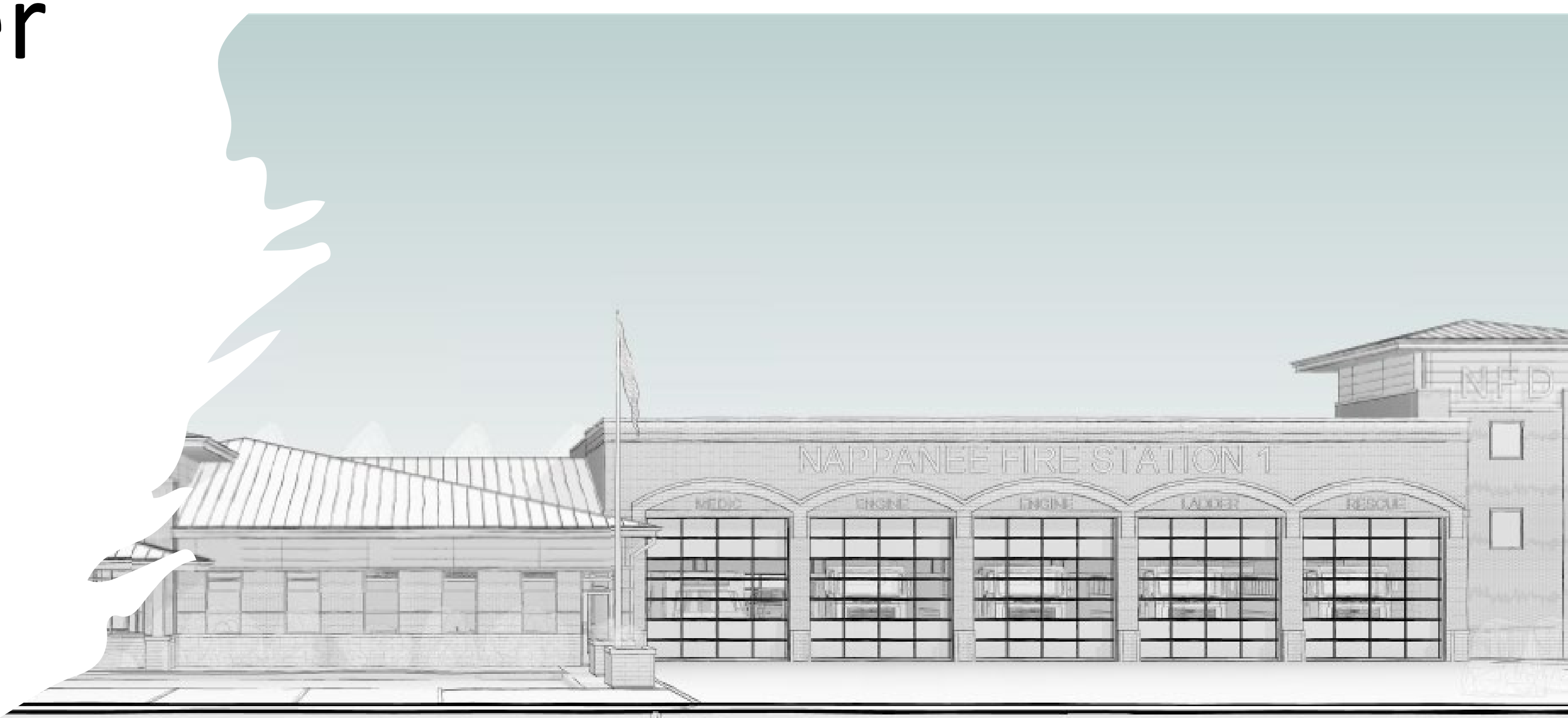
K2M DESIGN

Energy Efficiency in Fire Station Design

Thursday, October 24, 2024

RELATIONSHIPS BASED ON TRUST AND RESULTS



Agenda

1. Air Quality & Contamination Control
2. Project Overview
3. Approach
4. Incentives & Renewables
5. Conclusion

Air Quality & Contaminant Control

Common House Fire Contaminants

- Benzene
- Formaldehyde
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Asbestos
- Carbon Monoxide

