Micro Grid

Hardening, Expansion and Maintenance

Sustainable Approach to Resiliency

Presenters

John Bradley – NYU
Associate Vice President - Sustainability, Energy & Technical Services

Martin Kushner – NYU
Director - Office of Construction Management

Michael W Thornton – Vanderweil Engineers
Principal - Power Group

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1.0 Introduction

Since New York University has embarked on a Greening of the Campus NYU has reduced its GHG by its goal of 30% thru the expansion of its existing Micro Grid and supporting Cogeneration System. First Micro Grid on Campus was installed in 1980 Co generation system. This system ran for 30 years in Island mode configuration separated from the Utility. In 2010 the Micro Grid was expanded extending the 4160V Micro Grid system to 14 more substations to include a total of 23 buildings with normal power and 30 buildings with emergency power. This expansion in 2010 included the addition of Two solar Gas Turbines and HRSGs along with upgrades to its existing 2.4 MW Backpressure Steam Turbine.

During the Super Storm Sandy the system remained operational and seamlessly transitioned from synchronous parallel operation to Island mode operation during the Lower Manhattan power outage. After Sandy demand has increased for connection to the Micro Grid to expand the shelter in place capabilities for existing dormitories, housing, and assembly areas. These new loads impose increased demand on the campus Micro Grid. This demand is creating challenges in balancing economics with resiliency goals.

Opportunities for viable solutions are found through a mix of utilization of existing assets and strategic planning of new assets which provide a sustainable approach to increased campus resiliency. Increased importance is also emphasized on maintenance for Micro Grid resiliency.

1.0 Micro Grid and Generation Background

- **1980 Micro Grid and Cogeneration System**
  - 43 Buildings served by High Temp Hot Water
  - 21 Buildings served by Chilled Water
  - 12 Buildings served by Cogeneration System
  - (7) 900 kw Diesel Generators
  - 2.4 MW Steam Turbine
  - 4 Boilers (3 Hot Water, 1 Steam)
  - Plant operates in “Island Mode” with backup from Con Ed
- **2010 Micro Grid and Cogeneration System**
  - 43 Buildings served by High Temp Hot Water
  - 24 Buildings served by Chilled Water
  - 23 Buildings served by Cogeneration System
  - Two (2) 5.6 MW Solar Turbines
  - (7) 900 kw Diesel Generators
  - 2.4 MW Steam Turbine
  - 3 Boilers HTHW Boilers
  - Plant operates in “Parallel” with backup from Con Ed and sells back excess power

Buildings Served by NYU WSV Campus Cogeneration Plant

		Building Name	Address	Area served by Cogeneration plant		
				Heating	Cooling	Electrical
Zone 1	1	Warren Weaver	251M	158,590	158,590	158,590
	1a	Central Boiler Plant	251M SubB&Basement	INCLUDED ABOVE		INCLUDED ABOVE
	2	Stern KMEC	44W4	213,423	213,423	213,423
	3	Shimkin	50W4	89,951	89,951	89,951
	4	Bobst Library	70WSS	505,205	505,205	505,205
	5	Kimmel Student Ctr	60WSS	247,639	247,639	247,639
	6	King Juan Carlos	51-54WSS	61,310		
	7	Kevorkian Center	50WSS	11,960		11,960
	8	Judson Church *	55WSS	-		
	9	Van Hall	40WSS	257,259	257,259	257,259
	10	Furman Hall	89W3	168,566	168,566	168,566
	11	D'Agostino Dorm	110W3	144,268		144,268
	12	Hayden Dorm	33WSW	182,717		
	13	133-37 McDougal	137 McDougal	54,000	54,000	54,000
	14	Multi Faith Center	58WSS	92,000	92,000	92,000
Zone 2	15	Education Building	35W4	151,070		151,070
	16	Goddard Dorm	79WSE	76,964		76,964
	17	Silver Building	100WSE	258,155	258,155	258,155
	17A	Silver Chiller Plant	100WSE	INCLUDED ABOVE		INCLUDED ABOVE
	18	Waverly Building	29WP	60,329	60,329	60,329
	19	Brown Building	24Wav	124,526	124,526	124,526
	21	Weinstein Dorm	5UP	169,982		169,982
	20	Rufus Smith	25Wav	39,380		39,380
	22	19 University Place	19UP	69,021		
Zone 3	23	Tisch Hall	40W4	192,667	158,590	192,667
	23A	Refrigeration Plant	40W4 SubB&Basement	INCLUDED ABOVE		INCLUDED ABOVE
	24	Mercer Dorm	240M	298,336	158,590	298,336
	25	Coles Athletic Ctr	181M	177,109		
	26	Silver Towers I	110 Bleecker	227,472		227,472
	27	Silver Towers II	100 Bleecker	227,453		227,453
	28	505 LaGuardia Apts *	505 LaGuardia	227,453		
	29	WSV bldg 1	1 WSV	318,271		
	30	WSV bldg 2	2 WSV	318,271		
	31	WSV bldg 2	3 WSV	318,271		
	32	WSV bldg 4	4 WSV	318,271		
Zone 4	33	19 West 4th	19W4	128,679	128,679	
	34	Meyer Block	2-6WP, 707B	258,686	258,686	258,686
	35	Tisch School of Arts	715-19Bway	190,781	190,781	190,781
	36	Tisch School of Arts	721-25Bway	262,739	262,739	262,739
	37	3-5 Washington Pl.	3WP	42,576	42,576	
	38	285 Mercer St.	285M	24,084		
	39	Hebrew Union *	9W4	-	-	
	40	Genomics	12-16Wav	70,000	70,000	70,000
	41	Carter Hall	10WP		31,113	
Total square footage served				**6,737,434**	**3,500,284**	**4,551,401**

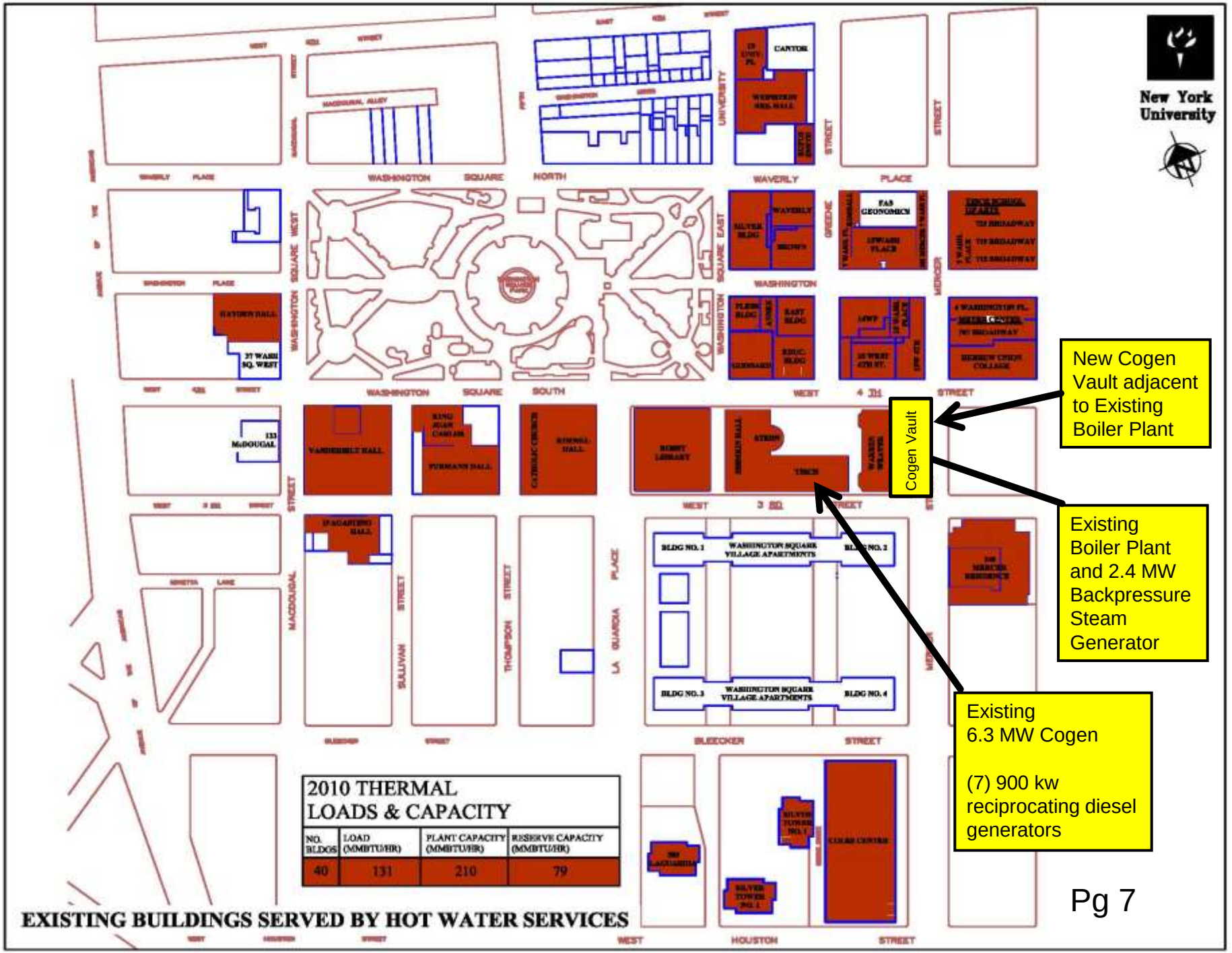
NEW YORK UNIVERSITY

Buildings Served by Expanded Cogen

Heating
6.7 million sqft

Cooling
3.5 million sqft

Cogen Electrical
4.5 million sqft


New York University
New Cogen Vault adjacent to Existing Boiler Plant
Cogen Vault
Existing Boiler Plant and 2.4 MW Backpressure Steam Generator
Existing 6.3 MW Cogen
(7) 900 kw reciprocating diesel generators
2010 THERMAL LOADS & CAPACITY
NO. BLDGS
LOAD (MMBTU/HR)
PLANT CAPACITY (MMBTU/HR)
RESERVE CAPACITY (MMBTU/HR)
40
131
210
79
EXISTING BUILDINGS SERVED BY HOT WATER SERVICES
WASHINGTON SQUARE NORTH
WASHINGTON SQUARE SOUTH
WASHINGTON SQUARE WEST
WASHINGTON SQUARE EAST
WAVERLY PLACE
MACDOUGAL STREET
SULLIVAN STREET
THOMPSON STREET
LA GUARDIA PLACE
BLEECKER STREET
HOUSTON STREET
WEST 3 RD STREET
WEST 4 TH STREET
BLDG NO. 1 WASHINGTON SQUARE VILLAGE APARTMENTS
BLDG NO. 2
BLDG NO. 3 WASHINGTON SQUARE VILLAGE APARTMENTS
BLDG NO. 4

