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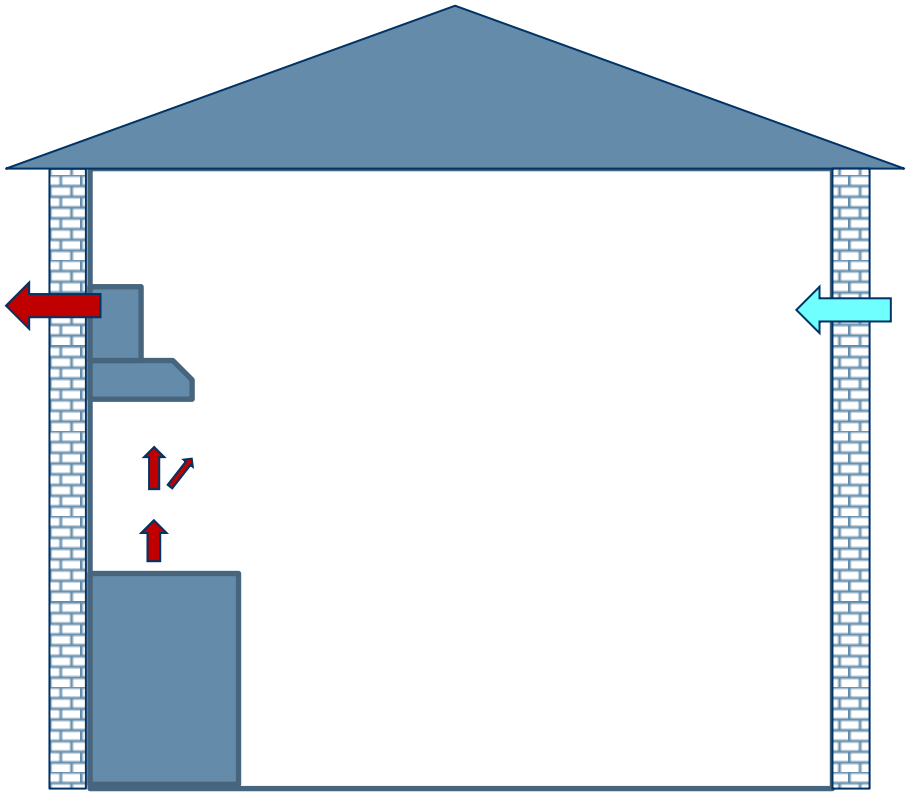
U.S. DEPARTMENT OF ENERGY

Performance of recirculating range hoods

Gabriel Rojas
Lawrence Berkeley National Lab / University of Innsbruck

NAPHN Conference - Oct. 6th 2017

Arguments for not installing extracting RH in energy efficient housing



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- Ventilation losses
- Make up air
  - disturbs MVHR
  - thermal comfort
- Air openings
  - infiltration
  - thermal bridge

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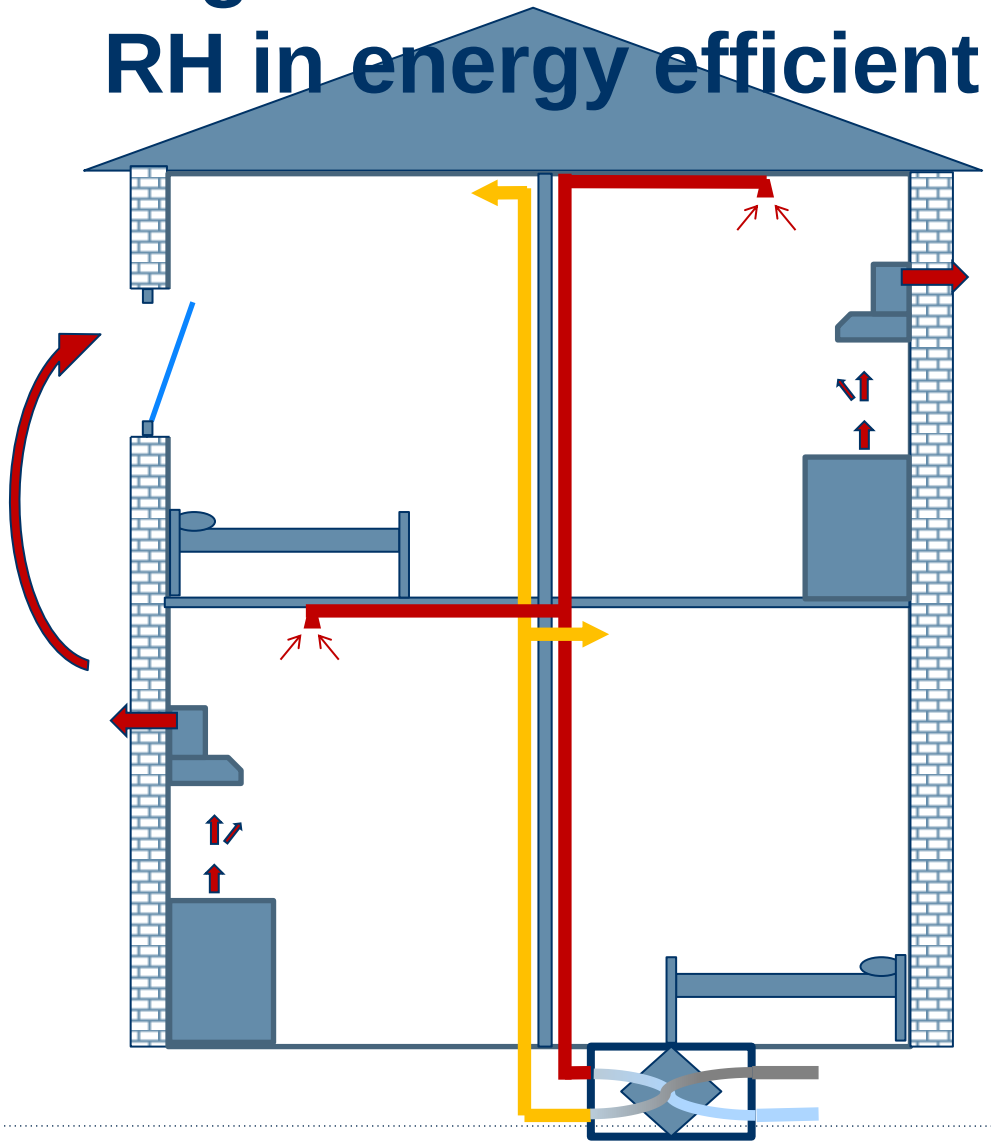

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Installation in MFH
- odor transfer
- duct routing

