

Comparison of Pumping Station's Life Cycle Cost

*Dry installed,
Horizontal Split Casing Centrifugal (HSCF)
pumpset based Positive suction pumproom*

versus

*Wet installed,
Submerged Centrifugal (SubCF)
pumpset based Flooded suction pumproom*



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Date: 24/12/2013

To : To whomsoever it may Concern

Work Order No : SK/EE/1735 Dated 11/09/2012

Subject : Performance Certificate

Due to summer of 2012-13, Western part of Saurashtra was facing acute scarcity so the GoG wanted to add a source of water for this region. it was decided to make & commission a pumping station of 300mld on war footing near the end of Dhrangadhara Branch Canal (DBC). Apprehending Land Acquisition problems, GWS&SB decided to avoid construction of HR, Underground pump room conventionally required for HSCF pumps.

In just 40days, we have commissioned a 300mld pumping plant (including Civil, Electrical & Mechanical works in all respects) using "Aqua" make SubmergedCFpumpsets(1364m³/hr @ 15m head, 10W + 3S, 110hp).

These pumps run continuously in very highly turbid "dead" bottom water of DBC & have yet given excellent performance in this scheme which is now a permanent source for Western Saurashtra - we recommend the use of "Aqua" make SubCF pumps for time, land space, cost saving; energy conscious yet flexible & robust pumping.

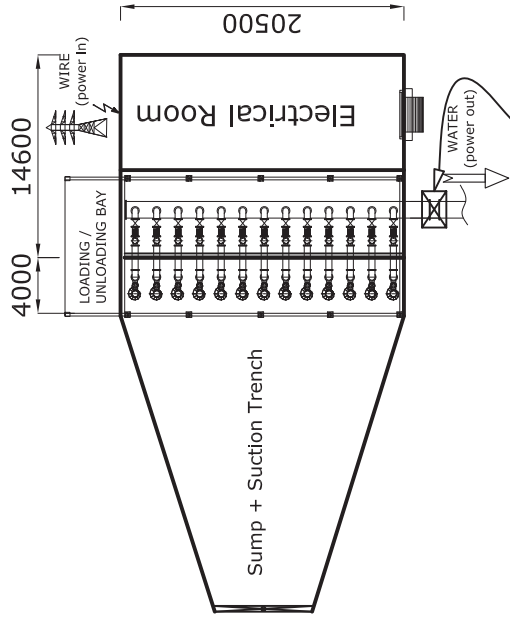

(N. H. Patel)

Chief Engineer, Z3 (Rajkot)

