Green Cooling in Public Procurement

How to advance the procurement of climate-friendly and energy efficient air conditioners in the public sector

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Abbreviations

AC	Air Conditioner
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
C4	Cool Contributions fighting Climate Change
CEGESTI	Centro de Gestion Tecnologica e Informatica Industrial
CFC	Chlorofluorocarbons
COP	Coefficient of Performance
EER	Energy Efficiency Ratio
F-Gases	Fluorinated greenhouse gases
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GPP	Green Public Procurement
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HEAT	Habitat, Energy Application and Technology GmbH
HFC	Hydrofluorocarbon
ICE	Costa Rican Institute of Electricity
IEA	International Energy Agency
ISEER	Indian Energy efficient Ratio
IPCC	Intergovernmental Panel on Climate Change
JP	Joint Procurement
KA	Kigali Amendement
LCC	Life Cycle Costing
LCCP	Life Cycle Climate Performance
MoEF&CC	Ministry of Environment, Forest and Climate Change's
MEPS	Minimum Energy Performance Standard
MIT	Mitigation scenario
MP	Montreal Protocol
MRA	Mutual Recognition Agreements
ODP	Ozone Depleting Potential
ODS	Ozone Depleting Substances
PA	Procurement Authority
PP	Public Procurement
RAC	Refrigeration and Air Conditioning
RAC&F	Air-Conditioning and Foam Sector
SPP	Sustainable Public Procurement
TEWI	Total Equivalent Warming Impact
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change

Summary

Green Cooling has a high potential to reduce costs, energy and the climate impact of public buildings. Surveys conducted in multiple countries in the framework of this study show that:

- Air conditioning in public buildings is often responsible for about 50% of total electricity consumption and single-split ACs alone account for approx. 40% of total installed cooling capacity.
- Replacing an average split AC installed in a public building within the cooling capacity range up to 7.4 kW with a Green AC of the same cooling capacity, an annual electricity saving of approx. 1,000 kWh on average can be achieved.
- The electricity saving potential amounts to 28% of the baseline electricity consumption, providing promising framework conditions in terms of energy cost savings for the conversion to Green ACs. Furthermore, with the envisaged annual growth rate of 4.4 % on average, demand is expected to increase.
- In addition to reducing energy consumption, replacing a conventional AC with a Green AC offers in average an annual GHG emission reduction potential of 1,100 kg CO_2eq, which equals to 52% of the baseline emissions.[1]

Enablers for and barriers preventing Green Cooling in public procurement can be divided into information and capacity-related, financial, technical, regulatory and political, structural as well as institutional categories. According to the respondents the following barriers are most dominant:

- Financial barriers, in particular the high initial investment costs that usually come with more efficient (Green) ACs. Procurement authorities (PA) still evaluate lowest purchase costs together with good product service as the main procurement criteria for ACs, without considering the life cycle costs of ACs. Even though the procurement of Green ACs generates cost savings, reducing costs are often not seen directly as a result of implementing GPP.
- Political & regulatory barriers, in particular the lack of (political) leadership to adopt more ambitious GPP targets and action plans.
- Technical barriers, in particular the lack of environmental procurement criteria to promote Green Cooling technologies.

Regarding the most important barrier, the financial barrier, respondents frequently agreed that consideration of lifecycle costs would enhance the implementation of GPP of cooling appliances. Furthermore, respondents described training of committed staff and awareness-raising among procurement units as important enablers towards enhanced GPP.

[1] In addition to reducing energy consumption, Green ACs almost completely avoid direct emissions caused by refrigerants leaking into the atmosphere during installation, operation and at end of life. While conventional split ACs use refrigerants with an average GWP of 1,829, Green ACs use propane as a refrigerant with a negligible GWP of 3

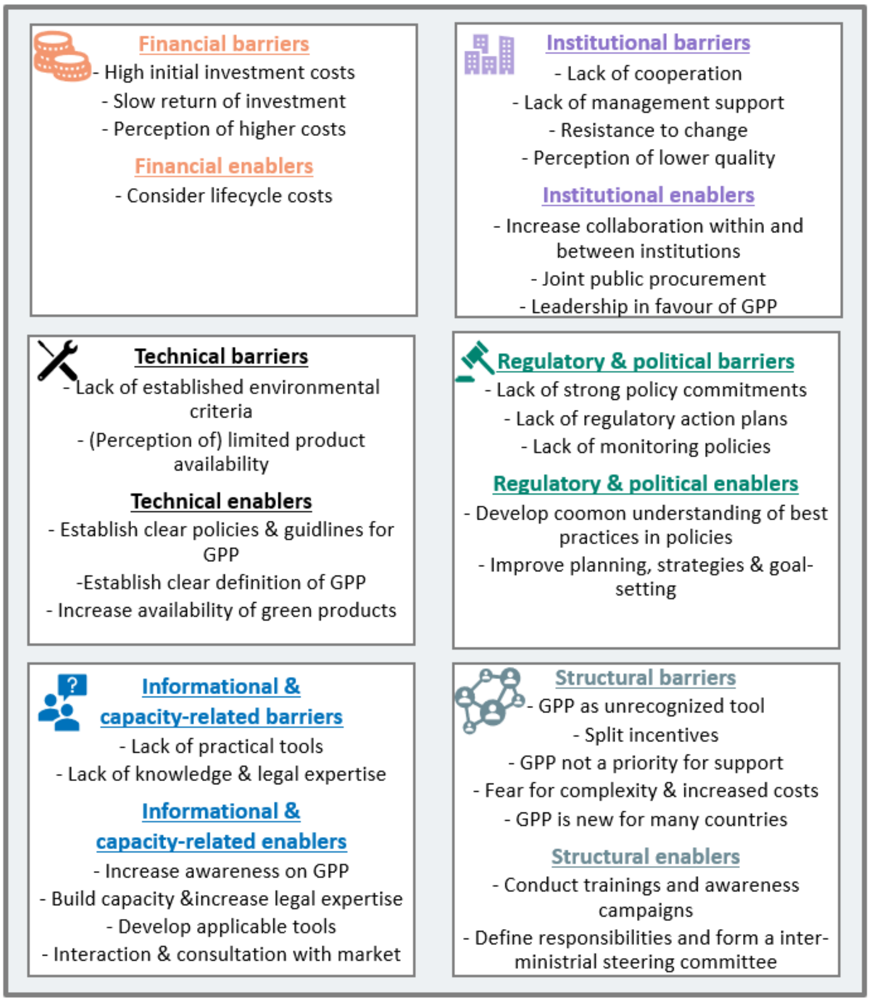


Figure 1 Barriers and Enablers of Green Public Procurement

In order to assess the performance of AC, three types of criteria are relevant:

- Technical Performance, including cooling capacity (measured in kWh, TONs, BTUs, etc.) and energy efficiency (measured as EER, COP, SEER, etc.)
- Life Cycle Costing (LCC) including the cost of purchase, transport, installation, maintenance, operation, and end-of-life (recycle of material, recovery and reuse or destruction of ozone-depleting or GHG refrigerants)
- Life Cycle Climate Performance (LCCP) or Total Equivalent Warming Impact (TEWI), measuring the climate impact of a product over its lifetime.

The information provided within this study shall serve as a basis on tackling barriers in introducing GPP as well as updating procurement criteria of room Air Conditioners in order to reduce cooling related energy consumption and GHG emissions of public buildings.

1. Background and Objective

Space cooling in buildings is growing at a massive rate. As of 2017, almost 129 million air conditioning units have been sold in the global market (JARN, 2018). Roughly 100 million small capacity single-split air conditioners (ACs) are at the forefront. This growth is driven by increasing ambient temperatures, growing middle-class populations and high urbanization rates.

Inefficient building and cooling management as well as inefficient cooling appliances using climate-damaging refrigerants result in growing energy use, costs and greenhouse gas (GHG) emissions. Without serious interventions, GHG emissions from buildings are expected to triple over the next three decades which calls for more efficient, climate-friendly appliances and buildings to decouple electricity use, costs and GHG emissions from this growing cooling demand.

In many countries space cooling in public sector buildings accounts for over 50% of building's energy demands, especially in tropical and subtropical areas. An energy audit conducted 2017 in 15 public buildings in Grenada found that space cooling was with up to 69% (Ministry of Education) by far the largest contributor in some buildings. Meanwhile public buildings have a huge potential to demonstrate and promote pioneering Green Cooling solutions, however the potential remains largely untapped. Despite the massive potential to cut energy costs and GHG emissions and the allegedly lighthouse function, public entities often struggle to procure state-of-the-art cooling technologies. Whereas advancing building codes and improving building design to reduce the cooling demand is the ultimate sustainable way forward as long-term measure (avoid and shift approach), immediate actions can be undertaken through the promotion of high efficiency air conditioners (ACs) using climate-friendly refrigerants, in the following stated as Green ACs.

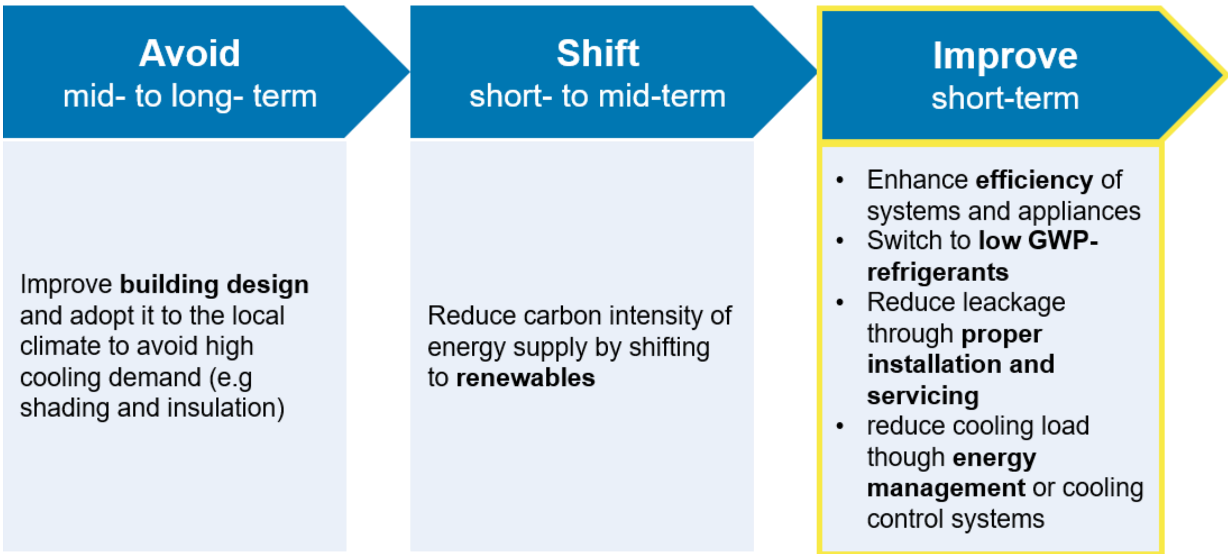


Figure 2 Avoid-, Shift- and Improve- approach to reach low-carbon buildings (Amended from PEEB, 2020)

The term "**Green Air Conditioner**" is used to define an environmentally-friendly room AC that stands in contrast with conventional room ACs that are currently in use. To qualify as a climate-friendly and energy efficient "Green AC", two fundamental criteria need to be fulfilled:

i) Use of climate- and ozone-friendly refrigerant with a low GWP, more precisely natural refrigerants such as propane;

ii) High energy efficiency (at least the top star label category in the target country).

Green ACs can be promoted through the regulatory framework of green public procurement. Sustainable and green public procurement plays a key role in raising awareness and bringing green technologies to the market faster.

The GIZ project “Cool Contributions fighting Climate Change” (C4), commissioned by the Federal Ministry of Environment, Nature Conservation and Nuclear Safety aims to further pursue an international control for F-gases, found in the refrigeration, air-conditioning and foam sector (RAC&F). The improved framework conditions will encourage the use of energy efficient RAC&F equipment and environmentally friendly natural refrigerants and blowing agents. In this context, the project sees great potential in the introduction of Green Cooling Technologies in public buildings through public procurement.

This study has been conducted:

a) to highlight the mitigation potential of space cooling in the public sector through the application of Green Cooling
b) to identify and analyse typical barriers that prevent public entities from procuring Green ACs,
c) to elaborate ways to overcome these barriers and draw general recommendations on how to advance Green ACs in public procurement
d) to identify best practices of sustainable and green public procurement and
e) to contribute to unlocking this huge potential of Green Cooling in the public sector.

The study focuses on single split-type ACs with a cooling capacity of up to 7.4 kW for use in public buildings, such as government administration buildings, hospitals or universities. Based on a comprehensive research and structured interviews with responsible facility managers, procurement units and regulatory authorities in Bangladesh, Costa Rica, Grenada, India, Iran and the Philippines, the potentials of GPP and the introduction of ambitious procurement criteria for Green ACs to save emissions and energy are presented. 22 surveys have been conducted and technical specifications related to building design and air-conditioning appliances in use from 11 buildings have been used for the analysis in Chapter 2.

At this point we would like to thank all participants of the study. The significance of this study could only be made possible through your openness and participation.

2. Air Conditioning in public buildings

In many countries, the public sector is responsible for large shares of national space cooling demand. Moreover, energy related emissions from space cooling often exceeds 50% of the total emissions in such buildings, without taking into account direct emissions from leaking refrigerants.
Based on the interviews of facility managers in Bangladesh, Costa Rica, Grenada, India, Iran and the Philippines, air-conditioning technologies in public buildings were analysed, taking into account energy performance and refrigerant use. Split AC systems with cooling capacities up to 7.4 kW (24,000 BTU/hour) are put into the spotlight, with the aim to assess the market potential of Green ACs. Green ACs are characterised by high energy efficiency and the use of refrigerants with minimum GWP, such as propane (R290). Such ACs are currently available in mini-split AC size classes with cooling capacities up to 7.4 kW.

