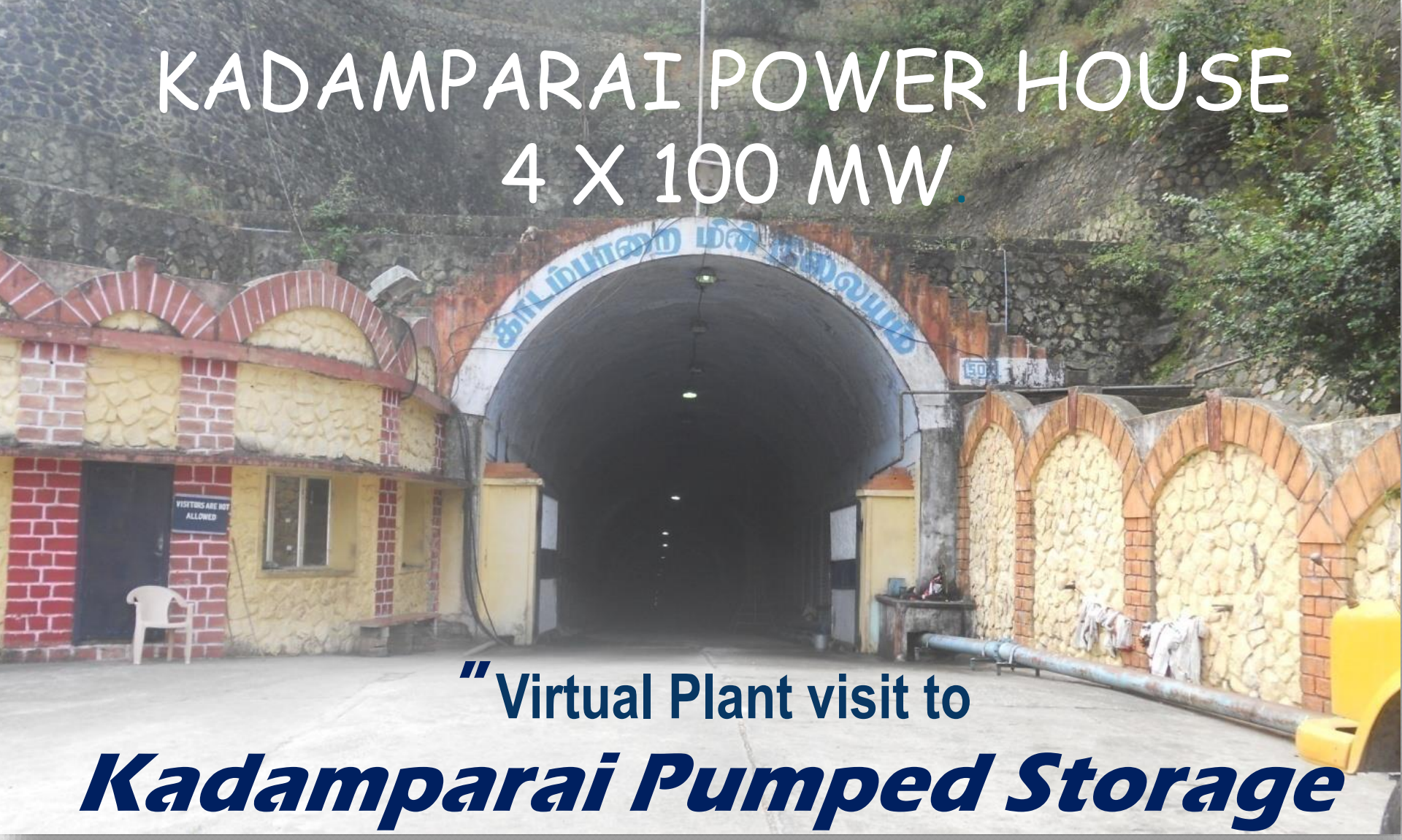
Kadamparai Pumped Storage Power Station

HEARTY WELCOMES TO EVERY ONE
PRESENT OVER.....

KADAMPARAI POWER HOUSE
4 X 100 MW.



"Virtual Plant visit to

Kadamparai Pumped Storage Power Station and Plant Operations"

- Kadamparai is the third major pumped storage scheme of the country developed during 1974-1989.
- The Kadamparai Power House is located at Anaimalai hills of Tamilnadu at 722 MSL between Kadamparai dam and Upper Aliyar dam in Southern regional power grid.
- The capacity of this scheme is 4 x 100 MW pumped storage plant of Tamil Nadu state was commissioned during seventh five year plan.

- But it is the first underground pumped storage of the country, also holds the merit of first successful pumped storage scheme of the country carried both pumping and generation modes of operation.

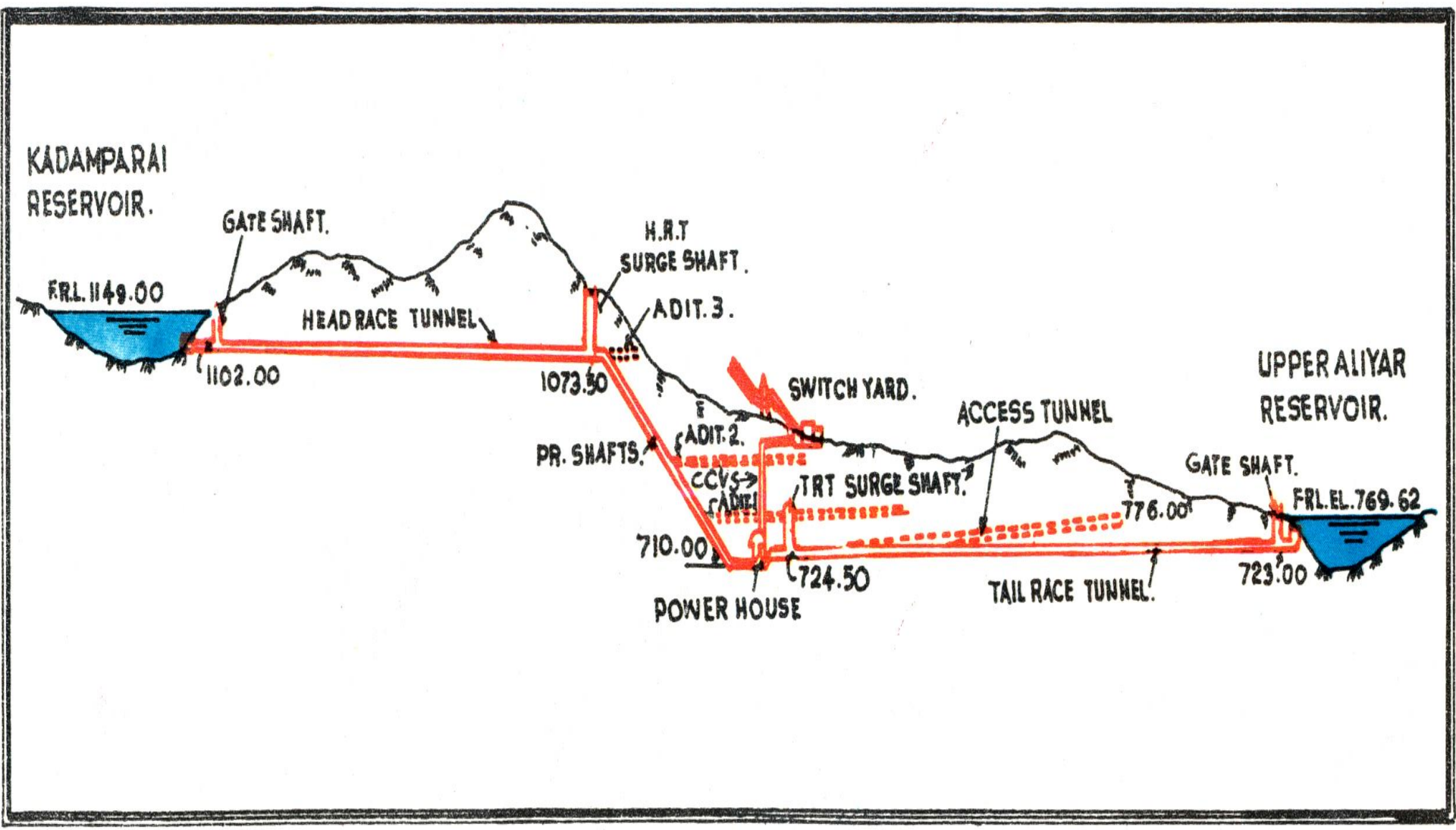
- The project was envisaged to store excess off –peak generation from nuclear, thermal and conventional hydro power in the state.

KADAMPARAI -"A boon for Power availability in the Southern Grid".

Kadamparai View

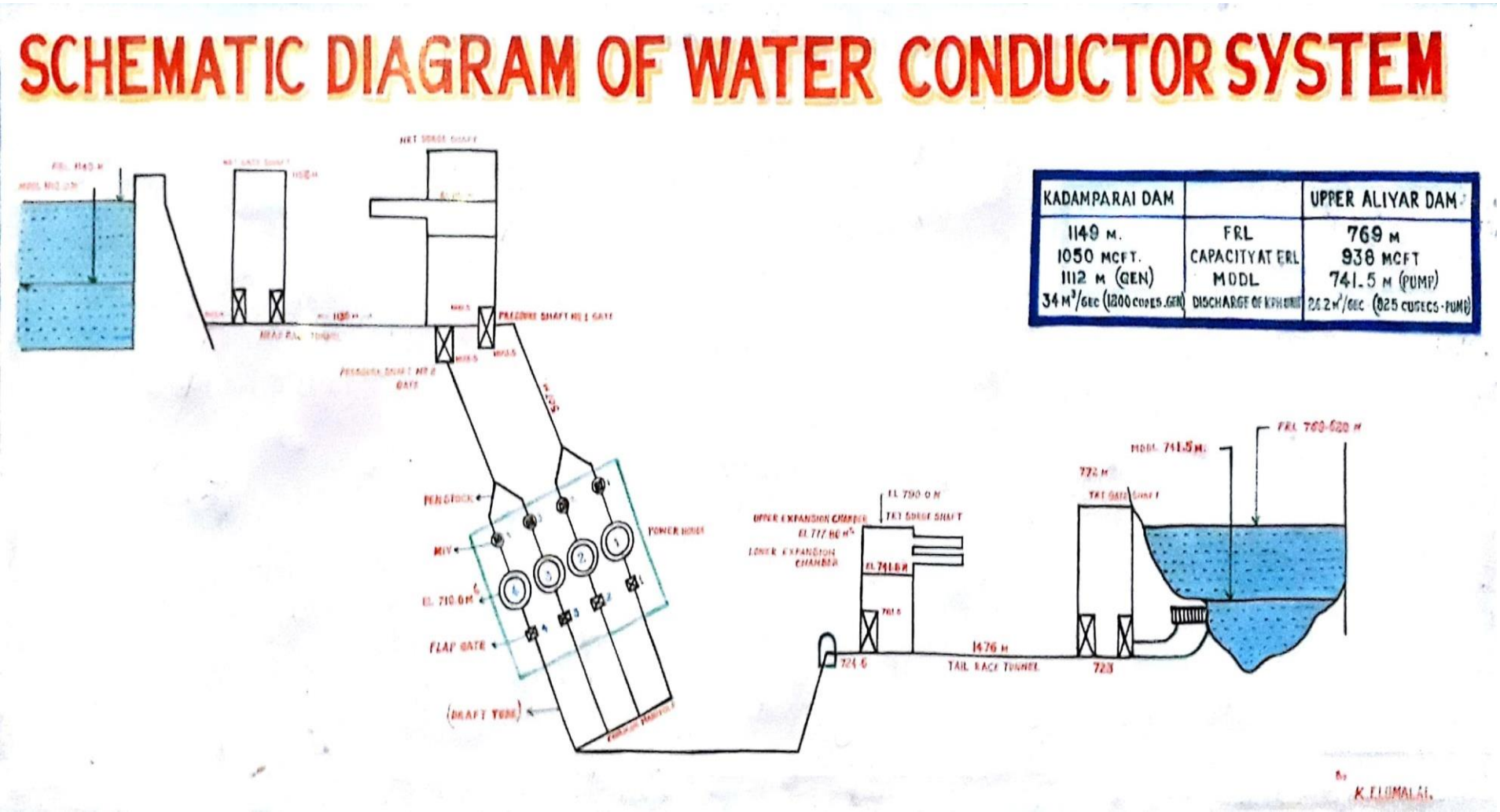
Slide show

Kadamparai Pumped Storage



KADAMPARAI TO UPPER ALIYAR RESERVOIR — PROFILE

KADAMPARAI POWER HOUSE



- The first unit (1x100MW) was commissioned on 17.10.1987.
- Subsequently the other Units were Commissioned on the respective dates.
- Unit II-26.02.1988,
- Unit III – 12.04.1989
- Unit IV- 16.12.1988.
- The capital cost of the Scheme is Rs 18050 Lakhs
- This is the first underground pumped Storage Scheme in Tamil Nadu Electricity Board and the biggest Hydro capacity.

Turbine Operating Parameters

Make of Generator / Turbine	
	UNIT 1 GEC BOVING UNITED KINGDOM
	UNIT 2,3&4 BHEL INDIA
Type of Turbine	Francis Reaction Reversible
HEAD for each Power House	
a)Maximum	1) 395 mts (GENERATOR MODE)
	2) 413 mts (PUMP MODE)
b)Minimum	1) 323 mts (GENERATOR MODE)
	2) 341 mts (PUMP MODE)
Speed of Machine	500 rpm

KADAMPARAI PSP- A Glance

- It generates 100 MW during Gen' cycle & consumes 110 MW during pumping cycle.
- Minimum capacity required for generation is 4 MU, and pumping is 0.96 MU.

Parameters	Kadamparai Dam (Upper Reservoir)	Upper Aliyar Dam (Lower Reservoir)
Reservoir Capacity	26.85MU	25.91MU
FRL (Full Reservoir Level)	1149 meters	762 meters
MDDL (Minimum Draw Down Level)	1112 meters	722 meters
Dead storage (in Million Cubic Feet)	170 MCFT	23 MCFT
Gross Storage (in Million Cubic Feet)	1080 MCFT	938 MCFT

Mode	Condition	Response Time
Generator	Stand still to on-line	5 min
Generator	On-line to full load	Few seconds
Motor	Stand still to synchronous condenser	9 min
Motor	Synchronous condenser to pump	1 min

Grid frequency prior to 2002

- Grid was operated at lower frequency [i.e between 48.5Hz&49.0Hz for more times till 2002 and less surplus power was available during off peak time.
- Surplus power was available in the grid during National holidays,& on Sundays by which time two or three units were utilized as pump at Kadamparai.

