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Green IT, China – France: similar reactions?

Abstract

Based upon a study carried out both in France and in China, this communication aims to answer the following question: Is it useful to invest in Green IT for Universities? This research provides information on the perception of individuals with respect to the label "green" placed on an IT object and also highlights the need to take into account the affective dimension of attitude in the Technology Acceptance Model. Our results may help in investment decisions regarding "green" technology.

Keywords: Technology Acceptance Model, Green IT, intercultural study

Résumé : Fondé sur une étude menée simultanément en France et en Chine, cette communication cherche à répondre à la question suivante : est-il utile pour une université d'investir dans des technologies de l'information vertes ? Cette recherche nous apporte des informations sur la perception des individus de la labellisation « verte » d'un objet IT et met également en exergue l'intérêt de prendre en compte la dimension affective de l'attitude dans le modèle d'acceptation des technologies. Nos résultats pourront aider à la décision dans l'investissement pour une technologie « verte ».

Mots-clés : Modèle d'acceptation des technologies, Technologies de l'information vertes, management interculturel.

1 Introduction

On 20th October 2009, the Gartner group displayed a report identifying the top 10 technologies for 2010. Green Information Technology appears to be one of the ten. Green IT covers many fields that can be gathered into two categories. Firstly, it means how an organization can use traditional IT in order to reduce its use of energy and to lower its pollution. Secondly it induces the use of specifically design IT. In this article we will refer to this second approach.

Global crisis has a paradoxical impact on the rise of Green IT. On one hand, companies try to speed up their investments in Green IT in order to lower their cost (Brodkin, 2008). On the other hand, Green IT investments suffer like all other IT investments in this crisis (Burnham, 2008).

But Green IT includes a far reaching element, namely the attitude towards environment. As Anable (2005) has described, it implies taking into account moral norms, global environmental attitudes, efficacy, identity and habits.

We will try to answer to the following research question: *Is it useful to invest in Green IT for Universities?*

This question is of managerial, theoretical and methodological interest. In the first place a managerial interest in the way it directly concerns international university general managers facing the strategic choice of leading their universities on the green path. Is there a benefit in investing in Green IT in terms of ROI or in terms of image? Does the famous Solow paradox apply here? Secondly there is a theoretical interest in introducing the users' green concerns into the classical Technology Acceptance Model (Davis & al., 1989). Does IT have to be green to be accepted by the users, or don't they mind ... or does it depend in which country they live? Finally, there is the methodological interest which concerns the comparison of French and Chinese perceptions and potential behavior under this universal concept of green. China invests massively in IT (Gao, 2007) and is concerned in reducing its energy consumption. It is interesting to observe the potential behaviour of graduate students facing the green choice.

This paper is divided into four parts. Section 2 presents a review of the literature, setting the background for our research question. Section 3 describes the methodology and section 4 details the insights obtained from our enquiry. Finally, section 5 provides conclusive remarks.

2 Theoretical framework and research model

2.1 From the Technology Acceptance Model

The Technology Acceptance Model (TAM) developed by Davis & al. (1989) represents an important theoretical contribution towards understanding IS usage and IS acceptance behaviours (Robey, 1996). This model is based on a model defined by Fishbein and Ajzen (1975) named the Theory of Reasoned Action (TRA) model. According to TRA, a model from social psychology mainly focusing on behavioural intention, to predict a person's performance of a specific behaviour we need to know more about a person's attitude and

subjective norm concerning this behaviour. This attitude and subjective norm will determine the behavioural intention which is considered as a good predictor of behaviour.

TAM is based on the TRA model. TAM introduces two new constructs: Perceived Usefulness (PU) and Perceived Ease of Use (PEU). Regarding Davis & al. (1989, p. 985) PU can be defined as the user's "subjective probability that using a specific application system will increase his or her job performance within an organizational context" and PEU is linked to "the degree to which the user expects the target system to be free of effort" (p. 985).

Figure 1 presents the TAM. We can see that both PU and PEU are predictors of attitude. This attitude that can be defined as the desirability of using the system for the user, and the PU, influence the individual's behavioural intention to use the system.

Regarding Davis & al. (1989, p. 985) the aim of TAM is "to provide an explanation for the determinants of computer acceptance that is general, capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified". For the past two decades, substantial empirical evidence has supported the TAM. In a meta-analysis study on TAM with 88 published studies, King and He (2006) concluded that the TAM is a valid and robust model. Since then, Turner and al. (2010) have displayed strengths and weaknesses in this model.

