



SUBSTATION TOPOLOGY PLANNING FOR RELIABILITY

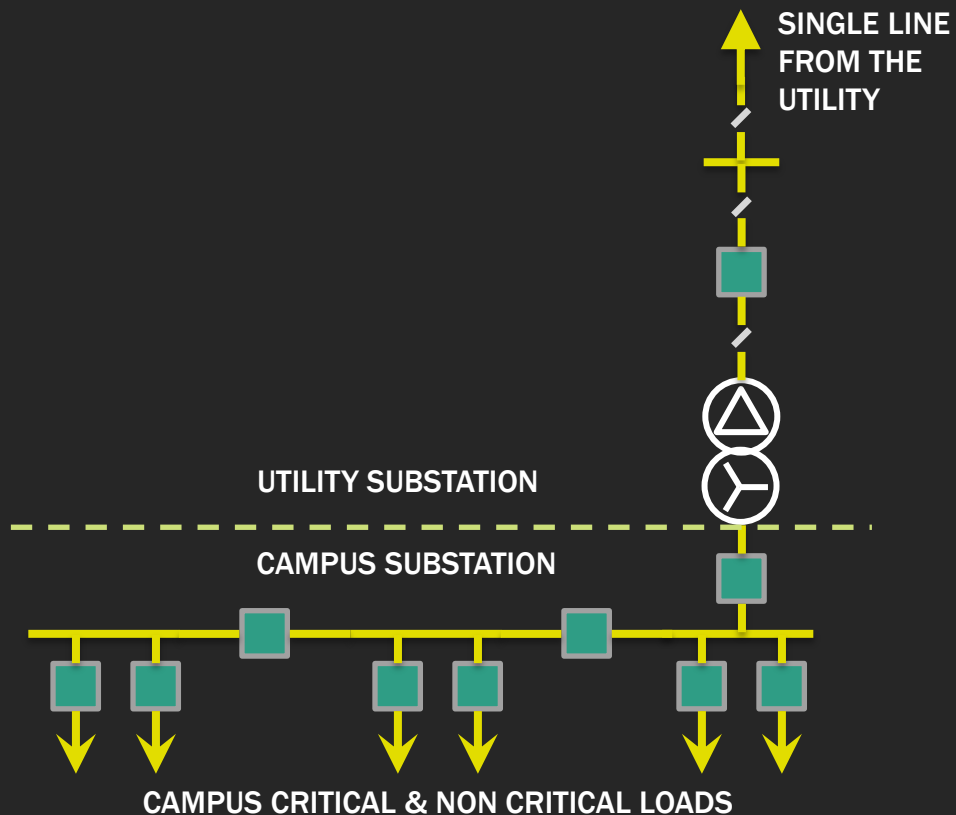
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Typically, you can only
improve what you control.

How can we optimize
reliability and resiliency when
we are served by outside
utilities? What are the costs
and benefits?

TYPICAL ELECTRICAL SYSTEM

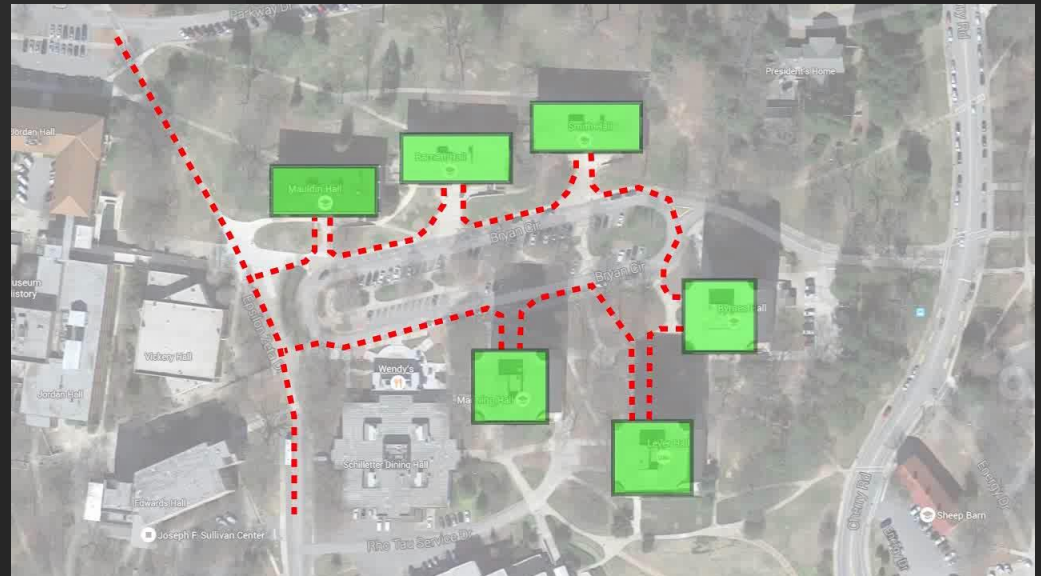
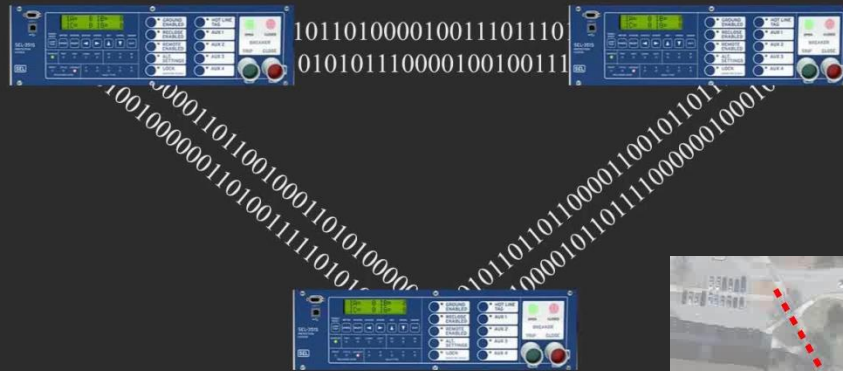