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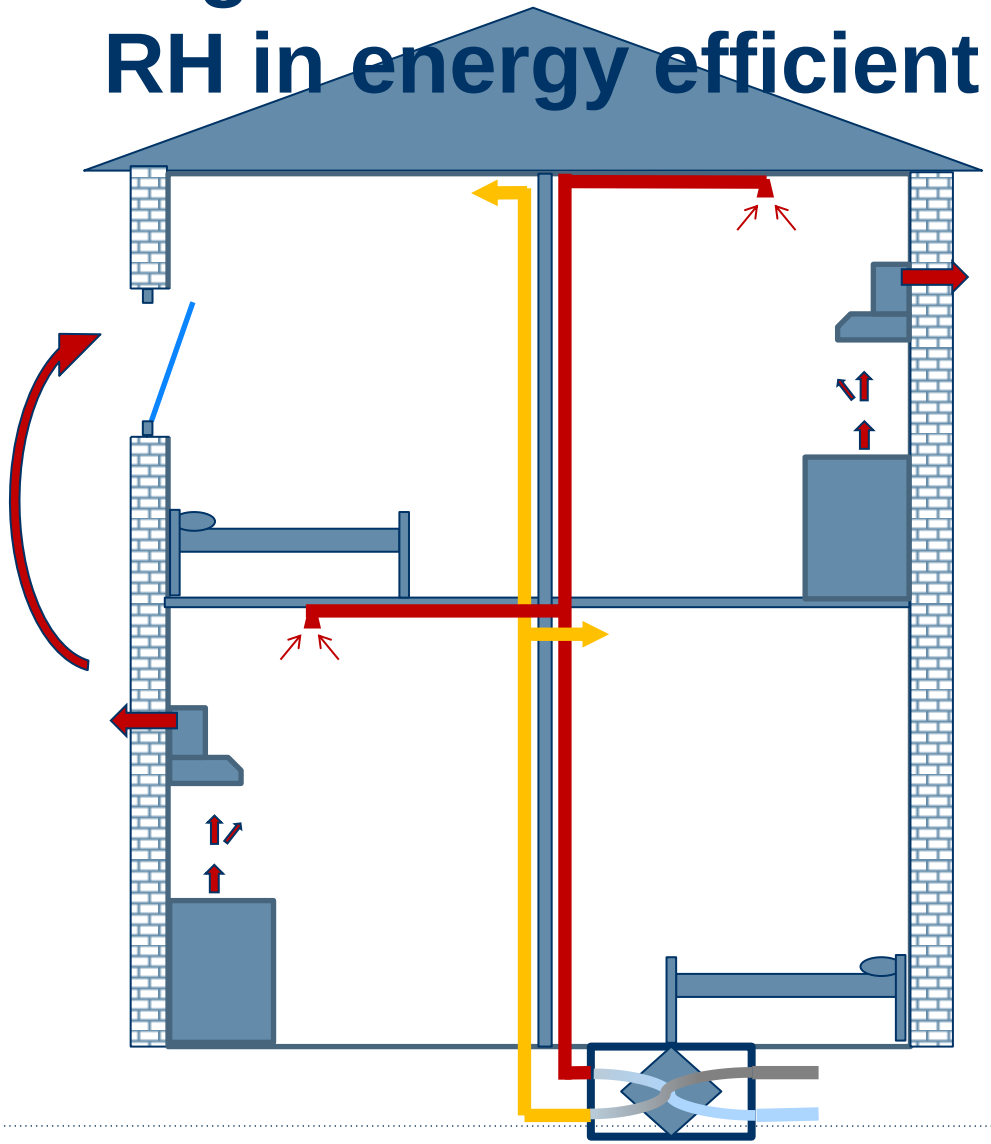

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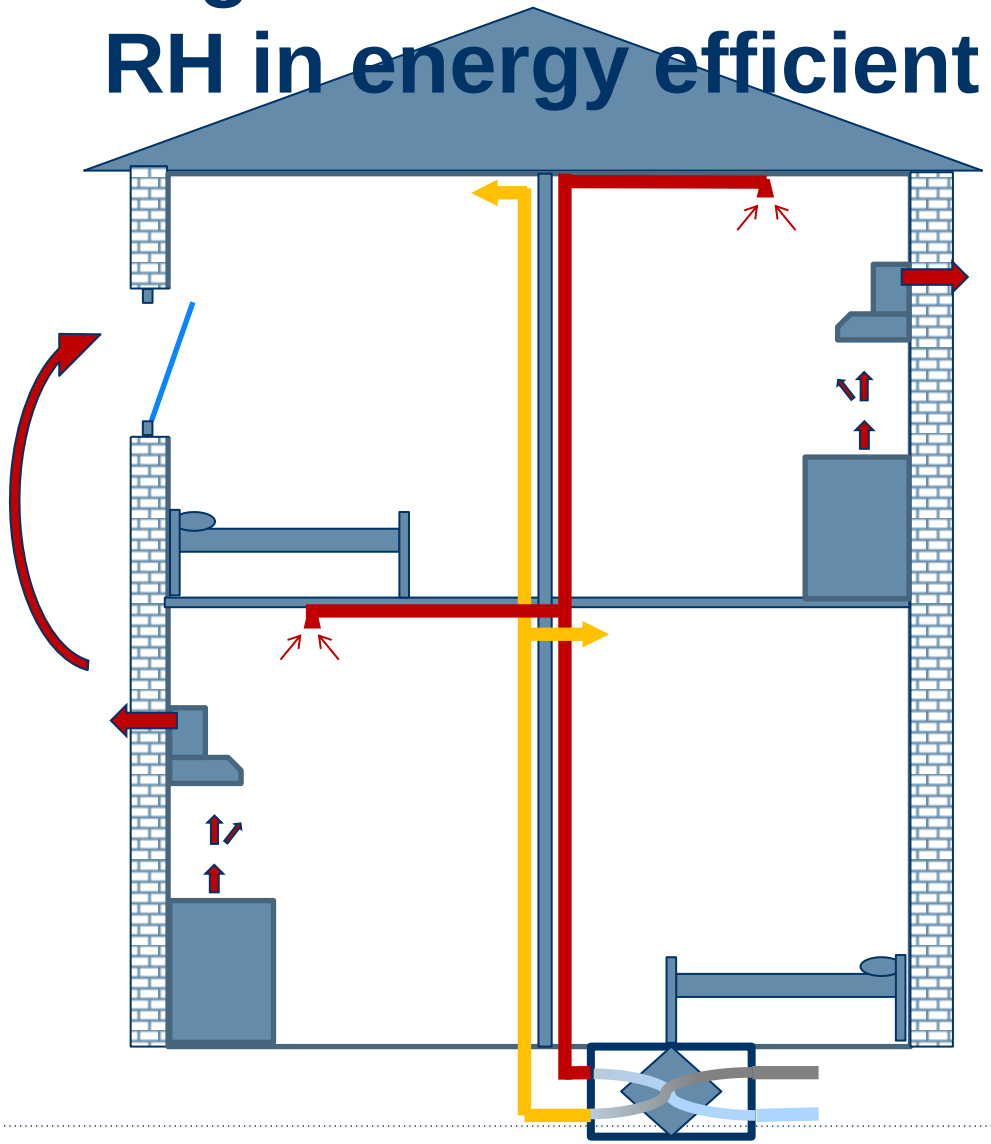

