

(Wind Pump)
(Shallow

-(Wind Turbine) :
(Wind Energy Potential)

Boreholes)

(WIND TOOL

()

)

»

«

(CFD)

()



Data Logger

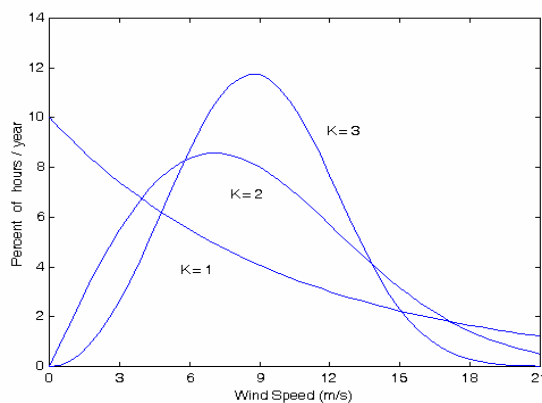
()

()

(h)

() C () K
v

$$h(v) = \left(\frac{K}{C}\right) \left(\frac{v}{C}\right)^{K-1} e^{-\left(\frac{v}{C}\right)^K} \quad \text{for } 0 < v < \infty \quad ()$$



K=

C=

(K=)

(K=)

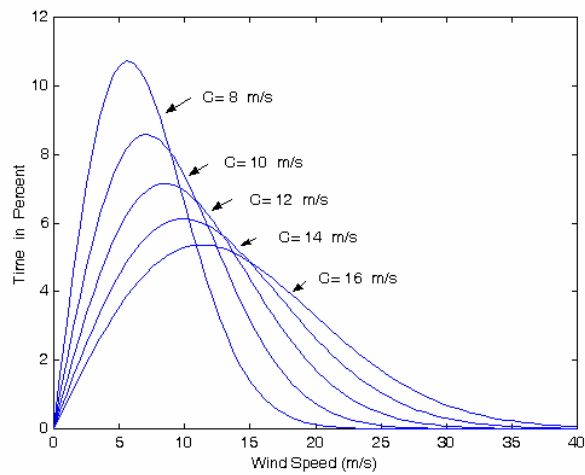
(v = 0)

(K=)

K

1 - Weibull

C . C K=



K=

/ /

(C,K)

K C

K c

P(v) v

p(v)

()

v

:

$$\int_0^v p(V)dV + \int_v^{\infty} p(V)dV = 1 \quad ()$$

: P(V)

$$\int_v^{\infty} p(V)dV = 1 - P(V) \quad ()$$

$$e^{-\left(\frac{V}{C}\right)^K} = 1 - P(V) \quad (1)$$

$$P(V) = 1 - e^{-\left(\frac{V}{C}\right)^K} \quad (2)$$

$$-\left(\frac{V}{C}\right)^K = \log[1 - P(V)] \quad (3)$$

$$K \log(V) - K \log(C) = \log\{-\log[1 - P(V)]\} \quad (4)$$

$$x = \log(V) \quad , \quad y = \log\{-\log[1 - P(V)]\} \quad (5)$$

$$B = -\log(C) \quad A = K \quad y = Ax + B \quad (6)$$

$$C = e^{-\frac{B}{A}} \quad , \quad K = A \quad (7)$$

$$y = Ax + B \quad A \quad (8)$$

WIND TOOL

WIND TOOL

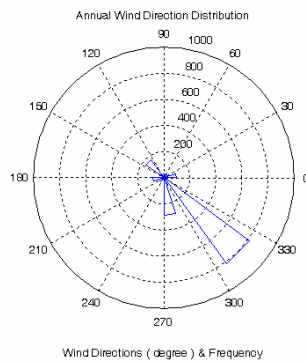
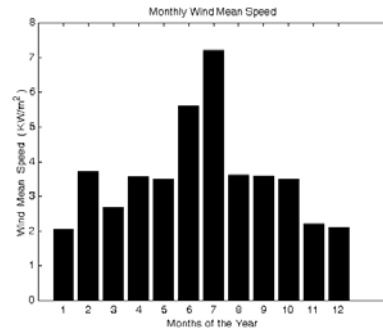
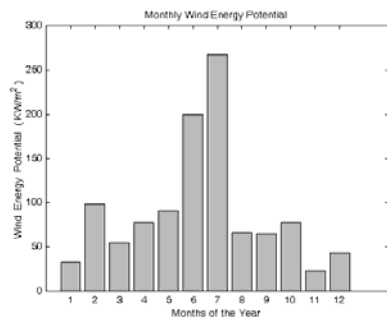
WIND TOOL