Low frequency pump operation

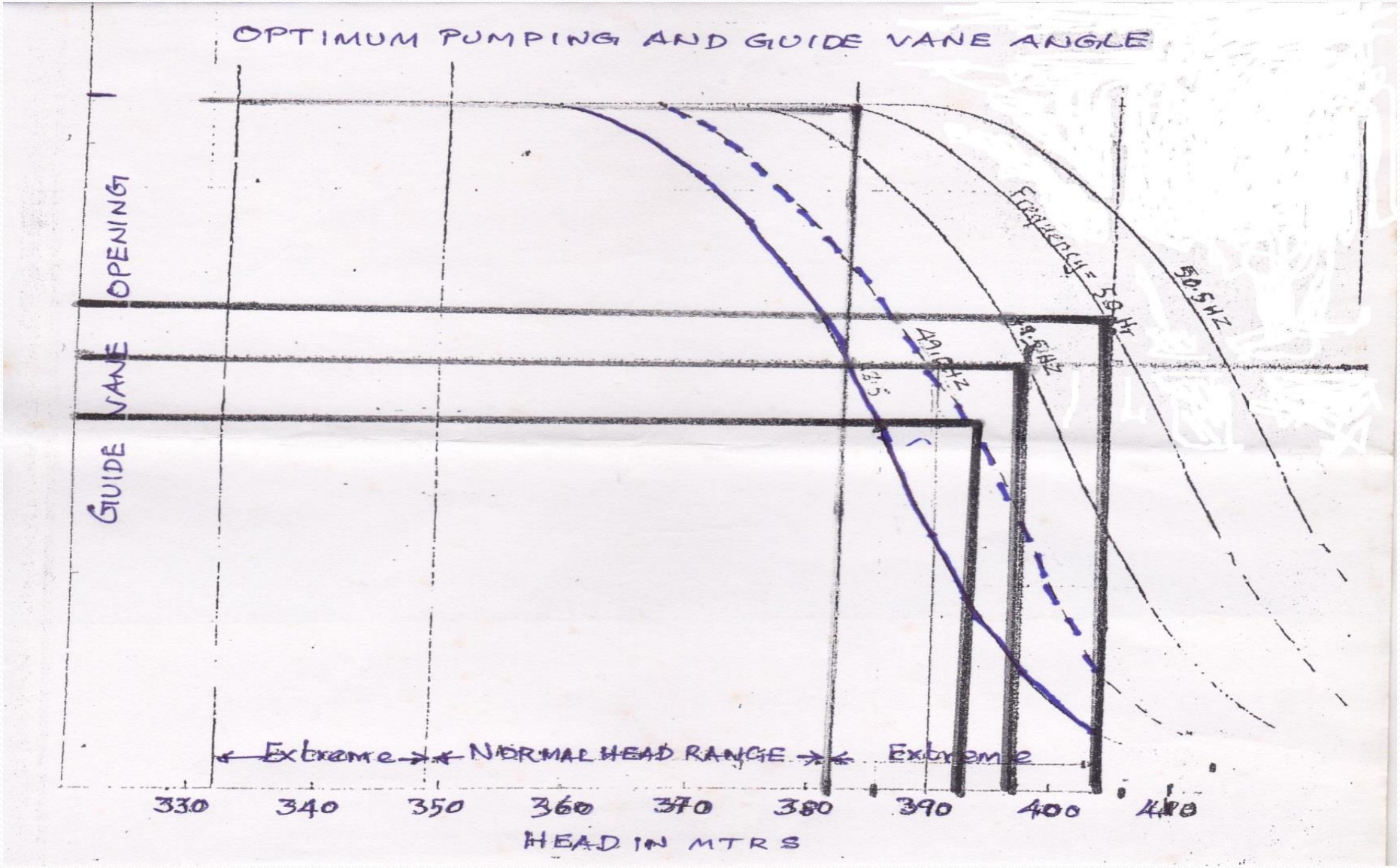
- For low frequency operation below 49.5 Hz and upto 48.5 Hz , the designer have recommended to limit the dynamic operating head to 381 m and to reduce the guide vane opening by 60 %.

- As the operating head and frequency was not matched as per their recommendation, this aspect was not tried at KPH.

- Radial feeder from a thermal station[MTPS] to KPH was tried and as it involves more switching isolation in all Sub stations ,this was not tried as a regular feature .

- TNEB has also checked the feasibility of using big size converter for one unit so as to increase pump running hours and to use the water for meeting peak demand. But due to economic reasons this idea was dropped.

Optimum pumping & frequency.



Operating frequency

- Frequency range was narrowed from ±3% to 1.0 % in 2003 and imposed the penal mechanism of deviation from schedule known as the UI mechanism in southern region.[ABT]

- This is only a commercial mechanism but this method has improved the operating frequency of southern region for longer duration above 49.5Hz

Performance of Pump operation after 2003.

- 2003-04----471MU --WIND CAP-1361MW
- 2004-05----232MU *---DO---------2040MW *
- 2005-06----555MU---DO----------2898MW
- 2006.07----416MU----DO---------3476MW
- 2007-08----403MU-----DO--------3857MW
- 2008-09----237MU**-----DO------4288MW * *
- 2009-10----490MU-----DO--------4890MW

Reason for low performance

* **DAM GEOMEMBRANE WORK-8 MONTHS- TOTAL SHUTDOWN.**

* * **POWER CUT IMPOSED IN TAMILNADU DUE TO SHORTAGE OF POWER.**

Pump performance-contd..

Year wise	Pump in MU	Wind installed MW
2009-10	**490**	**4907**
2010-11	***620***	**5904**
2011-12	**545**	**6988**
2012-13	**337**	**7162**
2013-14	**498**	**7270**
2014-15	**511**	**7394**
2015-16	**409**	**7553**
2016-17	**329**	**7801**
2017-18	**407**	**8136**
2018-19	**372**	**8535**

TANGEDCO Installed Capacity (as on date)

- Wind *8535.195
- SOLAR (With Roof top) *4179.411
- Hydro 2321.9

Generation and Pumping details of Kadamparai Power House

S.No	YEAR	GENERATION in MU	DISCHARGE in MCFT	CONSUMED in MU	WATER PUMPED in MCFT
1	2004-05	258.871	9707.66	310.936	8861.69
2	2005-06	581.400	21802.50	557.137	***15878.40***
3	2006-07	427.815	16043.06	412.801	11764.82
4	2007-08	456.564	17121.15	403.408	11497.12
5	2008-09	294.475	11042.81	238.548	6798.63
6	2009-10	499.260	18722.25	489.685	13956.03
7	***2010-11***	***572.140***	***21455.25***	***619.789***	***17664.00***
8	2011-12	510.537	19145.14	544.615	***15521.54***
9	2012-13	302.063	11327.36	337.254	9611.75
10	2013-14	505.190	18944.63	497.846	14188.61
12	2014-15	502.470	18842.63	511.277	14571.40
13	2015-16	413.410	15502.88	409.193	11662.01
14	2016-17	289.115	10839.00	328.575	9239.08
15	2017-18	384.335	14522.15	406.995	11662.5
16	2018-19	434.800	16465.50	371.855	10752.7
17	**2019-20**	**369.600**	**12884.10**	**386.060**	**10976.19**

Integration of RE (Wind) with Kadamparai PSP

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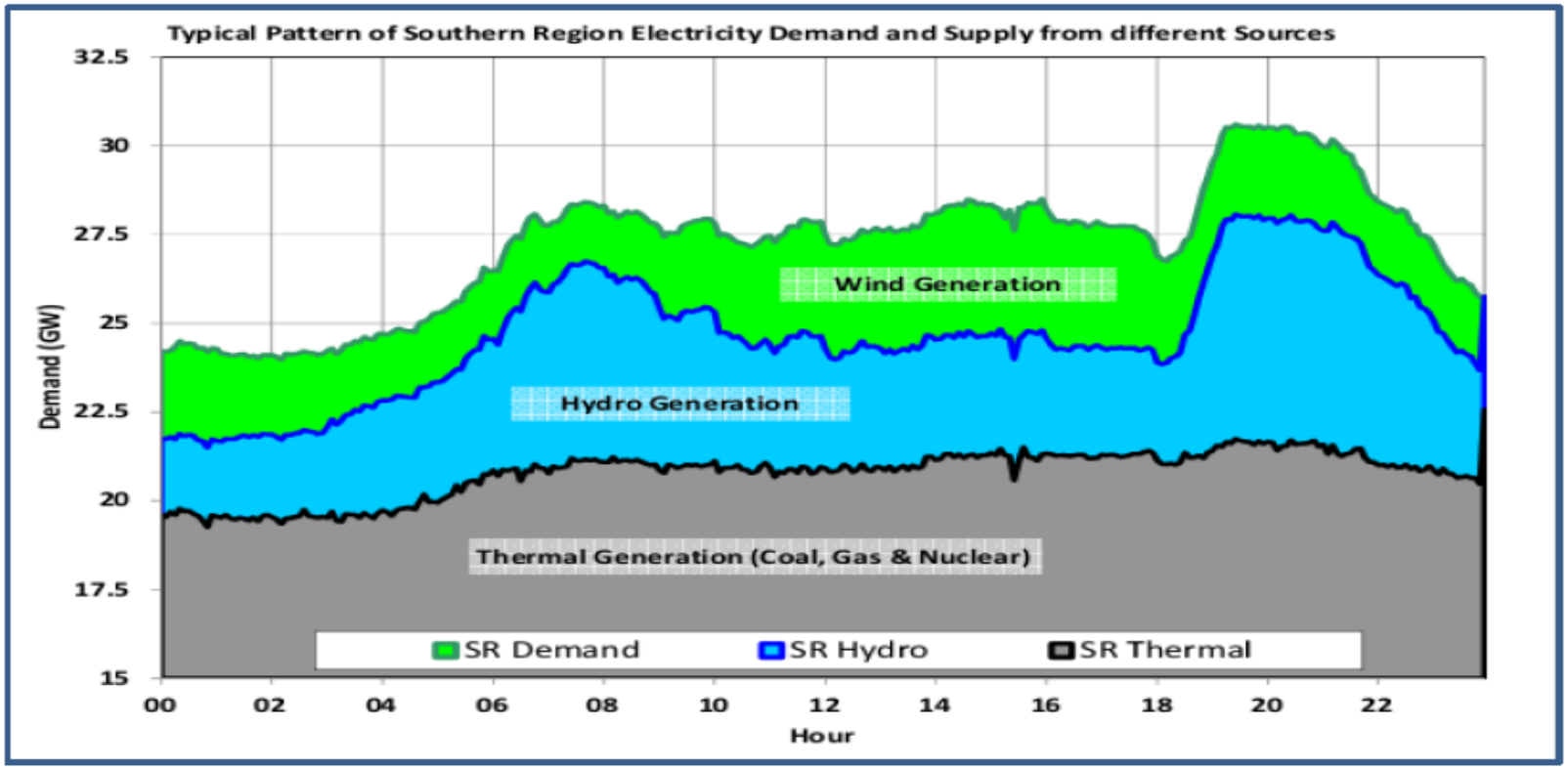
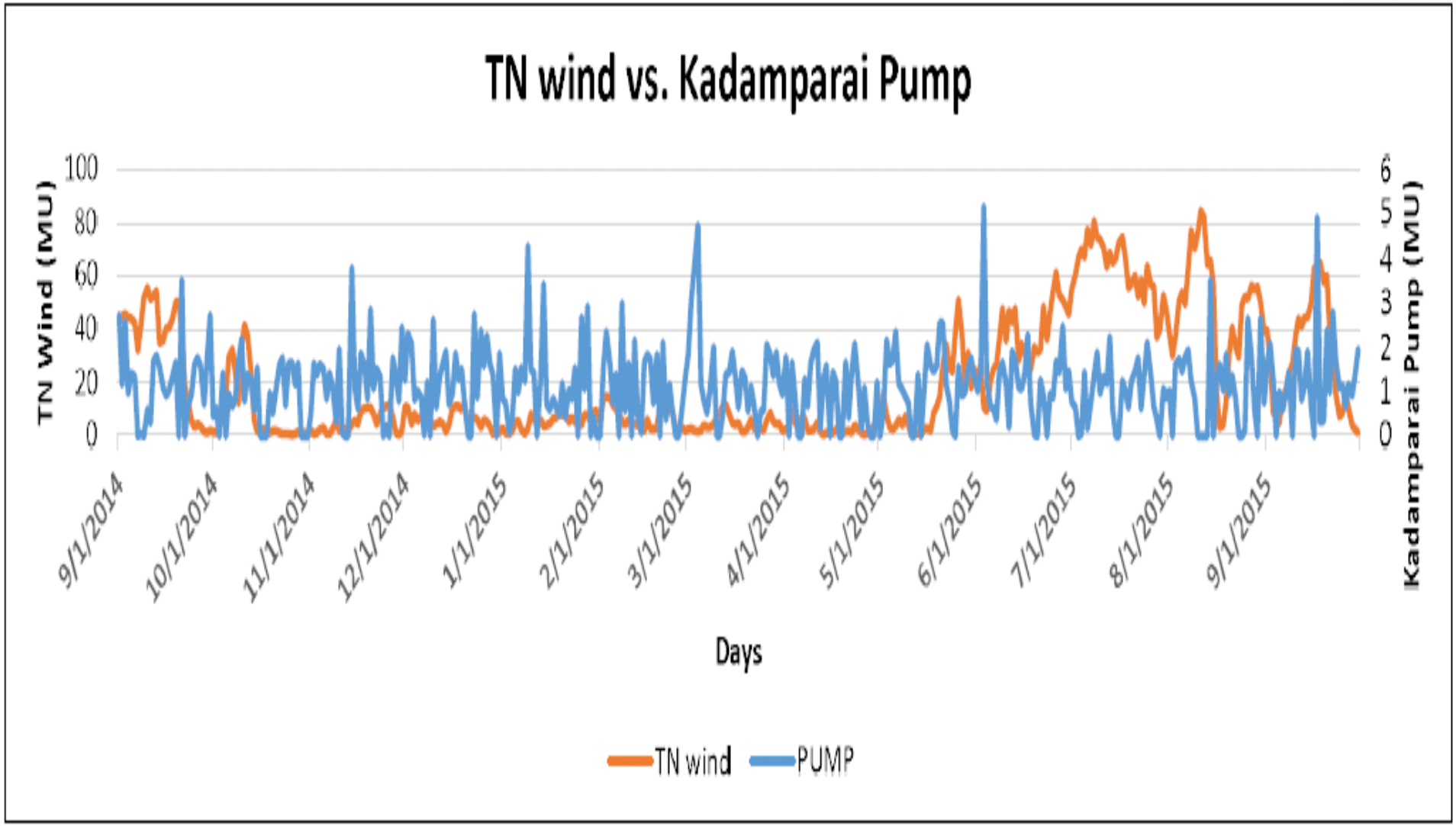
Wind in SR Grid.

