T&D Report 2005
Edition 5
Report & Database

The Growth of the World's T&D Systems
&
Markets for Transmission and Distribution Equipment
2005 - 2010

The T&D Report & Database
World Markets for Transmission and Distribution Equipment - Ed 5 - 2005

The report consists of 4 volumes

- Volume 1 -The Growth of the World's T&D Systems & Markets for T&D Equipment 2005 - 2010
- Volumes 2 to 4 - International and National Grid Maps

The database consists of one Excel file

Volume 1:

This volume contains market analysis and trend commentary, globally and separately for each country. The country sections contain text and the major markets contain a detailed summary of market parameters as in the following example.

Largest generator by capacity - 30% Top 3 producers by capacity - 65% Installed capacity - 7,770 MW - 40 Generators 12 generation companies Magyar Villamos Muvek Rt (MVM) had a "technical" 40% share of production in 2004. The top 3 have 65% and 6 companies each have at lea\st 5%. 10 are owned by private investors Tractebel, RWE, AES, ATEL, EDF, Croesus, E.ON
Large companies present Largest - MVM Other significant - EDF, EON, RWE
TSO - 1 state-owned company MAVIR Magyar Villamosenergia-ipari Reendszeriranyito Rt Legally unbundled
Network access - Single buyer model, with regulated third party access currently an issue awaiting decision
Monitoring of wholesale/balancing market - ni
Import capacity as % of installed capacity - 38%
DNOs - 6 regional distribution/supply companies owned by RWE, E.ON, EDF
Regulator -Hungarian Energy Office (HEO)
Implementation of market opening - 2003 Market opening 2005 - 67% Full market opening - 2005-2010
How charges are set - Regulated
Dominant single generator within balancing area - Yes
Number of active licensed suppliers - 26
Number of suppliers independent of DNO - 20
Number of suppliers with share > 5% - 7
Top 3 suppliers share - 56%
Switching since market opening Large eligible industrial users - 24% Small commercial / domestic - ni
Eligible customers 2004 - Non residential
Exchange - Pool
Transmission line length (120 kV) - 3,383 km Distribution line length - 156,228 km

This volume contains an outline of the major companies in the global T&D market with market shares, voltage analysis by country, and analysis of underground and overhead lines with data for Europe.

Forecasts of capital expenditure and demand for eight T&D product and business categories from 2004 to 2010 are included.

Network data

Volume 1 details historical data from 1970 to 2005 and annual forecasts from 2005 to 2010 of line lengths for transmission and distribution networks and system capacity for each of 184 countries. Also included are estimates of new installations and replacements (40 year life).

Transmission line lengths km
1. Installed line lengths km 1970-2010 (5 yrs)
2. Installed line lengths km 2004-2009 (1 yr)
3. Annual new and 40 year old line lengths km

Distribution line lengths km
4. Installed line lengths km 1970-2010 (5 yrs)
5. Installed line lengths km 2004-2009 (1 yr)
6. Annual new and 40 year old line lengths km

System capacity MVA
7. Installed capacity MVA 1970-2010 (5 yrs)
8. Installed capacity MVA 2004-2009 (1 yr)
9. Annual new and 40 year old capacity MVA

Market data

Market forecasts in current value $ annually from 2005 to 2010, with 2004 base year shown
10. T&D capital expenditure
11. Total T&D equipment market
12. Power and distribution transformers
13. Switchgear markets
14. Power systems
15. Utility automation
16. HV insulated cables
17. Overhead lines
18. Insulators, bushings and fittings
19. EHV transmission towers

Volume 3, 2, 4:

These three volumes contain a comprehensive portfolio of international and national Grid Maps. The maps are in separate documents so they can be used as a quick and easy reference tool.

International grids
UCTE
ETSO
CENTREL
UPS Russia
SUDEL
North Africa
Medring
Pan-Africa
South African Power Pool
West Africa
USA
Current and Vision 2030
Canada
USA-Canada interconnections
USA-Mexico interconnections
SIEPAC (Central America)
South America interconnections
ASEAN Power Grid
Country Grids – 64 countries covered
Europe – 30 countries
CIS – 4 countries
Africa Middle East – 6
Asia – 13
Latin America – 11
(The maps have been split into a separate volume because the size of the pdf file is so large.)