$$Y = AX + B \quad (Linear Regression)$$

WIND TOOL

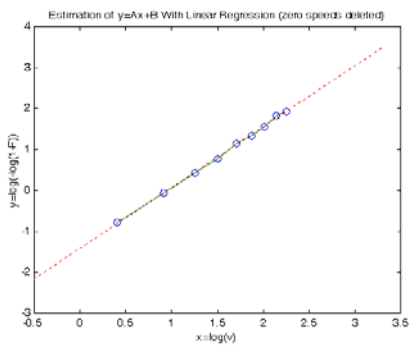
WIND TOOL

Iran Wind Data Analysis (IWDA)



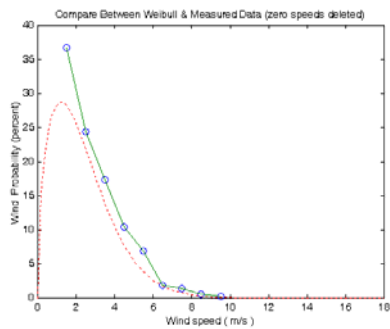
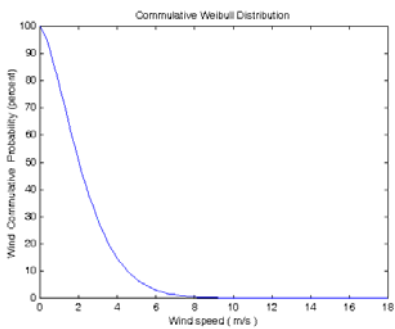
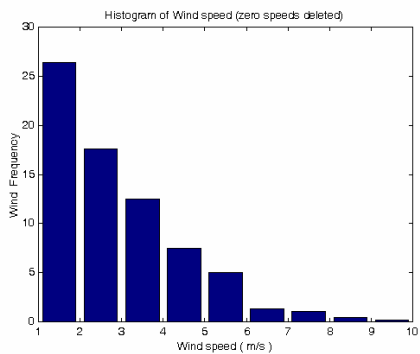
WIND TOOL

(
(
(
(
(
(



$$Y=AX+B$$

y x



جایگزینی انرژی باد به جای ... / حامد هوری جعفری و ...

نشریه انرژی ایران / سال هفتم / شماره ۱۵ / آبان ۱۳۸۱

()

()

()

() ()

1- Unit Hydrograph

)
()
()

(

جایگزینی انرژی باد به جای ... / حامد هوری جعفری و ...

نشریه انرژی ایران / سال هفتم / شماره ۱۵ / آبان ۱۳۸۱

جایگزینی انرژی باد به جای ... / حامد خوری جعفری و ...

نشریه انرژی ایران / سال هفتم / شماره ۸۵ / آبان ۱۳۸۱



)

(W/m²

W/m²

()

W/m² m/s

W/m² / m/s

جایگزینی انرژی باد به جای ... / حامد هوری جعفری و ...

