Heating & Cooling equipment: Fixing problems (sufficiency) and/or investing in a new equipment (efficiency)

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Abstract

Space heating and water heating consume over 5,000 TWh/a, nearly 50% of the primary energy consumption of the EU and more than 50% of greenhouse gas emissions in CO_2 eq. (in 2015). Space cooling equipment rates grew in the last years, due to climate conditions and comfort requests.
The most beneficial action to take is *first* to insulate and ventilate buildings to reduce energy needs and improve comfort and air quality by eliminating combustion particles and suppressing mould forming. Though this has to be reminded, whether households retrofit their house or not, they can anyway invest in a new system or develop low-cost strategies to improve their comfort. The H2020 project "HACKS – Heating and Cooling Knowhow and Solutions" works on both these axes: Firstly, for all consumers, especially for those who do not want to or cannot invest in a new system, it recommends strategies on how to improve comfort and air quality and lower energy bills. Secondly, for consumers ready to invest, it identifies and provides lists of most energy efficient products, enabling them to make informed decisions. Illustration: once the decision is taken to invest e.g. in a heat pump system, all other things being equal, there are large performance differences between products on the market.
In order to achieve a fast market transformation, all relevant stakeholders need to be involved: not only manufacturers and consumers but also installers, retailers, consumer organisations and governmental officers that design for example rebate programmes. The paper discusses different strategies to connect those stakeholders, within the HACKS project which is implemented in 15 countries in Europe from 2019 to 2022. It provides a broad overview of different strategies, environments and levels of success. Best practice examples are highlighted as well as the tools developed by the project (papers for each technology presenting the key points to watch, a product database showing market evolutions, a calculator, a catalogue of advices, communication campaigns, etc.).

Introduction – using the Topten approach for heating and cooling appliances

This paper presents the activities and first results of the HACKS project (09/2019-08/2022) – Heating and Cooling Knowhow and Solutions[1] – funded by the European research programme Horizon 2020. HACKS gathers 17 partners from 15 countries, most of whom have been working together for the last 15 years within the "Topten" movement. Topten's goal is to mitigate climate change and contribute to environmental protection, by transforming the market towards more energy efficient products. Since the differences between electrical

[1] For information on the HACKS project and its partners, see https://www.topten.eu/private/page/hacks. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 845231. The sole responsibility for this content lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.

appliances regarding their energy efficiency is still significant even when they provide a same level of service, a careful selection of these goods is key for a sustainable market transformation. Topten facilitates this selection process by providing, on its websites in free access, the latest market information on products to the benefit of consumers, producers and policy makers.
Working within a European network allows benefiting from synergies – when facing global technology developments or international manufacturers - while at the same time presenting market information tailored to the specific needs and context of local consumers.
Topten's main activities are the following:

- Identification and display of most energy efficient products: Products are selected and ranked based on sound market research and impartial evaluation considering criteria specific to the respective national markets.
- Policy advice: By showing the most energy efficient products on the market, Topten provides information on the Best Available Technology (BAT). With this evidence on the BAT, its technical know-how, and its policy recommendations, Topten supports the European Commission and other policy stakeholders in designing effective policy measures, such as minimum energy performance standards and energy efficiency labelling.
- Communication and dissemination: Topten cooperates with the media and other multipliers, such as environmental and consumer NGOs, which relay the Topten message as part of their work. Furthermore, Topten undertakes different communication activities targeting end-consumers.
- Cooperation with public procurers and retailers: Topten provides advice to public procurers, including the development of concrete procurement tools, such as templates for tender documents for example. It furthermore maintains a dialogue with the manufacturing industry of consumer goods, especially on upcoming technological innovations, focusing on the demand and interest for energy saving products. Moreover, Topten cooperates with large public and private buyers, including retailers, who make energy savings one of their priorities.

The start of the HACKS project marks a turning point in the Topten approach. While Topten had been working mostly on plug-in domestic appliances, focusing on heating and cooling appliances opens new dimensions because these are much more complex products which "interact" with the building's envelope:

- The energy consumption of heating and cooling appliances depends very much on their correct dimensioning: a super-efficient but oversized boiler may consume more than a poor performing smaller model. Hence providing advice only on product's performance is insufficient.
- Consumers hardly ever chose themselves the model that will be installed in their home: they (rightly) rely on specialised installers – who form a difficult target to reach when proposing information, training, possible change of suppliers, etc.
- The most beneficial action to take is first to insulate and ventilate buildings to reduce energy needs and improve comfort as well as air quality by eliminating combustion particles and suppressing mould forming. From an individual perspective (potential savings) as from a collective perspective (fight against climate change), this has to be communicated before providing advice on solely changing a boiler – which presents lower potential benefits – even if home insulation is a much bigger challenge and is not an obvious topic when the old boiler breaks down and has to be replaced.

