Instructor Guide

Tariff Analysis

T A R I F F   A N A L Y S I S

Instructor Guide

GENERAL INFORMATION FOR THE INSTRUCTOR

Module Use and Content

The "Tariff Analysis" module may be used as an independent instructional unit, or in conjunction with the other modules in EDI's two-week seminar on "Water Supply and Sanitation."

The module includes the following presentation materials:

- o An Instructor Guide
- o A Participant Manual
- o A slide/tape program
- o Suggested supplementary materials

Time Required

The module requires approximately six hours to complete.

Participant Manual and Instructor Guide

The Participant Manual contains all the information and instructions required to complete the module activities.

The Instructor Guide is organized so that Instructor Notes appear on the left-hand pages, opposite the Participant Manual pages printed on the right. (The Participant Manual pages in the Instructor Guide are identical to those in the actual Participant Manual.) The Instructor Notes include activities, discussion guidelines and suggestions on presentation. The time requirements are approximate, but following the suggested times will ensure that the module does not require more than six hours to complete.

The Instructor Guide and Participant Manual both contain reference copies of the visuals and the narrative text from the slide/tape program.

Slide/Tape program

Most of the instructional content for this module is presented in the slide/tape program, "Tariff Analysis." The slide/tape program includes 160 35mm slides synchronized with the narration on the accompanying audiocassette. The module package includes two identical tapes, one of which is simply a back-up duplicate. The slides are inserted in a carousel tray that most projectors will accommodate. The narration on the audiocassette is pulsed with audible tones. These tones are cues that the slide projector should be advanced immediately to the next slide. The narration is recorded on Side 1 of the audiocassette; Side 2 is blank.

Equipment and Materials

Presentation of the module by an instructor to a group of participants requires the equipment and materials listed below:

For the instructor:

- o One copy of the Instructor Guide
- o A flipchart easel, pad and markers, or chalkboard and chalk
- o One copy of the slide/tape program (slides and one audiocassette)
- o One slide projector and white projection screen
- o One audiocassette player
- o One copy of the supplementary materials

For the participants:

- o A copy of the Participant Manual for each participant
- o Paper and pencils for each participant

Optional:

- o Copies of the supplementary materials for each participant

Instructor Preparation

The "Tariff Analysis" module is not a self-instructional program. It requires an instructor who is well versed in the various issues of the water supply and sanitation sector.

Instructor preparation involves a review of the Instructor Guide to become familiar with the topics, sequence of activities and the content of the presentations. It is also useful to preview the slide tape program in order to become familiar with the content and the synchronization of the slides with the audio-cassette. If possible, the program should be previewed on the equipment that will be used during the actual presentation.

Equipment and Facilities Preparation

Preparation of the audiocassette for play requires rewinding it completely to the beginning and ensuring that the cassette is loaded into the player with "Side 1" showing at the top.

Preparation of the carousel tray of slides for viewing requires four steps. First, it is important to ensure that all the slides are inserted into the tray in sequential order, with the printed numbers showing at the top right corner, along the outer edge of the carousel tray. Second, the black plastic lock ring must be turned in the direction of the arrow marked "Lock" until the ring is secured on the tray. Third, the tray is placed in operating position by lowering it onto the projector and turning it clockwise until the tray drops down securely. Fourth, the projector must be advanced so the first slide, the title slide, appears on the screen.

Operation of the slide projector and audiocassette player should be checked prior to the presentation. At that time, it is advisable to arrange for power cords required to operate the projector and cassette player, extension cords and extra projector bulbs. It is also useful to determine who should be contacted if assistance is needed from an engineer or audiovisual specialist.

It is important to check that each participant will be able to see and hear the slide/tape program easily. To view the slides clearly, overhead and back lighting should be kept to a minimum.

INSTRUCTOR NOTES

<u>Introduction</u> Time required: 15 minutes

1. Refer participants to the Introduction in their manuals. Review the purpose of the module and the topic outline with them.

2. Introduce Part I of the slide/tape program and inform participants that it is the first of two parts. Explain that Part I includes an overview of the module and a discussion of economic efficiency as one of the aspects of Tariff Analysis. Part I of the slide/tape program is approximately 30 minutes in length.

3. Explain that participants will not need to take extensive notes during the slide/tape program because copies of the visuals and narrative text from the slide/tape program are provided in their manuals.

4. Turn on the equipment and make sure the title slide is projected when the music at the start of the program begins. When you hear the first tone, advance the slide projector immediately to the next slide. Continue advancing the slides at the sound of the tone until the narrator announces the end of Part I and you see a corresponding message projected on the screen.

INTRODUCTION

The "Tariff Analysis" module has been designed to acquaint the participant with the importance of setting reasonable prices -- tariffs -- for a country's scarce limited resources (land, labor, capital) so that they will be used wisely.

The topics covered in the module are listed here:

<u>Part I</u>

- o Overview of the module
- o Definition/description of tariffs
- o Aspects of Tariff Analysis
  - Economic Efficiency
  - Social Equity
  - Financial Autonomy
  - Administration
- o Implications of efficiency

<u>Part II</u>

- o Income Distribution (as it relates to Social Equity)
- o Advantage of financial autonomy for public utilities
- o Elements of administration of tariffs
  - Connection fees
  - Sewerage charges
  - Betterment taxes
  - Flat unmetered rates
  - Flat household rates
- o Types of administrative support
  - Meter readings
  - Billings
  - Collections

INSTRUCTOR NOTES

Discussion of Economic Efficiency　　　　Time required: 15 minutes

1. After participants have viewed the first part of the slide/tape program, ask them if they have any questions about the content.

2. Divide the class into groups of four to seven participants. Refer participants to the discussion questions in their manuals. Ask them to take ten minutes to record individual responses to each question and then to discuss them with the other members of their group. Instruct the group to select a representative who will summarize the group's discussion.

3. After ten minutes, stop the discussion. Ask the representative of each group to summarize the discussion. You or the group's representative can record the key points on the flipchart or board.

DISCUSSION OF ECONOMIC EFFICIENCY

These questions are provided to stimulate discussion of the content presented in the slide/tape program.

- When a water supply system is built and starts supplying a community, what types of economic costs are involved?

- The price that consumers will pay for water is relative to the benefits they perceive. Which group will have steeper demand and benefit curves -- low-income consumers or high-income consumers? Why? What implications does this have for the planner?

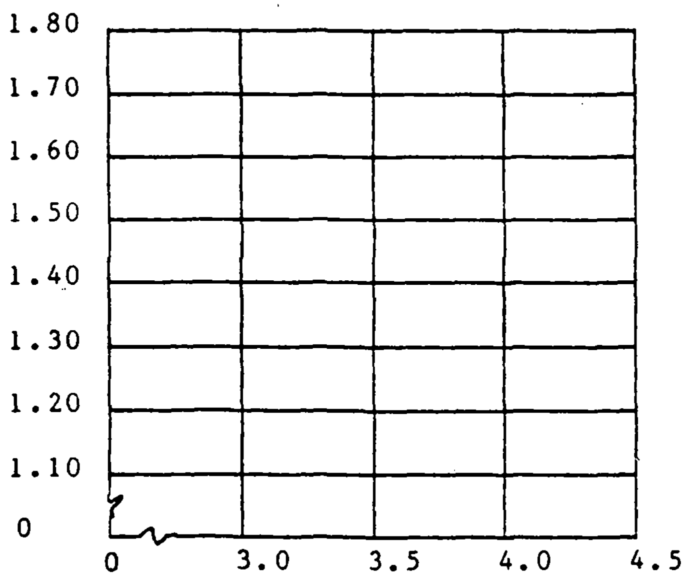
- Efficient consumption is one of the goals a tariff is designed to achieve. How does one determine the optimum production and consumption levels for a given groups?

<u>Price Elasticity of Demand</u> Time required: 30 minutes

1. Refer participants to the exercise on calculating the price elasticity of demand and instruct them to follow the directions and complete the exercise.

2. When participants have completed the exercise, review their results. Plot the points and construct the curve on your board or flipchart. (Answers are provided here for your convenience.)

q (m^3)	Δ q (m^3)	p $/$m^3$	Δ p $/$m^3$	$\frac{q_1+q_2}{2}$	$\frac{p_1+p_2}{2}$	$\frac{\Delta q}{\frac{q_1+q_2}{2}}$	$\frac{\Delta p}{\frac{p_1+p_2}{2}}$	Price Elasticity (7)÷(8)
1	2	3	4	5	6	7	8	9
4.19		1.10						
	0.19		-0.10	4.10	1.15	0.046	-0.087	-0.53
4.00		1.20						
	0.50		-0.27	3.75	1.34	0.133	-0.202	-0.66
3.50		1.47						
	0.50		-0.20	3.25	1.57	0.154	-0.127	-1.20
3.00		1.67						
	0.14		-0.05	2.93	1.70	0.048	-0.029	-1.62
2.86		1.72						



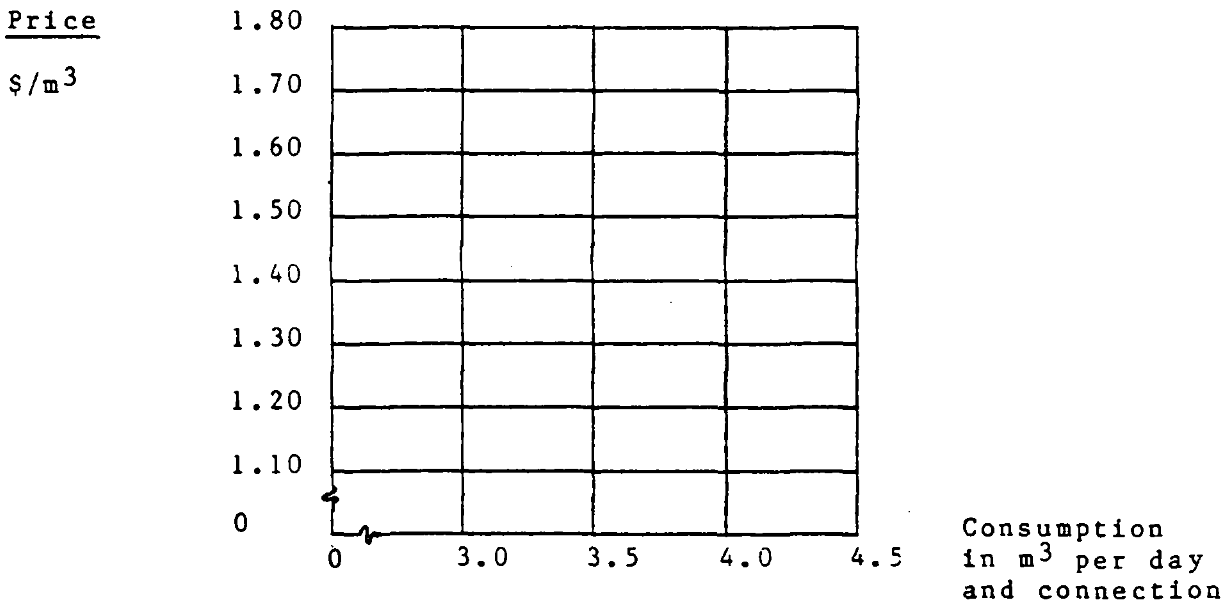
3. After reviewing the results of this exercise with participants, introduce Part II of the slide/tape program, which is approximately 30 minutes in length.

CALCULATION OF PRICE ELASTICITY OF DEMAND

For a given community, prices have been changed for water and the resulting consumption levels have been recorded in the table below.

Calculate the price elasticity of demand in the table and construct the demand curve in the diagram provided.

q (m^3)	Δ q (m^3)	p \$/m^3	Δ p \$/m^3	$\frac{q_1+q_2}{2}$	$\frac{p_1+p_2}{2}$	$\frac{\Delta q}{\frac{q_1+q_2}{2}}$	$\frac{\Delta p}{\frac{p_1+p_2}{2}}$	Price Elasticity (7)÷(8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
4.19		1.10						
4.00		1.20						
3.50		1.47						
3.00		1.67						
2.86		1.72						



INSTRUCTOR NOTES

Exercise: Calculation of AIC — Time required: 60 minutes

1. After participants have viewed the second half of the slide/tape program, ask them if they have any questions about the content.

2. Introduce the next activity by telling participants that they will now have an opportunity to apply the principles of tariff analysis to an actual case study.

3. Instruct participants to read the case study background information on pages P-4 to P-6 in their manuals. When they have completed that task, they should wait for further instructions.

EXERCISE: CALCULATION OF AIC

URUGUAY

OSE WATER SUPPLY AND SEWERAGE TARIFF STUDY

Background

1. Water supply and sewerage systems in Uruguay are (except for sewerage in Montevideo) managed by the Obras Sanitarias del Estado (OSE). There are about 240 different systems with about 420,000 water connections and 70,000 sewerage hook-ups. The portion of the population served with water house connections is estimated at about 90% in Montevideo and 50% in the remaining country. Sewerage coverage is about 20% where OSE has jurisdiction, and 60% in Montevideo under its Intendencia Municipal.

2. The earliest public water supplies were build around 1870 in Montevideo and were steadily expanded under a series of socially oriented governments. However, proportionately little was spent on the upkeep and replacement of installations. This trend accelerated during the last few decades resulting in deteriorating physical plants. Water unaccounted-for in the Montevideo system has climbed as high as 50%, making operations costly and inefficient.

3. The same gradual deterioration is true for the sector's human resources. On average, OSE's staff has become less qualified with fewer professionals and skilled technical staff. Those that have remained are for the major part older without the desirable rejuvenation of ideas. OSE risks falling behind in technical, administrative, and commercial development.

4. Aware of the risks, the OSE management is trying to pursue a more active investment policy. Since the country's macroeconomic authorities prefer water supply and sewerage works to be financed out of sector savings, OSE carried out a tariff study in 1980, hoping to generate larger surpluses while still considering social and economic objectives.

Exercise: Calculation of AIC (continued)

EXERCISE: CALCULATION OF AIC (Continued)

ANALYSIS OF OSE'S TARIFF POLICIES

5. To determine a tariff that is economically efficient for OSE, the marginal cost of the next major water supply expansion must be calulated. These costs will obviously vary for each of the 240 systems that OSE manages. OSE's policy however aims at a uniform tariff nationwide. Given the homogeneity of the country's topography and water resources, any economic distortions from a national tariff are acceptably low.

6. The most representative system expansion among the OSE system is the Paso Severino project for the Montevideo system. The works, costing about US$25 million in 1974 prices include the construction of additional reservoir capacity, increased transmission capacity, and additional service reservoirs and distribution mains. The production capacity of the Montevideo system is limited to 60 million m^3 per year. With the Paso Severino project, production will be able to increase beyond that level to satisfy growing demand. Construction of the main components will probably start in 1982 and end by 1986. OSE has estimated yearly amounts of water that the Paso Severino project will supply. These data are presented in Annex 1 to help calculate the discounted production, the discounted costs, and approximate marginal cost of producing water.

