Denny Substation Presentation at University of Washington

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Dear Guest

As you leave the room please
Switch off the lights and A/C.

Honduras
Is Rationalizing Energy
Thank you for understanding
Management

Estimado Huesped

Por favor al salir de su habitación
apague el Aire condicionado y las luces.

Honduras
Esta en Racionamiento de Energia
Gracias por su Compreñión

La Gerencia
Purpose & Learning Objectives

The purpose of this program is to share lessons learned through substation alternative analysis and 60% design and solution based equipment procurement request for proposals at Seattle City Light related to the complexity of installing a new 230/115/26/13.8 kV substation, new network distribution system within a downtown area and a transmission line that is part of the same Environmental Impact Statement process.

At the end of this presentation you will be able to gain awareness and understanding of the complexity and diversity of issues surrounding the design of a new substation in a modern downtown urban environment.
Presentation Outline

• Utility Overview Related to Substation Design & Substation Technical Overview
• Project Team
• Site Description
• Community Constraints
• Alt. Analysis & Equipment Procurement
• Summary of Urban Design Challenges
• Project Status
Background

• Proposed customer projects and changes in zoning prompted a look at available capacity in the South Lake Union area.

• Quanta Technology, LLC was brought on to evaluate load growth and recommend a course of action for Seattle City Light to ensure adequate capacity & reliability into the future.

• Quanta recommended building a new substation to power a 13kV network covering SLU & reinforce Denny Triangle. The substation should be expandable with 26kV feeders for the First Hill Network and possible radial feeders, as well.
Utility 101

- Long term and short term plans feed into capital plans land acquisition, etc.
- As development approaches, site plans solidify and criteria are refined, preliminary one lines are developed
- Studies to validate one lines and assumptions are performed as criteria are refined
- What are substation design criteria?
  - Safety requirements, fault current levels at the substation, fault current levels leaving the site, voltage regulation, contingency (N-1, N-2, etc.), voltage stability and avoiding voltage collapse in contingency, bus configurations, meeting operating criteria for normal and contingency conditions, operational requirements, want versus need, space consideration, consideration of ultimate layout and initial layout, constructability (present and future), cost, impact on neighbors, utility standards, schedule, margins…
Ultimate Build Out

- 13.8kV Distribution (Network): 4 subnets of 6 feeders per subnet, 600 Amps per feeder (24 feeders)
- (4) 75 MVA, 115-13.8kV transformers
- (2) 150 MVA, 230-115kV transformers
- (3) 90 MVA, 115-26kV transformers
- 26kV Distribution (Network & Radial): 1 subnet of 6 feeders per subnet plus 6 radial circuits (12 total)
- (7) bays of 115 kV Gas Insulated Switchgear (GIS)
- (4) breaker ring 230 kV Gas Insulated Switchgear
- 15 kV Arc Flash Rated Air Insulated Switchgear
- 26 kV Arc Flash Rated Air Insulated Switchgear
- (2) 115 kV Line Reactors with Gas Insulated Switchgear
- Total Transformer MVA of Ultimate Build Out: 870 MVA
Initial Build Out

- 13.8kV Distribution (Network): 2 subnets of 6 feeders per subnet (12 feeders) – 1 subnet into Denny Triangle / 1 subnet into South Lake Union
- (3) 75 MVA, 115-13.8kV transformers
- (4) bays of Breaker and a Half 115 kV Gas Insulated Switchgear (GIS)
- 15 kV Ring Bus for 4 Subnets with Redundant Fault Current Limiting Arc Flash Rated Air Insulated Switchgear
- (1) 115 kV Line Reactor with Gas Insulated Switchgear to Prevent Overload from Loop Flow
- Total Transformer MVA of Initial Build Out: 225 MVA
- Intercept exist high pressure fluid filled (HPFF)115kV T/L
Scope – What’s Unusual

