Southern California Edison
A.09-09-022 – Alberhill PTC & CPCN

DATA REQUEST SET C P U C - S u p p l e m e n t a l D a t a R e q u e s t - 0 1 0

To: CPUC
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Job Title: Senior Advisor
Received Date: 4/21/2021

Response Date: 5/6/2021

Question 01:
Provide the list of contingencies that render the Valley South to Valley North tie-lines ineffective.

Response to Question 01:
Please see the requested list of contingencies below.

N-1 Subtransmission Line Contingency	Subtransmission Line Violation
Auld-Moraga #1	Auld-Moraga #2
Valley EFG-Newcomb-Skylark	Valley EFG-Tap 39
Valley EFG-Newcomb-Skylark	Elsinore-Tap 39
Skylark-Tenaja	Moraga-Tap 150
Valley EFG-Elsinore-Fogarty	Skylark-Tap 22
Moraga-Pechanga	*Voltage (multiple substations)
Valley EFG-Triton	Moraga-Pechanga

Note 1: All violations are thermal overloads unless noted.

Note 2: In addition to the above subtransmission line contingencies, the system tie-lines are also ineffective in addressing N-1 transformer contingencies in the Valley South System as detailed further in the answer below.

In a radially designed electrical system, the most effective system tie-lines offer two-way transfer capability between two systems that can be used to address both N-1 subtransmission line contingencies and N-1 transformer contingencies.

SCE notes that the ineffectiveness of the system tie-lines created as part of the *Valley South to Valley North* alternative (as well as the *Valley South to Valley North to Vista* alternative, the *Valley South to Valley North with Distributed BESS in Valley South* alternative, the *Valley South to Valley North and Centralized BESS in Valley South* alternative, and the *Valley South to Valley North and Centralized BESS in Valley South and Valley North* alternative) is due to the system tie-lines being very limited in addressing capacity or operational issues in the Valley South System during contingency conditions (typical N-1 contingencies or more extreme N-2 subtransmission line or substation-type contingencies). The rationale for this is presented in the following paragraph.

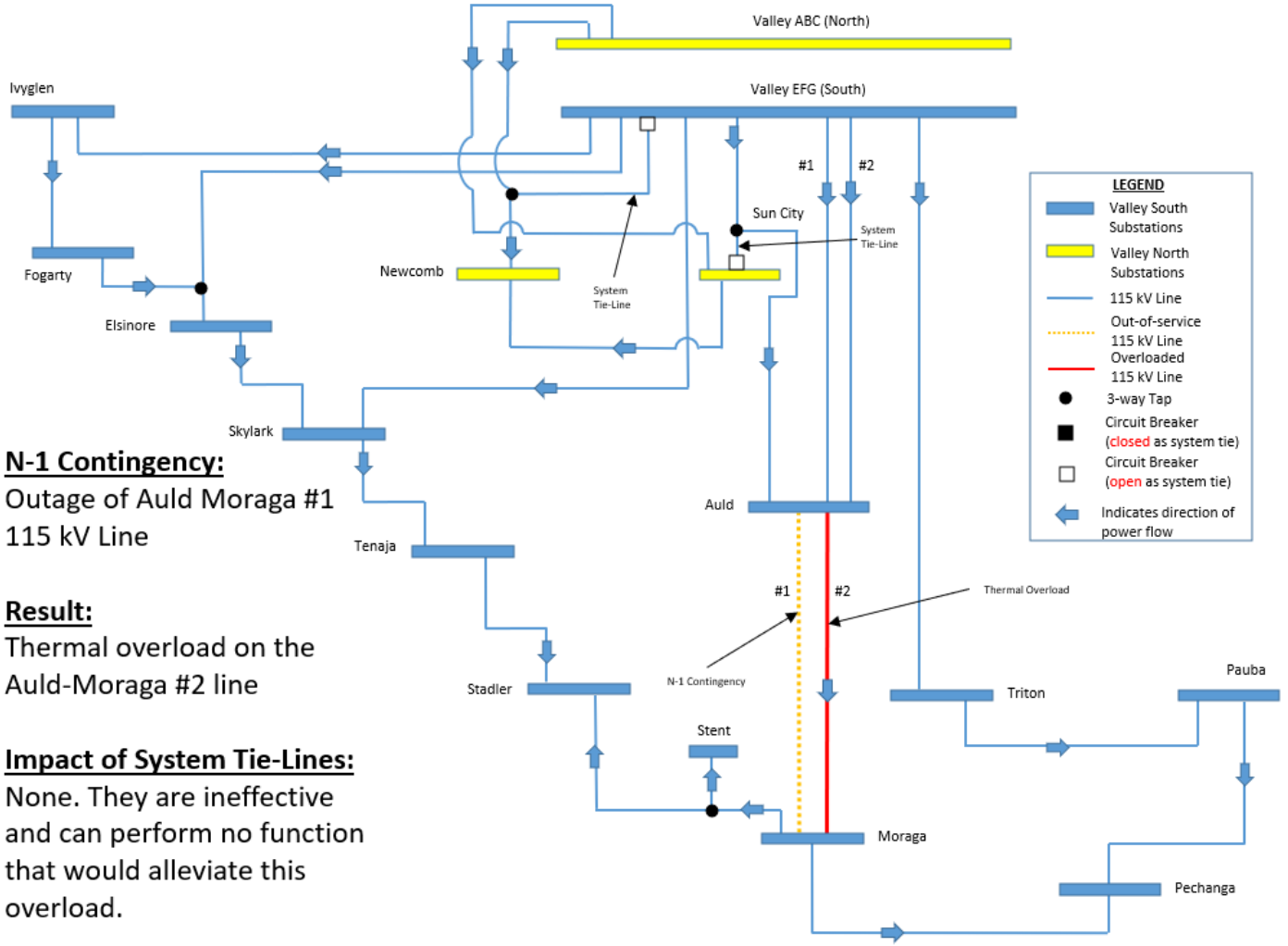
The scope of the *Valley South to Valley North* alternative(s) yields just two system tie-lines after the

initial loads are transferred from the Valley South System to the Valley North System to immediately address the transformer capacity shortfall of the Valley South System transformers (by transferring Newcomb and Sun City Substations). These two new system tie-lines; however, would not allow for any additional load to be transferred from the Valley South System to the Valley North System under N-1 subtransmission line or transformer contingency conditions and are thus considered ineffective. The reason for this is that the two system tie-lines (after the initial load transfer) only allow for those two substations to be transferred *back* to the Valley South System *from* the Valley North System under N-1 conditions and do not allow for any additional load to be transferred from the Valley South System *to* the Valley North System. In other words, they only work in one direction. This results in N-1 contingency capacity only for events that occur in the Valley North System and provides none for the Valley South System. Figure 1 illustrates this. In contrast, an alternative that includes a new adjacent system that is diverse in location (e.g., the *Mira Loma, Orange County, SDG&E*, and *Alberhill* alternatives) provides for effective system tie-lines to transfer load back and forth as needed to address (or minimize) N-1 contingencies as shown in Figures 2a and 2b below. This occurs for two reasons:

1) the initial transfer of load (upon construction of the alternative) relieves the loading of the existing system from the start, and
2) the resulting system tie-lines allow for additional load to be transferred

Figure 1

Valley South to Valley North Alternative



N-1 Contingency:
Outage of Auld Moraga #1 115 kV Line

Result:
Thermal overload on the Auld-Moraga #2 line

Impact of System Tie-Lines:
None. They are ineffective and can perform no function that would alleviate this overload.