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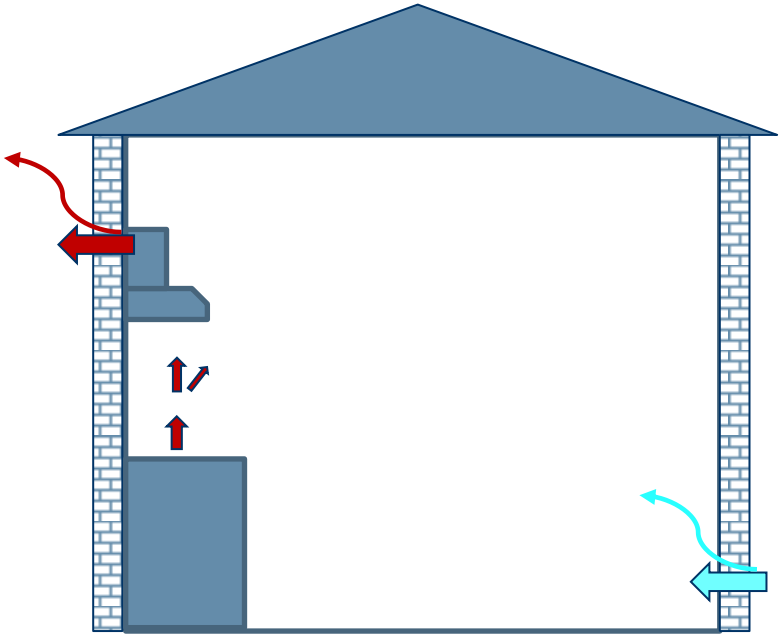
Energy

Energetic comparison - Method

Extracting RH



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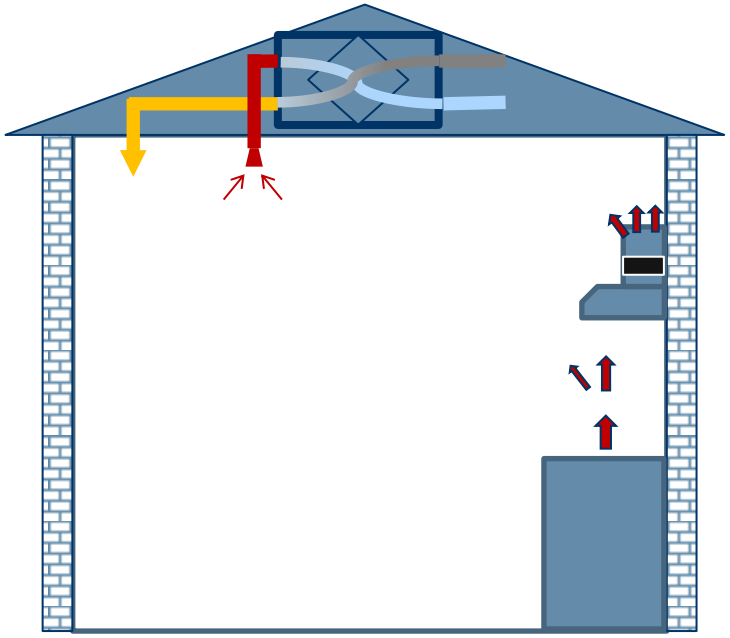

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A, B: Stack and wind coefficient
see ASHRAE. (1993). Calculating Air Exchange. In ASHRAE Fundamentals (1993, SI E ed., p. 23.18-23.19).

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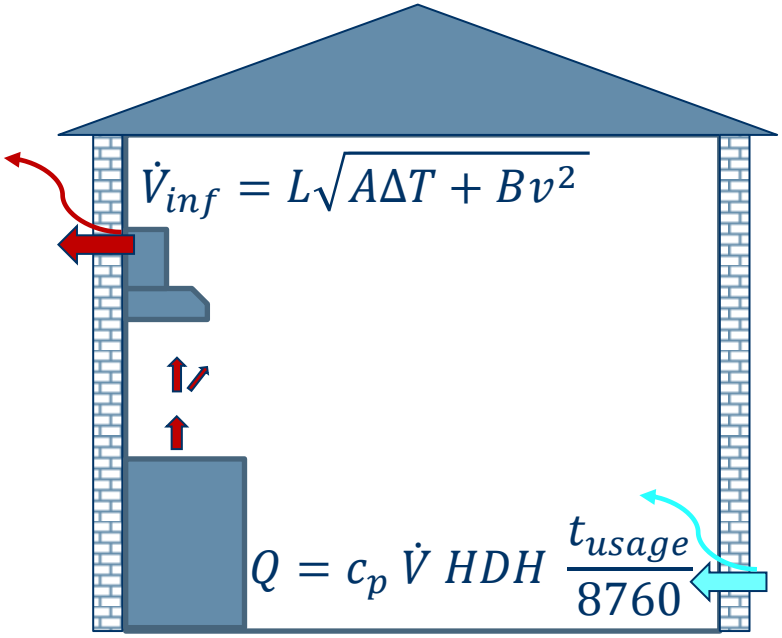

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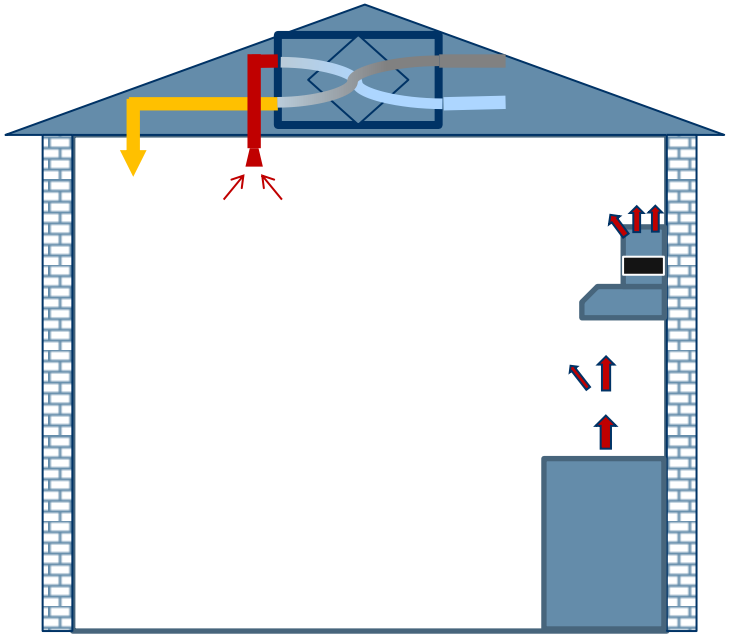

