

## Efficiency Indicators –Industry exercises

**Q1.** Calculate the national <u>aggregated energy intensity (TFC/GDP</u>, for 1990 & 2010). Describe its trend in one sentence.

Note: GDP is the sum of the value added (VA) across all sectors.

Sectors of the economy	Energy consumption (TFC) Value added		Energy i	Energy intensity			
	P	J.	Bn,201	0\$ PPP	MJ/U	S\$PPP	%
	1990 2010		1990	2010	1990	2010	1990-2010

Total	3491	4525	1093	1487		

Services	646	1120	643	1115	

Industry	2688	3225	375	310		
Food products	216	264	42	39		
Textiles	26	61	8	16		
Wood	69	100	5	7		
Paper and printing	364	512	18	24		
Chemicals and chemical products	535	557	38	29		
Other non-metallic mineral products	253	294	12	14		
Basic metals	552	642	18	20		
Machinery	151	182	129	61		
Transport equipment	78	71	36	33		
Construction	5	7	11	13		
Mining and quarrying	273	350	36	38		
Other manufacturing	165	186	21	18		

Others	157	179	75	62		
Agriculture, forestry and fishing	154	177	30	24		
Electricity, gas, steam, air conditioning, and water supply	3	3	45	39		

**Q1.** Calculate the national <u>aggregated energy intensity</u> (TFC/GDP, for 1990 & 2010). Describe its trend in one sentence.

Note: GDP is the sum of the value added (VA) across all sectors.

Sectors of the economy	Ene consul (Ti	ergy mption FC)	Value added		Value added		Energy	Energy intensity			Energy intensity
	F	5J	Bn,201	0\$ PPP	MJ/U	S\$PPP 🗲	%	1			
	1990	2010	1990	2010	1990	2010	1990-2010	F	nergy consumption		
								- 2			
Total	3491	4525	1093	1487	3.2	3.0			Value added		
									value auueu		
Services	646	1120	643	1115							

Industry	2688	3225	375	310		
Food products	216	264	42	39		
Textiles	26	61	. 8	16		
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**Q1.** Calculate the national <u>aggregated energy intensity (TFC/GDP</u>, for 1990 & 2010). Describe its trend in one sentence.

Note: GDP is the sum of the value added (VA) across all sectors.

Sectors of the economy	Ene consun (TF	rgy nption <sup>:</sup> C)	Val add	ue led	Energy i	intensity	Intensity change	Energy intensity
	Р	J	Bn,2010	0\$ PPP	MJ/U	S\$PPP	%	
	1990	2010	1990	2010	1990	2010	1990-2010	<b>Energy consumption</b>
							1	Value added
Total	3491	4525	1093	1487	3.2	3.0	-5%	value added
·	646	1120	642	1115				
Services	040	1120	043	1115				
Industry	2688	3225	375	310				
Food products	216	264	42	39				<b>T 1 1</b>
Textiles	26	61	8	16				Intensity change
Wood	69	100	5	7				
Paper and printing	364	512	18	24				
Chemicals and chemical products	535	557	38	29				=
Other non-metallic mineral products	253	294	12	14				En. intens. <sub>2010</sub> – En. intens. <sub>1990</sub>
Basic metals	552	642	18	20				<b>Fn</b> intens
Machinery	151	182	129	61				Lii. interis. 1990
Transport equipment	78	71	36	33				
Construction	5	7	11	13				
Mining and quarrying	273	350	36	38				
Other manufacturing	165	186	21	18				<b>Answer:</b> Energy Intensity decreased
							<b></b>	by 5% between 1990 and 2010
Others	157	179	75	62				
Agriculture, forestry and fishing	154	177	30	24				
Electricity, gas, steam, air conditioning, and water supply	3	3	45	39				

Services

Q2. Calculate the energy intensity of each sub-sector (1990 & 2010). List the top three energy-intensive sub-sectors as of 2010.