Goal: Resiliency through redundancy

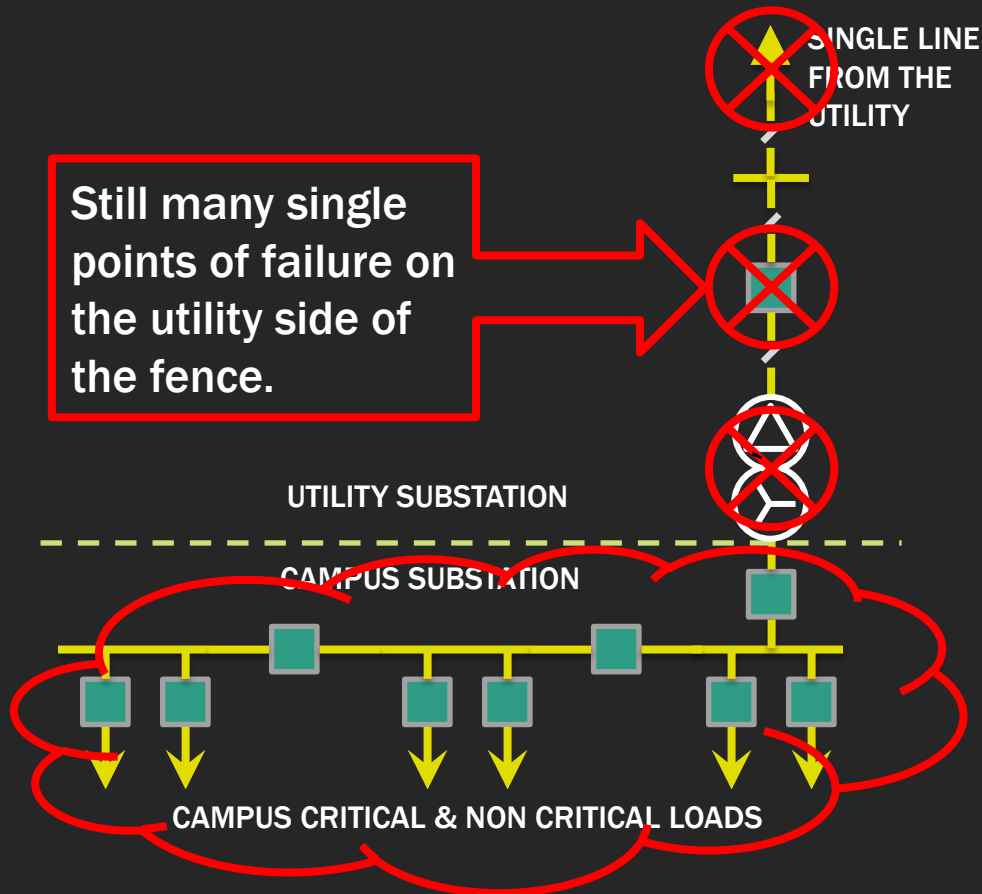
Typical Solutions

- Loop-fed buildings
- Self healing
- Segmentable systems

TYPICAL ELECTRICAL SYSTEM



TYPICAL ELECTRICAL SYSTEM

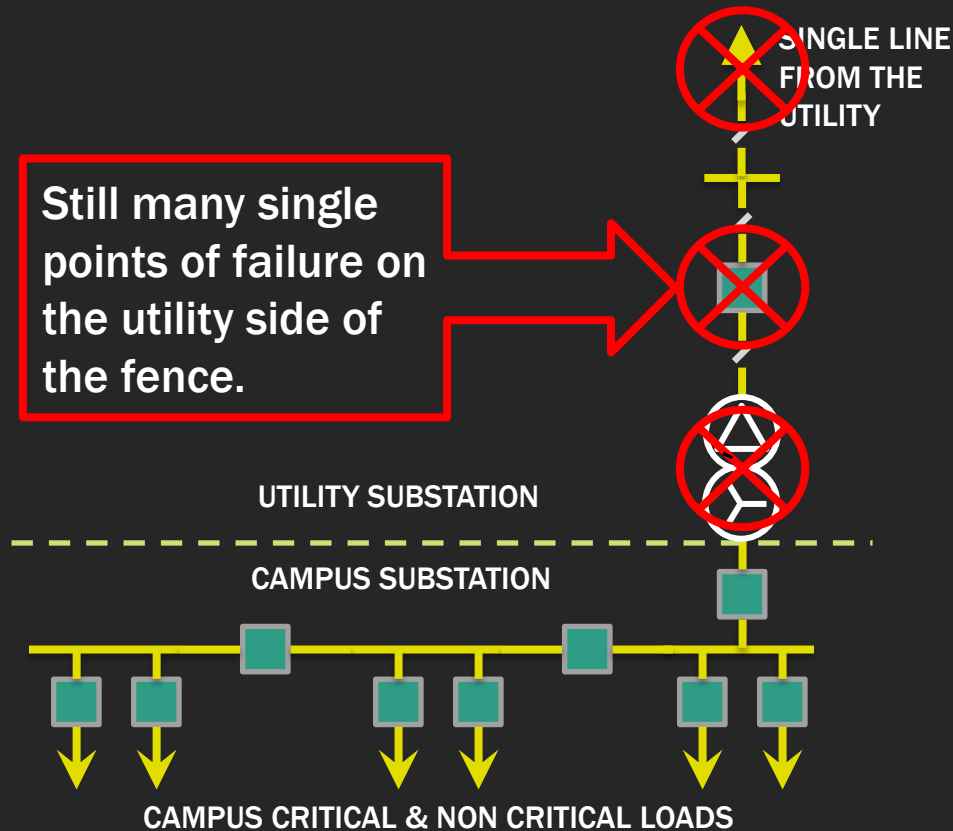


Electrical System Bingo

- Loops
- Segmentation
- Self Healing Loops
- Smart Grid
- Microgrid

We have heard them all.
Do they really get the
resiliency that is desired?
All “below the line” ...

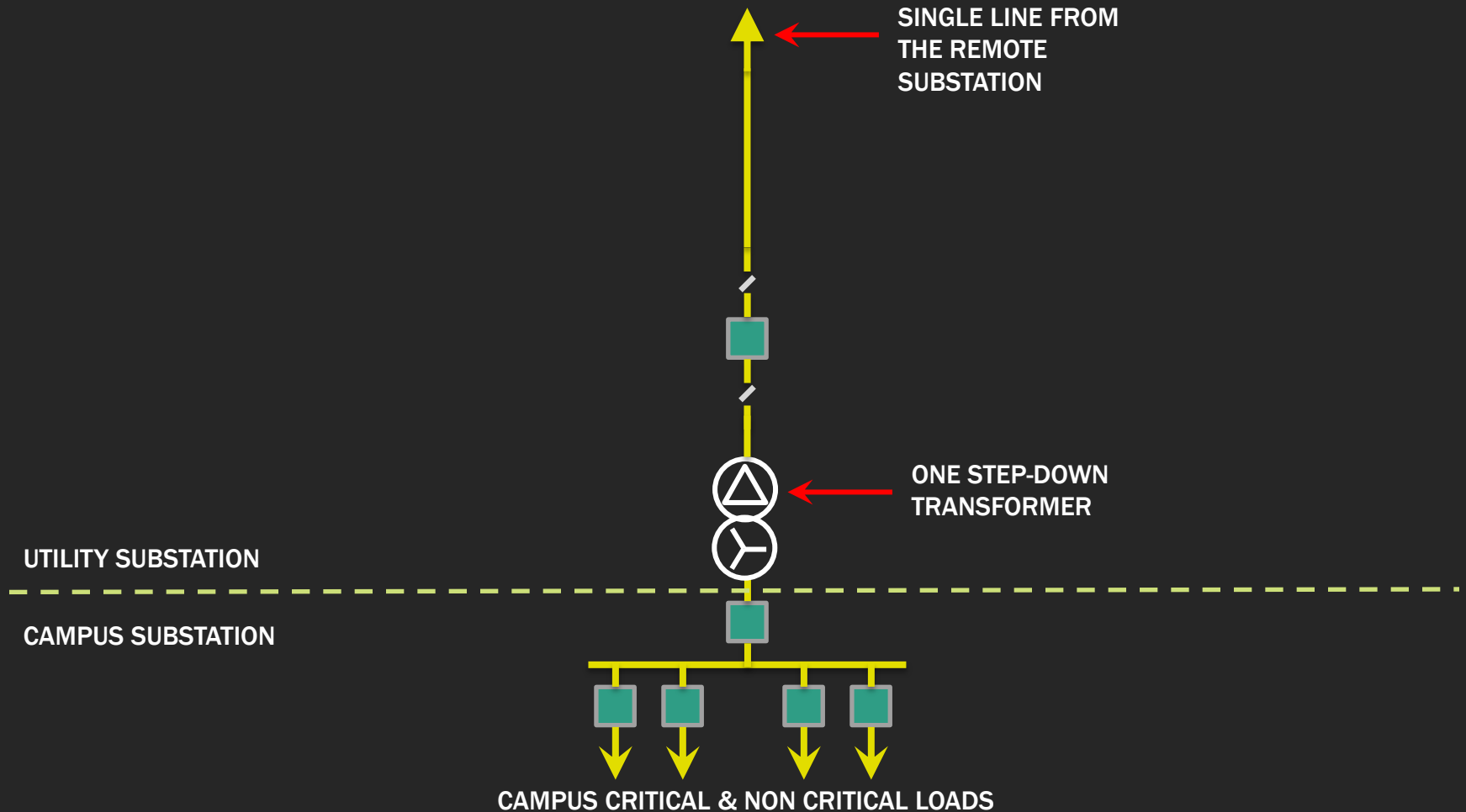
TYPICAL ELECTRICAL SYSTEM



Question: If willing to spend large capital on campus side infrastructure, why not spend on utility side also?

Challenges? Fix the single transmission line service first if not done already. If they say no, ask again... and again...

