

Ministry of Natural Resources, Energy and Mining  
Government of Malawi

# Integrated Resource Plan (IRP) for Malawi

**Volume I - Main Report - Appendices**

Draft Report - February 2017



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and  
Energy Exemplar (EE)

The IRP report is presented in the following volumes:

Volume I – Main Report

**Volume I – Appendices to Main Report** (this document)

Volume II – Demand Forecast

Volume III – Resource Assessment

Volume III – Appendices to Resource Assessment

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## Appendix I -

### Generation Expansion Plan by Scenario

Scenario 1 - Constrained - Installed Capacity (MW)

Installed Capacity (MW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Existing hydro	351	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363
Generic Solar	15	45	55	75	95	105	105	115	115	125	125	135	135	145	145	155	155	165	165	165
Kanengo	10	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Lilongwe	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Mzuzu	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Mapanga	0	10	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Generic Wind	0	0	15	15	15	30	30	30	30	45	45	45	45	60	60	60	60	60	60	60
Generic Biomass	0	0	10	30	30	40	60	70	70	70	70	90	90	90	90	100	100	100	100	100
Kammwamba	0	0	43	172	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
Tedzani IV	0	0	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
MSD (LFO)	0	0	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
SSD (HFO)	0	0	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Kapichira III	0	0	0	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
Mpatamanga	0	0	0	0	0	0	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Hamilton Falls	0	0	0	0	0	0	0	0	0	96	96	96	96	96	96	96	96	96	96	96
Fufu higher	0	0	0	0	0	0	0	0	0	0	163	163	163	163	163	163	163	163	163	163
Kholombidzo	0	0	0	0	0	0	0	0	0	0	0	200	200	200	200	200	200	200	200	200
Pamodzi	0	0	0	0	0	0	0	0	0	0	0	0	0	120	120	120	120	120	120	120
Generic Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	273	546	546	820	1093	1366
Lower Songwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	90	90	90	90
Total installed capacity	387	448	598	879	985	1020	1340	1360	1360	1481	1644	1874	1874	2019	2292	2585	2675	2958	3232	3505
Firm capacity	372	403	529	791	877	888	1208	1218	1218	1316	1478	1698	1698	1820	2093	2376	2466	2739	3013	3286
Peak load	449	526	614	709	781	864	953	1050	1155	1268	1391	1524	1668	1859	2049	2253	2475	2714	2972	3251
Reserve margin (%)	-17.2	-23.2	-13.8	11.6	12.2	2.8	26.8	16.0	5.5	3.8	6.3	11.4	1.8	-2.1	2.1	5.5	-0.4	0.9	1.4	1.1

Scenario 1 – Constrained - Annual Generation (GWh)

Generation (GWh)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Existing hydro	1902	2057	2057	1629	1624	1634	1575	1582	1580	1579	1575	1575	1575	1575	1604	1590	1614	1610	1621
Generic Solar	26	79	97	132	167	185	185	203	202	220	220	238	237	255	255	273	273	290	290
Kanengo	80	170	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lilongwe	48	51	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mzuzu	26	51	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mapanga	0	85	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Generic Wind	0	0	30	30	30	60	60	60	60	90	90	90	90	120	120	120	120	120	120
Generic Biomass	0	0	79	52	42	75	6	64	96	97	159	233	399	375	133	94	156	122	100
Kammwamba	0	0	320	1089	1596	1739	1417	1763	1923	1923	1921	1928	1923	1923	1923	1383	1724	1233	1001
Tedzani IV	0	0	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163
MSD (LFO)	0	0	45	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0
SSD (HFO)	0	0	89	4	4	5	0	3	4	6	4	3	51	9	4	3	4	5	3
Kapichira III	0	0	0	804	810	792	903	892	883	903	902	905	903	903	848	878	829	837	806
Mpatamanga	0	0	0	0	0	0	1370	1375	1360	1381	1370	1375	1370	1370	1370	1375	1370	1370	1358
Hamilton Falls	0	0	0	0	0	0	0	0	0	424	420	422	420	420	420	422	420	420	417
Futu higher	0	0	0	0	0	0	0	0	0	0	905	909	905	905	905	909	905	905	905
Kholombidzo	0	0	0	0	0	0	0	0	0	0	0	749	746	746	746	749	746	746	746
Pamodzi	0	0	0	0	0	0	0	0	0	0	0	0	0	894	894	896	894	894	894
Generic Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2034	4080	4068	6103	8137
Lower Songwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	326	326	326
Total generation	2081	2493	2917	3904	4437	4654	5679	6104	6272	6785	7730	8590	8785	9659	11420	12933	13613	15145	16887
Demand	2501	2936	3444	3971	4396	4867	5382	5943	6556	7223	7951	8744	9607	10597	11645	12781	14014	15350	16799
Net interchange	0	0	-517	-67	41	-213	297	162	-284	-438	-221	-154	-822	-938	-225	152	-401	-205	88
Unserviced energy	419.6	443.3	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 1 – Constrained - Annual Generation (GWh)

Generation (GWh)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Existing hydro	1902	2057	2057	1629	1624	1634	1575	1582	1580	1579	1575	1575	1575	1575	1604	1590	1614	1610	1621
Generic Solar	26	79	97	132	167	185	185	203	202	220	220	238	237	255	255	273	273	290	290
Kanengo	80	170	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lilongwe	48	51	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mzuzu	26	51	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mapanga	0	85	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Generic Wind	0	0	30	30	30	60	60	60	60	90	90	90	90	120	120	120	120	120	120
Generic Biomass	0	0	79	52	42	75	6	64	96	97	159	233	399	375	133	94	156	122	100
Kammwamba	0	0	320	1089	1596	1739	1417	1763	1923	1923	1921	1928	1923	1923	1923	1383	1724	1233	1001
Tedzani IV	0	0	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163
MSD (LFO)	0	0	45	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0
SSD (HFO)	0	0	89	4	4	5	0	3	4	6	4	3	51	9	4	3	4	5	3
Kapichira III	0	0	0	804	810	792	903	892	883	903	902	905	903	903	848	878	829	837	806
Mpatamanga	0	0	0	0	0	0	1370	1375	1360	1381	1370	1375	1370	1370	1370	1375	1370	1370	1358
Hamilton Falls	0	0	0	0	0	0	0	0	0	424	420	422	420	420	420	422	420	420	417
Fufu higher	0	0	0	0	0	0	0	0	0	0	905	909	905	905	905	909	905	905	905
Kholombidzo	0	0	0	0	0	0	0	0	0	0	0	749	746	746	746	749	746	746	746
Pamodzi	0	0	0	0	0	0	0	0	0	0	0	0	0	894	894	896	894	894	894
Generic Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2034	4080	4068	6103	8137
Lower Songwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	326	326	326
Total generation	2081	2493	2917	3904	4437	4654	5679	6104	6272	6785	7730	8590	8785	9659	11420	12933	13613	15145	16887
Demand	2501	2936	3444	3971	4396	4867	5382	5943	6556	7223	7951	8744	9607	10597	11645	12781	14014	15350	16799
Net interchange	0	0	-517	-67	41	-213	297	162	-284	-438	-221	-154	-822	-938	-225	152	-401	-205	88
Unreserved energy	419.6	443.3	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 2 – Unconstrained - Annual Generation (GWh)

Generation (GWh)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Existing hydro	1902	2057	2057	1629	1624	1634	1575	1582	1582	1695	1703	1706	1703	1705	1704	1703	1688	1676	1667	1684
Generic Solar	26	79	97	132	167	185	185	203	202	220	220	238	237	255	255	273	273	290	290	291
Kanengo	80	170	60	0	0	1	0	0	0	0	0	0	0	0	0	1	2	3	4	4
Lilongwe	48	51	15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Mzuzu	26	51	15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Mapanga	0	85	59	0	0	1	0	0	0	0	0	0	0	0	0	1	2	3	4	4
Generic Wind	0	0	30	30	30	60	60	60	60	90	90	90	90	120	120	120	120	120	120	120
Generic Biomass	0	0	79	52	42	75	6	64	95	111	138	200	200	201	195	225	233	274	361	295
Kammwamba	0	0	320	1089	1596	1739	1417	1763	1923	1497	1490	1491	1512	1502	1510	1517	1585	1705	1718	1591
Tedzani IV	0	0	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163
Kapichira III	0	0	0	804	810	792	903	892	889	677	662	661	662	658	658	669	691	713	720	710
Mpatamanga	0	0	0	0	0	0	1370	1375	1370	1370	1370	1375	1370	1370	1367	1378	1370	1370	1358	1386
Hamilton Falls	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	423	420	420	417	425
Fufu higher	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	905	905	905	909
Kholombidzo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	747	746	749
Pamodzi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	894	896
Lower Songwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	326	326
Generic Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2040
Total generation	2081	2493	2896	3900	4433	4651	5679	6102	6285	5824	5837	5923	5938	5975	5972	6474	7454	8391	9694	11594
Demand	2501	2936	3444	3971	4396	4867	5382	5943	6556	7223	7951	8744	9607	10597	11645	12781	14014	15350	16799	18370
Net interchange	0	0	-517	-71	37	-216	297	159	-270	1399	2114	2821	3669	-4621	-5672	-6305	-6556	-6950	-7090	-6758
Unserviced energy	419.6	443.3	30.9	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	4.4	8.5	15.4	17.5



Scenario 3 - Diversification - Installed Capacity (MW)

