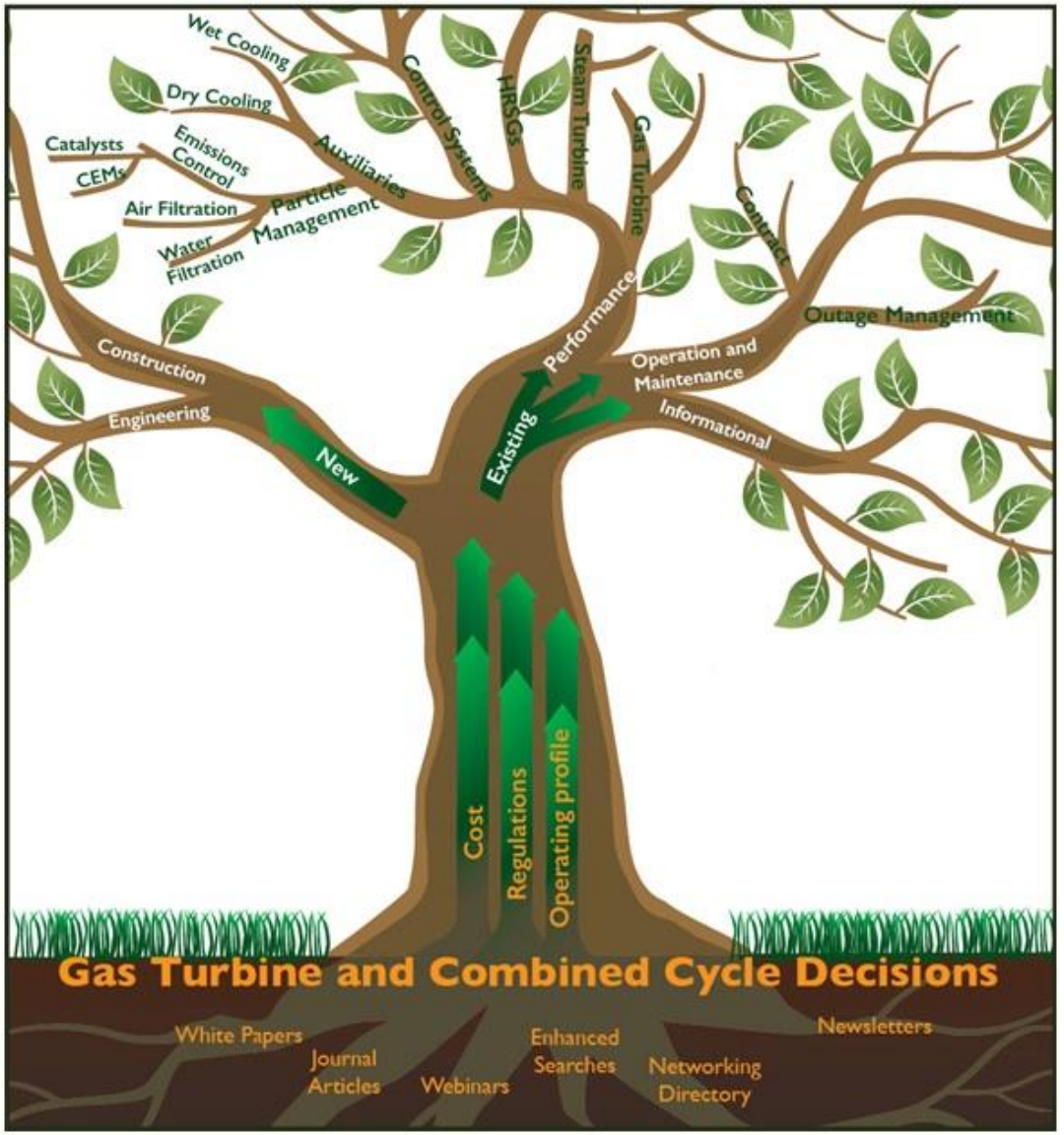
Hot Topic Hour – Gas Turbine Markets

March 10 overview of markets for systems and components along with details on a system to provide continuing insights.

Gas Turbine Product and Service Market Coverage

Forecasting each gas turbine-combined cycle product and service while identifying all the plants and projects ensures better accuracy for any individual product forecast.

The analysis of new technology is essential to determining future markets. Digital tools such as webinars provide the opportunity for cross pollination of insights from end users and suppliers
A decision system for end users is a critical segment of the program.



McIlvaine's Gas Turbine Subscription Service

Market Forecasts

- MW Forecasts by country and year
- *Sales forecasts for specific products such as intake filters, SCR equipment, valves & pumps*

Databases

- Existing Gas Turbine facilities worldwide with detailed information regarding gas turbine equipment, HRSG manufacturer, NO_x control equipment and other information.
- Proposed Gas Turbine facilities worldwide, including those under construction, in planning and permitting phase, and even those which have been cancelled or are on hold.

News and Updates

- News regarding Gas Turbine projects worldwide – every 2 weeks.
- Business-related news such as acquisitions, strategic business changes (such as Engie's divestment of assets) and regulatory developments.
- Highlights of all new projects as they are added to our database.
- Special topics and analyses
  - December: What is the Future of Natural Gas vs Coal? – in light of the Paris climate change negotiations.
  - *Jan/Feb: Who are the decision makers for sourcing products and services for gas turbine facilities in the U.S.?*
  - Mar/Apr: What (and where) is the potential market for combined cycle conversions?

Decision Makers in U.S.: Existing Plants

440 GW of gas turbine-generated power operating in the U.S. as the end of 2015

- 170 GW produced by top ten producers

Largest Gas Turbine Power Producers in the U.S.
Based on Capacity as of the end of 2015

Rank	Power Producer	Gas-Turbine Power Production		
		Total Capacity (MW)	Number of Facilities	Total Number of Units
1	**Calpine**	27,894	63	190
2	**Duke Energy**	25,061	42	242
3	**NextEra Energy**	20.735	18	132
4	**Southern Co**	19,919	30	138
5	**NRG Energy**	18,946	57	238
6	**Dynegy**	14,022	23	96
7	**TVA**	12,201	15	118
8	**Berkshire Hathaway**	11,812	24	107
9	**Engie**	10,260	19	57
10	**LS Power**	9,492	17	70

- Engie doubled its U.S. power generation capacity in 2011-12 through acquisitions
  - Engie announced on February 25th it was selling 8,700 MW to Dynegy and a private equity firm

Decision Makers in U.S.: New Plants

Largest Gas Turbine Power Developers in the U.S.

Rank	Power Producer	Gas-Turbine Power Projects	
		Total Capacity (MW)	Number of Facilities
1	**Panda Power Funds**	5,206	6
2	**Dominion**	2,958	2
3	**Exelon**	2,400	3
4	**Competitive Power Ventures**	2,075	3
5	**Advanced Power**	1,742	2
6	**Duke Energy**	1,640	1
7	**Coronado Power Ventures**	1,400	2
8	**NTE Energy**	1,290	3
9	**NextEra Energy**	1,277	1
10	**PSEG**	1,275	2

These are the largest power producers based on the capacity of proposed gas turbine power projects which are currently still on track – either in the approval or permitting process or currently under construction.