Ventilation losses (30min/day, 250m³/h, Vienna)
Additional infiltration (T=5.5C, v=3m/s)
Thermal bridge (U=6W/m²K)

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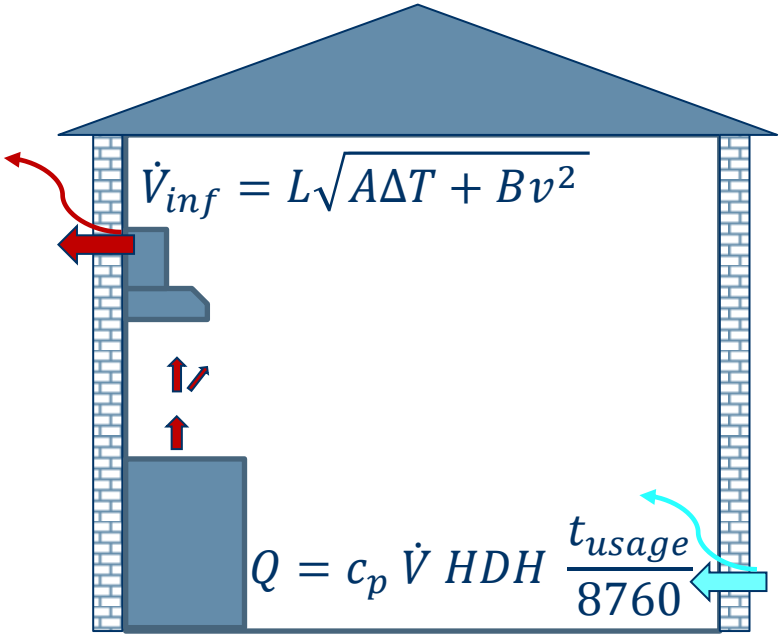

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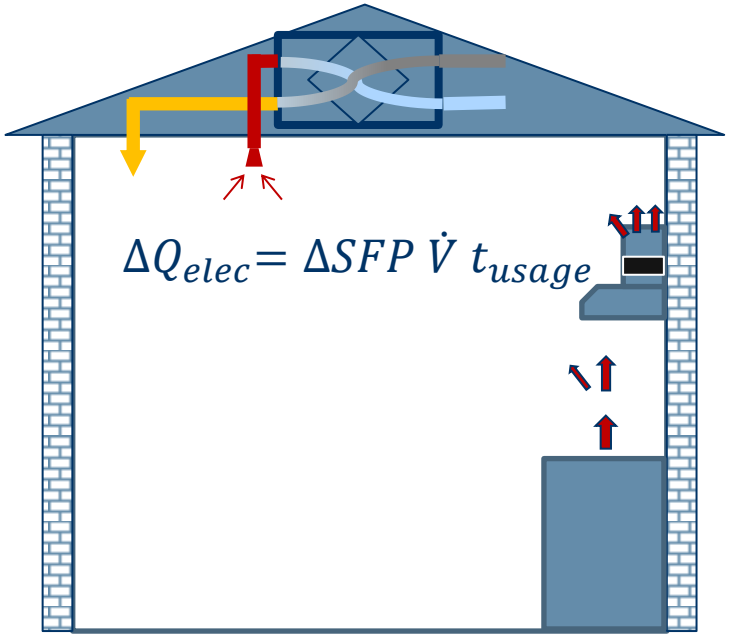

Higher MVHR setting (1ACH for 35m²)
Pressure drop filter (+0.05Wh/m³)
Embodied energy filter (20MJ/kg, 300g)

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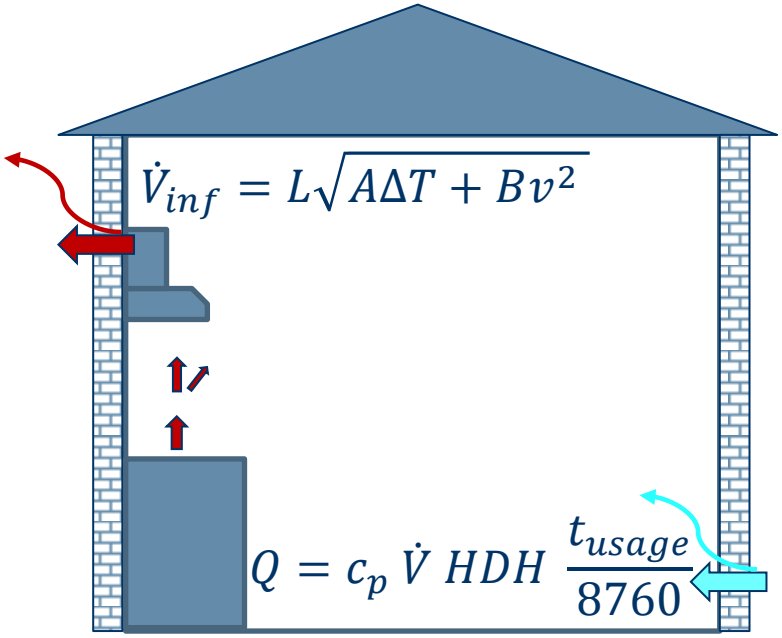

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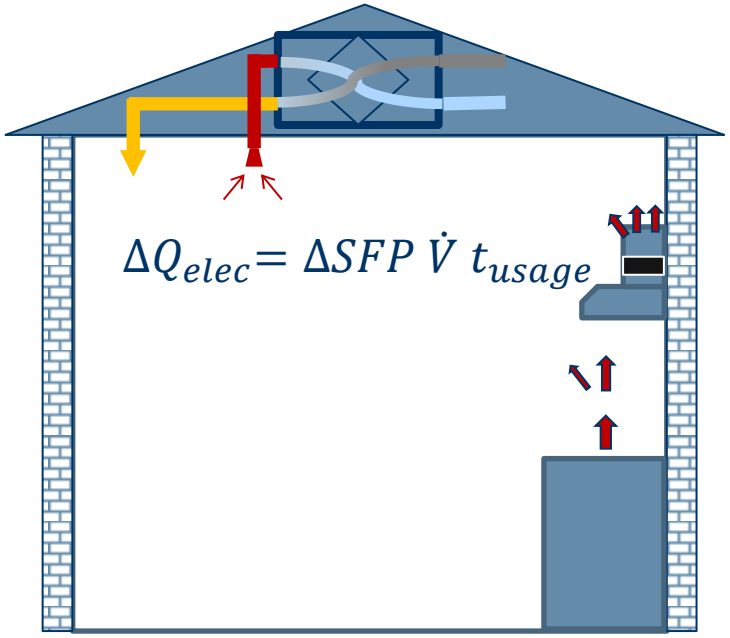

