

ASSESSMENT OF EMISSION FACTORS AND MITIGATION OPTIONS IN ELECTRICITY SECTOR OF TURKEY: A MODEL STUDY

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CO₂ Emissions & TURKEY

- Turkey ranks among the fastest growing energy markets in the world.
- energy-related CO₂ emissions have more than doubled since 1990.
- In 2008, the highest CO₂ increase is in energy sector by 114% comparing to 1990.
- GHG emissions in 2008 is about 367 Mtons,
→ 74% of this comes from energy production sector with 271 Mtons (TURKSTAT, 2010).



TURKEY's Electricity Sector

2009: Total national installed capacity is about 45.000 MW

1990: it was about 16.000 MW

the average annual growth rate of 5%.

Generation:

1990- about 58.000 GWh

2009- about 194.000 GWh

average growth rate is 6,7%

TURKEY'S Electricity Sector

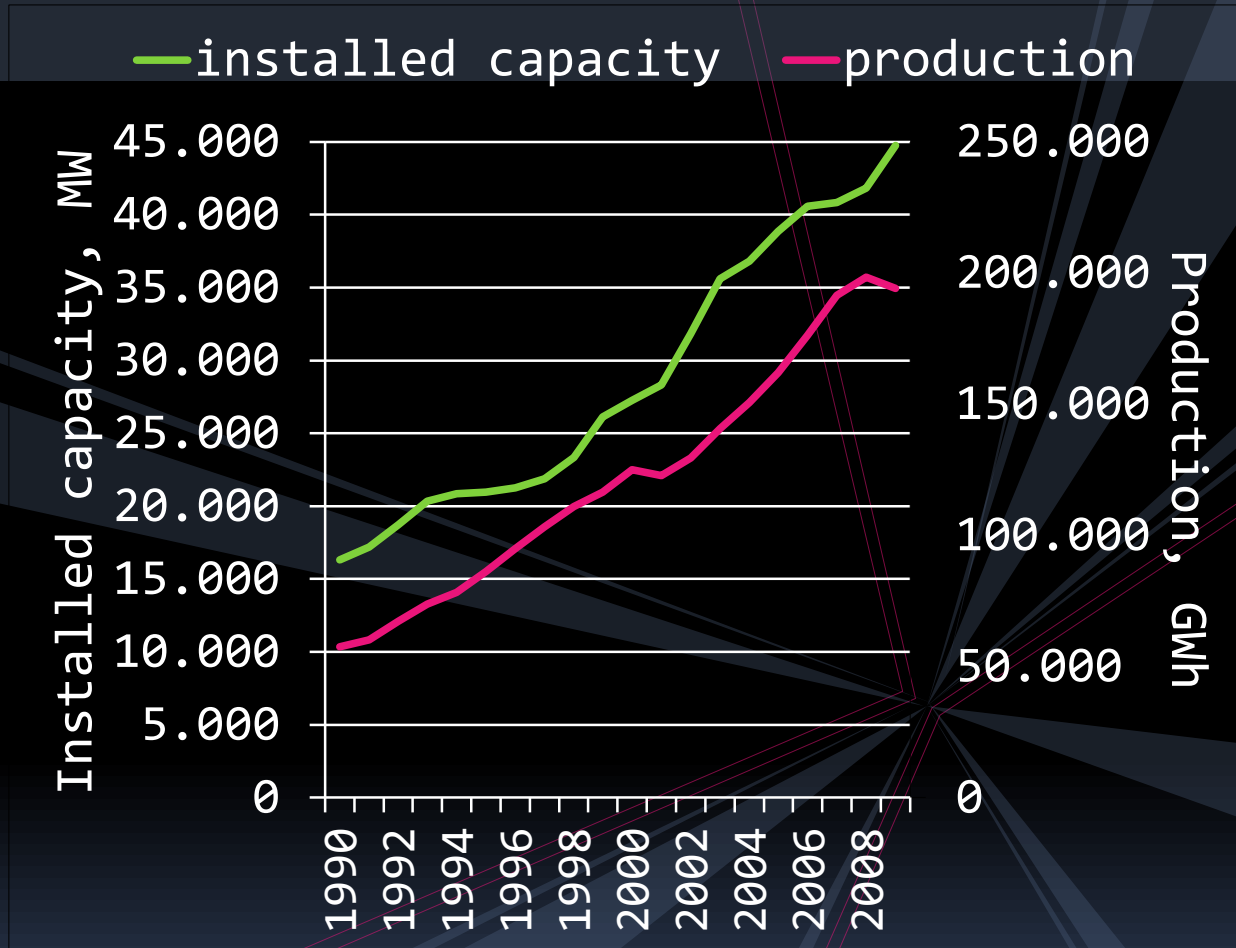


Figure 1: Development of Turkey's electricity sector (TETC, 2010)

Renewables in TURKEY

Turkey has significant potential of renewable energy sources for electricity production:

Wind: 40.000 MW with medium efficiency,

Hydro: 36.000 MW,

geothermal : 600 MW

solar: 380.000 GWh/year,

and biomass: about 12.000 GWh/ year

Ministry of Energy and Natural Resources of Turkey has recent Strategic Plan for 2010-2014 with the aim as the share of renewable energy resources within the electricity supply up to 30% which means significant CO₂ emission reduction.