2.1 Key results from the survey

Characteristic data of the 14 analysed public building sites are illustrated in Table 1, representing weighted averages of the best estimates provided by the surveyed facility managers and others sources:

- total air-conditioned space
- average temperature setting of the ACs
- total electricity consumption and specific for air conditioning (estimated % share of ACs in total electricity consumption)
- cooling capacities of installed ACs
- the relevance of split air-conditioning systems with up to 7.4 kW cooling capacity with regard to their share of the total AC cooling capacity in the building.

As a limited scope of data was provided for some of the building sites, the full evaluation of split AC technology was conducted for 10 buildings (see right column: *Number of split ACs up to 7.4 kW*).
Across the assessed buildings for which reliable information was available, air conditioning is responsible for approximately 49% of total electricity consumption (weighted average), despite relatively low shares in Bangladesh, Iran and partly in Grenada (General hospital). Room air set temperatures are in a range of 18 to 24°C (20°C on average).
Based on the provided data, benchmarking values were derived for area-specific AC energy consumptions (AC energy intensities) and AC cooling capacities. In weighted average, the AC energy intensity is in the range of 79 kWh/m², the installed AC cooling capacity per cooled space amounts to 102 W/m².
Distributed among 10 public buildings[2], single split ACs (up to 7.4 kW of cooling capacity) account for approximately 1,647 kW, corresponding to a 39% share of the total installed cooling capacity of 4.2 MW used for air conditioning within the fully evaluated sample of public buildings (Figure 32, graph on the left side). Split ACs with greater cooling capacities than 7.4 kW contribute 17% to the total installed cooling capacity, the remaining half is provided by other AC systems (window-type ACs, multi-split ACs, package/rooftop ducted systems, water chillers). In terms of total installations, 391 AC appliances were identified for the assessment, applying few estimations for the sites in India. Single split ACs up to 7.4 kW clearly dominate (74%, representing approximately 289 appliances, again applying few estimations for the sites in India) (see Figure 32, graph on the right side).

[2] Thereof, one building is supplied by large AC systems only (Grenada, Ministerial Complex).

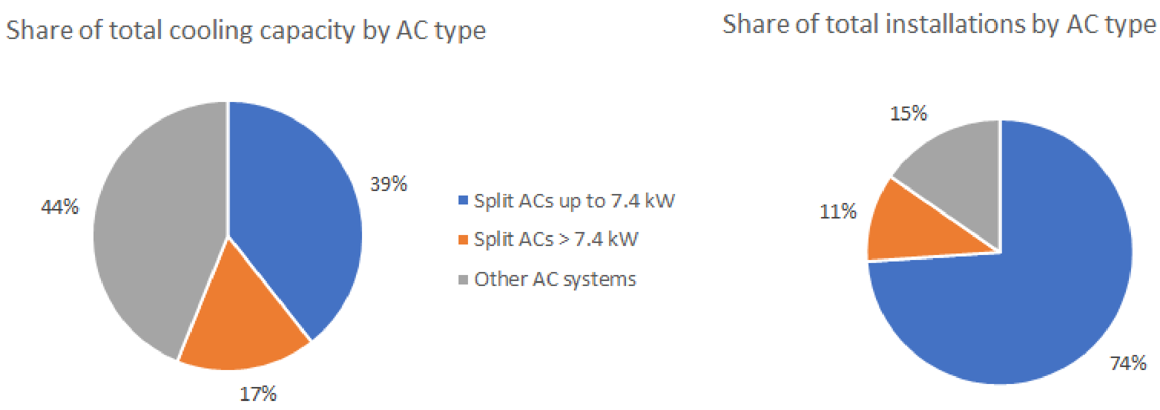


Figure 3 ACs in sample of public buildings by AC type: shares of total cooling capacity (left side), shares of total installations (right side)

Table 1 Air-conditioned space, electricity consumption, benchmarking (intensities of AC electricity and cooling capacity) and shares of single split ACs up to 7.4 kW of cooling capacity of the assessed public buildings

Country	Facility	Total air-conditioned space (m²)	Room air set temperature (°C)	Total electricity consumption (MWh/a)	AC electr. consumption (MWh/a)	AC share on electr. consumption	AC electr. intensity (kWh/m²)	Total cooling capacity (kW)	Cooling capacity/ area (W/m²)	Share of split ACs up to 7.4 kW on total cooling capacity	Number of split ACs up to 7.4 kW
Iran	German Iranian Chamber of Commerce	1,320	18-22	59	22	37.5%	17	139	105	11%	3
Iran	Chamran Hospital	4,000	22	Unknown	N/A	5%	N/A	252	63	55%	35
Philippines	Office	1,500	18	570	N/A	unknown	N/A	66	44	9%	2*
Philippines	Hospital	14,707	20	1,330	864	65%	59	1,274	87	9%	18
Costa Rica	Universidad de Costa Rica (UCR)	270,703[3]	N/A	17,436	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Grenada	Financial Complex Limited	4,064[4]	22-24	813	341	42%[5]	84	N/A	N/A	N/A	N/A
Grenada	General hospital	unknown	22-24	1,288	348	27%	N/A	331	N/A	97%	67
Grenada	Ministerial Complex	7,0003	18-26	1,235	741	60%	106	593	85	0%	0
Grenada	Ministry of Education	2,800[3]	18-24	326	225	69%	80	78	28	7%	2
Grenada	Police Training School	unknown	16-19	285	159	56%	N/A	134	N/A	93%	27
Grenada	Ministry of Infrastructure Development	6,749	N/A	1,235	741	60%*	110	N/A	N/A	N/A	N/A
India	DEBEL, DRDO, Ministry of Defence	unknown	24-25	N/A	N/A	N/A	N/A	215	N/A	100%	35*
India	Hindustan Aeronautics Ltd	500	N/A	N/A	N/A	70%	N/A	352	703	32%*	N/A
Bangladesh	Public Works Department	2608	22	799	160	20%	61	747	287	79%	79
Total		315,951		25,377	3,602			4,183			268
Average						49%[6]	79[7]		102[8]	39%[9]	

[3]* Estimated
[3] University campus consisting of 337 buildings
[4] Total floor area, no distinction of air-conditioned space in particular
[5] Including ventilation
[6] Based on total annual electricity consumption of 6.57 GWh, considering only sites for which AC-specific electricity consumption was given in a plausible range or could be derived.
[7] Weighted average based on the subtotals of all buildings for which total air-conditioned space and electricity consumption for AC was given in a plausible range: 2,935,000 kWh of electricity consumption for AC and 36,640 m² of air-conditioned space.
[8] Weighted average based on the subtotals of all buildings for which total air-conditioned space and installed cooling capacity was given in a plausible range: 2,755 kW of installed cooling capacity and 31,827 m² of air-conditioned space.
[9] Weighted average based on 3,435 kW of total installed cooling capacity.

2.2 Modelling of baseline AC and estimation of mitigation potentials

Based on the collected data for split ACs with cooling capacities up to 7.4 kW, the average characteristics for this appliance type are summarised in Table 2 (see baseline AC), using weighted averages in order to reflect the number of appliances represented by each data. Using this approach, the 'standard' cooling capacity within the single split AC size category is assumed as 5.3 kW. The averaged energy efficiency ratio (EER) adds up to 3.1 (in W/W), within a range from 2.49 up to 4.16. Likewise, broad ranges were given for operating hours and expected equipment lifetime, resulting in 2,352 annual operating hours (based on 45 hours per week) and 14.4 years of expected useful equipment lifetime on average. For these indicative values it should be noted that participating countries are characterised by greatly varying climate from one to another. Out of the split ACs with cooling capacities up to 7.4 kW, 44% were found to use R22, 55% to use R410A and 1% to use R32, resulting in an average GWP of 1,835. It should be noted that R22 has ozone depletion potential (ODP) in addition to a high global warming potential (GWP)[10]. The production and consumption of R22 is regulated in all countries in the course of the HCFC Phase-Out Management Plans, which is why there is great potential for a direct switch to Green ACs, especially when replacing those outdated technologies.
The refrigerant charge was found to be 1.94 kg on average (1.89 kg for ACs up to 7.4 kW) The approximate annual in-use leakage rate was derived in the range of 18.1% (based on data provided for refilling of refrigerant, referring to **all** AC systems). It is noteworthy that especially the data for energy efficiency and in-use refrigerant leakage (two sites, both Iran) rely on very few responses. This is particularly relevant when considering annual in-use leakage rates, as these are subject to vague assumptions which vary from country to country and the resulting emissions therefore differ greatly.

The mitigation potential by using Green ACs in public procurement is assessed by comparing the elaborated baseline AC with the performance characteristics of a Green AC in the same cooling size (based on the 5.0 kW model) which are provided in the right column of Table 2.

[10] According to IPCC Fifth Assessment Report (2014) R22 has and ODP of 0.06 and a GWP of 1760: https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf

Table 2 Key characteristics of average single split AC (cooling capacity up to 7.4 kW) used in public buildings compared with Green AC

Criterion	Baseline AC	Green AC[11]
Cooling capacity (kW)	5.3	5.3
Energy efficiency ratio (W/W)	3.1	4.3[12]
Annual operating hours (h)	2,352	2,352
Lifetime (years)	14	14
Refrigerant type	44% R22 55% R410A 1% R32	R290
Average GWP	1,835	3
Initial refrigerant charge (kg)	1.89	0.34
Annual refrigerant leakage (in-use, in relation to initial refrigerant charge)	18.1%	18.1%
Annual energy consumption (kWh)[13]	3,016	2,174
Total annual GHG emissions (kg CO_2eq)[14]	2,123	1,028
Direct annual GHG emissions (kg CO_2eq)	697	0.21
Indirect annual GHG emissions (kg CO_2eq)	1,426	1,028

By replacing an average split AC installed in a public building within the cooling capacity range up to 7.4 kW (baseline AC) with a Green AC of the same cooling capacity, annual electricity savings of 842 kWh can be achieved on average. The electricity saving potential amounts to 28% of the baseline electricity consumption, providing promising basic conditions for inverting into Green ACs. Moreover, a growing demand can be expected from the provided annual AC growth rate of 4.4% on average (responses ranging from 0 to 10%, based on the number of operating AC appliances at each site). The energy calculations are based on 2,352 annual operating hours and include a load factor of 0.75 (based on CDM Tool 29) for using EER values as energy performance indicator. Replacing one baseline AC with a Green AC of the same size offers annual GHG emission mitigation potential in the range of 1095 kg CO_2eq, including direct emissions, making up 64% of the total mitigation potential and indirect emissions, contributing the remaining 36%. The total mitigation potential represents a 52% share of the baseline emissions, assuming an averaged grid emission factor across the six interviewed countries of 0.473 kg CO_2/kWh.

In addition to looking at energy and emissions savings, including life-cycle costs in procurement criteria provides convincing arguments for buying Green ACs. The average 28% energy savings already mentioned above automatically lead to long-term cost savings. Results from the energy monitoring in a public building in Grenada from 2018 show that replacing an old AC with a R290 split AC paid for

[11] Examples for existing R290 models: Godrej GSC 12 GIG 5 DGOG, GSC 18 GIG 5 DGOG (both inverter type) and GSC 12 FG8 MOG, GSC 18 FG8 MOG (both fixed speed); EER for fixed speed ACs by Godrej between 3.9 and 4.0. An overview of existing Green AC Models can be found in Annex II

[12] EER estimated based on specifications given in Indian SEER (ISEER)

[13] Following the CDM calculation method (Tool 29)a, a load factor of 0.75 is taken into account.

[14] Indirect GHG emissions based on a grid emission factor of 0.473 kg CO2/kWh (average across the 6 interviewed countries), using the IFI dataset by UNFCCC.

itself after only 12 months (see Table 3). This highlights the relevance of using the Return on Investment (ROI) or life-cycle-analysis such as life cost assessments within procurement processes.

Table 3 Results from an energy monitoring in Grenada 2018

	Replaced R410a HFC-Unit	New R290 split AC Unit
Average consumption	16.93 kWh	8.41 kWh
Efficiency gain	50 %	
Total kWh consumption*	593 kWh	306 kWh
Operating Cost**	207 $	107 $
Savings	100 $	
Comparable unit cost***		1,180 $
Pay back in months		12
CO_2e	373.41	192.62

*measurements have been taken once a day, over a time period of 35 days
**referring to the entire monitoring period and an electricity price of 0.35$/kWh
***costs of an average split AC Unit sold in Grenada

2.3 Maintenance and refrigerant management practices

This chapter summarizes the interview results on maintenance and refrigerant management practices. Out of a wide range from once a year up to once a week, general maintenance was specified to be conducted every 6.1 months on average and refilling of refrigerant every 7 months on average. One respondent clarified that general maintenance and refilling of refrigerant are both carried out upon demand without a specific schedule. Only two answers were provided for refrigerant consumption, adding up to 55 kg of R22 and 23 kg of R410A annually. Under consideration of the aggregated refrigerant charge sizes at both sites, annual in-use leakage rates were found in a range from 18 to 32%, with the resulting weighted average (considering the number of AC installations for both sites) of 20.1%.

