# PLANT SERVICES

2024 eBOOK

Smart Solutions for Reliable Operations

## TECHNOLOGY DRIVES INDUSTRIAL SUSTAINABILITY

Sustainability and energy transition are no longer a choice for industry, with greenhouse gas emissions net zero targets on the horizon. The government is helping industry make this transition, helping to develop the technology and programs to decarbonize at scale. Many manufacturers have made significant progress, and we've highlighted a number of those companies here. This ebook also focuses on:

- **some the technologies already in use to measure and improve industrial sustainability**
- **how to design the most efficient compressed air system (industry's fourth utility, a significant energy consumer and inherently inefficient)**
- **the current state of U.S. industrial policy and efforts toward a government-supported, industry-led energy transition.**

# DEPARTMENT OF ENERGY DRIVES NEW U.S. INDUSTRIAL POLICY

Commercializing the energy transition will take government and industry working together

Written by

**Anna Townshend**
Managing Editor

The second-day keynote at the annual ARC Industry Forum 2024 focused on sustainability and commercializing the energy transition. Andrew Obin, managing director at Bank of America Securities Equity Research, outlined the current state of U.S. industrial policy, and Katheryn Scott, market analysis engineer, U.S. Department of Energy, Office of Energy Transitions, outlined DOE's plans for a government-enabled, private sector led energy transition.

### THE U.S. INDUSTRIAL POLICY

Andrew Obin, managing director at Bank of America Securities Equity Research, said, "The U.S. does now have industrial policy." Prior to the pandemic, the U.S. spent 0.4% of its gross domestic product (GDP) on industrial policy. Now, it's spending 2.8% of GDP, thanks largely to $1.8 trillion of stimulus in the Inflation Reduction Act.

The money is designed to peak in 2026 and run through 2031, and designed to be "sticky," Obin said. He added that, if the legislature changes leadership soon, proposed Republican cuts to the program only amount to 20%, including tax incentives, and the stimulus largely supports projects in red leaning states. Regardless of Congressional leadership, the funding should stick around, Obin predicted.

Bank of America estimates that industry will need $2.4 trillion of capex to meet net zero goals. "Reducing carbon footprint is actually very much the same as increasing efficiency. If you become more efficient, you will reduce your carbon footprint," Obin said.

Government is also pushing carbon reduction. In March 2022, the Securities and Exchange Commission proposed rule changes requiring certain climate-related disclosures in registration statements and periodic reports, including greenhouse gas emissions, Scope 1, Scope 2 and Scope 3. "We actually think, probably given what Scope 3 means, it's probably not going to happen the way it's envisioned just because the regulatory burden is going to be too much," Obin said.

Katheryn Scott, market, analysis engineer, U.S. Department of Energy, Office of Energy Transitions.

His outlook is positive about industry's ability to meet the net zero goals long-term. "I think the good news for the industry is that you already make the equipment and software, and it's probably one where there will be winners and losers. But the industry makes all of these products already," he added.

Obin's central message: sustainability equals capex, "and the government is very much in the driver's seat," he said. "It's going to happen this decade, whether you like it or not."

**WHERE IS GOVERNMENT DRIVING?**

Next up for the keynote was someone with some insight into governmental industrial policy and government plans to help industry decarbonize. Katheryn Scott, market, analysis engineer, U.S. Department of Energy, Office of Energy Transitions, was very happy to hear Obin's report on the government funding sticking around long-term.

"We are working so hard every day at the Department of Energy [DOE] to get those subsidies started and rolling, and that's really what I'm here to talk about is the plan that we've been creating, of how to use these subsidies to decarbonize the industry," Scott said. While DOE has billions of dollars of grants, cost shares and loan guarantees, net zero goals will take trillions of dollars, and it will need private-sector industry support.

"We've been really scrappy at the Department of Energy and thought about this as a government enabled, but private sector led energy transition," Scott said. She is part of DOE team that is leading this transition, researching the technologies available and what's needed, and talking with industry about how they want to tackle decarbonization.

