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MAIT

Energy Efficiency in Public Procurement of IT Hardware

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Acknowledgement

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Acronyms

BEE	Bureau of Energy Efficiency
CAGR	Compound Annual Growth Rate
CPU	Central Processing Unit
DDR	Double Data Rate
DeitY	Department of Electronics and Information Technology
DGS&D	Directorate General of Supplies & Disposals
EPAct	Environment Protection Act
EPEAT	Electronic Product Environmental Assessment Tool
EU	European Union
FEMP	Federal Energy Management Program
GFR	General Financial Rules
ICT	Information, Communication and Technology
KONEPS	Korea ON-line E-Procurement System
kWh	kilo Watt hour
LCC	Life Cycle Cost
MMTC	Metals and Minerals Trading Corporation of India
NASSCOM	National Association of Software and Services Companies
NIC	National Informatics Centre
NPV	Net Present Value
PMA	Preferential Market Access
PPM	Pages Per Minute
PSU	Public Sector Undertaking
RAM	Random Access Memory
SCADA	Supervisory Control and Data Acquisition
TEC	Typical Energy Consumption
TOE	Tonnes of oil equivalent
UPS	Uninterrupted Power Supply

Executive summary

India's primary energy consumption has increased to 637 million tonnes of oil equivalent in 2014 at a Compounded Annual Growth Rate (CAGR) of 5.7 per cent and the carbon dioxide emissions has increased to 2088 million tonnes at a CAGR of 5.9 per cent over the last five years. The Government of India has agreed to bring down the emission intensity of its GDP by 33 to 35 percent by 2030 from 2005 level. This requires proactive measures to be undertaken by each sector to encourage energy efficiency in order to achieve the committed emission targets.

The total electricity consumption by IT hardware equipment has increased to 21.7 billion kWh in FY14, or 2.2 per cent of the overall electricity generation in India. It has been estimated that the electricity consumption by IT hardware equipment in government establishments and public sector undertakings consumed 2.2 billion kWh of electricity in FY14 and it is expected to increase to 2.36 billion kWh in FY19 in the business as usual scenario. The procurement of energy-efficient IT equipment could generate a cumulative energy saving potential of 1.55–2.85 billion kWh, which is equivalent to CO_2 emission reduction of 1.5–2.7 million tons by FY19. The net present value savings that would accrue to the exchequer is expected to be between INR700 crores and INR1,300 crores by FY19.

This study was conceptualised to understand the technological development related to energy efficiency in IT equipment, procurement of IT equipment, and associated barriers in implementing energy efficient procurement by government establishments and public sector undertakings (PSUs).

An assessment was conducted with manufacturers of IT hardware equipment to understand technological developments and optimal life cycle of IT equipment. It was understood that technological developments and innovations over the last 5–6 years have led to significant improvements in the processing capacity and energy efficiency of IT hardware equipment. These latest technologies have resulted in the reduction of the energy consumption of IT equipment by 50–60 per cent.

In order to assess the adoption of latest energy-efficient technologies, interactions with government establishments and PSUs were conducted. It was understood that the procurement of IT equipment by government departments, traditionally, has been based on the least cost criteria, post complying with the prescribed technical specifications. Specific weightage and significance to energy efficiency of the equipment has not been considered to date. In addition, there is no policy to curtail the use of old and inefficient IT products after a certain period. As a result, the usage of IT equipment continues for more than 8–10 years as against the optimal life cycle of 5–7 years. Thus, there is an immense opportunity for energy savings if the IT equipment are replaced with energy-efficient technologies and by adopting optimal life cycle approach.

The review of policies adopted by some developed countries for IT procurement indicate the following best practices:

- Standards and labels are specified in technical specifications.
- Minimum energy consumption standards are available for all IT hardware equipment.
- Energy efficiency criteria is included in all relevant contracts and specifications.
- Life cycle cost based tools adopted by various countries (Australia, EU and Sweden)
- Maintenance of a database for energy efficient products by designated government agencies to assist procurers.
- Online calculators are available for the product category that help buyers estimates life cycle cost, typical energy consumption and cost savings

Given the potential for energy savings from IT devices, the following recommendations need to be implemented to promote the use of energy efficient IT equipment in India:

- **Short term — early adoption**: Create awareness around procurement based on life cycle cost and energy efficiency using creation of digital training tools, such as simple videos and online presentation in PSUs and government departments. A detailed database of energy efficient IT devices needs to be developed.
- **Medium term — updating standards**: Energy consumption standards could be updated with the latest version of Energy Star. Further, the adoption of energy consumption standards version 2.0 for servers and other relevant standards prescribed by Energy Star for displays, small network equipment and uninterrupted power supply units could be considered. There is a need for handholding support to indigenous manufacturers for upgrading to latest energy star specifications.
- **Long term — change in the General Financial Rules (GFR):** At present, the GFR is used for public procurement by government departments. According to these guidelines, a contract is awarded to the bidder based on the lowest capital costs. Provisions could be made in the GFR to incorporate energy efficiency criteria for the selection of vendors. Subsequently, selection based on the lowest life cycle costs could be also considered.

In order to assist the procurer to understand the life cycle cost of IT equipment, there was a need for a tool. There were two key tools in public domain, EPEAT and Energy star that provide assessment on energy consumption for IT equipment. However, these tools do not provide the comparison of Typical Energy Consumption (TEC) and Life Cycle Cost (LCC) (Annexure VII) for two different configurations of IT equipment. Thus, it was decided to develop an IT procurement tool in excel using Energy Star data base.

The tool evaluates the energy consumption of various specifications of IT products that are available, hence making it possible to arrive at an informed procurement decision. It is expected to facilitate procurement in two ways:

- The procurement department could check the energy consumption of various specifications of the IT device to be procured. Using this tool, a similar specification could be identified that is low in energy consumption. This would allow for the procurement of a more energy efficient device than what was initially planned.
- Once the procurement department receives bids from various vendors, it could check the energy consumption of various specifications that bidders have offered. Following this, the department would be able to make an informed decision on procuring equipment based on the electricity consumption of each specification.

1 Introduction

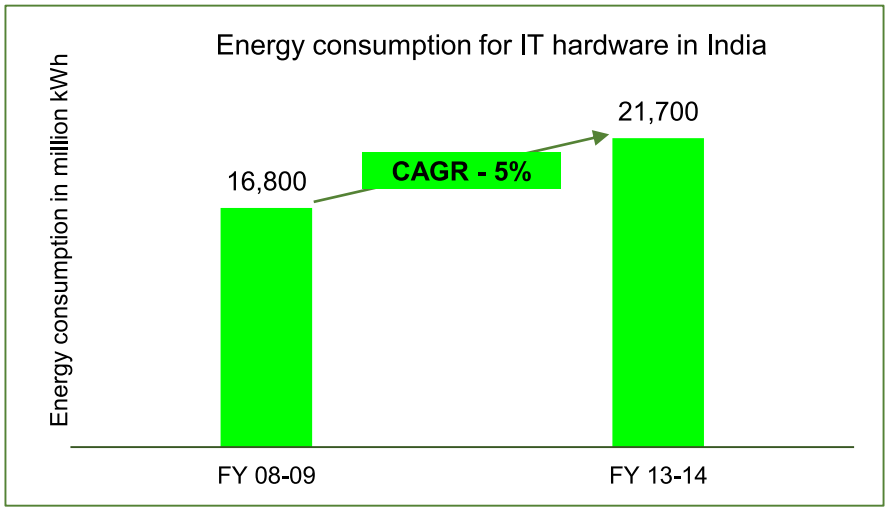
1.1 Energy consumption in IT hardware

India's primary energy consumption has increased from 484.2 million tonnes of oil equivalent (TOE)[1] in 2009 at 5.7 per cent CAGR to 637 million TOE in 2014. The carbon dioxide emissions has increased by 5.9 per cent[1] during the corresponding period. The Government of India has agreed to bring down the emission intensity of its GDP by 33 to 35 percent (56.2 gCO_2e/GDP to 36.5 gCO_2e/GDP) by 2030 from 2005 level. This requires proactive measures by each sector to encourage energy efficiency.

India's electricity availability in FY09 was 762 billion kWh[2] and ICT[3] equipment electricity consumption stood at around 3.1 per cent of the electricity available at 24 billion kWh[4]. The total electricity consumption by ICT increased 30 per cent (CAGR of 5 per cent) to 31 billion kWh in FY14 contributing to 3.2 per cent of the overall electricity generation of 975 billion kWh.[5]

As per secondary research, the energy consumption of IT hardware equipment (PCs, monitors, servers and printers) is approximately 70 per cent[6] of the total ICT consumption. The following figure indicates the estimated energy consumption of IT hardware.

Figure 1: Energy consumption for IT hardware in India (million kWh)



Source: Gartner research, KPMG analysis

Thus, the energy consumption by IT hardware equipment in India currently is estimated at 21.7 billion kWh. This is expected to increase with increased IT penetration.

[1] https://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2015/bp-statistical-review-of-world-energy-2015-full-report.pdf and KPMG analysis
[2] Load Generation Balance Report 2009–10, Central Electricity Authority, Ministry of Power
[3] IT industry is a sub sector of the Information and Communication technology (ICT) industry. ICT equipment comprises of IT devices along with communication devices (mobiles, handsets etc.) – KPMG analysis
[4] Gartner analysis, http://articles.economictimes.indiatimes.com/2010-08-22/news/27574096_1_energy-consumption-ict-infrastructure
[5] http://powermin.nic.in/power-sector-glance-all-india
[6] Recommendations on Approach towards Green Telecommunications, Telecom Regulatory Authority of India 2011

1.2 Procurement trends in India's IT hardware market

MAIT conducts a market appraisal on the IT market annually. The entire IT market comprises the following segments:

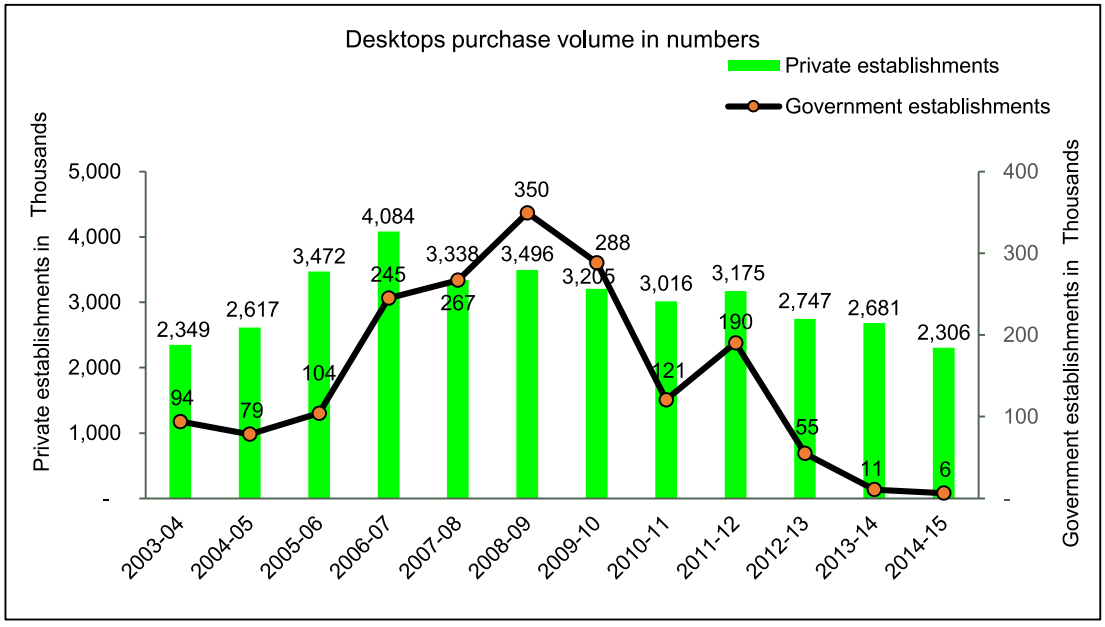
1. Private business establishments (factories, offices, outlets)
2. Government establishments
3. Household segment (households and small offices)

The following sub-sections provide the trends in the private and government establishments for key hardware equipment.

1.2.1 PCs/desktops

The following figure provides the annual desktop procurement for private and government establishments:

Figure 2: Indian desktop market scenario



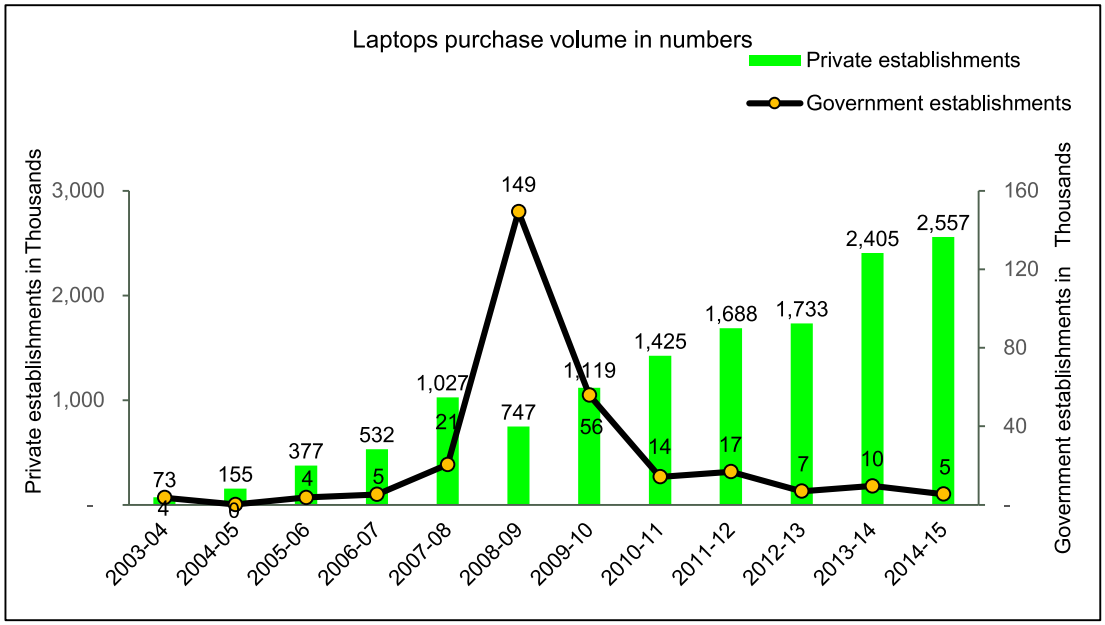
Source: MAIT, ITOPS reports and KPMG analysis

The desktop procurement volume in both private businesses and government establishments has shown a decline. The number of desktops installed in government departments increased at a significant CAGR of 30 per cent over FY04 and FY09 largely due to the rapid expansion of IT infrastructure. However, the purchase of desktops reduced significantly at a CAGR of 48 per cent between FY09 and FY15.The decline in desktop purchases may possibly be attributed to their required penetration levels having been already achieved. Moreover, either the replacement rate of desktops was slow or they were replaced with laptops.

1.2.2 Laptops

The following figure provides the annual laptop procurement trend for private and government establishments.

Figure 3: Indian laptop market scenario



Source: MAIT, ITOPS reports and KPMG analysis

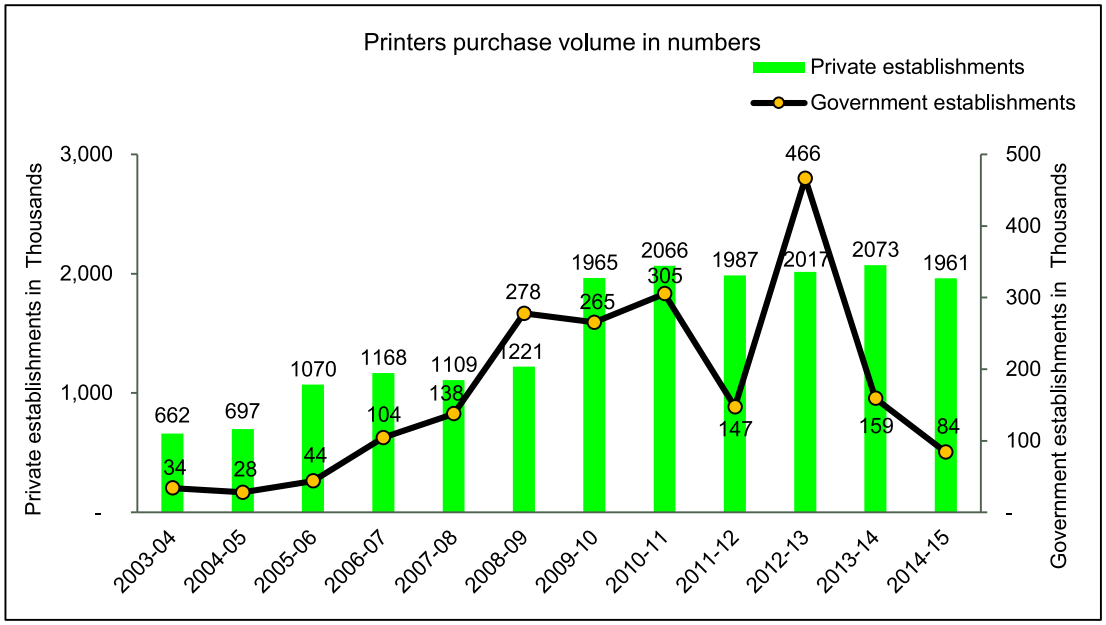
The number of laptop installations in government departments increased significantly at a CAGR of 110 per cent between FY04 and FY09, as laptops were adopted as a supplementary IT product to PCs/desktops. Since FY09, laptops have exhibited an overall decrease of 42 per cent CAGR in government establishments until FY15. If the replacement cycle for laptops is considered to be 4–5 years, a significant increase in laptop purchases between FY11–12 and FY13–14 may have been a possibility. Evidently, laptops procured 6–7 years ago are being replaced at a slow pace. It may be noted that the procurement process related to free laptop distribution schemes (launched by some state governments, such as the 'UP Laptop Distribution Scheme' and 'Tamil Nadu Laptop Distribution Scheme') is reflected in household procurement, given its end purpose.

