Optimizing Your Energy, Environmental, And Water Conservation Processes:

Where Can You Start?

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Editor's Note: Innumerable opportunities to improve equipment and systems already exist in every facility or plant. For starters, here are 302 places where technical upgrading may be feasible. This listing has been abstracted from a paper delivered at an AEE World Energy Engineering Congress.

POTENTIAL ENERGY USE OPTIMIZATION AND WATER CONSERVATION OPPORTUNITIES

1. Implement regular steam leak survey
2. Installation of condensate lines
3. Installation of cross connect lines on steam distribution systems
4. Installation of insulation on steam distribution systems
5. Installation of steam meter monitoring systems
6. Installation of steam meters
7. Investigate economics of adding insulation on presently insulated lines
8. Review mechanical drive standby turbines presently left in the idling mode
9. Review operation of long steam lines to remote single service applications

10. Review operation of steam systems used only for occasional services, such as winter-only tracing lines
11. Review pressure-level requirements of steam-driven mechanical equipment to evaluate feasibility of using lower pressure levels
12. Review temperature requirement of heating storage vessels and reduce to minimum acceptable temperatures
13. Survey condensate presently being discharged to waste drains for feasibility of heat recovery
14. Check flue for improper draft
15. Chiller retrofits
16. Cooling tower retrofits
17. Install air-atomizing burners (for oil-fired boiler systems)
18. Install automatic boiler blow-down control
19. Install automatic vent dampers on boilers
20. Install flue gas analyzers for boilers
21. Install low-excess-air burners (for oil-fired boiler systems)
22. Install pulse or condensing boilers/furnaces
23. Isolate off-line boilers
24. Provide proper water treatment to reduce fouling
25. Replacement of central plant with satellite boilers
26. Replacement of satellite boilers with central plant
27. Resize boilers
28. Shut down large boilers during summer and use smaller boilers
29. Upgrade of natural gas-fired boilers with new controls (low NO_x burners)
30. Check expansion and compression tank sizes
31. Chilled water temperature reset
32. Consolidation of existing HVAC equipment in either an existing building or group of buildings
33. Create air movement with fans
34. Duty cycling/demand control
35. Elimination or down-sizing of existing HVAC equipment in either an existing building or group of buildings by improvements in building envelop; reductions in lighting or plug loads; etc.
36. Fans and pump replacement or impeller trimming
37. Free cooling/injector cycle
38. Heat recovery from cooling oil in screw compressors

39. Heat recovery through desuperheating
40. Install a cold storage system
41. Install add-on heat pumps
42. Install air cleaners in HVAC system
43. Install booster pumps on hot water systems
44. Install decentralized water heaters
45. Install desiccant cooling systems
46. Install economizer cooling systems
47. Install evaporative precooling on 100 percent make-up air
48. Install evaporative cooled or water cooled condensers
49. Install ground or ground-water source heat pumps
50. Install indirect/direct evaporative cooling systems with or without a heat pipe and with or without heat recovery
51. Install modular HVAC units
52. Install roof-spray cooling systems
53. Install secondary pumping systems
54. Install variable air volume HVAC systems >50BP
55. Install water heater blankets on water heaters
56. Installation of liquid pressure amplifier on reciprocating compressor systems
57. Insulate hot water pipes
58. Insulate HVAC ducts
59. Insulate HVAC system pipes
60. Insulate water storage tanks
61. Insulation of low side refrigerant lines
62. Investigate use of gas engine driven chillers
63. Isolate off-line chillers and cooling towers
64. Liquid refrigerant pumps to reciprocating air-conditioning units for cold climates
65. Night setback or turning off equipment
66. Packaged air-conditioning unit replacement
67. Paint roofs with long lasting white roofing material
68. Preheat feedwater with reclaimed waste heat to reduce hot water heating system losses
69. Primary/secondary pumping configurations on central plants
70. Provision for avoiding artificial loading (hot gas bypass) at low loads
71. Reduce air flow rates in HVAC ducts
72. Reduce ammonia head pressure