In addition to the money available, DOE has released, "Pathways to Commercial Liftoff: Industrial Decarbonization," focused on eight industrial sectors: chemicals, refining, iron and steel, food and beverage, pulp and paper, cement, aluminum and glass. The report considers technologies for energy efficiency, industrial electrification, low-carbon energy, such as alternative feedstock, electrolytic hydrogen, and clean, on-site power, carbon capture utilization and storage (CCUS). "There are technologies ready in every sector," Scott said. "These are deployable technologies that are ready to be commercialized, and they have net positive economics, so we define that as above a 10% rate of return."

> **I think there's an opportunity here for United States businesses to take decarbonization and emissions reduction and put their companies in the driver's seat**
>
> [ Katheryn Scott, Market, Analysis Engineer, U.S. Department of Energy, Office of Energy Transitions ]

She does acknowledge the challenges for industry: market readiness, adoption rates, high delivery cost, and complex adoption. But DOE is stepping up – it has $90 billion worth of grants and cost share programs and $6 billion of industrial demonstrations that will be awarded in the next few months. "Section 48C" tax credits also are available for investment in advanced energy projects; DOE just closed its first round of $2.5 million, and another $2.5 million will be available later this year, Scott said.

"I think there's an opportunity here for United States businesses to take decarbonization and emissions reduction and put their companies in the driver's seat," she added.

**PANEL DISCUSSION: SUSTAINABILITY STARTS AT HOME**

Billy Bardin, director, global climate transition at Dow Inc., and Nathalie Marcotte, senior vice president at Schneider Electric, both outlined how their companies have long been working on their own sustainability goals in prelude to helping their customers do the same. It was clear that sustainability starts from the top-down, and company success depends on executive leadership dedicated to a net-zero future.

Dow will start work on a $6.5 billion net-zero ethylene cracker and derivatives facility at Fort Saskatchewan in Alberta, Canada, decarbonizing 20% of Dow's global ethylene capacity.

Schneider Electric started on its sustainability journey 10 years ago with its own digital transformation of its manufacturing facilities around the world. Making sustainability and digital transformation synonymous were key for advancing both missions, Marcotte said.

"We do have strong leadership support in our company, both from our CEO, executive leadership, as well as our board of directors. We see increasing demand from our investor community, from our customers and clients that decarbonization is important," Bardin said. "There is a way to do this profitably." Dow has demonstrated this with the strong business model and economics around its net-zero facility.

Caption...

"We've implemented a governance structure within the company that established a climate steering team, which is basically accountable to our CEO. That's our senior leadership team, and underneath that climate steering team, we have program management offices that are accountable for executing our climate transition work, whether that's Scope 1 or Scope 2 reductions, Scope 3 reductions, working on how we monetize the carbon reductions that are generated or looking at our metric systems and reporting areas that have a lot to do with the digital/data side of the architecture," Bardin said.

