PJM Generator Interconnection S40 Hegins 10.5 MW Feasibility / Impact Study

September 2007

Docs # 433236

General

Queue S40 is a Stonegate Renewable Energy, L.P. [or "Stonegate"] 10.5 MW Capacity Resource interconnection request consisting of two 5.7 MW methane gas-fueled synchronous generators. Initially a third future 5.7 MW generator was proposed as part of the Queue S40 request; however, this consideration was later asked to be removed by S40 Interconnection Customer. Queue S40 is located near Hegins, Schuylkill County, PA at the Commonwealth Landfill adjacent to Interstate 81 and Route 25. Queue S40 generation is scheduled for commercial operation in December, 2008.

Queue S40 has requested that all interconnection options be investigated. The options for generation interconnection to PPL EU are at 69kV, 23kV and 12kV.

Direct Connection (12 kV Option)

The S40 generation project **cannot** be connected to the 12 kV at the Hegins 69/12 kV Substation by means of an express feeder from that substation to the S40 site. The 12 kV express feeder for the S40 generator would be approximately 7.5 to 8 miles away from the Hegins 69/12 kV Substation. The voltage variation caused by connecting the S40 project to the 12 kV system at Hegins will far exceed 1.5 % on the Hegins Substation bus. This is in violation of PPL EU Reliability Principles and Practices. To control the voltage rise to meet PPL EU requirements, the S40 would have to absorb a significant amount of VARs from the EU system, limiting the amount of MW the S40 could generate.

Direct Connection (23 kV Option)

The S40 generation project can be connected to the 23kV at the Frailey 69/23 kV Substation by means of an express feeder from that substation to the S40 site. The 23 kV express feeder from the Frailey Substation will be using a portion of the existing Frailey 21-02, 23 kV line to provide the least cost alternative to the customer. The connection of the S40 project to the Frailey 69/23 kV Substation requires approximately 4 miles of new 23 kV line, substation modifications and the transfer of all existing 21-01 line 23 kV customers from the Frailey 21-01, 23 kV line to the Hegins 58-02, 12.47 kV line by converting approximately 13 miles of 23 kV line to 12 kV. The S40 project will then be on a dedicated feeder from the 23 kV substation.

The existing spare transformer at Frailey Substation is rated for 7.5 MVA. The customer's generation exceeds the capability of this transformer for failure of the in-service transformer. Therefore, a new 69/23 kV spare transformer for Frailey substation will need to be purchased by the customer to continue to generate at full capability if the in-service transformer failed. The customer will be responsible to obtain a transformer which meets specifications determined by PPL EU and will be approved by PPL EU prior to purchase. The cost of this transformer is **not included** in the cost estimate below.

The total magnitude cost estimate for 23 kV direct connection is approximately $**5,900,000**.

Preliminary Schedule (23 kV Option)

PPL EU will require between 36 and 48 months to complete engineering and construction activities in order to connect the customer to the dedicated 23kV circuit. This work can only begin after an ISA is signed and PJM authorizes PPL EU to proceed. Based on information to date, PPL EU cannot complete the required work for interconnecting the S40 project at 23 kV by the requested in-service date.

Notes:

- The ISA/CSA or an Interim Agreement must be signed by the S40, PJM and PPL EU before any PPL EU activities may commence.
- PPL EU recommends that an Interim ISA/CSA be completed during the Facilities Study stage to address critical path items, such as long lead-time purchases and the compressed project schedule.
- PPL EU may be restricted to scheduling outages during light loading periods, most likely the spring or fall seasons. This outage restriction may extend the schedule by 6 months or more if an outage season is missed.
- Excepting any operational, governmental and/or environmental regulatory delays, the use of additional resources, such as overtime, premiums for expedited material, and/or contractor labor, may enable PPL EU to decrease this construction period. It is also assumed that all right-of-way and easements are secured without impact on anticipated construction start dates.

