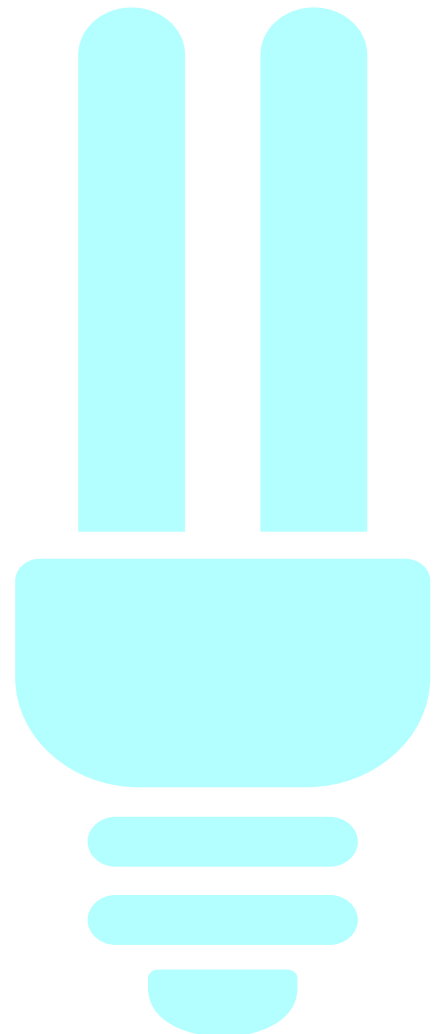


BRIEFING NOTE C

Delivering More Efficient Refrigeration, Air-conditioning and Heat Pumps: Policy, Financing and Investment



MAY 2018

Scope of the briefing note

The Ozone Secretariat has prepared three briefing notes to support parts A, B and C of the 9 – 10 July 2018 Vienna workshop on energy efficiency opportunities in the context of phasing-down hydrofluorocarbons (HFCs).

This briefing note, intended for part C, discusses the promotion of efficient refrigeration, air-conditioning and heat pump (RACHP) equipment, looking in particular at:

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- the most common policy measures used to improve RACHP equipment efficiency;
 - the role of research, development, deployment and diffusion (RDD&D) to improve efficiency; and
 - financing options to stimulate investments including innovative approaches and business models;
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The purpose of this information note is to provide a background for the parties. It is not meant to be exhaustive or in any way prescriptive.

Policy measures to improve the efficiency of RACHP systems

Towards a holistic strategy for RACHP efficiency

Before looking at specific policy measures, it is worth considering the ultimate goal of developing RACHP efficiency policies. For most governments, that goal is likely to be a combination of meeting the legitimate needs of consumers for thermal comfort, safe food and medicines while using the smallest amount of energy and keeping greenhouse gas emissions as well as costs to a minimum. Translating this goal into specific targets or outcomes – and developing a coherent policy for achieving them in the context of broader energy and environmental policies – can benefit from a holistic strategy. It is also important to note that some governments may choose to work together to identify and implement the most effective policy measures.

The strategy for RACHP-related policies adopted by any government would be most effective if compatible with, and integrated into energy and environmental policies generally, and specifically those policies that apply to buildings and in some cases transport. Failure to do so may result in inconsistencies, inefficiencies and contradictions. For example, energy labelling of air conditioning equipment will be far less effective in encouraging people to purchase highly efficient systems if electricity prices are heavily subsidised and consumers' energy bill savings are not large enough to justify the purchase of more efficient equipment. Taking varying national circumstances into account could promote the development of a coherent and effective RACHP efficiency policy – the current state of the market, the outlook for refrigeration, cooling demand and energy use, economic drivers, social and cultural considerations and national traditions surrounding policy-making. Effective policies often start by involving stakeholders through a public consultation on the development of a long-term vision and strategy aimed at achieving the policy goals.