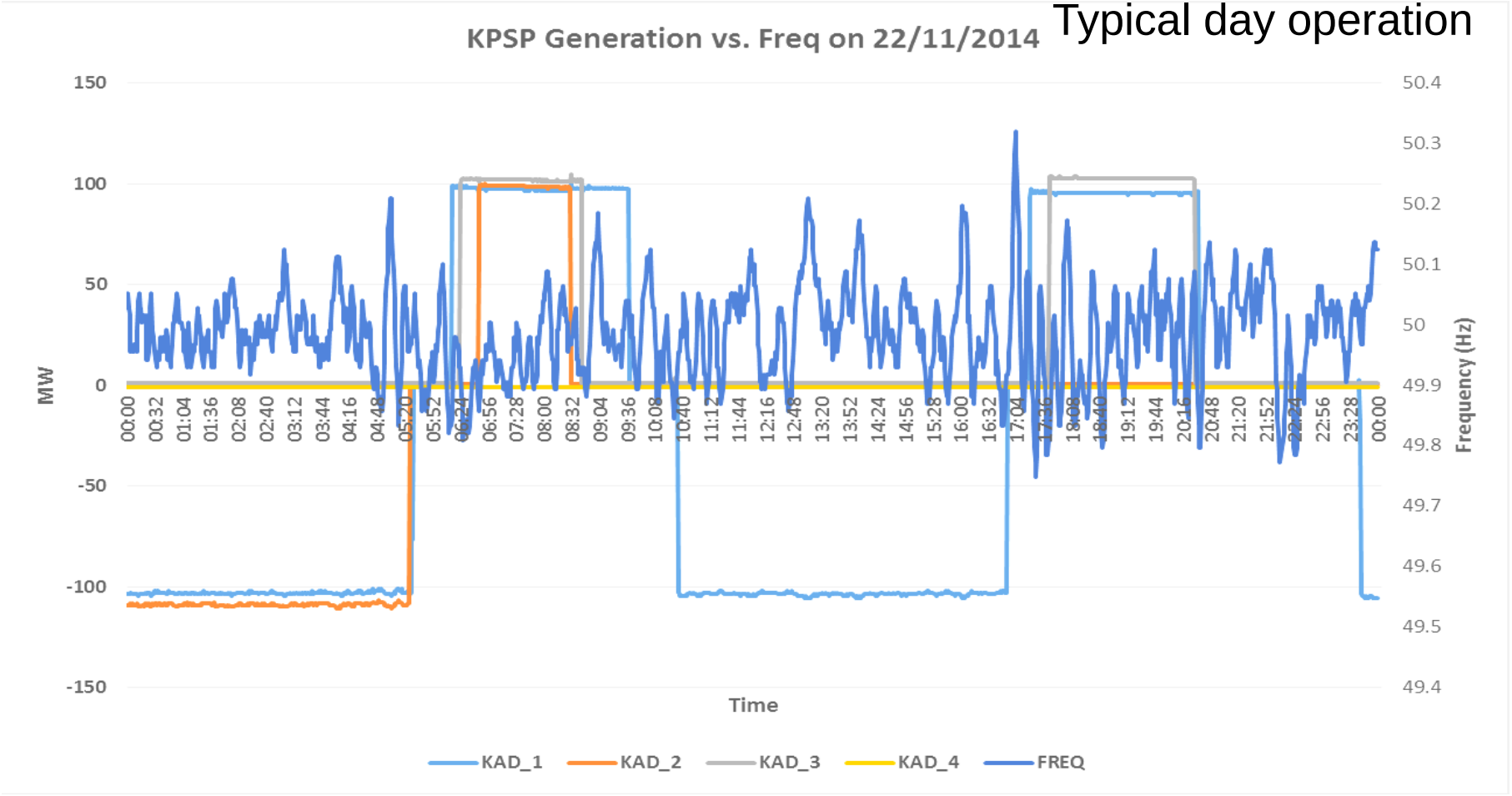
Management of Intermittency & Variability in Wind generation- Southern Region (July 2011)

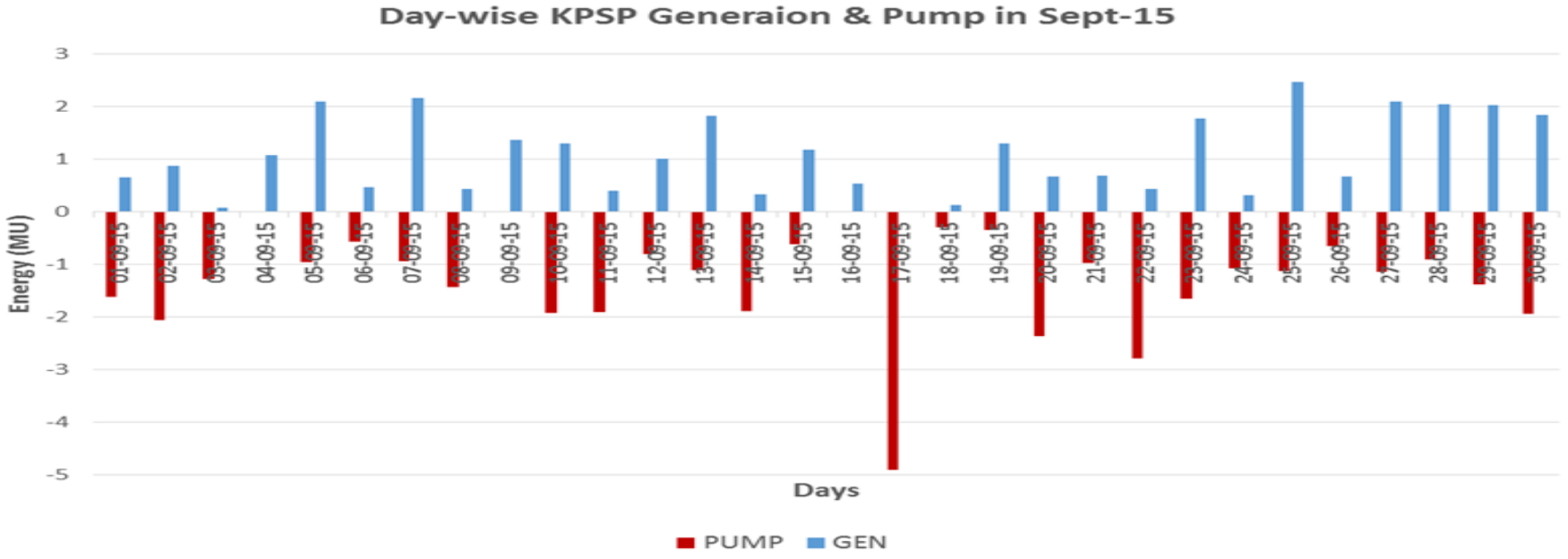


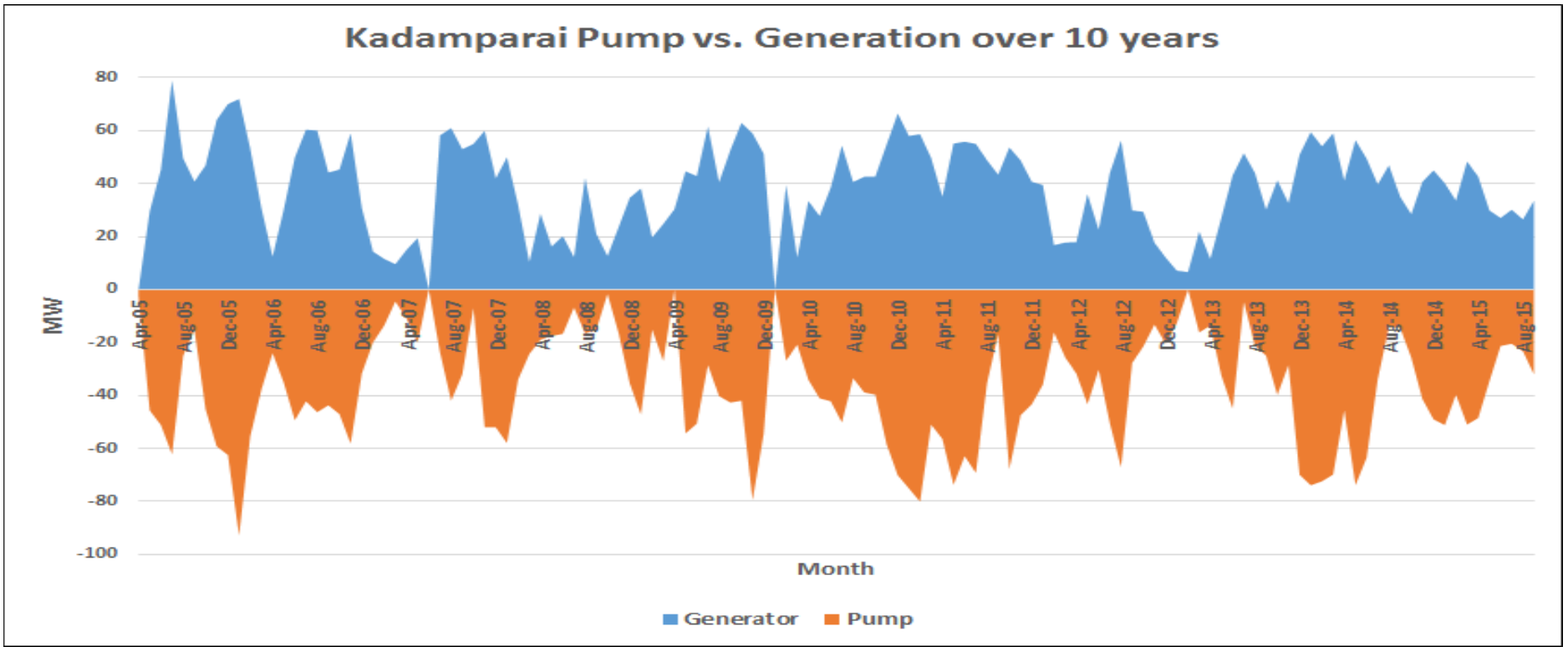

TN wind vs. Kadamparai Pump
TN Wind (MU)
100
80
60
40
20
0
Kadamparai Pump (MU)
6
5
4
3
2
1
0
9/1/2014
10/1/2014
11/1/2014
12/1/2014
1/1/2015
2/1/2015
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
Days
TN wind
PUMP

