

Corporate Energy Security
& Sustainability Conference
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Newport Beach, California

I. DOE Tools Familiarization - Dr. Anthony Wright, ORNL

Tony Wright works on the DOE Best Practices program for DOE. The Best Practices program provides tools and opportunities for energy saving at industrial facilities. Many of these opportunities involve little or no monetary investment. A wealth of information and technical assistance is available from the DOE. Last year, the program was located into the newly organized Industrial Technologies Program (former Office of Industrial Technology), which is under the Energy Efficiency and Renewables program. This industrial program offers collaborative R&D in the energy intensive industries, covering cross cutting technologies, grand challenges, and buildings. There is also Technology Delivery which includes tools, software, and demonstrations. Near term opportunities for savings and bottom line improvements are emphasized. DOE has a clearinghouse with information that will also handle questions. The main web site is www.eere.gov/industry/bestpractices. Case studies, tip sheets, software tools, fact sheets, brochures, reports, and training are available. The DOE has qualified specialists that work with industry in training for the use of the tools. These specialists are listed on the DOE web site. Plant-wide assessments can be done. There are also 26 universities that are Industrial Assessment Centers that will perform assessments without charge.

DOE advocates a measured approach to Energy Efficiency Improvements. This includes prioritizing targets and opportunities, analyzing potential solutions, and implementing the cost-effective measures. Opportunity assessment tools are designed to try to identify areas of greatest opportunity in integrated systems. Both air side and steam side tools are available. A fan tool and a CHP tool are under development. A NOx tool is being developed to identify potential opportunities for NOx reductions. The following tools are available on the web site:

Motor Master	Air Master
Pumping System	3EPlus
Steam System Scoping	ASDMaster
Steam Assessment	Process Heating
Assessment and Survey	

A plant energy profiler system is being developed which will utilize gross inputs (utility bills, fuel costs, etc.) and some gross equipment lists and tries to indicate the potential and magnitude for savings.

In the training area, there are awareness workshops, webcasts, end user training, and specialist training. DOE has a budget for nearly 50 training sessions in the current budget. The Alliance to Save Energy also sponsors training. Some training sessions are designed for presentation at major conferences. The DOE regional directors are the prime movers for these sessions. End user training is essentially free with the possible exception of meals and meeting rooms. There are training slots still open for 2004. ORNL (Michaela Martin) does a metrics report each year on the benefits of the overall Best Practices program. Training is no longer limited to the original 9 industries. Food processing, pharmaceuticals, healthcare, etc. are all starting to utilize these tools and opportunities. Last June, Sunoco did an end user training. This was followed up with a specialist training in the fall and then a plant assessment in November. Collaborative Targeted Assessments have been done on 76 plants: 21 forest products, 10 chemical, 14 refining, 20 mining, and 12 other. These were mostly large facilities with \$10 - 20 million operating budget. Projected savings from process heating were \$1.2 million/yr per facility at 14 facilities. There were also savings from pumps, air, steam, etc.

The plant wide assessments are done through a cost shared program in which companies bid for up to \$100,000 to do a plant assessment. The plant has to actually do the assessment and prepare a summary report. Proprietary information is not published. Over 20 companies reported savings ranging from \$1 million/yr to as high as \$52.5 million/yr per plant. One of the requirements for selection is a plan to replicate the savings at other plants. Over 50 assessments have been done. Identified opportunities are at the \$180 million/yr. Average energy savings are about 10 - 15%. Alcoa has been very active in this program. They have identified \$60 million of annual savings and have already realized \$16 million/yr. The Industrial Assessment Centers are university based centers that use faculty and students to provide no-cost, on site industrial assessments at eligible facilities. Roughly 240 students are in training each year. These are directed at smaller companies with energy bills between \$100 thousand/yr and \$2 million/yr. There are regional offices in Atlanta, Chicago, Boston, Denver, Philadelphia, and Seattle. Plus, there is a newsletter available from DOE entitled "Energy Matters".

The first book on energy system evaluation was written by Sir Oliver Lyle (A The Efficient Use of Steam) in 1947. Today DOE developed with industry assistance and support 4 key tools: the steam systems scoping tool, steam system survey guide, steam system assessment tool, and the 3E-Plus Insulation Appraisal Software. These are amongst the most downloaded tools on the DOE website (over 65,000 for the steam system survey guide).

The Steam System Scoping tool outlines the key elements of an excellent steam system. There are 26 areas for questions. In particular, questions about measuring, monitoring, testing, etc. are intended to bring the user into context with a particular facility. A fairly small XL spread sheet leads the user through a series of questions such

that a facility can be categorized. A point scoring system is used to “score” the plant. A summary is prepared indicating areas that need work. Based upon the scoring range, an estimate of the per cent of the energy bill savings can be developed.

The Steam System Survey Guide is a technical guide that covers 5 areas of steam systems: system profiling, steam properties, boiler operations, resource utilization, and steam distribution. Methodologies and algorithms are given for a wide variety of calculations associated with steam systems.

