

Scenario Analysis for Energy Conservation and CO2 Reduction in Iran

Paper presented in

17th REFORM Group Meeting

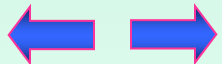
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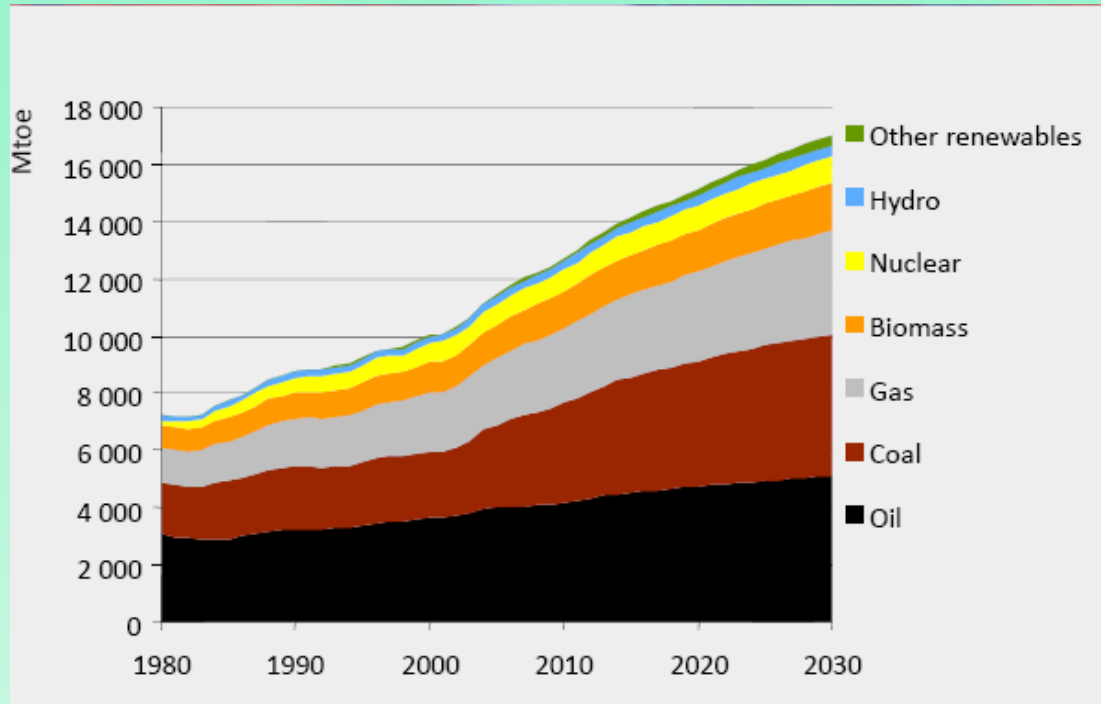
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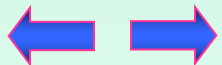
1.

World Primary Energy Demand, Reference Scenario

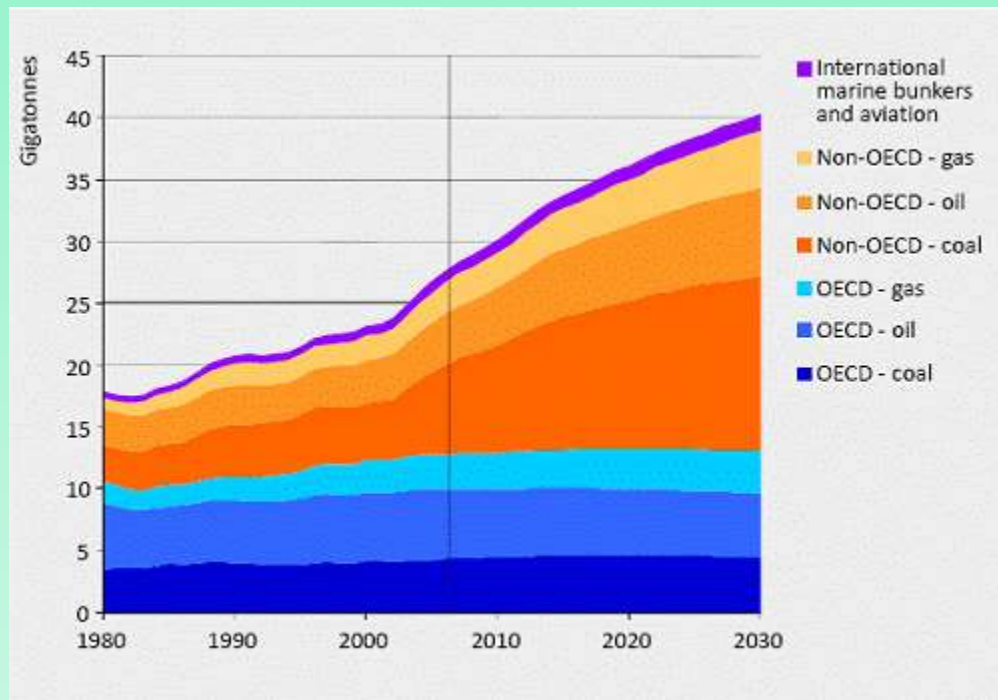


World energy demand expands by 45% between 2008 and 2030 – an average rate of increase of 1.6% per year – with coal accounting for more than a third of the overall rise

Source: "World Energy Outlook, 2008"

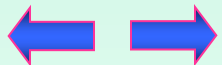


Energy-related CO₂ Emissions, Reference Scenario



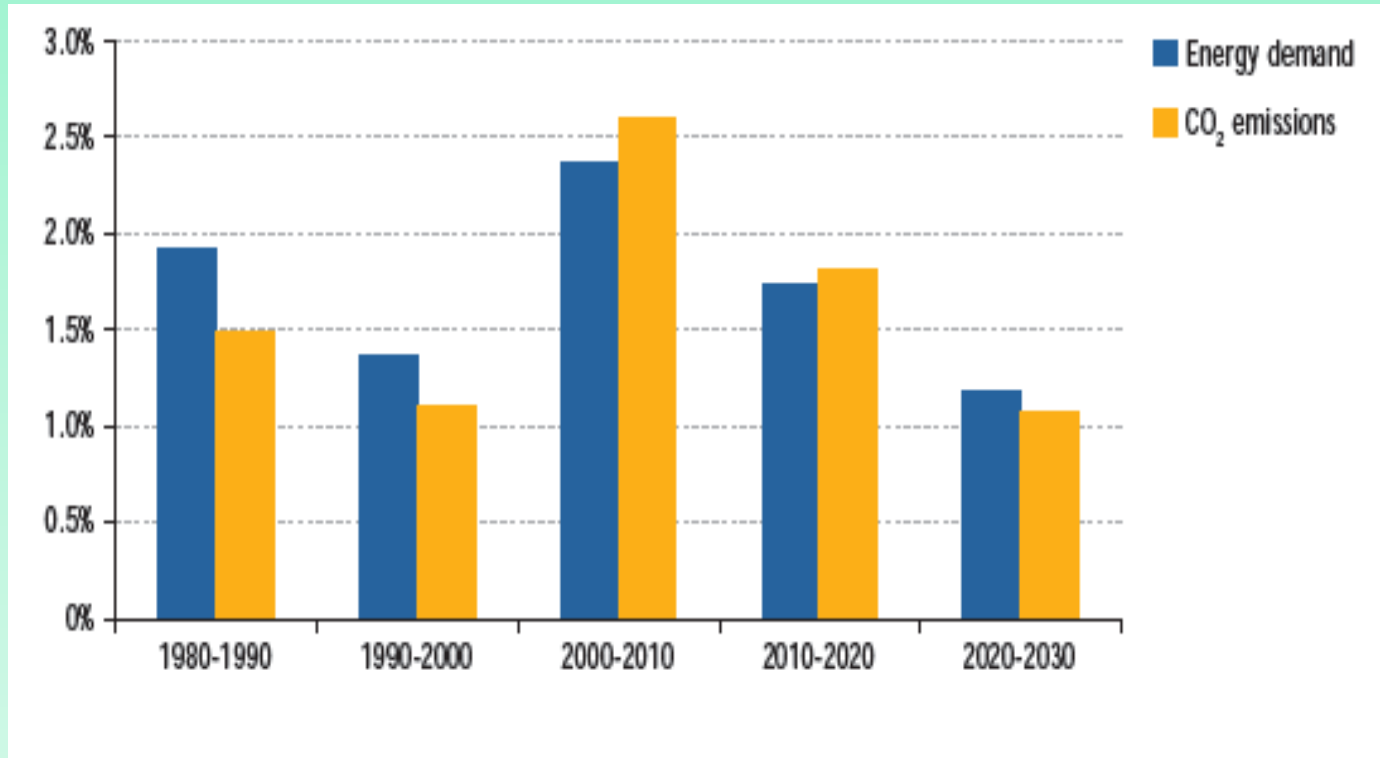
- 97% of the projected increase in emissions between 2008 & 2030 comes from non-OECD countries – three-quarters from China, India & the Middle East rise,
- Iron and steel production contributes most-around one-third- to the increase in industrial emissions, followed by non-metallic minerals, chemicals and petrochemicals production

Source: "World Energy Outlook, 2008"



1.

