KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
UNIVERSITAS KHAIRUN
FAKULTAS TEKNIK PROGRAM STUDI ARSITEKTUR
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BERITA ACARA

Pada hari Sabtu Tanggal 06 Desember 2014, Pukul 14.00 WIT. bertempat di AULA REKTORAT UNIVERSITAS KHAIRUN Lt. 4, telah dilaksanakan Workshop Teknik Elektro dengan tema :

" PERANCANGAN SISTEM ENERGI TERBARUKAN MENGGUNAKAN STANDAR AS4509.2 - 2002 "

Oleh ;

Kunaifi, ST., PgDipEnSt., M.Sc

Ternate, 06 Desember, 2014

Pemateri	Ketua Program Studi Teknik Elektro
Kunaifi, ST., PgDipEnSt., M.Sc	**M. Yunus Hi. Abbas, ST., MT**
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UIN SUSKA RIAU

KEMENTERIAN AGAMA
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SURAT TUGAS

Un.04/F.V/PP.00.9/ /2014

Yang bertandatangan di bawah ini:

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dengan ini menugaskan kepada :

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untuk melaksanakan tugas:

1. Melaksanakan pengabdian kepada masyarakat dengan menyampaikan pelatihan "Perancangan Sistem Energi Terbarukan menggunakan Standar AS 4509.2—2002" bagi pelaku pengembangan energi terbarukan di Maluku Utara pada tanggal 6 Desember 2014.
2. Mempresentasikan makalah ilmiah berjudul "Potensi Energi Biomassa di Provinsi Riau" dalam Seminar Nasional Keteknikan Fakultas Teknik Universitas Khairun, Maluku Utara, dan mengikuti seminar, tanggal 8 s/d 9 Desember November 2014.

Surat tugas ini diberikan dari tanggal 5 – 10 Desember 2014 (termasuk perjalanan).

Demikian surat tugas ini dibuat dengan sebenarnya untuk dilaksanakan sebagaimana mestinya.

Pekanbaru, 2 Desember 2014
Dekan

KEMENTERIAN AGAMA
UIN SUSKA RIAU
FAKULTAS SAINS DAN TEKNOLOGI

Dr. Hartono, M.Pd
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PERANCANGAN SISTEM ENERGI TERBARUKAN

MENGGUNAKAN STANDAR AS 4509.2—2002

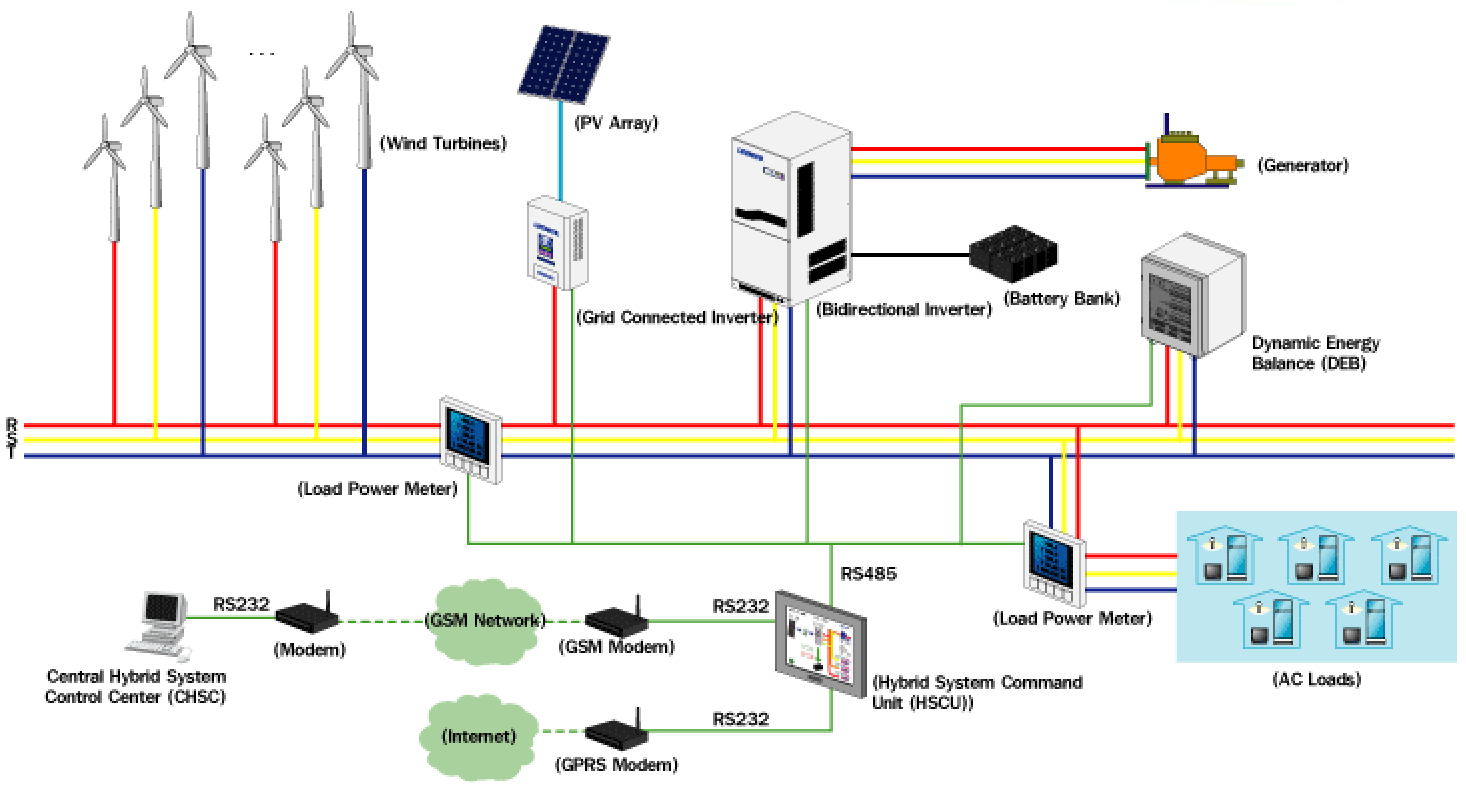
Disampaikan di Program Studi Teknik Elektro
Fakultas Teknik Universitas Khairun
Ternate – Maluku Utara, 6 Desember 2014

OUTLINE

- Tak kenal maka tak sayang:
  - ✓ CV singkat
  - ✓ EnReach
- Mengapa Energi Berkelanjutan?
  - ✓ **Kondisi yang menghawatirkan**: ledakan jumlah penduduk, kebutuhan dan suplai energi tidak seimbang, cadangan energi fosil semakin tipis, harga energi naik, bahan bakar fosil merusak lingkungan.
  - ✓ **Energi berkelanjutan sebagai solusi**: energi terbarukan dan efisiensi energi.
  - ✓ Contoh aplikasi ET di kawasan pedesaan.
- Desain Sistem ET dengan Standar AS 4509.2—2002.
- Diskusi.

