Distribution Rural Electrification Experiences in Peru

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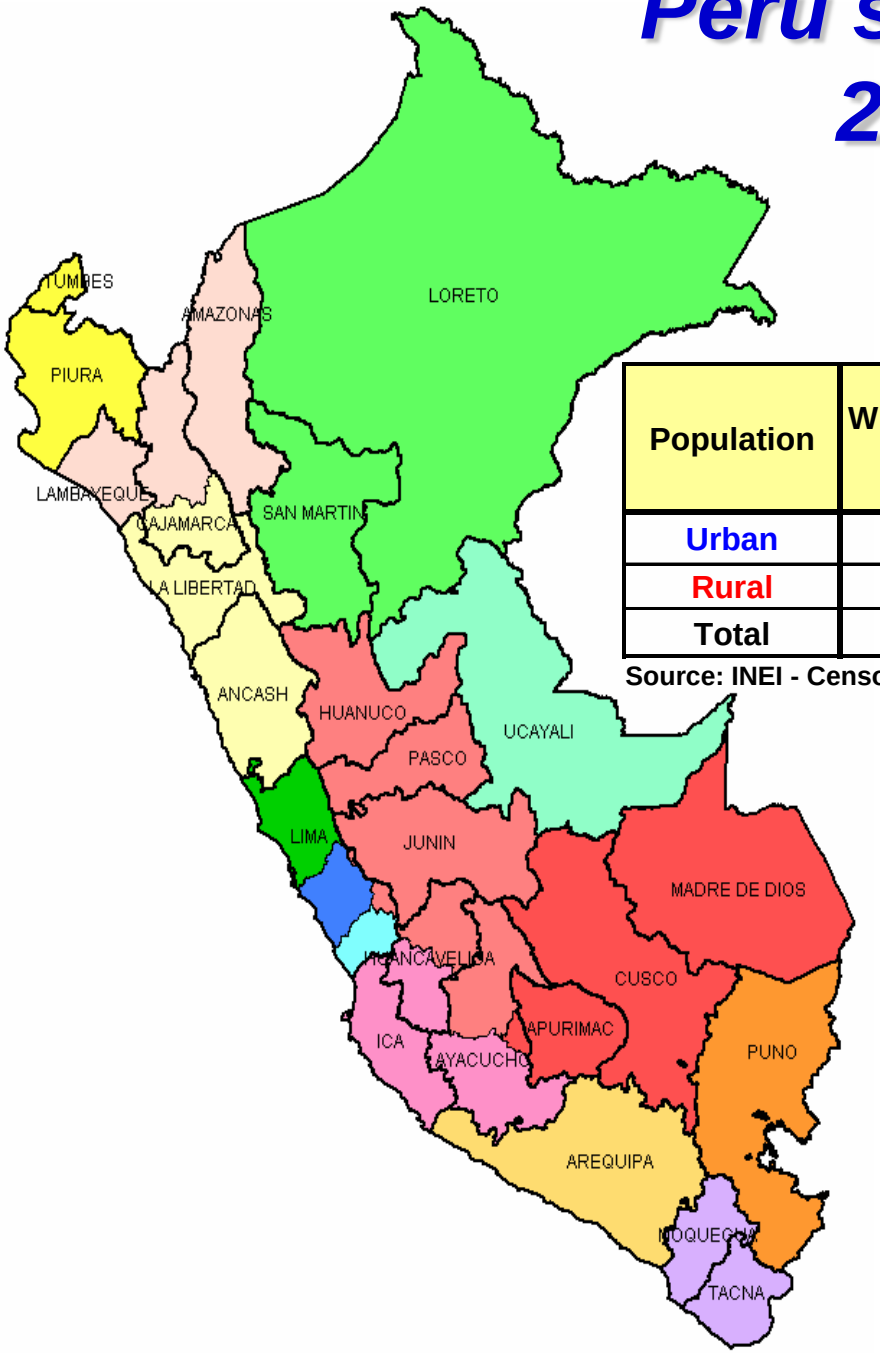
South America

Peru statistics 2007



Population	With electrical service	No Electrical Service	Total	No Service (%)
Urban	18 634 183	1 882 738	20 516 921	9.2%
Rural	1 958 130	4 582 148	6 540 278	70.1%
Total	20 592 313	6 464 886	27 057 199	23.9%

Source: INEI - Censos Nacionales 2007: XI de Población y VI de Vivienda

Problems of Rural Electrification in Peru

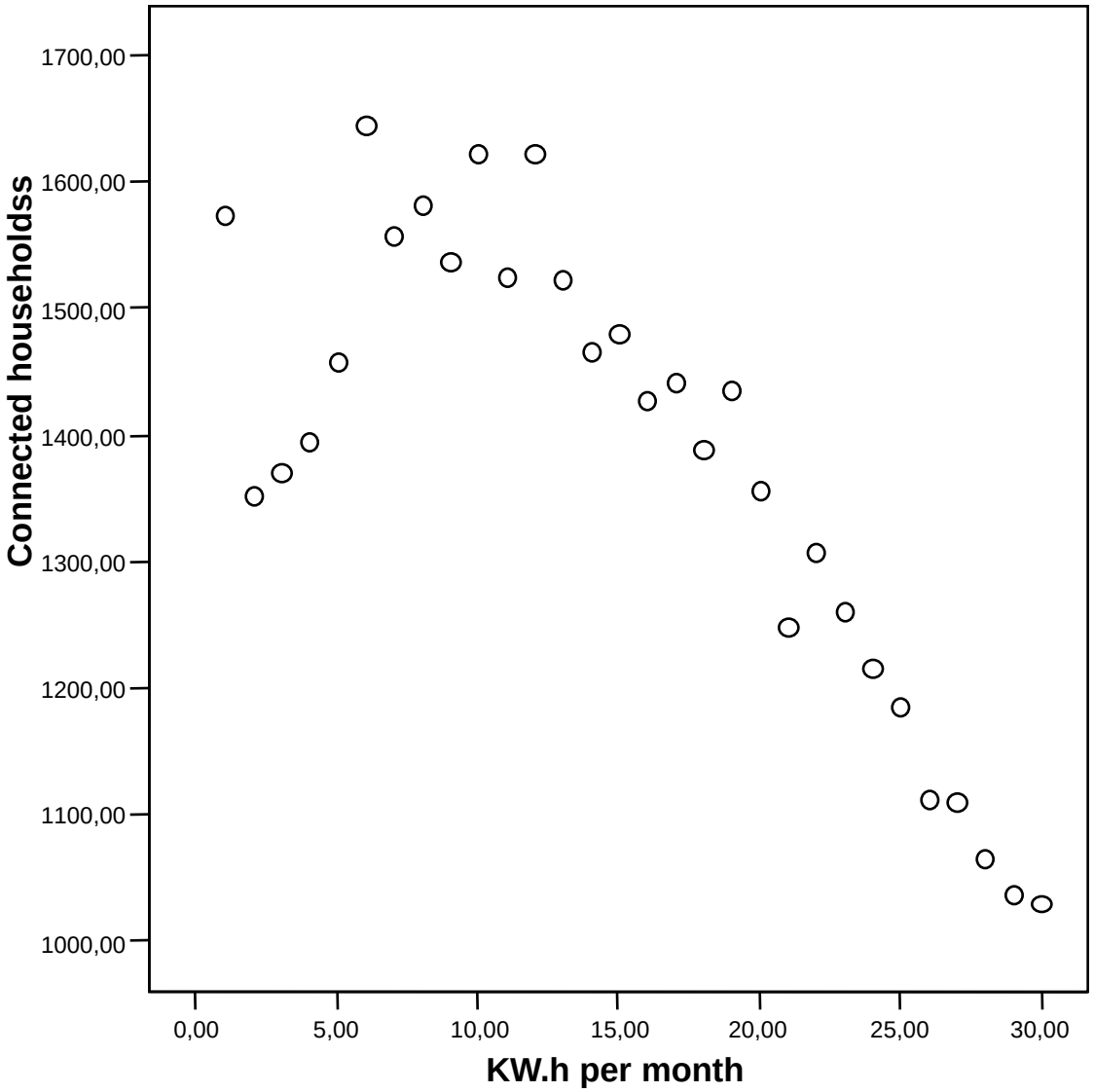
Physical andTechnical matters

1. High dispersion of rural consumers
2. Low consumption
3. Lengthy installations of primary feeders and secondary network.
4. Expensive costs of O&M

