



The Global Warming Impact of Insulation, Revisited

Allison A. Bailes III, PhD

MARQUIS Who'sWho® Who'sWho of American Women

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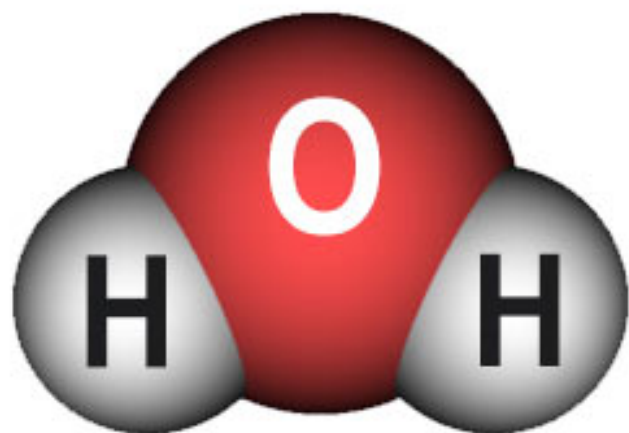






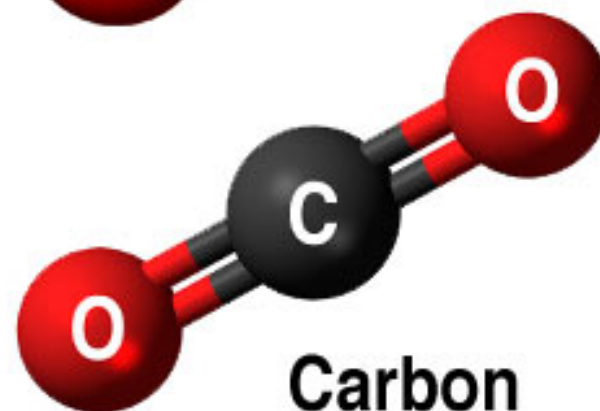
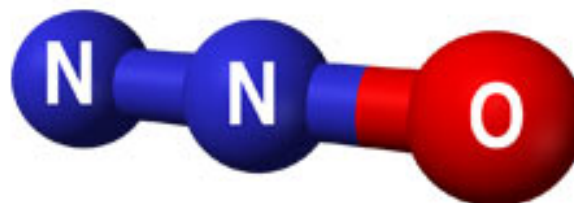
*Avoiding the
Global Warming
Impact of
Insulation*

By Alex Wilson,
2010

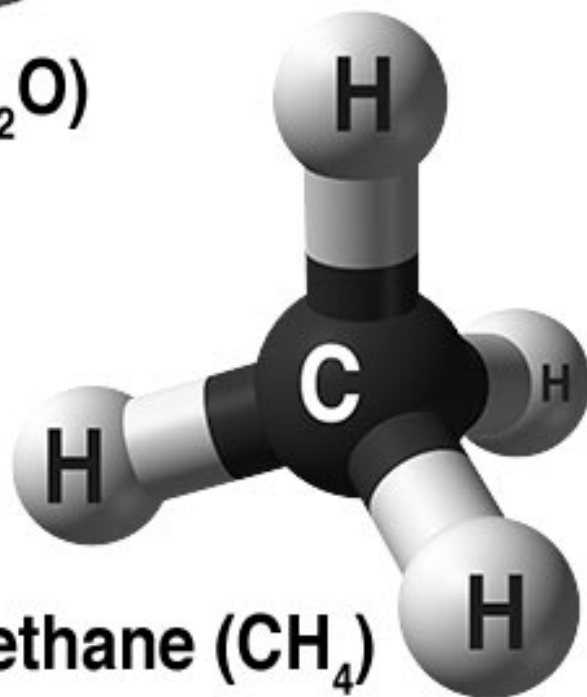


Water vapor (H_2O)

Nitrous oxide (N_2O)



Carbon dioxide (CO_2)

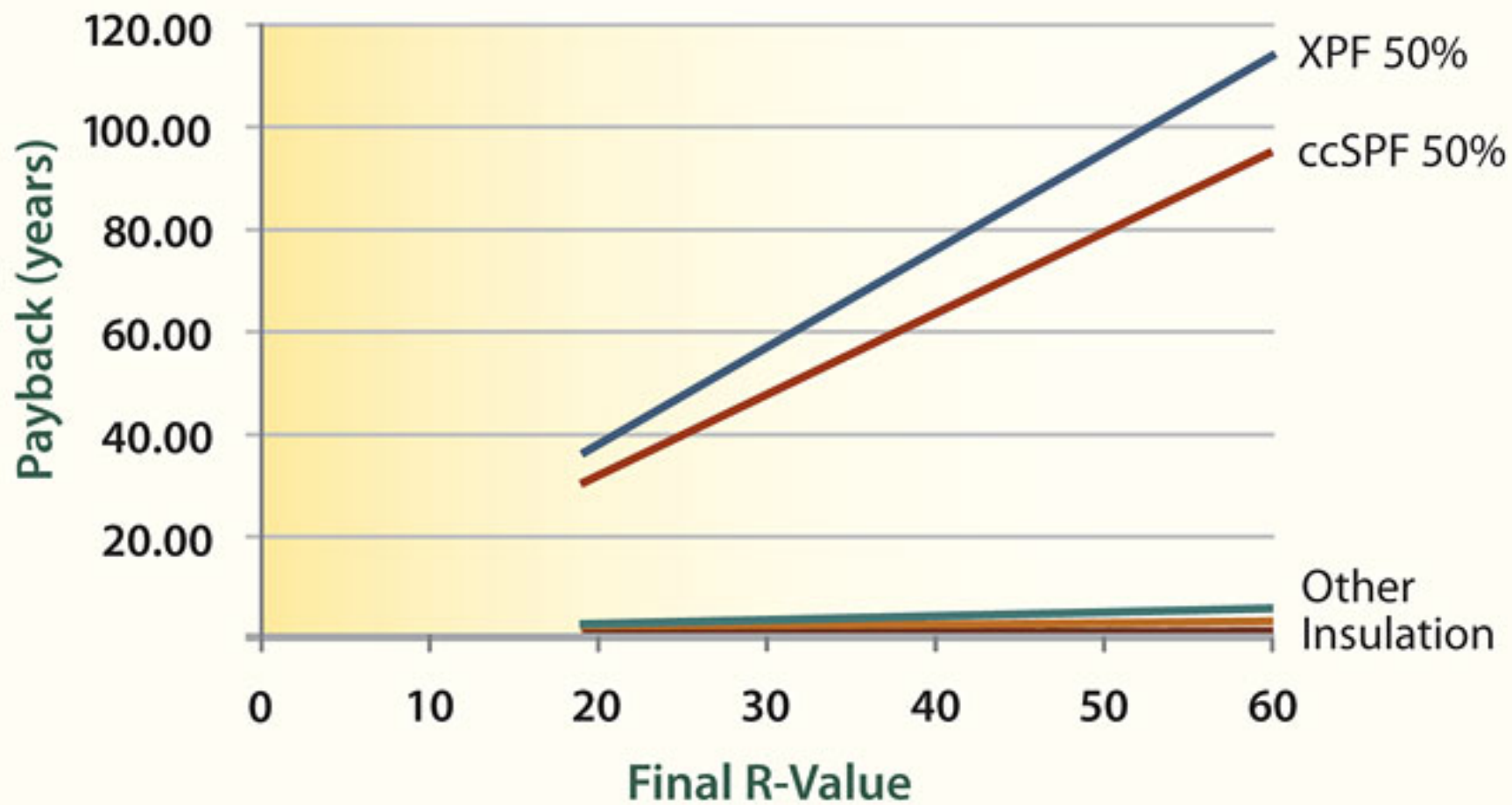


Methane (CH_4)

Global Warming Potential (GWP)

HFC-134a → GWP = 1,430

HFC-245fa → GWP = 1,030



***"Assumptions are key
in this analysis."***

Assumption #1

Manufacturers use
HFC-245fa for ccSPF
and
HFC-134a for XPS

Assumption #2

Payback is calculated for additional insulation after 2x6 wall is insulated with cellulose.

