RAINIONS OVERVIEW

By Mark DiCarlo

OVERVIEW

- The Problem
- The Solution
- Science
- Full Capture System
- Non-Full Capture System
- RainIons Video
- Footnotes

THE PROBLEM

- The World Health Organizations defines air pollution as the "contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere." [1]

- "Pollution kills more people worldwide each year than almost everything else combined – smoking hunger, natural disasters, war, murder, AIDS, tuberculosis and malaria." [2]

THE PROBLEM

"Climate change means a significant change in the measurements of climate, such as temperature, rainfall, or wind, lasting for an extended period – decades or longer." [3]

- **Earth's climate is changing and getting warmer. [4]**
- **"The planet's average surface temperature has risen about 2.05 degrees Fahrenheit (1.14 degrees Celsius) since the late 19th century." [4]**

THE PROBLEM

Climate change is causing harmful effects on the environment and endangering the health of mankind. [5]

Climate change:

- **Is causing sea levels to rise, which threatens ecosystems and coastal communities.** [5]
- **"Affects the social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter."** [6]
- **Increases the intensity, frequency and duration of heat waves which creates stress on the body and exacerbates the the top causes of deaths globally.** [7]
- **Increases the intensity and/or frequency of extreme weather events (droughts, flood, hurricanes, wildfires).** [8]
- **Is exacerbating the spread of diseases.** [9]
- **Could drive as many as one in six plant and animal species to extinction.** [10]

THE PROBLEM

"Scientists contribute the global warming trend observed since the mid-20th century to the human expansion of the "greenhouse effect" – warming that results when the atmosphere traps heat radiating from Earth toward space." [11]

Carbon dioxide (CO_2):

- **"CO_2 is the greenhouse gas most commonly produced by human activities and it is responsible for 64% of man-made global warming." [12]**

- **"Removing CO_2 from the air is the only hope for fixing climate change." [13]**

THE SOLUTION

Introducing RainIons:

- A 100% green technology company that eliminates air pollution via a unique combination of negative ions and precipitation.
  - Scientific studies validate negative ions eliminate air pollution. [14]
  - "Precipitation is the atmosphere's single most effective way of removing particulate pollution." [15]
    - This happens because "raindrops take the pollutants with them as they fall from the atmosphere," [15] including CO_2. [16]

THE SOLUTION

Scientifically proven to work!

- A recently completed feasibility study determined RainIons could eliminate airborne pollution by up 99%, including particulate matter 2.5 and smaller and CO_2.

SCIENCE

Atoms: [17]

- An atom is the basic unit that makes up all matter (substance) and the defining structure of elements.

Atoms are made up of three kinds of smaller particles:

- Protons: Positively charged
- Neutrons: Have no charge
- Electrons: Negatively charged

"Like charges repel each other; unlike charges attract." [18]

"Thus, two negative charges repel one another, while a positive (+) charge attracts a negative (-) charge." [18]

SCIENCE

Ions: [19]

- When at atom gains or loses electrons, they develop a charge.
- Ions are atoms that bear an electric charge.
- Positive Ion (Cation): An atom that loses electrons (has more protons than electrons), and thus has a positive charge.
- Negative Ion (Anion): An atom that gains electrons (has more electrons than protons), and thus has a negative charge.

SCIENCE

Positive Ions are found in: [20]

- Cities
- Chemicals and aerosols
- Electric/electronic appliances
- Vehicle exhaust fumes

Pollution carries a positive charge:

- Per the International Bio-Environmental Foundation (IBEF):

- "Nearly all of the airborne particles (e.g. dust, bacteria, chemical pollutants, virus and fungus spores, and the particles of moisture in which they are frequently trapped) that affect human health are also positively charged." [21]

SCIENCE

Negative Ions are naturally generated by:

- The Lenard Effect: "The generation of electric charges by the splashing of water." [22]
  - "High negative ion concentration gradients are detected in the vicinity of the waterfalls, whereas the increase of position ions was only moderate." [23]
  - "As water breaks up, the positive charge remains with the larger drop and the negative charge flies free with the fine spray, forming neg-ions (negative ions)." [24]

SCIENCE

Negative Ions are naturally generated by:

- Pyroelectric materials: Ability to generate an electric charge/potential and negative ions when they are heated or cooled/change in temperature. [25]
- Piezoelectric materials: Ability to generate an electric charge/potential and negative ions in response to stress. [26]
  - Note: All known pyroelectric materials are also piezoelectric. [27]
- Sunlight: Sunlight breaks apart air molecules to create negative ions. [28] Near the earth's surface, sunlight splits air molecules apart like it does in the stratosphere. [29]

SCIENCE

Air pollution is harmful/toxic:

- The toxicity derives from the chemical properties of a pollutant's molecular composition.
- By changing a pollutant's molecular composition/structure you can transform the pollutant into something safe.

SCIENCE

Negative (-) ions eliminate air pollution by:

- **(1) Neutralizing positively charged pollutants.**

- **(2) Making unstable pollutants even less stable (e.g., eventually causing decomposition), even if the molecule is not positively charged, and/or:**

- **(3) Utilizing the electron affinity of certain molecules to absorb electrons, even if the molecule is not positively charged.**

SCIENCE

Negative ions change the molecular composition of the pollutant to transform it into something safe by:

- **Purifying the pollutant/making the pollutant not-harmful/non-toxic.**
- **Causing the pollutant to decompose/dissolve.**
- **Making the pollutant too heavy to stay suspended in the air, which prevents humans from breathing in the pollutant. The pollutant then eventually decomposes/dissolves.**

SCIENCE

For Carbon Dioxide (CO_2), negative ions/electrons:

- **Can capture CO_2.**
- **One negative ion can capture 8-12 CO_2 molecules, with 11 being the expected value.**
- **The negative ion capturing the CO_2 transforms and purifies/breaks down/dissolves the pollutant.**

SCIENCE

Precipitation/water:

- Captures all types of pollution.
- "Precipitation is the atmosphere's single most effective way of removing particulate pollution." [15]
  - This happens because the "raindrops take the pollutants with them as they fall from the atmosphere," [15] including CO_2. [16]

FULL CAPTURE SYSTEM

The RainIons' full capture system uses:

- **Tourmaline (which is both pyroelectric and piezoelectric):**

- **Will generate negative ions when the temperature inside the system changes (pyroelectric) and when pressure is applied to it (piezoelectric).**

Sunlight:

- **Sunlight shining inside the system via transparent solar windows will break apart air molecules to create negative ions.**

Water:

- **The system will create mist, raindrops, streams, blasts, full shields of water/waterfalls insider the system to simulate precipitation.**

  - **The splashing of water inside the system will create negative ions via the Lenard Effect.**

  - **The precipitation/water will capture/trap pollution.**

FULL CAPTURE SYSTEM

The full capture system is designed to be a standalone system.

Use cases:

- **Industry: Eliminating pollution from a furnace flue gas or other gas streams.**
- **Atmospheric pollution elimination/capture (including CO2 and particulate matter 2.5 and smaller).**
- **Use over polluted cities (on top of buildings, attached to a hybrid airship, downwind from forest fires, etc).**

FULL CAPTURE SYSTEM
PROCESS FLOW CHART

POLLUTANTS

SMOKESTACK POLLUTION

PARTICULATE POLLUTION
(PARTICULATE MATTER)
- PM 10
- PM 2.5

CARBON MONOXIDE

SULFUR OXIDES

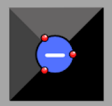
NITROGEN OXIDES

GROUND LEVEL OZONE

CARBON DIOXIDE (CO_2)

METHANE

SUNLIGHT



TOURMALINE

WATER

FULL CAPTURE SYSTEM
PROCESS FLOW CHART

POLLUTANTS

SMOKESTACK POLLUTION

PARTICULATE POLLUTION
(PARTICULATE MATTER)
- PM 10
- PM 2.5

CARBON MONOXIDE

SULFUR OXIDES

NITROGEN OXIDES

GROUND LEVEL OZONE

CARBON DIOXIDE (CO_2)

METHANE

SUNLIGHT

TOURMALINE

WATER

FULL CAPTURE SYSTEM
PROCESS FLOW CHART

POLLUTANTS

SMOKESTACK POLLUTION

PARTICULATE POLLUTION
(PARTICULATE MATTER)
- PM 10
- PM 2.5

CARBON MONOXIDE

SULFUR OXIDES

NITROGEN OXIDES

GROUND LEVEL OZONE

CARBON DIOXIDE (CO_2)

