

ENERGY SOLUTIONS and DISTRIBUTED POWER GENERATION

An Electrical Supply Option for The Mining Industry

Western Mining Electrical Association

Fall Meeting - 2001

Tucson, Arizona

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GE Industrial Systems - Las Vegas, NV

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MOTIVATION

- Electrical Rate Increases
- Brown & Black Outs
- Equipment Damage
- Product Losses
- Interruptible Rate Penalty Avoidance
- Long Term Independence
- Peak Shaving
- Expansion
- CHP Productivity
- Gas Rate Volatility
- Public Perception
- Business Stability & Reliability
- Safety
- Customer Satisfaction
- Quality

...is NOT in short supply

DEFINITIONS & ACRONYMS

- DG - Distributed Generation
- CHP - Combined Heat & Power
- BTU -
- MMBTU - One million BTU's
- Therm - One thousand calories (@ 4 BTU's)
- Enthalpy - Total amount of energy in something. (e.g. BTU's/lb.)
- Efficiency - Input Energy/Output Energy (utilable)
- PV - Photovoltaic (Solar Cells)
- IPP - Independent Power Producers
- IOU - Investor Owned Utility
- ESCO - Energy Services Company
- SCR -
- Heat Rate - BTU's needed to create 1kw-hr of electrical energy
- "9's" - Related to the reliability of energy supplies on an annualized basis

INDUSTRIAL ENERGY REVIEW

- Regulated Electricity Supplies
- Deregulated Natural Gas - Commodity Only
- Excess Capacity
 - Bulk Energy (Gas and Electricity)
 - Transmission
 - Delivery
- Inexpensive Energy
 - Electricity \$20 to \$40 per MWhr
 - Natural Gas \$2 to \$4 per MMBTU
- Stable Prices - Lack of Volatility