Common Turnout Gear Contaminants

- **Arsenic,**
- **Phthalate Plasticizers**
- **Polybrominated Diphenyl Ether Flame Retardants (PBDEs).**
- **Polycyclic Aromatic Hydrocarbons (PAHs)**
- **Hydrogen Cyanide**
- **Volatile Organic Compounds (VOCs)**

Key Design Considerations

- **Ancillary Areas**
  - Turn Out Gear Decontamination & Drying
  - Hose Drying / Training Tower
  - Locate Remote from Administrative Areas and Sleeping Quarters
- **Apparatus Bays**
  - Overhead vs In-Floor Radiant Heating in Apparatus Bays.
  - Tailpipe Emissions Extraction
  - Carbon Monoxide / Nitrogen Dioxide Monitoring, Exhaust & Makeup Air
  - Bi-Fold Doors vs Overhead Doors – HVAC & Lighting Interlock
- **Administration Area**
  - Cold Attic Design & Construction
  - Isolating Attic Air from Administrative Space
  - Air Locks to Apparatus Bays
  - Positively Pressurize Sleeping Quarters, Administrative Areas Relative to Attic & Apparatus Bay
  - Individual Thermostats in Each Dormitory

Key Design Considerations

- 7 Seconds to Open vs 14-21 seconds for Overhead Doors
- Full Unobstructed Height at Opening
- Light Curtain Photo Eyes, Edge Lit
- Faster Firefighter Response Time
- More Energy Efficient

Project Overview

Overview

The purpose of this Project was to construct a new approximately 17,000 gross square foot Fire Station immediately south of Grace Point Church located at 1155 North Main Street (SR 19), Nappanee, Indiana 46550 in Elkhart County. The overall project budget was $9-10 million and will utilize the design-build project delivery model.

Typical maximum occupancy in the building will be 8 people, except during shift change when the occupancy will increase to 16 people for a short duration. The maximum seating capacity of the Training Room is 50 people and is expected to rarely be used rarely used at or near full capacity.

Administrative Area	**Ancillary Area**
Corridors	Water / Compressor Room
Laundry	Tool Room
Office Areas	SCBA
Conference Room	Decontamination
Vestibule	Turnout Gear
Mechanical, Electrical & IT Rooms	Training Hose Tower
Lobby	
Fitness	**Apparatus Bays**
Training / Classrooms	
Kitchen / Dining / Dayroom	
Dorms	
Squad Room	
Airlock	
EMS Storage	