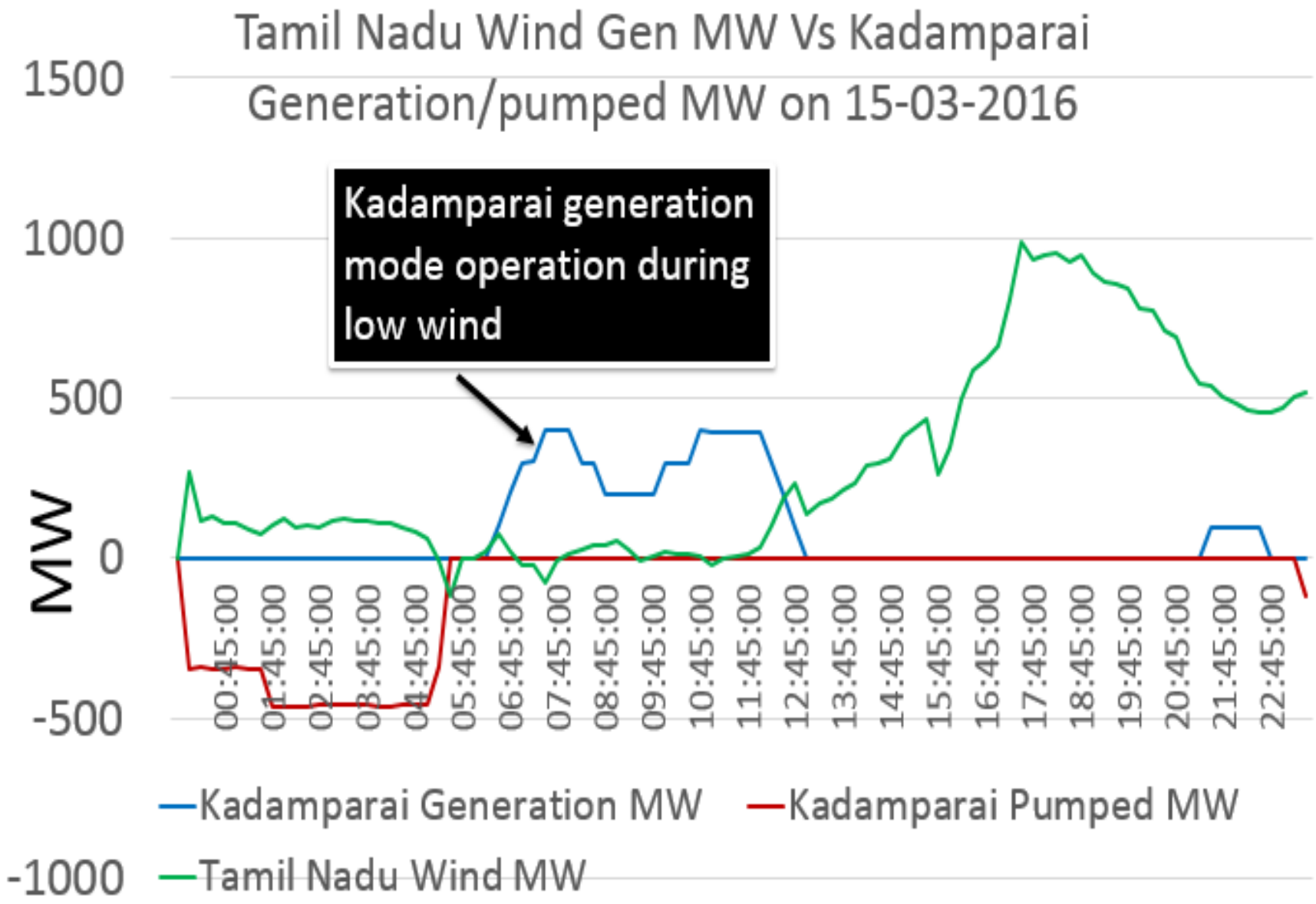
Kadamparai PSP Operation

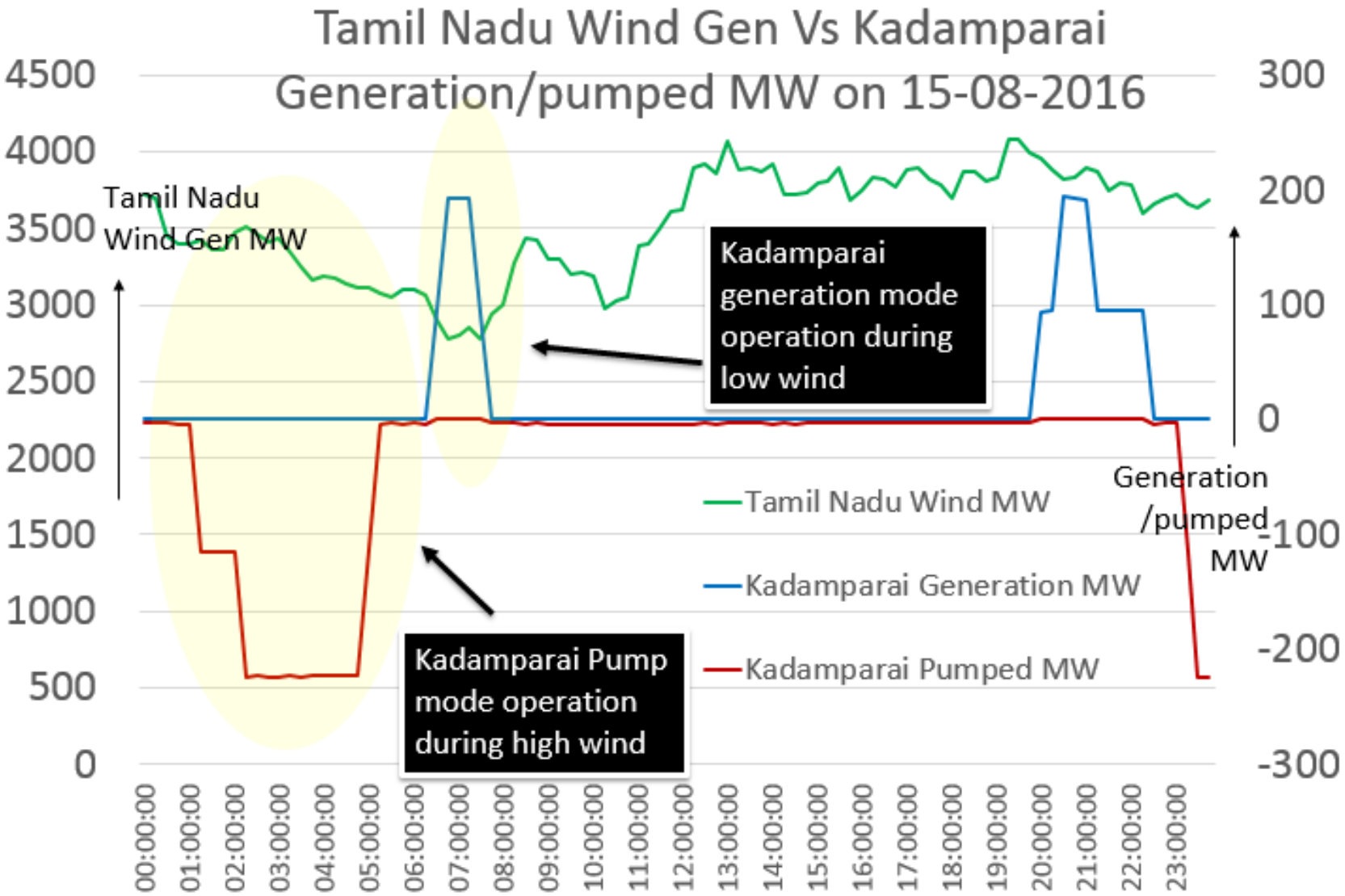
Typical day operation

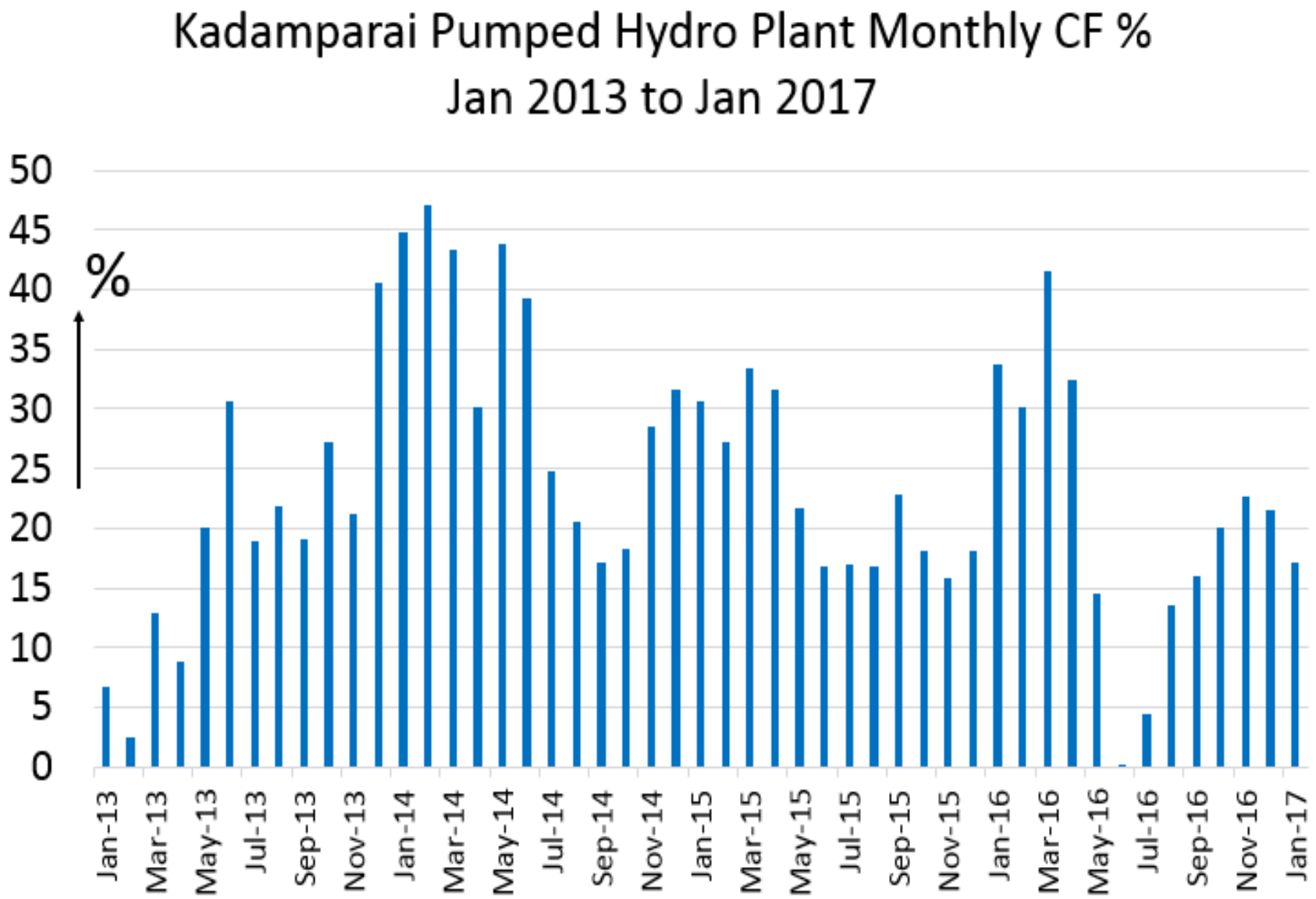


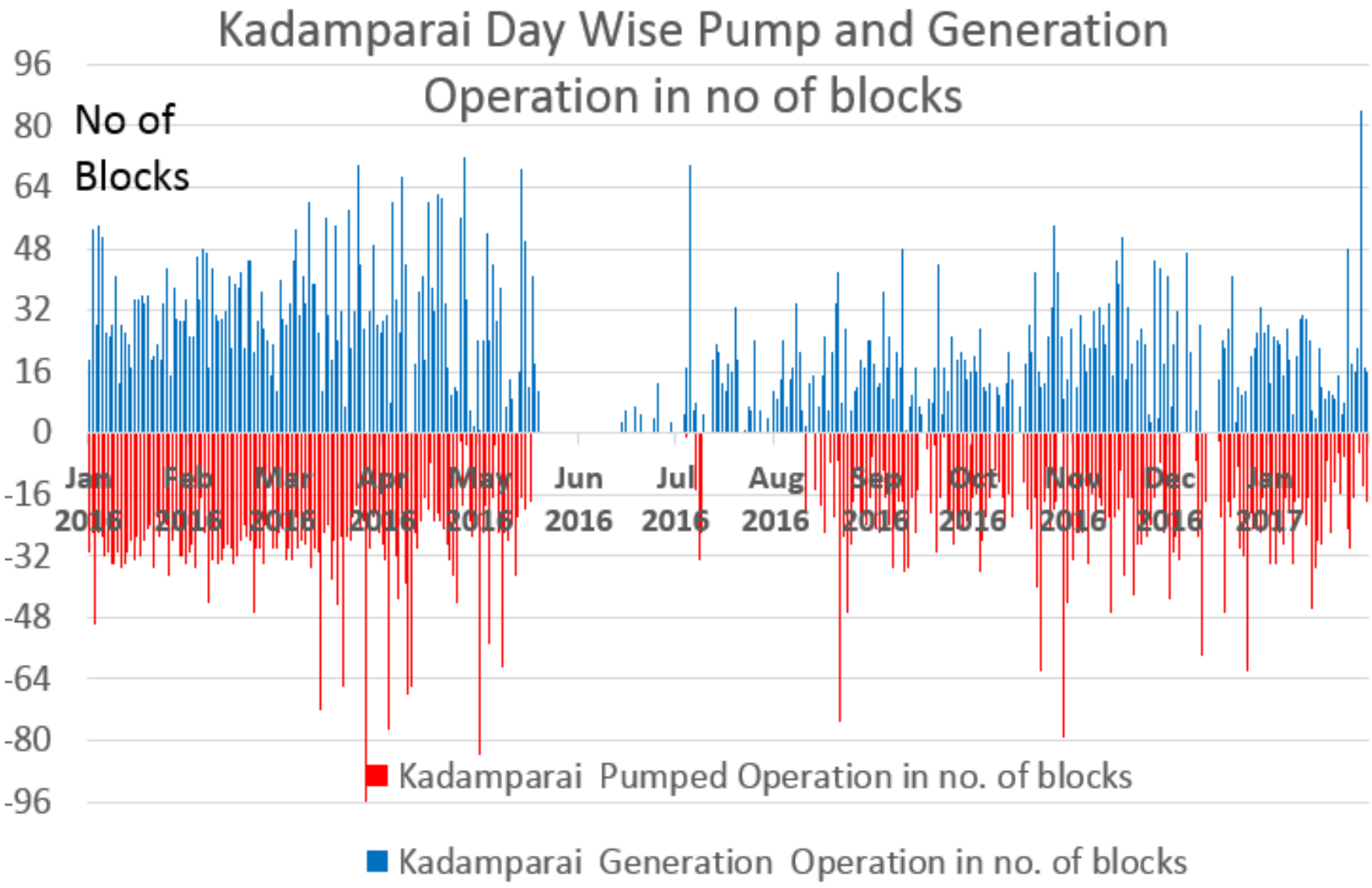

Day-wise KPSP Generaion & Pump in Sept-15
Energy (MU)
3
2
1
0
-1
-2
-3
-4
-5
01-09-15
02-09-15
03-09-15
04-09-15
05-09-15
06-09-15
07-09-15
08-09-15
09-09-15
10-09-15
11-09-15
12-09-15
13-09-15
14-09-15
15-09-15
16-09-15
17-09-15
18-09-15
19-09-15
20-09-15
21-09-15
22-09-15
23-09-15
24-09-15
25-09-15
26-09-15
27-09-15
28-09-15
29-09-15
30-09-15
Days
PUMP
GEN

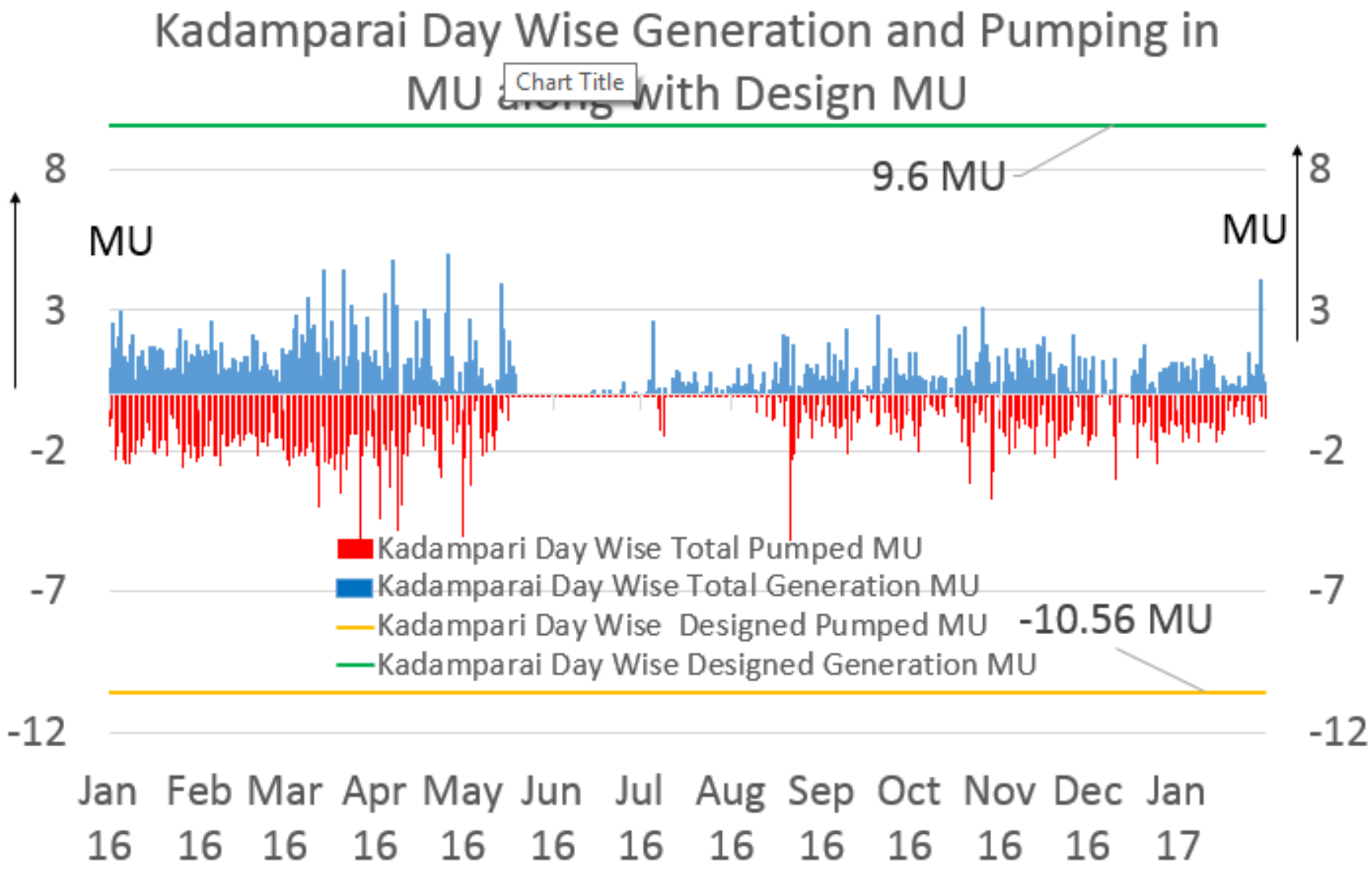

Kadamparai Pump vs. Generation over 10 years
MW
80
60
40
20
0
-20
-40
-60
-80
-100
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Dec-08
Apr-09
Aug-09
Dec-09
Apr-10
Aug-10
Dec-10
Apr-11
Aug-11
Dec-11
Apr-12
Aug-12
Dec-12
Apr-13
Aug-13
Dec-13
Apr-14
Aug-14
Dec-14
Apr-15
Aug-15
Month
Generator
Pump


Tamil Nadu Wind Gen MW Vs Kadamparai Generation/pumped MW on 15-03-2016
Kadamparai generation mode operation during low wind
1500
1000
500
0
-500
-1000
MW
00:45:00
01:45:00
02:45:00
03:45:00
04:45:00
05:45:00
06:45:00
07:45:00
08:45:00
09:45:00
10:45:00
11:45:00
12:45:00
13:45:00
14:45:00
15:45:00
16:45:00
17:45:00
18:45:00
19:45:00
20:45:00
21:45:00
22:45:00
Kadamparai Generation MW
Kadamparai Pumped MW
Tamil Nadu Wind MW


Tamil Nadu Wind Gen Vs Kadamparai Generation/pumped MW on 15-08-2016
4500
4000
3500
3000
2500
2000
1500
1000
500
0
300
200
100
0
-100
-200
-300
Tamil Nadu Wind Gen MW
Kadamparai generation mode operation during low wind
Kadamparai Pump mode operation during high wind
Generation /pumped MW
Tamil Nadu Wind MW
Kadamparai Generation MW
Kadamparai Pumped MW
00:00:00
01:00:00
02:00:00
03:00:00
04:00:00
05:00:00
06:00:00
07:00:00
08:00:00
09:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00

