Is It Really All About Energy?

February 23, 2022

2022 Energy Design Conference

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Franklin Energy, Energy Advisor

Why Do We Live In Houses?

Food, Clothing, SHELTER

A **shelter** is a basic architectural structure or building that provides protection from the local environment.

Having a place of shelter, of safety and of retreat, i.e. a home, is commonly considered a fundamental physiological human need, the foundation from which to develop higher human motivations.

Why Do We Live In Houses?

Construction of a home is the initial stage of enclosing space and controlling an environment. Ultimately, a home needs to not only stand intact over time but needs energy to control natural processes to maintain the right environment as well as preserve the structure.

Are you planning for that energy control and use?

Why Do We Live In Houses?

- Protection from the elements: wind, precipitation, temperature
- Safety
- Place to sleep
- Place to cook
- Place to gather
- Place to work (esp. in 2022)
- Place to accumulate “stuff”
- Entertainment
- Tinker in a garage

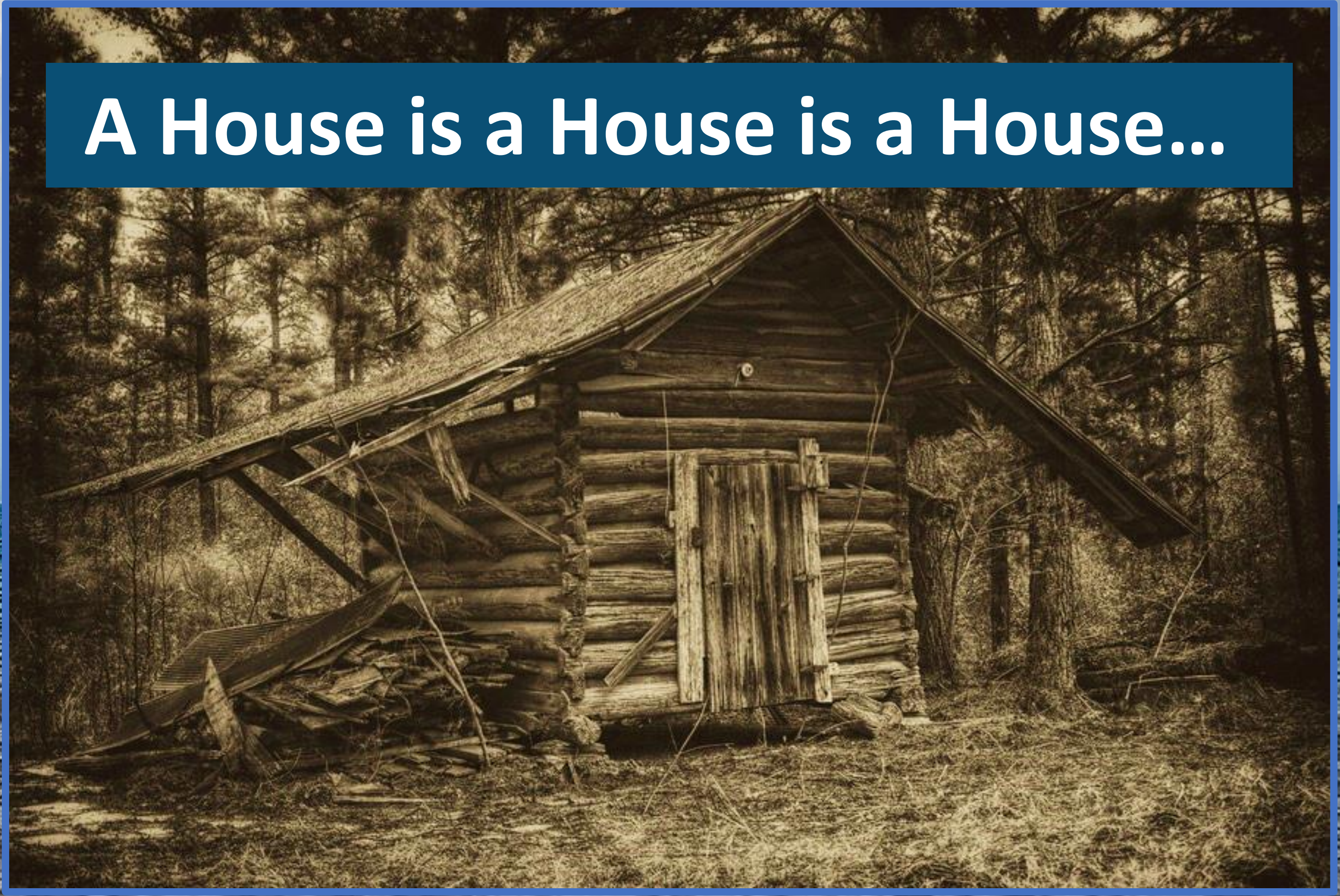
What Makes a House Livable?

Protection from the elements

(the environment) means control of…

Control Layers

Water (?)
Heat (?)
Air (?)



