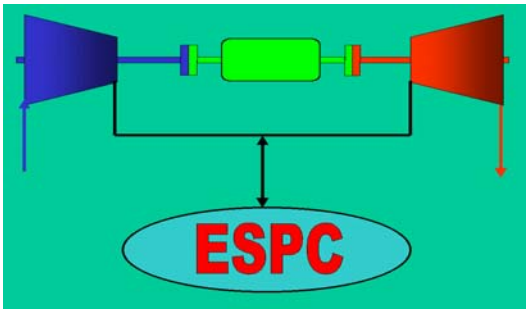
150, 300, 400 MW CAES Plants Based on Various Combustion Turbines

ESPC developed and patented a number of novel CAES plant concepts that are highly scalable and provide power generators with a number of practical and cost-effective choices and high degree of flexibility to meet variety of specific operational, economic and off-peak and peak loads and conditions to accommodate wind and other renewable energy requirements. These concepts are based on various combinations of the major standard off - shelf components- existing or new combustion turbines, air compressors, air expanders and heat recovery recuperator - all integrated with a compressed air storage and optimized for specific operational, economic and geological conditions.



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ESPC's Unique Experience in the CAES Technology

Engineering, Construction, Tests and Operations of the 110 MW CAES Projects -The Only CAES project in the USA

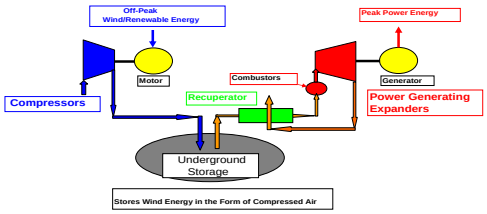
The Compressed Air Energy Storage (CAES) technology is the only technology that is capable of providing energy management in the range of thousands MWh- i.e. the energy storage during off-peak hours and energy generation during peak hours when the energy is needed and price is high.

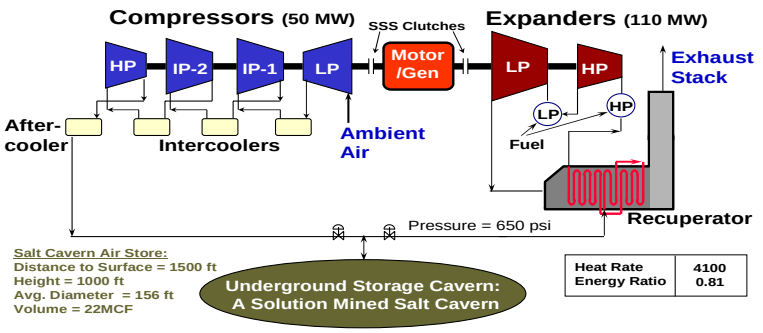
The simplified schematic (below) illustrates its CAES plant Major features:
During off-peak hours motor-driven compressors (blue component on the left) utilize the wind or a any other renewable energy and store it in the form of compressed air in underground reservoir
During peak hours the stored air is extracted from the storage, preheated and generates peak power by air expanders (red component on the right).

Alabama Compressed Air Energy Storage Plant
Peak Power 110 MW; 26 hrs of continuous Power Generation; Heat rate is 4000 Btu/kWh; Off-Peak Power 51MW, Capital Cost $600/kW

Schematic for AEC CAES Plant (110 MW – 26 Hour)

Simplified Schematic of CAES Plant





The significant interest in the CAES power plants is driven primarily by very extensive developments of the wind and other renewable resource projects and by the current emphasis on the coal/nuclear power plants (associated with very high current fuel/NG costs) – all requiring a significant load management.

ESPC is the only company that was involved in all stages of execution of the 110 MW CAES project- the only CAES project in the US - including the feasibility study, detail engineering, construction, performance tests and first three years of operation.

Electric Power Research Institute is very active in promoting of the CAES technology and co-sponsored the 110 MW CAES project for Alabama Electric Cooperative.

ESPC has five patents on the CAES technology- some of them were applied for the AEC CAES project .

Below is the ESPC team receiving EPRI's Award for Outstanding Performance in the execution of the 110 MW CAES project.

