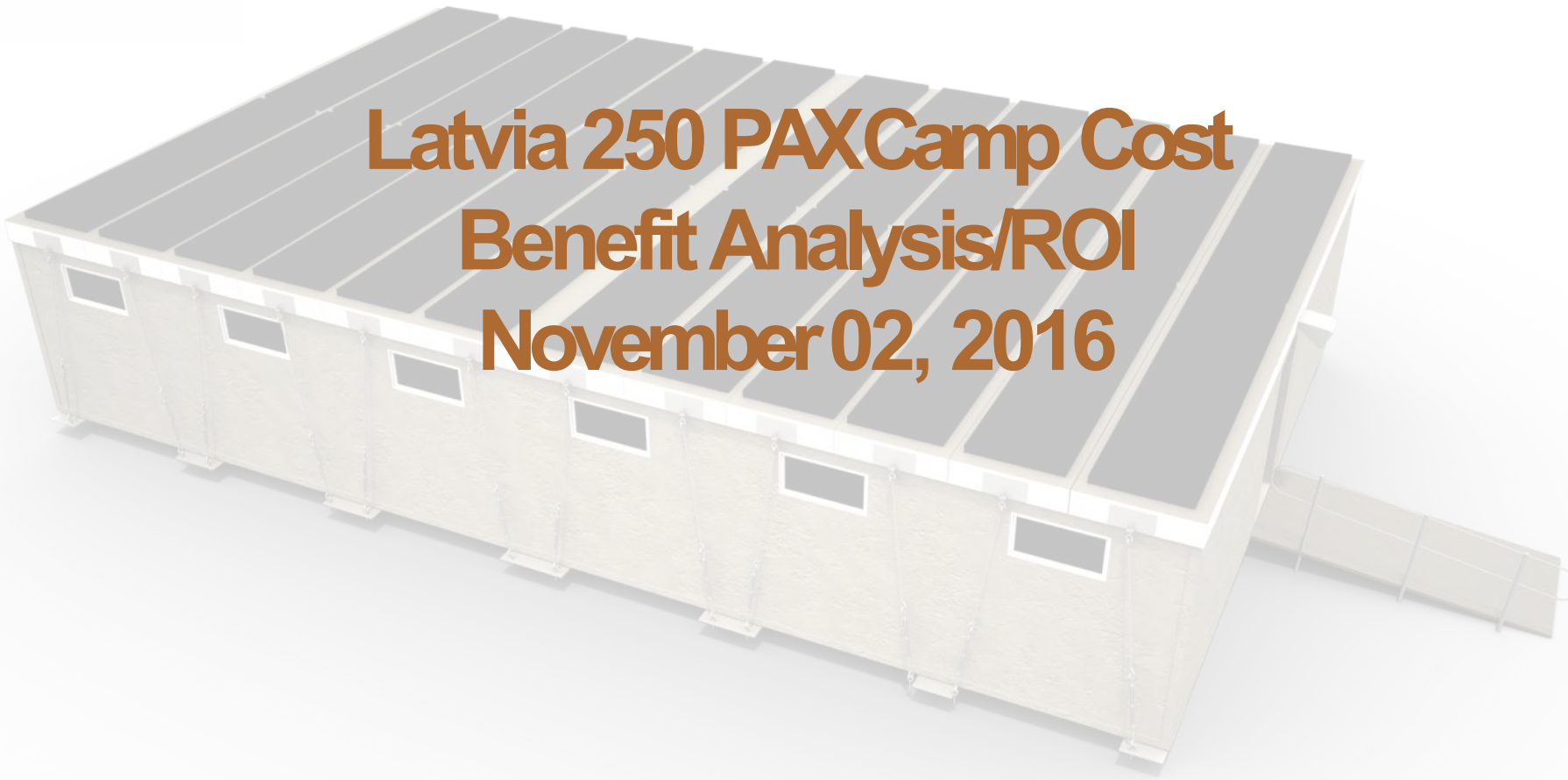
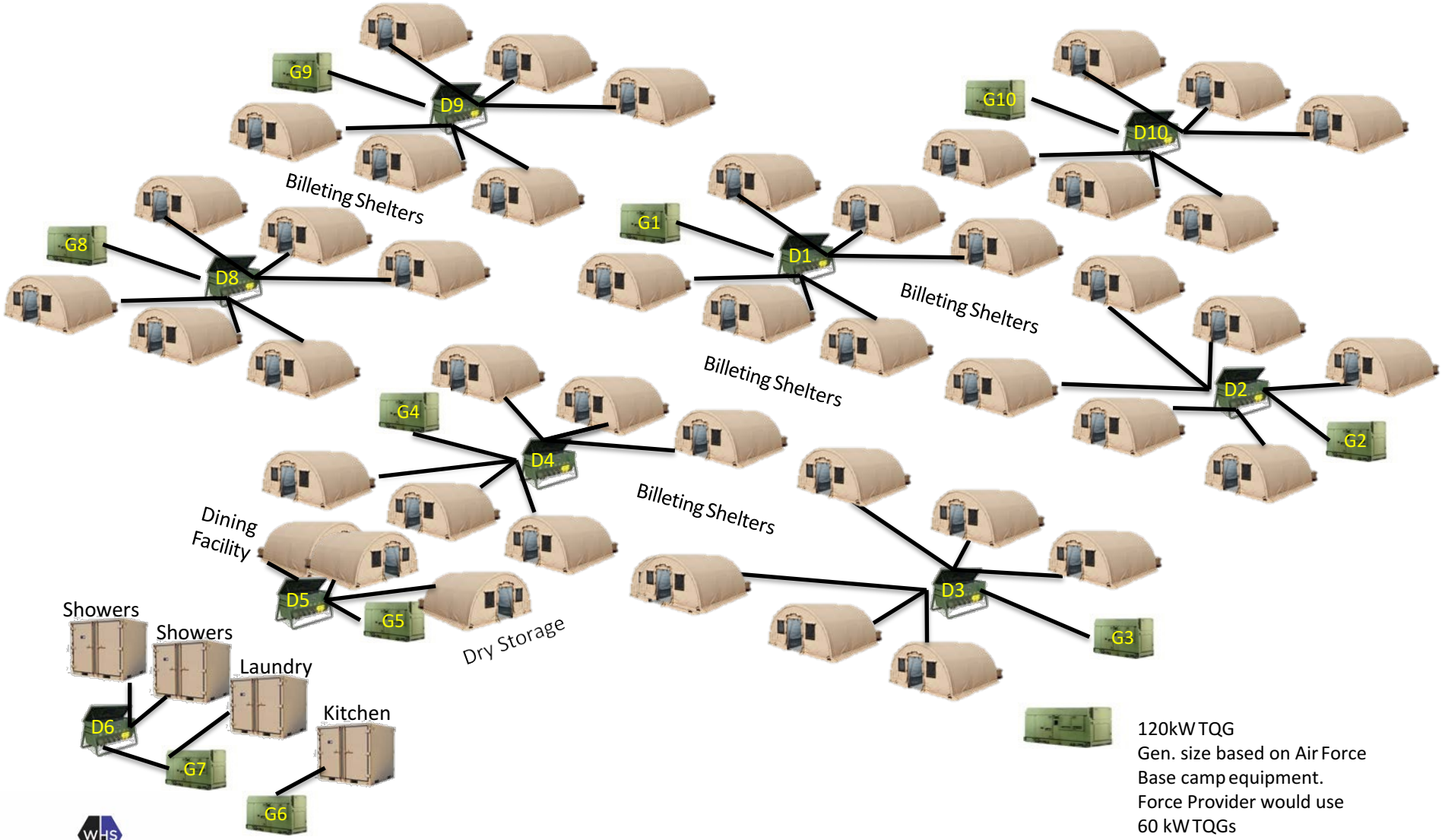
WORLD HOUSING SOLUTION



