#R17 Morgantown – Oak Grove 1250 MW

Generator Interconnection

This analysis was completed to assess the reliability impact for a new generator interconnecting to the PJM System as a Capacity Resource.

Network Impacts (Option #1 – 4 breakers/bay)

The R17 project was studied as a 1250 MW capacity into the four Oak Grove - Morgantown 230 kV circuits. R17 was evaluated for compliance with reliability criteria for summer peak conditions in 2011. Potential network impacts were as follows:

Network Impacts

Normal System

(Normal system with Queue R17 connected at 1250 MW Capacity output and all system facilities in service – no facility outages)

1. The Bowie Sub – Burtonsville 230 kV circuit #23045 is overloaded from 87% to 113% of its normal rating (608 MVA). The R17 project contributes approximately **159 MW** to cause the thermal violation. ***Also see Impact number 5.***

2. The Oak Grove - Bowie Sub 230 kV circuit #23045 is overloaded from 87% to 113% of its normal rating (608 MVA). The R17 project contributes approximately **160 MW** to cause the thermal violation. ***Also see Impact number 6.***

3. The Bowie Sub – Burtonsville 230 kV circuit #23042 is overloaded from 82% to 108% of its normal rating (608 MVA). The R17 project contributes approximately **160 MW** to cause the thermal violation. ***Also see Impact number 7.***

4. The Oak Grove - Bowie Sub 230 kV circuit #23042 is overloaded from 82% to 108% of its normal rating (608 MVA). The R17 project contributes approximately **160 MW** to cause the thermal violation. ***Also see Impact number 8.***

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

Overloaded facilities identified in the Normal System section, number 1 through 4 above, are also overloaded for various single contingencies as well as for certain Multiple Facility Contingencies listed in the next section below. The overload magnitudes for these facilities, under single contingency conditions, are greater than the normal system overloads but less than the Multiple Facility contingency overloads.

Multiple Facility Contingency

(Double Circuit Towerline contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

5. The Bowie Sub – Burtonsville 230 kV circuit #23045 is overloaded from 96% to 125% of its emergency rating (730 MVA) for the **tower** outage of Chalk Point to Bowie 230 V line and Oak Grove to Burtonsville 230 kV line (Cont Id. 5PEPC0). The R17 project contributes approximately **212 MW** to cause the thermal violation

6. The Oak Grove - Bowie Sub 230 kV circuit #23045 is overloaded from 96% to 125% of its emergency rating (730 MVA) for the **tower** outage of Chalk Point to Bowie 230 V line and Oak Grove to Burtonsville 230 kV line (Cont Id. 5PEPCO). The R17 project contributes approximately **212 MW** to cause the thermal violation.

7. The Bowie Sub – Burtonsville 230 kV circuit #23042 is overloaded from 93% to 122% of its emergency rating (730 MVA) for the **tower** outage of Bowie to Oak Grove 230 kV line and Oak Grove to Chalk Point 230 kV line (Cont Id. 7PEPCO). The R17 project contributes approximately **212 MW** to cause the thermal violation.

8. The Oak Grove - Bowie Sub 230 kV circuit #23042 is overloaded from 93% to 123% of its emergency rating (730 MVA) for the **tower** outage of Bowie to Oak Grove 230 V line and Oak Grove to Chalk Point 230 kV line (Cont Id. 7PEPCO). The R17 project contributes approximately **212 MW** to cause the thermal violation.

Short Circuit Analysis

No new circuit breakers were found to be overdutied as a result of Queue R17 generation addition.

Queue R17 may contribute short circuit current (above the threshold required for cost allocation) to previously identified overdutied circuit breakers. This will be determined for the R17 Impact study.

Stability Analysis

Will be performed for the Queue R17 Impact Study.

Contribution to Previously Identified Overloads
(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

9. The Conastone – Otter Creek 230 kV line is overloaded at 125% of its emergency rating (531 MVA) for the outage of Conastone – Peach Bottom 500 kV line (Cont Id. PJM17). The R17 project contributes approximately 67 MW to this overload.

