

# Hexayurt Shelter System



Applying whole systems  
thinking to refugee  
camps and disaster  
response



Vinay Gupta &  
Lindsey Darby

[hexayurt@gmail.com](mailto:hexayurt@gmail.com)  
<http://howtolivewiki.com/hexayurt/>  
847 275 8209

# Where did this come from?

- Sustainable Settlements Charette at Rocky Mountain Institute in 2002, with involvement from Dr. Eric Rasmussen Director of Strong Angel.
- Amory Lovins' work on decentralized infrastructure, autonomous buildings and turning goods into services (not “selling boilers” but “maintaining interior temperature.”)

# Why does it matter?

- With some development work, it creates the capability to manufacture and distribute high quality, long lifespan housing at a price similar to tents.
- Furthermore, these houses can be organized into camps, villages and even cities without creating enormous new infrastructure problems like open sewers.

# The Spectrum of Infrastructure

- Infrastructure comes in all kinds of scales, from personal (a box of matches) through to global (the GPS system.)
- Fine-grained, localized infrastructure is usually very resilient. Solar panels do not fail if the grid goes down all over the country because of a problem in some far-flung state.
- Localized infrastructure is particularly appropriate for refugees and disaster areas because it continues to work when everything else is broken.
- We can provide most services using these tools.

# Domestic Infrastructure

- Six kinds of pipes and wires come into the ordinary American house, bringing services from trillions of dollars of capital investment.
- Electricity, natural gas, clean water, sewage lines, communications and storm drains are all necessary for a house to function as a place to live.

# Replacing Pipes and Wires?

Pipe/Wire	Connects	Hexayurt	Cost/home
Electricity	National grid	Solar	<\$30
Gas	Natural gas system (pipelines, terminals)	Wood Gas	<\$20
Water	Water treatment plants, viaducts	Solar Pasteurizers	<\$5
Sewage	Sewer system, sewage treatment plants	Composting toilet	<\$20 ???
Communications	Wired telephones, exchanges, cell towers	\$100 computers? Cell phones?	<\$10 ?
Stormwater	Storm drains	Not required	-
(Transport)	Roads, rail	Beyond scope	-

# AA Battery Solar

- One panel (40W or more) per 40ish homes (or higher density.)
- 15 minute battery charger (Rayovac IC3, which protects batteries as it charges them fast, unlike other fast chargers.)
- 4AA batteries per person or per home.
- People walk to the charging station with their batteries, plug them in, wait for them to charge, then use them to power their appliances.
- Simple, granular, easy to install/use.

# AA Appliances

- Wood Gasification Stoves
- Andy Buxton's Personal Cooling System (SleepBreeze Ltd.) – a 4W air conditioner.
- Electric lights (cold cathode compact fluorescents like Eveready Double Bright flashlights or some Coleman lanterns.)
- FRS/GMRS radios.
- TVs, radios.
- Wind up devices may still have their place.



# Wood Gasification Stoves

- 30 years of combustion engineering embodied in a cheap sheet metal stove.
- AA batteries drive a fan (blast furnace.)
- 3KW heat output (same as a large gas burner.)
- 10x better fuel efficiency than open fires.
- 3x better than clay stoves.
- Off the shelf from <http://spenton.net/>
- \$15 in freight car quantities?

# Solar Water Pasteurizers

- Water held at 160F for several hours is sterilized.
- Water in a plastic bottle will reach this temperature in many areas of the world.
- Cheap melting-wax indicators show when the water is safe to drink.
- Basic solar cooker engineering (black bottles, reflectors) helps.
- Off the shelf from <http://safewatersystems.com/>

# Composting Toilets

- No pipes – like a portapotty but never needs to be emptied.
- Bacteria render the waste down into sterile fertilizer.
- US-style models are \$1200 but a basic model is a plastic bucket and some starter cultures.
- Nobody has yet mass produced a refugee style toilet as far as we can tell, but this is a commercialization issue, not a technology issue.
- Off the shelf from <http://biolet.com/>