Assumption #3

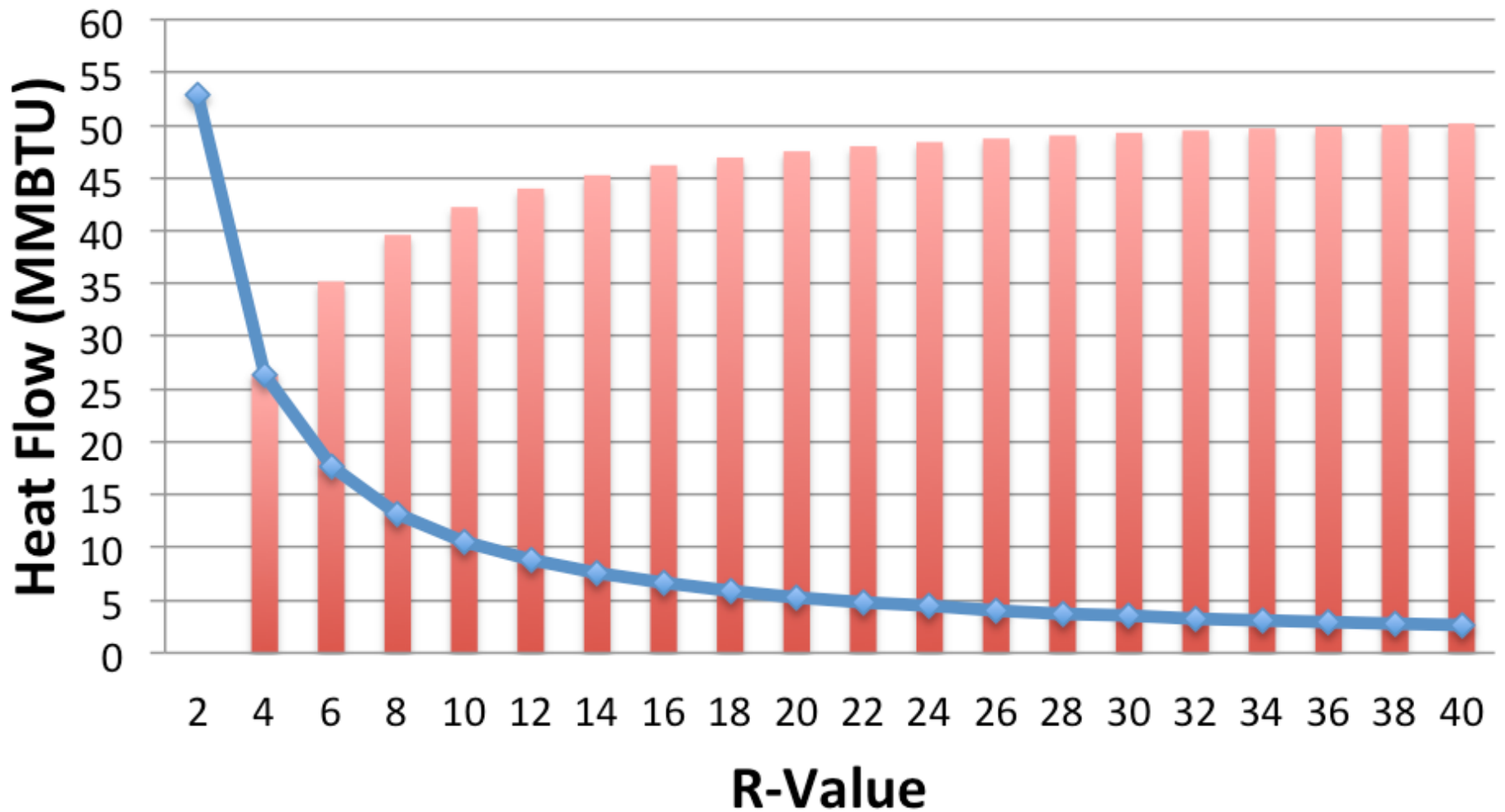
House is heated with
90 AFUE gas furnace.

**The Main Problem
with Wilson's
Payback Calculations**

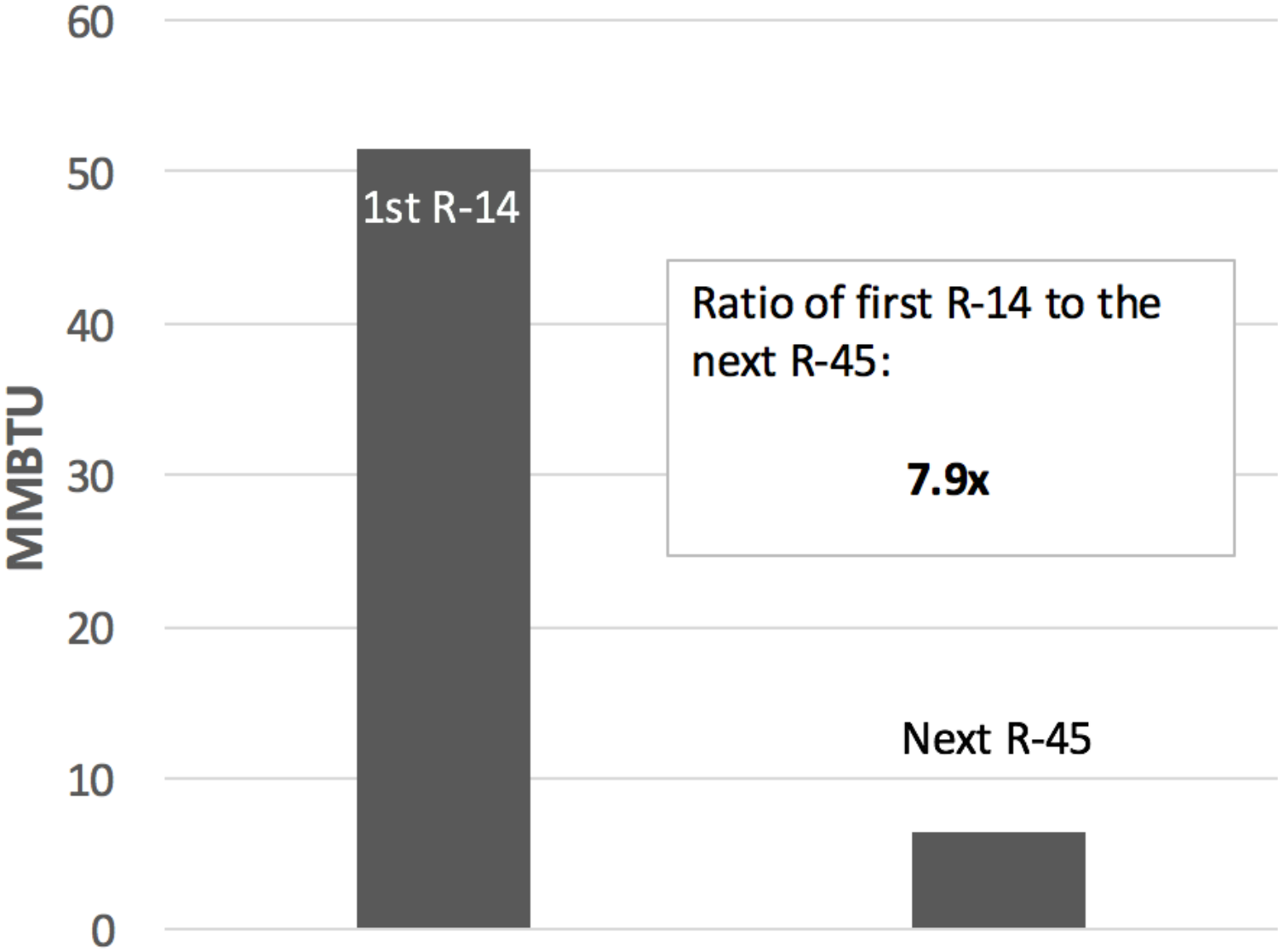
The Diminishing Returns of More Insulation

