

## DEMAND SCENARIOS IN TIMES-EFDA

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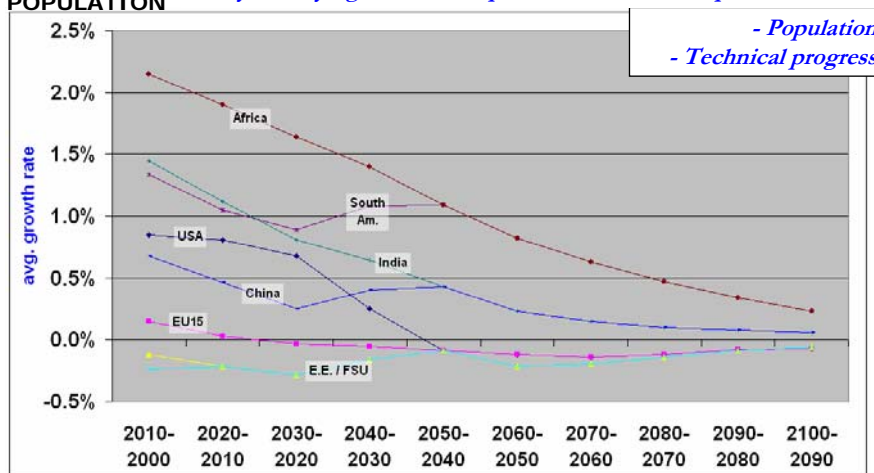
In the TIMES/EFDA model, a demand scenario is constituted by a set of annual demands for energy services, for each region and each period of the planning horizon. To derive these demands, 5 steps:

- *define a set of socio-economic drivers*
- *make assumptions on which driver to use to project each particular demand category (region/ time dependent);*
- *obtain projections for each driver of point 1 in each region/ time period;*
- *choose elasticities of each demand for its assigned driver (region/ time dependent);*
- *compute each demand*

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## HOW TO DEFINE ALTERNATIVE DEMAND SCENARIOS (1.a)

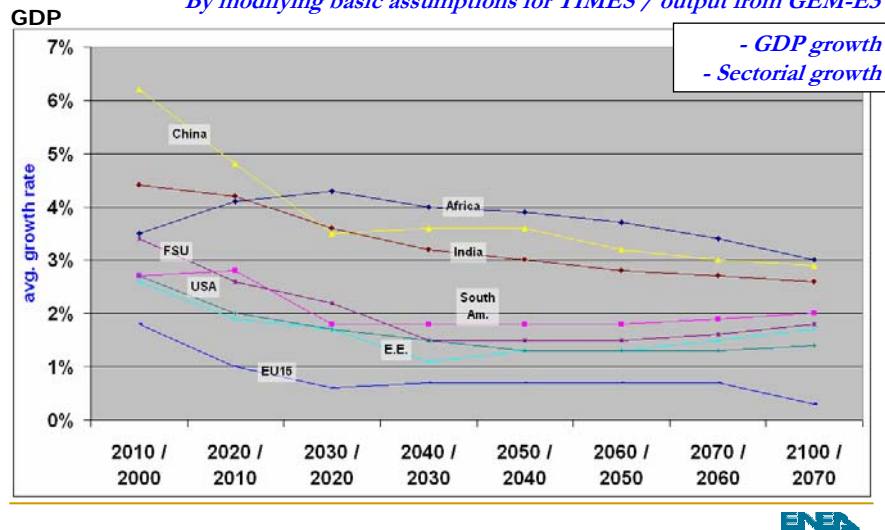
POPULATION *By modifying basic assumptions for TIMES / input to GEM-E3*



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## HOW TO DEFINE ALTERNATIVE DEMAND SCENARIOS (1.b)

By modifying basic assumptions for TIMES / output from GEM-E3



## HOW TO DEFINE ALTERNATIVE DEMAND SCENARIOS (2.a)

By working on the projection of energy service demands, changing the elasticity used to calculate each energy service demand (or the driver)

➔ But this requires to know how to change the elasticities, i.e. to give an assessment of the elasticities used for the Base case scenario

Demand Category	Driver	Driver Elasticity of Demands		
		Before 2050	Non-OECD regions	After 2050
		OECD regions		All regions
<b>Commercial demand</b>				
Space heating	Service sector production	0.5	0.7/0.5	0.3
Space cooling	Service sector production	0.8	0.8	0.4
Hot water heating	Service sector production	0.5	0.8	0.3
Lighting	Service sector production	0.8	1	0.4
Cooking	Service sector production	0.8	1	0.4
Refrigerators and freezers	Service sector production	0.8	0.8	0.4
Electric equipments	Service sector production	0.8	1	0.4
Other energy uses	Service sector production	0.5	0.8	0.4
<b>Industrial demand</b>				
Iron and steel	Sectoral production (I)	0.7	1	0.5
Non ferrous metals	Sectoral production (I)	0.8	1	0.5
Chemicals	Sectoral production (I)	0.8	1	0.5
Pulp and paper	Sectoral production (O)	0.8	1	0.5
Non metal minerals	Sectoral production (O)	0.8	1	0.5
Other industries	Sectoral production (O)	0.8	1	0.6
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## ASSESSMENT OF BASE CASE SERVICE DEMANDS : METHODOLOGY

As for the assessment it is not possible to use literature estimates (there is very poor literature on elasticities of *energy service demands*), the elasticities assumed for the Base case scenario have been evaluated through a three step analysis:

1. *for each region/period, it has been estimated the energy demand implicit in any projected energy service demand*
2. *for each region/period, it has been calculated the elasticity of energy demand, both to the driver utilized to project energy demand and to a measure of economic growth*
3. *after a wide review of the estimates about energy demand elasticities (for different regions), the elasticity of energy demand calculated in the previous step have been compared with the estimates coming from the literature (for each demand/sectorial level, depending on the availability of estimates)*

Starting from this assessment, it has been possible to define alternative demand scenarios, by modifying the elasticity of each demand for each country/region and by projecting the energy service demands through the elasticity values selected during the previous analysis.

