



DYNAMIC UTILITY MASTER PLANNING: BEST PRACTICES

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WHY DO MASTER PLANS CHANGE?



NO
PLAN



SEVERAL
POTENTIAL PLANS



CHANGES
TO PLAN

WHY DO MASTER PLANS CHANGE?

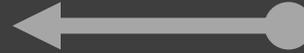
Changes or availability
of technology



**CHANGING
FACTORS**

WHY DO MASTER PLANS CHANGE?

Changes or availability
of technology



Availability of
funding



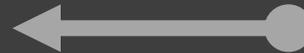
**CHANGING
FACTORS**

WHY DO MASTER PLANS CHANGE?

Changes or availability
of technology



Availability of
funding



Changes in
regulatory restrictions



**CHANGING
FACTORS**

STATIC VS. DYNAMIC MASTER PLANS

How do we invest given the
current conditions?

STATIC VS. **DYNAMIC** MASTER PLANS

How do we plan to invest in
the future given
unknown conditions?

DYNAMIC MASTER PLANNING STRATEGIES



Flexible planning toolkit



Day one buildout



Life cycle cost analysis



FLEXIBLE PLANNING TOOLKIT

How do we support projected demand while **providing flexibility** for changes in the campus master plan?



FLEXIBLE PLANNING TOOLKIT

1 Dynamic load model

2 Utility trigger analysis

3 Dynamic pricing models