Average Annual Growth in world primary energy demand and Energy-related CO₂ Emissions, Reference Scenario



Source: "World Energy Outlook, 2008"

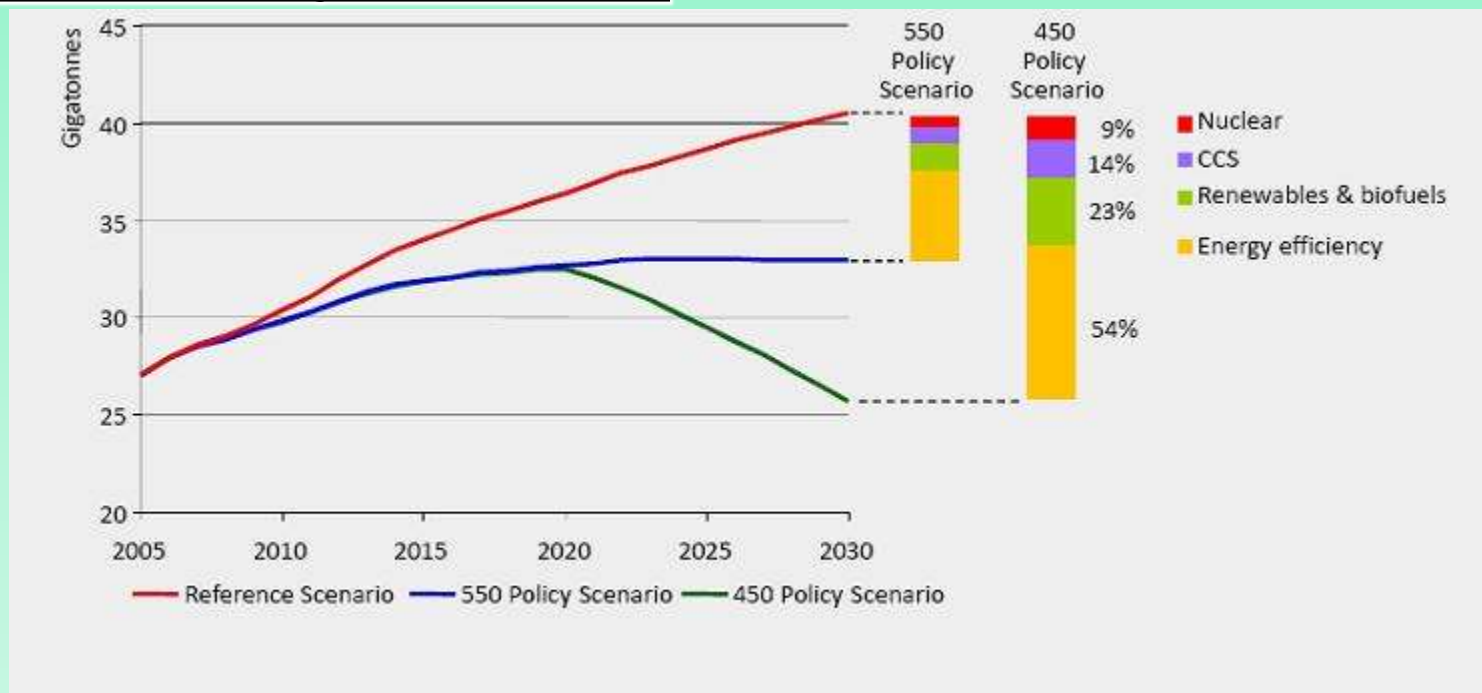
Average Annual Growth in world primary energy demand and Energy-related CO2 Emissions, Reference Scenario

Period	Trends	Reasons
1980 - 2006	Global energy related CO2 emissions rise : %1.7 per year	Expansion of natural gas and nuclear power in power mix
	Primary energy demand rise : %1.9 per year	
1990's	De-carbonization of energy sector started to slow and reverse	Fall back of nuclear power share and rise in coal use
2006	Tons of energy related CO2 emitted per \$1000 GDP : 0.45	De-carbonization of energy sector continues
2020	Tons of energy related CO2 emitted per \$1000 GDP : 0.35	De-carbonization of energy sector projected to continue
2030	Tons of energy related CO2 emitted per \$1000 GDP : 0.30	De-carbonization of energy sector projected to continue

Source: "World Energy Outlook, 2008"

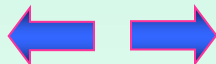
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Reductions in Energy-related CO2 Emissions in the Climate-Policy Scenarios



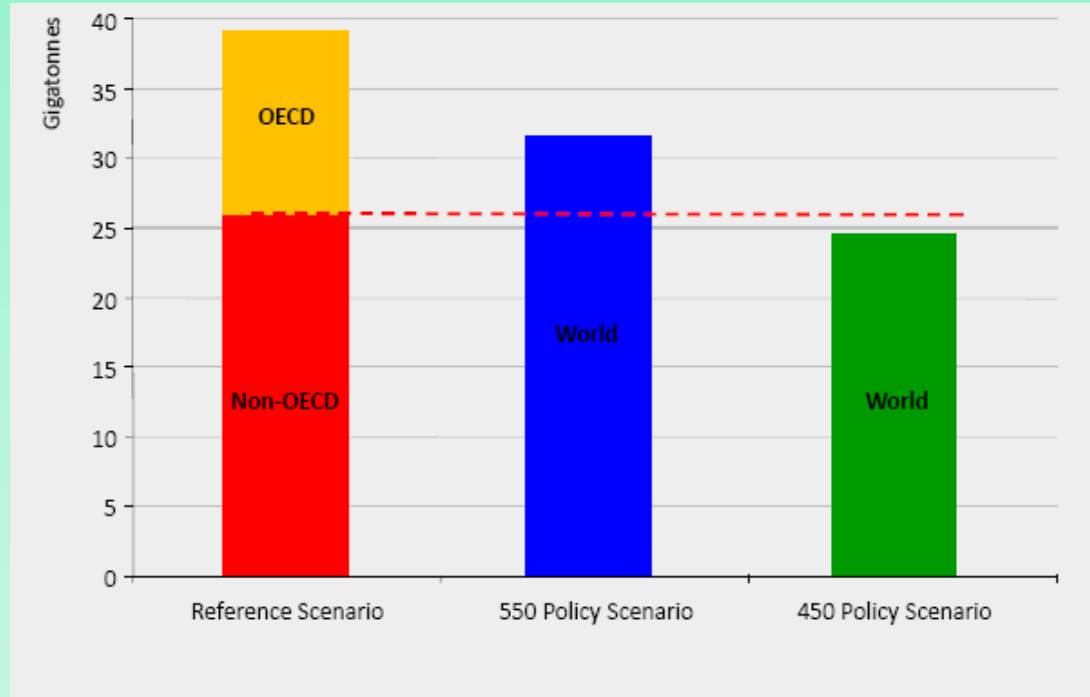
While technological progress is needed to achieve some emissions reductions, efficiency gains and deployment of existing low-carbon energy accounts for most of the savings

Source: "World Energy Outlook, 2008"



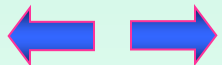
1.

World energy-related CO2 emissions by scenarios (2030)



OECD countries alone cannot put the world onto a 450-ppm trajectory, even if they were to reduce their emissions to zero

Source: "World Energy Outlook, 2008"



Key Results of Climate Policy Analysis

550 Policy Scenario

- Corresponds to a c.3°C global temperature rise
- Energy demand continues to expand, but fuel mix is markedly different
- CO2 price in OECD countries reaches \$90/tonne in 2030
- Additional investment equal to 0.25% of GDP

450 Policy Scenario

- Corresponds to a c.2°C global temperature rise
- Energy demand grows, but half as fast as in Reference Scenario
- Rapid deployment of low-carbon technologies – particularly CCS
- Big fall in non-OECD emissions
- CO2 price in 2030 reaches \$180/tonne
- Additional investment equal to 0.6% of GDP

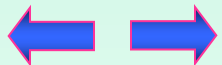
Source: "World Energy Outlook, 2008"

An Overview of Iran Economy and Energy Sector

GDP	210 Billion \$
- Agriculture	% 11.2
- Industry	% 41.7
- Service	% 47.1
Population	72.6 Million
- Growth	% 1.47
- Under 14	% 32
- Literacy	% 87
- Life Expectancy	70 yrs
GDP Growth Rate	% 2.5
GDP Per Capita	\$ 2890

Total Primary Energy Consumption	970 MBOE
- Power Gen.	% 28
- Household	% 27
- Transport	% 22
- Industry	% 14
- Others	% 9

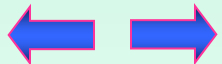
Source: "Energy Balance, Ministry of Energy, Iran - 2008"



Energy Production and Use, Iran

	Amount	Rank
Primary Energy Production	2121 MBOE	
Primary Energy Exports	1185 MBOE	
Primary Energy Imports	122 MBOE	
Primary Energy Use (+Power plants)	970 MBOE	
Oil Proven Reserve	132.5 bbl	3 (world), 2 (Middle East)
Oil Production	3.979 mbl/day	4 (world), 2 (OPEC)
Oil use	1.51 mbl/day	
Oil Exports	2.5 mbl/day	4 (world), 2 (OPEC)

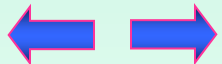
Source: "Energy Balance, Ministry of Energy, Iran - 2008"



Energy Production and Use, Iran

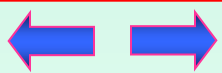
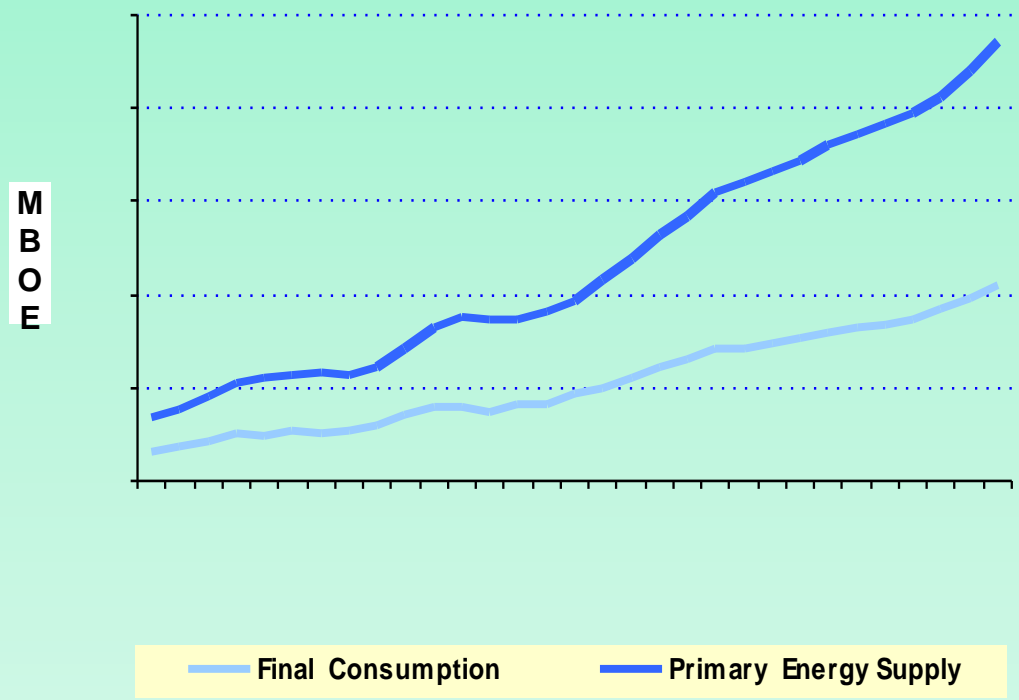
	Amount	Rank
Natural Gas Reserves	26.62 tcm	2 (world)
Natural Gas Production	83.9 bcm/year	7 (world)
Natural Gas Use (ex. Injection, vent, flare)	85.54 bcm/year	
Natural Gas Exports	3.56 bcm/year	
Natural Gas Imports	5.2 bcm/year	
Electricity Nominal Capacity	37.3 GW	
Electricity Production	155 bkWh/year	
Energy Use per capita	11.5 BOE/cap	
Energy Intensity (boe/million rials)	1.95	
Energy Factor (Consum. growth/GDP growth)	1.52	

