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A Futuristic View of Change in Energy Consumption and Related Energy Intensity in Bangladesh Using Complete Decomposition Model (CDM)

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Abstract: The decomposition technique has enabled us to identify the factors that influence the total energy use and structural change of economy. In the present study, a complete decomposition model is employed for analyzing the correlation between energy consumption and economic development of Bangladesh for the period of 2007-2030. The activity effects, intensity and structural effects of energy use on aggregative economy were discussed through intensifying the use of energy in individual economic sectors. The trends in energy use in low and high energy intensive groups of the country's economy are also evaluated to provide a basis of assessments of sustainability.

Key words: Complete decomposition model, energy consumption, energy intensity, activity effect, structural effect, intensity effect, Bangladesh

INTRODUCTION

The decomposition approach is a useful method of analyzing the development of the energy basis of an economy. This method enables us to separate out the different components of development as dependent on the overall activity, the change of structure of the energy use and also the effect of intensifying the use of energy in individual sectors.

Usually different countries are possessed with different stages of development having different resources in respect of material, manpower and available technology, there can not be any solution which is optimum for all the countries irrespective of their characteristics. Thus, the decomposition approach is applicable to explain the effect of energy planning on the development of any nation in an appropriate way.

The economy of any nation can be disaggregated into two groups: one consisting of low-energy intensive sectors and other consist of high-energy intensive sectors. When decomposition model is applied at the level one it is called single level decomposition or decomposition at group level. If decomposition is carried out at more than one level it is called multilevel decomposition. Each group could be further disaggregating into several sectors and then decomposed at sector level which is attributed to the decomposition level two (Fig. 1). For the present analysis multi level decomposition model is used to estimate the change in energy consumption and change in energy intensity in Bangladesh. Basically, the decomposition models lead to an approximate decomposition. This type of decomposition methods have been proposed by Reitler *et al*., (1987), Boyd *et al.* (1988), Dobbin and Claire (1988), Howarth (1991), Howarth and Schipper (1991), Park (1992) and Park *et al.* (1993). These approximate decomposition methods have some inherent limitations. Sun (1996) developed a Complete Decomposition Model (CDM) that can provide us with more reliable and accurate data of the development of the energy basis of an

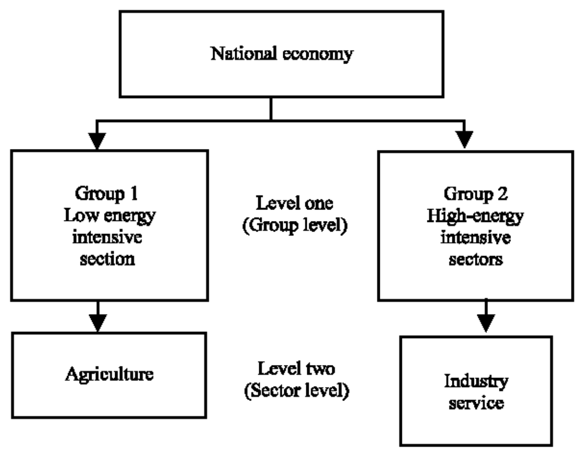

Fig. 1: Disaggregating of economy at various levels

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economy. By decomposition analysis it is possible to distinguish the different factors that influence the total energy use as also its structure as well as influences of different effects such as activity effects, intensity and structural effects of energy use on aggregative economy. The activity effect describes the impact of economic growth on the economy as a whole on energy consumption whereas the structural effect indicates the impact caused by a structural change in an economy that is a shift in the relative amount of economic activity across sectors. The intensity effect relates to the efficiency of energy use in the production of economic output that is this effect captures the quantity of energy used to produce a given level of economic output.

In this study, an effort has made for the first time to use the decomposition technique at the national level to analyze the development of energy base of the economy in practice with reference to Bangladesh. In this study, the change are decomposed in energy consumption and energy intensity in Bangladesh during 2007-2030. The change in energy consumption is decomposed into the scale of economic activity (the activity effect), the economic structure (the structural effect) and the sectoral technological level (the intensity effect). While the change of energy intensity is decomposed into sectoral energy intensity effect and sectoral structural effect.

