Chapter 4 Japanese Technologies

4.1 Japanese Companies

According to AfDB[64], as of January 2016, there are 440 bases of Japanese companies in Africa, out of which South Africa accounts for 46%, ranked at the top throughout all of the regions. Comparing by country, RSA is ranked 1st with 136 companies, far exceeding all other countries. This number is 31% of all Japanese companies in Africa. Then followed by Tanzania in 6th, with 26 companies, Mozambique in 11th with 10 companies and Zambia in 12th with 9 companies.

Through the Survey, interviews have been conducted with Japanese companies which relevant to the Survey. The main points of the interviews are the following.

・Interest and expectation of introducing Japanese technologies to Africa
・Countries in which the companies focus on the Southern African region.

The summary is shown below.

Table 4.1-1 Interest in the introduction of Japanese technologies to Africa

Electric Manufacture-A	Smart grid technologies
Electric Manufacture-B	Distribution equipment, including system stabilizing devices, smart grid technology and hydroelectric equipment
Electric Manufacture-C	Electric power supply control system, substation equipment, Smart grid technology, and gas turbine generators
Electric Manufacture-D	System stabilizing devices, transformers
Conductor Supplier	Special conductors (low-loss and increased capacity)
Heavy Electric Manufacture – A	Gas turbine generators, boilers
Heavy Electric Manufacture – B	Gas turbine generators, boilers
Heavy Electric Manufacture – C	Hydroelectric equipment
Heavy Electric Manufacture – D	Variable speed pump. Variable speed general hydroelectric equipment
Trading Company – A	High-efficient gas turbine generators, advanced subcritical coal fire equipment
Trading Company – B	High-efficient gas turbine generators
Trading Company – C	None
Trading Company – D	None
Trading Company – E	Special conductors (low-loss and increased capacity), Geothermal equipment
Trading Company – F	None
Trading Company – G	None

Source : JICA Survey Team

[64] Japanese Company list in African Business (2016)

Table 4.1-2 Countries on which Japanese companies are focusing in SAPP region

Trading Company – 1	RSA, Angola, Mozambique, Tanzania (reviewing possibility of thermal power generation business)
Trading Company – 2	RSA, Mozambique (focusing on acquiring resources)
Trading Company – 3	Botswana, Namibia (focusing on IPP business)
Trading Company – 4	Angola (reviewing possibility of thermal power business)
Trading Company – 5	Zambia, Mozambique (reviewing the possibility of application of Japanese technologies to transmission lines)
Trading Company – 6	Focusing in general
Trading Company – 7	Focusing in general

Source : JICA Survey Team

4.2 Japanese Technologies and demand of SAPP region

The Survey Team had activities to interview to power utilities in SAPP and relevant organizations to confirm their demand and worries about technical issues in daily work or future system planning. Following list shows marked comments from them through interviews.

Table 4.2-1 Technical demand from utilities and relevant organizations

Country	Needs
South Africa	- Environmental measures for existing coal thermal facilities - High efficiency gas-fired power facilities for gas-to-power programme - System stability measures against large scale renewable generation introduction - Transmission capacity enhancement on Ultra High Voltage grid in the metropolitan area (Gauteng) - Transmission tower/pylon technology for crowded area such as metropolitan area (Gauteng) (Multi-circuit tower) - Bulk power transmission technology (HVDC)
Botswana	- Diagnosis technique of the existing coal-fired power facilities - System stabilization and system operation for large scale renewable generators. - Maintenance technique of power system facilities
DRC	- River system management and its operation - Transmission and distribution improvement in Kinshasa metropolitan area
Angola	- Interconnection among isolated national transmission system
Zambia	- High efficient river water management and river system operation - Power system improvement method
Mozambique	- Transmission loss reduction method (operating aspect and designing aspect) - Transmission integration to meet high growth of metropolitan area - Power system operation with generation mix including renewables in northern area
Zimbabwe	- Power system facilities' maintenance

Source : JICA Survey Team

In addition, the Survey Team studied Japanese technologies which are expected to be able to introduce in Southern African region. The following are conceivable for the forecasted technological concerns in Southern African region and the SAPP system.[65]

・Reduction in transmission loss
・Reactive power control on the transmission network in a large area
・Instant removal of failures and minimizing the area of power failure
・Establishment of methodologies for capacity building of engineers

Based on the data collection, possible Japanese technologies introduced to Africa in near future are listed.

65 These were referred to and listed with reference to the concerns, which were questioned by many power utility engineers from the Southern African region in the JICA Power System Technology Training, consigned to Chubu Electric Power Co., Inc.

Table 4.2-2 Japanese technologies for SAPP region

Japanese technologies	Strength	Expected Effect	Issues for Introduction
Transmission facilities			
・Conductor			
Special Conductor (capacity-enhancement conductor)	About twice or threefold capacity compare to conventional conductor (ACSR) can be distributed at low-sag.	Applying to new transmission lines which are forecasted to have huge power flow, construction cost might be lower than the total construction cost, including the expansion of new transmission lines in the future.	Identification of the transmission segment of huge power flow Harmonization with the existing transmission line design. Procurement condition for on-site manufacturing
Special Conductor (Low-loss conductor)	Aluminum sectional space was increased (finer core wire) as compared with the conventional conductor to reduce electric impedance and loss might be minimized.	(1) Loss reduction by applying to huge power flow or long-distance transmission lines (2) If the transmission capacity the same as the conventional conductor is realized, the transmission line construction cost might be reduced by lighter conductor.	(2) Confirmation of the rough design based on the design standards for the transmission system, especially transmission pylon Procurement condition for on-site manufacturing
・Transforming facility technologies			
STATCOM	By controlling reactive power in the long-distance and/or heavy current carrying transmission line, securing the available transmission capacity and preventing loss of synchronism of generators. The world's largest self-commutated reactive power compensation device was developed.	Prevention of loss of synchronism of generators due to the distant generation place compared with the place of reactive power control and consuming in SAPP wide-area system.	Review of effective place of installation.
Direct current facilities (asynchronous connection facilities)	Having the operation records of asynchronous connection technology such as connection of systems with different frequency of 50Hz and 60Hz (frequency conversion (FC) technology) and Back to Back facilities.	In a wide area alternate current system, in order to simplify power flow control in the system, constraining only in the area expecting spread of failures.	Advanced system analysis is required to select the place of introduction.
・Advanced computerization system			
System stabilization system	Always calculate the system stability, using the current status and transmit control requirement to each separation point by failure and carry out system separation at the time of failure so that the scope of spread of failures would be minimized at the time of failure.	Control of errors by protective relays in case of complicated system composition and prevention of wrong judgment by operators	Determination of control area, classifying a wide area system.
System monitoring system (SCADA・Training simulator)	Based on the system information of status of failure, accumulated in SCADA system, which is always conducting remote monitoring control, by representing the complicated failure phase on the simulator by addition to contribute to improving skills of system operators.	Improvement of system operation skills and system operation quality by statistics of information of enormous system information	Organization of system operation rules, including power market design and establishment of the targets of improving skills of system operators.
Demand and sypply planning / adjustment system	Generation system planning in consideration of fuel procurement and consumption, real time supply and demand adjustment	Contribution of effective generation management and operation knowledge accumulation	
Facility management and diagnositic system	Integrated systematization including facilities deterioration diagnosis with IoT	Unified facilities management in electric power company Contribution of engineer knowledge management and the skill succession	
Thermal Facilities			
・Gas turbine technology			
Combined cycle gas turbine	Japanese technologies are predominantly superior for large capacity to small capacity, including efficiency	Applicable to countries with system capacity of more than 1,000MW Effective for balancing power source by introducing a large scale renewable energy.	
Small and medium capacity gas turbine	Highest efficiency is achieved by Kawasaki Heavy Industries and IHI for OCGT small and medium capacity.	Applicable to every country regardless of the system capacity. Effective for balancing power source by introducing a large scale renewable energy.	
Integrated coal gasification combined cycle (IGCC)	Gasification of coal and generation by combined cycle enable more efficient operation than the existing coal fired thermal.	IRP of South Africa considers application of IGCC. (Technologies seem to fit in because of the history of synthesized petroleum.) Suitable for wholesale of power to countries with coal resources and having the economic size commensurate with the generation cost (South Africa, Mozambique, Botswana, Zimbabwe → Southern Africa)	Verification phase

Japanese technologies	Strength	Expected Effect	Issues for Introduction
Gas turbine using high humid air (AHAT)	Control is easier than combined cycle. In addition, it is capable of water utilization specification restrictions and high efficient operation is possible.	Suitable for gas fired power generation for inland pipelines（Mozambique, Tanzania, South Africa, Angola）	Development phase
・Boiler technology			
Advanced subcritical coal-fired power (A Sub-C)	With 100MW class subcritical coal fired, efficiency (sending out) is 41%. It has been introduced in a domestic new electric company (Suzukawa Power Plant)	For small system capacity countries, it can be the candidate for sufficient clean coal technology.	No overseas track record
Ultra-supercritical coal-fired power (USC)	With the steam temperature of over 593°C, efficiency (sending out) will be 42% (HHV Criteria) , Single unit capacity over 600MW	Only limited to development in Japan, Korea and Europe. For such large system capacity countries as South Africa	Requiring special maintenance technologies derived from specific operation and parts.
Advanced Ultra-supercritical coal-fired power (A-USC)	With the steam temperature of over 700°C, efficiency (sending out) will be over 46% (HHV Criteria) Single unit capacity is about 1,000MW	For such large system capacity countries as South Africa	Requiring special maintenance technologies derived from specific operation and parts. Development phase
・Advanced computerization system			
Facility management and diagnositic system	Integrated systematization including facilities deterioration diagnosis with IoT	Unified facilities management in electric power company Contribution of engineer knowledge management and the skill succession	
Hydroelectric facilities			
Variable speed pumping	Pumping engine is variable according to the variable generation output to adjust supply capacity of the system	Forecasting the balancing load corresponding to introduction of large quantity RE	Selection of low generation cost source constituting pumping source
Variable speed general hydroelectric	Adjust for the highest efficient operation according to the highest water level which is variable.	Efficient operation is expected at small and medium capacity hydroelectric power plants.	Such conditions are required as 1. The water level of upstream reservoir is fructuate 2. Capacity of a unit is smaller than 20MW.
・Advanced computerization system			
River system operation	Water system consistency operation of selectable operation, priority Wh or W	Contribution of effective generation management and operation knowledge accumulation Expansion to river system operation simulator	

Source : JICA Survey Team

4.3 Seminar for Japanese Corporations

(1) 1st Seminar for Japanese Companies

On November 27, 2015, the Survey Team reported to Japanese companies about the purpose of the Survey and abstract of the 1st field survey. In order to obtain information and cooperation about the localities, the Survey Team and all participants had a conversation closely. The seminar was conducted adopting the following three compositions.

1. Purpose, period and objective results of the Survey
2. Overview of SAPP and the development projects by SAPP
3. The latest 10-year system planning published by Eskom in RSA.

On that day, many companies participated and a lively exchange of opinions was heard. One of main expectations of participants was the status of anew power system plan in South Africa and trends of generation development status of neighboring countries of RSA. Because South Africa is a large demand country and big market to supply electricity.

Figure 4.3-1 1st Seminar for Japanese companies

(2) 2nd Seminar for Japanese companies

In May 12, 2017 the Survey team reported the result of this Survey and consulted with Japanese companies in the 2nd Seminar for Japanese cooperation for the termination of the Survey.

Seventy six (76) attendees including officers from ministry of foreign affairs joined the seminar, and they checked carefully the objectives of this Survey.

On the seminar following significant comments were posted ;

- ✓ It is necessary to analyze the precise condition such as hourly surplus and deficit of each area for confirming the suitable solutions applicable.
- ✓ Huge introduction of renewable energy in SAPP area will affected regional system operations as well as wide area system operations regarding demand and supply balance. Japanese technologies against this features is fruitful and it can be available.

Source：JICA Survey Team

Figure 4.3-2　2nd Seminar for Japanese companies

4.4 Harare and Pretoria Seminars and Invitation Program to Japan (done)

(1) Harare and Pretoria Seminars

"Power Engineering Seminar", was held in Harare, Zimbabwe and in Pretoria, South Africa, on 6th and 10th October 2016 respectively which introduced SAPP current status and Japanese technologies to be able to adopt and overcome current and future critical situations. The power engineers from SAPP member states, relative organizations and Japanese companies were gathered these seminars. In these seminars, close conversations about engineering technologies were interchanged. And participants made close relationships.

Table 4.4-1 Attendant list of Harare (Zimbabwe) seminar on 6th October 2016

No	Title	FIRST NAME	LAST NAME	Organisation
1	**H.E. Mr.**	Yoshinobu	**Hiraishi**	Japanese Ambassador
2	**Mr.**	Kenji	**Miyagawa**	Embassy of Japan
3	**Mr.**	Masahiro	**Ishida**	Embassy of Japan
4	**Mr.**	Julian	**Chinembiri**	MD, ZESA
5	**Mr**	Wellington	**Tungati**	CEC
6	**Mr**	Clement	**Hakatombo**	CEC
7	**Mr.**	Emanuel	**Ngoyi**	SNEL
8	**Mr.**	Gaby	**Malonda**	SNEL
9	**Mr.**	Chapson	**Chikwa**	ZESCO
10	**Mr.**	Collins	**Mumba**	ZESCO
11	**Mr.**	Addjoy	**Nguwo**	ZESA
12	**Mr.**	Prince	**Muchenje**	ZESA
13	**Mr.**	Evans	**Chitate**	ZESA
14	**Mr.**	Sydney	**Zimba**	SAPP-CC
15	**Mr.**	Alison	**Chikova**	SAPP-CC
16	**Mr**	Antonio	**Santos**	RNT
17	**Mr.**	Antonio	**Moniz**	RNT
18	**Mr.**	Raymond	**Kanyinji**	ESCOM
19	**Mr.**	Wines	**Kalilombe**	ESCOM
20	**Mr.**	Tobias	**Mudzingwa**	ZERA
21	**Mr.**	Coen	**Bosch**	Nyangani Renewable Energy, IPP
22	**Mr.**	Luxmore	**Madiye**	Hunyani Power Station, IPP)
23	**Mr.**	Hiroto	**Kamiishi**	JICA HQs
24	**Mr.**	Shingo	**Naito**	JICA HQs
25	**Mr.**	Shumon	**Yoshihara**	JICA Zimbabwe Office
26	**Ms.**	Sayaka	**Ochida**	JICA Zimbabwe Office
27	**Mr.**	Kenjro	**Azuma**	JICA Zimbabwe Office
28	**Mr.**	Takeshi	**Kozu**	JICA RSA Office
29	**Mr.**	Takashi	**Hansaki**	JICA Zambia Office
30	**Mr.**	Masaharu	**Nogami**	Mitsubishi Corp.
31	**Mr.**	Keiji	**Higaki**	Toshiba
32	**Mr.**	Iwasuke	**Simada**	Toshiba
33	**Mr.**	Ken	**Kawabe**	Nippon Koei
34	**Mr.**	Kosuke	**Ambe**	Tokyo Rope MFG
35	**Mr.**	Shigeru	**Nagata**	Sumitomo Electric Industries
36	**Mr.**	Yuki	**Fukuda**	Toyota Tsusho

Table 4.4-2 Attendant list of Pretoria (RSA) seminar on 10th October 2016

No	Title	FIRST NAME	LAST NAME	Organisation
1	**Mr.**	Aaron	**Lentswe**	BPC
2	**Mr.**	Pego	**Mosalakatane**	BPC
3	**Ms.**	Olga	**Utchavo**	EDM
4	**Mr**	Maxcencio	**Tamele**	HCB
5	**Mr**	Luis	**Simone**	HCB
6	**Mr**	Thabiso	**Phate**	LEC
7	**Mr.**	Ntelane	**Sello**	LEC
8	**Mr.**	Wilson	**Masango**	SEC
9	**Mr.**	Joseph	**Ncwane**	SEC
10	**Mr.**	Sydney	**Zimba**	SAPP-CC
11	**Mr.**	Musara Chikondo	**Beta**	SAPP-CC
12	**Mr.**	Johannes Kandara	**Mukusuka**	NamPower
13	**Mr.**	Leandro Tulukeni	**Kapolo**	NamPower
14	**Ms.**	Bianca	**Christison**	Eskom
15	**Mr.**	Sicelo	**Cele**	Eskom
16	**Mr.**	Teboho	**Machabe**	Eskom
17	**Mr.**	Ntombi	**Chavalala**	Eskom
18	**Mr.**	Lyle	**Naidoo**	Eskom
19	**Mr.**	Dudu	**Radebe**	Eskom
20	**Mr.**	Jaamila	**Kombe**	Eskom
21	**Ms.**	Teresa	**Smit**	Eskom
22	**Mr.**	Kimberly van	**Niekerk**	Power Africa Coordinator's Office (USAID)
23	**Mr.**	Masanori	**Kudo**	Mitubisshi Corp.
24	**Mr.**	Martin	**Lippinkhof**	Mitubisshi Corp.
25	**Mr.**	Natascha	**Hartlett**	Mitubisshi Corp.
26	**Mr.**	Hiroyuki	**Tanaka**	Mitubisshi Corp.
27	**Mr.**	Arata	**Hori**	Mitsui
28	**Mr.**	Seiji	**Iijima**	Itochu
29	**Mr.**	Stefano	**Capriello**	Sumitomo Corp
30	**Mr.**	Toshiki	**Kashihara**	Sumitomo Corp
31	**Mr.**	Testuichi	**Hina**	Toyota-Tsusho
32	**Mr.**	Yuki	**Fukuda**	Toyota-Tsusho
33	**Mr.**	Vinesh	**Rajccomar**	MHPS
34	**Mr.**	Shigeru	**Nagata**	SEI
35	**Mr.**	Keiji	**Higaki**	Toshiba
36	**Mr.**	Iwasuke	**Shimada**	Toshiba
37	**Mr.**	Pietro	**Mendace**	Toshiba
38	**Mr.**	Kousuke	**Ambe**	Tokyorope
39	**Mr.**	Keisuke	**Fujioka**	Hitachi
40	**Mr.**	Yukihito	**Kikugawa**	Hitachi
41	**Mr.**	Hiokazu	**Tsukidate**	JETRO
42	**Ms.**	Kyla	**Oneil**	JETRO
43	**Mr.**	Eisuke	**Tachibana**	NEPAD
44	**Ms.**	Tichaknnda	**Simbini**	NEPAD

Table 4.4-3 Agenda of Harare and Pretoria Seminar

Data Collection Survey on South Africa Power Pool

Power Engineering Seminar in Zimbabwe

6 October 2016, Cresta Lodge Hotel

Time	Schedule	Speaker	
9:30	Welcome Remarks and Introduction of delegates	Mr. A. Chikova	SAPP C.C.
9:35	Opening speech	H.E. Mr. Y. Hiraishi	Japanese Ambassador
9:45	JICA's Energy Sector Assistance in Africa	Mr. Kamiishi	JICA HQs
10:20	Introduction of "Data Collection Survey on Southern African Power Pool"	Y.Takeyama	JICA Survey team
10:30	Tea break		
10:45	Session 1: Operations and maintenances 1. Transmission facilities ✓ GIS (Gas Insulated Switchgear) 2. Operation assisting equipment for substation 3. Tips for maintenance of thermal power	Y.Takeyama T.Yoshida M.Watanabe	JICA Survey team
11:45	Session 2: Special technique for construction of thermal power plant	M.Watanabe	JICA Survey team
12:00	Session 3: Integration with up-to-date techniques and knowhow 1. Overhead transmission line ✓ HTLS (High Temperature Low Sag Conductor) ✓ Low Loss conductor ✓ EGLA (External gapped line arrester) 2. Substation equipment ✓ Synchro. Circuit Breaker 3. Power system stabilization 4. Power system integration- Smart Grid 5. Power system integration- Battery technologies 6. To do the better system operations 7. Hydro power technique- Adjustable speed pumped storage plant 8. Thermal power plant ✓ New Technologies on Thermal ✓ USC and A-USC ✓ GTCC ✓ IGCC ✓ CCS ✓ Road Map	Y.Takeyama T.Yoshida T.Aoki M.Watanabe	JICA Survey team
13:00	Closing remark	Mr. A. Chikova	SAPP C.C.
13:15	Lunch break and discussions		

Source : JICA Survey Team

Data Collection Survey on South Africa Power Pool

Power Engineering Seminar in South Africa

10 October 2016, Sheraton Pretoria Hotel

Time	Schedule	Speaker	
9:30	Welcome Remarks	Mr. M. Beta	SAPP C.C.
9:35	Opening speech	Mr. Kamiishi	JICA HQs
9:45	JICA's Energy Sector Assistance in Africa	Mr. Kamiishi	JICA HQs
10:20	Introduction of “Data Collection Survey on Southern African Power Pool”	Y.Takeyama	JICA Survey team
11:30	Tea break		
10:45	Session 1: Operations and maintenances 1. Transmission facilities ✓ GIS (Gas Insulated Switchgear) 2. Operation assisting equipment for substation 3. Tips for maintenance of thermal power	Y.Takeyama T.Yoshida M.Watanabe	JICA Survey team
11:45	Session 2: Special technique for construction of thermal power plant	M.Watanabe	JICA Survey team
12:00	Session 3: Integration with up-to-date techniques and knowhow 1. Overhead transmission line ✓ HTLS (High Temperature Low Sag Conductor) ✓ Low Loss conductor ✓ EGLA (External gapped line arrester) 2. Substation equipment ✓ Synchro. Circuit Breaker ✓ Gas Transformer 3. Power system stabilization 4. Power system integration- Smart Grid 5. Power system integration- Battery technologies 6. To do the better system operations 7. Hydro power technique- Adjustable speed pumped storage plant 8. Thermal power plant ✓ New Technologies on Thermal ✓ USC and A-USC ✓ GTCC ✓ IGCC ✓ CCS ✓ Road Map	Y.Takeyama T.Yoshida T.Aoki M.Watanabe	JICA Survey team
13:00	Closing remark	Ms.Christison	Eskom.
13:15	Lunch break and discussions		

Source : JICA Survey Team

(2) Invitation Program in Japan

Two-week invitation scheme, namely "Power Engineering Programme" was conducted in Japan from 30 October to 12 November 2016. Sixteen (16) delegates on behalf of each SAPP member state were gathered in Japan to confirm suitable Japanese technologies to overcome SAPP issues. Table 4.4-4 shows delegates of this program and Table 4.4-5 shows schedule of this program. The delegates, who are or will be in charge of leading post of system planning and / or system development policies in each SAPP member state, were chosen by SAPP Coordination Centre and with the recommendation by SAPP management committee.

Table 4.4-4 Delegates of "Power Engineering Programme" in Japan

No	Name	Nationality	Company	Title
1	Mr. Alison Makosa Chikova	Zimbabwe	SAPP C.C.	Chief Engineer
2	Mr. Fokas Daniel Mshambala	Tanzania	Tanesco	Pricipal Engineer, Planning
3	Mrs. Phokoane Wilhemina Makhongoana	South Africa	Eskom	Chief Engineer, Grid Planning
4	Mr. Emanuel Malangu NGOYI	DRC	SNEL	Senior Engineer, Planning
5	Mr. Eudes Panzo	Angola	RNT	Chief Engineer, Planning
6	Mr. Hlopheho Moses Ntlamelle	Lesotho	SADC	Program Officer Energy
7	Mr. Abeauty Sikombe	Zambia	ZESCO	Chief Engineer
8	Mrs Olga Cheila Mariza Francisco Utchavo Madeira	Mozambique	EDM	Transmission Planning Engineer
9	Mr. Addjoy Nguwo	Zimbabwe	ZESA	Senior Electrical Design Engineer
10	Mr. Pego Mosalakatane	Botswana	BPC	Manager Planning and Project
11	Mr. Clement Hakatombo	Zambia	CEC	Senior Engineer, Planning
12	Mr Johannes Kandara Mukusuka	Namibia	NamPower	Senior Manager
13	Mr Joseph Vusie Ncwane	Swaziland	SEC	Senior Engineer, Planning
14	Mr Thabiso Phate	Lesotho	LEC	Senior Engineer, Planning
15	Mr David Pilato Chirindza	Mozambique	HCB	Senior Manager
16	Mr. Raymond Kanyinji	Malawi	ESCOM	Assistant Engineer

Table 4.4-5 Power Engineering Program agenda

Day		Type	Time	Content
30 Oct.	Sun.			Arrive at Nagoya
31 Oct.	Mon	Lecture & Site Visit	Morning	Orientation Lecture Outline of Chubu Electric Power Co., Inc.
			PM (1)	Site visit & lecture regarding Central Load Dispatching and Control Center, and System stabilizing equipments
			PM (2)	Site visit & lecture regarding Central Load Dispatching Center with renewable outpiut prediction equipment
1 Nov.	Tue.	Lecture & Site Visit	AM	Lecture Outline of Transmission line facility and its O&M, and Outline of Substation facility and its O&M
			PM	Site visit, NGK INSULATORS for NAS battery system
2 Nov.	Wed.	Lecture & Site Visit	AM	Lecture Outline of Thermal power plant facility and its O&M, Outline of Hydropower plant facility and O&M and river water management system
			PM	Site visit Kawagoe thermal power plant, LNG Gas fired power
3 Nov.	Thu.	Lecture & Site Visit	PM	Lecture & site visit Higashi-Shimizu Substation, Frequency Converter
4 Nov.	Fri.	Lecture, Presentation& Site Visit	AM	Lecture Outline of JERA Presentation Self-introduction(5min for each person)
			PM	Lecture & site visit OCCTO (Organization for Cross-regional Coordination of Transmission Operator, Japan)
5 Nov.	Sati.	Day-off	－	Day-off
6 Nov.	Sun	Day-off		In the evening, move to Hitachi-city
7 Nov.	Mon	Lecture & Site Visit	AM	Lecture & site visit MHPS (Mitsubishi Hitachi Power System) Hitachi Works, Thermal power equipment and HM (Hitachi Mitsubishi) Hydro, Hydroelectric equipment
			PM	Lecture & site visit Hitachinaka Coal Thermal Power Station
8 Nov.	Tue	Lecture & Site Visit	AM	Lecture & site visit Sumitomo Electric Toyoura Works, Overhead Transmission line, Low loss conductor, HTLS conductor
			PM	Lecture & site visit Hitachi Omika Works, PV panel, PCS, Energy storage system
9 Nov.	Wed	Lecture & Site Visit	AM	Lecture Introduction of Mitsubishi Electric technology, GIS, Gas transformer
			PM	Lecture & site visit Fuji Electric Tokyo Works, Smart grid system
10 Nov.	Thu	Lecture & Site Visit	AM	Lecture Tokyo Rope MFG, ACFR(Aluminum Conductor Fiber Reinforced) Japan Weather Association, Weather information for Renewable energy output prediction
			PM	Lecture & site visit Toshiba Futyu Works, TSC, Power system simulator, battery system
11 Nov.	Fri		AM	Closing ceremony & Farewell Party
			Afternoon	Move to Haneda Airport → Back to countries

Source：JICA Survey Team

Chapter 5 Examination of development effectiveness

5.1 Marshaling the development issues

5.1.1 Information of existing power system master plans of SAPP member states

(1) Power system master plan document and relevant information

Table 5.1-1 shows the gathered power system master plan documents and relevant information of SAPP member states.

Table 5.1-1 Power system master plan document and relevant information

State	Evidences of power system master plan	Remarks
Angola	Angola Energia 2025 – Ministterio da Energia e Agus (2015) - MINEA	Policy
Botswana	Electricity Supply Industry in Botswana, Power Supply and Demand in Southern Africa (2013) －BPC	Evidences on International conference
DR Congo	Nil	
Lesotho	Nil	
Malawi	Malawi's Mini Integrated Resource Plan 2016-2020 (2016) －MNREM	Unauthorisation by Government
Mozambique	Master Plan Update Project, 2012 - 2027 Final Master Plan Update Report (2013) – EDM	
Namibia	National Integrated Resource Plan (2011) – ECB	
RSA	Transmission Development Plan 2016 – 2025 (2015) – Eskom Integrated Resource Plan for Electricity 2010 – 2030 Update Report 2013 (2013) – DoE	Studying new Integrated Resource Plan
Swaziland	Nil	
Tanzania	Power System Master Plan 2016 Update (2016) – MoEM	JICA Study
Zambia	The Study for Power System Development Master Plan in Zambia (2010) － MEWD	JICA Study
Zimbabwe	System Development Plan (2015) – ZETDC	
SAPP	SAPP Pool Plan (2009) – SAPP	

Source : JICA Survey Team

As the table is represented, the documents and evidences gathered do not always have long-term planning and even some states do not have master plan.

RIDMP, given by SADC, states in 2012 that only six (6) member states submitted power system master plan document to create SADC master plan. (see Table 5.1-2). Compared to this, it is clear that SAPP member states are making efforts to realize their own system and standing face to face to plan the development.

Table 5.1-2 Summary of status of the policy framework of the SADC member states

Country	Energy policy/strategies	Energy master plan	Energy/electricity regulator
Angola			√
Botswana	Draft	√	In progress
DRC			
Lesotho			√
Malawi			√
Mauritius	√	√	
Mozambique	√	√	√
Namibia	√		√
Seychelles			
South Africa	√	√	√
Swaziland	√		
Tanzania	√		√
Zambia	√	√	√
Zimbabwe	√	√	√
SADC	√	Under development	√

Source : Regional Infrastructure Development Master Plan, Energy Sector Plan – SADC-DIS (2012)

(2) Overviews of the Power system master plans

Overview of gathered power system master plans and relevant evidences are shown in Table 5.1-2.

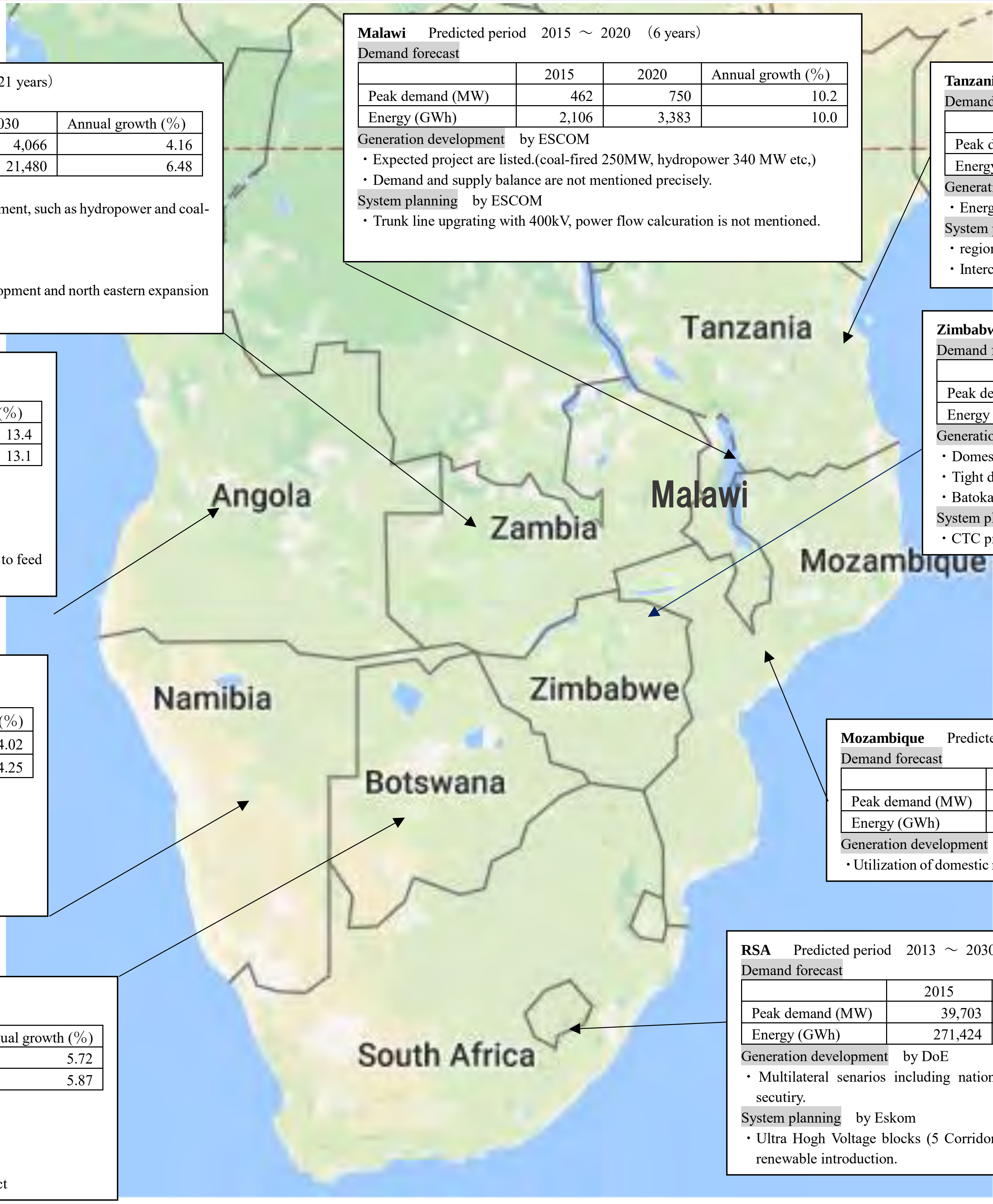
The followings are remarkable findings through the overview.

- Mostly, SAPP member states have power system master plan document and / or evidence that are equal.
- Master plan is a little bit elder, except that of RSA, Malawi, Zimbabwe, and Tanzania.
- Master plans gathered answered that every state utilizes national primal energy to generate the electricity.
- Most of master plans gathered do not mentioned system planning and other key issues, such as financial studies.

As it was mentioned in section 3.13, examining power system master plan in all SAPP member states synchronously is a key to find out the region-wide condition and to plan strategic direction mutually. Specifically master plan for SAPP should be examined every three years normally, but every five years no matter how long it takes.

Further, to realize all SAPP member state condition and direction of development of power system each other comprehensive study should be needed to do, like JICA master plan study to clear issues, such as financial direction of utility and electricity tariff perspective etc.

Therefore SAPP should have a role to make a rule of general master plan contexts.



Zambia Predicted period 2010 ～ 2030 (21 years)

Demand forecast

	2010	2030	Annual growth (%)
Peak demand (MW)	1,801	4,066	4.16
Energy (GWh)	6,120	21,480	6.48

Generation development by MEWD・ZESCO

・Primal energy utilization for generation development, such as hydropower and coal-fired.

System planning by MEWD・ZESCO

・Northern expansion is the first issue.

・Southern expansion for the Zambezi river development and north eastern expansion for the Luapula river expansion and ZTK project.

Malawi Predicted period 2015 ～ 2020 (6 years)

Demand forecast

	2015	2020	Annual growth (%)
Peak demand (MW)	462	750	10.2
Energy (GWh)	2,106	3,383	10.0

Generation development by ESCOM

・Expected project are listed.(coal-fired 250MW, hydropower 340 MW etc,)

・Demand and supply balance are not mentioned precisely.

System planning by ESCOM

・Trunk line upgrating with 400kV, power flow calcuration is not mentioned.

Tanzania Predicted period 2015 ～ 2040 (26 years)

Demand forecast

	2015	2040	Annual growth (%)
Peak demand (MW)	974	14,330	10.9
Energy (GWh)	6,310	87,890	10.7

Generation development by MEM

・Energy mix (gas-fired ; 40%, coal-fired ; 35%, hydropower ; 20%) is the goal.

System planning by MEM

・regional system integration with 400kV, 220k.

・Interconnector integration with EAPP, Zambia , Malawi, Mozambique

Angola Predicted period 2013 ～ 2025 (13 years)

Demand forecast

	2013	2025	Annual growh (%)
Peak demand (MW)	1,600	7,200	13.4
Energy (GWh)	8,900	39,000	13.1

Generation development by MINEA

・Hydropower and gas-fired are main role, and keen to promote them.

System planning by RNT

・Grid connection among northern, central and southern girds.

・In future, interconnection with DR Congo, with Namibia will be hopeful to feed surplus.

Zimbabwe Predicted period 2015 ～ 2038 (24 years)

Demand forecast

	2015	2038	Annual growth (%)
Peak demand (MW)	2,038	6,123	4.59
Energy (GWh)	10,964	32,182	4.59

Generation development by ZETDC

・Domestic resource utilization (hydropower, coal-fired (IPP)).

・Tight demand and supply balance for the present.

・Batoka Gorge hydropower is pilot to be stable the supply.

System planning by ZETDC

・CTC project isn main issue to integrate regional system.

Namibia Predicted period 2011 ～ 2031 (21 years)

Demand forecast

	2011	2031	Annual growth (%)
Peak demand (MW)	512	1,124	4.02
Energy (GWh)	3,231	7,432	4.25

Generation development by ECB

・"Gas-fired plus import" is least cost development.

"Gas-fired plus hydropower " is national energy policy oriented.

System planning by Nampower

・Roughly mentioned that grid expansion is underway in northern area.

Mozambique Predicted period 2012 ～ 2027 (16 years)

Demand forecast

	2012	2027	Annual growth (%)
Peak demand (MW)	563	3,293	13.8
Energy (GWh)	3,255	22,753	12.5

Generation development by EDM

・Utilization of domestic resource, such as hydro and gas are not mentioned precisely.

Botswana Predicted period 2012 ～ 2020 (9 years)

Demand forecast

	2012	2020	Annual growth (%)
Peak demand (MW)	578	902	5.72
Energy (GWh)	3,676	5,801	5.87

Generation development by BPC

・national primary energy utilization for electricity

・Energy import compensates chronic deficit.

System planning by BPC

・Grid expansion for northrern area and linking ZiZaBoNa project

RSA Predicted period 2013 ～ 2030 (18 years)

Demand forecast

	2015	2030	Annual growth (%)
Peak demand (MW)	39,703	72,495	4.00
Energy (GWh)	271,424	479,589	3.89

Generation development by DoE

・Multilateral senarios including national primal energy utilization for energy secutiry.

System planning by Eskom

・Ultra Hogh Voltage blocks (5 Corridors) for grid integration harmonizaed with renewable introduction.

DR Congo, Lesotho, Malawi and Swaziland were omitted due to no evidences

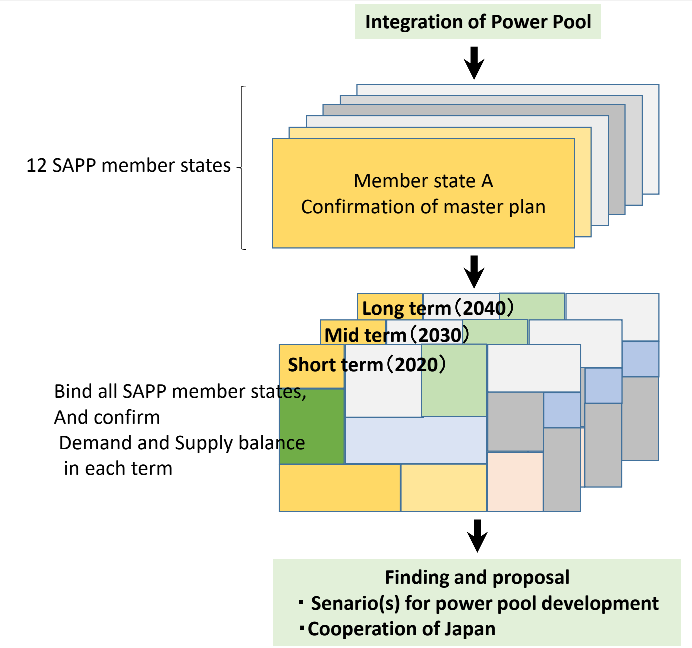
Source：JICA Survey Team

Figure 5.1-1 power system master plans and relevant information of SAPP member states overview

5.1.2 Power system development analysis for power pool development

(1) Analysis principle

The Survey is analyzed in accordance with the following steps to achieve the aim, integrating the pool formation and energizing the power trading in the pool.



Source : JICA Survey Team

Figure 5.1-2 Analysis steps

Step 1 ; Adjustment and calibration with current projects' status for generation development in each member state.

Generation development plan in 12 SAPP member states must be confirmed with the information about current status of each project listed. And newly designed projects should be put on the plan. Through these procedure, latest reliable generation development plan should be wrap up with the shape of list, namely generation development list.

Step 2 : Confirmation of supply balance in SAPP region

Binding all SAPP member states' generation development list gives SAPP overview in future decades. This procedure brings demand and supply balance perspective and brings necessity of interconnection and volume of power interchange.

(2) Concrete method for the principle

In order to Bind all SAPP member states meaningfully shown as Figure 5.1-2, following processes are practiced.

Process – 1 : Selection of demand forecast which has long term prediction and has adequacy in each state.

Process – 2 : Creation of demand and supply balance using demand forecast by process – 1.

As Figure 5.1-1 is mentioned, power system master plans gathered have different period of study and these establishment year are not same. Thus period of demand forecast in SAPP member states are not equal. In order to find out unified aspect for all SAPP member states' demand forecast, demand forecasts gathered should be examined.

(3) Demand forecast analysis

1) Methodology

Regulated demand forecasts to be worth examining are three.

1. demand forecast on SAPP Pool Plan 2009,
2. demand forecast on Power System Master Plan of each state, and
3. demand forecast on SAPP Annual Report 2015

All of them have peak demand forecast, thus MW, and energy consumption, thus GWh.

Following shows the characteristics of each demand forecast.

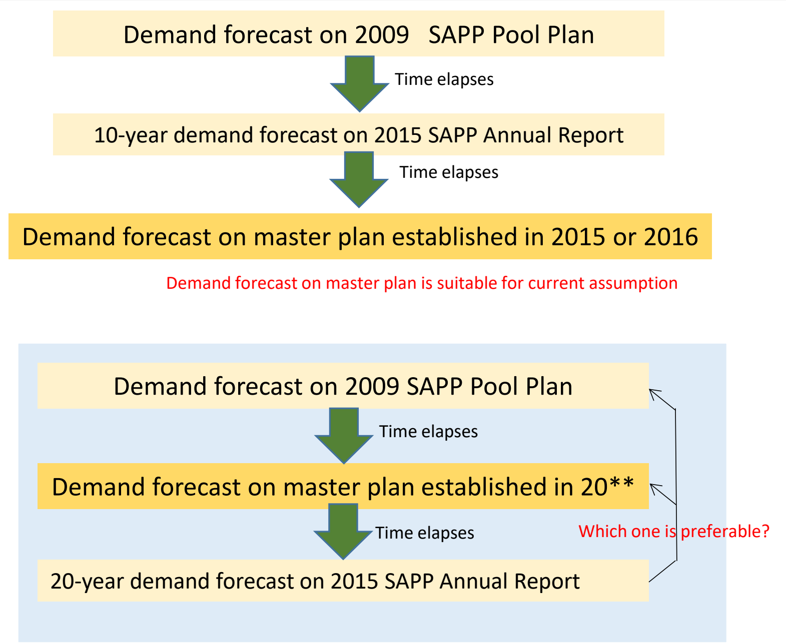
Table 5.1-3　　Characteristic of gathered demand forecast

SAPP Pool Plan 2009 （Publication in 2009）	
Merit	・This data was created with all SAPP member states with close negotiation.
Demerit	・Forecast data is the oldest among other options as publication is 2009. Therefore it has a risk of discrepancy. ・it presents data to 2025.
Power system master plan or relevant evidence in each state	
Merit	・The methodology is clear. ・Every information is midterm or long term demand forecast, beyond 10 years
Demerit	・Most information has risks, as these are issued 3 to 5 years ago, and each does not include current situation. ・Most information does not predict demand in 2040. (in 2030 at most)
SAPP Annual Report 2015 （Publication in 2015）	
Merit	・It would be refined in consideration with latest information.
Demerit	・It provide only 10 year future prediction. ・The methodology is unclear

Source：JICA Survey Team

The demand forecast to be applied should have long-term prediction data and aligned with current demand record if one can.

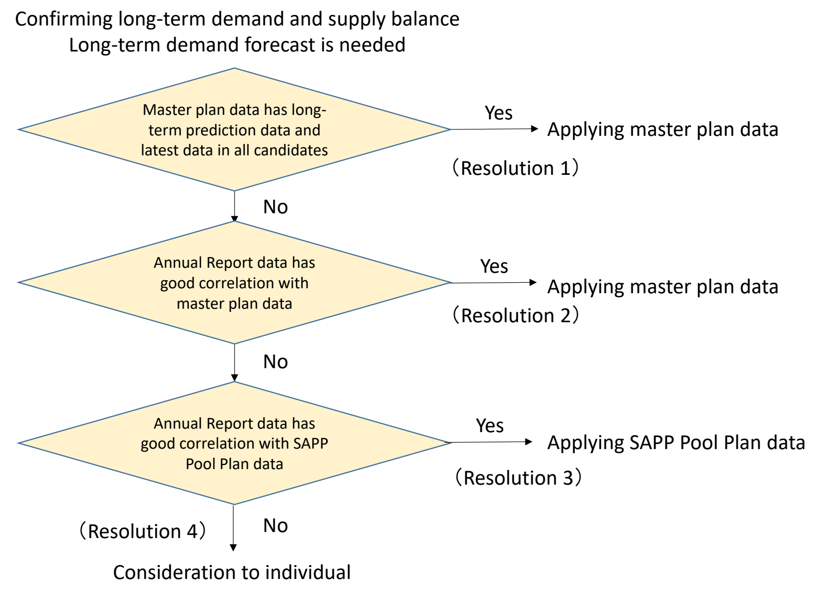
Three demand forecasts can be distinguished two types in terms of publication year. One is that Power System Master Plan is the youngest of all evidences. Another one is SAPP Annual Report is the youngest and Power System Master Plan is elder than SAPP Annual plan.



Source：JICA Survey Team

Figure 5.1-3　Transition of demand forecast determination

The former proves that demand forecast on Power System Master Plan is reliable to apply due to the result reflecting current condition. The latter should be checked which is the inherited to create SAPP Annual Report data (see Table 5.1-3). Therefore, demand forecast was chosen by decision procedure shown in Figure 5.1-4.



Source : JICA Survey Team

Figure 5.1-4　Demand forecast decision procedure

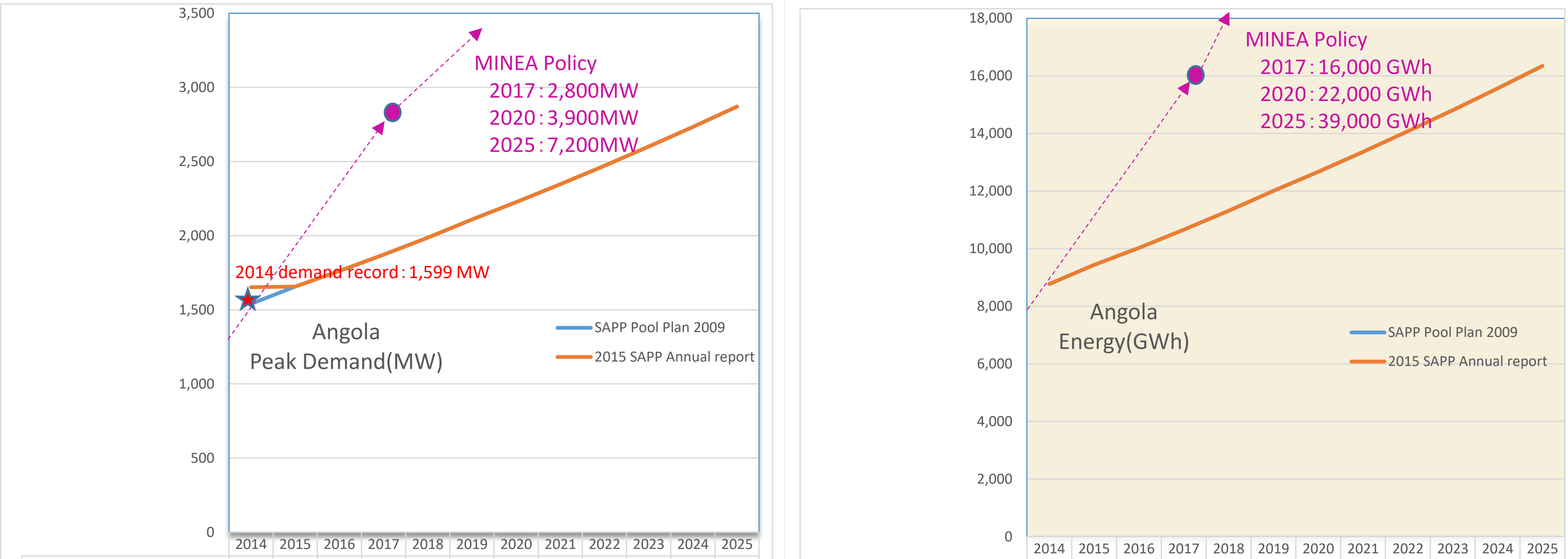
2) Comparison of evidences

Figures, such as Figure 5.1-5 to Figure 5.1-16 show the comparison of three demand forecasts aforementioned[66]. Moderate case is chosen the data illustrated on the figures.

Here, data on Angola Energia 2025 is on the figure for the refence. Also data on Malawi IRP is for the reference. Further, demand record in 2014 in each state put on each figure.

Analysis result is shown in Table 5.1-4.

[66] Some are two due to existence of evidences

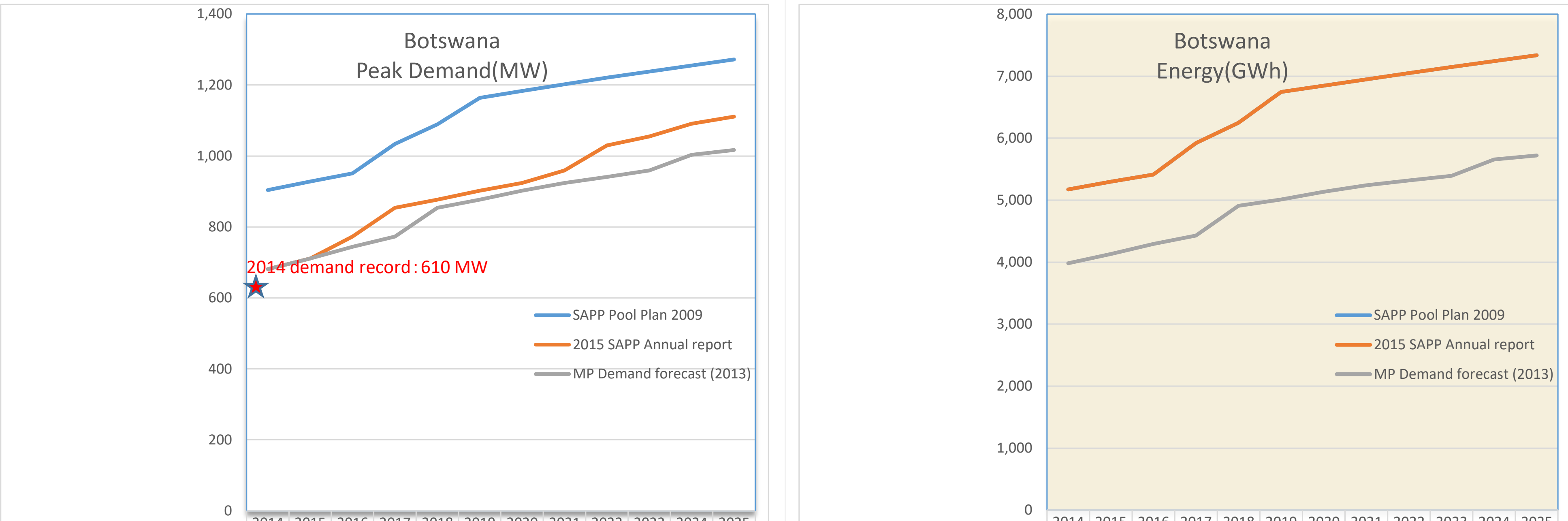


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	1,540	1,657	1,762	1,872	1,987	2,109	2,226	2,347	2,472	2,601	2,734	2,871
2015 SAPP Annual report	1,653	1,657	1,762	1,872	1,987	2,109	2,226	2,347	2,472	2,601	2,734	2,871

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	8,772	9,437	10,032	10,658	11,316	12,008	12,674	13,364	14,077	14,812	15,568	16,345
2015 SAPP Annual report	8,772	9,437	10,032	10,658	11,316	12,008	12,674	13,364	14,077	14,812	15,568	16,345

Source : JICA Survey Team

Figure 5.1-5 Demand forecast comparison (Angola)

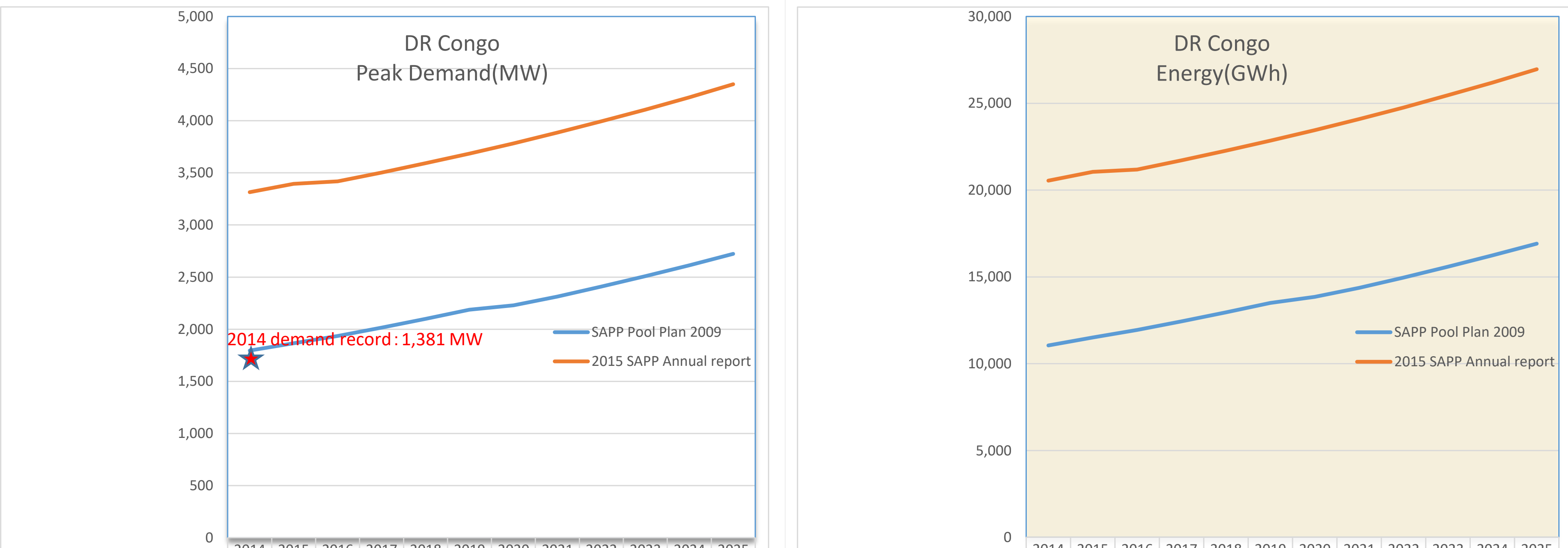


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	904	928	951	1,034	1,089	1,164	1,183	1,202	1,221	1,238	1,255	1,272
2015 SAPP Annual report	681	711	773	854	877	902	924	959	1,030	1,055	1,091	1,111
MP Demand forecast (2013)	681	711	744	773	854	877	902	924	941	959	1,003	1,017

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	5,173	5,298	5,411	5,919	6,247	6,744	6,848	6,949	7,049	7,147	7,243	7,336
2015 SAPP Annual report	5,173	5,298	5,411	5,919	6,247	6,744	6,848	6,949	7,049	7,147	7,243	7,336
MP Demand forecast (2013)	3,982	4,129	4,294	4,428	4,909	5,009	5,134	5,241	5,319	5,391	5,656	5,720

Source : JICA Survey Team

Figure 5.1-6 Demand forecast comparison (Botswana)

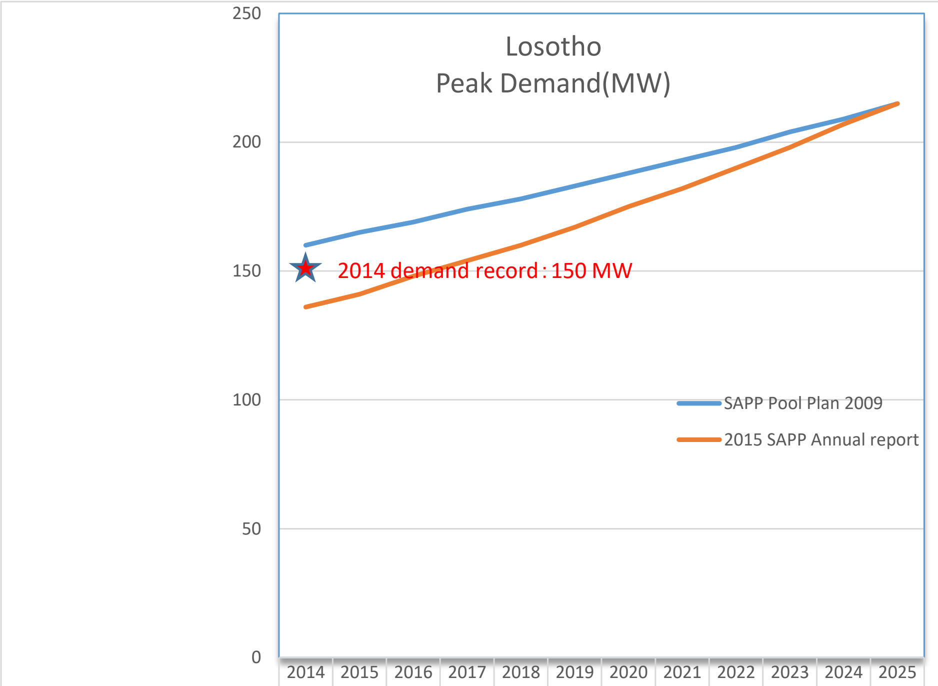


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	1,795	1,865	1,935	2,016	2,100	2,187	2,229	2,313	2,409	2,509	2,614	2,723
2015 SAPP Annual report	3,314	3,395	3,418	3,503	3,592	3,685	3,783	3,886	3,994	4,107	4,225	4,350

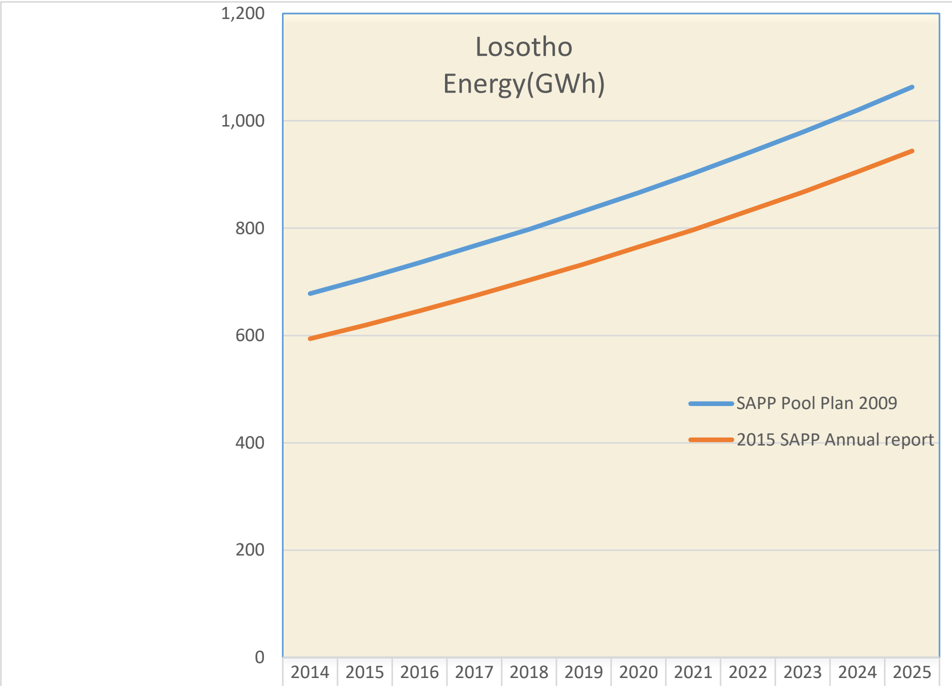
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	11,054	11,514	11,947	12,444	12,962	13,502	13,848	14,369	14,967	15,590	16,239	16,915
2015 SAPP Annual report	20,547	21,049	21,192	21,719	22,270	22,847	23,455	24,093	24,763	25,463	26,195	26,970

Source : JICA Survey Team

Figure 5.1-7 Demand forecast comparison (DR Congo)



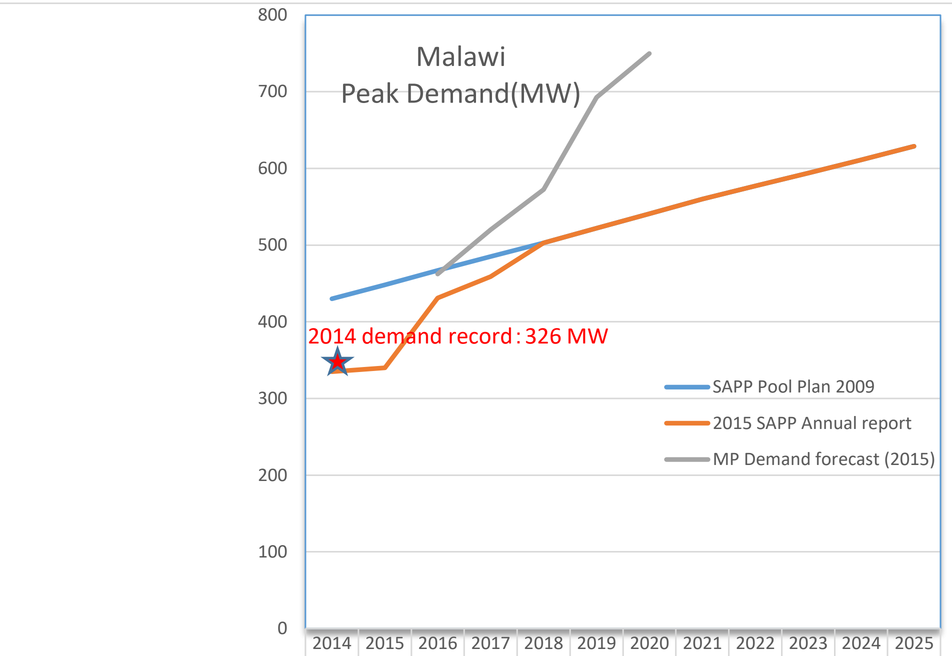
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	160	165	169	174	178	183	188	193	198	204	209	215
2015 SAPP Annual report	136	141	148	154	160	167	175	182	190	198	207	215



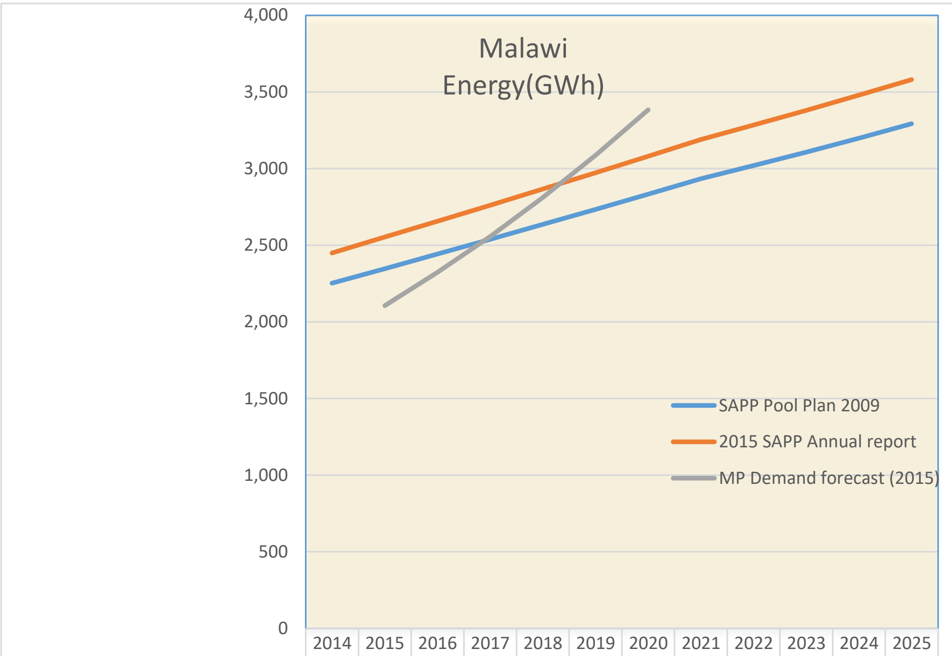
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	678	706	736	767	798	832	866	902	940	979	1,020	1,063
2015 SAPP Annual report	594	619	646	674	703	733	765	797	832	867	905	944

Source : JICA Survey Team

Figure 5.1-8 Demand forecast comparison (Lesotho)



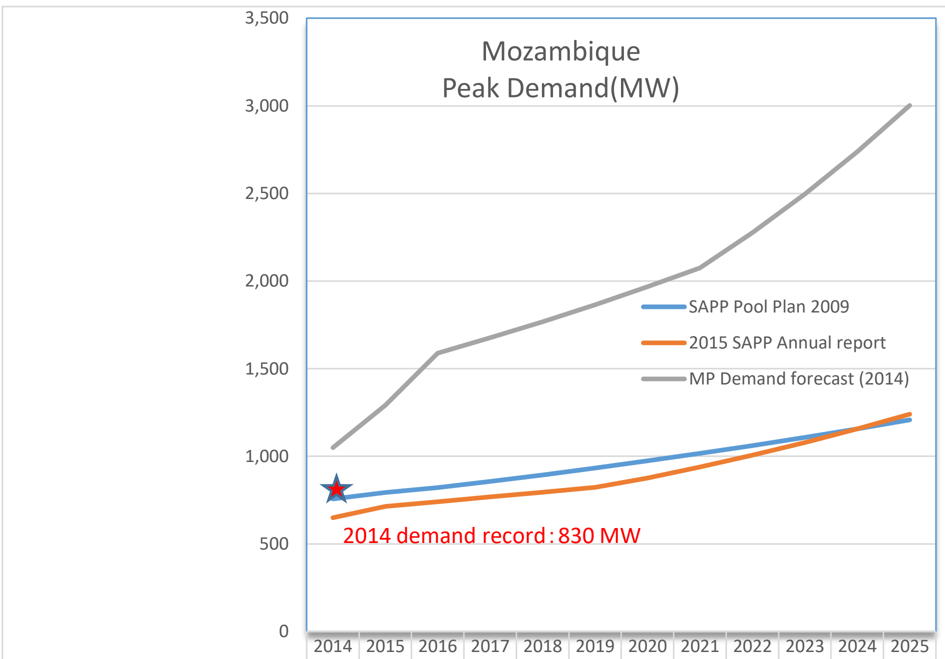
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	430	448	467	485	503	522	541	560	577	594	611	629
2015 SAPP Annual report	335	340	431	459	503	522	541	560	577	594	611	629
MP Demand forecast (2015)			462	520	573	693	750					



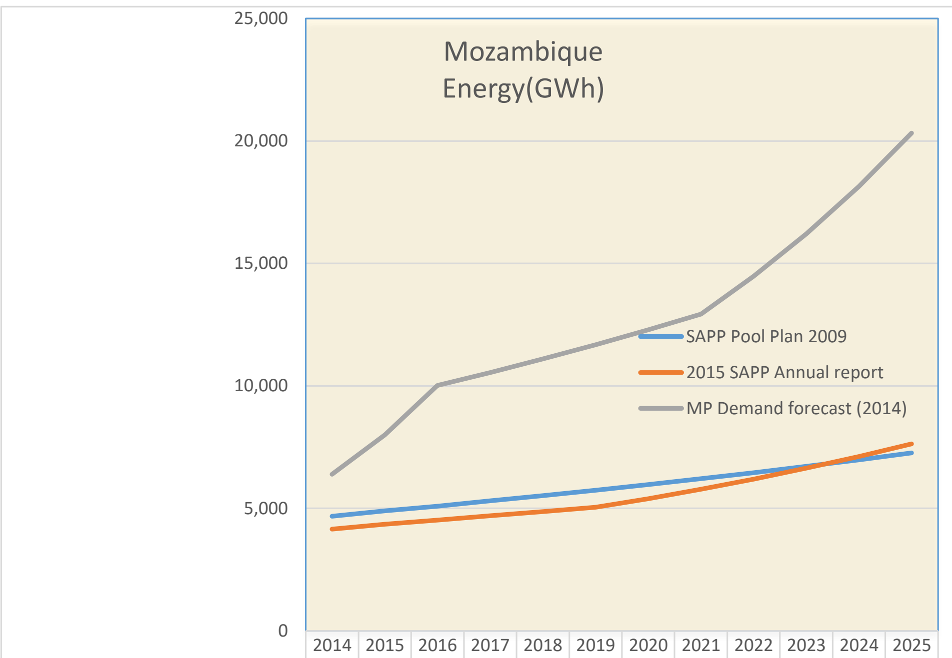
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	2,253	2,347	2,443	2,539	2,636	2,734	2,833	2,934	3,020	3,108	3,199	3,293
2015 SAPP Annual report	2,450	2,553	2,656	2,761	2,866	2,973	3,081	3,190	3,284	3,380	3,479	3,581
MP Demand forecast (2015)		2,106	2,323	2,558	2,812	3,087	3,383					

Source : JICA Survey Team

Figure 5.1-9 Demand forecast comparison (Malawi)



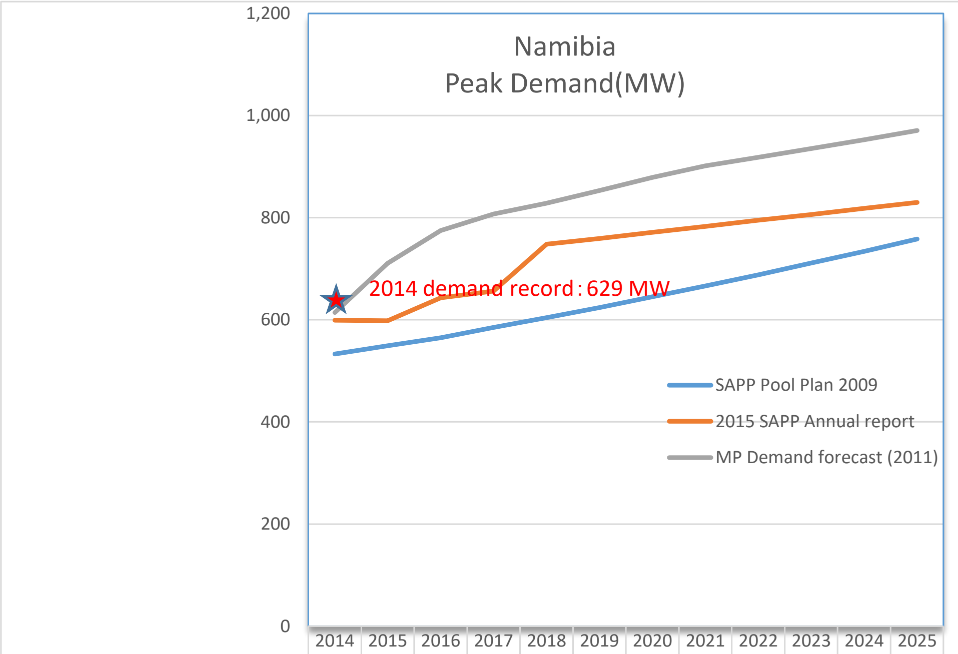
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	757	793	821	857	894	933	974	1,017	1,061	1,108	1,157	1,208
2015 SAPP Annual report	650	714	741	768	795	822	876	939	1,007	1,079	1,157	1,240
MP Demand forecast (2014)	1,049	1,291	1,589	1,676	1,768	1,865	1,967	2,075	2,276	2,496	2,738	3,002



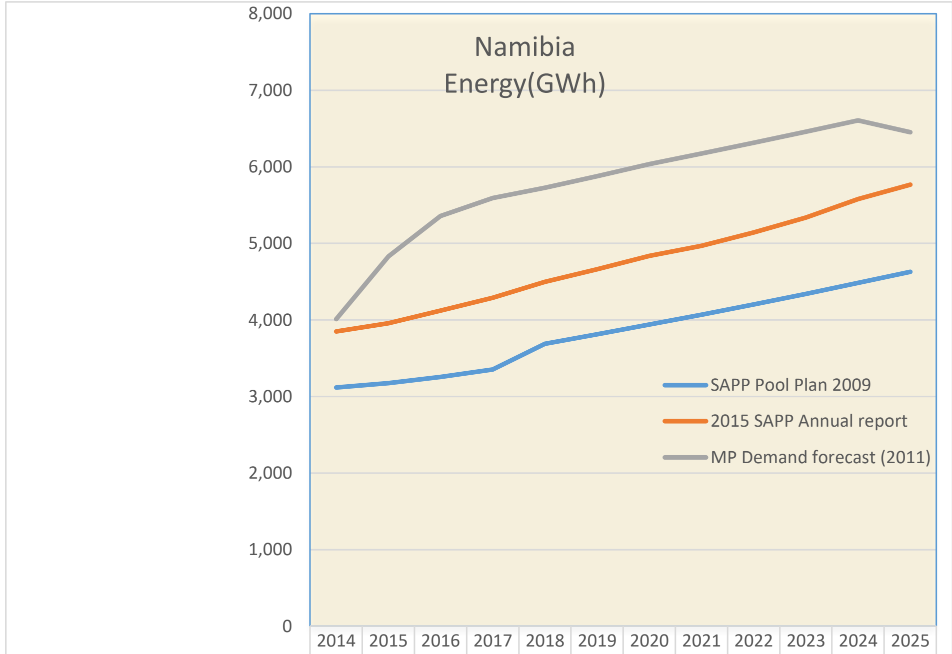
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	4,678	4,898	5,084	5,302	5,515	5,736	5,966	6,205	6,454	6,713	6,982	7,262
2015 SAPP Annual report	4,150	4,348	4,522	4,695	4,869	5,042	5,389	5,777	6,193	6,639	7,117	7,629
MP Demand forecast (2014)	6,390	8,001	10,019	10,543	11,095	11,676	12,287	12,930	14,477	16,210	18,149	20,321

Source : JICA Survey Team

Figure 5.1-10 Demand forecast comparison (Mozambique)



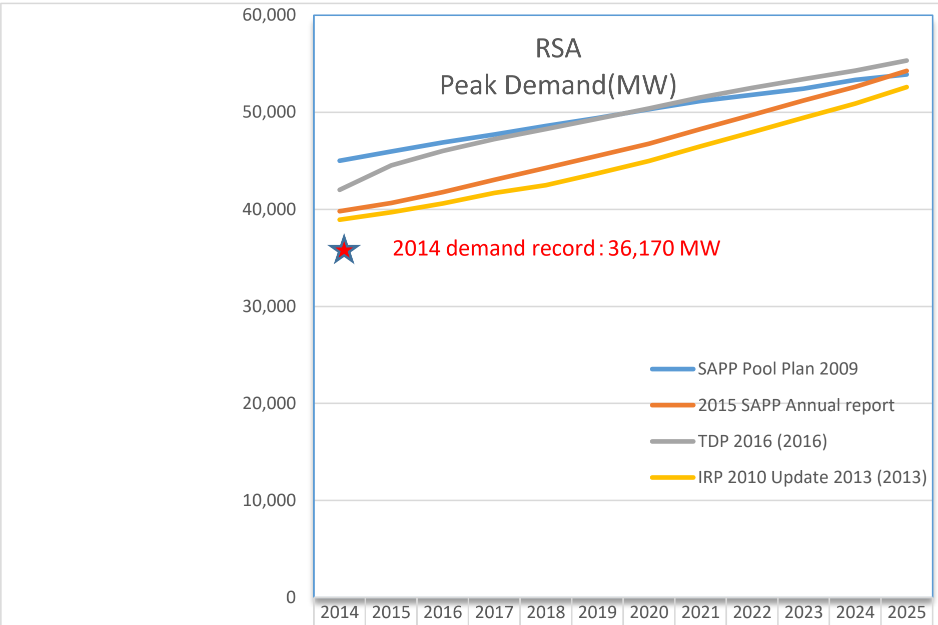
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	533	549	565	585	604	624	645	666	688	711	734	758
2015 SAPP Annual report	599	598	643	656	748	759	771	783	795	806	818	830
MP Demand forecast (2011)	614	711	775	807	828	853	879	901	918	935	953	970



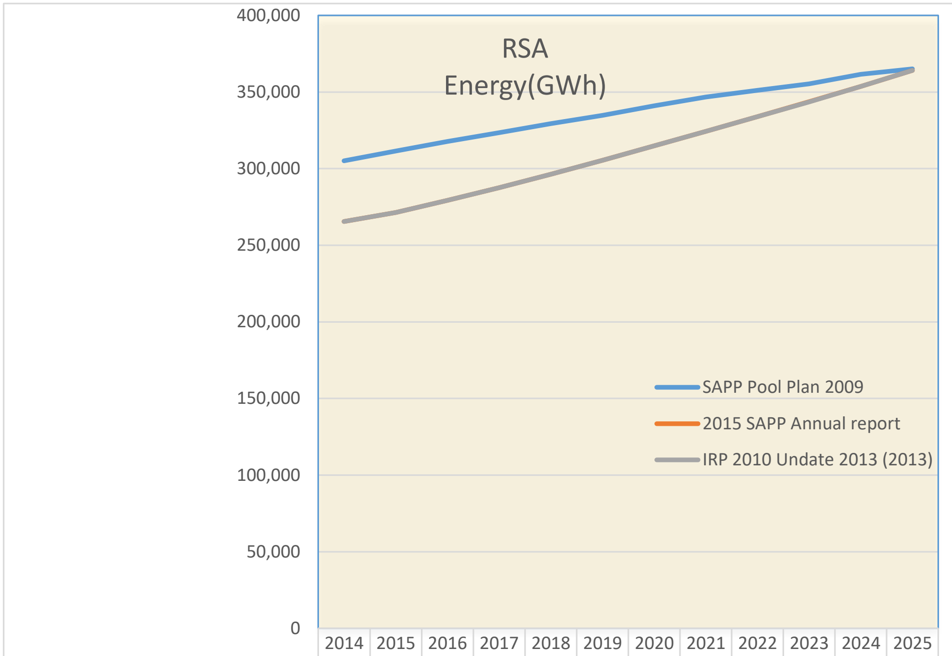
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	3,117	3,175	3,256	3,353	3,688	3,812	3,940	4,069	4,203	4,341	4,485	4,629
2015 SAPP Annual report	3,848	3,956	4,123	4,289	4,496	4,663	4,838	4,966	5,143	5,338	5,579	5,767
MP Demand forecast (2011)	4,011	4,829	5,357	5,593	5,726	5,878	6,036	6,173	6,314	6,459	6,608	6,452

Source：JICA Survey Team

Figure 5.1-11　　Demand forecast comparison (Namibia)