SCALE - 1:506
All Dimensions are in mm

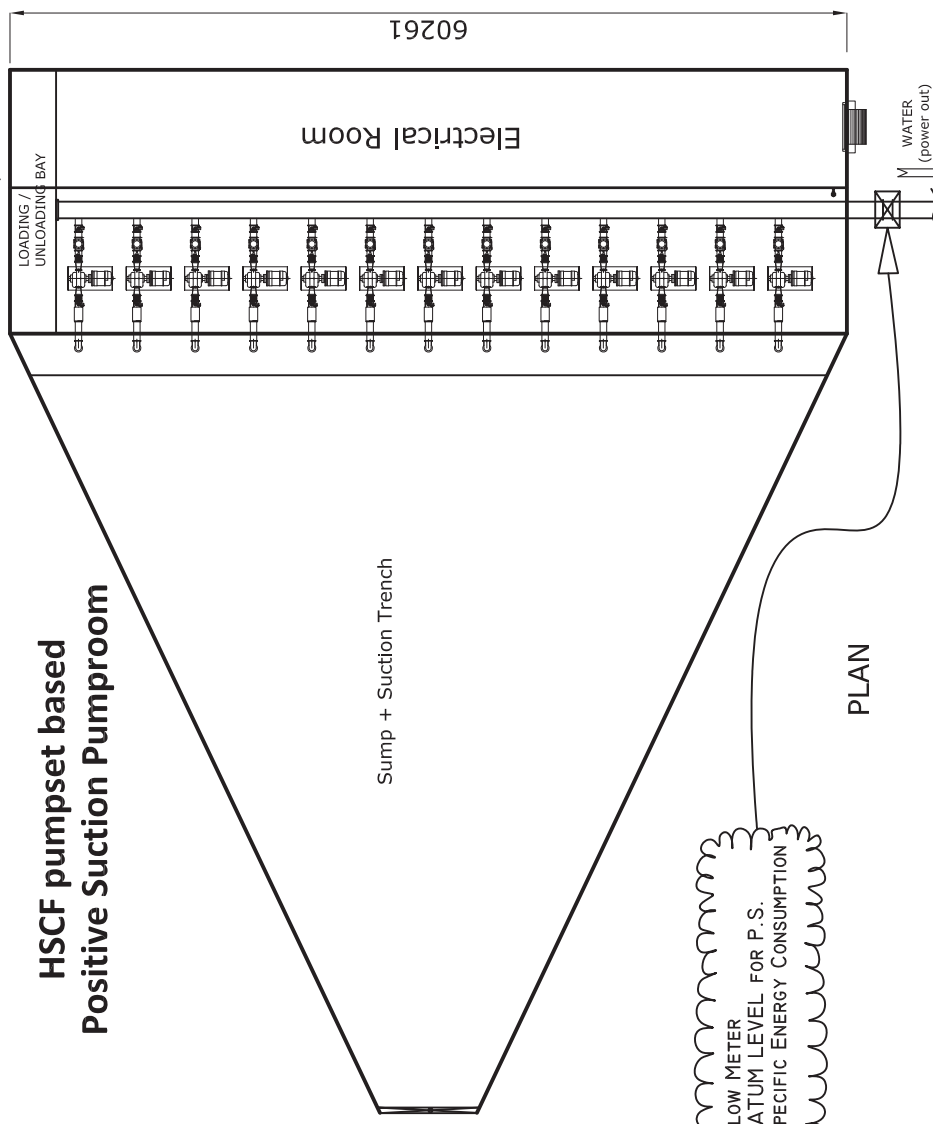
SPACE & LAYOUT COMPARISON

**SubCF pumpset based
Flooded Suction Pump room**



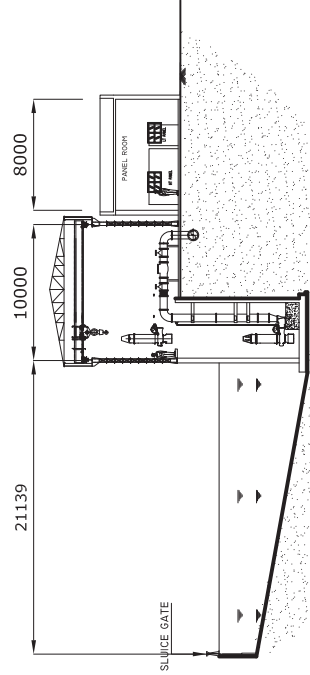
PLAN

**HSCF pumpset based
Positive Suction Pumproom**

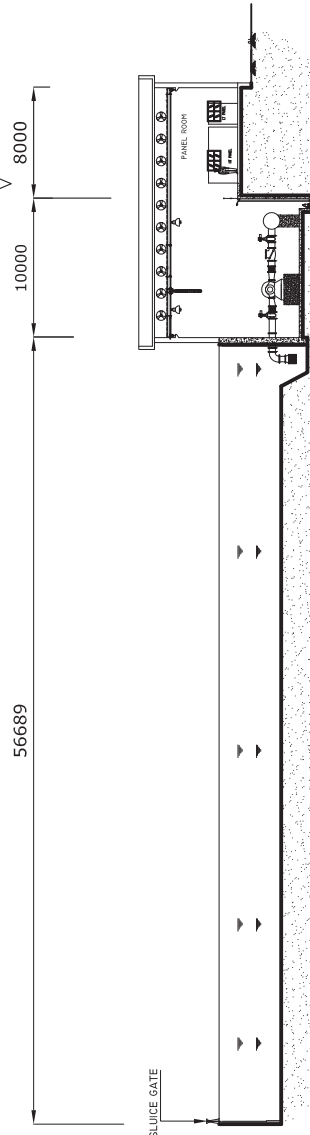


PLAN

FLOW METER
DATUM LEVEL FOR P.S.
SPECIFIC ENERGY CONSUMPTION



ELEVATION



ELEVATION

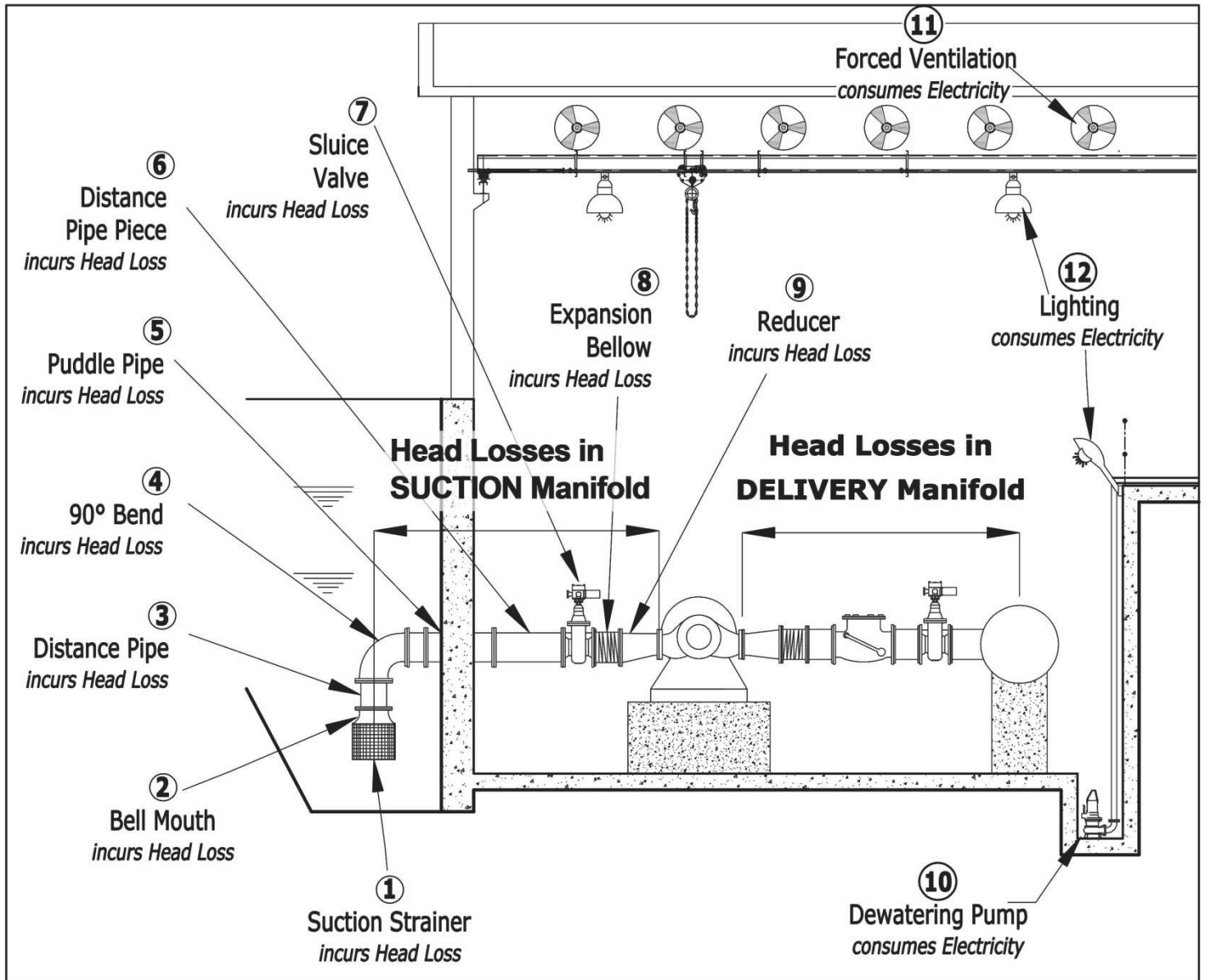
Conclusion : SubCF based Pumping Station is approx 53% More Economical, Saves approx 65% Land & Time to construct.

