

Ensuring Sustainable Coal Supply for Power Generation

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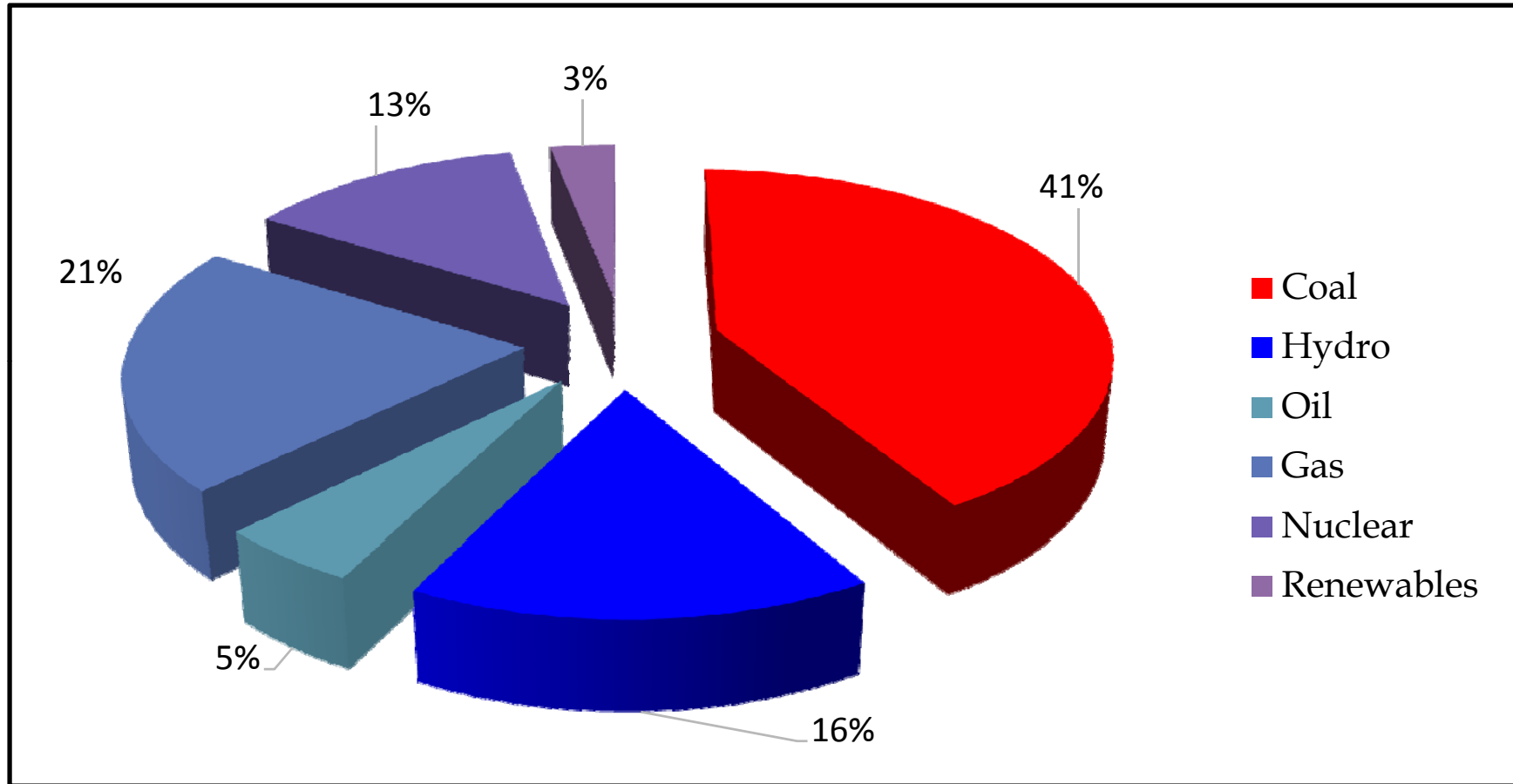
1. Introduction

1 Introduction

Every country has to effort for supplying electricity. There are many ways to generate electricity. If we choose the fossil fuel, coal has many advantages compare to others. Although firing coal impact the environment, it has a lot of incentives as the modern technologies can reduce the environmental impact to optimum level.