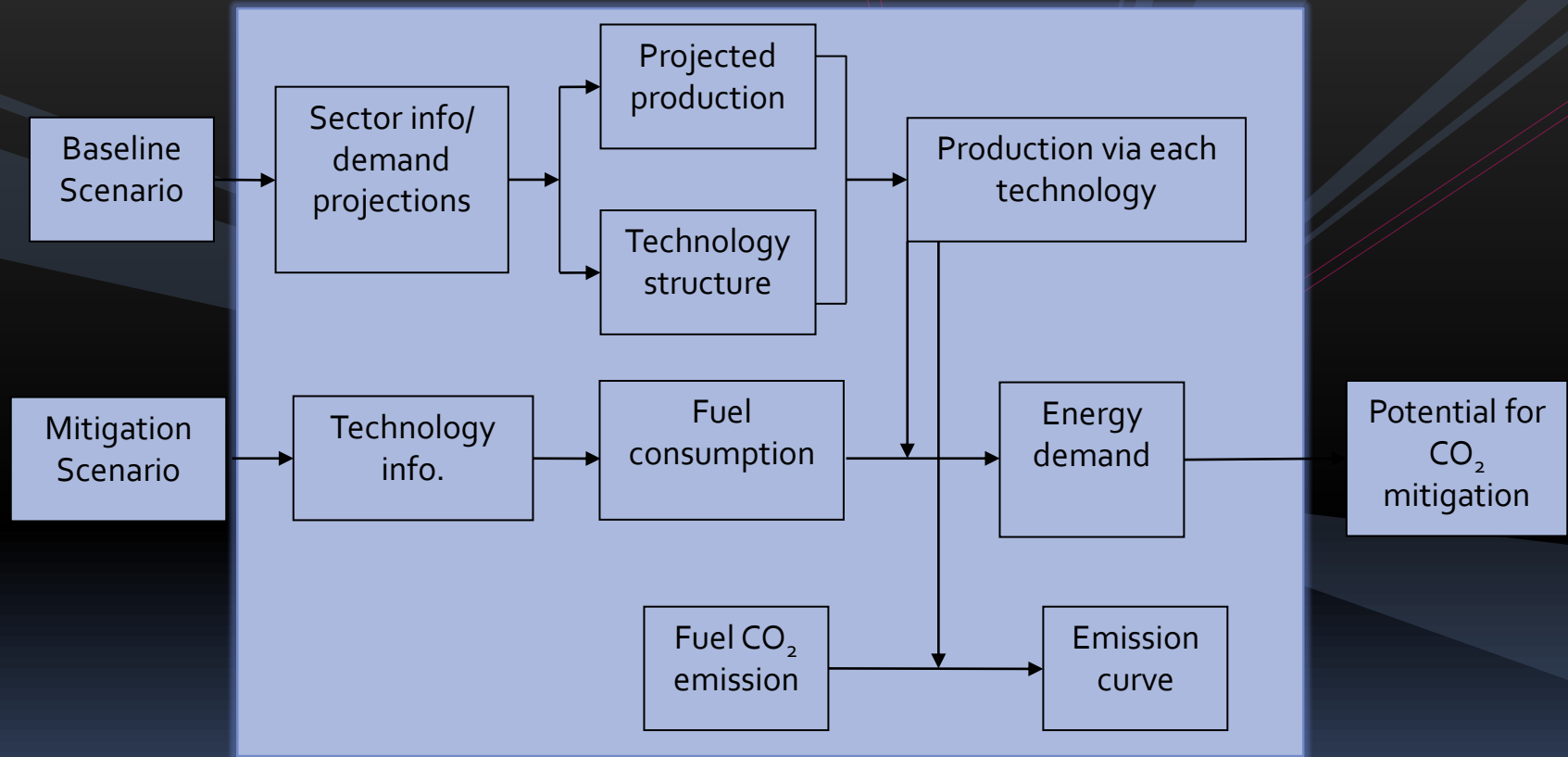
Methodology

- Integrated energy –environment and scenario based accounting model : LEAP (Long-range Energy Alternative Planning System) by SEI (Stockholm Environment Institute, 2008) was used to generate CO₂ emission scenarios for Turkish electricity sector.
- Lignite emission factor was calculated for Turkey, for the other fuels IPCC EF was used in LEAP.

Table:1 Fuel Specific Carbon Emission Factors

	Emission Factor, ton C/TJ
Lignite	31,78 (IPCC: 27,6)
Natural Gas (IPCC)	15,3
Hard&Import Coal (IPCC)	25,8
Fuel Oil (IPCC)	21,1
Diesel (IPCC)	20,2
Naphta (IPCC)	20,0

Figure 2: LEAP Analytical Procedure



Scenario Design (1)

- Business As Usual (BAU) Scenario
- Mitigation (Renewable) Scenario.

Main assumptions for both scenarios:

- ✓ All total demand will be supplied by domestic sources with same installed capacity,
- ✓ The fuel specific emission factors of all renewable energy sources are accepted as zero,
- ✓ Biomass share is same.

Scenario Design (2)

1. BAU Scenario : share of each primary energy sources assumed to be same range of 2009.
2. Mitigation Scenario: is established considering the economically viable renewable energy sources of Turkey with increasing share for:
 - ❖ hydropower
 - ❖ wind
 - ❖ geothermal

Renewable Ratio in Scenarios

- BAU Scenario: sharp increase at 2011; due to the high contribution of hydro energy. After 2011 the ratio begins to decrease slowly and 2020 ratio is around 2010 levels.
- Mitigation Scenario, there's sharp increase in 2011 due to higher contribution of wind energy, continuous increase till 2016, After 2017 it is around 62% as a stable level.