Capital COST Comparison of Optional Pumping Stations

Component/ Type of Installation <small>(IV - Intermediate Time Value, PV - Present Time Value, FV - Future Time Value)</small>				SubCF Pumping Station	HSCF Pumping Station	
Time Frame of Project Completion				month	3	18
Capital Cost : Civil Structure	Head Regulator	Total Component Capital Cost (IV - not time interest adjusted)	Rs.	2,00,00,000	2,00,00,000	
Capital Cost : Civil Structure	Approach Channel	Total Component Capital Cost (IV - not time interest adjusted)	Rs.	50,00,000	50,00,000	
Capital Cost : Civil Structure (Pump Room)	Pumpset Portion	Carpet Area	m ²	0	600	
		Cost of Pumpset portion of Pump		Rs.	0	1,05,00,000
	Electrical SwitchGear Portion	Carpet Area	m ²	0	360	
		Cost of Electrical portion of Pump Room		Rs.	0	3060000
	Cabling Trench Space	Cost of Cable Trench portion of Pump Room		Rs.	0	816000
	PumpRoom	Total Component Capital Cost (IV - not time interest adjusted)		Rs.	0	14376000
Capital Cost : Civil Structure	MS Structure over RWR <small>(for Hoisting SubCF pumps, included in HSCF pump room)</small>	required ?		✓	✗	
		Total Component Capital Cost (IV - not time interest adjusted)		Rs.	25,90,000	0
Capital Cost : Civil Structure	Electrical Room <small>(included in Pump Room itself in case of HSCF pumps)</small>	required ?		✓	✗	
		Total Component Capital Cost (IV - not time interest adjusted)		Rs.	10,20,000	0
Capital Cost : Civil Structure	RWR/ Sump	Total Component Capital Cost (IV - not time interest adjusted)	Rs.	29,78,750	74,33,200	
Capital Cost	Land Cost <small>(except Water body)</small>	Area	m ³	2450	7500	
		Rate/ m ²	Rs.	300	300	
		Total Component Capital Cost (IV - not time interest adjusted)		Rs.	7,35,000	22,50,000
CAPEX - Capital Cost : Pumping Station (Civil) (IV - not time interest adjusted)					73,23,750	2,40,59,200
				comparative %		100.0%
Capital Cost	Pumping machinery	Pump Set Qty. (W)	no.	10	10	
		Pump Set Qty. (S)	no.	3	3	
		Nearest Standard Motor Rating	kW	82	82	
		Approx. Total Rating of Installed pumping m/c	kW	1066	1066	
		Rate of Pumpset (Pump + Motor + Suction & Delivery manifolds)	Rs./kW	18805	18585	
		Rate of Common Header	Rs./kW	1725	2760	
		Lump Sum Capital Cost P/M		Rs.	2,55,25,370	2,63,94,160
CAPEX - Capital Cost : Pumping Station (Civil) + Pumping M/c (IV - not time interest adjusted)				-3,28,49,120	-5,04,53,360	
				comparative %	100.0%	153.6%

Conclusion: SubCF based Pumping Station is approx 53% More Economical, Saves approx 65% Land & Time to construct.

