WÄRTSILÄ

PRODUCT GUIDE

SOx scrubber technology

The environmental impact

Shipping is a global industry and the harmful emissions created from shipping fleets affect many regions worldwide. As a consequence the marine industry will in the coming years face tougher legislation on emissions around the world. These rules and regulations will force the marine industry to make difficult choices, however the benefits are a much cleaner air, resulting in a greener future for us all.

ENVIRONMENTAL COMPLIANCE

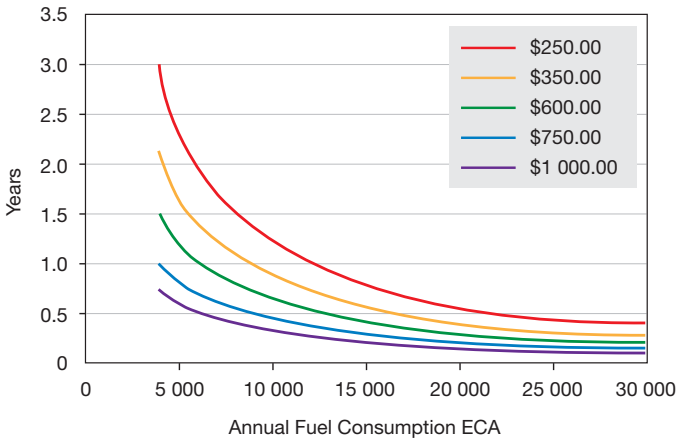
The rules range from the International Maritime Organization's MARPOL Annex VI, regulation 4 as detailed in resolution MEPC 259(68) to the European Union Directives 2012/33/EU. Some areas may also be faced with national or local rules.

Business as usual is no longer an option. To comply with incoming rules, ship owners must switch to costly low Sulphur fuel, or choose abatement technology. The requisite for sulphur levels in Emission Control Areas (ECA) is now 0.1% and will be 0.5% worldwide by either 2020, therefore the marine industry needs to choose a path on how to achieve compliance.

Integrated compliant solutions for all ship types

Wärtsilä exhaust gas cleaning technology is an economical and environmentally friendly solution for tackling all new and existing rules and regulations and are designed to provide flexibility and reliable operations wherever you operate.

Fig.1 Return on investment with a typical payback time of less than three years



10 MW main engine, 3 x 0.5 MW aux engines.
Total investment cost $3 million.

Exhaust gas cleaning meets the highest standards of compliance; recognised as a viable technology by the IMO, the European Union, the US Environmental Protection Agency and the British Parliament. Avoiding costly distillate fuel with a typical payback time of three years, depending on operational profile and trading pattern within ECA.

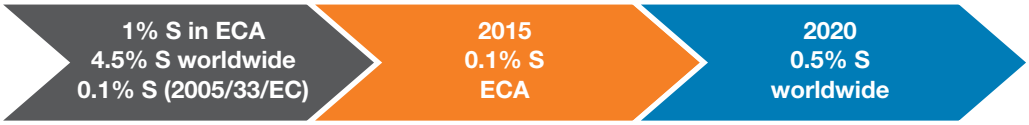
Wärtsilä's solutions are designed to provide flexibility and reliable operations wherever you operate. The systems are suitable for both new buildings and retrofitting of existing vessels having either 2-stroke or 4-stroke engines, as well as oil-fired boilers.

Wärtsilä have an unrivalled reference list, and data from operational exhaust gas cleaning units confirm sulphur oxide gas removal in excess of 98%. This means that by installing Wartsila SOx scrubber systems vessels are ECA compliant and the systems provide unparalleled reductions in harmful ship emissions.

Opting for Wärtsilä exhaust gas cleaning technology instead of switching fuel results in;

- Lower operating costs through access to less costly fuel
- Avoiding fuel switching, storage and availability and technical issues
- Reducing your operational impact on the environment

Fig.2 Existing and future regulations on emissions to air



S = Sulphur Emissions ECA = Emission Control Areas

Fig.3 Existing emission control areas

Emission Control Areas

WÄRTSILÄ OPEN LOOP SCRUBBER SYSTEM

Our scrubber system is based on the same technology as that used in Wärtsilä Hamworthy's inert gas systems for more than 50 years.