• Technical:
  – Limited space, compact design for present and future.
  – 4 Voltages, large network, urban area.
  – Network system distribution transformers have all secondaries in parallel.
  – Largest customer vault has 4 feeders.
  – Must avoid loop or reverse flow and islanding.
  – Need to limit fault duty from the substation.
  – Solution based equipment procurement.
  – High reliability and availability.
  – No split bus operation.
Technical Challenges

- Standard distribution equipment in vaults rated 25kA.
- Having entire 15kV bus electrically connected at all times creates high fault current condition. Not enough space to split bus and have 4 voltages though.
- Not possible to use impedance to limit fault current and avoid voltage collapse in N-1 condition with margin.
- Software had slight preference for inductors over all impedance in transformers (space problems/EMF).
- Constructability limit of around 18% on 45 MVA base.
- Options to limit fault current in substation: feeder, bus, experimental & impedance.
- Only have 2 procurement options available.
Technical Challenges

- Available space for 4 voltages
- Constructability for future transmission lines, vault locations, utility relocations, subsequent substation expansion, fault scenarios
- Working within budget constraints
- Identifying all technical requirements upfront in procurement process and working through selection process and workshops with potential suppliers
- Schedule constraints
- Permits
- SEPA process concurrent with design
Scope – What’s Unusual

• Non-Technical:
  – Urban area
    • Three sides with businesses and residences
    • One side is major gateway to downtown Seattle
  – Major customers
  – Street vacation – requires public benefit
  – Urban design merit – capital projects must fit the neighborhood and City requirements
  – SCL hasn’t built a substation in 30 years
Project Team

- Internal dedicated City Light team consisting of program manager, project managers, substation engineers, environmental, financial and administrative personnel plus support from across City Light.

- Consultant team which together included engineers (electrical, civil, structural, mechanical), architects, landscape design, environmental engineering, traffic engineers, SEPA specialists, public outreach, EMF consultant, acoustical analysts, value management, cost estimators, surveyors, urban designers and geotechnical personnel.

- Much of the consultant team was local to Seattle and had direct experience with the local communities, Seattle Design Commission and City Council. This has been very important in navigating through the political environment.
Environmental Process

- Decided to Issue Environmental Impact Statement Instead of Checklist
- Decided to Include Cross Town Transmission Line with Substation and Network Distribution System in Environmental Process
- Remediation – Greyhound Repair Facility
- Three T/L Options
- Public Out Reach
Permit Processes

• Building a Substation Anywhere is Difficult but in Downtown is a Different Game
• SEPA – State Environmental Protection Act
• Numerous City Processes/Agencies That Have Direct Input Into Permits
• Capital Improvement in City Limits
• Street Vacation
• Public Out Reach
• Risk
Where’s Denny Sub?
Area History
Area History
Area History
Area - Today
Site Description

• Three Parcels that were a Greyhound repair facility - Contaminated
  • Parcel 1 ~ 36,000 sqft
  • Parcel 2 ~ 80,000 sqft
  • Parcel 3 ~ 12,000 sqft
• Site was chosen because of it’s ability to emanate transmission and distribution circuits.
• Existing Broad to East Pine transmission HPFF 115kV line crossed the site.
Parcel Layout

Proposed Denny Substation Site

- Former City Investors Parcel
- Pontius Av N (Proposed Vacation)
- Former Greyhound Parcels (2)
Denny Substation Project Site
Site Remediation
COMMUNITY OUTREACH

COMMUNITY GROUPS:
- SLU Community Council Policy and Planning Committee
- South Lake Union Chamber of Commerce
- Cascade Neighborhood Council
- Lake Union Opportunity Alliance
- Denny Triangle Neighborhood Association
- Downtown District Council
- Cascade Area Business Neighbors (CABN)
- SLU Network Stakeholders
- Alley 24 Property management
- Downtown Seattle Association