Comparison of Pumping Machinery, Auxiliaries & Ancillaries

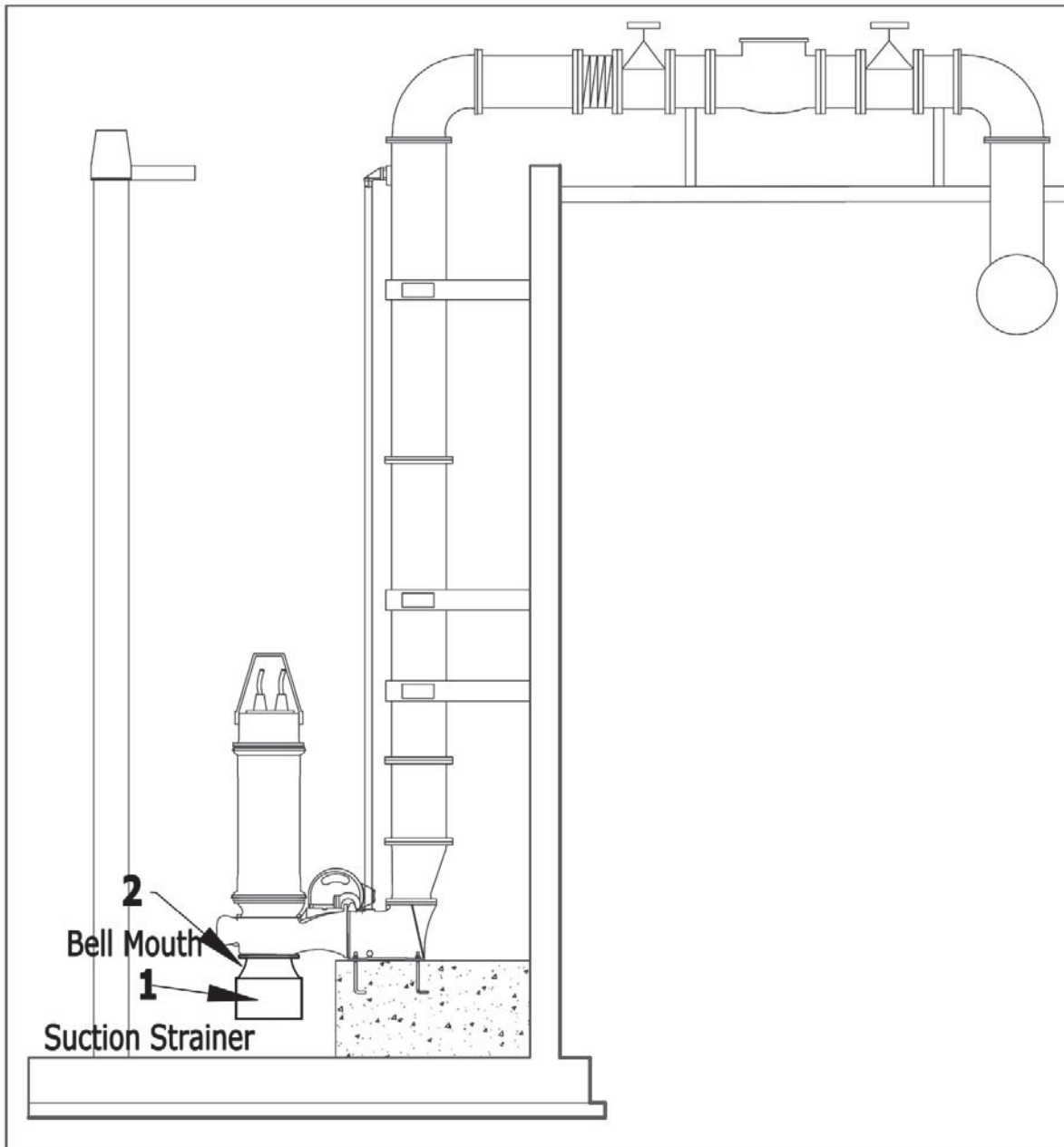


SubCF pumps are supplied with Suction Strainer (1) & Bell Mouth (2) as an Integral part of pumpset (i.e. at No Extra Cost).

Due to Submerged Installation, SubCF pumpsets :

- *Avoid Suction Manifold Ancillaries 3 to 9 (i.e. almost 77% Saving) thereby not only Reducing pumping machinery Cost but they also Reduce Suction Head Losses (thereby Save Power)*
- *Eliminate Risk of Flooding, Leakage, Seepage into pumphouse thereby eliminating the need of Dewatering pump (10).*
- *In SubCF pumpset piping, due to the In Line Axis of pipe - pump - motor (as compared to HSCF pumps & motors which are Perpendicular to piping);*
- *The pump to pump Spacing drastically Reduces which in turn results in a very compact pump room. The motors of SubCF are Self Water Cooled (unlike Air Blower Cooled TEFC CACA motors of HSCF) they Don't Need Additional Air Ventilation thereby raising Ambient Air Temperature within Motor room.*

Comparison of Pumping Machinery, Auxiliaries & Ancillaries



- *SubCF pumps are supplied with 1) Suction Strainer & 2) Bell Mouth as an Integral part of pumpset (i.e. at No Extra Cost).*
- *Mandatory auxiliaries in case of HSCF pumpset like,*
 - *3) Distance Pipe*
 - *4) Bend*
 - *5) Puddle Pipe*
 - *6) Distance Pipe Piece*
 - *7) Sluice Valve*
 - *8) Expansion Bellow*
 - *9) Reducer*

are not required by Submerged CF pumpsets thereby reducing Overall pumping machinery cost & Suction head losses too.

COMPREHENSIVE Cost Comparison between HSCF v/s SubCF PUMPING MACHINERY

(excluding EoT & Flow meter; but with unavoidable pump type specific Piping, Cable & Dewatering)

Sr. No.	Description of Manifolds	Size	Unit				
	Pumping Station	Sadulka					
	Numbers of Working Pumpsets	10	No.				
	Numbers of Standby Pumpsets	3	No.				
	Total Installed Pumpsets	13	No.				
	Discharge of Each Pumpset	1364	m ³ /hr				
	Head of Pumpset	15	m				
	KW of Pumpset	82	kW				
	Suction DN of Pumpset	400	mm				
	Delivery DN of Pumpset	300	mm				
	Suction Pipe Dia.*	500	mm				
	Delivery Pipe Dia.	450	mm				