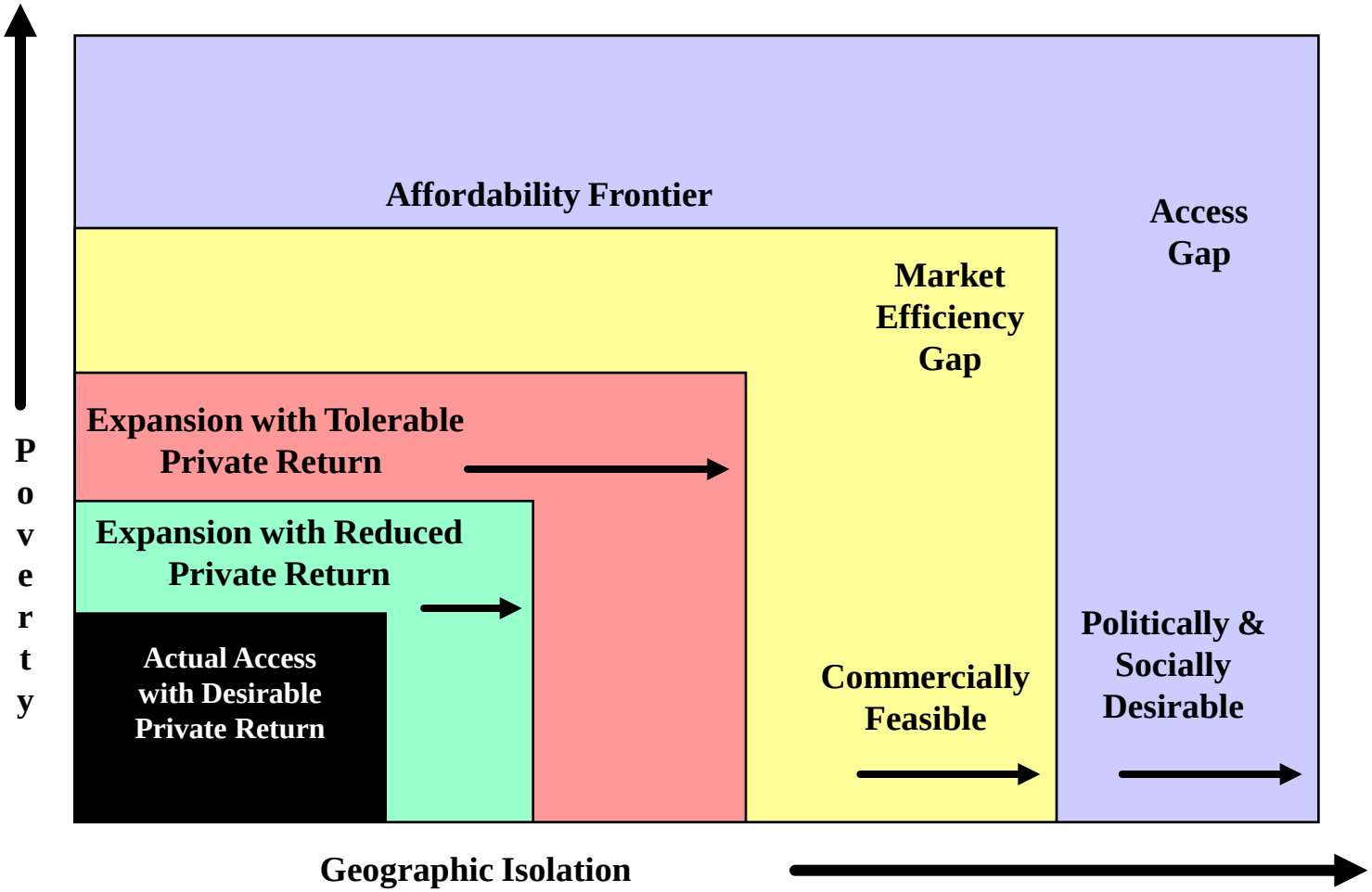
Economic matters

1. Low income consumers
2. A full cost recovering rural tariff would be more expensive than urban tariffs

Rural Consumption



Conceptual Access Gap Framework



Realities

- Rural costs of supply are more expensive than to urban areas.
- Existing rural tariffs generally do not cover the expansion of the electrical rural system.
- The level of investment required per consumer in rural areas is two to five times greater than that required in urban areas

Constraints

- Rural customers can not pay full cost recovering tariffs (economic).
- All low-income Peruvians must be treated equally (political).
- A tariff design must be aligned with the consumer's willingness to pay (socio-economic)

- What are possible solutions?

Possible solutions

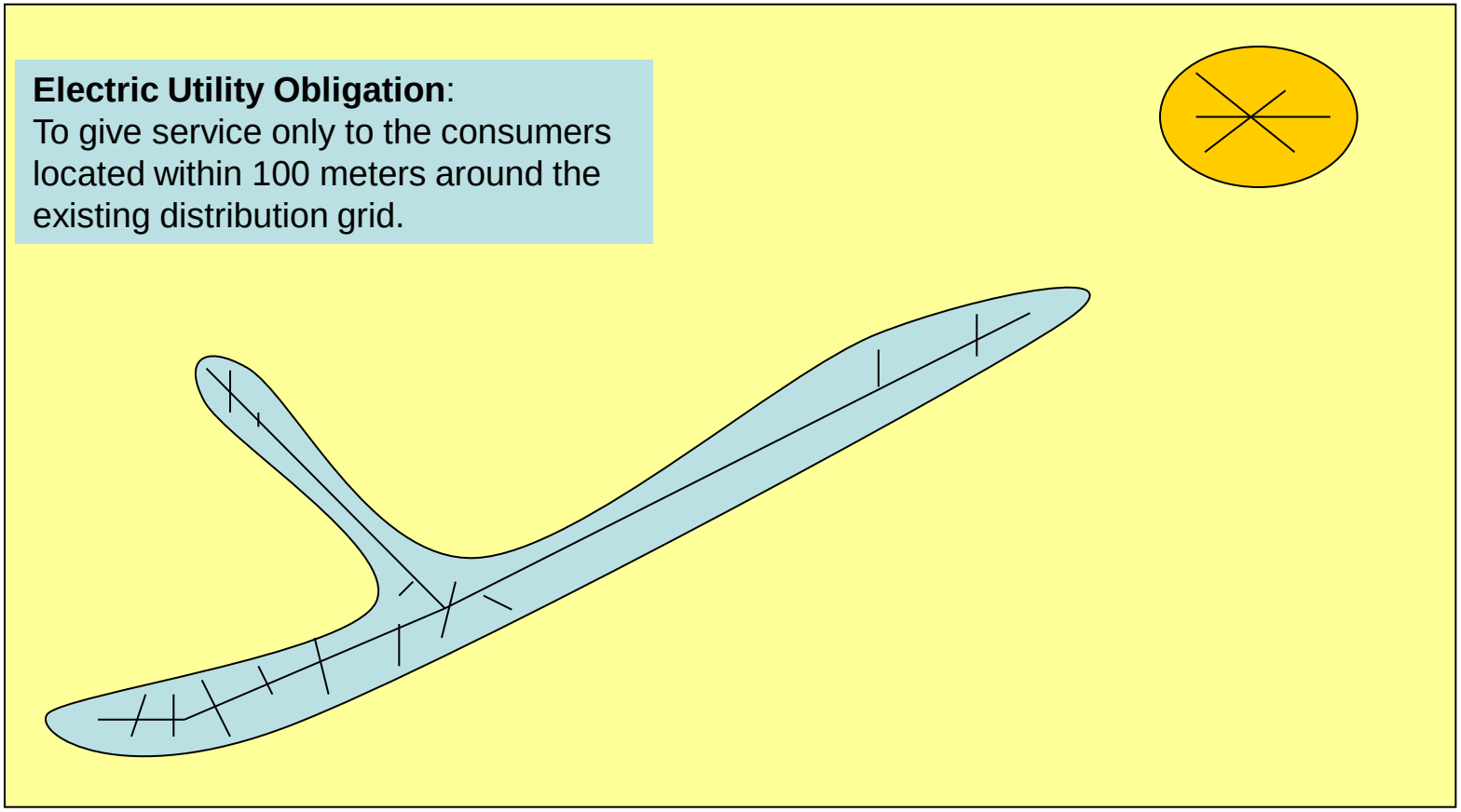
- To promote universal access to the rural areas investment subsidies are necessary (Economic).
- To promote the efficient award of investment subsidies, the State must provide subsidies to the utilities who request the lowest subsidy per connected customer (Economic).
- Tariffs charged to new rural consumers should be capped at the maximum regulated urban tariff (Political).