1.2.3 Printers (dot matrix, inkjet and laser)

The following figure provides the annual printer procurement volume for private and government establishments:

The sales growth for printers has attained stabilisation given that the total annual installation of printers for both private business establishments and government has registered a decrease of 0.03 per cent CAGR during the last five years. However, the composition of the printer market has changed, as the purchase of dot matrix and inkjet printers have exhibited a decline, whereas the efficient technology of laser printers has shown an increase.

Figure 4: Indian printer market scenario



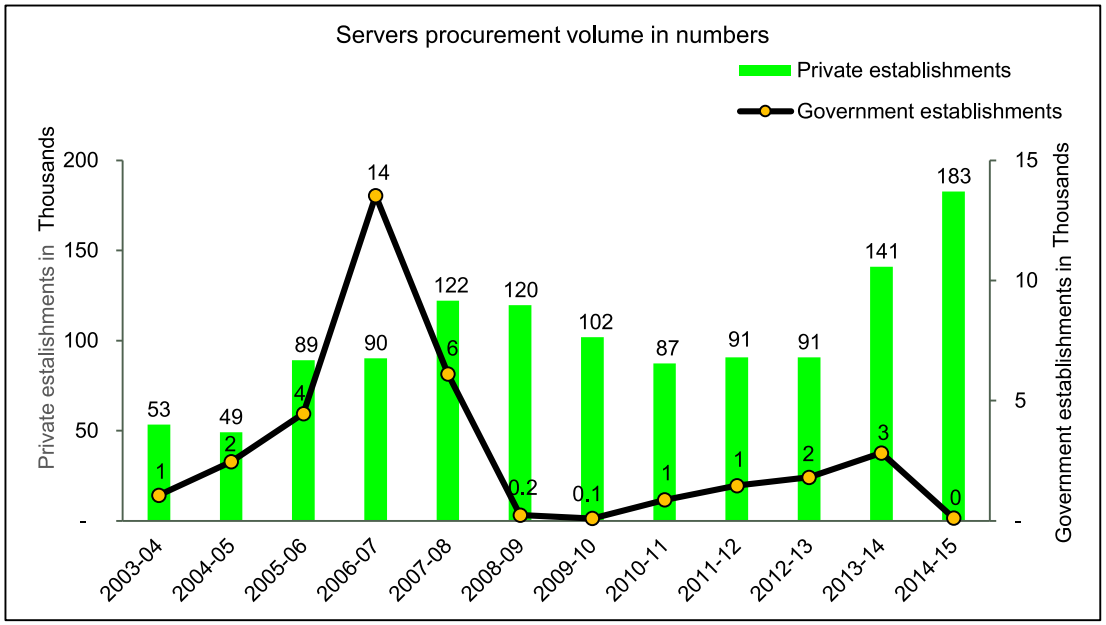
Source: MAIT, ITOPS reports and KPMG analysis

The purchase of dot matrix printers has declined by a CAGR of 13 per cent and that of inkjet printers by a CAGR of 32 per cent over the last five years. During the corresponding period, the purchase of laser printers has increased 16 per cent.

1.2.4 Servers

The following figure provides the annual server procurement for private and government establishments.

Figure 5: Indian server market scenario



Source: MAIT, ITOPS reports and KPMG analysis

In 2013–14, servers posted a procurement volume of 0.14 million, which is 1.5 times more than that of the previous year. In 2014–15, an additional growth of 30 per cent was achieved over the previous year. This growth was largely driven by the adoption of servers among small- and medium-scale businesses across India.

The overall purchase of servers in government establishments increased exponentially at a CAGR of 133 per cent between FY04 and FY07, primarily due to digital infrastructure growth and rising dependence on the internet. The purchase of servers in government establishments have reduced at a CAGR of 45 per cent between FY07 and FY15. This may be attributed to the average replacement life of servers, which is 7–10 years. Thus, a significant increase in the purchase of servers is likely in the near future. Further, the need for data storage, digitisation and cloud applications resulted in an increase in the purchase of servers in government establishments from FY11 to FY14.

1.3 Objectives of the study

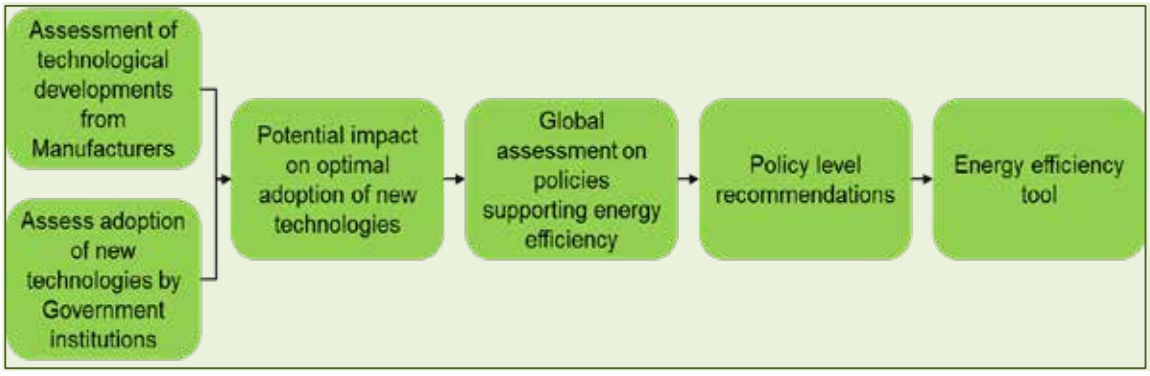
The earlier sections highlight that energy consumption by IT hardware is significant in India and the government institutions have a reasonable share of the overall procurement. The announcement of new ambitious schemes by Government of India such as Digital India campaign, Smart cities mission, Make in India initiative would not only strengthen the India's IT infrastructure but also increase the energy consumption by this sector. Therefore, it is pertinent to conduct a study on IT procurement (such as laptops, desktops, printers and servers) by government agencies and PSUs, in order to assess the energy consumption, energy saving potential and barriers associated with it.

The study is aimed at meeting the following key objectives:

1. Development of policy recommendations on public procurement policy for the procurement of energy-efficient IT products for government agencies and PSUs
2. Develop suitable tool to assist the procurement of IT equipment

The broad approach adopted for achieving the objectives has been illustrated in the figure below

Figure 6: Approach for the engagement



There has been interaction with IT manufacturers to understand the development of new technologies in IT equipment. Further there was extensive discussion with the government institutions to assess the adoption of new technologies. During the interactions, the barriers for technology adoption were discussed. A global assessment of key countries was undertaken to assess the best practices to encourage adoption. The following chapters provide the details of the assessment carried out in each of the identified areas.

2 Outcomes of stakeholder consultation

The stakeholder consultation process was carried out to understand the technology developments in IT hardware equipment and technology adoption by the government establishments and PSUs.

2.1 Stakeholder consultation to assess technology development

The study of the technology evolution of the IT products is based on detailed research as well as consultation with IT hardware manufacturers.

A detailed questionnaire (Annexure I) was circulated to secure the response from the manufacturers. The discussions with manufacturers helped to understand the improvement in energy efficiency and optimal life for different products. The details of the technology development in IT hardware is highlighted in Annexure II.

2.1.1 PCs, desktops and Laptops

Over a period of 5–6 years, the power consumption of PCs and desktops reduced 50–60 per cent[7] owing to technological developments in individual components such as display, memory, hard disk, processors and motherboard. In addition to savings on energy, the new PCs/desktops have enhanced productivity owing to the speed of processing.

The improvements in display, size and power management technologies have reduced power consumption of laptops by 40–60 per cent[8]

The optimal operational life cycle for PC's / laptops is typically considered to be five years owing to the following considerations[9]:

- Five- to six-year-old PC/laptop may not have enough RAM to run new versions of some software packages
- Replacement of add-on devices (batteries and, peripherals such as hard disks and motherboards) over a period of time increases the cost

2.1.2 Printers

The primary energy-consuming hotspot in a printer is the time when it starts and warms up. There have been considerable advancements in printer technologies such as automatic sleep / wake-up modes, instant start-up technologies, development of low-melt toners that have reduced power consumption by 50–70 per cent.[10]

The optimal operational life cycle for laser / inkjet printer is considered to be five years and Dot matrix printer is considered to be eight years owing to the following considerations:

- Reliability: To produce crisp and clear pages, the mechanical parts of printers need to work with high precision. Although a printer's replaceable parts such as ink, and toner cartridges, are important to print quality, other components eventually wear out. Mechanical wear and tear also reduces reliability in terms of paper jams and frustrating downtime.
- Speed: Due to longer operating periods, the speed of printing is reduced over time. For example, a standard desktop model printer would print 1–50 PPM. After 4–5 years, this number decreases considerably.

[7] Based on stakeholder discussions and actual energy consumption values
[8] Based on stakeholder discussions and actual energy consumption values
[9] Optimum Refresh Cycle and Method for Desktop Outsourcing, Intel, 2004
[10] Based on stakeholder discussions and actual energy consumption values

- Operating costs: The replacement of printer parts and consumables (ink, toner cartridges, etc.) would increase over a period of time.

2.1.3 Servers

The increased use of blade servers over traditional rack mounted servers, improvement in power supply technologies and data virtualisation have reduced power consumption by 50–60 per cent[11] in latest manufactured servers.

The optimal operational life cycle for servers is considered to be eight years considering the technological obsolescence over a period of time[12]. It is understood that failure to maintain proper temperature and humidity specifications may shorten the equipment life.

2.2 Stakeholder consultation to assess adoption of technology

As part of the study, stakeholder consultations with government departments/PSUs were conducted. The key objective of these stakeholder consultations was to understand the energy consumed by IT equipment, procurement and disposal policies, and barriers to the inclusion of energy efficiency in procurement.

A database of all major ministries and PSUs was developed using publicly available information. The following parameters was considered for shortlisting government departments/PSUs:

- Pan-India presence of departments/PSUs in India (number of offices/establishments across the country)
- Number of employees
- Extent of dependence on IT infrastructure (activities that required significant IT network infrastructure, for example, railway ticketing and internet banking)

Based on research and discussions, the following government departments/PSUs were shortlisted:

1. Indian Railways
2. National Thermal Power Corporation Limited (NTPC)
3. State Bank of India (SBI)
4. Directorate General of Supplies and Disposal
5. Bureau of Energy Efficiency (BEE)
6. Department of Expenditure, Ministry of Finance

Through secondary research and discussions with the government departments, the standard energy consumption, IT infrastructure, the extent of use of IT products and the average hours of usage were identified. The shortlisted departments were approached with a detailed questionnaire as provided in Annexure III.

The stakeholders were asked specific questions on the key stages in the life cycle of an IT product (computers, laptops, printers and servers):

1. Planning and purchasing
2. Deployment
3. Operation (including upgrade and life extension)
4. Disposal

[11] Based on stakeholder discussions and actual energy consumption values
[12] Stakeholder consultation, Intel

2.2.1 Planning and purchasing

Based on stakeholders' discussions with government departments and PSUs on the procurement process for IT equipment, the findings have been summarised below:

Table 1: Inputs from stakeholder consultation process on procurement

Criteria	Government departments	PSUs
Procuring agency	• Procurement is primarily carried out through the DGS&D. • In some cases, procurement is done by the departments themselves, if the products are required for a shorter duration, or if some changes are required in the technical specifications.	• Procurement is primarily done by organisations themselves.
Methodology	• Procurement is primarily based on a capital expenditure model on the least-cost method. • The DGS&D concludes the rate contract with registered suppliers, and the departments follow these rate contracts to the maximum extent possible. • Life cycle cost is, at present, not considered in the procurement process.	• Procurement is primarily done on a capital expenditure model basis on the least-cost method. • Life cycle cost is, at present, not considered in the procurement process.
Technical specifications	• The DGS&D, in consultation with suppliers, decides the technical specifications.	• The organisation, in consultation with suppliers or, in some cases, with external consultants, decides the technical specifications.
Energy efficiency	• Currently, there are no criteria related to energy-efficient products. • In some cases, BEE-labelled laptops and notebooks are sought, along with a notarised copy of the type test certificate from the original equipment manufacturer (OEM) of each model.	• Organisations such as the NTPC have defined the following criteria related to energy efficiency in the technical specifications: - Energy Star 5.0, RoHS certification - Trusted Platform Module (TPM) 1.2 • The SBI procures the latest available technology for most of its products. However, any specifications related to energy efficiency are currently not part of the tender.
Contract life	• The contracts are of 5–7 years for all products except for servers, where the contracts are for 7–9 years. • The warranty period varies between 3 and 5 years, followed by the AMC through local suppliers.	

2.2.2 Deployment and operations

2.2.2.1 PCs/desktops/laptops

The Ministry of Finance issued guidelines on the purchase of laptops in 2014. It stated the useful life to be four years from the date of issue, after which laptops could be replaced, i.e., in the fifth year. The revised useful life of laptops and desktops as specified by the Railway Board is also four years.

Following discussions with the government departments and PSUs, it was identified that the standard replacement period of PCs/desktops is 5–7 years. However, as PCs were 'working', despite being obsolete, their life would extend and the replacement would realistically occur after 8–10 years. During the discussion, it was understood that most IT products used by the employees were approximately 10 years old.

2.2.2.2 Printers

On an average, useful life of laser and inkjet printers is 3–5 years, and for dot matrix printers is 7–10 years.[13] It was understood that laser and inkjet printers are replaced within 7–8 years and dot matrix printers within 9–10 years.

2.2.2.3 Servers

The standard operating period for servers in an organisation is 24 hours per day, seven days a week. Servers may generally have some upgrade paths, but are limited, as each generation product incorporates technology advances available in different components. In many cases, it is less expensive to buy new products than to upgrade a product during the 3–5 years of its useful life, due to asset depreciation and decreased reliability. Further, the chances of component failures as the product ages increase. The average life of servers within the government departments, is 7–10 years.

2.2.3 Disposal

Based on stakeholders' discussions with government departments and PSUs on the process for disposing IT equipment, the findings have been summarised below:

Table 2: Inputs from stakeholder consultation process on disposal

Criteria	Government departments	PSUs
Frequency	• Products are disposed of when they are obsolete/not working. The products are used even beyond their useful/shelf life until they are in working condition, as practiced in the Indian Railways.	• Disposal is done at the end of the product's life or in some cases even before that. For example, at the NTPC, products are sometimes replaced before the end of their shelf life if their technology is deemed as obsolete.
Methodology	• An e-waste policy is considered for waste disposal. • The Indian Railways disposes of products through public e-auctioning at a reserved price, based on current market	• An e-waste policy is considered for waste disposal. The SBI disposes of products through the invitation of bids from selected e-waste recyclers. • The NTPC disposes of products (desktops, laptops and printers) through employees, who

[13] Industry reports, stakeholder consultations with leading printer manufacturers

Criteria	Government departments	PSUs
	conditions or the last auctioning value in the market.	purchase these products at a discount after five years of its useful life. For servers, the disposal is planned through MMTC (Metals and Minerals Trading Corporation of India) Ltd., via auctioning. The NTPC is currently said to be developing an e-waste policy for printers, scanners, servers and fax machines.
Salvage value	• Most stakeholders consulted do not consider the depreciated book value at the time of disposal. The disposal price is discovered at the time of bidding.	

2.3 Key barriers to procuring energy efficient IT equipment

The following are the key barriers to procuring energy-efficient IT equipment, as highlighted in the stakeholder discussion:

Table 3: Key barriers

Criteria	Detail
Policy/ regulation	The prevailing procurement methodologies under the GFR, 2005 (Annexure V), as well as the Central Vigilance Commission (CVC) guideline and policies related to Preferential Market Access (PMA) for domestic manufacturers do not encourage government departments and PSUs to adopt energy-efficient criteria as part of their technical specifications, as this may limit competition. Example: NTPC included EPEAT criteria as essential qualifying criteria until last year in order to procure reliable and energy efficient products. However, this was removed after DeitY's directive on not including any restrictive criteria while inviting tenders for procurement of electronic products as this may deprive indigenous manufacturer a level-playing field. Even BEE labelling for some IT products (although they are voluntary) are not included in the technical specifications of these departments.
Institutional arrangement	With respect to procurement for government departments, the technical specifications are decided by the DGS&D in consultation with suppliers. The DGS&D is not primarily involved with end users while prescribing technical specifications. Hence, factors such as life cycle cost, which may be beneficial for end users, are not given adequate importance when deciding the specifications. At present, standards that specify energy consumption for data centres, servers, UPS, displays and small network equipment are not available in India.
Awareness and capacity	In some cases, a road block to effective decision making is lack of awareness around efficient technologies that may be used in place of traditional products. For example, many departments are concerned that the use of energy-efficient servers may affect the performance and/or response time of applications and workloads being run.