The system operates in an open loop utilising seawater to remove SO_x from the exhaust. Exhaust gas enters the scrubber and is sprayed with seawater in three different stages. The sulphur oxide in the exhaust reacts with water and forms sulphuric acid. Chemicals are not required since the natural alkalinity of seawater neutralises the acid.

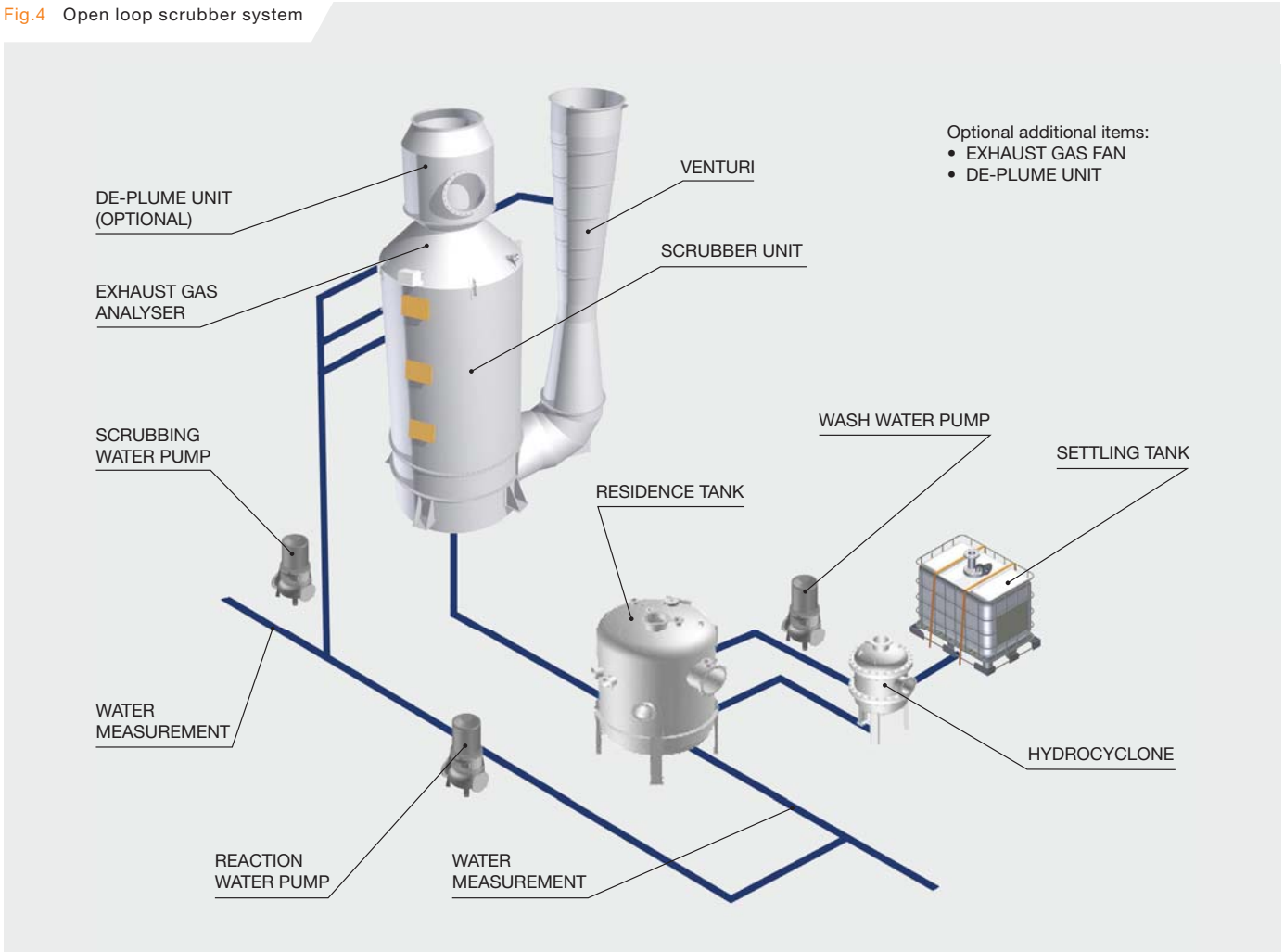
Wash water from the scrubber is treated and monitored at the inlet and outlet to ensure that it conforms with the MEPC 184(59) discharge criteria. It can then be discharged into the sea with no risk of harm to the environment.

