

# Accelerating Energy Efficiency in Indian Data Centers

Accelerating Energy Efficiency in Indian Data Centers  
through continuous improvement in HVAC system.

# Accelerating Energy Efficiency in Indian Data Centers

## AGENDA

- Analysis of water and air-cooled chillers
- Recommendation on water and air cooled chillers for ECBC-2017
- Recommendation on cooling tower for ECBC-2017
- Recommendation on pumps for ECBC-2017
- Recommendation on economiser for ECBC-2017
- Recommendation on system efficiency for ECBC-2017

# Accelerating Energy Efficiency in Indian Data Centers



## Chillers

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ECBC Compliant	ECBC+	SuperECBC																																																																																																			
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- Data received from Vendors for water cooled chillers.

ECBC COMPLIANT				AS PER VENDOR DESIGN		
		ECBC requirement		at AHRI		
Water cooled chillers	Chiller Capacity (Kw)	COP	IPLV	TR/Kwr	COP	IPLV
Water Cooled Screw	<260	4.7	5.8	82.2/288	5.3	6.06
Water Cooled Screw	≥ 260 & < 530	4.9	5.9	154.7/542	5.7	6.85
Water Cooled Screw	≥ 530 & < 1,050	5.4	6.5	300/1053	5.5	6.79
Centrifugal	≥ 1,050 & < 1,580	5.8	6.8	450/1579	6.3	6.85
Centrifugal	≥ 1,580	6.3	7	600/2106	6.3	7.18
ECBC +				AS PER VENDOR DESIGN		
		ECBC requirement		at AHRI		
Water cooled chillers	Chiller Capacity (Kw)	COP	IPLV	TR/Kwr	COP	IPLV
Water Cooled Screw	<260	5.2	6.9	82.2/288	5.3	6.06
Water Cooled Screw	≥ 260 & < 530	5.8	7.1	154.7/542	6.2/5.7	6.85
Water Cooled Screw	≥ 530 & < 1,050	5.8	7.5	300/1053	6.0	7.31
Centrifugal	≥ 1,050 & < 1,580	6.2	8.1	450/1579	6.5	7.09
Centrifugal	≥ 1,580	6.5	8.9	600/2106	6.6	7.51
ECBC Super				AS PER VENDOR DESIGN		
		ECBC requirement		at AHRI		
Water cooled chillers	Chiller Capacity (Kw)	COP	IPLV	TR/Kwr	COP	IPLV
Water Cooled Screw	<260	5.8	7.1	82.2/288	6/5.3	6.06
Water Cooled Screw	≥ 260 & < 530	6	7.9	154.7/542	6.3/5.7	6.85
Water Cooled Screw	≥ 530 & < 1,050	6.3	8.4	300/1053	6.3	7.61
Centrifugal	≥ 1,050 & < 1,580	6.5	8.8	450/1579	6.9	7.51
Centrifugal	≥ 1,580	6.7	9.1	600/2106	6.8	7.73

# Accelerating Energy Efficiency in Indian Data Centers

## Recommendation for water cooled Chiller

- .
- All vendors complying with COP and IPLV values for ECBC compliance, and hence can be accepted.
- For ECBC + and ECBC super recommendation is for compliance of either COP or IPLV.
- Chillers designed at different temperature shall be de-rated at AHRI-550-590 to comply ECBC norm.

# Accelerating Energy Efficiency in Indian Data Centers

- Data received from Vendor for Air cooled chillers.

ECBC Compliant				AS PER VENDOR DESIGN		
		ECBC requirement		at AHRI		
Air cooled chillers	Chiller Capacity (Kw)	COP	IPLV	TR/Kwr	COP	IPLV
Air Cooled Screw	<260	2.8	3.5	82.61/290	3.3	4.2
Air Cooled Screw	≥ 260 & < 530	3	3.7	120.7/423	3.1	4.51
Air Cooled Screw	≥ 530	3	3.7	151/530	3.0	4.69
ECBC +				AS PER VENDOR DESIGN		
		ECBC requirement		at AHRI		
Air cooled chillers	Chiller Capacity (Kw)	COP	IPLV	TR/Kwr	COP	IPLV
Air Cooled Screw	<260	3	4	82.61/290	3.3	4.2
Air Cooled Screw	≥ 260 & < 530	3.2	5	120.7/423	3.3	4.65
Air Cooled Screw	≥ 530	3.2	5	151/530	3.3	4.92
ECBC Super				AS PER VENDOR DESIGN		
		ECBC requirement		at AHRI		
Air cooled chillers	Chiller Capacity (Kw)	COP	IPLV	TR	COP	IPLV
Air Cooled Screw	<260	N/a	N/a			
Air Cooled Screw	≥ 260 & < 530	N/a	N/a			

# Accelerating Energy Efficiency in Indian Data Centers

## Recommendation for Air cooled Chiller

- All vendors are complying with COP and IPLV values for ECBC compliance, and hence can be accepted.
- Add one slab of chiller capacity above 530 KW. The chiller performance above 530 KW shall have COP of 3.0 and IPLV of 3.7 for ECBC compliance.
- For ECBC+ recommendation is to comply either COP or IPLV. For ECBC + chiller performance above 530KW shall have COP of 3.2 or IPLV of 5.