Installed Capacity (MW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Existing hydro	351	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363
Generic Solar	15	45	55	75	95	105	105	115	115	125	125	135	135	145	145	155	155	165	165	165
Kanengo	10	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Lilongwe	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Mzuzu	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Mapanga	0	10	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Generic Wind	0	0	15	15	15	30	30	30	30	45	45	45	45	60	60	60	60	60	60	60
Generic Biomass	0	0	10	30	30	40	60	70	70	70	70	90	90	90	90	100	100	100	100	100
Kammwamba	0	0	43	172	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
Tedzani IV	0	0	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
MSD (LFO)	0	0	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
SSD (HFO)	0	0	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Kapichira III	0	0	0	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
Lower Songwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fufu higher	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pamodzi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mpatamanga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hamilton Falls	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kholombidzo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Generic Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total installed capacity	387	448	598	879	985	1020	1130	1150	1313	1458	1758	1788	1884	2109	2382	2675	2675	2958	3232	3505
Firm capacity	372	403	529	791	877	888	998	1008	1171	1292	1592	1612	1708	1910	2183	2466	2466	2739	3013	3286
Peak load	449	526	614	709	781	864	953	1050	1155	1268	1391	1524	1668	1859	2049	2253	2475	2714	2972	3251
Reserve margin (%)	-17.2	-23.2	-13.8	11.6	12.2	2.8	4.7	-4.0	1.4	1.9	14.5	5.8	2.4	2.7	6.5	9.5	-0.4	0.9	1.4	1.1

Scenario 3 – Diversification - Annual Generation (GWh)

Generation (GWh)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Existing hydro	1902	2057	2057	1629	1624	1634	1632	1648	1614	1628	1587	1583	1575	1575	1600	1579	1614	1610	1621
Generic Solar	26	79	97	132	167	185	185	203	202	220	220	238	237	255	255	273	273	290	290
Kanengo	80	170	14	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Lilongwe	48	51	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mzuzu	26	51	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mapanga	0	85	17	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Generic Wind	0	0	30	30	30	60	60	60	60	90	90	90	90	120	120	120	120	120	120
Generic Biomass	0	0	79	52	42	75	139	203	196	153	65	168	308	349	119	70	156	122	100
Kammwamba	0	0	320	1089	1596	1739	1780	1915	1788	1694	1548	1854	1923	1923	1736	1125	1724	1233	1001
Tedzani IV	0	0	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163
MSD (LFO)	0	0	45	0	0	1	0	3	1	0	0	0	0	0	0	0	0	0	0
SSD (HFO)	0	0	89	4	4	5	9	32	24	5	2	4	4	4	3	3	4	5	3
Kapichira III	0	0	0	804	810	792	795	769	828	803	879	890	901	903	855	898	829	837	806
Lower Songwe	0	0	0	0	0	0	326	326	326	326	326	326	326	326	326	326	326	326	326
Fufu higher	0	0	0	0	0	0	0	0	905	905	905	909	905	905	905	909	905	905	905
Pamodzi	0	0	0	0	0	0	0	0	0	894	894	896	894	894	894	896	894	894	894
Mpatamanga	0	0	0	0	0	0	0	0	0	0	1370	1375	1370	1370	1370	1375	1370	1370	1358
Hamilton Falls	0	0	0	0	0	0	0	0	0	0	0	0	420	420	420	422	420	420	417
Kholombidzo	0	0	0	0	0	0	0	0	0	0	0	0	0	747	746	749	746	746	746
Generic Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2034	4080	4068	6103	8137
Total generation	2081	2493	2917	3904	4437	4654	5089	5326	6109	6882	8050	8496	9118	9954	11547	12987	13613	15145	16887
Demand	2501	2936	3444	3971	4396	4867	5382	5943	6556	7223	7951	8744	9607	10597	11645	12781	14014	15350	16799
Net interchange	0	0	-517	-67	41	-213	-292	-616	-447	-341	99	-247	-489	-643	-97	206	-401	-205	88
Unserviced energy	419.6	443.3	10.2	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 4 - Isolation - Installed Capacity (MW)

Installed Capacity (MW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Existing hydro	351	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363
Generic Solar	15	45	55	75	95	105	105	115	115	125	125	135	135	145	145	155	155	165	165	165
Kanengo	10	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Lilongwe	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Mzuzu	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Mapanga	0	10	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Generic Wind	0	0	15	15	15	30	30	30	30	45	45	45	45	60	60	60	60	60	60	60
Generic Biomass	0	0	10	30	30	40	60	70	70	70	70	90	90	90	90	100	100	100	100	100
Kammwamba	0	0	43	172	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
Tedzani IV	0	0	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
MSD (LFO)	0	0	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
SSD (HFO)	0	0	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Kapichira III	0	0	0	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
Mpatamanga	0	0	0	0	0	0	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Hamilton Falls	0	0	0	0	0	0	0	0	0	96	96	96	96	96	96	96	96	96	96	96
Pamodzi	0	0	0	0	0	0	0	0	0	0	120	120	120	120	120	120	120	120	120	120
Fufu higher	0	0	0	0	0	0	0	0	0	0	0	163	163	163	163	163	163	163	163	163
Generic Coal	0	0	0	0	0	0	0	0	0	0	0	0	273	273	273	546	820	820	1093	1366
Kholombidzo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200	200	200	200	200	200
Lower Songwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	90	90	90
Total installed capacity	387	448	598	879	985	1020	1340	1360	1360	1481	1601	1794	2067	2092	2292	2585	2858	2958	3232	3505
Firm capacity	372	403	529	791	877	888	1208	1218	1218	1316	1436	1618	1891	1893	2093	2376	2649	2739	3013	3286
Peak load	449	526	614	709	781	864	953	1050	1155	1268	1391	1524	1668	1859	2049	2253	2475	2714	2972	3251
Reserve margin (%)	-17.2	-23.2	-13.8	11.6	12.2	2.8	26.8	16.0	5.5	3.8	3.2	6.2	13.4	1.8	2.1	5.5	7.0	0.9	1.4	1.1

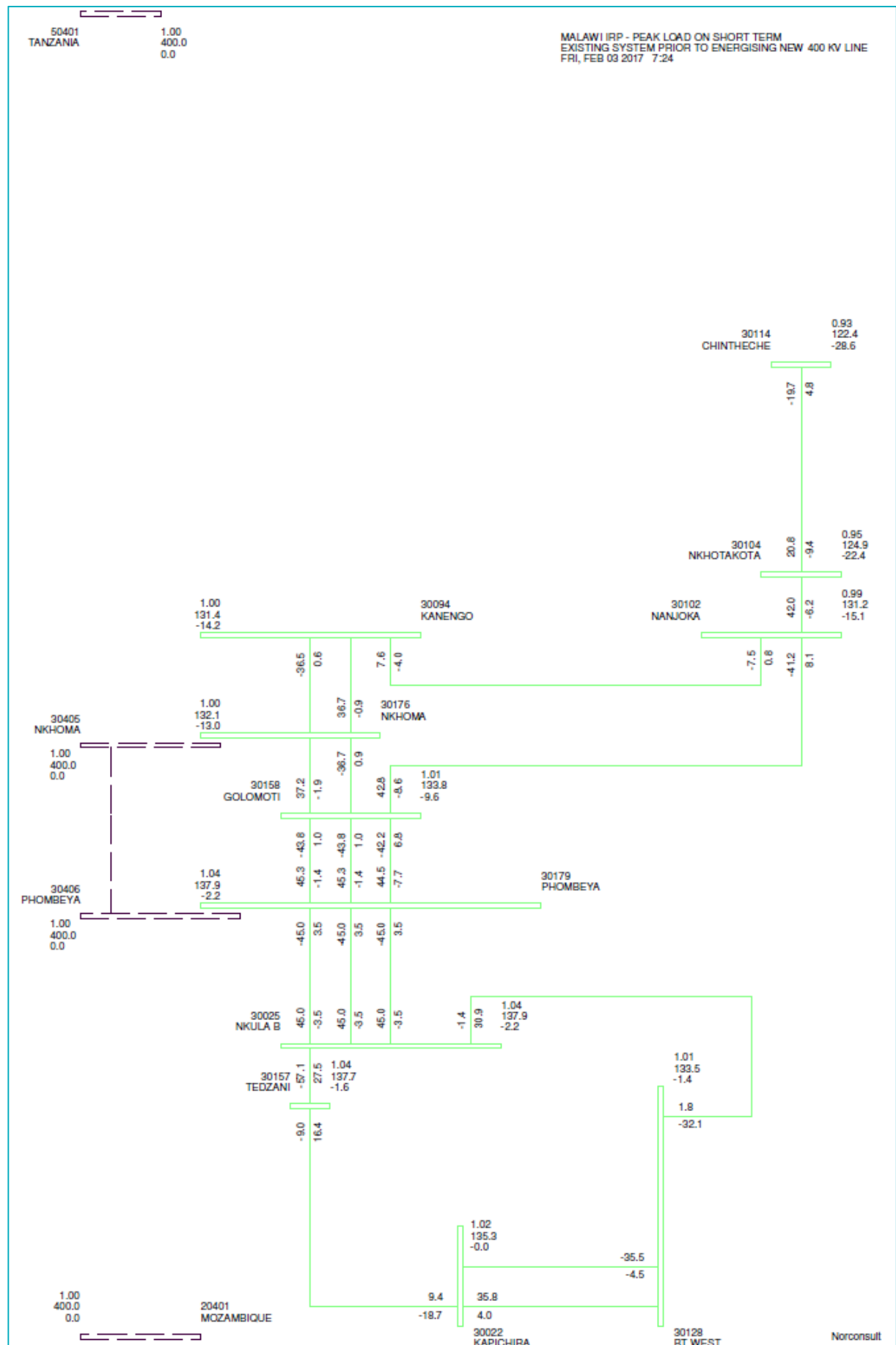
Scenario 4 – Isolation - Annual Generation (GWh)