Contoh Aplikasi ET

Contoh Aplikasi ET



PV-WT-DG-Inverter Hybrid System for Remote Area Power System (Island Electrification)

Contoh Aplikasi ET

Desain Sistem ET dengan Standar AS 4509.2-2002

1. Scope
2. Desain Sistem - Umum
3. Desain Sistem – kelistrikan
4. Desain Sistem – Pekerjaan Mekanikal dan Sipil
5. Kinerja Sistem
6. Latihan

Scope

- AS-NZS 4509-2 (2010) adalah standar Australis dan New Zealand tentang panduan perancangan sistem pembangkit stand-alone dengan penyimpan energi.
- Sesuai dengan Standar IEC (International Electrotechnical Comission)
- Digunakan dengan persyaratan industri.

Desain Sistem - Umum

Langkah Perancangan

A. Menentukan kriteria desain
   1. Kriteria umum
   2. Layanan energi dan pemilihan sumber energi
   3. Menghitung kebutuhan listrik

B. Konfigurasi sistem

C. Menentukan Ukuran Komponen
   1. Penentuan dan pemilihan komponen utama
   2. Metering dan Kendali
   3. Proteksi, swithing, isolasi

D. Desain Instalasi

E. Biaya

F. Dokumentasi

- Urutan tidak selalu mengikuti daftar ini.
- Untuk sistem kecil, beberapa tahap boleh dilewatkan

Desain Sistem - Umum

Kriteria Perancangan

A. Hambatan biaya
B. Kualitas daya (misal kualitas bentuk gelombang atau kontinuitas suplai)
C. Dampak lingkungan (misal: pemangkasan atau penebangan pohon, pekerjaa sipil, pengalihan aliran sungai untuk hydro system);
D. Penggunaan komponen existing
E. Perbandingan kontribusi genset dibanding RE
F. Level kebisingan
G. Ketersediaan suku cadang dan perawatan
H. Otomatis atau dikendalikan user
I. Estetika

Informasi yang dibutuhkan:

A. Design load energy (konsumsi energi harian);
B. Kebutuhan daya maximum a.c. dan d.c.
C. Surge demand.

Jika konsumsi energi harian melebihi 1 kWh/d, informasi variasi menurut musim juga diperlukan

Konsumsi energi harian (design load energy):

Design Load Energy = total daya x lamanya penggunaan

di mana:

- Design Load Energy: energi harian yang dikonsumsi oleh semua beban d.c. atau a.c (Wh)
- Daya: daya setiap peralatan (Watt)
- Lamanya penggunaan: rata-rata lamanya setiap beban digunakan dalam sehari (jam).

Jika sistem akan menyuplai beban a.c. dan d.c., maka dihitung terpisah. Proses ini akan menghasilkanE_{dc} (design dc load energy, Wh) and E_{ac} (design ac load energy, Wh)

Desain Sistem - Kelistrikan

Konsumsi energi harian (design load energy):

Untuk design dengan d.c. bus, konsumsi energi harian dihitung pada d.c. bus, sebegai berikut:

$$E_{tot} = E_{dc} + \frac{E_{ac}}{\eta_{inv}}$$

di mana:

E_{tot}: total design energy demand harian dari d.c. bus, (Wh)

η_{inv}: efficiensi inverter ketika menyuplai beban design a.c., tanpa satuan

Faktor efisiensi inverter diperkiakan berdasarkan efisiensi versus kurva beban inverter.

Jika profil beban dan kurva efisiensi keduanya tersedia, maka efisiensi inverter adalah efisiensi bobot.

Jika hanya kurva efisiensi yang tersedia, sedangkan profil beban tidak tersedia, maka efisiensi pafd daya 50% digunakan sebagai effiienci inverter.

Jika hanya efisiensi max yang tersedia, maka efisiensi inverter yang digunakan adalah efisiensi max dikurangi 10%

Kebutuhan daya max. :

Jika tidak bisa diukur langsung, daya maximum yang dibutuhkan diperkirakan berdasarkan pemilihan beban dengan menjumlahkan daya beban yang digunakan pada waktu bersamaan

Pemilihan mesti berdasarkan pada pemahaman pada pole penggunaan beban dan praktek pengelolaan beban.

Surge demand beban a.c. :

Surge demand berdasarkan pada pemilihan beban terkait dengan kondisi beban surge tertinggi.

Jika informasi yang lebih akurat tidak tersedia, surge demand untuk beban individu bisa diperkirakan dengan persamaan berikut:

$$\text{surge demand} = \frac{\text{power}}{pf \times \text{surge factor}}$$

di mana:

surge demand: dalam VA.

