White Paper

Reducing CO_2 Emissions Using Habonim CompAct Actuators

Author: Amit Traysman, Product Manager

Contents

1. Introduction

1.1. Abstract

This white paper examines the average reduction of CO_2 emissions achieved by using Habonim's CompAct Actuators compared to traditional two-piston actuators. The analysis is based on data from various actuator models and highlights the environmental benefits of adopting Habonim's innovative technology. Additionally, the energy equivalent of compressed air consumption is considered to provide a comprehensive assessment. The industrial sector, responsible for approximately 30% of global CO_2 emissions, stands to benefit significantly from more efficient technologies[1]. Habonim's CompAct Actuators, utilizing a four-piston design, offer a promising solution by reducing energy consumption and CO_2 emissions. This paper explores the extent of these reductions, the underlying mechanisms, and the broader implications for industrial sustainability. Reducing CO_2 emissions is crucial, as it is the primary driver of global climate change, with global emissions reaching over 35 billion tons annually[2]. Effective CO_2 reduction strategies can prevent millions of premature deaths and significant economic losses[3].

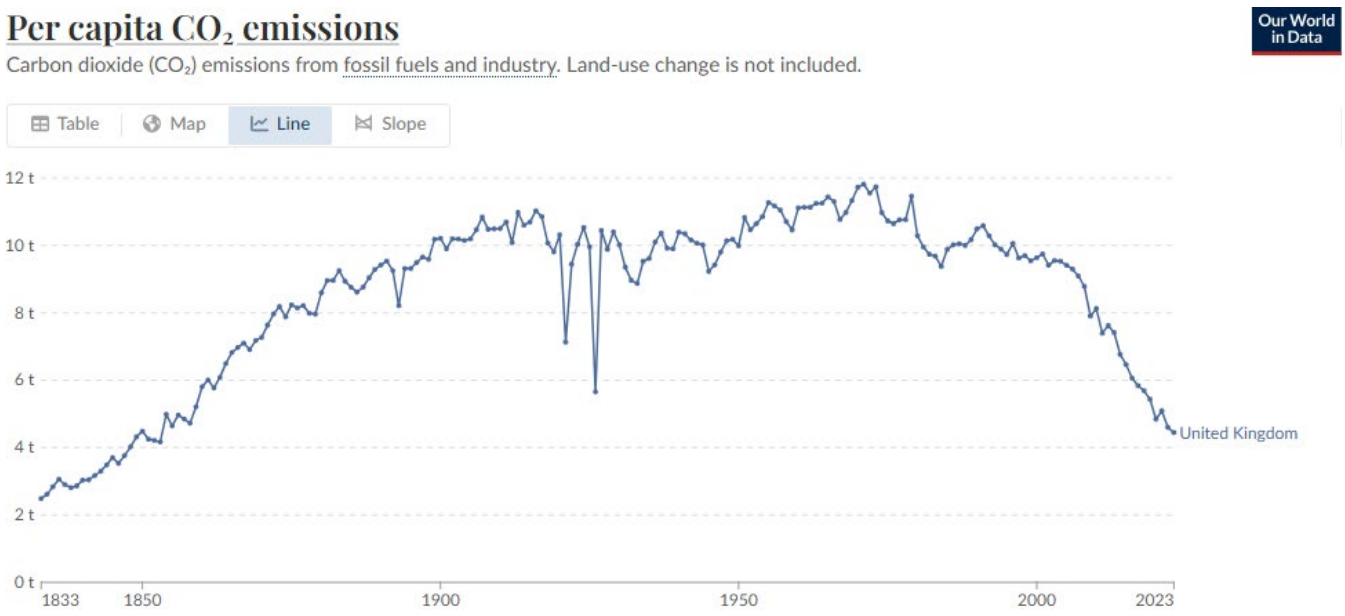

Figure 1: Global Carbon Budget (2024) – with major processing by Our World in Data (Specific for United Kingdom) [2]

1.2. Introduction

In the quest for sustainable industrial practices, reducing energy consumption and minimizing CO_2 emissions have become paramount. The industrial sector, encompassing a wide range of activities from manufacturing to chemical processing, is under increasing pressure to adopt technologies that can mitigate its environmental impact.
Habonim's CompAct Actuators present an innovative approach to addressing these challenges. By leveraging a four-piston design, these actuators offer enhanced efficiency and performance compared to traditional two-piston models. This paper delves into the mechanisms behind these improvements and evaluates the potential for significant CO_2 emission reductions.

