GEH: Gas Gen Perspective
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Introduction

Power Costs, Inc. respectfully submits these written comments providing a gas fired generators perspective as well as our comments on the presentations discussed during the recently reactivated North American Energy Standards Board (NAESB) Gas-Electric Harmonization (GEH) Forum meeting held on February 18-19, 2016.

- Company:
  - Software Development for Energy Markets
  - Founded 1992 / Privately Owned

- PCI Supported NAESB standard:
  - WEQ eTag 1.8.2
  - WEQ OASIS 2.0
  - WGQ 1.9, 2.0, 3.0

- Market:
  - 61% of North American Generation Capacity do Scheduling using PCI
    - Higher among Gas-Fired Gens
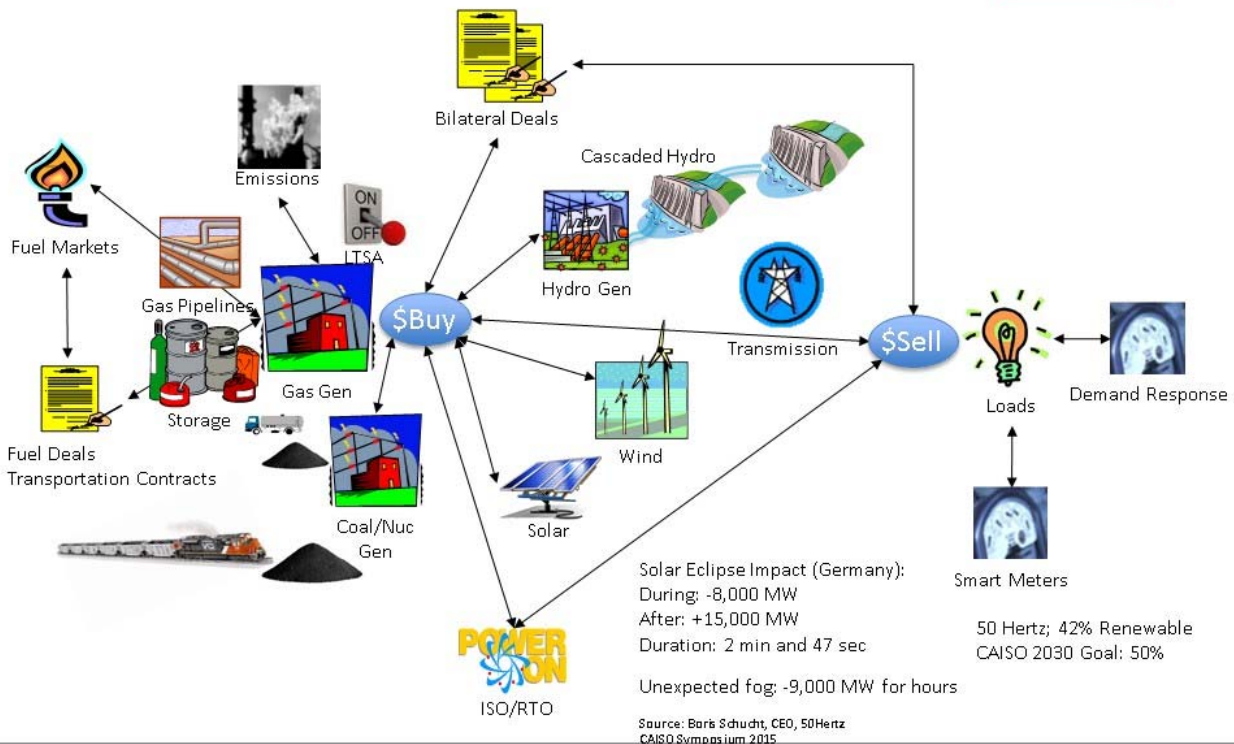 - 70% of Fortune 500 Utility & Energy companies

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PCI provides fuel, generation, and transmission scheduling solutions that is used by over 60% of the North American generation capacity. This includes scheduling both in traditional markets as well as in all ten North American ISO/RTO markets.

PCI supports NAESB protocols both on the gas and electric side of a generator.

Gas-Fired Generator Space

Bilateral Deals

Emissions

Cascaded Hydro

Fuel Markets

LTSA

Gas Pipelines

Hydro Gen

$Buy

Transmission

$Sell

Storage

Gas Gen

Demand Response

Loads

Fuel Deals
Transportation Contracts

Wind

Coal/Nuc Gen

Solar

Smart Meters

Solar Eclipse Impact (Germany):
During: -8,000 MW
After: +15,000 MW
Duration: 2 min and 47 sec

Unexpected fog: -9,000 MW for hours

50 Hertz; 42% Renewable
CAISO 2030 Goal: 50%

ISO/RTO

Source: Boris Schucht, CEO, 50 Hertz
CAISO Symposium 2015

If we look at the gas-fired generators space the generator can get gas from fuel markets and then use transportation contracts to transport them to either the plant or to storage. Some plants have dual fuel capabilities where fuel oil can be burned during advantageous or constrained circumstances.