4400 HDD, 1000 sf wall area

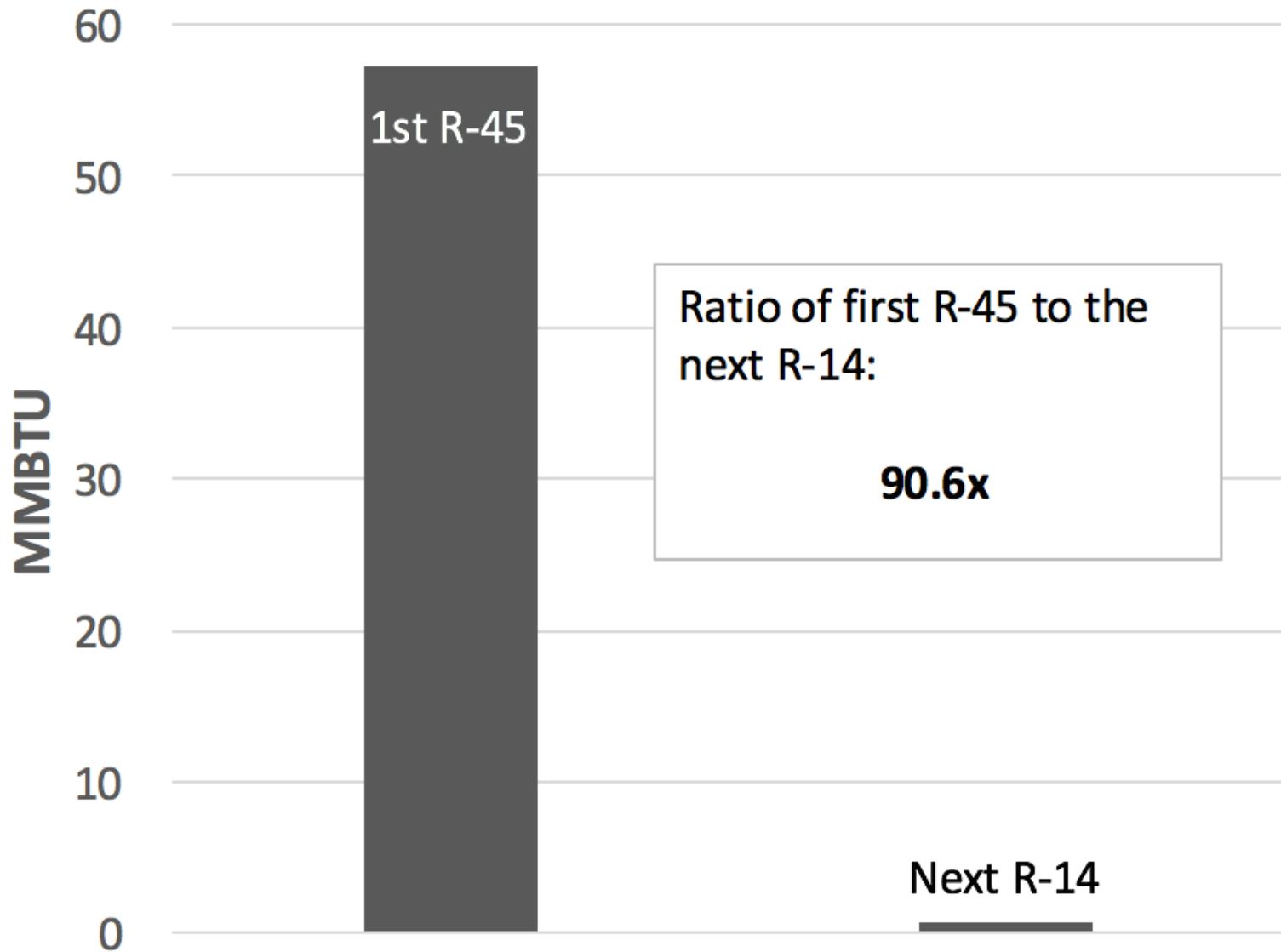
Reduction (compared to R-2) Heat Flow



Energy Savings by Insulation Cavity First



Energy Savings by Insulation Exterior First



$$\textit{Payback} = \frac{\textit{Cost}}{\textit{Savings/yr}}$$

- Cost = Embodied GW impact + blowing agent GW impact
- Savings = Reduction of GW impact because of energy savings
- Savings depends on how carbon intensive the energy source is

