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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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

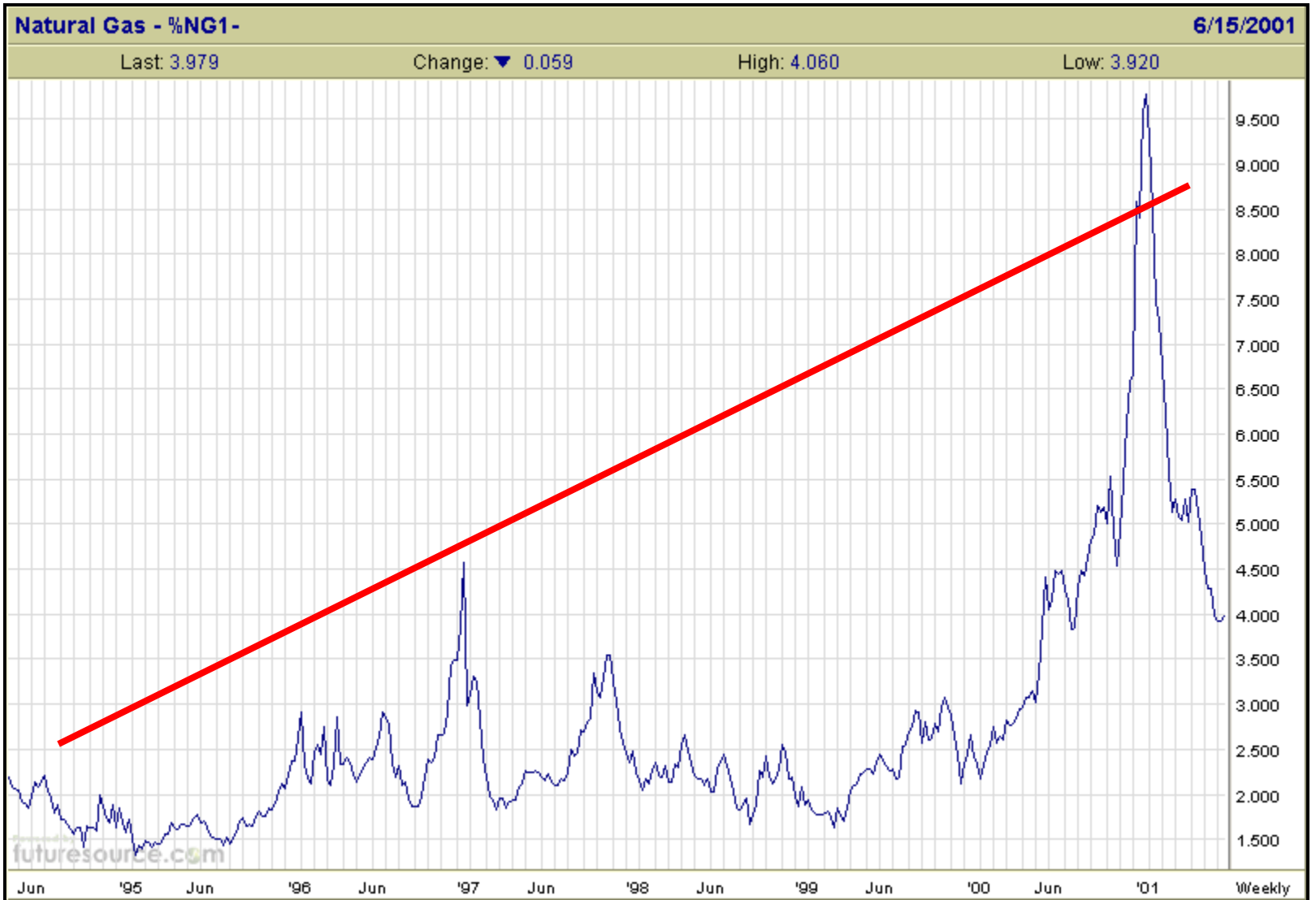
- Deregulation of Electricity Generation
- Marginal / Insufficient Generating Capacity
- Non-Functional Market
  - Numerous Generators
  - Insufficient Capacity
  - Numerous Suppliers Have Market Power
  - High Prices Bear No Relation to Cost
  - Unstable Pricing - High Levels of Volatility
- Electricity 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

