GENERAL COMPRESSION
Dispatchable Wind

# MEMORANDUM

TO: Peter Spaulding, California Energy Commission

FROM: Carlos Pineda, General Compression

CC: Brian Tracey, General Compression

DATE: October 12, 2007

SUBJECT: WIND STORAGE ENHANCED COMMENTS

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General Compression Inc. appreciates the opportunity to provide written comments in response to the October 3 CEC PIER information workshop covering the topic of Wind Storage Enhanced Technologies on the Grid. In particular, we would like to address the following questions as posed in the workshop:

1. *What technologies are available and what is the best approach to feasibly couple storage to accommodate wind-generating resources on the grid?*
2. *What are the market, regulatory, business/corporate, contractual barriers and uncertainties?*
3. *What are the steps necessary to put to practice? Steps might include studies, interconnection concepts and demonstration projects.*

## 1. Available Technology: Dispatchable wind power system using compressed air

General Compression is the developer and manufacturer of the Dispatchable Wind Power System (DWPS). The DWPS is designed to feasibly couple intermittent wind energy resources with economically sound storage allowing for the generation of firm, reliable energy, capacity, and ancillary services. The DWPS will provide measurable economic value to California ratepayers and improve transmission and distribution (T&D) utilization, help manage intermittency issues, and add to resource availability.

General Compression's DWPS is a unique renewable power system that has the ability to surmount the reliability and affordability obstacles that conventional variable resources have yet to achieve. The DWPS is designed to provide electricity and capacity to the power grid as dispatched by grid operators. The DWPS is capable of providing firm energy and ancillary services and it also provides an opportunity to address existing intermittent resource issues, as it can be configured to firm-up existing wind farms' non-firm output profile. Conventional wind's non-firm output can be particularly difficult for grid operators and ratepayers, as some sites provide their lowest output during peak periods. This scenario presents supply problems for a control area operator, results in negligible capacity payments to wind farms, and ultimately increased costs for ratepayers. Integration of intermittent resources requires management from control area operators and the impact can reach close to $5/MWh and potentially higher as the level of wind capacity penetration increases in various Western subregions[1].

The DWPS integrates an advanced compressor array in the nacelle of a utility-scale wind turbine and produces high-pressure air that is directly stored in underground caverns or surface pipes at pressures up to 100 atmospheres. The compressed air is expanded on demand with the aid of a thermal energy source. DWPS can use different storage media for the produced compressed air, including high-pressure pipelines or geologic formations such as excavated salt caverns, depleted gas fields or porous aquifers. California has indigenous geology such as depleted natural gas fields and aquifers that would optimize the DWPS' reliability and operations. EPRI recently confirmed that California

[1] The total operating cost impact ($/MWh) includes regulation, load-following, unit commitment and gas supply costs. See slide 8 for a summary of numerous integration cost studies in the following: www.eere.energy.gov/tribalenergy/pdfs/course_wind_milligan1.pdf

possesses suitable geologic resources for CAES plants at the Fall 2007 Electrical Energy Storage Applications and Technologies (EESAT) Conference.

The DWPS requires release and expansion of the stored high-pressure air to produce electricity using conventional steam or combustion turbine generating equipment. The clean, compressed air must be heated in order to produce the expanded power output for a cost-effective system. The thermal energy can be added to the pressurized air from a variety of CEC RPS eligible fuel sources, including biomass, biogas, geothermal or solar resources to name a few. The first generation DWPS may also run on natural gas, creating a highly efficient system (from the perspective of natural gas consumption) with renewable energy running the compression cycle of the gas turbine. The heat addition results in a facility with a heat rate of approximately 4,000 btu/kWh making the DWPS the most fuel-efficient dispatchable generator in the supply resource mix. The emissions level of the DWPS will also be lower than any maximum permissible limits set related to the California Greenhouse Gas (GHG) Emissions Performance Standard (EPS) implementation.

The operational flexibility of a DWPS is also notable as utilities and control area operators must manage dynamic resource portfolios and heavily congested areas. The DWPS can address intermittency resulting from vintage wind farms and it can also optimize for future transmission topology. The DWPS can be configured to be a peaking, intermediate or baseload resource depending on customer needs, asset optimization requirements or operators' reliability preferences. The cost effectiveness, reliability and flexibility characteristics inherent to the DWPS make it a valuable resource for utility resource planners and allow it to compete favorably with fossil power plants on all three important characteristics.

**2. Potential market, regulatory, and contractual challenges**

The CEC information workshop provided an effective forum to exchange information related to an anticipated increasing capacity of intermittent resources on the California power system. In light of growing consumer awareness, new state Renewable Portfolio Standards (RPS) and tightening environmental targets, and increasing fuel costs, the demand for power production from renewable energy resources is sharply increasing in California and almost every other US state. At the same time, consumers, business leaders and policymakers alike harbor fears of potential negative consequences in adding new energy sources, rising prices in particular. In order to successfully satisfy the very real demand for clean energy supplies, and the fears that accompany such a critical need, we must find solutions with desirable consequences like driving economic expansion, initiating new job creation, and delivering price stability. For variable or intermittent renewables such as wind to demonstrate these positive outcomes and become truly mainstream, they must surmount the critical reliability and affordability obstacles.

Long term contracting will be necessary as a catalyst to advance the goals of the clean energy technology sector. The development of new renewable energy technologies is capital intensive and requires extensive financing in the capital markets. Power generation is particularly capital intensive requiring not only investment in factories, but in a company balance sheet healthy enough to provide guarantees and warranties on products. While renewable energy companies such as General Compression continue to be extraordinarily successful at tapping private sources of investment capital and focusing it on this sector, our counterparts in industry and government can help. Utilities can go "technology long" on off-take agreements for promising technologies under framework agreements laying out specific technology and project development milestones. Regulators can support the utilities in this effort by insuring that new technologies are captured in the evolving policy (RPS, AB 32) guidelines and that utilities that support new technologies receive a favorable viewing on these contracts.

**3. Opportunities for demonstration projects and follow-up**

General Compression intends to propose that one of its demonstration projects be based in California. We have embarked on discussions with utilities that may be willing to partner with us on such projects, providing off-take agreements, siting options, and other collaboration in the development process. Assistance that the CEC could provide in terms of siting facilitation, funding support, and utility

contracting participation would foster the most acceptable and timely demonstration project development.

General Compression greatly appreciates the opportunity to submit these comments to the CEC PIER on Wind Storage Enhanced Technologies on the Grid. Please contact General Compression if any questions arise from these written comments. General Compression would be willing to provide additional data and/or responses to additional inquiries if that would help the CEC's review effort. General Compression looks forward to participating in future PIER staff workshops and will monitor forthcoming Program Opportunity Notices (PON) related to this topic.