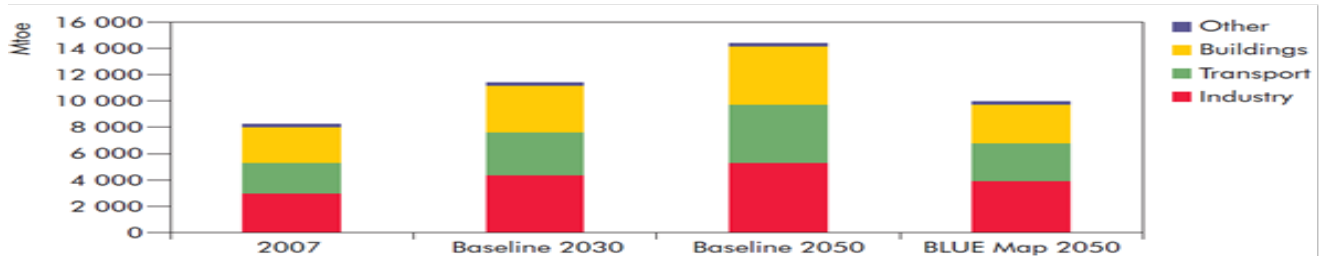


ENERGY LANDSCAPE BY 2050

Energy Distribution and Consumption by Sectors

Three main sectors are

- Industrial Sector (41% - 44%)
- Building (Residential & Commercial) Sector (34%)
- Transportation Sector (22%)



Possible Energy Future Scenarios in 2050

	Actual Value (2005)	The Baseline Scenario	The Blue Map Scenario
Distinguishing Characteristics	-	<ul style="list-style-type: none"> • Business-as-usual scenario • No new environmental policies 	<ul style="list-style-type: none"> • High energy efficiency • Implementation of highly strict decarbonization policies
Energy Demand (Mtoe/yr)	7748	15,638	10553
CO₂ Emissions (Giga tons)	27	62	14
Investment Requirement (Trillion \$ - 2005 Value)	-	254	299

Source : University Minneapolis, World Energy Scenarios to 2050: Issues and Options

The drivers

- Global Population Growth
- Concerns about Climate Change
- Carbon Footprint Reduction
- Rising Cost of Fossil Fuels
- Energy Security
- Energy Policies
- Technological Changes

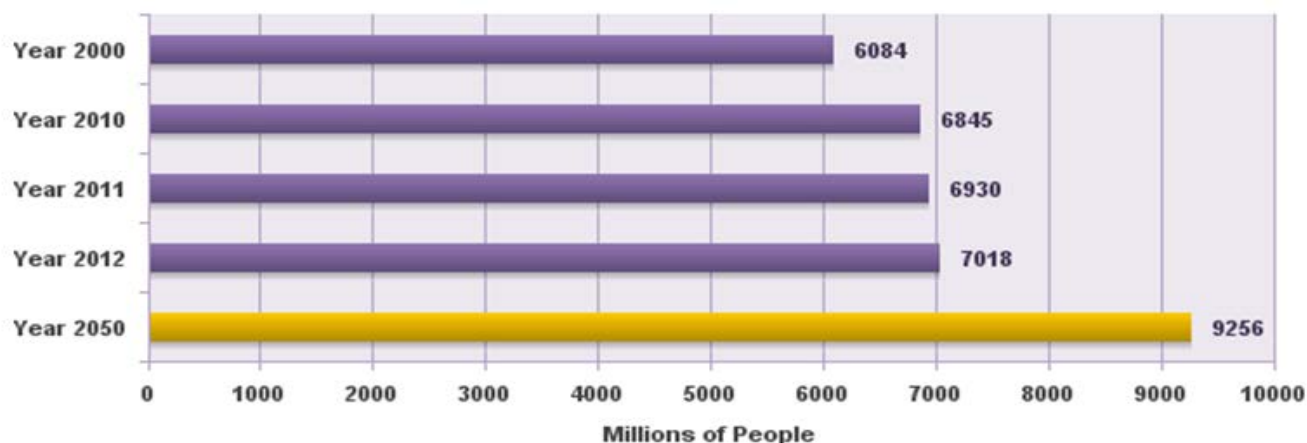
Global Population Growth

- Current Population - \approx 7 billion
- Population by 2050 - \approx 9.2 billion
- Less developed regions (Africa, Asia, and Latin America and the Caribbean are considered less developed) will account for 99 per cent of the expected increment to world population in this period, with Asia being the largest contributor.