However, whether households retrofit their house or not, they can invest in a new system or develop low-cost strategies to improve their comfort. Hence, HACKS works on both these axes: Firstly, for all consumers, especially for those who do not want to or cannot invest in a new system, it recommends strategies on how to improve comfort and air quality and lower energy bills with the existing system. Secondly, for consumers ready to invest, thanks to continuous market studies, it provides lists of most energy efficient products, enabling them to make informed decisions. For example, once the decision is taken to invest e.g. in a heat pump system, all other things being equal, there are large performance differences between products on the market (lifetime costs can increase twofold for this product group between products selected for their efficiency and least efficient models allowed on the market).

The HACKS project main activities

Heating and cooling: the need for action

Space heating and water heating consume over 5,000 TWh/a, nearly 50% of the primary energy consumption of the EU and more than 50% of greenhouse gas emissions in CO_2 eq. Space cooling equipment rates grew in the last years, due to climate conditions and comfort requests. Heating and Cooling (HAC) equipment are clearly an energy stake for the EU, especially since almost half of all buildings have individual boilers installed before 1992, with efficiency of 60% or less. For over 22% of individual gas boilers, 34% of direct electric heaters, 47%

of oil boilers and 58% of coal boilers, the intended technical lifetime has been surpassed (1-European Commission).
However, consumers in most cases are unaware that their HAC equipment is outdated and that it needs to be replaced (and even if they are aware, the typical attitude for such non visible appliances is for many people to replace only when it breaks). They are also unaware that the economic benefits and their monetization (cost saving, payback periods, demand response) and environmental benefits (improved air quality through a reduction of GHG and fine particles emissions, increased comfort) are very positive in the long-run and permanently reduce consumption. HAC equipment is not a main preoccupation for consumers: it is often located out of sight not prompting thoughts of replacement until it fails. Moreover, consumers are confused by the manifold information available on HAC equipment and alternative solutions. Since for the greater part they are not specialists in the topic, they can get easily overwhelmed by the terminology used in the sector and may feel helpless. In recent years, several Energy Labels have been introduced - simplifying the interpretation of product performance for consumers. However, these also remain rather complex to understand for a consumer with little technical knowledge. In addition, in the HAC sector, consumers depend heavily on third-parties (i.e. installers, retailers) for the selection, purchase and installation of new equipment. If an installer recommends a HAC product, it is very unlikely that consumers will challenge the general recommendation.
This situation, which was anticipated before the HACKS's activities started, was further studied in a so-called "HACKS base line report" (2-HACKS) in which each of the national teams mapped-out an overview for their country:

- The state of the art of heating and cooling technologies, policies and markets: specific national or local regulation for HAC equipment (country-specific minimum performance standards or requirements, mandatory information), or possible national voluntary schemes or labels and support schemes such as rebates, tax incentives, replacement programmes, and energy savings obligations.
- The existing stock and installed technologies, the expected savings per units in given conditions, the expected comfort and health improvements, assessing the HAC practices for the different climatic regions, identifying the most appropriate technologies for each context; and looking for innovative and original solutions that can reduce or offset the use of some HAC equipment.
- The market characteristics for HAC goods and services. It provides a detailed insight on the market mechanisms and structures, the key actors, the market patterns. Understanding the market structure for HAC products contributes to identifying the levers that HACKS partners must address to better reach consumers and motivate them to replace their inefficient HAC equipment.

This assessment helped to set national priorities and identify which systems are predominant in each country, what products should be replaced first; which products and solutions should be pushed to maximise energy savings and improve quality of life; and how to best motivate consumers (directly and indirectly). Thus, it guided the HACKS activities implemented at the national level and described below.

Fixing problems: introducing sufficiency measures

HACKS focuses on installed heating and cooling appliances that represent the most consuming appliances in households with the goal to replace existing equipment that has reached its technical lifetime or that is a candidate for an early replacement (see section below). However, as many households cannot change their equipment e.g. because of financial limitations or because they just rent their home, HACKS also includes in its analysis alternative solutions such as complementary smaller products. Such "energy sufficiency" measures can immediately lower the use or the energy consumption of the more complex main equipment. Examples are comfort fans, sun blinds and shading systems (instead of ACs), or equipment to reduce the energy consumption by reducing the output (saving taps and shower heads consuming less hot water) or optimize the energy consumption (thermostats).
The project has produced a so-called "HACKS Catalogue of Key Information Topics" (3-HACKS) that serves as a basis for national partners: they can find inspiration and adapt the topics to their national situations. The catalogue

- Introduces the concepts of comfort and air quality and recommendations to maintain good air quality
- Provides solutions for reducing the use of heating and cooling equipment while improving comfort and air quality, presenting for heating, hot water production and cooling:
    - contextual information: climate change, money savings, multiple benefits of the proposed solutions, examples of arguments to convince citizens that, whenever it can be, heating, hot water and cooling, should be reduced.
    - solutions relating to the equipment itself: e.g. limiting consumption by insulating pipes, using thermostat and programmers, acting against limescale in water heaters

    - and solutions relating to users' behaviour: e.g. adopting good habits with windows (opening/closing/shading) and temperature settings (appropriate to the room, the time of the day), tackling water leaks.
- Provides advice for choosing highly efficient HAC equipment for a variety of heating and cooling systems: e.g. pros and cons of available technologies, choosing transmitters, tips for a good sizing of the equipment
- Provides advice for using HAC equipment in an efficient way: e.g. maintain a convenient ambient temperature, check the tightness of the refrigeration circuit, use eco-labelled wood pellets, logs or chips.