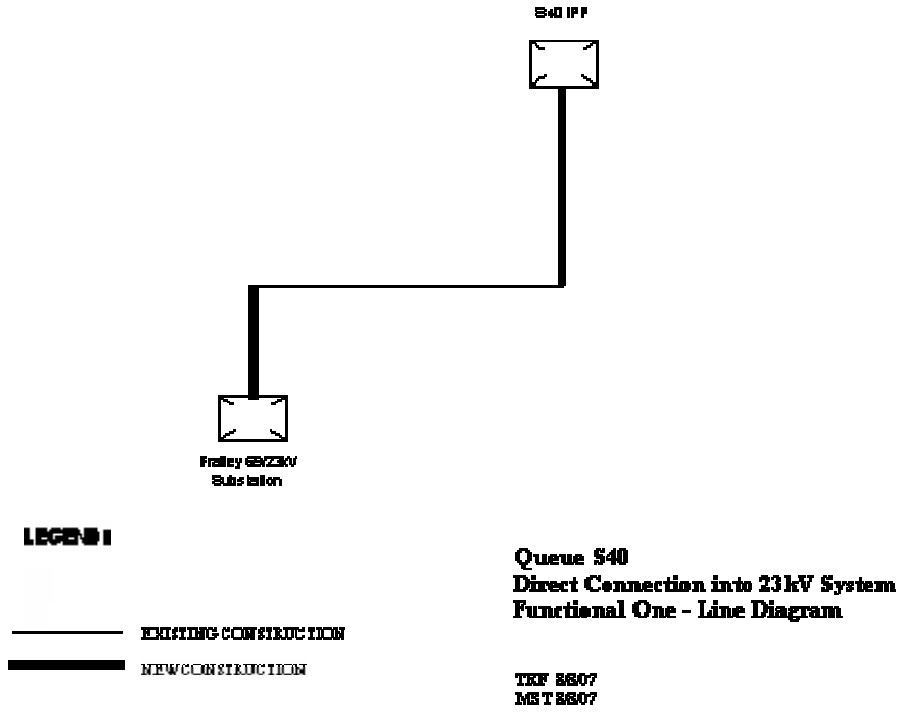


Figure 1 – Queue S40 Direct Connection 23 kV Option

Direct Connection (69 kV Option)

(Connection to the Eldred – Pine Grove 69 kV Line)

The S40 generation project can be connected to the existing Eldred – Pine Grove 69 kV line by means of a tap from that line to the S40 site. The 69kV tap for the S40 generator would be somewhere near the Hegins tap on the Eldred – Pine Grove 69kV line. See Figure 2 for a one-line diagram of the 69 kV interconnection.

