Builder 2.0

training and educating the next generation of construction professionals.

Today's learning objectives:

- *Explore building science principles*
- *Examine energy as it relates to buildings*
- *Examine durability in building systems*
- *Identify common energy modeling tools*
- *Understand the importance of testing*
- *Explore the benefits of verifying building performance*
- *Identify the challenges of incorporating building science principles into the community of builders*
- *Explain the importance of an integrated team approach to building projects*

Building Science 101

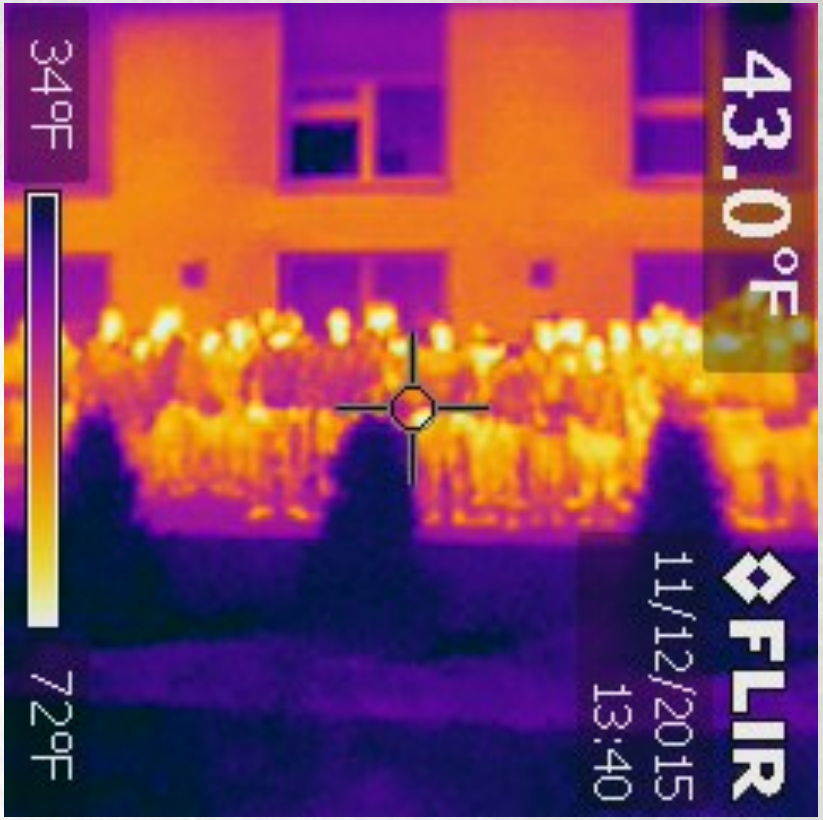
- Awaken the senses to energy!
  - Energy diary—how and where do we use energy?
  - Energy and the City, interview by National Public Radio
  - IR cameras day one!

Building Science 101

- Thermodynamics
  - Hot moves to cold
- Moisture properties
  - Wet moves to dry
  - Moisture in liquid and vapor form
- Structural properties
- Weather impacts

Building Science 101

- Building = Environmental separator
- Exterior conditions vary greatly
- Interior conditions should be comfortable
- Challenges abound!



Building Science 101

- Four important durability factors:
  - Air tightness
  - Thermal performance
  - Water vapor management
  - Bulk water management
- Ultimate goals:
  - Comfort, durability, affordability
  - Not "green," rather *good design* and *best building practices*