The Steam System Assessment Tool can evaluate key steam system improvement initiatives. This tool provides the potential to evaluate the impact in terms of cost of steam (or fuel) of various actions that might be taken. The basics of the ProSteam software are used as the basis for the software. Systems schematics are available as well as 1, 2, & 3 header systems. Equipment models are included for the main components (boilers, turbines, pumps, tanks, and heat exchangers). An example of a 2 Header system (400 psig and 20 psig) with 2 MW site load and a gas-fired boiler was demonstrated.

The system can be downloaded or run off the DOE CD. Macros have to be enabled. The system runs in conjunction with Microsoft Excel. The existing templates are read only, but new templates can be set up. The system should be set up to approximate the existing site. Power loads, boiler loads, fuel costs, etc. are all inputs to the system. The number of steam traps and the time since inspection are also inputs. A leakage rate and failure rate are estimated depending upon the time since last inspection. The model can then be run and checked against existing data. This validation step is necessary to “ground” the model as representative of current operation. Once validated, there are a number of potential improvements that can be investigated using the tool. Thus, if boiler efficiency were improved, what is the impact on the performance? Fuel costs, energy costs, and emissions reductions are calculated based upon the improved performance. Emissions credits are not evaluated in the calculation of cost savings. For improvements that increase output, emissions are compared against an average utility emissions rate/kwhr. Capital costs are not estimate with this tool. Operating savings are estimated to be compared against the capital cost to get a payback. In a situation with multiple boilers, the key is to focus on the boiler that is used to swing the load. A 2-day training seminar package is available to train users on the features of the system. An improved version of the software will be released in August.

An insulation appraisal tool is now available (3E-Plus). A new version will be issued shortly. Various pipes, tanks, and headers can be calculated for heat loss, depending upon conditions. Subsequently, the heat savings that result from adding various amounts of insulation are estimated.

The Steam Systems Source Book includes 3 main sections and is the second most popular download from the DOE website. There have been 19 Steam Energy Tips and 4 Technical Briefs published. One of the particularly important documents covers how to calculate the true cost of steam. The Guide to Low Emissions Boiler and Combustion Equipment is available. A new document on combined heat and power is being prepared.

Tony Wright can be contacted at ORNL at wrightal@ornl.gov The Alliance for Saving Energy has a website at www.steamingahead.org. The best practices website is www.oit.doe.gov/bestpractices.

II. Conference Introduction - Doug Peet, Trigen-Cinergy

Doug opened the conference with introductions. The conference is informal in nature so questions from the floor are welcome at any time. Energy issues are coming to the fore with such incidents as the Northeast Blackout, Hurricane Isabel, Homeland Security, etc. Due to a board meeting, Ralph Bailey formally of Dupont was not able to be present for the opening address. He asked Vince Albanese of Fuel Tech to provide the appropriate remarks.

Vince noted that the board meetings have changed in nature due to the issues created by the Sarbanes Oxley law that puts additional emphasis on corporate ethics and auditing. The critical message for this conference is the inseparability of energy and environmental issues with regard to security and economic growth. Ralph is Chairman of the board of Fuel Tech. Fuel Tech is the leading supplier of SNCR systems for NOx control. A substantial number of installations are in the industrial sector. He noted that the Government still seems to be treating the two as separate issues. In particular, the Energy bill is stalled in the Senate and the Clear Skies bill has not gotten to the floor. With air issues, the EPA has had a sea change approach in its attitude towards emissions. With the NOx SIP Call, the EPA has reaffirmed the cap and trade approach to emissions control (as opposed to emission rates, technology requirements, etc.). The concept of an emissions allowance provides for an eco-asset. NOx allowances traded for about \$2500/ton to \$8000/ton. For a reasonable sized industrial unit, such allowances can add up to a few \$ million per year. Purchase of emissions allowances, amounts to an increase in variable cost. Some utilities are dispatching against this cost. Putting a value on emissions provides the opportunity for a variety of optimization approaches. Risk management opportunities, including options, futures, and other derivatives, are becoming more prevalent.

Public interest groups, environmentalists, financial institutions, etc. are pressuring companies to be more transparent in their reporting. In particular, companies are being pressured to report on any potential environmental issues. Emissions allowances will have to be "market-to-market". Future environmental exposure (emissions controls, shut downs, etc.) need to be reported as a contingent liability. For a going concern, no one person can manage these assets individually. Five or six disciplines are likely to be needed including engineering, fuel, financial, environmental, legal, and asset management. These activities all detract from the activities needed to run the core business.

At best, cost minimization has to be carefully studied. Two new regulatory issues are in front of our industry. One is the air transport rule. This rule expands the NOx SIP

call expanding the region of application and increasing the requirements for emissions controls. The other issue is New Source Review. Last year, two of Fuel Tech's projects were stopped in Ohio, because a client was cited against NSR for replacing superheater tubes. Vince recommended that CIBO members pressure their Congressmen in support of the CIBO positions on the transport rule and NSR review.