Specific policy measures and interventions

The basic formula for an effective policy suite for energy efficient RACHP generally includes a combination of three basic 'ingredients':

- i. regulations** such as minimum energy performance standards (MEPS), which remove the poorest performing equipment and systems from the market;
- ii. information** such as labels, databases, tools, and training courses for a wide range of market actors including producers and end users (consumers); and
- iii. incentives** such as subsidies or tax rebates to increase the uptake of high efficiency products.

This combination of policies is commonly used to promote a range of efficient technologies such as in home appliances.

Measures targeting small mass-produced equipment

Regulations covering MEPS, for example, are well developed in many economies including China, India, the EU, US, and Australia. These can be easily replicated in economies that do not have such standards, and there is the opportunity to make them more stringent in most economies with little or no observable impact on purchase price. For small RACHP equipment, this is the most important measure to improve energy efficiency.

Providing information to market actors is key to enabling economically informed decisions to be made, especially if there are up-front costs to higher efficiency. Mandatory comparative energy labelling, intended to provide purchasers with information about the efficiency of products on the market, is also useful for policy makers to understand the market better for future regulation. Endorsement labels, such as ENERGY STAR¹, that simply draw attention to the most efficient products can be very effective in some situations because they make it very easy for consumers to buy more efficient products. They are also very useful as the basis for green procurement programmes and incentives.

¹ ENERGY STAR (www.energystar.gov) is an endorsement label that was established by the US Government in 1992 to provide simple, credible and unbiased information on energy efficiency that consumers and businesses rely on to make well-informed decisions.

Incentives may be useful to persuade the market to purchase more efficient equipment or systems. These can include subsidies, rebates, and tax incentives. For example, the Enhanced Capital Allowances in the UK allows companies to offset high efficiency investment costs against profits made. Other examples of financial incentives include:

- bulk purchasing schemes, which reduce the cost impact of new technologies by creating economies of scale for equipment suppliers and thereby also reduce the costs for end-users;
- utility obligation schemes, which incentivise electricity utilities to subsidise high efficiency RACHP products, based on the projected savings from reducing the need for building new generating capacity; and
- design support initiatives, which encourage end-users and equipment designers to investigate properly all energy efficiency opportunities prior to an investment decision.

Although incentives may have an impact on public budgets, they can be used strategically and in concert with regulations and labels, for example, to develop the high-efficiency end of the market, which in turn allows more stringent MEPS to be implemented in the future. Figure 1 illustrates the way regulation, labelling and incentives work together to transform the market.

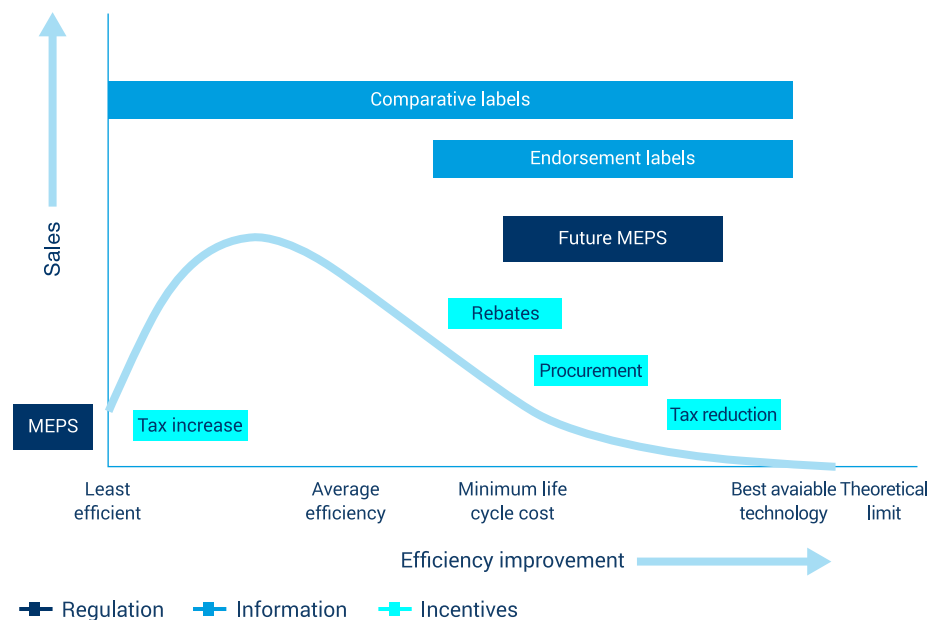


Figure 1: Market transformation policies to improve the efficiency of RACHP equipment²

More information on financing, including financial incentives, is provided in section 4.