Figure 2a

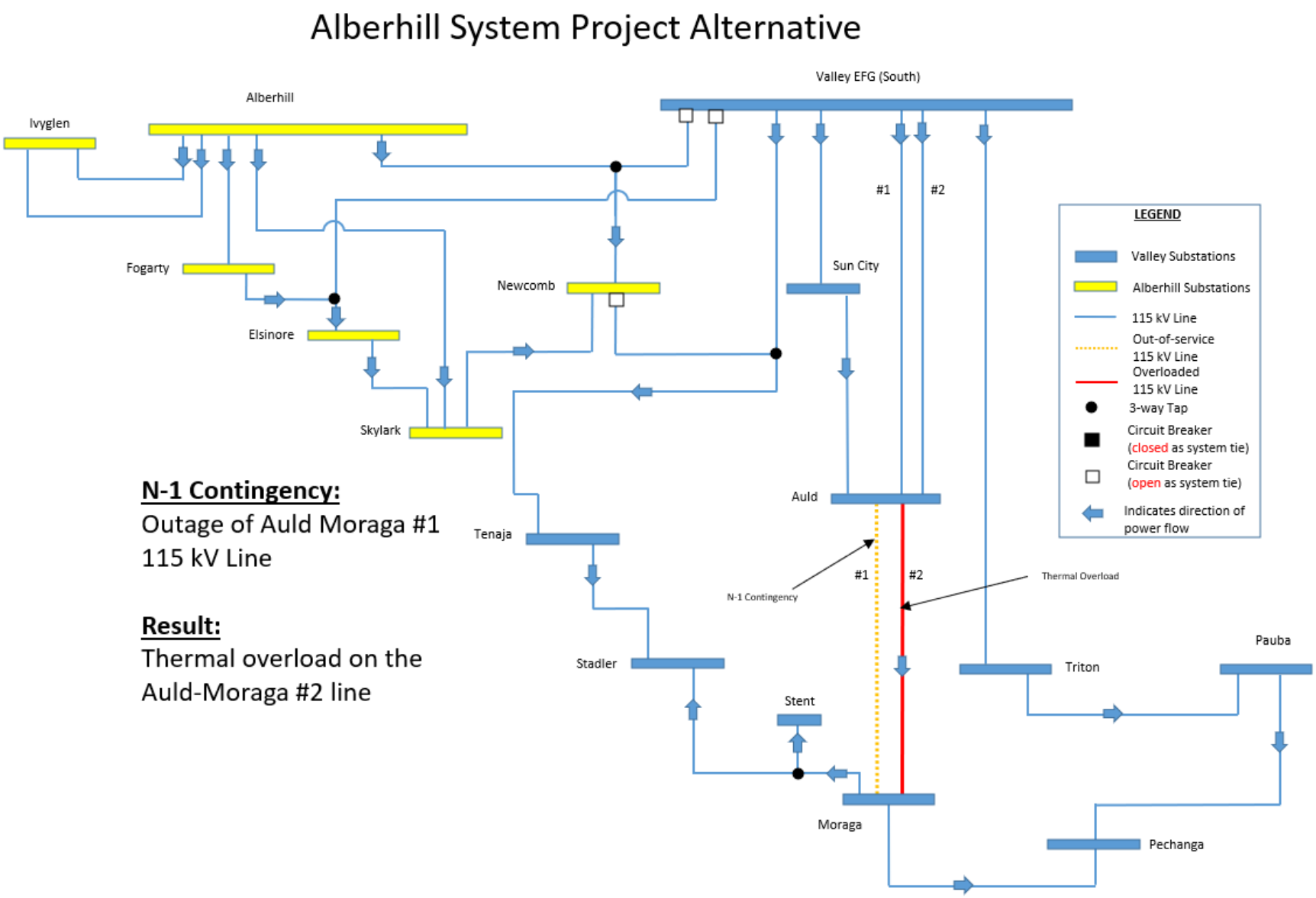
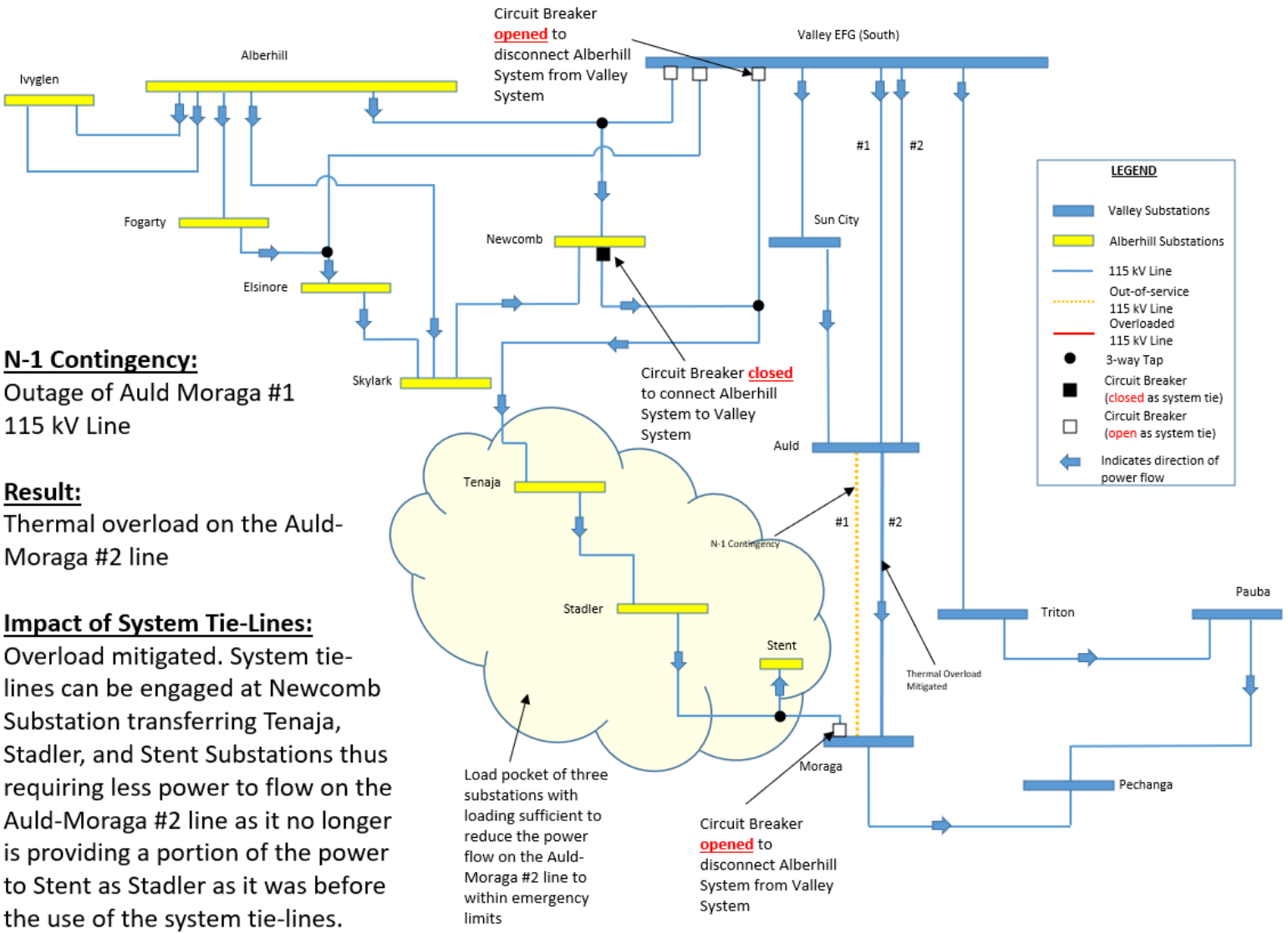

