CHAPTER 14

EXECUTION PLAN

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14.1 Finalization of Expansion Plan

14.1.1 Expansion Plans Discussed in Previous Section

As described in the preceding chapters, the Study Team has taken the following steps to come up with an economically optimum expansion plan.

In "Transmission / Substation Facilities Expansion Plan" (Chapter 6), the Study Team prepared two different expansion plans.

Case-A: The base plan in which any of the existing substations shall be expanded at the time when its peak load exceeds its installed capacity.

Case-B: A plan which takes the load shedding and overload operation into account. In this plan, any of the existing substations shall be expanded at the time when its peak load reaches 120% of its installed capacity.

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In "Conceptual Design of Target Facilities" (Chapter 7), the Study Team estimated the cost involved in each of the two expansion plans mentioned above.

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In "Economic Analysis" (Chapter 12), the Study Team made an economic analysis of Case-A and Case-B. As a result, it was confirmed that Case-B has an advantage over Case-A in terms of economic internal rate of return (EIRR).

Therefore, on the basis of Case-B, we shall finalize the master plan taking into consideration the results of the 4th field survey, opinions and requests of TANESCO, deferment of the projects that are planned to be carried out during 2002 and 2003, and so on. The final master plan shall be referred to as Case-B'.

14.1.2 Order of Projects

The year in which to execute each of the projects included in the expansion plan has been decided based on the following concept. 1st Priority is given to the facilities which was under an overload at the time of field study. Suitable measures (e.g., expansion) shall be taken earliest to the equipment to keep the facilities in sound condition. For equipment which has become so obsolescent that it might cause outages in the near future, it shall be replaced or rehabilitated as early as possible in consideration of the unfavorable effect to the current TANESCO's customers. Concerning equipment which is to be expanded to meet an increase in demand, the year in which to expand the equipment has been decided based on the results of demand forecast.

During the 4th field investigation, the Study Team presented its expansion plan (Case-A) to TANESCO. At that time, it was agreed that the projects planned to be executed in 2002/2003 should be selected as priority projects and that they should be subjected to detail designed. Although the above expansion plan was eventually revised, the projects that had been planned to be carried out in 2002/2003 were selected as priority projects in Case-B. In the final expansion plan (Case-B'), all those priority projects are planned to be carried out in 2003 and 2004 (the projects that were originally planned to be executed in 2002 are labeled Phase 1 projects, and those which were

originally planned to be executed in 2003 are labeled Phase 2 projects).

14.1.3 Deferment of Times to Start Projects

Concerning the projects that were planned to be started in 2002/2003 in Case-B, except for those which were already on-going at the time of the latest field survey, it is impossible to carry them out as scheduled in view of the time required for manufacturing and installation. Therefore, those projects, excepting the on-going ones, were deferred until 2004 or some other time when they become feasible. In this case, the projects originally planned for 2002 to 2004 will have to be executed in 2003 and 2004, hence the investment will concentrate in that year. To prevent this, the projects originally planned for 2004 were deferred to 2005. This deferment of the projects makes it necessary to continue implementing the load shedding until 2005. However, from the results of estimation in Case-B, it is considered that the decline in EIRR caused by the load shedding will not be very conspicuous. Deferment of projects in Dar es Salaam, Arusha, Kilimanjaro are shown in Table 14.1.1 and Table 14.1.2 respectively. Even some projects are defered, still many projects are concentrated in 2004 and 2005. However, this concentration seems to be unavoidable to relieve the critic distribution network in these regions

Table 14.1.1 Deferment of Projects in Dar es Salaam

Year	Name of S/S	Specification	Type	Remark	Name of Transmission Line	Specification	Type	Remark
2002	Mbezi S/S	33kV 15MVAx1	R/E	On Going				
	Bahari Beach S/S	33kV 15MVAx1	New	On Going	Tegeta-Bahari Beach	33kV 100mm^2 2cdt 13km	New	On Going
	Bagamoyo S/S	33kV 5MVAx1	New	=>2004(1st)	Tegeta-Bagamoyo	33kV 100mm^2 2cdt 60km	New	=>2004(1st)
	City Center S/S	33kV 30MVAx1	R/E	=>2004(1st)				
	Kurasini S/S	Switchgear	Replace	On Going				
	Ubungo S/S	33kV 15MVAx1	Expansion	On Going				
	Mikocheni S/S	33kV 15MVAx1	Expansion	=>2004(1st)				
	Magomeni S/S	33kV 15MVAx1	New	On Going	Magomeni-Magomeni Tap	33kV 100mm^2 1cdt 1km	New	On Going
	Tandika S/S	33kV 15MVAx1	New	=>2004(1st)	FZ III-Tandika	33kV 100mm^2 2cdt 5km	New	=>2004(1st)
	FZ III S/S	33kV Leadout	Expansion	=>2004(1st)				
	FZ I S/S	Panel, others	Replace	=>2004(1st)				
	FZ II S/S	Switchgear etc	Replace	=>2004(1st)				
2003	Sokoine S/S	33kV 15MVAx1	Expansion		City Center-Sokoine	33kV 100mm^2 1cdt 3km	Reinforce	
	City Center S/S	33kV Leadout	Expansion	=>2004(2nd)				
	Tandale S/S	33kV 15MVAx1	Expansion	=>2004(2nd)	Ubungo-Tandale Tap	33kV 100mm^2 2cdt 1km	New	=>2004(2nd)
	Ubungo S/S	33kV Leadout	Expansion	=>2004(2nd)				
	FZ III S/S	33kV 15MVAx1	Expansion					
	New Oysterbay S/S	132kV 45MVAx2	New	=>2004(2nd)	Ubungo-New Oysterbay	132kV 240mm^2 1cdt 8.5km	New	=>2004(2nd)
		33kV 15MVAx2						
	Ubungo S/S	132kV Leadout	Expansion	=>2004(2nd)				
	Oysterbay S/S	33kV 15MVAx1	R/E	=>2004(2nd)	New Oysterbay-Oysterbay	33kV 150mm^2 2cdt 1.6km	New	=>2004(2nd)
2004	Mbagala S/S	33kV 15MVAx1	Expansion	=>2005				
	Muhimbili S/S	33kV 15MVAx1	New	=>2005	Ilala-Muhimbili	33kV 100mm^2 1cdt 6km	New	=>2005
	Ilala S/S	33kV Leadout	Expansion	=>2005				
	TOL S/S	33kV 15MVAx1	New	=>2005	Ilala-TOL	33kV 100mm^2 2cdt 5km	New	=>2005
	Ilala S/S	33kV Leadout	Expansion	=>2005				
	University S/S	33kV 15MVAx1	New	=>2005	Ubungo-University	33kV 100mm^2 1cdt 7km	New	=>2005
	Ubungo S/S	33kV Leadout	Expansion	=>2005				
	Yombo S/S	132kV 45MVAx1	New	=>2005	FZ III-Yombo	132kV 240mm^2 1cdt 8.5km	New	=>2005
		33kV 15MVAx1	New	=>2005				
	FZ III S/S	132kV Leadout	Expansion	=>2005				
					Yombo-Mbagala	132kV 240mm^2 1cdt 10km	New	=>2005
	Kitunda S/S	33kV 15MVAx1	New	=>2005	Yombo-Kitunda	33kV 100mm^2 1cdt 3.9km	New	=>2005
	Mbagala S/S	132kV 45MVAx1	Expansion	=>2005	Kurasini-Mbagala	132kV 240mm^2 1cdt 16km	New	=>2005
	Kurasini S/S	132kV 45MVAx2	Expansion	=>2005	Ilala-Kurasini	132kV 240mm^2 1cdt 10km	New	=>2005
	Ilala S/S	132kV Leadout	Expansion	=>2005				
	Kurasini S/S	33kV 15MVAx1	Expansion	=>2005	Ilala-Kurasini	33kV 150mm^2 1cdt 7.1km	Reconductor	=>2005

Table 14.1.2 Deferment of Projects in Arusha, Kilimanjaro

Year	Name of S/S	Specification	Type	Remark	Name of Transmission Line	Specification	Type	Remark
2002	Njiro S/S	Switchgear	Replace	=>2004(1st)				
		132kV 45MVAx1	Expansion	=>2004(1st)				
	Mt. Meru S/S	33kV 10MVAx3	Expansion	=>2004(1st)	Njiro-Mt.Meru	33kV 100mm^2 7.3km	Reinforce	=>2004(1st)
	Kiyungi S/S	Switchgear etc	Replace	=>2004(1st)				
		132/33kV 45MVAx1	Expansion	=>2004(1st)				
	Boma Mbuzi S/S	Switchgear etc	Replace	=>2004(1st)	Kiyungi-Boma Mbuzi	33kV 100mm^2 7km	Reinforce	=>2004(1st)
		33kV 10MVAx1	Expansion	=>2004(1st)				
	Trade School S/S	33kV 10MVAx1	R/E	=>2004(1st)	Kiyungi-Trade School	33kV 100mm^2 10km	Reinforce	=>2004(1st)
	YMCA S/S	33kV 10MVAx1	New	On going				
	Marangu Sw/S	33kV	New	=>2004(1st)	Kiyungi-Marangu	33kV 100mm^2 43km	New	=>2004(1st)
2003	Unga LTD S/S	33kV 10MVAx3	R/E	=>2004(2st)	Njiro-Unga LTD	33kV 100mm^2 5.8km	Reinforce	=>2004(2st)
	Kiltex S/S	33kV 10MVAx1	R/E	=>2004(2st)				
	Machame S/S	33kV 5MVAx1	R/E	=>2004(2st)				
	Same S/S	Switchgear etc	Replace	=>2004(2st)				
2004	Usa River S/S	33kV 10MVAx1	New	=>2005	Njiro-Usa River	33kV 100mm^2 21.3km	New	=>2005
				=>2005	Tengeru-Usa River	33kV 100mm^2 12.5km	New	=>2005
	Monduli S/S	33kV 10MVAx1	New	=>2005	Njiro-Monduli	33kV 100mm^2 38.6km	New	=>2005

14.1.4 Requests and Opinions of TANESCO

During the 4th and 5th field survey, the Study Team presented the Case-A expansion plan to TANESCO. Concerning the times of execution and the contents of the proposed projects, TANESCO made the following comments, which were reflected in Case-B' where appropriate.

(1) Dar es Salaam

Table 14.1.3 Requests from TANESCO and Their Reflection to Master Plan (Dar es Salaam)

Requests from TANESCO	Reflection to Master Plan
Apply 240mm^2 conductors	Applied to New Oyseterbay-Ilala 33kV T/L and Kurasini-FZ-III33kV T/L
In coming feeder of Kinondoni S/S	Oysterbay-Kinondoni-Magomeni 33kV T/L
Add FZ III S/S～Chang'ombe S/S 33kV T/L	Added in 2002 as on going project
Apply steel pipe pole	Applied. See 14.3
Revise of specification FZ III S/S～Tandika S/S 240mm^2 1cct 10km (Meeting on Feb.28) 7.8km (Letter on May 15)	Considering maintenance, 150mm^2 2cct 10km is specified
Add FZ III S/S～Chang'ombe S/S 240mm^2 1cct in 2002	Added as on going project
Add Kurasini S/S～Chang'ombe S/S 240mm^2 1cct 5km in 2002	Added in 2003 because it was not on going project at the latest on-site survey
Add in coming feeder from New Oysterbay S/S to Tandale S/S	Added Magomeni S/S-Tandale S/S 33kV T/L
Demand escalation of Friendship S/S is not 0% but 3%	Modified to 3%
T/L length adjustment FZ III S/S - Yombo 132kV T/L 10km Mbezi S/S - Kawe S/S 33kV T/L 4.5km Ilala S/S - Kigogo S/S 33kV T/L 6km Ubungo S/S ～ University S/S 33kV T/L 3km	Modified
Accelerate schedule of Mburahati S/S construction	Original commissioning is scheduled in 2004, however, schedule is delayed to 2005 because of taking overload operation throughout study period and release project concentration in 2004.
Add Ubungo S/S - Mburahati S/S T/L Rehabilitation	Replace existing Ubungo - Ilala 33kV T/L with 150mm^2 2cct 7.5km T/L in 2005
Add Kisalawe 33kV feeder	Added See Table 14.4.1a
Introduction of auto-recloseres	Applied auto-recloseres on long feeders for ground fault protection
Introduction of pole mounted voltage regulators at some points at the end of	Shunt capacitors are applied in some S/S to avoid voltage drop. 33kV distribution system

long feeders	is also introduced to reduce loss and voltage drop. So, no pole mounted voltage regulators are concerned in this master plan.
Application of compact design T/L combined strung T/L	Not considered because these alternative designs shall be considered at B/D stage
Introduction of ring circuit	Applied to 132kV, 33kV transmission network. See system diagram
Apply environment tower	Not applied due to cost disadvantage. See 14.2.4
Accelerate schedule of Kurasini S/S 33kV Tr replace	Advanced from 2006 to 2005
Shift schedule of expansion of Sokoine S/S and FZ III S/S from 2004 to 2003	Modified
Rehabilitation of 33kV T/L from FZ I S/S to FZ III S/S and from FZ I S/S to Chang'ombe S/S 33kV substitute the construction of 33kV T/L from Chang'ombe S/S to FZ III S/S	Reflected in Master Plan
Rehabilitation of Mbezi S/S is on-going project by TANESCO. Installation of 2nd Tr shall be planed in 2007.	Reflected in Master Plan
Early expansion of Mbezi S/S substitutes the construction of new Kunduchi S/S	Reflected in Master Plan
Incoming feeder of Kigogo S/S is not come from Ilala S/S but tapped out from Ubungo S/S - Ilala S/S 33kV T/L	Reflected in Master Plan
Accelerate schedule of Msasani S/S expansion (2nd Tr) to 2004	Reflected in Master Plan
Upgrade Tandale S/S - Magomeni S/S interconnection	Modified from 100mm^2 to 150mm^2
Incoming feeder of Tandika S/S is not led out from FZ III S/S but from FZ I S/S	Reflected in Master Plan

