Full 3-phase diagrams can be very cumbersome. In a balanced system you only need to consider one phase.

### Per-phase Analysis

Balanced 3-phase systems can be represented by just one phase. We've already used this.

\[
P_{1\phi} = \frac{P_{3\phi}}{3} \quad Q_{1\phi} = \frac{Q_{3\phi}}{3}
\]

\[
S_{1\phi} = \frac{S_{3\phi}}{3}
\]

\[
S_{1\phi} = |S_{1\phi}| = \frac{S_{3\phi}}{3}
\]

Anything not Y-connected can be converted to a Y-equivalent.

\[
Z_Y = \frac{Z_A}{3}
\]

### One-Line Diagrams

In a balanced system neutral current is zero, so in one-line diagrams, even the neutral connections are omitted.

#### Some Important symbols

- **generator or motor**
- **transmission line**
- **transformer**
- **bus**
  - or **bus**
- **Load**
  - or **Load**
- **Circuit breakers**
  - **powered**
  - **general**
- **Switches**
  - **manual**
  - **powered**

#### Connection symbols:

- **delta**
- **wye**
- **wye with ground**

Can also include resistors, inductors, capacitors and impedances. Unfortunately these symbols are not as well standardized as you would think.

#### Example

3 generators

Load A Station A

Transmit line

Example

3 generators

Load A Station A

Generator G1

Generator G2

Generator G3

Load A Station A

Generator G4

Motor M

Load B

Station B
Impedance Diagrams

Same system

Component values are per-unit (pu).

If you didn't use pu values then you would have to transform impedances across the transformers.

A T model of the transmission line may be easier to work with

Reactance Diagrams

Same system

Ignore the line capacitances, and all resistors but those in the loads

Component values are per-unit (pu).

One-Line Impedance Diagrams

Component values are per-unit (pu).