Implementation of Green IT concepts in R. Macedonia

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***Abstract* — Green IT represents a collection of strategic and tactical initiatives which directly decrease carbon dioxide emissions caused by the computer usage of companies in many different ways. The contribution of this paper to the scientific discussion of Green IT is based on the research done among Macedonian companies and it proposes practices that will help improve the adoptability of Green IT in R. Macedonia.**

Keywords — Green IT, e-waste, motivation, virtualization, cloud computing, data center

I. INTRODUCTION

Getting a grip on climate change is one of the most important challenges for humanity for the 21st century. It is clear that information and communication technologies (ICT) have a key role in this process as ICT has a very important function in the transformation of our jobs and lives. Information technology is the central nervous system not only in the building of the business sector but also in the forming of governmental and social infrastructures [1].

Nevertheless the ICT industry is reliant on electrical energy whose availability is limited. With the growth of ICT the dependence of people on it grows too. The irresponsible use of electrical energy directly impacts the financial resources of organizations and inflicts permanent damage on the environment.

The ICT industry consumes up to 8% of the total electrical energy consumed in the European Union and is responsible for up to 2% of the total carbon emissions discharged into the atmosphere, which is same as that which is emitted by the aviation industry [1]. Additionally, recent studies show that on a global scale the electrical energy consumed by personal computers increases by 5% every year [1]. On average, the electrical energy consumed in small and medium sized firms amounts to 10% of their total IT budget, in extreme cases this can rise to 50%. Nowadays the cost of the electrical energy, consumed during the life of a typical computer, is greater than the cost of buying the computer itself [3]. In addition to the above mentioned facts, there is Moore's Law which states that the number of transistors that can fit onto an integrated circuit doubles roughly every 24 months. This theory in essence explains why electronic waste is the fastest growing type of waste in the world [3].

Due to the above it is clear that there is a need for discovering ways of implementing Green IT. Green IT is not just focused on the reduction of the IT industry's effect on the environment. It is also focused on the use of ICT in order to assist in the general reduction of organizations' effect on the environment, regardless of the type, form or size of the organization [1]. Here the term Green IT includes the systematic implementation of the criteria for environmental sustainability (safeguarding against pollution, recycling products, using clean technologies) during design, production, purchasing, operation and disposing of IT infrastructure and the implementation of the same criteria in terms of human and governance components of IT infrastructure [4].

Naturally, legislation is a key driver in the implementation of these changes in organizations and the way people live their lives. In many countries there already exists legislation and new laws in regards to the environment as an act of parliament, an example being the United Kingdom [5]. In the Republic of Macedonia the first step has been taken in the form of enacting the law on managing electronic waste. However, the challenges for the implementation and the development of this topic in Macedonia are huge [6].

II. MOTIVATION

The conceptual foundation of this paper is based on four most discussed topics in the Green IT area, virtualization, cloud computing, data center management; and the organizational motivation factors for Green IT adoption defined by Alemayehu Molla [7][8].

A. Virtualization

Virtualization as a technology is one of the easiest paths for implementing the practices of Green IT. Virtualization allows for better use of computer systems. More importantly it can help in the creation and maintenance of energy efficient and ecological data centers. Some of the advantages for the environment resulting from virtualization are:

- Costs of electrical energy - a physical server needs the same amount of electrical energy regardless of whether the processor is working with a big or small load.

- Costs of cooling - having less physical servers which emit heat in data centers reduces the load on the cooling system.
- Electronic waste - having less physical servers which will need to be replaced means having less electronic waste which companies have to deal with [13][14].

B. *Cloud computing*

The use of cloud computing has various direct, indirect and systematic consequences for the surroundings of working in the cloud.

Direct effects are, of course, the most visible and in this instance are a consequence of a significant decrease in the amount of hardware owned and a greater use of cloud resources. This is because of the fact that such services are centralized by third parties who are able to serve a number of customers simultaneously. A direct result is the reduction of the consumption of electricity by hardware and also electricity for cooling.

Indirect effects of cloud computing are connected to the reduction in CO_2 emissions as a result of its implementation and also whilst operating. Companies that use such services are able to focus more on their business as fewer resources will need to be dedicated to maintaining their services and infrastructure.