III. The National Electric System - Dejan Sobajic, EPRI

During 2003, there were major power outages around the world. In the course of 2 months there were 4 major outages in the US, Italy, England, and Denmark/Sweden. One US Senator, wondered whether this was the tip of the iceberg or a once in a lifetime occurrence. Electrons do not recognize borders. The US, Canada, and Mexico are reasonably interconnected. During the California fires, the Mexican system allowed southern California to keep the lights on. There are major interconnections to avoid large swings propagating across the country. A reliable electric system accounts for adequacy, availability, security, and efficiency. Planning, maintenance, operations, and markets are all inputs to the system. Processes for management include monitoring, assessment, and enhancement.

A major study is underway at EPRI. Some results have already been disseminated. One major point is that the system must be visualized now. Sensors, communications, integrated architecture, simulation, and visualization are all needed to get a good picture of the system and its propensity to disruption. An increase in system capacity is needed. Transmissions circuits are needed. Control centers, protection schemes, and infrastructure all need upgrading. The system was at or near the security of A N-1" about 10 years ago. During the last decade, little maintenance and upgrades have been done. We no longer have the situation that a system fault can be automatically tolerated without the system noticing.

Some "self healing" technologies are now available, including power switching and electronic flow control devices. The markets today are asymmetric. Supply is a major consideration. Demand is less well considered. In order to remedy the situation, a multi step process is needed starting with fixing immediate deficiencies and working through to the point where real time control is enables. An estimate of the cost is \$110 billion over the next 20 years. Transmissions lines, substations, control centers, and controls are all needed. The distribution system is also in need of upgrades. Distributed generation will require a different system in terms of protection and control up to the substation level. Another \$77 billion will be needed for distribution. On the market side, real time pricing, demand response, and load distribution. An additional \$40 billion will be required for these market issues. Thus over the next 20 years, over \$220 billion will need to be invested in the transmission and distribution network in the US.

IV. National Fuels Forecast - Ben Smith, Enercast

Enercast specializes in natural gas price forecasts, particularly on a seasonal basis. As fuel pricing tends to be related, some comments on coal, oil, biofuels, and renewables will also be included. Natural gas prices were at the \$2 level from 1980 to 2000. The last few years the price has risen to the \$5 level and is projected to remain at that level for some time. The pricing impact of end of season storage is mainly driven by the 9 year average level of 1000 TCF. Last year, the end of season was below 700 TCF. This caused the main concern in gas prices. This year, the level is projected to be about 900 TCF. North American production accounts for 99% of US supply. Canadian production has been declining. US conventional reserves have been diminishing. Resource depletion has driven exploration and production costs to increase. An increased rig count has not correlated to increased production. Unconventional sources (tight sands, shale, and coal bed methane) are expected to increase supply, but at additional cost. The net is that demand is increasing while supply is diminishing from traditional sources. Some 3 TCF of unconventional gas and 3 TCF of Alaskan gas (after 2018) are forecast to be needed by 2025. Strong economic growth is forecast for 2004 (4.5%). The 10 year forecast is over 3%. Worldwide economic growth, especially in China, is also increasing demand. This adds to the upward pressure on pricing. Demand destruction has already occurred. Many companies that could not afford the higher gas prices either switched to other fuels and shut down and moved.

While energy intensive sectors of industry will see their growth inhibited by higher fuel prices, industrial demand is still expected to grow by 2.6% (vs. 3.2 - 3.3% for GDP). For industrial demand, gas and electricity are expected to increase by over 40% in the next 20 years. Coal use in the industrial sector is expected to remain flat or in slight decline, primarily driven by reductions in steel making (less coke, electric arc, foreign supply). With current supply vs projected demand, a notional gap of 2.4 TCF is forecast by 2010. Imported LNG could supply some of that gap. This will be moderated by the difficulty of planning, permitting, and building LNG terminals. Perhaps 2 TCF could be available by 2010. There are 4 existing terminals that are being expanded. There are plans for 12 additional terminals in various stages of planning and permitting.

There are potentially 25 projects that are being considered. For seasonal pricing, weather is the strongest component, followed by economic activity and production. The economic activity and production move slowly. Weather is the largest variable with the highest degree of variability. Electric demand is strongly correlated to the ambient temperature, with the strongest increases being associated with warmer weather. Natural gas is more strongly correlated with cold weather. In the summer, the gas demand only increases when the ambient temperature is very high (over 90 F) when all of the peaking units are turned on.

Weather data is used along with the various futures exchanges to forecast seasonal weather patterns. Weather futures are traded on the Chicago Mercantile Exchange as there are companies that benefit from "good" weather and some that benefit from "bad" weather. The current medium is degree days. The market serves as a risk

mitigation feature in that hedging against “bad” weather provides a payment which acts like an insurance policy. Besides the “El Nino” circulation, there are more than a dozen factors which influence the weather. When the major circulation is quiet, the smaller factors can have a big impact on the weather. When the larger circulation patterns are in play, the smaller ones get swamped.

For the US, the Pacific Ocean is the major driver. This year, the major circulation is quiet. The forecast is for a cooler spring, but the Southern US will be warmer than average. The summer forecast will be released in April. Preliminary information indicates an average summer. With a “normal” summer, gas prices could be expected to decline to the \$4.00 - 4.50 level and then returning to the higher level in the winter months.