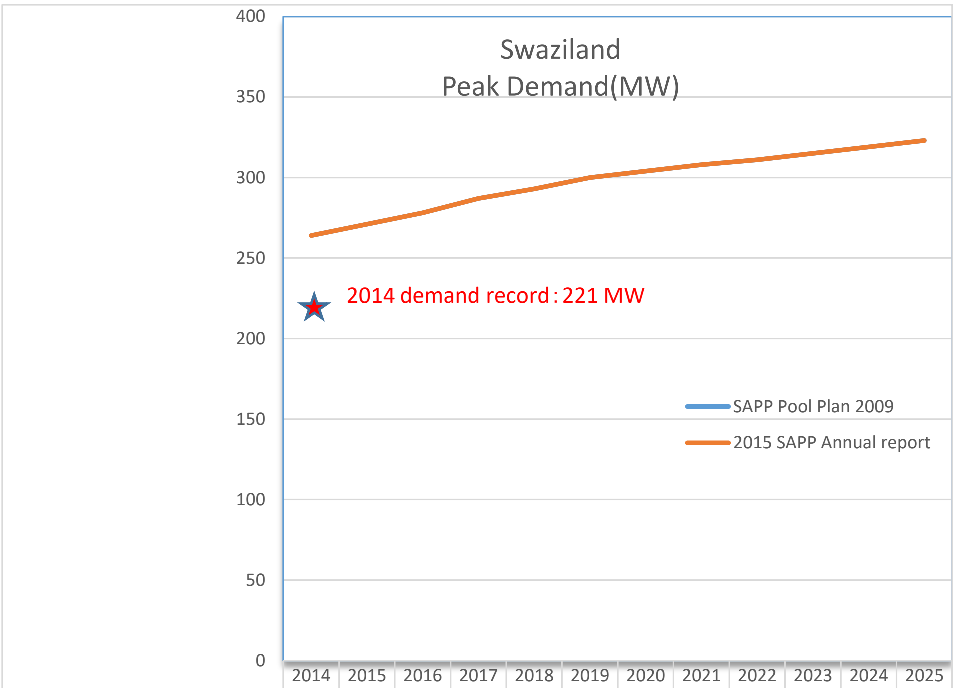
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	44,998	45,952	46,878	47,713	48,593	49,398	50,316	51,166	51,797	52,425	53,336	53,878
2015 SAPP Annual report	39,814	40,659	41,755	43,034	44,271	45,498	46,759	48,262	49,729	51,203	52,627	54,264
TDP 2016 (2016)	42,000	44,536	45,998	47,220	48,271	49,328	50,398	51,528	52,501	53,403	54,296	55,310
IRP 2010 Update 2013 (2013)	38,924	39,703	40,608	41,679	42,485	43,713	44,977	46,481	47,952	49,442	50,895	52,593



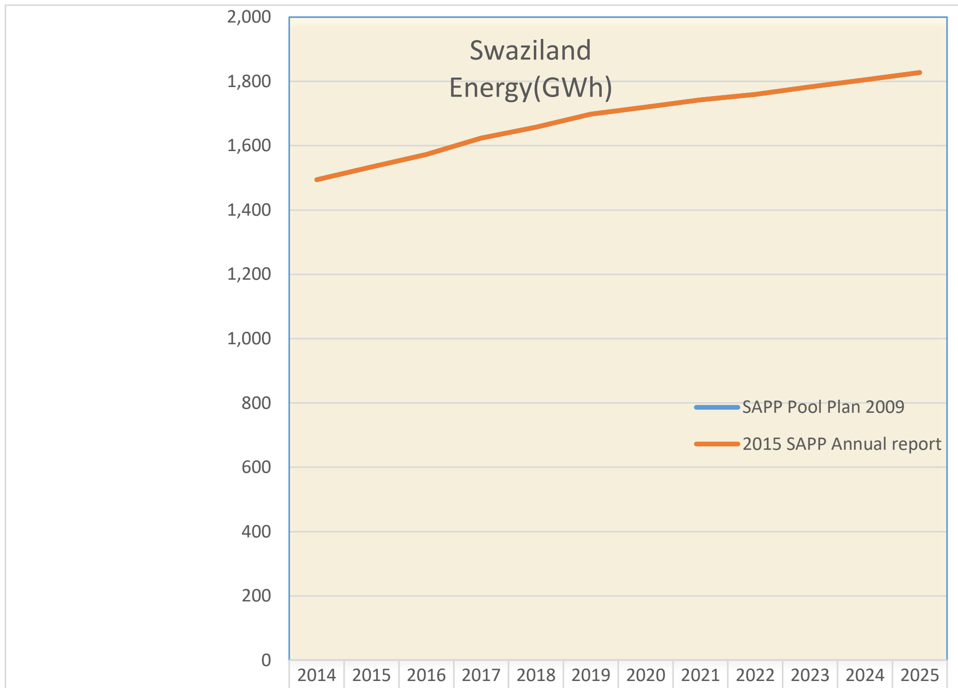
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	305,013	311,473	317,746	323,398	329,363	334,813	341,023	346,783	351,052	355,298	361,495	365,152
2015 SAPP Annual report	265,462	271,422	279,382	287,479	296,373	305,418	314,793	324,303	333,923	343,653	353,653	364,056
IRP 2010 Undate 2013 (2013)	265,462	271,422	279,382	287,479	296,373	305,418	314,793	324,303	333,923	343,563	353,653	364,056

Source：JICA Survey Team

Figure 5.1-12　　Demand forecast comparison (RSA)



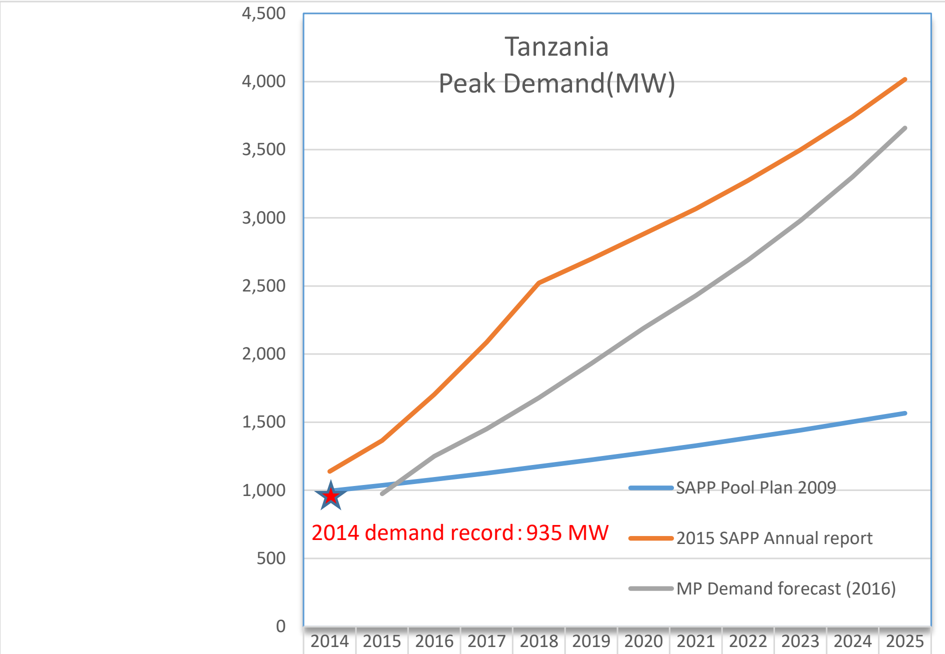
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	264	271	278	287	293	300	304	308	311	315	319	323
2015 SAPP Annual report	264	271	278	287	293	300	304	308	311	315	319	323



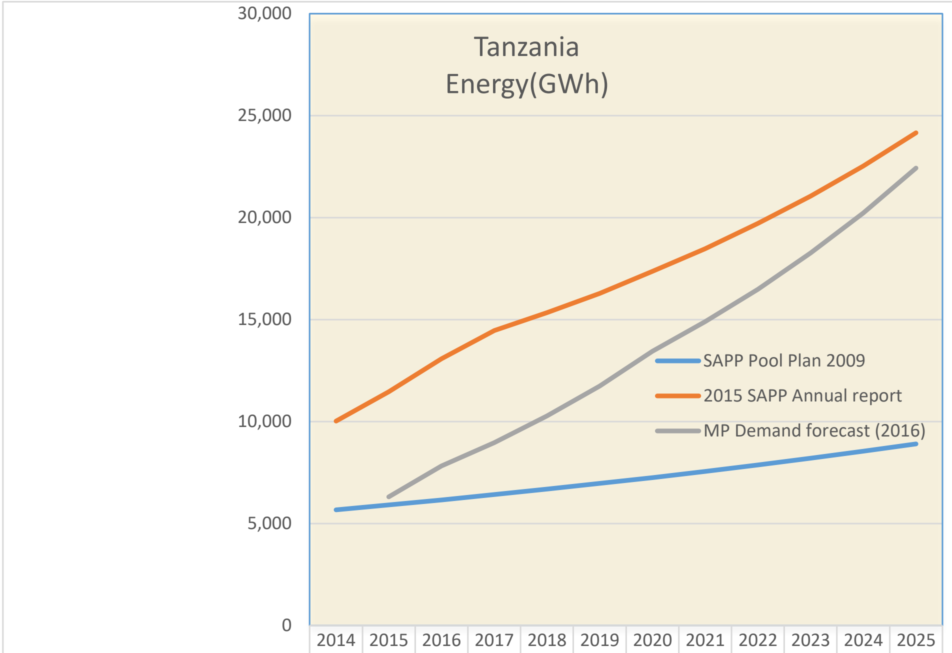
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	1,494	1,534	1,573	1,624	1,658	1,698	1,720	1,743	1,760	1,783	1,805	1,828
2015 SAPP Annual report	1,494	1,534	1,573	1,624	1,658	1,698	1,720	1,743	1,760	1,783	1,805	1,828

Source：JICA Survey Team

Figure 5.1-13　　Demand forecast comparison (Swaziland)



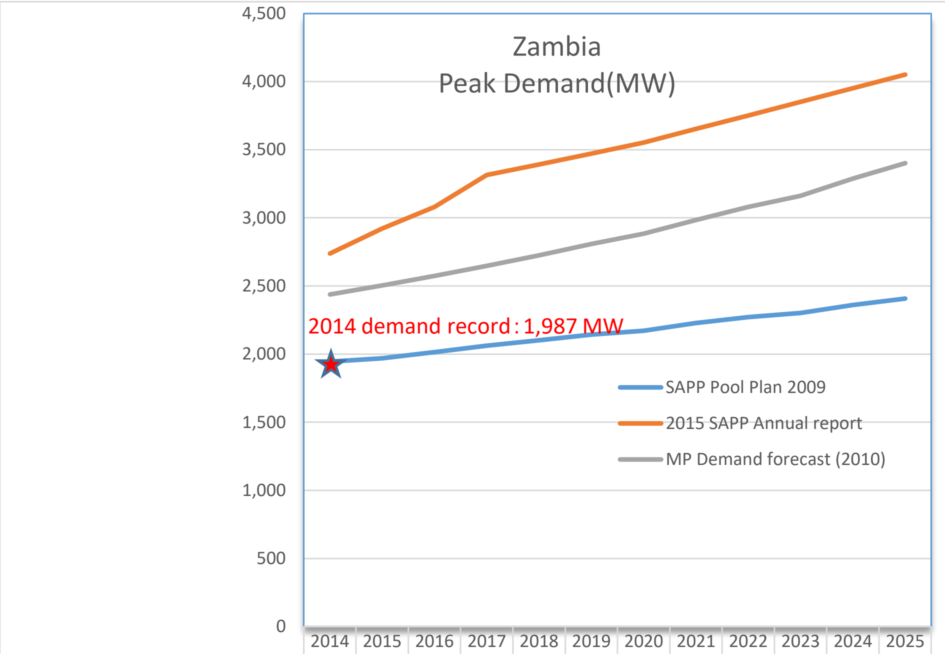
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	995	1,037	1,081	1,126	1,174	1,223	1,275	1,328	1,384	1,442	1,503	1,566
2015 SAPP Annual report	1,139	1,365	1,704	2,088	2,522	2,698	2,881	3,067	3,274	3,498	3,743	4,017
MP Demand forecast (2016)		974	1,250	1,450	1,680	1,930	2,190	2,430	2,690	2,980	3,300	3,660



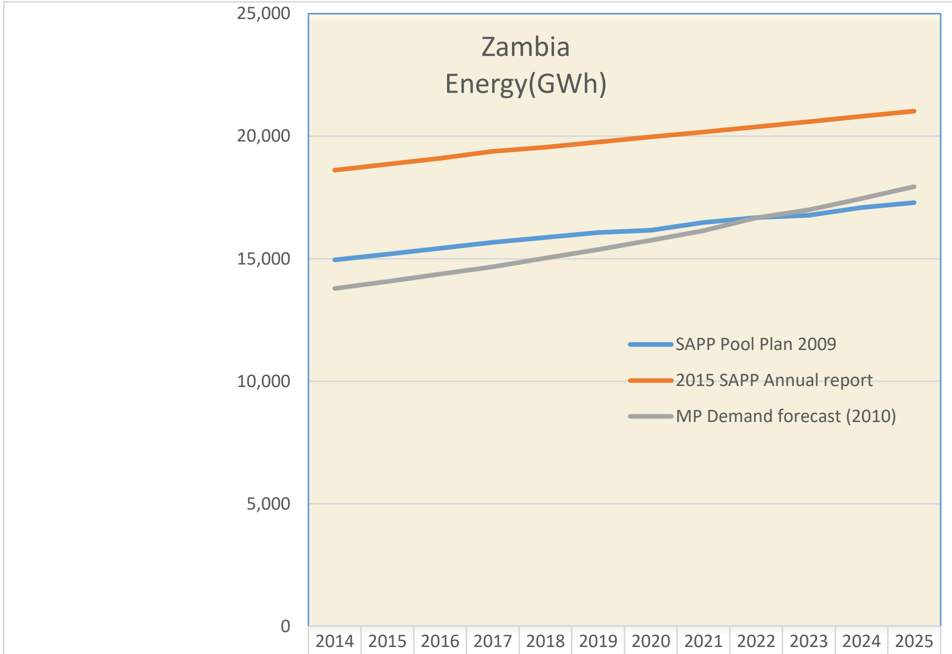
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	5,675	5,911	6,158	6,415	6,683	6,962	7,252	7,555	7,871	8,200	8,543	8,900
2015 SAPP Annual report	10,027	11,458	13,073	14,456	15,336	16,276	17,363	18,476	19,718	21,057	22,526	24,160
MP Demand forecast (2016)		6,310	7,820	8,970	10,270	11,740	13,440	14,890	16,490	18,270	20,230	22,430

Source：JICA Survey Team

Figure 5.1-14 Demand forecast comparison (Tanzania)



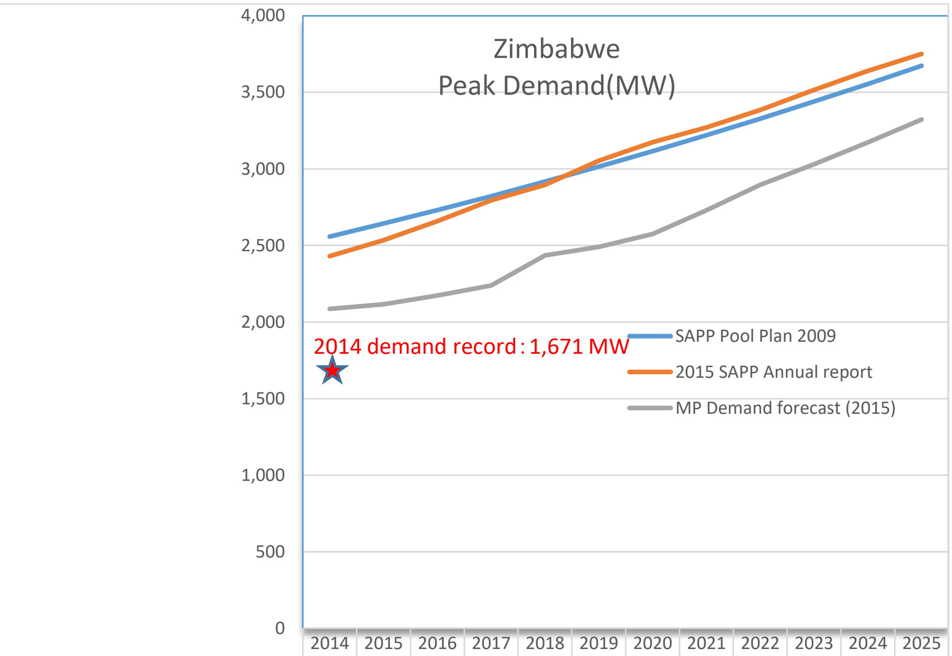
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	1,944	1,970	2,015	2,061	2,102	2,143	2,171	2,228	2,272	2,302	2,361	2,407
2015 SAPP Annual report	2,738	2,922	3,080	3,314	3,392	3,472	3,552	3,652	3,752	3,852	3,952	4,052
MP Demand forecast (2010)	2,438	2,504	2,574	2,647	2,725	2,808	2,883	2,984	3,080	3,161	3,288	3,401



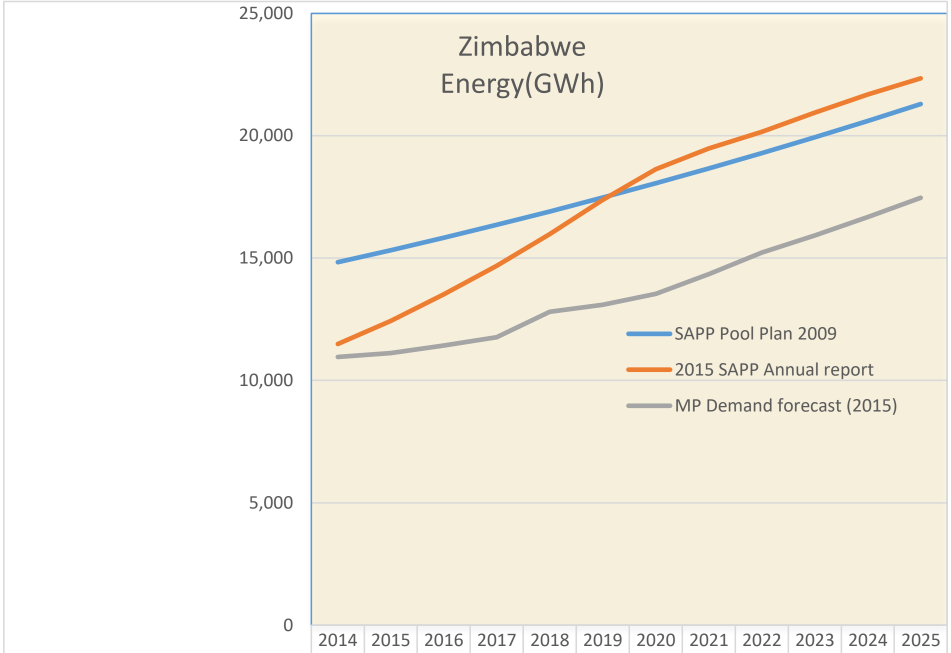
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	14,955	15,188	15,427	15,669	15,870	16,070	16,168	16,474	16,677	16,777	17,086	17,291
2015 SAPP Annual report	18,613	18,853	19,098	19,384	19,553	19,760	19,968	20,177	20,387	20,597	20,809	21,021
MP Demand forecast (2010)	13,784	14,069	14,370	14,667	15,022	15,378	15,749	16,142	16,667	16,996	17,458	17,946

Source：JICA Survey Team

Figure 5.1-15 Demand forecast comparison (Zambia)



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	2,558	2,643	2,731	2,822	2,917	3,014	3,115	3,220	3,327	3,439	3,554	3,674
2015 SAPP Annual report	2,430	2,535	2,659	2,795	2,895	3,053	3,174	3,270	3,384	3,515	3,640	3,751
MP Demand forecast (2015)	2,086	2,116	2,173	2,239	2,436	2,490	2,575	2,730	2,896	3,030	3,173	3,322



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAPP Pool Plan 2009	14,828	15,317	15,829	16,358	16,905	17,470	18,055	18,660	19,285	19,932	20,601	21,295
2015 SAPP Annual report	11,493	12,435	13,512	14,688	15,975	17,381	18,629	19,481	20,160	20,938	21,684	22,346
MP Demand forecast (2015)	10,964	11,122	11,421	11,768	12,803	13,087	13,534	14,349	15,221	15,926	16,677	17,461

Source：JICA Survey Team

Figure 5.1-16 Demand forecast comparison (Zimbabwe)

Table 5.1-4 Evaluation of objective demand forecasts

State	Transition	Power (Watt) Evaluation	Energy (Wh) Evaluation
Angola	2009 SAPP Pool Plan ↓ 2015 SAPP Annual Report	SAPP Annual Report data and data on SAPP Pool Plan 2009 is same. Data by MINEA is ambitious compared to current condition.	SAPP Annual Report data and data on SAPP Pool Plan 2009 is same. Data by MINEA is ambitious compared to current condition.
Botswana	2009 SAPP Pool Plan ↓ 2013 Master Plan ↓ 2015 SAPP Annual Report	Master Plan data was revised downward compared to SAPP Pool Plan data, but SAPP Annual Report revised upward a bit. SAPP Pool Plan data is less than SAPP Pool Plan data.	Data on Master Plan revises around 23%, 1,200 – 1,600GWh of equivalent magnitude, downward compared to SAPP Pool Plan data. But data on SAPP Annual Report returns to SAPP Pool Plan data.
DR Congo	2009 SAPP Pool Plan ↓ 2015 SAPP Annual Report	Data on SAPP Annual Report uplifts 1,500MW uplift from SAPP Pool Plan data. The reason of this uplift is unknown by the information that DR Congo is now studying demand forecast.	10,000GWh of magnitude uplifts to data on SAPP Pool Plan. (10,000 GWh seems demand of mining, with around 76% of load factor）
Lesotho	2009 SAPP Pool Plan ↓ 2015 SAPP Annual Report	SAPP Annual Report data and data on SAPP Pool Plan 2009 is same.	Data is 12 – 14 % downward of SAPP Pool Plan data.
Malawi	2009 SAPP Pool Plan ↓ 2015 SAPP Annual Report ↓ （2015 Mater Plan）	SAPP Annual Report data is corrected aligning SAPP Pool Plan data. （Data on Malawi IRP is assumed to policy to reach for）	SAPP Annual Report data is corrected aligning SAPP Pool Plan data. （Data on Malawi IRP is assumed to policy to reach for）
Mozambique	2009 SAPP Pool Plan ↓ 2014 Master Plan ↓ 2015 SAPP Annual Report	Master Plan data is much greater than data on SAPP Pool Plan, but data on SAPP Annual Report comes back to data on SAPP Pool Plan.	Master Plan data revised highly upward compared to SAPP Pool Plan data, but SAPP Annual Report data back to data on SAPP Pool Plan.
Namibia	2009 SAPP Pool Plan ↓ 2011 Master Plan ↓ 2015 SAPP Annual Report	Master Plan data was revised upward compared to SAPP Pool Plan data, but SAPP Annual Report revised downward a bit. SAPP Pool Plan data is a bit greater than SAPP Pool Plan data.	Master Plan data revised upward compared to SAPP Pool Plan data. But SAPP Annual Report data revises downward. But it is not lesser than SAPP Pool Plan data.
RSA	2009 SAPP Pool Plan ↓ 2013 IRP 2010 Update 2013 ↓ 2015 SAPP Annual Report ↓ 2016 TDP 2016 （Just peak demand）	Data on Master Plan, namely IRP revised downward compared to SAPP Pool Plan data. But data on TDPs recovered to reach SAPP Pool Plan data.	Master Plan data, namely IRP revised downward compared to SAPP Pool Plan data. Master Plan data and data on SAPP Annual Report is equal.
Swaziland	2009 SAPP Pool Plan ↓ 2015 SAPP Annual Report	SAPP Annual Report data and data on SAPP Pool Plan 2009 is same.	SAPP Annual Report data and data on SAPP Pool Plan 2009 is same.
Tanzania	2009 SAPP Pool Plan ↓ 2015 SAPP Annual Report ↓ 2016 Master Plan	Data on SAPP Annual Report and that on Master Plan are much bigger than data on SAPP Pool Plan.	Data on SAPP Annual Report and Master Plan data revised upward compared to SAPP Pool Plan data.
Zambia	2009 SAPP Pool Plan ↓ 2010 Mater Plan ↓ 2015 SAPP Annual Report	Data will grow as time goes by. Against 1,987 MW, the peak demand in 2014, deviation of Master Plan data is 400MW, and that of SAPP Annual Report data is 700 MW.	Data will grow as time goes by. Data on SAPP Annual Report is 12～20% greater than Master Plan data.
Zimbabwe	2009 SAPP Pool Plan ↓ 2015 SAPP Annual Report ↓ 2015 Master Plan	SAPP Annual Report data has a correlation with SAPP Pool Plan data. Master Plan data revises downward compared to data on SAPP Annual Report and SAPP Pool Plan data.	SAPP Annual Report data has a correlation with SAPP Pool Plan data. Master Plan data revises downward compared to data on SAPP Annual Report and SAPP Pool Plan data.

Source : JICA Survey Team

3) Demand tracks

✓ RSA

Demand of RSA donates 78% of all SAPP demand as of FY2014. And Eskom year by year updates demand forecast in consideration with recent energy sales. It is reported that record of energy sales is around 36GW, but net demand including suppress demand (real demand) will be 42GW in latest Transmission Development Plan. And it can be seen that forecasted data in 2014 is 36 % greater than that of actual record.

Following table shows the comparison among demand forecast data on SAPP Pool Plan, and that on two Transmission Development Plans in 2014, 2015, and that on IRP.

Data on SAPP Pool Plan seems ambitious value a bit compare to others. And aligning data on two TDPs, these are illustrated with some confidence.

Table 5.1-5 Comparison of peak demand tracks and demand forecast data in RSA

Schemes	2010	2011	2012	2013	2014
SAPP Pool Plan	41,524	43,283	45,125	47,085	49,116
Record / (provision)	35,850	36,543	35,896	35,896	36,170
IRP fundamental case	-	-	-	-	43,436
TDP 2014	-	-	-	-	39,790
Latest demand forecast(Non-constraint)	-	-	-	-	36,000
Latest demand forecast(Constraint)	-	-	-	-	42,000

Source : JICA Survey Team

✓ SAPP member counties except RSA

Recent five year's tracks of peak demand, 2010 – 2014, are shown in Table 5.1-6. This table also has demand forecast data on SAPP Pool Plan, and that on Master Plan of SAPP member states.

Generally, developing countries would overestimate their own future demands with ambitious and preferable perspective. In fact, however, power demand will not hike up in line with regional economic recession.

And it can be seen that demand record of Angola, Mozambique are greater than their SAPP Pool Plan data respectively, but it is not so great to hang over their Master Plan data.

And Tanzanian data is fresh as it publicated in December 2016.

Table 5.1-6 Comparison of peak demand tracks and demand forecast data in SAPP member states

Countries	Schemes (MW)	2010	2011	2012	2013	2014	Remarks
Angola	SAPP Pool Plan	1,114	1,217	1,320	1,426	1,540	Pool Plan Underestimate
	Record	796	870	1,072	1,072	1,599	
Botswana	SAPP Pool Plan	737	795	817	864	904	
	MP Forecast	-	571	580	644	681	
	Record	553	542	578	578	610	
DR Congo	SAPP Pool Plan	1525	1588	1655	1,723	1795	
	Record	1,081	1,050	1,040	1,166	1,381	
	SAPP Pool Plan	142	148	152	156	160	

Lesotho	Record	121	125	129	129	150	
Malawi	SAPP Pool Plan	306	376	394	412	430	
	Record	274	277	278	278	326	
Mozambique	SAPP Pool Plan	619	651	690	722	757	Pool Plan Underestimate
	MP Forecast	-	563	693	1,049	1,291	
	Record	549	616	706	706	830	
Namibia	SAPP Pool Plan	490	498	509	520	533	Pool Plan Underestimate
	MP Forecast	512	526	563	614	711	
	Record	564	611	611	611	629	
Swaziland	SAPP Pool Plan	223	233	245	255	264	
	Record	204	200	205	205	221	
Tanzania	SAPP Pool Plan	844	879	916	955	995	Peak demand in 2015 is 974 MW on PSMP 2016
	MP Forecast	1,109	1,131	1,355	1,692	2,073	
	Record	883	890	890	890	935	
Zambia	SAPP Pool Plan (*)	1,773	1,860	1,894	1,919	1,994	
	MP Forecast	1,801	2,080	2,214	2,299	2,438	
	Record	1,483	1,562	1,681	1,681	1,987	
Zimbabwe	SAPP Pool Plan	2,281	2,345	2,414	2,484	2,558	
	MP Forecast	-	1,846	1,866	2,086	2,116	
	Record	1,836	1,836	2,029	1,546	1,671	

This data is by PSMP 2012

Source：JICA Survey Team collected based on information from SAPP C.C.

4) Demand forecast data selected

Table 5.1-7 represents selection result of demand forecast which should be treated in the Survey with the reasons and notices.

It is noted that Angolan forecast data and Mozambican data have risks not to align the future demand, e.g. future demand will be greater than the data which the Survey applies due to current demand transition.

Therefore, these are paid attention to handle in after session.

Table 5.1-7　Result of demand forecast selection

State	Candidates	Result selected (Resolution No.)	Reason(s)	Remarks
Angola	2009　SAPP Pool Plan （2015 SAPP Annual Report）	SAPP Pool Plan（Resolution 3）		Peak demand record in 2014 is a bit greater than selected forecast data, SAPP Pool Plan forecast.
Botswana	2009　SAPP Pool Plan 2013　Master Plan （2015 SAPP Annual Report）	SAPP Pool Plan（Resolution 4）	Analysis for Wh recommends resolution 2, but analysis for Watt recommends resolution 4. Here, SAPP Pool Plan data should be applied because track of SAPP Annual Report can approach transition of SAPP Pool Plan.	
DR Congo	2009　SAPP Pool Plan （2015 SAPP Annual Report）	SAPP Pool Plan（Resolution 4）	SAPP Pool Plan data is the one provides long-term demand prediction with reasonable manner.	
Lesotho	2009　SAPP Pool Plan （2015 SAPP Annual Report）	SAPP Pool Plan（Resolution 3）		
Malawi	2009　SAPP Pool Plan （2015 SAPP Annual Report）	SAPP Pool Plan（Resolution 3）		Pead demand record in 2014 is around 30% lesser than selected forecast data, SAPP Pool Plan forecast.
Mozambique	2009　SAPP Pool Plan 2014　Master Plan （2015 SAPP Annual Report）	SAPP Pool Plan（Resolution 3）		Peak demand record in 2014 is 10 % greater than selected forecast data, SAPP Pool Plan forecast.
Namibia	2009　SAPP Pool Plan 2011　Master Plan （2015 SAPP Annual Report）	Master Plan　（Resolution 4）	SAPP Annual Report data is intermediate value between SAPP Pool Plan data and Master Plan data.　SAPP Annual Report data (Watt) is approaching track of SAPP Pool Plan data. However, SAPP Annual Report data (Wh) is approaching track of Master Plan data. Consequently, Master Plan data should be applied due to large tolerance.	
RSA	2009　SAPP Pool Plan 2013　IRP 2010 Update 2013 （2015 SAPP Annual Report） 2016　TDP 2016 （only peak demand）	Master Plan（Resolution 1）		
Swaziland	2009　SAPP Pool Plan （2015 SAPP Annual Report）	SAPP Pool Plan（Resolution 3）		
Tanzania	2009　SAPP Pool Plan （2015 SAPP Annual Report）2016 Master Plan	Master Plan（Resolution 1）		
Zambia	2009　SAPP Pool Plan 2010　Mater Plan （2015 SAPP Annual Report）	Master Plan（Resolution 4）	SAPP Annual Report data is a bit greater than SAPP Pool Plan data and Master Plan data. Meanwhile, gradient of Master Plan data (Watt) is similar to that of SAPP Annual Report data, and Master Plan data (Wh) is approaching track of SAPP Annual Report. Above all, Master Plan data should be applied.	Pead demand record in 2014 is around 20 % lesser than selected forecast data.
Zimbabwe	2009　SAPP Pool Plan （2015 SAPP Annual Report） 2015　Master Plan	Master Plan（Resolution 1）		Pead demand record in 2014 is around 20% lesser than selected forecast data.

Source：JICA Survey Team

Table 5.1-8 Demand forecast (peak demand)

Peak Demand	Angola	Botswana	DR Congo	Lesotho	Malawi	Mozambique	Namibia	RSA	Swaziland	Tanzania	Zambia	Zimbabwe	SAPP Total
2016	1,762	851	1,935	169	467	821	775	40,608	278	1,250	2,574	2,173	53,563
2017	1,872	1,034	2,016	174	485	857	807	41,679	287	1,450	2,647	2,239	55,547
2018	1,987	1,089	2,100	178	503	894	828	42,485	293	1,680	2,725	2,436	57,198
2019	2,109	1,164	2,187	183	522	933	853	43,713	300	1,930	2,808	2,490	59,192
2020	2,226	1,183	2,229	188	541	974	879	44,977	304	2,190	2,883	2,575	61,149
2021	2,347	1,202	2,313	193	560	1,017	901	46,481	308	2,430	2,984	2,730	63,466
2022	2,472	1,221	2,409	198	577	1,061	918	47,952	311	2,690	3,080	2,896	65,785
2023	2,601	1,238	2,509	204	594	1,108	935	49,442	315	2,980	3,161	3,030	68,117
2024	2,734	1,255	2,614	209	611	1,157	953	50,895	319	3,300	3,288	3,173	70,508
2025	2,871	1,272	2,723	215	629	1,208	970	52,593	323	3,660	3,401	3,322	73,187
2026	3,015	1,310	2,817	219	648	1,256	989	52,995	328	4,030	3,520	3,478	74,605
2027	3,165	1,348	2,915	224	668	1,305	1,014	54,745	333	4,430	3,646	3,642	77,435
2028	3,324	1,388	3,016	230	688	1,356	1,041	56,482	338	4,860	3,778	3,816	80,317
2029	3,490	1,429	3,121	235	708	1,410	1,068	58,547	343	5,340	3,918	3,997	83,606
2030	3,664	1,471	3,229	241	730	1,465	1,096	60,509	348	5,870	4,066	4188	86,877
2031	3,847	1,514	3,341	247	752	1,523	1,124	62,159	354	6,450	4,214	4389	89,914
2032	4,040	1,559	3,457	252	775	1,583	1,154	63,463	359	7,080	4,367	4599	92,688
2033	4,242	1,605	3,577	259	798	1,646	1,184	64,969	364	7,770	4,526	4822	95,762
2034	4,454	1,652	3,701	265	822	1,710	1,215	66,210	370	8,520	4,690	5,055	98,664
2035	4,677	1,701	3,830	271	847	1,778	1,246	67,414	376	9,350	4,861	5,301	101,652
2036	4,910	1,751	3,963	277	873	1,848	1,279	68,341	381	10,190	5,038	5,565	104,416
2037	5,156	1,803	4,100	284	899	1,921	1,312	69,621	387	11,100	5,221	5,837	107,641
2038	5,414	1,856	4,243	291	926	1,996	1,347	70,777	393	12,090	5,411	6,123	110,867
2039	5,684	1,911	4,390	298	954	2,075	1,382	71,736	399	13,160	5,608	6,423	114,020
2040	5,969	1,967	4,542	305	983	2,157	1,418	72,495	405	14,330	5,812	6,737	117,120
Growth rate	**5.22%**	**3.55%**	**3.62%**	**2.49%**	**3.15%**	**4.11%**	**2.55%**	**2.44%**	**1.58%**	**10.7%**	**3.45%**	**4.83%**	**3.31%**

Source : JICA Survey Team

Table 5.1-9 Demand forecast (Energy consumption)

Net Energy	Angola	Botswana	DR Congo	Lesotho	Malawi	Mozambique	Namibia	RSA	Swaziland	Tanzania	Zambia	Zimbabwe	SAPP Total
2016	10,032	5,411	11,947	736	2,443	5,084	5,357	279,834	1,573	7,820	14,370	11,421	356,028
2017	10,658	5,919	12,444	767	2,539	5,302	5,593	287,479	1,624	8,970	14,667	11,768	367,730
2018	11,316	6,247	12,962	798	2,636	5,515	5,726	296,379	1,658	10,270	15,022	12,803	381,332
2019	12,008	6,744	13,502	832	2,734	5,736	5,878	305,418	1,698	11,740	15,378	13,087	394,755
2020	12,674	6,848	13,848	866	2,833	5,966	6,036	314,790	1,720	13,440	15,749	13,534	408,304
2021	13,364	6,949	14,369	902	2,934	6,205	6,173	324,303	1,743	14,890	16,142	14,349	422,323
2022	14,077	7,049	14,967	940	3,020	6,454	6,314	333,929	1,760	16,490	16,667	152,21	421,667
2023	14,812	7,147	15,590	979	3,108	6,713	6,459	343,561	1,783	18,270	16,996	15,926	451,344
2024	15,568	7,243	16,239	1,020	3,199	6,982	6,608	353,651	1,805	20,230	17,458	16,677	466,680
2025	16,345	7,336	16,915	1,063	3,293	7,262	6,452	364,056	1,828	22,430	17,946	17,461	482,387
2026	17,198	7,438	17,623	1,107	3,394	7,553	6,608	366,034	1,850	24,680	18,461	18,280	490,226
2027	18,096	7,541	18,360	1,154	3,497	7,856	6,769	376,611	1,873	27,140	19,006	19,142	507,045
2028	19,040	7,645	19,129	1,202	3,604	8,171	6,932	387,506	1,896	29,830	19,578	20,057	524,590
2029	20,034	7,751	19,929	1,252	3,714	8,449	7,097	398,408	1,919	32,780	20,184	21,008	542,525
2030	21,079	7,859	20,763	1,305	3,828	8,840	7,264	409,140	1,943	36,000	20,823	22,012	560,856
2031	22,179	7,968	21,632	1,359	3,945	9,194	7,433	418,001	1,967	39,540	21,452	23,069	577,739
2032	23,337	8,078	22,537	1,416	4,065	9,563	7,609	425,856	1,991	43,410	22,099	24,172	594,133
2033	24,555	8,190	23,480	1,476	4,189	9,946	7,790	433,743	2,015	47,640	22,766	25,345	611,135
2034	25,836	8,304	24,462	1,537	4,317	10,345	7,976	440,862	2,040	52,270	23,453	26,569	627,971
2035	27,185	8,419	25,486	1,602	4,449	10,760	8,165	447,926	2,065	57,340	24,161	27,862	645,420
2036	28,604	8,536	26,553	1,669	4,585	11,191	8,359	454,617	2,090	62,480	24,891	29,249	662,824
2037	30,096	8,654	27,664	1,738	4,725	11,640	8,558	461,389	2,116	68,060	25,642	30,679	680,961
2038	31,667	8,774	28,821	1,811	4,870	12,107	8,762	468,272	2,142	74,130	26,416	32,182	699,954
2039	33,320	8,895	30,027	1,887	5,018	12,592	8,970	472,960	2,168	80,720	27,213	33,756	717,526
2040	35,059	9,019	31,284	1,966	5,172	13,097	9,183	479,589	2,194	87,890	28,035	35,408	737,896
Growth rate	**5.35%**	**2.15%**	**4.09%**	**4.18%**	**3.17%**	**4.02%**	**2.27%**	**2.27%**	**1.40%**	**10.6%**	**2.82%**	**4.83%**	**3.08%**

Source：JICA Survey Team

(4) Dependable capacity analysis in SAPP

Aforementioned power system master plan's data which authorized by their power utilities and / or their government are firm information to utilize the Survey.

The Survey attached the current information, such as current status of the project on the master plan, newly developed project etc., to the data.

Following tables of each SAPP member states show the result of calibration of generation development plan.

As it can be seen easily that many projects are IPP projects, not only thermals but even hydropowers. These conditions are very fragile and changeable dramatically due to fluctuation of global economy and / or strategy of business holders. Therefore it is noted that generation project on the lists are needed to clarify as soon as some changes detects.

Further, the Survey applies the assumption that bilateral agreements of power trade is stable during the period. That is why existing transmission capacity is used for generic power trade, and new power trade will be tended to flow as additional power on existing or new interconnector(s). Commencement of the year of each candidate was determined in consideration with information of the progress and following indicator regarding lead time.

Table 5.1-10 Indicator of lead time in each project integration scheme

Pre-feasibility Study conducting period	2-year
Feasibility Study conducting period	2-year
EIA conducting period	1-year
Preparation period for construction	2-year
Construction period	2-year (Gas-fired) 3-year (Coal-fired) 3-year (Hydro (Under 100 MW)) 5-year (Hydro (Under 1,000 MW)) 7-year (Hydro (Above 1,000 MW))

Source : JICA Survey Team

Followings are brief explanation of capacity transition of each member state.

1) Angola

Table 5.1-11 shows the result of Angola.

By 2020, 5,929 MW of hydropowers (Cambambe II - 720 MW, Caculo Cabaca - 2,100 MW, Laúca - 2,060 MW, Queve - 774 MW, Jamba ia oma - 78 MW, Jamba ia mina - 227 MW) and 720 MW of Soyo-1 gas-fired will be commenced firmly.

As of 2020, capacity will be grown to 8,370 MW (6,999MW of hydropower, 1,273 MW of gas-fired, and 98 MW of diesel). As of 2030, it will be grown to 8,859MW (7,299 MW of hydropower, 1,560 MW of gas-fired) with decommission of emergency diesel generators due to cost-effectiveness operation in line with the mention on Angora Energia 2025. In 2040 total capacity will be 8,859 MW (7,299 MW of hydropower, and 1,560MW of gas-fired) same as in 2030.

2) Botswana

Table 5.1-12 shows the result of Botswana.

100 MW of PV will be commenced in 2017, and Morupule B - 5 and 6, 300MW and IPP Green Field, 264 MW will be commenced by 2021.

Opara, diesel power plant will be renovated to gas-fired with CBM in 2021.

As of 2020, capacity will be grown to 1,332 MW (942 MW of coal-fired, 90 MW of diesel, and 200 MW of import). As of 2030, capacity will be grown to 1,482 MW (1,092 MW of coal-fired, 90 MW of gas-fired, and 200 MW of import). As of 2040, capacity is stable.

3) DR Congo

Table 5.1-13 shows the result of DR Congo.

Firm perspective toward 2020 is Busanga hydropower, its capacity is 240 MW, will be introduced gradually by support of China. Output from Ruzizi-3, 147 MW will be shared by DR Congo, Burundi and Rwanda. Therefore portion of DR Congo is 49 MW in 2018. Katende hydropower, 64 MW by India will be commenced in 2020.

As of 2020, total capacity will be 2,674MW (2,684MW of hydropower， 40MW is import, and 50MW is export) , and in 2030, total capacity will grow 2,794 MW (2,804MW of hydropower, 40MW is export, and 50 MW is import). In 2040, 5,094 MW is total capacity (7,604 MW of hydropower, 40 MW of import, and 2,550 MW for export). Inga-3 will be set in 2031 and around half of the capacity, 2,500 MW can be injected to RSA.

Small hydropowers for mining companies are not on the list because there are not on the grid.

4) Lesotho

Table 5.1-14 shows the result of DR Congo.

As of 2020, total capacity will be 301MW (227 MW of hydropower, 70MW is import), and in 2030, total capacity is same as that in 2020. Further, so does it in 2040.

Lesotho has impressive project, namely Kobong pumped storage power plant, Highland Water Projects. However, this project cannot fascinate Eskom, and therefore progressive steps are not seen.

5) Malawi

Table 5.1-25 shows the result of Malawi.

By 2020, Nkula A expansion, 12 MW will be commenced in 2018, Chizuma, 50 MW and Tedzani expansion, 18 MW will be in 2019, Kholombidzo, 280 MW will be in 2020.

As of 2020, total capacity will be 670 MW (629 MW of hydropower, 41MW of diesel), and in 2030, total capacity will be grown to 941 MW (900 MW of hydropower, 41 MW of diesel). In 2040 capacity will grow 1,291 MW (1,250 MW of hydropower, 41 MW of diesel).

Coal fired power plant is planning stage but this was not on the list because easy information was not given. Further Lweya hydropower, 15 MW on Malawi IRP was not on the list due to precise status was not gotten.

6) Mozambique

Table 5.1-26 shows the result of Mozambique.

Mozambique has two power supply area, southern area and north-central area. The Survey therefore wrapped up data for them.

By 2020, southern area has 165 MW in total, Kuwanninga (40 MW) and CTM (125 MW), and north-central area has 110 MW in total, Nacala (40 MW), JINDAL (10 MW[67]) and wind farm (60 MW).

As of 2020, total capacity will be 1,152 MW (southern ; 736 MW, north-central ; 416 MW).

In 2030 Mphanda Nkuwa hydropower (1,500 MW) and several developments will accomplish, and then capacity will grow 6,856 MW (southern ; 1,330 MW, north-central ; 5,526 MW).

Until 2030 big movement such as coal-fired developments and the Zambezi river basin developments will expect. However most of all projects are by IPPs, so future perspective is relatively fragile. To ensure and energize the development, government of Mozambique plans to implement Mphanda Nkuwa herself[68].

Government of Mozambique also states new hydropower project, namely Chemba-1 (600 MW) and Chemba-2 (400 MW). However, these are still conceptual status. And gas-fired power projects implied by EDM are also fragile. These are not on the list.

7) Namibia

Table 5.1-27 shows the result of Namibia.

Expectable project is Kudu gas-fired power (400 MW) in 2020.

As of 2020, total capacity will be 1,047MW (343 MW of hydropower, 81 MW of coal-fired, 23 MW of diesel, and 200 MW is import). In 2030, capacity will be grown to 1,486MW (hydropower ; 643 MW, gas-fired ; 400 MW, diesel ; 243 MW, and import ; 200 MW). Further, so does it in 2040.

Existing Van Eck coal-fired power plant, its capacity is 81MW, was commenced in 1974, so it will be demolished as 50-year life time. Also, Anixas diesel power plant, its capacity is 22.5MW, has 30-year life time. Paratus power plant, Nampower's property, is not accumulated, as it is temporary (waiting) capacity to meet coastal demand.

As for hydro development, Baynes hydropower plant would being studied to operate Namibia and Angola.

The Orange river development, between RSA and Namibia is not clear to way forward.

8) RSA

Table 5.1-28 shows the result of RSA.

IRP, South African power system master plan has lots of scenarios to change direction. The Survey adopted the SO moderate case[69] as the scenario due to preferable perspective, such as huge renewable introduction and generation shift to nuclear power from coal-fired power as a base-load generator.

By 2020, Medupi coal-fired (1,588 MW), Green field project (250 MW) for coal base-load IPP procurement programme, open cycle gas-fired (120 MW) and renewable (1,742 MW) for REIPPPP included CSP (300 MW) will be accomplished. Further, Ingula pumped-storage (1,332 MW) will be added.

As of 2020, total capacity will be 56,724 MW (664 MW of hydropower, 2,732 MW of pumped-storage hydro, 40,091 MW of coal-fired, 4,398 MW of gas-fired, 1,940 MW of nuclear, 3,123 MW of renewable, 640 MW of others, and import is 1,500 MW, export is 424 MW).

In 2030, total capacity will be grown to 94,206 MW (664MW of hydropower, 2,732MW of pumped-storage, 45,527MW of coal-fired, 18,084MW of gas-fired, 8,340MW of nuclear, 17,143MW of renewable,

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67 Surplus from captive power can be added.
68 Consortium among government of Mozambique, EDM and HCB
69 System Operator moderate case, which is provided system operator, Eskom.

and 640MW of others. Import is 1,500 MW and export is 424MW). In 2040, total capacity is 116,585MW (664 MW of hydropower, 2,732 MW of pumped-storage, 29,564 MW of coal-fired, 26,196 MW of gas-fired, 19,540 MW of nuclear, 34,033MW, and 280 MW of others. Import is 4,000MW and export is 424MW).

For the long-term perspective, dependent of coal-fired power will be changed to other generation candidate, such as renewable, gas-fired and nuclear.

Injection from Inga 3, 2500 MW will put in 2031. And instead future import (1,500 MW) by the case is not included in total capacity.

9) Swaziland

Table 5.1-29 shows the result of Swaziland.

No project to be commenced until 2020.

The utility utilizes its own hydropowers and imputed power from Eskom and EDM. No preferable projects exist. Swaziland is a coal rich country. But apparent project dose not arise. As for hydropower, Ngwempisi (120 MW) and Lubombo (200 MW) are picked up at news. But progress of them are not clear.

As of 2020, total capacity will be 360MW (60 MW of hydropower, and import is 300MW). In 2030 and 2040 the capacity will be same as in 2020.

As for captive power, Ubombo Sugar (41MW) and Royal Swaziland Suguar（64.5MW） were not accumulated in the list.

10) Tanzania

Table 5.1-30 shows the result of Tanzania.

By 2020, 1,025 MW gas-fired power development (Kinyerezi-1 extension (185 MW), Kinyerezi-2 (240 MW), Kunyerezi-3 (600 MW), Mtwara (300 MW), Somanga (240 MW)) will be accomplished. Also, 147 MW hydropower development (Rusumo (27 MW), Lower Kihansi extension (120 MW)) will be accomplished. Else, 600 MW renewables (400 MW of wind power and 200 MW of PV) will be done.

As of 2020, total capacity will be 4,343 MW (712 MW of hydropower, 400 MW of coal-fired, 2,265 MW of gas-fired, 600 MW of renewable, and 166 MW of diesel. Import is 200 MW[70]). This import will be form EAPP based on PSMP 2016.

As of 2030, total capacity will be 8,671 MW (1,588 MW of hydropower, 2,800 MW of coal-fired, 2,865 MW of gas-fired, 850 MW of renewable, 63 MW of diesel, and import is 400 MW). As of 2040, it will be grown to 9,996 MW (2,993 MW of hydropower, 3,400 MW of coal-fired, 2,290 MW of gas-fired, 850 MW of renewable, 63 MW of diesel, and import is 400 MW).

These are estimated by data on PSMP 2016. It is noted that future gas-fired on PSMP 2016 is managed to drop from the list due to uncertainty.

from hydro, 2,575MW from coal-fired, 2,677MW from gas-fired, 300MW from RE, and 60MW from diesel. Export is 50MW.

11) Zambia

Table 5.1-31 shows the result of Zambia.

By 2020, 941 MW of hydropower development (Kabompo Gorge (40 MW), Kafue Gorge Lower (750

[70] As for PSMP 2016, import is 400 MW at maximum. That has changed compare to PSMP 2012 (50 MW at maximum).

MW), Lusiwasi Lower (74 MW), Luchenene (34 MW), Mutinondo (43 MW)) and PV (300 MW) will be accomplished.

As of 2020, total capacity will grow 4,098 MW (3,388 MW of hydropower, 600 MW of coal-fired, 300 MW of PV and export is 190 MW). As of 2030, capacity will be 6,735 MW (6,025MW of hydropower, 600 MW of coal-fired, 300 MW of PV, and export is 190 MW). Further capacity will be 7,035 MW in 2040 (6,025MW of hydropower, 600 MW of coal-fired, 600 MW of PV, and export is 190 MW).

In Zambia, the first coal-fired, namely Maamba power plant phase-1 (300MW) conducted in 2016. And next phase, phase-2, its capacity is 300MW, will be conducted in 2020.

Diesel generators of ZESCO and that of CEC do not put on the list due to stand-by generators.

Recent progress is commencement of Kariba North Bank Expansion in 2013, and that of Itezhi Tezhi in 2015. Further, Kafue Gorge Lower project is ongoing by SINOHYDRO, China. Many projects were handled by Chinese contractor.

Lately, new information about the Luapula river development. SAPP PAU is now planning to study. From the point of this progress, Mumbotuta Falls, Mambilima Falls I, Mambilima Falls II, and Mambilima Falls V are put on the list.

12) Zimbabwe

Table 5.1-32 shows the result of Zimbabwe.

By 2020 Kariba south extension (300 MW, in 2018) and Gairezi (30 MW, in 2019) and Hwange-7 & 8 (600 MW, in 2019) will be accomplish.

As of 2020, total capacity will be 4,241MW (1,101MW of hydropower, 3,140MW of coal-fired. Export and import is same value, 150MW). In 2030, capacity will be grown to 6,574MW (hydro 1,914MW, coal-fired 4,360MW, gas-fired 300MW, and export 150MW, import as well). In 2040, total capacity will be 6,574MW (hydro 1,914MW, coal-fired 4,360MW, gas-fired 300MW, import is 150MW, export is as well).

Most of Zimbabwean generators are old coal-fired facilities, except Kariba South hydropower. According to the news, Hwange 1-6, old and huge coal-fired power plant is repairing with support from Indian capital. Coming back to operation will be 2022.

Table 5.1-11 Generation development analysis, capacity review Angola

Angola

Lot	Country declared	Utility	Project name(Pool Plan)(Latest info.)	Capacity(MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[MW]	2,226	2,347	2,472	2,601	2,734	2,871	3,015	3,165	3,324	3,490	3,664	3,847	4,040	4,242	4,454	4,677	4,910	5,156	5,414	5,684	5,969
	Existing					Existing																					
Hydro																											
H001	Angola	PRODEL	Mabubas(18MW)(25.6MW)	26			26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
H002	Angola	PRODEL	Cambambe(180MW)(960MW)	260			260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260
H003	Angola	PRODEL	Capanda(260MW)(520MW)	520			520	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520
H004	Angola	PRODEL	Matala(16MW)(40.8MW)	42			42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
H005	Angola	PRODEL	Luachimo(-)(36MW)-Lunda Norte	8.4			36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
H006	Angola	PRODEL	Chicapa(-)(34MW)-Lunda Sul	16			16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
H007	Angola	PRODEL	Biópio(8MW)(14.6MW)	14.6			15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
H008	Angola	PRODEL	Lomaum(-)(50+160MW)	65			65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
H009	Angola	PRODEL	Gove(-)(57.6MW)	60			60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Thermal																											
T001	Angola	PRODEL	Luanda	148			148	148	148	148																	
T003	Angola	PRODEL	Benguela-New	60			60	60	60	60	60	60	60	60	60	60											
T004	Angola		GTG	128			128	128	128	128	128	128	128														
T005	Angola		CD CFL	60	Diesel		60	60	60	60	60	60	60														
T006	Angola		CT Quartéis	15	Thermal		15	15	15	15	15	15	15														
T007	Angola		CT Viana	50	Thermal		50	50	50	50	50	50	50														
T008	Angola		CT Cimangola	96	Thermal		96	96	96	96	96	96	96														
T009	Angola		CT Mabor ou Cazenga	56	Thermal		56	56	56	56	56	56	56														
T010	Angola		CD Luanda Norte (Dundo)	0.8	Diesel		1	1	1	1	1	1	1														
T011	Angola		CD Lunda Sul (Saurimo)	2.1	Diesel		2	2	2	2	2	2	2														
T012	Angola		CD Moxico (Luena)	12.5	Diesel		13	13	13	13	13	13	13														
T014	Angola		CD Lunda Norte (Dundo)	15	Diesel		15	15	15	15	15	15	15														
T015	Angola		CD Luda Sul	7.5	Diesel		8	8	8	8	8	8	8														
	Planning				Expect Y.	Planning																					
Hydro																											
H101	Angola	PRODEL	Cambambe2	720	**2017**	5,959	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
H102	Angola	PRODEL	Caculo Cabaca	2100	**2020**		2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
H103	Angola	PRODEL	Laúca	2060	**2018**		2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060	2,060
H104	Angola		Queve	774	**2020**		774	774	774	774	774	774	774	774	774	774	774	774	774	774	774	774	774	774	774	774	774
H105	Angola	IPP	Jamba ia oma	78	**2020**		78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78
H106	Angola	IPP	Jamba ia mina	227	**2020**		227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227
H107	Angola/Namibia	PRODEL	Baynes (by Namibia)	300	**2026**								300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Thermal																											
T101	Angola	PRODEL	Soyo Ⅰ - Gas fired	720	**2018**		720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
T102	Angola	IPP	Soyo Ⅱ(2A, 2B) - Gas fired	720	**2022**					720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
T103	Angola	PRODEL	Boavista 1 (Benguela) - Gas fired, relocate	80	**2026**								80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
T104	Angola	PRODEL	Boavista 2 (Namibe) - Gas fired, relocate	40	**2026**								40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
						Total Capacity	8,370	8,370	8,370	9,090	8,942	8,942	9,362	8,919	8,919	8,919	8,859	8,859	8,859	8,859	8,859	8,859	8,859	8,859	8,859	8,859	8,859
						Hydopower	6,999	6,999	6,999	6,999	6,999	6,999	7,299	7,299	7,299	7,299	7,299	7,299	7,299	7,299	7,299	7,299	7,299	7,299	7,299	7,299	7,299
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	1,273	1,273	1,273	1,993	1,845	1,845	1,965	1,620	1,620	1,620	1,560	1,560	1,560	1,560	1,560	1,560	1,560	1,560	1,560	1,560	1,560
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	98	98	98	98	98	98	98	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	6,144	6,023	5,898	6,489	6,208	6,071	6,347	5,754	5,595	5,429	5,195	5,012	4,819	4,617	4,405	4,182	3,949	3,703	3,445	3,175	2,890

Source：JICA Survey Team

Table 5.1-12 Generation development analysis, capacity review Botswana

Botswana																											
Lot	Country declared	Utility	Project name	Capacity (MW)		**Year**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
						Demand[MW]	1,183	1,202	1,221	1,238	1,255	1,272	1,310	1,348	1,388	1,429	1,471	1,514	1,559	1,605	1,652	1,701	1,751	1,803	1,856	1,911	1,967
	Existing					Existing																					
Thermal																											
T001	Botswana	BPC	Morepule A	132	4x33MW		132	132	132	132																	
T002	Botswana	BPC	Morepule B	600	4x150MW		528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528
T003	Botswana	BPC	Orapa(OCGT)	90			90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Import																											
			Eskom, firm	150	2008-2012		150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
			EDM, firm	50	2007annually		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
			SNEL, firm	50	2009continuous																						
			ZESCO, non-firm	100	2014annually																						
	Planning				Expected Y	Planning																					
Thermal																											
T101	Botswana	BPC	Morepule-B phase2(5&6) Coal fired	300	**2020, 2021**		150	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
T102	IPP Greenfield		Coal fired	264	**2020, 2021**		132	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264
Solar																											
S101	PV - Unknown	-		100	**2017**		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
						Total Capacity	1,332	1,614	1,614	1,614	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482
						Hydopower	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Coal-fired	942	1,224	1,224	1,224	1,092	1,092	1,092	1,092	1,092	1,092	1,092	1,092	1,092	1,092	1,092	1,092	1,092	1,092	1,092	1,092	1,092
						Gas-fired	0	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
						RE(PV, Wind etc.)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
						Diesel and else	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	149	412	393	376	227	210	172	134	94	53	11	-32	-77	-123	-170	-219	-269	-321	-374	-429	-485

Source：JICA Survey Team

Table 5.1-13 Generation development analysis, capacity review DR Congo

DR Congo

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand [MW]	2,229	2,313	2,409	2,509	2,614	2,723	2,817	2,915	3,016	3,121	3,229	3,341	3,457	3,577	3,701	3,830	3,963	4,100	4,243	4,390	4,552
	Existing					Existing																					
Hydro																											
H001	DRC	SNEL	Inga 1	360		Installed	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
H002	DRC	SNEL	Inga 2	1,424		2,442	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424	1,424
H003	DRC	SNEL	Mpozo	2			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
H004	DRC	SNEL	Zongo1	75			75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
H005	DRC	SNEL	Sanga	12			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
H006	DRC	SNEL	Mobayi-Mbongo	11			11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
H007	DRC	SNEL	Kilubi	10			10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
H008	DRC	SNEL	Kymbi	17			17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
H009	DRC	SNEL	Koni	42			42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
H010	DRC	SNEL	Mwadingusha	68			68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
H011	DRC	SNEL	Nseke	248			248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248
H012	DRC	SNEL	Nzilo1	108			108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108
H013	DRC	SNEL	Lungudi	2			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
H014	DRC	SNEL	Ruzizi1	28			28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
H015	DRC	SNEL	Ruzizi2	27			27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
H016	DRC	SNEL	Bendera-Kyimbi1	17			17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Export																											
	→ BPC (Firm)			-50																							
	→ ZESA (Firm)			-50			-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
	→ ZESA (Non Firm)			-50																							
Import																											
	ZESCO for KCC (Firm)			40			40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
	ZESCO (Non Firm)			100																							
	Planning					Planning																					
Hydro																											
H101	DRC		Inga 3	4,800	4,800MW	**2026 -> 2031**												4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800
H102	DRC		Zongo2	120																							
H103	DRC		Busanga	240	4x60MW	**2020, 21, 22**	120	180	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240
H104	DRC		Katende	64		**2020**	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
H105	DRC		Ruzizi3	49	147MW fo	**2018**	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49
Export																											
	Inga 3 → RSA (Eskom)			-2,500	2026													-2,500	-2,500	-2,500	-2,500	-2,500	-2,500	-2,500	-2,500	-2,500	-2,500
						Total Capacity	2,674	2,734	2,794	2,794	2,794	2,794	2,794	2,794	2,794	2,794	2,794	5,094	5,094	5,094	5,094	5,094	5,094	5,094	5,094	5,094	5,094
						Hydopower	2,684	2,744	2,804	2,804	2,804	2,804	2,804	2,804	2,804	2,804	2,804	7,604	7,604	7,604	7,604	7,604	7,604	7,604	7,604	7,604	7,604
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
						Export	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-2,550	-2,550	-2,550	-2,550	-2,550	-2,550	-2,550	-2,550	-2,550	-2,550
						Surplus/Deficit	445	421	385	285	180	71	-23	-121	-222	-327	-435	1,753	1,637	1,517	1,393	1,264	1,131	994	851	704	542

Source：JICA Survey Team

Table 5.1-14 Generation development analysis, capacity review Lesotho

Lethoto

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand [MW]	188	193	198	204	209	214	219	224	230	235	241	247	252	259	265	271	277	284	291	298	305
	Existing					Existing																					
Hydro																											
H001	Lesotho	LHWP	Muela	72	3x24MW		72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72
H002	Lesotho	LEC	Mant-Sonyane	2	1.5MW,0.5MW		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Import																											
		No.3	Eskom Firm	24	2005 indefinite		24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
		No.17	EDM Firm	50	2008 annually		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Planning					Planning																					
Hydro																											
H101	Lesotho	LHWP	Kobong PS	1,200																							
H102	Lesotho	LHWP	Muela Ⅱ	73	2012		73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73
H103	Lesotho	LHWP	Oxbow	80	2017		80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
						Total Capacity	301	301	301	301	301	301	301	301	301	301	301	301	301	301	301	301	301	301	301	301	301
						Hydopower	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	113	108	103	97	92	87	82	77	71	66	60	54	49	42	36	30	24	17	10	3	-4

Source：JICA Survey Team

Table 5.1-15 Generation development analysis, capacity review Malawi

Malawi																											
Lot	Country declared	Utility	Project name	Capacity (MW)		**Year**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
						Demand[MW]	541	560	577	594	611	629	648	668	688	708	730	752	775	798	822	847	873	899	926	954	983
	Existing					Existing																					
Hydro																											
H001	Malawi	ESCOM	Nkula A	24	3x8MW	Installed	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
H002	Malawi	ESCOM	Nkula B	100	5x20MW	351	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
H003	Malawi	ESCOM	Tedzani 1	20	2x10MW		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
H004	Malawi	ESCOM	Tedzani 2	20	2x10MW		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
H005	Malawi	ESCOM	Tedzani 3	52.7	2x26.5MW		53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
H006	Malawi	ESCOM	Kapichira Phase1	64	2x32.4MW		64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
H007	Malawi	ESCOM	Kapichira Phase2	64	2x32.4MW		64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
H008	Malawi	ESCOM	Wovwe	4.35	3x1.45MW		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Thermal																											
T001	Malawi	ESCOM	Lilongwe	20	Diesel		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
T002	Malawi	ESCOM	Mzuzu	6	Diesel		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
T003	Malawi	ESCOM	Blantyre	15	Diesel		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
	Planning					Planning																					
Hydro																											
H101	Malawi	ESCOM	Nkula A - expansion	12	1x12MW	**2018**	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
H102	Malawi	ESCOM	Tedzani - expansion	18	1x18MW	**2019**	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
H104	Malawi	ESCOM	Kholombidzo	280		**2020**	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
H106	Malawi	IPP	Mboongozi	40		**2022**			41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
H108	Malawi		Chizuma	50		**2019**	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
H111	Malawi		Lower Fufu	100-150		**2026**							140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
H117	Malawi		Mpatamanga	350		**2035**																350	350	350	350	350	350
H123	Malawi		Songwe	65-340		**2022 -> 2029**										90	90	90	90	90	90	90	90	90	90	90	90
						Total Capacity	670	670	711	711	711	711	851	851	851	941	941	941	941	941	941	1,291	1,291	1,291	1,291	1,291	1,291
						Hydopower	629	629	670	670	670	670	810	810	810	900	900	900	900	900	900	1,250	1,250	1,250	1,250	1,250	1,250
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
						Import	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	129	110	134	117	100	82	203	183	163	233	211	189	166	143	119	444	418	392	365	337	308

Source：JICA Survey Team

Table 5.1-16 Generation development analysis, capacity review Mozambique

Mozambique

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[MW]	974	1,017	1,061	1,108	1,157	1,208	1,256	1,305	1,356	1,410	1,465	1,523	1,583	1,646	1,710	1,778	1,848	1,921	1,996	2,075	2,157
					51%	South	497	519	541	565	590	616	641	666	692	719	747	777	807	839	872	907	942	980	1,018	1,058	1,100
					49%	North-Central	477	498	520	543	567	592	615	639	664	691	718	746	776	807	838	871	906	941	978	1,017	1,057
	Existing					Existing																					
Hydro																											
H001	Mozambique	HCB	Cahora Bassa	2,075	5x415MW		2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075
H002	Mozambique	EDM	Chicamba	34	2x17MW		44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
H003	Mozambique	EDM	Mavuzi	52	3x14MW, 2x5MW		52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
H004	Mozambique	EDM	Corumana	17	2x8.3MW		17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Thermal																											
T001	Mozambique	EDM	CTM1	20	1x20MW Diesel		20																				
T003	Mozambique	EDM	Nacala	18	18x1MW Diesel		18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
T004	Mozambique	EDM	Temane	8	6x0.31MW, 2X2.6MW		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
T005	Mozambique	Aggreko	Aggreko	55	100, 122MW		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T006	Mozambique	Sasol+EdM	Ressano Gacia EDM/Sasol	175	18x9.73MW		175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
T007	Mozambique	Gigajoule	Ressano Gacia Gigawatt	120	13x9.34MW		120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
T008	Mozambique	EDM	Beloluane	40	40x1MW		40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
	Mozambique	EDM	Tevene	4	Diesel		4																				
	Mozambique	EDM	Inhambane	5	Diesel		5																				
Export																											
	<EDM>																										
			→ SEC (Firm)	-50			-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
			→ Nampower (Firm)	-50			-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
			→ BPC (Firm)	-50			-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
			→ LEC (Firm)	-50			-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
			→ Eskom (Firm)	-100			-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100
			→ Eskom (Firm) As Available																								
			→ ZESA (Non Firm)	50																							
			→ ZESCO (Non Firm) As requested																								
	<HCB>																										
			→ EDM (Firm)	-300	Wheel from HVDC, RSA		-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300
			→ EDM (Firm)	-200	Wheel from HVAC, RSA		-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200
			→ Eskom (Firm)	-1,150			-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150	-1,150
			→ Eskom (Firm)	-250			-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250
			→ ZESA (Firm)	-100			-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100
			→ ZESA (Non Firm) As Available																								
Import																											
			ZESCO (Firm)→EDM North	100			100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
			HCB (Firm)→EDM South	300			300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
			HCB (Firm)→EDM South	200			200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Planning					Planning																					
Hydro																											
H101	Mozambique	HCB	Cahora Bassa Norte <Noth/Central>	1,245	3x415MW	**2026**							1,245	1,245	1,245	1,245	1,245	1,245	1,245	1,245	1,245	1,245	1,245	1,245	1,245	1,245	1,245
H102	Mozambique	EDM/HCB	Mpanda Nkuwa <North/Central>	1,500	2x750MW	**2024**					1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
H105	Mozambique	EDM	Massingir <North/Central>	27		**2025**						27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
H106	Mozambique	EDM	Moamba Major <North/Central>	15		**2022**			15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
H107	Mozambique	EDM	Lurio II <North/Central>	120		**2022**			120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
H108	Mozambique	EDM	Tsate <North/Central>	50		**2023**				50	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120

Source：JICA Survey Team

Generation development analysis, capacity review Mozambique – Cont'd

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[MW]	974	1,017	1,061	1,108	1,157	1,208	1,256	1,305	1,356	1,410	1,465	1,523	1,583	1,646	1,710	1,778	1,848	1,921	1,996	2,075	2,157
					51%	South	497	519	541	565	590	616	641	666	692	719	747	777	807	839	872	907	942	980	1,018	1,058	1,100
					49%	North-Central	477	498	520	543	567	592	615	639	664	691	718	746	776	807	838	871	906	941	978	1,017	1,057
Thermal																											
T101	Mozambique	ACWA	Moatize(Surplus (Coal fired<North/Central>	300	toward 2,400MW,2x300, 3x600	**2025**						50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
T102	Mozambique		Nacala (Coal fied<North/Central>)	40		**2019**	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
T103	Mozambique	Jindal Stee	JINDAL Tete (Coal fired <North/Central>)	150		**2018**	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
T104	Mozambique	Ncondezi F	Ncondezi (Coal fired <North/Central>)	300		**2025**						300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
T105	Mozambique	EDM/Sasol	Temane (Gas fired<South>)	400		**2022**			400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
T106	Mozambique	Kuvaninga	Kuvaninga (Gas fired <South>)	40	10x4.01MW	**2017**	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
T107	Mozambique	ENI	Palma (Gas fired <North/Central>)	75								75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
T109	Mozambique	EDM	Coal fired Nacala <North/Central>	200					200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
T110	Mozambique	IPP	Coal fired Tete <North/Central>	1,200		**2022**			1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
T111	Mozambique	EDM	CTM 1 (Gas fired<South>)	96	2x48.065MW	**2018**	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96
T112	Mozambique	EDM	CTM 2 (Gas fired<South>)	29	1x28.87MW	**2018**	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
T114	Mozambique	EDM	Temane (Gas fired<South>)	100					100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
T115	Mozambique	EDM	CTM Conversion (T001 Diesel to Gas) (Gas fired<South>)	80		**2021**		80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
T116	Mozambique	ENRC	ENRC (Coal fired<North/Central>)	300		**2025**						300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Solar																											
S101	Mozambique	Scatec	Mocuba <North/Central>	30		**2019**	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
S102	Mozambique	Neon	Metoro <North/Central>	30		**2019**	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
					Total	Total Capacity	1,152	1,204	3,239	3,289	4,859	5,611	6,856	6,856	6,856	6,856	6,856	6,856	6,856	6,856	6,856	6,856	6,856	6,856	6,856	6,856	6,856
						Hydopower	2,188	2,188	2,323	2,373	3,943	3,970	5,215	5,215	5,215	5,215	5,215	5,215	5,215	5,215	5,215	5,215	5,215	5,215	5,215	5,215	5,215
						Coal-fired	50	50	1,450	1,450	1,450	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
						Gas-fired	508	588	1,088	1,088	1,088	1,163	1,163	1,163	1,163	1,163	1,163	1,163	1,163	1,163	1,163	1,163	1,163	1,163	1,163	1,163	1,163
						RE(PV, Wind etc.)	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
						Diesel and else	46	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
						Import	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
						Export	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300	-2,300
						Surplus/Deficit	178	187	2,178	2,181	3,702	4,403	5,600	5,551	5,500	5,446	5,391	5,333	5,273	5,210	5,146	5,078	5,008	4,935	4,860	4,781	4,699
					South Total	Total Capacity	736	788	1,303	1,303	1,303	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330
						Hydopower	0	0	15	15	15	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	508	588	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
						Export	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300	-300
						Surplus/Deficit	239	269	762	738	713	714	689	664	638	611	583	553	523	491	458	423	388	350	312	272	230
					North-Central Total	Total Capacity	416	416	1,936	1,986	3,556	4,281	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526
						Hydopower	2,188	2,188	2,308	2,358	3,928	3,928	5,173	5,173	5,173	5,173	5,173	5,173	5,173	5,173	5,173	5,173	5,173	5,173	5,173	5,173	5,173
						Coal-fired	50	50	1,450	1,450	1,450	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
						Gas-fired	0	0	0	0	0	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
						RE(PV, Wind etc.)	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
						Diesel and else	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
						Import	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
						Export	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000
						Surplus/Deficit	-61	-82	1,416	1,443	2,989	3,689	4,911	4,887	4,862	4,835	4,808	4,780	4,750	4,719	4,688	4,655	4,620	4,585	4,548	4,509	4,469

Source：JICA Survey Team

Table 5.1-17　Generation development analysis, capacity review　Namibia

Namibia																											
Lot	Country declared	Utility	Project name	Capacity (MW)			**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
						Demand[MW]	879	901	918	935	953	970	989	1,014	1,041	1,068	1,096	1,124	1,154	1,184	1,215	1,246	1,279	1,312	1,347	1,382	1,418
	Existing					Existing																					
Hydro																											
H001	Namibia	Nampower	Ruacana	343	3x80MW, 92MW		343	343	343	343	343	343	343	343	343	343	343	343	343	343	343	343	343	343	343	343	343
Thermal																											
T001	Namibia	Nampower	Anixas	22.5	1x22.5MW		23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
T002	Namibia	Nampower	Van Eck	81			81	81	81	81	81																
Import																											
			ZESA →　(Firm)	150			150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
			ZESCO →　(Firm)	50			50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Planning					Planning																					
Hydro																											
H101	Namibia	Nampower	Baynes	300	2x71MW, 3x156.75MW								300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Thermal																											
T102	Namibia	Nampower	Kudu Gas-fired	400			400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
		Nampower	Diesel						20	40	60	120	140	160	180	200	220	235	235	235	235	235	235	235	235	235	235
						Total Capacity	1,047	1,047	1,067	1,087	1,107	1,086	1,406	1,426	1,446	1,466	1,486	1,501	1,501	1,501	1,501	1,501	1,501	1,501	1,501	1,501	1,501
						Hydopower	343	343	343	343	343	343	643	643	643	643	643	643	643	643	643	643	643	643	643	643	643
						Coal-fired	81	81	81	81	81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	23	23	43	63	83	143	163	183	203	223	243	258	258	258	258	258	258	258	258	258	258
						Import	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	168	146	149	152	154	116	417	412	405	398	390	377	347	317	286	255	222	189	154	119	83

Source：JICA Survey Team

Table 5.1-18 Generation development analysis, capacity review RSA

RSA																											
Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[MW]	44,977	46,481	47,952	49,442	50,895	52,593	52,995	54,745	56,482	58,547	60,509	62,159	63,463	64,969	66,210	67,414	68,341	69,621	70,777	71,736	72,495
	Existing					Existing																					
Hydro																											
H001	RSA	Eskom	Drakensberg PS	1,000	4x250MW		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
H002	RSA	Eskom	Palmiet PS	400	2x200MW		400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
H003	RSA	Eskom	Gariep	360	4x90MW		360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
H004	RSA	Eskom	Vanderkloof	240	2x120MW		240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240
H005	RSA	Private	Friedenham	3			3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
H006	RSA	Eskom	First Falls	6	2x3MW		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
H007	RSA	Eskom	Second Falls	11	2x5.5MW		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
H008	RSA	Eskom	Ncora	2	2x0.4MW,1 x 1.3MW		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
H009	RSA	Eskom	Colley Wobbeles	42	3x14MW		42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
H010	RSA	Capetown City	Steenbras PS	180																							
Thermal																											
T001	RSA	Eskom	Arnot	2,352	270, 390, 396, 400		2,352	2,352	2,352	2,352	2,352	2,352	2,352	2,352	2,352	2,352	2,352	1,900	1,900	1,520	1,520	1,140	760	760	380		
T002	RSA	Eskom	Camden-RTS	1,561	3x200, 196, 2x195, 190, 185		1,140	760	380																		
T003	RSA	Eskom	Duvha	3,600	6x600		3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	2,875	2,300	1,725	575							
T004	RSA	Eskom	Grootvlei-RTS	1,200	6x200		1,200	1,200	1,200	1,200	1,200	940	752	376													
T005	RSA	Eskom	Hendrina	1,893	5x200, 2x195, 2x170, 168		1,893	1,893	1,893	1,893	1,893	1,893	1,893	1,893	1,893	1,893	1,683	1,496	1,309	1,122	935	561	187				
T006	RSA	Eskom	Kendal	4,116	6x686		4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	4,116	3,200	2,560
T007	RSA	Eskom	Komati-RTS	990	4x100, 90, 4x125		990	990	990	990	606	303															
T008	RSA	Eskom	Kriel	3,000	6x500		3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	2,000	1,500	1,000	500	0
T009	RSA	Eskom	Majuba	4,110	3x657, 3x713		4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110	4,110
T010	RSA	Eskom	Matla	3,600	6x600		3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	2,875	2,875	1,725	1,150	575							
T011	RSA	Eskom	Tutuka	3,654	6x609		3,654	3,654	3,654	3,654	3,654	3,654	3,654	3,654	3,654	3,654	3,654	3,654	3,654	3,654	3,654	2,925	2,340	1,755	1,170	585	0
T012	RSA	Eskom	Lethabo	3,708	6x618		3,708	3,708	3,708	3,708	3,708	3,708	3,708	3,708	3,708	3,708	3,708	3,708	3,708	3,708	3,708	2,965	2,372	1,779	11,866	593	0
T013	RSA	Eskom	Matimba	3,990	6x665		3,990	3,990	3,990	3,990	3,990	3,990	3,990	3,990	3,990	3,990	3,990	3,990	3,990	3,990	3,990	3,990	3,990	3,990	2,460	1,845	1,230
					37,774																						
T014	RSA	Aldwych International	Kelvin (Coal	214																							
T015	RSA	Sasol	Secunda (Coal	600	10x60MW		600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
T016	RSA	City of Tshwane	Pretoria West (Coal	180			300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
T017	RSA	City of Tshwane	Rooiwal (Coal	300																							
T018	RSA	Eskom	Acacia OCGT	171			171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171
T019	RSA	Eskom	Port Rex OCGT	171			171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171
T020	RSA	Eskom	Ankerlig OCGT	1,338			1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338
T021	RSA	Eskom	Gourikwa OCGT	746			746	746	746	746	746	746	746	746	746	746	746	746	746	746	746	746	746	746	746	746	746
T022	RSA	Sasol	Secunda OCGT(CCGT)	180	2x90MW		180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
T023	RSA	Sasol	Sasolburg OCGT	175			175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
T024	RSA	IPSA	Newcastle cogeneration CCGT	18			18	18	18	18	18	18	18	18	18	18	18										
T025	RSA	ENGIE, Legend Power Solutions, Mitsui	Dedisa Peaking OCGT	335			335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335
T026	RSA	ENGIE, Legend Power Solutions, Mitsui,Group five	Avon Peaking OCGT	670	670MW(4Units)		670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670

