

Sample Report

Decarbonization Study

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Executive Summary

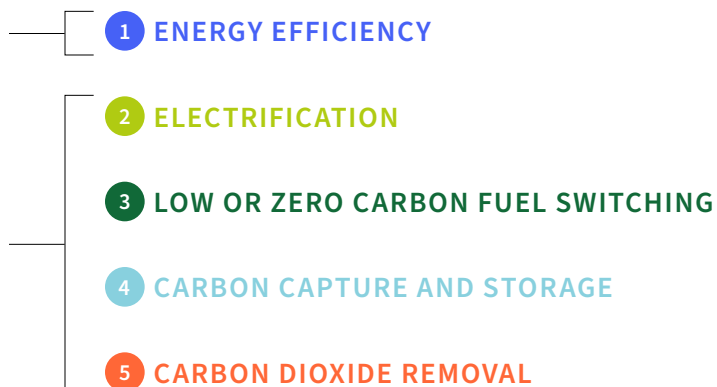
To support ABC Company in its overall sustainability journey, Foresight Management created a Scope 1 Greenhouse Gas Decarbonization Strategy with a specific focus on Scope 1 fuels of natural gas and fuel oil #6, both associated with running boilers and generating steam.

This report presents an overview of five decarbonization pathways, and how the decarbonization pathways create a larger strategy for decarbonizing ABC Company's Scope 1 emissions across their sites.

Five Decarbonization Pathways in this report

Pathway 1, Energy Efficiency, is a short-term solution for decarbonizing existing equipment.

Pathways 2 through 5 are long-term solutions that will allow for complete decarbonization. Within each Decarbonization Pathway, the report presents a range of example technologies to achieve carbon emissions reduction. Additionally, we explore Supply Chain Insetting as a potential pathway for reduction, though don't consider it a primary route.



Seven Site-Specific Strategies in this report

This report presents seven site-specific strategies based on unique facility operations and locations. The groupings are based on the geography and processes of the sites.

By building a framework of priorities, options, and impact, this strategy will guide ABC Company as it grows, enabling it to reduce its carbon footprint and achieve sustainability goals over time.

1. Site Group 1
2. Site Group 2
3. Site Group 3
4. Site Group 4
5. Site Group 5
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7. Site Group 7

Project Description & Methodology

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Project Description & Methodology

ABC Company has committed to halve emissions by 2030 and become net-zero for operational and supply-chain emissions by 2045. To meet this goal, ABC Company must build a strategy to remove, reduce, and offset greenhouse gas emissions associated with the burning of fossil fuels. The opportunities to decarbonize are site-specific and dependent on variables like a site's fossil fuel use, electrical grid carbon intensity, government policy, supply chains, and manufacturing processes.

To gather information for the decarbonization strategy, Foresight conducted two sets of evaluations that represent two different time horizons.

ENERGY EFFICIENCY EVALUATION

Intended to assess opportunities for decarbonization on existing equipment in the short-term.

DECARBONIZATION EVALUATION

Intended to assess opportunities to change or add new systems in the long-term.

Energy Efficiency Evaluation

To assess opportunities for short-term energy efficiency measures, the Foresight team conducted the following assessments:

- ASHRAE Energy Audit
- Master Facility Energy Audit
- Thermal Imaging Study
- Utility Analysis

ASHRAE ENERGY AUDIT

The scope of the energy audit adheres to the guidelines developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) for a Level 1 energy audit, including some aspects from Level 2. As described in ASHRAE's Procedures for Commercial Building Energy Audits, a Level 2 "Energy Survey and Analysis" will identify and provide the savings and cost analyses of all practical energy efficiency measures that meet the owner's/operator's constraints and economic criteria, along with the proposed changes to Operation and Maintenance (O&M) procedures.

MASTER FACILITY ENERGY AUDIT

With the goal of decarbonization, additional mindfulness was paid to natural gas and fuel oil #6 alongside the ASHRAE energy audit. Foresight prepared a benchmarking questionnaire for all facilities to establish an operational baseline for each individual facility. This information was used by the Foresight team to identify areas for improvement and assess decarbonization opportunity for corresponding areas. Any follow-up questions were sent back to the contact for clarification. For further information, please refer to the [Master Facility Audit Questions](#) in the Appendix.

