

References

- Apiwawamu Rata Nagamu 2010, 'Rice sector development in Sri Lanka', viewed 06 March 2013
http://www.agridept.gov.lk/images/stories/site/PDF/Projects/AWRN/Rice_AWRN.pdf
- Shukia, B D Srivastava, P K Ram, & Gupta, K 1992, 'Oil seed processing technology', *Central Institute of Agriculture Engineering*, India.
- Bureau of Energy Efficiency 2011, 'Manual on energy conservation measure in rice mill cluster Warangal', *Ministry of Power*, Government of India
- Central Bank of Sri Lanka 2011, Annual Report 2011.
- Ceylon Electricity Board 2011, 'Statistical Digest'
- Ceylon Electricity Board 2013b, 'Tariff 2013 April', <http://www.pucsl.gov.lk>
- Ceylon Electricity Board 2013a, Allowed charges for 2012, Viewed 2 April 2013.
<http://www.ceb.lk/download/residence/CEBAllowedCharges2012byPUCSL.pdf>
- CMG Motors 2004, 'PPA & PPC Series High Efficiency cast Iron Motors Specification (4th Edition)'.
 www.lib.mrt.ac.lk
- Rhodes, C 2013a, Small business and the UK economy, *Economics Policy and Statistic*, House of Commons Library, United Kingdom
- Rhodes, C 2013b, 'United States Agency for International Development (USAID)', 2003, Economic Impact of Poor Power Quality on Industry Sri Lanka, USAID--SARI/Energy Program.
- Manike, D 2005, 'Role of Bank in Financing of Small Scale Industries in Sri Lanka: A Case Of Smile I & II Loan Scheme', *International Conference on Management and Finance*, University of Colombo 2009.
- Department of Census and statistic 2012a, Paddy, 'Annual survey of Industries 2010', viewed 08 April 2013, <http://www.statistics.gov.lk/>
- Department of Census and statistic 2012b, Paddy, 'Statistics- Extent Sown, Harvested, Average yield and Production by District- 2011 Yala', viewed 04 April 2013, <http://www.statistics.gov.lk/agriculture/Paddy%20Statistics/PaddyStatsPages/ProvisionalEstimatesYala2011MT.pdf>

De Silva, AM & Yamao, M 'Rice pinch to war thrown nation: an overview of the rice supply chain of sri lanka and the consumer attitudes on government rice risk management', *The Journal of Agricultural Sciences*, Volume 4. No 2 2009 May

Ekasilp, W, Soponronnarit, S & Therdyothin, A. 1995, 'Energy analysis in white rice and par-boiled mills for cogeneration in Thailand'. *RERIC International Energy Journal*, 1995.

Electric & Machinery (PTE) Ltd 2006, AEEB.AEVB Series High Efficiency, IP55 Three-Phase cage Induction Motors, TECO.

Fernando, MTN Marikkar JMN Jayalath, KVNN & Subasinghe, SDJ 2002, 'Financial analysis of coconut oil extraction using locally manufactured baby expellers', COCOS (2000-2002), *Coconut Research Institute*, Lunuwila, Sri Lanka.

Gamawelagedara, WC Wickramasinghe, YM & Dissanayake, CAK 2006, 'Impact of rice processing villages on house hold income of rural farmers in Anuradhapura district' , *The Journal of agricultural Sciences*, volume 6, No. 02 may 2011

Global Agricultural information Network 2011, *Grain and Feed Annual*, India.

International Energy Agency 2008, 'Worldwide trends in Energy use and efficiency', France.

Leng, RA, 2008, 'Peak Oil, resource depletion, global warming, financial stress and future world food and feed production', *Livestock Research for Rural Development*, Volume 20, Number 1, January 2008

Nanayakkara, G, 2011,' Enhancing the capacity of banks to shaping development of SMEs', *Studies Postgraduate Institute of Management*, 23rd anniversary convention.

Palipane, KB 2000, 'Milling and quality improvement in rice, Rice congress 2000', *Department of Agriculture Peradeniya*, Sri Lanka.

Kumar, P, 2010, 'Training Manual on Energy Efficiency for small and medium Enterprises', *Asian Productivity Organization*, Japan.