DYNAMIC LOAD MODEL

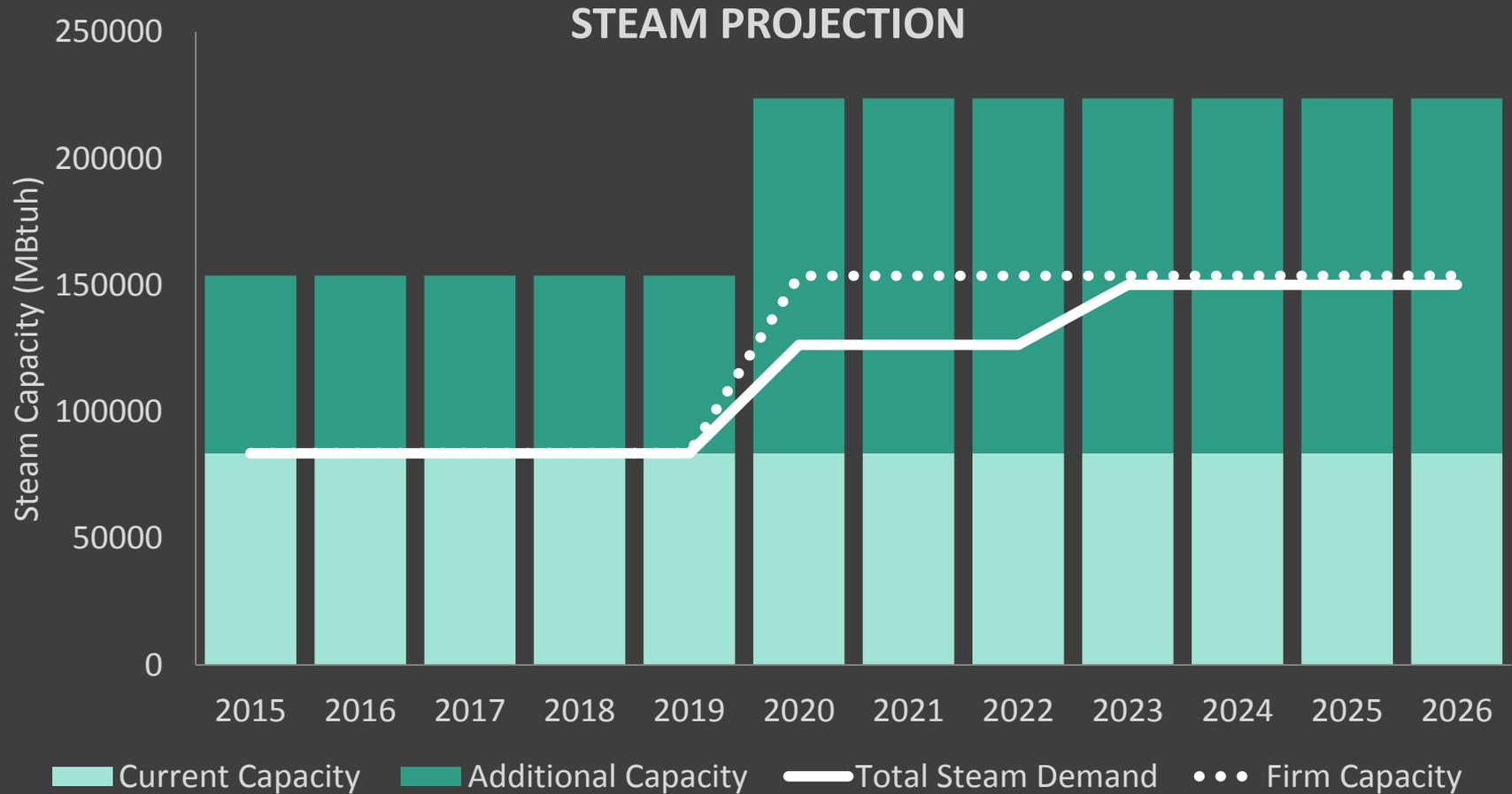
Boilers Located in CEP				Buildings on CEP Steam System			
Boiler	MBtuh	Date Installed	Life				
CEP#1	23,433	2009	40	<input type="checkbox"/>	Armour Academic Facility	<input checked="" type="checkbox"/>	Central Energy Plant (CEP)
CEP#2	23,433	2009	40	<input checked="" type="checkbox"/>	Atrium Building	<input checked="" type="checkbox"/>	Orthopedic Ambulatory Building
CEP#3	23,433	2009	40	<input type="checkbox"/>	Chiller Plant (PPP)	<input checked="" type="checkbox"/>	East Tower
CEP#4	13,390	2009	40	<input type="checkbox"/>	Cohn Research	<input checked="" type="checkbox"/>	AACC
CEP#5	70,000	2015	40	<input type="checkbox"/>	Jelke	<input checked="" type="checkbox"/>	Central HUB
CEP#6	70,000	2020	40	<input type="checkbox"/>	Johnston R. Bowman	<input type="checkbox"/>	New Research Building
				<input type="checkbox"/>	Kellogg Pavilion	<input checked="" type="checkbox"/>	Atrium Expansion
				<input type="checkbox"/>	Pavilion	<input checked="" type="checkbox"/>	Tunnel
				<input type="checkbox"/>	Professional Bldg. 1		
				<input type="checkbox"/>	Professional Bldg. 2		
				<input type="checkbox"/>	Professional Bldg. 3		

