



enviro news

Environmental Protection



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a message from
Omar S. Abdulhamid

EP General Manager

Environmental Protection continues to deliver world-class quality services aiming to enhance environmental performance, meet expectations, and achieve the Company goals.

Our people are our most valued asset and we strive to support them by providing them with the best training, committing to their safety in the workplace, encouraging innovation, and investing in technology to enrich Saudi Aramco's business and help solve major environmental problems.

As leaders, we also need to make sure that we make well informed

decisions, which take into account the many challenges faced by environmental entities within the energy sector. This is why the EP does not work alone, but through collaboration and communication with various organizations within the Company, enabling the Company to succeed in achieving its vision.

We strive to have the right Key Performance Indicators (KPIs), the right tools, the right targets, and the right people. These efforts demonstrate the Company's commitment and high level of accountability, which is one of Saudi Aramco's corporate values.

We aim to continue to build successful long-term relationships with our customers and stakeholders, as they are the key to knowledge sharing and to our acceleration. They are our partners, helping us to achieve environmental compliance, stewardship, and the protection of our most valuable natural resources.

Horizons

Yanbu' Refinery Water Conservation Initiative: 0.5 million cubic meters per year of wastewater

Raad B. Mulla and Venugopalaraju B. Sampathirao , Yanbu' Refinery Department

“Water is a priceless treasure, so save it with pleasure!” is the Yanbu' Refinery Department (YRD) Environmental Team motto, which captures the Company's drive and spirit regarding this blissful resource. Saudi Aramco is committed to the conservation of water resources to minimize the pressure on nonrenewable groundwater and maximize its availability for future generations. The Company strives to minimize its use of groundwater through the optimization of water consumption, minimization of water loss, maximizing wastewater reuse, and by promoting the use of sustainable alternatives to groundwater.

In alignment with a clearly defined

Corporate Water Conservation policy, YRD accorded the highest priority to its water conservation strategy, which focuses on optimizing water consumption and maximizing wastewater reuse. Since 2016, YRD has developed its Water Conservation Roadmap in collaboration with EP using high impact initiatives. These initiatives have resulted in a 40% reduction in water consumption at the refinery, as illustrated below in Figure 1.

This article discusses YRD's latest wastewater reuse initiative, which has successfully led to the reuse of 0.5 million cubic meters of wastewater per year. It is worth mentioning that YRD receives its water supply from

Marafiq, the Utility Company in Yanbu' Industrial City, and returns wastewater generated from refinery operations back to Marafiq.

In an effort to achieve YRD's ambitious targets, a comprehensive Water Conservation gap analysis was conducted in 2016, which resulted in a significant opportunity to reuse wastewater from the Sour Water Stripping (SWS) unit. The gap analysis revealed that approximately 17% of treated sour water was not being effectively utilized in the refinery, the excess water was being routed through drains, and ultimately returned back to Marafiq as wastewater.

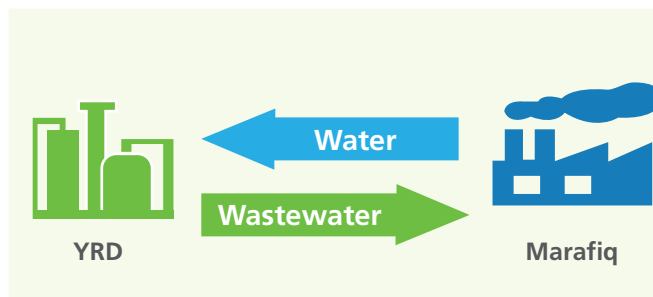
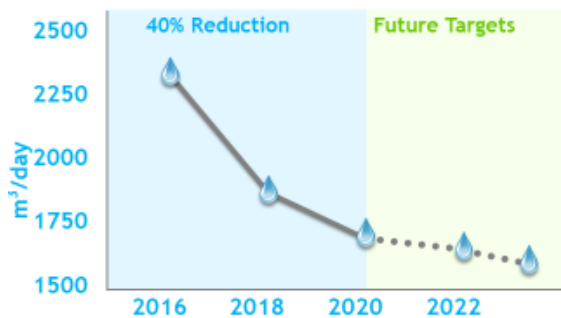


Figure 1: YRD Water Use. Reference: Raad Mulla, Venugopalaraju Sampathirao, and Jitendra Ramani. (January 24th, 2017). “YRD Wastewater Optimization Initiative in SWS.”

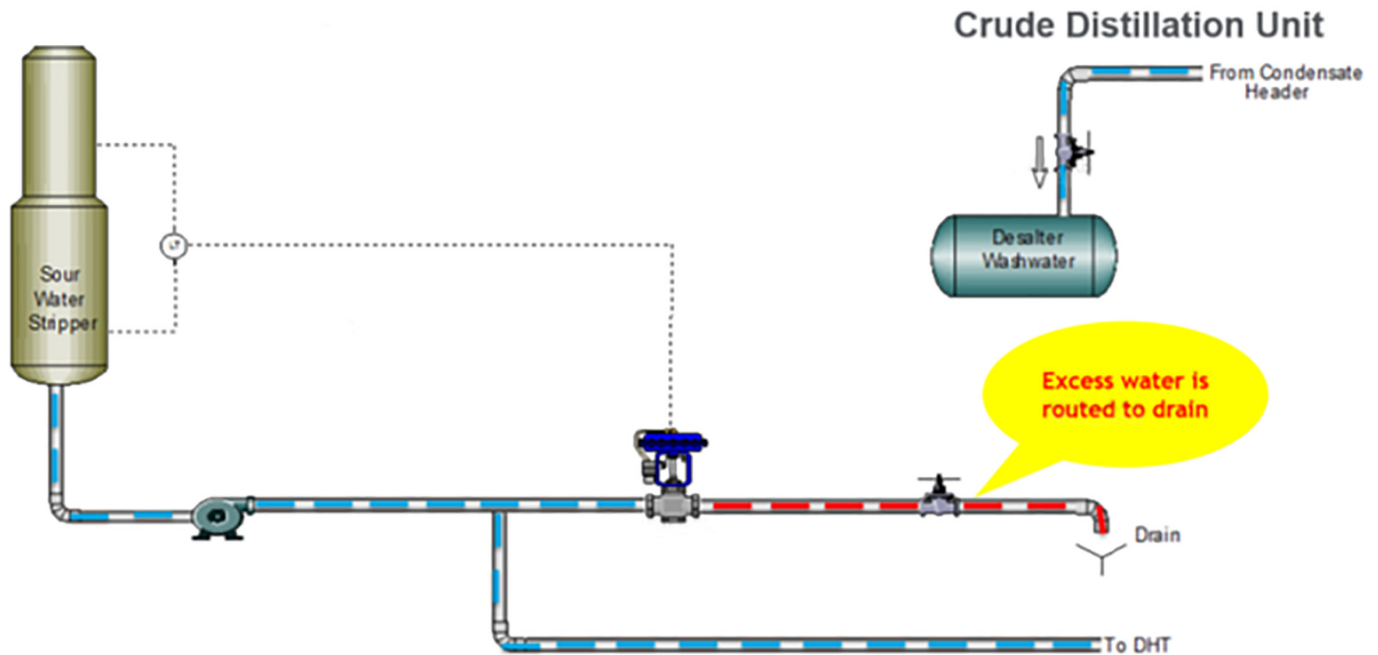


Figure 2: YRD Water Conservation Modifications (Problem). Reference: Raad Mulla, Venugopalaraju Sampathirao, and Jitendra Ramani. (January 24th, 2017). "YRD Wastewater Optimization Initiative in SWS."

The purpose of the SWS unit is to treat the sour water generated in the refinery. The sour water stripping process entails the removal of hydrogen sulfide (H₂S) and ammonia (NH₃) from sour water streams, which are fed to the sour water stripper from various plants at Yanbu' Refinery. Treated water from SWS is then reused in the refinery process units, mainly in the Diesel Hydro-Treater (DHT), but also used in the Naphtha Hydro-Treater (NHT), Light Naphtha Hydro-Treater (LNHT), and Isomerization (ISOM) units.