Latvia 250 PAX Camp Cost Benefit Analysis/ROI November 02, 2016

WORLD HOUSING SOLUTION LEX TM3 BARBARICUM ADS

Soft-Walled (Tent) 250 Man Camp



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Soft-Walled (Tent) 250 Man Camp

- (42) Billeting Shelters
  - (6) occupants each
    - 110 sq. ft. per occupant (per requirement)
  - Require replacing approximately every 5 years (PM FSS)

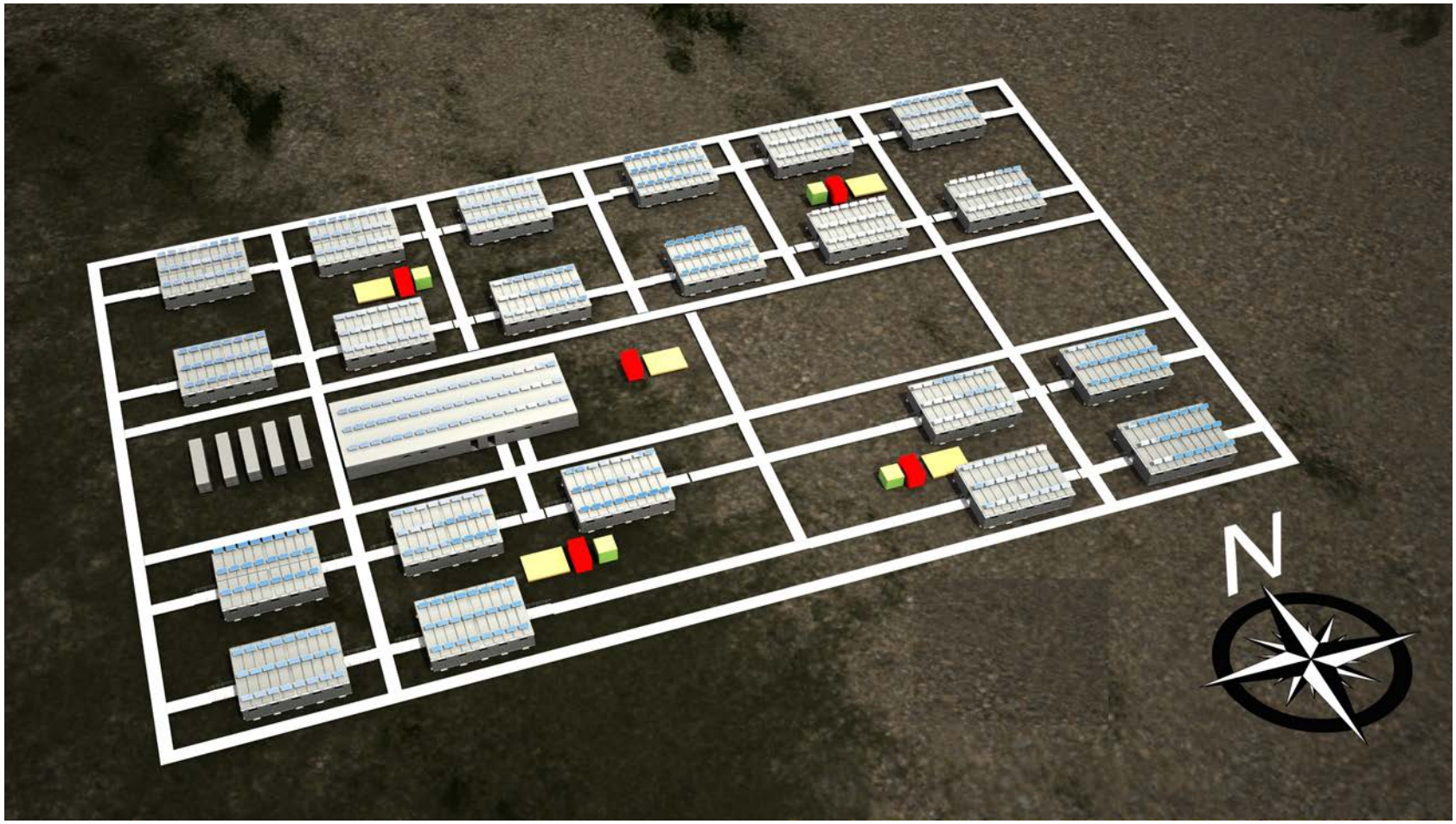
- Low efficiency Shelters
    - R values ~4 (https://www.army.mil/article/98542/Rigid_wall)
    - Thermal solar loading has significant impact during summer

- Enduring installation
  - Requires site preparation work to build platforms
    - Platforms are replaced every 2-3 years (PM FSS)

- (10) 120kW generators
  - 815kW maximum camp power requirement as spec'd

WHS Rigid-Walled 250 Man Camp

WHS Rigid-Walled 250 Man Camp



WHS Rigid-Walled 250 Man Camp

Energy Efficiency (Make the most of what you have)

- Average R-Value of 30 to keep more constant interior temperature
- Reduced power requirement for environmental control of interior temperature
- Utilizes energy storage to gain maximum use of locally generated electricity and drive down fuel requirement
- Harvests renewable power sources to decrease required power from onsite assets or locally sourced power

Power Surety (Confidence of always having power available)

- Energy storage insulates the camp from external power availability on the commercial grid (Incirlik)
- Renewable power sources with energy storage can be leveraged to continually support mission critical loads indefinitely
- Energy storage and renewables enable maximum use of available fuel if onsite generator power is the only option to run the camp

Host Nation Considerations

- Small impact on local commercial grid
- Ability to back feed additional renewable power to local grid if desired