Cultural aspects, for example, are relevant for study. Straub et al.(1997) discovered that TAM applied in the US and in Switzerland, but not in Japan, which suggested that the model may not predict technology use across all cultures. That is why it seems interesting to study this model in other countries.

2.2 Cultural aspects: the cultural difference in China vs France regarding Green IT

According to UNESCO, culture, in the broadest sense, is considered as "the totality of distinctive traits, spiritual and material, intellectual and emotional, which characterise a society or a social group. It encompasses, beyond the arts and literature, ways of life, fundamental human rights, value systems, traditions and beliefs". Declaration of Mexico on cultural politics. Global conference on cultural politics, Mexico City 26th July – 6th August 1982.

We will now look at the potential links between culture, cognition and behaviour.

Immersion and socialisation within a specific culture will orient our perception of events or our mode of thought (Bollinger & Hofstede, 1987). The article of Markus and Kitayama (1991) illustrates perfectly this assertion. In effect, comparing western and eastern cultures, they observe that those in the latter have a completely different concept of themselves. In this way, orientals place the emphasis on their relationship with others and their interdependence, whilst occidentals insist on their personal attributes, their autonomy and their independence.

An independent self flows from a belief according to which each person is unique (Sampson, 1977). The essential aspects of this perception are autonomy, being an independent person, egocentricity, being a entity alone, being distinct from the context.

The essential properties of an interdependent self are in perceiving that one's comportment is determined not only by oneself but at the same time by the manner in which others perceive

and react to the established social relationships. The individual cannot be separated out from the social context. Inner attributes are perceived as fluctuating and adaptable to their environment. Relations or links with others are an integral part of oneself.

Thus one sees appearing in the dimension of autonomy a clear distinction between the cultures here contrasted, eastern and western. A multitude of researches led by Triandis (Triandis, 1984; Triandis, Bontempo, Villareal, Asai & Lucas, 1988) label western cultures as individualist and eastern cultures as collectivist. Members of the former, notably in the United States, would be more oriented towards competition and would have little interest in the fate of their peer group. Members of the latter (i.e. the Chinese) feel more at one with and close to their peer group, according much more importance to their views.

Is this cultural difference going to flavour, further even to influence our relation to Green IT? Are the Chinese, being culturally more sensitive to context than the westerners, going to react differently to Green IT?

2.3 *Research Model*

In this article we will refer to the model of Yang and Yoo (2004) (see Figure 1). These authors distinguished the affective dimension from the attitude in the cognitive dimension. They showed that the predictive value of attitude was in the cognitive part and that the affective part had very little predictive value on intention of use.

In a culture where the relation to Green has not undergone the green propaganda that we know in the West, this model can provide answers to our problems. We know that in the West, the emotional valence associated with Green will be important. Will it affect the intention to use, in contrast to the results produced by Yang and Yoo? How will the valence of the cognitive attitude respond to a Green object? What will it be in China?

We're going to artificially play on the emotional dimension to see if it could be predictive of the behavior of use.

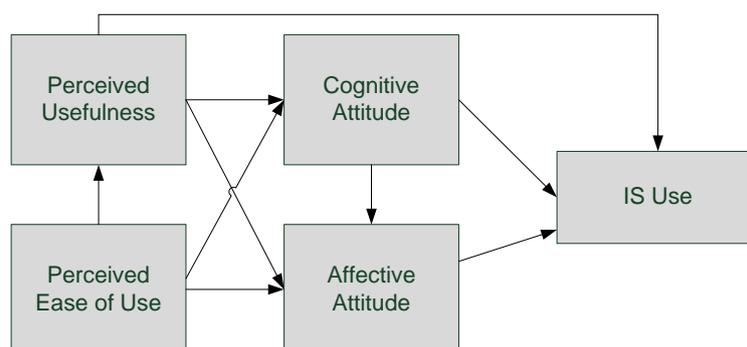


Figure 1: TAM - From Yang & Yoo (2004)

3 Methodology

3.1 Study context and sample characteristics

Data was collected from undergraduate students in China and in France. Students were asked to fill out computer usage surveys anonymously and submit them to the class instructors on a voluntary basis. The questionnaire was displayed online using Google forms. In appendix 1, you can find the context text given to French students.