Exercise: Calculation of AIC (Continued)

EXERCISE CALCULATION OF AIC (Continued)

The Average Incremental Cost (AIC)

7. The average incremental cost (AIC) approximates the long run marginal cost. It is defined as the ratio between a numerator equal to the sum of discounted capital and current costs over a specified period, and a denominator which is the sum of the discounted annual outputs related to the capital and current costs in the numerator. The AIC should be calculated each time a major capacity addition is decided upon and the annual production volumes should refer to the incremental output for the capacity addition over its useful life. The arithmetical formula for the AIC is the following:

$$AIC = \frac{\sum_{t=1}^{T} \frac{(\text{Capital Cost} + \text{Current Costs})_t}{(1 + r)^t}}{\sum_{t=1}^{T} \frac{(\text{Annual Incremental Project Output})}{(1 + r)^t}}$$

8. Here T stands for the number of years that the capacity addition is expected to serve plus the construction period, and "r" for the appropriate discount rate, equal to the opportunity cost of capital.

9. The AIC signals the approximate medium-term costs. It serves as a guide for investment decisions and smoothes the marginal cost curve since it spreads capital costs over an extended period. It also takes into account differing levels of capacity utilization by discounting annual outputs. Whenever demand is slow to grow into available capacity, outputs during early years will be relatively small, and the larger outputs during later years will be more heavily discounted. The combined effect will be a small present-value sum of water. Since the water sum appears in the denominator, the resulting AIC will be high, reflecting a poor scale and timing of investments.

10. The application of AIC pricing does not preclude the need for periodical adjustments during the lifetime of the addition. AIC is calculated in constant money and would recuperate the investment costs if charged over the project lifetime in a non-inflationary economy. Since tariffs are in current money to account for inflationary changes in operating costs, the AIC tariff will have to be periodically adjusted.

INSTRUCTOR NOTES

Exercise: Calculation of AIC (Continued)

4. Refer participants to the table of data on page P-7 of their manuals, and review it.

5. Tell participants that where Forecast Output and Investment and Operating Costs are shown, they should use the data to calculate the Average Incremental Cost (AIC) for the Montevideo System in 1980 prices.

6. Point out to participants that there is additional work space provided for them on page P-8 in their manuals.

7. After participants have completed this exercise, review the results with them (as provided here for the instructor on page I-8). You may wish to write the answers on the chart or board so that everyone can see them.

8. Summarize the solution to the exercise, as follows:

   The Paso Severino AIC

   The AIC has been calculated for the Paso Severino project using discount rates in constant prices of 10%. Over an assumed 30-year period the costs average out as N$ 3.6 per m^3. In addition, some allowance will have to be made for additional treatment and distribution works, and the average incremental cost of water during the next 20 years or so in the Montevideo area can be estimated in the order of N$ 4 per m^3. This should then be the tariff charged for consumption exceeding a basic allowance.

URUGUAY

OSE WATER SUPPLY & SEWERAGE TARIFF STUDY
CALCULATION OF THE AVERAGE INCREMENTAL COST (AIC) FOR THE
MONTEVIDEO SYSTEM
(1980 prices)

Year	Forecast Production (million m^3)	Existing Capacity (million m^3)	Incremental Production	Discount Factor	Discounted Production 10%	Investment Costs N$ million	Incremental Operating Costs N$ million	Total Incremental Costs	Discount Costs (1 N$ milli
1980	47.2			1.00					
1981	50.3			.91					
1982	52.0			.83		60			
1983	54.0			.75		108			
1984	57.0			.68		99			
1985	60.0			.62		111			
1986	64.1			.56			4		
1987	65.4			.51			5		
1988	67.4			.47			7		
1989	70.0			.42			10		
1990	72.6			.39			12		
1991	75.2			.35			14		
1992	77.9			.32			17		
1993	80.6			.29			20		
1994	83.2			.26			22		
1995	85.9			.24			25		
1996	88.5			.22			27		
1977- 2015 (18 years)	91.2			1.60			30		

EXERCISE: CALCULATION OF AIC (Continued)

URUGUAY

OSE WATER SUPPLY & SEWERAGE TARIFF STUDY
CALCULATION OF THE AVERAGE INCREMENTAL COST (AIC) FOR THE
MONTEVIDEO SYSTEM
(1980 prices)

Year	Forecast Production (million m^3)	Existing Capacity (million m^3)	Incremental Production	Discount Factor	Discounted Production 10%	Investment Costs N$ million	Incremental Operating Costs N$ million	Total Incremental Costs	Discoun Costs N$ mil
1980	47.2	60.0		1.00		-		-	
1981	50.3	60.0		.91		-		-	
1982	52.0	60.0		.83		60		60	
1983	54.0	60.0		.75		108		108	
1984	57.0	60.0		.68		99		99	
1985	60.0	60.0		.62		111		111	
1986	64.1	60.0	4.1	.56	2		4	4	
1987	65.4	60.0	5.4	.51	3		5	5	
1988	67.4	60.0	7.4	.47	3		7	7	
1989	70.0	60.0	10.0	.42	4		10	10	
1990	72.6	60.0	12.6	.39	5		12	12	
1991	75.2	60.0	15.2	.35	5		14	14	
1992	77.9	60.0	17.9	.32	6		17	17	
1993	80.6	60.0	20.6	.29	6		20	20	
1994	83.2	60.0	23.2	.26	6		22	22	
1995	85.9	60.0	25.9	.24	6		25	25	
1996	88.5	60.0	28.5	.22	6		27	27	
1977-2015 (18 years)	91.2	60.0	31.2	1.60	50		30	30	
					Total 102				Total

$$\text{Average Incremental cost} = \frac{\text{Discounted Incremental Costs (N\$)}}{\text{Discounted Incremental Production}} = \frac{366}{102} \quad \$3.6 \text{ per } m^3$$

EXERCISE: CALCULATION OF AIC (Continued)

You may wish to use the space provided for your calculations in completing the table on the preceding page.

INSTRUCTOR NOTES

Exercise: Income Impact of Tariff — Time Required: 60 minutes

1. Refer participants to the case background provided on page P-9 of their manuals and instruct them to review it.

2. When they have completed that task, they should wait for further instructions.

EXERCISE: INCOME IMPACT OF TARIFF

As a result of the 1980 tariff study OSE proposed a new tariff schedule. The new tariff schedule has two main categories: domestic and non-domestic. In addition, consumers in the tourism sector would be charged at the domestic rate, but with a peak surcharge of 100% during the months of December, January, and February. The proposed tariff structure is shown below:

	Consumption/month/connection		
Category	0-10 m^3	10-50 m^3	50+m^3
Domestic			
Monthly fixed charge	N$ 20	N$ 30	N$ 190
Consumption charge/m^3	-	N$ 4	N$ 4
Non-domestic			
Monthly fixed charge	N$ 40	N$ 80	N$ 280
Consumption charge/m^3	N$ 4	N$ 4	N$ 4

Thus a domestic consumer would pay for example

consuming 5 m^3	N$ 20 per month
consuming 30 m^3	N$ 30 + N$ 80 = N$ 110 per month
consuming 70 m^3	N$ 190 + N$ 240 = N$ 430 per month

and a non-domestic consumer would pay for instance

consuming 5 m^3	N$ 40 + N$ 20 = N$ 60 per month
consuming 30 m^3	N$ 80 + N$ 120 = N$ 200 per month
consuming 70 m^3	N$ 280 + N$ 280 = N$ 560 per month

and during December-February a connection in the tourism zone would pay double the above domestic rates.

The tariff differentiates between domestic and non-domestic consumers to promote income redistribution.

The tariff attempts to satisfy efficiency requirements by charging N$ 4 per m^3 for all domestic consumption above 10 m^3 and for all non-domestic consumption.

Exercise: Income Impact of Tariff (Continued)

3. Refer participants next to the table of data on page P-10 of their manuals.

4. Instruct them to show what proportion of average monthly income will go to pay for water consumption, by calculating what the monthly charge of the proposed tariff will be for each income group.

5. When the participants have completed the exercise, review the answers, as provided here. You may wish to write them on the chart or board for everyone to see.

Monthly Charge with Proposed Tariff (N$)	Monthly Charge as a Percentage of Income
-	-
20	1.4%
20	1.0%
20	0.7%
42	1.1%
58	1.2%
78	1.3%
102	1.3%
300	3.0%
490	4.4%

6. Conduct a brief discussion with the full group of participants to summarize this exercise. Ask them to share their opinions on whether they think this tariff is fair.

EXERCISE: INCOME IMPACT OF TARIFF (Continued)

Income Distribution by Household Size
1980 N$

Average Monthly Income (N$) 1980	No. of Households, Thousands	Percentage of Population	Estimated Consumption m^3/month	Monthly Charge with Proposed Tariff (N$)	Monthly Charge as a Percentage of Income
1,100	18.0	5	unknown		
1,375	60.0	16	3		
1,925	60.0	16	7		
2,700	70.0	18	9		
3,850	60.0	16	13		
4,950	38.1	10	17		
6,050	22.5	6	22		
7,700	22.4	6	28		
9,900	12.7	3	28		
11,000	17.2	4	85		
TOTAL	380.9	100			

INSTRUCTOR NOTES

<u>Discussion of Fees</u> — Time required: 15 minutes

1. Refer participants to discussion topic in their manuals.
2. Instruct them to take five minutes to record their thoughts and to be prepared to share their views with the rest of the group.
3. Conduct a discussion, encouraging participants to relate their utility's policies for the rest of the group.

DISCUSSION OF FEES

These questions are provided to stimulate discussion of the content of this module.

In addition to the water supply tariff, there is a series of other fees and levies that have an important effect on water consumption and the utility's financial situation. Among these are:

-- connection fees
-- sewerage charges
-- betterment taxes
-- various flat rates

To your knowledge, does your water utility levy such charges? What is their relative importance?

INSTRUCTOR NOTES

Exercise: Calculating the OEI — Time required: 15 minutes

1. Refer participants to that exercise on Operating Effectiveness Index (OEI) in their manuals.

2. Instruct them to follow the directions to calculate the OEI and fill in the appropriate data in the table provided. They should then also calculate the efficiency in collections and the accounted water, as indicated.

3. When participants have completed the exercise, review the calculations as provided here for the instructor. You may wish to write the answers on the chart or board for everyone to see.

	Year 1	Year 2	Year 3	Year 4
Collection Efficiency,%	96%	89%	87%	84%
Accounted Water, %	62%	62%	59%	57%
Operating Effectiveness Index, %	60%	55%	51%	48%

4. Ask participants to give their opinion of the changes over the 4-year time period.

EXERCISE: CALCULATING THE OPERATING EFFECTIVENESS INDEX

For the financial health of a water utility, it is vital to bill and collect fees effectively and to meter both consumption and production accurately. The table below provides metered water quantities and billings and collections for a water supply company over a 4-year period.

- o Calculate the Operating Effectiveness Index (OEI). Analyze further the OEI by calculating its two components: the efficiency in collections and the accounted water.

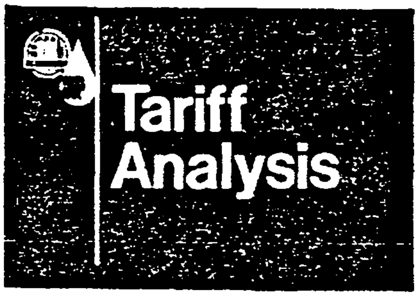
Billings, Collections, and Metered Water Quantities

	Year 1	Year 2	Year 3	Year 4
Billings, million $	250	280	300	310
Collections, million $	240	250	260	260
Collection Efficiency, %				
Water Production, million m^3	800	850	900	950
Water consumed, million m^3	500	530	530	540
Accounted Water, %				
Operating Effectiveness Index, %				

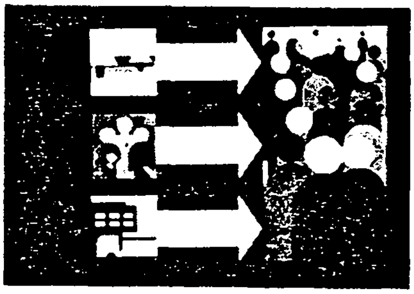
T A R I F F   A N A L Y S I S

SLIDE/TAPE PROGRAM VISUALS AND NARRATION

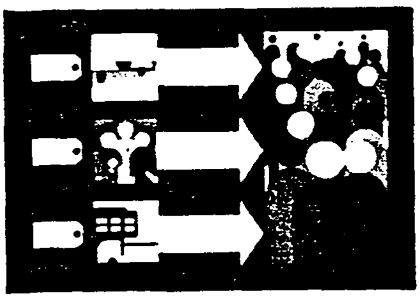
TARIFF ANALYSIS

1. 

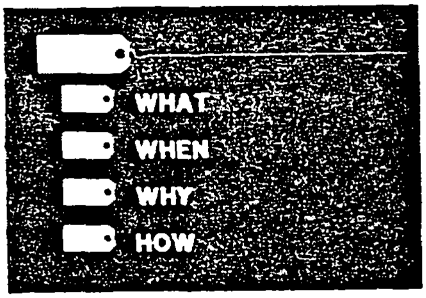
TITLE SLIDE:
Tariff Analysis

2. 

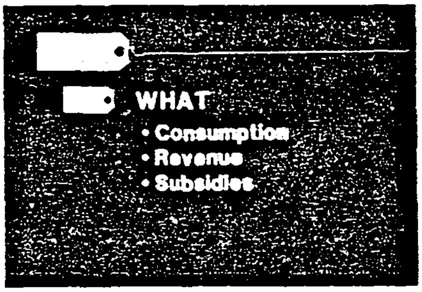
NARRATOR:
Every country faces a continual question of how to use scarce limited resources (that is, ... land, labor, and capital) to produce goods and services to satisfy as many human needs as possible.

3. 

Setting reasonable prices or tariffs on such resources may be the simplest way of ensuring that those resources will be used wisely--and that the highest priority uses are favored over those that are less essential.

4. 

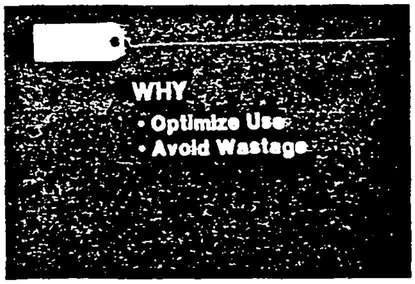
As a preface to our examination of tariff analysis, let's look briefly at what tariffs are, when they are charged, why they are necessary, and how they are set.

5. 

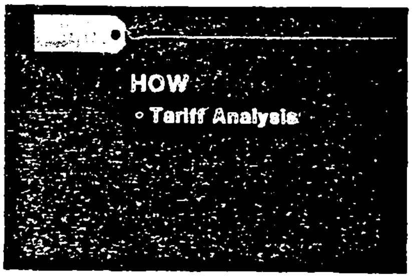
The tariff for an item is its price, the amount of money consumers must pay for a given resource. The price of a resource affects how much of it is consumed, how much revenue its producer (or supplier) will receive, and to what extent consumers may be subsidized.

6. 

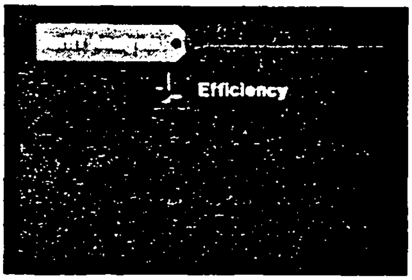
By tradition,the public utility sectors are more prone to levying tariffs than others. Among them are water supply and sanitation (which will be emphasized in this program), power, energy, and telecommunications.

7. 