Other unit constraints the generator has to worry about are; the amount of emissions that the burning of the fuel creates, the LTSA contracts that financially limits the ability to cycle the unit on and off. Bilateral contracts and ISO awards impacts the generator's schedules and offers.

Generated power reaches the load side using transmission either bilaterally agreed upon or by using a market. The markets could either be ISO/RTOs, bilateral, or exchanges.

Major competition and/or complements to the gas generators are; nuclear, coal, hydro, geothermal, demand response, wind, and solar. With the additional amount intermittent renewables, gas fired generators will be in more demand in the future to help balance and regulate the grid. Two main scheduling scenarios needs to be addressed better in this new world; known disturbances as well as forced or un-planned outages. At the CAISO 2015 Symposium the CEO from 50 Hertz shared some numbers for those cases; one was the 2015 solar eclipse and the other one involved unexpected fog.

The 2015 solar eclipse was a predictable event that produced swings of up to 15,000 MW during less than three minutes. That amount is the capacity equivalent of 30 36" pipelines. The extra intraday cycle would not help much to handle that kind of swing. Even 24 intraday cycles would probably not have

helped enough. Since this was a predicable event one could argue that it needs to be solved earlier; e.g., weeks out with the final touches in Day-Ahead with hourly (or sub-hourly) nomination volume capabilities.

50 Hertz is at 42% renewable and the renewable goal of California is by 2030 to have 50% renewables. So even if the next solar eclipse is years away, another scenario is more likely to impact solar generation; weather changes and specifically unexpected fog. In this case 50 Hertz reported that they had 9,000 MW of solar less than they had anticipated due to fog. In this scenario, more cycle with additional granularity would have helped.

A Gas Gen's Perfect Vs Real World
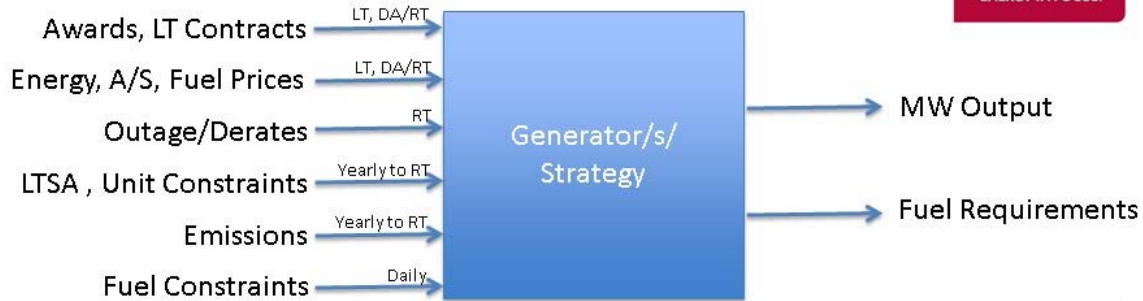
PCI ENERGY IN FOCUS.

- In a Perfect World...
  - Fuel Supply Availability = Generation Output Needs
  - No Start-up or Shutdown Costs or Constraints
  - No Emissions/Costs
  - No Outages or Temperature Derates
  - Perfect Linear I/O Curves over all Stages and Duct Firing
- In the Real World...
  - Daily Fuel Quantities and Electric Products/ISO Awards
  - LTSAs, Unit Characteristics
  - EPA, CARB
  - Outages and Temperature Swings
 - Multiple Configurations

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To understand the challenges of a gas generator we need to look at them in a perfect world and compare them to the real world. In some ways, the perfect world is closer to the eTag based transmission scheduling world than the real world which is closer to the pipeline world.