Energy in Buildings

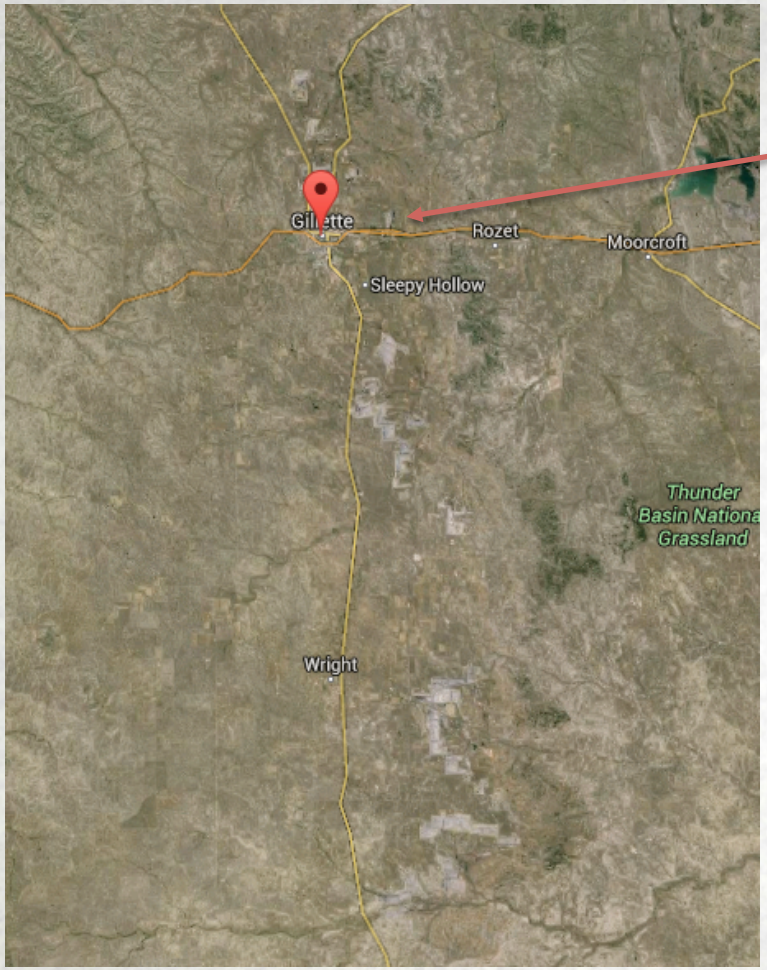
- Energy sources
  - Typically fossil fuel based
  - Electricity and natural gas
  - Where does the fuel come from?
  - Renewable, not as typical, but getting there
- Energy costs
  - Natural gas is inexpensive
  - Electricity is expensive

Just outside Gillete, WY

Zoom out view!

Nearly two miles long!!!

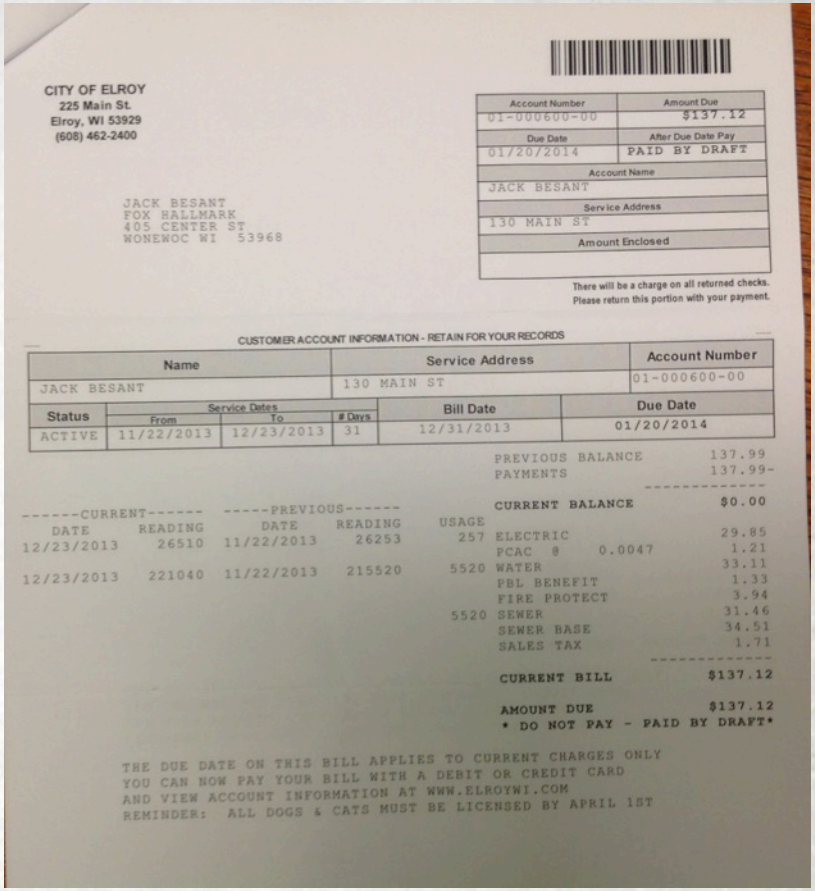
Zoom out view!



One of many!!

Energy in Buildings

- Site consumption
  - How much energy is consumed?
- Audits
  - Where is energy consumed?
- Analysis
  - Why is the energy consumed?



CITY OF ELROY
225 Main St.
Elroy, WI 53929
(608) 462-2400

Account Number	Amount Due
01-000600-00	$137.12
Due Date	After Due Date Pay
01/20/2014	PAID BY DRAFT
Account Name	
JACK BESANT	
Service Address	
130 MAIN ST	
Amount Enclosed	

There will be a charge on all returned checks.
Please return this portion with your payment.

