November 14, 2011

Chris Kirsten
California Independent System Operator, Inc.
250 Outcropping Way
Folsom, CA 9563

Re: Wärtsilä Comments on Flexible Ramping Product Straw Proposal

Dear Chris:

Wärtsilä North America, Inc. submits these comments on behalf of Wärtsilä Corporation ("Wärtsilä") in response to the "Flexible Ramping Products Straw Proposal" (the "Straw Proposal")[1] dated November 1, 2011, by the California Independent System Operator, Inc. ("CAISO"). In response to the request for comments set out in the Straw Proposal, we set out below: (i) an introduction to Wärtsilä and its engines' flexible ramping capabilities; (ii) our comments in support of the CAISO's proposal to create flexible ramping products; and (iii) our comments regarding specific operating requirements that should be implemented regarding flexible ramping products.

I. About Wärtsilä

Wärtsilä is a global leader in complete lifecycle power solutions for the marine and energy markets. Wärtsilä offers competitive and reliable solutions for base load power generation, grid stability and peaking, and industrial self-generation. We provide superior value to our customers with our distributed, flexible, efficient and environmentally advanced energy solutions. Through December 2010, Wärtsilä has delivered 4,500 power plants in 168 countries totaling over 47 GW.

Projects utilizing Wärtsilä engines include the recently reconfigured Humboldt Bay plant owned by Pacific Gas & Electric ("PG&E") and located near Eureka, California. The reconfigured plant consists of 10 Wärtsilä 18V50DF lean-burn dual-fuel engines with a total output of 162 MW. These dual-fuel engines run primarily on natural gas, but are capable of using ultra low sulfur diesel as a back-up fuel during times of natural gas curtailment. When compared to the existing 50 year old PG&E plant, the new facility will be 33% more efficient with 85% fewer ozone forming compounds and a 34% reduction of greenhouse gas emissions.

Wärtsilä's engines are ideal for providing ancillary services, load following, and supporting variable energy resources, such as wind and solar. A Wärtsilä non-spinning (but pre-heated) engine can reach 25

[1] Xu, Lin and Donald Tretheway, CAISO Flexible Ramping Products Straw Proposal (Nov. 1, 2011), available at http://www.caiso.com/informed/Pages/StakeholderProcesses/FlexibleRampingProduct.aspx.

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percent of its generating capacity in just 30 seconds when running on natural gas, and in 15 seconds when running on oil. From start order, it can reach full load in gas mode in five minutes and, in oil mode, three minutes. A typical Wärtsilä plant will reach these operating levels in a highly efficient manner: 46 percent net electrical efficiency at full load in simple cycle mode, 50 percent net electrical efficiency in combined cycle mode (when running on natural gas). The fact that Wärtsilä plants are made up of a number of smaller units enables them to dispatch at any output while maintaining full load efficiencies.

Wärtsilä's quick start, high ramping assets also help optimize the efficiency of less flexible resources by allowing them to operate at their optimal dispatch points. For instance, having Wärtsilä engines provide most fast ramping needs allows combined-cycle plants to ramp up and down less frequently and operate steadily at their most efficient levels. By conducting system analysis (Plexos models) on several large markets, Wärtsilä has consistently seen total system operational savings in the 4% to 8% range by injecting Wärtsilä plants in the system models. More information on this work could be made available to the CAISO if requested.

II. Wärtsilä Supports the CAISO's Efforts to Create New Flexible Ramping Products

Wärtsilä agrees with the CAISO's observation that increased market penetration by renewable energy resources has created new challenges for balancing generation with load. As more variable energy resources inject power onto the grid, the reserve capacity needed to provide certain ancillary services increases. Furthermore, with natural gas prices remaining low, many gas-fired generation resources are clearing their full capacity in energy markets across the country, leaving less available capacity to provide needed ancillary services. Thus, Wärtsilä is not surprised by the CAISO's observation that units in the real-time pre-dispatch process (RTPD) "sometimes lack sufficient ramping capability and flexibility to meet conditions in the five-minute real-time dispatch (RTD) during which conditions may have changed from the assumptions made during the prior pre-dispatch."[2]

Wärtsilä equipment, in fact, is being used in numerous locations to address similar concerns. For example, the Cogentrix-owned Plains End I and II power plants (231 MW total) near Denver, Colorado use twenty Wärtsilä 18V34SG engines and fourteen Wärtsilä 20V34SG engines, respectively, to balance Colorado's 1000 MW wind power capacity.