This catalogue will be further enriched and updated at the end of the project (summer 2022).
Each of the 15 national participating internet platforms thus presents extended advice sections not only on how to choose efficient products but also, generic principles on how to size products and how to use them in order to save energy, or how to e.g. avoid the use of cooling appliances while adapting indoor comfort by using sun blinds on the windows according to their orientation at the right moment of the day, using fans and ventilators, or natural ventilation especially at night, etc. For example, the landing page for cooling advice on the French internet platform proposes several sections: Cooling and climate, Alternatives to air conditioners, How to choose an air conditioner, How to best use air conditioners to consume less energy, Install and maintain an air conditioner (https://www.guidetopten.fr/grand-public/adviser/recommandations-et-conseils-sur-les-climatiseurs).

Investing in new equipment: introducing efficiency measures

HAC products cause a high energy consumption, so information on the energy consumption, costs, environmental aspects and identification of Best Available Technologies (BAT) is very useful. By displaying lists of BAT products, HACKS uses a pragmatic approach and promotes best products and best practices while remaining independent of commercial interests of market actors.
The objective is to participate in filling the information gap exposed above: the 15 HACKS dedicated websites provide precisely tailored information on the available solutions, organised by product categories (e.g. heat pumps, solid fuel boilers) providing consumers in a credible manner with clear recommendations on how to choose energy-efficient products, how to interpret the energy label, and with lists of super energy efficient models for each category online. Providing this comprehensive information aims at unlocking the full potential of multiple benefits of energy efficiency improvements. These multiple benefits can be a higher thermal comfort, a better indoor air quality, a reduction of environmental impact, an improvement of aesthetics, of the controls for the users, an added value for the property.

To reach these results and identify the BAT products (of which an example is provided in Figure 1), the project first developed so-called "Criteria papers" (4-HACKS) for eight product groups, i.e. a detailed research on air conditioners, circulation pumps, comfort fans, local space heaters, solid fuel boilers, space heaters, water saving taps and shower heads and water heaters. The primary objective of these papers is to help HACKS partners to develop knowledge on new product categories (as most partners do not rely on own engineers for the HACKS works), but the technical content may also support any interested person willing to find good products from an environmental point of view. Each paper is between 15 and 20 page-long and presents:

- an overview of the product's role in buildings
- the current EU regulations that apply for the product category, the expected impacts of those regulations, and the tools they provide to identify best products: energy labels and mandatory declarations in product fiches (e.g. power levels, type of refrigerant)
- proposed selection criteria for best products (those used by the European platform www.topten.eu)
- a brief technical overview is given (and more detailed technical input in annex)
- the list of product characteristics that will be relevant for consumers
- recommendations on how to find the data for this product category through market research
- additional information in the form of useful links, a glossary and a FAQ section gathering important topics for consumers

Each national partner then performs a market research for its country, assesses the selection criteria allowing to select only the most efficient models available on their local market (since the product offer is not homogeneous across Europe), double-check on paper the energy efficiency indexes that can be recalculated from the products' declarations, and displays those criteria and the corresponding product list on their website (Table 1).

Table 1 – Overview of the different HAC product categories displayed on the national platforms participating in the HACKS project

Equipment	AT	BE	CZ	FR	DE	IT	LU	PL	PT	ES	NO	LT	SE	UK	CH
Ventilators		✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓
Air conditioners	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓			✓
Intelligent thermostats															✓
Heat pumps	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Solid fuel boilers	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓	✓
Wood Pellets							✓	✓							
Local space heaters	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Heat pump water heaters	✓	✓	✓				✓	✓	✓					✓	✓
Electric water heaters, combined water heaters												✓			
Dehumidifiers															✓
Humidifiers			✓												✓
Taps and shower heads		✓	✓			✓		✓	✓	✓					✓
Circulation pumps		✓	✓			✓	✓	✓			✓	✓	✓		✓
Windows								✓					✓		✓
Insulation materials	✓						✓								
Doors								✓							
District heating													✓		
Windows								✓							
Solar Thermal collectors								✓							