PROJECT DESCRIPTION & METHODOLOGY

Energy Efficiency Evaluation, continued

THERMAL IMAGING STUDY

During the onsite facility energy audits, Foresight engineers performed thermal imaging studies to identify opportunities to improve the building envelope and processes for increased energy efficiency. Images, analysis, and recommendations are included in this report. For more details on the results of the [Thermal Imaging Study](#), see the Appendix.

UTILITY ANALYSIS

Utility analysis was performed based on historical energy bills and covers consumption as well as peak demand. While consumption assesses overall energy usage, peak demand assesses energy expense due to time of use rates.

Decarbonization Evaluation

In addition to assessing the short-term opportunities, Foresight constructed a long-term decarbonization strategy with the following steps:

- Group facility locations by site-specific decarbonization opportunities
- Quantify the decarbonization opportunity for short-term energy efficiency measures (ECMs) based on existing equipment and fuel use. (Pathway 1)
- Match the relevance of the non-energy efficiency decarbonization pathways (Pathways 2 to 5) to specific variables identified in the site grouping
- By site group, eliminate pathways that are not applicable and quantify the decarbonization opportunity for each group
- Build a broad corporate strategy for each site group using the Decarbonization Pathways — without identifying specific technologies — to find a low-cost path to net-zero emissions
- Using the broad strategies as guidelines, build site-specific strategies that integrate technologies within each of the Decarbonization Pathways

Five Decarbonization Pathways

Foresight constructed ABC Company’s Scope 1 Greenhouse Gas Decarbonization Strategy by evaluating five decarbonization pathways. The pathways provide a narrowed focus on the types of technologies that might be applicable at different locations.

Ultimately, the recommended strategy will include a combination of all five pathways — prioritized differently for each Facility Group.

In the [Decarbonization Technologies](#) section, we outline Initiatives and Projects/Technologies under each pathway.

This section can be used as a reference for deeper dives into implementing a decarbonization strategy.

PATHWAY 1

Short-term solutions for decarbonizing existing equipment



ENERGY EFFICIENCY

Use Less & Use Smarter

Addressing building envelopes, operations, and capital purchases



ELECTRIFICATION

Adopt Renewable Energy Options

Optimizing renewable energy purchasing from an ever-greening grid



LOW OR ZERO CARBON FUEL SWITCHING

Identify New Fuel Sources

Leveraging alternative fuel sources for reduced carbon emissions



CARBON CAPTURE & STORAGE

Immediately Remove What You Burn

Immediately remove carbon dioxide after burning fossil fuels.



CARBON DIOXIDE REMOVAL

Broadly Remove Carbon Dioxide

Removing carbon dioxide without the production of fossil fuels.

PATHWAYS 2 – 5

Long-term solutions allowing for complete decarbonization

PROJECT DESCRIPTION & METHODOLOGY

This table outlines initiatives and example projects to show how the decarbonization pathways can be implemented. This is not an exhaustive list, rather, it is intended to provide context for how sites can implement the strategies.