The complete decomposition model is used in the study to describe the change of energy use in Bangladesh; the change of energy intensity in Bangladesh and the contribution of activity, structural and intensity effect quantitatively for providing a basis of the assessments of sustainability.

MATERIALS AND METHODS

The available up-to-date data have used from different national and international sources like Bangladesh Bureau of Statistics (BBS), Bangladesh Power Development Board (BPDB), Petrobangla, Asian Development Bank (ADB) and the World Bank (WB) etc. The annual data of Gross Domestic Product (GDP) is converted into US$ at the rate of 2000. The GDP and commercial energy consumption of 2007 are considered as base values. In 2008, the GDP growth rate was 5.2% and it is considered at 10% in 2030.

The contribution of agriculture, industrial and service sector GDP are 22, 28 and 50%, respectively in 2007 (Bangladesh Bureau of Statistics, 1992). This figure will increase to 13, 45 and 42%, respectively in 2030. In 2008, the energy growth rate was 8% and it will rise to 9.5% in 2030 (Bangladesh Bureau of Statistics, 1992). The contribution of commercial energy consumption in agriculture, industrial and service sector are 11, 46 and 43%, respectively in 2007 (Bangladesh Bureau of Statistics, 1992). This figure rose to 5, 62 and 33%, respectively in 2030. The energy co-efficient was 1.53 in 2007 and this figure is estimated to be 0.95 in 2030.

The general decomposition model leads to an approximate decomposition because it has a residual term. In some studies the residual was omitted that caused a large estimation error. The residual was regarded as an interaction term that still leaves a new puzzle for analysis. The Complete Decomposition Model (CDM) is expected to overcome this problem. In the decomposition approach, changes in energy intensity between the base year and year t is influenced by intensity and structure effects which is given:

$$\begin{aligned} \Delta I_o t &= I_t - I_o \\ &= \sum(\Delta S_{it}\ I_{io}) + \sum(S_{io}\Delta I_{it}) + \sum(\Delta S_{it}\ \Delta I_{it}) \\ &= S_{effect} + I_{effect} \end{aligned} \quad (1)$$

This is an exact decomposition where Structural effect (S_{effect}) = $\sum (\Delta S_{it} I_{io}) + (1/2)\sum (\Delta S_{it} \Delta I_{it})$ and Intensity effect (I_{effect}) = $\sum(S_{io}\Delta I_{it}) + (1/2)\sum(\Delta S_{it} \Delta I_{it})$. Here:

$I_{io} + \Delta I_{it}, I_{io}$	=	Energy intensity of sector i in year t and 0, respectively
$S_{io} + \Delta S_{it}, S_{io}$	=	Output share of sector i in year t and 0
Δs_{it}	=	$S_{it} - S_{io}$
ΔI_{it}	=	$I_{it} - I_{io}$

The first term of Eq. 1 indicates the contribution of change in energy intensity in sector i. The second term represent the contribution of changes in sectoral share of sector i, while third term indicates the interaction between both factor changes in sector i.

In the decomposition approach, changes in energy consumption between the base year and year t is influenced by activity (GDP), intensity and structure effects as given:

$$\begin{aligned} \Delta E_{ot} &= Et - E_o \\ &= \sum(\Delta A_t S_{io} I_{io}) + \sum(A_o S_{it} I_{io}) + \\ &\quad \sum(A_o S_{io} \Delta I_{it}) + \sum(\Delta A_t\ \Delta S_{it}\ I_{io}) + \\ &\quad \sum(A_o \Delta S_{it} \Delta I_{it}) + \sum(\Delta A_t\ S_{io} \Delta I_{it}) + \\ &\quad \sum(\Delta A_t\ \Delta S_{it}\ \Delta I_{it}) \\ &= GDP_{effect} + S_{effect} + I_{effect} \end{aligned}$$

This is an exact decomposition where:

The activity effect $(GDP_{effect}) = \sum(\Delta A_t\ S_{io}\ I_{io}) + (1/2)\sum \Delta A_t\ (S_{io}\Delta\ I_{it} + \Delta\ S_{it} I_{io}) + (1/3)\sum(\Delta A_t\ \Delta\ S_{it}\Delta I_{it})$ (2)