Excel database

Network data
Transmission line lengths km
1. Installed line lengths km 1970-2010 (5 yrs)
2. Installed line lengths km 2004-2009 (1 yr)
3. Annual new and 40 year old line lengths km

Distribution line lengths km
4. Installed line lengths km 1970-2010 (5 yrs)
5. Installed line lengths km 2004-2009 (1 yr)
6. Annual new and 40 year old line lengths km

System capacity MVA
7. Installed capacity MVA 1970-2010 (5 yrs)
8. Installed capacity MVA 2004-2009 (1 yr)
9. Annual new and 40 year old capacity MVA

Voltage levels and underground/overhead lines
10. Analysis of voltage levels of T&D lines by km for 137 countries (7 spreadsheets)
11. Analysis of underground/overhead lines by voltage and km for 51 countries (6 spreadsheets)

Market data
Market forecasts in current value $ annually from 2005 to 2010, with 2004 base year shown
12. T&D capital expenditure
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20. Insulators, bushings and fittings
21. EHV transmission towers

Price of Volumes 1, 2, 3, 4 - £1,800
Price of Excel Database - £1400
Package price for reports and excel database - £2,400
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T&D

What is the T&D market?

The estimated size of the T&D market depends on the definition used. There is an increasing industrial trend for manufacturers to expand the limits of their business sector, to go beyond the provision of "classical" products and to add on additional services and value, increasing the size of the potential market.

In the past the definitions used in the T&D market have consisted of six product-based categories; power and distribution transformers, switchgear, HV insulated cables, OH bare lines, insulators and fittings and EHV towers. ***ABS has now expanded this definition to include power systems and utility automation***. Both of these segments include products plus technology and the provision of services. In some cases these cross over the barrier from capex into opex.

At the same time, while technology is expanding the horizons of T&D operation, the traditional purely "product" segments such as wires and cable remain vital to the transmission and distribution networks, which could not exist without them.

Some leading industry players are competing in the more restricted high tech sectors of the market, others in specific product segments and others in both.

In the 5th Edition of the T&D Report, ABS has viewed the issue dynamically and identified two markets. A broader market has been identified, encompassing all sectors, from basic products to the most advanced technology used today in transmission and distribution. Within that we have quantified an "addressable" market, within which the top end market leaders operate, which comprises 58% of the overall market.

Regional Market Size and Growth

The composition of demand varies considerably, with Asia, Europe and North America being the three largest regional markets. The first of these markets is primarily one of new installations, but the mature markets of Europe and North America are replacement markets.

Demand growth is substantially different from region to region, with the fastest growing markets at over double the rate of growth of the mature markets.

Unified Transmission Systems - The Age of the Large Grids

The T&D report contains a detailed analysis of the US transmission system, its development and history, its composition and current extent. The main recent failures and outages are listed and outlined.

A great deal of discussion is currently going on in the US as to the future transmission system of the US. The structure is repeatedly called the "engineering marvel" of the twentieth century in the US, but we are now in the twenty first century and new concepts are needed. The report outlines "Vision 2030", the concept of the Office of Transmission and Distribution of the US Department of Energy, which looks into the requirements of twenty first century America.

Other regions are facing similar demands. In Europe the EU has identified similar problems and is fast tracking projects to expand cross border interconnection capacity.

In China the problem is essentially the same but it has arisen from different needs. The vast pace of economic growth and power demand has created the need to move large amounts of high voltage power around the country. The transmission system was built to satisfy local and at the most regional needs. In the early days bulk the lack of adequate long distance transmission necessitated moving huge quantities of coal across long distances by rail, from the coal mines to the generation plants at the load centres, and in the process paralysing the industrial economy by denying it transport facilities. Today, China is on the way to creating a completely modern, unified power system with an EHV backbone linking every region in the country.

India and Brazil are moving in the same direction. The Medring, encircling the Mediterranean and interconnecting its littoral countries, is doing the same in its part of the world.

These developments are happening under national and regional cooperations. There is no global entity making it happen. The T&D Report outlines many of the initiatives and this inevitable trend of the future.

One country thought of this a long time ago, the Russian Federation. Despite many problems and difficulties caused by lack of investment and maintenance, the system that the UPS of UES RAO inherited from the Soviet Union is the longest and highest voltage Unified Transmission System in the world.

The ABS T&D Report, in addition to statistics and market outlines, contains important information about the main T&D companies.

The T&D market has been through a series of realignments, consisting of mergers and closures, in recent years, a process which is not yet finished. In the core market with high technology value-added, three companies dominate; ABB with a market share of (%) of the "addressable" market, followed by Siemens (now including VA Tech) with a combined (%) share and Areva (which has acquired Alstom's T&D interests) with (%). Each company has experienced difficulties and undergone restructuring.