(2) Arusha、Kilimanjaro

Table 14.1.4 Requests from TANESCO and Their Reflection to Master Plan (Arusha, Kilimanjaro)

Requests from TANESCO	Reflection to Master Plan
Convert Usa River S/S to Usa River Sw/S	Converted
Add 33kV T/L from Himo to Kifaru	Added
Accelerate schedule of Boma Ng'ombe S/S construction	Advanced from 2007 to 2005
Omit Tengeru 33/11kV S/S because this area will be fed by 33kV feeders	Omitted
Give higher priority on Unga LTD S/S rehabilitation due to heavy deterioration	Selected as 1st priority project
Change the order of Usa River Sw/S	Njiro B S/S scheduled in 2005, Usa River

and Njiro B S/S each other	Sw/S scheduled in 2006
Introduction of voltage regulator	Voltage regulator will be installed in Marangu Sw/S
Introduction of auto-recloseres	Applied auto-recloseres on long feeders for ground fault protection
Introduction of ring circuit	Applied to 33kV transmission network. See system diagram
Add 11kV Feeders below Unga LTD F1 Feeder 6km Replace Mt. Meru M05 Feeder 8km New Mt. Meru M06 Feeder 8km New Kiltex Sinon Feeder 6km New	Added See Table 14.4.1b
Add NYM CB,DS	Add in 2004
Add Lawate S/S expansion	Add in 2009
Monduli S/S is on going project	Treated as on going in 2002
Njiro S/S 33kVCB,DS expansion is on going	Treated as on going in 2002
Relocation of Marangu Sw/S	Shifted from Marangu Area to Mkuu Rombo Area

14.1.5 Expansion Plan (Case-B')

(1) Dar es Salaam

After making the modifications described above, the Study Team came up with Case-B' as the final expansion plan. Of the projects included in Case-B', those which are to be carried out by the end of 2004 were labeled priority projects, which were subjected to detailed design and economic analysis a second time. The expansion plan (Case-B') in the Dar es Salaam region is shown in Table 14.1.5. If all of the priority projects are carried out as planned, the number of overloaded or obsolescent substations in the region will decrease from 11 to 2 by the end of 2004.(City Center and Kurasini S/S will be remained)

The single line diagram, system diagram, and calculated power flow in the Dar es Salaam region as of the end of 2001, 2004 and 2010, respectively, are given in Fig. 14.1.1 through 14.1.9.

Table 14.1.5 Expansion Plan (Case-B') in Dar es Salaam

Year	Name of S/S	Specification	Type	Remark	Name of Transmission Line	Specification	Type	Remark
2002	Bahari Beach S/S	33kV 15MVAx1	New	Commissioned	Tegeta-Bahari Beach	33kV 100mm^2 2cdt 13km	New	Commissioned
	Kurasini S/S	Switchgear	Replace	by KfW	Ilala-Kurasini	33kV 150mm^2 2cct 7.1km	Reconductor	On Going KfW
	Ubungo S/S	33kV 15MVAx1	Expansion	by SIDA				
	Magomeni S/S	33kV 15MVAx1	New	by KfW	Magomeni-Magomeni Tap	33kV 100mm^2 1cdt 1km	New	On Going
	Mbezi S/S	33kV 15MVAx1	R/E	by TANESCO				
2003	Sokoine S/S	33kV 15MVAx1	Expansion		City Center-Sokoine	33kV 100mm^2 1cdt 3km	Reinforce	
	FZ III S/S	33kV 15MVAx1	Expansion					
					Chang'ombe-Kurasini	33kV 240mm^2 1cdt 5km	Reinforce	
					FZ III-FZ I	33kV 240mm^2 2cdt 4.0km	Replace	
					FZ I-Chang'ombe	33kV 240mm^2 1cdt 1.0km	Reinforce	
2004	Bagamoyo S/S	33kV 5MVAx1	New		Tegeta-Bagamoyo	33kV 100mm^2 2cdt 45km	New	On Going 2cct
Phase1	City Center S/S	33kV 30MVAx1	R/E	1x15-->1x30				
	Mikocheni S/S	33kV 15MVAx1	Expansion					
	Tandika S/S	33kV 15MVAx1	New	by KfW	FZ I-Tandika	33kV 150mm^2 2cdt 4.2km	New	
	FZ III S/S	33kV Leadout	Expansion	Tandika Line				
	FZ I S/S	Panel, others	Replace					
	FZ II S/S	Switchgear etc	Replace					
2004	City Center S/S	33kV Leadout	Expansion	Sokoine Line				
Phase2	Tandale S/S	33kV 15MVAx1	Expansion		Tandale-Magomeni	33kV 150mm^2 1cdt 3km	New	
	New Oysterbay S/S	132kV 45MVAx2	New		Ubungo-New Oysterbay	132kV 240mm^2 1cdt 8.5km	New	
		33kV 15MVAx2						
	Ubungo S/S	132kV Leadout	Expansion	NOB Line				
	Oysterbay S/S	33kV 15MVAx1	R/E	2x5-->1x15	New Oysterbay-Oysterbay	33kV 240mm^2 2cdt 1.6km	New	1cct
	Msasani S/S	33kV 15MVAx1	Expansion		New Oysterbay-Msasani	33kV 150mm^2 2cdt 5km	New	1cct
2005	Mbagala S/S	33kV 15MVAx1	Expansion					
	Muhimbili S/S	33kV 15MVAx1	New		Muhimbili Tap-Muhimbili	33kV 100mm^2 1cdt 0.5km	New	
	TOL S/S	33kV 15MVAx1	New		Ilala-TOL	33kV 100mm^2 2cdt 5km	New	1cct
	Ilala S/S	33kV Leadout	Expansion	TOL Line				
	University S/S	33kV 15MVAx1	New		Ubungo-University	33kV 100mm^2 1cdt 3km	New	
	Ubungo S/S	33kV Leadout	Expansion	University Line				
	Yombo S/S	132kV 45MVAx1	New		FZ III-Yombo	132kV 240mm^2 1cdt 12km	New	
		33kV 15MVAx1	New					
	FZ III S/S	132kV Leadout	Expansion	Yombo Line				
					Yombo-Mbagala	132kV 240mm^2 1cdt 10km	New	
	Kitunda S/S	33kV 15MVAx1	New		Yombo-Kitunda	33kV 100mm^2 1cdt 3.9km	New	
	Mbagala S/S	132kV 45MVAx1	Expansion		Kurasini-Mbagala	132kV 240mm^2 1cdt 16km	New	
	Kurasini S/S	132kV 45MVAx2	Expansion		Ilala-Kurasini	132kV 240mm^2 1cdt 10km	New	
	Ilala S/S	132kV Leadout	Expansion	Kurasini Line				

Year	Name of S/S	Specification	Type	Remark	Name of Transmission Line	Specification	Type	Remark
2005	Kurasini S/S	33kV 15MVAx1	Expansion					
	Kigamboni Sw/S	33kV	Rehabilitation					
	Tabata Sw/S	33kV	New					
	Mburahati S/S	33kV 15MVAx1	New		Ubungo-Ilala	33kV 150mm^2 2cdt 7.5km	Rehabilitation	1cct
	Ubungo S/S	33kV Leadout	Expansion	Ilala Line				
	Kurasini S/S	33kV 15MVAx1	Replace					
2006	Kinondoni S/S	33kV 15MVAx1	New		Kinondoni Tap-Kinondoni	33kV 100mm^2 1cdt 1.0km	New	
					Oysterbay-Ilala	33kV 240mm^2 2cct 6.3km	Reinforce	Upgrade
	Kawe S/S	33kV 15MVAx1	New		Mbezi-Kawe	33kV 100mm^2 1cdt 4.5km	New	
	Mbezi S/S	33kV Leadout	Expansion	Kawe Line				
	City Center S/S	33kV 30MVAx1	R/E	1x15-->1x30				
	Ilala S/S	132kV 45MVAx1	Expansion		Ubungo-Ilala	132kV 240mm^2 1cdt 7.5km	Reinforce	
		33kV 15MVAx1	Expansion		Ilala-City Center #2	33kV 100mm^2 1cdt 2.8km	Reconductor	
2007	Bahari Beach S/S	33kV 15MVAx1	Expansion					
	Tegeta S/S	33kV Leadout	Expansion	Bahari Beach Line				
	Kigogo S/S	33kV 15MVAx1	New		Kigogo-Kigogo Tap	33kV 100mm^2 1cdt 1km	New	
	Mbezi S/S	33kV 15MVAx1	Expansion		Tegeta-Mbezi	33kV 100mm^2 1cdt 8.4km	Reinforce	
	Tegeta S/S	33kV Leadout	Expansion	Mbezi Line				
2008	Chang'ombe S/S	33kV 15MVAx1	Expansion					
2009	Msasani S/S	33kV 15MVAx1	Expansion					
2010	Kariakoo S/S	33kV 15MVAx1	Expansion		Ilala-Kariakoo	33kV 100mm^2 1cdt 1.3km	Reinforce	
	Ilala S/S	33kV Leadout	Expansion	Kariakoo Line				
	Ilala S/S	33kV 15MVAx1	Expansion					

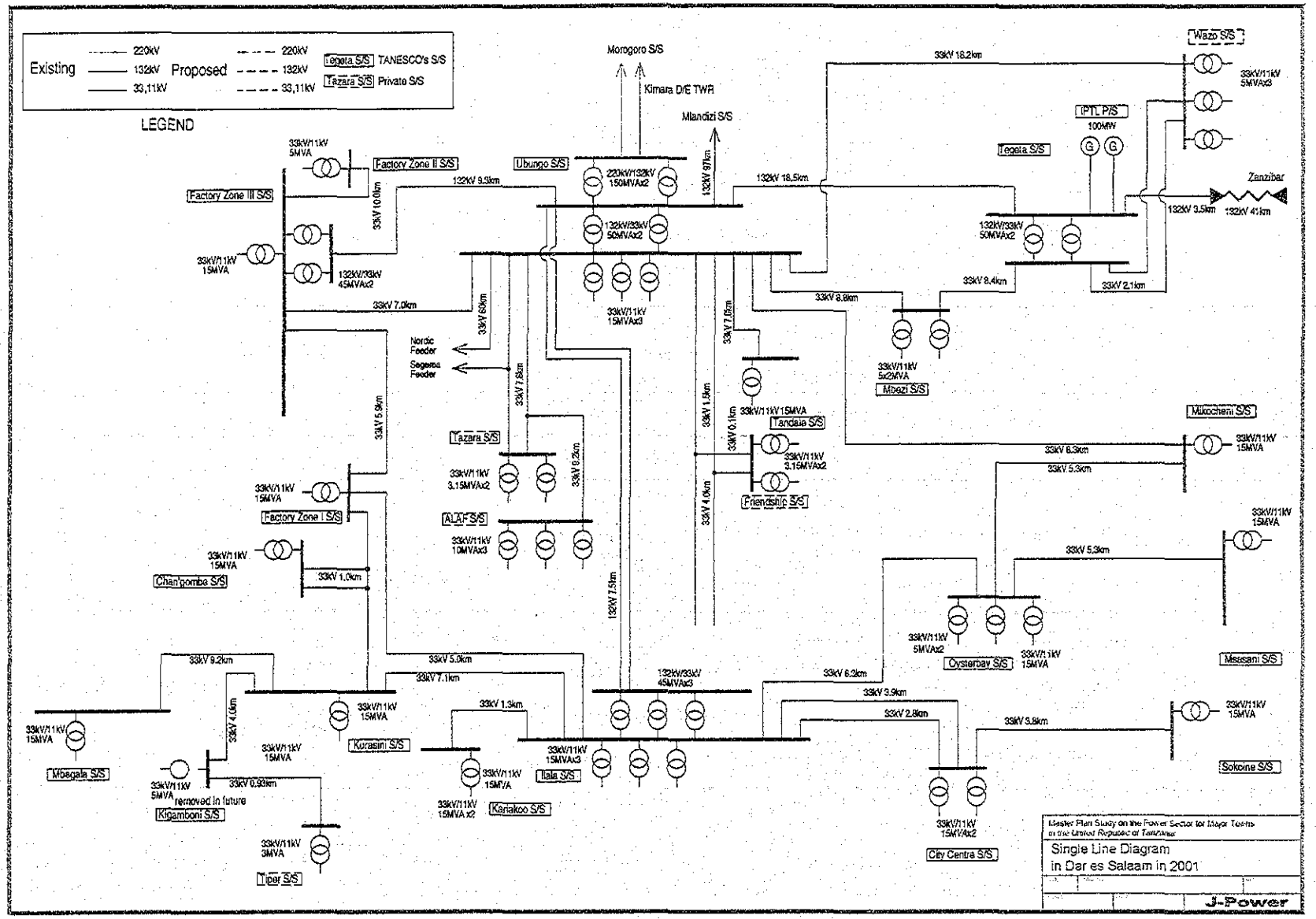

Fig. 14.1.1 Single Line Diagram (Dar es Salaam, 2001)