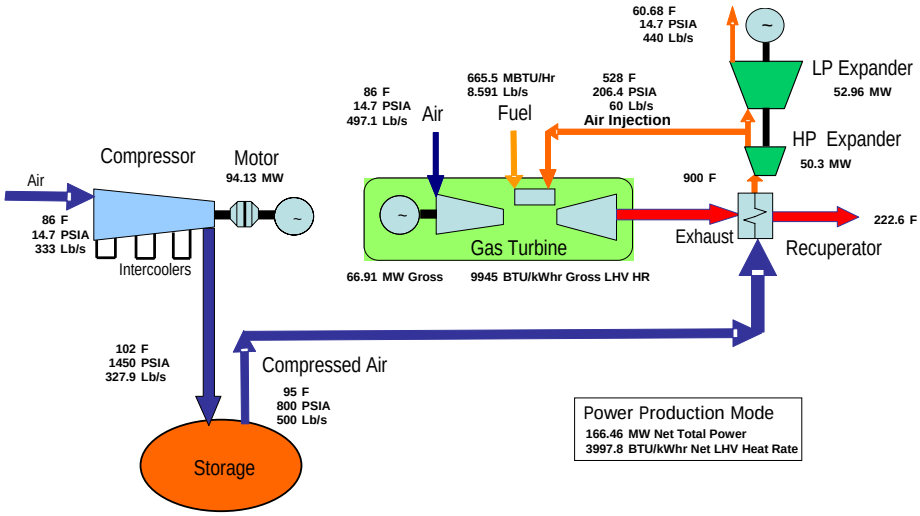
150 MW CAES Plant

Based on Novel Concepts Developed by ESPC

ESPC offers a number of approximately 150 MW CAES plant concepts based on specific economic, operational and ambient conditions based on “F” type of combustion turbines. Though the examples below are based on GE7211B combustion turbine they could be applied other “B” or similar type combustion turbines.

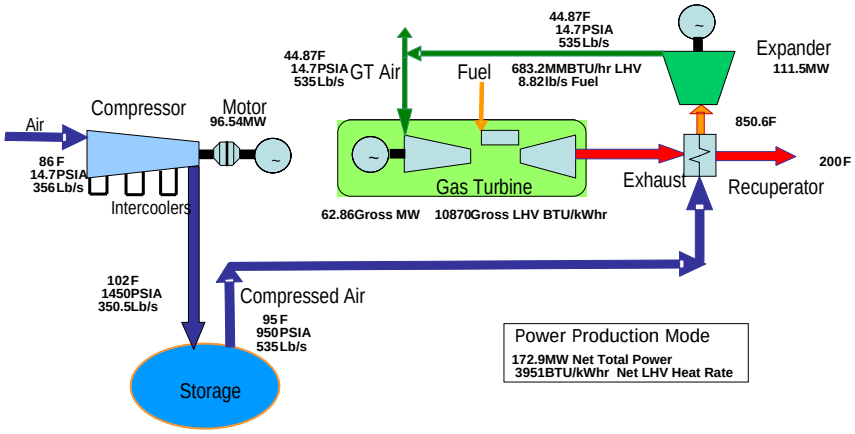
The novel CAES-AI Concept with the Bottoming Cycle is based on GE 7211B combustion turbine, and has the total power of approximately 170 MW and the fuel related heat rate of approximately 3800 Btu/kWh and that is approximately 40% of the heat rate (60% less fuel) of a combustion turbines and 60% heat rate (40% less fuel) of a combined cycle power plants.

CAES-AI with Bottoming Cycle



The novel CAES-AI with Bottoming Cycle & Inlet Chilling concept is based on GE 7211B has total power of 175 MW with similar to the above CAES-AI concept the fuel related heat rate of approximately 4000 Btu/kWh. This concept, due to the inlet chilling of the combustion turbine, is very effective in high ambient temperature regions.