Source: "Energy Balance, Ministry of Energy, Iran - 2008"



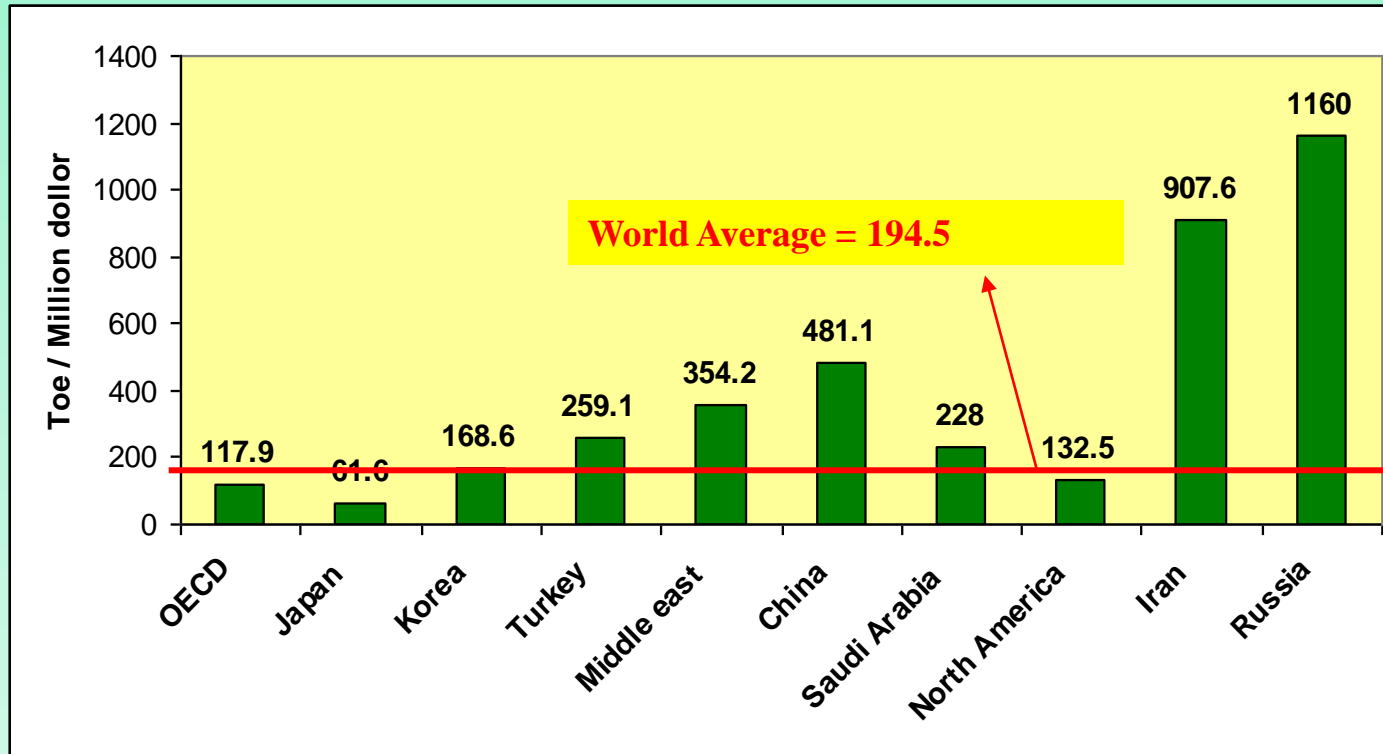
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Primary Energy Supply and Consumption, Iran (1974 – 2008)



Energy Intensity in Industry, Iran-World

Energy Intensity in Countries- 2008

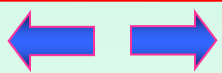
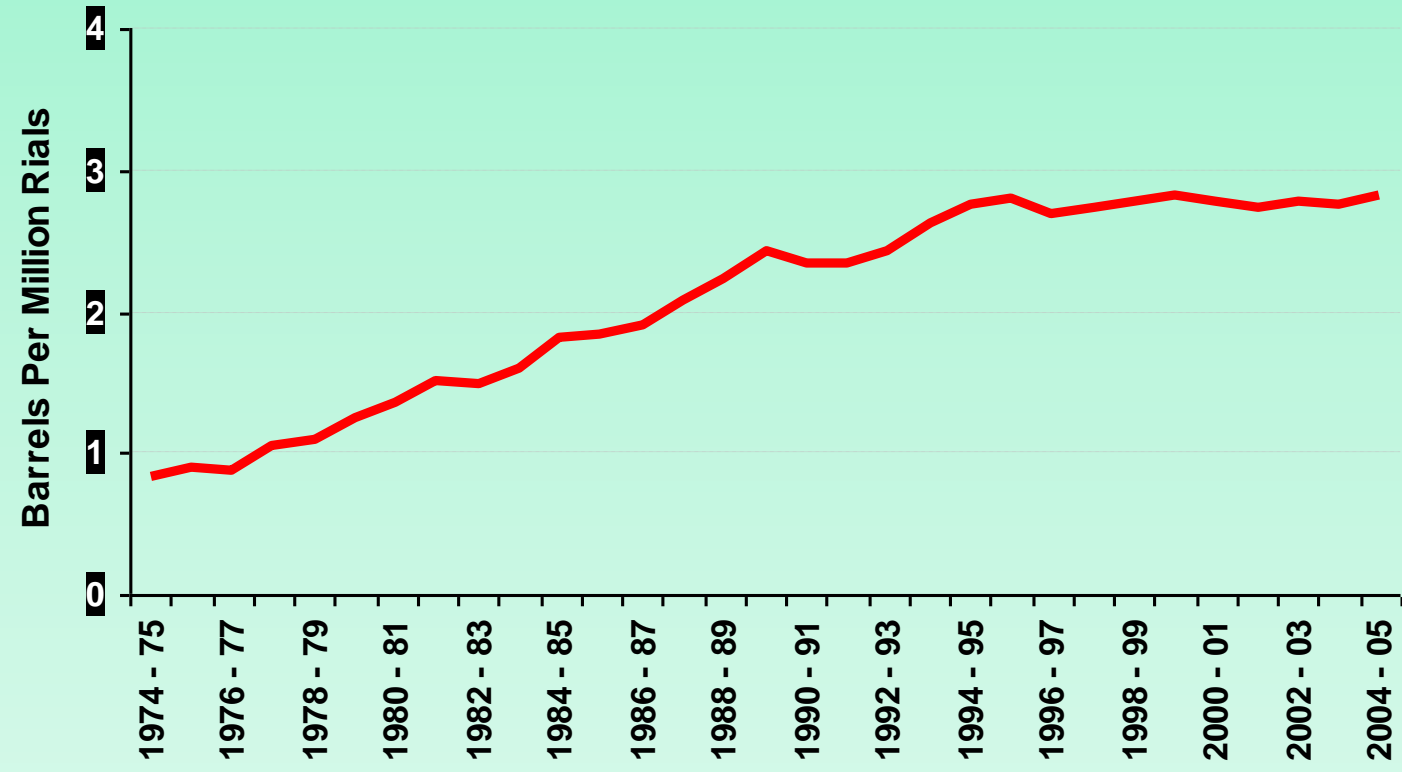


Energy Intensity in Iran is more than 4 times as much as World Average.

Source: "IFCO - 2008"

2.

Energy Intensity based on Constant 1997 Prices, Iran (1974 – 2005)



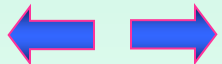
Energy Consumption, Iran-World

Comparison Between Iran & World Average,
in Terms of Industry Share in Energy Use

	Household & Commercial	Transport	Industry	Agriculture
World (2005)	36.74	30.98	29.71	2.59
Iran (2006)	45.81	29.03	21.20	3.96