3 alternative (with respect to the Base case and to the Base CPI case) scenarios have been defined:

- a High elasticity scenario,
- a Low elasticity scenario and
- a scenario based on implicit energy demand elasticities of the IEA World Energy Outlook 2004.



## ASSESSMENT OF BASE CASE SERVICE DEMANDS ELASTICITIES OF ENERGY DEMANDS - CHINA

	<i>driver</i>	2010- 2020	2020- 2040	2040- 2070	2070- 2100	<i>estimates of long-term elasticities from literature</i>
<b>Total final demand</b>	<b>GDP</b>	<b>0.4</b>	<b>0.4</b>	<b>0.4</b>	<b>0.5</b>	<b>0.4-0.7 (1, 2, 3, 4)</b>
Commercial	<i>value added</i>	0.5	0.5	0.2	0.4	1.2-1.9 (1)
	<i>Industry value added</i>	0.8	0.4	0.5	0.6	
Chemical	<i>value added</i>	0.5	0.4	0.5	0.6	
Iron-steel	<i>value added</i>	0.9	0.1	<b>-1.0</b>	0.2	0.95-1.29 (1)
Pulp / Paper	<i>value added</i>	0.6	0.0	0.4	0.6	
Non-ferrous met.	<i>value added</i>	0.6	<b>-0.4</b>	<b>-0.8</b>	0.3	
Non Metals	<i>value added</i>	1.0	0.4	0.3	0.5	0.41-0.97 (1)
Other Ind.	<i>value added</i>	0.9	0.7	0.6	0.7	
	<i>Residential GDP-cap.</i>	<b>-0.01</b>	0.2	0.2	0.2	1.0-3.5 (1)
Res. Lighting	<i>GDP-cap.</i>	0.8	0.8	0.8	0.8	
Res. Heat/Hot						
W. Cook.	<i>GDP-cap.</i>	<b>-0.1</b>	0.0	0.1	0.0	
Res.-Other electr.	<i>GDP-cap.</i>	1.1	1.1	0.5	0.2	2.17 (1)
	<i>Transport GDP-cap.</i>	0.8	0.9	0.7	0.4	0.9 (5)
Road Bus, Rail	<i>GDP-cap.</i>	0.2	0.1	0.1	0.0	
Aviation	<i>GDP</i>	1.0	1.2	0.9	0.7	
Trucks	<i>GDP</i>	0.6	0.6	0.6	0.5	
Road auto	<i>GDP</i>	1.0	1.1	0.8	0.6	
Navigation	<i>GDP</i>	1.2	1.0	0.7	0.5	

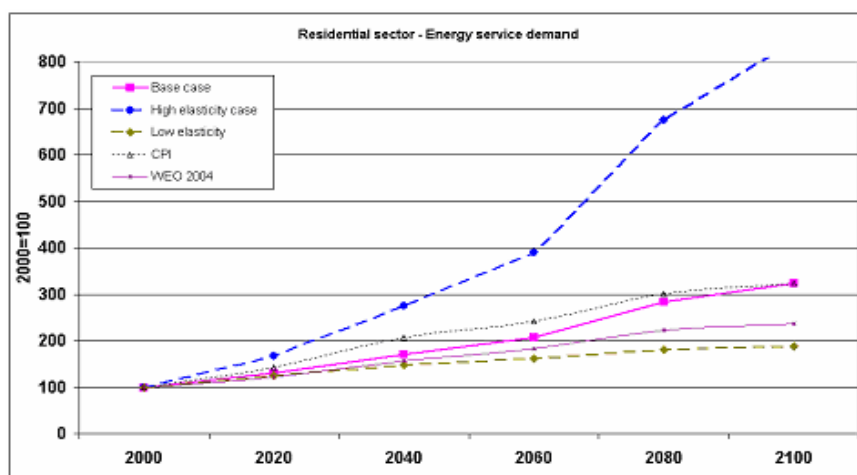


## ASSESSMENT OF BASE CASE SERVICE DEMANDS - CHINA

- The assessment of the Base case scenario described by the EFDA World model for China, carried out through the comparison between the elasticities of energy demand calculated from the model results and some estimates taken from the literature, showed that the Base scenario can be considered quite coherent with the literature, especially with regard to the industrial and transport sectors. The elasticities calculated from the model results are instead too low for the commercial and residential sectors.
- These conclusions are confirmed by the new projection of service demands, derived from the alternative values assumed for the elasticities (see the following figures).
- As a matter of fact, the evolution of household demand in the Base case is very close to the Low elasticity case. In the commercial and industrial sectors, the energy service demand can be considered as derived by assuming elasticity values equal to the average between the High case and the Low case. Finally, the Base case service demand growth is even higher than the historical one in transportation, so that it is quite close to the High elasticity case, particularly in the short and medium-term.
- As regards the other two scenarios, BaseCPI and WEO, the first one is quite different from the Base case: it is higher than the Base scenario, particularly in the medium period, for three out of the four sectors (residential, service and industry), while it is close to the Low elasticity case for the transport sector.
- On the contrary, the evolution of the scenario WEO is between the Base case and the Low elasticity case for all the energy service demands (in the service sector they are in fact almost identical to the Base scenario).