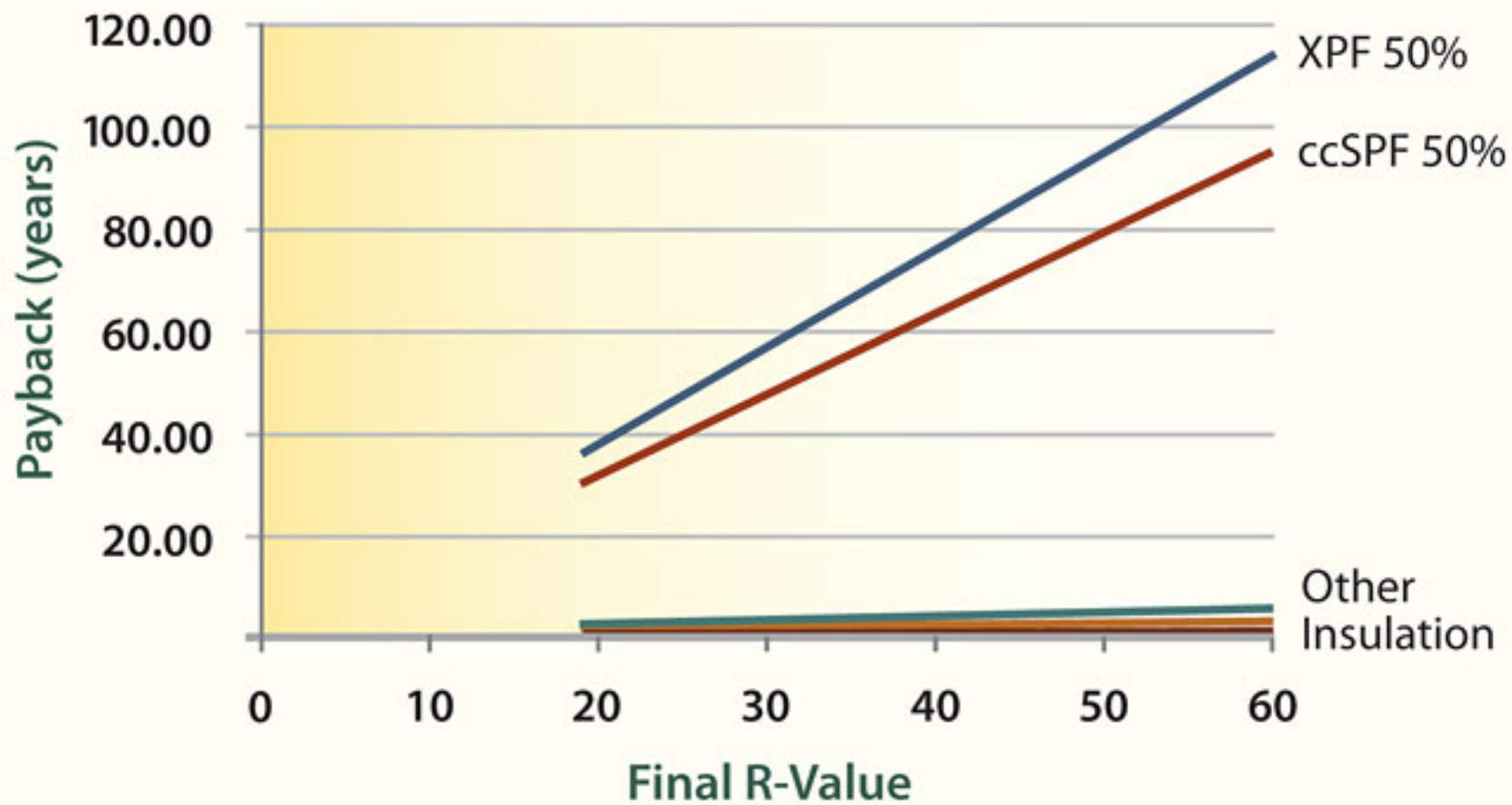
Energy Savings Ratio

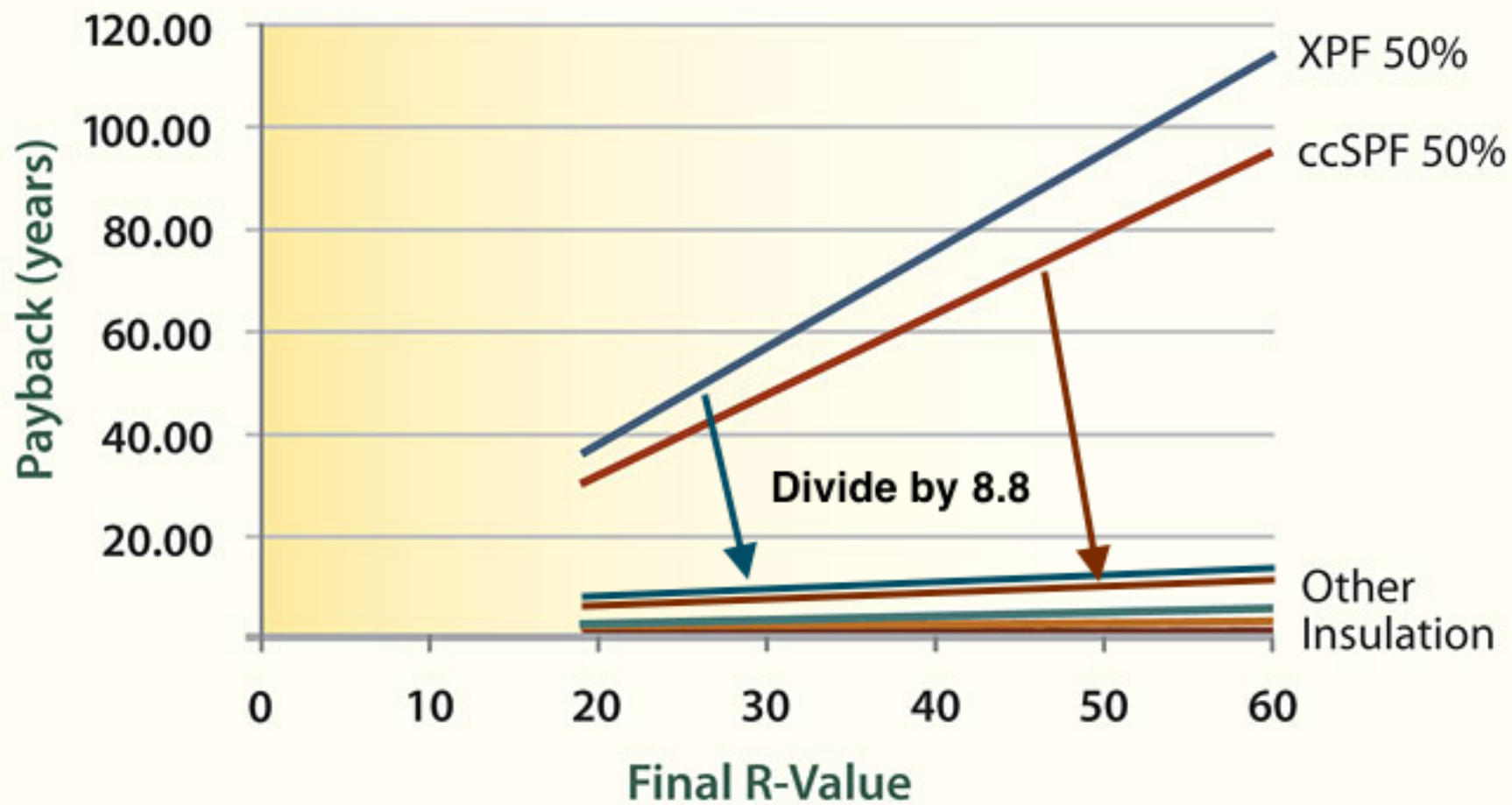
- Case 1: 6.54 MMBTU/1,000 sf/year
- Case 2: 57.3 MMBTU/1,000 sf/year