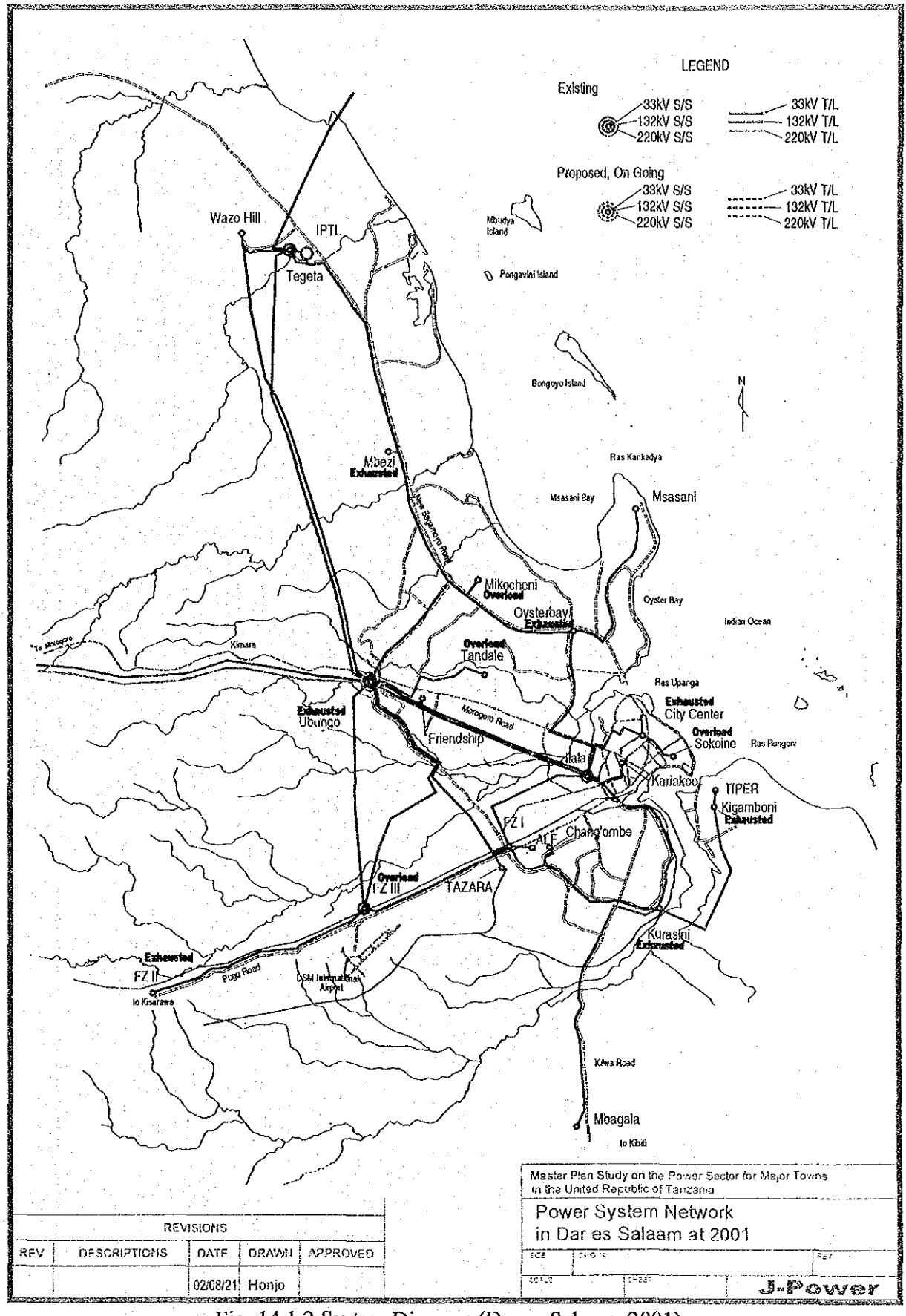

Fig. 14.1.2 System Diagram (Dar es Salaam, 2001)

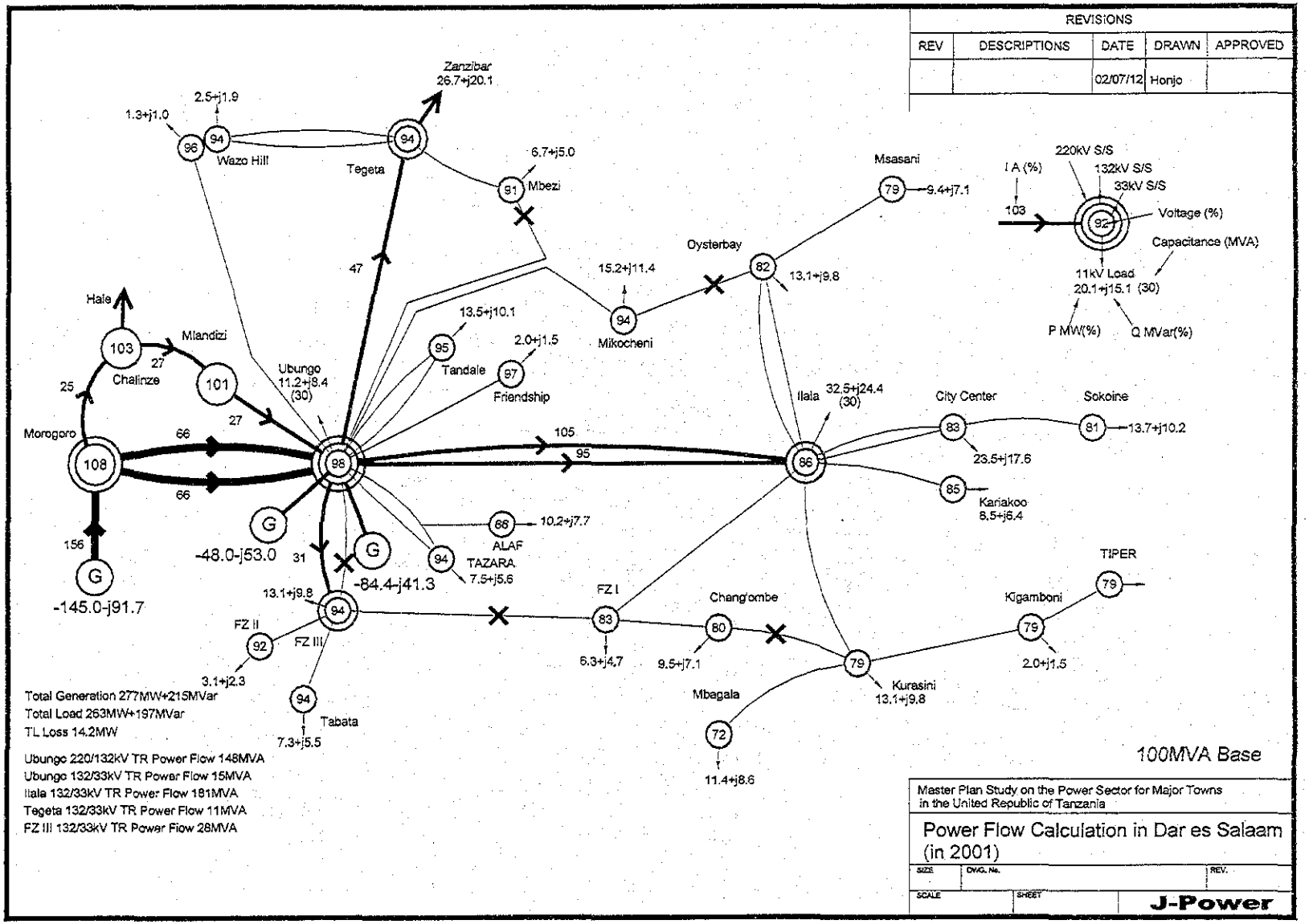

Fig. 14.1.3 Calculated Power Flow (Dar es Salaam, 2001)

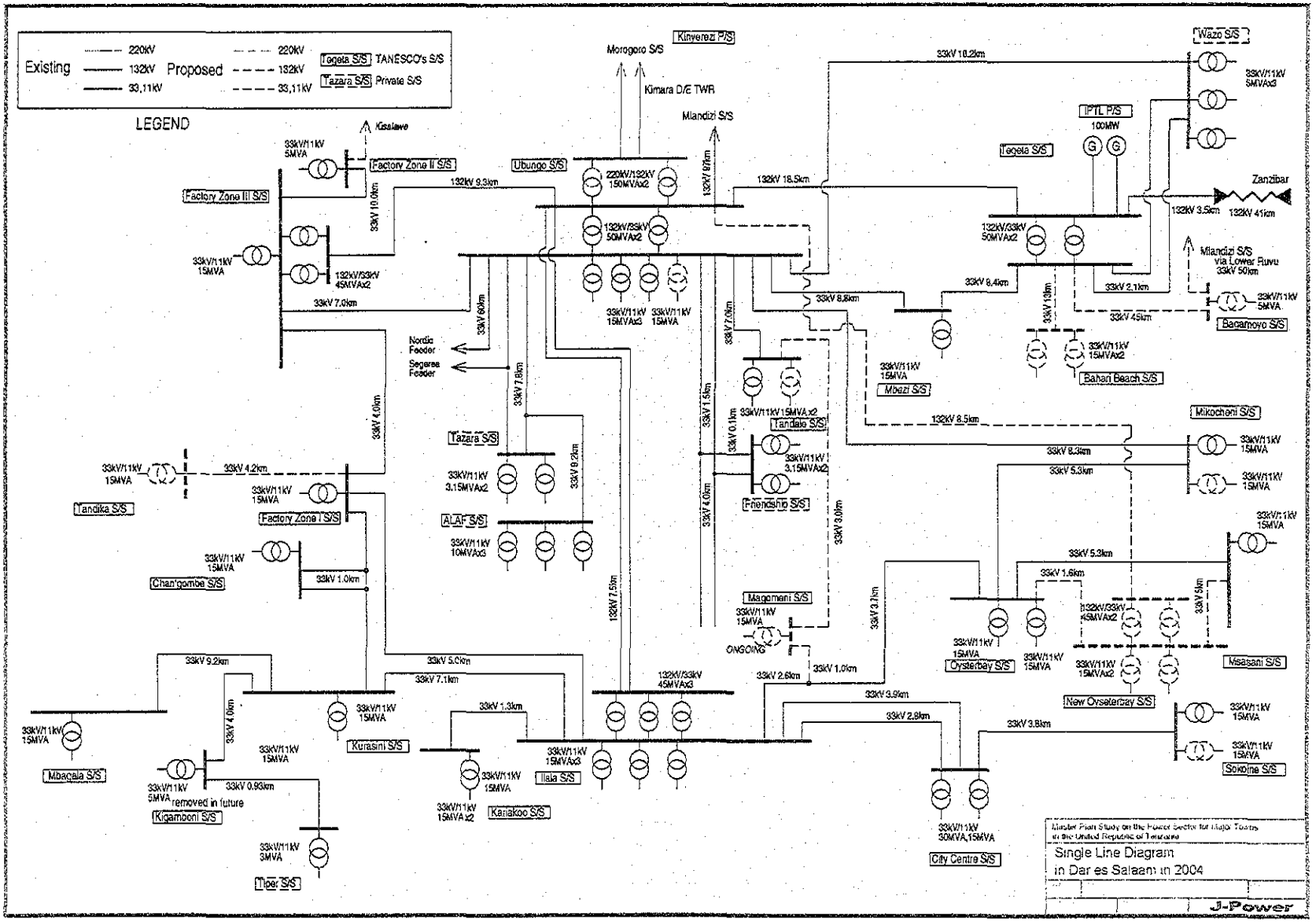

Fig. 14.1.4 Single Line Diagram (Dar es Salaam, 2004)