SUBSTATION CONFIGURATION: SINGLE RADIAL FEED

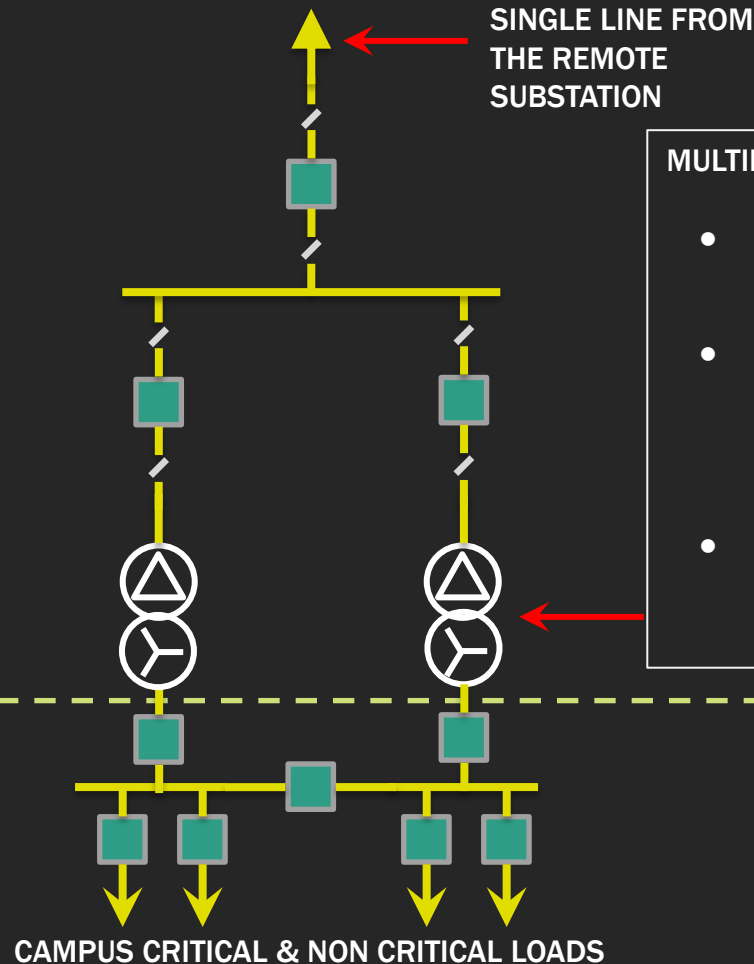


SUBSTATION CONFIGURATION: SINGLE BUS SINGLE BREAKER

- ❖ LEAST RELIABLE
- ❖ LESS OPERATIONAL FLEXIBILITY
- ❖ LOW COST

UTILITY SUBSTATION

CAMPUS SUBSTATION

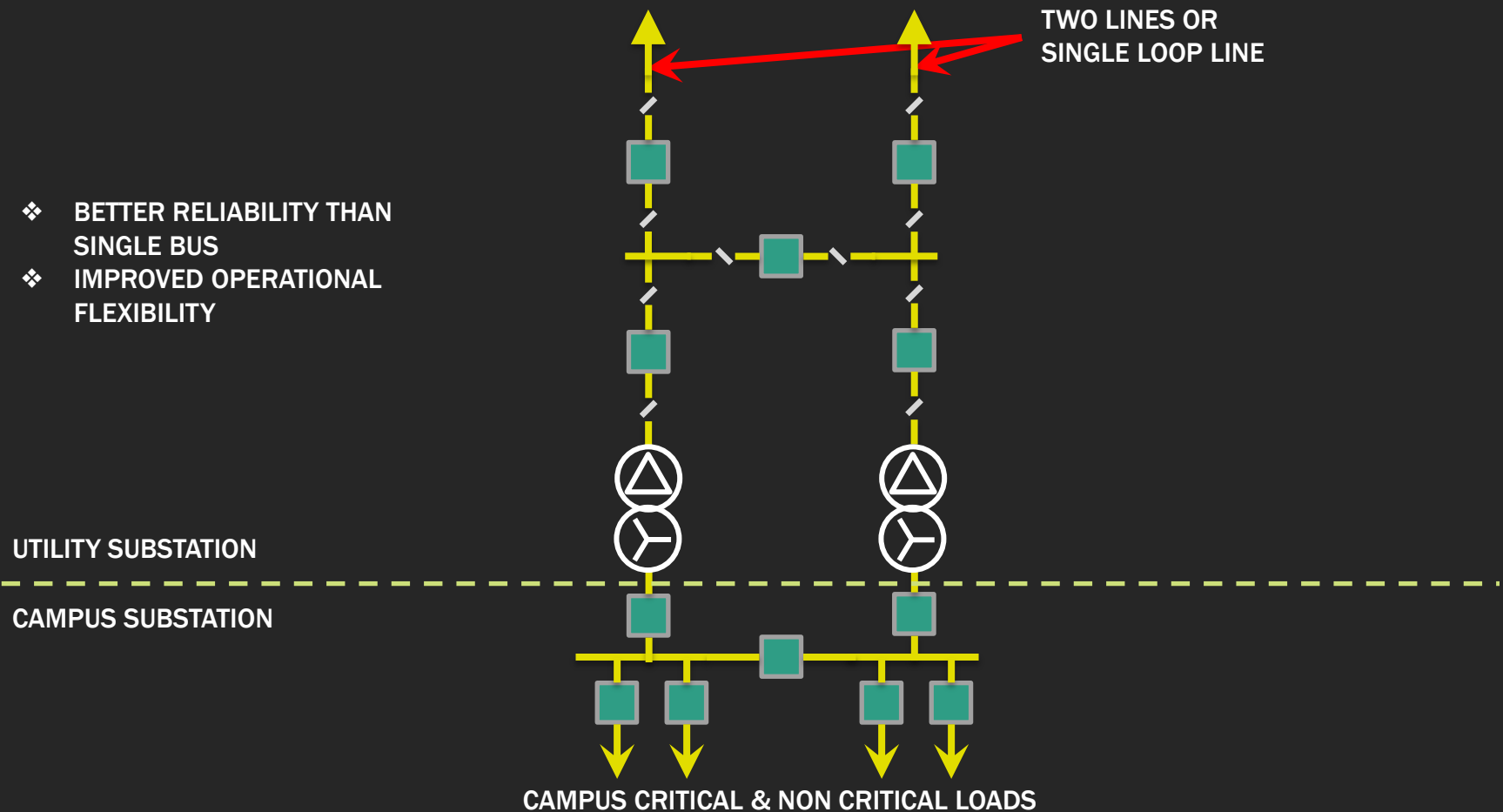


MULTIPLE TRANSFORMERS

- OPERATED IN PARALLEL TO SHARE THE LOAD AT BASE RATING
- ONAF/OFAF (OIL/AIR FORCED COOLING) RATED FOR MAXIMUM LOADING FOR TRANSFORMER OUTAGE CONDITIONS
- OPERATED IN N+1 CONFIGURATION I.E. WITH A STAND-BY TRANSFORMER