WHS/LexTM3 250 PAX Camp - Buildings & Power

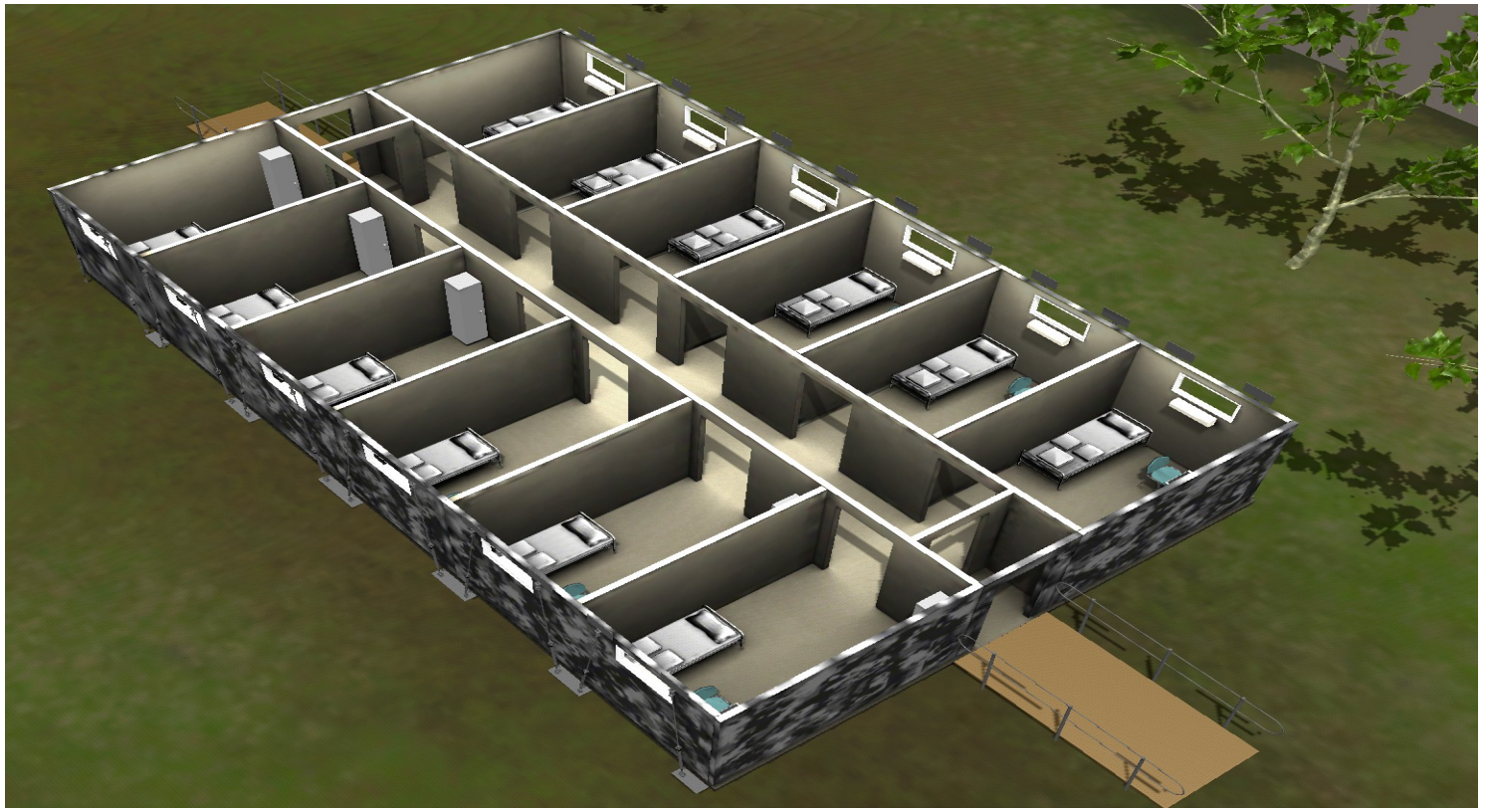
- (21) Billeting Shelters
  - (17) double occupancy with (12) pax each, 2 per room
    - 110 sq ft. per occupant (per requirement)
  - (4) single occupancy with (12) occupants each, 1 per room
- (1) Services building
  - Latrines, Laundry, Showers
- (1) Water Treatment System
  - (1) 20' Conex
- (1) Sewage Treatment System
  - (4) 20' Conex
- Service life of 15-20 years
  - High efficiency Shelters
    - R-values average 30 for roof, walls and flooring
- Semi-permanent installation
  - Requires minimal site preparation work to build platforms
- 505kW maximum camp power requirement as spec'd
- (4) 120kW generators paired with (4) hybrid power system
  - Generators operate to charge batteries and are then silent
- (1) 200kW generator for Services Building and Water/Sewage Treatment Systems

