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A NEW REALITY

Heating with Air Conditioners – fast and affordable transition towards carbon neutrality

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POLITECNICO MILANO 1863

topten.ch

EKZ

Heat pumps: hot topic!

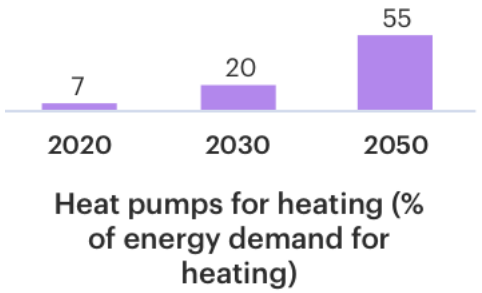
All heat pumping technology subtypes are becoming more popular

Air-to-air heat pumps have been rapidly becoming more widespread in recent years and now dominate global sales for buildings. In the United States, for example, annual shipments expanded from 2.3 million units in 2015 to 3.1 million in 2019.

Several factors have raised the popularity of air-to-air technologies, including policy development, upgraded construction standards that make heat pumps in new buildings more competitive, and growing air-conditioning demand.

IEA (2020), *Heat Pumps*, IEA, Paris https://www.iea.org/reports/heat-pumps

IEA (2021), Net Zero by 2050, IEA, Paris https://www.iea.org/reports/net-zero-by-2050



Heat pumps for heating (% of energy demand for heating)

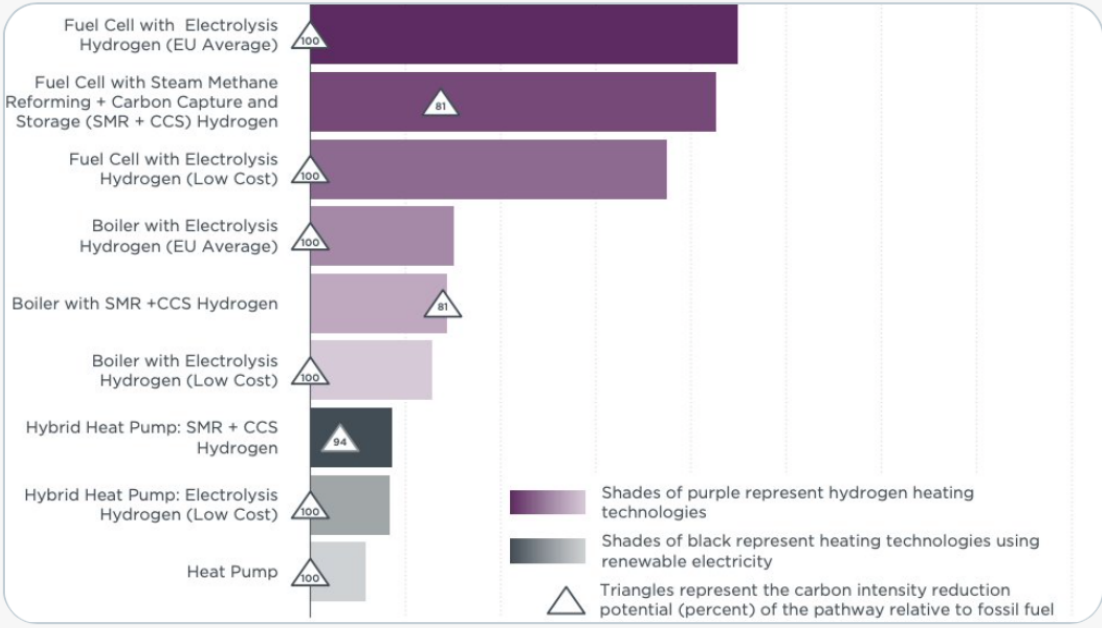
Con IKEA Clean Energy Services diventi ora fornitore autonomo di energia in modo semplice

Jan Rosenow @janrosenow · Mar 11

Heat pumps are far cheaper than hydrogen for heating EU homes concludes new @TheICCT study.

Costs include annuitized capital expenses, operating expenses, and fuel costs.

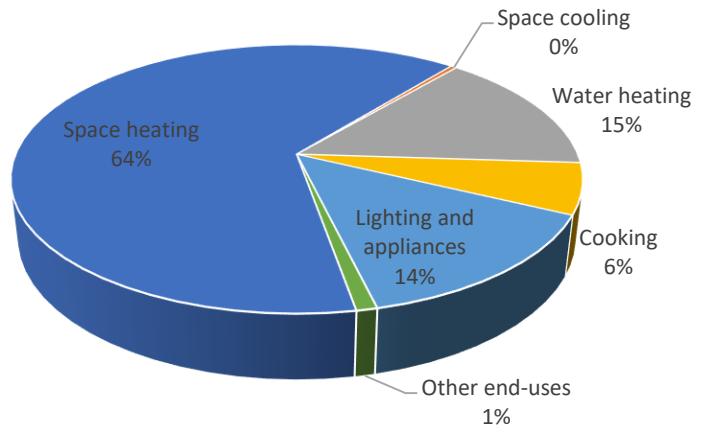
theicct.org/publications/h...