Alberhill System Project Alternative
Valley EFG (South)
Alberhill
Ivyglen
Fogarty
Elsinore
Skylark
Newcomb
Sun City
#1
#2
LEGEND
Valley Substations
Alberhill Substations
115 kV Line
Out-of-service 115 kV Line
Overloaded 115 kV Line
3-way Tap
Circuit Breaker (closed as system tie)
Circuit Breaker (open as system tie)
Indicates direction of power flow
N-1 Contingency:
Outage of Auld Moraga #1 115 kV Line
Result:
Thermal overload on the Auld-Moraga #2 line
Auld
Tenaja
N-1 Contingency
#1
#2
Thermal Overload
Stadler
Stent
Triton
Pauba
Moraga
Pechanga

Figure 2b

Alberhill System Project Alternative



N-1 Contingency:
Outage of Auld Moraga #1 115 kV Line

Result:
Thermal overload on the Auld-Moraga #2 line

Impact of System Tie-Lines:
Overload mitigated. System tie-lines can be engaged at Newcomb Substation transferring Tenaja, Stadler, and Stent Substations thus requiring less power to flow on the Auld-Moraga #2 line as it no longer is providing a portion of the power to Stent as Stadler as it was before the use of the system tie-lines.

Alternatively, a similar potential solution could include constructing system tie-lines similar to those associated with the *Valley South to Valley North* alternative(s) but not initially transfer any load from the Valley South System to the Valley North System. In this case, the Valley South transformer capacity issue would likely be addressed with some form of a DER solution. However, this variation of the *Valley South to Valley North* alternative would also not satisfy the objective of creating effective system tie-lines. While the newly created system tie-lines could be used in addressing N-1 transformer contingencies in the Valley South System (by transferring Valley South load to the Valley North System), they remain ineffective at reducing the impacts of the more common N-1 (and less common N-1-1 and N-2) subtransmission line contingencies (again, refer to Figure 1 above). In December 2020, SCE provided the CPUC Energy Division with additional details on effective system tie-line design for radial systems and this information is provided in the attachment titled "A.09-09-022 ED-Alberhill-SCE-Supplemental Data Request 010 Question 01.pdf".

SCE acknowledges that the two system tie-lines created as part of the *Valley South to Valley North* alternative(s) could offer some benefit to the Valley South System under more extreme contingency conditions (i.e., high-impact low-probability events) such as during a complete or partial outage of the transformer capacity serving the Valley South System. However, as reflected in values associated with the Flex-2 metrics reported in the Planning Study, performance under these extreme event conditions was relatively insignificant when viewed against the entirety of the load at risk under such an event. Thus, the *Valley South to Valley North* alternative(s) were ranked among the worst alternatives for the Flex-2 metrics. In contrast, alternatives that include creation of a completely new system (diversely located) and with system tie-lies between the boundaries of the two systems (e.g., *Mira Loma, Orange County, SDG&E, and Alberhill* alternatives) provide significantly more benefits under these extreme contingency conditions.

Depending on whether load would be transferred from the Valley South System to the Valley North System initially or be reserved only for Valley South System N-1 transformer contingencies, the performance of the system tie-lines is summarized below.

> *Valley South to Valley North* alternative with initial transfer of Newcomb and Sun City (transformer capacity issue in Valley South addressed by initial load transfer)
>
> - System tie-lines ineffective for Valley South System N-1 transformer contingencies and N-1 subtransmission line contingencies in either Valley South or Valley North
>
> *Valley South to Valley North* alternative without initial transfer of Newcomb and Sun City (transformer capacity issue in Valley South addressed by a DER solution)
>
> - System tie-lines effective for Valley South System N-1 transformer contingencies but ineffective for N-1 subtransmission line contingencies in either Valley South or Valley North
> - To meet planning criteria and eliminate reliance on the spare transformer for capacity mitigation in the Valley South System, a DER solution in the Valley South System must be sized to account for the Valley South System N-1 transformer conditions, that is to say by reducing system transformer loading to be below 896

MVA at all times.

In each scenario, the system tie-lines are not effective in addressing both types of N-1 contingencies that are planned for. In the first, they are ineffective because they offer only "one-way" transfers (e.g., Valley North *back* to Valley South) consequently providing no benefit to the Valley South System for N-1 transformer or line contingencies. In the second, they are ineffective because they offer only "one-way" transfers (e.g., Valley South to Valley North) for N-1 transformer contingencies and do not address any N-1 subtransmission line contingencies. This does not result in a robust system arrangement where system tie-lines typically offer "two-way" transfer capability thus providing both systems with N-1 contingency relief for either N-1 transformer or subtransmission line contingencies. For these reasons, SCE has described the *Valley South to Valley North* alternative's system tie-lines as ineffective as compared to those that would be created as part of system alternatives designed like the *Mira Loma, Orange County, SDG&E, and Alberhill* alternatives.

