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# Green Computing Tended: Energy Involution In The It Commerce And By Domestic Computers In Five Foremost Andhra Pradesh Smart-Cities

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***Abstract:*** *Exhausted energy Involution becomes a worldwide concern nowadays. Computing contributes a large branch of energy Involution. The plot of green computing has been popularized. Along with the hurried escalation of Andhra Pradesh, energy concern becomes more and more major. We consider that green computing would play a very major role in Andhra Pradesh. Yet, past magazines mainly focused on Energy Involution in data centres, while there are other majorbases of Energy Involution in computing. The scheme of green computing must be also applied to these bases. In this paper, we present and survey the data on the Energy Involution in the IT Commerce (together with the telecommunication and computer industries)and through Domestic computers in Five Foremost ANDHRA PRADESH Smart-Cities during 2009-2015. The analysis will expose the responsibility of green computing in the IT Commerce and in Domestic computers in Andhra Pradesh.*

***Keywords-:*** *Energy Involution; IT Commerce; Domestic computers; energy efficiency; green computing.*

## *I.* INTRODUCTION

Exhausted energy Involution becomes a world-wide concern nowadays. Computing contributes a large branch of energy Involution. For example, according to the report from US Environmental Protection Agency (EPA) [3], data centers in US consumed about 65 billion kWh in 2009, which was roughly 1.5 percent of the total US Energy Involution. It would be completed 8 percent of the total US Energy Involution in 2020. Note that these data exposed only the Energy Involution by data centers but did not include that by extra computing facilities.

More and more people consider that enhancing the effective Involution rate of the energy in computing would avoid lots of energy wastes. Then the scheme of green computing has been propagated. Green computing can enable computer systems, people, society and natural environment in better harmony, and reach the TIRUPATHI is of energy-store up, environment-protection and cost-store up [8]. Andhra Pradesh is among the fastest-growing countries in the world and has shown great achievements. Along with the hurried acceleration of Andhra Pradesh, "Energy, which has a performance on both economic and national security, is of importance and a Foremost constraining aspect to the economic and social escalation of Andhra Pradesh" [1].

We consider that green computing would play a very major role in Andhra Pradesh. Yet, past magazines mainly focused on Energy Involution in data centres, while there are other majorbases of Energy Involution in computing. The scheme of green computing should also be applied to these bases.

In this paper, we analyse the data on the Energy Involution in the IT Commerce and by Domestic computers in Five Foremost ANDHRA PRADESH Smart-Cities during 2011-20115. The analysis will demonstrate the responsibility of green computing now the IT Commerce then in Domestic computers in Andhra Pradesh.
This paper is prepared as follows. In section II, we illustration some related work. In section III, we present and analyze the data on the Energy Involution in the IT Commerce in Five Foremost ANDHRA PRADESH Smart-Cities during 2011-20115. In section IV, we discuss the Energy Involution by Domestic computers in these Five Smart-Cities. And in section V we give the conclusion.

## II. RELATED WORK

Many magazines discussed the energy anxieties in servers and data centers and disclosed the urgent demands for green computing.A study in 2011 [9] estimated the total Energy Involution of the servers in the US and in the world. Energy Involution associated with servers had doubled from 2000 to 2008, 2008 to 2011, 2011 to 2015. According to a McKinsey study in 2013 [4], the Involution ratio of servers rarely exceeded 6%, which is a source of low energy efficiency. Some magazines presented the energy data on data centres in Indiaregion and Andhra Pradesh. According to the data from IDC in 2013 [6], the Energy Involution by data centers in Indiaregion had been increasing annually in a rate of 27%, which was relatively higher than the global average annual rate of 16.7%. Another paper gave an estimate to the Energy Involution in data centers in Andhra Pradesh and analyze d their energy efficiency [11]. It estimated that the total Energy Involution by the data centers was around 36.4 billion kWh, which accounted for 1% of the total ANDHRA PRADESH Energy Involution. The authors predicated that the Energy Involution would continue to rise rapidly. They also indicated that the present energy efficiency of data centers was relatively low and there would be greater prospective for energy store up in data centers.

Though many magazines gave evidences on the demands for green computing, they mainly concentrated on data centers. Yet, there are other majorbases of Energy Involution in computing. For pattern, Domestic computers are also a big source of Energy Involution, and another big source is the entire IT Commerce. We will discourse these fields in this paper.