Control Layers

Water

Heat

Air

Consequences of Water Are Readily Apparent

Control Layers

Water

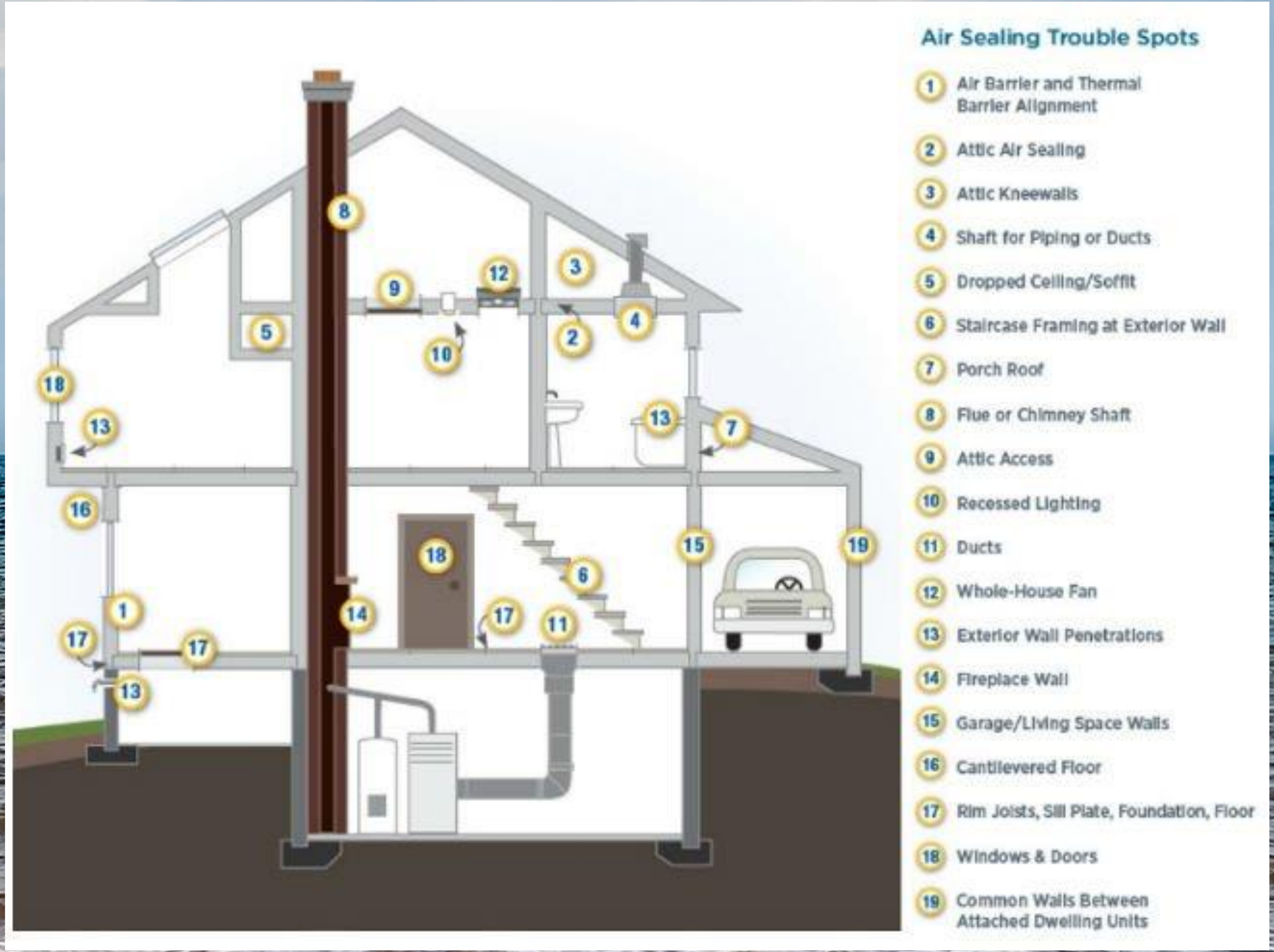
Heat

Air

Too tight? Energy transfer through walls, air & water vapor.

Control Layers

Water
Heat
Air



Control Layers

Water
Heat
Air

Air Loss:

“The DOE Windows and Building Envelope Research and Development Roadmap for Emerging Technologies shows that in 2010… in the residential and commercial sectors…infiltration accounted for greater energy losses than any other component of the building envelope, including fenestration and is responsible for over 4 % of all the energy used in the United States. Furthermore, the Roadmap shows that the addition of air barrier systems would have a payback that is much less than 5 years.”

~ Oak Ridge Lab Energy Savings and Moisture Transfer Calculator

Oak Ridge National Laboratory

Weatherization Assistant Software

Control Layers

Water

Heat

Air

Annual Energy and Cost Savings

Index	Recommended Measure	Components	Heating (MMBtu)	Heating ($)	Cooling (kWh)	Cooling ($)	BaseLoad (kWh)	BaseLoad ($)	Total (MMBtu)
1	Infiltration Redctn		16.6	166	0	0	0	0	16.6
2	High Eff Furnace	1	35.2	353	0	0	0	0	35.2
3	User-Spec Ceiling R	1	3.7	37	0	0	0	0	3.7
4	Horizontal Attic Scuttle		0.0	0	0	0	0	0	5.0
5	Wall Insulation	L1,L1 (2),L1 (3),L1 (4),L2 (6),L2 (7),L2 (8)	21.6	216	0	0	0	0	21.6
6	Kneewall Insulation	1	1.5	15	0	0	0	0	1.5

Annual Energy and Cost Savings

Index	Recommended Measure	Components	Heating (MMBtu)	Heating ($)	Cooling (kWh)	Cooling ($)	BaseLoad (kWh)	BaseLoad ($)	Total (MMBtu)
1	Infiltration Redctn		30.9	307	0	0	0	0	30.9
2	User-Spec Ceiling R	3	1.9	19	0	0	0	0	1.9
3	User-Spec Ceiling R	2	0.9	9	0	0	0	0	0.9
4	User-Spec Ceiling R	1	10.8	108	0	0	0	0	10.8
5	Horizontal Attic Scuttle		0.0	0	0	0	0	0	5.0
6	Sillbox Ins.	1	6.9	68	0	0	0	0	6.9
7	Foundation Ins.	1	7.9	78	0	0	0	0	7.9

Annual Energy and Cost Savings

Index	Recommended Measure	Components	Heating (MMBtu)	Heating ($)	Cooling (kWh)	Cooling ($)	BaseLoad (kWh)	BaseLoad ($)	Total (MMBtu)
1	Infiltration Redctn		21.0	304	0	0	0	0	21.0
2	Tuneup Heating System	1	8.9	128	0	0	0	0	8.9
3	DWH Pipe Insulation		0.0	0	0	0	246	12	0.8
4	Close off Stairwell/Attic Scuttle		0.0	0	0	0	0	0	10.0
5	Foundation Ins.	1	14.0	202	0	0	0	0	14.0
6	Attic Ins. R-38	1	12.2	176	0	0	0	0	12.2
7	Sillbox Ins.	1	3.9	57	0	0	0	0	3.9
8	Wall Insulation	1,1 (2),1 (3),1 (4)	40.1	579	0	0	0	0	40.1

Weatherization Assistant Software

Oak Ridge National Laboratory

Control Layers

Water
Heat
Air

Annual Energy and Cost Savings

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1	Infiltration Redctn		30.9	307	0	0	0	0	30.9
2	User-Spec Ceiling R	3	1.9	19	0	0	0	0	1.9
3	User-Spec Ceiling R	2	0.9	9	0	0	0	0	0.9
4	User-Spec Ceiling R	1	10.8	108	0	0	0	0	10.8
5	Horizontal Attic Scuttle		0.0	0	0	0	0	0	5.0
6	Sillbox Ins.	1	6.9	68	0	0	0	0	6.9
7	Foundation Ins.	1	7.9	78	0	0	0	0	7.9

Sq. ft. 2580 = 2580 * 8 = 20,640 cu. Ft.
4372cfm @-50 pascals = 4372 * 60 = 262,320 cfm/hr
262,320/20,640 = 12.7 ACH50
Est. annual savings: $307.00
Numbers above represent reduction to 2200 cfm

At 3.0 ACH50 (reduction to 1,033 cfm) = below:
Est. annual savings: $683.00

Annual Energy and Cost Savings

Index	Recommended Measure	Components	Heating (MMBtu)	Heating ($)	Cooling (kWh)	Cooling ($)	BaseLoad (kWh)	BaseLoad ($)	Total (MMBtu)
1	Infiltration Redctn		47.4	683	0	0	0	0	47.4
2	User-Spec Ceiling R	3	1.9	27	0	0	0	0	1.9
3	User-Spec Ceiling R	1	10.7	155	0	0	0	0	10.7
4	User-Spec Ceiling R	2	0.9	13	0	0	0	0	0.9
5	Horizontal Attic Scuttle		0.0	0	0	0	0	0	5.0
6	Sillbox Ins.	1	6.8	98	0	0	0	0	6.8
7	Foundation Ins.	1	7.6	110	0	0	0	0	7.6