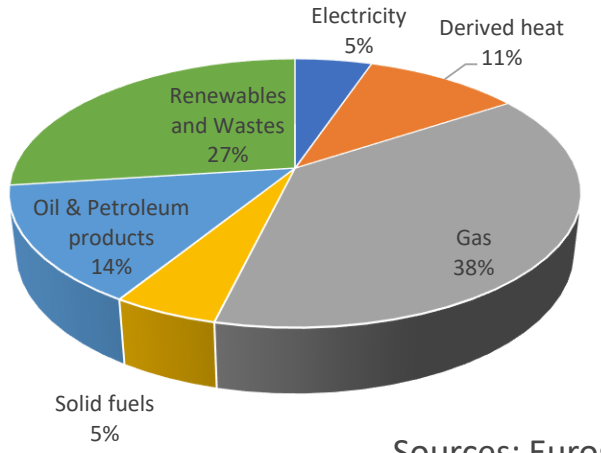
Actual situation: EU residential sector

- Heating is 2/3 of the total final energy consumption
- High percentage of fossil fuels
- Responsible for about 20% of the CO_2 emissions
- Slow intervention rate for buildings and systems
- High costs for intervention
- Technical limitations
- Ambiguity on fossil

Final energy consumption in the residential sector in EU-27 by end-use, 2018



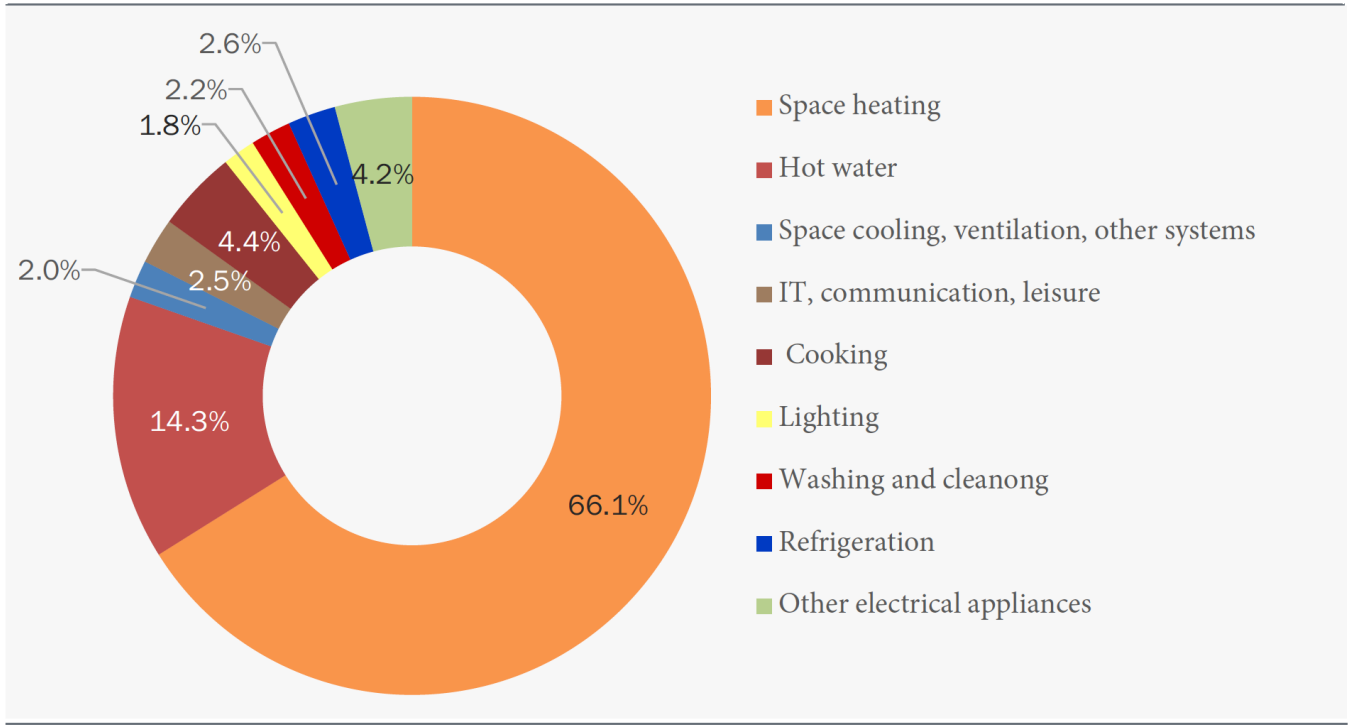
Share of fuels in the final energy consumption: heating in the residential sector, 2018



Sources: Eurostat

Switzerland: residential sector

Final energy use in Switzerland, household sector in 2019



Source: Prognos 2020

Main energy sources used for heating				
	1990	2000	2017	
	as %	as %	as %	IC*
Heating oil	60.9	57.8	39.4	0.7
Gas	9.2	14.6	20.7	0.6
Electricity	10.7	9.8	6.9	0.4
Wood	15.5	11.5	10.1	0.5
District heating	1.2	1.5	4.2	0.4
Solar collector	0.0	0.1	0.3	0.1
Heat pump	2.0	4.4	17.9	0.5
Others	0.4	0.1	0.3	0.1
None	0.0	0.2	0.3	0.1

1990, 2000: This information concerns residential buildings in which at least one person has their civil domicile.; 2017: This information concerns residential buildings as main place of residence for at least one person.
* Confidence interval: ± (in percentage points)
Sources: FSO - Population census, Survey on the energy sources of residential buildings

