Case Study
Implementation of Performance Contract in a Paper Mill

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National Environment Agency, Singapore

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Presentation Outline

- EE Market-Key drivers & Challenges
- Energy usage in paper industry
- Case study
  - Process followed
  - Project identification
  - Key terms of the performance contracts
  - Project execution
  - Project results
- Key learning
- Conclusion

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Setting the perspective

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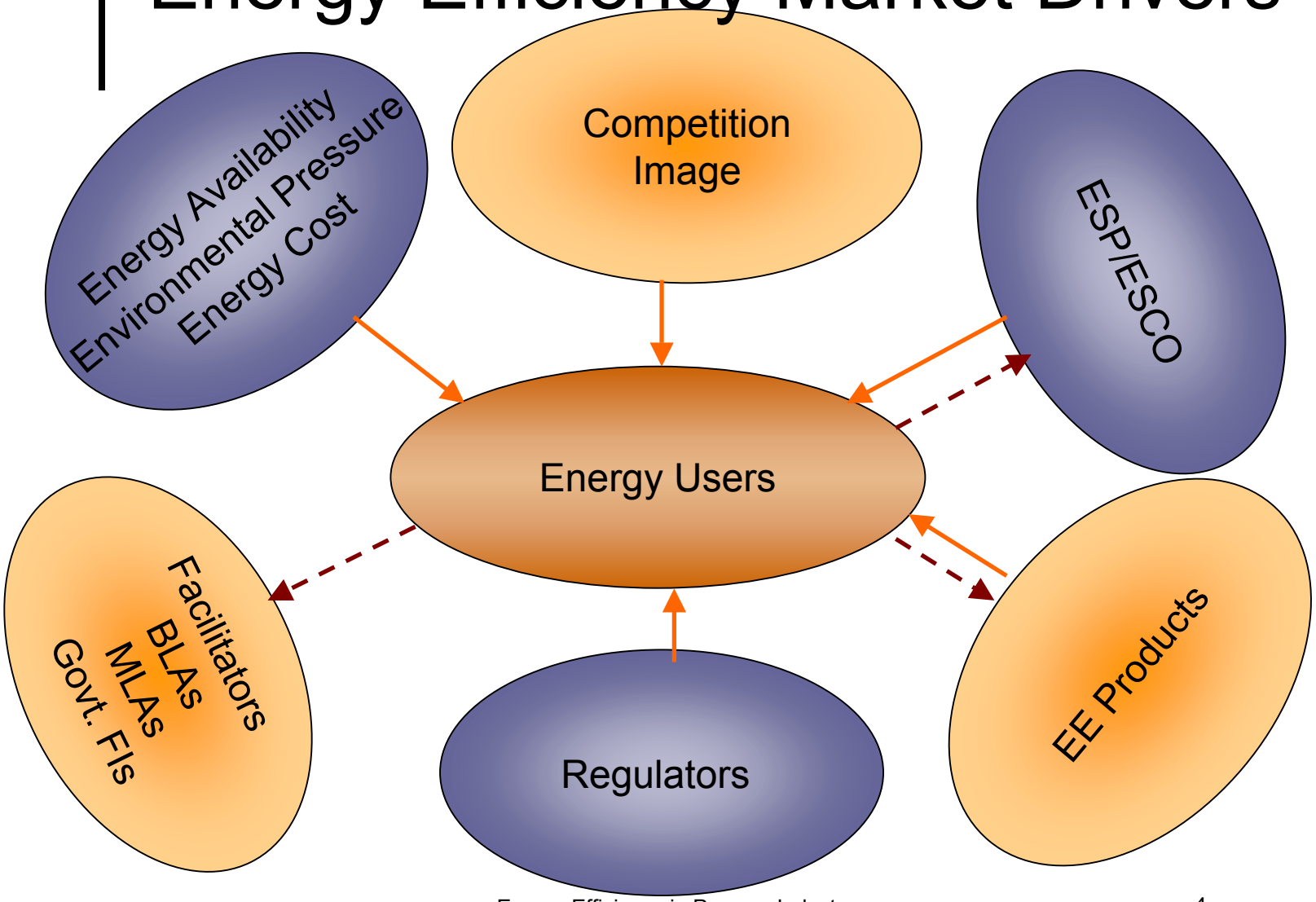
Energy Efficiency Market Drivers



Push ---→ Pull

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Energy Study in a Few Mills

Description	Unit	Unit A	Unit B	Unit C	Unit D	Unit E	Unit F
Capacity	TPD	70	40	350	150	150	100
Raw Material		Agro	Agro and Waste Paper	Wood Based	Wood Based	Waste Paper	Wood Based
Specific Consumption							
Power	kWh/T	1250	1100	1295	1369	955	1415
Steam	T/T	4.20	6.00	9.45	9.71	3.20	11.7
Water	m^3/T	240	100	250	200	-	-
Fuel (Coal)	T/T	-	1.25	0.96	1.78	0.58	2.34
Fuel (Rice Husk)	T/T	1.40	-	-	-	-	-
Energy Cost	Rs/T	5825	6500	4280	3440	3850	5955
Annual Energy Bill	Million Rs	127.7	57.0	485.0	150.0	190.6	188.5