2. Electric Power Sector

2 Electric Power Sector

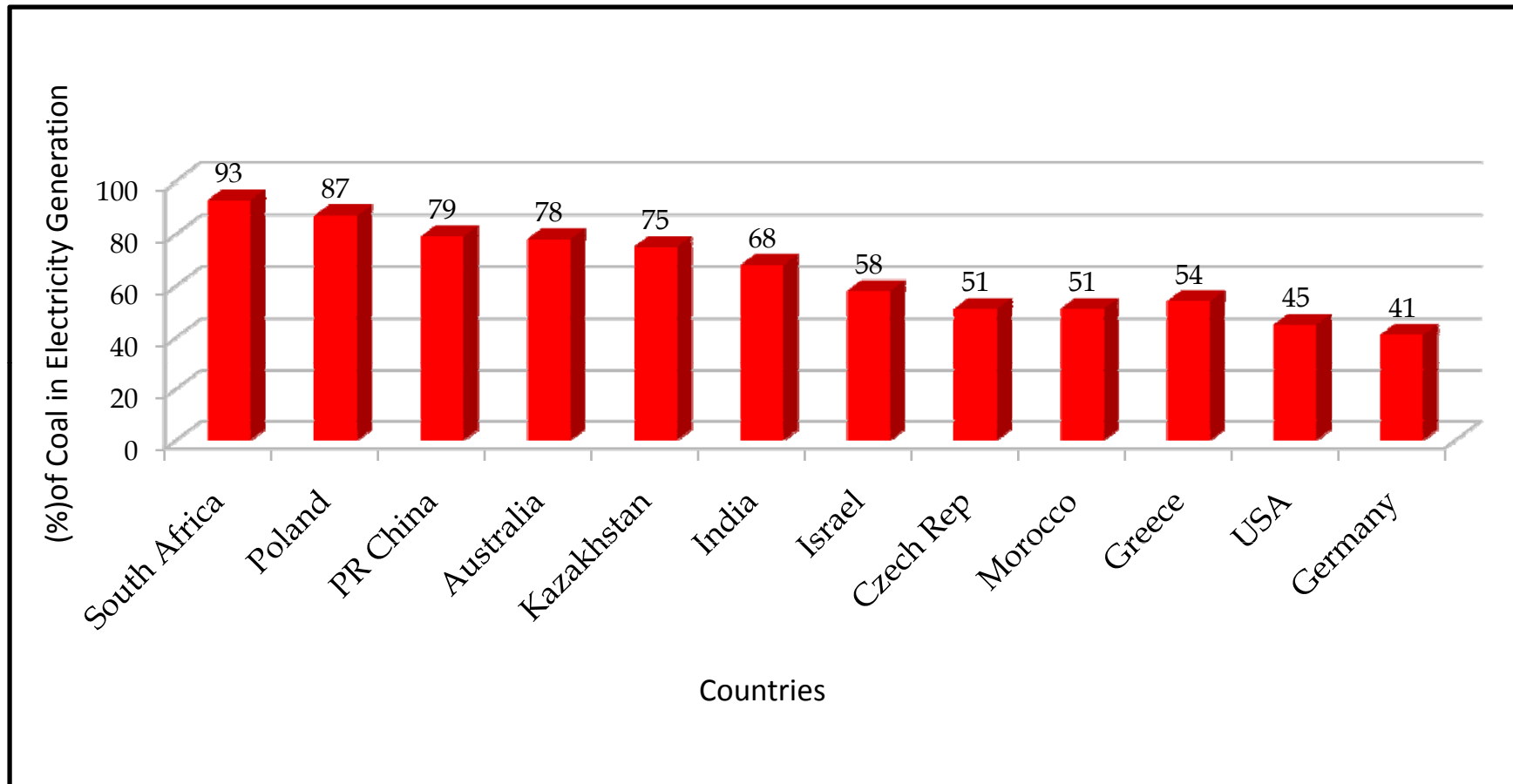


Source: IEA (2011)

Composition of Electricity Generation (World)

2

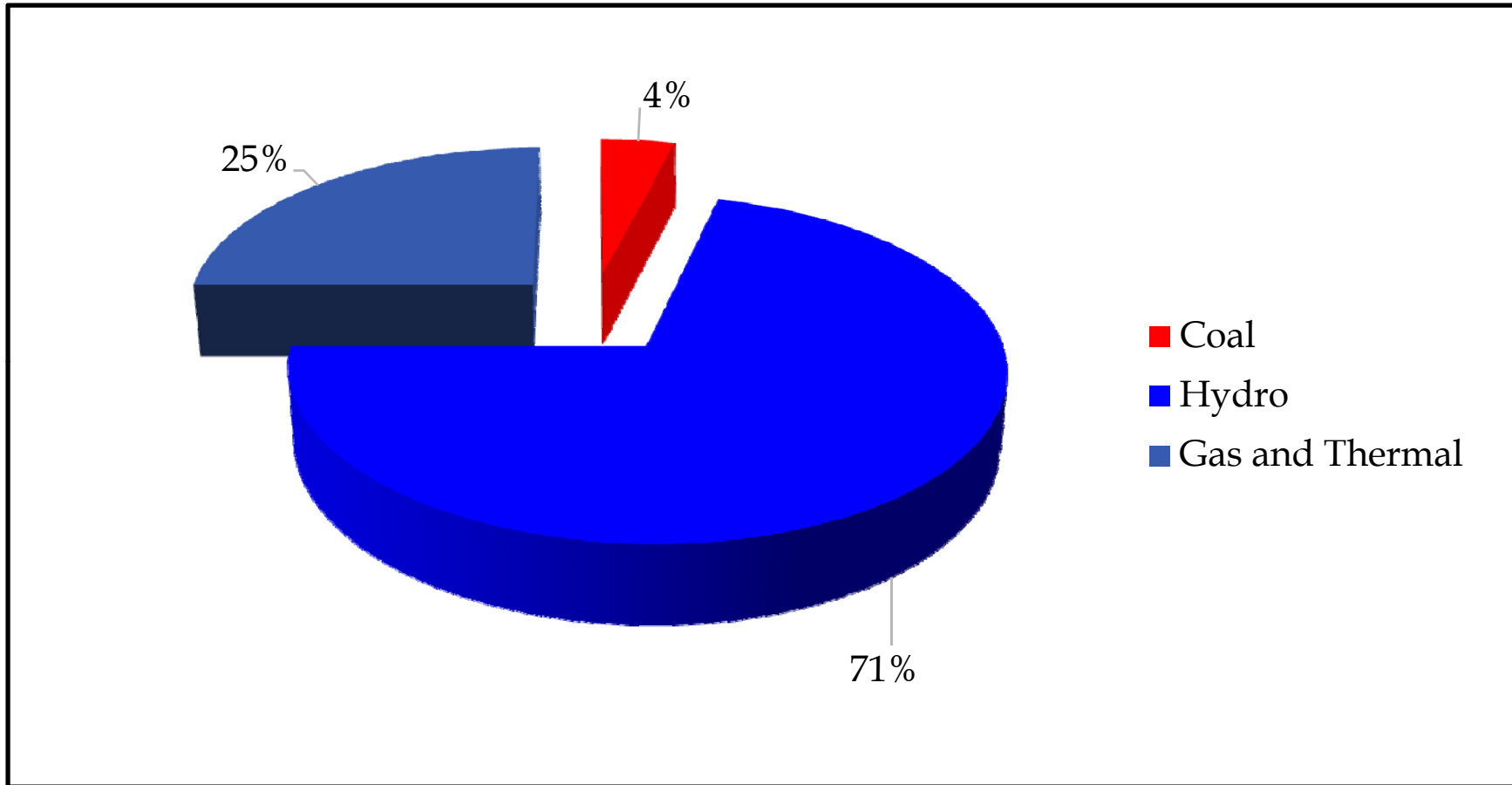
Electric Power Sector



Source: IEA (2012)

