SynerGreen

Home Perfection

WHOLE HOUSE PERFORMANCE ASSESSMENT

Sample Residence

Diagnostic Testing Results and Improvement Plan

Date

Prepared by Allen Gates

CERTIFIED PROFESSIONAL

Build It Green
Smart Solutions From The Ground Up

HOME PERFORMANCE WITH ENERGY STAR

EfficiencyFirst
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Client Information

Date of Site Assessment:	Date
Client Name:	Bill and Judy xxxxx
Address:	xxxxx xxxxx Rd.
City:	Deer Park
State-:	WA
Zip Code:	99xxx
Phone:	(509) xxx-xxxx
email:	xxxxx@gmail.com

Building Information and Weather Conditions

Number of Occupants:	3
Number of Floors:	2 + Basement
Year Built:	1900
Square Feet:	1,456
Outdoor Temp:	49°
Outdoor Humidity:	63%
Wind Speed:	Mild
Indoor Temp:	60°
Indoor Humidity:	80%

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Client's Concerns

1. Wants to live in an energy efficient house.
2. Wants to live in a comfortable, safe and healthy house.

Facts

The house:

1. is approximately 1,456 sq. ft. two story plus basement, built in 1900 with the front orientation facing west.
2. has a kitchen, dining room, living room, a loft, 2 bedrooms and 1 bathroom.
3. has a two-car detached garage.
4. has dual pane windows with vinyl frames.
5. has two attics with approx. R-19 value fiberglass insulation in one attic.
6. has 2 crawl spaces: the living room has R-19 floor insulation. The rest of the floors has no insulation.
7. has exterior wall insulation in the kitchen, first-floor bedroom and living room.
8. has a propane stove located in the living room and a Borg-Warner 96,000 BTU fuel oil furnace rated at 80% energy efficient which is located in the basement.
9. has the following electrical appliances that contribute to high energy usage:
   A. a 1999 50-gallon Whirlpool water heater located in the basement.
   B. a range top and oven located in the kitchen.
   C. a 2002 Kenmore 21 CF refrigerator located in the kitchen.
   D. a clothes washer and dryer located in the kitchen area.
   E. an oxygen machine in use approximately 16 hours a day.
   F. one space heater occasionally in use and one space heater in use approximately 16 hours per day.
   G. a trash compactor located in the kitchen.
   H. a freezer located in the garage that is over 40 years old.
   I. an electric heater located in the bathroom.
   J. a television running approximately 16 hour per day.
10. has no air conditioning.
11. has 22-can lights on the first floor.
12. has utility gaskets on the light switches and electrical outlets.
13. has 1-exhaust fan in the bathroom and 1 exhaust fan on the range-top in the kitchen.
14. has 6-supply air ducts on the first floor and 2 supply ducts on the second floor.
15. has 2-return air grills located on the first floor.
16. has limited supply and return air duct insulation.
17. has incandesces, fluorescence and LED lighting.
18. has smoke alarms and CO monitors.

Back portion of house – orientation is facing east

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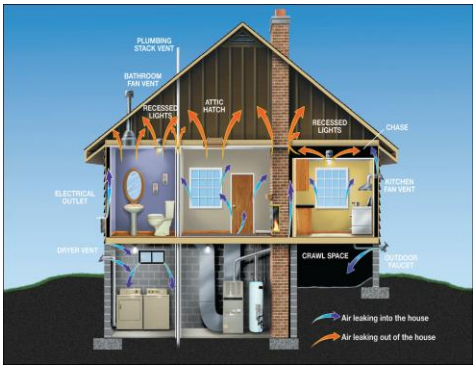
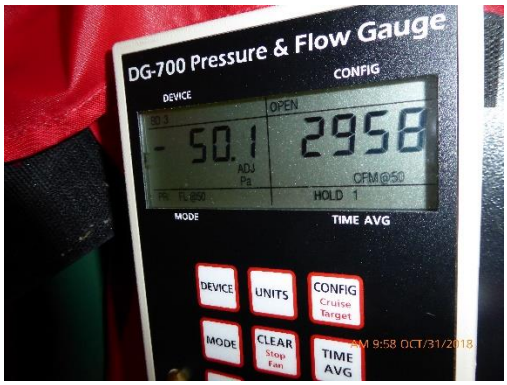
SynerGreen Findings – Summary