Sr. No.	Description of Manifolds	Size	Wt./ each	Qty./ Pump	Unit	Total Qty.	Rate/ Unit	Amount
(A) Suction Manifolds (DN - 500 mm)		* - being Inbuilt &/or submerged, these are Not Required in case of SubCF					Rs.	Rs.
1	Suction Strainer	500 mm	50	1.00	kg	50	130	6500
2	Bell Mouth	500 mm	120	1.00	kg	120	74	8880
3	D/F Distance Pipe Piece (Vertical)	500 mm	165	1.00	m	165	74	12210
4	90° D/F Bend	500 mm	290	1.00	kg	290	74	21460
5	Puddle/ Crippling Pipe in Wall	500 mm	295	1.00	m	295	74	21830
6	Electrically Operated Sluice Valve	500 mm	1	1.00	No.	1	224910	224910
7	D/F Distance Pipe Piece (Horizontal)	500 mm	165	1.00	m	165	74	12210
8	Expansion Bellow	500 mm	1	1.00	No.	1	30314	30314
9	Reducer - 500 mm x 400 mm	-	174	1.00	kg	174	74	12876
Total Cost of Suction Manifolds Rs. per pump							Rs.	3,51,190

(B) Delivery Manifolds (DN - 450 mm)								
1	Enlarger - 300 mm x 450 mm	-	130	1.00	kg	130	74	9620
2	Expansion Bellow	450 mm	1	1.00	No.	1	32672	32672
3	D/F Distance Pipe Piece (Horizontal)	450 mm	140	1.00	kg	140	74	10360
4	DPCV	450 mm	1	1.00	No.	1	108670	108670
5	D/F Distance Pipe Piece (Horizontal)	450 mm	140	1.00	kg	140	74	10360
6	Electrically Operated Butterfly Valve	450 mm	1	1.00	No.	1	155190	155190
7	D/F Distance Pipe Piece (Horizontal)	450 mm	140	1.00	kg	140	74	10360
8	All Flanged Tee - 45°	2232 mm x 2232 mm x	2970	1.00	kg	2970	74	219780
Total Cost Delivery Manifolds Rs./pump							Rs.	5,57,012

(C) Lead Cable (10 m)		* being Inbuilt &/or submerged, these are Not Required in case of SubCF						
1	Size of Alu. Cable 1R x 3.5C x 95 Sq. mm - 10 m		1	1.00	Lot	1	4437	4437

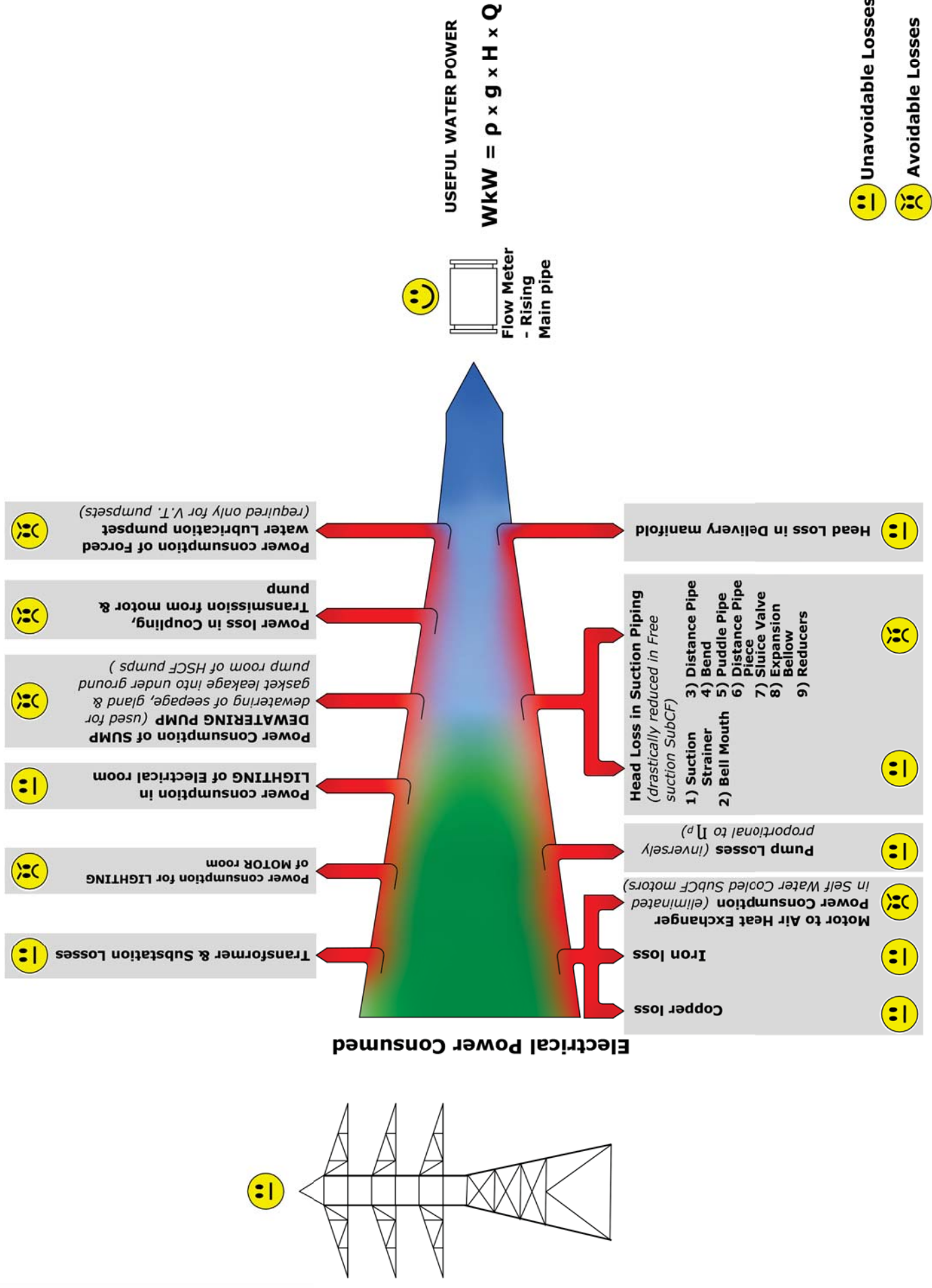
(D) Dewatering Pump (to keep UnderGround Pumproom dry)								
1	Dewatering Pump sets - 10 m ³ /hr x 10 m H - Electric Driven		5 hp	1.00	Set	2	17000	34000
2	Dewatering Pump sets - 10 m ³ /hr x 10 m H - Diesel Driven		5 hp	1.00	Set	1	24141	24141
Total Cost Dewatering System Rs.							Rs.	58,141