Generator/s/ Strategy

Awards, LT Contracts — LT, DA/RT →
Energy, A/S, Fuel Prices — LT, DA/RT →
Outage/Derates — RT →
LTSA , Unit Constraints — Yearly to RT →
Emissions — Yearly to RT →
Fuel Constraints — Daily →

Generator/s/ Strategy

→ MW Output

→ Fuel Requirements

Insanity: doing the same thing over and over again and expecting different results.
Albert Einstein
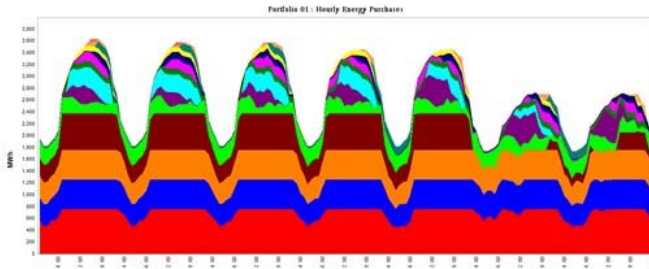
Key Point: Most Generators look at least 7 days out, even though markets are DA/TIM or RT/ID.

GEH Translation: Unless some of the inputs to the generator/s/ strategy changes; just running more cycles will create the same result.

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Generator schedules are derived from all of these real world constraints as inputs and the outputs are the generator's MW (and emissions) as well as fuel requirements. The schedule and the strategy won't change unless the inputs change. Since all of the constraints can't be adjusted on a real-time basis or even in the day-ahead time frame, the generator typically looks seven days out or more. During real-time a generator typically does not make any changes unless there are unexpected temperature changes or outages. If there are changes, a generator really needs the hourly (or sub-hourly) resolution to manage unexpected changes. More intraday, rateable cycles will not be as effective as allowing the existing cycles to have a greater granular resolution; i.e., hourly or less. Of course in a perfect world one would like to have both, but if you had to choose; increased resolution would be more beneficial that more ratable cycles.

Input Characteristics

- ## Awards, LT Contract
  - Gen Offer – ISO/Award – DA/RT
  - Gen Offer – Counterparty/Contract - LT
- ## Energy, A/S, Fuel Prices
  - Market – LT/DA/RT
- ## Outage/Derates
  - Planned or It Happens
- ## LTSA, Unit Constraints
  - During Construction/Utilization
- ## Emissions
  - During Construction/Utilization
- ## Fuel Constraints

Key Points:
Even if the Fuel side is perfect, there are many other aspects that drives a generator. With different time horizons.

Everything has to be monetized to optimize.

It should also be recognized that even if all the physical fuel constrains are handled perfectly there are still a number of other inputs that may dictate the behavior of the generator. Since these can all be conflicting constraints; not only in Real-Time/Intra-Day, but some of the constraints spans much longer time periods; e.g., emissions and LTSA are typically viewed on an annual basis. Hence, this cannot be solved with real-time/intraday physical scheduling. To solve the conflicting requirements, the generator monetizes all the input constraints first, before the MW and fuel schedules are derived.

Fuel Constraints
### Transportation Market?

- **Typically Modelled as Hard Physical Constraint, not a Price Sensitive Market**
- **Why?**
  - Market is Too Physical
    - The Financial Components are not 100% EDI available
      - Makes scheduling more difficult
  - Capacity Release
    - Not always a liquid market.
      - Not available everywhere; even with 3.0.
    - Available too late for some to change strategy
  - Generator Fuel Cost Recovery Clause
    - Sometimes provides lack of incentives to trade even unused firm
  - Services
    - Ratable
    - Hourly Non-Ratable
    - Swing over 16 hrs
    - Sub-Hourly?

| Data Set No.	Data Set Name	Creation	Download
5.4.17	Note / Special Instruction	N/A	EDI Only
5.4.20	Transactional Reporting – Capacity Release	N/A	EBB Only
5.4.21	Transactional Reporting – Firm Transportation	N/A	EBB Only
5.4.22	Transactional Reporting – Interruptible Transportation	N/A	EBB Only
5.4.23	Pre-approved Bidders List	N/A	EBB Only
5.4.24	Offer	EBB Only	EBB and EDI
5.4.25	Bid	EBB Only	EBB and EDI
5.4.26	Award Download	N/A	EBB and EDI
5.4.27	Withdrawal Download	N/A	EBB and EDI

The Result? Sub-optimal.
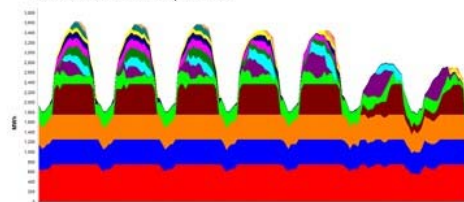
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Today, most fuel constraints cannot be monetized easily since the market is not very liquid. Capacity Release exists, but it is not a very liquid market and it is only available fully on EBBs. NAESB EDI does not exist for most of the Bid/Offer functions. Without efficient EDI, that market will not be very efficient.