III. Flexible Ramping Participation by Non-Spinning Resources

Wärtsilä has followed with interest the CAISO's recent attention to flexible ramping issues. Wärtsilä has substantial prior experience in this area based on its presence in major markets around the world and looks forward to sharing relevant aspects of such experience at the appropriate time in the CAISO's stakeholder process. For now, however, Wärtsilä is limiting its comments to urging that the final rules allow non-spinning resources to provide a five-minute upward flexible ramping product.

It is unclear from the Straw Proposal whether the CAISO intends to allow non-spinning resources to be used as the basis for providing such service. However, failing to use such resources could leave out a substantial source of very fast-ramping resources. It also could fail to capitalize on the savings achieved

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[2] Flexible Ramping Products Straw Proposal at p. 3.

from non-spinning resources, which use less fuel and release fewer air emissions than resources required to spin while waiting for dispatch instructions when providing a flexible ramping product. For instance, a pre-heated Wärtsilä non-spinning engine can reach 25 percent of its generating capacity in just 30 seconds when running on natural gas. From receipt of a start order, it can reach full load in gas mode in five minutes. In short, the ramping speed and fuel flexibility of Wärtsilä engines make them very strong candidates for providing load balancing and ancillary service products.

Additional information about Wärtsilä engine operating capabilities is provided in the following enclosed materials: (i) "Grid Stability Management with Flexible Power Plants" and (ii) "The Wind Enabler."

IV. Upcoming Stakeholder Process

Wärtsilä looks forward to participating in the CAISO's flexible ramping stakeholder process. Please contact us if you have any questions regarding the foregoing comments. In addition, Wärtsilä would be pleased to provide additional information about the ramping capabilities of Wärtsilä's engines to show how fast and accurate their ramping capabilities are, and to assist in developing the CAISO' flexible ramping rules.

Thank you for the opportunity to submit the foregoing comments.

Sincerely,

/s/ Mikael Backman

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Enclosures

GRID STABILITY MANAGEMENT WITH FLEXIBLE POWER PLANTS

AZER ENERJI,
SANGACHAL, AZERBAIJAN
Type: ....Baseload
Engines: .... 18 x Wärtsilä 18V50DF
Total output: .... 300 MW
Fuel: .... Natural gas
Delivered: 2008

THE BUSINESS OF POWER IS CHANGING – FOR GOOD

Geothermal and solar energy, biomass, liquid biofuels – and the wind. There is great potential in renewables, and we have the means to make it even greater. Through flexible multipurpose plants – optimized both for preserving grid stability and providing baseload power when needed – you will match supply and demand faster, prepare for any future challenges, and ensure better profitability.

A TYPICAL WÄRTSILÄ GRID STABILITY PLANT:

- Size range 50–500 MW
- Location in cities and grid nodes
- Fuel: natural gas, fuel oil, or both
- Capability for dynamic operation
- High efficiency, wide load range
- Compliance with local emission norms.

The greenhouse gas concentration in the atmosphere is higher than it has ever been during the past 650,000 years. A reduction of greenhouse gases by 50%–80% is needed from the current level by the year 2050.

The use of renewables in power generation offers one good solution for greenhouse gas reduction. In particular, the wind power market is growing fast. In 2009, 38,312 MW of wind power was added to the world's energy supply.

Whenever a non-dispatchable, volatile wind, or solar power component is added to the power generation portfolio, it presents additional challenges to system operators. Simultaneous load and wind power changes must be managed, and thermal power plants need to be ramped up and down more rapidly and frequently. The use of wind power leads to more frequent start and stops, but also reduces the average load of the thermal plant.

With an increasing wind capacity allotment, grid stability cannot be ensured merely by grid codes and transmission grid strengthening. As the existing thermal power plants were not originally designed for frequent starting and ramping up and down, new flexible and dynamic capacity is needed.