73. Reduce system flow rates
74. Reducing compressor speed in over capacity system
75. Reduction of non-condensable gases in the system
76. Replace absorption with electric drive chillers
77. Replace existing electric motors with efficient motors
78. Replaced forced air heaters with radiant heaters
79. Replace indirect fired heaters with direct fired heaters
80. Replacement of air conditioning & heating units with heat pumps
81. Replacement of inefficient window air-conditioners with SEER>9.0
82. Resizing of chillers
83. Retrofit with higher cop equipment
84. Staging of multiple chillers
85. Use energy efficient water heating systems
86. Use heat pump water heaters
87. Use of absorption to reduce electric demand
88. Use smaller water heaters for seasonal requirements
89. Utilize gas absorption chillers where appropriate
90. Variable speed drives for fans and pumps
91. Window air conditioning replacement with central system
92. Caulk and weather-strip doors and windows
93. Daylighting or skylighting with dual-glazed low “e” glass
94. Determine roof insulation values and recommend roof replacement as appropriate
95. Install air flow windows
96. Install exterior shading
97. Install interior shading
98. Install local ventilation systems for hot areas (versus central ventilation system)
99. Install movable windows
100. Install operable windows
101. Install reflective surfaces on roof and walls as appropriate
102. Install revolving doors or construct vestibules
103. Install storm windows and multiple glazed windows
104. Install vapor barriers in ceilings and roofs
105. Install vapor barriers in walls
106. Insulate ceilings and roofs
107. Insulate ceilings, roofs, floors, and walls using spray-on insula-

tion
108. Insulate floors
109. Insulate walls
110. Seal vertical shafts and stairways
111. Use tinted or reflective glazing or films
112. Weatherization/fenestration improvements
113. Window coverings and awnings
114. Window replacement
115. Install dimming control for areas close to windows
116. Install dimming controls with skylights
117. Install high efficiency electronic ballasts
118. Install high-pressure sodium lighting in selected areas
119. Install LED exist signs
120. Install LED traffic signals
121. Install low-pressure sodium lighting in selected areas
122. Interior and exterior lighting replacement
123. Lighting control improvements
124. Lighting for parking lots or athletic fields
125. Occupancy sensors (where applicable)
126. Reduce illumination levels
127. Reflective solar window tinting
128. Remove or replace lenses
129. Replace all incandescent bulbs with compact fluorescent
130. Use high-efficiency fluorescent lighting
131. Use reflectors to provide more efficient lighting
132. Use task lighting
133. Utilize light color material when reroofing to reduce solar gain
134. Utilize multiple switching for selected lighting levels in offices, conference rooms, etc.
135. Utilize natural lighting in perimeter office spaces
136. Utilize timers and photocells for controlling outdoor lighting
137. Heat recovery for water heating
138. Install double bundle chillers
139. Install piggyback (absorption systems)
140. Install water-loop heat pump systems
141. Preheat combustion air, feed water or fuel oil with reclaimed waste heat
142. Reclaim heat from boiler blowdown
143. Reclaim heat from combustion system flue

144. Reclaim heat from prime movers
145. Reclaim heat from refrigeration system hot gas
146. Reclaim heat from steam condensate
147. Reclaim heat from wastewater
148. Reclaim incinerator heat
149. Recover heat from light systems
150. Conversion of electric heaters to natural gas radiation/convection
151. Correct power factors
152. Electric heater replacement on standby generators with a heat pump
153. Install energy-efficient transformers
154. Installation of electrical meters
155. Investigate cutting impellers on pumps to match loads
156. Motor replacement with high efficiency motors >10 BP
157. Power factor correction depending on tariff considerations
158. Reduce power system losses
159. Reduction in demand charges through load shedding, operational changes, and/or procedural changes
160. Refrigerator replacement with high efficiency units
161. Replace oversized electric motors
162. Thermal energy storage systems
163. Transformer replacement with amorphous type transformers
164. Utilization of emergency generators during load shedding
165. Variable speed drive utilization
166. Install agricultural waste-fired boilers
167. Install geothermal space and water heating
168. Install skylights
169. Install solar heating where applicable
170. Install urban waste pyrolysis systems
171. Install urban waste-fired boilers
172. Photovoltaic system installation
173. Photovoltaic water pumping
174. Solar domestic hot water
175. Wind power generation
176. Wind power water pumping
177. Air compressor replacement/addition of receivers
178. Automate blow-off nozzles on air compressor storage tanks
179. Check proper size of air pressure regulators and lubricators