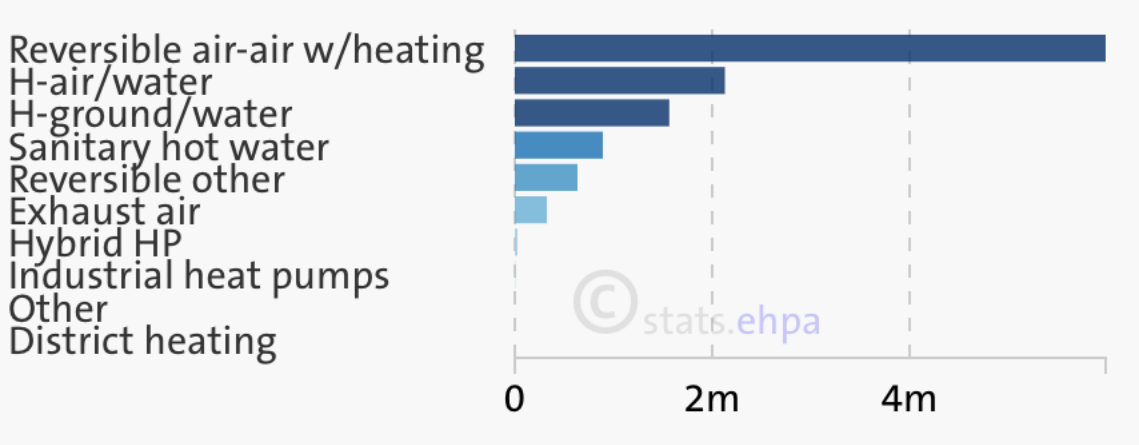
Heat pumps market status: EU

Sales 2018:

- 1,3 mio (all types)
- FR 300k, IT 200k
- DE, ES, NO, SE 100k

Air-air reversible, stock:

- More than 6 mio. installed
- Around a mio. in NO, SE

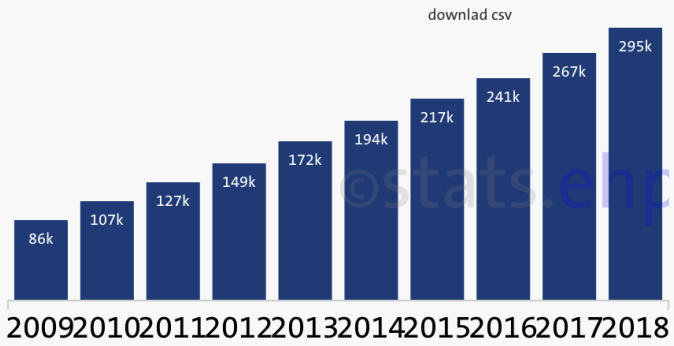


Market status: CH

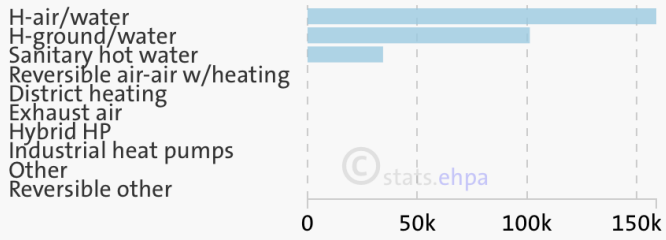
Heat pump sales overview

Heat pumps installed

Stock development



Type of HP



Heat pump sales per 1000 inhabitants (2017)