(E) Common Header			Qty.	C/c Dist.	Unit	Total Length	Rate/ m	Amount
1	2219 mm OD x 17.5 mm Thk.	SubCF	13	2.50	m	32.50	56564	Rs. 18,38,330
2	2219 mm OD x 17.5 mm Thk.	HSCF	13	4.00	m	52.00	56564	Rs. 29,41,328

ABSTRACT								
							HSCF	SubCF
1)	Rate per kW as GWSSSB, Electro-Mechanical SOR 2012-13					Rs./ kW	7400	12,010
2)	kW of Pump Set of Shadulka					kW	82	82
3)	Cost of each Pumpset					Rs. Rs.	6,06,800	9,84,820
4)	Nos. of Pump sets Installed					No.	13	13
Total Cost of Installed Pumpsets						Rs.	78,88,400	1,28,02,660
Add :	(A) Cost of Suction Manifolds					Rs. Rs.	45,65,470	-
Add :	(B) Cost of Delivery Manifolds					Rs. Rs.	72,41,156	72,41,156
Add :	(C) Cost of Lead Power Cable - 10 m					Rs. Rs.	57,681	-
Add :	(D) Cost of Dewatering Pumpset					Rs. Rs.	58,141	-
Cost of Elect. Ancillary						Rs./ kW	3415	3415
Cost of Common Header						Rs./ kW	2760	1725
TOTALIZED Cost of Pumping Machinery						Rs./ kW	24760	23945
<small>(up to Flowmeter - w/o EoT, w/o Flowmeter, w/o Transformer, w/o Substation)</small>						%	100.0%	96.7%

Even though HSCF PUMPSET is Apparently Cheaper (than SubCF); its TOTALIZED pumping machinery Cost is Slightly (3.3%) Higher (than SubCF Pumping Machinery)

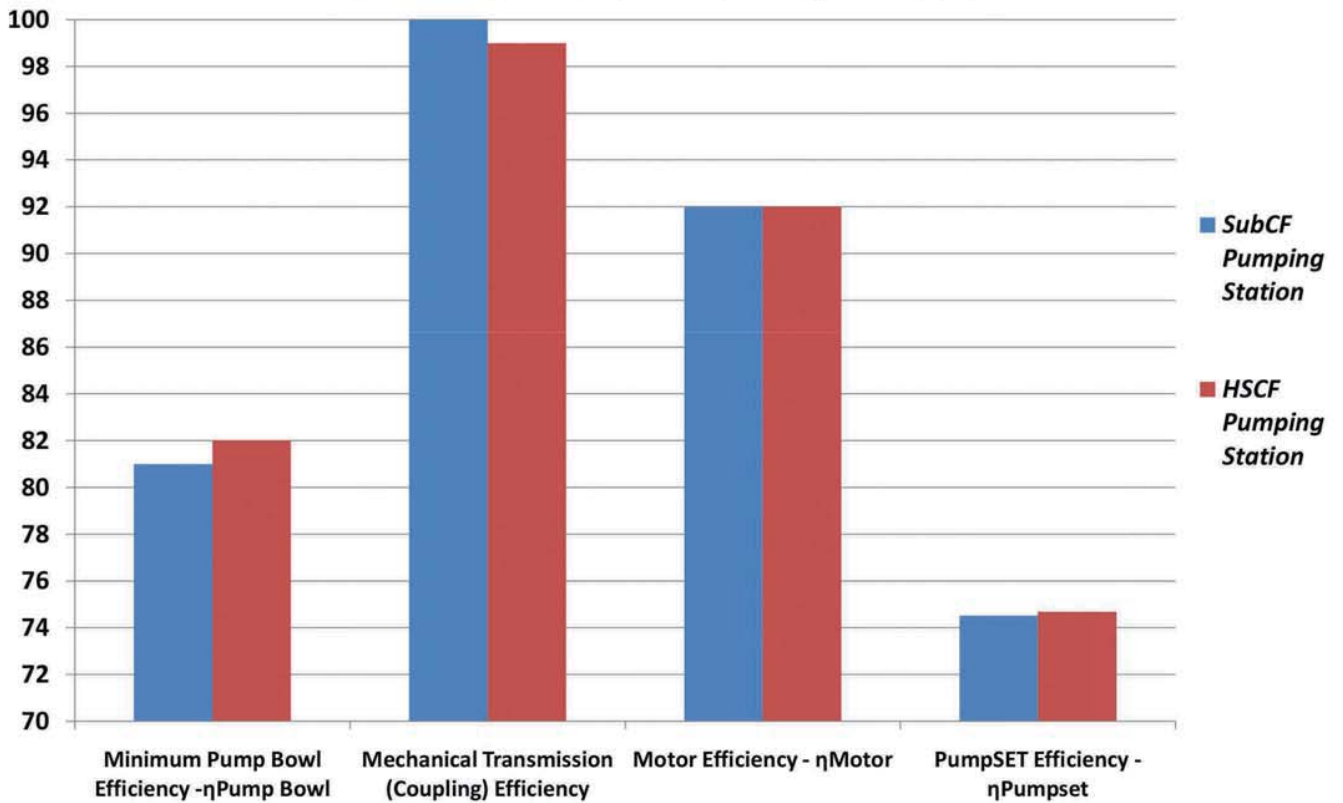
WIRE to WATER : Energy Losses of a Pumping Station