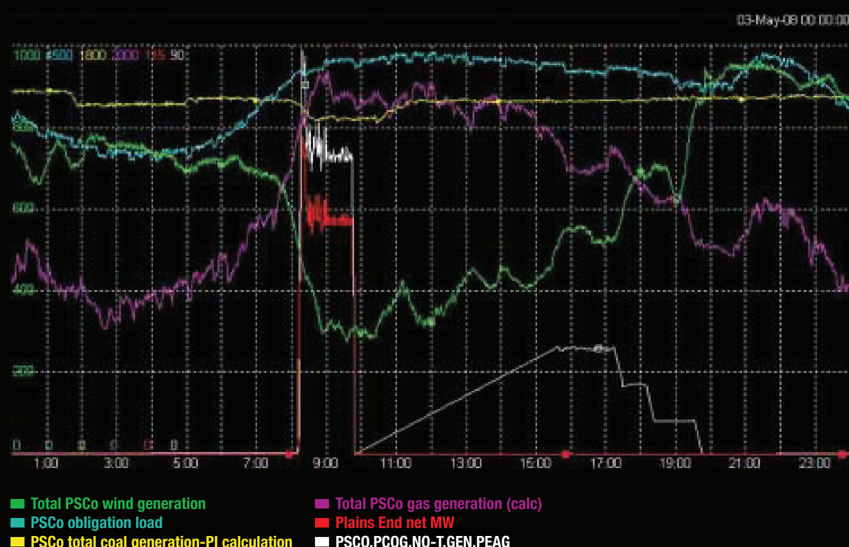
REQUIREMENTS FOR A BALANCED POWER SYSTEM:

- Base- and intermediate load capacity
- Flexible peaking power capacity
- Fast ramp up capacity for accurate load following
- Alert frequency and voltage control
- Efficient spinning reserve
- Fast starting non-spinning reserve
- Adequate reserve power
- Reliable and fast grid black-start capability

Traditionally, these functions have been managed by different types of power plants applying different technologies. These plants cannot change their operation mode, so they remain in their peaking or baseload

GOODMAN ENERGY CENTER,
KANSAS, USA
Type: .... Grid stability
Engines: .... 9 x Wärtsilä 20V34SG
Total output: .... 76 MW
Fuel: .... Natural gas
Delivered: 2007

Wärtsilä Flexible Grid Stability Plant, 100 MW, optimized for peaking and reserve power applications running on liquid fuel oils and/or natural gas.



The Plains End power plant is used to balance Colorado's 1000 MW wind power capacity.

PLAINS END I and II, COLORADO, USA
Type .... Grid stability
Engines .... 20 x Wärtsilä 18V34SG
+ 14 x Wärtsilä 20V34SG
Total output .... 231 MW
Fuel .... Gas
Delivered .... 2002 and 2008

role, whereas a Wärtsilä power plant can fulfil all these needs flexibly. The Wärtsilä plant can switch operation mode at any time, as the market requires, and perform all the tasks competitively and efficiently.

A WÄRTSILÄ POWER PLANT IS THE BEST SOLUTION FOR GRID STABILITY

Typical power needs for grid stability solutions are in the range of 50–500 MW. Wärtsilä power plants offer a combination of valuable features:

- Remote controlled operation
- Fast starting and stopping
- Fast loading:
  - 30 sec to 25% load on gas, 15 sec on oil from start order
  - 3 min to full load in oil mode
  - 5 min to full load in gas mode
- Wide load range, 30–100%
- 44% net electrical efficiency at full load on oil, 46% on gas
- Flat part-load efficiency curve
- Grid black-start without external power
- Compliance with local emissions legislation.

These features enable Wärtsilä power plants to offer all that is required for modern and efficient grid stability operation, and from a single power source.

OPTIMIZATION TO LOCAL CONDITIONS

- Multi-fuel operation
  - Natural gas (low 5 Bar/75psi pressure requirement)
  - Heavy fuel oil
  - Light fuel oil
  - Liquid biofuel
- Optimal plant sizing, multiple units for flexibility and reliability, expandable
- Easy to site, even within city limits
  - Light industrial look to the plant
  - Low impact of ambient conditions on plant performance
  - No water consumption
- Fast-track 12 months EPC delivery
- Competitive operation and management cost
  - Easy to operate
  - Global 24/7 local service, from more than 160 Wärtsilä service outlets
  - Ability to execute many starts and stops with no cost penalty or impact on maintenance needs
- Operations and maintenance agreements.

