March 2022

Additional comments on European Commission report Split AC

Introduction

This paper is a further follow up to the exchanges between EPEE and DG Clima on their report "The availability of refrigerants for new split air conditioning systems that can replace fluorinated greenhouse gases or result in a lower climate impact"[1]. Position papers on this topic were shared earlier by EPEE/JBCE on 20 April 2020 and by EPEE/JBCE/JRAIA on 17 February 2021.

In particular, we provide additional technical background to clarify why we stated "**there is no solid justification to support the claim made by Öko-Recherche that the criteria of cost-effectiveness, technical feasibility, energy efficiency and reliability would be fulfilled by R-290 in small split a/c below 7 kW capacity**", let alone higher capacities or multi-splits.

In the UK, two single-splits models with R-290 as refrigerant have been sold online on the market so far, while one model was announced for the EU market with a German Ecolabel, but not yet commercially available until today.

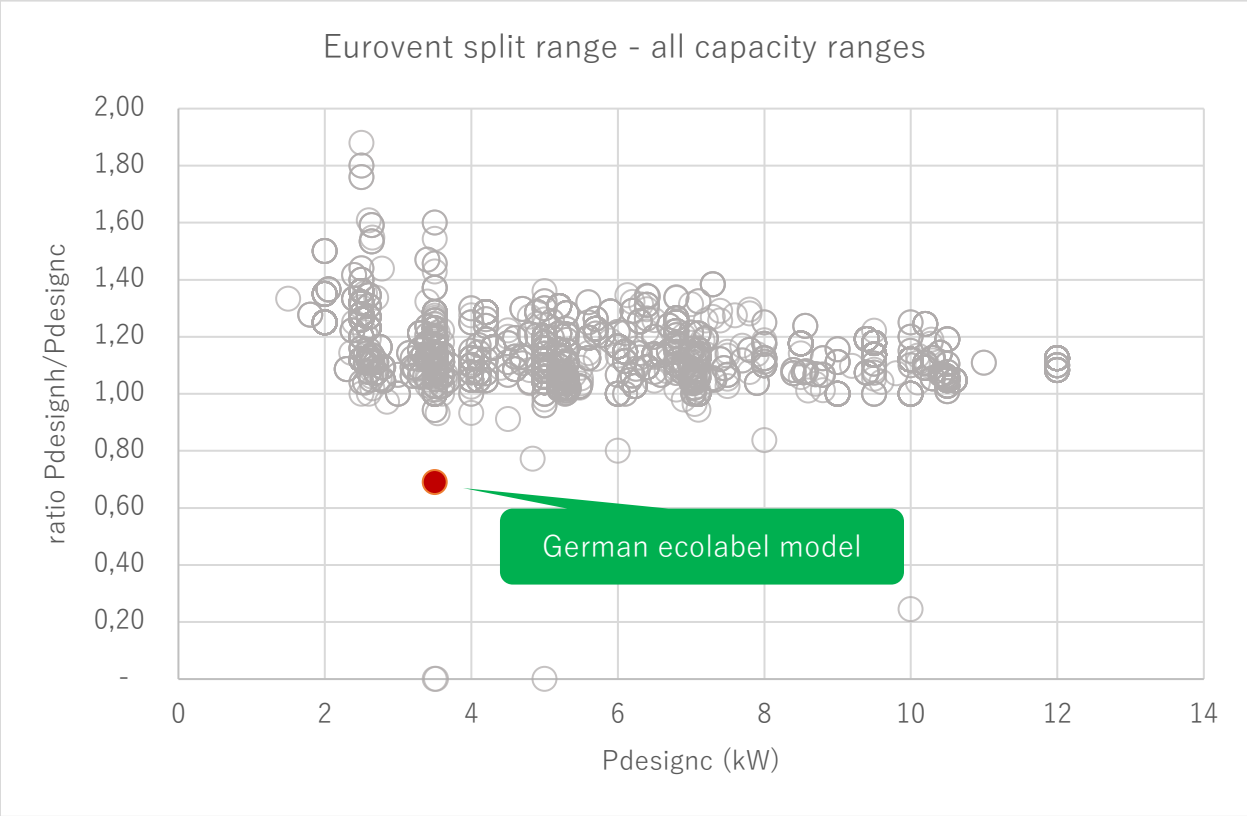
Heat pump capability: cooling & heating capacities

Since in UK and EU, air to air split units are used for both cooling and heating (thus being an air to air heat pump)[2], we analysed the declared capacities of these models. (Pdesignc and Pdesignh as defined in ((EC)206/2012), as well as their operation range.