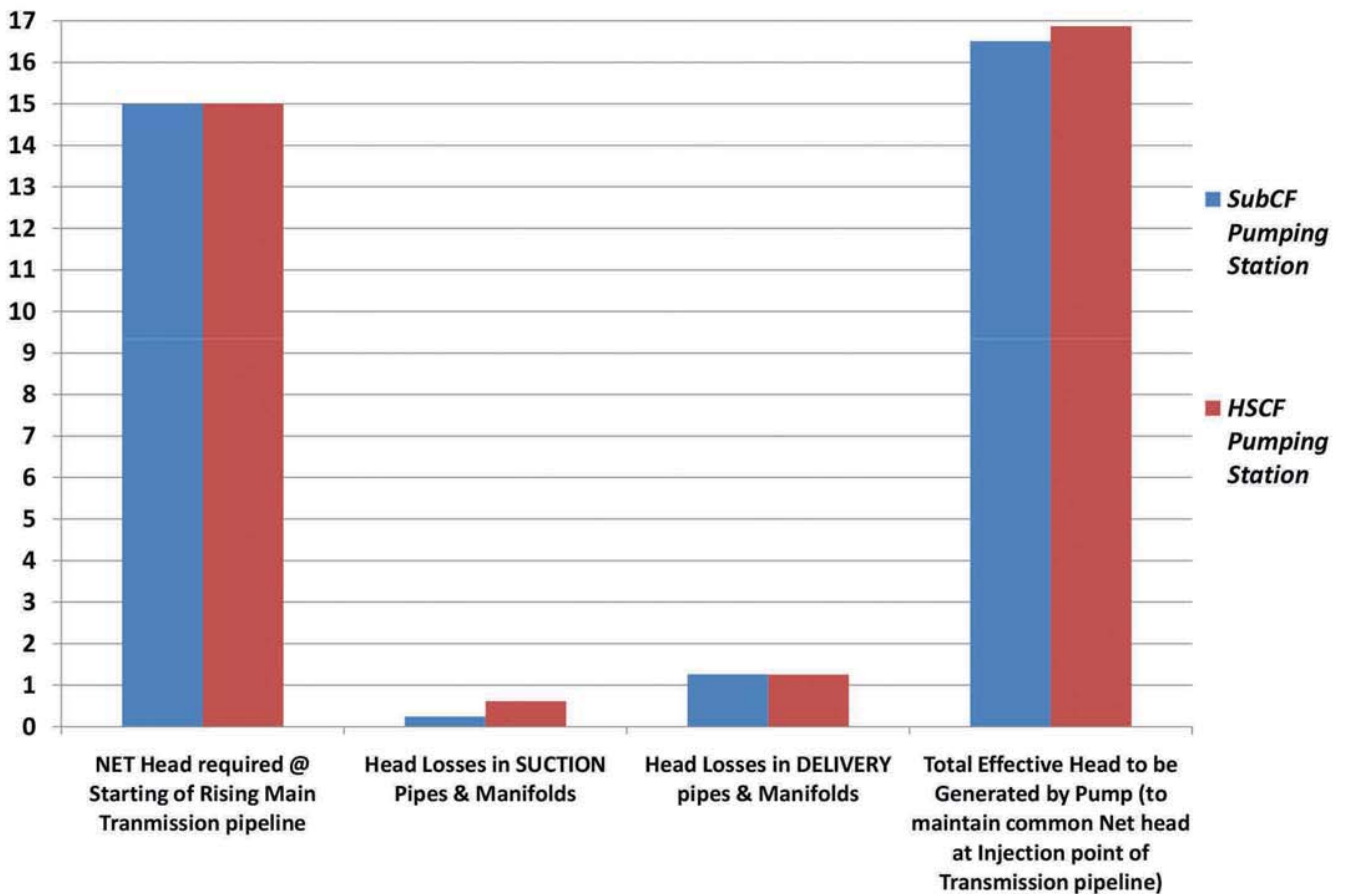
ENERGY Comparison of Optional Pumping Stations based either on SubCF or HSCF types of pumpsets
(adopted from original article published in 2013 Gujarat PHE's 38th Annual Day)