Weatherization Assistant Software

Control Layers

Water
Heat
Air

Annual Energy and Cost Savings

Index	Recommended Measure	Components	Heating (MMBtu)	Heating ($)	Cooling (kWh)	Cooling ($)	BaseLoad (kWh)	BaseLoad ($)	Total (MMBtu)
1	Infiltration Redctn		21.0	304	0	0	0	0	21.0
2	Tuneup Heating System	1	8.9	128	0	0	0	0	8.9
3	DWH Pipe Insulation		0.0	0	0	0	246	12	0.8
4	Close off Stairwell/Attic Scuttle		0.0	0	0	0	0	0	10.0
5	Foundation Ins.	1	14.0	202	0	0	0	0	14.0
6	Attic Ins. R-38	1	12.2	176	0	0	0	0	12.2
7	Sillbox Ins.	1	3.9	57	0	0	0	0	3.9
8	Wall Insulation	1,1 (2),1 (3),1 (4)	40.1	579	0	0	0	0	40.1

Sq. ft. 2550 = 2550 * 8 = 20,400 cu. Ft.
4550cfm @-50 pascals = 4550 * 60 = 273,000 cfm/hr
273,000/20,400 = 13.4 ACH50
Est. annual savings: $304.00
Numbers above represent reduction to 3000 cfm

At 3.0 ACH50 (reduction to 1,270 cfm) = below:
Est. annual savings: $686.00

Annual Energy and Cost Savings

Index	Recommended Measure	Components	Heating (MMBtu)	Heating ($)	Cooling (kWh)	Cooling ($)	BaseLoad (kWh)	BaseLoad ($)	Total (MMBtu)
1	Infiltration Redctn		47.5	686	0	0	0	0	47.5
2	Tuneup Heating System	1	7.4	107	0	0	0	0	7.4
3	DWH Pipe Insulation		0.0	0	0	0	246	12	0.8
4	Close off Stairwell/Attic Scuttle		0.0	0	0	0	0	0	10.0
5	Foundation Ins.	1	13.8	199	0	0	0	0	13.8
6	Attic Ins. R-38	1	12.1	175	0	0	0	0	12.1
7	Sillbox Ins.	1	3.9	56	0	0	0	0	3.9
8	Wall Insulation	1,1 (2),1 (3),1 (4)	39.7	573	0	0	0	0	39.7

Control Layers

Water
Heat
Air

Tighter

Infiltration meets ACH50 requirements - **Description**
DOE Zero Energy Ready Home (Revision 07)

Exhibit 2 DOE Zero Energy Ready Home Target Home.
The U.S. Department of Energy's Zero Energy Ready Home program allows builders to choose a prescriptive or performance path. The DOE Zero Energy Ready Home prescriptive path requires builders to meet or exceed the minimum HVAC efficiencies listed in Exhibit 2 of the National Program Requirements (Rev 07), as shown below. Whole house leakage must be tested and meet the following infiltration limits:

- Zones 1-2: ≤ 3 ACH50;
- Zones 3-4: ≤ 2.5 ACH50;
- Zones 5-7: ≤ 2 ACH50;
- Zone 8: ≤ 1.5 ACH50;

ENERGY.GOV Office of ENERGY EFFICIENCY & RENEWABLE ENERGY | Building America Solution Center

Is It Really All About Energy?

CIP

The Conservation Improvement Program (CIP) helps Minnesota households and businesses use electricity and natural gas more efficiently - conserving energy, reducing carbon dioxide emissions, and reducing the need for new utility infrastructure. CIP is funded by ratepayers and administered by electric and natural gas utilities.

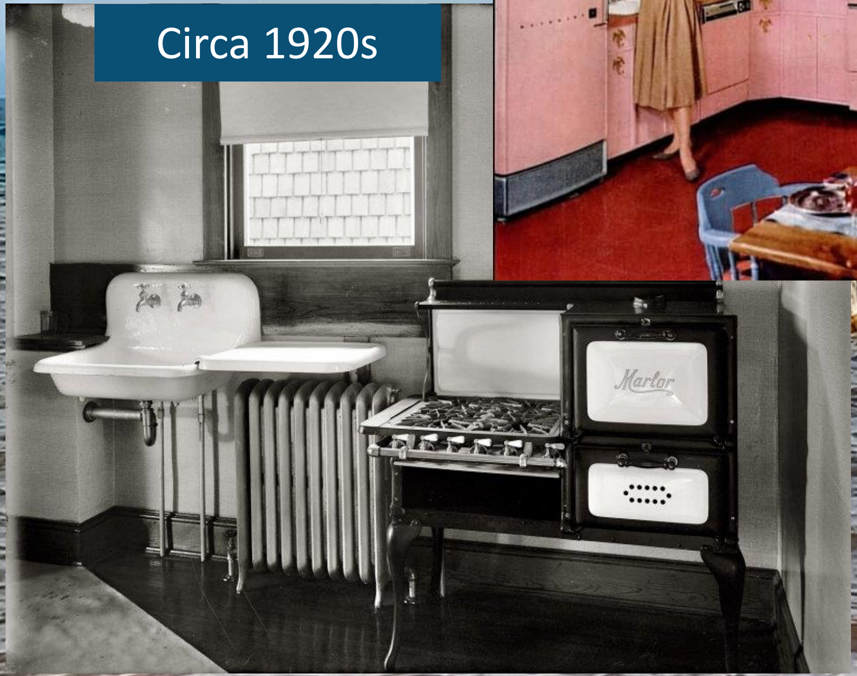
•Energy audits: trained energy consultant examines your home and offers specific advice on energy improvements.

•Rebates on high-efficiency heating, cooling, and water-heating appliances; CFL and LED lighting, etc.

•Air-conditioner cycling programs, which allow the utility to manage its peak energy demand in return for discounted electric bills for participating customers.

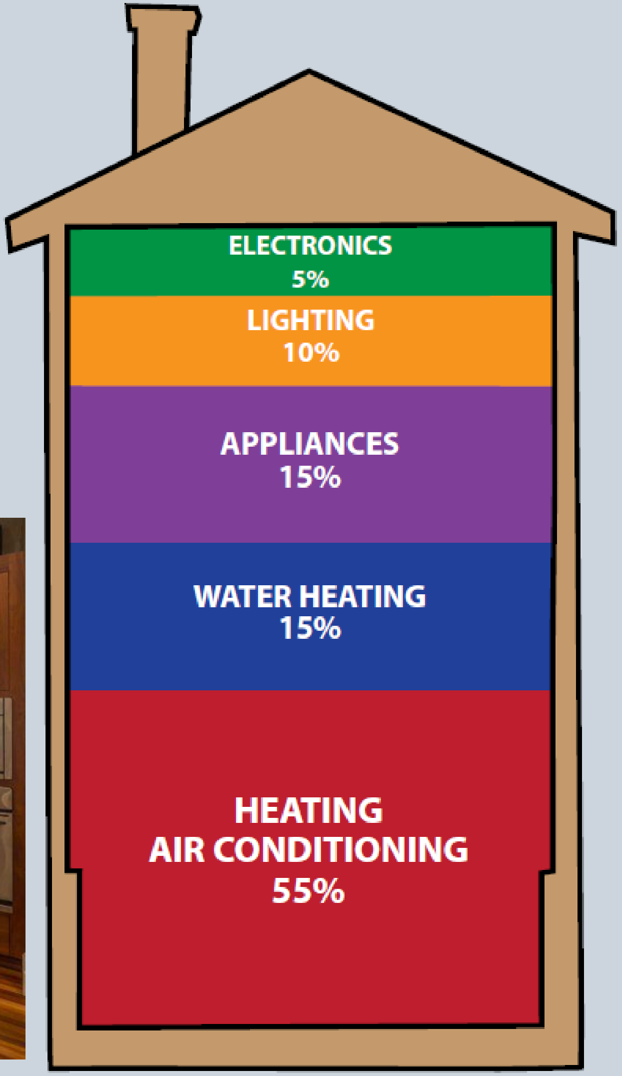
Is It Really All About Energy?