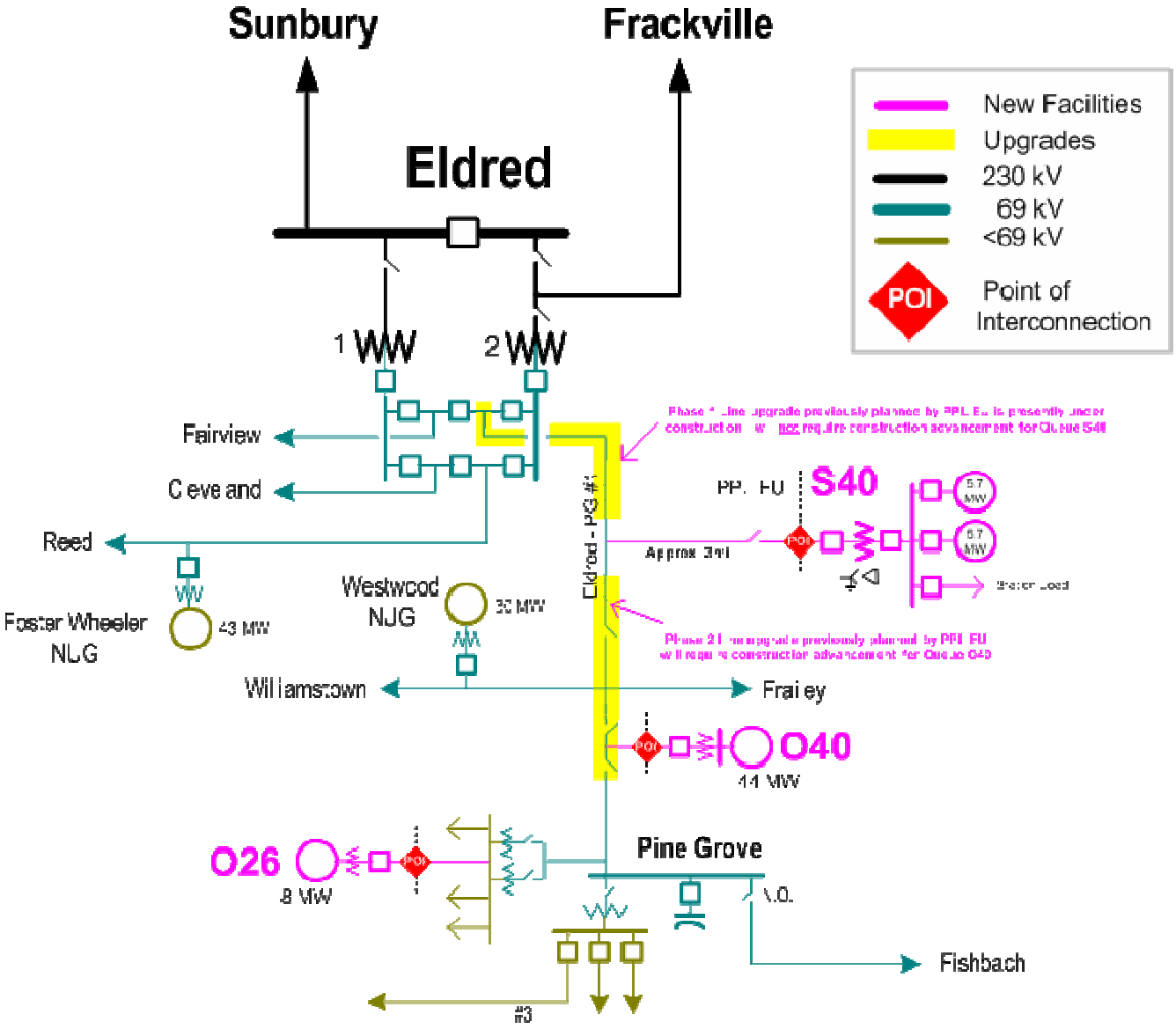


Figure 2 – Queue S40 Direct Connection (69 kV Option)

A new tap point will be created on the Eldred – Pine Grove 69 kV line for S40. This tap will be at a location determined by siting and engineering between grid 362S510 (Eldred substation) and 367S472 (Frailey substation). PPL Electric Utilities (PPL EU) will construct a tap from the Eldred – Pine Grove 69 kV line expected to be approximately 3 miles long and will terminate at a new 69 kV substation for Queue S40 at Commonwealth Landfill.

The 69 kV connection estimate is based on building approximately 3 miles of 69 kV transmission tap to a dead end structure somewhere on the developer's property. The exact point of interconnection has not been specified and so this estimate is only for a 69kV transmission line that will reach the S40 developer's property. The cost for the inter-tie transformer is not included in the cost estimate. The estimate also assumes there are no excessive costs or delays due to problems with siting, easement, right-of-way acquisition. The magnitude direct connection cost estimate is **$3,750,000** (excluding any applicable state or federal taxes).

A further breakdown of the direct connection costs for the **69 kV connection** is as follows:

$ 2,830,000	Transmission work for approximately 3 miles of 69 kV line
$ 140,000	Substation work
$ 50,000	69 kV Metering
$ 730,000	Siting and R/W Acquisition

After the Interconnection Service Agreement and Construction Service Agreement are signed, the time needed for siting and right-of-way acquisition work could be up to **24 months**. This could be decreased if the developer attains the right of way necessary for the 69kV line. The time needed to complete the transmission work is estimated to be **12 months** but could be less if the tap length is less than the estimated 3 miles. Substation work will be relatively short time frame and can be completed simultaneously with the 69 kV line construction.

Transmission Line Tap Direct Connection Work
$2,830,000 (69 kV Transmission tap)

The 69 kV tap for S40 will originate from the Eldred – Pine Grove 69 kV line near the present Hegins tap, grid block 363S481. The transmission tap then extends approximately 3 miles to terminate at grid block 379S489.

The above transmission direct connection cost includes construction of approximately 3 miles of 69 kV line consisting of three 556.5 kcmil 24/7 ACSR conductors and one optical fiber overhead ground wire (OPGW) for Direct Transfer Trip (DTT). The estimate assumes ten poles per mile including one self supporting custom designed angle foundation structure. Site preps for the steel poles and road costs are included.

Alternate Outlet for Continued Generation During PPL EU Maintenance

An alternate outlet for the generation was not requested. The S40 facility will not be able to generate into the PPL EU network during maintenance on the 3 mile line or during maintenance on the 69 kV equipment located at the S40's 69 kV Substation (Commonwealth).

Substation Requirements & Costs
$140,000

The estimated cost for modifications at Eldred (install DTT) is $140,000. This is based on the Eldred – Pine Grove 69 kV transmission line rebuild currently in progress to be completed. As part of this rebuild, OPGW will be installed. Consequently, fiber should be available at the proposed tap location for the S40 S40. The estimated engineering duration would be 3 to 4 months. This estimate also includes labor costs to review the S40 drawings, and for the Relay Test Department to test and commission the S40 equipment at the S40 site.

Metering Equipment Installation at the point of interconnection
$50,000

Metering Equipment will be installed at a suitable point at the S40 site. PPL EU will design and purchase the required metering equipment. Some equipment will need to be installed by the S40 developer. All metering equipment must meet applicable PPL EU tariff requirements as well as also must meet all applicable requirements of the PJM agreements. The estimated cost for Metering equipment and labor is **$50,000**. The lead time for metering equipment currently varies between 36 to 42 weeks.