BUSINESS STAKEHOLDERS:
- Alley 24 Property management
- Colwell Building – Plymouth Housing Group
- Balfour Place Apartments
- Vulcan
- Mirabella
- Amazon
- Play it Again Sports
- REI
- Feathered Friends
- Immanuel Lutheran Community Services
- Orion Center
- National Association of Industrial and Office Properties (NAIOP)
- University of Washington
- Fred Hutchinson and Seattle Cancer Care Alliance
- Group Health
- Institute for Systems Biology
- Cornish College of the Arts
- Bill & Melinda Gates Foundation
- Path
- Seattle Children’s Hospital Research
- Spring Hill Suites
- Pan Pacific Hotel
- St. Spiridon Orthodox Cathedral
(1) SEATTLE LAND USE CODE

- CURRENT ZONING REQUIREMENTS
- STREET CLASSIFICATION
- STREET LEVEL USE
- FACADE REQUIREMENTS
- LOT COVERAGE

City of Seattle

(2) CITY of SEATTLE COMPREHENSIVE PLAN

- URBAN CENTER / VILLAGE STRATEGY
- OPEN SPACE NETWORK
- SOUTH LAKE UNION - NEIGHBORHOOD PLANNING CONCEPTS

(3) NEIGHBORHOOD PLANS

SOUTH LAKE UNION URBAN DESIGN FRAMEWORK
SOUTH LAKE UNION NEIGHBORHOOD PLAN
SOUTH LAKE UNION REZONE LEGISLATION
GREEN STREET CONCEPT - THOMAS STREET
DENNY WAY STREETSCAPE CONCEPT PLAN
THE BLUE RING STRATEGY

GUIDING PLANNING PRINCIPLES
The Community – Local Transit

BUS ROUTES

ZIP CARS

BUS STOPS
The Community – Open Space
The Community – Land Use
The Community – Street Character & Gateways
The Community – Neighborhood Gateways & Edges
The Community – Street Character
The Community – Green Streets

(SOUTH LAKE UNION URBAN DESIGN FRAMEWORK DOCUMENT, DPD 2010)
The Community
Many Substation Alternatives

The set of graphics above document the progression of alternative analysis from project initiation to its current status. The set of graphics to the right document the selection process and advancement of alternatives.
Vacate vs. No Vacation

NO VACATION OF PONTIUS: DISTRIBUTION ROUTING

VACATION OF PONTIUS: DISTRIBUTION ROUTING

NO VACATION OF PONTIUS: TWO LEVELS

VACATION OF PONTIUS: ONE LEVEL
No Vacation Alternatives

NO VACATION ALTERNATIVE

- POTENTIAL OPPORTUNITY FOR FUTURE DEVELOPMENT
- NEED TO ACCOMMODATE SCL UTILITY DISTRIBUTION ROUTING, ACCESS AND MAINTENANCE
- 2 STORY STRUCTURE REQUIRED
- SMALLER FOOTPRINT
- GREATER TOTAL SQUARE FOOTAGE
- HIGHER CAPITAL COST
- LONG TERM MAINTENANCE AND OPERATIONS ISSUES
- BASEMENT FLOOR BELOW WATER TABLE
- EQUIPMENT IN CLOSER PROXIMITY TO RESIDENTIAL
Vacation Alternatives

VACATION ALTERNATIVES

- 1 STORY STRUCTURE
- GREATER SEPARATION BETWEEN TRANSFORMERS AND RESIDENTIAL
- LESS SQUARE FOOTAGE REQUIRED
- LOWER CAPITAL COST
- REQUIRES PUBLIC BENEFIT, i.e.:

  - recreational areas
  - playgrounds
  - skate park
  - dog park
  - pea patch
  - accommodations for food truck vendors
  - sculpture gardens
  - wi-fi connectivity
  - bicycle amenities
  - electric car charging stations
  - improve alley lighting and pedestrian experience
  - ?