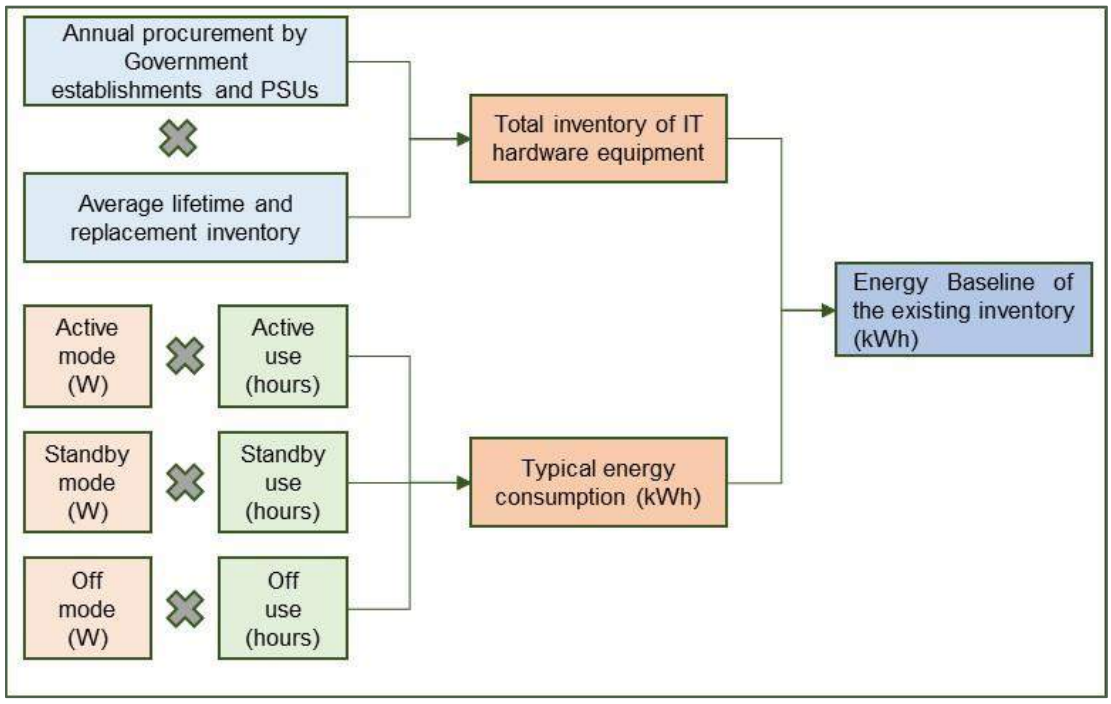
3 Estimation of baseline energy consumption and savings potential of IT hardware equipment

The stakeholder consultations highlight that the usage of IT equipment exceed the optimal life cycle. Given the technology improvements related to energy efficiency, it implies that there is a potential to save on energy through deployment of energy-efficient technologies and by aligning the usage to the optimal life cycle. In order to arrive at the savings, a baseline energy consumption has been computed and compared with potential scenarios of adopting optimal life cycle.

3.1 Estimation of energy baseline

To calculate the baseline energy consumption of PCs, laptops, servers and printers in government departments and PSUs, the following methodology was adopted, as illustrated in the figure below. This is one of the well-versed methodologies, adopted by many studies for estimating large-scale energy consumption by IT equipment.[14,15,16,17]

Figure 7: Methodology for estimating baseline energy consumption



Source: Lawrence Berkeley National Laboratory, Fraunhofer Centre for sustainable energy systems, KPMG analysis

[14] Computer usage and national energy consumption: Results from a field-metering study, Lawrence Berkeley National Laboratory, 2014
[15] Energy consumption of consumer electronics in U.S. homes in 2010, Fraunhofer Centre for Sustainable Energy Systems, 2011
[16] Electricity Used by Office Equipment and Network Equipment in the U.S.: Detailed Report and Appendices, Lawrence Berkeley National Laboratory, 2000
[17] Energy Consumption by Office and Telecommunications Equipment in Commercial Buildings, Volume I: Energy Consumption Baseline, Roth et al, 2002

3.2 Baseline energy consumption by government establishments and PSUs

The methodology for estimation of the current installed inventory base of PCs, laptops, printers and servers has been provided in Annexure IV. The inventory for the IT equipment has been provided below

Table 4: Estimating total IT inventory in government departments and PSUs

IT equipment	Total numbers as on March 2015
PCs/desktops	1,104,000
Laptops	244,000
Servers[18]	30,000
Printers	1,670,000

The typical energy consumption for PCs, laptops, printers and servers has been provided below based on the methodology provided in Annexure IV

Table 5: Summary of typical energy consumption of IT hardware equipment[19]

IT equipment	Typical energy consumption for a standard model (kWh/year)		
	FY05–09	FY09–12	FY13–15
PCs/ desktops[20,21,22,23,24]	269	186	123
Laptops[25,26,27]	130	67	32
Dot matrix printer[28,29,30]	191	103	71
Inkjet printer	106	64	32
Laser printer	755	461	312
Server[31,32]	Volume	Mid	High
	1,910	5,590	111,000

[18] Estimating Total Power Consumption by Servers in the U.S. and the World, Lawrence Berkeley National Laboratory, 2007
[19] Individual equipment wise power consumption and usage details are enclosed in Annexure VIII
[20] Computer usage and national energy consumption: Results from a field-metering study, Lawrence Berkeley National Laboratory, 2014
[21] Energy consumption of consumer electronics in U.S. homes in 2013, Fraunhofer Centre for Sustainable Energy Systems, 2014
[22] Personal Computers (desktops and laptops) and Computer Monitors Final Report, Preparatory studies for Eco-design Requirements of EuPs, IVF Industrial Research and Development Corporation, 2005
[23]Electricity Used by Office Equipment and Network Equipment in the U.S: Detailed Report and Appendices, Lawrence Berkeley National Laboratory, 2000
[24] Energy Consumption by Office and Telecommunications Equipment in Commercial Buildings, Volume I: Energy Consumption Baseline, Roth et al, 2002
[25] Computer usage and national energy consumption: Results from a field-metering study, Lawrence Berkeley National Laboratory, 2014
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[28] Energy consumption of consumer electronics in U.S. homes in 2010, Fraunhofer Centre for Sustainable Energy Systems, 2011
[29] Computer printers, Australia's Standby Power Strategy 2002 – 2012, 2013
[30] https://www.energystar.gov/
[31] Estimating Total Power Consumption by Servers in the U.S. and the World, Lawrence Berkeley National Laboratory, 2007
[32] Classification of servers based on convention of "International Data Corporation"

Based on the described methodology, Table 6 describes the results of the estimation of baseline energy consumption by government departments and PSUs.

Table 6: Estimation of baseline energy consumption by major IT equipment

IT equipment	Estimate of consumption (million kWh)
Desktops/PC	220
Laptops	17
Servers	1,530
Printers	516

As seen from Table 6, the estimated annual energy consumption of installed PCs, laptops, printers and servers in government establishments was approximately~ **2,200** (**2,283) million kWh (~210 MW)**[33] for FY14–15.

The overall potential cost savings from energy-efficient IT equipment calculated for the government establishments are detailed in the following section.

3.3 Estimation of energy savings

The estimation of potential energy savings from the replacement of existing IT equipment with energy-efficient alternatives was done using the following methodology[34]:

1. Estimation of new procurement every year (between FY15–16 and FY24–25) based on the following assumptions:
   - Growth of IT equipment has been considered based on the last five-year purchase trend.
   - An electricity tariff of INR 6 per kWh and an escalation of 3 per cent in the electricity tariff has been considered.
   - The following two scenarios have been considered for the replacement of existing installed stock with energy efficient product considering product life cycle :
     - Scenario I — According to the life cycle followed by government departments based on stakeholder discussions (eight years for printers, desktops and laptops, and 12 years for servers)
     - Scenario II — According to the suggested optimum life cycle as in Chapter 2 (five years for printers, desktops and laptops, and eight years for servers)
2. For each scenario, the energy consumption per year was calculated as the sum of baseline energy consumption for the previous year and increased energy consumption due to the addition of new products, and replaced products in the calculated year.
3. For each scenario, the possible energy savings achieved through the replacement of old products with newly procured products every year was calculated.[35]

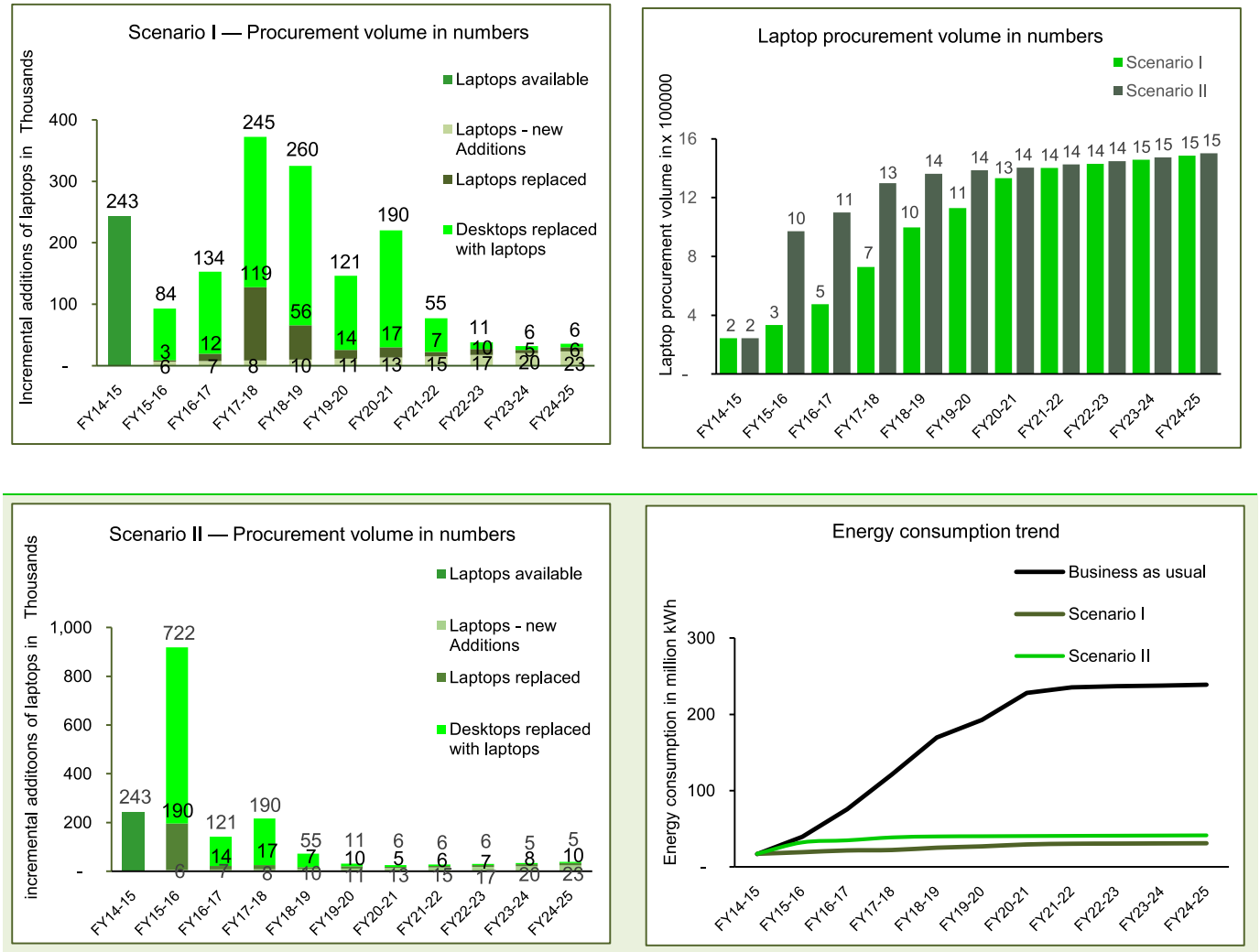
[33] Considering Plant Load Factor = 85 per cent
[34] Energy Consumption by Office and Telecommunications Equipment in Commercial Buildings, Volume II: Energy Savings Potential, Roth et al, 2002
[35] The newly procured products have been assumed to consume 10 per cent less energy from FY14-15 on a yearly basis

3.3.1 PCs and laptops

The following method was used to compute the energy consumption:

1. Factored an overall decline of 6 per cent for desktops and growth of 16 per cent for laptops (considering the last five years in both government and private business establishments)
2. All PCs/desktops to be replaced by laptops from FY15–16
3. Energy consumption of laptop decreases 10 per cent year-on-year from FY15–16

Figure 8: Procurement volume and energy consumption of laptops/desktops



Source: MAIT, ITOPS reports and KPMG analysis

As seen in the graphs above, over the next five years, 'replacement' is likely to contribute a greater share to the overall growth of laptops than 'additions'. This is due to the presence of inefficient laptops and desktops in government establishments and PSUs. The replacement of desktops with laptops would be significantly high as compared to 'laptop to laptop' replacements, since the desktop purchase trend during FY04–08 was much higher than that of laptops. In Scenario I, replacement is expected to dominate the purchase trend until FY21–22 and is likely to remain flat after FY22–23, until FY24–25.

In contrast, in Scenario II, the majority of replacements is expected until FY18–19 and then subsequently flatten out. In terms of energy consumption, as explained previously, most

government agencies do not replace their equipment either on a eight-year basis or five-year basis. Therefore, such equipment continues to remain operational in these establishments, consuming a significant amount of energy. Thus, replacing inefficient desktops and laptops with energy efficient equipment can generate additional benefits in terms of cost savings. In the 'business as usual' scenario (an assumed scenario with no replacments), energy consumption by laptops and desktops would reach 240 million kWh. However, in both scenarios, energy consumption is expected to be about 30–50 million kWh. Thus, energy savings of close to 200 million kWh can be anticipated by FY19–20 through energy-efficiency replacements.

3.3.2 Printers

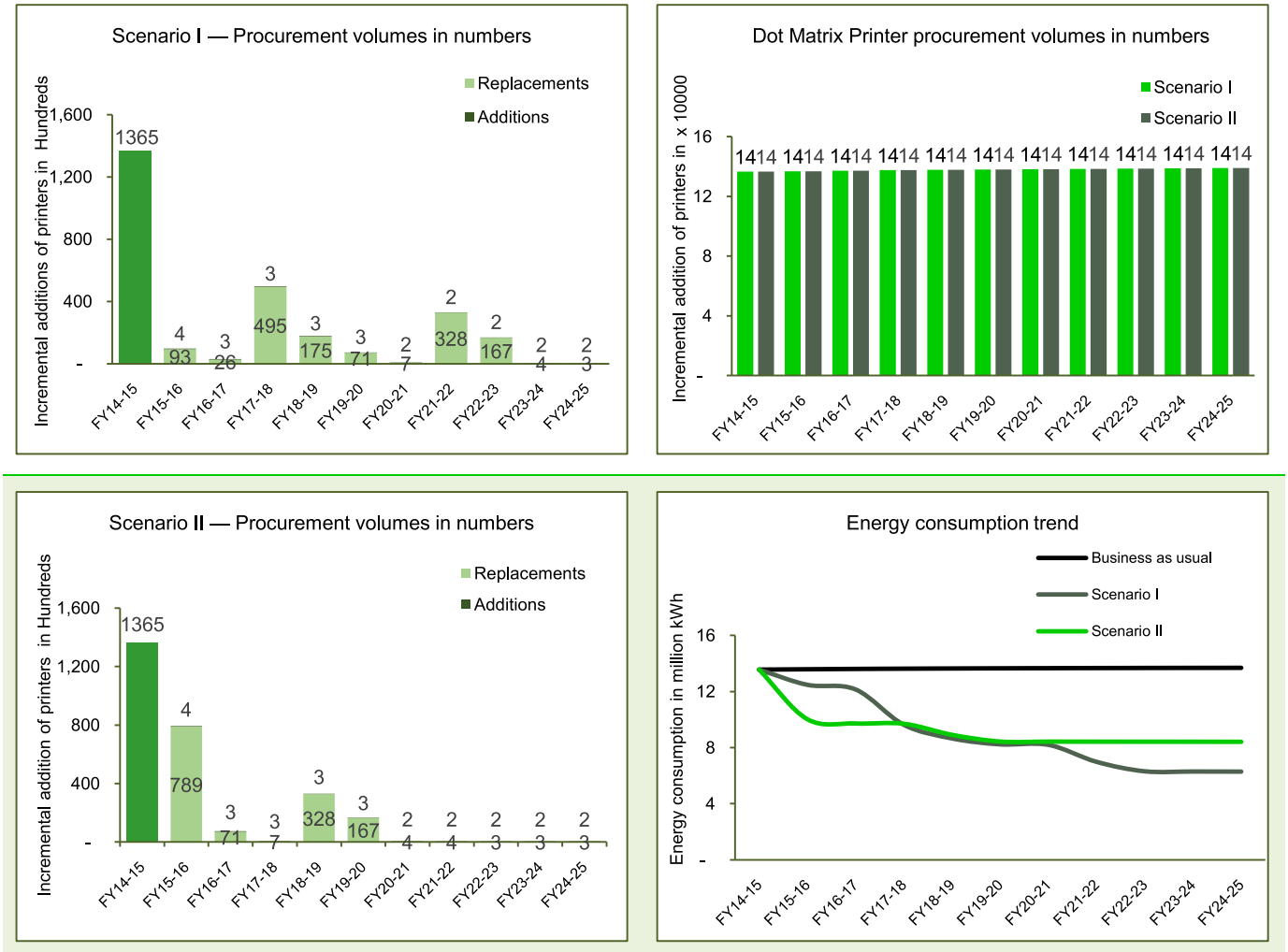
Step 1 — Factored an overall decline of 9 per cent for dot matrix printers, a decline of 12 per cent for inkjet printers and a growth of 2 per cent for laser printers (considering the last five years in both government and private business establishments).