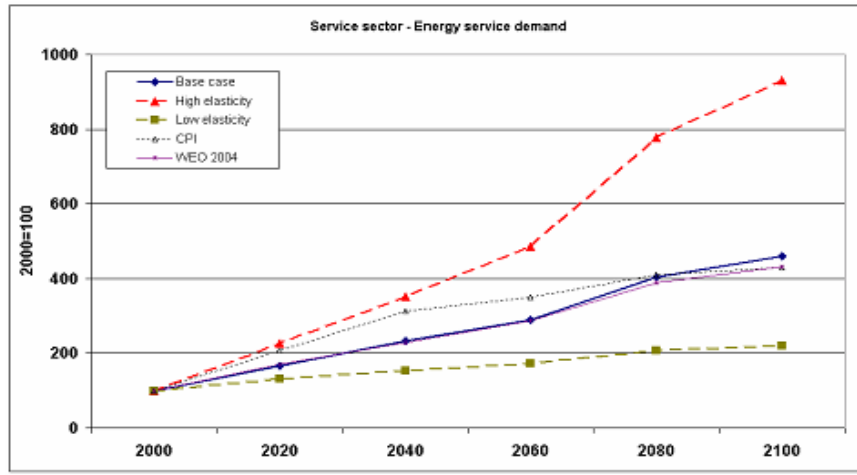
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## ALTERNATIVE SCENARIOS : CHINA – RESIDENTIAL SECTOR

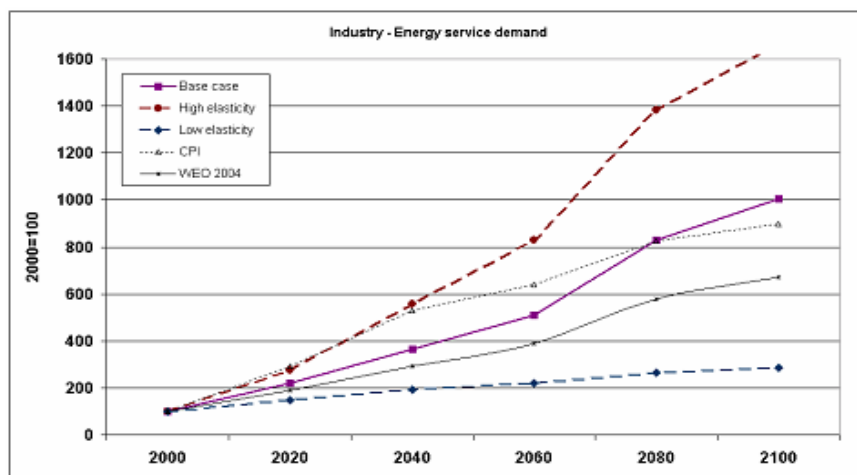


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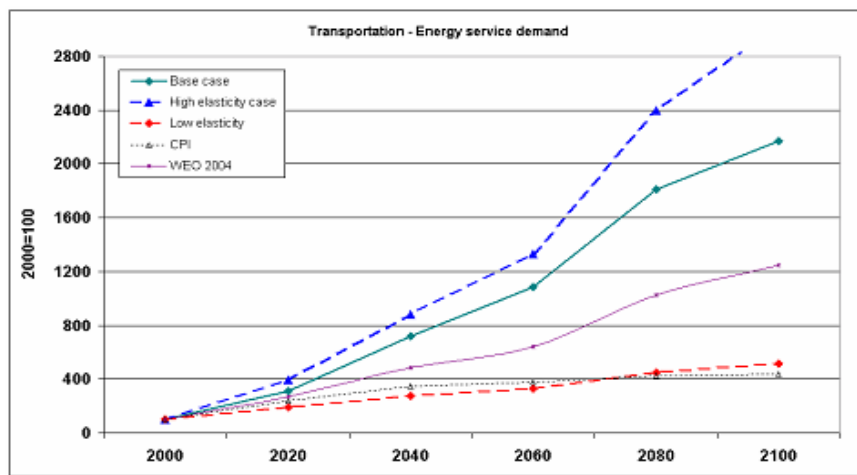
**ALTERNATIVE SCENARIOS:  
CHINA – SERVICE SECTOR**



**ALTERNATIVE SCENARIOS:  
CHINA – INDUSTRIAL SECTOR**



## ALTERNATIVE SCENARIOS: CHINA – TRANSPORT SECTOR



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## ASSESSMENT OF BASE CASE SERVICE DEMANDS ELASTICITIES OF ENERGY DEMANDS - INDIA