Pathway	Initiative	Project/Technology
ENERGY EFFICIENCY	<i>Boiler Capital Measures</i>	Boiler Upgrades
		Boiler Stack Economizer
	<i>Boiler Efficiency Measures</i>	Variable Frequency Drives (VFDs)
		Boiler Tune-Ups
	<i>Cogeneration Installation</i>	Combined Heat and Power (CHP) System Installation
	<i>Steam System Measure</i>	Pipes and Tank Insulation
		Steam Trap Installation/Tune-Up
		Turbine/Expansion Tank Installation
	<i>Other Efficiency Measures</i>	Rooftop Units Tune-ups and Replacement
		HLVS Fans Installation
		Energy Management Controls System
		Demand Control Ventilation
		Wi-Fi Programmable Thermostat
HVAC Setpoint Unification		
Tighten Up Building Envelope		
ELECTRIFICATION	<i>Electrification of Boilers</i>	Precision Boilers
	<i>Concentrated Solar Installation</i>	SunTrap™ Concentrated Solar Power (CSP) System
	<i>Heat Pump</i>	Ground Source Heat Pump*
		Air Source Heat Pump*
<i>UV Tank Sanitation System</i>	TankMaster™	
LOW OR ZERO CARBON FUEL SWITCHING	<i>Hydrogen Boilers</i>	Retrofit existing boilers and increase % hydrogen in boiler fuel mix
		Install boilers with capacity for % hydrogen fuel mix
	<i>Hydrogen Production or Acquisition</i>	Steam methane reformation
		Hydrolysis powered with renewable energy
		Purchase green hydrogen from off-site vendors
	<i>Biogas</i>	Biogas produced from an anaerobic digester
		Gasification of biochar from Hydrothermal Carbonization (HTC)**
	<i>Biomass</i>	Burn Hydrochar from Hydrothermal Carbonization (HTC)**
Burn biogenic waste for energy (wood or bagasse)		
		Pyrolysis for energy production
CARBON CAPTURE & STORAGE	<i>Carbon Emissions Reduction</i>	CO ₂ Scrubber
CARBON DIOXIDE REMOVAL	<i>Credit Purchase</i>	Purchasing Credits through Direct Air Capture and Storage
	<i>Regenerative Agriculture</i>	Demeter Certified Biodynamic
		Hydrochar from Hydrothermal Carbonization (HTC)**
<i>Credit Creation</i>	Biochar (charcoal) creation through pyrolysis	
INSETTING		Includes all above pathways, but directed within the supply chain

* not described in detail in technology section.

** Hydrothermal Carbonization (HTC) is described in detail under the technology section under low or zero carbon fuel switching, but may be characterized differently based on how sites use the waste.

Site Group Recommendations

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Site Group 5	—
Site Group 6	—
Site Group 7	—

Site Group Recommendations

This section provides an overview of the strategy and potential technology recommendations for each site group. The Site Group Strategies provide focus for piloting and implementing the next steps in decarbonizing ABC Company's Scope 1 Emissions.

The next steps will be to conduct feasibility studies and pilot the initiatives and technologies under each pathway. The [Decarbonization Technologies section](#) outlines potential initiatives and projects that fall under each pathway in more detail later in the report.

SHORT VS. LONG-TERM RECOMMENDATIONS

Foresight conducted an *Energy Efficiency Evaluation* and a *Decarbonization Evaluation* to create recommendations for each Site Group.

The Energy Efficiency Evaluation answers the question: Which locations have the largest opportunities for decarbonization impact for the least amount of money (tCO₂e/\$)?

The Decarbonization Evaluation answers the question: What decarbonization pathways can be implemented to align best with the specifics of each Site Group?

The recommendations are split because an investment in *Pathway 1 (Energy Efficiency)* is an investment in *existing* systems, and *Pathways 2 through 5 (Long-term Decarbonization Recommendations)* are investments in *new* systems. Therefore, in some instances investments in pathways 2–5 could negate gains in energy efficiency in the existing systems. It would not make sense, for example, to invest in a hydrogen boiler if a new energy efficient natural gas boiler was just purchased. The hydrogen boiler would make the natural gas boiler obsolete.