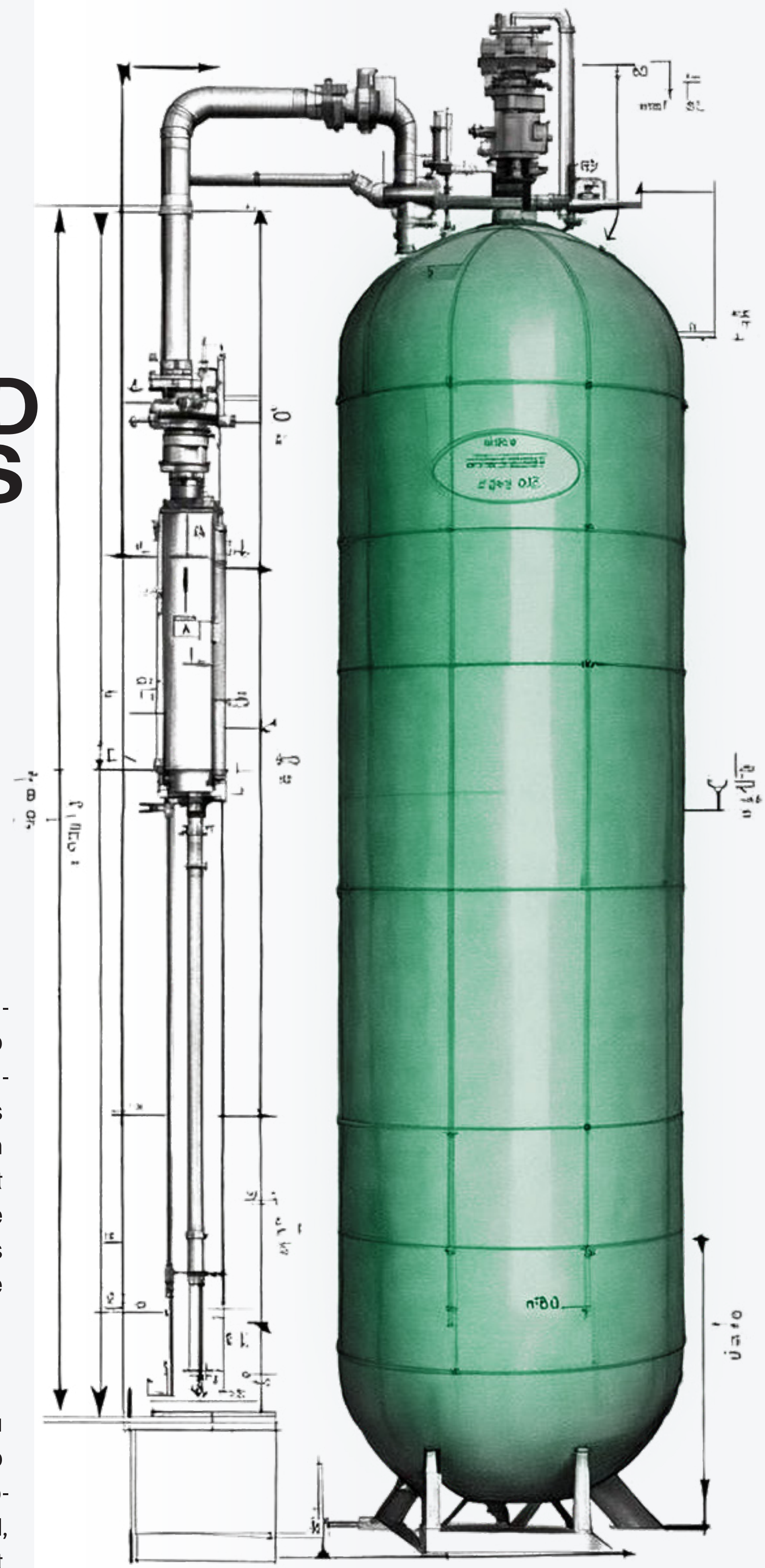
"You cannot control what you cannot measure. You need to put the foundation on the data aspect, so you've got all your data. For us and digital transformation, it seems a lot of people move from digital transformation to sustainability," Marcotte said. "We built this digital transformation consultancy, which works closely with our sustainability organization."

# 6 COMMON DESIGN MISTAKES IN COMPRESSED AIR SYSTEMS

Compressed air is inherently inefficient, but designing the right-sized system will maximize efficiency.

Written by

**Ron Marshall**
Instructor, Compressed Air Challenge



Compressed air systems are always essential parts of industrial plants, and we need to ensure they are well designed and will run efficiently. Compressed air auditing professionals frequently come across many common design mistakes made in installing this essential but inherently inefficient plant utility. This article discusses some of these nagging problems with some suggestions in how to avoid these costly design mistakes.

**1. COMPRESSORS ARE TOO LARGE**
Frequently the compressors purchased for a new facility will be too large, causing them to run very inefficiently. This is particularly problematic when only one compressor is purchased, putting all our eggs in one basket, and that

unit is a variable speed drive (VSD) compressor.