Description	Your House	Building Science Standards	Variance	Recommendations
Interior				
Air Infiltration	2958 CFM_{50} 0.79 ACH	1307 ≤ CFM_{50} 0.35 ACH	1651 CFM 0.44 ACH	Air seal all electrical, mechanical and plumbing penetrations leading into the living spaces.
Duct leakage (total)	282 CFM_{25} Approx. 17%	83 CFM_{25} ≤5%	199 CFM_{25} 12%	Air seal existing ducts where accessible in the in the basement and crawl space. Air seal all boots to the building material.
Utility Bill Analysis	$3.17 Ft^2	≤$0.40 Ft^2	≤$2.77 Ft^2	Air seal all electrical, mechanical and plumbing penetrations leading into the living spaces.
Insulation				
• Attic	R-19	≥R-50	R-31	Add cellulose insulation with a value of ≥R-50.
• Floor	R-19	R-30	R-11	Add insulation to all floors.
• Walls	Partially	R-13	R-13	Add cellulose insulation.
Attic Area	Unsealed	Air-sealed	Yes	Air-seal electrical, mechanical and plumbing penetrations.
Basement	Unsealed	Air-sealed	Yes	Air-seal electrical, mechanical and plumbing penetrations.
Lighting Efficiency	Incandescence, Flour., and LED's	LED's	Yes	Change all incandesces lighting to LED.
Doors & Windows	Dual-pane w/vinyl frames	Dual-pane low E, argon gas with vinyl frames	No	Weather strip exterior doors and replace the double door located in the living room.
Appliances				
Furnace & Ductwork	Borg-Warner 96000 BTU, 80% Energy Efficient Forced Air	≥95% eff. Sealed Combustion	Yes	Replace furnace with an ≥95% energy efficient unit. Use propane fuel. Capacity should be 60,000 BTU. Air seal and insulate existing and new ducts with R-8, where accessible. Enlarge the branches to accommodate more supply and return air flow. Add return air openings.
Refrigerator	Kenmore 2002 – 21 CF	2018 Energy Star	No	No recommendation.
Water Heater	Whirlpool – 1999-EF. 0.52 - 50 gal.	2018 - ≥0.95 EF with Heat Pump	37%	No recommendation.
A/C Condenser	None	≥14 SEER	Yes	Add air conditioning, if desired.
CAZ Testing				
Propane gas appliance	Stove	Pass	No	No propane gas leakage on the gas line and no CO detected in house.
Exterior				
Penetrations into the living space	Unsealed penetrations	Air seal all penetrations	Yes	Air-seal all electrical, mechanical and plumbing penetrations leading to the inside of the house.

Interior of House



Air infiltration areas



Blower door manometer - air infiltration measurement

Ventilation Standard – The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) sets ventilation standards. Ventilation is the *planned* moving of air through an area for the purpose of removing moisture, air pollution or unwanted heat. Air-infiltration is the *unplanned* inflow of outdoor air into the indoors, which is accompanied by an equal outflow of air from the indoors to the outdoors. Air moves in and goes out through unsealed electrical, mechanical and plumbing openings from the attic and crawl-space area into the living area.

Air Infiltration

By depressurizing the house, air leakage was measured at 2958 CFM_{50}. This amounts to about 0.79 air changes per hour (ACHn), or 18.96 air changes in a 24-hour period. The target is 0.35 ACH or 8.4 air changes in a 24-hour period.

Some of the contributors of air infiltration are:

1. Un-sealed electrical, mechanical and plumbing penetrations pulling in outside air into the living area or leaking inside air out, depending on pressure differences.
2. The 22 can lights.
3. The unsealed attic access cover.
4. The exterior doors.
5. The unsealed supply and return boots.

A properly air sealed conditioned space is a major component of a healthy and an energy efficient home.