180. Construction of new cogeneration facilities
181. Conversion of compressed air systems to distributed systems
182. Eliminate air leaks
183. Install automatic traps/drains in larger air systems
184. Install storage surge tanks to buffer compressed air load fluctuations
185. Installation of compressed air metering
186. Installation of gas meters
187. Landscaping/planting of trees to reduce air-conditioning loads
188. Molten carbonate fuel cell installation
189. Optimize loading with multiple air compressors
190. Recover waste heat from air compressor cooling system
191. Reduce excessive line air pressure losses, i.e., increase pipe diameter
192. Reduce line air pressure
193. Reduce plug loads using devices to shut off equipment not being used
194. Reduction in sewage pumping/sewage reduction
195. Replace air-driven motors with electric motors
196. Replace existing air compressors with more efficient units
197. Replace existing electric motors with efficient motors
198. Replace oversized air compressors
199. Rewire lighting and other systems to allow personnel to shut off sections of systems—rather than leaving entire systems running
200. Use after coolers in multi-stage air compressors
201. Use blower/fans instead of compressed air for cooling, drying, or blow-off operations
202. Use energy efficient air blow-off nozzles
203. Use energy efficient v-belts for air compressors
204. Use energy-efficient air drying systems
205. Use larger area air-intake filters
206. Use outside intake air for air compressors
207. Boilers—capture steam condensate for reuse
208. Boilers—install automatic blowdown controls for boilers
209. Boilers—install automatic controls to treat boiler make-up water
210. Dishwashers (replacement)—install low temperature dishwashers that sanitize primarily through the use of chemical

agents rather than high water temperatures

211. Dishwashers (retrofit)—install electric eye or sensor systems in conveyor-type machines so that the presence of dishes moving along the conveyor activates the water flow
212. Eliminate all single pass water use
213. Equipment cooling, control make-up water and reduce blowdown by adding temperature control valves to cooling water discharge lines in equipment such as air compressors and refrigeration systems
214. Equipment cooling, cool air compressors with a closed loop system
215. Evaporative cooling systems—consider side stream softening for very large cooling loads
216. Evaporative cooling systems—install drift eliminators or repair existing equipment
217. Evaporative cooling systems—install softeners for make-up water; side stream filtration (including nano-filtration, a form of low-pressure reverse osmosis); and side stream injection of ozone.
218. Evaporative cooling systems —install submeters for make-up water and bleed-off water for equipment such as cooling towers that use large volumes of water
219. Evaporative cooling systems control cooling tower bleed-off based on conductivity by allowing bleed-off within a high and narrow conductivity range. This will achieve high cycles of concentration in the cooling system and reduce water use in cooling tower.
220. Faucet replacement (infrared sensors) or automatic shut-off
221. Install central tower and remove once through cooling
222. Install irrigation control systems
223. Install subsurface irrigation
224. Install water flow restrictors on shower heads and faucets
225. Installation of automated watering systems for landscaping, golf courses, etc.
226. Installation of covers on swimming pools and tanks
227. Installation of devices to reduce the time flushometers are letting water flow
228. Installation of devices to save hot water by pumping water in the distribution lines back to the water heater so hot water is

not washed—for use in BOQ's and homes
229. Installation of industrial waste/sewage metering
230. Installation of water metering
231. Landscape irrigation—install irrigation timers to schedule sprinkler use to off-peak, night, or early morning hours, when water rates are cheaper and water used is less likely to evaporate.
232. Landscape irrigation—use low flow sprinkler heads instead of turf sprinklers in areas with plants, trees, and shrubs.
233. Landscape irrigation—use sprinkler controls employing soil tensiometers or electric moisture sensors to help determine when soil is dry, and gauge the amount of water needed.
234. Landscape irrigation—use trickle or subsurface drip irrigation systems that provide water directly to turf roots, preventing water loss by evaporation and runoff.
235. Low flow toilets
236. Painting—Recycle water used to collect overspray paint by treating water with dissolved air flotation and filter dewatering system to separate toxic solids
237. Photo and x-ray processing—install temperature control valve to reduce flow when not developing
238. Photo and x-ray processing—reduce flow to manufacturer's specifications for actual operating conditions
239. Photo and x-ray processing—install solenoid valve to shut-off rinse and cooling flows when product is not being developed
240. Plating and metal finishing—treat rinse water to recover valuable metals or chemicals to return to plating bath, with clean water returned to rinse system
241. Rinsing and cleaning—install timers and tamper-proof conductivity controllers to control quality of water in rinses
242. Rinsing and cleaning—install ultrasonic cleaning equipment
243. Rinsing and cleaning—install water-saving technologies or modification that are specifically geared toward each facility. Examples are counter-current rinsing, drag-out tanks or first stage static rinses, spray systems, flow reduction devices
244. Rinsing and cleaning—recalculate laundry formulas for less water use
245. Water conservation device installation (reduced pumping and water heating)