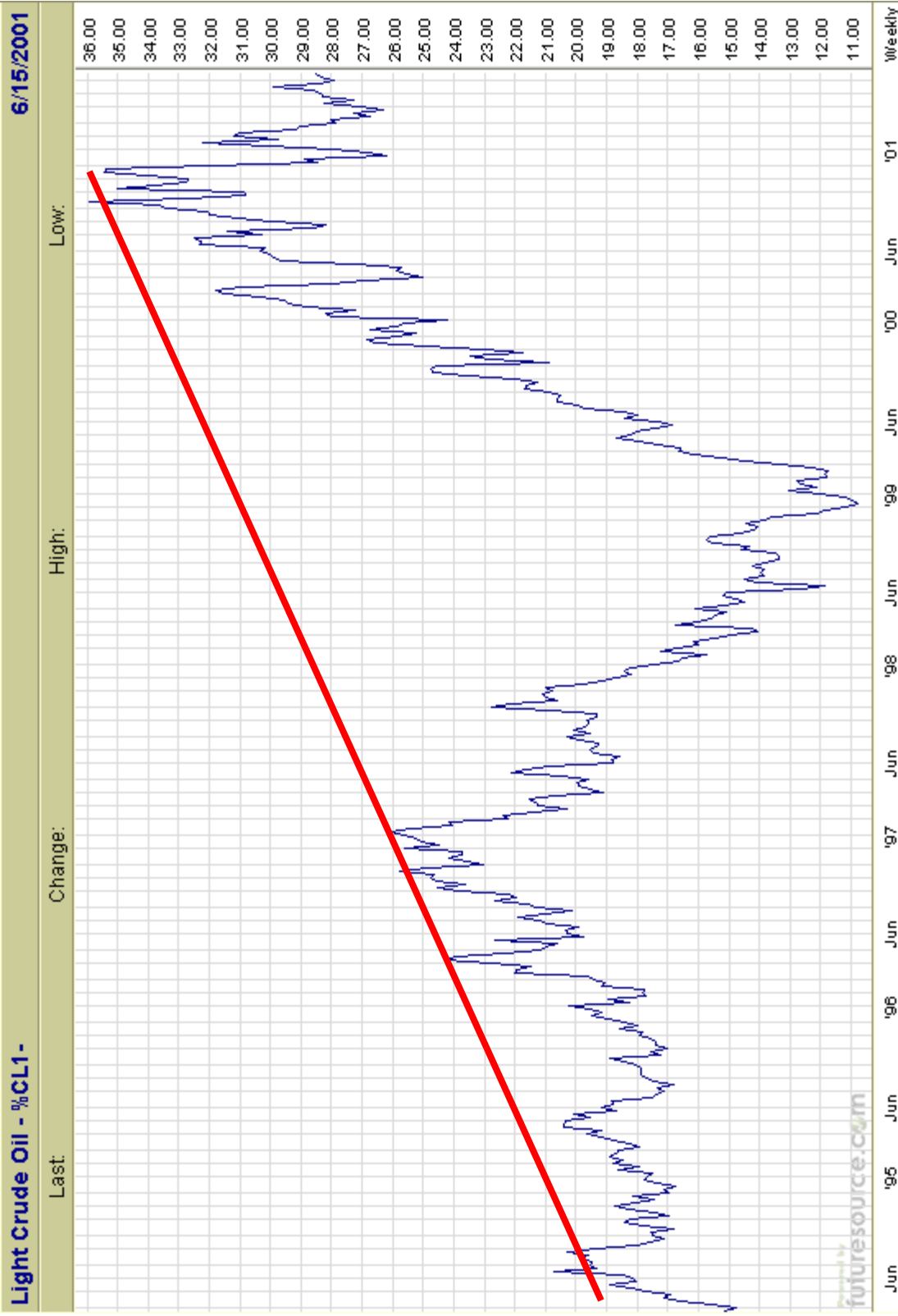
Historical Past

INDUSTRIAL ENERGY VIEW

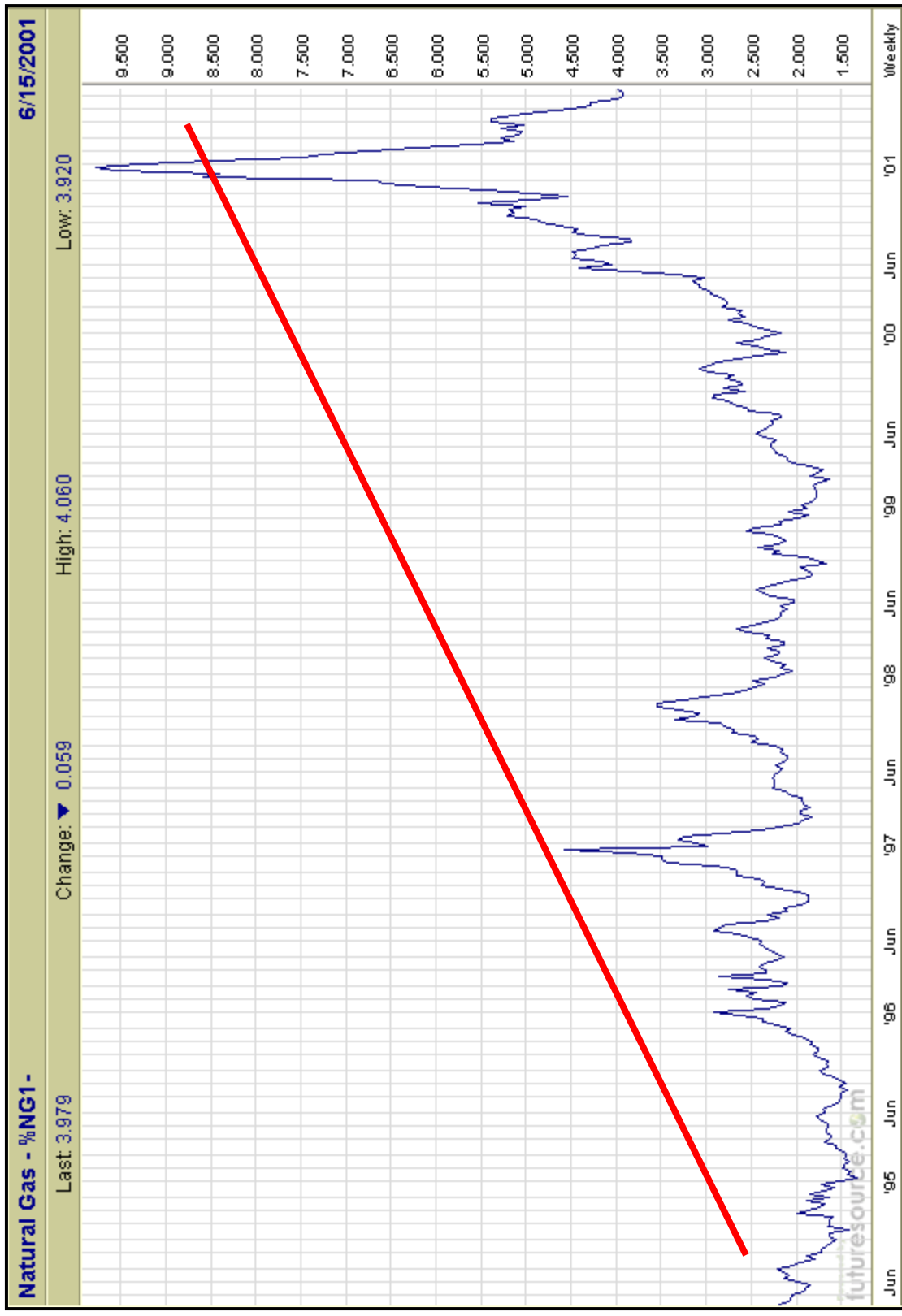
- Deregulation of Electricity Generation
- Marginal / Insufficient Generating Capacity
- Non-Functional Market
 - Numerous Generators
 - Insufficient Capacity
 - Numerous Suppliers Have Market Power
 - High Prices Bear No Relation to Cost
 - Unstable Pricing - High Levels of Volatility
- Electricity Cost
 - \$100 to \$500 per MWhr
 - \$3,000 + per MWhr Peak
- Natural Gas Cost
 - \$6 to \$9 per MMBTU
 - \$20 per MMBTU Peak