The question we wanted to create for the subjects can be summarized as: "Am I willing to participate in an environmental effort by using a computer defined as "green" even though I may have more difficulty in getting to use one, given that there would be less of them than there would be conventional computers.

For the French sample, it was composed of 168 students from a French University. They were studying business studies in their first year. Students were asked to volunteer to fill in the questionnaire. This enquiry was done during September 2009 and it took 2 days to finish collecting the surveys

For the Chinese sample, it was composed of 62 students from a Chinese University. They were also studying business studies in their first year. Students were asked to volunteer to fill in the questionnaire. This enquiry was done during October 2009 and it took 3 days to finish collecting surveys

3.2 Measurements

We used Davis et al.'s original measurement items for perceived usefulness (four items), perceived ease of use (four items), and green computer use.

Through several empirical studies, these items' validity and reliability have been established. Out of the original 12 pairs of affective and 7 pairs of cognitive measurement of Crites et al., three items were chosen for each group. Three semantic pairs for affective measures included good/bad, happy/annoyed, and positive/negative. Three semantic pairs for cognitive measures included wise/foolish, beneficial/harmful, and valuable/worthless. Two affective pairs (good/bad, positive/negative) and two cognitive pairs (wise/foolish, beneficial/ harmful) were chosen because they were used by Davis et al. Two additional pairs, one for affective and one for cognitive attitude, were chosen from the list of Crites et al.

Regardless of the TAM model, we have, according to the object of our core issue, wished to measure intention to use other computers than ecological computers. We measured the intention to use shared computers, computers called "classical" and laptops.

The following results have been processed using Statistica software. Analyses of variance have been conducted when it was a matter of distinguishing the part played by variance amongst the samples due to the residual and random factors. Correlation analyses were conducted when it was necessary to quantify and test the connection between two quantitative variables.

4 Empirical Results

4.1 Intentions to use various computer media and comparison with countries

For intentions to use various computer media and for the comparison of the two countries concerned, the results are presented in the following table:

Table 1: Average comparison

Legend

IUGC: Intention of use green computer
IUIR: Intention of use IT room
IUCC: Intention of use classic computer
IUPC: Intention of use portable computer

Groupe1 vs. Groupe2	t test for independant sample Comparaison of different informatic support according to country			
	Average Groupe 1	Average Groupe 2	t value	p
IUGCchn vs. IUGCfr	2,97	3,85	-3,55	0,00
IUIRchn vs. IUIRfr	5,32	4,65	3,09	0,00
IUCCchn vs. IUCCfr	3,24	2,99	1,01	0,31
IUPCchn vs. IUPCfr	2,43	4,58	-8,08	0,00

For a degree of use which is minimum the mark is 1, the maximum mark is 7:

- We see an average not to say weak score for the use of environmentally friendly computers (hereafter noted GC) both in China (m = 2.97) and France (m = 3.85), the difference between the two countries here being significant. The French say they are more willing to use GC as the Chinese.
- We see a high score for the use of computer rooms (hereafter noted IR) both in China (m = 5.32) but also in France (m = 4.65), the difference between the two countries being significant here. The Chinese say they are more willing to use IR as French.
- We see a low score for the use of laptop computers (PC noted below) in China (m = 2.43) and a rather high one in France (m = 4.58), the difference between the two countries being significant here. The French say they are more willing to use PC's as the Chinese.
- We see an average score for the use of classical computers (CC noted below) both in China (m = 3.24) and France (m = 2.99), the difference between the two countries being here non-significant. We find a mean score for the use of environmentally friendly computers (hereafter noted GC) both in China (m = 2.97) and France (m = 3.85), the difference between the two countries being significant in this case. The French say they are more willing to use GC then the Chinese.

4.2 Use of Green Computers by countries

Based on the TAM (see figure 1) you will find below the following variables: Perceived Usefulness (PU), Perceived Ease of Use (PEU), the Affective dimension of attitude (AA) and the Cognitive dimension of Attitude (CA).

Before addressing the scores of these variables, we verified that the internal cohesion of the questionnaire was respected.

The following table presents the results of the reliability testing using Cronbach alpha coefficients, which ranged from .68 to .87.

Table 2: Internal cohesion

Cronbach Alpha	PU	PEU	AA	CA
France	.86	.87	.82	.76
China	.71	.74	.78	.68

The coefficients of Alphas were above .70 except for the Cognitive dimension of Attitude in the Chinese case. It will be necessary in future to refine the translation for this dimension. However as the score is close to .70 we maintain this dimension.