The structural effect $(S_{effect}) = \sum(A_o \Delta S_{it} I_{io}) + (1/2)\sum \Delta S_{it}(A_o \Delta I_{it} + \Delta A_t\ I_{io}) + (1/3)\sum(\Delta A_t\ \Delta S_{it}\Delta I_{it})$ (3)

The intesity effect $(I_{effect})\ \sum = (A_o S_{io} \Delta I_{it}) + (1/2)\ \sum \Delta I_{it}\ (A_o \Delta\ S_{it} + \Delta A_t S_{io}) + (1/3)\sum(\Delta A_t S_{it}\ I_{it})$ (4)

Where:

E_t, E	=	Total energy used in year t and 0 (base year)
$I_{io}+\Delta I_{it}$, I_{io}	=	Energy intensity of sector i in year t and 0, respectively
$S_{io}+\Delta S_{it}$, S_{io}	=	Stands for output share of sector i in year t and 0
$A_o+\Delta A_t$, A_o	=	Stands for the level of aggregated activity in year t and 0, change of activity has defined
ΔA_t;	=	Change of structure, ΔS_{it} and change of intensity
ΔI_{it}	=	Parameters in the following way:

$$\Delta A_t = A_t - A_0$$
$$\Delta S_{it} = S_{it} - S_{io}$$
$$\Delta I_{it} = I_{it} - I_{io}$$

The 1st terms of the Eq. 2-4 represent the contributions of the change of GDP, sectoral share and intensity, respectively to the total change in energy consumption. The 2nd term represents the contribution of the change of one factor with sum of the partial changes of other two factors with respect to sector i. The 3rd term is the residual in the general decomposition model. It could be attributed either to GDP, sectoral share and intensity by equal impact. This contribution is dependent on all of the three changes and if only one of them goes to 0, the other effects disappears.

RESULTS AND DISCUSSION

The commercial energy consumption, GDP and aggregate energy intensity in Bangladesh for various benchmark years are shown in Table 1. The projected commercial energy consumption in Bangladesh during the period 2007-2030 increased by 7.5 fold which is greater than the GDP growth (6.8 fold) during the same period. The aggregate energy intensity of the national economy in the same period increased by 0.047 KGOE/US$-2000.

In the calculation the energy consumption in group-1 (low energy intensive sector which comprise agriculture) appeared to increase by 3.30 fold in the period 2007-2030 while in group-2 (high energy intensive sector which comprise industry, service and transport) the corresponding increase is 8 fold. The GDP of group-1, 4 fold increased in the period 2007-2030 while in group-2, the corresponding factor is 7.5 fold.

There are some interesting results about energy intensity for both groups. The energy intensity of low energy intensive group decreased by 23% during the period 2007-2030 while the energy intensity in high-energy intensive group increased by 7.5% during the same period as shown in Table 1.

Group-1 contributes -26% in total change in energy intensity while group-2 contribute 126% during the same period shown in Table 2. Again, group 1 contributes 4.3% in total change in energy consumption while group-2 contribute 95.7% during the same period shown in Table 3. Ali and Bukhari (2007) for Pakistan, made similar type of investigation. He showed that group 1 contributes only 8.5% in total change of energy consumption while

Table 1: Energy consumption, GDP and energy intensity in Bangladesh (Bangladesh Bureau of Statistics, 1992)

Bangladesh	2007	2007-2015	2015	2015-2020	2020	2020-2025	2025	2025-2030	2030
EC (MTOE)	28.72	24.94	53.66	31.69	85.35	51.11	136.46	78.36	214.82
GDP (mill. US$)	60412	39897.84	100309.84	58302.89	158612.7	96834.66	255447.4	155953.19	411400.5
I (KGOE/US$)	0.4754022	0.059	0.53	0.003	0.538	-0.0039	0.534	-0.012	0.522
Low energy intensive sector (Ag.)									
EC (MTOE)	3.25	1.847	5.097	1.73	6.828	0.677	7.505	3.236	10.74
GDP (mill. US$)	12478	7583.96	20061.96	8488.323	28550.29	7212.343	35762.63	17719.44	53482
I (KGOE/US$)	0.26	-0.00636	0.254	-0.0149	0.239	-0.0293	0.2098	-0.009	0.2
High-energy intensive sector (Ind.+Serv.)									
EC (MTOE)	25.45	23.112	48.56	29.96	78.52	49.068	127.59	76.49	204.08
GDP (mill. US$)	47934	32313.87	80247.87	49814.56	130062.4	89622.32	219684.8	138233.75	357918.5
I (KGOE/US$)	0.532	0.0742	0.605	-0.00142	0.604	-0.0229	0.581	-0.0106	0.57