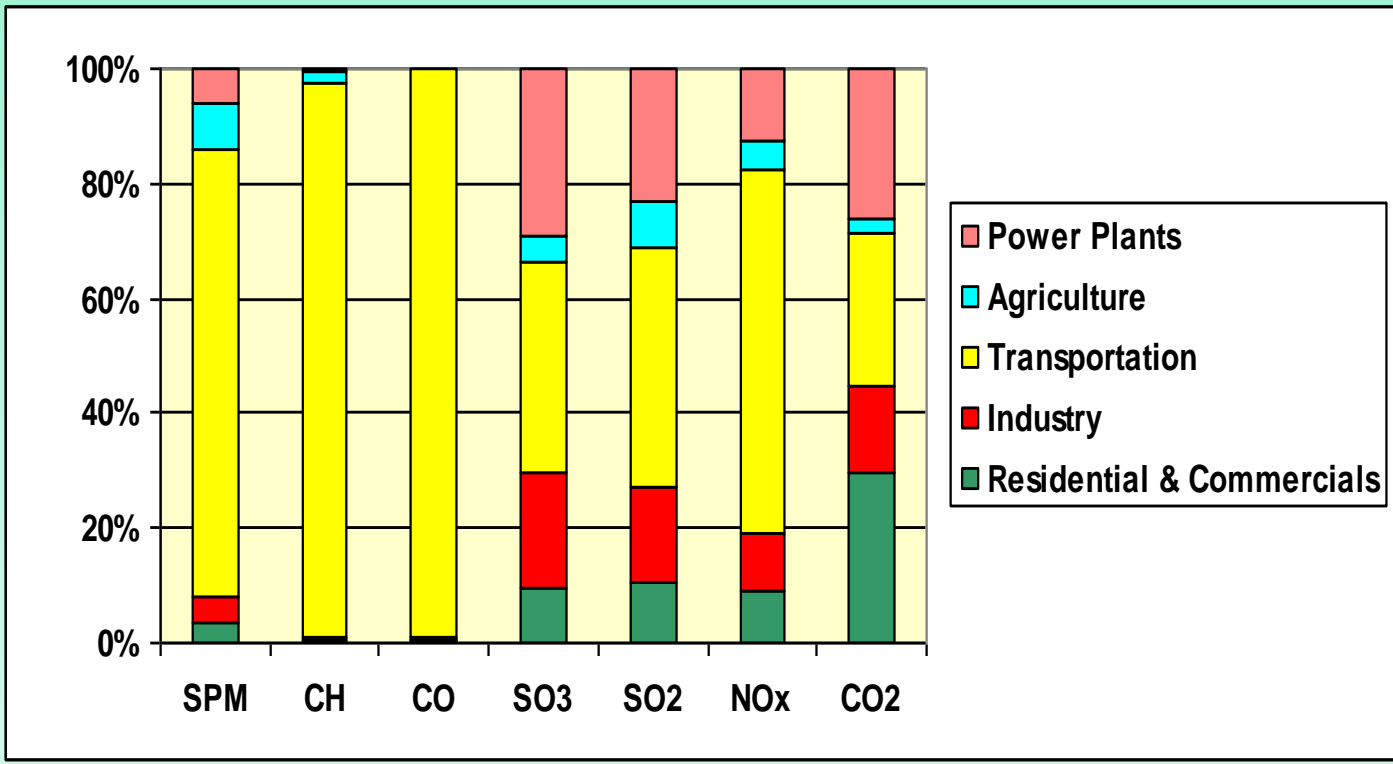
18.8% Share in GDP !

Source: "Energy Statistics of Iran-2008"

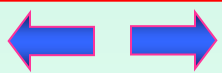


CO2 Emissions, Iran

Emissions / Share of Different Sectors – Iran – 2008

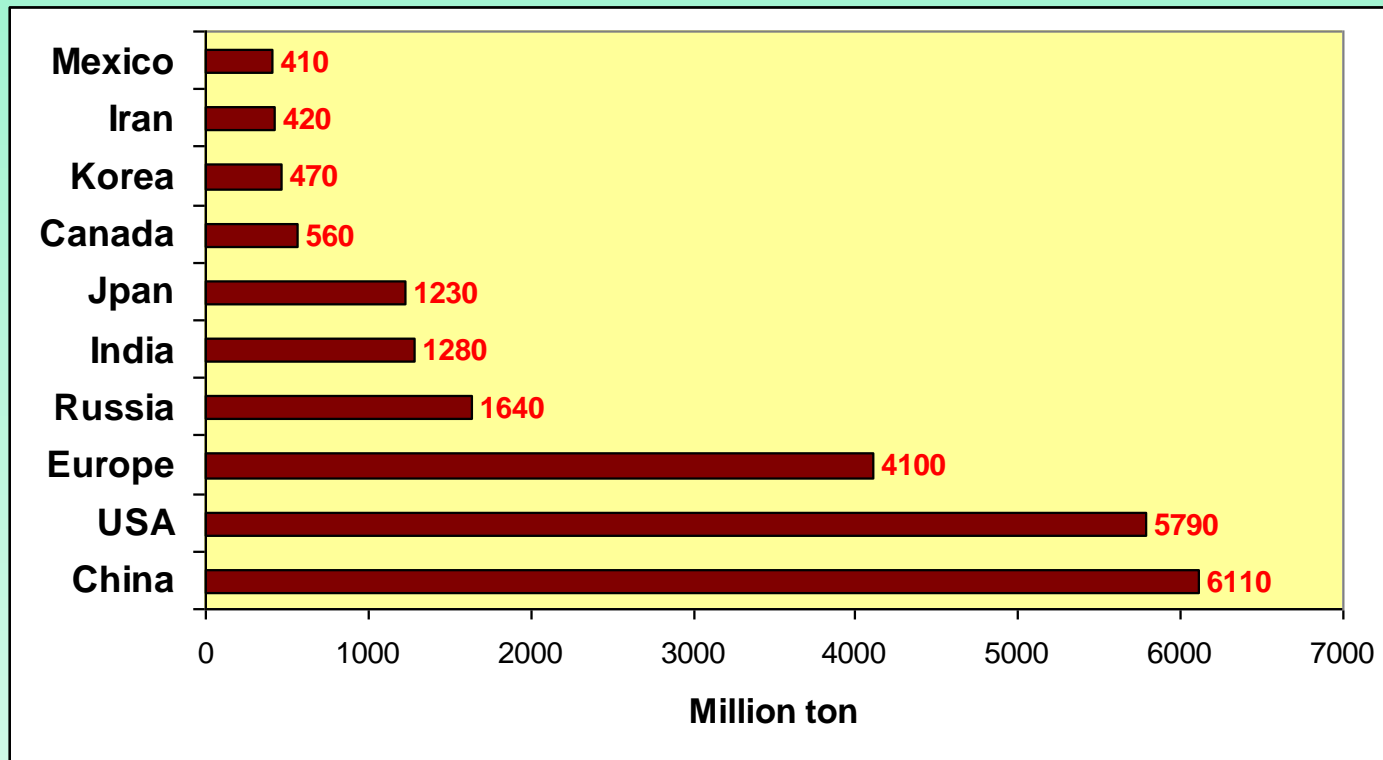


Source: "Energy Statistics of Iran-2008"

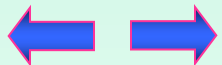


CO2 Emissions, Iran-World

Share of CO2 Emissions- 2008

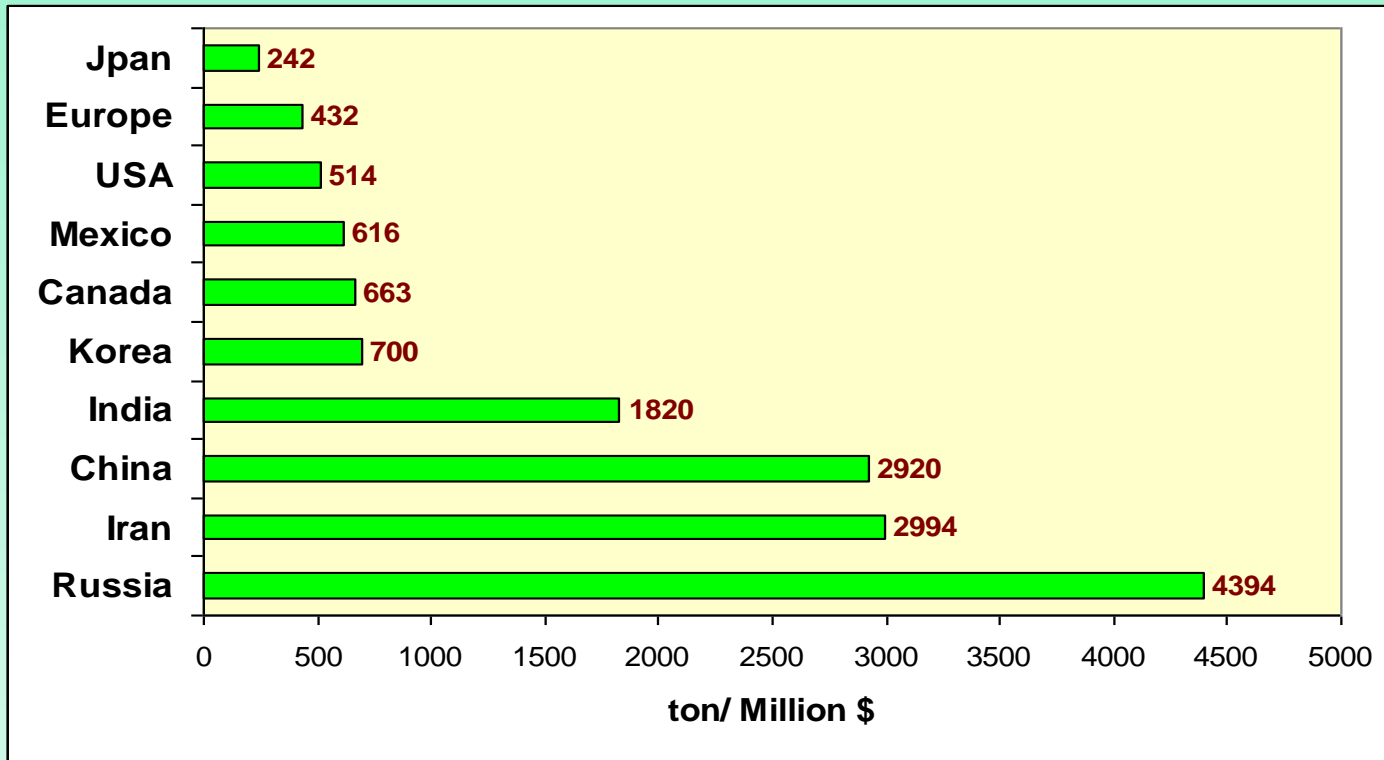


Source: "International Energy Annual- 2008 "

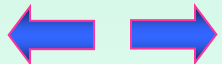


CO2 Emissions, Iran-World

CO2 Emissions / GDP- 2008



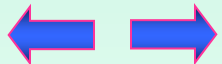
Source: "International Energy Annual- 2008 "



Energy Policies and Energy Subsidies in Iran

Although Iran does not have any comprehensive plan for energy, it has embarked some short run and medium run plans for energy production and consumption in different sectors:

- Heavy subsidization of energy use
- Meeting the OPEC production quota
- Development and utilization of Natural Gas
- Electrification of rural areas
- **And now cutting the energy subsidies and**

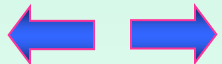


Energy Policies and Energy Subsidies in Iran

Iran's energy subsidies used to be one of the highest in the world. It ranged between 0.5 to 12 percent of GDP depending on different calculation method.

The local officials use the strict version of subsidies that includes only the direct payments by government or a difference between marginal or average cost and the price paid by consumers.

However, the agencies that report much higher estimates of subsidies include opportunity costs of energy products sales in the domestic market.