DSCLES Approach-Performance contract

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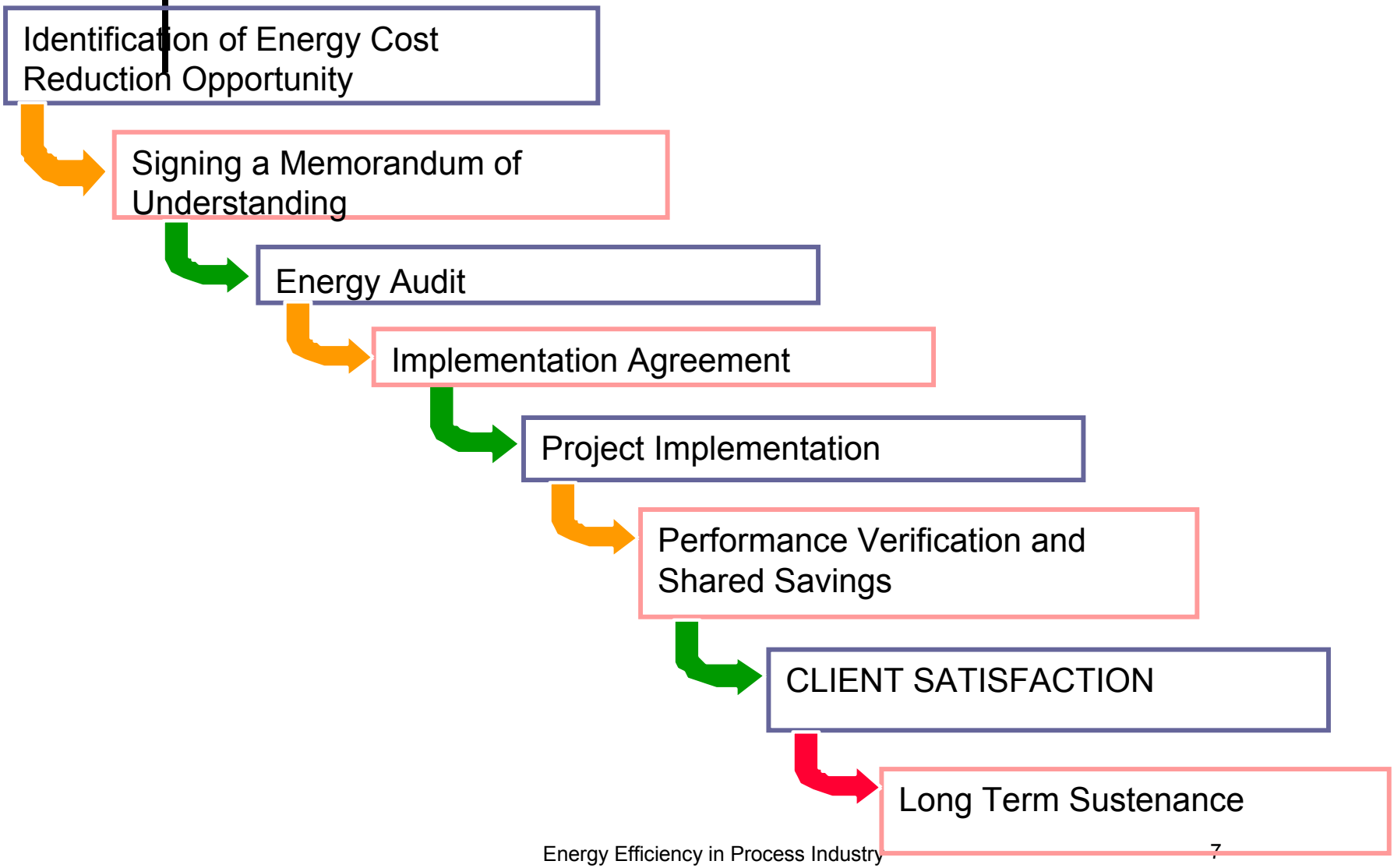
DSCLES Business Process



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Energy Cost Reduction Opportunities in Paper Manufacturing Operation

Input Management	Energy Efficient Equipment	Energy Efficient Systems
Fuel Switch Power Substitution Measurement and Accounting System	Pumps, Compressors, Fans, Chippers, Digestors, Paper Machines, Vessels, Heat Exchangers, Boilers, Conveyors	Waste Heat Recovery, Cogeneration, Process Synthesis, Process Integration, Power Distribution, Steam Distribution, Water Distribution, Material Handling, SCADA and DCS