JACK BESANT
FOX HALLMARK
405 CENTER ST
WONEWOC WI 53968

CUSTOMER ACCOUNT INFORMATION - RETAIN FOR YOUR RECORDS

Name	Service Address	Account Number
JACK BESANT	130 MAIN ST	01-000600-00

Status	Service Dates From	Service Dates To	# Days	Bill Date	Due Date
ACTIVE	11/22/2013	12/23/2013	31	12/31/2013	01/20/2014

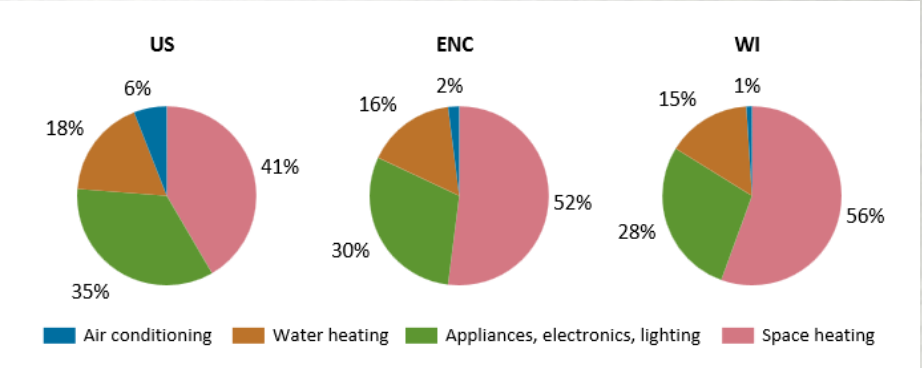
CURRENT DATE	CURRENT READING	PREVIOUS DATE	PREVIOUS READING	USAGE		
12/23/2013	26510	11/22/2013	26253	257	ELECTRIC	29.85
					PCAC @ 0.0047	1.21
12/23/2013	221040	11/22/2013	215520	5520	WATER	33.11
					PBL BENEFIT	1.33
					FIRE PROTECT	3.94
				5520	SEWER	31.46
					SEWER BASE	34.51
					SALES TAX	1.71

PREVIOUS BALANCE	137.99
PAYMENTS	137.99-
CURRENT BALANCE	$0.00
CURRENT BILL	$137.12
AMOUNT DUE	$137.12
* DO NOT PAY - PAID BY DRAFT*	

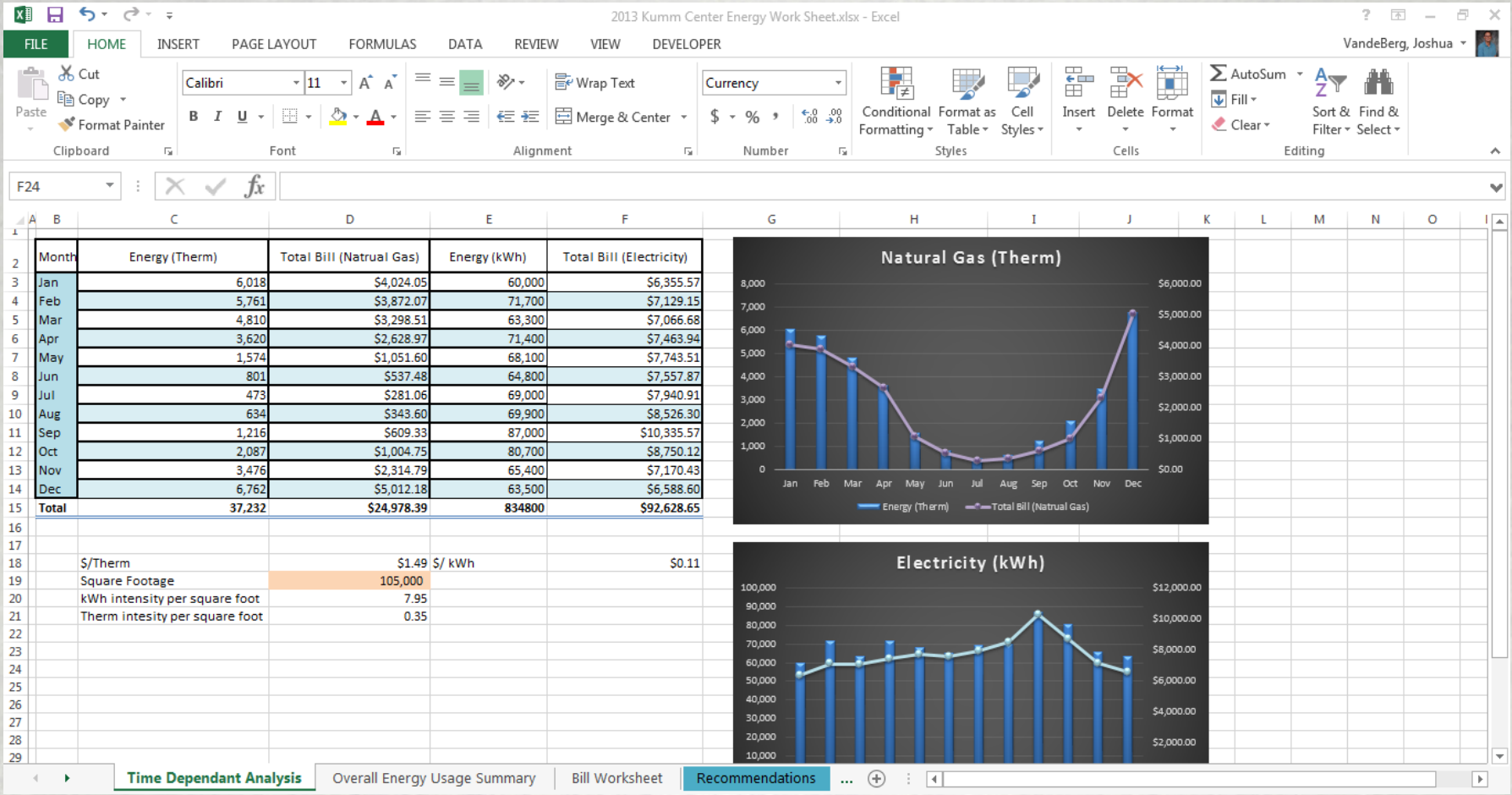
THE DUE DATE ON THIS BILL APPLIES TO CURRENT CHARGES ONLY
YOU CAN NOW PAY YOUR BILL WITH A DEBIT OR CREDIT CARD
AND VIEW ACCOUNT INFORMATION AT WWW.ELROYWI.COM
REMINDER: ALL DOGS & CATS MUST BE LICENSED BY APRIL 1ST