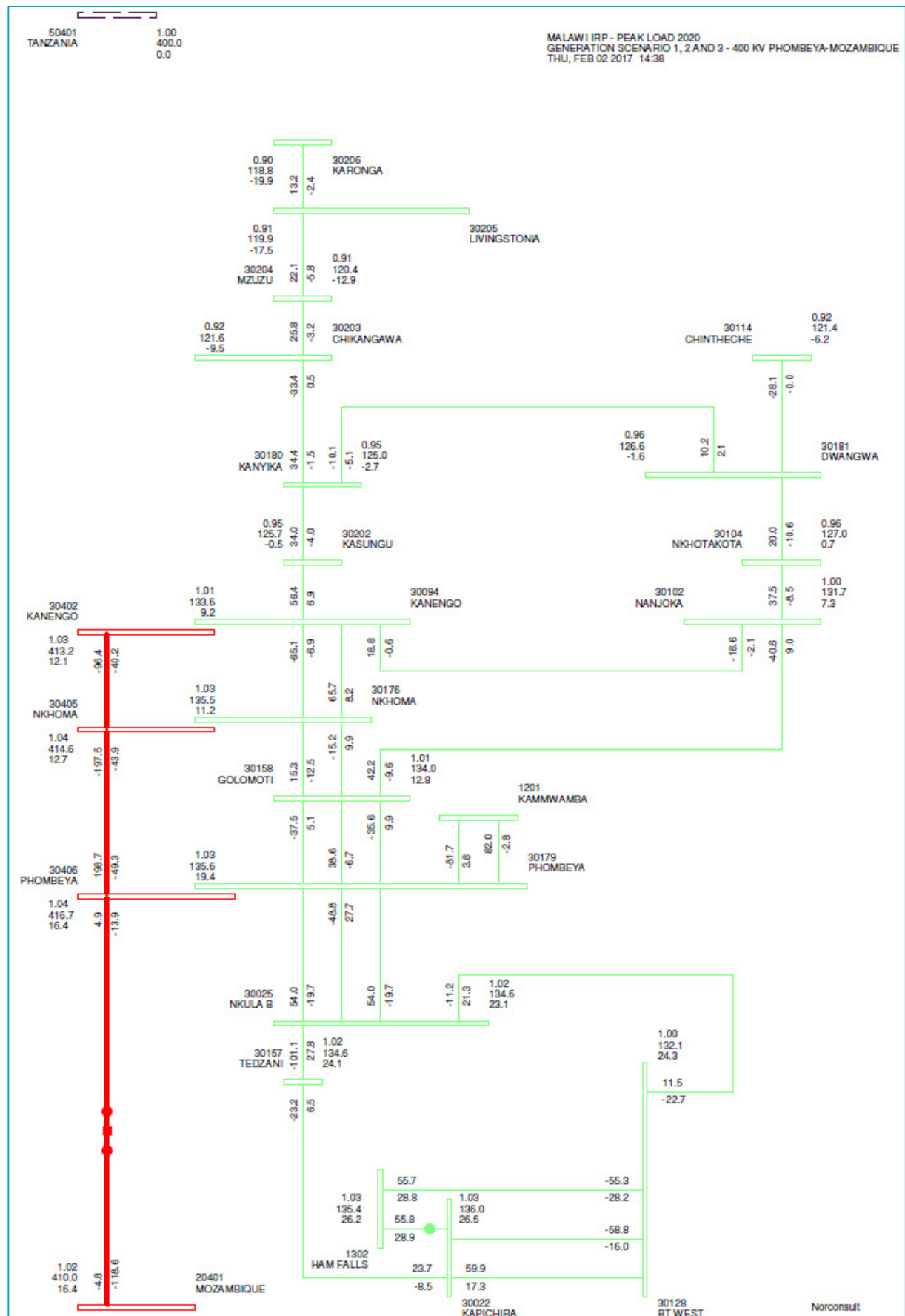
Generation (GWh)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Existing hydro	1902	2057	2057	1629	1597	1651	1575	1571	1582	1577	1578	1576	1575	1577	1578	1575	1573	1594	1575
Generic Solar	26	79	97	132	167	185	185	203	202	220	220	238	237	255	255	273	273	290	290
Kanengo	80	170	122	1	1	4	0	0	2	4	2	1	0	3	22	1	0	3	3
Lilongwe	48	51	35	0	0	1	0	0	0	1	1	0	0	1	6	0	0	1	1
Mzuzu	26	51	35	0	0	1	0	0	0	1	1	0	0	1	6	0	0	1	1
Mapanga	0	85	123	1	1	4	0	0	2	3	2	1	0	3	21	1	1	3	3
Generic Wind	0	0	30	30	30	60	60	60	60	90	90	90	90	120	120	120	120	120	120
Generic Biomass	0	0	83	66	46	116	0	11	322	423	351	320	4	274	351	82	11	233	138
Kammwamba	0	0	320	1138	1525	1883	1126	1668	1923	1923	1923	1761	1011	1653	1753	1226	582	1265	841
Tedzani IV	0	0	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163
MSD (LFO)	0	0	156	3	2	6	0	0	3	48	3	34	0	3	40	1	1	3	3
SSD (HFO)	0	0	156	4	3	29	0	1	23	69	34	53	0	18	58	2	1	27	3
Kapichira III	0	0	0	804	861	761	903	903	895	902	896	904	903	898	897	905	903	869	891
Mpatamanga	0	0	0	0	0	0	1370	1363	1377	1375	1370	1375	1370	1370	1370	1375	1367	1374	1358
Hamilton Falls	0	0	0	0	0	0	0	0	0	422	420	422	420	420	420	422	419	421	417
Pamodzi	0	0	0	0	0	0	0	0	0	0	894	896	894	894	894	896	846	894	871
Fufu higher	0	0	0	0	0	0	0	0	0	0	0	909	905	905	905	909	905	905	905
Generic Coal	0	0	0	0	0	0	0	0	0	0	0	0	2034	2034	2034	4080	6103	6103	8137
Kholombidzo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	747	749	746	747	746
Lower Songwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	326	326
Total generation	2081	2493	3379	3971	4396	4864	5382	5943	6555	7221	7948	8743	9607	10592	11641	12780	14013	15341	16791
Demand	2501	2936	3444	3971	4396	4867	5382	5943	6556	7223	7951	8744	9607	10597	11645	12781	14014	15350	16799
Net interchange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unserved energy	419.6	443.3	65.1	0.0	0.0	3.0	0.0	0.0	0.9	1.7	2.3	0.5	0.0	4.3	4.0	1.0	0.4	8.6	8.3