Source：JICA Survey Team

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[MW]	44,977	46,481	47,952	49,442	50,895	52,593	52,995	54,745	56,482	58,547	60,509	62,159	63,463	64,969	66,210	67,414	68,341	69,621	70,777	71,736	72,495
Nuc																											
N001	RSA	Eskom	Koeberg Nuc	1,940			1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940
Wind																											
W001	RSA	Eskom	Klipheuwel	3			3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W002	RSA	Eskom	Sere	100			100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	Planning					Planning																					
Hydro																											
H001	RSA	Eskom	Ingula PS	1,332	4x333MW Pump Turbines		1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332
Thermal	(Coal Baseload IPP Programme:2500MW, 2021)																										
T101	RSA	Eskom	Medupi Coal fired	4,764	6x794MW		1,588	1,588	3,176	3,176	3,176	4,764	4,764	4,764	4,764	4,764	4,764	4,764	4,764	4,764	4,764	4,764	4,764	4,764	4,764	4,764	4,764
T102	RSA	Eskom	Kusile Coal fired	4,800	6x800MW			800	1,600	3,200	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800
			Future Coal fired				250	250	1,000	1,600	2,200	2,200	2,200	2,200	2,200	2,700	2,700	2,700	3,700	4,450	5,200	5,950	5,950	6,700	8,200	8,950	11,200
	(Gas to Power Programme:3126MW, IRP 3910MW)																										
T104	RSA	IPP	CCGT	2,370			474	711	711	711	711	711	711	711	1,185	1,422	2,370	2,370	2,370	2,370	2,370	2,370	2,370	2,370	2,370	2,370	2,370
T105	RSA	IPP	Peak OCGT	3,126					805	1,610	1,610	2,415	2,415	2,415	3,105	3,910	3,910	3,910	3,910	3,910	3,910	3,910	3,910	3,910	3,910	3,910	3,910
			Future OCGT				120	480	480	480	480	480	1,320	3,000	4,680	5,160	5,160	5,280	6,360	6,360	7,320	7,320	8,040	11,040	11,040	11,040	11,160
			Future CCGT							710	710	2,840	2,840	2,840	2,840	2,840	2,840	2,840	2,840	2,840	2,840	2,840	2,840	3,550	3,550	3,550	4,970
Nuc																											
T106	RSA		Future Nuclear									3,200	3,200	4,800	6,400	6,400	6,400	8,000	8,000	9,600	11,200	12,800	14,400	14,400	16,000	17,600	17,600
Solar (towards 1450MW)																											
S101	RSA	IPP	PV total(Upcoming Window)	1,665	Window 1-3:2010MW		1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	1,070	160	20
			Future PV				350	840	1,400	2,190	3,050	3,980	4,980	5,980	6,980	7,980	8,980	9,980	10,980	11,980	12,980	13,980	14,980	15,980	16,980	17,980	18,980
CSP (towards 1000MW IRP objective)																											
C101		IPP	CSP total	300			300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
			Future CSP				0	0	0	0	0	0	0	0	0	0	2,600	3,700	4,900	5,000	5,000	5,600	5,600	6,100	6,100	6,100	6,400
Wind (towards 1850MW)																											
W101		IPP	Wind total	1,300	1850-1030		1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	370						
			Future Wind				0	0	0	0	320	640	1,190	1,510	1,830	2,470	2,790	3,430	4,070	4,710	5,350	5,990	6,310	6,950	7,270	7,590	8,230
Other																											
			Cogeneration etc.				2,700	2,700	2,700	2,700	2,700	2,700	640	640	640	640	640	640	640	640	640	640	280	280	280	280	280
Import																											
		SNEL	Inga3	2,500	2026→2031													2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
		No.1	HCB (Cahorra Bassa)-Firm	1,150	1998-2030		1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
		No.5	HCB (Cahorra Bassa)-Firm	250	2008-2014		250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
		No.23	EDM Firm	100			100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
		No.22	EDM Firm As Available																								
		No.31	ZESA NonFirm As Available																								
		No.21	ZESCO Non Firm As Available																								
			Future Import - Reference						1,125	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500

Source：JICA Survey Team

Generation development analysis, capacity review　RSA – Cont'd - 2

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[MW]	44,977	46,481	47,952	49,442	50,895	52,593	52,995	54,745	56,482	58,547	60,509	62,159	63,463	64,969	66,210	67,414	68,341	69,621	70,777	71,736	72,495
Export																											
		SEC Firm		-250			-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250
		LEC Firm		-24			-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24
		BPC Firm		-150			-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150
		Nampower Non Firm		-350																							
		ZESCO Non Firm		-300																							
		ZESA Non Firm		-300																							
						Total Capacity	56,724	58,231	62,354	66,479	69,475	77,885	77,724	81,948	87,336	90,273	94,206	98,784	102,367	104,165	106,848	108,842	109,190	113,925	125,437	113,928	116,585
						Hydopower	664	664	664	664	664	664	664	664	664	664	664	664	664	664	664	664	664	664	664	664	664
						Pumped storage	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732	2,732
						Coal-fired	40,091	40,511	43,269	45,089	46,905	47,930	47,439	47,063	46,687	46,462	45,527	43,163	42,826	41,284	40,697	39,221	36,289	35,174	43,766	30,247	29,564
						Gas-fired	4,398	4,995	5,800	7,315	7,315	10,250	11,090	12,770	15,614	17,136	18,084	18,186	19,266	19,266	20,226	20,226	20,946	24,656	24,656	24,656	26,196
						RE(PV, Wind etc.)	3,123	3,613	4,173	4,963	6,143	7,393	8,943	10,263	11,583	13,223	17,143	19,883	22,723	24,463	25,173	27,043	28,363	30,503	31,823	32,233	34,033
						Diesel and else	2,700	2,700	2,700	2,700	2,700	2,700	640	640	640	640	640	640	640	640	640	640	280	280	280	280	280
						Nuclear	1,940	1,940	1,940	1,940	1,940	5,140	5,140	6,740	8,340	8,340	8,340	9,940	9,940	11,540	13,140	14,740	16,340	16,340	17,940	19,540	19,540
						Import	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
						Export	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424	-424
						Surplus/Deficit	11,747	11,750	14,402	17,037	18,580	25,292	24,729	27,203	30,854	31,726	33,697	36,625	38,904	39,196	40,638	41,428	40,849	44,304	54,660	42,192	44,090

Source：JICA Survey Team

Table 5.1-19　Generation development analysis, capacity review　Swaziland

Swaziland

Lot	Country declared	Utility	Project name	Capacity (MW)		**Year**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
						Demand[MW]	304	308	311	315	319	323	328	333	338	343	348	354	359	364	370	376	381	387	393	399	405
	Existing					Existing																					
Hydro																											
H001	Swaziland	SEC	Maguga	19.8	2x9.9MW		19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
H002	Swaziland	SEC	Edwaleni	15	4x2.5MW, 1x5.0MW		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
H003	Swaziland	SEC	Ezulwini	20	2x10.0MW		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
H004	Swaziland	SEC	Maguduza	5.6	1x5.6MW		5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
	Import																										
			ESKOM →（Firm)	250	2000-2025		250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
			EDM →（Firm)	50	2003annually		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Planning					Planning																					
-	-	-	-	-			-	-	-																		
						Total Capacity	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4	360.4
						Hydopower	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	56	52	49	45	41	37	32	27	22	17	12	6	1	-4	-10	-16	-21	-27	-33	-39	-45

Source：JICA Survey Team

Table 5.1-20 Generation development analysis, capacity review Tanzania

Tanzania																											
Lot	Country declared	Utility	Project name	Capacity (MW)		Year	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
						Demand[MW]	2,190	2,430	2,690	2,980	3,300	3,660	4,030	4,430	4,860	5,340	5,870	6,450	7,080	7,770	8,520	9,350	10,190	11,100	12,090	13,160	14,330
	Existing					Existing																					
Hydro																											
H001	Tanzania	Tanesco	Pangani	68	2x34MW		68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
H002	Tanzania	Tanesco	Hale	21	2x10.5MW		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
H003	Tanzania	Tanesco	Nyumba Ya Mungu	8	2x4MW		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
H004	Tanzania	Tanesco	Kidatu	204	4X50MW		204	204	204	204	204	204	204	204	204	204	204	204	204	204	204	204	204	204	204	204	204
H005	Tanzania	Tanesco	Mtera	80	2x40MW		80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
H006	Tanzania	Tanesco	Lower Kihansi	180	3x60MW		180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
H007	Tanzania	Tanesco	Mwenga	4			4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
H008	Tanzania	Private	Kikuletwa	1																							
H009	Tanzania	Tanesco	Uwenba	1																							
Thermal																											
T001	Tanzania	Tanesco	Ubungo I	102	12x10.2MW		100	100	100	100	100	100	100														
T002	Tanzania	Tanesco	Tegeta GT	45			45	45	45	45	45	45	45	45	45												
T003	Tanzania	Tanesco	Ubungo II	105	35x5MW		105	105	105	105	105	105	105	105	105	105	105										
T004	Tanzania	Tanesco	Mtwara	18			18	18	18	18	18	18	18														
T005	Tanzania	Tanesco	Nyakato(Mwanza)-Diesel	63			63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
T006	Tanzania	Tanesco	Kinyerezi I	150			150	150	150	150	150	150	150	150	150	150	150	150	150	150	150						
T007	Tanzania	Tanesco	Somanga	8																							
T011	Tanzania	Songas Power	SongasⅡ	120			120	120	120	120	120																
T012	Tanzania	Songas Power	Songas I	42			42	42	42	42																	
T013	Tanzania	Songas Power	SongasⅢ	40			40	40	40	40	40	40															
T014	Tanzania	IPTL	TagetaIPTL-Diesel	103			103	103																			
			TPC (Biomass)	17																							
			TANWAT(Biomass)	3																							
T015	Tanzania	Dangote Industries Tanzania	Dangote Industries Tanzania	75																							
		IPP	Somanba Fungu(GT)	210			210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
		IPP	Somanba Fungu(CC)	110			110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
	Planning					Planning																					
Hydro																											
H101	Tanzania		Kakono	87	53 -> 87MW									87	87	87	87	87	87	87	87	87	87	87	87	87	87
H102	Tanzania	Tanesco	Rusumo Falls	27		**2019**	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
H104	Tanzania	Tanesco	Stiegler's phase1*	300	3000	EIA issues arise																					
H105	Tanzania	Tanesco	Stiegler's phase2*	600	1	EIA issues arise																					
H106	Tanzania	Tanesco	Stiegler's phase3*	1,200		EIA issues arise																					
H107	Tanzania		Mpanga	160	144->160MW													160	160	160	160	160	160	160	160	160	160
H108	Tanzania	Tanesco	Taveta-Mnyera	84	145->83.9MW												84	84	84	84	84	84	84	84	84	84	84
H109	Tanzania	Tanesco	Ruhudji	358															358	358	358	358	358	358	358	358	358
H110	Tanzania		Masigira	118															118	118	118	118	118	118	118	118	118
H111	Tanzania	Tanesco	Rumakali-520MW	222																222	222	222	222	222	222	222	222
H112	Tanzania	Tanesco	Songwe(Manolo)-177.9MW	88											88	88	88	88	88	88	88	88	88	88	88	88	88
			Songwe(Bupigu)-29.4MW	34																							
			Songwe(Sofre)-158.9MW	80																	80	80	80	80	80	80	80
			Malagarasi	45							45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
			Mnyera Ruaha	60											60	60	60	60	60	60	60	60	60	60	60	60	60
			Mnyera Pumbwe	123													123	123	123	123	123	123	123	123	123	123	123
			Mnyera Kwanini	144												144	144	144	144	144	144	144	144	144	144	144	144
			Mnyera Kisingo	120														120	120	120	120	120	120	120	120	120	120
			Mnyera Mnyera	137												137	137	137	137	137	137	137	137	137	137	137	137

Source：JICA Survey Team

Generation development analysis, capacity review　Tanzania – Cont'd

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[MW]	2,190	2,430	2,690	2,980	3,300	3,660	4,030	4,430	4,860	5,340	5,870	6,450	7,080	7,770	8,520	9,350	10,190	11,100	12,090	13,160	14,330
		Tanesco	Lower Kihansi Extension	120		**2019**	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
		SPP (IPP)	EA Power SPP	10	manage to delay					10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
		SPP (IPP)	Darakuta SPP	0																							
		SPP (IPP)	Mapenbasi SPP	10	manage to delay					10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
			Upper Kihansi	47																	47	47	47	47	47	47	47
			Kikonge	300																	300	300	300	300	300	300	300
			Iringa - Nginayo	52									52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
			Iringa - Ibosa	36									36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
Thermal																											
T101	Tanzania	Tanesco	Kinyerezi I Extension Gas fired	185		**2017**	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185				
T102	Tanzania	STAMICO	Kiwira coal fired phase1	400	seeking JV partner in 2014	**2019**	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
T103	Tanzania	STAMICO	Kiwira coal fired phase2	600											600	600	600	600	600	600	600	600	600	600	600	600	600
T104	Tanzania	Tanesco	Kinyerezi Ⅲ phase 1,2 Gas fired	600		**2020**	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
T105	Tanzania	Tanesco	Kinyerezi Ⅳ Gas fired	330													330	330	330	330	330	330	330	330	330	330	330
T106	Tanzania	Tanesco	Kinyerezi Ⅱ Gas fired	240		**2018**	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240				
T107	Tanzania	Sichuan Hongda Co.	Mchuchuma coal fired phase 1	150 x n				150	450	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
T108	Tanzania	Sichuan Hongda Co.	Mchuchuma coal fired phase 2	200 x n									600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
			Ngaka I coal fired	600						600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
			Ngaka Ⅱ coal fired	600																	600	600	600	600	600	600	600
T109	Tanzania	Tanesco	Mtwara(CCGT) Gas fired	300		**2020**	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
		Tanesco	Somanga(CCGT) Gas fired	240									240	240	240	240	240	240	240	240	240	240	240	240	240	240	240
		PPP	Somanga(CCGT) Gas fired	300									300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
			Zinga(Bagamoyo)(CCGT) Gas fired	200										200	200	200	200	200	200	200	200	200	200	200	200	200	200
Solar																											
			Dodoma	50		**2019**	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
			Kishapu - Sinyanga	150		**2020**	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Wind																											
			Singida	50		**2018**	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
			Singida	75		**2018**	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
			Makambako	100		**2019**	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
			Singida-Extension	50		**2019**	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
			Singida	100		**2020**	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
			Singida -Extension	50				50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Geothermal																											
			Future project									100	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Import																											
			PSMP - EAPP			**2019**	200	200	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
						Total Capacity	4,343	4,543	4,940	5,710	5,713	5,693	6,981	7,150	7,898	8,134	8,671	8,846	9,322	9,544	10,571	10,421	10,421	9,996	9,996	9,996	9,996
						Hydopower	712	712	712	732	777	777	865	952	1,100	1,381	1,588	1,868	2,344	2,566	2,993	2,993	2,993	2,993	2,993	2,993	2,993
						Coal-fired	400	550	850	1,600	1,600	1,600	2,200	2,200	2,800	2,800	2,800	2,800	2,800	2,800	3,400	3,400	3,400	3,400	3,400	3,400	3,400
						Gas-fired	2,265	2,265	2,265	2,265	2,223	2,103	2,603	2,685	2,685	2,640	2,970	2,865	2,865	2,865	2,865	2,715	2,715	2,290	2,290	2,290	2,290
						RE(PV, Wind etc.)	600	650	650	650	650	750	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850
						Diesel and else	166	166	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
						Import	200	200	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	2,153	2,113	2,250	2,730	2,413	2,033	2,951	2,720	3,038	2,794	2,801	2,396	2,242	1,774	2,051	1,071	231	-1,105	-2,095	-3,165	-4,335

Source：JICA Survey Team

Table 5.1-21 Generation development analysis, capacity review Zambia

Zambia																											
Lot	Country declared	Utility	Project name	Capacity (MW)		**Year**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
						Demand[MW]	2,883	2,984	3,080	3,161	3,288	3,401	3,520	3,646	3,778	3,918	4,066	4,214	4,367	4,526	4,690	4,861	5,038	5,221	5,411	5,608	5,812
	Existing					Existing																					
Hydro																											
H001	Zambia	ZESCO	Kariba North	720	4x180MW		720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
H002	Zambia	Kariba North Bank Extension Power Corporation Limited	Kariba North Bank Extension	360			360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
H003	Zambia	ZESCO	Kafue Gorge	990	6x165MW		990	990	990	990	990	990	990	990	990	990	990	990	990	990	990	990	990	990	990	990	990
H004	Zambia	ZESCO	Victria Fall A	8	2MW,2x3MW		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
H005	Zambia	ZESCO	Victria Fall B	60	6x10MW		60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
H006	Zambia	ZESCO	Victria Fall C	40	4x10MW		40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
H007	Zambia	ZESCO	Lusiwasi Upper	12			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
H008	Zambia	ZESCO	Lunzua	14.8	0.75MW		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
H009	Zambia	ZESCO	Musonda Falls	10	5MW		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
H010	Zambia	ZESCO	Chishimba Falls	15	6MW		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
H011	Zambia	ZESCO	Shiwa Ngandu	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
H012	Zambia	LHPC	Lunsemfwa	25			25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
H013	Zambia	LHPC	Mulungushi	31			31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
H014	Zambia	SPC: ITPC (Itezhi Tezhi Power Corporation)(ZESCO &TATA)	Itezhi Tezhi	120	2x60MW		120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Export																											
		SNEL（KCC） (Firm)		-40			-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40
		EDM (Firm)		-100			-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100
		Nampower (Firm)		-50			-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
		BPC (Non Firm)		-100																							
		SNEL (Non Firm)		-100																							
		Eskom (Non Firm)		-300																							
		ZESA (Non Firm)		-200																							
Import																											
		EDM → (Non Firm A	100MW from EDM																								
		ZESCO → (Non Firm)		300																							
	Planning					Planning																					
Hydro																											
H103	Zambia	ZRA	Batoka Gorge	1200	(2400MW)	**2024**					1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
H104	Zambia	CEC&TATA	Kabompo Gorge	40	2x17MW	**2020**	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
H105	Zambia	ZESCO	Kafue Gorge Lower	750	4x187.5MW	**2019**	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750
H106	Zambia	ZESCO	Lusiwasi Lower	74	86MW	**2019**	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74
H107	Zambia	Power Min	Luchenene	34	1x30MW	**2020**	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
H108	Zambia	Power Min	Mutinondo	43	1x40MW	**2020**	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
H109	Zambia	Lunzua Power Author	Kabwelume	96					96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96
H110	Zambia	Lunzua Power Author	Kundabwika	151					151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151
H111	Zambia	GRZ/DRC	Mumbotuta Falls	490								490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490
H112	Zambia	GRZ/DRC	Mambilima Falls I	126								126	126	126	126	126	126	126	126	126	126	126	126	126	126	126	126
H113	Zambia	GRZ/DRC	Mambilima Falls II	202								202	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202
H114	Zambia	GRZ/DRC	Mambilima Falls V	372								372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372
H118	Zambia	Western Power comp	Ngonye falls	40	40-60MW	**2020**	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Thermal																											
T101	Zambia	MCL	Maamba Coal fired	600	2x300MW	**2016, 2020**	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
Solar																											
S101	Zambia	IDC	n/a	300		**-2020**	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	600
						Total Capacity	4,098	4,098	4,345	4,345	5,545	6,735	6,735	6,735	6,735	6,735	6,735	6,735	6,735	6,735	6,735	6,735	6,735	6,735	6,735	6,735	7,035
						Hydopower	3,388	3,388	3,635	3,635	4,835	6,025	6,025	6,025	6,025	6,025	6,025	6,025	6,025	6,025	6,025	6,025	6,025	6,025	6,025	6,025	6,025
						Coal-fired	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	600
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Export	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190
						Surplus/Deficit	1,215	1,114	1,265	1,184	2,257	3,334	3,215	3,089	2,957	2,817	2,669	2,521	2,368	2,209	2,045	1,874	1,697	1,514	1,324	1,127	1,223

Source：JICA Survey Team

Table 5.1-22 Generation development analysis, capacity review Zimbabwe

Zimbabwe

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[MW]	2,575	2,730	2,896	3,030	3,173	3,322	3,478	3,642	3,816	3,997	4,188	4,389	4,599	4,822	5,055	5,301	5,565	5,837	6,123	6,423	6,737
	Existing					Existing																					
Hydro																											
H001	Zimbabwe	ZPC	Kariba South	750	6x125MW		750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750
H002	Zimbabwe	IPP(Nyangani Renewable Energy)	Pungwe A	2.7			3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
H003	Zimbabwe	IPP(Nyangani Renewable Energy)	Pungwe B	15.25			15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
H004	Zimbabwe	IPP(Nyangani Renewable Energy)	Duru	2.2			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
H005	Zimbabwe	IPP(Nyangani Renewable Energy)	Nyamhingura	1.1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Thermal																											
T001	Zimbabwe	ZPC	Hwange1-6	920	4x120, 2x220MW ->700				920	920	920	920	920	920	920	920	920	920	920	920	920	920	920	920	920	920	920
T002	Zimbabwe	ZPC	Munyati	100	-> 20		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
T003	Zimbabwe	ZPC	Bulawayo	90	3x30MW -> 20		90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
T004	Zimbabwe	ZPC	Harare	120	1x20MW, 2x30MW -> 30		120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Export																											
		Nampower (Firm)		-150	though Cprivi link		-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150
		Eskom (Non Fi	As Available																								
Import																											
		→ HCB (Firm)		100			100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
		→ SNEL (Firm)		50			50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
		→ HCB (Non F	As Available																								
		→ EDM (Non Firm)		50																							
		→ ZESCO (Non Firm)		200																							
		→ SNEL (Non Firm)		50																							
		→ Eskom (Non	As Available																								
	Planning					Planning																					
Hydro																											
H101	Zimbabwe	SPC(ZPC has developed SPV)	Kariba South Ext	300	2x150		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
H104	Zimbabwe	ZPC	Batoka Gorge	1200	4x300MW (4x300MW)						1,200	1,200	1,200	1,200	1,200	1,200	800	800	800	800	800	800	800	800	800	800	800
H105	Zimbabwe	Private Company owned by Zim.Gov.	Gairezi	30	2x15MW		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
H107	Zimbabwe	IPP	Tsanga	3.3													3	3	3	3	3	3	3	3	3	3	3
H108	Zimbabwe	IPP	Osborne	3													3	3	3	3	3	3	3	3	3	3	3
H110	Zimbabwe	IPP	Manyuchi	1.4													1	1	1	1	1	1	1	1	1	1	1
H111	Zimbabwe	IPP	Duru	2.3													2	2	2	2	2	2	2	2	2	2	2
H112	Zimbabwe	IPP	Siya	0.9													1	1	1	1	1	1	1	1	1	1	1
H113	Zimbabwe	IPP	Mutirikwi	1.4													1	1	1	1	1	1	1	1	1	1	1

Source：JICA Survey Team

Generation development analysis, capacity review Zimbabwe – Cont'd

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[MW]	2,575	2,730	2,896	3,030	3,173	3,322	3,478	3,642	3,816	3,997	4,188	4,389	4,599	4,822	5,055	5,301	5,565	5,837	6,123	6,423	6,737
Thermal																											
T101	Zimbabwe	ZPC	Hwange7-8 Coal fired	600	2x300MW		600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
T102	Zimbabwe	ZPC/ Private	Lupane Coal fired	300	2x150MW							300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
T103	Zimbabwe	Rio Zim	Gokwe North (Sengwa) Coal fired	1200	4x300MW							300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
T104	Zimbabwe	IPP	Lususu Coal fired	600	2x300MW		600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
T105	Zimbabwe	Co-Ash Resources	Waste coal fired	250			250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
T106	Zimbabwe	CASECO	CASECO Coal fired	600	2x300MW		600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
T107	Zimbabwe	Southern Energy	Southern Energy Coal fired	660	2x330MW		660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660
T108	Zimbabwe	ZPC	ZPC Diesel	120			120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
						Total Capacity	4,241	4,241	5,161	5,161	6,361	6,961	6,961	6,961	6,961	6,961	6,574	6,574	6,574	6,574	6,574	6,574	6,574	6,574	6,574	6,574	6,574
						Hydopower	1,101	1,101	1,101	1,101	2,301	2,301	2,301	2,301	2,301	2,301	1,914	1,914	1,914	1,914	1,914	1,914	1,914	1,914	1,914	1,914	1,914
						Coal-fired	3,020	3,020	3,940	3,940	3,940	4,540	4,540	4,540	4,540	4,540	4,540	4,540	4,540	4,540	4,540	4,540	4,540	4,540	4,540	4,540	4,540
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
						Import	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
						Export	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150	-150
						Surplus/Deficit	1,666	1,511	2,265	2,131	3,188	3,639	3,483	3,319	3,145	2,964	2,386	2,185	1,975	1,752	1,519	1,273	1,009	737	451	151	-163

Source：JICA Survey Team

(5) Demand and Supply balance analysis

Based on the realized dependable capacity analysis, demand and supply balance are examined.

1) Generation capacity analysis

Lower rows on tables, such as Table 5.1-11 to Table 5.1-22, show the total capacity of the state and balance between total capacity and forecasted demand in each future year.

Especially, overview of demand and supply balance in SAPP region in 2020, 2030 and 2040 are illustrated in Figure 5.1-17, Figure 5.1-18 and Figure 5.1-19 respectively.

Circular charts for SAPP member states on the figures represent total capacity. It is noted that Mozambique has two circular charts because there are grids, southern grid and north-central grid.

Outer circle shows the allocation of capacities from each kind of generator, and inner circle shows the distribution between a regional quota and export.

The title of circular charts values of capacity and predicted demand (peak demand) of the supply area, and its color indicates the reserve margin. Further, it is noted that measure for Angola and Mozambique is different from other member states due to the consideration of demand forecast.

Further, existing interconnectors and their operating capacity are on the figures for the reference. And interconnector candidates are also illustrated.

The balance in 2020 shows tightened situation in RSA. Definitely capacity in RSA is rich but total huge capacity of pumped storage, renewable and peaker gas-fired do not contribute firm energy generation. Thus, by 2020, RSA needs import energy for base-load or middle-load to secure the balance.

Further, margin in Namibia is short. Namibia therefore has to get some energy from other states which have surplus energy with interconnector.

As Figure 5.1-17 represents, suitable capacity will be prepared in all area except northern Mozambique when ongoing or expected projects toward 2020 will be committed.

Each area aims to achieve its own system operation by regional generators with domestic resources. It is clear that each SAPP member state aims to develop generation projects with domestic resources, especially northern states tend to increase hydropower capacities and southern states tend to introduce thermal capacities. In SAPP region, aggressive net exporter is only HCB, as IPP. However, most of power output from HCB flow into Mozambique system from Songo substation locates northern Mozambique to Apollo substation locates RSA directly without spilling out of northern Mozambique. Southern Mozambique can be given the power from HCB through MOTRACO system[71]. Power import magnitude, 500 MW, of southern Mozambique is from interconnector with Swaziland (capacity ; 1,300 MW) and another one with RSA (capacity ; 210MW). Ether of them is necessary to feed the power to southern Mozambique on the point of power import.

And the capacity of Swaziland, 360 MW, on the way from RSA to southern Mozambique, has to cover the demand, 304 MW. This balance, 56 MW is petty value for system operation.

Botswana, 1,332 MW of her capacity, has 1,183 MW for peak demand. This value is not sufficient in terms of two issues. One is 100 MW of total capacity is from renewable and two is that peak demand will happen

[71] Bulk power, 950MW trade to MOZAL, aluminum smelter, locates Matora, vicinity of Maputo and 300MW trade to EDM. Therefore, most of the power is for Mozambique.

in lighting period. Fortunately Botswana has interconnector with RSA. Therefore, Botswana can be supported by RSA which has rich surplus.

In 2030, Botswana and Swaziland will be not suitable in terms of the balance. DR Congo will be gotten the negative impact from Inga 3's delay.

In contrast, northern Mozambique will be a rich area with many generators. Perhaps capacity will be grown to eightfold of current capacity. Hydropower, such as Mphanda Nkuwa (1,500 MW), Cahora Bassa Norte (1,245 MW) will arise, and the bulk power should evacuate anywhere in SAPP area, plus existing interconnectors in northern Mozambique are the one to RSA with HVDC (1,500MW) and another one with Zimbabwe (700 MW). These have a few spaces to feed power more. Therefore, new interconnector(s) is needed to diversify.

Further, Evacuation line(s) should be implemented, hence Angolan capacity will grow twice and a half times of peak demand in 2030.

In 2040, power evacuation line from Inga 3 will be needed even though far future perspective is too difficult to foresee. And goal of each state's strategy, such as suitable generation mix will be achieved as Table 5.1-3.

Table 5.1-23 States applying generation mix having no main generation allocation in 2040

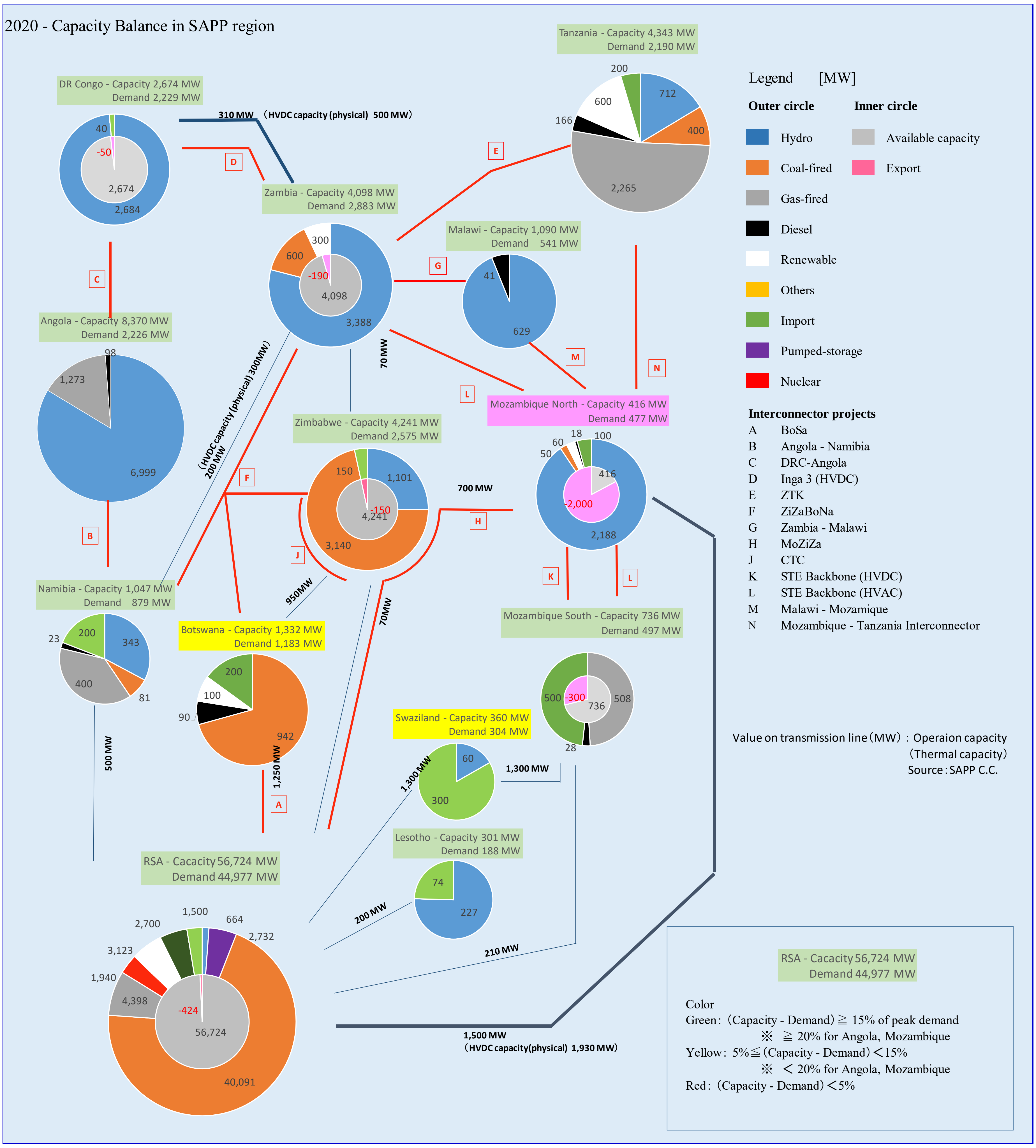
Country	Capacity allocation
Tanzania	Hydropower 30 %, Coal - fired 34 %, Gas - fired 23 %, Else 13 %
Mozambique (Nationwide)	Hydropower 47 %, Coal - fired 31 %, Gas - fired 16 %, Else 6 %
Namibia	Hydropower 43 %, Gas - fired 27 %, Else 30 %
RSA	Coal - fired 25 %, Gas - fired 22%, Nuclear 17 %, Else 36 %

Source：JICA Survey Team

As aforementioned, it is noted that total capacity estimated in many states involves capacity of PV. On the point of shape of daily load curve in each state, peak demand will even appear on lighting period (19:00 – 21:00). Therefore capacity of PV cannot contribute to substantial capacity.

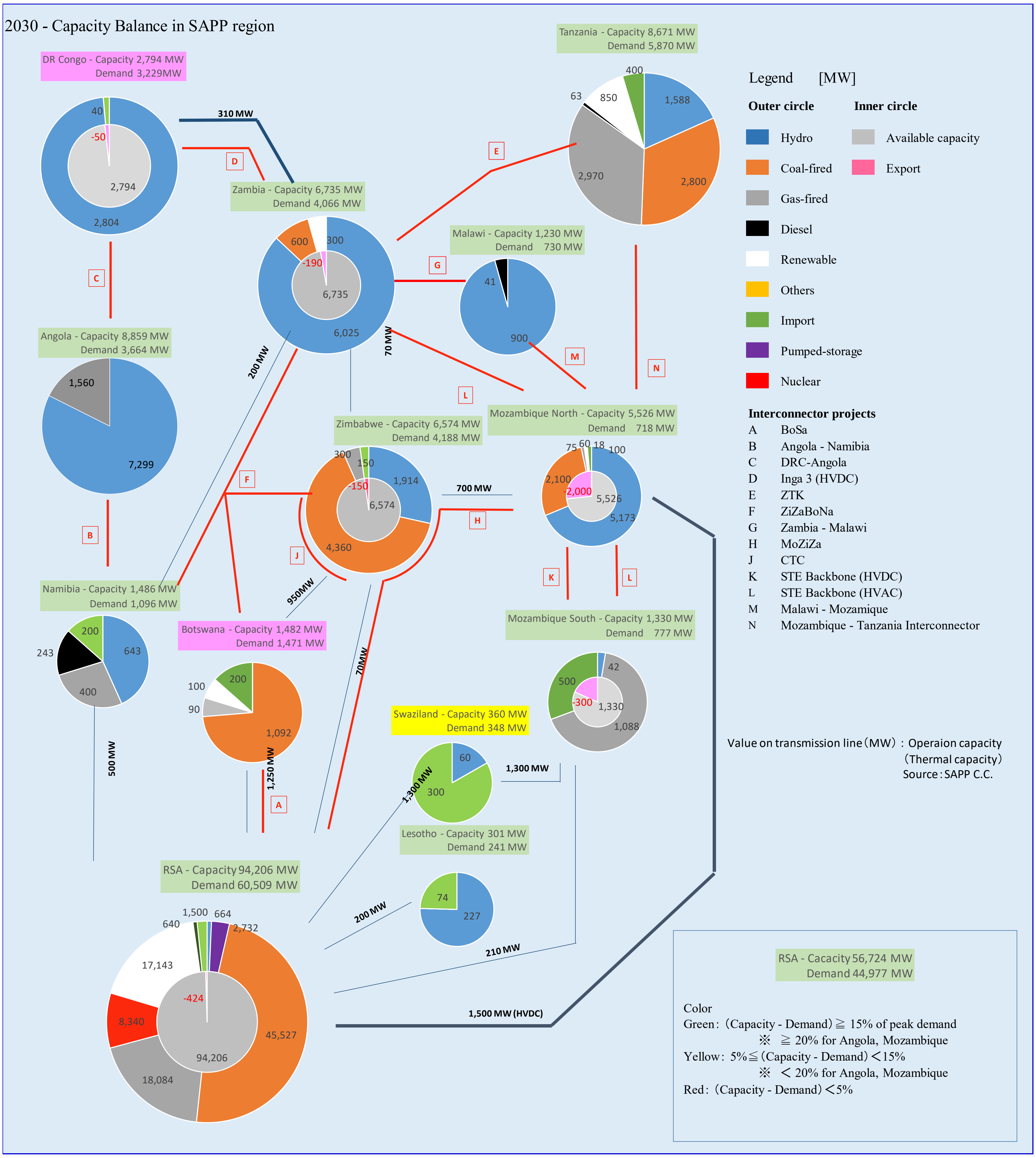
Also, frequently projects delay in Africa by several constraints. In this situation RSA is unique state to propose nuclear introduction. The constraint of generic power projects, such as hydropower, thermal power, and huge renewables, are environmental issue(s). Further nuclear introduction adds national consensus[72].

[72] Presidential state of the union, 2014 published 9,600MW nuclear introduction. And on governmental gazette, 14 December 2016 disclosed 9.6GW New Nuclear Build Programme. That shows nuclear introduction is prepared in line with IRP under Electricity Regulation Act



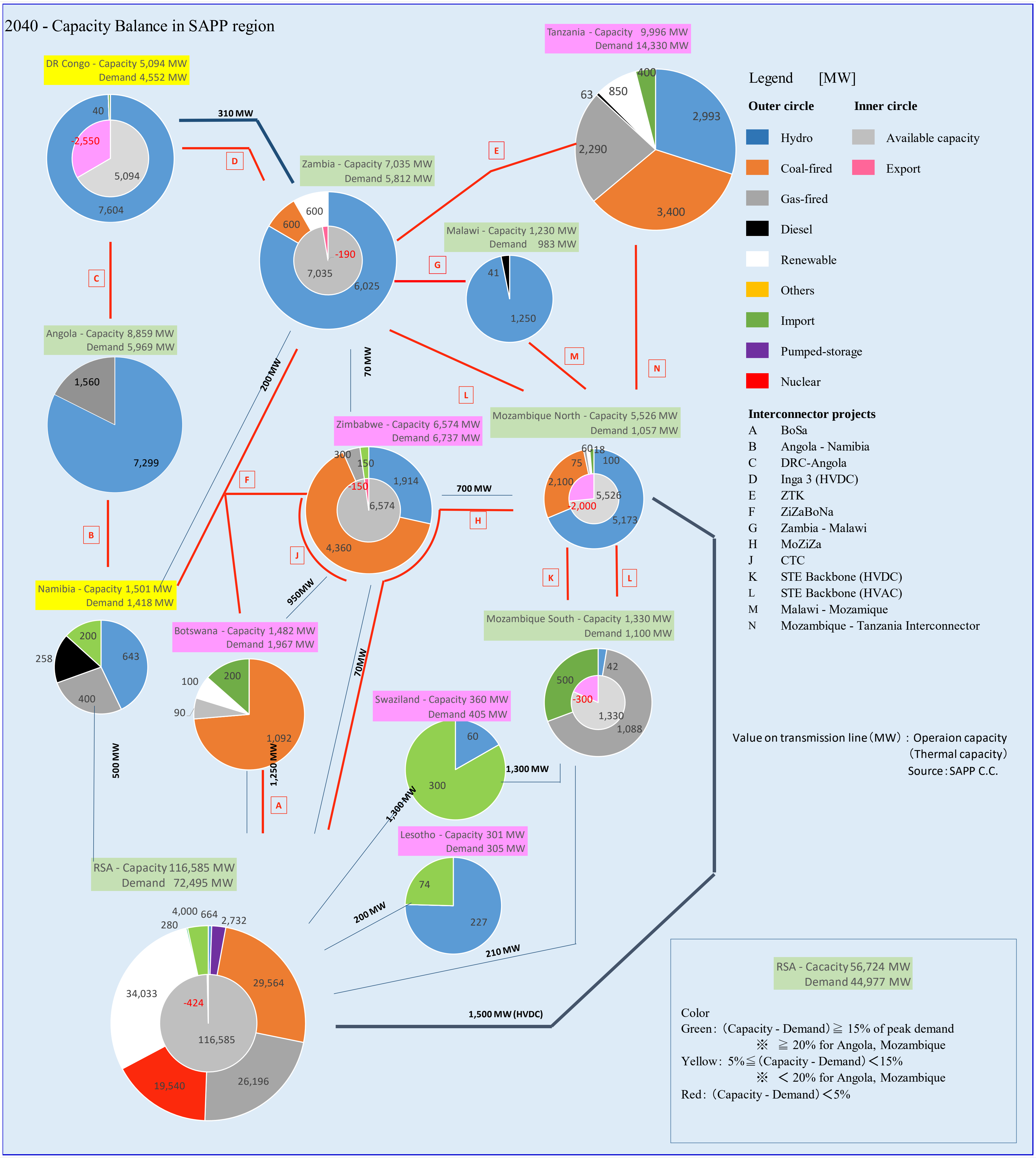
Source : JICA Survey Team

Figure 5.1-17　Demand and supply balance in SAPP　(Capacity review) 2020



Source : JICA Survey Team

Figure 5.1-18 Demand and supply balance in SAPP (Capacity review) 2030



Source：JICA Survey Team

Figure 5.1-19 Demand and supply balance in SAPP (Capacity review) 2040

2) Energy generated analysis

Table 5.1-24 to Table 5.1-35 show each state's energy estimate, and Figure 5.1-20 to Figure 5.1-22 show energy balance perspectives.

Circular charts for SAPP member states on the figures represent total energy generated[73]. It is noted that Mozambique has two circular charts because there are grids, southern grid and north-central grid.

Outer circle shows the allocation of energies from each kind of generator, and inner circle shows the distribution between a regional quota and export.

The title of circular charts values of energy generated and predicted energy consumption of the supply area, and its color indicates the reserve margin. Further, it is noted that measure for Angola and Mozambique is different from other member states due to the consideration of demand forecast.

The balance in 2020 shows tightened situation in RSA. Definitely capacity in RSA is rich but total huge capacity of pumped storage, renewable and peaker gas-fired do not contribute firm energy generation. Thus, by 2020, RSA needs import energy for base-load or middle-load to secure the balance.

Further, margin in Namibia is short. Namibia therefore has to get some energy from other states which have surplus energy with interconnector.

In 2030, DR Congo will be deficit condition due to delay of Inga 3 commission.

On the balance in 2040, southern SAPP, such as Southern Mozambique, Namibia and northern SAPP, such as Tanzania and DR Congo will be tight.

[73] Energy is calculated with normal availability, i.e. normal operation for hydropower with normal water level, and around 80 % for thermal power.

Table 5.1-24 Generation development analysis, energy review Angola

Angola																											
Lot	Country declared	Utility	Project name(Pool Plan)(Latest info.)	Capacity(MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	12,674	13,364	14,077	14,812	15,568	16,345	17,198	18,096	19,040	20,034	21,079	22,179	23,337	24,555	25,836	27,185	28,604	30,096	31,667	33,320	35,059
	Existing					Existing																					
Hydro																											
H001	Angola	PRODEL	Mabubas(18MW)(25.6MW)	26			60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
H002	Angola	PRODEL	Cambambe(180MW)(960MW)	260			941	941	941	941	941	941	941	941	941	941	941	941	941	941	941	941	941	941	941	941	941
H003	Angola	PRODEL	Capanda(260MW)(520MW)	520			2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401	2,401
H004	Angola	PRODEL	Matala(16MW)(40.8MW)	42			100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
H005	Angola	PRODEL	Luachimo()(36MW)-Lunda Norte	8.4			158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158
H006	Angola	PRODEL	Chicapa()(34MW)-Lunda Sul	16			70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
H007	Angola	PRODEL	Biópio(8MW)(14.6MW)	14.6			35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
H008	Angola	PRODEL	Lomaum(0MW)(50+160MW)	65			285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285
H009	Angola	PRODEL	Gove(-)(57.6MW)	60			263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263
Thermal																											
T001	Angola	PRODEL	Luanda	148																							
T003	Angola	PRODEL	Benguela-New	60																							
T004	Angola		GTG	128																							
T005	Angola		CD CFL	60																							
T006	Angola		CT Quartéis	15																							
T007	Angola		CT Viana	50																							
T008	Angola		CT Cimangola	96																							
T009	Angola		CT Mabor ou Cazenga	56																							
T010	Angola		CD Luanda Norte(Dundo)	0.8																							
T011	Angola		CD Lunda Sul(Saurimo)	2.1																							
T012	Angola		CD Moxico(Luena)	12.5																							
T014	Angola		CD Lunda Norte(Dundo)	15																							
T015	Angola		CD Luda Sul	7.5																							
	Planning					Planning																					
Hydro																											
H101	Angola	-	Cambambe2	720	**2017**		902	902	902	902	902	902	902	902	902	902	902	902	902	902	902	902	902	902	902	902	902
H102	Angola	-	Caculo Cabaca	2100	**2020**		8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278	8,278
H103	Angola	-	Laúca	2060	**2018**		8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121	8,121
H104	Angola		Queve	774	**2020**		3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051	3,051
H105	Angola	IPP	Jamba ia oma	78	**2020**		307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307
H106	Angola	IPP	Jamba ia mina	227	**2020**		895	895	895	895	895	895	895	895	895	895	895	895	895	895	895	895	895	895	895	895	895
H107	Angola/Namibia	-	Baynes (by Namibia)	300	**2026**								1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183
Thermal																											
T101	Angola	PRODEL	Soyo Ⅰ - Gas fired	720	**2018**		5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046
T102	Angola	IPP	Soyo Ⅱ(2A, 2B) - Gas fired	720	**2022**				5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046
T103	Angola	PRODEL	Boavista 1 (Benguela) - Gas fired, relocate	80	**2026**							210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
T104	Angola	PRODEL	Boavista 2 (Namibe) - Gas fired, relocate	40	**2026**							105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105
						Total generated	30,913	30,913	35,959	35,959	35,959	36,274	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456
						Hydopower	25,867	25,867	25,867	25,867	25,867	25,867	27,049	27,049	27,049	27,049	27,049	27,049	27,049	27,049	27,049	27,049	27,049	27,049	27,049	27,049	27,049
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	5,046	5,046	10,092	10,092	10,092	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	18,239	17,549	21,882	21,147	20,391	19,929	20,258	19,360	18,416	17,422	16,377	15,277	14,119	12,901	11,620	10,271	8,852	7,360	5,789	4,136	2,397

Source : JICA Survey Team

Table 5.1-25　Generation development analysis, energy review　Botswana

Botswana

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	6,848	6,949	7,049	7,147	7,243	7,336	7,438	7,541	7,645	7,751	7,859	7,968	8,078	8,190	8,304	8,419	8,536	8,654	8,774	8,895	9,019
	Existing					Existing																					
Thermal																											
T001	Botswana	BPC	Morupule A	132	4x33MW		925	925	925	925	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T002	Botswana	BPC	Morupule B	600	4x150MW		3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700
T003	Botswana	BPC	Orapa (OCGT)	90			473	473	473	473	473	473	473	473	473	473	473	473	473	473	473	473	473	473	473	473	473
Import																											
			Eskom, firm	150	2008-2012		1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117
			EDM, firm	50	2007 annually		372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372
			SNEL, firm	50	2009 continuous																						
			ZESCO, non-firm	100	2014 annually																						
	Planning				Expected Y	Planning																					
Thermal																											
T101	Botswana	BPC	Morupule-B phase2 (5&6) Coal fired	300	**2020, 2021**		1,051	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102
T102	IPP Greenfield		Coal fired	264	**2020, 2021**		925	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850
Solar																											
S101	PV-Unknow			100	**2017**		175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
						Total generated	8,739	10,715	10,715	10,715	9,790	9,790	9,790	9,790	9,790	9,790	9,790	9,790	9,790	9,790	9,790	9,790	9,790	9,790	9,790	9,790	9,790
						Hydopower	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Coal-fired	6,602	8,578	8,578	8,578	7,653	7,653	7,653	7,653	7,653	7,653	7,653	7,653	7,653	7,653	7,653	7,653	7,653	7,653	7,653	7,653	7,653
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	1,891	3,766	3,666	3,568	2,547	2,454	2,352	2,249	2,145	2,039	1,931	1,822	1,712	1,600	1,486	1,371	1,254	1,136	1,016	895	771

Source：JICA Survey Team

Table 5.1-26 Generation development analysis, energy review DR Congo

DR Congo

Lot	Country declared	Utility	Project name	Capacity (MW)		**Year**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
						Demand [GWh]	13,848	14,369	14,967	15,590	16,239	16,915	17,623	18,360	19,129	19,929	20,763	21,632	22,537	23,480	24,462	25,486	26,553	27,664	28,821	30,027	31,284
	Existing			2451.43		Existing																					
Hydro																											
H001	DRC	SNEL	Inga 1	360			2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400
H002	DRC	SNEL	Inga 2	1424			9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579
H003	DRC	SNEL	Mpozo	2.21																							
H004	DRC	SNEL	Zongo1	75			80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
H005	DRC	SNEL	Sanga	12			8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
H006	DRC	SNEL	Mobayi-Mbongo	11.4																							
H007	DRC	SNEL	Kilubi	9.9																							
H008	DRC	SNEL	Kymbi	17.2																							
H009	DRC	SNEL	Koni	42.12			200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
H010	DRC	SNEL	Mwadingusha	68			200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
H011	DRC	SNEL	Nseke	248			1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199	1,199
H012	DRC	SNEL	Nzilo1	108			570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570
H013	DRC	SNEL	Lungudi	1.6																							
H014	DRC	SNEL	Ruzizi1	28.2																							
H015	DRC	SNEL	Ruzizi2	26.6																							
H016	DRC	SNEL	Bendera-Kyimbi1	17.2																							
Export																											
			→BPC (Firm)	-50																							
			→ZESA (Firm)	-50			-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
			→ZESA (Non Firm)	-50																							
Import																											
			ZESCO for KCC(Firm)	40			298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298
			ZESCO (Non Firm)	100																							
	Planning					Planning																					
Hydro																											
H101	DRC		Inga 3	4,800	4,800MW	**2026 -> 2031**												28,032	28,032	28,032	28,032	28,032	28,032	28,032	28,032	28,032	28,032
H102	DRC		Zongo2	120																							
H103	DRC	2019	Busanga	240	4x60MW	**2020, 21, 22**	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261
H104	DRC		Katende	64		**2020**	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
H105	DRC		Ruzizi3	49	147MW fo	**2018**	193	193	193	193	193	193	193	193	193	193	193	193	193	193	193	193	193	193	193	193	193
Export																											
			Inga 3 →RSA (Eskom)	-2500	2026	**2026 -> 2031**												-17,520	-17,520	-17,520	-17,520	-17,520	-17,520	-17,520	-17,520	-17,520	-17,520
						Total generated	15,868	15,868	15,868	15,868	15,868	15,868	15,868	15,868	15,868	15,868	15,868	26,380	26,380	26,380	26,380	26,380	26,380	26,380	26,380	26,380	26,380
						Hydopower	15,942	15,942	15,942	15,942	15,942	15,942	15,942	15,942	15,942	15,942	15,942	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298
						Export	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-17,892	-17,892	-17,892	-17,892	-17,892	-17,892	-17,892	-17,892	-17,892	-17,892
						Surplus/Deficit	2,020	1,499	901	278	-371	-1,047	-1,755	-2,492	-3,261	-4,061	-4,895	4,748	3,843	2,900	1,918	894	-173	-1,284	-2,441	-3,647	-4,904

Source：JICA Survey Team

Table 5.1-27　Generation development analysis, energy review　Lesotho

Lethoto																											
Lot	Country declared	Utility	Project name	Capacity (MW)		**Year**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
						Demand [GWh]	866	902	940	979	1,020	1,063	1,107	1,154	1,202	1,252	1,305	1,359	1,416	1,476	1,537	1,602	1,669	1,738	1,811	1,887	1,966
	Existing					Existing																					
Hydro																											
H001	Lesotho	LHWP	Muela	72	3x24MW		410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410
H002	Lesotho	LEC	Mant-Sonyane	2	1.5MW,0.5MW		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Import																											
			Eskom Firm	24	2005indefinite		179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179
			EDM Firm	50	2008annually		372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372
	Planning					Planning																					
Hydro																											
H101	Lesotho	LHWP	Kobong Pumped storage	1,200																							
H102	Lesotho	LHWP	Muela Ⅱ	73	2012		90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
H103	Lesotho	LHWP	Oxbow	80	2017		410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410
						Total generated	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465	1,465
						Hydopower	914	914	914	914	914	914	914	914	914	914	914	914	914	914	914	914	914	914	914	914	914
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	599	563	525	486	445	402	358	311	263	213	160	106	49	-11	-72	-137	-204	-273	-346	-422	-501

Source：JICA Survey Team

Table 5.1-28 Generation development analysis, energy review Malawi

Malawi																											
Lot	Country declared	Utility	Project name	Capacity (MW)		Year	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
						Demand[GWh]	2,833	2,934	3,020	3,108	3,199	3,293	3,394	3,497	3,604	3,714	3,828	3,945	4,065	4,189	4,317	4,449	4,585	4,725	4,870	5,018	5,172
	Existing					Existing																					
Hydro																											
H001	Malawi	ESCOM	Nkula A	24	3x8MW		112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
H002	Malawi	ESCOM	Nkula B	100	5x20MW		290	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290
H003	Malawi	ESCOM	Tedzani 1	20	2x10MW		255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
H004	Malawi	ESCOM	Tedzani 2	20	2x10MW		255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
H005	Malawi	ESCOM	Tedzani 3	52.7	2x26.5MW		256	256	256	256	256	256	256	256	256	256	256	256	256	256	256	256	256	256	256	256	256
H006	Malawi	ESCOM	Kapichira Phase1	64	2x32.4MW		469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469
H007	Malawi	ESCOM	Kapichira Phase2	64	2x32.4MW		213	213	213	213	213	213	213	213	213	213	213	213	213	213	213	213	213	213	213	213	213
H008	Malawi	ESCOM	Wovwe	4.35	3x1.45MW		9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Thermal																											
T001	Malawi	ESCOM	Lilongwe	20			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T002	Malawi	ESCOM	Mzuzu	6			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T003	Malawi	ESCOM	Blantyre	15			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Planning					Planning																					
Hydro																											
H101	Malawi	ESCOM	Nkula A - expansion	12	1x12MW	**2018**	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
H102	Malawi	ESCOM	Tedzani - expansion	18	1x18MW	**2019**	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
H104	Malawi	ESCOM	Kholombidzo	280		**2020**	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242
H106	Malawi	IPP	Mbongozi	40		**2022**			198	198	198	198	198	198	198	198	198	198	198	198	198	198	198	198	198	198	198
H108	Malawi		Chizuma	50		**2019**	197	197	197	197	197	197	197	197	197	197	197	197	197	197	197	197	197	197	197	197	197
H111	Malawi		Lower Fufu	100-150		**2026**							834	834	834	834	834	834	834	834	834	834	834	834	834	834	834
H117	Malawi		Mpatamanga	350		**2035**																1,242	1,242	1,242	1,242	1,242	1,242
H123	Malawi		Songwe	65-340	90MW	**2022 -> 2029**										350	350	350	350	350	350	350	350	350	350	350	350
						Total	3,456	3,456	3,654	3,654	3,654	3,654	4,488	4,488	4,488	4,838	4,838	4,838	4,838	4,838	4,838	6,080	6,080	6,080	6,080	6,080	6,080
						Hydopower	3,456	3,456	3,654	3,654	3,654	3,654	4,488	4,488	4,488	4,838	4,838	4,838	4,838	4,838	4,838	6,080	6,080	6,080	6,080	6,080	6,080
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	623	522	634	546	455	361	1,094	991	884	1,124	1,010	893	773	649	521	1,631	1,495	1,355	1,210	1,062	908

Source：JICA Survey Team

Table 5.1-29 Generation development analysis, energy review Mozambique

Mozambique

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	5,966	6,205	6,454	6,713	6,982	7,262	7,553	7,856	8,171	8,499	8,840	9,194	9,563	9,946	10,345	10,760	11,191	11,640	12,107	12,592	13097
					53%	South	3,162	3,289	3,421	3,558	3,700	3,849	4,003	4,164	4,331	4,504	4,685	4,873	5,068	5,271	5,483	5,703	5,931	6,169	6,417	6,674	6941
					47%	North-Central	2,804	2,916	3,033	3,155	3,282	3,413	3,550	3,692	3,840	3,995	4,155	4,321	4,495	4,675	4,862	5,057	5,260	5,471	5,690	5,918	6156
	Existing					Existing																					
Hydro																											
H001	Mozambique	HCB	Cahora Bassa	2,075	5x415MW		15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15,287	15287
H002	Mozambique	EDM	Chicamba	34	2x17MW		79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
H003	Mozambique	EDM	Mavuzi	52	3x14MW, 2x5MW		241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241
H004	Mozambique	EDM	Corumana	16.6	2x8.3MW		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Thermal																											
T001	Mozambique	EDM	CTM1	20	1x20MW Diesel		88																				
T003	Mozambique	EDM	Nacala	18	18x1MW Diesel		79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
T004	Mozambique	EDM	Temane	8	6x0.31MW, 2X2.6MW		35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
T005	Mozambique	Aggreko	Aggreko	55	100, 122MW		241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241
T006	Mozambique	Sasol+EdM	Ressano Gacia EDM/Sasol	175	18x9.73MW		767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767
T007	Mozambique	Gigajoule	Ressano Gacia Gigawatt	120	13x9.34MW		526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526
T008	Mozambique	EDM	Beloluane	40	40x1MW		175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
	Mozambique	EDM	Tevene	3.6	Diesel																						
	Mozambique	EDM	Inhambane	4.5	Diesel																						
Export																											
	<EDM>																										
			→ SEC (Firm)	-50			-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
			→ Nampower (Firm)	-50			-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
			→ BPC (Firm)	-50			-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
			→ LEC (Firm)	-50			-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
			→ Eskom (Firm)	-100			-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745
			→ Eskom (Firm) As Available																								
			→ ZESA (Non Firm)	50																							
			→ ZESCO (Non Firm) As requested																								
	<HCB>																										
			→ EDM (Firm)	-300	Wheel from HVDC, RSA		-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2234
			→ EDM (Firm)	-200	Wheel from HVAC, RSA		-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745
			→ Eskom (Firm)	-1150			-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8563
			→ Eskom (Firm)	-250			-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1862
			→ ZESA (Firm)	-100			-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745
			→ ZESA (Non Firm) As Available																								
Import																											
			ZESCO (Firm)→EDM North	100			745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745
			HCB (Firm)→EDM South	300			2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2234
			HCB (Firm)→EDM South	200			1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1489
	Planning					Planning																					
Hydro																											
H101	Mozambique	HCB	Cahora Bassa Norte	1245	3x415MW								4,152	4,152	4,152	4,152	4,152	4,152	4,152	4,152	4,152	4,152	4,152	4,152	4,152	4,152	4152
H102	Mozambique	EDM/HCB	Mpanda Nkuwa	1500	2x750MW						10,456	10,465	10,465	10,465	10,465	10,465	10,465	10,465	10,465	10,465	10,465	10,465	10,465	10,465	10,465	10,465	10465
H105	Mozambique	EDM	Massingir	27								106	106	106	106	106	106	106	106	106	106	106	106	106	106	106	106
H106	Mozambique	EDM	Moamba Major	15					59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
H107	Mozambique	EDM	Lurio II	120					473	473	473	473	473	473	473	473	473	473	473	473	473	473	473	473	473	473	473
H108	Mozambique	EDM	Tsate	50						197	197	197	197	197	197	197	197	197	197	197	197	197	197	197	197	197	197

Source：JICA Survey Team

Generation development analysis, energy review Mozambique – Cont’d

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	5,966	6,205	6,454	6,713	6,982	7,262	7,553	7,856	8,171	8,499	8,840	9,194	9,563	9,946	10,345	10,760	11,191	11,640	12,107	12,592	13097
					53%	South	3,162	3,289	3,421	3,558	3,700	3,849	4,003	4,164	4,331	4,504	4,685	4,873	5,068	5,271	5,483	5,703	5,931	6,169	6,417	6,674	6941
					47%	North-Central	2,804	2,916	3,033	3,155	3,282	3,413	3,550	3,692	3,840	3,995	4,155	4,321	4,495	4,675	4,862	5,057	5,260	5,471	5,690	5,918	6156
Thermal																											
T101	Mozambique	ACWA	Moatize(Surplus (Coal fired<North/Ce	300	toward 2,400MW,2x300, 3x600							2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2102
T102	Mozambique		Nacala (Coal fied<North/Central>)	40			280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280
T103	Mozambique	Jindal Stee	JINDAL Tete (Coal fired <North/Centr	150			1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1051
T104	Mozambique	Ncondezi F	Ncondezi (Coal fired <North/Central>	300								2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2102
T105	Mozambique	EDM/Sasol	Temane (Gas fired<South>)	400					2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2102
T106	Mozambique	Kuvaninga	Kuvaninga (Gas fired <South>)	40	10x4.01MW		210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
T107	Mozambique	ENI	Palma (Gas fired <North/Central>)	75								394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
T109	Mozambique	EDM	Coal fired Nacala <North/Central>	200					1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1402
T110	Mozambique	IPP	Coal fired Tete <North/Central>	1200					8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8410
T111	Mozambique		CTM 1 (Gas fired<South>)	96	2x48.065MW		420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420
T112	Mozambique		CTM 2 (Gas fired<South>)	29	1x28.87MW		127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127
T114	Mozambique	EDM	Temane (Gas fired<South>)	100					438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438
T115	Mozambique	EDM	CTM Conversion (T001 Diesel to Gas) (Gas fired<South>)	80				350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350
T116	Mozambique	ENRC	ENRC (Coal fired<North/Central>)	300								2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2102
Solar																											
S101	Mozambique	Scatec	Mocuba	30			53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
S102	Mozambique	Neon	Metoro	30			53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
					Total	Total generated	7,827	8,090	20,974	21,171	31,627	38,444	42,596	42,596	42,596	42,597	42,597	42,597	42,597	42,597	42,597	42,597	42,597	42,597	42,597	42,597	42,597
						Hydopower	15,637	15,637	16,169	16,366	26,822	26,938	31,090	31,090	31,090	31,090	31,090	31,090	31,090	31,090	31,090	31,090	31,090	31,090	31,090	31,090	31,090
						Coal-fired	1,332	1,332	11,143	11,143	11,143	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450
						Gas-fired	2,501	2,851	5,392	5,392	5,392	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786
						RE(PV, Wind etc.)	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105
						Diesel and else	166	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
						Import	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468
						Export	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381
						Surplus/Deficit	1,861	1,885	14,520	14,458	24,645	31,182	35,043	34,740	34,425	34,098	33,757	33,403	33,034	32,651	32,252	31,837	31,406	30,957	30,490	30,005	29,500
					South Total	Total generated	4,078	4,341	6,940	6,940	6,940	7,047	7,047	7,047	7,047	7,047	7,047	7,047	7,047	7,047	7,047	7,047	7,047	7,047	7,047	7,047	7,047
						Hydopower	0	0	59	59	59	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	2,501	2,851	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723
						Export	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234
						Surplus/Deficit	916	1,052	3,519	3,382	3,240	3,198	3,043	2,883	2,716	2,542	2,361	2,174	1,978	1,775	1,564	1,344	1,115	877	630	373	105
					North-Central Total	Total generated	3,750	3,750	14,034	14,231	24,687	31,398	35,550	35,550	35,550	35,550	35,550	35,550	35,550	35,550	35,550	35,550	35,550	35,550	35,550	35,550	35,550
						Hydopower	15,637	15,637	16,110	16,307	26,763	26,772	30,924	30,924	30,924	30,925	30,925	30,925	30,925	30,925	30,925	30,925	30,925	30,925	30,925	30,925	30,925
						Coal-fired	1,332	1,332	11,143	11,143	11,143	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450
						Gas-fired	0	0	0	0	0	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
						RE(PV, Wind etc.)	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105
						Diesel and else	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
						Import	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745
						Export	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147
						Surplus/Deficit	946	833	11,000	11,076	21,405	27,985	32,000	31,857	31,709	31,556	31,395	31,229	31,056	30,876	30,688	30,493	30,290	30,079	29,860	29,632	29,395

Source：JICA Survey Team

Table 5.1-30　Generation development analysis, energy review　Namibia

Namibia

Lot	Country declared	Utility	Project name	Capacity (MW)			2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	6,036	6,173	6,314	6,459	6,608	6,452	6,608	6,769	6,932	7,097	7,264	7,433	7,609	7,790	7,976	8,165	8,359	8,558	8,762	8,970	9,183
	Existing			470.5		Existing																					
Hydro																											
H001	Namibia	Nampower	Ruacana	343	3x80MW, 92MW		1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803	1,803
Thermal																											
T001	Namibia	Nampower	Anixas	22.5	1x22.5MW		118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118
T002	Namibia	Nampower	Van Eck	81			355	355	355	355	355																
Import																											
	ZESA → (Firm)			150			1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117
	ZESCO → (Firm)			50			372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372
	Planning					Planning																					
Hydro																											
H101	Namibia/Angola	Nampower	Baynes	300	2x71MW, 3x156.75MW								1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724
Thermal																											
T102	Namibia	Nampower	Kudu Gas fired	400			2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803
		Nampower	Diesel						88	175	263	526	613	701	788	876	964	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029
						Total generated	6,568	6,568	6,656	6,743	6,831	6,739	8,551	8,638	8,726	8,813	8,901	8,967	8,967	8,967	8,967	8,967	8,967	8,967	8,967	8,967	8,967
						Hydopower	1,803	1,803	1,803	1,803	1,803	1,803	3,527	3,527	3,527	3,527	3,527	3,527	3,527	3,527	3,527	3,527	3,527	3,527	3,527	3,527	3,527
						Coal-fired	355	355	355	355	355	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118
						Import	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	532	395	342	284	223	287	1,943	1,869	1,794	1,716	1,637	1,534	1,358	1,177	991	802	608	409	205	-3	-216

Source：JICA Survey Team

Table 5.1-31 Generation development analysis, energy review RSA

RSA

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	314,790	324,303	333,929	343,561	353,651	364,056	366,034	376,611	387,506	398,408	409,140	418,001	425,856	433,743	440,862	447,926	454,617	461,389	468,272	472,960	479,589
	Existing					Existing																					
Hydro																											
H001	RSA	Eskom	Drakensberg PS	1,000	4x250MW		730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730
H002	RSA	Eskom	Palmiet PS	400	2x200MW		292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292
H003	RSA	Eskom	Gariep	360	4x90MW		400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
H004	RSA	Eskom	Vanderkloof	240	2x120MW		400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
H005	RSA	Private	Friedenham	3			25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
H006	RSA	Eskom	First Falls	6	2x3MW																						
H007	RSA	Eskom	Second Falls	11	2x5.5MW																						
H008	RSA	Eskom	Ncora	2	2x0.4MW,1 x 1.3MW																						
H009	RSA	Eskom	Colley Wobbeles	42	3x14MW		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
H010	RSA	Capetown Ci	Steenbras PS	180																							
					664																						
Thermal																											
T001	RSA	Eskom	Arnot	2,352	270, 390, 396, 400		14,422	14,422	14,422	14,422	14,422	14,422	14,422	14,422	14,422	14,422	14,422	9,986	9,986	7,989	7,989	5,992	3,995	3,995	1,997		
T002	RSA	Eskom	Camden-RTS	1,561	3x200, 196, 2x195, 190, 185		6,990	3,995	1,997																		
T003	RSA	Eskom	Duvha	3,600	6x600		22,075	22,075	22,075	22,075	22,075	22,075	22,075	22,075	22,075	22,075	15,111	12,089	9,067	3,022							
T004	RSA	Eskom	Grootvlei-RTS	1,200	6x200		7,358	7,358	7,358	7,358	7,358	4,941	3,953	1,976													
T005	RSA	Eskom	Hendrina	1,893	5x200, 2x195, 2x170, 168		11,608	11,608	11,608	11,608	11,608	11,608	11,608	11,608	11,608	11,608	8,846	7,863	6,880	5,897	4,914	2,949	983				
T006	RSA	Eskom	Kendal	4,116	6x686		25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	16,819	13,455
T007	RSA	Eskom	Komati-RTS	990	4x100, 90, 4x125		6,071	6,071	6,071	6,071	3,185	1,593															
T008	RSA	Eskom	Kriel	3,000	6x500		18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	10,512	7,884	5,256	2,628	
T009	RSA	Eskom	Majuba	4,110	3x657, 3x713		25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203
T010	RSA	Eskom	Matla	3,600	6x600		22,075	22,075	22,075	22,075	22,075	22,075	22,075	22,075	22,075	15,111	15,111	9,067	6,044	3,022							
T011	RSA	Eskom	Tutuka	3,654	6x609		22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	15,374	12,299	9,224	6,150	3,075	
T012	RSA	Eskom	Lethabo	3,708	6x618		22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	15,584	17	9,350	6,234	3,117	
T013	RSA	Eskom	Matimba	3,990	6x665		24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	12,930	9,697	6,465
T014	RSA	Aldwych Inte	Kelvin (Coal	214																							
T015	RSA	Sasol	Secunda (Coal	600	10x60MW		3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154
T016	RSA	City of Tshwa	Pretoria West (Coal	180																							
T017	RSA	City of Tshwa	Rooiwal (Coal	300																							
T018	RSA	Eskom	Acacia OCGT	171			899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899
T019	RSA	Eskom	Port Rex OCGT	171			899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899
T020	RSA	Eskom	Ankerlig OCGT	1,338			7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033
T021	RSA	Eskom	Gourikwa OCGT	746			3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921
T022	RSA	Sasol	Secunda OCGT(CCGT)	180	2x90MW		946	946	946	946	946	946	946	946	946	946	180	180	180	180	180	180	180	180	180	180	180
T023	RSA	Sasol	Sasolburg OCGT	175			920	920	920	920	920	920	920	920	920	920	175	175	175	175	175	175	175	175	175	175	175
T024	RSA	IPSA	Newcastle cogeneration CCGT	18																							
T025	RSA	ENGIE, Lege	Dedisa Peaking OCGT	335			1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174
T026	RSA	ENGIE, Lege	Avon Peaking OCGT	670	670MW(4U nits)		3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522

Source：JICA Survey Team

Generation development analysis, energy review RSA – Cont'd - 1

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	314,790	324,303	333,929	343,561	353,651	364,056	366,034	376,611	387,506	398,408	409,140	418,001	425,856	433,743	440,862	447,926	454,617	461,389	468,272	472,960	479,589
Nuc																											
N001	RSA	Eskom	Koeberg Nuc	1,940			14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445
Wind																											
W001	RSA	Eskom	Klipheuwel	3																							
W002	RSA	Eskom	Sere	100			175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
	Planning					Planning																					
Hydro																											
H001	RSA	Eskom	Ingula PS	1,332	4x333MW Pump Turbines		972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972
Thermal	(Coal Baseload IPP Programme:2500MW, 2021)-from Botswana																										
				refer to Botswana																							
T101	RSA	Eskom	Medupi Coal fired	4,764	6x794MW		11,129	11,129	22,257	22,257	22,257	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386
T102	RSA	Eskom	Kusile Coal fired	4,800	6x800MW			5,606	11,213	22,426	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638
			Future Coal fired				1,752	1,752	7,008	11,213	15,418	15,418	15,418	15,418	15,418	18,922	18,922	18,922	25,930	31,186	36,442	41,698	41,698	46,954	57,466	62,722	78,490
	(Gas to Power Programme:3126MW, IRP 3910MW)																										
T104	RSA	IPP	CCGT	2,370			3,114	4,671	4,671	4,671	4,671	4,671	4,671	4,671	7,785	9,343	15,571	15,571	15,571	15,571	15,571	15,571	15,571	15,571	15,571	15,571	15,571
T105	RSA	IPP	Peak OCGT	3,126					4,231	8,462	8,462	12,693	12,693	12,693	16,320	20,551	20,551	20,551	20,551	20,551	20,551	20,551	20,551	20,551	20,551	20,551	20,551
			Future OCGT				631	2,523	2,523	2,523	2,523	2,523	6,938	15,768	24,598	27,121	27,121	27,752	33,428	33,428	38,474	38,474	42,258	58,026	58,026	58,026	58,657
			Future CCGT							4,665	4,665	18,659	18,659	18,659	18,659	18,659	18,659	18,659	18,659	18,659	18,659	18,659	18,659	23,324	23,324	23,324	32,653
Nuc																											
T106	RSA		Future Nuclear				0	0	0	0	0	23,827	23,827	35,741	47,654	47,654	47,654	59,568	59,568	71,482	83,395	95,309	107,222	107,222	119,136	131,050	131,050
Solar (towards 1450MW)																											
S101	RSA	IPP	PV total(Upcoming Window)	1,665	Window 1-3:2010MW		1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	280	35
			Future PV				613	1,472	2,453	3,837	5,344	6,973	8,725	10,477	12,229	13,981	15,733	17,485	19,237	20,989	22,741	24,493	26,245	27,997	29,749	31,501	33,253
CSP (towards 1000MW IRP objective)																											
C101		IPP	CSP total	300			1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577
			Future CSP				0	0	0	0	0	0	0	0	0	0	13,666	19,447	25,754	26,280	26,280	29,434	29,434	32,062	32,062	32,062	33,638
Wind (towards 1850MW)																											
W101		IPP	Wind total	1,300	1850-1030		2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	648						
			Future Wind				0	0	0	0	561	1,121	2,085	2,646	3,206	4,327	4,888	6,009	7,131	8,252	9,373	10,494	11,055	12,176	12,737	13,298	14,419
Other																											
			Cogeneration etc.				9,461	9,461	9,461	9,461	9,461	9,461	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	981	981	981	981	981
Import																											
		SNEL	Inga3	2,500	2,026													17,520	17,520	17,520	17,520	17,520	17,520	17,520	17,520	17,520	17,520
			HCB (Cahorra Bassa)-Firm	1,150	1998-2030		8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563
			HCB (Cahorra Bassa)-Firm	250	2008-2014		1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862
			EDM Firm	100			745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745
			EDM Firm As Available																								
			ZESA NonFirm As Available																								
			ZESCO Non Firm As Available																								
			Future Import - Reference						8,377	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169

Source : JICA Survey Team

Generation development analysis, energy review RSA – Cont'd - 2

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	314,790	324,303	333,929	343,561	353,651	364,056	366,034	376,611	387,506	398,408	409,140	418,001	425,856	433,743	440,862	447,926	454,617	461,389	468,272	472,960	479,589
Export																											
		→ SEC Firm		-250			-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862
		→ LEC Firm		-24			-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179
		→ BPC Firm		-150			-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117
		→ Nampower Non Firm		-350																							
		→ ZESCO Non Firm		-300																							
		→ ZESA Non Firm		-300																							
						Total	309,445	316,363	341,569	365,269	379,869	431,229	428,561	449,641	477,462	485,186	496,156	520,389	535,227	543,749	560,181	564,580	550,840	584,678	587,063	582,481	596,998
						Hydopower	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875
						Pumped storage	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994
						Coal-fired	245,083	247,693	267,687	281,108	293,640	300,758	298,177	296,201	294,225	290,765	281,038	266,553	266,534	259,743	257,971	245,079	214,589	222,493	210,652	193,438	193,790
						Gas-fired	23,057	26,506	30,738	39,633	39,633	57,858	62,274	71,104	86,675	94,986	99,703	100,334	106,010	106,010	111,056	111,056	114,840	135,273	135,273	135,273	145,233
						RE(PV, Wind etc.)	6,517	7,376	8,357	9,741	11,808	13,998	16,714	19,027	21,339	24,213	40,191	48,846	58,026	61,425	62,669	68,048	70,360	75,862	78,174	78,893	83,097
						Diesel and else	9,461	9,461	9,461	9,461	9,461	9,461	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	981	981	981	981	981
						Nuclear	14,445	14,445	14,445	14,445	14,445	38,272	38,272	50,186	62,100	62,100	62,100	74,013	74,013	85,927	97,840	109,754	121,668	121,668	133,581	145,495	145,495
						Import	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	28,689	28,689	28,689	28,689	28,689	28,689	28,689	28,689	28,689	28,689
						Export	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157
						Surplus/Deficit	-5,345	-7,940	7,640	21,708	26,218	67,173	62,527	73,030	89,956	86,778	87,016	102,388	109,371	110,006	119,319	116,654	96,223	123,289	118,791	109,521	117,409

Source：JICA Survey Team

Table 5.1-32 Generation development analysis, energy review Swaziland

Swaziland

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	1,720	1,743	1,760	1,783	1,805	1,828	1,850	1,873	1,896	1,919	1,943	1,967	1,991	2,015	2,040	2,065	2,090	2,116	2,142	2,168	2,194
	Existing			69.4		Existing																					
Hydro																											
H001	Swaziland	SEC	Maguga	19.8	2x9.9MW		60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
H002	Swaziland	SEC	Edwaleni	15	4x2.5MW, 1x5.0MW		125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
H003	Swaziland	SEC	Ezulwini	20	2x10.0MW																						
H004	Swaziland	SEC	Maguduza	5.6	1x5.6MW																						
	Import																										
			Eskom → (Firm)	250	2000-2025		1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862
			Eskom → (Firm)	50	2003annually		372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372
	Planning					Planning																					
-	-	-	-	-			-	-	-																		
						Total	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419	2,419
						Hydopower	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185
						Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	699	676	659	636	614	591	569	546	523	500	476	452	428	404	379	354	329	303	277	251	225