2.0 Guiding Principles for Micro Grid and Utility Planning

1. Recommendations based on best lifecycle cost scenarios.

2. Maximize existing cooling tower capacities and limit new cooling tower installations due to noise, space, and visual issues.

3. Minimize space requirements for new equipment (locate new equipment in existing mechanical rooms).

4. Configure new equipment to limit requiring additional operating engineers.

5. Maximize overall system output, efficiency, and reliability. Lower heat thermal sink (heating and chilled water production) to increase waste energy utilization.

6. Provide for Micro Grid resiliency and life safety back up as additional buildings are added to system.

7. Mandatory Method of Procedures (MOP) for all switching and maintenance operations. Annual testing of ATSs

8. Increase annual training for Micro Grid operators to simulate

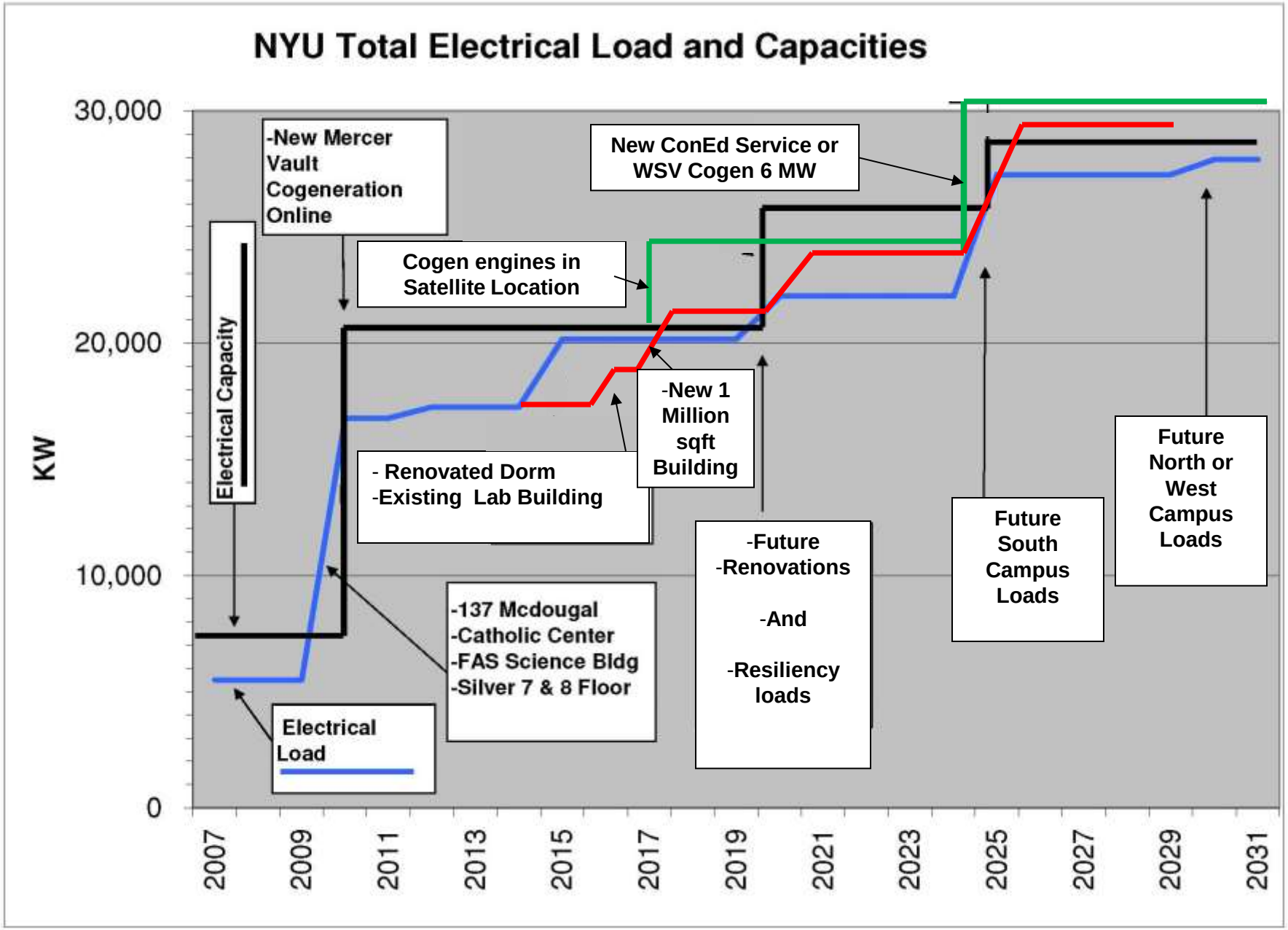
3.0 Electrical System Demands

and

Proposed Hardening

Items of Interest for Electrical

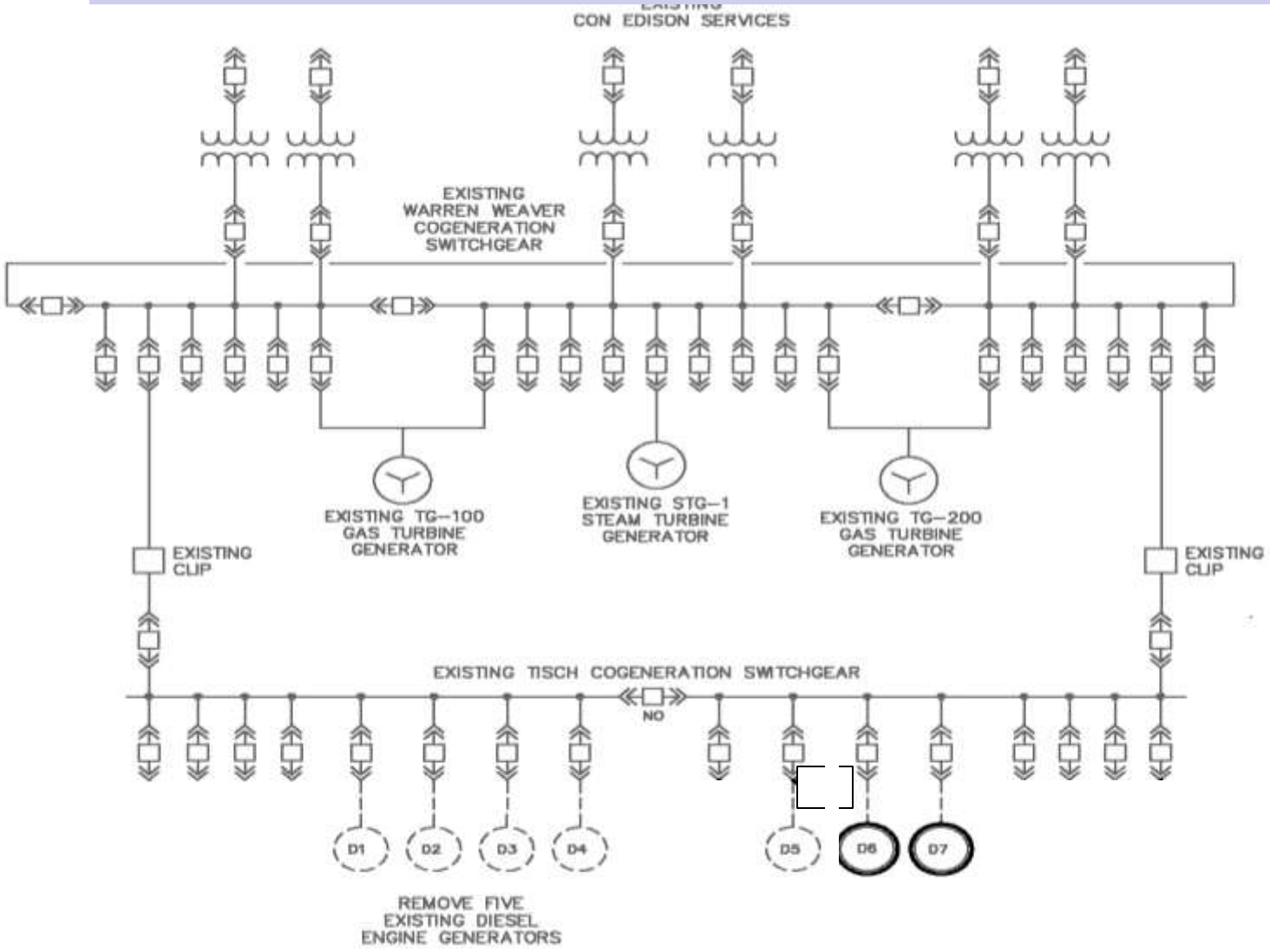
1) Cogen plant serves main loads for large percentage of annual hours. Power sold to ConEd has higher value to offset to new buildings.
2) Additional resiliency loads for dorms and science building require additional cogen capacity for New Buildings and Micro Grid hardening.
3) Proposed Base (Satellite Cogen 4.6 MW)
    1) Remove 5 of existing 7 diesels in Tisch Engine room
    2) Overhaul the remaining two (2) existing diesels (existing 300 hrs) this provides for life safety back up and standby power in island mode. (1.4MW)
    3) Install 3.2 MW of new cogen in Tisch Engine room.
4) Alternate (Satellite Cogen 4.8 MW)
    1) Remove all of existing 7 diesels in Tisch Engine room
    2) Install 4.8 MW of new cogen in Tisch Engine room
    3) Install a packaged emergency generator on roof of Tisch or WW
5) Reprogram load shed to include other less critical loads.(currently only chillers load shed 3 MW)
6) Upgrades to Existing Tisch 5kv gear and Tisch and Bobst Low voltage provided as an Option.