Partners adapt selection criteria to their national market, from the consumers' perspective – e.g. if there exist national labels to rely on, if there are a lot of small manufacturers to review, if the offer is not very good from the energy point of view, etc. For example, to select the heat pumps displayed in France, the HACKS partner used the criteria paper on heat pumps, cross-checked and merged product information from three sources (Topten.eu, Eurovent and EHPA databases), did a lot of internet research to complement the information and assess national availability of products, before deciding to base its selection criteria in terms of energy efficiency index. Different levels were chosen for the low temperature models (suitable for floor heating) and the high temperature models (suitable when using radiators) because the market research showed that there is no correlation between the two indices (a model can be super-efficient when used at 35°C but not particularly efficient when used at 55°C or vice versa). The precise levels of efficiency were set so that the product list would not be too long (selecting the really most efficient models) but would at the same time cover different brands and if possible price ranges. As an illustration, for the air to water type of products, the best "picture of the market" that was reached listed 763 models from 64 brand offered on the French market. After verifications (elimination of duplicates, of products lacking information, etc.) the list was reduced to 577 models from 56 brands; setting the selection criteria at eta_LT<190 (energy efficiency for the low temperature models) allowed to reduce the list to 54 models from 21 brands (it would have been 105 products with eta_LT<185), which after further verification on their effective availability went down to 43 models from 15 brands.

Figure 1 shows an example of how the product lists are displayed for the most energy efficient heat pumps models available on the Swiss market. Visitors can filter products, change the sorting order and click on product to see its full detailed information and a link to the manufacturer's website. The objective is to guide consumers in the hundreds of products available (as they cannot individually undertake the market studies carried out by the HACKS teams), select only the most efficient ones but provide enough choice (for example by not limiting the selection to only one brand).

The HACKS criteria papers and the European platform www.topten.eu focus on benchmarks at the European level and evolution of products from a technical point of view. Figure 2 shows an example in which the Topten selection criteria for circulation pumps were tightened in April 2020 from maximum efficiency index[2] 0.20 to 0.18 (0.23 is mandatory in Europe since August 2015 according to Ecodesign Regulation (EC) No 641/2009 for glandless standalone circulators and glandless circulators integrated in products). The reason for this was that a large set of new product data became available from a fourth manufacturer in March 2020 after six months of

[2] The lower the energy efficiency index, the more efficient the product.

communication. Manufacturers do not have influence on the Topten selection criteria but they are generally contacted:

- to complement desk research data on products' characteristics,
- in case of doubt on a product performance, e.g. if the energy class calculated by Topten is not the same as the one declared by the manufacturer. If no answer is provided or if the doubt persists, the product is not displayed on-line by Topten and may be signalled to national market surveillance authorities,
- when the selection depends on product information manufacturers are not obliged to publish. Though it is difficult and takes time, the Topten experience shows that it is possible to ask also for such information (e.g. an energy consumption according to a specific standard): at first, only front runner manufacturers accept to communicate and their products may be the only ones displayed, until their competitors want their products displayed as well, until it becomes an information that almost all manufacturers reaching a certain level of efficiency want to communicate because they want to be seen on the Topten websites. This incentive process can also support the data gathering and development of regulations at the European level (as seen in the case of professional cold products (5-ProCold)).

Figure 1 – example for the Swiss HACKS platform: www.topten.ch

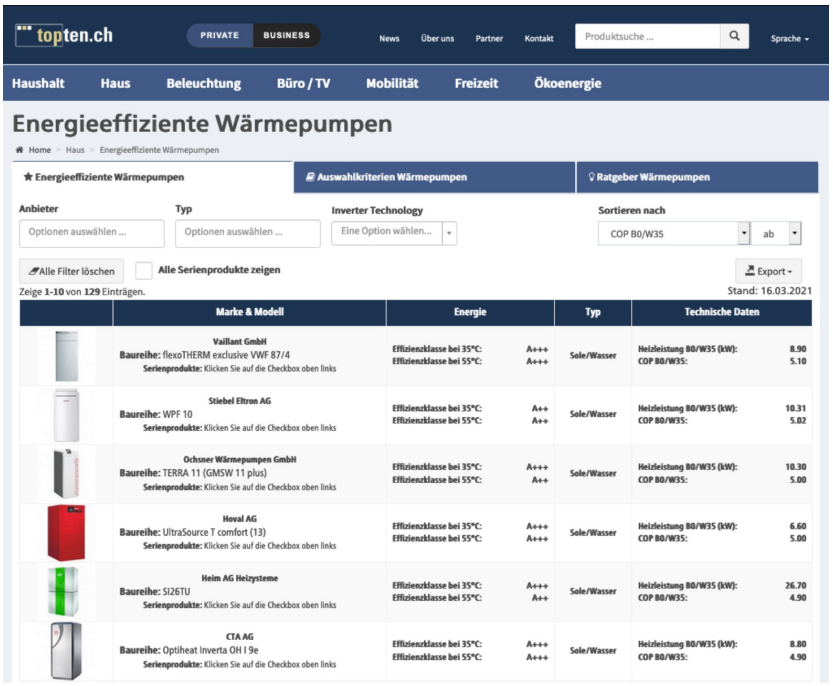
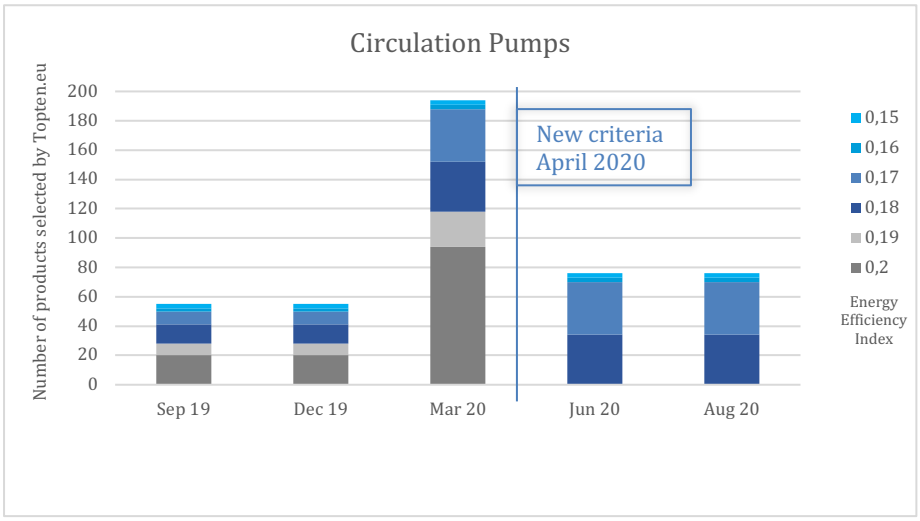