Concerning the decommissioning of ACs after their useful life and related refrigerant management, half of the responses indicated a poor level of organisation. Decommissioned ACs are disposed (no further clarification within the surveys) after checking for useful parts for reclamation and refrigerants are mostly purged or there is no contrary knowledge. The other half indicated a certain level of organisation which appears to be commonly informal for refrigerant handling. Such responses referred to government regulations or at least clearance by state auditors and/or the engagement of authorised waste companies for the disposal of the ACs. For refrigerant handling, this other half of responses indicated a variety of scenarios. Either it was indicated that the refrigerant stays inside the AC, reclamation was assumed without further knowledge, or it was clarified that a possible recovery of the refrigerant should be examined by the technicians in charge. Two out of nine answers (22%) indicated the existence of one authorised collection center for refrigerants.

3. Typical public procurement practice

3.1 Scope of public procurement

Public Procurement (PP) is a key economic activity of governments and public institutions. It refers to "*the acquisition of goods and services by governments or public sector organisations through a public contract*" (Witjes & Lozano, 2016, p. 38). PP covers a wide range of goods and services such as the acquisition of health care services, public transport, education, buildings, infrastructure, among others (The World Bank, 2017). Estimates suggest that PP accounts for 15-30% of the gross domestic product (GDP) in low-income countries and is therefore seen as an important policy tool to pursue societal, economic and environmental standards (Brammer & Walker, 2011; The World Bank, 2017). Under Joint Procurement (JP), two or more procuring authorities combine their procurement activities. Public authorities can then together create economies of scale, by procuring large volumes of products or services, while saving administrative costs and sharing of procurement skills and expertise (European Commission & DG Enviroment, 2008).

As soon socio-economic and environmental criteria are integrated into the procurement procedure, it is referred to as Sustainable Public Procurement (SPP) (Brammer & Walker, 2011). Figure 4 illustrates how SPP is built on the three main pillars of sustainable development – i.e. economic, social and environmental impact (European Commission, 2019). Procurement unit representatives from the sample countries referred to environmental aspects when they were asked about the most important sustainability aspects covered in conventional PP procedures.

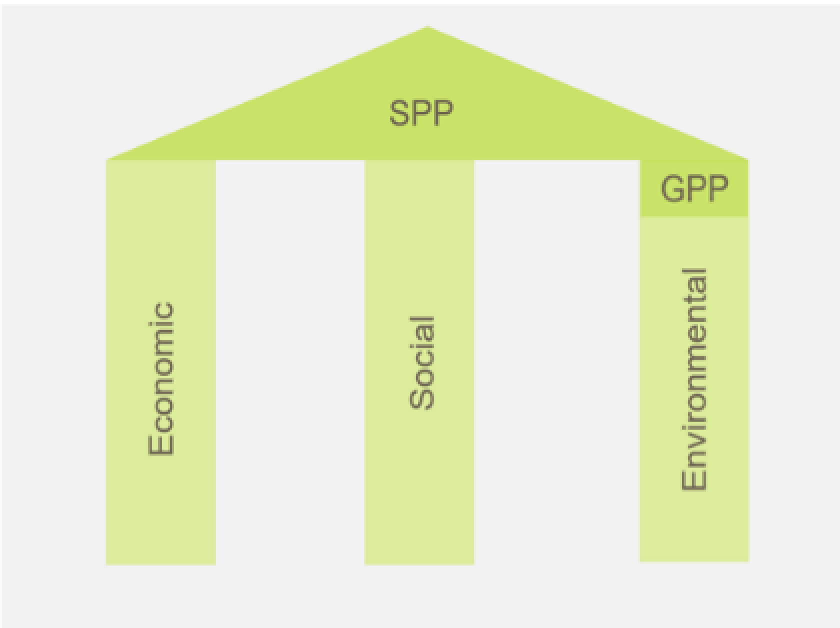


Figure 4 Sustainable Public Procurement and Green Public Procurement (adopted from GIZ (2019), adjusted by authors)

If environmental criteria obtain extensive focus during the procurement procedure, it is referred to as Green Public Procurement (GPP), as it is illustrated on the right-hand side of Figure 4. GPP is therefore defined as "*a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works* *with the same primary function that would otherwise be procured*" (Commission of the European Communities, 2008). Public authorities can use GPP to meet their environment-related targets, they can set an example to private consumers and can raise awareness among the society of environmental issues. GPP is said to encourage the spread of environmentally advanced technologies, innovation, research and development (R&D), as public authorities actively seek and prefer products or services that have the lowest negative impact on the environment throughout their life cycle (Brouwer et al., 2006; Uyarra & Flanagan, 2009). As opposed to evaluating investment costs, which is common under conventional PP, life cycle costs play a central role under GPP. This way, several characteristics of the product or service, such as energy efficiency, obtain more value during the procurement process. This means that products or services which meet a certain environmental standard have a higher chance of being purchased (see Section 0 for an elaboration on bid evaluation). GPP may cause spill over effects to the private sector, stimulating the adoption of environmental standards there as well, and increase awareness of environmental issues (European Commission, 2020; Simcoe & Toffel, 2014). In other words, due to their purchasing power, public authorities can make a significant contribution to sustainable production and consumption, by creating a clear incentive to the private sector for shifting to environmentally friendlier technologies and products.

Besides the **environmental benefits**, GPP also has **political benefits**, including it being an effective way to demonstrate a public authority's commitment to environmental protection. GPP, therefore, helps to establish high environmental standards and can (in)directly improve quality of life – seen as **social and health-related benefits**. Additionally, GPP has **economic benefits**, as it provides incentives for the industry to innovate, it promotes green products and innovative technologies and can save money when a product's life cycle is considered (Denjean et al., 2015; European Union, 2010). This way, innovative products can become cheaper through economies of scale, ultimately shifting the entire market towards greener products (European Commission, 2020; European Union, 2010; Simcoe & Toffel, 2014; Uyarra & Flanagan, 2009).

3.2 Description of public procurement procedure of cooling appliances

GPP can be an effective instrument to increase the share of environmentally friendly cooling appliances in buildings as public authorities are generally responsible for a variety of building types such as offices, schools or hospitals (The European Commission, 2016). Depending on the climatic zone, these buildings require heating, ventilation and/or air conditioning, of which the latter is typically important in hot and humid climates. As shown in Chapter 2, conventional cooling appliances use refrigerants with a high GWP and are often run highly inefficiently, thus having a large impact on the environment, which is why the wider use of climate and environmentally friendly alternatives is becoming increasingly important. Public authorities have the responsibility and opportunity to encourage investments in environmentally friendlier cooling appliances and can mandate energy performance improvements by increasing the standards of cooling appliances in their procurements (IEA, 2018).

PP usually follows a common procedure, which contains four principal stages, as shown in Figure 5. The PP procedure is often officiated in international and/or national law or agreements (Witjes & Lozano, 2016), which was also confirmed by the survey participants. PP is generally led by dedicated procurement staff, but the survey respondents clarified that (external) advisory committees may be consulted during the PP procedures. While GPP mainly follows the same process, some aspects are slightly different compared to conventional PP processes (see green elements in (Figure 5). Also, the survey revealed that countries may have specific GPP laws that influence procurement activities. The procurement procedure for cooling appliances is also based on the process illustrated in Figure 5.

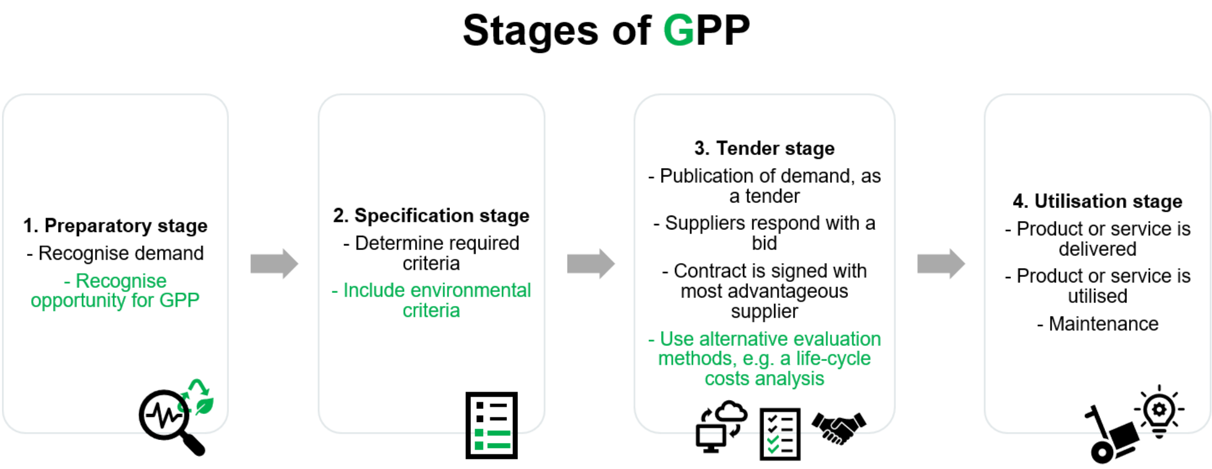


Figure 5 Standard (G)PP procedure. The elements in green indicate where GPP is additional to or different from conventional PP.

First, procurement authorities recognise and determine the demand for a product during the preparatory stage. For cooling appliances, this may include the realisation that conventional cooling appliances have a major impact on the environment and climate and therefor GPP regulations need to be applied.

Subsequently, PAs determine the required criteria of the good during the second stage: the specification stage. These may include minimum criteria, or descriptive, more advanced criteria. The survey revealed that specific GPP laws may determine minimum environmental criteria. PAs can include more ambitious environmental criteria to shift towards GPP. According to the surveys conducted, GHG emissions reduction, ozone depletion and air pollution are priority issues when implementing GPP (Figure 6). Additional procurement staff – for example, a technical unit – may be responsible for determining the technical aspects in the specification stage. For the procurement of cooling appliances, for example, procures can include criteria regarding high energy efficiency, professional installation and maintenance, refrigerants with very low GWP, such as hydrocarbons and extensive recycling practices.

Q: To what extent do you agree or disagree with prioritising the following environmental issues within GPP?						
Environmental issue	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Score
GHG emission reductions (CC mitigation)	0	0	0	2	10	22
Ozone depletion	0	0	0	2	9	20
Air pollution	0	0	0	3	8	19
Hazardous substances	0	0	1	3	7	17
Waste minimisation	0	0	0	6	5	16
Sustainable use of natural resources	0	0	1	5	5	15
Energy conservation	0	0	1	5	5	15
Soil protection	0	0	1	6	4	14
Water pollution	0	0	2	4	5	14
Biodiversity conservation	0	0	2	5	4	13

Legend

The colours correspond with the number of responses

0	2	4	6	8	10

The colours correspond with the level of agreement to the issue*

11	13	15	17	19	21

** "strongly disagree" equals -2, "disagree" equals -1, "neutral" equals 0, "agree" equals 1, "stongly agree" equals 2*

Figure 6 Priorities of environmental issues when implementing GPP[15]

The tender stage is the third procurement step, during which the procurement officers publish the specified demand publicly as "calls for tenders", often on online tender platforms, potential suppliers respond with a bid and a contract between PA and supplier is signed. In the bid, suppliers illustrate how they can meet the specifications and at what price. The supplier with the most advantageous bid wins the tender, which often means the bid that meets all criteria with the lowest price. However, there are other evaluation methods, by which quality criteria, such as environmental standards, become more significant. Four alternative evaluation methods which are relevant for GPP of ACs are:

- Monetising environmental criteria
- Transforming price into a quality score
- Assessing lifecycle costs, instead of purchase costs alone
- Environmental criteria considered admissibility criteria

PA may decide to monetise the environmental criteria or take a broader approach when assessing the best price for quality approach. For example, offers that meet certain environmental criteria could be discounted, making them competitive with the cheapest options. Secondly, the offered price can be transformed in a way that it is commensurate with the quality score – price is then valued in the same way as other product criteria (Bergman & Lundberg, 2013; UNEP, 2015; Witjes & Lozano, 2016). Thirdly, procurement units may decide to assess life cycle costs in the tender stage, as opposed to an

[15] Results derive from interviews with procurement units in the framework of the study in 2020

evaluation of purchase costs alone. For energy efficient cooling appliances, this may make a substantial difference. Energy efficiency differences can lead to a high variation in electricity consumption of cooling appliances and therefore affect the life cycle costs. The global best available air-conditioning equipment is up to five times more energy efficient than the least efficient ones currently available, but also has a higher purchase price. However, the life cycle cost benefits of a more energy efficient appliance highly depend on local electricity prices, which therefore also affects the return on investment (IEA, 2018).

In the fourth stage, the utilisation stage, the product is delivered and the procuring organisation utilises it (Witjes & Lozano, 2016). During this stage, any direct impacts of GPP may become clear. The survey revealed that with the application of GPP, procurement units expect an increase in energy efficiency and a lower demand for resources, as well as a reduction in GHG emissions and environmental impact. Some others expect an improved quality of life as a result from implementing GPP.

Survey results

While the four stages summarise global practices, each country defines its own priorities while procuring, mainly affecting Stage 2 and Stage 3 of the PP procedure (see Figure 5). For the procurement of cooling appliances, the survey revealed that good product service and low costs are the most important aspects. Suppliers or local representatives with a good reputation are also found important (Figure 7). Of the aspects that relate to GPP, respondents indicated that high energy efficiency and environmentally friendliness are important. Although the lifecycle costs were not identified as one of the most important priorities during PP of cooling appliances, it was the only characteristic that no respondent disagreed with. It should be noted, however, that it is not specified in the question whether these aspects relate to Stage 2 or Stage 3 of the PP procedure. It may make a difference for PAs to include the aspects as criteria in Stage 2, or when they are part of the evaluation in Stage 3.