- The UK models declared that the operation range in heating is applicable for climate outdoor temperatures not lower than 0°C, which basically make them not useful as a real heat pump in nearly all UK & EU markets.[3]
- The German Ecolabel model has a declared Pdesignh of 2.4 (with a bivalent point at -7°C and a corresponding capacity of Pd = 2.12 kW) and a Pdesignc of 3.5 kW, which indicates the heating/cooling design point ratio is 69 %. This means - taking 100 W/m² as an approximation and common rule of thumb for sizing the heating and cooling load in average climate zones - the unit would be capable of cooling a space of 35 m² but only be able to heat a space of 24 m², thus not providing a full heat pump solution. As can be seen

[1] c_2020_6637_en.pdf (europa.eu)
[2] The Lot 10 review study estimated that a split AC functions 350 hours at cooling full load, and 1400 hours in heating mode.
[3] Source: R290 Split user 20200703.pdf (electriq.co.uk)

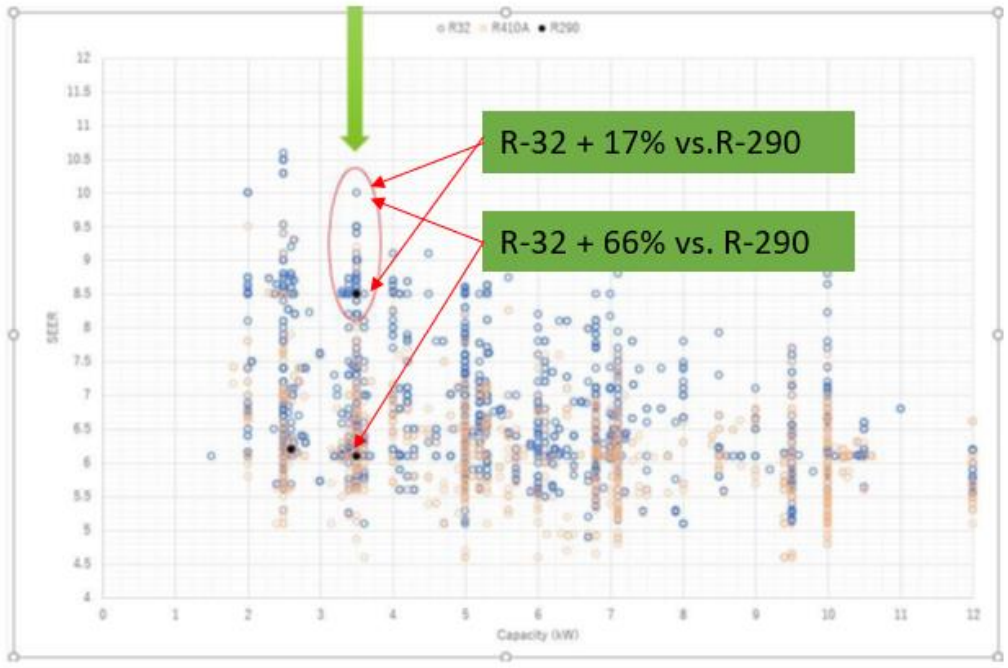
in below graph, current models in the market typically have a Pdesignh / Pdesignc ratio of 100% up to 180% or more, making them suitable for heating even in cold climates.[4]