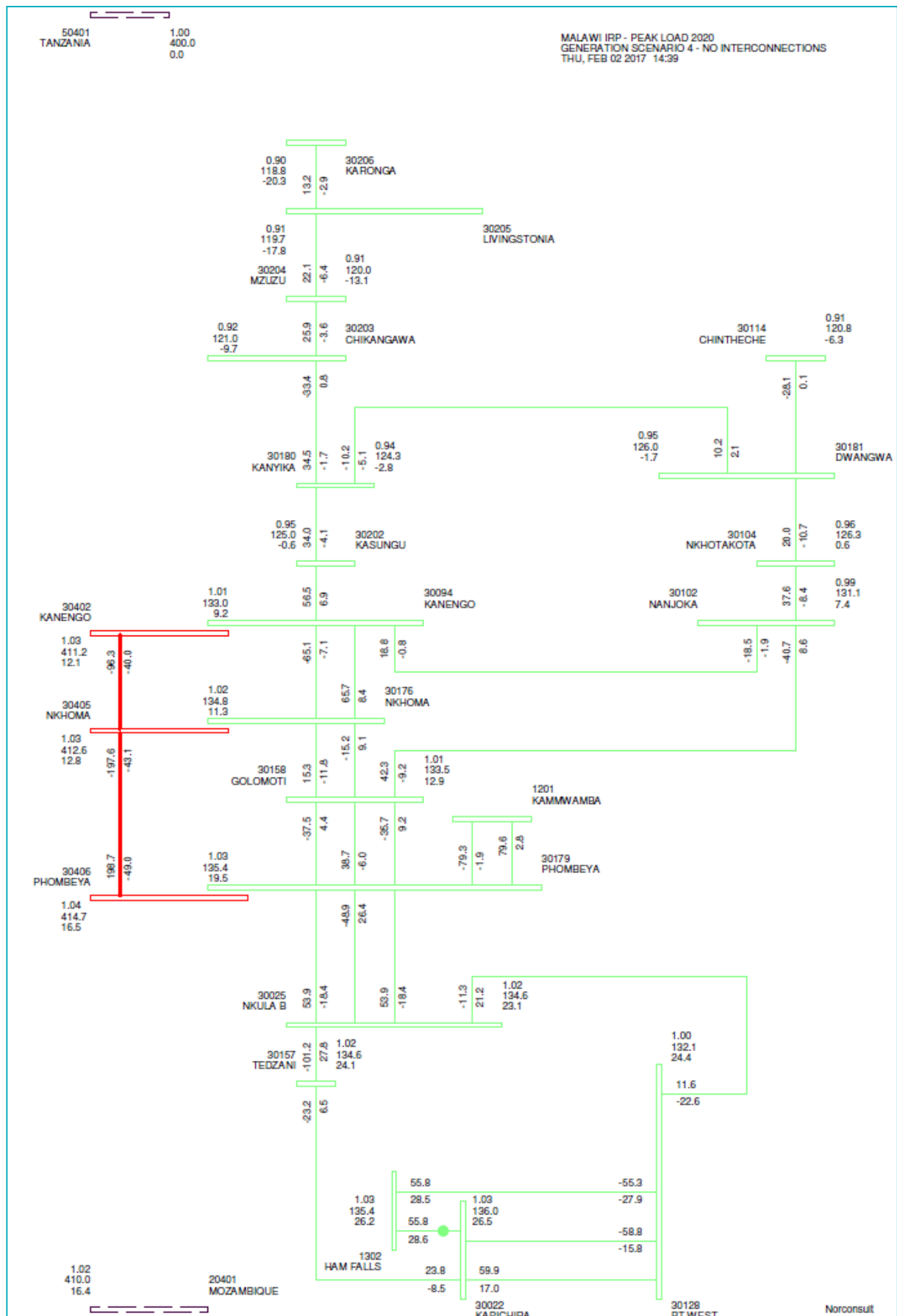
## Appendix II -

### Load Flow Diagrams

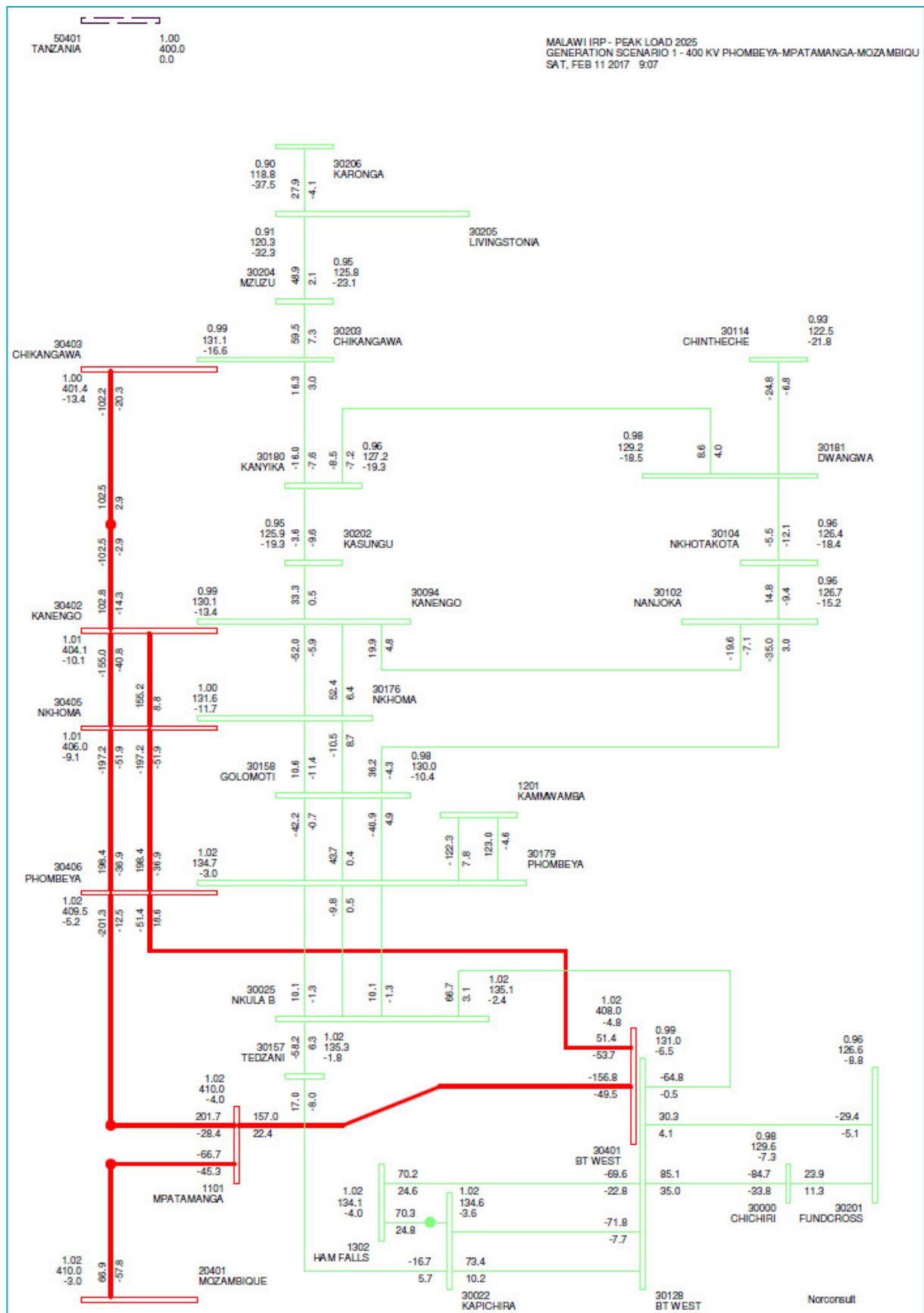
The following pages present single line diagrams for the main supply-demand scenarios. The power flow is shown at peak demand for stage 2020, 2025, 2030, 2035 and 2040.