Circa 1950s



Circa 1920s

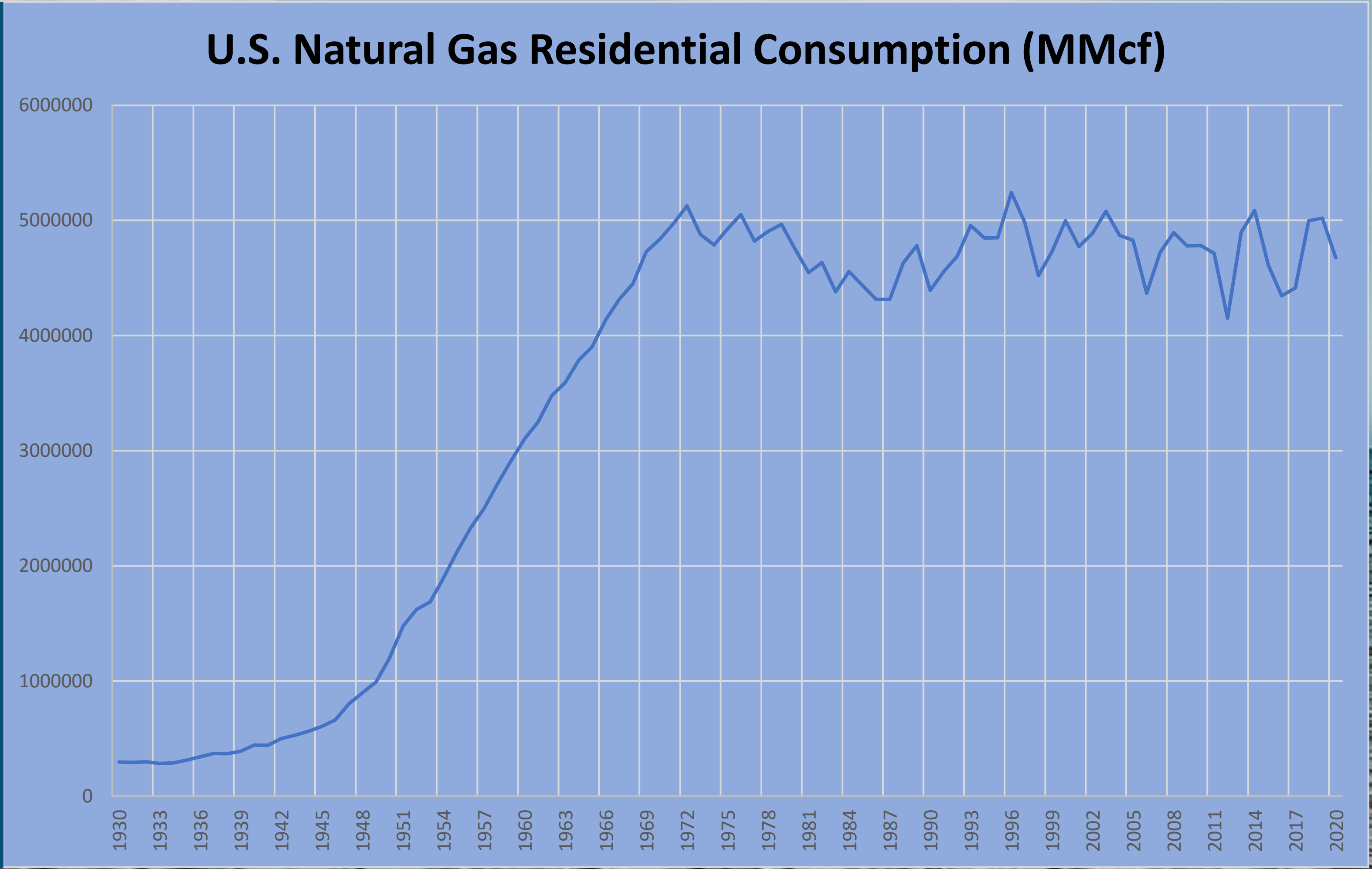
Circa 2000s



Is It Really All About Energy?

Sources of Energy: Electricity & Gas

Is It Really All About Energy?



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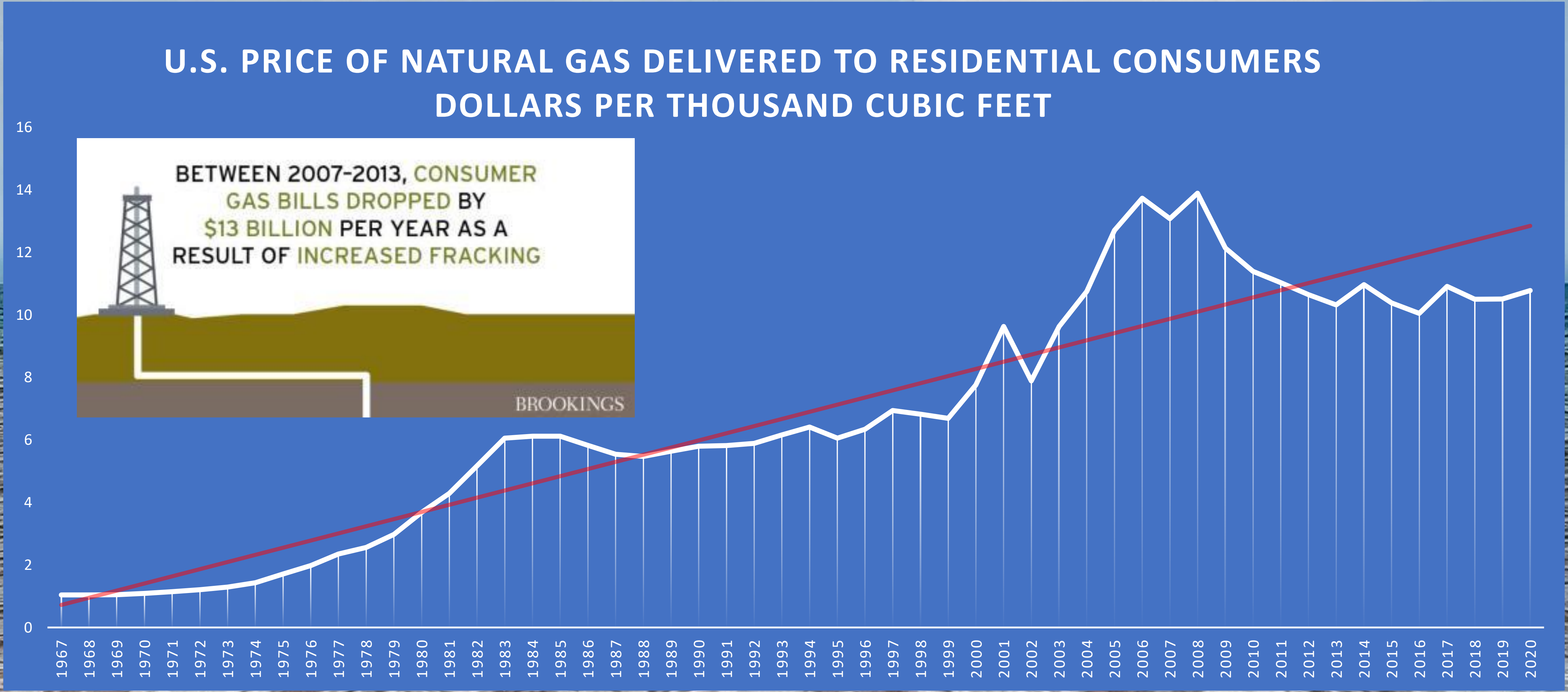

