

# **ENERGY BALANCES**

*A useful tool for  
Energy planning & Economic Development*

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# **OBJECTIVE**

**Developing an appropriate methodology for building National Energy Balances:**

- **Capable of serving as a tool for energy planning;**
- **Amenable to comparison in order to allow one country to assess its relative efficiency of energy uses and to benefit from the experiences of other countries.**

# **EXPECTED ACCOMPLISHMENT**

**The integration of these “National Energy Balances” in order to optimize the production, trade and use of energy in the region.**

# **FRAMEWORK**

**Energy Balance (EB) is conceived to:**

- **Analyze energy supply and demand;**
- **Analyze the characteristics of the socio-economic system and the energy system as part of it.**

# **EB STRUCTURE**

- **EB is a matrix consisting of a set of variables;**
- **The rows of the matrix indicate the economic activities and the columns indicate the energy carriers;**
- **The matrix is structured in such a way to reflect the interface with the economic structure;**
- **The EB must be sufficiently detailed in order to:**
  1. Show how energy flows into various economic sectors;
  2. Assess meaningful estimates of energy efficiency;
  3. Identify means of improving energy efficiency.

# APPROACH

- **Defining the economic and energy concepts and terms;**
- **Listing the components of these concepts and terms as much and as specific as possible;**
- **Measuring or estimating the energy flow into the economy by energy source and economic sector.**

# **ENERGY BALANCE MATRIX**

## **A Simple Example**

# **EB MATRIX COLUMNS**

**1. Crude Oil**

**2. Natural Gas**

**3. LPG**

**4. Naphtha**

**5. Gasoline**

**6. Jet Fuel**

**7. Gasoil / Diesel Oil**

**8. Residual Fuel Oil**

**9. Other Petroleum Products**

**10. Total Petroleum Products**

**11. Electricity**

**12. Coal**

**13. Total Commercial Energy**

**14. Noncommercial Energy**

# **EB MATRIX ROWS**

- 1. Indigenous Production (+)**
- 2. Imports (+)**
- 3. Exports (-)**
- 4. Bunkers (-)**
- 5. Stock Change (+ or -)**
- 6. Total Domestic Supply**
- 7. Extraction Sector Consumption**
- 8. Refining Industry**
- 9. Gas Industry**
- 10. Public Power Generation**
- 11. Transformation Sector Fuels & Consumption**
- 12. Transport & Distribution Losses**
- 13. Power Self-Generation**
- 14. Energy Available for Final Consumption**

# **EB MATRIX ROWS**

**15. Mining & Quarrying  
(non-energy)**

**16. Manufacturing**

**17. Transport**

**18. Household**

**19. Commercial &  
Services**

**20. Building &  
Construction**

**21. Agriculture**

**22. Unallocated Non-  
energy Products**

**23. Energy Final  
Consumption**

**24. Statistical Difference**





# **IMPORTANT ACTIONS**

- **The separation of energy consumption and losses in the energy production sectors from energy consumption in the end-use sectors is a MUST.**
- **Various methods of estimation will be used to fill all the cells in the EB matrix. These methods will be based on field surveys, comparative cases, economic and technical relationships, expert opinions, etc.**

# USEFUL TIPS

- The analysis of the energy flow will indicate the nature of the relationship between socio-economic development in the country and the growth and pattern of the country's energy demand.
- **This relationship can be used for identifying the major variables that explain energy demand and thus in forecasting future energy requirements.**
- The information in EB studies will and should provide decision makers with the input needed for selecting energy policies consistent with the country's development plans as well as with its energy position.

# **REQUIRED DATABASE**

**General Characteristics;**

**Economic Profile;**

**Energy/Economic interaction;**

**Domestic Prices;**

**Energy Supply;**

**Energy Demand;**

**Conversion Factors.**

# General Characteristics

- **Population and number of households by province;**
- **Climate: mean maximum temperature and mean minimum temperature per month and per province.**

# Economic Profile

- GDP components at market values at constant prices (Imports, exports, investment, government consumption, private consumption);
- GDP at factor cost by economic activity:
  - Oil value added;
  - Non-oil value added: Agriculture, Mining and quarrying (non-oil), Manufacturing, Transport and communication, Water and electricity, Construction, Wholesale and retail trade, Financial institutions and Government and other.
- Gross Capital formation by sector;
- Balance of payments;
- Employment by sector.