Public utility Commission 2012, 'Allowed charges for 2012', Ceylon Electricity Board (CEB), viewed 02 April 2013, <http://www.pucsl.gov.lk>

Samarajeewa, S & Gunathilake, HM, 2010, 'Consumer demand for coconut oil', *Coconut Research Institute of Sri Lanka*.

Wickremasinghe, SI, 2011, 'The status of SMEs in Sri Lanka and promotion of their innovation output through networking of S & T institutions, National Science Foundation', *Tech Monitor*, July- August 2011.

Rockwell Automation 1996, 'Application basics of operation of three-phase induction motors'.

Sri Lanka Sustainable Energy Act 2007, *Gazette of the democratic socialist republic of Sri Lanka*, 2007.

Task force 2003,' National strategy for small and medium enterprises sector development in Sri Lanka – white Paper, Task Force for small and medium enterprises development program, Colombo, *Institute of Policy Studies*, View date 25 March 2013.

http://www.ips.lk/publications/state_of_economy_report.html

Vision 2030, 2011, *Central Rice Institute*, Odisha, India.



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Appendix I

Four Poles CMG brand electric motors present prices on April 2013

Capacity (kW)	Type of motor	
	General	High Efficient
4.0	47,040.00	79,968.00
5.5	59,360.00	100,912.00
7.5	69,440.00	118,048.00
11.0	106,400.00	180,880.00
15.0	123,200.00	209,440.00
18.5	155,680.00	264,656.00
22.0	168,000.00	285,600.00
30.0	268,800.00	456,960.00



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Source: SM International (Pvt), Bambalapitiya