Half of top ten are private equity or private investment companies which develop merchant power plants in deregulated markets with a profit motive

Utilities such as Duke Energy operate only regulated plants, where rates are set through ratemaking proceeding

- Their motive is still profit, but income is effectively capped by the set rate
- Operating cost effectiveness become the key to profit

Identifying the Buyer's Objectives

Who are the decision makers?

- Not always big name utility companies
- Plus, ownership changes often in today's market

Why are there both regulated and unregulated (or merchant) power plants?

- Prior to 1997, electricity customers in the U.S. were served by regulated, monopoly utilities that handled generation, transmission and retail service.
- Beginning in 1997, some states began to allow non-utilities to generate power and sell it to a utility.
- In 1997, only 1.6 percent of U.S. electricity was produced by Independent Power Producers (IPP). That portion had increased to 35 percent by 2012, but the percentage is much higher for newer, natural gas-based power generation.

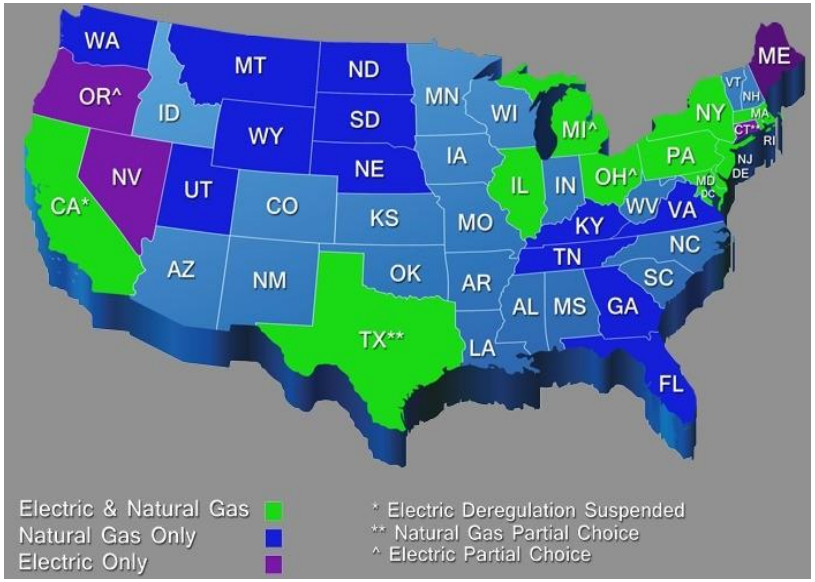
What's the difference?

- Regulated utilities go through a ratemaking process with the relevant State Utility Commission, which guarantees a reasonable profit based on reasonable expenses. These utilities are going to be more interested in **low cost solutions**, otherwise the cost may not be fully accepted by a utility commission.
- Unregulated – or merchant – power plants sell power into the competitive market, to other utilities or the grid operator. They are much more market oriented and motivated by profit, and will be interested in **cost effective solutions,** which might include efficiency improvements or lower long term maintenance and operation cost improvements.
- There are also hybrids – companies that hold both regulated and unregulated assets
- How do you tell if a facility is regulated or not?

Regulated or Merchant?

Until about 1997, 98.4 percent of power plants were regulated. Now, the lines are blurred. For example, Duke Energy owned both regulated and non-regulated plants until it sold its non-regulated plants to Dynegy in August 2014.

- A more reliable indication may be to look at **where power markets have been deregulated**.
- In the map below, the **purple and green states** are deregulated and likely to attract more merchant plants that are likely to have a longer term focus and be interested in more cost effective solutions.



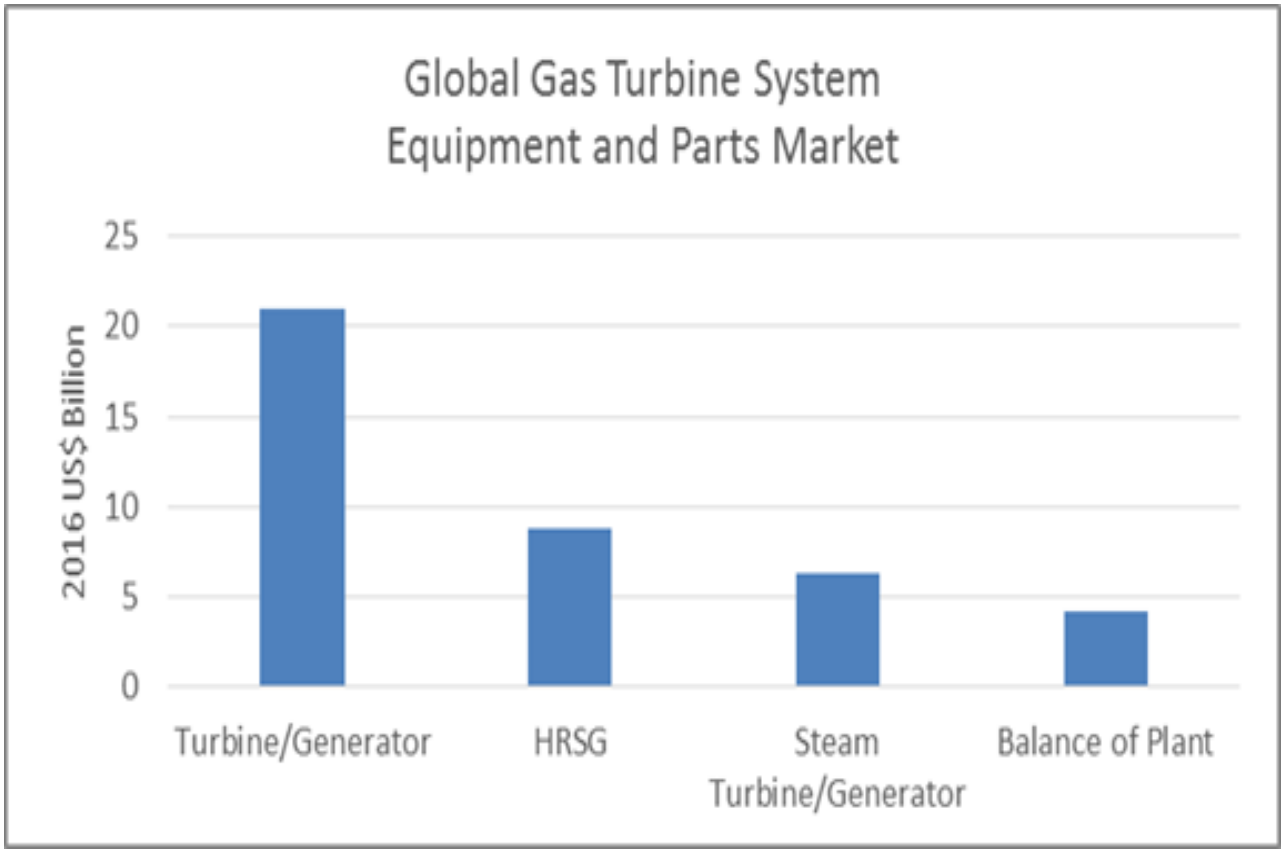
Where does Panda Power, the largest gas turbine developer in the U.S., operate?