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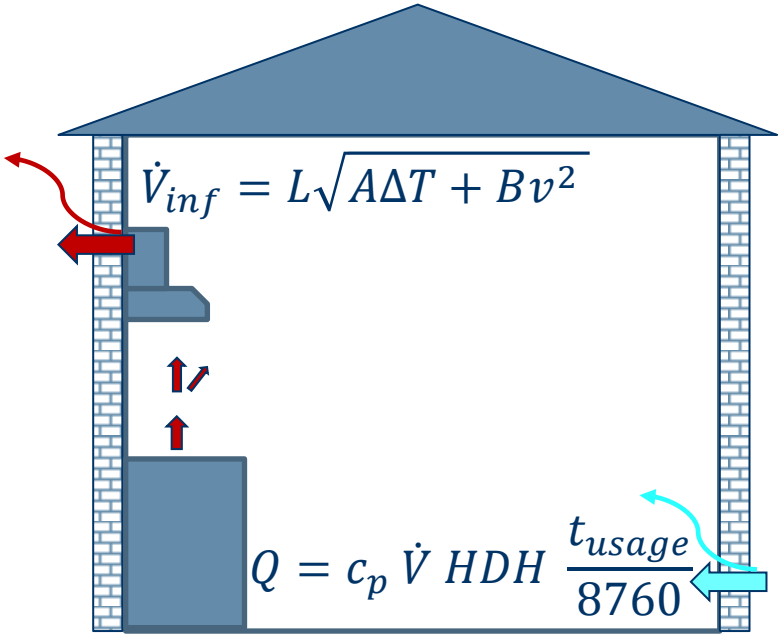

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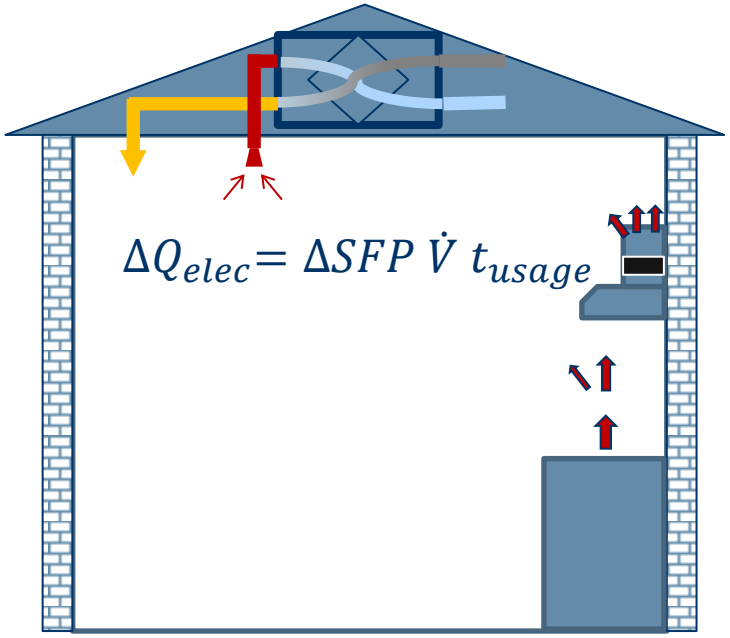

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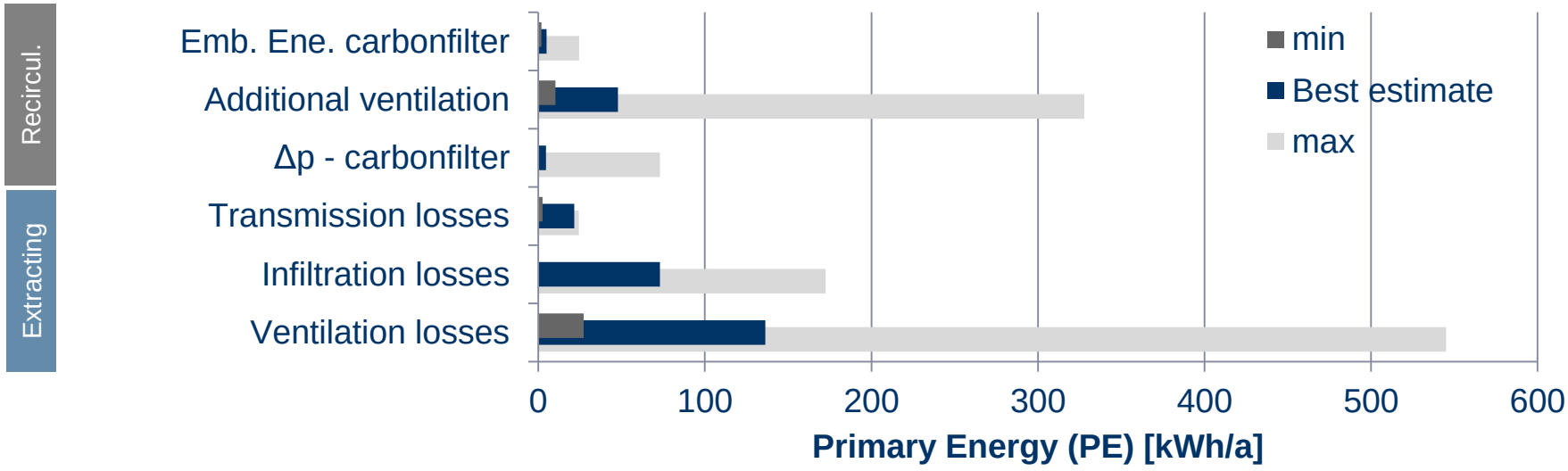
Energetic comparison - Results



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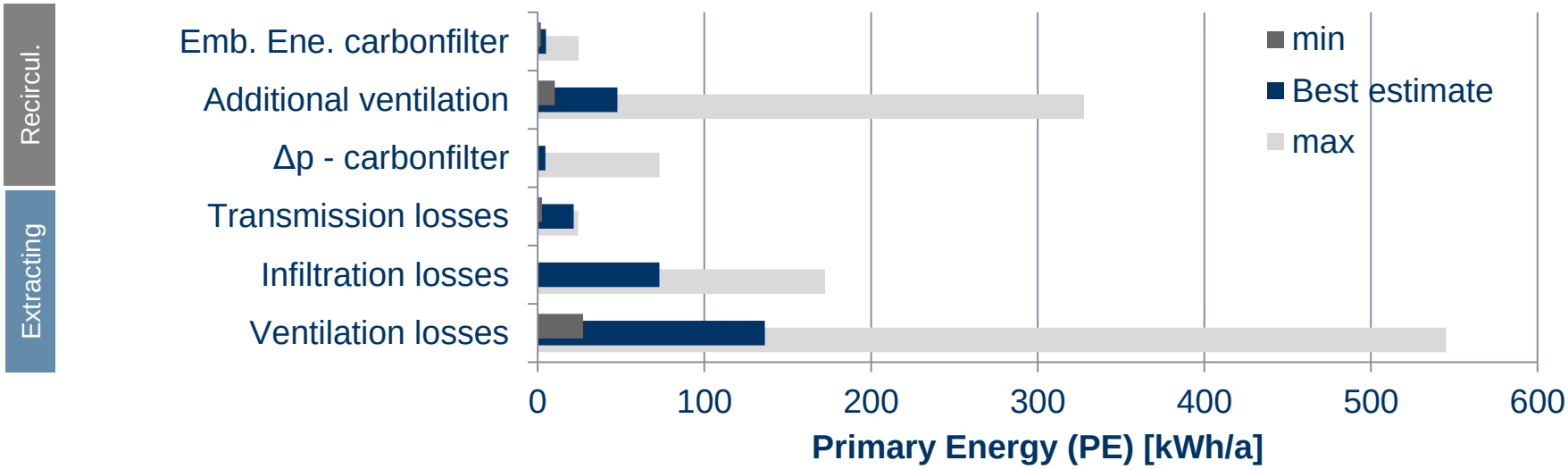

