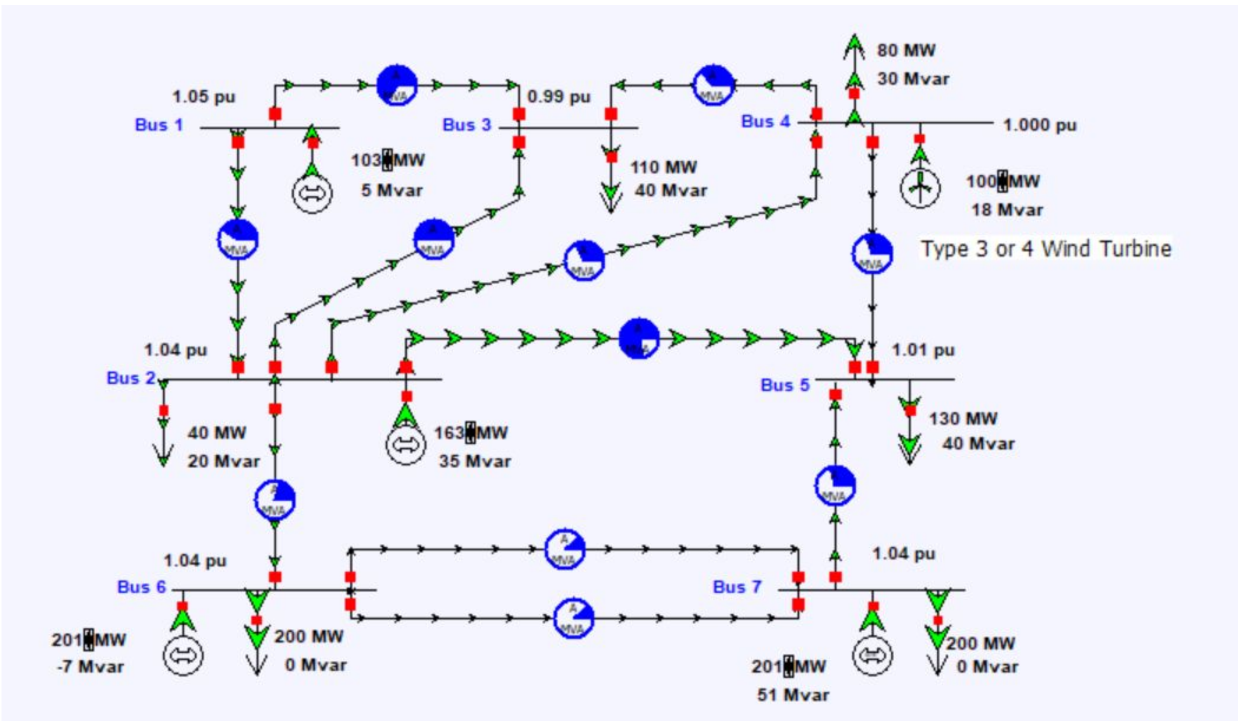
QV Voltage Curve Study Using Example 6.61:

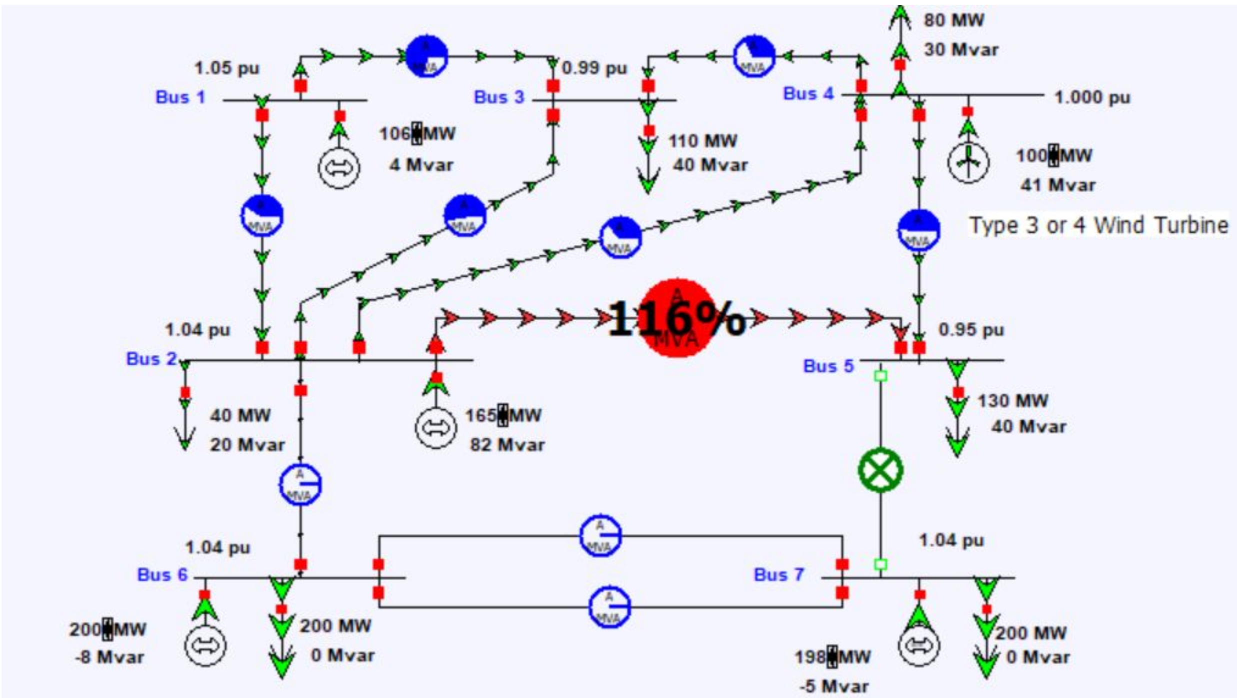
Overload the line between Bus 2 & 5 by closing the line between Bus 5 & 7. Create a contingency for a line overload between Bus 2 & 5, then plot the QV (including Base Case) curve for Bus 5 only using Power World. Discuss your findings and results.