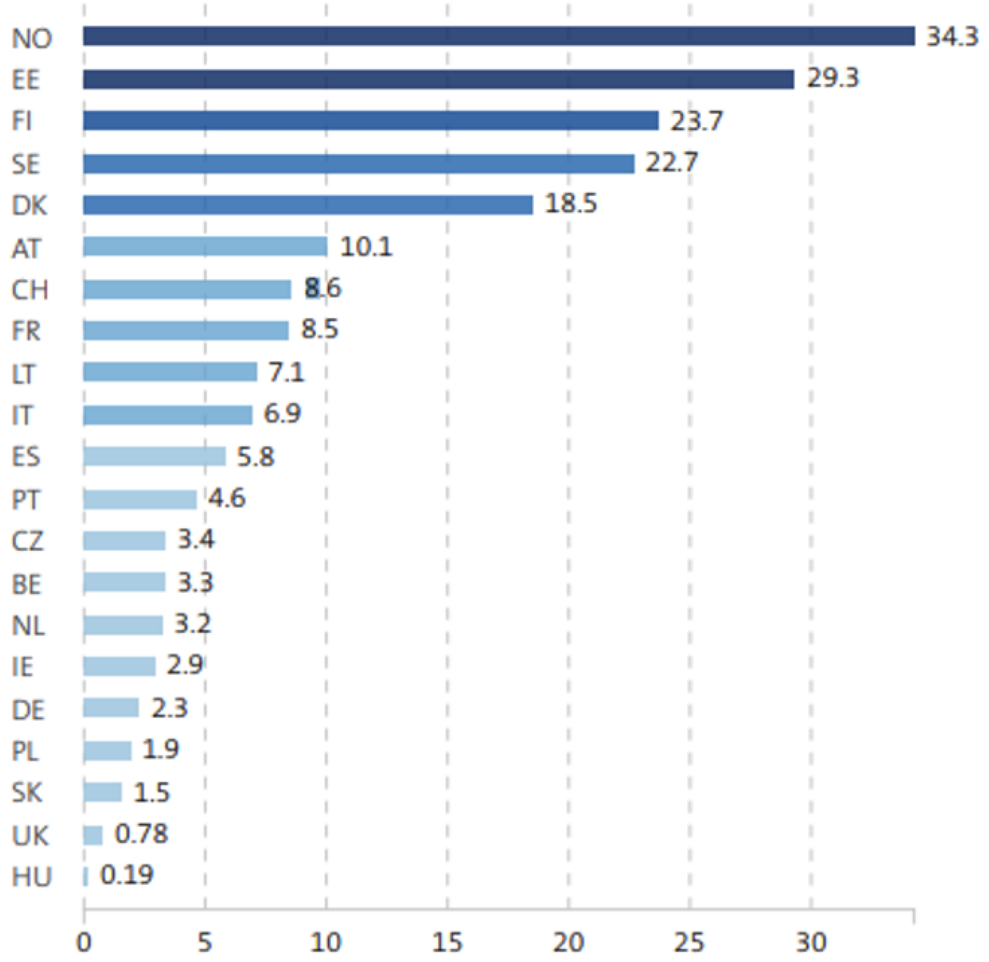


Figure 1: Heat pump sales 2017 per 1000 inhabitants, EHPA's European Heat Pump Markets and Statistics Report 2018

Heating and Cooling Knowhow and Solutions - HACKS H2020 project

The objective of HACKS project is to achieve market transformation for heating and cooling (HAC) appliances and improve comfort and health of European citizens.

To achieve this goal, 17 HACKS partners in 15 countries are working together, thanks to the financial support of the European Horizon 2020 programme.

HEATING AND COOLING
KNOWHOW AND SOLUTIONS
HACKS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 845231.

Incentive schemes

In the 15 HACKS countries financial support is available for the purchase of heating appliances/systems.

These schemes exist at the national (CZ, DE, FR, IT, LT, LU, PL, PT, UK), regional (AT, BE, CH, DE, ES, PL), and the local level (CH, DE, LU, FR, NO, PL, SE).

The most frequent are:

- Rebates and subsidies (virtually all countries).
- Reduced VAT for renovation (BE, FR, IT).
- Zero- or low-interest loans for comprehensive renovation works, including heating systems (FR, PL).

Please see the project material for more detailed information.

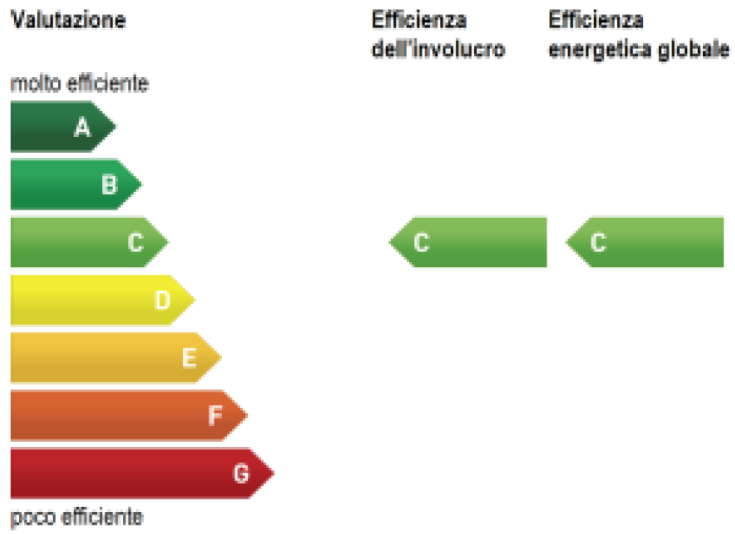
Incentive schemes in CH and legal framework

In case of **substitution of fossil or direct electric**, all heat pumps except air-air are supported. The installation should be certified by the “system-module for heat pumps”, by the installer. No incentive for systems installed in new buildings.

All the new installations or substitution are requiring a **construction permit** at municipal level, considering the **energy efficiency** cantonal regulation and the federal ordinance on **noise pollution**.

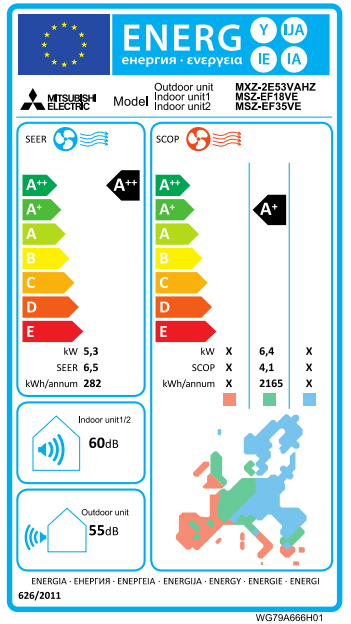
The **incentive level is differentiated by regions** and could include the new installation of a proper hydronic system for the heating distribution of hot water.

The **combination** of insulation measures and new heating systems **increases the incentive level** -> using the building certification scheme



topten.ch initiative – how the study started

- Finding good installation of air-air heat pumps for heating, in Switzerland (alpine and subalpine region)
- Preliminary survey with designer/installer and users:
  - Plans
  - Details
  - Systems
  - Consumption
  - Small survey in place, with inhabitants
- See if it works and how
- Next steps: propose a more detailed study