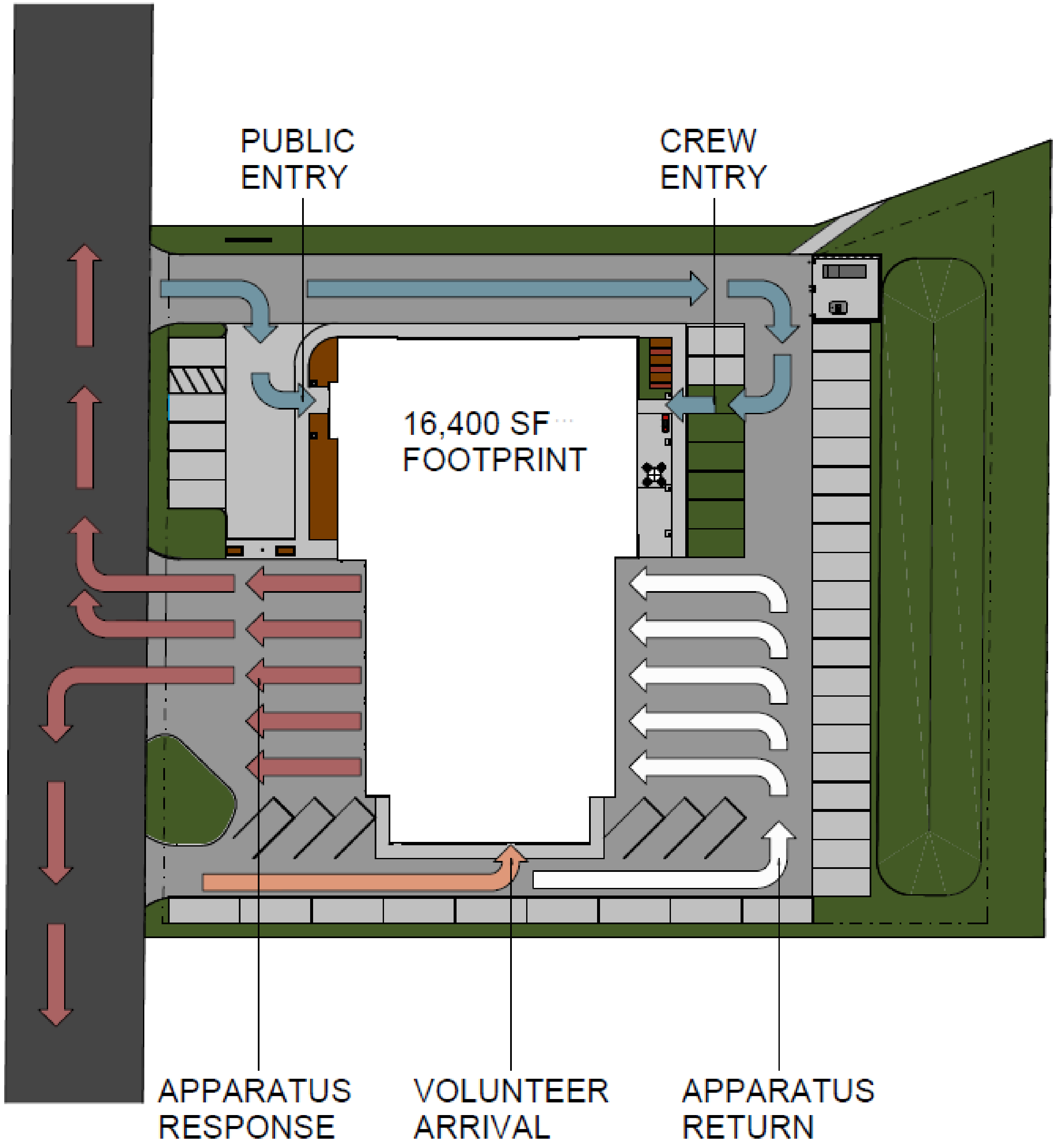
Space Program

WEIGAND CONSTRUCTION K2M DSA COMMONWEALTH ENGINEERS, INC.

FIRST FLOOR PLAN
NAPPANEE FIRE STATION

NAPPANEE

Space Program



Design Approach

Approach

Incremental systematic process to reduce carbon footprint in the most cost-effective and environmentally responsible manner. Perform a whole building energy model and life cycle cost analysis to evaluate and optimize building orientation & geometry, building envelope, HVAC systems and daylighting opportunities. Evaluate energy savings strategies with priority given to the lowest investment / highest environmental benefit by optimizing the following in order:

1. **Geometry**. Space program, building siting & orientation, massing and vertical and horizontal projections to take advantage of daylighting opportunities while minimizing summer solar load on fenestration.
2. **Envelope**. Optimize u-value, solar heat gain coefficient, infiltration to reduce peak HVAC loads thereby reducing energy consumption as well as HVAC and electrical system and infrastructure capacity which reduces first cost with a minimal investment in a high-performance building envelope design.
3. **Diversity**. Leveraging building diversity to turn down and turn off HVAC supply, outside and exhaust air flow and lighting when spaces have below design occupancy or are unoccupied.
4. **Equipment**. Incorporating ultra-high efficiency HVAC equipment and lighting that exceeds minimum energy code requirements.
5. **Renewable Energy**. Evaluate incorporating renewable energy measures. Renewable energy should only be considered after items 1-4 have been optimized to minimize investment, space and environmental impact of embodied energy and adverse impact on the environment associated with the extraction and refinement of raw materials, manufacture, transportation, installation, maintenance and ultimately disposal.