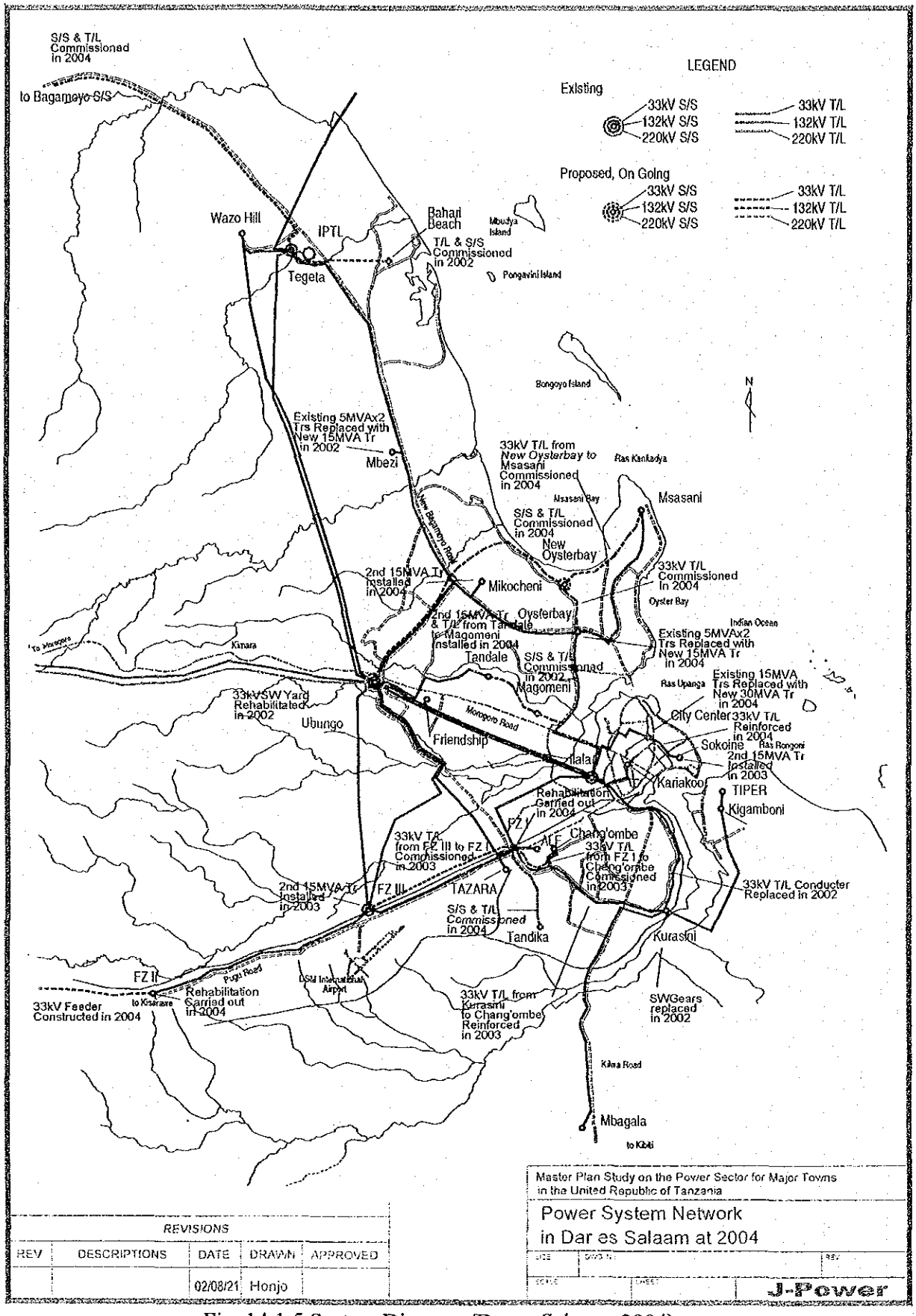

Fig. 14.1.5 System Diagram (Dar es Salaam, 2004)

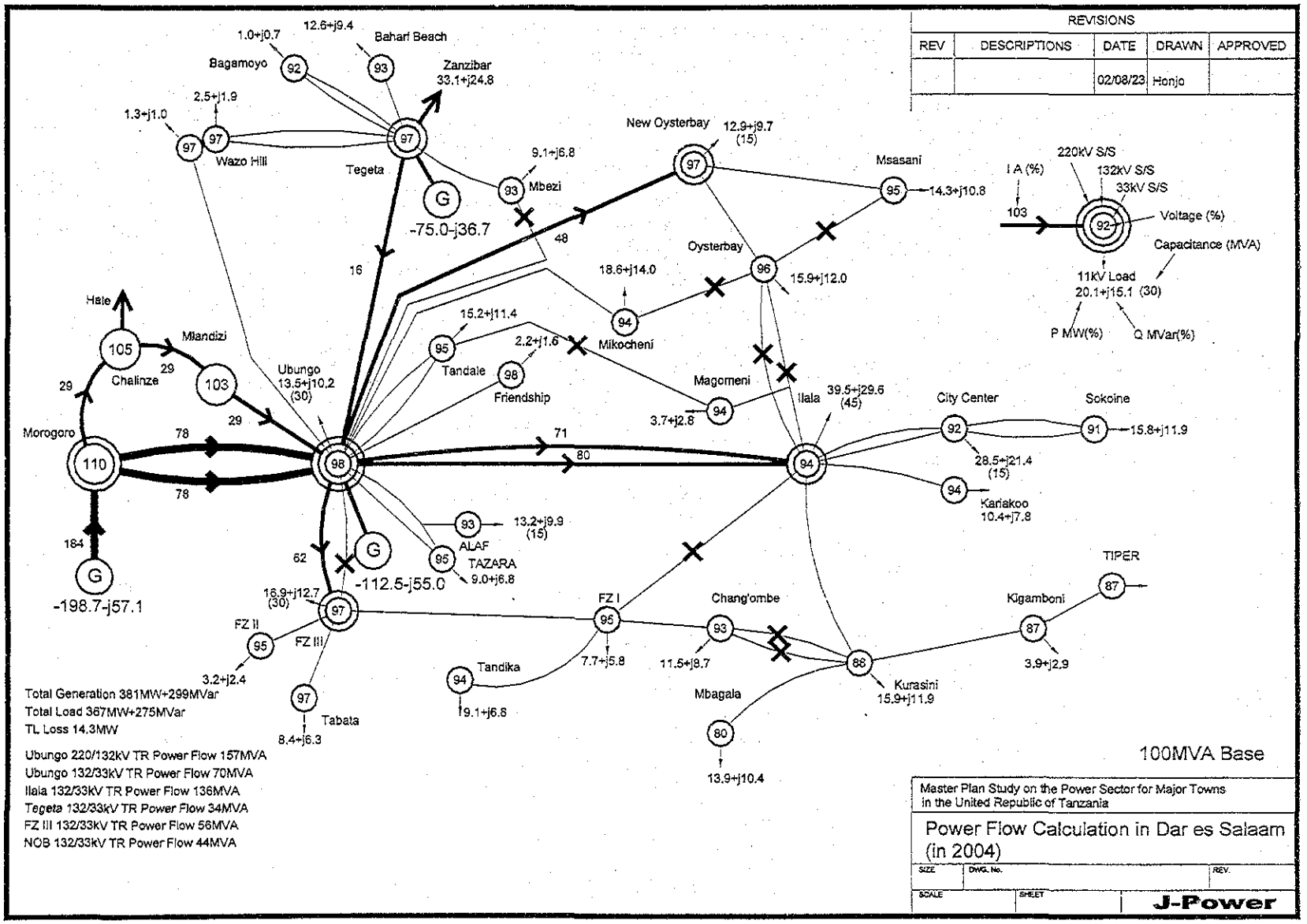

Fig. 14.1.6 Calculated Power Flow (Dar es Salaam, 2004)

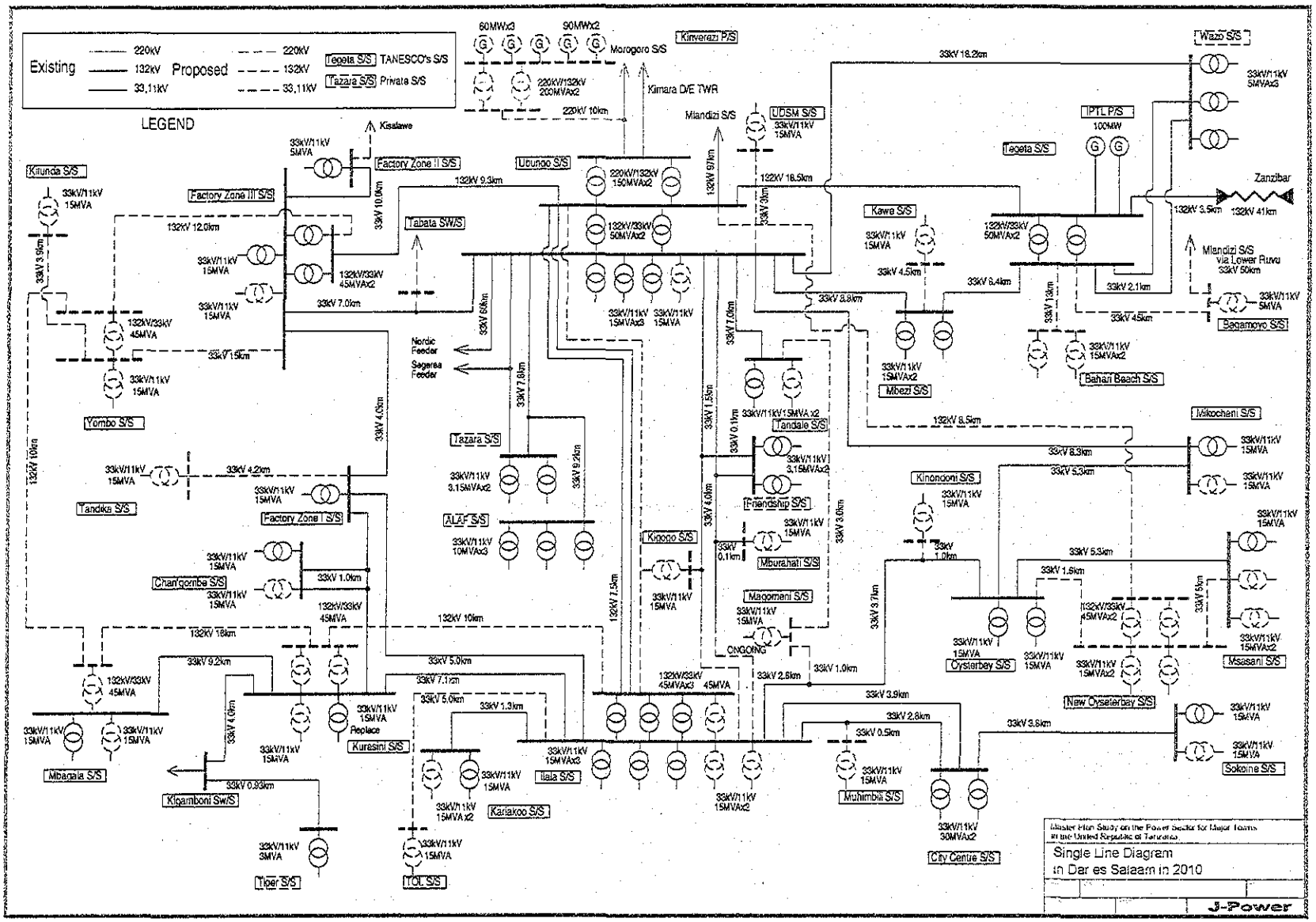

Fig. 14.1.7 Single Line Diagram (Dar es Salaam, 2010)