Reference 1 Jolly Diamante

JOLLY DIAMANTE

Wärtsilä supplied open loop scrubber systems to Korean yard STX Offshore & Shipbuilding for four new 45,000 dwt Ro-Ro ships for Italian owner Ignazio Messina & C. The vessels will burn residual fuel oil, and the scrubbers ensure that the 0.1% fuel sulphur content emission regulations can be met. These vessels are the first of their type to gain the RINA's Green Plus notation, and the Wärtsilä open loop scrubber systems are all MED certified. Ignazio Messina's vessel Jolly Diamante was the first ever vessel to operate commercially with a scrubber system when it entered service in December 2011.

Fig.4 Open loop scrubber system



WÄRTSILÄ CLOSED LOOP SCRUBBER SYSTEM

The Wärtsilä closed loop scrubber system works continuously in closed loop, which means that one does not need to worry about sea water alkalinity levels. This system is best suited for full time operation in low alkalinity areas (e.g. Great Lakes).

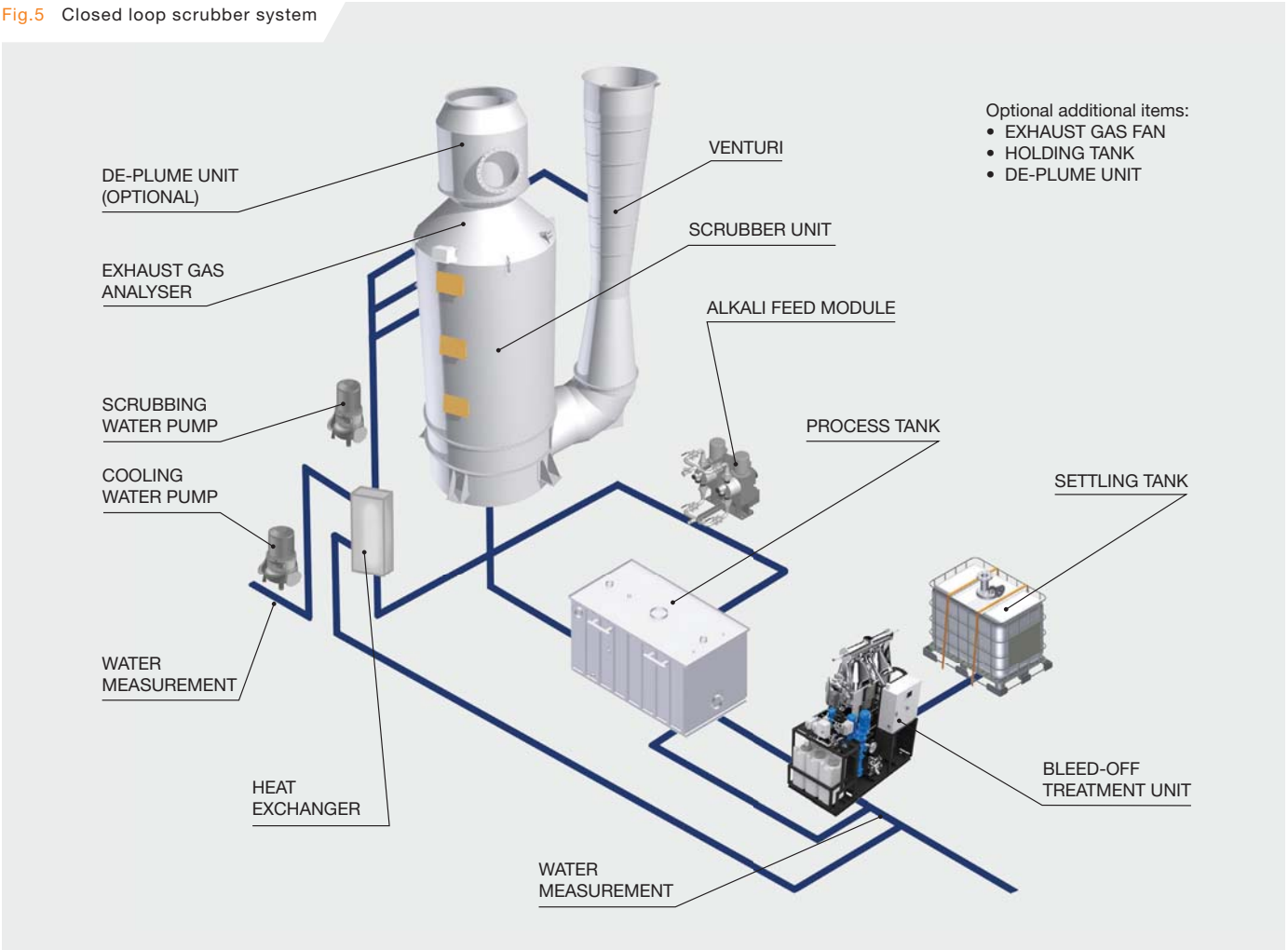
In a closed loop scrubber system, the exhaust gas enters the scrubber and is sprayed with sea water that has been mixed with caustic soda (NaOH). The sulphur oxides in the exhaust react with this mixture and are neutralised. A small bleed-off is extracted from the closed loop and treated to fulfil IMO requirements. Cleaned effluents can be safely discharged overboard with no harm to the environment. If operation in zero discharge mode is requested, the effluent can be led to a holding tank for scheduled and periodical discharge.