If we are particularly interested in the GC and its ability to be used, we obtain the following results:

Table 3: Differences by countries of TAM dimensions

		t test for independant sample Comparaison of Dimension of TAM's model for China and France				
		Average Groupe 1	Average Groupe 2	t value	dl	p
PUchn vs.	PUfr	4,01	4,46	-2,16	229	0,03
PEUchn vs.	PEUfr	2,78	3,12	-1,97	229	0,05
AAchn vs.	AAfr	2,41	2,84	-2,47	229	0,01
ACchn vs.	ACfr	2,46	2,02	3,00	229	0,00

- We see a fairly high score for PU in China ($m = 4.01$) and France ($m = 4.46$), the difference between the two countries being significant. The French perceive greater usefulness compared to the Chinese GC.

- We see an average score for PEU in China ($m = 2.78$) and France ($m = 3.12$), the difference between the two countries being significant here. The French consider GC as easier to use compared to Chinese.

- We see an average score for the AA in China ($m = 2.41$) and France ($m = 2.84$), the difference between the two countries being significant here. The French say they are more attracted by the GC for its emotional aspects compared to the Chinese.

- We see a score quite low not to say average for the AC in China ($m = 2.46$) and France ($m = 2.02$), the difference between the two countries being significant here. The Chinese say they are more attracted by the GC for its utilitarian aspects compared to French.

4.3 Priorization of the different computer media by country

Now, we want to compare for each country, the ranking of various computer media.

Table 4: Priorization in China

Variable	t value between different informatic support in China			
	IUGCchn	IUIRchn	IUCCchn	IUPCchn
IUGCchn	0,00			
IUIRchn	7,76	0,00		
IUCCchn	0,84	-7,24	0,00	
IUPCchn	-2,38	-10,15	-3,04	0,00

Taking into account only significant differences we can identify the following hierarchy:

The IR is the computer support that is presented as the most used among all media possible and it differs from all other media.

There is no difference between the GC and CC, they are both used less than IR but more than PC.

Finally the PC is mentioned as the least used of all.

Table 5: Priorization in France

Variable	t value between different informatic support in France			
	IUGCfr	IUIRfr	IUCCfr	IUPCfr
IUGCfr	0,00			
IUIRfr	5,27	0,00		
IUCCfr	-4,50	-9,85	0,00	
IUPCfr	3,77	-0,46	8,16	0,00

The two computer media that emerged as the most used by French students are the IR and the PC. The GC only comes in 3rd position. They are used significantly less than the two preceding media. Finally, the CC is amongst the different media offered to French students, and it is one that is significantly less used.

Taking into account only significant differences we can identify the following hierarchy:

There is no difference between the use of PC and IR, both are presented as the two computer media most used.

Then for GC, if the French subjects reported less desire to use the IR than PC, it seems that the French subjects prefer to use CC.

Finally, the CC presents the lowest scores of use of all the platforms offered. Further differences are significant compared to other media.

4.4. TAM Model and Green Computeur

We try now to assess the strength of behavioural intentions related to the use of GC in both countries.

The correlation matrices below present, following the TAM model, variables which may give us information: PU, PEU, AA and AC. We have also added to these matrices the IU of other computer media, namely IR, CC and PC.

We have also added into these matrices the IU of the other computer media named IR, CC and PC.

Table 6: Correlation matrix in China

Corrélations in China between different informatic support and dimensions of TAM N=62								
Variable	PUchn	PEUchn	AAchn	ACchn	IUGCchn	IUIRchn	IUCCchn	IUPCchn
PUchn	1,00							
PEUchn	0,45	1,00						
AAchn	0,60	0,48	1,00					
ACchn	0,61	0,45	0,81	1,00				
IUGCchn	0,15	0,36	0,45	0,35	1,00			
IUIRchn	-0,01	0,13	-0,09	-0,17	-0,03	1,00		
IUCCchn	-0,06	-0,13	-0,19	-0,14	-0,03	0,07	1,00	
IUPCchn	-0,05	-0,12	-0,01	-0,12	0,34	-0,23	0,07	1,00