<u>Highly efficient structures make hybrid system more viable and effective</u>

WHS – Billeting Detail

Double and Single Occupancy Configurations, 110sq;/PAX

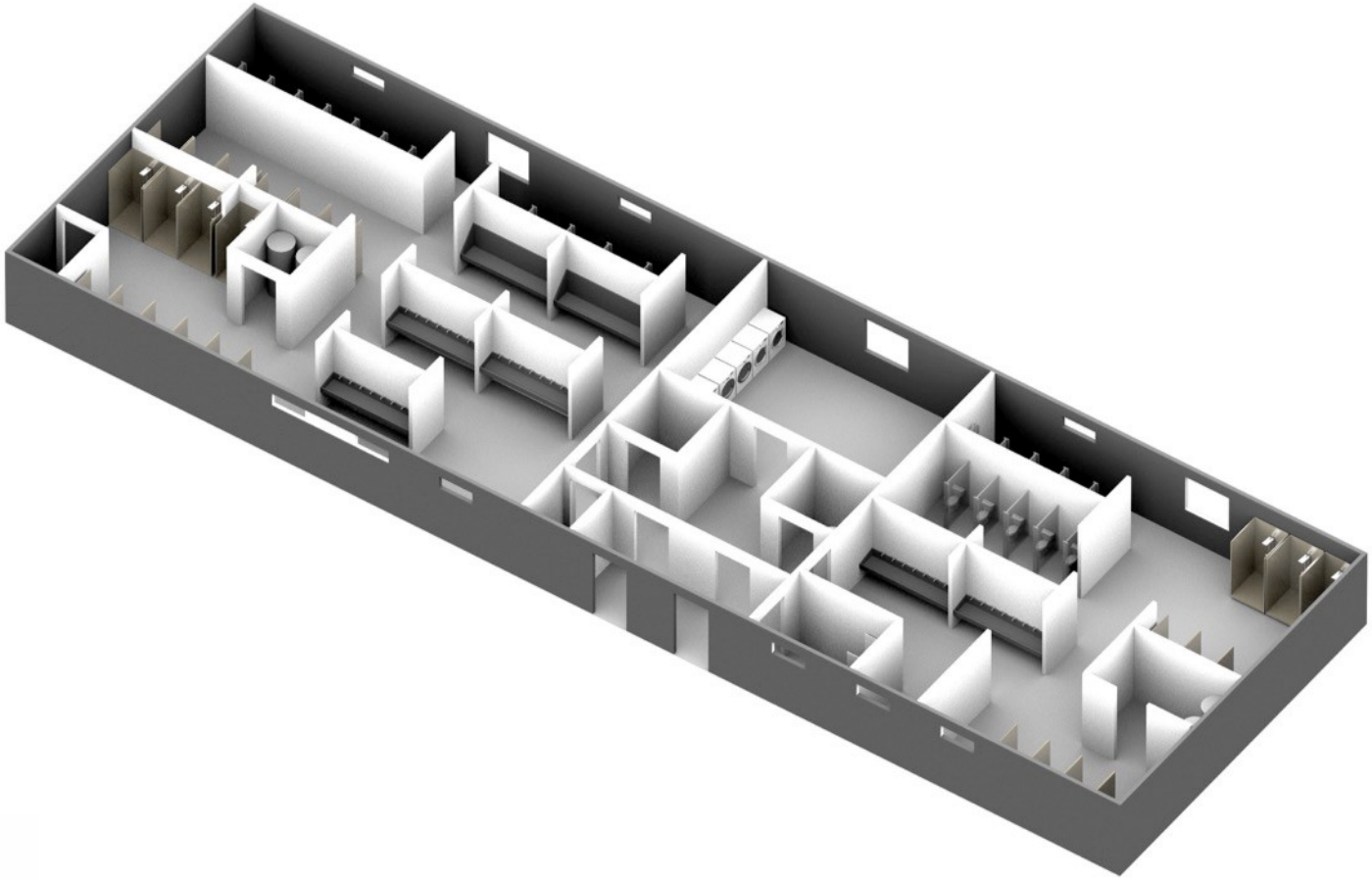
Unique Support Minimizes Site Prep



WHS – Latrine Design

Male and Female Latrine, Shower and Laundry Layout

23 Toilets, 26 Showers, 5 Washers, 5 Dryers



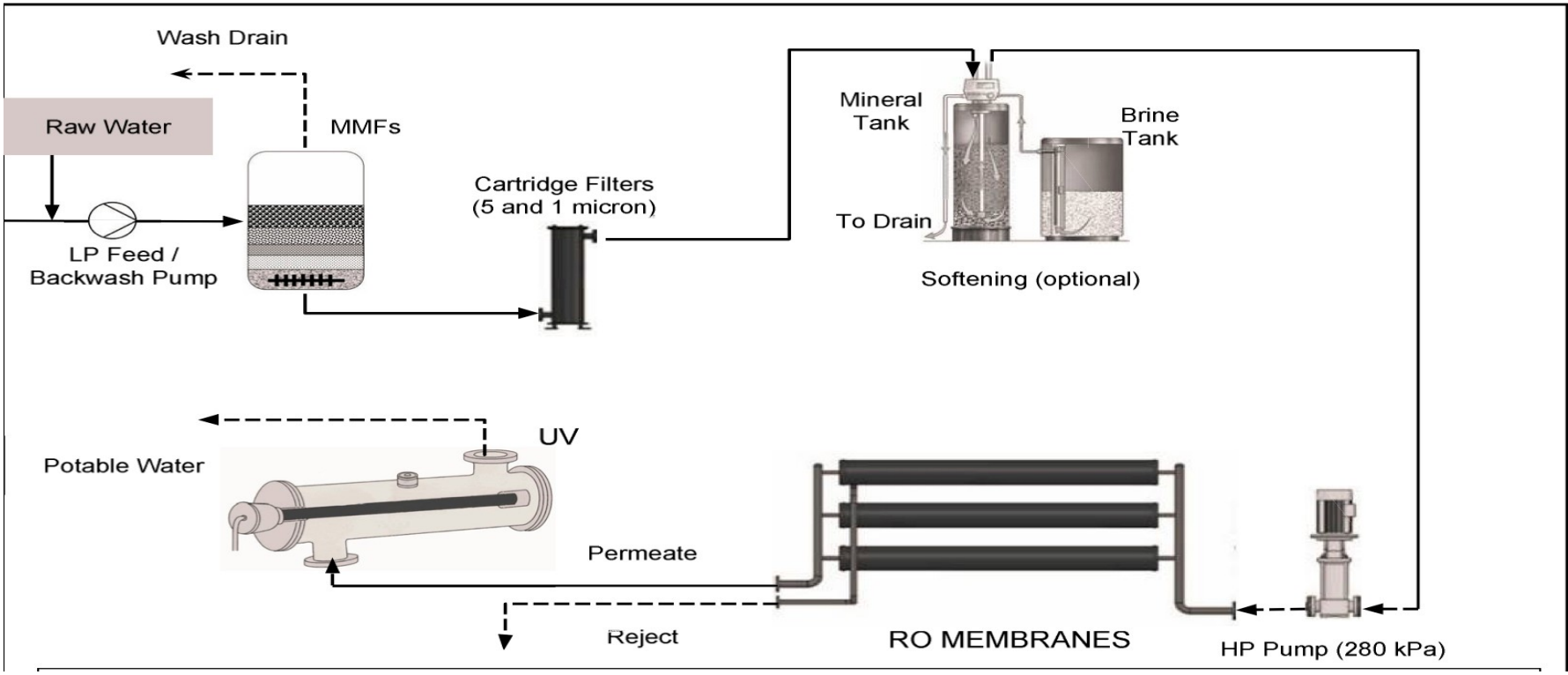
WHS – Latrine Execution

Male and Female Latrine, Shower and Laundry Layout – 3200 sft.

23 Toilets, 26 Showers, 5 Washers, 5 Dryers

WHS–Water Filtration Solution

Source water: Lake, river, stream, well or trucked
In water and Grey Water Processing Unit
Systems for 5,000 – 300,000 Gallons per day

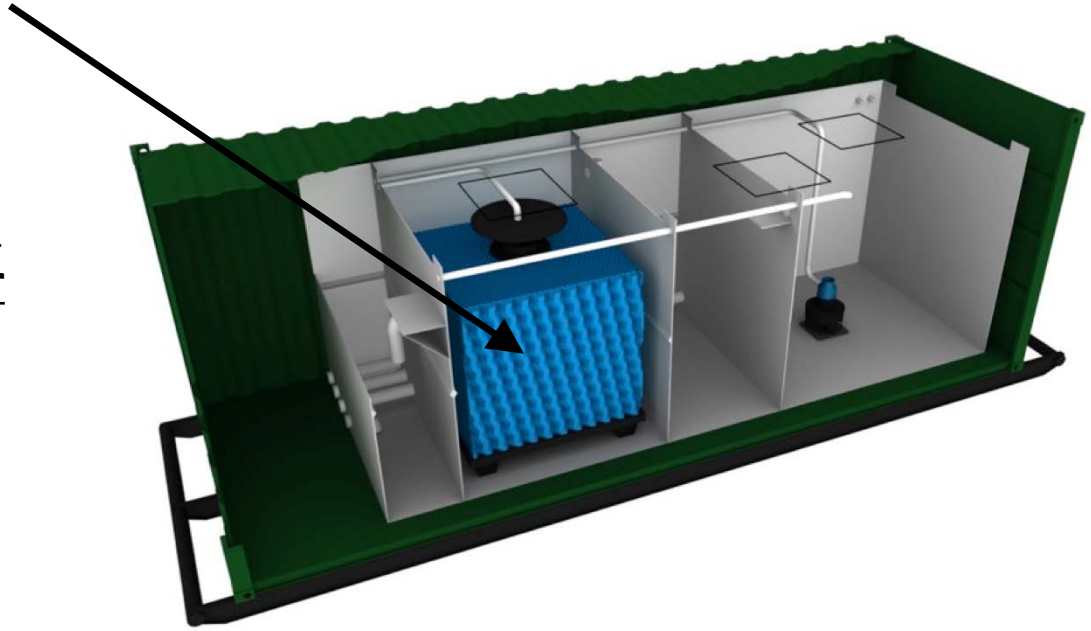


WHS – Waste Water Solution

AGBR® (aTached growth biological reactor)

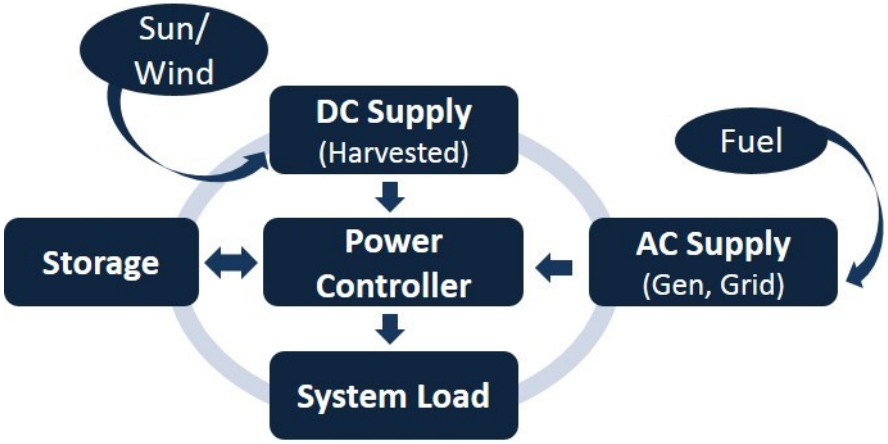
Treatment occurs on a permanent, self--cleaning media and passes through **UV for disinfection.**