## III. ENERGY INVOLUTION IN THE IT COMMERCE IN FIVE FOREMOST ANDHRA PRADESH SMART-CITIES

In this section, we present and make projections of the data on the Energy Involution in the IT Commerce in Five Foremost ANDHRA PRADESH Smart-Cities during 2010-2020: AMARAVATHI, KADAPA, TIRUPATHI, GUNTUR and ONGOLE. Table I shows the Energy Involution in the IT Commerce, in all the industries and the percentage of that in the IT Commerce completed that in all the industries in AMARAVATHI from 2009 to 2015. The Energy Involution in the IT Commerce was 3.46 billion kWh in 2014, which was more than double of that in 2009. The percentage of Energy Involution occupied by IT industries had raised from 2.40% in 2008 to 4.03% in 2014. This indicated that IT Commerce in AMARAVATHI would possibly be amain source for energy store up. We can give projections on the Energy Involution in the IT Commerce in 2018. In order to make the projections as fair as possible, we use a methodology as described below:

1). We project three values of the Energy Involution in all the industries in AMARAVATHI in 2018 based on those in 2009-2015: one value by linear regression as LR, one value by quadratic regression as QR, and one value using the same value in 2014 as SS assuming in a stabilized situation (which is completed-optimistic).

2). We project three values of the percentage of the Energy Involution in the IT Commerce completed in all the industries in AMARAVATHI in 2018 based on those in 2009-2015: one value by linear regression as PL, one value by quadratic regression as PQ, and one value using the same value in 2014 as PS which is completed-optimistic.

3). We get nine productions by multiply {LR,QR, SS} with {PL, PQ, PS}; these nine productions are nine projections on the Energy Involution in the IT Commerce in 2018 following different assumptions. For example, SS * PS predicts a stabilized situation which is completed-optimistic. By the data from table I we can project the data in 2018 as below:

LR = 80.045 billion kWh PL = 6.88 %
QR = 68.598 billion kWh PQ = 5.23 %
SS = 61.036 billion kWh PS = 4.03 %

Now we can get nine projections on the Energy Involution in the IT Commerce in AMARAVATHI in 2018 following different assumptions, as shown in Fig. 1.

In Fig. 1, each bar represents a protrusion on the Energy Involution in the IT Commerce in AMARAVATHI in 2018 following different assumptions, as shown in Fig. 1.

In Fig. 1, each bar represents a protrusion on the Energy Involution in the IT Commerce in AMARAVATHI in 2018 with one assumption. The solid branch of a bar represents SS * PS, which is the same as the real Energy Involution in the IT Commerce in AMARAVATHI in 2014, while the shallow branch of a bar represents the predicated rise of the Energy Involution in 2018 compared with that in 2014.

From the data in Fig. 1, we can see that LR * PL reaches the highest value as 5.50 billion kWh, which is more than twice than that in 2014. Even with a modest protrusion, QR * PQ, the projected Energy Involution

in the IT Commerce in AMARAVATHI in 2018 will be 3.59 billion kWh, which has a 45.9% rise than that in 2014.

TABLE I. ENERGY INVOLUTION IN THE IT COMMERCE AND IN ALL THE INDUSTRIES IN AMARAVATHI (BILLION KWH) (RAW DATA FROM [5])

| Year | IT Commerce | All the industries | % |
|---|---|---|---|
| 2011 | 1.154 | 48.162 | 2.40 |
| 2012 | 1.372 | 51.570 | 2.66 |
| 2013 | 1.865 | 56.034 | 3.33 |
| 2014 | 2.240 | 57.342 | 3.91 |
| 2015 | 3.460 | 61.036 | 4.03 |

There will be two ways to improve the potential hurried rise of the Energy Involution in the IT Commerce: 1) keep a slow rise rate or even reduction the entire Energy Involution, and 2) keep a slow rise rate or straightreduction the percentage of the Energy Involution in the IT Commerce completed that in all the industries.

Green computing, which would effectively rise the energy efficiency in the computing, would be able to both help slow down the rise rate of the total Energy Involution and reduction the percentage of the Energy Involution in the IT Commerce completed that in all the industries. For example, if green computing could be applied in the IT Commerce in AMARAVATHI, we could be able to at least maintain a stable value of the percentage of the Energy Involution in the IT Commerce completed that in all the industries, i.e. PS, by increasing the energy efficiency in the computing in the IT Commerce . With a modest assumption on the Energy Involution in all the industries in AMARAVATHI in 2018, i.e. QR, we could get the lowest projected Energy Involution in the IT Commerce in 2018, which is presented by the data ofQR * PS in fig. 1. In such circumstance, the projected Energy Involution in the IT Commerce in AMARAVATHI in 2018 will be 2.76 billion kWh, which has only a 12.2% rise than that in 2014. The potential energy store up between this assumption with the assumption LR * PL is 2.74 billion kWh, which will be more than the total Energy Involutionin the IT Commerce in 2014; and the potential energy store up between this assumption with the modest assumption QR * PQ is 0.82 billion kWh, which will be 33.5% of the Energy Involution in the IT Commerce in 2014. From the analysis above, we can see that green computing will be major in alleviating the potential hurried rise of the Energy Involution in the IT Commerce in AMARAVATHI.