NYU Total Electrical Load and Capacities
30,000
20,000
10,000
0
KW
2007
2009
2011
2013
2015
2017
2019
2021
2023
2025
2027
2029
2031
-New Mercer Vault Cogeneration Online
New ConEd Service or WSV Cogen 6 MW
Cogen engines in Satellite Location
Electrical Capacity
-New 1 Million sqft Building
- Renovated Dorm
-Existing Lab Building
-Future
-Renovations
-And
-Resiliency loads
Future South Campus Loads
Future North or West Campus Loads
-137 Mcdougal
-Catholic Center
-FAS Science Bldg
-Silver 7 & 8 Floor
Electrical Load

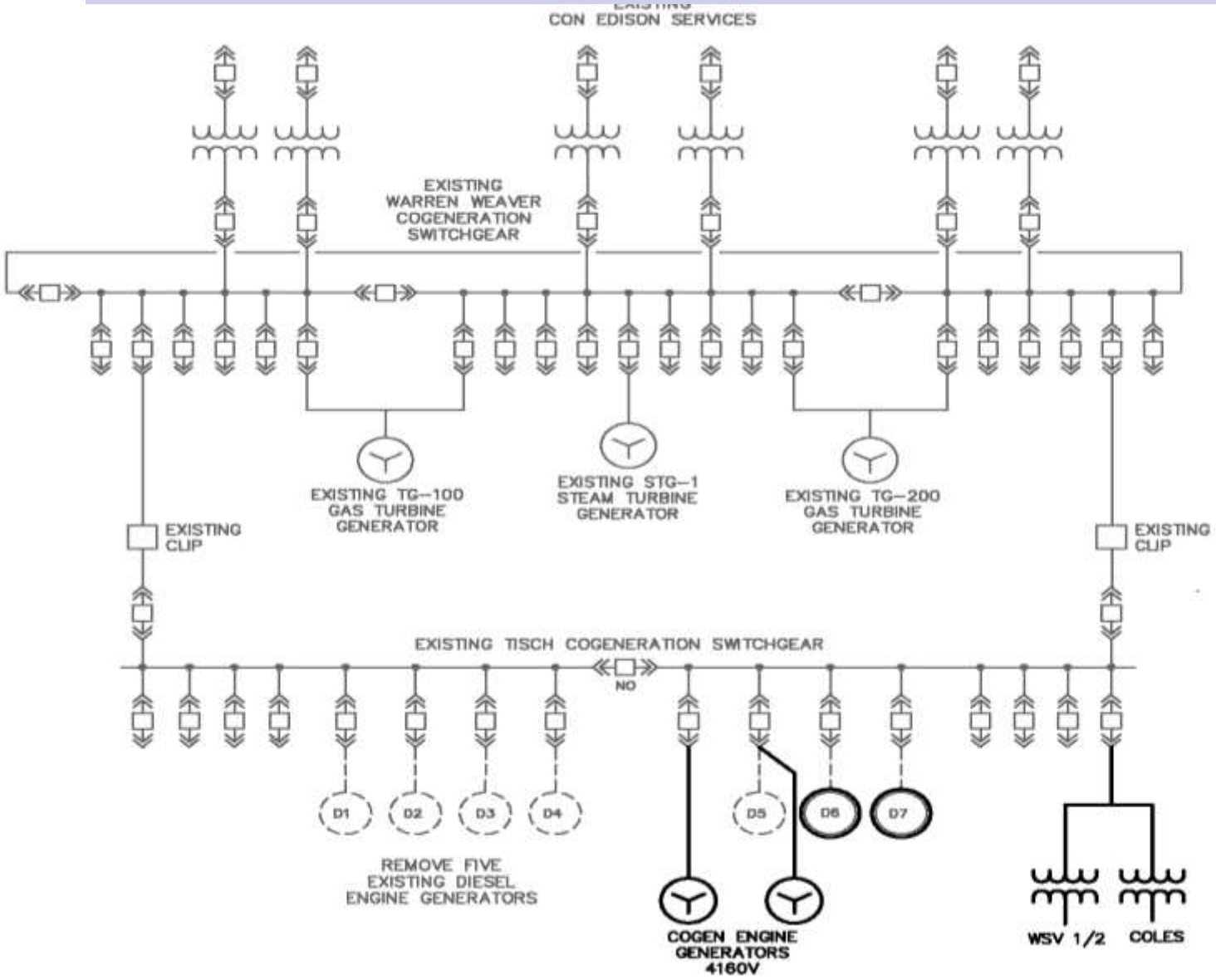
EXISTING BUILDINGS SERVED BY COGEN-ELECTRICAL

NYU Washington Square Campus Micro Grid/Cogen Building Electrical Loads and Plant Capacities									Cogen Out of Service Load Management		
Year	Loads - Building Name	Electric Load Demand (Kw)	Total Electric Load Projected (Kw)	Cogen Plant Capacity Installed (Kw)	Cogen Plant Capacity (N+1) (Kw)	ConEd Back up 13.2 Kv service (Kw)	Total Cogen N+1 & ConEd 13.2 KV (Kw)	Capacity Reserve One Engine Down (Kw)	5kv Capacity Reserve Both Gas Turbines off-line (Kw)	Reserve Capacity After Chiller Load Shed 3 MW (Kw)	Reserve Capacity Seasonal ST1&2 Swing to ConEd (Kw)
2010	Expanded Buildings - Central Utility Plant	15,000	15,000	13,400	7,900	13,200	21,100	6,100	0	0	0
Future Buildings - Utility Loads - West Run											
2010	Catholic Center	528	15,528	13,400	7,900	13,200	21,100	5,572	-2,328	672	1,872
2010	137 MacDougal	420	15,948	13,400	7,900	13,200	21,100	5,152	-2,748	252	1,452
2010	FAS Science Building	900	16,848	13,400	7,900	13,200	21,100	4,252	-3,648	-648	552
2010	Brown Building	0	16,848	13,400	7,900	13,200	21,100	4,252	-3,648	-648	552
2010	Silver Building	500	17,348	13,400	7,900	13,200	21,100	3,752	-4,148	-1,148	52
2011	Education & East Buildings	0	17,348	13,400	7,900	13,200	21,100	3,752	-4,148	-1,148	52
2011-2013	Demand Reduction Campus Improvements	-900	16,448	13,400	7,900	13,200	21,100	4,652	-3,248	-248	952
2013	Peak Campus Demand	16442		13,400	7,900	13,200	21,100	4,658	-3,242	-242	958
2014	Hayden Hall	550	16,992	13,400	7,900	13,200	21,100	4,108	-3,792	-792	408
2014	Silver Building	450	17,442	13,400	7,900	13,200	21,100	3,658	-4,242	-1,242	-42
2015h	Refurbish Tisch (2) Back up Generators 1.4 MW w/ Governor Upgrades	na	17,442	14,800	9,300	13,200	22,500	5,058	-2,842	158	1,358
2015	Science 707 Broadway	800	18,242	14,800	9,300	13,200	22,500	4,258	-3,642	-642	558
2016	Install new Cogen unit in Tisch 3.2 MW	na	18,242	18,000	12,500	13,200	25,700	7,458	-442	2,558	3,758
2017	New Building Site	2,475	20,717	18,000	12,500	13,200	25,700	4,983	-2,917	83	1,283
2017	Future Camus Resiliency Loads	400	21,117	18,000	12,500	13,200	25,700	4,583	-3,317	-317	883