power: konsumsi daya nyata saat running, watts

pf: faktor daya peralatan saat running, tanpa satuan

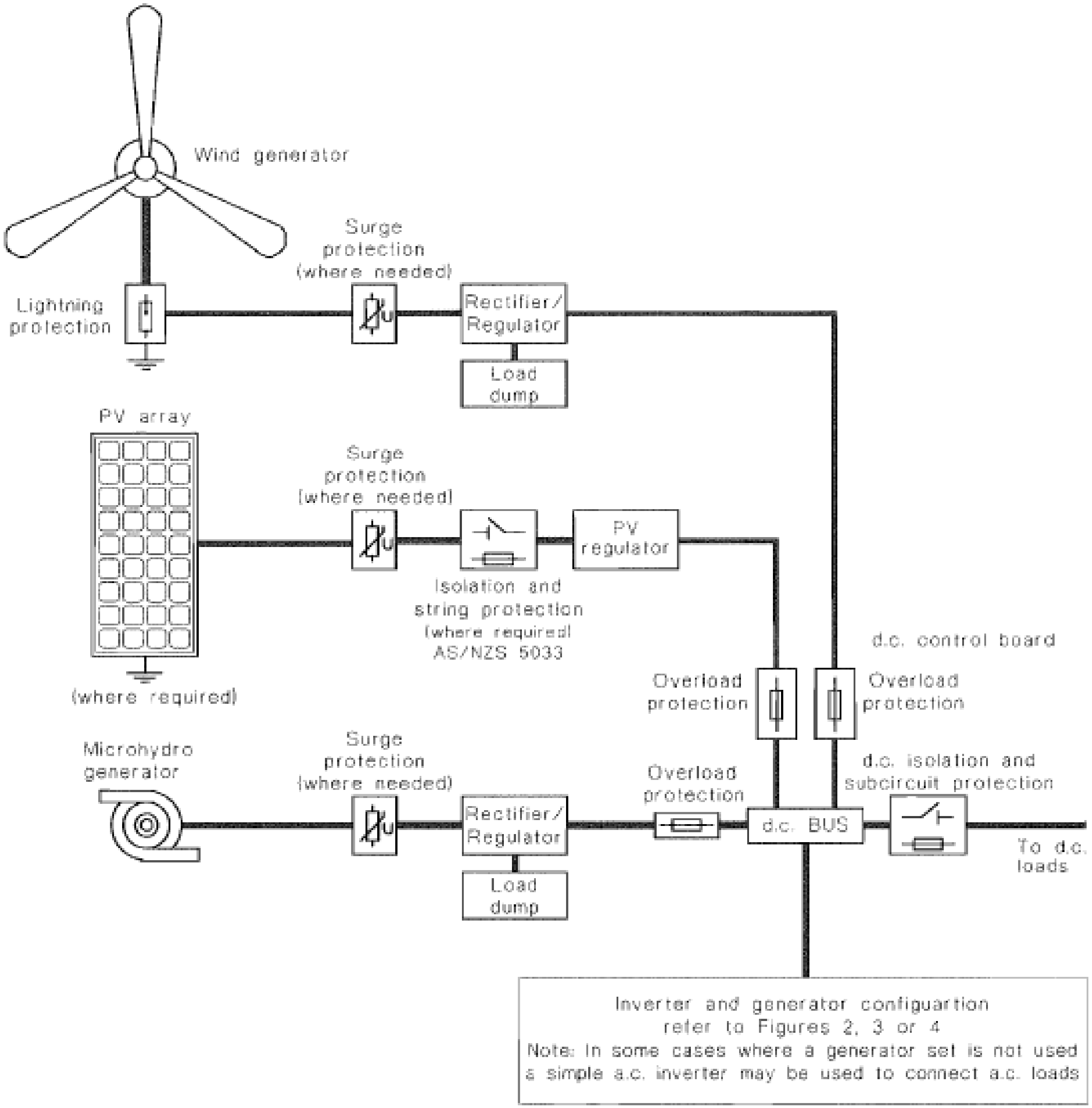
surge factor: tergantung tipe beban (1: beban resistif; 3: universal motor; 7: motor induksi)

Surge demand beban d.c. :

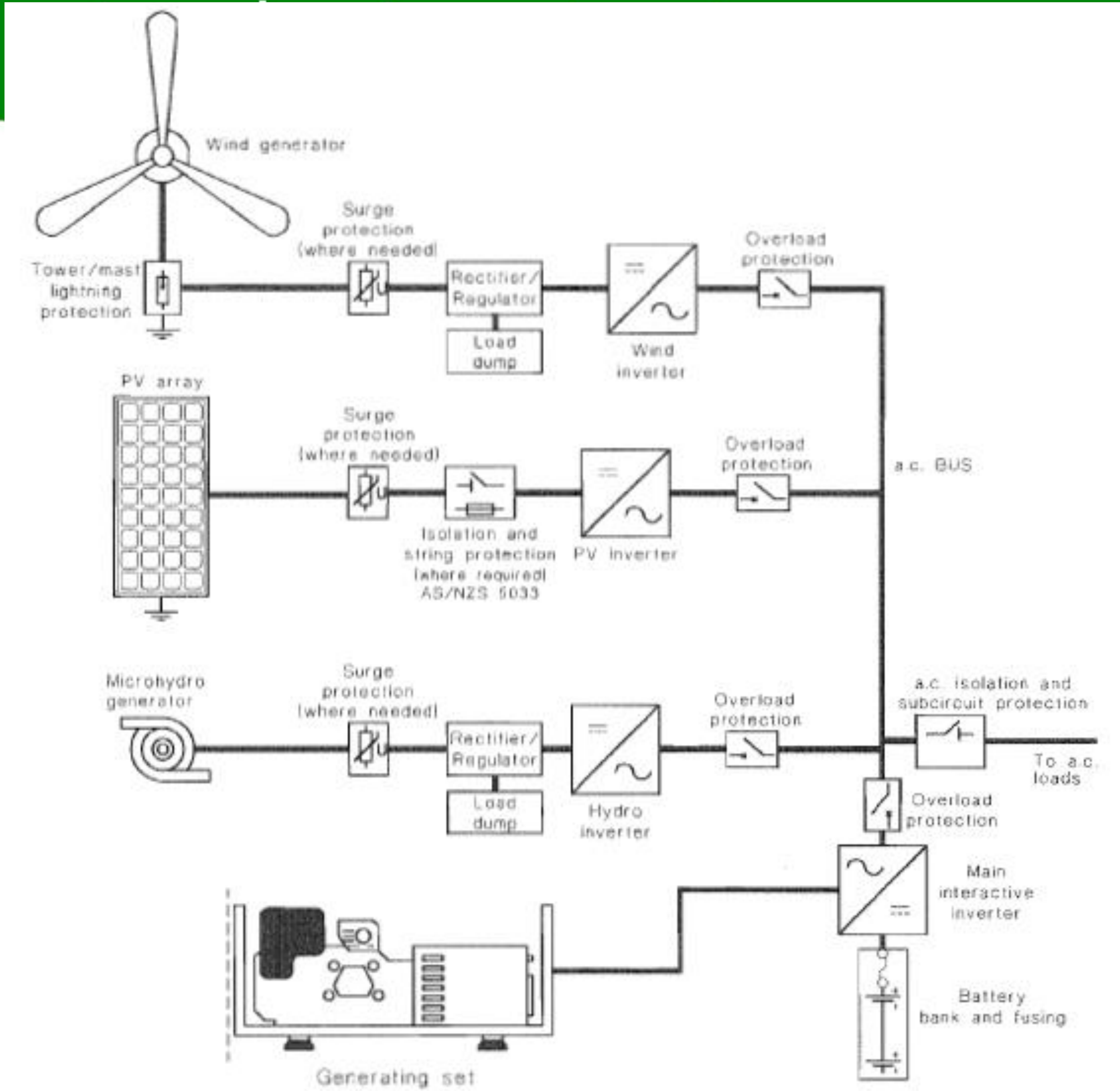
Ketika beban d.c. seperti motor yang mungkin menarik arus surge besar, maka surge demand d.c. Harus diperkirakan.