MIDWEST MEDICAL CENTER

Central Energy Plant

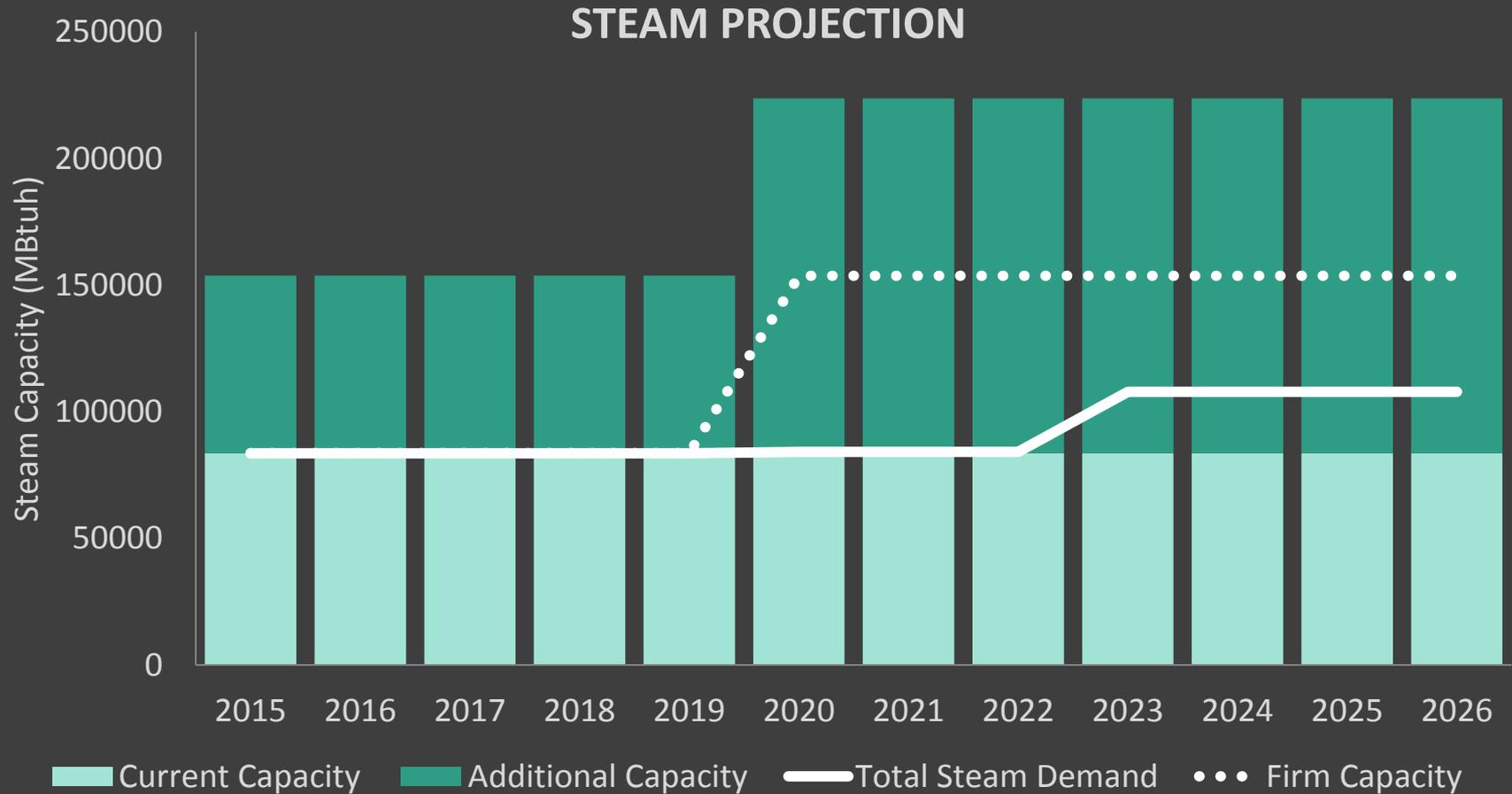


DYNAMIC LOAD MODEL





DYNAMIC LOAD MODEL





UTILITY TRIGGER ANALYSIS

BUILDING INVENTORY

	Construction Project	Load Profile	Cost to Construct (\$MM)	Size (sf)	Phase	Online Date
North Campus	Science Department Building 1	Education - Classrooms	\$ 3.00	20000	Existing	1/1/2000
	Math Department Building 1	Education - Classrooms	\$ 4.50	30000	Existing	1/1/2000
	Physics Lab	Education - Laboratory	\$ 4.50	30000	Existing	1/1/2000
	Chemistry Lab	Education - Laboratory	\$ 2.25	15000	Existing	1/1/2000
	Math Department Building 2	Education - Classrooms	\$ 2.25	15000	Existing	1/1/2001
	English Department Building 1	Education - Classrooms	\$ 3.00	20000	Existing	1/1/2001
	English Department Building 2	Education - Classrooms	\$ 22.50	150000	Existing	1/1/2001
	North Dormitory	Residences	\$ 3.00	20000	Existing	1/1/2001
	South Dormitory	Residences	\$ 12.75	85000	In Construction	4/1/2016
	French Department Building 1	Education - Classrooms	\$ 6.00	40000	In Construction	8/1/2016
	Natural Resources Department Building 1	Education - Classrooms	\$ 3.75	25000	In Design	2/20/2018
Dining Hall 1	Dining	\$ 8.25	55000	In Design	3/4/2020	
South Campus	East Dormitory	Residences	\$ 18.00	120000	Planned	5/1/2023
	West Dormitory	Residences	\$ 18.00	120000	Planned	6/1/2023
	Math Department Building 3	Education - Classrooms	\$ 7.50	50000	Planned	1/1/2026
	Natural Resources Department Building 2	Education - Classrooms	\$ 12.30	82000	Planned	4/1/2028
	Dining Hall 2	Dining	\$ 0.60	4000	Planned	8/1/2030
	Admissions Department	Offices	\$ 0.90	6000	Planned	9/1/2035
	Gym	Gym	\$ 15.00	100000	Planned	9/1/2035
Career Services	Offices	\$ 1.50	10000	Planned	10/1/2035	