Economic Analysis

ELECTRICITY			
Annual Electricity Consumption	115,146	kWh	
Electricity Peak Demand	29	kW	
RATE 523 - General Service - Medium (Effective 08/04/2023)	**Unit Cost**	**Units**	**Cost**
Consumption	$0.1124	$/kWh	$12,937
Demand Base Flat Charge for First 10 kW	$335.40	$/mo	$4,025
Demand for >10 kW	$15.31	$/kW	$3,491
Blended Rate	**$0.1776**	**$/kWh**	**$20,453**
RATE 521 - General Service - Small (Effective 10/02/2023)	**Unit Cost**	**Units**	**Cost**
Consumption	$0.1701	$/kWh	$19,589
Customer Charge	$48.50	$/mo	$582
Blended Rate	**$0.1752**	**$/kWh**	**$20,171**

NATURAL GAS			
Annual Natural Gas Consumption	344	mcf	
RATE 221 - General Service - Small (Effective 3/01/2023)	**Unit Cost**	**Units**	**Cost**
Distribution	$1.5034	$/mcf	$518
Customer Charge	$66.00	$/mo	$792
Supply (Estimated)	$5.00	$/mcf	$1,722
Blended Rate	**$8.8031**	**$/mcf**	**$3,032**

Economic Analysis

ECONOMIC ANALYSIS				
Administrative Area HVAC Alternative		1	2	3
		RTU VAV	Split Systems	Geothermal
Cooling Capacity	nom tons	13.2	18.1	18.1
Airflow Capacity	cfm	3,617.0	6,241.0	6,241.0
Number of Thermostatic Zones	ea	15	15	15
Annual Electricity Consumption	kWh	115,146	143,814	143,643
Electricity Peak Demand	kW	29	29	67
Annual Natural Gas Consumption	mcf	344	394	267
Annual Energy Consumption	mmbtu	737	885	757
Energy Use Intensity (EUI) (*)	btu/sf/year	42,830	51,405	43,965
Carbon Dioxide (CO2) Emissions	lbm/year	236,213	295,024	294,674
Annual Energy Cost	**$/year**	**$20,453**	**$23,674**	**$30,636**
Annual Water Consumption	ccf/year	287.2	287.2	287.2
Annual Water + Sewer Cost	**$/year**	**$6,549**	**$6,549**	**$6,549**
Annual Utility Cost	**$/year**	**$27,002**	**$30,223**	**$37,185**
First Cost	$ (one time)	**$406,020**	$452,720	$553,020
Inflation Reduction Act Direct Payments (30%) (**)	$ (one time)	$0	$0	$165,906
Net First Cost		**$406,020**	**$452,720**	**$387,114**
Annual Maintenance Cost	**$/year**	**$2,300**	**$4,250**	**$3,000**
Annual Escalation		3.0%	3.0%	3.0%
Administrative Area HVAC Alt Replacement Cost		$68,500	$96,000	$100,500
Administrative Area HVAC Alt Replacement Year		21	16	16
Life Cycle Cost (LCC) / Present Value (PV)	**15 years**	**$668,500**	**$761,520**	**$747,081**
	20 years	**$712,243**	**$833,875**	**$828,943**
	30 years	**$775,652**	**$897,584**	**$903,208**

(*) Energy Star Fire Station Median EUI is 63.5 btu/gsf/yr.

(**) This analysis assumes a direct payment amount equal to 30% of the installed cost of the solar geothermal system, prevailing wage and all applicable requirements of IRA 13102 are met.