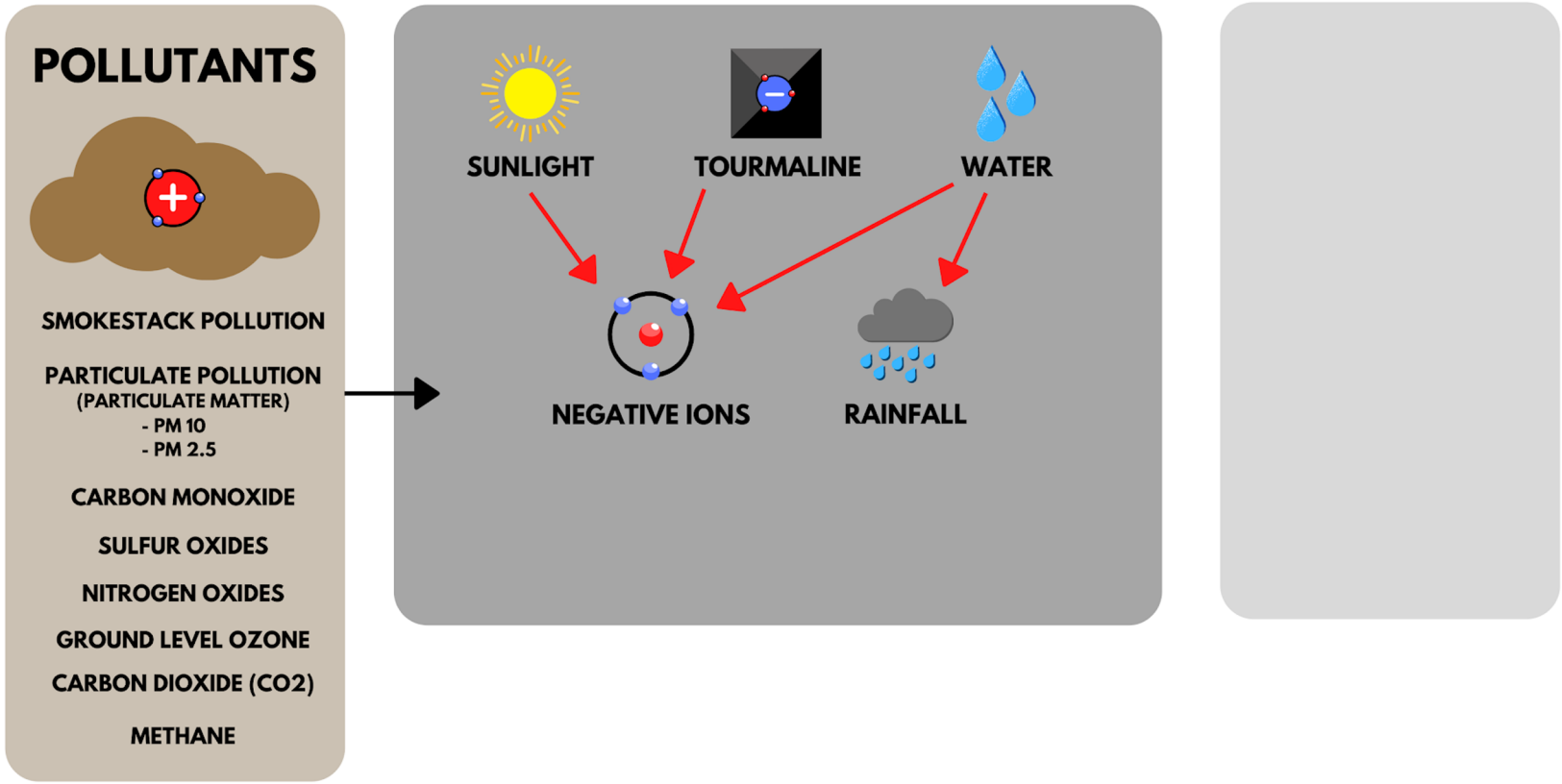
METHANE

SUNLIGHT

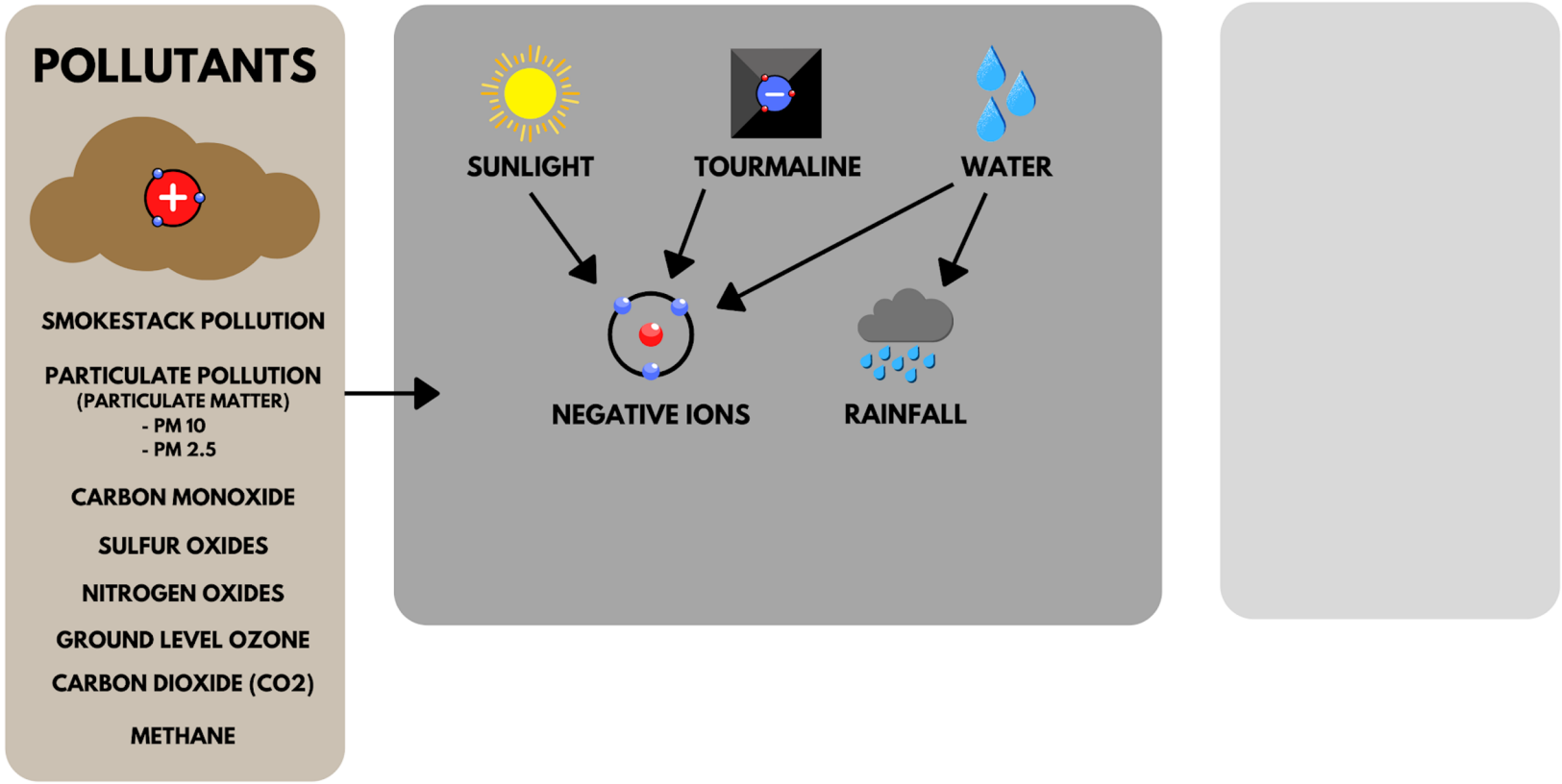
TOURMALINE

WATER

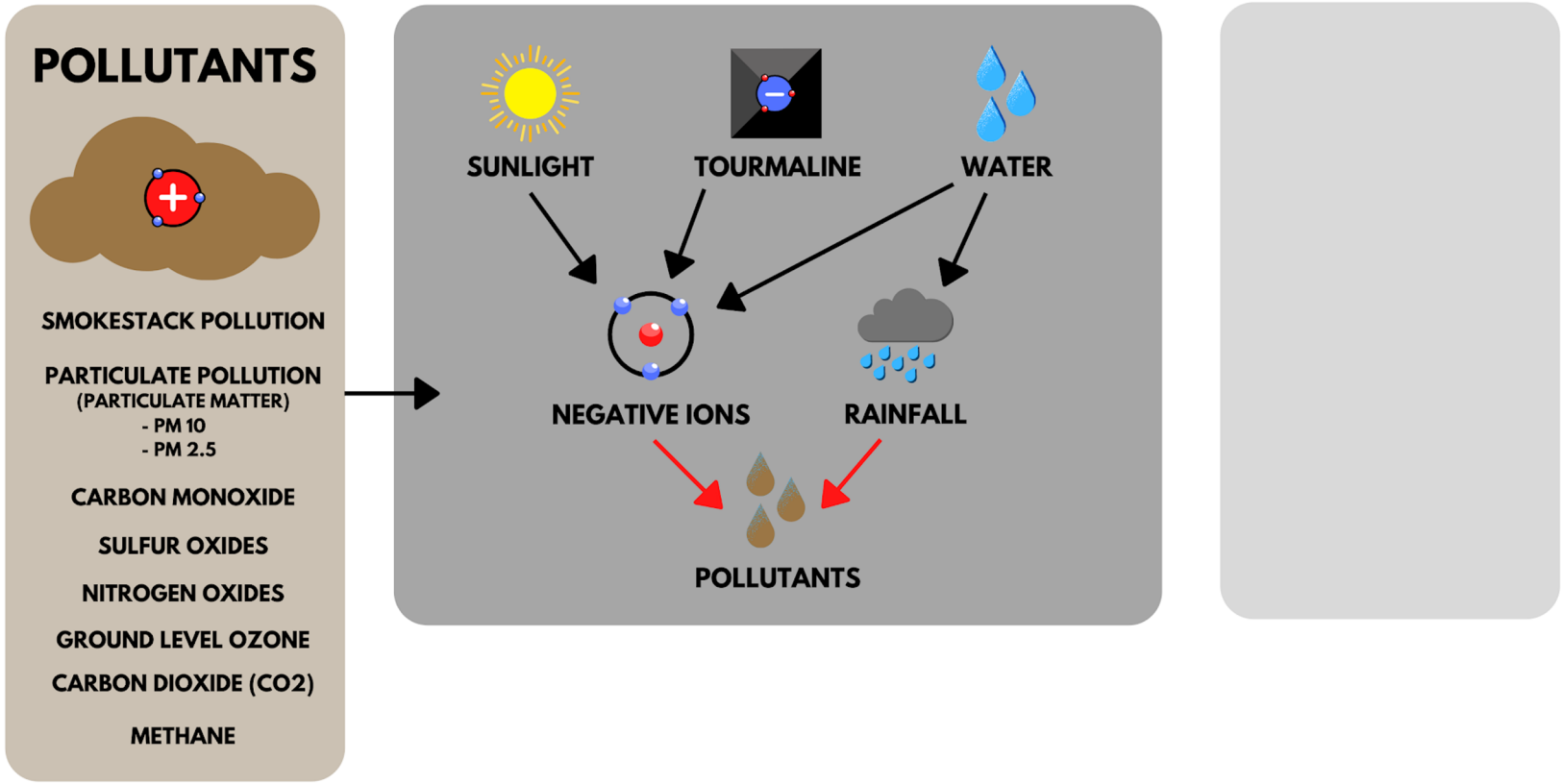
FULL CAPTURE SYSTEM
PROCESS FLOW CHART



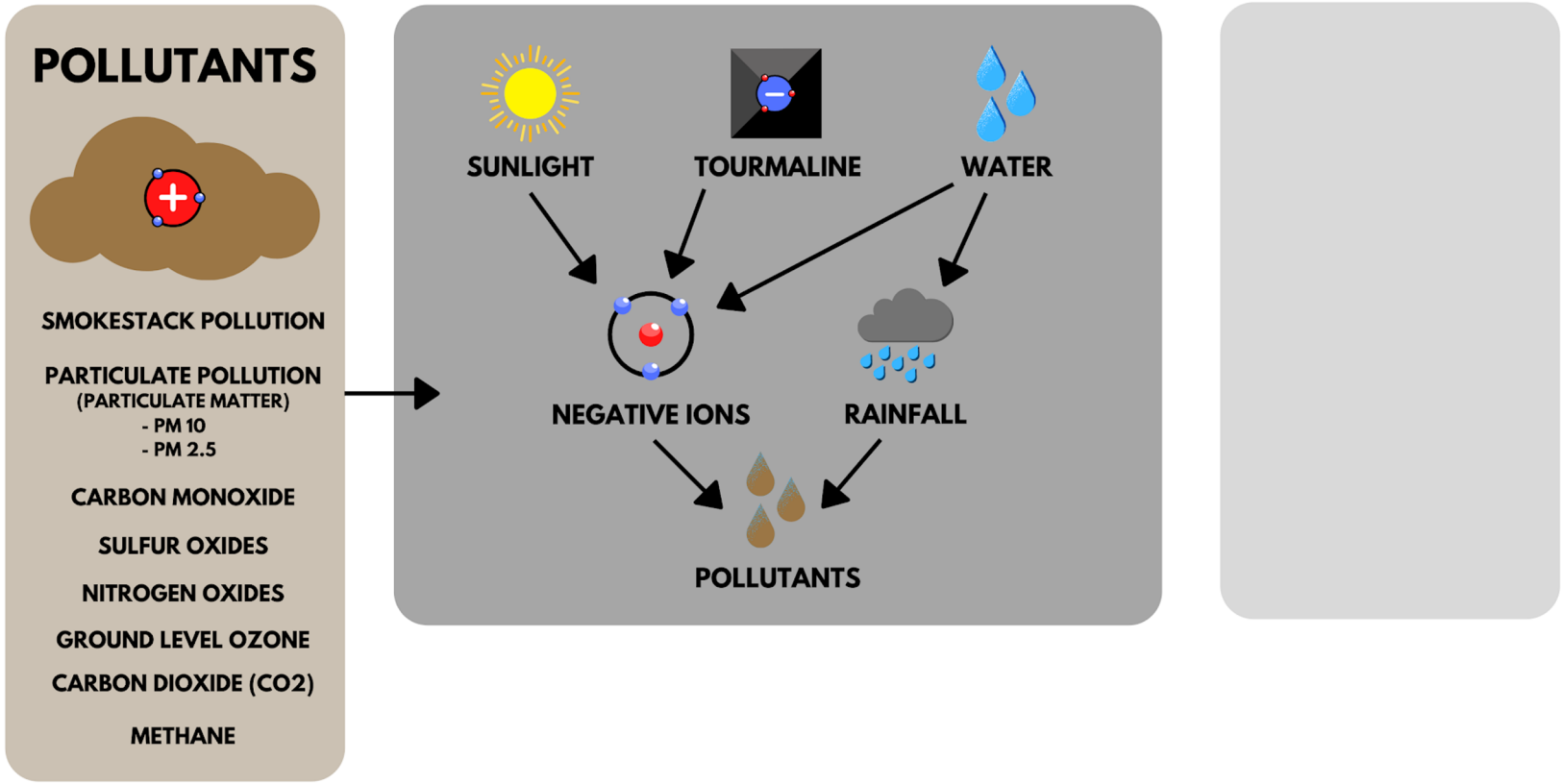
FULL CAPTURE SYSTEM
PROCESS FLOW CHART



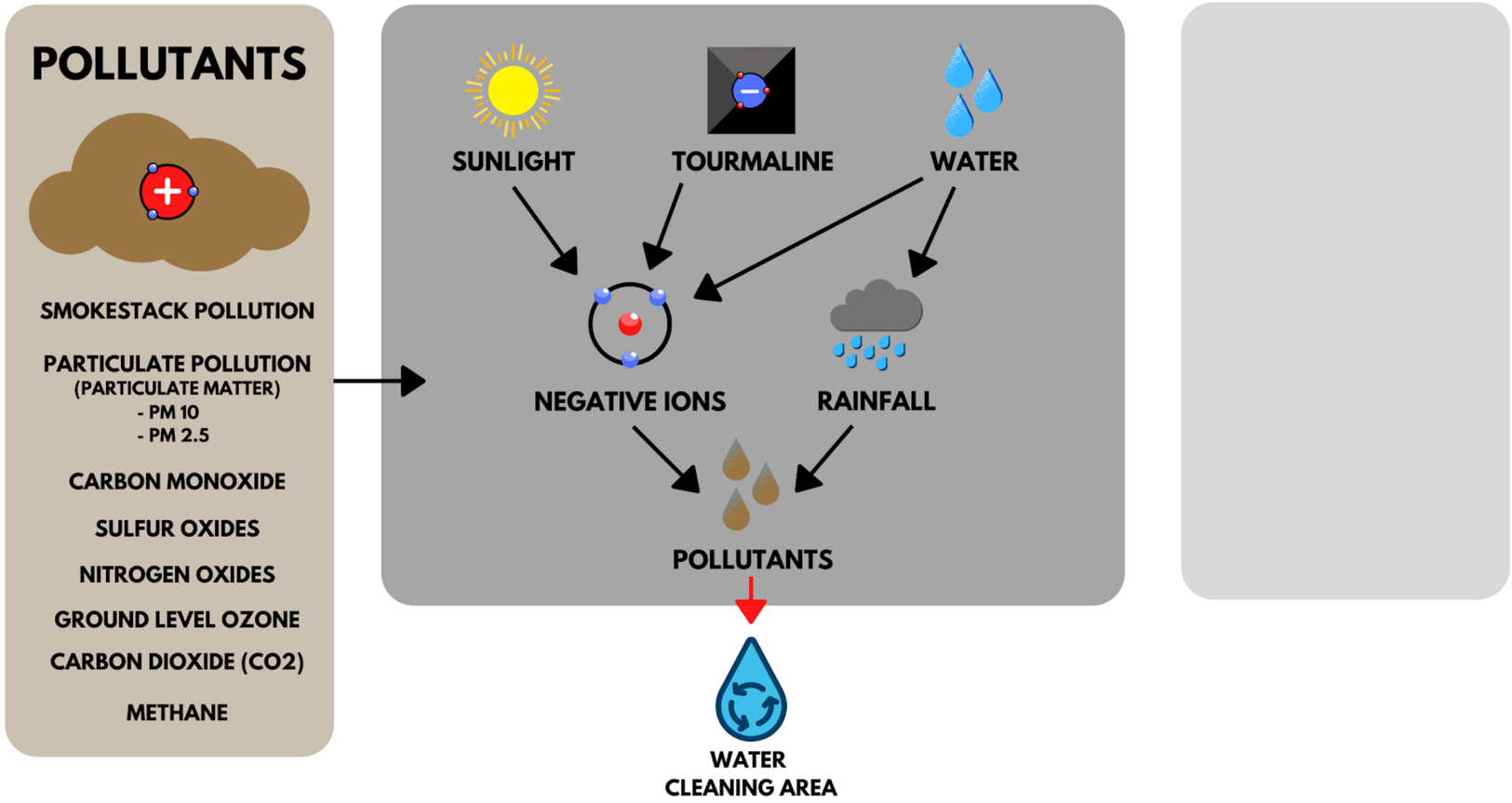
FULL CAPTURE SYSTEM
PROCESS FLOW CHART



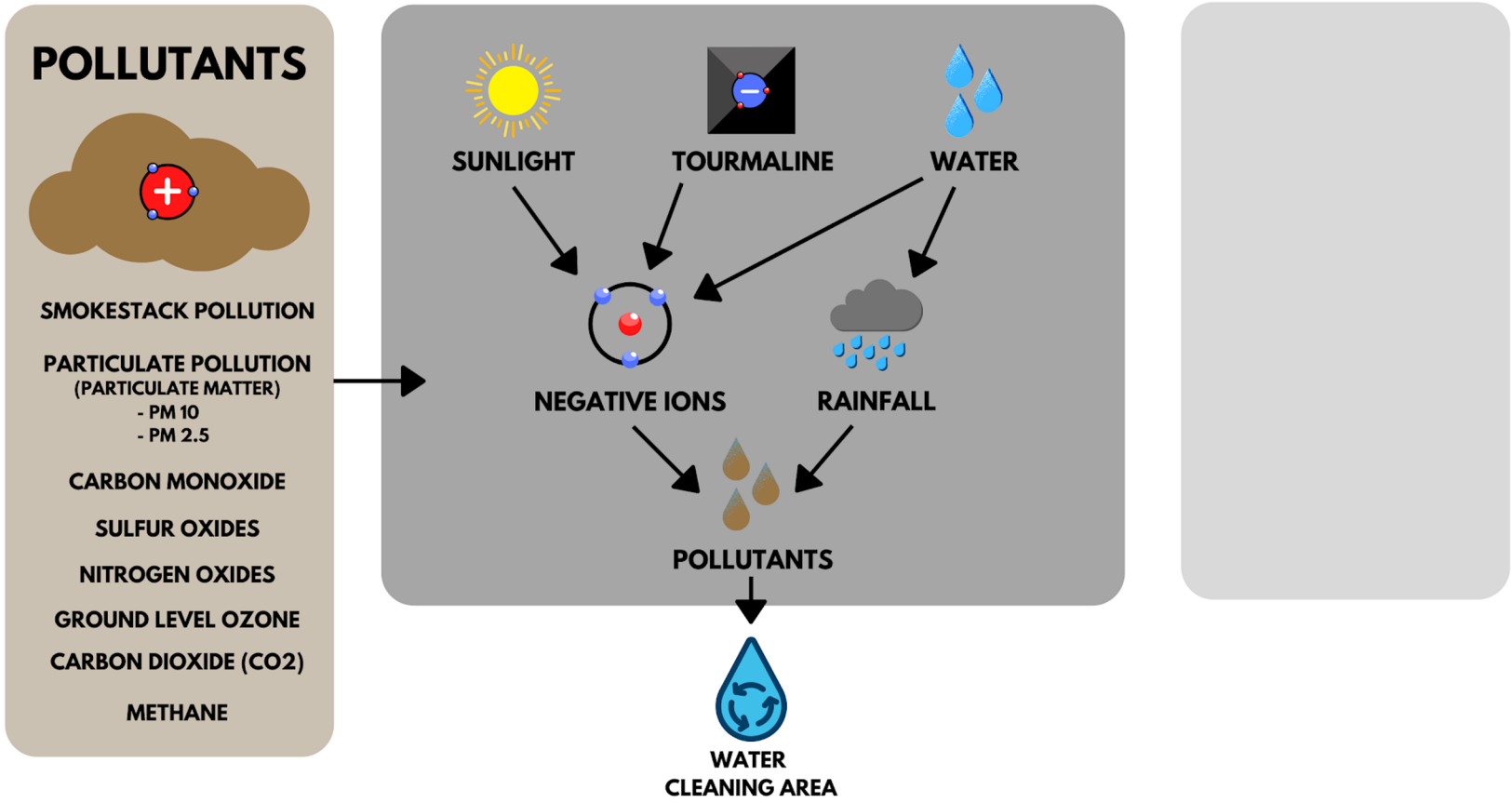
FULL CAPTURE SYSTEM
PROCESS FLOW CHART



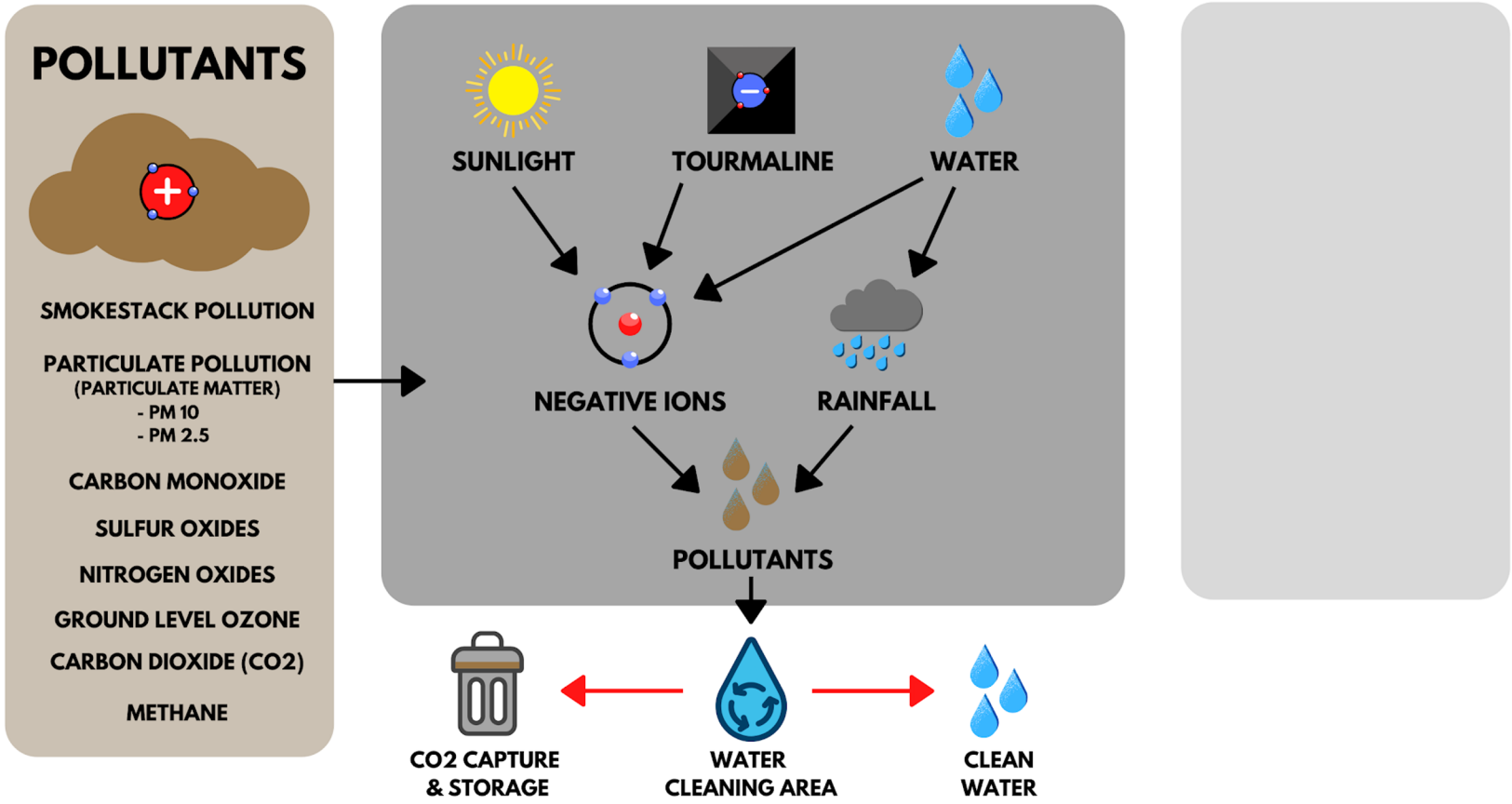
FULL CAPTURE SYSTEM
PROCESS FLOW CHART



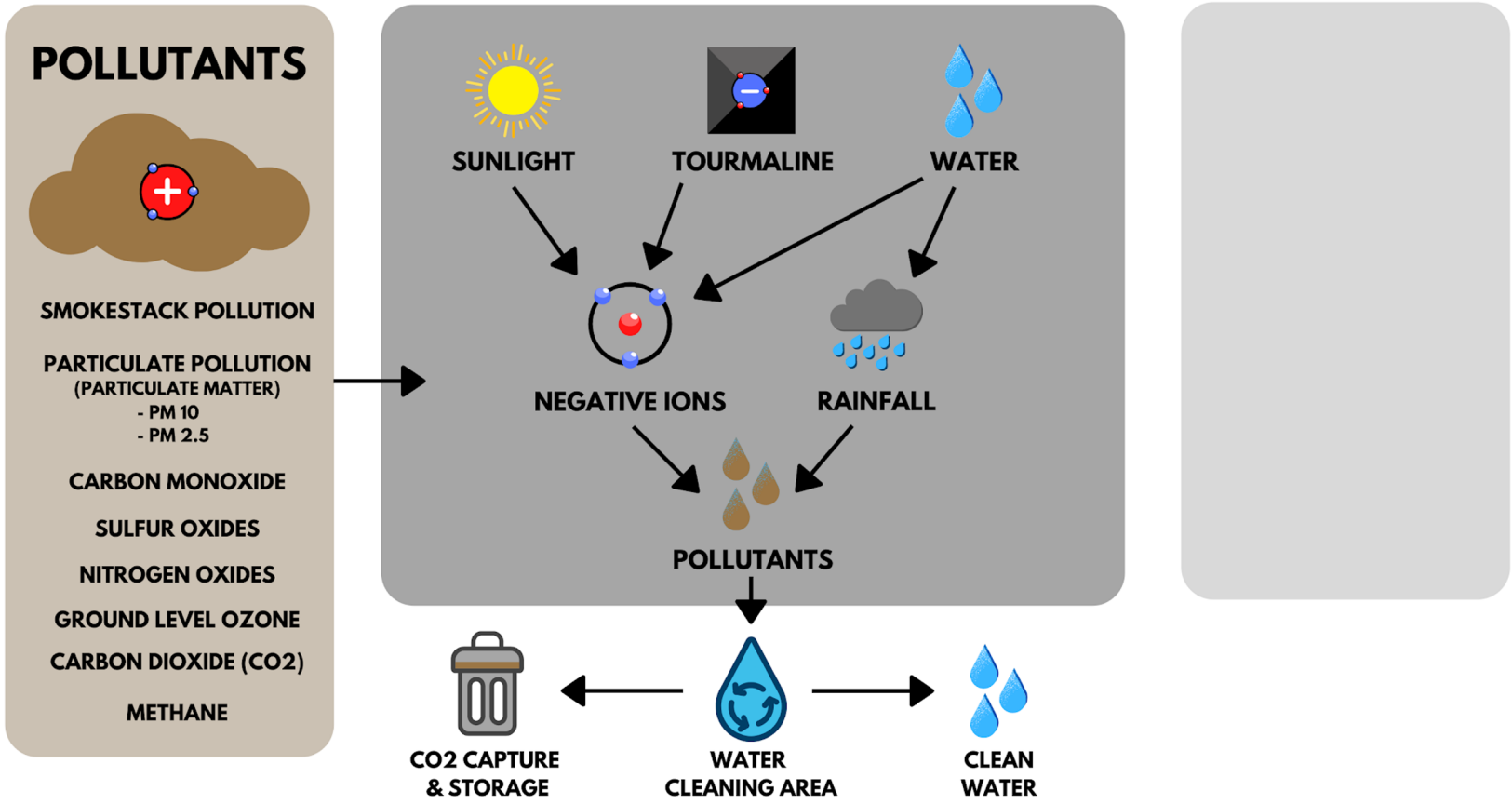
FULL CAPTURE SYSTEM
PROCESS FLOW CHART



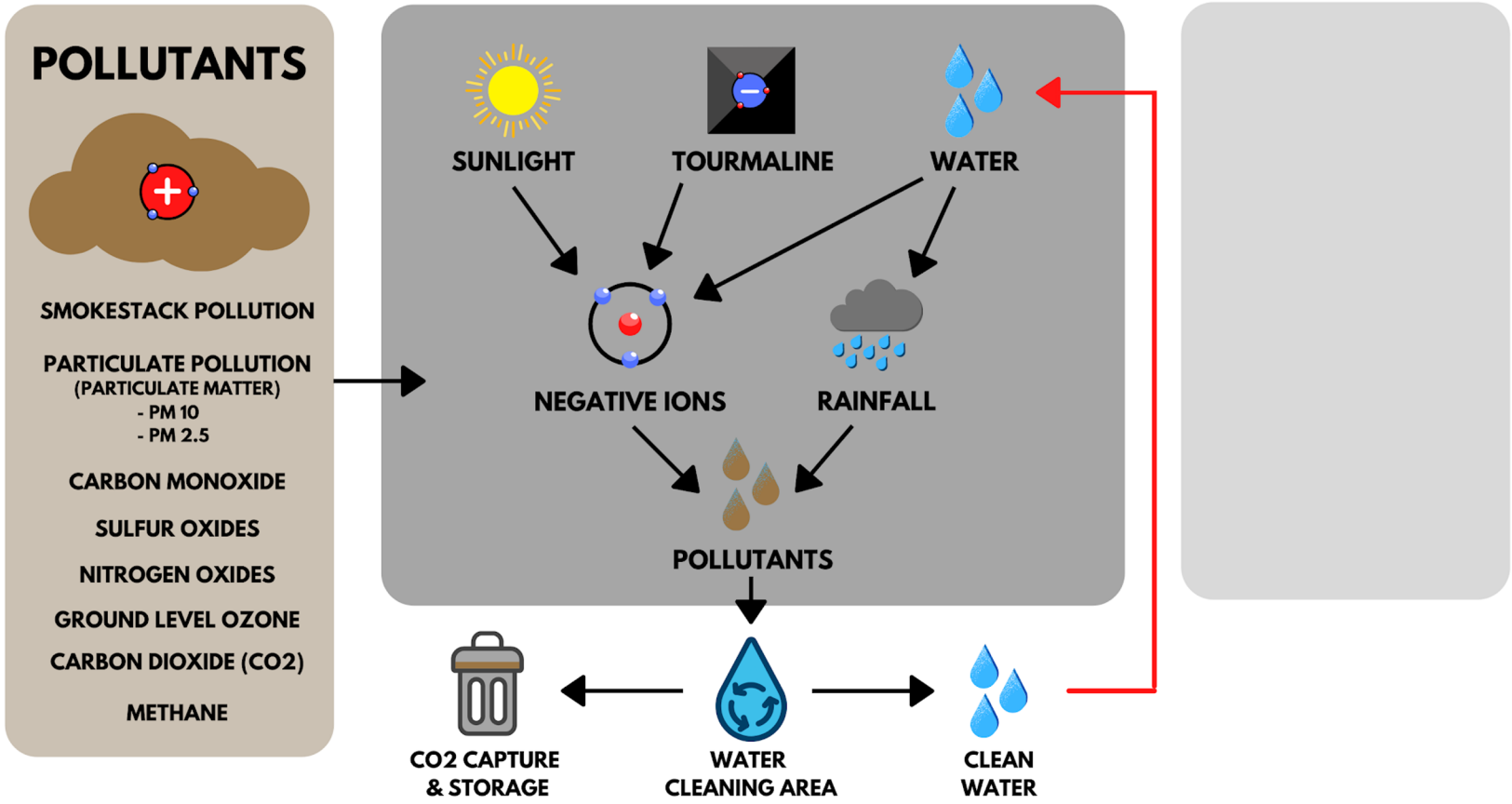
FULL CAPTURE SYSTEM
PROCESS FLOW CHART



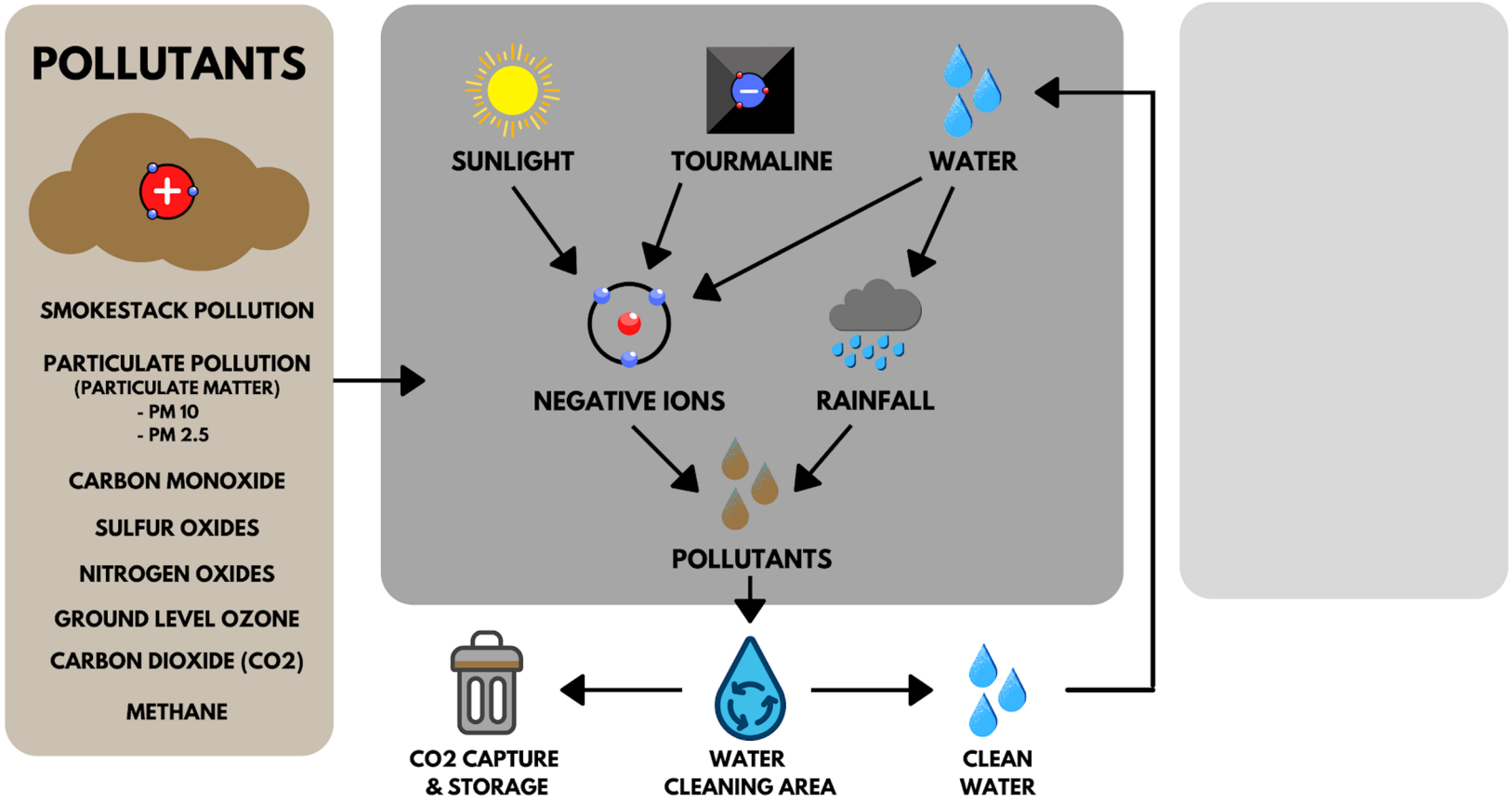
FULL CAPTURE SYSTEM
PROCESS FLOW CHART



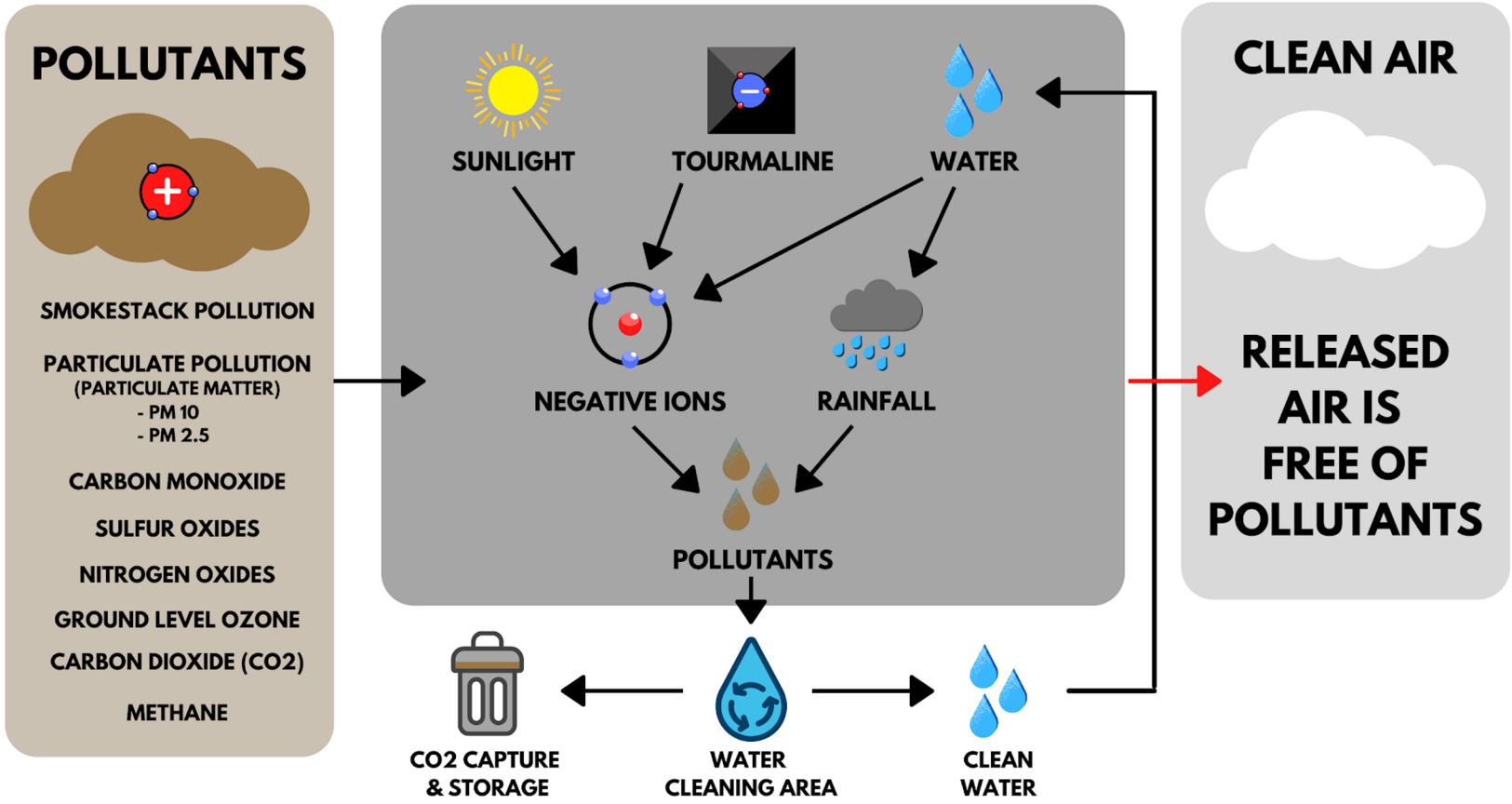
FULL CAPTURE SYSTEM
PROCESS FLOW CHART



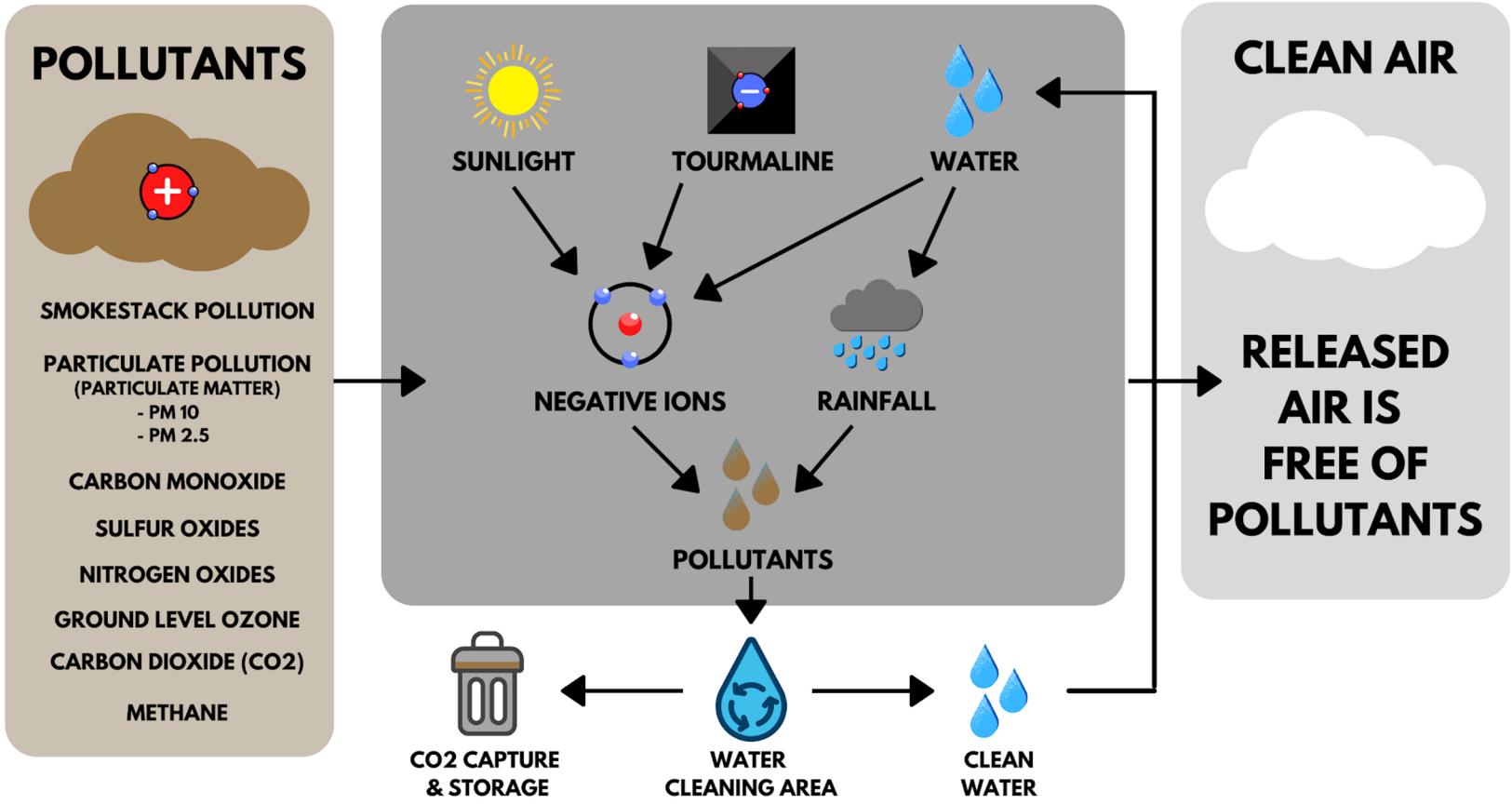
FULL CAPTURE SYSTEM
PROCESS FLOW CHART



FULL CAPTURE SYSTEM
PROCESS FLOW CHART



FULL CAPTURE SYSTEM
PROCESS FLOW CHART



FULL CAPTURE SYSTEM

