Balancing Power and Variable Renewables with Gas

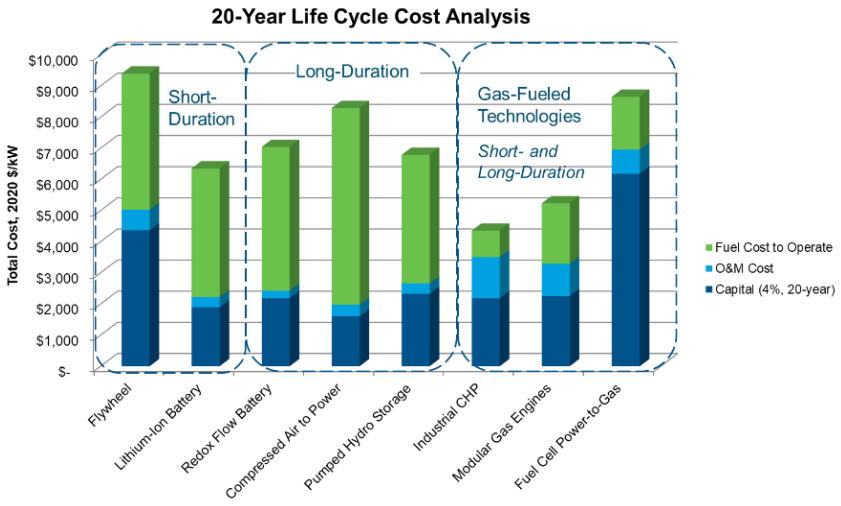
Flexible grid resources, such as natural gas and energy storage, can help manage the intermittency and variability of renewable energy resources, and minimize costs associated with a low-carbon power grid.

Planning for a High Renewable Energy Future

A low-carbon economy will be powered by an increasingly large share of renewable energy, specifically wind and solar. However, these renewable resources are inherently variable and uncertain since their output is weather dependent. In order to ensure system flexibility, utilities will need to balance the intermittent and variable energy output of renewables with other, more reliable, energy generation technologies whose power output can quickly ramp up or down. Gas and storage resources can quickly adjust their output to compensate for changes in renewable energy output and ensure a reliable & continuance balance between supply and demand.

Types of Flexible Grid Resources

Energy storage technology options are generally divided into two categories: short duration (< 4 hours) and long duration (> 4 hours). At the moment short duration technologies are more economically viable than long-duration technologies. There are also gas-fueled technologies, which tend to be more commercially viable than energy storage options.



Source: ICF, Energy Storage Comparison Analysis with Gas-Fueled Technology

Natural Gas as an Option for Flexibility

Long-duration energy storage technologies, which are a critical piece of a deeply decarbonized electricity system, are still in their infancy and too costly to deploy currently.[1] While grid-scale energy storage systems develop and become more cost-effective, utilities can use natural gas-fueled technologies to balance variable renewable energy output. Gas reciprocating engines have start-up times of about 3 to 5 minutes.[2] Additionally, gas-fueled technologies, such as industrial combined heat and power (CHP) and modular gas engines have the lowest lifecycle costs when compared to energy storage technologies. These technologies can also be fueled with renewable natural gas, providing the needed flexibility and greenhouse gas (GHG) reductions at the same time. In the future, these same technologies could be retrofitted to use hydrogen.[3] Existing natural gas infrastructure can also be used to support long-term storage of hydrogen and synthetic methane derived from

[1] Utility Dive, *DOE Initiative Seeks to Drop Long-Duration Storage Cost 90% in a Decade*, 2021
[2] Power-Gen International, *Mid-Sized Generation: Reciprocating Internal Combustion Engines or Combustion Turbine*, 2017
[3] https://www.2g-energy.com/products/hydrogen

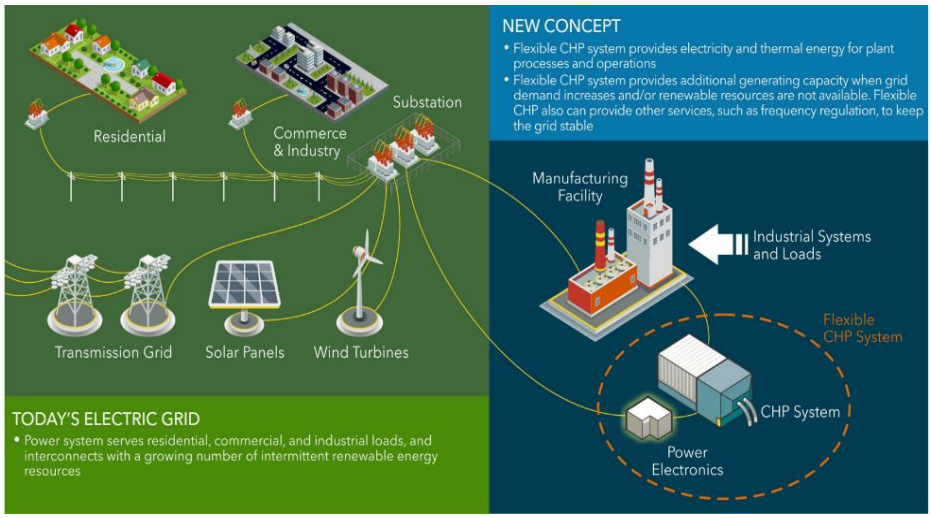
hydrogen, providing maximum utilization of renewable energy assets, and a cost-effective, reliable and resilient storage solution.

Flexible Grid Resources Minimize Cost of Decarbonization and Enhance Resiliency

While variable renewable energy resources are likely to play a large role in decarbonized electricity system, pairing these resources with flexible resources will minimize the cost of the low-carbon transition. Multiple studies of decarbonization scenarios have found that incorporating flexible grid resources that can provide power resiliency during periods of low renewable energy output will help reduce future electricity prices and save consumers significant amounts of money.[4,5]

Flexible Combined Heat and Power Systems

One way utilities can cost-effectively balance the intermittency of variable renewable energy is by leveraging CHP systems at small and medium manufacturers. CHP systems at industrial facilities can be especially lucrative for these small and medium manufacturers if they are sized to provide grid services, providing a win-win for both industrial facilities and grid operators.



Source: DOE, Flexible Combined Heat and Power Systems

Reciprocating engines can reach full load within 3-5 minutes[6]

Incentivizing Flexibility on the Grid

Flexible resources and capacity to balance variable renewable energy output can be incentivized through capacity and ancillary service markets that are technology agnostic. Capacity markets are forward looking markets "aimed at driving capacity investments three to five years ahead of when power needs to be delivered."[7] Ancillary service markets help maintain the flow of electricity and address imbalances between supply and demand. There is an opportunity for governments and utilities to provide additional incentives for customer-sited resources that take into account the grid balancing services these resources offer.

[4] Progress in Energy, *Role and Value of Flexibility in Facilitating Cost-Effective Energy System Decarbonization*, 2020
[5] Joule, *The Role of Firm Low-Carbon Electricity Resources in Deep Decarbonization of Power Generation*, 2018
[6] Power-Gen International, *Mid-Sized Generation: Reciprocating Internal Combustion Engines or Combustion Turbine*, 2017
[7] Energy Sector Management Assistance Program, *Bringing Variable Renewable Energy Up to Scale*, 2015