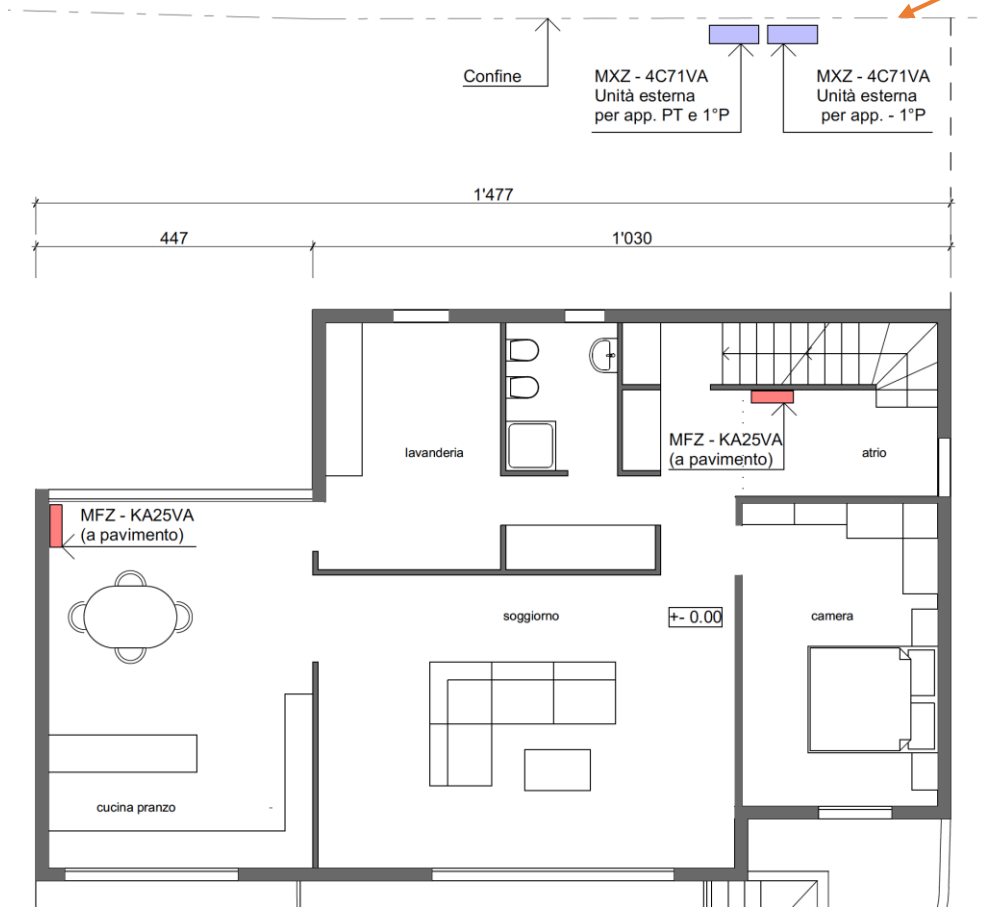


First actions at local level

- Discussions with installers on number of systems installed
- Open the discussion with the cantonal energy authorities in Ticino (south CH)
- Statistical data
  - 1/3 of the residential buildings are SFH
  - 36k over 231k buildings (15%) were using direct electric heaters in 2015
  - about 1000 installations of air-air heat pumps for heating (preliminary data)
  - a number of installations is not considered (office A/C, …)
- Research of documented and efficient case studies: 4 SFH Minergie (new or refurbished) + 1 non certified

Examples of air-air heat pump installations for heating

Noise control: outside

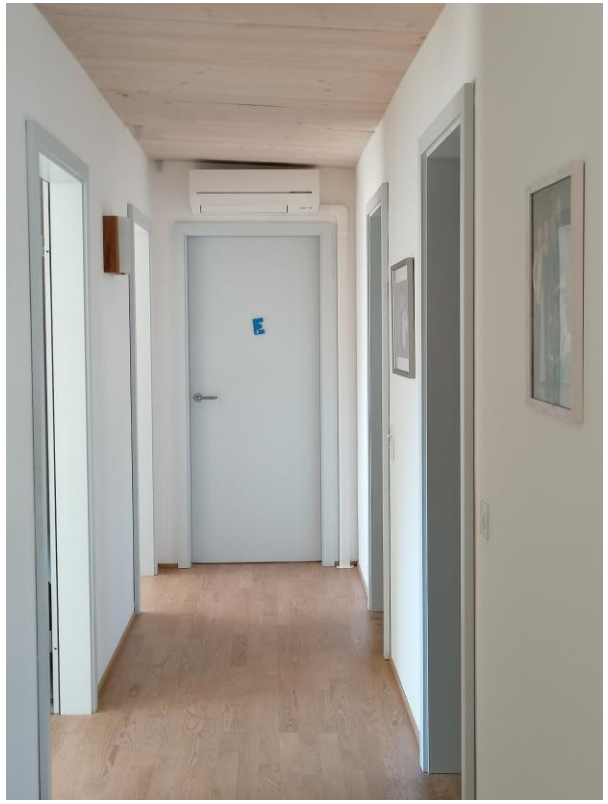


SPECIFICHE TECNICHE

MODELLO				Set	MXZ-4C71VA MXZ-4B71VA
				N. unità interne	Da 2 a 4
				Unità esterna	MXZ-4C(B)71VA
Alimentazione	Tensione/Freq./Fasi			V/Hz/n°	230/50/1
Raffreddamento	Capacità		nominale	kW	**7.1**
			min/max	kW	3.7-8.8
	Potenza Assorbita[1]		nominale	kW	1.68
	EER[2]				4.02
	Classe di efficienza energetica				A
	Consumo annuo			kWh	883
	Pressione sonora unità esterna		min/max	dB(A)	45/48
Riscaldamento	Capacità		nominale	kW	**8.6**
			min/max	kW	3.4-10.7
	Potenza Assorbita[1]		nominale	kW	1.705
	COP[2]				4.79
	Classe di efficienza energetica				A
	Pressione sonora unità esterna		min/max	dB(A)	48/52
Massima corrente assorbita				A	15.0
Unità esterna	Dimensioni		AxLxP	mm	710x840 (+30)x330
	Peso			Kg	58
Linee frigorifere	Diametri attacchi		Liquido	mm	6.35 x 4
			Gas	mm	9.52 x 3 + 12.7 x 1
	Lunghezza max (totale/ogni ramo)			m	60/25
	Dislivello max (UI sopra UE / UI sotto UE)			m	15/10
Refrigerante	Tipo				R410A
Campo di funz. garantito	Raffreddamento		min/max	°C	-10 ~ +43
	Riscaldamento		min/max	°C	-15 ~ +24