V. Energy Technology Alternatives & Limitations for Industrial Facilities - Bill Gurski, Alstom

Industrial customers face challenging conditions with global markets and competition, price competition, and increased cost of environmental compliance. Companies would prefer to spend their time, money, and resources on developing their own products rather than utilities. Aging boilers and energy systems imply difficulties with missions, reliability, capacity, and fuel costs. Implementation of various plans, both short term and long term, leads to improved reliability, lower emissions, fuel economy, capacity. Many of these are not implemented due to downsizing, mergers/sales, changes in plant operation, uncertainty, and lack of information on alternatives.

Some potential alternatives include fuel conversions, control upgrades, maintenance, and replacements. A fuel conversion is typically driven by fuel costs. Fuel flexibility and renewables are often drivers. Improved environmental performance or disposal of waste gases and solids also lead to fuel feed modifications. Boiler upgrades/uprates can add generation capacity. Many older units can add 10 - 15% capacity without major modifications. Efficiency and availability can be improved along with lower maintenance costs, less auxiliary fuel costs, and minimal auxiliary power costs (including rentals).

Site specific conditions will determine the economics. Two nearly identical units in two different locations burning different fuels will have different paybacks. Emissions retrofits need to take into account that generation still has to be the number one concern. The boiler needs to be reviewed a process from the fuel delivery to the stack. Energy audits need to be focused on the entire plant to evaluate economics and performance. The goal is to identify and prioritize actions to increase profitability. DOE has many tools that are available to help plants with these audits (as presented by Tony Wright in the preliminary session). Boilers, turbines, condensers, air heaters, FW heaters, gas turbines, HRSG, fans, heat exchangers, pumps, and process equipment all need to be taken into account.

An optimized plant retrofit (OPR) utilizes new models of boilers and turbines to reflect actual operating conditions and then evaluating changes. A joint project team design review process is utilized with the plant people to assure that the changes reflect plant conditions. An example from a utility upgrade showed a 40 - 45 MW gain on a nominal 600 MW unit. A steam turbine and boiler upgrade were part of the process. At least 3 additional MW were realized by the team effort. The partnership objectives include the elimination of nonvalue added costs, reduced cost of poor quality, and improved project execution.

VI. Lessons Learned From Energy Assurance - David Salem, US DOE

The DOE Office of Energy Assurance works with the Dept. of Homeland Security to assure the security and delivery of energy through the energy infrastructure. Major activities include SCADA protection, oil & gas pipeline security, visualization & simulation, and emergency response. Natural gas is a high priority for DOE as it provides 18% of the fuel for electric generation, 50% of residential energy, and 34% of industrial energy. Administration policy is to expand production and promote pipelines. Electricity is another main concern. There are over 200,000 miles of transmission lines connected to 950,000 MW.

Lessons learned from the Northeast Blackout include inadequate awareness, lack of maintenance, and lack of common communications procedures. Some NERC voluntary reliability standards were violated and may become mandatory at the federal level. From the Hurricane Isabel aftermath, there were similar issues of preparedness and communications. In general, we are not as well prepared as we should be. In most areas, we are still dependent upon land lines for communications rather than priority wireless. More trained people are needed. Decentralizing some of the decision making and individuals away from DOE HQ has been initiated.

VII. Renewable Energy Project Financing and Incentives - Jim Butcher, Black and Veatch

Renewables currently provide 2.3 - 2.4% of the electric generation including biomass, geothermal, and others. Biomass fuels include wood, biogas, agricultural residues, waste to energy, biodiesel, and animal wastes. Projects range in size from 0.1 - 75 MW. These can be low in cost and are available almost everywhere. Collection, transportation, and feeding are the basic issues. Nearly 50 different fuels ranging from peach pits to paper sludge were listed. Biomass combustion is one of the cheapest alternatives, particularly with co-firing with coal in limited amounts.

Geothermal energy is a mature technology with 8000 MW installed. The technology has low operation cost and high reliability. However, there are high development costs and limited resource availability. These resources are located mostly

in the West in the US. Steam lines are needed over a fair amount of land to feed the steam turbines at the main site.

Wind power is becoming more economical. Larger size machines are now up to 1.5 MW. Capacity factors range from 25 - 35%. The best wind areas are in the central US. Wind farms are the most common application rather than single windmills.

Solar energy is still rather expensive and has low capacity factor. Due to the variable nature of the sunshine, the power is not dispatchable. PV manufacturing capacity is about 600 MW/yr. Cost estimates run around \$8000/Kw. Parabolic trough systems are also finding applications in the Southwest. Many are using natural gas for supplementary energy. Central receiver plants have had a few demonstration units, but no commercial plants are in operation.

Small hydro is one of the most mature renewable energy technologies. However, most of the easy locations have been exploited. Permitting and siting new locations had become extremely difficult. Existing dams, existing unit upgrades, and aqueducts, are potential opportunities.