Fuel costs are handled very differently depending on whether the generator is part of a regulated utility or is an IPP. Some generators have fuel cost recovery clauses that hedges them from variations in the fuel cost. For those generators, buying firm transportation is an easier decision since they can recover the cost. IPPs typically cannot. Since fuel clause generators can recover the transportation cost, they will need a greater incentive to sell off that firm capacity that they are not using. Without a liquid market, there is capacity not being utilized the most effective. Even if the pipeline identifies the available capacity intraday, it is typically too late for a generator to change strategy to take advantage of it.

Another barrier to more liquid and effective markets are the ratable flows. As mentioned above, very few generators will sign up for firm transportation since these are typically ratable. If they do, they will only sign up for the minimum fuel requirements since those are around the clock capacity. However, the minimum limits of a generator is a fraction of the total. So they will use firm capacity for the base load and no-notice services to shape their fuel requirements. One presentation (Skipping Stone) suggested that this behavior was because the no-notice service was free. This is not our experience, instead the explanation is because it is the only way to create the daily shape a generator needs. Some pipelines accommodate the daily shape requirement by offering hourly service. Some do it by allowing a

generator to swing over 16 hrs ("on-peak swing"). But the number of pipelines offering these services are very few.

In summary, since there are very few firm transportation/nomination services that mimic electricity products; e.g., on-peak, super-peak, off-peak, custom. The generator will have to use firm service at the base and then no-notice to create the shape they need.

Evolution/Lessons Learned
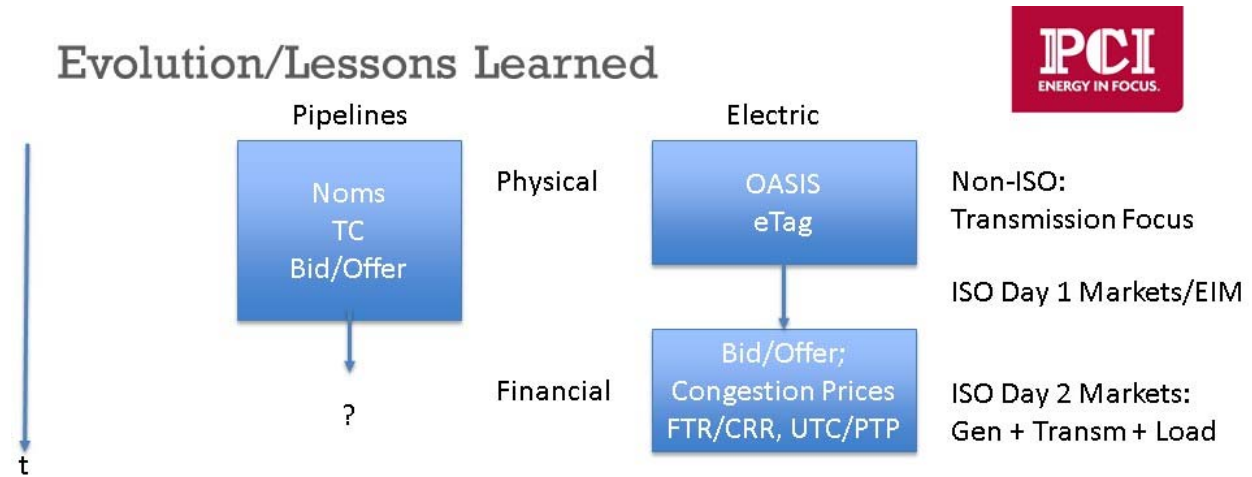
	Storage	Confirms	"DA" Volume	"RT" Volume
ISO Day 2	Yes (ESR)	Yes	90%	10%
Pipeline	Yes	Yes	80-90%	10-20%
eTag	N/A	N/A	N/A	90%

The Pipeline model is not that far away from an ISO Day 2 Market.
Main difference; it's not as Financial as an ISO Day 2.

Commenting on OATI's suggestion that lessons learned from the electricity markets should be factored in when proposing changes is correct. We should try to learn from others mistakes and experiences. Unfortunately, they proposed that we should ignore the lessons learned over the last decade or so and instead focus on the 1990's when the electricity markets were only using a physical scheduling model.

Over the last decade the electric industry has moved away from the eTag based physical scheduling model and instead the ISO Day 2 market model is being implemented and replacing eTags. When an ISO moves from a Day 1 market to a Day 2 market, the eTag requirement inside the market is removed and replaced by the ISO Day 2 model. The ISO Day 2 model allows for both physical (self-scheduling) and financial scheduling (bids/offers) of resources. This is a big step forward from the traditional physical scheduling since it creates a more liquid market that promotes greater efficiencies.