In the broader T&D market which includes wires and cables, the shares of these three leaders are diluted but they are still dominant. The share of an important player, GE Energy is unknown but significant. Second level players include about fifteen international companies, which are listed in the report.

The three leaders (ABB, Siemens and Areva) have all exited the wires and cables market, which has endured the most difficult conditions of all the business segments in the T&D market, with increased competition and over capacity of production.

The rest of the industry is composed of many, amounting to thousands, of medium and small companies, mostly concentrating in one or two business or product categories and operating within regional or national markets.

ABS has conducted thorough research of the market to produce in-depth analysis allowing the reader of the T&D Report Ed 5 2005 to define the global market, understand how it is evolving, what the major developments are and who are the companies shaping the market,

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Albania

Table 3.1: ESI Characteristics in Albania

Generators - 1 KESH Korporata Elektroenergjetika Shqiptare Vertically integrated state-owned power monopoly
Large companies present Largest – Only KESH
TSO – 1 KESH Korporata Elektroenergjetika Shqiptare Legally unbundled
TSO independence Ownership - Yes Legal form - Yes Organisation – Yes
TSO owner of grid assets – Yes, subsidiary of KESH
Network access – TPA legislation but no eligible customers or suppliers
Market model – Not yet agreed, regulated market planned for initial opening
Bilateral contracts – No
Monitoring of wholesale/balancing market – ni
Import capacity as % of installed capacity – 25%
DNO - 1 KESH subsidiary Separate from TSO – yes Managed
Regulator – Electricity Regulatory Authority (ERE) Ex-post
Implementation of market opening - None Market opening 2005 – 8% Full market opening - Not yet documented
How charges are set – Government sets
Dominant single generator within balancing area – 1
Number of active licensed suppliers – 1
Number of suppliers independent of DNO - 0
Number of suppliers with share > 5% - 1
Top 3 suppliers share – 100%
Switching since market opening Large eligible industrial users – 0% Small commercial / domestic – 0%
Eligible customers 2005 – 50GWh
Number of licensed suppliers other than DNOs – None
Exchange – None
Transmission line length (35 kV) – 3,812 km Distribution line length – 41,142 km

The government department responsible for power supply is the National Energy Committee, located in the same office as the Ministry of Public Economy and Privatisation. In 1997 operational responsibility for generation, transmission and distribution was vested in KESH, Kororata Elektroenergetike Shqipetare. Distribution is via 38 subsidiary distribution entities, including Shkoder, Elbasan and Vlora, which were subject to an unsuccessful pilot privatisation project. KESH as a whole and the distribution entities in particular require considerable restructuring to improve their operational efficiency, financial and commercial discipline. High levels of non-technical losses and widespread non-payment of electricity bills have become chronic.

The transmission system operates at 35, 110, 220 and 400 kV. Total line lengths amounted to 3,812 km in 2005.

The distribution network is comprised of 41,142 km of line at 10, 6 kV and 400 Volts.

Albania has the following international interconnections with Greece and FR Serbia Montenegro.

- One 400 kV crossing from Elbasan in central-southeast Albania to Kardia in Northern Greece, currently restricted to 230 MW due to the limited capacity of the 400/220 kV sub-station at Elbasan.
- Two 220 kV lines, one from Vau Dejes in Albania to Podgorica in Serbia Montenegro and a second from Fierze in Albania to Prizren Serbia Montenegro.
- A 110 kV line connects Bistrica in south Albania with Mourtas in western Greece. The system works in parallel with the European network via the 400 kV interconnection line from Elbasan to Kardia. In 1992 a total of 185 HV substations had a total installed capacity of 4,450 MVA.

A new link with Macedonia is planned.

Most of the equipment in the 220 and 110 kV substations is of older Chinese, Russian or Serbia Montenegron manufacture and many require substantial rehabilitation. In many cases spare parts are no longer available. Inadequate maintenance and development has resulted in a poor service which is not adequate or the country's needs. Work had begun on the reconstruction of parts of the Albanian electricity network on the basis of a joint study by ENEL and Albania's electricity corporation, with a substation in Tirana being modernised and future modernisation planned for other substations. The programme of work also includes the construction of new substations and the upgrading of the network's capacity, with most of the finance from an Italian government aid package. A Power Transmission System Feasibility Study has been conducted by Electroconsult of Italy, to plan for reliable operation by 2000 and to meet expected demand by 2005. The study recommended that the development of the transmission system be based on the following criteria.