	driver	2010-2020	2020-2040	2040-2070	2070-2100	estimates of long-term elasticities from literature
<b>Total final demand</b>	<b>GDP</b>	<b>0.4</b>	<b>0.6</b>	<b>0.4</b>	<b>0.3</b>	<b>0.7 - 1.24 (1, 2)</b>
Commercial	value added	0.7	0.8	0.3	0.4	1.27 (5)
Industry	value added	0.7	0.6	0.5	0.5	0.81 (5)
Chemical	value added	0.9	0.8	0.6	0.5	1.06 (5)
Iron-steel	value added	0.7	0.3	0.4	0.5	1.06 (5)
Pulp / Paper	value added	0.6	0.5	0.4	0.5	1.06 (5)
Non-ferrous met.	value added	0.3	-0.3	0.2	0.5	0.49 (5)
Non Metals	value added	0.5	0.3	0.4	0.5	0.49 (5)
Other Ind.	value added	0.2	0.4	0.6	0.6	0.49 (5)
Residential	GDP-cap.	0.01	0.3	0.2	0.1	0.5 - 1.3 (2)
Res. Lighting	GDP-cap.	0.2	0.8	0.7	0.6	0.88 (5)
Res. Heat/Hot W./Cook.	GDP-cap.	-0.1	0.2	0.1	0.0	
Res.-Other electr.	GDP-cap.	1.5	1.6	0.5	0.1	0.88 (5)
Transport	GDP-cap.	0.7	1.2	0.7	0.4	>1 (6, 7)
Road Bus, Rail	GDP-cap.	0.1	0.2	0.1	0.0	
Aviation	GDP	1.1	1.4	0.9	0.6	0.8 - 1.2 (6)
Trucks	GDP	0.4	0.9	0.6	0.4	
Road auto	GDP	0.6	1.3	0.8	0.5	
Navigation	GDP	1.2	1.2	0.7	0.4	

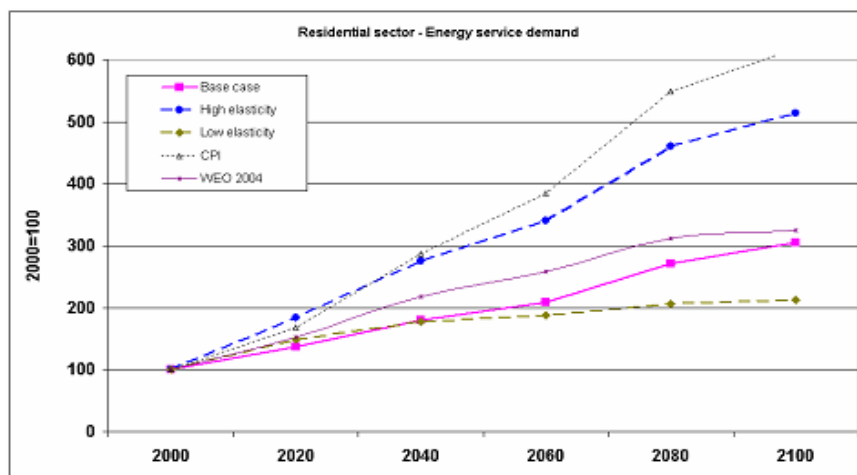
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## ASSESSMENT OF BASE CASE SERVICE DEMANDS - INDIA

- As regards India, the assessment of the Base scenario through the analysis of the implicitly assumed elasticities showed that the EFDA Base case is not far from being a "medium" scenario.
- In fact, the results are very similar to the ones just seen with regard to China: for industry and transport, the evolution of energy service demands in the Base scenario is coherent with the literature; on the contrary, it is too low for the commercial and residential sectors.
- These results are confirmed by the alternative projection of service demands derived from the high and low values assumed for elasticities (see figures 4.9-4.12). The evolution of service demand in the household sector is even slower than the one derived by assuming Low values of elasticities, especially in the medium-term. On the contrary, the Base case demand for transportation is close to the High elasticity case, while industrial and service demand are in the middle between the High and the Low elasticity scenarios.
- In the case of India the scenario BaseCPI is strongly higher than the Base case: apart from the transport sector, whose energy service demands are between the Low elasticity case and the Base scenario, in all other sectors it is even higher than the High elasticity case.
- The information coming from the scenario WEO seems coherent with the data above. In the service and transport sectors energy service demands are very similar to the BaseCPI and in both the residential and industrial sectors they also increase more than in the Base case.

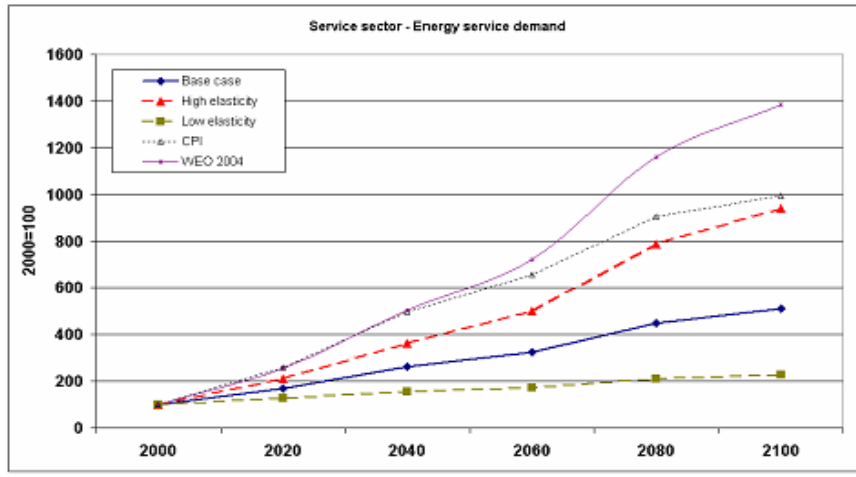
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## ALTERNATIVE SCENARIOS : INDIA – RESIDENTIAL SECTOR