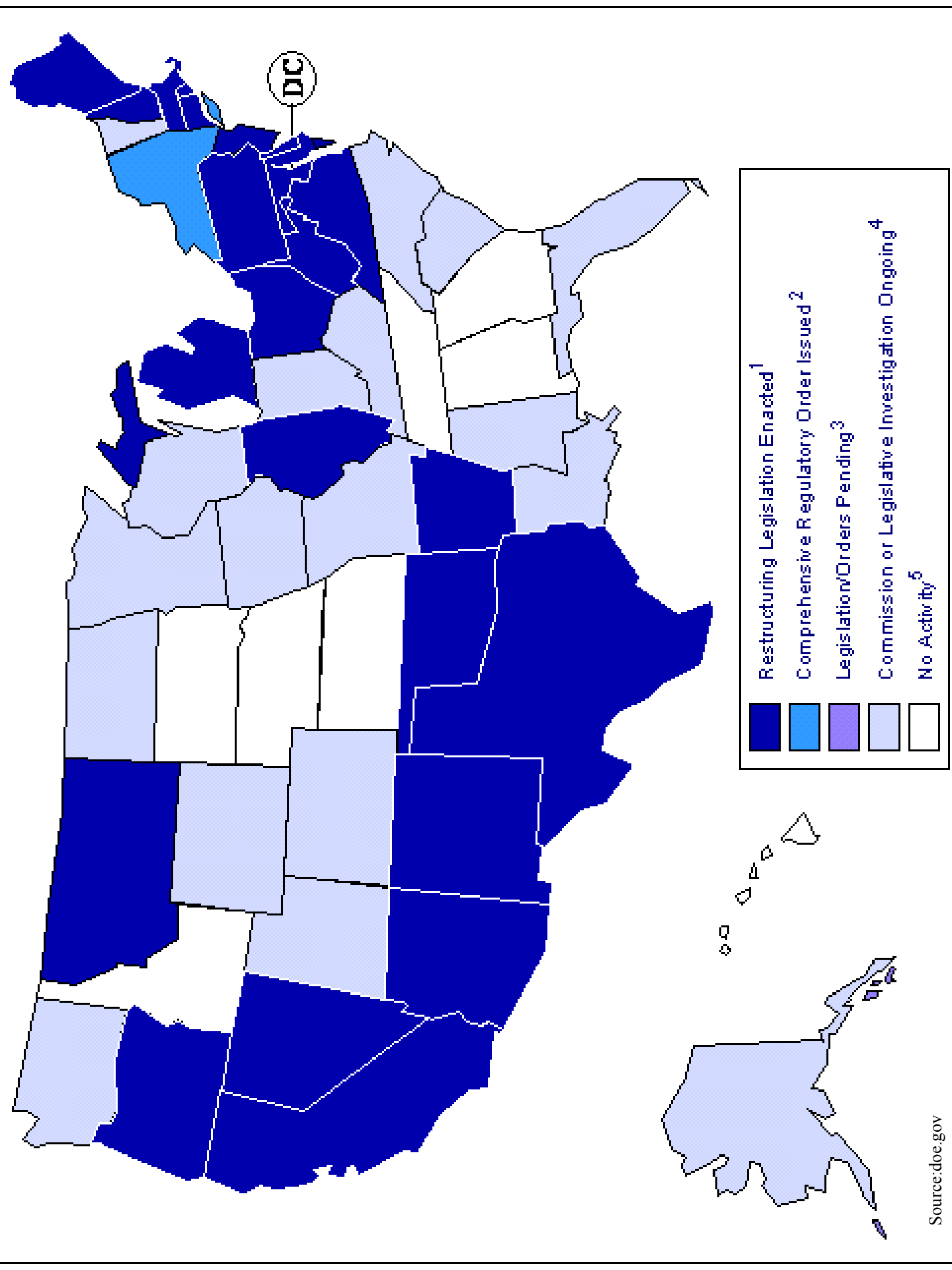
Recent History - Present

NYMEX Crude Oil



NYMEX Nat Gas





INDUSTRIAL ENERGY PREVIEW

Energy Intensive Industries Must:

- Play an Active Role in Energy Procurement and/or Generation
- Create Energy Options
 - Sources
 - Types
 - Technology
- Distributed Generation is an Option

The Future

PERFORMANCE CONTRACTING

Definition:

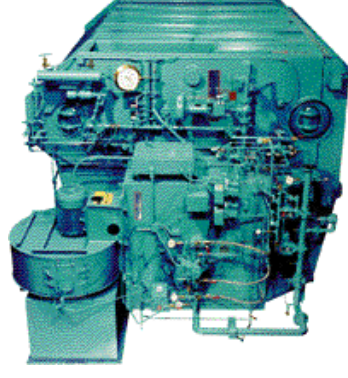
A contract, between a customer and an ESCO, with payments which are based on pre determined, measurable and verifiable performance criteria. In general, the performance criteria will be based on guaranteed future energy cost savings.

The contract establishes absolute minimums (savings) which will be met by the performance.

ENERGY COST SAVING AREAS of FOCUS

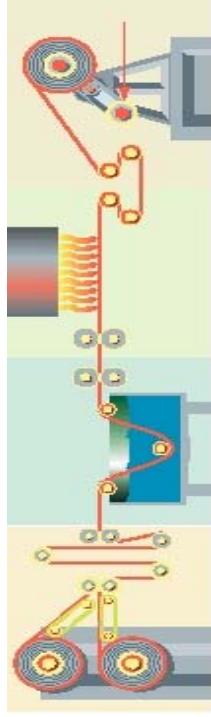


Supply Solutions



Demand Solutions

Process Productivity
Improvements

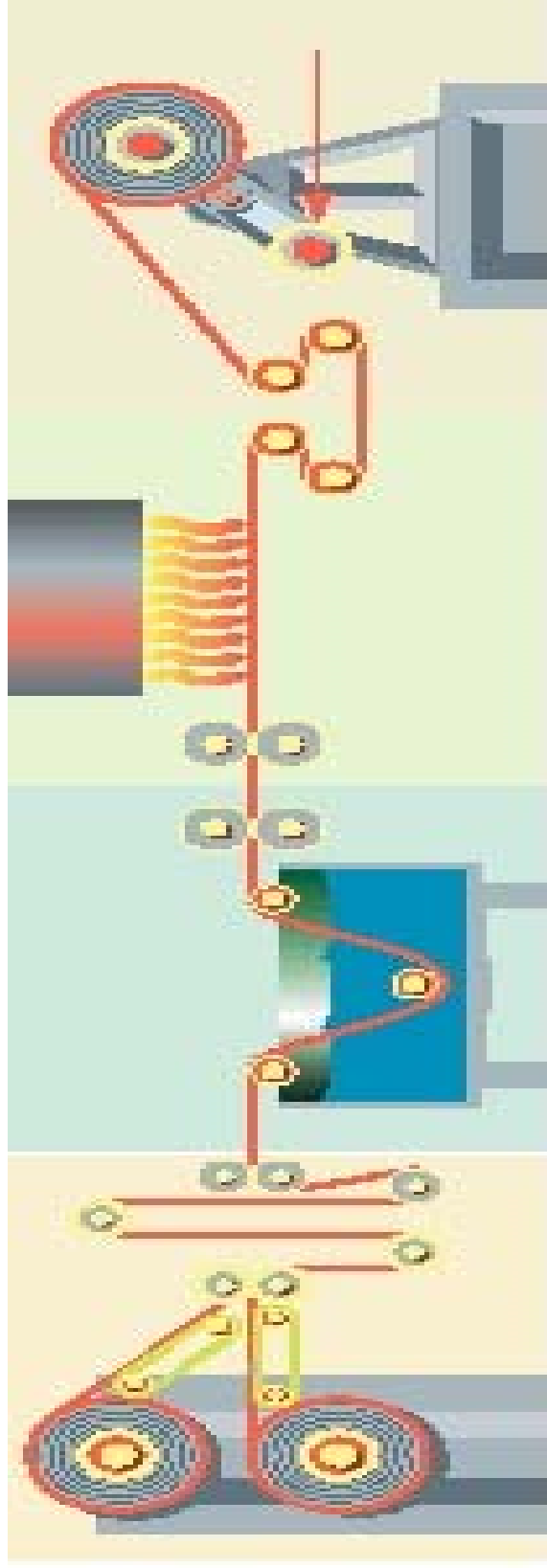


Monitoring & Serviceability

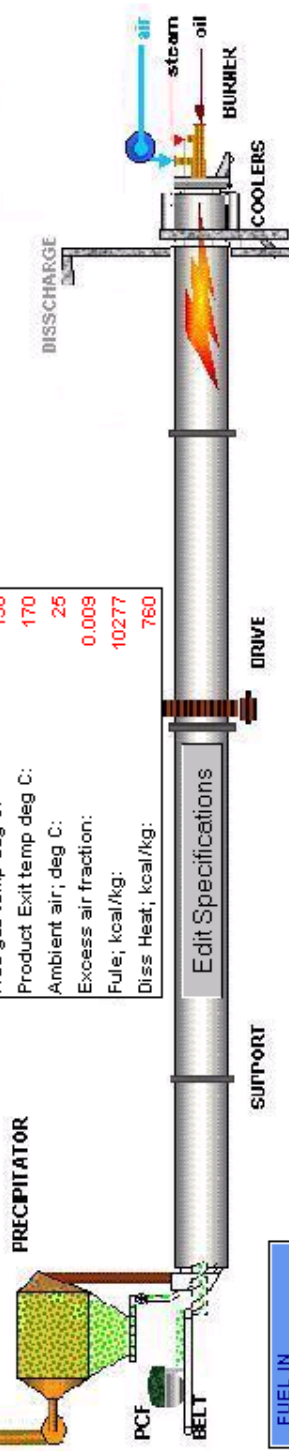


PROCESS & PRODUCTIVITY IMPROVEMENTS

- Process Line Through Put Increases
- Reduced Scrap
- Improved Quality Tolerance
- Automation and Intelligent Systems