Why does this happen? Well very few designers will get fired for sizing a compressor too large; however, if the compressors are too small, and the new installation can't make pressure, then serious trouble results. To avoid this situation design factors are added for safety, often making the compressor capacity larger than needed.

There will always be an element of doubt as to the final make-up of the compressed air demand. Design factors will be applied to account for future growth, unexpected load additions, and future flow due to leakage. By the time this process is done the final compressor size can end up being twice what is actually needed.

Oversized compressors consume significantly more energy than required, and energy is the biggest part of the overall compressor life cycle cost, often accounting for more than 90% of the 15-year total. Oversized VSD compressors that run at light loads are particularly problematic if they end up running below minimum speed, a condition that can allow condensed water to build up in the compressor lubricant, risking compressor damage.

**Tip:** This problem can be minimized by installing a system of multiple smaller compressors rather than one or two larger ones (see **Figure 1**).

**FIGURE 1**. Carefully selecting compressor sizing and control method can ensure efficient system operation. Compressor room piping should be sized for minimum pressure loss and should be arranged to ensure good air quality is delivered to downstream components like dryers and filters.

(Source: Atlas Copco)

**2. VSD COMPRESSOR IS TOO SMALL**

One of the best ways to save energy in a compressed air system with wide flow variation, like a shift-oriented plant, is to use a VSD controlled compressor in the mix with one or more fixed speed compressors; however, it is common to see the size of the variable compressor too small for efficient control.

It is human nature to want symmetry, so when a system uses, for example, two 100 hp fixed speed compressors, we naturally want to install a similar sized 100 hp VSD compressor. However, this would be a mistake and would create a "control gap" in system capacity within which the variable compressor would fight for control against one or more fixed speed compressors (see **Figure 2**).

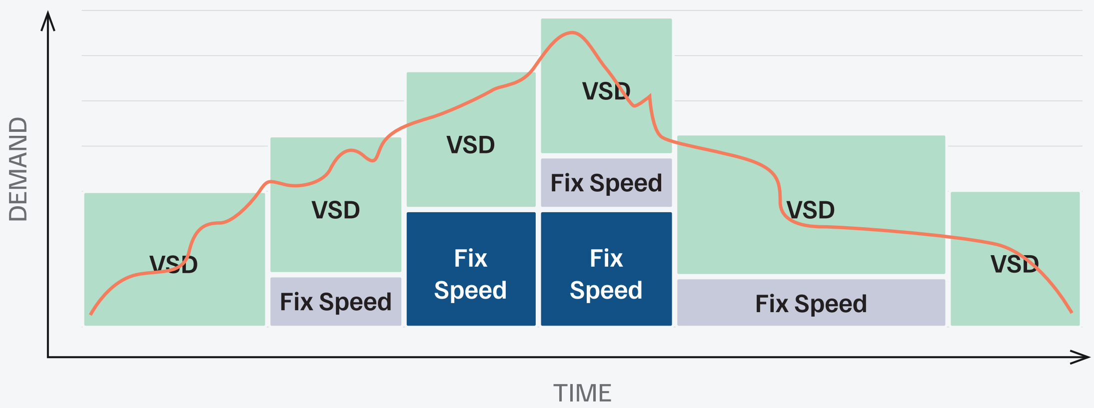



**FIGURE 2**. Proper sizing and good control settings selection will ensure variable speed drive compressors are not operating in a control gap. The settings should be arranged so the VSD is always the compressor supplying partial loads.

(Source: Compressed Air Challenge)

**Tip:** To avoid control gap the *variable range* of the VSD compressor must be equal to or larger than the largest fixed speed compressor with which it must work. This usually means purchasing the VSD of the next size larger at minimum.

### 3. INADEQUATE MAIN STORAGE RECEIVER SIZE

Very often system auditors run across installations with no main system storage, or with a very small storage receiver size of about one gallon per cfm compressor capacity. When this happens, the compressors will rapid cycle and often be out of control because the pressure is changing too quickly to maintain stability. Designing in properly sized system storage will slow pressure fluctuations down and allow efficient and orderly compressor control.