Energy in Buildings

- Normalized performance indicators
  - Energy use intensity
  - Accounts for differences in climate, size, occupancy, etc…
- Residential
  - WI: 103 MMBTU/year
  - MN: 113 MMBTU/year
- Commercial
  - Varies based on industry
  - www.eia.gov



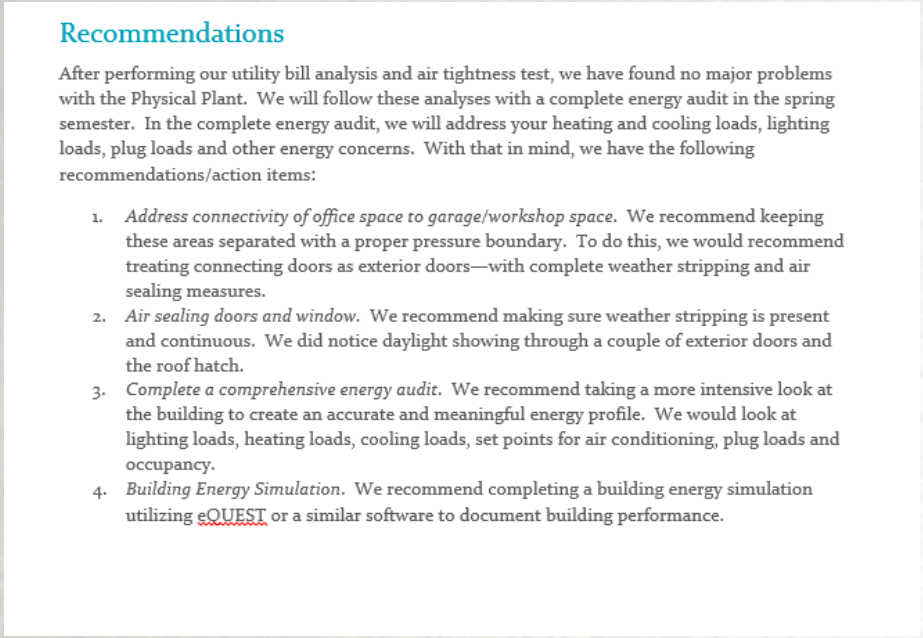
Energy in Buildings



Month	Energy (Therm)	Total Bill (Natrual Gas)	Energy (kWh)	Total Bill (Electricity)
Jan	6,018	$4,024.05	60,000	$6,355.57
Feb	5,761	$3,872.07	71,700	$7,129.15
Mar	4,810	$3,298.51	63,300	$7,066.68
Apr	3,620	$2,628.97	71,400	$7,463.94
May	1,574	$1,051.60	68,100	$7,743.51
Jun	801	$537.48	64,800	$7,557.87
Jul	473	$281.06	69,000	$7,940.91
Aug	634	$343.60	69,900	$8,526.30
Sep	1,216	$609.33	87,000	$10,335.57
Oct	2,087	$1,004.75	80,700	$8,750.12
Nov	3,476	$2,314.79	65,400	$7,170.43
Dec	6,762	$5,012.18	63,500	$6,588.60
Total	**37,232**	**$24,978.39**	**834800**	**$92,628.65**

	$/Therm	$1.49	$/ kWh	$0.11
	Square Footage	105,000		
	kWh intensity per square foot	7.95		
	Therm intesity per square foot	0.35		

Energy in Buildings



Recommendations

After performing our utility bill analysis and air tightness test, we have found no major problems with the Physical Plant. We will follow these analyses with a complete energy audit in the spring semester. In the complete energy audit, we will address your heating and cooling loads, lighting loads, plug loads and other energy concerns. With that in mind, we have the following recommendations/action items:

1. *Address connectivity of office space to garage/workshop space.* We recommend keeping these areas separated with a proper pressure boundary. To do this, we would recommend treating connecting doors as exterior doors—with complete weather stripping and air sealing measures.
2. *Air sealing doors and window.* We recommend making sure weather stripping is present and continuous. We did notice daylight showing through a couple of exterior doors and the roof hatch.
3. *Complete a comprehensive energy audit.* We recommend taking a more intensive look at the building to create an accurate and meaningful energy profile. We would look at lighting loads, heating loads, cooling loads, set points for air conditioning, plug loads and occupancy.
4. *Building Energy Simulation.* We recommend completing a building energy simulation utilizing eQUEST or a similar software to document building performance.

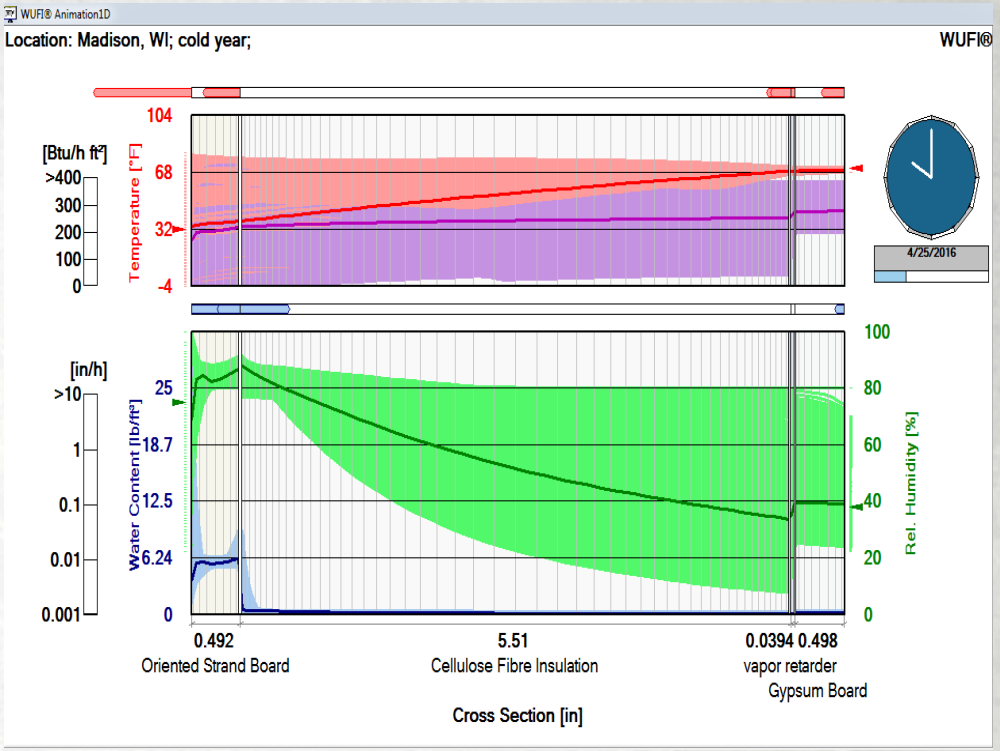
- Energy reduction strategies
- Envelope improvements
- Lighting
- Appliances
- Heating/cooling equipment
- Behavior

Durability

- How will our buildings hold up?
- https://www.youtube.com/watch?v=5NvDhNZNSBk
- Factors affecting durability:
  - Water—liquid and vapor
  - Thermal performance
  - Air tightness