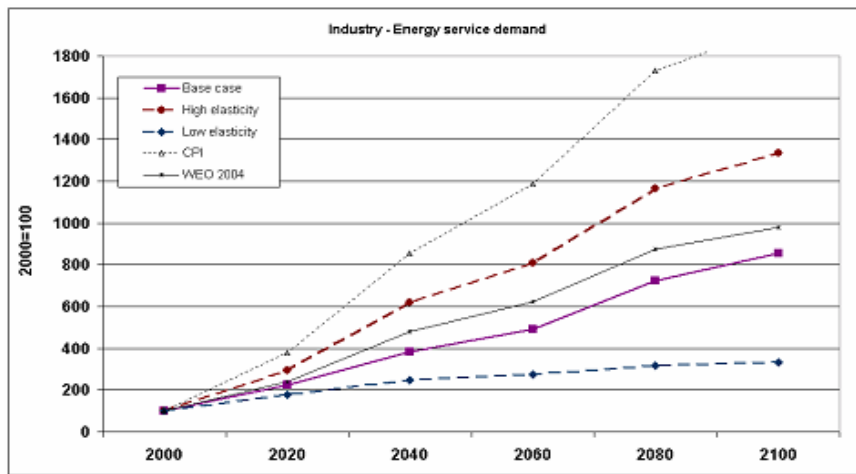


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**ALTERNATIVE SCENARIOS:  
INDIA – SERVICE SECTOR**

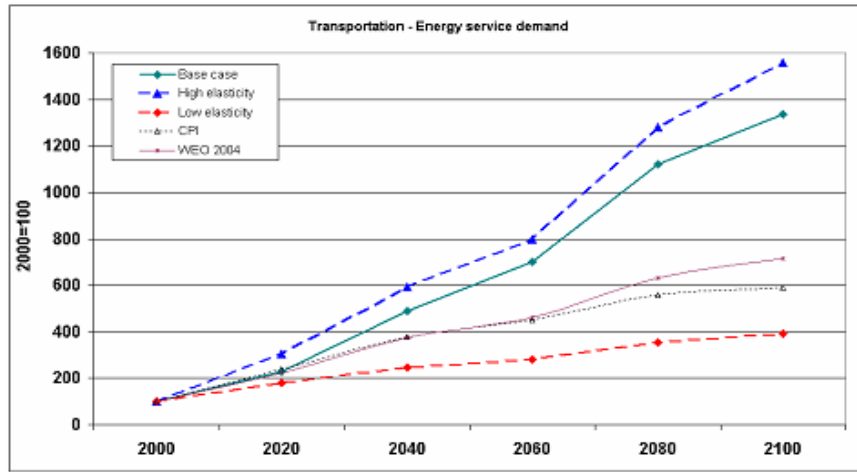


**ALTERNATIVE SCENARIOS:  
INDIA – INDUSTRIAL SECTOR**





## ALTERNATIVE SCENARIOS: INDIA – TRANSPORT SECTOR



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## ASSESSMENT OF BASE CASE SERVICE DEMANDS ELASTICITIES OF ENERGY DEMANDS – CENTRAL AND SOUTH AMERICA

driver EFDA model		2000	2020	2040	2070	2100	2000-2020	2020-2040	2040-2070	2070-2100
<b>Total final demand</b>	<b>GDP</b>	<b>13634</b>	<b>19142</b>	<b>28859</b>	<b>42373</b>	<b>54357</b>	<b>1.7%</b>	<b>2.1%</b>	<b>1.3%</b>	<b>0.8%</b>
Commercial	value added	651	838	1330	2095	2833	1.3%	2.3%	1.5%	1.0%
Industry		4245	8273	13489	21977	29828	3.4%	2.5%	1.6%	1.0%
Chemical	value added	1061	2207	3851	6451	8473	3.7%	2.8%	1.7%	0.9%
Iron-steel	value added	744	1765	3036	4657	5656	4.4%	2.7%	1.4%	0.65%
Pulp / Paper	value added	376	495	614	891	1153	1.4%	1.1%	1.3%	0.9%
Non-ferrous met.	value added	277	505	714	1019	1237	3.0%	1.7%	1.2%	0.6%
Non Metals	value added	232	464	719	1089	1408	3.5%	2.2%	1.4%	0.9%
Other Ind.	value added	1555	2837	4556	7870	11901	3.1%	2.4%	1.8%	1.4%
Residential		2757	2969	4126	5576	6416	0.372%	1.7%	1.0%	0.5%
Res. Lighting	GDP-cap.	327	163	276	517	817	-3.4%	2.7%	2.1%	1.5%
Res. Heat/Hot W./Cook.	population	2029	2004	2269	2440	2492	-0.1%	0.62%	0.24%	0.07%
Res.-Other electr.	households	402	802	1581	2619	3107	3.5%	3.4%	1.7%	0.6%
Transport		5981	7062	9914	12726	15280	0.8%	1.7%	0.8%	0.6%
Road Bus, Rail	population	381	423	475	513	525	0.53%	0.58%	0.3%	0.1%
Aviation	GDP	447	693	894	837	686	2.2%	1.3%	-0.2%	-0.7%
Trucks	GDP	3083	3937	6129	8610	11208	1.2%	2.2%	1.1%	0.9%
Road auto	GDP	1484	1092	1342	1806	2066	-1.5%	1.0%	1.0%	0.4%
Navigation	GDP	586	917	1074	960	794	2.3%	0.8%	-0.4%	-0.6%