Power Generation by Coal (%) in Some Countries

2 Electric Power Sector

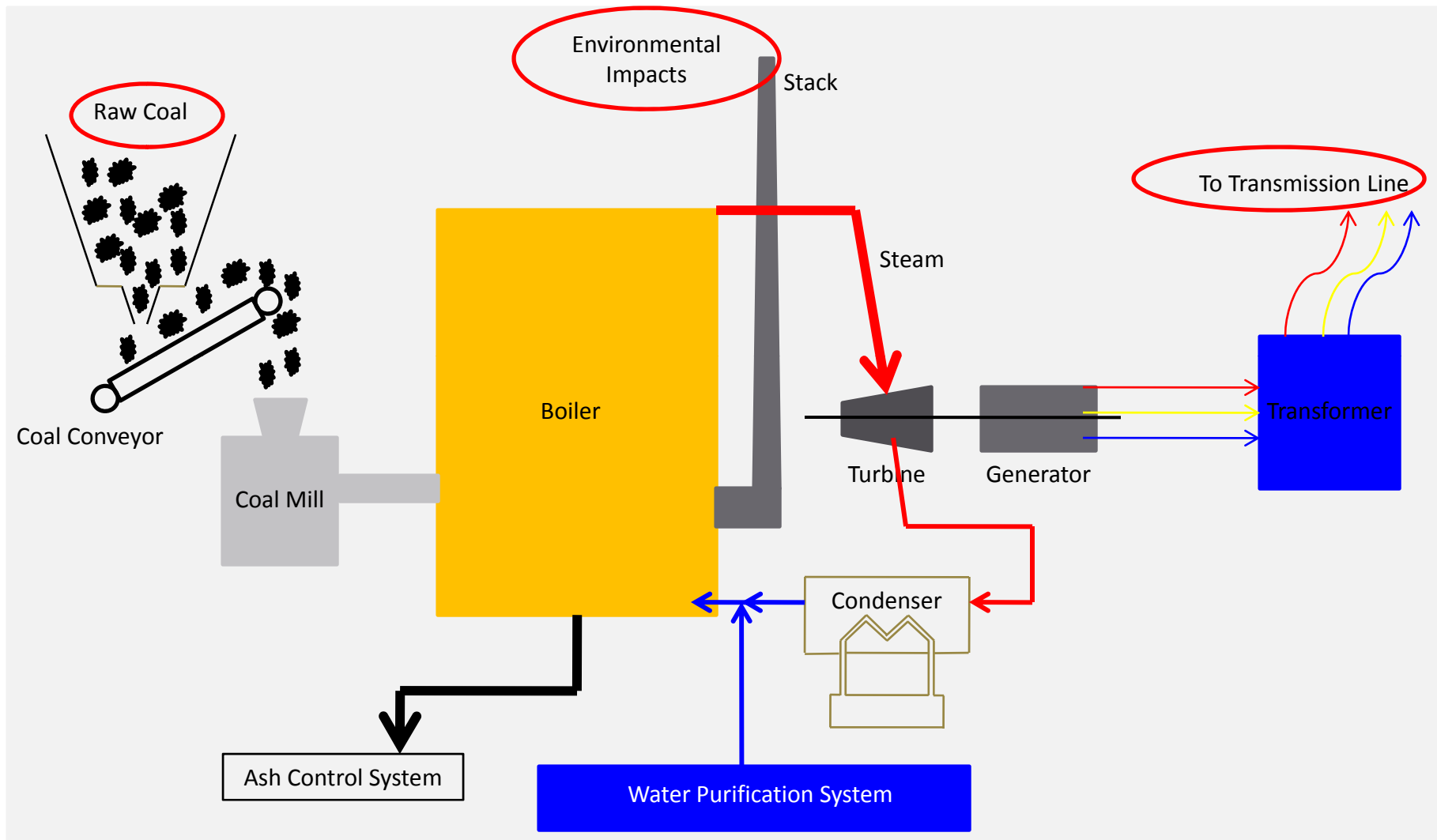


Source: MOEP

Composition of Electricity Generation (Myanmar)

3. Power Generation by Using Coal

3 Power Generation by using coal as fuel

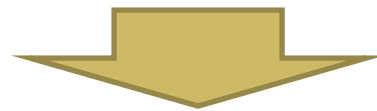


How electricity is generated by using coal?

4. Environmental Impacts by Coal Power Plant

4 Environmental Impacts by Coal Power Plant

A typical 500MW coal-fired power plant burns 1.4 million tons of coal and generates following amount of pollutants each year.



**3.7 million tons
Carbon Dioxide (CO₂)**

**10,000 tons Sulfur
Dioxide (SO₂)**

**10,200 tons
Nitrogen Oxide (NO_x)**

**720 tons
Carbon Monoxide (CO)**

**220 tons
Hydrocarbon**

**4lb
Cadmium**

**170 lb
Mercury**

**500 tons
Small Airborne Particles**

**225 lb
Arsenic**

**114 lb
Lead**

4 Environmental Impacts by Coal Power Plant

Reducing Environmental Impacts

Modern technologies can reduce the environmental impacts by coal power plants to acceptable level.

Washing Coal reduces the ash content of coal by over 50% resulting in less waste, lower sulfur dioxide (SO_2) emissions and enhancing the thermal efficiency of coal.

To reduce **NO_x emissions**, Selective Catalytic Reduction (SCR) and Selective Non-catalytic Reduction (SNCR) can be used. SCR is now widely used commercially and it can reduce NO_x emissions up to 80 to 90%.

In SO_2 reduction, wet limestone flue gas desulfurization (lime-desulfur) and seawater flue gas desulfurization can be used.

4 Environmental Impacts by Coal Power Plant

Controlling the particles emission from burning coal.

Electrostatic Precipitator (ESP) and Fabric Filters can collect up to 99% of particles from flue gas.

The non-combustible materials from coal are generated as waste when coal is burning. Use of high quality coal can reduce the production of coal waste. And coal waste can be used effectively, bottom ash as landfill and fly ash as cement addition.

4 Environmental Impacts by Coal Power Plant

Increasing the energy efficiency of power plant is also needed to mitigate the environmental impacts. The energy efficiency mainly depends on the **QUALITY OF COAL**. Therefore high quality coal should be chosen to minimize the environmental impacts by coal power plants. Lower sulfur and ash content , higher calorific value coal should be chosen.

5. Coal

5 Coal

Although there are other factors which influence the amount of energy of coal, the heating value (calorific value) of coal is mainly supplied by its carbon content.

Coal can be classified into four major types according to its calorific value:

Lignite

Sub-bituminous

Bituminous and

Anthracite

5 Coal

	Lignite	Sub-bituminous	Bituminous	Anthracite
Free of moisture (%)	25	10	10	5
Inherent Moisture (%)	10	12	10	5
Volatile Matter (%)	40	35	30	10
Sulfur Content (%)	0 ~ 8	0 ~ 5	0 ~ 5	0 ~ 5
Ash Content (%)	15	8	5	5
Fixed Carbon (%)	35 ~ 60	45 ~ 60	55 ~ 86	80 ~ 98
Net Calorific Value (Btu/lb)	5500 ~ 8300	8300 ~ 13000	11000 ~ 15000	13500 ~ 15000