**Tip:** Storage receiver sizing of 1 gallon per cfm is "old school." System designers have since realized a well-controlled system needs about 3-5 gallons per cfm storage capacity, and best-in-class systems have upwards to 10 gallons per cfm. So, for example, if a system has two 300-cfm compressors, and a one 460-cfm compressor, we would want between 1,380 and 2,300 gallons of total system storage receiver capacity. Best in class would have 4,600 gallons of storage divided between wet and dry receivers.

### 4. NO PLANNING FOR FAILURE

Once you've designed in some nice efficient compressors and properly sized the system, you'll need to take time to plan for future failure. Those compressors will not stay new forever, and there will be times where they will fail or need maintenance. If you want to ensure the failure is not a disaster, you will need to design in some backup capacity.

**Tips:** It is best to ensure pressure reliability by making sure you have at least enough backup capacity to ride out the failure of your

**Pipe Size** (inches ID)

| CFM | 10 | 8 | 6 | 5 | 4 | 3 | 2.5 | 2 | 1.5 | 1.25 | 1 | 0.75 | 0.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8000 | 30.8 | 48.6 | 84.2 | 121.6 | 191.0 | 329.0 | 507.6 | 723.6 | 1191.9 | 1621.0 | 2827.3 | 4587.6 | 8104.8 |
| 6000 | 23.1 | 36.5 | 63.1 | 91.2 | 143.3 | 246.8 | 380.7 | 542.7 | 893.9 | 1215.7 | 2120.4 | 3440.7 | 6078.6 |
| 4500 | 17.3 | 27.3 | 47.3 | 68.4 | 107.4 | 185.1 | 285.5 | 407.0 | 670.4 | 911.8 | 1590.3 | 2580.5 | 4559.0 |
| 3000 | 11.6 | 18.2 | 31.6 | 45.6 | 71.6 | 123.4 | 190.4 | 271.4 | 447.0 | 607.9 | 1060.2 | 1720.4 | 3039.3 |
| 1500 | 5.8 | 9.1 | 15.8 | 22.8 | 35.8 | 61.7 | 95.2 | 135.7 | 223.5 | 303.9 | 530.1 | 860.2 | 1519.7 |
| 1250 | 4.8 | 7.6 | 13.2 | 19.0 | 29.8 | 51.4 | 79.3 | 113.1 | 186.2 | 253.3 | 441.8 | 716.8 | 1266.4 |
| 1000 | 3.9 | 6.1 | 10.5 | 15.2 | 23.9 | 41.1 | 63.5 | 90.5 | 149.0 | 202.6 | 353.4 | 573.5 | 1013.1 |
| 800 | 3.1 | 4.9 | 8.4 | 12.2 | 19.1 | 32.9 | 50.8 | 72.4 | 119.2 | 162.1 | 282.7 | 458.8 | 810.5 |
| 600 | 23 | 3.6 | 6.3 | 9.1 | 143 | 24.7 | 38.1 | 54.3 | 89.4 | 121.6 | 212.0 | 344.1 | 607.9 |
| 500 | 1.9 | 3.0 | 5.3 | 7.6 | 11.9 | 20.6 | 31.7 | 45.2 | 74.5 | 101.3 | 176.7 | 286.7 | 506.6 |
| 400 | 1.5 | 2.4 | 4.2 | 6.1 | 9.6 | 16.5 | 25.4 | 36.2 | 59.6 | 81.0 | 141.4 | 229.4 | 405.2 |
| 300 | 1.2 | 1.8 | 3.2 | 4.6 | 7.2 | 12.3 | 19.0 | 27.1 | 44,7 | 60.8 | 106.0 | 172.0 | 303.9 |
| 250 | 1.0 | 1.5 | 2.6 | 3.8 | 6.0 | 10.3 | 15.9 | 22.6 | 37.2 | 50.7 | 88.4 | 143.4 | 253.3 |
| 200 | 0.8 | 1.2 | 2.1 | 30 | 4.8 | 8.2 | 127 | 18.1 | 29.8 | 40.5 | 70.7 | 114.7 | 202.6 |
| 160 | 0.6 | 1.0 | 1.7 | 2.4 | 3.8 | 6.6 | 10.2 | 14.5 | 23.8 | 32.4 | 56.5 | 91.8 | 162.1 |
| 120 | 0.5 | 0.7 | 1.3 | 1.8 | 2.9 | 4.9 | 7.6 | 10.9 | 17.9 | 24.3 | 42.4 | 68.8 | 121.6 |
| 100 | 0.4 | 0.6 | 1.1 | 1.5 | 2.4 | 4.1 | 6.3 | 9.0 | 14.9 | 20.3 | 35.3 | 57.3 | 101.3 |
| 80 | 0.3 | 0.5 | 0.8 | 1.2 | 1.9 | 3.3 | 5.1 | 7.2 | 11.9 | 16.2 | 28.3 | 45.9 | 81.0 |
| 60 | 0.2 | 0.4 | 0.6 | 0.9 | 1.4 | 2.5 | 3.8 | 5.4 | 8.9 | 12.2 | 21.2 | 34.4 | 60.8 |
| 40 | 0.2 | 0.2 | 0.4 | 0.6 | 1.0 | 1.6 | 2.5 | 3.6 | 6.0 | 8.1 | 141 | 22.9 | 40.5 |
| 20 | 0.1 | 0.1 | 0.2 | 0.3 | 0.5 | 0.8 | 1.3 | 1.8 | 3.0 | 4.1 | 7.1 | 11.5 | 20.3 |