Co-firing, geothermal, wind, and hydro retrofits are the lowest cost options. Government policies and incentives include mandatory renewable portfolios, production credits, and investment tax credits. Incentives must be planned into the project from the beginning. If a national target of 12% were to be adopted, nearly 25% of new additions would have to be renewables. One case study involved the Palmdale Water District. The district elected to buy a small amount of PV (30 Kw for \$300 K). The state provided a rebate of nearly 50%. Even so the payback is nearly 16 years. A second purchase will be a 950 Kw wind turbine at \$720 K after the rebate. Payback is 6 years. The district is also planning a hydro project. Project financing has all of the issues associated with conventional technologies and the added issues of perceived risks, EPC guarantees, small projects with associated higher specific development costs, and credit worthy participants.

VIII. Green Financing for Energy Efficiency Projects - Bob Bessette, CIBO

Tim Brown of the Delta Institute was originally going to give this talk. Energy efficiency is one of the lowest cost means of reducing emissions as well as saving energy. However, many of these projects are not being done. One reason has been NSR. Another has been money. The Delta Institute came up with the idea of creating a "green fund" for financing such projects. The idea was to gather funds from entities and institutions with environmental interests. These would be used to finance projects for smaller institutions that ordinarily would not qualify for project financing.

The Shaw Bank was preparing such a fund and Tim was called to a meeting on this issue. Bob looked into other potential funds. DSIRE is a database on the web showing programs that are available in all of the states for renewable energy and energy

efficiency projects www.dsireusa.org . The Clean Energy State Alliance from Vermont works with states that have access to funds for clean energy projects www.cleanenergyfunds.org/about.html . Energy efficiency projects automatically qualify as clean energy projects as they automatically reduce emissions. They also have a website. The California Energy Commission has a tremendous amount of information on their website, complete with names and contact information www.energy.ca.gov/commission/phone_list.html .

IX. Legislative & Regulatory Future for Energy Projects - Michael Dudasko, ENSR

Mike changed the topic somewhat to “Coping with Regulatory and Environmental Change”. Besides the Boiler MACT standards that will come out this week, there are new ozone/pm2.5 standards, greenhouse gas considerations, election year posturing, and post election year changes that will impact environmental compliance. Public drivers include “green” business considerations, sustainable development, and corporate “citizenship”. Agency drivers include reductions in budgets and increases in regulations. These have the impact of increasing the length of time to get permits, increasing fees, and increasing fines and penalties. The net of all of this is the there is more uncertainty and the likelihood that there will be fewer resources available to react to the changes.

Interest has escalated for computer based tools to help industry in meeting their compliance requirements. Computerized compliance assistance can provide a task management system, environmental data, track compliance metrics, and link to regulations. These can range from a spread sheet with lists of compliance dates to customized systems using productivity software to purchased software specific to the environmental needs (facility modeling, integrated EH&S, and on line compliance).

A needs assessment is crucial to evaluation and selection of an appropriate system. IT infrastructure is an important factor in the assessment. A written, functional specification is recommended. In one case study, a vertically integrated rancher had a myriad of ranches across state lines. As these ranches had to be visited on a regular basis, replication and input into a laptop computer was a necessity. A MS ACCESS database was set up with a tailored data structure. In this case, no commercial software was available that had all of the features that were desired. The same considerations are applicable to the industrial, commercial or institutional operation.

X. The Roll of the Third Party Owner/Operator - Chip O'Donnell, Cinergy

Third party ownership or operations of industrial plants could result from cost constraints, reliability/ availability, and risk mitigation. Risk mitigation involves financial considerations, core focus, and environmental considerations. Cinergy is the 6th largest buyer of coal in the US. As a third party, they might be able to buy fuel at better prices than the original industrial owner. Allowance purchasing is another area where a third party may bring experience and expertise that is not available with the

original owner. Reliability, predictability, and reduced costs are the goals for the third party owner/operator.

Solid fuel projects are starting to come back in the industrial energy arena due to the reduced volatility and availability of supply. Projects differ from location to location even within the same company. Therefore, specialized energy solutions need to be tailored to the customer's need. An ongoing business relationship must be contemplated. Third party ownership provides the opportunity for the industrial customer to focus on making product while the third party can focus on operating the power plant.

XI. Using Technology to Reduce Cost and Improve Reliability - Larry Tangel, Enercon

Combined heat and power can help address several issues that have been brought up today. Larry is representing the US Combined Heat and Power Association (Chairman). USCHPA works with DOE and EPA as well as states on interconnections, rule making, and applications for combined heat and power. A website is available.

Combined heat and power and cogeneration are interchangeable terms for USCHPA. Cogeneration can take advantage of a wide variety of technologies including IC engines, gas turbines, fuel cells, back pressure steam turbines, and industrial processes. Typical markets/industries for cogeneration include pulp and paper, chemical, refinery, food processing, and pharmaceuticals. Commercial buildings and hospitals are also candidates for combined heat and power.

The USDOE has established a goal to double the amount of cogeneration in the US. The EERE website has a wealth of information on ways to utilize CHP. Support for CHP can be enhanced by contacting your Senators and Congressman. USCHPA supports output based standards. Everybody is encouraged to join the USCHPA.
www.uschpa.admgt.com

XII. The Sutton Place Hotel - Chuck Ekstrom, Engineering

The hotel has been in operation for 20 years. The hotel was on an interruptible rate that saved \$95 K/yr. However, the utility has the right to cut power to the hotel on 30 minutes notice. This happened several times during the California energy crisis. Shutting off the power to the guests did not turn out to be a viable option. The penalty to keep the power on was \$9/Kwhr. The hotel ended up renting a portable generator to save several hundred thousand dollars.