Three Types of Subsidies

- #1--Initial cost of capital subsidy (US $100 million per year)
  - Isolated mini-grids under 500 KW power capacity installed.
  - Distribution (rural grids outside of utility concession)
  - Resources of subsidy: Fiscal fund, international loans (**US$ 50 millions**), Rural Electrification Fund (REF) (**US$ 17** millions) and donors.

- #2--Internal tariff subsidy (US $36)
  - To reduce the price of isolated generation. Resource: REF (**US$ 23** million per year)
  - To reduce de cost of the distribution added value (DAV) (the “distribution cost reduction” before to be applied to rural consumers) (**US$ 13** million per year). Resource of subsidy: The urban consumers.
- #3--Consumption subsidy (US$ 31 million per year)
  - To obtain similar tariffs between interconnected mini-grids and urban areas
  - To obtain similar tariffs between isolated mini-grids and urban areas
  - Resource of subsidy: The consumers whose consumption is higher than 100 kW.h per month.

Concession



Area of utility concession

Area of electrification project (Government obligation – Finance 90% of Initial cost of capital

Area of expansion (Government obligation)

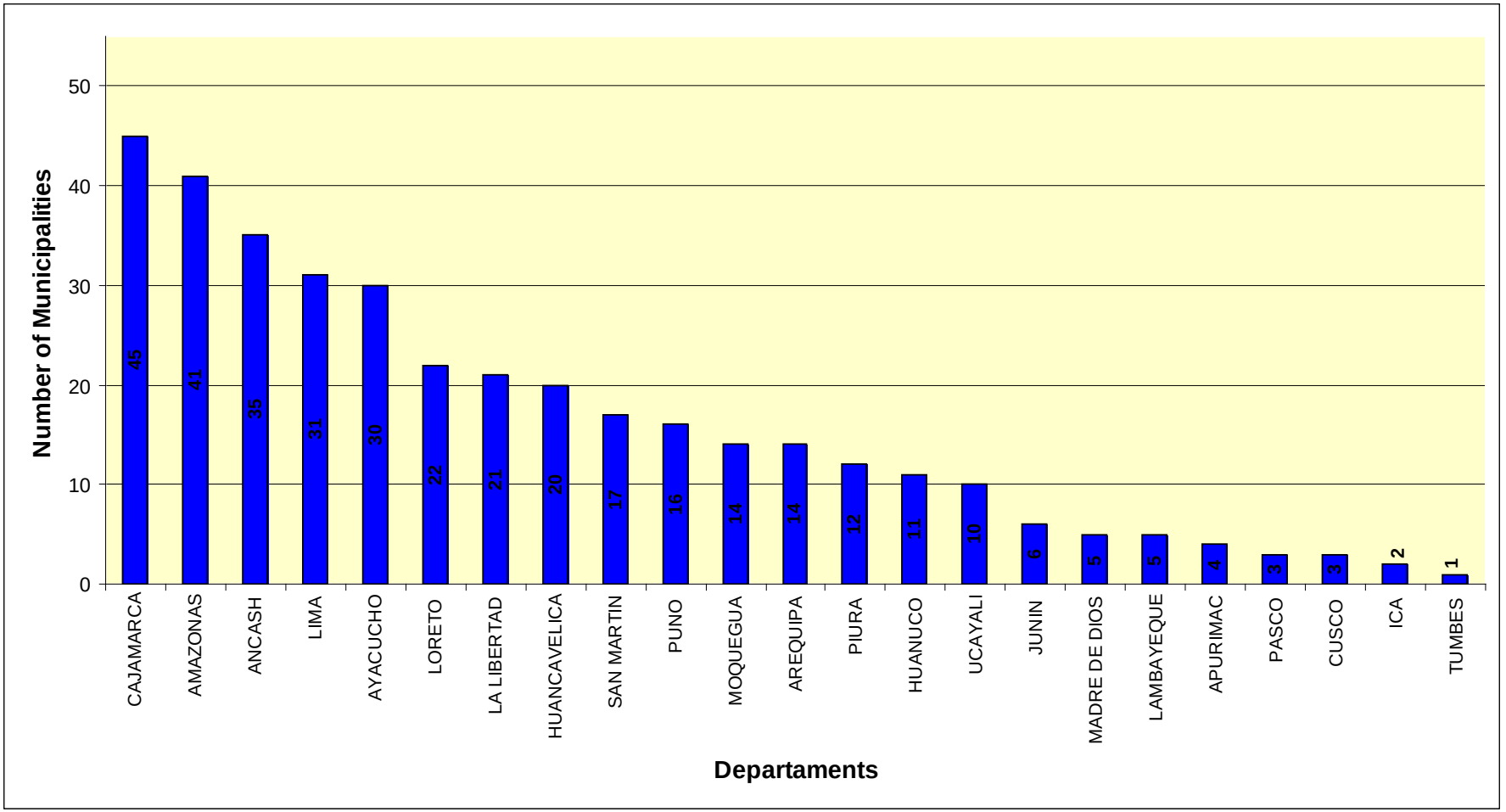
Concession

- The concessionaries are obliged to:
  - Supply electricity to all those within their concession
  - Apply a regulated tariff
  - Accomplish the requirements of quality of service.
  - Send to the Ministry and the Regulator technical, commercial and economical information.
  - To assure the supply of energy to their consumers through a contract of purchase of energy for the next 2 years.