Source：JICA Survey Team

Table 5.1-33 Generation development analysis, energy review Tanzania

Tanzania						Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Lot	Country declared	Utility	Project name	Capacity (MW)		Demand[GWh]	13,440	14,890	16,490	18,270	20,230	22,430	24,680	27,140	29,830	32,780	36,000	39,540	43,410	47,640	52,270	57,340	62,480	68,060	74,130	80,720	87,890
	Existing					Existing																					
Hydro																											
H001	Tanzania	Tanesco	Pangani	68	2x34MW		251	251	251	251	251	251	251	251	251	251	251	251	251	251	251	251	251	251	251	251	251
H002	Tanzania	Tanesco	Hale	21	2x10.5MW		52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
H003	Tanzania	Tanesco	Nyumba Ya Mungu	8	2x4MW		27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
H004	Tanzania	Tanesco	Kidatu	204	4X50MW		893	893	893	893	893	893	893	893	893	893	893	893	893	893	893	893	893	893	893	893	893
H005	Tanzania	Tanesco	Mtera	80	2x40MW		345	345	345	345	345	345	345	345	345	345	345	345	345	345	345	345	345	345	345	345	345
H006	Tanzania	Tanesco	Lower Kihansi	180	3x60MW		694	694	694	694	694	694	694	694	694	694	694	694	694	694	694	694	694	694	694	694	694
H007	Tanzania	Tanesco	Mwenga	4			17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
H008	Tanzania	Private	Kikuletwa	1																							
H009	Tanzania	Tanesco	Uwenba	1			3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Thermal																											
T001	Tanzania	Tanesco	Ubungo I	102	12x10.2MW		655	655	655	655	655	655	655														
T002	Tanzania	Tanesco	Tegeta GT	45			282	282	282	282	282	282	282	282	282												
T003	Tanzania	Tanesco	Ubungo II	105	35x5MW		655	655	655	655	655	655	655	655	655	655	655										
T004	Tanzania	Tanesco	Mtwara	18			126	126	126	126	126	126	126														
T005	Tanzania	Tanesco	Nyakato(Mwanza)-Diesel	63			375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375
T006	Tanzania	Tanesco	Kinyerezi I	150			1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034						
T007	Tanzania	Tanesco	Somanga	8																							
T011	Tanzania	Songas Power	SongasⅡ	120			721	721	721	721	721																
T012	Tanzania	Songas Power	Songas I	42			251	251	251	251																	
T013	Tanzania	Songas Power	SongasⅢ	40			242	242	242	242	242	242															
T014	Tanzania	IPTL	TagetaIPTL-Diesel	103			595	595																			
			TPC (Biomass)	17																							
			TANWAT(Biomass)	3																							
T015	Tanzania	Dangote Industries Tanzania	Dangote Industries Tanzania	75																							
		IPP	Somanba Fungu(GT)	210			1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472
		IPP	Somanba Fungu(CC)	110			771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771
	Planning					Planning																					
Hydro																											
H101	Tanzania		Kakono	87	53 -> 87MW									573	573	573	573	573	573	573	573	573	573	573	573	573	573
H102	Tanzania	Tanesco	Rusumo Falls	27			169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169
H104	Tanzania	Tanesco	Stiegler's phase1*	300	3000	EIA issues arise																					
H105	Tanzania	Tanesco	Stiegler's phase2*	600	1	EIA issues arise																					
H106	Tanzania	Tanesco	Stiegler's phase3*	1,200		EIA issues arise																					
H107	Tanzania		Mpanga	160	144->160MW													796	796	796	796	796	796	796	796	796	796
H108	Tanzania	Tanesco	Taveta-Mnyera	84	145->83.9MW												404	404	404	404	404	404	404	404	404	404	404
H109	Tanzania	Tanesco	Ruhudji	358															2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
H110	Tanzania		Masigira	118															664	664	664	664	664	664	664	664	664
H111	Tanzania	Tanesco	Rumakali-520MW	222																1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320
H112	Tanzania	Tanesco	Songwe(Manolo)-177.9MW	88											686	686	686	686	686	686	686	686	686	686	686	686	686
			Songwe(Bupigu)-29.4MW	34																							
			Songwe(Sofre)-158.9MW	80																	587	587	587	587	587	587	587
			Malagarasi	45							187	187	187	187	187	187	187	187	187	187	187	187	187	187	187	187	187
			Mnyera Ruaha	60											291	291	291	291	291	291	291	291	291	291	291	291	291
			Mnyera Pumbwe	123													592	592	592	592	592	592	592	592	592	592	592
			Mnyera Kwanini	144												694	694	694	694	694	694	694	694	694	694	694	694
			Mnyera Kisingo	120														577	577	577	577	577	577	577	577	577	577
			Mnyera Mnyera	137												662	662	662	662	662	662	662	662	662	662	662	662

Source：JICA Survey Team

Generation development analysis, energy review Tanzania – Cont'd

Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	13,440	14,890	16,490	18,270	20,230	22,430	24,680	27,140	29,830	32,780	36,000	39,540	43,410	47,640	52,270	57,340	62,480	68,060	74,130	80,720	87,890
		Tanesco	Lower Kihansi Extension	120		**2019**	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69
		SPP (IPP)	EA Power SPP	10	manage to delay					44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
		SPP (IPP)	Darakuta SPP	0																							
		SPP (IPP)	Mapenbasi SPP	10	manage to delay					44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
			Upper Kihansi	47																	336	336	336	336	336	336	336
			Kikonge	300																	1,268	1,268	1,268	1,268	1,268	1,268	1,268
			Iringa - Nginayo	52									263	263	263	263	263	263	263	263	263	263	263	263	263	263	263
			Iringa - Ibosa	36									186	186	186	186	186	186	186	186	186	186	186	186	186	186	186
Thermal																											
T101	Tanzania	Tanesco	Kinyerezi I Extension Gas fired	185		**2017**	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297				
T102	Tanzania	STAMICO	Kiwira coal fired phase1	400	seeking JV partner in 2014	**2019**	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803
T103	Tanzania	STAMICO	Kiwira coal fired phase2	600											4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
T104	Tanzania	Tanesco	Kinyerezi Ⅲ phase 1,2 Gas fired	600		**2020**	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
T105	Tanzania	Tanesco	Kinyerezi Ⅳ Gas fired	330													2,313	2,313	2,313	2,313	2,313	2,313	2,313	2,313	2,313	2,313	2,313
T106	Tanzania	Tanesco	Kinyerezi Ⅱ Gas fired	240		**2018**	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682				
T107	Tanzania	Sichuan Hongda	Mchuchuma coal fired phase 1	150 x n				1,051	3,154	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
T108	Tanzania	Sichuan Hongda	Mchuchuma coal fired phase 2	200 x n									4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
			Ngaka I coal fired	600						4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
			Ngaka Ⅱ coal fired	600																	4,205	4,205	4,205	4,205	4,205	4,205	4,205
T109	Tanzania	Tanesco	Mtwara(CCGT) Gas fired	300		**2020**	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102
		Tanesco	Somanga(CCGT) Gas fired	240									1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682
		PPP	Somanga(CCGT) Gas fired	300									2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102
			Zinga(Bagamoyo)(CCGT) Gas fired	200										1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402
Solar																											
			Dodoma	50		**2019**	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
			Kishapu - Sinyanga	150		**2020**	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263
Wind																											
			Singida	50		**2018**	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
			Singida	75		**2018**	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131
			Makambako	100		**2019**	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
			Singida-Extension	50		**2019**	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131
			Singida	100		**2020**	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
			Singida -Extension	50				88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
Geothermal																											
			Future project									701	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402
Import																											
			PSMP - EAPP			**2019**	1,402	1,402	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803
						Total Energy	24,240	25,379	28,288	33,632	33,568	33,547	42,444	43,638	48,820	49,894	53,203	53,921	56,585	57,905	64,301	63,267	63,267	60,288	60,288	60,288	60,288
						Hydopower	2,520	2,520	2,520	2,608	2,795	2,795	3,244	3,817	4,794	6,150	7,146	8,519	11,183	12,503	14,694	14,694	14,694	14,694	14,694	14,694	14,694
						Coal-fired	2,803	3,854	5,957	11,213	11,213	11,213	15,418	15,418	19,623	19,623	19,623	19,623	19,623	19,623	23,827	23,827	23,827	23,827	23,827	23,827	23,827
						Gas-fired	15,494	15,494	15,494	15,494	15,243	14,522	18,065	18,685	18,685	18,403	20,716	20,061	20,061	20,061	20,061	19,027	19,027	16,049	16,049	16,049	16,049
						RE(PV, Wind etc.)	1,051	1,139	1,139	1,139	1,139	1,840	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540
						Diesel and else	970	970	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375
						Import	1,402	1,402	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803
						Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Surplus/Deficit	10,800	10,489	11,798	15,362	13,338	11,117	17,764	16,498	18,990	17,114	17,203	14,381	13,175	10,265	12,031	5,927	787	-7,772	-13,842	-20,432	-27,602

Source：JICA Survey Team

Table 5.1-34 Generation development analysis, energy review Zambia

Zambia																											
Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	15,749	16,142	16,667	16,996	17,458	17,946	18,461	19,006	19,578	20,184	20,823	21,452	22,099	22,766	23,453	24,161	24,891	25,642	26,416	27,213	28,035
	Existing			2494.8		Existing																					
Hydro																											
H001	Zambia	ZESCO	Kariba North	720	4x180MW		5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183
H002	Zambia	Kariba North Bank Extension Power Corporation Limited	Kariba North Bank Extension	360			1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183
H003	Zambia	ZESCO	Kafue Gorge	990	6x165MW		5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251
H004	Zambia	ZESCO	Victria Fall A	8	2MW,2x3MW		662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662
H005	Zambia	ZESCO	Victria Fall B	60	6x10MW																						
H006	Zambia	ZESCO	Victria Fall C	40	4x10MW																						
H007	Zambia	ZESCO	Lusiwasi Upper	12			47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
H008	Zambia	ZESCO	Lunzua	14.8	0.75MW		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H009	Zambia	ZESCO	Musonda Falls	10	5MW		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H010	Zambia	ZESCO	Chishimba Falls	15	6MW		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H011	Zambia	ZESCO	Shiwa Ngandu	1			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H012	Zambia	LHPC	Lunsemfwa	25			99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99
H013	Zambia	LHPC	Mulungushi	31			122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122
H014	Zambia	SPC: ITPC (Itezhi Tezhi Power Corporation)(ZESCO &TATA)	Itezhi Tezhi	120	2x60MW		676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676
Export																											
		SNEL（KCC） (Firm)		-40			-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298
		EDM (Firm)		-100			-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745
		Nampower (Firm)		-50			-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
		BPC (Non Firm)		-100																							
		SNEL (Non Firm)		-100																							
		Eskom (Non Firm)		-300																							
		ZESA (Non Firm)		-200																							
Import																											
		EDM → (Non Firm /	100MW from EDM																								
		ZESCO → (Non Firm)		300																							
	Planning					Planning																					
Hydro																											
H103	Zambia	ZRA	Batoka Gorge	1200	(2400MW)						9,146	9,146	9,146	9,146	9,146	9,146	9,146	9,146	9,146	9,146	9,146	9,146	9,146	9,146	9,146	9,146	9,146
H104	Zambia	CEC&TATA	Kabompo Gorge	40	2x17MW		158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158
H105	Zambia	ZESCO	Kafue Gorge Lower	750	4x187.5MW		2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
H106	Zambia	ZESCO	Lusiwasi Lower	74	86MW		292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292
H107	Zambia	Power Min	Luchenene	34	1x30MW				134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134
H108	Zambia	Power Min	Mutinondo	43	1x40MW				170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170
H109	Zambia	Lunzua Power Authori	Kabwelume	96					378	378	378	378	378	378	378	378	378	378	378	378	378	378	378	378	378	378	378
H110	Zambia	Lunzua Power Authori	Kundabwika	151					595	595	595	595	595	595	595	595	595	595	595	595	595	595	595	595	595	595	595
H111	Zambia	GRZ/DRC	Mumbotuta Falls	490								1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932
H112	Zambia	GRZ/DRC	Mambilima Falls I	126								497	497	497	497	497	497	497	497	497	497	497	497	497	497	497	497
H113	Zambia	GRZ/DRC	Mambilima Falls II	202								796	796	796	796	796	796	796	796	796	796	796	796	796	796	796	796
H114	Zambia	GRZ/DRC	Mambilima Falls V	372								1,466	1,466	1,466	1,466	1,466	1,466	1,466	1,466	1,466	1,466	1,466	1,466	1,466	1,466	1,466	1,466
H118	Zambia	Western Power company	Ngonye falls	40	40-60MW		158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158
Thermal																											
T101	Zambia	MCL	Maamba Coal fired	600	2x300MW		4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
Solar																											
S101	Zambia	IDC	n/a	300			526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	1,051
						Total	20,102	20,102	21,379	21,379	30,525	35,216	35,216	35,216	35,216	35,216	35,216	35,216	35,216	35,216	35,216	35,216	35,216	35,216	35,216	35,216	35,742
						Hydopower	16,787	16,787	18,064	18,064	27,209	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900
						Coal-fired	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	1,051
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Export	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415
						Surplus/Deficit	4,353	3,960	4,712	4,383	13,067	17,270	16,755	16,210	15,638	15,032	14,393	13,764	13,117	12,450	11,763	11,055	10,325	9,574	8,800	8,003	7,707

Source：JICA Survey Team

Table 5.1-35 Generation development analysis, energy review Zimbabwe

Zimbabwe

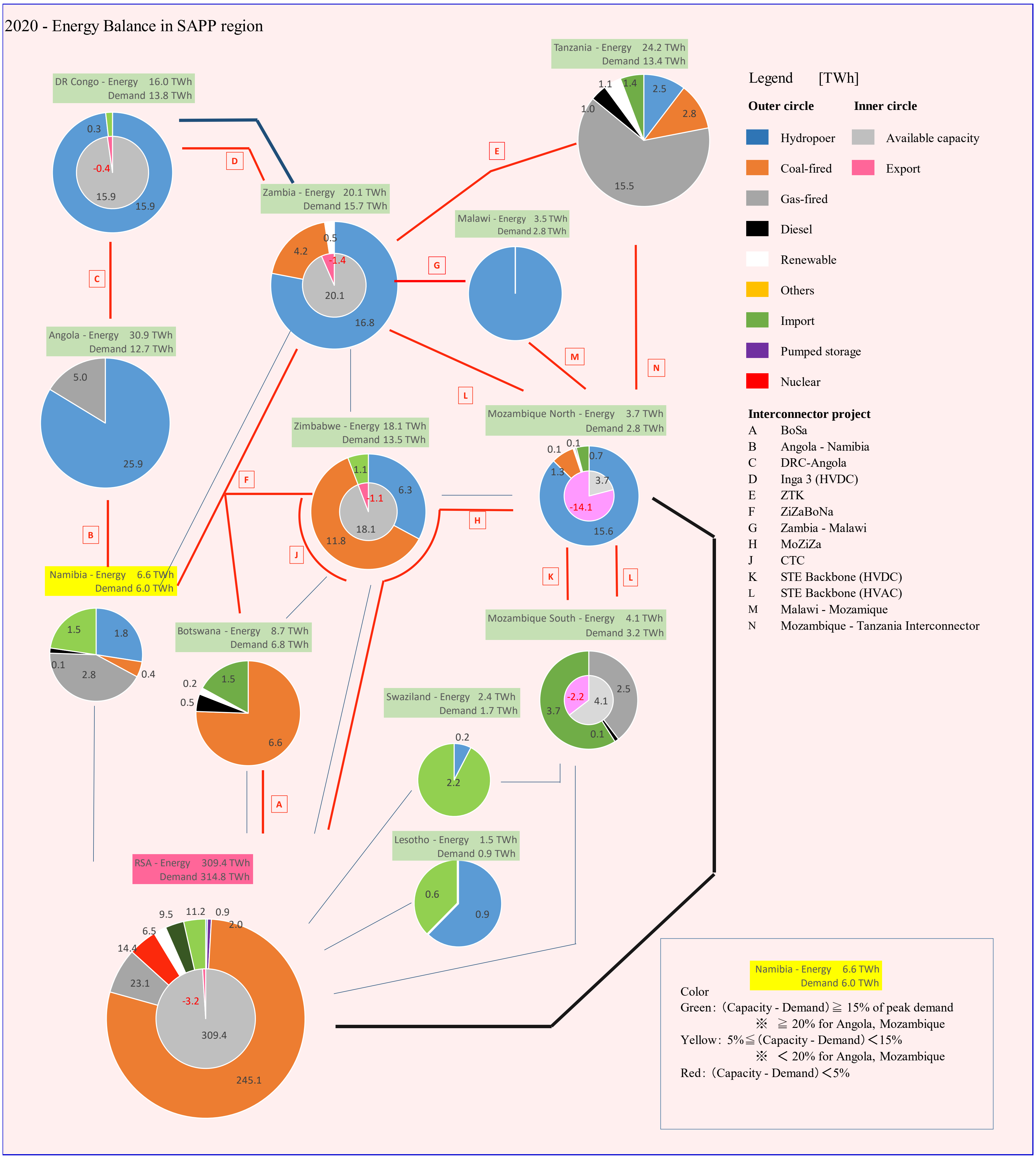
Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	13,534	14,349	15,221	15,926	16,677	17,461	18,280	19,142	20,057	21,008	22,012	23,069	24,172	25,345	26,569	27,862	29,249	30,679	32,182	33,756	35,408
	Existing			2001.25		Existing																					
Hydro																											
H001	Zimbabwe	ZPC	Kariba South	750	6x125MW		4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982	4,982
H002	Zimbabwe	IPP(Nyangani Renewable Energy)	Pungwe A	2.7																							
H003	Zimbabwe	IPP(Nyangani Renewable Energy)	Pungwe B	15.25																							
H004	Zimbabwe	IPP(Nyangani Renewable Energy)	Duru	2.2																							
H005	Zimbabwe	IPP(Nyangani Renewable Energy)	Nyamhingura	1.1																							
Thermal																											
T001	Zimbabwe	ZPC	Hwange1-6	920	4x120, 2x220MW ->700				3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827
T002	Zimbabwe	ZPC	Munyati	100	-> 20		394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
T003	Zimbabwe	ZPC	Bulawayo	90	3x30MW -> 20		394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
T004	Zimbabwe	ZPC	Harare	120	1x20MW, 2x30MW -> 30		307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307
Export																											
		Nampower (Firm)		-150	though Cprivi link		-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117
		Eskom (Non Fir	As Available																								
Import																											
		→ HCB (Firm)		100			745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745
		→ SNEL (Firm)		50			372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372
		→ HCB (Non F	As Available																								
		→ EDM (Non Firm)		50																							
		→ ZESCO (Non Firm)		200																							
		→ SNEL (Non Firm)		50																							
		→ Eskom (Non	As Available																								
	Planning					Planning																					
Hydro																											
H101	Zimbabwe	SPC(ZPC has developed SPV)	Kariba South Exte	300	2x150		1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183
H104	Zimbabwe	ZPC	Batoka Gorge	1200	4x300MW (4x300MW)				6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097	6,097
H105	Zimbabwe	Private Company owned by Zim.Gov.	Gairezi	30	2x15MW		158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158
H107	Zimbabwe	IPP	Tsanga	3.3																							
H108	Zimbabwe	IPP	Osborne	3																							
H110	Zimbabwe	IPP	Manyuchi	1.4																							
H111	Zimbabwe	IPP	Duru	2.3																							
H112	Zimbabwe	IPP	Siya	0.9																							
H113	Zimbabwe	IPP	Mutirikwi	1.4																							

Source：JICA Survey Team

Generation development analysis, energy review　Zimbabwe – Cont'd

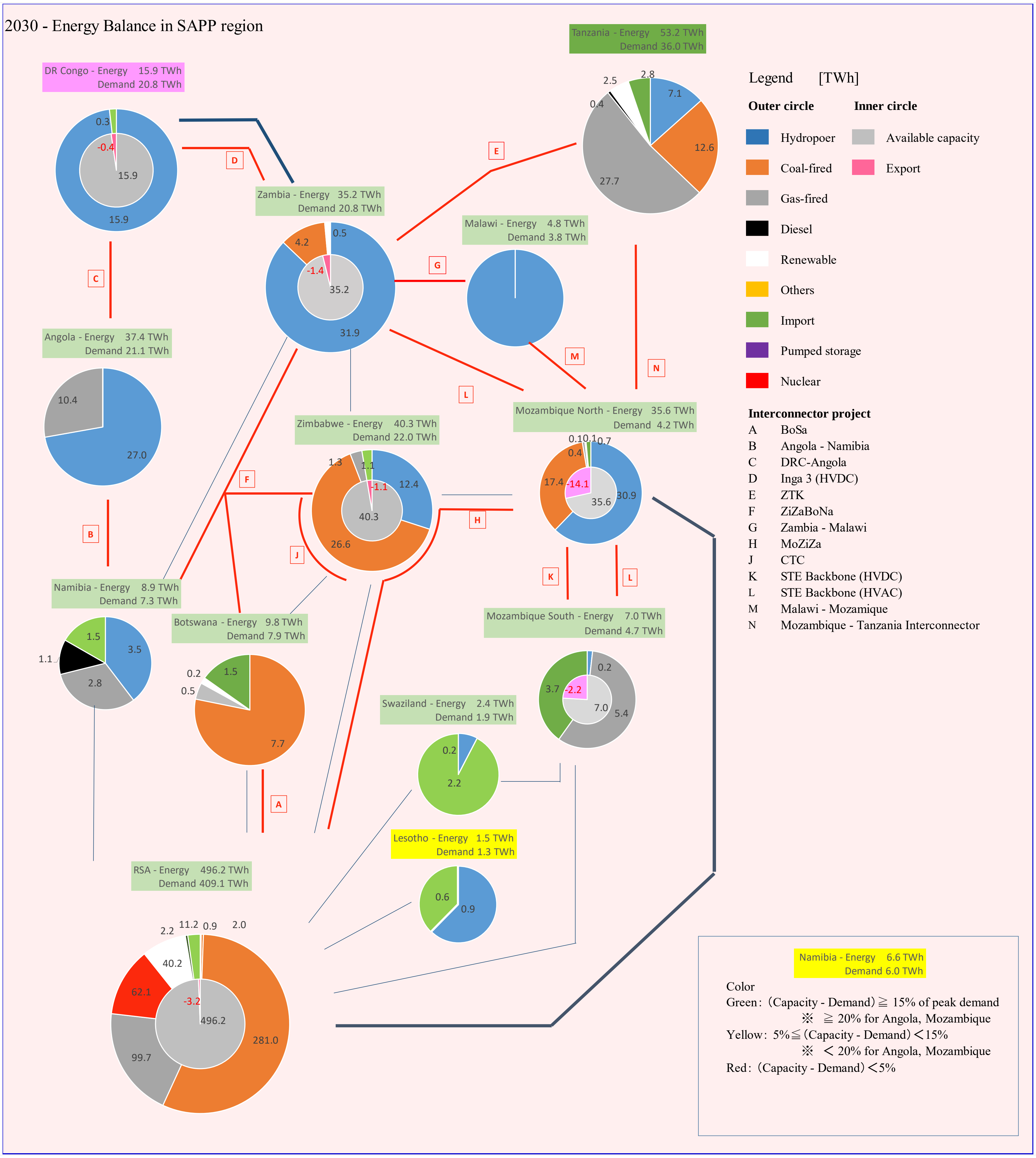
Lot	Country declared	Utility	Project name	Capacity (MW)		Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Demand[GWh]	13,534	14,349	15,221	15,926	16,677	17,461	18,280	19,142	20,057	21,008	22,012	23,069	24,172	25,345	26,569	27,862	29,249	30,679	32,182	33,756	35,408
Thermal																											
T101	Zimbabwe	ZPC	Hwange7-8 Coal fired	600	2x300MW		2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628
T102	Zimbabwe	ZPC/ Private	Lupane Coal fired	300	2x150MW							1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314
T103	Zimbabwe	Rio Zim	Gokwe North (Sengwa) Coal fired	1200	4x300MW							1,314	1,314	2,628	2,628	3,942	3,942	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256
T104	Zimbabwe	IPP	Lususu Coal fired	600	2x300MW		1,314	1,314	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628
T105	Zimbabwe	Co-Ash Resources	Waste coal fired	250			1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095
T106	Zimbabwe	CASECO	CASECO Coal fired	600	2x300MW		1,577	1,577	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154
T107	Zimbabwe	Southern Energy	Southern Energy Coal fired	660	2x330MW		3,469	3,469	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938
T108	Zimbabwe	ZPC	ZPC Diesel	120																							
						Total	17,500	17,500	33,784	33,784	33,784	36,412	36,412	37,726	37,726	39,040	39,040	40,354	40,354	40,354	40,354	40,354	40,354	40,354	40,354	40,354	40,354
						Hydopower	6,323	6,323	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,420
						Coal-fired	11,178	11,178	21,365	21,365	21,365	23,993	23,993	25,307	25,307	26,621	26,621	27,935	27,935	27,935	27,935	27,935	27,935	27,935	27,935	27,935	27,935
						Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						Import	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117
						Export	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117
						Surplus/Deficit	3,966	3,151	18,563	17,858	17,107	18,951	18,132	18,584	17,669	18,032	17,028	17,285	16,182	15,009	13,785	12,492	11,105	9,675	8,172	6,598	4,946

Source：JICA Survey Team



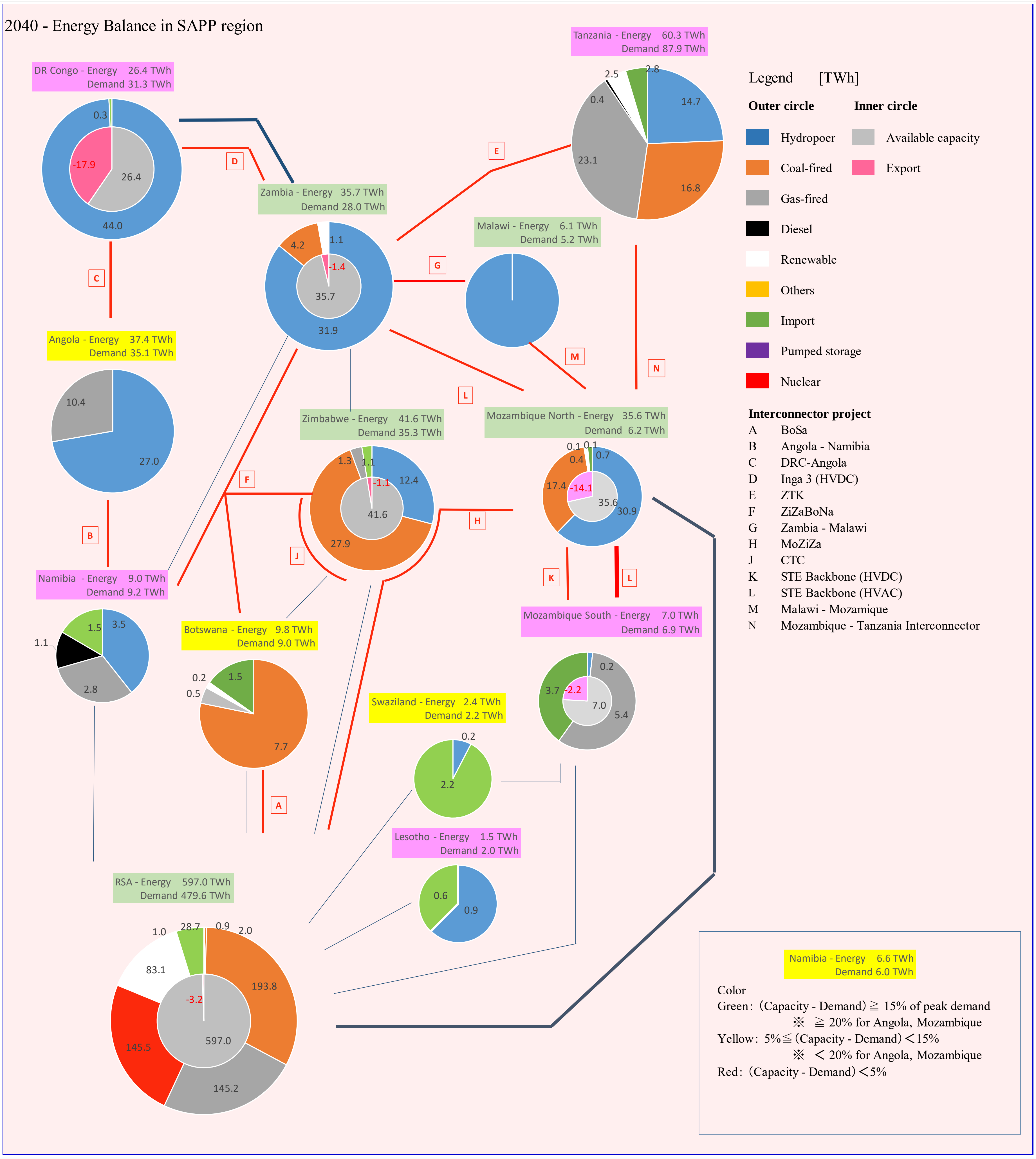
Source : JICA Survey Team

Figure 5.1-20 Demand and supply balance in SAPP (Energy review) 2020



Source : JICA Survey Team

Figure 5.1-21 Demand and supply balance in SAPP (Energy review) 2030



Source : JICA Survey Team

Figure 5.1-22 Demand and supply balance in SAPP (Energy review) 2040

3) Demand and supply balance in drought situation

Northern SAPP member states have many hydropower candidates compare to southern part of SAPP as aforementioned figures represent. And relatively generation capacity per a plant is big. Therefore, the fear of drought condition is definitely severe issue[74].

As for SAPP Pool Plan 2009, availability of hydropower was 66 % of normal condition, and that along the Zambezi river basin was 78 % of normal condition. In view of current condition of the Zambezi river basin, 60% of normal condition as availability in drought situation for all hydropowers would be applied and calculated the energy.

It is noted that drought situation would not always happen at all river basins. However, most of huge-sized hydropower plants and candidates are located along the Zambezi river basin and the Congo river basin. Thus, once critical drought situation hit the plants and candidates, the impact will be tremendously big and long period will be needed to recover normal dam water levels and river flows.

By the way, to estimate the energy from Inga 3 in this situation the Survey applied the portion for RSA is the value with contract ratio of total energy generated in the situation, i.e. 2,500 MW / 4,800 MW x total energy generated is for RSA.

As of 2020, DR Congo, Zambia, Malawi, and northern Mozambique might be met the critical situation. As you know, DR Congo has the Congo river basin and Zambia, Malawi, and northern Mozambique have the Zambezi river basin.

In 2030, DR Congo, Malawi, and Zambia might be. Further, in 2040, all northern states plus Angola might be[75].

Results are shown in Table 5.1-36 to Table 5.1-46. And demand and supply balance in SAPP are illustrated in Figure 5.1-24 to Figure 5.1-26 based on them.

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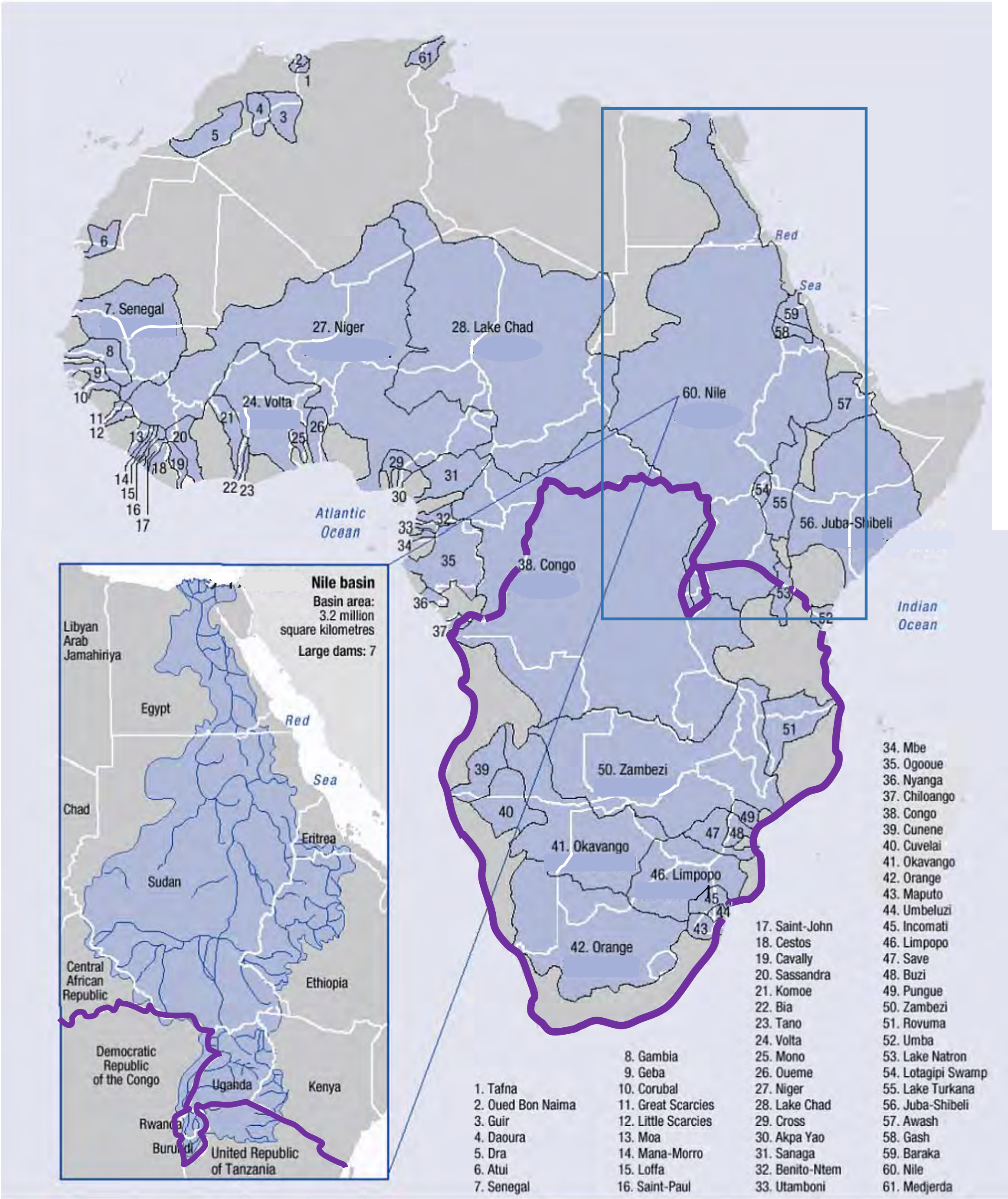
74 Recently, water level of dams along the Zambezi River is critical. Especially demand – supply condition in Zambia is tight.

75 Precisely, it is not realistic because river has different water condition.



Source : Survey Team using UNDP human development report (2006)

Figure 5.1-23 River basins in Africa

Table 5.1-36 Generation development analysis, energy review in drought Angola

Angola																														
Lot	Country declared	Utility	Project name(Pool Plan)(Latest info.)	Capacity(MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	Pool P2009 GWh	Dry Year GWh	Demand[GWh]	12,674	13,364	14,077	14,812	15,568	16,345	17,198	18,096	19,040	20,034	21,079	22,179	23,337	24,555	25,836	27,185	28,604	30,096	31,667	33,320	35,059
	Existing			1745.9					Existing																					
Hydro																														
H001	Angola	PRODEL	Mabubas(18MW)(25.6MW)	26						36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
H002	Angola	PRODEL	Cambambe(180MW)(960MW)	260						565	565	565	565	565	565	565	565	565	565	565	565	565	565	565	565	565	565	565	565	565
H003	Angola	PRODEL	Capanda(260MW)(520MW)	520						1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441
H004	Angola	PRODEL	Matala(16MW)(40.8MW)	42						60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
H005	Angola	PRODEL	Luachimo()(36MW)-Lunda Norte	8.4						95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
H006	Angola	PRODEL	Chicapa()(34MW)-Lunda Sul	16						42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
H007	Angola	PRODEL	Biópio(8MW)(14.6MW)	14.6						21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
H008	Angola	PRODEL	Lomaum(0MW)(50+160MW)	65						171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171
H009	Angola	PRODEL	Gove(-)(57.6MW)	60						158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158
Thermal																														
T001	Angola	PRODEL	Luanda	148																										
T003	Angola	PRODEL	Benguela-New	60																										
T004	Angola		GTG	128																										
T005	Angola		CD CFL	60																										
T006	Angola		CT Quartéis	15																										
T007	Angola		CT Viana	50																										
T008	Angola		CT Cimangola	96																										
T009	Angola		CT Mabor ou Cazenga	56																										
T010	Angola		CD Luanda Norte(Dundo)	0.8																										
T011	Angola		CD Lunda Sul(Saurimo)	2.1																										
T012	Angola		CD Moxico(Luena)	12.5																										
T014	Angola		CD Lunda Norte(Dundo)	15																										
T015	Angola		CD Luda Sul	7.5																										
	Planning								Planning																					
Hydro																														
H101	Angola	-	Cambambe2	720	**2017**					540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540
H102	Angola	-	Caculo Cabaca	2100	**2020**					4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967	4,967
H103	Angola	-	Laúca	2060	**2018**					4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873	4,873
H104	Angola		Queve	774	**2020**					1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831	1,831
H105	Angola	IPP	Jamba ia oma	78	**2020**					184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184
H106	Angola	IPP	Jamba ia mina	227	**2020**					537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
H107	Angola/Namibia	-	Baynes (by Namibia)	300	**2026**											1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183	1,183
Thermal																														
T101	Angola	PRODEL	Soyo Ⅰ - Gas fired	720	**2018**					5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046
T102	Angola	IPP	Soyo Ⅱ(2A, 2B) - Gas fired	720	**2022**							5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046	5,046
T103	Angola	PRODEL	Boavista 1 (Benguela) - Gas fired, relocate	80	**2026**										210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
T104	Angola	PRODEL	Boavista 2 (Namibe) - Gas fired, relocate	40	**2026**										105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105
									Total	20,565	20,565	25,611	25,611	25,611	25,926	27,109	27,109	27,109	27,109	27,109	27,109	27,109	27,109	27,109	27,109	27,109	27,109	27,109	27,109	27,109
									Hydopower	15,519	15,519	15,519	15,519	15,519	15,519	16,701	16,701	16,701	16,701	16,701	16,701	16,701	16,701	16,701	16,701	16,701	16,701	16,701	16,701	16,701
									Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Gas-fired	5,046	5,046	10,092	10,092	10,092	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407	10,407
									RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Import	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Surplus/Deficit	7,891	7,201	11,534	10,799	10,043	9,581	9,911	9,013	8,069	7,075	6,030	4,930	3,772	2,554	1,273	-76	-1,495	-2,987	-4,558	-6,211	-7,950

Source : JICA Survey Team

Table 5.1-37 Generation development analysis, energy review in drought DR Congo

DR Congo

Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	Pool Plan 2009 GWh	Dry Year GWh	Demand [GWh]	13,848	14,369	14,967	15,590	16,239	16,915	17,623	18,360	19,129	19,929	20,763	21,632	22,537	23,480	24,462	25,486	26,553	27,664	28,821	30,027	31,284
	Existing			2451.43					Existing																					
Hydro																														
H001	DRC	SNEL	Inga 1	360		1,440	2,400	1,882		1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440
H002	DRC	SNEL	Inga 2	1424		5,760	9,600	7,529		5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760
H003	DRC	SNEL	Mpozo	2.21																										
H004	DRC	SNEL	Zongo1	75		48	80	63		48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
H005	DRC	SNEL	Sanga	12		5	9	7		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
H006	DRC	SNEL	Mobayi-Mbongo	11.4																										
H007	DRC	SNEL	Kilubi	9.9																										
H008	DRC	SNEL	Kymbi	17.2																										
H009	DRC	SNEL	Koni	42.12		120	200	157		120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
H010	DRC	SNEL	Mwadingusha	68		120	200	157		120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
H011	DRC	SNEL	Nseke	248		720	1,200	941		720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
H012	DRC	SNEL	Nzilo1	108		342	570	447		342	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342
H013	DRC	SNEL	Lungudi	1.6																										
H014	DRC	SNEL	Ruzizi1	28.2																										
H015	DRC	SNEL	Ruzizi2	26.6																										
H016	DRC	SNEL	Bendera-Kyimbi1	17.2																										
Export																														
	No.26 →BPC (Firm)			-50																										
	No.27 →ZESA (Firm)			-50						-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
	No.28 →ZESA (Non Firm)			-50																										
Import																														
	No.33 ZESCO for KCC (Firm)			40						298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298
	No.34 ZESCO (Non Firm)			100																										
	Planning								Planning																					
Hydro																														
H101	DRC		Inga 3	4,800	4,800MW		22,995	18,035	**2026 -> 2031**												16,819	16,819	16,819	16,819	16,819	16,819	16,819	16,819	16,819	16,819
H102	DRC		Zongo2	120		284																								
H103	DRC	2019	Busanga	240	4x60MW	757	1,261	989	**2020, 21, 22**	757	757	757	757	757	757	757	757	757	757	757	757	757	757	757	757	757	757	757	757	757
H104	DRC		Katende	64		151			**2020**	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151
H105	DRC		Ruzizi3	49	147/3 contries	116			**2018**	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116
Export																														
	Inga 3 →RSA(Eskom)			-2,500	2026																-8,760	-8,760	-8,760	-8,760	-8,760	-8,760	-8,760	-8,760	-8,760	-8,760
									Total	9,505	9,505	9,505	9,505	9,505	9,505	9,505	9,505	9,505	9,505	9,505	17,564	17,564	17,564	17,564	17,564	17,564	17,564	17,564	17,564	17,564
									Hydopower	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	26,398	26,398	26,398	26,398	26,398	26,398	26,398	26,398	26,398	26,398
									Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Import	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298
									Export	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-9,132	-9,132	-9,132	-9,132	-9,132	-9,132	-9,132	-9,132	-9,132	-9,132
									Surplus/Deficit	-4,343	-4,864	-5,462	-6,085	-6,734	-7,410	-8,118	-8,855	-9,624	-10,424	-11,258	-4,068	-4,973	-5,916	-6,898	-7,922	-8,989	-10,100	-11,257	-12,463	-13,720

Assumed Capacity : 3,500MW

Source : JICA Survey Team

Table 5.1-38　　Generation development analysis, energy review in drought　Lesotho

Lethoto

Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	Pool Pool 2009 GWh	Dry Year GWh	Demand [GWh]	866	902	940	979	1,020	1,063	1,107	1,154	1,202	1,252	1,305	1,359	1,416	1,476	1,537	1,602	1,669	1,738	1,811	1,887	1,966
	Existing			148					Existing																					
Hydro																														
H001	Lesotho	LHWP	Muela	72	3x24MW	246	410	271		246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246
H002	Lesotho	LEC	Mant-Sonyane	2	1.5MW,0.5MW	0	4	3																						
Import																														
		No.3	Eskom Firm	24	2005indefinite					179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179
		No.17	EDM Firm	50	2008annually					372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372
	Planning								Planning																					
Hydro																														
H101	Lesotho	LHWP	Kobong Pumped Storage	1,200																										
H102	Lesotho	LHWP	Muela Ⅱ	73	2012	54	90	59		54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
H103	Lesotho	LHWP	Oxbow	80	2017	246	410	271		246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246
									Total	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097
									Hydopower	914	604	0	546	546	546	546	546	546	546	546	546	546	546	546	546	546	546	546	546	546
									Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Import	0	0	0	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
									Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Surplus/Deficit	231	195	157	118	77	34	-10	-57	-105	-155	-208	-262	-319	-379	-440	-505	-572	-641	-714	-790	-869

Source : JICA Survey Team

Table 5.1-39 Generation development analysis, energy review in drought Malawi

Malawi																														
						Drought Case			**Year**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Lot	Country declared	Utility	Project name	Capacity (MW)		Drought 60%	Pool Plan 2009 GWh	Dry Year GWh	Demand[GWh]	2,833	2,934	3,020	3,108	3,199	3,293	3,394	3,497	3,604	3,714	3,828	3,945	4,065	4,189	4,317	4,449	4,585	4,725	4,870	5,018	5,172
	Existing			390.05					Existing																					
Hydro																														
H001	Malawi	Escom	Nkula A	24	3x8MW	67	112	74		67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67
H002	Malawi	Escom	Nkula B	100	5x20MW	174	290	191		174	174	174	174	174	174	174	174	174	174	174	174	174	174	174	174	174	174	174	174	174
H003	Malawi	Escom	Tedzani 1	20	2x10MW	153	255	169		153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
H004	Malawi	Escom	Tedzani 2	20	2x10MW					153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
H005	Malawi	Escom	Tedzani 3	52.7	2x26.5MW	154	256	169		154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154
H006	Malawi	Escom	Kapichira Phase1	64	2x32.4MW	281	469	310		281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281
H007	Malawi	Escom	Kapichira Phase2	64	2x32.4MW	128	213	141		128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128
H008	Malawi	Escom	Wovwe	4.35	3x1.45MW	5	9	6		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Thermal																														
T001	Malawi	Escom	Lilongwe	20						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T002	Malawi	Escom	Mzuzu	6						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T003	Malawi	Escom	Blantyre	15						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Planning								Planning																					
Hydro																														
H101	Malawi	Escom	Nkula A - expansion	12	1x12MW				**2018**	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
H102	Malawi	Escom	Tedzani - expansion	18	1x18MW				**2019**	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57
H104	Malawi	Escom	Kholombidzo	280		745	1242		**2020**	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745
H106	Malawi	IPP	Mbongozi	40		119	198		**2022**			119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119
H108	Malawi		Chizuma	50					**2019**	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118
H111	Malawi		Lower Fufu	100-150		500	834		**2026**							500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
H117	Malawi		Mpatamanga	310		745	1242		**2035**																745	745	745	745	745	745
H123	Malawi		Songwe	65-340	90MW	210	350		**2022 → 2029**										210	210	210	210	210	210	210	210	210	210	210	210
						0																								
									Total	2,073	2,073	2,192	2,192	2,192	2,192	2,693	2,693	2,693	2,903	2,903	2,903	2,903	2,903	2,903	3,648	3,648	3,648	3,648	3,648	3,648
									Hydopower	2,073	2,073	2,192	2,192	2,192	2,192	2,693	2,693	2,693	2,903	2,903	2,903	2,903	2,903	2,903	3,648	3,648	3,648	3,648	3,648	3,648
									Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Import	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Surplus/Deficit	-760	-861	-828	-916	-1,007	-1,101	-701	-804	-911	-811	-925	-1,042	-1,162	-1,286	-1,414	-801	-937	-1,077	-1,222	-1,370	-1,524

Source : JICA Survey Team

Table 5.1-40　Generation development analysis, energy review in drought　Mozambique

Mozambique

Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	Pool P2009 GWh	Dry Year GWh	Demand[GWh]	5,966	6,205	6,454	6,713	6,982	7,262	7,553	7,856	8,171	8,499	8,840	9,194	9,563	9,946	10,345	10,760	11,191	11,640	12,107	12,592	13,097
									South	3,162	3,289	3,421	3,558	3,700	3,849	4,003	4,164	4,331	4,504	4,685	4,873	5,068	5,271	5,483	5,703	5,931	6,169	6,417	6,674	6,941
									North-Central	2,804	2,916	3,033	3,155	3,282	3,413	3,550	3,692	3,840	3,995	4,155	4,321	4,495	4,675	4,862	5,057	5,260	5,471	5,690	5,918	6,156
	Existing								Existing																					
Hydro																														
H001	Mozambique	HCB	Cahora Bassa	2,075	5x415MW	9,180	15,300	12,000		9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180	9,180
H002	Mozambique	EDM	Chicamba	34	2x17MW	47	46	10		47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
H003	Mozambique	EDM	Mavuzi	52	3x14MW, 2x5MW	144	237	86		144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
H004	Mozambique	EDM	Corumana	16.6	2x8.3MW	18	21	11		18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Thermal																														
T001	Mozambique	EDM	CTM1	20	1x20MW Diesel					88																				
T003	Mozambique	EDM	Nacala	18	18x1MW Diesel					79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
T004	Mozambique	EDM	Temane	8	6x0.31MW, 2X2.6MW					35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
T005	Mozambique	Aggreko	Aggreko	55	100, 122MW					241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241
T006	Mozambique	Sasol+EdM	Ressano Gacia EDM/Sasol	175	18x9.73MW					767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767	767
T007	Mozambique	Gigajoule	Ressano Gacia Gigawatt	120	13x9.34MW					526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526
T008	Mozambique	EDM	Beloluane	40	40x1MW					175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
	Mozambique	EDM	Tevene	3.6	Diesel																									
	Mozambique	EDM	Inhambane	4.5	Diesel																									
Export																														
	<EDM>																													
			→ SEC (Firm)	-50						-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
			→ Nampower (Firm)	-50						-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
			→ BPC (Firm)	-50						-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
			→ LEC (Firm)	-50						-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
			→ Eskom (Firm)	-100						-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745
			→ Eskom (Firm) As Available																											
			→ ZESA (Non Firm)	50																										
			→ ZESCO (Non Firm) As requested																											
	<HCB>																													
			→ EDM (Firm)	-300	Wheel from HVDC, RSA					-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234
			→ EDM (Firm)	-200	Wheel from HVAC, RSA					-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745
			→ Eskom (Firm)	-1150						-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563	-8,563
			→ Eskom (Firm)	-250						-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862
			→ ZESA (Firm)	-100						-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745
			→ ZESA (Non Firm) As Available																											
Import																														
			ZESCO (Firm)→EDM North	100						745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745
			HCB (Firm)→EDM South	300						2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234
			HCB (Firm)→EDM South	200						1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489
	Planning								Planning																					
Hydro																														
H101	Mozambique	HCB	Cahora Bassa Norte	1245	3x415MW		2,835	0											0	0	0	0	0	0	0	0	0	0	0	0
H102	Mozambique	EDM/HCB	Mpanda Nkuwa	1500	2x750MW	6,279	9,070	7,253						6,279	6,279	6,279	6,279	6,279	6,279	6,279	6,279	6,279	6,279	6,279	6,279	6,279	6,279	6,279	6,279	6,279
H105	Mozambique	EDM	Massingir	27		64	123	75							64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
H106	Mozambique	EDM	Moamba Major	15		35						35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
H107	Mozambique	EDM	Lurio II	120		284						284	284	284	284	284	284	284	284	284	284	284	284	284	284	284	284	284	284	284
H108	Mozambique	EDM	Tsate	50		118							118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118

Source : JICA Survey Team

Generation development analysis, energy review in drought　Mozambique – Cont’d

Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	Pool P2009 GWh	Dry Year GWh	Demand[GWh]	5,966	6,205	6,454	6,713	6,982	7,262	7,553	7,856	8,171	8,499	8,840	9,194	9,563	9,946	10,345	10,760	11,191	11,640	12,107	12,592	13,097
									South	3,162	3,289	3,421	3,558	3,700	3,849	4,003	4,164	4,331	4,504	4,685	4,873	5,068	5,271	5,483	5,703	5,931	6,169	6,417	6,674	6,941
									North-Central	2,804	2,916	3,033	3,155	3,282	3,413	3,550	3,692	3,840	3,995	4,155	4,321	4,495	4,675	4,862	5,057	5,260	5,471	5,690	5,918	6,156
Thermal																														
T101	Mozambique	ACWA	Moatize(Surplus (Coal fired<North/Central>	300	toward 2,400MW,2x300, 3x600										2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102
T102	Mozambique		Nacala (Coal fied<North/Central>)	40						280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280
T103	Mozambique	Jindal Stee	JINDAL Tete (Coal fired <North/Central>)	150						1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051	1,051
T104	Mozambique	Ncondezi P	Ncondezi (Coal fired <North/Central>)	300											2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102
T105	Mozambique	EDM/Sasol	Temane (Gas fired<South>)	400								2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102
T106	Mozambique	Kuvaninga	Kuvaninga (Gas fired <South>)	40	10x4.01MW					210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
T107	Mozambique	ENI	Palma (Gas fired <North/Central>)	75											394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
T109	Mozambique	EDM	Coal fired Nacala <North/Central>	200								1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402
T110	Mozambique	IPP	Coal fired Tete <North/Central>	1200								8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410	8,410
T111	Mozambique		CTM 1 (Gas fired<South>)	96	2x48.065MW					420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420
T112	Mozambique		CTM 2 (Gas fired<South>)	29	1x28.87MW					127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127
T114	Mozambique	EDM	Temane (Gas fired<South>)	100								438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438
T115	Mozambique	EDM	CTM Conversion (T001 Diesel to Gas) (Gas fired<South>)	80							350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350
T116	Mozambique	ENRC	ENRC (Coal fired<North/Central>)	300											2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102
Solar																														
S101	Mozambique	Scatec	Mocuba	30						53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
S102	Mozambique	Neon	Metoro	30						53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
								Total	Total generated	1,581	1,843	14,514	14,633	20,912	27,677	27,677	27,677	27,677	27,677	27,677	27,677	27,677	27,677	27,677	27,677	27,677	27,677	27,677	27,677	27,677
									Hydopower	9,390	9,390	9,709	9,828	16,107	16,171	16,171	16,171	16,171	16,171	16,171	16,171	16,171	16,171	16,171	16,171	16,171	16,171	16,171	16,171	16,171
									Coal-fired	1,332	1,332	11,143	11,143	11,143	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450
									Gas-fired	2,501	2,851	5,392	5,392	5,392	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786
									RE(PV, Wind etc.)	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105
									Diesel and else	166	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
									Import	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468
									Export	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381	-16,381
									Surplus/Deficit	-4,385	-4,362	8,060	7,920	13,930	20,415	20,124	19,821	19,506	19,178	18,837	18,483	18,114	17,731	17,332	16,917	16,486	16,037	15,570	15,085	14,580
								South Total	Total generated	4,078	4,341	6,916	6,916	6,916	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980
									Hydopower	0	0	35	35	35	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99
									Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Gas-fired	2,501	2,851	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392	5,392
									RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Diesel and else	88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Import	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723
									Export	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234	-2,234
									Surplus/Deficit	916	1,052	3,496	3,359	3,216	3,131	2,977	2,817	2,650	2,476	2,295	2,107	1,912	1,709	1,497	1,278	1,049	811	564	307	39
								North-Central Total	Total generated	-2,497	-2,497	7,598	7,716	13,995	20,696	20,696	20,696	20,696	20,696	20,696	20,696	20,696	20,696	20,696	20,696	20,696	20,696	20,696	20,696	20,696
									Hydopower	9,390	9,390	9,674	9,792	16,071	16,071	16,071	16,071	16,071	16,071	16,071	16,071	16,071	16,071	16,071	16,071	16,071	16,071	16,071	16,071	16,071
									Coal-fired	1,332	1,332	11,143	11,143	11,143	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450	17,450
									Gas-fired	0	0	0	0	0	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
									RE(PV, Wind etc.)	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105
									Diesel and else	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
									Import	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745
									Export	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147	-14,147
									Surplus/Deficit	-	-	4,564	4,561	10,714	17,283	17,147	17,004	16,856	16,702	16,542	16,375	16,202	16,022	15,834	15,639	15,437	15,226	15,006	14,778	14,541

Source : JICA Survey Team

Table 5.1-41 Generation development analysis, energy review in drought Namibia

Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case				2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Namibia						Drought 60%	Pool P2009 GWh	Dry Year GWh	Demand[GWh]	6,036	6,173	6,314	6,459	6,608	6,452	6,608	6,769	6,932	7,097	7,264	7,433	7,609	7,790	7,976	8,165	8,359	8,558	8,762	8,970	9,183
	Existing			470.5					Existing																					
Hydro																														
H001	Namibia	Nampower	Ruacana	343	3x80MW, 92MW	837	1395	921		837	837	837	837	837	837	837	837	837	837	837	837	837	837	837	837	837	837	837	837	837
Thermal																														
T001	Namibia	Nampower	Anixas	22.5	1x22.5MW					118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118
T002	Namibia	Nampower	Van Eck	81						355	355	355	355	355																
Import																														
	No.24 ZESA → (Firm)			150						1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117
	No.25 ZESCO → (Firm)			50						372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372
	Planning								Planning																					
Hydro																														
H101	Namibia/Angola	Nampower	Baynes	300	2x71MW, 3x156.75MW	1034	1724	1138								1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034
Thermal																														
T102	Namibia	Nampower	Kudu Gas fire	400						2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803
		Nampower	Diesel									88	175	263	526	613	701	788	876	964	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029
									Total	5,602	5,602	5,690	5,778	5,865	5,773	6,895	6,983	7,070	7,158	7,246	7,311	7,311	7,311	7,311	7,311	7,311	7,311	7,311	7,311	7,311
									Hydopower	837	837	837	837	837	837	1,871	1,871	1,871	1,871	1,871	1,871	1,871	1,871	1,871	1,871	1,871	1,871	1,871	1,871	1,871
									Coal-fired	355	355	355	355	355	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Gas-fired	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803
									RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Diesel and else	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118
									Import	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489
									Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Surplus/Deficit	-434	-571	-624	-681	-743	-679	287	214	138	61	-18	-122	-298	-479	-665	-854	-1,048	-1,247	-1,451	-1,659	-1,872

Source : JICA Survey Team

Table 5.1-42 Generation development analysis, energy review in drought RSA

RSA																														
Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	Pool P2009 GWh	Dry Year GWh	Demand[GWh]	314,790	324,303	333,929	343,561	353,651	364,056	366,034	376,611	387,506	398,408	409,140	418,001	425,856	433,743	440,862	447,926	454,617	461,389	468,272	472,960	479,589
	Existing								Existing																					
Hydro																														
H001	RSA	Eskom	Drakensberg PS	1,000	4x250MW		N/A	N/A		730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730
H002	RSA	Eskom	Palmiet PS	400	2x200MW		N/A	N/A		292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292
H003	RSA	Eskom	Gariep	360	4x90MW	240	400	264		240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240
H004	RSA	Eskom	Vanderkloof	240	2x120MW	240	400	264		240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240
H005	RSA	Private	Friedenham	3		15	25	17		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
H006	RSA	Eskom	First Falls	6	2x3MW																									
H007	RSA	Eskom	Second Falls	11	2x5.5MW																									
H008	RSA	Eskom	Ncora	2	2x0.4MW,1 x 1.3MW																									
H009	RSA	Eskom	Colley Wobbeles	42	3x14MW	30	50	33		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
H010	RSA	Capetown Ci	Steenbras PS	180																										
					664																									
Thermal																														
T001	RSA	Eskom	Arnot	2,352	270, 390, 396, 400					14,422	14,422	14,422	14,422	14,422	14,422	14,422	14,422	14,422	14,422	14,422	9,986	9,986	7,989	7,989	5,992	3,995	3,995	1,997		
T002	RSA	Eskom	Camden-RTS	1,561	3x200, 196, 2x195, 190, 185					6,990	3,995	1,997																		
T003	RSA	Eskom	Duvha	3,600	6x600					22,075	22,075	22,075	22,075	22,075	22,075	22,075	22,075	22,075	22,075	15,111	12,089	9,067	3,022							
T004	RSA	Eskom	Grootvlei-RTS	1,200	6x200					7,358	7,358	7,358	7,358	7,358	4,941	3,953	1,976													
T005	RSA	Eskom	Hendrina	1,893	5x200, 2x195, 2x170, 168					11,608	11,608	11,608	11,608	11,608	11,608	11,608	11,608	11,608	11,608	8,846	7,863	6,880	5,897	4,914	2,949	983				
T006	RSA	Eskom	Kendal	4,116	6x686					25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	25,239	16,819	13,455
T007	RSA	Eskom	Komati-RTS	990	4x100, 90, 4x125					6,071	6,071	6,071	6,071	3,185	1,593															
T008	RSA	Eskom	Kriel	3,000	6x500					18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	10,512	7,884	5,256	2,628	
T009	RSA	Eskom	Majuba	4,110	3x657, 3x713					25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203	25,203
T010	RSA	Eskom	Matla	3,600	6x600					22,075	22,075	22,075	22,075	22,075	22,075	22,075	22,075	22,075	15,111	15,111	9,067	6,044	3,022							
T011	RSA	Eskom	Tutuka	3,654	6x609					22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	22,406	15,374	12,299	9,224	6,150	3,075	
T012	RSA	Eskom	Lethabo	3,708	6x618					22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	22,737	15,584	17	9,350	6,234	3,117	
T013	RSA	Eskom	Matimba	3,990	6x665					24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	24,467	12,930	9,697	6,465
T014	RSA	Aldwych Inte	Kelvin (Coal	214																										
T015	RSA	Sasol	Secunda (Coal	600	10x60MW					3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154
T016	RSA	City of Tshwa	Pretoria West (Coal	180																										
T017	RSA	City of Tshwa	Rooiwal (Coal	300																										
T018	RSA	Eskom	Acacia OCGT	171						899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899
T019	RSA	Eskom	Port Rex OCGT	171						899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899
T020	RSA	Eskom	Ankerlig OCGT	1,338						7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033
T021	RSA	Eskom	Gourikwa OCGT	746						3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921	3,921
T022	RSA	Sasol	Secunda OCGT(CCGT)	180	2x90MW					946	946	946	946	946	946	946	946	946	946	180	180	180	180	180	180	180	180	180	180	180
T023	RSA	Sasol	Sasolburg OCGT	175						920	920	920	920	920	920	920	920	920	920	175	175	175	175	175	175	175	175	175	175	175
T024	RSA	IPSA	Newcastle cogeneration CCGT	18																										
T025	RSA	ENGIE, Lege	Dedisa Peaking OCGT	335						1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174
T026	RSA	ENGIE, Lege	Avon Peaking OCGT	670	670MW(4U nits)					3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522	3,522

Source : JICA Survey Team

Generation development analysis, energy review in drought RSA – Cont'd -1

Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	Pool P2009 GWh	Dry Year GWh	Demand[GWh]	314,790	324,303	333,929	343,561	353,651	364,056	366,034	376,611	387,506	398,408	409,140	418,001	425,856	433,743	440,862	447,926	454,617	461,389	468,272	472,960	479,589
Nuc																														
N001	RSA	Eskom	Koeberg Nuc	1,940						14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445	14,445
Wind																														
W001	RSA	Eskom	Klipheuwel	3																										
W002	RSA	Eskom	Sere	100						175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
	Planning								Planning																					
Hydro																														
H001	RSA	Eskom	Ingula PS	1,332	4x333MW Pump Turbines					972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972	972
Thermal	(Coal Baseload IPP Programme:2500MW, 2021)																													
				refer to Botswana																										
T101	RSA	Eskom	Medupi Coal fired	4,764	6x794MW					11,129	11,129	22,257	22,257	22,257	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386	33,386
T102	RSA	Eskom	Kusile Coal fired	4,800	6x800MW						5,606	11,213	22,426	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638	33,638
			Future Coal fired							1,752	1,752	7,008	11,213	15,418	15,418	15,418	15,418	15,418	18,922	18,922	18,922	25,930	31,186	36,442	41,698	41,698	46,954	57,466	62,722	78,490
	(Gas to Power Programme:3126MW, IRP 3910MW)																													
T104	RSA	IPP	CCGT	2,370						3,114	4,671	4,671	4,671	4,671	4,671	4,671	4,671	7,785	9,343	15,571	15,571	15,571	15,571	15,571	15,571	15,571	15,571	15,571	15,571	15,571
T105	RSA	IPP	Peak OCGT	3,126								4,231	8,462	8,462	12,693	12,693	12,693	16,320	20,551	20,551	20,551	20,551	20,551	20,551	20,551	20,551	20,551	20,551	20,551	20,551
			Future OCGT							631	2,523	2,523	2,523	2,523	2,523	6,938	15,768	24,598	27,121	27,121	27,752	33,428	33,428	38,474	38,474	42,258	58,026	58,026	58,026	58,657
			Future CCGT										4,665	4,665	18,659	18,659	18,659	18,659	18,659	18,659	18,659	18,659	18,659	18,659	18,659	18,659	23,324	23,324	23,324	32,653
Nuc																														
T106	RSA		Future Nuclear							0	0	0	0	0	23,827	23,827	35,741	47,654	47,654	47,654	59,568	59,568	71,482	83,395	95,309	107,222	107,222	119,136	131,050	131,050
Solar (towards 1450MW)																														
S101	RSA	IPP	PV total(Upcoming Window)	1,665	Window 1-3:2010MW					1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	1,875	280	35
			Future PV							613	1,472	2,453	3,837	5,344	6,973	8,725	10,477	12,229	13,981	15,733	17,485	19,237	20,989	22,741	24,493	26,245	27,997	29,749	31,501	33,253
CSP (towards 1000MW IRP objective)																														
C101		IPP	CSP total	300						1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577	1,577
			Future CSP							0	0	0	0	0	0	0	0	0	0	13,666	19,447	25,754	26,280	26,280	29,434	29,434	32,062	32,062	32,062	33,638
Wind (towards 1850MW)																														
W101		IPP	Wind total	1,300	1850-1030					2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	2,278	648						
			Future Wind							0	0	0	0	561	1,121	2,085	2,646	3,206	4,327	4,888	6,009	7,131	8,252	9,373	10,494	11,055	12,176	12,737	13,298	14,419
Other																														
			Cogeneration etc.							9,461	9,461	9,461	9,461	9,461	9,461	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	981	981	981	981	981
Import																														
		SNEL	Inga3	2,500	2,026																8,760	8,760	8,760	8,760	8,760	8,760	8,760	8,760	8,760	8,760
			HCB (Cahorra Bassa)-Firm	1,150	1998-2030					8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563	8,563
			HCB (Cahorra Bassa)-Firm	250	2008-2014					1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862
			EDM Firm	100						745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745
			EDM Firm As Available																											
			ZESA NonFirm As Available																											
			ZESCO Non Firm As Available																											
			Future Import - Reference									8,377	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169

Source : JICA Survey Team

Generation development analysis, energy review in drought RSA – Cont'd - 2

Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	Pool P2009 GWh	Dry Year GWh	Demand[GWh]	314,790	324,303	333,929	343,561	353,651	364,056	366,034	376,611	387,506	398,408	409,140	418,001	425,856	433,743	440,862	447,926	454,617	461,389	468,272	472,960	479,589
Export																														
		→ SEC Firm		-250						-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862	-1,862
		→ LEC Firm		-24						-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179	-179
		→ BPC Firm		-150						-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117
		→ Nampower Non Firm		-350																										
		→ ZESCO Non Firm		-300																										
		→ ZESA Non Firm		-300																										
									Total	309,095	316,013	341,219	364,919	379,519	430,879	428,211	449,291	477,112	484,836	495,806	511,279	526,117	534,639	551,071	555,470	541,730	575,568	577,953	573,371	587,888
									Hydopower	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525
									Pumped storage	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994
									Coal-fired	245,083	247,693	267,687	281,108	293,640	300,758	298,177	296,201	294,225	290,765	281,038	266,553	266,534	259,743	257,971	245,079	214,589	222,493	210,652	193,438	193,790
									Gas-fired	23,057	26,506	30,738	39,633	39,633	57,858	62,274	71,104	86,675	94,986	99,703	100,334	106,010	106,010	111,056	111,056	114,840	135,273	135,273	135,273	145,233
									RE(PV, Wind etc.)	6,517	7,376	8,357	9,741	11,808	13,998	16,714	19,027	21,339	24,213	40,191	48,846	58,026	61,425	62,669	68,048	70,360	75,862	78,174	78,893	83,097
									Diesel and else	9,461	9,461	9,461	9,461	9,461	9,461	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	2,243	981	981	981	981	981
									Nuclear	14,445	14,445	14,445	14,445	14,445	38,272	38,272	50,186	62,100	62,100	62,100	74,013	74,013	85,927	97,840	109,754	121,668	121,668	133,581	145,495	145,495
									Import	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	11,169	19,929	19,929	19,929	19,929	19,929	19,929	19,929	19,929	19,929	19,929
									Export	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157	-3,157
									Surplus/Deficit	-5,695	-8,290	7,290	21,358	25,868	66,823	62,177	72,680	89,606	86,428	86,666	93,278	100,261	100,896	110,209	107,544	87,113	114,179	109,681	100,411	108,299

Source : JICA Survey Team

Table 5.1-43 Generation development analysis, energy review in drought Swaziland

Swaziland																														
Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	Pool P2009 GWh	Dry Year GWh	Demand[GWh]	1,720	1,743	1,760	1,783	1,805	1,828	1,850	1,873	1,896	1,919	1,943	1,967	1,991	2,015	2,040	2,065	2,090	2,116	2,142	2,168	2,194
	Existing			69.4					Existing																					
Hydro																														
H001	Swaziland	SEC	Maguga	19.8	2x9.9MW	46.2	77	51		60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
H002	Swaziland	SEC	Edwaleni	15	4x2.5MW, 1x5.0MW	75	125	83		75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
H003	Swaziland	SEC	Ezulwini	20	2x10.0MW																									
H004	Swaziland	SEC	Maguduza	5.6	1x5.6MW																									
	Import																													
			Eskom → (Firm)	250	2000-2025					1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862	1,862
			EDM → (Firm)	50	2003annually					372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372
	Planning								Planning																					
-	-	-	-	-						-	-	-																		
									Total	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369
									Hydopower	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135
									Coal-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Import	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234
									Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Surplus/Deficit	649	626	609	586	564	541	519	496	473	450	426	402	378	354	329	304	279	253	227	201	175

Source : JICA Survey Team

Table 5.1-44 Generation development analysis, energy review in drought Tanzania

Tanzania

Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	PSMP GWh	Dry Year GWh	Demand[GWh]	13,440	14,890	16,490	18,270	20,230	22,430	24,680	27,140	29,830	32,780	36,000	39,540	43,410	47,640	52,270	57,340	62,480	68,060	74,130	80,720	87,890
	Existing								Existing																					
Hydro																														
H001	Tanzania	Tanesco	Pangani	68	2x34MW	151	251			151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151
H002	Tanzania	Tanesco	Hale	21	2x10.5MW	31	52			31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
H003	Tanzania	Tanesco	Nyumba Ya Mungu	8	2x4MW	16	27			16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
H004	Tanzania	Tanesco	Kidatu	204	4X50MW	536	893			536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536
H005	Tanzania	Tanesco	Mtera	80	2x40MW	207	345			207	207	207	207	207	207	207	207	207	207	207	207	207	207	207	207	207	207	207	207	207
H006	Tanzania	Tanesco	Lower Kihansi	180	3x60MW	416	694			416	416	416	416	416	416	416	416	416	416	416	416	416	416	416	416	416	416	416	416	416
H007	Tanzania	Tanesco	Mwenga	4		10	17			10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
H008	Tanzania	Private	Kikuletwa	1																										
H009	Tanzania	Tanesco	Uwenba	1		2	3			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Thermal																														
T001	Tanzania	Tanesco	Ubungo I	102	12x10.2MW					655	655	655	655	655	655	655														
T002	Tanzania	Tanesco	Tegeta GT	45						282	282	282	282	282	282	282	282	282												
T003	Tanzania	Tanesco	Ubungo II	105	35x5MW					655	655	655	655	655	655	655	655	655	655	655										
T004	Tanzania	Tanesco	Mtwara	18						126	126	126	126	126	126	126														
T005	Tanzania	Tanesco	Nyakato(Mwanza)-Diesel	63						375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375
T006	Tanzania	Tanesco	Kinyerezi I	150						1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034						
T007	Tanzania	Tanesco	Somanga	8																										
T011	Tanzania	Songas Power	SongasⅡ	120						721	721	721	721	721																
T012	Tanzania	Songas Power	Songas I	42						251	251	251	251																	
T013	Tanzania	Songas Power	SongasⅢ	40						242	242	242	242	242	242															
T014	Tanzania	IPTL	TagetaIPTL-Diesel	103						595	595																			
			TPC（Biomass)	17																										
			TANWAT(Biomass)	3																										
T015	Tanzania	Dangote Industries Tanzania	Dangote Industries Tanzania	75																										
		IPP	Somanba Fungu(GT)	210						1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472	1,472
		IPP	Somanba Fungu(CC)	110						771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771
	Planning								Planning																					
Hydro																														
H101	Tanzania		Kakono	87	53 -> 87MW	344	573										344	344	344	344	344	344	344	344	344	344	344	344	344	344
H102	Tanzania	Tanesco	Rusumo Falls	27		101	169			101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101
H104	Tanzania	Tanesco	Stiegler's phase1*	300	3000				EIA issues arise																					
H105	Tanzania	Tanesco	Stiegler's phase2*	600	1				EIA issues arise																					
H106	Tanzania	Tanesco	Stiegler's phase3*	1,200					EIA issues arise																					
H107	Tanzania		Mpanga	160	144->160MW	478	796														796	796	796	796	796	796	796	796	796	796
H108	Tanzania	Tanesco	Taveta-Mnyera	84	145->83.9MW	242	404													242	242	242	242	242	242	242	242	242	242	242
H109	Tanzania	Tanesco	Ruhudji	358		1,200	2,000															1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
H110	Tanzania		Masigira	118		398	664															398	398	398	398	398	398	398	398	398
H111	Tanzania	Tanesco	Rumakali-520MW	222		792	1,320																792	792	792	792	792	792	792	792
H112	Tanzania	Tanesco	Songwe(Manolo)-177.9MW	88		412	686											412	412	412	412	412	412	412	412	412	412	412	412	412
			Songwe(Bupigu)-29.4MW	34																										
			Songwe(Sofre)-158.9MW	80		352	587																	352	352	352	352	352	352	352
			Malagarasi	45		112	187							112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
			Mnyera Ruaha	60		175	291											175	175	175	175	175	175	175	175	175	175	175	175	175
			Mnyera Pumbwe	123		355	592													355	355	355	355	355	355	355	355	355	355	355
			Mnyera Kwanini	144		416	694												416	416	416	416	416	416	416	416	416	416	416	416
			Mnyera Kisingo	120		346	577														346	346	346	346	346	346	346	346	346	346
			Mnyera Mnyera	137		397	662												397	397	397	397	397	397	397	397	397	397	397	397

Source : JICA Survey Team

Generation development analysis, energy review in drought Tanzania – Cont'd

Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	PSMP GWh	Dry Year GWh	Demand[GWh]	13,440	14,890	16,490	18,270	20,230	22,430	24,680	27,140	29,830	32,780	36,000	39,540	43,410	47,640	52,270	57,340	62,480	68,060	74,130	80,720	87,890
		Tanesco	Lower Kihansi Extension	120		41	69		**2019**	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
		SPP (IPP)	EA Power SPP	10	manage to delay	26	44						26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
		SPP (IPP)	Darakuta SPP	0																										
		SPP (IPP)	Mapenbasi SPP	10	manage to delay	26	44						26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
			Upper Kihansi	47		202	336																	202	202	202	202	202	202	202
			Kikonge	300		761	1,268																	761	761	761	761	761	761	761
			Iringa - Nginayo	52		158	263									158	158	158	158	158	158	158	158	158	158	158	158	158	158	158
			Iringa - Ibosa	36		112	186									112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
Thermal																														
T101	Tanzania	Tanesco	Kinyerezi I Extension Gas fired	185					**2017**	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297	1,297				
T102	Tanzania	STAMICO	Kiwira coal fired phase1	400	seeking JV partner in 2014				**2019**	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803
T103	Tanzania	STAMICO	Kiwira coal fired phase2	600														4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
T104	Tanzania	Tanesco	Kinyerezi Ⅲ phase 1,2 Gas fired	600					**2020**	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
T105	Tanzania	Tanesco	Kinyerezi Ⅳ Gas fired	330																2,313	2,313	2,313	2,313	2,313	2,313	2,313	2,313	2,313	2,313	2,313
T106	Tanzania	Tanesco	Kinyerezi Ⅱ Gas fired	240					**2018**	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682				
T107	Tanzania	Sichuan Hongda	Mchuchuma coal fired phase 1	150 x n							1,051	3,154	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
T108	Tanzania	Sichuan Hongda	Mchuchuma coal fired phase 2	200 x n												4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
			Ngaka I coal fired	600									4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
			Ngaka Ⅱ coal fired	600																				4,205	4,205	4,205	4,205	4,205	4,205	4,205
T109	Tanzania	Tanesco	Mtwara(CCGT) Gas fired	300					**2020**	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102
		Tanesco	Somanga(CCGT) Gas fired	240												1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682	1,682
		PPP	Somanga(CCGT) Gas fired	300												2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102	2,102
			Zinga(Bagamoyo)(CCGT) Gas fired	200													1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402
Solar																														
			Dodoma	50					**2019**	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
			Kishapu - Sinyanga	150					**2020**	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263
Wind																														
			Singida	50					**2018**	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
			Singida	75					**2018**	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131
			Makambako	100					**2019**	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
			Singida-Extension	50					**2019**	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131
			Singida	100					**2020**	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
			Singida -Extension	50							88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
Geothermal																														
			Future project												701	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402	1,402
Import																														
			PSMP - EAPP						**2019**	1,402	1,402	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803
									Total Energy	23,232	24,371	27,280	32,589	32,450	32,430	41,147	42,111	46,902	47,434	50,345	50,832	52,430	53,222	58,742	57,708	57,708	54,729	54,729	54,729	54,729
									Hydopower	1,512	1,512	1,512	1,565	1,677	1,677	1,946	2,290	2,876	3,690	4,287	5,430	7,028	7,820	9,135	9,135	9,135	9,135	9,135	9,135	9,135
									Coal-fired	2,803	3,854	5,957	11,213	11,213	11,213	15,418	15,418	19,623	19,623	19,623	19,623	19,623	19,623	23,827	23,827	23,827	23,827	23,827	23,827	23,827
									Gas-fired	15,494	15,494	15,494	15,494	15,243	14,522	18,065	18,685	18,685	18,403	20,716	20,061	20,061	20,061	20,061	19,027	19,027	16,049	16,049	16,049	16,049
									RE(PV, Wind etc.)	1,051	1,139	1,139	1,139	1,139	1,840	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540	2,540
									Diesel and else	970	970	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375
									Import	1,402	1,402	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803	2,803
									Export	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Surplus/Deficit	9,792	9,481	10,790	14,319	12,220	10,000	16,467	14,971	17,072	14,654	14,345	11,292	9,020	5,582	6,472	368	-4,772	-13,331	-19,401	-25,991	-33,161

Source : JICA Survey Team

Table 5.1-45 Generation development analysis, energy review in drought Zambia

Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case Drought 60%	Pool P2009 GWh	Dry Year GWh	Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Zambia									Demand[GWh]	15,749	16,142	16,667	16,996	17,458	17,946	18,461	19,006	19,578	20,184	20,823	21,452	22,099	22,766	23,453	24,161	24,891	25,642	26,416	27,213	28,035
	Existing								Existing																					
Hydro																														
H001	Zambia	ZESCO	Kariba North	720	4x180MW	2400	4000	3137		2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400
H002	Zambia	Kariba North Bank Extension Power Corporation Limited	Kariba North Bank Extension	360		709.8	1183	928																						
H003	Zambia	ZESCO	Kafue Gorge	990	6x165MW		5256	4122		5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251	5,251
H004	Zambia	ZESCO	Victria Fall A	8	2MW,2x3MW		662	437		662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662	662
H005	Zambia	ZESCO	Victria Fall B	60	6x10MW																									
H006	Zambia	ZESCO	Victria Fall C	40	4x10MW																									
H007	Zambia	ZESCO	Lusiwasi Upper	12			125	82		47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
H008	Zambia	ZESCO	Lunzua	14.8	0.75MW					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H009	Zambia	ZESCO	Musonda Falls	10	5MW					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H010	Zambia	ZESCO	Chishimba Falls	15	6MW					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H011	Zambia	ZESCO	Shiwa Ngandu	1						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H012	Zambia	LHPC	Lunsemfwa	25						99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99
H013	Zambia	LHPC	Mulungushi	31						122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122
H014	Zambia	SPC: ITPC (Itezhi Tezhi Power Corporation)(ZESCO &TATA)	Itezhi Tezhi	120	2x60MW		676	446		676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676
Export																														
		SNEL（KCC） (Firm)		-40						-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298	-298
		EDM (Firm)		-100						-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745	-745
		Nampower (Firm)		-50						-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372	-372
		BPC (Non Firm)		-100																										
		SNEL (Non Firm)		-100																										
		Eskom (Non Firm)		-300																										
		ZESA (Non Firm)		-200																										
Import																														
		EDM → (Non Firm A	100MW from EDM																											
		ZESCO → (Non Firm)		300																										
	Planning								Planning																					
Hydro																														
H103	Zambia	ZRA	Batoka Gorge	1200	(2400MW)		3,658	6,097	4,782					3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658
H104	Zambia	CEC&TATA	Kabompo Gorge	40	2x17MW					158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158
H105	Zambia	ZESCO	Kafue Gorge Lowe	750	4x187.5MW		1,800	3,000	2,330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H106	Zambia	ZESCO	Lusiwasi Lower	74	86MW		175	292		175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
H107	Zambia	Power Min	Luchenene	34	1x30MW		80	134				80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
H108	Zambia	Power Min	Mutinondo	43	1x40MW		102	170				102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102
H109	Zambia	Lunzua Power Authoı	Kabwelume	96				880	581			227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227	227
H110	Zambia	Lunzua Power Authoı	Kundabwika	151			227	378				357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357
H111	Zambia	GRZ/DRC	Mumbotuta Falls	490			357	595							1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159
H112	Zambia	GRZ/DRC	Mambilima Falls I	126			1,159	1,932							298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298
H113	Zambia	GRZ/DRC	Mambilima Falls II	202			298	497							478	478	478	478	478	478	478	478	478	478	478	478	478	478	478	478
H114	Zambia	GRZ/DRC	Mambilima Falls V	372			478	796							880	880	880	880	880	880	880	880	880	880	880	880	880	880	880	880
H118	Zambia	Western Power company	Ngonye falls	40	40-60MW		95	158		95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
Thermal																														
T101	Zambia	MCL	Maamba Coal firec	600	2x300MW					4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
Solar																														
S101	Zambia	IDC	n/a	300						526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	1,051
									Total	13,000	13,000	13,766	13,766	17,425	20,239	20,239	20,239	20,239	20,239	20,239	20,239	20,239	20,239	20,239	20,239	20,239	20,239	20,239	20,239	20,765
									Hydopower	9,684	9,684	10,451	10,451	14,109	16,923	16,923	16,923	16,923	16,923	16,923	16,923	16,923	16,923	16,923	16,923	16,923	16,923	16,923	16,923	16,923
									Coal-fired	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205	4,205
									Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									RE(PV, Wind etc.)	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	526	1,051
									Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Import	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Export	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415	-1,415
									Surplus/Deficit	-2,749	-3,142	-2,901	-3,230	-33	2,293	1,778	1,233	661	55	-584	-1,213	-1,860	-2,527	-3,214	-3,922	-4,652	-5,403	-6,177	-6,974	-7,270