Source:
futuresource.com

NYMEX Nat Gas



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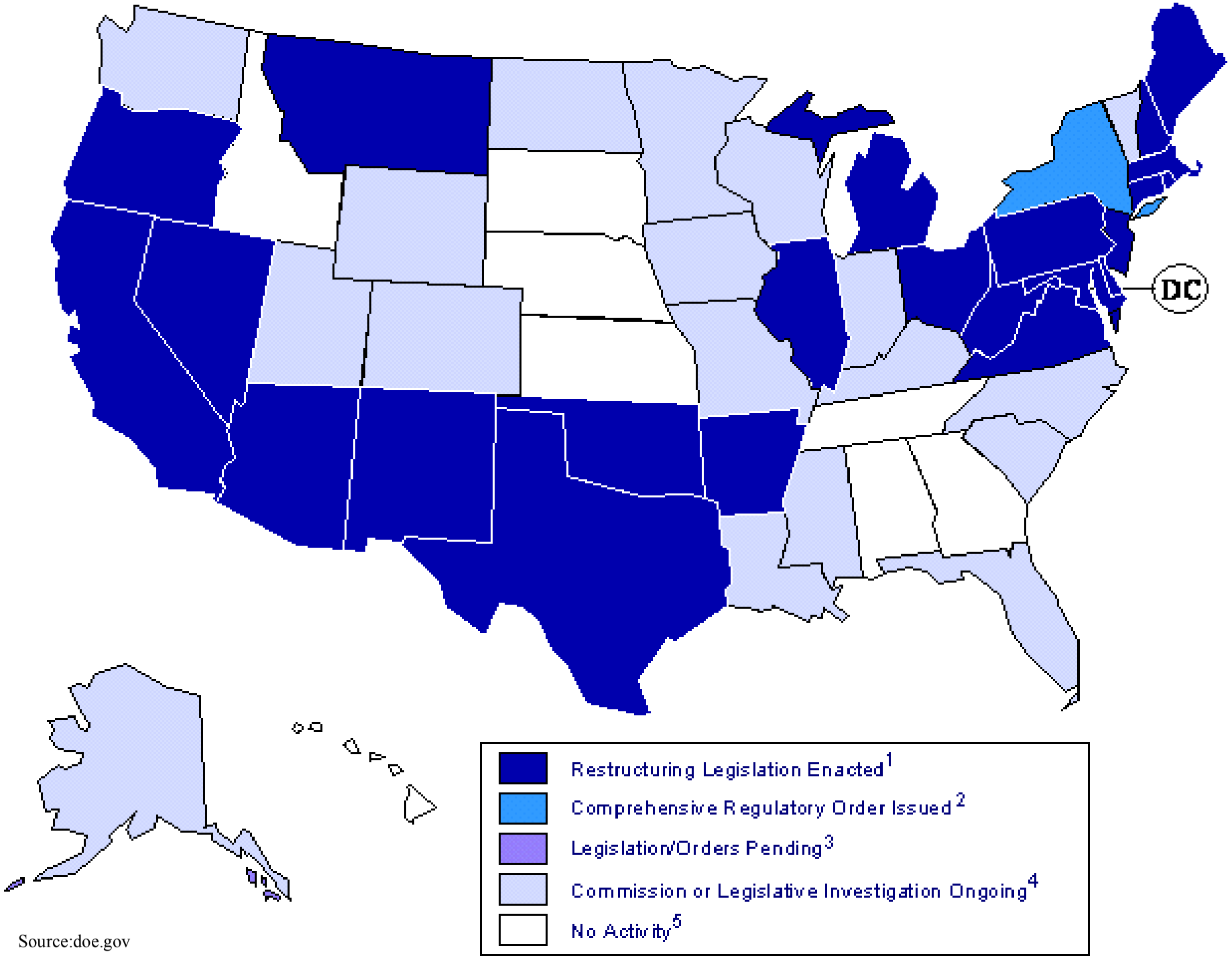
futuresource.com



Source:doe.gov

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:

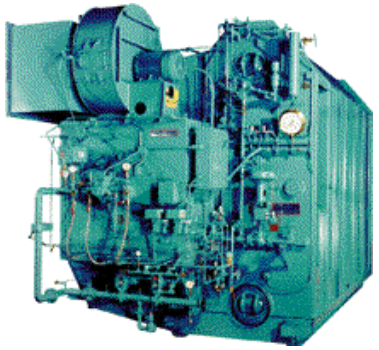
A contract, between a customer and an ESCO, with payments which are based on pre determined, measurable and verifiable performance criteria. In general, the performance criteria will be based on guaranteed future energy cost savings.

