Determined A Reference Price by CO_2 Abatement Cost for Window Films

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SO MANY PRODUCTS!

HOW WOULD YOU MAKE A CHOICE?

* All Trademarks search from Google

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Prices from Google

	Transmittance	IR Rejection	UV Rejection	Heat flow rate	Shading Coeff.	Total solar Energy Rejection	PRICE
	T_{vis}	R_{IR}	R_{Uv}	U-factor	SC	TSER	USD/m^2
Sun mark SH-70	72%	91%	99%	1.03	0.59	49%	126
V-KOOL 70	73%	94%	99%	0.94	0.5	55%	180
3M PR70	69%	97%	99.9%	0.99	58	50%	162
3M PRX90	88%	99%	99.9%	1.02	0.74	36%	180
3M P18ARL	19%	99%	99%	0.93	0.23	77%	58
3M 35AMRL	37%	99%	99%	1.02	0.36	74%	126

From Google

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IRREGULATED

From Google

CO_2 ABATEMENT COST

Abatement cost is defined by :

$$AC_t = \frac{C_{DEV} - C_{BAU}}{E_{BAU} - E_{DEV}} = \frac{\Delta C_t}{\Delta Et}$$

Notation	Definition	Unit
AC_t	Abatement cost of glazing system pasted window film	USD/Ton
C_{BAU}	Expenditure of electricity, not pasted window film	USD/y
C_{DEV}	Expenditure of electricity, pasted window film	USD/y
ΔC_t	Electricity billing difference between pasted and not pasted window film	USD/y
E_{BAU}	Amount of CO_2 emission, not pasted window film	Ton/y
E_{DEV}	Amount of CO_2 emission, pasted window film	Ton/y
ΔE_t	Emission difference between not pasted and pasted window film	Ton/y

	Orientation	W	S	E	N
Case1	Eff.	11%	11%	10%	7%
	abatement cost	-25.3	-26.3	-24.0	-15.2
Case2	Eff.	13.3%	13.8%	12.9%	9.3%
	abatement cost	-31.9	-33.1	-30.3	-19.4
Case3	Eff.	4%	4%	3%	3%
	abatement cost	-7.5	-7.6	-7.1	-4.7
Case4	Eff.	6%	6%	6%	3%
	abatement cost	-13.7	-14.2	-13.0	-8.2
Case5	Eff.	6%	6%	6%	3%
	abatement cost	-14.7	-15.0	-13.7	-8.7

case1	1 2 mm clear glazing with SF-1 attached
case2	12 mm clear glazing with SF-2 attached
case3	12 mm grey tinted glazing with SF-1 attached
case4	12 mm laminated glazing with SF-3 attached
case5	6 mm double clear glazing with SF-1 attached

