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Land Use and Energy

Module

Bachelor of Laws (Hons.) in Law and Land Administration
Faculty of Land Management and Administration
Patuakhali Science and Technology University (PSTU), Bangladesh

***This module is the outcome of the project "Integrating education with consumer behaviour relevant to energy efficiency and climate change at the universities of Russia, Sri Lanka and Bangladesh* (BECK)" co-funded by Erasmus+ Programme of the European Union.**

June 2021

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Course Details

Programme: Land Management and Administration
Degree: Bachelor of Laws (Hons.) in Law and Land Administration

Part A- Introduction

1. Course Code		LRT 223
2. Course Title	:	Land Use and Energy
3. Course Type	:	Core Course (Online)
4. Level/Term and Section	:	Level-2, Semester-II
5. Academic Session	:	2018-19 and onward
6. Pre-requisite (If any)	:	Not applicable
7. Credit Value	:	02 (Two)
8. Contact Hours	:	32 (Thirty-Two)
9. Total Marks	:	100
10. MOOC Objectives	:	The main objective of this MOOC is to produce skilled graduate ensuring green environment through building energy efficient land use.
11. Course Learning Outcomes (CLO)	:	At the end of the course, the student will be able to: **CLO-1:** Describe the importance of land use, energy, and energy efficiency and define the basic terminology including land use, land use planning, energy efficiency, energy consumption; **CLO-2:** Recognize the relationship between man and land as well as explain the historical evolution of land use study; **CLO-3:** Characterized the factors of land use change; **CLO-4:** Correlate the association between land use and energy; **CLO-5:** Analyse and explain the global trends in energy use and efficiency; **CLO-6:** Formulate local land use plan; and **CLO-7:** Understand and evaluate existing land use and energy policies in Bangladesh.

Part B- Content of the Course

Course Content	Specific Outcome(s)	Time Frame	Teaching Strategy(s)	Alignment with CLO
Introduction and Basic terminology: introduction to the module, land use, land use planning, energy efficiency, energy consumption	• To acquire the general idea about the course • To grasp the content and strategy for the class • To introduce the basic terminology	Week 1	• Audio-visual materials • Online lecturing • Group discussion • Q&A session	Developed interest of the students on LU & EE, and basic terminology linked with CLO 1.
Fundamental Aspects of Land Utilization: Man-land relationship, meaning of land use, and history of land use study	• To discuss man-land realationship • To make them able to explain the historicla evolutionof land use study	Week 2 Week 3	• Audio-visual materials • Online lecturing • Group discussion • Q&A session • Big data mining	Developed interest of the students on different environmental impacts of RETs linked with CLO 2.
Factors of land use change: biophysical factors (topography, soil characteristics), socio-economic factors (demographic, industrialization, urbanization, economic and technological, institutional, and cultural factors), globalization, natural variability, interaction of causes	• To idnetify the factors of land use change • To explain the interaction among the different factors of land use change	Week 4 Week 5	• Audio-visual materials • Online lecturing • Group discussion • Q&A session • Big data mining	Developed interest of the students on RE commercialization linked with CLO 3.
Land use and energy connection: impacts of energy on land use (conventional and non-conventional energy), impacts of land use on energy efficiency (mixed land use development, urban block development, transit-oriented development, combined heat and	• To explain the impacts of energy on land use change • To describe the impacts of land use on energy efficeincy	Week 6 Week 7	• Audio-visual materials • Online lecturing • Group discussion • Q&A session	Linked with CLO 4

Course Content	Specific Outcome(s)	Time Frame	Teaching Strategy(s)	Alignment with CLO
power, green spaces, energy support land use policies)			• Big data mining	
Global trends in energy use and efficiency: global trends, disaggregate indicators	• Analyse and explain the global trends in energy use and efficiency	Week 8	• Audio-visual materials • Online lecturing • Group discussion • Q&A session • Big data mining	Linked with CLO 5
Land use planning: definition, principles of land use planning, the planning process, the focus of land-use planning, land use planning at different levels, people in planning, steps in land-use planning	• To characterize the principles of land use planning • To identify the focus area of land use planning • To explain different planning level • To describe the people's relationship with planning • To explain different steps in land use planning	Week 9 Week 10 Week 11	• Audio-visual materials • Online lecturing • Group discussion • Q&A session • Big data mining	Linked with CLO 6
Land use and energy policies in Bangladesh: National Land Use Policy (2001), Bangladesh Energy Regulatory Commission Act (2003), National Energy Policy (2005), Renewable Energy Policy (2008), Sustainable and Renewable Energy Development Authority Act (2012), Action Plan for Energy Efficiency and Energy Conservation (2013), Sustainable Development Goals (2015-2030), Energy Efficiency and Conservation Master Plan up to	• To underline the land use and energy related policy in Bangladesh. • To recognize the energy regulatory act and action plan for energy regulation. • To assess the pros and cons of existing land use and energy policy in Bangladesh.	Week 12 Week 13 Week 14	• Audio-visual materials • Online lecturing • Group discussion • Q&A session • Big data mining	Linked with CLO 7

Course Content	Specific Outcome(s)	Time Frame	Teaching Strategy(s)	Alignment with CLO
2030, Energy Efficiency and Conservation Rules (2016) and other relevant policies and acts.				
Review Class	• To make an overview	Week 15	• Audio-visual materials • Online lecturing • Q&A session	Linked with all CLOs
Final Assessment		Week 16		

Part C- Assessment and Evaluation

- Online assessment and evaluation pattern of the University will be followed.

Part D- Learning materials

- Land Use and Energy Module
- Audio-visual materials (www.pstu.ac.bd, http://beck-erasmus.com).

Table of Contents

Chapter One:
Introduction and Basic Terminology

Introduction

Land is considered as the physical entity by means of topographical and spatial characteristics. It is the utmost gift of nature and categorised as the fundamental resource of human society and they have been using this resource and changing its utilization attributes by means of settlement, recreation, industrialization, urbanization, cultural functionalities, economic development, etc. However, land use has also been changing because of its biophysical determinants though effectiveness of such determinants can be varied by region to region.

Land plays an important role in global cycles of greenhouse gases. Land use activities can result in emissions of such greenhouse gases to the atmosphere or removal of greenhouse gases from the atmosphere. The United Nations Framework Convention on Climate Change (UNFCCC) acknowledges that land use can significantly reduce energy consumption or achieve energy efficiency and minimize climate change.

Energy efficiency or efficient energy use is basically defines using less energy to carry out the similar work and this way energy waste can be eliminated. The main aim of energy efficiency is to reduce required amount of energy in order to produce goods and services. The connection between land use and energy can be explained in two different ways: (a) impact of energy on land use; and (b) impacts of land use on energy efficiency.

The type of technology used for generating energy and the production processes significantly alters the land use pattern in the production and service area. On the other hand, the most efficient way of energy efficiency in the built environment can be achieved through land use planning with a view to lowering energy requirements/consumptions is reducing VMT using variety of methods including mixed-use development, urban block development, encouraging transport-oriented development. In addition, establishing combined head and power system, ensuring available green spaces, and energy support land use policies can unlock energy efficiency and ensure sustainable development.

Basic terminology

Land Use

Human use of land has a long history, may be more than 10,000 years. Land use is usually defined human utilization of land. It is understood as the series of work on land with the intention to produce products and/or benefits through using land resources. It is also considered as the management and modification of natural environment into built environment such as settlement or pasture or other use.

> According to J.L. Buck (1937), "land use is the satisfaction, which the farm population derives from the type of agriculture developed, the provision for future production and the contribution to national needs".
>
> According to Nanavati (1957), "land utilization is related to conservation of land from one major use to another general use" (Mandal, 1982).
>
> According to FAO (2000), "land use defined as the total of arrangements, activities, and inputs that people undertake in a certain land cover type".

Land use includes 'everything land is used for by residents of the country, from farms to golf courses, houses to fast food establishments, hospitals to graveyards etc.

Land Use Planning

The demands for arable land, grazing, forestry, wildlife, tourism and urban development are greater than the land resources available. In the developing countries, these demands become more pressing every year. The population dependent on the land for food, fuel and employment will double within the next 25 to 50 years. Even where land is still plentiful, many people may have inadequate access to land or to the benefits from its use. In the face of scarcity, the degradation of farmland, forest or water resources may be clear for all to see but individual land users lack the incentive or resources to stop it.

Land use planning refers to the process by which a society, through its institutions, decides where, within its territory, different socioeconomic activities such as agriculture, housing, industry, recreation, and commerce should take place. For example: all kinds of rural land use are involved: agriculture, forestry, wildlife conservation and tourism. Planning also provides guidance in cases of conflict between rural land use and urban or industrial expansion, by indicating which areas of land are most valuable under rural use.

Land use planning is a public policy exercise that designates and regulates the use of land in order to improve a community's physical, economic, and social efficiency and well-being. A land use plan may be prepared for an urban area, a rural area, or a region encompassing both urban and rural areas.

According to FAO (1993), "Land-use planning is the systematic assessment of land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land-use options."

Its purpose is to select and put into practice those land uses that will best meet the needs of the people while safeguarding resources for the future. The driving force in planning is the need for change, the need for improved management or the need for a quite different pattern of land use dictated by changing circumstances.

Land use planning (LUP) is an iterative process based on the dialogue amongst all stakeholders aiming at the negotiation and decision for a sustainable form of land use in rural areas as well as initiating and monitoring its implementation.

Energy Efficiency

Energy has been considered as one of the most crucial determinants for smooth economic development and people's livelihood in Bangladesh and many other countries. Energy efficiency refers to the efficient conversion and use of energy and is a measure of the productivity provided per unit of energy consumed. Energy efficiency or efficient energy use is basically defines using less energy to carry out the similar work and this way energy waste can be eliminated. The main aim of energy efficiency is to reduce required amount of energy in order to produce goods and services (NEED, 2019).

Energy Consumption

Energy consumption is the amount of power or energy consumed. Energy efficiency primarily depends on the technology and design. The effectiveness of these technologies is impacted by the ways people use them, here as energy consumption. Some of the common meanings associated with energy conservation include:

- ✓ Using less energy in a particular application
- ✓ Finding ways to purchase particular forms of energy at lower cost. This is usually accomplished by negotiating with energy providers or by using energy under less costly conditions. (Paradoxically, the latter method may increase energy consumption considerably.)
- ✓ Shifting to different energy sources of lower price
- ✓ Using "free" or "renewable" energy sources
- ✓ Shifting to energy sources that are considered to be more desirable, or less undesirable, with regard to non-efficiency concerns such as availability and pollution. Such shifts typically involve serious compromises.
- ✓ Conserving water and materials, as well as energy sources

References

Buck, J.L. 1937. Land utilization in China, University of Chicago Press.

Mandal, R.B. 1982. Land Utilization: Theory and Practice. Concept Publishing Company, New Delhi.

FAO 1993. Guidelines for land-use planning. Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO 2000. Land Cover Classification System (LCCS): Classification Concepts and User Manual. Food and Agriculture Organization of the United Nations, Rome, Italy.

NEED 2019. Intermediate Energy Infobook. National Energy Education Development Project, USA. Available at: https://www.need.org/wp-content/uploads/2019/10/Intermediate-Energy-Infobook.pdf. Retrieved on 10 April, 2021.

Chapter Two:
Fundamental Aspects of Land Utilization

Man-land Relationship

Land is considered as the physical entity by means of topographical and spatial characteristics. It is the utmost gift of nature and categorised as the fundamental resource of human society. Land is originated in between 480 and 360 million years ago during the mid-Paleozoic era. It supports population growth, economic and societal development in one hand. On the other hand, makes conflicts, litigation and, wars. FAO (1995) stated that "land is a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface including those of the near-surface, climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes, and swamps), the near surface sedimentary layers and associated groundwater reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc.)."

The UNCCD defines land as "the terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system."

Man-land relationship is an idea which implies the existence of societies in some sort of symbiotic relationship with their environment. It is the key component of geographical thought. However, it is also discussed in the other disciplines. The main philosophy of man-land relationship is interdependence, but the degree of interdependency or the scale of influence one on another is not same everywhere. Man-land relationship can be discussed in terms of three conceptual concepts including (1) general concept, (2) relative concept; (3) degree of dependency concept,

General concept

In general, there are two basic concepts of man-land relationship. First one is environment induced human activities and the second concept is man induced environment. The concept of environment induced human activities also refers as environmental determinism. This concept states that the history, culture, living style and the stages of development of a social group or nation are largely governed and controlled by physical factors of the environment including geographical location and the attributes of land surface. Arab geographer Al-Masudi said that people are humorous in area having abundant of water while they are short tempered in the dry land area. He also stated that the nomads who live in the open air are having strength, physical fitness and wisdom and those who live in closed areas of the cities are not like that.

On the other hand, man induced environment is the concept where man continuously change or alter the geographical environment including its topographical attributes with a view to improve their societal values as well as cope up with the changing environment. The physical environment is not same everywhere and somehow control the human activities. In the pre-historic age, human being was totally depended on the physical environment. During that time the environment determined where to live, how to get food and move forward. As civilization has evolved, dependency has diminished, and man has modified the physical environment by their own way to bring his own social, cultural and economic development.

Relative concept

Scholars Tan and Li (2017) describe man-land connection from three perspectives. The first view: man is the product of nature. They explained that evidently human history in the earth surface represents not more than 4 million years while Earth originated about 4.6 billion years ago hence man is the product of nature or land. The second view: land can exist independently without man but man can't. In the earth, there are thousand-millions of land parcels exist without man while man must have to live on the earth surface. And the third view: land does not make any demand for its existence in general but man is reliant on land for survival as well as man's other development including social, economic, technology, cultural, industrial etc. are somehow related to the land.

Degree of dependency concept

The evolution of man-land relationships can be broadly divided into four stages based on the degree dependency of human beings on nature. The first stage is the primitive civilization era, when productive forces were scarce and humans were forced to passively adapt to and overly rely on nature. The expression "determinism" is often used to describe this principle. The determinist theory holds that man's decisions and behaviour are merely consequences governed by causal laws. The second stage is the agricultural civilization era, during which human productivity improved significantly, and people began to use labour resources and eventually develop irrigation and farming techniques. At the time, man's relationship with the land could be defined as simple and low-level coordination. The third stage is the era of industrial civilization, during which the social productive force is rapidly expanded. Humans' active position was greatly enhanced under the influence of the concept that "man can conquer nature by his efforts." At this period, the man-land relationship was mostly associated with human conquest and dominance over nature. The fourth stage started in the 1980s and is still going on. The concept of sustainable development has strengthened the relationship between man and land (Xiaoyun et al., 2017). Sustainable development is that kinds of development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Meaning of Land Use

Land use is the use actually made of any parcel of land. It is a dynamic concept and pattern of land use as well as its concept has been changing in relation with time and space. Land use is determined because of the engagement of physical and socio-economic factors (described in chapter-3). Several geographers and academician define land use as the following way:

Freeman T.W. (1968) stated that land use means surface utilization of all developed and vacant land for a specific point at a given time and space.

Vink (1975) has mentioned that land use is any kind of permanent or cyclic human intervention on the environment to satisfy human needs and the land uses capability or land suitability is the potential capability of given tract and to support different types of land utilization under given cultural and socio-economic condition.

Young (1975) has mentioned that the land use at any given place and time 'results from decisions based on the interaction of five groups of factors: environmental, technological, economic, social and political'.

Campbell (1987) defines land use as "use of land by humans, usually with emphasis on the functional role of land in economic activities."

Lillesand and Kiefer (1987) stated that, "the term land us relates to the human activities associated with the specific piece of land, factures present on the earth surface."

Food and Agricultural Organization (1995) referred land use as "the function or purposes for which the land is used by the local human population and can be defined as the human activities which are directly related to land, making use of its resources or having an impact on them."

Nanavati (1957) opined that "land utilization is related to conservation of land from one major use to another general use" (Mandal, 1982).

So, land use is the human use of land for betterment their socio-cultural and economic conditions. It included the management and modification of the physical environment to the built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods.

Historical Development of Land Use Study

The development of land use survey initiated in Great Britain during early 1930s by sir Laurence Dudley Stamp, Professor of Geography at the London School of Economics. He made a survey of use of every parcel of land in Britain on a nation-wide-scale with a systematic and comprehensive manner. But Samuel Van Valkenburg acted key role in forwarding the concept and plan of World Land Use Survey. He proposed to form a 'Commission on World Land Use Survey' by the International Geographical Union to discuss the possibility of a world-wide land use survey on a scale of 1:1000000 and each sheet to be accompanied by explanatory memoirs. Valkenburg proposed the idea of world land use survey in April 1949 at the International Geographical Congress in Lisbon. The notable output of International Geographical Congress was that the International Geographical Union formed first 'Commission on World Land Use Survey'. The IGU appointed S. Van Valkenburg as chairman. Other members of the commission were L. Dudley Stamp, P. Gourou, L. Waibel, and H. Boesch. This commission had initiated land use survey in many parts of the world and constructed the world land use maps on as scale of 1:1000000. The main objective of world land use survey is "to record the present use of land in all parts of the world on a uniform system of classification and notation with such amplification as may be necessary locally". The commission classified the world land use into nine categories including some sub-categories and it is outcome of very careful opinions and views expressed by the members and the expert witnesses. The land use classifications are cited below:

1) Settlements and associated non-agricultural lands (dark and light red);
2) Horticulture (deep purple);
3) Tree and other perennial crops (light purple);
4) Cropland (brown);
   (a) Continual and rotation cropping (dark brown)
   (b) Land rotation (light brown)
5) Improved permanent pasture (yellow);
6) Unimproved grazing land (orange and yellow);
7) Woodlands (different shades of green);
   (a) Dense (Dark green)
   (b) Open (Medium green.)
   (c) Scrub (olive green)
   (d) Swamp forests (Blue green.)
   (e) Cut over or burned over forest (Stippled with the green of the respective colour)
   (f) Forest with subsidiary cultivation (Green with brown dots)
8) Swamps and marshes (blue); and
9) Unproductive land categories (gray).

Land Use Studies in Britain

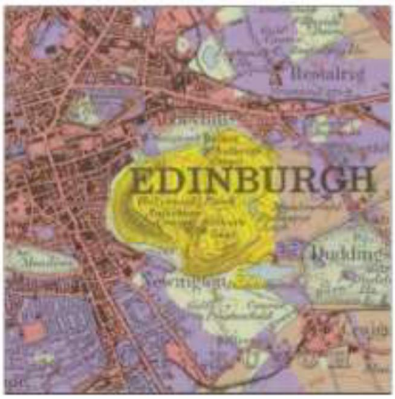
(a) First land use survey

Professor sir L. Dudley Stamp is known as the pioneer of land use studies because of his great monumental work carried out in Great Britain and encouraged as well as provided guidelines to the geographers and other academicians all over the world. Stamp established 'Land Utilization Survey in Britain' as an independent research organization in 1930 with a view to survey and record the use of every parcel of land in Britain. This organization was successfully classified land uses of Great Britain. Stamp's land use survey recorded six major categories as follows:

Table 2.1: Stamp's major categories of land use

	Category	Symbol	Colour
1.	Forest and Woodland	F	Dark Green
2.	Meadow and Permanent Pasture	M	Light Green
3.	Arable or Tilled Land	A	Brown
4.	Heathland, Moorland, Commons, and Rough Pasture	H	Yellow
5.	Gardens, Allotments, Parks, Orchards	G	Purple
6.	Land Agriculturally Unproductive (buildings, yards, mines, etc.)	W	Red

Figure 2.1: Land use in Great Britain (partial) in 1930s (adopted from Environment Agency, 2007)



(https://maps.nls.uk/series/land-utilisation-survey/info.html)

Figure 2.2: Land use classification using original categories in Edinburgh

Major categories further divided into some sub-categories as follows:

1) Forest and Woodland
   a) High forest-big trees sufficiently close for their crowns to touch, and useful for timber production.
   b) Coppice, or coppice with standards-woodland that is cut over every few years for fencing, posts, etc.
   c) Scrub-small bushes or trees unfit for cutting.
   d) Forest felled and not replanted.

   Sub-categories forest or woodland has a lettering like 'Fa', 'Fb', 'Fe', and 'Fd', and furthermore possible to differentiate by 'c' for coniferous, 'd' for deciduous, and 'm' for mixed lettering as Fa^c, Fa^d, Fa^m, etc.

2) Meadowland and permanent pasture: Rotation grass land should be excluded from this category.

3) Arable or tilled land: This category also includes rotation grass and fallow land. The areas used as 'market gardens' are differentiated by 'MG'.

4) Heathland, moorland, commons, and rough pasture: This category also includes swamp and marsh pasture.

5) Gardens, allotments, parks and orchards: Houses with gardens sufficiently large to grow a few vegetables or even flowers come in this category, because the area, though producing comparatively little, is still productive. Allotments are included in this category since they are merely gardens at a distance from the worker's house. Orchards are usually separately distinguished on the six-inch map, and so the symbol combined with the letter 'G' readily distinguishes them; but if the ground is used for grazing, the symbols may be combined 'GM', or where used for fruit and ground crops 'GA'.

6) Land agriculturally unproductive: This category includes not only buildings, yards, mines, cemeteries, etc., but also purely waste land. Many enthusiastic surveyors have been able to add a great deal to our knowledge of the utilisation of the countryside by definitely stating what is the actual character of land marked 'W' on their maps.

Adopted from Stamp, 1932

Large number of students from school, college and university were involved in this work. Stamp and his team completed the mapping of whole country in a scale of 1:10560 (6 inches to a mile) by Ordinance Survey.

Maps are issued in 'quarter sheet' and each sheet (quarter) represented an area of approximately 6 square miles including the explanatory details such as field boundaries, buildings and other cultural details. Mapping of the entire Britain was completed before the occurrence of the War-II (1939-45). Publication of maps in a scale of 1:63360 and explanatory reports started in 1933 and ended in 1948. Results of the survey were then published in a voluminous book entitled 'The Land of Britain: Its Use and Misuse' in 1962.

During World War-II, when economist and experts realized that Britain was going to fall into a food shortage, they started 'Grow More Food' campaign following Dudley Stamp's land use classification. This resulted in a 70 percent increase in food production in Britain during the War. Based on such achievement, Dudley Stamp's land use survey and its output (land use classification) was rewarded and established without any doubt.

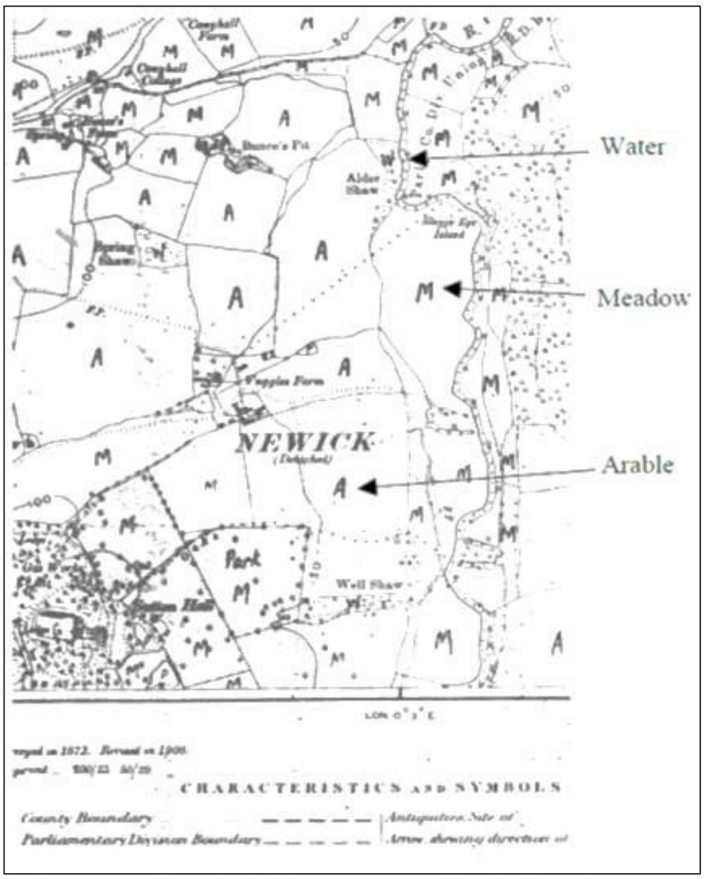


Figure 2.3: Sample field survey map (Southall et al., 2003)

(b) Second land use survey

A second land use survey in Great Britain was carried out by Alice Mary Coleman in the 1960s. He is one of the followers of Dudley Stamp who followed Stamp's approach of using volunteer-oriented land use survey and involved 3000 volunteers in his work. Maps were published and printed at a scale of 1:25000. More detailed land use types found in Coleman's land use survey than Stamp's classification. Coleman's land use survey recorded 70 different land use types and grouped them into 13 major categories. The major categories are as follows:

Table 2.2: Land use categories in second land use survey

	Category	Colour
1.	Settlement (Residential and Commercial)	Grey
2.	Industry	Red
3.	Transport	Orange
4.	Derelict Land	Black Stipple
5.	Open Spaces	Lime Green
6.	Grass	Light Green
7.	Arable	Brown
8.	Market Gardening, Etc.	Purple
9.	Orchards	Purple Stripes
10.	Woodland	Dark Green
11.	Heath, Moorland and Rough Land	Yellow
12.	Water and Marsh	Blue
13.	Unvegetated Land	White

Figure-2.4 presents total 55 land use categories printed using 11 colours.

Figure 2.4: Second land use survey colour conventions (Southall et al., 2003)

Figure-2.5 below provides two contrasting samples from the published maps.