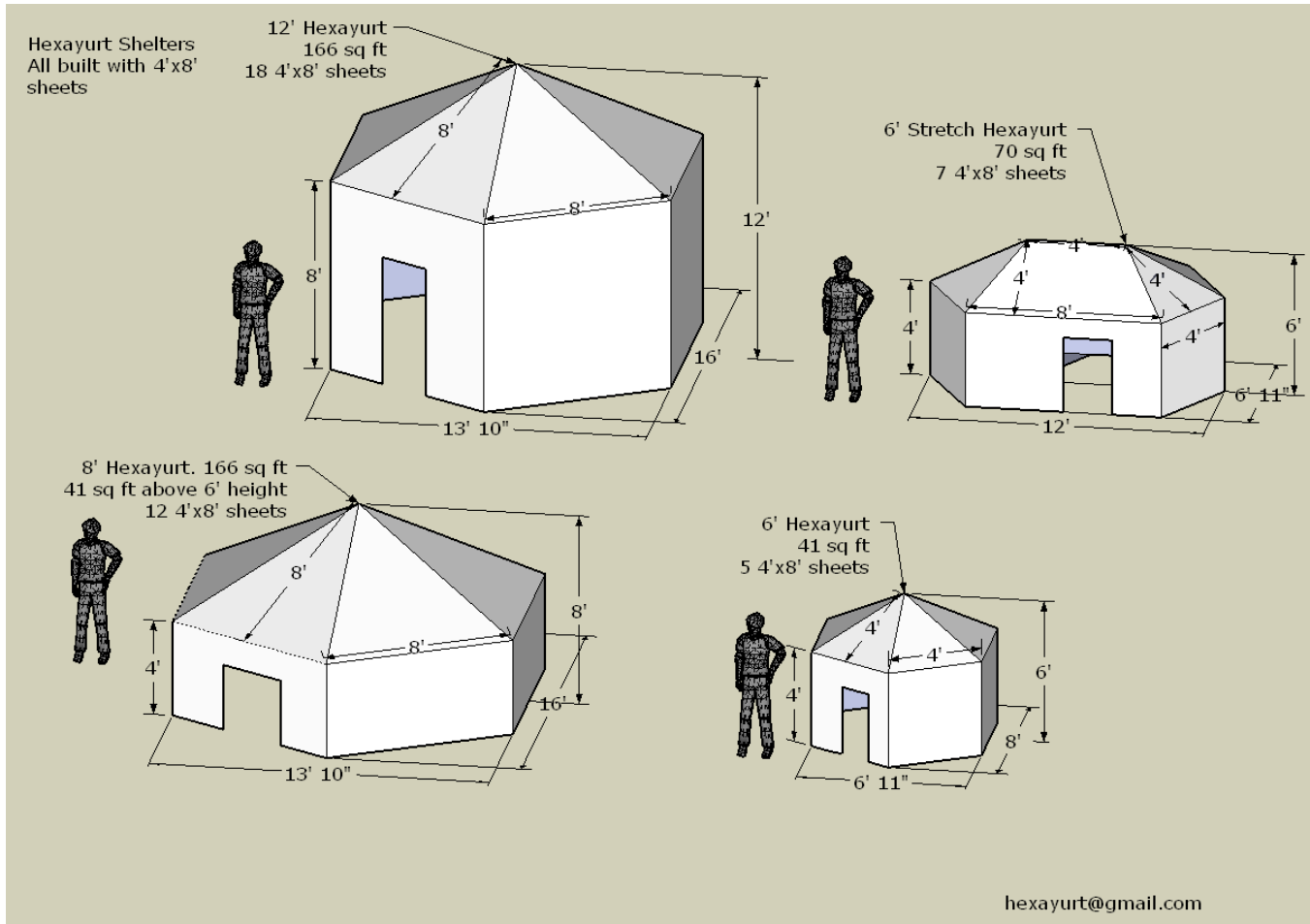
# Where does this get us?

- Electrical light at night, plus radios, perhaps cell phones.
- Great little stoves – 3KW max heat output, nearly smokeless, for cooking and heating.
- **Clean drinking water.**
- No open sewers.
- In short, possibly a better standard of services than folks had at home before their troubles started.

# What about the huts?

- The hexayurt is just an observation about shapes: 4x8 panels, when cut in half, can make a roof quickly and easily.
- This observation can be rendered into buildings made of more or less any sheet goods.
- Insulation like Thermax gives durable, warm houses.
- Cardboard like Hexacomb gives cheap, shippable houses.
- Exotic materials (aramid honeycomb) could give other properties, if needed.
- Hexayurts are held together with 600+ lb breaking strain high specification adhesive backed composite from 3M (colloquially known as “tape.”)

# Hexayurt Plans



# Strong Angel III Units



- Home Depot materials
- Built with unskilled helpers and craft knives
- Basically hard to get wrong
- The devil is in the details (particular how the tape is used.)









# Insulated Hexayurts

- A 40ft shipping container will fit around 80 units (1' x 4' x 8' boxes), less with the infrastructure package.
- \$200 to \$500 per unit, plus infrastructure.
- Can be made folding to speed assembly.
- Possibly 20 years of life (Thermax HD.)
- A little bulky and expensive for developing world disasters.

# Cheap Cardboard Hexayurts

- Manufacture with hexacomb cardboard.
- Ship the hexacomb core material flat.
- In the field, stretch out the hexagonal core material and press it into panels with plywood presses.
- \$100 shelters, fitted around 400 to the 20ft sea container.
- As with the Thermax HD, the outer facing of each board should be a foil product to reflect away the sunlight.
- Teams, training, testing.

# Civilization In A Box.

- The hexayurt design is public domain – please feel free to manufacture them free of all intellectual property constraints.
- All the other technologies are COTS.
- There is no rocket science here.

# Additional Information

- **Information Websites**

- HexaYurt and support systems <http://howtolivewiki.com/hexayurt>
- Movies on setting up HexaYurt and support systems <http://youtube.com> - search for HexaYurt
- Integrated Disaster Response Demonstration – STRONG ANGEL III  
<http://www.strongangel3.org>
- Sustainable Settlements Charrette: Rethinking Encampments for Refugees and Displaced Populations <http://www.rmi.org/sitepages/pid560.php>

- **Manufacturing Points of Contact**

- Insulation Panels: Steve Harasim, [harasim@dow.com](mailto:harasim@dow.com)
- Hexacomb: Mark Jacobson, [mjacobson@pregis.com](mailto:mjacobson@pregis.com)
- Stoves: James Becker, [webAdmin@spenton.net](mailto:webAdmin@spenton.net),  
Tim Taylor, [taylorwoodgas@cox.net](mailto:taylorwoodgas@cox.net)
- SleepBreeze Cooler: Andy Buxton, [acbuxton@btinternet.com](mailto:acbuxton@btinternet.com)
- Biolet Composting Toilet: Peter Andersson, [peterandersson@biolet.com](mailto:peterandersson@biolet.com)