In the ISO Day 2 market, all market participants enter bids/offers. By doing so, the confirmation process becomes intrinsic with all participants active and the ISO can do all the matching/scheduling at once. If this model would be introduced to the Pipelines, this could reduce or even eliminate the confirmation process and thus reduce the overall scheduling times. This would require that not only shippers would nominate, but all participants would "nominate" their position. The pipeline could then do the "Art of Scheduling" with all the data available at once and focus on discrepancies instead of chasing parties that don't confirm on time. Using a financial model to penalize participants could be a way to get all participants to submit their information on time.

The current Pipeline model of scheduling is closer to an ISO Day 2 market than the old eTag model and thus more attention should be given to the ISO Day 2 market model. The main difference between the Pipeline model and the ISO Day 2 market model is that the ISO Day 2 offers more financial market instruments that the Pipelines currently do and the confirmation process is different.

Observations

- For People to Change, there must be a Financial Incentive
- ISO Day 2 Markets have Market Instruments and Models to handle Constraint issues Financially
  - Congestion Pricing
  - UTC/PTP, FTR/CRR/TCC/TR
  - Awards, FinSched/Trade/Inter-SC/Transaction
- Generation and Pipeline Operations are much more time sequence complicated than Transmission
  - Faster scheduling helps but earlier should also be considered
- Markets and Granularity don't have to be the same
  - DA Markets are typically Hourly
  - RT Markets are typically Hourly, 15 or 10 min
  - If TIM was of hourly granularity (non-ratable) that would help

For people to change that must be a financial incentive (more opportunities or penalties). An ISO Day 2 market model has financial incentive as well as financial models to handle constraints and congestion. This is a more compatible model since both generation and pipeline operations are more time sequence complicated than the traditional physical transmission scheduling model (eTags).

Congestion is handled using financial means, not only in day-ahead or real-time, but there are abilities to hedge congestion far in advance by using FTR/CRR. These could translate into FTRs but as Financial Transportation Rights (instead of Transmission).

A key point is that markets and granularity does not have to be the same. On the electrical side you have Day-Ahead markets that are hourly in granularity, while Real-Time markets can be hourly, but also sub-hourly. In some cases offers are made using one granularity while the awards are of a lower granularity; e.g., hourly Real-Time offers but 5, 10, or 15 min awards.

It would be very helpful if the Timely and other cycles would to be of hourly granularity instead of daily.

Suggestions

- Alleviate/Reduce Fuel Constraint with a more Liquid (financial) Market
  - One size does not fit all.
  - There is no Silver Bullet.
  - NAESB can help with the interfaces
    - Enhance NAESB Cap Release Spec with Bid/Offer support for full EDI
    - Allow Bid/Offer Curves
    - Encourage/Define New Services
- Look at the ISO Day 2 Markets, not eTag, for faster and more effective scheduling ideas
  - ISO Day 2 Markets include both physical and financial scheduling; while eTag is just a physical scheduling environment
    - UTC/PTP, FTR, Congestion Pricing
    - Confirmation Processes
  - NAESB can help with the interfaces

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We don't believe that one size fits all nor that Rome was built in a day. We agree that we should proceed with caution and instead of making drastic changes; introduce changes incrementally. Making wholesale technological changes comes at a high cost and risk with very limited benefits.

The overall idea is to introduce services similar to an ISO Day 2 market to the pipelines and thus combining the best of the physical and financial scheduling worlds.

The current NAESB WGQ standards could be enhanced with the following concepts (details tbd);

Short-term (within NAESB control);
- Enhance standards to allow for hourly granularity and/or a "products" (on-peak/off-peak) concept to specify volumes in the different cycles. Maybe start with TIM/EVE and do ID in a later phase.
- Add EDI capabilities for all Capacity Release messages.
- Provide a standard for location definition.

Longer-term;
- More cycles.
- Replace confirmation process with an "ISO Day 2 market bid/offer" model.

With more and more intermittent renewables as part of the generator's portfolio; more granular, faster financial and physical scheduling models need to be part of the future.

For More Information

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  - Offers & Bids Management
  - Evaluate Bidding Strategies
  - Forecast LMPs
  - Automate XML Communications
  - ISO and Shadow Settlement

- **Deal Management**
  - Deal Capture
  - Bilateral Settlement
  - E-Tagging/OASIS Reservations
  - Gas Management

- **Contract Settlement**
  - Post Analysis
  - Energy Accounting
  - Tolling

- **Data Warehouse and BI Tools**
  - ODS and DataMarts
  - BI Analyzer

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