Step 2 — Every printer category is independent of the other. For example, dot matrix would be replaced only by dot matrix printers.

Step 3 — The energy consumption of printers has decreased 10 per cent y-o-y from FY15–16.

3.3.2.1 Dot matrix printers

Figure 9: Procurement volume and energy consumption of dot matrix printers

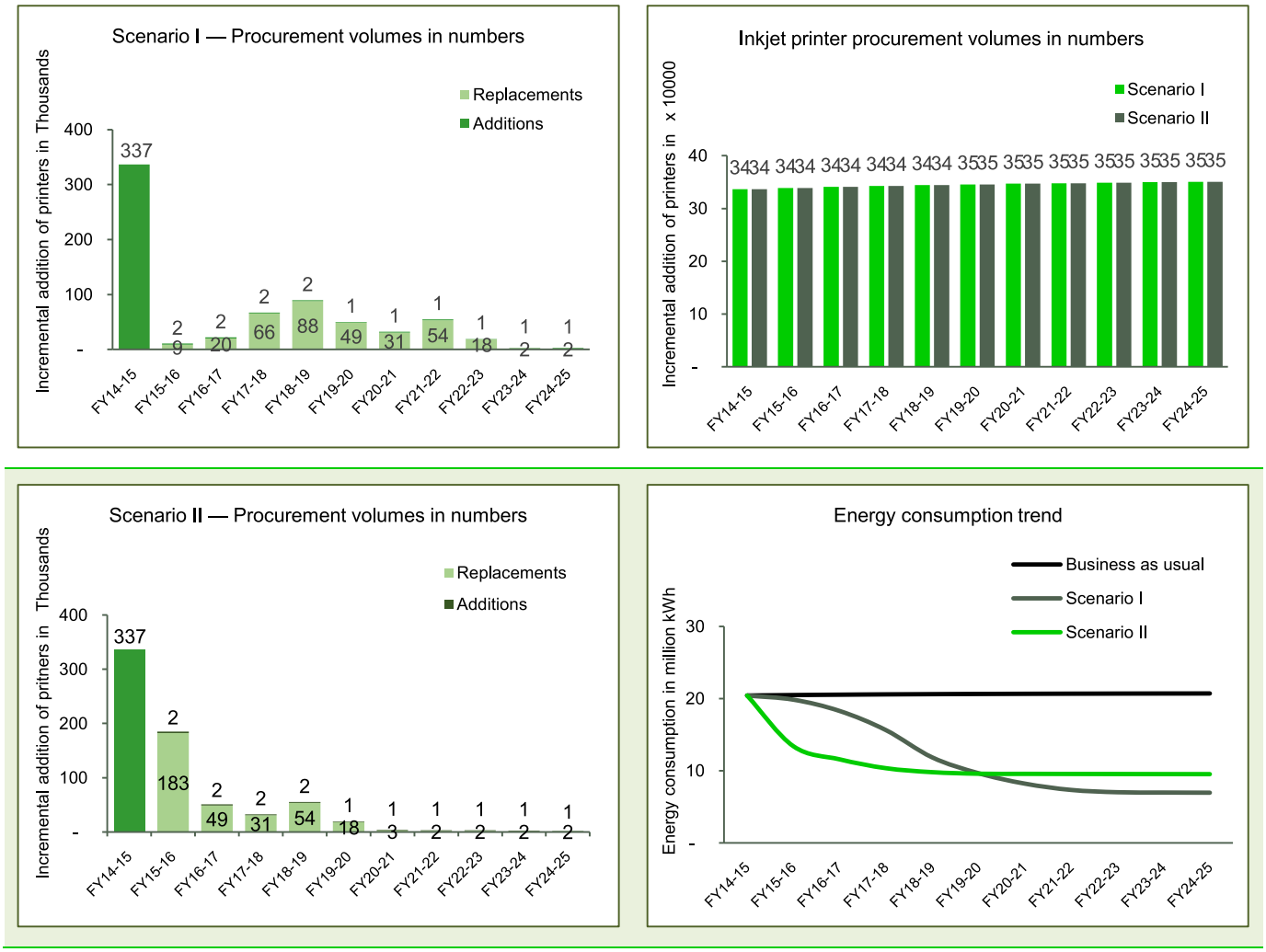


Source: MAIT, ITOPS reports and KPMG analysis

The purchase trends of dot matrix printers in government establishments and PSUs would remain almost constant, as additions and replacements tend to be minimal. It is primarily due to its unique advantages — low purchase costs, ability to handle multipart forms, operational and economic efficiency, the need for only fresh ribbons, rugged in nature, low repair costs and the ability to print on continuous paper. The Indian Railways is one of the major users of dot matrix printers, for the preparation of reservation charts, local train tickets, and so on. Dot matrix printers enable the printing of multiple copies, the use of different dimensions of the paper, low-cost advantage, etc. Considering Scenario I, major replacements could occur in FY18–19, and Scenario II could occur in FY15–16. There is no substantial reduction in energy consumption from previous versions, so energy savings could range between 5–6 million kWh by FY19–20.

3.3.2.2 Inkjet printers

Figure 10: Procurement volume and energy consumption of inkjet printers

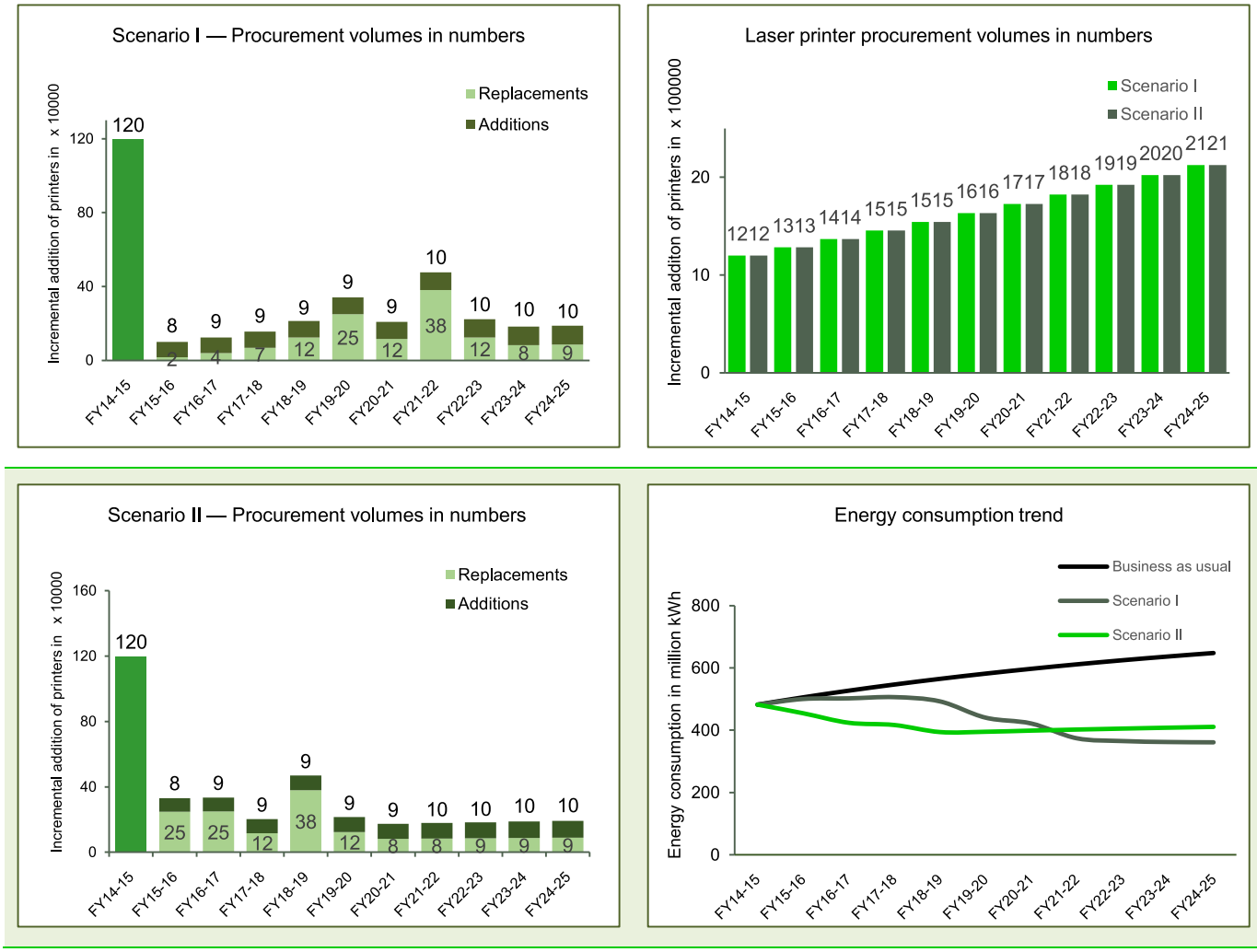


Source: MAIT, ITOPS reports and KPMG analysis

It has been observed that the trend of the inkjet printer is declining. It is anticipated that only 15,000 units would be procured in the next 10 years for government establishments and PSUs. Nevertheless, energy savings of at least 5 million kWh could be achieved by FY19–20 through the replacement of inefficient inkjet printers with efficient ones.

3.3.2.3 Laser printers

Figure 11: Procurement volume and energy consumption of laser printers



Source: MAIT, ITOPS reports and KPMG analysis

Laser printers are expected to play a pivotal role in printing technology in the future. In terms of replacement, laser printers follow a similar scenario trend to those of dot matrix and inkjet printers. However, the purchase trend volume is expected to double by FY24–25. The scope of energy efficiency in laser printers is growing rapidly. It is anticipated that the adoption of energy-efficient laser printers could save about 180–200 million kWh of energy by FY19–20.

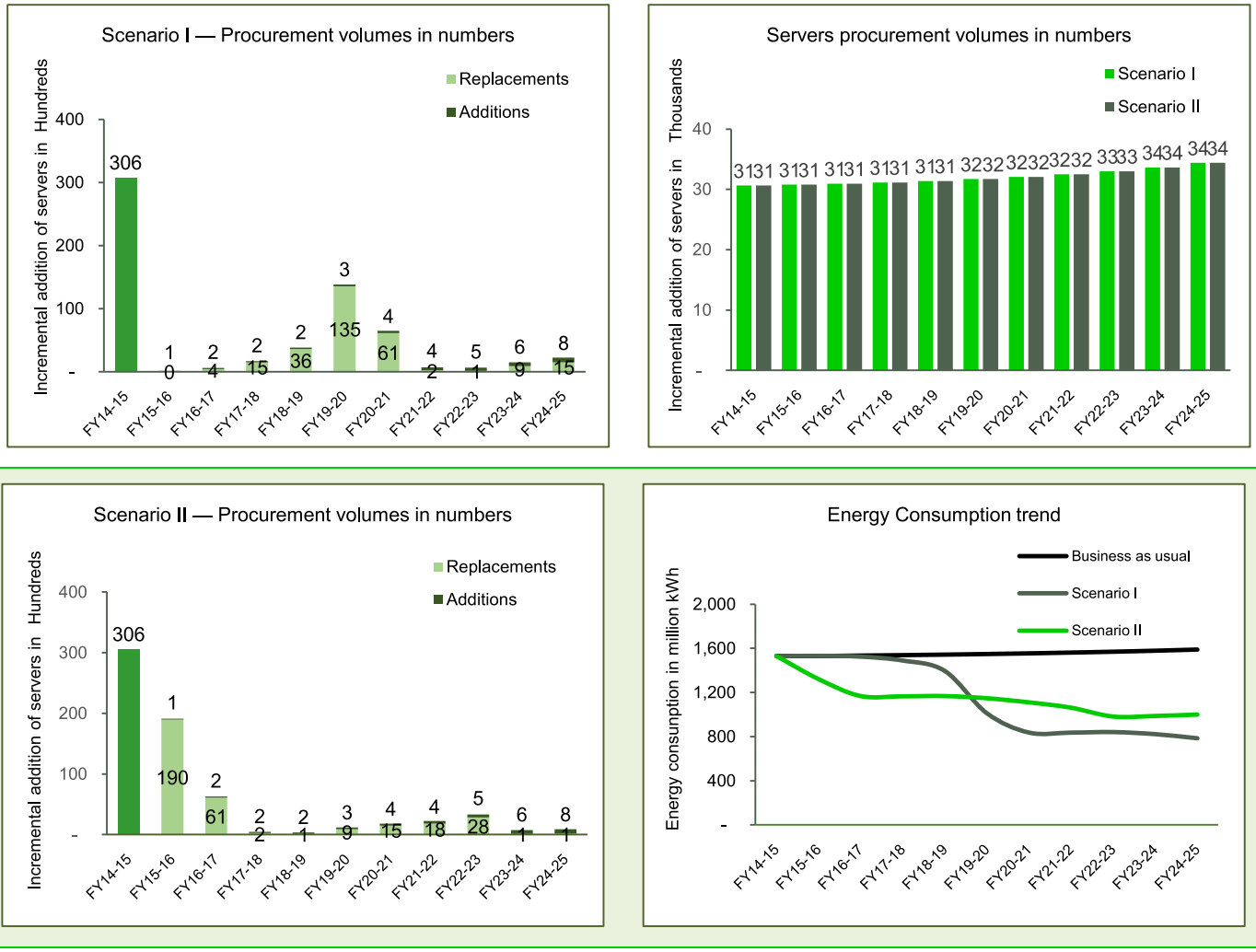
3.3.3 Servers

Step 1 — Factored an overall growth of +2 per cent for servers (considering the last five years in both government and private business establishments)

Step 2 — Old, inefficient servers to be replaced with new, efficient servers

Step 3 — Energy consumption of servers decreases 5 per cent y-o-y from FY15–16

Figure 12: Procurement volume and energy consumption of servers



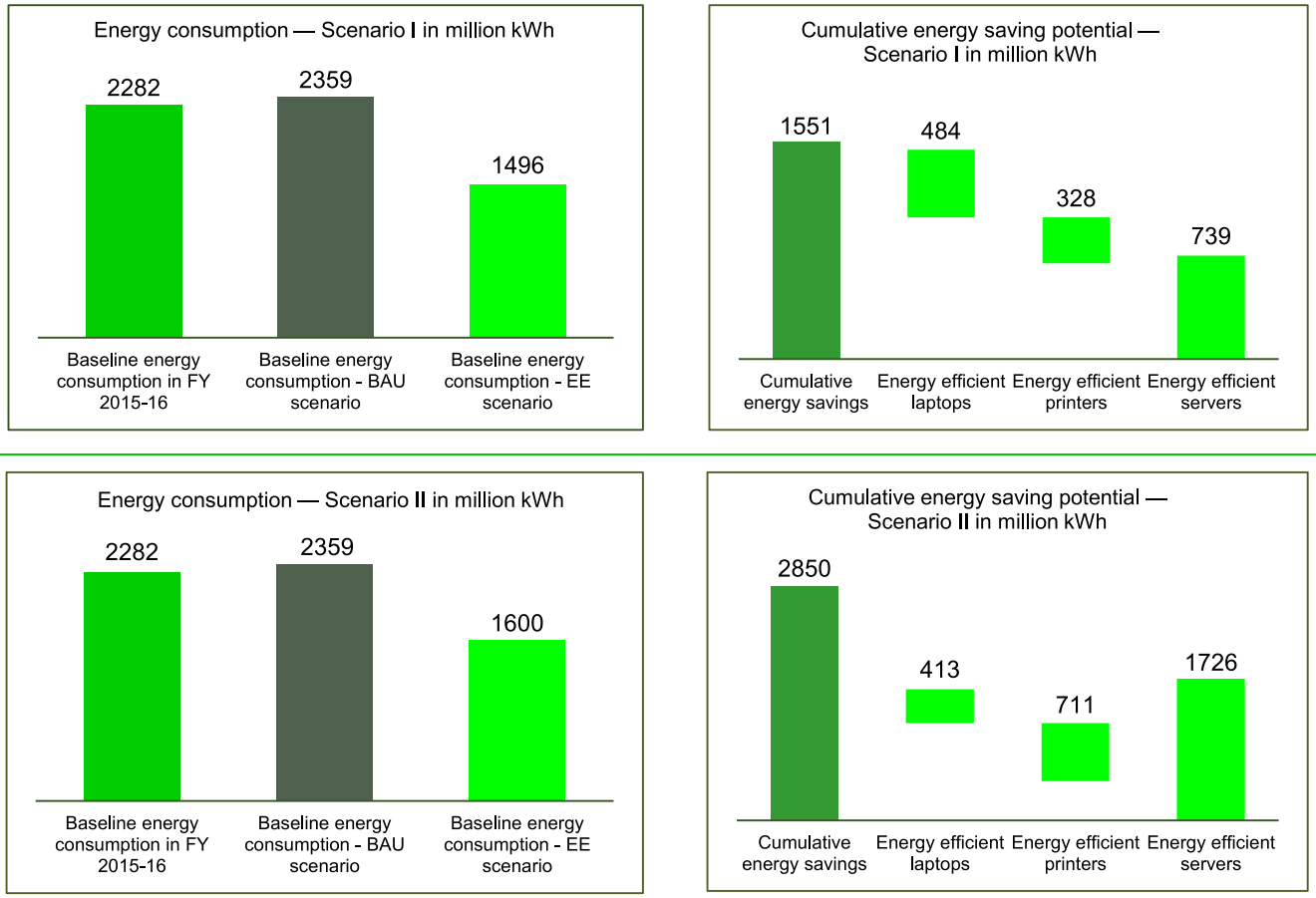
Source: MAIT, ITOPS reports and KPMG analysis

As explained above, servers are growing more rapidly due to new initiatives launched by the Government of India, such as Make in India and Digital India. The procurement trend has been increasing at 20 per cent CAGR for the last five years, and this trend is likely to continue, considering the government's recent initiatives. It is anticipated that more than 2,000 units by FY19–20 and 4,000 units by FY24–25 would be procured. The procurement would be a mix of low-, mid- and high-range servers. The replacement of old servers with energy-efficient ones is projected to save close to 400 million kWh of energy by FY19–20.