Pertimbangan utama adalah penentuan ukuran kabel untuk meminimalkan tegangan jatuh saat kondisi surge dan baterai menjaga surge.

Konfigurasi Sistem

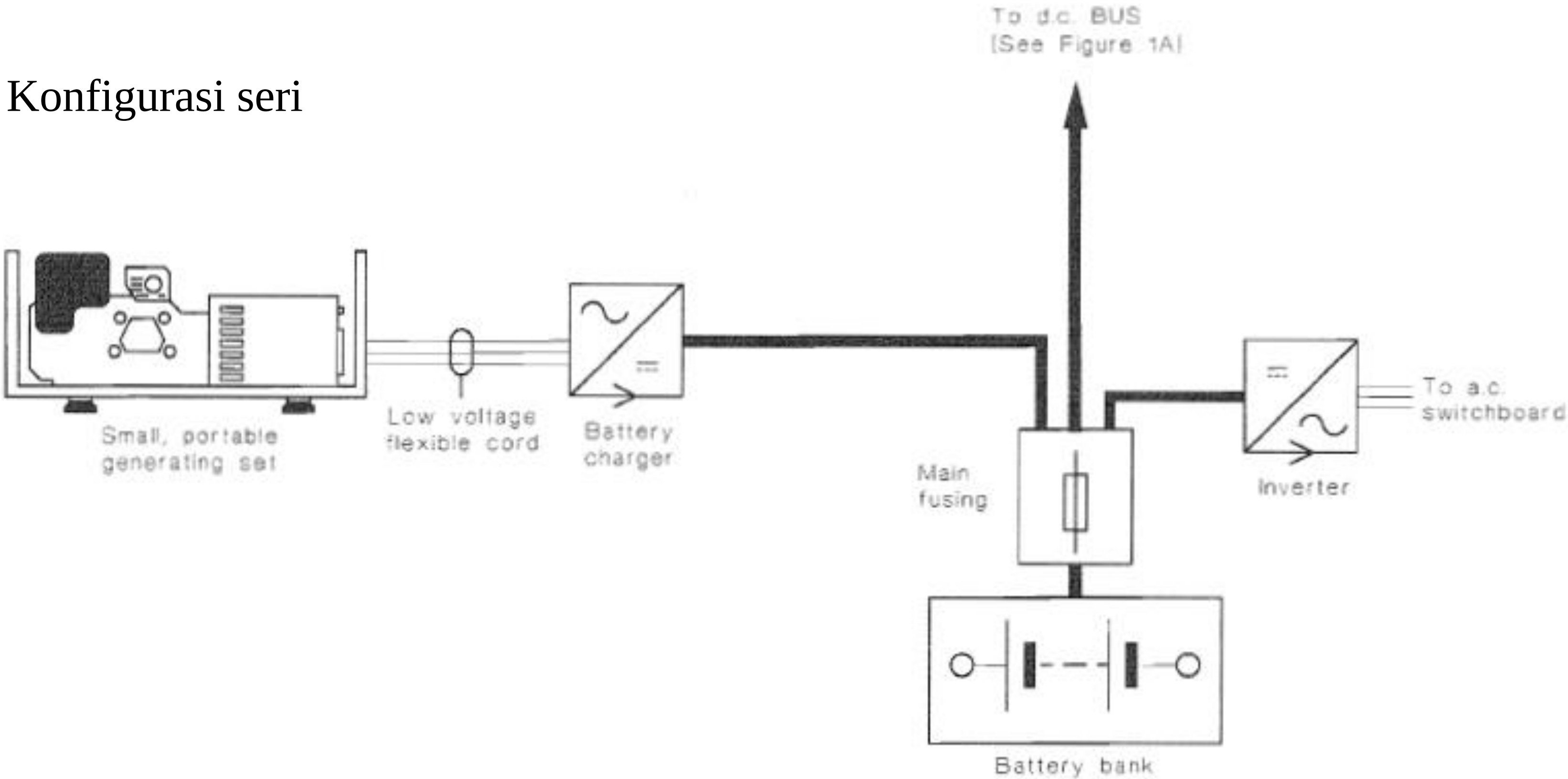


Konfigurasi Sistem



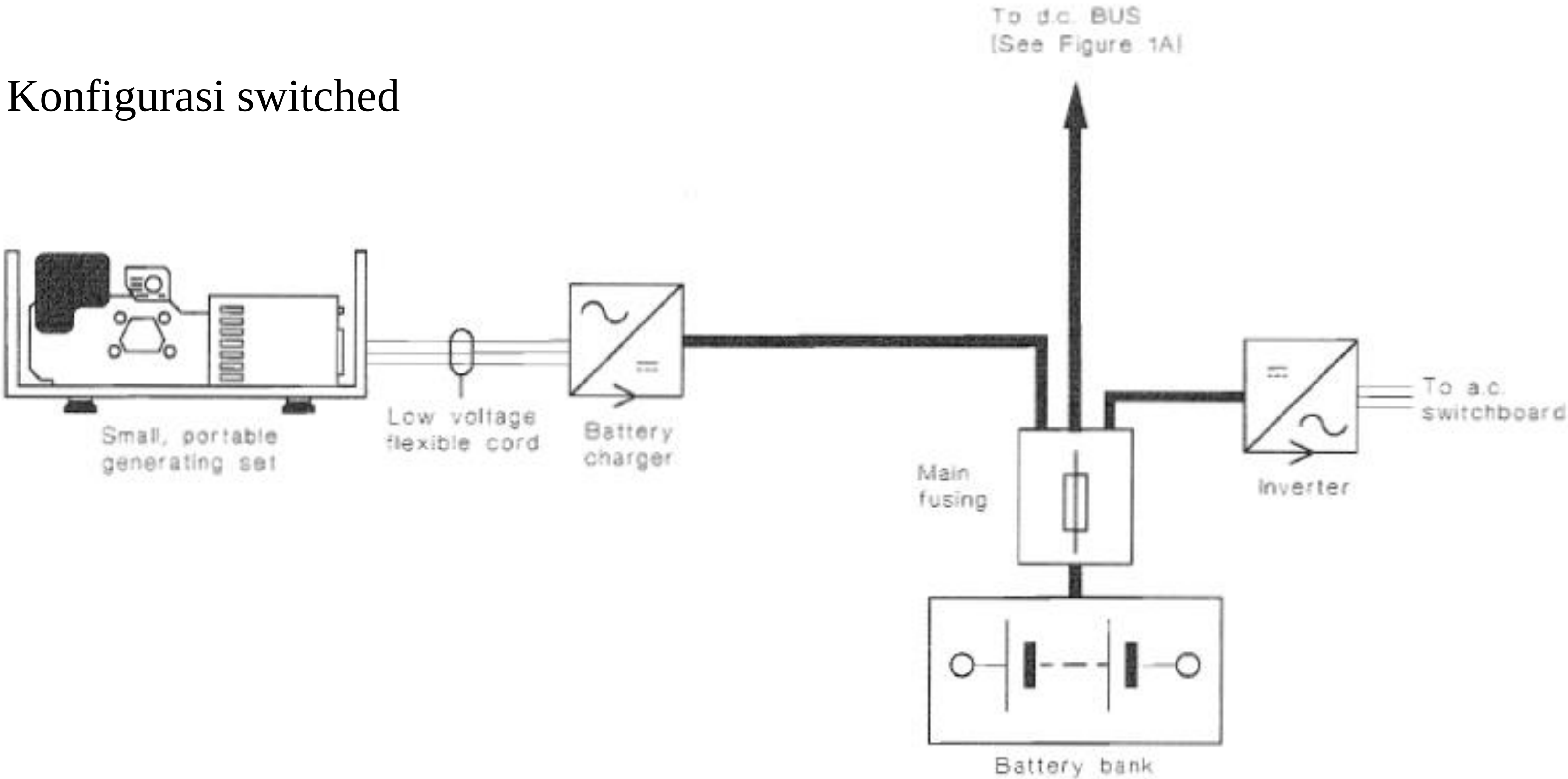
Konfigurasi Sistem

Konfigurasi seri



Konfigurasi Sistem

Konfigurasi switched



Konfigurasi Sistem

Konfigurasi paralel

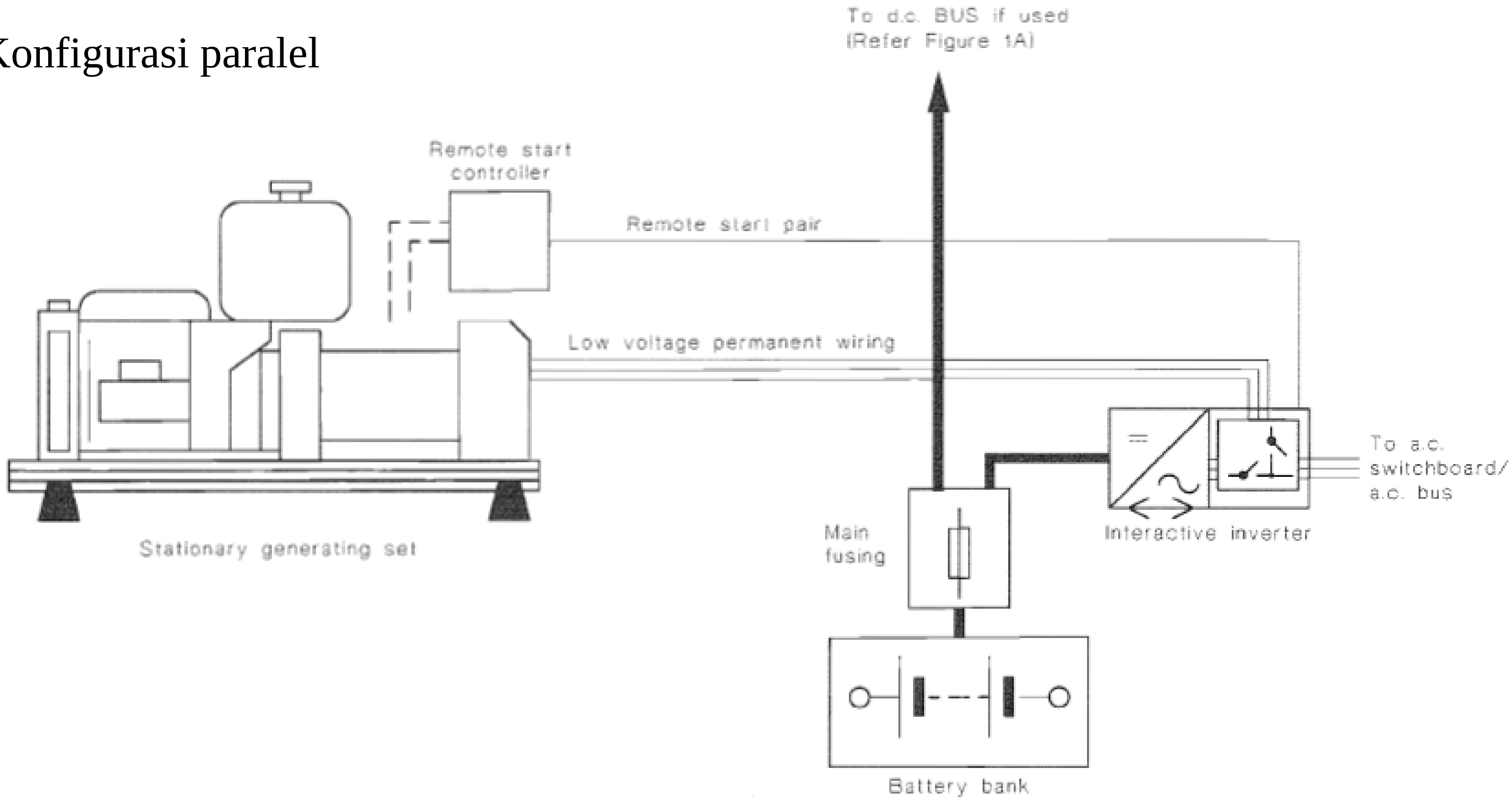


TABLE A2

D.C. LOADS

(1)	(2)	(3)	(4a)	(5a)	(4b)	(5b)	(6)	
Appliance	Number	Power	Winter or dry season		Summer or wet season		Contribution to maximum demand	Comments
			Usage time	Energy	Usage time	Energy		
		W	h	Wh	h	Wh	W	
Fluorescent lamp	3	40	4	480	3	360	120	Assumes all lamps may be on at the same time as any other appliance.
Compact fluorescent lamps	3	15	5	225	3	135	45	Assumes all lamps may be on at the same time as any other appliance.
Incandescent lamps	3	60	0.25	45	0.25	45	60	These lamps have low usage time, and are unlikely to be on at the same time. Only one lamp is considered for maximum demand purposes.
Refrigerator	1	70	—	800	—	1100	70	Refrigerator running time is unknown, but manufacturer's specs show 900 Wh daily energy consumption for 20°C ambient, and 70 W max. power consumption.
Daily load energy: d.c. loads (Wh)			(DC7a) →	1550	(DC7b) →	1640		
Maximum d.c. demand (W)						(DC8) →	295	

NOTES:

1 Columns (1) to (4a,b) contain data obtained from the user or field survey. Where practicable, power consumption data should be from actual measurements.