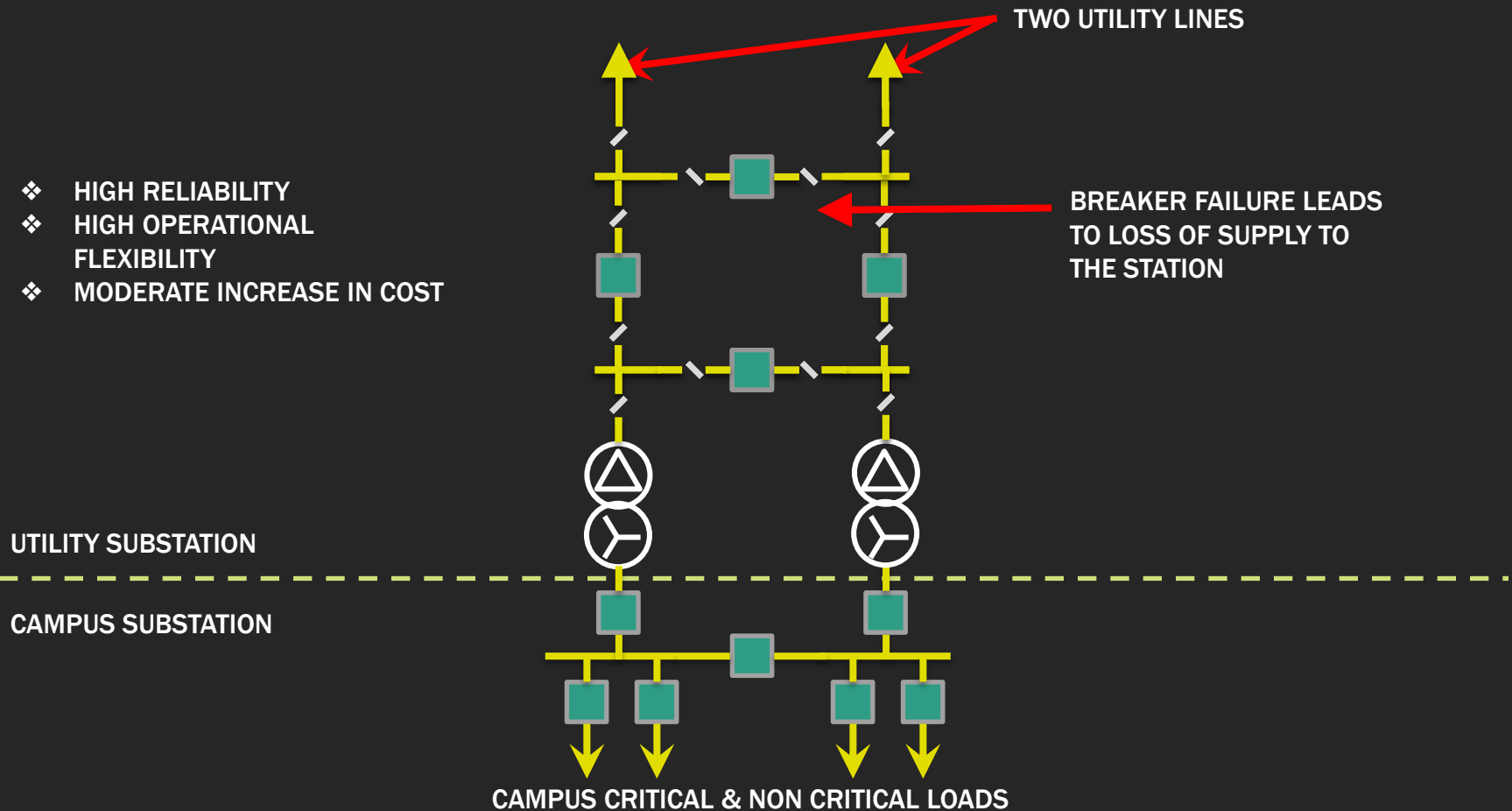
SUBSTATION CONFIGURATION: SINGLE BUS WITH SECTION BREAKER

- ❖ BETTER RELIABILITY THAN SINGLE BUS
- ❖ IMPROVED OPERATIONAL FLEXIBILITY



SUBSTATION CONFIGURATION: RING BUS

- ❖ HIGH RELIABILITY
- ❖ HIGH OPERATIONAL FLEXIBILITY
- ❖ MODERATE INCREASE IN COST

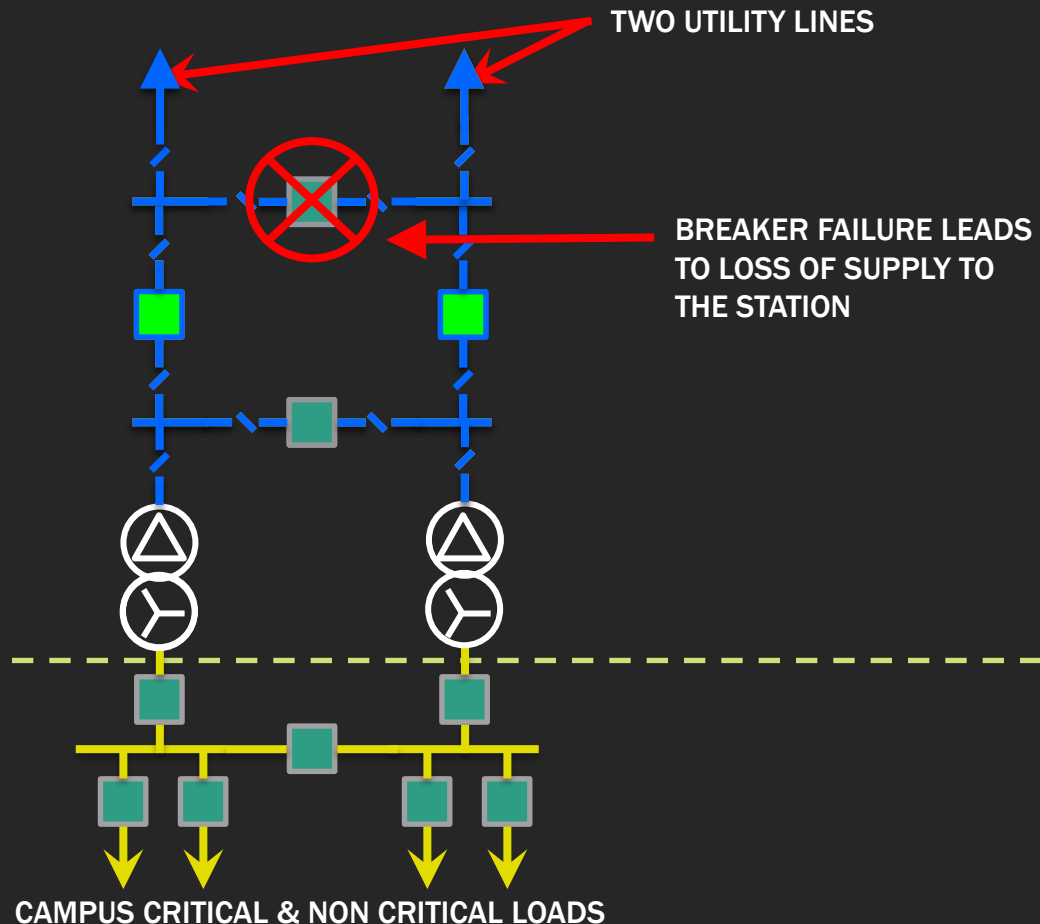


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- ❖ MODERATE INCREASE IN COST