Table 2: Contribution of groups to the total change in energy intensity

Time period	Low energy intensive group (Agri.) (Structural + Intensity)	High energy intensive group (Ind. + Serv.) (Structural + Intensity)	Total change (%)
2008-2015	-0.0068 (-1%)	0.344 (101%)	0.34 (100)
2015-2020	-0.045 (-13%)	0.362 (113%)	0.32 (100)
2020-2025	-0.118 (-44%)	0.404 (144%)	0.28 (100)
2025-2030	-0.137 (-53%)	0.398 (153%)	0.26 (100)
2008-2030	-0.308 (-26%)	1.507 (126%)	1.2 (100)

Unit: KGOE/US$-2000

Table 3: Contribution of groups to the total change in energy consumption (ΔE_{ot})

Time period	Low energy intensive group (Agri.)	High energy intensive group (Ind.+Serv.)	Total change (%)
2008-2015	7.47 (7%)	92.84 (93%)	100.31 (100)
2015-2020	13.08 (6%)	199.36 (94%)	212.44 (100)
2020-2025	15.59 (3.7%)	407.07 (96.3%)	422.66 (100)
2025-2030	28.85 (3.8%)	730.87 (96.2%)	759.72 (100)
2008-2030	64.99 (4.3%)	1430.14 (95.7%)	1495.13 (100)

Unit: MTOE

Table 4: Calculations for factor analysis for the change in energy intensity (ΔI_{ot})

Time period	Structural effect (%)	Intensity effect (%)	Total change (%)
2008-2015	0.05 (15)	0.29 (85)	0.34 (100)
2015-2020	0.15 (47)	0.17 (53)	0.32 (100)
2020-2025	0.3 (107)	-0.02 (-7)	0.28 (100)
2025-2030	0.35 (135)	-0.09 (-35)	0.26 (100)
2008-2030	0.85 (71)	0.35 (29)	1.2 (100)

Unit: KGOE/US$-2000

group-2 contributes 91.5% during the period 1960-1998. Table 4 repots the factor analysis of the change of energy intensity. For the total intensity change, structural effect is found to be positive in all sub period and intensity effect is also positive in the period 2008-2020, come negative in the period 2020-2030. The structural effect and intensity effect are both positive during the whole period (2008-2030). The energy intensity increased by 0.85 KGOE/US$ (71%) due to structural effect and there was 0.35 KGOE/US$ (29%) increase due to intensity effect during the period under consideration. As a result, the increase in aggregated intensity was 1.2 KGOE/US$ (100%) in the same period. The result indicates that the increase in aggregate energy intensity is due to the structural effect (71%) because during this period the structural changes appeared to be significant. Consequently, it appears that the aggregate energy efficiency reduced due to structural changes in the country.

Contribution of groups to the total change in energy intensity is shown in Table 2. Results indicate that high-energy intensive group contributes 126% in the aggregate energy intensity changes, during the whole time period considered. In all sub-period high energy intensive group shows large change (126%) and low energy intensive group shows negative changes (-26%) in total energy intensity changes. This is explained

Table 5: Sector wise Effect increase or decrease by fold for ΔI_{0t}

Agriculture	2010	2015	2020	2025	2030
Structural effect	0.26	-0.50	-1.19	-4.60	-5.1
Intensity effect	-0.34	-0.37	-0.12	-2.50	-2.9
Aggregate (ΔI_{0t})	-3.70	-34.00	-124.00	-283.60	-321.0
Industrial					
Structural effect	3.50	8.17	17.31	31.37	35.0
Intensity effect	0.89	2.47	204.00	-1.23	-2.0
Aggregate (ΔI_{0t})	4.00	9.40	15.20	18.00	19.0
Service					
Structural effect	-2.16	-3.40	-5.50	-9.00	-9.7
Intensity effect	2.00	2.20	1.00	1.00	0.5
Aggregate (ΔI_{0t})	2.00	1.50	-1.14	-2.80	-4.0

