

EM Town Garage	27-Jun-24								
Options, Costs and Emissions									

Option		Construction Cost [3]		Energy Use [4]		First Year Energy Cost		Total, 30 Years	30-yr. Life	Federal
#	Name [2]	Without Soft Costs	With soft costs	Electricity kWh/year	Propane Gal/year	No PV \$\$/year [7]	With PV \$\$/year	CO2 emissions lbs CO2e [1]	Cycle Cost \$\$\$ [5]	Incentive [6]
1	Prefab Metal, Propane Boiler	\$ 3,909,000	\$ 4,716,000	12,000	10,000	\$ 24,000		5,648,000	\$ 2,865,000	
2	Wood Frame, Propane Boiler	\$ 3,992,000	\$ 4,799,000	11,000	7,000	\$ 17,000		3,773,400	\$ 2,802,000	
3	Wood Frame, Air-to-Water Heat Pump	\$ 4,318,000	\$ 5,125,000	71,000	-	\$ 14,300	\$ 1,100	743,400	\$ 2,640,000	\$ 48,750
4	Wood Frame, Ground Source Heat Pump	\$ 4,318,000	\$ 5,125,000	54,000	-	\$ 12,100	\$ 1,100	653,400	\$ 2,651,000	\$ 281,050

NOTES

[1] Over 30 years. Total of energy emissions and emissions embodied in the building enclosure

Building Option	Embodied lbs CO2e	Operation lbs CO2e/yr
Prefab Metal, Propane Boiler	638,000	167,000
Wood Frame, Propane Boiler	323,400	115,000
Wood Frame, Air-to-Water Heat Pump	323,400	14,000
Wood Frame, Ground Source Heat Pump	323,400	11,000

[2] Wood Frame building is high performance -- see Assumptions page

[3] Costs for HP buildings, 3 and 4, include cost of PV. Efficiency VT and Federal incentives not included. Soft cost \$807,000 for all options. Air-to-water HP mechanicals cost less than ground source heat pump mechanicals, but require larger PV array. It is coincidental that the total construction cost is the same for both A2W HP and GSHP. Construction cost for GSHP mechanicals is \$40,000 more than for A2W HP; and

[4] For all options, this is the total the building consumes, regardless of source. Energy use and cost has been modeled hourly, but like EPA car ratings, "your mileage will vary." Trucks coming in cold is a wild-card and has been included in estimate, but generates uncertainty in totals. However, that energy impact

[5] 30-year Life cycle cost includes initial construction cost, replacement costs for mechanical items, energy costs. Residual building value at 30 years is estimated at 75% of initial construction cost. Energy costs in life cycle analysis for HP systems include costs for and savings from PV systems

[6] Federal incentive of \$244,000 for ground source system, \$48,000 for 65 kW PV for Air-to-water HP; \$37,500 for smaller 50 kW array for ground source heat pump. Feds make direct payment to Town. Efficiency VT incentives not

GSHP cost/Fed. Incentive	\$ 360,000	Borehole cost
Note: assumes US made equipment	\$ 610,000	total GSHP cost
	\$ 244,000	40% Fed incentive

[7] PV could be added for small electrical usage for Options 1 and 2. PV for Opt. 3 and 4 is sized to match estimated annual load. Monthly meter and efficiency charges are not offset by exported electricity credits. 65 kW included for air source building; 50 kW for ground source building

EM Town Garage		Assumptions for Energy Modeling	240624
Envelope	Building	Metal Building, per 2024 CBECS code	Efficient Wood Building
	Windows	R-3.5	R-3.5
	Skylights	none w/ 0.5 wsf lights	none w/ 0.5 wsf lights
	Doors	R-2.7	R-2.7
	Air/Vapor Barrier	Inner VB is inner skin of metal building panels	Full VB interior of walls, full VB on roof top, wall VB fully connected to roof VB
	Insulation Roof	R-42, 6" foam insulated steel panels	R-60 / U=.0167
	Insulation Walls	R-25 , 4" foam insulated steel panels	R-30
	Stem Wall	R-10 continuous rigid exterior	R-20 continuous rigid exterior insulation
	Slab under	f-0.434 by code, but modeled at 0.71 for 2" under 48" only	4" EPS under whole slab, R-18; f-0.2
	Slab edge	none	4" exterior of stem wall, up 4 ft and down 4'
	Overhead doors	R-6 -- no requirement	R-18
	Air Leakage rate	0.25 cfm75/sf. Shell 6 sides, equivalent to 0.19 cfm50/sq.ft. shell 6 sides	0.06 cfm50/sq.ft. shell 6 sides
Envelope Commissioning	yes	yes	
EM Town Garage			
Mech	Ventilation	Two exhaust fans, controlled on CO, NO2, RH and timer	Two exhaust fans, controlled on CO, NO2, RH and timer
	Domestic Hot	Tank off boiler, full recirc	HPWH, EF =3.0, controlled circulation
	Controls	programmable thermostat	programmable thermostat
	Heating	Propane or wood pellet boiler boiler, eff = 0.85, AFUE = 0.82	A2W HP and GSHP COPs modeled dynamically; or propane or wood pellet boiler Eff=0.85
	Cooling	office only, ASHP	office only, ASHP
	Lighting	LED	LED
	Plug Loads	Low	Low
NOTES:	Two truck ins and outs each day -- on AM, one PM, each 1 full air change when trucks come in or go out		