When talking about systematic consequences there are 3 aspects of efficiency which need to be taken into consideration:

- the physical location and design of the data center
- the architecture of the platform
- the architecture and access to the development of the applications which are being hosted [1]

C. *E-waste*

Electronic devices have unique characteristics which cause their production and usage to have great impact on the environment and society. This makes managing electronics problematic and challenging. Society and the environment face the following problems:

- Poor design and aggressive marketing by production companies
- Electronics contain many toxic substances which make electronic waste toxic
- Electronics contain many rare and precious materials
- The majority of electronic waste is improperly discarded and this means that the society and the environment pay the price for the poor and toxic design [9][17][18][19]

D. *Data center management*

Data centers have become key elements in the functioning of businesses, academic and governmental institutions and in every day communication. The number of data centers grows as our society and economy changes from paper based into digital. The EPA's report from 2007, estimates that the amount of electrical energy consumed by data centers in the USA in the period from 2000 to 2006 has doubled, reaching 61 billion kWh. According to current efficiency trends it is estimated that this number has doubled by 2011, reaching a level of more than 100 billion kWh. In dollar terms this amount is equivalent to 7.4 billion dollars spent on electricity costs [11].

When designing green data centers, understanding how much energy was used by the equipment is very important in order to be able to optimize it. For that purpose there is a need to:

- Have a clear picture how much energy the equipment is using at any given time
- Decrease the amount of physical infrastructure
- Install more servers on more powerful energy sources
- Have a monitoring and reporting platform for energy use
- Lower the costs of managing a data center [12]

E. *Organizational motivation factors for Green IT*

An organization is a collective whose behavior is influenced by human motivating factors. In the context of accepting information technology, motives can be defined as a desire which initiates activities of an organization to accept a specific innovatory system [16].

The motives can be analyzed from the aspect of their locus – origin or focus. The locus of the motivation can be internal or external, shown in *Fig. 1*. The internal refer to the mission, beliefs and system of values of the organization. The external motives come about from the intervention from government (formal) or market (informal) [15][4][15].

In terms of focus there are more groups, classified into two wider categories: techno-economic and socio-political. Techno-economic motives relate to accepting new technologies and systems for improving the operation of the organization and the socio-political for accepting specific systems under the influence of outside authority.

		Locus of motivation	
		Internal	*External*
Focus of Motivation	*Economic*	Eco-efficiency	Eco-responsive
	Regulatory/ Normative	Eco-effectiveness	Eco-legitimacy

Fig. 1 Locus and focus of motivation [4]

III. RESEARCH METHOD

The topic and goal of the research in this research paper is to understand how Information Technology in the Republic of Macedonia supports the corporate initiatives for sustaining the environment and how green methods impact on the operation of the IT industry as a whole, and also on other industries. Additionally, the research has the goal of encouraging the respondents to think about implementing the suggested ideas as possible solutions in their organizations.

Specific goals of the research are to find out:

- How many of the respondents are familiar with the existence of Green IT initiatives
- How many of the respondents understand the meaning of Green IT and how can it be of use to them in improving the efficiency in their organization
- How many of the respondents have already implemented some measures in their organizations
- What are the measures most commonly implemented
- Are companies familiar with the law for electronic waste and do they take measures for recycling old equipment

The research was conducted using an online survey tool, it was sent to 100 Macedonian companies and 30 responses were received in a period of two weeks.

The respondents are IT directors or owners of medium and big companies who are in decision making positions in the companies they work in. The organizations were selected from various industries but mainly from the IT sector, Communication service providers, the Banking sector and Government institutions. The basic principle governing the selection of a given organization is whether the organization has a significant implementation and reliance on IT and whether it has data centers at its disposal. The research on the Republic of Macedonia was done online using applications for creating questionnaires.

There were 25 questions divided into categories reflecting the goals of the research *Fig. 2*. Additionally, data about the number of laptops and desktop computers was collected, as well as the number of physical and virtual servers and the number of CRT and LCD monitors. The collected results were used for assessing the current situation in terms of the consumption of electrical energy and for giving suggestions of how to save electricity.