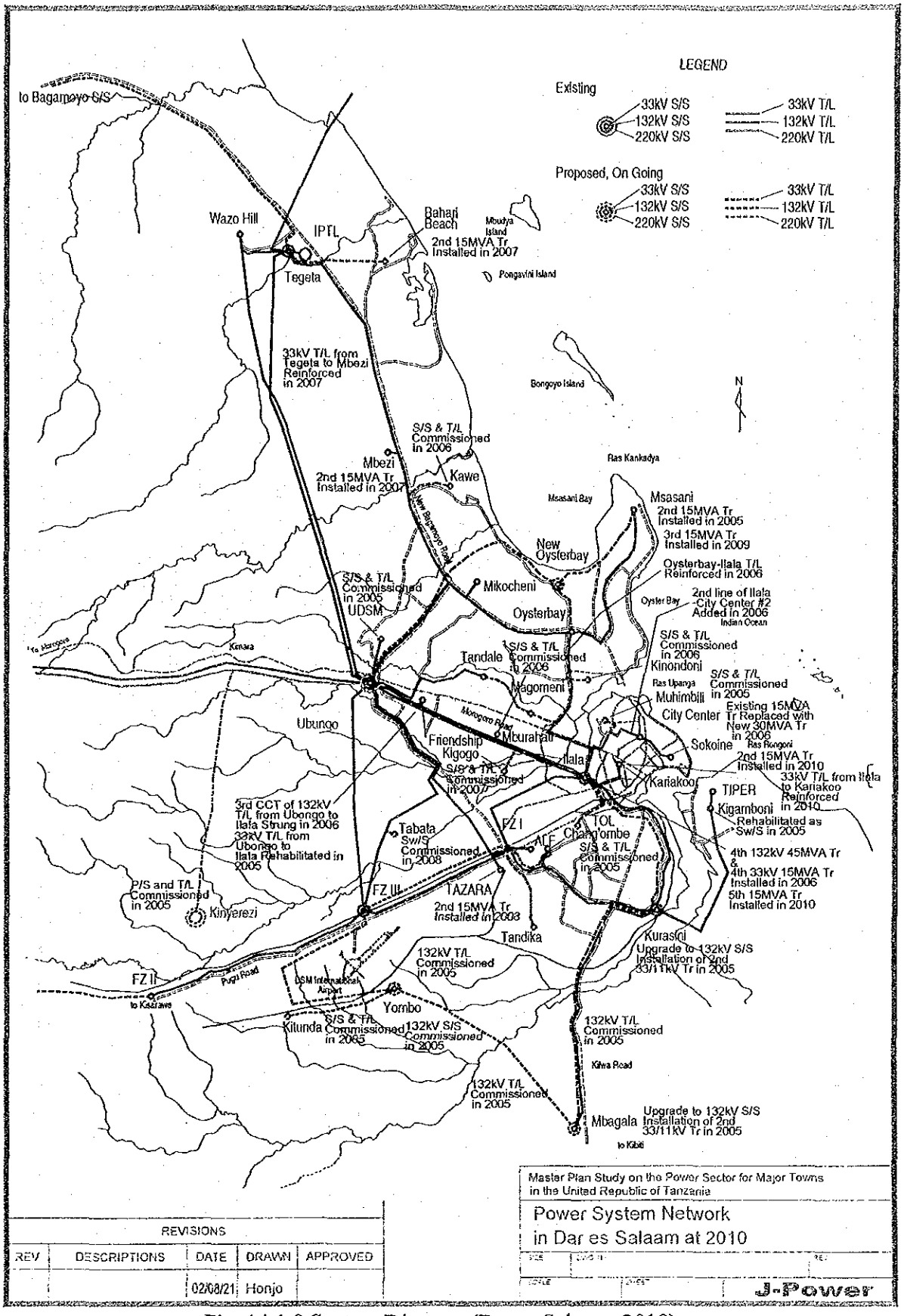

Fig. 14.1.8 System Diagram (Dar es Salaam, 2010)

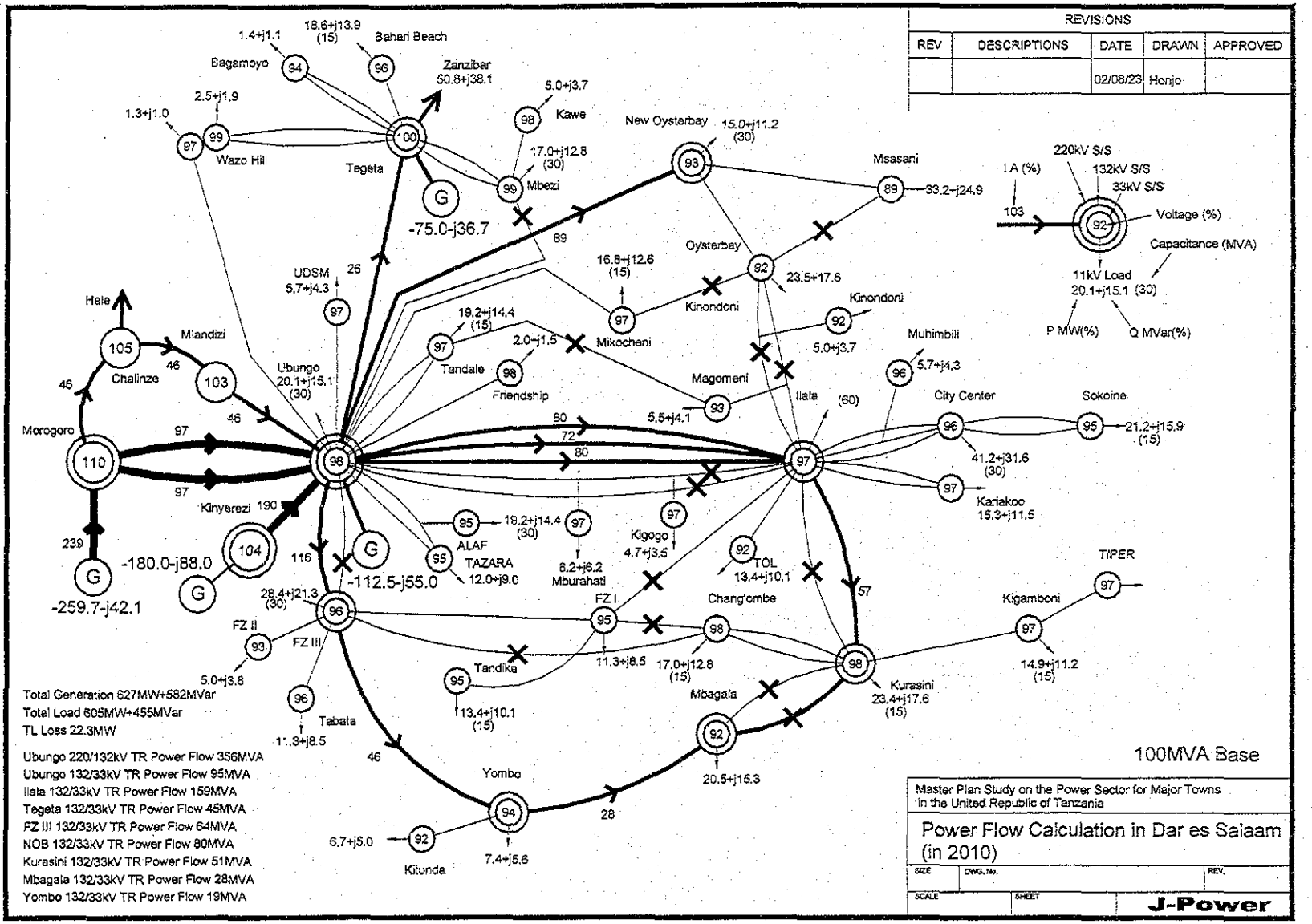

Fig. 14.1.9 Calculated Power Flow (Dar es Salaam, 2010)

(2) Arusha and Kilimanjaro

The expansion plan (Case-B') in the Arusha and Kilimanjaro is shown in Table 14.1.6. If all of the priority projects are carried out as planned, the number of overloaded or obsolescent substations in the regions will decrease from 8 to 0 by the end of 2004.

The single line diagram, system diagram, and calculated power flow in the Arusha and Kilimanjaro at the end of 2001, 2004 and 2010, respectively, are given in Fig. 14.1.10 through 14.1.18.

Table 14.1.6 Expansion Plan (Case-B') in Arusha and Kilimanjaro

Year	Name of S/S	Specification	Type	Remark	Name of Transmission Line	Specification	Type	Remark
2002	Njiro S/S	Switchgear	Replace	On going				
	Monduli S/S	33kV 2.5MVAx1	New	On going	Njiro-Monduli	33kV 100mm^2 38.6km	New	On Going 1cct
	YMCA S/S	33kV 10MVAx1	New	On going				
2003								
2004	Njiro S/S	132kV 45MVAx1	Expansion					
Phase1	Mt. Meru S/S	33kV 10MVAx3	Expansion		Njiro-Mt.Meru	33kV 100mm^2 7.3km	Reinforce	1cct→2cct
	Unga LTD S/S	33kV 10MVAx3	R/E	2x5-->3x10	Njiro-Unga LTD	33kV 100mm^2 5.8km	Reinforce	1cct→2cct
	Kiyungi S/S	Switchgear etc	Replace					
		132/33kV 45MVAx1	Expansion					
	Boma Mbuzi S/S	Switchgear etc	Replace		Kiyungi-Boma Mbuzi	33kV 100mm^2 7km	Reinforce	1cct→2cct
		33kV 10MVAx1	Expansion					
	Trade School S/S	33kV 10MVAx1	R/E		Kiyungi-Trade School	33kV 100mm^2 10km	Reinforce	1cct→2cct
	Marangu Sw/S	33kV	New		Kiyungi-Marangu	33kV 100mm^2 69km	New	1cct
2004	Kiltex S/S	33kV 10MVAx1	R/E	1x5-->1x10				
Phase2	Machame S/S	33kV 5MVAx1	R/E	1x2.5-->1x5				
	Same S/S	Switchgear etc	Replace					
	NYM P/S	CB,LS	Reinforce					
2005	Njiro B S/S	33kV 10MVAx1	New		Njiro-Njiro B	33kV 100mm^2 3km	New	1cct
	Sakina S/S	33kV 10MVAx1	New		Njiro-Sakina	33kV 100mm^2 13.2km	New	1cct
					Mt.Meru-Sakina	33kV 100mm^2 8.1km	New	1cct
					Njiro-Kiyungi	132kV 240mm^2 70km	Reinforce	1cct→2cct 1/2
	KCMC S/S	33kV 10MVAx1	New		Trade School-KCMC	33kV 100mm^2 3.7km	New	
	Trade School S/S	33kV Leadout	Expansion	KCMC Line				
	Boma Ngombe S/S	33kV 5MVAx1	New					
2006	Usa River Sw/S	33kV	New		Njiro-Usa River	33kV 100mm^2 21.3km	New	1cct
					Tengeru-Usa River	33kV 100mm^2 12.5km	New	1cct
	Njiro S/S	220kV 60MVAx1	Expansion					
		132kV 45MVAx1	Expansion		Njiro-Kiyungi	132kV 240mm^2 70km	Reinforce	1cct→2cct 2/2
	Kiyungi S/S	132kV Leadout	Expansion	Njiro Line				
2007	Gomberi S/S	33kV 5MVAx1	New		KCMC-Gomberi	33kV 100mm^2 4.9km	New	1cct
	KCMC S/S	33kV Leadout	Expansion	Gomberi Line				
2008	Themi S/S	33kV 10MVAx1	Expansion					
2009	Lawate S/S	33kV 5MVAx1	R/E	1x2.5-->1x5				
2010								

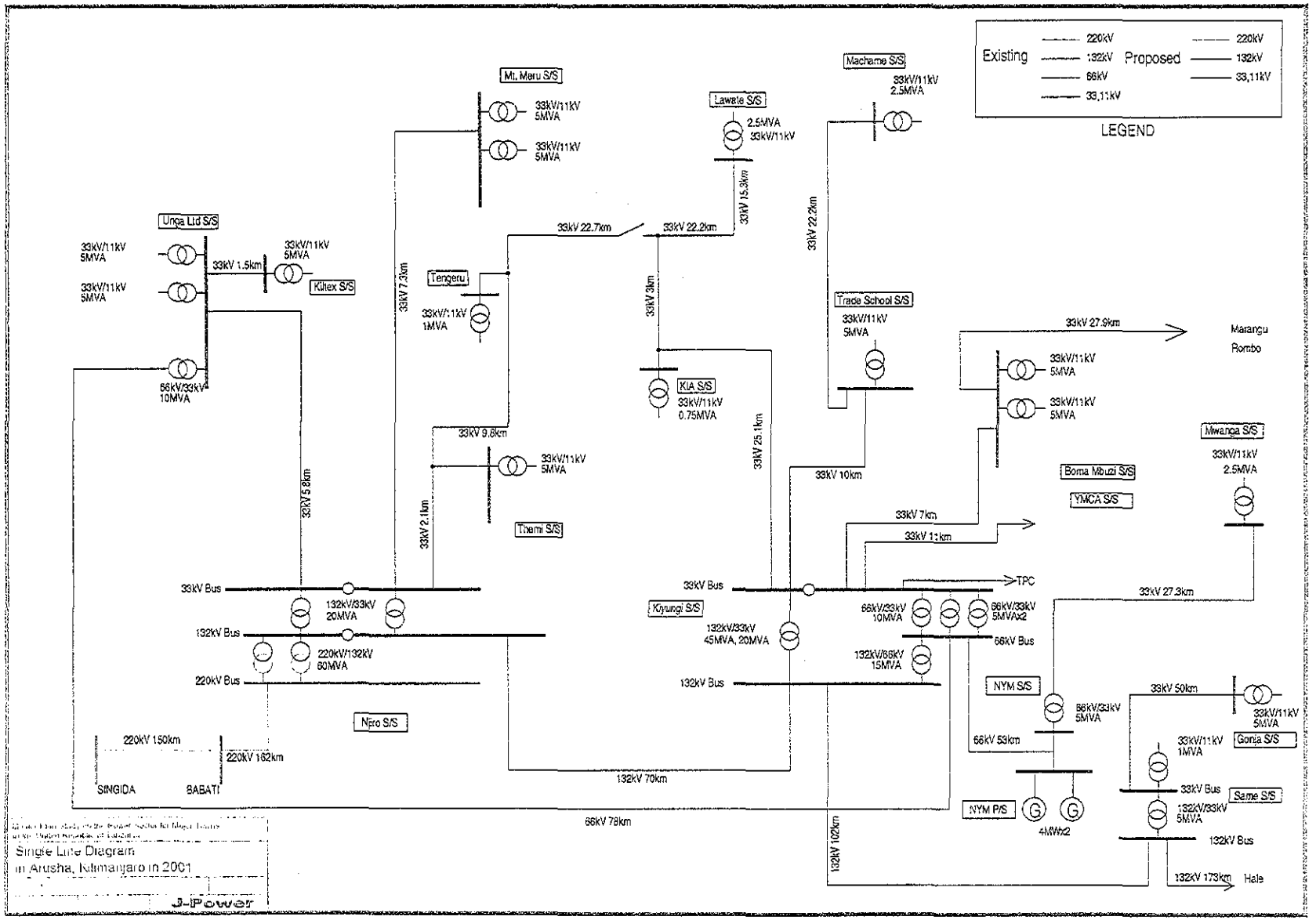

Fig. 14.1.10 Single Line Diagram (Arusha, Kilimanjaro, 2001)