Reference 2 Stena Line

STENA LINE

Two Ro-Ro vessels owned and operated by Stena Line, the Sweden based transport and ferry company, are to be retrofitted with Wärtsilä I-SOx closed-loop scrubber systems. The scrubbers will be installed on the 'Stena Transit' and 'Stena Transporter' ferries operating between Hoek van Holland in the Netherlands and Killingholme in the U.K. By installing Wärtsilä scrubber systems, the ferries will comply with the regulations covering emissions of sulphur oxides (SOx) while using conventional residual marine fuel (HFO). The operating routes of these two ferries fall within the North Sea's Sulphur Emission Control Area (SECA). The compact design of the I-SOx system saves space and it also facilitates easier and faster installation, thereby reducing the time that the vessels need to be out of service for retrofitting. As part of this contract Wärtsilä will, in addition to the scrubbers, also supply engineering support, technical advisor services, and commissioning of the systems.

Fig.5 Closed loop scrubber system



WÄRTSILÄ HYBRID SCRUBBER SYSTEM

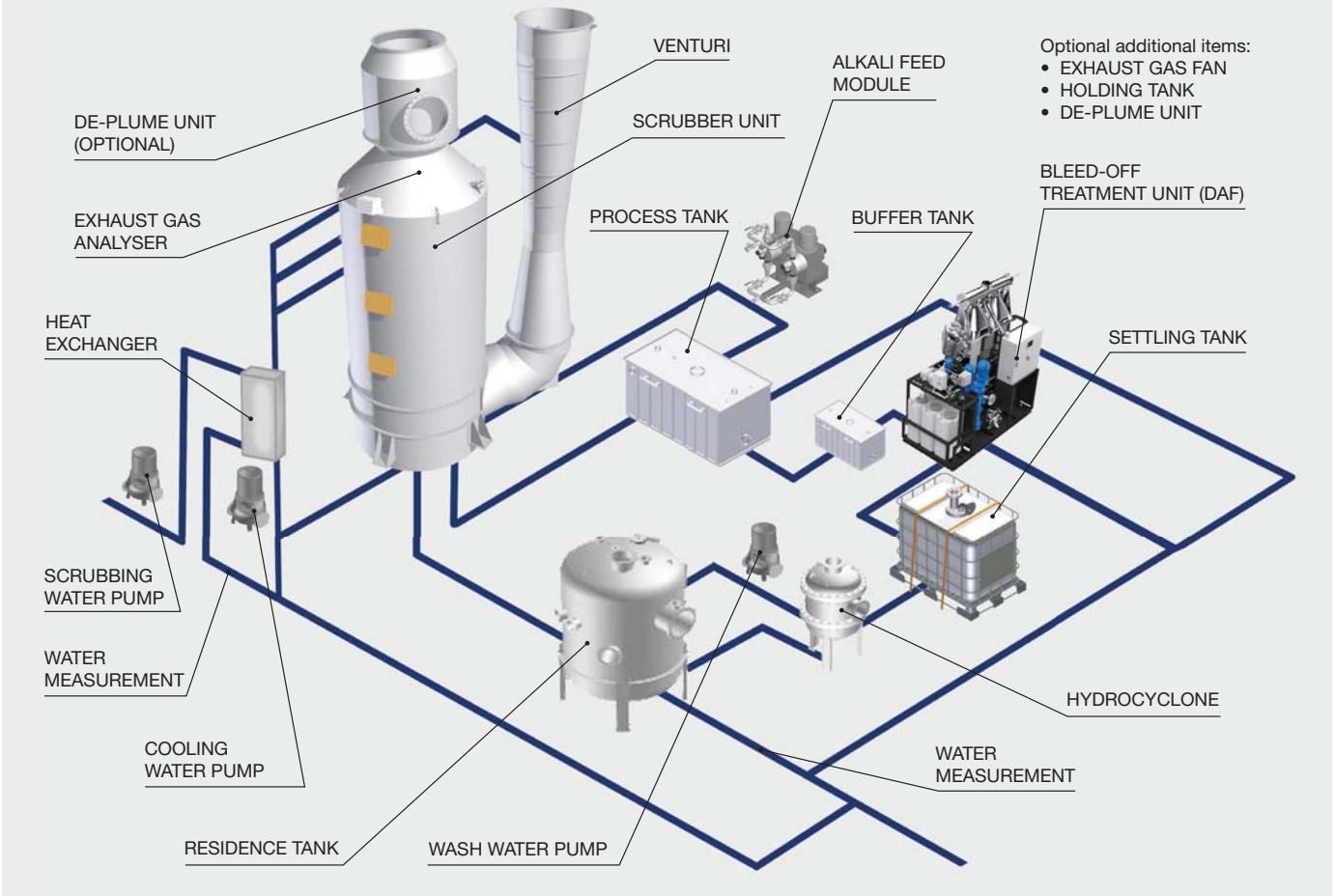