$$\frac{57.3}{6.54} = 8.8$$

→ 8.8x more energy savings

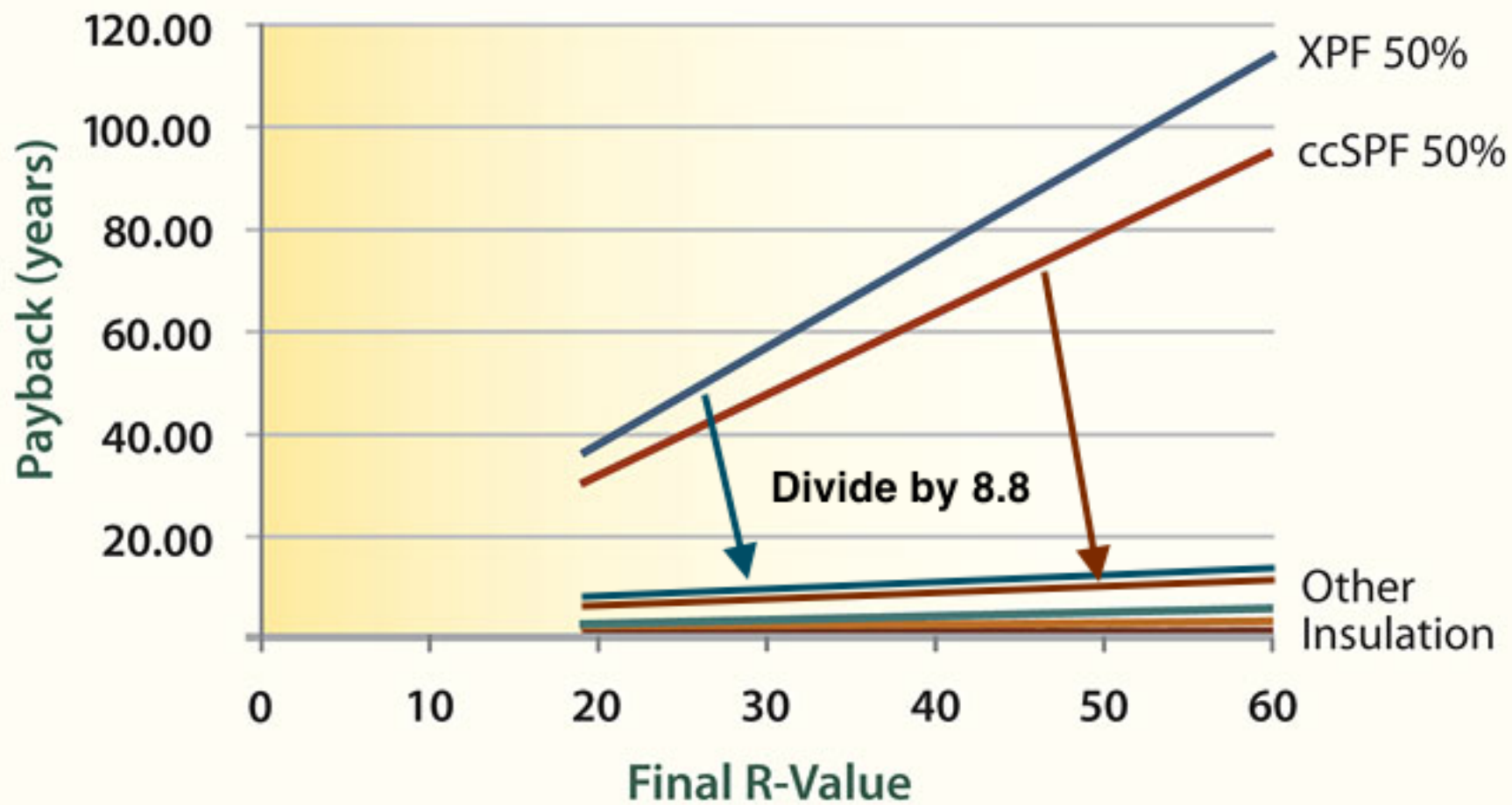
→ Payback = 8.8x smaller





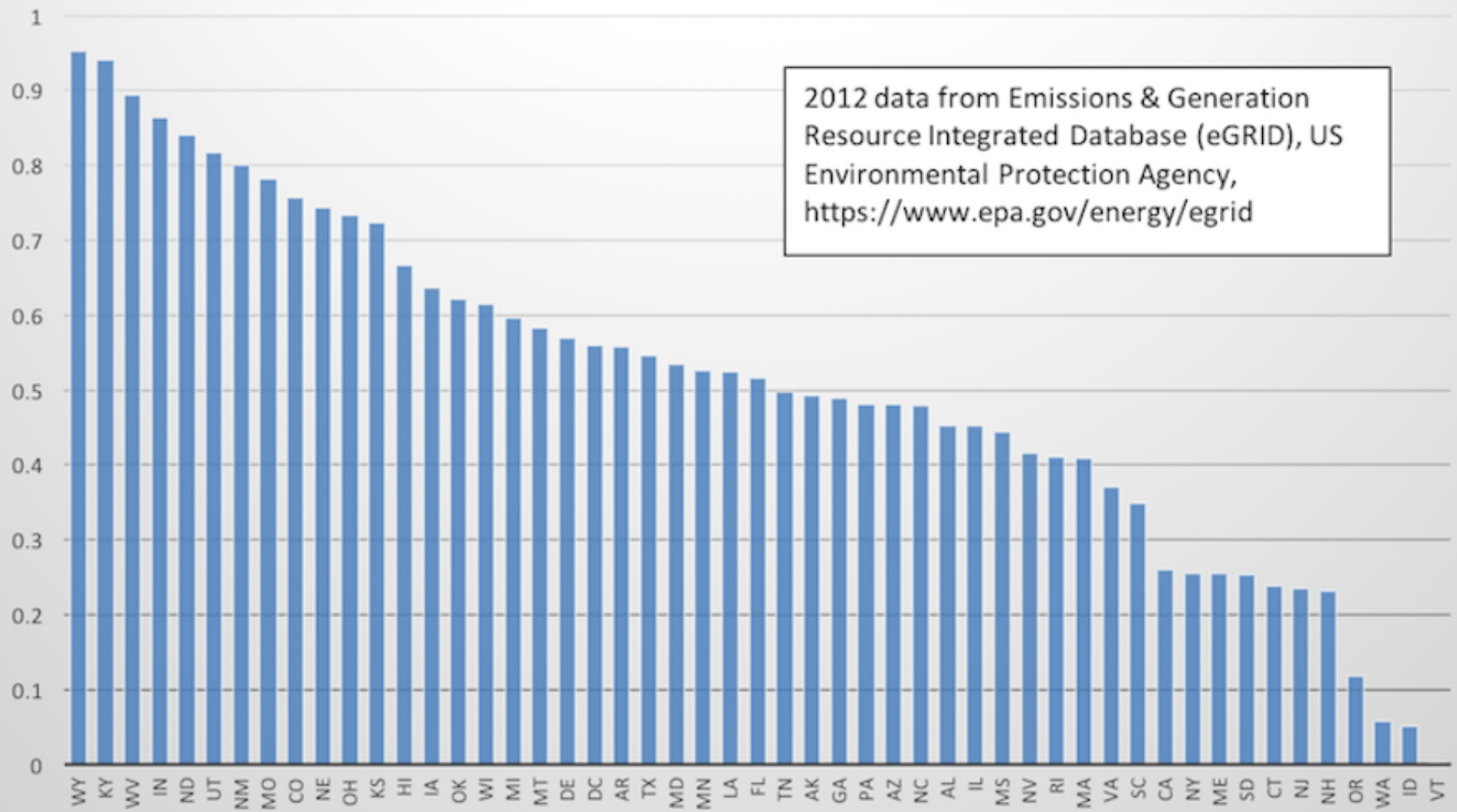
PHIUS+ 2015 R-Values

Example	Cities	Zone	Wall		Wall
Miami	Honolulu	1	19	-	27
Jacksonville	Phoenix	2	19	-	27
Charleston	Sacramento	3	15	-	31
San Francisco		Marine 3	19	-	23
Baltimore	Amarillo	4	31	-	51
Salem	Seattle	Marine 4	31	-	43
Providence	Flagstaff	5	31	-	43
Burlington	Billings	6	39	-	51
Duluth	Edmonton	7	49	-	65
Fairbanks		8	89		



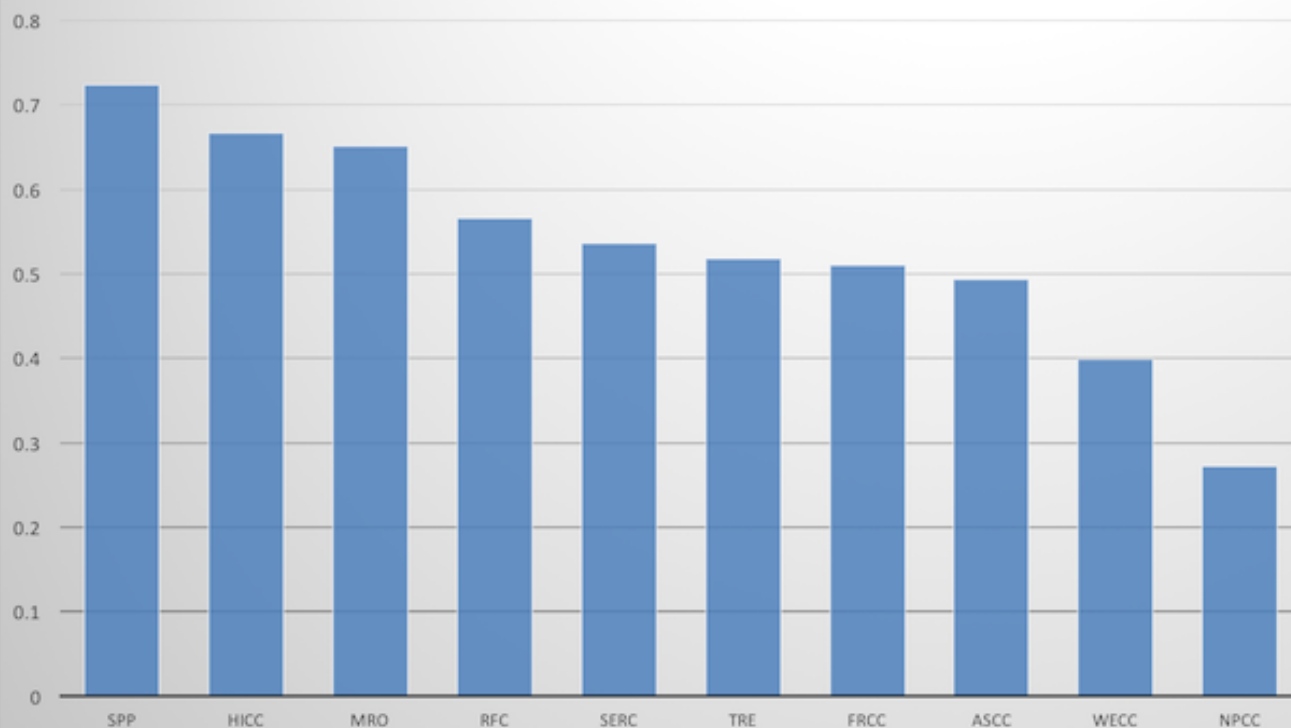
Carbon Intensity of Electricity by US State

