

Are traditional O&G specifications hampering your energy transition project's economics?

Five factors to consider when specifying your compression needs

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The energy transition represents significant opportunities to transform the entire energy value chain but will require new business approaches to make project economics work. Because those economics often depend upon tax incentives, a project's initial CAPEX takes on increasing importance. That's why energy-transition projects should tailor their specifications and procurement procedures to the requirements of their project rather than using ones designed for other industries, such as petrochemical and oil and gas, which have different business drivers and as a result, make manufacturing compressors more costly and time-consuming.

The evolving role of compressors in the energy transition

As the world shifts toward cleaner energy

sources and aims to reduce greenhouse gas emissions, industries face increasing pressure to decarbonize their operations. Industrial compressors, essential in sectors like manufacturing, petrochemicals, and energy production, play a pivotal role in this transition.

The energy transition is significantly impacting the demand for industrial compressors, necessitating innovations and adaptations in compressor technology to meet new requirements. It is also compelling businesses to rethink their approaches to energy consumption and efficiency.

Decarbonizing the highest CO₂-emitting industries

Public and private sector engagement and cooperation are critical in driving this transformation. The U.S. Department of Energy's (DOE) Industrial Decarbonization

Roadmap highlights the importance of targeting the highest CO₂-emitting industries, including petroleum refining, chemicals, iron and steel, cement, and food and beverage.

According to the DOE, these sectors account for 51% of energy-related CO₂ emissions in the U.S. industrial sector and 15% of the U.S. economy-wide total CO₂ emissions. To abide by the Paris Agreement and keep global warming to no more than 1.5°C, carbon emissions must be reduced 45% by 2030 and reach net zero by 2050. Effective decarbonization technologies within these industries could significantly reduce overall emissions, underscoring the importance of industrial compressors in achieving these goals through compressing CO₂ for sequestration or transport.

New thinking, new approaches required

As companies navigate the complexities of the energy transition, they often consider substantial investments in technologies, processes, and business models that may lie outside their traditional business scope. Strategies that worked for conventional projects may not be the best solutions for the energy transition.

Critical factors such as CAPEX, project

execution certainty, project lead time, and reliable & safe operations remain essential in project development. This raises an important question: Are there alternative approaches to specifying critical-duty compressors that can enhance my energy-transition projects?

Evolving needs: The crucial role of compressors in modern industry

Compression equipment is at the heart of any process plant's operations because it delivers the muscle moving gases through miles of piping, through reactors, for underground injection, etc. Process conditions can differ greatly and necessitate unique aerodynamic and rotor-dynamic designs tailored to the specific characteristics of the gas being compressed. Due to the complexity of the process and the value of the products produced, availability and reliability can be the most critical requirements.

In many cases, API standards serve as the foundational specifications for compressors, with individual companies adding practices and specifications unique to their product design and industry experience. In addition, engineering procurement companies (EPCs) that procure machines or build solutions for end-users typically have their own unique documentation and inspection requirements.

ETO versus CTO for energy-transition projects?

Such customization results in compressor offerings being engineered-to-order (ETO), optimizing them around specification compliance. In short, an ETO compressor package is a highly customized, bespoke product that is designed, engineered, and built by a manufacturer to meet an individual customer's requirements and specifications, while also adhering to the manufacturers own internal standards for performance, availability, reliability, and serviceability. Generally, ETO costs are not scalable, given the degree of customization involved.

In contrast, when compressor packages are configured-to-order (CTO), a manufacturer can adjust its base design to

the application requirements based on its internal standards, often saving a customer CAPEX and time because manufacturing costs and processes can be more scalable costs, such as standardized engineering, manufacturing, testing, and documentation as well as using in-stock components and materials.

The difference between ETO and CTO compressor solutions in terms of the latter's CAPEX and time savings can be substantial as we illustrate later in this article. In our experience with a growing number of energy-transition projects worldwide, CTO solutions can be plenty suitable for many, if not most, energy-transition projects and still provide the high availability and reliability their operations require.

Balancing customization and cost

As readers will know, engineered-to-order (ETO) compressor packages offer significant customization, but they come with higher design and manufacturing costs, longer lead times, and more complex supply chains. Here's what's at stake:

■ **Higher upfront costs:** ETO projects typically incur higher upfront costs due to extensive engineering and design efforts. Customization requires specialized work, which is inherently more expensive. Detailed requirement gathering, specialized design, and resource planning contribute to these higher costs.

■ **Customization time:** The development time for ETO compressor package is longer because each one is unique. The design phase includes gathering specifications, creating blueprints, and ensuring alignment with customer requirements. This comprehensive approach ensures the final product meets the exact needs of the customer but extends the project timeline.

■ **Resource planning:** Developing a comprehensive resource plan for ETO projects takes considerable time. Ensuring the availability of materials and manpower, plus putting complicated manufacturing processes to work adds to the project timeline, further contributing to the overall cost and complexity.

In contrast, a compressor built to an

OEM's standards using a CTO solution will often result in a much more cost-effective solution without sacrificing safety or reliability. Today's CTO compressors optimize aerodynamic, rotordynamic, mechanical design, and materials to ensure the highest levels of availability, performance, and serviceability.