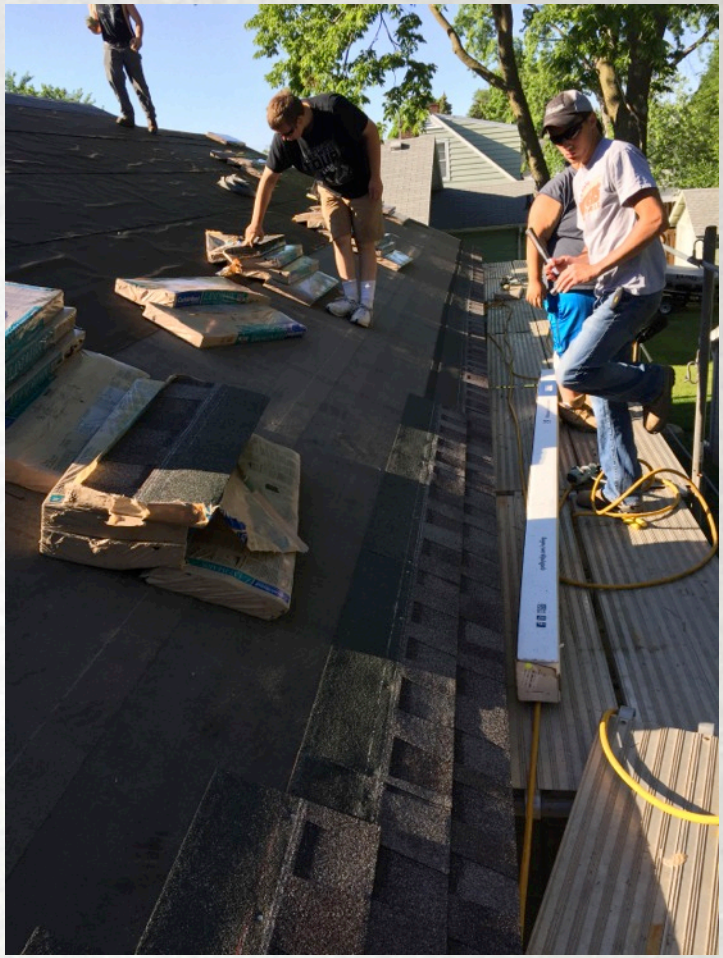
Durability—water management

- Water vapor
  - Winter: High indoor RH compared to outside (extended time)
  - Summer: High outdoor RH compared to conditioned interior (not very long)
  - Fall/spring: varies, but rather neutral
- Vapor open assemblies
- Manage indoor air



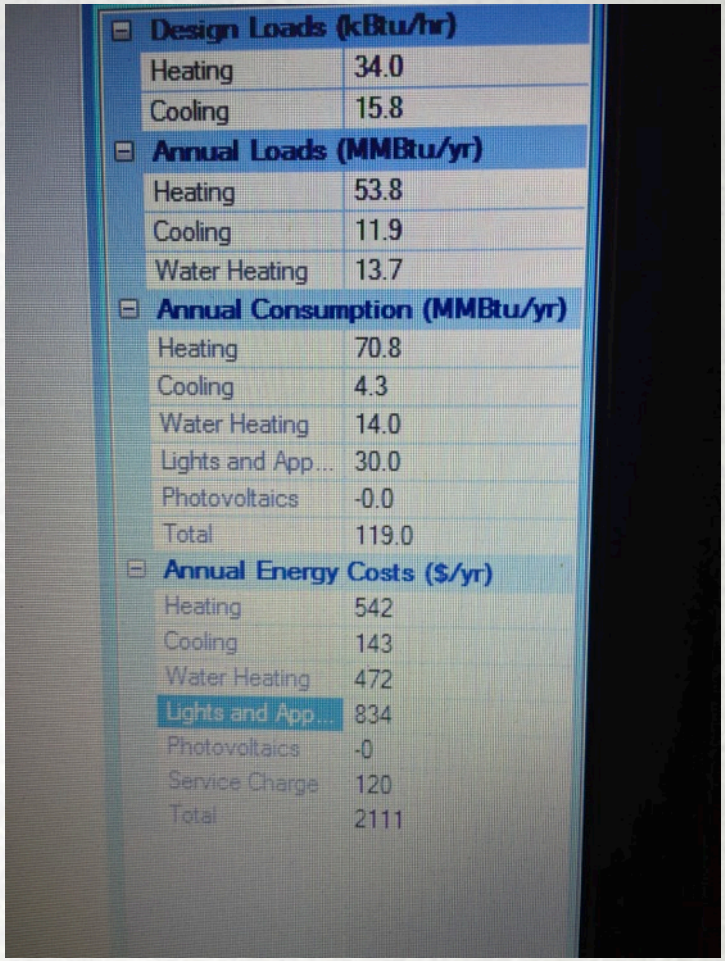
Durability—water management

- Liquid water sources:
  - Weather
  - Domestic water supply
  - From above, the side and below!
- Managing Liquid water
  - Flash properly
  - well defined drainage planes—with appropriate materials
  - Drain tile/sump