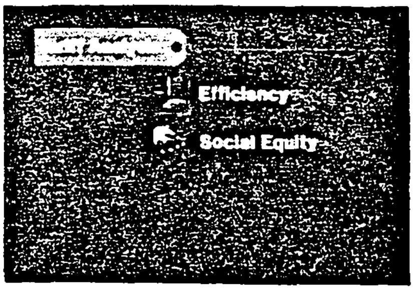
Tariffs are charged to optimize the use of scarce resources and to avoid wastage, in order to ensure that the resources are made available to as much of the country's population as possible.

8. 

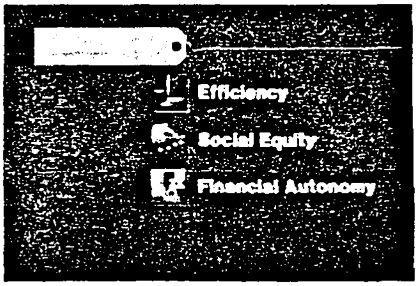
How these tariffs are set is the focus of this program. We will be concerned with four elements involved in tariff analysis.

9. 

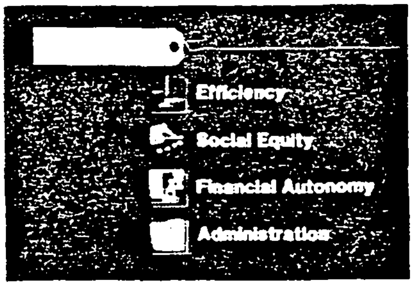
The first is efficiency--that is, calculating and charging a tariff that will ensure that consumers pay precisely what it costs to supply them with the water. By charging cost-based tariffs one is in effect letting the consumers make the decision of whether the benefits of water are worth more than the costs of supplying it. The cost/benefit analysis thus becomes the consumer's responsibility.

10. 

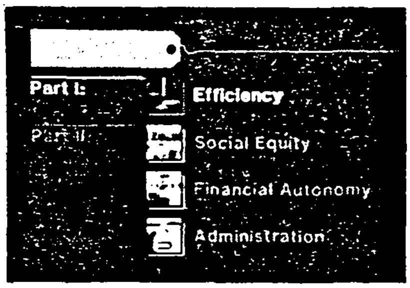
Our second area of concern will be the social equity effect that the tariff may have. Every tariff inevitably involves some redistribution of income from certain consumers to others. The tariff structure determines which consumers gain and which lose.

11. 

The third aspect of the tariff is the financial autonomy that results from the revenues generated. It is through the tariff revenue that a public utility can hope to become partially or fully financially autonomous... and in turn, the public utility can then reach institutional autonomy. It has the control over its own revenue and as a consequence over other decisions as well.

12. 

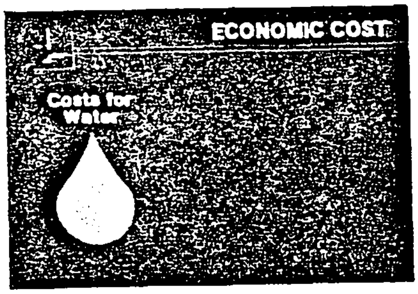
And finally, we will deal with the administration of tariffs. The interaction of consumption tariffs with connection fees and taxes will be discussed, along with what administrative capacity is required by the public utility to register consumption, bill for it and collect the revenue. This institutional capacity is often more important than the theory surrounding the setting of tariffs.

13. 

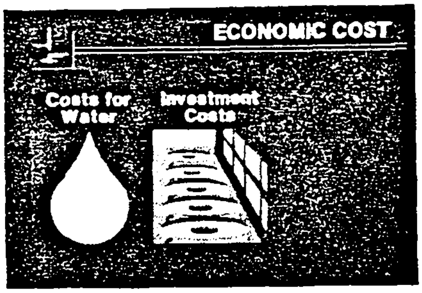
For now, in this part of the program, let's turn our attention again to the efficiency aspect of tariffs, keeping in mind that our goal is to determine the optimal allocation of resources.

14. 

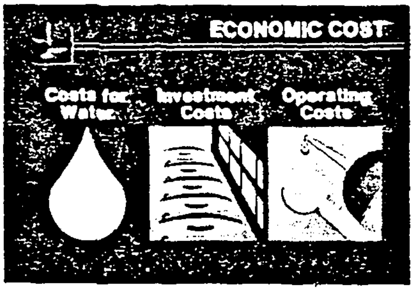
To arrive at a reasonable tariff, one first needs to understand what the costs are of supplying water to a population--that is, the economic cost of the water supplied. Economic costs are defined as the benefits foregone elsewhere in the economy by using scarce resources for a given purpose.

15. 

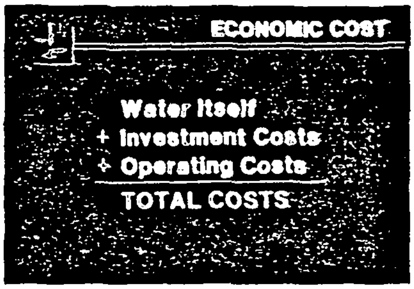
When a water supply system is built and starts supplying a community, there are several economic costs. First are the costs for the water itself. (These might include costs for purchasing rights to draw water. This is important because of the increasing scarcity of water.)

16. 

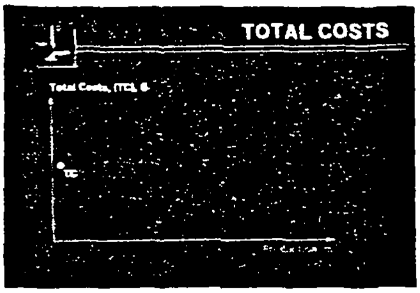
Secondly, there are the economic investment costs necessary to construct the production and distribution systems including the in-house installation. Various kinds of scarce resources such as land, labor and capital are used up to construct the water supply system.

17. 

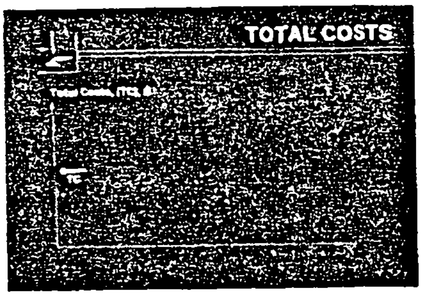
There are also operations and maintenance costs to make the system keep supplying good and safe water indefinitely. (The common items here are labor and energy costs.)

18. 

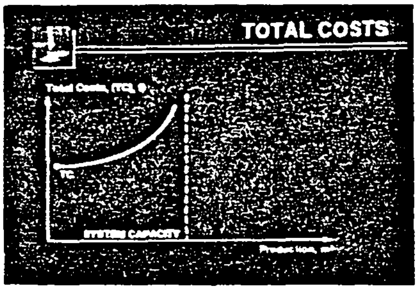
When those different costs are added, we can arrive at the total costs.

19. 

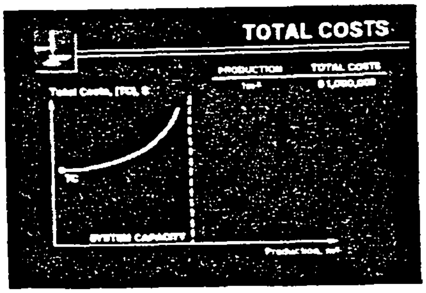
Total costs can be represented graphically. On the vertical axis we measure the total costs, while the horizontal axis measures the production in cubic meters. The first cubic meter produced requires very high costs in the form of the construction of the entire system.

20. 

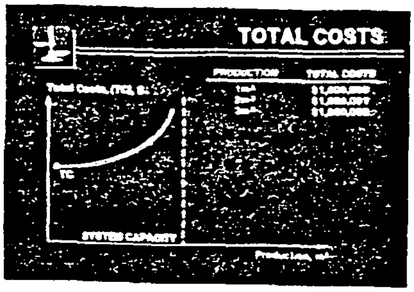
Thereafter the total costs increase only slowly with increasing output. The rate of growth is given by the operating costs per additional cubic meter supplied.

21. 

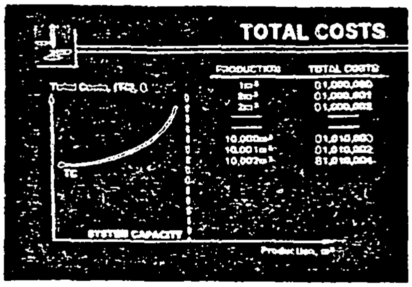
As the production level approaches the capacity of the system, costs will start rising faster. This is because breakdowns become more frequent, and operating costs increase, when facilities are utilized close to their full capacity.

22. 

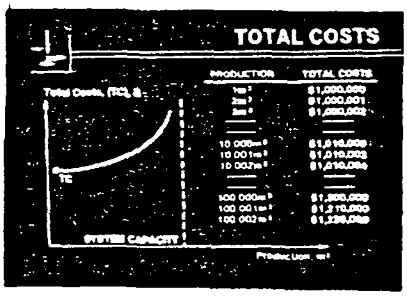
Total costs can also be presented in table form. In this example, we find that in order to produce the very first cubic meter, all the start up costs of $1,000,000 are necessary.

23. 

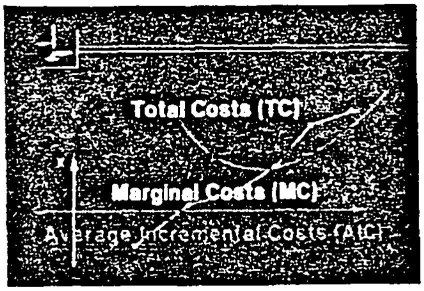
As production increases, total costs will increase only slightly at the rate of $1 per cubic meter ...

24. 

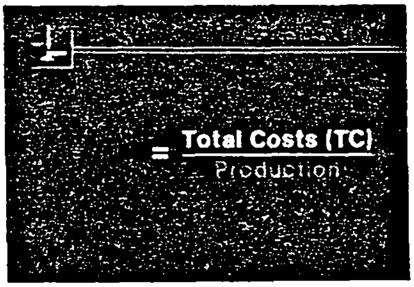
... and at higher production levels, the operating costs start increasing more rapidly at $2 per cubic meter.

25. 

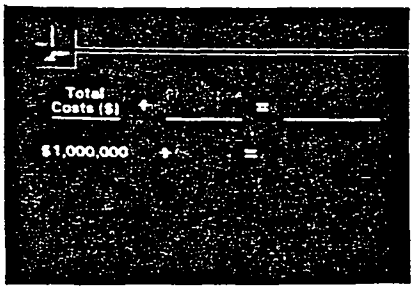
As production reaches and exceeds capacity, total costs will skyrocket in the face of system breakdowns.

26. 

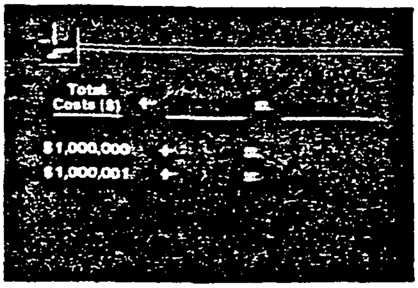
The concept of total costs is just one of the economic principles we'll examine here in reference to tariff analysis. An understanding of these basic principles is essential to the applications we'll be exploring later. Many of them can be illustrated with both tables and graphs commonly used by economists for a pictorial representation of the concept.

27. 

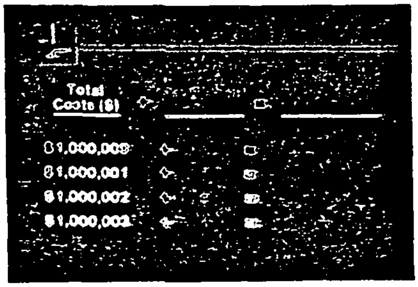
The next type of cost we'll look at is the average cost. Average cost is determined by dividing total costs by production, as in the example which follows.

28. 

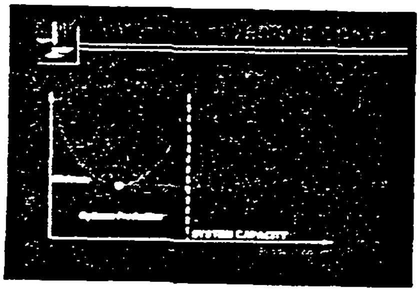
Total costs to produce the first cubic meter of water are $1,000,000 -- which, when divided by 1 -- yields average costs of $1,000,000 per cubic meter.

29. 

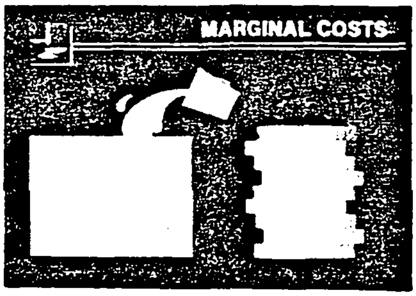
Total costs are $1,000,001 to produce 2 cubic meters -- which then yields average costs of $500,000 per cubic meter at that production level.

30. 

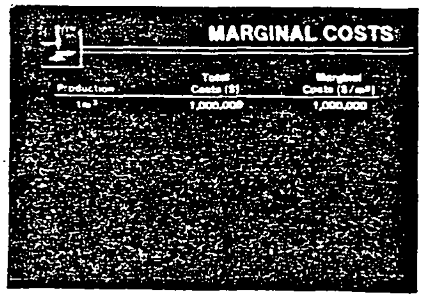
These average costs fall rapidly with increasing volume. Eventually average costs will rise when production surpasses the optimum level.

31. 

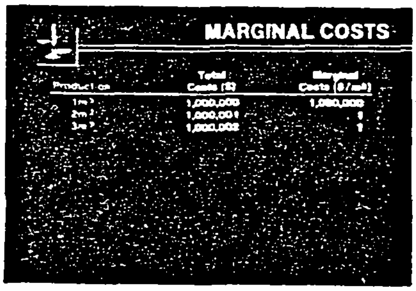
The average cost curve can be shown in graphic form. On the graph, the vertical axis measures the costs per cubic meter, and the horizontal axis measures the production level in cubic meters. You will notice that the average cost starts at a very high level and falls rapidly. Eventually it reaches a minimum corresponding to an optimum production level. Thereafter, it rises as production approaches the limits of the production capacity.

32. 

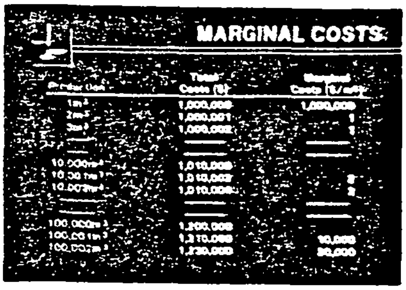
The last of the cost functions we'll address is marginal cost. The marginal cost is defined as the additional costs necessary to increase production by one cubic meter.

33. 

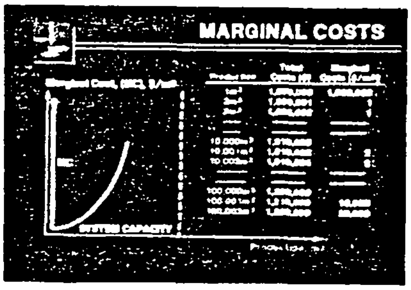
The marginal cost can be calculated from the total costs at each production level. The first additional cubic meter produced costs $1,000,000 which is then the marginal cost.

34. 