Air Sealing the Building

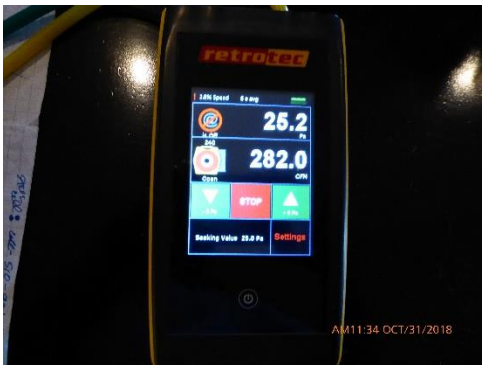
Air-sealing efforts are performed in accordance with the Building Performance Institute (BPI) Building Airflow Standard (BAS).

Ventilation Information	**CFM_{50}**	**ACHn**
Mech. Ventilation Required	≤946	≤0.25
Minimum Airflow (ASHRAE standards)	1307	0.35
Your Test Results	**2958**	**0.79**

Your test results show air sealing efforts needed in order to comply with ASHRAE standards. The target for air sealing is between 946 CFM_{50} and 1307 CFM_{50}.

Duct Leakage Measurements

Duct tester and manometer



Manometer reading

Furnace Output (76,800 BTUx21.7/1000)	1667 CFM Nominal Fan Flow	Percent
Total duct leakage	282	17
Duct leakage to the outdoors (DLTO)	N/A	N/A

There are 2 options to reduce duct leakage: air-seal the areas of leakage or replace the duct system with one that is sized, air-sealed and insulated properly. Duct leakage should be ≤5%.

System Air Flow Measurements

Supply and return air register and grill measurements were performed. Air flows to each room should be designed in accordance with ACCA Manual J, D & S standards for comfort and efficiency.

Location – 1st Floor	CFM	Register Size
Supply Air Flow	Reg/None	
1. Kitchen-Nook	65/70	12”x6”
2. Kitchen	57/74	12”x6”
3. Bathroom	55/94	12”x6”
4. Bedroom	105/131	12”x6”
5. Dining Room-Window	93/117	12”x6”
6. Dining Room	65/74	12”x6”

Location – 2nd Floor	CFM	Register Size
Supply Air Flow	Reg/None	
1. Loft	50/130	12”x8”
2. Bedroom 2	72/72	12”x8”
Total Supply Air Flow	**562/762**	
Return Air Flow		
1. Kitchen	75	26”x8”
2. Dining Room	172	26”x8”
Total Return Air Flow	**247**	

Air flow measurements indicate:

1. Furnace delivers 1667 CFM; total supply air measured with registers on is 562 CFM. Total supply air measured with registers off is 762 CFM.; total return air measured at 247 CFM.
2. Total estimated supply air flow measured at 34% of capacity with registers on and 46% of capacity with registers off; total estimated return air flow measured at 15% of capacity.
3. Insufficient supply air flow due to duct leakage, small supply main, small branches, small boots and restrictive air registers.
4. Insufficient return air flow due to small return main, small branches, restricted size of existing openings and not enough openings.

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Utility Bill Analysis

Utility bills are a useful tool for gauging a building's energy efficiency and measuring energy savings from retrofits. Both improvement in comfort and economic benefits from energy conservation are compared to the costs in order to set priorities and make decisions. Energy is measured by kilowatt hour (kWh) for electricity, therm for natural gas and gallons for propane.

Energy consumption is classified into 2 categories: base-load consumption and seasonal consumption. *Base-load consumption consists of water heating, refrigeration, clothes dryer, lighting, entertainment center, spa, swimming pool, etc. Seasonal consumption consists of heating and cooling usage.*