Appendix II

CMG brand high efficient four poles motors specifications

KW	Motor frame	Speed [r/min]	Efficiency [%] at % full load			Power factor [cos φ] at % full load			Current			Torque				Moment of Inertia J=½GD2 [kg·m²]	Weight of foot mount motor [kg]	
			100	75	50	100	75	50	Full load I _N [A]	Locked rotor I _L /I _N	t _e ¹⁾ time [sec]	Full load T _N [Nm]	Locked rotor T _L /T _N	Pull up T _U /T _N	Break down T _B /T _N			
1500 r/min = 4 poles																		
0.55	80A	- 19	1440	81.0	80.4	77.0	0.71	0.62	0.49	1.4	8.4	30	3.6	2.7	2.5	3.0	0.00020	21
0.75	80B	- 19	1445	83.1	82.4	79.2	0.72	0.63	0.50	1.8	7.4	28	5.0	3.3	3.0	3.4	0.00025	23
1.1	90S	- 24	1440	85.7	85.7	83.7	0.77	0.7	0.57	2.4	7.7	35	7.3	3.3	2.6	3.2	0.0005	30
1.5	90L	- 24	1440	85.8	85.7	83.6	0.76	0.68	0.55	3.2	7.9	25	9.9	3.5	2.8	3.2	0.0006	34
2.2	100LA	- 28	1455	86.9	86.7	84.8	0.84	0.78	0.66	4.3	8.4	22	14.4	3.7	3.4	4.9	0.0007	40
3	100LB	- 28	1455	87.6	87.6	85.9	0.84	0.79	0.68	5.7	8.5	17	19.7	2.7	2.4	3.3	0.0009	50
4	112M	- 28	1445	87.7	88.3	87.7	0.88	0.83	0.74	7.3	7.8	13	26.4	2.7	2.5	3.1	0.002	57
5.5	132S	- 38	1460	89.7	90.1	89.2	0.83	0.78	0.65	10.3	7.3	13	36.0	2.0	1.8	3.1	0.003	95
7.5	132M	- 38	1465	91.0	91.4	90.6	0.83	0.77	0.64	13.8	8.7	12	48.9	1.8	1.6	3.3	0.007	98
11	160M	- 42	1470	91.8	92.0	91.1	0.85	0.82	0.74	19.6	7.1	20	71.5	2.3	1.6	2.6	0.089	141
15	160L	- 42	1470	91.8	91.7	90.7	0.84	0.81	0.73	27.0	7.6	10	97.4	2.6	1.6	2.7	0.103	163
18.5	180M	- 48	1475	92.3	92.7	92.2	0.88	0.85	0.81	32.0	7.3	10	120	2.5	1.8	2.9	0.16	195
22	180L	- 48	1475	92.7	93.1	92.8	0.91	0.88	0.81	36.5	7.4	10	142	2.3	1.7	2.8	0.18	215
30	200L	- 55	1480	93.9	93.9	93.2	0.89	0.84	0.75	51	7.9	15	194	2.4	2.0	3.2	0.31	293
37	225S	- 60	1485	94.6	94.6	93.9	0.90	0.88	0.82	61	8.1	20	238	2.4	1.7	2.9	0.53	370
45	225M	- 60	1485	94.5	94.5	93.9	0.90	0.87	0.81	74	8.1	13	289	2.1	1.7	2.4	0.58	395
55	250S	- 70	1480	94.5	94.8	94.3	0.90	0.90	0.88	90	7.5	13	355	2.5	1.7	2.7	0.79	487
75	250M	- 70	1485	94.8	94.9	94.4	0.91	0.89	0.81	122	7.9	7	482	2.9	2.0	3.0	0.90	536
90	280S	- 80	1489	95.2	95.2	94.5	0.91	0.89	0.84	145	7.0	13	577	2.5	1.9	3.0	1.60	692
110	280M	- 80	1492	95.9	95.9	95.1	0.92	0.90	0.86	174	7.2	7	704	2.4	2.1	3.1	1.89	787
132	315S	- 85	1486	95.6	95.5	94.7	0.87	0.85	0.80	220	7.9	15	848	2.3	1.8	2.6	2.73	1100
150	315M	- 85	1485	95.7	95.7	95.0	0.87	0.86	0.81	250	8.3	15	964	2.2	1.2	2.6	3.04	1135