Effluent is pumped out and **can be used for sub--surface irrigation or discharge into a waterway for dilution.**



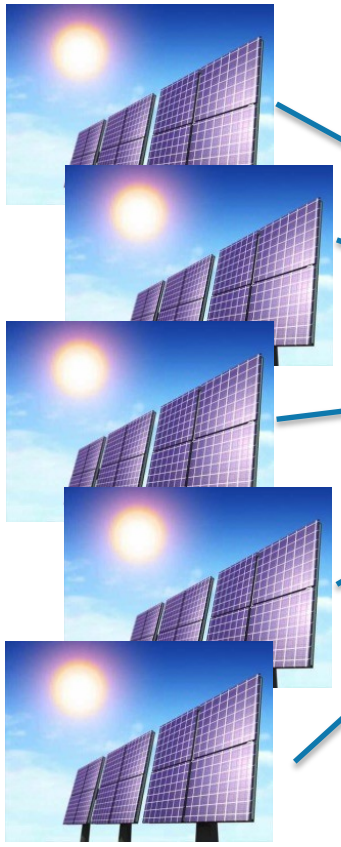
LexTM3 – Hybrid Power

- (4) Independent hybrid systems with roof mounted solar arrays, power converters and batteries
  - Redundancy
    - Decreased susceptibility to grid power outages
  - Modular/Scalable
    - The system is scalable to increase both solar & battery (ESMs) penetration
  - Direct and indirect benefits of a hybrid system – clean conditioned power and ability to protect highly sensitive electronics
  - Transportable
    - 20' Conex



LexTM3 – ESM Concept

5 Solar Inputs



Grid Input

Energy Storage Module (ESM)

200kWh Battery Energy Storage

200kW Output

Loads
220/380VAC,
50Hz

120kW Generator

Hybrid tactical power system dramatically reduces generator fuel consumption through intelligently managing both power sources AND loads

WORLD HOUSING SOLUTION

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WHS Building/Soft-Walled Shelter Comparison

ONE WHS has equivalent living area of TWO 20' x 32' Soft-Walled Shelters

- 1600 sq. ft.
- Walls = R16, Roof = R40, Floor = R32
  - Building as a whole = R30
  - Surface Area = 4500 sq. ft.
    - Used in heat loss applications
- (21) Buildings are required for 250 Man Camp (110 sq. ft. per Pax.)

- 640 sq. ft.
- R4 with insulated liner
  - Radiant barriers have little benefit in cold climates
  - Surface Area = 1950 sq. ft.
    - Used in heat loss applications
- (42) Shelters are required for 250 Man Camp (110 sq. ft. per Pax.)

Building/Shelter Heat Loss Comparison

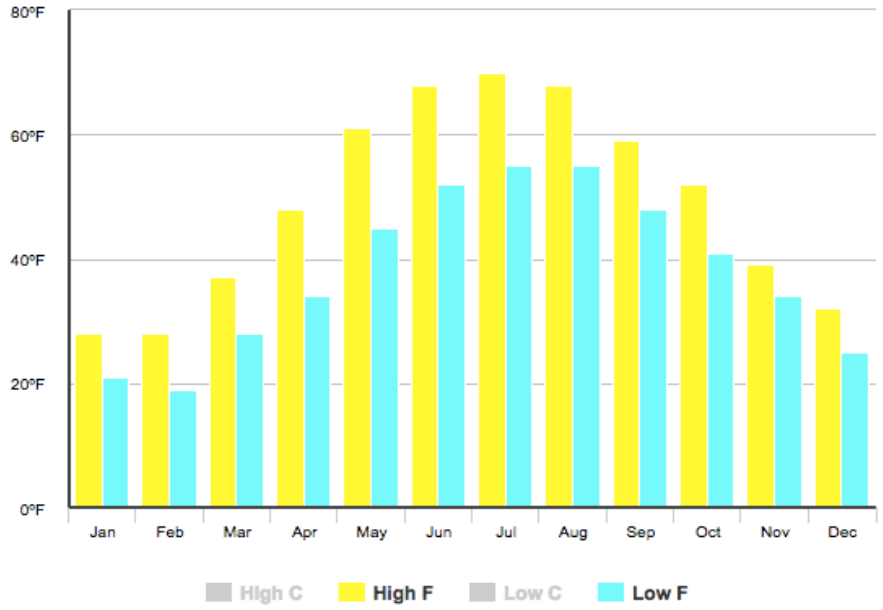
Heat transfer/loss analysis was performed for each month of the year

- Equation: Ht = UAdt
  - Ht = heat transfer (Btu/hr) (3412 Btu/hr = 1kW)
  - U = heat transfer coefficient = 1/R
  - A = total surface area of structure
  - dt = Inside/outside temperature difference (annual inside temp. of 70F)
- Heating analysis only looks at Billeting structures
  - Actual numbers/benefits will be slightly greater
- Analysis focuses on heating/cooling differences
- Other loads are considered equivalent between camps
  - Water heaters (6 hours a day @18kW, 8 units = 864 kW-hr/day)
  - Laundry (6 hours a day @5.6kW, 10 units = 336 kW-hr/day)
  - Soldier equipment (12 hours at 300W, 250 units = 900 kW-hr/day)
  - Lights (6 hours @130W, 170 units = 132 kW-hr/day)
  - Water/Sewage Treatment (12 hours @55kW = 660 kW-hr/day

2.89MW-hr/day baseline load (120kW average power)

Latvia Annual Temperatures

- Moderate climate
- Cooling not often necessary
  - May – August best for solar but energy demand is at lowest
- Heat could be required throughout the year
  - Lows in mid 50s in July/August



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High °C	-2	-2	3	9	16	20	21	20	15	11	4	0
High °F	28	28	37	48	61	68	70	68	59	52	39	32
Low °C	-6	-7	-2	1	7	11	13	13	9	5	1	-4
Low °F	21	19	28	34	45	52	55	55	48	41	34	25

Building/Shelter Heat Loss Comparison

- For Soft-Walled Camp, total energy loss in one year would be 1363 MW-hr
- For WHS Camp, total energy loss in one year would be 210 MW-hr
  - •WHS saves 85% in wasted thermal energy (1153 MW-hr reduction) based on Latvia climate
- Ancillary Loads between two camp configurations are assumed equivalent and do not factor into calculations

	WHS	So;--Walled
Month	**kW–hr/day**	**kW–hr/day**
January	997	6479
February	1041	6767
March	797	5183
April	642	4175
May	354	2304
June	199	1296
July	155	1008
August	155	1008
September	354	2304
October	532	3455
November	731	4751
December	930	6047

Heat loss (energy requirement)

Total Camp Energy Consumption by Month

- Baseline daily load of 2890kW-hr added to daily heating requirement for both camps
- WHS camp averages 3.2MW-hr less energy usage per day
  - Does not factor in efficient water treatment or LSA
- 144kW Average power for WHS Camp
  - 126kW in July to 164kW in Jan.
- 276kW Average power for Soft-Walled
  - 162kW in July to 402kW in Jan.