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

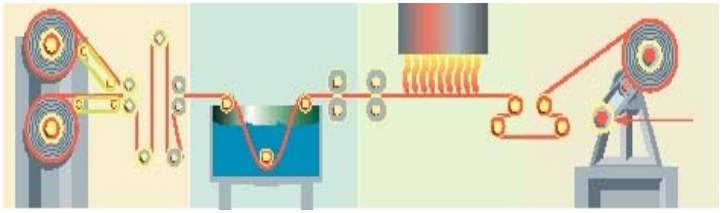
ENERGY COST SAVING AREAS of FOCUS

Supply Solutions

Demand Solutions



Process Productivity Improvements

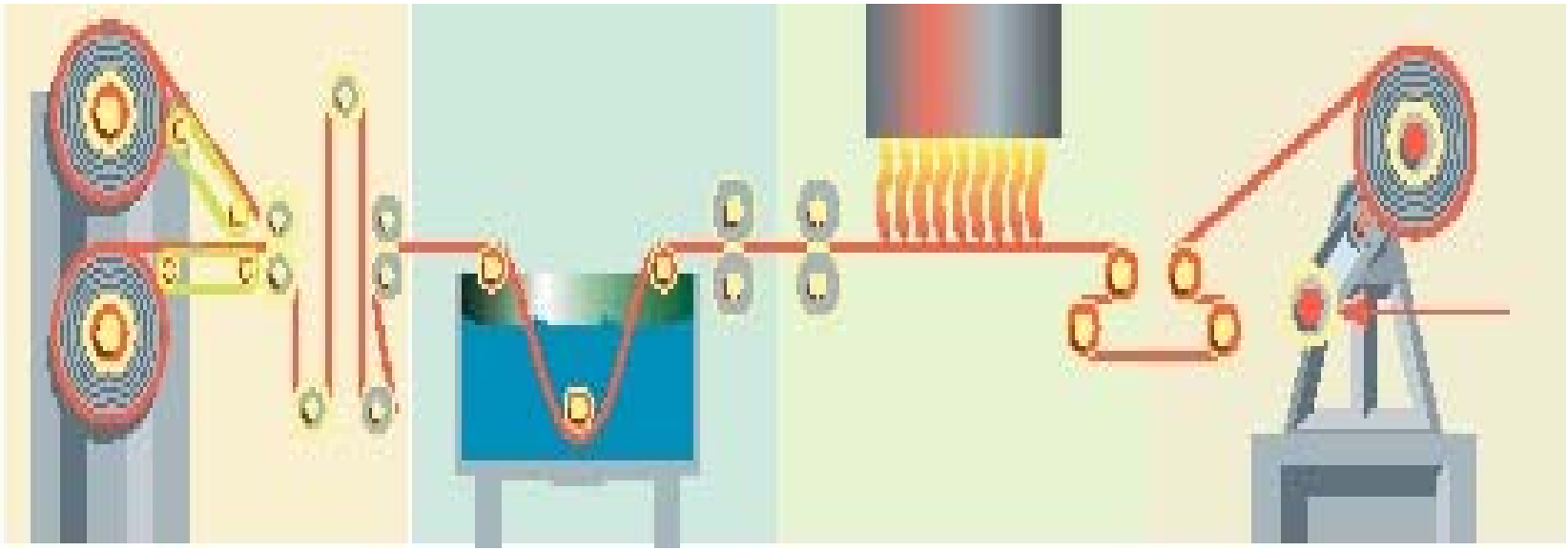


Monitoring & Serviceability

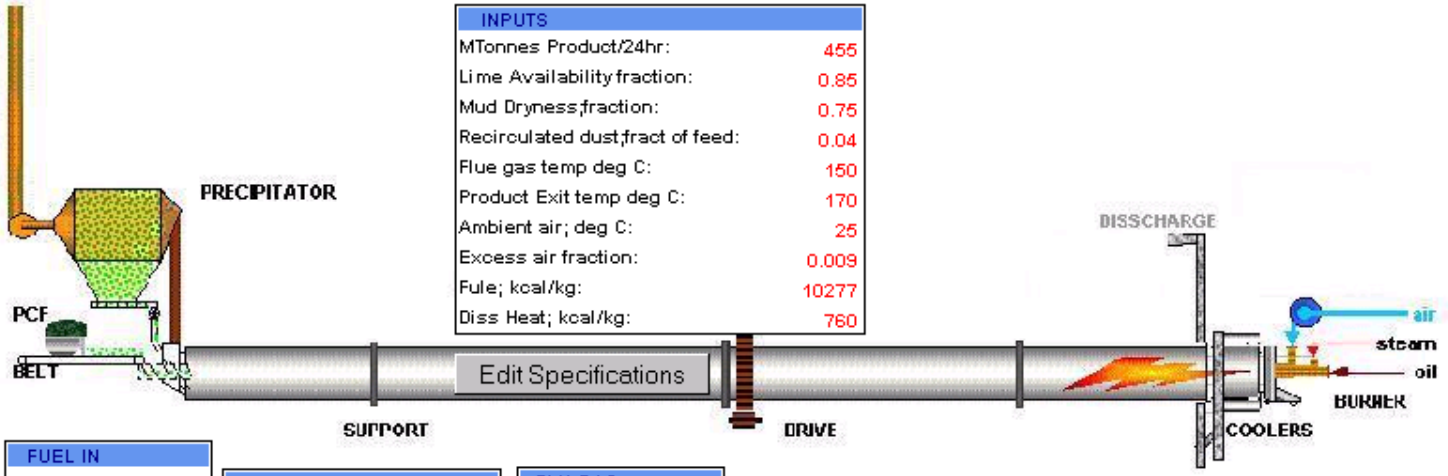
Ener.ge

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



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

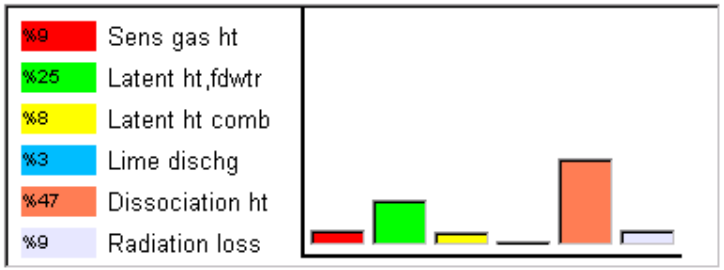
HEAT OUT	
Sens gas ht:	38936
Latent ht,fdwtr:	110163
Latent ht comb:	33346
Lime dischg:	11454
Dissociation ht:	204118
Radiation loss:	37725