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Case study-PC in 100 TPD Agro-waste based paper mill

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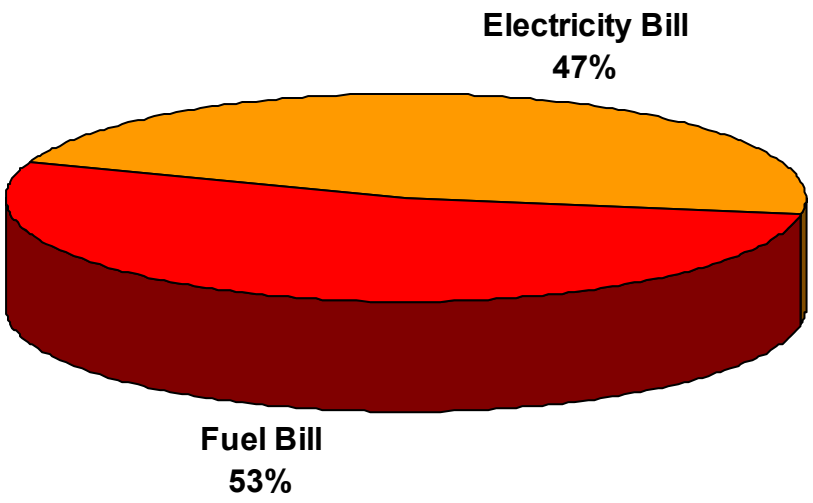
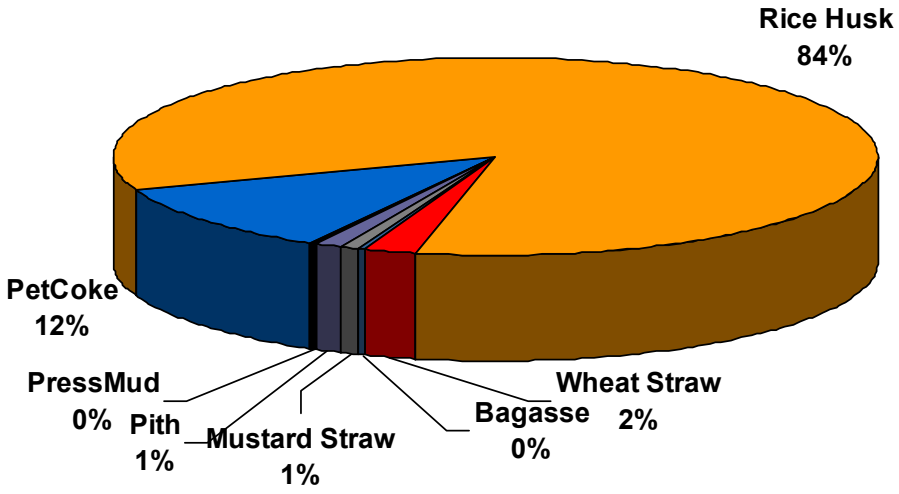
Overall Energy Scenario-As was



Total Energy Bill
Rs. 243 Mn



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Energy Saving Opportunities Identified During Energy Audit

S No	Energy Conservation Measures	Power Saving (kW)		Heat Saving (LkCal/hr)	Annual Savings	Investment	Payback
		Min	Max		Ms Rs	Ms Rs	yr
1	Boiler Feed Pump Efficiency Improvement	26.0	50.0		1.28-1.56	0.20-1	0.7
2	Water pumping efficiency improvement	38.0	50.0		1.47	0.70	0.5
3	Brown Stock washer Pumping Efficiency Improvement	62.5	89.3		2.78	2.00	0.7
4	Unbleached Centricleaner Efficiency Improvement	39.0	39.0		1.23	0.30	0.3
5	Bleached Pump Efficiency Improvement	35.0	35.0		1.03	0.30	0.3
6	LP steam usage for Lye mixture	14.0	14.0		0.34	0.10	0.3
7	P M/c # 3 hood exhaust recirculation			0.55	0.28	0.50	1.8
8	P M/c # 3 hood system – installation of closed hood			2.8-5.7	1.5-3	5-6*	2-3
9	Heat recovery from Vacuum Condenser at P M/C # 3			3.15	1.60	0.70	0.5
10	Separate vac pumps for felt boxes P M/c 1,2 & 3	20.0	20.0		0.64	0.20	0.3
11	Replacement of inefficient vacuum pumps at PM/c 1&2	Savings can be calculated after confirming the energy saving options. Please see the details.					
12	Double dilution system for PM/c # 3 fan pump system	50.0	71.0		2.00	1.00	0.5
13	Fan Pump Efficiency Improvement at P M/c # 3	38.0	38.0		1.24	0.20	0.3
14	Fan Pump Efficiency Improvement at P M/c # 1	5.7	5.7		0.18	0.10	0.6
15	Fan Pump efficiency improvement at P M/c # 2	7.0	7.0		0.26	0.10	0.4
	Total	***340***	***403***	***6.5 – 9.4***	***13.68***	***12.20***	***0.9***
	Savings from low investment project	***340***	***403***	***3.7***	***12.18***	***7.20***	***0.6***