Energy Modeling

- REMrate
- PHPP/WUFI passive
- Manual J
- REScheck
- Beopt
- eQuest



Energy Modeling

- Requires excellent field data collection and/or detailed construction documents
- Heat loss/gain
  - Conductive losses
  - Infiltration losses
  - Solar gains/internal gains
- Plug/appliance loads
- Lighting
- Hot water

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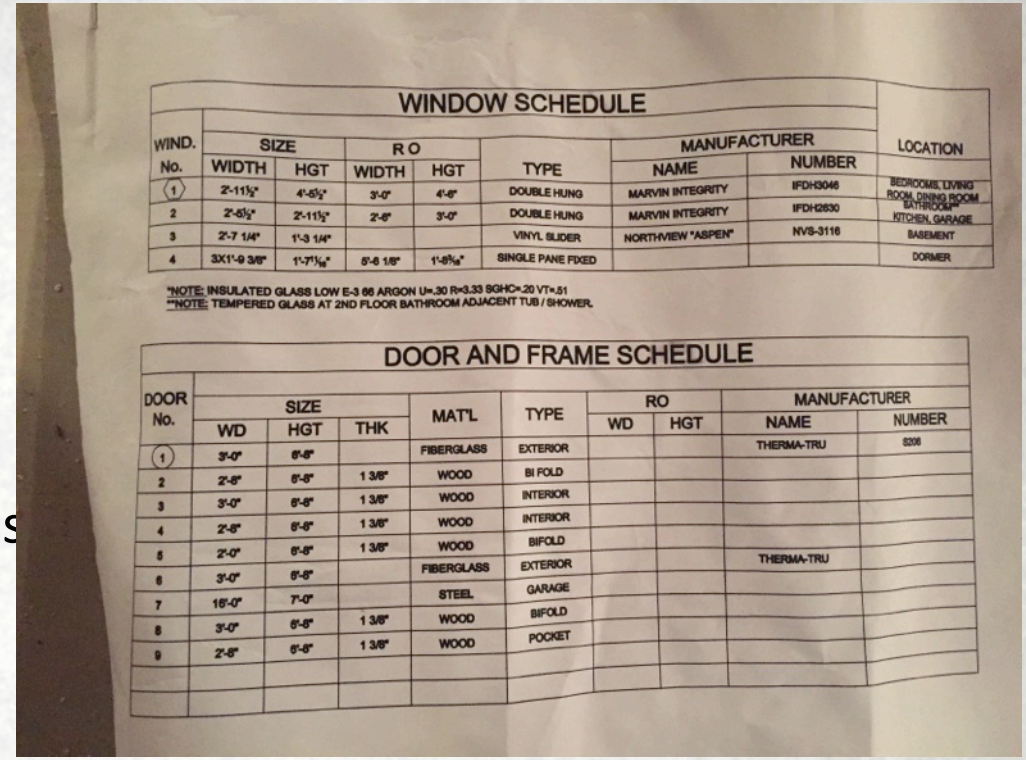


WINDOW SCHEDULE

WIND. No.	SIZE WIDTH	SIZE HGT	R O WIDTH	R O HGT	TYPE	MANUFACTURER NAME	MANUFACTURER NUMBER	LOCATION
1	2'-11½"	4'-5½"	3'-0"	4'-6"	DOUBLE HUNG	MARVIN INTEGRITY	IFDH3046	BEDROOMS, LIVING ROOM, DINING ROOM, BATHROOM
2	2'-5½"	2'-11½"	2'-6"	3'-0"	DOUBLE HUNG	MARVIN INTEGRITY	IFDH2630	KITCHEN, GARAGE
3	2'-7 1/4"	1'-3 1/4"			VINYL SLIDER	NORTHVIEW "ASPEN"	NVS-3116	BASEMENT
4	3X1'-9 3/8"	1'-7 1/16"	5'-6 1/8"	1'-8 5/16"	SINGLE PANE FIXED			DORMER

*NOTE: INSULATED GLASS LOW E-3 66 ARGON U=.30 R=3.33 SGHC=.20 VT=.51
**NOTE: TEMPERED GLASS AT 2ND FLOOR BATHROOM ADJACENT TUB / SHOWER.