10. The High Ridge - Howard (line #2332-A) 230 kV line is overloaded from 117% of its emergency rating (923 MVA) for the **tower** outage of Waugh Chapel to Brandon Shores 2342 & 2343 (Cont Id. 6BGE). The R17 project contributes approximately 93 MW to this overload.

11. The Conastone – Peach Bottom 500 kV line is overloaded at 152% of its emergency rating (2598 MVA) for the **generator** outage of Fordmill90 and Fordmill91 generators at buses 4565 & 4569 (Cont Id. PE506). The R17 project contributes approximately 213 MW to this overload.

Network Upgrade Requirements

New System Reinforcements
(Upgrades required to mitigate reliability criteria violations, i.e. "Network Impacts", initially caused by the addition of this project generation)

1. The estimated cost to upgrade the Bowie - Burtonsville 230 kV circuit (23045) is **$3,400,000**. This cost represents the addition of a second 230kV conductor to circuit 23045 from Bowie to Burtonsville (approximately 8 miles).
This upgrade also mitigates Multiple Facility Contingency Network Impact number 5.

2. The estimated cost to upgrade the Oak Grove - Bowie 230 kV circuit (23045) is **$5,000,000**. This cost represents the addition of a second 230kV conductor to circuit 23045 from Oak Grove to Bowie (approximately 12 miles).
This upgrade also mitigates Multiple Facility Contingency Network Impact number 6.

3. The estimated cost to upgrade the Bowie - Burtonsville 230 kV circuit (23042) is **$3,400,000**. This cost represents the addition of a second 230kV conductor to circuit 23042 from Bowie to Burtonsville (approximately 8 miles).
This upgrade also mitigates Multiple Facility Contingency Network Impact number 7.

4. The estimated cost to upgrade the Oak Grove - Bowie 230 kV circuit (23042) is **$5,000,000**. This cost represents the addition of a second 230kV conductor to circuit 23042 from Oak Grove to Bowie (approximately 12 miles).
   This upgrade also mitigates Multiple Facility Contingency Network Impact number 8.

   In order to bundle the above circuits, the existing lattice tower line structures are required to be replaced with new steel poles, foundations and new conductors. Engineering design work will need to be performed as well as the regulatory work related to obtain the necessary CPCN (Certificate of Public Convenience and Need). The cost estimates include material (steel poles, conductor, shield wire, insulators/hardware/grounding), construction, engineering and CPCN filings.

   The **estimated construction time is approximately four years**. This schedule assumes that all the necessary engineering work and issuance of the CPCN can be completed within the first year. The scheduling of outages will be very critical.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by Queue R17. Queue R17 % allocation cost responsibility will be calculated for the Impact Study)

9. Conastone – Otter Creek 230 kV Upgrade:

   PPL upgrade

   The PPL portion of the Conastone to Otter Creek line (from Otter Creek to the point where ownership changes to BG&E) can be upgraded by reconductoring approximately 17.2 miles of 795 kcmil 30/19 ACSR conductor (Ratings 425/531 MVA Summer Normal/Emergency based on conductor temp @125^{O}C) with new 795 kcmil 30/19 ACSS (new ratings 516/632 MVA Summer Normal/Emergency, conductor operating temperature of 160^{O} C)

   No terminal equipment upgrade is required at Otter Creek, it is currently built with 2000 amp rating equipment. The estimated cost of this upgrade is **$8.5 million.** Estimated construction time is **36 months.**

   This upgrade will result in minimal change to the impedance of the line.
   Existing Z = 0.0042 + j 0.0266 pu
   New Z = 0.0048 + j 0.02676 pu

   BG&E Upgrade

   The BG&E portion of the Conastone to Otter Creek line can be upgraded by Reconducting from Gorsuch Mills to the Pennsylvania State Line (change of ownership to PPL). The existing circuit 2302 conductor is 1,590 kcmil 45/7 ACSR from Conastone to Gorsuch Mills and 795 kcm 30/19 ACSR from Gorsuch Mills to the PA State Line.
   Assumptions:

- Reconductor with 1,590 kcm ACSR from Gorsuch Mills to PA line to match capability of remainder of line.
- Length of this line section is 1.7 miles.
- Towers can be reinforced instead of replaced.
- Based on previous estimate by R.W.M. for PJM (B48) study on circuit 22008

The estimated cost of this upgrade is **$700,000**. Estimated construction time is **36 months**.