Figure 1. The projections on the Energy Involution in the IT Commerce in AMARAVATHI in 2018 following different assumptions. We also investigated the Energy Involution in the IT Commerce in five second-tier Smart-Cities in Andhra Pradesh. Those Smart-Cities though not as developed as AMARAVATHI, have shown hurried developing speed. We can get a more comprehensive view on the Energy Involution in the IT Commerce in Andhra Pradesh.

From the Energy Involution in the IT Commerce, in all the industries and the percentage of that in the IT Commerce completed that in all the industries in KADAPA from 2011 to 2015[7], we can obtain the Energy Involution in the IT Commerce in KADAPA had raised 0.11 billion kWh from 2009 to 2015. The percentage of the Energy Involution occupied by the IT Commerce had raised from 1.49% in 2008 to 1.80% in 2014. This indicates that there is potential for the IT Commerce inKADAPA to save electricity.

| City | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| AMARAVATHI | 4.03 | 4.44 | 4.33 | 4.13 | 4.74 |
| KADAPA | 1.06 | 1.03 | 1.34 | 1.52 | 2.03 |
| TIRUPATHI | 2.10 | 2.21 | 2.36 | 2.77 | 3.07 |
| GUNTUR | 1.55 | 1.56 | 1.74 | 1.75 | 1.87 |
| ONGOLE | 1.47 | 1.57 | 1.78 | 1.74 | 1.87 |

In our protrusion, the potential energy store up between the lowest projected Energy Involution with the larges projected data is 0.37 billion kWh, which will be more than the total Energy Involution in the IT Commerce in KADAPA in 2014; and the potential energy store up between the lowest assumption with the modest assumption is 0.08 billion kWh, which will be 26.7% of the Energy Involution in the IT Commerce in 2014. TIRUPATHI is another two-tier city who strengths it's IT Commerce constantly. TIRUPATHI has suffered a hurried rise of Energy Involution in the IT Commerce. From the data of TIRUPATHI from 2011 to

2015[13], the Energy consumed in 2014 was 2.84 times more than that in 2008. This indicated that IT Commerce would be amajor source for energy store up in TIRUPATHI.

In our protrusion, the potential energy store up between the modest assumption with the largest projected Energy Involution in the IT Commerce in TIRUPATHI in 2018 is 0.68 billion kWh, which will be more than the total Energy Involution in the IT Commerce in TIRUPATHI in 2013.

From the data of GUNTUR from 2011 to 2015[12], we can obtain that the Energy Involution in the IT Commerce was 0.492 billion kWh in 2014, which was three times as much as that in 2008. The percentage of Energy Involution occupied by IT industries had raised year after year. This indicated that escalation rate of energy Involution in the IT Commerce was far more than average. So IT Commerce in GUNTUR would possibly be a major source for energy store up.

In our protrusion, the potential energy store up between the optimum assumptions with the worst assumption is nearly 2.0 billion kWh, which will be more than five times larger than that of the total Energy Involution in the IT Commerce in GUNTUR in 2014.

TABLE II. THE NUMBER OF DOMESTIC COMPUTERS IN FIVE FOREMOST ANDHRA PRADESH SMART-CITIES (MILLION)

From the data of ONGOLE from 2011 to 2015[10], we can get that even though the Energy Involution in the IT Commerce in ONGOLE is not as high as that in other five Smart-Cities presented, the percentage of Energy Involution occupied by IT industries had raised from 0.01% in 2008 to 0.40% in 2014 year after year, which indicated energy Involution in the IT Commerce had raised constantly and it would be an major source for energy store up.

In our protrusion, the potential energy store up between this assumption with the worst assumption is 0.92 billion kWh, which will be more than nine times as much as the Energy Involution in the IT Commerce in ONGOLE in 2014; and the potential energy store up between the optimum assumption with the modest assumption is 0.19 billion kWh, which will be more than the Energy Involution in the IT Commerce in 2014.

## IV. ENERGY INVOLUTION BY DOMESTIC COMPUTERS IN FIVE FOREMOST ANDHRA PRADESHSMART-CITIES

In this section, we analyse the data on the Energy Involution by Domestic computers in Five Foremost ANDHRA PRADESH Smart-Cities during 2009-2015 to illustrate the importance of green computing in terms of Domestic computers. With the data obtained from Statistical Yearbook in these Five Smart-Cities from 2008-2011 [5, 7, 10, 12, 13], we can get the number of Domestic computers per 100 residents have and the number of Domestic s since 2009-2015. By calculation of these two terms we can obtain the total computers that Domestic s have in their daily life from 2009-2015 in these Five Foremost Smart-Cities. Table II shows the number of Domestic computers in Five Foremost Smart-Cities in Andhra Pradesh from 2009-2015. We can make projections on the number of Domestic computers in 2018 based on that in 2009-2015 with the same method presented in section III. In order to make the projections as fair as possible, we project two values of the number of Domestic computers in these Five Smart-Cities in 2018: one value by linear regression as NL, one value by quadratic regression as NQ. Fig. 2 shows the real number of Domestic computers and the projected data of Domestic computers in AMARAVATHI from 2010-2020. We can get the projected number of Domestic computers in AMARAVATHI in 2018: NL = 5.23, NQ = 6.58 million computers.