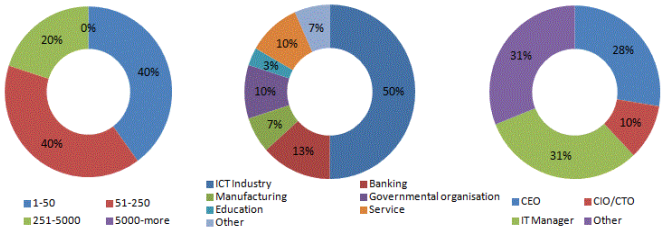

Fig. 2 Research demographics

The collected results were used to create an overview of where Macedonia stands in terms of worldwide activity in implementing Green IT. The final goal was to draw up an overview of the situation in Macedonia in terms of Green IT. Methods and measures are drawn up to help organizations to become more aware of their role in overall electricity consumption and what effect this has on the environment and the financial means of the organization. A strategy that Macedonia could implement country-wide and on the organizational level will also be defined.

IV. Results

According to the research conducted in 30 Macedonian companies, in total the respondents said they have 657 physical and 598 virtual servers. This would give a rough estimate that, on average, 47% of the infrastructure of Macedonian companies is virtual. Such numbers could be an encouraging indication of the acceptance of virtualization and the understanding of its benefits. Indeed, as much as 53% of the respondents said that virtualization and consolidation are especially important for energy efficiency. 37% have already implemented virtualization and as much as 43% are in the process of implementation. However, if we look at the individual results, depending on the size of the company, we can see that energy efficiency was not the overriding reason for the implementation of virtualization; most of the respondents (39.19%) said this was not such an important reason. The graph in *Fig. 3* shows the individual results and it can be seen that most of the respondents said that between 10-19% of their IT infrastructure was virtualized.

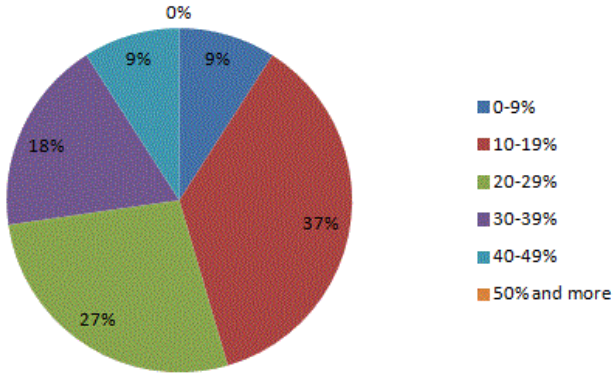

Fig. 3 Virtualization of infrastructure in Macedonia

From the accumulated results it can be concluded that it is only in the next few years that virtualization will achieve its rightful place on the market. At the moment its position in Macedonia is negligible due to the costs of licenses and the lack of knowledge about the advantages of virtualization for companies and for the environment.

If you take these results and compare them to the research carried out by Symantec in 2009 [13], which had 1,052 responses from all over the world, you can see that Macedonia does not differ much from world trends (taking into account the two year gap between the two researches). In the Symantec survey, 41% felt virtualization is especially important, in comparison to the number in Macedonia, which was 53%. 42% of the respondents in the Symantec survey had already implemented virtualization in comparison to 37% in Macedonia. We can, however, conclude that Macedonia lags behind in the awareness of the benefits of virtualization in respect to the environment, specifically energy efficiency. 46% of respondents in the Symantec survey judged virtualization to have a very important role in improving energy efficiency in data centers while around 40% did not think it was that important.

Only 10% of Macedonian companies at the time of the survey used any cloud computing services and 23% said they were in the process of implementation. If we compare these results to those of the research conducted by Symantec (2009)[13] which says that 57% of the respondents viewed cloud computing as a green initiative and 23% have enthusiastically switched to such services, then we can

conclude that Macedonia is not far behind the rest of the world if you take into account the fact that these kinds of services are only offered by foreign IT companies and the fact that there is still a doubt about the security of data which is in the cloud among Macedonian companies. The result of the above two restricting factors is that the environmental advantages of cloud computing are forfeited.

Over a third of Macedonian companies have never taken part in the initiative by producers and suppliers for exchanging old equipment for new or for recycling IT equipment, *Fig. 4*, another third do this occasionally, whilst only 20% do this often. Additionally, 40% of the respondents taken into consideration whether products are energy efficient and whether they are produced and distributed following sustainable processes and 90% are willing to pay more for an identically functioning product which is energy efficient.