BELOW GRADE DISTRIBUTION ROUTING PLAN

BELOW GRADE DISTRIBUTION ROUTING SECTION
Co-Development
3 Alternatives

NO STREET VACATION OPTION

STREET VACATION OPTIONS

ALT. 1

ALT. 2

ALT. 3
NO VACATION ALTERNATIVE

- OPPORTUNITY FOR FUTURE DEVELOPMENT
- NEED TO ACCOMMODATE SCL UTILITY DISTRIBUTION ROUTING, ACCESS, AND MAINTENANCE
Project Web Site

- Search “Denny Substation Seattle”
Alternative 1

above grade equipment

basement level

substation equipment
Alternative 1
Alternative 1
Alternative 1 at Grade
Alternative 1 Below Grade
Alternative 1 Civil
Alternate 1 Wall & Roof

**Alternate 1 Basement & Foundation Plan**

**Alternate 1 Roof Screen Plan**

**Alternate 1 Street Level Plan**

**Notes:**
1. Column layout is preliminary and is subject to change.
2. Roof screen system to be supported by independent structural framing system inside basement.
3. Precast concrete slabs:
   - 15,000 square feet
   - 13.5 feet below yard slab elevation.

**Section**

Alternate #1 -- Figure 7-1
Alternative 1 - GIT
Alternative 2

substation - translucent screen wall
Alternative 2

full site conceptualized as the primordial forest
Alternative 2

POTENTIAL USES: recreation area
Alternative 2

AERIAL CONCEPT RENDERING LOOKING NORTH

SITE PLAN

SECTION LOOKING NORTH
Alternative 2
Alternative 2 Civil

FIG. 5-4
ALT. 2 CIVIL
DUCT BANKS

NOTES:
1. DUCT BANK ROUTING IS PRELIMINARY. REQUIRES FURTHER COORDINATION WITH SUBSTATION ELECTRICAL DESIGN.
2. LIMITS OF SUBSTATION DUCT BANKS CORRESPOND WITH ANTICIPATED SURFACE RESTORATION.
Alternate 2 Wall & Roof

ALTERNATE 2 YARD PLAN

ALTERNATE 2 ROOF FRAMING PLAN

NOTES:
1. COLUMN LAYOUT IS PRELIMINARY AND IS SUBJECT TO CHANGE.
2. ROOF SCREEN SYSTEM TO BE SUPPORTED BY INDEPENDENT STRUCTURAL FRAMING SYSTEM INSIDE THE SUBSTATION.

COLUMN

UPPER ROOF SCREEN

LOWER ROOF SCREEN

CLOSERLY SPACED STEEL PIPE SCREENING SYSTEM, 12" DIAMETER, MIN

24" CONCRETE WALL

SLAB ON GRADE

SPREAD FOOTINGS

ALTERNATE #2 -- FIGURE 7-2
Alternative 3

“...elevated park...”
Alternative 3

circulation - site flows
Alternative 3

lifting the site edge
Alternative 3
Alternate 3 Learning Center
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<th>Date</th>
<th>Description</th>
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<td>Schedule Update to SLU Network Stakeholders Group</td>
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<td>12/19/14</td>
<td>90% Substation Design Complete</td>
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<td>Substation Construction Notice to Proceed Given to Contractor</td>
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<td>Council Hearing Approving EIS</td>
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<td>DISTRIBUTION PACKAGE #1 – DENNY NETWORK</td>
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<tr>
<td>4/6/17</td>
<td>Denny Network (P1) Complete</td>
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Project Status

- Final EIS is under development
- Performance based equipment procurement contracts awarded
- Distribution network design almost 90%
- Substation design almost 90%
Urban Design Challenges

• Budget & Schedule – Urban design costs/issues
• Community impact/influence – Policies
• Schedule & Planning
  – Permitting
  – Alternative Analysis & Alternative Site Analysis
  – Environmental Impact Statement
• Permits, Street Vacation, Urban Design Merit
• Load density drives move to network
• Not much room in streets for infrastructure
Thank you for your time!

http://www.seattle.gov/light/denny_sub/substation.asp

QUESTIONS?