Energy Consumption Categories

1. Annual base-load consumption (2017/2018):

Electric	$2,201 = 48%

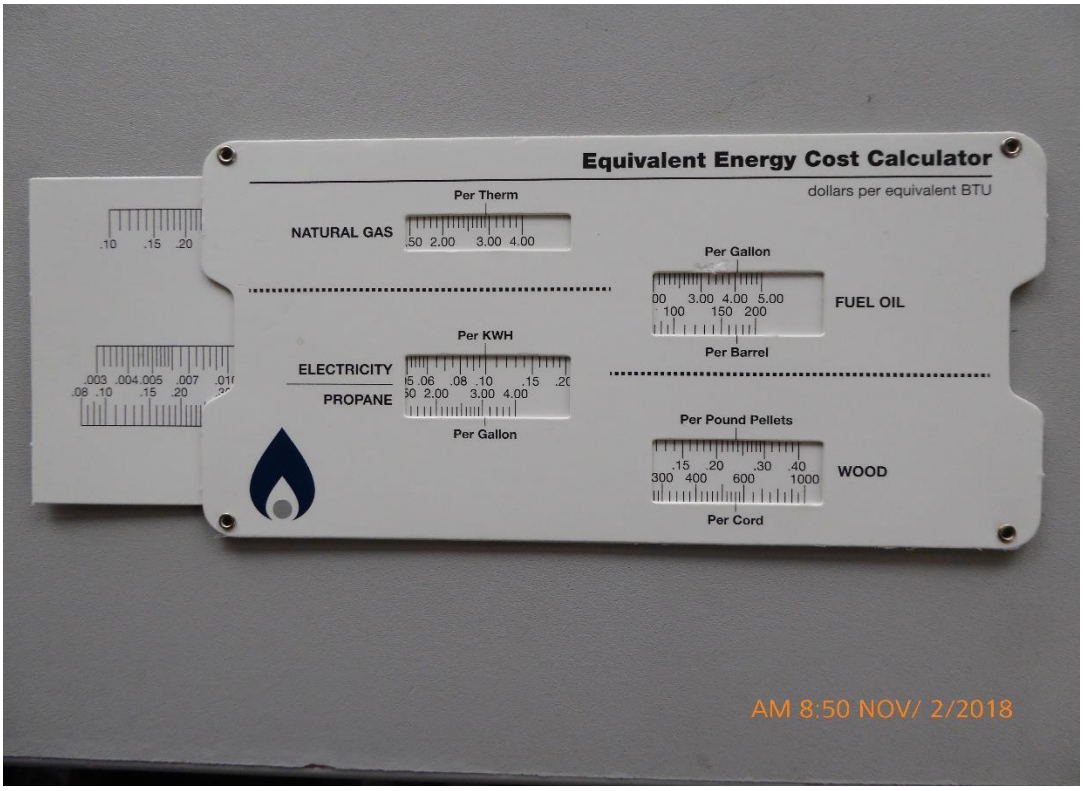
2. Annual seasonal consumption (2017/2018):

Electric	$ 0 = 00%
Fuel Oil	$ 1515 = 33%
Propane	$ 893 = 19%
Total	$4,609 = 100%

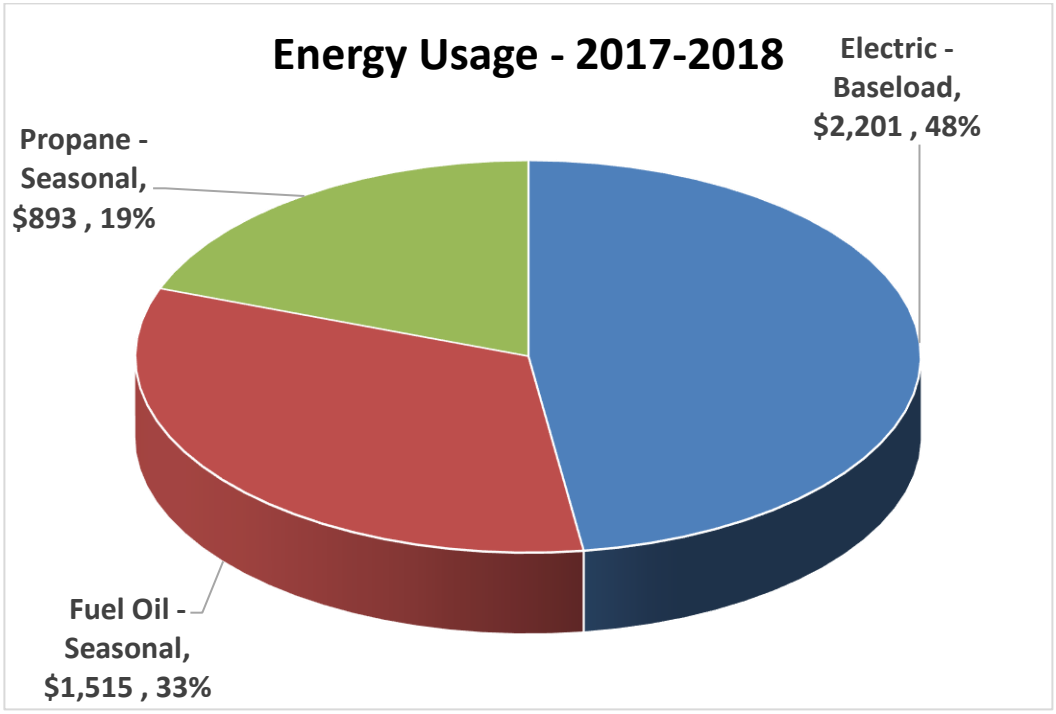
Energy Consumption Comparison.