in kg CO₂ / kWh produced



Carbon Intensity of Electricity by Region

in kg CO₂ / kWh produced

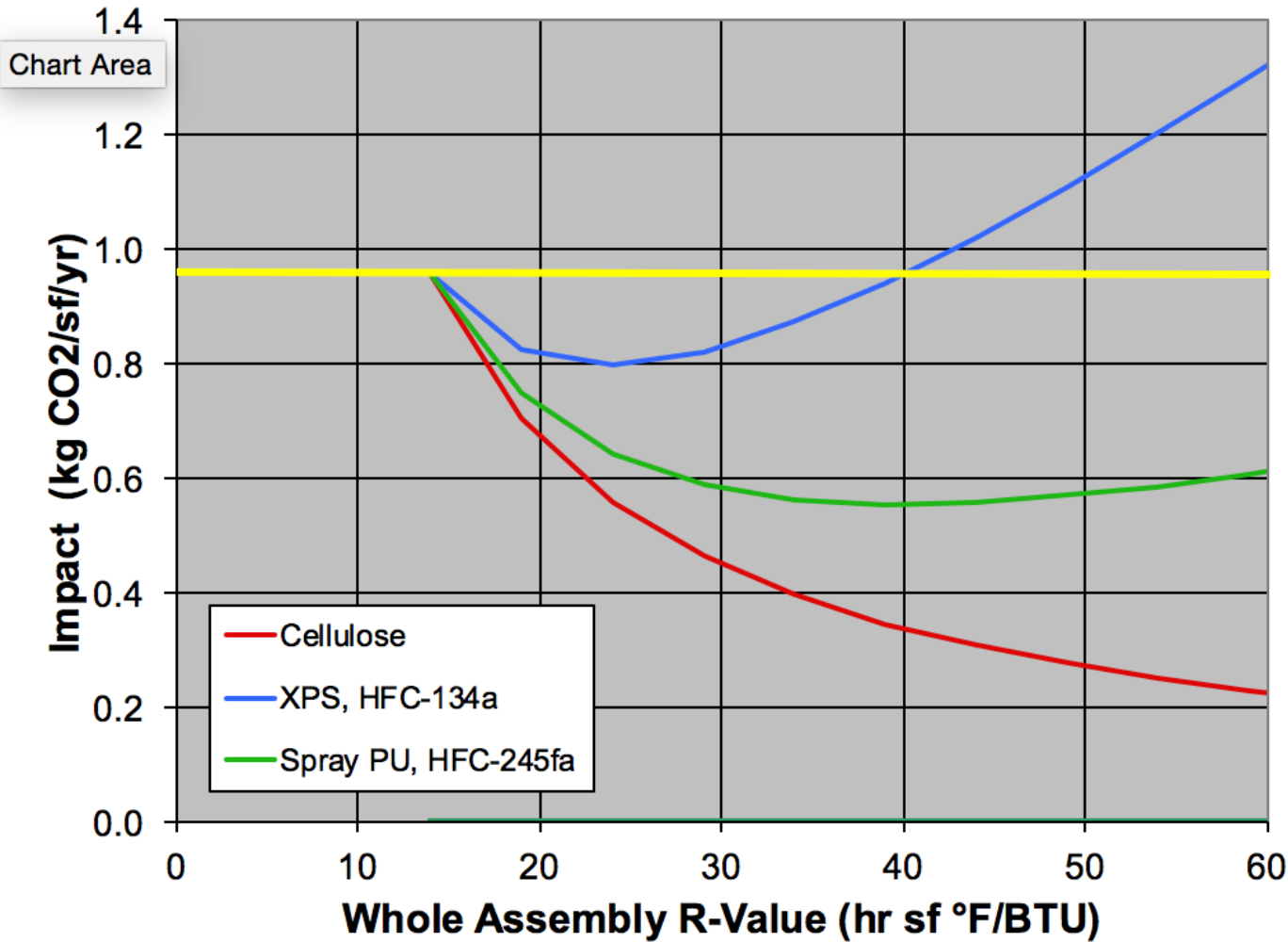


Regional Interconnect Names

SPP	Southwest Power Pool
HICC	Hawaiian Islands Coordinating Council
MRO	Midwest Reliability Organization
RFC	Reliability First Corporation
SERC	SERC Reliability Corporation
TRE	Texas Regional Entity
FRCC	Florida Reliability Coordinating Council
ASCC	Alaska Systems Coordinating Council
WECC	Western Electricity Coordinating Council
NPCC	Northeast Power Coordinating Council

2012 data from Emissions & Generation Resource Integrated Database (eGRID), US Environmental Protection Agency, <https://www.epa.gov/energy/egrid>