The hotel had 1.2 MW of load. They investigated several energy savings opportunities and implemented absorption chillers and improved lighting. The load was reduced to around 900 KW. For the size range that is involved, an IC engine was selected. A rich burn, IC engine was deemed to be proven technology. The boilers were removed from the hotel. Four 250 KW engines were purchased for combined heat and

power. A large hot water tank is used to store the hot water so that the engines can run at steady load and the water demand can vary.

The plant was \$1.5 million turnkey. The gas company provided a rebate of \$500K. The system is interconnected with the utility, but is capable of being isolated from the grid. The net equivalent power generation including the evaluation of the heat works out to be 6.5 cents/kwhr, including a 0.5 cents/kwhr exit charge. The grid price was 10.5 cents/kwhr. The maintenance contract is \$2/run hour.

XIII. Back Up Power and Cogeneration - Chris Lyons, Solar Turbine

Although central station electricity is quite reliable and relatively inexpensive, today's equipment demands are such that there are many systems that need very steady, reliable power supply (especially hospitals, computer systems, refrigeration, temperature sensitive equipment, etc.).

If there is a power interruption, a typical back up generator needs a battery to turn a start up motor to get a back up generator on line. Power management systems are important for managing the switch over from grid power to back up power. Mobil power units of 5 MW and 14 MW are available. Solar now has IC engines in their power group. Over 400 MW of mobil/standby units were sent to the Northeast within 24 hours of the blackout last August. IC engines are somewhat more efficient than gas turbines. O&M costs are less (5 mills/Kwhr) than for IC Engines (10 mills/kwhr).

One example of a turnkey plant in Texas is a 20 Mwe CHP plant in Texas with 4 heat recovery boilers with supplementary firing. Steam flow is guaranteed at 100%. The plant is owned by Solar/Caterpillar. CHP generally has good economics when the facility heat to electric ratio is 1.3:1 and the electric price is roughly twice natural gas (ie 8 cents/Kwhr vs \$4/MMBTU). CHP for reliability is also a consideration as utility investment in transmission and distribution has lagged. "Island mode" is a consideration (ie offshore platform) where all of the back up is provided for reliability on site.

Gas turbines can provide relatively more higher temperature/pressure steam than IC engines, especially when supplementary fired. The IC engines make use of the jacket water, which is primarily a hot water system. With supplementary firing, the overall energy recovery is over 85%. Without supplementary firing, the recovery is more like 75%. With the higher temperature exhaust, the exhaust gas can be sent directly to an absorption chiller for chill water (HVAC). If there is a use for very low grade heat, the energy can be recovered from lubricating oil, water cooling, air coolers, etc. Under these conditions, 92% energy recovery can be achieved.

Solar is coming out with a 4.6 Mwe recuperated gas turbine with a 38.5% open cycle efficiency. The NOX level is guaranteed at 5 ppm @15% O2. The expectation is that it will run at closer to 2 ppm. The recuperator was considerably beefed up and a much higher alloy was used. The recuperator was tested through 15,000 cycles.

XIV. Controlling Your Energy Future - Dennis Finn, Wartsila

Distributed generation contributes to energy security and sustainability, particularly when CHP is deployed. The utilization of biofuels can also provide additional support for this goal. Diesel engines fit well in this application. Large gensets can provide rapid load support (spinning reserve), peak shaving, and reactive power support. Island mode and black start capability are both possible. These engines provide some additional flexibility for liquid and gaseous hydrocarbon fuels such that added fuel diversity can be realized.

In one plant in Denver, 20 IC engines were deployed to give 110 MW power output at a station in Denver. The plant was designed to give full output at 98 F and 6,000 ft altitude. The plant can go from zero to full load in 10 minutes from a “warm” start. Another feature that was valued by the customer was the rapid load change capability (more than 5%/min). Plant availability ranged from 99.4 to 99.9%. It was pointed out that 100% availability was not reported as IC engines have a planned maintenance program that have very short outage periods (0.1%).

One example of a back up system was a plant in Taiwan that suffered an earthquake. The plant had a 25 MW on site distributed generation system. The earthquake caused a loss of power for 21 days. The plant DG system allowed the plant to keep operating and to meet key deliveries. The plant has since installed another 50 MW. During the Northeast blackout, the Detroit Metro Airport DG facility was able to bring the airport back into service. The automated back up starter had not been tested upon installation. As a result, the startup took longer than planned. Again, it is important to check out equipment before actual use. An additional DG system has been installed next to the control tower with hot water recovery.

“Biodiesel” is a term used for vegetable oils that have been esterified. These fuels have been considered a renewable fuel with zero net contribution to greenhouse gases. These fuels are very low in sulfur ($\ll 1$ ppm sulfur). Biodiesels have considerably lower emission levels of particulates, VOCs, CO, and toxic emissions. The NO_x emissions are somewhat increased. Orimulsion has also been used in diesel engines. A 60 MW installation is in Finland and another installation is in South America. Due to the carbon trading system that is coming in 2005, there are about 25 assorted gen sets in Germany and the Netherlands.