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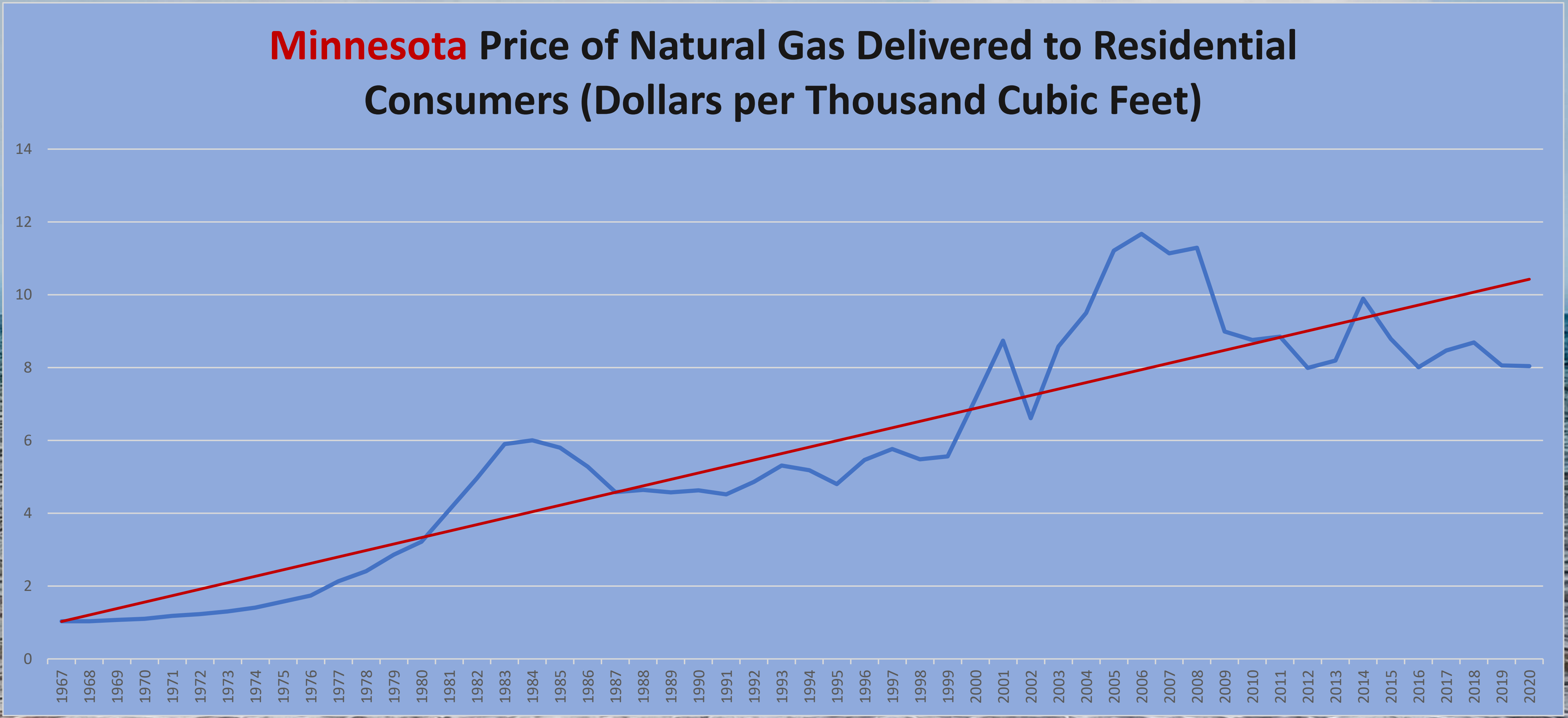
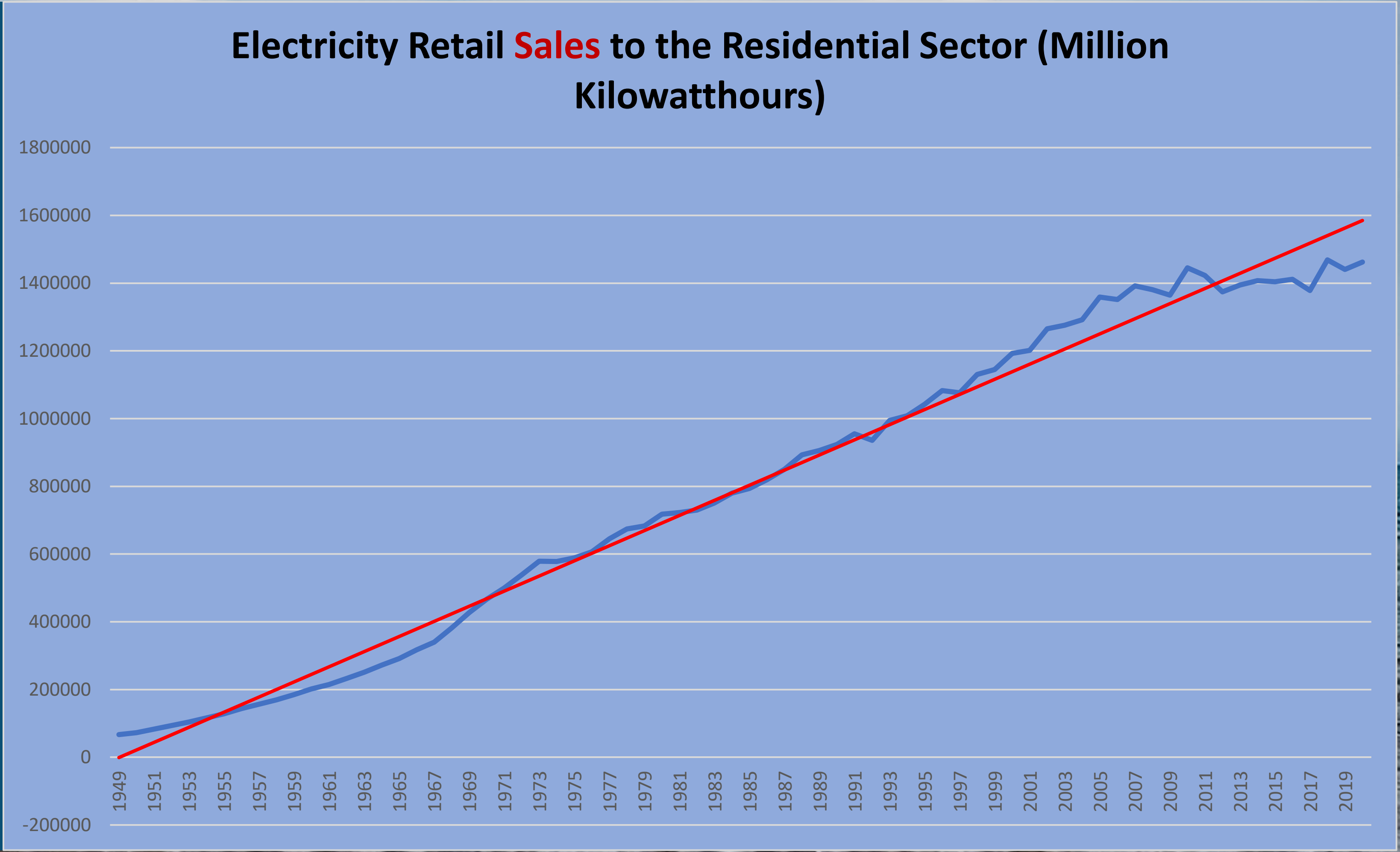