Coal Quality Analysis

5 Coal



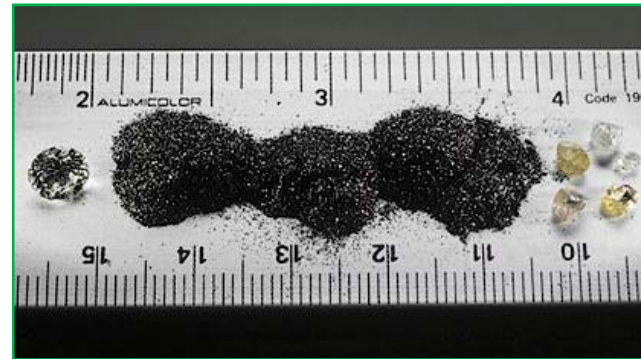
Lignite



Sub-bituminous



Bituminous



Anthracite

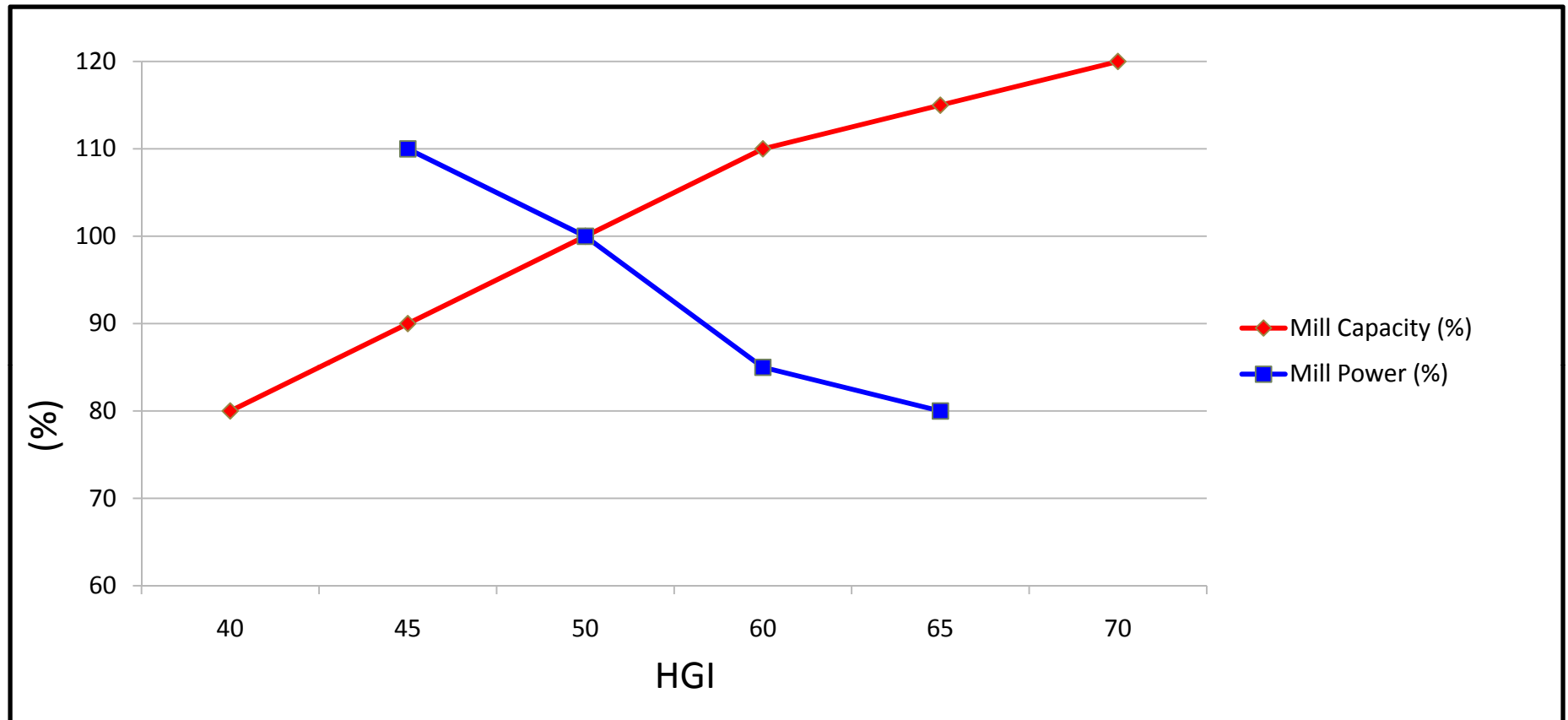
Sample of Coal

5 Coal

HGI

HGI stands for Hardgrove Grindability Index which was developed in the 1930s to measure relative difficulty of grinding coal for pulverized coal boiler furnace.

5 Coal



Source: ACARP

HGI vs. Mill Power & Capacity

NOTE: HGI of steam coal should be minimum of 40.

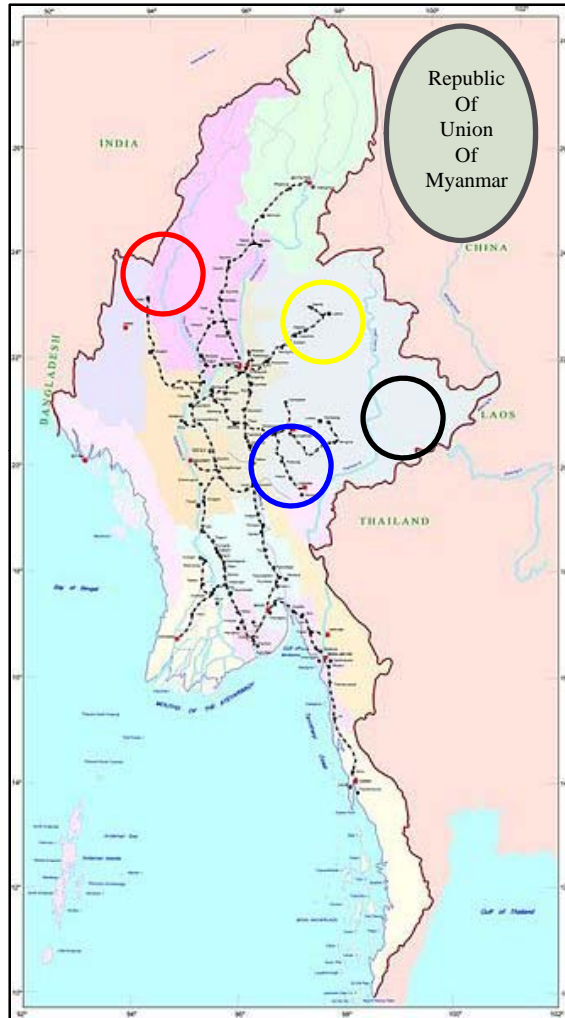
5 Coal

Deposit	Location	Coal Type	Reserves (million ton)
Darthwekyaut	Kalewa, Sagaing	Sub-bituminous Lignite	38
Paluzawa	Kalewa, Sagaing	Sub-bituminous	89
Kalewa	Kalewa, Sagaing	Sub-bituminous	87
Harpu	Lashio, Shan (North)	Lignite	11
Kyese, Mansan	Lashio, Shan (North)	Lignite	18
Tigyit	Pinlaung, Shan (South)	Lignite	20
Wankyan	Eastern Shan	Lignite	16
Mainghok	Eastern Shan	Lignite Sub-bituminous	117
Narpakaw	Eastern Shan	Lignite	10

Source: Department of Geological Survey and Mineral Exploration (DGSE)

Myanmar's Major Coal Mines which have reserves of over 10 million tons

5 Coal



Kalewa Area
Total Coal Reserves - 214 million tons
Coal Type - Lignite and Sub-bituminous

Lashio Area
Total Coal Reserves - 29 million tons
Coal Type - Lignite

Tigyt Area
Total Coal Reserves - 20 million tons
Coal Type - Lignite

Eastern Shan Area
Total Coal Reserves - 143 million tons
Coal Type – Lignite and Sub-bituminous

Source: Department of Geological Survey and Mineral Exploration (DGSE)

Myanmar's Major Coal Mines which have reserves of over 10 million tons

5 Coal

	Kalewa	Lashio	Tigyit	Eastern Shan
Heat Value (Btu/lb)	11750 ~ 11920	8530 ~ 10440	5000 ~ 7500	6000 ~ 12000
Sulfur Content (%)	0.52 ~ 0.78	0.39 ~ 1.04	0.46 ~ 0.96	0.4 ~ 1.17
HGI	34 ~ 42	20 ~ 27	20 ~ 27	Data not available
Ash Content (%)	4.4 ~ 5.8	2.3 ~ 8.1	8 ~ 12	2 ~ 16

Source: No.(3) Mining Enterprise and Tigyit Power Plant

Quality Analysis of Coal from Three Major Coal Mines of Myanmar

Domestic Coal Prices (kyats/ton)		
Kalewa	Lashio	Tigyit
40000 ~ 50000	20000 ~ 35000	33000

Remark: Kalewa and Lashio coal prices are excluding transportation charges.
Tigyit coal price is price at Tigyit Power Plant.