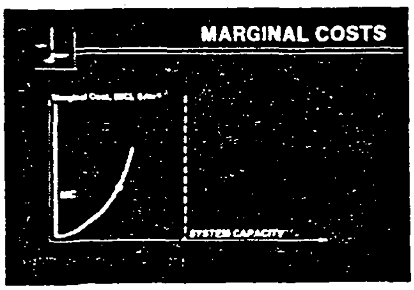
To increase production from 1 to 2 cubic meters, total costs will rise by $1, which is then equal to the marginal cost. Successively, additional cubic meters each cost $1.

35. 

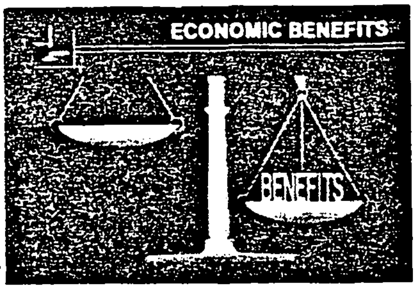
Eventually marginal costs start increasing as the production system approaches and finally exceeds design capacity. With still higher production levels, marginal costs will escalate rapidly. Eventually, squeezing more production out of existing capacity will lead to a system breakdown, and it will be cheaper to invest in an additional system.

36. 

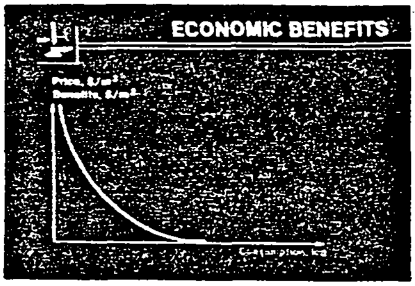
The marginal cost curve can also be depicted on a graph. Costs in $ per cubic meter are measured along the vertical axis. For each production level, the marginal cost is shown. It starts from a very high level, falls steeply, and then starts rising, as seen here.

37. 

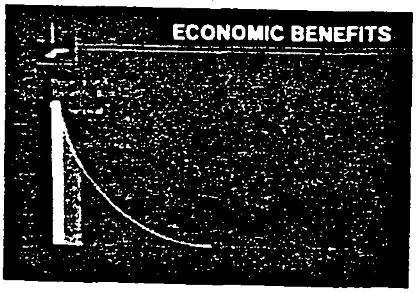
The inter-relationship between the average and marginal costs can be shown in the same diagram. Notice that the marginal cost curve intersects the average cost curve where average costs are a minimum.

38. 

With that background of costs behind us, let's look next at the benefits that water produces.

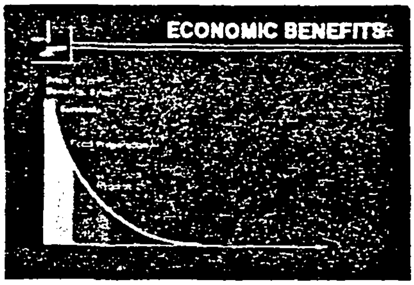
39. 

The benefits of water consumption can be depicted with a demand curve. Specifically, the demand curve shows that the price that consumers will pay is relative to the benefits they perceive.

40. 

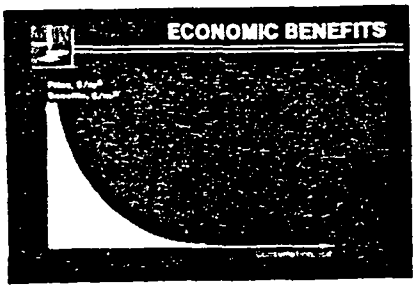
If the consumer is without any water, his need for it to survive will be acute. He will pay a very high price for this amount of water because his perception of the benefits of this water will be equally high. The consumer may want additional water for food preparation. This is an important, but less critical use; so the consumer will pay somewhat less for this amount of water.

41.



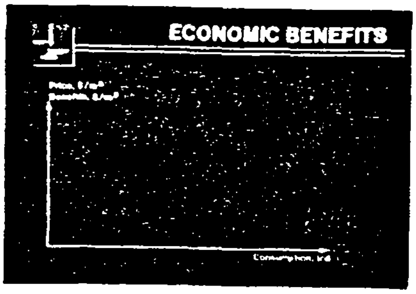
The consumer will pay even lower prices for additional water for hygiene and will pay the lowest price for noncritical uses of water, such as recreation. This demand curve, then, shows that the price that consumers are willing to pay is based on their perception of the value of the water.

42.

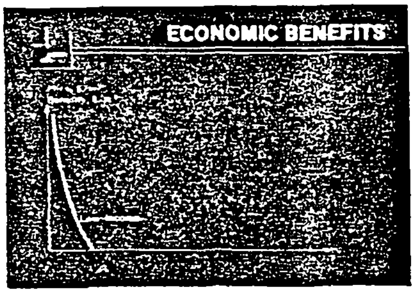


The area under the demand curve, therefore, represents the total economic benefits perceived by the consumer.

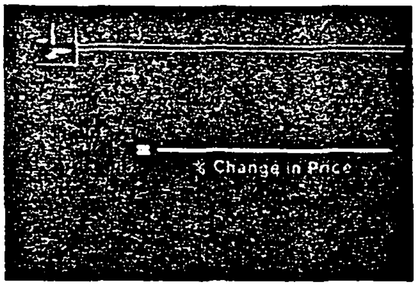
43.



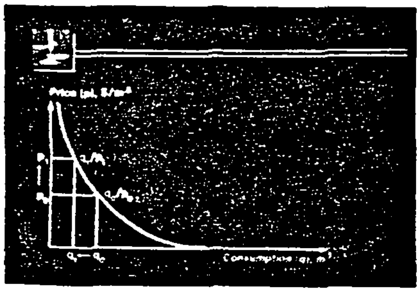
The benefit and demand curves will likely vary with different income groups. High-income consumers will probably have higher consumption levels. The benefits from additional water consumption will gradually level off and eventually reach zero. At that point, they will derive no further benefits from consuming additional water.

44. 

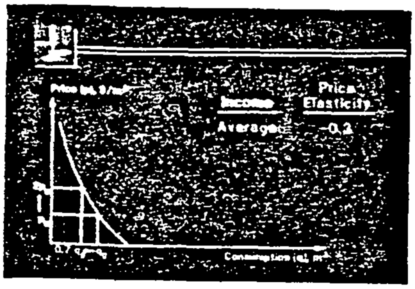
Low income consumers will likely have steeper demand and benefit curves than high-income consumers at identical consumption levels. The benefits reach zero sooner than for high income consumers. This is because low income consumers have fewer water uses since their material standard of living is lower.

45. 

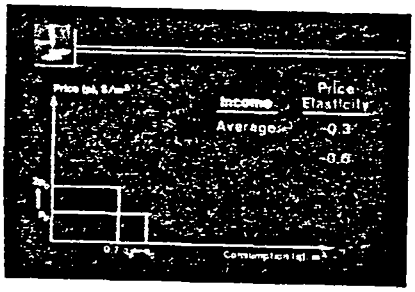
The shape of each consumer's demand curve is expressed through the price elasticity of demand. The elasticity is defined as the percentage change in consumption which follows from a percentage change in price.

46. 

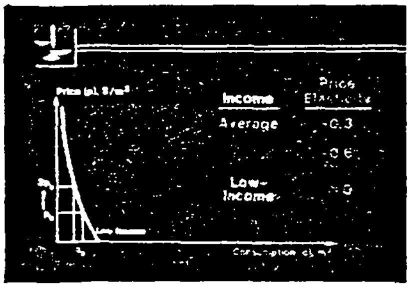
For the given demand curve, the consumer is actually consuming the quantity, q_0 m^3 at a price of p_0 \$ per cubic meter. After the price rises to p_1 he decreases his consumption to q_1. The elasticity is then negative, since consumption decreases as the price increases.

47. 

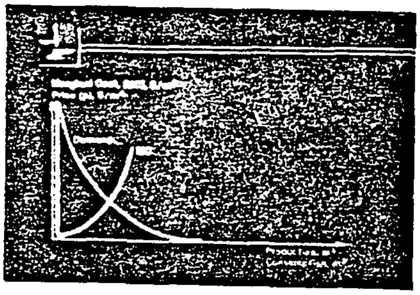
Many studies have calculated the price elasticity of demand on average to be in the order of - 0.3. This implies that for a tariff increase of 100%, per capita consumption would drop by about 30% in the short term.

48. 

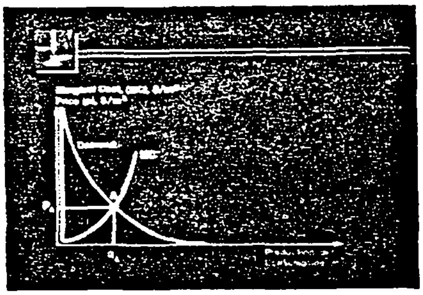
For high-income consumers, the same studies have shown elasticities that are as high as - 0.6. This is entirely consistent with a more gradual demand curve for higher-income consumers.

49. 

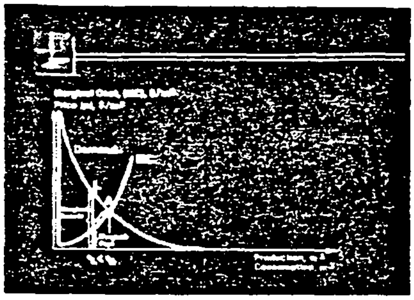
For low-income consumers, the studies have shown elasticities that are close to zero. This would indicate an almost vertical demand curve where consumers are consuming close to their absolute basic needs.

50. 

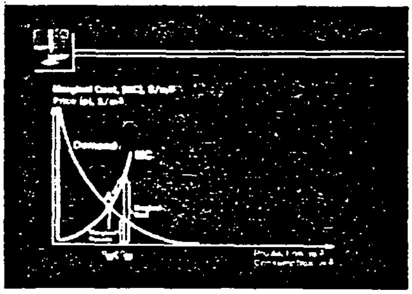
If we combine the marginal cost curve and the demand curve, we can determine the optimum point of production and consumption. This graph shows the two curves with the vertical axis measuring benefits and costs in $ per cubic meter, and the horizontal axis measuring cubic meters of consumption and production.

51. 

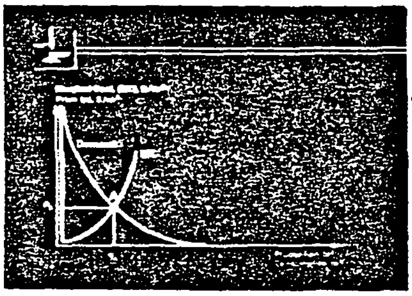
The marginal cost curve and the demand curve intersect at point A. There, the quantity produced and consumed would be q_A cubic meters and the price would be p_A $ per cubic meter. This is the optimum production and consumption level.

52. 

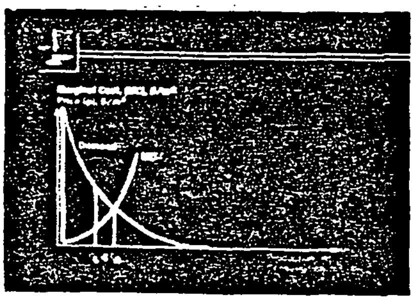
To understand why q_A is the optimum production and consump-sumption level, we can study what would happen if a lesser quantity, q_L were produced. It would be worthwhile to increase production from this level, however, since each additional cubic meter produced and consumed would have higher marginal benefits than marginal costs. It would pay to increase production and consumption to point q_A. Only here is the value of the last cubic meter consumed precisely equal to the marginal cost of producing it.

53. 

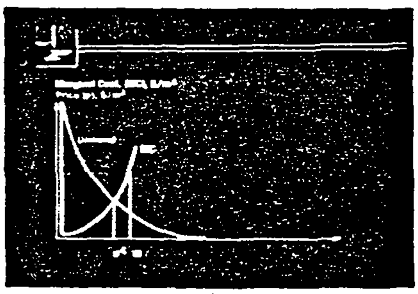
Similarly, if a quantity q_M, (more than q_A) cubic meters were produced and consumed, too much would be produced. The marginal costs of producing the last cubic meter would be higher than the marginal benefits. It would pay off to decrease production to the level q_A where the marginal benefits are exactly equal to the marginal costs.

54. 

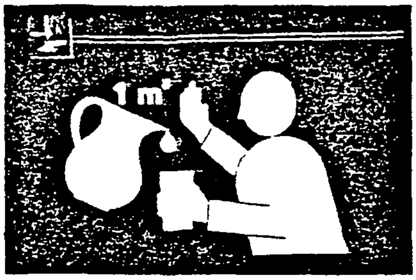
So the optimum level is q_A cubic meters produced and consumed. The price p_A would be the tariff and would be equal to the marginal cost at that particular production level.

55. 

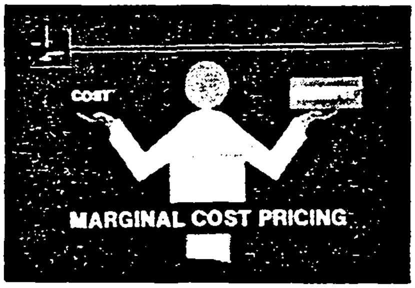
By producing q_L which is less than the optimum q_A, society would lose the benefits illustrated by the shaded area. By increasing production from q_L to q_A, society could gain greater benefits than could be realized by utilizing those same resources elsewhere in the economy.

56. 

Similarly, by producing q_M which is more than the optimum level q_A, society is losing benefits as indicated in the shaded area in the figure. By cutting back production from q_M to q_A, society could re-direct the saved resources to gain higher benefits elsewhere in the economy.

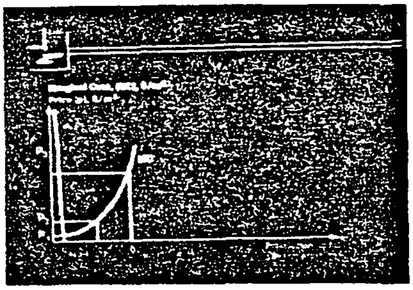
57. 

The principles of marginal cost pricing, then, indicate how to find the optimum production and consumption level. All we have to do is to charge a tariff equal to the marginal cost. If the additional water offered is consumed, then we increase production until the last cubic meter offered is not consumed. If the last cubic meter is not consumed, we know that we are producing slightly too much.

58. 

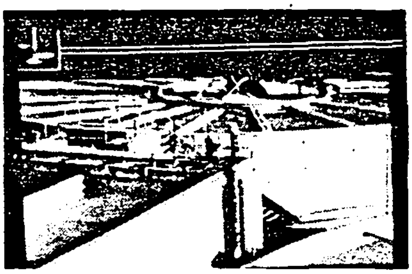
Marginal cost pricing, in effect, becomes a way of making consumers perform their own cost/benefit analysis. Whatever they do not consume at marginal cost prices is economically unjustified. As long as additional supply is offered and consumed, the investments are economically justified.

59.



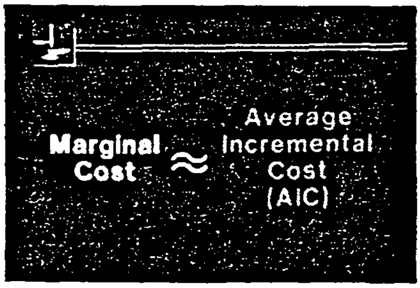
Although strict marginal cost pricing is optimum from the efficiency point of view, it is difficult to apply in practice. With different production levels, the price would need to be recalculated and changed constantly and it would become administratively impractical.