Existing 4160V Micro Grid – One Line Diagram

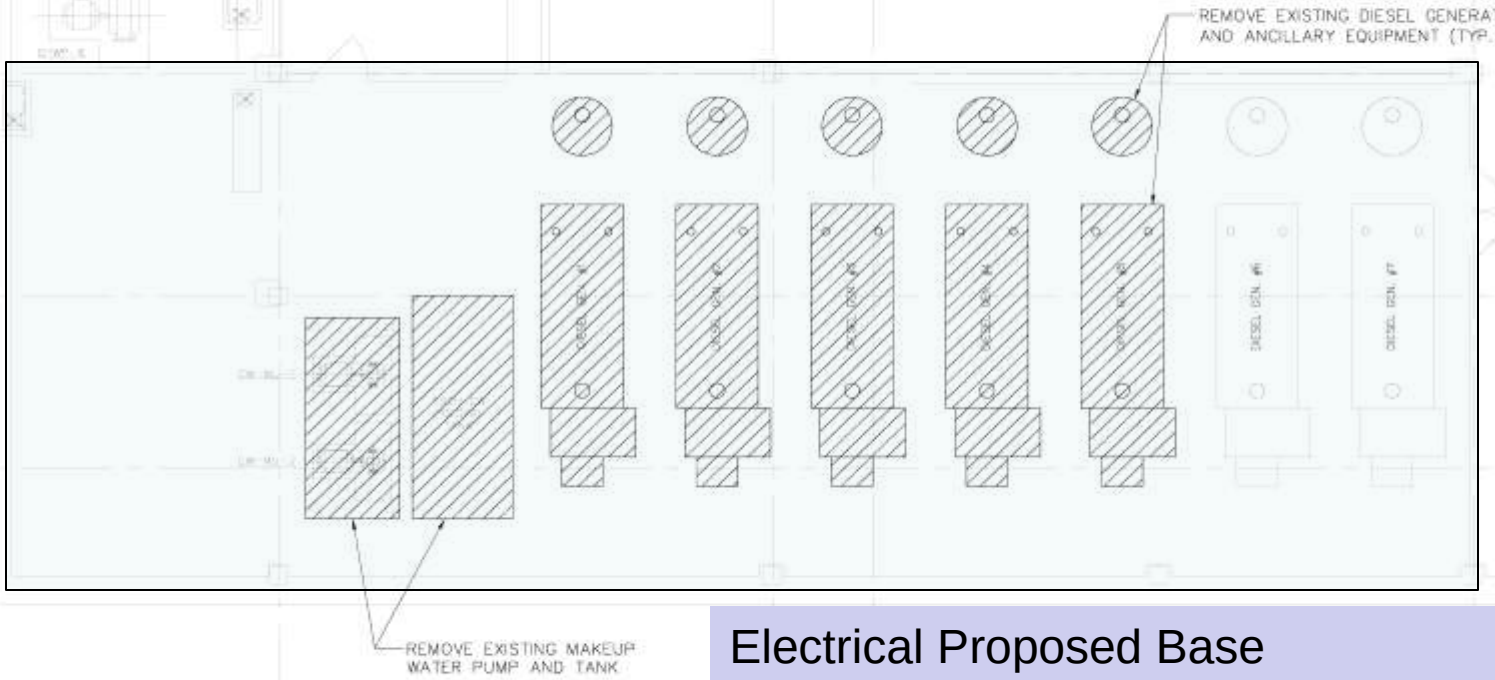


Proposed Base – One Line Diagram



Proposed Base Scope – 2 New Generators

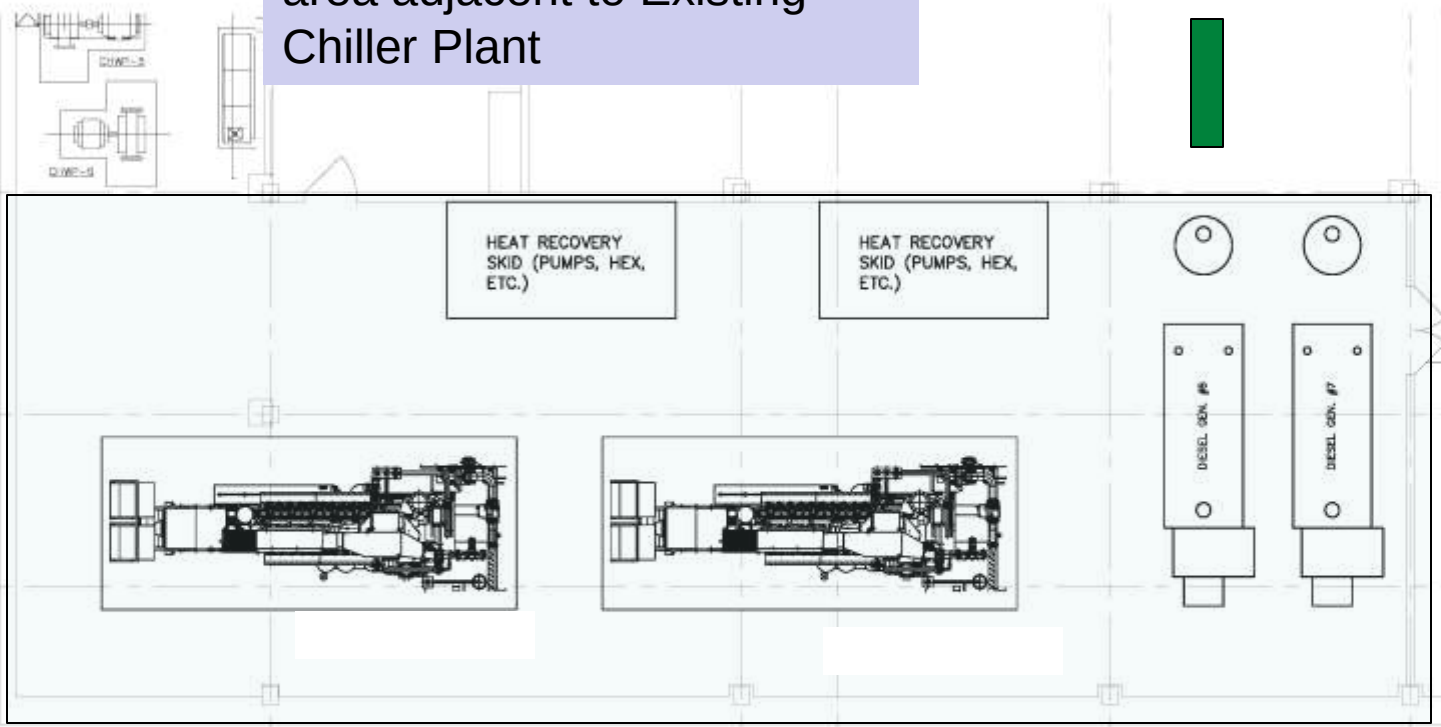
Cellar Plant Area Old Cogen area adjacent to Existing Chiller Plant



Electrical Proposed Base Demolition Scope
Remove 5 of 7 Generators 3.5 MW
Current Available Capacity 1.4 MW