Figure 2 – Evolution of the number of BAT products list for circulation pumps on www.topten.eu between September 2019 and August 2020, based on energy efficiency indexes.



Tools supporting both sufficiency and efficiency

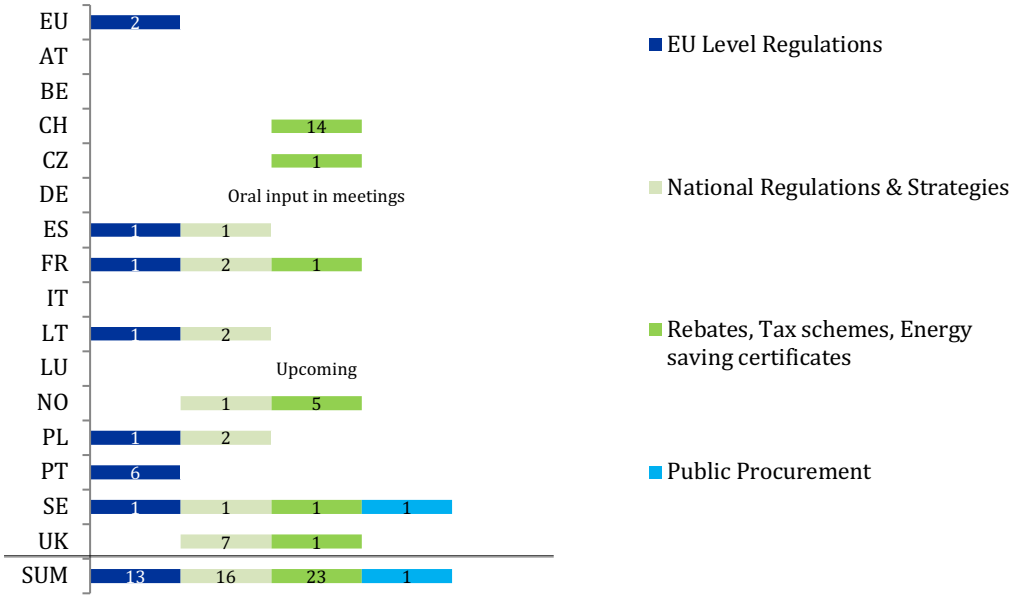
Beyond the BAT product lists and the advice sections, HACKS partners work on two additional tools that combine efficiency and sufficiency aspects.

A first tool is to formulate policy recommendations

During the first year and a half of the project, the HACKS partners have developed a number of policy recommendations for different types of appliances. While the SARS-CoV-2 pandemic is the predominant topic in all countries during large parts of the project implementation period, many governments are still rapidly progressing in compiling climate strategies and / or subsidy programmes to boost the economies also for green recovery. Most partners were able provide relevant policy makers with input on best available HAC technologies, efficiency criteria and suggest ways of integrating this input into upcoming regulations and projects. Before the pandemic hit, in total 53 policy recommendations were submitted between September 2019 and February 2020 for the following four levels of policy instruments (see Figure 3):

- EU level Regulations
- National regulations and strategies
- Financial tools: rebates, tax schemes, energy saving certificates
- Public procurement

Figure 3 – Distribution of the 53 HACKS policy recommendations developed between September 2019 and February 2020



In order to provide decision makers with even more complete input, HACKS partners engaged in collaborations with other environmental and civil organisations and expanded their policy recommendations to include aspects of fair financing and energy poverty, greenhouse gas and particle emissions (air pollution), energy grid development or necessary training of installers. Participation in NGO communications campaigns on European levels was successful in raising awareness not only with policy makers but also the general public (e.g. campaigns from the technical green non-governmental organisation ECOS on air cooling[3]).
Significant progress and momentum in policy development is scheduled for the second half of the project, especially with regards to the coming review of the energy labelling and Ecodesign regulations for heating and cooling appliances.