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Key Features-Performance contract

- Assumptions
- Project scheduling
- M&V plan
- Savings sharing mechanism
- Variations and impacts

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Assumption-Calculation of Shared Savings

- Plant Operating hours 24 Hrs/day
- Operating Days 330 Days / year
- Cost of Electricity 3.90 Rs / kWh
- Cost of Rice Husk 1600 Rs / MT

Project Schedule

Project Description	Activity Schedule	Total Time	Responsibility
Boiler Feed Water Pumping system			
Common pump for two boilers	• Historical Data Collection & Measurement • Preliminary Assessment • Baseline Establishment • Measurement and Instrumentation • Agreed PMV protocol finalization. • Freezing Equipment specifications & Vendor • Equipment order & Procurement • Construction • Commissioning • PMV	• 4 D • 5 D • 4 D • 2 W • 1 D • 1 W • 4 W • 2 W • 1 W • 2 D	• DSCLES • DSCLES & Company • DSCLES • Company/Equip supplier • DSCLES & Company • DSCLES & Company • Company / Equip Supplier • Company / Equip Supplier • Company / Equip Supplier • DSCLES & Company

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Project Schedule…

Project Description	Activity Schedule	Total Time	Responsibility
LP Steam usage for Lye Mixture			
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Typical M& V plan

Project	Savings impact	M&V parameters	Measurement duration-hrs
High efficiency pump for pulp mill	Reduction of electricity consumption	Power input	3
		Frequency	3
		Pulp flow	3
		Pump pressure	3
		Pulp production	24
LP steam usage for lye mixing	Increasing power output from BP TG set	Back water flow	3
		Back water inlet & outlet temp.	3
		Process steam pressure & temp.	3
			8
		TG inlet pressure & temp.	8
		TG exhaust pressure & temp.	8
		TG steam flow	8
		TG Power generation	

Shared Savings Formula

SN	Project Description	Investments (in Rs)	Calculated Energy Savings (in Rs) per Year	DSCLES Share (of annual savings)	Installment Period (months)	Base ROI =C/B*100%
	A	B	C	D	E	F
1	Common pump for two boilers	200,000	1,280,000	25%	12	**640%**
2	Installation of new pump along with VFD	700,000	1,560,000	25%	12	**223%**
3	Installation of VFD and installation of new high efficiency pump	2,000,000	2,780,000	25%	12	**139%**

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Shared Savings Formula

SN	Project Description	Investments (in Rs)	Calculated Energy Savings (in Rs) per Year	DSCLES Share (of annual savings)	Installment Period (months)	Base ROI =C/B*100 %
	A	B	C	D	E	F
4	Installation of high efficiency pump unbleached centricleaner pump	300,000	1,230,000	25%	12	**410%**
5	Installation of high efficiency pump Bleached centricleaner pump	300,000	1,030,000	25%	12	**343%**

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Shared Savings Formula

SN	Project Description	Investments (in Rs)	Calculated Energy Savings (in Rs) per Year	DSCLES Share (of annual savings)	Installment Period (months)	Base ROI =C/B*100 %
	A	B	C	D	E	F
6	LP steam usage in lye mixture	100,000	150,000	25%	12	**150%**
7	Recirulating the PM/c # 3 exhaust	500,000	285,000	25%	12	**57%**
8	Heat recovery from vacuum condenser	700,000	1,650,000	25%	12	**236%**
9	Installation of new vacuum pump for wire section in PM/c # 3	200,000	624,000	25%	12	**312%**

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Shared Savings Formula

SN	Project Description	Investments (in Rs)	Calculated Energy Savings (in Rs) per Year	DSCLES Share (of annual savings)	Installment Period (months)	Base ROI =C/B*100%
	A	B	C	D	E	F
10	Double dilution system for PM/c # 3 approach system	1,000,000	2,000,000	25%	12	**200%**
11	Replacement of fan pump in PM/c # 2	100,000	180,000	25%	12	**180%**
12	Replacement of fan pump in PM/c # 1	100,000	240,000	25%	12	**240%**

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Impact of Variations-Financial Savings

SN	Performance Linkage and DSCL Share	Reduction in DSCLES Share in Savings
1	Energy Savings Achieved 75%-99% of "C"	2.5% of "D" per 5% reduction in savings
2	Energy Savings Achieved 50%-75% of "C"	5% of "D" per 5% reduction in savings
3	Energy Savings Achieved Less than 50% of "C"	10% of "D" per 5% reduction in savings