3.3.4 Estimation of energy efficiency potential for IT hardware equipment

In addition, energy consumption projection and the energy efficiency potential of each IT hardware equipment in government establishments and PSUs for FY19–20 and FY24–25 are provided below:

Figure 13: IT hardware energy consumption and saving potential for FY19–20



Source: MAIT, ITOPS reports and KPMG analysis

Basis the sections and analysis presented above, the estimated total energy and cost savings possible by FY19–20 has been shown in Table 7.

Table 7: Energy and cost saving potential until FY19–20

Particular	Scenario I	Scenario II
Energy savings in million kWh	**1,551**	**2,850**
NPV of energy cost savings (INR crore)	**705**	**1,373**

It can be seen from the graphs that if the 'business as usual' scenario persists, the baseline energy consumption would increase from 2,282 million kWh to 2,350 million kWh in the next five years. As per the study, through energy efficiency, it is possible to reduce close to ~1,500–2,800 million kWh (cumulative) of energy savings by FY19–20. Servers with a replacement period of 8–12 years have the highest energy efficiency potential of about ~700–1,700 million kWh of energy savings by FY19–20. Servers are followed by conversion — from desktops to laptops. This represents energy saving potential of approximately ~400 million kWh of energy by FY19–20. Desktops are followed by printers, as significant potential exists in the replacement of old and inefficient printers with energy-efficient laser printers. The energy-saving potential by FY19–20 is ~300–700 million kWh.

4 Global assessment on policies supporting energy efficiency procurement

An analysis of best practices adopted globally was undertaken to understand the manner in which other nations incentivise the adoption of energy-efficient IT equipment. This section highlights the summary of key initiatives adopted by the USA, Australia, the European Union, Korea and China.

4.1 The United States of America

The following standards and labelling programmes/initiatives have been implemented for procurement decisions in the US to accelerate the adoption of energy efficiency technologies:

- **Energy Star programme**[36]

  Established in 1992, Energy Star is a US Environmental Protection Agency-driven voluntary programme aimed at involving manufacturers in the promotion of energy-efficient appliances and environmental protection. Energy Star standards cover more than 70 product categories, including office equipment such as computers, printers, laptops and servers. These products are awarded the Energy Star label primarily on the basis of fulfilling minimum energy consumption benchmarks under standard test conditions.

- **Electronic Product Environmental Assessment Tool (EPEAT)**[37]

  EPEAT is a comprehensive global environmental rating system that helps purchasers identify eco-friendly computers, laptops, printers and other electronic products. Products are measured against both required (mandatory) and optional criteria, and rated according to the number of criteria met. These criteria include compliance with environmental and energy-efficient standards and requirements. EPEAT is a resource that purchasers use to identify high-performance, environmentally preferable products.

The USA Government has adopted the following policy initiatives to help ensure public procurement and the use of energy efficient office equipment (including IT equipment, such as computers, laptops, printers and servers)[38][39]:

4.1.1 Federal Energy Management Program (FEMP), 1995[40]

Established in 1995 under the administration of the USA Department of Energy's Office of Energy Efficiency and Renewable Energy, the FEMP provides information on energy efficient and renewable energy products, as well as technologies that agencies can procure to meet federal laws and requirements.[41]

- Under the FEMP, the laws and regulations mandating energy efficient purchase by Federal agencies are as follows:
  - The Energy Policy Act (EPAct) of 2005 and the Executive Order (E.O.) 13423 both require Federal agencies to purchase energy-consuming products that are ENERGY STAR® qualified or meet FEMP-designated efficiency requirements.
  - The EPAct mandates Federal agencies to incorporate energy-efficiency criteria into relevant contracts and specifications.

[36] https://www.energystar.gov/
[37] www.epeat.net/
[38] Buying Energy-Efficient Products, Lawrence Berkeley Laboratory, 2006
[39] Energy Efficiency Policy in the United States: Overview of Trends at Different Levels of Government, National Renewable Energy Laboratory, 2009
[40] Energy-Efficient Product Procurement for Federal Agencies, US FEMP, DOE/GO-102012-3642 Revised August 2012
[41] Energy-efficient Public Procurement: Best Practice in Program Delivery, SEAD Initiative Procurement Working Group, 2013

- The key implementation steps under the energy efficient procurement process for Federal agencies are:
  - FEMP product efficiency requirements set minimum efficiency levels for product categories that have the potential to generate significant Federal energy savings.
  - The FEMP guiding principles for setting energy efficiency requirements include energy savings potential, life cycle cost effectiveness, verified energy performance and the consumption of product with industry-recognised testing standards.
  - The FEMP gathers market data points for the product category and is mandated to set energy efficiency levels at the top 25 per cent of the category. It then compares the life cycle cost of this 25 per cent against the least efficient or base models. If the combination of purchase price and operating cost discounted over the life of the product is less for the top 25 per cent than the base models, the product category is eligible to meet FEMP-designated efficiency levels.
  - The final step is to verify the top 25 per cent requirement meeting products from three or more sources and thereby issue efficiency requirements, and guidelines that encourage Federal agency acquisition and use.
- The FEMP offers online calculators for the product category (Office IT equipment tool for PCs, laptops and printers created by Energy Star, in this case) that help buyers estimate life cycle energy and cost savings.
- The FEMP does not label or otherwise recognise specific products as being efficient. Rather, it publishes the required efficiency level for a product category, and any individual product that meets that efficiency level qualifies. Federal procurement officials are required to specify or select only those products that meet the designated efficiency levels.

4.1.2 Federal Acquisition Regulations (FAR)

- In 2011, the FAR mandate all federal agencies to meet at least 95 per cent of their annual acquisition requirement for electronic products with Electronic Product Environmental Assessment Tool (EPEAT)-registered electronic products, unless there is no EPEAT standard for such products.
- Federal agencies shall advance sustainable acquisition by ensuring that 95 per cent of new contract actions for the supply of products and for the acquisition of services (including construction) require that the products are primarily energy-efficient (ENERGY STAR® or Federal Energy Management Program (FEMP)-designated), environmentally preferable (e.g., EPEAT-registered, or non-toxic or less toxic alternatives) and made with recovered materials.[42]

4.2 Australia

The Government of Australia has actively adopted the following two strategies to help ensure the procurement of energy-efficient IT equipment:

4.2.1 Green ICT policy guidelines by the Northern Territory Government (NTG), Australia, 2013[43]

The Green ICT policy recommends that all NTG services should follow these guidelines to reduce the environmental impact of ICT usage. The recommendations cover equipment production, operation, energy reduction and efficiency, recycling and reuse. There are suggestions on how to address these at the procurement stage itself.

[42] Public Procurement Of Energy Efficient Products, Lessons from Around the World, Energy Sector Management Assistance Program, 2012
[43] Green ICT, Policy and Guidelines Information Communications Technology, Northern Territory Government, 2013

- IT equipment are also covered under this policy and include:
  - Workstations (laptops, desktop PCs, netbooks, etc.)
  - Servers
  - Printers, multifunction devices
- The guidelines recommend the procurement of energy-efficient products:
  - To lower pollution and carbon dioxide emissions, the entire life cycle of ICT equipment must be considered. This includes consideration for 'green' manufacturing at the design stage itself. Any energy-conscious manufacturing corporation would need to consider the materials being used, designing for the end of life, reuse and extension of life, energy conservation, end of life actions, and packaging, etc.
  - All future ICT procurement must require the supplier to provide energy usage and environmental protection information in their proposed solutions in their request for tender (RFT) responses. The EPEAT is being recognized as one that covers current environmental attributes. All agencies are encouraged to incorporate this tool in their RFT responses.
  - RFTs could incorporate the following requirements of suppliers:
    - Indicate whether the proposed solution is registered in the EPEAT
    - Supply information for power consumption (watts, where applicable) in the following modes:
      - On/active mode
      - Sleep mode
      - Standby/off mode
    - Provide an indication of internal power supply efficiency (if applicable) as per the USA Energy Star-referenced tests.
    - Provide a demonstration of any power-management capabilities of new equipment.
    - Minimum standards for qualification requirements of an IT equipment are:
      - Computers (and notebooks) must comply with the requirements of the US ENERGY STAR® Program Requirements for Computers Version 4.0 test and performance specification
      - Cathode Ray Tube (CRT) and Liquid Crystal Display (LCD) monitors must comply with Tier 1 and Tier 2, respectively, of the US ENERGY STAR® Program Requirements for Computer Monitors Version 4.1 test and performance specification
        - Printer and (multifunction devices) MFD (imaging) equipment to comply with the requirements of the US ENERGY STAR® Program Requirements for Imaging Equipment Version 1.0 test and performance specification (Tier 1)
      - All products to be supplied with power-management features enabled
  - Preferential weightage to be given to the suppliers with products that have low overall energy consumption (55–65 per cent), that reduce overall wastage and use fewer resources (15–25 per cent), with low environmental impact packaging (0–10 per cent), with low operating noise levels (0–10 per cent) and any additional environmental benefits of their products (5–15 per cent).

4.2.2 Australian Government ICT Sustainability Plan 2010–2015, 2013[44]

The mandatory environmental standards specific to energy efficiency used in Australian Government agencies for ICT procurement under the ICT Sustainability Plan 2010–2015 are:

- The EPEAT Silver rating, or equivalent selected as a minimum standard of environmental performance for relevant ICT equipment (including PCs, laptops, printers and servers)
- Compliance with the current Energy Star version for relevant ICT equipment
- Product take-back and appropriate reuse or resource recovery (a) mobile devices, such as mobile phones, PDAs and Blackberry devices; (b) toner cartridges; and (c) ICT equipment covered by the National Television and Computer Recycling Scheme under the National Waste Policy (NWP)

To help ensure that the government's objectives in relation to ICT sustainability are achieved, priority needs to be given to environmental criteria.

4.3 The European Union

The European Union has established the following policy guidelines and criteria:

4.3.1 Green Public Procurement (GPP) for Office IT equipment[45]

GPP is a voluntary instrument. There is, however, an EU-wide agreement for central government departments to procure office IT equipment that meets Energy Star efficiency requirements. This document provides the EU GPP criteria developed for the Office IT equipment product group (PCs and desktops).

Some criteria related to energy efficiency are as follows:

- All products shall meet the latest Energy Star standards for energy performance.
- Energy management functions shall be present on the hardware itself (for all products).

GPP recommends applying a 'total cost of ownership methodology' when awarding a contract. This means that instead of considering just the purchase price of the product when assessing the one that offers the best value for money, the contracting authority would consider the life cycle cost (LCC) over the estimated period of device ownership.

4.3.2 Buy Smart+: Green Procurement in Europe, 2014[46]

Buy Smart+ is a project funded by the European programme "Intelligent Energy Europe". Under this project, guidelines for "Procurement and Climate Protection" were released and intended for public and private procurement bodies and for offering support to consider ecological aspects in buying decisions. The salient features are:

- Various eco labels, such as Energy Star, European "Ecolabel", TCO, EC marking, Blue Angel, Nordic Swan and EPEAT have been used by European agencies for procuring office IT equipment. These guidelines recommend that labels can be included in public-sector contract awards, subject to the condition that the buyer cannot request a specific label; instead they can only insist on knowing the particular label's given characteristics. Mention of "or equivalent" is thus mandatory.
- Determine award criteria, e.g., better eco-efficiency, and their weighting when evaluating tenders. The award criteria must relate to the subject matter of the contract.
- For the comparison of offers, purchasing, operating and disposal costs are evaluated over the expected useful lifetime (life cycle cost). Calculation tools have been provided for each

[44] Sustainable Procurement In The Australian Government Report 2013
[45] Green Public Procurement Office IT equipment Technical Background Report, Report for the European Commission – DG-Environment by, 2011
[46] Guideline for procurement of office equipment, BUY SMART+ Green Procurement in Europe, 2012

product to compare the cost-efficiency of all offers. Providers must guarantee the maximum level of power and energy consumption for the calculation.

- During the procurement process, the following criteria may be evaluated:
  - Use total cost approaches based on a life cycle assessment.
  - Opt for a strategy that assigns points on the basis of a product's environmental or energy.
  - Define a targeted minimum threshold in terms of performance so as to assign additional points to encourage suppliers to submit an innovative bid.

4.3.3 Other initiatives

- The European Union's public authorities are encouraged to factor energy efficiency and other sustainability criteria into the award decision, recommending environmental award criteria to account for at least 15 per cent of the total points.
- A database for energy-efficient products is available, containing only products available in the EU markets and qualified under the latest active Energy Star specifications. Visitors can navigate using the menu per category of products and then use filters to view relevant products per product category and sub-category. Products registered under previous specifications can be found in the Archive.
- The EU database is updated regularly based on the US EPA database (for products available in the EU), and includes products directly registered with the EU, as managed by the European Commission.[47]

4.4 Korea

Korea's Act on Encouragement of Purchase of Green Products directs public agencies to purchase goods that feature at least one of the energy-efficient labels or eco-labels listed below[48]:

- A voluntary e-standby label, which certifies products that meet a low standby power requirement (below 1 Watt), covering office equipment and consumer electronics, such as personal computers, monitors, printers, scanners and TVs
- A mandatory standby label, a warning label for products not meeting minimum requirements for standby power, targeting TVs, computers, monitors, printers, multifunction devices, set-top boxes and microwave ovens

The following initiatives are part of their public procurement process:

4.4.1 Preference for EE products is highlighted through an alternative bidding system with extra points

Contracts are awarded to the most appropriate bidder, taking into account quality, performance, and EE. Moreover, registered energy efficient products are given extra points in the bid evaluation process.[49]

4.4.2 Database of energy-efficient products

Korea ON-line E-Procurement System (KONEPS) is an online On-line E-procurement System — a single window for comprehensive information on the procurement of all public organisations, providing a one-click online service for effective government procurement. KONEPS maintains a database of special category of energy efficient products.

[47] Public Procurement Of Energy Efficient Products, Lessons from Around the World, Energy Sector Management Assistance Program, 2012
[48] Korea's Energy Standards & Labeling, Market Transformation
[49] Korea's Promotion Policies for Energy-Efficient Products 1448International Workshop on Promotion of International Energy Efficient Procurement in Government Purchases, 2007

4.5 China[50]

The Ministry of Finance, along with the National Development and Reform Commission, published a formal list of energy-efficient products for public procurement in 2007. Certified by a Chinese certification organisation, the list of products have been issued as the List of Energy Efficient Products for Government Procurement, or simply the Energy Efficiency List, and covers computers and printers in its product category.

When procuring products from a category appearing on the Energy Efficiency List, Federal, state and municipal agents must give priority to energy-efficient products on the Energy Efficiency List. In government procurement activities, the procurement officer must make explicit the assessment standards for product energy efficiency requirements, conditions for product qualification and priority of energy efficiency procurement in all tender documents (including negotiation documents and price request documents).

4.6 Key learnings from global best practices

The following table summarises the key learnings from the global best practices

Table 8: Key learnings from global best practices

Criteria	Detail
Policy/regulation	• Minimum energy consumption standards is available for all IT hardware equipment • Standards and labels are specified in most of the technical specifications • Energy efficiency criteria is included in relevant contracts and specifications. • LCC-based tools adopted by various countries (Australia, EU and Sweden)
Institutional arrangement	• Priority is given to EE products in all tender requirements. • Maintenance of a database for energy-efficient products by designated government agencies to assist procurers • Measurement of IT-based energy consumption through separate meter system being encouraged to monitor the energy savings achieved by using energy-efficient products.
Awareness and capacity	• Online calculators are available for the product category that help buyers estimates life cycle cost, typical energy consumption and cost savings.