Alberhill System Project

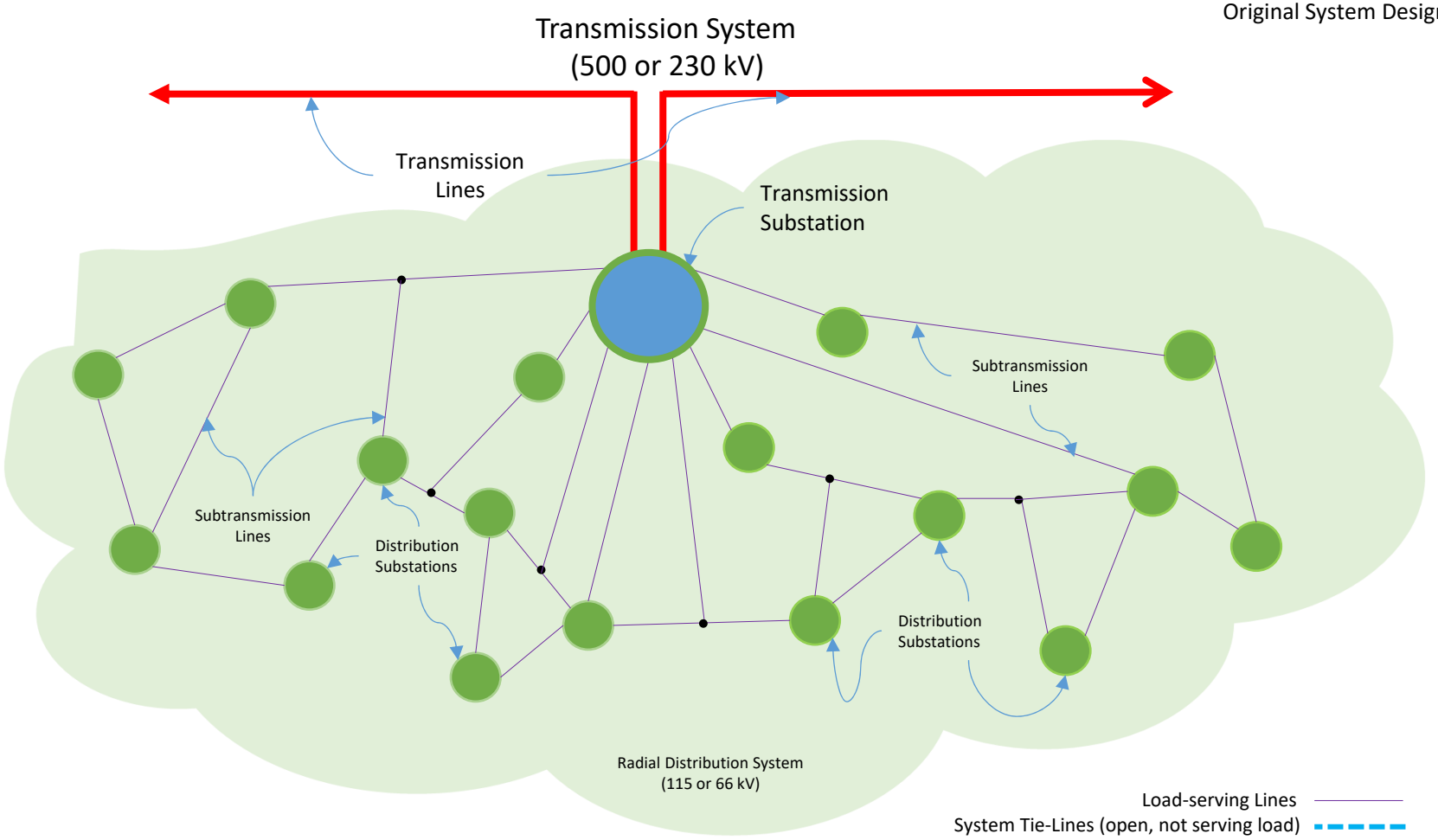
Power Systems Analysis Deep Dive

12/17/2020

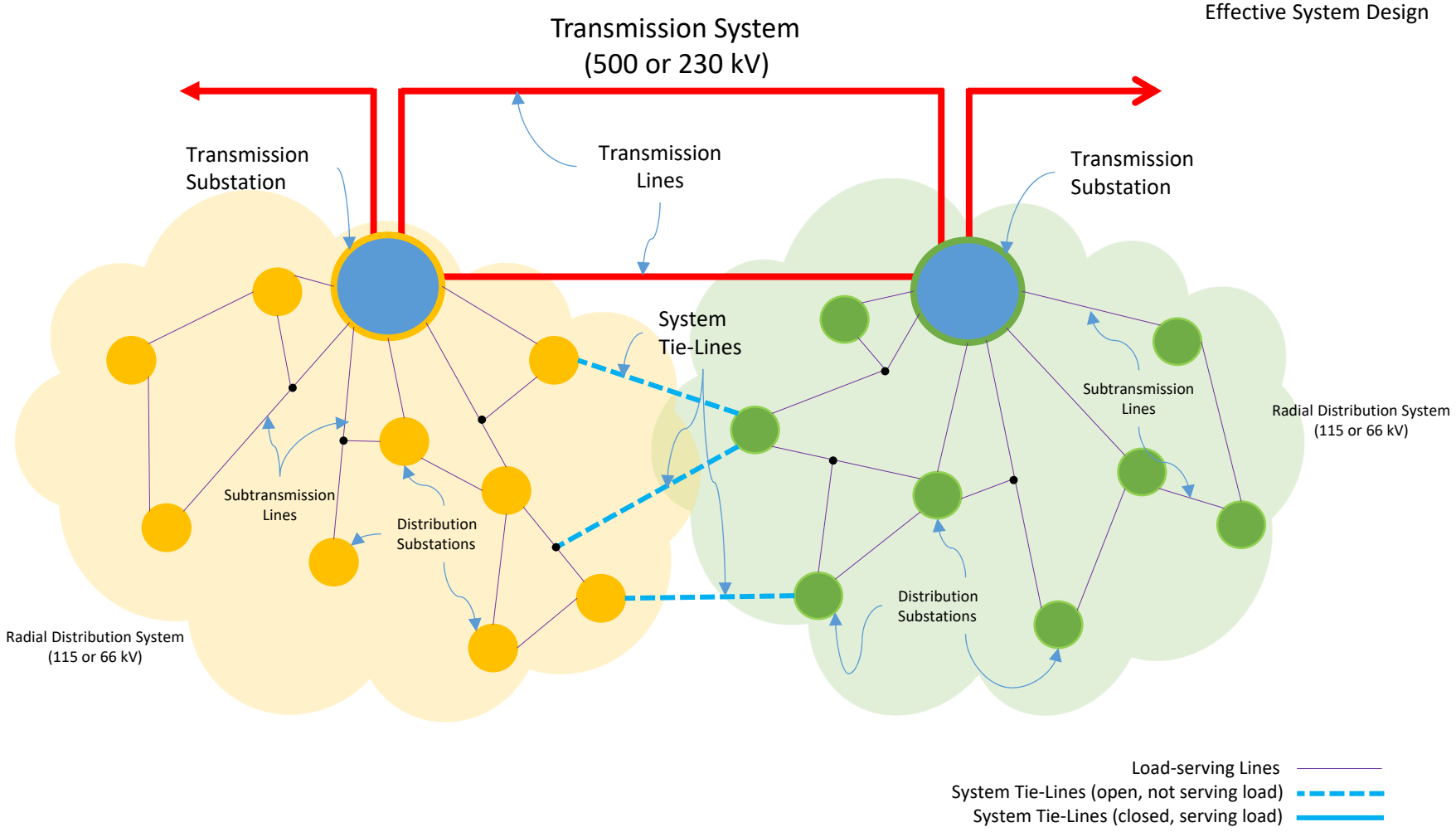
Tie-Line Road Map

- How are system tie-Lines created?
  - Typically created by reconfiguring the source lines of substations transferred to adjacent systems
    - Initial transfers relieve capacity constraints
    - Remaining source lines become system tie-lines
  - Most effective and operationally flexible way to create effective tie-lines is by transferring substations on the border of the where two systems meet.
    - Load pockets and associated substations that are not integral (and thereby difficult to separate from) to the network design of the subtransmission system.
    - Substations located near source transmission substations generally are connected to many of the subtransmission source lines that emanate from the source substation and create a "hub" for additional power to flow to other substations downstream.
    - Transfer of a more centralized "hub" substation in the network of subtransmission lines adversely affects the network and its ability to transmit power to the rest of the system.
    - This can be overcome, but generally requires the construction of more subtransmission lines which would effectively bypass the "hub" substation, resulting in more scope than may be initially recognized by simply looking at an electrical schematic diagram.
    - Power flow analysis, studying both normal conditions (N-0) and abnormal conditions (N-1), is required to determine the necessary scope.
  - Depending on the available capacity of adjacent systems, it is common that a new system and transmission substation (230 kV or 500 kV high-side voltage) is needed to transfer meaningful amounts of load (entire distribution substations). The creation of effective system tie-lines can often require subtransmission line construction not only to transfer multiple distribution substations but to ensure the newly configured networks are adequately designed for contingencies.