Queue S40 Generating Station Revenue Metering and SCADA Requirements

For PJM: Queue S40 will be required to install necessary equipment to provide "Revenue Metering (KWH, KVARH)" and real time data (KW, KVAR, KV) for the Interconnection Customer's generating resource. See PJM Manuals M-01 and M-14D, and the PJM Tariff.

For PPL EU: Queue S40 will be required to install necessary equipment to provide bi-directional "Revenue Metering (KWH, KVARH)" and real time data (KW, KVAR, circuit breaker status, and 24 kV voltages) for the Interconnection Customer's generating resource.

SCADA
Queue S40 will be required to install a PPL EU compatible SCADA RTU and the associated phone line to the closest PPL EU service center. Note that this will be a dedicated 4 wire analog phone circuit which is a special order causing long lead time service from the phone company.

S40 Generator and GSU Modeling for the 69 kV Connection

Per the S40 supplied data the following was used in modeling the generator and GSU

S40 Generator: 7.1 MVA base. 10.5 MW Net injected in to PPL EU system. 0.8 PF but operated between 0.9 lead and 0.9 lag. Saturated sub-transient reactance = 13.8% on 7.1 MVA base.

GSU (Step-up Transformer): 20 MVA, 69 / 4.16 kV transformer, Impedance is 8% with X/R ratio of 10 (assumed) at 20 MVA base. S40 must provide more detailed data for future studies.

Siting, Right-of-Way Acquisition, & Environmental Impact
$730,000

Siting and right-of-way acquisition for a new line is based on 69 kV construction/operation and no future plans for 138kV or future double circuit operation of this tap. PaPUC certification is not required because the line is being designed and constructed to operate at less than 100 kV. However, PPL EU may submit a Letter of Notification because the length exceeds 2 miles. The estimate does not include costs for mitigating extraordinary environmental, archaeological or cultural impacts. The estimate does not include costs to litigate or condemn property, should that become necessary. The estimated cost for siting and R/W is **$730,000.** The estimated time to site and acquire right of way for a project of this magnitude is 24 months.

Preliminary Schedule (69 kV)

PPL EU requires up to 24 months for siting and right-of-way acquisition for 69kV connection. Up to 24 months could be required to complete engineering & construction activities. Queue S40 should be informed that this work can only begin after an ISA is signed and PJM authorizes PPL EU to proceed.

To minimize the siting time frame, PPL suggests that the S40 developer secure the necessary rights-of-way for the transmission tap. S40 must ensure, however, that the standard PPL EU R/W agreement is used in this process. It should also be noted that an Interstate 81 crossing will most likely be required. PPL estimates the permitting process to take an estimated 9 months.

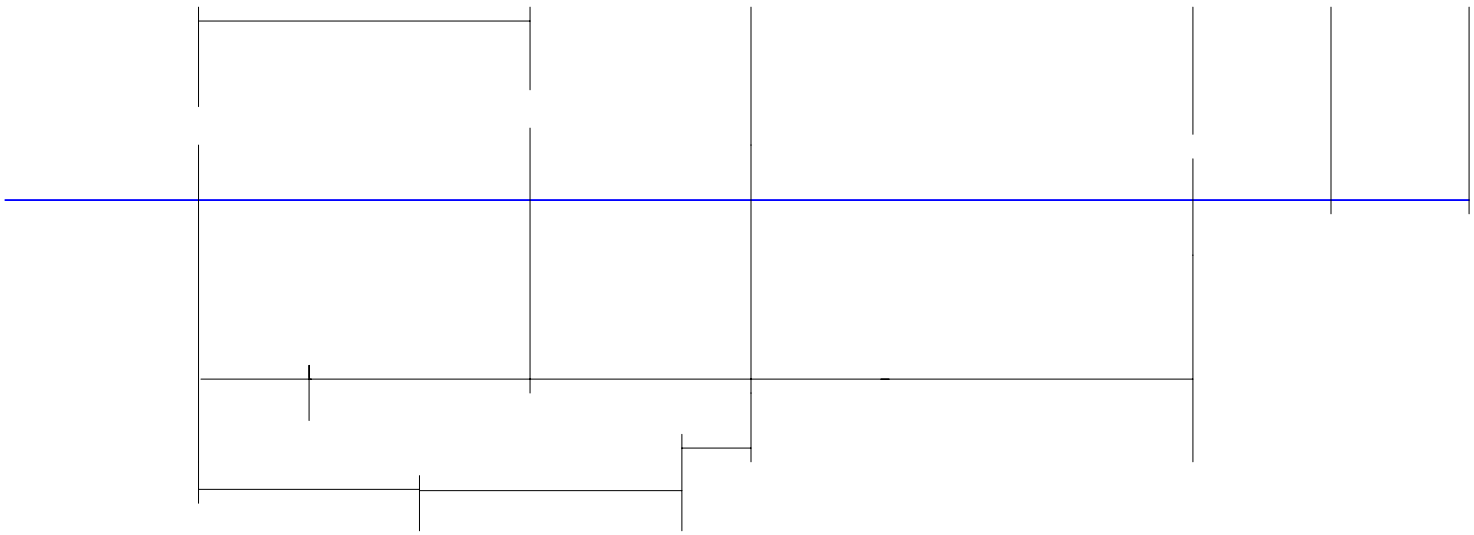
Design and construction can begin after right-of-way has been secured and is estimated to take 12 months. Construction must be scheduled for light load periods and may be affected by the Eldred – Pine Grove 69 kV rebuild project.