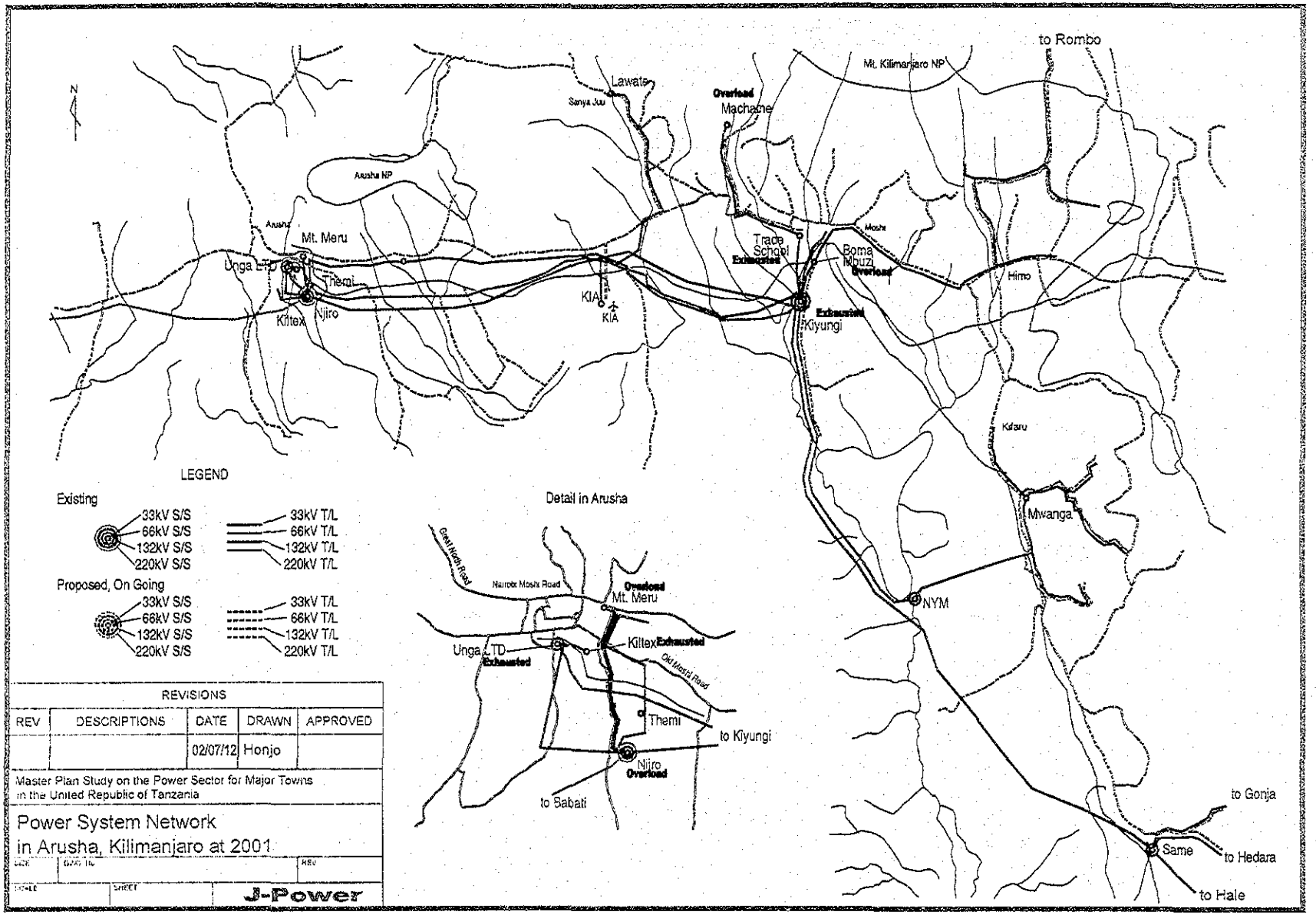

Fig. 14.1.11 System Diagram (Arusha, Kilimanjaro, 2001)

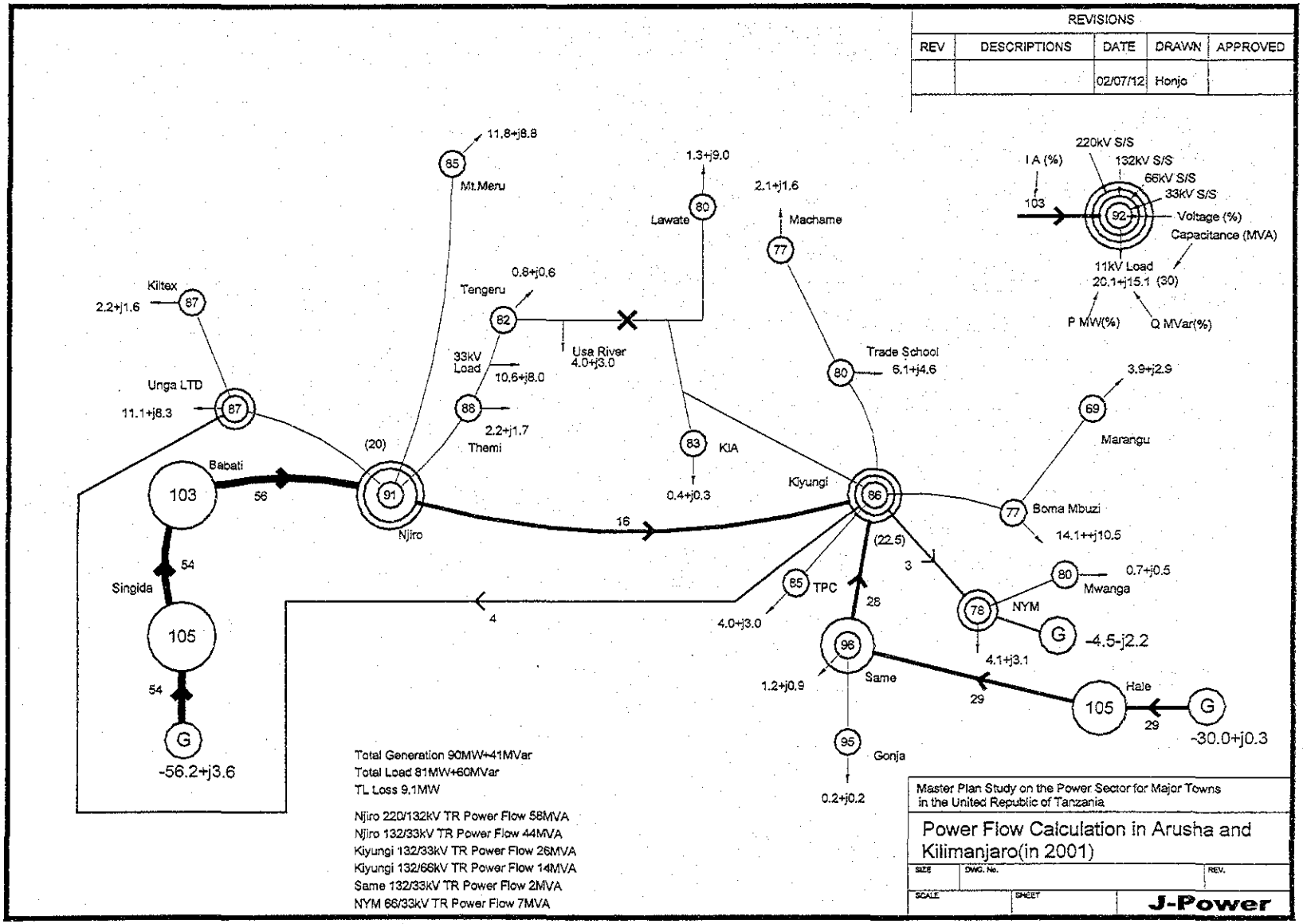

Fig. 14.1.12 Calculated Power Flow (Arusha, Kilimanjaro, 2001)

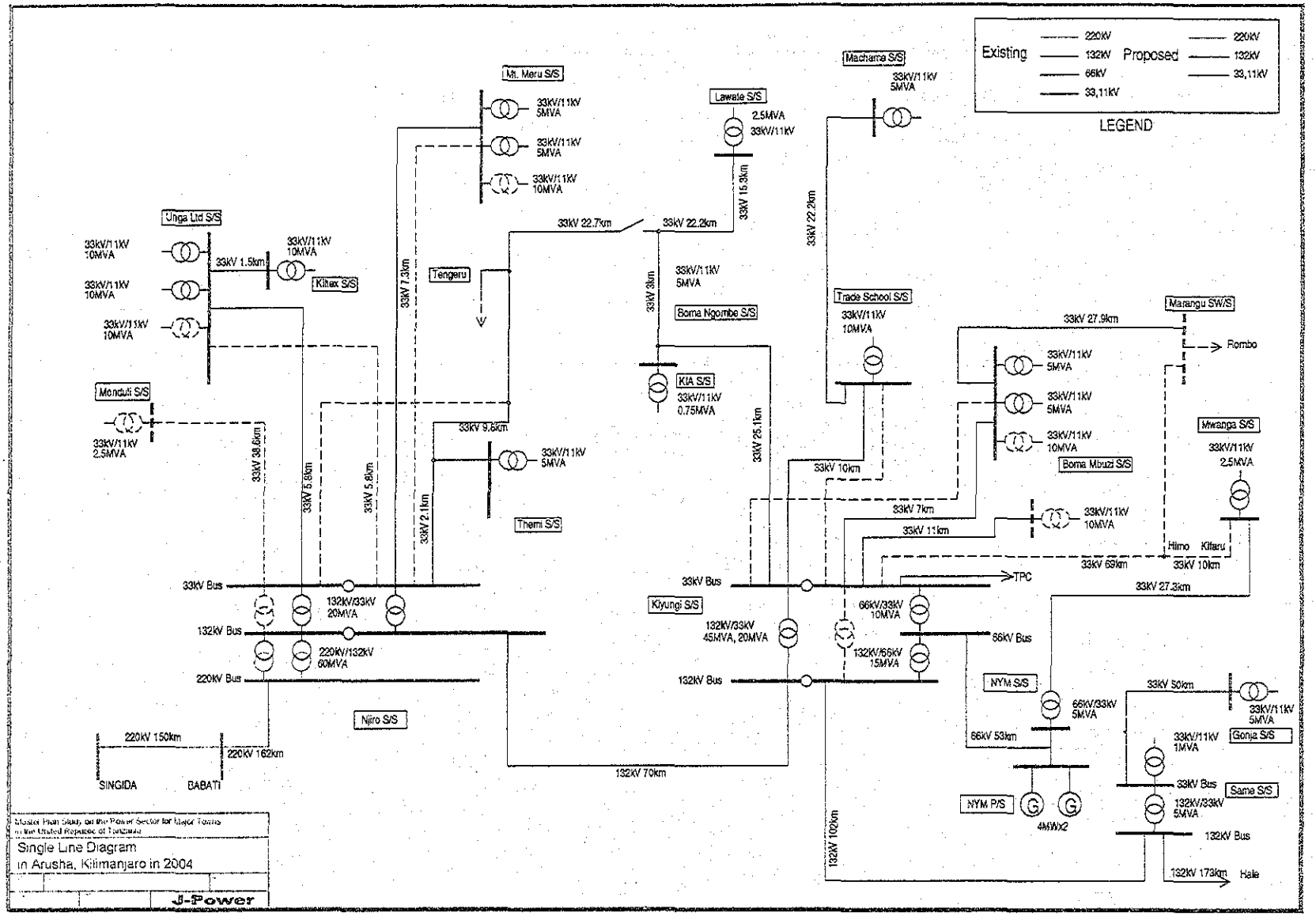

Fig. 14.1.13 Single Line Diagram (Arusha, Kilimanjaro, 2004)