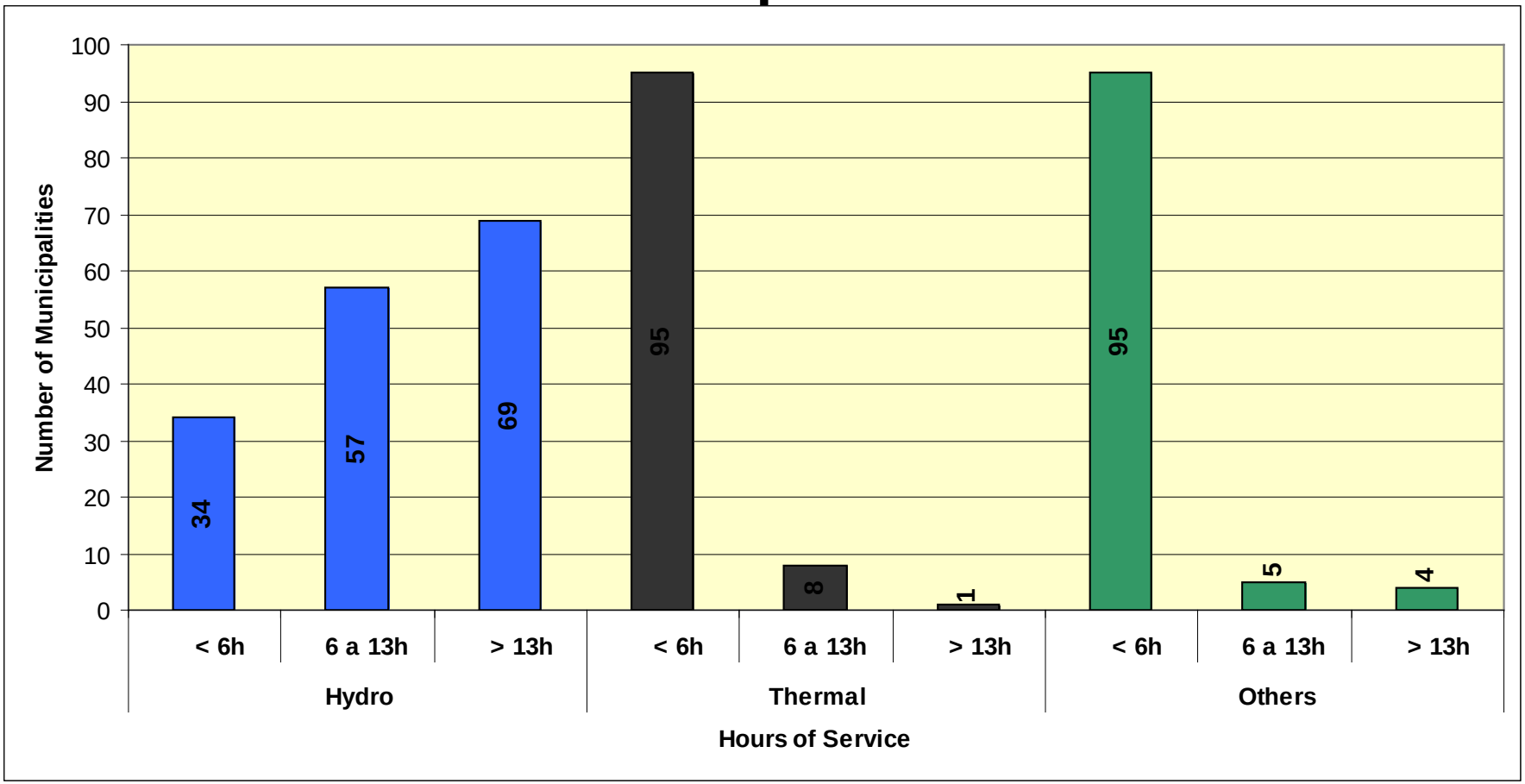
#1--Initial capital cost subsidy

- Implementation Criteria (isolated mini-grids)
  - Subsidies are provided for isolated mini-grids projects **outside of a** utility's concession with a power capacity under 500 KW.
  - The subsidy for isolated mini-grids expansion (mini hydro/thermal power plants) must be no higher than US$ 1000 per consumer.
  - The isolated mini-grids are transferred to the municipality.
  - The municipalities operate without concession
  - The law concedes the municipalities the rights to set their own tariff and to determine the conditions of the service (number of hours of operations)
  - The service is provided generally between 6 to 13 hours per day and the consumers pay a fix charge that varies between US$ 3 to US$ 10 per month.
  - Generally the municipality covers with its own budget the cost of fuel and maintenance.
  - There are approximately 368 municipalities in Peru

Number of Isolated Mini-grids Without Concessions



Isolated Mini-grids Attended by Municipalities



#1--Initial capital cost subsidy

- Implementation Criteria (for grid expansion and isolated mini-grid expansion)
  - Subsidies are provided for electrification projects **outside of a** utility's concession.
  - The subsidy for grid expansion (conventional with wires, poles, services and meter) must be no higher than US$ 1000 per consumer.
  - The utility must cover at least 10% of the initial cost of capital
  - The main criterion used to select proposed electrification projects is the lowest subsidy required per consumer under the premise of an established maximum tariff.

Capital cost subsidies awarded under competition

Round	Total cost of capital (Thousand US$)	Government Subsidy		Utility participation		Number of services
		Amount (Thousand US$)	Percentage	Amount (Thousand US$)	Percentage	
Round I	22 637	17 331	77%	5 306	23%	19 454
Round II	44 167	33 881	77%	10 286	23%	46 417
Round III	40 632	32 080	79%	8 552	21%	43 377
Total	107 435	83 292	78%	24 144	22%	109 248

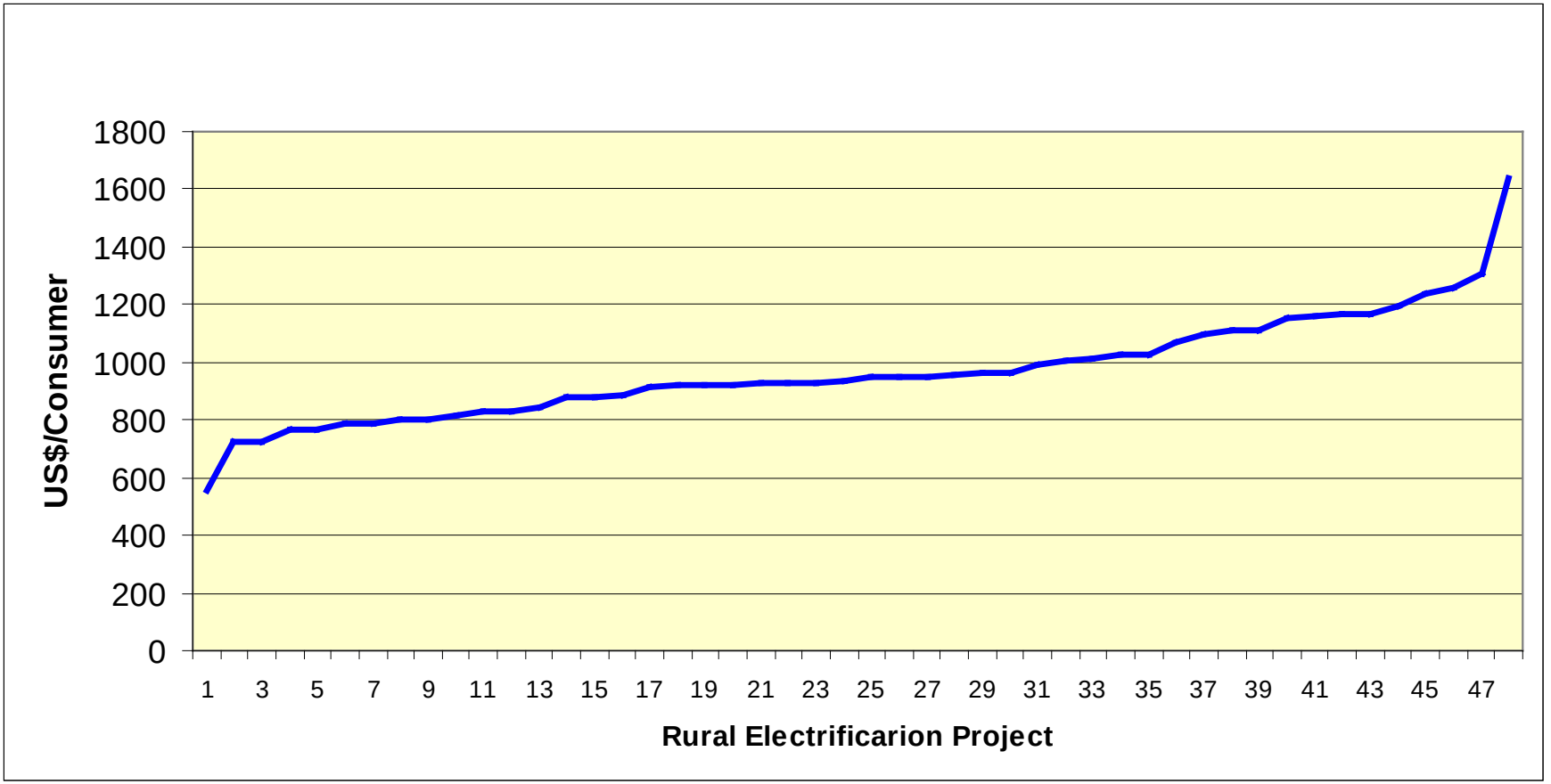
The cost average per consumer is US$ 983

Rural Electrification Projects – Cost per consumer (2008) -

Ítem	Sub-Proyect	Cost per consumer
1	PSE Conchucos	552.8
2	PSE Bellavista II Etapa Sector San José de Sisa-Ramales Nuta	721.2
3	PSE Yrimaguas II Etapa	726.8
4	PSE Pomalca Tuman Cayalti	765.9
5	Eje de Desarrollo Tucume-Jayanca-Motupe-Olmos	769.3
6	PSE Huaylas	787.9
7	PSE Cajabamba Parte Alta y Baja-José Manuel Quiroz-José S	789.3
8	Electrificación Rural de los Distritos de Ilave-Acora	801.0
9	PSE Eje de Desarrollo Tucume-Jayanca-Motupe-Olmos II Etap	801.1
10	PSE Chulucanas III y IV Etapa Fase II	814.4
11	PSE Eje Porcón IV V y VI Etapa	832.3
12	Electrificación de Localidades de Huancavelica	833.2
13	PSE Moyobamba I Etapa-Ramal Los Ángeles y PSE Rioja I Eta	840.7
14	PSE Laredo-Poroto-Simbal II Etapa	875.6
15	PSE Eje Huacariz	877.2
16	PSE San Miguel	884.8
17	Electrificación Rural Cabanillas III Etapa	910.6
18	PSE Magdalena-San Juan	918.3
19	PSE Tarma Chanchamayo	922.3
20	PSE Usquil-Huaranchal	924.1
21	PSE Sto. Domingo-Chalaco-Huancabamba	924.8
22	PSE Eje de Desarrollo Jaén Bagua	927.3
23	PSE Llapa San Silvestre de Cochán	927.5
24	PSE Huánuco Ejes Panao-Ambo	931.9