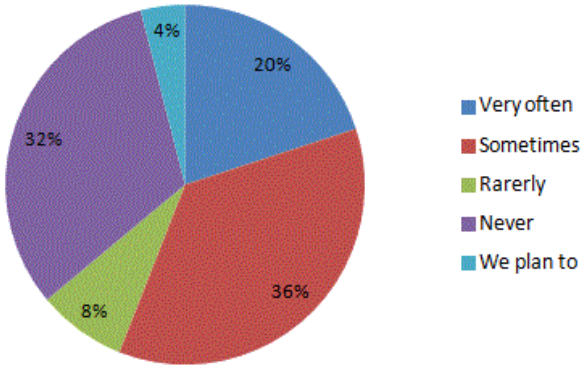

Fig. 4 Participation of companies in the initiative for exchanging equipment old for new

If we conduct an analysis of what type of company gave which kind of response and how many computers it had at the time of the survey; we can conclude that for 1,082 desktop computers, 264 laptop computers and 132 physical servers the future is uncertain after their use as ICT equipment is discontinued. Nevertheless the ICT industry is best at managing electronic waste.

Additionally half of the companies that recycle their equipment are aware of and are informed about the level of ethics in the practices implemented by the company which recycles their electronic waste.

Only 28% of the respondents make use of services for collecting equipment after they reach the end of their useful life. 40% do use these services, as shown in the *Fig. 5*.

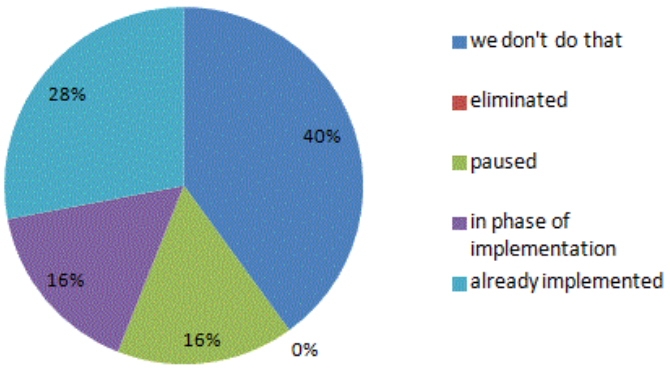

Fig. 5 Preferences of the options among producers and sellers for collecting sold equipment after reaching the end of their life

Taking into account the fact that this survey was conducted in the time when the Law for electrical and electronic waste management was being drawn up in 2011, my expectation would be that this number has gone up significantly. Just as many companies (28%) actively try to decrease the use of toxic materials in production or end products as opposed to 36% who do not do this at all, shown in *Fig. 6*.

In the Republic of Macedonia most of the companies do not have targets for energy efficiency improvement of the energy used by the IT infrastructure; this deduction is due to 66% of the respondents stating so. A positive piece of information is the fact that 43.33% of the respondents said that they plan to define such targets. Exactly the same percentages of respondents do not have matrices defined so that they would be able to document the organizational progress towards improving the energy efficiency of the IT department. 57% do make analysis of the electricity bills but only 23.33% monitor the costs directly generated by the IT equipment. 13.33% are not even able to give a rough estimation of their monthly electricity bill and that gives an impression that this proportion of the respondents are not aware at all of the contribution of the IT equipment to the company's electricity costs, *Fig. 6*.

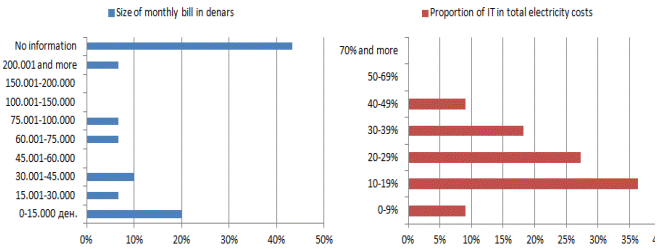

Fig. 6 Size electricity bills (left), Proportion of IT in total electricity costs (right)

The biggest proportion of respondents (36.36%), are aware of the contribution of the IT equipment to the total energy consumption in the company and they estimate that their IT equipment accounts for 10-19% of the total cost for electricity. The rest of the percentages can be seen in the picture below.

From the data received we can clearly conclude that in Macedonian companies electricity consumption is not explicitly connected with the energy consumption of IT equipment, since it is not measured or monitored. Macedonian companies put virtually no effort into trying to find ways to improve their IT efficiency. There is a need for awareness building in the IT departments, as well as the rest of the companies; IT Managers need to be made conscious that what they do affects the environment. It is very important to be able to measure and monitor the energy consumption of the IT equipment in order to be able to track the progress of efficiency. Actions that can help as well include: building a green it strategy, implementation of adequate matrices and tools, results tracking and defining actions for improvement.