ENERGY EFFICIENCY PATHWAY

Investment in short-term solutions for decarbonizing existing equipment



LONG-TERM DECARBONIZATION PATHWAYS

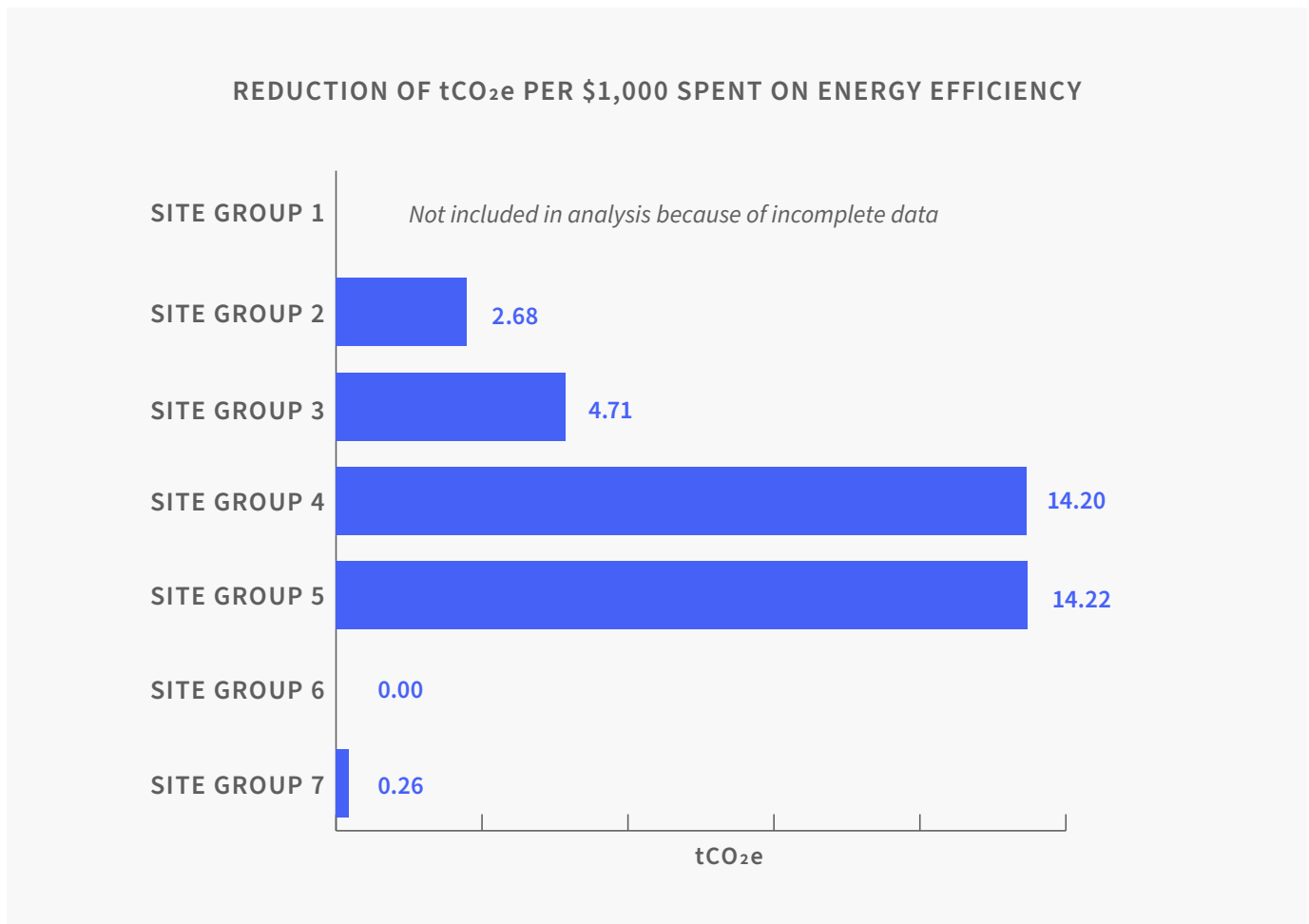
Investment in long-term solutions allowing for complete decarbonization



1 ENERGY EFFICIENCY

The most impactful energy efficiency measures are short-term upgrades in high-use, carbon-intensive processes. Efficiency efforts can present the lowest cost short-term options for decarbonization because they can be implemented without any major disruption to existing infrastructure. Unfortunately, efficient burning of fossil fuels is still burning fossil fuels and generates greenhouse gas emissions.