	WHS	So;--Walled
	Rigid-Walled	Soft-Walled
Month	**kW–hr/day**	**kW–hr/day**
January	3889	9371
February	3933	9659
March	3689	8075
April	3534	7067
May	3246	5196
June	3091	4188
July	3047	3900
August	3047	3900
September	3246	5196
October	3424	6347
November	3623	7643
December	3822	8939

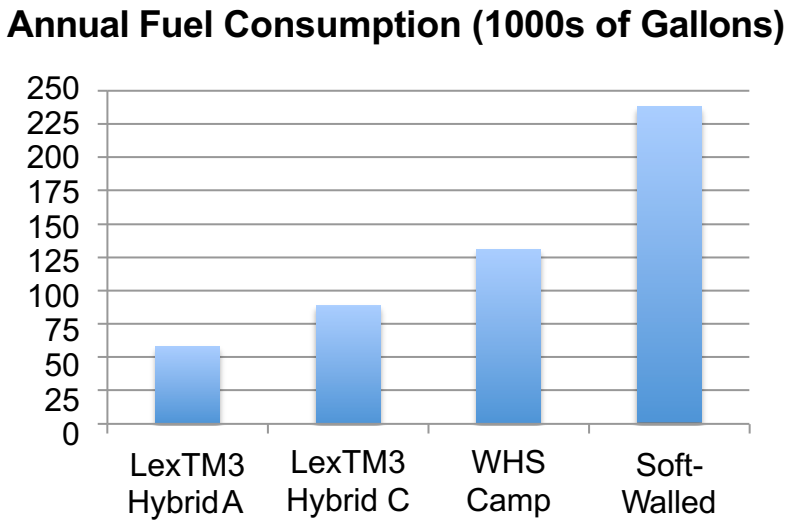
Total Dai

Modeling and Simulation

- Monthly average power loads were modeled in HOMER Energy Software
- 4 camp configurations were analyzed to provide options
  - WHS Camp with LexTM3 Hybrid System A
    - 750kW PV
    - 2.4MW Energy Storage
  - WHS Camp with LexTM3 Hybrid System C
    - 250kW PV
    - 0.8MW
  - WHS Camp with generators only
  - Soft-Walled Shelters with generators only

Cost Benefit Analysis/ROI Assumptions

- Fully burdened fuel at $10/$15/$20/gal
- Soft-Walled shelter platforms are replaced every 3 years
  - $0.441M
- Soft-Walled shelters are replaced every 3 years
  - $1.5M
- WHS Camp has 15 year life
  - Site prep ~ $0.03M
- ROM Camp Procurement Costs
  - WHS Camp with Generators = $12.5M
  - WHS Camp with LexTM3 Hybrid A = $23M
  - WHS Camp with LexTM3 Hybrid C = $17M
- LexTM3 hybrid systems require battery replacement after 7 years



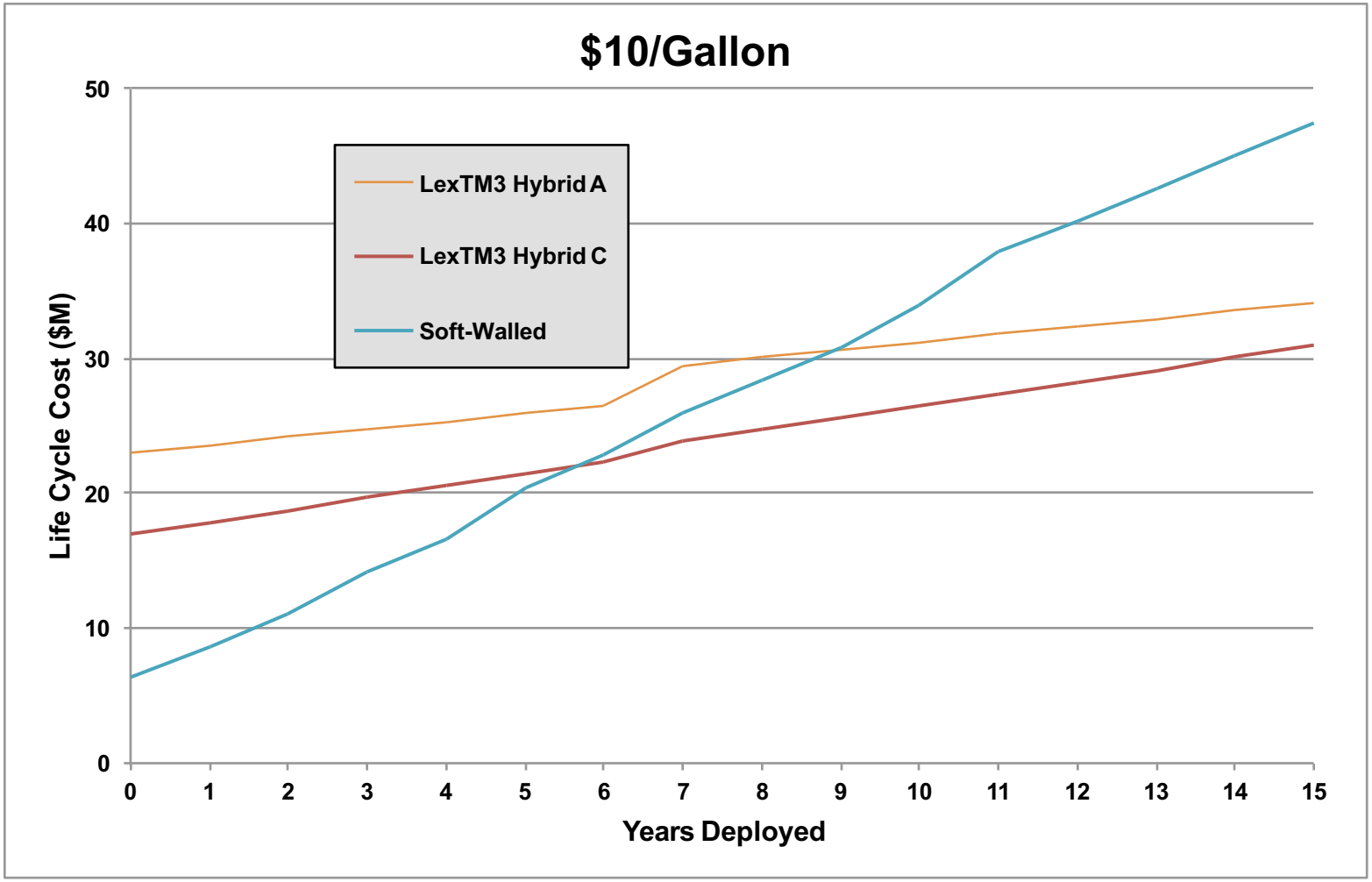
Modeling and Simulation Results

- Simulation compared 100% off-grid operation
  - Diesel generators only or generators used in hybrid configurations
- WHS Camp with LexTM3 Hybrid A reduces fuel consumption by 76%
  - 38% of Camp annual energy needs are met with Solar Array
  - Battery storage provides 15 hours of autonomy (silent watch)
- WHS Camp with LexTM3 Hybrid C reduces fuel consumption by 63%
  - 6% of Camp annual energy needs are met with Solar Array
  - Battery storage provides 5 hours of autonomy (silent watch)