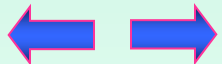
Energy Policies and Energy Subsidies in Iran

	Household	Industry	Agriculture	Transport	Commercial	Others	Total
Gasoline	-	0.1	0.0	17.6	0.0	0.1	17.8
Kerosene	7.5	0.0	0.2	-	0.1	0.2	8.2
Gas oil	1.3	3.8	4.2	15.0	0.6	1.4	26.3
Heavy Fuel Oil	-	9.9	0.1	0.6	1.2	0.2	11.9
LPG	2.6	0.0	-	0.4	0.2	-	3.1
Electricity	10	8	3.3	-	1.1	3.4	25.7
Natural Gas	4	2.5	-	-	0.5	-	7
Total	25.4	24.4	7.8	33.5	3.6	5.3	100
Source: Ministry of Energy, 2001							



Consequences of Energy Subsidies in Iran

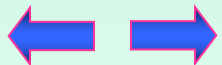
- i. Higher energy consumption and waste**
- ii. Weakening incentives for innovation and using efficient technologies**
- iii. Degrading environment by lowering quality of air in urban areas**
- iv. Placing a heavy burden on government budget**
- v. Cross-border smuggling of oil products to neighboring countries**



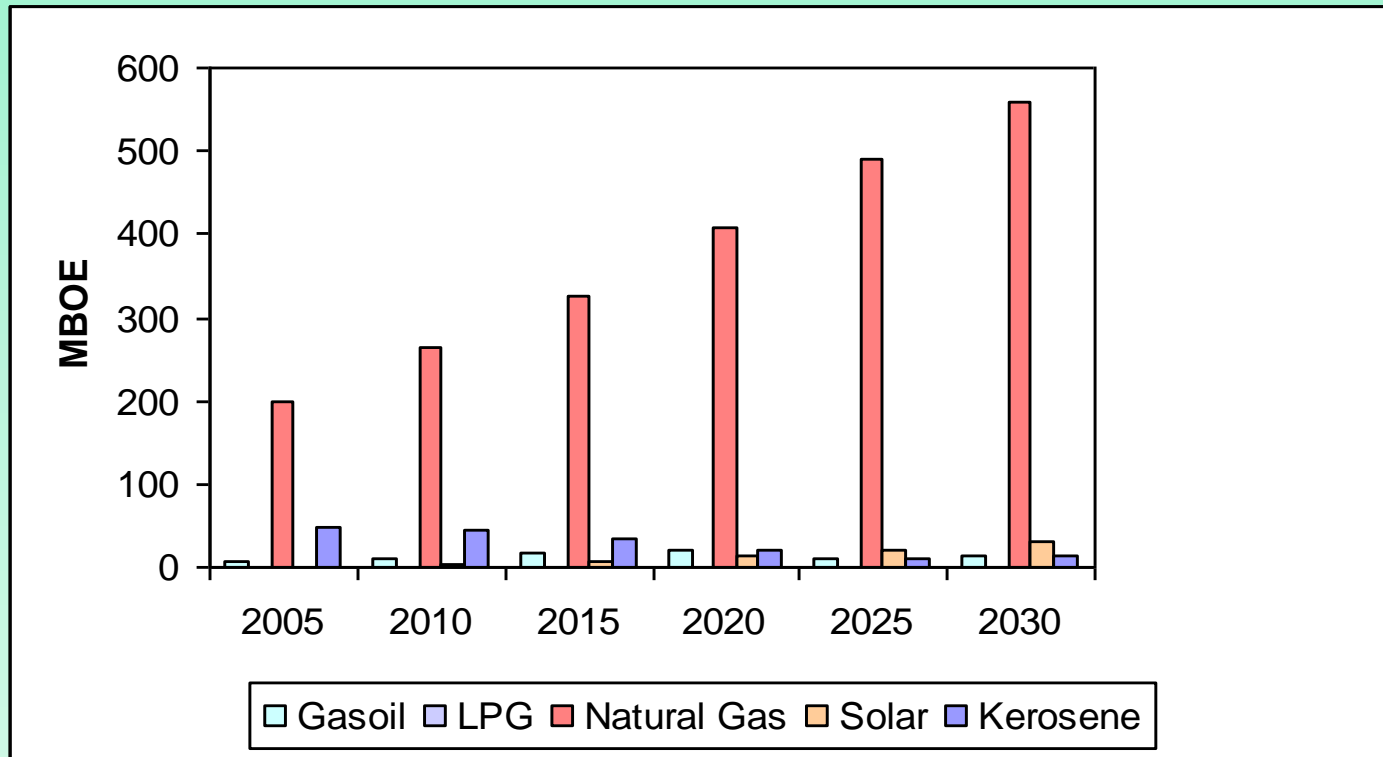
4.**GDP & Population Growth Assumptions in
BAU Scenario (2005-2030)**

% per year	2005-2010	2011-2020	2021-230
GDP growth	5.5	3.4	3
Population growth	1.3	1.4	0.9

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

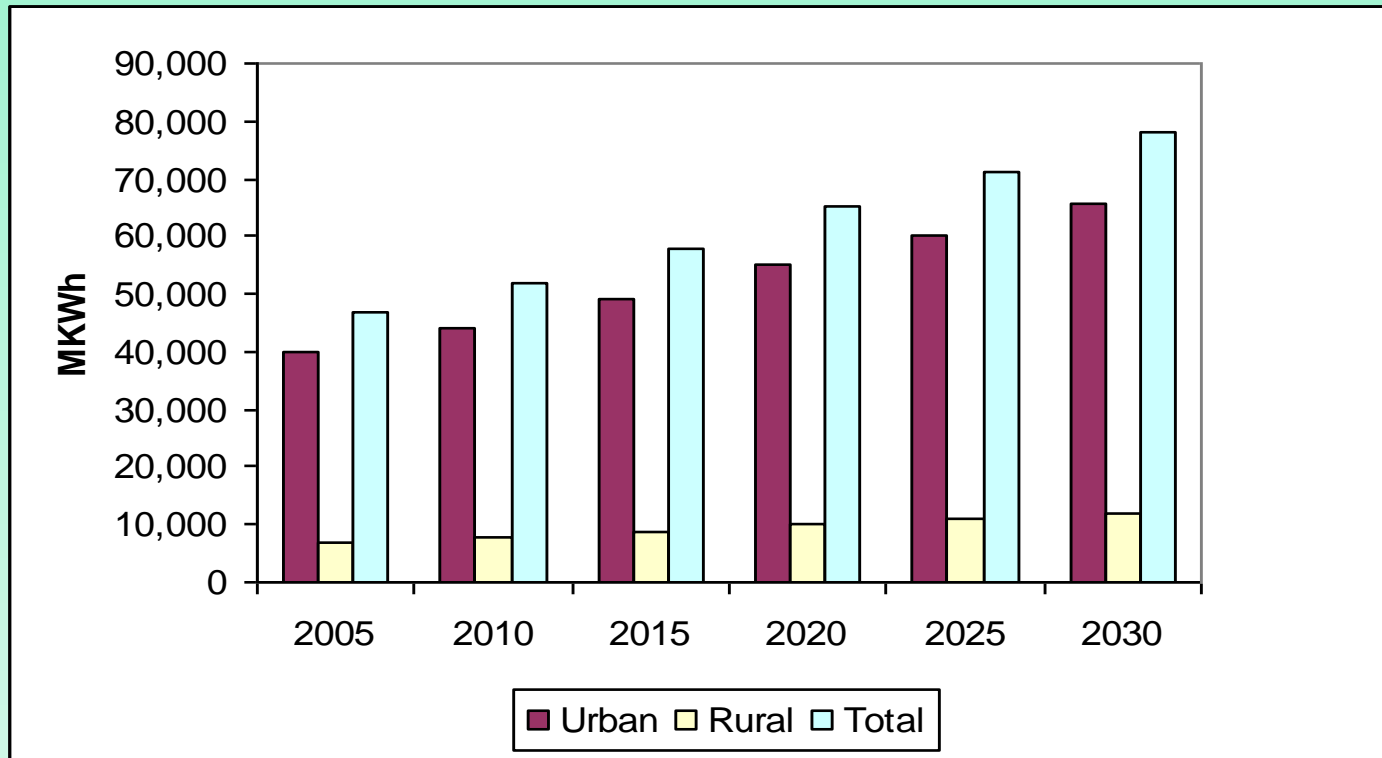


Energy Demand by Household, mboe BAU Scenario (2005-2030)



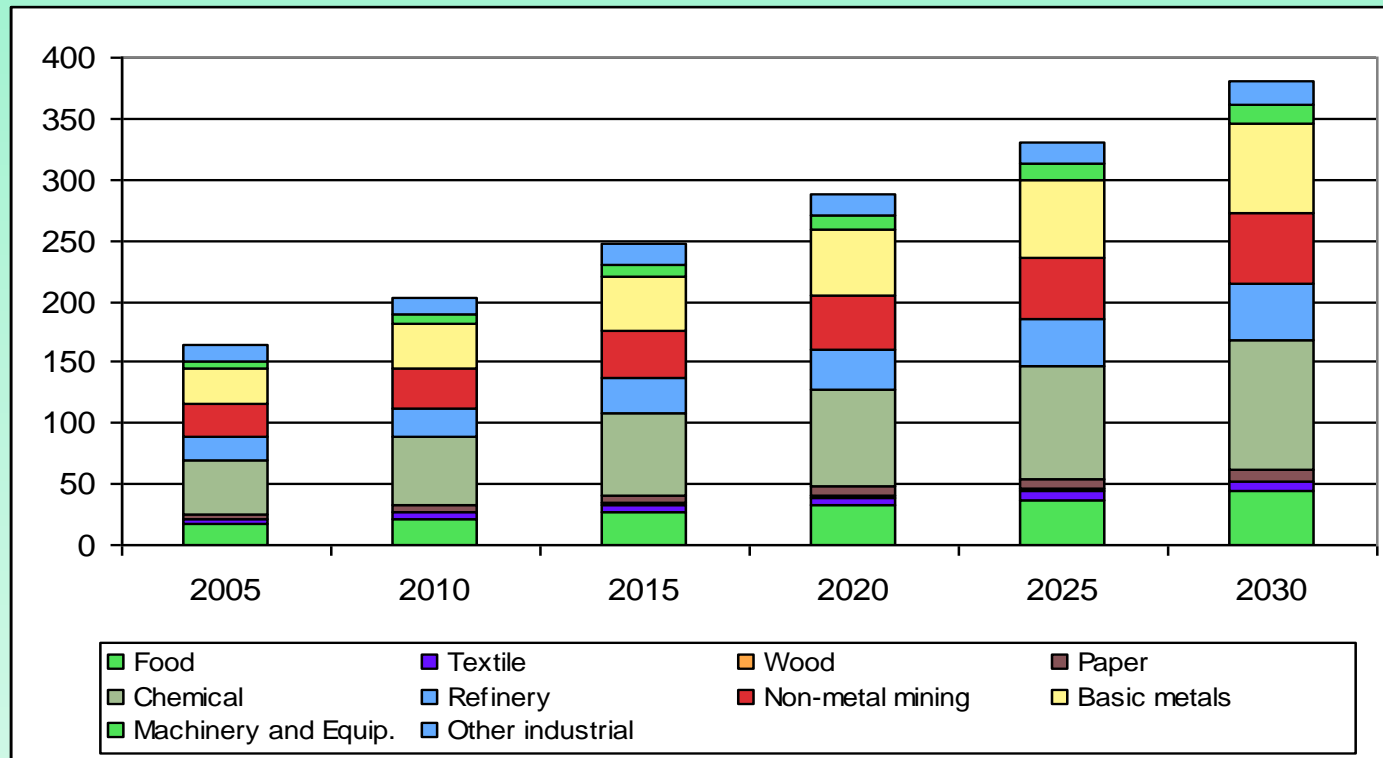
Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