Sectors of the economy	Energy consumption (TFC)		lue led	Energy intens		Intensity change	
	F		Bn,201	O\$ PPP	MJ/U	S\$PPP	%
	1990 2010		1990	2010	1990	2010	1990-2010
	1990	2010	1990	2010	1990	2010	1990-20

Total	3491	4525	1093	1487	3.2	3.0	-55
Services	646	1120	643	1115			

Industry	2688	3225	375	310		
Food products	216	264	42	39		
Textiles	26	61	8	16		
Wood	69	100	5	7		
Paper and printing	364	512	18	24		
Chemicals and chemical products	535	557	38	29		
Other non-metallic mineral products	253	294	12	14		
Basic metals	552	642	18	20		
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Electricity, gas, steam, air conditioning, and water supply	3	3	45	39		

Services

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Sectors of the company	Ene consur (Tf	Energy consumption (TFC) Value added PJ Bn,2010\$ PPP		Energy i	ntensity	Intensity change	
	P			O\$ PPP	MJ/US\$PPP		%
	1990	2010	1990	2010	1990	2010	1990-2010
Total	3491	4525	1093	1487	3.2	3.0	-5%

646

1120

643

1115

#### **Energy intensity**

Energy consumption Value added

Industry	2688	3225	375	310		
Food products	216	264	42	39		
Textiles	26	61	8	16		
Wood	69	100	5	7		
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**Q2.** Calculate the <u>energy intensity</u> of each <u>sub-sector</u> (1990 & 2010). List the top three energy-intensive sub-sectors as of 2010.

Sectors of the economy	Ene consui (Ti	ergy mption FC)	Va ado	lue ded	Energy intensity		Intensity change		
	F	וי	Bn,2010\$ PPP		Bn,2010\$ PPP		MJ/U	S\$PPP	%
	1990	2010	1990	2010	1990	2010	1990-2010		

Total	3491	4525	1093	1487	3.2	3.0	-5
Comisso	646	1120	643	1115	1.0	1.0	

Industry	2688	3225	375	310	7.2	10.4	
Food products	216	264	42	39	5.1	6.8	
Textiles	26	61	8	16	3.1	3.7	
Wood	69	100	5	7	13.0	14.9	
Paper and printing	364	512	18	24	20.3	21.7	
Chemicals and chemical products	535	557	38	29	14.2	19.4	
Other non-metallic mineral products	253	294	12	14	20.6	20.7	
Basic metals	552	642	18	20	30.7	32.4	
Machinery	151	182	129	61	1.2	3.0	
Transport equipment	78	71	36	33	2.2	2.2	
Construction	5	7	11	13	0.5	0.5	
Mining and quarrying	273	350	36	38	7.5	9.3	
Other manufacturing	165	186	21	18	7.9	10.3	

Others	157	179	75	62			
Agriculture, forestry and fishing	154	177	30	24	5.2	7.5	
Electricity, gas, steam, air conditioning, and water supply	3	3	45	39	0.1	0.1	

**Q2.** Calculate the <u>energy intensity</u> of each <u>sub-sector</u> (1990 & 2010). List the top three energy-intensive sub-sectors as of 2010.



Industry	2688	3225	375	310	7.2	10.4	
Food products	216	264	42	39	5.1	6.8	
Textiles	26	61	8	16	3.1	3.7	
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Basic metals	552	642	18	20	30.7	32.4	
Machinery	151	182	129	61	1.2	3.0	
Transport equipment	78	71	36	33	2.2	2.2	
Construction	5	7	11	13	0.5	0.5	
Mining and quarrying	273	350	36	38	7.5	9.3	
Other manufacturing	165	186	21	18	7.9	10.3	

#### **Answer:**

- 1. Basic metals (32.4 MJ/\$)
- 2. Paper and printing (21.7 MJ/\$)
- Non-metallic mineral products (20.7 MJ/\$)

Others	157	179	75	62			
Agriculture, forestry and fishing	154	177	30	24	5.2	7.5	
Electricity, gas, steam, air conditioning, and water supply	3	3	45	39	0.1	0.1	

**Q3.** Calculate and describe <u>energy intensity trends</u> of each sub-sector between 1990-2010. Which sub-sector became <u>less intensive</u>?