2 IEA, 2018: Perspectives for the Energy Transition: The Role of Energy Efficiency, available at www.iea.org

To be most effective, performance-specific interventions and policy measures can be complemented by broader national level policies covering building energy codes and standards (regulations), fiscal policies (incentives), and equipment energy labels and capacity-building programmes (information). At the same time, national governments' support for energy-efficiency policies at the local level, where investment decisions are often taken and implemented, can greatly facilitate market transformation. An effective policy suite could therefore also include local policies, planning and building energy code enforcement (regulations), targeted financial incentives for buildings, equipment, pilot and demonstration projects. Policy responses should also ideally address the capacity needs in the public system for policy making, implementation, enforcement and sector development³.

For small mass-produced equipment (such as domestic refrigerators or room air-conditioners), the combination of information initiatives (e.g. energy labelling schemes) and regulatory measures (e.g. MEPS) is well suited and can be justified in terms of contributing to national energy savings or climate targets as well as multiple benefits generated.

Measures targeting larger equipment and systems

Different types of intervention may be required for other parts of the RACHP market; in particular for large building air-conditioning systems as well as retail and industrial refrigeration systems. The approach described above may be less suited for these systems for two main reasons:

- i. testing and performance requirements are difficult to standardise, replicate and scale across a range of relatively non-standard or bespoke systems; and
- ii. testing of equipment may be much more costly, making compliance monitoring and reporting more expensive to undertake.

In these cases, efficiency improvements in larger systems typically combine a different mix of interventions across the supply chain, and can include:

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- training of designers of buildings and industrial processes;
 - training of builders and equipment installers;
 - accreditation schemes for builders, installers and installations;
 - regular reporting of energy consumption and carbon emissions;
 - mandatory energy audits;
 - the use of energy management systems (EMS), such as ISO50001⁴, with tax incentives tied to the roll-out of such systems; and
 - specific requirements related to ongoing and regular maintenance of RACHP systems to ensure equipment runs at optimally efficient levels, any leakages are detected, etc.
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³ IEA, 2018: *Perspectives for the Energy Transition: The Role of Energy Efficiency*, available at www.iea.org

⁴ <https://www.iso.org/iso-50001-energy-management.html>

It is noteworthy that a number of countries have had positive experiences with the use of Energy Management Systems (EMS) such as ISO50001 to promote efficiency in companies and especially in energy intensive industries that rely extensively on refrigeration (e.g. chemicals, food and beverage production). In Germany, for example, companies can obtain tax breaks for implementing ISO50001. According to recent analysis by the German government, this incentive based program has delivered over twice (3% versus 1.35%) the targeted reduction in energy intensity across the country's production sector⁵.

Supporting or complementary policy measures

As well as implementing policy measures to overcome market barriers, governments could undertake other complementary activities including:

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- messaging to raise awareness about targets that have been adopted to achieve societal and/or sustainable development objectives, such as the Nationally Determined Contributions (NDCs) under the Paris Climate Agreement,
 - messaging to raise awareness about specific energy efficiency targets or the Sustainable Development Goals (SDGs), with information on how these targets impact on RACHP industries in order to provide certainty to different actors, and to increase the likelihood of longer term investments in the sector;
 - messaging to consumers about the multiple benefits of RACHP efficiency improvements;
 - removing 'perverse' subsidies, notably for fossil fuels, which reduce the value of efficiency investment decisions by artificially lowering energy prices;
 - monitoring RACHP markets to ensure longer term targets are on track;
 - undertaking compliance activities to ensure that regulations are being followed and setting a fair, level playing field; and
 - carrying out evaluations of policy measures to ensure they are effective and continuously improved.
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3.