The method through which H₂S and NH₃ are removed in SWS is

similar to teapot heating. First, sour water is fed to a teapot-like drum called the Low Pressure (LP) sour water degassing drum. The vapors that come out of the LP degassing drum are made up of light hydrocarbons containing H₂S that are sent to the Sulfur Recovery Unit (SRU). When the "teapot is ready," the liquid leftovers are skimmed off and poured into small cup-like slops. The remaining liquids inside this teapot-like drum are cooled and mainly transferred into the DHT, which acts as a high-pressure cooker-like system.

As part of the subject water conservation initiative,

modifications were implemented involving the installation of new piping and changes to the operation scheme were made by re-routing the excess treated water to the crude unit desalter as washwater. Crude unit desalters are two-stage electric desalters that remove sediment and salt from the crude oil charge. The desalter's internals consist mainly of distributors and electrodes. Water is added before the crude enters the desalters to help remove the salt from the crude oil. A mixing valve disperses the water through the crude oil, which dilutes the total salt content. The electrodes generate an electric field that causes the diluted

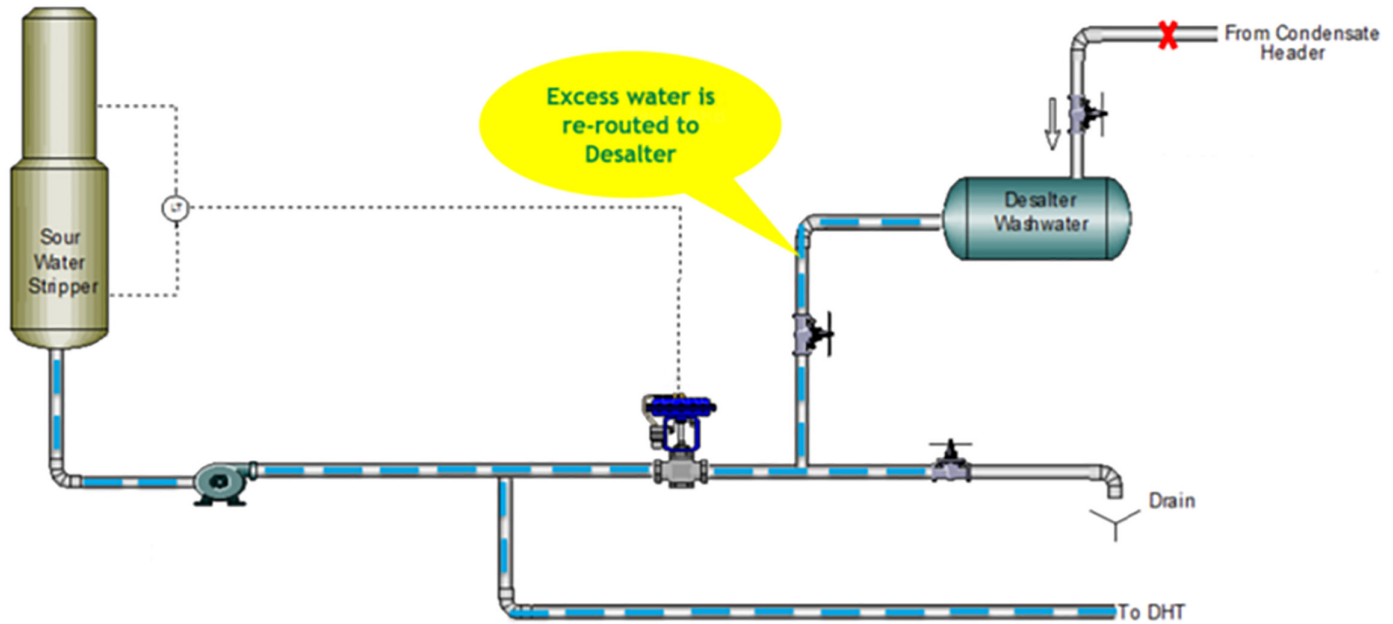


Figure 3: YRD Water Conservation Modifications (Solution). Reference: Raad Mulla, Venugopalaraju Sampathirao, and Jitendra Ramani. (January 24th, 2017). "YRD Wastewater Optimization Initiative in SWS."

saltwater droplets to combine into larger, heavier droplets, which settle to the bottom of the desalter.

The project was commissioned successfully in 2019, enabling Yanbu' Refinery to reuse the excess wastewater, and therefore saving an equivalent amount of condensate water that was originally used in the desalter.

In summary, some of benefits captured by this initiative are:

1. Minimizing the transfer of 1370 m³ per day of wastewater to

Marafiq for treatment.

2. Reducing the refinery's operating costs by lowering process water purchases from Marafiq.

3. Participated indirectly in efforts to reduce energy consumption by 163 MW and 800 tons of associated emissions from Marafiq desalination plant.

4. Last but not least, this initiative has encouraged YRD employees to come up with additional water conservation initiatives, promoting a water conservation culture in the

organization.

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(Photo Source: Shutterstock)

The Story Behind Acrylamide: How safe is your food?

Hassan Alzain and Abdullah Al-Subaie, EP

Acrylamide (or acrylic amide) is a chemical substance, a naturally occurring by-product organic compound discovered in a large variety of foods during high-temperature cooking processes (above 120°C) such as grilling, baking, roasting, frying, toasting, and similar cooking methods. Acrylamide in foods was discovered in April 2002, by a group of Swedish scientists showcasing a scientific research paper indicating the presence of the acrylamide compound, with the $\text{CH}_2=\text{CHC}(\text{O})\text{NH}_2$ formula, whenever foods are subjected to high levels of heat. Prior to the Swedish scientific study, foods were not tested for acrylamide since no one was aware of its presence in foods under specific circumstances.

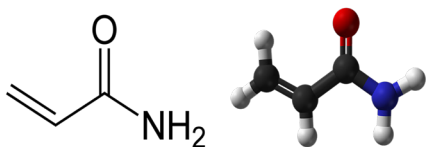


Figure 1: shows the Acrylamide-2D-skeletal and Acrylamide-3D-balls-modelling respectively (left to right).

Acrylamide and Food

Acrylamide has been present in foods since humans started cooking, it forms from nutrients

in sugars and an amino acid (asparagine) that are naturally found in foods. Under high cooking temperatures, acrylamide has been found principally in food originating from plants that we eat in our day-to-day lives, such as chips, coffee, cakes, cereals, crisps, biscuits, root vegetables, roasted potatoes, toast, almonds, and chocolates. Acrylamide is not typically associated with seafood, meat products, raw plant-based foods, and foods cooked by steaming or boiling. Some foods, such as potato chips, French fries, breakfast cereal, and toast contain high volumes of acrylamide.

Acrylamide and Health

Since the discovery of acrylamide in foods in 2002, the potential health impact and assessment of biological effects on humans has significantly attracted the attention of the scientific community. Acrylamide, as a substance in general, is considered highly toxic in nature and is likely to be carcinogenic if consumed in high doses over a long period of time. To date (as of 2019), international epidemiological studies suggest that acrylamide consumption from foods in low doses is highly unlikely to result in any increase to people's risk of developing cancer. The World Health Organization, the U.S.

Food and Drug Administration and the majority of health and regulatory bodies around the globe have not reached definitive conclusions regarding health risks associated with acrylamide in foods. In addition, they do not recommend that consumers alter their dietary habits in order to avoid the consumption of acrylamide and advise consumers not to panic and to live their lives as usual until further scientific toxicology studies of food surveys and exposure assessments are conducted and peer-reviewed on a global scale. Currently, innovative strategies are in-place to identify, establish, and implement methodologies to reduce the volume of acrylamide in foods until further guidelines are implemented by the scientific community.

How to Reduce Acrylamide at Home

The United States Food and Drug Administration and the Saudi Food and Drug Authority recommend reducing the consumption of acrylamide by ensuring that food is prepared in the following manner:

- Follow cooking guidelines found on packaged food labelling for foods such as potatoes, chips, and cakes in



Figure 2: shows French fries cooked until golden yellow in color and dark brown in color respectively (left to right).