#	Billing	kWH's	kWH Cost	F.O. Gal	F.O. Cost	Propane Gal	Propane Cost	Total Cost	
1	Oct 18	1480	$ 139.70					$ 139.70	
2	Sept 18	1670	$ 159.68					$ 159.68	
3	Aug 18	1740	$ 166.36					$ 166.36	
4	July 18	1420	$ 132.53					$ 132.53	
5	June 18	1510	$ 141.80					$ 141.80	
6	May 18	1560	$ 147.67			116.30	$ 251.44	$ 399.11	
7	April 18	1910	$ 183.58					$ 183.58	
8	Mar 18	2190	$ 213.92	177.80	$ 545.92			$ 759.84	
9	Feb 18	1820	$ 173.83					$ 173.83	
10	Jan 18	2960	$ 297.36	169.00	$ 524.32			$ 821.68	
11	Dec 17	2890	$ 289.77			107.80	$ 245.00	$ 534.77	
12	Nov 17	1660	$ 155.27	144.80	$ 444.85	176.50	$ 352.98	$ 953.10	
	Totals	22810	**$ 2,201.47**	**491.60**	**$ 1,515.09**	**400.60**	**$ 849.42**	**$ 4,565.98**	
							$ 43.24	$ 43.24	Tank Rental
							$ 892.66	**$ 4,609.22**	

1. Electric cost - $0.10 per kWH
2. Fuel oil cost - $3.08 per gallon
3. Propane cost - $2.12 per gallon + tank rental of $43.24 per year (or $2.23 per gallon incl. tank rental)



Electricity at $0.10 per kWH is equal to fuel oil at $4.00 per gallon and propane at $3.05 per gallon.



It costs an *estimated* $3.17 per square foot to operate the house ($4,609/1456 square feet); high energy use is approximately 48% which is related to baseload expense.

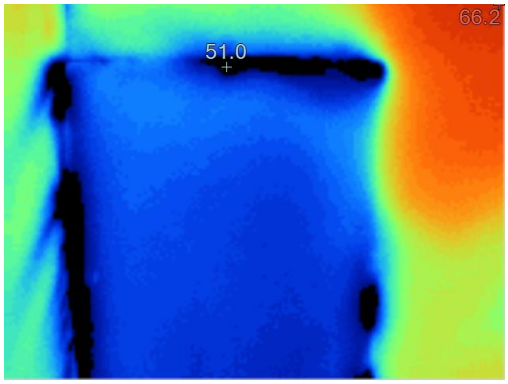
The "Energy Indexes for Buildings" table shown below is a guide in assessing building energy efficiency.