5 Coal

Date	Unit Generation (MWh / day)	Coal		Unit (KWh / ton)	Remark
		Consumption (Tonnes)	Quality (Btu/lb)		
7.10.07	918.90	1,007	6,750	913	Tigyit Coal
8.10.07	923.65	1,010	6,760	915	Coal
9.10.07	1,135.20	860	8,500	1,320	Kalewa Coal

Source: Tigyit Power Plant

Typical Coal Consumption at Tigyit Power Plant

5 Coal

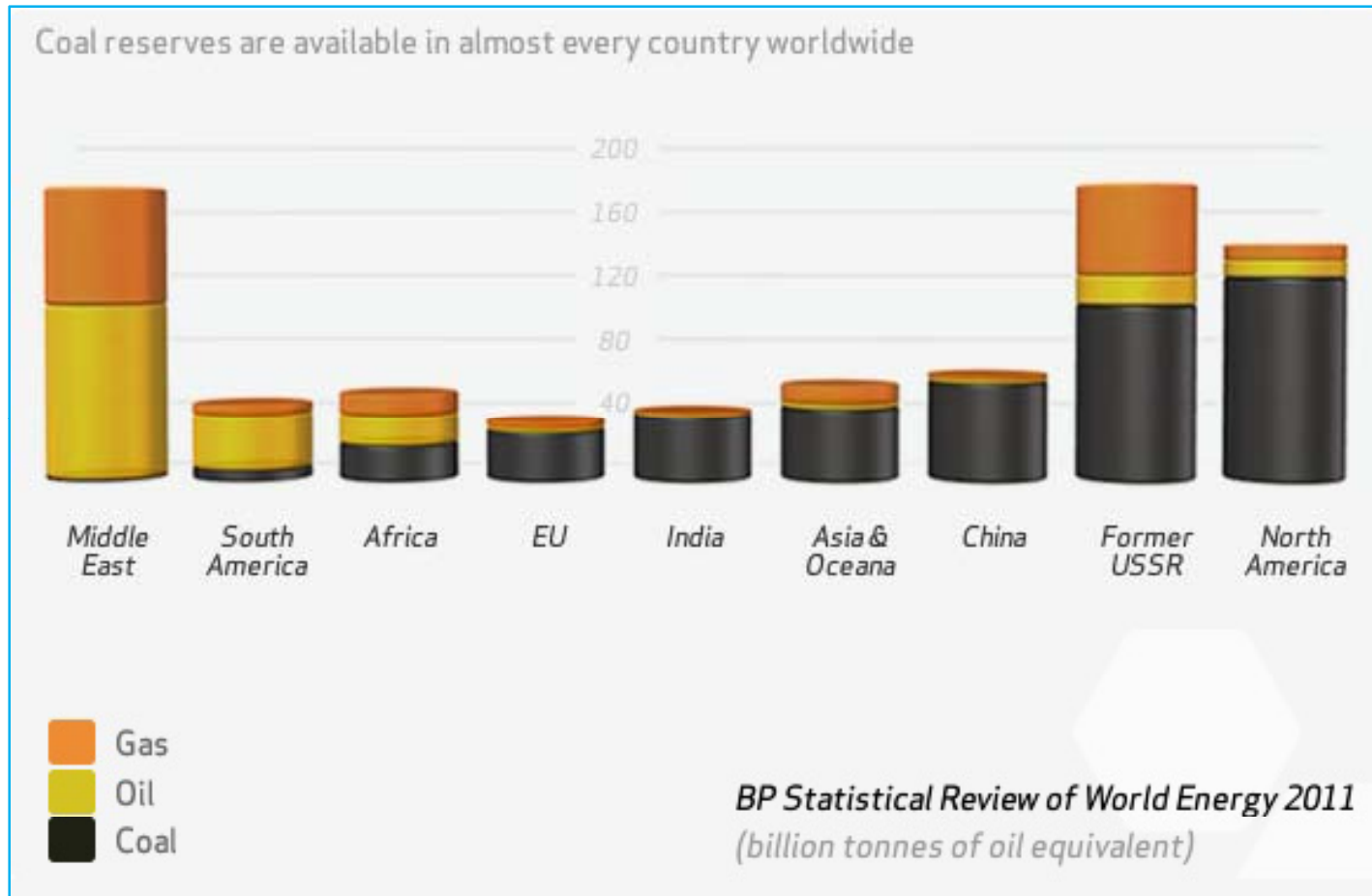


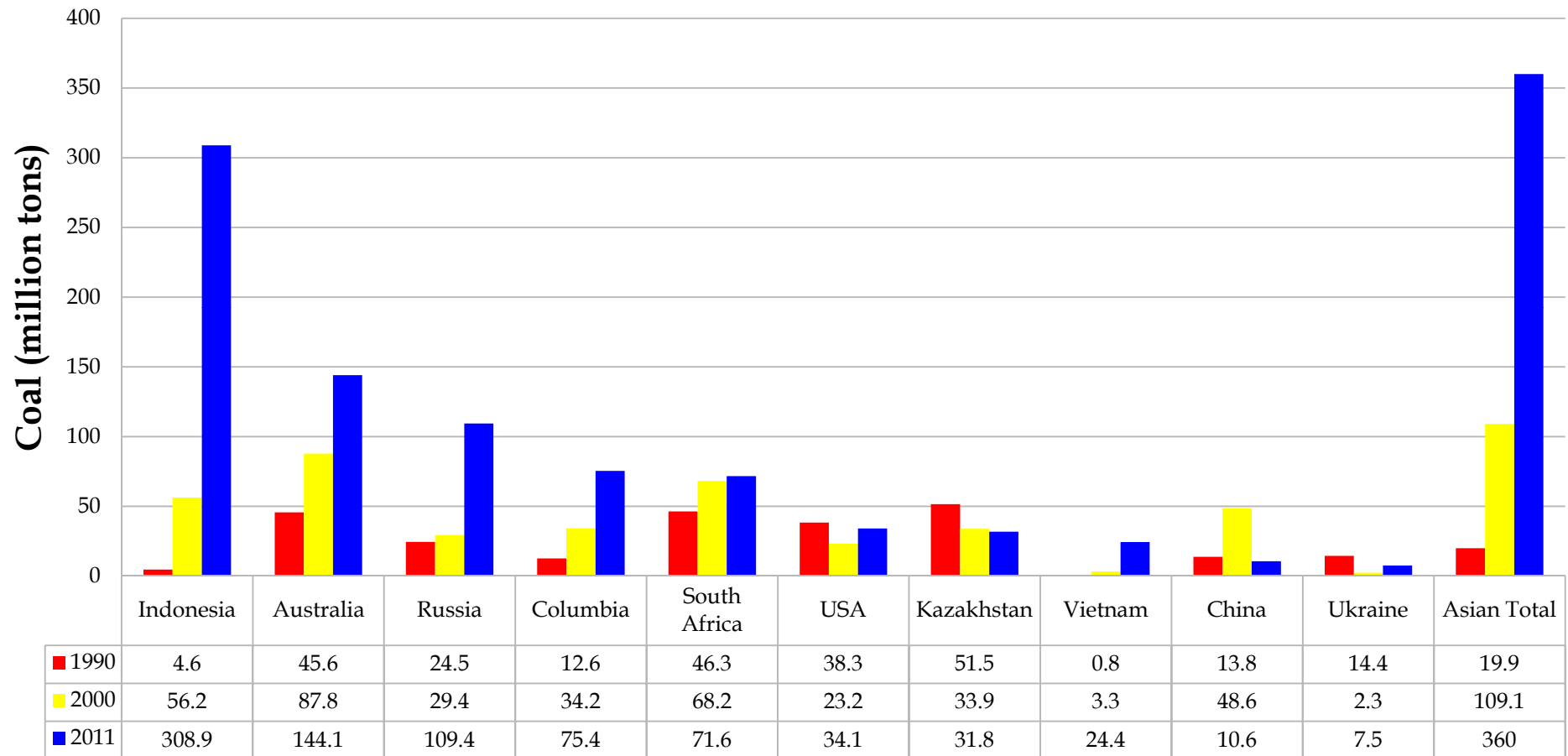
Chart Credit to worldcoal.org

World's Major Fossil Fuel Reserves