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Impact of Variation-ROI

SN	Change of ROI over base ROI	Reduction in DSCLES Share
	Increase(+) / Decrease(-) in ROI	
1	Change in ROI = 0 to +/- 20 %	0.5% of Change in ROI per 1% change in ROI from 0 and upto 20%
2	Change in ROI = +/- 20% to +/- 30 %	1% of Change in ROI per 1% change in ROI from 20% and upto 30%
3	Change in ROI = +/- 30% to +/- 50 %	1.2% of Change in ROI per 1% change in ROI from 30% and upto 50%
4	Change in ROI = +/- 50% to +/- 70 %	1.6% of Change in ROI per 1% change in ROI from 50% and upto 70%
5	Change in ROI > +/- 70%	1.7% of Change in ROI per 1% change in ROI ABOVE 70%

Sample Project

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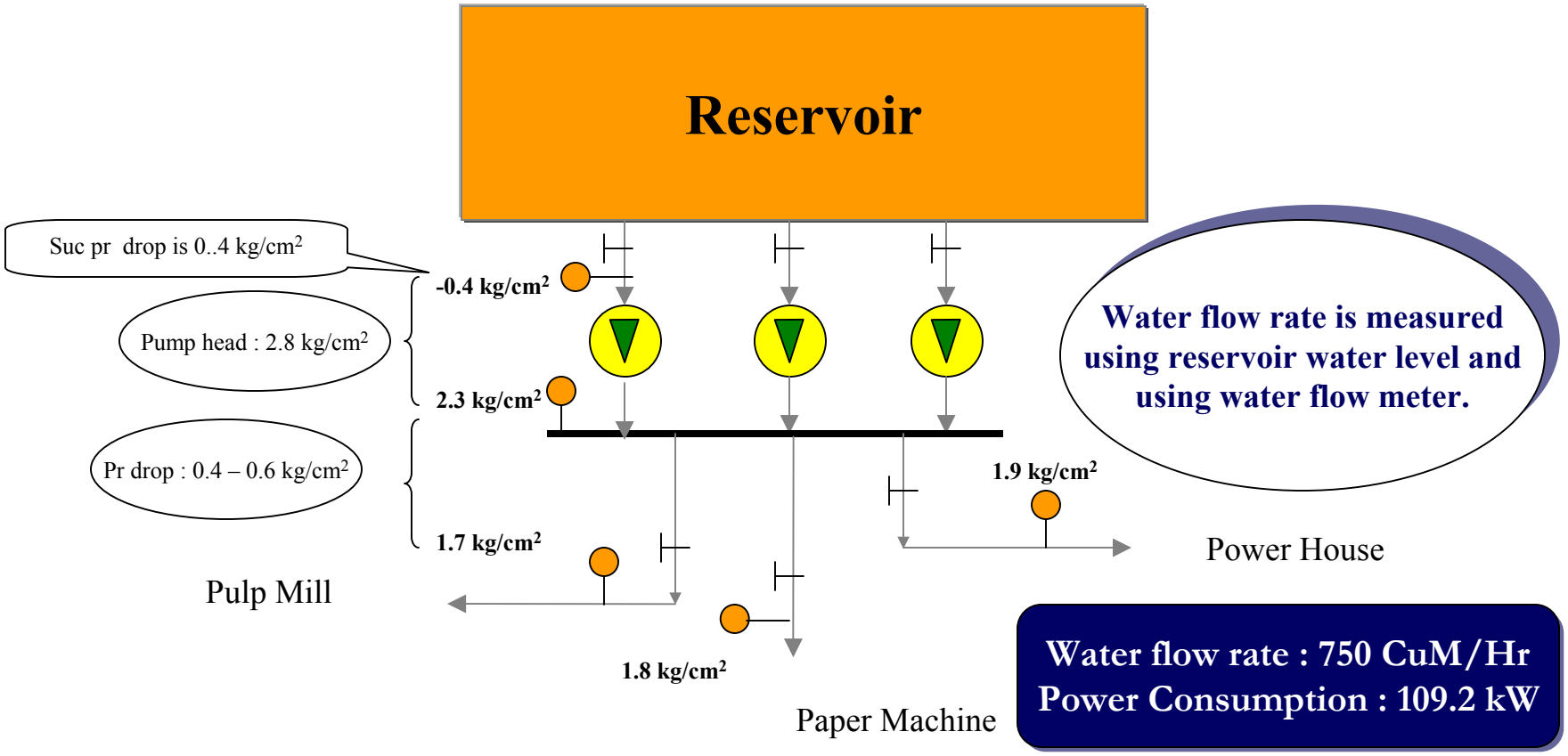
Water Pumping



* Note: Tube well pump that are considered for sustenance is separately analyzed and included in the sustenance report. These pumps savings were not identified earlier.