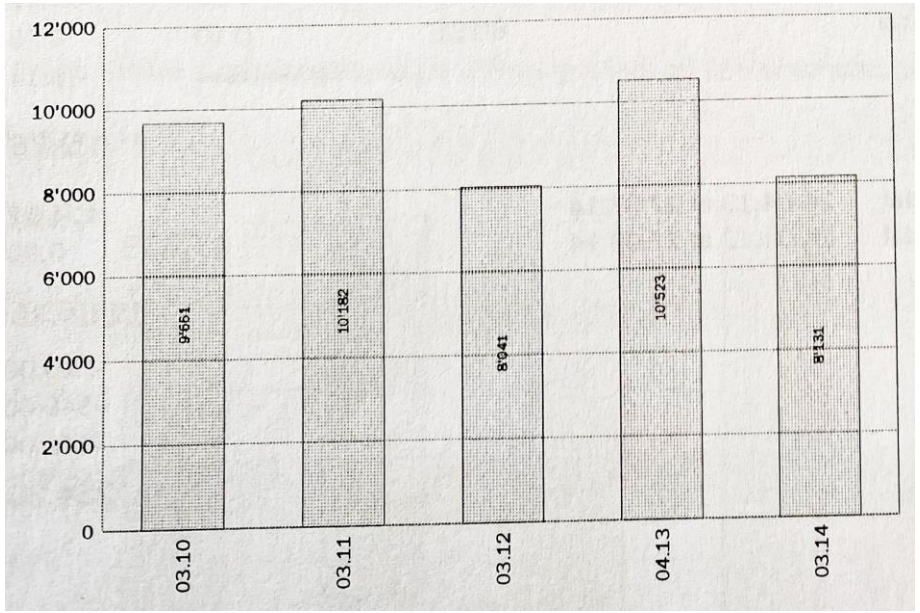
Lp@1m = 52 dB(A),
48 in night function

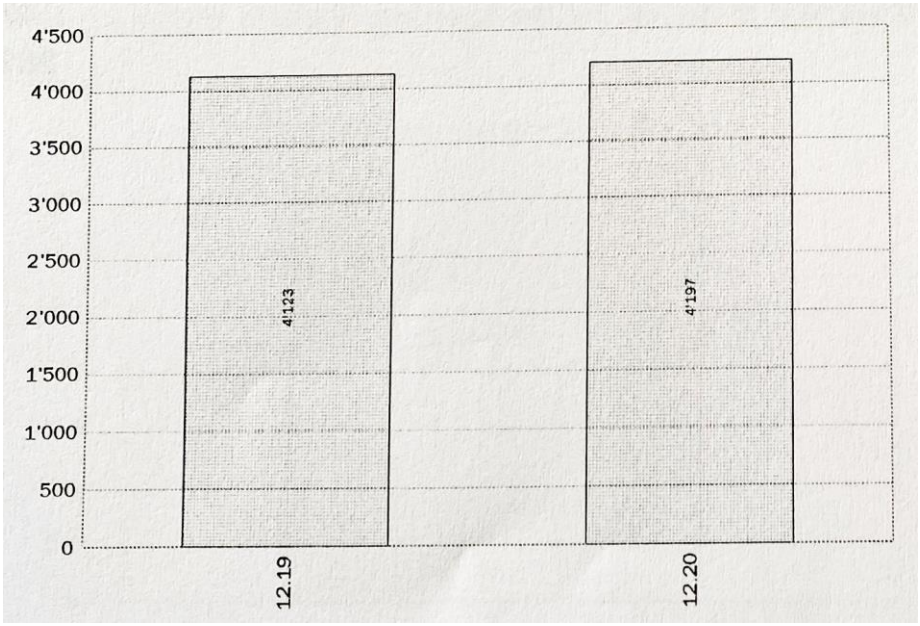
Noise control: inside units



Lw from 41 at max power down to 19 dB(A) – all installation were made 3 to 6 years ago.

Consumption and costs





House 1: in average per year: from 25 to 11 kWh/day and from 1’800 Sfr to 1’000
Energy performance (considering all systems): from 91 to 40 kWh/m^2y of final energy

It includes everything: new appliances, new heat recovery system, …., heating, hot water.

Investment costs

- The cost for a new air-air heat pump, compared to a similar air-water is 30-50% less
- It comprises internal units and distribution system
- A new underfloor heating could cost 40-100.- Sfr. per m^2

For a typical SFH, new or without distribution system, the investment could be 20-50k lower.

For existing buildings is necessary the INSULATION of the envelope, in order to reduce power (and size, and consumption) and increase the comfort!