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Coal

Top Ten Coal Exporting Countries

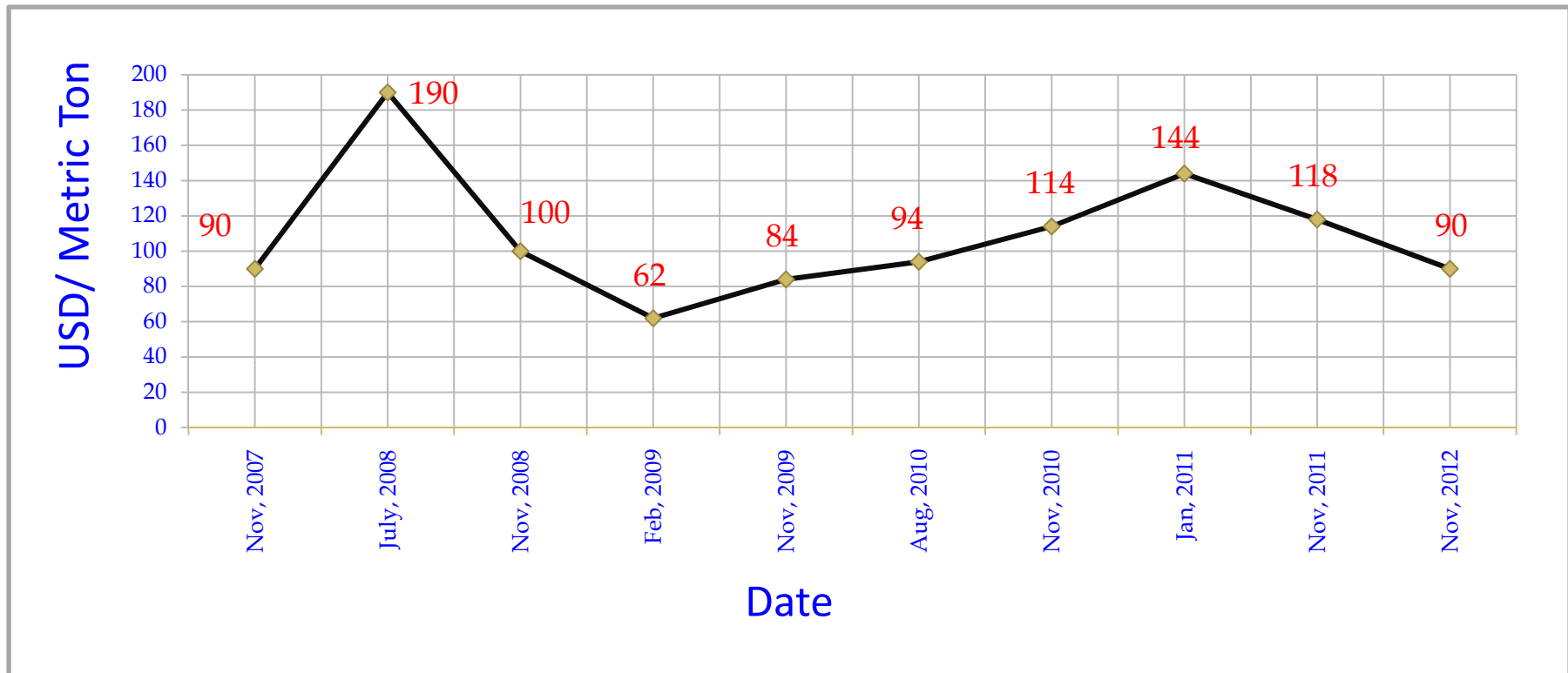


Source: IEA "Coal Information 2012"

Top Ten Coal Exporting Countries

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Coal



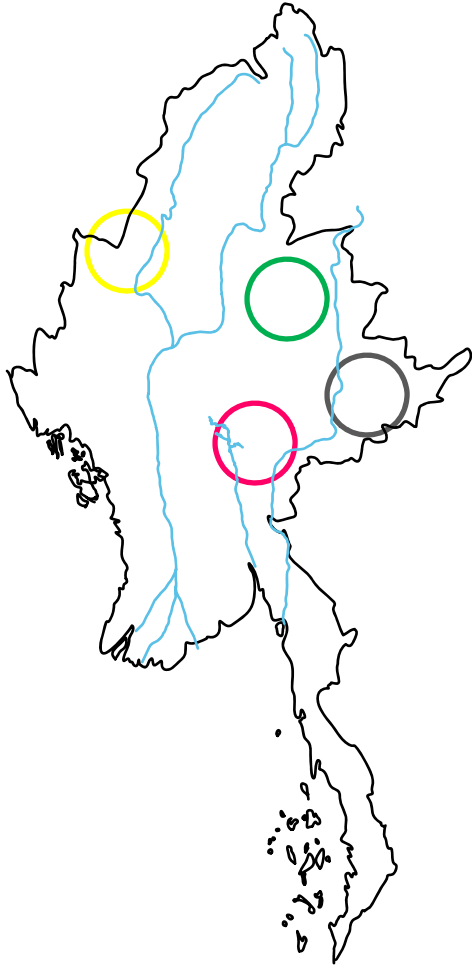
Source: Index Mundi

Australian Coal Price Chart

Description: Australian Thermal Coal, 12000Btu/lb,
Less than 1% Sulfur, 14% Ash content
FOB at Newcastle/ Port of Kembla

