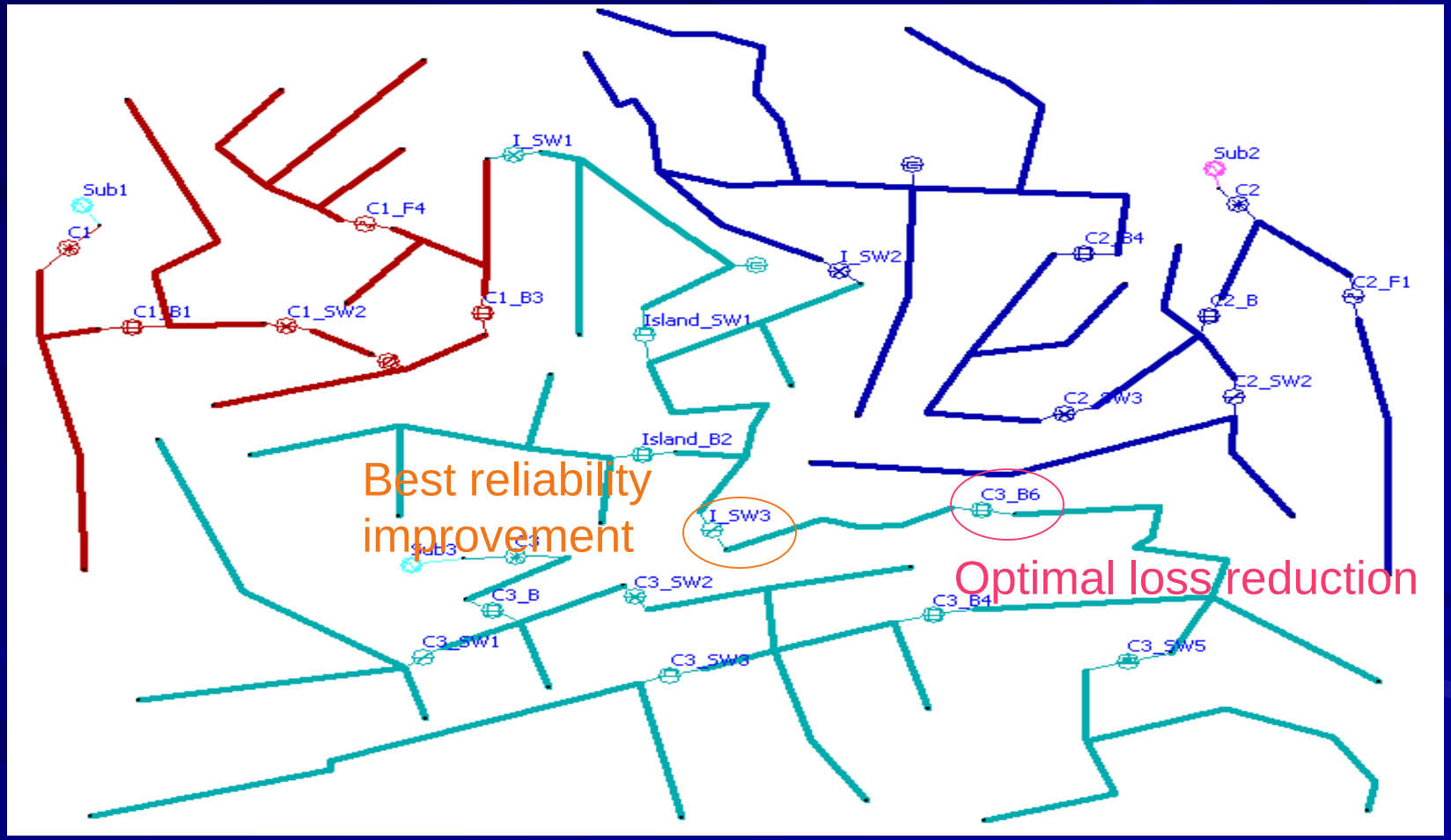
Case Study


Sub1
C1
C1_F4
I_SW1
C1_B1
C1_SW2
C1_B3
Island_SW1
I_SW2
Sub2
C2
C2_B4
C2_F1
C2_B
C2_SW2
C2_SW3
Island_B2
C3_B6
I_SW3
Sub3
C3
C3_SW2
C3_B
C3_B4
C3_SW1
C3_SW5
C3_SW6

Circuit Load and System Load



Optimum Locations



Analysis Results

DG Effects on System Reliability and Loss

Time point	3am			6am			12pm			6pm		
	C1_B3	C1_F4	DIF*	C1_B3	C1_F4	DIF	I_SW3	C3_B6	DIF	Island_SW1	C1_F4	DIF
System Loss (%)	4.15	4.14	0.01	4.21	4.19	0.02	4. 35	3. 90	0.45	5.45	3.81	1.64
$SAIDI_{SYS}$ Improvement (%)	27.74	25.81	1.93	20.25	20.25	0	42.41	35.44	6.97	20.25	18.99	1.26

* DIF stands for the difference of system loss and SAIDI improvement by placing the DG at optimal loss location and optimal reliability location.

Economic Considerations

- Assume 5 ¢ per kwHr
- 9am-5pm
- (1097kw – 975kw) x 8hr x $.05 = $48.8

$48.8 ? 6.97% reliability improvement

DG Placement for Best Reliability

- If DGs are to be shut down when circuits experience outages, then DGs should be placed in circuits that have the lowest failure rates.
- If DGs can be operated as islands, then DGs should be placed in circuits that have the highest failure rates.

Conclusions

- DG placement in a circuit
- DG placement in a system of circuits
- Optimal DG placement