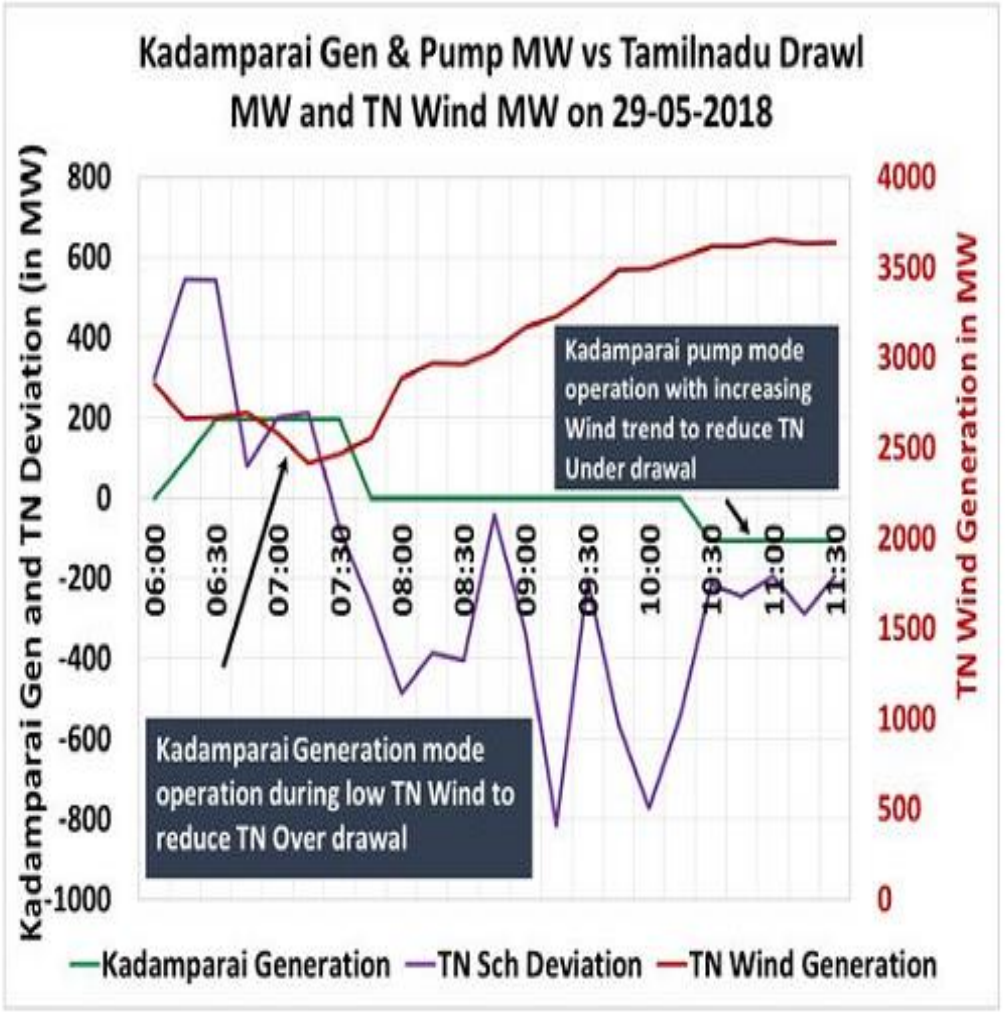

Kadamparai Pumped Hydro Plant Monthly CF %
Jan 2013 to Jan 2017
%
50
45
40
35
30
25
20
15
10
5
0
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17


Kadamparai Day Wise Pump and Generation Operation in no of blocks
No of Blocks
96
80
64
48
32
16
0
-16
-32
-48
-64
-80
-96
Jan 2016
Feb 2016
Mar 2016
Apr 2016
May 2016
Jun 2016
Jul 2016
Aug 2016
Sep 2016
Oct 2016
Nov 2016
Dec 2016
Jan 2017
Kadamparai Pumped Operation in no. of blocks
Kadamparai Generation Operation in no. of blocks


Kadamparai Day Wise Generation and Pumping in MU along with Design MU
Chart Title
9.6 MU
-10.56 MU
MU
MU
8
3
-2
-7
-12
Kadampari Day Wise Total Pumped MU
Kadamparai Day Wise Total Generation MU
Kadampari Day Wise Designed Pumped MU
Kadamparai Day Wise Designed Generation MU
Jan 16
Feb 16
Mar 16
Apr 16
May 16
Jun 16
Jul 16
Aug 16
Sep 16
Oct 16
Nov 16
Dec 16
Jan 17

Kadamparai Gen'/Pump operation vs TN Dev' / Wind Gen'

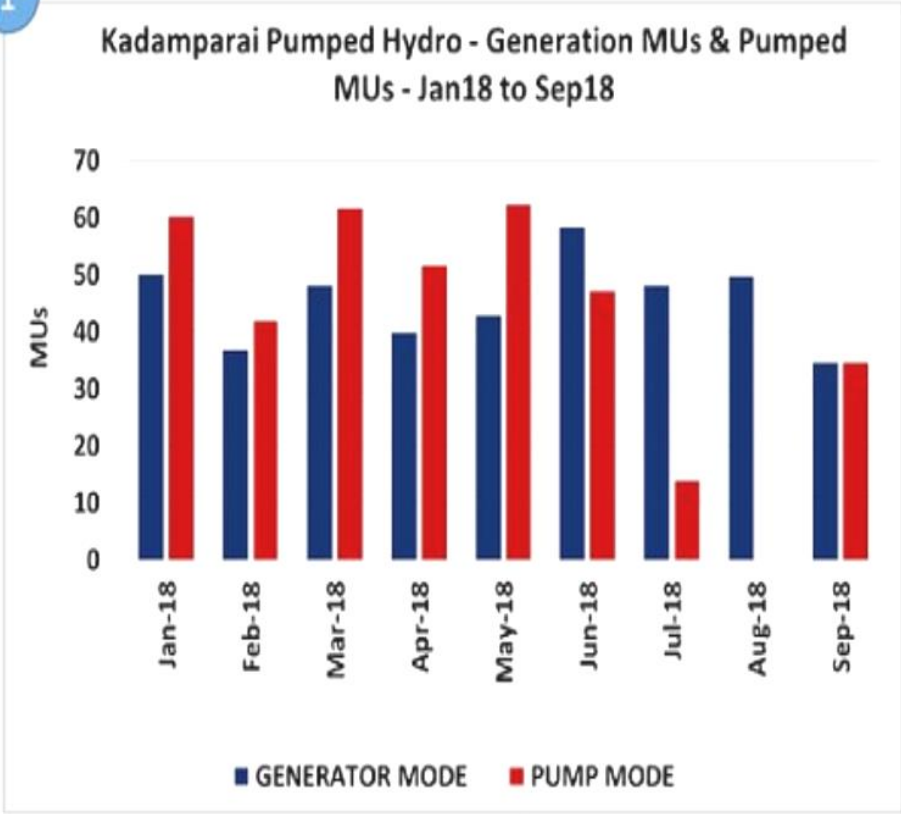
- Gen' & Pump Mode within a span of few hours on the same day.
- Gen' mode with the sudden decrease in wind generation to reduce over-drawl from grid.
- Pump mode to counter the sudden increase in wind generation and reduce under-drawl from grid.



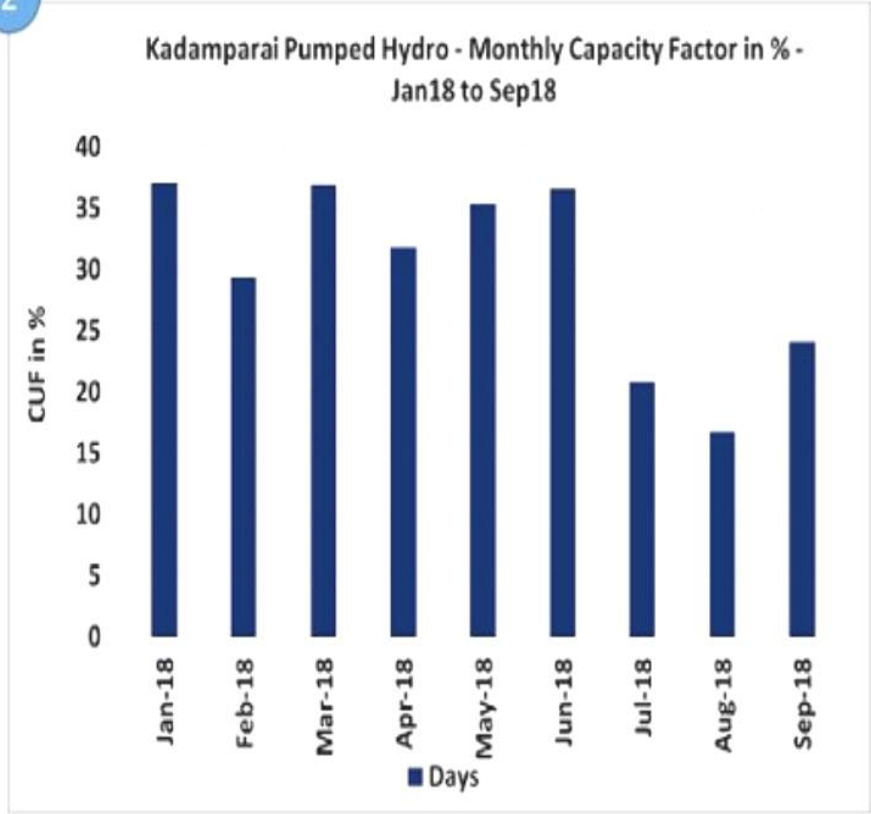
Generation details – MU's & CUF

- Average monthly pump/generation MU of the plant is around **45 MUs**
- Average monthly Capacity Utilisation Factor of the plant is around **30%**

1



2



Integration of RE (Solar/Wind) with Kadamparai PSP

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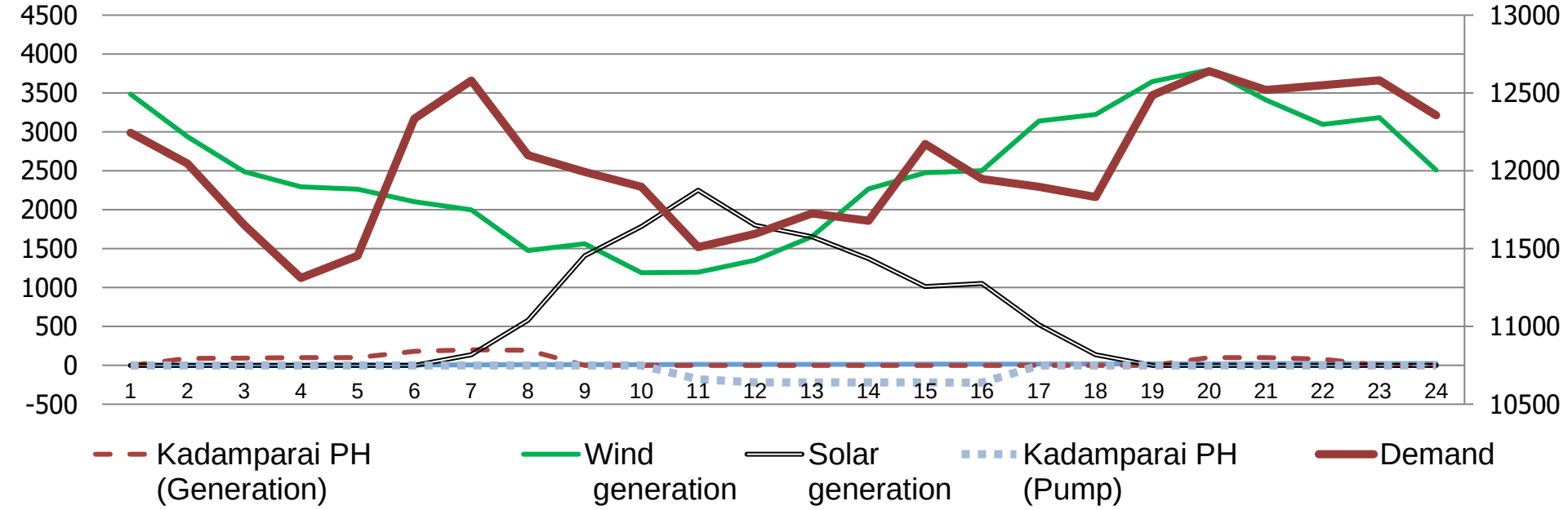
Recent Scenario