60.

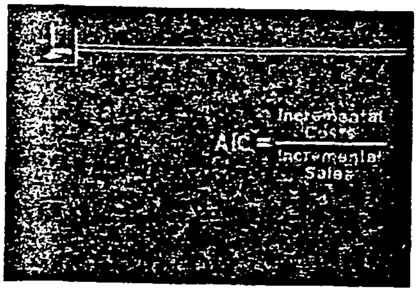


Another closely related difficulty with strict marginal costs is that investments are, for the most part, big and lumpy. Capacity is not increased by a few cubic meters each time but by many thousands of cubic meters. This creates a problem in determining the marginal cost that measures the additional cost for each incremental cubic meter.

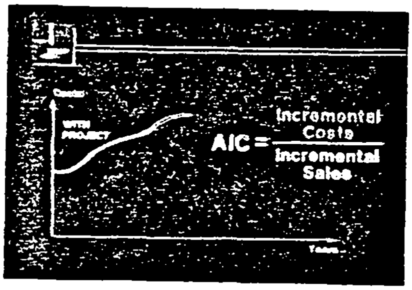
61.



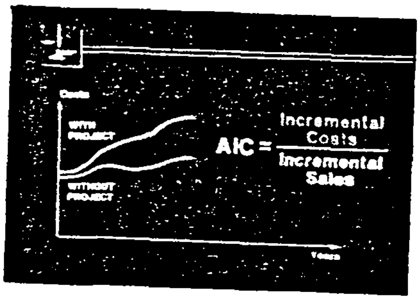
In order to overcome these difficulties, we will approximate the marginal cost with another tariff. It is called the average incremental cost of water (or AIC).

62. 

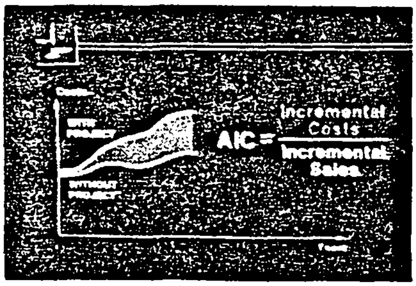
The average incremental cost is the tariff that results when incremental costs from a project are divided by the incremental water sales attributable to the same project. Its effect is to smooth out the sharp variations in the strict marginal cost.

63. 

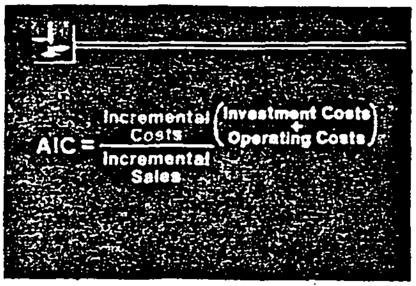
In order to calculate the incremental costs of the project, we first have to figure the costs over time with the project constructed ...

64. 

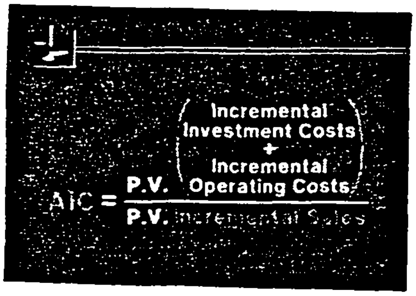
... and then compare them to the cost level that would exist without the project constructed.

65 

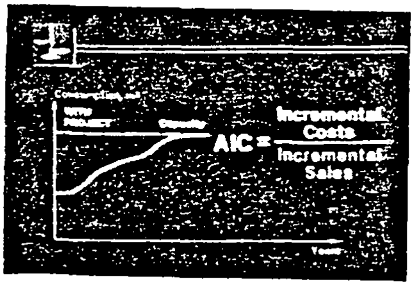
The difference between the two curves is the shaded area and amounts to the project's incremental costs.

66. 

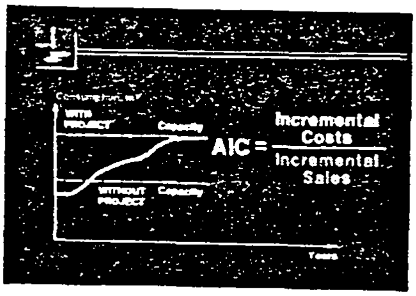
The incremental costs will be both the additional investment costs and the additional operating costs that are attributable to the project.

67. 

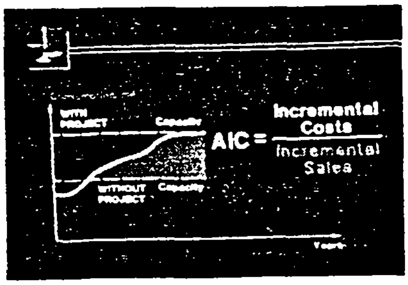
The project's incremental investment and operating costs will occur over a period of many years. In order to make costs in different years comparable they are all discounted and expressed as a present value sum of investment and operating costs.

68. 

The calculation of the project's incremental sales is analogous. We will first have to consider the water consumption that results with the project. Consumption increases steadily until it reaches the capacity with the project and becomes constant during the rest of the project lifetime.

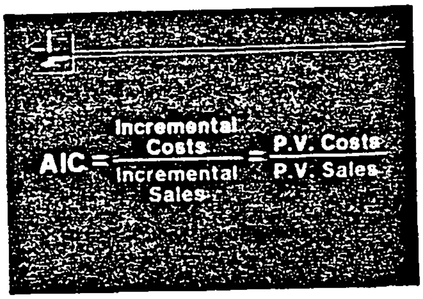
69. 

We will then show the consumption that is expected without the project. It would increase up to the constant level given by the capacity without the project and continue constant.

70. 

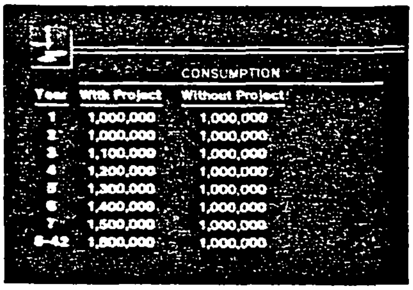
The difference between the consumption level with the project and the level without the project equals the project's incremental water sales, shown here as the shaded area.

71.



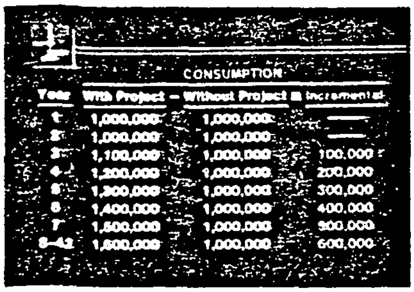
It is more valuable to receive the benefits of water consumption early after the completion of a project. This is because a resource received early can be put to productive use or satisfy a present need. The incremental water sales are therefore discounted just like costs, and their total is expressed as a present value sum of all incremental water sales.

72.



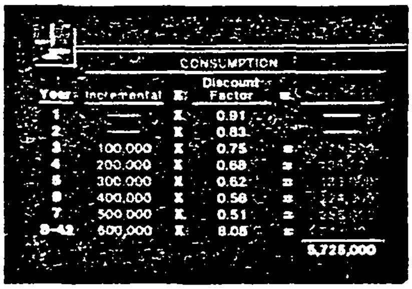
In order to apply this theory, let's consider, for example, a water supply system where the "without project" capacity is 1,000,000 cubic meters per year and which is fully utilized. A project is to be constructed which will add 600,000 cubic meters per year. The project will be ready by the end of year 2, after which it will be able to satisfy demand that grows steadily to a level of 1,600,000 cubic meters per year as shown in the table. Consumption with the project will then remain constant through year 42.

73.

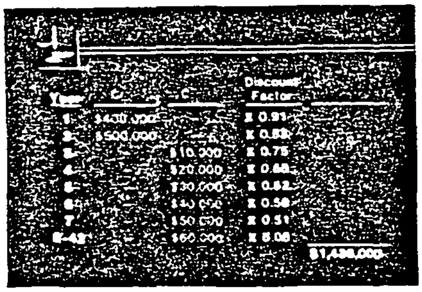


The incremental water consumed can then be calculated as the "with project" sales less the "without project" sales. Incremental consumption will increase from a level of 100,000 m^3 in year 3 to a level of 600,000 m^3 that will remain constant from year 8 through 42.

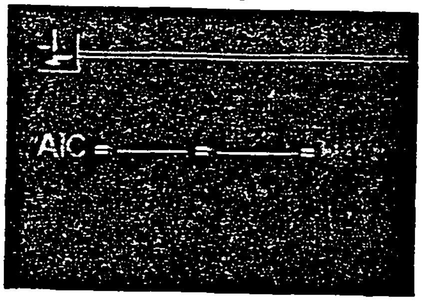
74.



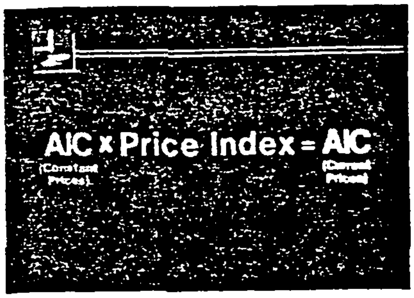
The incremental water sales can then be discounted by multiplying each year's incremental sales by the appropriate discount factor. The incremental water sales over the useful life of the facilities over forty years are approximately 5,700,000 cubic meters.

75. 

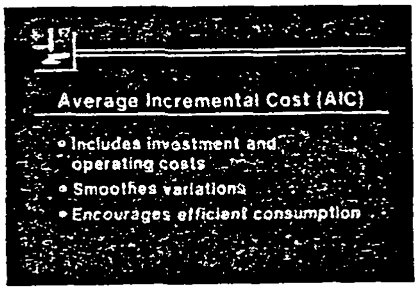
Assume that the project investment costs are $400,000 in year 1, and $600,000 in year 2, and that incremental unit operating costs are $0.1 per cubic meter. We can discount all these costs at 10% by multiplying by the appropriate discount factors. The total discounted investment and operating costs are then approximately $1,400,000.

76. 

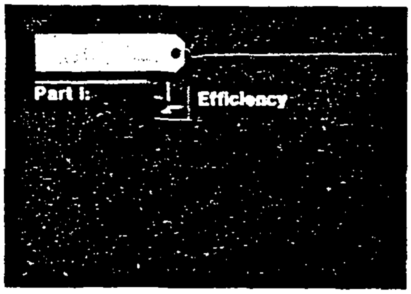
The average incremental cost is the sum of discounted investment and operating costs divided by the sum of discounted incremental water sales. With our example it is $1,400,000 divided by 5,700,000 cubic meters, or about $0.25 per cubic meter. This is the cost that approximates the marginal cost. If charged over the lifetime of the project it would recuperate the project investment and operating costs in real terms.

77. 

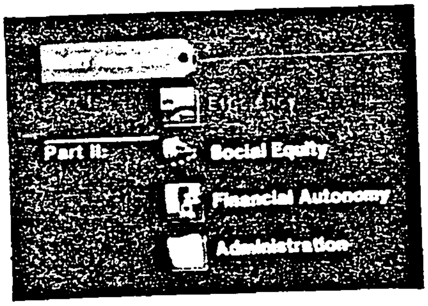
The calculation of the average incremental cost (AIC) is first done using constant prices. In order to keep up with inflation, the average incremental cost measured in constant prices needs to be adjusted with a price index to convert it into current prices.

78. 

The advantage of the average incremental cost is that it includes both investment and operating costs and smoothes the variations that the theoretical marginal cost would produce in the tariff. The AIC will signal the cost to the consumers and will encourage efficient consumption, (provided the consumption is metered).

79. 

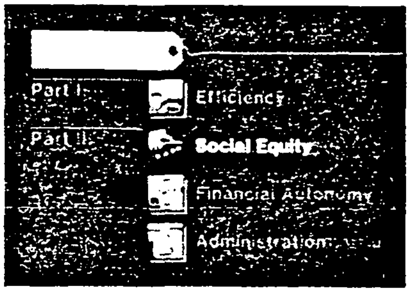
This efficient consumption is, after all, one of the goals the tariff is designed to achieve.

80. 

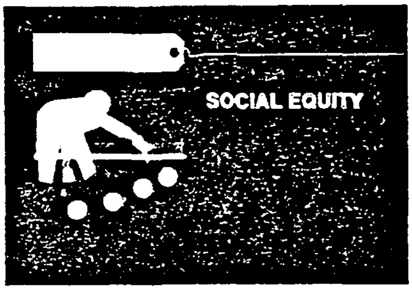
In Part II, we will address the other elements of tariff analysis--social equity, financial autonomy, and administration.

(END OF PART I)

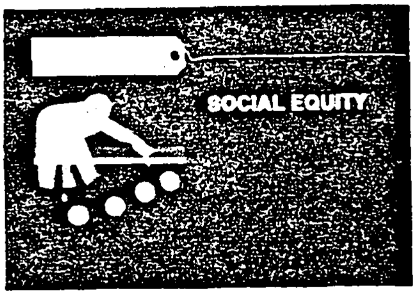
TARIFF ANALYSIS -- Part II

81. 

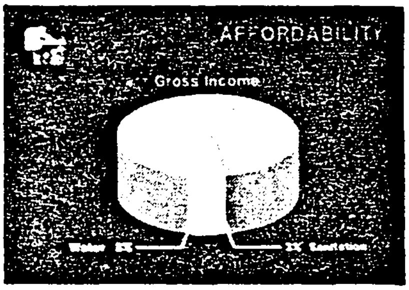
This part of the program will explore the other elements of Tariff Analysis. We'll turn our attention first to Social Equity.

82. 

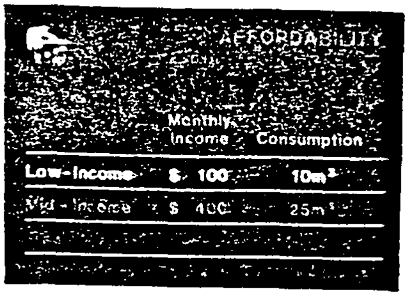
Tariffs should be set in light of income levels for two reasons: The first is affordability. If a uniform tariff is charged equally to everybody, the poorest segments would not be able to afford water. They would continue using unsanitary water sources which would result in a loss of society's health benefits.

83. 

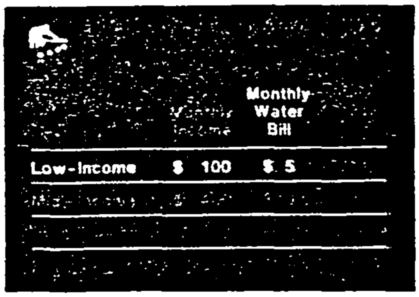
On grounds of social equity, it is also desirable to help those with very low incomes by subsidizing their water consumption.

84. 

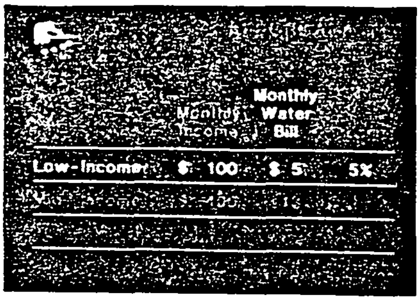
The rule of thumb for affordability is that consumers should never have to pay more than 3% of their gross family income for water supply. Likewise they should never have to pay more than 3% for their sanitation services. Each of those percentages corresponds to about one day's salary per month.