CAES with Bottoming Cycle & Inlet Chilling



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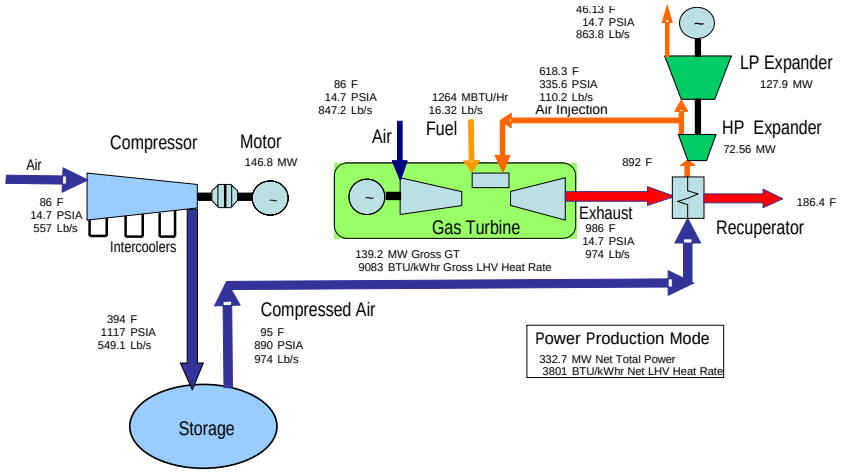
300 MW CAES Plant

Based on Novel Concepts Developed by ESPC

ESPC offers a number of 300 MW CAES plant concepts based on specific economic, operational and ambient conditions based on “F” type of combustion turbines. Though the examples below are based on GE9171 E combustion turbine they could be similarly applied other “E” or “EA” combustion turbines.

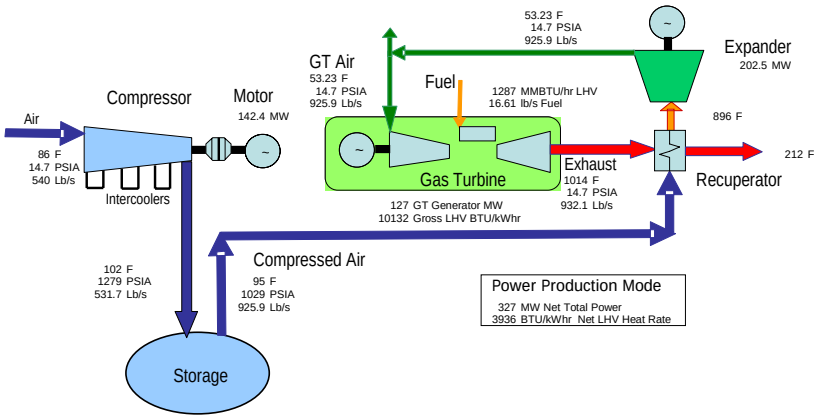
The novel CAES-AI Concept with the Bottoming Cycle is based on GE 9171E combustion turbine, and has the total power of approximately 333 MW and the fuel related heat rate of approximately 3800 Btu/kWh and that is approximately 40% of the heat rate (60% less fuel) of a combustion turbines and 60% heat rate (40% less fuel) of a combined cycle power plants.

CAES-AI with Bottoming Cycle



The novel CAES-AI with Bottoming Cycle & Inlet Chilling concept is based on GE 9171E and has total power of 327 MW and has the fuel related heat rate of approximately 4000 Btu/kWh. This concept, due to the inlet chilling of the combustion turbine, is very effective in high ambient temperature regions.

CAES with Bottoming Cycle & Inlet Chilling



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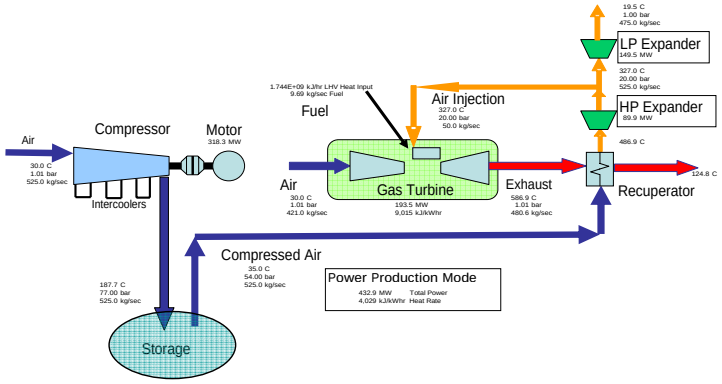
400 MW CAES Plant

Based on Novel Concepts Developed by ESPC

ESPC offers a number of 400 MW CAES plant concepts based on specific economic, operational and ambient conditions based on “F” type of combustion turbines. Though the examples below are based on GE7241FA combustion turbine they could be similarly applied other “F” combustion turbines.