(a) Rural fenlands (b) Briton Ferry, near Swansea

Figure 2.5: Samples from Second Land Use Survey 1:25,000 sheets (Southall et al., 2003)

Land Use Studies in Cyprus

Robert Rees Rawson and Kenneth Royston Sealy from the Department of Geography, London School of Economics remain memorable for their work in Cyprus. They introduced land utilization maps of Cyprus in 1956 at a scale of 1:250000. The maps were prepared based on the stereoscopic examination of about 10,000 air photographs (1:10000 to1:13000) taken in 1949. They used proposed land use classification by the Old-World Division of the World Land Use Survey. The categories are as follows:

1. Settlements and associated non-agricultural lands (dark and light red)
2. Horticulture (deep purple)
3. Tree and other perennial crops (light purple)
4. Cropland (brown)
   a) Continual and rotation cropping (dark brown)
   b) Land rotation (light brown)
5. Improved permanent pasture (managed or enclosed) (light green)
6. Unimproved grazing land
   a) Used (orange)
   b) Not used (yellow)
7. Woodlands
   a) Dense (dark green)
   b) Open (medium green)
   c) Scrub (olive green)
   d) Swamp forests (blue green)
   e) Cut over or burnt over forest areas (green stipple)
   f) Forest with subsidiary cultivation (green with brown dots)
8. Swamps and marshes (fresh and salt-water, non-forested) (blue)
9. Unproductive land (grey)

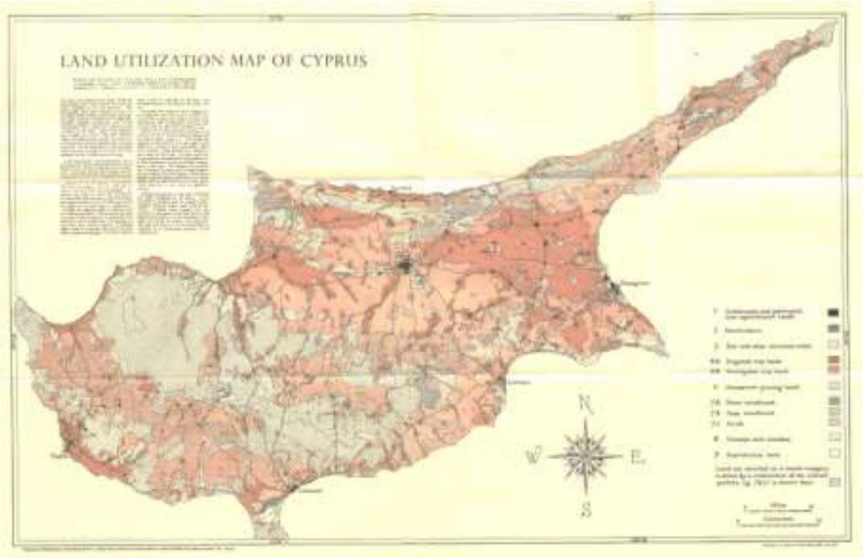


Figure 2.6: Land Utilization Map of Cyprus (Rawson and Sealy, 1956)

However, the proposed classifications were used with one modification because of the significance of irrigation. They sub-divided class 4: cropland into two classes: 4A as irrigated cropland (flat brown) and 4B as unirrigated cropland (stippled brown).

Land Use Studies in Italy

Although Italy responded to the recommendation made by the Commission on World Land Use Survey of the International Geographical Union (IGU) to carry out land utilization survey but they follow the concept of surveying and mapping of a committee formed headed by Vito Carmelo Colamonico. Land use maps of Italy including Sicily and Sardinia comprised of 26 sheets (20 of Italian main land, 3 of Sicily, and 3 of Sardinia) and were prepared under the direction of the committee at a scale of 1:200000. The full series consists of land use maps and text were presented in the IGU congress in New Delhi, India in 1956. Each series represent maps of separate region of Italy and also contains description of geographic aspects, sketch and statistical materials. Total 21 categories of land uses were presented in the maps. Land use categories are as follows:

1. Arable land,
2. Arable land with fruit trees,
3. Arable land irrigated,
4. Arable land irrigated with fruit trees,
5. Rice fields,
6. Gardens,
7. Vineyards,
8. Olive groves,
9. Vineyards with olive trees,
10. Citrus,
11. Orchards (mellow fruits),
12. Orchards (dry fruits — almond, nuts),
13. Deciduous woodland,
14. Coniferous woodland,
15. Mixed woodland,
16. Chestnut forests,
17. Dry meadows,
18. Irrigated meadows,
19. Pastures,
20. Unproductive land,
21. Settlement.

Land Use Studies in Poland

Kubijowicz prepared first land use map of south-east Poland. He classified land use into 7 categories as follows:

1. Unproductive land;
2. Woodland;
3. Grassland;
4. Areas with a predominance of meadows over arable land;
5. Areas with a predominance of arable land over meadows and meadows and pastures jointly over arable land;
6. Areas with a predominance of arable land over meadows and pastures; and
7. Areas with arable land exceeding 50 per cent of the total area.

In the postwar (World War-II) period, a project on land use mapping for agricultural reconstruction was initiated by the Director K. Dziewoński of the Research Section of the Central Office for Physical Planning. The results of land use were presented in topographic maps on a scale of 1:100000 and following land use classification was used:

Table 2.3: land use classification

Category	Symbols	Colours
Arable and fallow land	R	Orange
Orchards and gardens	O	Brown
Meadows and pastures	L and P	Light Green
Woodland	L	Dark Green
Non-agricultural uses (built-up areas)	Z	Red
Unproductive land	N	Pink

Source: Jankowski, 1975

During 1960s, a new-fangled study of land utilization pattern was initiated by J. Kostrowicki on the basis of agricultural typology, regionalization and planning.

Land Use Studies in U.S.A.

In U.S.A., different states have undertaken different land us classification to meet the current land use problems exist in the state. The first land use study was directed by J.W. Powell at the end of the 19th century in order to identify the possible areas of irrigation, dry farming and pasturage. Francis J. Marschner started his monumental work on land uses in the mid-1940s. Firstly, he prepared State land use maps at a scale of 1:1000000 using the aerial photographs of the late 1930s and the early 1940s. Later, he presented major land uses of the country excluding Islands and Alaska in a map on a scale of 1:5000000. The Agricultural Research Service under the US Department of Agriculture published Marschner's land use map in 1950. The map comprises eight colours presenting 12 major land uses and the metropolitan cities as follows (Figure 2.7):

1. Cropland and pasture land (red dots overprinted on yellow),
2. Cropland, woodland and grazing land (red dots on light green),
3. Irrigated land,
4. Forest and woodland grazed,
5. Forest and woodland mostly un-grazed,
6. Sub-humid grassland and semiarid grazing land,
7. Open woodland (pinon, juniper, aspen groves, chaparral and brush),
8. Desert shrubland grazed,
9. Desert mostly un-grazed,
10. Alpine meadows and mountain peaks above timber line,
11. Swamp,
12. Marshland,
13. Metropolitan cities

Source: Marschner, 1950

Figure 2.7: Land use map of U.S.A., 1950

Land Use Studies in China

Land use survey was directed in China during 1929-1933 by John Lossing Buck. This survey covered a total of 38,256 farmers from 16786 farms in 168 localities of 22 Provinces in China. The purpose of Buck's survey was threefold: "first, to train students in the methods of research in land utilization; second, to make available knowledge of China's agriculture, for its improvement as a basis of national agricultural policies; and, third, to make available to people in other countries…certain elementary information about land utilization, food, and population in China". A full-fledged land utilization survey was started in the People's Republic of China in 1978 incorporating two objectives i.e. creating geo-environmental database, and evaluate land resources along with its capability and crop suitability. Several mapping scales were fixed including 1:1000000 scale for mapping whole country, 1:200000 scale for provinces and regions and 1:50000 scale for sample areas.

Land Use Studies in Japan

The Geographical Survey Institute (GSI) is mainly responsible for preparing national land use maps through land utilization surveys in Japan. The GSI compiled first land use map of entire Japan and composed them into three large-sized sheets at a scale of 1:800000. This map was used after World War-II with a view to increase food production, management of destroyed land in the country and so on. Japan enacted the General Land Development Law in 1950 aimed to enlarging and improving the cultivable lands for increasing agrarian production and developing hydro power, etc. In 1953, land use mapping (1:25000) was started to meet the targets of the General Land Development Law. By 1966, one-third of the country was covered with eight colour composed land use maps.

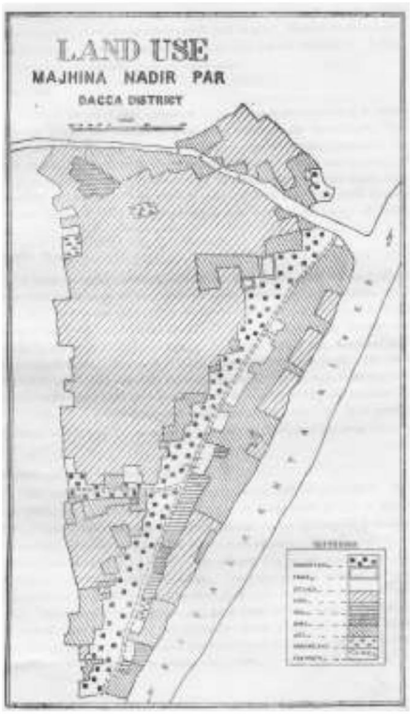
Furthermore, in Hokkaido, the GSI started land use mapping at a scale of 1:200000 in 1961 and completed in 1965. In 1973, Japan had changed land use mapping scale from 1:50000 to 1:25000. The GIS surveyed about 88,000 km^2 and prepared 700 sheets by the end of 1978 (Gojo and Kobayashi 1980; Himiyama and Jitsu, 1998).

Land Use Studies in India

The development of land use survey was initiated by Professor L. Dudley Stamp. In 1938, Professor L. Dudley Stamp attended the 25th Indian Science Congress organized at Calcutta. Professor Stamp motivated Indian geographers about the importance of conducting land use study. After the congress, Indian geographers have conducted land use survey in the various parts of the country. In India, pioneer work on land use was made by Professor Shiba Prasada Chatterjee, the father of Indian geography. Chatterjee conducted land use study in two districts of West Bengal namely 24 Parganas (1945) and Howrah district (1952). He led land use study in 24 Parganas with a view to disclose the impacts of physical properties like soil and climate as well as the demographic pressure on land use. In Howrah, Chatterjee conducted land use survey in two steps. Firstly, Chatterjee and his team prepared 1200 land utilization maps of 813 villages at a scale of 1:3960. In second step, they prepared 33 land utilization maps at a scale of 1:15840.

Land Use Studies in Bangladesh

Land use studies in Bangladesh conducted by Bangladeshi geographers in various parts of the country received inspiration from the Commission on World Land Use Survey. Nafis Ahmed and Fazle Karim Ahmed made first initiatives in conducting land use survey in Bangladesh. They conducted land use study in Majhina Nadir Par, is a village situated on the bank of river Shitalakshya in 1956.



Source: Ahmed and Khan,1957

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Chapter Three:
Factors of Land Use Change

Introduction

Land use change is mainly the result of individual desires about the change of a unit of land into another land utilization type. Collectively, personal desires make changes land use at a level of higher physiographic unit. It is the outcomes of environmental conditions and socio-economic, cultural, political and institutional condition as well as the interaction of the determinants. On the basis of origin, determining factors of land use change can broadly be divided into two categories, i.e. (a) biophysical/natural factors and (b) societal/anthropogenic factors. The spatio-temporal change of land use is the result of both physical environment and the social economy. Further, societal or anthropogenic factors can be distinguished into demographic, economic, cultural, technological and institutional factors.

Biophysical Factors

Biophysical variables are the specific limiting or supporting determinants of land use change. The effectiveness of such determinants can be varied by region to region. Researchers confirmed about the influential effectiveness of biophysical constraints within a physiographic unit. However, major biophysical determinants are topography (slope, elevation), soil characteristics, etc. These constraints determine the nature and rates of land use change among different physiographic units or regions through defining the natural capability or capacity of land. Moreover, they are also influential for determining the value of land.

Topography

Structure of land use and its spatial distribution are influenced by the topography of that land. If the topography such as slope and elevation of the area are in favourable condition then it is possible to produce crops intensively, for example, recent floodplain of Bangladesh, floodplain of India, etc. On the other hand, if gradient and elevation are such that it is difficult to use normally, then extensification process can be observed for crop production in those areas and most the land is left uncultivable temporarily or permanently or change its use, for example, most of mountainous areas of the world. The intensification process of land use depends on the nature of terrain of floodplains. Not only that the gradient and altitude are so important that they regulate other physical factors such as soil quality and at the same time affects the social factors. Altitudinal gradient effects on the organic composition of soil by controlling the balance of soil water, weathering and erosion of soil and other geological process and these influence on the development of vegetation and soil genesis. Chen et al. (2001) revealed that land use somehow oriented based on slope e.g., the land use requires more human input such as slope farmland, terrace farmland etc. are distributed in the gentle gradient area whereas those require little input such as bush land, dense woodland is distributed in the high gradient areas.

Moreover, human settlement and other socio-economic activities are largely influenced by the gradient. The residents of hilly area can convert a piece of land into settlement in favourable condition otherwise not.

Soil Characteristics

The extent to which a piece of agricultural land will be cultivated or lying fallow depends largely on the productivity of the land and productivity depends on the physical environment such as soil properties, erosion and other climatic condition. Production can be reduced about 4 percent because of deteriorating soil quality which may be happened by soil erosion or other mechanisms. If the fertility of the land is low, then it can be cultivated for a period of time (extensively) and if the fertility is too high, then the land can be used intensively. But, if the fertility is not present at all, then the agricultural land no longer suitable for cultivation. Hence, the owner converts it to another use, thereby changing the land use. Moreover, it is identified that the loss of soil fertility and deterioration of soil quality (physical, chemical or biological) are the key causes of land use change specifically from natural or semi-natural forest to managed or cultivated forest land in the highland areas.

Socio-economic Factors

Anthropogenic alteration that is for socio-economic wellbeing have been reported as the most influential for land use change through the process of demographical change, industrialization, urbanization, economic and technological improvement, institutional factors, cultural factors and globalization. And these anthropogenic alterations along with other natural and environmental process have been identified as the endless and evolving process. Furthermore, socio-economic factors have significant effects on the natural or environmental factors.

Demographic Factors

Change of population is often investigated as one of the driving forces of global land use change. The world's population has grown at a rapid rate over the past two hundred years. In the 1800s, the world population was about 1 billion but in 2019 this population has increased to 7.7 billion. This rapid growth has put tremendous pressure on nature and the environment especially on the land. In order to provide shelter to the additional population, people are constantly changing the agricultural land, forest land, etc. and setting up settlements, urban growth centres, industries. It is well documented that per capita farming land has been shrinking due to rapid demographic change that causes the reducing of agricultural productivity and ultimately conversion of farming land into other use. Migration is also considered as the key factor of radical land use change and is happened basically due to the over population. A large number of people migrate from rural to urban or peri-urban, also near to industrial area with a view to receive services or take advantages from urban and industrial areas. This migration changes the land use pattern of the service areas.

The figure shows the process of land use change through establishing initial housing that occupies only a small portion of the green-field and day by day initial housing requires more land for other use. Finally, the housing including other uses occupies more land than the green-field.

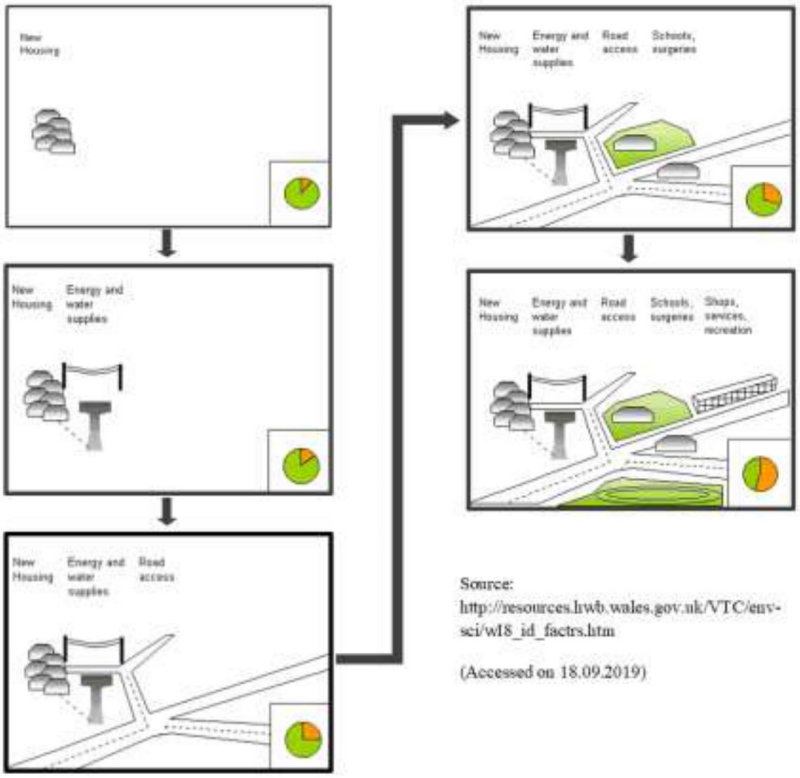

Figure 3.1: Process of land use change

Industrialization

Industrialization is a set of processes for economic transformation (from primary to secondary economic activities) through mechanization instead of manual production, started in the late seventeenth century. The entire world has gone through this massive transition which has a distinct impact upon the conversion of agricultural land and forestry. In addition, the pattern of societal value and life style has greatly impacted by this transition. City population had started to increase and the trend is continuing and creating new urban sprawls. Road construction for industrial development or industrial development for road construction has high rate of agricultural land encroachment. Therefore, land use change can be observed in all stages of the transition and its associated development. It is estimated that about 58.35 million hectors built-up area increases in between the year of 1700 to 2016.

Economic Factors

Industrialization is the main economic factor of land use change. However, other economic factors may be land value, income from land etc. Many scholars found monetary rationality focusing monthly income from land and land price as the key contributors for farmer's decision to land transformation. Farah et al. (2019) explored the probability of agricultural land transformation on the basis of decreasing monthly income form agriculture in two cities of Punjab, Pakistan namely Faisalabad and Sahiwal. Scholars found that a decrease of 1000 Rupees monthly agricultural income can contribute to increase the likelihood of crop land transformation by 70 percent or more. Earlier studies found that land owner's decision to change land use is highly associated with land value.

Urbanization

Urbanization is the process of increasing urban areas, its population coming from rural area or other urban hemisphere, built-up area, etc. It is evident that most of the urban people are engaged with the secondary and tertiary economic activities. This process is considered as a profound cause of irretrievably decreasing agricultural and forest land. In addition, real estate development is found as a new contributor in urbanization process in many developed and developing countries, which may convert open space, farm or forest land into built-up area. In some cases, urbanization synchronized with industrialization and increase land use change tremendously.

Institutional Factors

Almost, in all cases institutional arrangements both formal and informal make land use decision. First of all, land ownership and tenure system are by product of law and conceivably consider as the main factor of land use change. In addition, the policies of economic development of any country accelerate the development of the industry of that country which is directly associated to the foster of land transformation.

Cultural Factors

Land has a close relationship with human culture and values. In particular, the indigenous people have historically developed close ties to the land. They have been using the land for their livelihood. Lambin et al. (2003) explored that land use decisions can be changed or exist on the basis of land manager's personal histories, attitudes, beliefs, and individual perceptions. In addition to that, land use is changing in various ways e.g., park, theaters, theme parks, etc. to meet the recreation needs of the urban as well as peri-urban people in almost every country. Moreover, in some cases, religious culture contributes to change the use of land by constructing religious place of worship, educational institute, etc. On the other hand, opportunity of surge of income in urban areas or decreasing income in rural areas can be another sociocultural cause of land use change.

Globalization

Globalization acts as integrator of product, places, peoples, services, industries, policies, etc. and underlying force of land use change around the world by eliminating regional barriers and implementing unifying theme. It has a great impact on the other factors of land use change through green certification, eco-labeling, information technologies, etc. Sustainable land management policies of all the countries under the auspices of the United Nations are replaced based on the policy decisions made by the various programs of the United Nations and its various organizations. World's economic landscape in urban areas largely depends on internationalization of the industrial activities. The cities that have seen a surge in foreign investment have seen a surge in development over the last two decades. On the other hand, the development of cities where investment is low has remained stagnant. These all about related to land use change.

Natural Variability

Almost, all types of hazards including flood, cyclone, storm surge, tornado, landslides, bushfire, heatwave, etc. have short-term and or long-term effects on land use change. In addition, hazardous prone area having other land transformation factors make acute alteration of land use. On the other hand, land use changes may also occur during land use planning or land management or land development for managing hazards or minimizing its effects. For example, polder construction, cyclone shelters, bridge-culvert for draining flood water, embankments, afforestation projects, etc. play important role in changing land use as a post hazard management activity.

Interaction of Factors

In most cases, more than one factor together changes land uses of a certain area. The combination of these factors will change the use of land, depending largely on the environmental and climatic condition of the area. In addition, land use is also regulated by the laws and policies of that area. Most institutional land use changes are based on human needs, environmental impact and legal issues. But at the individual level, land use changes with the increase in population, the breakup of the joint family system by introducing monopoly family, the value of land, the suitability of land, and so on. In addition, natural disasters often affect land use in some areas, especially the pattern of land use.

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Chapter Four:
Land Use and Energy Connection

Introduction

Land use is usually defined as the human utilization of land. It is also considered as the management and modification of natural environment into built environment such as settlement, agriculture, transportation, industry, recreation, and open space. And, energy has been considered as the central determinant for smooth economic development and people's livelihood in Bangladesh and many other countries.

The world's urban population is projected to increase by about 2.5 billion by 2050. Virtually almost 90 percent of the increased population will be in Asia and Africa. These additional populations need more new and improved housing and associated infrastructures leading significant increase in energy.

We derive this energy from oil, gas, hydropower, solar, nuclear, geothermal, and other types of energy with a view to generate electricity for lighting our home, office, industry, etc. and operating/charging our appliances; to power our automobiles; and to run the industry.

Energy efficiency or efficient energy use is basically defines using less energy to carry out the similar work and this way energy waste can be eliminated. The main aim of energy efficiency is to reduce required amount of energy in order to produce goods and services.

The tools and techniques of land use are impressive potential to reduce community's energy consumption and that are also required for improving the economy, and mitigating climate change. On the other hand, extraction of fuel (oil/coal/gas), storage, construction of production facilities, the production and distribution processes on neighboring uses and the disposal of waste of energy have different land use and environmental impacts. Hence, it is understood that there are two different views on the connection between land and energy i.e. (a) energy significantly alter the landscape during its different processes (excavation to waste disposal) and (b) land use has significant impacts on energy and its efficient use.

Impacts of Energy on Land Use

Energy has been considered as one of the most crucial determinants for smooth economic development and people's livelihood. The per capita energy consumption rate is a basic indicator for determining economic modernization of a country. Hence, it is well said that countries are more developed when per capita energy consumption is higher. The main sources of energy are fossil fuels, nuclear power, and renewable energy. Production, transmission, and distribution process of these energy have significant land use impacts.

Fossil Fuels and Nuclear Energy

Fossil fuels are forms of organic carbon formed beneath of the earth's surface due to excessive heat and pressure of the earth crust. Most available and easy-to-use fossil fuels are coal, oil, and natural gas. Around 70%-80% of global energy comes from these non-renewable sources. On the other hand, the use of nuclear reactions to generate energy is known as nuclear power. In 2018, nuclear energy produces around 10% of the world's electricity (World Nuclear Association, 2021). Fossil fuels including coal mining, oil and natural gas extraction as well as nuclear power generation have remarkable impacts on land use.

Coal

Land transformation occurs both directly and indirectly during the different stages of coal-fuel cycle. In one hand, coal mine alters land use directly by destroying top soils and cleaning vegetation. On the other hand, act as fuel for power plant operation, associated infrastructure, waste indirectly affects the land use. Mining excavation, methods of mining (surface/underground), coal extraction, waste disposal and other related processes can transform the land from one use to another which also has several other environmental implications. Several researchers revealed coal mining subsidence as a serious human geological disaster in China (Du and Sun, 2005; Qu et al., 2006; Wu et al., 2009; Ma et al., 2019), India (Rehman et al., 2020), Greece (Loupasakis et al., 2013), Korea (Choi et al., 2009), etc. Scholars argued that land subsidence causes damage to cultivable land, forest area, urban neighbourhood, and overall landscape ecology nearby the mining area. Hoque et al (2013) argued that direct and indirect land use transformation occurred at and/or surrounding area of Barapukuria coal mine of Bangladesh.

Coal-fired power stations establish due to abundance and effectiveness of coal for producing electricity. Hence, coal as fuel indirectly alters the land uses. Fthenakis and Kim (2009) estimated that 6–33 m2/GWh of land transformation require for the entire operation including powerhouse, switchyard, coal storage, stack, walkways, cooling towers etc. of a 1000 MW coal-fired power plant. Coal-fired power plants produce almost 10 Gt of carbon dioxide per year (IEA, 2018), identified as the single most contributor of global greenhouse gas emission in 2018.

Another indirect effect of coal-mining is related to its fuel for mining operation. Wood usage for mine operation that account for huge land transformation by both deforestation and afforestation process.

Wickham et al. (2007) identified about five times indirect forest losses than direct land use change in Appalachia due to coal mining. It is also examined that about 40 percent of fly ash and bottom ash are deposited in land or mine filling (indirect effect) in Europe which have several negative effects including contamination in the groundwater and disruption the aquatic systems.

Oil

Oil and gas exploration and exploitation have been causing significant impacts on land use/cover change. For example, Dami et al. (2014) explored that 59,078 sq.km bare land converted in between 2001-2008 to other use including oil and gas infrastructure, associated settlement of the newly migrated population due to employment in the industries, agriculture for meeting the demand of additional foodstuff, vegetation increased due to afforestation project etc. in oil and gas production community of Kwale in Delta State of Nigeria (Matemilola et al., 2018).

Furthermore, oil development has other negative consequences including contamination of water, air, and land, health effects, and road wear and tear. The main concerns are that restoring land from oil activities takes a very long time, and that the removed forest area may not recover when the operations are decommissioned (Hebblewhite, 2017). The boreal forest in Canada, for example, is changing as a result of oil and gas exploration, transportation, and human settlement expansion. Appiah et al. (2020) found that oil infrastructure expansion had a greater impact on forests than on water, farming land, or barren land. They discovered 0.234 percent deforestation in north-eastern British Columbia from 1975 to 2017.

Natural Gas Extraction

The technologies are used in extracting natural gas have significant direct and indirect impacts on land use. Natural gas is extracted into deep well using fracking method. In this method, water, sand, and chemicals are injected into the deep well which makes crack in the rock layer and withdrawal natural gas through the cracks and fill up the well. Although, a small amount of land is required for deep well, usually 28-36 square meter, but provision of infrastructure and creation of vehicle network is needed to maintain supply chain, supply raw materials to the gas fields, for example, sand for fracking, and supply gas to the potential users. Both, the technologies (creation of deep well) and the facilities (establishing infrastructure and vehicle network) can transform land use pattern in the associated areas. In addition, injecting wastewater into the wells pose some risk of seismic activity which may cause of land use alteration, but, seismic risk related to injecting wastewater is much smaller than the carbon capture and storage systems have.