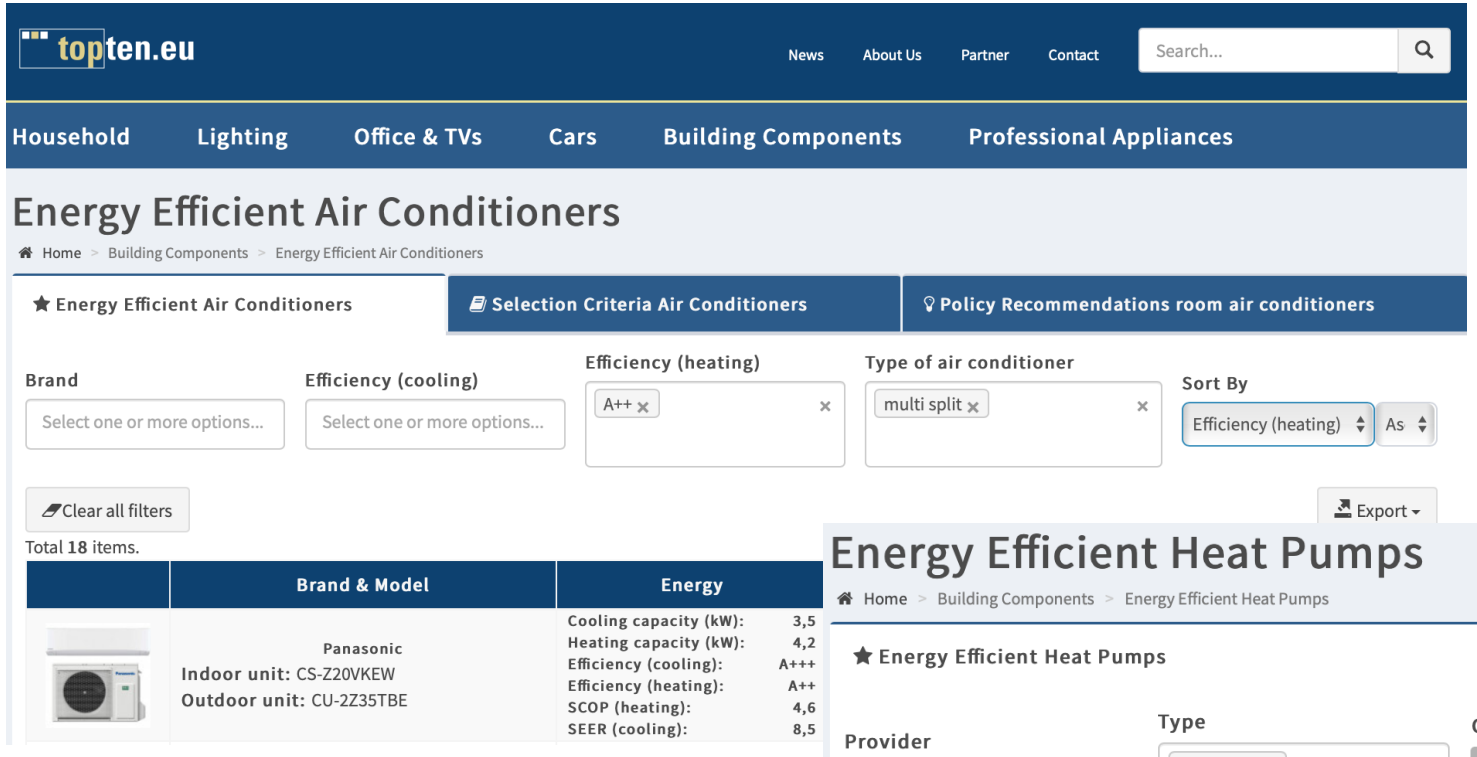
In existing building the space for installation is limited!

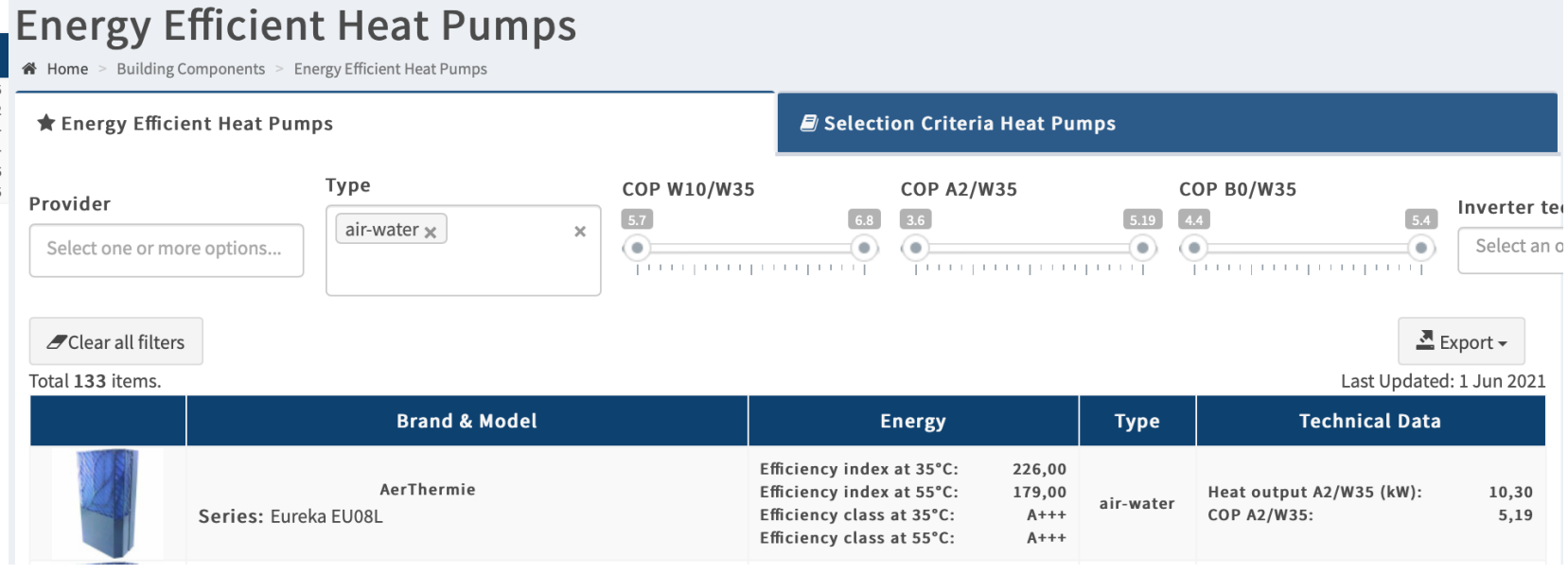
Same size… different cost!