- Pennsylvania (3 projects), Texas (2 plants being expanded) and Maryland (1 plant)
- All in deregulated states

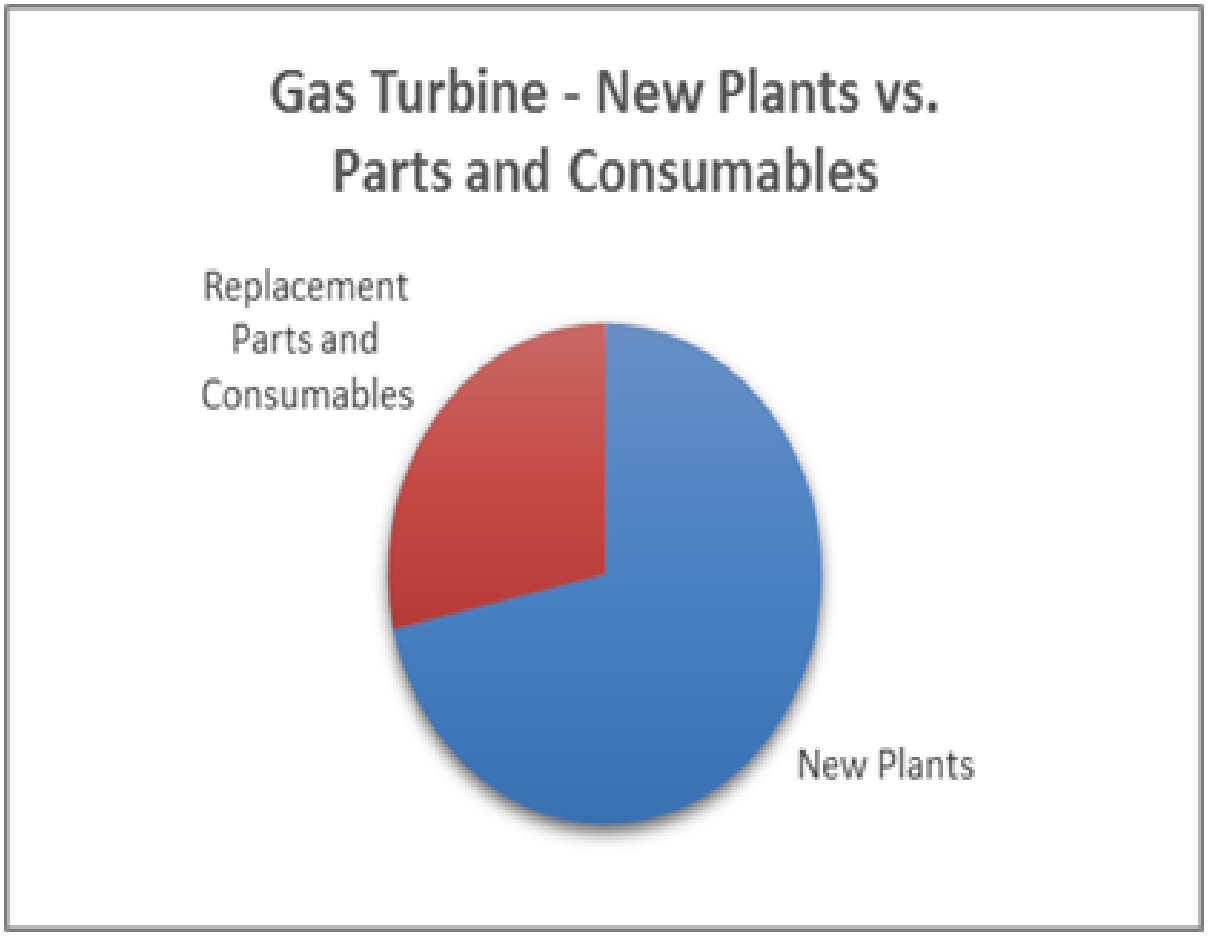
$40 Billion Gas Turbine Market

- The present market for gas turbine system equipment and parts is $40 billon. The market will grow faster than GDP over the next 10 years, but the rate of growth for systems is subject to a number of variables. The rate of growth for some individual products will be much higher.
- The revenue for gas intake filters at double digit rates even if the number of units does not.
- Hard coatings for rotating components is another high growth segment due to FAC.
- Valve management programs will grow faster than sales of individual valves.
- Zero liquid discharge systems will increasingly be chosen over the discharge of treated wastewater.
- The HRSG and Steam turbine markets will grow faster than the gas turbines due to retrofit of the steam cycle at existing plants.

Market Segmentation by Major Component



New vs. Consumables and Repairs



2017 Gas Turbine Market $ billions

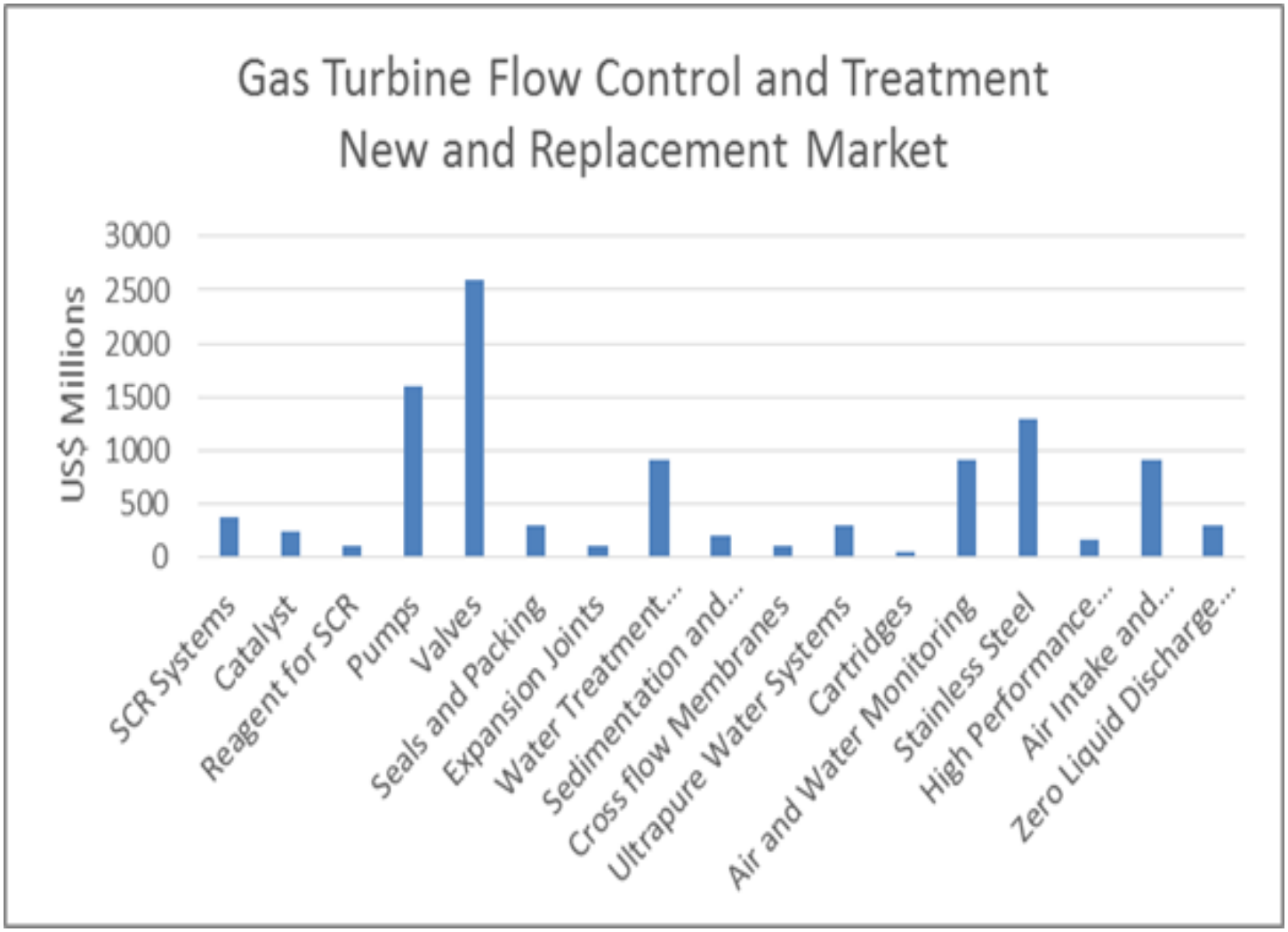
	Turbine/gen	HRSG	Steam turbine /gen	Balance of plant	Total
New plants	15	6.3	4.5	3	28.8
Replacement parts and consumables	6	2,5	1.8	1,2	11.5
Total	21	8.8	6.3	4.2	40.3