Q: What of the following priorities does your organisation define as being part of public procurement with regards to the procurement of ACs?								
Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	*I do not know*	*Does not apply*	**Score**
Purchase based on good product service (maintenance, spares availability, product warranty)	0	0	1	3	7	1	3	17
Purchase based on economically most advantageous tender	0	1	0	5	6	0	0	16
Purchase from suppliers/local representatives with good reputation	0	1	1	2	7	3	0	15
Procurement from suppliers with safety standards (safe operations, etc.)	0	0	3	4	4	1	0	12
Purchase based on highest energy efficiency	0	0	0	4	4	1	1	12
Purchase of environmentally friendly products / services	0	1	0	5	4	0	1	12
Purchase from local / national sources / suppliers	0	1	2	4	3	0	1	9
Purchase from environmentally friendly suppliers	0	1	1	4	3	0	1	9
Procurement of innovative products / services	0	1	2	6	1	0	0	7
Purchase based on lowest life cycle costs	0	0	2	3	2	1	2	7
Purchase from suppliers with human rights standards (> min. wage, no child labour, etc.)	1	1	2	4	2	1	0	5
Purchase of branded products	2	0	4	3	2	0	0	3
Purchase from suppliers with diversity standards (share of minorities, female workers, etc.)	1	2	3	2	2	0	0	2
Reduce purchase needs (buy less, extend product use, etc.)	2	0	3	1	2	0	0	1

Legend

The colours correspond with the number of responses

0	1	2	3	4	5	6

The colours correspond with the level of agreement to the statements*

1	3	5	7	9	11	13	15

** "strongly disagree" equals -2, "disagree" equals -1, "neutral" equals 0, "agree" equals 1, "stongly agree" equals 2*

Figure 7 Priorities regarding the procurement of ACs[16]

[16] Results derive from interviews with procurement units in the framework of the study in 2020

4. Barriers

Although the implementation of GPP leads to many advantages – as shown in Chapter 3 – public authorities do not yet exploit GPP to its fullest potential (UNEP, 2017). In addition to GPP being a new concept for many countries, several types of barriers to implementing more sustainable and greener procurement have been identified in the literature (UNEP, 2015).

4.1 Overview of typical barriers of Green Public Procurement

These barriers are very diverse and can be divided into financial, structural, institutional, technical, informational or capacity-related as well as regulatory and political barriers. Although the types of barriers are diverse and presented individually here, they are often related and interconnected. An overview of the barriers is presented in

Financial barriers

Financial barriers are mainly related, directly or indirectly, to the higher initial investment costs of environmentally friendly products, compared to conventional products and are said to be the biggest and most important barrier to GPP implementation (Brammer & Walker, 2011; Brouwer et al., 2006; European Commission, 2019; Montalban et al., 2017; UNEP, 2017). If only the investment costs are evaluated in the procurement process, which is common under conventional PP, environmentally friendly products are therefore perceived as more expensive (Butler & Keaveney, 2014). However, environmentally friendly products can lead to a reduction of costs during their lifetime, for example through energy savings, and thus be cheaper when assessing life cycle costs (also see table 3). Nonetheless, there may be a shortage of tools to conduct life cycle assessments (see informational and capacity-related barriers). Another aspect of high upfront investment cost is that the return on investment may take longer, which is a barrier for GPP when fast return of investment is a procurement criterion. Long-term cost benefits of high-efficiency technologies induced by energy savings may - in some cases - not guarantee a sufficiently fast return on investment (Butler & Keaveney, 2014).

Institutional barriers

Institutional barriers are specifically linked to the institutions that are involved in the procurement process and can be divided into inter-institutional and intra-institutional barriers. First, inter-institutional barriers relate to a lack of cooperation between public authorities, potentially leading to unfulfilled opportunities of – for example – coordinated information exchange on best practices (Chrintz, 2011; European Commission, 2019; UNEP, 2017; Zemgale Planning Region, 2017). This includes a lack of measurement and monitoring of environmental and/or social outcomes of GPP shared between institutions (UNEP, 2017).

Secondly, intra-institutional barriers relate to the extent GPP is anchored in an organisation. This can be expressed through a lack of management support and resources dedicated to GPP (Brouwer et al., 2006; Delmonico et al., 2018; Montalban et al., 2017). Possible consequences of this include competing procurement practices (i.e. lack of personnel in procurement teams, which are overwhelmed with their workload), no systematic implementation and integration of GPP in management systems, and lack of time and resources to develop GPP criteria (Brammer & Walker, 2011; Brouwer et al., 2006; Delmonico et al., 2018; PRIMES, n.d.; UNEP, 2017). In addition, resistance to change in combination with a lack of incentives among employees may result in conserving the conventional procurement practices (Butler & Keaveney, 2014).

Technical barriers

Technical barriers can be summarised in two main categories: a lack of established criteria for environmentally friendly products and a lack of available environmentally friendly products that meet these criteria. Literature suggests that there are limited established environmental criteria, sustainability standards, or profound ecolabels that PAs can apply in their GPP process (Chrintz, 2011; European Commission, 2019; Zemgale Planning Region, 2017). Additionally, PAs may not have access to applicable, uniform definitions of GPP (Hasanbeigi et al., 2019).

Another technical barrier is the potentially limited availability of products that meet the environmental criteria (Butler & Keaveney, 2014; Hasanbeigi et al., 2019; UNEP, 2017). This may be a result of a lack of exhaustive criteria in combination with a limited (environmental) awareness among suppliers (Zemgale Planning Region, 2017).

Regulatory & political barriers

Regulatory and political barriers may be related to a lack of strong policy commitments or regulatory action plans, as well as a lack of political and/or regulatory leadership and support towards GPP (Brammer & Walker, 2011; Butler & Keaveney, 2014; Hasanbeigi et al., 2019; UNEP, 2017). Additionally, a shortfall of enforcing rules and regulations has been identified, as well as a lack of monitoring and evaluation of implemented GPP policies (UNEP, 2017).

Informational & capacity-related barriers

PAs may experience a lack of information and applicable tools to implement GPP. These informational and capacity-related barriers can be related to a lack of market knowledge, limited awareness of the importance of GPP and technological expertise. Capacity-related barriers may arise from a shortage of practical tools to define and apply environmental criteria in the procurement process (Brammer & Walker, 2011; Chrintz, 2011; European Commission, 2019; Hasanbeigi et al., 2019).

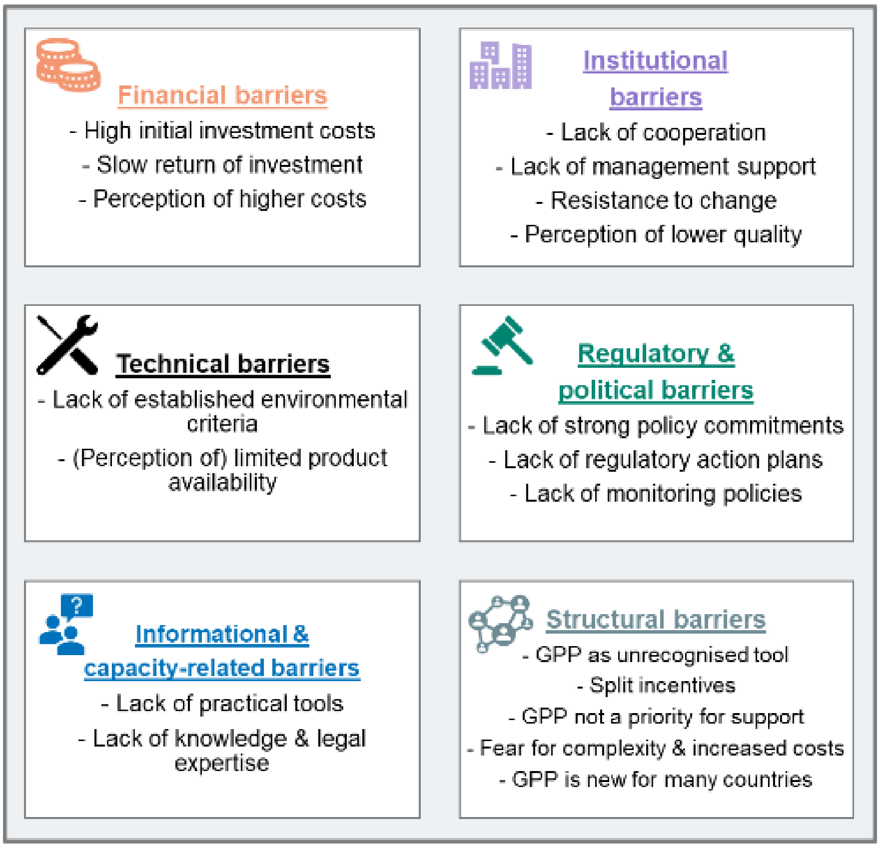
PAs may have insufficient knowledge about methods to measure life cycle costs – one of the key aspects of GPP (GIZ, 2019; Montalban et al., 2017; UNEP, 2017). Moreover, a lack of legal expertise, legal guidelines and uncertainty about the legal possibilities of incorporating environmental criteria are potential barriers to GPP (Brammer & Walker, 2011; Chrintz, 2011; Hasanbeigi et al., 2019). PAs may also experience a lack of information on the suppliers' activities and operations and perceive environmentally friendly products as products with lower quality (Brammer & Walker, 2011; Delmonico et al., 2018; Hasanbeigi et al., 2019; UNEP, 2017).

Structural barriers

Structural barriers to GPP are barriers that are beyond the control of individuals or institutions and shape the overall context of PP. They may be seen as overarching barriers anchored in the current PP environment. A structural barrier to enhanced implementation of GPP may be that the purchasing power of public authorities is not a commonly recognised tool towards an environmentally friendlier society (UNEP, 2017). In addition, there is a question of split incentives, i.e. the organisation advocating for GPP would not be the entity benefiting from the implementation of GPP and may not see direct results (Brouwer et al., 2006; Montalban et al., 2017). At the same time, this means that authorities that forward procurement requests to the central procurement units usually have little influence on the outcome. Overall, promoting GPP might not be a priority to support by – for example – civil society organisations (Brammer & Walker, 2011; Brouwer et al., 2006).

On the PA side, fears of a more complex procurement procedure and increased costs are identified as potential structural barriers (PRIMES, n.d.). In addition, aspects of the barriers described above, such as the competing procurement priorities, insufficient monitoring and evaluation, and lack of strong political leadership, may also be seen as structural barriers. Furthermore, GPP is a new concept for many countries – as stated before, which would require a common understanding and aligning of environmental targets with financial incentives. This realignment or rephrasing of priorities is a potential structural barrier to GPP (UNEP, 2015; UNEP DTU Partnership, 2016).

Figure 8 Overview of barriers to implementation of Green Public Procurement, based on various literature sources



4.2 Cooling specific barriers- Survey results

Barriers indicated by procurement authorities

When the respondents were asked openly[17], they indicated diverse barriers to enhanced GPP of cooling appliances in their countries. All barrier types as presented in the literature study (Section 0) were mentioned, except for institutional barriers. Below, an analysis of the respondents' answers is presented.

The majority of the respondents mentioned **financial barriers** to enhanced procurement of climate-friendly and energy efficient cooling appliances when they were asked openly. These respondents predominantly indicated high investment costs and budgetary limitations as important financial barriers.

After financial barriers, **technical barriers** were mentioned most frequently. Within this barrier type, the respondents mainly indicated limited availability of cooling appliances that comply with high environmental standards. Moreover, some respondents pointed at low minimum standards, an immature market for climate-friendly cooling appliances and a lack of business sector's commitments to adapt the supply of ACs to comply with environmental standards. In addition, respondents from Costa Rica perceive the technical applicability of environmentally friendly cooling appliances to common buildings in their country as limited.

Several survey respondents highlighted **informational and capacity-related barriers**. They mainly illustrated a lack of technical and market-related knowledge among procurement staff. In addition, the complexity of the technical conditions and product information was mentioned as a barrier.

The respondents also identified a few **regulatory or political barriers**. They illustrated that there is no responsible entity or legal reference for enforcement of GPP and a lack of specific policies. In addition, a few respondents touched upon structural barriers, by describing a lack of awareness on Green Cooling, but also by illustrating a fear of complexity.

Same results were obtained during the validation workshop. When the respondents were asked to indicate their level of agreement with pre-defined barriers[18], they generally confirmed the barriers which were indicated in the answers to the open-ended questions and literature study (Figure 9). Moreover, there was often consensus in their level of agreement. The most relevant results are discussed below.

As described before, the majority of respondents indicated **financial barriers** when they were asked to openly describe the three most important barriers to enhanced GPP of cooling appliances. This result is also shown when they were asked to indicate their level of agreement with the barrier related to costs of climate-friendly and energy efficient ACs - a majority of the respondents (strongly) agreed with the existence of a financial barrier. This may be closely related to the **informational barrier** on lifetime costs of environmentally friendly cooling appliances, as about half of the respondents agreed that a lack of this information is a barrier to GPP.

[17] Respondents were asked to name the most important barriers (up to three) that prevent public entities from procuring Green ACs.
[18] Respondents were asked about the extent to which they agree or disagree with predefined barriers to purchase Green AC through public procurement (Likert-scale questions).