Wärtsilä additionally provide hybrid solutions. These solutions have the flexibility to operate in both open and closed loop. This provides a flexibility of operation in low alkaline waters as well as the open ocean. The hybrid approach enables operation in closed loop mode when required, for instance whilst in port and during maneuvering using NaOH as a buffer. The system can be operated in zero discharge mode for a limited period. When at sea the switch can be made to open loop using only seawater.

Reference 3 MV Tarago

MV TARAGO

Wilh. Wilhelmsen ASA has retrofitted their Mark IV RoRo, MV Tarago, with a Wärtsilä V-SOx hybrid scrubber system. Wärtsilä's hybrid solution for this vessel is the world's largest multi-stream scrubber removing sulphur and particulates from the exhaust gases of the vessel's main and auxiliary engines. The innovative project is being verified by Marintek, the Norwegian Marine Technology Research Institute, and aims to endorse the viability of scrubbing as an efficient and cost effective solution for ECA compliance. Following the success of this project Wärtsilä also supplied its Hybrid Scrubber Systems to four new Post-Panamax car carriers built for Wilhelmsen Lines Shipowning Malta (WLSM), a subsidiary of Oslo-based Wilh. Wilhelmsen ASA. These vessels were delivered from the Hyundai Samho Heavy Industries (HSHI) yard in South Korea, a subsidiary of HHI.