Is It Really All About Costs?



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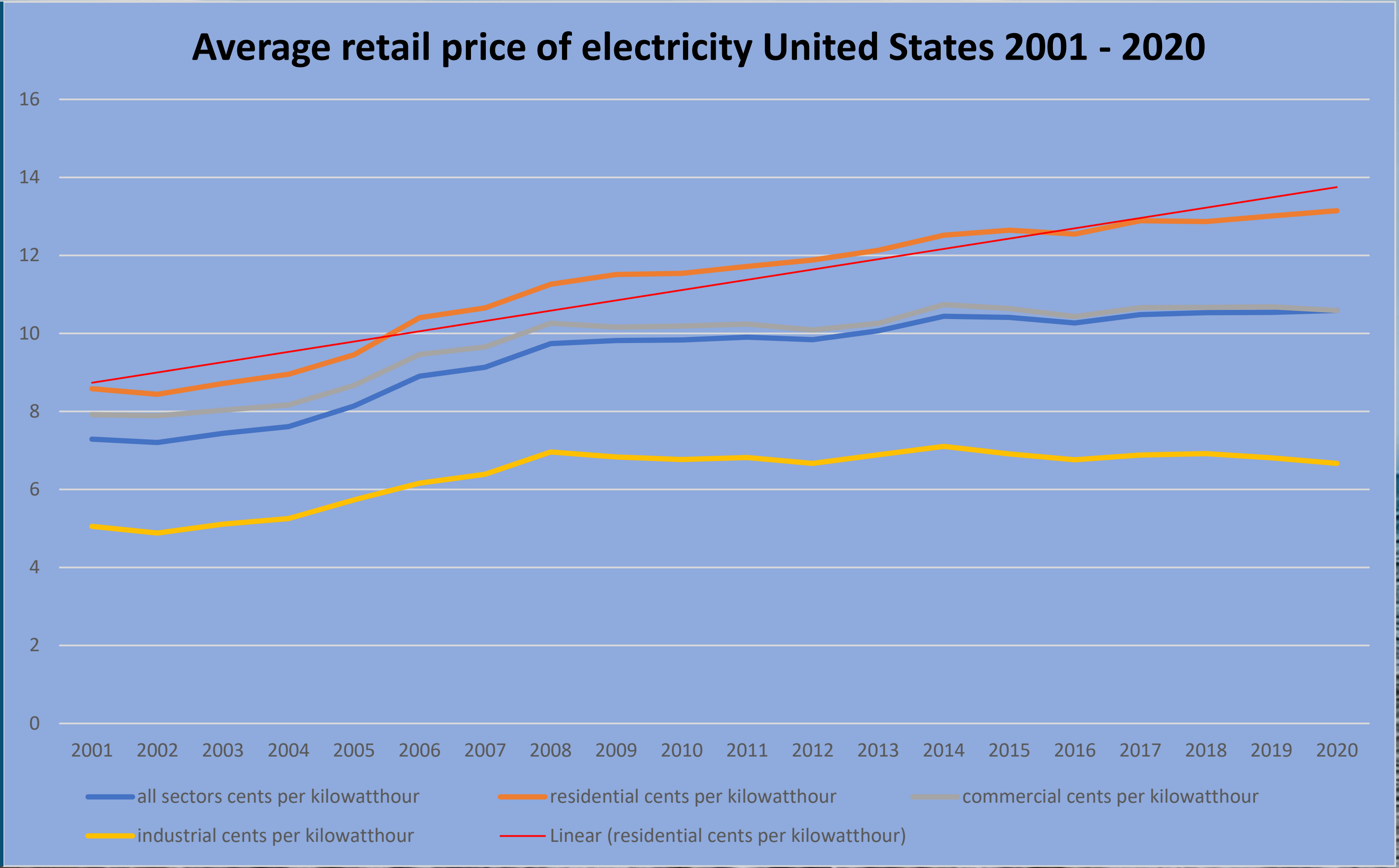
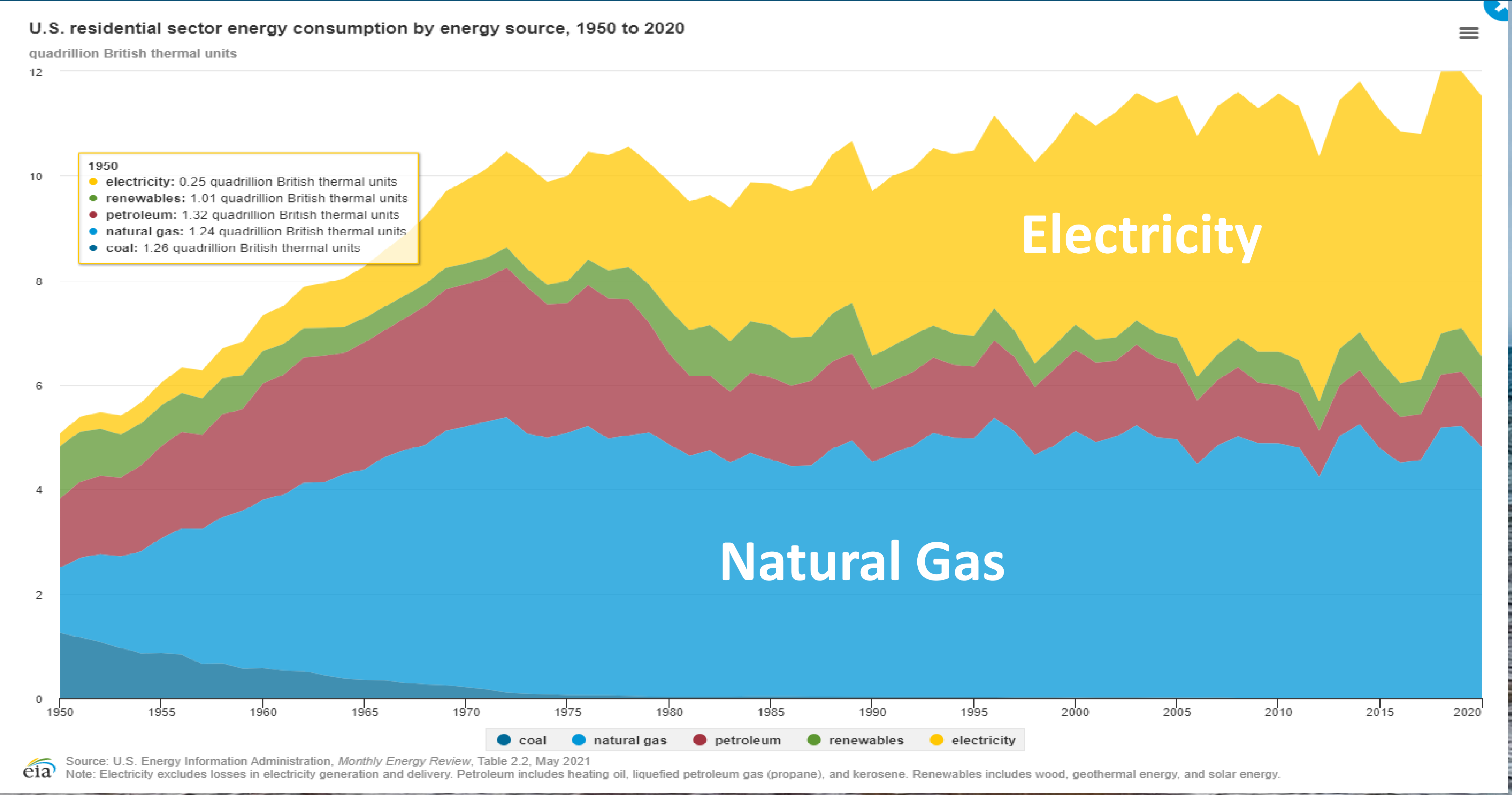