Sectors of the economy	End consu (T	ergy mption FC)	Val ado	lue led	Energy intensity		Intensity change
		ง	Bn,201	O\$ PPP	MJ/U	S\$PPP	%
	1990	2010	1990	2010	1990	2010	1990-2010
Total	3491	4525	1093	1487	3.2	3.0	-5%
Services	646	1120	643	1115	1.0	1.0	

Industry	2688	3225	375	310	7.2	10.4	
Food products	216	264	42	39	5.1	6.8	
Textiles	26	61	8	16	3.1	3.7	
Wood	69	100	5	7	13.0	14.9	
Paper and printing	364	512	18	24	20.3	21.7	
Chemicals and chemical products	535	557	38	29	14.2	19.4	
Other non-metallic mineral products	253	294	12	14	20.6	20.7	
Basic metals	552	642	18	20	30.7	32.4	
Machinery	151	182	129	61	1.2	3.0	
Transport equipment	78	71	36	33	2.2	2.2	
Construction	5	7	11	13	0.5	0.5	
Mining and quarrying	273	350	36	38	7.5	9.3	
Other manufacturing	165	186	21	18	7.9	10.3	

Others	157	179	75	62			
Agriculture, forestry and fishing	154	177	30	24	5.2	7.5	
Electricity, gas, steam, air conditioning, and water supply	3	3	45	39	0.1	0.1	

**Q3.** Calculate and describe <u>energy intensity trends</u> of each sub-sector between 1990-2010. Which sub-sector became <u>less intensive</u>?



Industry	2688	3225	375	310	7.2	10.4	45%
Food products	216	264	42	39	5.1	6.8	32%
Textiles	26	61	8	16	3.1	3.7	20%
Wood	69	100	5	7	13.0	14.9	15%
Paper and printing	364	512	18	24	20.3	21.7	7%
Chemicals and chemical products	535	557	38	29	14.2	19.4	37%
Other non-metallic mineral products	253	294	12	14	20.6	20.7	0.4%
Basic metals	552	642	18	20	30.7	32.4	5%
Machinery	151	182	129	61	1.2	3.0	156%
Transport equipment	78	71	36	33	2.2	2.2	0.2%
Construction	5	7	11	13	0.5	0.5	4%
Mining and quarrying	273	350	36	38	7.5	9.3	23%
Other manufacturing	165	186	21	18	7.9	10.3	30%

Others	157	179	75	62			
Agriculture, forestry and fishing	154	177	30	24	5.2	7.5	44%
Electricity, gas, steam, air conditioning, and water supply	3	3	45	39	0.1	0.1	12%

**Q3.** Calculate and describe <u>energy intensity trends</u> of each sub-sector between 1990-2010. Which sub-sector became <u>less intensive</u>?



Others	157	179	75	62			
Agriculture, forestry and fishing	154	177	30	24	5.2	7.5	44
Electricity, gas, steam, air conditioning, and water supply	3	3	45	39	0.1	0.1	12

**Q4.** Do results of Q1 & Q3 confirm or contradict each other? Explain why.

Sectors of the economy	Ene consur (Ti	ergy mption FC)	Va ado	lue led	Energy i	ntensity	Intensity change
	PJ			O\$ PPP	MJ/US\$PPP		%
	1990	2010	1990	2010	1990	2010	1990-2010
Total	3491	4525	1093	1487	3.2	3.0	-5%
Services	646	1120	643	1115	1.0	1.0	0.05%
	-						

Industry	2688	3225	375	310	7.2	10.4	45%
Food products	216	264	42	39	5.1	6.8	32%
Textiles	26	61	8	16	3.1	3.7	20%
Wood	69	100	5	7	13.0	14.9	15%
Paper and printing	364	512	18	24	20.3	21.7	7%
Chemicals and chemical products	535	557	38	29	14.2	19.4	37%
Other non-metallic mineral products	253	294	12	14	20.6	20.7	0.4%
Basic metals	552	642	18	20	30.7	32.4	5%
Machinery	151	182	129	61	1.2	3.0	156%
Transport equipment	78	71	36	33	2.2	2.2	0.2%
Construction	5	7	11	13	0.5	0.5	4%
Mining and quarrying	273	350	36	38	7.5	9.3	23%
Other manufacturing	165	186	21	18	7.9	10.3	30%

Others		157	179	75	62			
Agriculture, f	prestry and fishing	154	177	30	24	5.2	7.5	44%
Electricity, ga	as, steam, air conditioning, and water supply	3	3	45	39	0.1	0.1	12%

Q4. Do results of Q1 & Q3 confirm or contradict each other? Explain why.