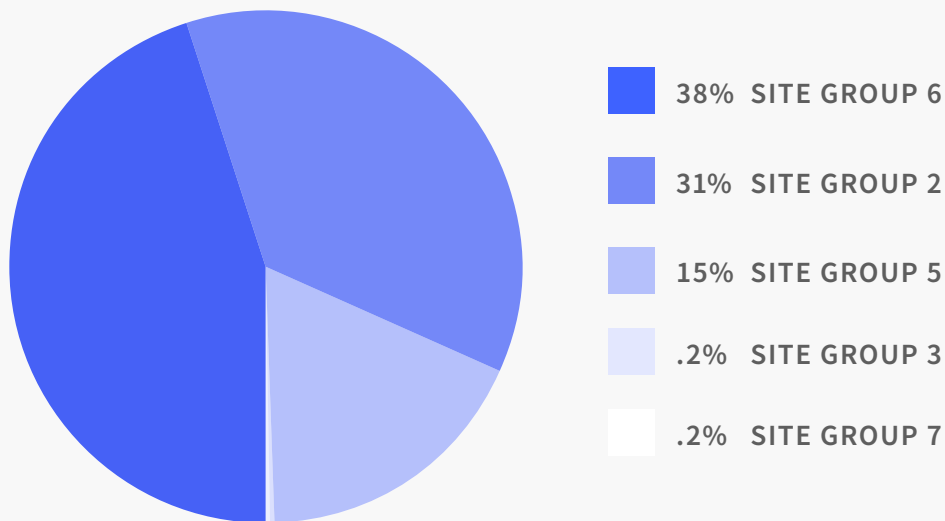
The chart below shows where the opportunity exists to have the most impact on decarbonization. Because of production volumes and the age of some of the equipment, Site Group 5 presents the largest opportunity for decarbonization per dollar spent.



SITE GROUP RECOMMENDATIONS

1 ENERGY EFFICIENCY

TOTAL POTENTIAL tCO₂e REDUCTION FROM ENERGY EFFICIENCY PROJECTS



Site	Energy Efficiency Recommendation
Site Group 1	Boiler Replacement*
	Cogeneration of Combined Heat and Power*
Site Group 2	VFD Installation
	Boiler Replacement
Site Group 3	Boiler Replacement
	Cogeneration of Combined Heat and Power
	High Volume Low Speed Fans Installations
Site Group 4	Boiler Replacement
	Cogeneration of Combined Heat and Power
Site Group 5	Boiler Replacement
	Cogeneration of Combined Heat and Power
Site Group 6	-
Site Group 7	Boiler Replacement
	Cogeneration of Combined Heat and Power

*Provided that the boilers are old and inefficient.

Site Group 3

Site Group 3 activities include drying, selecting, shaping, preparing, assembling, preheating, and toasting. Most of the processes are fueled by electricity, but steam is used in processes related to drying, preheating, and toasting. Natural gas is used as well.

At most sites, winter usage is about 30% more than summer usage, which indicates an opportunity to electrify and insulate about 10% of the total site load. About 80% of site emissions should be dealt with using concentrated solar. For the remaining 10%, carbon capture or removal practices are the only remaining options for decarbonization.

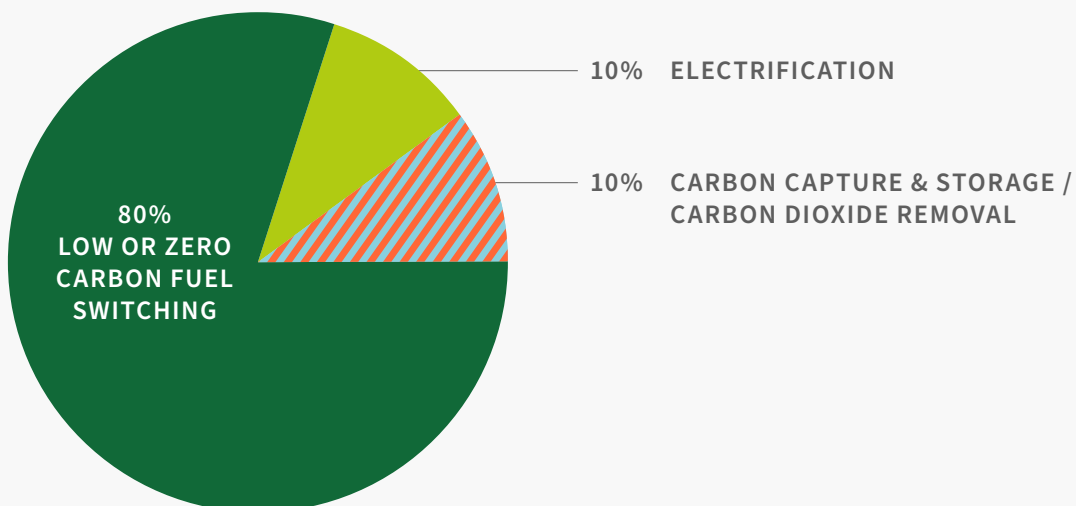
ENERGY EFFICIENCY RECOMMENDATIONS

- Boiler Economizer
- CHP Installation
- HVLS Fans Installation (recommended as a strategy regardless of other pathways selected)