6. Transportation and Power Transmission

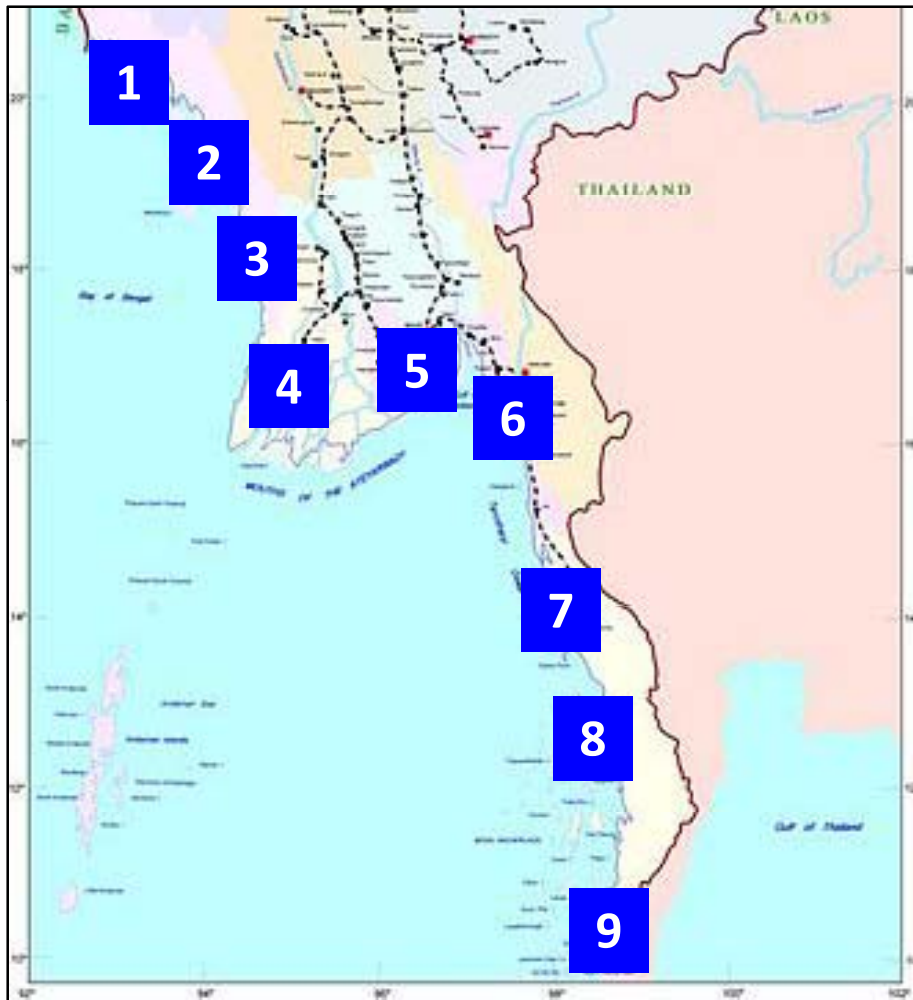
6 Transportation and Power Transmission



Transportation Facilities of Major Coal Mines

	Railway	Motorway	River
Kalewa	Nil	Poor	Chindwin, Myitthar
Lashio	Good	Good	Nil
Tigyit	Good	Fair	Nil
Eastern Shan	Nil	Fair	Nil

6 Transportation and Power Transmission



Name of Port

- | | |
|---|-------------|
| 1 | Sittwe |
| 2 | Kyautphyu |
| 3 | Thandwe |
| 4 | Patheingyi |
| 5 | Yangon |
| 6 | Mawlamyaing |
| 7 | Dawei |
| 8 | Myeik |
| 9 | Kawthaung |

Seaports of Myanmar

6 Transportation and Power Transmission

	Voltage Level (kV)	Line Length (miles)
Present	500	-
	230	1,982.65
	132	1,542.24
	66	2,511.60
Future	500	1295
	230	3873.86
	132	280.5
	66	995