Sectors of the economy	Ene consur (TF	ergy nption FC)	Val add	ue led	Energy i	ntensity	Intensity change		Ener consumpti	gy on (TFC)	Valu adde	ie ed
	P	ų.	Bn,2010	)\$ PPP	MJ/US\$PPP %				PJ		Bn,2005\$ PPP	
	1990	2010	1990	2010	1990	2010	1990-2010		1990	2010	1990	2010
-												
Total	3491	4525	1093	1487	3.2	3.0	-5%	-	100%	100%	100%	100%
Services	646	1120	643	1115	1.0	1.0	0.05%	Г	18%	25%	59%	75%
									0%	0%	0%	0%
Industry	2688	3225	375	310	7.2	10.4	45%		77%	71%	34%	21%
Food products	216	264	42	39	5.1	6.8	32%		6%	6%	4%	3%
Textiles	26	61	8	16	3.1	3.7	20%		1%	1%	1%	1%
Wood	69	100	5	7	13.0	14.9	15%		2%	2%	0%	0%
Paper and printing	364	512	18	24	20.3	21.7	7%		10%	11%	2%	2%
Chemicals and chemical products	535	557	38	29	14.2	19.4	37%		15%	12%	3%	2%
Other non-metallic mineral products	253	294	12	14	20.6	20.7	0.4%		7%	7%	1%	1%
Basic metals	552	642	18	20	30.7	32.4	5%		16%	14%	2%	1%
Machinery	151	182	129	61	1.2	3.0	156%		4%	4%	12%	4%
Transport equipment	78	71	36	33	2.2	2.2	0.2%		2%	2%	3%	2%
Construction	5	7	11	13	0.5	0.5	4%		0%	0%	1%	1%
Mining and quarrying	273	350	36	38	7.5	9.3	23%		8%	8%	3%	3%
Other manufacturing	165	186	21	18	7.9	10.3	30%		5%	4%	2%	1%
								J	0%	0%	0%	0%
Others	157	179	75	62					5%	4%	7%	4%
Agriculture, forestry and fishing	154	177	30	24	5.2	7.5	44%		4%	4%	3%	2%
Electricity gas steam air conditioning and water supply	3	3	45	39	0.1	0.1	12%		0%	0%	4%	3%

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#### **Q4.** Do results of Q1 & Q3 confirm or contradict each other? Explain why.

										Shar	es	
Sectors of the economy		gy ion (TFC)	Val add	ue led	Energy i	ntensity	Intensity change		Energ consump (TFC)	/ tion	Valu adde	: t
	PJ		Bn,201	O\$ PPP	MJ/U	S\$PPP	%		PJ		Bn,2005	PPP
	1990	2010	1990	2010	1990	2010	1990-2010		1990	2010	1990	2010
Total	3491	4525	1093	1487	3.2	3.0	-5%		100%	100%	100%	100%
Services	646	1120	643	1115	1.0	1.0	0.05%	ר	18%	25%	59%	75%
									0%	0%	0%	0%
Industry	2688	3225	375	310	7.2	10.4	45%		77%	71%	34%	21%
Food products	216	264	42	39	5.1	6.8	32%		6%	6%	4%	3%
Textiles	26	61	8	16	3.1	3.7	20%		1%	1%	1%	1%
Wood	69	100	5	7	13.0	14.9	15%		2%	2%	0%	0%
Paper and printing	364	512	18	24	20.3	21.7	7%		10%	11%	2%	2%
Chemicals and chemical products	535	557	38	29	14.2	19.4	37%		15%	12%	3%	2%
Other non-metallic mineral products	253	294	12	14	20.6	20.7	0.4%		7%	7%	1%	1%
Basic metals	552	642	18	20	30.7	32.4	5%		16%	14%	2%	1%
Machinery	151	182	129	61	1.2	3.0	156%		4%	4%	12%	4%
Transport equipment	78	71	36	33	2.2	2.2	0.2%		2%	2%	3%	2%
Construction	5	7	11	13	0.5	0.5	4%		0%	0%	1%	1%
Mining and quarrying	273	350	36	38	7.5	9.3	23%		8%	8%	3%	3%
Other manufacturing	165	186	21	18	7.9	10.3	30%	1	5%	4%	2%	1%
								1	0%	0%	0%	0%
Others	157	179	75	62				1	5%	4%	7%	4%
Agriculture, forestry and fishing	154	177	30	24	5.2	7.5	44%	1	4%	4%	3%	2%
Electricity, gas, steam, air conditioning, and water supply	3	3	45	39	0.1	0.1	12%		0%	0%	4%	3%

**Answer:** Aggregated energy intensity decreased due to structural changes. (i.e. share of services sector, which has very low energy intensity, increased from 59% to 75%.)