Nuclear Energy

Land is required in the different phases of nuclear power generation such as mining ore, establishing power station, management, transportation, and finally waste disposal. Approximately 330000 tones/year uranium ore (0.1% Uranium Oxide) is needed for operating a nuclear power station of 1000-Megawatt electrical power output. These amounts of ore can be obtained from underground, surface or solution mining based on the geological setting of the neighborhood. Approximately 7 ha land is mandatory to be ore mined for producing 1000-Megawatt electrical power for one year. Fthenakis and Kim (2009) found that land transformation is higher in the case of nuclear power production than coal-fired energy in USA. In addition, large buffer area is needed for transporting fuel materials and waste.

The areas are isolated and free from usual development but are being used as wildlife habitats through biodiversity and conservation programmes by many nuclear energy operators. Moreover, reprocessing of spent fuel needs further land transformation through establishing transportation system, operation of reprocessing plant etc.

Renewable Energy

The decision makers around the world are well known about our limitation regarding the fossil fuels we have. In addition, oil price fluctuations, increasing changes in climatic condition and its associated impacts on the world economy have motivated many countries in the world producing renewable energy both in small and large scale. Renewable energy is the sources of energy which is naturally replenishing and virtually inexhaustible in duration. The energy is collected from naturally replenished sources on a human timescale. Most common renewable energy sources are wind energy, solar energy, biomass, hydropower, and deriving energy from waste, etc. These renewable energy sources have significant implications in natural landscape change.

Wind Energy

Wind energy is becoming familiar as the non-conventional source of energy in many parts of the world. China has the highest installed wind capacity, 221 gigawatts (GW), and the largest wind farm, 7965 megawatts (MW), in the world. United States is the second largest wind capacity country (96.4 GW) and followed by Germany (59.3 GW), India (35 GW), Spain (23 GW), United Kingdom (20.7 GW), France (15.3 GW), Brazil (14.5 GW), Canada (12.8 GW), Italy (10 GW) etc. Agricultural land, livestock grazing, fallow land, etc. are the most compatible land uses for wind energy production because of height and noise issues for establishing wind turbines. In the area of residential or commercial, siting wind turbines are not feasible because adjacent buildings impede the wind in one hand. On the other hand, the noise created due to turbine cross the recommended noise-level (25-40 dB at night with 10 dB higher for daytime) of the International Standards Organization (ISO). The noise created due to wind turbines may vary depending on the power capacity and types of turbine use as well as available wind speed. Usual ranges of noise created by wind turbines is 96-108 dB. Therefore, establishing wind turbines need to change the present land use of agricultural, livestock grazing and fallow land. Although these changes are happened in a small scale but have significant impacts. In addition, establishing infrastructure for construction of wind turbines, operation and maintenance, and energy supply system need alteration of land uses in the production and service areas.

Solar Energy

The demand and use of solar energy have been increasing around the world using two popular methods i.e., Photovoltaic (PV) farms and concentrated solar power (CSP). Total capacity of solar-powered electricity has reached to 227 gigawatts electrical (GWe) in 2015 and represents about 1% share of global electricity production.

PV farms and CSP are large scale centralized methods of solar energy production which require a huge volume of insolation as well as land use concern. The National Renewable Energy Laboratory (NREL) reported that the average required land area (direct use) is about 7.3 acres for producing per MW electricity in the United States. Denholm and Margolis (2008) found that depending on available insolation, about 114–261 square meter land is usually needed to fulfil per person's energy demands using PV methods. Land use changes (through forest clearance, construction activities, etc.) for solar energy production are observed at different rate in many countries like United States, China, etc. which have several potential effects in soil erosion.

Biomass

Biomass is considered as the fourth largest source of energy while the first, second, and third sources are oil, coal, and natural gas respectively. It encounters about 6.41% of total global energy consumption. It is the largest sources of renewable energy that can be produced from different sources of raw material such as agricultural crops, forestry and wood processing residues, algae, household wastes, industrial wet wastes, etc. Biomass energy such as biogas and biofuel can be used for cooking, heating, electricity production, and also be used as transport fuel. Like other developing countries of South and Southeast Asia, biomass energy is being used as the main source of household energy in Bangladesh.

Global demand of biomass energy has doubled in the last four decades and still increasing (Singh and Wahid 2015). Although 0.5 to 1.7 percent of agricultural land is currently used to grow biofuel raw materials but has a great potentiality to be produced both small-scale and large-scale production. The production of biomass is largely depending on the available cultural land and land use policy which might increase land transformation. The effect of biomass on land use is largely due to the cultivation and processing of feedstock, as well as transporting fuel to the power plant. Successful biomass energy production involves intensive planning for longer period that takes into account alternative land uses and resource conflicts.

Hydropower

Hydropower is the world's largest renewable source for electricity generation, accounting for 71% of all renewable energy and 16.4% of global electricity supply from all energy sources. As contrast to electricity derived from fossil fuels, increasing hydropower energy output holds the potential to reduce greenhouse gas emissions. Hydropower is often touted as a low-cost, low-carbon, advanced technology for satisfying growing energy needs and boosting economic growth. River basin management and reservoir creation for establishing a hydropower plant as well as its associated economic activities may trigger the changing nature of social status and economic well-being, resulting in changes in land use and land cover (LULC), and hydrologic patterns in the water basin area. In addition, a hydropower project can contribute to increase urbanization through reducing flood risk and improving development activities. And off course, urbanization is one of the leading causes of land use change in recent decades.

A large-scale hydropower plant includes construction of structures such as roads, dams, culverts, tunnels, power station infrastructure, and electricity power grids, leads clearing of forest and relocating human settlements. In addition, the reservoir's inundation on land could kill ecosystems, destroy infrastructure, and settlements, harm livelihood, etc.

Waste Energy

The World Commission on Dams reported that about 40-80 million of people displaced due to the socio-economic consequences of dam establishment activities. Later, a research on 'land use and renewable energy planning' estimated that indirect deforestation rises between 11.3% and 59% and land use for agriculture increase between 7% and 50% due to hydropower development in any give site for any given year (Wu, 2018).

Water-to-energy (WTE) process has a strong significance to land use alteration. Agricultural or commercial uses of land can be transformed to solid waste disposal site in order to generate utility and industrial fuel. According to the origin of waste, solid waste can be categorized as (a) municipal solid waste (MSW) includes food-kitchen-green waste, paper waste, product packaging waste, appliance waste, etc.; (b) industrial solid waste (ISW) includes inert industrial waste (chemically or biologically non-reactive) and non-hazardous waste; and (c) healthcare solid waste (HSW) also called as solid medical waste (SMW) includes plastic discarded gloves, syringes, bandages, human or animal tissues, cloths, etc.. However, the extent of economic or agricultural losses incurred by solid waste dumping varies by location, but typically all biodiversity is destroyed from such territory. Particularly, biodiesel generation from municipal solid waste requires available land surface ignoring food feedstocks which contribute to global land-use change.

Impacts of Land Use on Energy Efficiency

Isolated land use pattern makes housing scattered, sparse population densities, distanced average commuting or personal trips, etc. are directly related to increasing vehicle miles traveled. Vehicle miles traveled or VMT is a performance measure widely used in land use and transportation planning with a view to sufficient energy use. It is defined by measuring total amount of distance traveled by all vehicles in a spatial unit over a fixed period of time, usually one year. VMT is considered as a crucial proxy data for identifying vehicle emission, energy consumption, etc.

Energy efficiency or efficient energy use is basically defines using less energy to carry out the similar work and this way energy waste can be eliminated. The main aim of energy efficiency is to reduce required amount of energy in order to produce goods and services. The most efficient way of energy efficiency in the built environment can be achieved through land use planning with a view to lowering energy requirements/consumptions is reducing VMT.

Sustainable development and energy conservation can be achieved through reducing vehicle miles travelled using variety of methods including mixed-use development, urban block development, encouraging transport-oriented development. In addition, establishing combined head and power system, ensuring available green spaces, and energy support land use policies can unlock energy efficiency and ensure sustainable development.

Mixed Land Use Development

Mixed land use development in the sense of urban development and planning or zoning refers as the blended land use that combines at least two distinct types of compatible land uses such as residential, commercial, institutional, cultural, or entertainment uses into one space, it may be in the same building or in close proximity to each other, where those functions are to some degree physically and functionally integrated, and that provides pedestrian connections. For instance, mixed use development can be vertical where a single building could include a business on the first floor and residential uses on the upper floors or can be horizontal where a range of different structures on the same site each perform a definite objective, such as a neighborhood area that has housing buildings, office buildings, playground, park, shop and other facilities (Figure 4.1).

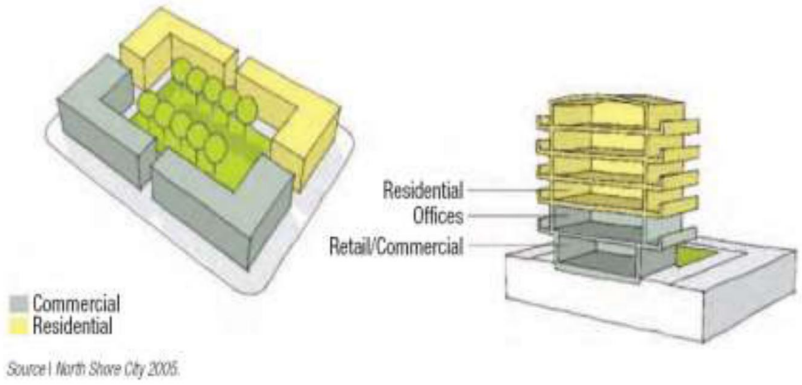

Figure 4.1: Mixed land use on the Block and Building Scale

Mixed land use development increases the neighborhood's liveliness and makes the urban environment more attractive. Mixed land use development is more realistic than mono-functional neighborhood in order to reducing energy demand for motorized travel, average travel distances (commuting or personal trips), and promote walking and other non-motorized travel. One of the earliest cities in North America that adopted mixed-use development policy is Toronto in Canada. City planners started to promote high density development by blending land uses near to metro stations during the rapid expansion of city's transit network in 1960's. In 1980, Metro Toronto regional government's Metroplan formulated to encourage the mixed-use aligning transit nodes and corridors. The local government first played a role in 1986 with a zoning bylaw under the Toronto legal framework that allowed for commercial, residential, and institutional units to be mixed.

The zoning bylaw was revised in 2013 and continues focusing on accommodating a blended land use. Mixed-use developments exist throughout the Toronto area, but most of Toronto's mixed-use zones are located in the downtown core because of the local political and planning history that concentrated on mixing land uses close to transit networks. The concept of mixed land use of Toronto has adopted in the other cities of Canada and the United States to bring similar changes.

Urban Block Development

Scholars define urban block as a part of urban area that is spatially isolated by road network from the surrounding parts It is also called as the residential cluster encompassed by road network. Towers (2005) identified three types of urban blocks such as tower block, linear block, and perimeter block. He investigated the same amount of floor space could be arranged in tower, linear, and perimeter block but need to control its height. He estimated that same result can be achieved in fifteen-story tower, five-story linear, and three-story perimeter block. There is no fixed size for an urban block, it may vary across the cities around the world. The appropriate size of an urban block is up to 120 m considering walkable, active, and livable urban space but sometimes it may be accepted up to 500 m in high-rise urban areas. In Tokyo-Japan size of typical urban block is 50 m width while it is 70-100 m in Vienna or Paris, 100-120 m in New York and Washington D.C. Urban block represents mixed uses and public shops exist in the ground floor usually linear pattern and connected with road network. Hence, energy savings can be achieved through decreasing energy demand for motorized travel.

Transit Oriented Development

Intergovernmental Panel on Climate Change stated that energy generation and consumption is the key contributor that emits almost two-third of greenhouse gas emissions. Cities particularly its transport system and household requirements (heating and cooling) are the dominant sources of energy consumption. It is estimated that world energy demand will rise about 1.3% yearly up to 2040. Transit oriented development (TOD) can contribute to reduce a certain amount of GHG emission from urban areas. TOD is an urban land use and transport planning tool that focuses on the mixed-use development within the walking distance of transit stop for maximizing the transport service efficiency. The concept of TOD has been started since late 1980s. Distance between origin and destination is the key factor in TOD that motivate or demotivate the users to use the transit or not. Many scholars identified that the standard walking distance is 10 minutes from house, business, or leisure spot to public transport. However, this distance may vary depending on the location and user specific needs.

Combined Heat and Power (CHP)

A country can achieve energy efficiency by introducing and incorporating combined heat and power (CHP) system in individual level and/or district level. CHP is the heat and power production system that operate in a single process. Combined heat and power (CHP) at district level usually called as district heating with combined heat and power (CHP-DH) is a system or process of generating heat at central level and distributing it to the users' premises through insulated pipes. However, the actual benefit of CHP-DH is higher in mixed-use development rather than single use. Nevertheless, CHP at individual level also provides an outstanding opportunity to supply head and power at many buildings like hotels, educational institutions, medical centers, residential houses, etc.

Green Spaces

Most of the urban areas are considered as the center of heat generation and commonly called as urban heat island is largely depends on solar insolation, wind speed, cloud cover, humidity, vegetation coverage, construction materials, etc. Urban heat islands consume vast amount of colling energy during summer season. Sufficient green spaces in urban areas support minimizing air temperature across horizontal and vertical scales and diminishing cooling energy prerequisites inside the urban area and its periphery. Some scholars explain green spaces as the "natural air conditioner" that can reduce building energy and create barrier to release carbon dioxide, nitrogen dioxide and ozone gases in the air.

Energy Support Land Use Policies

FAO (1993) defines land-use planning as "the systematic assessment of land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land-use options." Land use planning and regulations are the public policy exercise that designate and regulate the use of land in order to improve a community's physical, economic, and social efficiency and well-being. These regulations are also involved in achieving energy efficiency or diminishing marginal energy demand. Many scholars identified land use policies as the root cause of land use change. Land use policies can attain energy conservation by incorporating several sections regarding mixed use development, urban block formation, transport-oriented structural development, establishment of combined heat and power system, green fields development, improvement of mass transport, walking, cycling access, etc.

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Chapter Five:
Global Trends in Energy Use and Efficiency

Introduction

This chapter is fully copyright to IEA 2008 and no contribution by the Authors of this module. The chapter will be used only for education purposes. It examines energy use by final consumers in the main end-use sectors: industry, households, services and transport (excluding international aviation and marine transport) and. CO_2 emissions that result from this final energy consumption are also covered, including indirect emissions from the use of electricity and heat. However, the analysis does not include either the fuels used in the energy sector for the production of electricity and heat or for the transformation of crude oil into refined petroleum products.

Trends in the development of final energy and CO_2 emissions by sector and energy commodity are presented, together with aggregate indicators showing final energy intensity (final energy use per unit of gross domestic product (GDP)) and energy use per capita in different countries and regions. These aggregate indicators have the advantage that they can be compiled on a reasonably consistent basis for all countries and regions and so allow comparisons of trends and levels across different countries.

However, such indicators are not sufficiently detailed to explain fully the factors affecting energy consumption and CO_2 emissions. More detailed energy indicators are required to make the link between drivers of demand and their impact on overall energy consumption. Such disaggregated information is much less readily available. Comprehensive and detailed data for all end-use sectors are available for a group of 16 IEA countries. This has allowed more detailed indicators to be constructed for these countries, including a decomposition analysis to quantify the impact of the different factors affecting final energy use.

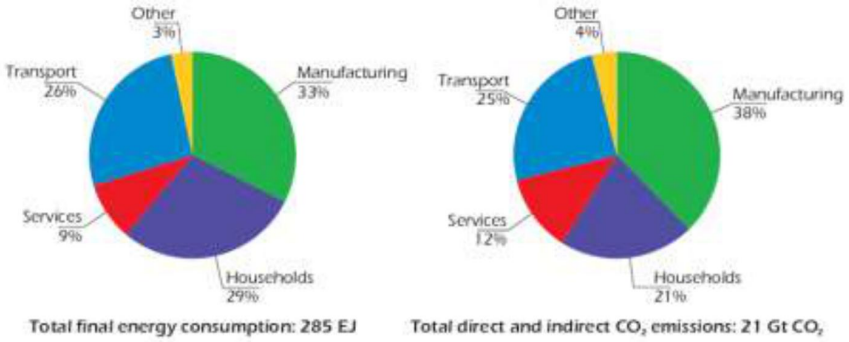
Global Trends

Between 1990 and 2005, global final energy consumption increased by 23%. Energy consumption grew most quickly in the service and transport sectors, both sectors showing an increase of 37%. These increases were driven by strong growth in activity in these sectors for many countries. Figure 5.1 shows that in 2005, manufacturing industry was the end-use sector that globally consumed the most energy, with a 33% share. It was followed by households (29%) and transport (26%).

Trends in CO_2 emissions are driven by the amount and type of energy used and the indirect emissions associated with the production of electricity. Between 1990 and 2005, global CO_2 emissions from final energy use increased to 21.2 Gt CO_2, a rise of 25%. Manufacturing was again the most important sector in 2005, with a share of 38%, but for CO_2 emissions the share from transport (25%) was higher than for

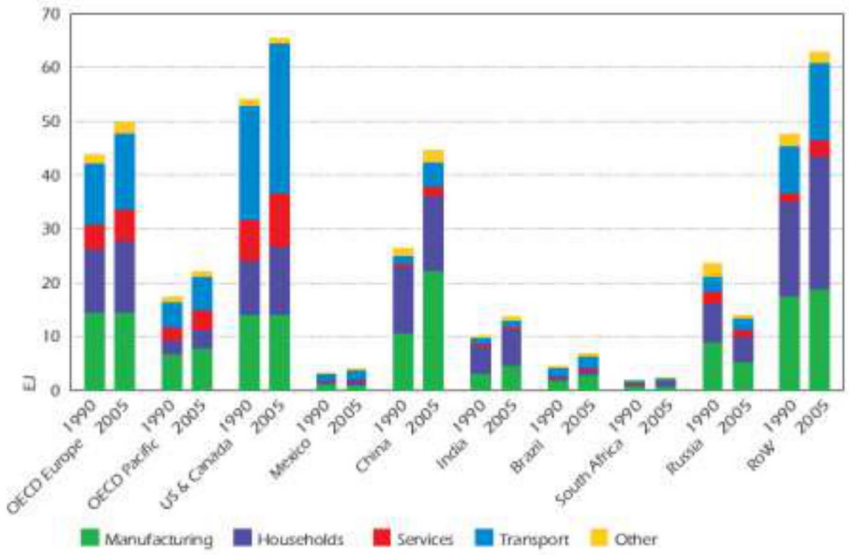
households (21%). The sectors rank differently depending on whether energy or CO_2 emissions are being considered, as they do not all use the same mix of energy commodities and so have different average levels of CO_2 emissions per unit of energy consumption.

Figure 5.1: Shares of Global Final Energy Consumption and CO_2 Emissions by Sector, 2005



Sources: IEA, 2007a; IEA, 2007b; IEA, 2007c.
Note: Other includes construction and agriculture/fishing.

Figure 5.2: Total Final Energy Consumption by Sector



Sources: IEA, 2007a; IEA, 2007b; IEA estimates.
Note: Other includes construction and agriculture/fishing.

Trends in energy use varied significantly amongst countries and regions (Figure 5.2). Between 1990 and 2005, final energy use grew less quickly in OECD countries (+19%) than in non-OECD countries (+27%). In OECD countries, the growth was mostly due to increasing transport energy consumption.

In 2005, the transport sector accounted for 35% of total final energy use. The service sector was the second fastest growing sector, but since it only accounts for about 14% of final energy use the impact of its increase on overall energy use was less important. Despite showing only a small increase in energy consumption, the manufacturing sector retains a substantial share of total final energy use in OECD countries at 27%.

Non-OECD countries show a very different picture. In these countries manufacturing and household energy use dominates, with shares in 2005 of 38% and 36% respectively. In contrast, despite growing most rapidly between 1990 and 2005, the transport sector only accounts for 17% of total energy use.

Energy use in China is increasing most quickly amongst the major economies, due to rapid economic growth. Between 1990 and 2005, China's manufacturing energy demand more than doubled, transport energy use almost tripled and the service sector increased its consumption by three and a half times. Overall, China's final energy use increased by 69% over this period. In contrast, Russia currently has significantly lower energy consumption in all sectors of the economy when compared to 1990. Total final energy consumption decreased by 41% between 1990 and 2005, as a result of the major economic restructuring that took place in the early and mid-1990s. Most of the decreases in energy use occurred before 1998 and since then final energy use has been more stable.

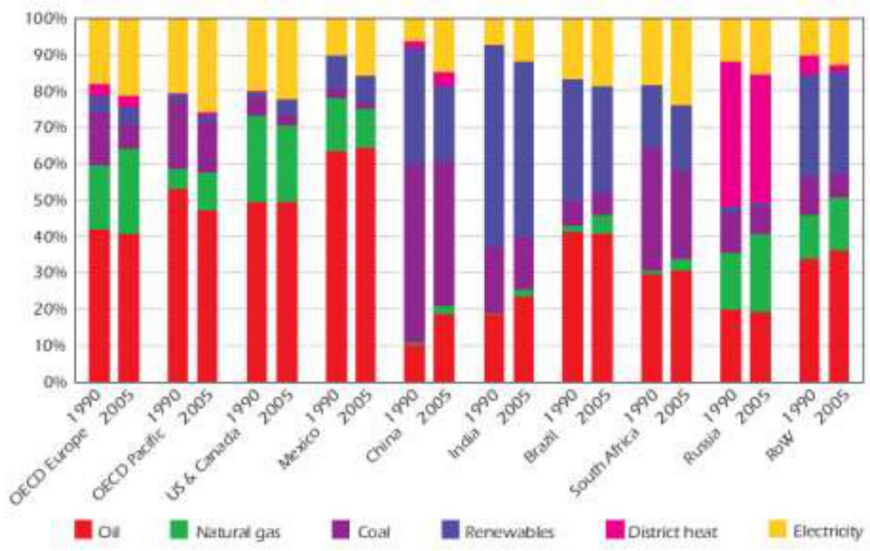
Not only does the pattern of sectoral energy use vary significantly between OECD and non-OECD countries, but the final energy mix is also quite different (Figure 5.3). Due to the relative importance of the transport sector in the OECD countries, oil products accounted for 47% of total final energy use in 2005. Natural gas and electricity were the other major energy commodities with shares of 20% and 22% respectively. In contrast, the use of coal is declining and in 2005 it accounted for just 6% of total final energy use.

Oil products also have the largest share of consumption in non-OECD countries, accounting on average for 28% of total final energy use in 2005. In many of these countries, oil products are used not only for transport, but are important fuels in industry and households. With a share in 2005 of 25%, use of combustible renewable energy (mostly biomass) is also significant, particularly in India. However, the share of renewable is slowly declining due to the increased use of other energy commodities, such as electricity. Electricity now represents 14% of final energy use in non-OECD countries. Direct coal use remains important in some countries (such as China) and has an overall share of final consumption in non-OECD countries of 18%. The share of district heat is in decline, but its use is still significant in some transition economies, such as Russia.

Non-OECD countries experienced a faster growth in CO2 emissions (+39%) than OECD countries (+15%). In the OECD the increase in CO2 emissions was slightly less than the increase in final energy use, meaning that the CO2 intensity of final energy use has fallen. However, the reverse was true in non-OECD countries, which consequently experienced an increase in the carbon intensity of energy use (Figure 5.4).

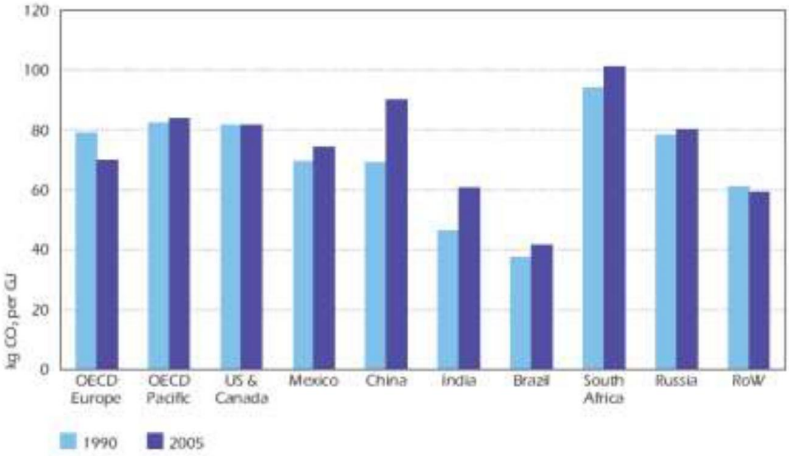
Countries with a high share of renewable energy (e.g., India and Brazil) have a lower carbon energy mix than the global average. On the other hand, countries with a high share of coal use (e.g., South Africa and China) have much higher carbon intensity. The fuels used to produce electricity and the conversion efficiency of this production play a key role in the overall carbon intensity of the final energy mix.

Figure 5.3: Total Final Energy Consumption by Energy Commodity



Sources: IEA, 2007a; IEA, 2007b; IEA estimates.
Note: Excludes fuel use in electricity and heat production.

Figure 5.4: Carbon Intensity of the Final Energy Mix



Sources: IEA, 2007a; IEA, 2007b; IEA, 2007c; IEA estimates.

A starting point for understanding the differences in the evolution and absolute levels of final energy use amongst countries is to examine some aggregate energy indicators that show energy use divided by a measure of activity that drives energy demand. For the overall economy, total final energy consumption (TFC) per unit of gross domestic product (GDP) and energy use per capita are the most commonly used aggregate indicators.

The ratio of TFC to GDP measures how much energy is needed to produce one unit of economic output. In order to perform cross-country comparisons, a common measure of GDP must be used. Two main approaches are used to convert GDP in national currency to a common unit of measure: conversion at market exchange rates (MER) and at purchasing power parity (PPP). The MER approach simply uses actual exchange rates to convert GDP or value-added in national currencies to a common currency, such as the United States dollar (USD). In contrast, the PPP approach defines a "basket of goods" (or services) and then equalizes the purchasing power of various currencies to "buy" these goods in their home countries. These special exchange rates are then used to convert GDP or value-added to USD. In both cases the analysis presented here uses exchange rates for the year 2000 to translate national currencies to USD.