The focus of this study is to provide a detailed analysis of the environmental benefits associated with Habonim's CompAct Actuators. Through a comprehensive comparison with traditional actuators, we aim to highlight the advantages of this technology in promoting industrial sustainability. Additionally, the paper considers the broader implications of adopting such efficient technologies in the industrial sector.

1.3. Problem statement

Industrial automation systems often rely on pneumatic actuators, which consume significant amounts of energy and contribute to CO_2 emissions. Traditional two-piston actuators are less efficient, leading to higher energy consumption and greater environmental impact. These actuators typically require more compressed air to achieve the same torque as more advanced designs, resulting in higher energy use. For example, in the chemical processing industry, pneumatic actuators are used extensively for controlling valves and other equipment, leading to substantial energy use. Similarly, in the manufacturing sector, actuators are critical for automation processes, where inefficiencies can result in increased operational costs and emissions.

The inefficiency of traditional actuators not only increases operational costs but also exacerbates environmental issues by contributing to higher CO_2 emissions. As industries face growing pressure to adopt sustainable practices, finding more efficient actuator solutions becomes imperative.

Addressing these inefficiencies is crucial for industries aiming to reduce their carbon footprint and improve sustainability. By adopting more efficient technologies like Habonim's CompAct Actuators, industries can achieve substantial energy savings and contribute to global efforts to combat climate change.

1.4. Background

Habonim's CompAct Actuators are designed with four-piston technology[4] that doubles the torque of standard pneumatic actuators while maintaining a smaller footprint. This innovative design leverages the principles of mechanical advantage and optimized air flow to achieve higher efficiency. The four-piston configuration allows for a more balanced distribution of force, reducing the amount of compressed air required to generate the same torque as traditional two-piston actuators.

Compared to other existing technologies, Habonim's CompAct Actuators offer superior performance and efficiency. Traditional two-piston actuators, for instance, are less efficient due to their higher air consumption and larger size. Electric actuators, while efficient in certain applications, often lack the robustness and reliability required for heavy-duty industrial use. Hydraulic actuators, on the other hand, can provide high torque but are typically more complex and expensive to maintain.

The development of Habonim's CompAct Actuators involved extensive research and testing to optimize the design and performance. Key milestones included the successful implementation of the four-piston technology, achieving significant reductions in air consumption. These actuators have been rigorously tested in various industrial applications, demonstrating their reliability and efficiency in real-world conditions.

By adopting Habonim's CompAct Actuators, industries can benefit from reduced energy consumption, lower CO_2 emissions, and improved operational efficiency. The compact design also minimizes space requirements and material use, further contributing to sustainability goals.

2. Methodology and Data Analysis

2.1. Methodology

The analysis compares the air consumption and CO_2 emissions of Habonim's CompAct Actuators with traditional two-piston actuators. Data from various actuator models, including torque ranges and air consumption metrics, are used to calculate the average reduction in CO_2 emissions. The energy equivalent of compressed air consumption is also considered.
The energy equivalent of compressed air consumption varies widely depending on system efficiency. While this study uses a value of 0.11 kWh per cubic meter of air, high-efficiency systems can have energy equivalents ranging from 0.08 to 0.18 kWh per cubic meter. For less efficient systems, this value can be as high as 0.90 kWh per cubic meter. Therefore, the CO_2 emission reductions achieved by using Habonim's CompAct Actuators would be even more pronounced in less efficient systems.