**Q5.** If the **best-available-technology (BAT)** were adopted, what industrial sub-sector would have the <u>largest energy saving?</u>

	Ene consu	ergy mption	Va ade	lue Jed	BAT	Energy saving potential
	I		Bn,201	.0\$ PPP	MJ/US\$PPP	PJ
	1990	2010	1990	2010	2010	2010
Industry						
Food products	216	264	42	39	4.6	
Textiles	26	61	8	16	0.8	
Wood	69	100	5	7	7.2	
Paper and printing	364	512	18	24	14.7	
Chemicals and chemical products	535	557	38	29	14.0	
Other non-metallic mineral products	253	294	12	14	21.4	
Basic metals	552	642	18	20	25.4	
Machinery	151	182	129	61	0.5	
Transport equipment	78	71	36	33	1.1	
Construction	5	7	11	13	0.2	
Mining and quarrying	273	350	36	38	6.4	
Other manufacturing	165	186	21	18	2.3	

**Q5.** If the **best-available-technology (BAT)** were adopted, what industrial sub-sector would have the <u>largest energy saving?</u>

	End consu	ergy mption	Va ad	lue ded	BAT	Energy saving potential		Energy saving
	1	PJ Bn,2010\$ PPP M		MJ/US\$PPP	PJ	-	potential	
	1990	2010	1990	2010	2010	2010		=
Industry								
Food products	216	264	42	39	4.6			
Textiles	26	61	8	16	0.8			BAI * Value added
Wood	69	100	5	7	7.2			_
Paper and printing	364	512	18	24	14.7			_
Chemicals and chemical products	535	557	38	29	14.0			Actual Energy consumption
Other non-metallic mineral products	253	294	12	14	21.4			fierder Energy consumption
Basic metals	552	642	18	20	25.4			
Machinery	151	182	129	61	0.5			
Transport equipment	78	71	36	33	1.1			
Construction	5	7	11	13	0.2			
Mining and quarrying	273	350	36	38	6.4			
Other manufacturing	165	186	21	18	2.3			

**Q5.** If the **best-available-technology (BAT)** were adopted, what industrial sub-sector would have the <u>largest energy saving?</u>

	Energy consumption         Value added           PJ         Bn,2010\$ PPP		BAT MJ/US\$PPP	Energy saving potential PJ	•	Energy saving potential			
	1990	2010	1990	2010		2010	2010		=
Industry									
Food products	216	264	42	39		4.6	-84.4		
Textiles	26	61	8	16		0.8	-47.6		BAT * Value added
Wood	69	100	5	7		7.2	-51.3		_
Paper and printing	364	512	18	24		14.7	-165.4		-
Chemicals and chemical products	535	557	38	29		14.0	-155.7		Actual Energy consumption
Other non-metallic mineral products	253	294	12	14		21.4	9.7		netual Energy consumption
Basic metals	552	642	18	20		25.4	-138.4		
Machinery	151	182	129	61		0.5	-151.3		
Transport equipment	78	71	36	33		1.1	-34.9		
Construction	5	7	11	13		0.2	-4.0		
Mining and quarrying	273	350	36	38		6.4	-108.6		
Other manufacturing	165	186	21	18		2.3	-144.6		

**Answer:** Paper and printing (Potential saving of 165.4 PJ)



**Q6.** <u>Energy intensity of cement industry</u> is lower than BAT. Can we conclude that the country's cement production is highly energy efficient? Explain why.</u>

Note: consider that clinker production is part of cement production process. Clinker-to-cement ratio should be around 0.75-0.85 unless clinker is imported/exported.