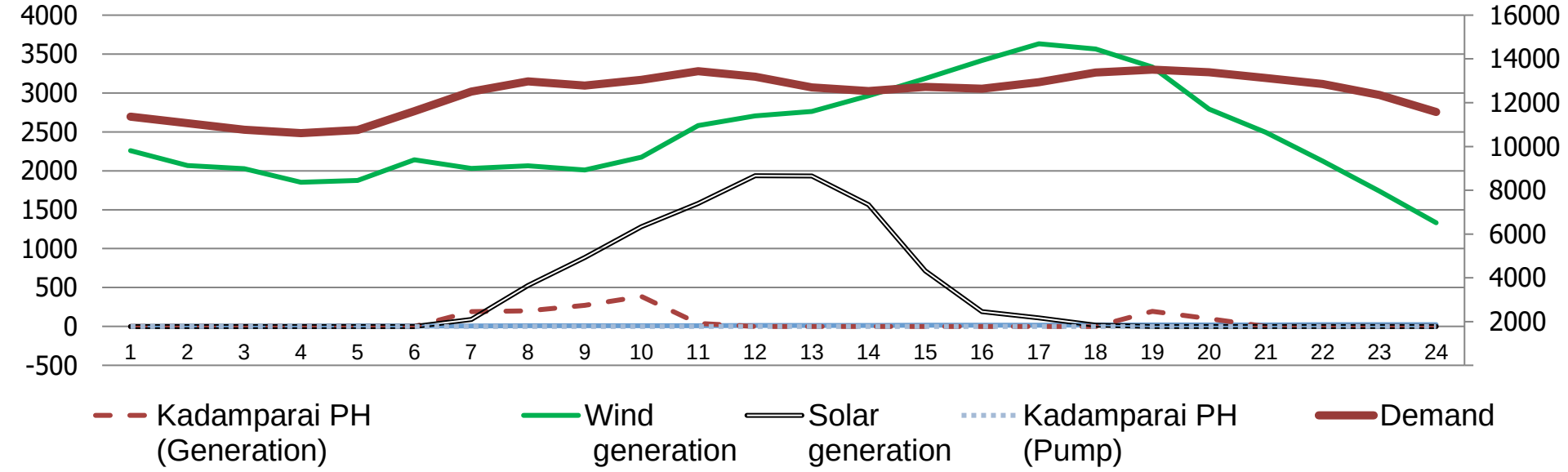
15-08-2019

in MW



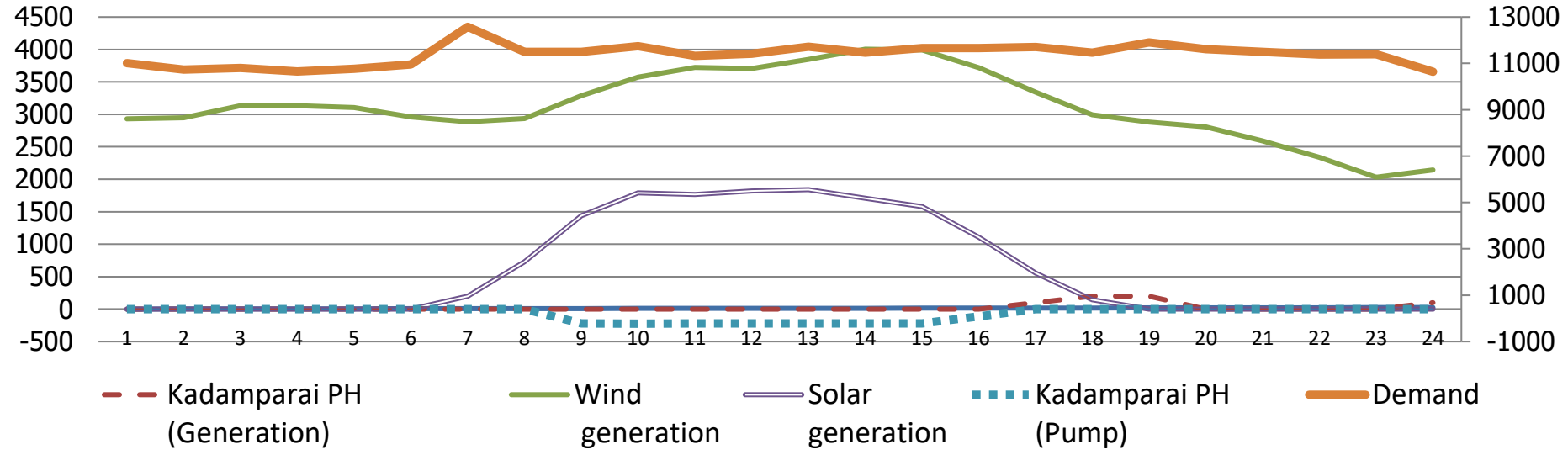
16-08-2019

in MW



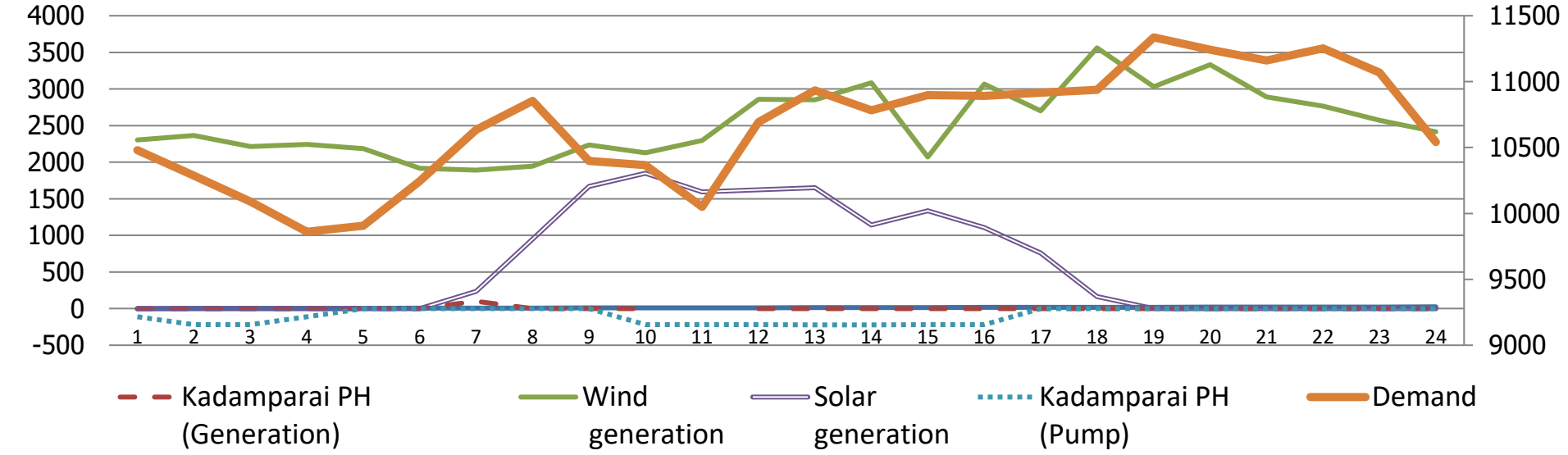
15-08-2020

in MW



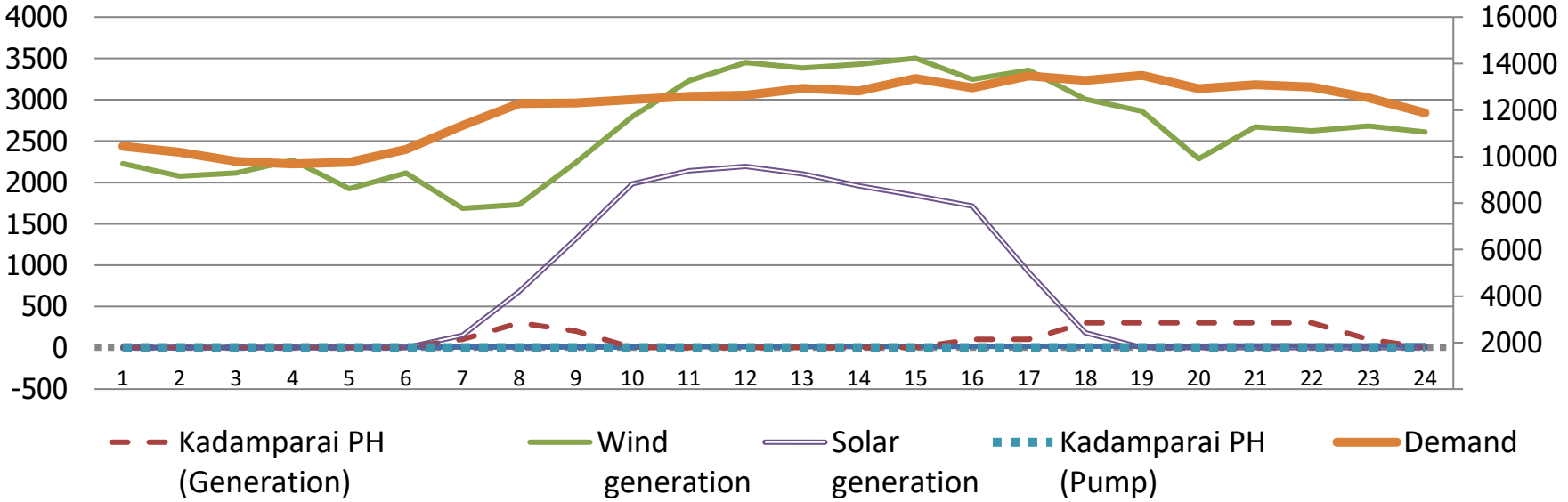
16-08-2020 SUNDAY

in MW



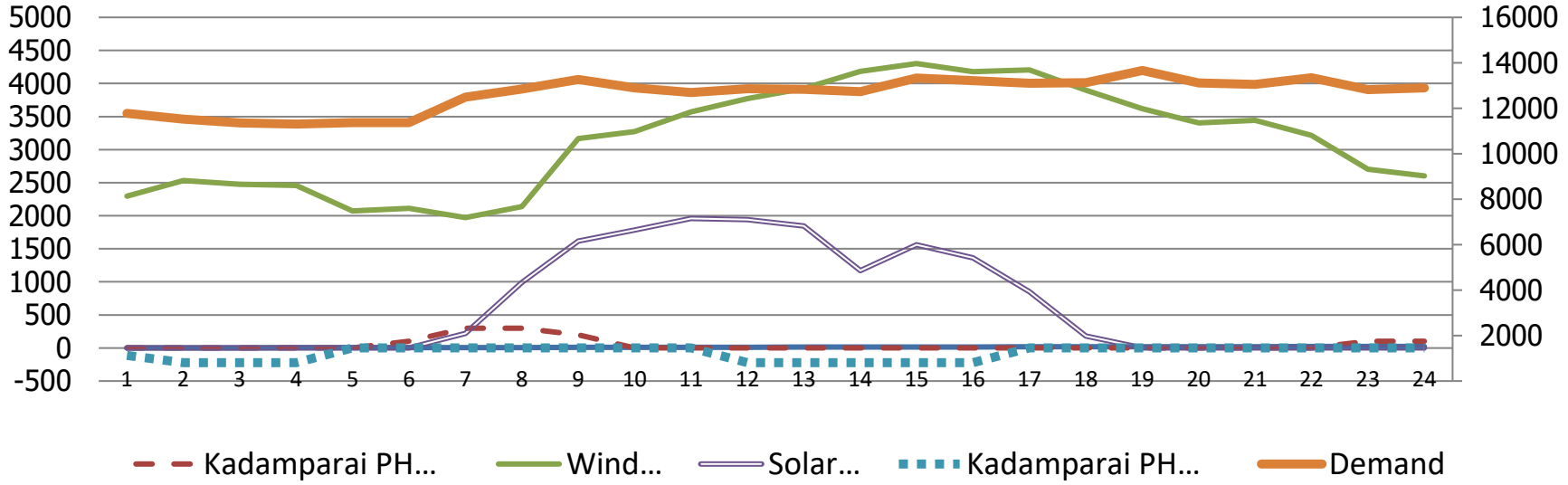
17-08-2020

in MW



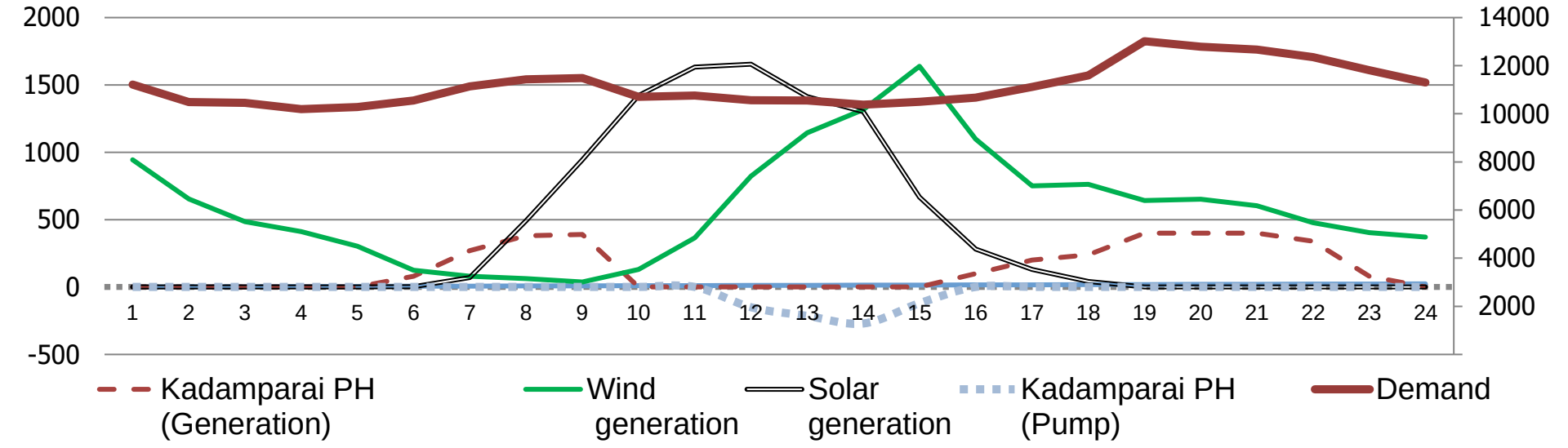
18-08-2020

in MW



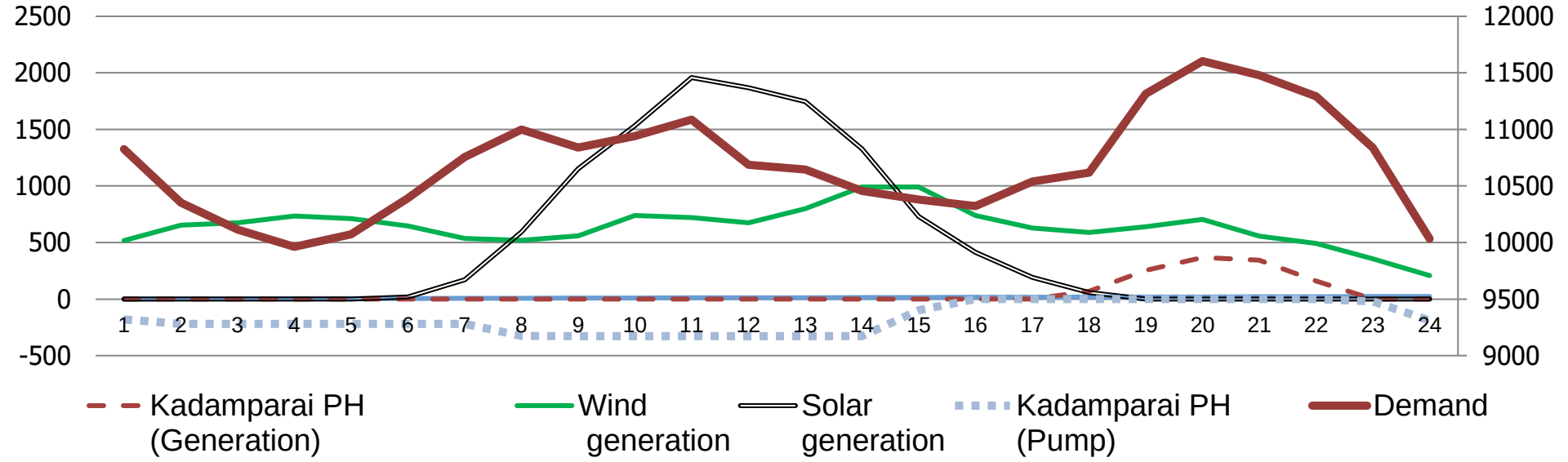
17-08-2019

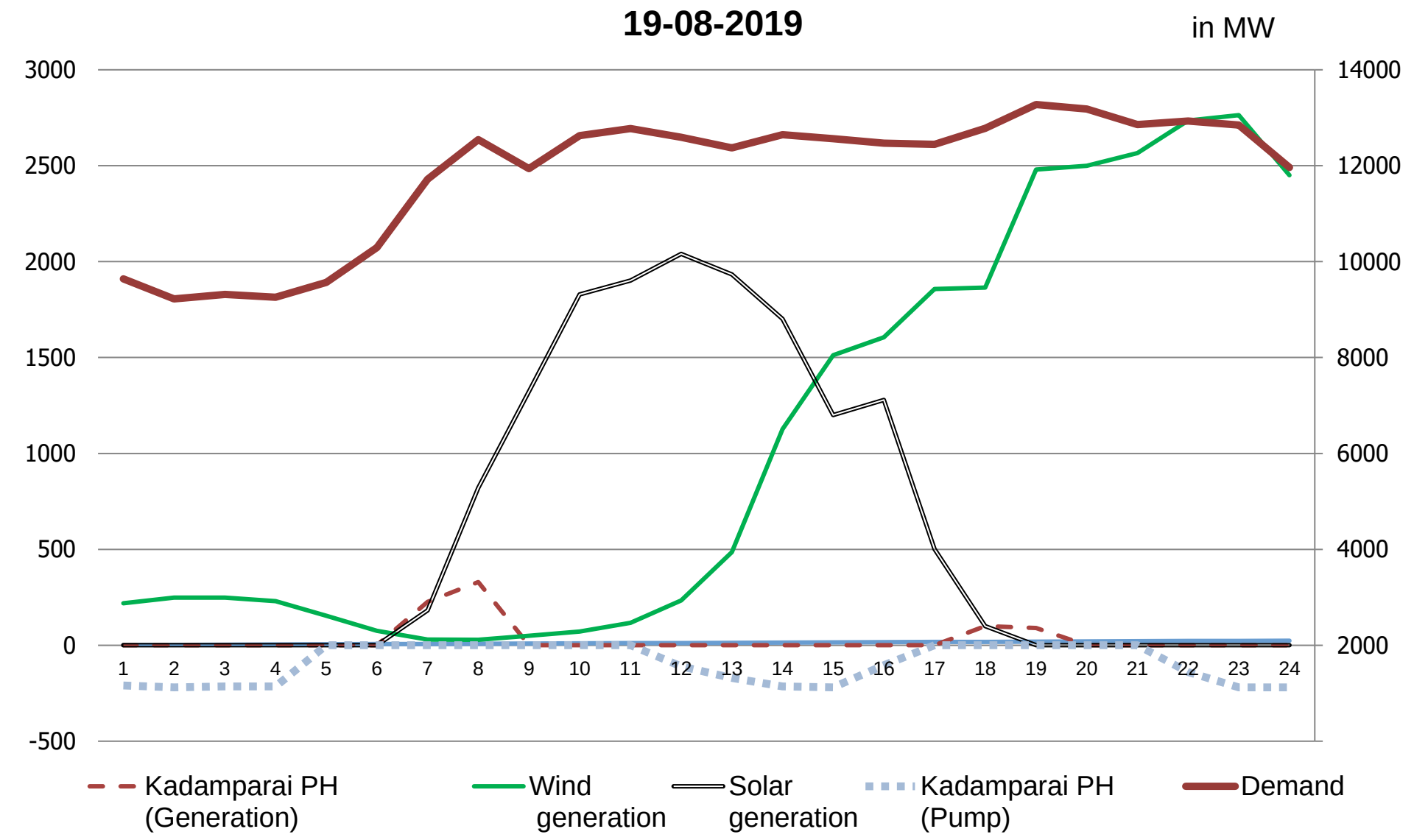
in MW

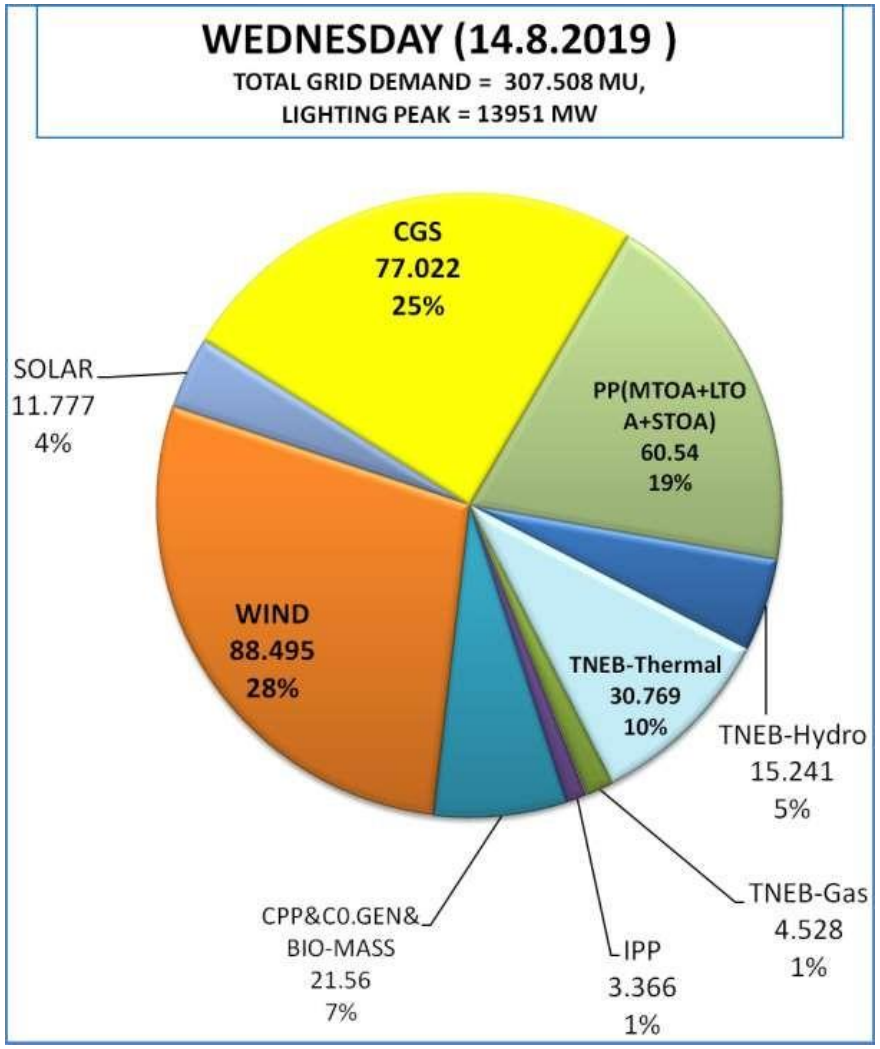


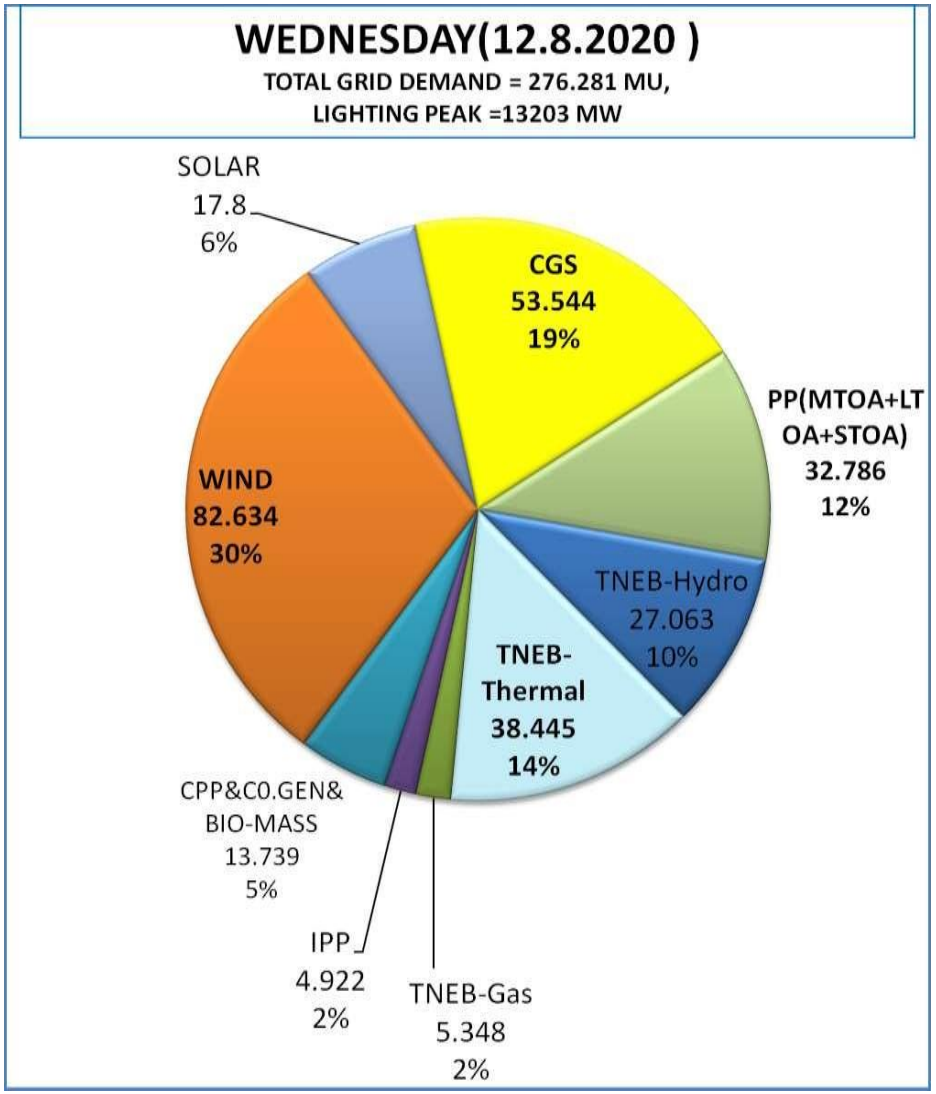
18-08-2019 sunday

in MW




19-08-2019
in MW
3000
2500
2000
1500
1000
500
0
-500
14000
12000
10000
8000
6000
4000
2000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Kadamparai PH (Generation)
Wind generation
Solar generation
Kadamparai PH (Pump)
Demand





	ALL TIME HIGH	
CONSUMPTION	369.940 MU	12.4.2019
DEMAND	16151 MW	3.4.2019

Fire in Transformer Bay

- The main transformer bay of underground hydropower station is constructed deeply underground and connected with the switch yard through power cable shaft .Transport passage is called as access tunnel and is of 1 km in length . The transformers placed in two locations inside the cavern. Unit 3&4 transformers were damaged in a fire accident in Oct'90.

Equipments damaged in fire

- 7 Nos unit power transformers ,single phase, 45 MVA: 11kv/230kv were damaged
- 230KV cables-7 runs-length each about 300m connected between transformer and switchyard in power cable shaft 2 were damaged
- EOT Crane
- unit 3 & 4 bus duct
- Power house lift and switchyard lift.

Challenges faced

- Dam leakage -reservoir level regulation and geo-membrane installation.
- upper dam filling through pump operation after geo-membrane installation.
- Frequent start/stop-components failure in stator/turbine.