INPUTS	
MTonnes Product/24hr:	455
Lime Availability fraction:	0.85
Mud Dryness fraction:	0.75
Recirculated dust fract of feed:	0.04
Flue gas temp deg C:	150
Product Exit temp deg C:	170
Ambient air, deg C:	25
Excess air fraction:	0.009
Fule, kcal/kg:	10277
Diss Heat, kcal/kg:	760



Edit Specifications

FUEL IN	
Dry air:	622.8
N2:	478.3
O2:	144.5
H2O:	9.3
Oil:	41.3
CaO:	268.6
Inerts:	47.4

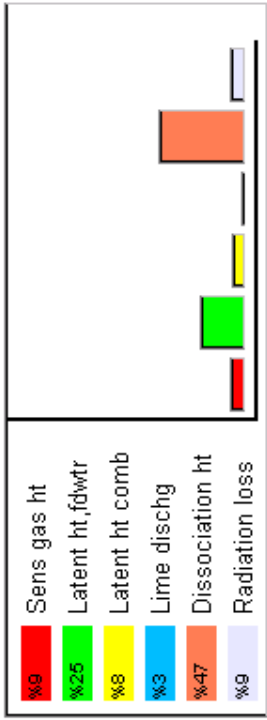
HEAT OUT	
Sens gas ht:	38936
Latent ht, fdwtr:	110163
Latent ht comb:	33346
Lime dischg:	11454
Dissociation ht:	204118
Radiation loss:	37725

FLU GAS	
Dry Gas:	819.33
H2O:	247.80
CO2:	339.76
N2:	478.29
O2:	1.29
O2%:	0.16

GENERAL	
MM BTU/ST Product:	4.84
Barrels of oil/day:	374
Cost per day (\$):	7,480
Cost per year (\$):	2,692,800

HEAT IN	
Fuel:	424499
Sens oil heat:	2478
Sens air heat:	3970
Dry Feed:	4796

OUTPUTS	
Flue gas	423.0 deg K
Product	316.0 Kg/min
CaCO3	480 Kg/min
Cp air	0.25
Dry virgin feed	527 Kg/m
Cp N2	0.25
CO2 from diss	211 Kg/m
CO2 for comb	143
O2	0.23
Cp O2	128.7
Flugas	56.8
Gas Cp	0.002
heat out	0.46
heat in	617.2
Dry Feed_recic	Kg/min
Water in mud	182.69
Cp CO2	Kg/m3



VirtualMill Tools ... Economic Analysis

Previous Oil Cost Per Day: \$14,363 Reduced Daily Cost: \$488 Previous Oil Cost Per Year: \$5,170,680 Reduced Annual Cost: \$175,886

MOTIVATION

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MONITORING AND SERVICEABILITY

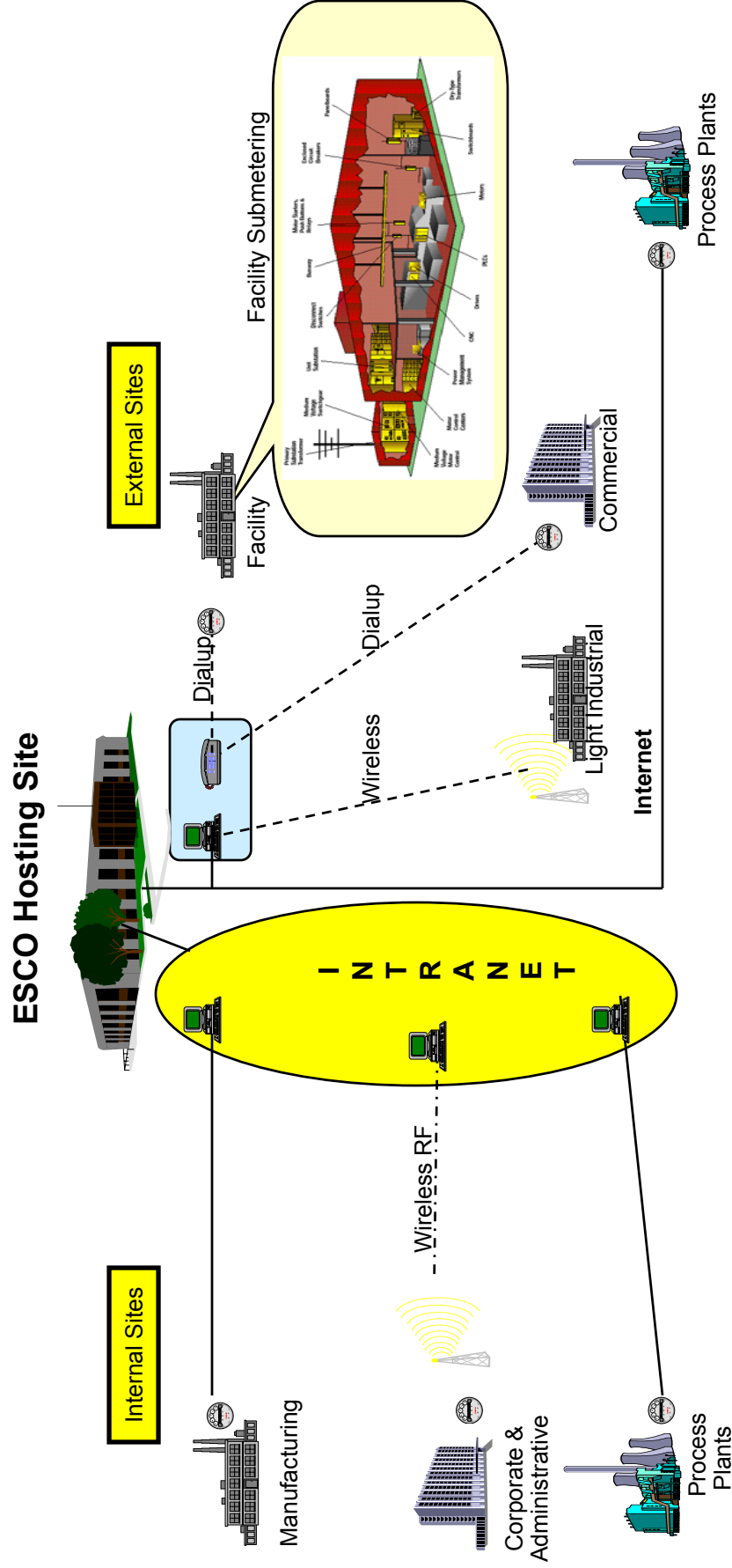
- Aggregation and Variation Analysis
- Benchmarking and Savings Quantification
- Real Time Monitoring and Peak Shaving
- Long-term Service Agreements