The role of RDD&D to improve the efficiency of RACHP systems

Beyond policy intervention, the rapid development and deployment of energy-efficient and low-carbon technologies in the buildings sector would benefit from strong public support for RACHP-related Research, Development, Demonstration

and Deployment (RDD&D), given the relative lack of private-sector activity. Technologies to improve the efficiency of energy use in buildings experienced vastly different rates of development. Lighting, particularly LEDs and CFLs, has seen enormous sustained growth in patents filed since the early 1990s, which has accelerated further in the last decade. In contrast, technologies for improving building insulation have changed little.

This is due to the commodity-based nature of building materials and products as well as generally low profit margins in the industry, both of which act as a disincentive to invest in research and development. In addition, there is generally a slow rate of adoption of new technologies across the building value chain (which includes designers, architects, builders, installers, etc.)⁶.

The following are some opportunities for effective public RDD&D related to RACHP⁷:

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- a step change in the diffusion of efficient cooling technologies – the average residential air conditioners in use today, for example, operate with a seasonal cooling performance of less than 6, whereas equipment with a rating of 10 or higher are already available on the market⁸;
 - substantial improvements in the performance of other RACHP technologies such as heat pumps, including better responsiveness (the time it takes for heating output to respond to temperature changes) and better control of humidity to reduce the overall need for cooling, particularly in hot and humid climates;
 - a lowering of the cost of high-performance building envelope components, such as advanced insulation, dynamic shading and highly insulated windows;
 - whole-building energy renovation measures with 30% to 50% or greater improvement in energy intensity and with the aim of achieving negative life-cycle costs (positive economic returns relative to investment when energy savings are considered); and
 - a reduction in the cost of solar thermal cooling technology for buildings by 40% or more, including major reductions in installation and maintenance costs.
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The potential economic and environmental benefits of technological advances in RACHP design and operation may justify a substantial increase in RDD&D spending.

6 IEA, 2013: *Transition to Sustainable Buildings: Strategies and Opportunities to 2050*

7 IEA, 2017: *Energy Technology Perspectives*

8 IEA analysis, 2018: Higher figures indicate higher efficiencies. They refer to the seasonal energy efficiency ratio (SEER), which is the ratio of output cooling capacity to electrical energy input, adjusted for the overall performance of the device for the weather over a typical cooling season in a given country.

Financing RACHP efficiency

Increasing energy efficiency usually requires an upfront investment cost, with the benefits being repaid in the future. Many energy efficiency investments are currently self-financed from savings, revenue or tax revenues; for example, households could use savings, income, loans or (re)mortgages. An IEA investment report suggests that as much as 60% of all energy efficiency measures are self-funded⁹. In addition to self-funding, there is also a wide range of financial instruments currently available that seek to overcome the issue of up-front energy efficiency investment costs, for example:

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- **Dedicated credit lines**, or soft loans, where public funding decreases the cost of energy efficiency measures, and includes concessionary terms such as repayment periods.
 - **Energy service contracting**, through the use of ESCOs (energy service companies), to reduce the energy bill of the beneficiary. The ESCO may install more efficient equipment, or use less expensive fuel sources.
 - **Energy performance contracting (EPC)**, where an ESCO provides the energy efficiency improvement and the beneficiary of the measure pays in relation to contractually agreed improvements in efficiency or energy savings.
 - **Leasing**, where the beneficiary obtains the use of efficient equipment or plant, on a rental basis.
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These mechanisms have usually benefitted from seed funding from public resources such as national treasuries or from international funding sources such as the multilateral development banks and some bi-lateral development agencies. The long-term aim is that they become commercially viable and the market offers them as services without any form of public funding.