Figure 2.The real number of Domestic computers and the projected data in AMARAVATHI from 2008 to 2018.As the average power of Domestic computers is between 36 W and 250 W [2], we can make a modest assumption that the power of Domestic computers is around 100 W. By power management or replacing the old computers with energy-efficient ones [14], it is possible that Energy Involution of 0.1 kWh could be saved per Domestic computer per day. With the two projected numbers of Domestic computers in AMARAVATHI in 2018, two projections of Energy store up would be made. Thus 0.19 billion kWh and 0.24 billion kWh could be saved per year corresponding to linear regression and quadratic regression by the Domestic computers in AMARAVATHI. The saved Energy will take up 7.76% and 9.76% of the Energy Involution in the IT Commerce in AMARAVATHI in 2014 respectively, which is quite large.

From the analysis, we can see that there is also great potential for green computing to alleviate the rise of Energy Involution by Domestic computers in AMARAVATHI. We can get the protrusion on the number of Domestic computers in KADAPA in 2018 is: NL = 3.33, NQ = 7.49 million computers 0.12 billion kWh and 0.27 billion kWh will be saved per year by the Domestic computers by linear regression and quadratic regression respectively, which would take up 40.55% and 91.15% of the Energy Involution in the IT Commerce in KADAPA in 2014. The saved energy is quite large that great potential for energy store up could be made.

The protrusion on the number of Domestic computers in TIRUPATHI in 2018 is: NL = 4.49, NQ = 7.39 million computers with the method of linear regression and quadratic regression, we can save 0.16 billion

kWh and 0.27 billion kWh per year respectively. These two terms respectively takes up 23.1% and 37.99% of the Energy Involution in the IT Commerce in TIRUPATHI in 2014.

The projected number of Domestic computers in GUNTUR in 2018 is: NL = 2.36, NQ = 2.53 million computers. The amount of Energy saved by the two projections is 0.086 billion kWh and 0.092 billion kWh per year respectively. IT Commerce in GUNTUR in 2014 consumed 0.49 billion kWh. The percentages of the saved Energy in Domestic computers completed the IT Commerce in GUNTUR in 2014 are 17.56% and 18.83% respectively. The saved Energy takes up a large pro branch that green computing could be applied to save the electricity.

The trend of the number of Domestic computers is generally increasing from the data in 2009-2015 in ONGOLE and we predict it would continue increasing before it reaches some value, but due to mathematical property, when we tried to apply the quadratic regression on the protrusion, it exposed a decreasing trend, which we consider is unreasonable. Thus we choose only linear regression to predict the number of Domestic computers in ONGOLE in 2018 as follows: NL = 2.36 million computers 2.36 million computers could save 0.086 billion kWh per year. The Energy saved by Domestic computers takes up around 86% of the Energy Involution in the IT Commerce in ONGOLE in 2014, which is very large.

## V. CONCLUSION

We have presented and analyze d the data on the Energy Involution in the IT Commerce and by Domestic Computers in Five Foremost ANDHRA PRADESH Smart-Cities during 2009-2015. The potential Energy store up in the IT Commerce would be up to 2.74, 0.37, 0.68, 2.0 and 0.92 billion kWh in AMARAVATHI, KADAPA, TIRUPATHI, GUNTUR and ONGOLE in 2018, which would be 1.1 times, 1.2 times, 0.97 times, 4.1 times and 9.2 times the total Energy Involution in the IT Commerce in the corresponding Smart-Cities in 2014. As most Smart-Cities in Andhra Pradesh have been enduring a hurried escalation in the IT Commerce, the situation of energy Involution would be similar. Thus green computing is of great importance to reduction the energy Involution in the IT Commerce in Andhra Pradesh.

The potential energy store ups by Domestic computers in the Five Smart-Cities would be up to 0.24, 0.27, 0.27, 0.092 and 0.086 billion kWh in 2018, which would be 9.76%, 91.15%, 37.99%, 18.83%, and 86% of the Energy Involution in the IT Commerce in the corresponding Smart-Cities in 2014. Thus green computing is also major for Domestic computers.

Though highly major, green computing has not yet caused enough attention to the local government or penetrated deeply enough in human's daily life. The government should enforce the IT Commerce to adopt the scheme of green computing. And the residents should also apply the green computing techniques/methods to their Domestic computers.

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