- 110 kV lines should be interconnected to operate as a mesh similar to the 220 kV system.

- A single contingency including an outage of a 220 kV line, a 100 kV line or a substation transformer should not cause a thermal overload or a curtailment of load.
- New 110 kV transformers will be either 16, 25 or 40 MVA with an overload capability of 30%.
- The minimum operating range of the 110 kV line to be 105kV and the maximum 125 kV, with a normal level of 117 kV. The minimum and maximum voltage level should not be exceeded for any single contingency.
- The minimum and maximum operating range of the 220 kV line should be 209 kV and 245 kV with a normal level of 220 kV. The minimum and maximum voltage level should not be exceeded for any single contingency.
- The system shall not cascade into a major outage for a three phase fault that would result in the loss of the largest generator or a major 220 kV line.

The present 220 kV bulk system is adequate for load requirements up to 2005 but the 110 kV system is not adequate, either in transmission facilities or in transformer capacity.

Albania faces a very difficult situation, with a lack of power, limited interconnection capacity and other technical and organisational problems concerning the operation of the system. Although Albania is not a formal member of UCTE, it is interconnected synchronously within the UCTE 2 and considering its geographical position it will probably eventually be interconnected to the main UCTE grid together with the other power systems in the region.

14. Methodology of Models and Forecasts

Methodology

The methodology of the market size estimates and forecasts of development of the transmission and distribution systems consisted of four stages, combining a top-down and a bottom-up approach. This methodology was found to be effective in creating the forecasts of electrical generating capacity in ABS Power Predictor, the companion study to the present volume. This has been augmented with independent forecasts for individual product groups which incorporate import and export data and where available production data.

ABS has now built up a series of over 20 separate forecasts of different components and aspects of the electricity supply industry globally. This collection of separate forecasts is valuable in providing validation of each forecast. For example, a database and forecast has been constructed for power and distribution transformers from commercial data (import, export and production figures). From the T&D Study, we can estimate transformer demand as a constituent of total capex, since we have established how capex is broken down. Each of these separate estimates either confirms of contradicts the other and we can reconcile them.

Stage 1 - T&D forecasts

The Master Database

All available data about electrical installed capacity, transmission and distribution that we can locate is entered into a master database, which ABS started in 1993 and is continually up-dating. We have been able to augment this unique database continually since it was started and additional retrospective data become available all the time. Each report in this series is therefore based on better source data than it predecessors and sometimes the figure change radically. Generally there is less information available about transmission and distribution than about generation.

Basic information about electricity generation and consumption is included in the database historically from 1970 to the present for every country and for the major countries representing 83% of the world's installed capacity as far back as 1950. Original information about transmission and distribution is included in the database for 154 countries, varying in extent. In some cases it is extensive and over a period of time, in other cases it is restricted to circuit lengths of transmission and/or distribution lines at one point in time. The database contains information on the following areas:

- Installed generating capacity (MW), analysed by fuel type
- Transmission line lengths by voltage (kV),
- MV and LV distribution line lengths by voltage (kV and V),
- Transmission and distribution system capacity (MVA)
- Capital expenditure on generation, transmission and distribution, in some countries overall and in some cases broken by generation, transmission and distribution separately.

Information has been obtained from utility company reports, national industry association reports, national government statistics and international agencies.

The data available to the analyst is variable. Some very small national utilities have published exemplary reports for many years, with all the information required. There are several in Africa, the Middle East and Asia. The records of these countries are extremely valuable in providing benchmarks for similar economies where only the most elementary electrical statistics exist and which have to be modelled.

Most of the industrialised countries publish reasonably comprehensive information but by no means all. Data about distribution systems is much less common that for transmission. Detailed information is now becoming available for many of the former Comecon countries, which is a major advance on the accessible information available for the earlier editions of this report.

The data comes in so many forms and from so many sources that many conversions were required, the most common being from miles to kilometres. The sources were not all for the same year, so care is taken to ensure that data is recorded in the right year, where necessary being projected forwards or backwards to the base year for forecasting.

ABS is also building a library of maps of international systems and national networks, mostly reproduced from maps published by national TSOs and major utilities.

Capital expenditure validation

We have located national capital expenditure data published by utilities for transmission and distribution for 19 individual countries, representing 63% of the world's total estimated capital expenditure on transmission and distribution.

The major manurfacturers of T&D equipment and systems publish various reports and presentations with varying amounts of data. Some of these are detailed and contain market size estimates and shares for the major manufacturers. The definitions and product categories differ from company to company but overall these sources provide valuable confirmations of order of magnitude and rankings.