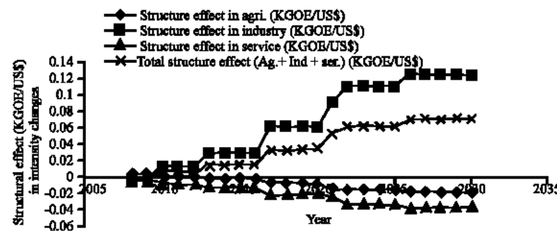

Fig. 2: Sector wise structural effect in change in energy intensity

as due to an improved efficiency of energy use in relatively high-energy intensive group. In agriculture sector the structural effect decrease by 5.1 fold in 2030 compared to 2008 and the intensity effect also decrease by 2.9 fold during the same period shown in Table 5. The aggregate effects in agriculture appeared to decrease by 321 fold in 2030 compared to 2008 shown in Table 5. In industrial sector the structural effect increase by 35 fold in 2030, compared to 2008 and the intensity effect also decrease by 2 fold during the same period shown in Fig. 2. The aggregate effects in industry increase by 19 fold in 2030 compared to 2008.

In service sector the structural effect decrease by 9.7 fold in 2030 compared to 2008 and the intensity effect also increase by 0.5 fold during the same period shown in Table 5 The aggregate effects in service sector decrease by 4 fold in 2030 compared to 2008. It can be concluded that the structural effect of agriculture and service sector have negative trend but in industrial sector it shows positive trend. The overall structural effect is positive. A positive structural effect implies a structural shift to more energy intensive economic sectors like some manufacturing industries. It also means that the share of energy intensive sectors to GDP has increased compared to base year. This is the indication of the phase transition from agriculture to industry. The positive trend of the structural effect reflects the positive growth of GDP however more energy will be required to produce the projected GDP. More energy intensive structural change means creation of large-scale new industrial activity with

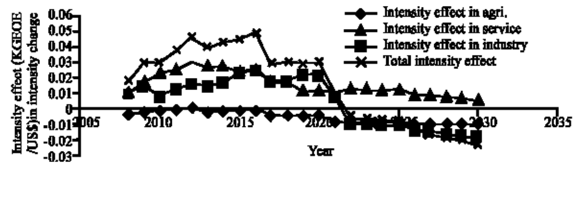

Fig. 3: Sector wise intensity effect in change in energy intensity

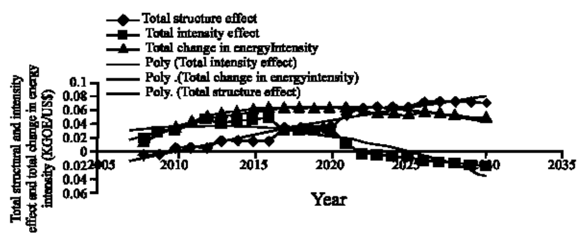

Fig. 4: Aggregate effect in change in energy intensity

large employment opportunities. It may be concluded that our industrial sector plays a dominant role over agriculture and service sector which can give a dynamic sustainability. The pure energy intensity effect gives a measure of the improvement in energy efficiency, changes in technology, fuel mix changes and other factors that are not related to activity or structure. A positive effect signifies a higher energy use per unit of GDP implying worsening energy efficiency while a negative pure intensity effect indicates an improvement in energy use per unit of GDP.

Figure 3 shows that the intensity effects of all sectors have decreasing trend. An analysis of the intensity effect which describes the effects of technological changes and changes in production system shows that energy intensity had decreased most in the agriculture, industry and service sectors after 2020.

This is due to the technological changes of changes in production systems and facilitated a decrease in the energy-needed fir a certain economic output. Thus the economic effectiveness of energy use increased. The agriculture sector intensity effect shows negative magnitude. The aggregate intensity effect also shows the decreasing trend after 2020 in which agriculture and industrial sector play dominant roles.