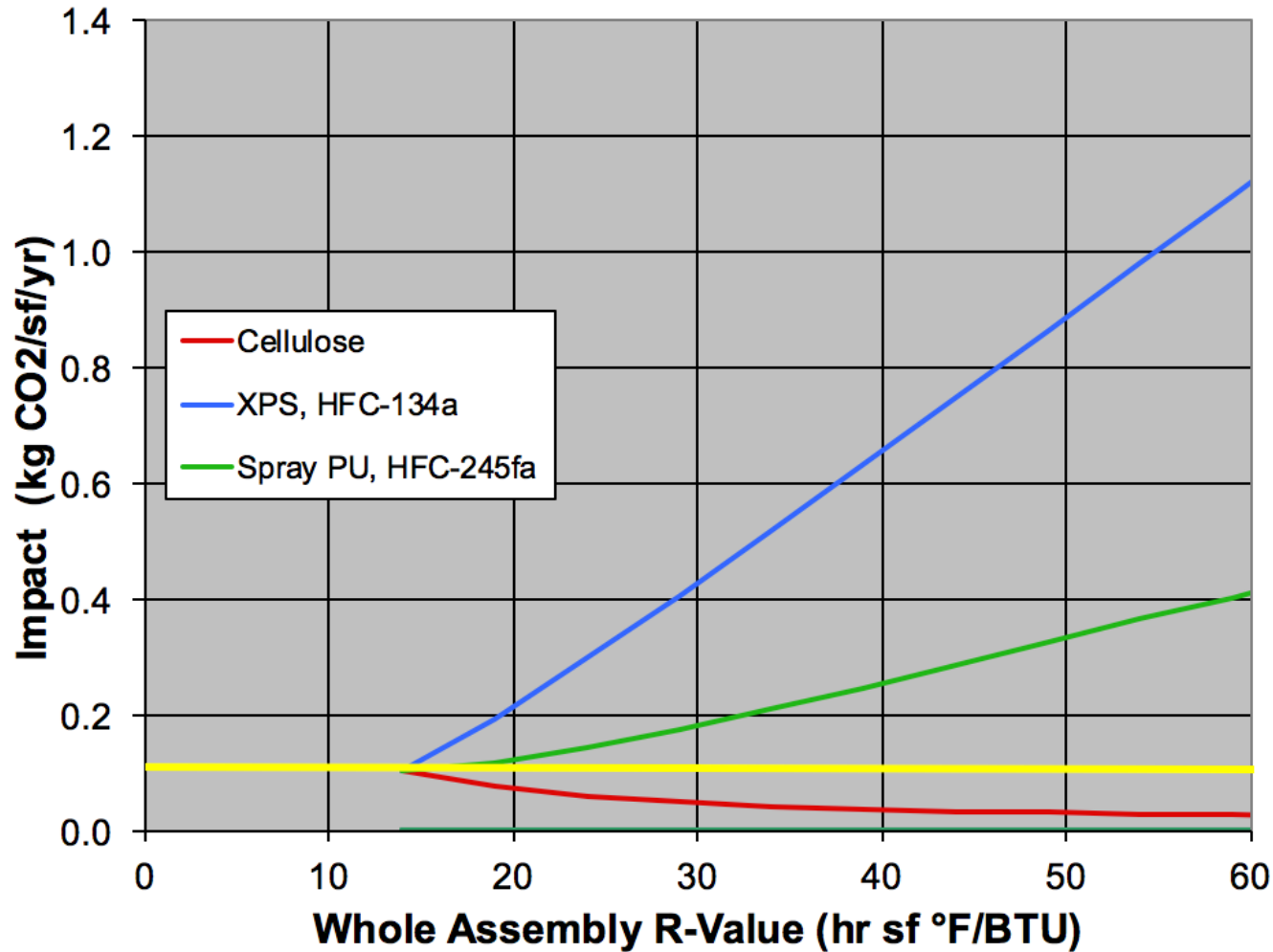
Global Warming Impact Energy Use + Embodied GWP



Heating: Electricity
HP COP: 2.5
Furnace AFUE: NA
Carbon: 0.95 kg CO₂/kWh
Ref R-value: 14
Climate: 5,000 HDD
BA Release: High
Lifespan: 50 yrs

Insulation GWP Tool v1-2
by David White

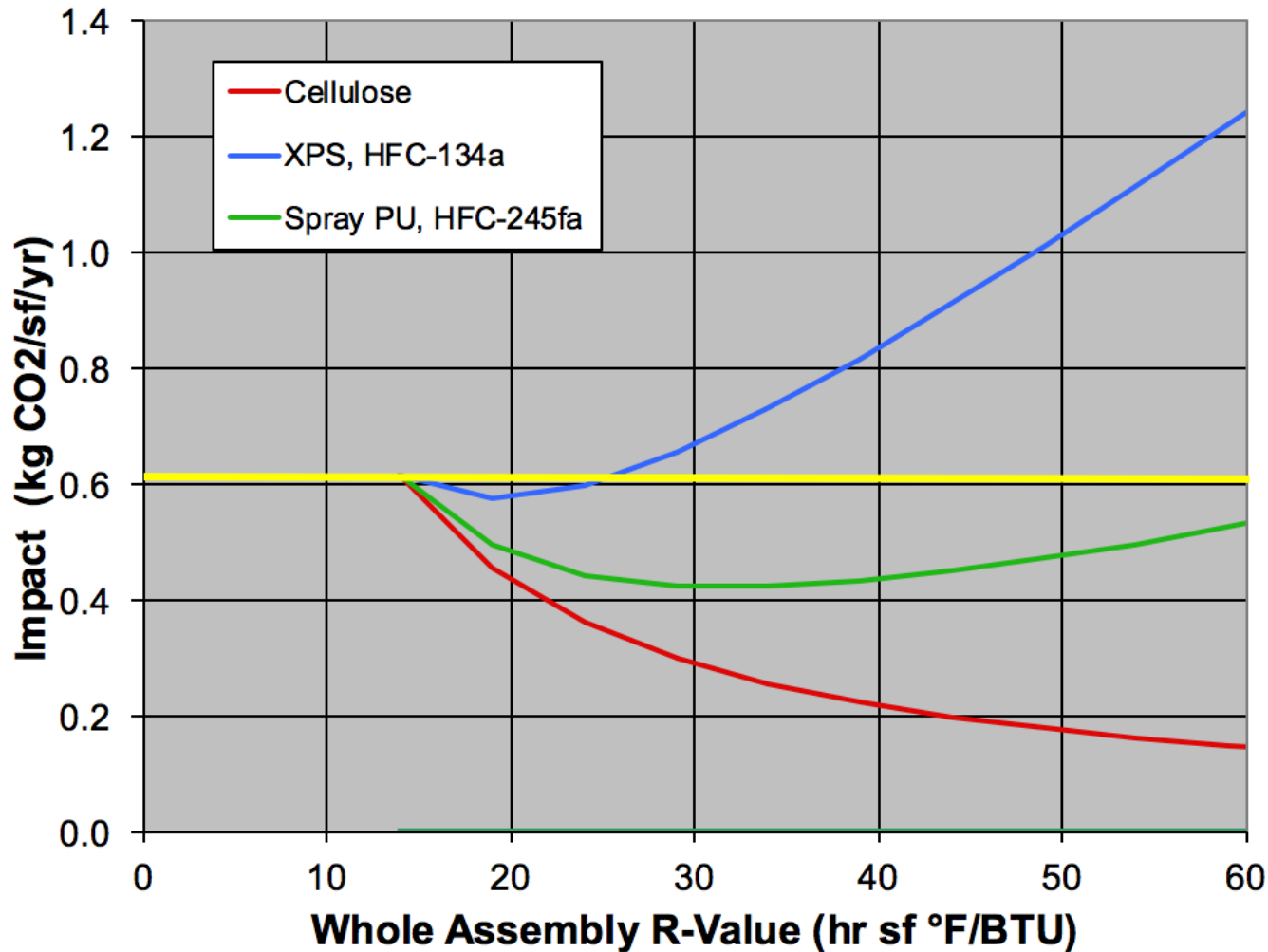
Global Warming Impact Energy Use + Embodied GWP



Heating: Electricity
HP COP: 2.5
Furnace AFUE: NA
Carbon: 0.10 kg CO₂/kWh
Ref R-value: 14
Climate: 5,000 HDD
BA Release: High
Lifespan: 50 yrs

Insulation GWP Tool v1-2
by David White

Global Warming Impact Energy Use + Embodied GWP



Heating: Natural Gas
HP COP: NA
Furnace AFUE: 95
Carbon: 0.232 kg CO₂/kWh
Ref R-value: 14
Climate: 5,000 HDD
BA Release: High
Lifespan: 50 yrs

Insulation GWP Tool v1-2
by David White

Closed Cell SPF

- ccSPF can have much lower GW impact
- Blowing agents: water or next generation



XPS

- XPS still uses 134a (probably)
- No reason to use it because there are good substitutes



Takeaways

- GW impact isn't as simple as it seemed
- Blanket condemnation of XPS & ccSPF based on payback not warranted
- Avoid XPS
- Use ccSPF with other blowing agents
- Use David White's calculator for more refined guidance