Based on information to date, PPL EU cannot complete the required work for interconnecting S40 project at 69 kV by the requested in-service date of October 2008. A **Fall 2009** in-service date is most probable, but delays could push the in-service-date beyond that estimate.

Notes:

- The ISA/CSA or an Interim Agreement must be signed by Queue S40, PJM and PPL EU before any PPL EU activities may commence.
- PPL EU recommends that an Interim ISA/CSA be completed during the Facilities Study stage to address critical path items, such as long lead-time purchases and the compressed project schedule.
- PPL EU may be restricted to scheduling outages during light loading periods, most likely the spring or fall seasons. This outage restriction may extend the schedule by 6 months or more if an outage season is missed.
- Procurement lead-times for metering equipment may extend to 42 weeks. Meter design, procurement and installation schedules must be implemented accordingly.
- Excepting any operational, governmental and/or environmental regulatory delays, the use of additional resources, such as overtime, premiums for expedited material, and/or contractor labor, may enable PPL EU to decrease this construction period.

- The S40 connection will be to PPL EU's 69 kV system. It should be recognized that PPL EU's longer term plan is to convert all 69 kV facilities to 138 kV. However, at this point in time, there are currently no plans to convert the Eldred-Pine Grove 69 kV line to 138 kV within the next 15 years. Further, to assist S40 and avoid delays caused by filing a full Siting Application for the proposed transmission tap, PPL EU will design the tap to 69 kV standards rather than 138 kV. While not anticipated, should future system conditions require PPL EU to convert to 138 kV, S40 will be responsible for all costs associated with conversion of the above transmission tap to 138 kV standards. This is in addition to any costs associated with converting S40's 69kV substation to accept 138 kV facilities.



Self-Excitation, Regulation, and Flicker Requirements

S40 proposes to use a synchronous motor to produce electrical power. Consequently, self-excitation from the transmission system should not be a concern.

Preliminary PPL EU load flow studies indicate that in order to eliminate excessive voltage deviation. S40 will need to operate near unity power factor, or slightly leading at the 69 kV interconnection point. Future studies will determine a desired power factor that S40 should maintain for proper operation.

Generator Regulation or Reactive Support Requirements

As required by PJM tariff, the Interconnection Customer shall design its S40 Facility to maintain a composite power factor delivery at continuous rated power output at the generators terminals at a power factor of at least 0.95 leading (absorbing VARs) to 0.90 lagging (supplying VARs). For interconnection at 69 kV, Queue S40 generation will operate near unity power factor or slightly leading or lagging. PPL EU will determine exact requirements during Study.

Network Impacts (23 kV and 69 kV Options)

The Queue S40 project was studied as a 10.5 MW injection into the Frailey 23 kV bus and the Eldred – Pine Grove 69 kV line. The project was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Local System Impacts (Normal system conditions with all facilities in service)
There are no anticipated problems.

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

No Problems were identified

Multiple Facility Contingency
(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

No Problems were identified

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)

No problems were identified

Short Circuit
No problems identified.

Stability Analysis
Not required for generating stations less than 30 MW.

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

None.

The first phase of the Eldred – Pine Grove 69 kV rebuild project (previously planned by PPL EU) is currently in progress and will upgrade the line from Eldred to the Hegins tap. There is no need for advancement costs for this part of the project because it is already in progress. However, if the interconnection for S40 taps the Eldred – Pine Grove 69 kV line below the Hegins tap, the second phase of the Eldred – Pine Grove 69 kV rebuild project will need to be advanced to accommodate S40 interconnection. S40 may have responsibility for the time value of money needed for advancement of Phase 2 work.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

None