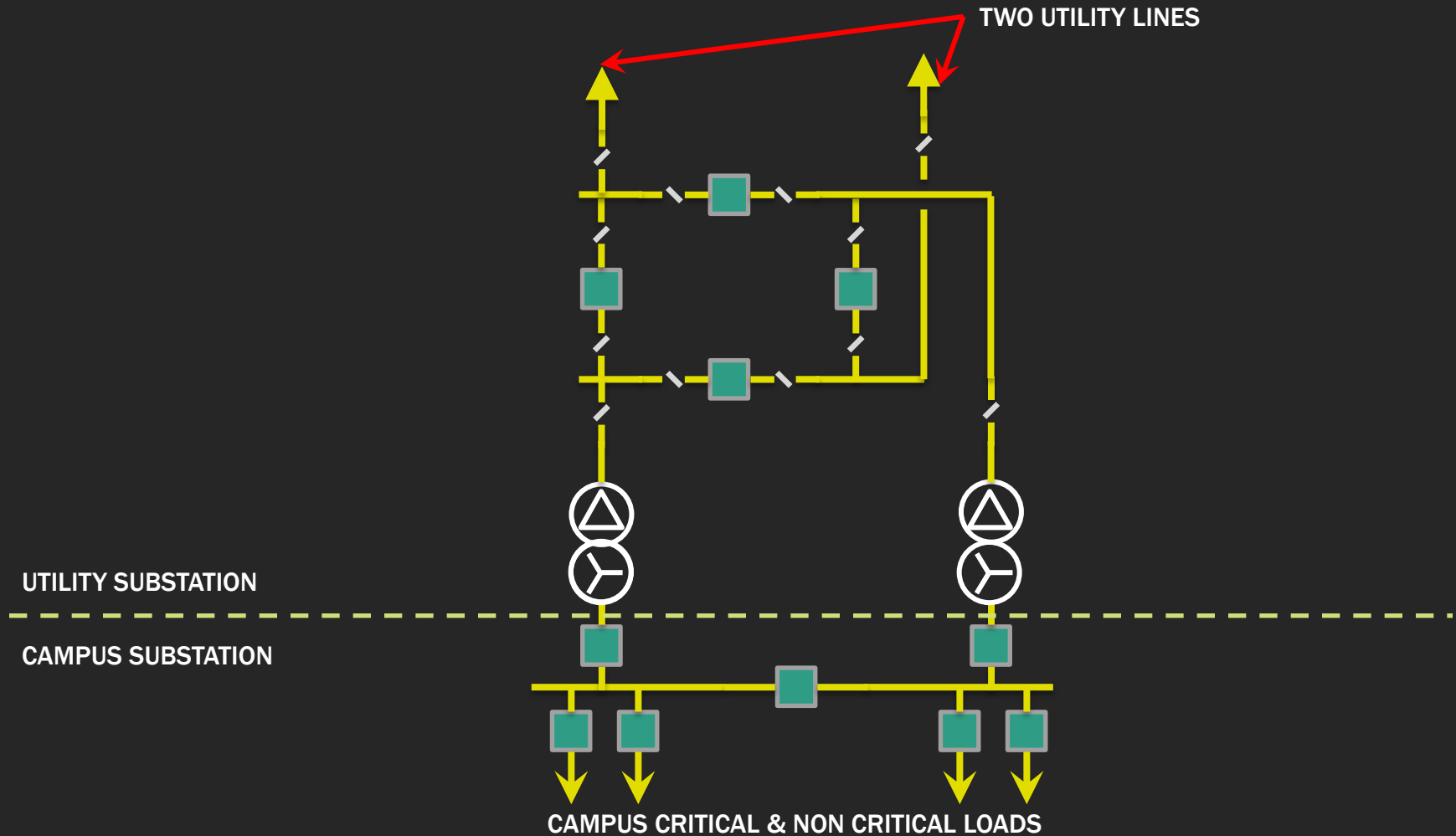


SUBSTATION CONFIGURATION: RING BUS

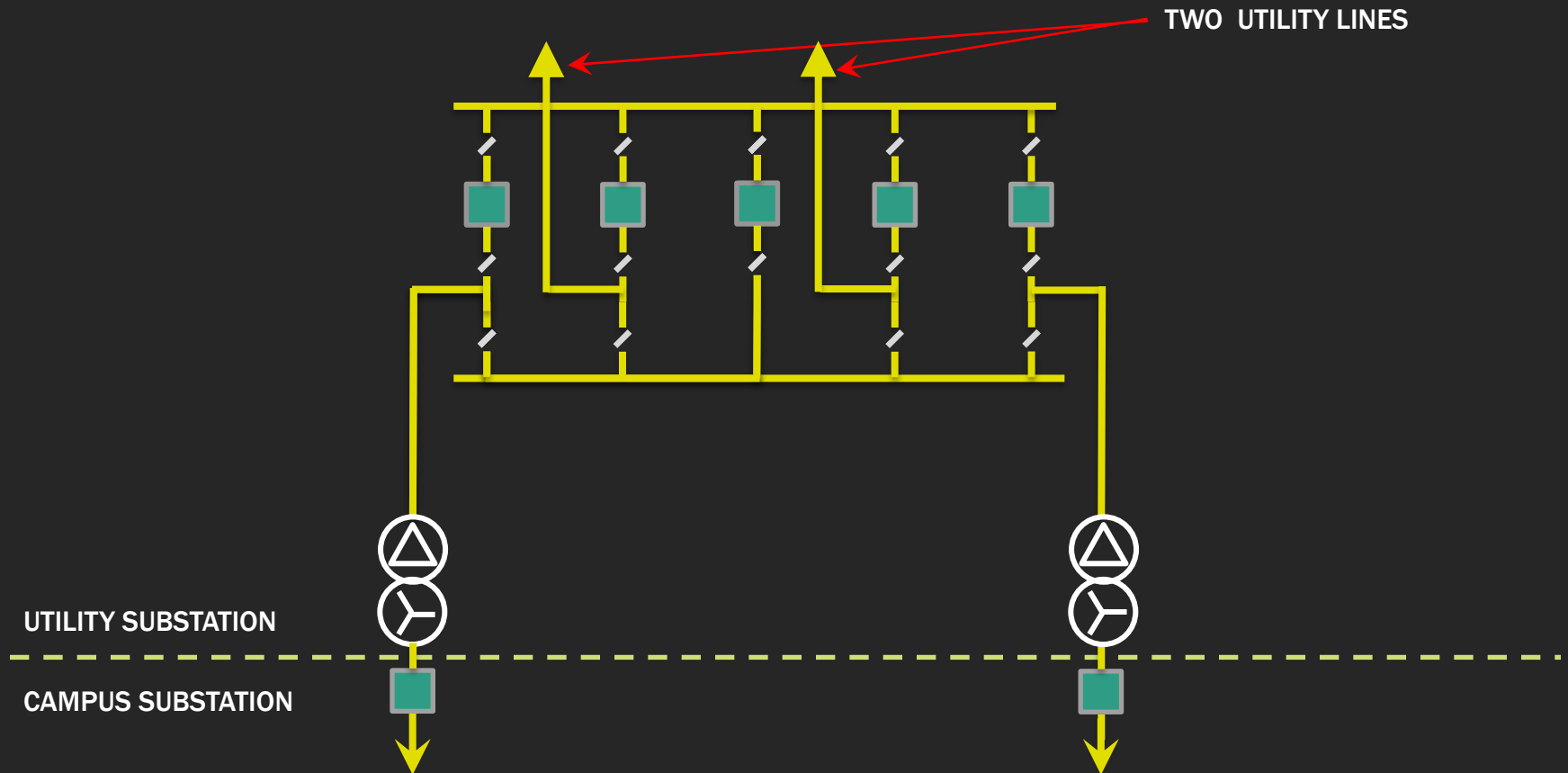
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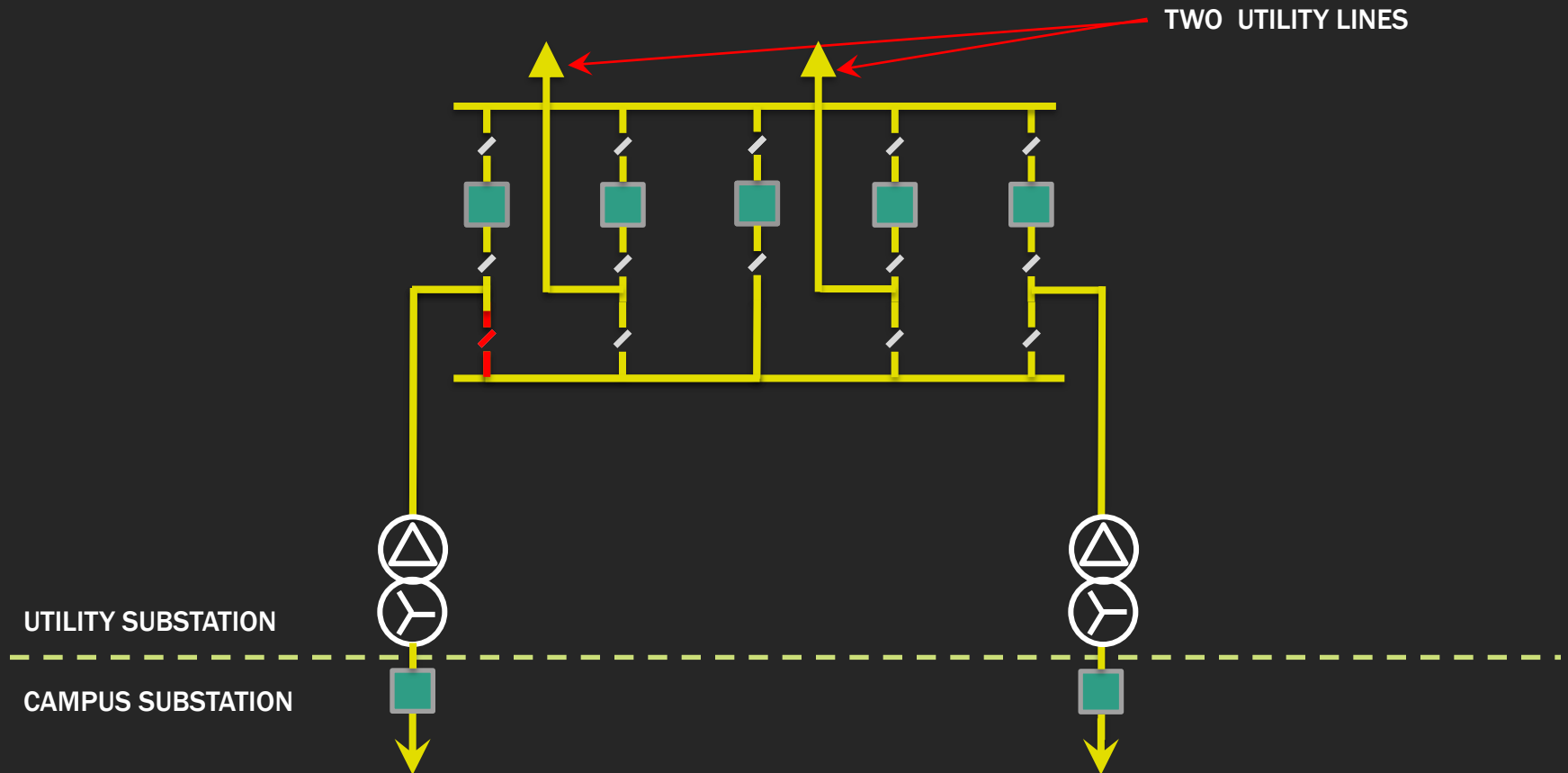
SUBSTATION CONFIGURATION: RING BUS-ALTERNATIVE