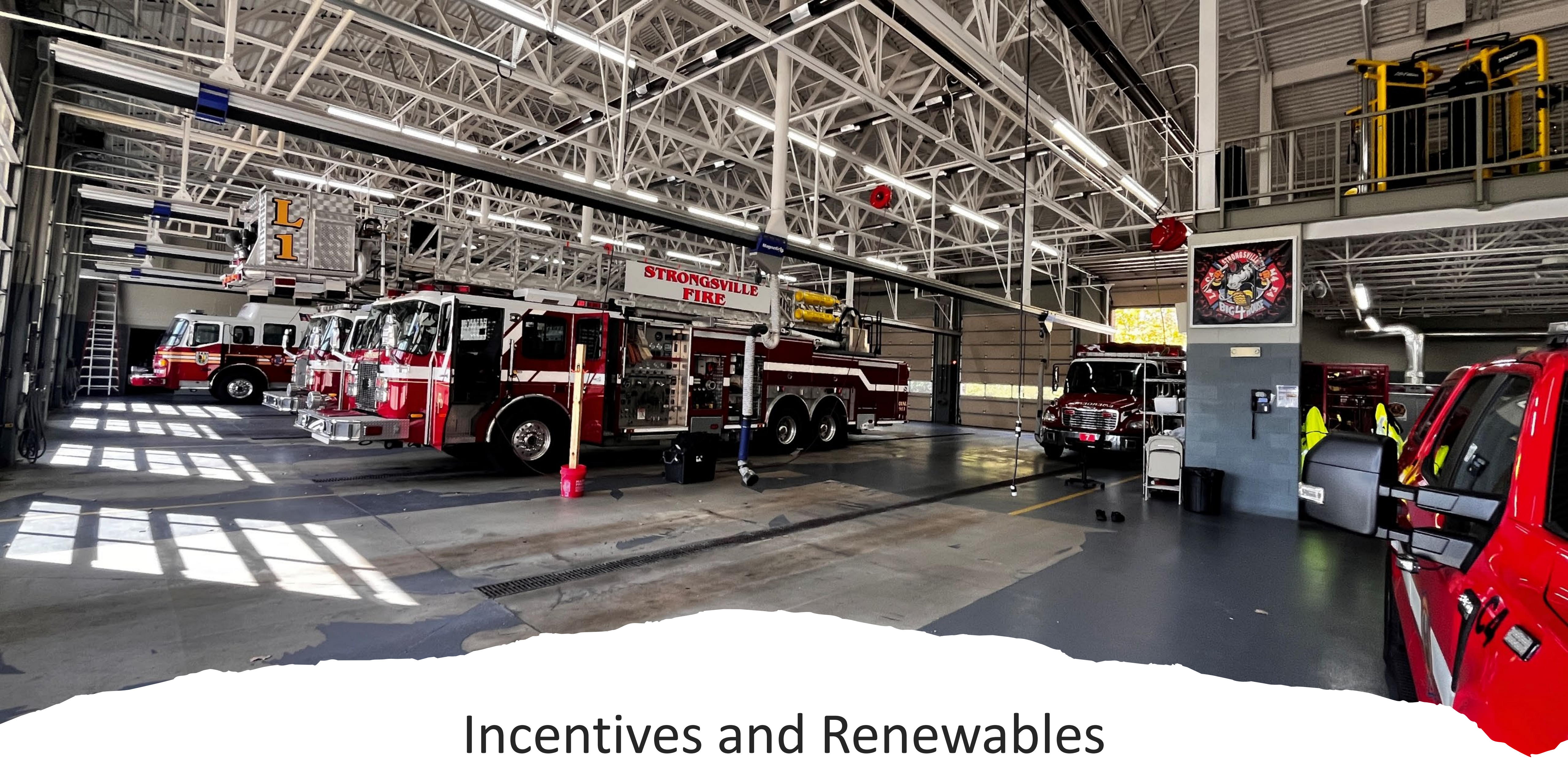
Administrative Area HVAC System Analysis