2.2. Data and Analysis

2.2.1. Technical Specifications

The analysis compares the air consumption and CO_2 emissions of Habonim's CompAct Actuators with traditional two-piston actuators from three different manufacturers. The following models were included in the study:

- **Habonim CompAct Actuators:** Models C20, C25, C30, C35, C45, C60, C75
- **Traditional Two-Piston Actuators:** Models from Manufacturer A, Manufacturer B, and Manufacturer C

	Habonim CompAct Actuator					
	Size / Model	DA Torque At 5.5 Bar Nm	CCW Cm^3	CW Cm^3	CCW / Nm	CW / Nm
	C20	35	120	150	3.43	4.29
	C25	72	250	330	3.47	4.58
	C30	119	440	540	3.70	4.54
	C35	208	740	800	3.56	3.85
	C45	408	1330	1330	3.26	3.26
	C60	967	3200	3200	3.31	3.31
	C75	1786	5760	5760	3.23	3.23
		Average of CCW/Nm & CW/Nm			*3.42*	*3.86*

Table 1: Sample for data origin

cm^3 to m^3 CCW	kWh/1Nm CCW	gC02/Nm Torque CCW	cm^3 to m^3 CW	kWh/1Nm CW	gC02/1Nm Torque CW	gC02/1Nm CCW - CW Average	gC02 per 365 Actuator Cycles	GBP kWh Cost	GBP Cost/1Nm Average	CCW Cm 3 - CW Cm3 Average Air Consumption / Cycle	GBP Cost per 365 Actuator Cycles
0.000003429	0.00003117	0.0050	0.000004286	0.00003896	0.0063	0.0057	145.1373	£ 0.25	£ 0.00000877	135.0	£ 0.86

Table 2: Sample for data analysis

2.2.2. CO_2 Emission Data

Direct CO_2 Emissions: Calculated based on air consumption and energy required to compress air.

Energy Consumption: Each cubic meter of air used consumes 0.11 kWh of electrical energy (Source: https://solvair.co.uk/energy-savings/#:~:text=How%20do%20you%20assess%20your,the%20calculation%201m%C2%B3%20%3D%200.11%20kW.).

CO_2 Emissions per kWh: UK average of 162 gCO_2/kWh (2023 Average).

Average Cost of Electricity: 24.5 pence (GBP) per kilowatt-hour (kWh) in the UK (2024).

2.2.3. Efficiency Metric

Habonim CompAct Actuators: Average air consumption per Nm of torque is significantly lower than that of traditional two-piston actuators.

	Habonim CompAct Actuator								
	Size / Model	DA Torque At 5.5 Bar Nm	CCW Cm^3	CW Cm^3	CCW / Nm	CW / Nm	gC02 per 365 Actuator Cycles	GBP Cost per 365 Actuator Cycles	Torque Range
	C20	35	120	150	3.43	4.29	145.14	£ 0.86	30-50Nm
	C25	72	250	330	3.47	4.58	311.78	£ 1.94	50-100Nm
	C30	119	440	540	3.70	4.54	526.79	£ 3.35	100-150Nm
	C35	208	740	800	3.56	3.85	827.82	£ 4.73	150-250Nm
	C45	408	1330	1330	3.26	3.26	1429.87	£ 7.19	250-450Nm
	C60	967	3200	3200	3.31	3.31	3440.29	£ 17.57	450-1000Nm
	C75	1786	5760	5760	3.23	3.23	6192.52	£ 30.82	1000-2000Nm

Table 3: Sample for calculated data for CompAct Actuators

Average data of '2-Piston' Design on the Market				
Size / Model - Torque Range	Average gC02 per 365 Actuator Cycles	Average GBP Cost per 365 Actuator Cycles	Percentage Difference - Compact vs '2-Piston' Design	CompAct vs '2-Piston' Average
30-50Nm (C20)	232.72	£ 2.09	60%	
50-100Nm (C25)	489.74	£ 4.48	57%	
100-150Nm (C30)	765.87	£ 7.36	45%	
150-250Nm (C35)	1424.84	£ 13.97	72%	52%
250-450Nm (C45)	2050.76	£ 19.75	43%	
450-1000Nm (C60)	4464.83	£ 38.06	30%	
1000-2000Nm (C75)	9616.57	£ 80.54	55%	

