Net Zero Buildings.....
65 percent conservation
35 percent renewables

5 – 10 – 20 – 40 -60 @ 1.5
5 – 10 – 20 – 40 -60 @ 1.5
R-5 glass
R-10 slab
R- 20 basement
R-40 walls
R-60 roof
Airtightness 1.5 ach@50 Pa
Beyond Net Zero....

5 – 10 – 20 – 40 -60 @ 1.5
R-5 glass..........can’t do much better now
R-10 slab..........R-20
R- 20 basement....R-40
R-40 walls.........R-60
R-60 roof..........R-80
Airtightness 1.5 ach@50 Pa....1.0 ach@50 Pa
<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical</td>
<td>5 ach@50</td>
</tr>
<tr>
<td>Getting rid of big holes</td>
<td>3 ach@50</td>
</tr>
<tr>
<td>Getting rid of smaller holes</td>
<td>1.5 ach@50</td>
</tr>
<tr>
<td>Beyond Net Zero</td>
<td>1.0 ach@50</td>
</tr>
<tr>
<td>Getting German</td>
<td>0.6 ach@50</td>
</tr>
</tbody>
</table>
A Building is an Environmental Separator
• Control heat flow
• Control airflow
• Control water vapor flow
• Control rain
• Control ground water
• Control light and solar radiation
• Control noise and vibrations
• Control contaminants, environmental hazards and odors
• Control insects, rodents and vermin
• Control fire
• Provide strength and rigidity
• Be durable
• Be aesthetically pleasing
• Be economical
Water Control Layer
Air Control Layer
Vapor Control Layer
Thermal Control Layer
Brick veneer/stone veneer

Drained cavity

Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass

Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder

Concrete block

Metal channel or wood furring

Gypsum board

Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
- Brick veneer/stone veneer
- Drained cavity
- Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass
- Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder
- Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)
- Uninsulated steel stud cavity
- Gypsum board
- Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
Brick veneer/stone veneer
Drained cavity
Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass
Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder
Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)
Insulated wood stud cavity
Gypsum board
Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
Steel studs
Taped and painted 1/2" gypsum wall board as interior finish
No cavity insulation
Gypsum board sheathing; exterior rated with joints taped/sealed
Mineral fiber insulation boards
Metal hat channel
Fiber cement siding
- Single top plate
- Taped and painted 1/2" gypsum board on inside face of stud
- 2x6 @ 24” o.c. advanced framing
- Remaining cavity filled with 3 1/2” fiberglass or cellulose insulation
- 2” high density spray foam (SPF) (2.0 pcf) against exterior sheathing
- OSB or plywood exterior sheathing
- Housewrap
- Furring strips
- Cladding
- Spray foam insulation at rim joist
Single top plate

Taped and painted 1/2" gypsum board on inside face of stud

2x6 stud wall @ 24" o.c.

5" high density spray foam (SPF) (2.0 pcf) against exterior sheathing

OSB or plywood sheathing

Housewrap

Furring strips

Cladding

Spray foam rim joist insulation
Single top plate

Taped and painted 1/2" gypsum wall board as interior finish

2x6 interior framing member @ 24" o.c.

Plywood/OSB sheathing; joints taped/sealed

Cellulose insulation in wall cavity

Plywood/OSB sheathing

Housewrap

Furring strips

Cladding

Cellulose insulation at rim joist

Capillary break

Ledger board

Plywood cavity closure at top of assembly

2x3 exterior truss
2x3 interior wall

Taped and painted 1/8" gypsum wall board as interior finish

Cellulose insulation in 2x3 interior wall stud spaces

Plywood cavity closure at top of assembly

Single top plate

2x4 exterior wall @ 16" o.c.

3 1/2" high density spray foam (SPF)(2.0 pcf) against exterior sheathing

Plywood or OSB sheathing

Housewrap

Furring strips

Gladding

6" high density spray foam (SPF)(2.0 pcf) on inside of rim joist
Single top plate

Taped and painted 1/2” gypsum wall board as interior finish

2x6 @ 24” o.c. interior framing

Fiberglass or cellulose insulation in interior stud cavity

2x3 exterior framing member

Substrate to support spray foam

4’1/2” high density spray foam (SPF)(2.0 pcf)

Cladding

Spray foam insulation at rim joist

Closure board

Minimum 1/8” drainage and ventilation gap between closure board and cladding
Cast-in-place concrete core

ICF inner and outer faces (typically EPS)

Taped and painted 1/2" gypsum board as interior finish

Furring strips

Cladding
5" foil-faced polyisocyanurate insulating sheathing in three layers (11/4", 2", 11/2"); extend outer edge of roof overhang; joints staggered

Continuous fully-adhered air barrier continuous with membrane over wall sheathing

1/2" plywood sheathing with H-clips

3/8" plywood roof sheathing with H-clips; attach to roof framing using galvanized wood screws (min. length 71/8"

Fully-adhered peel and stick roof membrane

Asphalt roof shingles

1 1/2" x 3 1/2" lookout framing at 24" o.c. with two layers of insulating sheathing

Stainless steel drip edge

3" crown moulding

1/2" x 8" trim board

1/2" plywood

1/2" beadboard soffit

1" x 8 1/4" frieze board

Extend insulating sheathing on wall up to plywood on underside of roof insulating sheathing; joints staggered and taped on outer layer

Continuous rim board

1/2" plywood wall sheathing

Continuous fully-adhered air barrier membrane over plywood sheathing

1 1/2" LSL roof rafter

11 3/4" netted cellulose insulation

1/2" gypsum wall board; painted with latex paint

Bottom of ceiling joist

11/8" netted cellulose insulation

1/2" plywood sheathing

Continuous fully-adhered air barrier membrane over plywood sheathing

Building Science Corporation
Mechanical Systems
Mechanical Systems
Cooling System To Make It Cold
Mechanical Systems
Cooling System To Make It Cold
Dehumidification System To Make It Dry
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Cooling System To Make It Cold
Dehumidification System To Make It Dry
Heating System To Make It Warm
Mechanical Systems
Cooling System To Make It Cold
Dehumidification System To Make It Dry
Heating System To Make It Warm
Energy Recovery System To Keep It Cold and Dry and Warm and Comfortable
Mechanical Systems
Cooling System To Make It Cold
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Energy Recovery System To Keep It Cold and Dry and Warm and Comfortable
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Distribution System To Make It Uniform
Range Hoods Are A Special Kind of Hell
Don’t Try to Combine Them......
Cooling System makes it cold
Dehumidification System makes it dry
Heating System makes it warm
ERV keeps it cold and dry and warm and comfortable
Distribution System makes it uniform