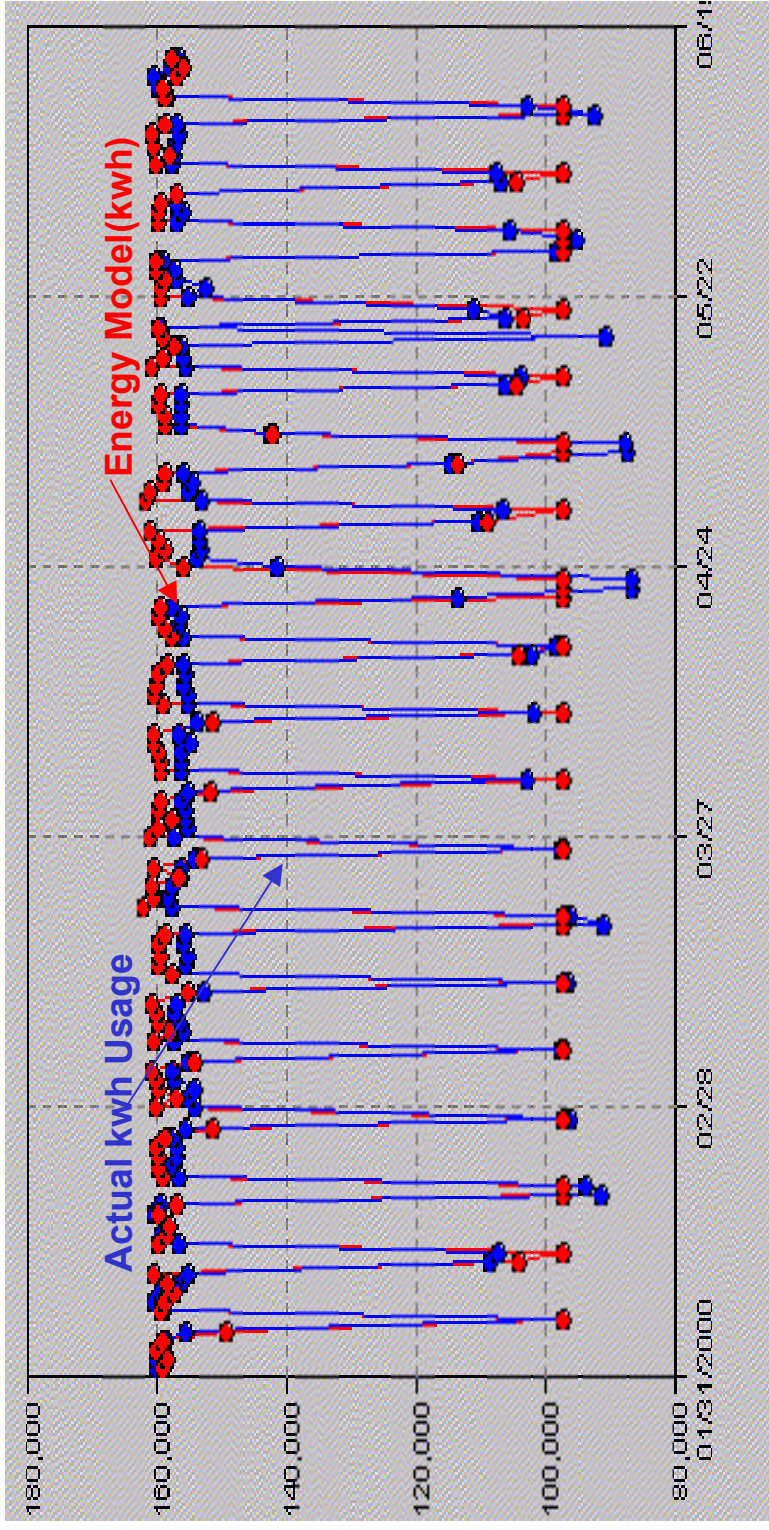
ESCO RESPONSIBILITIES:

- All Installation & Configuration
- Installation & Configuration @ External Vendors
- Basic Monitoring & Analysis
- Advanced Analysis & Consulting
- LTSA
- Local Servers
- Central Servers

Monitoring & Analyses



System Modeling To Predict Usage ...