Table 4: Sample for calculated data for average 2-piston design

2.2.4. Graphical Representation

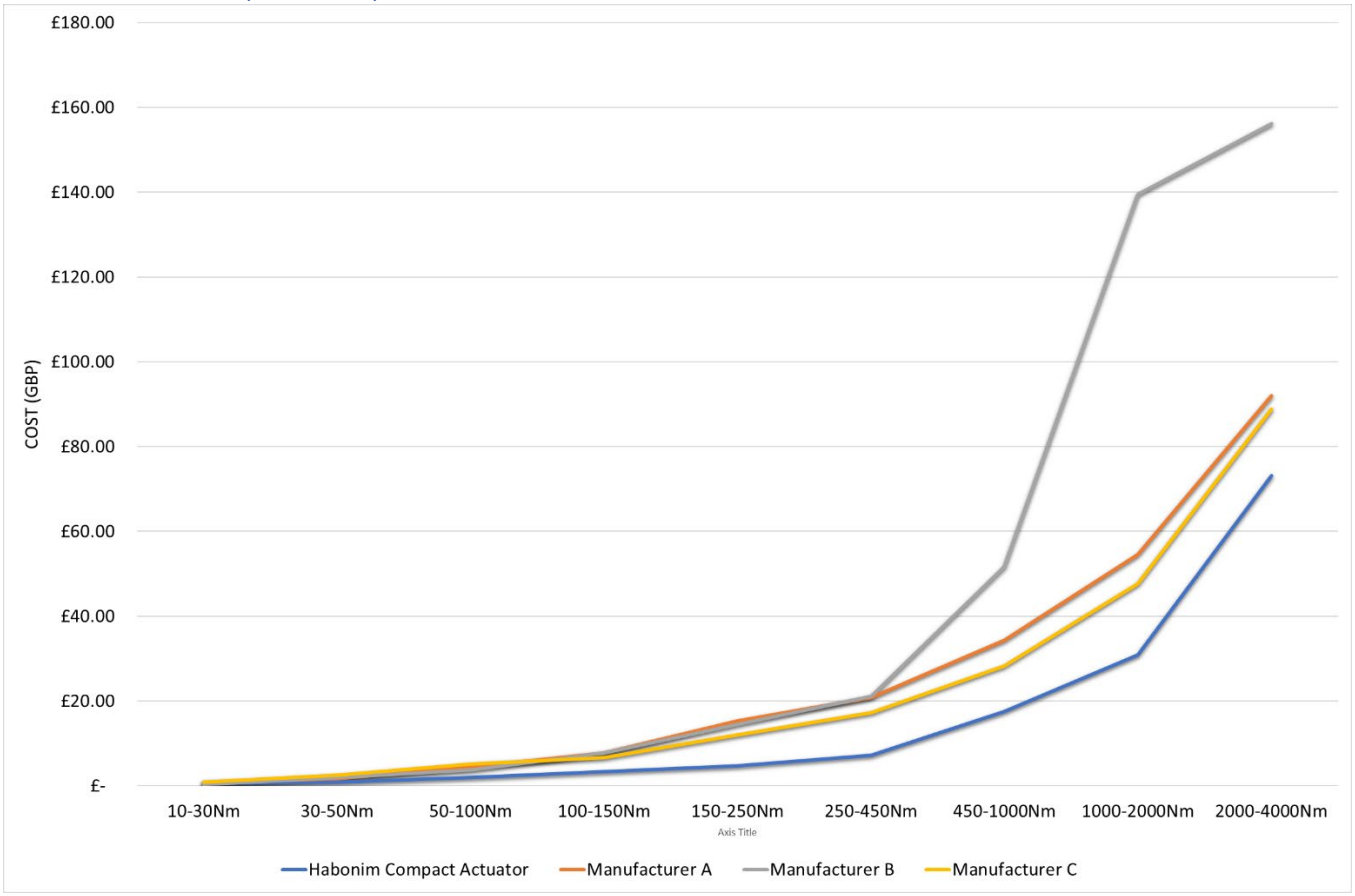

Figure 2:GBP cost per 365 actuator cycles

2.2.5. Analysis

The data shows that Habonim's CompAct Actuators consume less air per Nm of torque compared to traditional two-piston actuators. This reduction in air consumption translates to lower energy use and, consequently, lower CO_2 emissions. The energy equivalent of compressed air consumption is factored into the analysis to provide a more accurate assessment.

3. Solutions and Future Developments

3.1. Solution

Habonim's CompAct Actuators reduce CO_2 emissions through several key mechanisms:
Lower Air Consumption The four-piston design of Habonim's CompAct Actuators requires less air to generate the same torque as traditional two-piston actuators. This design leverages mechanical advantages, such as optimized air flow and balanced force distribution, to achieve higher efficiency. By reducing air consumption, these actuators lower the energy required for operation, resulting in significant CO_2 emission reductions.