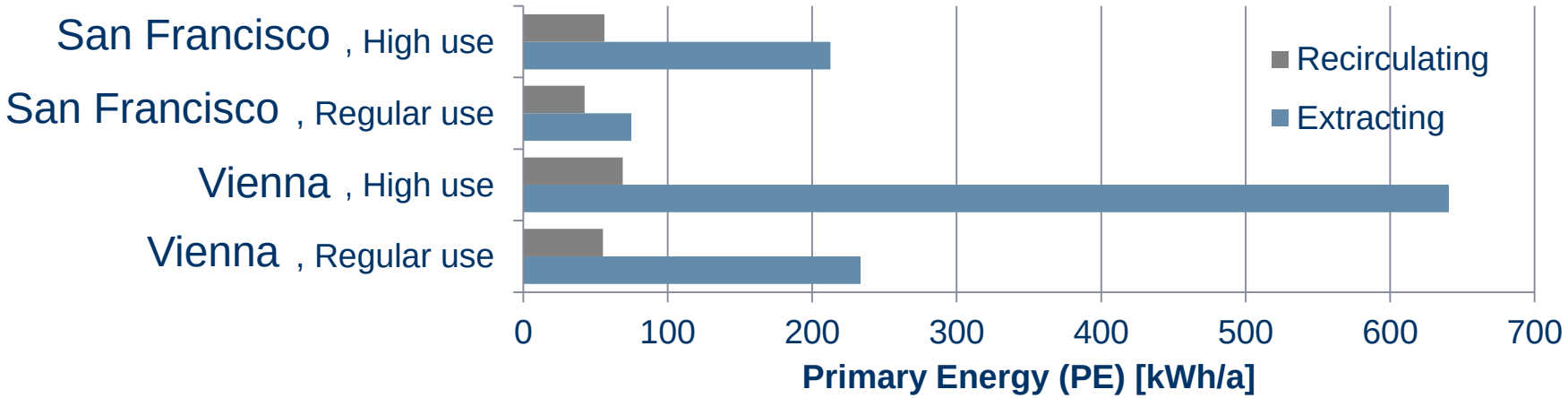

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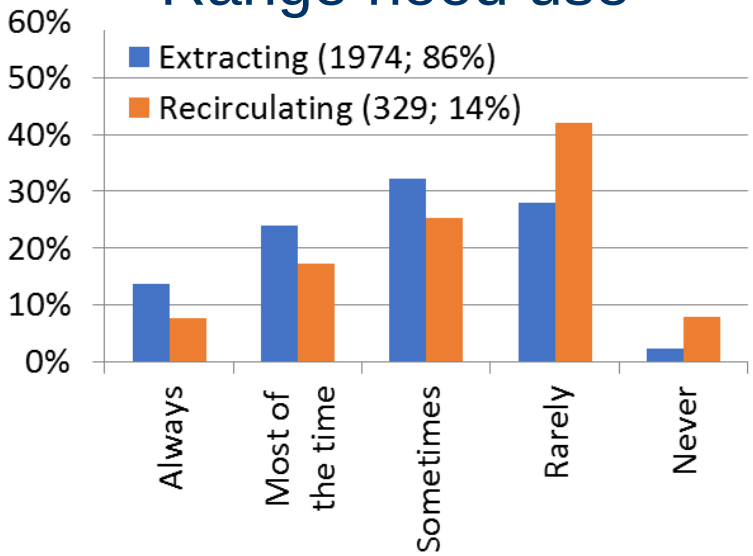
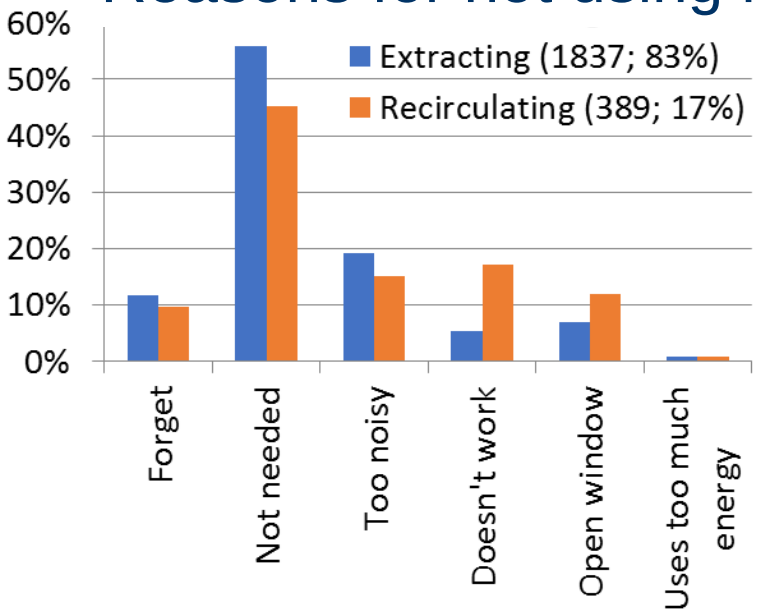
Subjective performance

Range hood performance – Survey data

Range hood use(1)



Reasons for not using it(1)



(1) Chan, W. R., Kim, Y., Singer, B. C., Walker, I., & Sherman, M. H. (2016). Healthy Efficient New Gas Homes (HENGH) Field Study Protocol.
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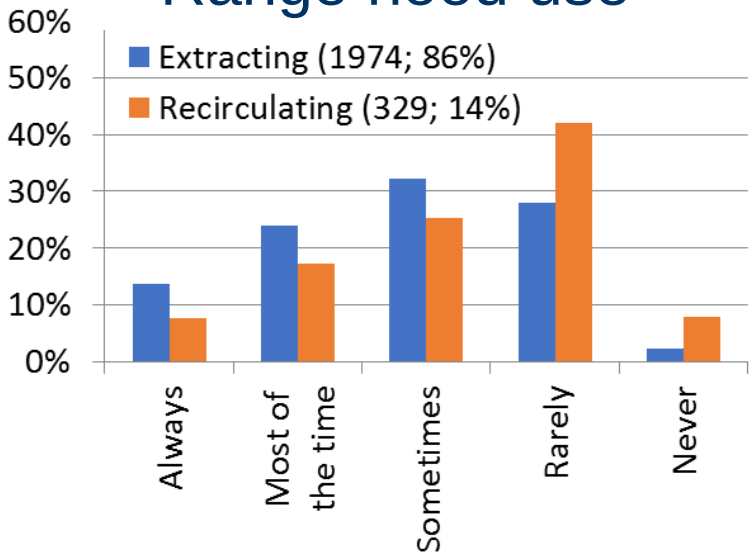