نشریه انرژی ایران / سال هفتم / شماره ۱۵ / آبان ۱۳۸۱

W/m^2 m/s

W/m^2

m/s

W/m^2

$/ m/s$

Station	Wind Mean Speed (m/s)	Wind Mean Energy Potential (W/m ²)	Number of Shallow boreholes	Maximum Depth (m)	Mean Flow Rate (m ³ /h)
ABADAN	2.3	32.3	**	**	**
ABADEH	2.2	49.5	**	**	**
ABALI	1.8	34.3	TEH.	TEH.	TEH.
AHAR	2.6	39.0	1045	36.00	5.90
AHVAZ	2.5	25.5	18	18.52	5.00
ALESHTAR	2.1	26.2	13	**	**
ALIGOODARZ	4.6	74.20	483	45.00	7.00
ANAR	2.5	47.9	**	**	**
ARAK	1.1	13.3	1522	**	10.80
ARDEBIL	4.6	161.7	1779	29.00	5.13
ARDESTAN	3.6	90.8	15	49.00	5.10
ASTARA	0.9	5.50	**	**	**
AVAJ	4.2	83.80	626	70.00	3.00
BABOLSAR	1.8	12.2	24767	24.00	3.80
BAFGH	1.6	13.0	133	64.00	13.40
BAFT	2.9	57.4	17	40.00	10.80.
BAM	2.6	37.5	KER.	KER.	KER.
BANDAR ABASS	2.5	23.2	**	**	**
BANDAR ANZALI	1.9	22.2	**	**	**
BANDAR DAIER	2.9	76.8	636	85.00	8.80
BANDAR LENGEH	2.5	31.3	218	70.00	7.03
BANDAR MAHSHAHR	3.2	60.8	**	**	**
BEHBAHAN	1.2	9.13	153	14.00	12.63
BIRJAMAND	2.4	44.0	21	13.00	2.00
BIJAR	4.5	94.50	879	20.00	4.00
BIRJAND	2.0	25.8	44	52.00	2.50
BOJNURD	2.3	50.8	478	50.00	2.71
BOROOJEN	3.0	36.6	81	48.00	5.00
BOSHROOYEH	0.9	7.30	25	45.00	12.70
BOSTAN	2.6	30.0	**	**	**
BROUJERD	3.8	65.3	664	45.00	6.50
BUSHEHR	2.0	25.0	**	**	**

جایگزینی انرژی باد به جای ... / حامد هوری جعفری و ...

نشریه انرژی ایران / سال هفتم / شماره ۱۵ / آبان ۱۳۸۱

Station	Wind Mean Speed (m/s)	Wind Mean Energy Potential (W/m ²)	Number of Shallow boreholes	Maximum Depth (m)	Mean Flow Rate (m ³ /h)
BUSHEHR COASTAL	4.4	135.56	**	**	**
CHAHBAHAR	3.9	55.8	25	40.00	5.00
CHITGAR	1.1	14.2	TEH.	TEH.	TEH.
DARAN	1.9	36.2	192	48.00	5.60
DEHLORAN	1.3	9.40	**	**	**
DEZFUL	1.3	12.3	96	15.00	20.69
DOGONBADAN	2.0	36.0	32	25.00	8.00
DOUSHAN TAPPEH	1.9	14.3	TEH.	TEH.	TEH.
EGHLIDE FARS	4.3	209.9	289	90.00	7.40
ESFAHAN	1.6	13.7	332	48.00	28.30
ESLAMABAD GHARB	1.3	17.1	420	38.00	9.80
FASSA	1.1	10.4	316	70.00	12.00
FERDOUS	2.4	17.9	22	40.00	7.84
FIROUZKOOH	1.9	33.4	56	46.00	6.54
FIROUZKOOH (POLL.)	**	***	56	46.00	6.54
FOROUDGAH LAMERD	2.1	30.3	698	80.00	10.00
GARMSAR	2.0	25.5	110	50.00	4.00
GHAEN	2.5	40.4	165	55.00	3.78
GHARAKHIL GHAEMSHAHR	1.9	11.0	16154	24.00	2.60
GHAZVIN	1.3	10.4	2298	100.00	4.90
GHOM	1.7	20.0	484	48.00	80.00
GHOCHAN	1.5	8.00	468	60.00	3.00
GHORVEH	3.2	94.4	2155	50.00	6.00
GOLMAKAN	2.4	43.7	**	**	**
GOLPAIGAN	1.9	38.6	604	47.00	9.20
GONABAD	1.7	16.6	156	100.00	4.48
GONBADE GHABOOS	0.8	5.20	10179	25.00	7.00