[50] Green Public Procurement in China: Quantifying the benefits, IISD, 2015

5 Recommendations on encouraging energy efficient IT hardware

The recommendations are based on key barriers to the procurement of energy-efficient IT equipment (chapter 2) and key enablers identified in global analysis (chapter 4)

5.1 Changes in policy

5.1.1 Inclusion of energy efficiency criteria in procurement policy

At present, the public procurement policies do not specify the need for an IT product to confer with an energy consumption standard. The technical specifications as outlined in DGS&D rate contracts also do not always mention the need for a BEE/Energy Star endorsed product/equipment. Certain PSUs incorporate Energy Star-rated products as one of their qualifying criterion in the technical specifications.[51] Also, in government procurement, 'typical energy consumption' is not used in the technical specifications for comparison of IT products. The manufacturers whoever meets the technical specifications mentioned in the rate contracts will be qualified for bidding, irrespective of the energy consumption of the products.

Hence, in most of the cases, bidder based on lower capital costs are selected who may or may not supply the most energy-efficient product. Thus, there is a need to incorporate energy efficiency criteria into procurement policies to encourage energy efficient equipment.

Energy efficiency criteria incorporation can be done primarily through the following methodologies:

- Adopt the standards and labelling schemes prescribed by BEE: The BEE has set voluntary standards on office IT equipment, such as notebooks, laptop computers and printers. The BEE standards have been prepared on the basis of recognised Energy Star specifications (Version 5.0 for computers, first launched in 2008 and Version 1.2 for printers). These are endorsement labels that act as approval seals and are awarded to models that meet technical criteria as specified by the authorised agency or organisation. It is intended to help procurement officers easily identify and specify products that meet a given energy efficiency standard. Globally countries such as the US, Europe and Korea, are adopting standards and labelling programmes/schemes to use energy-efficient IT equipment, as well as mandating their use in internal procurement processes.

As amendments to key procurement policies, the following could be suggested:

- There is a need to emphasise on procurement based on minimal energy standards in government policies. Including minimal energy efficiency as a criterion in existing policies may help governments procure energy-efficient products. Thus the GFR would need to be amended as under

  General Financial Rules

  Rule 160. Transparency, competition, fairness and elimination of arbitrariness in the procurement process: (xiv) Contract should ordinarily be awarded to the lowest evaluated bidder whose bid has been found to be responsive, ***compliance with energy standards prescribed by BEE*** *and who is eligible and qualified to perform the contract satisfactorily as per the terms and conditions incorporated in the corresponding bidding document. However, where the lowest acceptable bidder against ad-hoc requirement is not in a position to supply the full quantity required, the remaining quantity, as far as possible, be ordered from the next higher responsive bidder at the rates offered by the lowest responsive bidder.*

[51] Bureau of Energy Efficiency, Government of India

- Encourage usage of LCC: The typical energy consumption of IT equipment is less compared to other electronic/electrical appliances. However if the procurement is done in bulk, the overall energy consumption is high. Thus LCC gains a prominence and it becomes important consideration to compare IT equipment based on LCC.

  A case in point is the 'Buy Smart IT LCC calculation tool' in Europe. It has been seen that countries such as the UK and Australia are increasingly emphasising the importance of life cycle cost in their procurement processes for IT equipment, such as computers, servers, printers and laptops. Online calculators are available for the product category that help buyers estimates, typical energy consumption, life cycle cost and cost savings. In the Indian context, the EE procurement tool developed can enable comparison of the lifecycle costs This allows selection of supplier offering the best model they have instead of just the cheapest model that meets the bid specifications.

5.2 Institutional strengthening

Some countries have created databases of qualified products — with brands, makes and models — to facilitate energy-efficient product purchases. Generally, a nodal agency would establish minimum criteria, and manufacturers could apply to have their products included in the database. It would help provide greater comfort to the purchasing agency to know that multiple qualified products exist.

The BEE launched the Standards and Labelling Programme in 2006 to provide consumers the scope to make informed choices on energy saving, thereby offering them cost-saving potential. Currently, the standards have been established under two categories — mandatory and voluntary. The BEE has specified energy consumption standards for 14 appliances, including office IT equipment, such as notebooks, computers and printers, under the BEE's voluntary scheme using Energy Star specifications. However, there are certain areas that need to be strengthened:

1. Energy Star has specified energy consumption standards for servers (including data centers). It launched version 2.0 for servers with effect from October 2013. However, a similar standard has yet to be adopted in India for servers. Energy Star-certified servers come in several form factors — blade, multi-node, rack-mounted and pedestal.
2. Under the office equipment category, the standards were specified only for printers, copiers, multifunction devices (MFDs) and scanners. However, Energy Star has specified displays (monitors), enterprise servers, small network equipment, uninterrupted power supplies and voice over internet protocol (VoIP), in addition to what were specified.
3. Energy Star updates its version for computers, PCs and notebooks at regular intervals. The BEE, too, could update its standards for such equipment. The comparison of versions between the Energy Star and BEE is presented below:

Table 9: Comparison of BEE and Energy Star versions

	Laptops/PCs/notebooks
BEE	Adopted version 5.0 of Energy Star dated July 2014
Energy Star	Version 6.1 effective dated September 2014

Thus energy consumption standards could be updated with the latest version of Energy Star guidelines for computers, laptops and notebooks.

Further, governments and departments may consider adopting energy consumption standards version 2.0 for servers and other relevant standards prescribed by Energy Star for displays, small network equipment and uninterrupted power supply units.

5.3 Awareness and capacity building

There is a need to create awareness around procurement based on life cycle cost in PSUs and the government departments. The creation of digital training tools, such as simple videos and online presentation on efficiency can rapidly build the capacity of government agencies to move toward a more energy efficient procurement. There is also a need for handholding support to indigenous manufacturers for upgrading to latest energy star specifications.

6 IT product life cycle cost analysis

One of the suggested policy recommendation is usage of the LCC tool. The available tools were evaluated and it was realised that a tool specific needs to be developed in order to provide Typical Energy Consumption (TEC) and Life Cycle Cost (LCC) of IT equipment

6.1 Analysis of available energy efficiency tools

It was understood that globally, two primary tools/calculators are available to assist user in evaluating the energy efficiency of an IT product. These tools are:

- Electronic Product Environmental Assessment Tool (EPEAT)
- Energy Star Calculator — savings calculator for Energy Star-qualified office equipment

6.1.1 Electronic Product Environmental Assessment Tool (EPEAT)

EPEAT is a web based tool that was developed under a contract between U.S.EPA and Eastern Research Group Inc (ERG). Since its inception, the system has continued to evolve through active stakeholder participation. It is a comprehensive global environmental rating system that helps purchasers identify eco-friendly computers and other electronics equipment. The following table provides the details of inputs and output for the tool

Table 10: Features of EPEAT

Inputs	Outputs

• Product [Maximum 3 products]
  • Product Type [Desktop, LCD, Notebook]
  • Number of Product Purchased
  • EPEAT Registration [Yes, No]
  • EPEAT Registration Tier [Bronze, Silver, Gold, Don't know]
 	
OR Alternatively (based on data availability)
  • Total number of Energy Star
  • % of computer with power management feature
  • Average Lifespan of unit
 	
OR Alternatively (based on data availability)
• Number of product purchased
• Unit energy cost
• EPEAT Registration Criteria
  • Material use
  • Energy
  • Packaging
	• Energy savings
	• Primary material savings
	• Greenhouse gas emission savings
	• Air emission savings
	• Water emission savings
	• Toxic material savings
	• Municipal solid waste savings
	• Hazardous waste savings
	• Cost savings

The database has certain assumptions for a conventional product viz desktop, laptop etc. Based on the user inputs, energy consumption is determined considering the wattage available for the product type and the operating period defined in the database. This is then compared with the consumption of the conventional product to determine energy savings.

6.1.2 Energy Star calculator

This excel based calculator was developed by the US EPA and the Department of Energy to estimate the energy consumption and operating costs of office equipment and savings with Energy Star. The tool follows the comprehensive Energy Star database, which is updated regularly and covers all IT products; The following table provides the details of inputs and output for the tool

Table 11: Features of Energy Star

Inputs	Outputs
• Commercial or residential use • Location • Electricity Rate ($/kWh) • Quantity (number of laptops, Computers)	• Annual Electricity cost savings • Annual Electricity savings (kWh) • Annual Electricity cost • Annual Electricity consumption by ENERGY STAR unit(s) (kWh) • Annual Emissions reduction (pounds of CO2) • % Savings with ENERGY STAR • Total additional purchase price for ENERGY STAR unit(s) • Simple payback period for additional initial cost (years) • Assumed equipment lifetime (years) • Life Cycle Electricity cost savings • Life cycle Electricity savings (kWh) • Net cost savings

The database has certain assumptions for a conventional product viz desktop, laptop etc.. Based on the user inputs, energy consumption is determined considering the wattage available for the product type and the operating period defined in the database. This is then compared with the consumption of the conventional product to determine energy savings.

6.2 Need for developing energy-efficiency tool

EPEAT does not provide the following aspects

- Typical energy consumption for a particular specification of product. For example the energy consumption of desktop with quad core process 4 and 16 GB RAM will differ with 2 Core processor and 2 GB RAM
- LCC of product that will typically evaluate the capital cost, operating cost and energy cost
- EPEAT doesn't have analysis for printers

Energy Star has a comprehensive database and provides LCC, but does not provide differential energy consumption based on configuration of a product.

Given the aforesaid, there was a need felt to develop a tool leveraging the exhaustive database of energy star. The tool has been developed based on the following objectives

- Understand the typical energy consumption of a desktop, laptop and printer based on the configuration provided

- Present value of recurring expenses, such as O&M costs
- Present value of energy costs
- Lifetime energy consumption
- Life cycle cost of an IT product
- Greenhouse gas (GHG) emission during the life of the product

6.3 Development of a life cycle cost tool

The developed tool is excel based and provides computations for three IT equipment i.e. desktop, laptop and printers. The following table provides the details of inputs and output for the tool

Table 12: Features of developed tool

Inputs	Outputs
For Desktop/ Laptop Option A [Drop down Menu] – 3 Equipment • Processor Model • Graphic Card • CPU speed • CPU cores • Memory Option B [In case user is not aware on specifications] • Indicated Power • Hard disk drives • Ethernet Ports • Quantity [for LCC] • Cost [for LCC]	• Typical Energy Consumption of the 3 equipment • Life Cycle Cost for the 3 equipment

Based on the first drop-down selection of specification by the user, the remaining drop-down are populated for further selection by the user. Once all the drop down values are selected, the tool retrieves the TEC value from the database and displayed it to the end user. The database consists of TEC for various specifications and is based on Energy Star. LCC is calculated using quantity of the IT product, retrieved TEC and capital cost. The detailed methodology for the tool has been provided in Annexure IX.

7 Limitations of the study

This study involved a collection of primary and secondary data through extensive stakeholder consultation for the purpose of understanding the current procurement and disposal policies of IT products in government departments and PSUs, as well as the evolution of product technology for energy efficiency. There are certain limitations associated with the methodology and outcomes of this study:

1. Primary data collection: The primary data collected through questionnaires (for government departments/PSUs and manufacturers) covered only a limited sample. Data and findings from these questionnaires were extrapolated to reflect the views of the overall market. Most of the projections are estimates and results may show a slight deviation from the facts.
2. Baseline energy consumption estimation: To estimate the baseline energy consumption of government departments and PSUs, a number of assumptions were made:
   - Considering IT equipment to only consist of PCs/laptops, desktops and printers
   - Assuming 'government establishments' (from the IT performance reports, MAIT) to cover all government departments/PSUs offices/buildings/premises
   - Considering an average range of electricity consumption by a standard IT equipment (PC/desktop, laptop and printer).
3. Secondary data: This was collected from a limited sample size of manufacturers and secondary resources for tool development and product technology evolution.
4. Tool: The calculation of average electricity consumption by energy-efficient devices was estimated statistically through the latest available database of energy-efficient equipment qualified under Energy Star. It was also assumed that the user would be in a position to enter the input pertaining to its current device, on the basis of measurement and sampling analysis. Whenever a new Energy Star version is introduced, the tool would need to be updated.
5. Policy recommendations: Various policies related to the procurement and disposal of IT equipment in India and other countries were assessed during this study. Recommendations were made to procure energy-efficient IT products in government departments and PSUs.

8 Annexures

Annexure I — Questionnaire for manufacturers/suppliers

The following IT hardware products are being considered for the study:

1. Monitor
2. Servers
3. Personal computers/laptops
4. Printers, scanners and other multi-function devices
5. UPS systems
6. Motherboards
7. CPUs
8. Power Supply Units

With respect to above product portfolio, we are keen to understand the following:

A. Understanding of the products

1. What are the type of the products offered to the government departments/PSUs
   - Which type of government agencies, departments have you been supplying, for example, NIC, Indian Railways, SBI, and Income Tax India.
2. What are the typical
   - life
   - failure rate
   - operating periods/usage of these products?
3. What are the typical cost ranges — capital cost as well as O&M costs for these products?
4. Is any life cycle cost assessment been conducted for these product by the firm that takes into account various factors, such as technology evolution, market requirements, energy consumption, environment friendly and demand of the product?
5. Will you be adopting any different strategy toward selling environment friendly/energy efficient products vs traditional products?
6. Will you specify or suggest government agencies to procure energy efficient product while traditional low cost product is available for delivering the same output?
7. What was the first hand reaction by the agency, if yes
8. What are the hot-spots within products with respect to high energy consumption
   - Processing power vs. power consumption statistics
   - Heat recovery and accounted loss
   - Product longevity, upgrading them and their modularity
   - Depreciation of product from time of product launch, and requisite waste handling measures required along with designated waste handler, details of scrap value assessment where possible
9. What are the methodologies adopted by government department/PSUs for the procurement of the product
   - For how many years do these contracts last usually?
   - What are the common values of these contracts — both for efficient and traditional products?

- What kinds of capex/opex models have been executed with government department and PSUs?
- Are O&M services also part of the contract(s) entered into? If yes, for how many years? What are the services provided under the operational support?
- Are disposal policies also defined by the procuring agencies? If not, what are the services provided for the disposal of these products?
- Does the technical specifications of a tender issued by the procurer also define aspects related to providing energy-efficient components?
- Are the procurements taking place on least-cost method? Have you encountered quality cost-based evaluation in your bidding to government agencies?
- Opinion about extended producers' responsibility in taking back the old used products.
- Opinion about barriers shown in replacing inefficient product with energy-efficient product by the government agencies.

B. Initiatives taken/considered to bring in energy efficiency in IT hardware

10. What are the initiatives taken by the firm to adopt energy efficiency?
11. What has been the trajectory for these products over the last 10 years in terms of innovation and technology, related to:
    - Product design — to bring in energy efficiency/environmental aspects
    - Type of materials used for various equipment
    - Advancement in technology, which is oriented toward reduction in energy consumption by the end user
    - Changes in the energy consumption of these products and energy savings (if noted) achieved by adopting such measures
    - Are these energy-efficient products adopted by private players
    - Any tool available for the user to select the energy-efficient product while bidding

- Is the company EPEAT registered?
    - Are any other environmental compliance criteria (RoHS, etc.) being considered in the regulatory framework?

C. Market penetration for efficient equipment in the IT segment

12. What is the penetration of energy-efficient technology in government agencies that you work for?
13. What is the typical sales trend (turnover) for energy efficient vs. traditional products?
    - What is the penetration level and the rate of penetration that have been observed over the past 3–5 years for such products in government departments/PSUs?
    - What is the ease of transitioning government organisations to newer energy-efficient products?
    - How frequently are old products being replaced with technologically advanced products?

D. Key barrier with respect to energy-efficient products

14. What are the major barriers associated with procurement of energy-efficient IT equipment under various categories:
    - Technology, political, information and capacity, finance, institutional arrangements and social?
    - Which is the most prominent barrier in the scale of 1–5, 1 being the lowest and 5 is the highest?
15. Do you see these barriers being less among private players? How does the procurement process differs and what could the government departments do to overcome these gaps?

Annexure II — Technological developments in IT Equipment

The following provides the details of technological developments of IT Equipment

Impact on energy consumption in PCs / desktops owing to technology developments

Technology development	Associated impact on energy consumption
Hard drive: • Use of static-based drives instead of motor-based drives	• Solid State Drives (SSD) hard drives consumed 50–60 per cent less energy than traditional motor-based hard disk drives (HDDs)[52].
Memory: • Use of DDR3 (Double Data Rate 3) and DDR4 memory instead of DDR and DDR2	• DDR 3 uses 20–25 per cent less power than DDR 2 memory and withstands higher voltage[53].
Power management systems: • Speed of processor dependent on power source: full performance on AC source and reduced performance on DC source • Dual-mode power-delivery system — both active and standby/sleep power levels[54]	• Lower power consumption as the device enters sleep/standby mode, during which time the processor draws less energy.
Monitors • CRT monitors replaced with LCD displays; increasingly, manufacturers using an array of LEDs in place of fluorescent lighting, which reduces electricity consumption	• An LCD screen reduces power consumption by ~30 per cent relative to a CRT screen; the use of an LED display further reduces power consumption by ~5 per cent[55]. • LCD monitors consume less power and reduce the consumption of lead as a manufacturing input material.