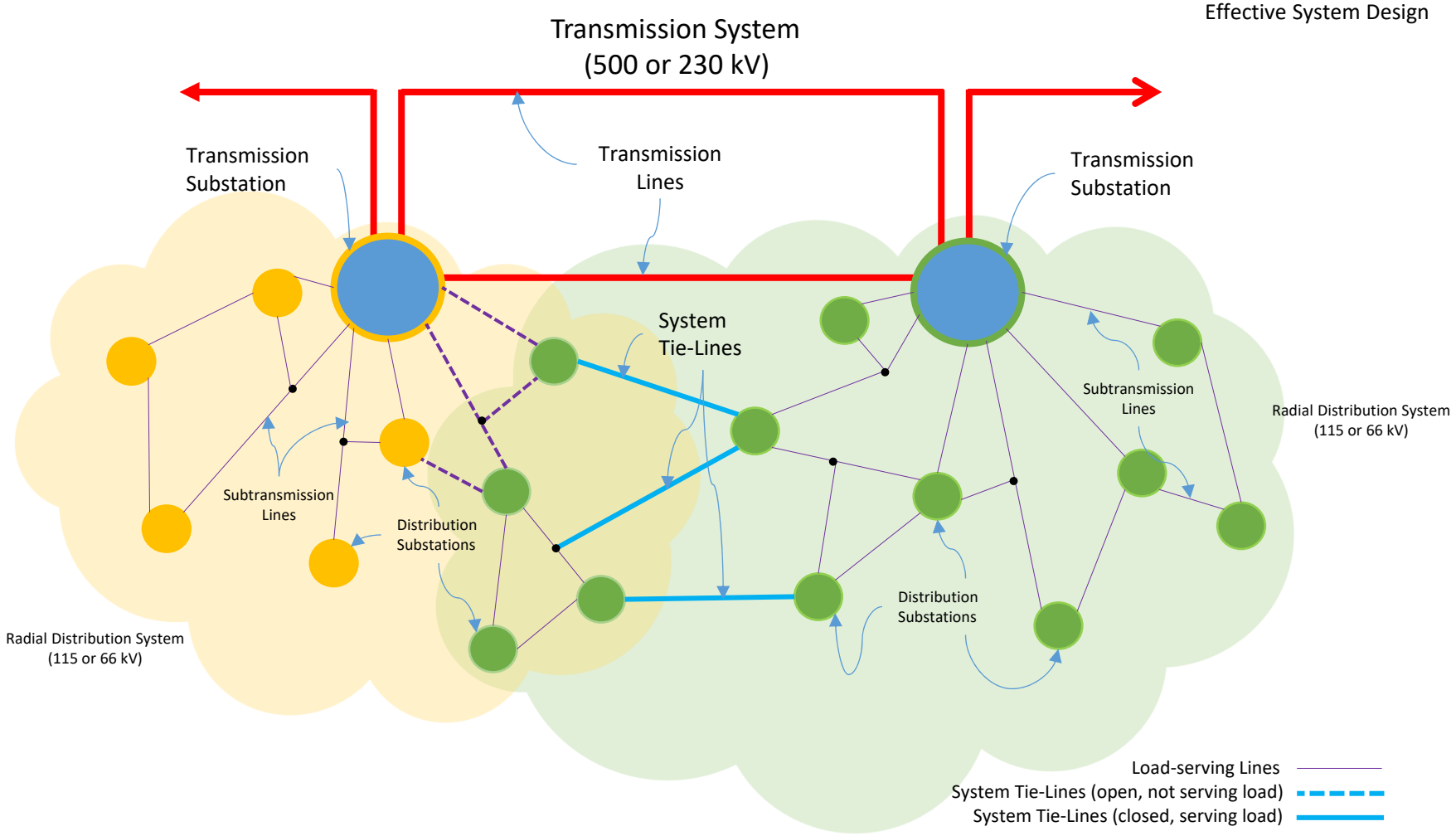
Original System Design



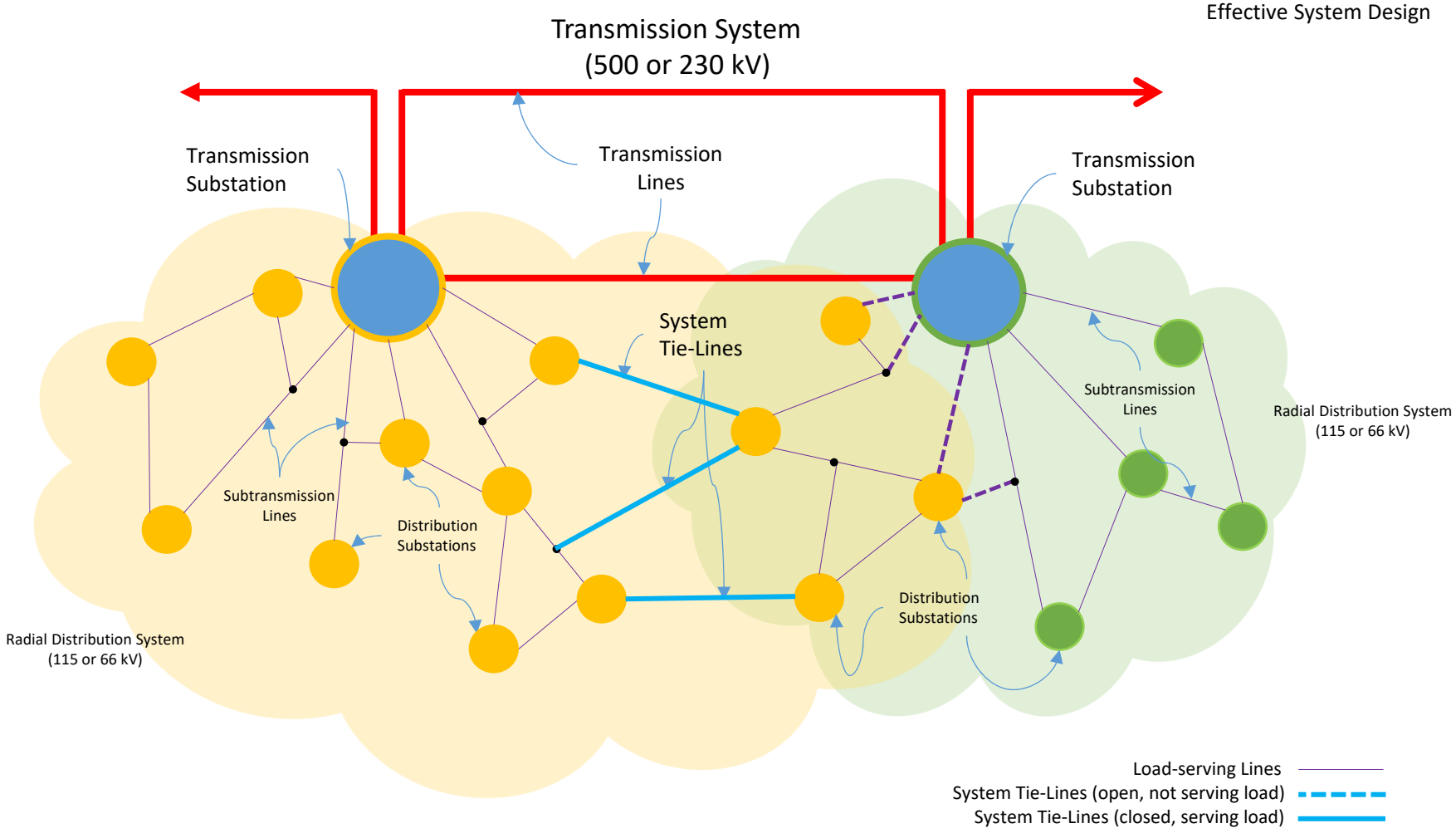
Radial Distribution System with no system tie-lines