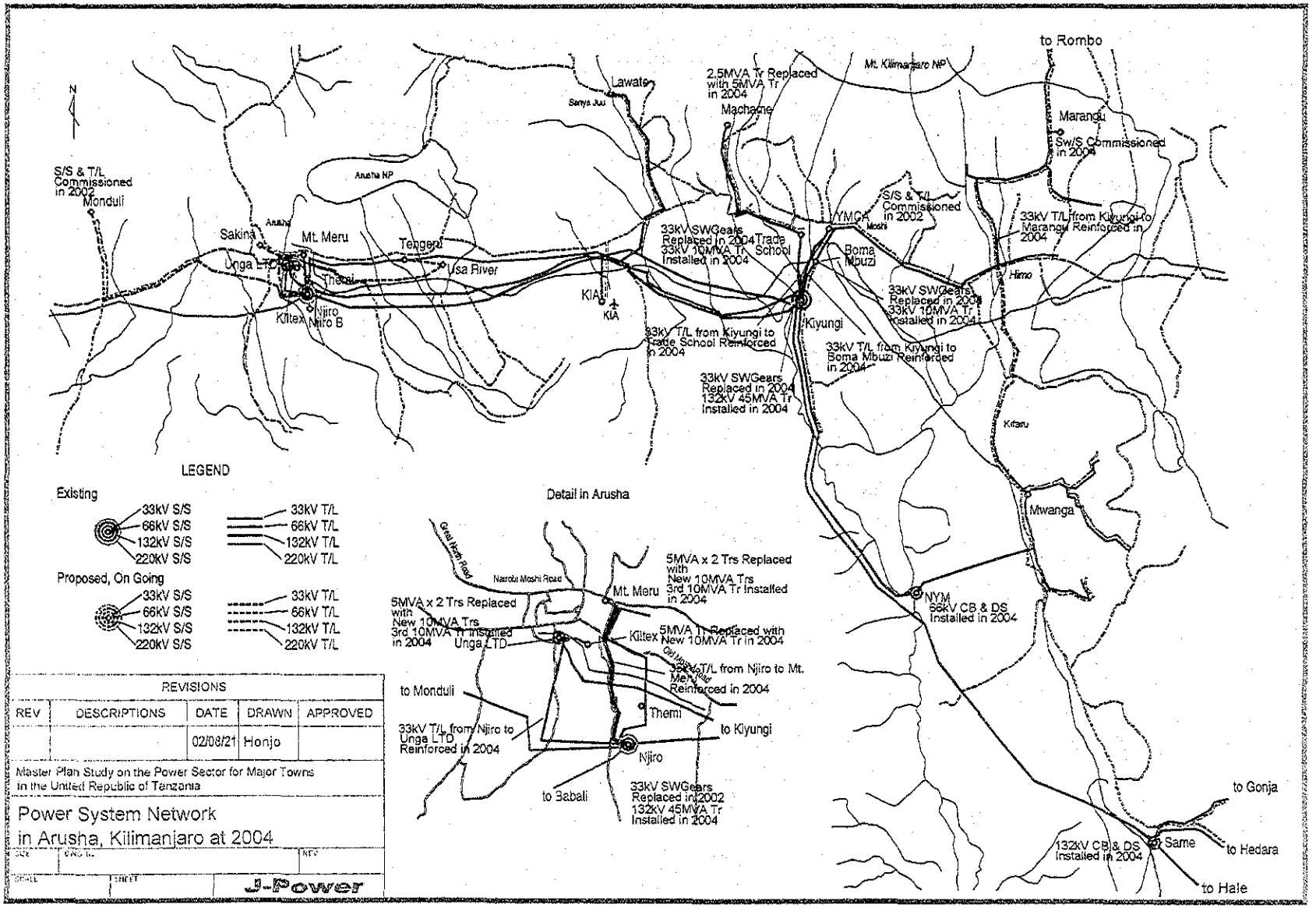

Fig. 14.1.14 System Diagram (Arusha, Kilimanjaro, 2004)

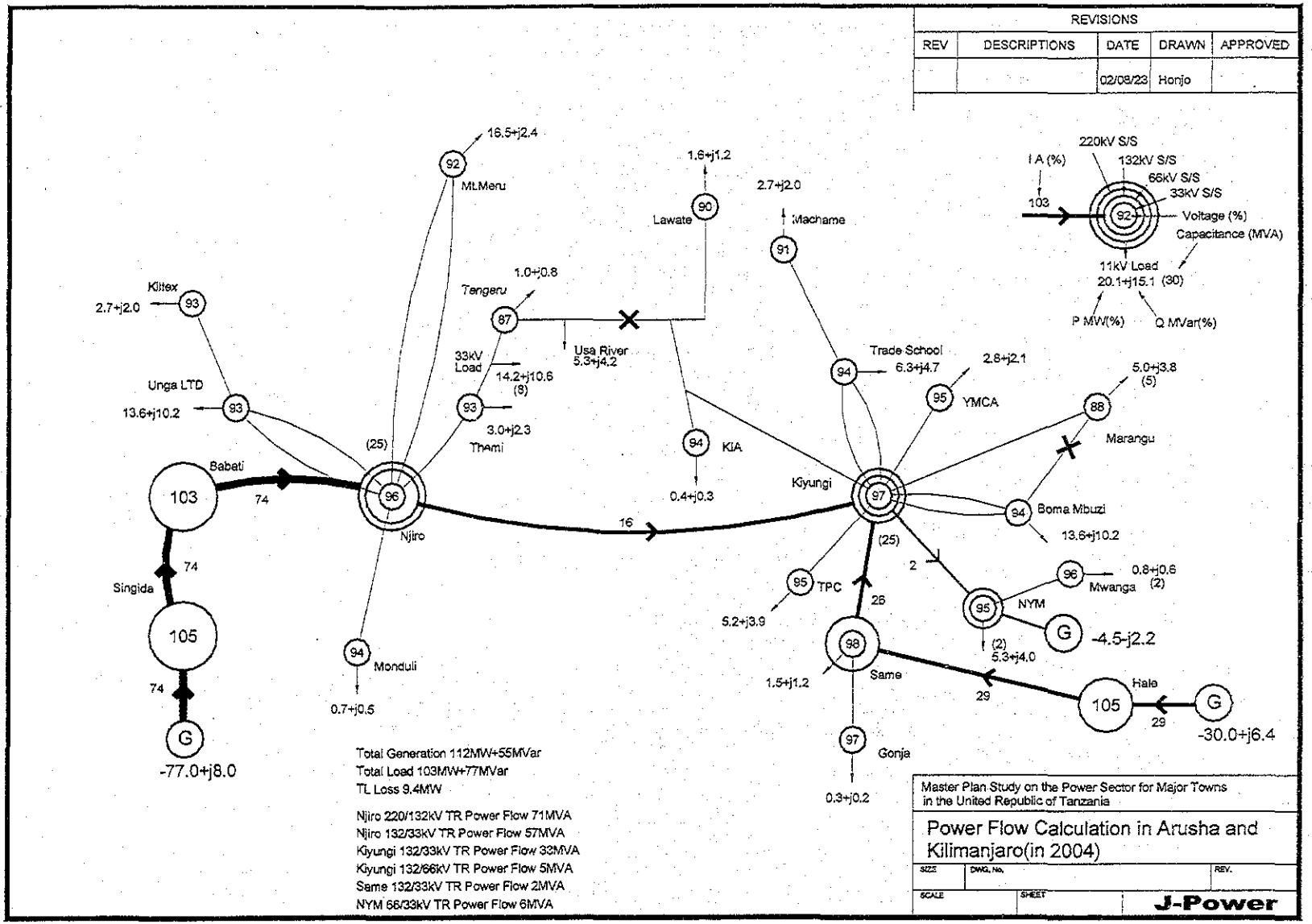

Fig. 14.1.15 Calculated Power Flow (Arusha, Kilimanjaro, 2004)

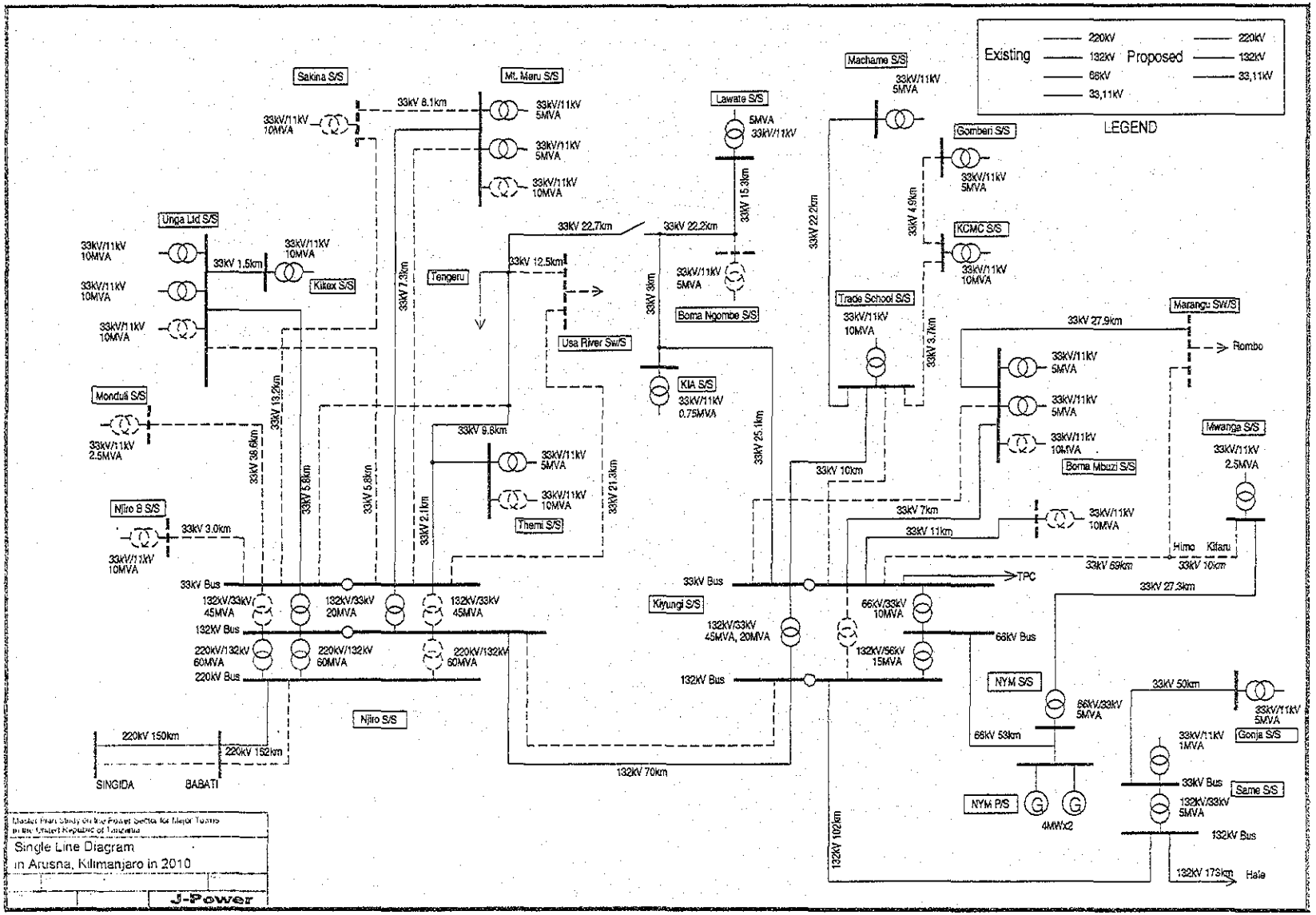

Fig. 14.1.16 Single Line Diagram (Arusha, Kilimanjaro, 2010)