UTILITY TRIGGER ANALYSIS

UTILITY UPGRADES

Utility	2/8/2016 Description	Cost to Construct (\$MM)	Upgrade Capacity	Total Capacity After Upgrade	Building Demanding Upgrade	Total Time to Implement Upgrade (days)	Is Upgrade Complete?	Month s Late	Months to Start
Baseline Heating Capacity			84000	84000					
Heating Upgrade 1	Expand Central Plant	\$ 1.200	42000	126000	South Dormitory	365	yes		
Heating Upgrade 2	Purchase Agreement with Neighbor	\$ 0.750	42000	168000	Natural Resources Department Building 1	250	no		16.4
Heating Upgrade 3	Not Identified								
Baseline Cooling Capacity			0	0					
Cooling Upgrade 1	Construct Central Plant	\$ 12.000	12000	12000	Science Department Building 1	730	yes		
Cooling Upgrade 2	Install Chillers in South Dormitory	\$ 1.200	1200	13200	South Dormitory	120	no	5.6	
Cooling Upgrade 3	Install Chillers for Dining Hall	\$ 0.975	500	13700	Dining Hall 2	120	no		172.3
Emergency Power Capacity			10	10					
Emergency Power Upgrade 1	Install Generators in Central Plant	\$ 13.000	4	14	Dining Hall 1	730	no		25.2
Emergency Power Upgrade 2	Not Identified								
Emergency Power Upgrade 3	Not Identified								
Sewer Capacity			35	35					
Sewer Upgrade 1	Install RO System	\$ 20.000	40	70	Math Department Building 2	400	yes		
Sewer Upgrade 2	Upgrade Current System	\$ 3.000	10	110	East Dormitory	365			75.8
Sewer Upgrade 3	Not Identified								
Storm Water Capacity			30	30					
Storm Water Upgrade 1	Install South Campus System	\$ 8.000	50	80	East Dormitory	365	no		75.8
Storm Water Upgrade 2	Not Identified								
Storm Water Upgrade 3	Not Identified								
Currently Available Computers			2000	2000					
Computer Purchase 1	Admissions Department	\$ 0.060	50	2050	Admissions Department	120	no		234.2
Computer Purchase 2	Career Services	\$ 0.030	25	2075	Career Services	60	no		237.2
Computer Purchase 3	Not Identified								

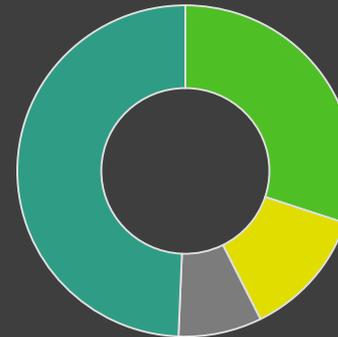


UTILITY TRIGGER ANALYSIS

OUTPUT DASHBOARD

Site Construction Status	Square Feet	
Existing Buildings	300,000	sf
Buildings In Construction	125,000	sf
Approved Buildings	80,000	sf
Planned Buildings	492,000	sf
Total Capacity Programmed for Site	997,000	sf