10. High Ridge – Howard 230 kV Upgrade: The existing circuit 2332-A has 1590 Kcmil conductor which will need to be replaced. The estimated cost to rebuild the structures to accommodate new 2167 Kcmil ACSR conductor is **$16,000,000** and it will take approximately **60 months**.

    Assumptions:
    - Length of line 8.0 miles
    - 2+ year CPCN process at a cost of $500,000
    - Existing tower removal at a cost of $1M included.

11. Conastone – Peach Bottom 500 kV Upgrade: To mitigate a 52% overload of the Conastone – Peach Bottom 500 kV circuit a second circuit will need to be built.

    PECO portion of the Conastone – Peach Bottom line:

Substation work at Peach Bottom	$ 2,500,000
Construct 6.25 miles of 500kV line	$10,000,000
	$12,500,000

    This estimate do not include the cost of new right of way.
    Construction of the new line will take approximately **30 months** after the right of way is acquired.

    Note: It should be noted that PJM Queue P04 project also requires widening of about two miles of this right of way for their direct connection line and would use the last remaining terminal position that exists at Peach Bottom substation. If Queue P04 proceeds with their project it may complicate right of way acquisition and double the substation costs at Peach Bottom.

    BGE portion of the Conastone – Peach Bottom line:

    1. Build new 500 kV line adjacent to existing circuit 5012 from Conastone to Pennsylvania State Line at an estimated cost of **$48,000,000** and a construction time of approximately **84 months.**
       Assumptions:
       - Acquire 150 ft. wide R/W adjacent to existing R/W, mostly rural land at $100,000 per acre
       - 2 to 3 year CPCN process prior to land acquisition
       - Length of line 9.6 miles

2. Install one 500kV breaker at Conastone **$1,500,000**. Breaker installation can be completed concurrently with the line construction.

Contribution to Previously Identified Circuit Breaker Upgrade Requirements due to Short Circuit contribution from Queue R17