	Ene consur	rgy nption	Va ado	lue led	BAT	
Ustry Food products Textiles Wood Paper and printing Chemicals and chemical products Other non-metallic mineral products Cement (Physical production, Mt) Clinker (Physical production, Mt) Descinated b		Р	u U	Bn,201	0\$ PPP	MJ/US\$PPP
		1990	2010	1990	2010	2010
Industry						
Food products		216	264	42	39	4.6
Textiles		26	61	8	16	0.8
Wood		69	100	5	7	7.2
Paper and printing		364	512	18	24	14.7
Chemicals and chemical products		535	557	38	29	14.0
Other non-metallic mineral products		253	294	12	14	21.4
Cement (Physical production, Mt)		159	189	48	52	3.8 GJ/t
Clinker (Physical production, Mt)		84	97	23	25	3.1 GJ/t
Basic metals		552	642	18	20	25.4
Machinery		151	182	129	61	0.5
Transport equipment		78	71	36	33	1.1
Construction		5	7	11	13	0.2
Mining and quarrying		273	350	36	38	6.4
Other manufacturing		165	186	21	18	2.3

BAT		Energy saving potential
MJ/US\$PPP		PJ
2010		2010
4.6		-84.4
0.8		-47.6
7.2		-51.3
14.7		-165.4
14.0		-155.7
21.4		9.7
3.8 GJ/t	◀	
3.1 GJ/t		
25.4		-138.4
0.5		-151.3
1.1		-34.9
0.2		-4.0
6.4		-108.6
2.3		-144.6

and the second		
clinker-to-coment ratio		
Cilling to content tato		

**Q6.** <u>Energy intensity of cement industry</u> is lower than BAT. Can we conclude that the country's cement production is highly energy efficient? Explain why.</u>

Note: consider that clinker production is part of cement production process. Clinker-to-cement ratio should be around 0.75-0.85 unless clinker is imported/exported.

	Ene consur	rgy nption	Value added Bn,2010\$PPP		
	P	u U			
	1990	2010	1990	2010	
Industry					
Food products	216	264	42	39	
Textiles	26	61	8	16	
Wood	69	100	5	7	
Paper and printing	364	512	18	24	
Chemicals and chemical products	535	557	38	29	
Other non-metallic mineral products	253	294	12	14	
Cement (Physical production, Mt)	159	189	48	52	
Clinker (Physical production, Mt)	84	97	23	25	
Basic metals	552	642	18	20	
Machinery	151	182	129	61	
Transport equipment	78	71	36	33	
Construction	5	7	11	13	
Mining and quarrying	273	350	36	38	
Other manufacturing	165	186	21	18	





clinker-to-cement ratio		

IEA 2019

**Q6.** <u>Energy intensity of cement industry</u> is lower than BAT. Can we conclude that the country's cement production is highly energy efficient? Explain why.</u>

Note: consider that clinker production is part of cement production process. Clinker-to-cement ratio should be around 0.75-0.85 unless clinker is imported/exported.

								Energy Intensity				
	Ene consur	Energy consumption		lue ded	BA	r	Energy saving potential			MJ/US\$PPP		
	P	PJ		Bn,2010\$ PPP		\$PPP		LA		1990	2010	
	1990	2010	1990	2010	20	0		2010				
Industry												
Food products	216	264	42	39	4.	;		-84.4		5.1	6.8	
Textiles	26	61	8	16	0.			-47.6		3.1	3.7	
Wood	69	100	5	7	7.	:		-51.3		13.0	14.9	
Paper and printing	364	512	18	24	14	7		-165.4		20.3	21.7	
Chemicals and chemical products	535	557	38	29	14	D		-155.7		14.2	19.4	
Other non-metallic mineral products	253	294	12	14	21	4		9.7		20.6	20.7	
Cement (Physical production, Mt)	159	189	48	52	3.8 (	J/t				3.3	3.6	
Clinker (Physical production, Mt)	84	97	23	25	3.1 (	J/t				3.7	3.9	
Basic metals	552	642	18	20	25	4		-138.4		30.7	32.4	
Machinery	151	182	129	61	0.	i i		-151.3		1.2	3.0	
Transport equipment	78	71	36	33	1.			-34.9		2.2	2.2	
Construction	5	7	11	13	0.			-4.0		0.5	0.5	
Mining and guarrying	273	350	36	38	6.			-108.6		7.5	9.3	
Other manufacturing	165	186	21	18	2.			-144.6		7.9	10.3	

**Answer:** Production of clinker is very low compared to cement, which indicates that clinker may be imported. This explains why energy intensity of cement is very low.