<http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf>

TOP TEN COUNTRIES WITH THE HIGHEST POPULATION					
#	Country	2000 Population	2010 Population	2012 Population	2050 Expected Pop.
1	China	1,268,853,362	1,330,141,295	1,343,239,923	1,303,723,332
2	India	1,004,124,224	1,173,108,018	1,205,073,612	1,656,553,632
3	United States	282,338,631	310,232,863	313,847,465	439,010,253
4	Indonesia	213,829,469	242,968,342	248,645,008	313,020,847
5	Brazil	176,319,621	201,103,330	193,946,886	260,692,493
6	Pakistan	146,404,914	184,404,791	190,291,129	276,428,758
7	Bangladesh	130,406,594	156,118,464	161,083,804	233,587,279
8	Nigeria	123,178,818	152,217,341	170,123,740	264,262,405
9	Russia	146,709,971	139,390,205	142,517,670	109,187,353
10	Japan	126,729,223	126,804,433	127,368,088	93,673,826
TOP TEN Countries		3,618,894,827	4,016,489,082	4,096,137,325	4,950,140,178
Rest of the World		2,466,012,769	2,829,120,878	2,921,709,597	4,306,202,522
Total World Population		6,084,907,596	6,845,609,960	7,017,846,922	9,256,342,700

NOTES: (1) The Top 10 Most Populated Countries of the World Table was updated for June 30, 2012.



<http://www.internetworldstats.com/stats8.htm>

Year	Population
1	200 million
1000	275 million
1500	450 million
1650	500 million
1750	700 million
1804	1 billion
1850	1.2 billion
1900	1.6 billion
1927	2 billion
1950	2.55 billion
1955	2.8 billion
1960	3 billion
1965	3.3 billion
1970	3.7 billion
1975	4 billion
1980	4.5 billion
1985	4.85 billion
1990	5.3 billion
1995	5.7 billion
1999	6 billion
2006	6.5 billion
2009	6.8 billion
2011	7 billion
2025	8 billion
2043	9 billion
2083	10 billion

<http://geography.about.com/cs/worldpopulation/a/mostpopulous.htm>

GDP Growth

On average, world economic growth will be, slightly above 3 %/year for the next thirty years, a figure comparable to the past thirty years (3.3 %/year from 1970 to 2000 and 3.0%)

Energy Security

Below demonstrates some examples of future supply security concerns:

- China's Guangdong Nuclear Power Corp.'s subsidiary Taurus Minerals did a A\$2.2 billion acquisition of Australian listed Extract Resources. Extract owned the Husab uranium project in Namibia which is said by Extract to be the fourth largest uranium-only deposit in the world having measured resources of 84 million pounds uranium and indicated resources of 274 million pounds (Swakop Uranium is the local wholly-owned subsidiary of Taurus and is developing Husab).

- Canadian PM Stephen Harper met with India's Prime Minister Manmohan Singh to fast-track the 2010 India-Canada nuclear deal so a lot of Canadian uranium will be going to India.
- Australia-India talks that were recently concluded resulted in an agreement to see Australian uranium exported to India for its huge pending nuclear power program. Again this is a deal tying up a lot of uranium.
- Turkey imports more than 70 percent of its energy, primarily fossil fuels, and electricity demand has been growing an average of eight percent per year over the past decade. Current Turkish leaders plan to turn the country into the nuclear energy poster child. Russia is going to build, and own, the Turkish plants, running them presumably using fuel from the motherland. This is now the adopted Russian business model for selling its nuclear technology to nuclear newcomers. If successful, and there's no reason to believe they won't be highly competitive, this will take a lot of Russian supply off market.

These long term deals locking up future supply means less uranium for the rest of the world going forward, the likely consequence is a scramble for other sources of energy an "*energy self-sufficiency*" agenda.