# Energy/Economic interaction

- **Total energy consumption:**
  - **Total petroleum products consumption;**
  - **Total natural gas consumption; and**
  - **Total electricity consumption.**
- **Per capita energy consumption**

# Domestic Prices

- **Average retail price of each energy product; and**
- **Taxes and subsidies on the price of each energy product.**

# Energy Supply

- Primary Energy Supply;
- Secondary Energy Supply  
(Transformation Sector);

# Energy Demand

- **Energy Consumption;**
- **Sectorial Analysis.**

# Primary Energy Supply

- Crude Oil;
- Natural gas;
- Hydropower;
- Coal;
- Biomass;
- Nuclear power; and
- Renewable energy.

# **Secondary Energy Supply**

- **Refining industry (for each refinery);**
- **Gas processing industry (for each unit); and**
- **Electricity generation.**

# Crude Oil

- 1. Reserves;**
- 2. Gross production by field (excluding condensates);**
- 3. Specific gravity of each type of crude oil;**
- 4. Crude oil consumption in the field if any:**
  - a. For power generation;**
  - b. For other purposes (specify);**
- 5. Losses and torches if any;**
- 6. Net crude oil production;**
- 7. Crude oil transported from the field to terminals;**
- 8. Crude oil consumed in pumping stations if any;**
- 9. Crude oil supplied to the local refineries;**
- 10. Crude oil exported;**
- 11. Stock variation in field tanks and export terminals;**
- 12. Crude oil imports by type of crude (API).**

# Natural gas

1. **Reserves;**
2. **Gross production:**
  - a. **Associated with crude oil;**
  - b. **Non-associated;**
3. **Net calorific value of each type of natural gas;**
4. **Gas consumption in the field:**
  - a. **For power generation;**
  - b. **For other purposes;**
5. **Gas re-injected into wells;**
6. **Gas flared;**
7. **Net natural gas production;**
8. **Natural gas supplied to gas processing units;**
9. **Imports of natural gas;**
10. **Natural gas consumed in compression stations if any;**
11. **Natural gas distribution:**
  - a. **Power generation;**
  - b. **Industrial sector;**
12. **Gross production of condensates;**
13. **Average density of condensates;**
14. **Utilizations of condensates .**

# Hydropower

1. **Installed capacity of each generation center;**
2. **Volume of waterfalls;**
3. **Electricity generated;**
4. **Internal consumption;**
5. **Transmission losses;**
6. **Peak load demand.**

# Coal

1. Proven reserves;
2. Annual production;
3. Net calorific value;
4. Internal consumption in coal mining;
5. Exports;
6. Imports;
7. Stock changes;
8. Consumption in industrial sector;
9. Consumption in other sectors (specify).

# **Biomass**

- 1. Annual production of each type of biomass energy: fuel wood, charcoal, dung ... etc;**
- 2. Net calorific value of each type under the standard conditions of combustion;**
- 3. Trade of each type if any;**
- 4. Consumption of each type in:**
  - a. Household sector;**
  - b. Agriculture sector;**
  - c. Other sectors (specify)**

# Nuclear power

**All relevant information concerning the undertaken projects of nuclear power, if any.**

# Renewable energy

**All relevant information concerning the undertaken projects (solar, wind, geothermal, ... etc.) if any.**

# Secondary Energy Supply

- Refining industry (for each refinery);
- Gas processing industry (for each plant);
- Electricity generation.