- Production Data Forecasts Usage

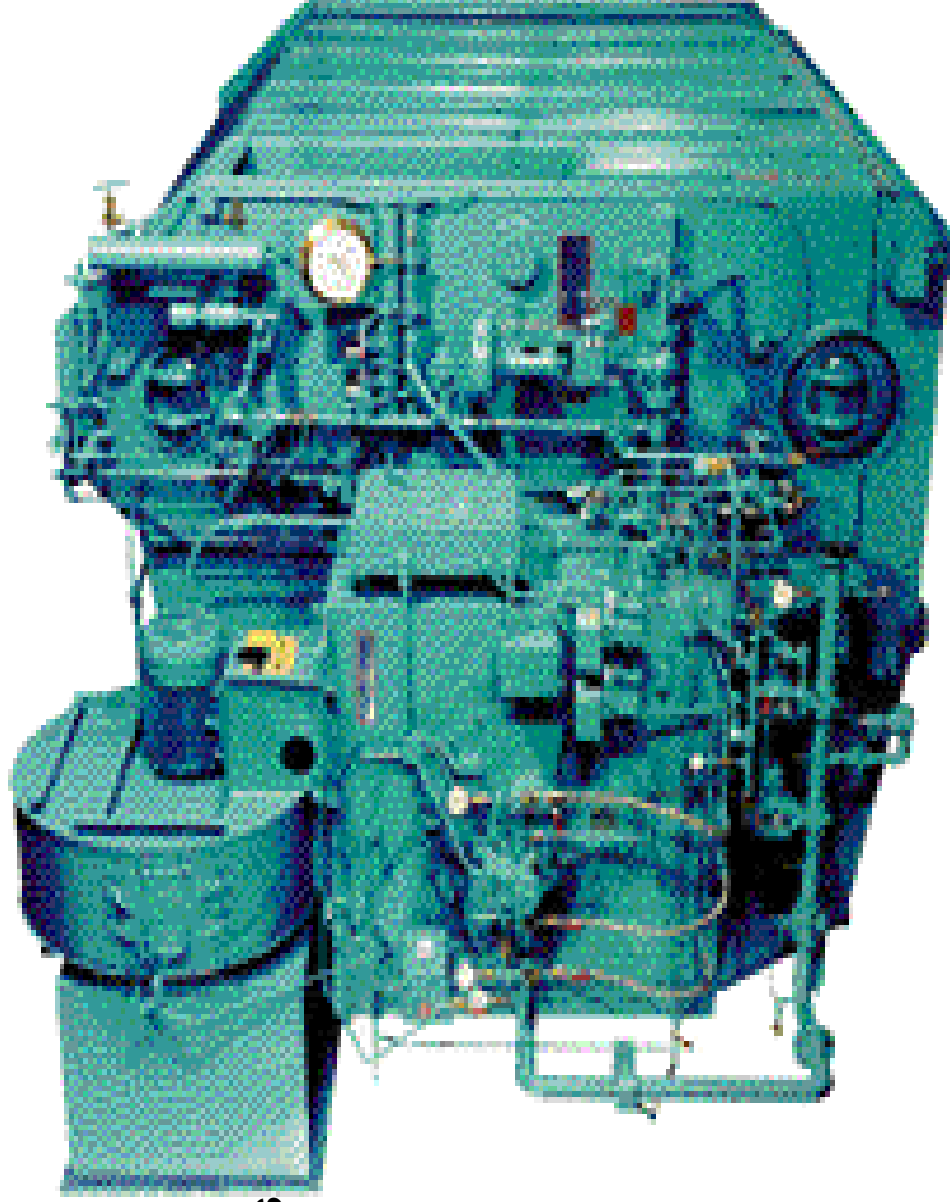
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...is **NOT** an issue

DEMAND SIDE SOLUTIONS

- Chiller Systems
- Compressed Air
- Boiler controls
- Heat Recovery Steam Sys
- Steam Systems
- ID & FD Fans
- Cooling Towers
- Motors
- Material Handling
- HVAC



DEMAND SIDE ENERGY PROJECTS

Long Term:

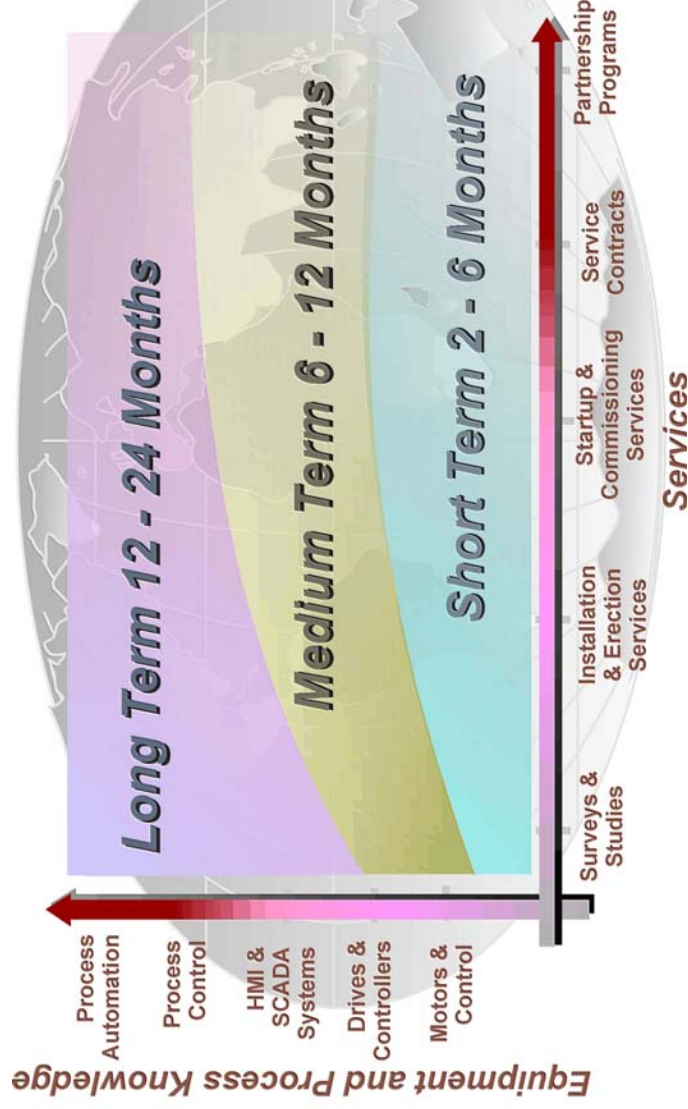
- Integrate Energy, Process, Technology
- Service Contracts
- Customer Supplier Partnerships

Medium Term:

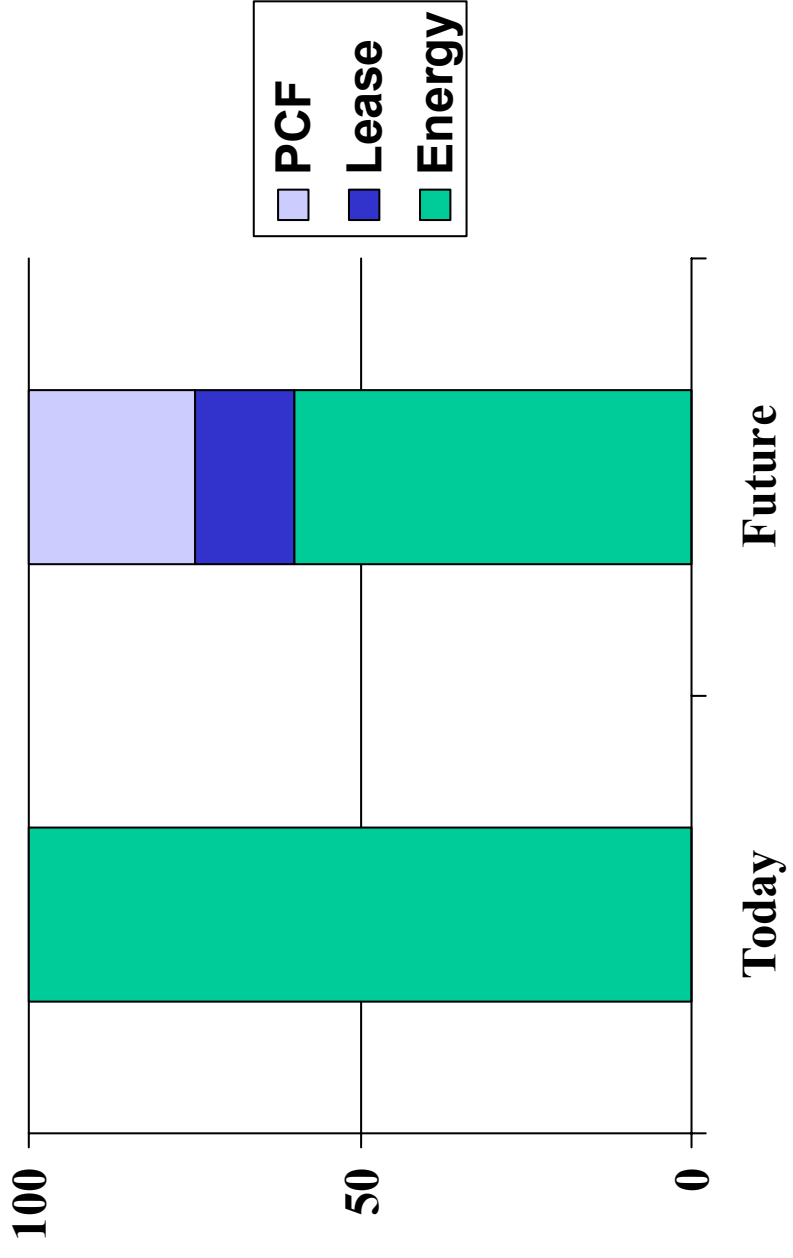
- Detailed Designs
- Project Construction Phase
- Measure & Verify Savings
- Integrate Performance Ideas

Short Term:

- Due Diligence/Site Assessment
- Project Evaluation & Selection
- Energy Consumption Models
- Conceptual Design
- Short Cycle Projects
- Energy monitoring



DEMAND SIDE PROJECT CASH CONVERSION



Operating Costs Converted to Positive Cash Flow

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SUPPLY SOLUTIONS



- Critical Power Systems
- Demand Peak Shaving
- Power Purchase Strategies
- Standby Generation
- Distributed Generation

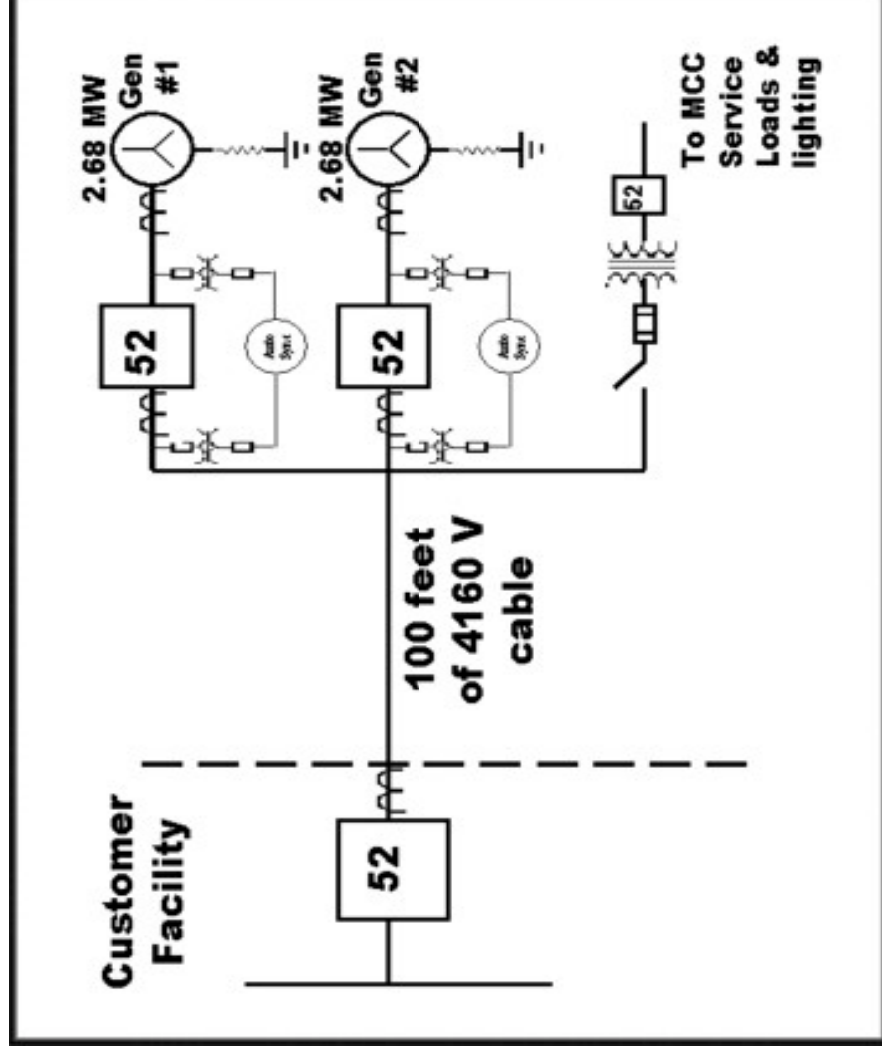
DISTRIBUTED GENERATION

Definition:

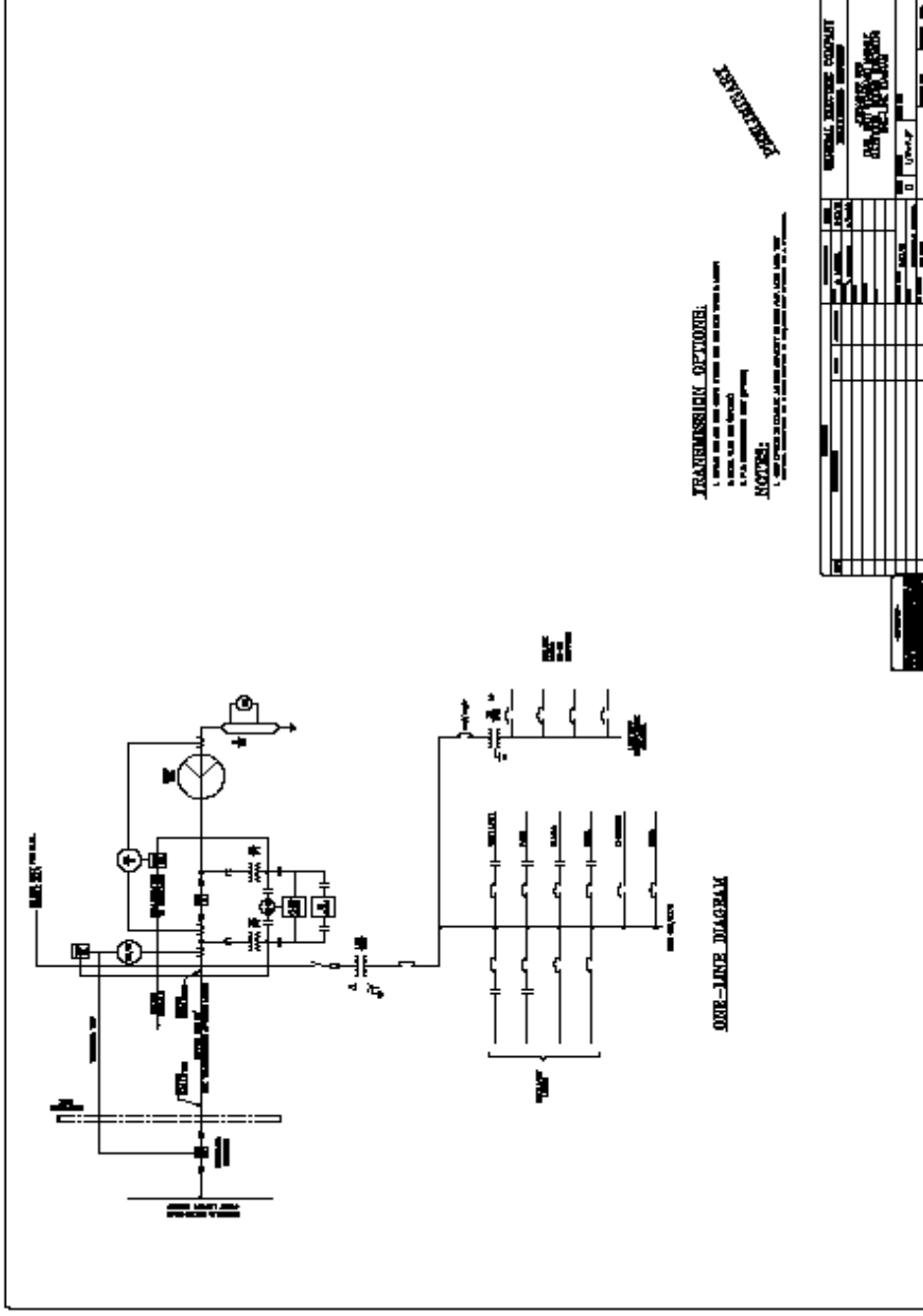
A small output electrical power generating plant which supplies peaking or base load energy and is operated in either an island or grid-parallel configuration.

The plant is sited adjacent to the customer load for which it was evaluated, sized and will serve.

SIMPLIFIED ONE-LINE DIAGRAM



SINGLE GENERATOR ONE-LINE DIAGRAM



DG SOURCE TECHNOLOGIES

- RENEWABLES
 - Hydro
 - Wind
 - Solar
 - Fuel Cells

- TRADITIONAL TECHNOLOGIES
 - Combustion Turbines
 - Reciprocating Engines
 - Energy Storage Systems (High electrical efficiency)

A Broad Array of Options to Meet Site Specifics

RENEWABLES (Wind, Water and Sun)

- "Green Air"
- Low Operating Costs
- High Capital Costs/kW
- Intermittent Operation - Low Capacity Factor
- Require Real Estate - kW/sq.-ft is low
- System Integration
- Costly

MICROTURBINES

- Lower Air Emissions
- Modular & Scalable
- Lower Maintenance Costs
- Run on Wide Array of Gas and Fuel
- Low pressure gas
- Quiet

- Little Operational History
- Minimum Service and Distributor Support
- Low Efficiencies
- Low Unit output
- Simple Cycle

FUEL CELLS

- Low Air Emissions
- Minimal Maintenance
- CHP Applications
- Utilize Low-Quality gas
- Quiet

- Limited Dealer and Service Support
- Utilize High-Quality Water
- Very Expensive

RECIPROCATING ENGINES

- Mature Technology
- Know Operating and Performance History
- Strong Available Product and Service Support
- Rapid Start Diesels
- High Efficiency Natural Gas Reciprocating Engines
- Wide range of sizes and outputs

- Non-island applications for impact
- Public Perception
- Air Emissions
- Shorter Maintenance Cycles

DG FOSSIL FUELS

- **BY-PRODUCTS**
 - Digester Gas
 - Landfill Gas
 - Oil and Coal Field Gas
- **STANDARD FUELS**
 - Natural Gas
 - Diesel
 - Heavy Oil
 - Coal

Cost & Site Availability are Key Evaluators

DISTRIBUTED vs. CONVENTIONAL GENERATION

CONVENTIONAL

- Develop and Operate “Central Station” Facility
- Long Overall Development Times (4-12 years)
- Lengthy Siting & Permitting Cycle
- Transmission Delivery Issues
- Indexed Pricing to Customers
- Performance Risk to Customer
- Low Development cost/kW

DISTRIBUTED

- Develop and Operate Incremental Capacity sited near loads
- Short Overall Development Times (6-15 months)
- Transmission System Eliminated
- Increased Power Reliability and Quality for Remote Loads
- Capacity Related Issues are Minimized
- Optional Modular Units
- Cost Based Generation
- Higher Initial Capital and Maintenance Cost/kW

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DG DEVELOPMENT PROCESS

- Prepare a Plant Energy Plan
- Understand Usage Profiles for Electricity, Gas and Fuels
- Identify and Implement Cost Effective Conservation Projects
- Distributed Generation Assessment
- DG Feasibility Study and Development Plan
 - Technical
 - Cost & Schedule
 - Economic
 - Financial
 - Environmental & Permitting
 - Development & Partnering Options
 - Fuel Supplies & Power Marketing Options
 - Electric Utility Interconnection
 - Natural Gas Pipeline Interconnection
 - Water & Wastewater
- Review the Feasibility Study and Make a Decision