<http://www.mining.com/web/the-red-queen-syndrome/>

Energy Policies

- With the energy landscape changing rapidly, there is the need for effective leadership and collaboration amongst economies. Countries will have to look at cross-border trade for electricity, energy sources such as Liquid Natural Gas (LNG) etc.
- As emerging economies need fuel to spur further growth, supplies stand to be choked off, killing economies before they have had time to mature. This contributes to the high demand and the higher prices.
- But China has recently released its new energy plan and it effectively ends the pause on new nuclear construction. Any reactors currently under construction will be allowed to continue but new reactors will be required to use third-generation technology, the EPR or AP1000. An initial regulatory framework will be drafted by Mar-2013 and, after a public comment period, written into law by Jul-2013. Inspections, to see if plants are up to the new code, will be allowed prior to the July legislation so the next restarts are expected in the third quarter of 2013.

Carbon Footprint

- Kyoto Protocol
- EU Climate Policy

By 2030

- **Coal production** is also expected to double between 2000 and 2030, with most of the growth taking place in Asia and in Africa, where more than half the coal would be extracted in 2030.

- **World oil production** is projected to increase by about 65% to reach some 120 million bl/day in 2030: as three quarters of this increase comes from OPEC countries, OPEC accounts for 60% of total oil supply in 2030 (compared to 40% in 2000).

Energy Consumption will increase at a rate of 1.8 %/yr. Contribution by energy sources:

Oil	-	34 %	
Coal	-	28 %	
NG	-	25 %	
Nuclear & Renewables	-	13%	

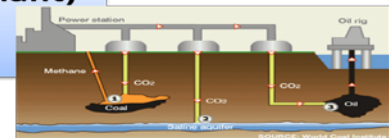
CO₂ will increase at a rate of 2.1 %/yr.

Technological Changes

Electricity Technology

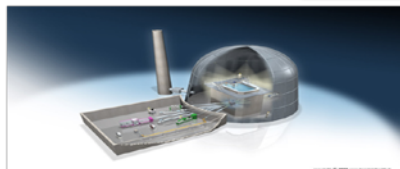
Conventional Technology (Coal, Oil and Gas fired power plant)

- Integration of carbon capture and storage
- Efficiency improvement of gas turbine



Renewable technology

- 3rd Gen PV cells Solar energy Up to 41% power efficiency
- Higher capacity and more efficiency of wind turbine
- More expansion of micro hydro power station
- More efficient geothermal power plant (Binary Cycle PP)
- Integration of Tidal and Wave Energy to Grid



Nuclear Technology

- 4th Gen of nuclear reactors with higher efficient use of fuel
- Sustainable nuclear waste management

Heat Technology

Geothermal

- Heat pump
- Steam generator

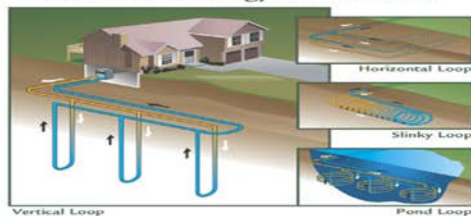
Solar (Solar thermal)

- Solar heater
- Solar drier

Biomass (Agriculture by products waste)