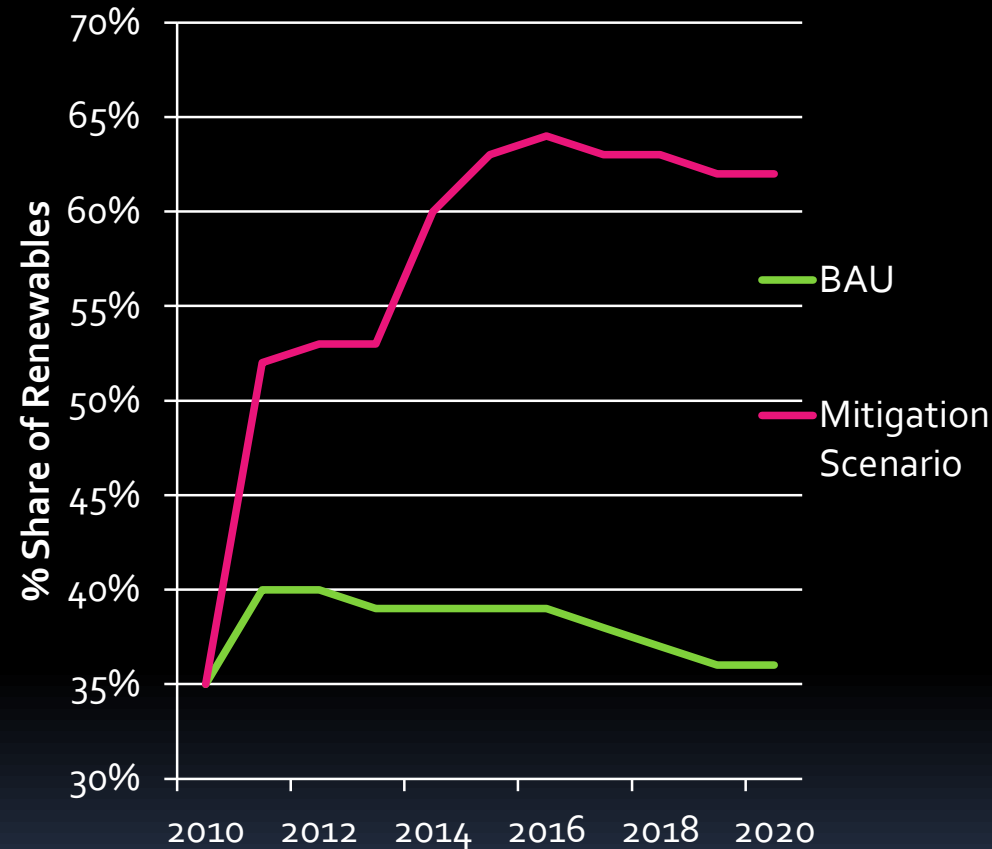


Figure 3: Renewable shares of Scenarios

Results

Carbon emission factor for lignite in Turkey is calculated as 31,78 tC/TJ where IPCC's emission factor is 27,6 tC/TJ.

➤ **BAU Scenario:** if no controls were made in Turkey for next decade, there's likely to be totally 1,4 billion tons of CO₂ will be emitting to the atmosphere corresponding to 3,4 million GWh electricity production.

➤ **Mitigation Scenario:** the contribution of renewable energy is increasing continuously and it will be about 62% at 2020.

In mitigation scenario, compared with BAU Scenario between 2010 and 2020 the overall mitigation of CO₂ emissions is estimated as ~300 (298,3) million tons for the same electricity production of BAU Scenario.

Results

Years	Electricity Supply, GWh	BAU Sce. CO ₂ thousands ton	Mitigation Sce.CO ₂ thousands ton	CO ₂ Mitigation thousands ton
2010	224.900	99.500	99.500	-
2011	239.100	100.100	92.700	7.400
2012	254.100	106.000	96.100	9.900
2013	270.000	116.500	106.300	10.200
2014	287.000	123.700	98.100	25.600
2015	305.000	131.500	94.400	37.100
2016	324.200	137.800	100.400	37.400
2017	344.500	147.900	110.800	37.100
2018	366.100	158.800	117.700	41.100
2019	389.100	172.000	127.600	44.400
2020	413.600	185.900	137.800	48.100
Total	3.417.600	1.479.400	1.181.400	298.300

CONCLUSION

- ✓ Only partial potential of hydropower, wind, geothermal and biomass energy is considered for Mitigation Scenario.
- ✓ No using of solar energy potential and nuclear energy.

Based on this research:

- ✓ strict renewable policies should be established since Turkey has significant renewable energy potential for electricity production, which means significant reduction potential with less cost.
- ✓ Furthermore, in the long run, carbon capture and storage may be one of the most promising technological solutions to curb the CO₂ emissions from the continued use of coal in Turkey.



THANK YOU