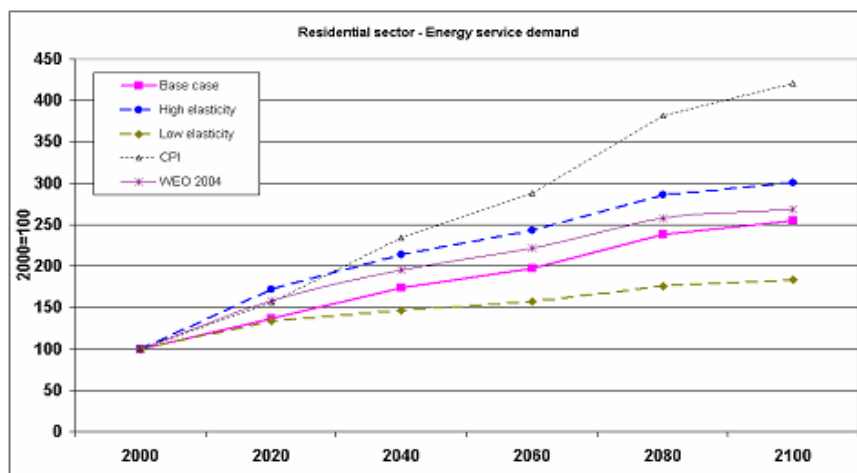
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## ASSESSMENT OF BASE CASE SERVICE DEMANDS – CENTRAL AND SOUTH AMERICA

- The comparison of five scenarios allow us to assess the EFDA CPI and Base scenarios. The following pictures show projected sectoral energy service demand for Latin America.
- In the residential and service sector the CPI scenario can be considered as it was a “*very high elasticity growth case*” while the EFDA Base scenario is a true base case, very close to (but a little bit lower than) the *WEO 2004 implicit elasticity scenario* and higher than the low elasticity case.
- In the industrial sector, the *WEO 2004 implicit elasticity scenario* yield a true base case, as energy service demands are placed in the middle between the High and Low elasticity scenarios. While the Base case is quite high, as it is “above” the High elasticity case, and EFDA CPI scenario show even much higher projected energy service demands for the whole period.
- In the transportation sector the *WEO 2004 implicit elasticity scenario* is placed between the High elasticity scenario and the Base case. The EFDA Base case is very close to the low elasticity scenario while the CPI projections are a little bit lower.

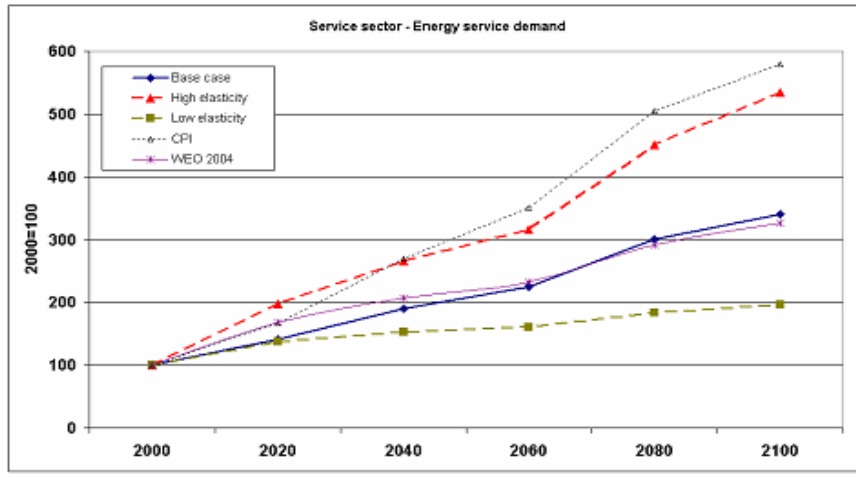
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## ALTERNATIVE SCENARIOS : CENTRAL AND SOUTH AMERICA – RESIDENTIAL SECTOR

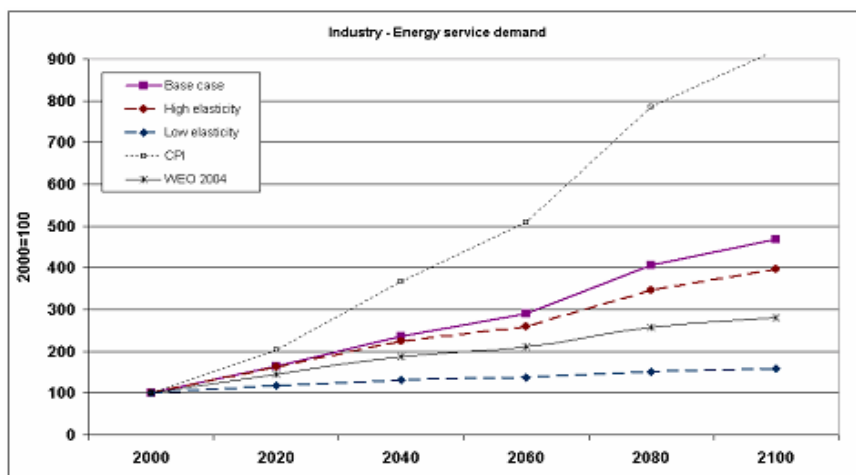


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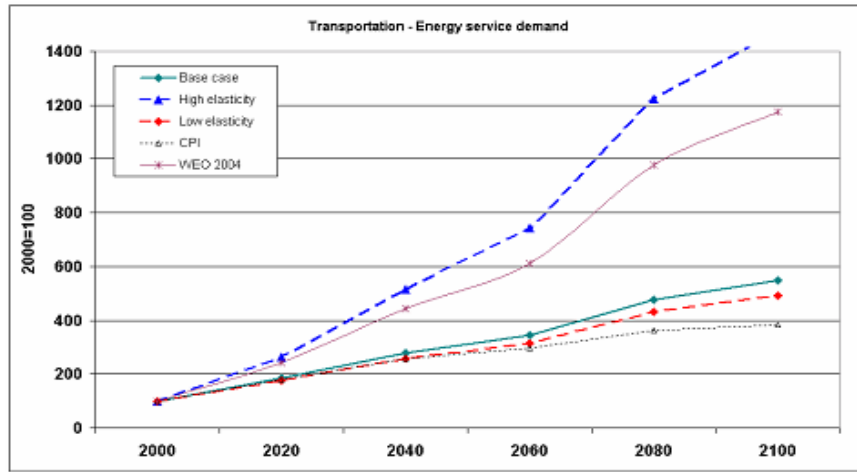
**ALTERNATIVE SCENARIOS : CENTRAL AND SOUTH AMERICA – SERVICE SECTOR**