Although the respondents did not mention it frequently when they were asked about barriers openly, about half of the respondents strongly agreed that a lack of strong **political and organisational leadership** is a barrier to enhanced GPP of cooling appliances. The same number of respondents strongly agreed that there is a lack of supportive **policies, regulations** and **incentives**. However, a few respondents strongly disagreed with the existence of this barrier, which reduced the total level of agreement on the barrier. No pattern related to any in-country situation could be identified to explain these diverse answers.

In addition, substantial consensus was found on informational and capacity-related barriers like a **lack of established criteria** for environmentally friendly cooling technologies and a **lack of methods and trainings** to compare offers of such technologies.

Q: To what extent do you agree or disagree with each of the following barriers to purchase Green AC through public procurement?

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Score
Green AC are more expensive	0	0	3	6	3	12
Lack of strong political and organisational leadership on GCPP	0	0	2	4	4	12
Limited established (uniform) criteria for green cooling technologies	0	0	3	5	3	11
Lack of methods to compare offers of green cooling technologies	0	2	1	6	2	8
Lack of information on lifetime costs for green cooling technologies	0	2	3	5	2	7
Lack of training of procurement staff and adequate tools on GCPP	1	1	2	4	3	7
Lack of supportive policies, regulations and incentives for GCCP	2	1	2	2	4	5
Lack of time and resources to develop GCPP criteria	2	1	2	3	3	4
Lacking choice/availability of green cooling technologies (incl. trained technicians)	0	4	1	4	2	4

Legend

The colours correspond with the number of responses

0	1	2	3	4	5	6	7

The colours correspond with the level of agreement to the statements*

0	1	3	5	7	9	11	13

** "strongly disagree" equals -2, "disagree" equals -1, "neutral" equals 0, "agree" equals 1, "stongly agree" equals 2*

Figure 9 Overview of barriers to purchase Green ACs through public procurement. The colours correspond with the barrier types categorised in Figure 3

Discussion and comparison with literature study

In many cases, the respondents confirmed the barriers identified in the literature study, as presented in Section 0, both when asked openly and when indicating their level of agreement. Although in some cases the respondents gave slightly conflicting answers, a consensus was found in their observations. When diversity in responses was found, it may be explained with country-specific circumstances and different perceptions or interpretations.

A relevant result from the surveys in the light of the literature study relates to **financial barriers**. Although financial barriers are the most important barriers to enhanced implementation of GPP according to literature, not all respondents mentioned a financial barrier when asked openly, or not as prominently as may have been expected when comparing to the literature study. On the other hand, the level of agreement on the financial barrier, together with regulatory and political barriers, is the most relevant barriers. The combination of answers to the open-ended questions and the indicated level of agreement cautiously confirms the importance of financial barriers as identified in the literature study, but it may indicate that costs are not the most obvious barrier in all of the countries under assessment in this research. For example, although in India costs appear to be a very important barrier, in Costa Rice, where GPP is already a more common practice, costs seem to be a less prominent barrier.

It is worth noting that financial barrier can considered a so-called "showstopper" for GPP, which means that after successfully removing this barrier, other barriers, such as informational and knowledge barriers, are less relevant or disappear entirely.

For several barriers, their existence or relevance is not (fully) confirmed by the survey results. In particular, the respondents indicated divergent levels of agreement on whether there is **a lack of time and resources to develop GPP criteria** and whether there is a **lack of availability of cooling appliances** that comply with the environmental criteria. On the former, a substantial number of respondents indicated a high degree of agreement, though a few did not agree with the barrier. In addition, it was not mentioned when the respondents were asked openly. This combination of results may suggest that the barrier is not very prevalent. Although a large share of the respondents mentioned the **lacking availability of environmentally friendly products** as a barrier, quite some respondents did not agree with this observation. More in-country research is needed to establish where and how the barrier is most relevant. The same applies to barriers related to policies and regulations. Although a **lack of strong and organisational leadership** was found to be one of the two most important barriers when respondents were asked to indicate their level of agreement, the survey results do not suggest that there is a **lack of supportive policies or regulations**. Therefore, further research is needed to determine which aspects of regulatory and political matters are lacking to enhance GPP of cooling appliances.

Another notable difference compared to results found in the literature is that institutional barriers were not mentioned by the respondents. Although a few answers lean towards institutional barriers (e.g. by indicating lack of knowledge and awareness among staff and an absence of responsible entity), none of them included aspects like a lack of cooperation between organisation or management support. Overall, the respondents mainly indicate barriers outside their own control – external barriers they would need to overcome before they experience the ability to implement GPP. With this, they hardly recognise barriers that are within their own control or perhaps created by themselves.

5. Ways to overcome barriers

5.1 Overview of typical enablers of Green Public Procurement

Many of the barriers described in Chapter 4 already imply ways to overcome them. Hence, potential enablers, i.e. ways to overcome barriers, can be categorised in the same way as the barriers. However, the enablers are often interrelated and should not be seen as standalone solutions to enhance the spread of GPP for cooling appliances. The enablers generally relate to increasing awareness of the importance of GPP, the (financial and environmental) benefits of GPP and the applicability of GPP. An overview of the enablers identified in literature is presented in Figure 10.

As discussed in Chapter 4, several barriers relate to a lack of information or capacity-related matters. **Informational and capacity-related enablers** have been found most frequently in literature, which may be related to the general awareness around GPP and environmental issues. Increasing awareness of GPP issues and advantages and capacity building among procurement officials may therefore contribute to enhanced GPP (Butler & Keaveney, 2014; Montalban et al., 2017). The latter includes increasing the legal expertise in applying or integrating environmental criteria during tender procedures (Zemgale Planning Region, 2017). Furthermore, developing simple, applicable but comprehensive tools and environmental criteria for products could drive the implementation of GPP (Montalban et al., 2017; PRIMES, n.d.). Interaction and consultation with market players, as well as market research, could also benefit the knowledge about the market conditions, sustainability practices of suppliers, and products (e.g. lifetime costs and environmental impact) (PRIMES, n.d.). Finally, GPP might be enhanced by increasing awareness that large-scale application of GPP, for example by JP of environmentally friendly products, could reduce costs of these products through economies of scale.

Although **financial** barriers, or the perception thereof, have been identified as the most important barriers, not many **enablers** were found in literature that could help overcome these. Most predominantly, considering lifecycle costs and eliminating the initial financial hurdle – the investment costs – were found as important enablers, closely related to advantages of JP described above. Considering lifecycle costs could tackle the perception of higher costs, whereas reducing investment costs would require more far-stretching (financial) interventions, or more frequent use of JP (Brammer & Walker, 2011; Montalban et al., 2017; PRIMES, n.d.).

The **technical and regulatory or political enablers** identified in literature are closely connected. They predominantly include establishing clearer policies and guidelines regarding GPP, clear definitions of GPP (both categorised as technical enablers) and develop a common understanding of best practice policies (categorised as a regulatory or political enabler) (Butler & Keaveney, 2014; Montalban et al., 2017; Zemgale Planning Region, 2017). In addition, increased availability of products that comply with the environmental criteria could enhance the implementation of GPP (technical enabler), as well as increased planning, strategies and goal-setting (Brammer & Walker, 2011; Montalban et al., 2017).

Regarding **institutional enablers**, literature mainly suggests increasing collaboration within and between institutions (Butler & Keaveney, 2014; PRIMES, n.d.). Joint public procurement is suggested as an enabler related to inter-institutional collaboration, that would possibly resolve other hurdles to GPP simultaneously (e.g. financial barriers), as discussed in Section 0 (PRIMES, n.d.). In addition, intra-institutional leadership that is in favour of GPP could act as a catalyst to greater adoption of GPP (Brammer & Walker, 2011).

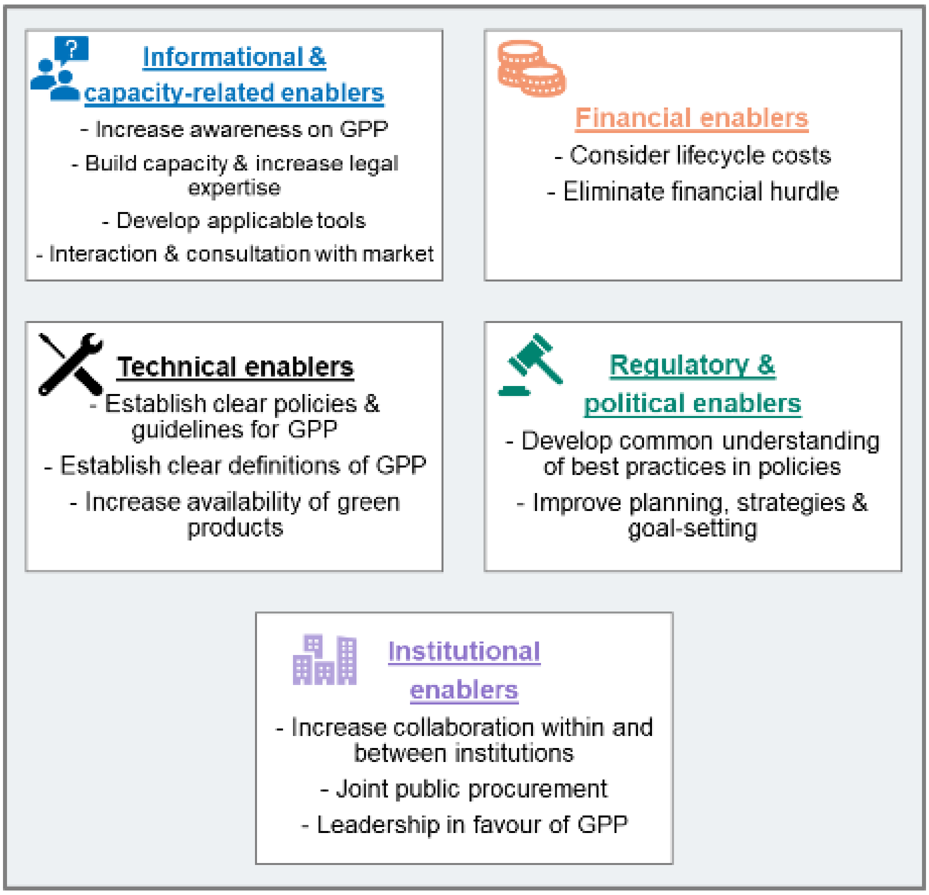


Figure 10 Overview of typical enablers for implementation of Green Public Procurement

5.2 Cooling specific enablers - Survey results

The respondents suggested divergent enablers when they were asked openly[19], covering all categories of possible enablers. Most predominantly, the respondents mentioned **informational or capacity-related enablers**, mainly focusing on increasing the capacities of procurement staff. They described training of committed staff and awareness-raising among PAs as important potential enablers towards enhanced GPP.

Also, the respondents often mentioned **technological improvements as potential enablers**. They illustrated a need for such improvements to current cooling appliances so that the availability of compliant cooling appliances would increase. However, these suggestions may also have to do with a need for more information sharing on already-existing technological, economic and environmental features of environmentally friendly cooling appliances and may therefore be related to the informational and capacity-related barriers described above.

In line with the frequently mentioned financial barriers, **enablers related to costs** were often highlighted, too. The respondents suggested that investment costs of the implementation of environmentally friendly cooling appliances could be reduced through discounts, subsidies or a stronger and more competitive market. Regarding the remaining types of enablers, respondents suggested that a stronger and

[19] Respondents were asked to name the most important enablers (up to three) that facilitate public entities in procuring Green ACs.

improved regulatory framework, enhanced inter-institutional collaboration and support can boost the implementation of GPP for cooling appliances.

When respondents were asked to indicate their level of agreement with pre-defined enablers[20], every suggested enabler was agreed upon, though to different degrees (Figure). Most predominantly, the respondents strongly agreed that training of procurement officials and increasing awareness among them would enhance GPP of cooling appliances. This is in line with the enablers that were mentioned most frequently when respondents were asked openly – enablers that mainly focussing on increasing capacities of procurement staff. In addition, the majority of respondents confirmed the need for clear policies and regulations for GPP.

Regarding the most important barrier, the financial barrier, respondents frequently agreed that **consideration of lifecycle costs** would enhance the implementation of GPP of cooling appliances. In addition, a majority of the respondents strongly agreed that an increased availability of green ACs would stimulate GPP. During the validation workshop, training of procurement units was mentioned as the most important enabler, followed by the relevance of the availability of Green ACs.

Q: To what extent do you agree or disagree with each of the following enablers for purchasing Green AC through public procurement?

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Score
Train procurement officials on GCPP (application of tools, understanding of criteria)	0	0	1	6	4	14
Increase awareness of GCPP benefits among procurement officials	0	0	3	3	5	13
Ensure clear policies and regulations on GCPP	0	0	2	3	5	13
Ensure consideration of a Life Cycle Costing approach for green cooling technologies	0	0	1	8	2	12
Increase availability of green cooling technologies	0	1	3	1	6	12
Increase cooperation between authorities (e.g. through joint procurement) on GCPP	0	0	4	2	4	10
Ensure clear definition of criteria for green cooling technologies	0	1	3	3	4	10
Monitoring GCPP processes and communicating the results	0	0	4	5	2	9

Legend

0	1	2	3	4	5	6	7

The colours correspond with the level of agreement to the statements*

0	1	3	5	7	9	11	13

* "strongly agree" equals -2, "disagree" equals -1, "neutral" equals 0, "agree" equals 1, "stongly agree" equals 2

Figure 11 Overview of enablers to purchase Green ACs through public procurement – level of agreement on suggested enablers. The colours correspond to the enabler types categorised in Figure 7[21]

Discussion and comparison with literature study

Based on the overall agreement on suggested enablers, it may become evident that there is not a 'one-size-fits-all' solution to enhance GPP of cooling appliances. Although strong agreement was found on increasing capacities of procurement staff, e.g. through training and applicable tools, a mix of

[20] Respondents were asked about the extent to which they agree or disagree with predefined enablers for purchasing Green AC through public procurement (Likert-scale questions).
[21] Results derive from interviews with procurement units in the framework of the study in 2020

different policy elements might be needed to accompany this enabler. More detailed research into specific country cases may be necessary to identify the potentially most successful enablers.