Ítem	Sub-Proyect	Cost per consumer
25	PSE Eje de Desarrollo Chicalyo-Ferreñafe-San Miguel	946.2
26	SER Tambogrande	948.0
27	PSE San Gregorio	951.8
28	PSE Santa Cruz de Chuca	958.6
29	PSE Combayo	960.6
30	PSE Chungui	965.7
31	PSE Bajo Aguatía	991.0
32	PSE Valle Chillón	1003.8
33	PSE La Encañada-Sucre-Miguel Iglesias-La Libertad de Pallán	1010.9
34	PSE Julcán	1025.1
35	PSE Chancay	1030.0
36	PSE Pacanga-Pueblo Nuevo	1068.9
37	PSE Pozuzo Palcazu II Etapa Ramal 2	1098.0
38	PSE Mazuko I Etapa	1111.9
39	PSE Valle del Vilcanota II y III Etapa	1113.9
40	PSE Chulucanas III y IV Etapa Fase I	1152.7
41	PSE Cospan Asunción	1160.2
42	Challabamba	1164.9
43	PSE Ayabaca IV Etapa Fase I	1169.1
44	PSE Micro Cuenca Crisnejas Distritos Baños del Inca-Llaconor	1192.5
45	PSE Satipo V Epata Cuenca Río Negro-Pangoa	1234.1
46	PSE Lacco Yavero	1261.7
47	PSE Pucallpa-Campo Verde	1311.3
48	PSE Jaén-Cutervo	1636.3

Rural Electrification Cost (2008)



Peruvian Electricity Concessions Law

- Mandated requirements for distribution tariff setting
  - Remuneration of the distribution activity through the setting of the distribution added value (DAV)
  - Reference model company for each typical sector (urban, semi urban and rural) (**not** utility's actual costs)
  - New Replacement Value (assets as new every regulatory period)
  - Efficient cost of operation and maintenance
  - Standard losses

Key point: tariffs are based on estimated efficient costs **not** actual costs.

Formula of DAV calculation

$$DAV = \frac{a\,NRV + O\&M}{MD}$$

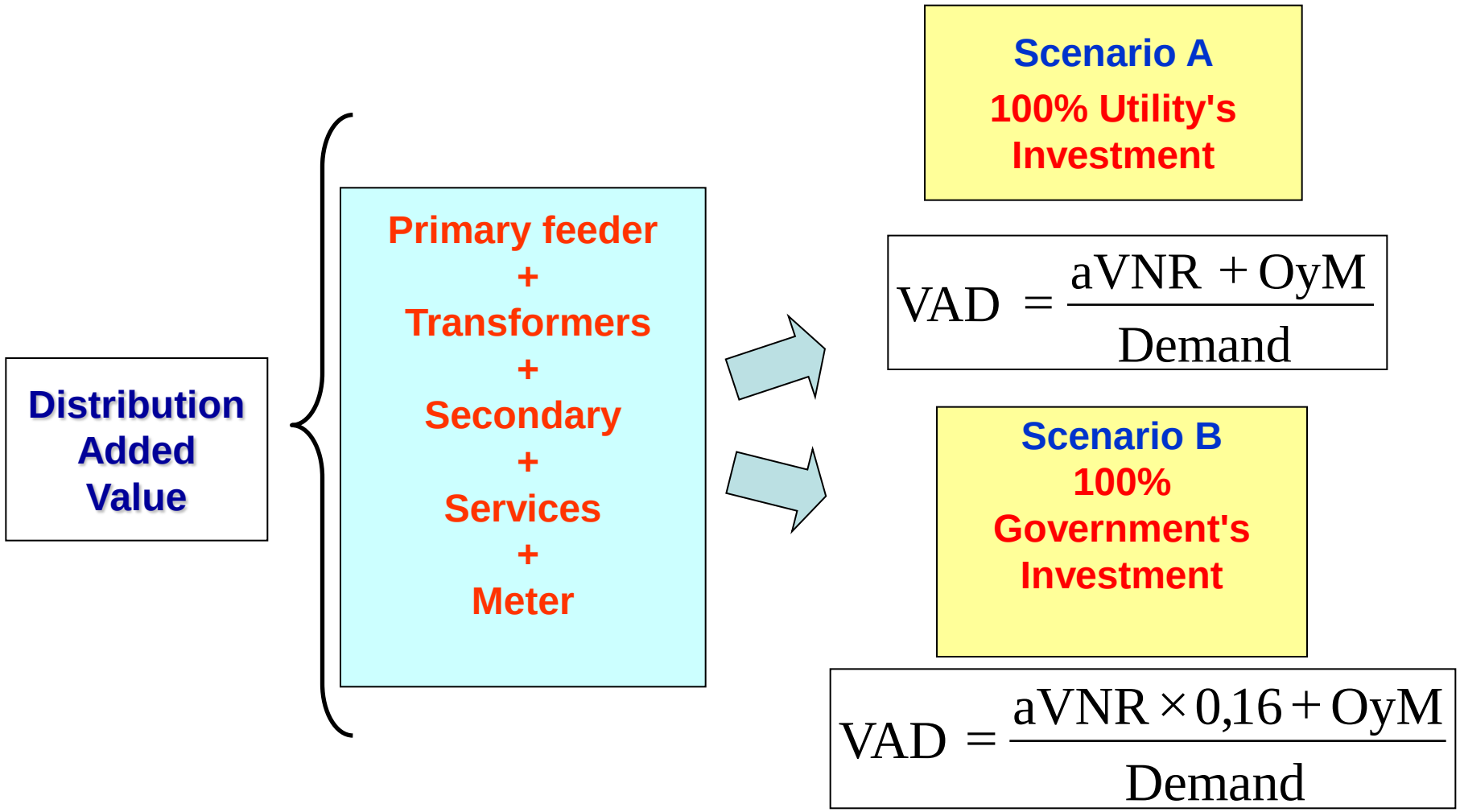
Where:

a VNR = NRV annuity (Efficient Electric Investment)

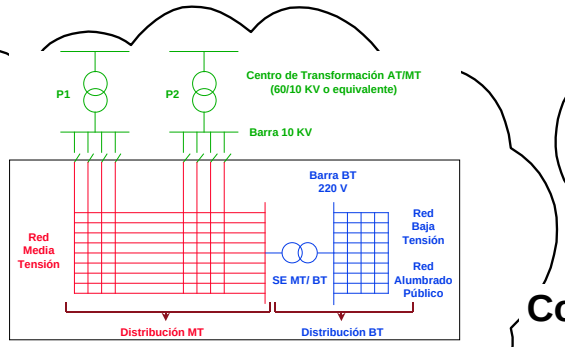
O&M = Efficient operation & maintenance cost

MD = Annual maximum peak load of the electric distribution system

Components of the Distribution Added Value

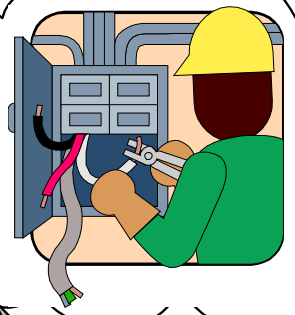


Distribution Added Value Calculation



Cost of Capital

Cost of Operation & Maintenance



Cost of commercialization

MODEL COMPANY

DATA:
- Peak load
- Customers
- Operation & maintenance costs
- Installation costs

TARIFFS

Medium Voltage DAV &
Secondary Voltage DAV

Technical standards

Medium Voltage	Urban	Rural
Level of Voltage	13.2 KV/7.62 kV- 10 KV	22.9/13.2 kV
Phases	Predominantly 3Φ	Predominantly 1Φ - Earth Return (one wire)
Line		
Wire	Alloy Aluminium Still Conductor (AASC)	Aluminium Conductor Still Reinforced (ACSR)
N° Estructures/km	14	9
Span (meters)	70	115