Contact Info

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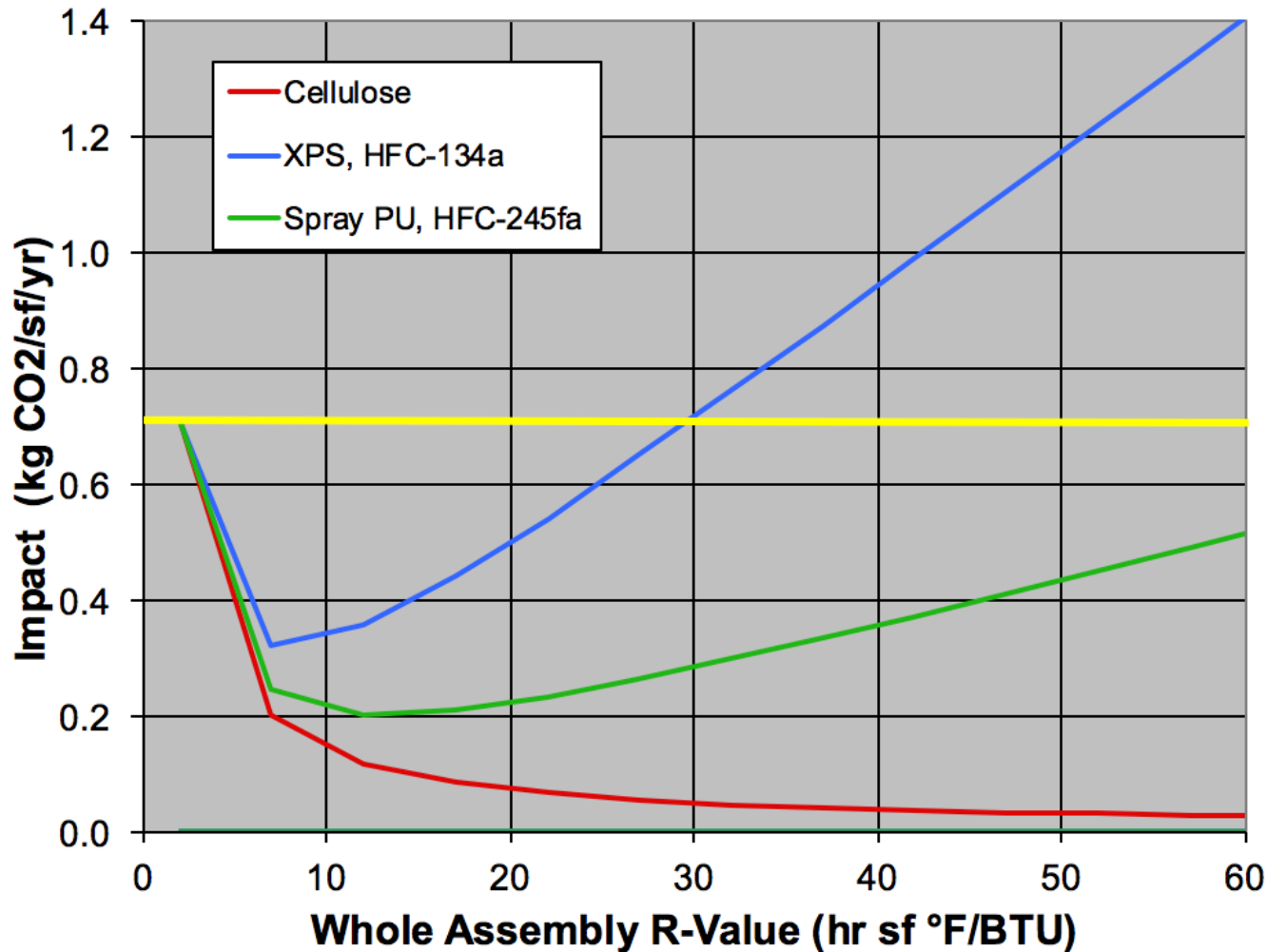


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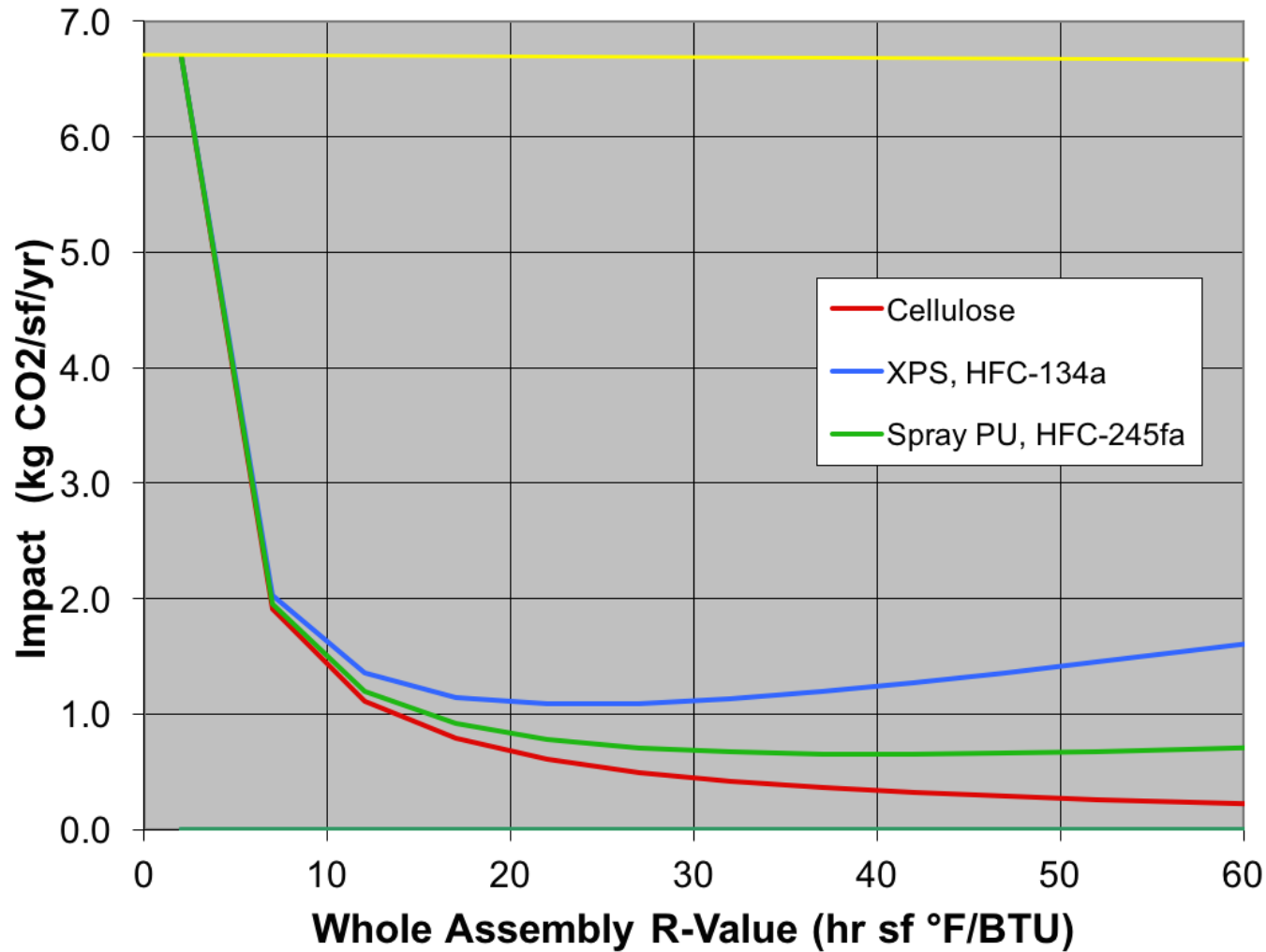
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