**ALTERNATIVE SCENARIOS : CENTRAL AND SOUTH AMERICA – INDUSTRIAL SECTOR**



## ALTERNATIVE SCENARIOS: CENTRAL AND SOUTH AMERICA – TRANSPORT SECTOR



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## ASSESSMENT OF BASE CASE SERVICE DEMANDS ELASTICITIES OF ENERGY DEMANDS - AFRICA

driver EFDA model		2000	2020	2040	2070	2100	2000-2020	2020-2040	2040-2070	2070-2100
<b>Total final demand</b>	<b>GDP</b>	<b>13731</b>	<b>15914</b>	<b>21337</b>	<b>30939</b>	<b>38450</b>	<b>0.7%</b>	<b>1.5%</b>	<b>1.2%</b>	<b>0.7%</b>
Commercial	value added	219	226	356	695	1001	0.2%	2.3%	2.3%	1.2%
Industry	value added	2063	2843	4218	8307	12486	1.6%	2.0%	2.3%	1.4%
Chemical	value added	389	596	938	1932	2939	2.2%	2.3%	2.4%	1.4%
Iron-steel	value added	306	667	1171	1955	2145	4.0%	2.9%	1.7%	0.31%
Pulp / Paper	value added	26	39	62	118	170	1.9%	2.4%	2.2%	1.2%
Non-ferrous met.	value added	92	112	140	205	225	1.0%	1.1%	1.3%	0.3%
Non Metals	value added	75	130	203	385	554	2.8%	2.3%	2.2%	1.2%
Other Ind.	value added	1174	1300	1703	3710	6452	0.5%	1.4%	2.6%	1.9%
Residential	value added	8785	9676	12570	15486	16918	0.5%	1.3%	0.7%	0.3%
Res. Lighting	GDP-cap.	424	180	303	744	1339	-4.2%	2.7%	3.0%	2.0%
Res. Heat/Hot W./Cook.	population	8273	9332	11894	13972	14658	0.6%	1.22%	0.54%	0.16%
Res.-Other electr.	households	88	165	373	770	920	3.2%	4.2%	2.4%	0.6%
Transport	value added	2664	3169	4193	6451	8045	0.9%	1.4%	1.4%	0.7%
Road Bus, Rail	population	560	653	821	991	1058	0.8%	1.15%	0.6%	0.2%
Aviation	GDP	326	470	561	578	512	1.9%	0.9%	0.1%	-0.4%
Trucks	GDP	945	1115	1870	3415	4898	0.8%	2.6%	2.0%	1.2%
Road auto	GDP	449	424	381	928	1105	-0.3%	-0.5%	3.0%	0.6%
Navigation	GDP	384	506	559	538	473	1.4%	0.5%	-0.1%	-0.4%

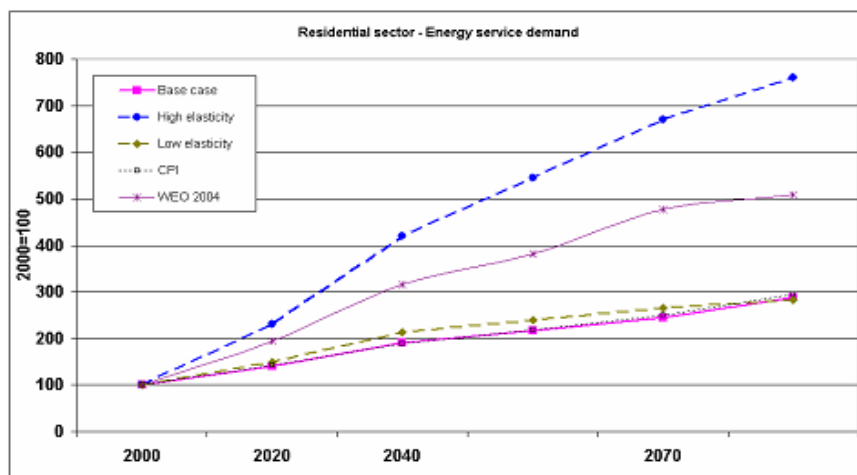
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## ASSESSMENT OF BASE CASE SERVICE DEMANDS – AFRICA