Wärtsilä has delivered numerous 50–500 MW grid stability power plants worldwide, including to sensitive areas such as California, USA, with very stringent emission limits.

Wärtsilä power plants have proven grid support performance, including for grids with high wind power concentration and challenging operative conditions.

Wärtsilä power solutions enable a smoother transition to a modern and sustainable energy mix, and a balanced and cost effective overall power system.

WÄRTSILÄ

Wärtsilä is a global leader in complete lifecycle power solutions for the marine and energy markets. By emphasising technological innovation and total efficiency, Wärtsilä maximises the environmental and economic performance of the vessels and power plants of its customers. Wärtsilä is listed on the NASDAQ OMX Helsinki, Finland.

05.2010 / Bock's Office / Litoset

The Wind Enabler

AUTHOR: **Mikael Backman,** Director, Market Development, Power Plants, Wärtsilä in North America

Balancing power in a grid that has significant variable generation, such as wind or solar, is a challenge for any utility. Some utilities in the USA are finding the efficient and flexible quick start capacity of gas engines to be a good solution.

System balancing

Utilities, system operators, and regulators are increasingly faced with the challenge of incorporating large amounts of generation with variable output into regional grids. It is a challenge that is particularly significant in the USA, which installed almost 10,000 MW of wind power generators in 2009 alone. This challenge is not unique, system operators have always had to deal with load variability, but wind generation does add to the aggregate variability.

By nature, load and wind variability are uncorrelated and statistically independent so the addition in aggregate variability is not linear. However, in some areas operators have experienced difficult situations where load may be ramping up, while the wind is ramping down.

While discussions regarding the cost of this wind power integration are still ongoing, it is clear that a number of key measures have to be considered in order to successfully and reliably plan, operate, and balance a system with large amounts of variable generation. This article discusses some major aspects that play a role in the integration issues.

Geographical diversity

A geographically and electrically large balancing area for electricity supply and demand, or co-operation between smaller balancing areas, has several benefits such as:

1) The correlation in output variations between multiple wind plants diminishes if they are further apart (geographical diversity).
2) A large balancing area will also have more flexible generation installed.
3) Since the incremental variability is non-linear, this will result in a lower ratio of reserve capacity required.

Thus, the relative variability in generator output is reduced when the operating area is increased. Several studies have illustrated the benefits of increasing balancing area sizes (Ernst 1999, EWITS 2009, Ahlstrom 2008, Milligan & Kirby 2007, Holttinen 2007). Holttinen, for example, notes that the total reserve requirements in the Nordic countries would double if they operated as separate markets, rather than the combined Nordpool market. Strong connections and good co-ordination between markets can be as effective as a large single balancing area. Denmark, for instance, has strong connections to both the Nordic systems and the German system. Consequently, they can balance wind variability and accommodate high levels of renewable generation. Conversely Ireland, or the ERCOT market in Texas are both electrical islands with weak interconnections, and have to contain enough balancing resources internally. Though there are clear benefits to enlarging the balancing area, this alone cannot provide a single solution. A combination of targeted measures, including a fleet of flexible generation sources, is needed to fully accommodate large amounts of variable generation.

Transmission expansion

The best locations for wind and solar plants are typically not where the majority of the load is, but rather in remote areas with limited transmission resources. In the USA, a number of studies have been conducted on expanding the main transmission lines, and transmission upgrades have already been carried out in western Texas and other areas to mitigate this problem. Historically, building major transmission lines in the USA has been very difficult, costly, and time consuming, and the regulatory framework regarding cost allocation, especially on interstate lines is still under discussion.

In addition to these difficulties, transmission lines have substantial losses and variable generation will only utilize a small part of the total transmission capacity. This will increase the cost of each kWh delivered over the system. Locating flexible generation plants along these transmission lines could help the line utilization issue, as these plants would be dispatched when the wind or solar plant is not producing. This positioning of flexible generation is new, since many of these plants have typically been located within the load pockets, downstream of the major transmission lines. Their modularity and environmental aspects allowed them to generate power closer to the load, without the need for additional transmission investment or losses.