Technical standards

Low Voltage	Urban	Rural
Level of Voltage	220 Volts	440/220 Volts
Phases	Predominantly 3Φ	Predominantly 1Φ
Transformer	**> 50 - 400 KVA**	**1.5 KVA - 50 KVA**
Grid		
Wire	Aluminium	Aluminium
N° Estructures/km	28	14
Span (meters)	35 m	70 m

Relevant standard cost of operations and maintenance

Activity	Urban	Rural
Medium Voltage (US$/km)	489	142
Low Voltage (US$/km)	573	180
Public Lighting (per light)	10	6

Relevant Standard of quality

Technical	**Urban**	**Rural**
SAIDI	16	47
SAIFI	9	19
Product (voltage drop)		
Medium Voltage	5%	6%
Low Voltage	5%	7.50%

Relevant differences in consumption

Residencial	Urban	Rural Consolidated	Rural Expansion
Average monthly consumption per consumer (kW.h)	100	30	12

Rural Tariff for a Distribution Company (DISCO)

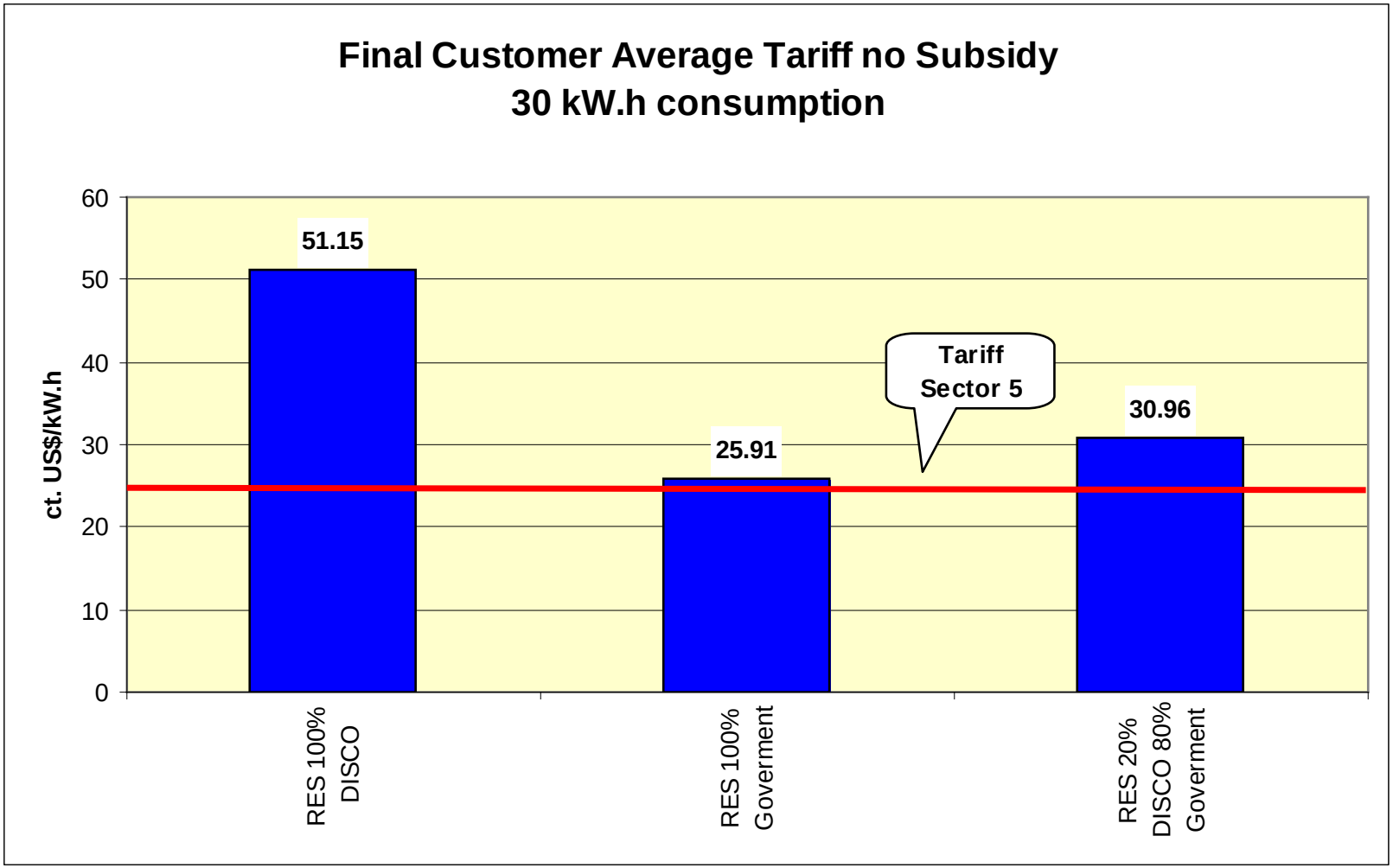
	Sector 5	Scenario A (1)	Scenario B (2)	RES 20% DISCO 80% Goverment
New Replacement Value - NRV (thousand US$)				
NRV medium voltage	2,210.5	795.8	795.8	795.8
NRV low voltage	3,504.2	1,261.5	1,261.5	1,261.5
Service medium voltage	---	78.0	78.0	78.0
Service low voltage	---	577.5	577.5	577.5
Total	5,714.7	2,712.8	2,712.8	2,712.8
Annual Investment Cost (thousand US$)				
Primary distribution	274.4	98.8	---	19.8
Secondary distribution	435.0	156.6	---	31.3
Service medium voltage	---	9.7	---	1.9
Service low voltage	---	71.7	---	14.3
Replacement Cost (thousand US$)				
Primary distribution	---	---	15.8	12.6
Secondary distribution	---	---	25.1	20.0
Service medium voltage	---	---	1.5	1.2
Service low voltage	---	---	11.5	9.2
Annual O&M (thousand US$)				
Primary distribution	96.0	34.6	34.6	34.6
Secondary distribution	156.6	56.4	56.4	56.4
Service medium voltage	---	0.3	0.3	0.3
Service low voltage	---	8.9	8.9	8.9
Peak Load (kW)				
Primary distribution	3,057.0	395.0	395.0	395.0
Secondary distribution	2,458.0	395.0	395.0	395.0

Distribution Added Value - DAV				
DAV medium voltage US$/kW-month	9.7	29.1	10.8	14.5
DAV low voltage US$/kW-month	19.3	59.5	21.1	28.8