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	O2 for comb	143		Cp CO2	0.23	
Product	316.0	Kg/min	Cp O2	0.23		Flugas	1067	Kg/min
CaCO3	480	Kg/min	CO2 from C comb	128.7		Gas Cp	0.29	
Cp air	0.25		H2O from H comb	55.8		heat out	435743	Kcal/min
Dry virgin feed	527	Kg/m	O2 fract in dry flug	0.002		heat in	435744	Kcal
Cp N2	0.25		Cp H2O	0.46		Dry Feed_recic	548.08	
CO2 from diss	211	Kg/m	Stoicmetr air	617.2	Kg/min	Water in mud	182.69	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: $175,686

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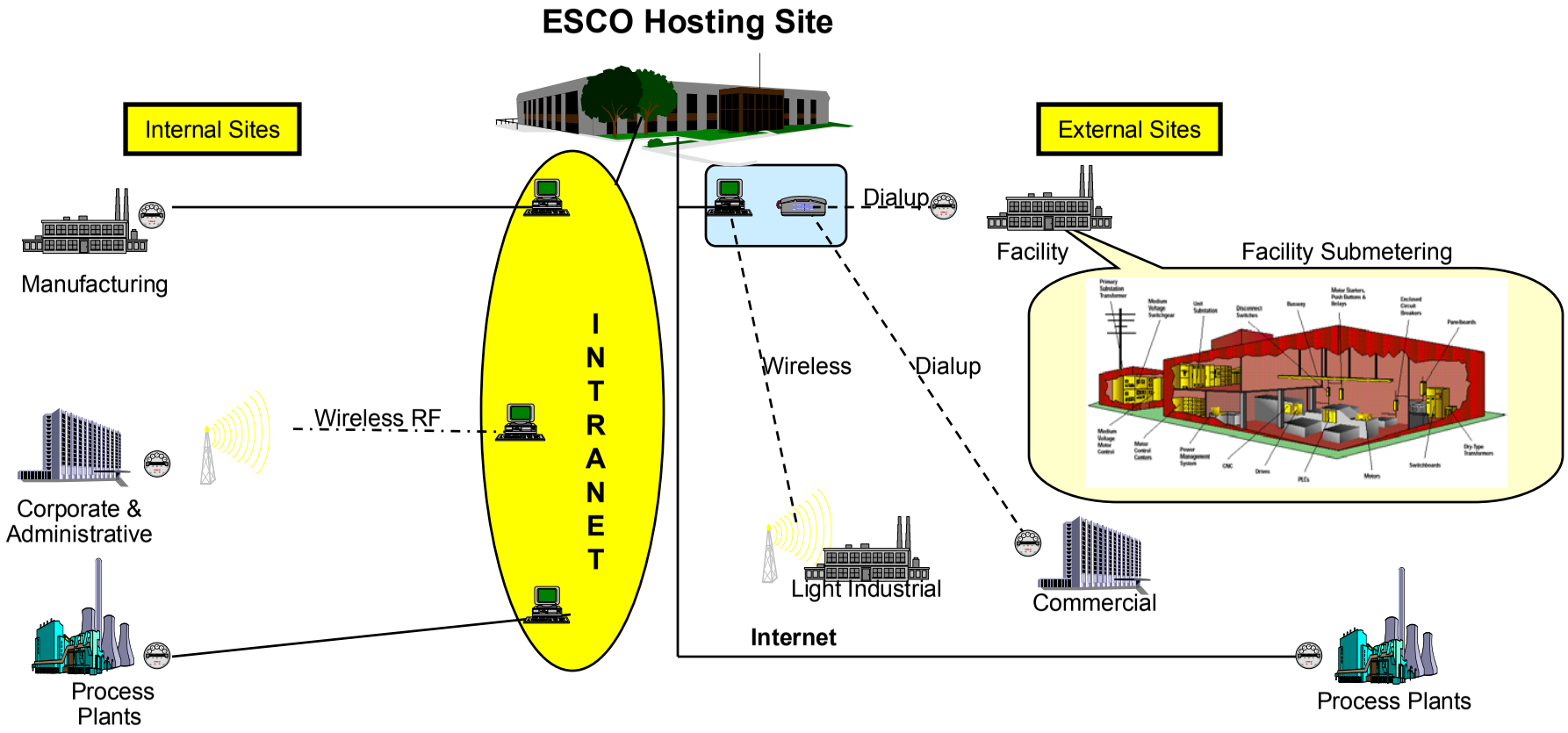
MONITORING AND SERVICEABILITY