The specific design/size will be tailored to the specific use case:

- The top compartment of the system is where the clean water will be stored.
- The middle compartment is where the air cleaning/purification occurs.
- The bottom compartment will be divided into two sections:
  - Section 1 is where the polluted water will be stored for cleaning.
    - The polluted water will be cleaned with a biodegradable cleaning solution that will eliminate the pollution and leave no harmful footprint on the earth.
    - The clean water will be reused in the system.
  - Section 2 is where the captured CO_2 will be stored for reuse in pharmaceuticals, beverages, enhanced oil recovery, etc.

FULL CAPTURE SYSTEM

All of the systems will have controls that provide the capability to be monitored/controlled remotely and directly on the system itself to allow adjustments to:

- **Speed and location of the fans.**
- **Location, direction and length of the cylinder tube fans.**
- **The amount of air the fans are taking in and the exhaust is releasing.**
- **Locations of the tourmaline mesh filters.**
- **Temperature of the system.**

FULL CAPTURE SYSTEM

All of the systems will have controls that provide the capability to be monitored/controlled remotely and directly on the system itself to allow adjustments to (continued):

- **Amount of pressure/power the water nozzles are releasing, to include:**
  - **Size, intensity, duration and direction of water released.**
- **Humidity level.**
- **Amount of sunlight being let in.**
- **Amount of water being drained from the middle to third compartment.**

FULL CAPTURE SYSTEM

Transparent solar cells/windows and concentrated solar collectors will be distributed on the system.

- **The amount of sun the solar windows allow in will be adjustable.**
- **The solar cells/windows and concentrated solar collectors will power the system and let sunshine into the middle compartment to break apart air molecules to create negative ions.**
- **Solar batteries will allow surplus solar energy to be stored for use during non daylight hours.**