- Removal of 25 ton mass rock over the control room due to a crack in the crown.

Kadamparai dam leakage

- 67 m heigh,480m length - RR masonry dam with earthen dam on both sides was commissioned in 1984. Leakage during commissioning of dam was about 200 Lpm.
- Out of 68 vertical shafts, leakages were predominant in shafts 7,13,19,34,41 and 46 and increased from 200 to1000 Lpm in 1997-98. Many measures like chemical mortar plugging by under water divers, grouting from top of dam racking, packing and pointing were under taken to arrest the leakage.

Leakage in vertical shaft 19

Leakage in vertical shaft 41

leakage in the drainage gallery

Leakage and reservoir level

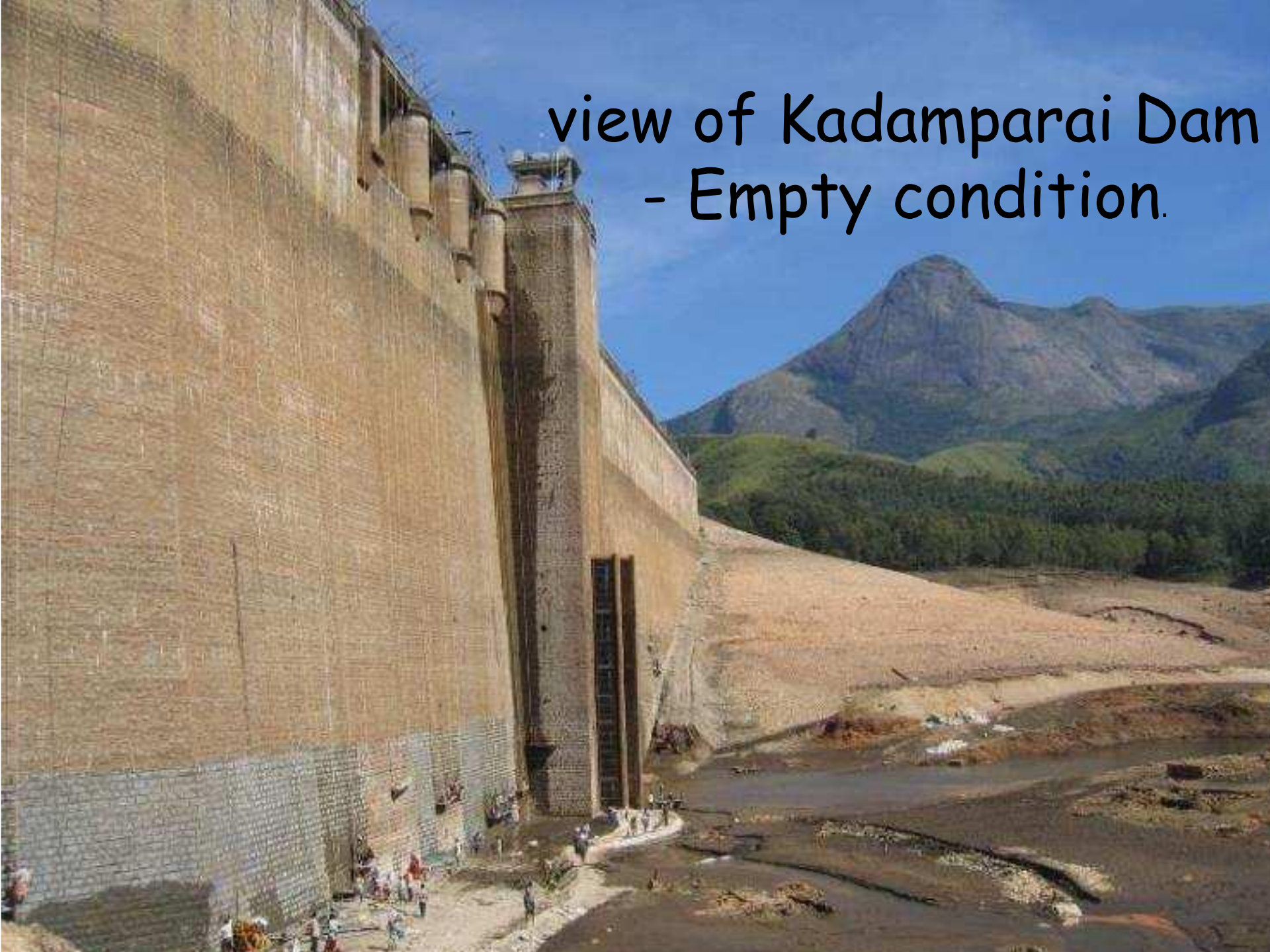
- However, over the years, the seepage increased and in 2003 the maximum operating level was pegged at 75 % of maximum height to limit the seepage.
- In 2003 the leakage was around 15,000 Lpm and rose to 25,000 Lpm in 2004.
- Hence upper reservoir regulated at a lower level and it was according to inflow& pump operation.

Geo-membrane installation

- Various methods adopted in Kadamparai dam to reduce the leakage had not given any fruitful result ,instead the leakage was increased from 1000 to 4000 Lpm.
- It was further increased from 4000 Lpm to10000 Lpm in 2002-03.Then it went to 15000 Lpm. Maximum leakage recorded was about 25,000 Lpm in July -Aug 2004.
- Hence it was decided to go for geo-membrane installation instead of conventional methods.

Dam empty

- For fixing Geo-membrane in the upstream face of Kadamparai Dam, the upper reservoir was emptied in Sept 2004 and water stored in the lower reservoir to its full capacity with a program to use the water in summer 2005. [i.e., after completion of geo-membrane installation work].


view of Kadamparai Dam
- Empty condition.