24	**RISCALDAMENTO + RAFFRESCAMENTO**			
240.0	Generatore di Calore	12'600.00		
240.1	Condotte Frigorifere TP	3'845.00		
240.2	Accumulo Caldo/Freddo	1'450.00		
240.3	Bollitore ACS	4'675.00		
240.4	Gruppi di Distribuzione	1'730.00		
240.5	Prestazioni di Servizio	1'160.00		
240.6	Organi di Sicurezza	390.00		
240.7	Armature	1'480.00		
240.8	Trasporto e Montaggio	8'250.00		
240.	Produzione di Calore		35'580.00	
240.	Produzione di Calore			35'580.00
242.	Condotte Geberit - Mepla		7'925.00	
242.	Condotte Geberit - Mepla			7'925.00
243.0	Serpentine a Pavimento	1'980.00		
243.1	Isolazione a Pavimento	3'054.00		
243.2	Collettori Distribuzione	690.00		
243.3	Regolazione Serpentine	1'340.00		
243.4	Trasporto e Montaggio	5'750.00		
243.	Distr. Caldo + Raffrescamento		12'814.00	
243.	Distr. Caldo + Raffrescamento			12'814.00
244.0	Ventil Convettore	2'750.00		
244.1	Condotte	1'685.00		
244.2	Trasporto e Montaggio	1'750.00		
244.	Raffreddamento		6'185.00	
244.	Raffreddamento			6'185.00
248.	Isolazioni		2'845.00	
248.	Isolazioni			2'845.00
24	**RISCALDAMENTO + RAFFRESCAMENTO**			**65'349.00**

	Quantità	Prezzo unitario	Sconto	Importo netto
Unità motocondensante esterna Inverter a pompa di calore Mitsubishi MXZ-3054 VA	1.00 PZ	3'020.00		3'020.00
Unità motocondensante esterna Inverter a pompa di calore Mitsubishi MXZ-4 D72 VA	1.00 PZ	4'176.00		4'176.00
Unità interna murale con comando a raggi infrarossi Mitsubishi MSZ-SF 25 VA	7.00 PZ	607.50		4'252.50
Condotta frigorifera in rame isolata, completa di fissaggio	1 AC	2'970.00		2'970.00
Telaio di supporto per unità motocondensante, incluso bacinella raccogli condensa	2.00 PZ	190.00		380.00
Trasporto e montaggio di tutto quanto descritto	1 AC	9'135.00		9'135.00
Messa in servizio	1 AC	350.00		350.00
TOTALE OFFERTA (IVA ESCLUSA)			**CHF**	**24'283.50**

Good products on the market?





Not easy to compare efficiency level
e.g. best products on topten.eu:
- SCOP 5,1 for air-air
- SCOP 5,7 for air-water
-> 0,6 points but is only 12%

Effects for utilities

+ Reduction in power installed -> reduction in peak load -> less costs?
+ Better load management
+ Removal of locking time
+ Service continuity
+ Primary energy factor improvement (actual energy mix is 128 gCO_2/kWh, renewable electricity is 16 gCO_2/kWh)
+ Less compensation for CO_2 emissions
+ New market opportunities (heating as service)?
- Tariff structure consistent with energy saving (not regressive, at least?)

Cost and tariff: an example

Consumption category	**H5 - SFH 7'500 kWh/y**	**H6 – SFH 25'000 kWh/y**	
Product:	standard	standard	
Network tariff:	7.15	5.51	+29.76 %
Energy cost:	6.84	6.33	+8.06 %
Public taxes:	2.25	2.21	+1.81 %
Taxes for subventions (RIC):	2.30	2.30	0.00 %
Total (ct.Srf./kWh excl. VAT):	**18.54**	**16.35**	**+13.39 %**

Data from https://www.strompreis.elcom.admin.ch for postal code CH-6900

Conclusion

- Cost benefit for users is positive
- Comfort level is good (nobody complained, neither the tenants)
- In general the CO_2 and energy consumption is at least halved, compared to direct electric systems
- Air-water systems are more efficient, but investment costs are huge or installation is really hard

Remember: for comfort and consumption reduction -> insulation first!

There are still a lot of inefficient systems… the transition is too slow.

References for past (and future) studies

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Thank you

- Authorities (SPAAS Cantone Ticino)
- Ticinoenergia association and Minergie agency
- Building designers and installers
- All families providing data
- HACKS project
- Topten.ch
- EKZ