The government role becomes one of maintaining an enabling environment to allow the market to function. More and more new financial products and business models are emerging which aim to overcome large upfront costs of upgrading and purchasing new systems, and even periodic maintenance costs¹⁰. Examples include:

⁹ IEA 2014, *World Energy Investment Outlook*

¹⁰ EEFIG (Energy Efficiency Financial Institutions Group) (2015), *Energy Efficiency – The First Fuel for the EU Economy: How to Drive New Finance for Energy Efficiency Investments, Final Report Covering Buildings, Industry and SMEs*, EEFIG, http://bpie.eu/wp-content/uploads/2015/10/Final_Report_EEFIG_v_9.1_24022015_clean_FINAL_sent.pdf

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- **Energy service agreements (ESA)**. These pay-for-performance service contracts are between a third-party investor and an asset owner, and aim to deliver energy savings as a service. An ESA is an extension of the shared-savings models or similar provided through EPCs but the arrangement is simpler because the fee for service is not linked to energy savings that may vary over time and often require some form of monitoring and verification.
 - **Energy efficiency investment funds** that seek to invest in energy efficiency projects, often targeting the generation of ongoing operational cost savings and carbon emission reductions. Their funds are usually from socially responsible investors and public financial institutions.
 - **On-bill financing and repayment**, where the energy supplier pays for the up-front investment, which is repaid through the beneficiary's energy (or other) bill.
 - **On-tax financing**, where an up-front investment is repaid through beneficiary's tax returns. The liability is linked to the building.
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Both on-bill and on-tax financing are attractive as means to collect future payments and are well established (e.g. energy bills and local tax bills). By building on a previous payment collection structure, there is a credit history, and a lower likelihood of defaulting. This increased level of repayment certainty should also mean a lower repayment rate.

5.

Wider (non-equipment) energy efficiency considerations

Alternative approaches to reducing energy consumption can complement efforts to improve the energy efficiency of the RACHP equipment. Here are three examples:

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- Comprehensive planning and design techniques such as district cooling.¹¹ District cooling has potential to reduce electricity demand from air conditioning at times of peak load, helping to avoid expensive transmission system upgrades, electricity capacity additions and decentralized backup generators in the case of some developing countries to deal with prolonged blackouts.

¹¹ District cooling systems supply cold water through pipes in combination with cold storage. Cold water can be produced from waste heat (such as from power generation or industry) through the use of absorption chillers; from free cooling sources such as lakes, rivers or seas; and via electric chillers.' District energy in cities, UNEP 2015.

- Sustainable energy transition through buildings policy to incentivise planning and reward energy performance at district level rather than exclusively for individual buildings. The combination of district and building-level efficiency is helping cities around the world realize cost-effective de-carbonization of heating and cooling demand in buildings by i) providing scale to integrate large-scale renewables and waste heat and ii) optimizing energy efficiency across multiple buildings.¹²
 - A broader approach to reduce or eliminate the need for the space cooling and refrigeration services altogether. For example, two different approaches can be used to reduce or eliminate the demand for data centre cooling. The first is to locate data centres in cool geographic locations – then ‘free’ cooling can be used. Facebook and Google have located their server farms in northern Scandinavia, where the cold ambient climate greatly reduce the need for equipment cooling.¹³ Alternatively, it would be possible to design the computers to run at a steady but much higher air temperature e.g. 30°C instead of 20°C – then free cooling can be used even in relatively warm climates.
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6.

Concluding comments

Achieving greater efficiency of RACHP equipment can be greatly facilitated by policy intervention. Given the nature of the market and the number of barriers that exist, it is unlikely that the market would transform on its own.

Fortunately, a number of tools are available to policy makers looking to achieve that kind of transformation. Regulations, information and incentives are the most common tools used by policy makers, with an important distinction between how these are applied to the two main types of RACHP equipment (small versus large). In addition, policy responses to rising cooling demand can be more effective when developed in a holistic manner, in concert with other energy policies and considering specific national, regional and local circumstances.