Electricity Demand by Residential Sector, MkWh BAU Scenario (2005-2030)



Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

Energy Demand by Industries, mboe BAU Scenario (2005-2030)



Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

4.**Energy Demand by Power Plants, GWh**
BAU Scenario (2005-2030)

	2005	2030	Growth (%)
Total Fuel	458,500	717,184	+1.81
Gas Oil	47,312	44,827	- 0.22
Natural Gas (existing plants)	326,435	309,289	- 0.22
Natural Gas (new plants)		282,729	
Solar Heat Power Plants		37.28	
Heavy Fuel	84,753	80,302	- 0.22
Ave. Efficiency Factor (%)	39.7	46.1	

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

Energy Demand by Transport Sector, mboe
BAU Scenario (2005-2030)

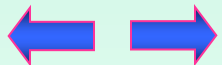
	2005	2030	Growth (%)
Gasoline	108	161	1.62
Gasoil (buses and trucks)	88	156	0.99
CNG	6	8	2.31
Gasoil (train)	2	5	3.82
Jet fuel	10	20	2.69
Ship fuel	2.48	3.82	1.75
Total	217	354	1.98

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

Energy Demand by Other Sectors, mboe BAU Scenario (2005-2030)

	Public			Commercial			Agriculture		
	2005	2030	Gr.	2005	2030	Gr.	2005	2030	Gr.
Gasoline	0.85	0.66	-1.0	0.06	0.03	- 3	0.09	0.12	0.91
Kerosene	1.83	0.95	- 2.6	0.47	0.21	- 3	0.50	0.17	- 4.06
Gas Oil	5.88	7.52	1.0	4.45	4.74	0	24.00	25.90	0.31
Fuel Oil	2.10	0.03	- 15.0	10.34	5.24	- 3	0.03	0.01	- 4.87
Electricity	13.42	22.84	2.0	5.27	17.51	5	10.00	26.60	3.66
N. G.	0.16	4.68	14.0	34.17	57.84	2			
Total	24.00	37.00	1.67	54.77	85.57	2	35.00	52.80	1.60

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"



Total Primary Energy Demand by Sectors, BAU Scenario (2005-2030)

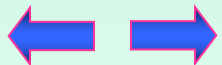
	2005 (mboe)	Share (%)	2030 (mboe)	Share (%)	Growth (%/year)
Households	259	37.2	592	42.8	3.4
Industries	135.6	19.4	326	23.6	3.6
Transport	218	31.5	356	25.8	2
Public	11	1.6	14	1.0	1
Commercial	49.5	7.1	68	4.9	1.3
Agriculture	24.5	3.5	26.2	1.9	0.3
Total	698	100	1,382	100	2.8
Electricity	272		440		1.9
Total (+Elect.)	970		1,822		2.6

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

CO2 Emissions in BAU Scenario (2005-2030)

		2005	2010	2020	2030
Oil					
	Demand - BAU	460	541	607	651
	CO2- emission	205.2	241.3	270.7	290.3
Gas					
	Demand – BAU	535	678	994	1,303
	CO2- emission	154.6	195.9	287.3	376.6
Total		359.8	437.2	558	667.1
<p>One barrel Oil contains 446 kg CO₂ , and one barrel oil equivalent gas contains 289 kg CO₂</p>					

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"



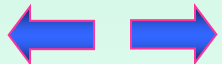
Scenario 1 - High Efficiency

Assumptions:

Focus only on energy intensity factors in different sectors, while keeping all other factors such as using renewable energies constant.

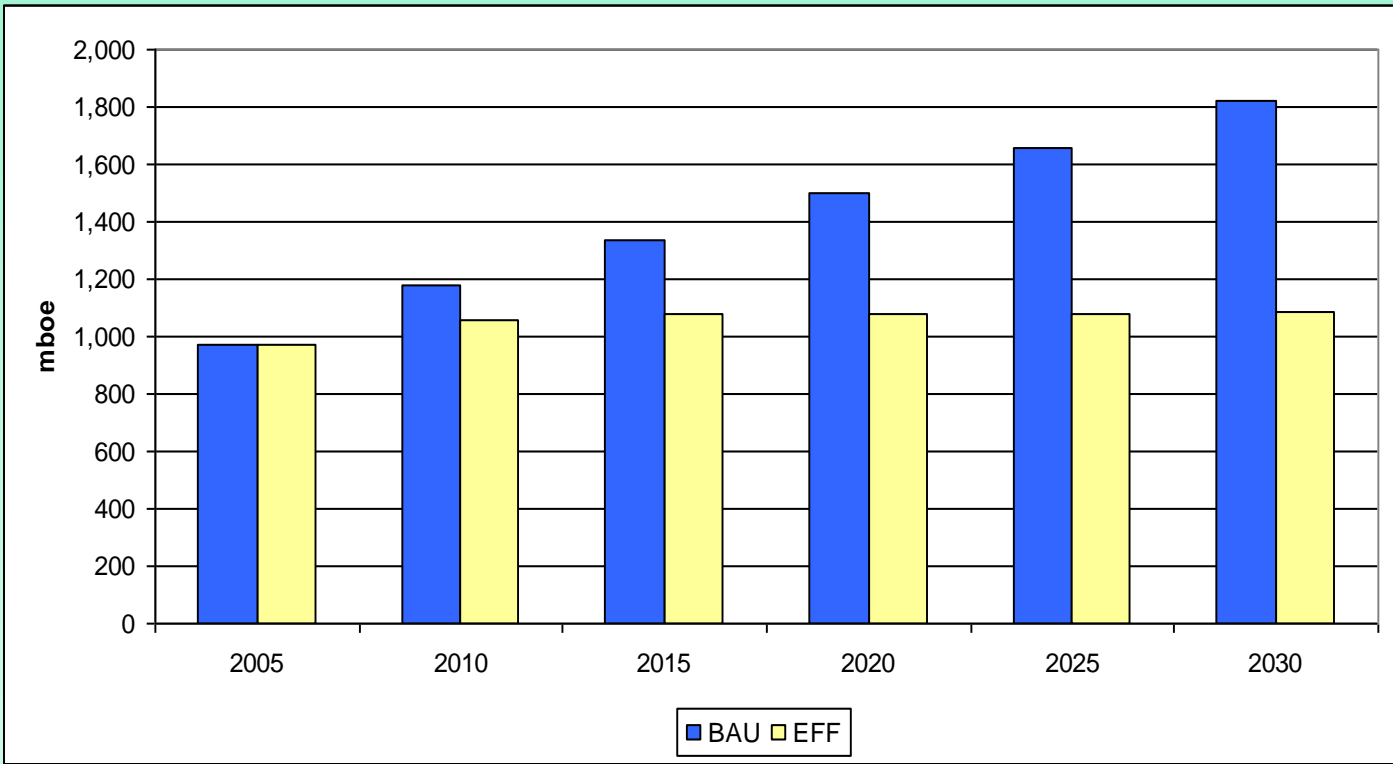
- **Technology Advancement**
 - low consumption light bulbs and appliances
 - improvement in production processes
 - cars with more efficient engines
- **Changes in structure of economy**
 - in favor of less energy intensive production processes
- **Price Reform**
 - people will be more vigilant in their use of energy

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

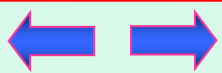


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Total Primary Energy Demand in High Efficiency and BAU Scenarios (2005-2030), mboe