Higher Efficiency The enhanced efficiency of Habonim's CompAct Actuators translates to lower energy consumption. This efficiency not only reduces operational costs but also minimizes the environmental impact by lowering CO_2 emissions.
Smaller Footprint The compact design of Habonim's CompAct Actuators minimizes space requirements and material use. This smaller footprint allows for easier integration into existing systems and reduces the overall environmental impact of manufacturing and installation.
Energy Equivalent Consideration Factoring in the energy equivalent of compressed air consumption provides a comprehensive understanding of the environmental impact. By considering the energy required to compress air and the associated CO_2 emissions, the analysis offers a more accurate assessment of the benefits of adopting Habonim's CompAct Actuators.

3.2. Future Developments

Habonim continues to innovate and improve its actuator technology. A recent development is the **Habonim Power CompAct Actuator**[5], which offers even greater efficiency and performance. This new actuator builds on the success of the original CompAct design, incorporating advanced materials and smart control systems to further enhance its capabilities.
The Power CompAct Actuator features a patented four-piston scotch-yoke design that combines the benefits of a high-power scotch-yoke mechanism with the balance and compactness of the four-piston system. This innovative design generates maximal power and high start, and end torques, which are crucial for many valve applications. The Power CompAct unit is significantly faster in opening and closing, using less compressed air to operate, which contributes to its high efficiency and reduced CO_2 emissions.

3.2.1. Key Features and Power CompAct

Key features of the Power CompAct Actuator include:

- **High Power-to-Size Ratio**: The actuator provides almost 100% higher power-to-size ratio compared to traditional high-torque scotch-yoke actuators, while being much more compact.
- **Fast and Efficient Operation**: The actuator's design ensures quick opening and closing times, reducing the overall energy consumption.
- **Durability and Low Maintenance**: The evenly balanced forces of the four pistons and short travel, provide unmatched high cycle life without maintenance for hundreds of thousands of operations.
- **Versatile Mounting Interface**: The actuator offers a multi-optional mounting interface, making it adaptable to various applications.

These ongoing innovations will help industries achieve even greater energy savings and sustainability goals. The integration of smart control systems and the use of advanced materials in the Power CompAct Actuator represent significant steps forward in actuator technology, ensuring that Habonim remains at the forefront of environmentally friendly industrial solutions.

4. Conclusion

4.1. Conclusion

Habonim's CompAct Actuators offer a viable solution for reducing CO_2 emissions in industrial applications. Our innovative design and higher efficiency make them a superior choice compared to traditional two-piston actuators. By leveraging the four-piston technology, these actuators achieve significant reductions in air consumption and energy use, which directly translates to lower CO_2 emissions.

The introduction of the Habonim Power CompAct Actuator further enhances these benefits, offering even greater efficiency and performance. With its high power-to-size ratio, fast operation, and durable design, the Power CompAct Actuator represents the next step in environmentally friendly actuator technology.

Adopting our CompAct Actuators can help industries meet sustainability goals and reduce their carbon footprint. By considering the energy equivalent of compressed air consumption, this white paper provides a comprehensive assessment of the environmental benefits of these actuators. As industries continue to seek more efficient and sustainable solutions, our actuators stand out as a leading choice for reducing CO_2 emissions and promoting environmental responsibility.