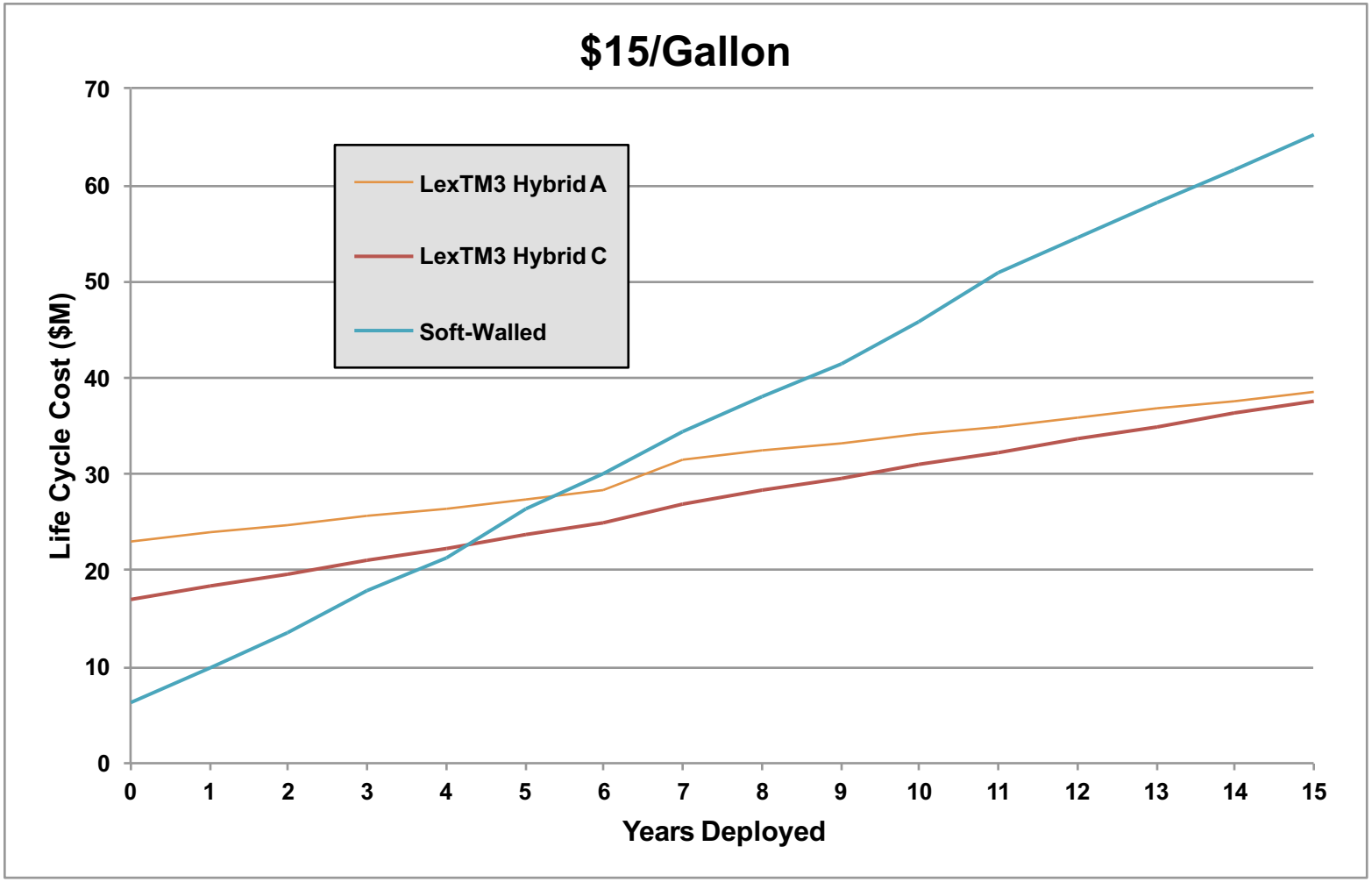
Configuration	Solar Array (kW)	Storage (kW-hr)	Annual Fuel (k/Gal)	% Fuel Reduction	Silent Watch (hours)	Renewable (%)
LexTM3 Hybrid A	750	2400	58	76%	15	38
LexTM3 Hybrid C	250	800	89	63%	5	6
Soft-Walled	0	0	238	N/A	0	0

Configuration	Initial Cost ($M)	$10/Gal ROI (y)	$15/Gal ROI (y)	$20/Gal ROI (y)
LexTM3 Hybrid A	23	9	5	4
LexTM3 Hybrid C	17	5.5	4	3
Soft-Walled	6.3	N/A	N/A	N/A