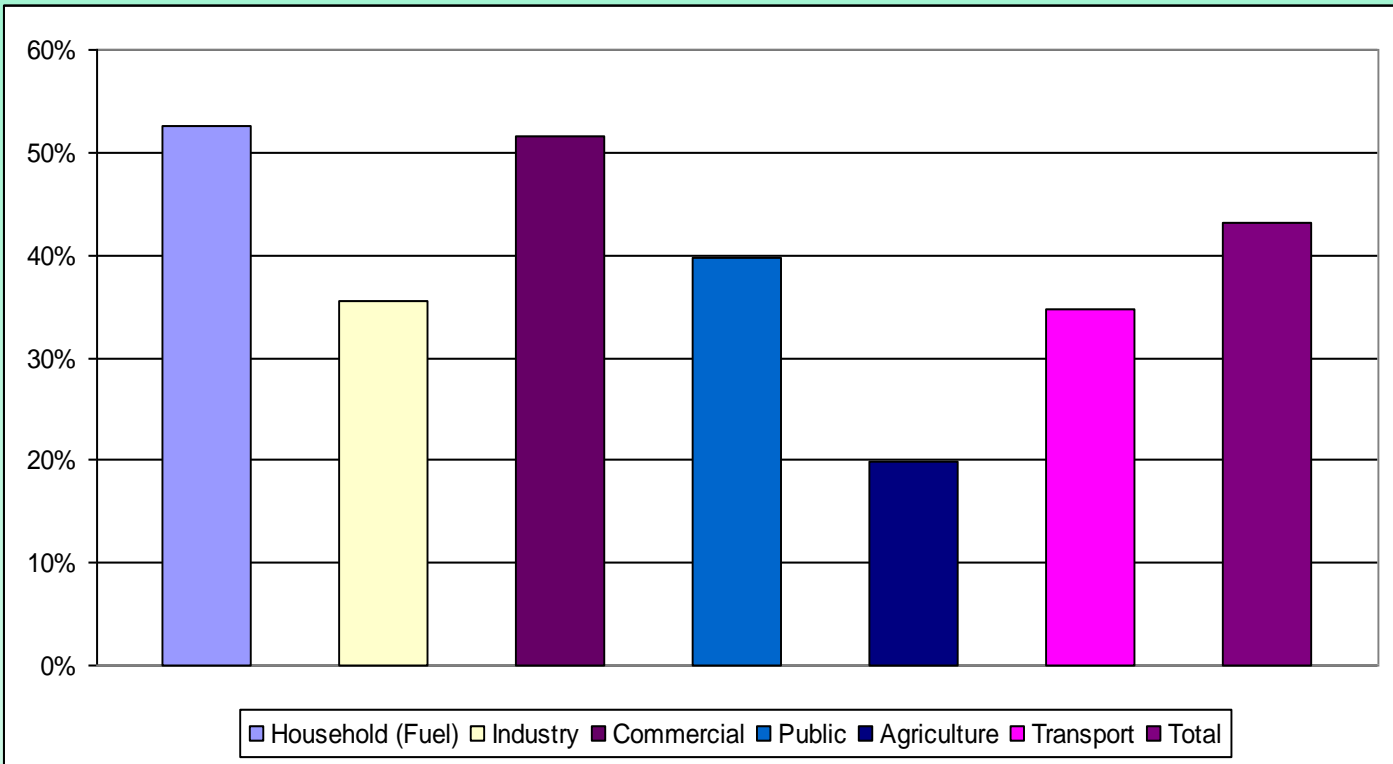


Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

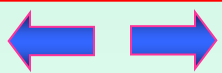


5.

Reduction in TPE Demand in High Efficiency Scenario and Different Sectors (2005-2030), %



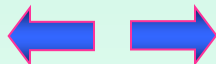
Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"



CO2 Emissions Reduction in High Efficiency Scenario

		2010	2020	2030
Oil				
	Saving	42	132	92
	CO2- emission Saving	19.6	61.5	89.5
Gas				
	Saving	81	293	538
	CO2- emission Reduction	23.4	84.7	155.5
Total	CO2-emission Reduction	43.0	146.2	244.0
<p>The BAU scenario is a basis for comparison. Savings are in MOBE and the CO2-emissions are in MT.</p>				

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"



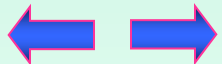
Scenario 2 - High Renewable

Assumptions:

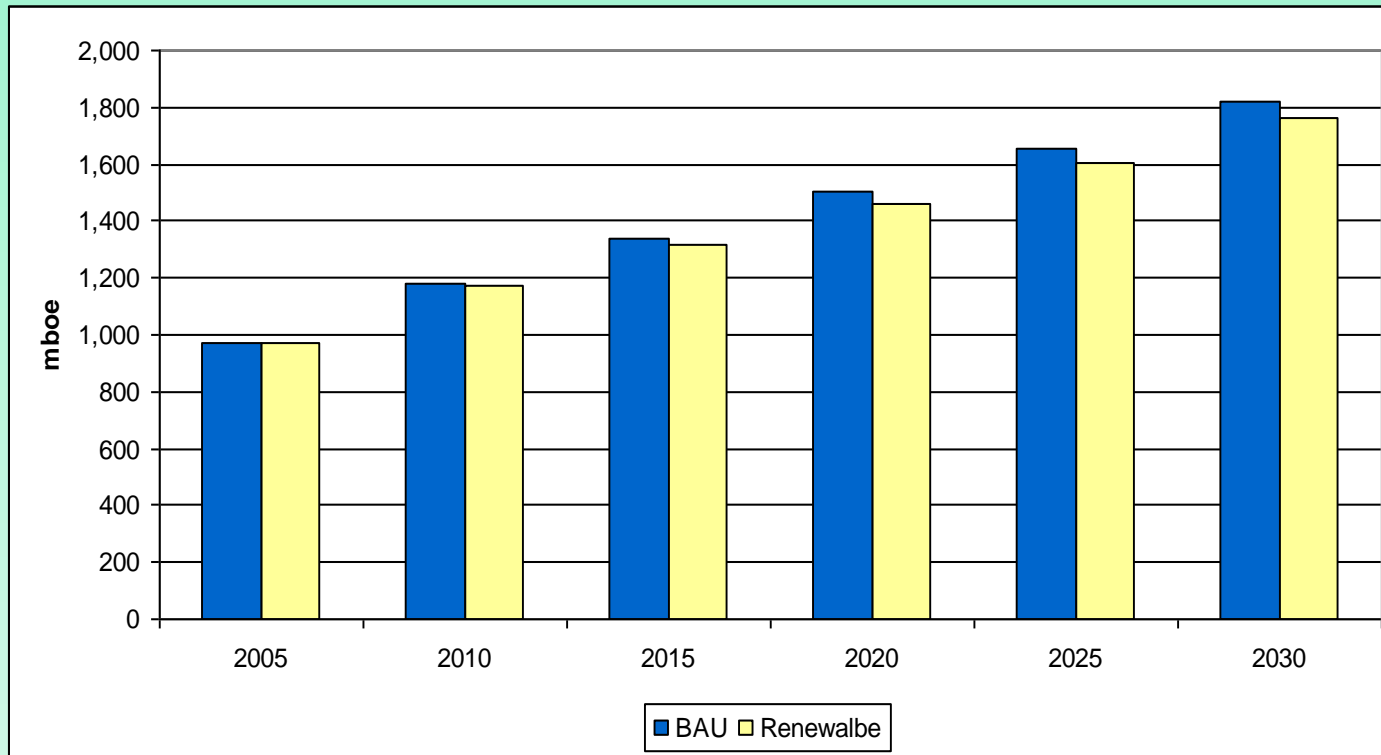
Focus only on renewable energies potential in Iran, while keeping the energy parameters at BAU level.

- **Review of various studies conducted on RE resources**
 - national and international studies
 - different sectors
- **Examine all potential resources in Iran**
 - wind, hydro, biomass, geothermal, solar
- **Targeting**
 - share of renewable energies will reach %16 in 2030

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"



Total Primary Energy Demand in High Renewable and BAU Scenarios (2005-2030), mboe

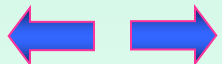


Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

CO2 Emissions Reduction in High Renewable Scenario

		2010	2020	2030
Oil				
	Saving	3	20	48
	CO2- emission Saving	11.4	9.3	22.4
Gas				
	Saving	8	72	163
	CO2- emission Reduction	2.3	20.8	47.1
Total	CO2-emission Reduction	3.7	30.1	69.5
<p>The BAU scenario is a basis for comparison. Savings are in MOBE and the CO2-emissions are in MT.</p>				

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"



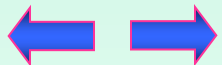
Scenario 3 - Combined Efficiency & Renewable

Assumptions:

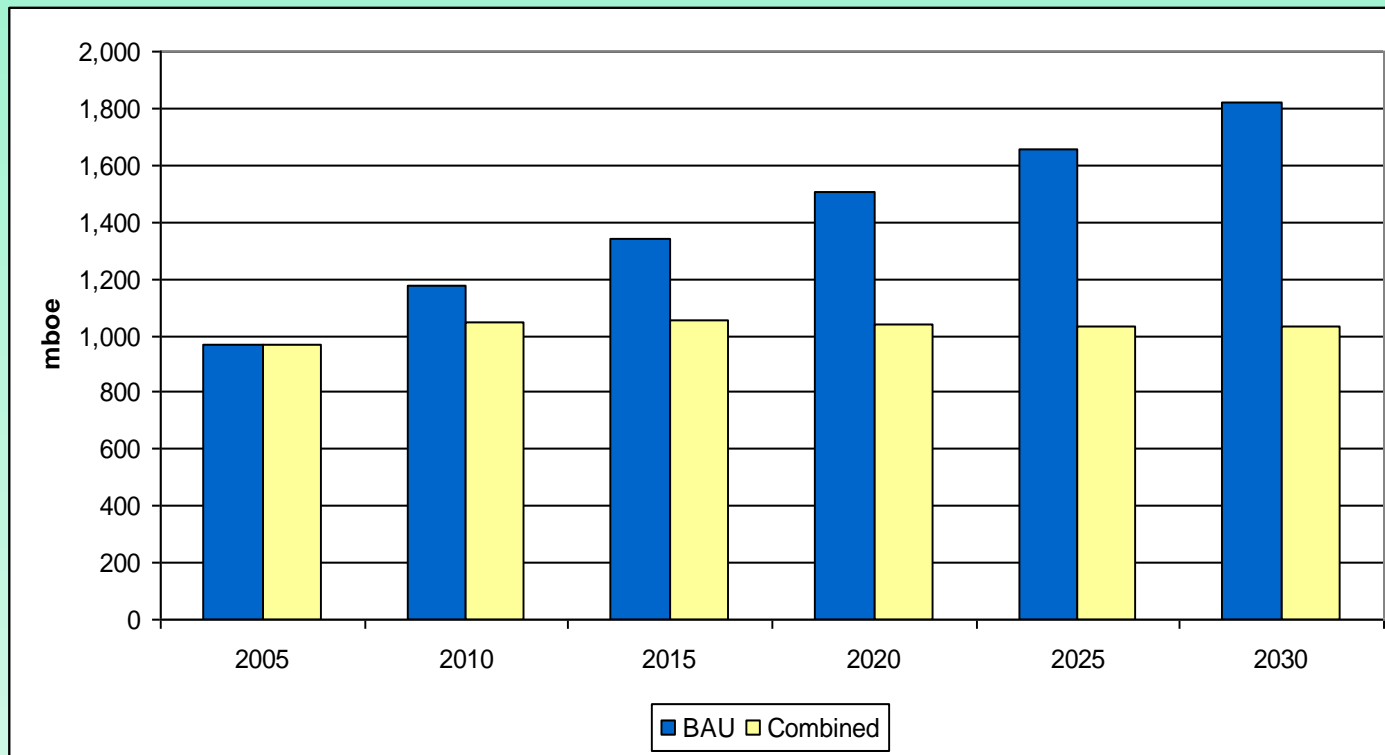
We combine high-renewable and high-efficiency scenarios.