On a year to year basis the new plant market will fluctuate. For example, the world additions in 2017 will be 87,000 MW but only 76,000 MW in 2018. So if no more projects are added for 2018, the new equipment market will be 13% smaller. We are forecasting revenues through 2021 but there are huge variables. Vietnam may or may not cancel an 80,000 MW program for coal-fired boilers and substitute natural gas and renewables. If China proceeds with its huge coal gasification program it will be piping gas to turbines in all the major cities.

Faster growth for Repair Parts

- Due to normal operating temperatures, there is considerable deterioration of parts and need for replacement. The more recent practice of cycling operations as many as 200 times per year is creating flow accelerated corrosion (FAC) problems and increasing part deterioration rates. As a result, the present market for parts and consumables of US$11.5 billion will grow faster than the new plant market.
- Another reason for the comparative gain of parts over new product purchases is the increasing ratio of plants in place to new plants being constructed.

Valves and Pumps lead Component purchases



2017 New and Replacement Market for Gas Turbines - $ millions

Product	New and replace
SCR systems	370
Catalyst	240
Reagent for SCR	110
Pumps	1600
Valves	2600
Seals and packing	300
Expansion joints	100
Water treatment chemicals	900
Sedimentation and Centrifugation	200

2017 New and Replacement Market for Gas Turbine Components - $ millions

Product	New and replace
Cross flow membranes	100
Ultrapure waster systems	300
Cartridges	50
Air and water monitoring	900
Stainless steel	1300
High performance Coating	150
Air intakes and replacement filters	900
Zero liquid Discharge systems	300

Pumps and Valves will be the Largest Product Purchases

- More than $4 billion will be spent for pumps and valves in 2016. Some of the product forecasts incorporate portions of other forecasts. For example the forecasts for stainless steel and high performance coatings are in part included in the pumps and valves forecasts.
- There is a very large market for treatment chemicals including corrosion control and scale inhibitors. Intake water treatment for the steam and cooling systems, ultrapure water treatment for fogging nozzles, and wastewater treatment all require substantial yearly expenditures for chemicals.
- The rate of growth for various products in coming years will be driven by a number of variables, as shown in the following slides.

General factors impacting market

Factor	Driver	Market Impact
Fuel price	Low gas prices	Based on long term forecast not present prices
Alternative power generation	High cost of offshore wind, subsidies	Europe moving back to gas
Electricity prices	Regulated vs. unregulated	Total cost of ownership
National policies	Boost exports	Finance plants in developing countries

Low gas prices could last several years depending on decisions in Saudi Arabia and the time it will take for reduced supply to drop below demand.
Some European countries re-opening gas plants because of lower cost compared to wind and solar.
Decisions are different depending on whether the utility is regulated or private.
Total cost of ownership is more important for utilities who must compete.

Drivers impacting Product Markets

Product	Driver	Market impact
Air intake filters	Higher efficiency for turbine protection	Could boost market by 50%
SCRs	Regulations in Europe and elsewhere	Big increase in market where required
Pumps	FAC and other cycling challenges	Market growing faster than total GT market
Valves	FAC and other cycling challenges	Market growing faster than total GT market
Seals	Pump, valve, compressor and new turbine designs	Market growing faster than total GT market
Zero liquid discharge (ZLD) systems	Regulations, aridity and reluctance to wait for water permits	Growing market in U.S., China and elsewhere
Stainless Steel	New turbine designs	Continuing opportunity for high performance materials
steam turbines	Addition of steam turbine to existing peakers to meet energy and greenhouse gas goals	Substantial market impact as many plants are upgrading
HRSG	Fast start needed	New design needed

Regulatory Drivers

Pollutant	Driver	Market impact
Greenhouse gases	Limits or penalties on CO_2 emissions	Negative impact on market vs. renewables but positive vs coal
Harm to aquatic life	Regulations forcing less intake and less once through water	ZLD, dry cooling, municipal water reuse
Water discharge limits	U.S. has new regulations	More ZLD
NO_x emissions	Tough regulations in U.S. and potential new regulations in Europe	Steady positive impact on SCR and urea markets as prices are lowered in various countries

Components

Fast start HRSGs

The changing role of combined cycle gas turbine installations is prompting boiler designers to come up with a new generation of flexible steam generators capable of fast startup and rapid rampdown.