DOOR AND FRAME SCHEDULE

DOOR No.	SIZE WD	SIZE HGT	SIZE THK	MAT'L	TYPE	RO WD	RO HGT	MANUFACTURER NAME	MANUFACTURER NUMBER
1	3'-0"	6'-8"		FIBERGLASS	EXTERIOR			THERMA-TRU	6206
2	2'-6"	6'-8"	1 3/8"	WOOD	BI FOLD				
3	3'-0"	6'-8"	1 3/8"	WOOD	INTERIOR				
4	2'-8"	6'-8"	1 3/8"	WOOD	INTERIOR				
5	2'-0"	6'-8"	1 3/8"	WOOD	BIFOLD				
6	3'-0"	6'-8"		FIBERGLASS	EXTERIOR			THERMA-TRU	
7	16'-0"	7'-0"		STEEL	GARAGE				
8	3'-0"	6'-8"	1 3/8"	WOOD	BIFOLD				
9	2'-8"	6'-8"	1 3/8"	WOOD	POCKET				

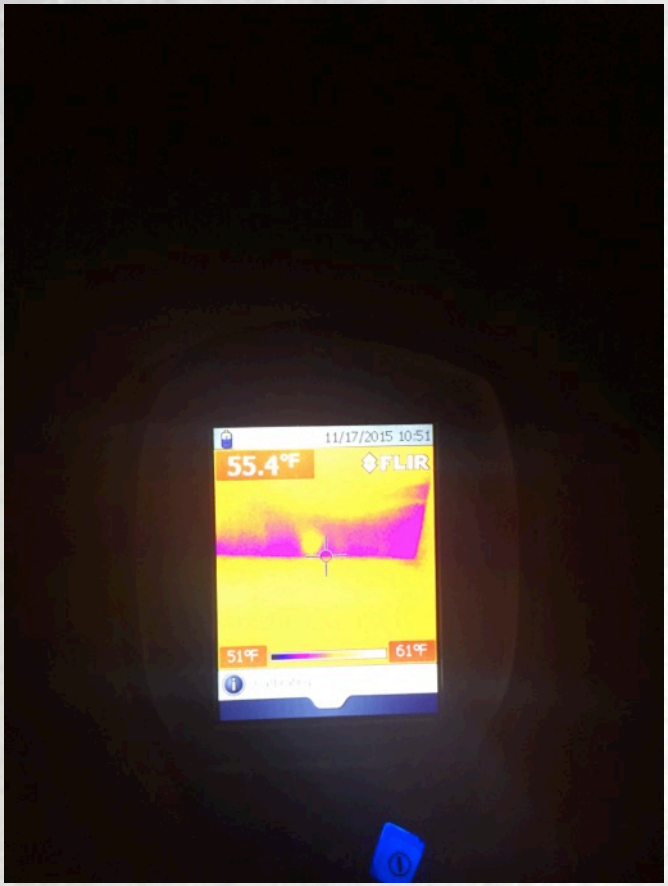
Building performance testing

- Air tightness testing
  - ACH50 for residential
  - ACH75 for commercial
  - Insist on air tightness goals early (we like 1ACH50 or tighter)
- Air infiltration is a durability concern—moisture travels with the air, getting into our envelope assemblies.

Building performance testing

- Pre-test
  - Done once the air tight layers are installed and *before* they are covered up
  - Air seal while running the blower door
  - Air seal beyond your air tightness target
- Post-test
  - After the pre-test—assure all penetrations are sealed
  - Tough to improve the numbers

Building performance testing



Building performance testing

- Big buildings can benefit, too
- Establish air tightness goal
- Find infiltration points
- Air seal and retest
- Adjust heating, cooling and ventilation

Verification of building performance

- Follow up audit
- Monitoring
- Re-commission equipment, if necessary
- Compare modeled performance to actual
- Add to the database of research!

Building science in the industry

- Education
  - High schools—construction academies
  - Two year programs
  - Four year programs
- Residential building
  - Builders associations
  - Contractors
  - Lenders
- Commercial building

Integrated team approach

- Western's Center for Building Innovation
- Architectural Technology
- Building Systems Technology
- HVAC/R
- Wood Tech
- Landscape Horticulture

Integrated team approach

- Working in interdisciplinary teams
- Various, but regular levels of involvement throughout project
- Engaged from pre-design through the final walk through
- Contractors, designers, clients, and building performance

Questions?

- Thank you
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  - Western Technical College
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  - 608-785-9103 office