Station	Wind Mean Speed (m/s)	Wind Mean Energy Potential (W/m ²)	Number of Shallow boreholes	Maximum Depth (m)	Mean Flow Rate (m ³ /h)
GORGAN	0.7	2.50	10179	25.00	7.00
HAJIABAD HORMOZGAN	**	***	64	49.00	10.25
HAMEDAN FOROUDGAH	1.8	23.7	1080	54.00	8.00
HAMEDAN NOZHEH	3.0	46.9	1080	54.00	8.00
HASANABADE DARAB	2.0	34.2	2574	80.00	14.00
ILAM	2.1	28.0	38	45.00	13.00
IRANSHAHR	3.3	47.5	422	48.00	15.70
IZEH	1.6	13.1	21	18.00	7.00
JASK	3.7	48.8	87	32.50	6.80
JAZIREH ABOMOOSA	3.2	47.6	**	**	**
JAZIREH GHESHM	2.9	42.3	255	90.00	3.53
JAZIREH KISH	3.6	69.2	12	25.00	3.80
JAZIREH SIRI	3.5	64.6	**	**	**
JEOPHISICS TEHRAN	2.5	21.1	12111	60.00	3.65
JOLFA	2.2	46.4	100	50.00	4.58
KABOOTARABAD	1.0	11.3	**	**	**
KAHNOUJ	2.7	65.7	**	**	**
KANGAN JAM	2.8	53.8	624	54.00	4.00
KANGAVAR	1.3	21.8	1493	42.00	7.50
KARAJ	2.3	26.6	12111	60.00	3.65
KASHAN	0.4	2.80	337	48.00	9.50
KASHMAR	1.2	8.30	14	60.00	17.00
KENARAK CHAHBAHAR	2.5	39.0	25	40.00	5.00
KERMAN	2.7	44.0	61	70.00	4.50
KERMANSHAH	2.1	17.8	1639	35.00	9.00
KHALKHAL	1.4	15.5	658	29.00	4.50
KHASH	3.5	59.9	198	49.00	22.00

Station	Wind Mean Speed (m/s)	Wind Mean Energy Potential (W/m ²)	Number of Shallow boreholes	Maximum Depth (m)	Mean Flow Rate (m ³ /h)
KHODABANDEH	3.8	96.6	**	**	**
KHOOR BIABANAK	1.2	10.8	**	**	**
KHOOR BIRJAND	4.5	133.4	44	52.00	2.50
KHORRAMABAD	2.7	25.6	212	20.00	13.00
KHORRAMDAREH	3.7	65.2	**	**	**
KHOY	0.8	16.7	534	35.00	4.50
KOOHRANG	1.6	25.4	**	**	**
KOUDASHT	1.7	15.9	124	33.00	**
LAR	1.8	35.8	258	50.00	10.00
LORDEGAN	1.2	11.8	46	45.00	13.00
MAHABAD	1.6	27.2	797	35.00	7.62
MAKOO	1.6	38.9	**	**	**
MALAYER	2.8	43.6	483	48.00	8.00
MANJIL	6.3	476.1	27	35.00	13.00
MARAGHEH	1.8	31.4	5612	38.00	4.94
MARIVAN	1.8	18.0	148	16.70	6.10
MARVAST	4.0	62.7	195	69.00	23.00
MASHHAD	3.0	27.8	2180	110.00	3.50
MASJED SOLEYMAN	1.6	21.1	17	15.00	9.83
MESHKINSHAHR	1.2	44.2	569	28.00	4.71
MIANDEH JIROFT	1.0	11.1	4280	40.00	16.80
MIANEH	1.7	26.5	2935	32.00	5.03
MINAB	0.7	5.50	967	50.00	8.78
MORAVEH TAPPEH	2.0	27.8	123	24.00	2.00
NAEIN	3.2	55.5	20	37.00	50.00
NAHAVAND	1.0	10.7	152	40.00	14.00
NATANZ	1.5	30.3	**	**	**
NEHBANDAN	2.8	65.8	32	50.00	17.55
NEYSHABOOR	1.3	16.7	131	110.00	3.24
NOUSHAHR	2.4	24.0	4230	24.00	2.80
OMIDIYEH	2.6	45.2	**	**	**