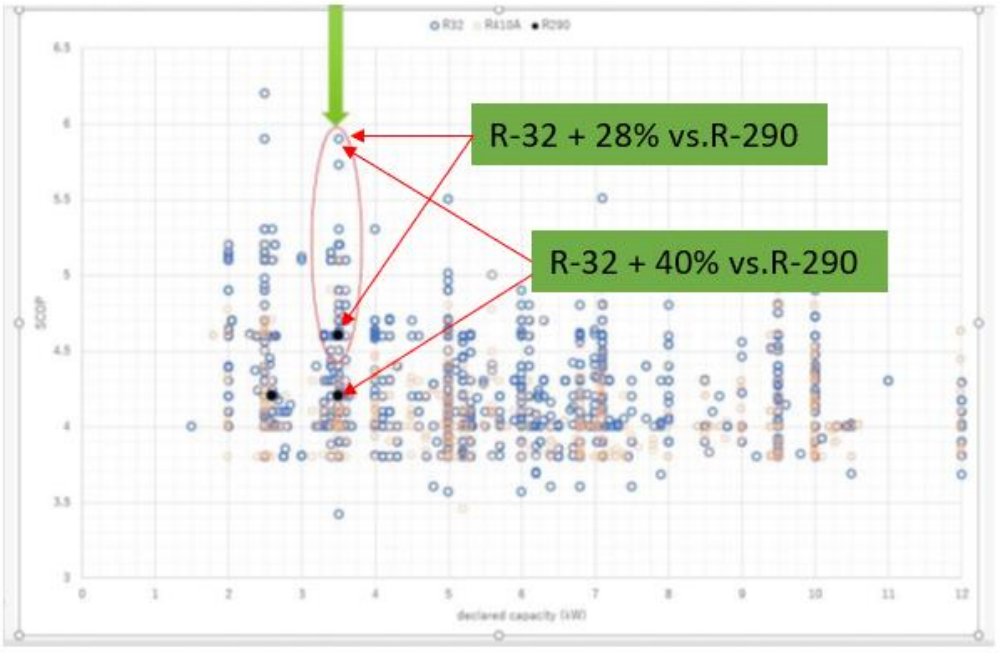


Current energy efficiency (SEER & SCOP)

Below graphs show the declared seasonal energy efficiency ratios of the 3 single splits R-290 models in cooling (SEER) and heating (SCOP), compared to other models currently available in UK and EU market.[5] The German ecolabel model using R-290 refrigerant has a cooling seasonal energy efficiency ratio (SEER) of 8.5, while models that use the refrigerant R-32 achieve SEER values that are up to about 20% higher. Using the same sources, the difference would be even larger in heating mode, with the best available 3.5 kW model (which also has a higher heat output) having 28 % higher efficiency than the Ecolabel model (SCOP = 4.6).

[4] Source: Eurovent database + Blauer Engel website
[5] Source : Eurovent database


R-32 + 17% vs.R-290
R-32 + 66% vs. R-290
SEER
Capacity (kW)


R-32 + 28% vs.R-290
R-32 + 40% vs.R-290
SCOP
declared capacity (kW)

Refrigerant charge per room size

The international safety standard IEC 60335-2-40 contains requirements for the permissible refrigerant charge per m² of room size, taking into account the flammability and toxicity characteristics of the refrigerant, the likelihood of the formation of a flammable atmosphere and the risk of ignition. Industry relies on safety standards to fulfil the requirement of EU safety regulations and to place products on the EU market. In particular, the EN version of the IEC standard, called EN 60335-2-40 is a harmonised standard that can be used to proof compliance with the Low Voltage Directive (2014/35/EU), which is a CE marking directive.

The sizing, as mentioned above, is assumed to be 100 W/m² (can be lower or higher depending on the type of building envelope), while warmer climates require higher specific W/m² for cooling and colder climates need higher W/m² for heating usage.

An additional factor to consider is the distance between the indoor and outdoor unit, which requires additional refrigerant charge. Typically in the EU and UK markets, split models allow up to 20 m piping length, some even up to 30 m distance to ensure sufficient installation flexibility.

The diagram below shows how the German Ecolabel model compares to the refrigerant charge limits defined for a wall mounted indoor unit in the current IEC 60335-2-40 safety standard (edition 6 = straight blue line) and the revised safety standards (edition 7[6] = dotted lines).