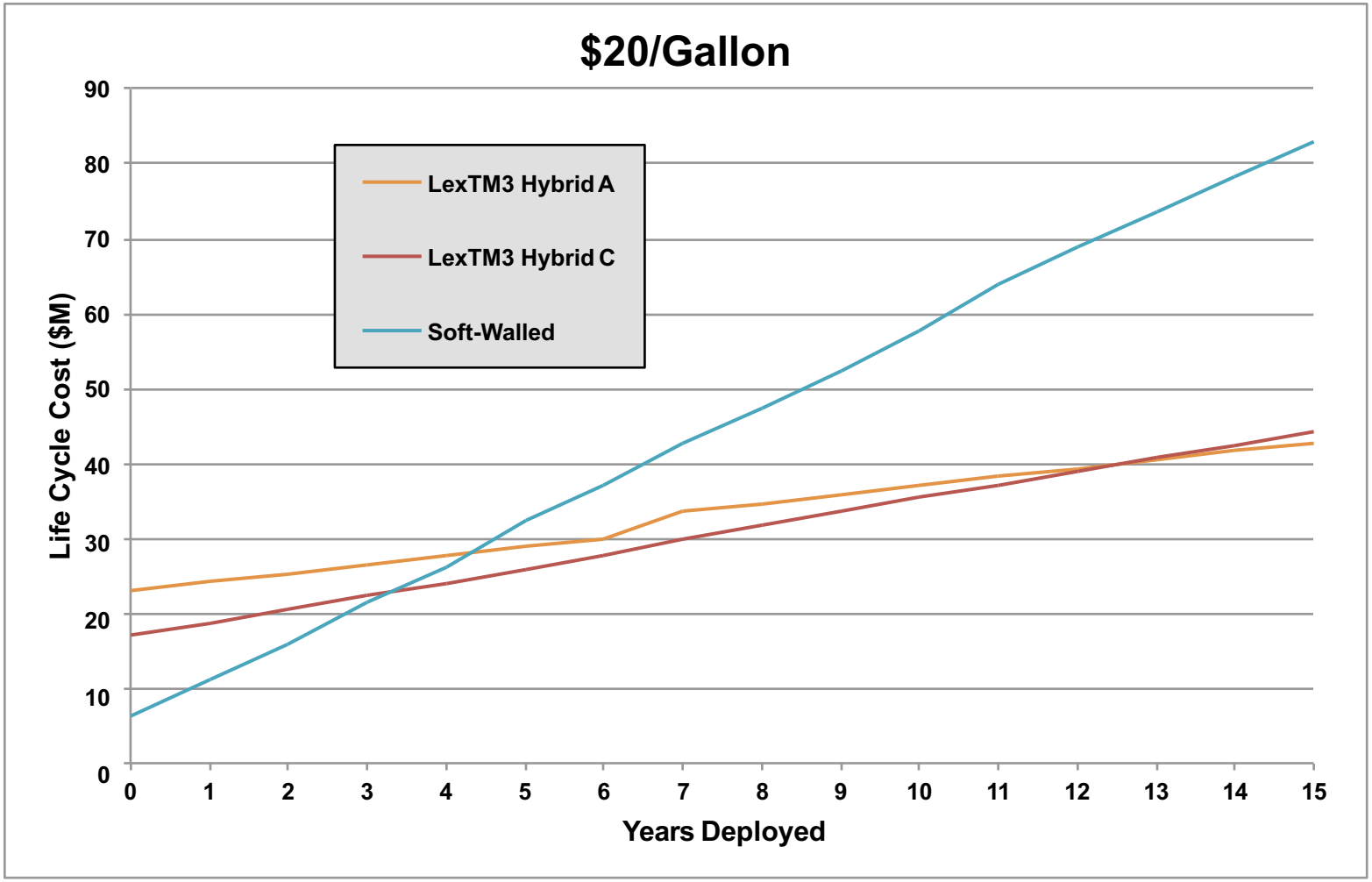
Projected Lifecycle Cost



Projected Lifecycle Cost

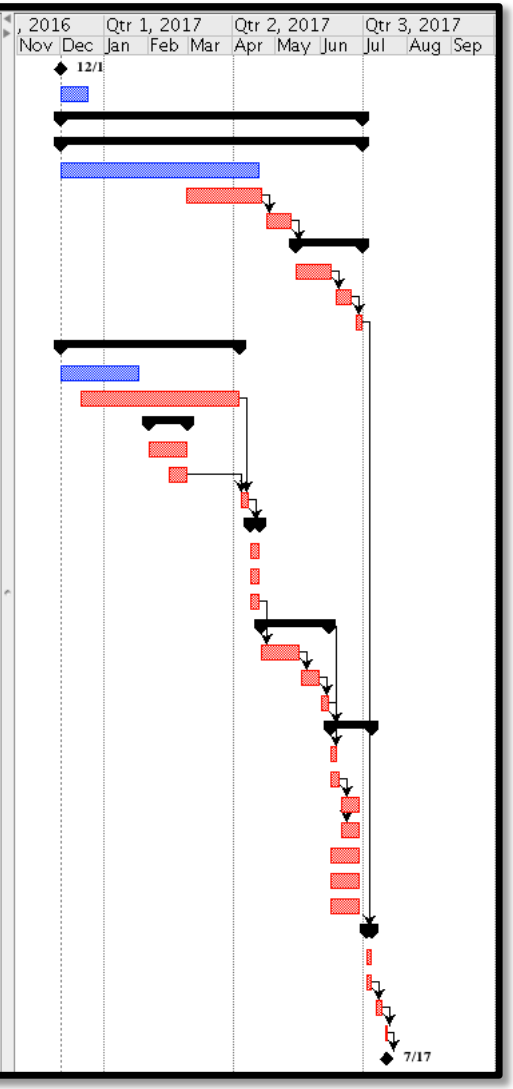


Projected Lifecycle Cost



Project Schedule – 8.5 Month Completion

	Name	Duration	Start	Finish
1	Project Award Date	0 days	12/1/16 8:00 AM	12/1/16 8:00 AM
2	Finalize Design Details	15 days	12/1/16 8:00 AM	12/21/16 5:00 PM
3	**Manufacturing**	152 days?	**12/1/16 8:00 AM**	**6/30/17 5:00 PM**
4	**Hybrid System (LexT**	152 days?	**12/1/16 8:00 AM**	**6/30/17 5:00 PM**
5	Procurement	100 days?	12/1/16 8:00 AM	4/19/17 5:00 PM
6	Build	40 days?	2/26/17 8:00 AM	4/21/17 5:00 PM
7	Testing	15 days?	4/24/17 8:00 AM	5/12/17 5:00 PM
8	**Shipping**	35 days?	**5/15/17 8:00 AM**	**6/30/17 5:00 PM**
9	Ocean Freight to Ri	20 days?	5/15/17 8:00 AM	6/9/17 5:00 PM
10	Riga Customs	10 days?	6/12/17 8:00 AM	6/23/17 5:00 PM
11	Transport to Site	5 days?	6/26/17 8:00 AM	6/30/17 5:00 PM
12	**Buildings (WHS)**	90 days?	**12/1/16 8:00 AM**	**4/5/17 5:00 PM**
13	Procurement	40 days?	12/1/16 8:00 AM	1/25/17 5:00 PM
14	Build	80 days	12/15/16 8:00 AM	4/5/17 5:00 PM
15	**Solar System**	20 days?	**2/1/17 8:00 AM**	**2/28/17 5:00 PM**
16	Procurement	20 days?	2/1/17 8:00 AM	2/28/17 5:00 PM
17	Build	10 days?	2/15/17 8:00 AM	2/28/17 5:00 PM
18	Transport to WHS Facilit	5 days?	4/6/17 8:00 AM	4/12/17 5:00 PM
19	**Integration at WHS Fac**	5 days?	**4/13/17 8:00 AM**	**4/19/17 5:00 PM**
20	Building Prep	5 days?	4/13/17 8:00 AM	4/19/17 5:00 PM
21	Wiring Pre Fit	5 days?	4/13/17 8:00 AM	4/19/17 5:00 PM
22	Packing	5 days?	4/13/17 8:00 AM	4/19/17 5:00 PM
23	**Shipping**	35 days?	**4/20/17 8:00 AM**	**6/7/17 5:00 PM**
24	Ocean Freight to Riga	20 days?	4/20/17 8:00 AM	5/17/17 5:00 PM
25	Riga Customs	10 days?	5/18/17 8:00 AM	5/31/17 5:00 PM
26	Transport to Site	5 days?	6/1/17 8:00 AM	6/7/17 5:00 PM
27	**System Construction**	22 days?	**6/8/17 8:00 AM**	**7/7/17 5:00 PM**
28	Site prep	3 days?	6/8/17 8:00 AM	6/12/17 5:00 PM
29	Latrine Build	5 days?	6/8/17 8:00 AM	6/14/17 5:00 PM
30	Latrine Plumbing	10 days?	6/15/17 8:00 AM	6/28/17 5:00 PM
31	Latrine Wiring	10 days?	6/15/17 8:00 AM	6/28/17 5:00 PM
32	Billeting Build	15 days?	6/8/17 8:00 AM	6/28/17 5:00 PM
33	Billeting Wiring	15 days?	6/8/17 8:00 AM	6/28/17 5:00 PM
34	Billeting Solar Install	15 days?	6/8/17 8:00 AM	6/28/17 5:00 PM
35	**Hybrid System Instal**	5 days?	**7/3/17 8:00 AM**	**7/7/17 5:00 PM**
36	ESM Placement	5 days?	7/3/17 8:00 AM	7/7/17 5:00 PM
37	Electrical Connection	5 days?	7/3/17 8:00 AM	7/7/17 5:00 PM
38	Operational Testing	5 days?	7/10/17 8:00 AM	7/14/17 5:00 PM
39	Camp Commissioning	1 day?	7/17/17 8:00 AM	7/17/17 5:00 PM
40	Project Complete	0 days?	7/17/17 5:00 PM	7/17/17 5:00 PM



WORLD HOUSING SOLUTION

LEX TM3

BARBARICUM

Conclusions

Efficient structures and hybrid energy systems significantly reduce energy and fuel consumption

Hybrid Energy Camp provides power surety

- WHS Camp with LexTM3 Hybrid A, has the greatest energy and fuel savings
  - Provides 38% of camp energy needs via Solar Array
  - Allows for up to 15 hours silent operations
  - Reduces fuel consumption by 76% compared to Soft-Walled camp operating on generators in Latvia climate conditions

- WHS Camp with LexTM3 Hybrid C, has the greatest payoff over 6-14 years for all fuel prices
  - $15M/$28M/$38M savings over 15 years compared to Soft-Walled camp
    - ($10/Gal,$15/Gal,$20/Gal)
  - Allows for up to 5 hours silent operations
  - Reduces fuel consumption by 63% compared to Soft-Walled camp operating on generators in Latvia climate conditions