Is It Really All About Costs?



Is It Really All About Costs?

Year	Median Home Value	Annual Household Median Income	MHV/Income	Annual Income % of Cost
1950	$7,400	$2,990	2.47	40.41%
1960	$11,900	$4,970	2.39	41.76%
1970	$17,000	$8,734	1.95	51.38%
1980	$47,200	$17,710	2.67	37.52%
1990	$79,100	$29,943	2.64	37.85%
2000	$119,600	$55,030	2.17	46.01%
2010	$221,800	$49,445	4.49	22.29%
2020	$374,900	$67,521	5.55	18.01%

Is It Really All About Costs?

MORTGAGE AMORTIZATION SCHEDULE

ENTER VALUES		
Loan amount		$239,900.00
Interest rate	* SEE CURRENT *	3.00%
Loan term in years		30
Payments made per year		12
Loan repayment start date		1/1/2022
Optional extra payments		$0.00

LOAN SUMMARY			
Scheduled payment	$1,011.43	Utility Costs=	$200.00
Scheduled number of payments	360	Mortgage + Utility Costs=	$1,211.43
Actual number of payments	360	Over 30 years=	$436,114.11
Years saved off original loan term	0.00		
Total early payments	$0.00		
Total interest	$124,214.11	Total Int. & Principal=	$364,114.11
LENDER NAME	Happy Customer Bank, NA		

MORTGAGE AMORTIZATION SCHEDULE

ENTER VALUES		
Loan amount		$249,900.00
Interest rate	* SEE CURRENT *	3.00%
Loan term in years		30
Payments made per year		12
Loan repayment start date		1/1/2022
Optional extra payments		$0.00

LOAN SUMMARY			
Scheduled payment	$1,053.59	Utility Costs=	$100.00
Scheduled number of payments	360	Mortgage + Utility Costs=	$1,153.59
Actual number of payments	360	Over 30 years=	$415,291.85
Years saved off original loan term	0.00	Amount saved=	$20,822.25
Total early payments	$0.00		
Total interest	$129,391.85	Total Int. & Principal=	$379,291.85
LENDER NAME	Happy Customer Bank, NA		

Is It Really All About Costs?

"Cheap" Car

- Noisy
- Leaky
- Low safety rating
- Poor performance
- Poor gas mileage
- Lasts 15 years

Monthly Payment =	$350.00
Monthly Fuel =	$350.00
Monthly Total =	$700.00

"Expensive" Car

- Quiet
- Comfortable/no air leaks
- High safety rating
- Great performance
- Exceptional gas mileage
- Lasts 25 years

Monthly Payment =	$450.00
Monthly Fuel =	$175.00
Monthly Total =	$625.00

Is It Really All About Costs?

A Texas Builder Explains Total Cost of Ownership

"The old school of return on investment says you typically need to pay it back in about 6 years or so. With green building it's a whole different story, and when I explain this to prospective clients they get it, whether they're a wage earner buying an entry level home or an upper income person buying their second or third luxury move-up product. The return on investment on what you spend for green building is typically realized the first month you're in the home.

Here's a real example of a 3,000 square-foot home with a $300 month average utility bill. If you spend $10,000 additional on the green aspects of the home, you can reduce that energy cost to $150 per month. At today's mortgage rates, the $10,000 you spend costs you about $30 per month. You've saved $150 in utility costs and you've spent $30 to do it. Your positive cash flow that first month is $120, and it will be at least $120 a month after that. Whenever I've explained that to a customer, whether they're buying a $100,000 home or $3 million home, they've never failed to embrace it and find great value in it."

–T.W. Bailey Sr., president of Bailey Family Builders, Frisco, Texas

www.energy.gov/eere/buildings/zero-energy-ready-homes

Is It Really All About Costs?