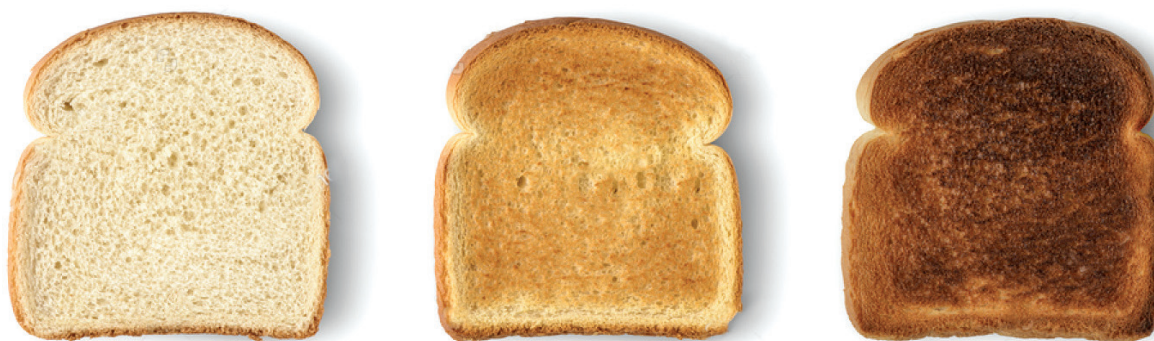


Figure 3: shows slices of bread toasted until light brown in color and dark brown in color respectively (left to right).

order to cook these foods in healthy ways as stated by the manufacturer. Steaming and boiling of foods are safe food cooking methodologies when compared to frying, grilling, roasting, and baking.

- Do not over fry, toast, bake or roast highly starchy foods. Cook French fries until they turn a golden yellow color, avoid dark brown color (see Figure 2). Cook toast until it turns a light brown color, avoid dark brown color (see Figure 3). Very brown areas should be avoided since they contain the highest volume of acrylamide.
- Acrylamide accumulates the most when foods are cooked

over long periods of time or in very high temperatures (above 120°C). Always ensure that food reaches a safe and desirable state within shorter cooking periods by cooking food in smaller quantities, rather than in larger quantities.

- Eat a healthy and well-balanced diet that suits your dietary needs and always stay up-to date with the latest awareness information regarding acrylamide consumption.

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Products from Carbon Dioxide

Salman Aldossari,EP

Carbon dioxide (CO₂) is composed of one carbon and two oxygen atoms. In the atmosphere, CO₂ is emitted from both natural and anthropogenic (man-made) sources. Natural sources include volcanos, decomposition, ocean release and respiration. Man-made sources of carbon dioxide come mainly from burning of various fossil fuels for power generation and transportation. The largest source of greenhouse gas (GHG) emissions from human activities is from burning fossil fuels for electricity, heat, and transportation (Figure-1).

Carbon dioxide, a key GHG that influences global climate change, is steadily increasing annually (416 ppm in 2020) (1). Greenhouse gases trap heat and increase the global temperature. Human activities are responsible for almost all of the increase in greenhouse gases in the atmosphere over the last 150 years. Although increased levels of carbon dioxide CO₂ have negative health and environmental impacts, recently governments and industries have shown renewed interest to utilize CO₂ for a number of reasons. Climate change mitigation has

been by far the most important driver. The 2015 Paris Agreement provides a framework for stronger climate action to limit the increase in global average temperatures to well below 2°C above pre-industrial levels. CO₂ use has the potential to play a vital role in reducing emissions as part of a broad portfolio of CO₂ mitigation options. It has been shown to be a useful feedstock for a variety of industrial products. From fuel to concrete, CO₂ is a primary building block, a valuable commodity, which can be used both directly and as a feedstock.

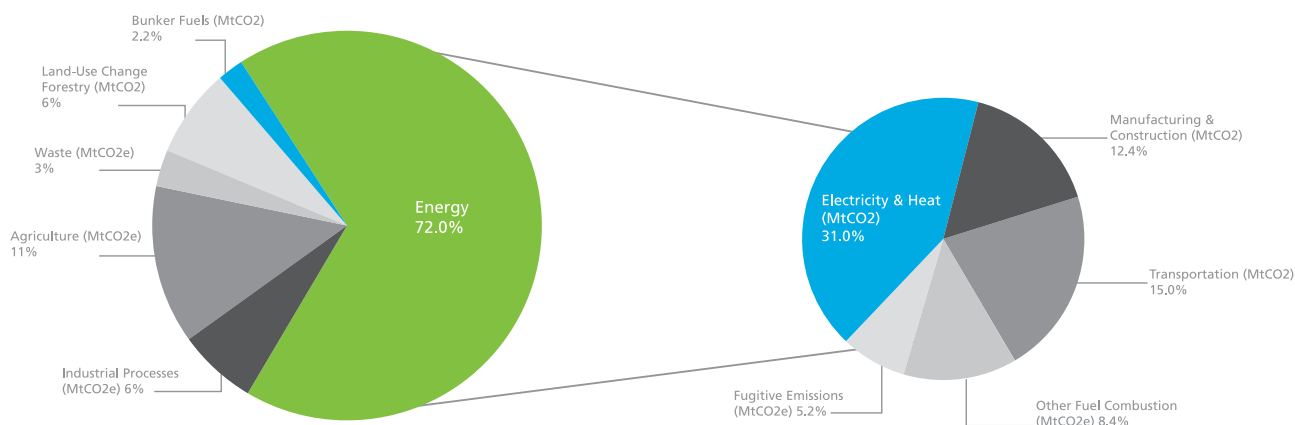


Figure-1

Notes

Globally, the primary sources of GHG emissions are electricity and heat (31%), transportation (15%), agriculture (11%), forestry (6%) and manufacturing (12.4%). Energy production of all types accounts for 72% of all emissions.

Source

Climate Analysis Indicators Tool (World Resources Institute, 2017).

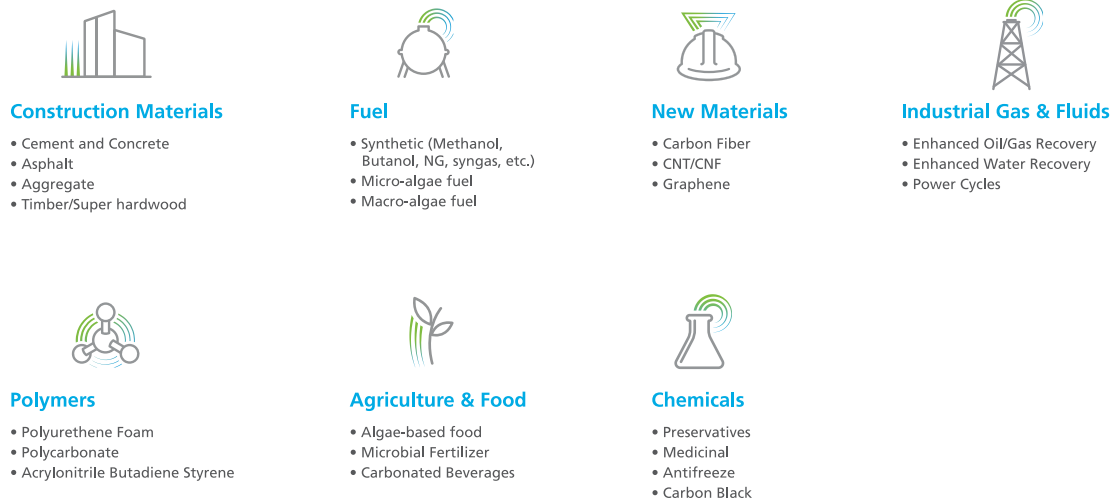


Figure-2: CO₂ utilization options

Hence came the concept of carbon capture, utilization and storage (CCUS).