85. 

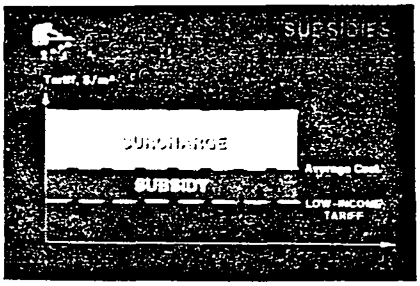
Now consider a typical income distribution in a developing country where the low-income households earn $100 per month, the mid-income households earn $400 per month and the high-income households earn $1,000 per month. Assume that each low-income household is consuming 10 cubic meters monthly, the mid-level households 25 cubic meters and the high-income households 50 cubic meters.

86. 

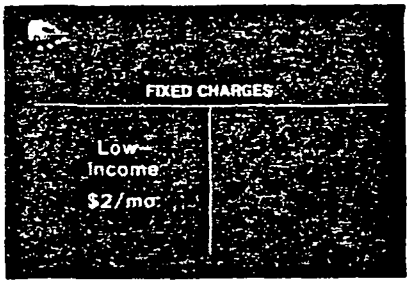
If a uniform tariff of $0.5 per cubic meter were charged for water consumption, the low-income households would pay $5 per month, the mid-income households $13 per month, and the high-income households $25 per month.

87. 

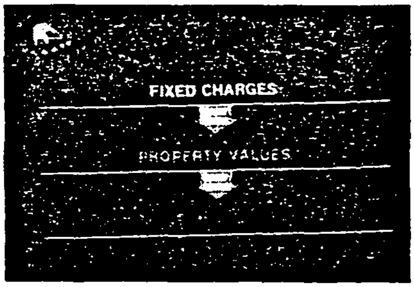
As a share of their income the low-income households would pay 5%, the mid-income households 3%, and the high-income households 2%. Besides being inequitable, the tariff would be unaffordable to the low-income consumers.

88. 

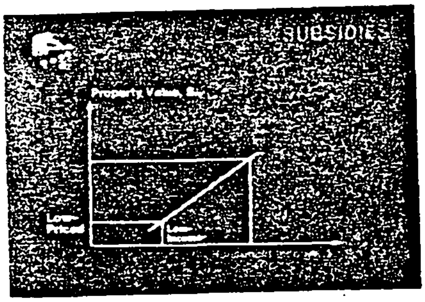
The solution for making charges both affordable and more equitable is to subsidize the consumption of low-income consumers. One way to gain full financial control over the subsidies is to finance them by putting a surcharge on the consumption of high-income consumers. Such a subsidy within the tariff structure is called a cross subsidy.

89. 

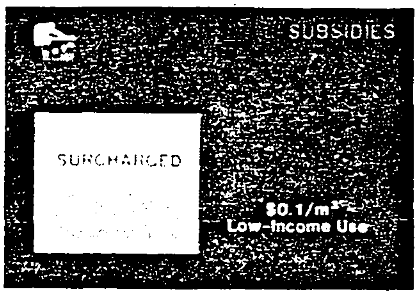
There are two easy ways for achieving cross-subsidies from high-income to low-income consumers. One direct way is to have fixed monthly charges that vary with the income but not with water consumption. A low-income family might pay a fixed charge of $2 per month and a high-income family $20 per month.

90. 

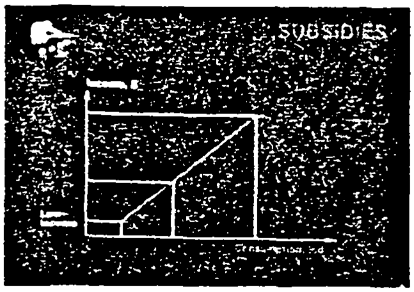
Income data are difficult to obtain or keep up to date. So instead of having the fixed charges vary with income levels, they usually vary with a proxy for income. This proxy is often the property value of the residence of the family. Such property values are relatively accessible since they form the basis for municipal taxation.

91. 

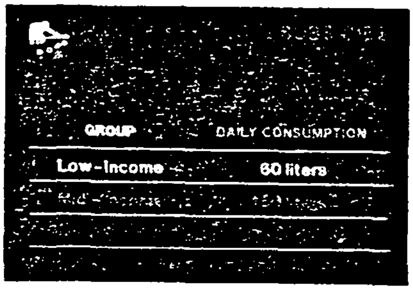
A good correlation exists between the household income and the residential property value. High-income consumers live in high-priced residences. Low-income consumers live in low-priced properties.

92. 

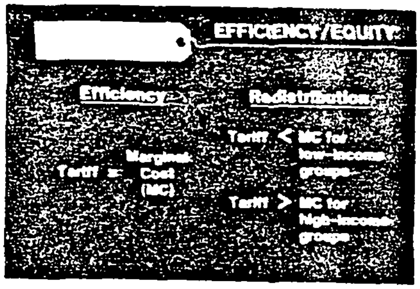
A second way to redistribute income is through consumption charges that increase progressively with higher consumption. Consumption above a certain level, say $10m^3$/month, would be charged substantially above cost. Consumption below this level of $10m^3$/month would be charged below cost at a subsidized rate. Since low-income consumers tend to be concentrated below $10m^3$ per month (while high-income consumers often consume above that) the effect is a redistribution.

93. 

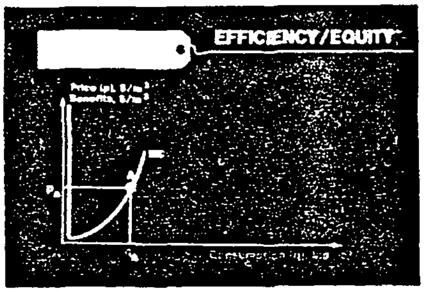
Per capita water consumption increases with income, as shown here. High-income consumers consume more water per capita than middle-income people -- who, in turn, consume more than the low-income group.

94. 

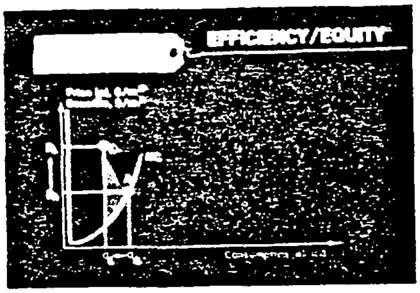
A low-income consumer may only consume 60 liters per day. A mid-income consumer may consume 150 liters per day. A high-income consumer may consume 300 liters per day since he has the funds to buy all kinds of water-consuming appliances, to have a sewerage system and modern bath and so on.

95. 

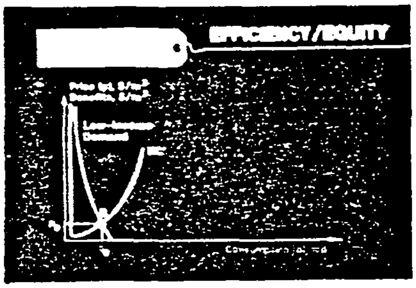
There may be some conflict between the ways to achieve the objectives of efficiency and redistribution. Efficiency requires that all consumers be charged the marginal cost. In contrast, a tariff that will redistribute income will necessarily charge <u>less than marginal cost</u> to low-income consumers and <u>more than marginal cost</u> to high-income consumers.

96. 

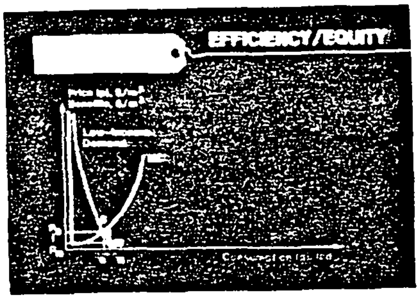
Charging tariffs that deviate from marginal costs will introduce losses in economic efficiency. The size of these losses are determined by the demand curves and the price elasticities. Consider, for example, the situation of a high-income consumer shown here. The efficient price would be p_A for a consumption of q_A cubic meters. This optimum point corresponds to the intersection between the marginal cost curve, MC, and the demand curve -- which means that the benefits from the last liter consumed are exactly equal to the costs of producing it.

96. 

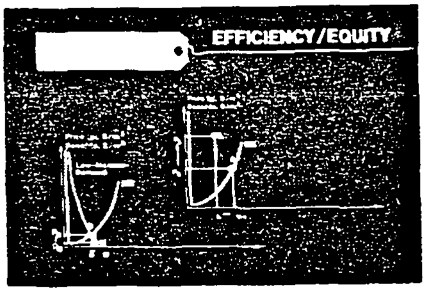
Now, in order to redistribute income, the tariff to high-income consumers is raised to p_L. As a result they decrease their consumption to q_L cubic meters. The resulting loss in efficiency is shown by the shaded area.

98. 

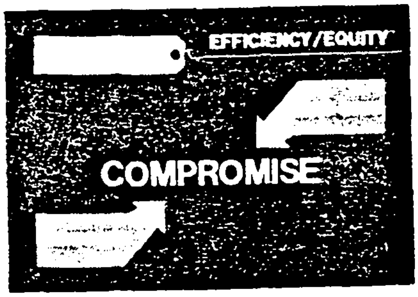
In the case of low-income consumers the loss in efficiency will be less, since the price elasticity of their demand curve is lower than that of high-income consumers. As a result, the demand curve will be more vertical than for high-income consumers. Consider the situation where the optimum point would be a price of p_B and a consumption of q_B cubic meters per month. This optimum corresponds to the intersection between the demand curve and the marginal cost curve -- indicating that the benefits from the last liter consumed are exactly equal to the costs of producing it.

99. 

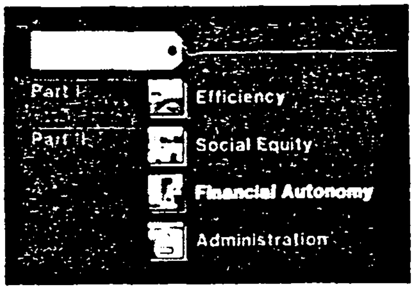
With a goal of subsidizing the low-income consumers, the tariff is lowered to p_M, which produces an increase in consumption to q_M. The loss in efficiency is given by the shaded area which is small, since the demand curve is almost vertical.

100. 

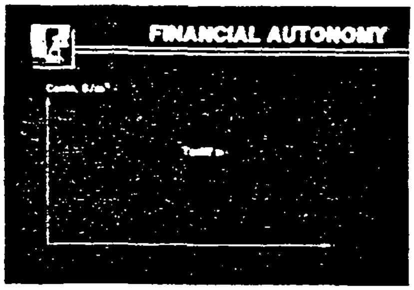
So, the inefficiencies introduced by tariffs that redistribute income are relatively small for low-income consumers but larger for high-income consumers. If asked to subsidize too much, high-income consumers could conceivably drill their own wells and cease drawing water from the public water system. This would increase the inefficiencies and no income would be redistributed. (One would have killed the goose that laid the golden egg.)

101. 

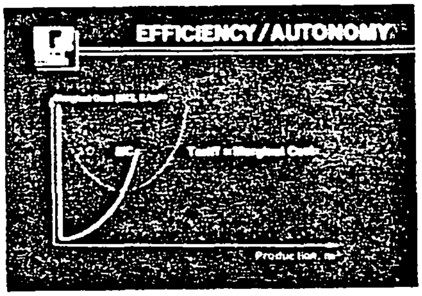
Because of such conflicting effects and practical limits, we cannot define one perfect tariff that would be completely efficient and socially equitable. Every case should be examined with its objectives in mind. The trade-offs and limitations should be evaluated so that a fitting compromise is reached.

102. 

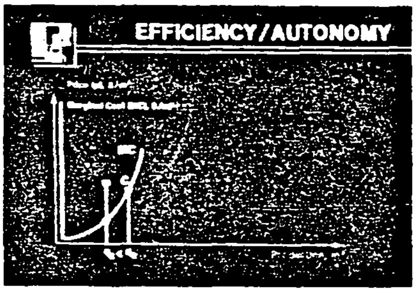
The next objective of a tariff that we'll examine is to achieve financial autonomy for the public utility.

103. 

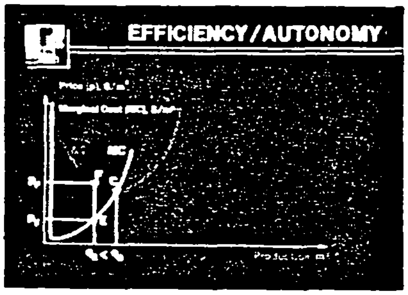
This amounts to having the tariff recover all investment and operating costs on an average basis. To achieve financial autonomy, the tariff level should be at least equal to the average cost, as shown here.

104. 

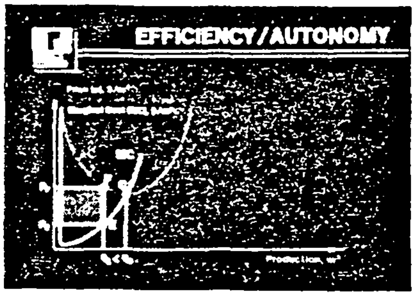
But to achieve economic efficiency, the tariff should be equal to the marginal cost. Since the marginal and average cost curves are different, we need to explore the effect that marginal cost pricing would have upon financial autonomy.

105. 

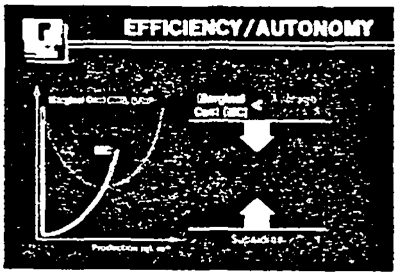
Assume first that the utility is producing q_E m^3, which is less than q_C. The quantity -- q_C -- is the production level where the average and marginal cost curves intersect.

106. 

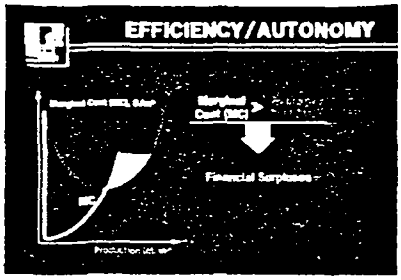
The efficient price at production q_E, then, would be the marginal cost, q_E, which, in turn, is less than the average cost p_F .

107. 

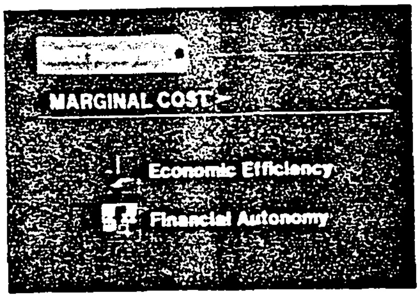
Since p_E is below the price p_F on the average cost curve, the result would be financial deficits, as shown by the shaded area.

108. 

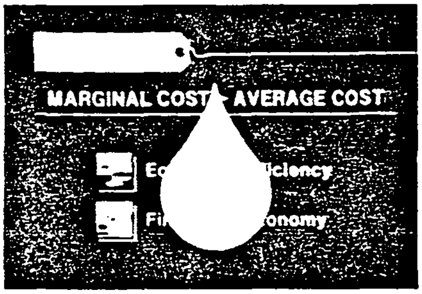
Whenever the utility produces less than the level where the average cost and marginal cost curves intersect, the marginal cost is below the average cost. Charging the economically efficient price would then result in financial deficits, which would need to be covered by subsidies from outside the sector. (This could be done from general tax revenue.)