Table 7: Correlation matrix in France

Corrélations in France between different informatic support and dimensions of TAM N=168								
Variable	PUfr	PEUfr	AAfr	ACfr	IUGCfr	IUIRfr	IUCCfr	IUPCfr
PUfr	1,00							
PEUfr	0,30	1,00						
AAfr	0,43	0,35	1,00					
ACfr	0,16	0,14	0,54	1,00				
IUGCfr	0,22	0,21	0,36	0,28	1,00			
IUIRfr	-0,06	0,17	-0,02	0,04	0,17	1,00		
IUCCfr	-0,10	-0,07	-0,15	-0,20	-0,14	-0,03	1,00	
IUPCfr	0,04	0,04	0,04	0,02	0,05	0,20	0,02	1,00

To check if the correlations obtained are similar to those of the TAM model, we compared them with the traditionally observed correlations (see Figure 3).

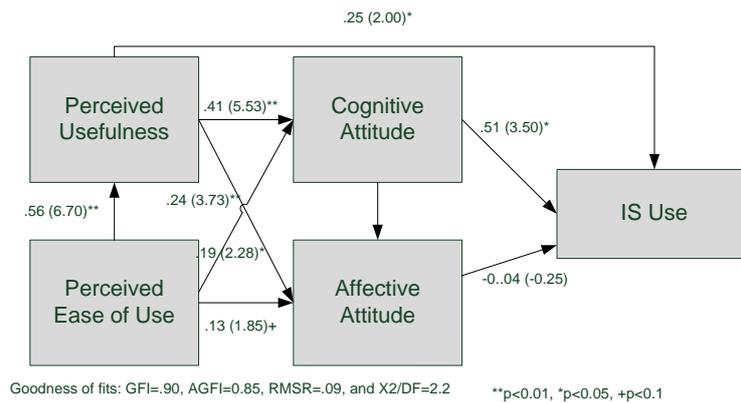


Figure 2 : Revised TAM with Separated Affective and Cognitive Attitude

Table 8: Comparison of the correlations between the affective dimension of attitudes and other variables in the TAM model. The correlations marked with a different index differ significantly

Correlation	Yang & Yoo 2003	First Study, France	Second Study, China
rAA-CA	0,45 ^a	0,54 ^a	0,81 ^b
rAA-IS	-0,04 ^a	0,36 ^b	0,45 ^b
rAA-PEU	0,13 ^a	0,35 ^b	0,48 ^b
rAA-PU	0,24 ^a	0,43 ^b	0,6 ^b

In this table we compare between the 3 studies, the links that the affective dimension of attitude has with other variables in the TAM (cognitive dimension, behavioural intention, ease of use and perceived usefulness).

What we are mainly seeing is that the strength of the bond is significantly higher in our study than in Yang and Yoo (2003). The most interesting difference is certainly that the AA-IS link goes from -.04 to .36. It seems that the green label has reinforced the importance of the affective part of the attitude in the TAM model and, as indicated by the latter correlation has increased its predictive value for use.

5 Discussion

In this study, we would like to establish if it would be suitable for universities to invest in computers designated as ecological. In other words, would students be ready to use such computers?

The point of equilibrium will be situated somewhere between the undeniable ecological factor (ecological computers would have a reduced impact on the environment compared with classical computers) and the number of workstations made available (ecological computers are more expensive to buy and thus, for a fixed budget, universities would not be able to buy as many compared with what we may refer to as called classical computers). It is a matter, therefore, of judging whether students would be ready to play their ecological part by having fewer computer workstations available on their campus.

We perceive very clearly an intention to use ecological desktop computers which is moderate not to say low amongst French students compared with their Chinese counterparts. The French prefer to use notebook computers whilst the Chinese regard their computer suites as privileged IT support. It is interesting to note the marked difference between the two cultures in the matter of notebook computer support. Whilst the French put the notebook in first place the Chinese put it in last place. We will not be going too far if we construct interpretations on the cultural plane (Triandis, 1982) in respect of the collectivist versus individualist aspects of the two societies. The reasons are evidently plural notably on the structural plane: French students have a power of purchase greater than that of Chinese students but it is interesting to bring out that an individualistic society like France will emphasise personal and private IT support whilst a collectivist society like China will emphasise IT support common to a group as occurs in a computer suite.

This observation permits us to put forward a first recommendation with respect to France at least. It would seem that the use of notebook computers puts a brake on the use of ecological computers. It would, thus, be pertinent to explore the possibility of transferring Green technology directly onto notebook computers rather than onto desktop computers.