Fig.6 Hybrid scrubber system



WÄRTSILÄ I-SOx SCRUBBER SYSTEM

Where there are space restrictions that prove a challenge for scrubber system operations, Wärtsilä's innovative I-SOx scrubber system overcomes these issues and eases the installation process.

Wärtsilä's I-SOx scrubber system operates as a conventional V-SOx Wärtsilä scrubber with the exception that the exhaust gas flow enters directly from the bottom.

The Wärtsilä I-SOx system is designed for saving space and providing operational flexibility. The fact that the system has a reduced footprint and no external venturi means that installation is made easier, which consequently reduces the time the vessel is out of service.

Inline scrubber system

COMPLETE SHIP DESIGN

Wärtsilä can also provide complete ship design and a variety of pump systems. Having the largest installed base of any marine scrubber supplier and a dedicated test laboratory, has enabled Wärtsilä to optimise their products to be reliable, easy to operate and easy to install.

A number of different features can easily be added to the design:

- Open loop
- Closed loop
- Hybrid system
- Integrated scrubber
- Mainstream scrubber
- Improved particulate matter capture
- Fan assistance for lower back pressure
- De-plume to avoid a potential steam plume
- Turn-key delivery with onboard modifications and fine-tuning of the system

RETROFIT SOLUTIONS - TURNKEY SUPPLY

Wärtsilä can develop tailored retrofit turnkey solutions in close cooperation with the customer - from the very first enquiry - until the system is successfully delivered and the project complete. The main phases of a Wärtsilä turnkey project are:

PHASE 1

Initial Phase

- Information collection: ship details and operating profile
- Price indications (previous projects)

PHASE 2

Feasability/ concept engineering

- Ship survey
- Equipment configuration
- Concept/GA Interfacing verifications
- Feasibility report
- Capex/opex estimates
- Project outline

PHASE 3

Basic engineering; project planning; contractors' selection

- Basic engineering
- Preliminary approvals
- Final project plan
- Sub-contractors selection
- Firm offer and contract for turnkey delivery

PHASE 4

Detailed engineering and procurement

- Completion of basic engineering
- Detailed engineering
- Procurement
- Drawings approvals from class
- Installation preparations

PHASE 5

Construction and installation

- Equipment delivery for prefabrication/ installation
- Prefabrication
- Installation works and site management

PHASE 6

Approvals and commissioning

- Tests
- Approvals from Flag/Class
- Commissioning
- Crew trainings
- Hand over
- Start of lifecycle support

Wärtsilä's service network reaches almost all corners of the world. This extensive coverage ensures that plant operators receive fast and effective response to their maintenance needs.

Our services & support solutions range from basic support, installation and commissioning, performance optimization, upgrades and conversions to service projects and agreements focusing on overall equipment performance and asset management.

Wärtsilä can also support plant owners with O&M agreements that offer the following benefits:

- **Ensured productivity** throughout the lifecycle of the asset
- **High availability** with minimized unplanned downtime
- **Predictability** of maintenance costs over the medium to long term
- **Attention to safety** and environmental aspects

SUPPORT THROUGHOUT THE ENTIRE LIFECYCLE

At Wärtsilä we strive constantly to do what is best for you. This includes optimising the lifecycle value of your installations by offering precisely what you need; a promise we can deliver on since we provide the marine industry's most complete portfolio of products, integrated solutions and global services.

By prioritising operational efficiency, environmental excellence, fuel flexibility and 24/7 support, we work with you to find your shorter route to robust growth, greater profitability and regulatory compliance. This is why today, every third vessel in the world has a Wärtsilä solution onboard.

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ENERGY
ENVIRONMENT
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