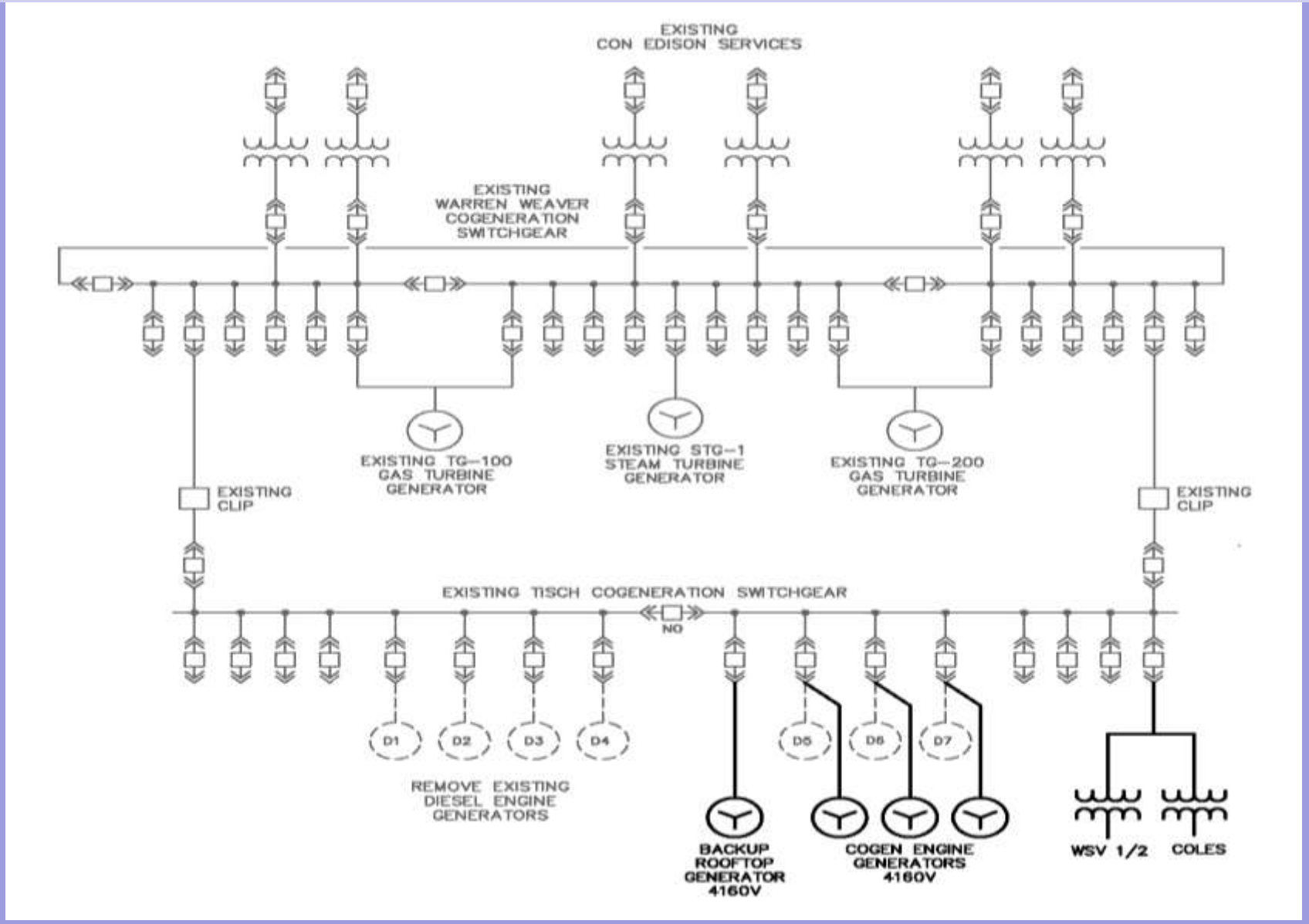
Proposed Base Scope – 2 New Generators

Cellar Plant Area Old Cogen area adjacent to Existing Chiller Plant



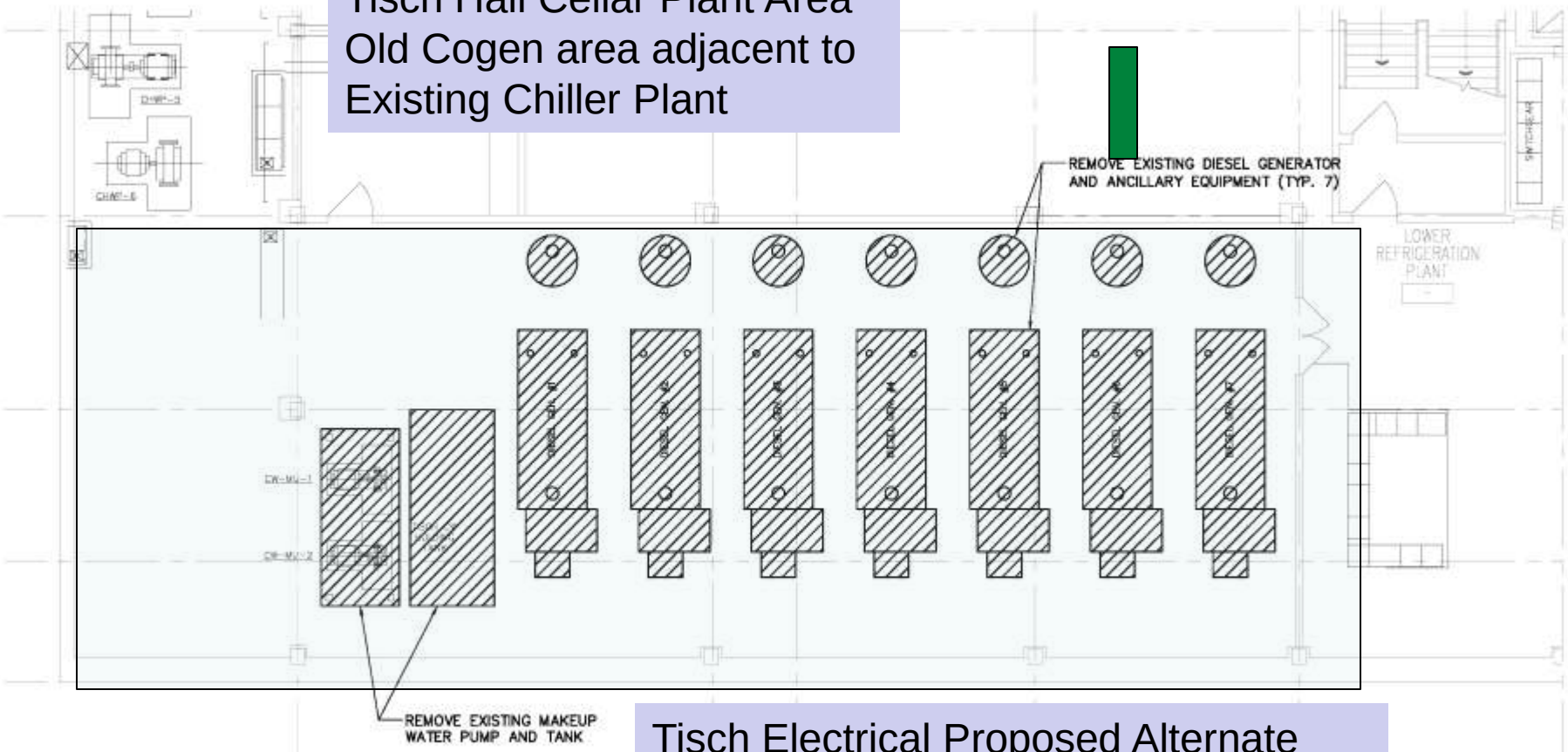
Electrical Proposed Base Installation Scope
Install 2 New Generators 3.2 MW

Proposed Alternate Scope – One Line Diagram



Proposed Alternate Scope – 3 New Generators

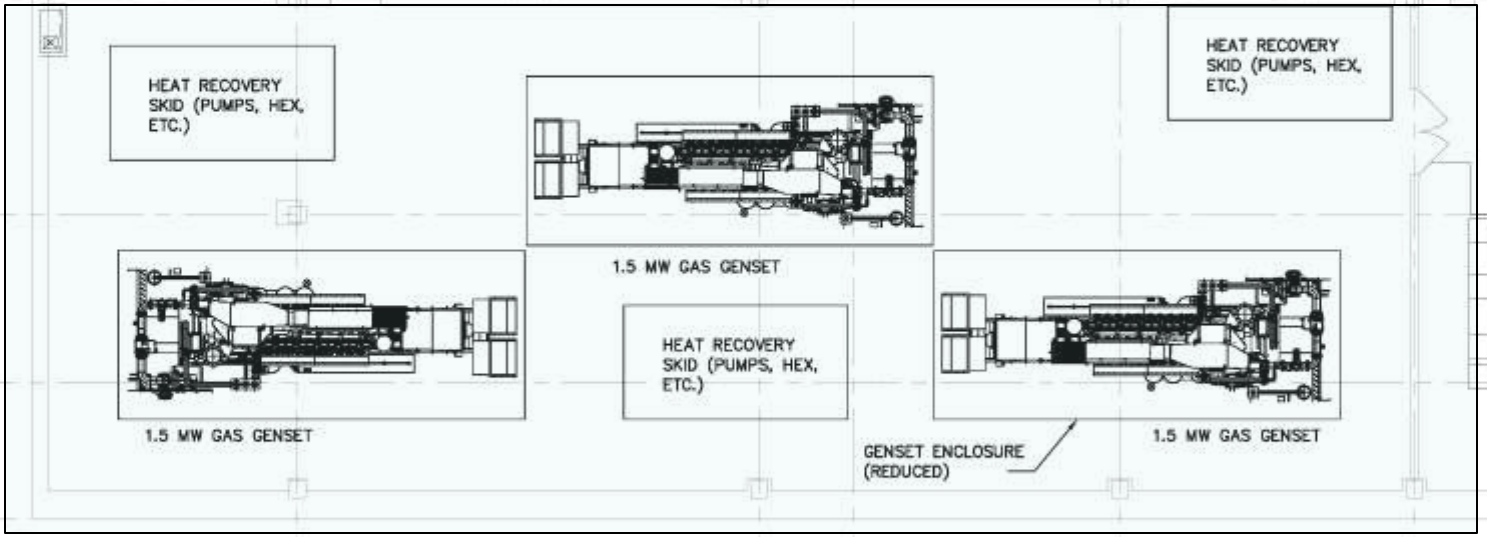
Tisch Hall Cellar Plant Area
Old Cogen area adjacent to
Existing Chiller Plant



Tisch Electrical Proposed Alternate
Demolition Scope
Remove 7 of 7 Generators 4.9 MW
Current Available Capacity 1.4 MW