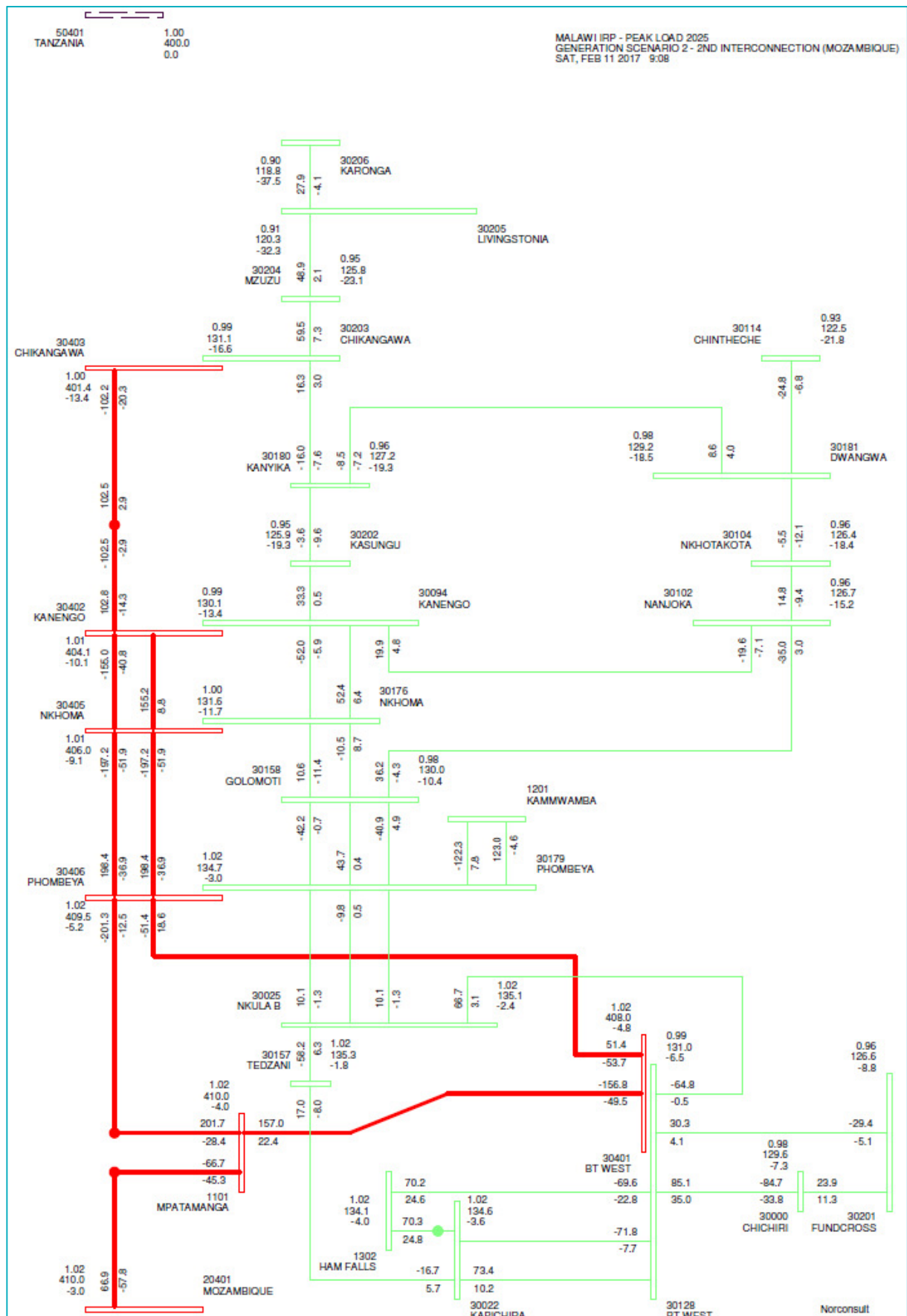


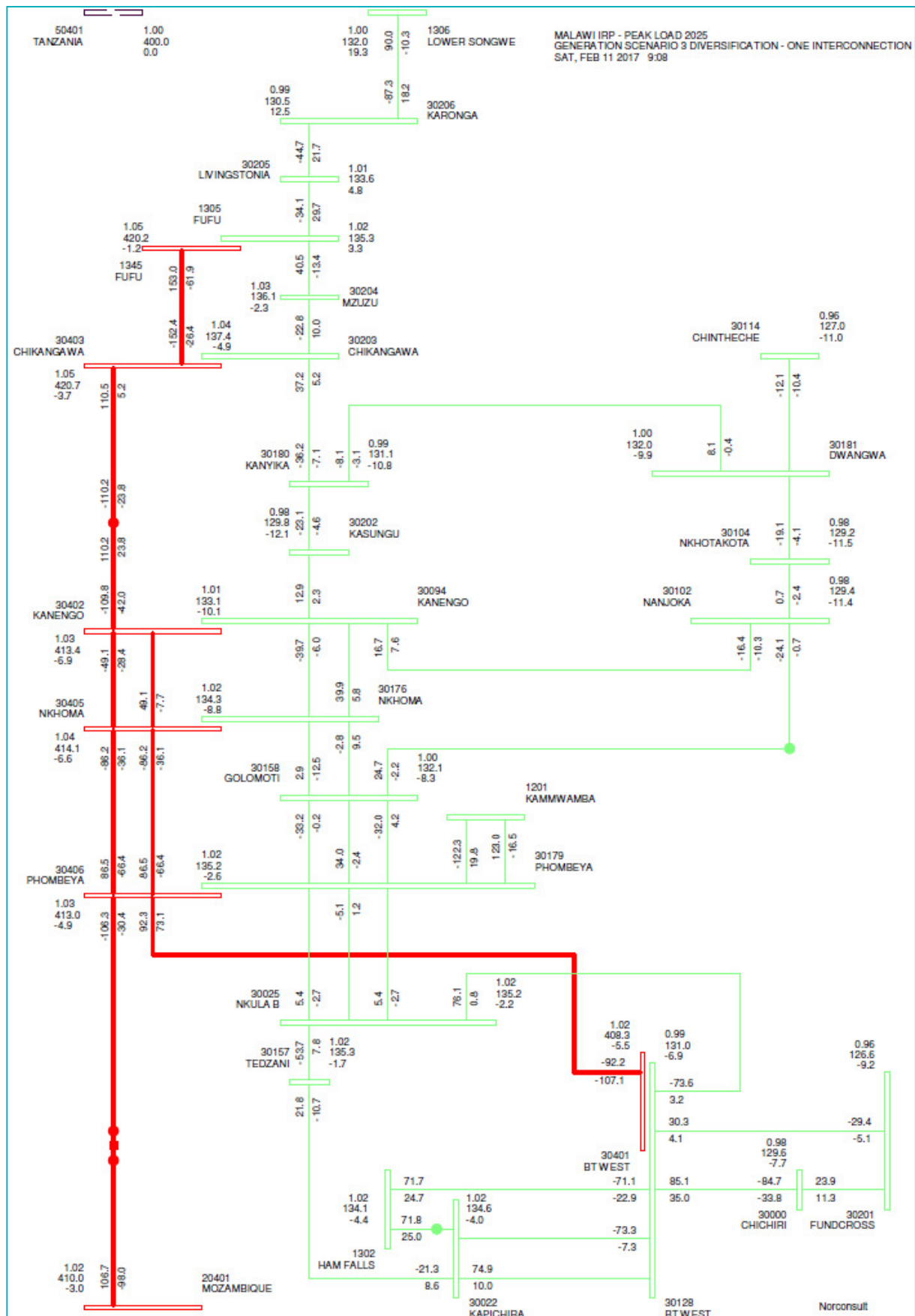


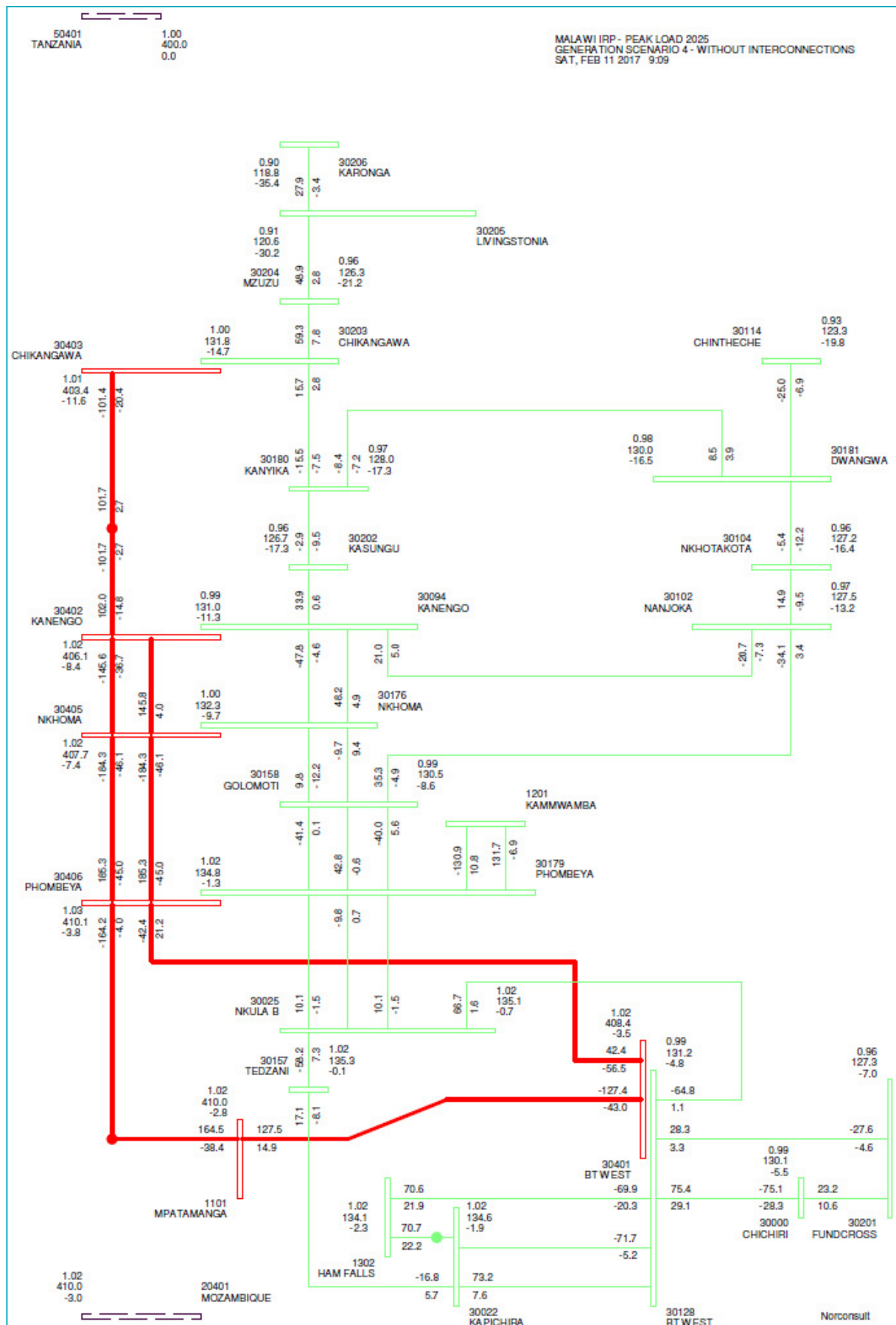


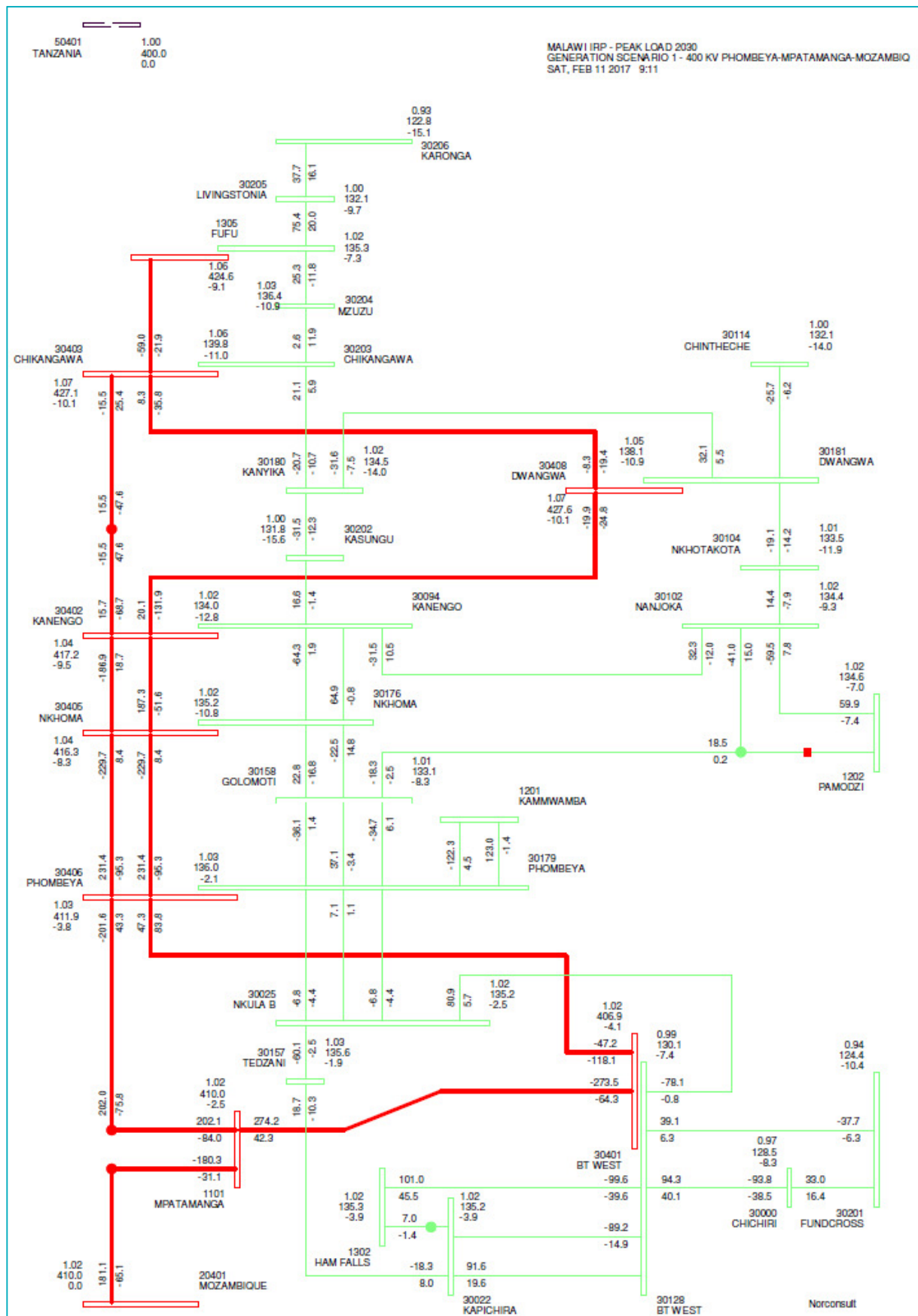




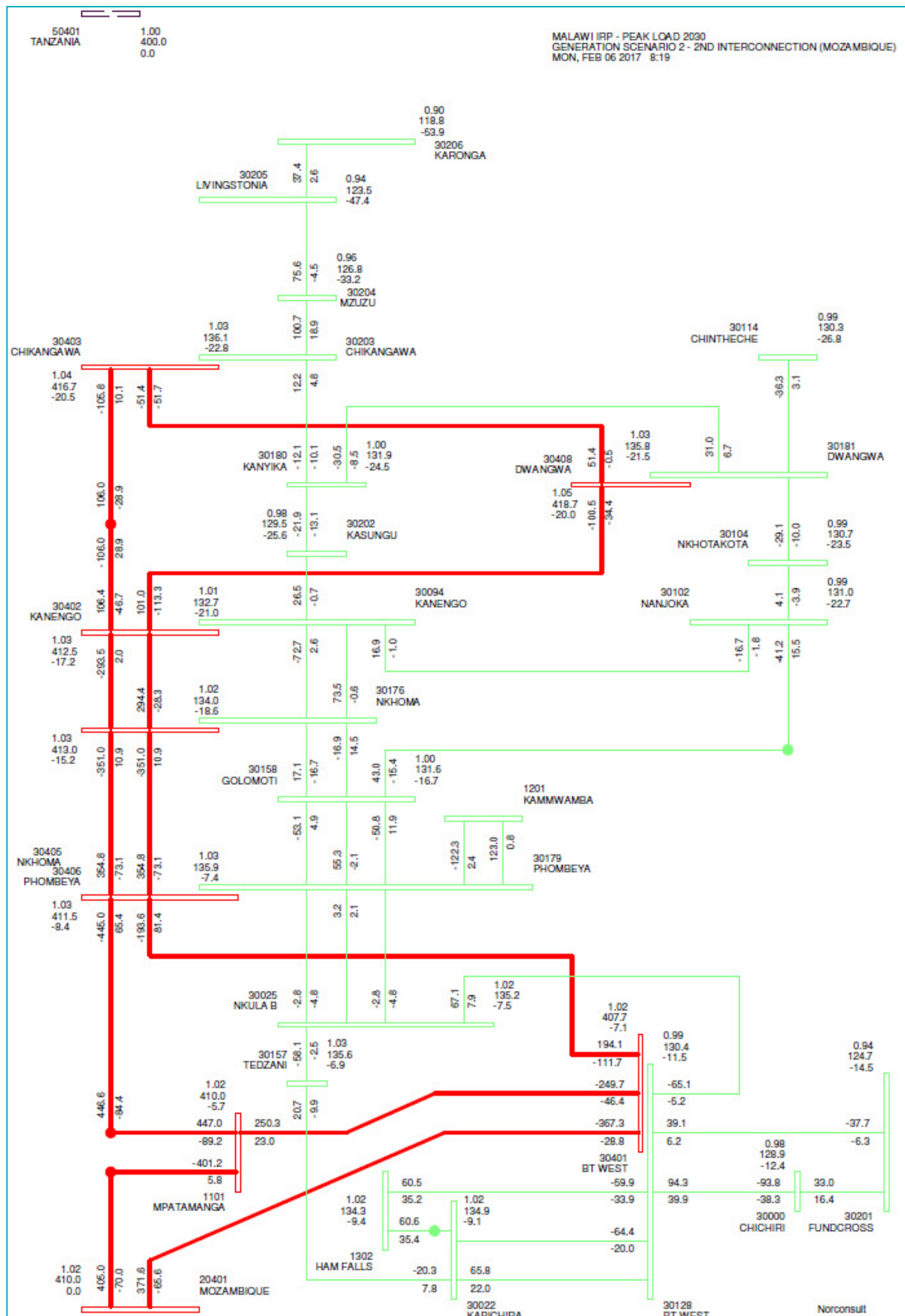


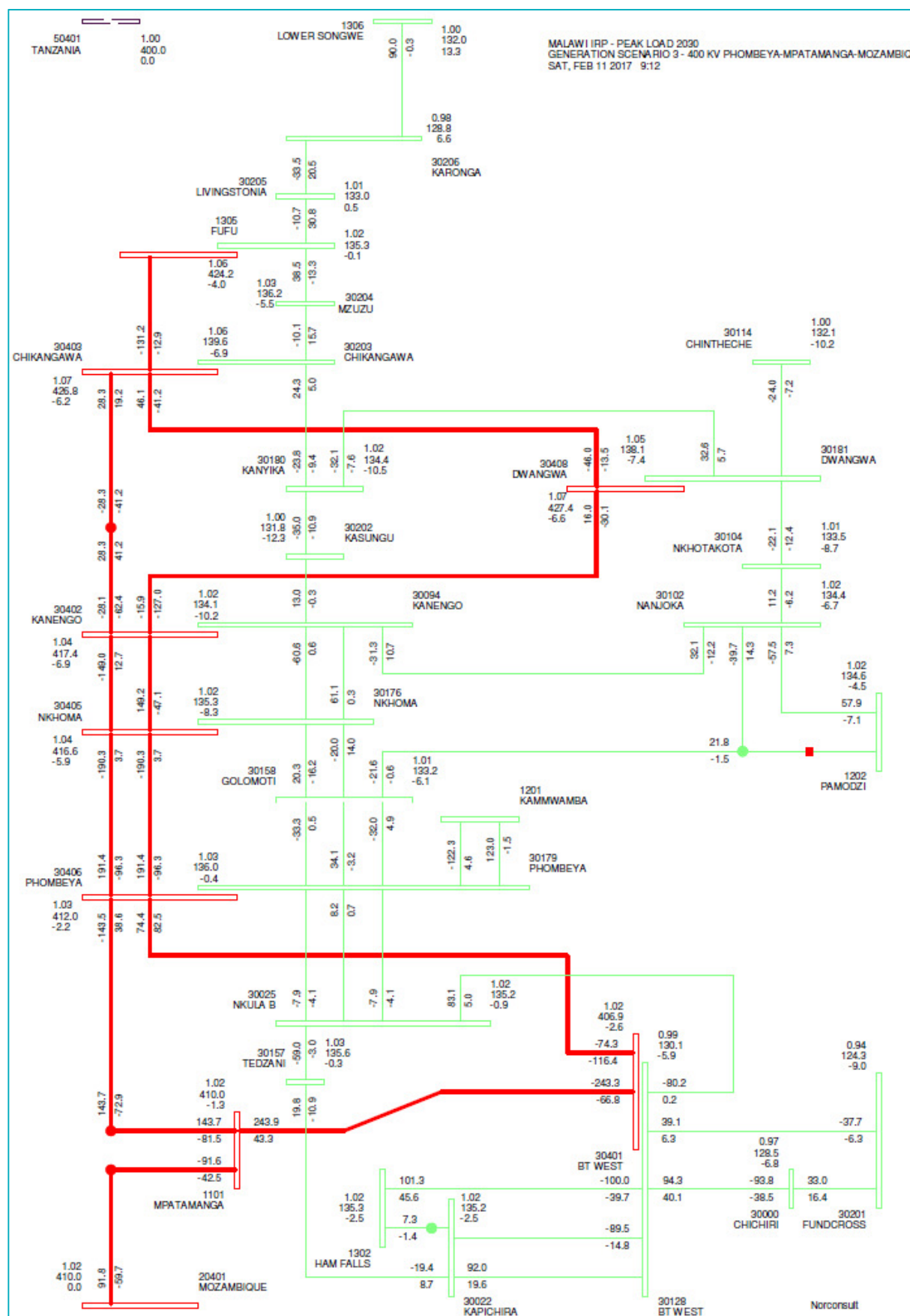


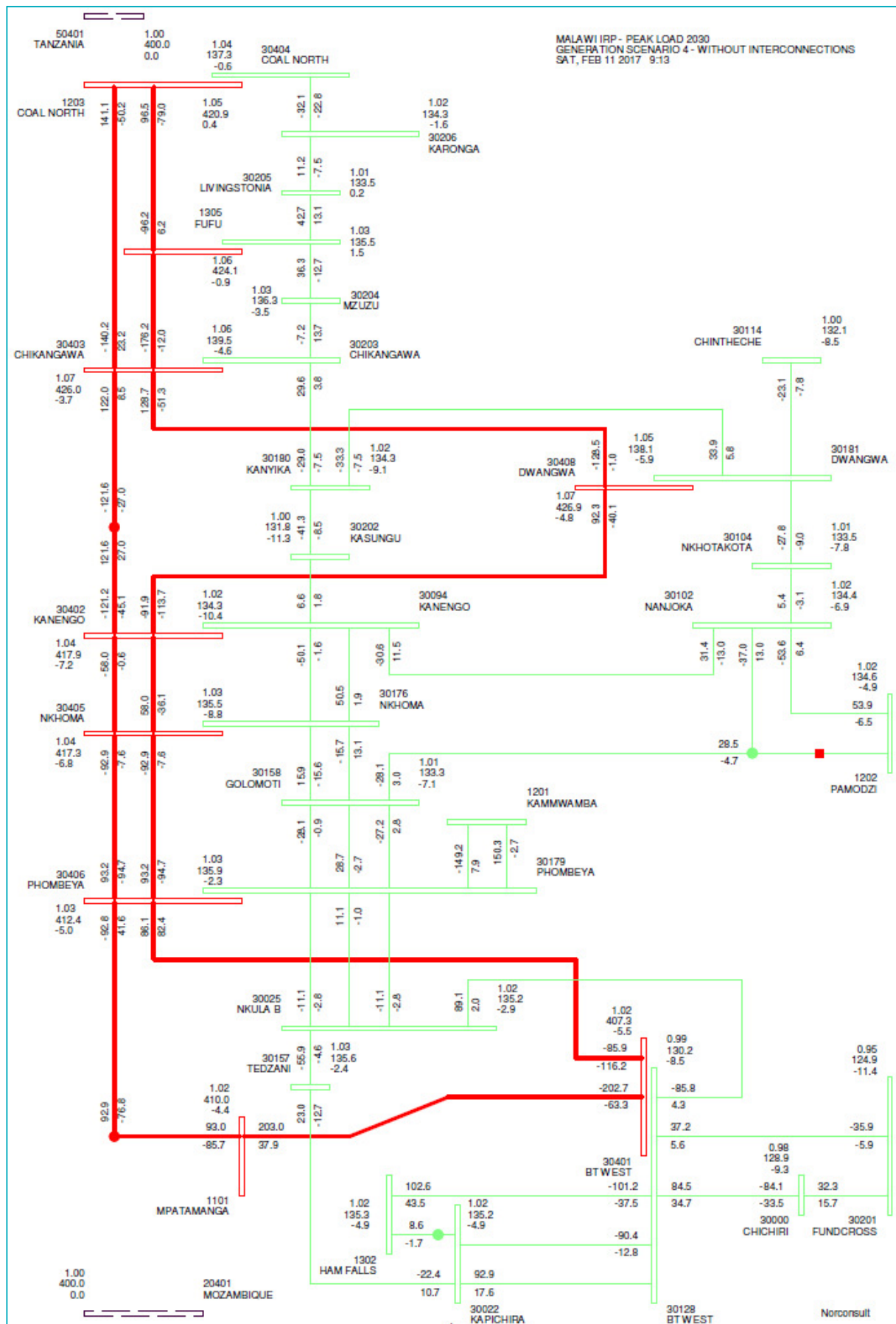




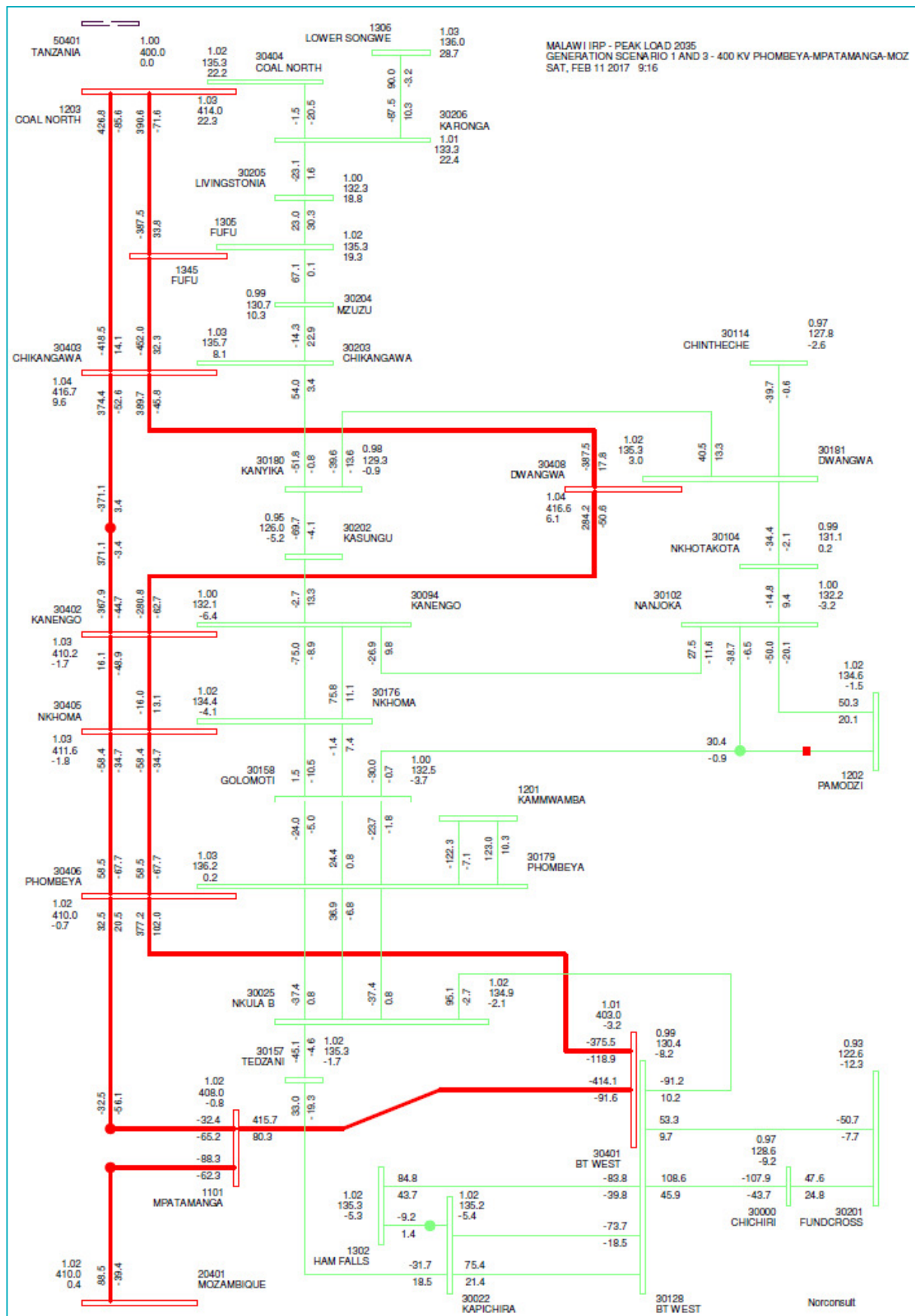


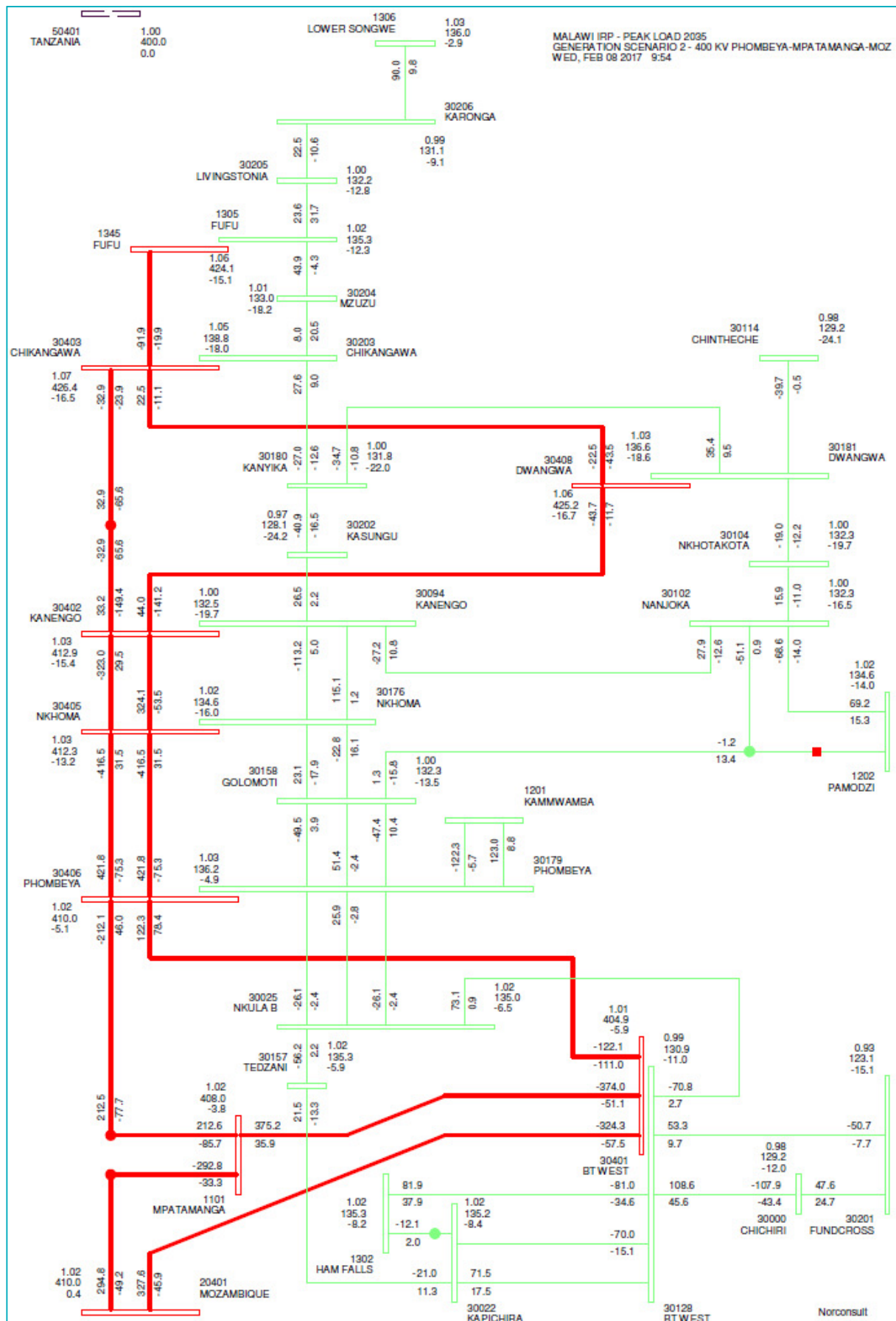


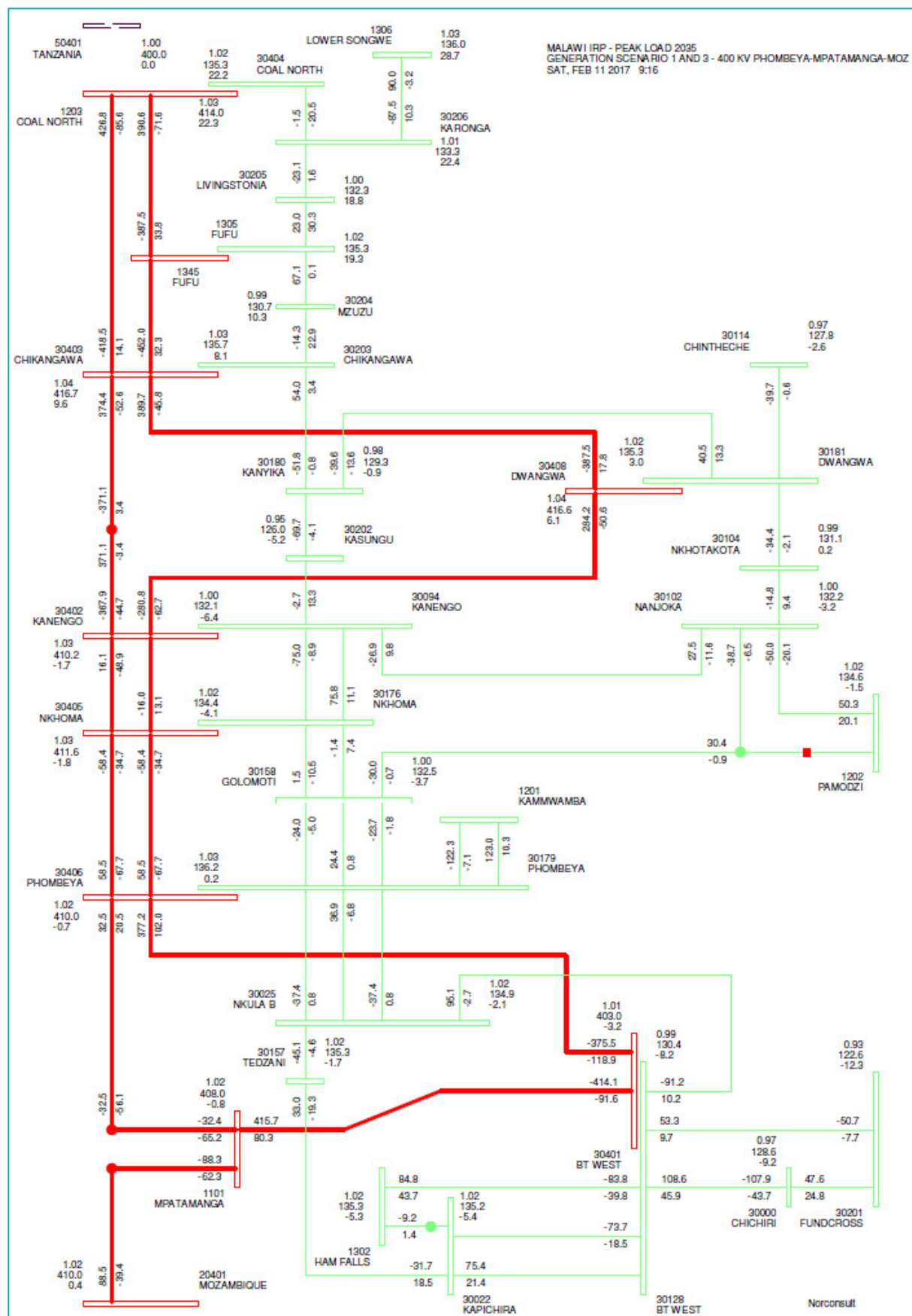


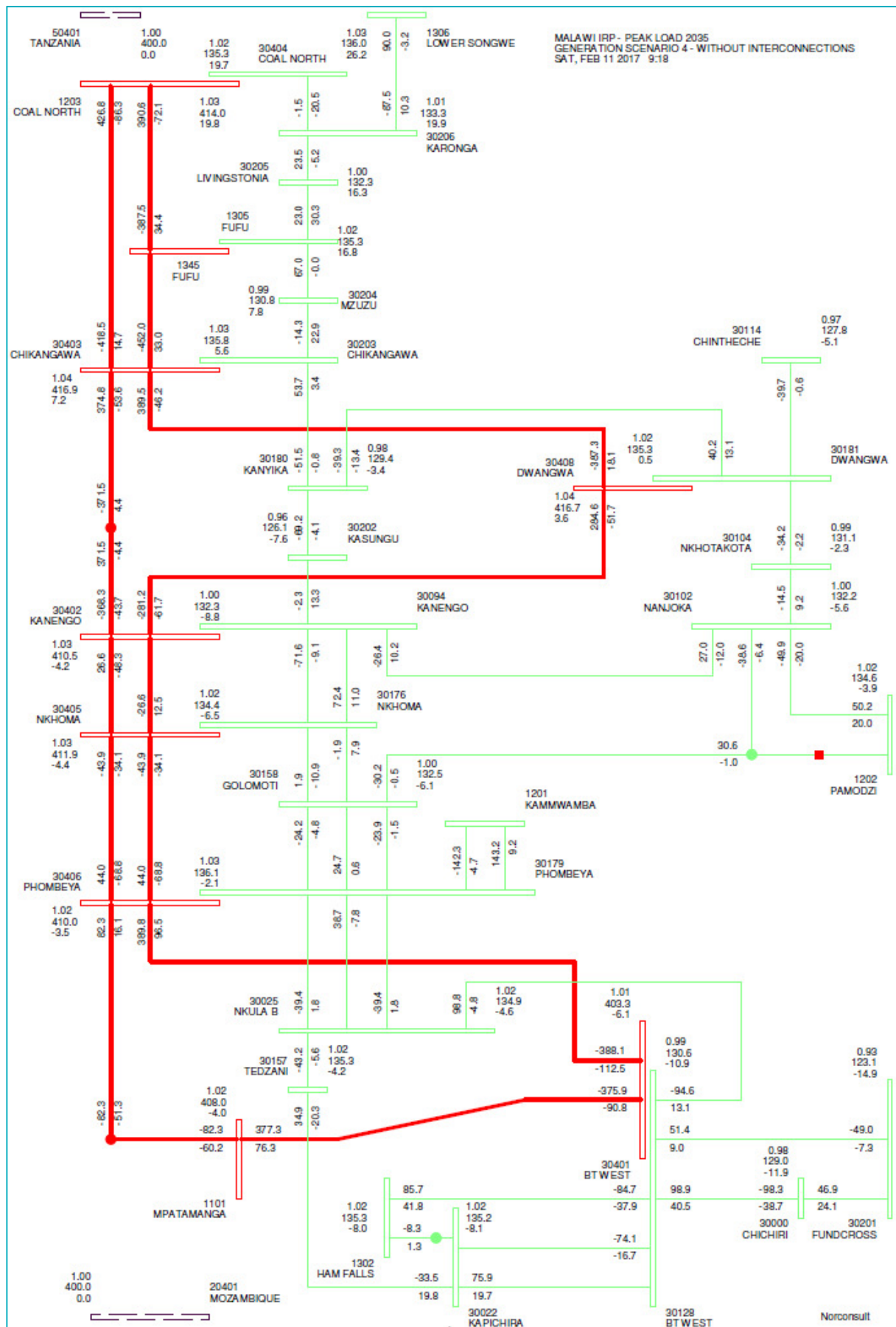












## Appendix III - Cost Estimate – Transmission Grid

Transmission line and substation cost estimates are presented on the following pages (price level as of January 2017). Cost estimates reflect economic costs based on international competitive bidding and includes equipment, transport, construction/erection and commissioning etc. – i.e. equipment installed and ready for operation, but excludes any taxes and duties and financing costs.