Energy Indexes for Buildings (Total Energy)
Residential Energy Krigger & Dorsi-04

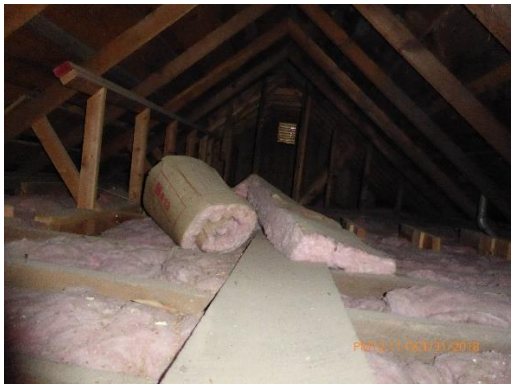
$/Ft²/Yr		Btu/Ft²
$1.21-$1.60	**24 KWh/ft²**	
	Little or no insulation, plentiful air leakage and inefficient space-conditioning systems. Swimming pool, sauna or other high energy users present. Occupants may be careless.	100,000
$0.81-$1.20	**18 KWh/ft²**	75,000
	Major problems with air leakage, insulation or space-conditioning efficiency. High hot water usage, inefficient appliances, and/or high electricity use by occupants.	
$0.41-$0.80	**12 KWh/ft²**	50,000
	Notable air leakage, insulation, or space-conditioning efficiency problems. Average appliance and water heating usage. Fairly careful occupants.	
$0.10-$0.40	**6 KWh/ft²**	25,000
	Small energy savings possible. Newer buildings with tight, well insulated building shells. Energy-efficient mechanical systems and appliances. Careful occupants.	
0	**0 KWh/ft²**	0

Annual dollars per square foot, Btu's per square foot, or kilowatt-hours per square foot are rough indicators of building energy efficiency.

Seasonal and base load numbers are estimated using an industry accepted formula shown in *Residential Energy* by Krigger & Dorsi.



Infrared image of the attic access cover in the upstairs bedroom.



Attic insulation of R-19 value with insulation not properly installed.

Smoke being sucked into the ceiling assembly thru the can light fixture.

Same as above.

Supply air boot not air-sealed to the building material.

Supply air filter in openings restrict delivered air flow.

Supply air register restricts delivered air flow.

Return air opening is too small for the sheet metal duct.

.

Same as above on second return air opening.

The hole on the floor is too large for the propane gas line. It needs to be air-sealed.

Partially insulated ductwork.

The freezer, located in the garage, is over 40 years old and is not energy efficient.

Findings

1. Air-infiltration (air moving into the house) and air exfiltration (air moving out of the house) are coming from:
   A. The un-sealed electrical, mechanical and plumbing penetrations from the attic and crawl space areas into the living space.
   B. The unsealed sheet metal boots.
   C. The unsealed propane gas line opening.
2. Furnace operates on fuel oil and is a forced air system with a capacity sized at 96,000 BTU. It is 80% energy efficient.
   A. The furnace capacity is oversized for the cubic footage of the house.
   B. The supply air main and branches are too small for the capacity of the furnace.
   C. The return air main and branches too small for the capacity of the furnace.
   D. The supply air boots and return air openings are not air sealed to the building material.
   E. The supply air registers are too restrictive for proper delivered air flow.
3. Lighting is incandescent, fluorescent and LED.

Recommendations

Interior

1. Attic Areas
   A. Air-seal all electrical, mechanical and plumbing penetrations and openings (that are accessible) to the living space.
   B. Install rulers every 250 Ft. and blow-in fiberglass insulation to total approx. 14" (≥R-50).
   C. Replace attic access cover in master bedroom and insulate the back of the cover and weather strip around the opening.
2. Furnace and Ductwork
   A. Replace existing furnace with a 60,000 BTU, 95% energy efficient unit. Use propane as the fuel.
   B. Replace and enlarge supply air main, branches, boots and return air main, branches and boots.
   C. Insulate all ductwork where accessible.
   D. Install additional properly sized return air ductwork throughout the house where feasible.
   E. Replace supply air registers to allow for more delivered air into the living space.
   F. Cut larger openings in the existing 2 return air locations.
3. Lighting – Replace incandescent lights with LED's.
4. Basement
   A. Air seal electrical, mechanical and plumbing penetrations and openings (that are accessible) to the living space.
   B. Install R-19 value floor insulation where accessible.
5. Insulate exterior walls that have no insulation.
6. Replace old freezer with one that is energy efficient.

Exterior

Air-seal all electrical, mechanical and plumbing penetrations that lead into the living space.