Many respondents confirmed that the consideration of AC's lifecycle costs would be an enabler for GPP, but it was less frequently mentioned when the respondents were asked openly. Therefore, awareness of this element may be covered under more training of procurement staff. Overall, the respondents showed a high degree of agreement for enablers regarding training and capacity building, although it was not mentioned frequently when they were asked openly. This may suggest an overarching barrier and related enabler – the current lack of awareness and knowledge regarding green procurement practices, for which the procurement staff might need external support to overcome it. This may be related to the observation that none of the respondents mentioned internal or intra-institutional barriers or issues – as described under Section 4.2.

6. Selected country cases

6.1 GPP in Costa Rica

Costa Rica is seen as a pioneer in SPP and GPP in Latin America, because of three main aspects. The country has developed an extensive legal framework for SPP, it has published far-stretching information materials for (green) procurement, and institutionalisation of GPP through official committees.

Legal framework & information availability

Costa Rica was the first country in Latin America to implement detailed sustainability-related procurement laws. The positive influence of the procurement laws on GPP implementation was confirmed by the respondents of the survey. In addition, the Costa Rican government published a manual for the implementation of green purchases in the public sector in 2008 (Stamm et al., 2019). Since the publication of the GPP manual in 2008, the Costa Rican legal framework and information availability regarding green and sustainable procurement has grown continuously. Most predominantly, the government established **admissibility criteria** for various product groups, of which a few relate to environmental criteria – energy efficiency of electric appliances, recyclable plastics, and recyclable fibres in paper. These criteria prohibit the procurement of products that do not meet certain environmental standards, for example, low energy efficiency for products that require high energy consumption. In other words, a product's compliance with admissibility criteria is evaluated before the evaluation of, for example, costs (Stamm et al., 2019).

Institutionalisation

In Costa Rica, several influential committees advise on different procurement, and determine corresponding laws or other practices of PP (Stamm et al., 2019). These committees are hosted by different ministries and their core responsibilities include steering, coordination and implementation of PP practices. In addition, the Costa Rican governmental procurement departments work in close collaboration with CEGESTI, a consultancy firm specialised in sustainable development, that supports the development of the legal framework (Stamm et al., 2019). CEGESTI mainly aims at enhancing the implementation of GPP and provided a handbook for public authorities to advance their GPP.

Success factors[22]

CEGESTI determined several key success factors in the GPP guide, which was published by the Costa Rican government (CEGESTI, n.d.). The success factors can help in effectively implementing GPP. These factors include but are not limited to:

- Mention of the desired sustainability aspect of the product or service in the tender title. This attracts the attention of suppliers who are ambitious in terms of sustainability standards. For cooling appliances, the title of the tender might include "energy efficient" or "climate-friendly".
- Evaluation of the entire lifecycle of a product when assessing its potentially negative impact on the environment. Based on their expert judgment or market research, for example, PAs can

[22] As identified by CEGESTI

assess what sustainability improvement may be achieved and what aspects are within reach. The latter question also helps procurement staff not to exclude (too many) suppliers and therefore to stay within the limits of procurement law.

- Within organisations, enhanced collaboration between procurement staff and technical staff. The staff could assess tenders and bids together, to ensure technical compatibility while drafting the tender and evaluating bids. The survey revealed that such a practice already occurs in Iran.
- More creativity in bid evaluation methods, especially in assigning scores to certain (for example, environmental) criteria.
- Enhanced monitoring and verification processes, which increases the ability to assess the impacts of the full lifecycle of the procured product or service.

Costa Rican best practice case: Institute of Electricity (ICE)

A Costa Rican good practice case on GPP is the Costa Rican Institute of Electricity (ICE). Although the ICE has been a forerunner in GPP for several years, it has been under pressure from the Costa Rican population to reduce their negative environmental impact. That, in combination with their own environmental awareness, increased their GPP ambitions (Stamm et al., 2019). The ICE appointed a Committee of Green Procurement, in cooperation with CEGESTI. The Green Procurement Committee which is, in addition to the country-wide committees, in the process of standardising calls for tender, to make GPP more feasible and easily accessible. Moreover, all environmental criteria are admissibility criteria at the ICE, meaning that bids that do not meet these (high) environmental criteria are not considered for procurement (Stamm et al., 2019). These are additional to the legally determined admissibility criteria, as described above. ICE's evaluation of bids is then only based on the price. The ICE has stated their interest in collaborating at an international level for further development of GPP, as they are the leading institute in Costa Rica in terms of GPP (Stamm et al., 2019).

Summary of best practices in Costa Rica

The success factors in Costa Rica, as shown for instance through the ICE GPP case, can be summarised into enhanced collaboration, enforcement, and verification. The assigning of advisory GPP bodies and GPP committees within organisations enhances the collaboration between procurement staff of different organisations, as well as internal collaboration, between the procurement staff and technical staff. In addition, Costa Rica has shown that law enforcement from higher levels of governance are effective for increased implementation of GPP. Mainly the admissibility criteria are useful for setting clear minimum criteria, and they enable the procurement staff to explore more specific (environmental) criteria for products under procurement. Verification and monitoring are necessary to track these success cases, and transfer obtained knowledge from one case to another.

6.2 Bulk Procurement of room ACs in India

In 2017, the Indian ESCO Energy Efficiency Services Limited (EESL) prepared a bulk procurement of 100,000 energy efficient (minimum 5.2 ISEER) split ACs for residential and public institutions. The bulk procurement was carried out in cooperation with the Indian government with the objective to accelerate the market penetration of top efficiency cooling appliances by aggregating the demand for the technology and establishing a demand market for participating manufacturers, thereby leading to rapid reduction in prices (TERI et al., 2017).

The tender requirements mandated that the manufacturers design, manufacture, supply, install, and provide after-sales O&M with extended customer support. While the government preferred to utilize environmentally friendly refrigerants in order to enable more manufacturers to participate in the tender, there was no restriction on refrigerant GWP as long as they complied with the Ministry of Environment, Forest and Climate Change's (MoEF&CC) regulatory requirements (TERI, 2019).

In May 2017, the tender resulted in 60,000 units to be supplied by Panasonic with an ISEER 5.2 room ACs using HFC-410A refrigerant (GWP of 2088) and 40,000 units with an ISEER 5.2 using HC-290 refrigerant (GWP of 1) supplied by the Indian manufacturer Godrej & Boyce. The total cost per unit inclusive of design, manufacture, supply, installation, 3-year comprehensive warranty, and specified customer support is INR 44,320 (US$687.16; €614.023) for both the suppliers. The approximate value of the tender was about INR 443 Crores million (~US$68 million; ~€61 million).

Lessons learned

The leverage of bulk procurements: By aggregating the demand of several institutions and market actors, EESL was able to meet lower prices for energy efficient split ACs which would have been more expensive in disaggregated orders. In doing so, the procurement helped several entities in affording and accessing high efficiency ACs with lower life cycle costs.

Acceleration of sustainable refrigerant market development: Although the tender didn't specify a refrigerant GWP limit and hence didn't plan to promote technology with superior overall environmental performance, it was encouraging to see that 40% of the bids went towards the low-GWP refrigerant HC-290 in line with the HFC phase-down plans stipulated under the Kigali Amendment to the Montreal Protocol. In this way, the procurement helped local manufacturers to accelerate the market penetration of a sustainable refrigerant solution, thereby paving the way for ACs with HFC alternatives.

Need to factor in life cycle costs and climate impact: With regard to the climate impact, the procurement only included high energy efficiency levels in its technical specifications. The result of the tender however shows that with a refrigerant GWP limit a higher climate performance would have been possible, leading to optimized climate performance. Further, from a life cycle cost perspective, it wouldn't have been necessary to put the lowest purchase price as a key criterion as with an efficiency of ISEER 5.2 the systems have a highly attractive internal rate of return. The usage of metrics that evaluate the costs and GHG impacts, such as life-cycle-costing, the life cycle climate performance (LCCP) and total equivalent warming impact (TEWI) can help to optimize the life cycle cost and climate performance in future tenders.

6.3 Other best practice cases for GPP

Based on several best practice cases, applicable enablers can be found to a variety of barriers. Although the cases, presented in

Country	Product	Procuring organisation	Key success factors	Related to category of barriers & enablers
South-Korea [a]	LED Lights	National Health Insurance Service	Country-wide legal mandate to purchase environmentally friendly products	Regulatory & political
			Establishment of Internal Green Procurement Guidelines	Regulatory & political
			Inclusion of LED lights in the internal energy saving initiative	Regulatory & political
Japan [a]	Ballpoint pens	Japanese ministries	Institutionalised legal framework for green procurement, which mandatory for all central government organisations, in order to enhance GPP	Regulatory & political
			availability of information about eco-labelled products. Ministry of Environment had facilitated awareness raising on this	Informational and capacity-related
Denmark [b]	Indoor and outdoor lighting	City of Kolding	Division of tender into three sub-groups, to allow SMEs to bid as well as larger suppliers.	Technical and/or institutional
			Creativity in award criteria and scoring: - Life-cycle costs (55%), of which Purchase price (35%), lifetime (35%) & operating costs (30%) - Energy efficiency (25%) - Light quality (20%)	Informational and capacity-related and/or regulatory and political
			Before procurement process started, dialogues with a number of potential suppliers, to obtain knowledge about possible sustainability aspects.	Institutional
United States [c]	Various cooling appliances	Various US departments	Sector-specific fact sheets and websites on HFC use & feasible alternatives	Informational and technical
			Case study to explore possibilities	Informational and technical

Figure 12, cover different types of product groups, the identified "lessons learnt" could be translated to the procurement of environmentally friendly cooling appliances and other countries. Two relevant elements of the best practices can be highlighted. On the one hand, it should be noted that there is no single solution that applies to all countries as each country has its own requirements. On the other hand, whether or not a best practice case is relevant also depends on the phase in which the development of the national procurement process is at. Different examples are relevant for processes in the infant stage than for more mature processes.

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United States [c]	Various cooling appliances	Various US departments	Sector-specific fact sheets and websites on HFC use & feasible alternatives	Informational and technical
			Case study to explore possibilities	Informational and technical

Figure 12 Best practice cases for GPP

a: https://www.oneplanetnetwork.org/sites/default/files/case_studies_140317_web.pdf

b: https://ec.europa.eu/environment/gpp/pdf/GPP_Good_Practices_Brochure.pdf

c: https://www.oneplanetnetwork.org/webinar-promoting-ozone-climate-friendly-refrigerants-and-air-conditioning-technologies

7. Green AC criteria and ways to move forward

Like the introduction of energy and ecolabels, the voluntary instrument of green public procurement can lead to high energy and overall emission savings and supports the market uptake of climate-friendly and energy efficient technologies.
As observed in the European Union due to the HFC phase down according to the EU F-gas Regulation, the HFC phase down under the Kigali Amendment will likely lead to higher HFC prices globally, that will further accelerate the transition to more climate-friendly and sustainable refrigerants. Procurement authorities will want to avoid new investment in obsolete HFC technology that will be expensive to operate and service and will also want to reduce refrigerant emissions from existing equipment. It is generally more cost effective to replace older operating equipment that was inefficient at purchase, poorly installed, and badly maintained than to retrofit equipment to a new refrigerant (SPLC & IGSD, 2020).

During the validation workshop, participants were asked where they identify the greatest need for support to promote Green ACs in public procurement. The need for training for procurement units on Green Cooling technologies and their evaluation criteria was mentioned first, followed by the need for awareness raising. Support in setting up evaluation criteria for ACs was also seen as relevant.
This chapter covers procurement actions for Green ACs. The criteria focus on split ACs, nevertheless, the recommended admissibility criteria also apply to other type of unitary ACs.

The purchase of new split ACs, either in a whole building or a particular space, has a big influence on building energy consumption. A new AC installation should remain in place until its replacement with a more efficient solution is economically and environmentally viable. Besides, an evaluation of the surrounding conditions and actual cooling demand is recommended prior to the purchase of a new AC, including the verification of actual cooling demand (many ACs are oversized), and potential measures to reduce the cooling demand (e.g. improvement of thermal insulation, sun blinds, etc.). For cooling demand profiles with moderate load conditions over longer times, the selection of inverter-technology is appropriate.
When purchasing, installing, maintaining and disposing air conditioning systems, a few basic aspects should be considered at all times:

Key Environmental Impacts	GPP approach for ACs
Energy Consumption	- Ensure purchase of inverter-type ACs with high energy performances - Select ACs with capacities in accordance to cooling demand - Use cooling control systems
Use of high GWP / ODP refrigerants	- Purchase ACs using low GWP refrigerants like natural refrigerants
Refrigerants leakages	- Ensure installation, maintenance and decommissioning according to international good-practices
Generation of hazardous waste	- Reuse or recover old equipment - Establish an extended producer responsibility (EPS)

7.1 Admissibility Criteria for Green ACs

Admissibility criteria prohibit the procurement of products that do not meet certain environmental standards, for example, low energy efficiency or the use of environmentally harmful substances. Often procurement criteria of ACs do not reflect international feasible MEPS or international efforts to phase-down HFC refrigerants.