# Accelerating Energy Efficiency in Indian Data Centers



## Cooling Towers

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ECBC Compliant	ECBC+	SuperECBC
<ul style="list-style-type: none"><li>✓ Equipment Type: Open circuit cooling tower Fans</li><li>✓ Rating Condition: 35°C entering water 29°C leaving water 24°C WB outdoor air</li><li>✓ Efficiency: 0.017 kW/kWr 0.31 kW/ L/s</li></ul> <p>ECBC Reference ECBC 2017 Section 5.3.2</p>	<p>Repeat ECBC Compliant and:</p> <ul style="list-style-type: none"><li>✓ Additional VFDs shall be installed in the cooling towers.</li></ul> <p>ECBC Reference ECBC 2017 Section 5.3.2</p>	<ul style="list-style-type: none"><li>✓ Same as ECBC+</li></ul>



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Cooling tower performance								
Sr No.	Description	CW In	CW Out	Flow Rate	Fan power	Chiller capacity	Performance	Performance
		Deg C	Deg C	M3/Hr	KW	KWr	Kw/Kwr	Kw/Ltr/Sec
1	Cooling Tower -1	35	29	1667	31.9	10548	0.003	0.069
2	Cooling Tower-2	35	29	195	9.1	1055	0.009	0.168
3	Cooling Tower-3	35	29	125	3.7	703.2	0.005	0.107
4	Cooling Tower-4	35	29	98	3.7	570	0.006	0.135
5	Cooling Tower-5	35	29	75	3.2	316	0.010	0.154
6	Cooling Tower-6	35	29	37.5	1.7	158	0.011	0.163

# Accelerating Energy Efficiency in Indian Data Centers

## Recommendation for Cooling tower.

- Cooling tower should be designed at actual site condition and shall be rated at ECBC compliant condition (35/29/24).
- Cooling tower performance shall be rated on either power consumption/Cooling capacity or power consumption/ water circulation rate (Cooling capacity shall be chiller rated capacity as per AHRI 550-590).
- ECBC recommendation of efficiency 0.017kw/Kwr. or flow 0.31kw/l/s is acceptable. However there is a huge scope of improvement efficiency improvement in CT requirement for ECBC compliance.

# Accelerating Energy Efficiency in Indian Data Centers

Recommendation for Cooling tower.

- Performance improvement in cooling tower fan can be done with VFD installation on Cooling tower fan for ECBC + and ECBC super.
- Cooling tower performance specified in ECBC compliance at above design condition is liberal. CT performance can be specified as 0.012 Kw/Kwr. or 0.17 Kw/lit./sec. In future same can be taken in to consideration.

# Accelerating Energy Efficiency in Indian Data Centers



## Pump Efficiency

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ECBC Compliant	ECBC+	SuperECBC
<ul style="list-style-type: none"><li>✓ Chilled Water Pump (Primary and Secondary): 18.2 W/ kWr with VFD on secondary pump</li><li>✓ Condenser Water Pump: 17.7 W/ kW</li><li>✓ Pump Efficiency (minimum): 70%</li></ul> <p>ECBC Reference ECBC 2017 Section 5.3.1</p>	<ul style="list-style-type: none"><li>✓ Chilled Water Pump (Primary and Secondary): 16.9 W/ kWr with VFD on secondary pump</li><li>✓ Condenser Water Pump: 16.5 W/ kWr</li><li>✓ Pump Efficiency (minimum): 75%</li></ul> <p>ECBC Reference ECBC 2017 Section 5.3.1</p>	<ul style="list-style-type: none"><li>✓ Chilled Water Pump (Primary and Secondary): 14.9 W/ kWr with VFD on secondary pump</li><li>✓ Condenser Water Pump: 14.6 W/ kWr</li><li>✓ Pump Efficiency (minimum): 85%</li></ul> <p>ECBC Reference ECBC 2017 Section 5.3.1</p>

# Accelerating Energy Efficiency in Indian Data Centers

## ECBC Compliant

Sr No	Chiller capacity	CHW In	CHW Out	CHW flow	Pump Eff.	Pump power require to meet ECBC compliance	Head require to meet ECBC compliance
	KW	in Deg F	in Deg F	M3/Hr		w/Kwr	Meter
1	260	44	54	40.3	70%	18.2	30.20
2	530	44	54	82.1	70%	18.2	30.20
3	1050	44	54	162.6	70%	18.2	30.20
4	1580	44	54	244.6	70%	18.2	30.20