Variable generation forecasts

As with wind variability, errors in wind forecasts add to system load forecast errors, in the same uncorrelated, non-linear way as output variability. This ultimately increases the flexibility needed within the balancing area. Much work is being done on wind forecasting, both on long-term forecasting to predict the average output over the year, season or lifetime of the assets, and for short-term forecasting. The short-term forecasts would be used by utilities or balancing areas to forecast the next few hours or days, and continued improvement in these models is expected to provide increasingly accurate forecasts.

Market structures

Energy market structures and generation scheduling/dispatch are some of the most important means of using the inherent flexibility of existing and future power systems. Sub-hourly energy markets (5 min, 10 min or 15 min clearing) can provide economic incentives for flexible generation to respond to load and wind fluctuations, and also provide future incentives for markets with insufficient flexible generation installed. When this flexible generation is restricted to hourly movements by scheduling rules, it not only results in lost opportunities for the generators, but increases overall generation costs and has a negative effect on system reliability.

Large wind events are relatively slow compared to the instantaneous failure of a large generator or transmission line. The "firming" needs of wind, i.e. counteracting the output change of the wind generation with dispatchable generation, can be met with the capabilities of sub-hourly energy markets and non-spinning reserve. Still, some Balancing Authorities (BA) use →

Table 1 – Annual averages of ancillary services prices.

	2002	2003	2004	2005	2006	2007	2008
	Annual Average USD/MW-hr						
California (Reg = up + dn)							
Regulation	26.9	35.5	28.7	35.2	38.5	26.1	33.4
Spin	4.3	6.4	7.9	9.9	8.4	4.5	6.0
Non-spin	1.8	3.6	4.7	3.2	2.5	2.8	1.3
Replacement	0.9	2.9	2.5	1.9	1.5	2.0	1.4
ERCOT (Reg = up + dn)							
Regulation		16.9	22.6	38.6	25.2	21.4	43.1
Responsive		7.3	8.3	16.6	14.6	12.6	27.2
Non-spin		3.2	1.9	1.6	4.2	3.0	4.4
New York							
Regulation	18.6	28.3	22.6	39.6	55.7	56.3	59.5
Spin	3.0	4.3	2.4	7.6	8.4	6.8	10.1
Non-spin	1.5	1.0	0.3	1.5	2.3	2.7	3.1
30 Minute	1.2	1.0	0.3	0.4	0.6	0.9	1.1
New England (Reg + "mileage")							
Regulation			54.64	30.22	22.26	12.65	13.75
Spin					0.27	0.41	1.67
10 Minute					0.13	0.34	1.21
30 Minute					0.01	0.09	0.06

Source: Brendan Kirby

regulation for firming wind output, even though it is several times more expensive than the other ancillary service (A/S) products (see Table 1). Allowing non-spinning reserve and supplemental operating reserves to firm wind, in combination with a short-term energy market, will decrease wind integration costs dramatically.

In the USA, about half of the load is served through deregulated markets operated by Independent System Operators (ISO's) or Regional Transmission Organizations (RTO's). Many of these markets operate short-term energy scheduling in the 5 to 15 min interval range. Energy markets that are not deregulated or organized through an exchange still serve a large geographical part of the country. These are generally bilateral markets or markets without an exchange where power can be bought and sold and generally consist of smaller balancing areas. Wind integration studies typically show lower integration costs for ISO or RTO markets than non-ISO/RTO markets (see Table 2).

Markets with frequently clearing intervals can reduce both costs and the amount of regulation needed, since a more frequent redispatch will enable these regulating units to return to their preferred operating point faster, and optimize the system more frequently. These markets will generally have a lower cost of integrating variable resources, and greater overall system efficiency.

Forecasts improve as you move closer to real time, and because of improved wind output forecasts, markets utilizing sub-hourly clearing markets also enable a better utilization of the renewable generation installed. They provide conventional generation with greater ability to adjust to changing wind conditions at the optimal system cost and efficiency. Sub-hourly clearing markets have the least total forecast errors, and can avoid situations where the entire market price is "lifted" due to the response required by reserve capacity or expensive regulation services.