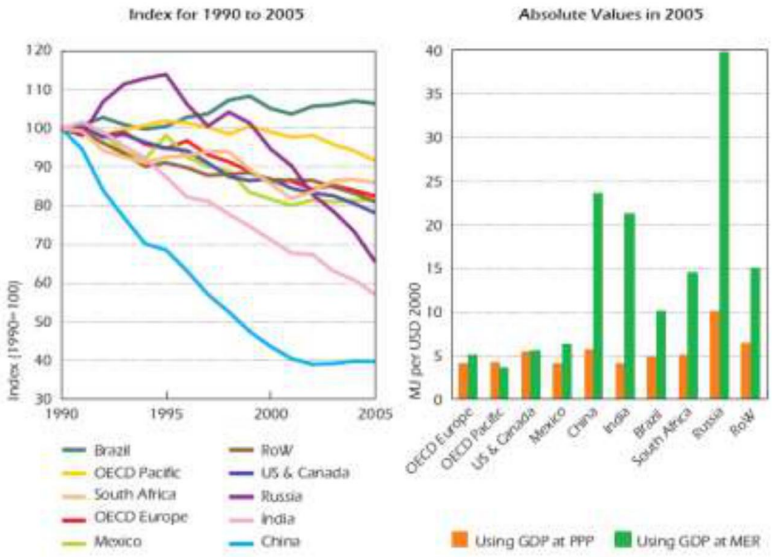
The two approaches produce different results for the level of TFC per GDP (or aggregate final energy intensity), which can affect how countries compare with one another (Figure 5.5). Using GDP at PPP, aggregate final energy intensity in 2005 varies from 4.0 MJ per USD in Mexico to 10.1 MJ per USD in Russia. When using GDP at MER, TFC per GDP varies from 3.6 MJ per USD in OECD Pacific to 39.8 MJ per USD in Russia. Using MER, all the non-OECD countries presented in the analysis use more energy per unit of GDP than those in the OECD.

However, these differences narrow considerably and sometimes completely disappear when calculating aggregate final energy intensity based on GDP at PPP.

Several factors explain why these variations in energy consumption levels per unit of economic output are so different amongst countries. Part of the difference reflects variations in energy efficiency. However, it would be misleading to rank energy efficiency performance according to a country's energy consumption per GDP measured using either PPP or MER. The ratio is affected by many non-energy factors such as climate, geography, travel distance, home size and manufacturing structure. This highlights the need for more detailed indicators to take account of these factors and to separate out the role of energy efficiency.

Trends in aggregate final energy intensity reveal that all countries and regions analysed have shown a decline since 1990, with the exception of Brazil. In general, non-OECD countries have shown a faster rate of reduction than OECD countries. In many cases these reductions can be attributed to strong efficiency improvements due to the introduction of modern, efficient technologies and processes. For instance, an analysis for China (LBNL, 2006) has shown that improved energy efficiency, particularly in industry, was one of the main factors driving down energy use per unit of GDP during the 1990s. On the other hand, changes in the structure of the economy can act either to increase or decrease the level of aggregate final energy intensity. In the case of Brazil, strong increases in energy use, particularly in the manufacturing and transport sectors between 1990 and 2005, coupled with modest economic growth, led to a slight rise in aggregate final energy intensity.

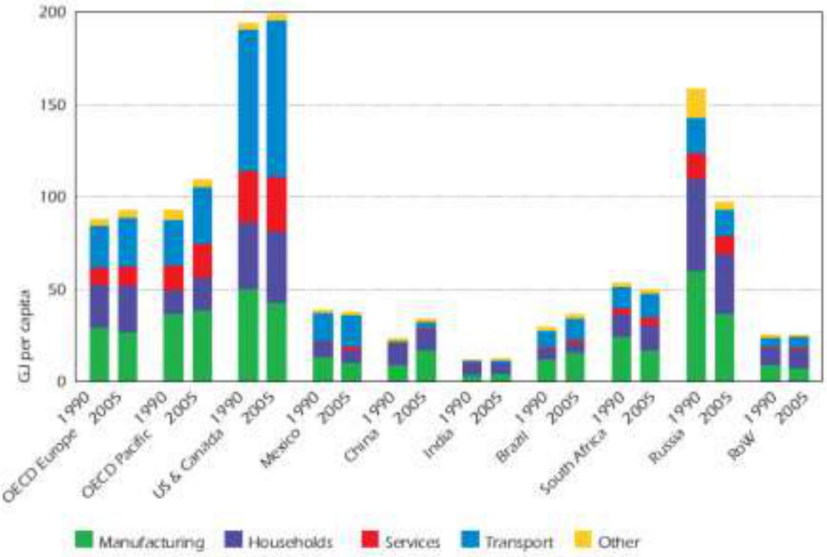
Figure 5.5: Total Final Energy Consumption per Unit of GDP



Sources: IEA, 2007a; IEA, 2007b; IEA estimates.

An alternative aggregate indicator to TFC per GDP is final energy use per capita (Figure 5.6). This indicator measures the amount of final energy "used" per person in a country. In contrast to aggregate final energy intensity, this indicator shows an increase for most countries and regions. For the OECD, energy use per capita increased by 6% between 1990 and 2005, while the increase in non-OECD countries was 1%. However, Russia is a significant exception, with energy use per capita having fallen by 39% over this period. This is linked with falling wealth, as measured by GDP per capita. Indeed, if Russia is excluded from the calculation for non-OECD countries, then per capita energy use in the remaining countries increased by 14% between 1990 and 2005. South Africa has also experienced a small decrease in energy use per capita over this timeframe. China, which showed the most significant decrease in TFC per GDP between 1990 and 2005, had the biggest increase in energy use per capita over this period (+47%), reflecting growing personal wealth (GDP per capita). In terms of absolute levels, the United States and Canada are by far the largest consumers of energy on a per person basis, at almost 200 GJ per capita. This level is around twice that seen in other parts of the OECD. In contrast, energy use per capita in India is only 13 GJ in 2005. On average, energy use per capita in non-OECD countries is only 23% of the level seen in the OECD.

Figure 5.6: Total Final Energy Consumption per Capita



Sources: IEA, 2007a; IEA, 2007b; IEA estimates.
Note: Other includes construction and agriculture/fishing.

The aggregate indicators, final energy use per GDP and final energy use per capita, are two very different ways of looking at the link between developments in final energy consumption and some of the most important underlying drivers. Both these indicators can be constructed for a wide range of countries and are useful for simple cross-country comparisons.

However, neither indicator includes sufficient information about the factors impacting energy consumption to understand fully what is happening. More detailed end-use data are needed for each sector concerning activity levels, structural effects and efficiency trends to develop disaggregate indicators that can provide a more complete explanation of changes in final energy use and the associated CO2 emissions. The development of these detailed indicators has been the main focus of the IEA energy indicators work.

Disaggregate Indicators

Comparable and disaggregated end-use information about the patterns of energy consumption in all end-use sectors (manufacturing, households, services and transport) is available for 16 IEA countries for the period from 1990 to 2005. This information, coupled with economic and demographic data, can then be used to construct indicators that identify the factors behind increasing energy use and those that restrain it. One of the most important issues to understand from an energy policy perspective is to what extent improvements in energy efficiency have been responsible for the declines in final energy intensity seen in the different IEA countries. To understand the role of energy efficiency, it is necessary to separate the impact of changes in sub-sectoral energy intensities (which are used as a proxy for energy efficiency) from the effects of changes in economic structure and other factors that influence the demand for energy. This is done using a decomposition approach that separates and quantifies the impacts of changes in activity, structure and energy intensities on final energy use in each sector and country (Box-1). The results of the sector decompositions are then aggregated to analyse country-wide trends.

Box-1

Decomposing Changes in Energy Use

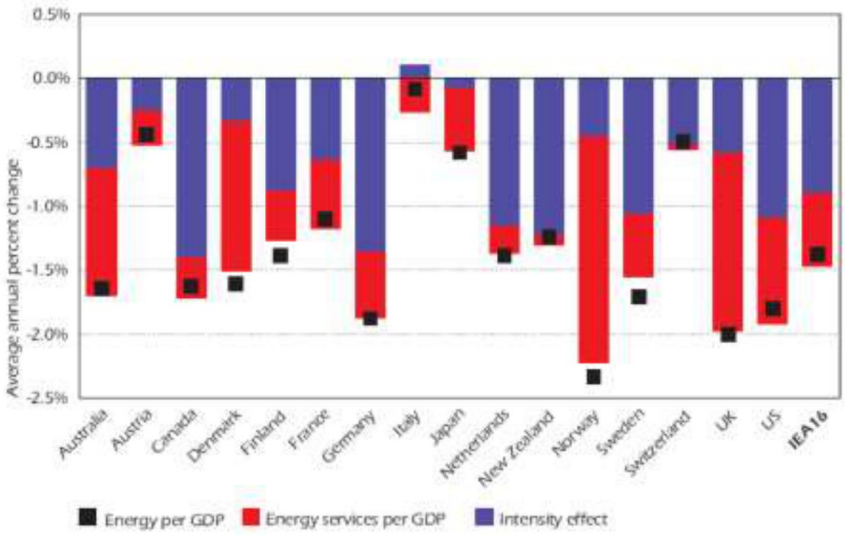
The IEA methodology for analysing energy end-use trends distinguishes between three main components affecting energy use: activity levels, structure (the mix of activities within a sector) and energy intensities (energy use per unit of sub-sectoral activity). Depending on the sector, activity is measured as value-added, passenger-kilometres, tonne-kilometres or population. Structure further divides activity into industry sub-sectors, transportation modes, or measures of residential end-use activity. Using an appropriate measure of end-use activity, energy intensities are then calculated for each of these sub-sectors, modes or end-use activities.

The energy intensity effect, which is used as a proxy for changes in energy efficiency, separates out how changing energy intensities influence energy consumption for a particular sector. This is done by calculating the relative impact on energy use that would have occurred between a base year (usually 1990 in this publication) and a future year (usually 2005) if the aggregate activity levels and structure for a sector remained fixed at base year values while energy intensity followed its actual development. A similar approach is used to calculate the activity and structure effects, which together represent the energy service effect. See IEA, 2007b for further details.

The separation of impacts on energy use from changes in activity, structure and intensity is critical for policy analysis. Most energy-related policies target energy intensities and efficiencies, often by promoting new technologies. Accurately tracking changes in intensities helps measure the effects of these new technologies.

Changes in energy consumption per GDP in each country are attributed to changes in the ratio of energy services to GDP and to changes in energy efficiency (actually sub-sector energy intensities) for more than 20 end-uses. The intensity effect for the whole economy is calculated as the aggregate impact of the sectoral intensity effects. The results of aggregate impact calculations show that the energy intensity effect and the decoupling of energy services demand and GDP since 1990 have both contributed to reduced energy consumption per unit of GDP in the IEA16 (Figure 5.7). However, declining end-use intensities (the energy intensity effect) have been the most important factor. Some 65% of the total decline in energy use per GDP for the IEA16 can be attributed to reductions from the energy intensity effect.

Figure 5.7: Changes in TFC/GDP Decomposed into Changes in Energy Services/GDP and Intensity Effect, 1990 - 2005



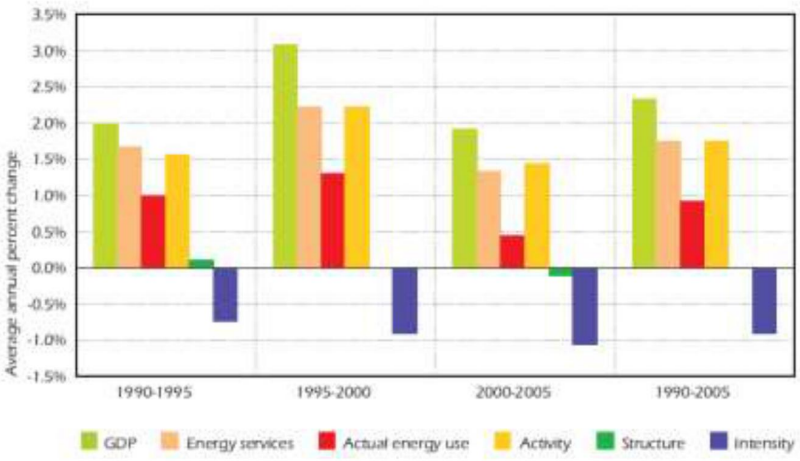
Source: IEA indicators database.
Note: The figure only shows the relative changes since 1990 and so does not reflect absolute advances in energy efficiency. Some countries had achieved higher levels of energy efficiency than others prior to 1990.

The relative contribution of changes in energy services per GDP and the intensity effect to the overall trend varies among countries. With the exception of Italy, all countries show that the intensity effect contributed to reducing the ratio of energy use to GDP: for most countries, it was the dominant factor. This is particularly true in the case of Canada, the Netherlands, Germany, New Zealand, Sweden and the United States. In contrast, for Norway and the United Kingdom, changes in energy services per unit of GDP were most important.

The reasons for the different trends in the intensity effect amongst countries are complex. Canada and the United States show large intensity reductions, but had high levels of energy use per GDP in 1990 and are now slowly converging to the IEA average. The sharp intensity declines seen in Germany were helped by the widespread closure of inefficient industrial plants following reunification. In the Netherlands, the intensity improvements were driven by the household and freight transport sectors. Countries that initially had lower energy use per GDP have generally seen smaller declines in intensity. This is the case for Denmark and Japan. In Austria, intensity improvements in households and passenger transport were partially offset by increased intensity in services. A similar picture is seen for Italy, where increased energy intensity in the service sector more than offset reductions in other sectors, leading to a small overall increase in the energy intensity effect.

Examining the three effects discussed in Box 1- activity, structure and intensity - makes it possible to analyse in more detail how the factors affecting total final energy consumption in the IEA16 have evolved over time (Figure 5.8). In the early 1990s, GDP growth was relatively low (2% per year) and, with the decline in the intensity effect partly offsetting the combined impacts of activity and structure, final energy use increased by an average of 1% per year. In the mid- to late 1990s, economic growth accelerated. The demand for energy services also increased more rapidly. There was some increase in the rate of energy intensity reduction during this period, but it was not sufficient to prevent the rate of final energy demand growth rising to an average of 1.3% per year. After 2000, economic growth and the demand for energy services again slowed; the structure effect became negative. This slowing of underlying service demand, coupled with a further increase in the rate of energy intensity reduction, was sufficient to keep the growth in final energy use to below 0.5% per year.

Figure 5.8: Factors Affecting Total Final Energy Consumption, IEA16

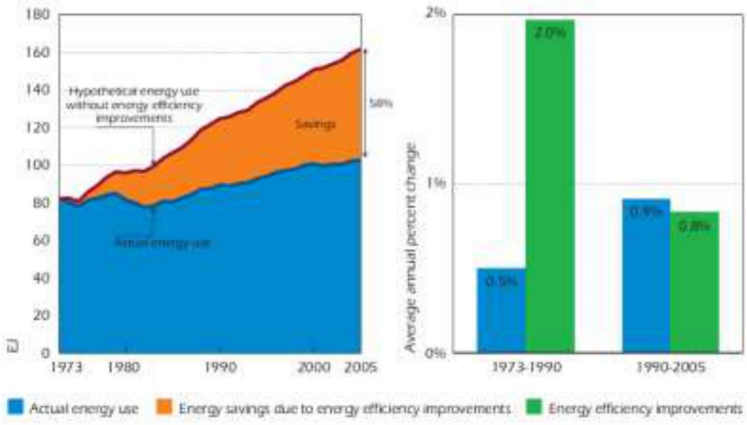


Source: IEA indicators database.

Further analysis of the developments in the intensity effect at a sector level show that, between 1990 and 2005, improvements in the manufacturing sector were most important in restraining growth in total final energy consumption. Energy intensity reductions in households and services were also important at different times. In the household sector, significant improvements in space heating intensity resulted in strong energy savings in the early 1990s. In contrast, the savings from the service sector made an impact only in the late 1990s, during a period of high economic growth in this sector. Intensity improvements in the transport sector played a smaller role. It is possible to use this decomposition approach to track the historical role of energy efficiency in shaping final energy use patterns in IEA countries. Between 1990 and 2005, the overall improvement in energy efficiency in all end-use sectors of the economy for the IEA16 was 0.9% per year. These improvements led to energy and CO2 savings of 15% and 14% respectively in 2005. This represents an annual energy saving of 16 EJ in 2005 and 1.3 Gt of avoided CO2 emissions. It also translates into fuel and electricity cost savings of at least USD 180 billion in 2005. However, the efficiency gains were much lower than in previous decades; energy efficiency improvements for a group of 11 IEA countries (IEA11) averaged 2% per year between 1973 and 1990. Had the earlier rate of energy efficiency improvement been sustained then there would have been no increase in energy use in the IEA since 1990. However, there are some signs that the rate of improvement may be increasing slightly in the last few years.

Figure 5.9 shows that over the longer term, the savings from improved energy efficiency are even more significant. Without the energy efficiency improvements that occurred between 1973 and 2005, energy use in the IEA11 would have been 58%, or 59 EJ, higher in 2005 than it actually was. This makes energy savings the most important "fuel" in the IEA11 for this time period- i.e. the amount of energy saved in 2005 was slightly higher than the actual consumption of oil, or of electricity and natural gas combined.

Figure 5.9: Long-Term Energy Savings from Improvements in Energy Efficiency, All Sectors, IEA11



Source: IEA indicators database.

These findings provide an important policy conclusion: that the changes caused by the oil price shocks in the 1970s and the resulting energy policies did considerably more to control growth in energy demand and reduce CO2 emissions than the energy efficiency and climate policies implemented since the 1990s.

Summary

[1] Between 1990 and 2005 global final energy use increased by 23% while the associated CO2 emissions rose by 25%. Most of the growth in energy use and CO2 emissions occurred in non-OECD countries.

[2] Globally, energy consumption grew most quickly in the transport and service sectors, driven by rising passenger travel and freight transport, and a rapid expansion in the service economy.

[3] Oil products remained the most important final energy commodity with a global share of 37% in 2005, driven by their use in transport. Electricity consumption is growing rapidly in many countries; its global use increased by 54% between 1990 and 2005. Traditional biomass and coal both remain important in non-OECD countries although their shares of total final energy use are declining.

[4] Energy use has been increasing more slowly than economic activity in most countries. As a result, global energy intensity, calculated in terms of final energy use per unit of gross domestic product (GDP), fell by 26% between 1990 and 2005. The reductions in energy intensity were largest in non-OECD countries, due to a combination of structural changes and efficiency improvements.

[5] In contrast, final energy uses per capita increased in most countries between 1990 and 2005. This increase was linked to growing wealth which leads to increase per capita demand for energy-using goods and services. On average, final energy use per capita in non-OECD countries is only 23% of the level in the OECD.

[6] Better understanding of the factors affecting energy consumption, including the role of energy efficiency, requires indicators based on more detailed data than are available in the IEA statistical balances. However, this more detailed information is currently only available on a comparable basis for some IEA countries.

[7] Analysis with these disaggregate indicators for 16 IEA countries (IEA16) shows that improved energy efficiency has been the main reason why final energy use has been decoupled from economic growth. Without the energy efficiency improvements that occurred between 1973 and 2005 in 11 of those countries, energy use would have been 58%, or 59 EJ, higher in 2005 than it actually was. However, since 1990 the rate of energy efficiency improvement has been much lower than in previous decades.

[8] These findings provide an important policy conclusion — that the changes caused by the oil price shocks in the 1970s and the resulting energy policies did considerably more to control growth in energy demand and reduce CO2 emissions than the energy efficiency and climate policies implemented in the 1990s.

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Chapter Six:
Land Use Planning

Definition

The demands for arable land, grazing, forestry, wildlife, tourism and urban development are greater than the land resources available. In the developing countries, these demands become more pressing every year. The population dependent on the land for food, fuel and employment will double within the next 25 to 50 years. Even where land is still plentiful, many people may have inadequate access to land or to the benefits from its use. In the face of scarcity, the degradation of farmland, forest or water resources may be clear for all to see but individual land users lack the incentive or resources to stop it.

Land use planning refers to the process by which a society, through its institutions, decides where, within its territory, different socioeconomic activities such as agriculture, housing, industry, recreation, and commerce should take place. For example: all kinds of rural land use are involved: agriculture, forestry, wildlife conservation and tourism. Planning also provides guidance in cases of conflict between rural land use and urban or industrial expansion, by indicating which areas of land are most valuable under rural use.

Land use planning is a public policy exercise that designates and regulates the use of land in order to improve a community's physical, economic, and social efficiency and well-being. A land use plan may be prepared for an urban area, a rural area, or a region encompassing both urban and rural areas. The driving force in planning is the need for change, the need for improved management or the need for a quite different pattern of land use dictated by changing circumstances.

Food and Agriculture Organization of the United Nations stated that

> *"Land-use planning is the systematic assessment of land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land-use options."*

The working group on integrated land use planning (WGLUP) has formulated the following basic understanding:

> *"Land use planning (LUP) is an iterative process based on the dialogue amongst all stakeholders aiming at the negotiation and decision for a sustainable form of land use in rural areas as well as initiating and monitoring its implementation."*

This basic understanding contains the following definitions:

1. The core element in land use planning is the dialogue amongst all participants to reach decisions based on consensus. A major task of land use planning is to accompany and motivate the participants and those affected in order to attain a conciliation of interests concerning land resources, types and extent of land use.
2. The dialogue-orientated learning and negotiation process amongst the participants leads to the development of their planning capacities and to sustaining co-operative relations at local level.
3. Participants in land use planning are direct and indirect land users, as well as those affected by the consequences of land use activities. Another group is formed by people who often have political or economic influence; this includes authorities, organisations, middlemen and women, processing industries for agricultural products, etc. However, the most important target group in land use planning is made up of the direct land users.
4. The Land Use Planning process covers all steps extending from the collection of data and information through its processing, analysis, discussion and evaluation right up to the negotiation for a consensus concerning the form of land use to be practised. This includes the prerequisites for preparing, initiating and implementing the plan. However, in the context of the technical co-operation, during the LUP process not necessarily all planned measures to be carried out will be implemented in their entirety.
5. "Iteration" means putting the result of the decision-making process into practice and converting it into a situation specific step-by-step planning. It is a repeated or recurring process that seeks to reach an optimal solution. New developments and knowledge gained during the planning process are incorporated and may require revision and updating. This may result in a repetition of steps which have already been taken and e.g. can mean a renewed data collection, analysis, discussion and decision.
6. Land use planning is first and foremost a process of clarification and understanding between people who together wish to change something and prepare future actions systematically. In the process, the elements of a plan are worked out co-operatively. The core part of a planning process is therefore a commonly desired objective to be achieved by implementing the plan. Time planning is linked to the physical/geographic/ecological planning of areas, and the two are mutually dependent.

7. Rural areas, in contrast to urban areas are characterised by agricultural and forestry production having relatively low population and building densities. Infrastructure, facilities or services have a relatively low importance.
8. Land use is considered to be sustainable when it is both socially and environmentally compatible desired by the society, technically viable and when it makes economic sense. This means:
    - Social justice: When considering the effects of planning measures, attention should be paid to the distribution and kind of benefits. Those should be spread in such a way that even socially weak parties should participate in the process.
    - Long-term sustainability of natural resources: The land utilisation type must be designed to ensure that the natural basis of living is sustained in the long-term run, i.e. the use of the land should correspond to its natural potential. Existing environmental damage should be minimised and damaging developments avoided by supporting and developing suitable approaches.
    - Acceptance and social compatibility: The measures applied are to be desired, accepted, supported and largely carried out by those affected by them. The effects of such measures can only be sustainable if they are socially compatible and culturally suitable and if they take into account local knowledge and capacities.
    - Economic efficiency: The measures planned should be designed to contribute to the long-term security of the economic basis of living of the people. Therefore, the measures should be self-financing and thereby economically justified. In this way, they contribute to the improvement of the living conditions and to the overall economic development.
    - Viability: The planned measures should be sound with the level of tolerance of the local population in terms of technology, economy and organisation. Decisions are generally guided by the local technological understanding and culture as well as the available resources. Even if large expenses can be considered as investments for the future, the magnitude must be assessed realistically and the amortisation should be kept within clear time limits. This applies particularly to major infrastructural measures.

Principles of Land Use Planning

Land use planning creates the prerequisites required to achieve a type of land use, which is sustainable, socially and environmentally compatible, socially desirable and economically sound. It sets in motion social processes of decision making and consensus building concerning the use and protection of private, communal or public areas.

1. Land use planning is orientated to local conditions in terms of both method and content: Planning approaches often fail because global models and implementation strategies are applied and taken over automatically and uncritically. But LUP is not a standardized procedure which is uniform in its application world-wide. Its content is based on an initial regional or local situation analysis.
2. Land use planning considers cultural viewpoints and builds up on local environmental knowledge: Rural societies or groups can often provide complex indigenous knowledge of the environment. If this is the case, such local knowledge should be part of the basis for planning and implementing a sustainable land use.
3. Land use planning takes into account traditional strategies for solving problems and conflicts: Traditional rural societies have their own way of approaching problems and settling conflicts concerning land use. In the process of land use planning, such mechanisms have to be recognised, understood and taken into account.
4. Land use planning assumes a concept which understands rural development to be a "bottom-up" process based on self-help and self-responsibility: The population should actively participate in the process of LUP. The results of planning and the implementation of measures can only be sustainable if plans are made with and by the people, not behind them or even against them. Planning is therefore not just a matter for experts, but should be carried out together with those affected by it. To ensure a feeling of ownership concerning self-help activities, people who are affected have to be involved in the planning process from the early beginning.
5. Land use planning is a dialogue, creating the prerequisites for the successful negotiation and co-operation among stakeholders: The core task of LUP consists of initiating a process of communication and co-operation which "allows all participants to formulate their interests and objectives in the dialogue". On the basis of sound decisions, a sustainable form of land use is proposed "whereby the aims and interests of other participating groups are taken into account to the greatest possible extent". An important element of participation-orientated LUP is the identification of the various groups of participants and differentiating them in terms of their use of and access to land resources. In addition, their position on the social scale (gender approach) and their capacities, either as stakeholders or as members of authorities and of other organisations have to be considered.