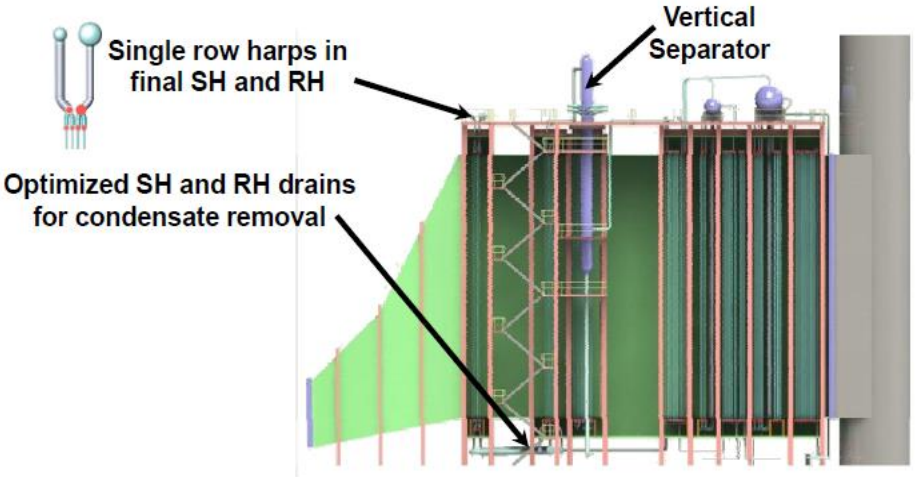
- Gerard Van Dijk, chief executive officer at NEM, explains that the 'DrumPlus' design is an HRSG that allows a power plant to start up from cold in 10 minutes. "It allows the plant to respond very fast to fluctuations in the grid due to the electricity production of renewables. One way the company achieves this is through the design of a vertical once-through boiler which, rather than containing a high-pressure steam drum, is instead drumless. This enables structural integrity to be maintained under the same steam conditions, but using thinner material for the enclosure. Thinner material reduces the fatigue impact from varying thermal expansion and suffers less from through wall stress.
- Other manufacturers are pursuing drumless designs. John DiVitto, business development manager for HRSGs at Babcock & Wilcox, explains: "We've had to make design changes to be able to be flexible and take into account the different physical changes that are occurring in the HRSG due to these rapid ramping events, both up and down.“
- In another design approach, Jean-Francois Galopin, chief technology officer at Belgian HRSG manu-facturing group CMI, explains that they too are currently developing a patent pending system to limit the drum wall thickness. Galopin adds: "We are improving our calculation capabilities to better simulate the startups. The first steps of the pressure increase are the most important, but most difficult to exactly simulate.“
- IST has a drumless design for smaller units.

B&W fast start HRSG

babcock & wilcox power generation group

Conclusions

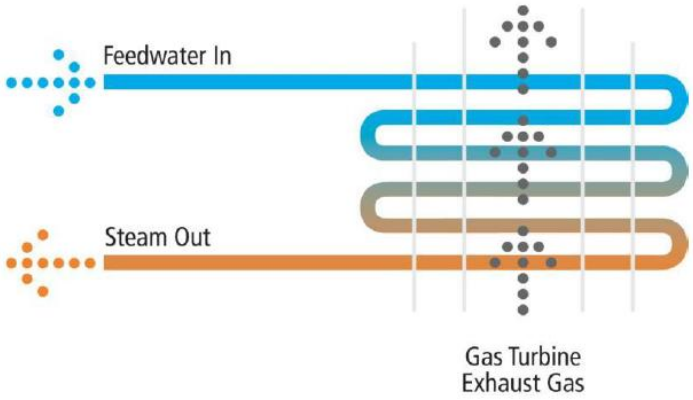
- New concept for rapid start HRSG through the use of vertical separators
- Developed to meet the demands and needs for an HRSG into today's environment
- Enhanced fatigue tolerance for dispatching and cycling a combined cycle plant through thinner pressure part components



Larry Hiner, manager of boiler product lines for B&W's global power division, outlines the major features of its natural circulation design: "We've made very flexible tube bundles. We have a lot of care that we put into the attemperator design to be able to handle the change in loads. Same with the drain systems for this type of unit: it's not just a maintenance type drain, but is integral to its ability to start up very quickly."

IST Drumless Design for smaller units

“Drumless” Design



- All tubes thin-walled → low thermal mass → fast cycling
- Compact lightweight pressure bundle
- Simple once through steam path
- Zero Blowdown (no blowdown treatment)

Components at one plant - Chuck Lenzie Generating Station

- **Commercial operation:** Power block 1, January 2006; power block 2, March 2006
  EPC contractor: Fluor Energy & Chemicals Group
  Owner's engineer: Washington Group International (now part of URS Corp)
  Type of plant: Combined cycle (two 2 x 1 power blocks)
  Key personnel
  Regional director: Tom Price
  Asst regional director: Brian Paetzold
  Operations manager: Forrest Hawman
  Maintenance manger: Dave Hall
  Plant engineers: Shane Pritchard, Andy Gaither
  Environmental manager: George Brewer
  Safety manager: Ernie Wilson
  Gas turbines
  Manufacturer: GE Energy
  Number of machines: 4
  Model: 7FA (PG7241)
  Control system: Mark VI
  Combustion system: DLN 2.6**Fuel:** Gas only
  Water injection for NOx control? No
  Water injection for power augmentation? No
  Air inlet house: GE Energy
  Air filters: Donaldson Company Inc
  Inlet-air cooling system, type: Chiller
  Generator, type: Hydrogen-cooled
  Manufacturer: GE Energy
  GSUs: Alstom
  HRSGs
  Manufacturer: Aalborg Industries (now CMI EPTI LLC)
  Control system: DeltaV (Emerson Process Management)

- **Duct burner:** Coen Company Inc
  SCR: Peerless Mfg Co
  CO catalyst: Englehard Corp (now BASF Catalysts LLC)
  Water treatment
  HRSG internal treatment, type: AVT
  Chemical supplier: Nalco Co
  Reverse osmosis system: Aquatech International Corp**Demineralizer:** Aquatech International Corp
  Cooling-water treatment system: Aquatech International Corp
  Cooling-water chemical supplier: Nalco Co
  Wastewater treatment system, type: ZLD
  Steam turbine
  Manufacturer: GE Energy
  Number of machines: 2
  Model: D11
  Generator, type: Hydrogen-cooled
  Manufacturer: GE Energy
  GSUs: Alstom
  Balance of plant
  DCS: DeltaV (Emerson Process Management)
  Condenser, type: Air-cooled
  Manufacturer: GEA Power Cooling Inc
  Wet cooling towers: Baltimore Aircoil Co
  Boiler-feed pumps: KSB Inc
  Condensate pumps: Flowserve Corp
  Circulating-water pumps: Flowserve Cor

Listen to the Customer - Seals Example

The turbine user groups provide valuable insights relative to problems and potential opportunities to solve those problems CCJ reports these discussions

Identifying Seal Problems – Seal Liberation

- Plant personnel investigating the problem asked 7EA users via the organization's online forum if they had heard of, or had experienced, seal liberation. One respondent said some pictures posted to the site revealed the affected seals had been inserted into slots in the shroud, as shown in Figs 7 and 8, and that these likely were replacements. Traditionally, he continued, seals are an integral part of the machined shroud casting. The user suggested replacement insert seals can be successful provided the proper seal material is used and the inserts are staked securely and final-machined to the original circumference
- The next the speaker shared the history of the second-stage shroud blocks. The owner had purchased a repaired set with 18,000 service hours from a third-party vendor in 2011. According to the documentation provided, the pre-owned shroud blocks were weld-repaired as needed. Then the old seals were removed and grooves were machined into the blocks to receive the replacement seals. After installation, the new seals were machined to engine specifications and a coating was applied. Visual and dye-penetrant inspections were used to confirm the quality of work.