**Note:** Table shows feet per second velocity at pressure, best in class 20 to 30 fps in compressor room header, 30 to 40 fps on main distribution piping

**FIGURE 3**. Example feet per second velocity for a 100-psi system

(Source Marshall Compressed Air Consulting).

largest compressor and still be able to maintain the pressure during system peaks. And be sure to design in well-located service ports so that rental compressors can be installed if the worst happens. These service ports should be located before system air dryers to ensure good air quality even when hot and wet diesel driven compressors with inadequate after-coolers are used.

## 5. PIPING IS TOO SMALL AND/OR IS IN THE WRONG LAYOUT

System designers always have a tradeoff to consider between the cost of the main system piping and the size installed. Very often, no calculations will have been done in determining the pressure drop across system piping, and size will be decided by the piping contractor. The size therefore often ends up being the diameter of the discharge port on the compressor resulting in excessive pressure differentials.

Best-in-class systems ensure the air velocities within the main system piping at the chosen operating pressure are always between 20 to 30 feet per second for compressor room header piping, and

**Be aware that there will be times in the future where the air drying system will fail, so slope the piping carefully away from the direction of flow and install drains at all low spots.**

between 30 and 40 feet per second for main plant distribution piping (see **Figure 3**). Always consider arranging the plant piping in a loop or multiple loop system to reduce the pressure loss. Pressure drop in piping varies with the square of the flow changes, so a parallel feed of pipe will have one quarter the pressure loss compared to a single pipe of the same size.

**Tips:** Be aware that there will be times in the future where the air drying system will fail, so slope the piping carefully away from the direction of flow and install drains at all low spots. Ensure all entrances and exits from main distribution are from the top of the pipe to ensure the best air quality, should moisture be present in times of failure. Using this sizing advice, your system should have a total pressure loss (not including dryers and filters) of less that 2% of the system pressure. So, for a 100-psi system, the pressure loss in the main distribution system end-to-end should be less than 2 psi.

### 6. PURCHASING CHEAP AND INEFFICIENT COMPONENTS

Designers should be aware that the energy consumption of a compressed air system is by far the largest life cycle cost of running the system. For this reason, premium efficiency compressors, air dryers, filters, and condensate drains should always be considered with an eye to the total cost of operation, not just the purchase price.