Set-up Prior to the use of QV:



Initial Condition for QV Analysis:

The line between Bus 5 & 7 will be closed which will overload the line between Bus 2 & 5.



Contingency setup to remove overloaded lines:

Contingency for Bus 2 & 5 is on line 5 below.

Contingency Analysis

Contingencies | Options | Results

Records | Set | Columns | Options

	Label	Skip	Category	Processed	Solved	Include Remedial Actions	Screen Allow	Post-CTG AUX	Islanded Load	Islanded Gen	Global Actions	Transient Actions	Remedial Action	Custom Monitor Violation	Violation	Max Branch %	Min V
1	L_00001Bus1-00002Bus2C1	NO		NO	NO	YES	NO	none									
2	L_00001Bus1-00003Bus3C1	NO		NO	NO	YES	NO	none									
3	L_00002Bus2-00003Bus3C1	NO		NO	NO	YES	NO	none									
4	L_00002Bus2-00004Bus4C1	NO		NO	NO	YES	NO	none									
5	L_00002Bus2-00005Bus5C1	NO		NO	NO	YES	NO	none									
6	L_00002Bus2-00006Bus6C1	NO		NO	NO	YES	NO	none									
7	L_00003Bus3-00004Bus4C1	NO		NO	NO	YES	NO	none									
8	L_00004Bus4-00005Bus5C1	NO		NO	NO	YES	NO	none									
9	L_00007Bus7-00005Bus5C1	NO		NO	NO	YES	NO	none									
10	L_00006Bus6-00007Bus7C1	NO		NO	NO	YES	NO	none									
11	L_00006Bus6-00007Bus7C2	NO		NO	NO	YES	NO	none									

Setting up QV Curve Plots:

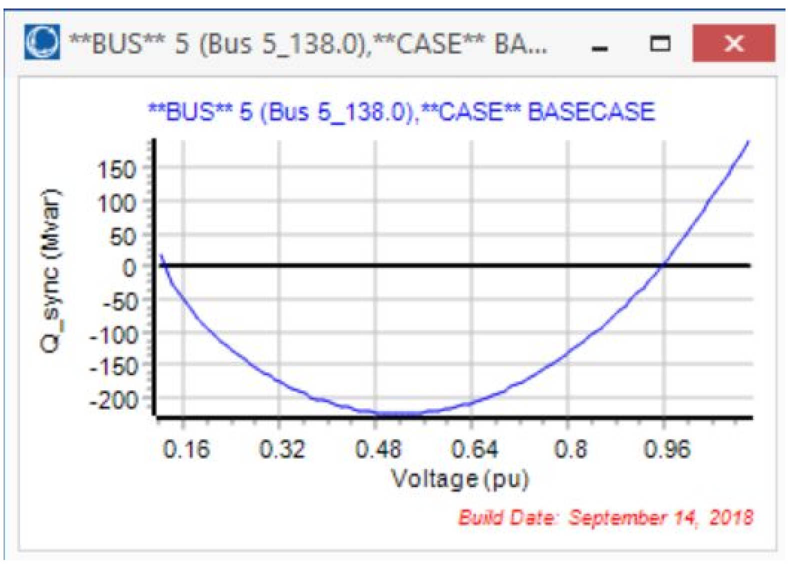
From the Add-on Ribbon, click on the QV curve for Bus 5 and turn on the plotting feature.