Source : JICA Survey Team

Table 5.1-46 Generation development analysis, energy review in drought Zimbabwe

Zimbabwe

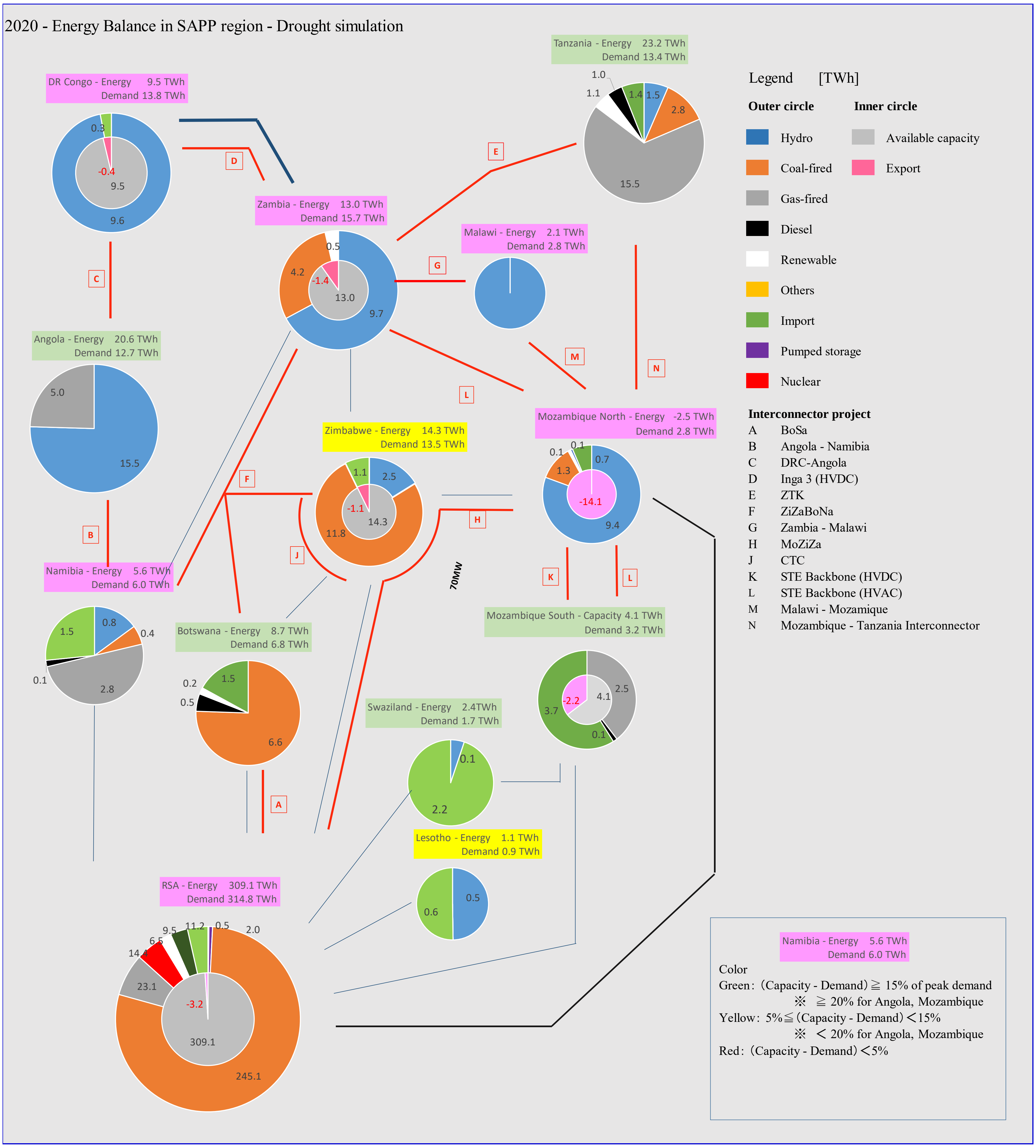
Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	Pool P2009	Dry Year GWh	Demand[GWh]	13,534	14,349	15,221	15,926	16,677	17,461	18,280	19,142	20,057	21,008	22,012	23,069	24,172	25,345	26,569	27,862	29,249	30,679	32,182	33,756	35,408
	Existing								Existing																					
Hydro																														
H001	Zimbabwe	ZPC	Kariba South	750	6x125MW	2,400	4,000	3,137		2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400
H002	Zimbabwe	IPP(Nyangani Renewable Energy)	Pungwe A	2.7																										
H003	Zimbabwe	IPP(Nyangani Renewable Energy)	Pungwe B	15.25																										
H004	Zimbabwe	IPP(Nyangani Renewable Energy)	Duru	2.2																										
H005	Zimbabwe	IPP(Nyangani Renewable Energy)	Nyamhingura	1.1																										
Thermal																														
T001	Zimbabwe	ZPC	Hwange1-6	920	4x120, 2x220MW ->700							3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827	3,827
T002	Zimbabwe	ZPC	Munyati	100	-> 20					394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
T003	Zimbabwe	ZPC	Bulawayo	90	3x30MW -> 20					394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394	394
T004	Zimbabwe	ZPC	Harare	120	1x20MW, 2x30MW -> 30					307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307
Export																														
		Nampower (Firm)		-150	though Cprivi link					-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117
		Eskom (Non Fir	As Available																											
Import																														
		→ HCB (Firm)		100						745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745	745
		→ SNEL (Firm)		50						372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372	372
		→ HCB (Non F	As Available																											
		→ EDM (Non Firm)		50																										
		→ ZESCO (Non Firm)		200																										
		→ SNEL (Non Firm)		50																										
		→ Eskom (Non	As Available																											
	Planning								Planning																					
Hydro																														
H101	Zimbabwe	SPC(ZPC has developed SPV)	Kariba South E	300	2x150	710	1,183	928		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H104	Zimbabwe	ZPC	Batoka Gorge	1200	4x300MW (4x300MW)	3,658	6,097	4,782				3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658	3,658
H105	Zimbabwe	Private Company owned by Zim.Gov.	Gairezi	30	2x15MW	95	158			95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
H107	Zimbabwe	IPP	Tsanga	3.3																										
H108	Zimbabwe	IPP	Osborne	3																										
H110	Zimbabwe	IPP	Manyuchi	1.4																										
H111	Zimbabwe	IPP	Duru	2.3																										
H112	Zimbabwe	IPP	Siya	0.9																										
H113	Zimbabwe	IPP	Mutirikwi	1.4																										

Source : JICA Survey Team

Generation development analysis, energy review in drought　Zimbabwe – Cont'd

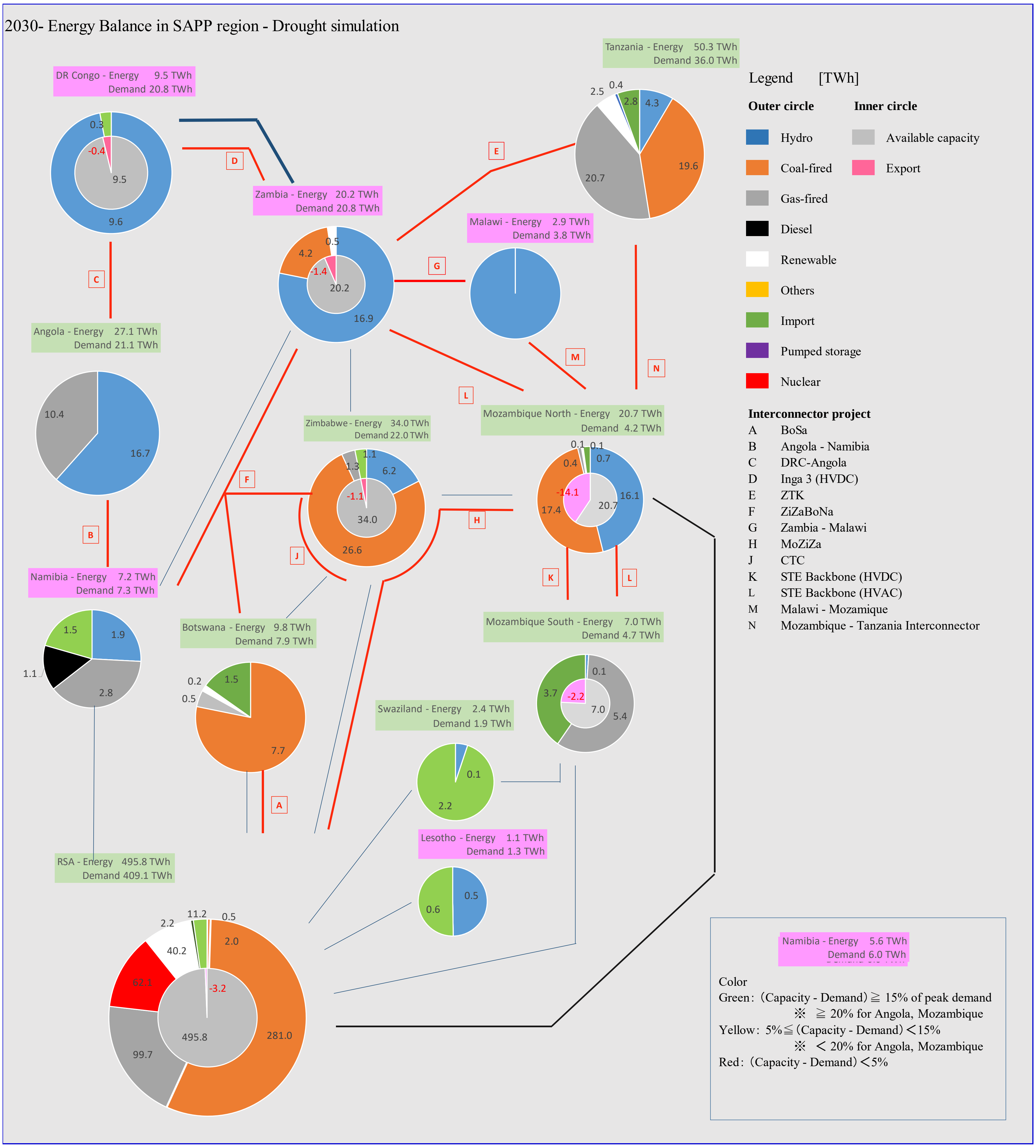
Lot	Country declared	Utility	Project name	Capacity (MW)		Drought Case			Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
						Drought 60%	Poor P2009 GWh	Dry Year GWh	Demand[GWh]	13,534	14,349	15,221	15,926	16,677	17,461	18,280	19,142	20,057	21,008	22,012	23,069	24,172	25,345	26,569	27,862	29,249	30,679	32,182	33,756	35,408
Thermal																														
T101	Zimbabwe	ZPC	Hwange7-8 Coal fired	600	2x300MW					2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628
T102	Zimbabwe	ZPC/ Private	Lupane Coal fired	300	2x150MW										1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314
T103	Zimbabwe	Rio Zim	Gokwe North (Sengwa) Coal fired	1200	4x300MW										1,314	1,314	2,628	2,628	3,942	3,942	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256
T104	Zimbabwe	IPP	Lususu Coal fired	600	2x300MW					1,314	1,314	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628	2,628
T105	Zimbabwe	Co-Ash Resources	Waste coal fired	250						1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095
T106	Zimbabwe	CASECO	CASECO Coal fired	600	2x300MW					1,577	1,577	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154
T107	Zimbabwe	Southern Energy	Southern Energy Coal fired	660	2x330MW					3,469	3,469	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938	6,938
T108	Zimbabwe	ZPC	ZPC Diesel	120																										
									Total	13,672	13,672	27,517	27,517	27,517	30,145	30,145	31,459	31,459	32,773	32,773	34,087	34,087	34,087	34,087	34,087	34,087	34,087	34,087	34,087	34,087
									Hydopower	2,495	2,495	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153
									Coal-fired	11,178	11,178	21,365	21,365	21,365	23,993	23,993	25,307	25,307	26,621	26,621	27,935	27,935	27,935	27,935	27,935	27,935	27,935	27,935	27,935	27,935
									Gas-fired	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									RE(PV, Wind etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Diesel and else	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
									Import	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117	1,117
									Export	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117	-1,117
									Surplus/Deficit	138	-677	12,296	11,591	10,840	12,684	11,865	12,317	11,402	11,765	10,761	11,018	9,915	8,742	7,518	6,225	4,838	3,408	1,905	331	-1,321

Source : JICA Survey Team



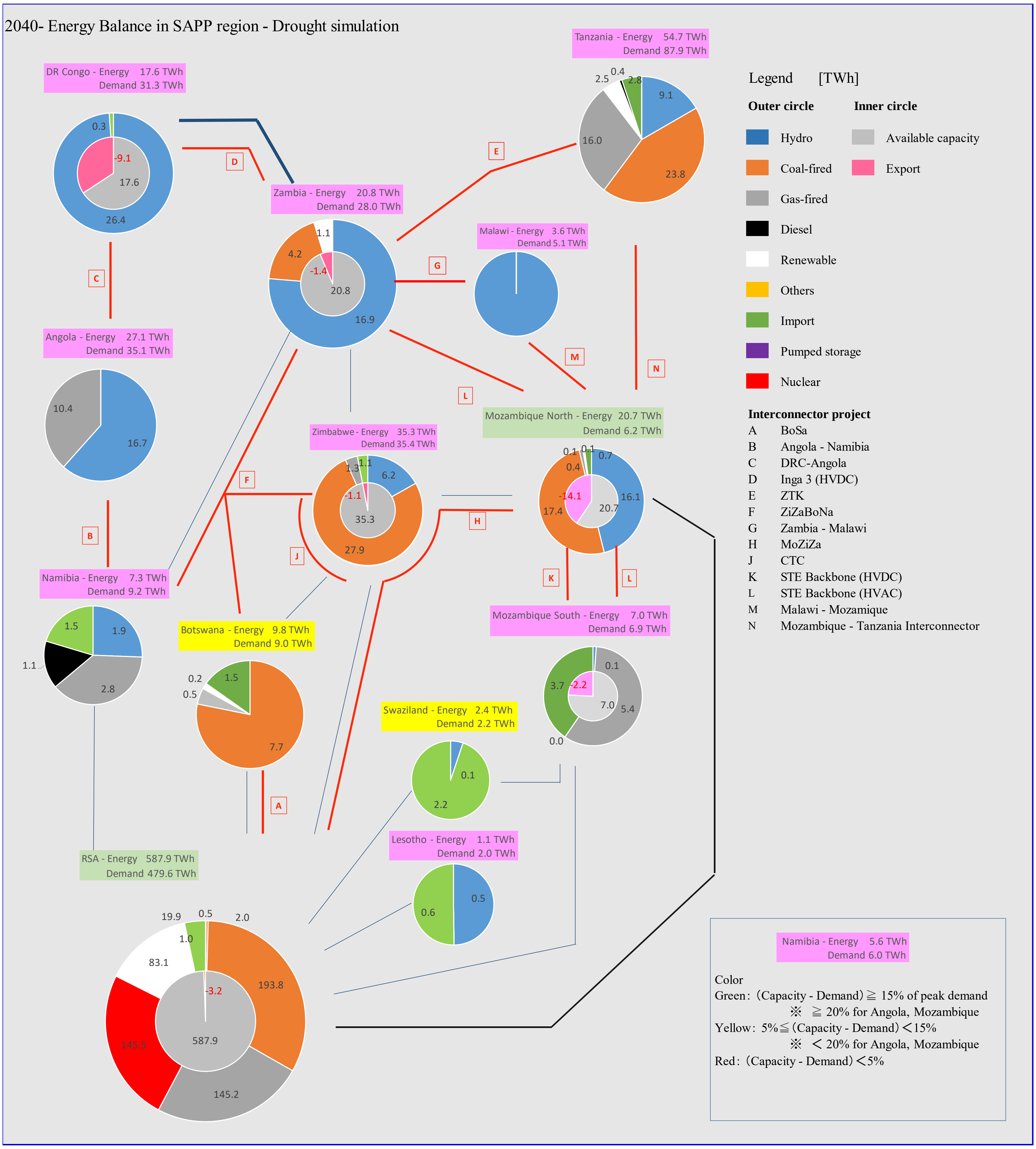
Source : JICA Survey Team

Figure 5.1-24 Demand and supply balance in SAPP (Energy review in drought) 2020



Source : JICA Survey Team

Figure 5.1-25 Demand and supply balance in SAPP (Energy review in drought) 2030



Source : JICA Survey Team

Figure 5.1-26 Demand and supply balance in SAPP (Energy review in drought) 2040

5.1.3 System planning analysis

Based on the result of generation development plan analysis, system planning of each SAPP member state was analyzed. Demand forecast and expected commencement year of each generation project was given from aforementioned sections. However, precise information to utilize the power flow calculation, such as demand magnitude of each substation etc. cannot be obtained from evidences of power system master plan. Therefore, the Survey applied simple calculation, i.e. confirmation to be able to feed the power from generation project focused to load center of the state, and diagnosed the system configuration. Further, at the moment some of interconnector projects' specification, such as transmission capacity and trading magnitude etc., are not clear. The Survey therefore applied fundamental specification of conductor [76] which usual applied as an interconnector.

It is noted that precise load flow calculation will be needed to analyze whole systems when specification, such as allocation of demand at substations, conductor specification etc. will be apparent.

Figure 5.1-27 - Figure 5.1-65 show the system planning diagrams for each SAPP member state.

System planning diagram has normally four (4) scenes, as of 2016, as of 2020, as of 2030, and as of 2040 for a state[77]. Dot line(s) represents the transmission line(s) to be committed in the designated ages.

These diagrams also represent interconnectors to be implemented in collaboration with national grid.

Followings are brief explanation of each state's perspective.

1) Angola

Figure 5.1-27, Figure 5.1-28, Figure 5.1-29 and Figure 5.1-30 show the transition of grid integration.

By 2020, northern system integration will be necessary for hydropower generation development along Kwanza river basin and for introduction of Soyo 1 gas-fired.

By 2030, interconnection among central, southern and northern regions and co-development of Baynes hydropower and Angola – Namibia interconnector will be commenced.

By 2040, grid enhancement for northwestern system and connection between mainland and Cabinda area via Inga will be commenced.

2) Botswana

Figure 5.1-31, Figure 5.1-32, Figure 5.1-33 and Figure 5.1-34 show the transition of grid integration.

Currently, trunk transmission line lied down between Zimbabwe and RSA via Gabonone, capital of Botswana, nationwide gird has not been achieved yet.

By 2020, corridor will be strengthened by BoSa project. And nationwide trunk grid will be accomplished by 2030 to connect the entrance of ZiZaBoNa project making it possible to energize power trade between northern SAPP area and southern SAPP area.

It is noted that BoSa project has a technical option, 500 kV design. That is why make it possible to upgrade 500 kV for corridor(s) near future.

3) DR Congo

Figure 5.1-35, Figure 5.1-36, Figure 5.1-37 and Figure 5.1-38 show the transition of grid integration.

DR Congo's system binds Inga 1 and Inga 2, the downstream of Congo river and load center, Kinshasa,

[76] 4 bundled Bison or 4 bundled Tern, its thermal capacity is 1,600 MW, will be applied.
[77] Except RSA

the capital of DR Congo and Brazzabille, Republic of the Congo, and binds hydropowers and Katanga province with ±500kV HVDC. And in Kivu province some hydropowers and feeders exist.

Generation development plan, especially hydropower development in DR Congo is fragile, therefore grid expansion is also fragile. In terms of this aspect, the Survey focuses Inga 3 development and interconnector for Angola.

In accordance with Inga 3implementation, new HVDC line(s) will be commenced by 2030.尚、The line(s) will be extended to Zambian border. 1,300 MW, net quota for local mining industry will be fed to Katanga province with HVDC line(s). Thus, 3,800 MW in total, 2,500 MW for RSA and 1,300 MW, will be transported by HVDC[78].

Interconnector for Angola will be committed in 2040.

4) Malawi

Figure 5.1-39, Figure 5.1-40, Figure 5.1-41 and Figure 5.1-42 show the transition of grid integration.

In the early 2020s, interconnector between Malawi and Mozambique will be committed, especially will be accessed at Phombeya. And trunk system in Malawi will be upgraded to 400kV gradually.

As for interconnector between Malawi and Tanzania, it will be accomplished in the late 2020 in line with Songwe river basin in collaboration with Tanesco.

Construction for interconnector between Malawi and Zambia will be delayed compare to other interconnectors.

5) Mozambique

Figure 5.1-43, Figure 5.1-44, Figure 5.1-45 and Figure 5.1-46 show the transition of grid integration.

Currently southern gird and north-central grid is not connected yet.

By 2020, southern grid will be grown to Temane with 400 kV to meet gas-fired power plant commission, and power line(s) will be commenced for coal-fired IPP projects in northern grid.

In the early 2020s, 400 kV Caia – Namialo trunk transmission line will be grown to bind northern and central Mozambique and interconnector for Malawi will be also accomplished.

From middle to late 2020s, hydropower development will be energized. Therefore, national grid integration will be needed.

By 2030, many interconnector projects, such as Malawi - Mozambique Interconnector, STE backbone and MoZiSa and Zambia - Mozambique Interconnector will be successful to accomplish. Here, STE backbone will be implemented in the late 2020s and 2030s to secure the reliance with double HVDCs.

6) Namibia

Figure 5.1-47, Figure 5.1-48, Figure 5.1-49 and Figure 5.1-50 show the transition of grid integration.

Currently power injection from Ruacana hydropower, from Walvis Bay, coastal area, and from RSA are concentrated to Windhoek.

As of 2020, Kudu gas-fired development and 400kV trunk system enhancement for northern area will be commenced. And especially in 2020s, 400kV transmission line integration to access Ruacana and Baynes hydropowers are main issues.

[78] Capacity of HVDC technologies state of the art is 8,000 MW（DC±800kV、Connecting AC voltage 500kV in China）. And operating facility has its capacity, 8,000 MW (connecting AC voltage is 400kV) in India.

HVDC system, one of ZiZaBoNa components has the capacity of 300 MW. When generation development is energized in SAPP northern area, this capacity might be upgraded to 600 MW.

7) RSA

Figure 5.1-51, Figure 5.1-52 and Figure 5.1-53 show the transition of grid integration.

These were composed by the plan on TDP 2016. Double 765kV trunk lines will accomplished before or after 2020. And 400 kV system integration in northern region in line with implementation of BoSa project will be commenced.

400 kV transmission integration in southern coastal area to prepare gas-fired and nuclear generation developments will be the middle of 2020s.

8) Tanzania

Figure 5.1-54, Figure 5.1-55, Figure 5.1-56 and Figure 5.1-57 show the transition of grid integration.

Tanzania is now constructing 400 kV trunk system and this will be accomplished in 2020. Further, connections with Kenya and with Zambia will be commenced in the early 2020s to the middle of 2020s.

Interconnector with Malawi will be set in line with introduction of Songwe hydropowers in the late 2020s.

9) Zambia

Figure 5.1-58, Figure 5.1-59, Figure 5.1-60 and Figure 5.1-61 show the transition of grid integration.

In 2016, 330kV evacuation transmission line from Lusaka, capital of Zambia to Lumwana, North-Western province via Itezhi Tezhi hydropower has been commenced.

In early first decade of the 2020s ZTK project will be commenced and in the middle of the2020s southern Zambian trunk system, its voltage is 330kV will be commenced to evacuate the power from Batoka Gorge hydropower and Maamba coal-fired. Further, in the late of the 2020s connection with Namibia and Zimbabwe, components of ZiZaBoNa project will be commenced.

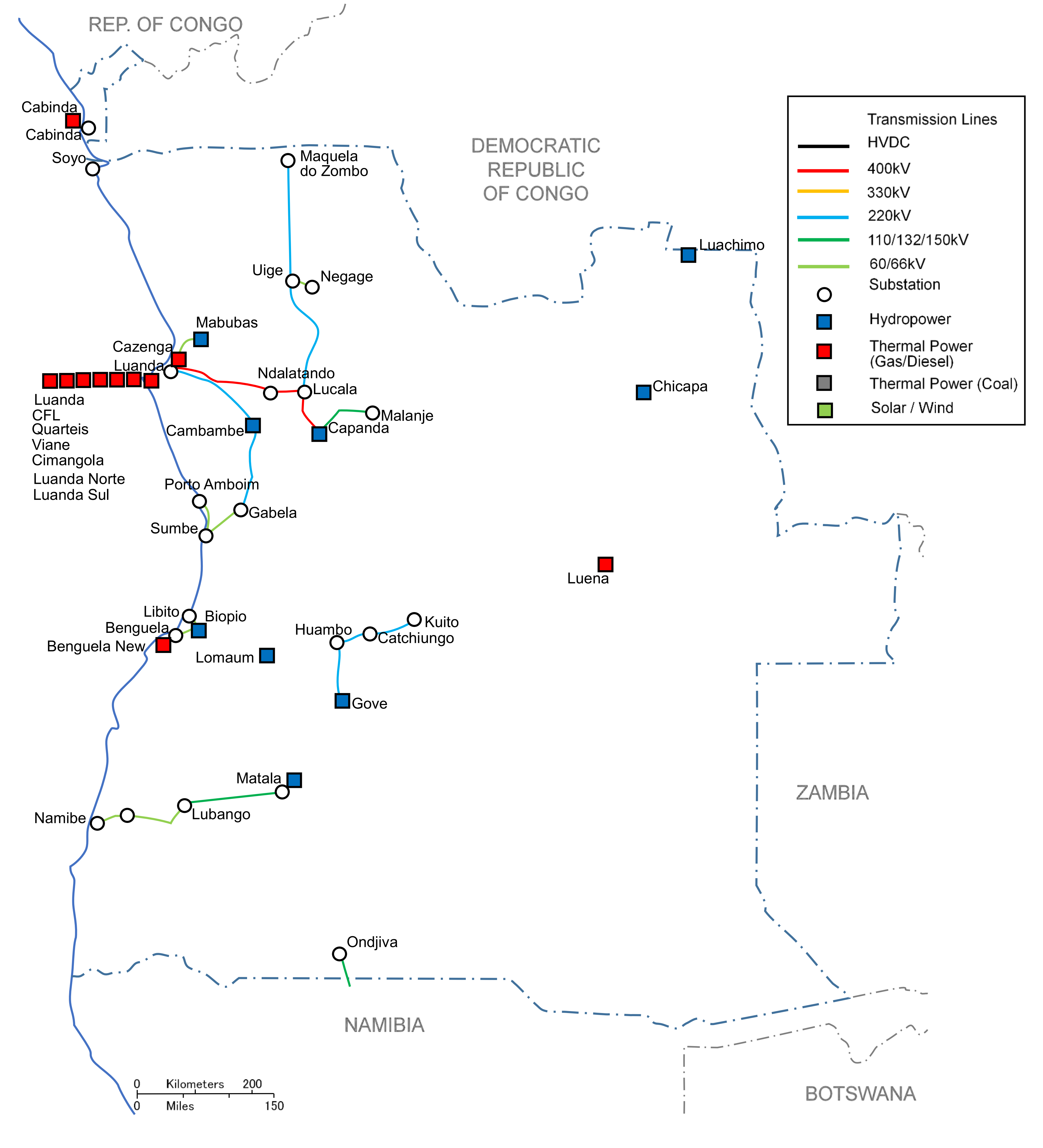
Integration in north-eastern area will be also commenced in the middle of the 2020s to prepare the hydropower development along Luapula river basin.

10) Zimbabwe

Figure 5.1-62, Figure 5.1-63, Figure 5.1-64 and Figure 5.1-65 show the transition of grid integration.

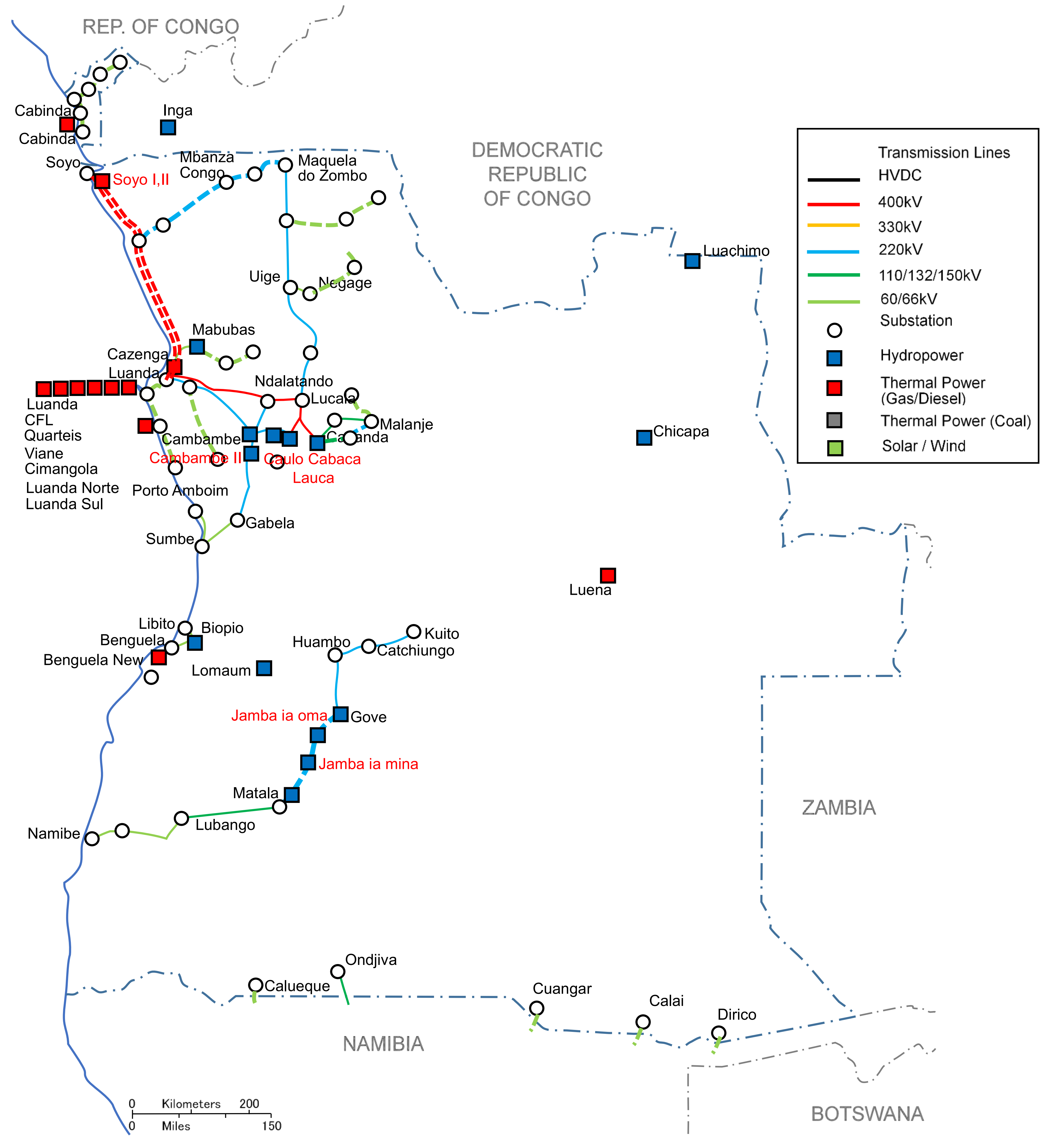
Zimbabwean grid waits huge-sized coal-fired power plants by IPP in short term and needs to implement trunk line. Therefore trunk line from western Zimbabwe to load center will be commenced in 2020.

By 2030, connection between Mozambique and RSA with MoZiSa project will be commenced.