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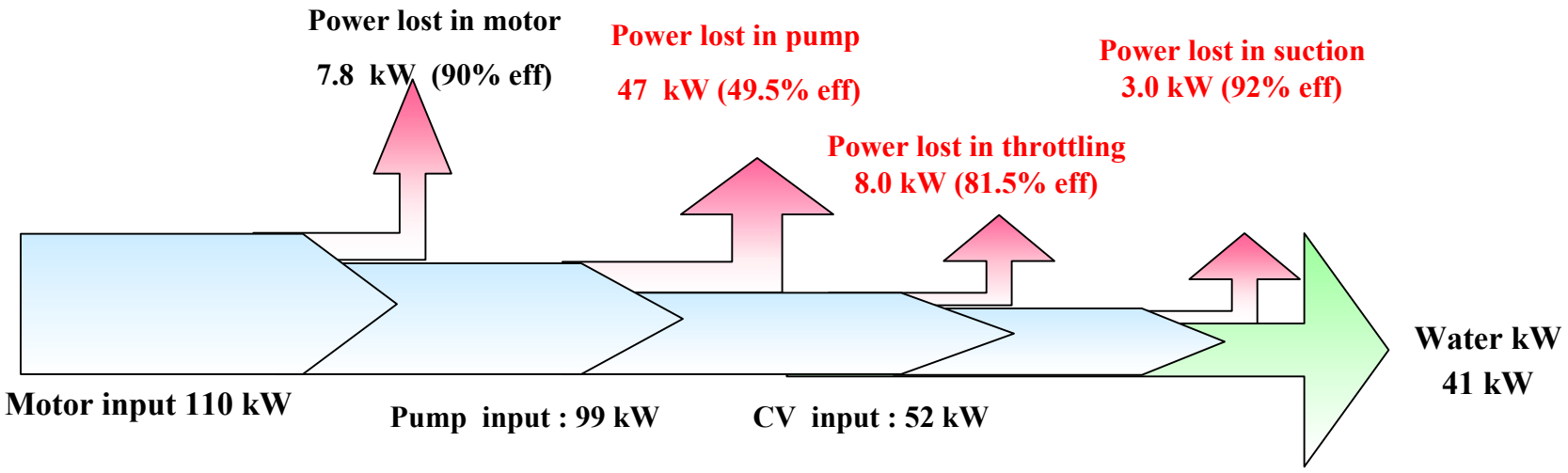
Water Pumping

Present system



System Efficiency is only 37%
Target System Efficiency 75%

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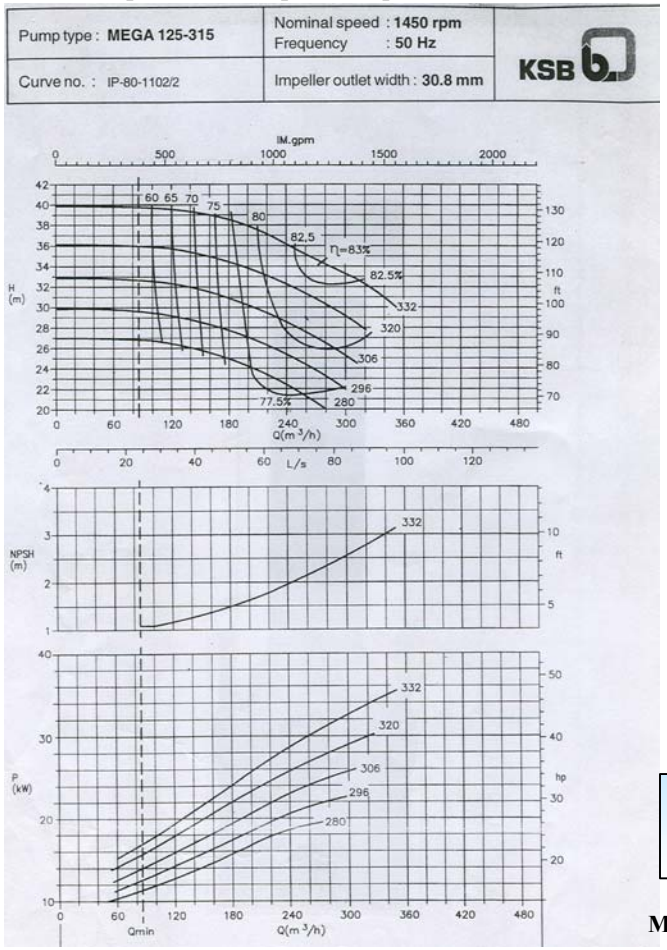
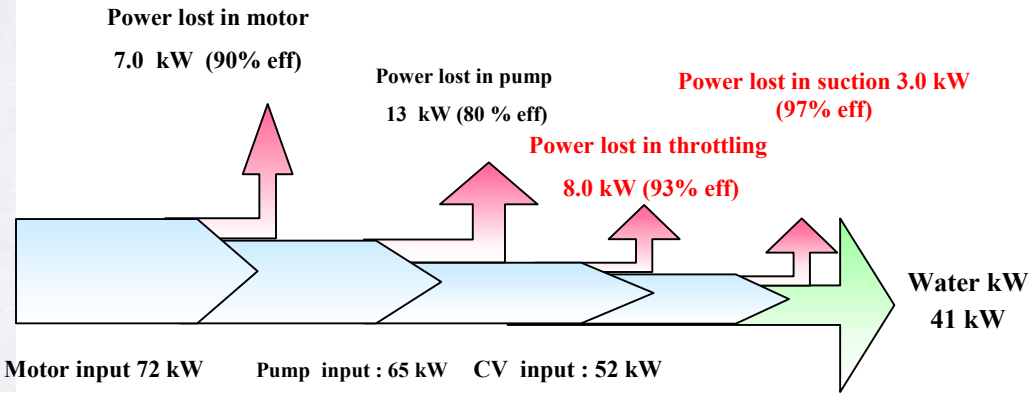
Installation of new pump