There are three types of performance criteria that apply to selection of refrigeration and air conditioning equipment (SPLC & IGSD, 2020):

1. Technical Performance, including cooling capacity (measured in kWh, TONs, BTUs, etc.) and energy efficiency (measured as EER, COP, SEER, etc.)
2. Life Cycle Costing (LCC) including the cost of purchase, transport, installation, maintenance, operation, and end-of-life (recycle of material, recovery and reuse or destruction of ozone-depleting or GHG refrigerants)
3. Life Cycle Climate Performance (LCCP) or Total Equivalent Warming Impact (TEWI), measuring the climate impact of a product over its lifetime.

Technical Performance Criteria like the (S)EER or the COP can give a first overview on products efficiency[23]. The life cycle costing "can be used to compare the economic efficiency of products by taking into account all relevant costs. In many cases, environmentally friendly products prove to be the most economic option - despite the higher cost of acquisition" (UBA, 2017). In order to assess the total climate impact of cooling appliances it is recommended to use the TEWI as a basis of assessment. The TEWI demonstrates the total environmental impact of a cooling system during its operating life. The method takes into account direct emissions of refrigerant leaking to the atmosphere as well as indirect emissions resulting from the energy consumption during equipment lifetime. Unlike the LCCP, the TEWI does not include emissions from production, disposal and transport of equipment, as these values are usually difficult to determine. To calculate the total emissions of air conditioning systems using the TEWI method, device- and country-specific parameters are required, as shown in Figure 12.

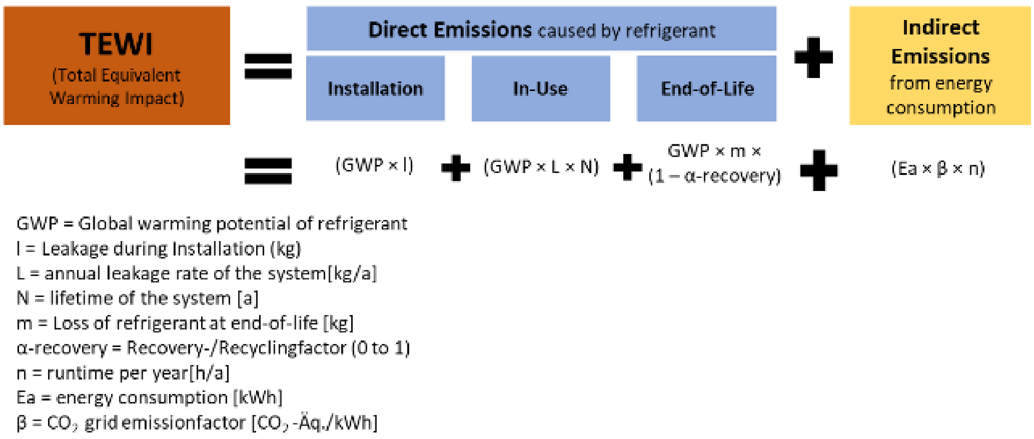

Figure 13 Total-Equivalent-Warming Impact calculation

[23] More information on SEER and COP in Annex I

Indicate in the call for tenders that information on energy efficiency, refrigerant type and GWP, reuse and recovery options etc. should be submitted by the contracting partner. The TEWI can be calculated by the contracting authority or the contractor.

Table *3* lists relevant admissibility criteria for the evaluation of split ACs in the context of GPP and is intended to support contracting authorities in the selection process. The scoring and points listed are only intended as a guide for weighting the criteria.

Further valuable resources in setting up admissibility criteria for ACs are:

- Blue Angel Ecolabel for stationary ACs. Basic award criteria are available on the website[24].
- EU Energy Label Regulation for ACs, only covering units under 12 kW
- Procurement recommendations for climate-friendly refrigerants developed by the Sustainable Purchasing Leadership Council (SPLC) Action Team on Climate-friendly Refrigerants, in partnership with the Institute for Governance & Sustainable Development (IGSD)
- Nordic criteria for Green Public Procurement (GPP) for alternatives to high GWP HFCs in RAC products developed by Nordic Council of Ministries

Air-conditioning systems are to be procured, if possible[25] with natural refrigerants[26] as well as the currently highest energy efficiency standard in the respective country (SEER or EER). In this context, it is now even possible for split appliances to define or demand Blue Angel criteria. If split ACs are carrying Ecolabels, which are recognized by the government, for example in the form of a Mutual Recognition Agreements, these can simplify procurement decisions, as the evaluation regarding ecological standards already took place in the awarding phase. "The most valuable labels from a GPP perspective are those which are based on objective and transparent criteria and which are awarded by an independent third party. These labels can play a particular role in developing technical specifications and award criteria, and in verifying compliance" (Nordic Council of Ministries, 2020).

[24] https://www.blauer-engel.de/en/products/electric-devices/stationary-air-conditioners

[25] depending on the availability of the equipment and the refrigerant as well as the existing installation and maintenance infrastructure

[26] for room air conditioners usually propane (R290), for centralized air conditioning systems hydrocarbons (such as R290), and, depending on the building specifications, CO2 (R744) or ammonia (R717)

Table 4 Proposed admissibility criteria for single split ACs

Criteria	Feature	Metric	Description	(1) Weighting	(2) Points	Scoring (1) x (2)
Technical Performance	**Technical Specifications**		Must be an inverter type split AC	Minimum Criteria		
	Energy efficiency	Energy Efficiency Ratio (EER) Seasonal Energy Efficiency Ratio (SEER) Coefficient of Performance (COP)	Minimum criteria: current MEPS or highest Energy Efficiency Class Bidder must provide product description / documentation of SEER/EER and results from certified testing laboratory *Example of assessment points:* *SEER < 5 = 0 points* *5 < SEER < 7 = 1 point* *SEER > 7 = 2 points*	20%		
	reliability	Warranty	lubricant and materials compatibility, service life	10%		
	Air filter		Indoor units must be fitted with air filters that can be easily cleaned	Minimum Criteria		
Life Cycle-Cost Performance	**LCC**		Including costs of purchase, installation, repair and maintenance, operation an uninstallation	20%		
Environmental Performance	**Ecolabel**		Ecolabel must be nationally recognized	10%		
	Refrigerant used	GWP of Refrigerant	AC systems are to be procured, if possible[27] with natural refrigerants. Bidder must provide information on GWP and ODP of contained refrigerant. Refrigerants restricted under the Montreal Protocol (CFCs & HCFCs) are forbidden. *Example of assessment points:* *GWP > 700 = 0 points* *10 < GWP < 700 = 1 point* *GWP < 10 = 2 points*	10%		
	TEWI/LCCP	CO_2eq.	Bidder must provide all relevant data on refrigerant type, charge size and EER.	25%		
	Noise emissions	Dezibel	Noise emissions must be stated in the product documentation[28]	5%		

[27] depending on the availability of the equipment and the refrigerant as well as the existing installation and maintenance infrastructure
[28] Please relate to UBA 2016: Basic Award Criteria for Stationary air conditioners: DE-UZ 204-201608-en Criteria-2020-01-10.pdf (blauer-engel.de) p. 9

Annex III contains an example of a tender questionnaire for split ACs to be filled in by the contractor during the tendering process.

All procurement requests for air conditioning systems must be forwarded immediately to the procurement unit responsible for the product type to evaluate the products in accordance to the admissibility criteria.
If no such room air conditioners are available, special care should be taken to avoid substances regulated under the Montreal Protocol, especially HCFC R22. In the case of HFC alternatives, the global warming potential (GWP) must be kept as low as possible and therefore the procurement of appliances and systems with e.g. HFC R410A (GWP 2088) should be avoided. HFC R32, although also a controlled substance under the Montreal Protocol with a medium climate effect (GWP 675), is currently the most compatible alternative in many countries where appliances with natural refrigerants are not available yet.

7.2 Strategies to move forward

Table 5 Guiding Steps

Assess the Green Cooling potential in the public sector
In order to get an idea of Green Cooling potential in your public building it is helpful to conduct an Inventory of cooling technologies in use and an assessment of technology options. The Inventory delivers important data to analyse GHG emission, energy and cost saving potentials.
GIZ Proklima can provide further guidance on how to conduct a Cooling Inventory and references on Best Available Green Cooling Technologies
Secure commitment and define Green AC procurement target
Make a clear commitment to green public procurement by getting the support of a relevant government agency or the organization's procurement authority (ideally from the top of the hierarchy) and define responsibilities. Form a working group or an inter-ministerial steering committee, that should at least consist of central procurement authorities, ministries of environment, finance and industry/ economic affairs, to coordinate for inter-ministerial coordination of technical competencies for developing green criteria, access to manufacturers and industries and the implementing of public procurement
Incorporate GPP/SPP in overarching high-level policy goals, procurement regulations and specific policies
To accelerate the market uptake of Green ACs, mobilize budget/funds to cover higher upfront costs
Signing Mutual Recognition Agreements (MRAs) with the eco-label programs in other countries such as Germany, Japan, Korea, Australia, New Zealand, Canada, USA, to enable the GPP scheme to recognize green air conditioners certified by those eco-labeling programs (IIEC, 2019).
Coordinate with state and local authorities to remove barriers and accelerate the market uptake of Green ACs
Formulating or updating Green Public Procurement guideline
Green Public Procurement guideline and manuals improves the legal framework and increases information availability regarding green and sustainable procurement. Pre-formulated tender guidance documents and contract award criteria can facilitate the process. *Green ACs in Public*

Procurement Action Plans including different stringent levels of procurement criteria in accordance to MEPS and HFC phase-down timeline will engage political commitment.
Define or update admissibility criteria for the purchase of cooling equipment and adopt environmental performance criteria (e.g TEWI, ecolabels) and Life-Cycle Cost Assessments in the tendering process to reduce financial barriers and improve environmental impacts.
If your country has no experiences in green procurement yet it is recommended to first *focus on products where you can easily assess environmental criteria and where a large selection of eco-friendly options are already available and learn from other countries for the criteria development.* With that your organisation can gain first experiences in the process of GPP.
Improve public procurement processes
On the basis of the manuals, guidelines and international best practices and model criteria, public procurement procedures and documents can be updated.
Use Bulk or Joint Procurement to reduce financial and institutional barriers. Large purchasers (e.g. government agencies or other organizations) can often result in discounts that help justify the purchase price of new equipment. Purchasers can work with suppliers to negotiate bulk purchase discounts.
It will simplify the process if you centralize procurement processes and establish a central procurement entity or a central procurement portal also allowing bulk procurement
In some cases and in the case of larger investments alternative solutions like Product Service Systems (PSS)[29] or Energy Performance Contracts (EPC)[30] with energy service companies (ESCOs) can be an highly effective method costs and environmental impacts.
Training of stakeholders and awareness raising on Green Cooling
Conduct trainings on GPP and the potential and advantages of Green Cooling in general for all relevant personnel involved in procuring Cooling equipment. Pay special attention on increasing capacities of procurement staff on Life Cycle Costs and evaluation of TEWI.
Conduct Awareness-Raising Campaigns on GPP as well as the relevance of Green ACs in public buildings.

[29] Product-service systems (such as refrigeration as a service) are contractual arrangements where the supplier does not sell a product but a related service to the customer, such as leasing a car.
[30] Under an EPC arrangement an external organisation (ESCO) implements a project to deliver energy efficiency and uses the stream of income from the cost savings to repay the costs of the project, including the costs of the investment

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Annex I Political Background: Montreal Protocol and Kigali Amendment

Montreal Protocol

The Montreal Protocol on Substances that Deplete the Ozone Layer is an environmental treaty that has been ratified by every country in the world. It was adopted in 1987 to regulate the production and consumption of ozone depleting substances (ODS). The release of these chemicals, known as ODS, into the atmosphere leads to damage to the stratospheric ozone layer – a shield that protects life on Earth from the sun's ultraviolet radiation. In addition, many ODS represent potent greenhouse gases that harm the global climate. The regulation of the Montreal Protocol represents a phase-out of ODS. Therefore, timetables have been introduced that differ for developed and developing countries. Responsibilities e.g. for controlling trade, import and export of ODS and data reporting are equal but differentiated. Responsible for the treaty's governance is the Meeting of the Parties, which is technically supported and prepared by an Open-ended Working Group. Both hold annual meetings. Assistance is provided to the Parties by the Ozone Secretariat. Financial and technical support to the Montreal Protocol for developing countries is given by the Multilateral Fund. The reduction in ODS achieved so far amounts to 98% compared to 1990 levels.[31]

Montreal Protocol Amendment for HCFCs

In the RAC sector, hydrochlorofluorocarbons (HCFCs) have been commonly used gases. As they are classified as ODS, their phase-out is determined by the Montreal Protocol. HCFCs not only damage the ozone layer but, similar to other ODS, also the climate, as they have a high global warming potential (GWP). For this reason, the Parties' decision in 2007 was to accelerate the phase-out of HCFCs. The phase-out of these gases was reached by 2020 for developed countries and will be reached by 2030 for developing countries.[32]

Kigali Amendment

To replace chlorofluorocarbons (CFCs) and HCFCs, hydrofluorocarbons (HFCs) were introduced as alternatives in the RAC sector. Although they do not damage the ozone layer, their GWP is high. This problem was addressed in 2016 at the 28th Meeting of the Parties in Kigali, Rwanda with the Kigali Amendment to the Montreal Protocol. The amendment adds HFCs to the list of controlled substances and sets their phase-down of 80-85 % by the 2040s. The timeline for the reduction ofHFCs is again different for developed and developing countries. For ratifying countries, the Kigali Amendment entered into force in 2019.[33]

[31] UNEP n. d.b
[32] ebd.
[33] ebd.