Site Construction Status

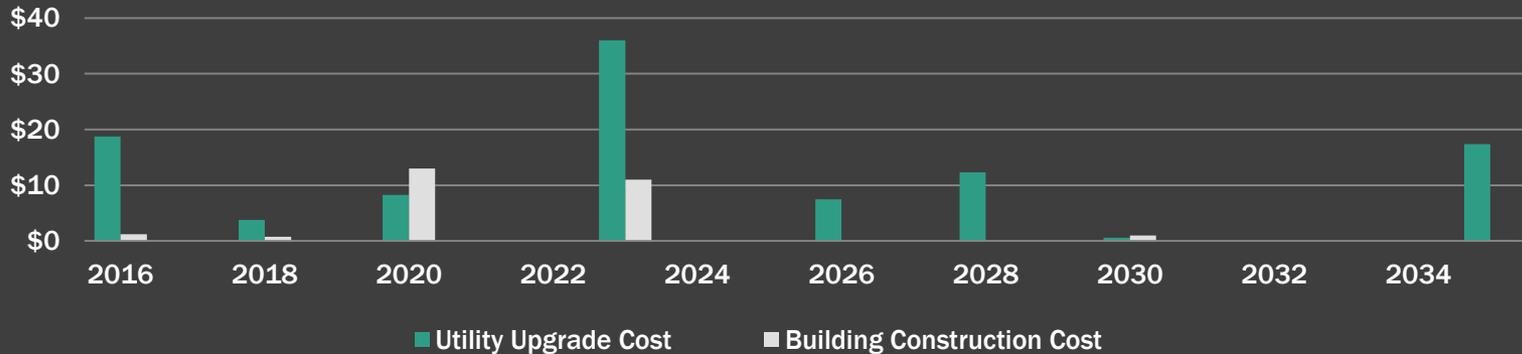
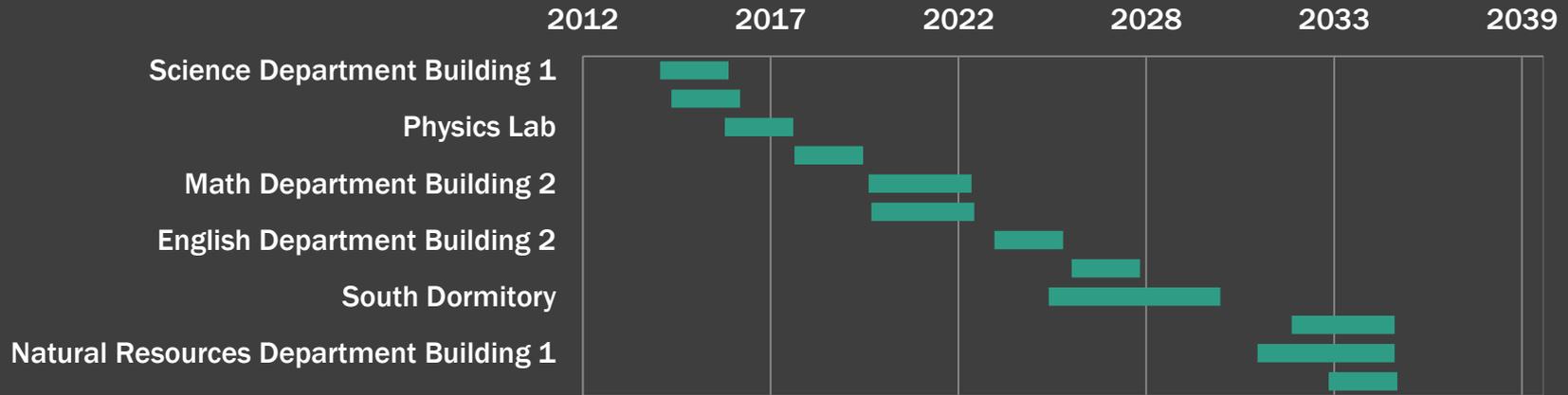


Site Metrics			
	Current Capacity	Current Capacity Will be Exceeded by Building	Current Capacity will be Exceeded in:
Heating	126000 MBTU	French Department Building 1	5.8 months
Cooling	12000 tons	South Dormitory	1.8 months
Emergency Power	10 MW	Dining Hall 1	49.5 months
Sewer	70 MGD	East Dormitory	88.0 months
Storm Water	30 MGD	East Dormitory	88.0 months
Computers	2000 Compute	Admissions Department	238.2 months



UTILITY TRIGGER ANALYSIS

OUTPUT DASHBOARD





DAY ONE BUILDOUT

How do we support currently required utilities while **providing flexibility** for future load additions?