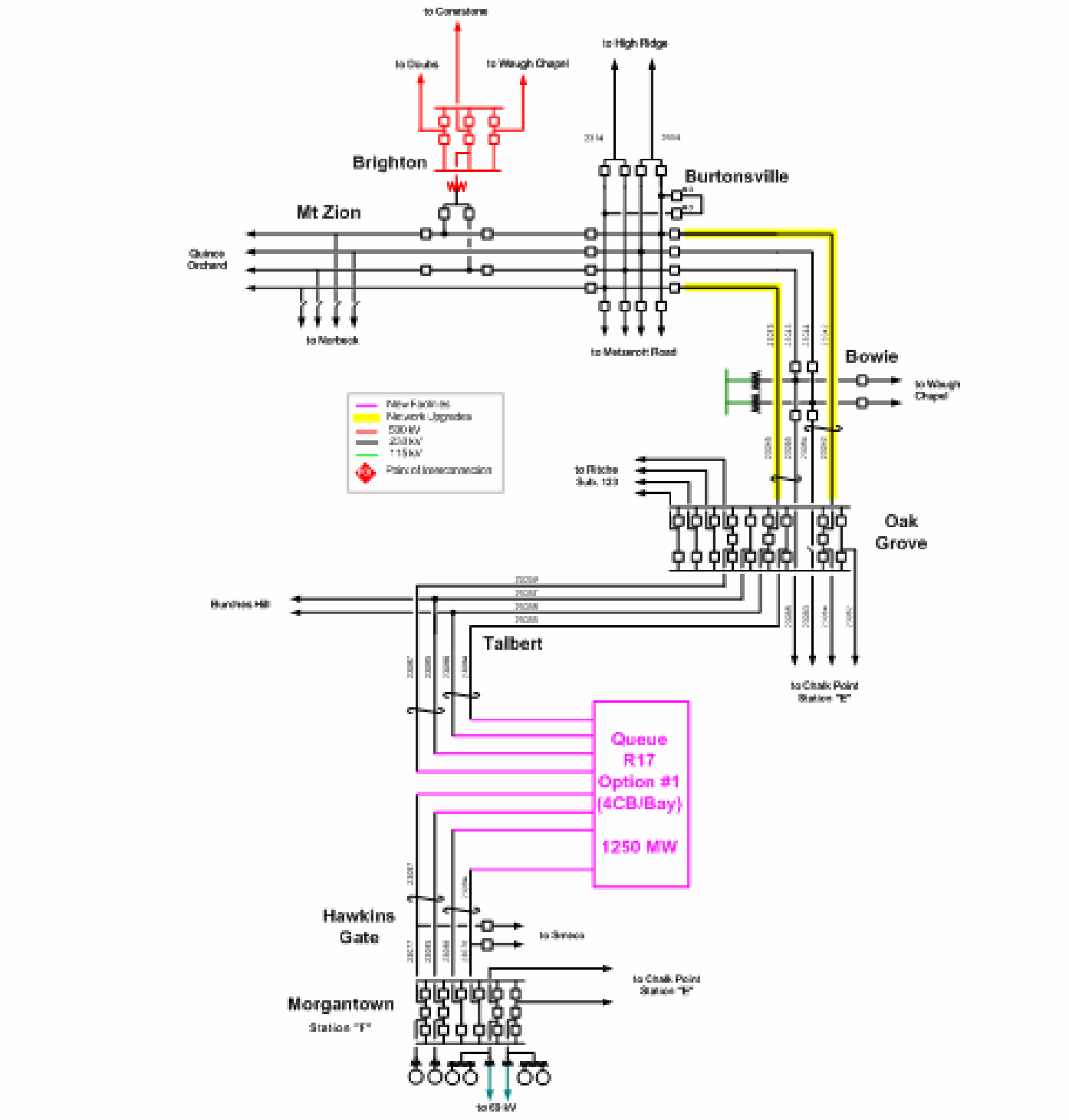
TBD

Option #1 (4 breakers / bay) total Network Upgrade cost estimate for reinforcements number 1 through 11.

$ 16,800,000	**New Reinforcements (1-8)**
$ TBD	**Circuit Breaker Upgrade Requirements**
$ 87,200,000*	**Previously Identified Reinforcements (9-11)***

*** Queue R17 would only be responsible for an allocated % of this cost. Queue R17 allocation to Previously Identified Reinforcements will be calculated for the Queue R17 Impact Study.**

Option #1 – 4 breakers / Bay
PEPCO System Upgrade Requirements Reference One Line Diagram



OPTION #2

3 breakers / bay interconnection station design

Network Impacts

In addition to the Network Impacts identified for Option #1 the following were identified:

Multiple Facility Contingency

(Double Circuit Towerline contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

1. The Talbert Tap – Oak Grove 230 kV circuit #23066/23084 is overloaded from 63% to 116% of its emergency rating (680 MVA) for the **tower** outage of Oak Grove – Talbert tap – R17TAP87 230 kV circuit #23087 and the Oak Grove – Talbert Tap – R17TAP85 230 kV circuit #23085 (Cont Id. 12PEPCO_B). The R17 project contributes approximately **356 MW** to cause the thermal violation.

2. The Talbert Tap – Oak Grove 230 kV circuit #23069/23087 is overloaded from 63% to 116% of its emergency rating (680 MVA) for the **tower** outage of Oak Grove – Talbert Tap – R17TAP86 230 kV circuit #23086 and Oak Grove – Talbert Tap – R17TAP84 230 kV circuit #23084 (Cont Id. 10PEPCO_B). The R17 project contributes approximately **356 MW** to cause the thermal violation.