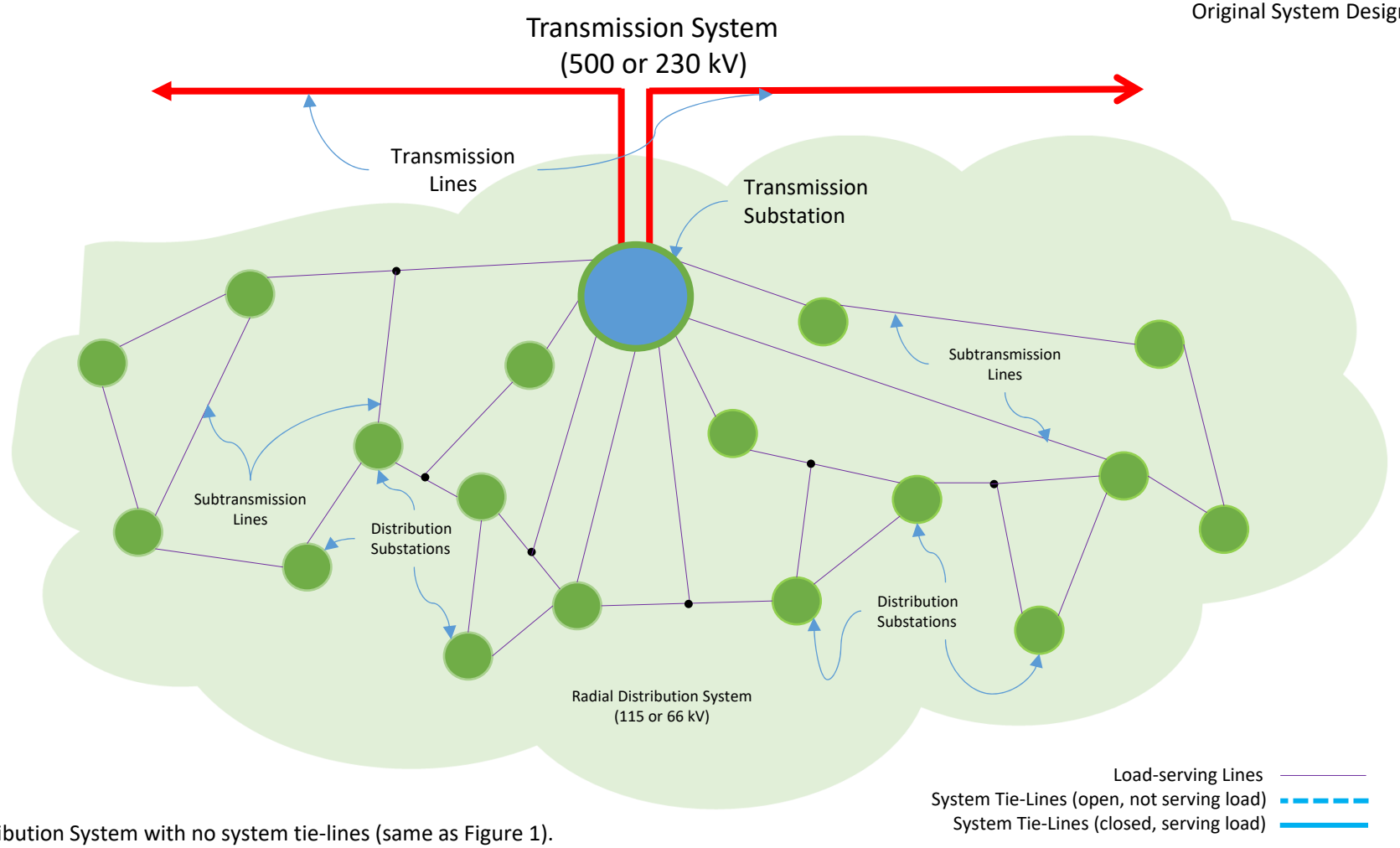
(2) Radial Distribution Systems with *effective* system tie-lines located "downstream" at the intersection of the two systems thus allowing for bi-directional transfer of substations without interfering with the reliable and safe operation of the remaining network following a transfer.



(2) Radial Distribution Systems with *effective* system tie-lines. Following an incident on the system to the left, the system on the right is able to effectively transfer significant load from the system on the left to provide relief and improving reliability and resiliency.