**Tip:** Don't forget about system components supplying and conditioning the air at the end uses of a compressed air system. Very often poor design at this location can cause local pressure loss of 15 to 20 psi through under sizing. These items should be always selected for peak flow of each individual compressed air demand, not the average. Careful component selection at this location can go a long way in reducing the required system pressure, while reducing the cost of system operation. Δ

# ESG SOFTWARE ANALYSIS: SUSTAINABILITY FOR INDUSTRY NEEDS DATA AND AUTOMATION

ARC Advisory's report on emerging ESG software makes a case for its importance in advancing industrial sustainability.

Written by

**Anna Townshend**
Managing Editor

In early 2023, ARC Advisory Group, a technology market research firm, released the "ESG Software Emerging Market Analysis Report," written by Peter Manos, director of research for ARC Advisory Group. Manos focuses on trends related to energy transition, industrial sustainability and digital transformation and talked with Plant Services about his software vendor emerging market research and sustainability trends for industry.

The market report considered 30 different software vendors, a wide variety of large enterprise and smaller software companies. About half a dozen are large publicly traded companies, which have added tracking and reporting and analysis capabilities for ESG to a large portfolio of software solutions, often enterprise resource planning (ERP), enterprise asset management or risk management tools. “And the other two dozen are in some very evolutionary pathways that got them to have ESG software in their mix,” Manos says.

Some companies have a legacy in traditional financial reporting (tracking income statements, cash flow, and balance sheets) or operational risk management or ORM (object-relational mapping) solutions. The largest pathway outside of the main enterprise software vendors are legacy environmental, health, and safety (EHS) solutions that have added ESG capabilities. Some are offering EHSS (or environmental, health, safety, and sustainability) solutions, and others are adding ESG modules to EHS solutions.

**I’m not seeing a lot of what people might have expected: Tier One end users to go with Tier One vendors to put the solutions in the space, as it’s a pretty open market. It’s not totally driven from that perspective.**

[ Peter Manos, director of research for ARC Advisory Group ]

Manos says Tier One end users are engaging equally vigorously with Tier Three-sized solution providers because the skills sets are so specialized. “I’m not seeing a lot of what people might have expected: Tier One end users to go with Tier One vendors to put the solutions in the space, as it’s a pretty open market. It’s not totally driven from that perspective,” Manos says.

He says he was also encouraged to see ESG executives embrace transparency. In line with long-term goals set by the Paris Climate Accords, most companies can meet 80% of their long-term net zero goals, but the last 20% will require more transparency between end user communities, solutions providers and the stakeholders and communities they both serve. For more on global sustainability standards, click here.

“Transparency is going to help those solutions come forward and the alliances and partnerships and creativity to be unleashed to address the 20% that we don’t know how we’re going to get there yet,” Manos says.

**We are paying for the costs of the more energy inefficient equipment, either indirectly or directly,**

[ Peter Manos, director of research for ARC Advisory Group ]

Likewise, accountability up the supply chain is going to also differentiate "leaders from followers," Manos says. Many industries have or are getting a firm grasp on their own carbon footprints, but sustainability will extend beyond the plant walls, both upstream and downstream of the supply chain. "We are paying for the costs of the more energy inefficient equipment, either indirectly or directly," Manos says.

At a point in the future, when industrial decision-makers weigh options by looking at the total lifecycle costs, and sustainability will be part of doing business, Manos calls this the sustainability singularity. The name is in reference to artificial intelligence (AI) singularity, the point at which AI becomes self-aware, or the event horizon of a black hole, at which point nothing can return. "The third definition of singularity aside from the physics and IoT one is, 'Hey, we're all on an island; this planet is a single system'," Manos says. For more on sustainability in the supply chain, click here.

The ARC report indicates that ESG software can be a key factor for enabling the decisions that have to be made about internal facility changes and changes to the industry as a whole. Where there's still negativity around ESG and emissions reduction from many industries, and where, "There's economic backlash, some of it is valid; some of it's bogus. But how do you decide those issues: with more ESG data, not with less," Manos says. ∆

For more information about the new ARC Advisory emerging market report, click here.