Component/ Type of Installation <small>(IV - Intermediate Time Value, PV - Present Time Value, FV - Future Time Value)</small>			SubCF Pumping Station	HSCF Pumping Station	
Capital Cost (outflow)	Energy Cost (PumpSets + Auxiliaries)	Total Capacity	mld	300	300
		Working hours per day	hr	22	22
		Pump Set Qty. (W)	no.	10	10
		Pump Set Qty. (S)	no.	3	3
		Individual Pump Flow	m ³ /hr	1364	1364
		NET Head required @ Starting of Rising Main Transmission pipeline	m	15	15
		Head Losses in SUCTION Pipes & Manifolds	m	0.25	0.62
		Head Losses in DELIVERY pipes & Manifolds	m	1.27	1.26
		Total Effective Head to be Generated by Pump <small>(to maintain common Net head at Injection point of Transmission pipeline)</small>	m	16.51	16.87
			%	100.0%	102.2%
		Pump Bowl Efficiency - $\eta_{\text{Pump Bowl}}$	%	81.0	82.0
		Mechanical Transmission (Coupling) Efficiency	%	100.0	99.0
		Motor Efficiency - η_{Motor}	%	92.0	92.0
		PumpSET Efficiency - η_{Pumpset}	%	74.52	74.69
		Pump Bowl Input (bkW) @ Effective Head generated by pumpset	bkW	75.70	76.42
		Motor (pumpset) Power Input Including Transmission losses	kW	82.3	83.9
			kWh per day	18101	18458
		Lighting of Electrical Room	Unit Rating (kW)	0.1	0.1
			qty / working + Standby	1	1
			Working hours	12	12
			kW / Day	15.60	15.60
		Lighting of Pump Room	Unit Rating (kW)	0.04	0.04
			qty / working + Standby	0.3	1.0
			Working hours	12	12
			kW / Day	2.06	6.24
		Auxiliary Power Consumption of Sump Pump (used for dewatering of seepage, gland & gasket leakage into under ground pump room)	Unit kW rating	0.0	1.1
			qty / working pump	0	1
			Working hours/ day	0	8
			kW / Day	0.00	44.00
		Forced Ventilation Exhaust of Pump Room	Current A	3.8	3.8
			Volt V	240	240
			Power Factor	1.0	1.0
			kW	0.9	0.9
			Qty / Working	0.25	1.00
			kW / Day	50.16	200.64
Cummulative AUXILIARY Power Consumption	kW / Day	68	267		
	%	100%	393%		
Pumpset + Auxillary power consumption	kW / Day	18,169	18,725		
Transformer, Electrical Substation & Miscellaneous Losses	kW / Day	2%	2%		
Total PS Power Consumption (Wire to Water)	kW / Day	18,533	19,100		
	%	100.0%	103.1%		
	kW/m3	0.061777	0.063667		
<i>In this case, even though Bowl Nozzle pump efficiency of HSCF is in fact 1% HIGHER (than that of SubCF), due to Elimination/Reduction of various Ancillaries & auxiliaries; the SPECIFIC POWER Consumption of SubCF based Pumping STATION is In Fact 3.1% LOWER.</i>					

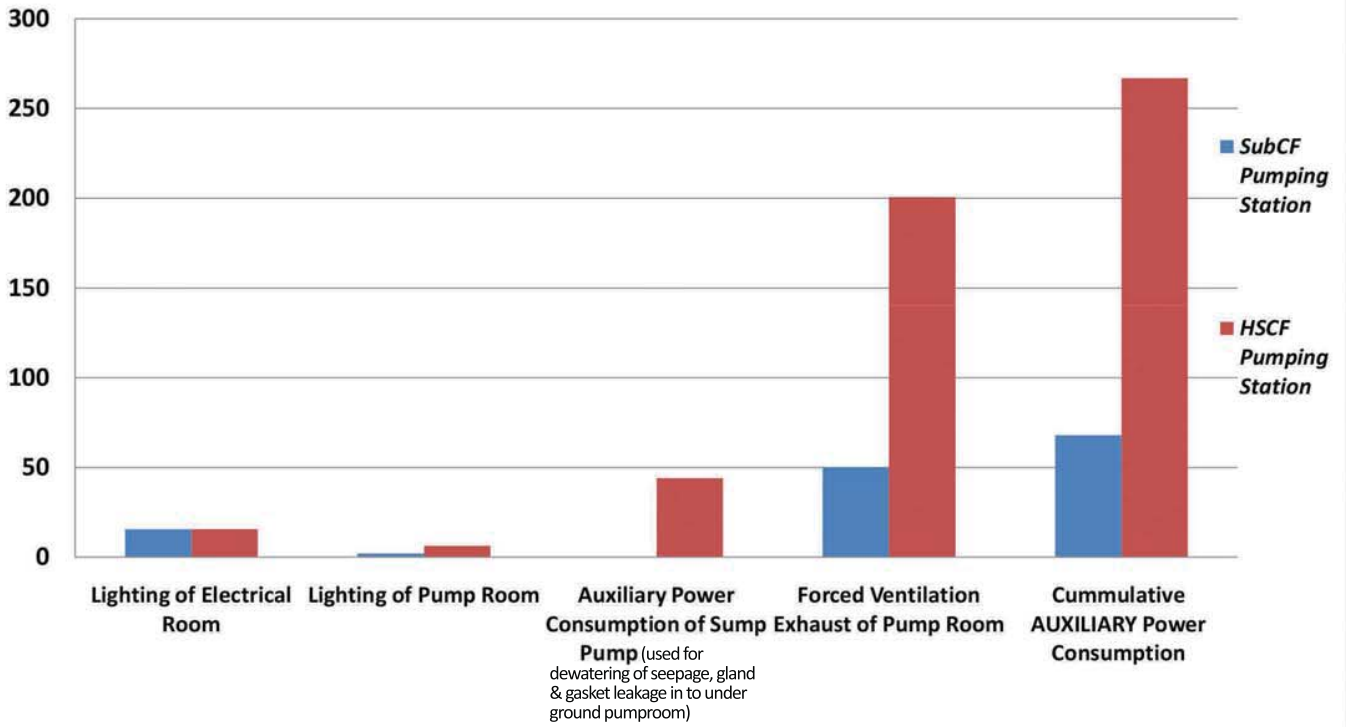
Comparison of Pump v/s PumpSET Efficiency (%)



Comparison of HEAD LOSSES (m) in Manifolds



Comparison of AUXILLARY Power Consumption (kW)



Comparison of Power Consumption