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

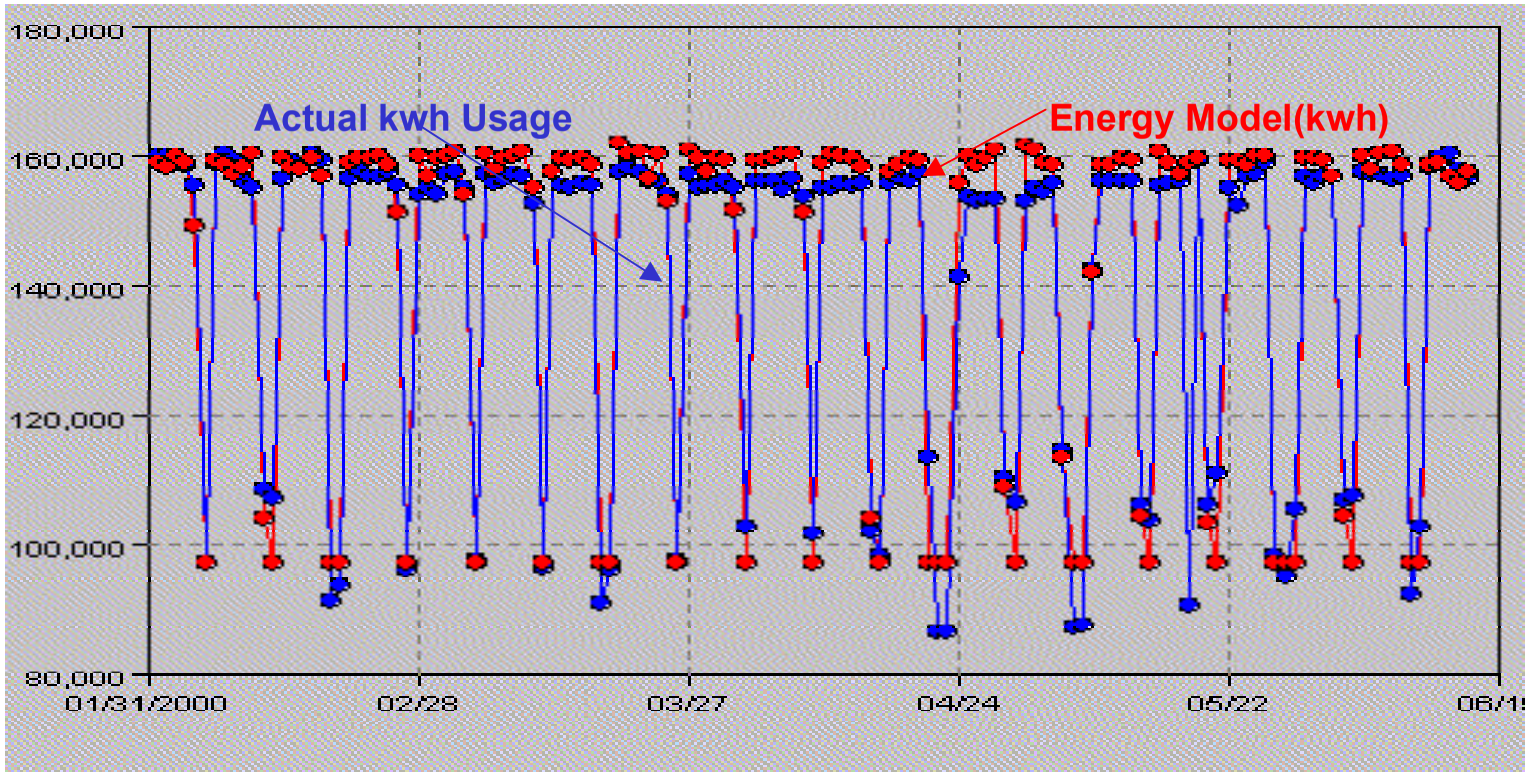
ESCO RESPONSIBILITIES:
- All Installation & Configuration
- Installation & Configuration @ External Vendors
- Basic Monitoring & Analysis
- Advanced Analysis & Consulting
- LTSA
- Local Servers
- Central Servers

Monitoring & Analyses



Enterprise Level Integration of Energy Generation, Demand, Production and Cost Trends

System Modeling To Predict Usage ...