- **The systems will also have the ability to run on electricity as a backup.**

A pump station in the top compartment will transfer water via stainless steel pipes to the middle compartment and provide the applicable water pressure.

FULL CAPTURE SYSTEM

The middle compartment will be lined with tourmaline and water-nozzles.

- **The diameter of water released from the nozzles is flexible.**
- **Size of the water released will range from 3+" to pure mist.**
- **The water pressure released from the nozzles must be capable of producing powerful water blasts like a fire hose (approximately 290 psi) on the high end, down to mist and drip/drop power (approximately 10 psi) capability on the low end.**
- **Nozzles must also be capable of emitting microbubbles.**
  - **"Micro-bubbles are bubbles smaller than one millimeter in diameter, but larger than one micrometer."** [30]

FULL CAPTURE SYSTEM

The middle compartment will also contain:

- **Waterproof video cameras to monitor operations.**
- **Air ion counter.**
- **Heating and cooling capability to control the temperature.**
- **Tourmaline mesh filters on the bottom of the system for polluted water drainage when the water option is used for cleaning.**
- **Humidity level monitoring capability.**

FULL CAPTURE SYSTEM

The middle compartment will also contain (continued):

- **Relative humidity gauge:**
  - **Relative humidity: "Is the amount of water vapor the air actually has (the absolute humidity) compared to the amount of moisture the air can hold at that temperature."** [31]
  - **Factors that affect relative humidity include atmospheric pressure, wind and temperature.** [32]
  - **Negative ions can exist stably when humidity is 40-60%."** [33]
  - **This is why the flow & size of the water, temperature, fan speed, and the amount of air being taken in and released will all be adjustable, for every nozzle/inlet & outlet valve in the system.**
    - **This will allow the optimum environment for negative ions to be maintained.**

FULL CAPTURE SYSTEM

Rails that allow additional fans and a series of tourmaline mesh filters will be positioned inside the middle compartment.

