

### Optimizing your energy storage.

How to make the right moves at the right time, regardless of policy, technology or market forces.

### Energy storage has become a major factor in the grid.

Energy storage has a growing role to play in an evolving grid – not the least of which is the opportunity it provides for renewables to further penetrate the market and eliminate the need for peaking power plants.

This renewable penetration has been caused by decreasing costs along with increased carbon reduction and elimination policies leading to the retirement of fossil fuel generators. Today's overall generation mix is increasingly intermittent, requiring fast reacting generation. For the most part this has been supplied by quick ramping gas turbines, but batteries can also respond quickly.

Long-term, energy storage delivers opportunities via energy arbitrage, peak shaving and load leveling. Energy arbitrage can be particularly helpful when market conditions begin to show characteristics similar to the 'duck-curve' from excessive renewable generation in certain hours and not enough during some peak use times. Additionally, it enables operators to introduce non-spinning reserves into the mix or add black start capabilities. Energy storage also offers unique flexibility from a scalability perspective compared to traditional power plants. Having a larger number of small battery units spread out, as opposed to one large gas turbine, has the potential to reduce the need for transmission expansion.

In the short-term, it can improve power quality through ancillary services, such as frequency and voltage control. It can also assist in contributing to ancillary service markets or requirements, which can be an additional source of revenue.

### Where does it play in your portfolio?

There is not one player or stakeholder who can control what is happening with energy storage, or command a meaningful influence over the impact it will have on their region, business or investment.

Primarily led by battery-based technologies, energy storage is delivering profound benefits for many areas in the electric power sector. Question is, how to optimize? Because whoever captures the most value, will win in a complex and dynamic market.

The battery industry is evolving much like PV, with battery costs decreasing by 80% – from approximately US\$1,000/ kWh in 2010 to approximately \$227/kWh in 2016. At the current rate, that will mean between 2025–2030, battery pack costs will fall below \$100/kWh. By 2020, over 29.4 GW of new storage capacity is forecast to be deployed worldwide across all sectors.<sup>1</sup>

Big movers in the corporate sector include Daimler – which plans to invest \$1 billion in two large battery factories – and Tesla Motors, which of course, continues to make massive investments in its battery factory. Activities such as these will impact global utilities. Morgan Stanley projects market demand growth for energy storage will go from approximately \$300 million a year, to as much as \$4 billion in the next 2-3 years.<sup>2</sup>

<sup>&</sup>lt;sup>1</sup> Capgemini, World Energy Markets Observatory, 2017.

<sup>&</sup>lt;sup>2</sup> Stephen Byrd & Adam Jonas, Morgan Stanley, 'Energy Storage: An Underappreciated Disruptor' 5 February 2019.

Politicians and social awareness can supercharge energy storage. Witness the global PR generated in South Australia with Tesla's 100 MW lithium ion battery near Jamestown, a small town in the state's mid-north. New government backed schemes to increase residential use are there to endear voters, meet emission targets, and, in some instances, save the taxpayer from investing in upgrades to an old system.

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You would imagine that playing in the energy storage space would be a sure bet. However, the complexities involved with decision making for both the private and public sectors, with regard to investment, policies, technology selection, and pace of adaptation, require the ability to comprehend and manage very complex environments.

The focus needs to be on optimizing every decision to make the right move at the right time. For private interests, it can mean capturing new profit opportunities for each decision made. For governments, it is about ensuring global competitiveness compared with other nations and being a desirable place to run a business and live.

With the promise of reduced barriers to investment in the generation, transmission and distribution infrastructure, as well as reduced system operation and balancing costs, it is little wonder that energy storage is often referred to as the 'Holy Grail' of energy technologies.

WARNING

## Once you know you want to play in the energy storage space, how do you go forward?

#### The opportunities can be complex to identify.

Firstly, you need to have a picture of forecasted energy prices, which will be a function of forecasted demand, renewable generation, transmission constraints, and other variables.

Secondly, the ability to understand other revenue streams such as ancillary service contributions including load following and spinning reserve services is critical. As with any type of planning process, it is important to take uncertainty into account as well. While the analysis can be complex, the opportunities are there, and Energy Exemplar is the market leader in simulation software that provides powerful insights into complex market opportunities.

### And how will your investments in storage technologies justify themselves?

#### Energy Exemplar's software suite has functionality that can effectively analyze opportunities.

One of the most important features is the ability to develop market price forecasts which show what kind of revenue you could expect from an energy storage unit.

The platform produces expansion plans showing what type of resource mix could be expected in future years and how that would impact market prices in the long term. Nodal and sub-hourly modeling allows for detailed consideration of transmission constraints and ancillary service capabilities.

The platform provides ways to consider uncertainty introduced through stochastics. Stochastic capabilities allow for the introduction of randomly generated variables based on exogenous or endogenous sampling. Scenario management also allows for modeling and comparing various future scenarios and sensitivities. These techniques are essential in understanding the full range of possible outcomes from leveraging energy storage.