[52] Industry report on Green SSD- Samsung
[53] The evolution from DDR2 to DDR3 and its impact on Signal Integrity- *Inphi Corporation*
[54] PC Energy-efficiency Trends and Technologies- Intel
[55] Green Computing: Issues on the Monitor of Personal Computers, *International Journal Of Engineering And Science,* Vol.3(2), 2013

Technology development	Associated impact on energy consumption
Processors[56] • Use of power-efficient processors automatically (and intelligently), which balances performance and power consumption • Use of turbo-boost technology that increases processor frequency and drives speed • Use of hyper-threading technology for simultaneous multi-threading within each processor core (up to two threads per core or eight threads on a quad-core processor) • From improved processor architecture to bandwidth-intensive applications deliver 3.5 times more bandwidth than previous-generation processors	• Power-efficient processors are capable of operating at a low voltage; use power more efficiently to generate less heat • Efficiency has improved in the last 10 years to give increased battery life to laptops and lowered desktop power consumption from 150W to 30W[57].
Motherboards • Use of energy-efficient solid capacitors, ferrite core chokes and lower RDS (resistance drain-to source) MOSFETs (metal–oxide–semiconductor field-effect transistors)[58] • Increased power phases of the central processing unit voltage regulator from 3 to 4 phase design • Increased amount of copper on the printed circuit board (PCB)	• Energy-efficient motherboards consume 20–30 per cent less power than traditional motherboards. • Power phase switching technology helps deliver power only when required, depending on the CPU workload • Increased copper on PCBs provides effective thermal cooling by spreading heat more efficiently

Impact on energy consumption in laptops owing to technology development

Technology development	Associated impacts on energy consumption
Display • Increased use of LED back lighting as a standard display instead of LCD Power management	• Power consumption reduction by ~35–45 per cent and reduction in dimensions with better picture quality, colour

[56] http://www.intel.in/content/dam/doc/technology-brief/performance-xeon-5500-performance-that-adapts-to-your-business-environment-brief.pdf
[57] Stakeholder discussion with global processor manufacturer
[58] Stakeholder discussion with leading motherboard manufacturer

Technology development	Associated impacts on energy consumption
• Allow to switch automatically to lower, power-saving speed or to higher-performance speed, according to workload[59]	reproduction capability and contrast ratio[60]

Impact on energy consumption in printers owing to technology development

Technology development	Associated impacts on energy consumption
• At present, printers have automatic sleep and wake-up modes, having quick and instant start-up technologies, which reduce time and energy consumed	• Quick and instant start 'fuse' provides up to 50 per cent energy savings over traditional fuse.
• Use of LED-based technology instead of fluorescent tubes in copiers	• LED-based tubes consume four times less energy in low-power mode and 1.4 times less energy in copy mode[61].
• Low-melt toners, designed to melt at lower temperatures, which help reduce energy consumption materials[62]	• Low-melt toners have a melting point 20–25°C (lower than previously used toners) that require less heat and energy to melt
• Use of induction heating (IH) (used for magnetic flux to generate heat) and on-demand fixing technologies (localised heat generation to reduce wastage of energy) to improve a printer's overall heat efficiency	• Use of IH and on-demand fixing technologies reduce total electricity consumption (TEC) by ~50-60 per cent[63].

Impact on energy consumption in servers owing to technology development

Technology development	Associated impacts on energy consumption
• Use of blade servers instead of rack-mounted servers for space, delivery of more power per unit of processor to reduce power costs	• Blade servers reduce power consumption by 20 per cent over rack-mounted servers[64].
• Use of 80-plus platinum power supplies in servers[65]	• The 80 plus power supplies improves efficiency by 2 per cent and reduces power supply losses by 50–60 per cent

[59] PC Energy-efficiency Trends and Technologies- Intel,
[60] Efficiency Improvement Opportunities in PC Monitors: Implications for Market Transformation Programs, IPEEC, 2013
[61] Industry study- HP printers, http://www.hp.com/hpinfo/newsroom/feature_stories/2009/09energyprinting.html
[62] Stakeholder discussion with global printer manufacturer
[63] Energy-Saving Technologies, Canon
[64] http://www.dell.com/learn/us/en/uscorp1/dell-environment-energy-efficiency?c=us&l=en&s=corp&~ck=bt
[65] Stakeholder discussion with global Server manufacturer

Technology development	Associated impacts on energy consumption
• Virtualisation decouples software and services from hardware and reduces power use, conserves space and resources, provides greater system flexibility and provides a greater return on investment	• The consolidation of multiple applications on to a single server could reduce space and energy requirements 20–80 per cent
• Power-management functions reduce power use of the server, as workload gets reduced to enable lower power idle state	• Using power-management capabilities could reduce server power consumption by 2.5–8.5 per cent depending on the workload characteristics and the average utilisation of servers
• Graphic processing units are used to accelerate calculation-intensive operations, which generates a substantial degree of heat. The use of variable speed fans and improved air flow through servers lead to reduced energy consumption	

Annexure III — Questionnaire for government departments and PSUs

Products identified:

A. Monitor
B. Servers
C. Personal computers/laptops
D. Printers, scanners and other multi-function devices
E. UPS systems
F. Motherboards
G. CPUs
H. Power Supply Units

With respect to above product portfolio, we are keen to understand the following:

A. IT Hardware products and their energy consumption

1. Which are the current IT hardware products in use? (Please provide database of all the IT hardware products in use along with list of suppliers/brands)
2. What is the standard life, failure rate and operating periods/usage for these products?
3. What are the standard cost ranges — capital cost as well as O&M costs for these products?
4. For such products, was any life cycle cost assessment conducted? If yes, please provide details of the assessment.
5. What is the contribution of IT products toward overall energy consumption? Please provide data for the following:
   - Total cost of energy consumption by IT products on an annual basis over the last five years (Please provide the cost of energy product wise in order to identify major energy contributing products).
   - Future energy projections for the next 3–5 years
6. Do you have monitoring, reporting and verification framework system in your organisation to measure energy consumption?

B. Energy efficiency in IT hardware

7. Are you upgrading the existing products to newer products which are energy efficient?
8. What is the current penetration of energy-efficient IT hardware products in your organisation? What is the percentage of these products (in terms of value) out of total IT products procured annually?
9. Does the organisation, senior management and procurement staff understand the impact of using energy-efficient products? Are they eager to move onto a more energy-efficient environment?
10. Is there awareness and understanding of existing government policies that are in place pertaining to energy efficiency?
11. Will you be adopting any different strategy toward procuring environment friendly/energy-efficient products vs traditional products?
12. What are the initiatives taken by the firm to bring in energy efficiency in these products? Has there been changes in technical specifications to define aspects related to providing energy-efficient components — Energy Star, EPEAT, etc.?

13. Has there been any cost savings in energy consumption due to usage of energy-efficient products in the last 2–3 years? If yes, please provide the cost saving details for the last three years.
14. How frequently are you conducting the energy efficiency assessment of your equipment?
15. What are the other methodologies that are followed by your organisation to adopt energy efficiency and an environment-friendly approach?
16. What is the status of SDC policy?
17. Is there any training/capacity building programme conducted by system integrators/suppliers for the energy-efficient products available?

C. Procurement process

18. What are the approach/methodologies adopted with respect to procurement of products? For how many years are these contracts entered into?
19. What are the standard value of these contracts — both for efficient and traditional products?
20. Are the procurement happening primarily through DGS&D? If yes, are the specifications decided by DGS&D? In which cases, do you procure on your own?
21. If you procure on your own, do you set specific criteria? Will that criteria include energy efficiency aspects? Do you consider EPEAT/Energy Star while procurement?
22. Do you have tools to assess the sustainability criteria, environmental and energy criteria?
23. Does the procurement happens on least-cost method or quality cost-based evaluation?
24. What kind of models are being executed with suppliers — capex or leasing? If leasing is one of the options considered for procurement, what are the products procured and which methodology do you adopt?
25. If not, would there be a possibility of leasing it? What would be the barriers that you may encounter?
26. Do we consider life cycle costs or only capex costs?
27. If only capex model, why are you not considering life cycle costs and any specific reasons?
28. Are O&M services also part of the contract? If yes, for how many years? What are the services provided under operational support?

D. Disposal process

29. How frequently the products are being changed? Do you wait for seven years to phase out equipment? Any specific reasons for seven years, when the technology becomes obsolete in two or three years?
30. What are the current methodologies followed for disposal of IT products, for example auctioning, whether GFR rule is adopted for disposal, etc.?
31. What are the methodologies adopted for determining the salvage value of IT products at the time of disposal? What are the typical depreciation value considered for such products?
32. What is your opinion about extended producers' responsibility in taking back the old/used products?
33. What is the extent with which you adopt e-waste policy?

E. Expectations from green procurement guideline and energy procurement tool

34. Are you satisfied with Electronic Product Environmental Assessment Tool (EPEAT)?
35. What are the limitations and shortcomings of the tool?
36. If a new tool is developed for consumers to evaluate the effect of a product on the environment, what are going to be your expectations from such a tool?
    - This tool will be user-interfaced wherein the data, such as type of product, rated power consumption, life of the product and operating period, will be fed in to produce output in terms of impact of energy consumption for the next 20 years, life cycle cost of the products, taxation (VAT, etc.), depreciation, incentive possible, environmental impact, suitable alternatives, cost curve for replacement, etc.
    - Please provide your suggestions/expectations.

F. Views on green procurement policy for IT infrastructure

37. What are your views on the policy recommendations for improving EE in IT infrastructure?

Annexure IV — Methodology for Baseline energy consumption

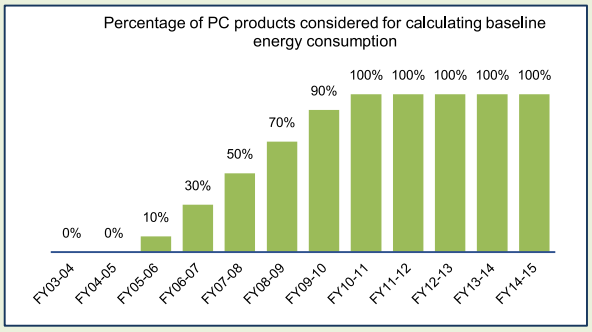
A. Methodology for computing current inventory of IT equipment

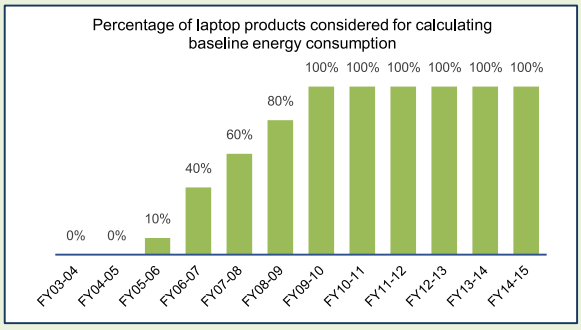
Step 1: Annual purchase by government departments/PSUs — To estimate the current inventory of PCs, laptops, printers and servers, the purchase trends of each IT equipment in government establishments was studied. This data has been collected using the results of the Industry Performance Annual Reports prepared by MAIT between FY03–04 and FY14–15.

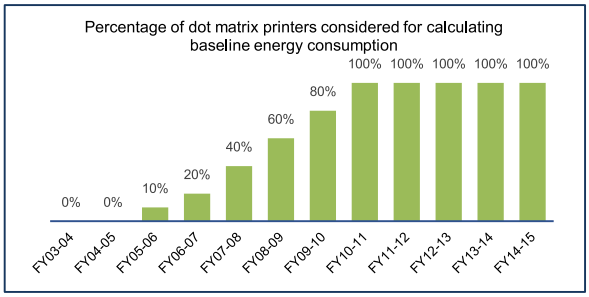
Step 2: Average lifetime of product and replacement in stock — The installed devices per annum were multiplied with the average lifetime of the product to calculate the current installation base. As discussed previously, it was primarily seen in government departments that the replacement period for PCs is 5–7 years; for laptops, 4–5 years; for printers, 4–8 years (depending on technology); and servers, 7–10 years. It is assumed that there is an average life cycle and a retirement period (the time period after the useful life during which devices are slowly retired) for each product. Over the retirement period, the number of devices was considered to gradually decrease by 20–30 per cent annually.

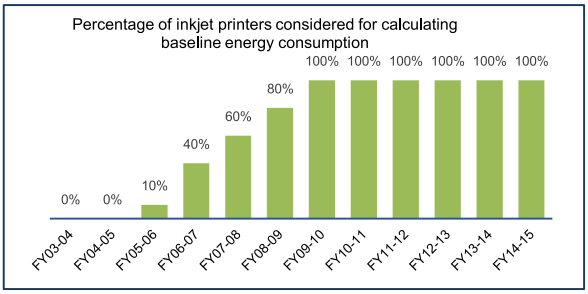
Assumptions in estimating IT product retirement

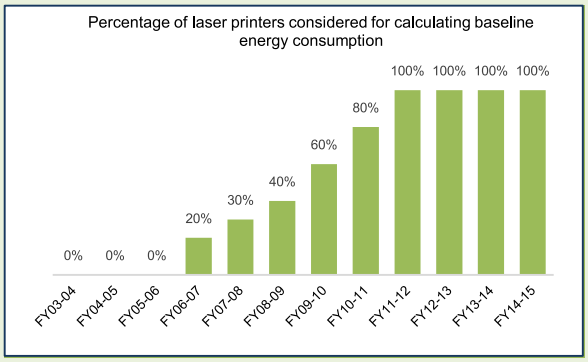
The following assumptions have been made to calculate the retirement period for different IT products:

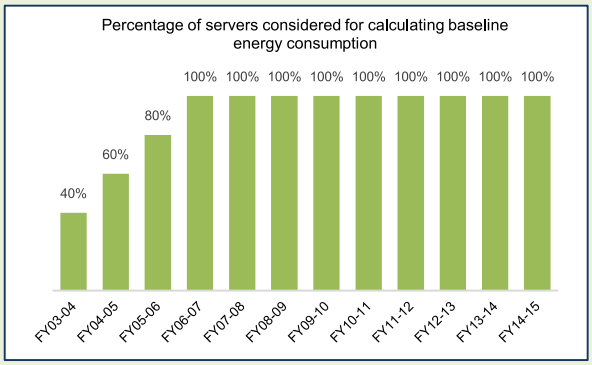












For example, for PCs, between FY10–11 and FY14–15, 100 per cent of products were considered for evaluating baseline energy consumption. However, for FY09–10, only 80 per cent of the products were considered for evaluating baseline energy consumption. It is assumed that in FY09–10, the remaining 20 per cent of the products were replaced in subsequent years i.e., FY10–11 or FY11–12. A similar approach was adopted for other equipment as well. The retirement percentage was obtained based on research conducted during the study.

Step 3: Using the annual installed data, the average lifetime and gradual replacement of old products, an estimate of the total inventory, was made.

B. Estimating the annual energy consumption PCs, laptops, printers and servers

Step 1: It has been observed that along with a reduction power consumption by mode, usage patterns have also evolved over the years for various IT products. For example, in PCs, over a period of time, the use of the active and standby modes has decreased and increased, respectively.[66] Therefore, considering both aspects, the IT equipment inventory was divided into three categories based on vintage — between FY05–06 and FY07–08, between FY08–09 and FY11–12 and from FY12–13 to date. The combined effect of decrease in standby energy consumption and the difference in the operating mode of equipment usage, has led to an overall decrease in PC energy consumption.

The average energy consumption in each mode (active, standby and switched off) and its corresponding average usage in a year for all IT equipment have been estimated through secondary research (detailed studies comprising field surveys, statistical approximations and manufacturer data).

Step 2: The average power for each mode was multiplied with the respective usage under each mode (for different time periods) to calculate the annual Typical Energy Consumption (TEC) of the product in kWh.

Step 3: The average annual consumption of an equipment was then multiplied with the number of installed devices (corresponding to the year of installation), and the total energy consumption through all devices currently installed was then estimated.

[66] Reference: KPMG Analysis based on stakeholder consultation and secondary research conducted as a part of this study. Please refer footnote number 46, 47, 48, 49, 50, 51, 52

Annexure V — Excerpts of General Financial Rules, 2005

The General Financial Rules (GFR), developed by the Ministry of Finance in 2005, establishes the principles of general financial management and procedures for government procurement. All government purchases must strictly adhere to the principles outlined in the GFR.

The following are key excerpts on the government procurement of goods, outlined in the GFR:

Procurement of goods — under procurement of goods, there are 27 rules (Rule no: 135 to Rule no: 162), which would help a user to procure goods from vendors.