COMMITTED LINES															
Voltage [kV]	Lines and Substations					Distance [km]	Conductor type	Circuits	Tower type	Cost estimate [MUSD]	In service by				
	From	Status	Transformers No.	Ratio	To						Scen 1	Scen 2	Scen 3	Scen 4	
400	Phombeya	New	1	400/132	200	173	2x Bluejay	1	Y Tower	DbCkt	Sunk	2018	2018	2018	2018
INTERCONNECTORS															
Voltage [kV]	Lines and Substations					Distance [km]	Conductor type	Circuits	Tower type	Cost estimate [MUSD]	In service by				
	From	Status	Transformers No.	Ratio	To						Scen 1	Scen 2	Scen 3	Scen 4	
400	Matambo	New	1	400/220	200	210	3x Tern	1	Varies	SgCkt	79.7	2019	2019	2019	-
	Matambo				Border	110	3x Tern	1	V Tower			2019	2019	2019	-
	Border				Cassapa T	45	3x Tern	1	V Tower			2019	2019	2019	-
	Cassapa T				Phombeya	55	3x Tern	1	V Tower			2019	2019	2019	-
	Mozambique2	Existing			Blantyre West	215	3x Tern	1	Varies	SgCkt	71.2	-	2026	-	-
	Mozambique2				Border	110	3x Tern	1	V Tower			-	2026	-	-
	Border				Blantyre West	105	3x Tern	1	V Tower			-	2026	-	-



NEW LINES/SUBSTATIONS AS RESULTS FROM IRP STUDIES														
Voltage [kV]	Lines and Substations				Distance [km]	Conductor type	Circuits	Tower type	Cost estimate [MUSD]	In service by				
	From	Status	Transformers No. Ratio MVA	To						Status	Transformers No. Ratio MVA	Scen 1	Scen 2	Scen 3
400	Nkhoma	Existing		Kanengo	New	2 400/132 200	3x Tern	1	Y Tower	SgCkt	52.6	2020	2020	2020
	Kanengo	Existing		Chikangawa	New	1 400/132 200	3x Tern	1	Y Tower	SgCkt	111.0	2022	2022	2022
	Phombeya	Existing		Blantyre West	New	2 400/132 200	3x Tern	1	Y Tower	SgCkt	52.6	2023	2023	2023
	Mpatamanga	Power plant		Blantyre West	Existing		3x Tern	1	Y Tower	SgCkt	21.9	2023	2023	2023