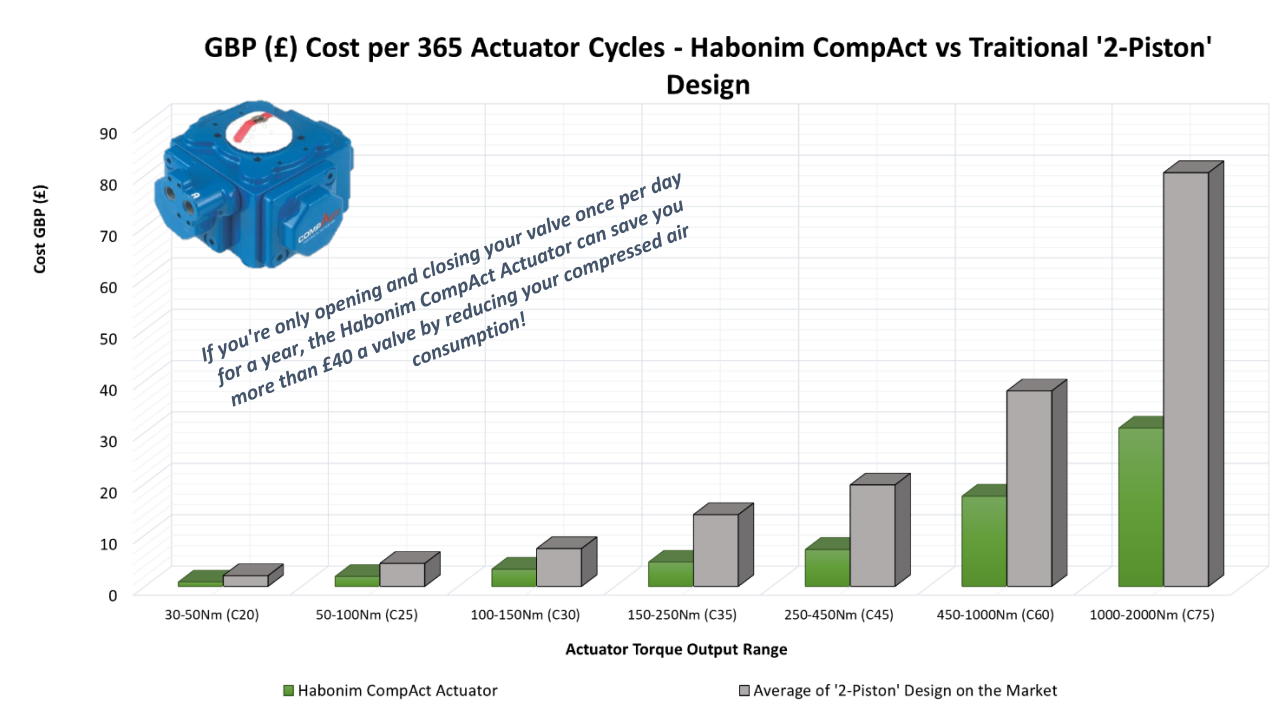

Figure 3: GBP (£) Cost per 365 Actuator Cycles - Habonim CompAct vs Traditional '2-Piston' Design