Additionally, as part of the research, the respondents were asked to provide the number of CRT and LCD monitors there are in their companies. The purpose was to gather information in order to be able to provide data about how much energy was consumed by the CRT monitors that were in use at the time of the research, and compare this to the energy consumed by the LCD monitors. This information would also be used to provide information about how fast an investment in new LCD monitors (that are know as far more energy efficient) would be

returned, in order to replace the CRT monitors (which are known for their toxicity).

If a standard computer and monitor works for 8 hours a day, 20 days in a month and the average power of CRT monitors is 100W and for LCD 20W then the average energy consumed by CRT and LCD monitors will be 192 kWh and 38.4 kWh respectively.

If we consider the fact that the old CRT monitors waste energy (around 2 Wh) even in standby (the computer is turned off but not the monitor), and if we say that usually employees do not turn off the monitor when finishing with work except for weekends then for the rest of the day CRT monitors consume around 7.6 kWh.

When the research was conducted in 2011, Macedonian companies had a total of 525 CRT monitors. If we take the 1 kWh electricity price from 2011 of 0.09 euro, then the yearly costs for electricity for this number of CRT monitors reached 9,324 euro. The total calculated amount of money may seem low, but it should be analyzed with respect to the fact that it accumulates the equipment of only 30% of the companies and with respect to the company's turnover per year. The companies could have invested this amount of money right away in 12 new LCD monitors to replace the CRTs and the investment would have been returned in the first year. Today, the return on the investment would have happened even quicker because of the improved efficiency of LCD monitors, their lower price and the higher price of electricity. It goes without saying that the replaced CRT monitors should be replaced in an ethical and environmental friendly way.

As part of this research the participants were also asked to provide information about the number of desktops that the companies have and the percentage of them that are left turned on overnight. 30 Macedonian companies in 2011 had in total 4,612 desktop computers. From this number around 30% or 1,391 were left turned on overnight for different reasons. I assume that the same number of computers was not left on every night.

If we have in mind that a typical desktop computer has power of 70W, then a typical computer that is turned off outside of working hours (thus working 8h/day) consumes around 134.4 kWh.

A computer that is not turned off even for weekends and does not go into standby, but works 24 hours, consumes around 403.2 kWh.

If we take the 1 kWh electricity price from 2011 as 0.09 euro, then the annual costs for electricity for 1,391 desktop computers is 75,236 euro and for one that works only for 8h is 50,157 euro, which is not a negligible amount compared with the yearly turnover of the companies in R. Macedonia, again having in mind that this amount states for the devices of only 30% of the companies. If Macedonian companies define a policy that employees are punished for not turning off their computers when leaving work or install software that turns all the computers off automatically, the cost can decrease by 30%. Additionally wake on line technology can be implemented for when a computer needs to be used outside normal working hours: this would enable access to computers only when there is a need.

In *Fig. 7* the ratings of Macedonian companies for factors of motivation are shown. The respondents were asked to rank the given factors of motivation from 1 (strongly agree) to 6 (strongly disagree) as factors of motivation for the implementation of Green IT in Macedonian companies. From the results it is possible to conclude that reducing costs is or would be the basic reason for implementing Green IT practices. This is followed by considerations of the environment which points to the high level of awareness of Macedonian companies of the effect of the IT industry on the environment. The factor which had the smallest rating is the implementation of Green IT practices as a result of the activities of the competition. This partially points to the inertness of Macedonian companies in following worldwide trends. If we put the below results into Molla's matrix we see that most companies are in Eco efficiency quadrant – internal locus and economic type of motivation which shows that Macedonian companies wish to implement practices and technologies that improve the eco sustainability of IT while at the same accomplishing economic goals such as reducing costs.