6. Land use planning is a process leading to an improvement in the capacity of the participants to plan and take actions: The participatory methods used in all planning steps of LUP promote the technical and organisational capabilities of all participants, thereby extending their capacity to plan and to act. In the medium term, this qualification process leads to an improvement in the capacity of local groups for self-determination.
7. Land use planning requires transparency. Therefore, free access to information for all participants is a prerequisite: Transparency in planning and the extent to which stakeholders are informed, strengthen both their willingness and capacity to participate in planning and decision-making. It increases the motivation of the people for creating sustainable results. An open exchange of information leads to discussions about objectives among the key figures and promotes the willingness to reach a consensus. The dissemination of information in the local language(s) contributes to an improved transparency. In addition, it strengthens the trust of the population in land use planning activities.
8. The differentiation of stakeholders and the gender approach are core principles in land use planning: A prerequisite for realistic land use planning is the detailed analysis of the various interest groups. The aim is to find out the various interests of the participants in order to create a basis for the negotiation and decision-making process. Men and women often do not have the same access to land and have specific ways of articulating themselves. Different interests are arising from the economic and social character of their roles and scope of duties. Therefore, the role of gender is an important criterion when differentiating stakeholders.
9. Land use planning is based on interdisciplinary cooperation: The ecological, economic, technical, financial, social and cultural dimensions of land use make it necessary to work with an interdisciplinary approach. Land use planning provides many interfaces with other technical disciplines and planning fields. It uses a broad spectrum of tools. A one-sided view of planning will be avoided due to the interdisciplinary and intersectoral configuration of the planning groups.
10. Land use planning is an iterative process; it is the flexible and open reaction based on new findings and changing conditions: LUP is more than the preparation of a planning document; it is an iterative process. Iteration is both the principle and the method simultaneously. New developments and findings are specifically observed and incorporated into the planning process. It may lead to the revision of decision and the repetition of steps already taken. This can render superfluous both analyses and data bases which would have been set up at some expense. Iterative planning requires flexibility in planning, but in no way constitutes a "concealed lack of planning".

11. Land use planning is implementation-orientated: Land use planning has to consider how the negotiated decisions and the solutions identified are to be implemented. LUP does not end with the land use plan. The implementation of limited measures (e.g. the development of cultivation techniques which conserve land resources) right at the outset, or parallel to the LUP process, plays an important role in increasing the trust of the people in the village as far as the planning process is concerned.

Planning Process

Land-use planning can be expressed in the following questions:

- *What is the present situation?*
- *Is change desirable? If so:*
  - What needs to be changed?

    Land-use problems and opportunities are identified by discussions with the people involved and by the study of their needs and the resources of the area.
  - How can the changes be made?

    Planners seek a range of ways to make use of the opportunities and solve the problems.
  - Which is the best option?

    Decision-makers choose the best option, based on forecasts of the results of implementing each alternative.
  - How far is the plan succeeding?

    Once a land-use plan is put into effect, planners monitor progress made towards its goals and change the plan if necessary.

Focus Area of Land Use Planning

1) Planning is for people: People's needs drive the planning process. Local farmers, other land users and the wider community who depend on the land must accept the need for a change in land use, as they will have to live with its results. The planning team must find out about people's needs and also the local knowledge, skills, labour and capital that they can contribute. It must study the problems of existing land-use practices and seek alternatives while drawing the public's attention to the hazards of continuing with present practices and to the opportunities for change. Local acceptability is most readily achieved by local participation in planning. The support of local leaders is essential while the participation of agencies that have the resources to implement the plan is also important.

2) Land is not the same everywhere: Land is, self-evidently, the other focus of land-use planning. Capital, labour, management skills and technology can be moved to where they are needed. Land cannot be moved, and different areas present different opportunities and different management problems. For example: hazard prone area and other depredated area need specific management. Good information about land resources is thus essential to land-use planning.

3) Technology: A third element in planning is knowledge of land-use technologies: agronomy, livestock husbandry and other means by which land is used. The technologies recommended must be those for which users have the capital, skills and other necessary resources; that is, appropriate technology. New technologies may have social and environmental implications that should be addressed by the planner.

4) Integration: A mistake in early attempts at land-use planning was to focus too narrowly on land resources without enough thought given to how they might be used. Good agricultural land is usually also suitable for other competing uses. Land-use decisions are not made just on the basis of land suitability but also according to the demand for products and the extent to which the use of a particular area is critical for a particular purpose. Planning has to integrate information about the suitability of the land, the demands for alternative products or uses and the opportunities for satisfying those demands on the available land, now and in the future.

Land Use Planning at Different Levels

Land-use planning can be applied at three broad levels: national, district and local. These are not necessarily sequential but correspond to the levels of government at which decisions about land use are taken.

Different kinds of decision are taken at each level, where the methods of planning and kinds of plan also differ. However, at each level there is need for a land-use strategy, policies that indicate planning priorities, projects that tackle these priorities and operational planning to get the work done.

The greater the interaction between the three levels of planning, the better. The flow of information should be in both directions (Fig. 1).

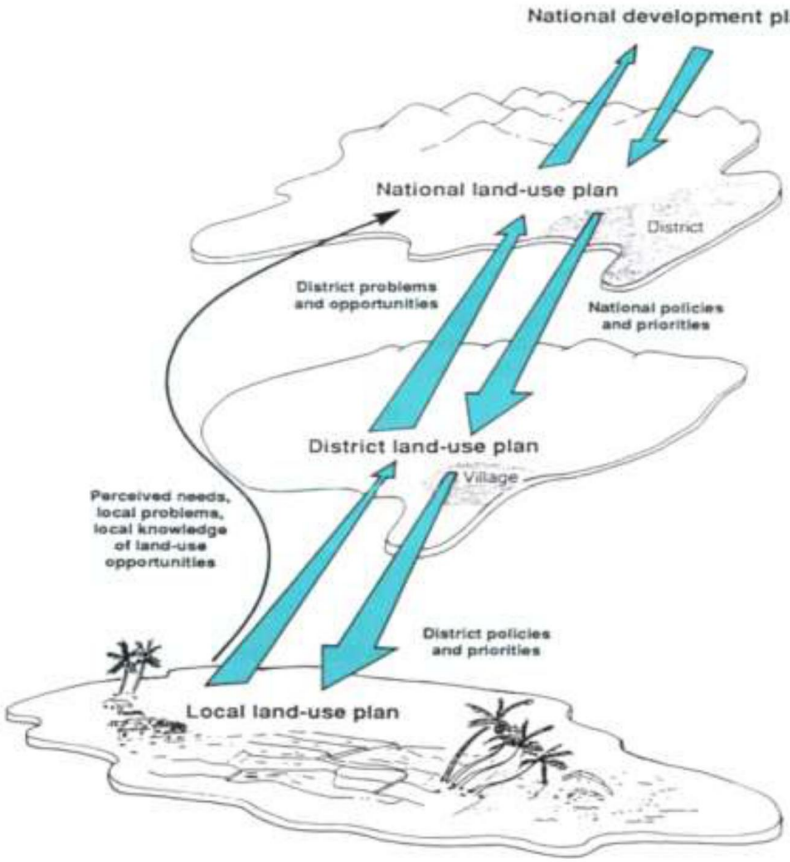

Figure 6.1: Two-way links between planning at different levels

At each successive level of planning, the degree of detail needed increases, and so too should the direct participation of the local people.

National Level

At the national level, planning is concerned with national goals and the allocation of resources. In many cases, national land-use planning does not involve the actual allocation of land for different uses, but the establishment of priorities for district-level projects. A national land-use plan may cover:

- land-use policy: balancing the competing demands for land among different sectors of the economy food production, export crops, tourism, wildlife conservation, housing and public amenities, roads, industry;
- national development plans and budget: project identification and the allocation of resources for development;
- coordination of sectoral agencies involved in land use;
- legislation on such subjects as land tenure, forest clearance and water rights.

District Level

When planning is initiated nationally, national priorities have to be translated into local plans through district. Conflicts between national and local interests will have to be resolved. The kinds of issues tackled at this stage include:

- the meeting of developments such as new settlements, forest plantations and irrigation schemes;
- the need for improved infrastructure such as water supply, roads and marketing facilities;
- the development of management guidelines for improved kinds of land use on each type of land.

Local Level

The local planning unit may be the village, a group of villages or a small water catchment. At this level, it is easiest to fit the plan to the people, making use of local people's knowledge and contributions. Where planning is initiated at the district level, the programme of work to implement changes in land use or management has to be carried out locally. Alternatively, this may be the first level of planning, with its priorities drawn up by the local people. Local-level planning is about getting things done on particular areas of land - what shall be done where and when, and who will be responsible.

Examples are:

- the layout of drainage, irrigation and soil conservation works;
- the design of infrastructure - road alignment and crop marketing, fertilizer distribution, milk collection or veterinary facilities;
- specific crops on suitable land.

Requests at the local level, e.g. for suitable areas to introduce tobacco or coffee, must be met with firm recommendations. For instance, "this land is suitable, this is not; these management practices are needed; it will cost so much and the expected returns are so much".

Planning at these different levels needs information at different scales and levels of generalization. Much of this information may be found on maps. The most suitable map scale for national planning is one by which the whole country fits on to one map sheet, which may call for a scale from 1:5 million to 1:1 million or larger. District planning requires details to be mapped at about 1:50000, although some information may be summarized at smaller scales, down to 1:250000.

For local planning, maps of between 1:20000 and 1:5000 are best. Reproductions of air photographs can be used as base maps at the local level, since field workers and experience show that local people can recognize where they are on the photos.

Starting at the local level: bottom-up planning

"Bottom-up" planning is initiated at the local level and involves active participation by the local community. The experience and local knowledge of the land users and local technical staff are mobilized to identify development priorities and to draw up and implement plans.

The advantages are:

- local targets, local management and local benefits. People will be more enthusiastic about a plan seen as their own, and they will be more willing to participate in its implementation and monitoring;
- more popular awareness of land-use problems and opportunities;
- plans can pay close attention to local constraints, whether these are related to natural resources or socio-economic problems;
- better information is fed upwards for higher levels of planning

The disadvantages are that:

- local interests are not always the same as regional or national interests;
- difficulties occur in integrating local plans within a wider framework;
- limited technical knowledge at the local level means technical agencies need to make a big investment in time and labour in widely scattered places;
- local efforts may collapse because of a lack of higher-level support or even obstruction.

People in Planning

Land-use planning involves getting many different people to work together towards common goals. Three groups of people are directly involved (Figure 6.2):

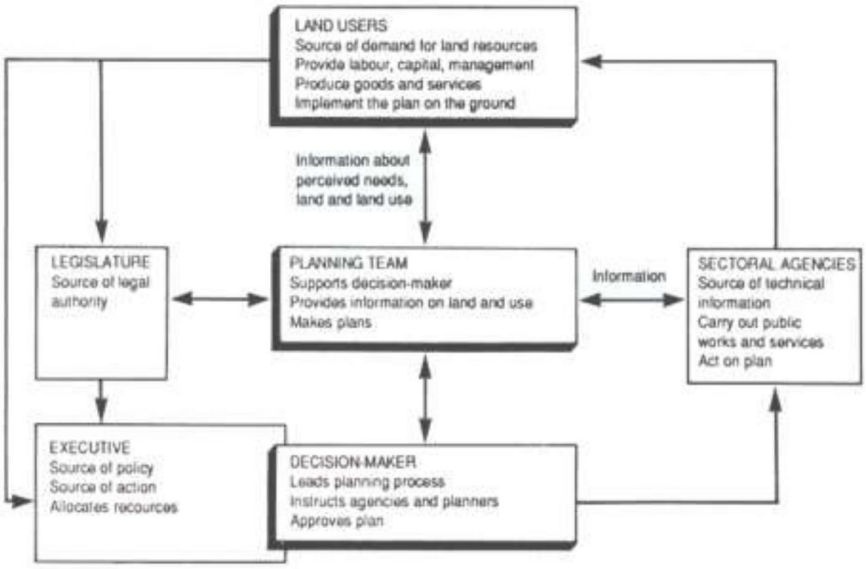

Figure 6.2: People in planning

1. Land users: These are the people living in the planning area whose livelihood depends wholly or partly on the land. They include not only farmers, herders, foresters and others who use the land directly but also those who depend on these people's products, e.g. operators in crop or meat processing, sawmills and furniture factories. The involvement of all land users in planning is essential. Ultimately, they have to put the plan into effect and must therefore believe in its potential benefits as well as in the fairness of the planning process. The experience and determination of local people in dealing with their environment are often the most neglected, as well as the most important, resource. People will grasp development opportunities that they themselves have helped to plan more readily than any that are imposed on them. Without the support of local leaders, a plan is not likely to succeed. Achieving effective public participation in planning is a challenge. Planners have to invest the time and resources needed to secure participation through local discussions, by broadcasting and newspaper articles, through technical workshops and extension services. Imagination, a sincere interest in people and the land as well as a willingness to experiment mark the more successful efforts.

2. Decision-makers: Decision-makers are those responsible for putting plans into effect. At national and district levels, they will usually be government ministers; at the local level, they will be members of the council or other authorities. The planning team provides information and expert advice. The decision-makers guide the planning team on key issues and goals while also deciding whether to implement plans and, if

so, which of the options presented should be chosen? Although the leader of the planning team is in charge of day-to-day planning activities, the decision-maker should be involved at regular intervals. Decision-makers also have a key role in encouraging public participation through their willingness to expose their decisions and the way they are reached to public scrutiny.

3. The planning team: An essential feature of land-use planning is the treatment of land and land use as a whole. This involves crossing boundaries between disciplines (natural resource, engineering, agricultural and social sciences), so teamwork is essential. Ideally, a team needs a wide range of special expertise; for example, a soil surveyor, a land evaluation specialist, an agronomist, a forester, a range and livestock specialist, an engineer, an economist and a sociologist. Such a range may only be available at the national level. At the local level, a more typical planning team may consist of a land-use planner and one or two assistants. Each must tackle a wide range of jobs and will consequently need specialist advice. Government agency staff and universities may be useful sources of assistance.

Steps in Land-Use Planning

(For details see FAO 1993: Guidelines for land-use planning)

Step 1: Establish goals and terms of reference

Responsibility: decision-makers and planners together

a) Define the planning area
b) Contact the people involved
c) Acquire basic information about the area
   - land resources
   - present land use
   - infrastructure
   - population
   - land tenure
   - social structure
   - government
   - NGOs
   - commercial organizations
d) Establish the goals
e) Make a preliminary identification of problems and opportunities
f) Identify constraints to implementing improvements
g) Establish the criteria for making decisions on land use
h) Set the scope of the plan
i) Set the planning period
j) Agree on the content and format of the plan
k) Decide on operational questions for the planning project: personnel, cooperating agencies, timing, budget

Step 2: Organize the work

Responsibility: planning team leader and administrator

a) List the planning tasks and activities. For each task
   - identify the people and organizations responsible for or contributing to it
   - set out the resources needed
   - estimate the time needed
b) Decide which tasks need to be completed before others can be commenced
c) Draw up a work plan for the project as a whole (table, bar chart or critical path analysis)
d) Draw up individual, personal work plans
e) Allocate money and equipment
f) Arrange administrative matters and logistics
   - Check and arrange security clearances for staff and equipment, e.g. for the purchase and use of maps, air photographs and computers
   - Budget for staff, equipment and transport costs

- Provide for
    - transport (vehicles, spares, fuel, servicing)
    - equipment
    - office facilities
- Provide and coordinate technical support
    - inputs from other agencies
    - field assistance
    - laboratory
    - cartography
    - secretarial
- Make provision for wet or hot seasons, public and local holidays, contingencies and iteration of steps in the planning process.

Step 3: Analyse the problems

Responsibility: planning team

a. Collect data on the existing situation; where possible, compile maps
    - population
    - land resources
    - employment and income
    - present land use
    - production and trends
    - infrastructure
b. Sources: maps, satellite imagery, air photographs, censuses, departmental records. Check in the field whether the sources are reliable and up to date
c. Identify and map
    - land units
    - land-use systems
d. Identify problems of land use
    - nature and severity, land units and land-use systems affected
    - analysis of causes
e. Methods: interviews with land users, local leaders, extension staff, agencies; field reconnaissance
f. Prepare problem statements

Step 4: Identify opportunities for change

Responsibility: planning team

a) Based on the goals from Step I and problem statements from Step 3, isolate problems for which solutions other than land-use planning must be sought

b) Generate a range of options for solving each problem, in terms of:
   - opportunities: the people, land resources, improved technology, economic measures, government action
   - land-use strategies: no change, maximum production, minimum investment, maximum conservation, maximum equity
   - kinds of production, the role of conservation, self-reliance versus external investment
c) Develop realistic options that best meet the needs of production, conservation and sustainability and that minimize conflicts of land use
d) Prepare outline budgets and time frames for each option
e) Present the problem statements (from Step 3) and the alternatives for change in terms suitable for public and executive discussion

Responsibility: decision-makers

a) Decide if the goals are attainable
b) Select the priority problems
c) Choose the most promising alternatives for a feasibility study; specify targets
d) Specify action needed at other levels of planning

Step 5: Evaluate land suitability

Responsibility: planning team

a) Describe land-use types in sufficient detail for subsequent analysis
b) Select land qualities and land characteristics to be used in comparisons of land-use requirements with land
c) Map the land units and determine their relevant land characteristics and qualities
d) Set limiting values to land-use requirements, to be used for determining class limits for land suitability. Take into account sustainability and the ratio of benefits to inputs
e) Match land use with land:
   - compare land-use requirements with land qualities or characteristics to determine provisional land suitability classes
   - consider modifications to land-use types, in order that they become better suited to the land
   - consider land improvements that could make the land better suited to the land use
f) Map land suitability for each land-use type

Step 6: Appraise the alternatives: environmental, economic and social analysis

Responsibility: planning team

a) The following studies refer first to individual combinations of land use with land units that have been classed as suitable in physical terms and, second, to alternative combinations of land use that are being considered in the plan.

   - Environmental impact assessment: soil and water resources, pasture and forest resources, wildlife conservation, resources for tourism and recreation; off-site effects.
   - Financial analysis: are the proposed land-use types profitable for the farmer or other land users?
   - Economic analysis: what is the value of the proposed changes to the community, within and beyond the planning area? Are there areas of land of critical importance (for production or conservation) for certain uses?
   - Social impact: what effects will the proposed changes have on different sections of the community, especially women, minority groups and the poor?
   - Strategic planning: how do the proposed changes in land use affect wider aspects of rural development planning, including national goals?

Step 7: Choose the best option

Responsibility: planning team

a. Set out a series of options for the allocation or recommendation of land-use types to land units. Also state their evaluation in terms of land suitability and environmental, economic and social analysis.
b. Set out the consequences of these options in terms of the goals and planning objectives.
c. Present the options and their consequences in a way that is appropriate for review.

Responsibility: planning team and decision-makers

a. Make arrangements for consultations with the communities affected as well as with the implementing agencies; obtain views about feasibility and acceptability.
b. Assemble and review the comments received. In the light of these, make any necessary changes to the options.

Responsibility: decision-makers

a) Decide if the response to comments is adequate.
b) Consider the options in terms of goals and policy criteria.
c) Choose the best option.
d) Authorize preparation of the plan.

Step 8: Prepare the land-use plan
Responsibility: planning team

a. Prepare maps - the basic or master land-use plan and supporting maps.
b. Set out the land-use allocations and recommendations, based on the preferred option selected in Step 7. Give descriptions of land-use types, including management recommendations on each kind of land.
c. Set targets for achievement, by land-use type, area and agency. Specify how they will be reached. Check that they are within the capabilities of the agencies and infrastructure.
d. Draw up logistic preparations, specifying the capital works, recurrent inputs and responsibilities for implementation.
e. Establish mechanisms for monitoring progress and revising the plan (Step 10).
f. Make arrangements for research needed to support the plan.
g. Determine the finance needed for each operation and determine sources of funds.
h. Write the report - executive summary, main report, maps and appendixes.
i. Establish mechanisms for communication with, and the participation of, all institutions involved.
j. Prepare public relations material.

Step 9: Implement the plan

Responsibility: implementing agencies and planning team together

Implementation involves a wide range of practical activities, many of which lie beyond the scope of these guidelines. The following refer specifically to roles that the planning team may undertake.

a. Ensure that the changes recommended in the plan are correctly applied in the plan; be available for technical consultations; discuss with implementing agencies any suggested modifications.
b. Help to maintain communications between all people and institutions participating in or affected by the plan, i.e. land users, sectoral agencies, government, non-governmental organizations, and commercial organizations.

c. Assist in coordination of the activities of the implementing agencies.
d. Assist in institution-building by strengthening links between existing institutions, forming new bodies where necessary and strengthening cooperation.
e. Focus on the participation of the land users; ensure adequate incentives.
f. Organize research in association with the plan; ensure that results from research are communicated and, where appropriate, incorporated into the plan.
g. Arrange for education and training of project staff and land users.

Step 10: Monitor and revise the plan

Responsibility: planning team

a. List the goals and criteria achievement agreed in Step 1. Add any that emerged later in the planning period.
b. Gather data relevant to each criterion of attainment: physical, economic and social.
c. Compare what has been achieved with what was planned. Identify elements of success and failure.
d. Seek explanations for failures. Were they caused by:
    - Incorrect assumptions of the plan?
    - Changed economic or political circumstances?
    - Logistic problems of implementation?
    - Problems of communication and participation?
e. Review the goals: are they still valid?
f. Initiate modification or revision of the plan:
    - minor modifications through action by implementing agencies;
    - larger revisions by the preparation of proposals and reference back to decision-makers.

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Chapter Seven:
Land Use and Energy Policies in Bangladesh

Introduction

Bangladesh is one of the most densely populated but lowest land-man ratio (about 0.06 ha/per person) counties in the world having about 157.85 million people with its 147570 square kilometers territory (FAO, 2013; Siddik et al., 2018). It is projected that Bangladesh will have more than 190 million by 2030 and for meeting the demand of the additional population a significant amount of energy will have to be produced by altering present land use (Islam and Hassan, 2011).

Bangladesh is mainly an agrarian country and that about two-third population of the country was directly or indirectly depended on agriculture (Marbourg, 2015). The country has a total of 7.946 million ha net cropped land in the fiscal year of 2016-17 (BBS, 2018). Researchers found that yearly about 1 percent of agricultural land has been transformed into non-agricultural land (Planning Commission, 2009). Despite the importance of agricultural land one of the main challenges for the country is to prohibit the alteration of agricultural land.

The Government of Bangladesh has huge energy demand for supplying required energy to its people and industries. Hence, efficient energy use is out national energy security issue and we do not have any room for wasting our energy. The Government aims to improve about 20% national primary energy consumption per gross domestic product/GDP in 2030 compared to the energy intensity level in 2013. This goal will not be attained without the Government's strong leadership, peoples' consciousness and actions to realize it. The Government has formulated and enacted several energy policies in order to correlate demand and supply side energy management.

This chapter will summaries all relevant policies of land use and energy in Bangladesh.

National Land Use Policy 2001

Background

Bangladesh is an agricultural country. Agriculture is the source of one-third of national income of this country and the livelihood of two-thirds of the people. Therefore, the importance of land and water resources in Bangladesh is immense. Land is the basic natural resource that is the source of all the daily necessities of human life, industrial products, consumer goods, health care materials, etc. Bangladesh is inhabited by about 130 million people in 14.4 million hectares of land while the amount of cultivable land is only 17 percent. Due to the increase in population, the amount of per capita land is decreasing day by day. With the economic progress, the trend of urbanization is increasing, industrial development is taking place, roads, hospitals and educational institutions are constantly expanding, as a result of which the amount of agricultural land is gradually shrinking. The total cultivable land in 1983-84 was 20.2 million acres which has come down to 17.5 million acres in 1997. An illustration of availability, agricultural use and other uses of cultivable land can be obtained from the following two tables (Table 7.1 & 7.2).

Table 7.1: Availability of Land in Bangladesh (1974-96)

	Thousand Acres (%)		
Year / Use	**1974**	**1990**	**1996**
a) Cultivable land (Net cropped + cultivable waste)	23.198 (66)	23.209 (62)	21.561 (59)
(i) Net cropped land	20.977 (59)	21.837 (58)	19.280 (53)
(ii) Cultivable waste	2.221 (7)	1.372 (4)	2.281 (6)
b) Forest	5.508 (15)	4.591 (12)	5.315 (14)
c) Not available for cultivation	6.576 (19)	9.721 (26)	9.788 (27)
Total land	35.282	37.521	36.664

Source: BBS, 1998

Table 7.2: Land Use in Bangladesh (Thousand Acres)

Land Use	**Year**	
	1983-84	**1997**
a) Cultivable land	22674	20209
(i) Cropped land	20238	17449
(ii) Cultivable waste	2436	2760
b) Housing	867	1027

Source: BBS, 1998

The best use of land and water resources depends on proper land use planning. Land, water resource and natural environment play a special role in domestic production. It is possible to coordinate the use of these three natural resources through a specific policy and ensure optimal use of limited land.

Determination of zone according to land use

1. Zoning according to special use is one of the most important steps to ensure proper use of land and to prevent arbitrary use. City corporations and municipalities of the country work to make the benefits of civic amenities and development activities accessible to all citizens. The location of the residential area should be at a reasonable distance from the commercial or industrial area. This distance is also largely dependent on safe and fast transportation.
2. Despite the provisions of the Town Improvement Act, 1953, residential and commercial areas in large cities have not development as planned way in many cases. In addition to numerous shops, markets and clinics, small industrial factories are being set up in the areas identified as residential areas. An immediate solution of this unwanted situation is desirable.
3. While some controls are visible in urban areas, they are completely absent in rural areas. Villages are being expanded by filling up valuable agricultural land, small markets are swelling and consuming the adjacent crop lands, small and cottage industries are being set up near the owner's house leaving the government-sanctioned industrial area (BSCIC) as vacant. Addressing this situation, a new act called Village Improvement Act may be introduced. Loan should be easily accessible for building rural infrastructure, especially for planed housing.
4. Demarcation of present and future residential areas is essential for maintaining the ecological balance. The place for this can be specified in advance. Lands, forest, hilly lands, wetlands or special types of gardens which are already known for their geographical location cannot be altered without the approval of the appropriate authorities, i.e., these types of land cannot be used as residential or industrial areas.
5. City corporations/ municipalities will prepare a zoning map of land for different purposes in their respective jurisdictions. Each zone will be identified as a residential, commercial and industrial area. As a result, the overall city-life will expand in a well-organized manner.
6. Appropriate use of land also needs to be ensured in the vast terrain outside the urban area. A zoning map should be made under the supervision of the Upazila Parishad to facilitate the future expansion of the villages and growth centers in the areas under the jurisdiction of the Upazila Parishad. The main objective will be to ensure that cultivable land is not used unnecessarily for the expansion of villages.

Similar steps will have to be taken in setting up small scale industries and commercial establishments in growth centers.