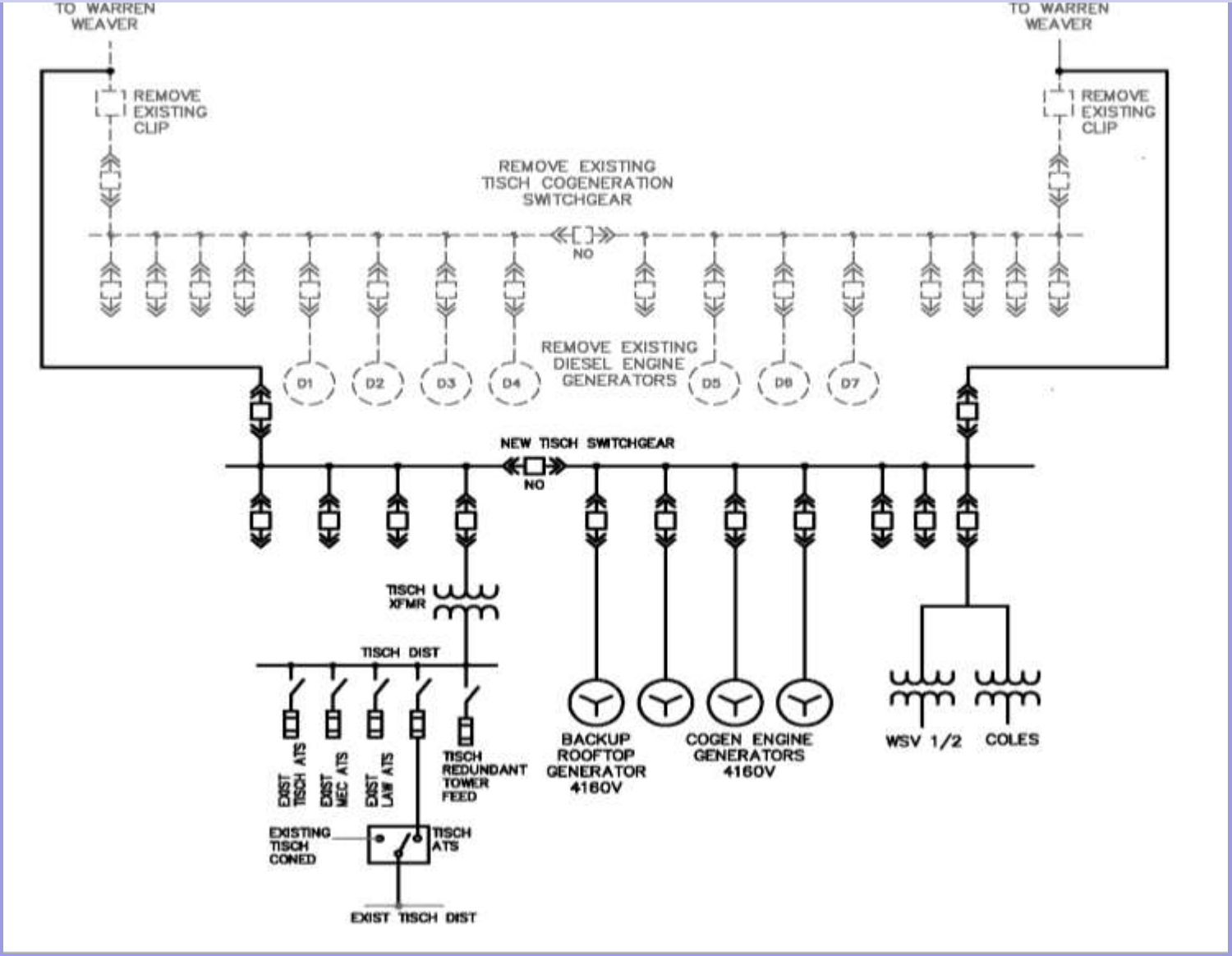
Proposed Alternate Scope – 3 New Generators

Tisch Hall Cellar Plant Area
Old Cogen area adjacent to
Existing Chiller Plant



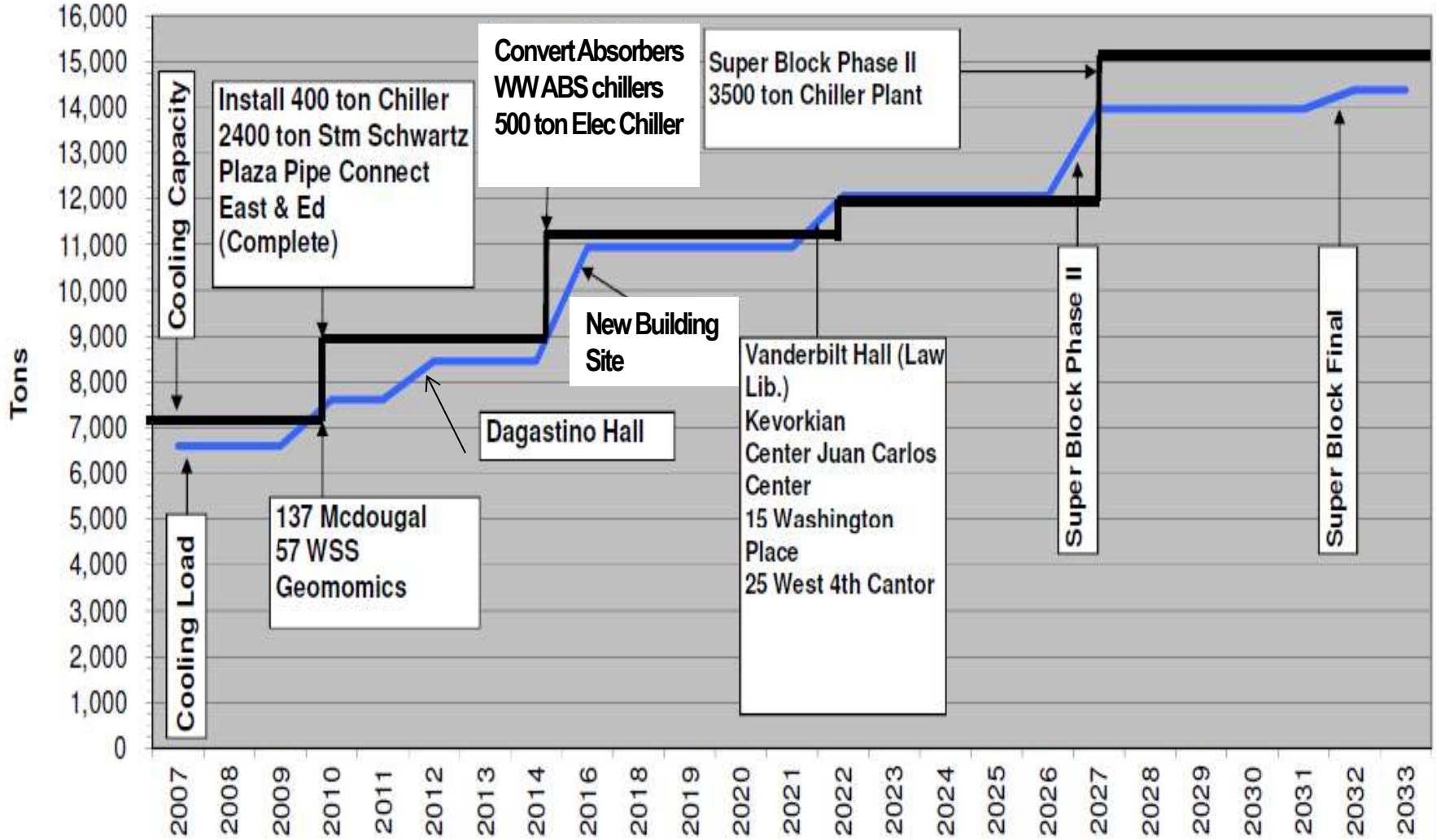
Tisch Electrical Proposed Alternate Scope
Installation Scope
Install 2 New Generators 3.2 MW (Nat Gas)
Install 1 New Generator 1.6 MW (No 2 FO)

Proposed Alternate Scope – Switchgear Upgrade
One Line Diagram



4.0 Chilled Water System Load Balancing

NYU Total Cooling Load and Supply



Chilled Water Items Completed for preparation for Campus Growth and New Building Site

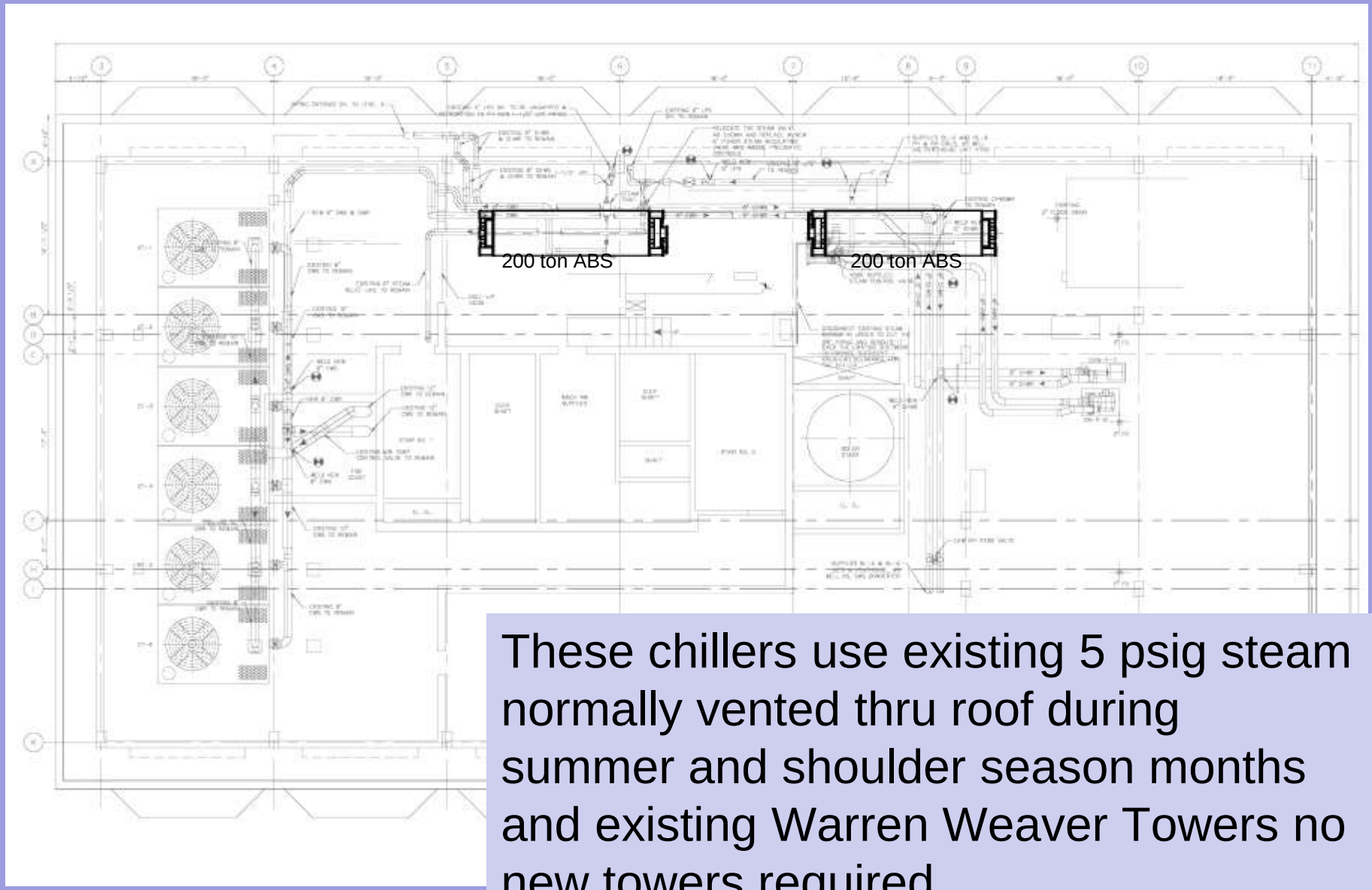
1) New 2400T steam chiller installation was timed with Cogeneration project. (Operational)
2) North Plant Absorption Chiller 400 ton (Installed)
3) Replacement Installation of Tisch Cooling Towers 4-5 (Operational) Direct Drive Fans
4) Towers 1-3 (In Progress)