- Burner (Boilers)
- Cooking stove

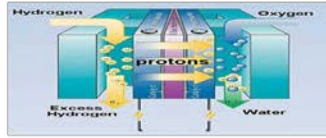
Geothermal Energy for the Home



Fuel Technology

Hydrogen

- Electrolysis
- Biomass gasification
- Advanced low GHG hydrogen production



CNG/LPG
- CNG, LPG, biogas



Biofuels

- Ethanol
- Biodiesel
- Biogas



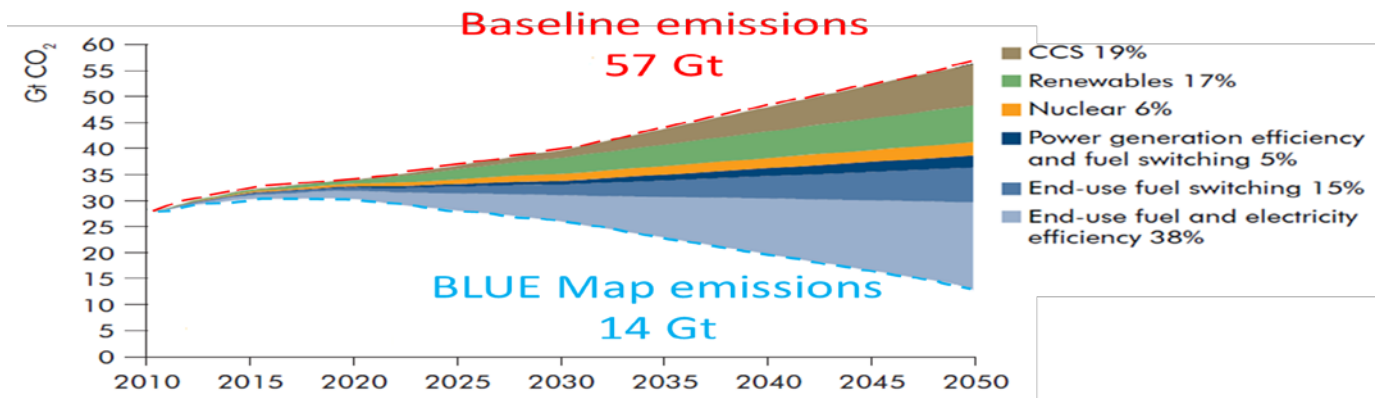
Synthetic fuels
- GTL and CTL

Electricity

- EVs and PHEV (Plug-in hybrid electric vehicle)



CO₂ Emission Reduction by 2050

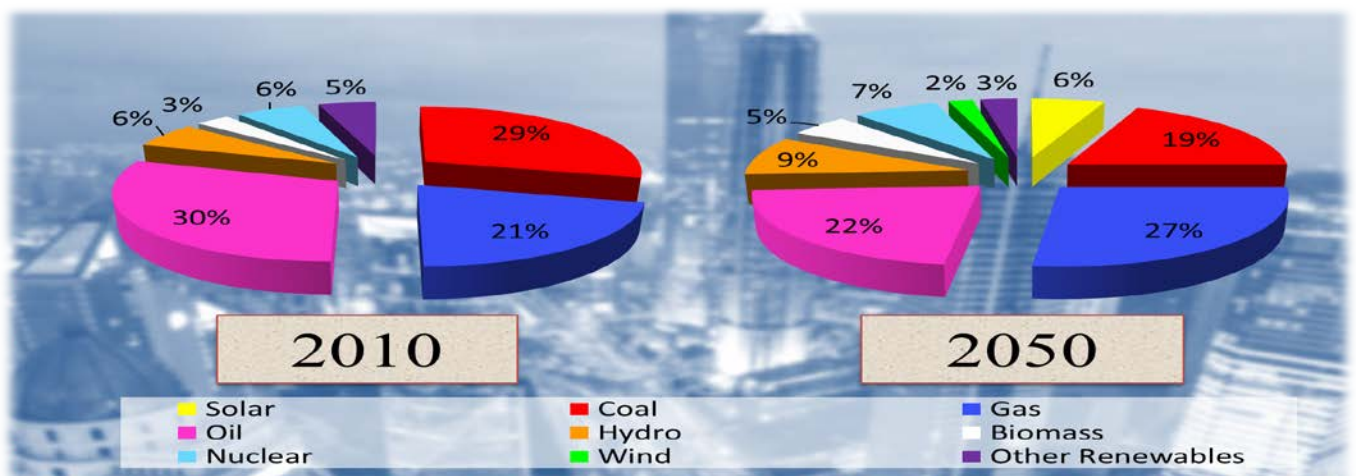


•By 2050, CO₂ emission will be reduced approximately 50% compared to 2010 due to improved technology and environmental law legislation.

•This amounts to about 43 Gt of CO₂ emissions reduction.

Source : IEA Energy Technology Perspectives 2010

World Energy Mix by 2050



Source : Shell Sustainability Report 2011

Conclusions

- Fossil fuel will still be a major contribution of energy landscape with higher efficiency
- The ratio of renewable energy use will increase due to technological advancement ,especially in OECD countries.
- Both OECD and Non-OECD countries will be obliged to carbon mitigation policy
- CCS will be applied to all fossil energy sector
- Material sciences will play a major role in technology development