2 Columns (5a,b) = Column (2) × Column (3) × Columns (4a,b).

3 Column (6) = n × Column (3) if these items contribute to the maximum demand scenario,
where
n = the number of items specified in Column (2) which actually contribute to the maximum demand.

4 Cell (DC7a,b) = Sum of Columns (5a,b), as appropriate.

5 Cell (DC8) = Sum of Column (6).

6 In cases where large loads are known to occur during certain months (e.g. during harvesting), this worst case load situation should be considered explicitly.

Table A3 A.C. LOADS

(1)	(2)	(3)	(4a)	(5a)	(4b)	(5b)	(6)	(7)	(8)	(9a)	(9b)	
Appliance	No.	Power	Winter or dry season		Summer or wet season		p.f.	Contribution to max. demand	Surge factor	Contribution to surge demand		Comments
			Usage time	Energy	Usage time	Energy				(potential)	(design)	
		W	h	Wh	h	Wh		VA		VA		
TV	1	80	3	240	1.5	120	0.8	100			100	Contribution to max. Demand is based on an assumed power factor of 0.8.
Stereo	1	20	3	60	3	60						Stereo power usage is an estimate based on measurements of other stereo systems. Nameplate rating is likely to be excessive.
Computer	1	120	3	360	3	360	0.8	150			150	Contribution to max. Demand is based on an assumed power factor of 0.8.
Blender	1	150	0.083	13	0.083	13						Usage time is based on 5 minutes per day (i.e. $\frac{5}{60}$ hour per day).
Vacuum cleaner	1	1000	0.071	71	0.071	71	0.8	1250	3	3750	3750	Usage time is based on 1 hour per fortnight (i.e. 1/14 hour per day). Surge demand is taken as 3 times the running demand (assuming running power factor of 0.8), which is typical for universal motors (i.e. $\frac{1000 \times 3}{0.8}$).
Washing machine	1	300	0.32	96	0.32	96						Usage time is based on 3 loads per week at 0.75 hour per load (i.e. $\frac{3 \times 0.75}{7}$ hour per day).
Electric drill	1	600	0.071	43	0.071	43						Usage time is based on 1 hour per fortnight (i.e. $\frac{1}{14}$ hour per day).
Iron	1	1200	0.14	168	0.14	168						Usage time is based on 1 hour per week (i.e. $\frac{1}{7}$ hour per day).
Water Pump	1	300	3	900	1.5	450	0.7	429	7	3000	429 (See Note 11)	Usage time estimated is based on water usage requirements. Surge is taken as 7 times the running demand, which is typical for induction machines.
Daily Load Energy: a.c. Loads (Wh)			(AC10a)	1951	(AC10b)	1381						Only one of vacuum, washing machine, drill, iron to be used at any one time
½ hour maximum demand - (VA)							(AC11)	1929				
Surge demand - (VA)										(AC12) →	4429	

(continued)

Penentuan Ukuran Komponen

NOTES TO TABLE A3:

1 Columns (1) to (4a), (4b) and (6) contain data obtained from the user or field survey.

2 Columns (5a,b) = Column (2) × Column (3) × Columns (4a,b).

3 Column (7) = if the item contributes to the maximum demand,
where
n = the number of items specified in Column (2) which actually contribute to the maximum demand.

4 Column (8) is the ratio of apparent power during start-up surge to that when running, and depends on the type of load. As a guide, use 1 for resistive loads, 3 for universal motors (hand-held tools and most kitchen appliances), and 7 for induction motors.

5 Column (9a) = Column (7) × Column (8).

6 Column (9b) = Column (9a) if the item's surge contributes to the surge demand (usually the item with largest surge), or Column (7) if the item's running power contributes to surge demand.

7 Cells (AC10a,b) = Sum of Columns (5a,b).

8 Cell (AC11) = Sum of Column (7).

9 Cell (AC12) = Sum of Column (9b).

10 Values in Columns 7 and 8 may need consideration of load diversity.

11 It is assumed that, since the vacuum cleaner is manually started and infrequently used, a starting surge concurrent with the pump is unlikely. Since the pump has smaller surge, its continuous running demand is used instead.

12 In cases where large loads are known to occur during certain months (e.g. harvesting), this worst case load situation should be considered explicitly.

TABLE A4

MISCELLANEOUS SYSTEM DESIGN INFORMATION

Item	Symbol	Source[1]	Ref.	Value	Units	Refer Clause	Notes
Summer/wet months			M1	Oct, Nov, Dec, Jan, Feb, Mar			
Winter/dry months			M2	Apr, May, Jun, Jul, Aug, Sep			
Average inverter efficiency	η_{inv}	Manufacturer's data	M3	85%		3.1.4.1	This is less than the peak efficiency quoted in manufacturer's specifications.
Design load energy – winter/dry	E_{tot}	$\frac{AC10a}{M3} + DC7a$	M4	3846	Wh	3.1.1 3.1.4.1	
Design load energy – summer/wet	E_{tot}	$\frac{AC10b}{M3} + DC7b$	M5	3265	Wh	3.1.1 3.1.4.1	
Design tilt angle		Design decision	M6	45°		3.4.3.4	
Maximum demand at d.c. bus (approximately)		$\frac{AC11 \times 0.8}{M3} + DC8$	M7	2110	W	3.1.4.2	pf of 0.8 is assumed
Nominal system voltage	V_{dc}	Design decision	M8	24	V	1.3.36 3.4.1	
Approximate d.c. current at maximum demand		$\frac{M7}{M8}$	M9	88	A	3.4.1	
System configuration		Design decision	M10	Switched		3.3.1 3.3.3	

1 Values for AC10a, AC10b and AC11 are from Table A3. Values for DC7a, DC7b and DC8 are from Table A2.

Penentuan Ukuran Komponen

TABLE A5

SELECTION OF DESIGN MONTHS

Solar radiation data source: Australian Solar Radiation Data Handbook

Measurement location: Brisbane, latitude 27.5°S

Ref.	Item (units)	Source	Value												
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
DM1	Irradiation on tilted plane (kWh/m² or PSH)	From resource data[1] and M6	5.5	5.5	5.6	5.3	4.8	4.9	4.9	5.7	6.2	5.4	5.1	5.2	5.5
DM2	Load (kWh/d)	From M1, M2, M4 and M5[2]	3.26	3.26	3.26	3.85	3.85	3.85	3.85	3.85	3.85	3.26	3.26	3.26	3.56
DM3	Ratio $\frac{\text{Resource}}{\text{Load}}$	$\frac{\text{DM1}}{\text{DM2}}$	1.68	1.68	1.72	1.38	1.25	1.27	1.27	1.48	1.61	1.65	1.56	1.59	1.54
DM4	Worst and best months	Select after inspecting DM3[3]			Best		Worst								

1 In this example, the site was considered to have no appreciable difference in irradiation compared to the measurement location and hence no adjustment was required. See Clause 3.2.2.