Program - 1 million sqft Multi Use Multi Tower Site

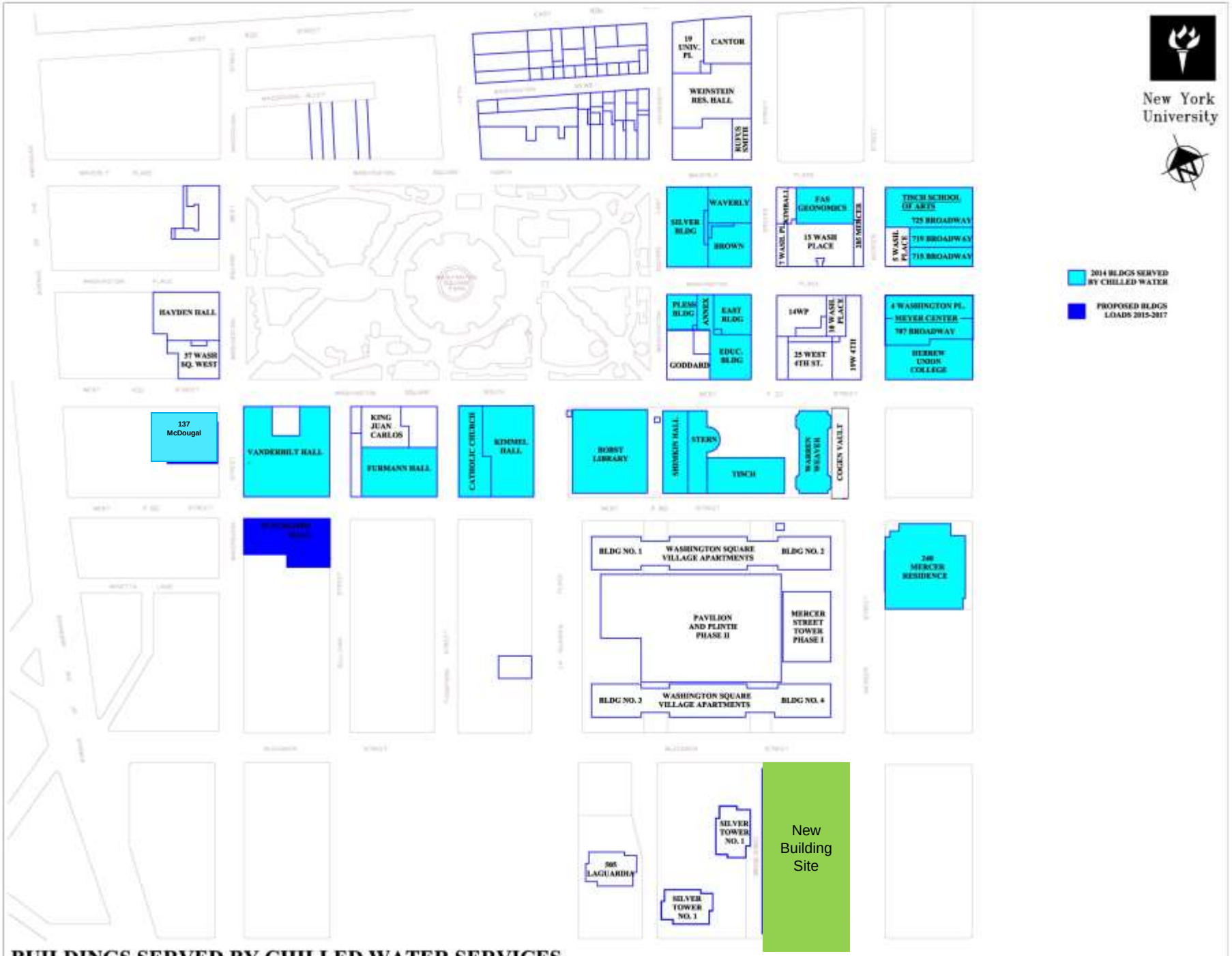
Chilled Water Enabling Projects Proposed

1) Install two 200 tons single effect (5psig steam) absorption chillers in WW penthouse in location of previous Abs machines.
2) Convert three existing absorption chillers from operating on HTHW to 150 psig HP steam
3) Add 500 ton electric chiller in Tisch in location of Hot Water Pumping for Abs. (load curtailment dispatch and load management)
4) Add a chilled water pump and Condenser water pump to in central chiller plant. (dispatch able for load curtailment and DeltaT improvement from Central Plant)

Warren Weaver 400 tons of 5 psig Absorbers



These chillers use existing 5 psig steam normally vented thru roof during summer and shoulder season months and existing Warren Weaver Towers no new towers required



BUILDINGS SERVED BY CHILLED WATER SERVICES

NYU Washington Square Campus Micro Grid/Cogen Chilled Water System - Building Chilled Water Loads and Plant Capacities

Year	Building Name	Chilled Water Load (tons)	Total CHW Load (tons)	Chilled Water Capacity (tons)	Installed N+1 Capacity (tons)	Reserve Future Cap. (tons)
Central Chilled Water Plant						
2007	Central Utility Plant (Separate) Existing Buildings	5,645	5,450	7,800	6,500	1,050
2009	Schwartz Plaza Chilled Water Street Crossing Upsize	na	5,450	7,800	6,500	1,050
2009	New 2400 ton Stm Chiller in WW	na	5,450	7,800	6,500	1,050
2010	New Tisch cooling tower cells 4 & 5 – new 2400 ton chiller	na	5,450	10,200	7,800	2,350
2010	Catholic Center	200	5,650	10,200	7,800	2,150
2010	137 MacDougal	135	5,785	10,200	7,800	2,015
2010	FAS Science Building	320	6,105	10,200	7,800	1,695
2011	Connect Education/east Building to Central Plant with 24 inch	na	6,105	10,200	7,800	1,695
2011	Education & East Buildings	670	6,775	10,200	7,800	1,025
2014	Dagastino Hall Chiller Replacement with Plant Chilled Water Connection to CUP	340	7,115	10,200	7,800	685
2015	Convert existing Tisch absorbers to 150 lb Steam from HTHW (500 Ton pickup)	na	7,115	10,700	8,300	1,115
2015	Upgrade of Cooling Towers 1,2, & 3(This also includes required maintenace pick up of capacity produces energy savings and additional capacity in chillers 400 tons)		7,115	11,100	10,700	1,565
2015	Install Single Effect Absorption Chiller in penthouse of Warren Weaver (2)200 Ton units (uses 5 psig steam saves on venting of steam during shoulder months) and new 500 Ton Electric in Tisch	na	7,115	12,000	11,100	1,965
2014	New Building Site Load	1800	8,915	11,500	9,100	185