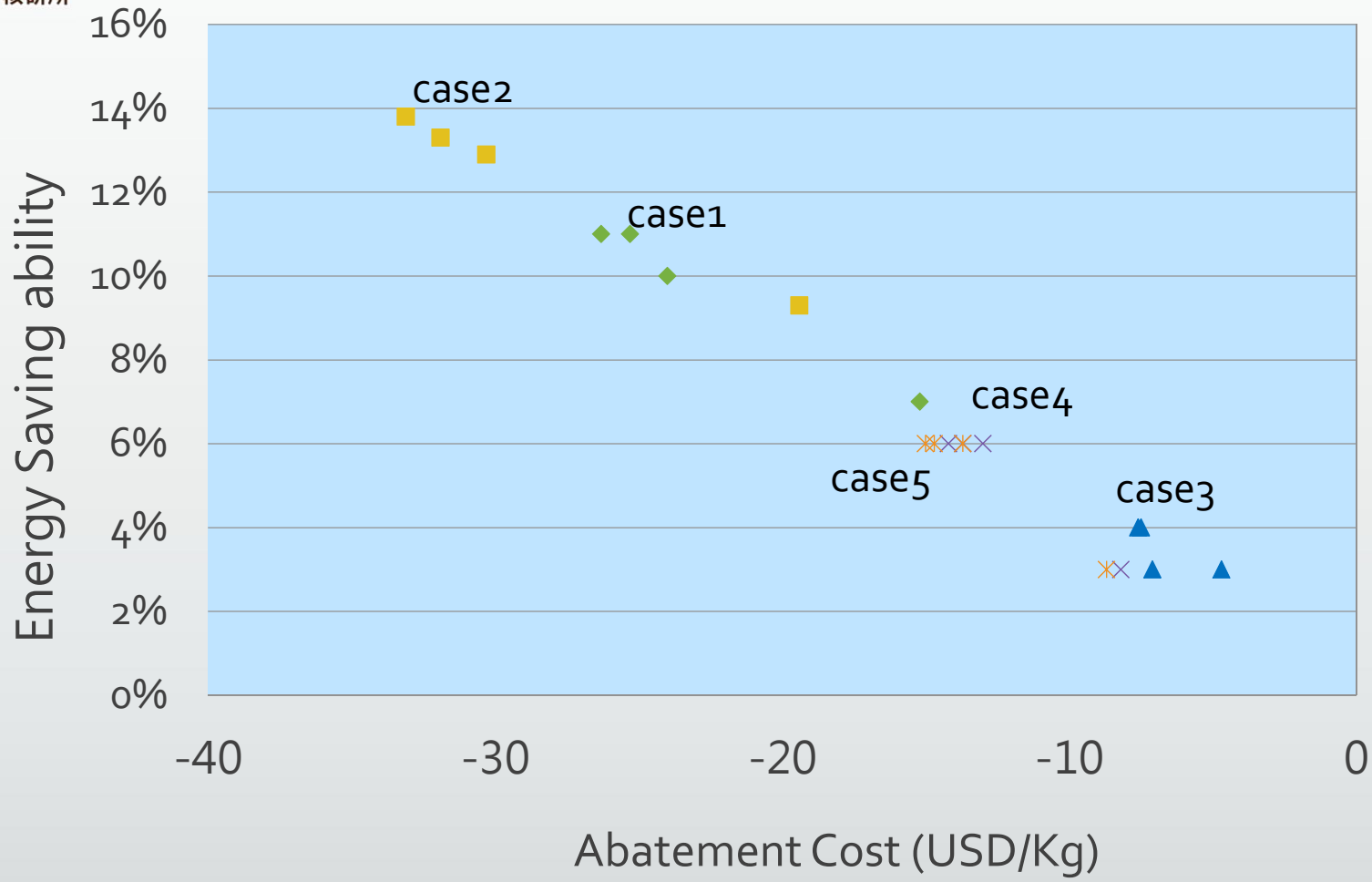
Unit of abatement cost is USD/Kg

The electricity rate is set 0.08965USD/KWh
The coefficient of electricity emission takes 1.03Kg/KWh

Blue : Calculated by CEESR

Black : Data Adapted from: Chunying Li et.al. Energy and Buildings, 102(2015) 129-138

Energy saving ability with the abatement cost



Different status, but have a same trend :

"the higher the energy-saving ability the lower the abatement cost or even get a more negative value"

case1	1 2 mm clear glazing with SF-1 attached
case2	12 mm clear glazing with SF-2 attached
case3	12 mm grey tinted glazing with SF-1 attached
case4	12 mm laminated glazing with SF-3 attached
case5	6 mm double clear glazing with SF-1 attached

Plotted by CEESR

How to link the PRICE

with the ENERGY SAVING ABILITY

Energy-Saving Ability

Defined the energy-saving ability η as the following

$$\eta = \frac{consumption_{BAU} - consumption_{DEV}}{consumption_{BAU}}$$

BAU means the glazing not pasted window film
DEV means the glazing pasted window film

BALANCE

THE INVESTED AND THE SAVED MONEY

The saved money should equal to the invested money during the life-time of a window film.

$$C_{invest} = C_{saved}$$

Therefore, the abatement cost should be zero.

DETERMINE THE PRICE

$$C_{invest} = \frac{Area \times Price\ per\ area}{Life\ time}$$

$$C_{saved} = Annual\ Electricity\ consumption \times Electricity\ Rates \times Energy\text{-}saving\ ability$$

$$Price = \frac{C_{saved} \times life\ time}{Area}$$

Set electricity rates charged 0.08965 USD/KWh and Life time was 10 years

RESULTS

Orientation	W	S	E	N
1 2 mm clear glazing with SF-1 attached				
Derived price (USD/m²)	39.12	40.75	37.19	23.58
EFF	11%	11%	10%	7%
12 mm clear glazing with SF-2 attached				
Derived price (USD/m²)	49.42	51.27	46.91	29.97
EFF	13%	14%	13%	9%
12 mm grey tinted glazing with SF-1 attached				
Derived price (USD/m²)	11.65	11.76	10.94	7.34
EFF	4%	4%	3%	3%
12 mm laminated glazing with SF-3 attached				
Derived price (USD/m²)	21.21	22.06	20.15	12.78
EFF	6%	6%	6%	3%
6 mm double clear glazing with SF-1 attached				
Derived price (USD/m²)	22.73	23.29	21.29	13.43
EFF	6%	7%	6%	4%