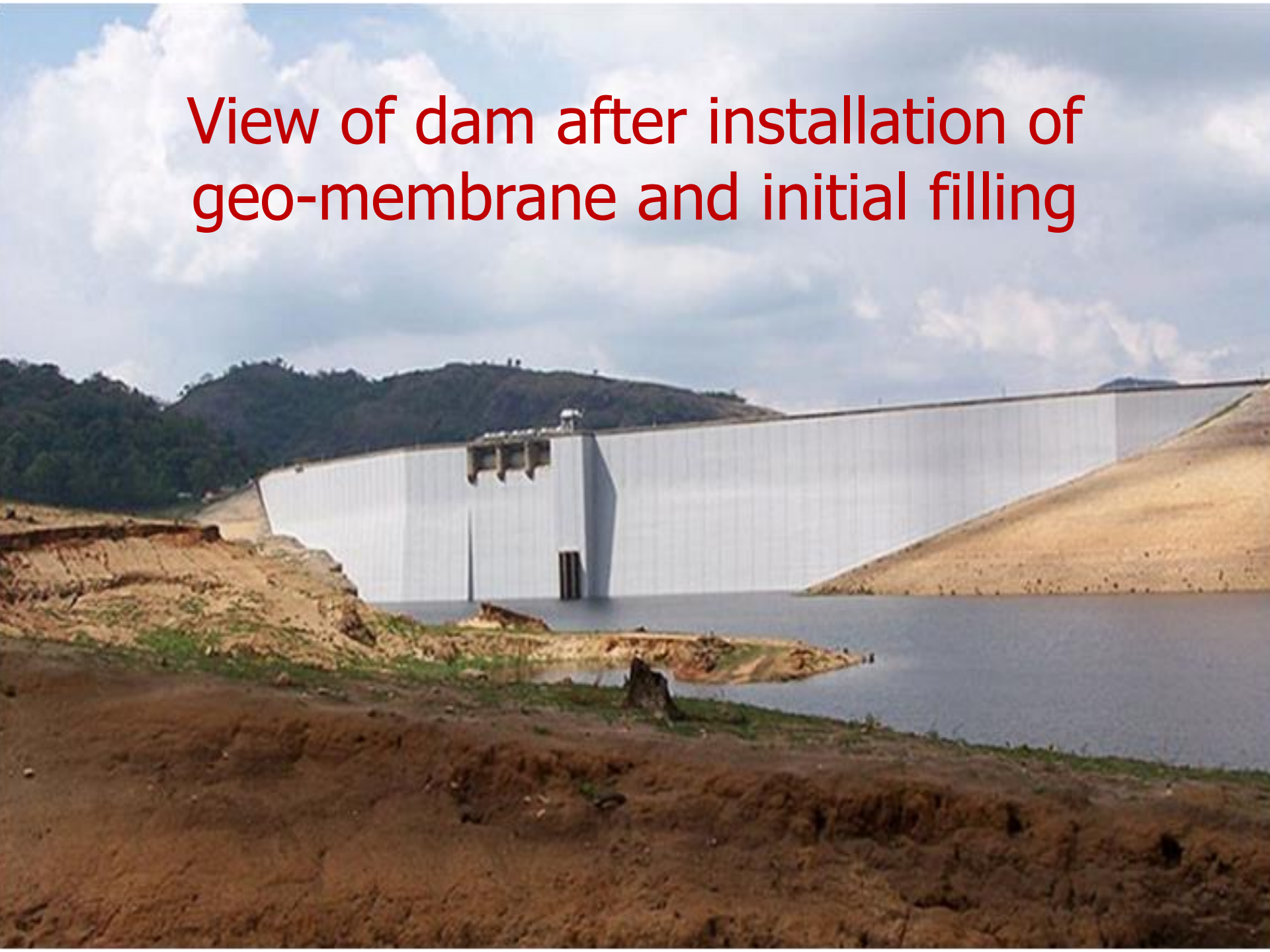

work in progress
The PVC geo-composite was laid over the anti-puncturing geotextile

Geo-membrane installation work in progress.

Upper reservoir filling

- First time one unit was operated as pump in April 2005 using SFC for filling water in Kadamparai dam after completion of geo-membrane work.
- Being summer period and as there was no inflow to Kadamparai dam ,water was filled by pumping from the lower reservoir.
- This was an achievement and useful record in the operation history of the power house.
- The summer demand was met in 2005 by utilizing Kadamparai pumped storage.

VIEW OF HRT INTAKE-WATER FLOW


View of dam after installation of
geo-membrane and initial filling


Kadamparai dam at Full level

Effect of Geo-membrane

- The installation of the exposed PVC Geo-composite provided as a rehabilitation measure proved efficient in the control of leakage.
- Seepage was less than 100 lpm when measured at FRL in 2005 monsoon.[i.e., after installation of Geo-membrane].

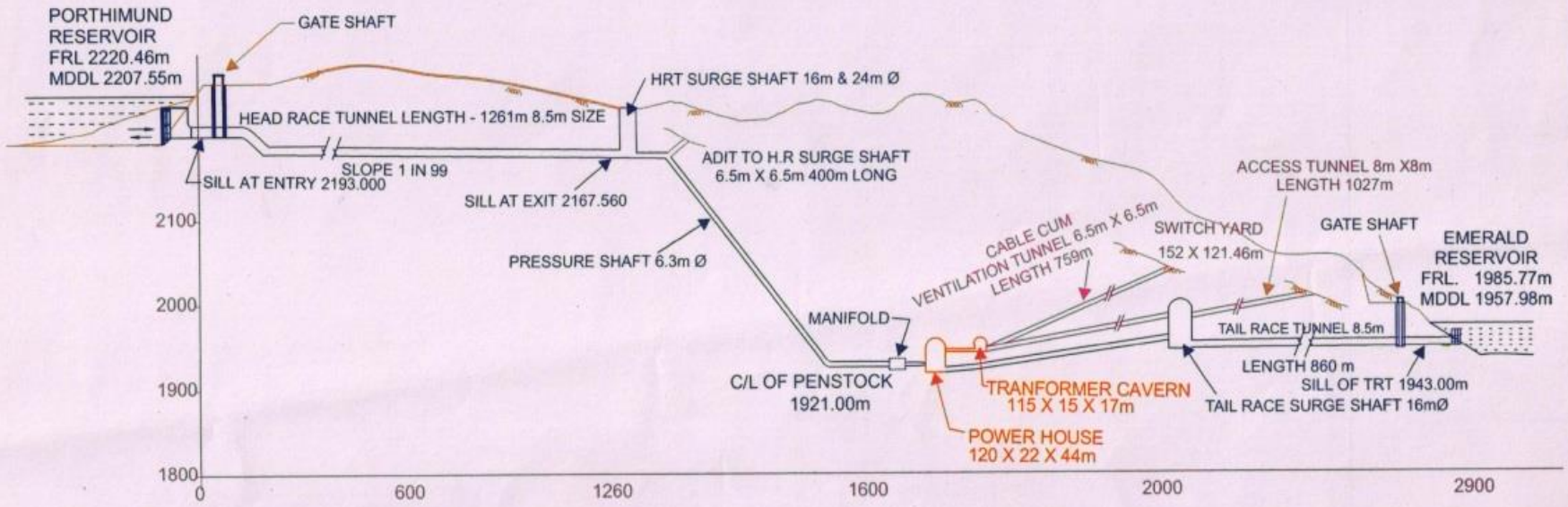
Area & cost

- Geo-membrane fixed in the upstream face was for 17500 sq.m and at an expenditure of 12 cores.
- The Kadamparai dam is operated at FRL after this work and the leakage is very minimum .
- No repairs done on geo-membrane at Kadamparai.

Future PSS operation.

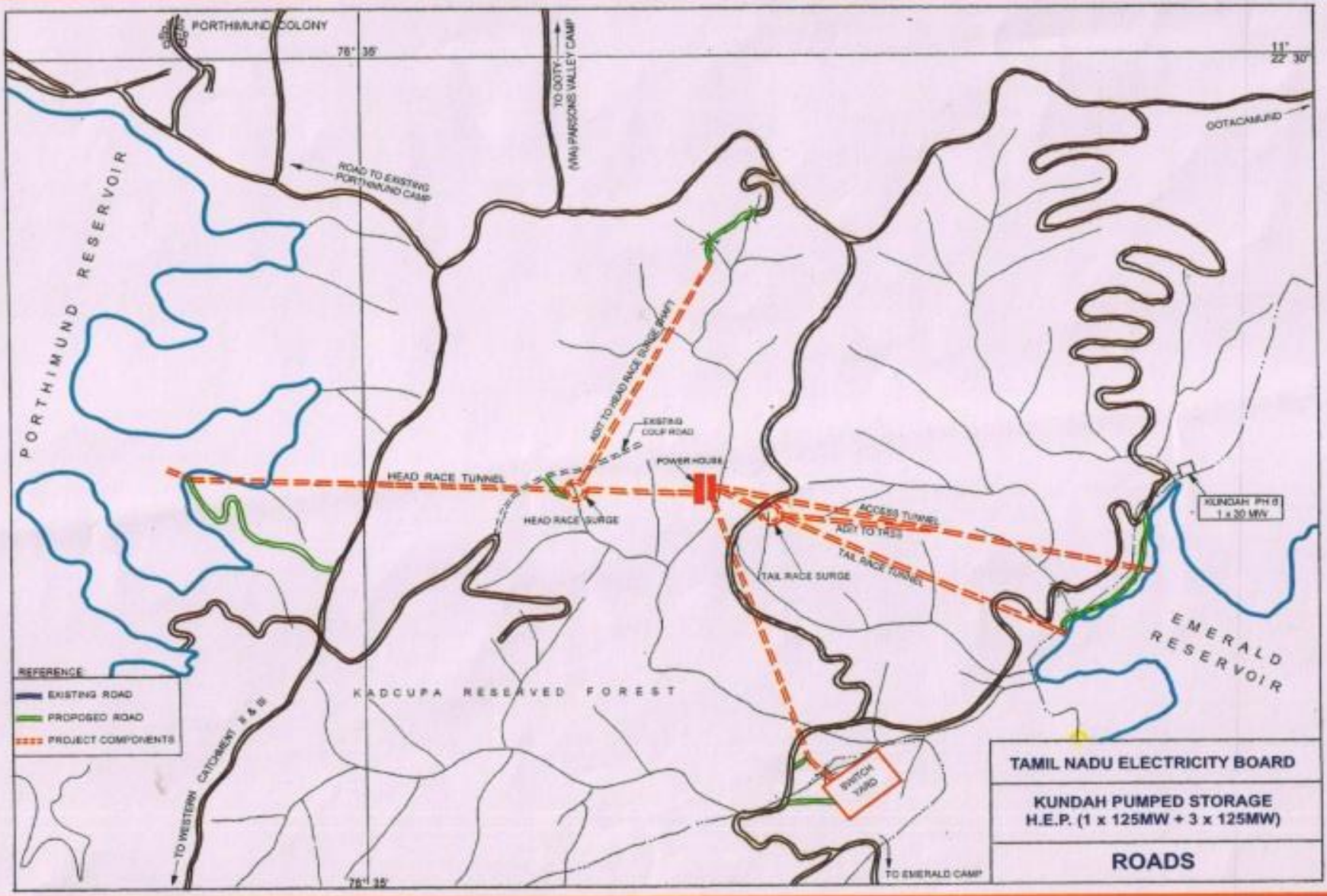
- Operation mode change from turbine to pump and pump to turbine may be the future requirement for PSS in our regional grid since frequency limitation and deviation from schedule is being narrowed and moving towards nearer to 50Hz& 150 mw respectively.
- .The use of PSS as frequency regulator is also expected soon in our grid.
- A need may come for synchronous condenser operation of hydro/PSS in our region and this is due to more wind usage, which is also one of the reasons for low voltage level in network.

KUNDAH PUMPED STORAGE HEP (4X125 MW)
THE NILGIRIS



PROFILE

KUNDAH PUMPED STORAGE HEP (4X125 MW)
THE NILGIRIS




TLB 740S
TEREX

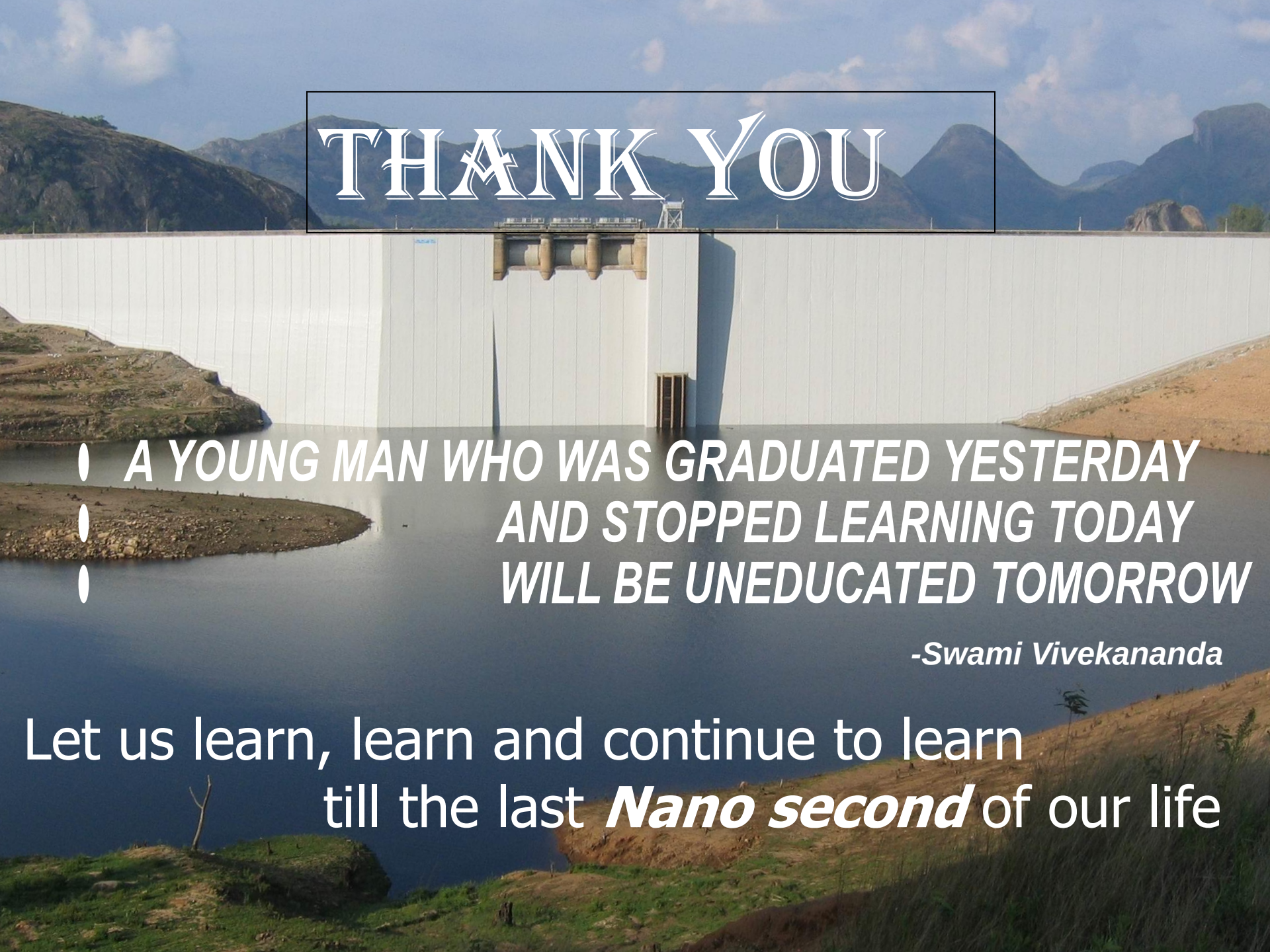
A-QUESTION

- What are services that Kadamparai PSS have provided so for and how the revenue to the SEB is assessed from pumped storage?

- How it is valued when it is a net user of energy ?

The answer is---

- Kadamparai has proved its participation in 2003-04 where severe draught was prevailed in the state. It was used during 2008-09, when the state was under serious shortage of power with heavy dose of power cut. Whenever unforeseen outages were faced from thermal stations, Kadamparai was used to its full capacity to avoid some load shedding.
- Kadamparai PSS is a good shock absorber and a fine operating tool in the hands of load dispatching engineers and is useful in the maintenance of power system reliability .
- Revenue assessment is a difficult task. But its operation gives hope for planning further addition of PSS in Tamil Nadu.


THANK YOU
A YOUNG MAN WHO WAS GRADUATED YESTERDAY
AND STOPPED LEARNING TODAY
WILL BE UNEDUCATED TOMORROW
-Swami Vivekananda
Let us learn, learn and continue to learn
till the last Nano second of our life

Complied by

Er.N.S.Namasivayam,ME.,MIE.,
Superintending Engineer,
Hydro-RMU/TANGEDCO.

sehydrormu@gmail.com,
nsnamasivayam@gmail.com
Mob:+919442513551