LONG-TERM DECARBONIZATION RECOMMENDATIONS (PATHWAYS 2 – 5)

- Concentrated Solar and Storage + Steam System
- Lasers & Infrared
- Renewable Energy Feasibility Study
- Generate and retire carbon credits from biochar/ charcoal production
- Smokestack carbon capture – Direct Air Capture DAC

LONG-TERM DECARBONIZATION PATHWAY STRATEGY



Site Group 4

The bulk of ABC Company emissions are generated in Site Group 4. The need for high temperatures in multiple processes, plus the production of various waste flows provides unique opportunities for low and zero carbon fuel switching.

The defining opportunity for decarbonization is in the waste streams. Hydrothermal Carbonization will accommodate the solids removal needed to make AD productive and efficient, while also producing a biochar that can be used as a biogenic fuel or captured as an offset. With more efficient AD operations, we will produce reliable renewable natural gas.

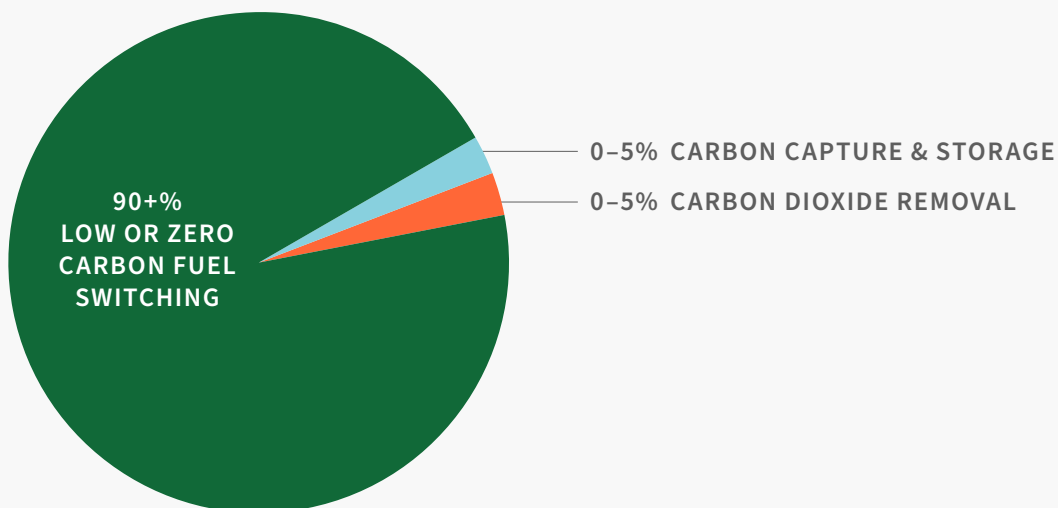
ENERGY EFFICIENCY RECOMMENDATIONS

- Boiler Replacement
- Boiler Economizer
- CHP Installation
- Capacitor Bank/Turbine Installation
- Steam Trap Installation/Tune-Ups (recommended as a strategy regardless of other pathways selected)
- Short-term steam system efficiency upgrades (insulation, controls, condensate, lower P/T)

LONG-TERM DECARBONIZATION RECOMMENDATIONS (PATHWAYS 2 – 5)

- Hydrothermal Carbonization with gasification of biochar + Anaerobic digester
- Smokestack carbon capture
- Generate and retire carbon credits from biochar/charcoal production

LONG-TERM DECARBONIZATION PATHWAY STRATEGY





foresight

MANAGEMENT



Ready to talk? We're here to help!

Schedule a call with our Vice President to learn more about building a Decarbonization Roadmap for your company.

[CHAT WITH MIKE](#)

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