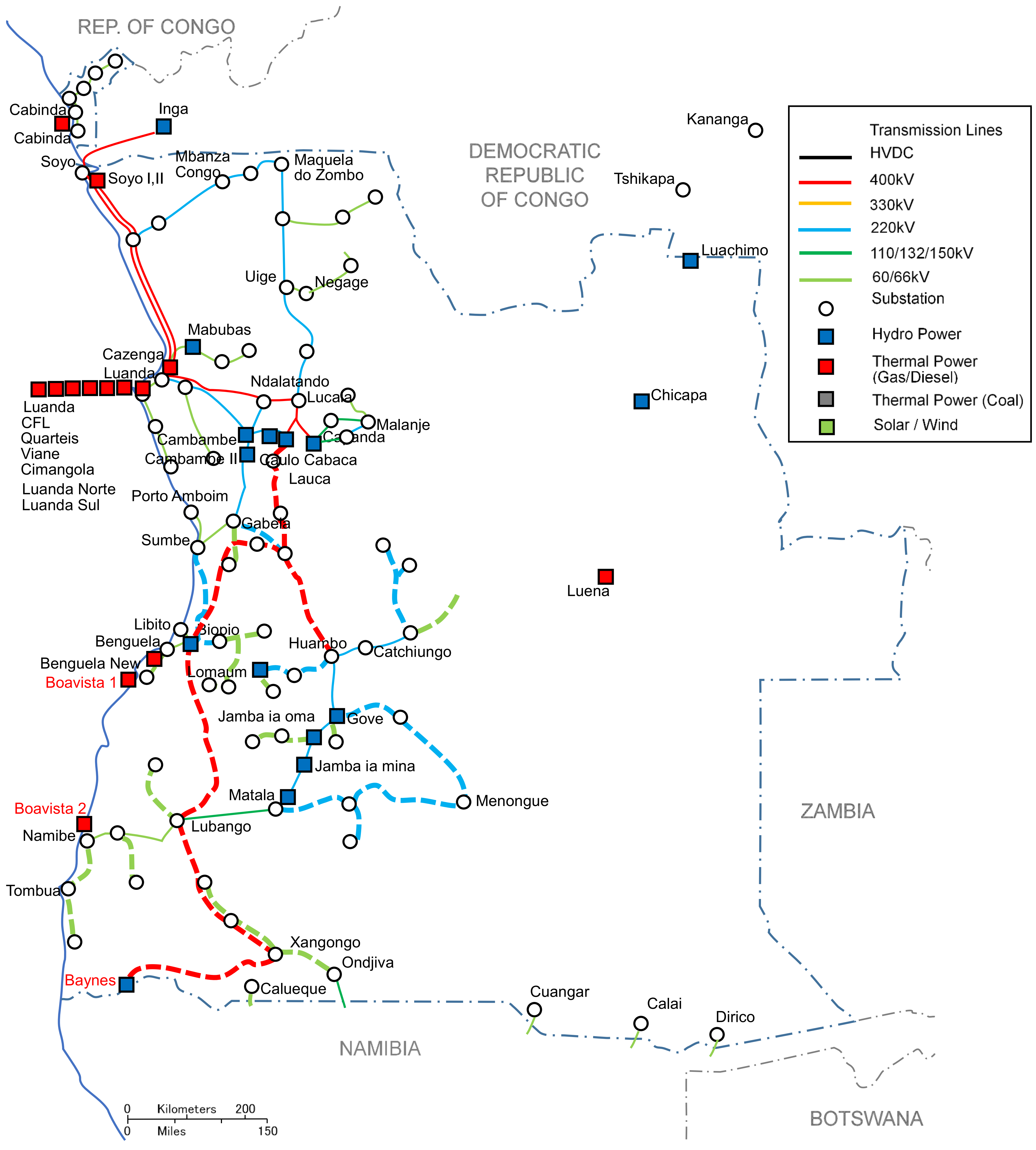
Source : JICA Survey Team

Figure 5.1-27 System planning (Angola) current condition



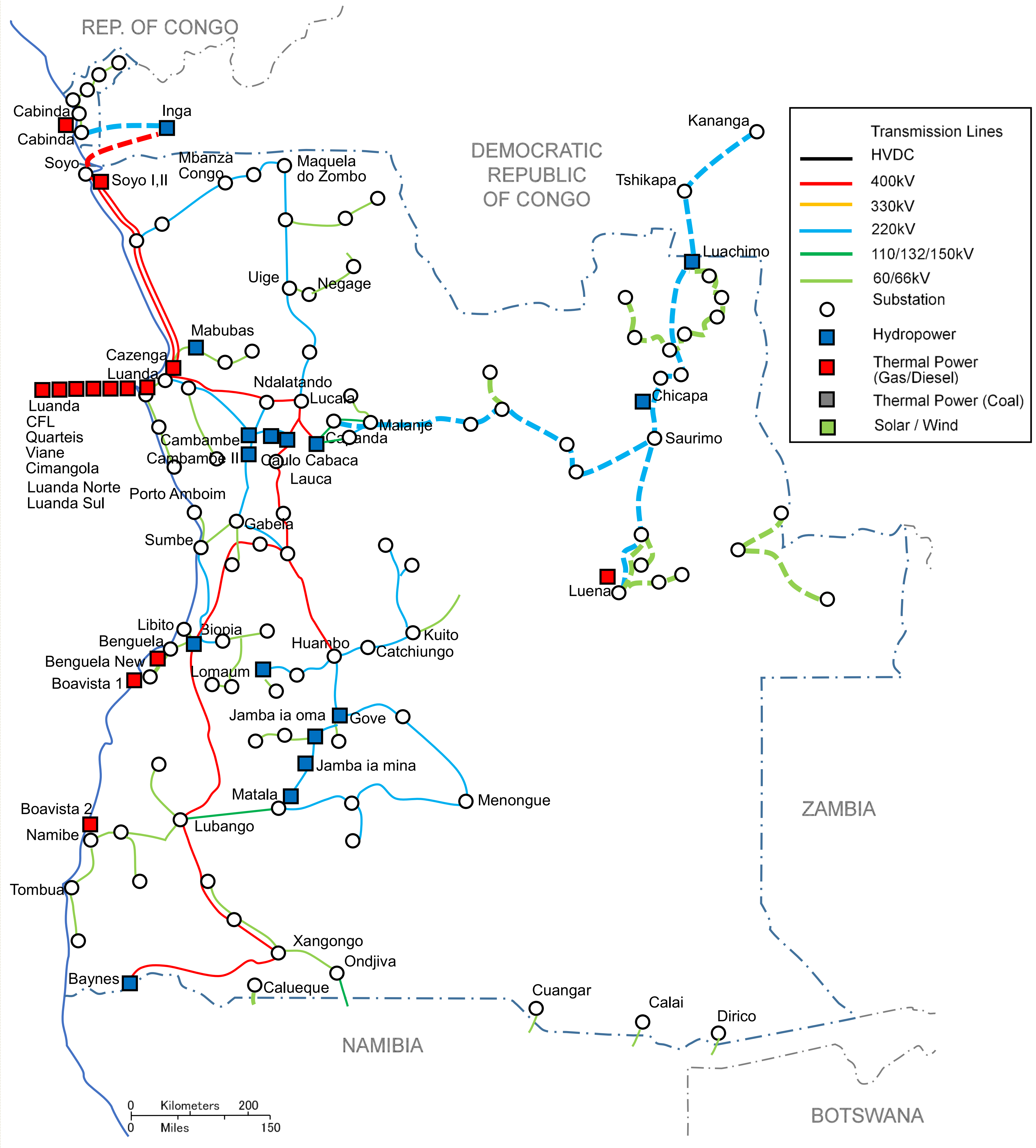
Source : JICA Survey Team

Figure 5.1-28 System planning (Angola) 2020 perspective



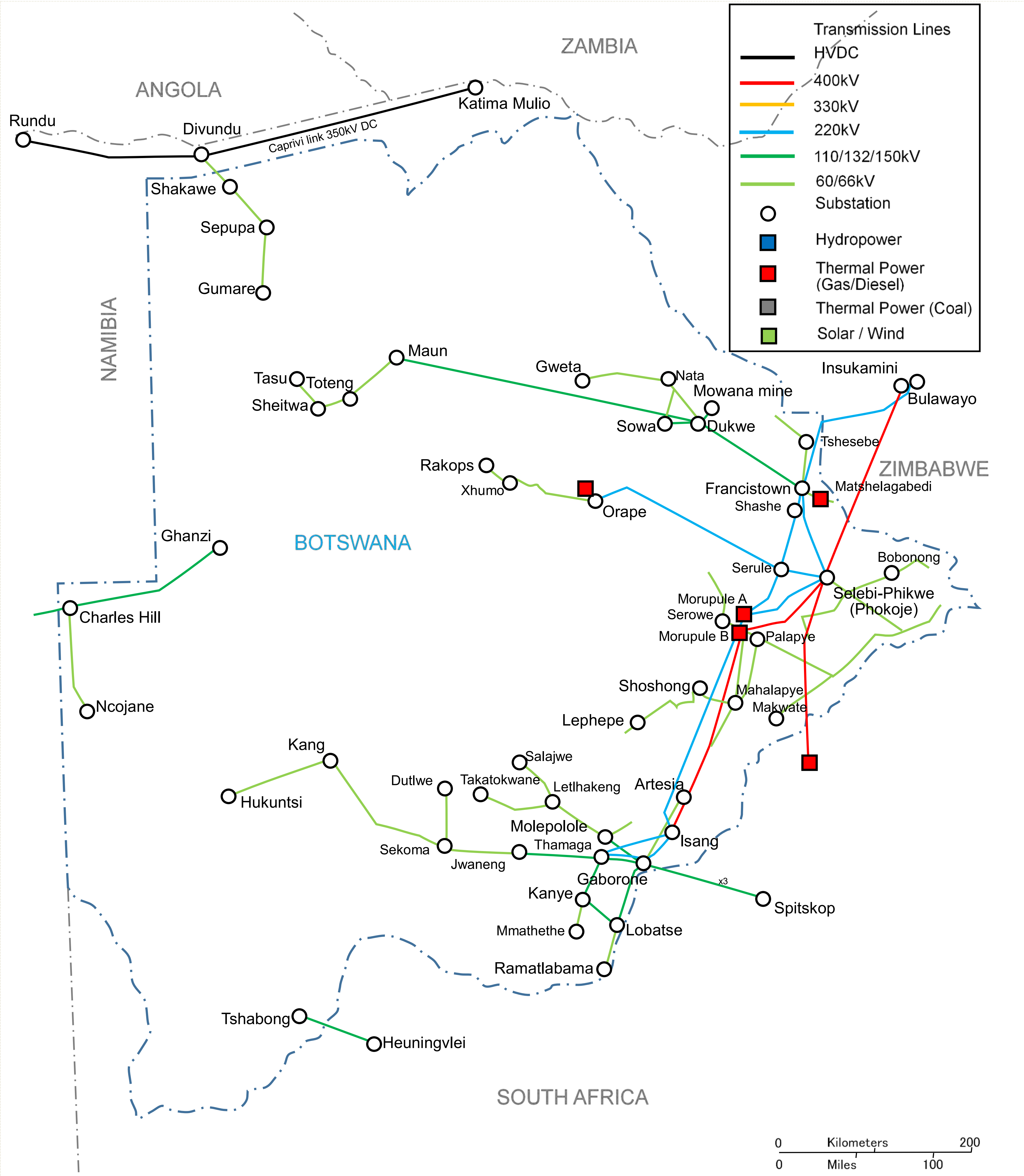
Source : JICA Survey Team

Figure 5.1-29 System planning (Angola) 2030 perspective



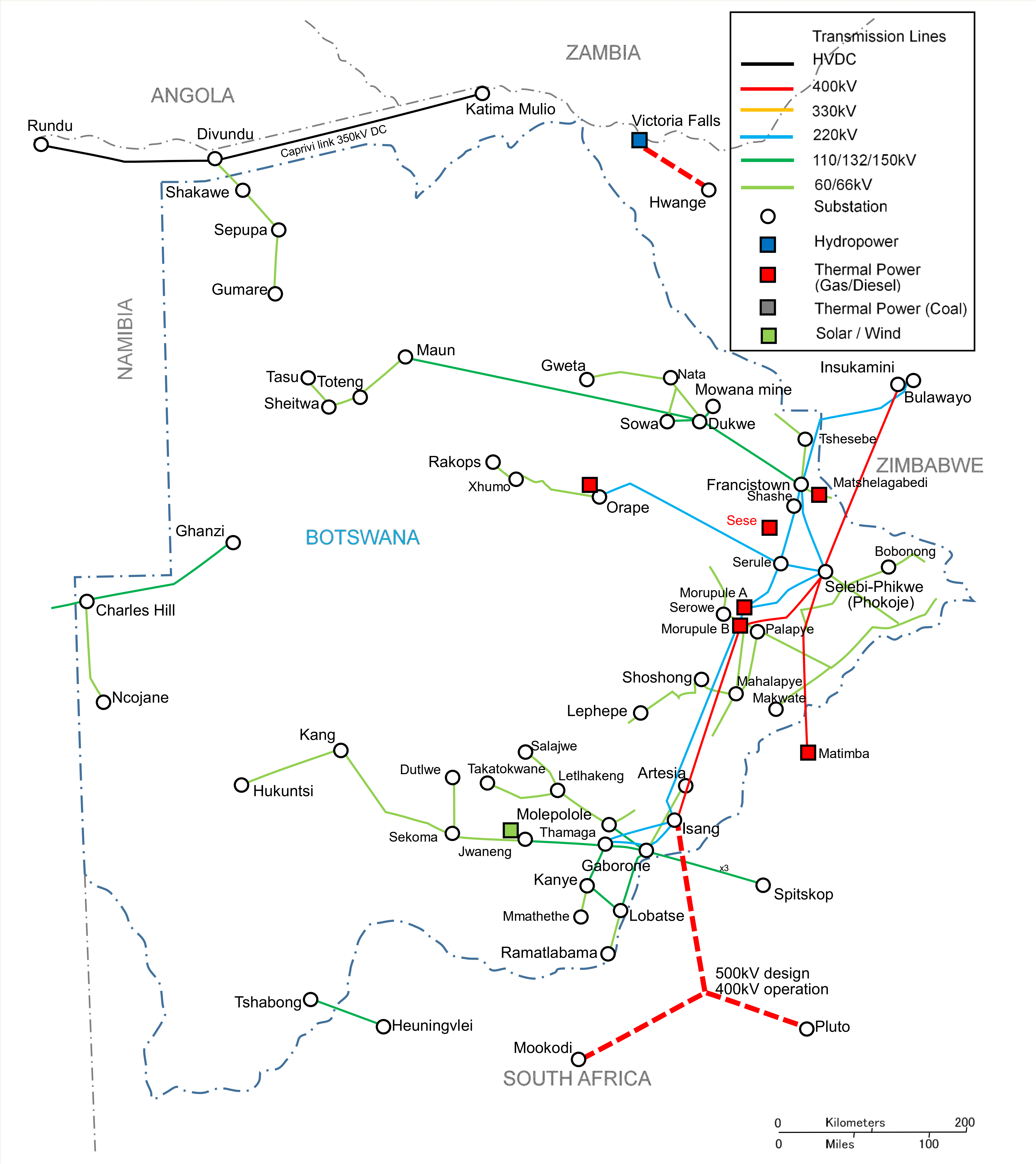
Source : JICA Survey Team

Figure 5.1-30 System planning (Angola) 2040 perspective



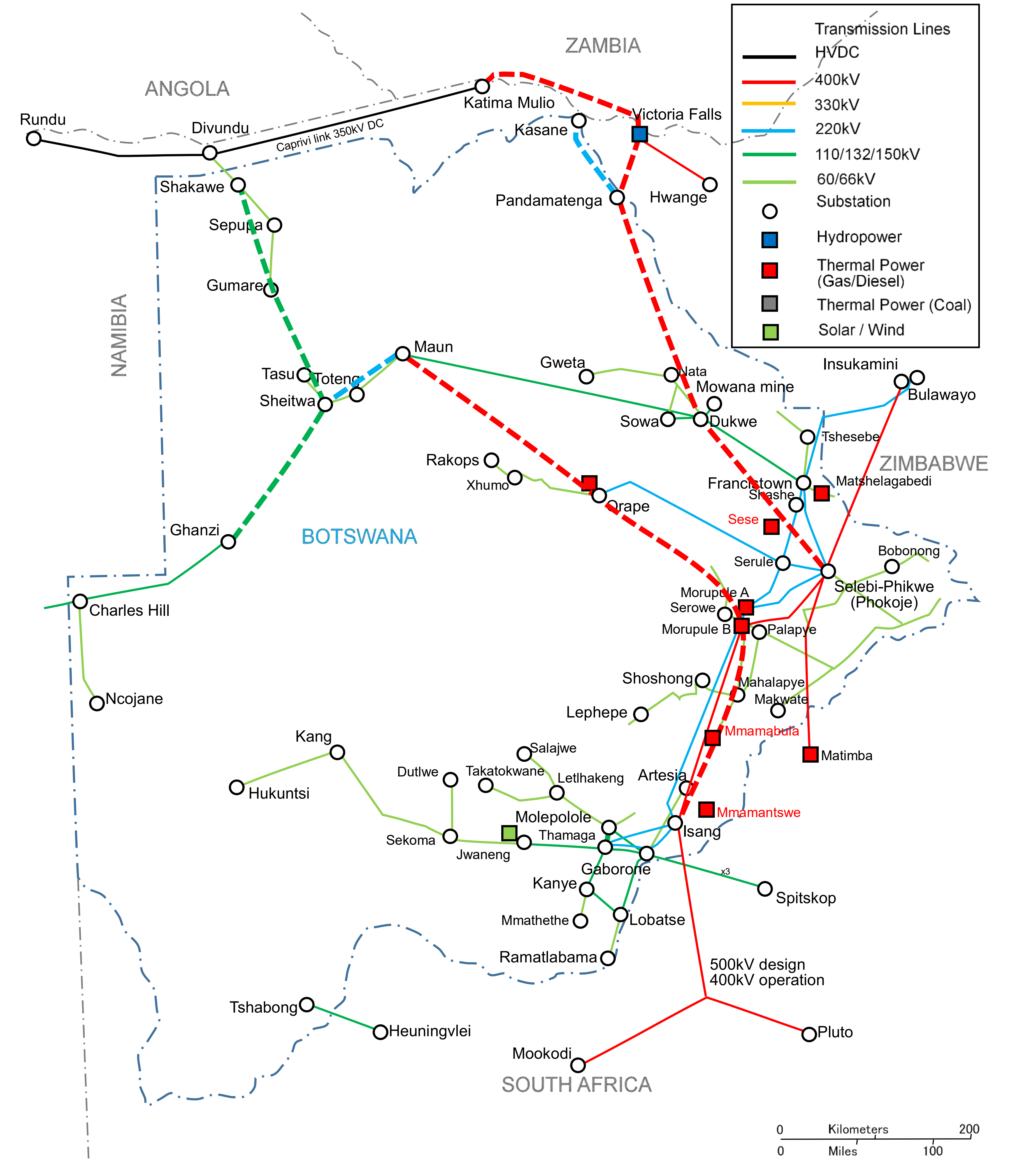
Source : JICA Survey Team

Figure 5.1-31 System planning (Botswana) current condition



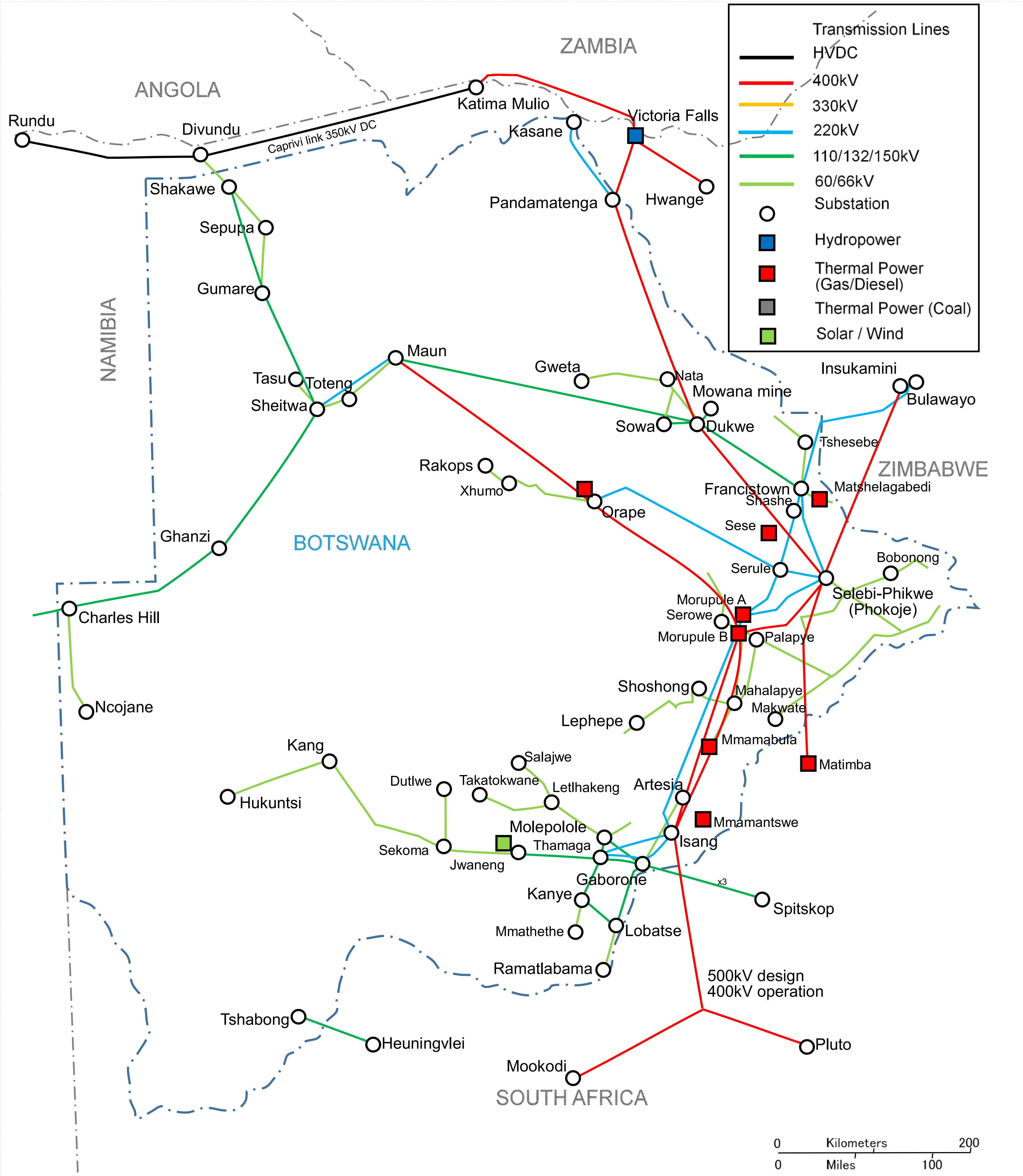
Source : JICA Survey Team

Figure 5.1-32 System planning (Botswana) 2020 perspective



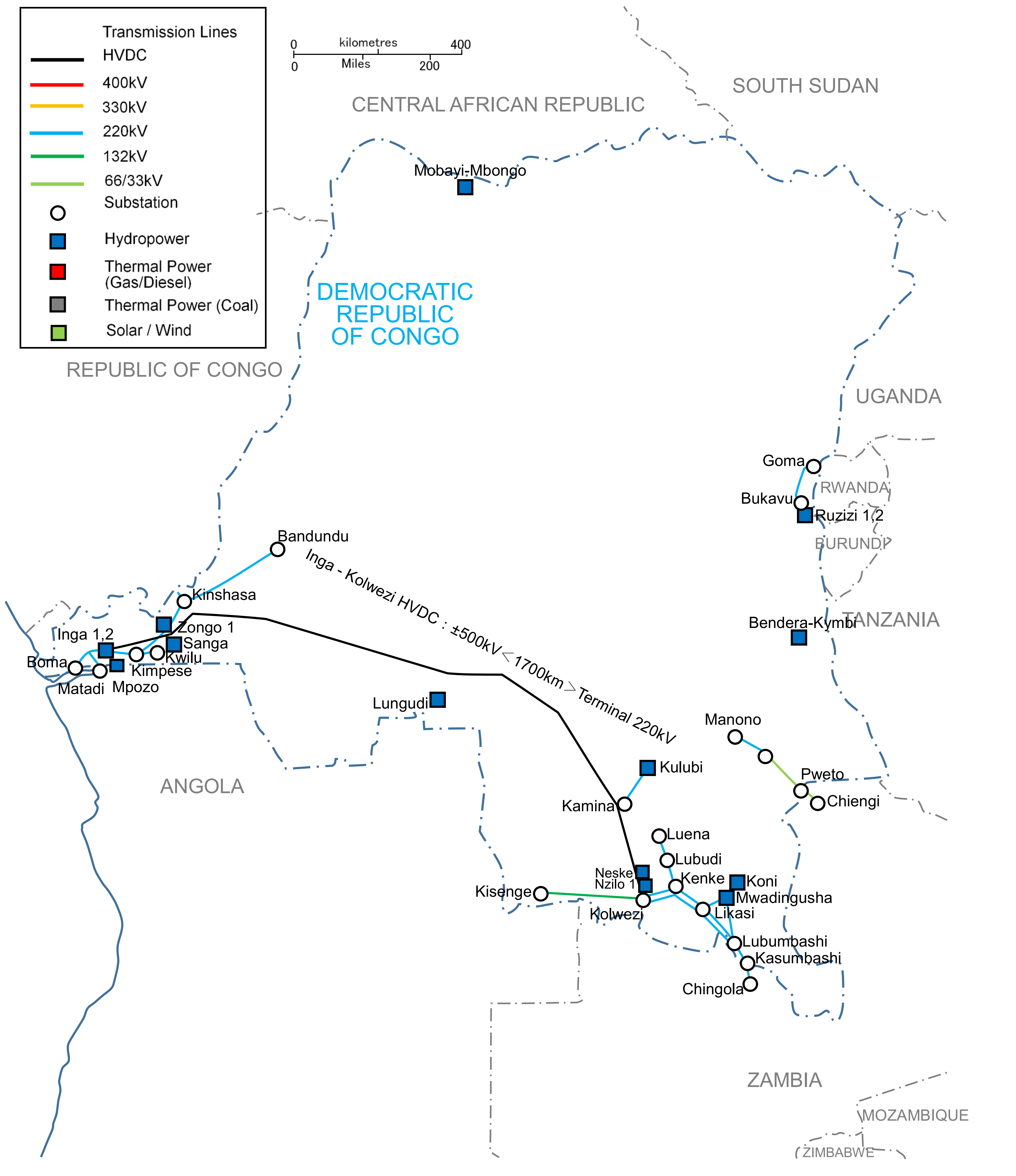
Source : JICA Survey Team

Figure 5.1-33 System planning (Botswana) 2030 perspective



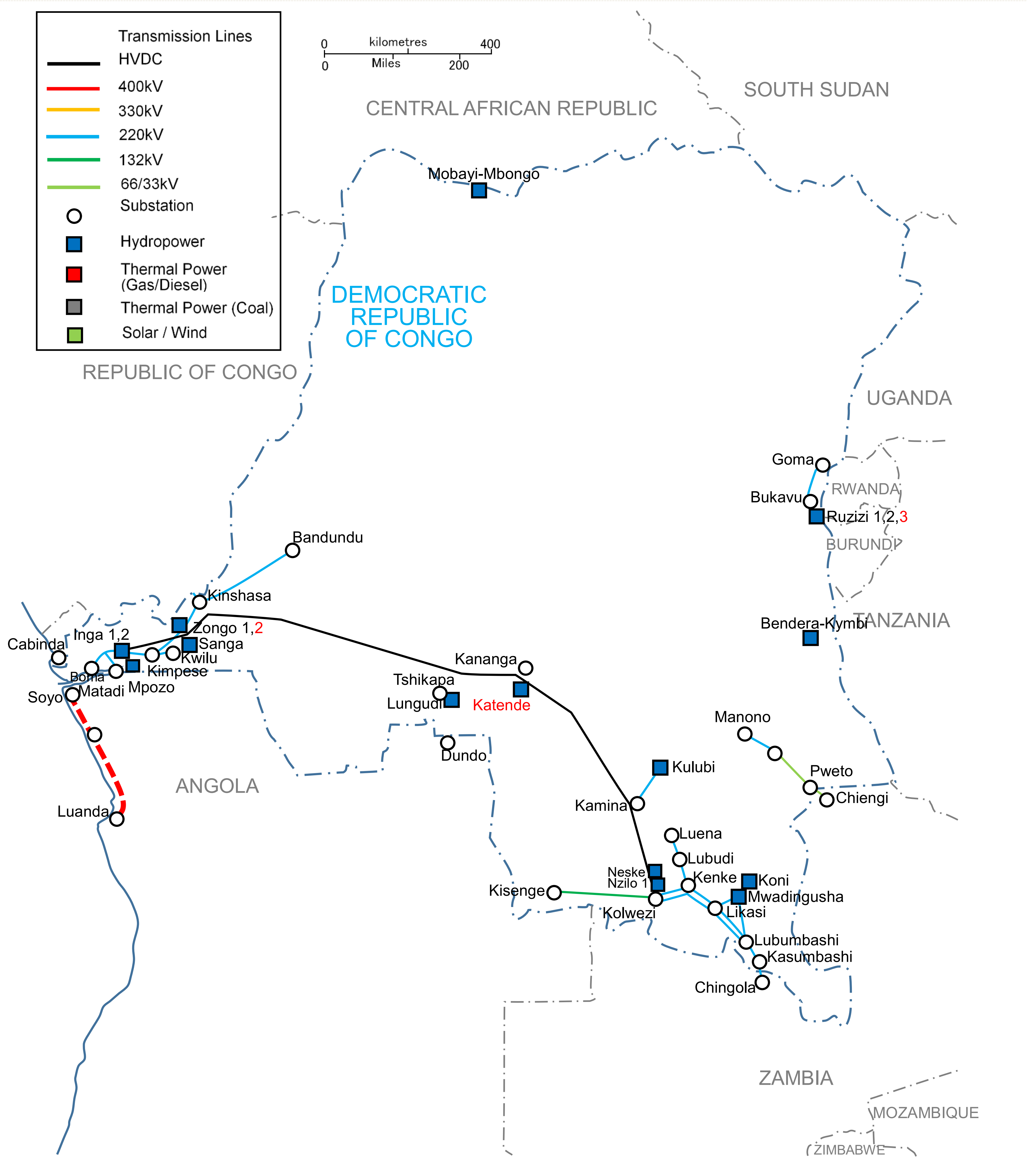
Source : JICA Survey Team

Figure 5.1-34 System planning (Botswana) 2040 perspective



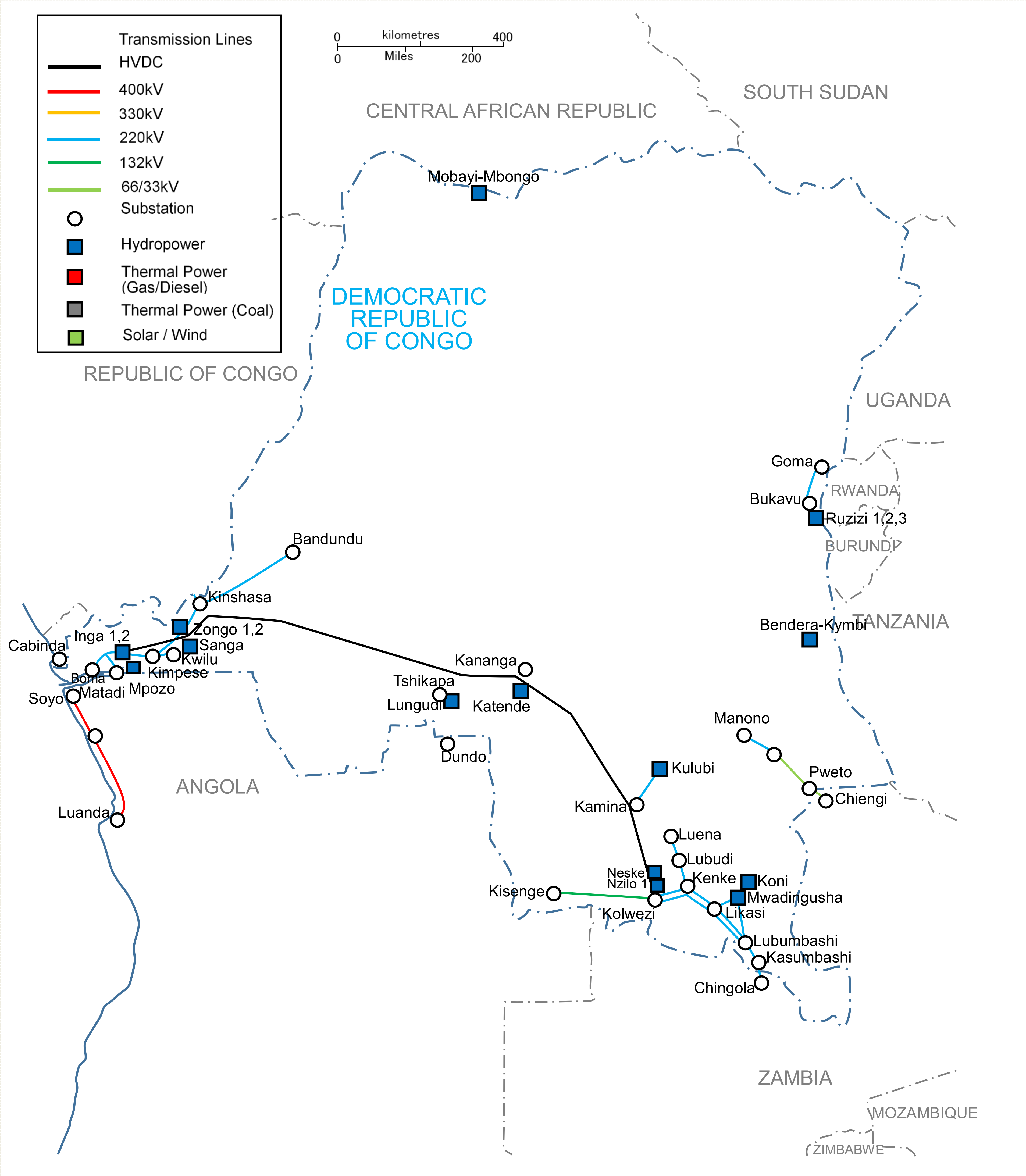
Source : JICA Survey Team

Figure 5.1-35 System planning (DR Congo) current condition



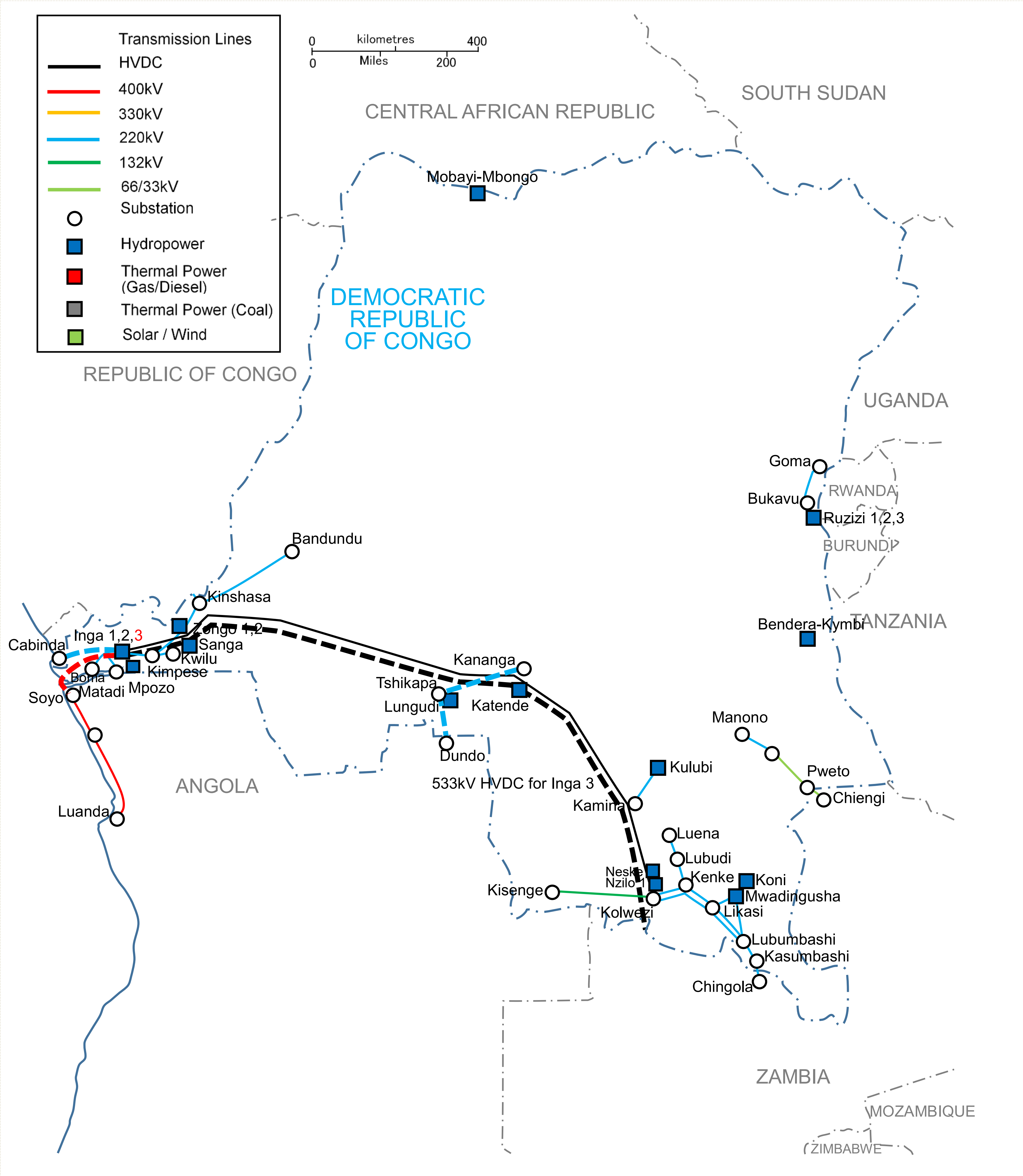
Source : JICA Survey Team

Figure 5.1-36 System planning (DR Congo) 2020 perspective



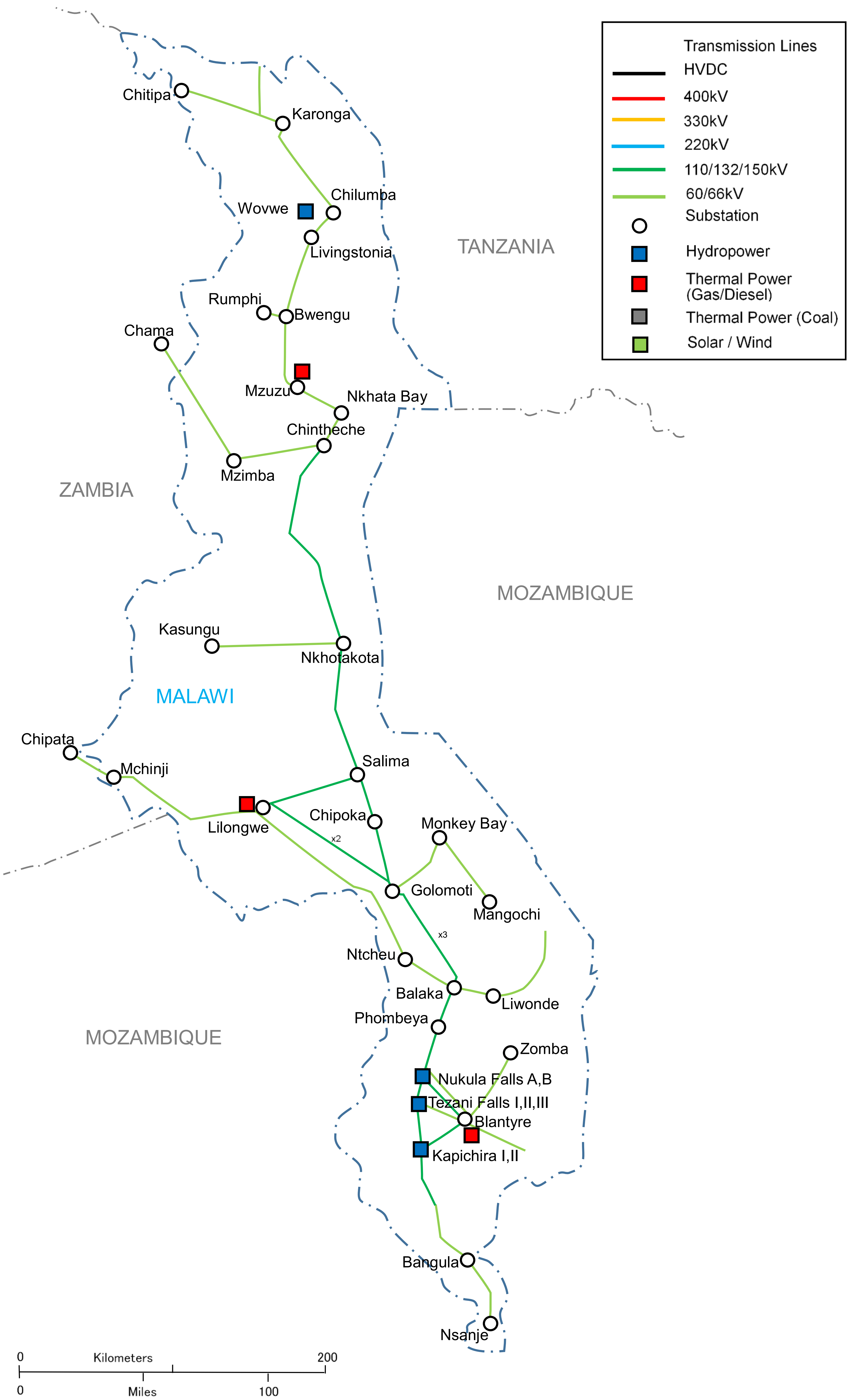
Source : JICA Survey Team

Figure 5.1-37 System planning (DR Congo) 2030 perspective



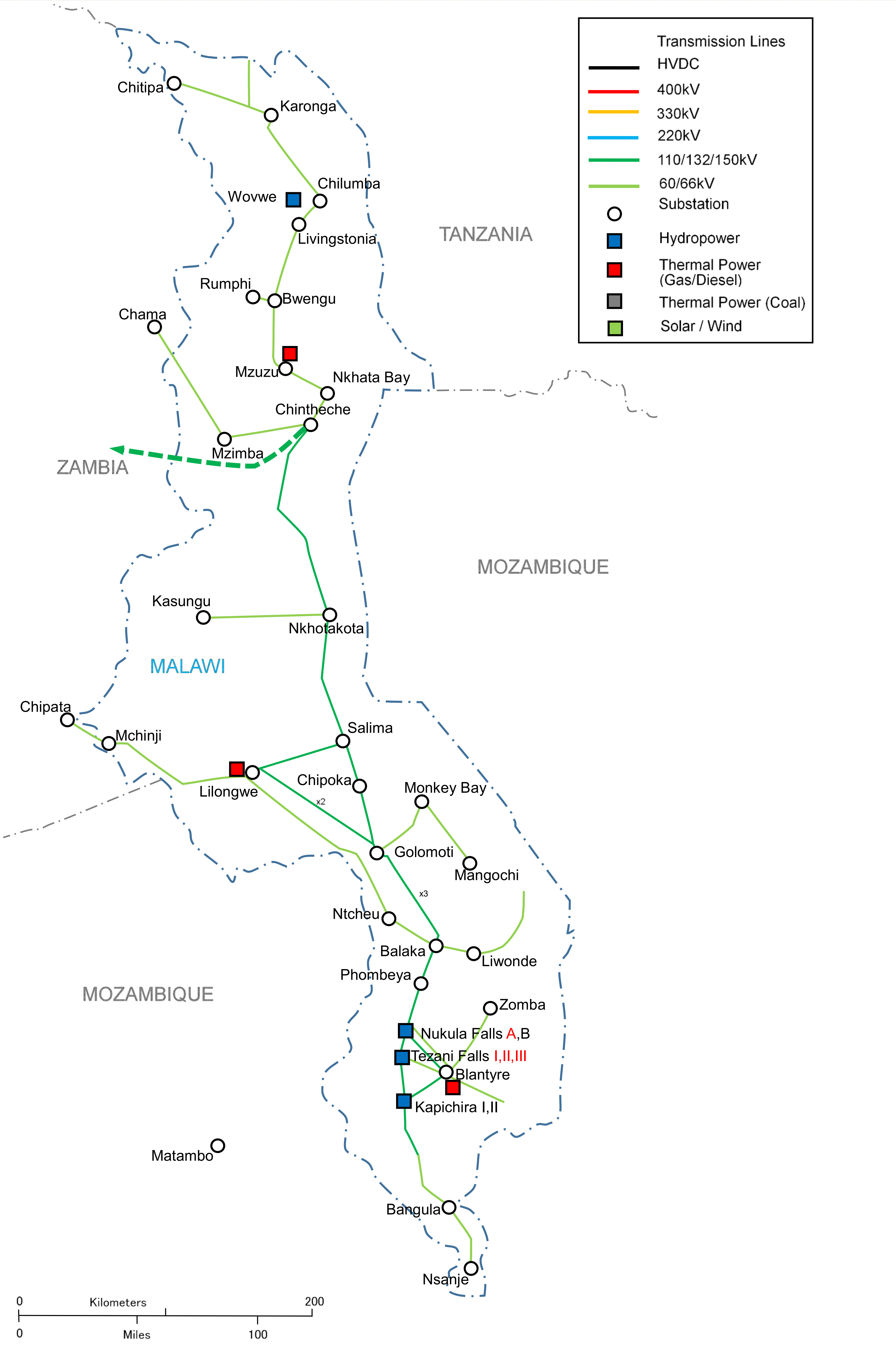
Source : JICA Survey Team

Figure 5.1-38 System planning (DR Congo) 2040 perspective



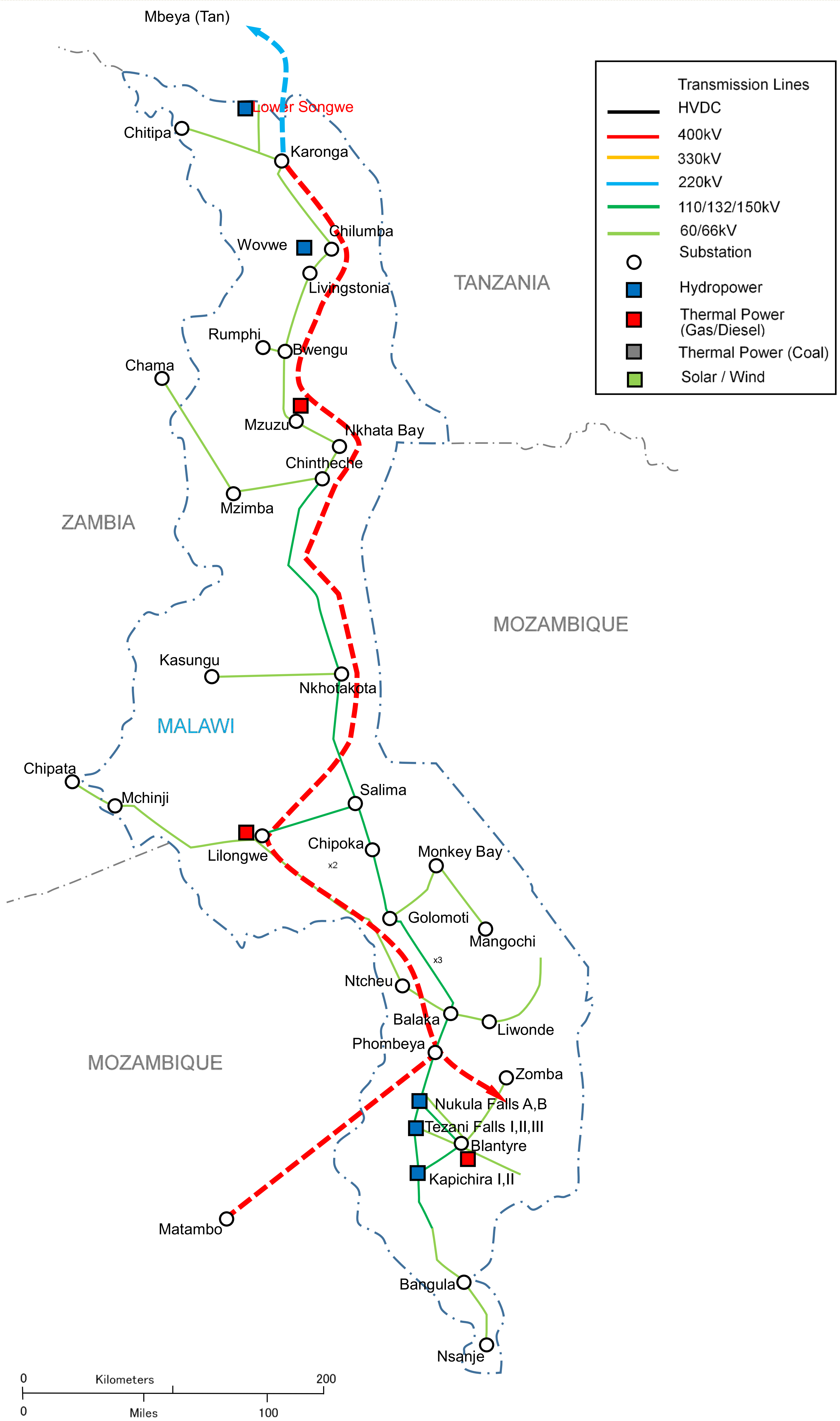
Source : JICA Survey Team

Figure 5.1-39 System planning (Malawi) current condition



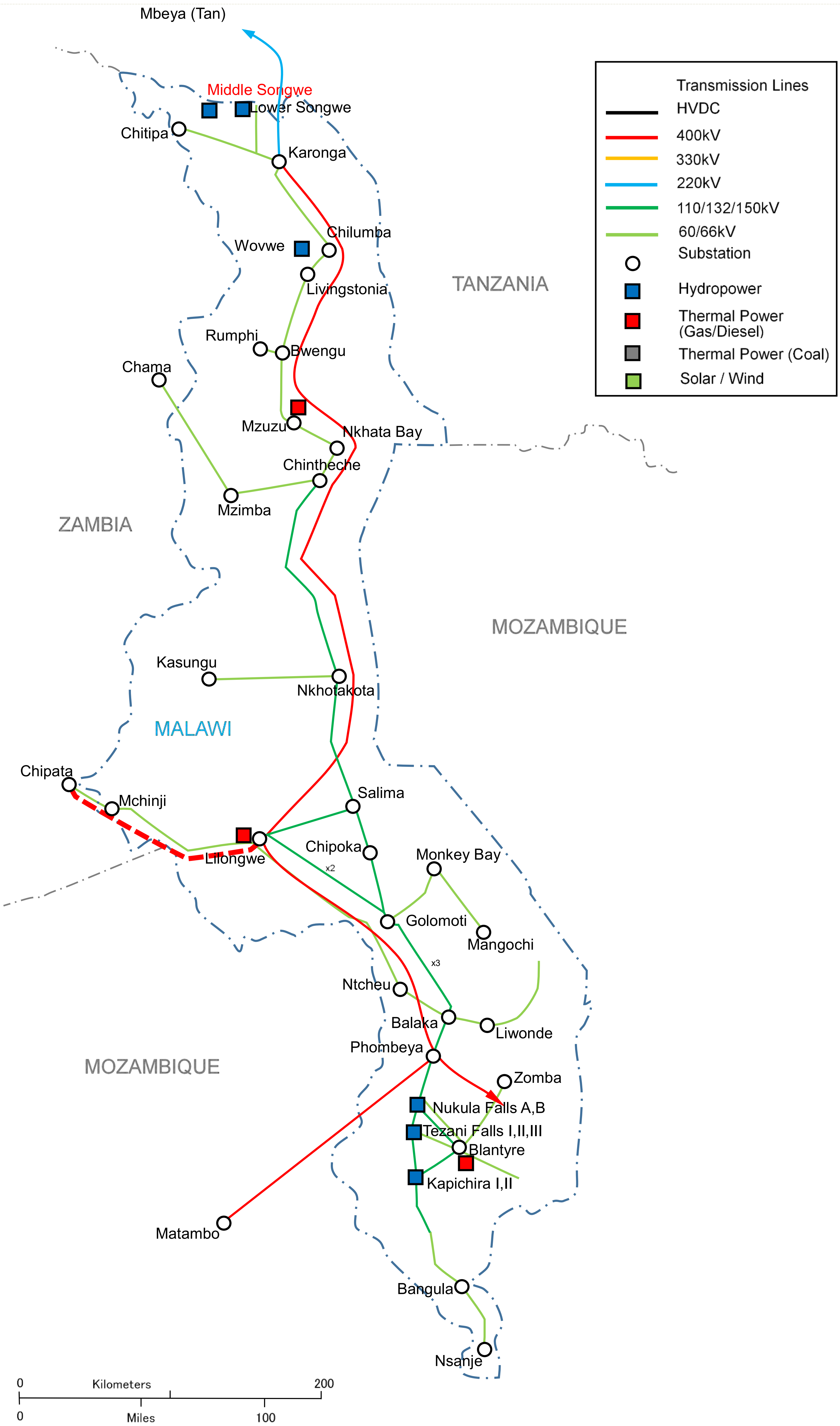
Source : JICA Survey Team

Figure 5.1-40 System planning (Malawi) 2020 perspective



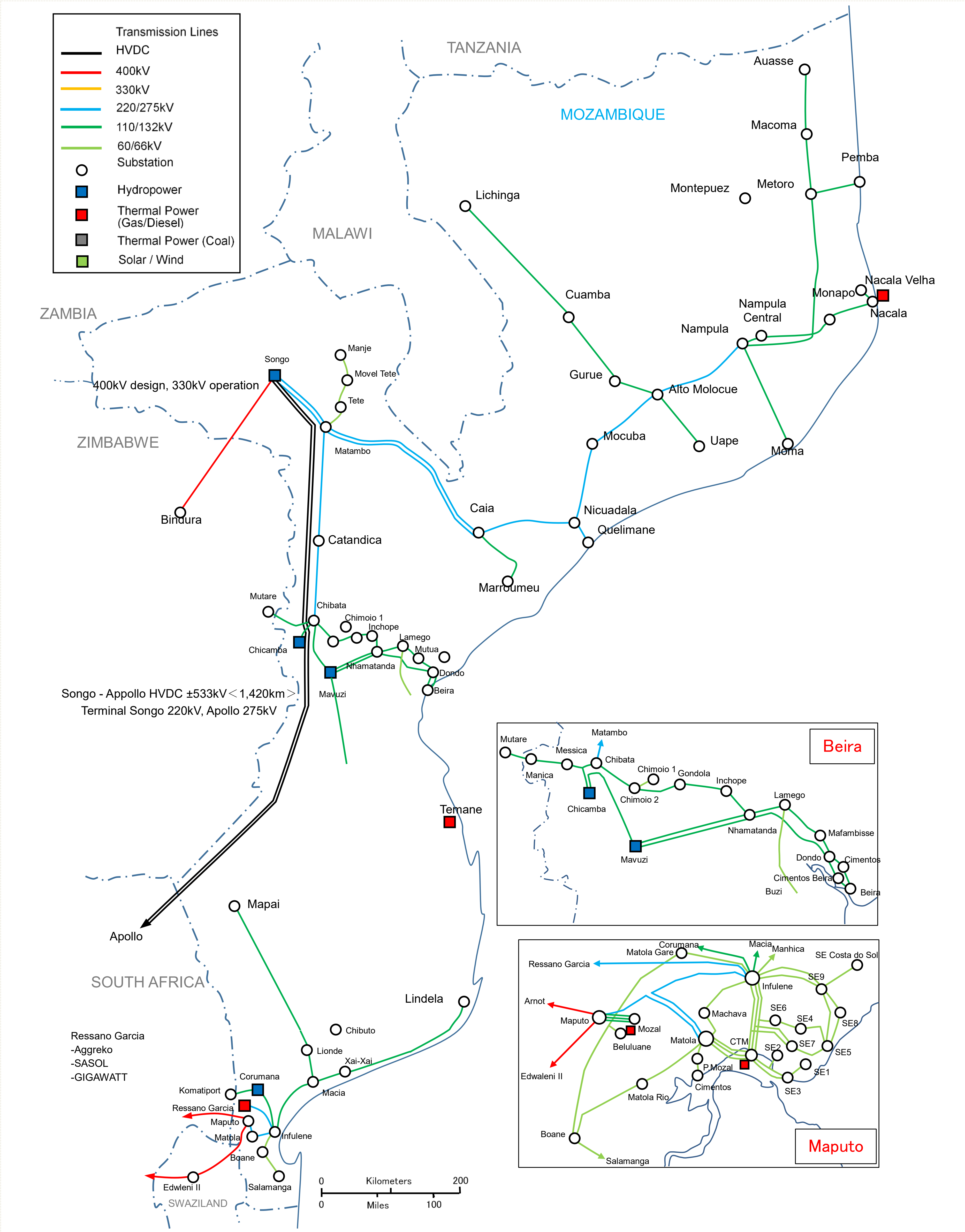
Source : JICA Survey Team

Figure 5.1-41 System planning (Malawi) 2030 perspective



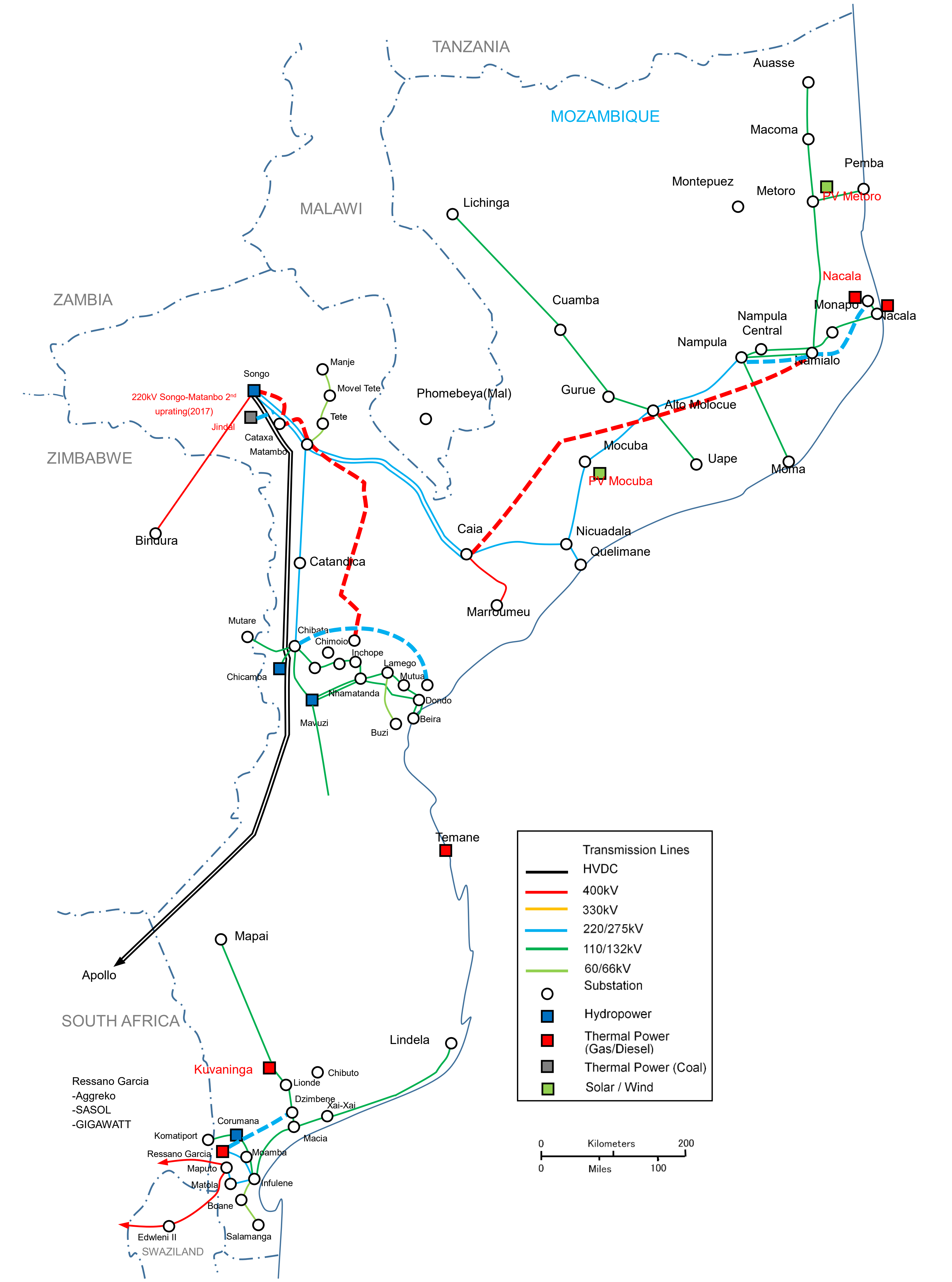
Source : JICA Survey Team

Figure 5.1-42 System planning (Malawi) 2040 perspective



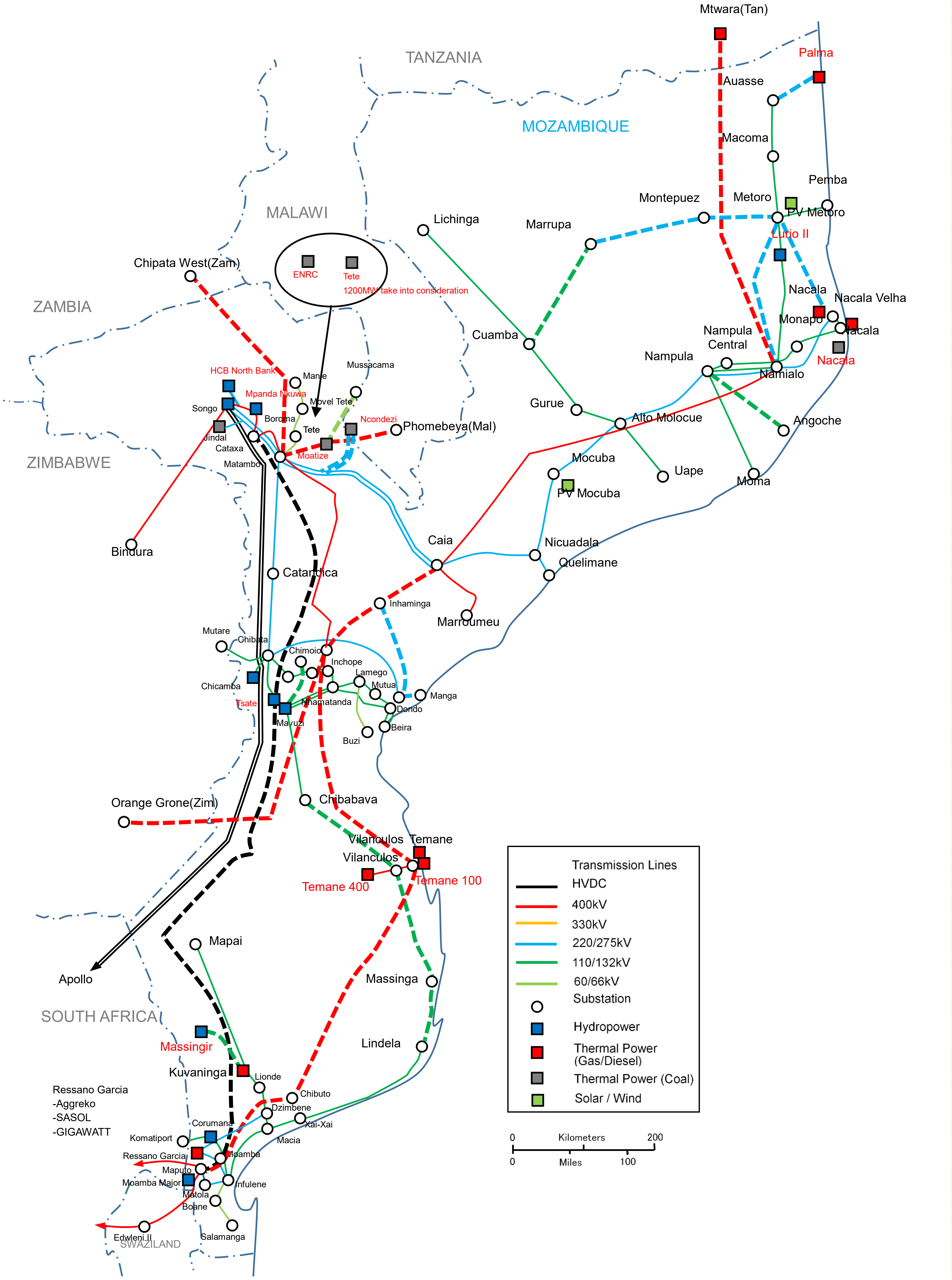
Source : JICA Survey Team

Figure 5.1-43 System planning (Mozambique) current condition



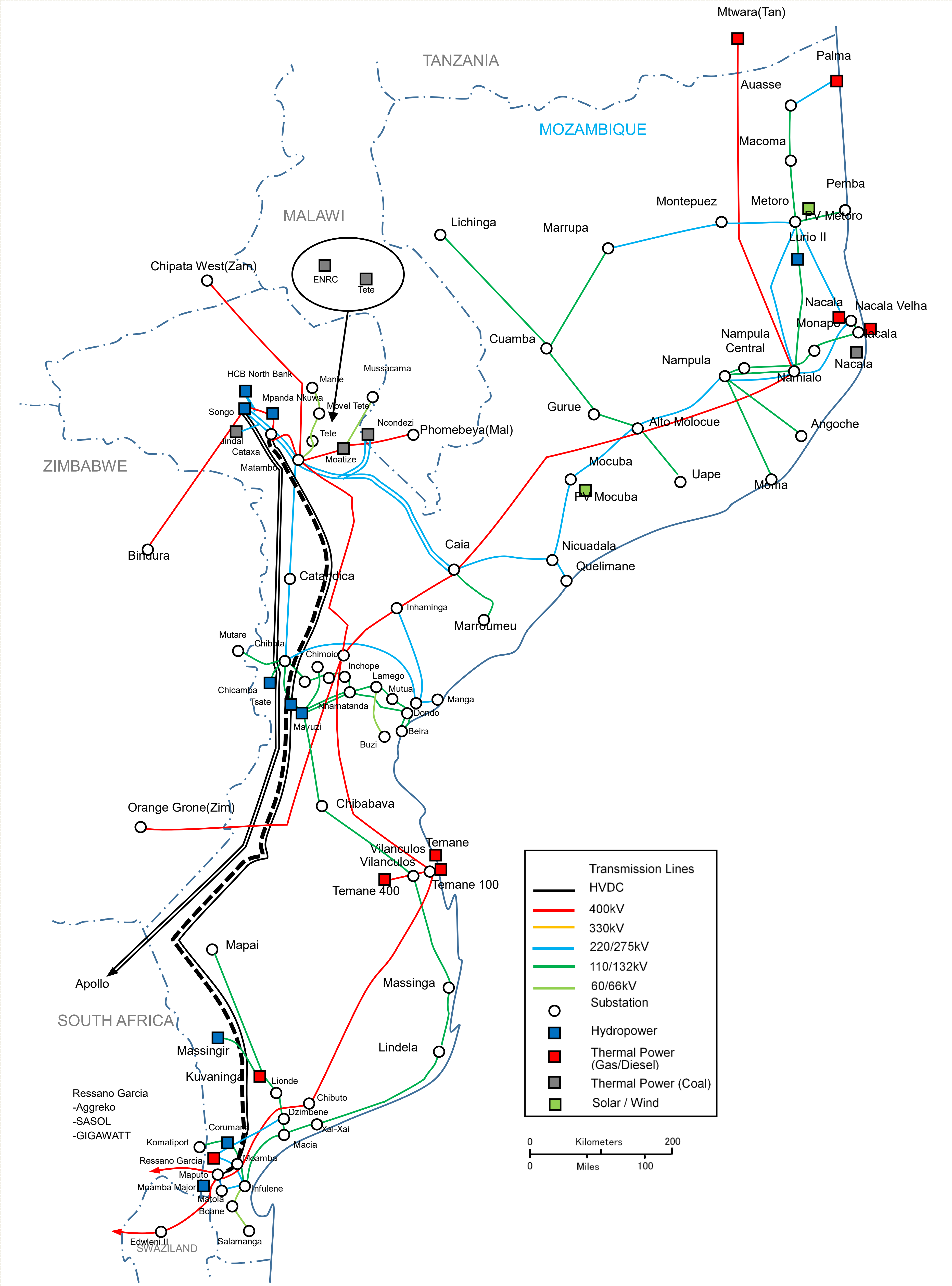
Source : JICA Survey Team

Figure 5.1-44 System planning (Mozambique) 2020 perspective



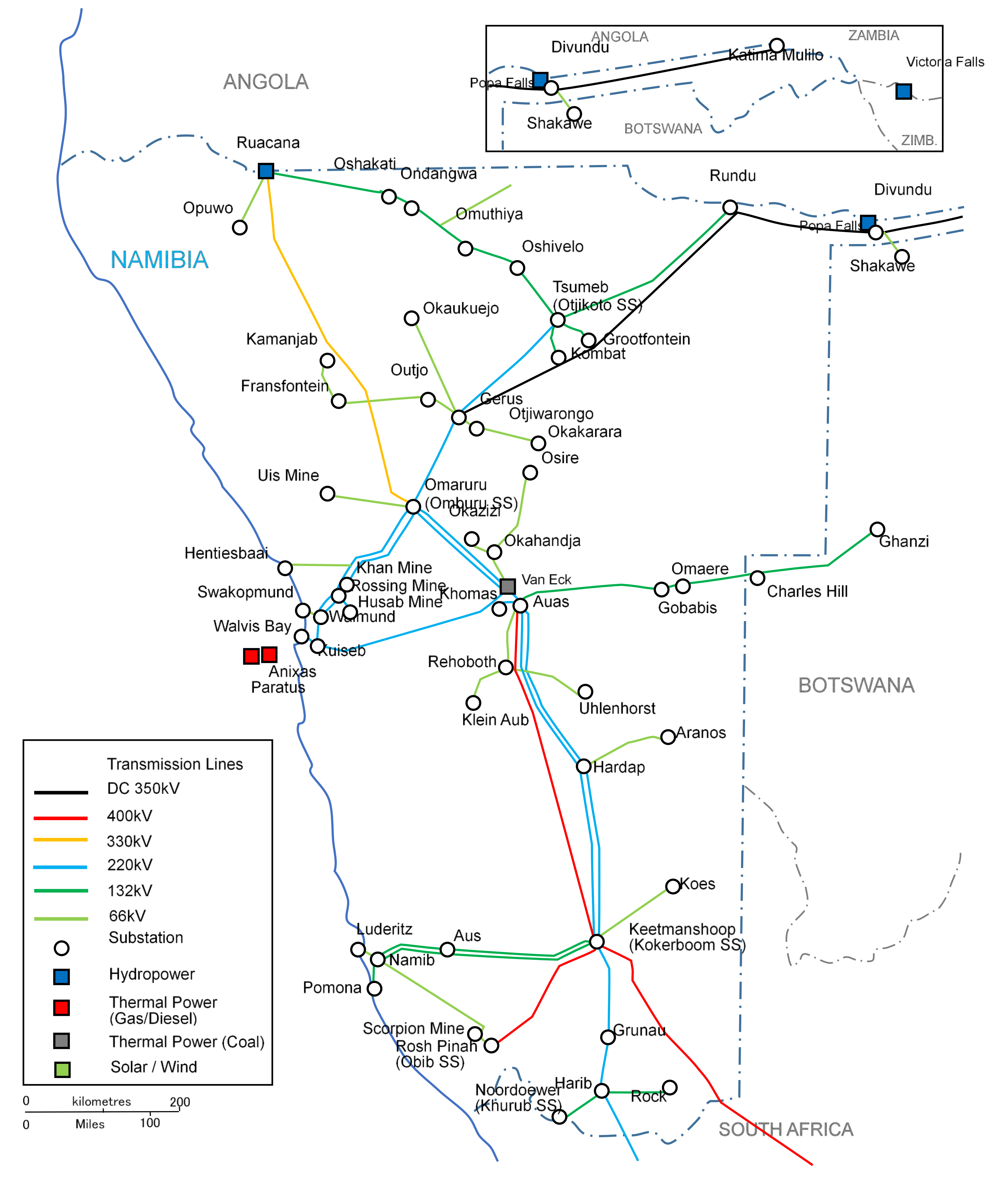
Source : JICA Survey Team

Figure 5.1-45 System planning (Mozambique) 2030 perspective



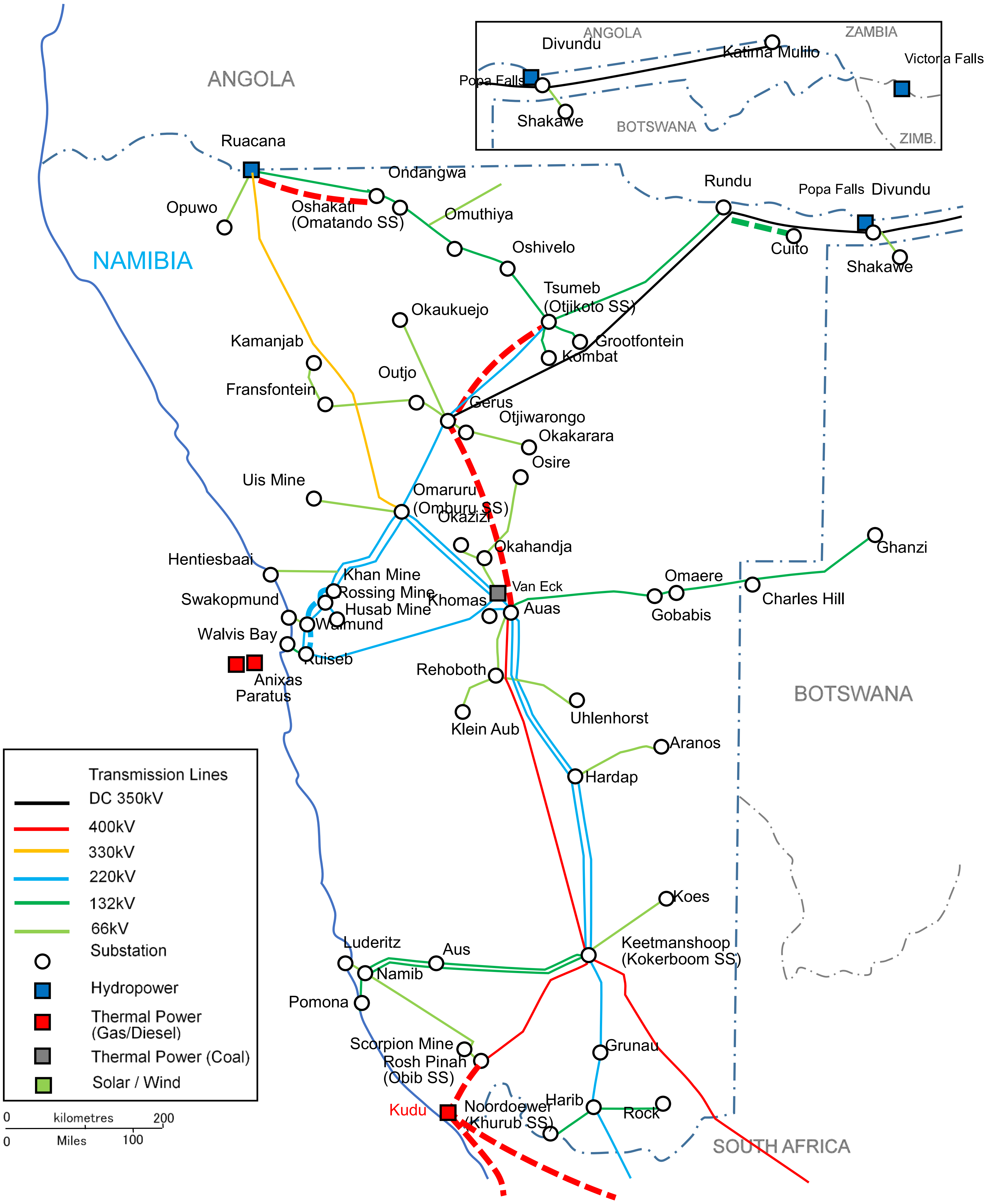
Source : JICA Survey Team

Figure 5.1-46 System planning (Mozambique) 2040 perspective



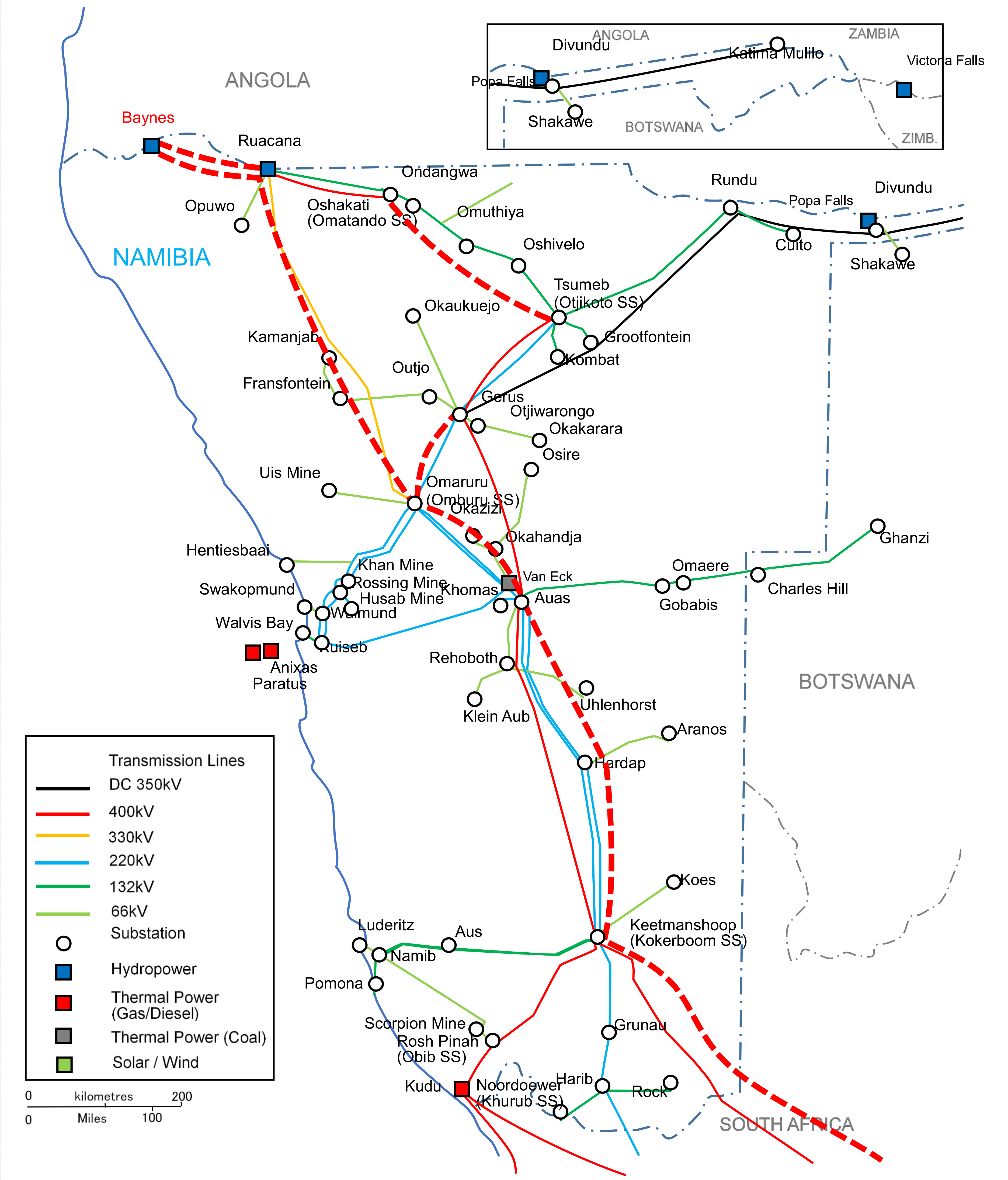
Source : JICA Survey Team

Figure 5.1-47 System planning (Namibia) current condition



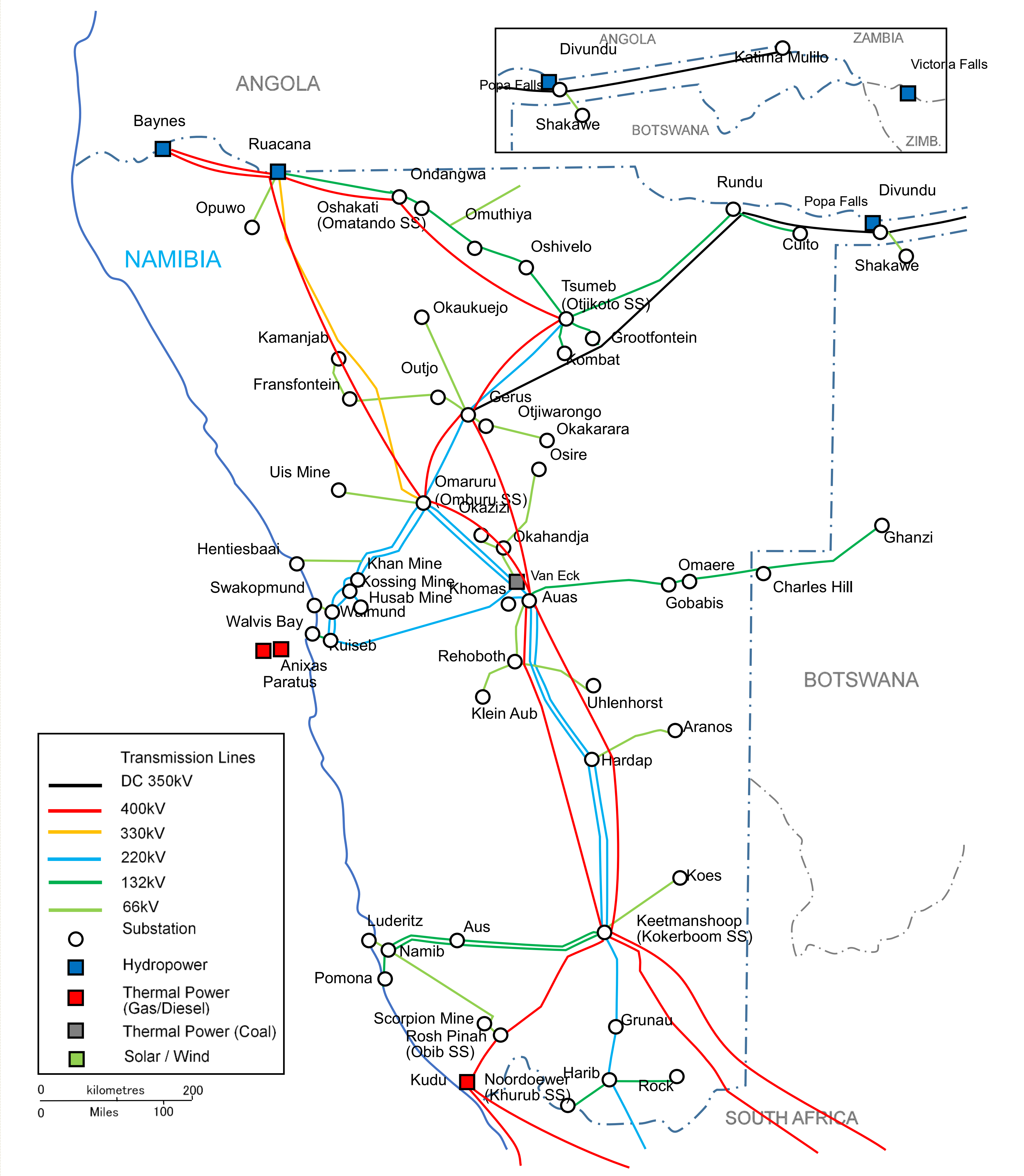
Source : JICA Survey Team

Figure 5.1-48 System planning (Namibia) 2020 perspective



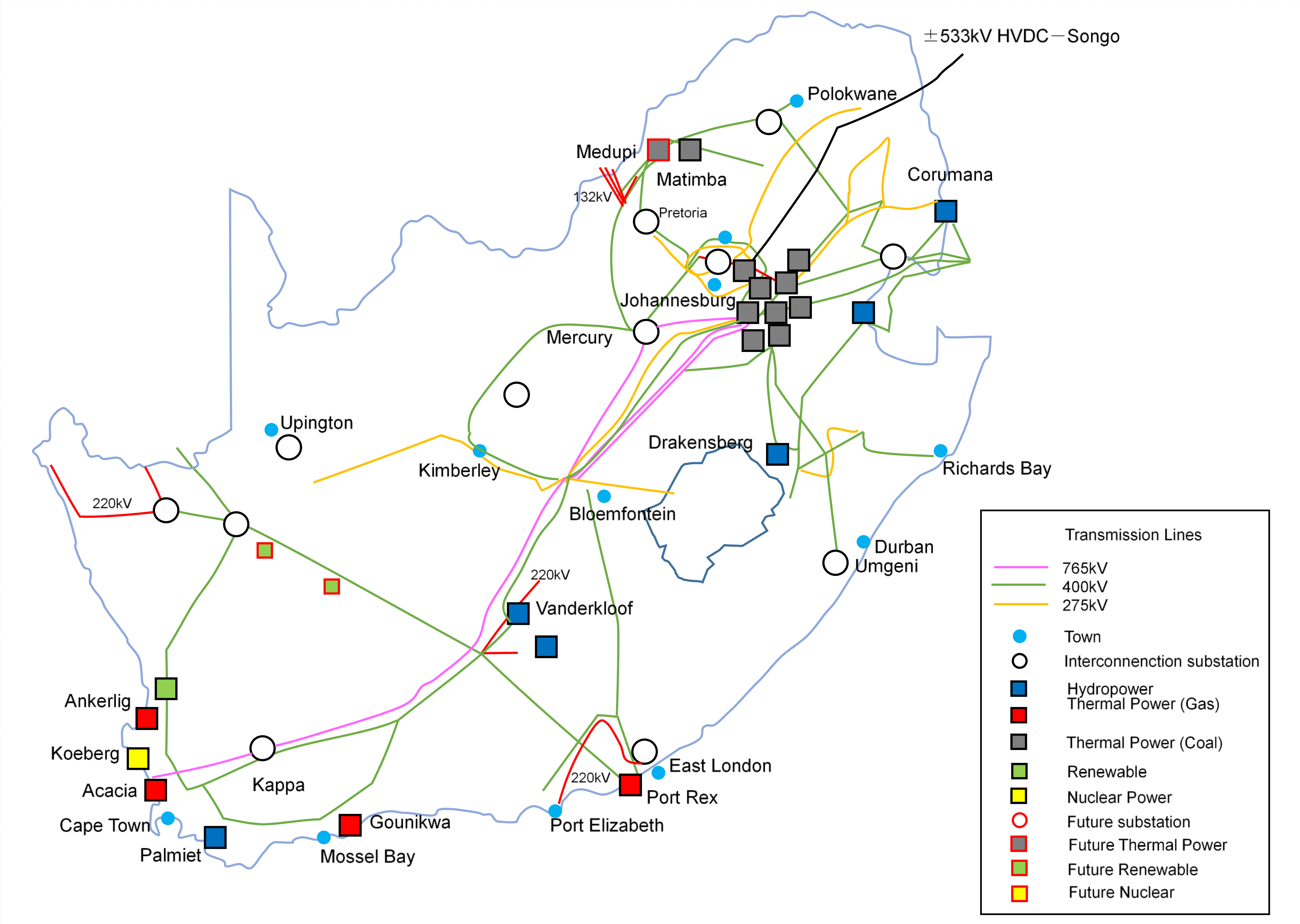
Source : JICA Survey Team

Figure 5.1-49 System planning (Namibia) 2030 perspective



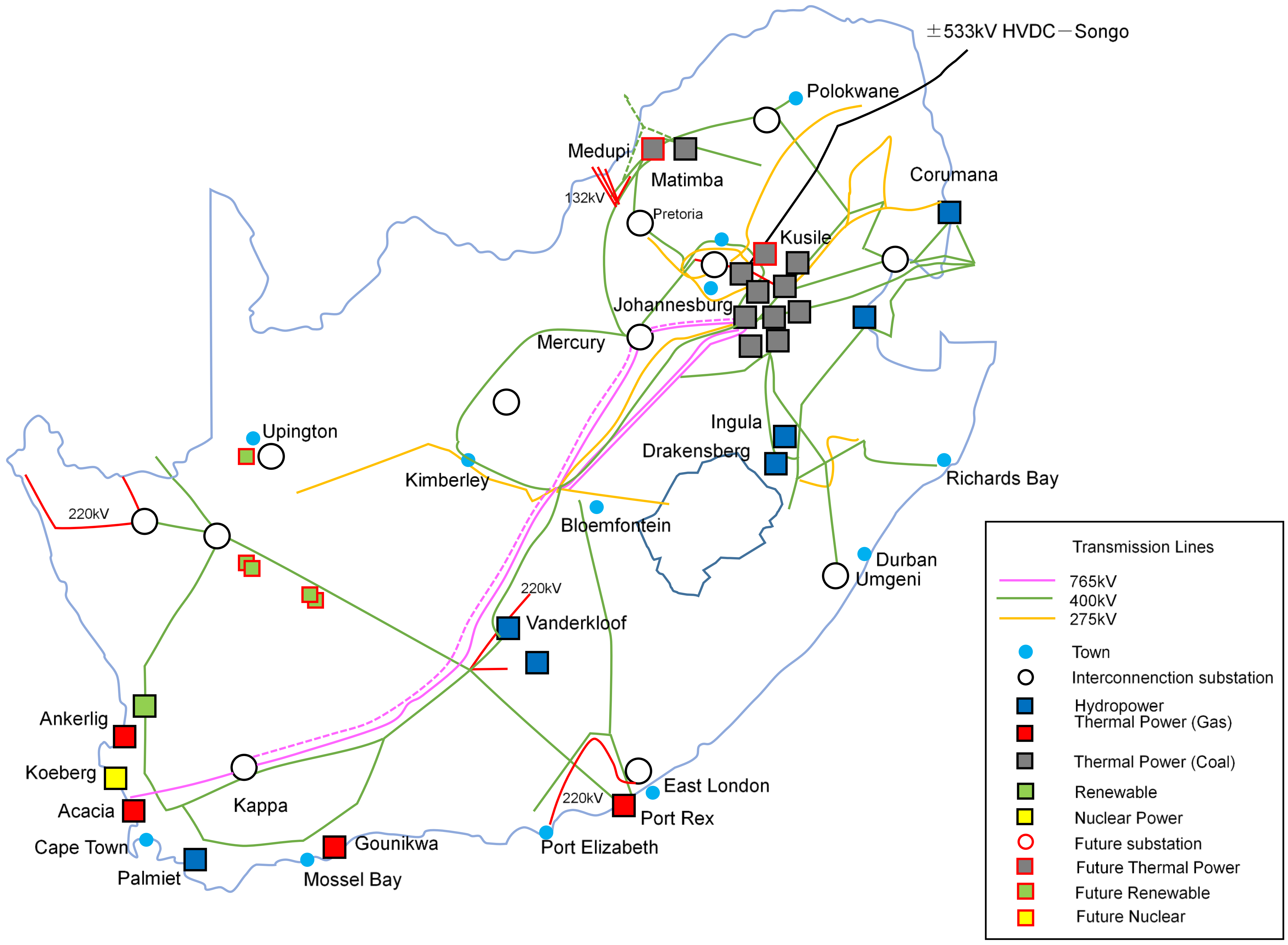
Source : JICA Survey Team

Figure 5.1-50 System planning (Namibia) 2040 perspective



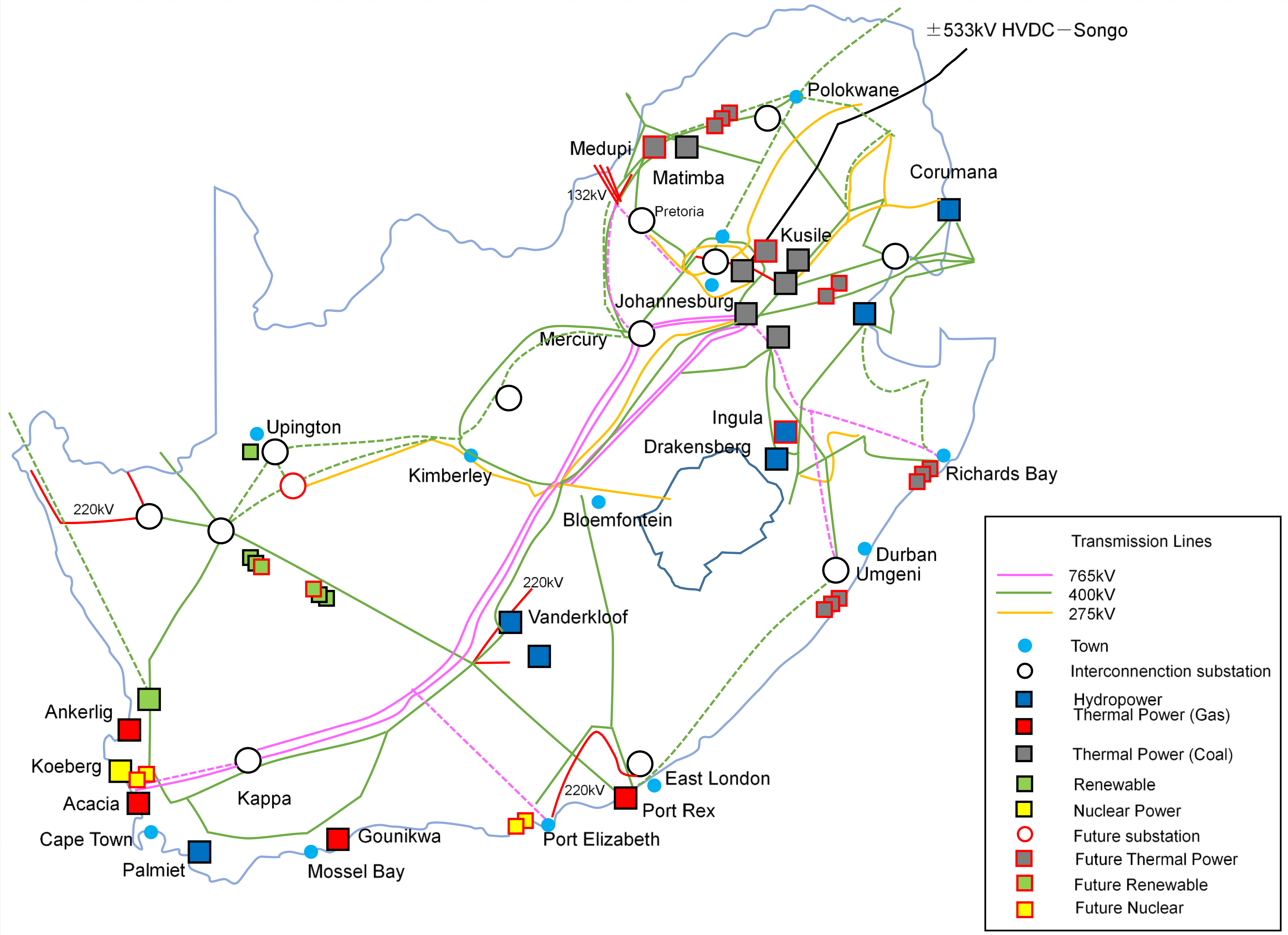
Source : JICA Survey Team

Figure 5.1-51 System planning (RSA) current condition



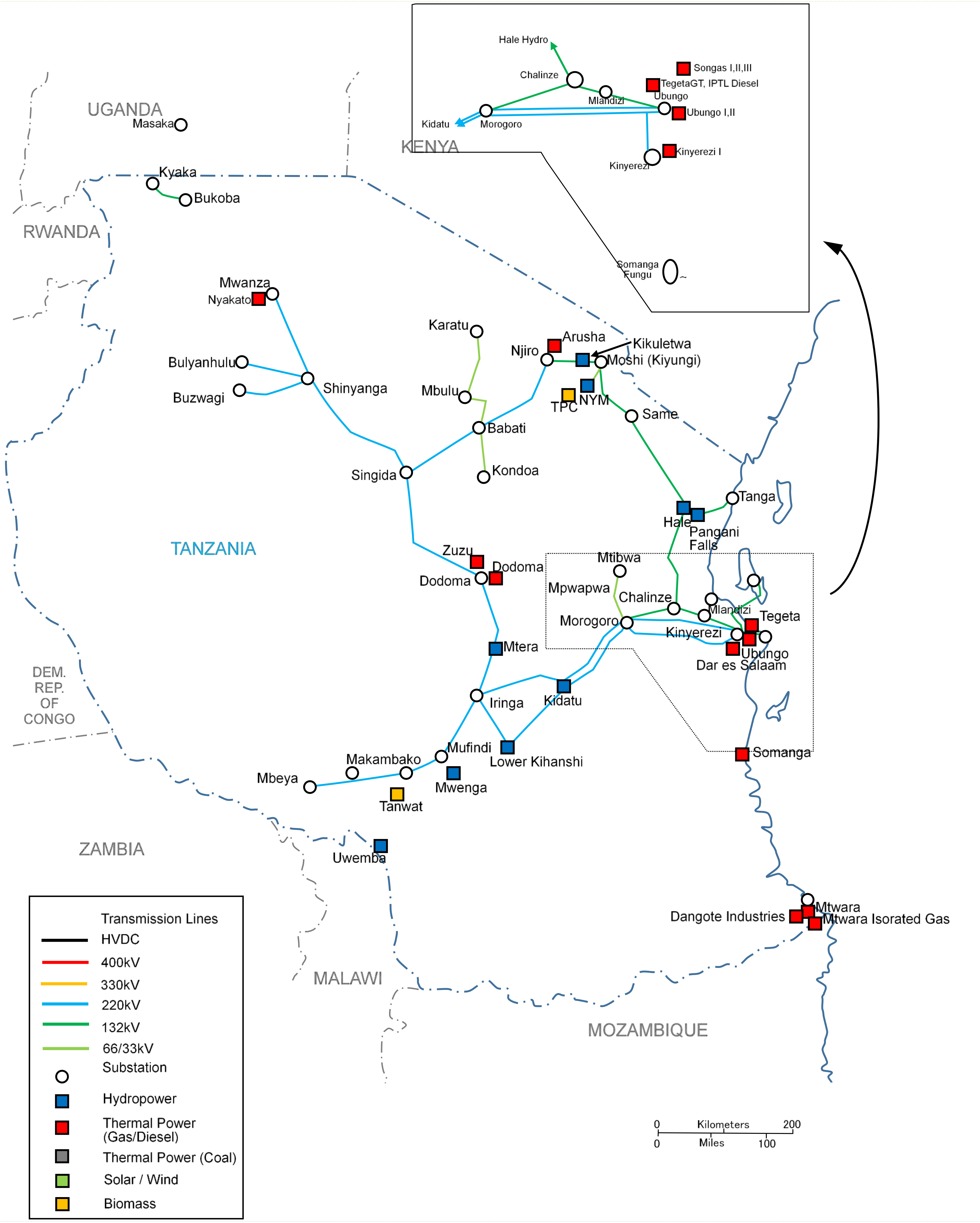
Source ： JICA Survey Team

Figure 5.1-52　System planning (RSA) 2020 perspective



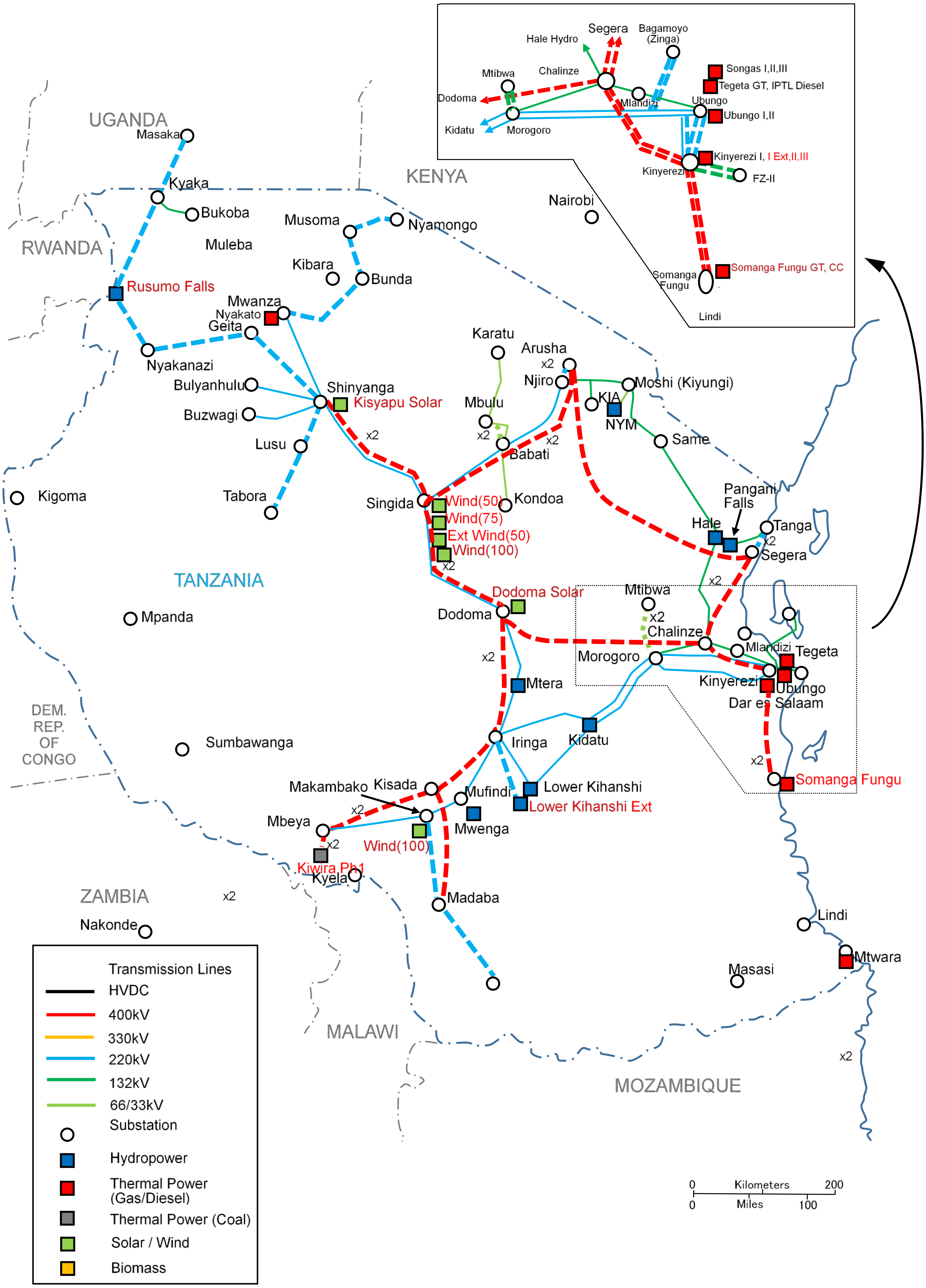
Source：JICA Survey Team

Figure 5.1-53 System planning (RSA) 2030 afterwards



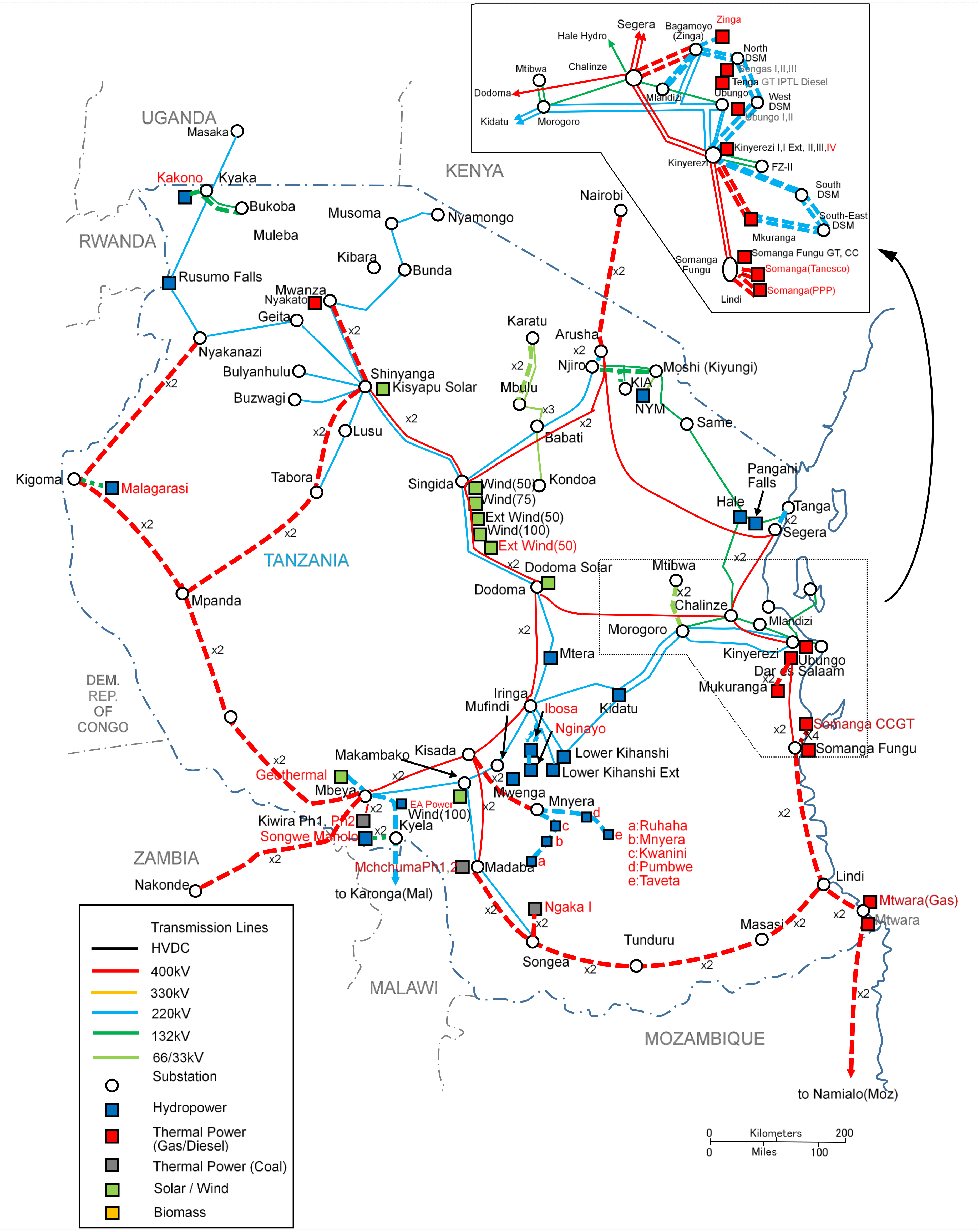
Source : JICA Survey Team

Figure 5.1-54 System planning (Tanzania) current condition



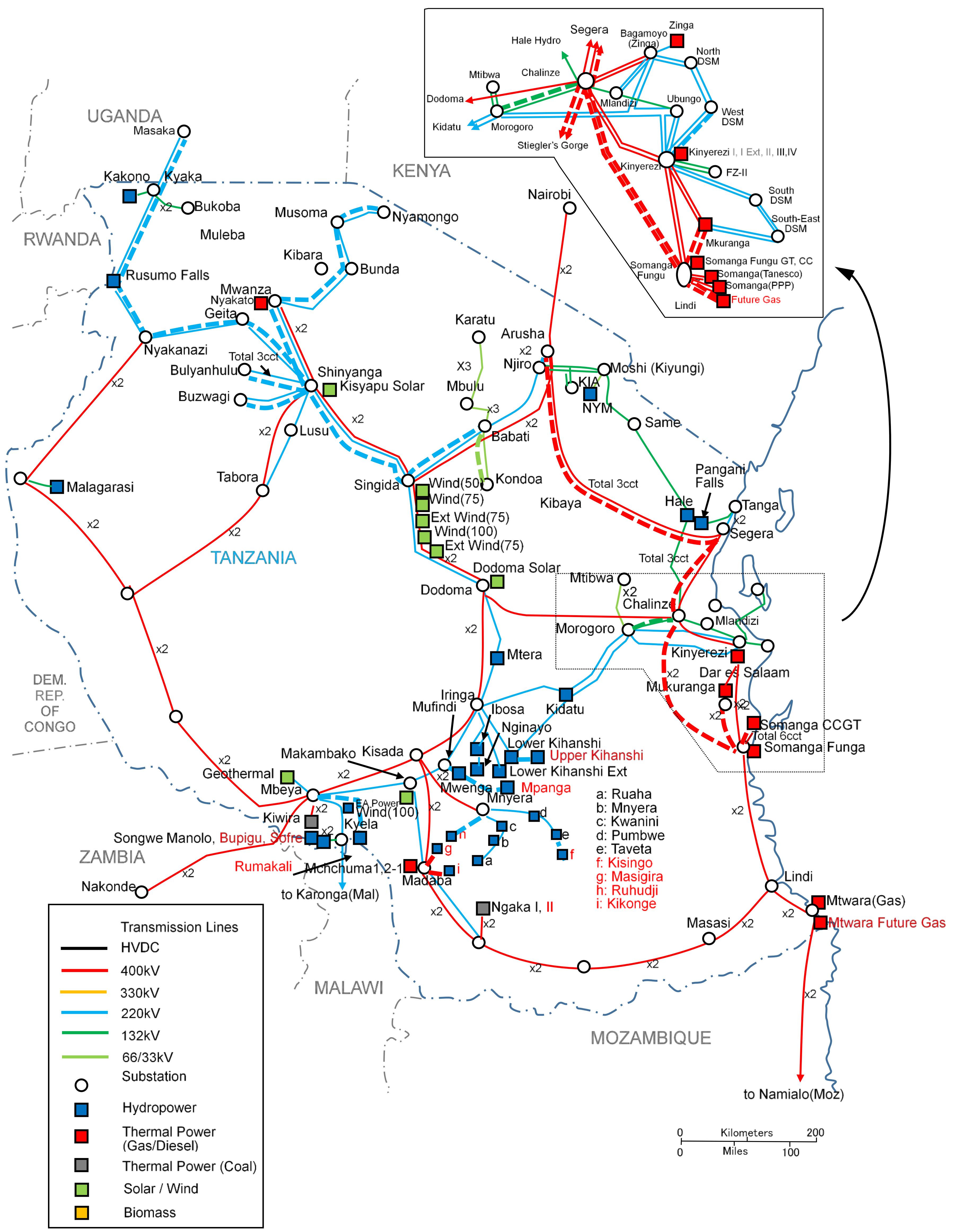
Source : JICA Survey Team

Figure 5.1-55 System planning (Tanzania) 2020 perspective



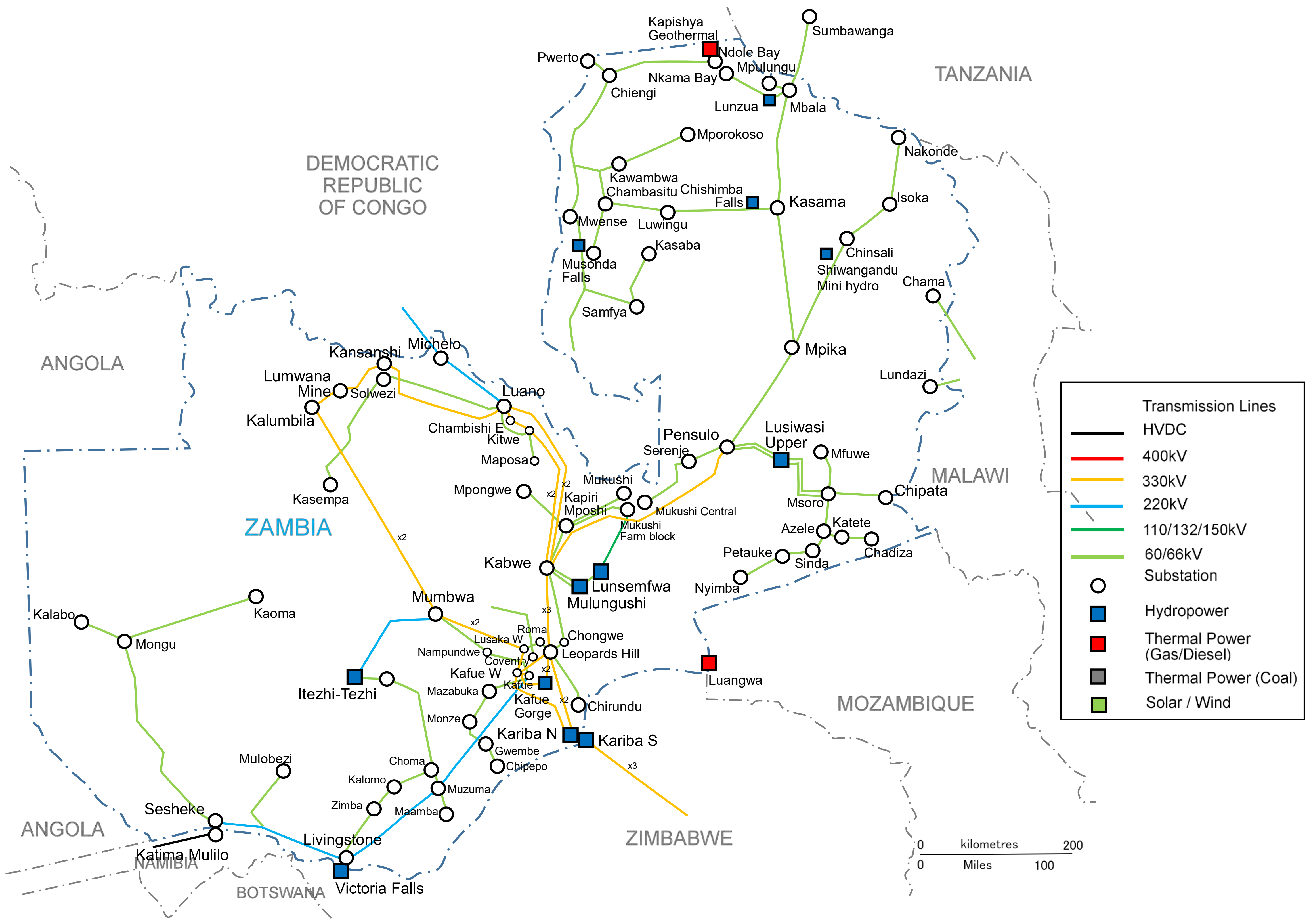
Source : JICA Survey Team

Figure 5.1-56 System planning (Tanzania) 2030 perspective



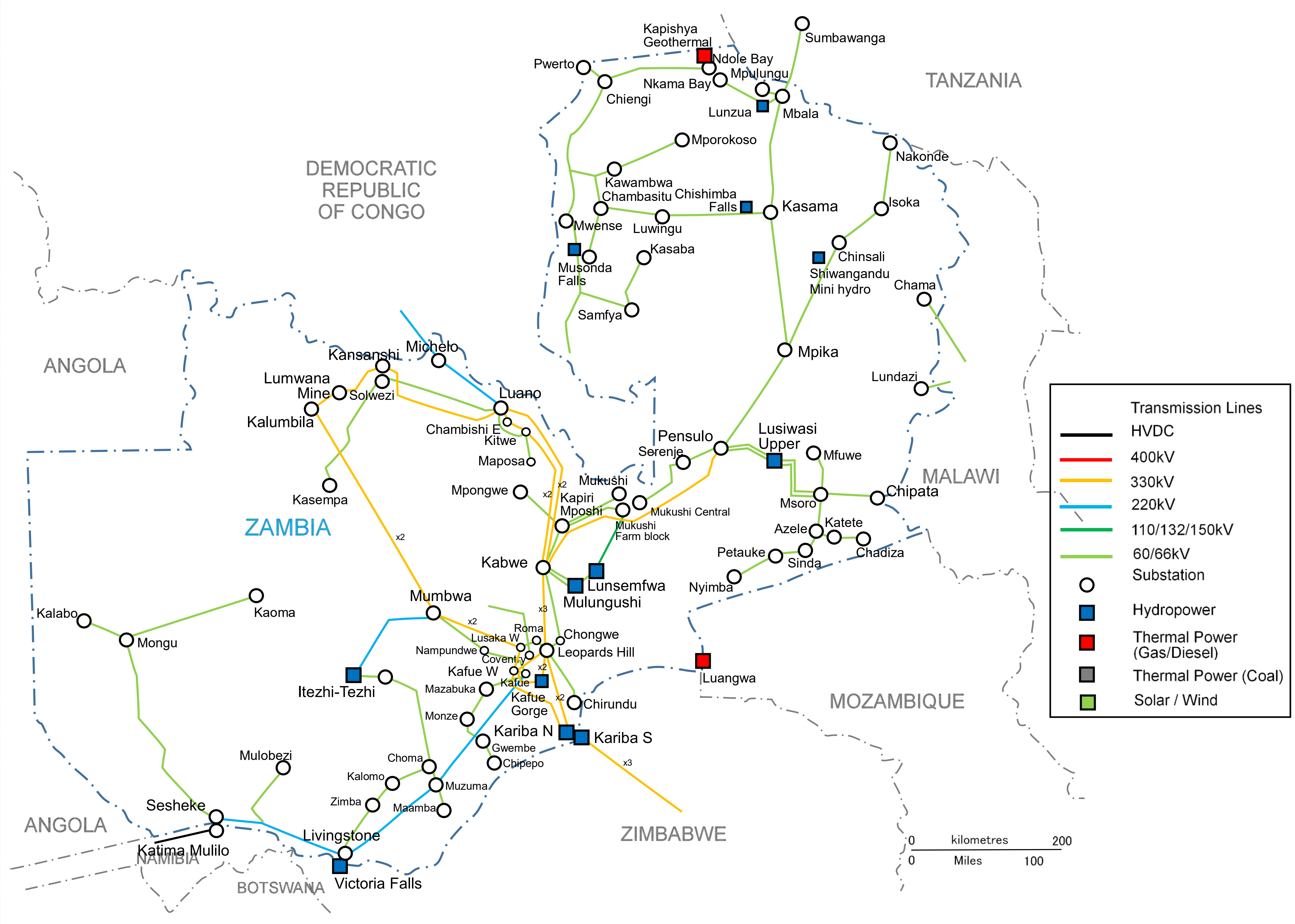
Source : JICA Survey Team

Figure 5.1-57 System planning (Tanzania) 2040 perspective



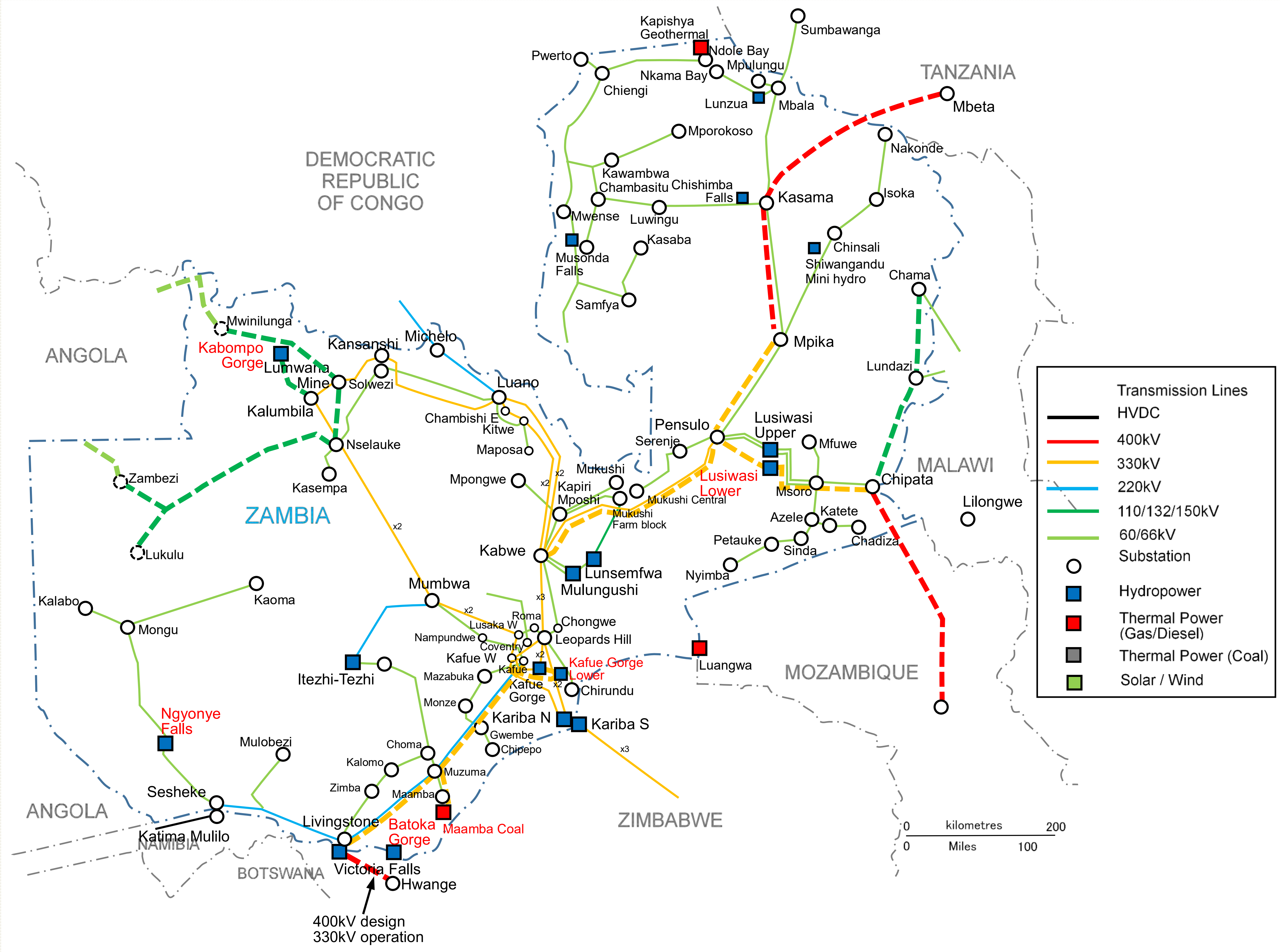
Source : JICA Survey Team

Figure 5.1-58 System planning (Zambia) current condition



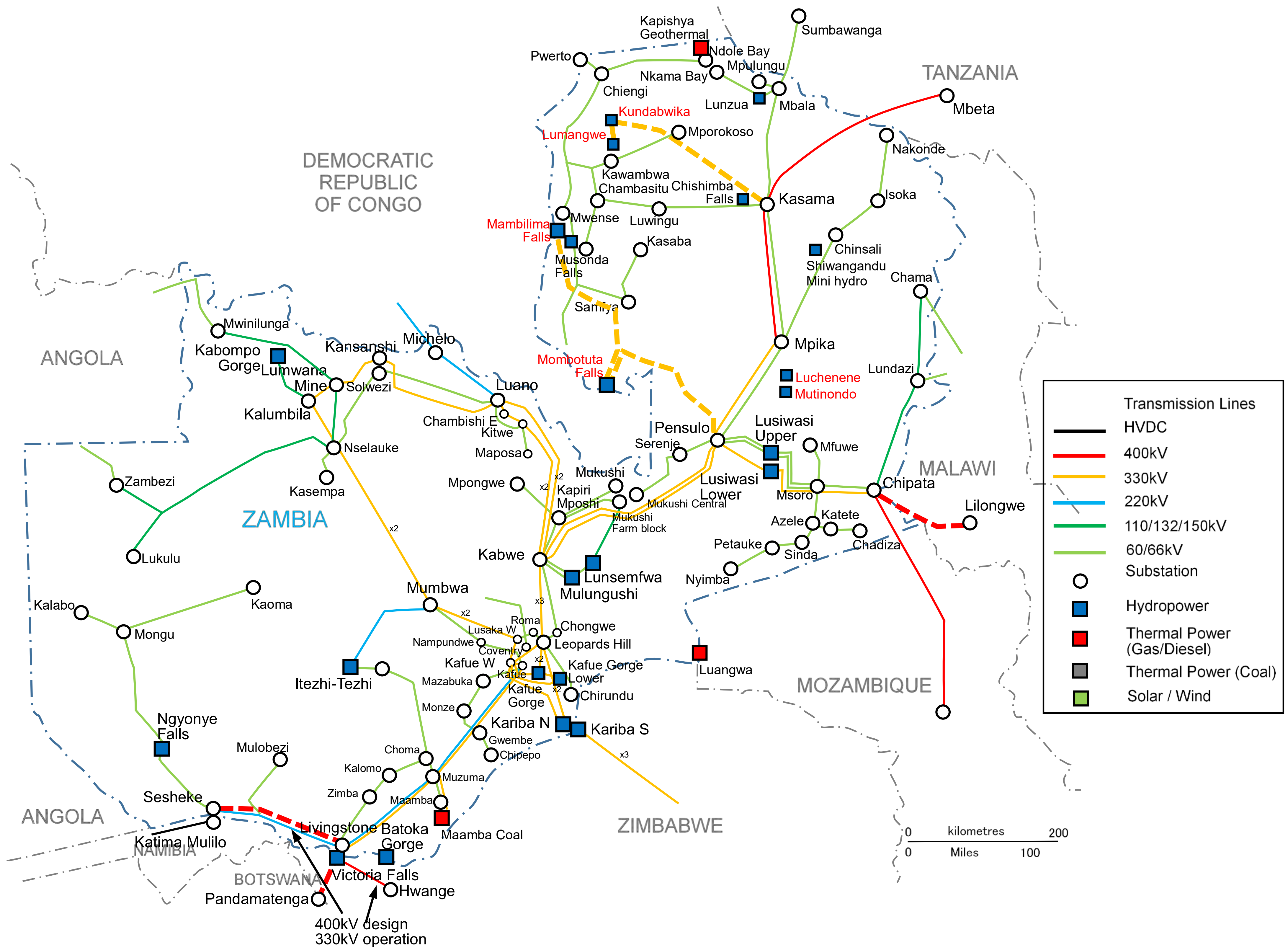
Source : JICA Survey Team

Figure 5.1-59 System planning (Zambia) 2020 perspective



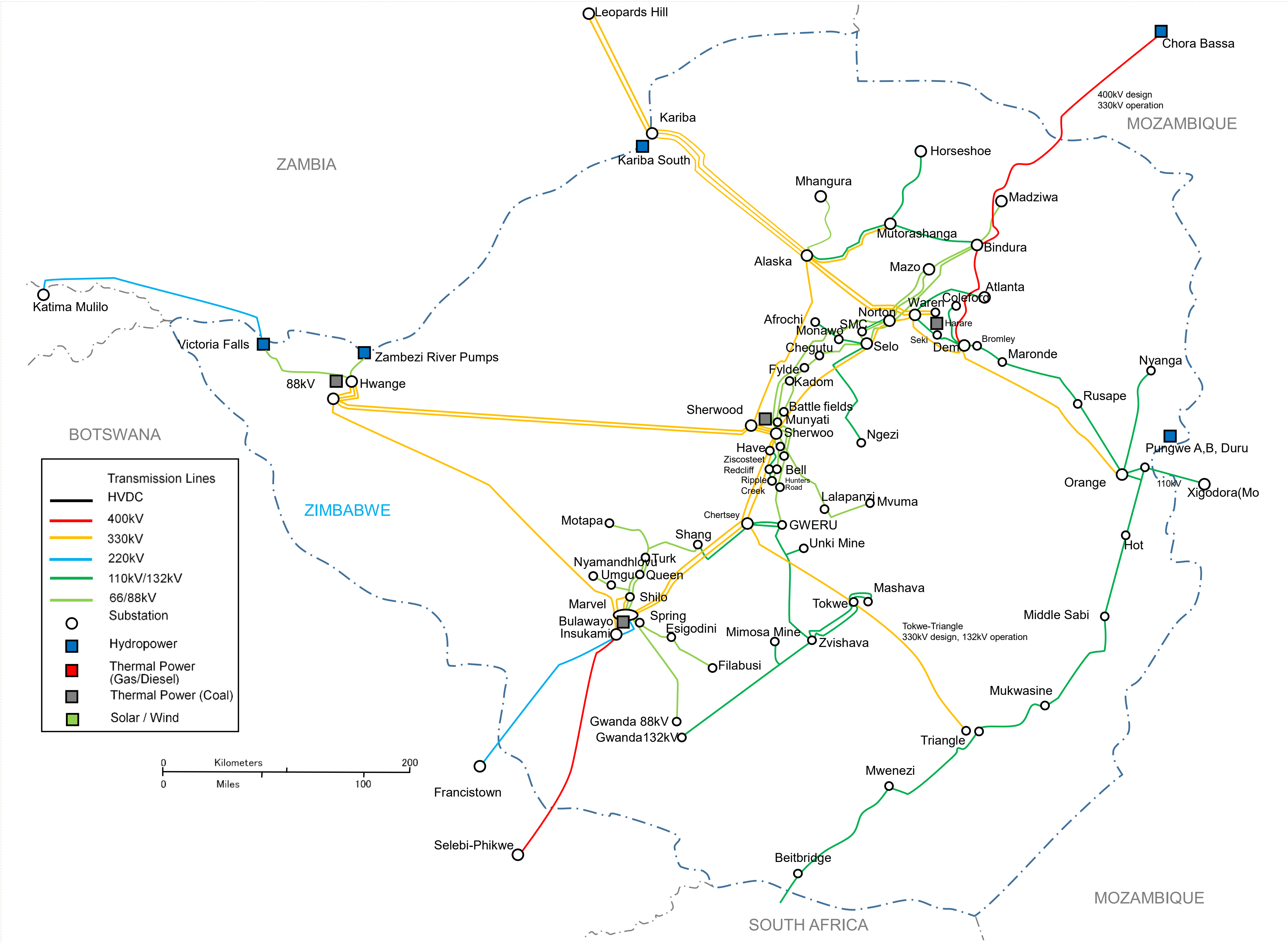
Source : JICA Survey Team

Figure 5.1-60 System planning (Zambia) 2030 perspective



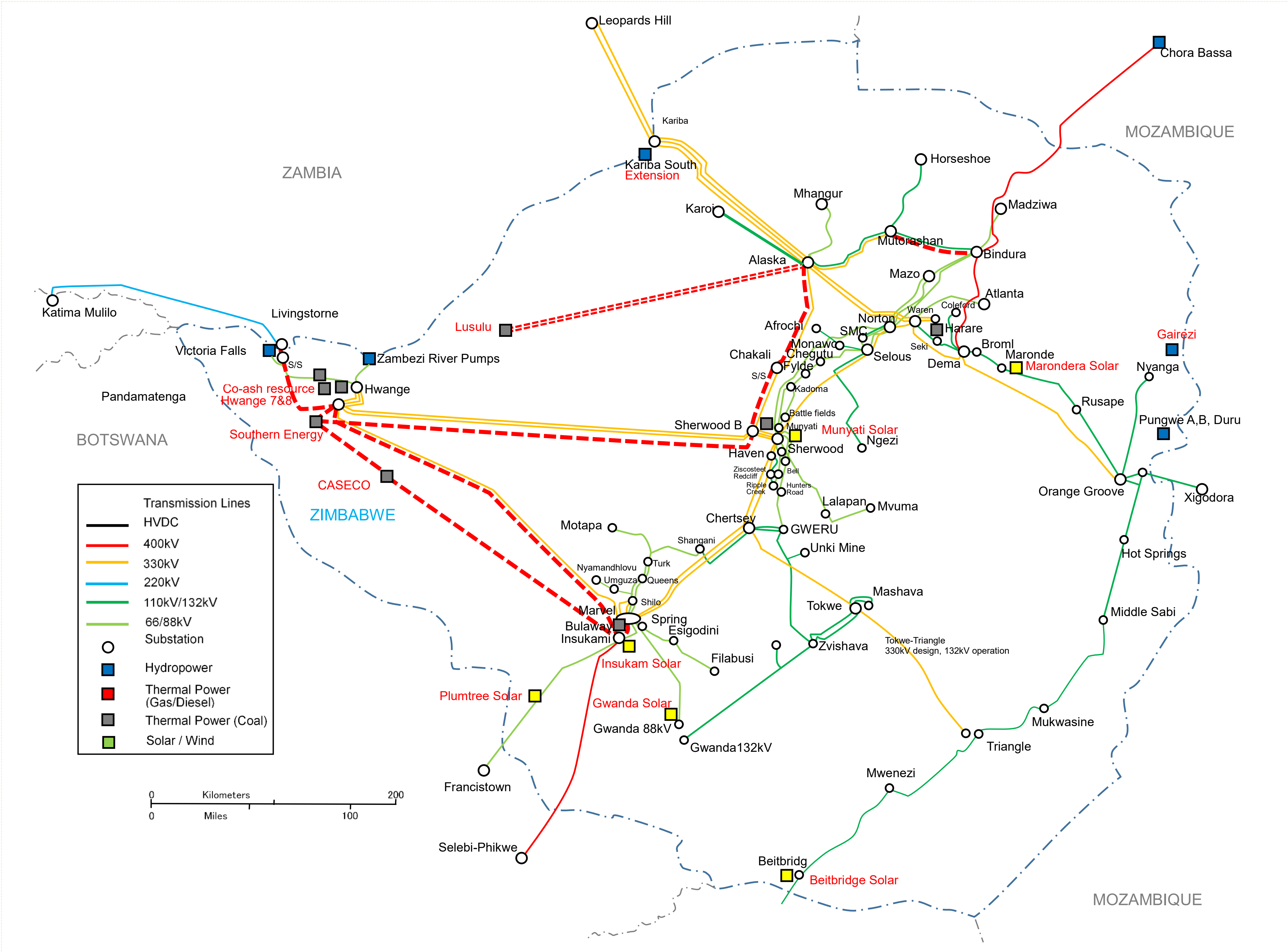
Source : JICA Survey Team

Figure 5.1-61 System planning (Zambia) 2040 perspective



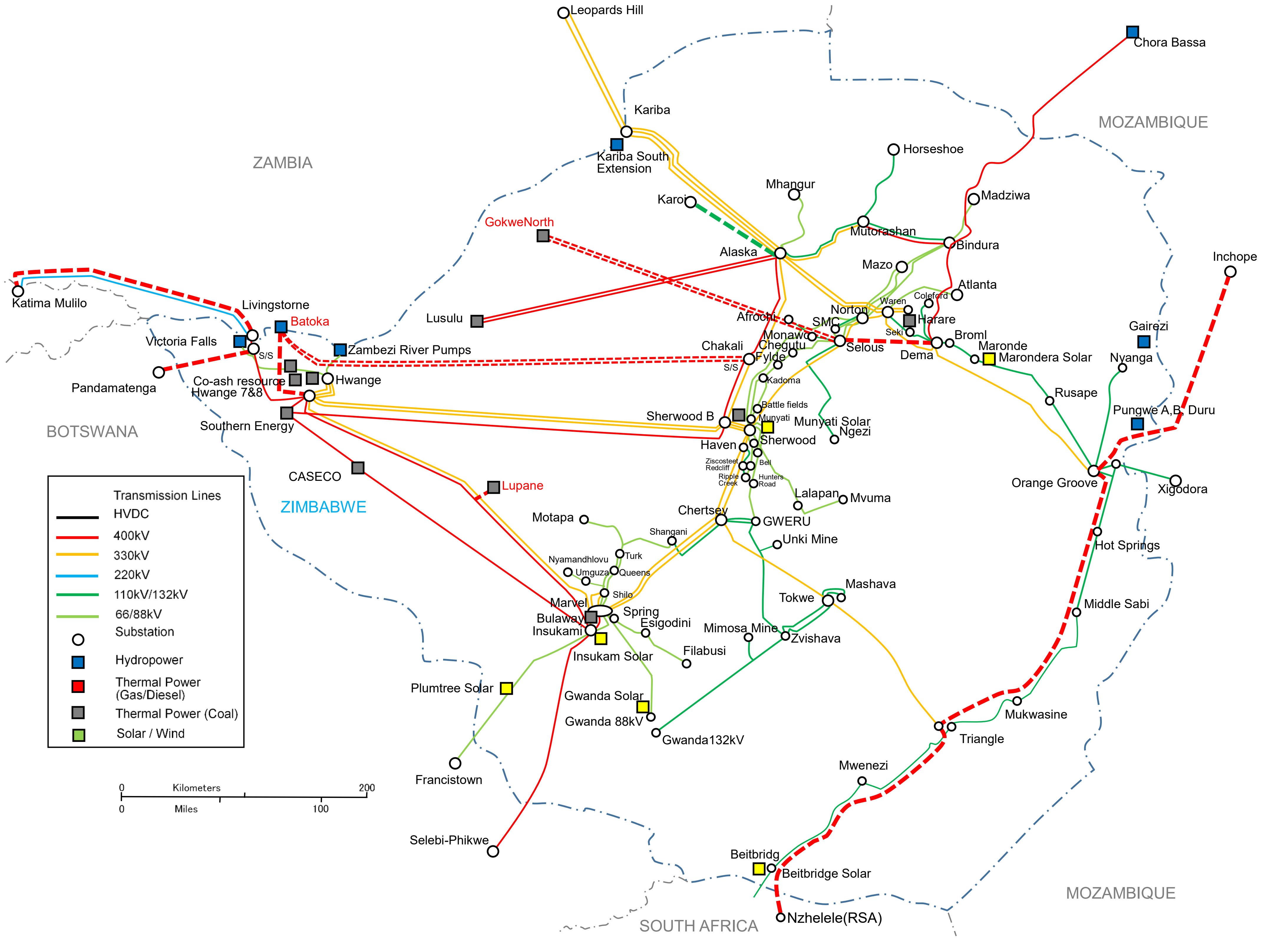
Source：JICA Survey Team

Figure 5.1-62　System planning (Zimbabwe) current condition



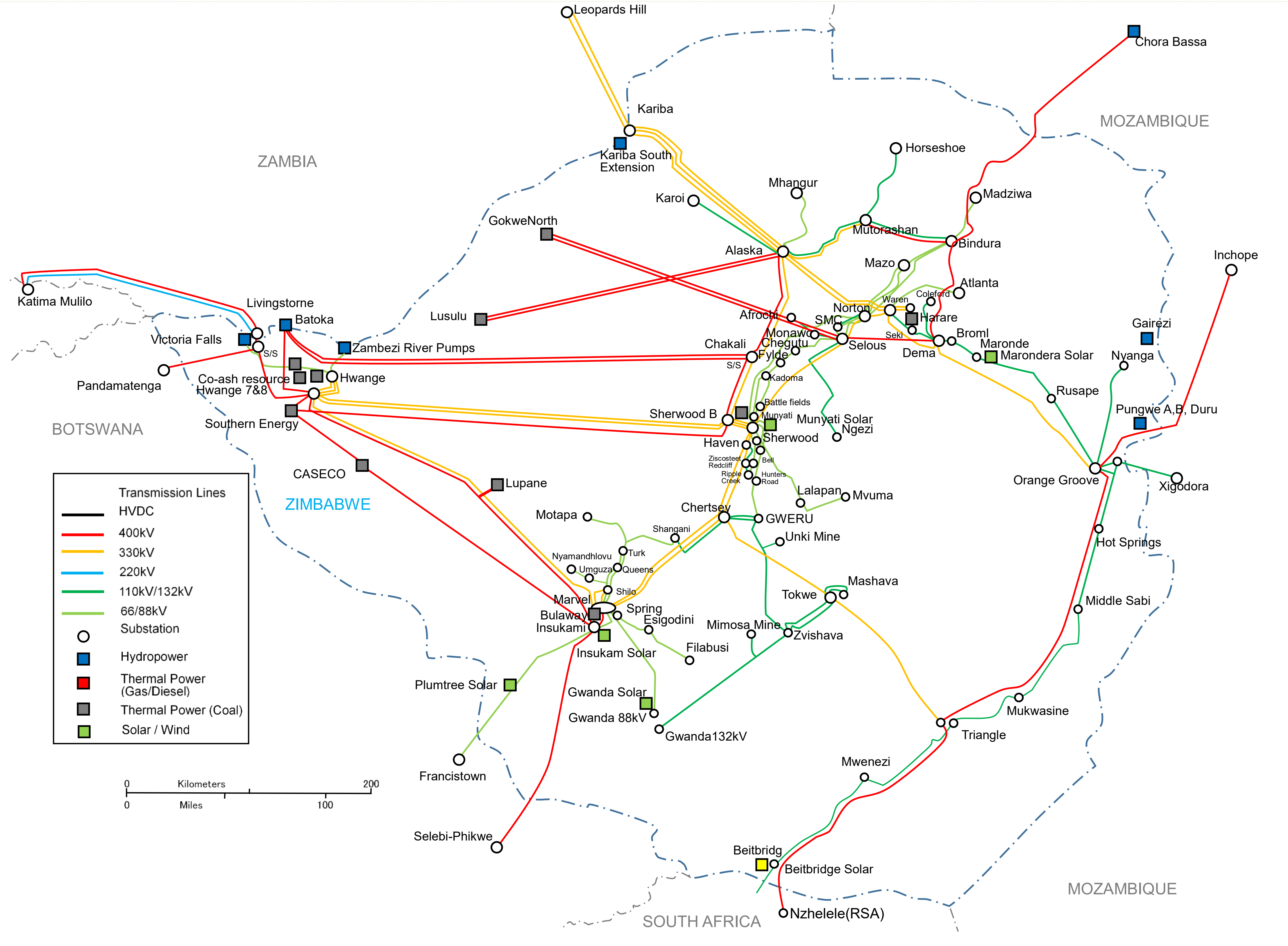
Source : JICA Survey Team

Figure 5.1-63 System planning (Zimbabwe) 2020 perspective



Source : JICA Survey Team

Figure 5.1-64 System planning (Zimbabwe) 2030 perspective



Source : JICA Survey Team

Figure 5.1-65 System planning (Zimbabwe) 2040 perspective

5.1.4 **Analysis on the point of power cooperation (interconnection)**

(1) Necessity of power cooperation in terms of Demand and supply balance

Table 5.1-47 to Table 5.1-48 show the group to rescue the deficit of capacity or energy in a certain area based on aforementioned analyses on section 5.1.2.

1) Supplement group for peak demand

Table 5.1-47 and figures, such as Figure 5.1-66 to Figure 5.1-68 show result of supplement group for peak demand. As they mentioned, northern Mozambique, Swaziland and Botswana will be able to receive the capacity through existing interconnectors[79]. In 2030, and in 2040, supplement through existing interconnectors can be useful and be efficient.

2) Supplement group for energy

Table 5.1-48 and figures, such as Figure 5.1-69 to Figure 5.1-71 show result of supplement group for energy generated.

Rule of making group is following,

1. Prioritize supplement from neighboring state which has abundant energy.
2. Here, definition of abundant is net surplus, which can calculate that, subtract 110% of demand from total energy generated.
3. And the state has deficit needs to gather energy in order from closest to fill 110% of own demand.

In 2020, energy generated in RSA will be 309.4TWh, and predicted demand is 314.8TWh. Therefore, secured energy is 340.34TWh, 110% of predicted demand, and the deficit, 36.88TWh should be collected from neighboring states or any other states in SAPP. In terms of this, RSA should strengthen interconnector to gather the power from SAPP northern states, and the interconnector with Botswana should be strengthen the capacity because the power from SAPP northern states cumulate on the interconnector.

In 2030, tight balance can be seen at limited area, but in 2040, groups to be shared power will be increased.

RSA, huge surplus holder, therefore, should cooperate with surrounding states and northern unity, such as Mozambique, Tanzania and Zambia should be cooperated with each other.

3) Supplement group for energy in drought condition

Table 5.1-49 and Figure 5.1-72, Figure 5.1-73 show result of supplement group in drought situation in 2030, and in 2040.

Grouping in 2030 shows a unity among Mozambique, Tanzania and Zambia same as 2). And Namibia needs to unite western states.

In 2040, groups become apparently. Northern Mozambique is the supply center of the group.

And it is added that routes to evacuate the abundant power in RSA to other SAPP state. In terms of this, trunk transmission lines, like corridors to feed the power all over SAPP area.

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[79] This is judged by the transmission capacity of existing route and current firm contract of power trade. Secured energy (110% of demand) is not normal but target to ensure the state's supply operation.

Table 5.1-47 Grouping for capacity

2020			2030			2040		
No.	Area requiring capacity	Area to cooperate	No.	Area requiring capacity	Area to cooperate	No.	Area requiring capacity	Area to cooperate
2020-1	Northern Mozambique	Zimbabwe	2030-1	DR Congo	Zambia	2040-1	DR Congo	Zambia
2020-2	Swaziland	Southern Mozambique	2030-2	Swaziland	Southern Mozambique	2040-2	Swaziland	Southern Mozambique
2020-3	Botswana	RSA	2030-3	Botswana	RSA	2040-3	Botswana	RSA

Source : JICA Survey Team

Table 5.1-48 Grouping for energy

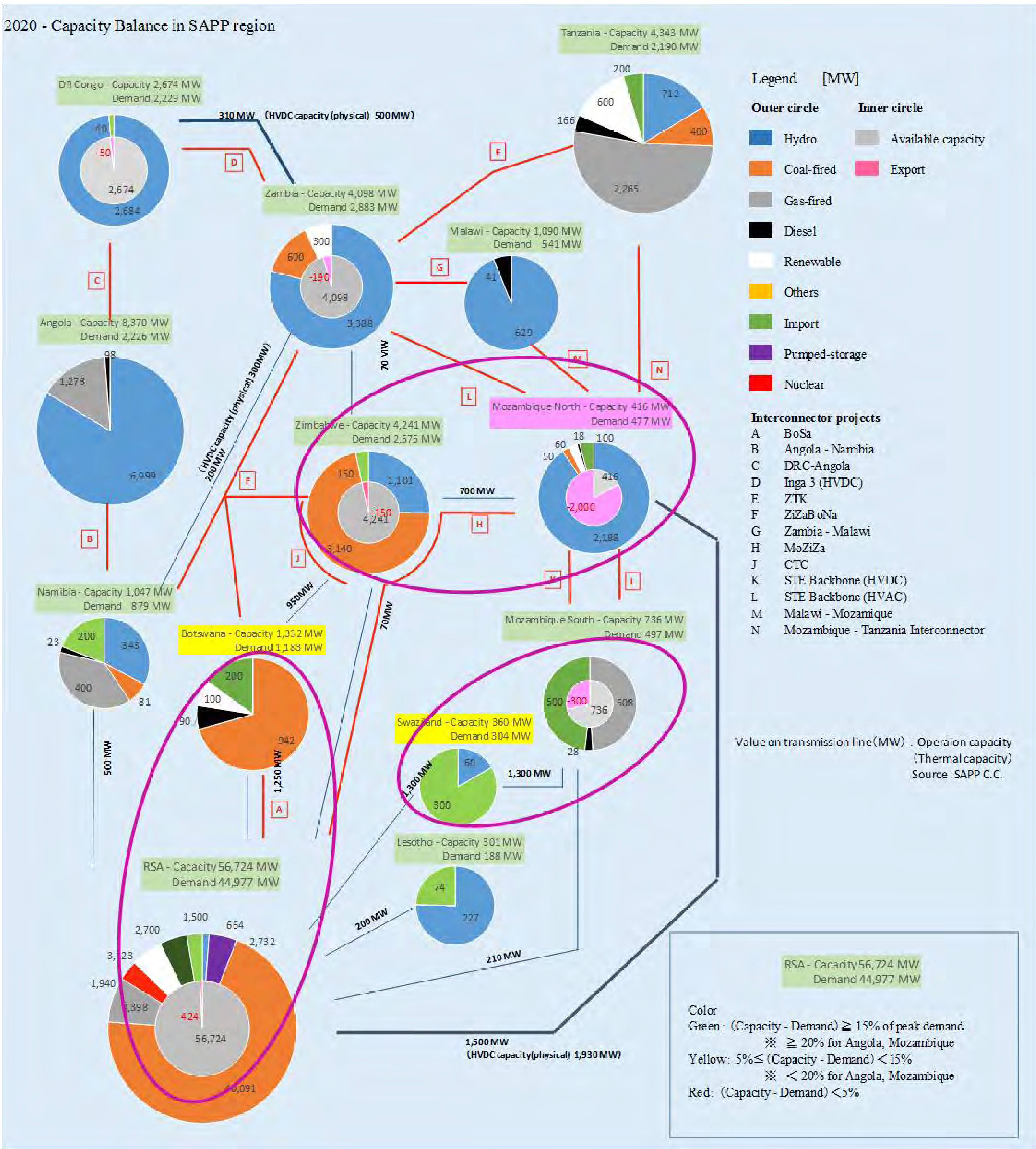
2020			2030			2040		
No.	Area requiring energy	Area to cooperate	No.	Area requiring energy	Area to cooperate	No.	Area requiring energy	Area to cooperate
2020-1	RSA	Botswana Zimbabwe Zambia	2030-1	DR Congo	Zambia	2040-1	DR Congo	Zambia
2020-2	Namibia	Zambia				2040-2	Namibia	RSA
						2040-3	Botswana	RSA or Zimbabwe or Zambia
						2040-4	Tanzania	Zambia Northern Mozambique
						2040-5	Southern Mozambique	Northern Mozambique
						2040-6	Swaziland	RSA
						2040-7	Lesotho	RSA

Source : JICA Survey Team

Table 5.1-49 Grouping for energy in drought condition

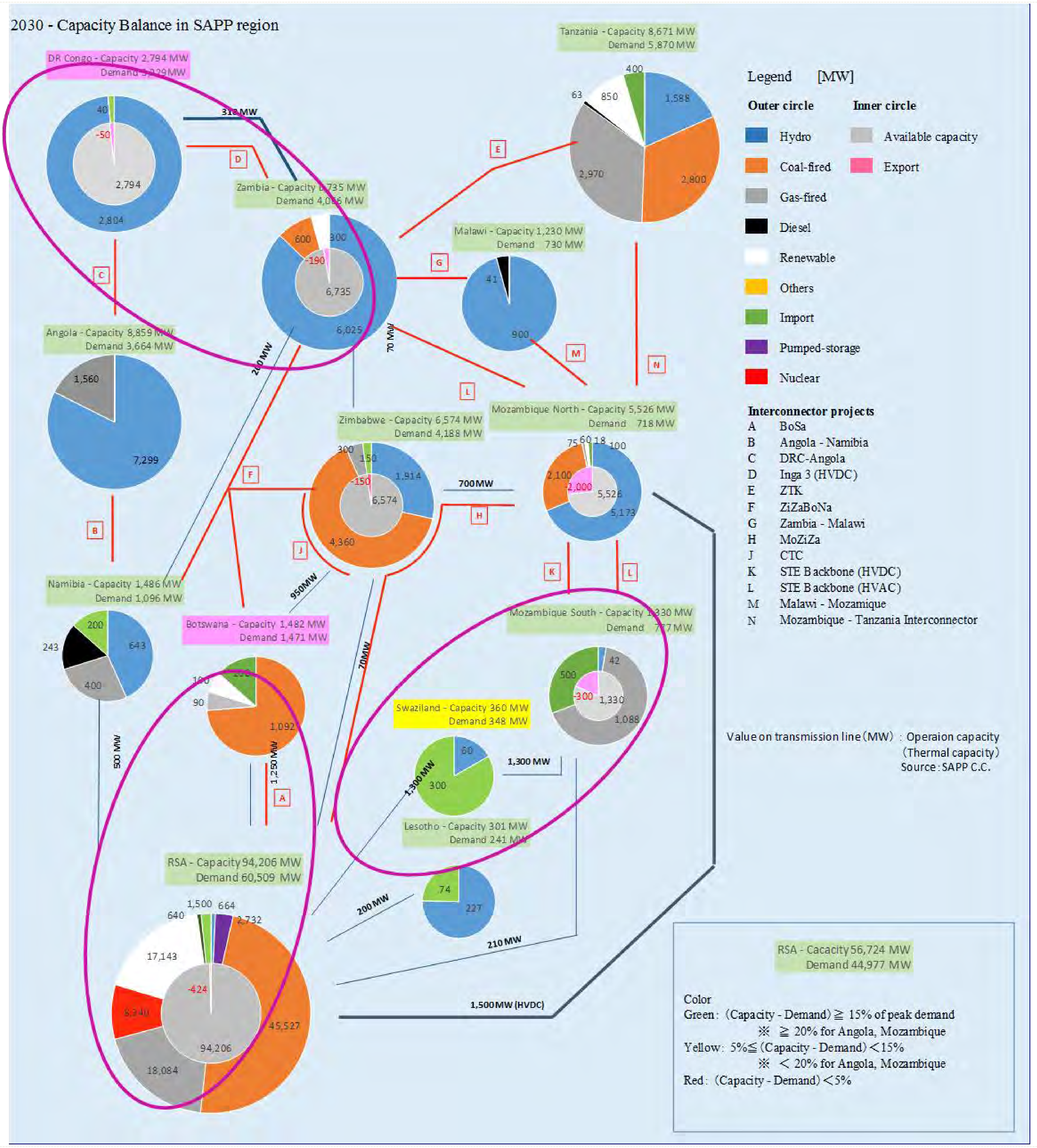
2030			2040		
No.	Area requiring energy	Area to cooperate	No.	Area requiring energy	Area to cooperate
2030-1	Zambia	Tanzania or Zimbabwe or Northern Mozambique	2040-1	Zambia	Northern Mozambique
2030-2	Malawi	Northern Mozambique	2040-2	Malawi	Northern Mozambique
2030-3	DR Congo	Angola	2040-3	Tanzania	Northern Mozambique
			2040-4	Southern Mozambique	Northern Mozambique

Source：JICA Survey Team



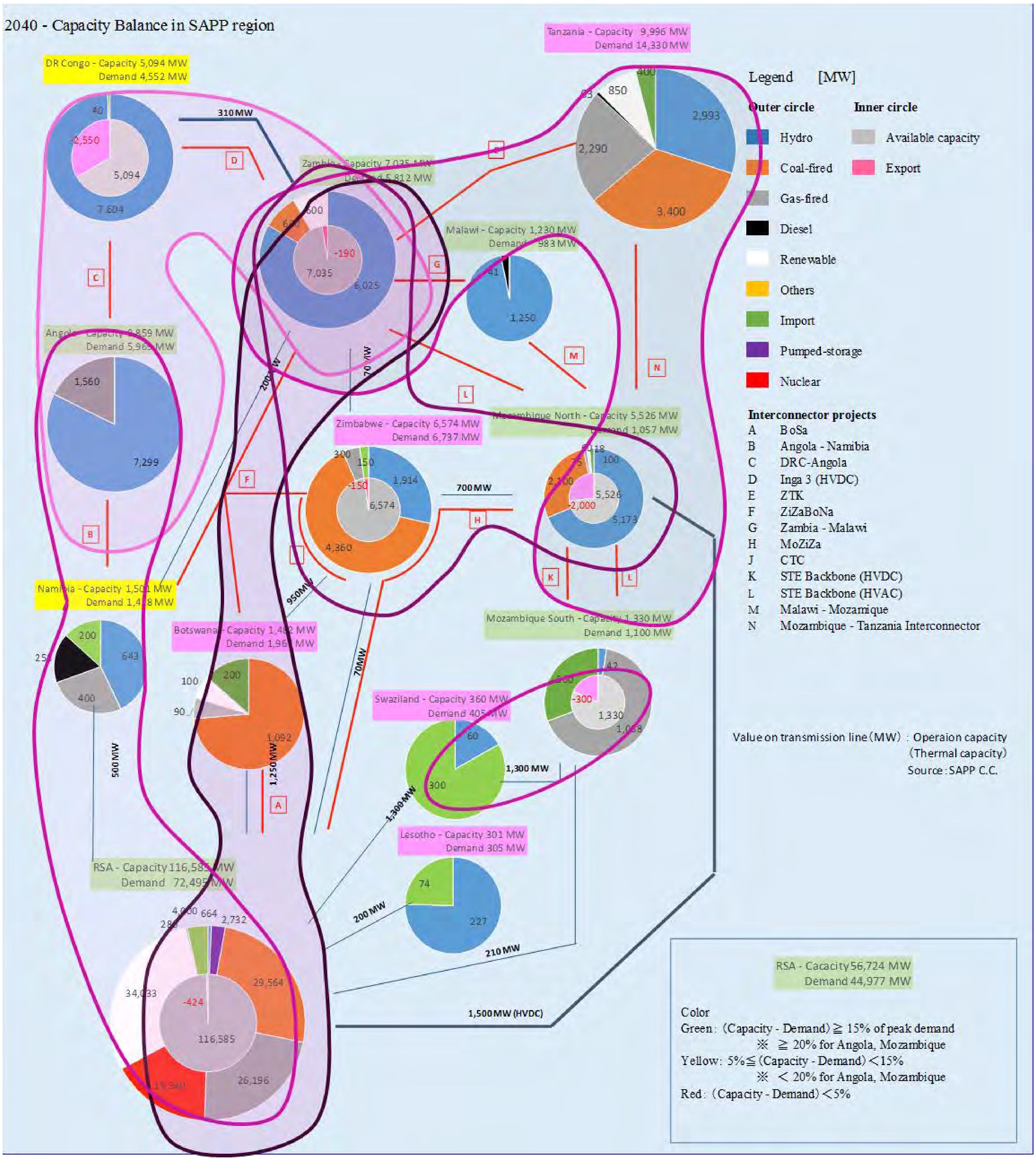
Source : JICA Study Team

Figure 5.1-66 Grouping for capacity dependence as of 2020



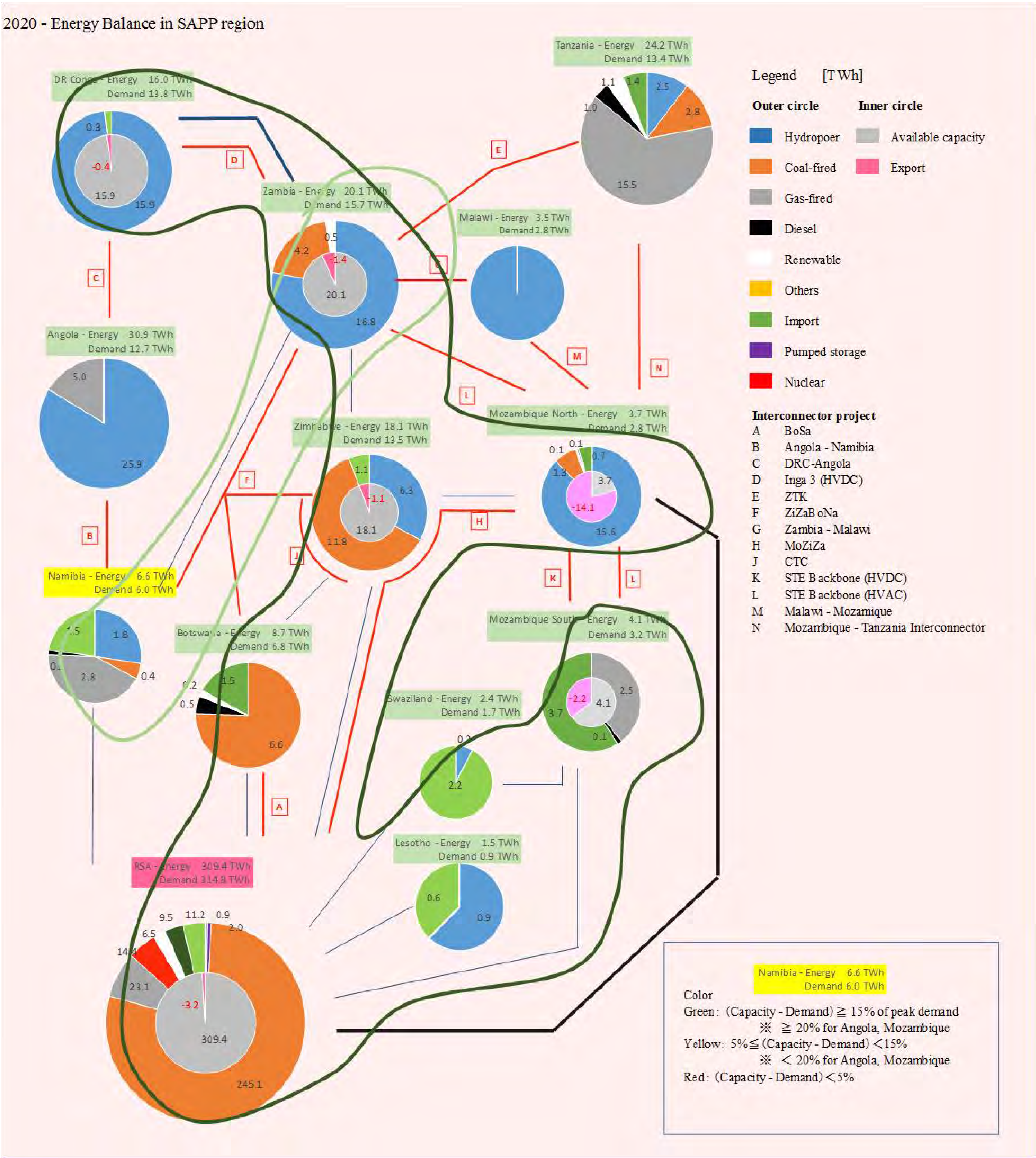
Source : JICA Study Team

Figure 5.1-67 Grouping for capacity dependence as of 2030



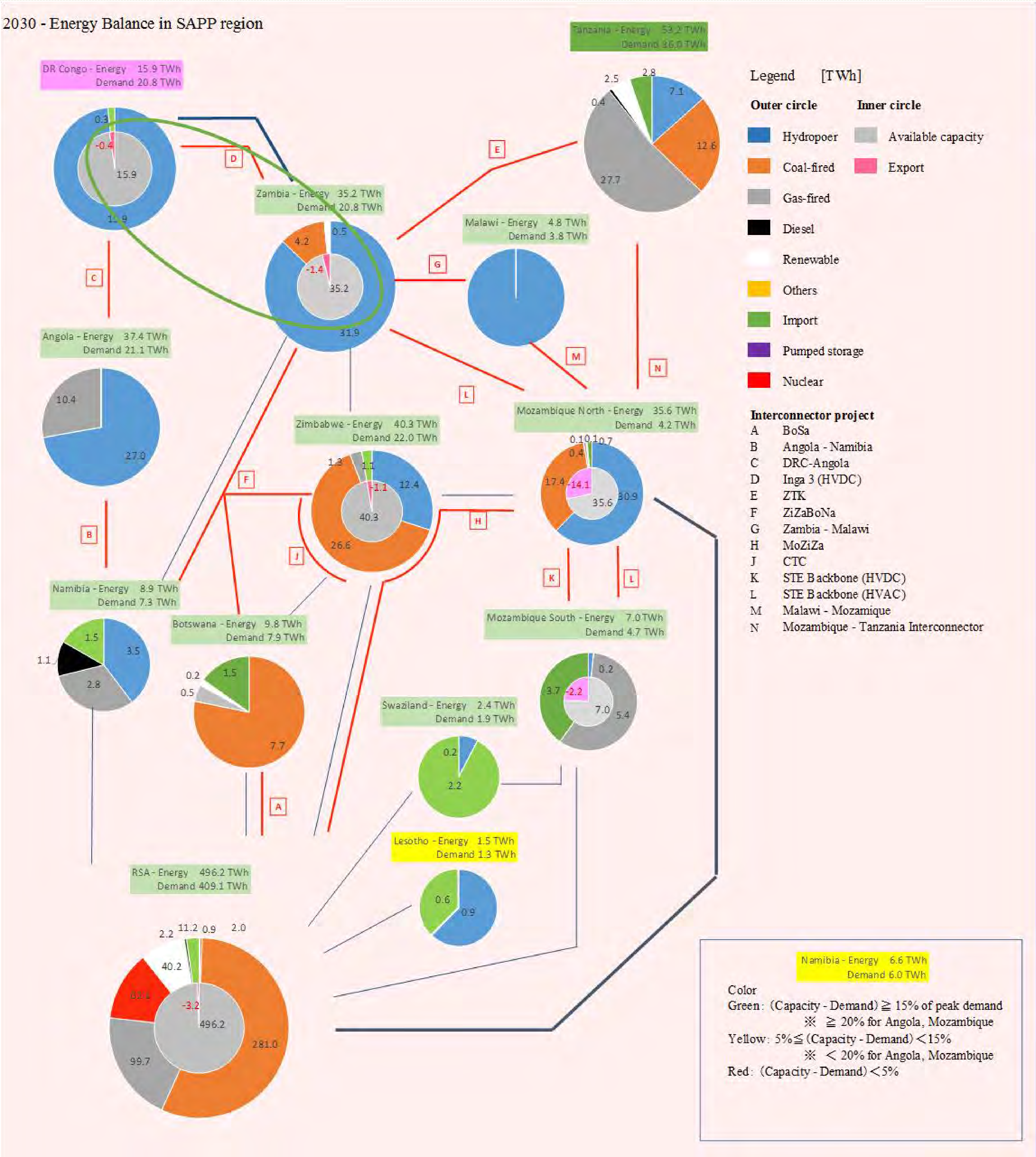
Source：JICA Study Team

Figure 5.1-68 Grouping for capacity dependence as of 2040



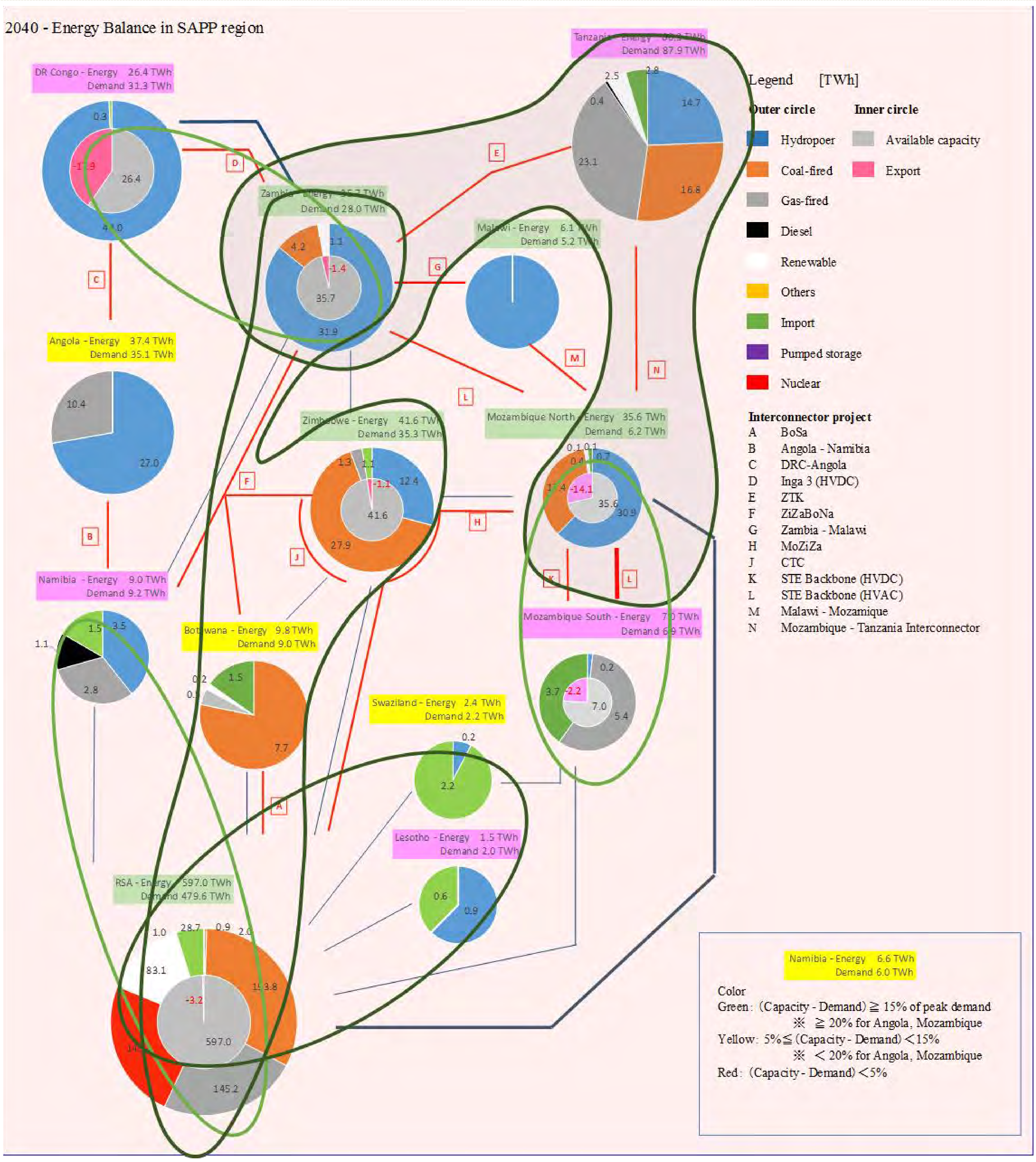
Source：JICA Study Team

Figure 5.1-69 Grouping for energy dependence as of 2020



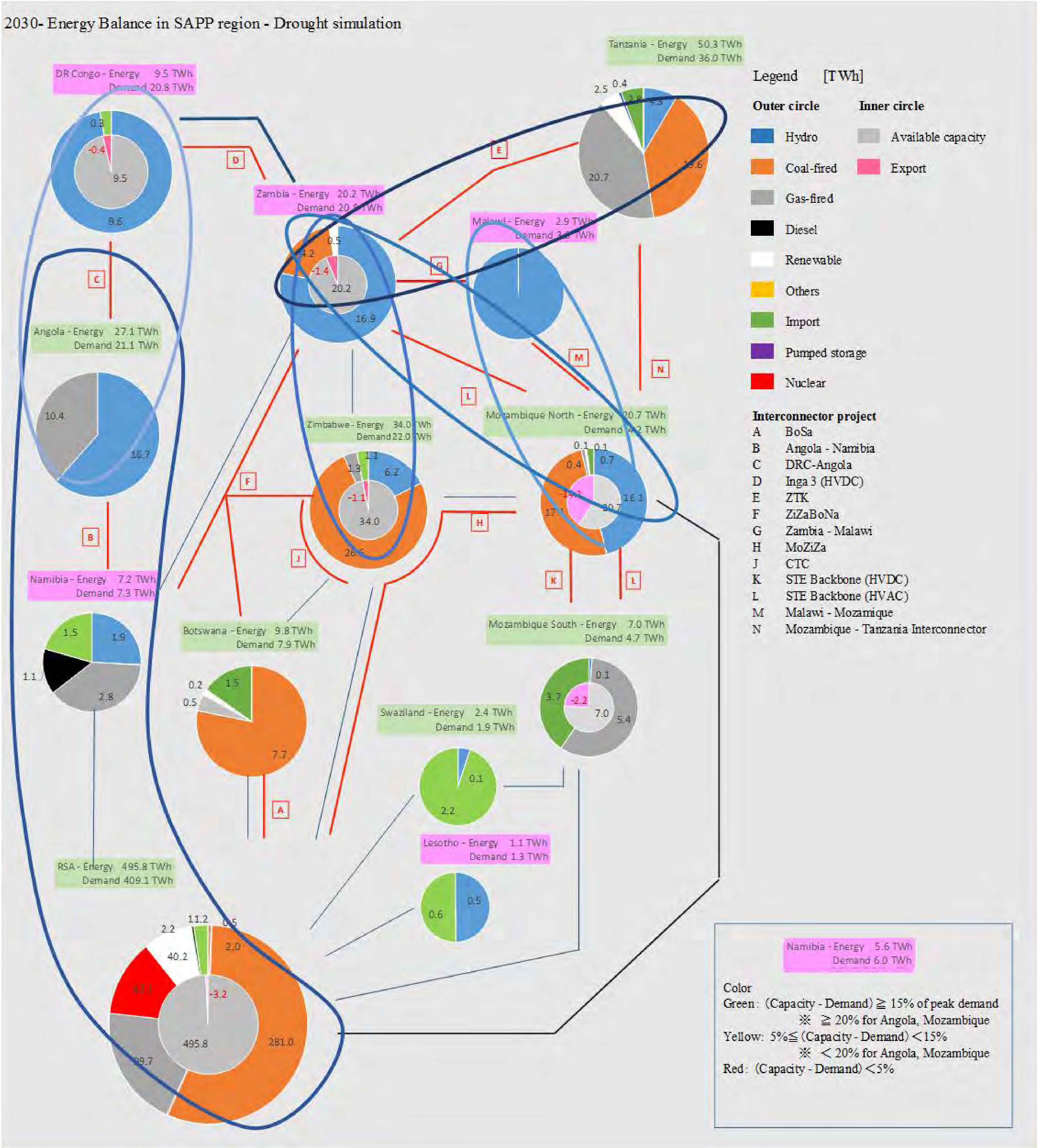
Source：JICA Study Team

Figure 5.1-70 Grouping for energy dependence as of 2030



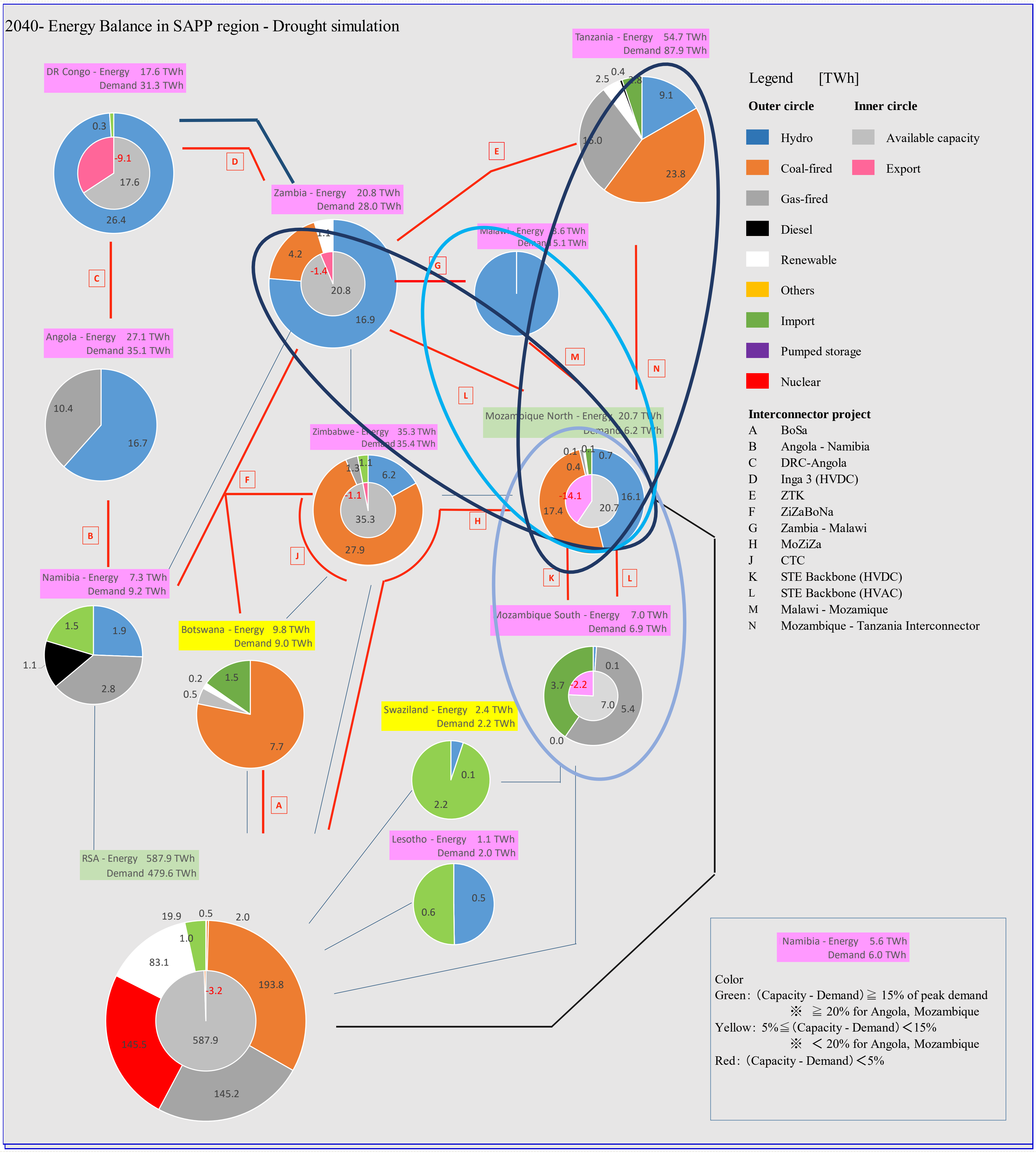
Source：JICA Study Team

Figure 5.1-71 Grouping for capacity dependence as of 2040



Source：JICA Study Team

Figure 5.1-72 Grouping for energy dependence in drought as of 2030



Source: JICA Study Team

Figure 5.1-73 Grouping for energy dependence in drought as of 2040

(2) Sequence and priority of interconnector development

On Chapter2, three purposes are shown for interconnector development.

- Elimination of power transaction congestion
- Connection among not-interconnected countries
- Power transmission from new large-scale generation projects

The Survey sets the priority of interconnector project though all of them are important.

First priority : Elimination of peak congestion transaction,
Second priority : Power transmission from new large-scale generation projects, and
Third priority : Connection among not-interconnected countries

Urgent issue is the first priority to change the current situation, thus the countermeasure must be conducted as soon as possible. Second, interconnector development collaboration with generation development is the fundamental requirement to formulate power pool. In terms of this, the project hit this requirement should investigate the adequate commission period. And last, connection with not-interconnected county, especially individual development project of interconnector can be set the commission period in consideration with suitable generation project which is source for power trade.

In accordance with above mentioned methodology, the Survey arranged the sequence of developments, namely interconnector projects and generation project as Figure 5.1-74.

Following is brief explanation of the figure.

1) Short term scheme in 2020

The fastest project to be conducted is BoSa project. As Table 5.1-48 represents, this interconnector gives tightening linkage between RSA and northern SAPP states.

2) Mid term scheme by 2030

Interconnector projects collaborating generation development, such as Zambia – Mozambique Interconnector project, STE backbone project and Angola – Namibia Interconnector project are suitable for second priority with Tete coal-fired, Mphanda Nkuwa hydropower and Baynes hydropower respectively. They are put on the chart based on generation commissioning year.

It is noted that introduction of Baynes hydropower depends on not only implementation of interconnector but integration of both states, Angola and Namibia.

Zambia – Mozambique Interconnector project and Tete coal-fired project will give the benefit to bind both supply area, namely northern Mozambique and Zambia. Also, STE backbone project and Mphanda Nkuwa project will give the benefit to bind both supply area northern and southern Mozambique.

As for northern Mozambique, interconnector projects, namely Malawi – Mozambique Interconnector, MoZiSa Project and Tanzania – Mozambique Interconnector[80] do not have relation with any generation project at the moment. These will feed a part of power from huge-sized generator(s). In terms of this, the

[80] Implementation of Tanzania – Mozambique Interconnector will be triggered by gas-fired power plant around border of Tanzania and Mozambique. At the moment, gas-fired development is unclear but atmosphere to energize the development can be heard. If this realized, this interconnector might be accelerated.