The greater intention to use ecological computers in France than is the case in China is confirmed in table 3 where all the variables inherent in TAM are greater in France than in China. The French find ecological computers more effective and easier to use, and have a more favourable attitude towards them. Only the cognitive dimension in the attitudes concerning ecological computers is higher in China than in France.

On the other hand the analysis of the correlation matrices gives birth to several interesting observations. If, as we have just pointed out, the French have emotionally a greater inclination than the Chinese towards ecological computers (which is hardly surprising given the green wave which is rolling over the West) the correlation between the intention to use and the emotional dimension of attitude is stronger in China than in France. And, more globally, the emotional dimension correlates strongly with all the other dimensions of the TAM model in France but especially in China.

These diverse pieces of information permit us to put forward a second piece of advice: in the development (in a manner which remains to be defined) the emotional capacity of the Chinese with respect to Greenness, it is extremely likely that their intention to use will rise in proportion. Let us remember that an intention to use is in several models of behavioural prediction (Ajzen, 1991, 2002), the final level before exhibiting the behaviour itself.

This advice is confirmed by table 8 where we have compared the correlation coefficients obtained by Yang and Yoo (2004) with those obtained in our two studies. One observes that green labelling has led to a rise in all the scores of the correlation coefficients between the different variables of the TAM.

Compared to the results traditionally observed in the TAM and more particularly those of Yang and Yoo (2004), results which underline the weak significance of the emotional dimension of attitudes in the prediction of the use of the technology in question, we obtain some results which permit us to suppose that, depending on the object targeted, the emotional dimension has a high correlation value.

We have varied the emotional dimension across the labelling of our research object in choosing an object highly valued, and that in a universal fashion, namely ecology, in the incidence here of ecological computers.

In introducing into the TAM model this highly valued object, we have given rise to very strong correlations between the emotional dimension of attitude and the variables of the TAM model: PU, PEU, IS and CA.

The emotional dimension of attitude is strongly correlated with the IUGC whilst ecological computers offer nothing extra over classical computers and furthermore are more expensive to buy (cf., experimental objective). The labelling of computers as Green Computers creates for the user a positive valency in attitude. This latter correlates strongly with the IUGC, the PU and the PEU.

In summary, to label as green an IT object, creates a correlation between the emotional dimension with the collection of dimensions of the TAM model which permits prediction of consequent commercial interest.

Is this cultural ? We have reproduced the same experimental protocol in China in order to verify if in a culture non-westernised, we would be able to rediscover the same corpus of results.

We thought that sensitiveness to Green issues supposedly less marked in China, coupled with a greater need for computers due to a smaller existing IT field should give place to a smaller influence of green in the emotional dimension of attitudes.

The results obtained, however, are even more marked than in France. All the correlations associating the emotional dimension in attitudes and any other variable of TAM are not only greater than those obtained by Yang and Yoo (2004) but also than those obtained in France in the first study.

6 Conclusion

In the introduction we asked the following question “Is it useful to invest in Green IT for Universities?”. We can respond in the affirmative to this question. But usefulness varies according to the country that we are in. Thus we can say that in France, investing in Green IT can be a strategy of differentiation. The emotional aspect impacts on the intention to use, and can be used as an incentive for students coming into a particular university. The aim is to give a green and modern image to the university.

In China, emotional impact is very strong too, but the intention to use is lower. In that way, the usefulness of investing in Green IT is in terms of cost reduction in order to maximize the global efficiency. The aim is to accord a modern and rigorous image to the university.

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Appendix 1

Text given to students:

The instructions were as follows:

The University of XXXXX should invest in the renewal of its computers. Mindful of global warming and the importance of energy that represents a computer park of hundreds of computers, the IUT would buy equipment called an eco-label. The traditional use computers constantly 100% of available power that is 500 watts and that, whatever the use you make of it. The new green computers adjust the power generated based on your use. For example, if the active programs that will mobilize 20% of the total power, the system will not consume more than 100 watts, saving energy.

Certainly, it helps to limit the performance of computers (adaptation period between the passage of 20% to 100%). Moreover, this investment will be 25% more expensive than a standard investment but will reduce energy consumption and hence emissions of CO₂ in the atmosphere. It will therefore represent 25% of purchasing items and less. The following questionnaire aims to gather your thoughts vis-à-vis suggestion.