Proposed pump curve



Installation new energy efficiency pump. This will reduce the pump power consumption but will not reduce the throttling losses.

Power saving : Rs 38 kW
Annual saving : Rs.1.18 Mn
Investment : Rs. 0.40 Mn
Payback period : 4 months



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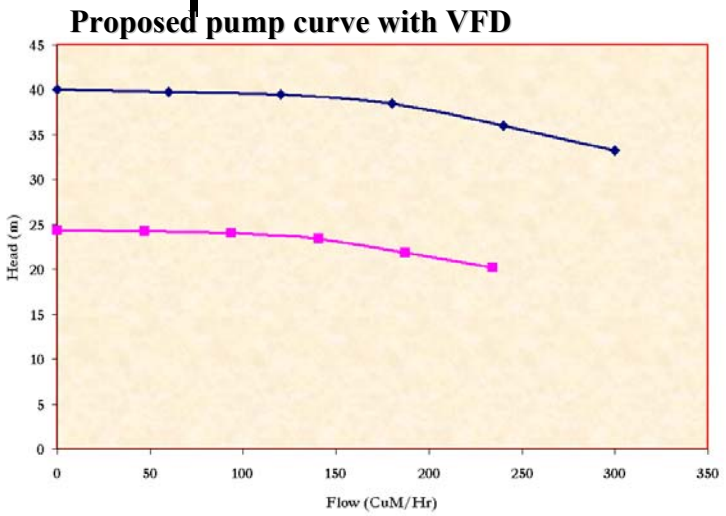
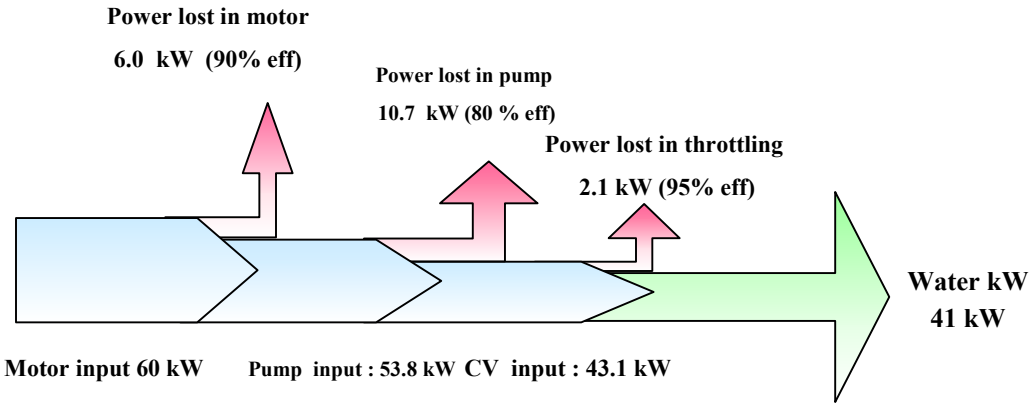
Installation of new pump along with VFD



Installation new energy efficiency pump. This will reduce the pump power consumption but will not reduce the throttling losses.