CCU is the process of capturing CO₂ and recycling it back into different products. CCU offers an opportunity to combat global warming by reducing GHG emissions from major industries. CCU aims to use the captured CO₂ for conversion into other substances or products with higher economic value (e.g., plastics, concrete, and biofuel) while retaining the carbon neutrality of the production processes⁽²⁾. The industry has been innovatively active in converting CO₂ to products such as fuel, plastics, concrete, and other forms of commodities using alternative and renewable sources of energy. Below diagram illustrates the many processes where captured CO₂ can be beneficially utilized in the industry (Figure-2).

Some of these processes and

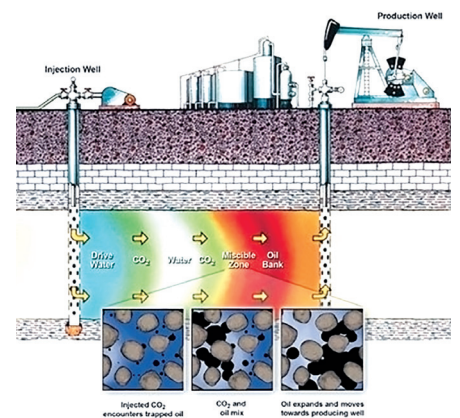
products are more mature than others; some have greater carbon reduction than others; some have larger total market potential than others; some have longer sequestration vs. carbon recycling (or upcycling) capabilities than others. This article will shed some light on some of the opportunities available to convert CO₂ to a resource.

1. CO₂- enhanced hydrocarbon recovery

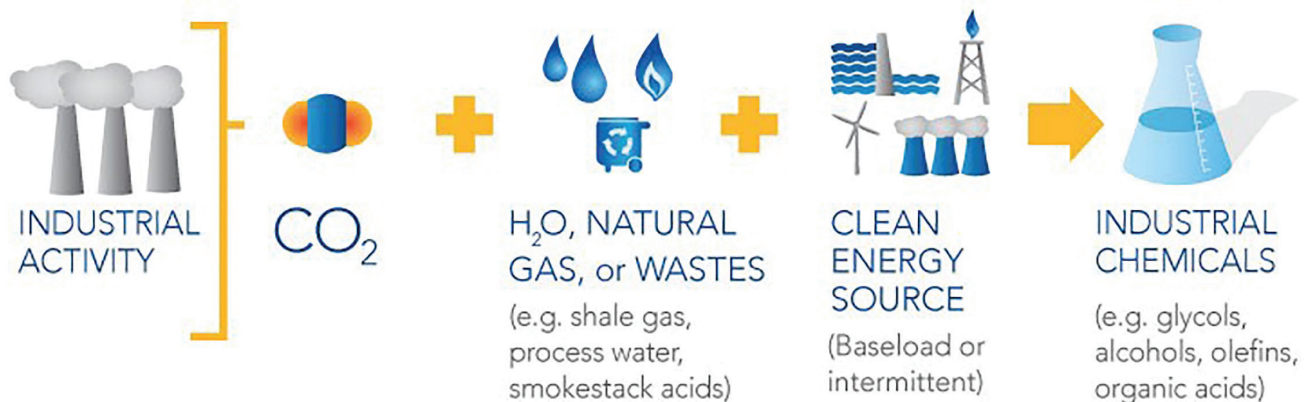
CO₂-enhanced oil recovery and enhanced oil recovery are techniques in which captured CO₂ is compressed and injected into oil and gas reservoirs to maintain reservoir pressure and increase production. Oil and gas formations offer excellent near-term potential for CO₂ storage because the geological conditions that trap oil and gas are also conducive to long-term geologic storage of CO₂.

2. Chemicals from CO₂

Reducing CO₂ to its constituent components using catalysts and using chemical reactions to build products, such as methanol, urea (to use as fertilizer) or polymers (for use as durable products in buildings or cars), could utilize 0.3-0.6 GtCO₂ a year in 2050, at costs of between -\$80 to \$300



Source: <https://www.energy.gov/fe/science-innovation/oil-gas-research/enhanced-oil-recovery>



Source: <http://llchemical.com/technology/>

per ton of CO₂. The industry is advancing in this area; below are some chemicals that can be produced from waste CO₂:

- Using electricity and catalysts to make chemicals from carbon, e.g., glycol, a key component of anti-freeze and,
- Using novel catalysts to make polypropylene carbonate from CO₂. This plastic can be used for coatings, adhesives, foams and packaging and can
- replace other plastics in these applications that are currently made from oil.
- Producing polyurethane foams. The German polymer manufacturer Covestro started producing an innovative foam component made of 20%.



Source: <https://www.bioplasticsmagazine.com/en/news/meldungen/20160623-Covestro-opens-industrial-scale-CO2-toPolyols-plant.php>

CO₂.

3. Biofuel from CO₂

Use of CO₂ from power plants or industrial applications to grow algae/biomass. Algenol is commercializing a technology that produces ethanol and other fuels from algae. At the company's facilities in India and Florida, their process allows algae to convert sunlight, seawater and waste CO₂ into sugar much faster than through natural photosynthesis. The waste CO₂ is sourced from other industries. Through fermentation, the sugar is converted into ethanol and biomass, which is further refined to green gasoline, jet fuel and diesel. (4)

4. Construction Material

As urbanization increases, CO₂ can be used to "cure" cement, or in the manufacture of aggregates. Doing so stores some CO₂ for the long term and could displace emissions-intensive conventional cement. Carbon utilization in the cement industry alone could consume more than 2 Mt CO₂/year. This capture and utilization process can be extended to more precast products and will continue for years to come (5).

Examples of Saudi Aramco efforts in CCU

Globally, approximately 230 million ton of CO₂ is utilized annually. Saudi Aramco has embarked on several initiatives contributing to CCU:

Saudi Aramco Engineering Procedure (SAEP-13) has been

updated to reflect a new requirement to seek alternative carbon capture sequestration/ utilization technologies that promote Circular Carbon Economy (CCE) for new capital projects.

Hawiyah Gas Plant is designed to have the capability to capture and process 45 million standard cubic feet of CO₂ at Hawiyah Gas Plant. The captured CO₂ is then piped 85 km to the 'Uthmaniyah oil field and injected into the oil reservoir, sequestering the gas while also helping to maintain pressure in the reservoir and recover more oil.

Saudi Aramco is working closely with industry partners through the Oil & Gas Climate Initiative (OGCI) to expedite the development of carbon capture, utilization and storage technologies and other GHG solutions. Solidia® technologies is one of OGCI's portfolio companies. Solidia has developed patented systems for producing lower emissions cement and concrete cured with carbon dioxide rather than water.

In conclusion, although the atmospheric concentration of CO₂ is steadily increasing annually and, in turn, showed negative health and environmental impacts, it **has been shown** to be a useful feedstock for a variety of industrial products. From fuel to concrete, CO₂ is a primary building block, a valuable commodity, which can be used both directly and as a feedstock. However, there are several problems and challenges to overcome before such large-scale utilization could be achieved. Current advanced CO₂ utilization activities are in the areas of

(i) chemicals production, (ii) mineralization processes, and (iii) plastics and polymer production. These areas are among the most promising in reducing CO₂ emissions and offsetting capture costs.

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Moving from a Linear to a Circular Carbon Economy

Saudi Aramco innovation is where the rubber meets the road

Nabil Hijazi, EP

Embracing the concept of a Circular Carbon Economy and the goals set forth in Saudi Arabia's Vision 2030, Saudi Aramco puts into action an innovation that transforms the waste produced by used tires to help build up the Kingdom's highways.

Each year, approximately 20 million waste tires are generated Kingdomwide, bringing with them potential environmental and safety concerns. Meanwhile, only about 5% of these tires are currently being reused in some form.

A new concept introduced by the Company is looking to transform these waste tires into a resource. The innovative concept is to turn crumb rubber from the tires into a form of asphalt— asphalt rubber (AR) for use in laying and maintaining roads. The innovation is one of several projects under the Corporate Green Energy Program led by EP.

Using recycled tires in asphalt pavement has significant environmental benefits, in addition to improved safety and reduced maintenance costs. AR minimizes scrap tires, thereby

reducing tire stockpiles that are breeding grounds for a variety of pests, such as mosquitoes and other insects. Tire stockpiles, are a prime component of illegal dumping and a source of air pollution when burned.