Turbine Component Sealing

- **Turbine component sealing** was the subject of a presentation encompassing more than a dozen slides. Minimizing leakage is important because of its negative impact on power output and fuel consumption. Seals should be checked seasonally during borescope inspections and replaced if damaged. At a minimum, replace seals during hot-gas-path inspections at 24,000 equivalent operating hours or 900 equivalent starts, the group was told. Interestingly, some D5s and D5As may never require an HGP inspection because they don't start often and operate most years at a very small fraction of the period hours (2% or less).
- The speaker said the seals on the inside and outside diameters of the R1 vane segments impact performance most. About half of the total performance loss caused by ineffective sealing occurs at these locations. Another 11% of the total loss occurs at the R1 ring segments and yet another 10% from leakage by static and ring seals. This means about three-quarters of the performance loss attributed to ineffective sealing typically occurs in Row 1. Here's a summary of the material presented:
- R1 vane seals reduce the loss of cooling air between vane segments thereby preventing distortion of the airfoils.
- R1 static seals prevent ingestion of hot gas into the disc cavity, thereby minimizing the potential for rotor-disc damage.
- R1 isolation ring seals reduce the leakage of cooling air between isolation right segments, helping to prevent blade-ring distortion.
- R1 ring-segment seals reduce the flow of cooling air from between ring segments, thereby minimizing the potential for blade-ring distortion.
- R1 seal pins prevent hot-gas ingestion into the blade shank cavity, minimizing the possibility of blade cracking.
- R1 blade seal plate prevents hot-gas ingestion by the blade shank cavity to help prevent blade cracking.
- The same seals in Row 2 have a relatively minor impact in performance loss when they leak—roughly one-fifth of the average R1 loss.

Dry Gas Seal advantages

- Dry gas seals substantially reduce methane emissions. At the same time, they significantly reduce operating costs and enhance compressor efficiency.
- Economic and environmental benefits of dry seals include:
  - Gas Leak Rates. During normal operation, dry seals leak at a rate of 0.5 to 3 scfm across each seal (1 to 6 scfm for a two seal system), depending on the size of the seal and operating pressure. While this is equivalent to a wet seal's leakage rate at the seal face, wet seals generate additional emissions during degassing of the circulating oil. Gas from the oil is usually vented to the atmosphere, bringing the total leakage rate for dual wet seals to between 40 and 200 scfm, depending on the size and pressure of the compressor. Mechanically Simpler.
  - Dry seals systems do not require elaborate oil circulation components and treatment facilities. ??Reduced Power Consumption. Because dry seals have no accessory oil circulation pumps and systems, they avoid "parasitic" equipment power losses. Wet systems require 50 to 100 kW per hour, while dry seal systems need about 5 kW to power per hour. Improved Reliability. The highest percentage of downtime for a compressor using wet seals is due to seal system problems. Dry seals have fewer ancillary components, which translates to higher overall reliability and less compressor downtime. Lower Maintenance.
  - Dry seal systems have lower maintenance costs than wet seals because they do not have moving parts associated with oil circulation (e.g., pumps, control valves, relief valves). Elimination of Oil Leakage from Wet Seals. Substituting dry seals for wet seals eliminates seal oil leakage into the pipeline, thus avoiding contamination of the gas and degradation of the pipeline.

ZLD

Many gas turbine operators are choosing zero liquid discharge systems

Operating ZLD Systems from McIlvaine GTCC Supplier Program

Operating Facilities	ZLD Supplier	Location	Size (MW)	Startup
Altamonte – Edison	Degremont	Italy	757	2006
Colusa – Pacific Gas & Electric		California	712	2010
Jack County – Brazos Electric	Aquatech	Texas	620	2011
Magnolia – City of Burbank		California	387	2005
Sherman – Panda Power	GE	Texas	750	2014
Red Hawk – Arizona Public Service	Veolia	Arizona	1,060	2002
Riverside – City of Riverside		California	96	2011
Rocky Mountain – Xcel		Colorado	705	2004
Roseville – City of Roseville		California	162	2007
Russell City – Calpine		California	635	2013
Temple – Panda Power	GE	Texas	760	2014

New ZLD Projects from McIlvaine GTCC Supplier Program

Project	Location	Size (MW)	Expected Startup
Bowie CCGT - Southwestern Power Group	Arizona	500	2016
Stonewall CCGT - Green Energy Partners/Panda	Virginia	778	2017

A large number of ZLD systems are anticipated for the arid areas of the Middle East and China but also for areas with plentiful water where there is difficulty or delay in obtaining water discharge permits. Local cities, States, and Provinces often have tougher limits than the national standards.

Doosan - Chihuahua 435 MW CC Power Plant Power Plant Boiler Feed Water Make-up

- Contract : 1999
- Start: 2001
- Owner Electricidad Aguila de Altamira S. de R.L. de C.V.
- Client Mitsubishi Heavy Industries
- Engineer DHT
- Location Chihuahua, Mexic0

- Scope: Design, fabricate, supply, installation supervision, commissioning and training of the water treatment systems, consisting of 3 main process technologies: Demineralization System Zero Liquid Discharge Waste Water Treatment
- Domestic Sewage Treatment o Equipment: dual media filters, R.O system, Decarbonator, CIP system, Chemical dosing system, heat exchanger, Demineralizer, Neutralization system and a wastewater system.
- Feed water: Well water Feed
- water TDS:1500mg/l
- Permeate Conductivity 20 µS/cm
- Permeate flow: 220 gpm
- Demineralized Water: 14 MΩ-cm
- Capacity: 317,000 GPD

Use of Treatment Chemicals is critical

- George Davies, combustion turbine department manager for Turlock (California) Irrigation District's Walnut Energy Center, explained that
- Walnut is a 250-MW, 7EA-powered 2 × 1 combined cycle with a "state-of-the-art" ZLD system. It also is the only power plant that has outsourced ZLD operation and maintenance to a third-party services firm (CH2M Hill subsidiary Operations Management International, known as OMI).
- Dan Sampson, Nalco Co's (Naperville, IL) power-industry technical consultant spoke about the challenges presented by ZLD.
- Sampson offered a few rules-of thumb: Developers, he said, are prone to buy the lowest-price system designed to handle the required flow. One problem with this approach is that the reference water analysis for design work usually is uncertain and any deviation from design almost always translates to a loss in capacity.
- Consequently, ZLD systems almost never meet their nameplate ratings. For decision-making, assume the following:

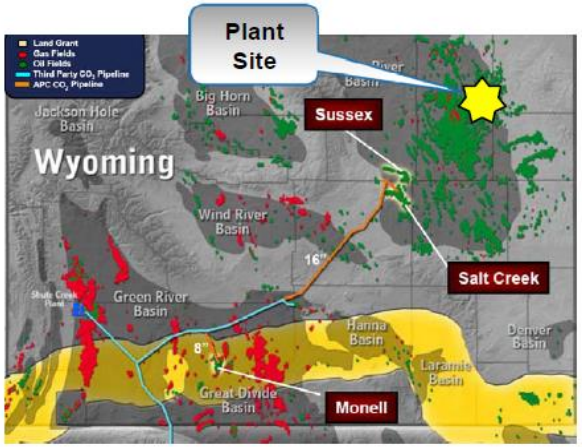
  - Mechanical reliability, 75% to 95%; assume a nominal 80%.
  - A 20% degradation in output between system overhauls/cleanings.