(1) Rural Electrification System 100% DISCO

(2) Rural Electrification System 100% Goverment

Final Rural Retail Tariffs

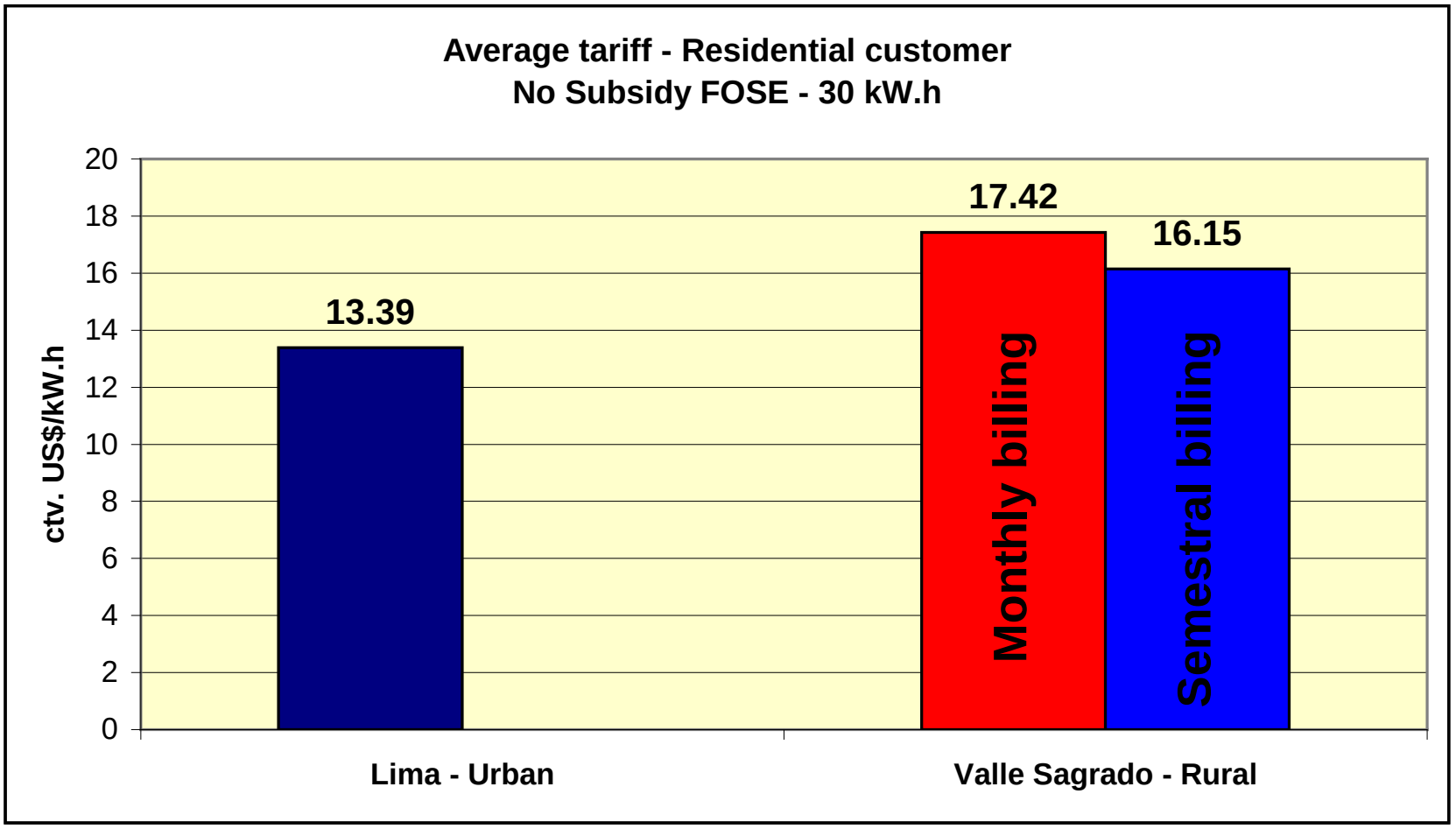


#2--Internal tariff subsidy

Internal Tariff Subsidies – Objectives –

- Isolated Generation Price Internal Subsidy
  - Objective: compensate the differential between the isolated generation prices with the bus bar price of the national interconnected system
- Distribution Added Value Internal Subsidy
  - Objective: compensate the differential price between rural and urban areas

Final Rural Retail Tariffs: With DAV Subsidy (#2)



#3--Consumption subsidy

Electricity Social Compensation Fund (FOSE)

Law 28307

Consumers	Typical sector	Monthly tariffs reduction - Consumption <= 30 KW.h	Monthly tariffs reduction - Consumption >= 30 KW.h and <= 100 Kw.h
Inerconected System	Urban	25%	7,5 kW.h
	Rural	50%	15 kW.h
Isolated System	Urban	50%	15 kW.h
	Rural	62.50%	18,75 kW.h

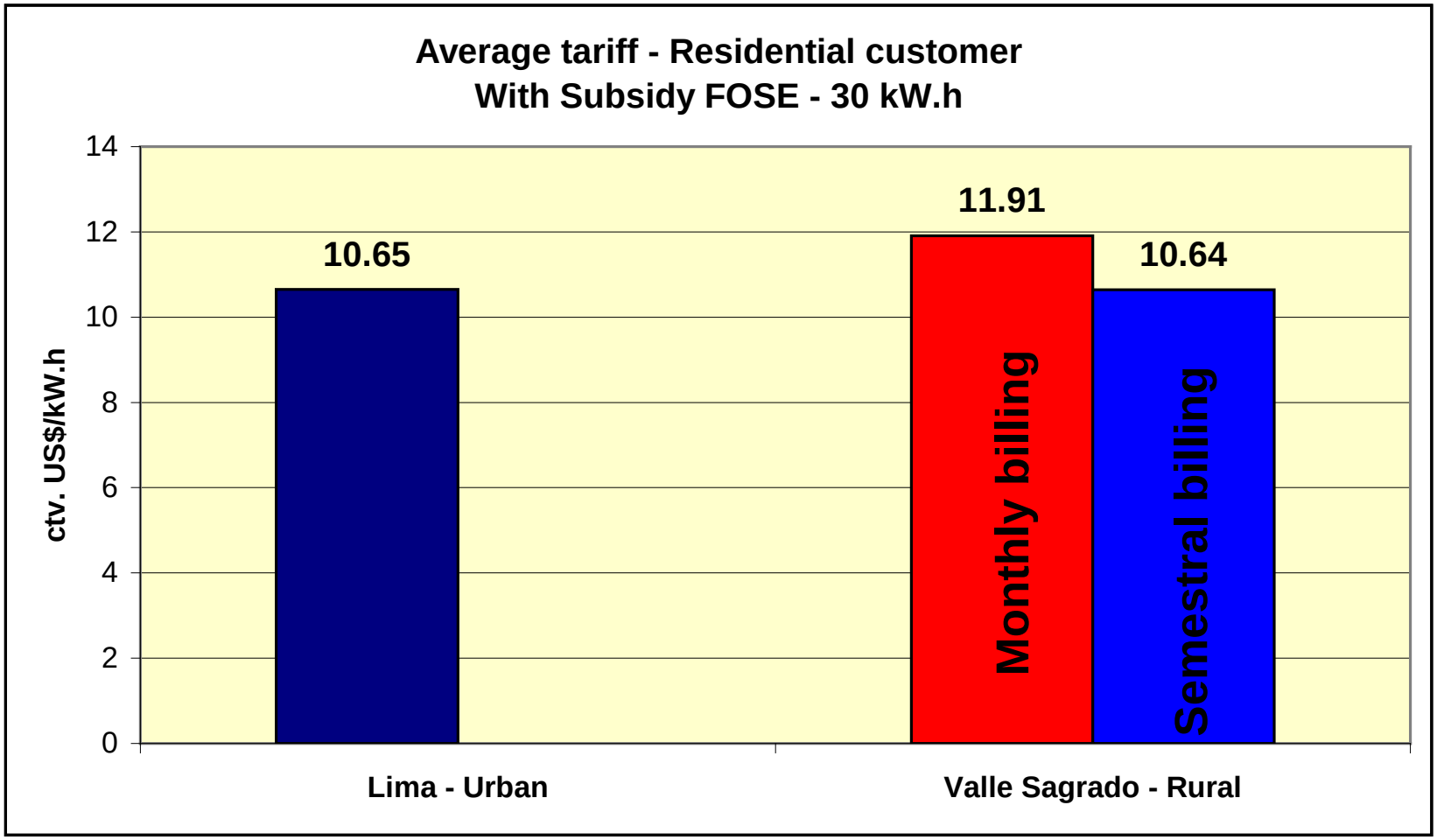
Electricity Social Compensation Fund (FOSE)

Range	Interconected	Isolated	Total	Percentage
0-30 kW.h	1 150 155	141 527	1 291 682	
31-100 kW.h	1 188 228	97 166	1 285 394	55%
> 100 kW.h (1)	2 031 648	72 705	2 104 353	45%
Total	4 370 031	311 398	4 681 429	100%

(1) Consumers with consumption > 100 kW.h are charged with 3% over their energy bill consumption.