Financing efficiency improvement is a challenge. Policy makers may wish to consider existing financial instruments, as well as innovations in how efficiency improvements are funded. Finally, RDD&D can play a very important role. Advancements in the state-of-the-art in the realm of RACHP technologies are likely to be critical in an increasingly urbanized and climate-constrained world.

¹² <http://www.districtenergyincities.org/>

¹³ Facebook and Google located their server farms in northern Scandinavia, where the cold ambient climate greatly reduces the need for equipment cooling (<https://www.wired.com/2012/01/google-finland/>)

Barriers to improving cooling system efficiency and possible policy responses

A. Barriers

Based on the information provided across briefing notes A, B and C, there is clearly good potential for achieving greater efficiency in RACHP equipment. Greater efficiency is both technically possible and financially viable, and policy makers have numerous tools at their disposal to mitigate the negative consequences of a dramatic rise in RACHP demand and related energy use over the next decades.

Unfortunately, numerous barriers can be observed, affecting both policy and market actors. The following is a non-exhaustive overview.

Information barriers

Equipment purchasers and end users may not have access to all the information required to make informed choices about the best available technologies on the market.

Financial barriers and market failures

Equipment purchasers and end users may not have the financial resources to buy high-efficiency RACHP equipment and/or may base investment decisions on low upfront/capital cost rather than lifecycle cost.

Importantly, purchasers and end-users tend to consider only, or at least primarily benefits that are of direct relevance to them, e.g. lower operating costs. In most cases, peak demand reduction or global environmental benefits are not considered in purchasing decisions.

Equipment suppliers, meanwhile, may not design their equipment in a holistic manner (e.g. considering strategies for customers to reduce cooling loads) or may have an interest/strategy to target customers who tend to purchase less expensive and less efficient equipment.

Suppliers may be locked in to old inefficient designs or simply lack the financial resources to develop more efficient designs.

Patent protections may also affect the adoption of certain efficiency technologies.

Misaligned incentives and behavioural barriers

Developers, such as residential property developers, may not have an incentive to invest in RACHP equipment with a higher upfront but lower lifecycle cost; they may instead choose to invest in technologies with a lower upfront cost in order to lower the overall cost of their development project (and thereby increase their profit margin).

In some cases, purchasers and end-users may be wary of newer technologies and may opt to continue operating older equipment even if it is inefficient and carries a high operating (energy) cost. This barrier is of course also linked with financial barriers that may prevent an end-user from upgrading outdated equipment.

Behavioural issues can also extend into areas like maintenance, where end-users are either unaware of – or unwilling to adopt - maintenance regimes that would increase the efficiency (and reduce related GHG emissions) of their equipment.

Governance barriers

Governments may lack the capacity and/or expertise, particularly at the local level, to enact, implement and enforce new policies and regulations. In parallel, governments may be struggling with constrained public budgets, which limit their ability to provide financial incentives, develop awareness programmes, certifications schemes, etc.

To overcome these and other barriers, and to realise the potential of energy efficiency, it is helpful for a range of policy measures to be implemented at the national level and for financial mechanisms to be put in place where appropriate. Please refer to the table below for possible policy responses to these barriers, organised according to stakeholders and the challenges they face.