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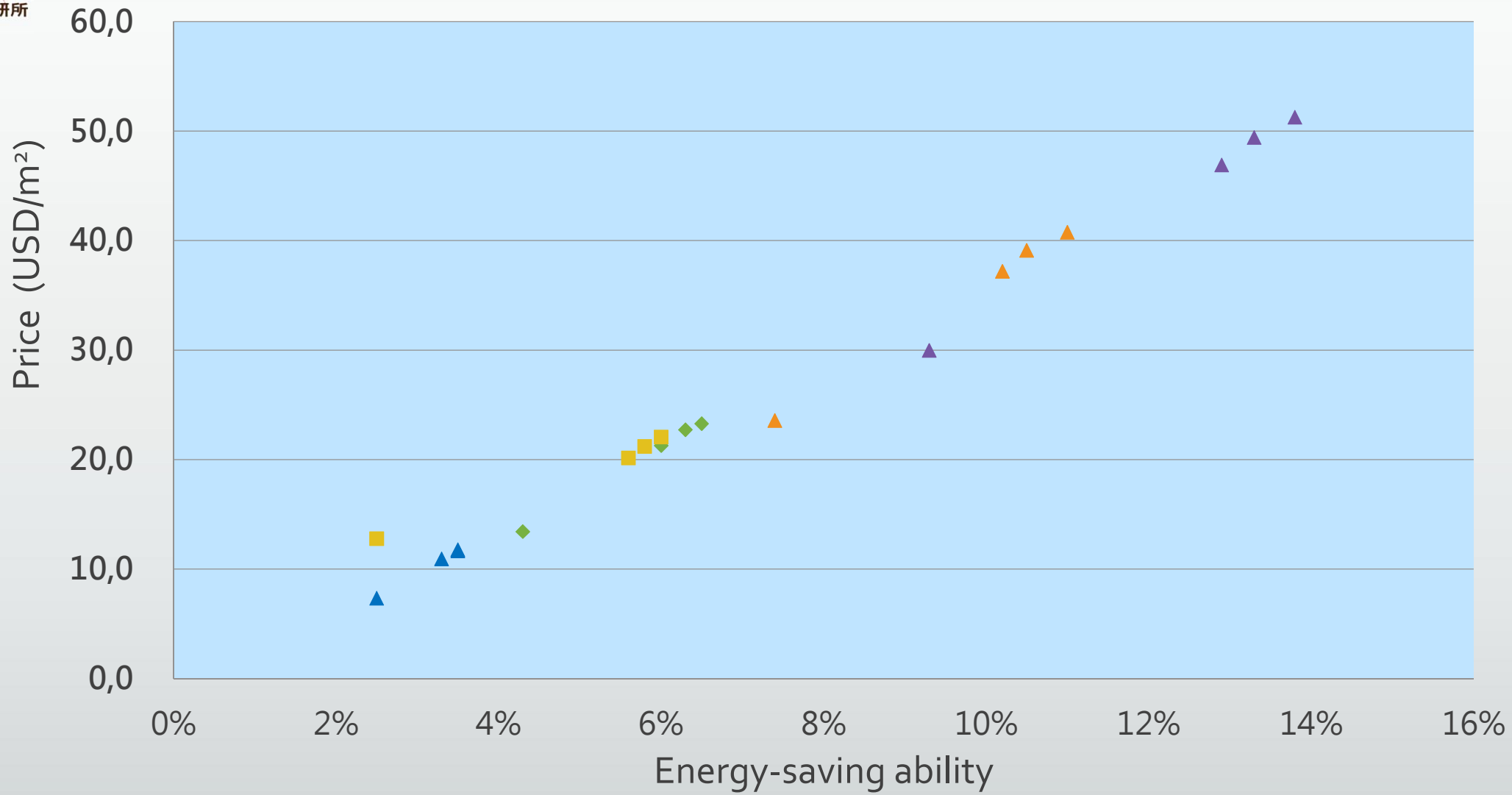
Black : Data Adapted from: Chunying Li et.al. Energy and Buildings, 102(2015) 129-138

Derived price with the energy-saving ability



Plotted by CEESR

Compared the result with IWFA's and U.S.DOE's

- IWFA 4-9USD/ft^2 (about 40-90USD/m^2)
- U.S.DOE 2-8USD/ft^2 (about 20-80USD/m^2)

Our estimated results are 7-51 USD/m^2

Energy Analysis for Window Films Applications in New and Existing Homes and Offices, IWFA February 7, 2012
Karma Sawyer, Windows and building envelope research and development roadmap for emerging technologies, US.DOE, 2014

GSA Protection Standards

Performance Criteria	Protection Level	Hazard Level	Description of Window Glazing Response
1	Safe	None	Glazing does not break. No visible damage to glazing or frame.
2	Very High	None	Glazing cracks but is retained by the frame. Dusting or very small fragments near sill or on floor acceptable.
3a	High	Very Low	Glazing cracks. Fragments enter space and land on floor no further than 3.3 ft. from the window.
3b	High	Low	Glazing cracks. Fragments enter space and land on floor no further than 10 ft. from the window.
4	Medium	Medium	Glazing cracks. Fragments enter space and land on floor and impact a vertical witness panel at a distance of no more than 10 ft. from the window at a height no greater than 2 ft. above the floor.
5	Low	High	Glazing cracks and window system fails catastrophically. Fragments enter space impacting a vertical witness panel at a distance of no more than 10 ft. from the window at a height greater than 2 ft. above the floor.

Adapted from: http://www.emswindowfilm.com/scotchshield_blast.htm

CONCLUSION

- Administration should work out a Performance Criteria or Standard of window film.
- Based on the energy-saving ability of a window film to determine its price is available.
- The plot of CO_2 abatement cost refers to inversely proportional to the energy-saving, however, the derived price is proportional to the energy-saving ability.
- By this method, the result is also consisted with the IWFA's and USDOE's reports.

Thank You
for Your Attention