A second tool is the HACKS's calculator

In order to help consumers and their installers to get a first generic assessment of their current heating system and compare their performance with alternative new systems, the project has developed a simplified calculator[4] (for now it concerns heating but a second tool targeting cooling is under development).

[3] https://www.coolproducts.eu/uncategorized/this-summer-heatwave-goodbye-to-portable-air-conditioners/
[4] English version: https://calculator.topten.eu/?country=uk

Visitors can:

- enter simple personal data on their homes (dwelling area, climate zone, number of inhabitants, current heating system, production of sanitary hot water, etc.)
- select alternative heating systems (more efficient)
- select possible home insulation measures (reduce the energy demand)
- and compare the results in terms of energy needs, energy consumption, costs and CO_2 emissions.

Though the calculator's framework is generic (based on average numbers at the European level), it contains a lot of parameters that are customised for each country. The calculator shows that insulation measures are often more beneficial than changing only the heating system, but also allows comparing average running costs and CO_2 emissions of alternative heating solutions.

Spread the word and disseminate the many HACKS contents

At the midterm of the project, the HACKS project has already produced a lot of content. The challenge to actively transform the market, and even more at the time of the global pandemic which has focused the public's and the media's attention and which has disturbed markets, is to disseminate energy efficiency content. All HACKs partners have developed – and adapted – national dissemination plans with two main axes: direct communication towards consumers and partnerships with stakeholders called "multipliers" because they multiply the HACKS messages towards their own networks and target groups.

Targeting the media and consumers

As all projects supported by H2020, HACKS has set itself goals in terms of dissemination and two specific reports (February 2021) present the partners' activities during the first half of the project with this regard: the HACKS Media outreach campaign (6-HACKS) report and the HACKS Consumer involvement campaign report (7-HACKS).

Media outreach

The HACKS partners have each elaborated a marketing plan to promote the content they produce on energy efficient heating and cooling products and solutions. The content is available on their national HACKS online platform, often hosted on existing Topten platforms, that benefit from an already existing awareness. All marketing plans of the partners include a strategy on media outreach, covering online and offline publications across partner countries, informing consumers about the HACKS campaign.

Collectively, partners should reach 20 million media contacts (listeners, readers and viewers) in the final year of the project (September 2021 – August 2022). Most partners will calculate at the end of the project the equivalent economic value of coverage received in journals, magazines, newspapers and websites, with the objective of reaching a media coverage worth half a million Euro if they had had to pay of it. As of February 2021, in a context that saw many HACKS activities delayed because of the Covid pandemic, 6,614,630 people have been reached with information on HACKS. This number is assumed to be under-estimated as for some partners it covers only the social medial reach and not yet the online and print press reach.

The defined target concerning page views is to reach collectively between 900,000 and 1,750,000 page views in the last year of the project (cumulated between September 2021 and August 2022). As of end of January 2021, HACKS-related content on partner websites reached 898,343 page views since the beginning of the project (in September 2019).

The activities undertaken are of various types: preparing short TV transmissions, a video for the WWF YouTube channels, producing press releases, newsletters, using Twitter, Facebook, Linked-in but also Whatsapp message feeds, and other social networks and news channels.

Consumer involvement campaigns

The consumer campaigns aim at involving citizens and raise their awareness about the benefits of efficient heating and cooling equipment. They should inform and motivate consumers to replace their old and inefficient heating and cooling equipment by online and offline media activities.

Once the product lists and advice pages are displayed on the respective internet platforms, national teams continuously work on their visibility (e.g. through specific pages, Search Engine Optimisation activities, sometimes keywords campaigns, production of infographics, of a comic book) and on interaction with visitors (online contact forms, FAQ sections).

Depending on countries, they provide as many services as possible to visitors, such as:

- "Deep links" allowing visitors to click on a specific product of his / her interest to see where it is sold and possibly buy it (in 5 countries). This service is at an experimental stage at the moment, and concerns a limited number of product categories because the HAC products are most often sold by installers not using deep links. For the more standardised products such as ventilators, when online retailers are too numerous to

feature all of them on the HACKS platform, their selection is based on retailer's acceptance to provide information on- and to link back to the HACKS/Topten platform. When this is not possible or when the process is starting, the HACKS partners try to establish links towards comparison sites in order to provide the widest possible choice to their visitors.

- Raffles and competition (13,000 consumers have participated in a HACKS raffle in four countries).
- Rebate overview for HAC products when they are available from governmental and utilities' efficiency support programmes (in five countries).
- Links towards certified installers (in four countries)
- Cooperation with consumer organisations (in six countries).