109. 

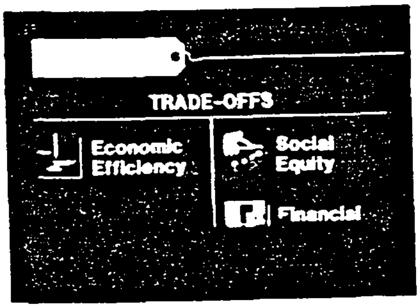
When the utility produces <u>more</u> than the level where the average cost and marginal cost curves intersect, the marginal cost is <u>above</u> the average cost. Charging the economically efficient price would then result in financial surpluses, so there would be no need for subsidies from outside the sector.

110. 

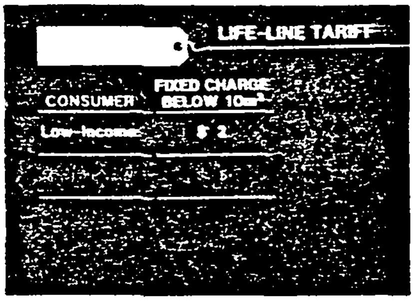
Whenever the marginal cost is above the average cost, there would be no conflict between economic efficiency and financial autonomy. The economically efficient tariff based on the marginal cost would be more than sufficient to produce financial autonomy.

111. 

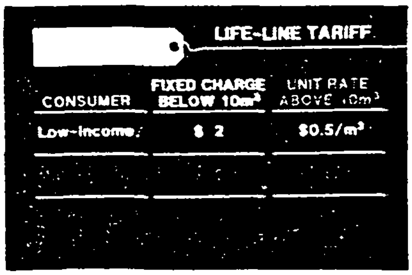
It is likely that the water supply sector is at a stage of development where new projects are more costly than past projects. Marginal costs will therefore be above historical average costs. In such circumstances, efficient pricing that charges the marginal cost of new projects will also favor financial autonomy since the tariff will be above historical average costs.

112. 

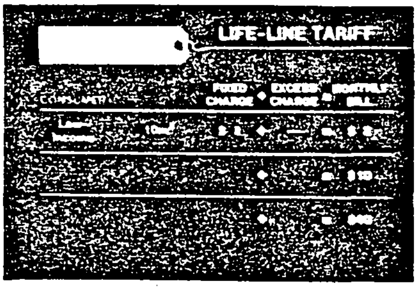
We have seen that there is a trade-off between economic efficiency and social equity in tariff setting. We have also seen that there could be a trade-off between the objectives of economic efficiency and financial autonomy. How then do we compromise between these conflicting objectives?

113. 

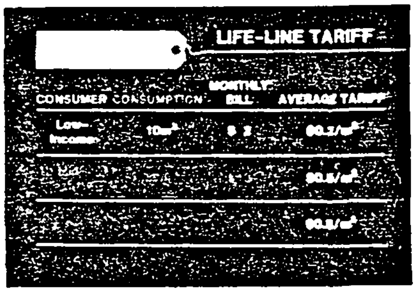
The suggested compromise is the life-line tariff. Here all consumers have the right to consume a life-line monthly amount of water (for instance, 10 cubic meters) and would pay a fixed charge that varies with the income level. For example, low-income consumers might pay $2, mid-income consumers might pay $5, and high-income consumers $20 for the first 10 cubic meters. Through the varying fixed charges, social equity would be favored. Since the fixed charge must be paid -- even if consumption is below 10 m^3 -- low-income consumers are encouraged to make full use of their life-line amount. This is consistent with the goal of satisfying the basic needs for water and producing full health benefits.

114. 

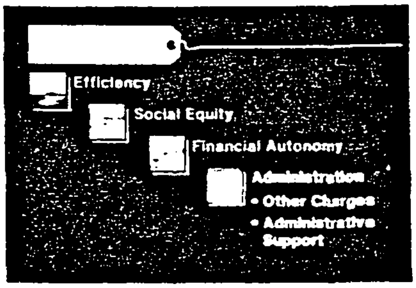
For any consumption above 10 cubic meters per month, consumers would pay a unit rate equal to the average incremental cost (for instance, $0.5 per cubic meter). This unit rate would encourage an efficient consumption pattern.

115. 

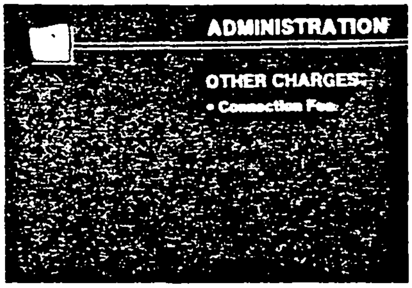
For example, under such a lifeline tariff, a low-income consumer of 10 cubic meters would pay a monthly water bill of only $2, while a mid-income consumer of 20 cubic meters per month would pay $10, and the high-income consumer of 50 cubic meters monthly would pay $40.

116. 

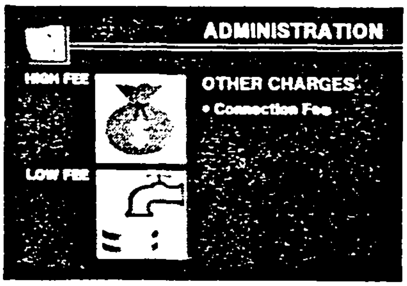
So on average the tariff for a low-income consumer would be $0.2 per cubic meter, for a mid-income consumer it would be $0.5, and for a high-income consumer it would be $0.8.

117. 

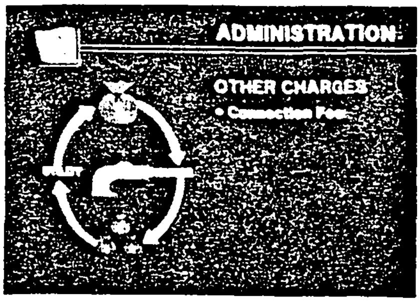
The final element to consider if a tariff is to be fully effective involves the administration of the tariff. This includes a series of other charges that either complement or substitute for tariffs on consumption. In addition, a support system is required in order to produce the economic and financial effects intended.

118. 

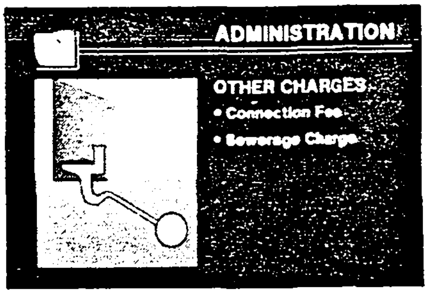
One important charge that attempts to recover some of the fixed costs of a water system is the connection fee. It is a one time fee to defray at least the cost of the house connection itself. It will be levied in addition to the cost of indoor plumbing for which the consumer alone is responsible.

119. 

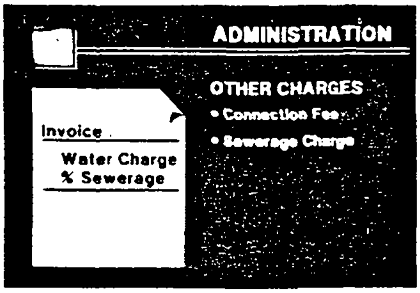
The connection fee can vary as a proportion of the total consumer charges. Some utilities attempt to use it as an important source of revenue. Others try to make it as low as possible in the belief that a high connection fee would discourage low-income consumers from connecting.

120. 

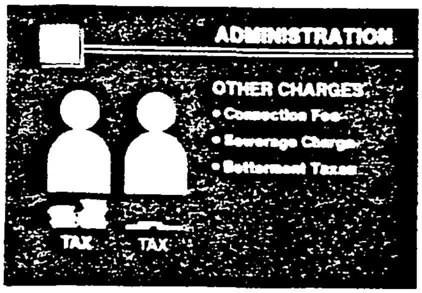
In order to solve the cash flow problem that a high connection fee represents for low-income consumers, the utility may finance the charge over a period of several years. The connection fee can thus be paid so that the monthly payment plus the bill for consumption will never exceed the 3% of the consumer's household income.

121. 

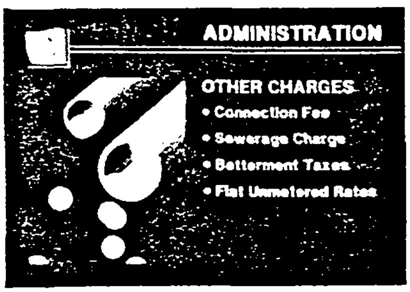
Another charge is the sewerage charge which is naturally linked to the water tariff. The disposal of the waste water generated is a direct consequence of the provision of water.

122. 

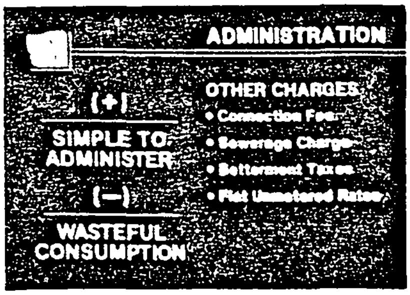
Sewerage is therefore charged as a percentage of the water bill. For example, the surcharge on account of sewerage could be 100% of the water bill. Of course, it is only levied in cases where the consumer does have a sewerage hook-up.

123. 

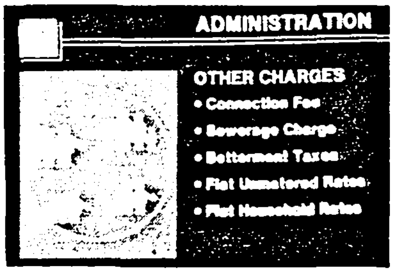
An alternative levy to pay for expensive sewerage works is the betterment tax. Here the cost of the works is allocated to the beneficiaries in proportion to their respective benefits. A beneficiary who derives twice as much benefit as another would pay twice as much.

124. 

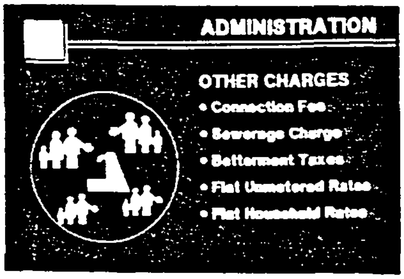
In many water supply systems, consumption is not universally metered. In these cases, flat unmetered rates are necessary. These will not vary with consumption, since it is unknown how much water is sold. At most, they can vary with the diameter of the connection.

125. 

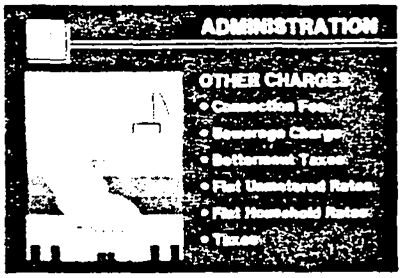
Flat unmetered rates have the one advantage of being simple to administer. However, the disadvantages are substantial. Economic efficiency cannot be promoted since there is no relation between the water bill and the amount consumed. In effect, the marginal tariff to the consumer will be zero. The consumption will increase up to the point where the marginal benefits are zero, and the consumption pattern will be wasteful.

126. 

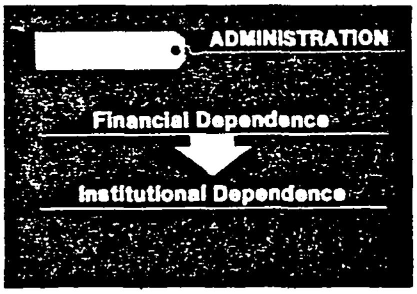
For systems without house connections, water can best be charged as a tax per household benefitting from the system, or a flat household rate.

127. 

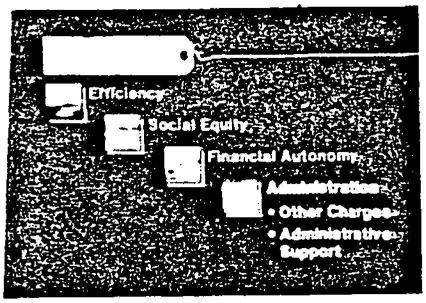
Such flat rates are particularly applicable for public standposts. All families within a certain distance from the public standpost will then pay a charge.

128. 

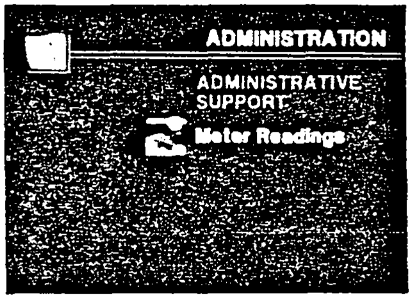
Many water supply services, both in urban and rural areas, receive subsidies out of municipal and other taxes. In the case of rural areas, these subsidies are necessary since the low-income beneficiaries cannot be expected to pay for much more than operations and routine maintenance. In urban areas, such subsidies gradually diminish with the use of tariff structures including cross subsidies.

129. 

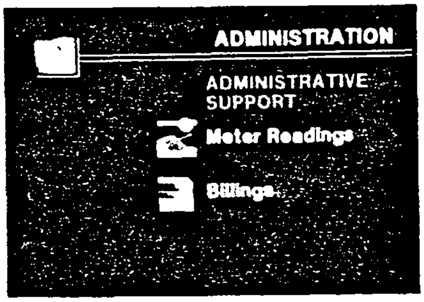
The fact remains that lack of financial autonomy has some very real disadvantages. It is difficult to rely upon municipal or national budgets for the subsidies to be available when needed. Financial dependence breeds institutional dependence. When outside bodies provide the funding, they may unduly influence decisions on project selection, staffing, and on tariff policies.

130. 

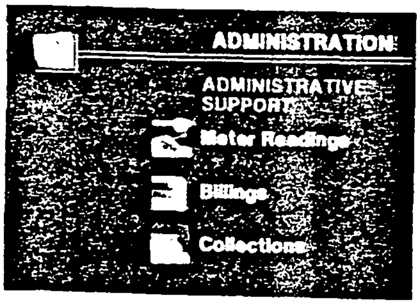
The effectiveness of any tariff is only as good as the administrative support available to implement it.

131. 

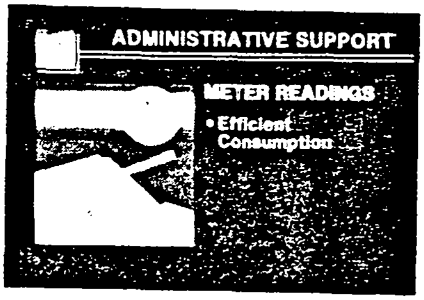
First and foremost, meter readings (as a type of this support) must be extensive and carefully administered.

132. 

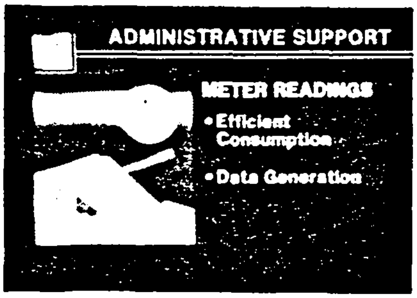
The meter readings have to translate into correct and timely billings. The utility's customers must get prompt feedback so that they may adjust their future consumption accordingly.

133. 