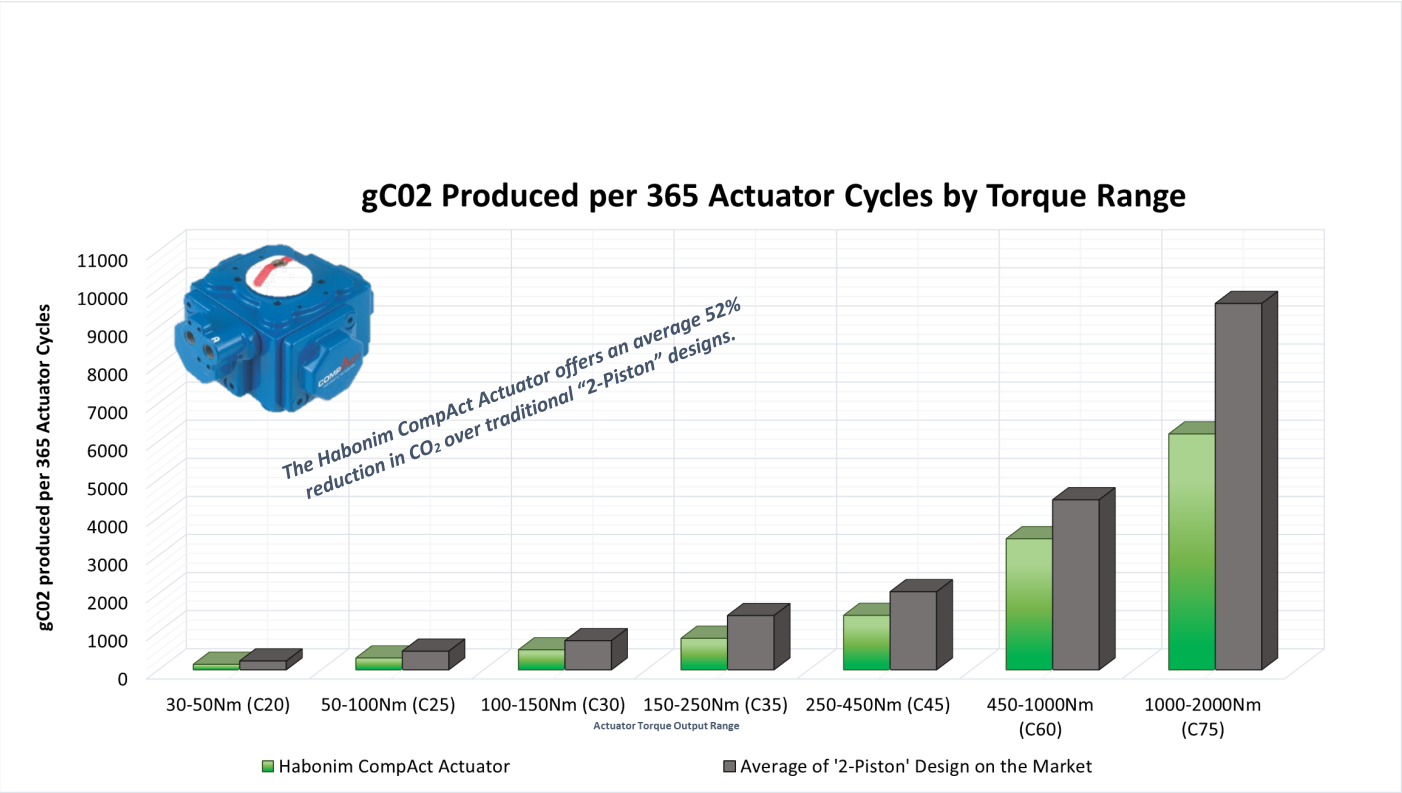

Figure 4: gC02 Produced per 365 Actuator Cycles by Torque Range

4.2. References

1. Our World in Data. CO_2 and Greenhouse Gas Emissions [Internet]. Available from: https://ourworldindata.org/CO_2-and-other-greenhouse-gas-emissions
2. Our World in Data. CO_2 emissions [Internet]. Available from: https://ourworldindata.org/CO_2-emissions Figure 1: Global Carbon Budget (2024) – with major processing by Our World in Data. "Annual CO_2 emissions – GCB" [dataset]. Global Carbon Project, "Global Carbon Budget" [original data].
3. NASA. Reducing Emissions to Lessen Climate Change Would Yield Dramatic Health Benefits [Internet]. Available from: https://climate.nasa.gov/news/3134/reducing-emissions-to-lessen-climate-change-would-yield-dramatic-health-benefits-by-2030/
4. Habonim. Power CompAct Actuator - Fast and Efficient Operation [Internet]. Available from: https://www.habonim.com/power-compact-actuator
5. Habonim. Habonim Power CompAct Actuator - How it Works? [Internet]. Available from: https://www.habonim.com/how-it-works
6. Züst S, Gontarz A, Wegener K. Energy Equivalent of Compressed Air Consumption in a Machine Tool Environment [Internet]. 2013. Available from: https://doi.org/10.3929/ethz-a-009959904

4.3. Disclaimer

The information contained in this white paper is for general informational purposes only. While we strive to ensure the accuracy and completeness of the information presented, we make no representations or warranties of any kind, express or implied, about the completeness, accuracy, reliability, suitability, or availability with respect to the white paper or the information, products, services, or related graphics contained in the white paper for any purpose. Any reliance you place on such information is therefore strictly at your own risk.

In no event will we be liable for any loss or damage including without limitation, indirect or consequential loss or damage, or any loss or damage whatsoever arising from loss of data or profits arising out of, or in connection with, the use of this white paper.

Through this white paper, you may be able to link to other websites which are not under the control of Habonim. We have no control over the nature, content, and availability of those sites. The inclusion of any links does not necessarily imply a recommendation or endorse the views expressed within them.

Every effort is made to keep the white paper up and running smoothly. However, Habonim takes no responsibility for, and will not be liable for, the white paper being temporarily unavailable due to technical issues beyond our control.