	Mpatamanga	Existing		Cassapa T			3x Tern	1	Y Tower	SgCkt	7.8	2023	2023	2023
	Mpatamanga 2	Existing		Cassapa T 2			3x Tern	1	Y Tower	SgCkt	7.8	2023	2023	2023
	Cassapa T			Phombeya	Existing		3x Tern	1	Y Tower	SgCkt	22.0	-	-	2023
	Nkhoma 2	Existing		Kanengo 2	Existing		3x Tern	1	Y Tower	SgCkt	25.1	2023	2023	2023
	Chikangawa	Existing		Fufu (Higher)	New	1 400/132 200	3x Tern	1	Y Tower	SgCkt	73.0	2027	2033	2025
	Kholombido	Power plant		Phombeya	Existing		3x Tern	1	Y Tower	SgCkt	10.9	2028	2034	2030
	Kanengo	Existing		Dwangwa	New	1 400/132 200	3x Tern	1	Y Tower	SgCkt	85.7	2028	2028	2028
	Dwangwa	Existing		Chikangawa	Existing		3x Tern	1	Y Tower	SgCkt	33.0	2030	2030	2030
	Chikangawa	Existing		Coal North	New		3x Tern	1	Y Tower	SgCkt	96.7	2031	2036	2031
	Fufu (Higher)	Existing		Coal North	Existing		3x Tern	1	Y Tower	SgCkt	40.9	2031	2036	2029
	</													