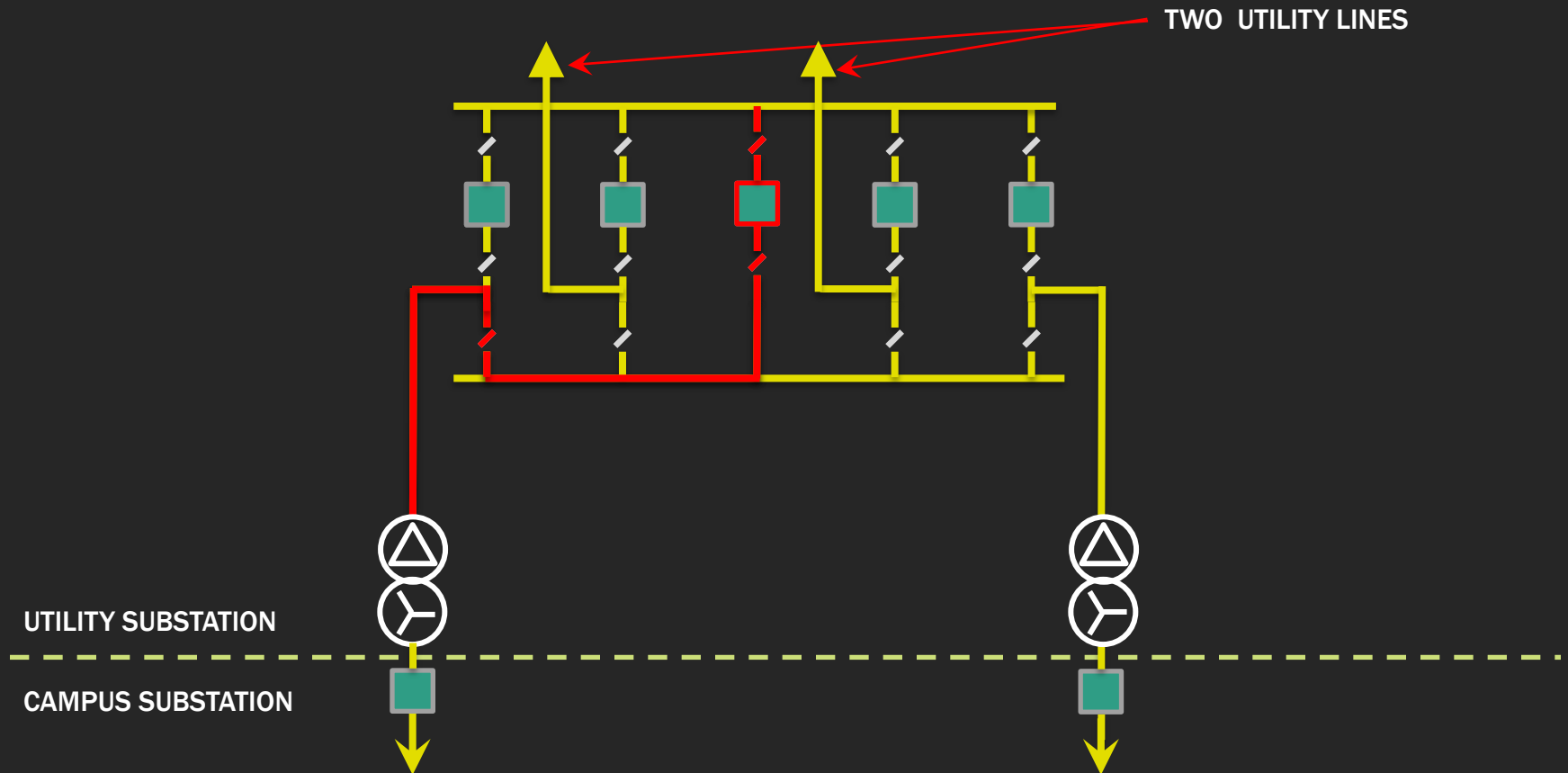
SUBSTATION CONFIGURATION: MAIN & TRANSFER BUS