## ECBC +

Sr No	Chiller capacity	CHW In	CHW Out	CHW flow	Pump Eff.	Pump power require to meet ECBC +	Head require to meet ECBC +
	KW	in Deg F	in Deg F	M3/Hr		w/Kwr	Meter
1	260	44	54	40.3	75%	16.9	30.05
2	530	44	54	82.1	75%	16.9	30.05
3	1050	44	54	162.6	75%	16.9	30.05
4	1580	44	54	244.6	75%	16.9	30.05

## ECBC Super

Sr No	Chiller capacity	CHW In	CHW Out	CHW flow	Pump Eff.	Pump power require to meet ECBC Super	Head require to meet ECBC Super
	KW	in Deg F	in Deg F	M3/Hr		w/Kwr	Meter
1	260	44	54	40.3	85%	14.9	30.02
2	530	44	54	82.1	85%	14.9	30.02
3	1050	44	54	162.6	85%	14.9	30.02
4	1580	44	54	244.6	85%	14.9	30.02

# Accelerating Energy Efficiency in Indian Data Centers

## Recommendation for Chilled water pumps.

- Pump designed at different water flow rate shall be rated as per AHRI condition chiller flow requirement.
- For any instance total pump head of chilled water system should not be more than 30 Meter for compliance of ECBC , ECBC + and ECBC super at given pump efficiency.
- Balance all the requirements are acceptable and pump power should be rated for W/Kwr. (Chiller capacity in kwr. at AHRI condition)
- There is a scope of improvement in chilled water pump head requirement in ECBC+ and ECBC super.

# Accelerating Energy Efficiency in Indian Data Centers

## ECBC Compliant

Sr No	Chiller capacity	Condenser capacity	CW In	CW Out	CW flow	Minimum Pump Eff	Pump power require to meet ECBC compliance	Head require to meet ECBC
	KW	KW	in Deg F	in Deg F	M3/Hr		w/Kwr	Meter
1	260	313	85	94.3	52.1	70%	17.7	22.68
2	530	628	85	94.3	104.6	70%	17.7	23.05
3	1050	1231	85	94.3	204.9	70%	17.7	23.30
4	1580	1831	85	94.3	304.8	70%	17.7	23.57

## ECBC +

Sr No	Chiller capacity	Condenser capacity	CW In	CW Out	CW flow	Minimum Pump Eff.	Pump power require to meet ECBC +	Head require to meet ECBC +
	KW	KW	in Deg F	in Deg F	M3/Hr		w/Kwr	Meter
1	260	305	85	94.3	50.7	75%	16.5	23.27
2	530	621	85	94.3	103.4	75%	16.5	23.27
3	1050	1219	85	94.3	203.0	75%	16.5	23.49
4	1580	1823	85	94.3	303.5	75%	16.5	23.64

## ECBC Super

Sr No	Chiller capacity	Condenser capacity	CW In	CW Out	CW flow	Minimum Pump Eff.	Pump power require to meet ECBC Super	Head require to meet ECBC Super
	KW	KW	in Deg F	in Deg F	M3/Hr		w/Kwr	Meter
1	260	303	85	94.3	50.5	85%	14.6	23.45
2	530	614	85	94.3	102.2	85%	14.6	23.61
3	1050	1212	85	94.3	201.7	85%	14.6	23.71
4	1580	1816	85	94.3	302.3	85%	14.6	23.80

# Accelerating Energy Efficiency in Indian Data Centers

Recommendation for Condenser water pumps.

- Pump designed at different water flow rate shall be rated as per AHRI condition condenser flow requirement.
- For any instance total pump head of condenser water system should not be more than 24 Meter for compliance of ECBC , ECBC + and ECBC super at given pump efficiency.
- Balance all the requirements are in order and condenser pump power should be rated for W/Kwr (chiller capacity in kwr@ AHRI condition).
- There is a scope of improvement in condenser pump head requirement in ECBC+ and ECBC super.