period of these projects was put on the chart in accordance with commissioning year of expected generation project.

ZiZaBoNa project - phase 2 has high degree of transaction freedom. Therefore, this project completion will be set in or after the accomplishment of rich surplus in northern SAPP states. Source of the surplus will be Batoka Gorge hydropower or Gokwe North coal-fired power in Zimbabwe, thus the commercial operation year of them are contributes to the accomplishment of the interconnector. Meanwhile, before the accomplishment, integration of Botswanan national grid integration and CTC integration must be done.

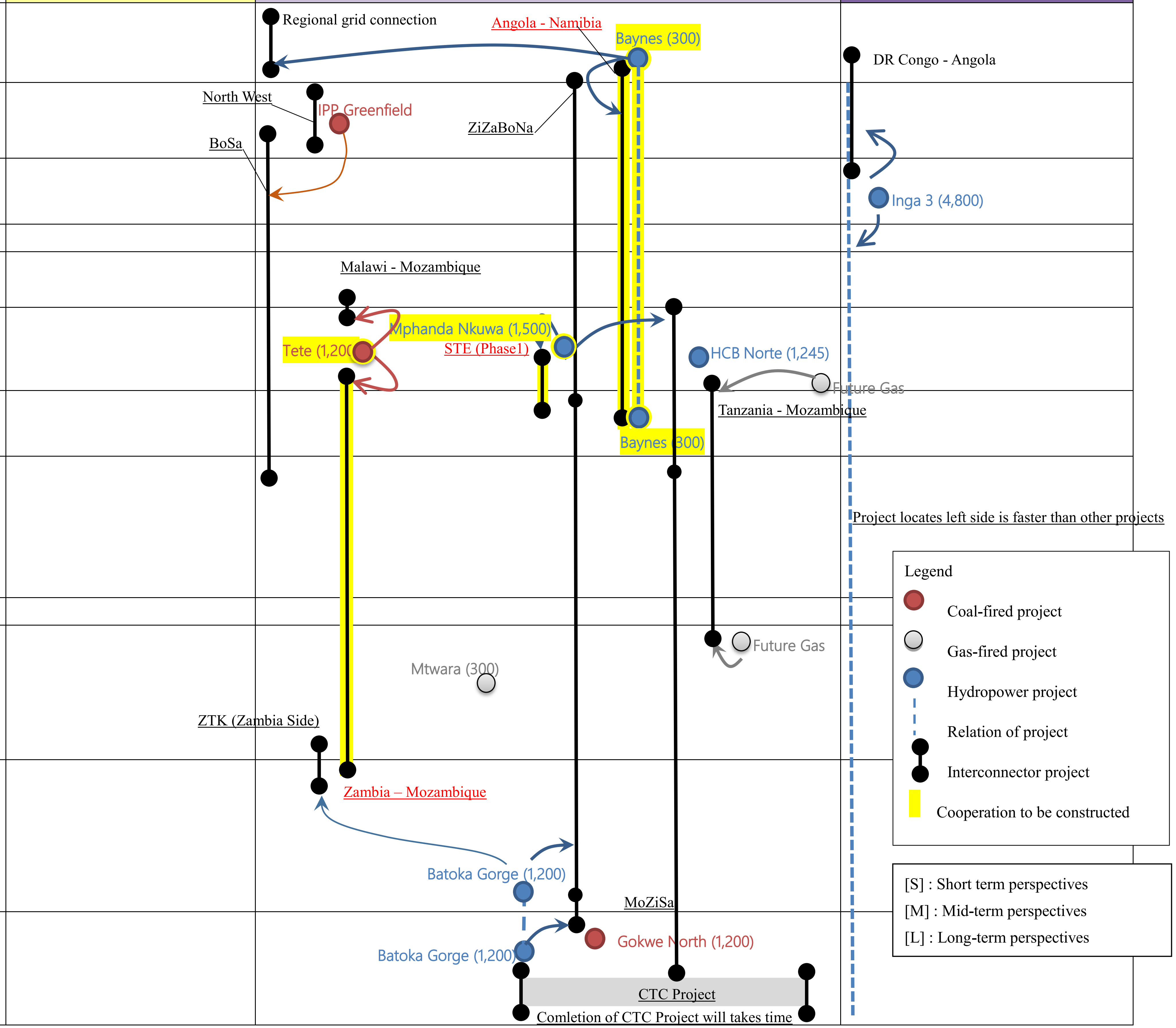
CTC, Central Transmission Corridor, composes diversified transmission lines in widespread Zimbabwean area. Therefore, the Survey minds the wholly accomplishment will be delay and grows gradually. In this project power line from Batoka Gorge hydropower and southern section, Orange Grove – Triangle will be constructed sooner compare to other sections.

DR Congo – Angola interconnector will be arised by trigger of Inga 3 project.

Inga 3 project, 2,500MW evacuation for RSA is delay. And space of existing transmission route from Inga to RSA is few for this magnitude. In order to feed the power in future, the examination of the route should be done at the moment.

Figure 5.1-74 Correlation between interconnector projects and generation projects

	Image of the future	- 2020	- 2030	- 2040
Angola	[S] Grid connection, north, central and south [M] National grid integration and preparation of interconnector [L] Enhancement of interconnector(s)			
Botswana	[S] Interconnector implementation for congestion compensation [M] Regional grid integration for power power transferring country Coal-fired IPPs arise			
DR Congo	[S] Grid integration [M] Regional hydros construction and grid integration [L] Inga 3implementation plus interconnector construction			
Lesotho	—			
Malawi	[S] Regional grid and hydro implementation [M] Interconnector implementation [L] Trunk system integration			
Mozambique	[S] Gas-fired arises in southern part [M] Grid connection Huge-sized hydro, coal-fired are energizing the country, plus gas-fired arises			
Namibia	[S] Gas-fired power plant supports balance [M] Hydro plus interconnector implementation			
South Africa	[S] Renewable introduction and coal-fired introduction by Eskom [M] Nuclear and gas-fired are committed. Coal-fired IPP will join [L] Decommission of Eskom's coal-fired Implementation of nuclear, coal-fired and gas-fired.			
Swaziland	—			
Tanzania	[S] Gas-fired plants arise [M] Interconnector prepares to support regional balance Implementation of coal-fired, gas-fired and hydropower [L] Generation-mix will be conducted			
Zambia	[M] Huge-sized hydropower(s) commits Cross-border coal-fired implementation, and interconnector conducts [L] Regional grid renovation			
Zimbabwe	[S] Tight balance [M] Huge-sized hydropower and coal-fired IPP conduct Trunk grid upgrades to 400kV			



[S] : Short term perspectives
[M] : Mid-term perspectives
[L] : Long-term perspectives

5.2 Scenario and direction to be aimed

The scenario to way forward and direction to be aimed for SAPP is following based on the analysis so far.

(1) Short term (- 2020)

In short term, issues to be resolved in terms of huge-wide—area, namely SAPP grid and of regional grids in SAPP are two,

…Smooth development and planned commission of generation projects to cover the tight supply situation.

…Interconnector extension for avoiding power trade congestion

Table 5.2-1 shows firm projects committed in a few years listed on Table 5.1-11 to Table 5.1-22. However, as is often the case with the region, information of construction progress tends to be delayed. To secure regional balance these projects should be on track (on time).

Table 5.2-1 Projects under construction and ongoing project to be committed near future

State	2017	2018	2019
Angola	Cambambe 2（720MW）	Lauca（2,060 MW） Soyo I （720 MW）	
DR Congo		Ruzizi 3（49 MW）	
Lesotho	Oxbow（70 MW）		
Malawi		Nkula A exp.（12 MW）	Tedzani exp.（18 MW）
Mozambique		CTM 1 （96 MW） CTM 2（29 MW）	Mocuba（30MW） Metoro（30MW）
Namibia		Kudu（400 MW）	
RSA	Ingula（1,332 MW）	Medupi 2 Units（1,588 MW） Kusile 1 Unit（800 MW）	Medupi 2 Units（1,588 MW） Kusile 1 Unit（800 MW）
Tanzania	Kinyerezi I exp.（185 MW）	Kinyerezi II （240 MW）	Rusumo Falls（27 MW） Lower Kihansi（120 MW） Kiwira（400 MW）
Zambia			Kafue Gorge Lower（750 MW） Lusiwasi Lower （74 MW）
Zimbabwe		Kariba South exp.（300 MW）	Gairezi（30 MW） Hwange 7-8（600 MW）
Total（MW）	2,307	6,294	4,467

Row of RSA mentioned Eskom's assets
This table excludes renewable
Source：JICA Survey Team

Aforementioned, new interconnectors arise after certification of SAPP priority project of interconnector. These are,

・Project to mitigate power trade congestion in a reflection of current trading allocation

・Project modified SAPP priority project in a reflection of acceleration idea for interconnector construction

・Project for new generation project appearance

The first one is a pressing issue to be solved and BoSa project is explicit one for this issue.

(2) Mid-term (- 2030), long-term (- 2040) scenario

In mid-term, period until 2030 and in long-term, period until 2040, issues to overcome and direction to way forward is,

① Acceleration of generation SAPP priority project implementations

Current tight demand and supply balance is caused by delay of generation development.

SAPP Priority projects, especially designated hydropower projects are well-studied over and over and are reached reasonable verifications. Creation of cheap generation cost is common demand for all SAPP member states. Specifically, hydropower in northern SAPP area will be preferable candidates to help enhancement of system capacity of SAPP system.

In the meanwhile, Inga 3 project is doubtful to create cheap electricity but will be delayed due to delayed progress.

② Coal-fired and gas-fired power plants implementation to meet the demand instantly

Nowadays, implementation of coal-fired and/or gas-fired power plants are one of suitable countermeasure to overcome the firm capacity shortage, especially in resource-rich counties. To meet the demand as soon as possible, construction period of coal-fired (especially mid-sized coal-fired) and gas-fired power plants are relatively shorter than that of hydropowers. Further, as for gas-fired power plant, in future it is easy to renovate to high efficient model, such as CCGT from OCGT with the budget.

③ Implementation of interconnector(s) synchronized with generation development

Construction of transmission line(s) including interconnector(s) for item ① and item ② should be rightfully faster than corridor plan. If the transmission line(s) contribute to corridor, e.g. transmission line to be constructed is a component of corridor(s), that is reasonable and strategic.

④ Wide-area formation to achieve generation (Energy) mixture against risks

Ratio of generation capacity in northern SAPP states leans hydropowers. To compensate risks of hydropower (construction delay and/or drought condition), these states must have interconnector (or enhance the trunk transmission lines) with neighboring state(s) which has firm capacity, such as coal-fired or gas-fired power plants in order to enlarge and secure the (merged) system capacity[81].

If the interconnector to form the item ③ satisfies this purpose, it will be efficient.

⑤ Huge-wide-area formation led to from item ③ and ④ (corridor(s))

Construction of interconnector(s) for connecting generator(s) and grid in terms of item ③ and interconnector(s) to achieve wide-area formation to make firm generation-mix give future huge-wide-area formation to energize power interchange freely. That means corridor(s).

Assumption and provision give direction to be aimed by SAPP as Table 5.2-2.

[81] Nowadays, water level of the Lake Kariba is severe, once the water declines under critical level, its recovery wants two or three years at least.

Table 5.2-2 Scenario and direction to be developed in the Survey

Short term in 2020	
Generation	Acceleration of current constructing and ongoing projects
Transmission (Interconnector)	Development of interconnector and regional trunk transmission line(s) to avoid occurring power trade congestion.
Mid-term in 2030	
Generation	Huge-sized hydropower development to pursue least generation cost. Development and promotion of coal-fired and gas-fired to secure the firm capacity
Transmission (Interconnector)	Development of interconnector(s) synchronized with development of SAPP Priority Generation Projects Development of interconnector(s) to ensure the reliability of power supply from coal-fired / gas-fired power plants in neighboring countries to deal with drought condition (to establish wide-area supply territory) Development of interconnector(s) contribute to establish future corridor(s)
Long-term in 2040	
Generation	Development of huge-wide-area generation, such as Inga-3
Transmission (Interconnector)	Accomplishment of Corridors

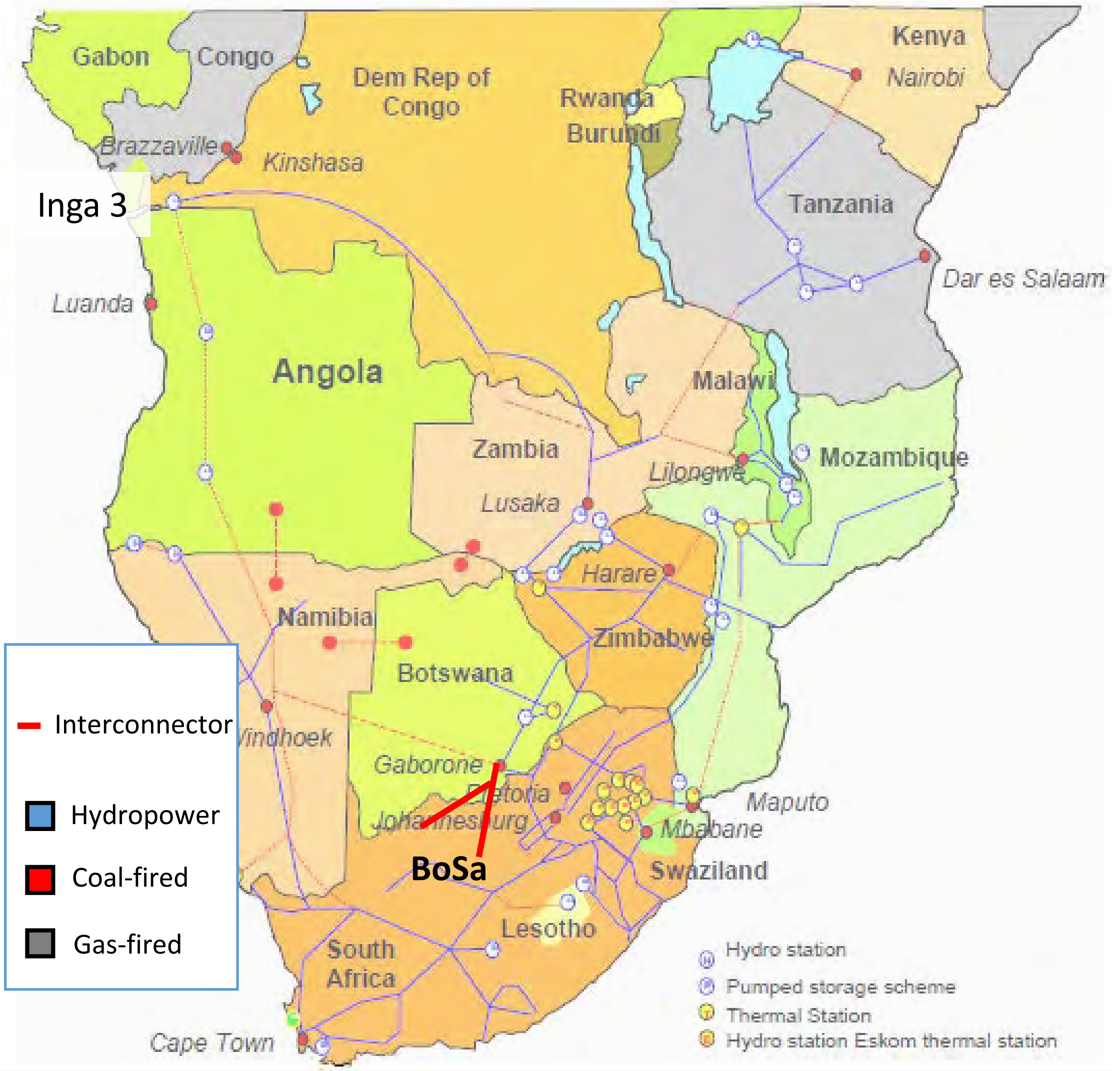
Source : JICA Survey Team

5.3 Eastern corridor plan, in line with scenario

Here, concrete steps would be studied based on aforementioned scenario and directions.

1. Short term scheme (project implementation for power trading congestion compensation)

As the short term scheme around 2020, BoSa project is recommendable one to achieve the preferable condition. BoSa project can strengthen the linkage between southern and northern area of SAPP.



Source：JICA Survey Team

Figure 5.3-1 Short-term perspective

Remarkable issue is the design, as aforementioned. 400kV or 500kV design will be chosen for BoSa project by the propose from Eskom. 500kV design study will be the future strategic plan to implement longitudinal trunk line for evacuating the power from northern region.

According to SAPP C.C., dominant options to evacuate the power, 2,500 MW from Inga 3 to RSA are two, one is HVDC line from far northern side to RSA, another one is 500kV HVAC from far northern side to RSA.

Therefore, final decision of BoSa project design must be paid attention and surrounding projects' progress are also.

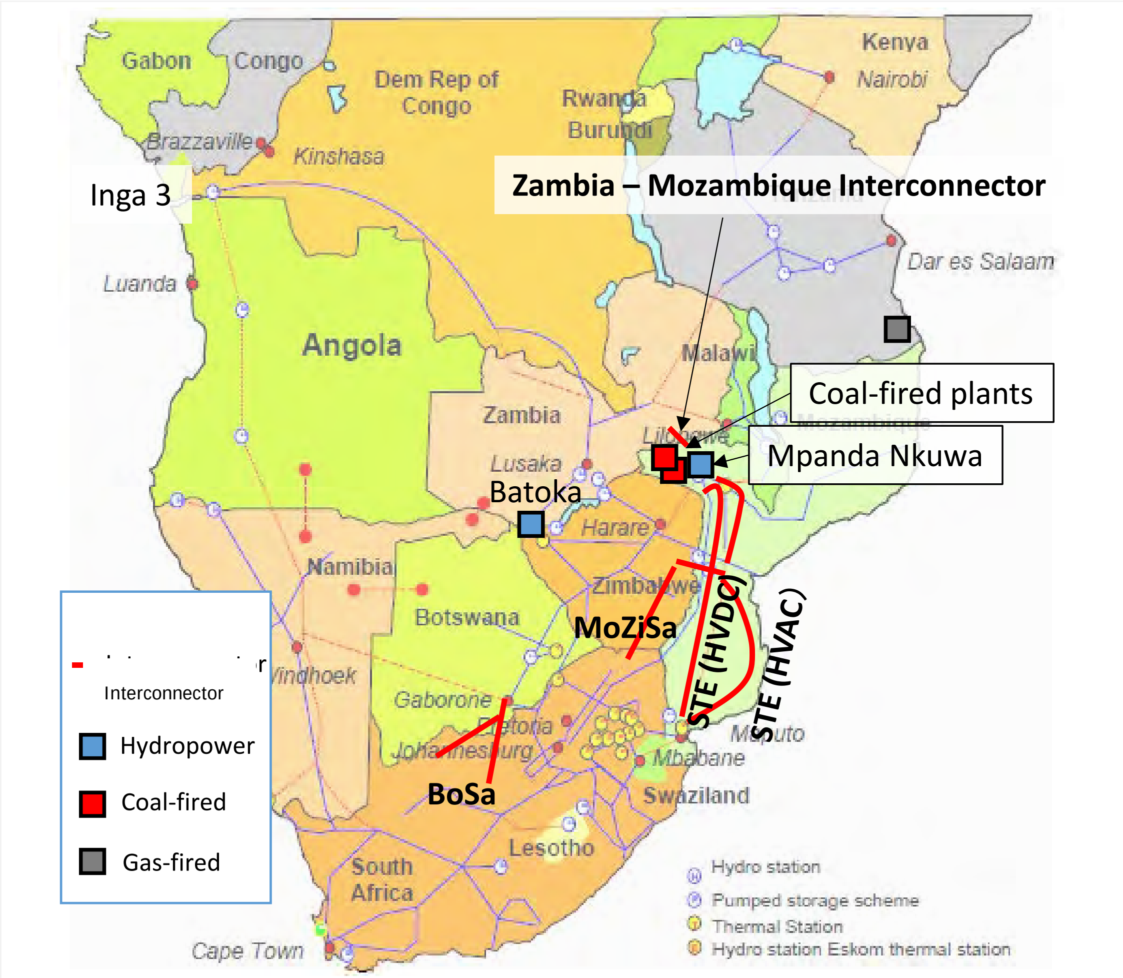
2. Mid term scheme（Huge-sized hydropower and thermal power plants' introduction in collaboration with interconnector）

In 2030, Batoka Gorge hydropower plant, SAPP priority project, will be introduced with 2,400MW of total capacity (Zambian side : 1,200MW, Zimbabwean site : 1,200MW)

In addition, Zambia – Mozambique Interconnector in collaboration with Tete 1,200MW coal-fired power plant will be introduced. This event gives Zambian system generation-mix and gives wide-supply area. As for Mozambican system, especially northern Mozambican system can be given Zambian hydropower's capacity.

Plus, coal-fired power plant(s) by IPPs will be introduced by trigger of connection between Mozambique and Zambia. This can affect energetic interconnector introduction, such as MoZiSa and / or STE backbone (HVAC).

Mphanda Nkuwa, SAPP priority project allocated in northern Mozambique will be commenced in this period. Bulk power from these generation projects needs STE backbone (HVDC) to feed the power to southern SAPP area, especially Maputo and RSA.



Source : JICA Survey Team

Figure 5.3-2　Mid-term perspective

3.　Long term scheme（Huge-wide-area generation introduction and formation of corridors）

In 2040, bulk power evacuation route from Inga 3 should be solved for long term perspective because this issue will be influenced with all SAPP member states.

The evacuation route from Inga 3 is now being studied by Eskom. Cogent options are following two designs as shown in Table 5.3-1. And design of BoSa project, utilization of 500kV design might be the preparation of this strategy.

It is noted that each option has merit and demerits.

Table 5.3-1 Transmission option's trade-off for Inga 3

All HVDC route	500kV HVAC from Zambia to RSA
Merit ・Transmission loss can be minimized ・Transferring countries cannot be given the issue of system stability.	Merit ・Transferring countries can be given the loss reduction compared to existing transmission loss.
Demerit ・Transferring countries which have to maintain HVDC transmission line cannot benefit the power from Inga 3. ・Negotiation of HVDC maintenance will be need to transferring countries. ・Huge investment cost will be needed to fund by RSA and DR Congo	Demerit ・Excessive investment compared to own system capacity.

Source : JICA Survey Team

Here, the Survey would propose new concept to evacuate the power from SAPP northern side and to solve the demerits mentioned above as shown in Figure 5.3-3.

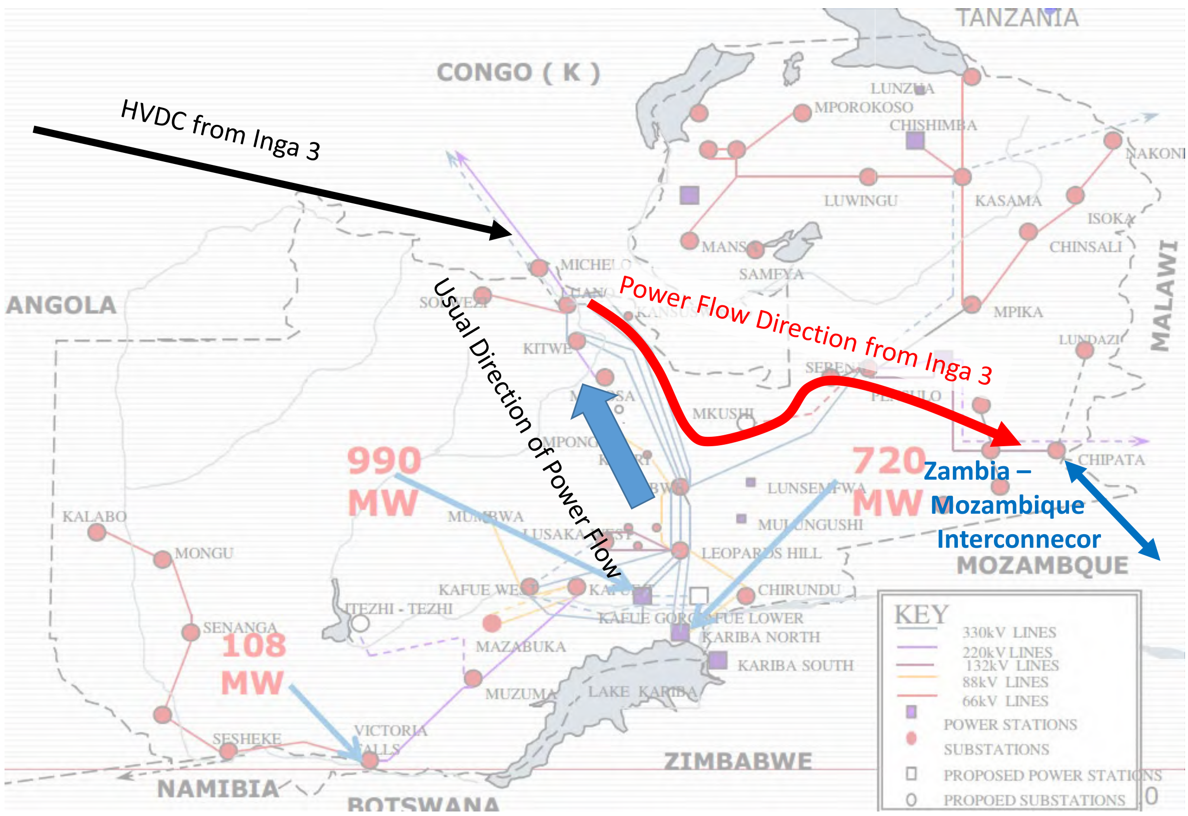
1) Proposal of power flow route from Inga 3

Premise and requisite

1、HVDC installation to evacuate the power from site of Inga 3 will be installed between Inga 3 and Katanga province, Zambian border

2、Zambia – Mozambique Interconnector will be introduced in mid-term. The power flow direction will be fundamentally from Mozambique to Zambia.