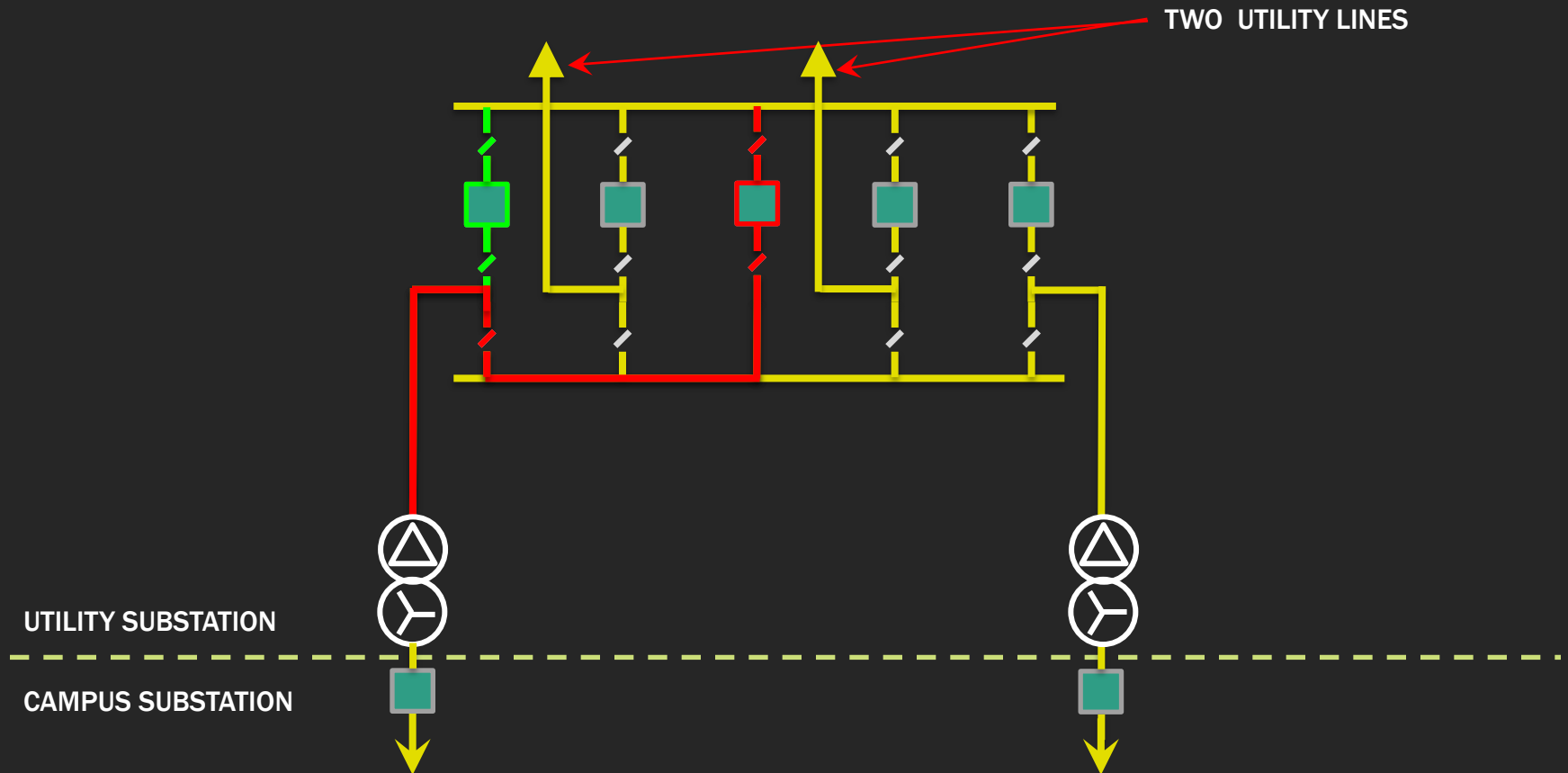
SUBSTATION CONFIGURATION: MAIN & TRANSFER BUS



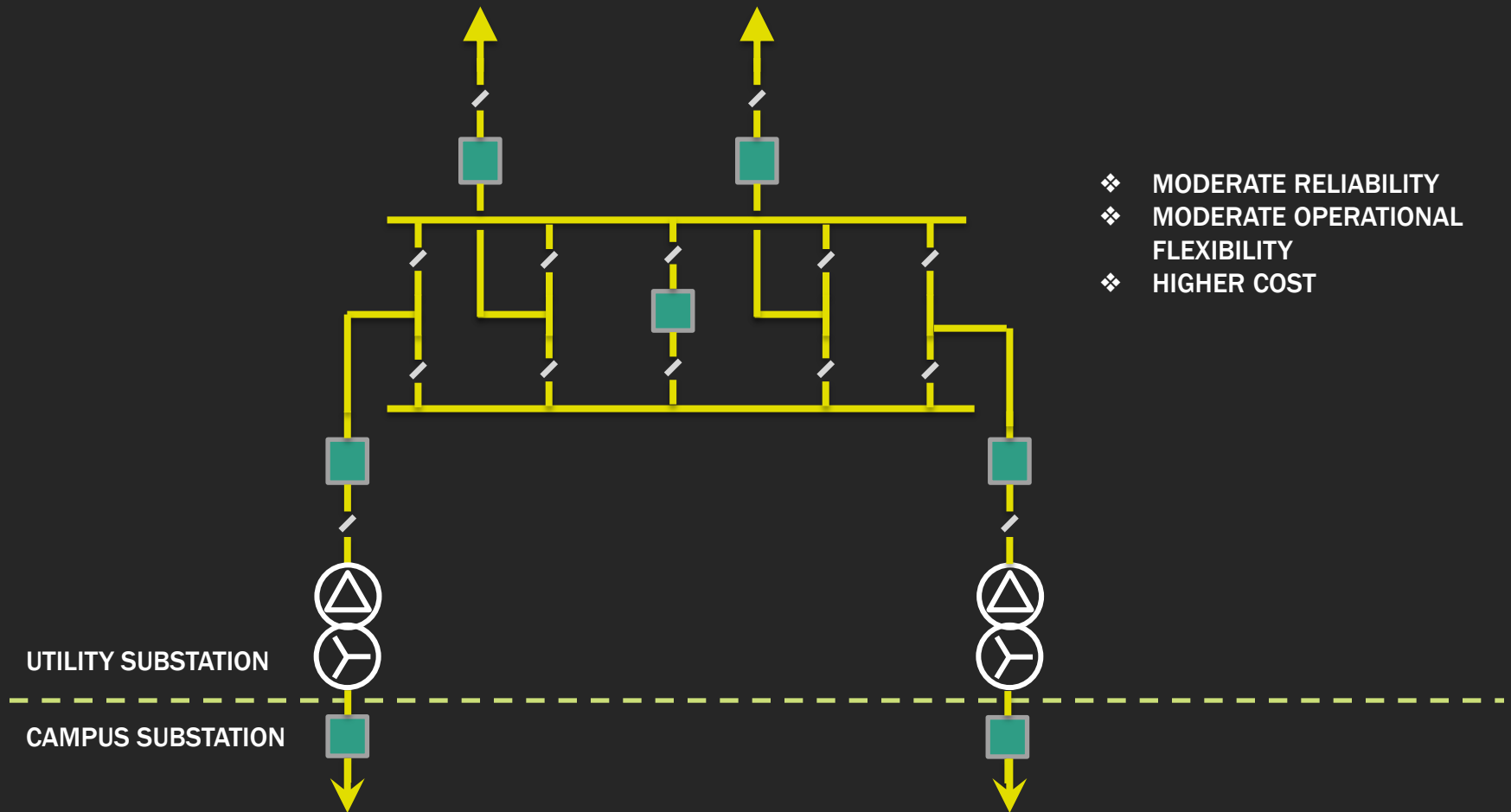
SUBSTATION CONFIGURATION: MAIN & TRANSFER BUS