- ***Rule 137. Fundamental principles of public buying:*** *The specifications in terms of quality, type etc., as also quantity of goods to be procured, should be clearly spelt out keeping in view the specific needs of the procuring organisations. The specifications so worked out should meet the basic needs of organisation without including superfluous and non-essential features, which may result in unwarranted expenditure. Care should also be taken to avoid purchasing quantities in excess of requirement to avoid inventory carrying costs.*
- ***Rule 140. Powers for procurement of goods:*** *The Ministries or Departments have been delegated full powers to make their own arrangements for procurement of goods. In case however, a Ministry or Department does not have the required expertise, it may project its indent to the Central Purchase Organisation (e.g., DGS&D) with the approval of competent authority.*
- ***Rule 141. Rate Contract:*** *The Central Purchase Organisation (e.g., DGS&D) shall conclude rate contracts with the registered suppliers, for goods and items of standard types, which are identified as common user items and are needed on recurring basis by various central government ministries or departments. The ministries or departments shall follow those rate contracts to the maximum extent possible.*
- ***Rule 160. Transparency, competition, fairness and elimination of arbitrariness in the procurement process:*** *(xiv) Contract should ordinarily be awarded to the lowest evaluated bidder whose bid has been found to be responsive and who is eligible and qualified to perform the contract satisfactorily as per the terms and conditions incorporated in the corresponding bidding document. However, where the lowest acceptable bidder against ad-hoc requirement is not in a position to supply the full quantity required, the remaining quantity, as far as possible, be ordered from the next higher responsive bidder at the rates offered by the lowest responsive bidder.*

Annexure VI - Suggestions recommended in draft procurement bill

The Public Procurement Bill, 2012 was introduced in the last Lok Sabha and was referred to the Parliamentary Standing Committee on Finance by the Honourable Speaker on May 2012. No report was given by the Standing Committee and the bill has lapsed since then.

Subsequently, the Finance Minister in his 2015 General Budget speech announced (in the para 72) that the Parliament needs to take a view soon on the Public Procurement Law. It has been decided to undertake public opinion on the law.

A review of the Public Procurement Bill was sought and invited comments and suggestions from NGOs, Civil Society Organisations, individuals, consulting firms, law firms, etc., by 10 April 2015.

Suggestions recommended on draft public procurement bill

a. Section 7: *While assessing the need under sub-section (1), the procuring entity shall, to the extent possible, take into account the estimated* **capital cost or capital and (/or) operational and/or life cycle cost** *of the procurement and shall also decide on the following matters…*

b. Section 21: (1) Save as otherwise provided in this Act or the rules made thereunder or in any other law for the time being in force, the evaluation criteria shall relate to the subject matter of procurement and may, as applicable, include —

   a) the price;

   b) the cost of operating, maintaining and repairing goods or works; **or life cycle costs**

c. Section 30-35: 1) Subject to the provisions of this Act and the rules made thereunder, a procuring entity may procure a subject matter of procurement by means of any of the following methods, namely:

   a) open competitive bidding; or

   b) limited competitive bidding; or

   c) two-stage bidding; or

   d) single source procurement; or

   e) electronic reverse auctions; or

   f) request for quotations; or

   g) spot purchase; or

   h) life cycle cost-based bidding

   i) any other method of procurement, as may be notified by the central government in consonance with the principles set forth in Chapter II of this Act

Annexure VII - Estimating life cycle costs

The life cycle cost of an asset may be expressed by a simple formula —

Life cycle cost = Capital cost

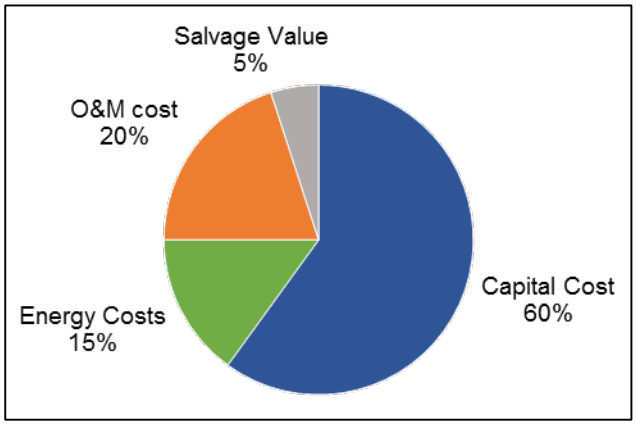
+ Lifetime operating costs

+ Lifetime maintenance costs

+ Disposal costs[67]

– salvage value

Figure 14: Life cycle cost of an IT product



However, ascertaining a measure of each variable in the formula could be challenging. The future costs are usually subject to a level of uncertainty that arises from a variety of factors, including:

- Prediction pattern of the IT asset's usage over time
- Nature and scale of operating costs
- Need for, and cost of, maintenance activities
- Impact of inflation on individual and aggregate costs
- Prediction of the length of an asset's useful life
- Significance of future expenditure compared with present-day expenditure

The longer the period, the more difficult is it to estimate future costs. However, as discussed in previous sections, most of the IT products have useful life of 3–5 years, barring servers that have a useful life of about 7–8 years. Considering this scenario, with appropriate assumptions, life cycle cost of an IT product could be computed.

Benefits from LCC

The information generated by an LCC analysis could assist procurement agencies and government departments at various stages in the life of an asset. The concept of an asset's life cycle provides a framework to document and compare alternatives. When a life cycle cost analysis has been prepared for each option under consideration, it is possible to:

- Calculate the NPV of each option
- Consider projected cash flow in the context of the funding available
- Identify issues related to the ultimate disposal of the asset, if any

Decision makers can leverage this information, in conjunction with any other operational or policy constraints, as part of the selection process.

[67] It is not applicable for government organisations as most of the products are auctioned or sold to the manufacturers

A well-documented LCC process, justifying a relatively high initial cost offset by reduced long-term costs (energy efficiency options), provides clear evidence for consideration during any review or audit process. In the context of government agencies, it also provides a useful record of the rationale for the decision during the procurement of a particular product.

Annexure VIII – Average electricity consumption of IT hardware equipment

Table 13: Average electricity consumption of PCs/desktops

IT equipment		Typical energy consumption for a standard model								
		FY05–09			FY09–12			FY13–15		
		Active	Stand by	Off	Active	Stand by	Off	Active	Stand by	Off
PCs/ desktops	Power (W)	73.7	2.6	2	66.1	2	1.5	58.5	1.6	0.9
	Usage (hr/yr)	3,510	330	4,920	2,670	1,314	4,776	1,980	2,190	4,590
	TEC (kWh/ year)	269			186			123		

Table 14: Average electricity consumption of laptops

IT equipment		Typical energy consumption for a standard model								
		FY05–09			FY09–12			FY13–15		
		Active	Stand by	Off	Active	Stand by	Off	Active	Stand by	Off
Laptops	Power (W)	39	2.6	2	32	2	1.5	26.8	1.6	0.9
	Usage (hr/yr)	3,030	550	5,180	1,750	1,752	5,258	840	3,066	4,854
	TEC (kWh/ year)	130			67			32		

Table 15: Average electricity consumption of printers

IT equipment			Typical energy consumption for a standard model								
			FY05–09			FY09–12			FY13–15		
			Active	Stand by	Off	Active	Stand by	Off	Active	Stand by	Off
Printers	Dot Matrix	Power (W)	55	26	3	45	13	2	33	9	1
		Usage (hr/yr)	394	6,263	2,102	394	6,263	2,102	394	6,263	2,102
		TEC (kWh/ year)	191			103			71		
	Inkjet	Power (W)	50	13	7	30	8	4	20	4	1.5
		Usage (hr/yr)	200	6,034	2,486	200	6,034	2,486	200	6,034	2,486
		TEC (kWh/ year)	106			64			32		
	Laser	Power (W)	550	100	8	400	60	4	280	40	2
		Usage (hr/yr)	200	6,034	2,486	200	6,034	2,486	200	6,034	2,486
		TEC (kWh/ year)	755			461			312		

Table 16: Average electricity consumption of servers (volume, mid and high servers)

IT Equipment		Typical energy consumption for a standard model		
		Volume	Mid	High
Servers	Usage (hr/yr)	8,760		
	Power (W)	218	638	12,682
	TEC (kWh/year)	1,910	5,590	111,000

Annexure IX — Detailed Methodology of the Tool

The aim of this tool is to calculate the energy consumption of IT equipment whose specifications are entered by the user. Two different approaches in TEC calculation have been adopted, where an individual set of specifications is to be entered. After employing different mathematical formulas upon the specifications, TEC values are obtained. At the end, TEC values are compared. To make an informed analysis, the following parameters are used:

- Capital Cost (INR)
- Present Value (PV) — Recurring (INR)
- Present Value (PV) — Salvage Value (INR)
- Life cycle cost (INR)
- Energy Consumption — Annually (KWh)
- Energy Consumption — Lifetime (KWh)

In order to understand the tool, it is implicit to understand the two aforementioned methodologies in detail. The following paragraphs elaborate the two computing options the tool provides:

Option 1

In a nutshell, this methodology is based on finding a laptop/desktop identical to the specifications entered by a user. A database of the latest energy-efficient laptops is used for searching and retrieving TEC values. This database has been built by using the data points available from Energy Star.

Following are the specifications that this methodology requires:

- Processor model
- Graphics card type
- CPU speed, GHz
- CPU cores, number
- Memory (RAM), in GB

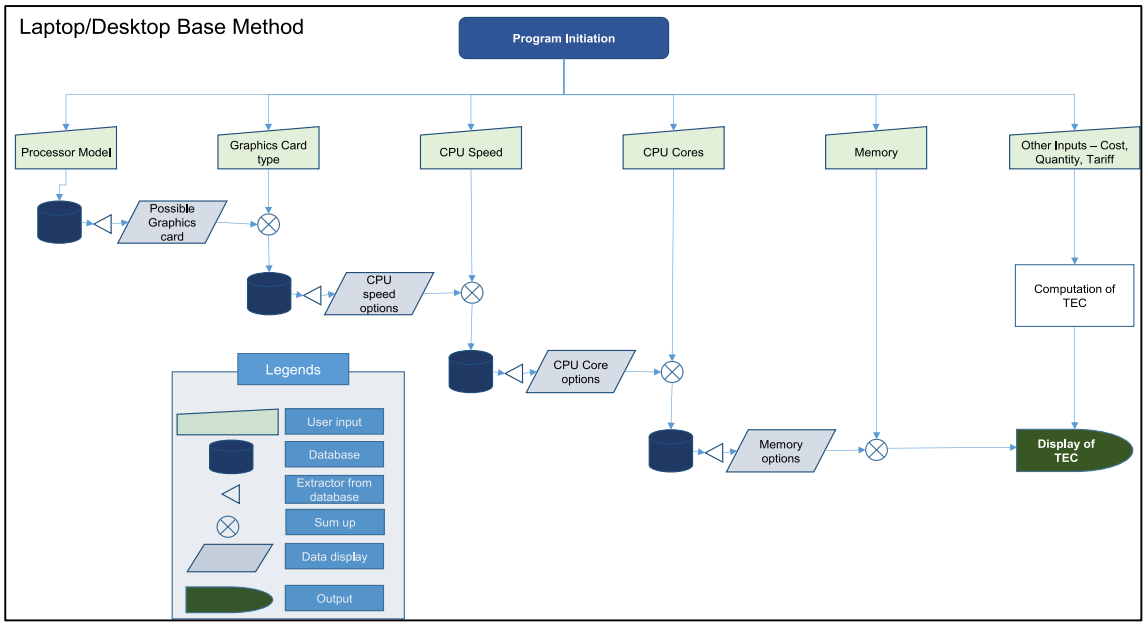
To make this tool user-interactive, a drop-down list of all specifications is made available to users for selection. The values in the drop-down list are populated at run time, based on previously selected specifications. Therefore, laptop configurations not available in the database are not visible to users, which minimises inconvenience. It is also possible to go back and change a previously selected specification. This action reverses the process, so a user has to again select the subsequent specifications. The following workflow is followed in TEC calculation:

- Quantity — this parameter represents the number of laptops/equipment to be procured. Only after entering the quantity can specification values be entered.
- Cost — this parameter represents the capital cost of a single laptop in INR. This parameter is independent and neither restricts nor enables other specifications.
- Processor model— [Default: Blank] [Value type: Text] [Field type: List] [Validation: Drop down]. This parameter represents a laptop's processor model. Users can select any model from the processors available in the list.

- Graphics card type — [Default: Blank] [Value type: Text] [Field type: List] [Validation: Drop down]. This parameter represents the graphics card type of a laptop among the choices integrated therein, discrete or any graphics, which are not applicable for printers.
- CPU speed — [Default: Blank] [Value type: Numeric] [Field type: List] [Validation: Drop down]. This parameter represents the speed (GHz) of laptop processors. Users can select any available speed from the list.
- CPU cores — [Default: Blank] [Value type: Numeric] [Field type: List] [Validation: Drop down]. This parameter represents the number of processor cores in a laptop.
- Memory — [Default: Blank] [Value type: Numeric] [Field type: List] [Validation: Drop down]. This parameter represents a laptop's memory (RAM) capacity.

An overview of the methodology is depicted below in Figure 15:

Figure 15: Option 1 methodology



The specifications mentioned in the chart are entered in the sequence detailed above. As a small processing step, the laptop category among 0, I1, I2, I3, G1 and G2 is determined from the product's processor speed and number of cores. Each category represents a particular product value range. Finally, a string search method is used to retrieve TEC value from the database. Laptop category, processor model, memory, cores and speed values constitute the search string. A corresponding string of these values for each data point is already stored in the database. So, when a string search is done, only a perfect match value is retrieved.

This methodology is repeated for two additional laptops/desktops, as the tool provides a feature that can compare TEC values of three laptops simultaneously.

8.1.1 Option 2 — User-defined input

In this methodology, the laptop is considered a workstation, available to a user 24x7. Most of the time, a laptop stays in either sleep, long idle or short idle mode. There are short bursts of time when the laptop switches to active mode; however, the overall TEC of the laptop depends mostly on the energy it consumes during the sleep or idle modes. Following are the specifications that users enter:

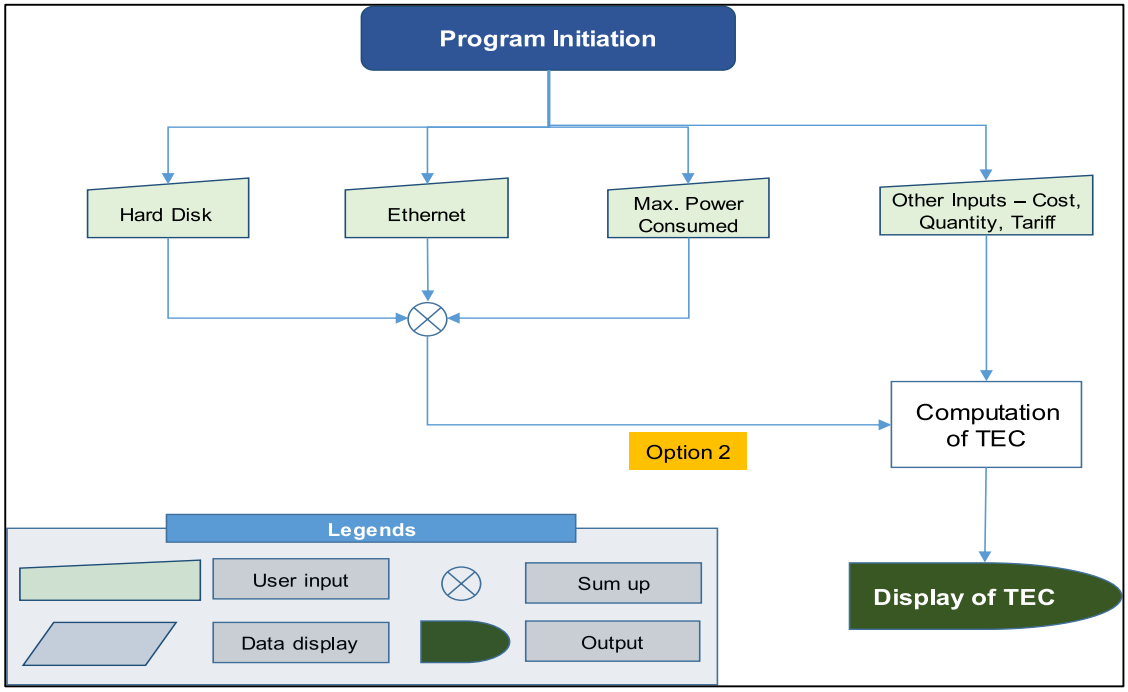
- Maximum measured power (W) — [Default: Blank] [Value type: Numeric] [Field type: Text box] [Validation: Greater than 0]. This parameter represents the maximum power of a laptop.

This specification can be obtained from a laptop's specification sheet or from the laptop's manufacturer.

- Hard disk drives, number — [Default: Blank] [Value type: Numeric] [Field type: Text box] [Validation: Greater than 0]. This parameter represents the number of hard disks or storage devices present in a laptop.
- Ethernet, number — [Default: Blank] [Value type: Numeric] [Field type: Text box] [Validation: Greater than 0]. This parameter represents the number of energy-efficient Ethernet ports present in a laptop.

An overview of the methodology is depicted in Figure 16 below:

Figure 16: Option 2 methodology



The TEC calculation formula is also derived from Energy Star computer requirements v6.1. The following formula is used for the calculation:

PTEC_MAX = 0.28 x (PMAX + NHDD x 5) + 8.76 x PEEE x (TSLEEP + TLONG_IDLE + TSHORT_IDLE)

- PMAX = Measured maximum power consumption (W)
- NHDD = Number of installed hard disk drives (HDD) or solid state drives (SSD)
- PEEE is an EEE allowance of 0.2W per IEEE (Institute of Electrical and Electronics Engineers) 802.3az-compliant (Energy Efficient Ethernet) Gigabit Ethernet port

The values entered by users are directly used in the formula to arrive at the maximum power consumption value. In this method, the quantity needs to be entered to enable the specifications. Further, the 'cost of laptop' parameter is required in this methodology, whose default value and boundary conditions are identical, as in the methodology.

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