2 Values for M1, M2, M4 and M5 are from Table A4.

3 Refer Clause 3.4.2.6.

Penentuan Ukuran Komponen

TABLE A8-1

PHOTOVOLTAIC ARRAY AND REGULATOR SIZING AND SELECTION (PART 1)

Item	Symbol	Source	Ref.	Value	Units	Refer Clause	Notes
Oversupply co-efficient	f_o	Design decision	PV1	1		3.4.2.5	Equals 1 if the system includes a generating sets.
Nominal battery efficiency (coulombic)	η_{coul}	From manufacturer's specifications	PV2	90%		1.3.8 3.4.2.2 3.4.3.11.1	Approximately 90% to 95% is typical for lead acid batteries. This depends strongly on the charging regime used.
Selected module		Brand and model	PV3	XYZ 80			
Nominal module power	P_{stc}	From manufacturer's specifications	PV4	80	W		
Nominal module voltage		From manufacturer's specifications	PV5	12	V		
Module short-circuit current	I_{sc}	From manufacturer's specifications	PV6	5.2	A		
Module current at 14 V at operating temp.	$I_{T,V}$	From manufacturer's specifications	PV7	4.8	A	3.4.3.9	In areas where module operating temperatures significantly exceed NOCT, manufacturer's data should be consulted to determine the current in such conditions. Module current can be significantly diminished by high temperatures due to changes in the IV curve.
Manufacturer's tolerance on current output		From manufacturer's specifications	PV8	5%		3.4.3.7	
Derating factor for soiling	f_{dirt}	Design decision	PV9	95%		3.4.3.7	Depends on site conditions

NOTE: This work-sheet assumes the use of standard (switched) regulators only, not maximum power point tracking regulators.

Penentuan Ukuran Komponen

TABLE A8-2

PHOTOVOLTAIC ARRAY AND REGULATOR SIZING AND SELECTION (PART 2)

Item	Symbol	Source[1]	Ref.	Worst month	Best month	Annual average	Units	Refer Clause	Notes
Irradiation on tilted plane	H_{tilt}	From DM1	PV10	4.8	5.6	5.5	h	3.2.2	
Design load energy for array sizing		From DM2	PV11	3846	3265	3555	Wh		
Design load Ah		$\frac{PV11}{M8}$	PV12	160	136	148	Ah		
Required array output		$\frac{PV12}{PV2}$	PV13	178	151	165	Ah		
Daily charge (Ah) output per module		(1-PV8) × PV7 × PV9 × PV10	PV14	20.8	24.3	23.7	Ah	3.4.3.9	
Number of parallel strings required		$\frac{PV13 \times PV1}{PV14}$	PV15	8.6	6.2	6.9		3.4.3.11	
Number of parallel strings used	N_p	Design decision, based on PV15 data	PV16	7				3.4.3.11 3.1.6	
Nominal solar fraction for design month	f_{sol}	$\frac{PV16}{PV15}$	PV17	82%	112%	101%		1.3.46 3.4.6	Solar fractions of approximately 90% or above, should be treated with some caution.

1 Values for DM1 and DM2 are from Table A5. Value for M8 is from Table A4.

Penentuan Ukuran Komponen

TABLE A8-3

PHOTOVOLTAIC ARRAY AND REGULATOR SIZING AND SELECTION (PART 3)

Item	Symbol	Source[1]	Ref.	Value	Units	Refer Clause	Notes
Number of series modules per string	N_s	$\frac{M8}{PV5}$	PV18	2			
Total number of modules in array	N	PV16 × PV18	PV19	14			
Regulator current rating required		PV6 × PV16 × 1.25	PV20	45.5	A	3.4.8.2	
Selected regulator		Brand and model	PV21	REG 30-Deluxe		3.4.8.2	Large arrays may need to be split into sub-arrays. Considerations are— (a) availability of high current regulators; (b) improved fault tolerance; and (c) more staged battery charging.
Regulator current rating		From manufacturer's specifications	PV22	30	A	3.4.8.2	
Number of regulators/sub-arrays required		$\frac{PV20}{PV22}$, rounded up	PV23	2			

1 Value for M8 is from Table A4.

Penentuan Ukuran Komponen

TABLE A9

BATTERY CHARGER SIZING AND SELECTION (SEE CLAUSE 3.4.10)

Item	Symbol	Source	Ref.	Value	Units	Refer Clause	Notes
10 h rate capacity of selected cell/block		From manufacturer's specifications	BC1	380	Ah	3.4.10.2	For parallel system: Values BC1 to BC4 may be used as a check against inverter charging capacity.
10 h rate capacity of battery bank	C_{10}	BC1 × B12[1]	BC2	760	Ah	3.4.10.2	
10 h charge rate for battery Bank	I_{10}	$\frac{BC2}{10}$	BC3	76	A	3.4.10.2	
Recommended max. charging current		From manufacturer's specifications	BC4	100	A		
Selected battery charger		Brand and model	BC5	ABC 75-24		3.4.10.1	For parallel systems, the inverter also performs battery charging.
Selected charger capacity	I_{bc}	From manufacturer's specifications	BC6	75	A		For parallel systems, these cells are determined by the inverter's charging capacity, or that portion of the charging capacity that is used.
Selected charger nominal efficiency	η_{bc}	From manufacturer's specifications	BC7	70%			
Selected charger nominal power factor	pf_{bc}	From manufacturer's specifications	BC8	0.8			
Max. charge voltage at typical max. output current	V_{bc}	Typically 2.4 V per cell × B13[1]	BC9	28.8	V	3.4.7.4 3.4.10.3	
Battery charger max. apparent power	S_{bc}	$\frac{BC6 \times BC9}{(BC7 \times BC8 \times 1000)}$	BC10	3.9	kVA	3.4.10.3	

1 Values for B12 and B13 are from Table A7.

Penentuan Ukuran Komponen

TABLE A10

GENERATING SET SIZING AND SELECTION (SEE CLAUSE 3.4.11)