Certain generator characteristics are very valuable in firming variable generation, such as quick start, fast ramping, high part- and full load efficiency. Currently there are very few US energy market incentives that reward a generator for having high ramp rate capabilities, or for having a faster start than that required by ancillary service markets for providing non-spinning reserve (currently 10 minutes). There is room for much improvement in future markets, both for cost optimization and efficiency gains, by recognizing the attributes and offering incentives for the use of new, modern generation fleets combined with sub-hourly clearing markets.

Flexible generation

Having a deep pool of flexible, quick, and efficient resources that can respond to both load variations and wind variations reduces the cost of system balancing, and helps increase system reliability. It also makes life a lot easier for the system operator who must continuously balance a system within certain parameters, like an ACE, Area Control Error, that measures the flow in and out of a balancing area over its interchanges to other areas. The ramping capability of this generation will be even more valuable in the future, as transmission construction may not keep up with increases in variable generation. The amount of flexible resources required will depend partly on the magnitude of the ramps resulting from the net load, which considers both the variation of load and wind output, and also on the balancing areas' ability to forecast the ramps. Flexible generation with high efficiency, low minimum load, quick start, and good ramping capabilities will be an important factor in accommodating large amounts of variable generation.

Future changes

Numerous industry working groups, task forces, and regulatory bodies across the USA are currently studying different aspects of integrating large amounts of variable resources, and Wärtsilä is participating in several of these groups. This integration will not only affect the issues discussed above, but also change the way long-term system planning is conducted. Historically, system planning has not considered the same level of quick start, fast ramping resources as may be needed in the future. Power system variability was addressed in resource planning studies by identifying an economic resource mix to meet a time varying load profile, and reserve and transmission planning by identifying a single loss of source requirements. Higher levels of variable generation will change future planning studies by integrating more variability or ramping requirements within the local area.

Gas engine benefits

The natural gas fuelled, lean-burn, medium-speed engine has high reliability, high efficiency, and low emissions, and power plants based on these engines have been optimized for absolute maximum flexibility. Gas engines are much more efficient running at part load than large combustion turbines, and have superior full load efficiency. A plant with multiple Wärtsilä gas engines enables plant owners to operate at a very low minimum plant output, with all of the generator sets in operation, to economically provide spinning reserve and energy. Wärtsilä spark ignited gas engines have an outstanding simple-cycle efficiency, and a gas engine plant will typically have a plant net heat rate of 8600 to 8700 Btu/kWh, HHV (depending on the specific engine choice), and will stay below 10,000 Btu/kWh, HHV even at half load. With a gas turbine, the heat rate increases dramatically at partial load.

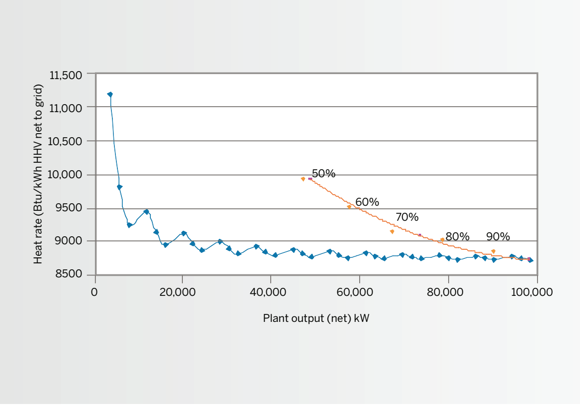


Fig. 1 – Efficiency mode vs spinning reserve mode for a 100 MW plant.

Through optimization for absolute flexibility, these plants have no derating at up to very high elevations or extremely warm ambient temperatures. This means there is full performance when really needed on a hot summer day. This is achieved using air-cooled radiators that consume virtually no water.

The engines can provide rapid response to system frequency variations. When required, the gas engine technology can supply grid voltage support through the generation of reactive power, and these plants also offer black start capability, all at a very competitive capital cost.

In the USA, such gas engine plants usually run in either of two modes; in spinning reserve mode, all the engines will be turned down, ready for ramping up as needed. In efficiency mode, only as many engines as needed to deliver the required power output will be dispatched at full load. This allows optimum plant efficiency to be maintained at any plant output, see Figure 1.

Most of these plants are set to achieve full output in less than 10 minutes from start order, and typically start producing power after about 2 minutes. Wärtsilä is now also offering start sequences that allow full synchronization from start order in 30 seconds, and full plant output in 5 minutes. These starts cause no additional wear on the engines, so there is no starting cost, no limitation on the number of starts per day, nor any minimum or maximum run times or down times.