Buses

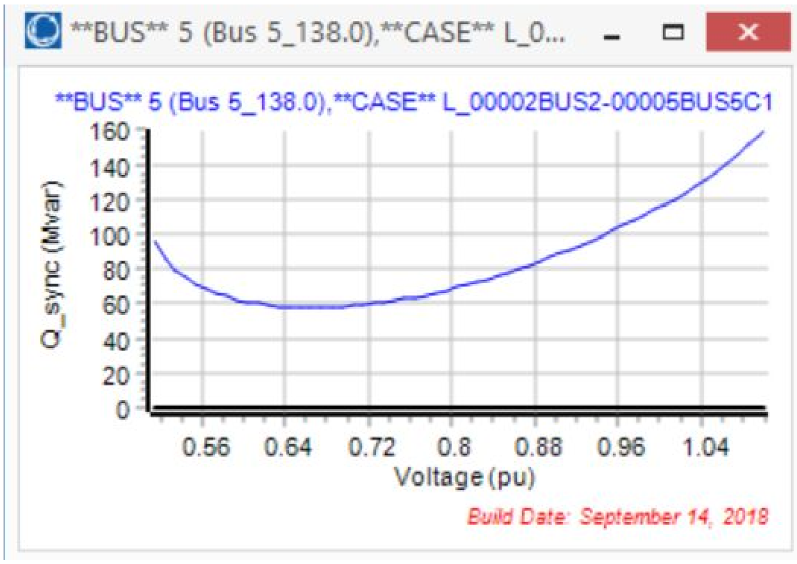
	Number	Name	Nom kV	QV Selected	Min Volt	Max Volt	Step Size
1	1	Bus 1	138.00	NO			
2	2	Bus 2	138.00	NO			
3	3	Bus 3	138.00	NO			
4	4	Bus 4	138.00	NO			
5	5	Bus 5	138.00	YES			
6	6	Bus 6	138.00	NO			
7	7	Bus 7	138.00	NO			

QV Curves Results:

Base Case

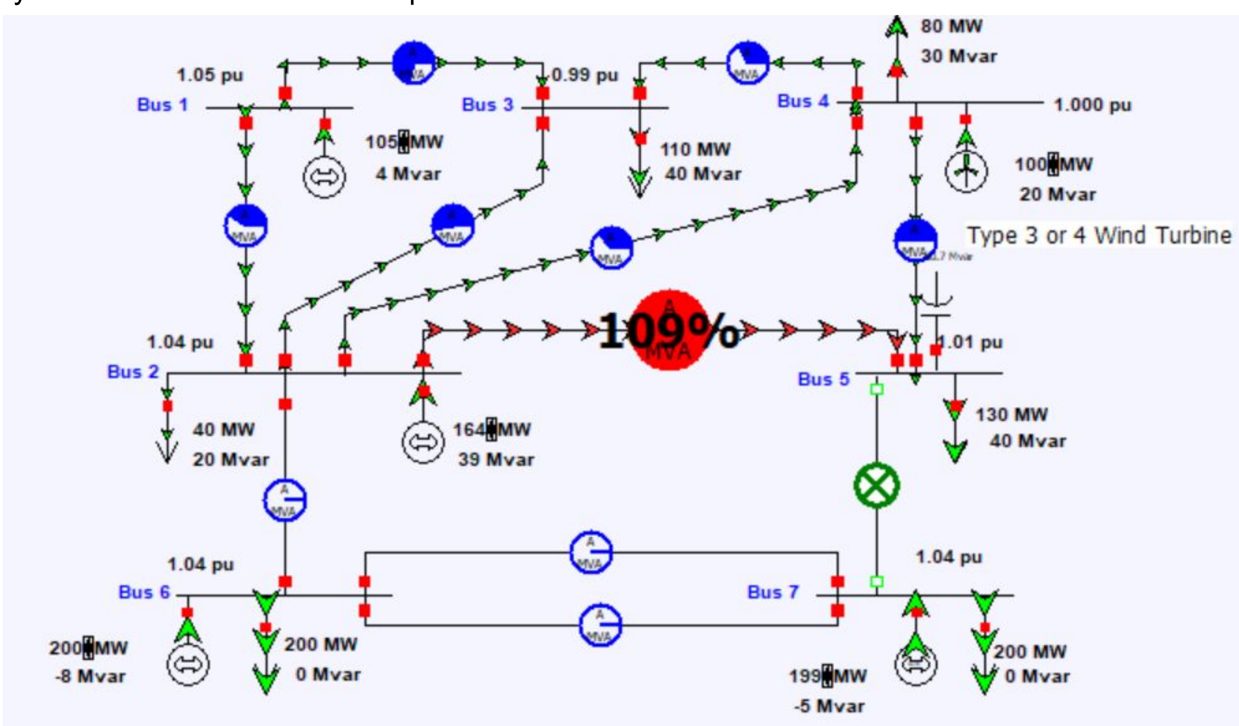


The Base Case plot shows .96 p.u. to be the Base Case operating point prior to contingency analysis. This curve also shows the maximum MVAR load increase Bus 5 can handle before voltage collapse: approximately, 225 (MVARS). The voltage collapse occurs when the stability limit is reached which indicates dQ/dV = 0. For this case, the stability limit is approximate .52 p.u. For Bus 5 to remain stable, the operating point must be .52 p.u. Or greater.

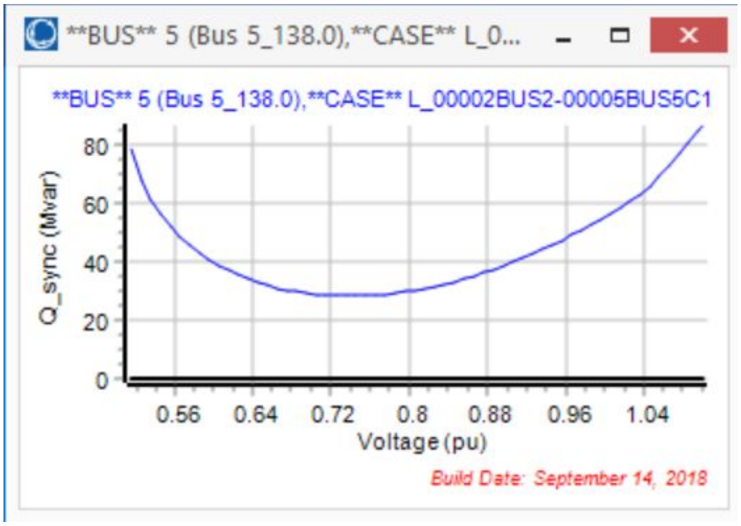


Under contingency, there is no solution. The system went into voltage collapse and there is no base case operation point since the graph never crosses the x-axis. For stability, the system needs an injection of 56-58 MVARs (additional generation). This occurs at approx. .68 volts p.u. In order to increase voltage stability and move beyond the critical point, we should inject more than 56-58 MVARs into the system.

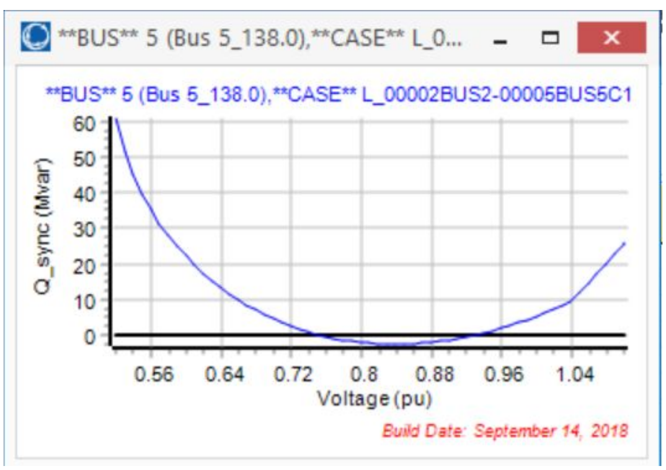
At bus 5, we can add a switch shunt capacitance of about 60 to stabilize the system. Here is the system with the switch shunt capacitance:



Graph of QV after adding the switch shunt:



The injection of the 60 MVARs (switched shunt) is a function of the voltage, and because the voltage is so small, the system doesn't reach a stable operating point. I am going to increase the nominal voltage of the switch shunt to 110 MVARs to obtain a voltage operating point of approximately 1.0 p.u. Here is the QV curve with 110 MVARs of switch shunt:



Clearly, we need more MVARs for the system to become stable from a voltage stand point. Let's increase the switch shunt to 130 MVARs.

After increasing the switch shunt to 130 MVARs, the system finally stabilizes. Now if the load increases by 15 MVARs, we will reach the collapse point at Bus 5 under contingency. Even with an injection of 130 MVARs Bus 5 is susceptible to collapse because an increase in load of 15 MVARs can land Bus 5 at its critical point.