Power saving : Rs 50 kW
Annual saving : Rs.1.56 Mn
Investment : Rs. 0.70 Mn
Payback period : 5 months



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Water Pump – Options available

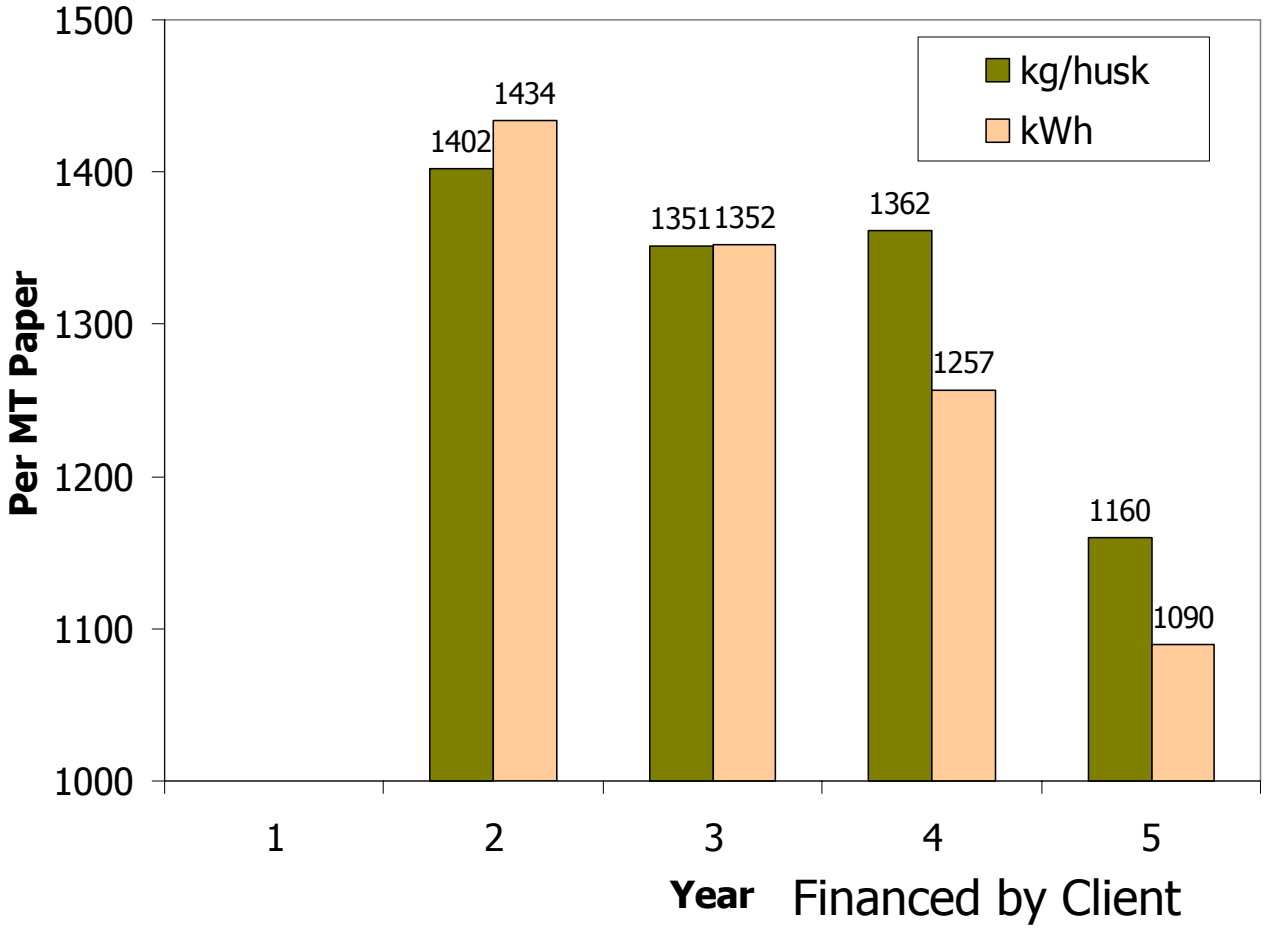
#	Options	Implementation issues
1	New high efficiency pump	New pump can be installed. And suction throttling need to be avoided as it may induce problems related to cavitations.
2	Separate pump along with VFD	Individual pumps for the sections such as paper machine, pulp mill and power house along with VFD will help in maintaining desired pressure with minimum throttling. Pumps can be put in auto by sensing discharge pressure and hook it up with pump VFD. However, to start with the system can be run in manual mode.

Power Saving : 38 - 50kW
Annual Saving : Rs. 1.18-1.56 Mn
Investment : Rs. 0.40-0.70 Mn
Payback period : 4-5 months

Project status

- New pump has been installed and relocated to reduce the discharge head.
- The paper mill has achieved a saving of 28 kW, equivalent to Rs. 870000/year.

Overall Achievement



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Key Learning

- Good diagnostic study and understanding of clients concern on implementation issues- critical success factors
- Organizational and financial capacity puts limitation on speed of implementation
- Forming joint project team and working together over three years led to achievement of results better than target.

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Thank You

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