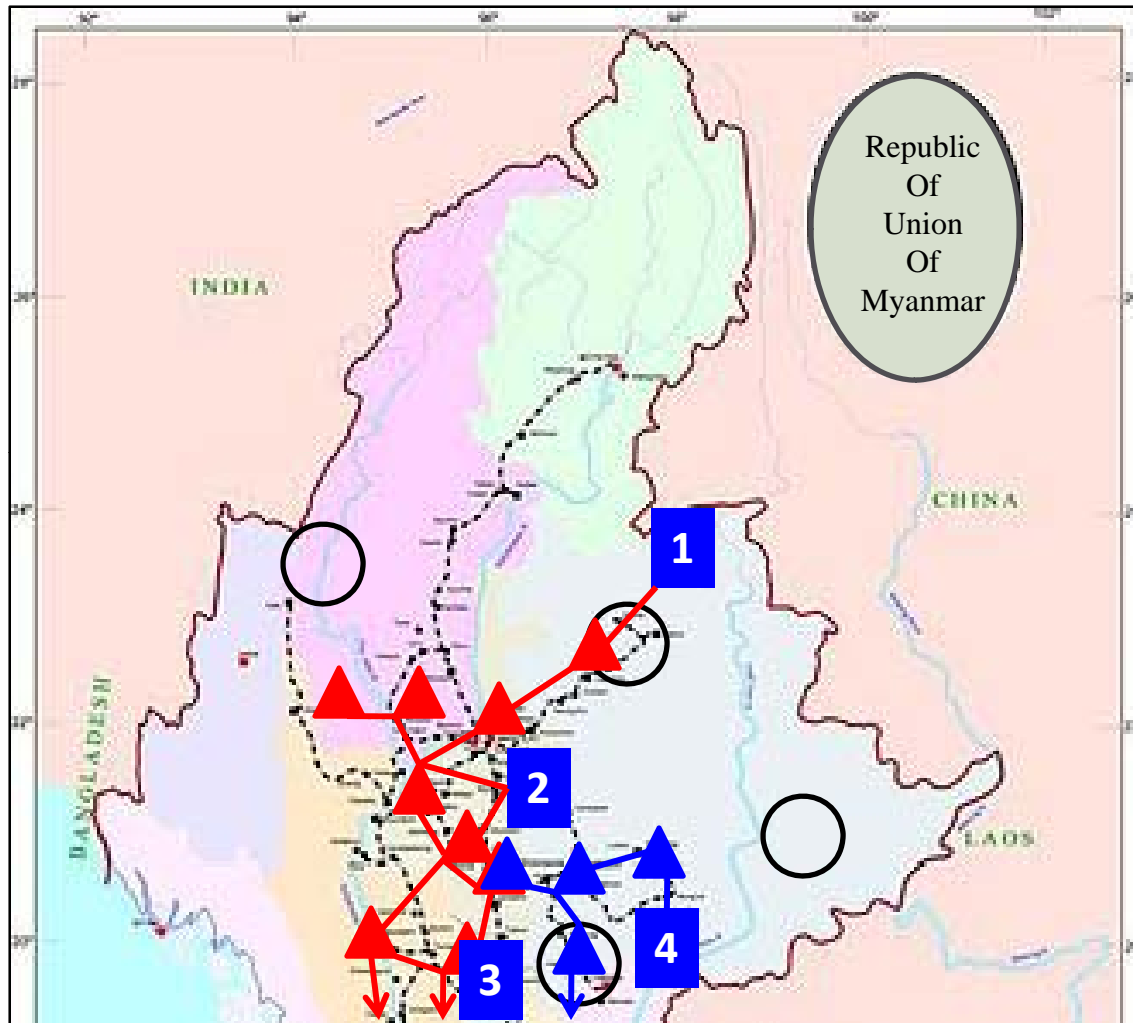
Transmission Lines

	Voltage Level (kV)	Installed Capacity (MVA)
Present	500	-
	230	3,990.0
	132	1,783.5
	66	2,580.6
Future	500	4000
	230	700
	132	805
	66	170

Substations

Existing and Future Facility for Power Transmission

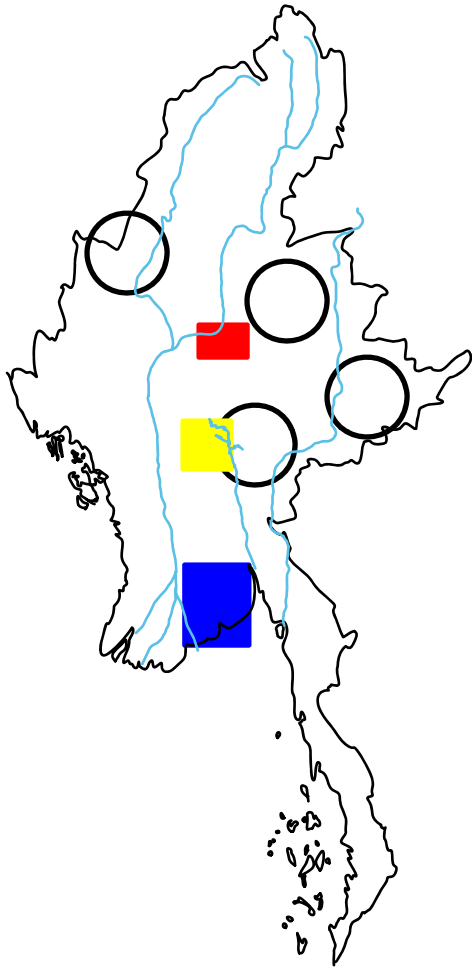
6 Transportation and Power Transmission



- Major Coal Mines
- 1 Existing Hydropower Station
- ▲ Existing 230kV Substation
- ▲ Existing 132kV Substation

Major Coal Mines and Existing Transmission Facility

6 Transportation and Power Transmission



- Mandalay Area
Max. Power Demand – 170 MW (2012)
- Nay Pyi Taw Area
Max. Power Demand – 80 MW (2012)
- Yangon Area
Max. Power Demand – 830 MW (2012)

Major Coal Mines and Load Centers

7. Considering to develop coal-fired power plant

7

Considering to develop coal-fired power plant

Year	Maximum Demand (MW)	Increased (%)
2010	1371	-
2011	1588	15.8
2012	1850	16.49
2013	2128	15
2014	2447	15
2015	2814	15
2016	3236	15

Source: MOEP

In 2020, maximum demand will be 5660MW and in 2030, 23000MW.
(Increased rate = 15%)



Reserved Power 30% = 6900 MW



Therefore, we have to implement the power plants minimum capacity of
 $23000+6900=29900$ MW
at the end of 2030.

Power Demand Forecast

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Considering to develop coal-fired power plant

Type of Generation	Capacity (MW)
Hydropower	2660.0
Gas and Thermal	714.9
Coal	120.0
Total	3494.9

Source: MOEP

Installed Capacity of Existing Power Plants

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Considering to develop coal-fired power plant

Considering to develop coal-fired power plant, I would like to highlight three things, these are-

- (a). Environmental Impacts
- (b). Access to Transmission Line (to major load center)
- (c). Sustainable Coal Supply

(a). Modern technologies to reduce the environmental impacts caused by coal power plants are acceptable and more technologies are researched. (Described in part-4)

Choosing good quality coal can reduce the environmental impacts and increase the efficiency of power plants.

7

Considering to develop coal-fired power plant

(b). Access to Transmission Line

- ❑ According to location of major coal mines, Kalewa and Eastern Shan are quite far from load center. So, power plants near these coal mines will need new transmission line.
- ❑ It is easy to access existing transmission lines, if considering power plants along the Ayeyarwady River.(from Mandalay to Pyay)
- ❑ It is also easy to access transmission line, if considering power plants near Yangon area.

7

Considering to develop coal-fired power plant

(c). Sustainable Coal Supply

1. Considering Kalewa and Lashio coal for power generation

- Except its lower grindability, the properties of Kalewa coal are quite good for power generation. (A power plant of 600MW is now implementing near Kalewa)

- The properties of Lashio coal is unfavorable for power generation.

7

Considering to develop coal-fired power plant

2. Considering coal-fired power plant along Ayeyarwady River (Mandalay to Pyay)

- Both domestic and foreign coals can easily be transported, although transportation capacity will have limitations because of river's depth.
- Easy access to existing transmission lines.

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Considering to develop coal-fired power plant

3. Considering coal-fired power plant near seaports

- Only foreign coal should be used because of poor transportation facility from local coal mines.
- Coal price may be more expensive. But quality of coal would be better.
- Yangon Port, the busiest port in Myanmar, can only accept maximum of 15000 DWT ships. Thilawa port (opposite of Yangon) can accept 25000DWT maximum. It may be a restraint for supplying coal for large power plants.
- Dawei Deep-sea Port would be able to handle 100000DWT maximum.

8. Conclusion

8

Conclusion

For ensuring sustainable coal supply for power generation in Myanmar,

❑ Quality of domestic coal is not suitable for firing alone. Therefore, both domestic and foreign coal supply should be taken in account. Along the Ayeyarwady River (from Mandalay to Pyay) would be the most favorable location.

❑ Power plants near Yangon (including Thilawa SEZ) would be suitable because of easy access to Myanmar's largest load center and good seaports nearby.

❑ Power plants near Dawei would have some incentives. Dawei SEZ and deep seaport would need large amount of power in near future. Deep seaport can handle very large coal carriers.

THANK YOU