Two official international energy agencies publish estimates for Europe and the world, and these figures are within 5% and 3.7% respectively.

Stage 2

A set of models was created for all countries, based on the date categories in the Master Database.

- Installed generating capacity, MW
- Transmission line lengths, circuit km
- Distribution line lengths, circuit km
- Transformer capacity, MVA
- Capital expenditure on transmission and distribution, US$
- Capital expenditure on HV transformers
- Capital expenditure on switchgear
- Capital expenditure on power systems
- Capital expenditure on utility automation
- Capital expenditure on HV insulated cable
- Capital expenditure on insulators, lightning arresters and fittings
- Capital expenditure on EHV transmission towers

These models forecast system data in five year intervals from 2000 to 2010 and annually from 2005 to 2010 and product data annually from 2005 to 2010. Where past data is available it has been entered and where not available, estimates have been made. The global market was modelled on different criteria; installed generating capacity, transmission line lengths and transformer capacity and a series of projections made. Time series projections have been made on the basis of a number of variables.

The design of transmission and distribution networks varies considerably. Although there are patterns, there are also many exceptions to the patterns. This is apparent when comparing the ratios of network step-down transformer capacity (MVA) to installed generating capacity (MW). These ratios range from just under 2.2 to 7.5 and can be classified into three ranges. The high ratios exist in advanced countries with high levels of industrialisation and residential coverage. The lowest levels exist in countries with very little industrialisation and low domestic electrification. The patterns are clearer in the top and bottom category (> 6 and < 4) than in the middle group (4-6).

MVA: MW > 6

33 countries have transmission and distribution systems with MVA capacity 6 or more times the installed generating capacity, ranging from 2-3 times generating capacity in the transmission and sub-transmission systems and 3-4 in the distribution system. They are mostly High Income, with dense population concentrations (using World Bank classifications) in the Pacific, Europe and North America.

Seven are Upper Middle Income countries among the richer Eastern European countries. Hong Kong, Macau and several Caribbean islands also come into this category. These are the systems with well developed ring main grids serving large numbers of urban domestic consumers and a wide range of industrial and commercial customers. Typically these systems employ a lot of MV distribution drawing electricity from different generating sources to provide backup in case of power outages.

MVA: MW - 4 to 6

62 countries have an MVA: MW ratio between 4 and 6, indicating an intermediate network of both transmission and distribution. This compares with 42 in the previous study, indicating a substantial development of systems. These countries can be classified into several groups, ranging for those large countries which have specifically identified inadequate EHV and HV transmission as an obstacle to development; notably India and China.

Medium sized Upper Middle and Lower Middle Income countries. These include many of the CIS states and others scattered around the world, without any significant pattern. They also include geographically small countries without a need for much transmission capacity.

MVA: MW < 4

Countries with an MVA: MW ratio of < 4 mostly have Lower or Lower Middle Income economies, primarily developing countries in Asia or Africa. These countries have low electrification ratios. Because of distance and low demand in rural areas, isolated systems and renewable sources are used to reduce the need for transmission. The priority in these countries is to deliver power for centralised use, particularly industrial or governmental. In some African countries the numbers of electricity customers is extremely small. Malawi has 41,000 domestic consumers out of a total of 53,000, Mozambique has 128,000 out of 149,000 and Namibia has only 1,029 rural customers out of a total of 1,453. It was not the first priority of the planners to distribute power widely and the most basic radial networks are used, transporting power from the generating point direct to a few single users.

In many Low Income countries it is imperative to substitute electricity or another commercial fuel for firewood. High levels of deforestation often exist and are on the increase. This not only causes ecological problems but uses too much labour inefficiently. In Nepal forest covers 37% of the land area and is diminishing at 100,000 hectares a year, while only 15,000 hectares are being reforested. It is estimated that in the worst cases family members spend no less than five hours a day searching for firewood with the consequent loss of productive labour to the economy.

Rural electrification is regarded as a priority in Upper Middle and Lower Middle Income developing countries which are through the first economic hurdle, for several reasons. There is a genuine desire on the part of governments to improve living conditions and to increase literacy by enabling people to read at night. Perhaps a more pressing reason is a direct result of the rush for development, the need to reduce the flow of rural population into cities. The emergence of "mega-cities" in the developing world is a phenomenon of the last two to three decades and has urgent implications for network planners. The population of Mexico City now exceeds 17 million. In the last fifteen years over 2,600 MW of generating capacity has been installed to pump water and to process waste for the burgeoning population of the city. Before the massive inflow of rural population no electricity was consumed for water and waste, which were catered for locally. The consequent drain on the economy and the retardation of development is obvious. If rural areas had been electrified the emigration to cities would have been reduced and local economies enhanced. The inefficiency is compounded by the fact that when populations arrive in cities not only is the cost of other infrastructural support services higher but large urban areas then have to be electrified. There will be changes in the pattern of electrical distribution in these countries.