Working with multipliers

The success of HACKS in achieving market transformation for heating and cooling appliances lies deeply on the participation of several key stakeholders - called "multipliers" because they relay the HACKS' messages to their own target groups. Their wide variety of expertise, networks, communication channels and connections with consumers contributes to the development of different and important activities together with the partners. Multipliers include various stakeholders; each has its own specific characteristics that will be brought to the partnership, such as contact networks, inputs, language, communication channels, audience and that will improve the project's capacity building capabilities. Also their expectations differ and require different approaches, collaboration methods and tools, which partners have to take into consideration.

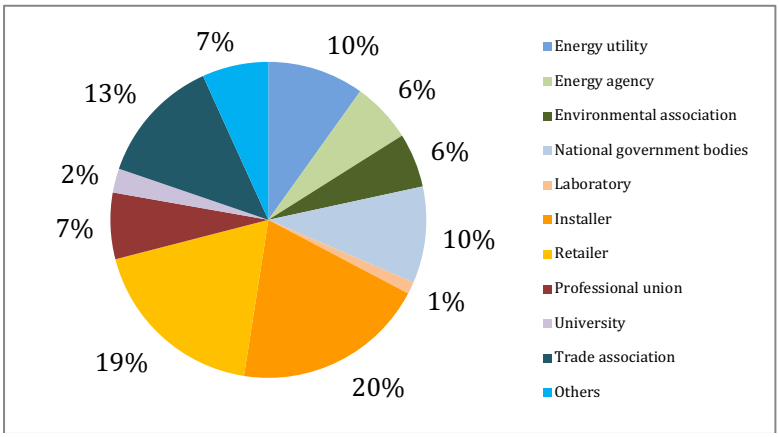
- Retailers and installers are key actors for this project as they make the direct link between HAC products manufacturers and consumers. Their influence on both is very relevant and crucial for the project, but the technical way to engage and cooperate with each one is very distinct and challenging especially for installers.
- National authorities and decision makers are responsible for policy design and definition of financial mechanisms, so their involvement is important to boost market transformation towards more efficient HAC products on the basis of real market data.
- Environmental and civil organisations support consumers decision making and have direct contact with specifically needed target groups. Their contact networks are usually very broad and organised and additionally they often have well-established projects, campaigns and communication channels where these issues can easily be integrated.
- Utilities and housing associations are focused on their brand reinforcement and on their clients' satisfaction. Participation in projects like HACKS is appreciated because it is good for their image on the market. Moreover, utilities often have legal obligations regarding energy efficiency measures.
- Universities and research centres can provide the technical knowledge essential for the development of project specific content and activities and for the collaboration with some stakeholders. They benefit from the access to updated market data.
- Professional and trade associations, though generally not energy efficiency-oriented, may profit from the project's simple language and overall reach, to promote their expertise. They represent a good starting point to contact and engage retailers and installers (and manufacturers who are often contacted when preparing the BAT product lists).
- Professional (private and public) procurement can profit from detailed specifications and tailored information to be used in their calls for tenders in order to reduce their operating costs. Although globally progressing still at a low pace, as price is still the prevalent factor in the decision-making, Green procurement is gaining momentum. That is why, when they exist, shining examples for efficient and cost-effective equipment are important drivers for market transformation.

In the first half of the project (September 2019 – February 2021), all partners have developed activities with multipliers and engaged with new ones. However, the fact that six months after the beginning of the HACKS project, a general forced lockdown due to the coronavirus pandemic had a huge impact on most of the planned activities: Most public meetings, participation in events, face-to-face contact campaigns were put on hold, affecting important dissemination and visibility activities to initiate new contacts that could not be equally compensated by new approaches like video conferences.

Nevertheless, benefitting from previous partnerships that could be extended to the HAC topic, partners managed to reach 142 partnerships (Figure 4). A detailed analysis of these partnerships is presented in the HACKS report on the Multipliers' involvement campaign (8-HACKS). HACKS partnerships are for example:

- A utility or a local government using the BAT product lists as a basis for rebate programmes
- Co-organisation of workshops on energy poverty
- Energy advisers being informed of the HACKS services`
- Participation in European wide campaigns organised by environmental NGOs
- Technical input for policies on building renovation
- Working with installer and retailer networks
- Research projects on BAT products

Figure 4 - Distribution of the 142 HACKS partnerships with multipliers (February 2021)



Project Evaluation, conclusions and outlook

HACKS, while implementing the Topten approach, covers a wide range of activities, from detailed market and technical studies to dissemination to various target groups including the general public. This versatility offers many different types of indicators for evaluation. A city modifies its procurement policy; a utility decides on a rebate programme; policy makers favour ambitious regulations; NGOs communicate on energy savings in homes in order to link individual behaviour and climate change issues; retailers choose to adopt energy efficient positioning and revise their product range; installers dedicate more time and attention to best practices; manufacturers develop new efficient models and strongly market them; consumers' demand for efficient models grow – Though these decisions depend on the strategies stakeholders decide to adopt, HACKS may weigh, more or less explicitly, in all of these decisions transforming markets.