XV. Biomass and Renewable Energy Development Potential - Ted Guth, Consultant

Ted has done a lot of permitting work in California for a variety projects. The early projects in California were financed as qualified facilities with fuel costs at near zero. Once the industry was established, the price of fuel went to \$10 - 15/ton. In the 90s, this jumped to \$25 - 30/ton, to the point where several plants were uneconomical.

During the mid 90s prices dropped back to \$20 - 25/ton. Currently the price level is \$15 - 20/ton.

There are now 31 plants in operation (down from 55) utilizing 7 million tons/yr. A farmer cost for annual prunings at about 1 ton/acre is about \$20/acre. The supplier needs to collect and haul those prunings to a plant if it is to be utilized. This may cost \$5/ton. In general, open burning is more polluting than utilization. Thus, some state subsidy can be argued to utilize the waste. Typically, biomass fuels are about 10 MMBTU/ton. Thus, the costs in the range of \$15 - 20/ton result in \$1.50 - \$2.00/MMBTU fuel. With the costs for O&M, fuel, and capital, the COE ranges from 7 - 9 cents/MMBTU. Power Purchase agreements tend to run at 5.5 - 6.0 cents/MMBTU.

The State of California has set a goal of 20% renewable energy by 2017. Local considerations include siting, regulations, local perceptions, and costs. Many air districts do not recognize the differences amongst solid fuels. Due to the non-attainment status of California, BACT applies. This is a moving target, particularly in California. The financial community is skittish because of the contraction in the State from 55 plants to 31 plants. They are reluctant to finance another plant that might go under.

XVI. What Do I Do With Old Boilers? - Phil Peterson, Bibb & Associates

For the purposes of this meeting, a reference boiler of 100,000 pph saturated steam at 200 psig firing natural gas with #2 oil as back up. Water treatment consists mainly of softening. Reasonably stable operation was assumed with an annual maintenance allowance. A 20-year useful life was assumed.

For an existing boiler, one of the first questions is how much continued life is anticipated. Does the boiler run well? Make up water quality and water treatment reliability are a key concern for a boiler. Plant records and record keeping practices are important in estimating potential problems. Predicting failures or failure rates can be done with a variety of techniques, including many non-destructive techniques.

Repetitive failures are generally an indication of other problems. Finding the root cause of the problem is the key to elimination. In order to meet new regulations, new burners or flue gas recirculation may be needed. Refractory repair is not insignificant. Tube repairs can range from isolated tubes to whole sections. Control repair/replacement can provide efficiency benefits as better control of fuel and air is realized. This also tends to improve emissions as well.

If the boiler is in relatively poor condition, it may be more cost-effective to replace it. Capacity considerations need to be taken into account. This includes auxiliary equipment as well as the boiler. Outsourcing is one means of avoiding the issues internally. Arrangements such as 3rd party steam supply, inside the fence ownership, O&M contracts, and partnerships can all be considered. One of the comments from a participant indicated that in their studies at plants, they often have multiple boilers, where

it may be more cost-effective to look for ways to reduce peak requirements in order to be able to eliminate the need for the extra standby boiler.

XVII. Optimization of Generation Assets - Denis Oravec, Automation Applications

Automation Applications provides process control and information systems. Over half of their business is in energy management. The industrial utility operating challenge is to get the most out of their system in a reliable and economic manner. In a typical powerhouse, the boilers, headers, and prime movers (if utilized) will be involved in such an evaluation. As a strategy, maximizing the steam supplied by self generating (internal fuel) assets and distributing the steam in an efficient manner leads to a lowest cost system.

A “rule based” supervisory control system can satisfy the multi-variable multiple constraint requirements. Boiler load allocation concerns generating steam at the lowest cost. The steam demand would be allocated across multiple boilers with the lowest variable cost at that moment. This is comparable to economic dispatch on an electric power grid. There may be global constraints in addition to the normal boiler constraints that need to be considered.

An example might be total annual usage of a given fuel, or a process limitation in the plant. Maintaining stable header pressures for all combinations of fuel, boilers, and load demand is required. Once internal assets are loaded, power (or steam) purchase needs to be managed. As the price of electricity can be variable in many locations, it is sometimes economical to sell power into the grid rather than buy power or to maintain load to internal requirements. An economic sell advisor provides information on what could be sold and how. There may also be penalties for exceeding loads. A load shedding advisor provides information on what the load levels are and what penalties would be involved.

At one plant in Canada, the energy savings approached \$500 K in the first month. Biomass utilization increased 12%. Purchased natural gas was reduced by 40%. Purchased power was reduced by 30%. The overall product cost reduction was \$10/ton. At a paper mill in the Southeast, purchased gas was reduced by 14% and purchased power was reduced by 13%. Turbine load allocation increased electric production by 5%.