DAY ONE BUILDOUT

Time capital expenditures to maximize benefits



DAY ONE BUILDOUT

Time capital expenditures to maximize benefits

Allows flexibility to incorporate new technology



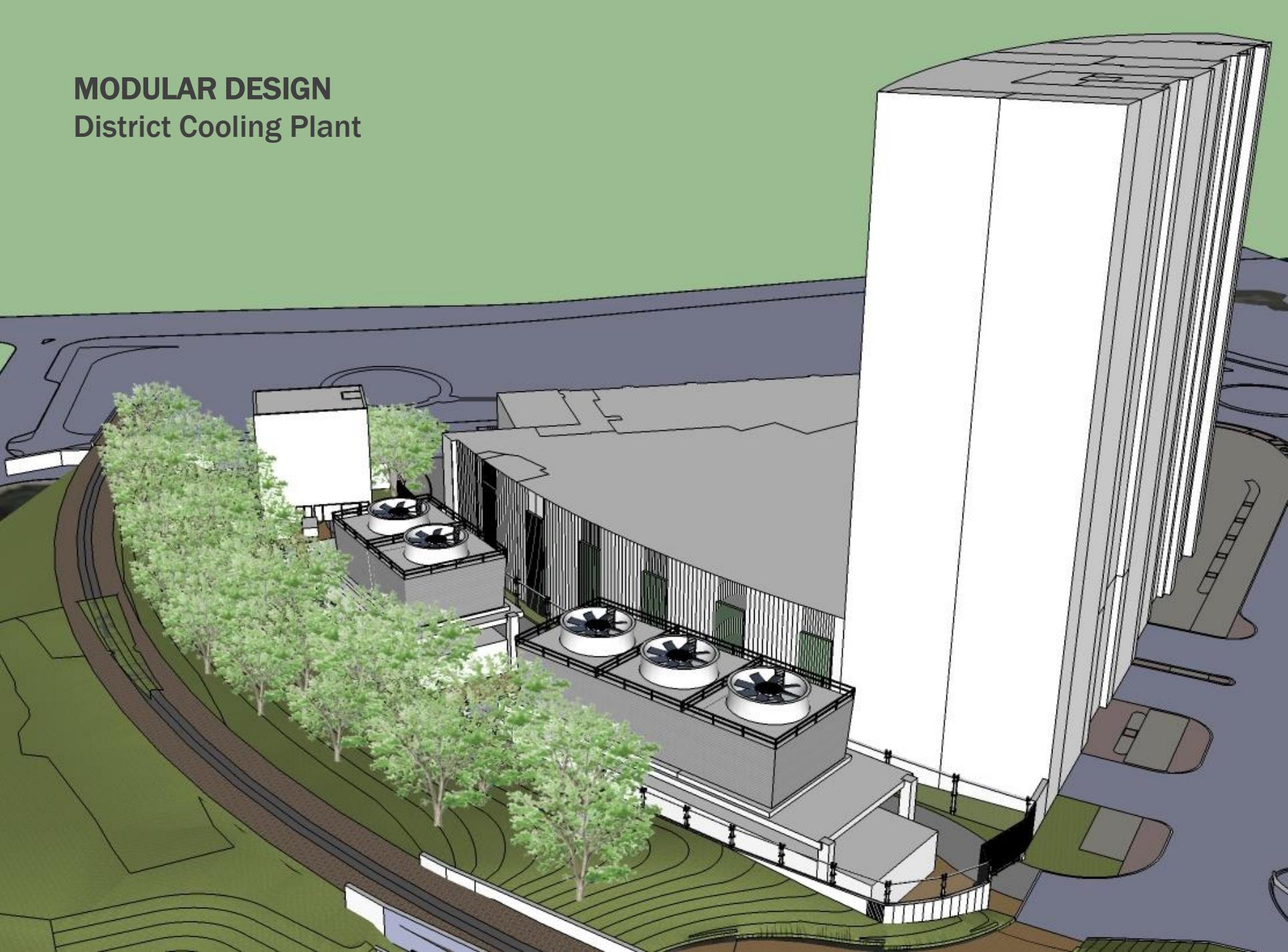
DAY ONE BUILDOUT

Time capital expenditures to maximize benefits

Allows flexibility to incorporate new technology

Requires planning for supporting infrastructure

MODULAR DESIGN
District Cooling Plant





LIFE CYCLE COST ANALYSIS

How do we compare utility options while **providing flexibility** for changing factors?