7. In case of preparation of zoning map, if more than one Upazila is involved, i.e. one zone of one Upazila extends to the adjoining Upazila, in that case the work can be done under the supervision of the concerned district council.
8. A zoning law will be formulated at the national level under which local government bodies will prepare zoning maps in their respective jurisdictions. The zoning map cannot be changed if it is once prepared and approved by the concerned authorities. Provisions for compliance with strict conditions will be included in the zoning law if any change is required. Assistances to the Revenue Office of the Deputy Commissioner for the preparation of the map will be provided as required.
9. Adequate training should be provided to the elected representatives of local government bodies i.e. City Corporations, Municipalities, District Council, Upazila Council etc. and government officials and employees on zoning concepts and skills in preparation of zoning maps. This responsibility can be assigned to one or more training institutes in this country.

Objectives

- To resist the current trend of alarming decline in the total amount of used agricultural land to produce adequate food for a growing population.
- To control rationally the unplanned expansion of residential area, the establishment of industry and the marketing process through introduction of zoning system for ensuring optimal use of land according to physical differences in the different regions of the country;
- To ensure optimal utilization of naturally originated char land in the river, haor or ocean basin for the rehabilitation of landless;
- To conserve future potential land especially government Khas lands for various developmental activities;
- To ensure that land use is compatible with the natural environment;
- To make the best use of land for poverty alleviation and increase employment and to play supportive role in preventing the increase in the number of landless;

- To conserve natural forests, prevent riverbank erosion and hill cutting;
- To prevent land pollution; and
- To ensure the use of small amount of land by constructing multi-storied buildings for government and non-government organizations.

Areas of Land Use

(a) Agriculture

Although the production of food grains has increased significantly in the last few years, food grains have to be imported from abroad almost every year to meet the deficit. The population is growing by about 25 lakhs every year and the amount of additional food required stands at about 4.5 lakh tons. Productive power is gradually declining because of unplanned or arbitrary use of arable land.

In this country, agricultural land is not being used only for agricultural sector or food production. According to an estimate by the Planning Commission, about 15 percent of the land in rural areas that was used by farmers or villagers for housing and agriculture during 1980s while now stands at about 30 percent. Moreover, the amount of agricultural land is decreasing day by day as a result of urbanization, industrialization, housing, road network and other infrastructure. The optimal use of land will be possible by constructing multi-storied buildings in these non-agricultural sectors.

In the case of land acquisition for developmental or any other purpose, however, in many cases considerable care was not taken in determining the amount of land required. As a result, a huge amount of fertile land has become unfit for agricultural work. Both unplanned use and misuse of acquired land are going on. About 25 percent of the acquired agricultural land at different times is currently unused or being used for unproductive purposes. It is imperative to prevent such misuse or wastage of land.

Although agricultural land is generally privately-owned property, its use needs to be in line with overall national and social needs. Most of the farmers in Bangladesh are small and marginal and a large part of them are sharecroppers. The question of protecting the interests of these small and marginal farmers is very important. Land should to be used in such a way that these farmers will not hamper in the future. The current trend of declining the overall amount of agricultural land used for adequate food production for a growing population for various reasons needs to be resisted.

The steps described in the national agricultural policy to make the best use of land for crop production have to be followed properly. It is important to determine the area of irrigable land in terms of availability of ground water.

On the one hand, it will prevent such desertification process to some extent, but on the other hand, it will ensure the proper use of a valuable natural resource like water. Acquisition of irrigable agricultural land should be prohibited completely. Fertile agricultural land where at present two or more crops are grown or land which has potential for the production of such crops cannot be used for non-agricultural work by any means such as private construction, housing, brick kiln etc. If land is required for development work in the non-agricultural sector and non-agricultural Khas land is available for it, the use of Khas land should be given priority. In the absence of absolutely alternative arrangements, a minimum amount of relatively barren land can be acquired.

(b) Residential

The massive expansion of urban areas in the last few decades and the influx of people from rural areas to urban areas have put enormous pressure on land use. On the other hand, land is being used to build more and more houses to meet the needs of the growing population. With the exception of some areas in the eastern part of Bangladesh, almost all of the country is floodplain. Agricultural land is usually shrinking due to the need for housing construction. In this situation, in addition to strict adherence to urban housing regulations, proactive steps need to be taken to minimize the use of additional land for housing in rural areas. Housing in city corporation municipalities and police station headquarters should be controlled on the basis of specific policies. Demand of city dweller and the protection of environment can be balanced by avoiding the construction of uncontrolled commercial and other establishments in urban residential areas. The local administration has to play an active role in reducing the construction of houses on fertile land in rural areas as well.

(c) Forest

It is well known that forest can play a crucial role in maintaining natural balance. Most of the total forest area of the country is distributed in Chittagong Hill Tracts, Sylhet Region, Madhupur Region, Sundarbans etc. Experts believe that at least 25 percent of the land should be forested for environmental equilibrium. Currently, the forest cover in Bangladesh is limited and below this standard. Establishment of various industries, defective transports, etc. is recognized as the cause of air pollution. Extensive afforestation in arable and char lands can greatly prevent this pollution.

Hence, there is a need to create extensive forests in the reserve forest and other forests and ensure proper conservation of existing forest lands. With the proper implementation of the National Environment Policy-1992 and National Forest Policy-1994, the overall situation is expected to improve.

(d) Industrialization

We need to make massive industrial efforts to survive in today's world economy. In order to sell products at competitive prices in both domestic and international markets, it is possible to do so through modern technology-based production and marketing processes. In this case, creating a favorable environment for setting up industries is essential. In the past decades, large areas have been identified for setting up industries in different parts of the country, especially in Dhaka, Chittagong and Khulna.

Huge amounts of land have been acquired by the Bangladesh Small and Cottage Industries Corporation (BSCIC) for setting up BSCIC industrial estates across the country and even in some remote areas. Expected industrial establishment and production has not been effective due to various reasons in these industrial areas. Many areas are being used for different purposes. Especially in the BSCIC areas, almost all the acquired lands are lying unused, with a few exceptions. On the other hand, despite having vacant plots in the industrial city, the industrial entrepreneurs are either not getting the required land or they are not keen on setting up industries there for whatever reason. Many are producing by setting up various small and cottage industries outside the industrial city but at a short distance.

Easy and improved communication systems, tax rebate facilities, uninterrupted and adequate supply of electricity and gas are some of the factors that are important in selecting the location of a private enterprise. It is common to see that industrial and commercial areas have developed along the main roads in the country and this trend is likely to continue in the future. The Ministry of Industries may take the following measures:

- initiatives to reserve approximately 500 yards of land on either side of the country's main roads for future industrialization;
- if the allotted owners are not interested in setting up the industry in the BSCIC industrial estates within a certain period of time or if they are unable to do so, they can reclaim the plots and give the allotment to the interested industrialists on the condition that they go for industrial production within the specified period; and

- discourage the setting up of any other small or cottage industries within a radius of 10 km if space is available in the BSCIC industrial city.

(e) Wetlands

The country has about 25,000 km long river-ways. These rivers and other wetlands together produce about 1.4 million tons of fish annually in about 4.3 million hectares of land. But still, we are still lagging far behind in terms of potential fishery production. If proper fish farming is done in the open and closed water bodies in a scientific manner at present, it may be possible to achieve the target of increasing fish production to 20 lakh tones during the Fifth Five Year Plan.

Wetlands are shrinking due to continuous siltation of rivers, filling up of soil, disruption of normal flow of water in low lying areas and construction of various structures including roads. These leads to the following problems:

- Increase flood intensity during the monsoon season;
- Lack of adequate water for navigation during the dry season;
- Limited fish farming;
- Insufficient water for irrigation;
- Increase salinity;
- Water-logging;
- Lack of water for various activities like washing clothes, bathing etc.

It is need to ensure in such a way that the conventional areas for fish production, such as rivers, canals, beels, haor-baors, etc., will not face any adversity. In many parts of these conventional areas, there is a tendency to transform huge areas to agricultural land as water dries up in the summer. We have to keep in mind that increasing agricultural land will not solve this problem along. Increasing agricultural land by altering wetlands will also lead to various problems such as loss of natural equilibrium, fish protein deficiency by the people. Efforts should be made to produce crops and fishery resources simultaneously through integrated implementation of National Agriculture Policy and National Fisheries Policy. Tea gardens located in greater Sylhet and Chittagong districts are a significant source of our export income. Rubber gardens exist in Chittagong Hill Tracts and some other parts of the country. There are also orchards. These special types of gardens need to be conserved. For this, the land currently being used or intended for use cannot be used in any other purpose in any consideration. The valuable trees existing in these lands cannot be destroyed indiscriminately and the natural fertility of the land should not be destroyed as well.

(f) Coastal Region

In the southern part of the country, huge chars have risen from the sea floor and will rise more in the future. The process of raising the chars from the sea floor will be accelerated through the implementation of land reclamation projects. Although the technology of artificially creating chars from the seabed is expensive, this method can also be used for national needs. Various activities such as afforestation, creation of housing for landless people, identification of land required for public easement, improved farming with adequate drainage system, strengthening of cyclone management system etc. in the new char lands have to be done. This requires the formulation of a clear outline at the national level which can be done through the formation of an inter-ministerial task force.

(g) Char land

Many chars arise in the country on both sides of different rivers and in natural wetlands like haor-baor, shrinking river etc. In addition to providing settlements to the landless through a policy in these char lands, efforts are also being made to build housing for them through the Adarsha Gram (Ideal Village) and Shelter Project. Priority should be given to the families affected by river bank erosion in these cases.

(h) Other Use

In addition to the areas described above, land use is increasing for a number of reasons. Various types of infrastructure such as educational institutions, playgrounds, hat-bazaars, offices-courts, functions and residences of security forces, dairy and poultry farms etc. have been constructed all over the country for economic and social wellbeing. There is constant pressure to build more and more such infrastructure. A boundary line can be drawn effortlessly for building additional infrastructure. The full use of the entire land under the existing infrastructure must first be ensured. Even then, if additional land is required, it should be kept to a minimum. The river is excavated to maintain its navigability and to facilitate irrigation. As a result, the available soil due to excavation has to be used for land development and conservation in a planned manner.

Extensive use of bricks in construction and establishment of brick kilns everywhere has led to natural and environmental degradation of the country including changes in land class. To prevent this, the use of stone blocks made of crushed sand cement as an alternative to bricks in construction should be encouraged, which will also help prevent the destruction of buildings in an earthquake.

Key aspects of land use policy

1. Agricultural land must be used for agriculture as much as possible and no physical change of land can be brought without the permission of the concern authority.
2. Must ensure land use of absent owners of agricultural land.
3. Fragmentation system of agricultural land should be limited to reasonable amount.
4. All city corporations and municipalities and in other cases the concerned Upazilas will identify land use zones in their respective areas.
5. Map of the demarcated zones needs to be prepared.
6. The Revenue Office of the concerned Deputy Commissioner will provide necessary assistance in preparing the zoning map by the local government bodies.
7. Once the zoning map has been approved by the concerned authority, it cannot be changed except in specific areas and conditions.
8. The country will have a zoning law. The zoning map by various local government bodies must be compiled with by all under the power of this Act. The zoning map by the different local government bodies must be under the power of this Act.
9. Construction of model houses and planned residential areas for rural areas should be encouraged.
10. In order to ensure optimal use of housing land, construction of multi-story buildings instead of single-story buildings should be encouraged in urban and rural areas.
11. Forest declared by the Ministry of Forest and Environment will be identified as forest lands.
12. Initiatives should be taken to conserve, maintain and expand the existing forest lands.
13. Coastal areas need to be effectively green forested.
14. Social forestry needs to be encouraged.
15. Existing reservoirs must be kept open and cannot be filled. In the case of small privately-owned ponds, the responsibility will be on the owner and on the large reservoirs such as river, canal, haor-baor and beel, the responsibility will be vested in the people and the government. Regular renovation and re-excavation of reservoirs require achieving this target.

16. The flood control embankment will be used as a road as far as possible.
17. Suitable trees should be planted in the dam in a planned way.
18. The excavated cavity for the construction of the dam should be used as reservoir for fish culture and poultry rearing. The required soil for constructing a flood control dam should be arranged by re-excavating the filled reservoir in the vicinity without creating new reservoir as much as possible.
19. It is necessary to ensure that the construction of the dam does not cause water-logging.
20. Land cannot be acquired for construction of roads other than national highways, regional roads and District-Upazila, Upazila-Upazila connecting roads only. In cases where acquisition is essential, housing and fertile agricultural land should be avoided as much as possible. Construction of intra-village/ inter village roads in rural areas should be in planned manner.
21. New industries-factories have to set up in certain zones. For this, it is to be ensured that industrial support services are easily available in the vicinity.
22. Certain type of industry-factory will only be set up in fixed certain places for those industries-factories.
23. Proper arrangements and procedures for disposal of industrial wastes should be strictly followed so that no harm is done to the land or the environment.
24. To ensure secured movement of transports on the main roads of the country, service lanes should be built on both sides of the main roads for pedestrians and 10 to 20 feet wide space should be allotted for afforestation on both sides of the main roads for the development and beautification of the environment.
25. If industries can be built inside the BSCIC areas than any other small and cottage industry in 10 kilometer radius of BSCIC is to be discouraged.
26. Land used for tea garden, rubber garden etc. should be identified through survey to ensure proper use. Tea garden land is not to be used in other purpose in any consideration.
27. Chittagong Hill Tract Districts will be included in survey activities.
28. Aboriginal societies living in different parts of Bangladesh will be given land rights in accordance with the prevailing law and their social rights will be protected.

Public Awareness Rising

No national policy can be fully implemented unless it is understandable and acceptable to the larger population. The same applies to land policy. It is need to make the people aware of the limitations of agricultural land in the country, the need for adequate food production, the need for extensive fish farming to make protein food easily available, the expansion and conservation of afforestation, the maintenance of environmental equilibrium, etc. The desired results cannot be achieved through law enforcement alone. When people are aware enough about this, they will not easily use their fertile land for housing. He will try o take alternative measures on his own.

National Land Use Committee

A National Land Use Committee headed by Hon'ble Prime Minister will be constituted as follows for the purpose of implementation, monitoring and giving necessary directions to the National Land use Policy.

Table 7.3: National Land Use Committee

Hon'ble Prime Minister	**Chairman**
Minister, Ministry of Land	Vice-Chairman
Minister, Ministry of Local Government, Rural Development and Cooperatives	Member
Minister, Ministry of Finance	"
Minister, Ministry of Education	"
Minister, Ministry of Water Resources	"
Minister, Ministry of Industries	"
Minister, Ministry of Home Affairs	"
Minister, Ministry of Agriculture	"
Minister, Ministry of Communications	"
Minister, Ministry of Health and Family Welfare	"
Minister, Ministry of Environment and Forest	"
Minister, Ministry of Law, Justice and Parliamentary Affairs	"
Minister, Ministry of Housing and Public Works	"
Minister, Ministry of Fisheries and Livestock	"
Minister Ministry of Planning	"
Cabinet Secretary, Cabinet Division	"
Principal Secretary to the Prime Minister	"
Concerned Secretaries	"
Representative of Federation of Bangladesh Chamber of Commerce and Industry	"
Secretary, Ministry of Land	Member-Secretary

Land Use Implementation Committee

A Land Use Implementation Committee will be formed to assist the National Land Use Committee as follow:

Table 7.4: Land Use Implementation Committee

Minister, Ministry of Land	**Convener**
Minister, Ministry of Local Government, Rural Development and Cooperatives	Member
Minister, Ministry of Agriculture	"
Minister, Ministry of Communications	"
Minister, Ministry of Environment and Forest	"
Minister, Ministry of Planning	"
Secretary, Local Government Division	"
Secretary, Ministry of Agriculture	"
Secretary, Ministry of Communications	"
Secretary, Ministry of Environment and Forest	"
Secretary, Ministry of Planning	"
Secretary, Ministry of Housing and Public Works	"
Secretary, Ministry of Land	Member-Secretary

Bangladesh Energy Regulatory Commission Act, 2003

Constitution of the Commission

This Act shall be called the Bangladesh Energy Regulatory Commission Act, 2003. It is the 13th no. Act of 2003. This Act is to make provisions for the establishment of an independent and impartial regulatory commission for the energy sector

[1] The Commission shall consist of a Chairman and four Members.

[2] The Chairman and the Members shall be appointed by the President on the basis of the proposal of the Ministry and they shall be full-time officers of the Commission.

[3] The Chairman and two Members shall have to be appointed as soon as the Act comes into force and after one year from such appointment the rest two members shall have to be appointed.

[4] The Chairman shall be the Chief Executive of the Commission.

Functions of the Commission

Subject to the provisions of this Act, functions of Commission shall be as follows:

a) to determine efficiency and standard of the machinery and appliances of the institutions using energy and to ensure through energy audit the verification, monitoring, analysis of the energy and the economy use and enhancement of the efficiency of the use of energy;

b) to ensure efficient use, quality services, determine tariff and safety enhancement of electricity generation and transmission, marketing, supply, storage and distribution of energy;

c) to issue, cancel, amend and determine conditions of licences, exemption of licences and to determine the conditions to be followed by such exempted persons;

d) to approve schemes on the basis of overall program of the licencee and to take decision in this regard taking into consideration the load forecast and financial status;

e) to collect, review, maintain and publish statistics of energy;

f) to frame codes and standards and make enforcement of those compulsory with a view to ensuring quality of service;

g) to develop uniform methods of accounting for all licencees;

h) to encourage to create a congenial atmosphere to promote competition amongst the licencees;

i) to extend co-operation and advice to the Government, if necessary, regarding electricity generation, transmission, marketing, supply distribution and storage of energy;

j) to resolve disputes between the licencees, and between licencees and consumers, and refer those to arbitration if considered necessary;

k) to ensure appropriate remedy for consumer disputes, dishonest business practices or monopoly;

l) to ensure control of environmental standard of energy under existing laws; and

m) to perform any incidental functions if considered appropriate by the Commission for the fulfilment of the objectives of this Act for electricity generation and energy transmission, marketing, supply, storage, efficient use, quality of services, tariff fixation and safety improvement.

Receipt of Complaint of Consumer and Disposal

[1] Every licencee shall make arrangements for necessary numbers of complaint centers to receive complaints or inconvenience of the consumers regarding energy, service or matters connected therewith and shall publish notices from time to time with information regarding the location of centers of communication.

[2] Any consumer may submit his inconvenience or complaint to the said center over telephone or in writing.

[3] All complaints received from the consumer and the information regarding their settlement shall have to be recorded in writing in a register at that center.

[4] After receipt of any information or complaint regarding the inconvenience from the consumer, licencee shall settle it within 7 (seven) days and shall follow the code of practice made by the Commission in this regard.

[5] If the licencee, in spite of being informed by the consumer regarding his inconvenience or complain, fails to settle in due time and in due process, the said consumer may submit the matter in writing to the Commission for taking action.

[6] Commission shall pass necessary order not exceeding 7 (seven) days from the date of receipt of such application.

National Energy Policy (NEP) 2005

Background

Improving access to energy in Bangladesh is a fundamental contribution to poverty reduction and key to attaining the United Nations Millennium Development Goals. As energy is prerequisite for social and economic development it is essential to move towards sustainability in energy systems both in order to protect natural life-support systems on which humanity depends, and to eradicate poverty. With rapid change of global as well as domestic situation it has become necessary to update National Energy Policy (NEP) of Bangladesh, which was formulated in 1996 to proper exploration, production, transmission, distribution and rational use of energy sources to meet the growing demand on a sustainable basis. It involves survey, exploration, exploitation and distribution of indigenous natural gas; development of coal in the northern part of the country: establishment of petroleum refining facility and distribution systems; and establishment of power generation plants and networks for transmission and distribution of electricity. It is also necessary to take proper steps to enhance renewable energy development activity to meet the future challenge.

Energy demand in Bangladesh is rising swiftly. Demand is outstripping the production and transmission & distribution capability. Especially power demand exceeds generation capacity. There are also some bottlenecks in power transmission and distribution system. All these leads to increased load shed and poor quality of power supply.

Out of 140 million people about 50 million have direct access to electricity. Per capita electricity generation in 2005 was only 158 kWh. In 2003-04 about 1.24 million households had piped natural gas connections and only 2.32% of total households used kerosene as cooking. Per capita consumption of commercial energy and electricity in Bangladesh is one of the lowest even among the developing countries. At present about 65% of total final energy consumption is met by different type of traditional biomass fuels (e.g. agricultural residues, wood fuels, animal dung etc.).

Shortcomings of the past energy development programmes and management practices are identified as follows:

(a) It has not been possible to undertake systematic survey, exploration and exploitation of energy resources throughout the country due to financial constraints. As a result, it has not been possible to ensure balanced development of energy resources of different zones of the country and balanced development of different sub-sectors of the energy sector.

(b) It has not been possible to undertake systematic development of Power Generation, Transmission and Distribution projects and rational use of electricity in the country.

(c) Expansion of energy consuming sectors e.g. industrial sector have been constrained due to shortage and unreliable supply of commercial energy.

(d) Energy agencies have not been operated and managed efficiently.

(e) Energy prices have not been set on a rational basis.

(f) Effective measures have not been taken to ensure proper use of energy through integration of economic development activities.

(g) Unplanned and inefficient use of fuels is contributing to environmental degradation.

(h) Adequate attention has not been given to meet the total energy needs of rural areas.
(i) Adequate attention has not been given to undertake systematic research programmes to develop indigenous technological capabilities.
(j) Adequate attention has not been given to develop trained manpower for the efficient management of the sector.

Government made vision and policy statement in 2000 for power sector development. Government's vision is to provide reliable and affordable power to all by 2020. To materialize the vision Gas, prime fuel for power generation provides a special window of opportunity. Again, to increase the security and reliability of power supply, diversified use of fuel shall get importance. Considering all these there should be homogeneous development of all segments of energy sources and sector to achieve the desired goal. It is essential to take measures on both the supply and demand side in order to improve access to advanced low-emission energy forms and to renewable energy sources, and to improve the energy efficiency.

To ensure sustainable development of energy sector, updated National Energy Policy will address various issues to overcome shortcomings mentioned above.

Objectives

The objectives of the revised National Energy Policy (NEP) are outlined as follows.

[1] To provide energy for sustainable economic growth so that e economic development activities of different sectors are not constrained due to shortage of energy.

[2] To ensure optimum development of all the indigenous energy sources.

[3] To meet the energy needs of different zones of the country and socioeconomic groups.

[4] To ensure sustainable operation of the energy utilities

[5] To ensure rational use of total energy sources.

[6] To ensure environmentally sound sustainable energy development programmes, with due importance to renewable energy, causing minimum damage to environment.

[7] To encourage public and private sector participation in the development and management of the energy sector.

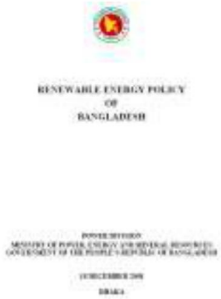
[8] To integrate energy with rural development to boost rural economy.

[9] To bring entire country under electrification by the year 2020.

[10] To ensure reliable supply of energy to the people at reasonable and affordable price.

[11] To develop a regional energy market for rational exchange of commercial energy to ensure energy security.

Renewable Energy Policy, 2008



Energy is one of the basic ingredients required to alleviate poverty and socio-economic development. Government of the People's Republic of Bangladesh (GOB) has issued its Vision and Policy Statement in February 2000, to bring the entire country under electricity service by the year 2020 in phases, in line with the direction of the Article 16 of 'The Constitution of the People's Republic of Bangladesh,' to remove the disparity in the standards of living between the urban and rural areas through rural electrification and development. The energy prospect is generally assessed on the basis of available commercial sources of energy i.e., fossil fuel like gas, coal, oil etc. Worldwide, there is a major transition underway in the energy sector. It is happening due to the following three major reasons:

(i) A decline in fossil fuel availability, their predicted gradual extinction in the next few decades and the resultant price volatility due to demand-supply gap.

(ii) The need to drastically cut global emissions for mitigating climate change (80% reduction by 2050).

(iii)The need for energy security.

In Bangladesh efficient utilization of renewable energy resources is yet to assume commercial dimensions and hence rational policy dissemination on renewable energy usage is essential. The renewable energy includes solar, wind, biomass, hydro, geo-thermal, tidal wave etc. Renewable energy (RE) in the form of traditional biomass is the main source of primary energy in the country comprising some 35-60% percent of total primary energy use. The size and economic potential of the renewable energy resources (e.g., solar photovoltaic, solar thermal power, wind power, biogas, etc.) in Bangladesh are yet to be determined and the capacity of renewable energy development is presently low. Although investment costs of renewables are generally higher compared to fossil fuel alternatives, this option becomes economically viable when all externalities (e.g. environmental cost, health hazards etc.) and lower operating cost are taken into consideration.

Sources of renewable energy

The major sources of renewable energy are:

(a) Solar

There are two systems of solar power. (i) Solar photovoltaic (PV) systems are in use throughout the country with over 300,000 household-level installations having capacity of about 15 MW (November 2008). Scaling-up of solar PV systems assisted by the development partners are being implemented through Infrastructure Development Company Limited (IDCOL), Rural Electrification Board (REB), Local Government Engineering Department (LGED), Bangladesh Power Development Board (BPDB), NGOs and Private Organizations implementing solar energy program. There is a strong potential for solar energy within the country. (ii) Solar Thermal Power/Concentrating Solar Power (CSP) technology involves harnessing solar radiation for generation of electricity through a number of steps finally generating mechanical energy to run a generator. This technology needs to be disseminated in the country to supplement the power supply.

(b) Wind Energy

Wind Energy has also made some inroads but its potential is mainly in coastal areas, and offshore islands with strong wind regimes. These coastal settings afford good opportunities for wind-powered pumping and electricity generation. Presently there are 2 MW of installed wind turbines at Feni and Kutubdia.

(c) Biomass

Bangladesh has strong potential for biomass gasification-based electricity. More common biomass resources available in the country are rice husk, crop residue, wood, jute stick, animal waste, municipal waste, sugarcane bagasse etc. This technology can be disseminated on a larger scale for electricity generation.

(d) Biogas

Biogas mainly from animal and municipal wastes may be one of the promising renewable energy resources for Bangladesh. Presently there are tens of thousands of households and village-level biogas plants in place throughout the country. It is a potential source to harness basic biogas technology for cooking, and rural and peri-urban electrification to provide electricity during periods of power shortfalls.