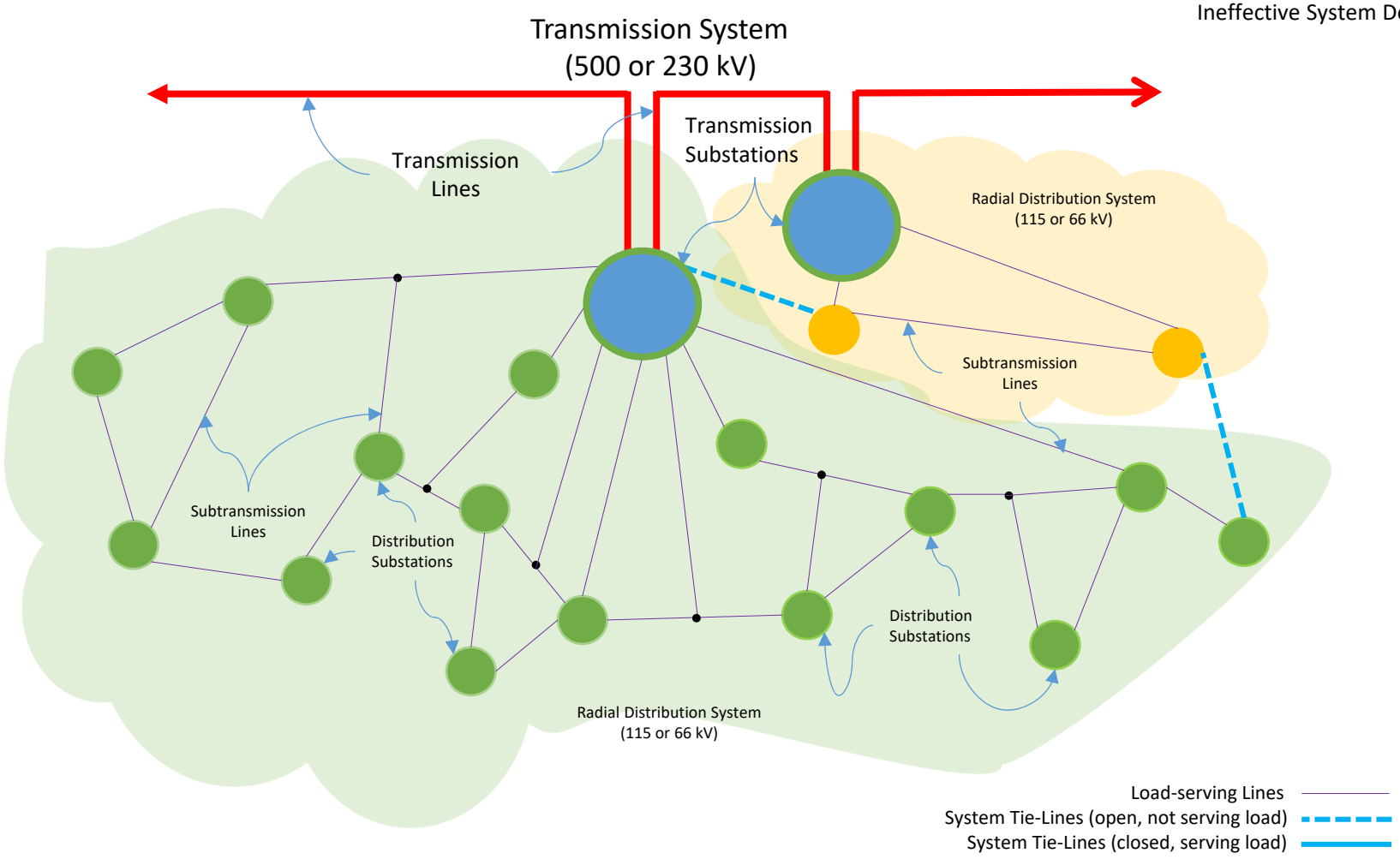


(2) Radial Distribution Systems with *effective* system tie-lines. Following an incident on the system to the right, the system on the left is able to effectively transfer significant load from the system on the right to provide relief and improving reliability and resiliency.



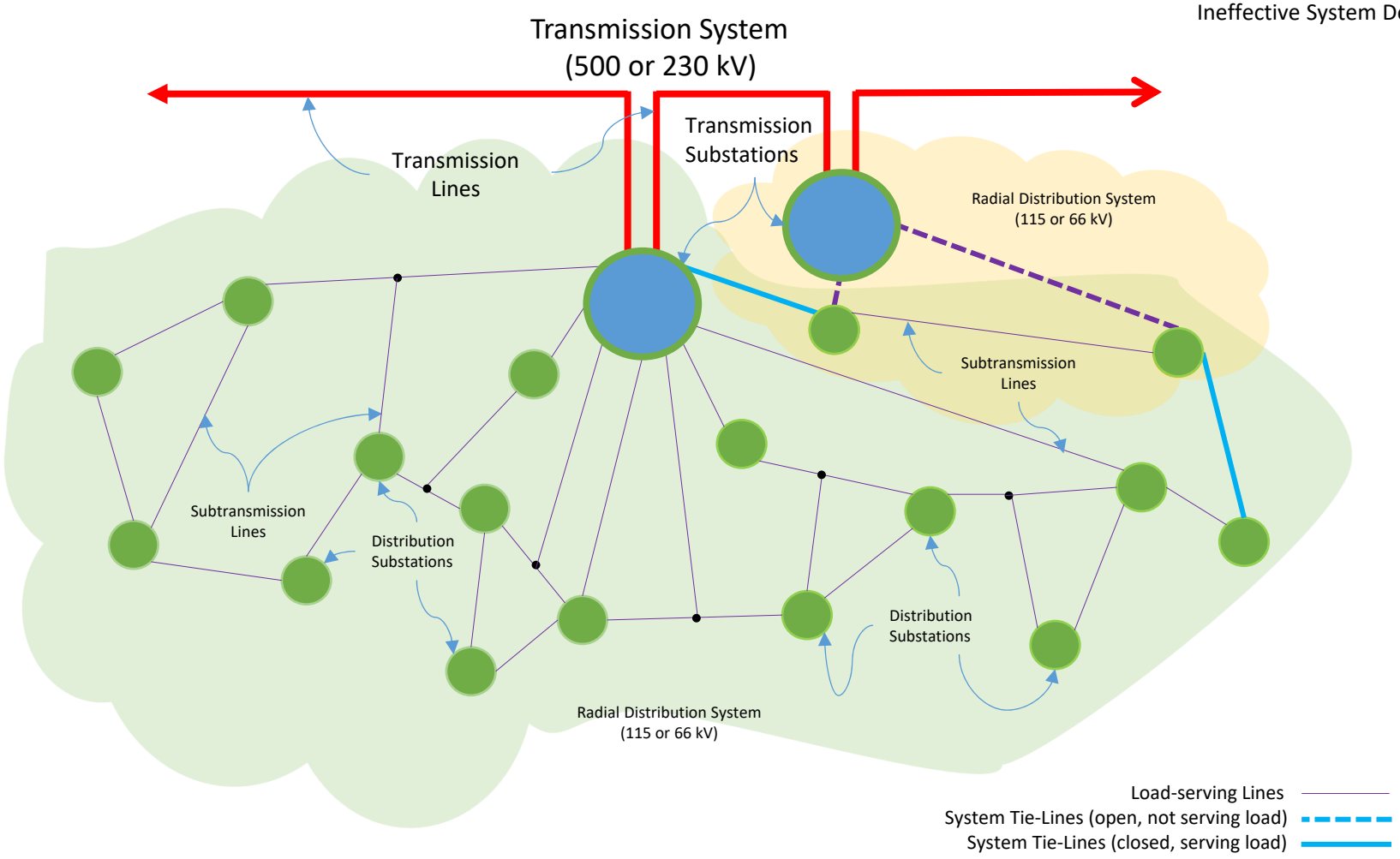
Radial Distribution System with no system tie-lines (same as Figure 1).

Ineffective System Design



(2) Radial Distribution Systems with *ineffective* system tie-lines *not* located "downstream" at the intersection of the two systems thus not allowing for bi-directional transfer of substations without interfering with the reliable and safe operation of the remaining network following the transfer.