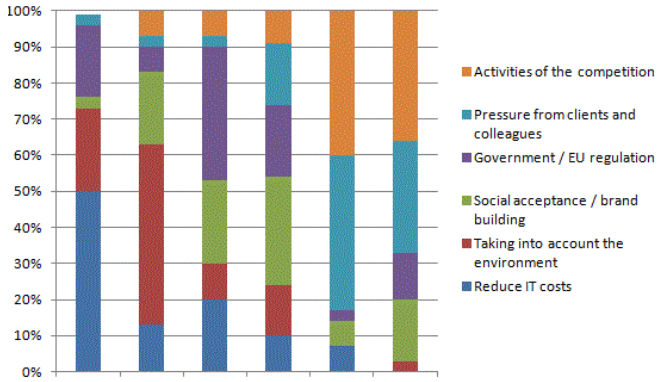

Fig. 7 Factors for accepting/implementing green practices

In *Fig. 8* the factors which prevent Macedonian companies from implementing Green IT practices are once again shown. One main factor is the cost of Green IT solutions together with the lack of clarity of the business model behind Green IT. Although it is true that the cost of green IT solutions is higher than other solutions however in the long run this is compensated by the gains from it, which includes reducing costs for consumed electricity. Unfortunately there is a lack of Green IT in the strategic planning of companies. Not enough analysis is done on the cost of specific solutions compared to the long term gains after its implementation.

Most of the respondents feel that a lack of pressure from the European regulations does not have a negative impact on the implementation of these practices.

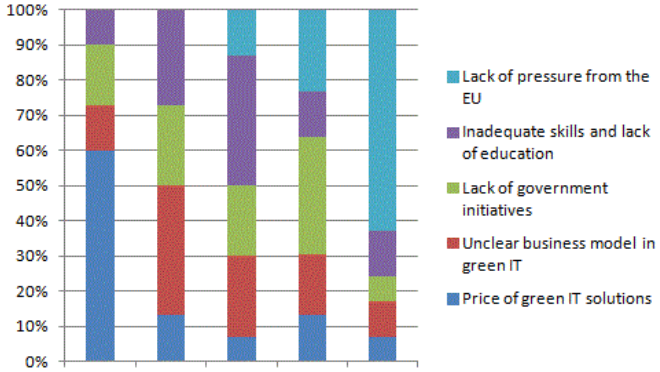

Fig. 8 Factors restricting the acceptance of green practices

V. CONCLUSION

ICT is a source of problems but luckily a source of many solutions. In general companies differ between each other by the ability to implement, transform and deliver Green IT practices. That is why Molla uses the concept of G-Readiness [15].

According to Molla G-Readiness is defined as an organization's capability in Greening IT (that is applying environmental criteria to its IT technical infrastructure as well as within its IT human and management practices across the key areas of IT creation, sourcing, operations, and disposal) in order to reduce IT, business process, and supply chain related emissions, waste and water use; improve energy efficiency; and generate green economic rent.

Molla defines five components of G-Readiness, that is, attitude, policy, practice, technology, and governance [7].

Having this in mind, Green IT is not just simple implementation of technology but rather combination of the five components mentioned above that need to work in mutual correlation.

In Macedonia implementation and acceptability of the practices, the awareness and motivation depend in a large extend on the type and size of organization. Medium to big size companies from the IT industry have shown serious steps towards implementation of certain Green IT practices. Nevertheless these steps are not part of a particular strategy for energy efficiency improvement and the results of the practices implemented are not measured.

The most commonly implemented practices are remote desktop solutions, client education not to leave computers on after working hours, printing optimization and virtualization.

All 30 Macedonian companies have in total 657 physical and 598 virtual servers that show the extent to which virtualization is accepted among Macedonian companies as a practice. This is the positive example when speaking about implementation of certain practices in Macedonian companies. Unfortunately, at the moment of research none of the companies were using software for tracking IT energy consumption. This represents evidence that the results of implementation of certain steps are not measured.

Another interesting fact is that only 17% of the respondents think that liquid cooling is very important and 10% think that is not important at all even thought this method of cooling is most efficient at the moment.

Awareness of the side effects of the implementation of information technology on the environment and how to have an effect on these side effects is at a very low level. There is a need of education for companies to increase awareness about the possibilities offered by implementing Green IT. Additionally, there is a need for implementing certain policies in companies in order to aid the process of implementing Green IT.

The Government and legal system also have an important role to play in the process of implementing certain practices and the enacting of the Law on Electronic Waste is a welcome first step; it obliges companies to take care of electronic waste.

What can be done in regards to electronic waste is to produce cleaner products, to produce products which last longer and to take back previously sold products for reuse or recycling.

Without a doubt there is a need to engage all sections of society in effort to maintain our environment as it is.

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