ADVANTAGES OF VAV RTU VS SPLIT SYSTEMS	ADVANTAGES OF VAV RTU VS GEOTHERMAL
• Lower first cost	• Significantly lower first cost, even after factoring in 30% Cost Reduction from Inflation Reduction Act
• Lower life cycle cost	• Lower life cycle cost
• Smaller capacity required due to being able to take advantage of diversity	• Smaller capacity required due to being able to take advantage of diversity
• No indoor mechanical room space required	• No indoor mechanical room space required
• Less outdoor equipment space required.	• Well field not required
• Less maintenance cost	• Less maintenance cost
• Can utilize fan arrays and multiples compressors for redundancy, reduced vibration and noise	• Can utilize fan arrays and multiples compressors for redundancy, reduced vibration and noise
• Variable air volume system is more energy efficient	• Comparable to slightly better energy efficiency with advanced energy efficiency measures such as demand control ventilation and zone level occupancy sensor setback
• Easier to incorporate advanced energy efficiency measures such as demand control ventilation and zone level occupancy sensor setback	
• Less penetrations through the building exterior (roof and/or exterior walls)	• Does not require a dedicated outdoor air unit.
• Can better accommodate higher outside air volumes required for densely occupied spaces while leveraging diversity to keep overall outside air cfm low	• Can better accommodate higher outside air volumes required for densely occupied spaces while leveraging diversity to keep overall outside air cfm low
• Far easier to provide air side economization	• Far easier to provide air side economization
• Far easier to operate fan continuously to provide code required outdoor air even when space conditions are within set point.	• Far easier to operate fan continuously to provide code required outdoor air even when space conditions are within set point.
• Far easier to provide additional thermostatic zones	• Far easier to provide additional thermostatic zones
• Far easier and less expensive to incorporate high efficiency filtration, UVC, bipolar ionization and humidification	• Far easier and less expensive to incorporate high efficiency filtration, UVC, bipolar ionization and humidification
• More flexible with respect to changes to floor plan / zoning.	• More flexible with respect to changes to floor plan / zoning.

Benchmarking

UTILITY ANALYSIS			
		Proposed	**Median**
Annual Electricity Consumption	kWh	115,146	170,716
Electricity Peak Demand	kW	29	43
Annual Natural Gas Consumption	mcf	344	511
Annual Energy Consumption	mmbtu	737	1,093
Energy Use Intensity (EUI)	btu/sf/year	42,830	63,500
Carbon Dioxide (CO2) Emissions	lbm/year	236,213	350,210
Annual Energy Cost	**$/year**	**$20,453**	**30,324**
Annual Water Consumption	ccf/year	287.2	287
Annual Water + Sewer Cost	**$/year**	**$6,549**	6,549
Annual Utility Cost	**$/year**	**$27,002**	**36,873**

Annual Energy Savings of Proposed vs Median		
Consumption	mmbtu	**356**
Carbon Dioxide (CO2) Emissions	lbm/year	**113,997**
Cost ($)		**$9,870.60**
Cost (%)		**32.6%**



Incentives and Renewables

Utility Incentives

NISPCOs custom incentives program for new construction allows agricultural, large commercial, governmental, industrial, institutional and non-profit customers to obtain incentives for making electric and natural gas energy efficiency improvements above minimum code requirements. Eligible NIPSCO customers include those currently billed under electric Rates 520, 521, 522, 523, 524, 525, 526, 531 Tier 1, 532, 533, 541, 543 or 544 and natural gas Rates 221, 225, and 251.

If the project's estimated incentive exceeds $10,000, it requires pre-approval before purchase and installation of efficient equipment. Incentives are calculated based on how much is saved in kilowatt hours (kWh) for electricity and/or therms for natural gas. The 2024 incentive rates are as follows:

$0.10/kWh for electric lighting projects

- $0.12/kWh for electric non-lighting projects
- $1.00/therm for natural gas savings

The current incentive program requires that all projects must be completed by November 16, 2024 to be eligible and all applications must be submitted within 90 days of measure(s) installation. Since the 2025 and 2026 Incentive Programs have not been published yet, we are unable to determine the potential utility incentives this project might receive.