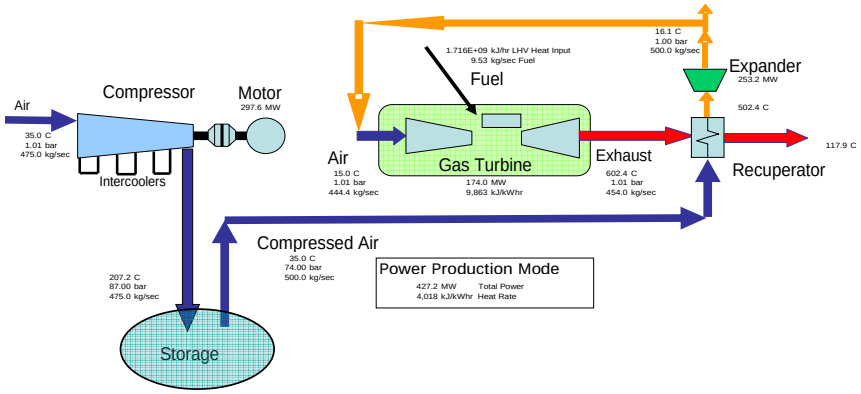
The novel CAES-AI Concept with the Bottoming Cycle is based on GE 7241FA combustion turbine, and has the total power of approximately 433 MW and the fuel related heat rate of approximately 4000 Btu/kWh and that is approximately 40% of the heat rate (60% less fuel) of a combustion turbines and 60% heat rate (40% less fuel) of a combined cycle power plants.

CAES-AI Based on GE 7241with Bottoming Cycle



The novel CAES-AI with Bottoming Cycle & Inlet Chilling concept is based on GE 7241FA has total power of 427 MW with similar to the above CAES-AI concept the fuel related heat rate of approximately 4000 Btu/kWh. This concept, due to the inlet chilling of the combustion turbine, is very effective in high ambient temperature regions.

CAES-AI with Bottoming Cycle & Inlet Chilling



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ESPC with its subcontractors is delivering CAES projects on EPC basis.

Estimated specific costs of the overall project including underground storage is approximately $550/kW. Delivery time is approximately 24 months, primarily controlled by a combustion turbine delivery

These concepts are based on various combinations of the major standard off – shelf components- existing or new combustion turbines, air compressors, air expanders and heat recovery recuperator – all integrated with a compressed air storage and engineered for specific operational, economic and geological conditions.

ESPC has a number of qualified EPC contractors for delivery of CAES projects with typical warranties and guaranties and with typical commercial terms.

As it relates to the selection of a combustion turbine, customers have a choice of selection a Combustion turbine based on their preferences and ESPC will design/engineer the CAES plant based on the selected combustion turbine. These h&m balances are based on GE7FA, GE 7EA and GE 7B CTs for 400 MW, 300 MW and 150 CAES plants respectively

Other suppliers of typical components include but not limited to:
Air Compressors: MAN Turbo, Dresser-Rand, and Ingersoll-Rand
Turbo-Expanders: MAN Turbo, Skoda, Atlas Copco, and Hitachi
Recuperator: RGP Engineering, Nooter/Eriksen, Deltech, and BHEL

The novel CAES plant concepts move CAES technology towards lower capital costs, shorter delivery times, and higher operational flexibility.

EPRI validated novel ESPC concepts and jointly with ESPC presented them to a number of utilities/power generation companies in the US.

ESPC is involved in a number of CAES projects based on the novel CAES concepts that are in various stages of development: the 300 MW project in Shanghai area, China is in relatively advanced stage;170-300 MW project for a NY utility, and several projects in Europe.

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