Adopting the principles of a Circular Carbon Economy – where carbon or its emissions are reduced, reused, recycled, and removed (4R), EP recently teamed up with Consulting Services Department (CSD), Western Region Distribution Department (WRDD), Distribution and Terminal Projects Department (D&TPD), and the Transportation and Equipment Services Department (T&ESD) to complete a pilot.

A piloted section 160 meters long, 5 meters wide, and 7 centimeters thick was used which included AR pavement with a rubber content that was increased from the standard 10% of total asphalt weight to 20%.

The AR mixture was produced using an innovative “modified dry mix method.” This method allowed the team to eliminate the process of pre-blending and

conveying the asphalt and rubber, as the crumb rubber was added directly into the hot mix asphalt plant. The piloted section will be monitored throughout the summer to ensure performance and durability under extreme weather conditions. Once approved, the new method will be included in Company standards with subsequent outreach to the national stakeholders for Kingdomwide implementation.

Technology unlocks a remarkable recycled product

AR is a special type of asphaltic paving material in which more than 15% of the binder content is crumb rubber from recycled waste tires. From a pavement engineering point of view, AR offers mechanical properties that are superior to conventional asphalts. As an example, AR has better resistance to permanent deformation, yes, we are referring to those annoying depressions or grooves worn into the road by heavy haul trucks. AR has greater resistance to oxidation, meaning less cracking of roads. AR pavements also help to reduce



This photograph shows a typical waste tires dump site. (Photo Source: Shutterstock)

Since the 1960s, asphalt mixture produced with recycled tire rubber modified bitumens have been used in different parts of the world as solutions for different quality problems. Despite some, downsides, in the majority of the cases they have demonstrated road pavement enhanced performance.

roadway noise produced by traveling vehicles, they have a darker tone of black, and a shinier appearance.

Producing AR has its own challenges since the high content of crumb rubber makes the binder much more viscous than conventional bitumen. This makes it difficult to handle with the equipment available in the Kingdom. To overcome this, Aramco engineers researched and successfully developed an innovative method to produce the mix without major investments.

An up close and personal look at the AR pavement innovation

Mohammed Rayes from the Western Region Distribution Department, a member of the team that implemented AR pavement at the North Jiddah Bulk Plant Expansion Project shared his personal story about the remarkable innovation:

“Delivering a successful project that is being implemented for the first time in Saudi Aramco was a truly unique endeavor. I was able to work with a strong technical team to complete the deployment of AR pavement technology using a distinctive process that were deployed for the first time in Saudi Arabia.

During my assignment with CSD, I began by researching the

economic and technical aspects of the challenge to discover the key values and any possible obstacles for deploying a new process, which is adds a high content of crumb rubber in the binder (about 20%).

I worked to address all challenges of implementing this technology, such as the limited local market demand for used tires and developing a new mixing process. Personally, the effort proved rewarding as I enhanced my research skills in identifying problems and developing lists of alternative solutions for technical challenges.

One of the main solutions we identified was the dry process for the asphalt mixing, which allowed us to avoid pumping issues faced with the wet process. While I was working on the feasibility study of the AR technology, I noticed vast opportunities to encourage recycling across the Kingdom.”

Collaboration, teamwork, and communication

Nabil Hijazi, the EP- project leader for the AR pavement initiative commented that essential ingredients for innovation; namely collaboration, teamwork and communication, characterized the initiative from day one. These are the hallmarks of our Company, and truly facilitated the successful execution of the pilot. Nabil elaborated that the pilot project

using crumb rubber for road construction at the North Jiddah Bulk Plant Expansion Project provides an opportunity to employ a sustainable construction method in alignment with Sustainable Development Goal (SDG) 12 “Responsible Consumption and Production.” The 17 SDGs, also known as the Global Goals, were adopted by all United Nations member states. in 2015 as a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030.

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The above photographs show the innovative concept of turning crumb rubber from tires into a form of asphalt used in laying and maintaining roads, such as the road construction project at North Jiddah Bulk Plant Expansion Project

In Depth

Should We Feed Stray Cats?

Chris Boland, EP



Feral cats can be cute – but is it wise to feed them? (Photo source: Wikipedia/creative commons)

I love cats. I owned a cat growing up and formed a deep bond with it. I loved its companionship. I admired its graceful athleticism. I laughed at its downright weirdness. So I understand completely why many people in our communities tenderly leave food out for those poor stray cats that abound in our neighborhoods.

I hear the mournful calls of the hungry kittens and find myself so tempted to feed them so I can end their hunger and suffering. But my training in ecology has taught me that feeding stray cats only leads

to more cats and therefore more suffering. And as I will explain below, this leads to other animal suffering and human suffering as well.

Below I discuss three reasons why we should not feed stray cats.

Feeding hungry stray cats only leads to more hungry stray cats

First, by feeding feral cats we increase their chances of survival. Obviously this is the intention, but it simply means that these well fed cats now have enough energy to

produce more kittens. Lots more kittens.

Numerous scientific studies have shown that feeding stray cats drastically increases their reproductive rate. As a result, the density of feral cat populations skyrocket in places where people routinely feed stray cats. That is, the number of cats in the neighborhood continues to increase as long as people continue to feed the cats. Every year, more and more cats are born into the population, which simply results in ever increasing numbers of starving kittens. By feeding



Feeding hungry stray cats only leads to more hungry stray cats, thus increasing the amount of suffering (Photo source: Wikipedia/creative commons)

hungry cats, we simply produce more hungry cats. By feeding one kitten, we are producing around four more hungry kittens. By feeding one kitten, we increase the number of kittens that are suffering.

Feeding stray cats kills our wildlife

Second, cats are exceptionally gifted predators. They are incredibly good at stalking and catching small mammals, birds, and reptiles, especially wild cats. Many people laugh when I say that cats are supreme hunters. They think about their own lazy, chubby pet sprawled imperiously on the couch and couldn't imagine it leaving the living room let alone chasing down a rare bird. While this may be true for your cat, the feral cats in our communities have been selected to be highly successful predators.

They are tough, cunning, and motivated.

Feral cats spend hours each night stalking and catching their prey. If there are 5,000 cats in Dhahran and each cat kills only one bird every week, then cats are killing over a quarter of a million birds per year, plus reptiles, plus mammals. Without a doubt this is having a tremendous impact on our native fauna.

You may be thinking "But there are no wild animals in our communities." Well this simply is not true. In Dhahran alone we have recorded 265 different species of native birds, along with 12 reptile species, and five types of mammals, including the incredibly cute Desert Hedgehog and the mouse-like Sundevall's Jird. Many of these species are rare and endangered and sadly many fall victim to feral cats

every night of the year. Most of the birds recorded in Dhahran are migratory species that have flown thousands of kilometers to be here. They are weary and rest in low shrubs and many are lost to these feral hunters. As a result, most of us only ever get to see large doves and pigeons on campus, and rarely catch a glimpse of the dozens of species that end up in cats' mouths.

Globally, cats have caused the extinction of dozens of species, and they are most certainly contributing to the scarcity of birds in our communities. I am sure that virtually everyone in Saudi Arabia would much rather see a hedgehog or a kingfisher than yet another stray cat.

Feeding stray cats makes humans sick

The most terrifying reason why we should not feed stray cats is

because of the extreme risk of spreading toxoplasmosis, which is probably the most common disease you've never heard of. Sadly, I have heard of it because my friend's baby boy is now permanently blind because of it. More on that later.

What is toxoplasmosis?

Toxoplasma gondii is a single-celled protozoan parasite with a worldwide distribution. The way it maneuvers its way through its primary hosts, cats, and then manipulates the behavior of its secondary hosts (birds and mammals, including people) is extraordinary.

Toxoplasma lives in the intestines of domestic and feral cats. There it reproduces sexually, multiplying repeatedly to produce literally millions of cysts, each containing a "fertilized egg" (or more correctly, a zygote) of the *Toxoplasma* parasite. Vast quantities of these cysts are released into the environment through the cat's feces, waiting to infect a new host.