# Refining Industry

1. Design capacity;
2. Crude intake by type of crude;
3. Gross production by product;
4. Internal consumption by product:
  - a. For electricity generation;
  - b. For other purposes.
5. Losses and flares;
6. Net production by product; Sales by product (excluding bunkers):
  - a. Local market;
  - b. Exports.
7. Imports by product;
8. Bunkers by product;
9. Stock change by product:
  - a. At refinery;
  - b. At export terminal.

# **GAS PROCESSING INDUSTRY**

- 1. Design capacity;**
- 2. Natural gas intake;**
- 3. Net calorific value of gas intake;**
- 4. Internal consumption:**
  - a. For electricity generation;**
  - b. For other purposes.**
- 5. Losses and flares;**
- 6. Net production by product (sweet gas and liquids);**
- 7. Net calorific value of each product;**
- 8. Sales by product:**
  - a. Local market;**
  - b. Exports.**
- 9. Stock change by product:**
  - a. At plant site;**
  - b. At export terminal.**

# Electricity Generation

- **Public power generation (for each generation center):**
  - Type of the units (GT, ST, DE);
  - Installed capacity by unit;
  - Fuel intake by fuel type;
  - Gross production by type of generators;
  - Internal consumption and losses;
  - Net production;
  - Transmission losses.
- **Self-power generation (in oil and gas fields, refineries, gas processing units, major industries):**
  - Installed capacity by type of generator;
  - Fuel intake by fuel type;
  - Gross production.
- **Water desalination (Capacity and production)**

# ENERGY CONSUMPTION

- **Natural gas consumption:**
  - Electricity generation;
  - Industry, as:
    - Fuel gas;
    - Self power generation;
  - Feedstock.
- **Petroleum products:**
  - Domestic consumption by product;
  - Stock changes at the distribution centers.
- **Electricity consumption:**
  - Household sector;
  - Commercial/services sector;
  - Public Administration (lighting, air conditioning and others) sector;
  - Industrial sector;
  - Agriculture sector;
  - Public lighting.

# **SECTORIAL ANALYSIS**

- **Transport Sector;**
- **Household sector;**
- **Commercial and Services Sector;**
- **Building and Construction Sector;**
- **Mining and Quarrying Sector;**
- **Agriculture and Fishing Sector;**
- **Manufacturing Sector.**

# TRANSPORT

- Road transport
- Air transport
- Sea transport

# ROAD TRANSPORT

- **Number of vehicles by type of fuel, and year made:**
  - **Passenger cars by size of engine and/or horsepower:** Private cars; Government cars; Taxis;
  - **Trucks by dwt:** Private; Public; Government;
  - **Pick-ups by horsepower:** Private; Public; Government;
  - **Buses by load number of passengers:** Private; Public; Government; School.
- **Average distance driven per year per each type of vehicles;**
- **Average fuel consumption per each type of vehicles;**
- **Transit vehicles:** Number of passenger cars; Number of trucks.

# **AIR & SEA TRANSPORT**

## **Air transport**

- **Jet fuel sales to national airlines;**
- **Jet fuel sales to foreign airlines;**
- **Number of passenger flights by type of aircraft;**
- **Number of freight flights by type of aircraft;**
- **Number of passengers;**
- **Weight of goods;**
- **Number and types of national fleet.**

## **Sea transport**

- **Sales of marine diesel and fuel bunkers to:**
  - **International ships, cargo and tankers;**
  - **National ships, cargo and tankers.**
- **Number of coastal ships and cargo by type, size and dwt;**
- **Number of deep-water ships, cargo and tankers by type, size and dwt;**
- **Number of passengers and distance traveled;**
- **Weight of goods transported and distance traveled**

# HOUSEHOLD (HH)

1. Number of HH by province;
2. Average size of HH by province;
3. Number of houses by type of construction and air condition and heating system;
4. Average floor space of each type of houses by province;
5. Consumption of Electricity, LPG, Kerosene, Gas oil, Fuel wood and charcoal and other biomass products (mollus, dung ... ect.) in HH;
6. Average consumption of Electricity, LPG, Kerosene, Gas oil, Fuel wood and charcoal and other biomass products (mollus, dung ... ect.) in each type of houses;
7. Pattern of consumption of each energy product in each type of houses: (cooling, heating, lighting, cooking, appliances).