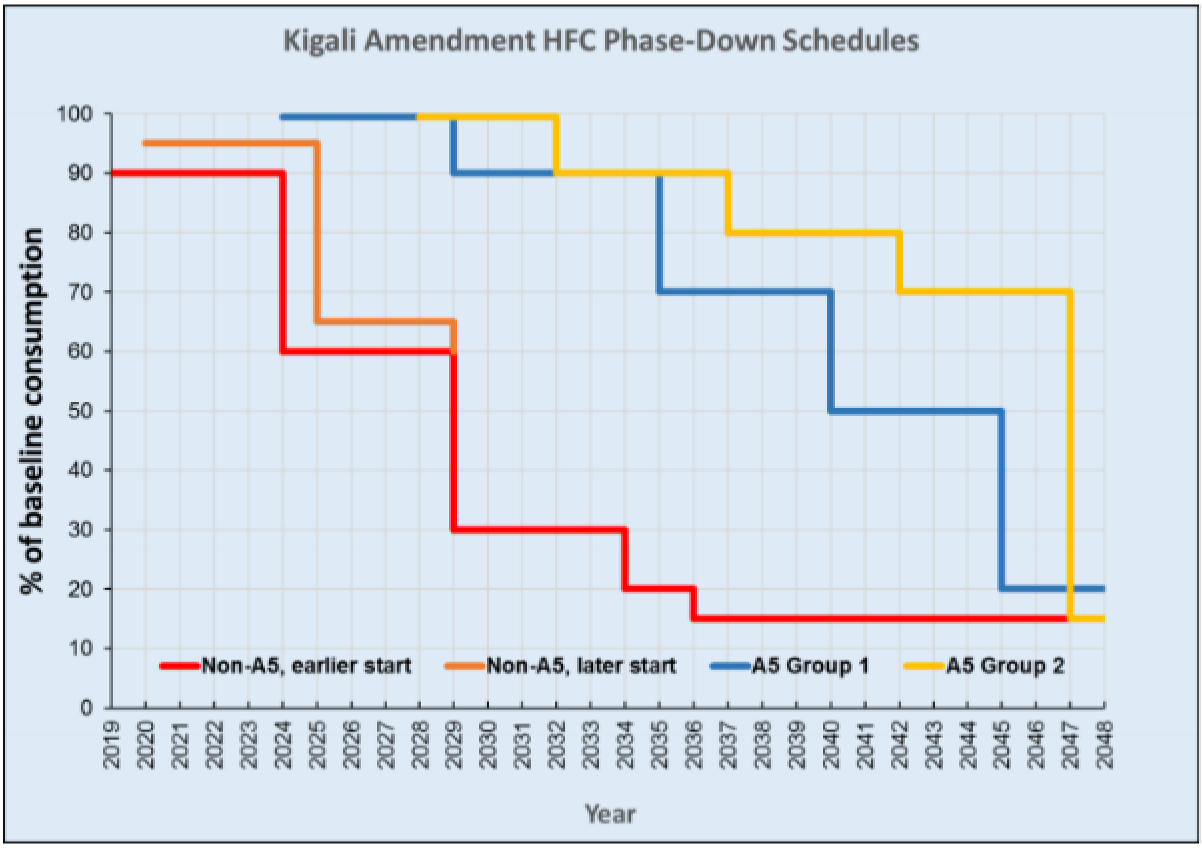

Figure 14 HFC Phase-down schedules of the Kigali Amendment

UNEP n. d.a, p. 2

Annex II: Specifications of split ACs

Split residential AC **Split commercial AC**	• The systems consist of two elements: (1) the condenser unit containing the compressor mounted outside the building and (2) the indoor unit (evaporator) supplying cooled air to the room. Both units are connected via refrigerant piping (ductless split) • This product group refers to "single" split systems, i.e., one indoor unit is connected to one outdoor unit. Please, when reporting unit numbers, avoid double counting and regard systems as a whole.	

Figure 15 Split residential and commercial ACs

Refrigerants

At the moment, split ACs mainly use R22, R410A or R32 as refrigerant. Due to the classification of R22 as HCFC and ODS, it is included in the phase-out process of the Montreal Protocol. For developed countries, this process has already been completed; developing countries will complete it by 2030. R410A and R32 are mainly being used as a substitute for ODS in split ACs, although both refrigerants are HFCs with a high GWP (see table 1) and are therefore included in the ongoing phase-down under the Kigali Amendment. Since 2019, developed countries have started to reduce HFCs (in Europe the phase-down has already started in 2015). For developing countries, the freeze of HFC consumption levels has to begin in 2024 and in some cases in 2028.

Other alternatives are HFC/hydrofluorooelefins (HFO) blends (not yet available for split ACs) and propane (R290). The properties of the named refrigerants differ.[34]

Table 6 Refrigerants of Split ACs adapted from the GIZ Proklima input (supported by the U4E Air Conditioners Taskforce experts) in UNEP 2017, p. 28

Refrigerant	R22	R410A	R32	HFC/HFO blends[35]	R290
GWP[36]	1,760	1,924	677	150-300	3
Refrigerant Efficiency	High	Low	High	Medium	High
Refrigerant Cost[37]	Low/Medium	Medium/High	Medium	High	Low
ISO 817 Safety Classification	A1 – lower toxicity and non-flammable	A1 – lower toxicity and non-flammable	A2L – lower toxicity and lower flammability	A2L – lower toxicity and lower to higher flammability	A3 – lower toxicity and higher flammability
Environmental controls and use restrictions	Globally subject to HCFC phaseout	Sectoral use capped and/or subject to subsector bans in some countries due to GWP	No ban for ACs. Substance is subject to controls under MP / KA	No ban for ACs. Substance is subject to controls under MP / KA	No ban

[34] UNEP 2017, p. 27
[35] Not yet available, still under investigation
[36] Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report, 2013
[37] GIZ 2019, p. 15.: While these are indicative of current costs, future costs of R290, H32 and low-GWP blends will depend significantly on the scale of production due to the Kigali Amendment to the Montreal Protocol, and may be lower if sufficient scale is achieved.

The table shows that all the available split AC refrigerants have a very high GWP compared to the alternative natural refrigerant R290. Furthermore, R290 is the only refrigerant that is not subject to legal restrictions.

R290

The refrigerant designation R290 is given to the hydrocarbon propane (C_3H_8), a naturally occurring gas. It has favourable thermodynamic properties and is therefore an energy efficient refrigerant. The following properties influence cycle efficiency: low liquid and vapour viscosities, high liquid specific heat, high liquid and vapour thermal conductivities and high latent heat. These properties lead to reductions in pressure losses and improvements of heat transfer and are best met by R290 compared to the common refrigerants R22, R407C, R410A. To serve as a commercial refrigerant, R290 needs a high degree of purity and a very low water content. Although the refrigerant is classified as refrigerant of low toxicity but higher flammability, it is only flammable when it comes to a certain concentration range of it in the air.[38] Besides its high efficiency, the refrigerant stands out for its negligible GWP[39] and low cost[40]. More detailed information regarding R290 is available in the GIZ's R290 Split Air Conditioners Resource Guide.

Overview of selected available Green AC models

Brand & Model	Energy	Type	Link
Godrej: GIC 24 MGP5-WAR	Cooling capacity (kW): 6.3 ISEER (Indian): 4.75 Energy Rating: 5 Star	Inverter split AC	https://www.godrej.com/p/appliances/Split-Air-Conditioners/GIC-24-MGP5-WRA
Godrej: GIC 18 LAH 5 GWQG	Cooling Capacity (kW): 5.3 ISEER: 5.2 Energy Rating: 5 Stars	Inverter split AC	https://www.godrej.com/p/appliances/Split-Air-Conditioners/GIC-18-LAH-5-GWQG
Midea MSAEBU-12HRFN7-QRD6GW	Cooling Capacity (kW): 3.8 SEER: 8.5	Inverter split AC	More information upon request
electriQ: 12WMINV	Cooling Capacity (kW): 3.5 SEER: 6.1 Energy Rating: A++	Inverter split AC	https://www.appliancesdirect.co.uk/p/eiq-12wminv/electriq-eiq12wminv-wall-split-air-conditioner
electriQ: 9WMINV	Cooling Capacity (kW): 2.6 SEER: 6.2 Energy Rating: A++	Inverter split AC	https://www.appliancesdirect.co.uk/p/eiq-9wminv/electriq-eiq9wminv-air-conditioner

[38] GIZ 2019, p. 20 f.
[39] UNEP 2017, p. 28
[40] ebd.

Annex III: Tenderer questionnaire concerning green public procurement of split ACs

Tender title	
Tenderer	
Tenderer's address	

Does the product have an international valid eco-label?	
If the Air-Conditioner has eco-label certification, certifying all minimum criteria (e.g. Blue Angel) the criteria indicated below are deemed to have been met. In such cases, the remainder of the questionnaire can be skipped. However, the figures requested in the questionnaire must be provided, and must be confirmed by the tenderer.	☐ Yes

The product does not have an equivalent label	
The split AC has neither the Blue Angel eco-label for vacuum cleaners nor an equivalent label. Using the following questionnaire and the substantiations required by it as a basis, you must show that your product meets the mandated requirements.	☐ Yes

Environmental requirements pertaining to contractual deliverables

Split AC must meet the following requirements for the contractual product in question. If your product does not meet the specified minimum criteria, your offer will be excluded from consideration.

No.	Criterion	Comments	Proof submitted?[41] to be completed by the tenderer)
1	**Rated input power**		
	The device's rated input power while being used amounts to XX or less watts. This input power was measured in accordance with XX. Rated input power= _______ Watt	Minimum criterion Proof of compliance:)	☐
2	**Energy efficiency**		

[41] Proof is to be submitted in the form of the questionnaires in the documents listed under "Comments."

<table>
<tr><td></td><td>Minimum criteria like current MEPS or highest Energy Efficiency Class:
SEER > 7
Energy efficiency Class > 5 Stars / A

Bidder must provide product description / documentation of SEER/EER and results from certified testing laboratory

Power consumption = _______ kWh
SEER/EER =
Energy Efficiency Class =</td><td>Minimum criterion
Proof of compliance:)</td><td>☐</td></tr>
<tr><td>3</td><td>Refrigerant</td><td></td><td></td></tr>
<tr><td></td><td>Air-conditioning systems are to be procured, if possible[42] with natural refrigerants (Hydrocarbon).
GWP < 10 and no ODP
Bidder must provide information on GWP and ODP of contained refrigerant

GWP =
ODP =
Refrigerant charge =</td><td>Minimum criterion
Proof of compliance:)</td><td>☐</td></tr>
<tr><td>4</td><td>Air Filter</td><td></td><td></td></tr>
<tr><td></td><td>Indoor units must be fitted with air filters that can be easily cleaned</td><td></td><td>☐</td></tr>
<tr><td>5</td><td>Noise Emissions</td><td></td><td></td></tr>
<tr><td></td><td>Noise emissions must be stated in the product documentation
<table>
<tr><th rowspan="2">Rated capacity (P_{rated}) in cooling or heating operation</th><th colspan="2">Requirements for the sound power level at rated capacity</th></tr>
<tr><th>Indoor units</th><th>Outdoor units</th></tr>
<tr><td>≤ 4.5 kW</td><td>≤ 50 dB(A)</td><td>≤ 58 dB(A)</td></tr>
<tr><td>4.5 kW < P_{rated} ≤ 6 kW</td><td>≤ 55 dB(A)</td><td>≤ 62 dB(A)</td></tr>
<tr><td>6 kW < P_{rated} ≤ 12 kW</td><td>≤ 58 dB(A)</td><td>≤ 68 dB(A)</td></tr>
</table>
Figure 16 Recommended requierements for noise emissions[43]</td><td>Minimum criterion
Proof of compliance:)</td><td>☐</td></tr>
<tr><td>6</td><td>Material requirements concerning the plastics used</td><td></td><td></td></tr>
<tr><td></td><td>In plastic constituitive components, no substances are to be used that are classified as follows:
• carcinogens pursuant
• mutagens pursuant
• reprotoxic substances pursuant</td><td>Minimum criterion
Proof of compliance:)</td><td>☐</td></tr>
</table>

[42] depending on the availability of the equipment and the refrigerant as well as the existing installation and maintenance infrastructure
[43] UBA 2016: Basic Award Criteria for Stationary air conditioners DE-UZ 204-201608-en Criteria-2020-01-10.pdf (blauer-engel.de)

	• Substance of particular concern on any other grounds pursuant		
7	**Durability / Lifetime**		
	The durability requirements for split ACs are as follows:	Minimum criterion Proof of compliance:)	☐
8	Maintenance and recycling-friendly design		
	The devices are to be designed and built in such a way that they can be easily repaired, as well as dismantled so as to readily and quickly allow recyclable components to be sorted. This means the following: - It is to be possible to loosen the relevant connections using conventional tools, whereby such connections are to be readily accessible - A dismantling manual for companies that handle end-of-life devices is to be provided, with the goal of recovering the maximum amount resources.	Minimum criterion Proof of compliance:)	☐
9	**Spare parts provisioning**		
	The tenderer is to guarantee that the spare parts needed to repair the device will be kept in stock for at least eight years as from phaseout of the device. "Spare parts" means parts that typically fail in connection with usual product use. Parts whose lifetime normally exceeds that of the product itself do not qualify as spare parts.	Minimum criterion Proof of compliance:)	☐

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