(e) Hydro

Microhydro and minihydro have limited potential in Bangladesh, with the exception of Chittagong and the Chittagong Hill tracts. Hydropower assessments have identified some possible sites from 10 kW to 5 MW but no appreciable capacity has yet been installed. There is one hydro power plant at Kaptai established in the 1960s with present installed capacity of 230 MW.

(f) Other sources

Other renewable energy sources include bio-fuels, gasohol, geothermal, river current, wave and tidal energy. Potentialities of these sources are yet to be explored.

Objectives

The objectives of renewable energy policy are to:

(i) Harness the potential of renewable energy resources and dissemination of renewable energy technologies in rural, peri-urban and urban areas;

(ii) Enable, encourage and facilitate both public and private sector investment in renewable energy projects;

(iii) Develop sustainable energy supplies to substitute indigenous non-renewable energy supplies;

(iv) Scale up contributions of renewable energy to electricity production;

(v) Scale up contributions of renewable energy both to electricity and to heat energy;

(vi) Promote appropriate, efficient and environment friendly use of renewable energy;

(vii) Train; facilitate the use of renewable energy at every level of energy usage.

(viii) Create enabling environment and legal support to encourage the use of renewable energy.

(ix) Promote development of local technology in the field of renewable energy.

(x) Promote clean energy for CDM; and

(xi) Achieve the targets for developing renewable energy resources to meet five percent of the total power demand by 2015 and ten percent by 2020.

Institutional Arrangements

An institution, Sustainable Energy Development Agency (SEDA), shall be established under the Companies Act, 1994, as a focal point for sustainable energy development and promotion, 'sustainable energy' comprising renewable energy and energy efficiency. SEDA Board will comprise of representatives of stakeholders including business community, academics and/or representative from Bangladesh Solar Energy Society, NGOs, financial institutions and implementing agencies. The responsibilities of SEDA as a company shall be to:

(i) Provide coordination of sustainable energy planning, including action plans linking together the activities of several agencies or organizations;

(ii) Promote awareness of renewable energy and other clean energy technologies and integrate their development within overall national energy policy and development;

(iii) Support demonstration of new technologies and new business models for renewable energy and other clean energy technologies;

(iv) Support establishment of small and medium renewable energy enterprises and providers;

(v) Enable systematic development of renewable energy projects and opportunities through energy audits;

(vi) Create market opportunities and start-up business models for sustainable energy technologies in Bangladesh, such as energy services companies and rural energy providers;

(vii) Develop financing mechanisms and facilities by using grant, subsidy and/or carbon/CDM fund for public and private sector investments in all forms of sustainable energy;

(viii) Collect data and assess the renewable energy resource base, especially in the context of rural energy master plan;

(ix) Provide fund for the development of standardized renewable energy configurations to meet common energy and power applications, such as solar, biogas and bio-diesel for mechanical irrigation and improved community practices for forest management and conversion and use of fuel wood by using grant, subsidy and/or carbon/CDM fund;

(x) Stimulate market development for sustainable energy technologies, such as improved cook stoves and household biogas digesters;

(xi) Provide financial support in the research and development of renewable energy technology;

(xii) Implement policies for mitigation of environmental issues arising out of use of Renewable Energy; and

(xiii) Solicit and processing of grid connected renewable energy projects.

Power Division of the MPEMR or its assignee will facilitate the development of renewable energy until SEDA is formed.

Overall policy formulation and development functions of renewable energy shall lie with the Power Division of the MPEMR.

Resource, Technology and Program Development

1) SEDA in conjunction with the Power Division of the MPEMR shall be responsible for determining the priorities for renewable energy technology development and program implementation.
2) SEDA shall support capacity building, technology development, and market development sufficient to boost the share of electricity generated from renewable energy technologies.
3) All power utilities, Local Government Engineering Department (LGED), other interested government departments, private agencies and NGOs are to develop renewable energy development program for implementation throughout the country.
4) Electricity generated from renewable energy projects, both in public and private sectors may be purchased by power utilities or any consumer through mutual agreement (less than 5 MW).
5) Renewable energy project sponsors may use existing electricity transmission and distribution systems, if there is adequate capacity, to supply electricity to its customers through mutual agreement between the project sponsor and the owner of transmission/distribution facilities. The sponsor will require to pay a wheeling charge to the owner of transmission/distribution facilities. The wheeling charges shall be determined by Bangladesh Energy Regulatory Commission (BERC) in consultation with the Power Division of MPEMR.
6) In addition to electricity generation, renewable energy for solar heating and biogas or other means like cooking etc shall be developed.
7) SEDA will encourage human resource development and local production of renewable energy equipment, facilitate and monitor quality of renewable energy equipment, and will assist to setup quality control laboratory to test the renewable energy equipment.
8) For large biomass electricity projects (i.e. greater than 1 MW) the project developer must demonstrate that the biomass is being sustainably harvested and that no adverse social impact will result from that development.

9) Production and use of bio-fuels may be encouraged in limited scale without jeopardizing the existing crops.

Investment and Fiscal Incentives

1. Existing renewable energy financing facility shall be expanded that is capable of accessing public, private, donor, carbon emission trading (CDM) and carbon funds and providing financing for renewable energy investments.
2. To prompt renewable energy in power sector, all renewable energy equipment and related raw materials in producing renewable energy equipment will be exempted from charging 15% VAT. SEDA or power division of the MPEMR or its assignee until SEDA is formed, will fix up the acceptable mechanism to reach the benefits of tax exemption to end users in consultation with NBR.
3. In addition to commercial lending, a network of micro-credit support system will be established especially in rural and remote areas to provide financial support for purchases of renewable energy equipment.
4. Power Division of MPEMR will facilitate investment in renewable energy and energy efficiency projects. SEDA, in co-operation with local government offices, will set up an outreach program to develop renewable energy programs.
5. SEDA will consider providing subsidies to utilities for installation of solar, wind, biomass or any other renewable/clean energy projects.
6. Private sector participation including joint venture initiatives in renewable energy development will be encouraged and promoted. Power Division of MPEMR/SEDA may assist in locating the project(s) and also assist in acquiring land for renewable energy project(s).
7. Renewable energy project investors both in public and private sectors shall be exempted from corporate income tax for a period of 5 years from the date of notification of this policy in the official gazette and it will be extended periodically following impact assessment of tax exemption on renewable energy.
8. An incentive tariff may be considered for electricity generated from renewable energy sources which may be 10% higher than the highest purchase price of electricity by the utility from private generators.

9. To promote solar water heaters, use of electricity and gas for water heating will be discouraged. In this regard necessary steps will be considered accordingly.
10. For successful implementation of renewable energy projects and initiatives lending procedure will be simplified and strengthened.

Regulatory Policy

a) Renewable energy project(s), to sale electricity from plants shall be required to get power generation license from BERC if the capacity of the project(s) is 5 MW or more.

b) Power Division of MPEMR and SEDA, in consultation with BERC will create a regulatory framework encouraging generation of electricity from renewable energy sources.

c) BERC shall approve the energy tariff in consultation with Power Division of MPEMR/SEDA as per the provision of the BERC Act 2003 if the capacity of renewable energy project(s) is 5 MW or more. Electricity distributors may offer "green energy" tariffs, which provide consumers an opportunity to co-finance through their electricity bills the development of new renewable energy sources.

Sustainable and Renewable Energy Development Authority Act, 2012

This Act may be called as the Sustainable and Renewable Energy Development Authority Act, 2012. This is the 48th no. Act of 2012. This Act is to make provisions for the establishment of the Sustainable and Renewable Energy Development Authority to ensure energy security.

Establishment of the Authority

[1] After the commencement of this Act, the Government shall, by notification in the *official Gazette,* establish an Authority to be called the Sustainable and Renewable Energy Development Authority.

[2] The Authority shall be a body corporate, having perpetual succession, and a common seal, with power, subject to the prior approval of the Government, to acquire, hold and dispose of property, both movable and immovable, and shall by the said name sue and be sued.

Responsibilities and functions of the Authority

Responsibilities and Functions of the Authority shall be as follows, namely: –

[1] to take necessary measures to create public awareness and motivation for efficient use of power and energy and its conservation;

[2] to encourage the use of power and energy efficient equipment and take necessary steps for standardization and labeling of power and energy using equipment and appliances;

[3] to establish testing laboratories or provide assistance in establishing laboratories in order to test and certify on standard equipment of using energy;

[4] to encourage energy efficiency and conservation related research and development and to identify innovative financing for implementation of projects or associated works relating thereto, and arrange necessary training in this behalf;

[5] to assist the Government in making and implementation of energy efficient building code;

[6] to make regulation for qualification and competency of energy manager and energy auditors and selection of accredited energy auditor firm;

[7] to coordinate the implementation activities of energy efficiency and conservation in government, semi-government and autonomous bodies and create commercial market for sustainable energy in private sector through demonstration;

[8] to assist the Government in making necessary laws, rules, regulations for sustainable energy development;

[9] to identify energy inefficient equipment and take necessary measures to stop its production, import and sales;

[10] to take necessary measures to declare designated consumers of different energy consumers or category of consumers;

[11] to prepare and update inventory of renewable energy resources and associated technologies, indicating its geographical location of sites and verify its suitability for commercial use after assessing possibilities of its exploitation;

[12] to provide necessary technical assistance in preparing CDM or similar type of activities;

[13] to prepare short, medium and long-term development project to extend the use of renewable energy with specific targets and take necessary steps to implement it;

[14] to provide technical and financial assistance in research, development, demonstration and training on renewable energy;

[15] to take necessary steps for creating public awareness and motivation in order to encourage the use of renewable energy in public and private sector;

[16] to assist to identify sources of financing and make necessary arrangement to provide financial incentives to attract and encourage private investment in renewable energy sector;

[17] to send tariff proposal of renewable energy to Bangladesh Energy Regulatory Commission established under section 4 of Bangladesh Energy Regulatory Commission Act, 2003 (Act No.13 of 2003), upon discussion with the Government;

[18] to assist the Government to coordinate the implementation of renewable energy development related activities in government, semi - government and autonomous bodies;

[19] to encourage commercialization of renewable energy and energy efficiency activities in private sector through implementation of pilot project;

[20] to assist the Government to formulate, update and implementation of policies made under this Act, including revision of Renewable Energy Policy;

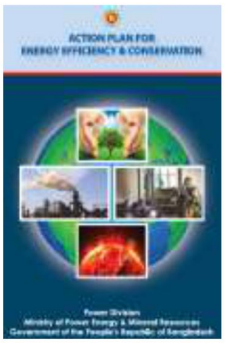
[21] to coordinate with different Ministries, Divisions and organizations in matters related to sustainable energy;

[22] to establish linkage with regional and international organizations on sustainable energy;

[23] to perform such other functions as may be prescribed by rules or by the Government, from time to time.

Action Plan for Energy Efficiency and Energy Conservation 2013

Background



The demand for energy is increasing day by day due to accelerated industrialization, rapid urbanization, infrastructure development and an emerging consumer society. Till date, gas has remained the major source of primary energy in the country. Coal would be a much cheaper source of energy for the country with new reserves found recently which are promising. The government is also considering having electricity from a nuclear power plant, as well as exploring other options like regional power sharing.

In recognition of the need to promote sustainable energy in the country, encompassing renewable energy, energy efficiency and energy conservation, the government has enacted the Sustainable and Renewable Energy Development Authority (SREDA) as a national nodal organization for promoting such energies in the country.

With a view to promoting sustainable energy in the country, the Renewable Energy Policy envisages to generate 5% electricity from renewable resources by 2015 and increase it to 10% by 2020. The focus of renewable energies will be on off-grid and remote areas to provide energy services to the poor as well as urban areas where street lights can be solar powered and high-rise buildings are already mandated to include 15% solar energy.

As part of its sustainable energy agenda, the government is actively striving to promote Energy Efficiency (EE) and Energy Conservation (EC). These are two areas which are mutually complementary, where significant amount of power / energy can be saved and redirected for other economic use in the country.

Outdated boilers, inefficient motors and use of old technologies are costing heavily through inefficient energy use. Bangladesh needs to opt for low consumption and low-cost smart technologies by bringing policy changes in its import and production of technologies that use energy. At the same time leakage, pilferage and waste of energy at all levels needs to be brought under control through effective means.

Some initiatives have already been taken up by the government in this regard, but more needs to be done. For example, use of gas meters in households in some areas has yielded positive results. It needs to be extended to other commercial consumers like hotels, restaurants, shops using gas burners, etc. and expanded in all areas for households. That will bring about a good reduction in the wastage in gas by the domestic and commercial users.

Efficient energy use at every level including generation, transmission, distribution in the supply side and in demand side; introduction of energy efficient household appliances; energy efficient equipment in the industries; CFL bulbs and energy efficient electric fans in households, offices and industries etc. can bring about a significant saving in energy through increased efficiency. Introduction of green building technology, energy efficient bricks, smart technologies that cut or reduce power supply when equipment are not in use or rooms are not occupied can save energy through conservation.

As the economic growth increases, the share of energy from commercially available sources (coal, gas etc.) will increase. Also rural consumers will move away from bio-mass, which is now a primary source of energy in rural areas, thereby increasing the demand on energy. In order to balance the energy need between supply and demand, energy efficiency across all sectors of the economy is critical component in the growth strategy being pursued by the government.

Objectives of Energy Efficiency Action Plan

Government of Bangladesh has adopted this Action Plan to consolidate efforts and coordinate different EE & EC programs and measures towards achieving a set of national targets under a single government umbrella through establishment of SREDA. The Action Plan will also recognize EE & EC measures and programs associated with sectoral and national interests, putting emphasis on government priorities. It is also expected that those intervention will be further accelerated by both government and non-government stakeholders through a variety of possible ways.

In continuation of this Action Plan, comprehensive study on sectoral energy efficiency status will be conducted for preparation of a Master Plan on Efficient Energy Management with a view to exploring the prospective areas of energy savings in different tiers, which will be commencing subsequently, to meet the specific needs.

Vision

Government has s stated vision of improving the primary and secondary energy saving level for sustainable energy security including low carbon emission.

Mission

In line with its vision statement, the government has set the following target to ensure sustainable energy security:

- 10% of primary and secondary energy saving by 2015
- 15% by the 2021 and
- 20% by 2030

Ongoing Energy Efficiency Activities

The summary of ongoing activities is as follows:

[1] Steps have been taken to introduce energy efficiency building concept in the National Building Code (revision). In addition to that energy efficiency measure, alternative and renewable energy subjects have been introduced in the national Text Book Curriculum of schools, madrasas and colleges.

[2] Installation of solar panels for solar power production in all the government, non-government and autonomous institutions are going on.

[3] Installation of energy saving CFL, T-5 tube light instead of incandescent bulb and replacement of electronic ballast by magnetic ballast activities are going on.

[4] Free CFL distribution program (replacement of incandescent bulb with CFL bulb) has been conducted to demonstrate the energy saving and cost saving benefits of CFL and to encourage its use by consumers.

[5] Energy Star Labelling Program has been started to motivate the users to use energy efficient appliances. BSTI has star marked six appliances (fan, air conditioner, refrigerator, CFL bulb, Ballast and electric motors) so far.

[6] Efficient Rice Husk Parboiling Program has been initiated for replacement of 50 (fifty) thousand inefficient boilers with efficient ones, which will save about half of the rice husk for other uses.

[7] Improved Cook Stove Program is going on the replace the inefficient cook stoves in urban and rural areas to save the primary energy resource-biomass.

[8] Improving Kiln Efficiency in the brick manufacturing industry in going on which will save half of the fuel cost, while reducing carbon emissions by half.

[9] Electricity Week program has already been launched since 2010 with a view to promote energy saving campaigns at consumer and school levels. In this program, prizes were also awarded to the champions related to electricity saving at their level. Essay competitions on energy saving topics were conducted in the schools/madrasas and the successful children were awarded nationally to encourage them on energy saving issues. This program is nationally observed on 7th December each year.

[10] Some energy audits are being conducted in limited scale through Energy Audit Cell under Electrical Advisor and Chief Electrical Inspector.

Energy Efficiency in Power Generation

The interventions for improving 'Energy Efficiency' in the Power Generation Sector are as follows:

- ✓ Rehabilitation of the old and inefficient power plants as per the Policy Guidelines for Enhancement of Private Participation in the Power Sector.
- ✓ Replacement or repowering of some of the power plants that are still running at very low efficiency and their availability beyond their economic life time.
- ✓ To take possible energy efficiency measures, each power plant must have a responsible technical person who will identify the possible energy loss, and take measures for prevention of the same in the power station and assist the energy audit system in the power sector. This person should be trained and strengthen to perform the job responsibly.
- ✓ Timely procurement of spare parts and adhering to the maintenance schedule must be followed by all the power plants for keeping the plant operational at standard level.
- ✓ In-house capacity building and proper training of the operation and maintenance people of the power plants as per standard practice.
- ✓ Online Interface meters are to set up at the energy dispatch point from the power station to the grid to monitor the energy generation.
- ✓ All the new coal-based power plants are to be designed with supercritical boilers and gas based simple cycle base load power stations as combined cycle ones for higher energy output.
- ✓ The peaking power plants will not be allowed to run in base load to avoid unscheduled heat loss.

Energy Efficiency in Power Transmission

The losses in transmission, whilst not high and are mostly at the level of international standards for a highly concentrated system. The network operation has suffered problems with insufficient capacity and the prevailing need to correct voltage drops, which leads to less efficient dispatch. The following table sets out systems operations for the past 8 years:

Table 7.5: HV Transmission Losses Bangladesh

Year	GWh Net Generated	GWh Transmitted	Losses (GWh)	Losses (%)
2004-05	21408	20430	723	3.42
2005-06	22978	21955	783	3.44
2006-07	23267	22053	718	3.15
2007-08	24946	23962	984	4.06
2008-09	26533	25584	949	3.8
2009-10	29247	28344	903	3.42
2010-11	31355	30442	913	3.31
2011-12	35118	34100	1018	3.22

Source: PGCB

Key Issues in Transmission sector

The key issues in the transmission system concerning energy efficiency can be summarized as:

- ✓ Higher system loss and voltage drop o Low power factor
- ✓ Insufficient transmission capacity in certain areas
- ✓ Overloaded transformer in certain areas

Action for Transmission Network Management of Long-Distance Gridline

Energy efficiency improvement interventions in the power transmission sector are as follows:

- ✓ Power factor and voltage drop: There are currently two voltage regulation projects underway which will rapidly improve the line losses. These will add approximately 950MVar of capacitor banks and reduce line losses by 128GWh per year.
- ✓ Prevention of Forced outage, blackout and synchronization mismatch: There are some mismatches in the current level of fault setting of the large substations around Dhaka. This could lead to system intervention and blackout. Power Grid Company of Bangladesh (PGCB) should identify the substations and take necessary correction and replacement of undersized protective devices for smooth operation.
- ✓ Up-gradation of line and transformer capacity: PGCB should identify the lower loaded transformer and transmission line considering future demand -generation growth.

- ✓ Automatic Generation Control, Smart grids and System Metering: PGCB should regularly evaluate the economic load dispatch merit order, current load dispatch system and identify the proposed measures to be adopted to enhance energy efficiency. This will include automatic generation control in SCADA (Supervisory Control and Data Acquisition) system, smart grids, proper system metering etc.
- ✓ In-house capacity building and human resource strengthening measures: PGCB will identify possible training programs to promote in-house measures in transmission network operation and maintenance.
- ✓ Islanding the grid connectivity: for managing long distance grid lines for efficient management of the grid loss.

Energy Efficiency in Power Distribution

Efficiency gains in the metropolitan distribution systems have rapidly increased over the past 9 years. Total losses in the system were 14.72°/o at the end of 2007-08 and are expected to drop in single digit within a few years. Two major contributing factors have been identified: (i) upgrading of overloaded components and (ii) subsequent reduction of theft. Whilst the overall Dhaka system still has a low power factor (PF), averaging 0.85, the introduction of KVA tariff approved by BERC, is compensating for some of the losses; and at the same time providing a signal to the consumers for up-gradation of their equipment or changing the procedures to reduce PF.

The lack of financial viability of most of the PBSs in the REB, and in several of the urban utilities, poses a major constraint for internal funding of the necessary infrastructure to alleviate overloaded and aging systems.

Long distribution lines (33 KV and 11KV), over loading of distribution transformers, hooking of distribution line from another distribution line result in huge voltage drop and energy loss especially in REB distribution lines. Steps are being taken to solve them and these technical issues will be solved in phases.

Table 7.6: Efficiency Improvement Trend of Transmission and Distribution lines

Item	**Fiscal Year**						
	2000-01	2005-06	2007-08	2008-09	2009-10	2010-11	2011-12
Transmission Line (230 &132kV) (Ckt. Km.)	3738	6844	7848	8330	8465	8616	8949
Distribution Line (KM)	176179	264891	256143	259963	269877	274347	281123
Distribution Loss (%)			14.72	14.57	13.49	12.66	12.1
System Loss (Tr.& Dist.) (%)	28.43	21.3	18.16	17.25	15.9	15.21	14.5

Key Issues in Power Distribution

The key issues related to system loss in distribution sectors are-

- ✓ long distance distribution lines and feeders as well as overloaded distribution substations.
- ✓ Low power factor.
- ✓ Insufficient metering system and proper billing and lack of standardized service drop practice.
- ✓ Pilferage of energy.

To improve and set the targets to reduce distribution system loss of power distribution utilities of Bangladesh, Key Performance Indicators (KPI) has already been set up by Power Division. Achievement or failure of targets of KPI will lead to financial incentives or punishments.

Energy Efficiency Interventions in the Power Distribution Sector

- ✓ Upgradation of distribution lines and substations: Distribution utilities will identify the areas with lines and substations overloading and issues concerning load distribution and feeder lines and prepare a priority list for replacement and financing. Load balancing in the distribution areas should be followed.
- ✓ Power Factor Improvement: Power distribution utilities will assess the current distribution power factors as well as prepare action plan and take necessary measures to address this issue.
- ✓ Modern Metering and service drop: Distribution utilities will adopt standard service drop practices and proper metering system. Each power connection should have proper metering {preferably Pre-paid meters for Low Tension consumers and remote metering for High Tension consumers) and billing system.
- ✓ Prevention of pilferage and in-house Capacity building: distribution utilities will identify possible pilferage prevention measures and proper training to enrich in- house capacity building of the personnel serving in the sector.

Initiatives for Demand Side Energy Efficiency

In Bangladesh, there is a widespread prevalence of low cost, less efficient, high energy consuming equipment which do not take into account the life cycle costs, particularly where the energy cost component is very low and subsidized. Often in buildings, where insulation and energy saving measures are overlooked deliberately to save costs by the developers, the end user unknowingly suffers from higher energy costs over the time.

(a) Demand Side Management through Metering

Introduction of meters in various spheres can effectively add to DSM of power consumption and contribute to saving a good deal of power in many ways. This additional power can be used for peak time compensation or for diverting to industries.

Time of Use (TOU) metering: Time of use meters (peak and off peak) are under rollout for all commercial and Industrial users in the Dhaka Metropolitan region. Over 41,000 meters were installed in 2009 and the consumers' response by shifting load to off peak has increased the system load factor by nearly 3%. There is still scope to increase this further to about 7% with greater awareness and an increased delta between the peak and off-peak tariff.

Prepaid Metering: To minimize technical and non-technical losses, BPDB has undertaken a pilot project in Chittagong for pre-paid meter installation. The distribution areas in Chittagong were chosen as the pilot project area, where 12,000 single-phase meters,1000 three-phase meters, 150 check meters were installed in the 11 KV feeder areas of Stadium and Khulshi along with insulated steel-reinforced aerial concentric conductor cables. DESCO has a pilot prepaid metering project in Uttara and the BPDB is implementing several additional pilot projects in Agrabad under Chittagong district, Syllhet, Bogra and Sirajganj district. Result from the latter pilots demonstrated an almost 10-20% reduction in unusual consumption, which inspired other utilities to install Unified Advance Pre-Paid Meter all over the country in the first phase, 35,000 pre-paid meters will be installed and 2 million meters will be installed in subsequent phases.

(b) Identification of Energy Inefficient Equipment and Appliances

By taking appropriate steps through imposing restrictions the production, importation and identification of energy inefficient equipment and appliances will be phased-out from the market gradually. This will contribute significantly to energy conservation in the country. BSTI is now working on standardize 6 products for making them energy efficient through its Standards & Labelling project. However, a greater number of equipment and appliances need to be brought under proper standards and labelling program in the country. Also, there needs to be sound monitoring of the import of electrical appliances to ensure that no old energy inefficient technologies are brought into the country

(c) Demand Savings Program

More recently the Government has taken initiatives to control consumption of electricity in the public and private sectors. The Government estimates that a saving of around 350MW of electricity has been achieved by undertaking actions like keeping the urban shopping malls and shopping centers closed after 8 p.m. Consumers are encouraged to keep the temperature of air-conditioners at 25° Celsius or higher and are prohibited to use air conditioner in the evening peak hours. Staggered working hours and holidays have also been introduced to reduce peak demand. In addition, the following interventions may be imposed namely:

i. Introducing master meter in market place

ii. Discouraging unnecessary lighting and illumination in community centres, shops and market places, commercial residential buildings and filling stations. In particular saree shops, auto showrooms and small shops are using way too many lights including high power fluorescent bulbs and yellow sodium lights. Steps should be taken banning such lights and restricting the shops to use a certain number of CFLs based on a fixed square foot of space.

These initiatives will be continued as a part of awareness generation program.

(d) Energy Efficiency in the Construction Sector

The New Building Code is under preparation which would address the EE issues and practices in buildings. The Code includes a set of minimum standards for electrical and electronic engineering installations covering all building types: residential, apartments, commercial, office buildings and warehouses etc. Several international and regional documents, codes and regulations have been used as references in developing this Building Code.

The EE and Sustainability Section of Building Code is aimed at enhancing the design and construction of buildings through the use of concepts having positive environmental impact; sustainable construction practices involving energy efficient bricks; encouraging efficiency and conservation of energy, water and building materials; and promoting resource efficiency. It proposes both mandatory and voluntary measures for "green buildings". In future, SREDA in consultation with the relevant organizations will identify the possible areas of incentives and provide certification for green buildings.

(e) CFL Distribution Program

Government has already launched CFL distribution program all over the country with the support of World Bank. A total of 18 million CFL will be distributed free of cost to the consumers in two phases. 10.5 million CFL have been distributed in 2011 and the rest of 7.5 million CFL will be distributed within December 2013. Nearly, 400 MW power is expected to be saved through this program. In the meantime, LED is considered to be more energy efficient and already in the market. Power Division/SREDA will consider undertaking similar program to promote LED in the country. Awareness raising program will be continued for the use of energy saving bulbs (i.e.CFL, LED etc.).