# COMMERCIAL & SERVICES

- **Public services;**
- **Private Services;**
- **Commercial Services.**

# PUBLIC SERVICES

- **Government buildings:**
  - Number of offices;
  - Number of employees;
  - Average area of the office;
  - Electricity consumption in the government buildings;
- **Hospitals:**
  - Number of beds;
  - Energy consumption by fuel type (electricity, LPG, other fuels);
- **Schools and Universities:**
  - Number of classrooms;
  - Number of labs and other facilities;
  - Energy consumption by fuel type (electricity, LPG, other)
- **Hotels:**
  - Number of beds;
  - Number of staying nights;
  - Energy consumption by fuel type.
- **Mosques and Churches:**
  - Number of mosques and Churches;
  - Average area per mosque or Church;
  - Electricity consumption.
- **Public lighting:**
  - Roads and highways;
  - Recreational areas.

# PRIVATE SERVICES

- **Number of employees in the private sector;**
- **Number of offices in the private sector;**
- **Average floor space of the office;**
- **Energy consumption (elect., LPG, kerosene ... etc.).**

# COMMERCIAL SERVICES

- **Number of Banks;**
- **Number of Real Estate Offices;**
- **Number of Shopping Centers;**
- **Other Shopping Areas**
- **Energy consumption by type of activity.**

# **BUILDING & CONSTRUCTION**

## **Building**

- Number of new buildings by type (governmental bldg., houses, shops, etc);
- Average floor space of each type of buildings;
- Number and types of equipment used in the buildings activity, and average working hours per each equipment;
- Amount of raw materials used in each type of building;
- Energy consumption by fuel type.

## **Construction**

- Length and width of constructed roads;
- Energy consumption by fuel type in each category;
- Amount of raw material used in each type of construction: cement, stones, sand... etc.

# MINING & QUARRYING

## Oil and gas extraction

- Energy consumption in exploration and drilling activities by type of fuel;
- Energy consumption in production activities by type of fuel.

## Non-oil activities

- Volume of stones extracted;
- Number and types of equipment used and their working hours;
- Energy consumption by fuel type.

# AGRICULTURE & FISHING

## Agriculture

- Cultivated area:  
Irrigated and Non-irrigated;
- Agriculture production;
- Irrigation:
  - Number of pumps used in the irrigation activities per type and size of pump;
  - Average working hours and fuel consumption per pump.
- Mechanization:
  - Number of tractors and other equipment per type and size;
  - Average working hours and fuel consumption per equipment.

## Livestock

- Number and type of cattle;
- Areas reserved for livestock activities;
- Energy consumption by fuel.

## Fishing

- Fishing production;
- Number of fishing boats by type and size of engine;
- Average working hours and fuel consumption per each type of boats.

# MANUFACTURING

## Sub-sectors

1. Food, beverages and tobacco;
2. Textiles, wearing apparel and leather;
3. Wood and wood products;
4. Paper products, printing and publishing;
5. Chemicals, rubber and plastic products (other than refineries);
6. Non-metal mineral products;
7. Basic metal products;
8. Fabricated metal products, machinery and equipment;
9. Other transformation industries.

## Data Required

- Electricity consumption (self produced and from the national grid separately);
- Consumption of other energy products by type;
- Non-energy products feedstock (raw materials);
- Annual production of each industry;
- Number of employees in each industry;
- The share of energy cost in the total production cost of each industry

# CONVERSION FACTORS

<b>From:</b>	<b>Volume</b>	<b>Weight</b>	<b>Volume Or Weight</b>
<b>To:</b>	<b>Weight</b>	<b>Volume</b>	<b>Energy Equivalence</b>
<b>You need to know →</b>	<b>Specific gravity of the energy product</b>		<b>Heat content of unit volume/weight</b>
<b>Then use</b>	<b>Volume/weight conversion factor</b>		<b>Heat conversion factor</b>

Thank You