B&W Oxyfuel with ZLD

babcock & wilcox power generation group

B&W and Black Hills: Project Overview

- **100MWe Oxy-fuel pulverized coal greenfield plant located in Campbell County, Wyoming**
- **Application submitted to the DOE for CCPI-3**
- **Plant in-service by 2016**
- **Project Team:**
  - **Black Hills Corporation, host utility**
  - **The Babcock & Wilcox Company**
  - **Air Liquide Engineering and Construction**
  - **Battelle, Pacific Northwest Division**



Black Hills Demonstration Project

Milestone	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Selection	★										
Award		★									
Engineering											
NEPA and Permitting											
Procurement											
Installation											
Commissioning and Startup											
Test Period											
Monitoring											

Intelligence System and detailed Information on Products such as Valves

- **GTCC Valves Decision Guide by Bob McIlvaine - Hot Topic Hour June 4, 2015**
- Power Point sequence used as a basis for the discussion in the June 4 Webinar.
- **Cost Benefits of Critical Valve Repair in the Heat Recovery Steam Generator**
- Modern advance frame combined cycle power facilities operate in a dispatch environment where cold starts, accelerated ramp rates and low load conditions are the norm and where Balance of Plant (BOP) equipment accounts for more than half of all forced outages. An analysis by Pentair revealed that valves are a significant contributing factor in forced outages, primarily based on their application numbers and the severity of their service applications. This article focuses on small bore vent valves and drain valves, reporting research findings that repairing these valves is more prudent and economical than replacing them.

- ***Revision Date:*** 6/3/2015
- ***Tags:*** 221112 - Fossil Fuel 化石燃料, Pentair, Valve, Heat Recovery Steam Generator, Life Cycle Cost, Optimization, Service & Repair, Heat Recovery, Fast Start, Power Engineering

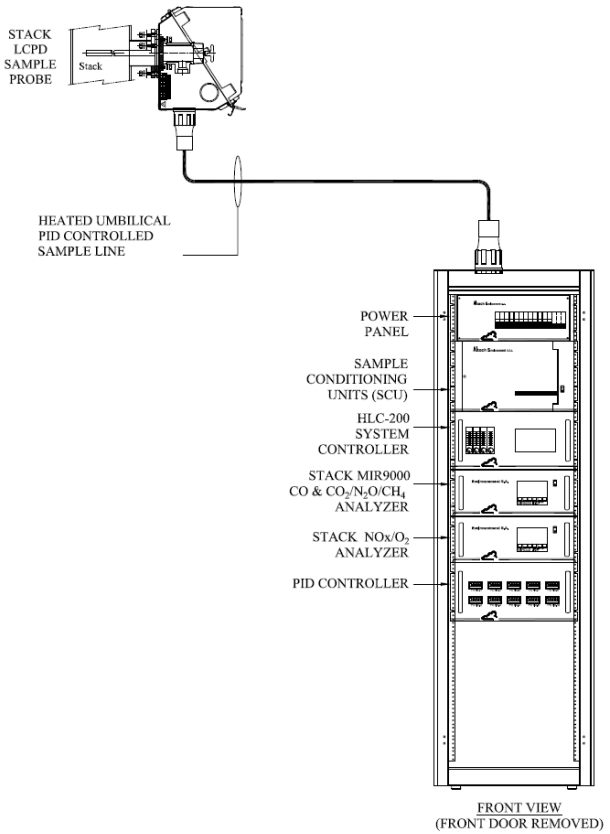
Intake Filter Housing and Components

- **Gas Turbine Intake Filters Webinar - Hot Topic Hour May 21, 2015**
- The session covered four route maps in the Gas Turbine Combined Cycle Air Treatment Guide
- ***Revision Date:*** 5/21/2015

- **Addressing Moisture Issues by McLeod Stephens, Nederman - Hot Topic Hour May 15, 2014**
- McLeod explained that the filter is part of a train of treatment elements with the screen, weather hood coalescers, filters, evaporative cooler and droplet eliminator.
- ***Revision Date:*** 5/15/2014
- ***Tags:*** 221112 - Fossil Fuel 化石燃料, Nederman, Air Inlet House, Air Filter, Air Filtration, Air Intake

CEMS Integrators are Important Suppliers

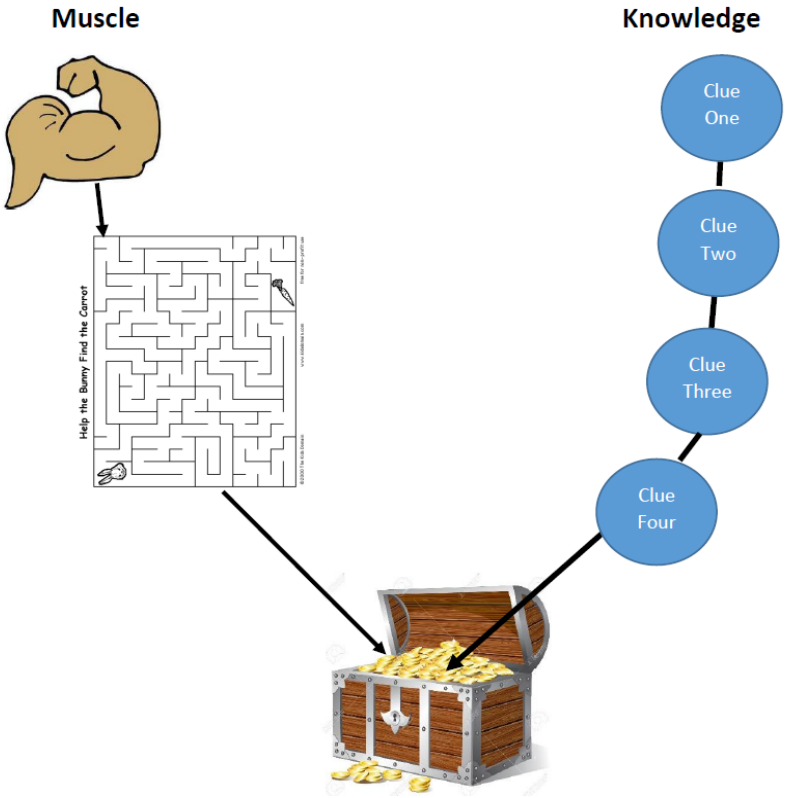
- CEMS system integrators combine multiple pollutant measurement analyzers with methods for extraction and treatment of the sample to be measured.
- The measurement of ammonia slip has become increasingly important along with measurement of NO_x, and CO.
- This schematic of the Altech offering is typical of the integration and customized emissions monitoring and process solutions specifically built to meet the Gas Turbine Market.
- Industry approved analyzers using application specific techniques, along with Altech's own design sampling system, distribution unit, communication and temperature controller are incorporated.
- Experienced Service Department and large on-site parts inventory are needed by the turbine users who are often relatively small and under staffed compared to a big coal-fired power plant personnel roster.



