The combined cycle, 60 years and counting,

Most technologies develop in essentially the same way: A capable "tinkerer" gets an idea, does a little thinking, heads for his or her workshop, and starts fiddling. Think of Thomas A Edison here. If something promising develops, an engineer or scientist often refines the idea, and real-world tests are conducted. Successful tests bring on members of the Gucci-shoe clan offering their "help."

It hasn't happened quite that way in the electric power industry since Edison's time. "Developments" in this industry for the last century typically have been "refinements" of successful ideas and hardware, or the application of proven technologies from other industries.

Consider the development of the combined cycle—"evolution" might be a better word. The world's first industrial gas turbine (GT) was installed by Brown, Boveri & Cie 70 years ago to supply the city of Neuchatel (Switzerland) electric power. Efficiency of the 4-MW machine was 17.4%. The fact that there was little snow to shovel in the vicinity of this plant evidently set the Btu-chasers to work.

The first GT for generating electric power here was installed in a combined-cycle arrangement at Oklahoma Gas & Electric Co's Belle Isle Station in June 1949 (Fig A). Exhaust from a 3.5-MW engine developed by General Electric Co was used to preheat feedwater for a conventional 35-MW steam/electric unit until the plant's retirement in 1980. The relatively few combined cycles installed in the US before the late 1960s involved the integration of GTs with conventional boilers. Most often, the gas turbines were substituted for forced-draft fans.

It wasn't until economic finned-tube production emerged in the late 1950s that efficient integration of the Brayton and Rankine cycles was possible. At first, the use of finned-tube heat-recovery steam generators (HRSGs) dominated in the chemical and refining industries, which needed both steam and electricity. One advantage of the GT/HRSG cogeneration system was that it eliminated many auxiliaries needed for a conventional fired-boiler/steam-turbine arrangement.

The first pre-engineered combined cycle for electric generation known to the editors began commercial operation at Wolverine Power Supply Cooperative Inc, Cadillac, Mich, in 1968. It is still in service (Fig B).

The 21-MW single-shaft unit, powered by a GE Energy Frame 5, was transitioned from base-load to peaking service in 1998, not having operated for periods between 1985 and 1998 because of economic reasons. Evidence that at least some GTs, like fine wine, get better with age: The unit now delivers more than 24 MW. It has approximately 144,000 hours of service and 1100 starts.

GE's pre-engineered combined cycles are known by the acronym STAG™ (for STeam And Gas). The first four STAG units were single shaft and powered either by a Frame 3 or Frame 5 GT; they all were in service before the end of 1972.

It was obvious that the market leader's pre-engineered combined-cycle idea was a good one. In 1970-1971, Westinghouse Electric Corp (now Siemens Energy Inc), Turbo Power & Marine Systems Inc (now Pratt & Whitney Power Systems), Turbodyne Corp (now part of Dresser-Rand), and Stone & Webster Engineering Corp (now part of The Shaw Group Inc) all announced their versions of a pre-engineered combined cycle.

Westinghouse's offering was called PACE, TPM's Turbo Steam Pac, and S&W's FAST. Each had a distinguishing feature. For example, FAST was completely air-cooled; TPM's FT4-2s exhausted to conventional Babcock & Wilcox Co boilers

A. The first GT for generating power in the US was removed from host Bell Isle Station in 1980, preserved for display at GE Energy's Schenectady campus, and dedicated a National Historic Mechanical Engineering Landmark by ASME on Nov 8, 1984

Wolverine Power Supply Co-op

B. Wolverine Power Supply Cooperative Inc's STAG 105 looks almost new after 41 years of service. Moving from left to right: steam turbine, generator, load gear, vertical exhaust transition from the gas turbine to the heat-recovery steam generator and stack, and the GT package further down. Bolted flange in lower left-hand corner is part of the condenser