Inflation Reduction Act

The Inflation Reduction Act introduced and expanded tax credits for clean energy technologies. The Inflation Reduction Act's "elective pay" (often called direct pay) provisions, allow tax-exempt and governmental entities will, to receive a payment equal to the full value of tax credits for building qualifying clean energy projects.

Applicable entities can use direct pay for 12 of the Inflation Reduction Act's tax credits, including for generating clean electricity through solar, wind, and battery storage projects; building community solar projects that bring clean energy to neighborhood families; installing electric vehicle (EV) charging infrastructure; and purchasing clean vehicles for state or city vehicle fleets.

Inflation Reduction Act Provision 13102.
Solar photovoltaic falls under "*Investment Tax Credit for Energy Property*" (26 US Code § 48, pre-2025). Under this provision a governmental entity can receive a direct payment of 6% of qualified investment (basis).

Credit is increased by 5 times for projects meeting prevailing wage and registered apprenticeship requirements. Initial guidance on the labor provisions is available here. Credit is increased by up to 10 percentage points for projects meeting certain domestic content requirements for steel, iron, and manufactured products. Credit is increased by up to 10 percentage points if located in an energy community.

Solar PV Analysis

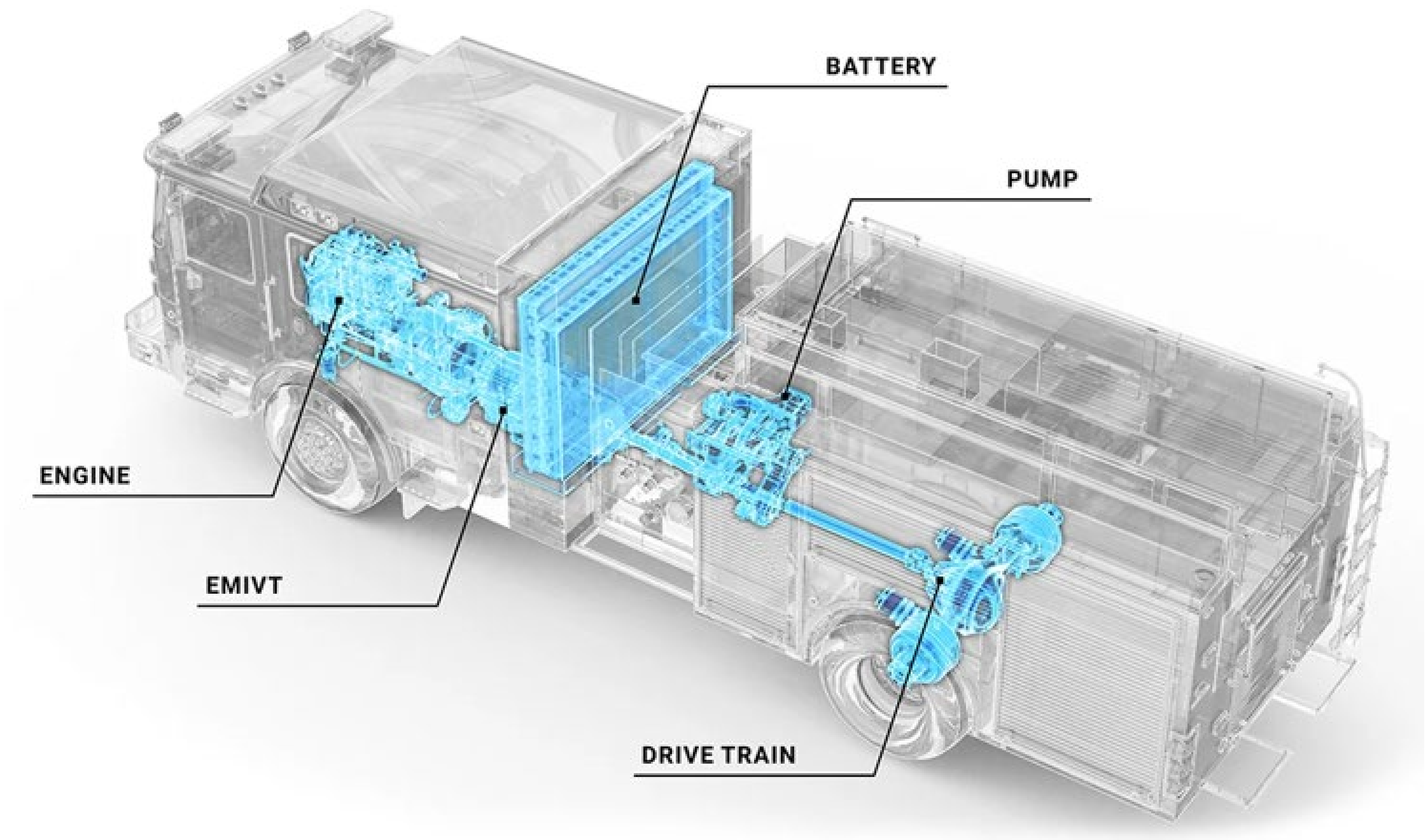
SOLAR PV ANALYSIS		
Apparatus Bay Roof Area	8,269	gsf
System Density	17.55	gsf/kW
System Size	10	kW
System Roof Area	176	gsf
Roof Area Coverage	2%	
Annual Electricity Generated per Installed kW	1,314	kWh/kW
Annual Electricity Generated	13,140	kWh/kW
Installed Cost per Watt	$2.60	$/watt
First Cost (Installed)	$26,000	
Annual Savings	$1,476	$/year
Simple Payback Period	17.6	years
Direct Payment %	30%	
Direct Payment Amount	$7,800	
Net First Cost (Installed)	$18,200	
Adjusted Simple Payback Period	12.3	years