Basic GFT System

Increased Market Share Treasure Hunt where Knowledge beats Muscle

The increase in market share can be likened to a treasure hunt where knowledge of 4 key clues prevails over muscle . Uncoordinated sales activity can be a maize



Clues

1. Value proposition
2. Specific market potential
3. Prospect and Customer Identification
4. Coordination

The value proposition is the first clue. Why will the product reduce the total cost of ownership more than the competitor's product in each specific industry and process within that industry? Muscle is a big promotional investment claiming superiority. Knowledge is creditable facts and research which is organized and available to those who can best use it.

The second clue is the specific market potential in each geography, industry and process. Muscle is top down guesstimates based on a myriad of statistics and assumptions. Knowledge is the bottoms up analysis of each industry and process.

The third clue is the identification of projects and customers. Large customers and large projects represent a major portion of the market. They need to be identified long before the typical sales lead would be received. Within the purchasing entity there are behind-the-scene decision makers who are very important. To increase market share it is important to reach these individuals.

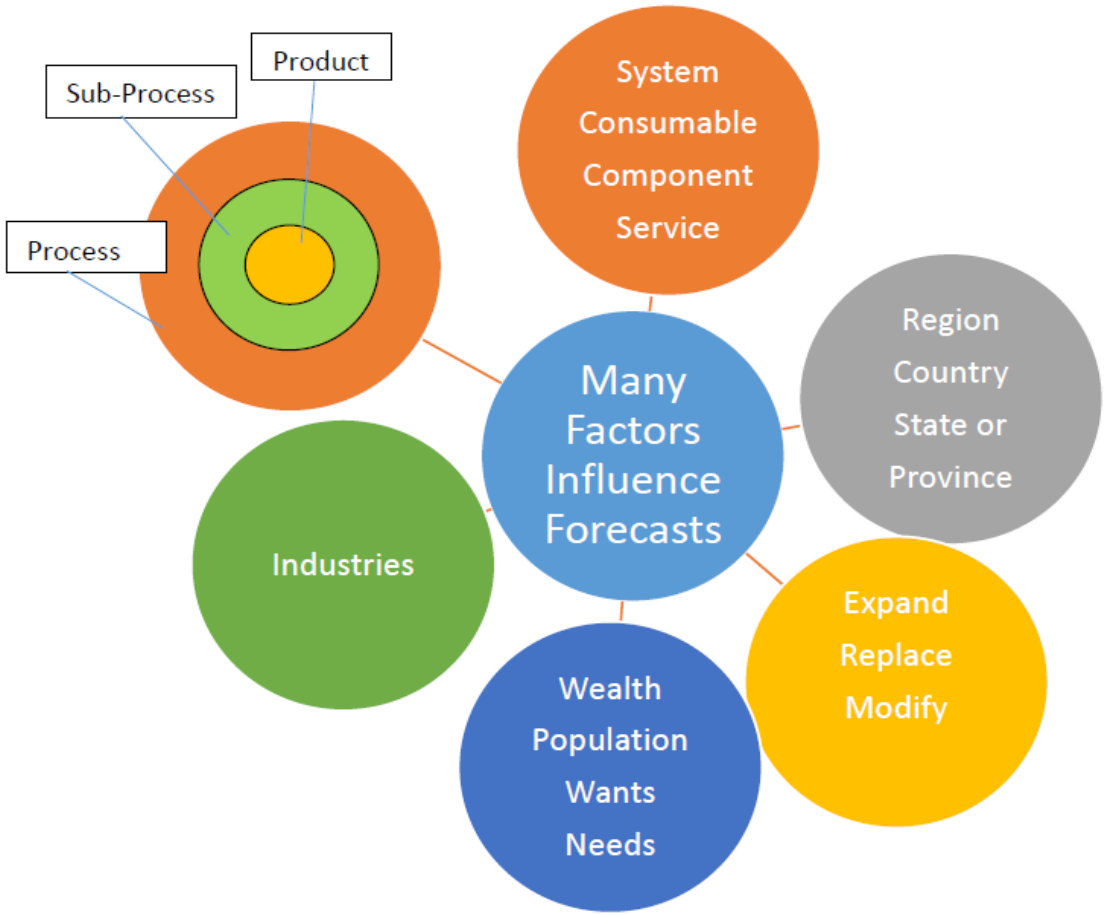
The fourth clue is a coordination. Management, engineering and sales should all be involved in creating value propositions for each product in each industry. Market forecasts should be in sufficient detail to create quotas or targets for each sales territory.

Detailed forecasting by Product, Industry, and Process is Invaluable

Each gas turbine product and service needs to be analyzed by the process and sub process for each region and then by sales territory within that region.

With rapid changes in gas prices it is essential to update the forecasts quarterly.

The accurate forecasting of large components such as turbines and HRSGs improves the accuracy on forecasting components such as pumps and valves.



Recorded Webinars

Webinar Date	Subbject and links
February 25, 2016	**Zero Liquid Discharge** 84 minutes **MORE**
December 3, 2015	**NOx Reduction** 58 minutes **MORE**
October 1, 2015	**Power Plant Water Treatment Chemicals** 29 minutes **MORE**
September 24, 2015	**Power Plant Water Monitoring** 68 minutes **MORE**
September 10, 2015	**Power Plant Pumps** 49 minutes **MORE**
August 6, 2015	**Gas Turbine Emission Control and Exhaust Systems** 62 minutes **MORE**
June 4, 2015	**Power Plant Valves** 67 minutes **MORE**
May 21, 2015	**Gas Turbine Intake Filters** 95 minutes **MORE**

March 24 NO_x Control Hot Topic Hour

March 24, 2016 ***Decisions***	**NO_x Control -** Review of the issues and options for NO_x control in power, cement, steel, and waste to energy plants as well as mobile diesel vehicles. **Click Here to Register**

Cross pollination among industries will be facilitated by the review of options and issues for gas turbine NO_x, CO, and VOC reduction in contrast to other industries. A gas turbine emission control decision guide will be updated prior to the meeting. Input from suppliers prior to the event is encouraged

April 21 Hot Gas Filtration Hot Topic Hour

April 21, 2016 ***Decisions***	**Hot Gas Filtration** - Issue and Option for particulate capture. in power, cement, steel, and waste incineration. **Click Here to Register**

Cross pollination among industries will be facilitated by the review of options and issues for gas turbine air intake reduction in contrast to other industries. A gas turbine air intake emission control decision guide will be updated prior to the meeting. Input from suppliers prior to the event is encouraged.

The same debates of membranes vs. laminates and efficiency vs. pressure drop are common to many industries.

Tour of Gas Turbine Supplier Program Website

- A quick tour of the Gas Turbine Combined Cycle Supplier Program website will take only a few minutes.
- The remaining time can be used to answer individual questions while displaying website information.
- If you want details on technology or markets in a specific country they can quickly be displayed.