The structural effect and intensity effect of all sectors shown in Fig. 4, it found that the structural effect increase by 19 fold in 2030 compared to 2008 and the intensity effect also decrease by 1.3 fold during the same period shown in Table 6. For an increased structural effect, industrial sector plays a dominant role. Both effects show the positive trend for a chosen path of sustainable development (Table 6) (Fig. 5).

Table 6: Aggregate activity, structural and Intensity effect increased or decreased by fold for ΔI_{0t}

Factors	2010	2015	2020	2025	2030
Structural effect	1.3	4.0	9.0	17.0	19.0
Intensity effect	1.8	2.8	1.8	-0.4	-1.3
Total change (ΔI_{0t})	2.6	4.6	4.8	4.1	3.6

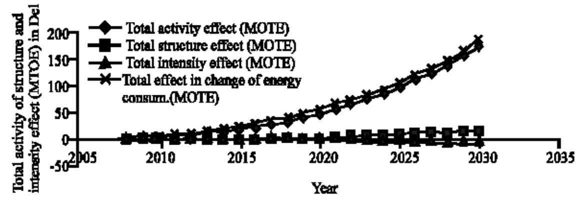

Fig. 5: Aggregate effect in change in energy consumption

The factor analysis for the change in energy consumption is shown in Table 7. The change in energy consumption increases to 1350, 130 and 14.6 MTOE by activity effect, structural effect and intensity effect respectively during the period of consideration. The activity effect is the greatest in the sectors where the total energy flows are the highest. In all sub period energy consumption allows increased value by activity effect and structural effect. In the period 2020-2030 the energy consumption decreases by intensity effect. The activity and structural effect hold positive values all throughout the period (2008-2030) indicating the strong industrialization process of Bangladesh during this period and a shift of economy towards more energy intensive sectors. The aggregate energy consumption is 1495 MTOE in which the contribution of activity effect, structural effect and intensity effect are 90, 9 and 1%, respectively. It is concluded that the activity effect plays a dominant role in energy consumption during the period under consideration. Punyong *et al.*, 2008 shows that in Thai industry the energy consumption increase by activity effect (11506.38 KTOE) and structural effect (1713.61 KTOE) but decrease by intensity effect (-139.99 KTOE) during the period 1988-2002.

Contributions of different groups to the total change in energy consumption are reported in Table 3. High-energy intensive group contributes a large increase while low energy intensive group contributes a small increase in the total increase of aggregate energy consumption during the period under consideration. Results indicate that the increase in aggregate energy consumption was 1495 MTOE in which high-energy intensive group contributes 95.7% and low energy intensive group contributes 4.3% in the study period of 2007- 2030. These results reconfirm the preceding findings that high-energy intensive group is mainly responsible for improved efficiency of energy uses in the country during

Table 7: Calculations for factor analysis for the change in energy consumption (ΔE_{ot})

Time period	Activity effect (%)	Structural effect (%)	Intensity effect (%)	Total change (%)
2008-2015	76.02 (76)	3.93 (4)	20.36 (20)	100.31 (100)
2015-2020	181.76 (86)	14.75 (7)	15.93 (7)	212.44 (100)
2020-2025	384.12 (91)	41.18 (10)	-2.64 (-1)	422.66 (100)
2025-2030	708.56 (93)	70.18 (9)	-19.02 (-2)	759.72 (100)
2008-2030	1350.47 (90)	130.04 (9)	14.62 (1)	1495.13 (100)

Unit: MTOE

Table 8: Sector wise effect increase or decrease by --fold for ΔE_{ot}

Agriculture	2010	2015	2020	2025	2030
Activity effect	3.30	12.40	28.200	47.50	81.60
Structural effect	0.02	-0.06	-0.340	-11.40	-19.00
Intensity effect	-0.40	-0.50	-2.000	-6.00	-10.00
Aggregate (ΔE_{0t})	3.30	11.30	22.000	26.00	46.00
Industrial					
Activity effect	3.40	14.00	36.500	75.40	137.50
Structural effect	3.60	10.50	30.500	78.80	131.60
Intensity effect	0.95	3.30	4.300	-3.20	-8.36
Aggregate (ΔE_{0t})	3.60	13.40	33.500	66.00	116.50
Service					
Activity effect	3.40	13.00	30.000	58.00	102.00
Structural effect	-2.30	-4.40	-10.000	-23.00	-38.00
Intensity effect	2.00	2.70	1.780	2.60	2.00
Aggregate (ΔE_{0t})	2.70	8.00	16.400	30.00	52.00