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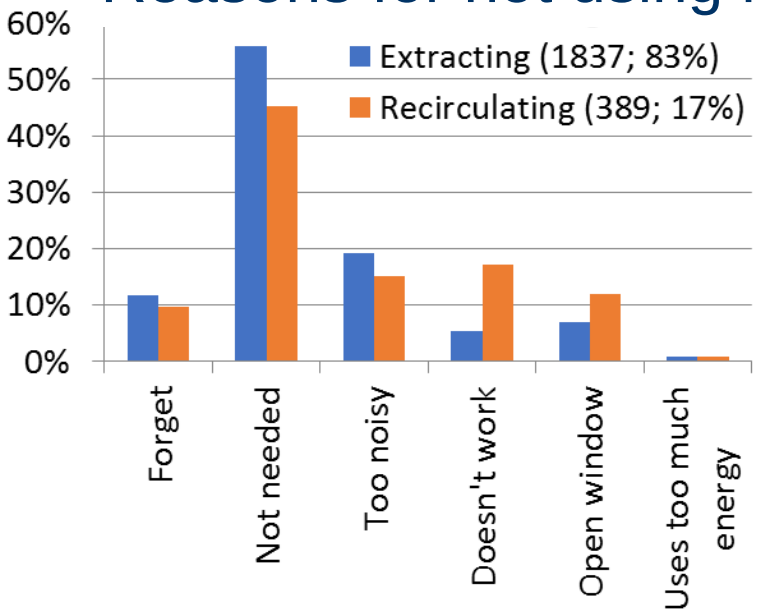
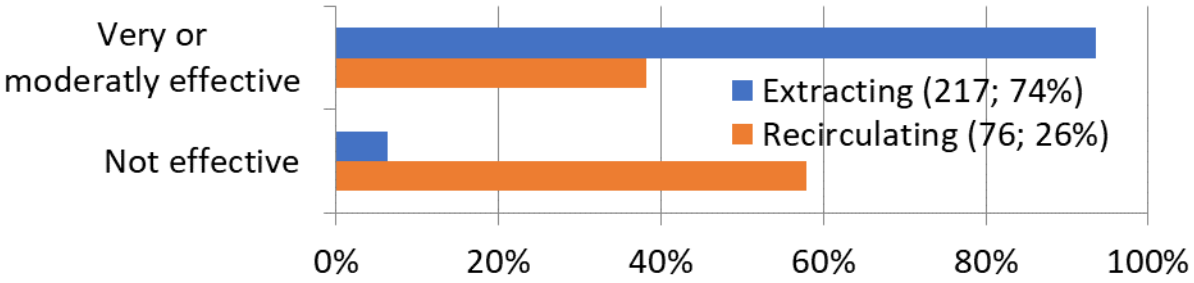


Perceived effectiveness(2)



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Measured performance

Capture efficiency of (extracting) hoods - Literature review

Summary

- CE varies strongly 15-98%, depending on:
  - Geometry/type (coverage, hood volume, height,…)
  - Air flow
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- Not much on recirculating hoods…

Range hood consumer test report (GER)

test Wandhauben mit horizontalem Schirm, 90 cm breit

Gewichtung		Miele PUR 97 W Art.-Nr. 9884040		Siemens LC97BC532[9] EAN 4 242003650530		Ikea Klarluft Art.-Nr. 803.045.83	
Betriebsart		Abluft	Umluft	Abluft	Umluft	Abluft	Umluft
Mittlerer Preis ca. (Euro)		745		565		350[8]	
Preisspanne (Euro) ca.		740 bis 810		485 bis 640			
Zusätzliche Kosten für Umluftbetrieb ca. (Euro)[1]		Entfällt	128	Entfällt	75	Entfällt	39
Nachkaufpreis Geruchsfilter pro Jahr ca. (Euro)[2]		Entfällt	158	Entfällt	98	Entfällt	13
Stromkosten pro Jahr ca. (Euro)[3]		17	15	5	8	28	22
Baugleichheiten		**Siemens LC97BC532** ist baugleich mit **Bosch DWB097A50** (540 Euro), **Siemens LC94BA521** ist baugleich m					
test - QUALITÄTSURTEIL	100 %	GUT (1,7)	GUT (2,2)	GUT (1,9)	BEFRIEDIGEND (2,6)	BEFRIEDIGEND (2,6)	AUSREICHEND (3,6)
FUNKTION	40 %	sehr gut (1,5)	gut (2,2)	gut (2,0)	befried. (3,0)	gut (2,1)	ausreich. (3,6)*)
Fett- / Geruchsbeseitigung		++/++	+/○	+/++	○/○	+/++	○/–
Dampfbeseitigung im Abluftbetrieb[4]		+	Entfällt	+	Entfällt	○	Entfällt
GERÄUSCH	20 %	sehr gut (1,5)	befried. (2,7)	sehr gut (1,4)	befried. (3,0)	befried. (3,4)	ausreich. (4,1)
HANDHABUNG	20 %	gut (2,0)	gut (2,1)	gut (2,2)	gut (2,2)	befried. (2,6)	befried. (2,6)
Gebrauchsanleitung / Montage		++/○	++/○	+/+	+/+	+/⊖	+/⊖
Bedienen / Reinigen		+/+	+/+	+/○	+/○	+/○	+/○
Filterwechsel / Spülmaschinenfestigkeit der Fettfilter		+/++	+/++	○/+	○/+	+/+	+/+
Ausleuchtung der Kochstelle		+	+	++	++	○	○
ENERGIEVERBRAUCH	10 %	gut (2,3)	gut (2,1)	sehr gut (1,1)	sehr gut (1,5)	befried. (3,3)	befried. (2,8)
VIELSEITIGKEIT	5 %	gut (2,0)		gut (2,0)		befried. (3,0)	
SICHERHEIT	5 %	sehr gut (1,0)		gut (2,0)		sehr gut (1,0)	
AUSSTATTUNG / TECHNISCHE MERKMALE							
Energieeffizienzklasse laut Anbieter / Geräusch (dB(A))[5]		B / 53	Entfällt / 64	A+ / 52	Entfällt / 66	B / 69	Entfällt / 75
Anschlussleistung / Leistung in höchster Stufe (W)[5]		209 / 119	209 / 100	139 / 24	139 / 57	270 / 232	270 / 175
Breite x Höhe x Tiefe ca. (cm)		90 x 101 x 50		90 x 95 x 50		90 x 115 x 45	
Leuchtmitteltyp / Wechsel ohne Kundendienst möglich		LED / ❑		LED / ❑		Halogen / ■	
Lampenanzahl x Watt		2 x 4,5		3 x 3		2 x 10	
Geprüfter Geruchsfilter / regenerierbar laut Anbieter		Entfällt	DKF 12-1, Art.-Nr. 6228731 / ❑	Entfällt	00705432, Art.-Nr. LZ53451 / ❑	Entfällt	Nyttig Fil 559, Art.-Nr. 900.279.72 / ■
Lüfterstufen[6] / Intensiv / Lüfternachlauf		3 / 1 / ❑		3 / 1 / ❑		3 / 0 / ❑	
Maximale Luftfördermenge (m^3/h)[5]		432	293	467	332	612	499