The red area in the graph means that the application would be considered unsafe unless it was installed in a machinery room or completely with all components outdoors, which is not the case with air-to-air split units.

The R-290 refrigerant charge is 380 g for a piping length of 5 m and requires 12 g per extra meter, with a maximum piping length of 20 m. The max refrigerant charge is therefore 380 + (15x12) = 560 g.

To repeat our conclusions made above (Pdesignc = 3.5 kW, Pdesignh = 2.4 kW, SEER = 8.5, SCOP = 4.6), with a specific design of 100 W/m² (heating and cooling), this single split unit is suitable for cooling a 35 m² room, but in heating mode it can only serve a 24 m² room to function as a real heat pump.

Plotting the standard charge of 380 g and the max charge of 560 g on the graph, it shows that a 24 m² room is just on the boundary line of acceptable safety, on the condition that the unit complies with enhanced tightness (Ed 7, neither finalised at global level, nor harmonised as EN standard). Under the current safety standard (Ed 6, not yet harmonised as EN standard), the unit is only acceptable as safe if the piping length is limited to 5 m (with the standard refrigerant charge of 380 g). This means the unit minimum room size is around 24 m², which is at the same time the maximum room size it is able to provide heating for. Obviously, split air to air heat pumps need to be developed for a range of room sizes, and not exactly for one room size.

[6] Not yet adopted at IEC level and typically taking several years to be adopted as an EN harmonized standard.

In case 200 W/m² is applied (the heating space is 12 m²), the product is not suitable according to the current safety standard.

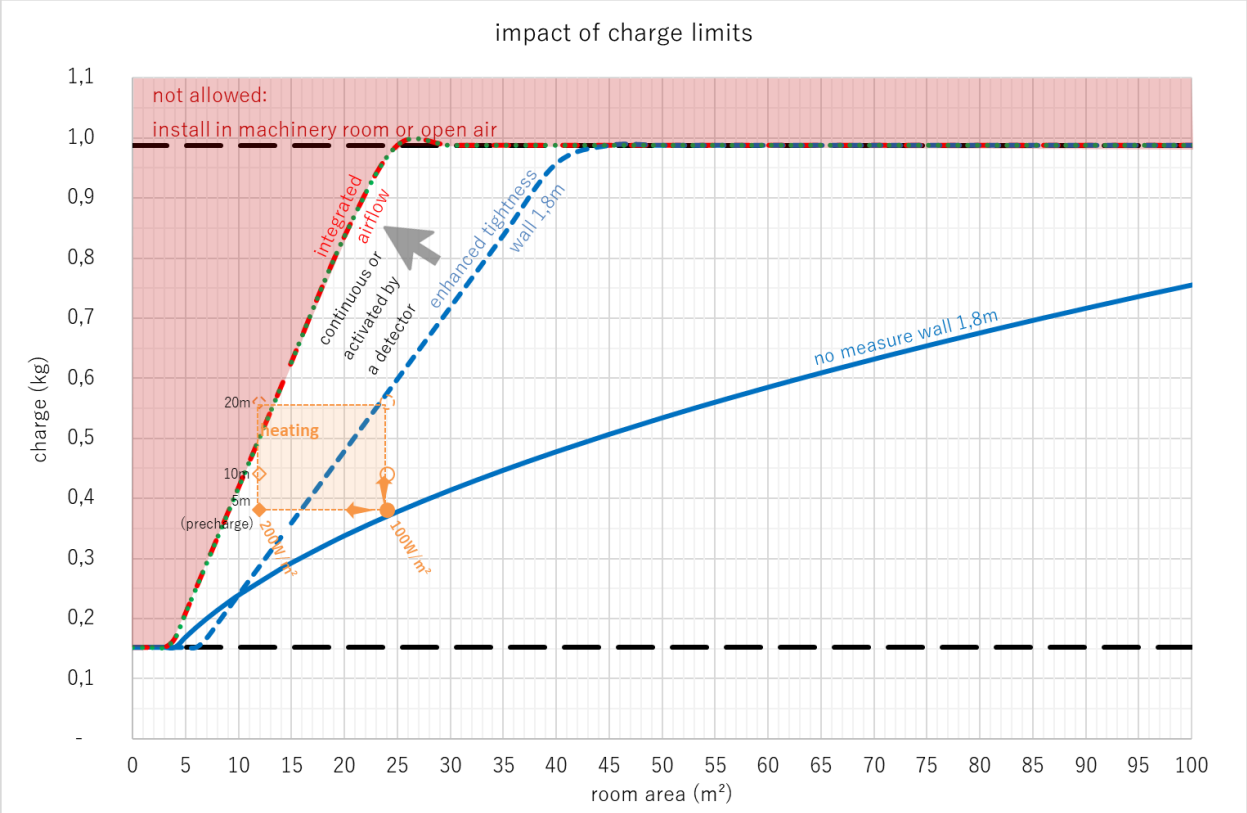
If, according to the revised standard (Ed 7), the integrated air flow rate is applied to the maximum allowed pipe length of 20 m, the product would fall into the red zone. Note that there are products on the EU market which even require flexibility to go up to 30 m piping distance.