SUBSTATION CONFIGURATION: MAIN & TRANSFER BUS



SUBSTATION CONFIGURATION: DOUBLE BUS SINGLE BREAKER



SUBSTATION CONFIGURATION: B-1/2

BREAKER FAILURE
DOES NOT AFFECT
SUPPLY CONTINUITY

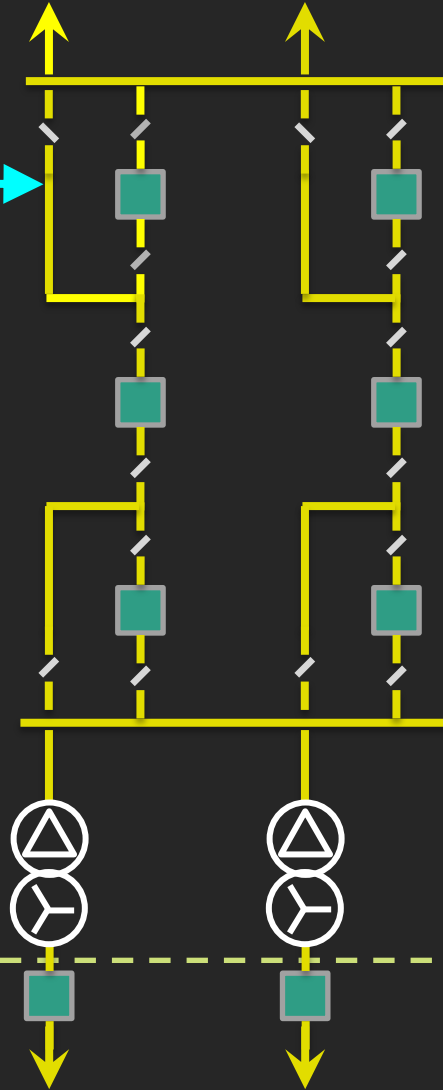


TWO UTILITY LINES

- ❖ HIGH RELIABILITY
- ❖ HIGH OPERATIONAL FLEXIBILITY
- ❖ HIGHER COST

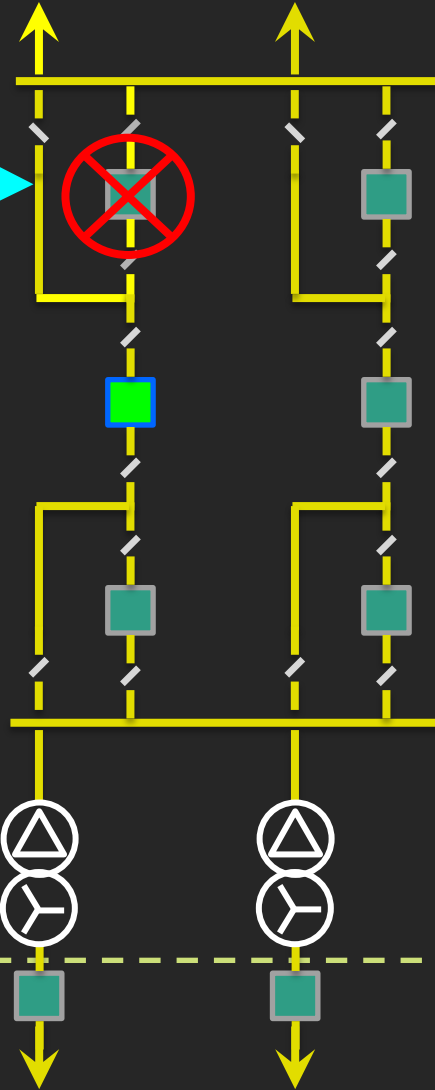
UTILITY SUBSTATION

CAMPUS
SUBSTATION



SUBSTATION CONFIGURATION: B-1/2

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TWO UTILITY LINES

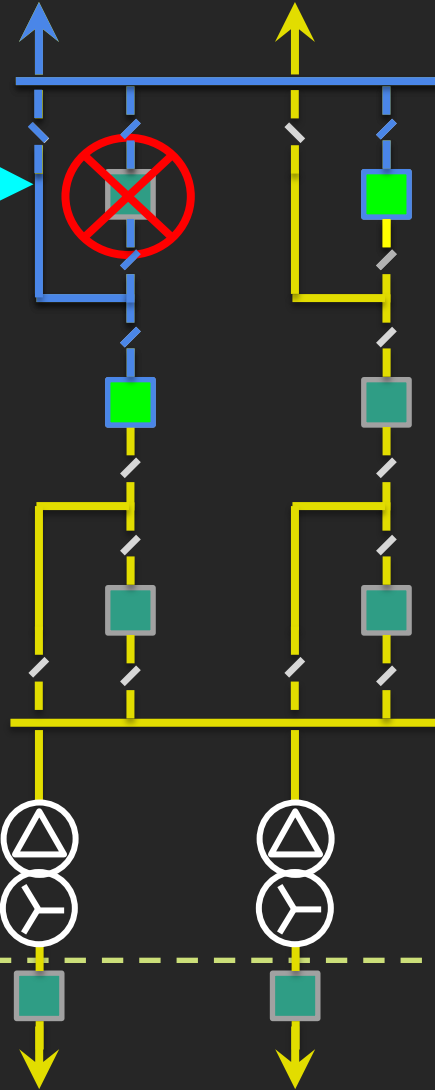
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UTILITY SUBSTATION

CAMPUS
SUBSTATION

SUBSTATION CONFIGURATION: B-1/2

BREAKER FAILURE
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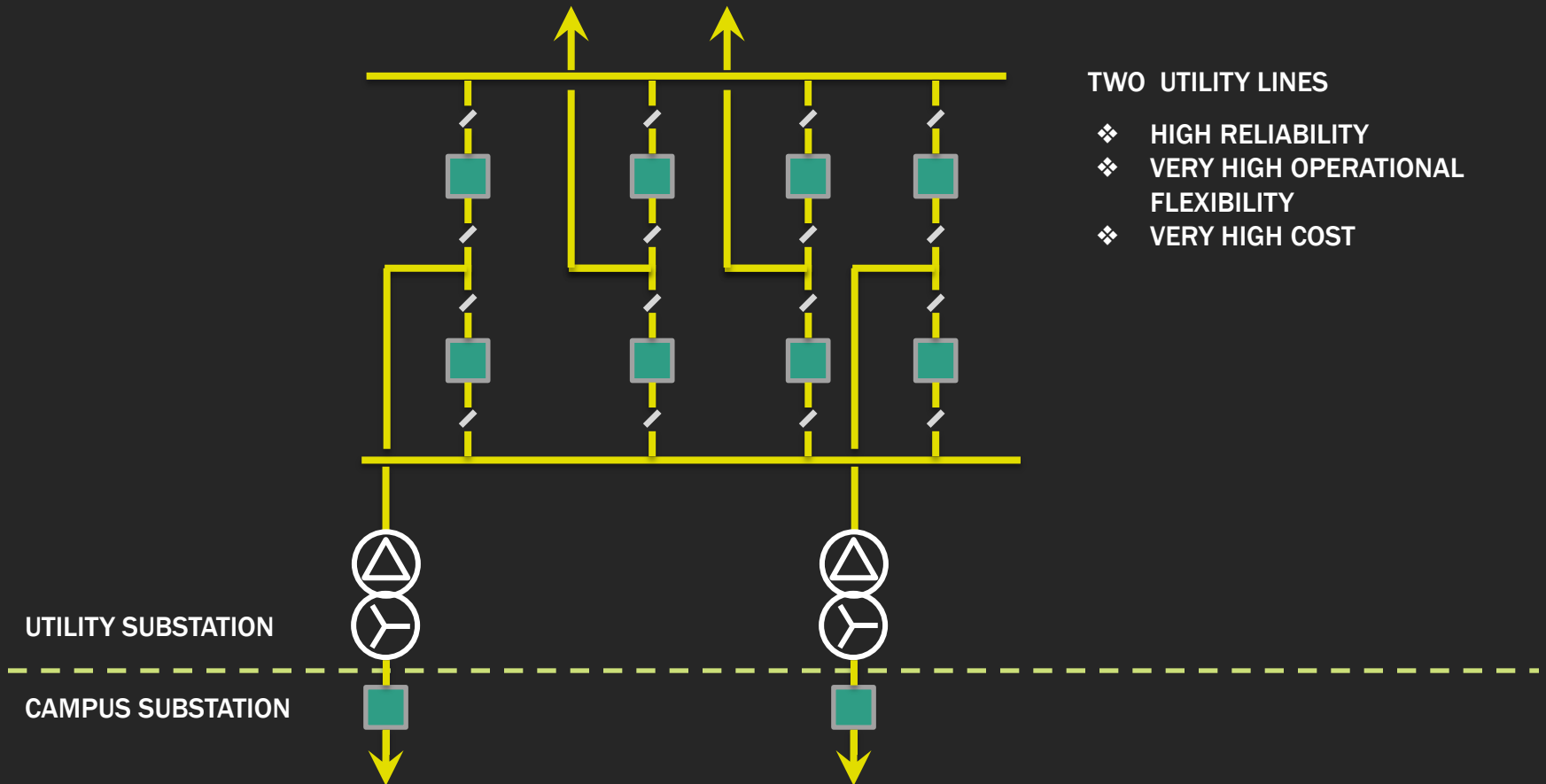
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UTILITY SUBSTATION

CAMPUS
SUBSTATION

SUBSTATION CONFIGURATION: DOUBLE BUS DOUBLE BREAKER



SUBSTATION CONFIGURATION: COMPARISON

Configuration	Reliability	Cost
Single Busbar	Least	100%
Single Busbar with Sectionalizer	Low	120%
Main & Transfer	Low	140%
Double Bus Single Breaker	Moderate	175%
Ring Bus	High	125%
Breaker & Half	High	145%
Double Bus Double Breaker	High	190%

CONCLUSIONS

Push for the same level of reliability from the utility as you are willing to spend on your campus.

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The level of service reliability is a risk management discussion and what can be afforded by the campus... what is an outage(s) worth?

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