Grease and odour removal tests based on ISO 61591 of 21 different models

Tests in extraction and recirculation mode

In recirculation mode: Odour removal mostly medium to insufficient, only two models good or very good

Source: Stiftung Warentest. (2016, March). Frische Luft in der Küche. Stiftung Warentest, 64–73. Retrieved from https://www.test.de/Dunstabzugshauben-Die-besten-gegen-Dampf-Geruch-und-Fett-4980444-0

Recent publication

(TNO, Netherlands)

Table 4: cooking emissions per experiment expressed as peak concentrations.

T_{pan} [° C]	Number of hamburgers	Wasemkap	Ventilation [dm^3/s]	Max. $PM_{2.5}$ [$\mu g/m^3$]	Max. EC (soot) [$\mu g/m^3$]	Max. NO_2 [$\mu g/m^3$]	Max. O_3 [ppb]
180	3	-	21	194	1.47	-	-
180	3	-	21	195	1.38	274	-
220	3	-	21	894	3.04	-	-
220	3	-	21	615	1.41	350	-
220	3	-	21	808	0.82	358	-
220	Only oil	-	21	751	2.88	222	-
220	3	Recirculation	21	569	2.81	126	-
220	3	Recirculation	21	512	0.64	138	-
220	3	Recirculation*	21	595	0.42	91	-
220	3	Plasma	21	561	6.34	667	69 – 194
220	3	Plasma	21	507	0.76	1155	166 - 441

** free flow towards ceiling to prevent disturbance of the air flow pattern under the hood.*

Source: Efficiency of recirculating hoods, P. Jacobs, W. Borsboom, AIVC 2017 conference proceedings

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PM2.5 reduction ~30%

NO2 reduction ~60%(when new) to ~20%(after some use)

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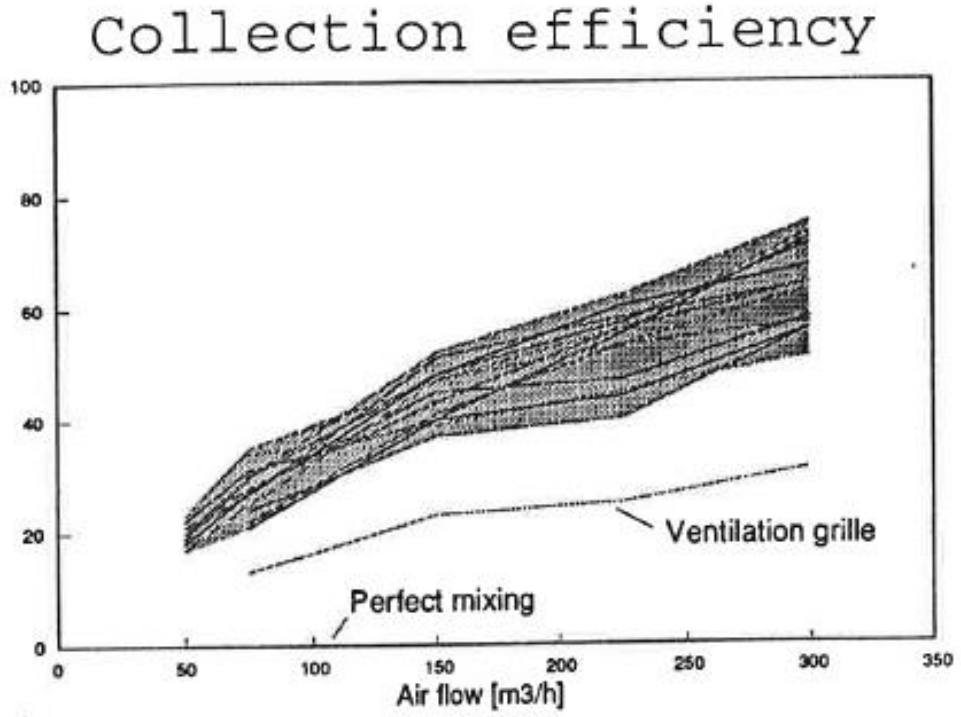
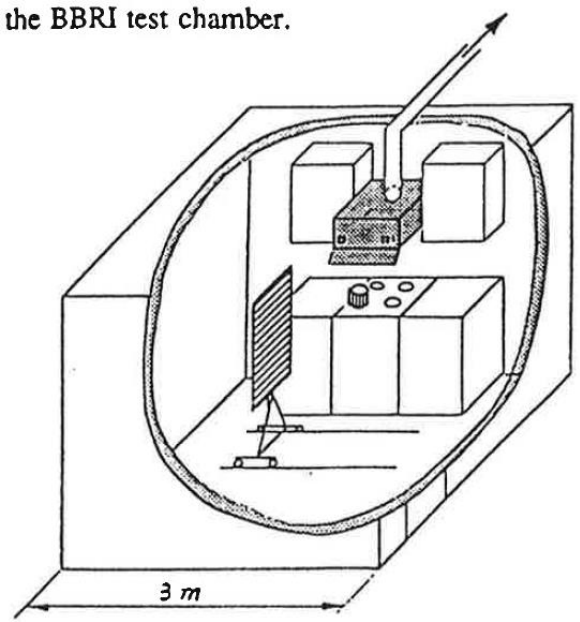
Pollutant removal of continuous ERV?





Source: Efficiency measurements of kitchen hoods, B. Geerinckx, P. Wouters, P. Voordecker, AIVC 1992 conference

Summary & Outlook

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- Recirculating hoods can notably save energy in PH
- Their IAQ performance (in combination with ERV) still unclear, especially for PM
- Testing of recirculating RHs currently underway

Thank you for your attention!

Check out current survey
kitchen-ventilation.lbl.org

Financial support by the Max Kade foundation
http://maxkadefoundation.org/