185	315LA	- 85	1487	96.2	96.3	95.6	0.90	0.89	0.80	298	7.8	8	1185	2.4	1.3	2.5	3.43	1280
200	315LB	- 85	1486	95.6	95.8	95.1	0.88	0.86	0.80	330	9.0	7	1287	2.4	1.3	2.7	3.62	1330
220	315LC	- 85	1485	95.9	95.9	95.4	0.89	0.87	0.81	381	7.5	7	1415	2.4	1.3	2.7	3.89	1400
250	315LX	- 85	1485	95.9	95.9	95.3	0.88	0.86	0.81	412	8.9	7	1608	2.4	1.4	2.7	4.14	1480
280	355LA	- 110	1489	96.1	95.8	95.0	0.84	0.79	0.73	483	4.9	10	1795	1.6	1.3	2.3	7.82	2080
315	355LB	- 110	1490	96.6	96.5	95.9	0.87	0.86	0.79	520	5.3	10	2019	1.5	1.3	2.4	8.27	2125
355	355LC	- 110	1489	96.5	96.5	95.9	0.88	0.87	0.81	580	5.0	9	2277	1.5	1.3	2.4	8.90	2240
400	355LD	- 110	1490	96.3	96.1	95.3	0.88	0.86	0.80	658	5.1	8	2564	1.4	1.4	2.4	9.76	2340
450	355LX	- 110	1491	97.0	97.0	96.5	0.88	0.86	0.79	734	5.5	8	2882	1.7	1.5	2.6	10.76	2510
500	400LA	- 110	1494	96.9	96.7	96.0	0.88	0.87	0.81	813	5.8	7	3196	1.9	1.6	2.8	18.68	3010
560	400LB	- 110	1490	96.8	96.9	96.7	0.87	0.87	0.83	925	5.2	9	3589	1.7	1.5	2.5	19.70	3200
630	400LX	- 110	1490	96.9	97.0	96.8	0.87	0.86	0.82	1040	5.4	11	4038	1.5	1.2	2.5	21.64	3320
800	450L	- 125	1492	96.8	96.3	95.3	0.89	0.87	0.82	780 ²⁾	6.7	-	5121	1.7	1.3	3.0	37.1	5700
1000	450L	- 125	1495	96.9	96.4	95.3	0.90	0.88	0.82	960 ²⁾	6.6	-	6401	1.6	1.2	3.0	46.4	6100
PPC series 415V 50Hz																		
37	225S	- 60	1485	94.6	94.6	93.9	0.90	0.88	0.82	61	7.7	20	238	2.4	1.7	2.9	0.53	370
45	225M	- 60	1485	94.5	94.5	93.9	0.90	0.87	0.81	74	7.8	13	289	2.1	1.7	2.4	0.58	395
55	250M	- 65	1480	94.5	94.8	94.3	0.90	0.90	0.88	90	7.1	13	355	2.5	1.7	2.7	0.79	487
75	280S	- 75	1485	94.9	94.8	94.2	0.90	0.89	0.84	123	6.9	13	482	2.9	2.0	2.9	0.92	655
90	280M	- 75	1489	95.2	95.2	94.5	0.91	0.89	0.84	145	7.4	13	577	2.5	1.9	3.0	1.60	692
110	315S	- 80	1484	95.3	95.3	94.5	0.86	0.83	0.77	188	6.6	25	708	2.0	1.3	2.5	1.96	985
132	315MA	- 80	1486	95.6	95.5	94.7	0.87	0.85	0.80	220	6.9	13	848	2.3	1.2	2.6	2.73	1100
160 ³⁾	315MB	- 80	1485	95.6	95.7	95.0	0.87	0.86	0.81	268	6.6	15	1029	2.0	1.1	2.4	3.04	1135
200	355LA	- 100	1488	96.0	95.8	95.1	0.87	0.84	0.78	335	7.5	10	1284	2.3	1.3	2.7	3.62	1480
225	355LC	- 100	1485	95.7	95.8	95.6	0.87	0.85	0.78	376	7.1	10	1447	2.4	1.3	2.7	3.89	1500
250	355LD	- 100	1487	96.1	96.1	95.6	0.87	0.85	0.80	416	7.6	10	1606	2.5	1.4	2.7	4.14	1630
280	355LE	- 100	1485	95.8	95.8	95.4	0.88	0.86	0.80	462	5.3	10	1801	1.5	1.3	2.4	7.82	2080