the study period. For change of energy consumption in agriculture sector, activity effect increase by 81.6 fold, structural effect decrease by 19 fold and intensity effect also decrease by 10 fold in 2030 compared to 2008, shown in Table 8. The aggregate effects in agriculture increase by 46 fold in 2030 compared to 2008 shown in Table 8. In industrial sector the activity effect increase by 137.5 fold, structural effect increase by 131.6 fold and the intensity effect decrease by 8.36 fold in 2030 compared to 2008. The aggregate effects in industry increase by 116.5 fold in 2030 compared to 2008. In service sector the activity effect increase by 102 fold, structural effect decrease by 38 fold and the intensity effect also increase by 2 fold in 2030 compared to 2008, shown in Table 8. The aggregate effects in service sector decrease by 4 fold in 2030 compared to 2008.

It is concluded from Table 8 that the activity effect increase faster in industrial as compare to agriculture and service sector, again structural effect increased in industry sector and decreased in agriculture and service sector which indicates that the economy shifting form agriculture to industrial and which is vital and necessary for sustainable development of Bangladesh. The intensity effect also decreases in agriculture and industrial sector and almost constant in service sector, this is one of the indications of sustainable development of Bangladesh.

From the aggregate of the activity effect, structural effect and intensity effect of all sectors, we found that the activity effect increase by 116 fold in 2030 compared to 2008. The structural effect increase by 71 fold during the same period and the intensity effect also decrease by 5.2 fold shown in Table 9. The aggregate changes in energy consumption increase by 80 fold in the whole studied period. In the aggregate change in energy consumption activity and structural effect play a dominant role which is positive sign for sustainable development. On the other hand intensity effect decreases slowly and after 2022 its magnitude is negative which indicates that less energy is needed to produce one unit of GDP output which also indicates that the country is forwarding towards the path of sustainability.

Table 9: Aggregate activity, structural and intensity effect increased or decreased by fold for ΔE_{ot}

Total	2010	2015	2020	2025	2030
Activity effect	3.4	13.33	33.0	65.00	116.0
Structural effect	1.5	5.10	16.4	42.00	71.0
Intensity effect	1.8	3.50	3.0	-1.24	-5.2
Total change (ΔE_{0t})	3.2	10.70	24.3	45.60	80.0

CONCLUSION

The present study has been conducted on the factor analysis for the change of energy intensity and energy consumption in Bangladesh in the period 2007-2030, based upon the Complete Decomposition Model. The following conclusion can be drawn from this study:

The energy intensity of low energy intensive group was decrease by 23% in the time period 2007-2030 while the energy intensity in high-energy intensive group was increase by 7.5% during the same period. The increase in aggregate energy intensity is due to the structural effect (71%) because during this period the structural changes appeared significantly.

In all sub-period high energy intensive group shows large change (126%) and low energy intensive group shows negative changes (-26%) in total energy intensity changes. This could be a result of improved efficiency of energy use of relatively high-energy intensive group. Again, it can be concluded that the structural effect of agriculture and service sector shows negative trend but in industrial sector it shows positive trend. The overall structural effect is positive, due to the positive trend of industrial sector and this is the indication of the phase transition from agriculture to industry.

In the case of change in aggregate energy consumption the activity effect increase faster in industrial compare than agriculture and service sector, again structural effect increased in industry sector and decreased in agriculture and service sector. Group-1 contributes 4.3% in total change in energy consumption, while group 2 contributes 95.7% during the period. The aggregate energy consumption is 1495 MTOE in which the contribution of activity effect, structural effect and intensity effect are 90, 9 and 1%, respectively. It is concluded that the activity effect plays a dominant role in energy consumption during the period under consideration. The aggregate energy consumption was 1495 MTOE in which high-energy intensive group contributes 95.7% and low energy intensive group contributes 4.3% in the study period 2007-2030. These results reconfirm preceding findings that high-energy intensive group is mainly responsible for improved efficiency of energy uses in the country, during the study period.

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