Solar PV

- The simple payback of solar PV after factoring in the maximum 30% inflation Reduction Act (IRA) direct payment is 12 years based on an electricity consumption rate of $0.11/kwh.
- The size of the solar array will be very small, only 10 kW due to:
  - The building design is efficient and for 99% of the hours per year the peak load will be less than 30 kW even during the day in the summer months.
  - The winter monthly peak is only 19 kW.
  - Oversizing the array and relying on net metering (selling back to the utility) has a pay back of roughly 30 years (after factoring in the maximum 30% direct payment from the IRA) since the rate the utility pays is a customer for electricity is approximately $0.04/kWh.
  - Please note that the maximum estimated peak electrical demand of 146.5 kW is for sizing the electrical service and emergency generator only. At most the building may operate near this peak 8 hours per year.
- Our design was optimized so the opportunity for capturing additional energy savings from ultra-high efficiency (costly and often higher maintenance cost) HVAC equipment and renewables such as Solar PV and Geothermal is very small.

Electric Vehicle Charging

- Significant Impact to Electrical Service Size
- Significant Impact to Emergency Generator Size
- Fire Engine EV is Emerging Technology



Conclusions

- Optimizing Building Geometry, Envelope and Diversity, can make significant investment in ultra-high efficiency HVAC Equipment and Renewable Energy less attractive from both an environmental impact and an economic point of view.
- Said another way, it matters less from an energy conservation standpoint which HVAC system is selected, whether or not ultra-high efficient equipment is selected or renewable energy is incorporated. The priority after optimizing Geometry, Envelope and Diversity can trend toward reduced maintenance, reliability and performance in lieu of further energy savings.
- Leveraging Diversity and taking advantage of low natural gas utility cost relative to electricity (5.9X higher) were critical in making RTU VAV the lowest energy cost alternative on this project.