3、Power flow direction in longitudinal route in Zambian grid is usually south to north (for copperbelt area)



Source : JICA Survey Team

Figure 5.3-3 Evacuation route of power from Inga 3 in Zambia

Figure 5.3-3 illustrates the perspective of Inga 3 power direction from northern border in Zambia to Chipata West substation, the entrance of Zambia – Mozambique interconnector which applies 400kV.

330kV is the highest voltage class on current Zambian grid. 330kV as the highest voltage class is applied on Zambian and Zimbabwean grid only. Further, Zimbabwean grid prepares upgrading the trunk system from 330kV to 400kV. That's why ZETDC constructs and plans transmission line with 400kV design and initially operates 330kV. And near future she will change the facilities in line with the triggers which is internal issues, such as demand expansion or is external issues, such as bulk power injection from outer area.

As aforementioned demand and supply balance represents, demand magnitude of Zambia and of Zimbabwe is almost same, and transmission loss in Zambia and Zimbabwe is also same because of same voltage class. However, deviation of transmission loss between Zambian and Zimbabwean grid occurs in Zambia will remain in case of upgrading of trunk transmission line in Zimbabwe, from 330kV to 400kV.

Further, longitudinal route in Zambia, especially from northern Zambian border to Kabwe, the center of Zambia is much elder, which was born in 1960s (see Table 5.3-2). These lines should be renovated in near future to strengthen the backbone in Zambia. Zambia – Mozambique Interconnector is now set to apply 400kV-HVAC design, and therefore surrounding facility, such as Chipata West－Pensulo should be studied to apply 400kV-HVAC.

Power injection from Inga 3 will decline the power magnitude of longitudinal route, namely northern Zambian border to Kabwe. Further, power flow on Zambia – Mozambique Interconnector flow into Lusaka area will be declined by this injection.

Table 5.3-2 Existing transmission lines in Zambia

Section	Conductor	Length (km)	Tower type	Voltage・Capacity (kV, MVA)	Number of tower	COD
Pensulo - Msoro	2 x Bison	-	Steel lattice	330, 700MVA	-	2015
Msoro – Chipata West	2 x Bison	-	Steel lattice	330, 700MVA	-	2015
Leopard Hill – Kabwe 1	2 x Bison	97	Steel lattice	330, 700 MVA	217	1960
Leopard Hill – Kabwe 2	2 x Bison	97	Steel lattice	330, 700 MVA	217	1965
Leopard Hill – Kabwe 3	2 x Bison	97	Steel lattice, Guyed	330, 700 MVA	217	1972
Kabwe – Kitwe 2	2 x Bison	211	Steel lattice	330, 700 MVA	520	1972
Kabwe – Kitwe 3	2 x Bison	211	Steel lattice, Guyed	330, 700 MVA	520	1983
Kabwe – Luano 1	2 x Bison	251	Steel lattice	330, 700 MVA	565	1960
Kabwe – Luano 2	2 x Bison	251	Steel lattice, Guyed	330, 700 MVA	565	1960
Kabwe – Pensulo	2 x Bison	298	Steel lattice	330, 700 MVA	664	1960

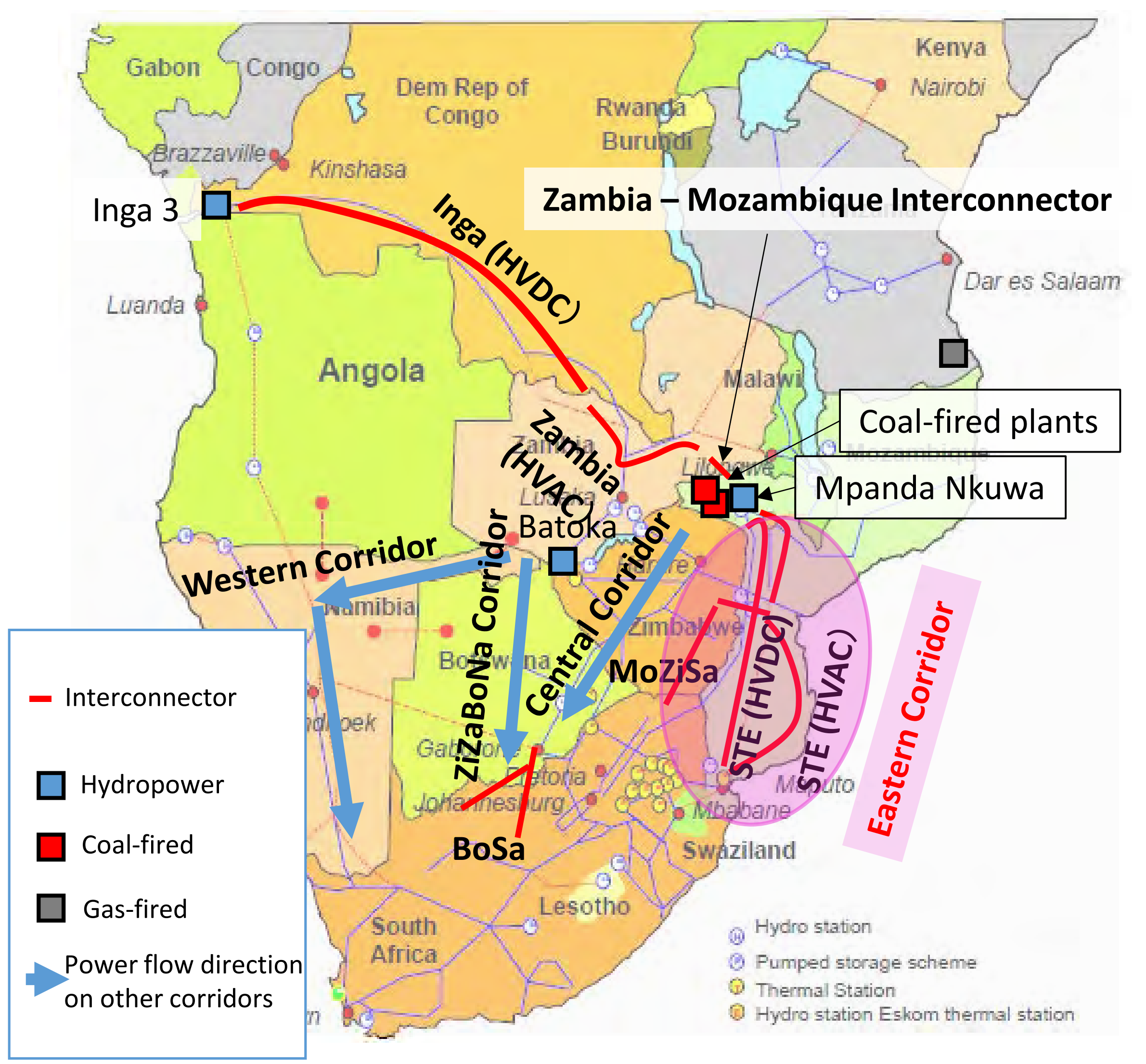
Source : JICA Survey Team using evidence from ZESCO

As aforementioned system planning assumed, HVDC, from Inga site to Katanga province will feed 2,500MW for RSA plus 1,300MW for industry, such as mining company. It will push up the mining industry development around Katanga province including Copperbelt area and push the grid integration in eastern DR Congo and northern Zambia.

Thus, it will be possible to flow into northern Zambian border to entrance of Zambia – Mozambique Interconnector through Zambian national grid. Withdrawn power to Mozambique will ride on HVDC, STE backbone project and HVAC, MoZiSa toward southern SAPP area. Here, these routes can be called eastern corridor.

The eastern corridor can be easily established with existing interconnector projects. And it also can give the efficient regional system renovation with least cost and its expansion.

In the long-term, several corridors will be created, such as ZiZaBoNa corridor, Central corridor with Zimbabwean grid, etc. To organize flexible routes with corridors gives SAPP a fruitful power trade and secured power system with rich generation mix.



Source：JICA Survey Team

Figure 5.3-4 Long-term perspective beyond 2040

Chapter 6 Formulation of expected project list

The purpose of the Survey is to pick up the projects which should be provided practical Japan's support in line with the formulation of SAPP grid. In this Chapter, the project(s) expected should be selected based on facts and analysis of the Survey with directionality to aim for in the Survey.

6.1 Evaluation of generation project

The projects on the generation development lists, as expected is extracted into the short list.

The evaluation factors are as follows,

Table 6.1-1 Evaluation factor for generation project

Factors	Specifications
Absolute prerequisite 1	Project to be evaluated meets "scenario to be considered and direction to be aimed"
Absolute prerequisite 2	Project to be evaluated is "greenfield" and public sector, such as government can develop it.
Absolute prerequisite 3	Project to be evaluated has no constraints, such as environmental issue and / or developing process, such as conflict of international river development etc.
Premium factor	Evaluated project is a SAPP priority project

Source : JICA Survey Team

Table 6.1-2 Expected generation projects

Expected project	Countries to be developed	Capacity（MW）	COY (Preferable condition)
Baynes hydro	Angola, Namibia	600 （Angola : 300, Namibia : 300）	2026
Mphanda Nkuwa hydro	Mozambique	1,500	2024
HCB Norte hydro	Mozambique	1,250	2026
Batoka Gorge hydro	Zimbabwe, Zambia	2,400 （Zimbabwe : 1,200, Zambia : 1,200）	2024
Tete 1,200MW coal-fired	Mozambique	1,200	2022
Future gas-fired	Mozambique	—	—
Future gas-fired	Tanzania	—	—

Source : JICA Survey Team

Brief explanation of the result is below,

(1) Hydropower project

Recently there are lots of IPP's projects such as not only thermal power but renewable energy including hydropower. As for hydropower projects, selectable project is the one which has huge-sized capacity remaining on international river. All of selected projects are SAPP priority project.

Here, some projects are gathering momentum; Mumbotuta Falls (490MW), Mambilima Falls I (126MW), Mambilima Falls II (202MW), and Mambilima Falls V (372MW), which are located on international river, the Luapula river basin between Zambia and DR Congo. SAPP PAU is now planning to do the study of them in 2017. However, Pre-FS, which conducted in 1978 to 1981, for them remains and subsequent studies are not conducted at that time. Therefore these projects cannot be evaluated in the Survey.

As for Inga 3 project, giving strong benefit to SAPP member states, is now in procurement status. Inga 3 project is not selected because it is not green field.

(2) Thermal power project

The development of thermal power is mainly proposed by IPP. Therefore, almost all projects do not meet absolute prerequisite 2. However, recently information of project which meet the demand appeared.

One is the plan to construct 1,200MW Advanced USC coal-fired power plant in Tete which is power source for Zambia-Mozambique interconnector that was signed between Zambian government and Mozambique government in March, 2016. Another is gas-fired power development in Mtwara region which is power source for Tanzania-Mozambique interconnector that was signed between Tanesco and EDM in 2016[82]. However, these projects are difficult to clarify absolute prerequisite 3 because these status is still in an early stage.

(3) Renewable energy project

The renewable energy development for power sector in SAPP will be almost developed by IPP as far as we know. Thus it does not meet absolute prerequisite 2.

6.2 Evaluation of the interconnector project

Apart from the process in section 6.1, all interconnector projects are listed because relative merits in all projects are not desirable.

The evaluation factors are as follows;

Table 6.2-1 Evaluation factor for interconnector project

Factors	Specifications
Absolute prerequisite 1	Project to be evaluated meets “scenario to be considered and direction to be aimed”
Absolute prerequisite 2	Generation project selected is energized by the interconnector to be evaluated in terms of power trade vitalization.
Absolute prerequisite 3	Interconnector to be evaluated makes contribution to formulation of wide-area supply area
Premium factor	Project to be evaluated is a SAPP priority project

Source：JICA Survey Team

The result of evaluation is shown as Table 6.2-2.

On the table, degree of accumulation on absolute prerequisite 1 for each project indicates ◎, ○ or △ in order of dominance.

Brief explanation of the result is below,

[82] This is illustrated on Figure 5.1-57.

Table 6.2-2 Expected interconnector projects

Projects	Countries concerned	COY (preferable condition)	Evaluation			
			Absolute prerequisite 1	Absolute prerequisite 2	Absolute prerequisite 3	Premium
BoSa Project	Botswana, RSA	2021~22	◎ (Short term), (Mid term), (Long term)	–	–	–
CTC Project	Zimbabwe	2021～29	△ (Long term)	–	–	★
ZTK Project（Zambia Side）	Zambia, Tanzania	2022～23	–	–	○	★
Malawi – Mozambique Interconnector	Malawi, Mozambique	2021～23	–	–	○	★
ZiZaBoNa Project	Zambia, Zimbabwe, Botswana, Namibia	2022~24	△ (Long term)	Batoka Gorge （2,400 MW）	–	★
DR Congo - Angola	DR Congo, Anglra	2031	–	–	–	
MoZiSa Project	Mozambique, Zimbabwe, RSA	2024～28	○ (Mid term), (Long term)	Mphanda Nkuwa, HCB Norte Tete 1,200MW coal-fired （3,945 MW）	○	★
STE Project (HVAC)	Mozambique	2024	○ (Mid term), (Long term)	Mphanda Nkuwa, HCB Norte （2,745 MW）	○	★
STE Backbone Project （HVDC Phase 1）	Mozambique	2025	○ (Mid term), (Long term)	Mphanda Nkuwa, HCB Norte （2,745 MW）	–	★
Angola – Namibia	Angola Namibia	2026	–	Baynes （600 MW）	–	★
Tanzania – Mozambique Interconnector	Tanzania, Mozambique	2026～29	–	Tanzanian gas-fired Mozambican gas-fired （N/A）	○	–
Zambia – Mozambique Interconnector	Zambia, Mozambique	2022～23	○ (Mid term), (Long term)	Mphanda Nkuwa, HCB Norte Tete 1,200MWcoal-fired （3,945 MW）	○	–
STE Backbone Project (HVDC Phase 2）	Mozambique	–	△ (Long term)	Mphanda Nkuwa, HCB Norte （2,745 MW）	–	★

Source：JICA Survey Team

On the point of factor 1, BoSa Project is the most preferable one. This project brings alleviation of power trade congestion in short term and becomes a component of transmission corridor for interchanging the power between RSA and other northern SAPP states in subsequent period.

On the point of factor 2, Interconnectors in Mozambique such as MoZiSa project etc. are prioritized.

6.3 Evaluation from the point of financial aspects

(1) Projects for financial analysis

Table 6.3-1 shows the projects to be analyzed. These items are set with power flow direction and its power sources to feed the power on the interconnector in accordance with its absolute prerequisites 1 and 2 (see ///).

(2) Approach for financial analysis

➢ Wheeling charge approach by SAPP

It is necessary to establish the transmission business model in order to recover the investment by charging the wheeling cost and covering the operation and maintenance costs because the transmission facility generally does not produce the profits by itself.

The basic mechanism to recover the transmission investment cost by SAPP is by "take-or-pay" principle. The users of the transmission lines basically pay the capacity charge as an off-taker for the use of the capacity of the system. The capacity charge is calculated by the construction cost of the transmission line system. In addition, the energy charge will be paid for the actual use of the system, which is calculated by the operation and maintenance costs.

Under this costing approach, the project sponsors are allowed to recover certain level of return on investment in addition to the investment and maintenance costs. The majority of the costs, which is from the initial investment, can be recovered by the capacity charge. Thus the stable capital return can be expected. This will allow the SAPP financial approach of the transmission system to expedite the investment on the projects.

➢ Financial analysis in the Survey

The characteristics of the SAPP approach are the specific evaluation of the transmission system for the actual, operating system. On the other hand, the Survey intends to evaluate the new projects that are not yet implemented or designed. Thus the approach would be unique for this purpose.

The main objectives of the financial analysis in the Study would be the following.

(a) To compare the multiple transmission projects from the financial viewpoint.

(b) To evaluate the transmission system as a joint project of the generation (or existing generation plant(s)) and transmission since the power trade expects to take place by specifying the generation source[83].

(c) To assess the benefits of the power trade by considering the power purchase price, which comprises of the generation and transmission charges[84].

In order to study the aspects, it is desirable to have the cost of the generation and transmission for each

[83] The transmission projects originally expect to recover the investment by a certain pricing system. Thus the sole analysis for the transmission line is not required. Yet the consolidated analysis of the generation and transmission would be effective.

[84] From the viewpoint of the seller, the economic benefit is obvious because the surplus of the generation can be sold to other countries. Therefore the study on this would not be necessary.

case. However, the number of the projects is many. The combination of the generation and transmission would be a huge amount. Given the progress of the projects, some do not have the cost estimate data. Therefore, the study assumes a model case for which the project design and costs are estimated. The actual steps for the study are the following.

Table 6.3-1 Lists of projects for financial analysis

#	Name of Transmission Line	Location		Transmission Line Length (km)				Generation for trading
		From (Country A)	To (Country B)	Total	New Construction Portion	Existing Portion 1 (Country A)	Existing Portion 2 (Country B)	Type of Plant (Hydro, Gas, Oil, etc)
1	BoSa Project	Botswana/ Morupule B	South Africa/ Pluto	575.00	360.00	215.00	0.00	Coal
2-1	Angola Namibia Interconnector (1)	Angola/ Baynes	Namibia/ Ruacana	164.00	164.00	0.00	0.00	Hydro
2-2	Angola Namibia Interconnector (2)	Namibia/ Baynes	Angola/ Xangongo	264.00	264.00	0.00	0.00	Hydro
3	DRC Angola Interconnector	DR Congo/ Inga	Angola/ Luanda	542.00	542.00	0.00	0.00	Hydro
4-1	ZiZaBoNa Project (1)	Zambia/ Batoka	Namibia/ Tsumeb	1,265.00	315.00	0.00	950.00	Hydro
4-2	ZiZaBoNa Project (2)	Zambia/ Batoka	Botswana /Pandamatenga	233.00	233.00	0.00	0.00	Hydro
5	MoZiZa Project	Mozambique/ Songo	South Africa/ Nzhelele	1,235.00	1,235.00	0.00	0.00	Hydro
6-1	Zambia Mozambique Interconnector (1)	Mozambique/ Matambo	Zambia/ Pensulo	564.00	564.00	0.00	0.00	Coal
6-2	Zambia Mozambique Interconnector (2)	Zambia/ Kariba	Mozambique/ Matambo	1,101.00	564.00	537.00	0.00	Hydro
7-1	Tanzania Mozambique Interconnector (1)	Tanzania/ Mtwara	Mozambique/ Namiaro	478.00	478.00	0.00	0.00	Gas
7-2	Tanzania Mozambique Interconnector (2)	Mozambique/ Songo	Tanzania/ Mtwara	1,740.00	1,740.00	0.00	0.00	Hydro
7-3	Tanzania Mozambique Interconnector (3)	Mozambique/ Nacala	Tanzania/ Mtwara	624.00	624.00	0.00	0.00	Gas
8	STE Backbone HVDC	Mozambique/ Cataxa	South Afrca/ Arnot	1,576.00	1,276.00	0.00	300.00	Hydro
9	STE Backbone HVAC	Mozambique/ Songo	South Afrca/ Arnot	1,694.00	1,394.00	0.00	300.00	Hydro
10-1	ZTK (1)	Zambia/Kariba	Tanzania/Mbeya	1,153.00	647.00	506.00	0.00	Hydro
10-2	ZTK (2)	Tanzania/Kinerezi	Zambia/ Nakonde	1,092.00	1,092.00	0.00	0.00	Gas

Source : JICA Survey Team

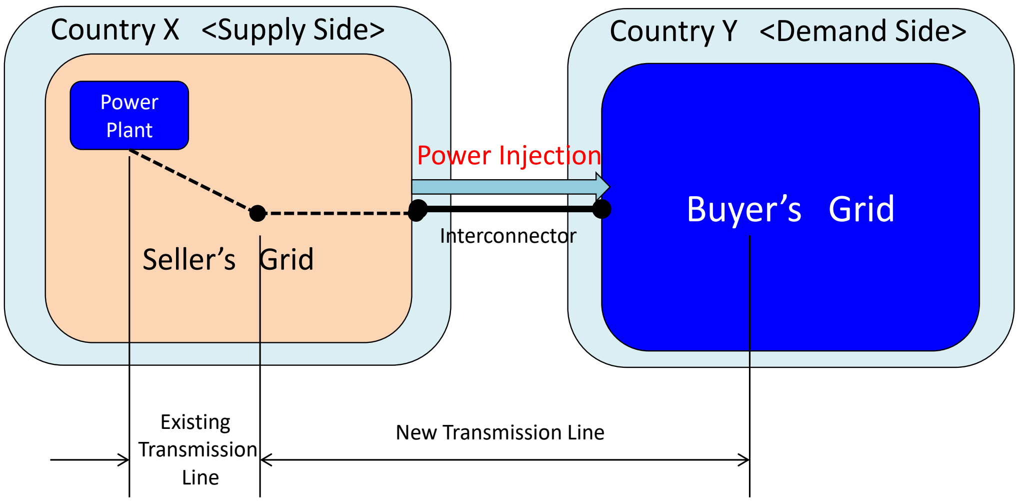
(a) To simulate some representative plants for hydro, gas-fired, and coal-fired generation, and to estimate the generation costs for each type.

(b) To estimate a most reasonable transmission route for each transmission system and to estimate the wheeling charge based on the transmission length.

(c) To sum up the generation and transmission costs and to calculate the expected power purchase price.

(d) To compare the expected power purchase price with the cost of generation and transmission cost of a certain country, and to study the economic benefit of the power trade.

The model of the power trade can be conceptualized in the below figure.



Source : JICA Survey Team

Figure 6.3-1 Overview of power trade model

The power export from the exporting country (control area) is transmitted through the existing and new transmission lines. In some cases, the transmission could be via a third country. On the part of the power importing country (control area), the transmission could also be through the existing and new transmission lines. The model will handle such cases. The wheeling charge could be calculated for both of existing and new transmission segments as shown in Figure 6.3-1.

(3) Assumptions

The assumptions for the financial analysis are established as follows.

1) Generation Costs

The standard plants for hydro, gas-fired and coal-fired are assumes as summarized in the table. The standard generation costs can be established as follows. The fuel cost data re based on the actual from South Africa.

Life time of each power plant can apply 40 years for hydropower and 25 years for thermal power, respectively. These are originally applied for depreciation period.

Initial investment cost are assumed by middle or large-sized power plant, above 300 MW and set the amount referred to recent tracks of international project.

Operation and maintenance cost and heat rate can be set by experience of Japanese power utilities.

Fuel cost can be set by the experience in RSA.

These assumptions are applied to create levelized cost of electricity in their life time.

Table 6.3-2 Assumptions for generation cost

Item	Unit	Type of Generation Plant			Remarks
		Hydro	Coal-fired	Gas-fired	
Project life	year	40	25	25	
Capital Cost	US $/kW	2,300	2,000	800	
Capacity Factor	percent	70.0	85.0	75.0	
Fixed O&M Cost	US$/kW-year	8.72	50.00	16.00	
Varibale O&M Cost	US$/kWh	0.0015	0	0	Thermal; included in fixed cost
Heat Rate	Btu/kWh	-	9,306	7,101	
Fuel Cost	US$/MMBtu	0	2.013	5.867	South Africa Data
Interest Rate	percent	10.0	10.0	10.0	
Levelized Cost of Electricity	US cents/kWh	4.1	5.5	5.8	

Source : JICA Survey Team

2) Transmission costs

The wheeling charge for the existing transmission lines can be based on the current price of the actual SAPP trading. The charge is calculated by having a unit transmission length, which is 2.7 x 10^{-4} US cents/kWh-km. This price reflects the current prices. In addition the wheeling charge for the new transmission lines for international power trades can be based on the feasibility study of ZiZaBoNa project, which is 30.0 x 10^{-4} US cents/kWh-km. The unit cost considers the cost recovery of the investment on the new transmission lines as well as the operation and maintenance costs. This also complies with the new pricing method, which is under consideration by the SAPP office[85]. The prices for these cases are calculated according to the length of the transmission lines. The unit of the costing is US cents/kWh.

3) Price of generation and transmission in buyer's country

It is very difficult to determine a uniform cost of the generation and transmission for the buyer's country

[85] Even though the exact cost are different by each transmission, the transmission project in the Study have limited differences in the transmission cost per unit length and wheeling amount that have different voltage levels. The use of the data would be appropriate for the purpose of the analysis. The difference of the existing segment from the new one is due to the facts that the reevaluation of the transmission assets have not been made and that the costing is charged based on the open capacity available for the international trade, subtracting the capacity for domestic use.

because the generation costs by generation type and the transmission length are different from one country to another. It is also not easy to obtain the data for all the countries on the analysis.

Thus an estimate of the cost would be based on the residential power tariff in each country. The power tariff comprises of generation, transmission and distribution (including marketing). The average percentages of the generation and transmission components and the distribution components are 70% and 30%, respectively[86]. Therefore the cost of services of generation and transmission is assumed to be 70% of the power tariff, and it will be compared with the power import price.

4) Results of Analysis

The result of the analysis for each transmission project is summarized in Table 6.3-3, which shows the comparison of the power trade cost and the generation/transmission cost in the buyer's country.

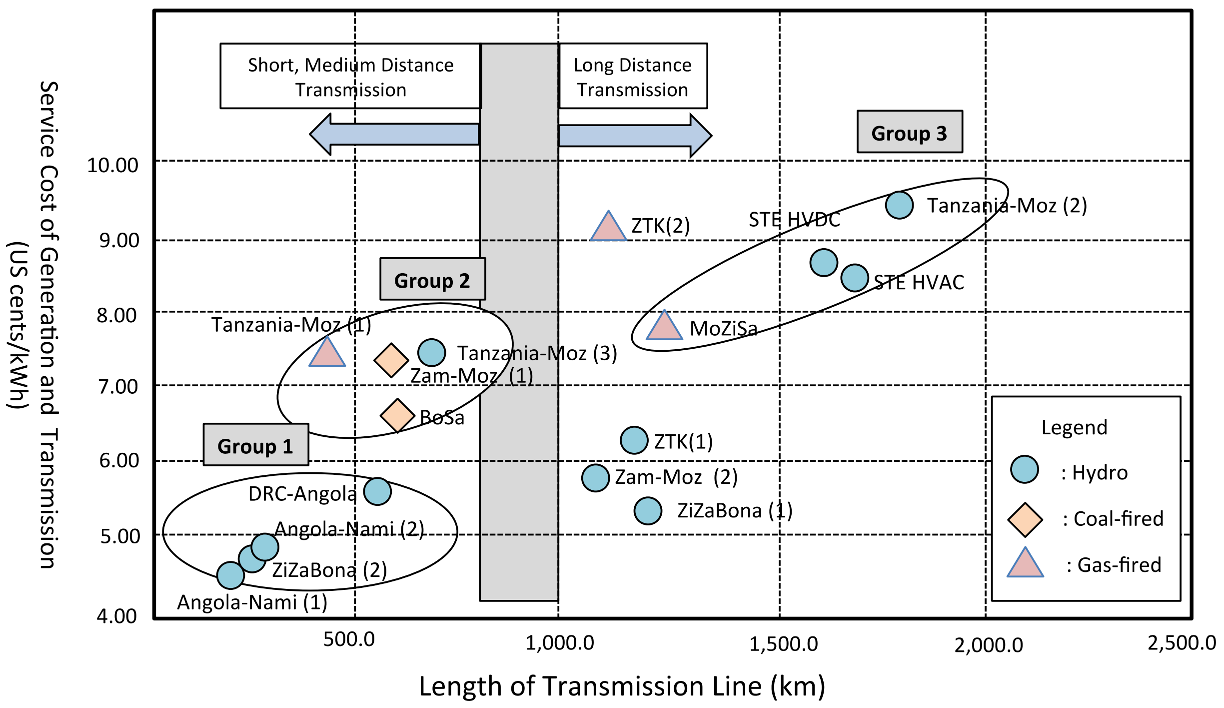
Table 6.3-3 Assumptions for transmission cost

No	Transmission Line Project		Power Trade		Generation Cost	Transmission Line Cost (Indicative Wheeling Charge)			Combined Service Cost by Power Pool (G & T)	Current Residential Power Tariff at Buyer's Country (Estimated G&T Portion)	Economic Benefit by Power Pool	
			Seller	Buyer		New Construction	Existing 1	Existing 2				
					US cents/kWh	US cents/kWh			US cents/kWh	US cents/kWh	US cents/kWh	Decrease in Cost (%)
1	10-1	ZTK (1)	Zambia/Kariba	Tanzania/Mbeya	4.10	1.941	0.13662	0	6.18	8.60	2.42	39.2%
2	2-1	Angola Namibia Interconnector (1)	Angola/ ENE	Namibia/ NamPower	4.10	0.49	0.00	0.00	4.59	6.17	1.58	34.3%
3	2-2	Angola Namibia Interconnector (2)	Angola/ ENE	Namibia/ NamPower	4.10	0.79	0.00	0.00	4.89	6.17	1.28	26.1%
4	7-3	Tanzania Mozambique Interconnector (3)	Mozambique/ Nacala	Tanzania/ Dar es Salaam	5.50	1.87	0.00	0.00	7.37	8.60	1.23	16.7%
5	4-1	ZiZaBoNa Project (1)	Zambia/ ZESCO	Namibia/ NamPower	4.10	0.95	0.00	0.26	5.30	6.17	0.87	16.3%
6	4-2	ZiZaBoNa Project (2)	Zambia/ ZESCO	Botswana/ BPC	4.10	0.70	0.00	0.00	4.80	4.82	0.03	0.5%
7	7-2	Tanzania Mozambique Interconnector (2)	Mozambique/ Songo	Tanzania/ Dar es Salaam	4.10	5.22	0.00	0.00	9.32	8.60	-0.72	-7.7%
8	6-2	Zambia Mozambique Interconnector (2)	Zambia/ ZESCO	Mozambique/ EDM	4.10	1.69	0.14	0.00	5.94	3.77	-2.17	-36.6%
9	7-1	Tanzania Mozambique Interconnector (1)	Tanzania/ Mtwara	Mozambique/ Nacala	5.80	1.43	0.00	0.00	7.23	3.77	-3.47	-47.9%
10	1	Bosa Project	Botswana/ BPC	South Africa/ ESKOM	5.50	1.08	0.06	0.00	6.64	3.16	-3.48	-52.4%
11	3	DRC Angola Interconnector	DRC/ SNEL	Angola/ ENE	4.10	1.63	0.00	0.00	5.73	1.47	-4.26	-74.3%
12	5	MoZiZa Project	Mozambique/ HCB	South Africa/ ESKOM	4.10	3.71	0.00	0.00	7.81	3.16	-4.64	-59.5%
13	6-1	Zambia Mozambique Interconnector (1)	Mozambique/ EDM	Zambia/ ZESCO	5.50	1.69	0.00	0.00	7.19	2.03	-5.17	-71.8%
14	9	STE Backbone HVAC	Mozambique/ Songo	South Afrca/ Arnot	4.10	4.18	0.00	0.08	8.36	3.16	-5.20	-62.2%
15	8	STE Backbone HVDC	Mozambique/ Cataxa	South Afrca/ Arnot	4.10	4.73	0.00	0.08	8.91	3.16	-5.75	-64.5%
16	10-2	ZTK (2)	Tanzania/Kinerezi	Zambia/ Nakonde	5.80	3.276	0	0	9.08	2.03	-7.05	-77.7%

Source : JICA Survey Team

Figure 6.3-2 shows the analysis result with illustration.

[86] The percentage of the generation, transmission and distribution components are different by country due to the situation of the facilities, commercial operation and others. It is however difficult to obtain accurate data from each power utility to compare them on the same basis. The Study therefore established the assumption of the distribution component to be 30% of the total cost.



Source : JICA Survey Team

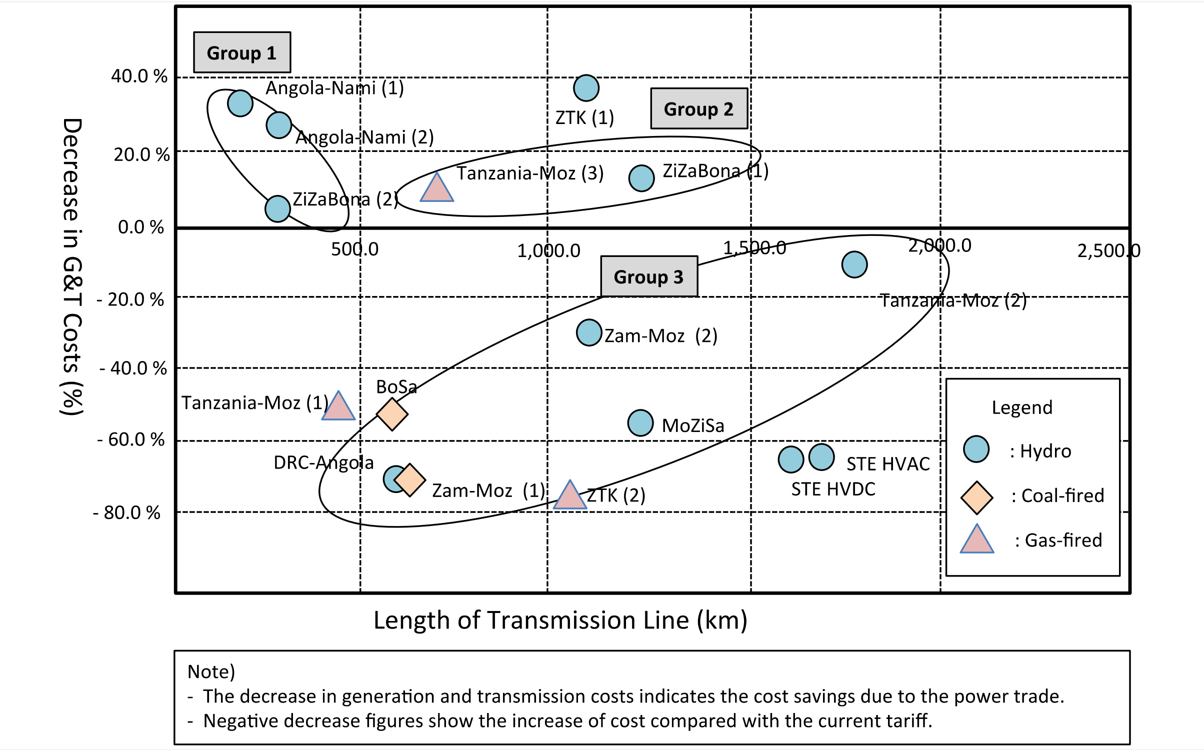
Figure 6.3-2 Relation between cost of generation and transmission, and transmission length

The vertical and horizontal axes indicate the cost of the generation and transmission for the power trade and the transmission line length, respectively. The legend shows the types of generation for the power trading sources for specific projects.

The analysis results can be categorized into three groups. Group 1 is ones that have relatively short distance of the transmission and the power trade by hydro power plants. Group 2 is ones that have relatively long distance of transmission and the power trade by thermal power plants. And group 3 is ones that have long distance of transmission lines, over 1,000 km. The cost of the generation and transmission for group 1 is the cheapest followed by group 2 and group 3.

Overall observation is that the cost of the transmission to the total is becoming larger when the transmission length is more than 1,000 km. This would give impacts on the economics of the project.

The following figure, Figure 6.3-3 also shows the relation between the cost reduction of the power trade and the length of transmission line.



Source : JICA Survey Team

Figure 6.3-3 Cost reduction of power trade and transmission Length

The vertical and horizontal axes indicate the cost saving by the power trade reduced from the current power tariff, and the transmission line length, respectively. The legend shows the types of generation for the power trading sources for specific projects.

The projects can be categorized into three groups. Group 1 projects are ones that transmit the hydropower generation by short transmission lines. Group 2 are ones that trade hydropower generation by a relatively short transmission line. Group 3 include ones that are difficult to cover the generation and transmission costs of the new construction and hence to confirm the economic benefits due to the current low power tariff.

In group 1, Angola - Namibia interconnector project has relatively low costs in generation and transmission, the cost reduction would be expected. In group 2, ZiZaBoNa project has a low generation and transmission cost, and the cost reduction can be confirmed. In group 3, there are some projects that have low generation costs. It is not however obvious to confirm the economic benefits due to the current power tariff in the importing countries. Project such as the Tanzania - Mozambique interconnector may have different results in the economic benefits depending on the directions of the current even though the transmission facility is the same. In case of Tanzania as an importer, since the power tariff in Tanzania is relatively high, the power trade from Mozambique to Tanzania can expect the cost reduction.

(4) Observations

The financial analysis has been conducted for the power trade by interconnectors by the uniform technical basis of the costs and benefits. The analysis has also examined the impacts of the various factors on the project formulation. It is not an easy task to establish optimum assumptions because the projects have different stages of the technical study and the accuracy of the cost estimates. Nevertheless the analysis has provided the important insights for the future project design. The specific matters can be summarized in the following.

1) Transmission Distance

The assumption is that the wheeling charge is proportional to the length of the wheeling. The relation between the length of the transmission line and the economics has been observed. While the long transmission line could have a less viability than the shorter one.

2) Generation Costs

The study assumes standard plants by generation type and establishes the generation costs. In reality however, the liberalized costs are different by each project and the marginal cost are also different by season and time of the day. For instance, the thermal plants can utilize the surplus capacity of generation when the domestic demand is lower than the capacity. The marginal cost of operation would be mostly the increased fuel costs. It is therefore required to examine the scenarios of generation for each project and analyze the financial aspect accordingly.

3) Existing Transmission Segment

In the cases where the length of the existing transmission lines is long, the total wheeling charge is calculated low because the rate of the wheeling charge for the existing segment is less expensive. This is due to the assumption that the pricing of the existing segment follows the ongoing SAPP rules. On the other hand, the SAPP is examining the new pricing mechanism in the SAPP transactions; the review would need to be considered once the revision on the current pricing system is made.

4) Power tariff

In the analysis, the power tariff is based on the average cost of electricity the power trade also assumes the deals throughout the year around. When the cost of the peak hours is high, the benefit of the power import could be expected. The detailed examinations would need to be conducted in the feasibility of each project. The current power tariff could also be reviewed from the cost recovery viewpoints.

5) Benefit from viewpoints of system operation

The benefits on the improvement of the system operation and the security of system are not considered in this study due to the installation of the new domestic and international transmission lines. It would be effective to carry out the technical assessment for each case.

The new construction of the transmission lines assumes to be utilized only for the international trade. The lines however may be used for the domestic transmission. In this case, the cost allocation of the international trade with the domestic one would need to be evaluated. This would be one of the future study issues. For instance, when the domestic network has been congested and the new lines are also used to resolve the issue, the new lines have two uses for both of international and domestic. The cost of transmission line should be covered by the both uses.

6.4 Applicable Japanese technology stand for expected projects

For extracted projects, such as generation projects and interconnector projects aforementioned, possibility of Japanese technology application was evaluated. Especially Japanese technologies which is introduced to engineer who belong to SAPP power sector, and which requested by them during power engineering seminar and power engineering program in Japan[87] are prioritized to introduce to improve current situation and to be a profitable for future power system.

(1) Generation (Main facilities)

The recent delivery record of main equipment for generation facility in Asia and Africa shows that manufacturers in India and China have the dominant market share regarding almost all equipment for hydropower.[88] Other manufacturers are not stand many of chance about price competitiveness. In addition, in case of huge-sized hydropower development in SAPP region, it is striking that both huge cost for civil engineering work such as dam construction and small cost for delivery of generation facilities compared to dam construction are gathered as a blanket order and procurance[89]. Thus there is potential deal for order separated from civil work even though Japanese product, such as generator, hydraulic turbine, is better than others on the point of its performance. In addition it is expected to introduce Japanese technology in case of expansion of generation facilities in existing dam.

On the other hand, there is much potential to introduce Japanese technology for thermal power facilities especially gas-fired thermal power and coal-fired power with high efficiency boiler.

Therefore, only project of coal-fired power and gas-fired power are highly acclaimed.

(2) Generation (Auxiliary / Operation facilities)

It is requested to inform the Japanese technology regarding operational management of power station, which seeks to introduce IoT, and facilities about environmental countermeasure from engineers belong to SAPP countries' power sector. Especially there are strong demands about reduction of Opex and permanent maintenance power for adequate management approach to maintain facilities.

Japanese enterprise have technical capabilities for these demands such as sensing and development of data analysis system, which has been storage and enhanced through long-standing cooperation with Japanese electric power company.

In addition, as for hydropower, it is focused on two technologies; one is the efficient usage of hydro potential on one river system developed by same company/utility. Another is the operation technique for high range operation management which can cover not only base load but also peak load. On the view point of these demands, it is effective to apply the Japanese technology.

(3) Interconnector / national transmission line

Japanese technologies which are provisional for transmission line (especially conductor) falls roughly into two categories as follows ;

- Loss reduction of long length transmission line from huge power source to load center.
- Increase of transmission capacity and loss reduction harmonized at the densely huge demand area such as capital region.

The Japanese technologies such as low-loss conductor and capacity increasing conductor are expected to introduce SAPP countries from these points of view.

[87] Details of each technology are shown in appendix of seminar and program in Japan.
[88] These facilities go toe-to-toe with others.
[89] It is mandated to procure a large majority of materials from Chinese manufacturer in case of construction works which is funded by China. Thus a portion of Japanese enterprise have a strategy to introduce Japanese technology through Chinese manufacturer according to establishing a joint venture with them.

Especially, as for capacity increasing methodology, light-weight capacity increasing conductor which is contained carbon fiber as core of conductor is recently focused all over the world. It can achieve both increasing capacity and reducing transmission loss. Light-weight capacity increasing conductor can be produced by carbon-core supplied by Japanese manufactures and conductor producer at local firm can produce itself.

Therefore, it is necessary to consider with a view to transfer of Japanese technology for local production in mind, which is correspondent to these demands.

(4) Others

Expects for these technologies, it is worth to consider the introduction of power system stabilization technology to South African system as of this moment. South African system has two huge load centers, one is Gauteng province centered on Johannesburg and another is Cape Town. These two regions of which distance is almost 1,300 km, are connected with 765kV backbone transmission line. Angle deviation between separated two huge demand area are around 70 degrees which is concerned about transient stability. Further, to overcome the rapid demand increase, and / or to transfer electric power through long distance, low-loss conductor and HTLS, High Temperature Low Sag conductor, such as ACFR have recently gotten popular.

At the seminar in Harare and Pretoria, there were lots of inquiries regarding technology of system stability control. Thus it is confirmed that power system stabilizing technology is of capital interest to them.

6.5 Expected project list

From the aforementioned analysis, expected project list of generation project and that of interconnector project have been created as Table 6.5-1 and Table 6.5-2 respectively.

On Table 6.5-1, possibilities of Japanese technologies are represented with symbols, like double circles (more feasible), single circle (feasible). And columns of evaluation show the result of absolute prerequisite -1, 2 and 3 with circles, and the result of premium condition with star.

Also, on Table 6.5-2, possibilities of Japanese technologies are represented specific name. And columns of evaluation show the result of absolute prerequisite -1, 2 and 3 with symbols, like double circles (more suitable), single circle (suitable), and triangle (ordinary). Also the result of premium condition with star.

Table 6.5-1 Expected project list (generation project)

Name	Location	Supply allocation	Capacity (MW)	COY (preferable)	Japanese technologies		Evaluation				Status	Remarks
					Main body	Auxiliaries	1	2	3	Premium		
Baynes (hydropower)	Angola, Namibia	Base load	600	2026	―	○	○	○	○	★	Inter utility MoU (RNT, Nampower) signed in June 2016 Preparation of FS update	
Mphanda Nkuwa (hydropower)	Mozambique	Base load	1,500	2024	―	◎	○	○	○	★	Waiting for endorsement by government of Mozambique about demise of project consortium	
HCB Norte (hydropower)	Mozambique	Base load	1,250	2026	―	◎	○	○	○	★	After mobilization for Mphanda Nkuwa, studies will be conducted.	
Batoka Gorge (hydropower)	Zambia, Zimbabwe	Base load	2,400	2024	―	○	○	○	○	★	FS in progress by support of WB. Investors conference was held in December 2016.	AfDB has been joined as financial advisor, and collect supports to establish IPP or PPP scheme. (February 2017)
Tete 1,200MW (coal-fired)	Mozambique	Base load	1,200	2022	○	◎	○	○	―	―	Preliminary study accomplished	
Future Gas-fired (gas-fired)	Mozambique	Base load / middle load	N/A	N/A	○	◎	○	○	―	―		Planning to do in Pande/Teman, Ruvma area, but conceptual. IPP project awarded gas utilization project. (December 2016)
Future Gas-fired (gas-fired)	Tanzania	Base load / middle load	N/A	2022～	○	◎	○	○	―	―	In Mtwara. Tanesco and Symbion are planning to construction.	Planning to do in Mtwara～Somanga

Source : JICA Survey Team

Table 6.5-2　Expected project list (Interconnector project)

Name	Countries concerned	COY (preferable)	Evaluation				Financial advantage	Japanese technologies	Status	Remarks
			1	2	3	Premium				
BoSa Project	Botswana, RSA	2021~22	◎	－	－		－	HTLS	Detail FS in progress (December 2016)	Botswanan side will be by her budget.
CTC Project	Zimbabwe	2021～29	△	－	－	★	－	Low loss conductor	Preparation of detail FS (December 2016)	Section, Orange Grove-Triangle is overlapping with MoZiSa Project.
ZTK Project （Zambia-Side）	Tanzania, Zambia	2023～23	－	－	○	★	○	Low loss conductor	Preparation for phase-1 (December 2016) Stakeholder meeting for phase-2 was held in December 2016.	Tanzanian side; FS for Section, Mbeya-Tunduma was terminated. (December 2016)
Malawi – Mozambique	Malawi, Mozambique	2021~23	－	－	○	★	－	Low loss conductor	Detail FS in progress（December 2016）	Norway, KfW, EIB, WB are funded
ZiZaBoNa Project	Zambia, Zimbabwe, Botswana, Namibia	2022～24	△	○	－	★	○	Low loss conductor	Detail FS was terminated. Financial analysis in progress (December 2016)	Profitability of Phase-1, existing 220kV line with Caprivi Link (HVDC)) is studying.
DR Congo - Angola	DR Congo, Angola	2031	－	－	－	－	－	Low loss conductor	N/A	Surplus energy should be estimated specifically.
MoZiSa Project	Mozambique, Zimbabwe, RSA	2024～28	○	◎	○	★	－	Low loss conductor, HTLS	Evaluation of inception report in progress（December2016)	A part of the project is overlapping with STE Backbone Project (HVAC).
STE (HVAC)	Mozambique	2024	○	○	○	★	－	Low loss conductor	Waiting for an approval to change the project formation	Committed in collaboration with Mphanda Nkuwa Project. A part of the project, section Temane – Maputo (950 MW) will be implemented in advance.Temane A part of the project is overlapping with MoZiSa Project.
STE (HVDC Phase 1）	Mozambique	2025	○	○		★	－	HVDC	Waiting for an approval to change the project formation	－
Angola - Namibia	Angola, Namibia	2026	－	△		★	○	Low loss conductor	Intergovernmental MoU and Inter Utility MoU have signed. (December 2015) Preparation of FS is in progress. (December 2016)	－
Tanzania - Mozambique	Tanzania, Mozambique	2026～29	－	○	○	－	○	Low loss conductor, HTLS	Project teams are formatted in EDM and in Tanesco.	－
Zambia - Mozambique	Zambia, Mozambique	2022～23	○	◎	○	－	－	HTLS	Fund by NEPAD IPPF for FS. Preparation of FS is in progress. (December 2016)	－
STE (HVDC Phase 2）	Mozambique	N/A	△	○		★	－	HVDC	－	－

Source：JICA Survey Team

6.6 Environmental Impact Assessment regarding the project on short list

In this section, some projects which are shown in the list in chapter 6.4 and are recommended by SAPP engineers in Planning sub-committee is evaluated EIA regarding generation and transmission. Evaluation of projects have concepts with the idea of JICA Guidelines for Environmental and Social Considerations (2010). Thus projects are evaluated regarding checkpoints reflects on each category's JICA Environmental Checklists[90] through EIA report and / or interview to key person.

- Expected project of hydropower

Batoka Gorge hydropower, the expected project and listed in SAPP priority projects, is under feasibility study from December 2015 supported by WB. This project is also mentioned as the most development possibility project in the Zambezi river basin according to "The Study for Power System Development Master Plan in Zambia" implemented in 2010. Thus data collection and hearing has done including latest information such as actual condition of environment. Further, this project will match mid-term perspective, namely large-sized hydropower development.

- Expected project of thermal power

There are few project participating governmental agency because most of thermal power projects are by IPPs.

However, the project of coal-fired power project in Tete province, Mozambique is a power source of interconnector project signed by Zambian and Mozambique government. Thus this project is assumed to develop with taking control by governmental agency. In addition this project is prospective to introduce high efficiency coal-fired thermal power adopting Japanese technology. Thus evaluation of EIA regarding this project has done here.

Further, this project will match mid-term perspective, namely mid.-sized thermal power development to ensure the wide area's demand and supply control.

- Expected project of transmission line

Both of significant expected projects, STE backbone (HVAC) and MoZiSa project, are located in northern Mozambique. Because hydropower and thermal power potentials are extremely rich, and nowadays northern coastal area in Mozambique leads to Tanzanian border is energizing natural gas exploitation. Here, STE backbone project (HVAC) is applied this study.

As of the end of 2016, a part of this project, Temane – Maputo is negotiating the construction preparation in correspondence with Temane gas-fired implementation.

(1) Batoka Gorge hydropower project

Batoka Gorge hydropower project is dam type hydropower station which is located between Lake Kariba and Victoria Falls. The development of the Zambezi River, which is an international river along Zambia and Zimbabwe, is managed by ZRA (Zambezi River Authority). As well as Kariba Dam, which is preceding project, hydropower station is developed by two organizations; north side was by ZESCO and south side was by ZPC. The feasibility study of the project, supported by WB, has done in 1993 and reviewed in 2015. However the project schedule is delayed.

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90 https://www.jica.go.jp/english/our_work/social_environmental/guideline/ref.html

Batoka Gorge hydropower project is SAPP priority project. And as Zimbabwean power system master plan mentioned, this project is one of main drivers for generation development in Zimbabwe. Further, not only regional generation fleet but international generation fleet to feed ample energy it will be.

1) Interview

Outline of project was explained by member of Batoka Gorge Hydro-Electric Scheme Project Management Unit (PMU) and it was confirmed whether there are issues of environmental and social consideration or not.

Original capacity of the project is 1,600 MW (Zambian side : 800 MW, Zimbabwean side : 800 MW). But this was updated to 2,400 MW (1,200 MW on each side) on FS. Grid access in Zambian side will be 330kV transmission lines that now are ongoing to upgrade by WB and JICA. And that in Zimbabwean side will be trunk system, Alaska – Sherwood.

The hearing details are as follows.

Table 6.6-1 Interviewee for Batoka Gorge hydropower project

Date	Name	Organization	Position
29th Sep. 2016	Mundia Simainga (Mr.)	ZESCO	Senior Manager – Consultancy Service Division
7th Oct. 2016	Stephen Musarurwa (Mr.)	ZETDC	Power Development Engineer

Source : JICA Survey Team

Table 6.6-2 Outline of Batoka Gorge hydropower project

Contents	Spec.
Reservoir	
Catchment Area	508,800 km^2
Average Annual Runoff	1,070 m^3/s
High Water Level	762 m asl
Low Water Level	746 m asl
Surface Area	23 km^2
Storage Capacity	1,392 million m^3
Dam	
Type	Arch - Gravity
Crest el.	766 m
Crest Length	720 m
Height	181 m
Spillway	
Gate	7
Spillway width	118 m
Overflow (Sill elevation)	743.5 m
Power House	
Type	Outdoor
Number	2 (North bank, South bank)

Turbine	Francis 12 units @ 200MW
Installed Capacity	2,400MW

Source: JICA Survey Team

2) Environmental Consideration

EIA of the project is not completed and under reviewing by regulatory agency as of October 2016. This information gathered by hearing from committee members of PMU who belongs to ZESCO and ZETDC. According to hearing from both committee members, there is no issues because of quite limited environmental impacts although it is very important project due to remarkable large economic effect. Main contents of environmental impacts are as follows; it is not necessary the resettlement due to no residence in the planning area, and influence for heritage or national park is fairly limited. On the other hand, most impact is for tourist business with white water such as rafting and kayak. Instead, number of affected people is limited and it can not be the factor of project's stagnation considering the benefit of Batoka Gorge project.

Following table shows the member of PMU, to conduct this project for your information.

Table 6.6-3 Member of Batoka gorge hydropower project management unit （PMU）

Organization	Name	Title	Work Place
ZRA	E. Kasaro	Project Manager	Lusaka
	K. Kaluba	Senior Manager	Lusaka
	B. Philemon	Senior Manager	Lusaka
	P. C. Mwiinga	Hydrologist	Lusaka
	L. Pfaira	Procurement Manager	Lusaka
	E. Dharabhani	Accountant Projects	Kariba
ZETDC	S. Musarurwa	Power Development Engineer	Harare
ZPC	A. Ramandi	System Engineer	Harare
ZESCO	M. Simainga	Senior Manager - Consultancy Services	Lusaka

Source : JICA Survey Team

Table 6.6-4 Environmental checklist (Batoka hydropower)

Category	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N (b) N (c) Y (d) Y	(a) under review (b) under review (c) hearing (d) hearing
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) tourist business (b) tourist business
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) hearing
2 Pollution Control	(1) Water Quality	(a) Does the water quality of dam pond/reservoir comply with the country's ambient water quality standards? Is there a possibility that proliferation of phytoplankton and zooplankton will occur? (b) Does the quality of water discharged from the dam pond/reservoir comply with the country's ambient water quality standards? (c) Are adequate measures, such as clearance of woody vegetation from the inundation zone prior to flooding planned to prevent water quality degradation in the dam pond/reservoir? (d) Is there a possibility that reduced the river flow downstream will cause water quality degradation resulting in areas that do not comply with the country's ambient water quality standards? (e) Is the discharge of water from the lower portion of the dam pond/reservoir (the water temperature of the lower portion is generally lower than the water temperature of the upper portion) planned by considering the impacts to downstream areas?	(a) Y (b) – (c) – (d) – (e) Y	(a) hearing (c) operation is usually run-of-river and partially cover peak demand (d) (e) no discharge from lower portion
	(2) Wastes	(a) Are earth and sand generated by excavation properly treated and disposed of in accordance with the country's regulations?	(a) –	(a)It is required to manage by EPC contract.

Category	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country' s laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) –	
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) Is there a possibility that the project will adversely affect downstream aquatic organisms, animals, plants, and ecosystems? Are adequate protection measures taken to reduce the impacts on the ecosystem?	(a) N (b) – (c) Y	(c)There is no issues except for muddy water by construction because power station type is run-of-river.
	(3) Hydrology	(a) Is there a possibility that hydrologic changes due to the installation of structures, such as weirs will adversely affect the surface and groundwater flows (especially in "run of the river generation" projects)?	(a) N	(a)No diversion
	(4) Topography and Geology	(a) Is there a possibility that reductions in sediment loads downstream due to settling of suspended particles in the reservoir will cause impacts, such as scouring of the downstream riverbeds and soil erosion? Is there a possibility that sedimentation of the reservoir will cause loss of the storage capacity, water logging upstream, and formation of sediment deposits at the reservoir entrance? Are the possibilities of the impacts studied, and adequate prevention measures taken? (b) Is there a possibility that the project will cause a large-scale alteration of the topographic features and geologic structures in the surrounding areas (especially in run of the river generation projects and geothermal power generation projects)?	(a) N (b) Y	(a)Downstream is Kariba lake and upper stream is valley. (b)Such as access road and transmission line.

Category	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) Y (b) – (c) – (d) – (e) – (f) – (g) – (h) – (i) – (j) –	(a) According to hearing, reservoir is also valley so that there are no resident and no need for resettlement.
	(2) Living and Livelihood	(a) Is there any possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there any possibility that the project causes the change of land uses in the neighboring areas to affect adversely livelihood of local people? (c) Is there any possibility that the project facilities adversely affect the traffic systems? (d) Is there any possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (e) Is the minimum flow required for maintaining downstream water uses secured? (f) Is there any possibility that reductions in water flow downstream or seawater intrusion will have impacts on downstream water and land uses? (g) Is there any possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? (h) Is there any possibility that fishery rights, water usage rights, and common usage rights, etc. would be restricted?	(a) – (b) Y (c) Y (d) Y (e) Y (f) N (g) Y (h) Y	(a)Influx of heavy vehicles and foreign workers (d)Influx of foreign workers (e)Operation as run-of-river type

Category	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a) – (b) –	
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) – (b) – (c) – (d) –	It is required to manage by EPC contract.

Category	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(a) – (b) – (c) –	It is required to manage by EPC contract.
	(2) Accident Prevention Measures	(a) Is a warning system established to alert the inhabitants to water discharge from the dam?	(a) –	Survey Team inform the water discharge alarm system in Japan during Power Engineering Program in Japan
	(3) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) – (b) – (c) – (d) –	Dam: ZRA Power Station: ZESCO, APC
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects in the mountains including large areas of deforestation). (b) In the case of dams and reservoirs, such as irrigation, water supply, and industrial water purposes, where necessary, pertinent items described in the Agriculture and Water Supply checklists should also be checked. (c) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities).	(a) – (b) – (c) –	
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) –	

Source: JICA Survey Team

1)	Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are requested to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2)	Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located

(2) Coal-fired power project in Tete

In May, 2016, Government of Zambia and Government of Mozambique jointly subscribed inter-governmental MoU, composing coal-fired power project in Tete. This[91] will be high efficiency coal-fired power station planning to place nearby coal mine in Tete province. And it would be planned to feed power to Zambia after commissioning Zambia - Mozambique interconnector.

1) Interview

Outline of the project was explained by Power Generation division of EDM and it was confirmed whether there are issues of environmental and social consideration or not.

The hearing details are as follows.

Table 6.6-5 Interviewee for coal-fired power project in Tete

Date	Name	Organization	Position
12 Oct. 2016	Narendra Gulab (Mr.)	EDM	Director – Power Generation Directorate

Source : JICA Survey Team

Table 6.6-6 Information of coal-fired power plant in Tete

Contents	Spec.
Installed Capacity	1,200MW
Fuel	Coal
Combustion	Powdered Coal
Steam Condition	USC (Ultra Super Critical) or sub alternate class
Cooling System	Cooling Tower
Desulfurization equipment	Under consideration

Source: JICA Survey Team

2) Environmental Consideration

EIA report of the project was not completed as of October, 2016. Instead, the most critical issue of environmental and social consideration is resettlement which is not only for this project but for all generation projects. As the plan of the project is to construct the power station at or nearby coal mine mouse, there will be is no influence against issue of resettlement.

[91] IGMoU mentioned governments jointly studies introduction of advanced USC. (A-USC)

Table 6.6-7 Environmental Checklist (coal-fired power plant in Tete)

Category	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) – (b) – (c) – (d) –	Under Feasibility Study
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) – (b) –	Under Feasibility Study
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) –	Under Feasibility Study
2 Pollution Control	(1) Air Quality	(a) Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust emitted by the power plant operations comply with the country’s emission standards? Is there a possibility that air pollutants emitted from the project will cause areas that do not comply with the country’s ambient air quality standards? Are any mitigating measures taken? (b) In the case of coal-fired power plants, is there a possibility that fugitive dust from the coal piles, coal handling facilities, and dust from the coal ash disposal sites will cause air pollution? Are adequate measures taken to prevent the air pollution?	(a) Y (b) Y	It is required to institute on construction stage.
	(2) Water Quality	(a) Do effluents including thermal effluents from the power plant comply with the country’s effluent standards? Is there a possibility that the effluents from the project will cause areas that do not comply with the country’s ambient water quality standards or cause any significant temperature rise in the receiving waters? (b) In the case of coal-fired power plants, do leachates from the coal piles and coal ash disposal sites comply with the country’s effluent standards? (c) Are adequate measures taken to prevent contamination of surface water, soil, groundwater, and seawater by the effluents?	(a) Y (b) Y (c) Y	It is required to institute on construction stage.
	(3) Wastes	(a) Are wastes, (such as waste oils, and waste chemical agents), coal ash, and by-product gypsum from flue gas desulfurization generated by the power plant operations properly treated and disposed of in accordance with the country’s regulations?	(a) –	(a) It is required to institute on construction planning stage.
	(4) Noise and Vibration	(a) Do noise and vibrations comply with the country’s standards?	(a) Y	(a) It is required to institute on construction stage.
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N	(a) hearing

Category	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
2 Pollution Control	(6) Odor	(a) Are there any odor sources? Are adequate odor control measures taken?	(a) N	(a) hearing
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) hearing
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms? (e) Is there a possibility that discharge of thermal effluents, intake of a large volume of cooling water or discharge of leachates will adversely affect the ecosystem of surrounding water areas?	(a) Y (b) Y (c) – (d) Y (e) Y	It is required to institute on construction planning stage.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b) – (c) – (d) – (e) – (f) – (g) – (h) – (i) – (j) –	(a) hearing (b) N/A (c) N/A (d) N/A (e) N/A (f) N/A (g) N/A (h) N/A (i) N/A (j) N/A

Category	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
4 Social Environment	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is sufficient infrastructure (e.g., hospitals, schools, and roads) available for the project implementation? If the existing infrastructure is insufficient, are any plans developed to construct new infrastructure or improve the existing infrastructure? (c) Is there a possibility that large vehicles traffic for transportation of materials, such as raw materials and products will have impacts on traffic in the surrounding areas, impede the movement of inhabitants, and any cause risks to pedestrians? (d) Is there a possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (e) Is there a possibility that the amount of water used (e.g., surface water, groundwater) and discharge of thermal effluents by the project will adversely affect existing water uses and uses of water areas (especially fishery)?	(a) Y (b) Y (c) Y (d) Y (e) Y	It is required to institute on construction planning stage.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) hearing
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) hearing
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) – (b) –	(a) N/A (b) N/A
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) – (b) – (c) – (d) –	It is required to manage by EPC contract.

Category	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(a) – (b) – (c) –	It is required to manage by EPC contract.
	(2) Accident Prevention Measures	(a) In the case of coal-fired power plants, are adequate measures planned to prevent spontaneous combustion at the coal piles (e.g., sprinkler systems)?	(a) –	It is required to introduce facilities as well as coal mine's piles.
	(3) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) – (b) – (c) – (d) –	Coal Mine: Developer of Coal Mine Power Plant: EDM
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities). (b) Where necessary, pertinent items described in the Ports and Harbors checklist should also be checked (e.g., projects including construction of port and harbor facilities).	(a) – (b) –	(a) N/A (b) N/A
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, and global warming).	(a) –	(a) N/A

Source: JICA Survey Team

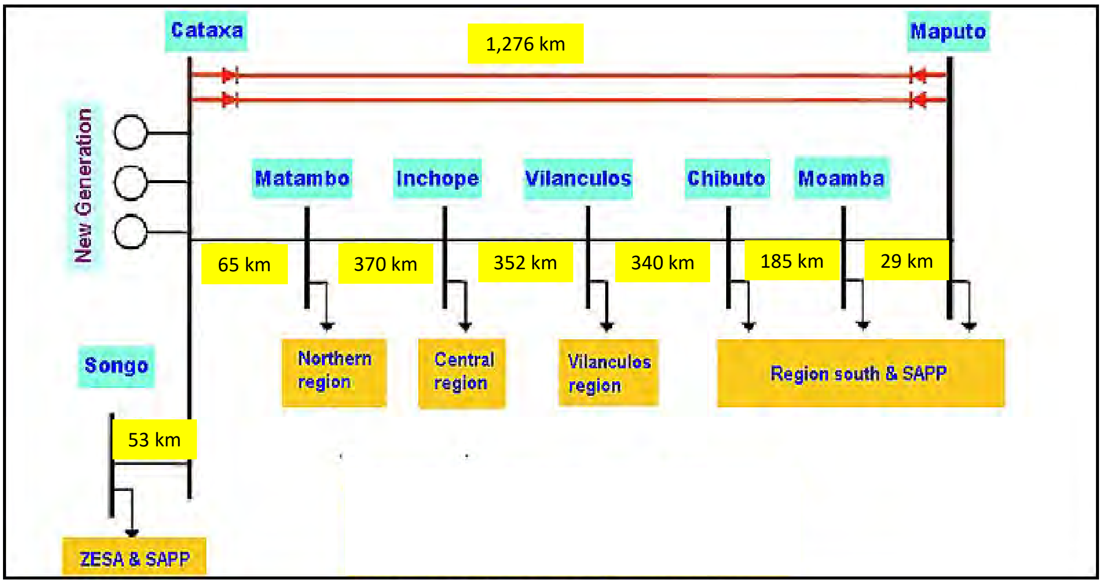
1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are requested to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience

2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

(3) STE backbone project (HVAC)

STE backbone project is transmission project to feed power from northern Mozambique where is rich source area of huge hydro and coal to southern Mozambique, especially Maputo, capital of Mozambique, and to South Africa. Further this project has a big deal contains to integrate national grid. This project is separated two phases. Phase 1 contains a 400 kV HVAC transmission line and a 500 kV HVDC Transmission line from northern Mozambique to southern Mozambique. Phase 2 compose a 500 kV additional HVDC transmission line; finally the project contains single 400 kV HVAC line and two 500 kV HVDC lines; the detail diagram shows Figure 6.6-1. Instead development of transmission line between Cataxa and Inchope is integrated with MoZiSa Project to send power from Mozambique to South Africa via Zimbabwe. As of October, 2016, EIA is updating by contracting consultant.

STE backbone project (HVAC) has a long transmission line, around 1,341 km, through central Mozambique with reducing transmission losses and with feeding power along the way.



Source : EDM (2016)

Figure 6.6-1 Outline of STE backbone project

1) Interview

Outline of project was consulted by transmission network division of EDM[92] and it was confirmed whether there are issues of environmental and social consideration or not.

[92] As of October, 2016, the project team and a person in its charge was not made for this project.

The hearing details are as follows.

Table 6.6-8 Interviewees for STE backbone project (HVAC)

Date	Name	Organization	Position
12 Oct. 2016	Ms. Esmeralda Calima Ms. Olga Cheila Utchavo Ms. Aissa Naino Ms. Yara Assia Cabra	EDM Transmission Network	Deputy Director
13 Oct. 2016	Ms. Olga Cheila Utchavo Ms. Aissa Naino	EDM Transmission Network	
14 Oct. 2016	Ms. Esmeralda Calima	EDM Transmission Network	Deputy Director

Source : JICA Survey Team

Table 6.6-9 Components of STE backbone project (HVAC)

	Section	Length (km)	Cap. (MW)	Expected year	Progress, Status	EIA report/ Environmental issues
	STE backbone AC 400kV Songo - Cataxa	53	970	2020	FS done (2011)	EIA updating (2016) There is no problem
1	STE backbone AC 400kV Cataxa - Matambo	65	970	2020	FS done (2011)	EIA updating (2016) There is no problem
2	STE backbone AC 400kV Matambo - Inchope	370	970	2020	FS done (2011)	EIA updating (2016) There is no problem
3	STE backbone AC 400kV Inchope - Vilanculos	352	970	2021	FS done (2011)	EIA updating (2016) There is no problem
4	STE backbone AC(phase 1) 400V Vilanculos-Maputo	554	970	2021	FS done (2011)	EIA updating (2016) There is no problem
5	STE backbone DC Phase I 535kV Cataxa - Maputo	1,276	N/A	2020	FS done (2011)	EIA updated (2016) There is no problem
6	STE backbone DC Phase II 535kV Cataxa - Maputo	1,276	N/A	2024	FS done (2011)	EIA updated (2016) There is no problem

Source : JICA Survey Team

2) Environmental Consideration

Regarding the STE Backbone project, EIA report of the project is under updating and have not yet finalized as of October, 2016[93]. Therefore the issues of environmental and social consideration about this project are checked by the verbal confirmation. The biggest issue of this project will be resettlement, but no critical problem regarding this was gotten from the interview. Table 6.6-10 shows the Environmental Checklist provided by JICA, which is filled in the information obtained from hearing. Further it is needed to clarify the details with information on EIA report and relevant evidences.

Furthermore, it is found out that there is no worries and concerns of structures and disruption of nature on the point of environmental and social consideration on the envisaged route of STE backbone project (see, Table 6.6-10)

93 JICA Survey Team confirmed the progress of the project through site survey.

Source : JICA Survey Team

Figure 6.6-2 Envisaged route of STE backbone project

Table 6.6-10 Environmental checklist: (STE backbone HVAC)

	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N (b) N (c) – (d) –	(a) EIA updating (b) EIA updating (c) N/A (d) N/A
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) hearing (b) hearing
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) –	(a) N/A
2 Pollution Control	(1) Water Quality	(a) Is there any possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? If the water quality degradation is anticipated, are adequate measures considered?	(a) –	(a) N/A
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country’s laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) hearing
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country’s laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate measures taken to prevent disruption of migration routes and habitat fragmentation of wildlife and livestock? (e) Is there any possibility that the project will cause the negative impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and ecosystem due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In cases where the project site is located in undeveloped areas, is there any possibility that the new development will result in extensive loss of natural environments?	(a) – (b) – (c) – (d) – (e) – (f) –	(a) N/A (b) N/A (c) N/A (d) N/A (e) N/A (f) N/A

	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
3 Natural Environment	(3) Topography and Geology	(a) Is there any soft ground on the route of power transmission and distribution lines that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there any possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken the matters?	(a) – (b) – (c) –	(a) N/A (b) N/A (c) N/A
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) – (b) – (c) – (d) – (e) – (f) – (g) – (h) – (i) – (j) –	(a) hearing (b) N/A (c) N/A (d) N/A (e) N/A (f) N/A (g) N/A (h) N/A (i) N/A (j) N/A
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (c) Is there any possibility that installation of structures, such as power line towers will cause a radio interference? If any significant radio interference is anticipated, are adequate measures considered? (d) Are the compensations for transmission wires given in accordance with the domestic law?	(a) – (b) – (c) – (d) –	(a) N/A (b) N/A (c) N/A (d) N/A
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) –	(a) N/A
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) –	(a) N/A

	Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
4 Social Environment	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) – (b) –	(a) hearing (b) hearing
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) – (b) – (c) – (d) –	(a) N/A (b) N/A (c) N/A (d) N/A
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(a) – (b) – (c) –	(a) N/A (b) N/A (c) N/A
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) – (b) – (c) – (d) –	(a) N/A (b) N/A (c) N/A (d) N/A
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Road checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities).	(a) –	(a) N/A
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed, (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) –	(a) N/A

Source: JICA Survey Team

1)	Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including experiences in Japan)
2)	Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Chapter 7 Studies for future cooperation

7.1 Proposal

Based on the Survey, the Survey Team would recommend following additional cooperation for SAPP, not only funding the projects.

- Aggressive cooperation to assist the activities of SAPP PAU
- Expert(s) dispatching to cooperate with power utilities which deal with the project(s)
- Implementation of Power System Master Plan for SAPP member state(s) which has or will have the project(s)

(1) Aggressive cooperation to assist the activities of SAPP PAU

Through site surveys, the Survey Team recognized role of each organization to boost SAPP priority projects.

Table 7.1-1 Organizations to play role in driving projects

Organization	Contribution / Position
SAPP C.C.	Project supervision and its support. SAPP PAU must report the progress and issue of the project to SAPP C.C. to confirm and/or resolve it.
SADC	SADC DIS must recognize the report from SAPP C.C., and SADC DIS should report this to SADC energy ministers' conference.
COMESA	Funds to priority project to study detail. And supervise the project
SAPP PAU	All projects are driven on this organization's supervision substantially. To boost the progress of the project(s), SAPP PAU supports utilities.
Power Utilities	Work for the project. SAPP PAU assists them

Source : JICA Survey Team

As aforementioned, SAPP PAU (Project Advisory Unit), supported by WB, has been established to boost the projects. And this organization is under SAPP C.C.

SAPP PAU supports power utilities which study comprehensive tasks for the project with engaging consultant and/or supporting directly with proper specialists. Total member of SAPP PAU is only five. Therefore, acceleration of all projects needs to enhance the man-power to coordinate all projects. In terms of this, JICA should assist this task.

(2) Expert(s) dispatching to cooperate with power utilities which deal with the project(s)

At the result of the Survey, the Survey Team focuses interconnectors locates eastern side of SAPP[94]("Eastern Corridor", we say). To go forward steadily, it is needed to assist the power utilities, such as Zambia, Tanzania, Mozambique to support technical role directly.

(3) Implementation of power system master plan and technical support for nationwide engineering issues for SAPP member state(s) which has or will have the project(s)

Same as (2), to ensure the implementation of Eastern corridor or RSA and states, all of which benefit from Inga 3, it is also needed to build the capacity of the power utilities related and to establish the power system master plan to correspond the demand.

[94] BoSa, MoZiSa, and STE Backbone (HVAC), Zambia - Mozambique, and Tanzania – Mozambique interconnectors

Table 7.1-2 Power system master plan study activities by JICA

Country	JICA's activities – Master plan study
Tanzania	Ongoing (June 2014 – March 2017)
Mozambique	Ongoing (November 2016 – September 2017)
Zambia	Done in 2010. (Need to amend to fit current situation)
Angola	Preparation status, it will be done in 2017

Source : JICA Survey Team

As this table represents, each member state already conducted or is conducting the master plan studies. However, JICA Survey Team would point out that Zambia needs to do the work again to clarify current situation and check the potential to be not net exporter of power but important system operator.

Geographically Zambia will be a hub in northern area in SAPP, adjacent to DR Congo, Tanzania, Mozambique, Malawi and Angola. Interconnector plans to Mozambique, Malawi arises. Further, Angola would hope to connect to Zambian system near future. JICA master plan study in Zambia could not involve the possibility of interconnectors with neighboring counties unfortunately, just considering perspective of power export of surplus, and more, to make plan in consideration with upgrading trunk system[95] , feeding power from Inga-3 and measurement of economic power trading.

As for interview with Zambian engineers in ZESCO, several ideas arise to feed the power from Inga-3.

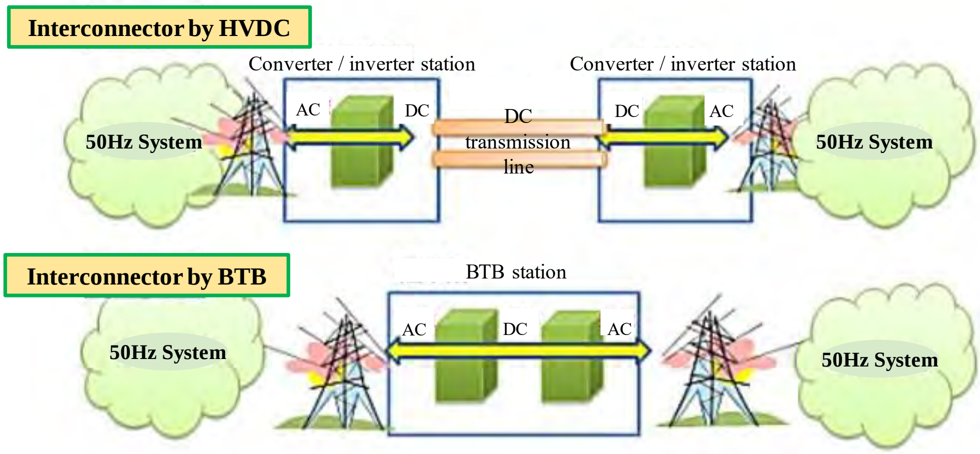
Based on these dramatical situation, the Survey Team recommends the revision of Zambian power system master plan study, including suitable system operations[96], like back to back facility.

(4) Technical support

Further, RSA, locates receiving end of Eastern corridor, has the biggest system capacity in SAPP region. The system operation of RSA including future nationwide system development will have an impact on influence future SAPP development. Therefore, cooperation with RSA, especially with Eskom is one of kernel issues to recognize future Sub-Saharan African power system.

Many queries were gathered at the power engineering seminar and the power engineering program in Japan to find out new seeds to overcome their situation, such as system fluctuation by renewables' power output, long distance power feeding, etc. The Survey Team therefore recommends the comprehensive cooperation with Eskom including advanced technical training and support.

[95] Zimbabwean system applies 330kV as highest voltage class, however, she will move to upgrade to 400kV sooner or later.
[96] In future, SAPP system would be needed to consider anti-synchronous system, using special technologies, such as BTB (back to back) to stabilize each area



Systems which apply same frequency can be linked with AC transmission line(s) each other. This is the simple solution, but critical risks, such as frequency disturbance etc. will spread internally as the system grow widespread. To overcome this problem, interconnection with DC technologies. In Japan Minami-Fukumitsu station, locates on the border between Chubu Electric Power Company and Hokuriku Electric Power Company, has back to back facilities organizing two thyristor valves. That is the reason why HVAC loop configuration among triparty entities, such as Chubu Electric Power Company, Hokuriku Electric Power Company and Kansai Electric Power Company, involves the risk causing power system disturbance. BTB at the border between Chubu and Hokuriku can simplify the system control against this disturbance.

Source：Survey team wrapped it up from article on Nikkei-technology

Figure 7.1-1　Back to back solution

Table 7.1-3　Technical support options for RSA

Theme	Abstract
Double-circuit transmission pylon designing	Supports for transmission pylon (tower) designing enhancing transmission capacity and reducing land expropriation.
Operational technics on balancing dispatching with gas-fired generators against output fluctuation from renewable energies	Supports for measures to compensate and stabilize the power dispatch by renewable energies with sustainable generation source like gas-fired power plants.
Regional power dispatch and system control with smart-grid technologies	Solution to power output stabilization methodologies with energy storages and control devices in huge renewable energy installation area, and wide-area system control harmonized with the solution
Countermeasures for regional reactive power control and system stabilities	Solution to continuously maintain system stability controlling reactive power flow in normal situation and to secure the transient stability in parallel.
O & M technics for coal-fired power plant	Supports for maintaining the reliability and efficiency of coal-fired power plant

Source：JICA Survey Team