Station	Wind Mean Speed (m/s)	Wind Mean Energy Potential (W/m ²)	Number of Shallow boreholes	Maximum Depth (m)	Mean Flow Rate (m ³ /h)
OMIDIYEH(PGN)	2.6	45.2	**	**	**
OMIDIYEH (AGHAJARI)	2.2	58.9	**	**	**
OROOMIEH	2.0	15.2	16684	40.80	5.10
PARSABAD MOGHAN	1.5	11.8	100	25.00	3.68
PAYAM	**	***	**	**	**
PIRANSHAHR	1.6	27.2	131	36.00	4.32
RAFSANJAN	3.9	79.9	73	50.00	10.48
RAMHORMOZ	2.1	20.3	80	12.00	12.84
RAMSAR	2.6	20.8	3227	24.00	1.70
RASHT	1.0	10.1	**	**	**
RAVANSAR	3.0	81.5	608	43.00	10.00
ROBAT POSHTBADAM	2.8	25.8	**	**	**
SABZEVAR	2.5	28.9	611	80.00	2.30
SAD DOROUDZAN	1.8	13.9	**	**	**
SAFIABAD DEZFUL	0.7	5.90	96	15.00	20.69
SAGHEZ	2.3	44.9	1283	32.00	5.48
SAHAND	4.9	139.4	**	**	**
SANANDAJ	2.2	29.2	1287	38.00	4.00
SAR POL ZOHAB	0.9	18.5	146	30.00	10.00
SARAB	1.9	27.9	584	48.00	12.34
SARAKHS	2.4	27.5	54	35.00	5.00
SARAVAN	3.5	60.1	283	45.00	8.00
SARDASHT	2.2	28.1	106	30.00	5.50
SAVEH	1.8	34.8	114	**	0.40
SEM NAN	0.9	7.50	35	40.00	3.40
SHAHR BABAK	2.4	39.8	239	48.00	14.50
SHAHR KORD	1.0	8.20	302	48.00	10.60
SHAHREZA	2.9	30.8	**	**	**
SHAHROUD	0.9	7.30	88	20.00	2.20

جایگزینی انرژی باد به جای ... / حامد هوری جعفری و ...

نشریه انرژی ایران / سال هفتم / شماره ۱۵ / آبان ۱۳۸۱

Station	Wind Mean Speed (m/s)	Wind Mean Energy Potential (W/m ²)	Number of Shallow boreholes	Maximum Depth (m)	Mean Flow Rate (m ³ /h)
SHARGH ESFAHAN	2.6	30.8	332	48.00	28.30
SHIRAZ	2.2	20.7	1561	122.00	8.50
SHOMALE TEHRAN	1.0	7.90	12111	60.00	3.65
SHOSHTAR	3.1	65.2	286	15.50	24.36
SIRJAN	2.8	69.4	181	48.00	14.20
TABASS	1.2	11.7	7	45.00	11.00
TABRIZ	3.3	42.1	2571	60.00	3.11
TAKAB	1.8	52.9	80	12.00	6.00
TEHRAN MEHRABAD	2.3	23.5	12111	60.00	3.65
TORBATE HEYDARIEH	2.0	28.0	378	55.00	13.00
TORBATE JAM	3.7	90.0	45	65.00	4.50
YASOUJ	0.9	12.4	134	30.00	8.00
YAZD	3.1	30.3	979	69.00	4.00
ZABOL	6.7	352.3	**	**	**
ZAHAK	5.1	209.9	**	**	**
ZAHEDAN	3.6	80.5	186	49.00	5.00
ZANJAN	3.2	30.3	2770	37.00	6.09
ZARGHAN	1.1	7.70	1204	36.00	10.00
ZARINEH OBATO	4.1	110.2	**	**	**
SHARGH TABRIZ	**	***	2571	60.00	3.11

-
- 1- Fraenkel, P. ,Barlow, R. , Crick, F. , Derrick, A. , Bakalders V. , Windpumps: A guide for development workers, IT publication, IT power and Stockholm Environment Institute, 1993.
 - 2- W. D. Musial, S. M. Hock, Wind Energy 1995: Solar Energy Division, Presented at the Energy and Environmental Expo. 95, Houston, Texas, (Jan. 29 - Feb. 1), ASME press, 1995.
 - 3- D. A. Spera, Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME pres, new york, 1995.
 - 4- R. Hunter, G. Elliot. Wind-Diesel Systems: A guide to the technology and its implementation, Cambridge University Press, UK, 1994.
 - 5- Jamil,M. , Parsa, S./ “ Wind Energy Density of MERC Solar Site, “ Renewable Energy Conference and Workshop “ Cairo- Egypt, April 14-18 1996.