- **Production Data Forecasts Usage**

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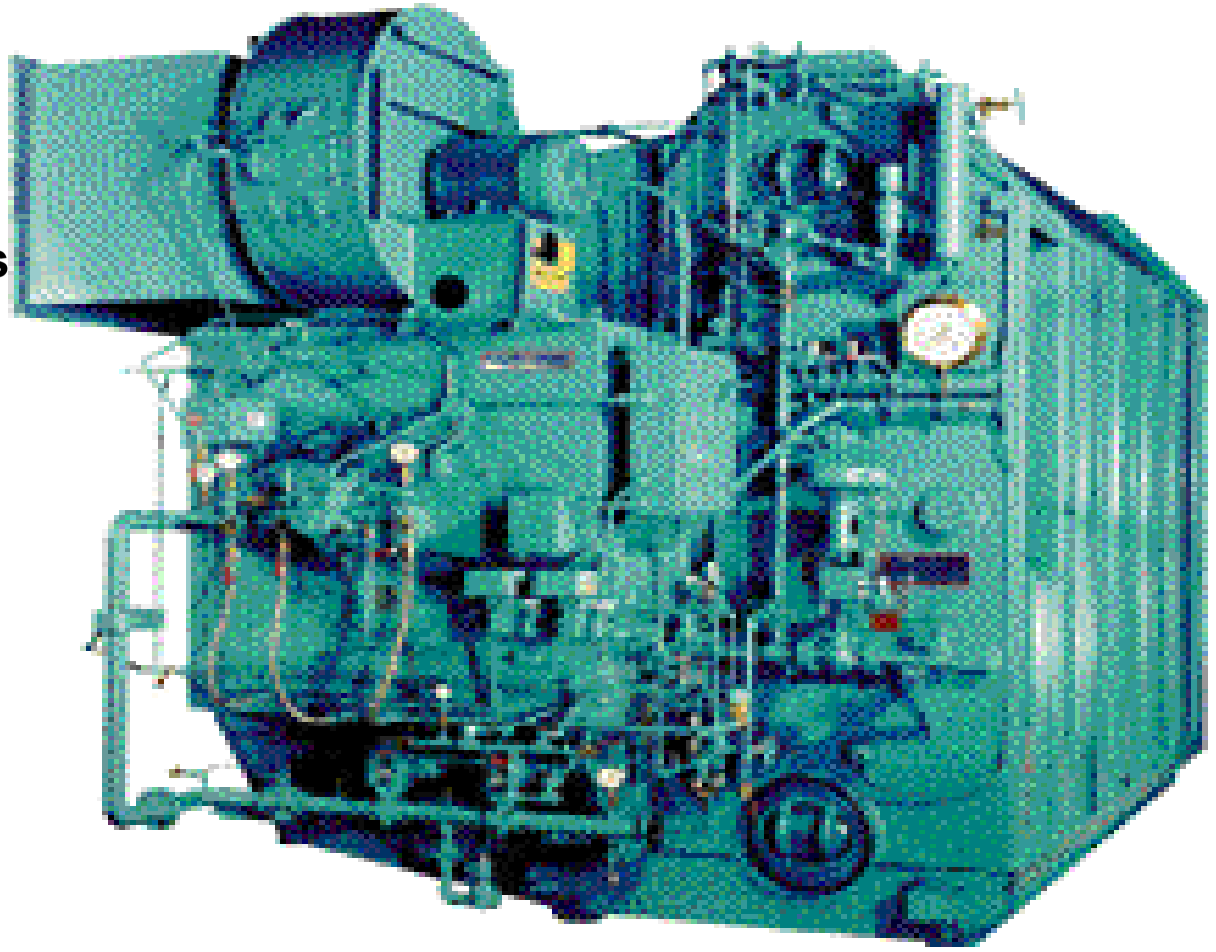
DEMAND SIDE SOLUTIONS

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



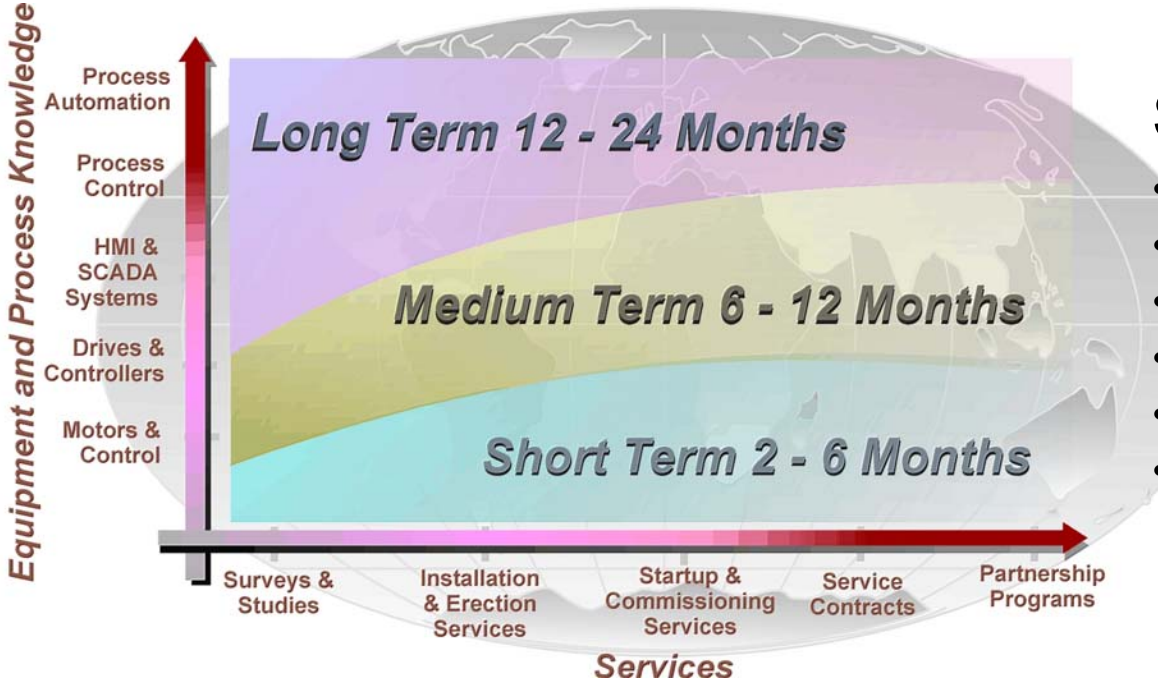
DEMAND SIDE ENERGY PROJECTS

Long Term:

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

Medium Term:

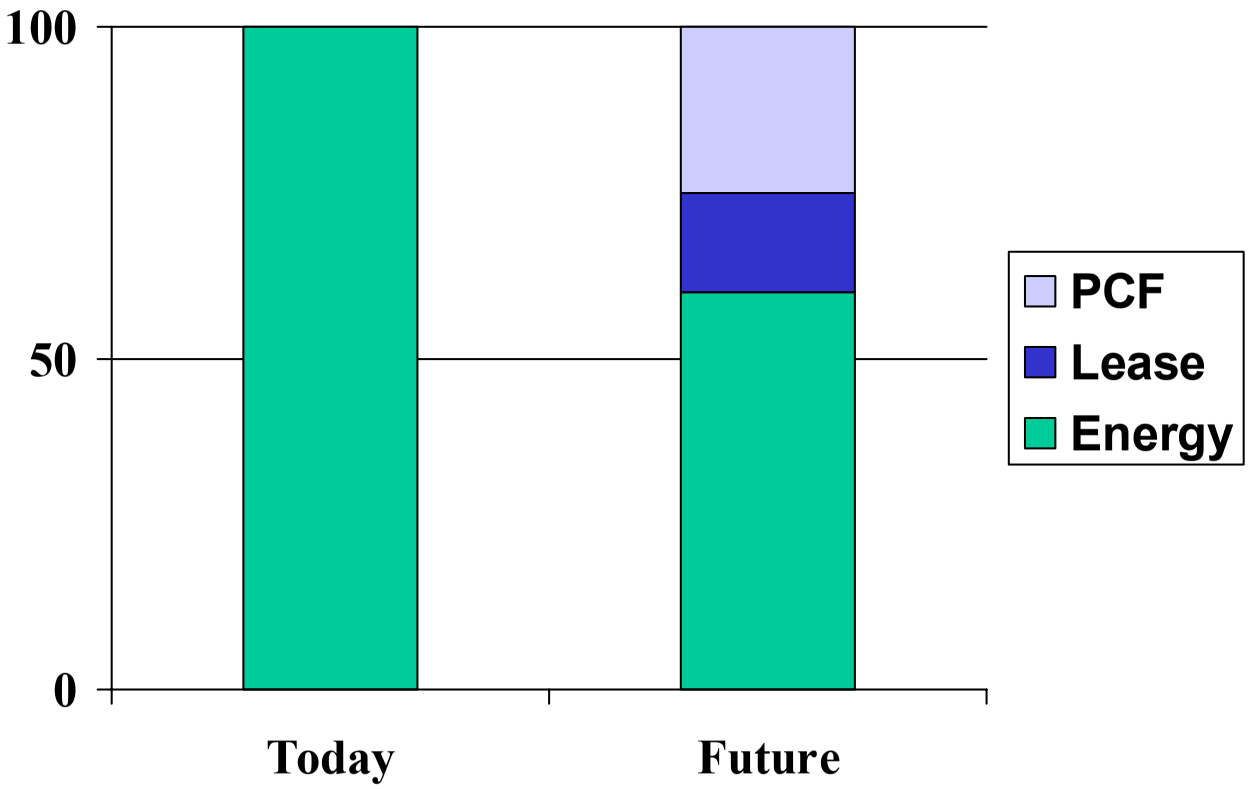
- **Detailed Designs**
- **Project Construction Phase**
- **Measure & Verify Savings**
- **Integrate Performance Ideas**