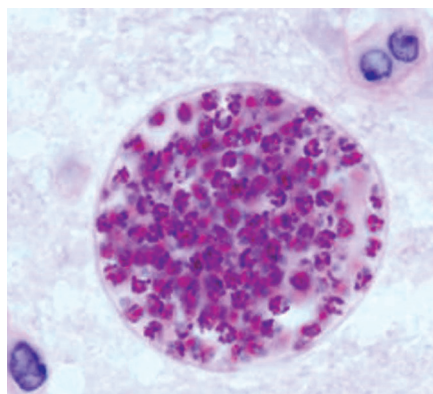
Now these cysts are incredibly resilient and will persist in the environment for months – years in fact. They can be submerged in fresh water, salt water, frozen in ice, baked in the sun, and they still survive. Not even the relentless Saudi summer will destroy a *Toxoplasma* cyst.

So there they remain, millions of them, in the sand or soil or grass, or washed into puddles or gutters, until eventually another animal accidentally eats them, whether it is a bird pecking at a seed, a

mouse eating a crumb, or a child playing in the garden. If the cyst ends up in the animal's mouth, then that animal is infected for life.

Once inside the animal or child, the *Toxoplasma* cysts (now called tachyzoites) again multiply rapidly. They essentially colonize the new host, invading the healthy cells and destroying tissues. Eventually the infection localizes in the muscles and nerves, especially in the brain. *Toxoplasma* loves to invade the brain.

Now this is where the *Toxoplasma* parasite becomes truly extraordinary. Once in the brain it causes the behavior of the animal or human to change. For instance, it causes animals to lose their sense of fear. In Australia, for example, kangaroos infected by *Toxoplasma* lose their fear of cars, and as a result they are killed by cars far more often than uninfected kangaroos. Amazingly animals infected with *Toxoplasma* begin to love the smell of cat urine; in fact they become sexually attracted to it. They seek it out,



Toxoplasmosis cysts in a mouse brain (Photo source: Jitinder P Dubey/Wikipedia/creative commons)

leading them to ingest yet more *Toxoplasma* cysts. It also means the animal is more likely to be eaten by a cat, which allows the *Toxoplasma* to infect a new cat's intestines, thus continuing its remarkable (and rather gross) life cycle.

Toxoplasmosis in humans

Toxoplasmosis is one of the most common parasitic infections in humans. In fact perhaps 40% of the world's population is infected with *Toxoplasma gondii* due to direct ingestion of the cysts from cat excrement.

Many people are infected by eating beef, lamb, camel or goat that had eaten the *Toxoplasma* parasite during their lives. These people had either eaten meat that was not thoroughly cooked (remember *Toxoplasma gondii* can survive extreme temperatures), or had swallowed the cysts after handling the uncooked meat. However, most people are infected by accidentally swallowing the cysts in their garden from cat feces.

How likely it is that someone might accidentally ingest *Toxoplasma* cysts? The rate of toxoplasmosis infection in humans varies from country to country. In Saudi Arabia the rate of infection is around 32%. That is, one in three people are infected with this disease.

In Saudi Aramco's Dhahran community, there are around 5,000 cats. The vast majority of those are likely to be infected with toxoplasmosis. If each cat defecates once per day, and if



Stray cats hunt and kill so much native wildlife – each time we feed stray cats we are reducing the number of Hoopoes and other birds in our communities (Photo: Jem Babbington)

each cat is infected with active toxoplasmosis in its intestines for three weeks per year, then there are 105,000 infected cats produced every year in Dhahran alone. Each cat contains hundreds of thousands of *Toxoplasma gondii* cysts, which then remain in the environment for months.

Remember that fresh water doesn't kill the cysts. So if it rains, or if we hose down an area, we simply wash the cysts into gutters and drains, and ultimately into our irrigation water, which brings the cysts back onto our lawns and playing fields. The global average is over 400 cysts per square foot. Since cats prefer to defecate in loose sand, gardens and children's sand boxes, then the density of cysts in our communities is likely to be much higher.

What happens if a person becomes infected with toxoplasmosis?

Only a single cyst needs to be consumed to trigger an infection in humans. The ingested cysts transform into tachyzoites and begin multiplying in earnest. This can make a person quite sick with fever, fatigue, and headaches. If a small baby is infected, these fevers can be life threatening. My friend's baby boy in Australia ingested some cysts; the fever was so bad that he became blinded, permanently. I think about that every day.

The risk is greatest in pregnant women and their unborn babies. If infected with toxoplasmosis in the first trimester, one in ten fetuses will be lost (probably more

as this is likely to be an under-reported statistic). Because of this, pregnant women must especially avoid changing litter boxes and must be very careful when gardening or playing with other kids in the sand.

In most healthy people, the immune system will neutralize *Toxoplasma gondii* quite quickly. However, the disease remains in the body for the rest of their life.

There is a misconception that toxoplasmosis has no effects on humans. Unfortunately this is not true. An increasing number of studies are finding very strong effects of toxoplasmosis infection. For instance, infected people have impaired motor performance – they move and react slower, as a result, they are three times more likely to be involved in car accidents. Infected people are statistically more likely to suffer obsessive compulsive disorder, bipolar disorder, depression and suicide. What's more, long-term infection of toxoplasmosis is now well recognized as one of the most important risk factors in schizophrenia.

Stray cats also spread rabies and the plague. Yes the same plague that killed a third of all people in Europe, China and the Middle East in the early 1300s, literally hundreds of millions of people. Even today, on average one person dies from cat-associated plague every year in the US where the number of feral cats and the prevalence of rabies and plague is much lower than in Saudi Arabia.

Please don't feed stray cats

So what can be done about this alarming problem? There is no vaccine to protect against toxoplasmosis in animals or humans. Clearly, the answer is to dramatically reduce the number of stray cats in the community. This starts by not feeding strays. If you want the companionship of a cat, be a responsible cat owner. Keep it inside at night, put a bell on its collar, have it neutered by a vet, and love it like crazy.

I hope this information convinces you to be strong enough to not feed a begging stray cat. See it as an opportunity to practice ethical decision-making by placing the much greater long-term benefits of not feeding cats above the short-term peace felt by feeding a kitten. Believe me, I know it is hard. As a person who has devoted his career to protecting and caring for animals, it is especially hard. But if our role in life is to minimize suffering then one way we can achieve that is by not feeding stray cats.

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A stray cat eating a wild bird (Photo source: Shutterstock)

Groundwater Vulnerability to Pollution (DRASTIC Method)

Rayan Alnasser, Muhammad Alrayaan, Fahad Alghamdi, EP

Abstract

Groundwater is a valuable non-renewable resource that needs to be protected. Collecting data to establish control measures for preserving and protecting it is required through the drilling of monitoring wells (which is expensive) and document review. Since collecting groundwater data from all over the Kingdom would be time consuming and economically infeasible, prioritizing areas & aquifers that are at higher risk from external pollutants is needed. The DRASTIC method is one of the most popular methods used today for assessing groundwater vulnerability for prioritization proposes. This method depends on seven (7) key parameters to calculate a groundwater vulnerability index which is later used to develop a conceptual map that classifies groundwater vulnerability and risks to contamination. These seven (7) parameters are summarized as following:

- Depth to water (D)
- Net recharge (R)
- Aquifer media (A)
- Soil media (S)
- Topography (T)
- Vadose (unsaturated) zone (I)
- Hydraulic conductivity (C)

Each parameter is evaluated based on a rating from 1 to 10 and has a weighted multiplier (depending on parameter importance), which ranges from 1 to 5. The vulnerability index which is also called (for this method) the DRASTIC Index (DI) is calculated after acquiring the values of each parameter utilizing the equation below:

$$D = 5D+4R+3A+2S+1T+5I+3C$$

Once DI is calculated, a groundwater vulnerability map is developed and is used to identify potential risks arising from different operations at various locations. This will help in prioritizing sites with higher groundwater vulnerability and aid in developing mitigation plans and measures to control external risks, thus reducing drilling and sampling expenses.