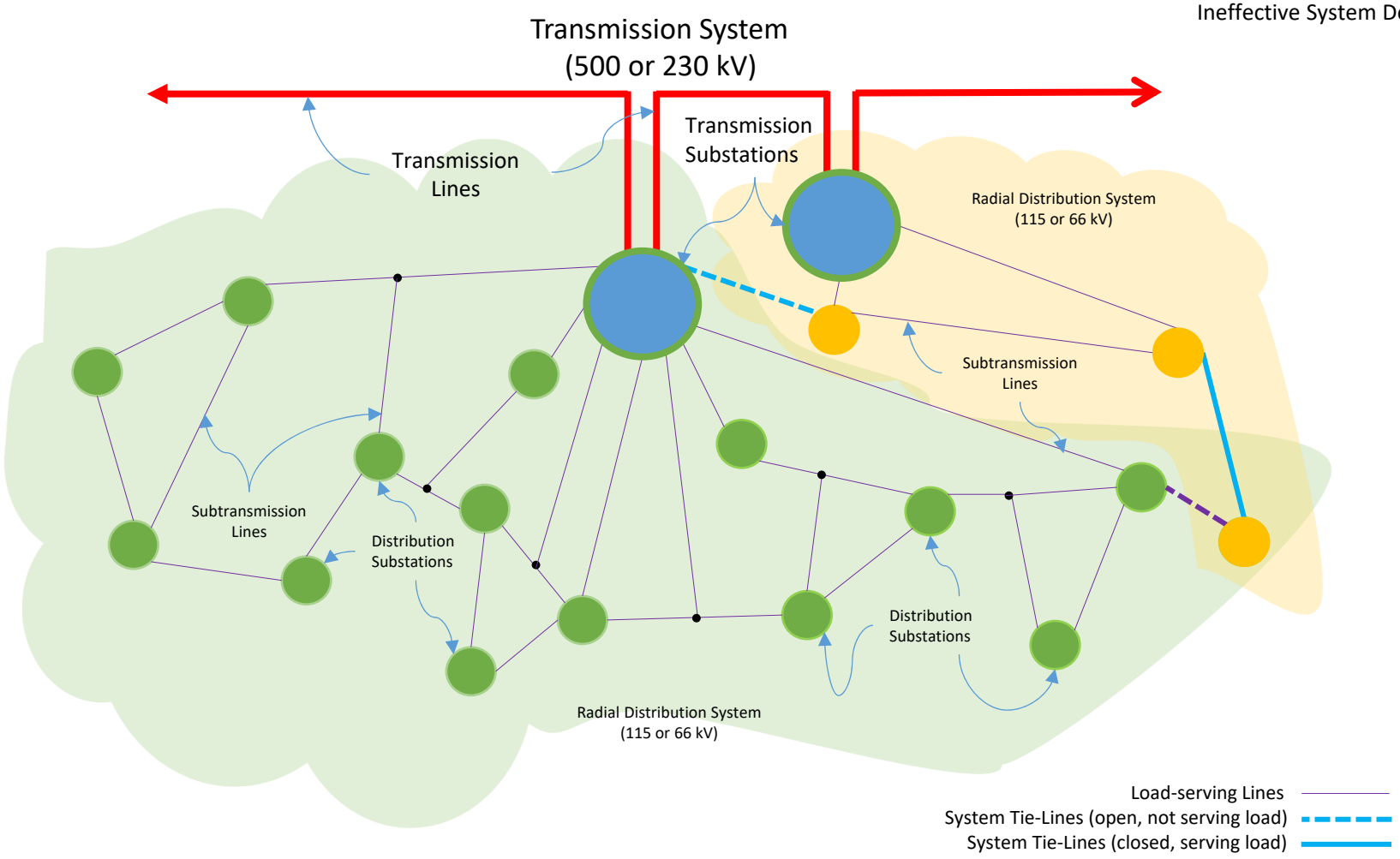
Ineffective System Design



(2) Radial Distribution Systems with *ineffective* system tie-lines *not* located "downstream" at the intersection of the two systems thus limiting bi-directional transfer of substations without interfering with the reliable and safe operation of the remaining network following a transfer.

In this example, the system on the left is able to transfer back the two substation that the system on the right initially transferred.

Ineffective System Design



(2) Radial Distribution Systems with *ineffective* system tie-lines *not* located "downstream" at the intersection of the two systems thus limiting bi-directional transfer of substations without interfering with the reliable and safe operation of the remaining network following a transfer.

In this example, the system on the right is unable to transfer more than one substation from the system on the left thus severely limited its effectiveness.

Tie-Line Road Map

- What benefit metrics in the Planning Study reflect effectiveness of system tie-lines and how do the metrics account for this?
  - The benefits of system tie-lines are reflected in Flex-1 and Flex-2 Metrics
    - Flex-1 – ability to transfer load to adjacent systems in response to N-2 events
      - N-2 single event initiates two unplanned line outages
      - N-1-1 contingencies (unplanned line outage coincident with a planned outage) were considered in the original analysis but were confirmed to be very infrequent
        - In reality system tie lines when available are used to proactively or reactively mitigate N-1-1s
        - If tie-lines are not available maintenance or construction are limited to times of year when N-1-1s will not result in loss of service
    - Flex 2 – ability to transfer load to adjacent systems to recover from loss of transformers at Valley South
  - The power system analysis considers all contingencies and appropriate line ratings, and implements the load transfers enabled by the alternative tie-lines to minimize EENS
    - Monetized benefits reflect probabilities of outages

Tie-Line Road Map

- Why are ASP tie-lines effective?
  - ASP creates a new source substation which allows additional substation transfers via tie-lines beyond those permanently transferred
  - ASP creates 3 system tie-lines requiring limited scope
  - The substations which can be transferred between the Valley South and Alberhill System are located on the boundaries of each system
    - Scope to construct the tie-lines is minimized
    - Transfers have limited impact on the rest of the systems and limit the introduction of additional constraints
    - Should future additional tie-lines be needed, ASP is well positioned to accommodate it with relatively minor scope

Tie-Line Road Map

- What other alternatives have similarly effective tie-lines and why?
  - SCE Orange County has relatively effective tie-lines which come as a result of the system configuration that transfers the initial two substations. This happens to be the “equilibrium” point of the Valley South System thus allowing the reconfiguration to occur with tie-lines which remain that could transfer a significant amount of additional load during contingencies.

  - SDG&E and Mira Loma also have reasonably effective tie-lines but each have limitations as compared to ASP and SCE Orange County. SDG&E and Mira Loma are limited to the amount of relief they can provide due to which substations they are able to next transfer under N-1 conditions (how much they are loaded and how they fit in the network)

Tie-Line Road Map

- Why are VS-VN tie-lines not considered effective?
  - The minimal scope required to perform the initial transfer to provide transformer relief does not produce effective tie-lines because the two substations initially transferred are examples of those for which once removed adversely affect the continuity of the network as the lines used to transfer them, remove integral lines from the network.
  - Tie-lines only allow transfer of load back from Valley North to Valley South
    - No new transmission substation is created (and the associated additional capacity); thereby limiting the amount of relief that can be provided due to the limited available transformer capacity in Valley North
  - Modifications to lines emanating from Valley have significant impact to the system
    - Tapping into lines at Valley Substation eliminates the required second source line for substations elsewhere in the system
    - Substantial scope would be required to construct second source lines