¹⁾ t_e time applies to Ex e motors only (see page 24)

²⁾ For the hazardous location version the rating will be 150kW and performance data as per PPA

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³⁾ Current at 690V 50Hz
Notes on page 15 also apply.
CMG Motors | PPA 0811 (edition 4.3.0)

Source: CMG motors Product catalog, 4th edition.

Appendix III

TECO brand general four poles motors specifications

4 Poles 50 Hz, Synchronous Speed 1500 rpm, Class F insulation, S1 (MCR) Duty, Efficiency Class EFF2

Output		Full Load Speed (RPM)	Frame Size	% Efficiency			% Power Factor			Full-load Current			LRC FLC	Torque			Rotor GD ² (Kg-m ²)	Cast Iron frame motor Wt (Kg)	A1 frame motor Wt (Kg)
KW	(HP)			Full Load	75% Load	50% Load	Full Load	75% Load	50% Load	380V (A)	400V (A)	415V (A)		FLT Kg-m	LRT FLC (%)	BDT FLC (%)			
0.12	0.16	1320	63M	57	57.5	53.5	72	62.5	49	0.44	0.42	0.41	440	0.088	210	220	0.001	---	4.8
0.18	0.25	1320	63M	60	61	57.5	73	63.5	50	0.62	0.59	0.57	440	0.133	210	220	0.002	---	5
0.25	0.33	1350	71M	65	65	61.5	74	63.5	49	0.79	0.75	0.72	520	0.18	210	220	0.003	---	6.3
0.37	0.50	1340	71M	67	68	64.5	75	65	49.5	1.12	1.06	1.03	520	0.269	210	220	0.003	---	6.5
0.55	0.75	1390	80M	71	71.5	68	75	65.5	50.5	1.57	1.49	1.44	520	0.385	240	230	0.005	15	9.5
0.75	1	1380	80M	74.5	75	73	76	66.5	52	2.01	1.91	1.85	600	0.529	230	230	0.007	16	10
1.1	1.5	1395	90S	76.2	76.5	74	77	68	52.5	2.85	2.71	2.61	600	0.767	230	230	0.009	22	11
1.5	2	1390	90L	78.5	79.5	78	79	70	55.5	3.67	3.5	3.37	600	1.05	230	230	0.013	27	15.5
2.2	3	1410	100L	81	82	80.5	81	73.5	59.5	5.09	4.85	4.67	700	1.518	230	230	0.024	34	20
3	4	1410	100L	82.6	83.5	83	82	75.5	62.5	6.73	6.4	6.17	700	2.07	230	230	0.032	35	23.5
4	5.5	1435	112M	84.2	85	84	82	75.5	62	8.8	8.37	8.07	700	2.712	230	230	0.052	44	30
5.5	7.5	1440	132S	85.7	86	85	83	78	68	11.7	11.2	10.8	700	3.716	230	230	0.106	61	40
7.5	10	1440	132M	87	87.5	86.5	84	79.5	69.5	15.6	14.8	14.3	700	5.068	230	230	0.146	73	51
11	15	1460	160M	88.5	89.5	89	85.5	80.5	69.5	22.1	21	20.2	700	7.331	220	290	0.332	113	---
15	20	1465	160M	90.3	90.5	90	85.5	80.5	71	29.5	28	27	700	9.967	220	310	0.442	133	---
18.5	25	1470	180M	90.7	91	90	86	81.5	71	36	34.2	33	750	12.25	220	260	0.607	167	---
22	30	1470	180M	91.5	91.5	90.5	86	81.5	71	42.5	40.4	38.9	750	14.56	220	270	0.679	181	---
30	40	1475	200M	92	92	91.5	87	83	64	56.9	54.1	52.1	720	19.79	220	260	1.111	232	---
37	50	1480	225S	92.7	92.5	92	87.5	84.5	76.5	69.3	65.8	63.5	720	24.33	220	230	1.911	287	---
45	60	1480	225M	93.3	93	92.5	87.5	84	75.5	83.7	79.6	76.7	720	29.58	220	250	2.335	322	---
55	75	1480	250M	93.3	93	92.5	87.5	84.5	76.5	102	97.2	93.7	720	36.16	220	230	2.755	385	---
75	100	1485	280S	93.6	93.5	92.5	88.5	86.5	80	138	131	126	720	49.14	220	230	5.123	510	---
90	125	1485	280M	94.4	94	93	88	85	76.5	165	156	151	720	58.97	220	260	6.433	600	---
110	150	1485	315S	94.7	94.5	93.5	89.5	87.5	81.5	197	187	181	690	72.07	210	220	12.412	930	---
132	175	1485	315M	94.8	94.5	94	89.5	87.5	81	236	225	216	690	86.49	210	220	13.963	1010	---
160	215	1485	315L	95	94.5	94	90	88.5	83.5	284	270	260	690	104.8	210	230	16.401	1070	---
200	268	1485	315L	95.2	95	94.5	90	89	84	355	337	325	690	131	210	220	19.282	1170	---
250	335	1490	355M	95.5	95	94.5	91	90	86	437	415	400	690	163.3	210	220	31.752	1720	---
315	422	1490	355L	95.8	95.5	94.5	91.5	91	87.5	546	519	500	690	205.7	210	220	39.311	1870	---

Note :

1. FLC = full-load current, LRC = locked rotor current.
FLT= full-load torque, LRT = locked rotor torque, BDT=breakdown torque or pull-out torque
2. Tests and performance tolerances are in accordance with EN60034
3. To obtain the ampere values of 220V 50Hz, multiply the 380 volt values by the factor of 1.73
4. Aluminium frame motors AEAUVK (foot-mounted) , AEGVUK (flange-mounted) and AEAUVUP (Foot and flange mounting) are up to frame size 132M only
Cast iron frame motors (Model AEEVUK, AEUVUK and AEEVUP) are from frame size 80 through 355L
5. Weights shown above are for foot-mounted motor.
6. Data is subject to change without prior notification.

Source: TECO motors three phase low voltage squirrel cage motor Product catalog.

Appendix IV

Format of data collection form in the field level

Questionnaire for Data collection

1. Owner of business.....
2. Name of mills:.....
3. Address:.....
4. Products:.....
5. Raw materials:.....
6. Type of machine:.....
7. Land ownership:
8. Investment:.....
9. Loans:.....
10. Numbers of employments:.....
11. Started date business:.....
12. Monthly product:.....
13. Monthly energy cost.....
14. Energy consumption variation on quality of product.....
15. Tariff category:.....
16. General running time:.....
17. Possibility of stop at the peak hours.....
18. Distance from the Transformer.....
19. Technology of machine:.....
20. Technology acquiring methods:.....
21. Present price of product/byproducts:.....
22. 12 months electricity bill:.....
23. 12 months production:.....
24. Data logging
 - a. Date.....b. Time.....c. Input.....
 - d. Output.....e. Logged file.....

Other details

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.....
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