There are a few Upper Middle Income countries in Africa with an MVA: MW ratio of 4 or less.

These ratios form one of the data in-puts used to model the systems where no information exists and in others to validate it.

Stage 3

A literature search together with interviews with executives in the power and engineering industries have been conducted to construct a set of ratios of the composition of total capital cost for `its components; land purchase or way rights, design and engineering, construction, M&L direct cost, FLOH indirect field cost and finance cost. There are wide variations in the composition of these costs. Average figures should not be used without careful evaluation of each situation but as an indicator. For example, there is a land cost in constructing distribution networks for Greenfield developments but there is no additional land cost in up-

grading either underground cables or overhead lines. Important issues in the transmission and distribution sector were explored in these interviews.

A set of models was constructed for product composition within the market when producing the first edition of this report in 1996. These models have been reviewed and adjustments made in 1999, in 2002 and 2004.

Stage 4

The final stage of analysis was a bottom-up examination of every estimate in the spreadsheets. Each figure was scrutinised in the light of market experience and carefully evaluated. Particular attention has been paid to evaluation of the actual achievements of governments against published development plans and targets. This is an area requiring considerable experience of the markets because the outcomes are not always obvious. An example is a comparison between India and Taiwan. Some knowledge of the Indian power market will reveal very quickly that India has not achieved a single power target in the Development Plans throughout the past fifty years and it is wise to be conservative about the targets in the current Ninth Plan. In comparison, Taiwan has an extraordinary record of economic development and with a very efficient power utility it is easy to accept that targets will be met. However, Taiwan is also experiencing a growing tide towards grass roots democracy and rapidly escalating public awareness about environmental issues. This is largely because of the pace of economic development which has lead to unchecked exploitation of resources and lack of controls. As a result of this Taipower has had to revise its annual plans repeatedly, as protestors block the construction of new power stations and overhead transmission lines.

Large country models – USA, China, Russia, Brazil

The Federal Electrical Reliability Council of the United States (FERC) publishes the most comprehensive information and analysis of the country's electricity industry provided by any country, with one exception; data about transmission below the bulk system operated at 230 kV and above is not collected and consolidated.

Information was obtained for as many large investor owned and Federal or State-owned utilities as possible and samples of 207 municipals and 198 rural cooperatives were itemised. The numbers sampled and the universes in each category are shown below.

Table 14.1: Sample composition of US utilities

Ownership	Sampled	Universe
Investors	187	216
Federal or State	119	189
Municipal transmission	207	1,085
Municipal distribution	207	1,718
Cooperative transmission	198	603
Cooperative distribution	198	764

Note that the municipals and cooperatives are a mixture of transmission and distribution companies, which accounts for the lower numbers than the totals published by FERC. The data from the sampled utilities was weighted up to the universe values to give a total estimate of distribution lines for the US. The figures estimated in Ed 3 of this report were higher than those in Ed 2, firstly because of actual growth but also because a larger sample was employed and we consider that the previous estimate was too low.

Russia publishes data for transmission but not for distribution. However, Ukraine has published comprehensive data from 400 V to 800 kV, which has enabled us to construct a model for Russia, making allowance for the long EHV transmission installations spanning the vast distances of the Russian Federation.

Likewise, China publishes data down to 35 kV but no lower. India publishes comprehensive figures for all transmission, distribution and reticulation. We have used these to model China but have made one allowance. The term "electrification" does not necessarily mean household electrification. In India a village is classified as "electrified" by the Ministry of Power if only one electric connection point exists. 86% of villages are classified as "electrified" but only 32% of rural households have direct access to electricity. In China electrification applies to households. This means that a ratio of reticulation to distribution in China will be higher than in India. However, it will not be that much higher because villages where electrification is only to one point are relatively small places and the additional wires to reach every household are not very long.

In Brazil, comprehensive data is given for urban transmission and distribution and for additions in the annual update of the 10 Year the Plan, to distribution in rural areas. The original installed base in rural areas is not given. We have had to make a judgemental estimate of the installed base prior to the new electrification programme.

16. Transmission & Distribution System Forecasts

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