- **The mesh filters will also have tourmaline fused onto them.**
- **These mesh filters will also cover the front of the system where the fans pull in the polluted air and the back exhaust vent/vents where the clean air will be released.**
- **The exhaust vents will have the capability to have a series of tourmaline mesh filters evenly spaced close together to one another that the clean air will travel through before being released into the environment.**

FULL CAPTURE SYSTEM

Polluted air will be:

- Pulled into the middle compartment via tourmaline fans.
  - One large fan will be located on the front of the system.
  - Additionally, multiple, flexible, expandable/retractable, stainless steel cylinder tubes, lined with tourmaline, and tourmaline fans, will be able to be connected on all four sides on the front of the system.
    - This will allow pollution and dust to be pulled into the system from all directions.
    - The size, number and length of the tubes are flexible, again, depending on the size of the system being utilized.
    - The capability to use the water on the fans while in motion will also be available.

FULL CAPTURE SYSTEM

Tourmaline:

- When tourmaline is heated or cooled, or when pressure is applied to it, tourmaline becomes electrically charged and creates negative ions.

- In the full capture system, tourmaline will be heated and cooled:

  - When the heating and cooling system modifies the temperature to create the optimum humidity level for stable negative ions to exist.

  - When the temperature of the air changes.

  - When the water feature is used, and the water is a different temperature than the air.

FULL CAPTURE SYSTEM

In the full capture system, tourmaline will have pressure applied to it:

- **When the tourmaline fans are in motion.**
- **When air flows through the mesh filters.**
- **When the air/exhaust/pollutants flows across the surface of the tourmaline.**
- **When the water feature is used and water impacts the tourmaline filters and rocks.**

FULL CAPTURE SYSTEM

Water option:

To ensure the maximum number of negative ions are created and spread evenly, the full capture system will send water streams, pulses, microbubbles, drips and mist throughout the entire surface of the system:

- **High, medium, low… top to bottom… side to side… across the surface of the tourmaline mesh and rock filters distributed throughout the system.**
- **The water hitting the tourmaline rocks will simulate a waterfall to create negative ions.**
- **The water hitting the mesh filters will break up into fine spray to form negative ions.**
- **The temperature of the system, speed of the fans, flow, size and pressure of the water, and the amount of air being taken in and released will be regulated to ensure optimum humidity levels for negative ions to exist stably.**

FULL CAPTURE SYSTEM

Water option (continued):

The system will also have the capability to:

- Periodically create rain drops and mist to simulate weather precipitation.

- Create a wall of water over all of the air exhausts/outtake valves to ensure all pollution the negative ions do not eliminate is captured.

FULL CAPTURE SYSTEM

Water option (continued):

- The polluted water will then be drained through tourmaline mesh filters and stored in the third compartment for cleaning.

- CO_2 will be stored in a separate chamber in the third compartment.

  - Note: In the Full Capture System, CO_2 will be purified by the negative ions and also capture by water/precipitation.

NON-FULL CAPTURE SYSTEM

The RainIons non-full capture system is designed to be integrated with other technology/devices/equipment:

Use cases:

- **Vehicle emission pollution reduction:**
  - **Integration into vehicle mufflers/tailpipes.**
- **Industrial exhaust applications:**
  - **Integration into wet scrubbers, electrostatic precipitators, etc.**
  - **Lining the inside of factory smokestacks.**
- **Machinery:**
  - **Integration into the exhaust of tractors, lawn mowers, leaf blowers, tillers, etc. (Anything with an internal combustion engine exhaust pipe).**

NON-FULL CAPTURE SYSTEM

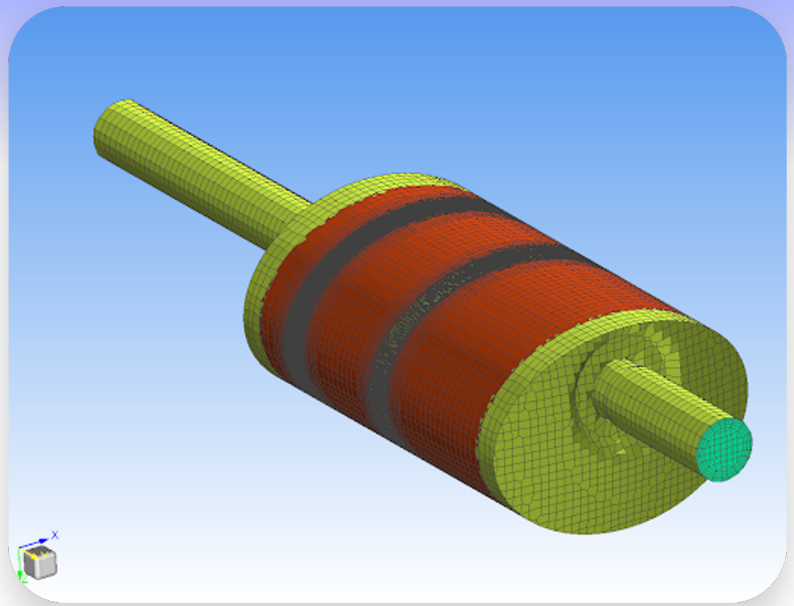
Use cases (continued):

- Heating, Ventilation & Air Conditioning (HVAC).
- Life sciences (hospitals, operating rooms, etc.).
  - Note: Negative ions can eliminate bacteria, [34 & 35] fungi, [34 & 36] and viruses. [37, 38 & 39]
- Integration into CO_2 capture systems.

NON-FULL CAPTURE SYSTEM

The RainIons non-full capture system uses:

- Pyroelectric materials that have the ability to generate an electric charge and negative ions when heated/cooled.
- Piezoelectric materials that have the ability to generate an electric charge in response to stress/pressure. Note: All know pyroelectric materials are also piezoelectric.
- Uniquely designed and placed filters.
  - Filters will guide the flow of exhaust onto the materials without causing any back pressure concerns.
- Water/vapor that is present in the operation (e.g., water/vapor that is part of the internal combustion engine process).

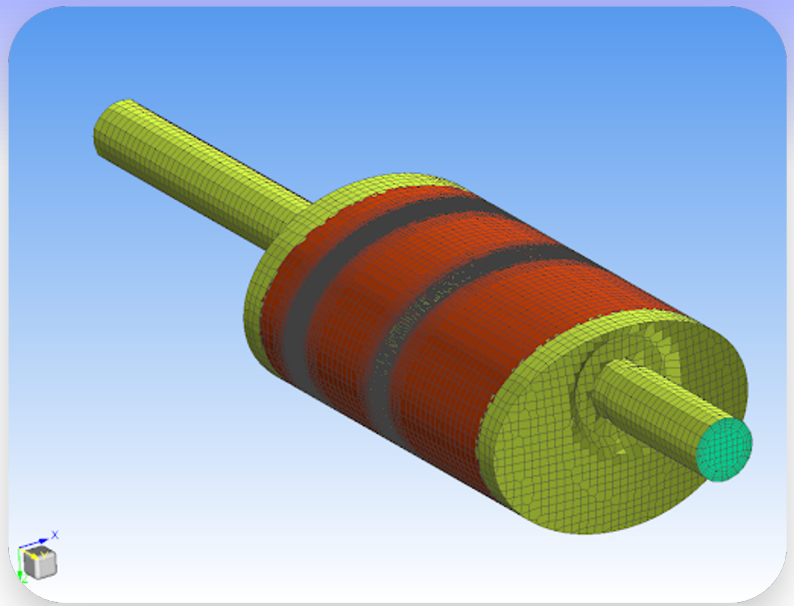


NON-FULL CAPTURE SYSTEM

RainIons muffler/tailpipe example:

- **The entire inside of the muffler/tailpipe will be lined/infused with a high negative ion count tourmaline powder.**

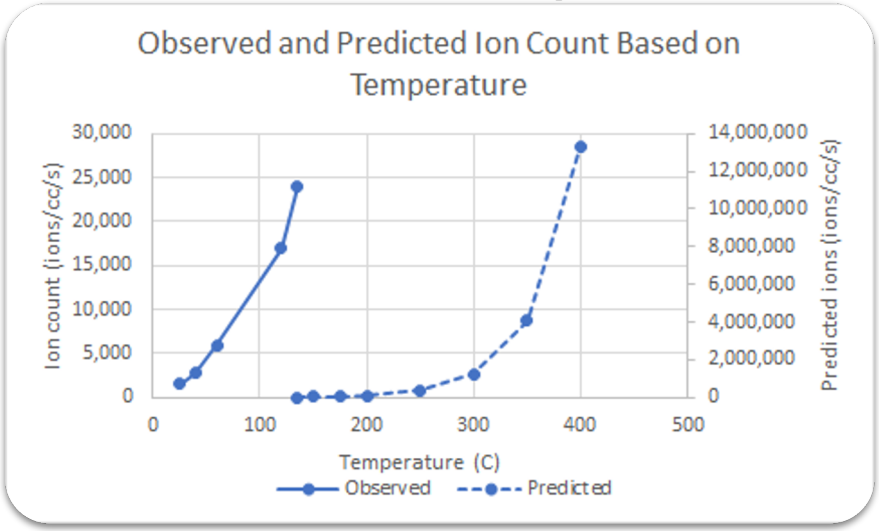
- **Uniquely designed tourmaline fused filters will be placed:**
  - **In the muffler anywhere there is a perforated tube/tubes (muffler designs vary).**
    - **The filters will surround the tube but not block the main flow of exhaust out of the muffler toward the tailpipe.**
  - **In the tailpipe on a slant/angle to direct the flow of exhaust onto the tourmaline without causing any back pressure concerns.**



NON-FULL CAPTURE SYSTEM

RainIons muffler/tailpipe example:

- The temperature change and pressure of the exhaust on the surface of tourmaline will generate negative ions.
- The filters will break and water/vapor into a fine mist/spray to generate negative ions via the Lenard Effect.
- The amount of negative ions will increase as the temperature and surface pressure increases.