(f) Street Light Program

The government is considering the replacement of street lights by LED. Already a few streets in Dhaka have been converted to solar street lights for show-casing the effect through public-private partnership. Conventional street lights will be replaced subsequently by LED or solar lamps in phases. The government also has a plan to discontinue the production of incandescent bulb in near future to support the above program.

(g) LED Security Lighting in Urban Areas

To reduce the large peak demand for lighting in the night time, LED security lighting will be introduced in urban areas. Power utilities will conduct public awareness program to install solar/LED security lighting system in industrial, commercial and large housing areas preferably powered by solar system.

(h) Commercial and Industrial FL Re-lamping Program

Replacement of magnetic ballast set of T8 4-ft fluorescent light (FL) with latest generation electronic ballast energy saving type TS 18mm 4-ft FL set can save an average of 11 W per lamp and also give relatively more light output. Replacement of magnetic ballast with latest generation electronic ballast can also save an average of 7 W per lamp. The replacement program is already going on in large industries and domestic complexes. Commercial and industrial FL Re-lamping program will be more effective by using good quality of EBs & TS lamps.

Energy Efficiency and Energy Conservation in Key Program Areas

EE in the Industrial Sector Power and industrial sectors are the main consumers of primary energy. Due to inefficient and old boilers, furnaces and motors used in the industries, a huge amount of energy is being wasted.

As per provisions of SREDA Act, government should notify the sectors as Designated Consumers in order to bring them under EE compliance. For that to happen, firstly there is a need to conduct a bench mark survey in the industries to identify and prioritize the sub-sectors considering the amount of use of energy by them and its wastage. Based on the survey report,the government can go for the following actions:

- ✓ Policy decision on how to obligate the sector to reduce their energy consumption.
- ✓ Creating enabling situations for their capacity building as may be necessary with the support of SREDA.

(a) Energy Audit Program

As per provision of SREDA Act it is mandatory for all the designated energy consumers to get energy audit conducted by Accredited Energy Auditors and to designate or appoint an Energy Manager.

The SREDA Act has mandated the Authority to look after the Energy Auditing activities. SREDA will carry out the Certification of Energy Managers & Energy Auditors in order to create a cadre of professionally qualified energy managers with expertise in energy management, project management, financing and implementation of energy efficiency projects and policy analysis. To conduct these activities the necessary regulations and documents will be prepared.

(b) Improved Cook Stove Program

Cooking is the other area where a large amount of primary energy is required. Basically, fire woods are the most widely used form of biomass for cooking around the country, particularly in rural areas which bears the larger segment of population. About 82.6o/o of the people are using firewood and agricultural residuals for cooking purpose. An amount of 8 million cft of wood are used annually of which, 63% is for cooking and 37% is for industrial and commercial purposes. This is leading to rapid deforestation in the country and reducing natural forests which are carbon sinks and thus acts against global warming. Improved cook stove (ICS) is the suitable alternative for increasing fuel efficiency in rural cooking system, which brings the following benefits:

- ✓ The introduction of Improved Cook Stove (ICS) can save nearly 50o/o of energy and keep the kitchen smoke free.
- ✓ Bring major health benefits as the design draws off smoke and toxic gases, reducing the high prevalence of asthma of mother and child in the country from indoor air pollution.

- ✓ Each ICS can save 1.7 tons of C02 per year thus making a net contribution to global emissions reduction for reducing the effects of climate change.

SEO project of GIZ has developed a business model to make the ICS program in a sustainable manner. Up to now 0.4 million of ICS has already been distributed through their partner organizations under this project. It is targeted 100°Ai coverage of ICS within 2030. Awareness generation will be required to popularize this stove and an integrated and coordinated effort will be needed to reach the target. A separate action plan will be developed to disseminate this program in larger scale to cover 30 million households by 2030.

(c) Rice Husk Parboiling Program

In Bangladesh about 90% of all harvested rice is parboiled and most of them in conventional boilers. There are nearly 50,000 rice husking mills around the country which produce about 28 million tons of rice a year. The husking mills are usually operated by traditional technology using rice husk as fuel. This system is not safe and energy efficient and produce smokes that pollute the environment and create health hazard."

Improved Rice Husk Parboiling System (IRPS) developed by the Sustainable Energy for Development (SEO) project of GIZ has demonstrated a saving of up to 50% energy used for parboiling. These systems are smoke free and reduce the threat of possible boiler explosions.

SEO project is providing technology and sensitizing the mill owners to popularize this technology. Besides, commercial banks are being mobilized to provide credit support to replace these boilers. As of now 40 IRPS husking mills have replaced the traditional system.

The SEO initiative may save up to 2-4 million tons of rice husk, which can be used to generate electricity (>100 MW). To replace the total traditional system in the country, a massive program needs to be initiated by involving Bangladesh Bank and other commercial banks. A steering committee will be formed to coordinate the program and annual target will be fixed to replace all boilers within 2021.

(d) Improved Brick Kiln Program

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In the last 15 years, Bangladesh has enjoyed consistent economic growth of five to six percent annually. Rapid urbanization in the country has created a booming construction industry and spurred the production of 8.6 billion bricks each year, with demand for the bricks rising at an annual rate of about 5.28 percent.

Yet, the brick-making industry remains largely unregulated. About 4000 brick kilns are listed in Bangladesh (actual data would be much higher it is anticipated as more number of kilns are growing by the day) and most of them are energy inefficient and highly polluting to the environment. The industry emits around 6 million tonnes of C02 annually, making it one of the largest sources of greenhouse gas emissions in the country.

The United Nations Development Program (UNDP) and the Global Environment Facility (GEF) have introduced energy efficient, smokeless brick-making technology to curb greenhouse gas emissions in Bangladesh through a project titled "Improving Kiln Efficiency in the Brick Making Industry". For the energy efficient kilns, the new device known as the Hybrid Hoffman Kiln (HKK), originally developed in Germany, was used to replace the older, highly pollutant brick-making technology. It was later modified in China and remodelled to accommodate the specific needs of Bangladesh's brick- making industry. As a result, the new brick-making technology is now maximally efficient, eco-friendly and cost-effective.

Following successful demonstration of the energy efficiency kiln in Phase-I, 15 additional demonstration projects have been undertaken in Phase-II. The World Bank has adopted the UNDP model to undertake a program for replacing another 14 brick kilns. With the newly introduced smokeless technologies, the industry will operate under higher efficiency, better energy control capabilities, higher rates of production and processing, all of which could bring about reduced production cost, improved product quality, lower local pollution and reduced greenhouse gas emissions. Demonstrations show about 50% or so reduction in C02 emissions. It is targeted to replace all traditional brick kiln by the energy efficient brick kiln by 2021.

(e) Introduction of Solar Water Heater

Solar Water Heaters (SWHs) are replacing gas and electric heaters in urban areas to reduce energy consumption in many countries. This is now widespread in many developing cities and has become a standard practice in Nepal and most of India as well. The market for solar water heater and its manufacturers is well established in the region. Several companies in Bangladesh are also selling solar water heaters. Introduction of SWH to replace gas and electric heater will be introduced in the new Building Code Updates.

A pilot project has been implemented in the tanneries and significant improvement in energy use was noted, which created lot of interest in that sector for SWH.

Therefore, it needs further scaling up in other leather industries and expansion into other industries and service sectors with special focus on dyeing, textile, hospitals and hotels in Bangladesh.

All rest houses belonging to the government and semi-government organizations will be brought under solar water heating system. Government will take action to promote solar water heating technology in industrial, commercial and residential sectors as well through SREDA.

(f) Retrofitting Urea Fertilizer Plants for Improving Energy Use

Seven Ammonia-Urea complexes (six public and one international/private) have been built since 1961. The total installed capacities of these plants are 2.9 Million Tons of urea and 1.9 Million Tons of ammonia per year. Almost all the plants are more than twenty years old. The specific energy consumption (SEC- the natural gas in MCF consumed to produce a ton of urea) of those plants are more than double (46 MCF/Ton urea) that of state-of-the art urea plant (22 MCF/ Ton urea). Therefore, the best option is to replace the very old plants by new ones and retrofit the other plants where possible. Power Division/SREDA will take up the issue with the Ministry of Industry for rehabilitation and modernization of the urea fertilizer plants to make them energy efficient.

(g) Steel Mill Furnace Rehabilitation for Energy Efficiency

The steel re-rolling mills process steel ingots into iron rods and flat bars. The total annual production of all mills in Bangladesh is about 2.5 million tons. The process used in Bangladesh is fairly crude and energy inefficient. Out of 250 mills, 225 are not using modern technologies. The Specific Energy Consumption (SEC) of different mills are relatively high at about 75-90 cubic meters of gas per ton of steel compared to a modern mill of energy consumption with about 30 - 40 cubic meter of gas per ton of steel.

Titas Gas Transmission & Distribution Company along with other gas distribution companies will conduct the motivational campaign among the mill owners and the industry entrepreneurs to improve the efficiency of the industry's boilers and furnaces. The Titas employees will receive special training very soon to conduct the energy audit of the industry's boilers and furnaces.

(h) Energy Efficiency of Gas Burners

The traditional gas burner wastes huge amount of natural gas in the domestic sector. The majority of cook stoves are made locally and are not efficient. These are fitted with inefficient burners and low-quality regulators. They do not have any built-in ignition system. Lighting these stoves are cumbersome and also hazardous due to which many users keep the burners on and idle, rather than repeating the exercise of putting them off and on frequently. So, there is a need to standardize the gas burners and to make it compulsory in marketing this product.

a) Improved Natural Gas Stove: Introduction of improved natural gas stove has the potential to replace over 4 million stoves and save 4 billion cubic feet of natural gas per year. The Titas Gas Distribution Company will standardize the improved gas burner and subsequently the Energy Division will take necessary actions to gradually phase out all inefficient gas burners through all gas distribution companies by 2015.
b) Introduction of Gas Meters: The government charges for gas use goes by fixed monthly rates for domestic and industrial consumption rather than on the amount of gas consumed. This encourages the users to keep the burners on and burning the gas as they pay the same at the end of the month. This can only be stopped by installing gas meters. Some piloting in urban areas has provided good results. The efforts need to be expanded to cover the whole country as soon as possible.

(i) Utilization of Exhaust Heat/ steam

A large number of industries and power plants are producing heat and steam as by- products or waste. The waste heat of industries/power plants could be used as a source of energy for cogeneration in other industries such as for chilling, drying or any other suitable purposes. With this technology the optimal energy may be used by an industry while leading to diversification and expansion. The cogeneration technology, though common in the region, would require some demonstration in Bangladesh. Power Divisions will identify suitable industries and implement demo-projects by 2015 to popularize it. Besides, a study will be conducted in captive power generation to explore the possibilities of cogeneration in this sector and scale up the good practices that have made by some industries.

(j) Cogeneration of Energy from Sugar Cane Bagasse

Bangladesh, having about 15 cane sugar mills, annually produces around 8,750,000 million tons of bagasse which is sufficient to produce power with minimum investment. In the north-western region, which is starved for energy, the sugar cane bagasse will be a great energy resource for cogeneration. This is also an advantage as all the sugar-producing units were installed in the same region.

A feasibility study will be conducted to assess the cost effectiveness of setting up sugar bagasse-based power plants in this region.

(k) Energy Star Labelling Program

A legal instrument will be necessary to launch the Energy Star Labelling program. SREDA Act and EE&EC Rule will provide legal support to start this program. A regulation will be formulated for proper implementation of this program.

Awareness generation will be needed for the industries/importers/other stakeholders to embrace this program. Hence, number of seminars will be arranged involving different stakeholders.

BRESL project is assisting the BSTI to develop energy standards and levelling with improve mitigation technology for six common electrical appliances e.g., (i) air conditioners, (ii) refrigerators, (iii) electric fan, (iv) electric motors, (v) electronic ballasts for fluorescent tubes and (vi) CFL. This will help to promote energy efficient equipment to the end users at domestic and commercial sectors. In this regard, establishment of full-fledged testing laboratory in BSTI is also under process. SREDA will prepare a regulation on Energy Star Labelling program to bring it under legal coverage.

l) Energy Efficiency of Boilers

Most of the industries are running with inefficient boilers. Air-fuel ratio regulators are also not available in most of the industries such as power plants, fertilizer industries, paper industries etc., which causes wastage of huge quantity of fuel. Gas utilities will identify the industries running with inefficient boiler and will keep pressure to these industries to improve their boiler efficiency and to ensure the air-fuel ratio regulator.

Creating Incentives for EE & EC

Best results can be achieved by providing concrete incentives at all levels - individual, corporate, industrial - for energy saving. For example, in other countries, a certain percentage of an individual's household electric bill is reduced if he/she is able to reduce consumption of electricity to a certain extent than the previous bills. Similarly, industries are provided concessions in certain ways if they are able to reduce energy use by adopting newer technologies, equipment and appliances. SREDA is expected to come up with appropriate rules to this effect. But until SREDA comes into being, the Power Division may initiate some rules in this regard to test the ground.

Awareness Campaign Program

The following energy saving and energy conservation related issues are currently being used for general public awareness-

a) Not to use AC, electrical iron, water pump during peak hour.
b) To avoid unnecessary electrification in the shopping malls, commercial or residential places."
c) To motivate the people to finish their regular work by using daylight.
d) To use standard auto gas burners for cooking purposes for efficient use of gas.
e) To maintain the temperature of AC not below 25° C in the government and semi- government offices to set an example for the private and other sectors.
f) To motivate the people to use energy saving bulbs instead of incandescent bulbs.
g) To motivate the people to use energy efficient electrical appliances.

Different approaches and programs will be designed to generate awareness to mass people. In this regard TV spots, discussions, street campaigns, school campaigns, competitions with prizes, etc. will be taken into consideration. The strategies for such awareness campaigns will be needed to be formulated.

Inclusion of EE & EC in Primary, Secondary, Higher Secondary Schools and the Madrasah Curricula

It is recognized that awareness rising on EE & EC has to start from the roots of the nation for making it sustainable in the long run. To grow awareness on energy efficiency and conservation issues among the young generation, The School Text Book Board will review the curricula at primary, secondary and higher secondary levels and incorporate the necessary messages for EE & EC. As such, a committee will be formed by the government to review the existing curricula and incorporate the necessary topics in the text books at all levels for the students.

EE & EC School Program for "Switch off"

Energy saving has turned into a social demand around the globe in the face of acute energy scarcity globally and the concerns for protection and preserving the environment which is directly affect by energy consumption. Therefore, the awareness campaigns are focusing on changing the perceptions of consumers and their energy use habits in order to reduce their energy saving effectively.

The EE & EC School Program initiative will focus on children as they are the most conscientious individuals in society. Once they become dedicated advocates for EE & EC, they can motivate their families to change their energy use practices to minimize the use, conserve energy and use energy efficient appliances. Incorporation of EE & EC messages in the school curriculum at all levels (mentioned above) will be one approach. The other approach will be through launching of direct program to disseminate EE & EC information through the following:

Showing of video clips and documentaries on energy efficiency and conservation practices and their benefits.

- ✓ Organizing spot quiz.
- ✓ Introducing appropriate posters in schools.
- ✓ Organizing thematic art competition.
- ✓ Motivational talks by experts or professionals

The government will pass orders to the primary, secondary schools and madrasas all over the country to this effect. The students will be encouraged to take an active part in School Energy Saving Program avowing to switch off the electric bulbs /appliances when not of use, using more daylight for work and conserving gas and other energy resources. This program is expected to be initiated soon in the country and will be continued round the year.

Electricity Week Program

The government has been dedicating a week in the year as Electricity Week for mass awareness on EE & EC. This program has already been launched since 2010 as an energy saving campaign at the consumer and school levels. In this program, prizes are awarded to the champions who contributed to maximum electricity saving at their levels. Essay competitions on energy saving topics in the schools/madrasahs were conducted and the succeeded children were awarded nationally to encourage energy savings. This program is nationally observed from 7th December each year.

Sustainable Development Goals (2015-2030)

The Sustainable Development Goals (SDGs) or Global Goals are a collection of 17 interlinked goals designed to be a "blueprint to achieve a better and more sustainable future for all". The SDGs were set in 2015 by the United Nations General Assembly and are intended to be achieved by the year 2030. They are included in a UN resolution called the 2030 Agenda or what is colloquially know as Agenda 2030. Amongst 17 interlinked goals of SDGs, 4 goals (goal 7, 11, & 12) are more or less related to land use and energy.

Goal-7: Affordable and Clean Energy

Outcome Targets

7.1: ensuring universal access to affordable, reliable and modern energy services;

7.2: increasing substantially the share of renewable energy in the global energy mix; and

7.3: ensuring to make double the global rate of improvement in energy efficiency.

Means of Implementation Targets

7.a by 2030 enhance international cooperation to facilitate access to clean energy research and technologies, including renewable energy, energy efficiency, and advanced and cleaner fossil fuel technologies, and promote investment in energy infrastructure and clean energy technologies

7.b by 2030 expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, particularly LDCs and SIDS

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable

Outcome Targets

11.1 by 2030, ensure access for all to adequate, safe and affordable housing and basic services, and upgrade slums;

11.2 by 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons;

11.3 by 2030 enhance inclusive and sustainable urbanization and capacities for participatory, integrated and sustainable human settlement planning and management in all countries;

11.4 strengthen efforts to protect and safeguard the world's cultural and natural heritage;

11.5 by 2030 significantly reduce the number of deaths and the number of affected people and decrease by y% the economic losses relative to GDP caused by disasters, including water-related disasters, with the focus on protecting the poor and people in vulnerable situations;

11.6 by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality, municipal and other waste management; and

11.7 by 2030, provide universal access to safe, inclusive and accessible, green and public spaces, particularly for women and children, older persons and persons with disabilities.

Means of Implementation Targets

11.a support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning;

11.b by 2020, increase by x% the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, develop and implement in line with the forthcoming Hyogo Framework holistic disaster risk management at all levels; and

11.c support least developed countries, including through financial and technical assistance, for sustainable and resilient buildings utilizing local materials.

Goal-12: Ensure sustainable consumption and production patterns

Outcome Targets

12.1 implement the 10-Year Framework of Programmes on sustainable consumption and production (10YFP), all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries;

12.2 by 2030 achieve sustainable management and efficient use of natural resources;

12.3 by 2030 halve per capita global food waste at the retail and consumer level, and reduce food losses along production and supply chains including post-harvest losses;

12.4 by 2020 achieve environmentally sound management of chemicals and all wastes throughout their life cycle in accordance with agreed international frameworks and significantly reduce their release to air, water and soil to minimize their adverse impacts on human health and the environment;

12.5 by 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse;

12.6 encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle;

12.7 promote public procurement practices that are sustainable in accordance with national policies and priorities; and

12.8 by 2030 ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.

Means of Implementation Targets

12.a support developing countries to strengthen their scientific and technological capacities to move towards more sustainable patterns of consumption and production;

12.b develop and implement tools to monitor sustainable development impacts for sustainable tourism which creates jobs, promotes local culture and products; and

12.c rationalize inefficient fossil fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities.

Energy Efficiency and Conservation Master Plan up to 2030

Overview & Scope

Energy Efficiency & Conservation Master Plan (EE&CMP) is considered as the key documents representing all relevant legal, institutional, operational action plans for EE&C and their implementation. The Master Plan currently focusing on the industrial, residential and commercial sector to be energy efficient. However, EE&CMP is planning to focus on the transportation, energy tariff and utilities sector in the upcoming amendment. Figure 7.1 presents major components of EE&C master plan.

Source: SREDA, 2016

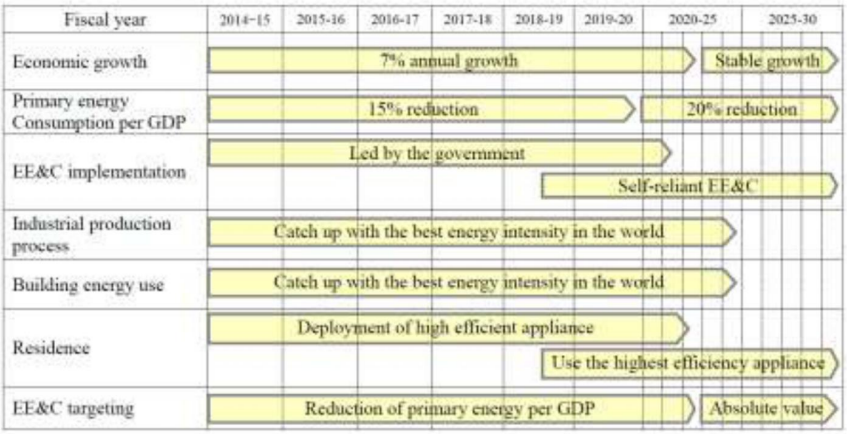
Figure 7.1: Planning and Implementation Components in EE&CMP

Target for 2030

Before setting EE&C targets or actions, we have to have the baseline data on sector wise energy potential (possible amount of energy reduction) and current EE&C. EE&C potential or the possible amount of energy reduction can be achieved through replacing highest energy efficient products/equipment in all the desired sectors. Understanding EE&C potential is essential for identifying how much energy we have been wasting and how realistic and appropriate is the EE&C targets. 'Primary energy consumption per Gross Domestic Product (GDP)' is set as the evaluation indicator in EE&CMP for analysing and identifying the progress of EE&C. The baseline data on present energy consumption was calculation based on the primary energy consumption excluding transportation and biomass and GDP in 2013-14. Results of baseline data shows that the primary energy consumption per GDP is about 2.37 ktoe/billion BDT.

EE&CMP, EE&C target and roadmap are set as Table 7.7. The targets for 2021 and 2030 are set with due consideration of the EE&C potential and current energy consumption status: low electrification ratio, industries' consumption, insufficient environmental protection measures, improvement in work conditions and modernization of life styles, etc. The final goal of EE&C policies is to realize a self-reliant cycle in which people proactively and voluntarily save energy, rather than through compulsory EE&C activities. It is aimed to accomplish the target for realizing the self-reliant EE&C society by 2030.

Table 7.7: EE&C Implementation Roadmap (2015-30)



EE&C Programs, Targets and Methodology

Major EE&C programs and associated targets and their methodology are summarized in Table 7.8. Energy Management Program is mainly focused on the promotion of energy efficiency in the industrial sector, EE Labeling Program in residential sector and EE Building Program in buildings. Other EE&C programs (such as those of finance and data collections) concern all industrial, residential and commercial sectors.

Table 7.8: Summary of EE&C Programs in Action Plan

Program	Target	Methodology
Energy Management Program (EMP)	Large Industrial Energy Consumers	▪ Large energy consumer designation ▪ Energy Manager, Certified Energy Auditor and Accredited Energy Auditor certification with qualification and examination system ▪ Energy audit (mandatory/voluntary) ▪ Energy consumption reporting (mandatory) ▪ Benchmarking

Table 7.8 Summary of EE&C Programs in Action Plan…

Program	Target	Methodology
EE Labeling Program (EELP)	Residential Consumers	▪ Label certification / Laboratory accreditation system ▪ Standardization of EE measurement method and Star Label Rating criteria ▪ Star Label Standardization (Unification) ▪ Participation of manufactures, porters and retail shops (mandatory/voluntary) ▪ MEPS (Minimum Energy Performance Standard) ▪ Effective means to be developed to stop entry of bellow standard and energy inefficient products/items in the market.
EE Building Program (EEBP)	Buildings	▪ New version of BNBC [Revised] Implementation ▪ GBG development ▪ Manual and Rating system introduction ▪ Incentive mechanism to be developed for following GBG and its implementation ▪ Certification of GB
EE&C Finance Incentive Program	Private Companies	▪ Low-interest loan for EE&C investment ▪ Preferential taxation on high efficiency equipment/appliances and/or EE&C investment ▪ Subsidy for EE&C investment ▪ Other incentive mechanisms
Government's Own Initiatives	Government	▪ Green Purchase Program for Eco-friendly public procurement ▪ Obtain ISO14001 and 50001 certification
Energy Consumption Data Collection	Government	▪ Energy consumption data by fuel ▪ Energy consumption data by sector and sub-sector ▪ Energy intensity data
Global Warming Countermeasure	All	▪ Formulation and quantification of national carbon market ▪ Carbon abatement project as capacity development ▪ Awareness raising

Approaches of EE&C programs to meet target

Although every member of the society is responsible for energy use, EE&C policies and programs may represent heavy burdens on some establishments and individuals. Following points are taken into account:

- EE&C policies should be applied first on large energy consumers and eventually include small and medium sized enterprises (SMEs).
- The policies should start in a limited scope (narrow range) and expand to wide range, as administrative capacity building fostered.
- E&C policies should start on voluntary basis and will be shifted to mandatory basis.
- EE&C policies should not be prioritized and enforced without providing basic regulations and measures for ensuring safety for life, health and environment. For example, the pollution control in the industrial sector has not yet been carried out at sufficient level, though environmental equipment (water pollution control equipment) consumes energy. Thus, before applying mandatory energy efficiency label on home appliances, regulation for assuring safety and minimum performance should be provided.
- Keyword is not “reduction of energy,” but “rational energy use.” People need more energy for better and convenient life but without misuse.
- Try all means to assure that correct EE&C goals will be set and achieved by all parties.

The Energy Efficiency and Conservation Rules 2016

There are two distinct rules in the energy efficiency and conservation rules 2016 that are relevant to the land use and energy.

Rule-7: Assistance in Construction of Energy Efficient Buildings
The Sustainable and Renewable Energy Development Authority (SREDA) will take necessary steps to encourage the construction of energy efficient buildings under provision of Rule 7.1. Furthermore, under the Rule 7.2, the authority will provide necessary assistance to the Ministry of Housing and Public Works and concerned stakeholders for the construction of energy efficient buildings.

Rule-11: Support for the activities of government, semi-government and autonomous organization

The authority may assist in the following matters for the establishment and procurement, construction and other functions of government, semi-government and autonomous institutions for the conservation, saving and adoption and implementation of renewable energy activities. Such as-

a) Purchase of energy efficient labelled products and other energy efficient products as per the provisions of Rule 6.

b) Design and implementation of energy sustainable buildings for construction of new buildings.

c) Undertake energy saving activities including low-cost energy saving in the existing buildings and infrastructures.

d) Invest in retrofitting low-cost energy efficient lifecycle technology in the existing buildings.

e) Undertake energy efficient measures in road lighting, water extraction, transport of people and goods in road, rail, water, and air ways.

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