3. The R17TAP87 - Talbert Tap 230 kV circuit #23087 is overloaded from 63% to 116% of its emergency rating (680 MVA) for the **tower** outage of Oak Grove – Talbert Tap – R17TAP86 230 kV circuit #23086 and Oak Grove – Talbert Tap – R17TAP84 230 kV circuit #23084 (Cont Id. 10PEPCO_B). The R17 project contributes approximately **356 MW** to cause the thermal violation.

4. The R17TAP84 - Talbert Tap 230 kV circuit #23084 is overloaded from 59% to 108% of its emergency rating (730 MVA) for the **tower** outage of Oak Grove – Talbert tap – R17TAP87 230 kV circuit #23087 and the Oak Grove – Talbert Tap – R17TAP85 230 kV circuit #23085 (Cont Id. 12PEPCO_B). The R17 project contributes approximately **356 MW** to cause the thermal violation.

5. The R17TAP85 - Talbert Tap 230 kV circuit #23085 is overloaded from 50% to 109% of its emergency rating (730 MVA) for the **tower** outage of Oak Grove – Talbert Tap – R17TAP86 230 kV circuit #23086 and Oak Grove – Talbert Tap – R17TAP84 230 kV circuit #23084 (Cont Id. 10PEPCO_B). The R17 project contributes approximately **431 MW** to cause the thermal violation.

6. The R17TAP86 - Talbert Tap 230 kV circuit #23086 is overloaded from 50% to 109% of its emergency rating (730 MVA) for the **tower** outage of Oak Grove – Talbert tap – R17TAP87 230 kV circuit #23087 and the Oak Grove – Talbert Tap – R17TAP85 230 kV circuit #23085 (Cont Id. 12PEPCO_B). The R17 project contributes approximately **431 MW** to cause the thermal violation.

Network Upgrade Requirements

In addition to the Network Upgrade Requirements identified for Option #1 the following were identified:

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. "Network Impacts", initially caused by the addition of this project generation)

1. The estimated cost to upgrade Oak Grove- Talbert is **$4,100,000** (10 miles).
2. The estimated cost to upgrade Oak Grove – Talbert is **$4,100,000** (10 miles)
3. The estimated cost to upgrade Talbert – R17 is **$5,300,000** (13 miles)
4. The estimated cost to upgrade Talbert – R17 is **$5,300,000** (13 miles)
5. The estimated cost to upgrade Talbert – R17 is **$5,300,000** (13 miles)
6. The estimated cost to upgrade Talbert – R17 is **$5,300,000** (13 miles)

In order to bundle the above circuits, the existing lattice tower line structures are required to be replaced with new steel poles, foundations and new conductors. Engineering design work will need to be performed as well as the regulatory work related to obtain the necessary CPCN (Certificate of Public Convenience and Need). The cost estimates include material (steel poles, conductor, shield wire, insulators/hardware/grounding), construction, engineering and CPCN filings.