5.0 Heating System,

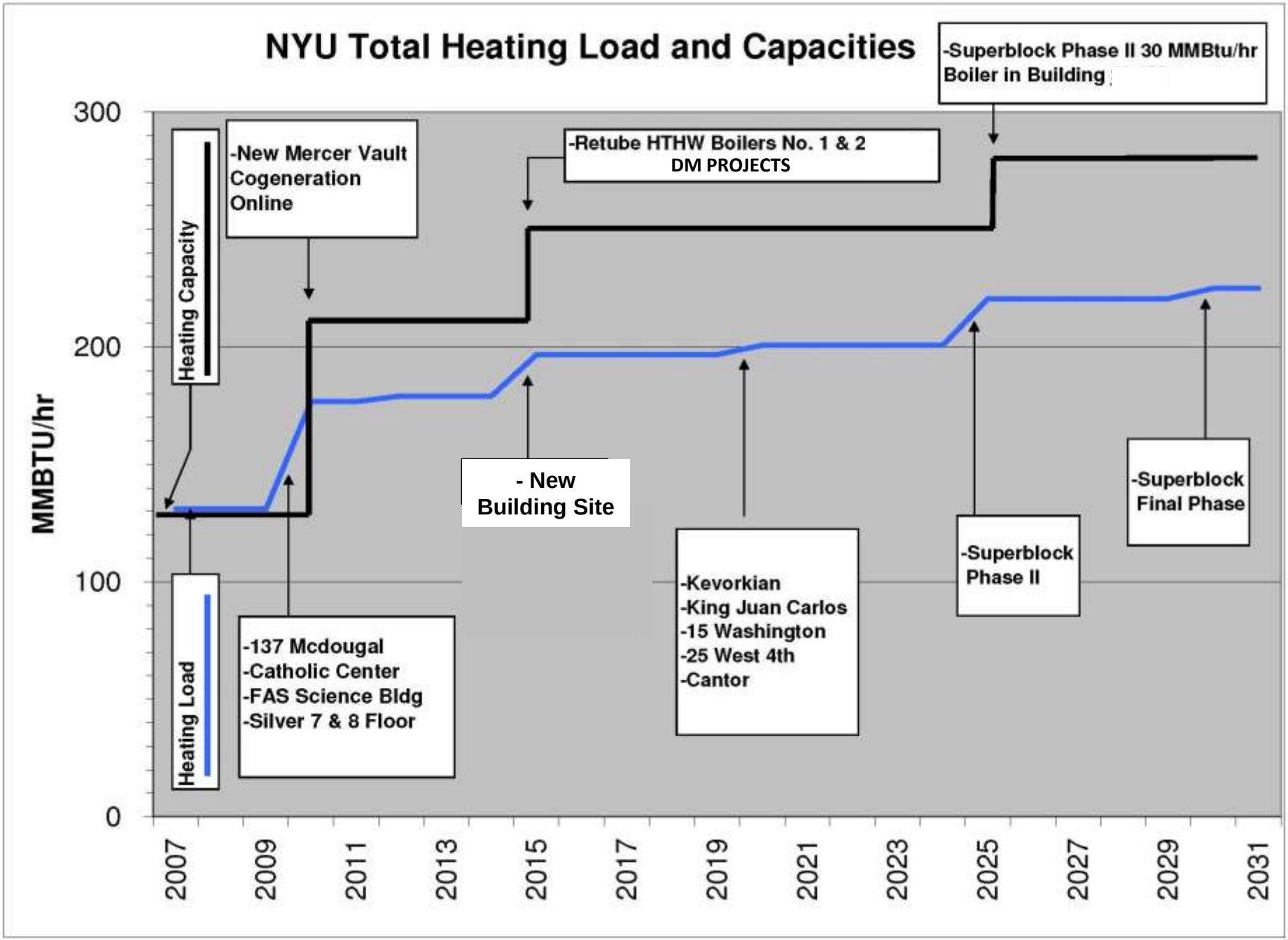
Thermal Sink Utilization

and

Supply Diversity Strategy

Items of Interest for Heating

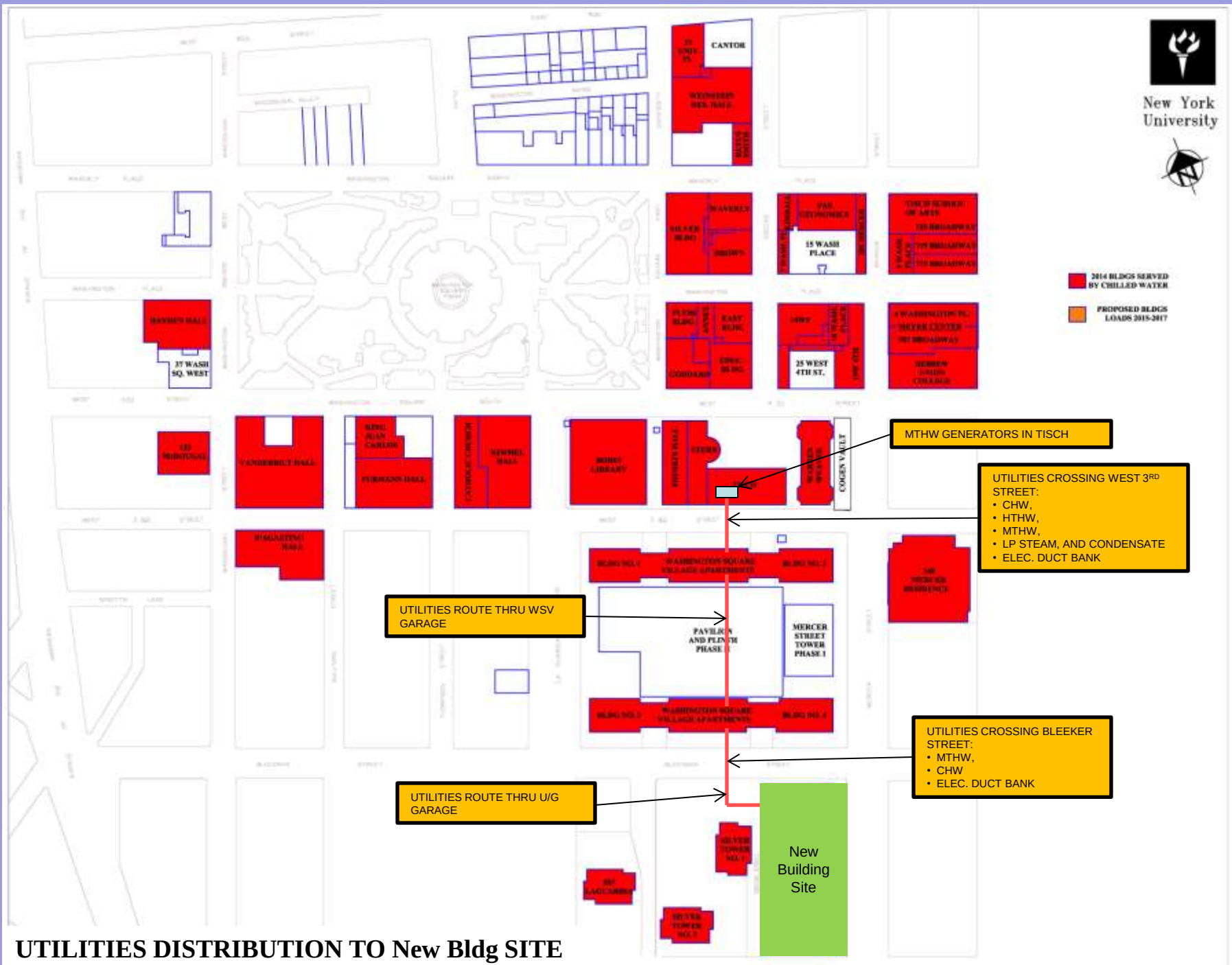
1) Upgraded plant (2010) has capacity for New Site.
2) No new program space required until after New Site.
3) Medium temperature hot water (MTHW) loop Recommended for New Building SIte.
    a) Utilizes HTHW in WSV no new HTHW distribution piping added..
    b) WSV Boilers can back up New Building Site when Cogen is curtailed.
    c) If there is a HTHW zone shutdown or repair WSV the MTHW system can supply heating and Dom HW to New Building Site.
    d) Future MTHW boilers can be added to WSV for additional South Block buildings without operator attendance.(no increase in Operator Labor)
    e) Allows for expansion to other South Block Buildings in future.
    f) Simpler piping system and heat exchange at building.
    g) Allows for thermal storage in loop during plant transients without HTHW distribution problems.


NYU Total Heating Load and Capacities
-Superblock Phase II 30 MMBtu/hr Boiler in Building
-New Mercer Vault Cogeneration Online
-Retube HTHW Boilers No. 1 & 2
DM PROJECTS
Heating Capacity
Heating Load
MMBTU/hr
300
200
100
0
- New Building Site
-137 Mcdougal
-Catholic Center
-FAS Science Bldg
-Silver 7 & 8 Floor
-Kevorkian
-King Juan Carlos
-15 Washington
-25 West 4th
-Cantor
-Superblock Phase II
-Superblock Final Phase
2007
2009
2011
2013
2015
2017
2019
2021
2023
2025
2027
2029
2031

NYU Washington Square Campus Micro Grid/Cogen Heating System - Building Heating Loads and Plant Capacities						
Year	**Building Name**	**Heating Load (MMBtu/hr)**	**Total Heating Load (MMBtu/hr)**	**Heating Installed Capacity Gas Curtailment Capacity (MMBtu/hr)**	**Installed N+1 Capacity (MMBtu/hr)**	**Reserve Future Cap. (MMBtu/hr)**
2013	Existing Buildings - (2) HRSGs and (3) HTHW Boilers	160	160	215	150	(10)
2013	WSW Load Shed During Gas Curtailment	160	127	215	150	23
Future Buildings - Utility Loads - West Run						
2014	Silver Building	8	135	215	150	15
2016	HTHW Boiler # 2 Upgrade work (+10 mmBtu/hr)	na	135	225	160	25
2016	HTHW Boiler # 1 (+ 10MMBtu/hr)	na	135	235	170	35
2017	Medium Temperature Loop	na	135	235	170	35
2017	New cogen engines in Tisch	na	135	247	182	47
2017	New Building Site	18	153	247	182	29

BUILDINGS SERVED BY HOT WATER SERVICES

Site Piping and Conduits - Street Crossings for New Building Site



UTILITIES DISTRIBUTION TO New Bldg SITE

6.0 Load Management

1. Importance of 480V load management of future and renovated Buildings
   a) Load segregated in new building and renovated design.
      1. Split panel feeds to housing unit.
      2. Refrigerators and dedicated outlets for Computers and or Communication Devices
      3. Select dedicated Fan Coil units on essential power panel
      4. House loads hall lights , heating, water and elevators on essential power
   b) Non essential loads are disputable during island mode operation for power flow control during Utility outages

2. Load shed
   1. Heavy Equipment ie Chillers and pumps first tier
   2. Non Essential building loads second tier
   3. Non Critical buildings third tier

7.0 Sustainably Choices For Growth

1. Select most economical size equipment without over sizing.
2. Provide diversity in supply in central system sharing to reduce redundancies
3. Use lower energy input waste energy when ever possible.
    a) Single effect chillers
        a) MTHW
        b) 5 psig steam
    b) Serve low energy intensive buildings with MTHW as much as possible.
        a) 200-230 DegF MTHW

Questions and Comments