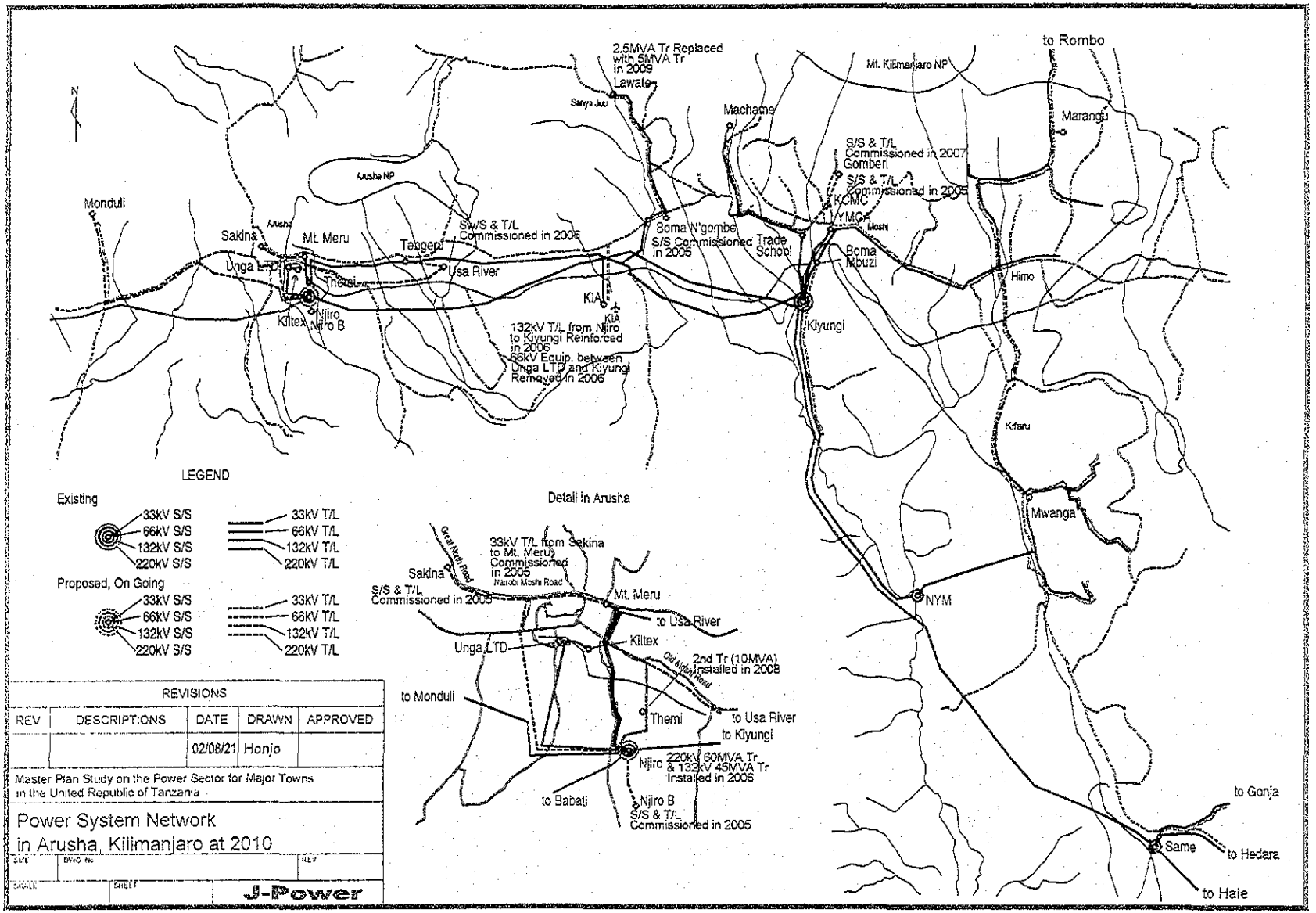

Fig. 14.1.17 System Diagram (Arusha, Kilimanjaro, 2010)

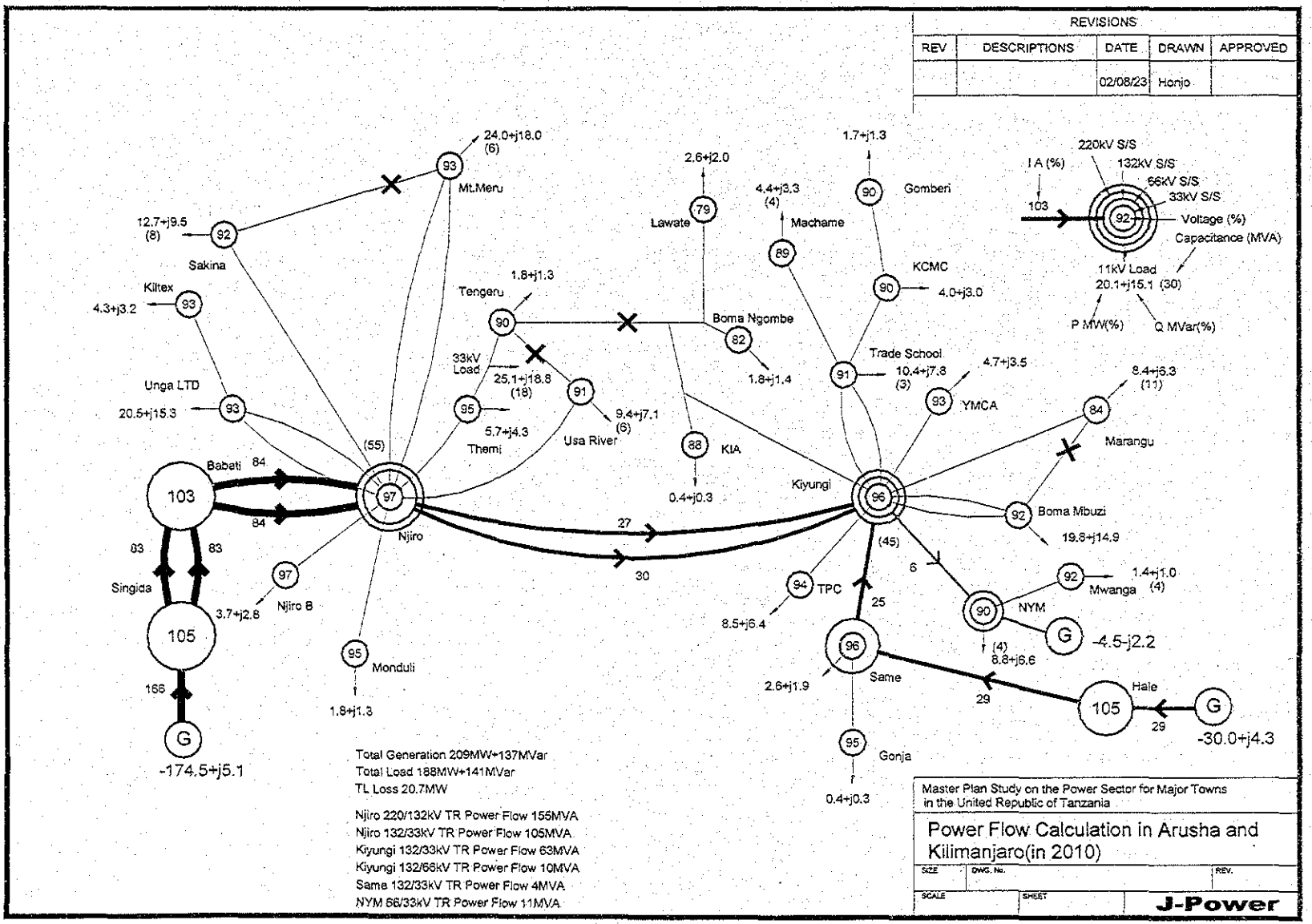

Fig. 14.1.18 Calculated Power Flow (Arusha, Kilimanjaro, 2010)

14.1.6 Var Compensation

For the purpose of repress the voltage drop on 33kV bus of each S/S within 90% at the peak load time, appropriate var compensators are simulated at the power flow calculation regarding Case-A. Demand of S/S of Case-B' is similar to that of Case-A, however, small modification such as installation year was done at detailed study. Accordingly, the capacity of var compensation is also revised a little. Simulated capaciter bank at power flow calculation of Case-B' is shown in Table 14.1.7 and 8.

Table 14.1.7 Simulated Capacitor Bank Dar es Salaam Case-B' Unit MVA

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
UBG	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
ILL	30.0	30.0	45.0	45.0	45.0	45.0	45.0	60.0	60.0	60.0
CCR			15.0	15.0	15.0	15.0	30.0	30.0	30.0	30.0
KRS		30.0	30.0							15.0
ALF		10.0	10.0	15.0	15.0	30.0	30.0	30.0	30.0	30.0
NOB				15.0	15.0	30.0	30.0	30.0	30.0	30.0
BHB								15.0	15.0	15.0
MBZ					15.0	15.0	15.0	15.0	30.0	30.0
CGM							15.0	15.0	15.0	15.0
SKN								15.0	15.0	15.0
MKC									15.0	15.0
TDK										15.0
TDL										15.0
KGB										15.0
FZ3				30.0	30.0	30.0	30.0	30.0	30.0	30.0
SUBTOTAL	60.0	100.0	130.0	150.0	165.0	195.0	225.0	270.0	300.0	360.0
ADDITIONAL		40.0	30.0	20.0	15.0	30.0	30.0	45.0	30.0	60.0
UBG(G 11,33kV)	23.0									
UBG1	41.3	41.3	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0
TGT1		36.7	36.7	36.7	36.7	36.7	36.7	36.7	36.7	36.7
KNY2				22.0	44.0	44.0	66.0	66.0	88.0	88.0
SUBTOTAL	64.3	78.0	91.7	113.7	135.7	135.7	157.7	157.7	179.7	179.7
ADDITIONAL		13.7	13.7	22.0	22.0	0.0	22.0	0.0	22.0	0.0
GRANDTOTAL	124.3	178.0	221.7	263.7	300.7	330.7	382.7	427.7	479.7	539.7
ADDITIONAL		53.7	43.7	42.0	37.0	30.0	52.0	45.0	52.0	60.0

Table 14.1.8 Simulated Capacitor Bank Arusha、Kilimanjaro Case-B' Unit MVA

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NJR	20.0	20.0	22.5	25.0	30.0	35.0	40.0	45.0	55.0	55.0
MTM		0.0	0.0	0.0	3.0	3.0	6.0	6.0	6.0	6.0
USA		0.0	0.0	0.0	3.0	3.0	4.0	4.0	6.0	6.0
SAK		0.0	0.0	0.0	0.0	0.0	0.0	4.0	8.0	8.0
KYG	22.5	22.5	22.5	25.0	30.0	35.0	40.0	45.0	45.0	45.0
TSC		0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.0
MCM		0.0	0.0	0.0	2.0	3.0	3.0	4.0	4.0	4.0
NYM		1.0	1.0	2.0	2.0	2.0	3.0	3.0	3.0	4.0
MWG		0.0	1.0	2.0	2.0	2.0	2.0	3.0	3.0	4.0
MRG		2.0	3.0	5.0	5.0	5.0	8.0	8.0	11.0	11.0
HAL1		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33kV		0.0	3.0	8.0	8.0	8.0	8.0	12.0	18.0	18.0
SUBTOTAL	42.5	45.5	53.0	67.0	85.0	96.0	114.0	137.0	162.0	164.0
ADDITIONAL		3.0	7.5	14.0	18.0	11.0	18.0	23.0	25.0	2.0
NYM6	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
SUBTOTAL	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
ADDITIONAL										0.0
GRANDTOTAL	44.7	47.7	55.2	69.2	87.2	98.2	116.2	139.2	164.2	166.2
ADDITIONAL		3.0	7.5	14.0	18.0	11.0	18.0	23.0	25.0	2.0

Comparing the result of Case-A and Case-B', voltages of each S/S of Case-B' are slightly lower than that of Case-A due to the delay of system reinforcement.

In Dar es Salaam, installation of 132kV system in FZ III-Yombo-Kurasini-Ilala area is scheduled in 2004 in Case-A and it is postponed upto 2005 in Case-B'. Accordingly serious voltage drop around Kurasini S/S especially on Mbagala S/S is expected. If the upgrade of Kurasini S/S will be delayed for long term, alternative measure against the voltage drop such as the installation of capacitor or load shedding maybe needed.

In Arusha, Kilimanjaro region, on Case-B' calculation, the load of Lawate S/S and Boma Ngombe S/S revised at outside, therefore, severe voltage drops are shown on Fig. 14.1.18. As there is no certain information of load forecast of Lawate S/S and Boma Ngombe S/S, therefore estimated demand curve is applied to the calculation. For this reason, the reinforcement of transmission line around this area is not considered in master plan. However, Lawate S/S is located at the end of Kilimanjaro 33kV system and Boma Ngombe area is populated rapidly, voltage problem is likely occurred there. Preparation of preventive measure is highly recommended.

Although the result of simulation shows the necessity of var compensation, the most of var compensation equipment cost is not included in the project cost on the master plan study. The reason of this is mentioned below.

Voltage drop on transmission (not distribution) system is caused by high impedance of power equipment such as transmission lines, transformers and also caused by poor power factor of load. Reinforcement of transmission system is the answer for former problem. For poor power factor, the installation of capacitor banks by TANESCO is one of the answers however, not only answer. For example, TANESCO may give customers the power factor incentive to keep the power factor around one and make them install var compensation equipment. Another reason is that the modeled power factor in the calculation is set sever value "0.80". Accordingly the most of var compensation equipment cost is not included in the project cost, however, some capacitors are supposed to be installed in primary S/S.