Introduction

Groundwater is a precious non-renewable resource for Saudi Arabian communities and industries. Saudi Arabia has been mindful of preserving and protecting it for future generations. A baseline understanding of the current groundwater conditions at a specific area is required before developing an effective plan to preserve/protect an aquifer.

Establishing this baseline is usually acquired from data collected utilizing piezometers, groundwater monitoring wells, and literature review. It is not economically feasible to drill these wells all over the Kingdom, which is why prioritization (based on groundwater vulnerability to pollution) is a must.

Methodology

Groundwater vulnerability is "The tendency or likelihood for contaminants to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer" (National research Council, 1993). There are multiple methodologies used today to evaluate the hydrogeological settings of an aquifer, measure the vulnerability of groundwater to external pollutants, and assess areas where groundwater contamination is likely to occur. The DRASTIC method is one of the most common ones utilized to achieve that purpose (Aller et al., 1987). The DRASTIC method depends on seven (7) key parameters to calculate a vulnerability index (DRASTIC Index). These parameters are based on the physical settings of the aquifer of concern which are summarized as the following:

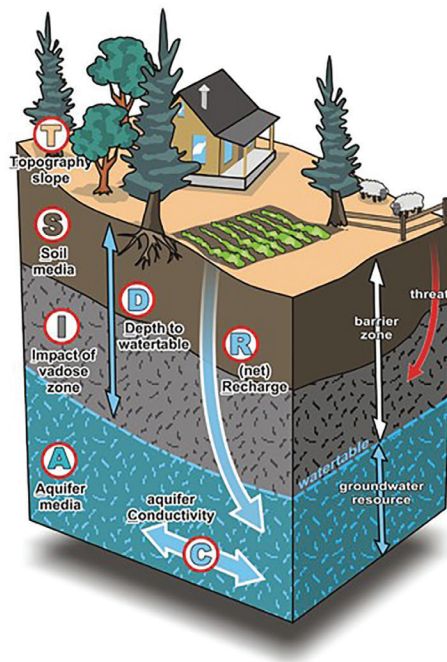


Figure 1: DRASTIC Index Parameters

Depth to water (D): which is the vertical distance from the ground surface to water table

Net recharge (R): is the total quantity of water infiltrating from ground surface to an aquifer annually

Aquifer media (A): an underground media that holds water in permeable rocks, fractured rocks or unconsolidated materials (gravel, sand, etc.)

Soil media (S): the uppermost portion of the unsaturated zone which is characterized by biological activity

Topography (T): the shape and features of land surfaces (focuses on land surface slope)

Vadose (unsaturated) zone (I): the area which is unsaturated between the ground surface and the top of the water table

Hydraulic conductivity (C): a physical parameter used to

measure the ability of material to transmit fluids in fractures and pore spaces due to differences in the hydraulic gradient.

There is a significant positive correlation between areas where groundwater contamination incidents have occurred and the DRASTIC vulnerability index, which is why this method is popular (Baker, 1990). A series of literature reviews and field studies are required to quantify the values of each of the above mentioned parameters. This includes but not limited to:

- Reviewing geotechnical and geological reports to identify soil properties, geology, topography, etc.
- Collect samples from piezometers and groundwater monitoring wells located in the vicinity of the site of concern
- Quantify the agricultural

development and public utilization of the groundwater

- Conduct intensive studies to acquire rainfall, drainage class, and slope data
- Interpretation of geological mapping and field testing to understand soil and hydrogeological properties

It is important to note that the DRASTIC method is a ranking system that is based on weights and ratings. Each parameter is evaluated based on a rating from 1 to 10 (least significant to most significant). Weighted multipliers which range from 1 to 5 are then applied to each parameter to set their actual relative importance (where 5 indicates high importance and 1 indicates low importance).

The DRASTIC Index (DI) is computed by summation of the products of rating and weights of each factor. High DI values

HYDROGEOLOGIC PARAMETERS	RANGE	RATING	WEIGHT
Depth to Water (feet)	0 – 5	10	5
	5 – 15	9	
	15 – 30	7	
	30 – 50	5	
	50 – 75	3	
	75 – 100	2	
	100 +	1	
Net Recharge (inches)	0 – 2	1	4
	2 – 4	3	
	4 – 7	6	
	7 – 10	8	
	10 +	9	
Aquifer Media	Massive Shale	2	3
	Metamorphic / Igneous	3	
	Weathered Meamorphic / Igneous	4	
	Thin bedded SS, LS, Shale Sequences	6	
	Massive Sandstone	6	
	Massive Limestone	6	
	Sand and Gravel	8	
	Basalt	9	
	Karst Limestone	10	
Soil Media	Thin or Absent	10	2
	Gravel	10	
	Sand	9	
	Shrinking and / or Aggregated Clay	7	
	Sandy Loam	6	
	Loam	5	
	Silty Loam	4	
	Clay Loam	3	
	Nonshrinking and Nonaggregated Clay	1	

Topography (%)	0-2	10	1
	2-6	9	
	6-12	5	
	12-18	3	
	18+	1	
Impact of Vadose Media	Silt / Clay	1	5
	Shale	3	
	Limestone	6	
	Sandstone	6	
	Bedded Limestone, Sandstone, Shale	6	
	Sand, Gravel with significant Silt and Clay	6	
	Metamorphic / Igneous	4	
	Sand and Gravel	8	
	Basalt	9	
	Karst Limestone	10	
Hydraulic Conductivity (gpd/ft ²)	1 – 100	1	3
	100 – 300	2	
	300 – 700	4	
	700 – 1000	6	
	1000 – 2000	8	
	2000+	10	

Table 1. DRASTIC rating and weighting values (Aller et al., 1985).

indicate that groundwater vulnerability to external pollutants is high. The following equation is used to calculate DI (Aller et al., 1987)

$$D = 5D + 4R + 3A + 2S + 1T + 5I + 3C$$

The final DI score is then classified into vulnerability classes as adopted by others for the Saudi Region (Ahmed, Nazzal, & Zaidi, 2017);

- Low Vulnerability (<122)

- Medium Vulnerability (122-144)
- High Vulnerability (144-166)
- Very high Vulnerability (>166)

Applications

The final step in this method is to create a visualized map to help with the risk interpretation process. This is usually done by utilizing Geographical Information System (GIS) applications through the mapping of each parameter

in an individual layer and then combining them into a single map. The final vulnerability map will be used to assist with the prioritizing of areas with high groundwater vulnerability and identifying potential risks that may arise from different operations at various locations, which will ultimately help in providing an efficient and practical method to reduce data collection expenses. Also, the vulnerability map will aid in understanding the level of mitigation plans and measures

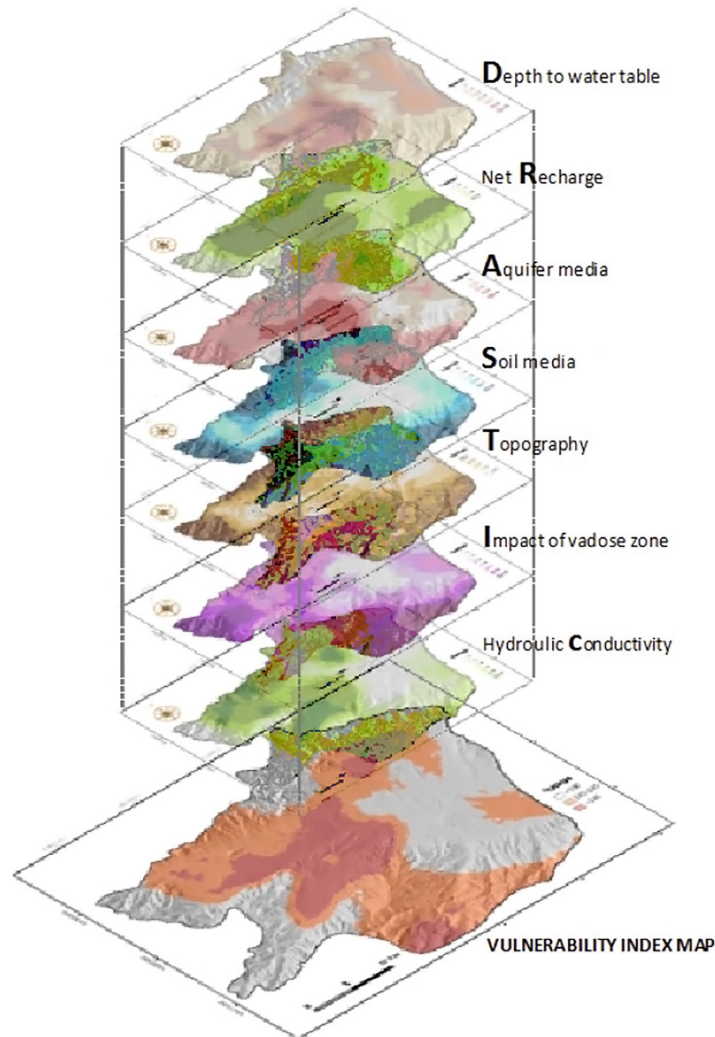


Figure 2: Groundwater Vulnerability index map

required to control external risks.