To conclude, this is a growing market and we at Wärtsilä see a distinct role and market need, now and in the future, for *flexible power generation.*

Table 2 – Wind integration costs study results.

Date	Study	ISO/RTO	Wind capacity penetration	Integration cost: USD/MWh of wind output	Energy Market interval
3/05	NYISO	ISO/RTO	10%	Very low	5 minute
12/06	Minnesota/MISO	ISO/RTO	31%	USD 4.41	5 minute
2/07	GE/Pier/CAIAP[a]	ISO/RTO	33%	USD 0– USD 0.69	10 minute
3/07	Avista	No	30%	USD 8.84	1 hour
3/07	Idaho Power [b]	No	30%	USD 7.92	1 hour

Source: Brendan Kirby

(a) Includes two-thirds wind and one-third solar and includes cost increases of regulation and load following assigned to regulation.
(b) Reduced from USD 16.16 in September, 2007, settlement proceedings.

Fig.2 – Power plants based on Wärtsilä gas engines have been optimized for maximum flexibility.

REFERENCE: FLEXIBLE POWER GENERATION, USA

The 202 MW STEC power plant in Nursery, Texas.

THE WIND ENABLER

Wärtsilä currently has about 1600 MW of power output, either installed or under construction, in the USA. Many of these plants are dedicated to flexible utility generation. These plants typically run between 1000 and 4000 hours per year, and are owned by Investor Owned Utilities (IOU's), Municipal Utilities, and Independent Power Producers (IPP's). Some of the more recent major projects include:

- A contract signed in November 2009 with Golden Spread Electric Cooperative, Inc. (GSEC), a consumer-owned public utility in Texas. The 170 MW, 18 engine Antelope Station, near Abernathy, is to be located close to significant wind farm generation, and in addition to providing summer peak generation, will serve to stabilize the grid when the output from the wind farms changes unexpectedly.
- At the beginning of 2008, South Texas Electric Cooperative (STEC), a non-profit generation and transmission co-operative headquartered in Nursery, Texas, bought 24 gas engines from Wärtsilä for a 202 MWe gas-fired power plant. The plant is now in its final stages of completion and is scheduled to be fully commercial by April 2010. The plant will be connected to the ERCOT (Electric Reliability Council of Texas) grid and supply power and ancillary services to STEC's co-operative members. The plant is expected to run about 4000 hours per year.
- The first of the Plains End plants in Colorado was installed in 2002, with 20 engines and a total output of 111 MW. In 2008, Wärtsilä supplied 14 more Wärtsilä 20V34SG engines for a combined total output of 230 MW. The power is contracted to Public Service of Colorado, (Xcel) who uses the plant as a quick start asset for wind firming, the supply of ancillary services products, and for peak shaving.

These are but a few examples of the more recent plants being built in the USA based on Wärtsilä gas engines, but it is clear that this is a growing market for 200+ MW gas engine plants. Today, Wärtsilä has installed about 40 plants of varying sizes across the USA and Canada. With the development of these plants, bringing even more value to both markets and market participants, we expect more gas engines to be installed and to provide system support over the coming years.

Fig. 1 – Fortunately most faults in the electrical transmission system are intermittent in nature and involve only one or two phases and ground. Three phase permanent faults are very rare.

Dynamics of the low voltage ride through capabilities of generators

AUTHOR: Mats Östman, Senior Development Manager, Power Plants Technology, Wärtsilä Power Plants

The ability to support the grid during deep voltage transients caused by network disturbances depends on both the technical features and load of the connected generator, and the dynamic characteristics of the grid. This article looks at the issues involved.

Reciprocating engine sets with synchronous generators are well suited to the modern electrical grid, especially with the increasing penetration of renewable and distributed generation. Reciprocating engine based generation offers a number of inherent features, namely fast start-up and rapid loading times, an unlimited number of starts without service penalties, and great load following capabilities. These features, combined with a very high electrical efficiency in excess of 44% in electricity generation only or over 85% in CHP applications, make them very well suited to support, dynamically and economically, electrical grids. This type of generation is excellent in balancing natural fluctuations in the network from other →