The Topten approach has been carried out at the European level since 2006, in up to 18 countries, covering each time more product categories. It has been evaluated roughly every three years within given projects funded by the European Union. The last available evaluation carried out by the Oeko Institute (9-Topten Act) concluded, for a 42 months project implemented in 16 countries, the following cumulated lifetime savings of products purchased due to the Topten websites:

- electricity savings of over 1,000 GWh
- electricity costs reduction of 216 million Euros
- and reduction of GHG emissions of 607,000 t CO_2 eq

This evaluation was based on a visitors' survey on super-efficient products' purchases. Additional indicators were taken into account such as collaboration with retailers further promoting BAT models, the organisation of product competitions stimulating product efficiency improvement and collaboration with professional procurers which purchasing power influence the market development.
Although several teams used their Topten knowledge to produce policy recommendations for EU Ecodesign and Energy Label regulations, these recommendations were not included in the calculations of the project impact. However, an external study, conducted 2015 by a renowned evaluation specialist on behalf of the WWF (10-INFRAS) has shown that the impacts of the Topten policy recommendations exceed by far the other types of impacts. One example of Topten's successful intervention in the policy making process at EU-level is the tightening of the A+++ class for air conditioners by about 10%. Thanks to its market analysis and testing of products according to the new standard, Topten revealed that appliances on the market were already fulfilling the first planned A+++ class requirements before the enforcement of the new label in 2011.

In the framework of the HACKS project, the funding programme Horizon 2020 asked for an evaluation in terms of saved GWh and involved consumers. A methodology has been developed and accepted by the EASME (European Agency for Small and Medium Enterprises, which manages H2020) to assess these as best as possible considering the fact that, within the market transformation tool box, HACKS/Topten is considered as a "soft measure" in the sense that it provides factual information and link it to positive outcome (energy demand reduction thanks to the transformation of the demand and of the supply sides of the market) – as opposed to "hard measures" (such as investments in R&D leading to a higher machine's output) which impacts are easier to quantify.

A series of indicators is monitored and will be used to evaluate the savings and related avoided CO_2 emissions or to convert into "involved consumers". This evaluation is planned for the last year of the project when the new HAC product categories will have been fully developed (September 2021 – August 2022). A first evaluation at least on the savings was already done at the midterm of the project covering the period September 2019 – March 2021 and is planned to be published in June 2021 (11-HACKS).

The HACKS evaluation methodology considers project impacts from various sources:

- Pages views on the HACKS platforms for 40% of the impact. A certain share of the page views lead to expected actions taken by consumers, which allows the calculation of saved kWh based on assumptions concerning the actions, the products, their lifetime, energy consumption and expected savings. The consortium performed an analysis of the EU stock, EU sales and energy efficiency benchmarks for each product group to project product improvement based on research from the EU preparatory studies, knowledge on technologies, and the partners' experience with HAC equipment[5]. For each product group, a number of page views is estimated as necessary to consider that one consumer realises the projected savings.
- Media contacts (defined as when a reader, a listener or a viewer has been in contact with the project such as through a published article, or e.g. as part of a television programme) for 15% of the impact. Here also, based on expert judgement, a number of media contacts is estimated as necessary to consider that one consumer realises the projected savings.
- Partnerships with stakeholders (installers, retailers, consumer organisations, other multipliers) for 30% of the impact. A conservative assumption of 600,000 saved kWh over the cumulated product's lifetime was assigned to each partnership (for example if a partnership is concluded with a retailer improving its range of fixed ACs and training its salespersons in the use of the HACKS calculator).
- Actions targeting manufacturers for 15% of the impact. The assumption of expected savings per manufacturer involved as the effect of the project duration is also set at a relatively conservative hypothesis (1 GWh in average over the cumulated product's lifetime). The Topten platform's experience shows that displaying energy information for specific products – i.e. bringing transparency to the market – stimulates manufacturers; many of them make a lot of efforts to improve their product's efficiency and performances (including changing their product lines) to be able to feature their products online.

The four above indicators were monitored during the first half of the project in the participating countries, (i.e. not yet at the project's cruising speed, and sometimes still with missing information) resulting in savings of 243.9 GWh final energy and providing evidence that the HACKS project is on track to deliver the expected savings by the end of the project.
In addition to this quantitative encouraging preliminary evaluation, it is interesting to note that the Topten approach seems to also fit less standardised products that it usually works on: there are very large energy performance differences between products on the market. It is important to underline those differences, even if for a heating or a cooling system it is also crucial to work on the building's envelope with which the system interacts, in order to first reduce the energy needs for the heating and cooling services, before identifying which technology and which model is best suited. The challenge for the second part of the project will be to convince installers and retailers to use the HACKS inputs to change their daily practices and provide their client with arguments to choose the most efficient products and solutions.

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All the HACKS documents can be downloaded from https://www.topten.eu/private/page/hacks-deliverables

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