While the landscape is increasingly complex in the energy industry there are many opportunities present and Energy Exemplar delivers top of the line software that provides insightful takeaways in order to make informed decisions.

## It is important to recognize that not all decisions are created equal.

Energy Exemplar's simulation and modeling platform uniquely integrates electric power, gas, and water systems, co-optimizing each stream and underpinning the world's most bankable forecasting and planning decisions in the industry. Governments also use our technology to direct billions of dollars into their nations' energy futures with the utmost certainty, enabling them to confidently solve challenges ranging from power intermittency and loss of grid support due to fossil and nuclear plant retirements, to managing power grid ramping, and delivering operational flexibility.



### BELOW ARE THE KEY AREAS WHERE OPTIMIZING YOUR DECISIONS WILL CAPTURE TENS-OF-MILLIONS IN PROFIT, AVOID COSTLY ERRORS, AND PROVIDE NEW COMPETITIVE ADVANTAGES:

- Reduction in transmission network congestion
- Provision of reserve services and co-optimization of these services with energy provision
- Transmission and distribution network investment deferral
- Grid stabilization and intermittancy/transmission
  loss reduction

- Sub-hourly chronological unit commitment
- Bidding strategies
- Load leveling, energy smoothing and peak shaving for renewable sources.

For India, Energy Exemplar is forecasting with incredible accuracy what the impact of 175 GW renewables will be for 2022.

#### HERE'S HOW TO OPTIMIZE PROFIT CAPTURE AND OPERATIONAL PERFORMANCE FOR STORAGE:

- Model the optimal build-out for storage
- Accurately capture/predict costs overtime
- Plan for ancillary services to assign the storage plant with the right value
- Generate maximum revenue when the energy stream is variable, and account for how a specific market is set-up
- Model sub-hourly, to the minute or second, to optimize operational performance

- Model with laws, regulations, and subsidies in mind
- Understand how the unit is being compensated (i.e. subsidies) and incorporate it into modeling
- Effectively calculate the dropping price.

With the objective of minimizing cost while abiding by all constraints and capturing unique characteristics such as capacity degradation, the assets in any energy portfolio will be optimally committed and dispatched while meeting demand.

## Identifying short and long-term goals for maximum return.

With countless interactions going on, it is best to run hundreds of simulations to answer the questions more precisely and thoroughly. You can then select the right course of action that meets your exact needs.

Our software represents all types of energy storage technologies and identifies areas for profit improvement as well as total cost reduction. This includes the computation of savings from production costs, congestion charges and reduction in losses with short-term and long-term modeling.

#### SHORT-TERM APPLICATIONS

- Solve chronological unit commitment using sub-hourly resolution
- Optimize bidding strategies for energy time shifting
- Identify and evaluate revenue stream opportunities in the energy and reserve market
- Model renewable energy smoothing, peak-shaving, and load-leveling

#### LONG-TERM APPLICATIONS

- Carry out cost-benefit analysis of transmission and distribution network deferrals
- Assess potential benefits from reduced transmission congestion
- Model grid stabilization and transmission loss reduction
- Determine storage build-out
- Estimate long-term storage usage
- Forecast locational marginal prices (LMP)

Energy Exemplar software is being used to determine the roll-out pace for renewables across the EU for the greatest net benefit.

# Use your data to capture more profit and improve operational performance.

Our customers count profit in the tens-of-millions per decision made using our optimized simulations and models. Governments attract billions in investment based on our accurate forecasts, which uniquely combine stochastic analysis with unparalleled computing power.

To truly know that you have the best insights, trial our software free of obligation, to see the profound impact optimal decision making will have for you.

Our team of software and energy markets experts will help you see how valuable it is to run a multitude of highly accurate forecasts, allowing you to hone in on the one that benefits you the most.



Create as many 'what if' scenarios you need using real world data.



Hone in on the result you want and make the right decision at the right time, capturing new profit and becoming more operationally efficient.

# Join a global community of energy decision makers, influencers, and policy makers.

#### Compare your performance, gain peer support and invaluable new global insights.

The most important feature of our simulation and modeling software is the cohort of industry professionals and experts – 1500 users at 300 organizations in 52 countries – who continually make it the best it can be.

When you use Energy Exemplar software, you benefit from the direct input of customers and a global network of thought leaders, policy makers, regulators, utilities, researchers, consultants, universities, and OEMs across all markets.

This unique global community ensures that our products meet the demands and real world requirements of customers. It is the software that our customers helped to develop and now count on to make decisions influencing billions of dollars of investment, revenues, and mission critical facilities.

This is a truly invaluable network for all participants, made even stronger by our provision of regular opportunities for the Energy Exemplar community to meet. These include annual user group meetings in Europe, North America, and Asia Pacific.

We look forward to welcoming you soon.





### energyexemplar.com

APAC/Middle East Adelaide, Australia Ph: +61 8 8361 9312 EMEA London, United Kingdom Ph: +44 208 899 6500

General inquiries: info@energyexemplar.com Customer support: support@energyexemplar.com

#### Americas

Salt Lake City, Utah Ph: +1 208 255 3900