FOSE collection : Million US$ 30.7 per year

Final Rural Retail Tariffs: Without Capital Cost, DAV & FOSE Subsidies (#1, #2 and #3)



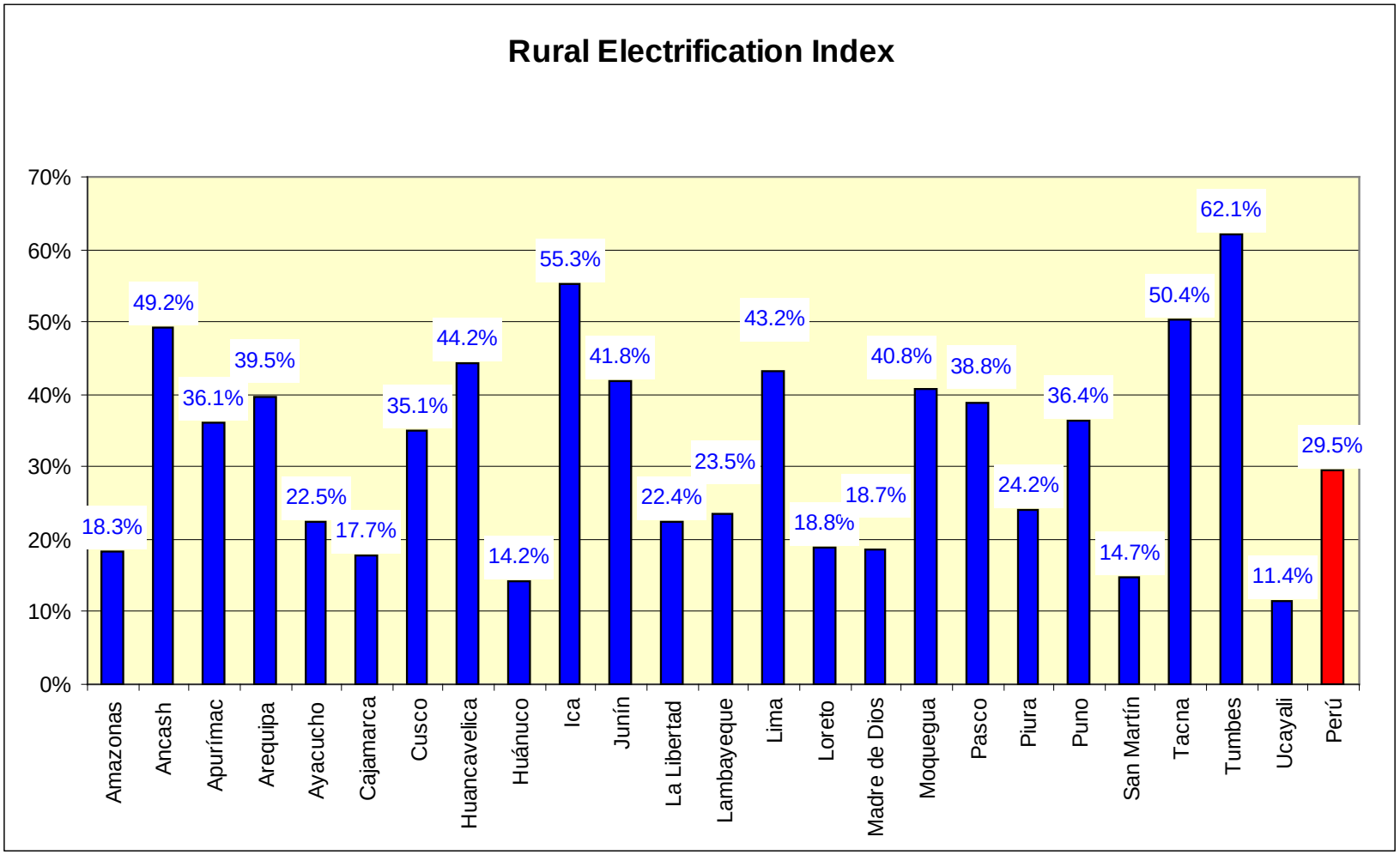
Conclusions

- The subsidies to the initial cost of capital are necessary to promote the expansion of the rural systems.
- The subsidized initial cost of capital must be incorporated as sunk capital and the tariff must pay the reposition and the cost of O&M.
- The subsidies to DAV (capital and O&M) are very important for reducing tariff disparities between rural and urban consumers within a single electricity concession.
- The rural tariff must recognize the economic cost of service to the utilities. Thus, the subsidies must be given by the urban consumer with high consumption of energy.
- The subsidies to the consumption are very important to equalize rural tariffs with urban tariffs paid by customers in the capital of the republic.

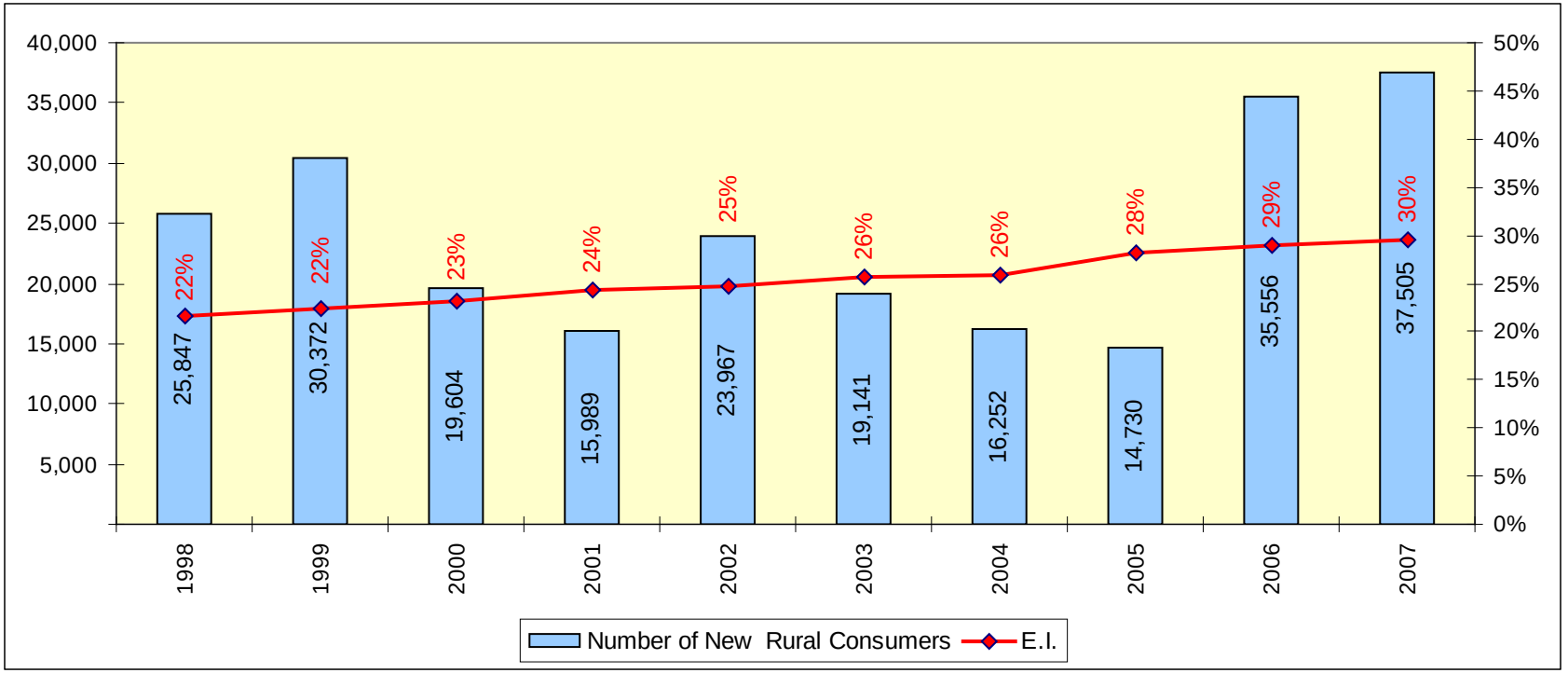
Thank you !

Appendix

Peruvian Rural Electrification Index



Number of New Rural Consumers VS Rural Electrification Index



Effective Mechanism for Management of the Subsidy Fund

- The problem of the Value Added Tax (VAT)
  - Who is responsible for the construction of the rural grid expansion or isolated mini-grid?
    - The government (central, regional or municipality).
    - The electric distribution utility.
  - What is the effect of VAT in the subsidy fund?
    - If the government directly constructs the grid expansion or isolated mini-grid, the VAT is charged to the subsidy fund.
    - If the utility constructs the grid expansion, the VAT is not a cost.

Capital Cost Subsidies Granted in Peru

Mechanism of Subsidy / Entity that built the grid extension	Number of Projects (a)	Cost of each project (thousands of US$)	Valued Added Tax (/2)	Apport to the project over total cost (%) (/3)	Initial Subsidy Fund (thousands of US$)	Net fund	Number of financed projects
	(a)	(b)	(c)	(d)	(e)	(f)	(f/a)
Without competition (/1)							
Ministry of the sector/ Regional government/ Municipalities	10	100	19%	0	1000	810	8
With competition							
Electric Distribuition Utility (10%)	10	100	0	10%	1000	1100	11
Electric Distribuition Utility (20%)	10	100	0	20%	1000	1200	12

/1 Usually the government cosntruct the facilities
/2 Utility pass the VAT to the final consumer through tariffs
/3 Utilities to obtain the funds apport a percentage of the initial cost of Capital