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

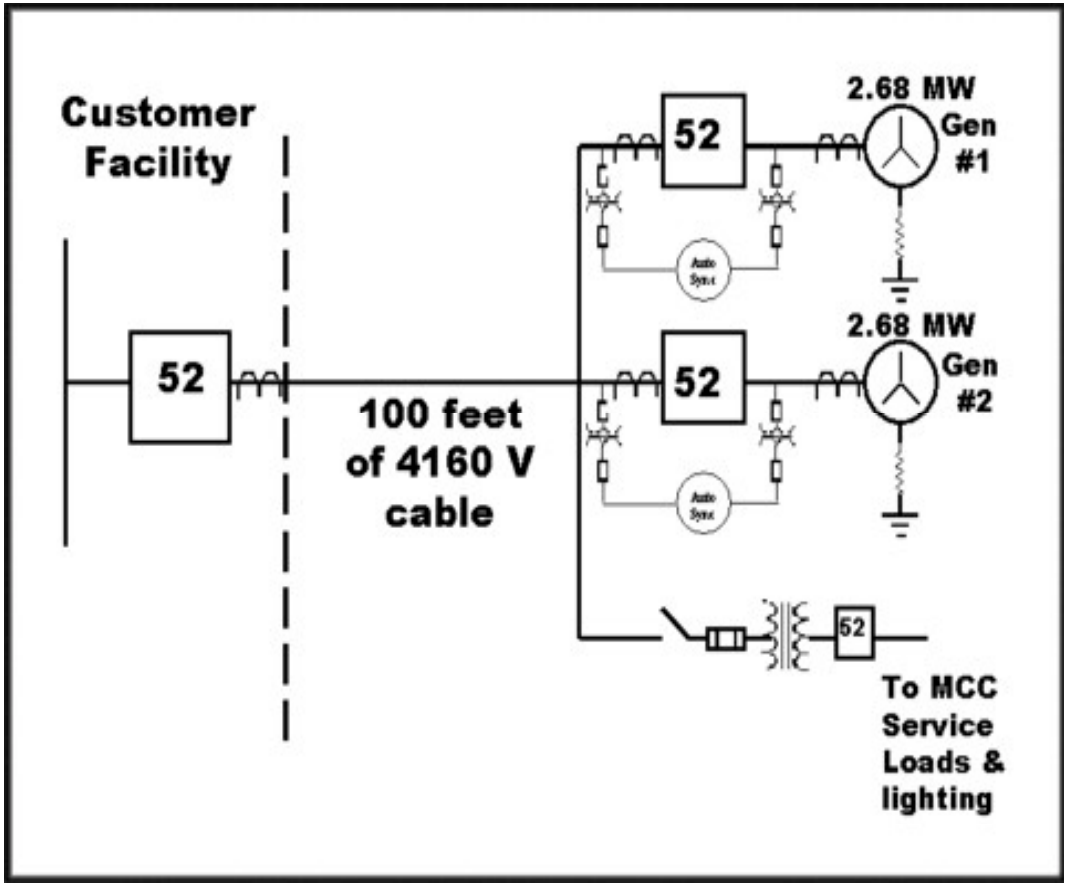
DISTRIBUTED GENERATION

Definition:

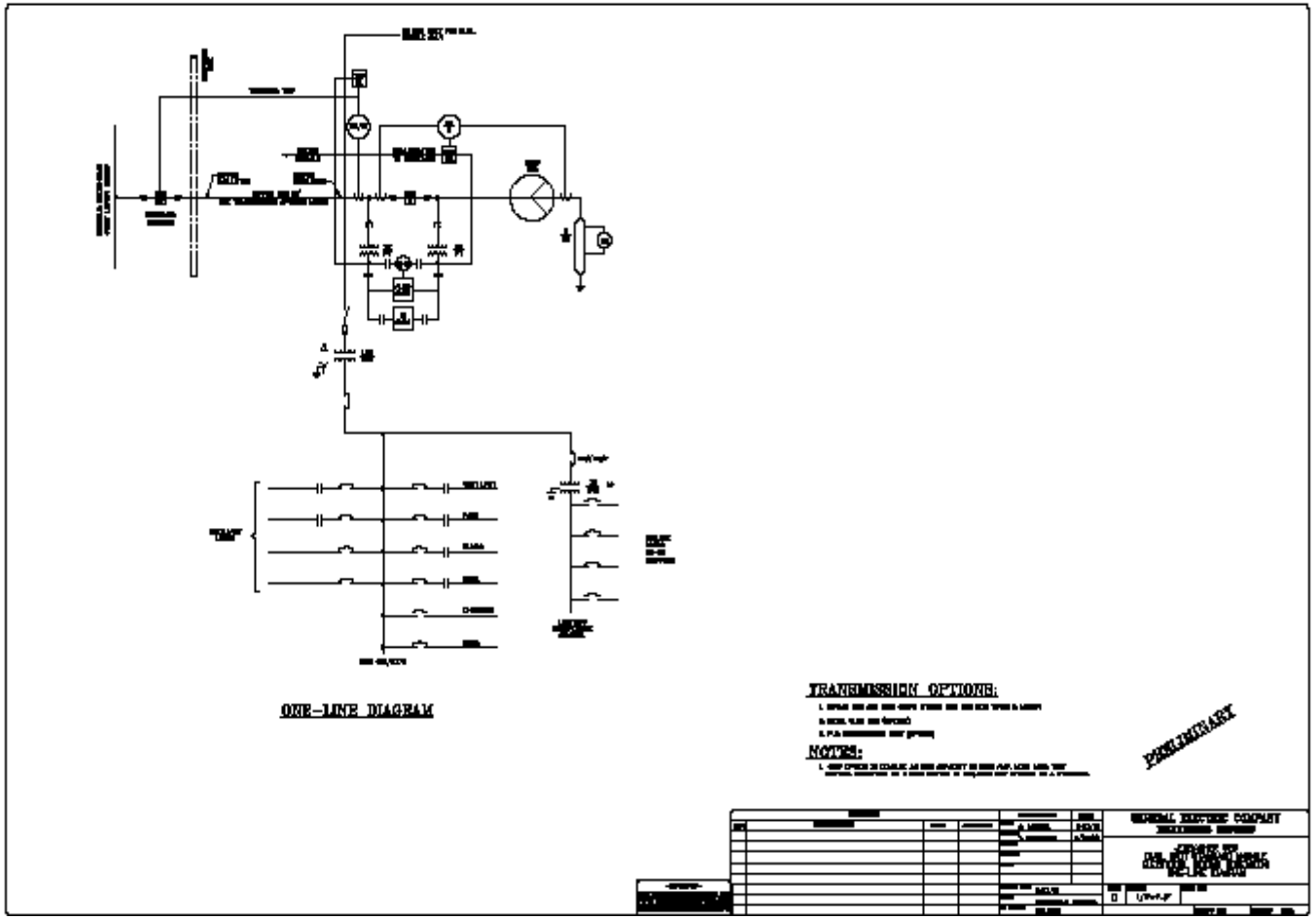
A small output electrical power generating plant which supplies peaking or base load energy and is operated in either an island or grid-parallel configuration.

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