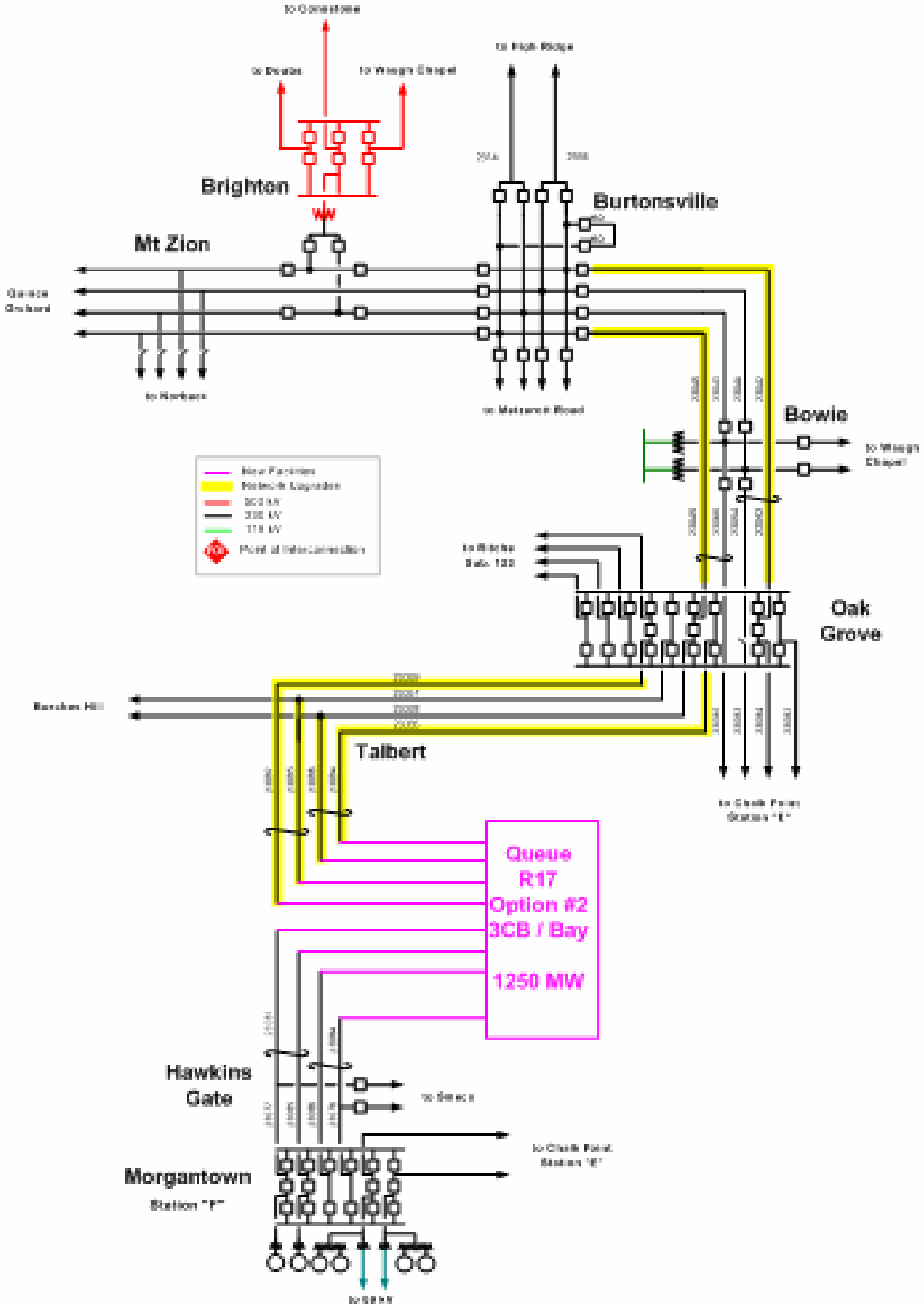
The **estimated construction time is approximately four years**. This schedule assumes that all the necessary engineering work and issuance of the CPCN can be completed within the first year. The scheduling of outages will be very critical.

Option #2 (3 breakers / bay) total Network Upgrade cost estimate for reinforcements number 1 through 11.

$ 16,800,000	**New Reinforcements (1-8) Identified for Option #1**
$ TBD	**Circuit Breaker Upgrade Requirements**
$ 87,200,000*	**Previously Identified Reinforcements (9-11)***
$ 29,400,000	**Additional New Reinforcements (1-6) Identified for Option #2**

*** Queue R17 would only be responsible for an allocated % of this cost. Queue R17 allocation to Previously Identified Reinforcements will be calculated for the Queue R17 Impact Study.**

Option #2 – 3 breakers / Bay
PEPCO System Upgrade Requirements Reference One Line Diagram



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