LIFE CYCLE COST ANALYSIS

Allows for dynamic option analysis



LIFE CYCLE COST ANALYSIS

Allows for dynamic option analysis

Includes utility consumption forecasting



LIFE CYCLE COST ANALYSIS

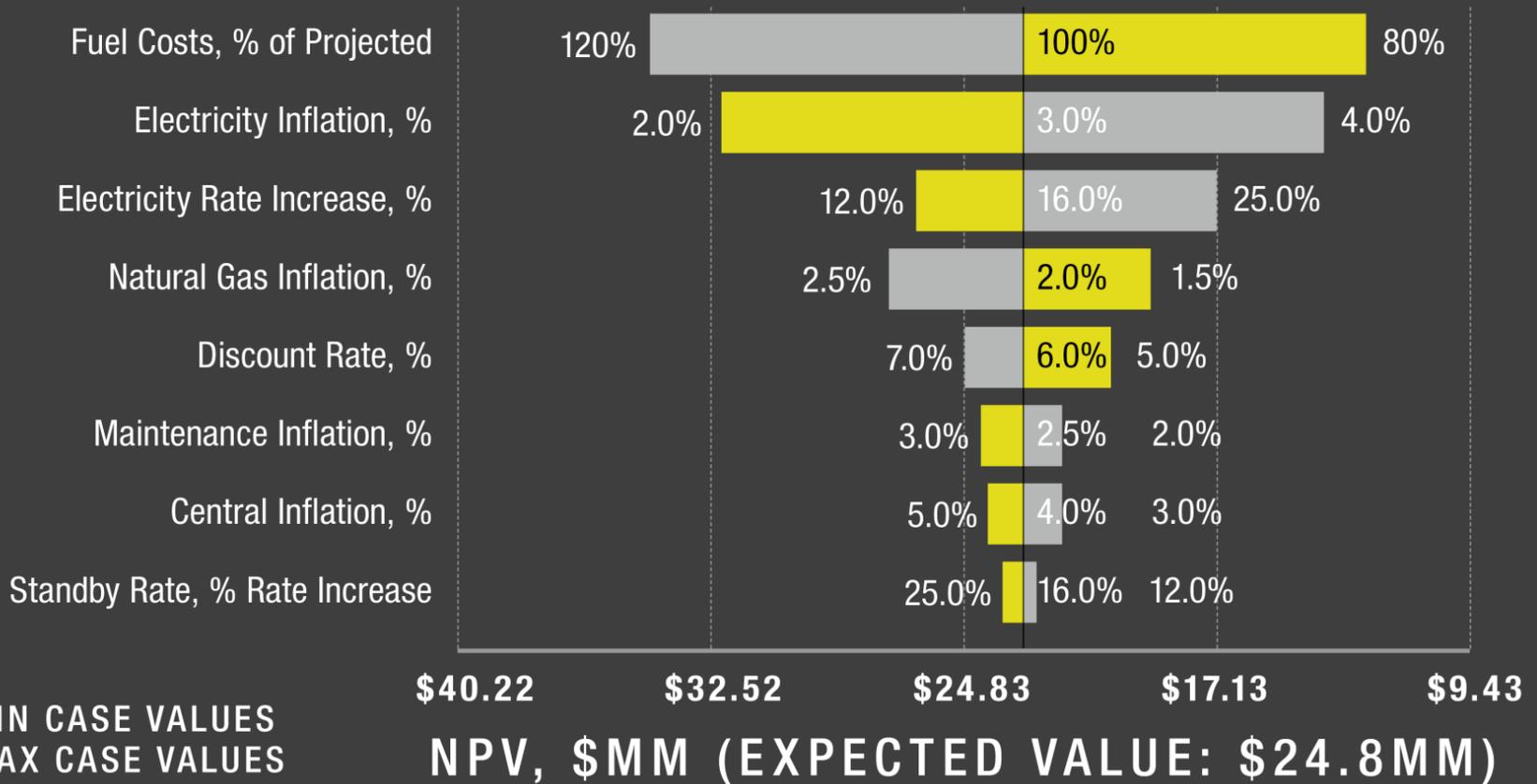
Allows for dynamic option analysis

Includes utility consumption forecasting

Allows for a flexible timeline



TORNADO CHARTS



STATE AGENCY

Utility System Analysis



SUMMARY

Flexibility over the entire lifetime of the utility master plan

SUMMARY

Flexibility over the entire lifetime of the utility master plan

Collaborative effort between stakeholders

SUMMARY

Flexibility over the entire lifetime of the utility master plan

Collaborative effort between stakeholders

Cost-effective and robust plan

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