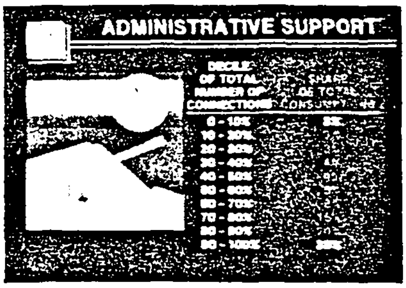
The billings must be collected in a thorough and timely fashion. If not, customers will soon realize this and the tariff will not promote efficient consumption, social equity, and financial autonomy.

134. 

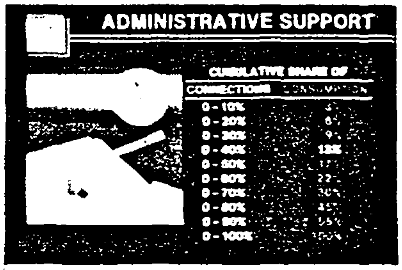
There are many benefits of metering. One is that it enables consumers to evaluate their own marginal benefits and costs. This leads to more efficient consumption. The proof is that the introduction of metering into a previously unmetered system has been shown to lower per capita consumption by 40%.

135. 

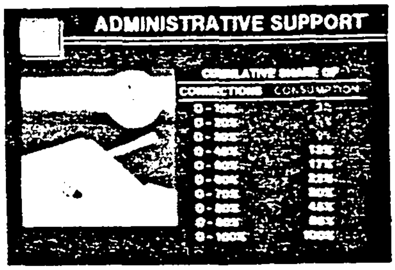
In addition, metering generates a wealth of statistical data on consumption levels and their distribution. These are invaluable when it comes to projecting demand, finding the least-cost design, making financial projections, and designing tariff structures.

136. 

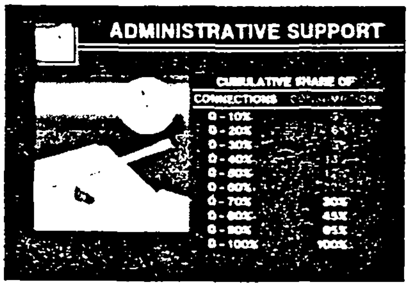
For instance, through analyzing metering data, it is possible to calculate the statistical distribution of different consumer groups. In this table, all house connections have been divided into deciles in order of ascending average consumption. Each decile's share of the total water consumption is also depicted. We can see that the highest consuming decile (the group falling within 90-100% of the total number of consumers) accounts for 35% of all water consumed. At the other end of the scale, the lowest 10% account for only 3% of all water consumed.

137. 

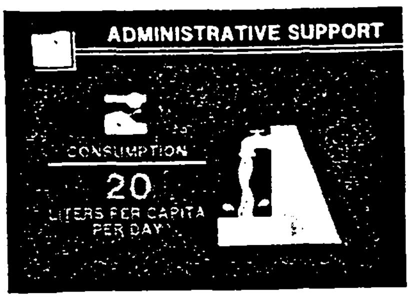
The consumption pattern can also be shown on a cumulative basis. Here the cumulative share of connections in ascending order of consumption is shown against their cumulative share of total water consumed. This table shows that the lowest 40% of all connections account for only 13% of the water consumed.

138. 

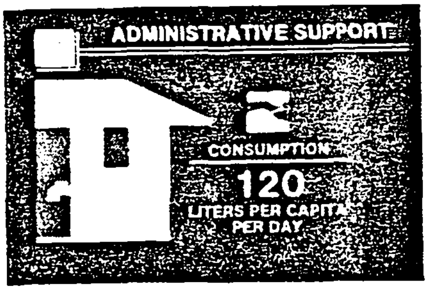
The table shows that metering can be judiciously applied to control a major share of consumption. For instance, by metering the 60% largest connections, one can control about 87% of the total water consumed, i.e. 100 less 13%.

139. 

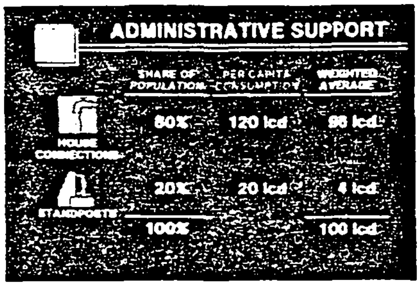
The distribution of consumption is also important for constructing tariff structures that will redistribute income. In general, it can be expected that the highest 30% of consumers will, in some form, have to subsidize the lowest income consumers.

140. 

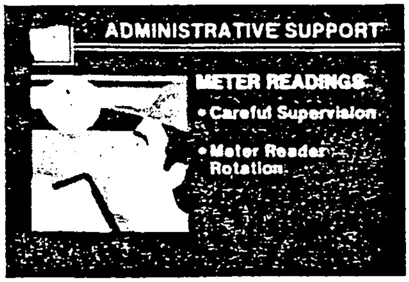
One group that will typically be subsidized is the group of consumers drawing water from public standposts. This consumption is usually unmetered. The per capita consumption for the population served from standposts is, at the most, 20 liters per day.

141. 

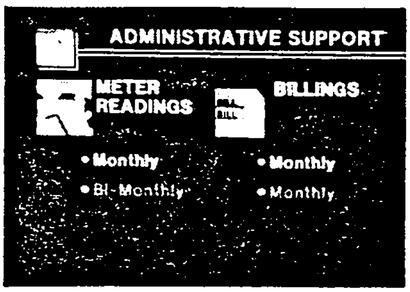
On the other hand, the average consumption level in the population with house connections can easily be 120 liters per capita per day.... and often much more.

142. 

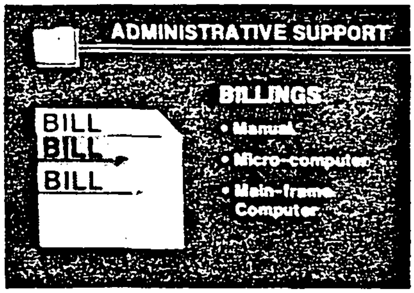
Assuming that 80% of a population is served through house connections with 120 liters of per capita consumption, their weighted consumption is 96 liters per capita per day. The remaining 20% of the populaton served through standposts have a weighted consumption of 4 liters per capita per day. The latter is only 4% of the total average of 100 liters per capita per day.

143. 

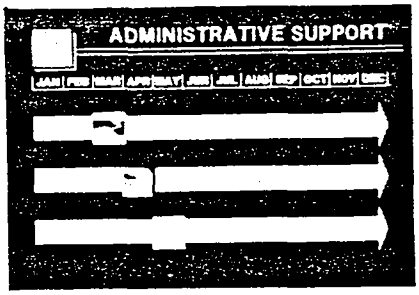
Consumption readings need to be carefully supervised to prevent careless or inaccurate readings. One way is to build controls into the billing program. Another is to rotate the meter readers in order to prevent collusion between them and the consumers.

144. 

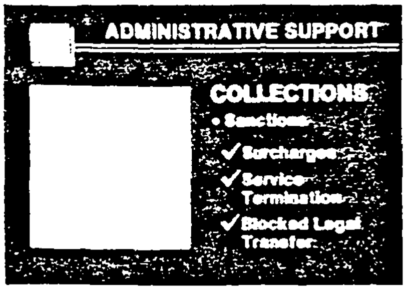
The frequency of readings is either monthly or bimonthly. If readings are made monthly, then the corresponding billings should also be monthly. In the case of bimonthly readings, the billings are still done monthly and are based on half the bimonthly consumption. Monthly billings permit a better control over consumption and a more even cash-flow.

145. 

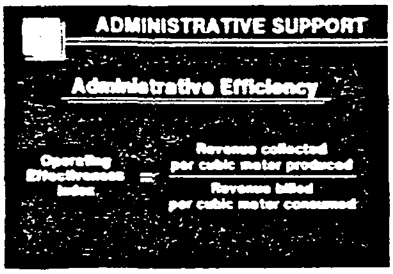
Billings are done either manually or by computer. Manual billings are cost-effective only for the smaller systems. As the number of connections grows, billing with micro-computer becomes more attractive. With still larger systems, main-frame computers become necessary, (first contracted outside and later based inside the utility, as the volume increases).

146. 

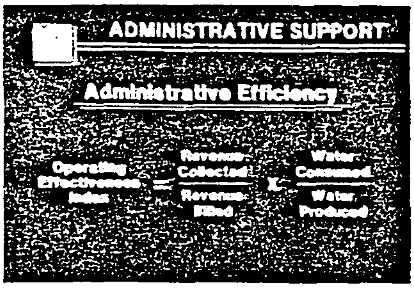
Billings are done continuously to different sectors of a utility's service area. In this fashion, the administrative burden is evened out, along with the utility's cash-flow. Collections of the amounts billed are done continuously as well. The consumer may be given 30 days to pay his bill. Thereafter the bill becomes overdue. The consumer may be granted another 30 days to pay his overdue bill.

147. 

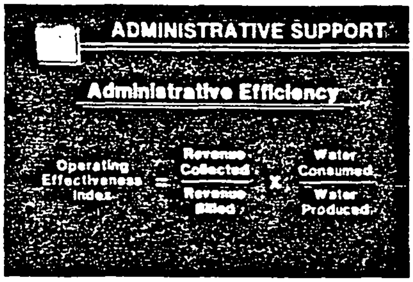
In order to ensure that bills are collected, the utility has several sanctions. It can impose surcharges on overdue bills. For those bills still not paid after 60 days, it can cut off service to the customer. Service is then not restored until all overdue bills and fines are paid. (Finally, in some countries, legal title to a property is impossible to obtain until all overdue utility billings are up to date.)

148. 

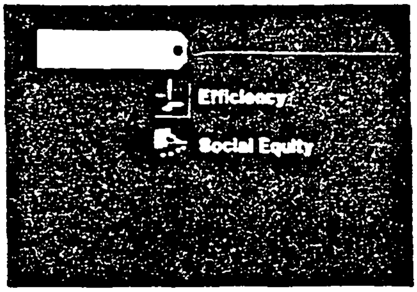
The overall administrative efficiency of a utility is measured by the operating effectiveness index, OEI. It is defined as the revenue collected per cubic meter produced, divided by the revenue billed per cubic meter consumed.

149. 

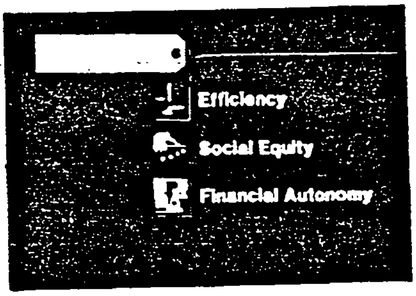
In turn, the operating effectiveness index can be separated into the product of the revenue collected as a share of the revenue billed times the metered water consumed as a share of the water produced.

150. 

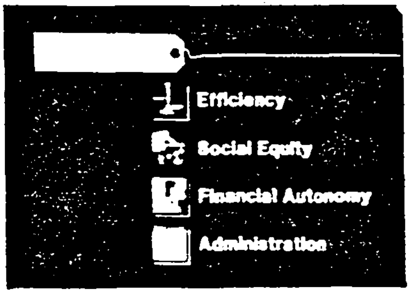
The first part of the operating effectiveness index measures the efficiency in the utility's billings and collections. Ratios that are consistently below 100% and dropping imply that there is a firm consumer resistance against paying bills. Moreover, it shows that the utility is administratively not strong enough to enforce its billings.

157. 

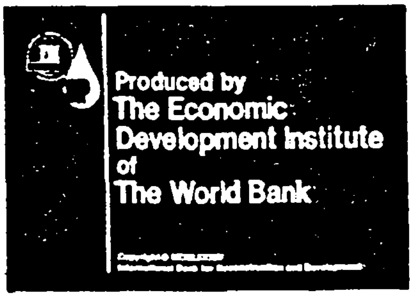
It should foster social equity through the redistribution of income within the tariff structure.

158. 

In addition, the tariff should promote financial autonomy by covering at least the average costs of providing water.

159. 

And finally, the tariff should be administratively feasible to implement. To this end any tariff needs a good administrative support system to achieve its objectives.

160. 

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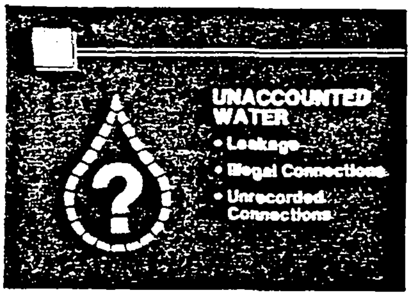
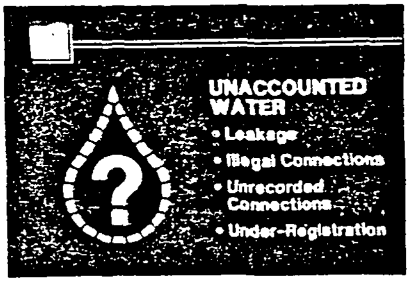
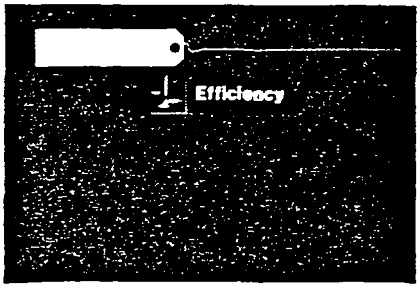
154. 

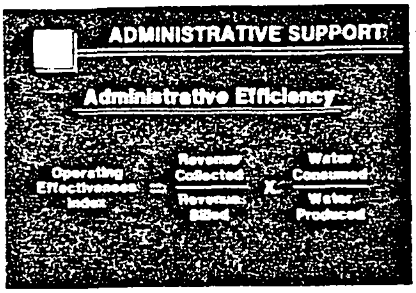
On the other hand, there may be connections, made legally, but which the utility has not recorded and therefore not included in the billings due to administrative inefficiencies.

155. 

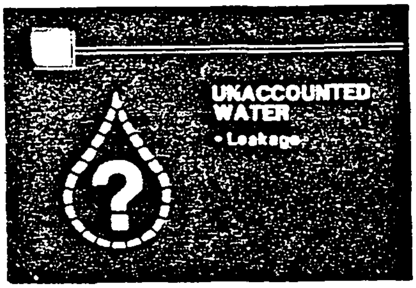
Sometimes consumption is under-registered, either because of unmetered connections or because of malfunctioning meters.

156. 

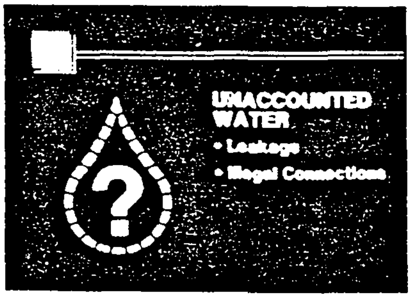
In summary, tariff analysis must comprise four elements. The tariff should favor economic efficiency in the production and consumption of water.

151. 

The second factor, the share of metered water produced that is eventually consumed, measures the efficiency in the utility's metering and operating departments. It is also called the utility's water accounted for. In very well managed utilities, the percentage could be as high as 90%. More commonly, it is 70% or lower.

152. 

The difference between the metered production and the metered consumption is referred to as the unaccounted water. It can have many explanations. One is simply the leakage in the distribution system.

153. 

...Another is the existence of illegal connections that consumers have made themselves to the distribution system.