Item	Symbol	Source[1]	Ref.	Value	Units	Refer Clause	Notes
Alternator surge ratio		Typically 2.5	G1	250%		3.4.11.3 3.4.11.4	
Generating set oversize factor	f_{go}	Minimum and typical 10%	G2	1.1		3.4.11.2 3.4.11.4	
Maximum ambient temperature during operation		See note	G3	45	°C	3.4.11.5	Maximum ambient temperature should account for temperature rise within the generating set enclosure (if any), as well as climate.
Derating factor for temperature		From manufacturer's specifications	G4	0.5%	per °C above reference	3.4.11.5	Data from Table 4 may be used in the absence of manufacturer's data.
Reference temperature		From manufacturer's specifications	G5	25	°C	3.4.11.5	
Derating for temperature		If G3>G5, then 1-(G3-G5) × G4, otherwise 1	G6	0.9		3.4.11.5	
Max. humidity		From manufacturer's specifications	G7	50%		3.4.11.5	
Derating factor for humidity		From manufacturer's specifications	G8	1.0%	per 10% above reference	3.4.11.5	Data from Table 4 may be used in the absence of manufacturer's data.
Reference humidity		From manufacturer's specifications	G9	60%		3.4.11.5	
Derating for humidity		If G7>G9, then $\{1-\frac{(G7-G9)\times G8}{0.1}\}$, otherwise 1	G10	1		3.4.11.5	For consistency, humidity has been treated as a fraction (see Clause A2.2)
Altitude		Depends on location	G11	500	m	3.4.11.5	
Derating factor for altitude		From manufacturer's specifications	G12	1%	per 100 m above reference	3.4.11.5	Data from Table 4 may be used in the absence of manufacturer's data.
Reference altitude		From manufacturer's specifications	G13	300	m	3.4.11.5	
Derating for altitude		If G11>G13, $1-\frac{(G11-G13)\times G12}{100}$	G14	0.98		3.4.11.5	
Total derating factor for temperature, humidity and altitude		G6 × G10 × G14	G15	0.88		3.4.11.5	

(continued)

Penentuan Ukuran Komponen

TABLE A10 *(continued)*

Item	Symbol	Source[1]	Ref	Value	Units	Refer Clause	Notes
Series system:							
Suggested minimum generating set rating	S_{gen}	$\frac{BC10 \times G2}{G15}$	G16	4.8	kVA	3.4.11.2	
OR							
Switched system:							
Apparent power to run loads while charging		See note	G17	1.8	kVA	3.4.11.3	Equals some portion of maximum demand, depending on load management considerations. In this example, the vacuum cleaner, water pump and television are on (i.e. computer is excluded). See Table A3.
Load surge while charging		See note	G18	6.8	kVA	3.4.11.3	Equals some portion of surge demand, depending on load management considerations. In this example, the vacuum has the highest surge and the water pump and television are taken at running demand (computer is excluded). See Table A3.
Required generating set rating (based on maximum demand calculations)		$\frac{(BC10 + G17) \times G2}{G15}$	G19	7.1	kVA	3.4.11.3	
Required generating set rating (based on surge calculations)		$\frac{(BC10 + G17) \times G2}{G1 \times G15}$	G20	5.3	kVA	3.4.11.3	
Suggested min generating set rating	S_{gen}	The larger of G19 and G20	G21	7.1	kVA	3.4.11.3	
OR							
Parallel system:	*Parallel system calculations are not considered in this worked example since a different inverter would be required.*						
Minimum generating set rating (based on maximum demand calculations)		$\frac{(AC11 - IN9) \times G2}{G15 \times 1000}$	G22	N/A	kVA	3.4.11.4	Not applicable as value is negative.
Minimum generating set rating (based on surge calculations)		$\frac{(AC12 - IN11) \times G2}{G1 \times G15 \times 1000}$	G23	N/A	kVA	3.4.11.4	
Minimum generating set rating (based on battery charging requirements)		$\frac{BC10 \times G2}{G15}$ + allowance for load	G24	N/A	kVA	3.4.11.4	Not applicable as data in Table A9, cells BC5 to BC10 must have appropriate data from interactive inverter specifications
Suggested min. generating set rating	S_{gen}	The largest of G22, G23 and G24	G25	N/A	kVA	3.4.11.4	

NOTE: Use of cells G16 to G25 is dependent on system configuration (refer cell M10 in Table A4).

(continued)

Penentuan Ukuran Komponen

TABLE A10 *(continued)*

Item	Symbol	Source[1]	Ref.	Value	Units	Refer Clause	Notes
Generating set selection							
Selected generating sets		Make and model	G26	XYZ 6.5			There may be a minimum size restriction for generating set in parallel systems. See Clause 3.4.11.4, Note.
Generating set rating		From manufacturer's specifications	G27	6.5	kVA		
Monthly generating set run time (see Clause 3.4.11.6)							
Generating set run time for equalizing charge		$\frac{B18 \times 30}{B17}$	G28	6.5	hours per month	3.4.11.6	
Worst month							
Generating set run time required for maintaining full SOC		If $PV17_{worst} < 100\%$, then $\frac{(1 - PV17_{worst}) \times PV11_{worst} \times 30}{BC6 \times PV2 \times M8}$, otherwise 0	G29	13	hours per month	3.4.11.6	
Nominal generating set run time	T_{gen}	G29 + G28	G30	19.5	hours per month	3.4.11.6	This is a nominal figure only. Actual operating conditions will affect.
Best month							
Generating set run time required for maintaining full SOC		If $PV17_{best} < 100\%$, then, $\frac{(1 - PV17_{best}) \times PV11_{best} \times 30}{BC6 \times PV2 \times M8}$, otherwise 0	G31	0	hours per month	3.4.11.6	
Nominal generating set run time	T_{gen}	G31 + G28	G32	6.5	hours per month	3.4.11.6	This is a nominal figure only. Actual operating conditions will affect.

1 Values for AC11 and AC12 are from Table A3. Values for M8 is from Table A4. Values for IN9 and IN11 are from Table A6. Values for B17 and B18 are from Table A7. Values for PV2, $PV11_{best}$, $PV11_{worst}$, $PV17_{best}$ and $PV17_{worst}$ are from Table A8. Values for BC6 and BC10 are from Table A9.

Penentuan Ukuran Komponen

TABLE A11

BATTERY VENTILATION (FROM AS 4086.2)

Item	Symbol	Source[1]	Ref	Value	Units	Notes
Maximum charge rate of battery (from all sources)		BC6 + PV7 × PV16	V1	108.6	A	
Minimum exhaust ventilation rate		0.003 × V1 × M8	V2	78.2	L/s	
Minimum vent area for natural ventilation		100 × V2	V3	782	cm^2	

1 Value for M8 is from Table A4. Value for BC6 is from Table A9. Values for PV7 and PV16 are from Table A8.

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