# Accelerating Energy Efficiency in Indian Data Centers



## Economizers

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ECBC Compliant	ECBC+	SuperECBC & Level III
<ul style="list-style-type: none"><li>✓ Note while the ECBC requires economizers in all large buildings (as is written in the ECBC+ level) , it is not considered common practice in data centers and it will unlikely be followed. Therefore we recommend waiving the economizer requirement for data centers at the compliant level.</li></ul>	<p>Each cooling system in data centers with an IT load &gt; 100kW* shall include at least one of the following:</p> <ul style="list-style-type: none"><li>✓ An air economizer capable of modulating outside-air and return-air dampers to supply 50% of the design supply air quantity as outside-air.</li><li>✓ A water or pumped refrigerant economizer capable of providing 50% of the expected system cooling load at outside air temperatures of 10°C dry-bulb/7.2°C wet-bulb and below.</li></ul> <p>Exception:</p> <ul style="list-style-type: none"><li>✓ Projects in warm-humid climate zones are exempt.</li><li>✓ Projects with only daytime occupancy in the hot-dry are exempt.</li><li>✓ (c) Individual ceiling mounted fan systems is less than 3,200 liters per second exempt.</li></ul> <p>ECBC Reference ECBC Section 2017 5.3.3.1 (not including red text)</p>	<p><b>SuperECBC</b> Same as ECBC+</p> <p><b>Recommendations for Level III</b> Data centers in excess of 100kW shall utilize economizers. Each cooling system shall include at least one of the following:</p> <ul style="list-style-type: none"><li>✓ An air economizer capable of modulating outside-air and return-air dampers to supply 100% of the design supply air quantity as outside-air. *</li><li>✓ A water or pumped refrigerant economizer capable of providing 100% of the expected system cooling load at outside air temperatures of 10°C dry-bulb/7.2°C wet-bulb and below. *</li></ul> <p>No exceptions*</p>

# Accelerating Energy Efficiency in Indian Data Centers

## Recommendation for economizer

- Recommendation of use of economizer for ECBC compliance is waived off and is ok.
- Recommendation of use of economizer for ECBC + & ECBC super is same and it can be accepted.

# Accelerating Energy Efficiency in Indian Data Centers

## Chiller Plant- Performance Approach 32

Buildings may show compliance by optimizing the total system efficiency for the chiller plant instead of the individual equipment efficiencies listed under the prescriptive requirements. This alternate compliance approach is applicable for central chilled water plants in all building types. The total installed capacity per KW refrigeration load shall be less than or equal to maximum threshold requirements as specified below.

Equipment that can be included in central chilled water plant side system for this alternate approach are chillers, chilled water pumps, condenser water pumps, and cooling tower fan.

Compliance check will be based on annual hourly simulation.

ECBC Compliant	ECBC+	SuperECBC
✓ Water Cooled Chill Plant Maximum Threshold (kW/kWr) of 0.26	✓ Water Cooled Chill Plant Maximum Threshold (kW/kWr) of 0.23	✓ Water Cooled Chill Plant Maximum Threshold (kW/kWr) of 0.20
ECBC Reference ECBC 2017 Section 5.4	ECBC Reference ECBC 2017 Section 5.4	ECBC Reference ECBC 2017 Section 5.4

# Accelerating Energy Efficiency in Indian Data Centers

## ECBC Compliant

Sr No	Chiller capacity	COP	Chiller Power Consumption.	CHW Pump Power	CW Pump Power	Cooling tower fan Power	Total System Power
	KW		KW	Kw/Kwr	Kw/Kwr	Kw/Kwr	Kw/Kwr
1	260	4.7	55.3	0.0182	0.0177	0.017	0.266
2	260	4.9	53.1	0.0182	0.0177	0.017	0.257
3	530	5.4	98.1	0.0182	0.0177	0.017	0.238
4	1050	5.8	181.0	0.0182	0.0177	0.017	0.225
5	1580	6.3	250.8	0.0182	0.0177	0.017	0.212

## ECBC +

Sr No	Chiller capacity	COP	Chiller Power Consumption.	CHW Pump Power	CW Pump Power	Cooling tower fan Power	Total System Power
	KW		KW	Kw/Kwr	Kw/Kwr	Kw/Kwr	Kw/Kwr
1	260	5.2	50.0	0.0169	0.0165	0.017	0.243
2	260	5.8	44.8	0.0169	0.0165	0.017	0.223
3	530	5.8	91.4	0.0169	0.0165	0.017	0.223
4	1050	6.2	169.4	0.0169	0.0165	0.017	0.212
5	1580	6.5	243.1	0.0169	0.0165	0.017	0.204

## ECBC Super

Sr No	Chiller capacity	COP	Chiller Power Consumption.	CHW Pump Power	CW Pump Power	Cooling tower fan Power	Total System Power
	KW		KW	Kw/Kwr	Kw/Kwr	Kw/Kwr	Kw/Kwr
1	260	5.8	44.8	0.0149	0.0146	0.017	0.219
2	260	6	43.3	0.0149	0.0146	0.017	0.213
3	530	6.3	84.1	0.0149	0.0146	0.017	0.205
4	1050	6.5	161.5	0.0149	0.0146	0.017	0.200
5	1580	6.7	235.8	0.0149	0.0146	0.017	0.196

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## Recommendation for Overall Chiller plant performance.

- Recommendation is to specify range wise overall chiller plant performance. Overall chiller plant performance should not be more than summation of individual component performance.
- “compliance check will be based on annual hourly simulation” is site/project specific condition and will not be rated on common platform hence chiller plant performance should not be rated at this condition.

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Thank You