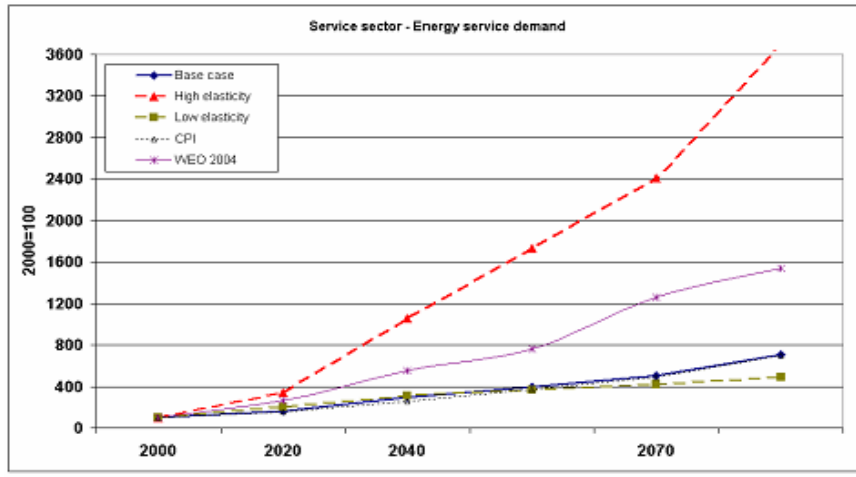
- The assessment of the CPI and Base scenarios for Africa is carried out in this section by comparing sectoral energy service projected demand coming from different scenarios.
- In the residential and commercial sector, energy service demands coming from both the EFDA Base and the CPI scenarios are almost equivalent to that coming from the Low elasticities case. In these two sectors it seems that the *WEO 2004 implicit elasticity scenario* yields a “true” base case, as it is always placed between the High and the Low elasticity scenarios.
- Projections for Industry are almost equivalent for the *WEO 2004 implicit elasticity scenario*, the CPI scenario and the EFDA Base scenario: one of these scenarios can be considered the “true” base case.
- In transportation, both CPI and EFDA Base case are lower than the Low elasticity case, while projections coming from WEO 2004 show a dramatic increase, even higher than the High elasticity case, that seem quite unrealistic.



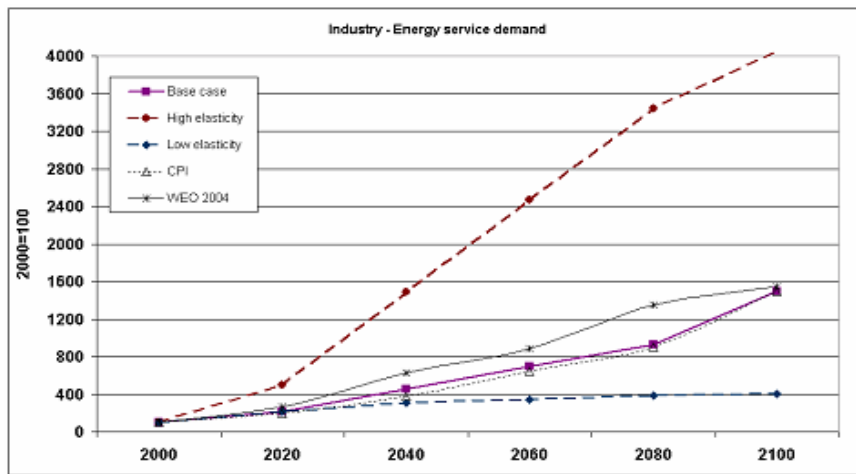
## ALTERNATIVE SCENARIOS: AFRICA – RESIDENTIAL SECTOR



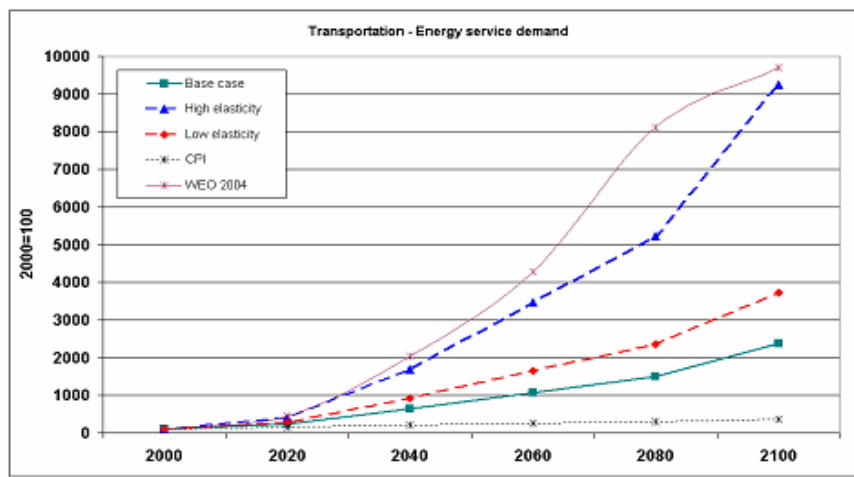
**ALTERNATIVE SCENARIOS:  
AFRICA- SERVICE SECTOR**



**ALTERNATIVE SCENARIOS:  
AFRICA - INDUSTRIAL SECTOR**



## ALTERNATIVE SCENARIOS: AFRICA – TRANSPORT SECTOR



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## DEMAND SCENARIOS IN TIMES-EFDA: SOME CONCLUSIONS

A first evaluation of the five different scenarios shows that:

- Projected demand based on WEO implicit elasticities behave as a true base case (is placed between the High and low growth projections) for most of the regions. There are some exceptions linked to the evolution of the service sector (for IND, WEU, FSU, ODA MEA) and the transportation sector (for MEA, ODA, AFR).
- Projected demand coming from Base CPI scenario are higher than demand coming from Base scenario; there are few exceptions: a) all the sectors for US, b) the transportation sector in all the regions but WEU. In general projected demand from the CPI scenario are very high for developing countries; estimates for the transportation sector are often lower than the Low Elasticity Growth case.
- Base projection behave quite well as a true base scenario for most of the regions. In some cases Base projections are closer to the Low growth scenario (i.e. the residential sector for WEU, US AFR and the service sector for ODA and AFR). In only two cases the projections are more similar to a High growth scenario (Industry in MEA and CSU). Base scenario is also close to the projection based on the WEO 2004 implicit elasticities in three cases over four.

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