NON-FULL CAPTURE SYSTEM

RainIons muffler/tailpipe example:

- **The system will create a tremendous quantity of negative ions created inside the muffler tailpipe.**
- ***Depending on the amount of surface area and temperature, between 50,000 and 10,000,000 negative ions will be created every square centimeter every second.***
- **The surface of the pyroelectric/piezoelectric material/materials will spontaneously polarize, allowing water vapor in the air to function as negative ions, increasing the pollution reduction potential.**

VIDEO

http://www.youtube.com/watch?v=MR3QFyW0dEA

FOOTNOTES

- [1] *Air Pollution.* (2016). World Health Organization, Africa. Retrieved from https://www.afro.who.int/health-topics/air-pollution
- [2] J. Conca. *Pollution Kills More People Than Anything Else.* Forbes. (2017, Nov 17).
- [3] *What is climate change?* Environmental Protection Agency. Retrieved from https://www.epa.ie/climate/communicatingclimatescience/whatisclimatechange/#:~:text=Climate%20change%20means%20a%20significant,to%20long%20periods%20of%20warmth.
- [4] *Climate Change: How Do We Know?* NASA. Global Climate Change. Vital Signs of the Planet. Retrieved from https://climate.nasa.gov/evidence/
- [5] *A Human Health Perspective on Climate Change.* Environmental Health Perspectives and the National Institute of Environmental Heath Sciences. (April 22, 2010). Retrieved from https://www.niehs.nih.gov/health/materials/a_human_health_perspective_on_climate_change_full_report_508.pdf
- [6] *Climate change and health.* World Health Organization. (February 1, 2018). Retrieved from https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health
- [7] *Information and public health advice: heat and health.* World Health Organization. Retrieved from https://www.who.int/globalchange/publications/heat-and-health/en/
- [8] *Extreme Weather and Climate Change.* Center for Climate and Energy Solutions. Retrieved from https://www.c2es.org/content/extreme-weather-and-climate-change/
- [9] Renee Cho. *How Climate Change is Exacerbating the Spread of Disease.* State of the Planet. Earth Institute. Columbia University. (September 4, 2014). Retrieved from https://blogs.ei.columbia.edu/2014/09/04/how-climate-change-is-exacerbating-the-spread-of-disease/
- [10] Carl Zimmer. *Study Finds Climate Change as Threat to 1 in 6 Species.* The New York Times. (April 30, 2015). Retrieved from http://www.nytimes.com/2015/05/05/science/new-estimates-for-extinctions-global-warming-could-cause.html?_r=0
- [11] *The Causes of Climate Change.* (2016). NASA. Global Climate Change. Vital Signs of the Planet. Retrieved from https://climate.nasa.gov/causes/
- [12] *Causes of Climate Change.* European Commission - Energy, Climate Change, Environment. Retrieved from https://ec.europa.eu/clima/change/causes_en
- [13] *Removing CO_2 from the Air Only Hope for Fixing Climate Change, New Study Says.* Inside Climate News. (October 6, 2016). Retrieved from https://insideclimatenews.org/news/06102016/climate-change-removing-carbon-dioxide-air-james-hansen-2-degrees-paris-climate-agreement-global-warming/
- [14] Shu-Ye Jiang, Ali Ma and Srinivasan Ramachandran. *Negative Air Ions and Their Effects on Human Health and Air Quality Improvement.* International Journal of Molecular Sciences. (September 28, 2018). Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6213340/
- [15] Richard A. Lovett. *Global Warming Silver Lining? Arctic Could Get Cleaner.* National Geographic News. (September 25, 2011). Retrieved from https://www.nationalgeographic.com/news/2011/9/110923-global-warming-soot-air-pollution-science-environment/#close
- [16] *The Slow Carbon Cycle.* NASA Earth Observatory. (June 16, 2011). Retrieved from https://earthobservatory.nasa.gov/features/CarbonCycle/page2.php
- [17] Sharp, T. (2013, June 5). "What is an Atom?" *Livescience.* Retrieved from http://www.livescience.com/37206-atom-definition.html
- [18] *Coulomb's Law.* Encyclopedia Britannica. (2015). Retrieved from http://www.britannica.com/EBchecked/topic/140105/Coulombs-law
- [19] *Ion.* (2015). *Encyclopedia Britannica.* Retrieved from http://www.britannica.com/EBchecked/topic/292705/ion
- [20] Cjean-Yves Cote. *The Ion Miracle. The effects of negative ions on physical and mental well-being.* Pages 68-81. (April 13, 2013).
- [21] C. Judd, Research Specialist and Independent Wellness Consultant. *Negative Ions Vs Positive Ions. The effects of negative ions on physical and mental well-being.* Tree Sap Enterprises. (pril 14, 2010). Retrieved from http://ezinearticles.com/?Negative-Ions-Vs-Positive-Ions&id=4112374
- [22] P. Madl, E. Del Guidice, VL Voeiko, A. Tedeschi, P. Kolarz, M. Gaisberger, and A. Hartl. *Evidence of Coherent Dynamics in Water Droplets of Waterfalls.* Water Journal, Multidisciplinary Research Journal, Volume 5, pages 60-61. (July 20, 2013). Retrieved from http://www.waterjournal.org/uploads/vol5/madl/WATER.2013.7.Madl.pdf
- [23] P. Kolarz, M. Gaisberger, P. Madl, W. Hoffman, M. Ritter, and A. Hartl. *Characterization of Ions at Alpine Waterfalls.* Atmospheric Chemistry and Physics, 12, 3687-3697. (2012). Retrieved from https://acp.copernicus.org/articles/12/3687/2012/acp-12-3687-2012.pdf
- [24] F. Soyka and A. Edmonds. *The Ion Effect.* Bantam Books, Inc., page 24. (1977).

FOOTNOTES

- [25] *Pyroelectricity.* Science Daily. Retrieved from https://www.sciencedaily.com/terms/pyroelectricity.htm
- [26] D. Ponnamma, G.J. Ogunleye, P. Sharma, and M.A. Aimaadeed. *Piezo- and Thermoelectric Materials from Bioplymer Composites.* Biopolymer Composites in Electronics, Chapter 12, pages 333-352. (2017) Retrieved from https://www.sciencedirect.com/science/article/pii/B9780128092613000127?via%3Dihub
- [27] C.R. Bowen, J. Taylor, E. LeBoulbar, D. Zabek, A. Chauhn and R. Vaish. *Pyroelectric materials and devices for energy harvesting applications.* Energy & Environmental Science. Issue 12. (2014). Retrieved from https://pubs.rsc.org/en/content/articlelanding/2014/ee/c4ee01759e#!divAbstract
- [28] D. Mann, D. *Negative Ions Create Positive Vibes.* WebMD (May 28, 2003). https://www.webmd.com/balance/features/negative-ions-create-positive-vibes#1
- [29] J. Allen, J. Chemistry in the Sunlight. (January 27, 2002). https://earthobservatory.nasa.gov/features/ChemistrySunlight
- [30] J.V. Prajapati, Y.K. Agrawal. Synthesis, Characterization and Application of Micro-bubbles: A Review. International Journal of Pharmaceutical Sciences and Research, Volume 3, Issue 6, page 1532. (June 1, 2012).
- [31] Atmospheric Moisture. Physical Geography I GY250 Class Homepage. Jacksonville State University, Jacksonville, Alabama. (September 1, 2011). Retrieved from http://www.jsu.edu/dept/geography/mhill/phygeogone/unit2/atmoistf.html
- [32] P. Black. *Watershed Hydrology, Second Edition.* Lewis Publishers, an imprint of CRC Press LLC, page 105. (1996). Retrieved from https://books.google.com/books?id=pLwFN1d59VsC&pg=PA105&lpg=PA105&dq=Watershed+Hydrology+relative+humidity+factors&source=bl&ots=zb6tJtUrRT&sig=miDORDFjJMAlqX0iDl3k0icmxlw&hl=en&sa=X&ei=sX9TVcDFMYXItQXmuIH4Bg&ved=0CB4Q6AEwAA#v=onepage&q=Watershed%20Hydrology%20relative%20humidity%20factors&f=false
- [33] M. Nemoto. *You state that negative ions are found around a waterfall. Does rain or my shower produce negative ions?* IonTrading. Universal Plan Co., Ltd. (19990 2015).Retrieved from http://www.n-ion.com/e/faq-04-34.html
- [34] Jin-Soo Park, Bong-Jo Sung,[2] Kyung-Soo Yoon, [2] and Choon-Soo Jeong. *The bactericidal effect of an ionizer under low concentration of ozone.* BMC Microbiology. (2016; 16: 173). Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4967512/#:~:text=Negative%20and%20
- [35] Natasha McDowell. *Air ionisers wipe our hospital infections.* New Scientist. (2003, Jan 3). Retrieved from https://www.newscientist.com/article/dn3228-air-ionisers-wipe-out-hospital-infections/
- [36] J.M. Shargawi, E. D. Theaker, D. B. Drucker, T. MacFarlane and A. J. Duxbury. *Sensitivity of Candida albicans to negative air ion streams.* Journal of Applied Microbiology. (1999 Dec; 87(6):889-97. Doi: 10.1046/j.1365-2672.1999.00944.x.) Retrieved from https://pubmed.ncbi.nlm.nih.gov/10664912/
- [37] Marie Hagbom, Johan Nordgren, Roly Nybom, Kjell-Olof Hedlund, Hanz Wigzell, and Lennart Svensson. *Ionizing air affects influenza virus infectivity and prevents airborne-transmission.* Scientific Reports. (2015; 5: 11431). Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4477231/
- [38] B.W. Mitchell, D.J. King. *Effect of negative air ionization on airborne transmission of ewcastle disease virus.* Avian. Dis. (1994; 38:725–732). Retrieved from https://pubmed.ncbi.nlm.nih.gov/7702504/
- [39] Carmen Alonso, Peter C. Raynor, Peter R. Davies, Robert B. Morrison and Montserrat Torremorell. *Evaluation of an electrostatic particle ionization technology for decreasing airborne pathogens in pigs.* Aerobiologia (Bologna). (2016; 32(3): 405–419). Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4996881/