XVIII. Opportunities to Reduce Cost of Energy from Coal Fired Boilers - Keith Moore, Phenix, Ltd

As case in point, a coal-fired stoker supplied steam for an agricultural plant which was being pressured to burn low sulfur coal to meet new environmental requirements. The plant was closing down over the increased cost of the fuel (\$75/ton delivered to the plant). Energy cost was about half the cost of the product. The goal for this problem was

to reduce this cost by half. The Rockwell International slagging burner formed the basis of a burner technology for reducing SO₂ and NO_x. This burner operates at a high temperature and uses limestone injection to capture sulfur under reducing conditions. The CaS is encapsulated in the molten slag.

With these conditions the NO_x level was around 10 ppm. The reducing gases are directed into the existing boiler to burnout the hydrocarbon gases. In this evaluation, the low sulfur coal could be blended with a higher sulfur coal to reduce coal costs. Carbon in the ash is down to 0.1%. Due to the sulfur capture, the stack gas temperature could be lowered. With the high intensity burners, pulverized coal is utilized.

For the cost of a pulverizer, air heater, and the burner system, a stoker system can be converted to a PC unit with efficiency savings. The added cost on a coal basis for the limestone is less than \$1/ton of coal. Testing in Canada gave results of about 0.15 lb/MMBTU NO_x and 0.7 lb/MMBTU SO₂. The cost of a retrofit on a large unit was estimated to be about \$80/KW. Costs will be higher for smaller units.

XIX. Corporate Energy Management & Energy Efficiency - Chris Russell, Alliance to Save Energy

The Alliance to Save Energy is not a government agency. It is also not Greenpeace. This independent group attempts to bridge the gap between industry and advocates in order to facilitate energy efficiency and savings. One of the key issues in working with Corporate executives is “What is it for me?” People often confuse energy efficiency, energy conservation, and energy management. Energy conservation is sitting in the dark and wearing a sweater. Energy efficiency is using less energy to get the same result. Energy management is getting the most out of the energy we use.

The US Dept of Commerce just issued a report on “Manufacturing in America” in January. Amongst the normal concerns of global competition, tort and liability cost, health care costs, and taxes, the energy security and cost issues made the top 10 list of problems. For many manufacturers, energy is about 5 - 10% of product cost or less.

It may be 20 - 25% of the controllable costs. It may impact several other line items including insurance, labor, health and safety, and capacity utilization. The “top 10 energy mistakes” include brush fire or project only mentality, fear of embarrassment, belief that accountants have complete and accurate cost information, failure to measure impacts (before, during, and after), not getting outside training, not integrating energy management tasks with production goals and targets, failure to assess and prioritize efforts, disconnects between purchasing, production, and finance, no set roles and accountability, and it’s not all financing.

One program done with NYSERDA recommended the following: engage business with a business philosophy, address perceptions of risk, provide actionable resources, and demonstrate success stories. A key feature is to relate how energy

management can lead to “top line” growth as opposed to “savings”. Another key issue is low awareness. This is mainly due to the organizational structure to manufacture a product. As a result, it is difficult to align the goals and objects of the various people that need to act. Speed, quality, and reliability are factors that impact the manufacturing process.

Energy management contributes to all of these. Energy management is an ongoing task that needs to have goals and objectives linked to operations and performance. Top management support is critical. The Alliance web site is www.ase.org. An additional site is www.steamingahead.org. The following are additional sites of interest to the energy producer and consumer:

* "Manufacturing in America." U.S. Department of Commerce. Comprehensive recommendations for improving the competitiveness of U.S. manufacturing. Derived from 20 industry roundtables conducted in 2003. http://www.commerce.gov/DOC_MFG_Report_Complete.pdf

* Executives for Energy Efficiency: Recommendations for promoting improved industrial performance through increased energy efficiency. www.ase.org/programs/industrial/e4ee <http://www.ase.org/programs/industrial/e4ee>

* Steam Efficiency: Impacts from Boilers to the Boardroom (C. Russell) www.ase.org/steamingahead/library/boilertoboard.pdf <http://www.ase.org/steamingahead/library/boilertoboard.pdf>

* Justifying Energy Efficiency Projects to Management (C. Russell) www.ase.org/steamingahead/library/justifying.pdf <http://www.ase.org/steamingahead/library/justifying.pdf>

* Cash Flow Impacts of Steam Efficiency (C. Russell) www.ase.org/steamingahead/archives/2003_07-08.htm http://www.ase.org/steamingahead/archives/2003_07-08.htm

* The Dirty Dozen of Energy Efficiency Waste (Fred Schoeneborn) http://www.ase.org/steamingahead/archives/2003_07-08_links/dirtydozen.pdf

* Enbridge Gas Distribution's Steam Saver Program Results (Bob Griffin) (66 steam plant audits, summary report) www.ase.org/steamingahead/archives/misc_links/enbridge03.pdf

http://www.ase.org/steamingahead/archives/misc_links/enbridge03.pdf

* U.S. DOE's BestPractices Steam: resources for self-led energy improvements in steam plants.

www.oit.doe.gov/bestpractices/steam

<http://www.oit.doe.gov/bestpractices/steam>

* Steaming Ahead: the Alliance to Save Energy's steam information and networking resource. www.steamingahead.org

<http://www.steamingahead.org>