The likelihood to be in the red zone increases for units with a smaller capacity (smaller size rooms or rooms with more than 100 W/m² load) due to the size of the room, as well as for units with a larger capacity which need higher refrigerant charges.

In edition 7 of the IEC standard, an additional provision allows to use the maximum releasable charge instead of the full equipment charge, based on several conditions. This extends the possible scope of application, however we have not seen any evidence that this would result in a possible range of R-290 products up to 12 kW.

As existing Ecodesign studies already demonstrated, in order to obtain highly efficient appliances for both cooling and heating, the amount of refrigerant must be increased. This applies under the condition of sufficient Pdesign capacities in combination with piping length of at least 20 m (some up to 30 m) and a limitation of the maximum allowable refrigerant charge to 1 kg. A typical difference between an efficiency model with R-32 that is the same as the R-290 Ecolabel model, and the highest energy efficiency R-32 models in the market shows the refrigerant charge difference can be more than 160%.

The example above shows the critical limitation in term of application and efficiency for a relatively small appliance (2.4 kW in heating) and questions the conclusion by the EU Commission and their consultant on the feasibility of using R-290 for higher capacities. We have not seen any evidence or assessment from DG Clima, nor their consultants, that R-290 can be used across the split range (neither up to 7 nor up 12 kW) based on such conditions. We also have not seen such analysis for floor standing indoor units (which have more strict requirements), nor for multi split types.



Legend :

Limit in current edition of IEC 60335-2-40 (Ed 6)
Limit in next edition of IEC 60335-2-40 (Ed 7) without additional measures

Limit in next edition of IEC 60335-2-40 (Ed 7) if product has enhanced tightness

Limit in next edition of IEC 60335-2-40 (Ed 7) if product is foreseen with continuous airflow or airflow activated by detector

Conclusion

The demonstration above shows that, even with the latest more favourable safety standard drafts which will not be adopted and available in Europe for many years, the Öko-Recherche claim cannot be made on the basis of the very limited units in the market and in non-EU markets, nor without a proper assessment.

As installation conditions vary widely across Europe, we do not believe that even small single split systems would currently be able to switch to R-290 let alone higher capacity products .

By assuming so, the future legislative landscape risks leaving the market unable to provide solutions for a large number of cases (to name a few: small rooms/apartments, highly performant heating devices for colder climates.)

About EPEE:

EPEE represents the Refrigeration, Air-Conditioning and Heat Pump industry in Europe. Founded in the year 2000, EPEE's membership is composed of over 50 member companies as well as national and international associations from three continents (Europe, North America, Asia). With manufacturing sites and research and development facilities across the EU, which innovate for the global market, EPEE member companies realize a turnover of over 30 billion Euros, employ more than 200,000 people in Europe and also create indirect employment through a vast network of small and medium-sized enterprises such as contractors who install, service and maintain equipment. Please see our website (https://www.epeeglobal.org/) for further information.