B. Possible policy responses

| STAKEHOLDER | CHALLENGE | EXAMPLES | POSSIBLE POLICY RESPONSES |
|---------------------------------|--|--|--|
| Purchasers and end users | Lack of awareness | Many end users are unaware of the energy saving potential. | Information measures including labels and awareness raising campaigns quick reference guides, online tools, short videos, online lifecycle cost calculators as well as financial incentive measures such as tax breaks for the purchase of more efficient equipment. |
| | Lack of understanding | RACHP systems can be complex and many end users may not understand the technical issues related to its energy use. | |
| | Lack of information | There is a lack of good information for end users that explains energy efficiency in cooling systems. | |
| | Focus on capital cost | Many end users purchase RACHP equipment on the basis of lowest capital cost rather than lifecycle cost. | |
| | Purchaser is not the end user | A residential property developer, for example may have little interest in the running costs of cooling systems, leaving the building occupier with significant extra energy costs. | Regulatory measures such as MEPS and building codes, alongside financial incentives such as tax breaks for efficient equipment purchases. |
| | Lack of incentives to consider efficiency | End users get no benefit from certain “big picture” gains such as reducing the maximum demand on the electricity supply system or achieving substantial reductions in CO ₂ emissions. | |
| Government Stakeholders | Lack of regulatory capacity | A number of countries do not have MEPS, labels, incentives or other policy measures in place and may lack regional harmonization of standards | There are organizations that can facilitate best practice sharing across countries. Countries can also seek funding and/or in-kind support from other multi-lateral agencies and funding bodies. In some cases, there may be an opportunity to pool resources and/or reduce costs for policy development by borrowing learnings, tools, from other countries |
| | Lack of policy measures for larger RACHP equipment | Few countries have policy measures in place to encourage high efficiency design in large RACHP systems or certification schemes for installers. | |

| STAKEHOLDER | CHALLENGE | EXAMPLES | POSSIBLE POLICY RESPONSES |
|---|---|---|---|
| | No consideration of externalities of environmental issues | Long-term cost impact of greenhouse gas emissions not taken into account. | Setting of national targets and participation in international fora can help place RACHP efficiency improvements in context and create a more attractive environment for investment. |
| | Financial constraints | Lack of access to financial support to fund incentive programmes. | Countries can seek funding and/or in-kind support from multi-lateral agencies and funding bodies. |
| Finance companies, or investors, in energy efficiency projects | Lack of knowledge | Finance companies would invest in efficiency if the investment and returns were clearer. Consistent reporting of energy performance through labelling or other reputable communication channels reduces the uncertainty to investors and gives confidence that an investment will make the claimed financial returns. | Information measures including labels as well as setting national targets / signing up to global commitments. |
| | Scale of investment | Many of the energy efficiency projects for cooling are by nature relatively small, making them less attractive, especially with increased transaction costs with multiple smaller projects. | Regulatory measures such as MEPS and robust standards can create harmonization across the market and encourage bulk purchasing / procurement schemes that are more attractive for financiers. |
| | Lack of technical understanding | A lack of technical understanding of energy efficiency related issues may lead to overestimates of the risks of employing energy efficient technologies. | Information measures such as awareness raising campaigns and training programmes on efficiency for financial sector representatives. |
| | Internalising externalities | For efficiency projects, some of the benefits accrue to third parties (e.g. lower pollutants benefit wider society), whereas some polluting investments may inflict harm on third parties. Externalities need to factor in efficiency project assessments. | Financial incentives to favour or promote efficiency projects over more polluting projects can help and governments could re-design policies that distort the business case for energy efficiency (e.g. fossil fuel subsidies). |
| Equipment designers, installers and maintenance contractors | Focus on capital cost | Many suppliers are concerned that they will lose market share if they do not provide equipment at the lowest possible cost. There may be resistance from local manufacturers with concerns about financing and technology constraints. | RDD&D programmes, with support from multilateral funds and institutions in developing countries. Overarching targets and policy certainty can also help to assuage concerns by suppliers and their investors. |

| STAKEHOLDER | CHALLENGE | EXAMPLES | POSSIBLE POLICY RESPONSES |
|-------------|---|---|--|
| | Lack of customer information | When specifying a plant the end user often provides little useful information that would enable the designer to optimise the efficiency. | Information measures & training and certification schemes in 'parallel' disciplines like engineering, design, architecture. In existing sites: mandatory energy audits, CO ₂ reporting & incentive schemes tied to energy management systems (EMS) like ISO50001. |
| | Poor ability to present lifecycle costs | Because end users often show little interest in the lifecycle energy efficiency, a significant proportion of suppliers may not have the skills to present the case for a more efficient design. | Information campaigns as well as training and skills development programmes and certification schemes |
| | Lack of relevant skills | Refrigeration and air-conditioning technicians may be inadequately trained on energy efficiency, refrigerant handling and other good practices. | |