- **Total energy demand in 2030**
 - 1030 MBOE (%43 saving compare to BAU)
- **Average growth rate**
 - will be %0.2 per year (2005-2030)

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"



Total Primary Energy Demand in Combined and BAU Scenarios (2005-2030), mboe

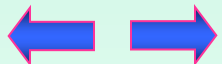


Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

CO2 Emissions Reduction in Combined Scenarios

		2010	2020	2030
Oil				
	Saving	4.4	151	249
	CO2- emission Saving	20.5	117	116
Gas				
	Saving	88	348	630
	CO2- emission Reduction	25.4	100.6	183
Total	CO2-emission Reduction	45.9	217.6	298
<p>The BAU scenario is a basis for comparison. Savings are in MOBE and the CO2 emissions are in MT.</p>				

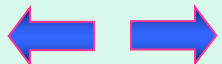
Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"



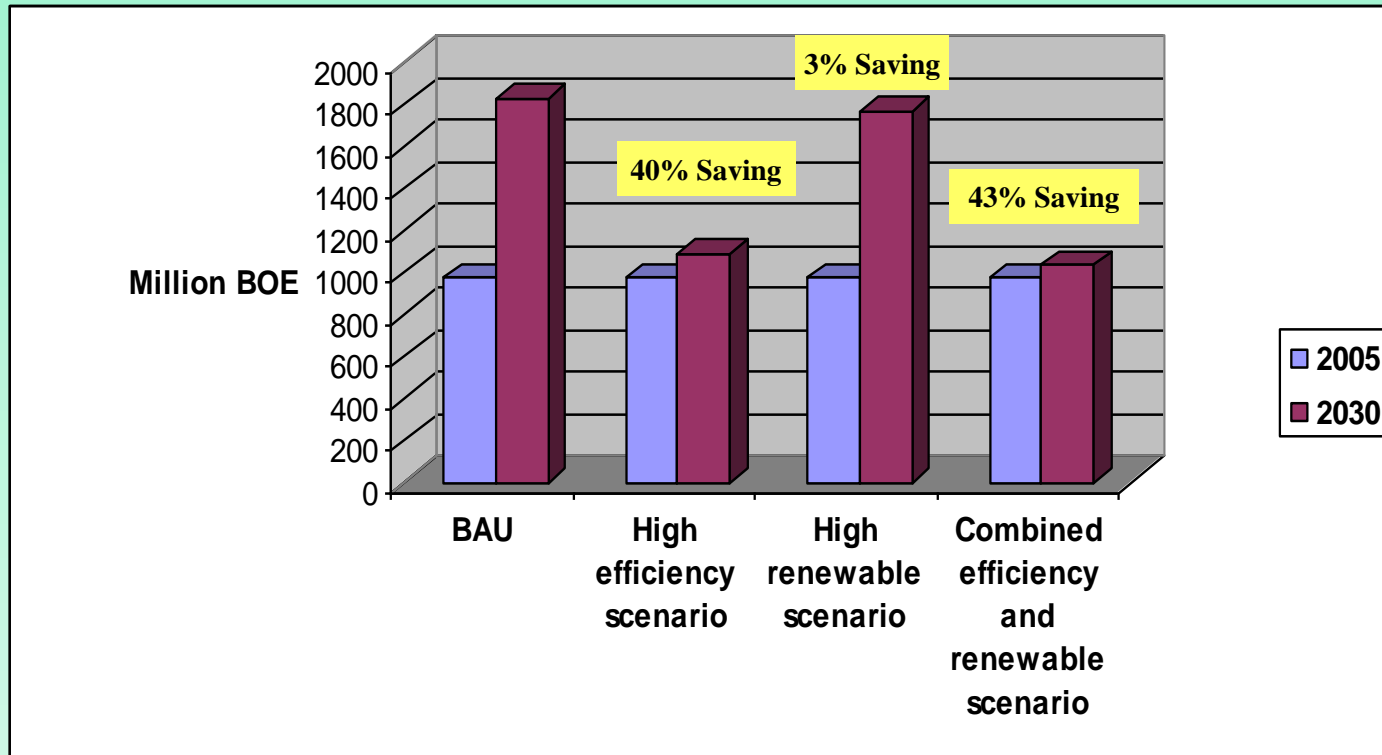
Comparison of Scenario Results (2005-2030)

Scenario	Primary Energy Demand (mboe)		Growth per year (%)	Savings vs. BAU by 2030 (%)
	2005	2030		
BAU	970	1,822	2.6	-
High-Efficiency	970	1,084	0.4	40
High Renewable	970	1,760	2.4	3
Combined	970	1,030	0.2	43

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

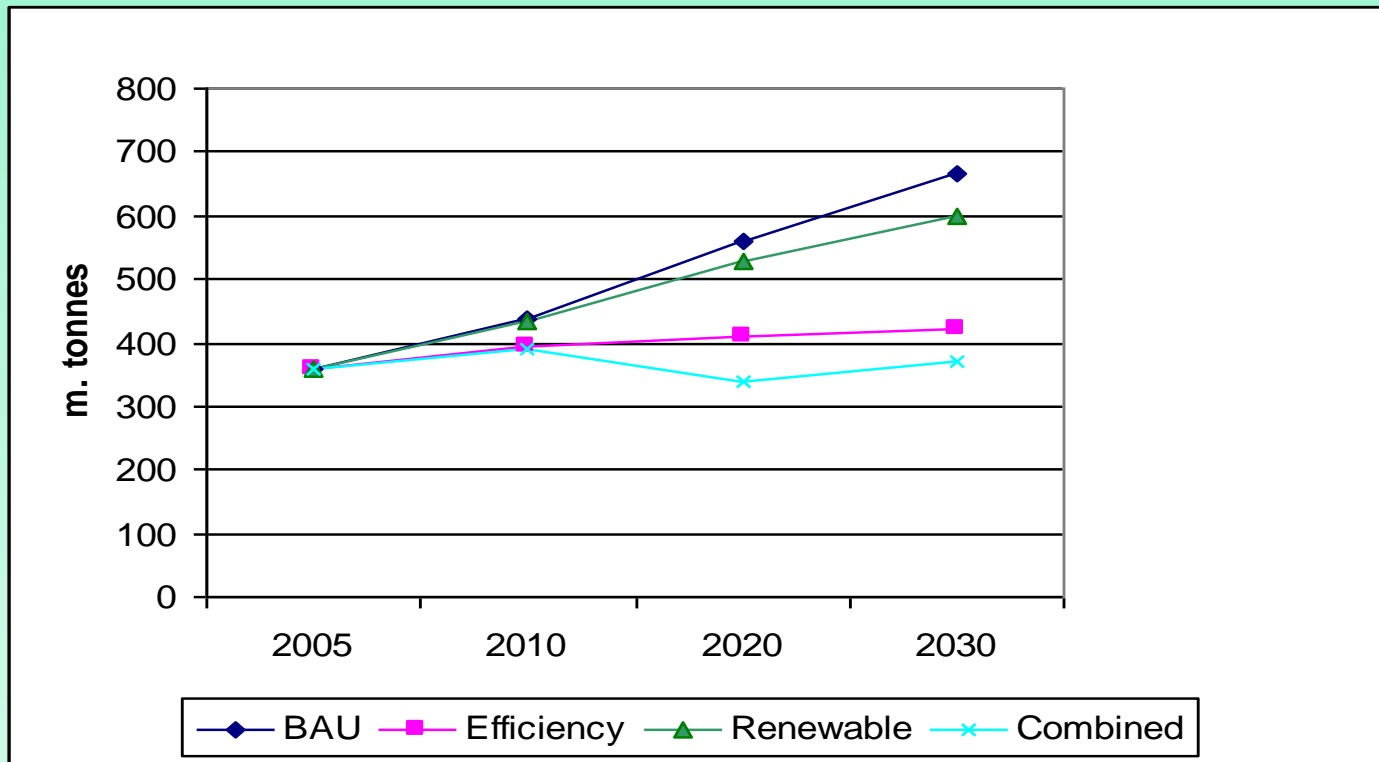


Iran Primary Energy Demand, Scenarios



Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

CO2 Emissions in Alternative Scenarios (2005-2030)



Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"

CO2 Emissions in Alternative Scenarios (2005-2030)

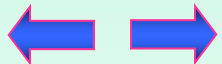
Reduction in energy-related CO2 emissions in different scenarios (2005 – 2030)

% 36.58 in efficiency scenario

% 10.42 in renewable scenario

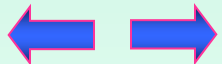
% 44.67 in combined scenario by 2030

Source: "Energy Scenarios for Iran, Iran/ Germany, 2009"



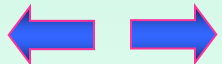
Conclusions

- Current energy trends of the world are obviously unsustainable, socially, environmentally and economically.
- To avoid "rapid and irreversible" climate change, we need a major decarbonisation of the world's energy system.
- Iran energy demand expands by 87.7% between 2005 and 2030, an average rate of increase of 2.6% per year, with natural gas accounting for the most rise by 3.5%, and Kerosene with the most decline by 4.6%.
- Energy intensity in Iran's industry sector is 4.6 times greater than the World average.
- Share of industry sector in Iran is 21%, while the World average is 30%. This implies that we have a long way to go in order to become an industrial country.



Conclusions

- Rank of Iran in the world, with respect to CO2 emissions /GDP reconfirms the inefficient use of energy in different sectors
- Iran's energy subsidies are one of the highest in the world and has had counterproductive consequences on energy demand. It ranges between 0.5 to 12 percent of GDP depending on different calculation method.
- Iran energy demand in different sectors between 2005 and 2030, with process industries accounting for the most rise by an average rate of 3.6% per year, followed by 3.4% for residential and 2% for transportation.
- Iran energy demand in different scenarios between 2005 and 2030, by an average growth rate of 2.6% (BAU), 0.4% (efficiency), 2.4% (renewable) and 0.2% (combined) per year
- Should the combined scenario be followed, 45 percent reduction in CO2 emissions can be realized by 2030.



Thanks for your attention