246. Water reclamation
247. Xeriscaping with native plants
248. Check belt tension on electric motors
249. Check for air leaks in HVAC system
250. Check flue for improper draft
251. Checking for oversized pumps, that currently operate with a discharge valve in a throttled condition, to lower system pressure
252. Clean air filters in ducts
253. Clean and maintain lighting systems
254. Clean boiler surfaces of fouling
255. Clean evaporator and condenser surfaces of fouling
256. Development of peak-shaving strategies
257. Dishwashers (operational modifications)—limit water temperature and flow rate settings to manufacturer's recommendations. (To avoid compromising the sanitation process, do not set water temperature below 180 degrees F.)
258. Exhaust hot air from attics
259. Lower heating and raise cooling temperature setpoints
260. Lower hot water temperature
261. Lower humidification temperature
262. Lower humidification setpoints
263. Maintain steam traps
264. Raise dehumidification setpoints
265. Raise evaporator or lower condenser water temperature
266. Rebalance ducting systems
267. Rebalance piping systems
268. Reduce hot water consumption
269. Reduce operating hours for escalators and elevators
270. Reduce operating hours for lighting systems
271. Reduce operating hours for space heating and cooling systems
272. Reduce operating hours for ventilation systems
273. Reduce operating hours for water heating systems
274. Reduce the generation of indoor pollutants
275. Reduce ventilation rates
276. Reduce water or steam flow rates in pipes
277. Remove scale from water and steam pipes
278. Repair ducting and piping leaks
279. Repair steam system controls

280. Reset hot/chilled water temperature
281. Reset supply air temperatures
282. Set heating setpoints back when the building is not occupied
283. Steam trap maintenance and replacement
284. Use load-shedding
285. Energy Management Control System (F-MCS) Installation, replacement, and alteration
286. Install demand limiting control system
287. Install duty cycling control system
288. Install economizer cooling control system
289. Install hot/chilled water supply temperature reset control system
290. Install supply air temperature reset control system
291. Install temperature setup/setback control system
292. Install time of day control system
293. Install ventilation purging control system
294. Installation of single building controllers (DDC)
295. On/off controls (electronic time clocks)
296. Check steam trap sizes to verify they are adequately sized to provide proper condensate drainage
297. Consider opportunities for flash steam utilization in low temperature processes
298. Consider pressuring atmospheric condensate return systems to minimize flash losses
299. Consider relocation or conversion of remote equipment such as steam-heated storage
300. Evaluate insulation of all uninsulated lines and fittings previously thought to be uneconomic
301. Evaluate potential for cogeneration in multi-pressure steam systems presently using large pressure-reducing valves
302. Evaluate production scheduling of batch operation and revise to minimize startups and shutdowns

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ABOUT THE AUTHOR

Walter P. Smith, Jr., P.E., CEM, is president of ETSI Consulting, Inc. He has a degree in chemical engineering from the University of Virginia. Mr. Smith worked two years as a process engineer for DuPont, and held R&D and manufacturing positions with the North American operations

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In 1980 ETSI Consulting was formed. In 1993 Mr. Smith retired from BASF and expanded ETSI into a full-service ESCO. ETSI is a worldwide network of experts providing a wide range of energy, manufacturing, process/business optimization, and training services. Specialty areas include energy audits, process optimization, feasibility/specialty studies, E.M. organization/program implementation, and training workshops/seminars on a wide variety of energy technologies.

Mr. Smith has provided selected energy consulting services to many industrial clients. He has lectured internationally on energy management and congeneration technology and provided energy consulting to more than 150 clients worldwide.

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