# ONE COMPANY'S JOURNEY TO NET-ZERO GREENHOUSE GAS EMISSIONS

Peter Garforth says there's no secret to reducing greenhouse gas emissions, it takes top-to-bottom planning.

Written by

**Peter Garforth**
Consultant

A The latest shift in energy management toward net-zero greenhouse gas (GHG) emissions within the next two or three decades puts industrial sustainability management as a priority and pathway to success.

This will be no mean feat, and no company has yet found the perfect answer. Toward the end of last year, I talked with the global and North American sustainability leaders from the major Italian tissue paper manufacturer, Sofidel.

Recognizing the climate priority, in 2008 Sofidel joined WWF Climate Savers, committing to establish science-based targets for GHG reduction. In the first decade, the goal to reduce energy-related scope 1 and 2 emissions by 23% was comfortably met. Like all effective industrial programmes, the bar was raised with

**Sofidel, in partnership with a Swedish company, is assessing the feasibility of scaling up cost-effective production of biogas from the various biomass waste streams associated with paper production.**

a 40% reduction target set to be achieved by 2030, approved by the Science Based Targets initiative in 2020.

Early prioritization was put on improving operational energy efficiency, which reduces both scope 1 and scope 2 emissions. An equal short-term priority was on reducing the average GHG content of electricity through renewable electricity contracts and selective local initiatives, significantly cutting scope 2 levels.

In the next phase, they will respond to growing pressure to focus on significantly reducing direct emissions. As all energy intensive industries find, this is a major challenge, especially if the goal is effectively their elimination.

Sofidel, in partnership with a Swedish company, is assessing the feasibility of scaling up cost-effective production of biogas from the various biomass waste streams associated with paper production. The possible use of green hydrogen is on the radar screen, and its use will largely be driven by how its price and availability evolves in various markets.

Depending on the local grid, scope 1 emissions may be reduced by electrification of some fundamental production processes. This has the obvious risk that the future GHG performance shifts into the hands of the local power supplier and their ongoing generation mix decisions.

By joining the WWF Climate Savers initiative, Sofidel committed to pursue science-based targets irrespective of the demands of local regulation. This is an important principle for a global company given the vast spread of climate regulation across the world. It is a sound business risk-mitigation approach given the uncertainty of the scope of future regulation. It also sets the stage for maximizing the different GHG reduction opportunities at each site, while delivering on the overall corporate goals.

**This snapshot of one global company's approach to net-zero GHG manufacturing exemplifies the complexity and multi-dimensional challenge.**

Sofidel's sustainability management approach recognizes that each site is different, and these differences should be reflected in local energy plans. These include the age of the plant and its efficiency potential; the GHG content and cost of local utilities, carbon pricing and penalties, incentives, and of course, regulation. Local remuneration aligned with local GHG targets is already in place.

Looking at this from the overall corporate view, this creates a portfolio of GHG reduction opportunities, which together must deliver the overall targets. The portfolio perspective will ultimately allow investment decisions to be prioritized to achieve maximum GHG reduction with the least cost and managed risk. While not quite at the level of integrated simulation to support GHG reduction decisions, Sofidel is headed in this direction.

Like many companies, Sofidel's scope 3 emissions are large, constituting 60% of its total carbon footprint. The bulk of this comes from transporting materials. Again, like many of their peers, this is an area that will gain more attention in the not-too-distant future.

The role of its supply chain on the footprint is also beginning to be actively managed. With an initial focus on pulp suppliers, vendor science-based performance targets are set and incorporated into contractual arrangements. These are scored on a regular basis and vendors failing to meet them are given a reasonable period to turn things around.

This snapshot of one global company's approach to net-zero GHG manufacturing exemplifies the complexity and multi-dimensional challenge.

Sofidel will be the first to admit there will be many twists in the road, but many opportunities as well. My thanks to its team in allowing me a glimpse into its efforts. ∆