Where customization is often specified is in areas around the compressor. Adopting an OEM standard for a CTO compressor package can result in:

■ **Lower upfront costs:** CTO designs reduce engineering and design costs as companies can reuse existing templates, avoiding the need for extensive customization. This results in lower upfront costs compared to ETO projects.

■ **Manufacturing efficiency:** CTO compressor solutions use standard designs, stock materials, standardized manufacturing processes, and internally approved vendors, all resulting in reduced production time and costs.

■ **Project cycle times:** CTO designs significantly reduce project development and delivery time. The ability to use standard engineering designs allows companies to reduce the basic design phase, accelerating the process and enabling faster project completion. It also reduces multiple iterations of clarifications, drawing revisions, and delays due to communications and reviews with client-mandated, third-party vendors.

■ **Procurement and stock management:** Applying type approval and frame agreements optimizes planning and ensures adequate stock materials and procurement through approved vendors with which the CTO manufacturer has frame agreements. This simplifies procurement processes and saves time and resources, contributing to overall project efficiency.

Five factors to consider when choosing the right compression solution for energy transition projects

The choice between ETO and CTO compressor packages depends on the balance between high customization needs and project efficiency goals. As mentioned, »

COMPRESSOR COST CONTAINMENT

ETO FACTORS AFFECTING COSTS AND LEAD TIMES	IMPACT DESCRIPTION	CTO POTENTIAL COST SAVINGS	CTO POTENTIAL LEAD-TIME SAVINGS
#1 Design criteria not applicable to the service	Restrictions on aerodynamic, rotordynamic, mechanical design, and/or materials specified aimed at adding reliability can be overkill for the applications (e.g., limits on tip Mach #, tip speed, flow coefficients, impeller construction methods, yield stress, etc.).	5-10%	0-4 weeks
#2 Unique package specifications <i>(e.g., on-skid piping/wiring, auxiliary systems)</i>	Specific requirements for wiring, piping, valving, paint, sub-suppliers, component redundancy, component placement, etc., add both time and cost in engineering and packaging in compressor train skid design/size, seal gas panels, and lube oil systems.	5-8%	3-5 weeks
#3 Mandated sub-vendors	This includes sub-vendors for control panels, GBs, drive systems, auxiliary systems, instrumentation, and valves.	4-8%	0-4 weeks
#4 Customized documentation	All required information is contained in the standard drawings and documentation, but customizing the documents to meet a specific format will introduce costs, time, and potential errors.	2-5%	4-6 weeks <i>(for final ETO documents)</i>
#5 Inspection & test plan	Witness and hold points, mechanical/performance test protocols (e.g., Type I test, string test, etc.) all add cost and time to compressor builds.	2-10%	4-12 weeks

many process plants almost reflexively use API standards along with extensive internal specifications for compressors, motors, auxiliary systems, and steam turbines – using those standards to define various aspects of the machinery as well as documentation and testing requirements. Then, EPCs may add their own requirements.

While some compression applications and user scenarios may require those specifications, many others may not. To help readers decide, the following table defines five factors that impact the costs and time of ETO compressor packages and should be considered. Importantly, it offers some ranges of each factor's cost and time savings if a CTO compressor package is chosen, based on the experience of Siemens Energy's compression industry experts.

Conclusion: CTO compressor packages can save substantial CAPEX and time for energy transition projects

As the table shows, these five factors can be primary cost drivers in ETO compressor solutions. Conversely, a CTO compressor solution can offer significant CAPEX and time savings while also providing more than sufficient performance, availability, and

reliability for a particular energy-transition application or use case.

While the potential time savings would not necessarily be arithmetically cumulative because the activities would likely occur on concurrent tracks, the potential cost savings can be significant, thereby ranging from 10-30%. Coupled with some degree of time savings of, say, 4-12 weeks, such cost savings should be reason enough for end users and EPCs involved in energy-transition projects to consult with their compressor suppliers on whether an ETO or CTO compressor package will best suit their specific requirements.

Deciding between ETO and CTO compressor packages depends on a careful evaluation of customization needs versus capital-efficiency goals. Clearly, ETO packages offer tailored solutions that meet specific requirements and have their place in compression solutions. At the same time, CTO packages can provide significant cost and time savings through streamlined processes and reusable designs.

Balancing the tradeoffs between these two approaches is essential for achieving successful economic outcomes in energy transition projects, ultimately contributing to a more sustainable industrial landscape in the years ahead.

HOW A CTO APPROACH COULD HAVE REDUCED COSTS BY ≈10% FOR A RECENT CO₂ PROJECT REQUIRING SINGLE-SHAFT COMPRESSORS

In a recent CO₂ project for single-shaft compressors, where ETO specifications were applied by the end user, the following cost increases occurred:

- Auxiliary systems cost increased by ≈25% resulted in **an overall project cost increase of 3%**.
- Additional engineering and project management required for spec compliance resulted in **an overall project cost increase of 7%**

CONCLUSION: If the customer had taken a CTO approach, the project could have realized an approximate 10% cost reduction, without compromising industry standards, safety, or reliability.

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