TCO

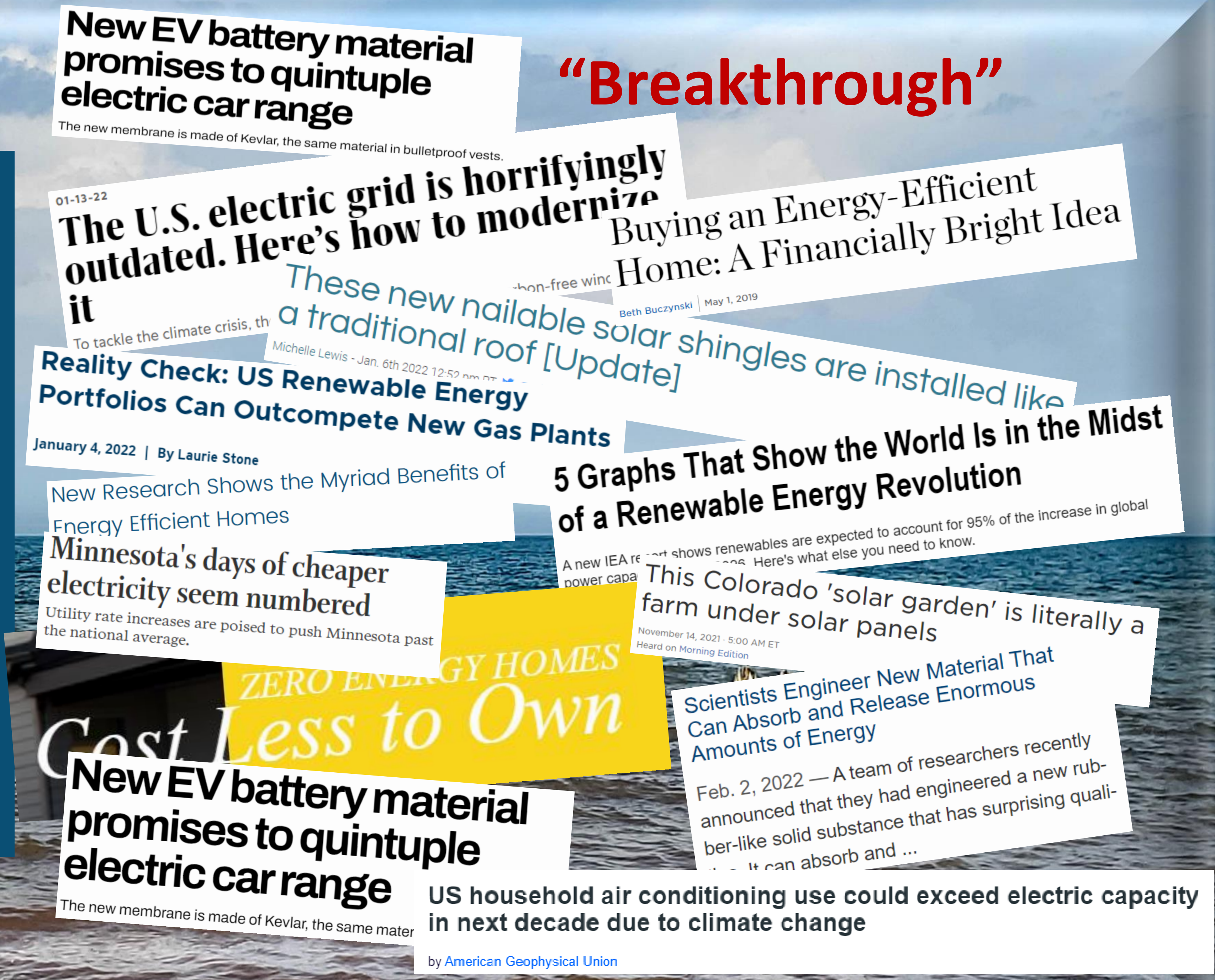
		Life in Years	Cost for 20 years
Cheap Windows	$10,000.00	10	$20,000.00
Expensive Windows	$15,000.00	20	$15,000.00

TCO + Utilities Cost/Savings

	Extra Fuel Costs	Cost/20 yrs	Total Cost/20 yrs
Cheap Windows	$150.00	$3,000.00	$23,000.00
Expensive Windows	$0.00	$0.00	$15,000.00

What about the future?

"Breakthrough"



What about the future?

Enginuity's innovative E|ONE can handle a home's power and heating needs

"E|ONE, a Combined Heat and Power System (CHP) that serves as a home's all-in-one device for virtually all of its heating and power needs…size of a standard home hot water heater…4-stroke…piston engines…turns natural gas into energy "

Utility's "almost 70 percent of that heat goes completely unused…supply heat and hot water…"

What about the future?

AMORPHOUS SILICON PHOTOVOLTAIC GLASS

(PV glass)

What about the future?

Koenigsegg's Compact 63-Pound Quark Electric Motor Can Produce 335 Horsepower

Pictured next to a 330ml energy drink.

GM 355 BASE ENGINE CAST IRON VORTEC HEADS FLAT TAPPET CAM 1PC RMS HP & TORQUE: 385 HP / 405 FT LBS

What about the future?

Grid Optimization

"The grid of the future must also support electric vehicles and charging stations, newly connected communities, and increased integration of carbon-free resources like solar and wind.

Strengthening the electric grid will lessen disruptions caused by malicious actors, reduce power outages in homes across America, and help lower energy bills for all Americans by moving cheaper, cleaner electricity to where it is needed most."

~Department of Energy
Reimagining and rebuilding America's energy grid

Grid Optimization

Department of Energy

Reimagining and rebuilding America’s energy grid

- ***Micrograds*** are a self-sufficient group of energy sources, like solar or wind, that support the energy needs of a local footprint, like a college campus or hospital complex. Microgrids can disconnect from national infrastructure to continue to operate while the main grid is down. Because of this, microgrids can strengthen grid resilience, decrease power outages, and provide energy resources for faster system response and recovery.
- ***Demand Response*** is a consumer’s reaction to a high demand for electricity. By limiting or postponing power consumption, during a time of high demand, consumers can help utilities manage increased strain on the grid. Some utilities provide consumer rebates for demand response.
- ***Advanced Metering,*** or smart metering, lets consumers know how and when they are using electricity so they can reduce their usage. Advanced metering could also help consumers reduce their electric bills by making them aware of periods of time that have a higher cost of electricity.
- ***Grid Scale Energy Storage Devices*** can help utilities continue to provide power during peak loads, when the grid may not be able to support all power needs. These devices can store electricity generated from carbon free sources so it can be used when it is needed most.
- ***Grid Hardware*** is critical for carrying, converting, and controlling power. Most of the grid modernization efforts have been focused on advanced digital information and communication technologies, but the physical equipment necessary to move power needs to be updated as well.

All Electric?

Key Findings
The new all-electric, single-family home has a lower net present cost than the new mixed-fuel home in every city we studied: Austin, TX; Boston, MA; Columbus, OH; Denver, CO; Minneapolis, MN; New York City, NY; and Seattle, WA.

- Electricity as conveyor of energy
- Multiple fuels to produce
- Centralized control of emissions
- EV Cars/homes: storage, back to grid
- House as passive user of energy to production and storage and supplier of energy
- Smart technology controlling house “on-the-grid” to address “wasteful” grid problems

Is It Really All About Energy?

Old Way:

New Way:

Is It Really All About Energy?

In Summary: No & Yes

- No. Structure, pipe and wires, paint, etc. count too.
- Yes. Without energy a house is just a fancy box that’s too cold, too hot, too wet, too dry, etc.
- No. Personal choices matter: layout/design, room choices/sizes, location, etc.
- Yes. We can’t all live in Florida or bison-hide teepees. (Well, we COULD…)

Is It Really All About Energy?

"Clean energy solutions have consistently become more cost-effective and have been deployed more quickly than nearly every forecast has predicted. And now, the pace of the energy transition is becoming unstoppable."

Jules Kortenhorst
Chief Executive Officer, RMI

Is It Really All About Energy?

Brian Wimmer/Energy Advisor
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