Limitations

The DRASTIC method is used to evaluate sites and calculate numerical ratings based on the hydrogeological settings of a system. Other factors that have major effects on groundwater vulnerability such as groundwater contamination sources and groundwater receptors can be used separately or combined with this method for more in-depth evaluation.

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(Photo Source: Shutterstock)

Water Sustainability Matters: A successful water conservation initiative story

Sultan M. Ahmari, Hawiyah NGL Recovery Plant Department (HNRPD)

Water is a challenge

Water scarcity is considered one of the main environmental challenges in the Kingdom of Saudi Arabia due to the depletion in the non-renewable water resources. To overcome the high domestic water demand, the Kingdom produces about 6.6 million m³ of desalinated water every day, which makes it the largest desalinated water producer in the world. Water conservation has become a main national interest in Saudi Arabia for sustainable growth, as stated in the Kingdom's National Water Strategy. In Saudi Aramco, optimizing water demand and maximizing wastewater reuse are key pillars in the Company's efforts to conserve groundwater reserves; in this regard, Hawiyah NGL plant is also doing its part.

Hawiyah NGL plant is designed to recover Natural Gas Liquids to support the Kingdom's hydrocarbons demand in the petrochemical and power generation sectors. For its daily

operations, Hawiyah NGL has several water systems such as cooling towers, fire water, drinking water and water process needs. In addition, Hawiyah NGL operates two Amine Sweetening Units (ASUs), each requiring a daily water make-up of 76 m³; which is sourced from local water wells.

Remarkable assessment

A multidisciplinary team from operation and engineering conducted a water conservation assessment to minimize the total water demand at Hawiyah NGL. The assessment revealed a viable reuse opportunity to minimize the volume of fresh water used as make-up in the ASU. Laboratory analyses of selected wastewater streams revealed feasibility for reuse without process risks, since the composition of the candidate streams after treatment matched the required parameters and concentration levels for reuse in the ASU. The team developed an engineering package to reroute, filter, and convey selected

wastewater streams to the ASU. The design package was finalized and put on stream in January 2019. For Sultan Ahmari, one of the team members at HNRPD, water is "precious to our country and what we have accomplished is a reflection of the Company's commitment to water conservation and sustainability."

Benefits

With the implementation of this initiative, Hawiyah NGL achieved water savings of approximately 76 m³ per day.

Conclusion

The Company is continuously looking for opportunities to conserve water in its operations and communities. In this regard, Hawiyah NGL is currently exploring opportunities to upgrade its sewage treatment plant to reuse standards to further support the Kingdom's objective to expand its wastewater reuse infrastructure.



Hawiyah NGL Plant (Photo source : HNGLPD Electronic Gallery)



Hawiyah NGL Plant (Photo source: HNGLPD Electronic Gallery)

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Health Risks of Mobile Phone Technology

Adnan Masoudy and Salim Khasawinah, EP

Introduction

This article explains why the radio frequency energy from mobile phones does not pose health risks. From the very inception of mobile phone technology there have been unfounded concerns in this regard and this has increased with the advent of 5G. Moreover, there is a lot of misinformation about mobile phone technology being propagated through the internet and social media that needs to be addressed in an objective and systematic manner. Along these lines, this article covers the types of radiation emitted by mobile phones, their potential health effects, previous studies and statements from leading international organizations.

Mobile Phones and Radio frequency

Radio frequency energy is what transmits and receives signals that enable users to make calls, receive images and sign in to their favorite web site. Radio frequency is a type of radiation specifically called electromagnetic radiation. When radiation is mentioned, danger signs may pop up in one’s head as they may associate it with nuclear radiation. However, there is no reason to be alarmed as radiation simply refers to waves that transmit energy. The majority of these radiation waves are not energetic enough to pose the health risks associated with nuclear radiation as discussed below.

Electromagnetic Radiation Spectrum

The electromagnetic spectrum as shown in Figure 1 is a graphical portrayal of types of radiation waves from the least energetic to the most energetic. The right side of the electromagnetic radiation spectrum (shaded in red) has very energetic types of radiation called X-rays and gamma rays which can ionize atoms and destroy DNA and hence named “ionizing radiation.” The left side of the spectrum is shaded green and labeled “non-ionizing radiation.” Non-ionizing radiation” simply does not have enough energy to ionize atoms or cause damage to DNA. Before discussing non-ionizing radiation in more detail, let us consider

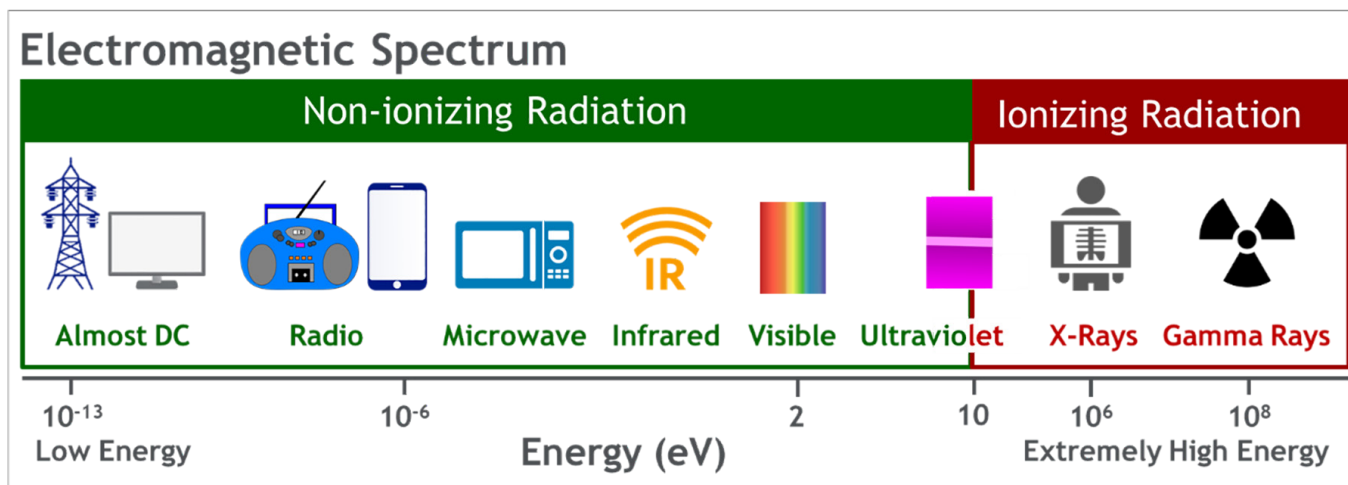


Figure 1: The Electromagnetic Radiation Spectrum

ultraviolet radiation, which spans the boundary between ionizing and non-ionizing radiation. Ultraviolet radiation is sub-divided into three ranges based on energy namely Ultraviolet A (UVA), Ultraviolet B (UVB) and Ultraviolet C (UVC). UVA and UVB are within the non-ionizing section of the spectrum, while part of UVC is energetic enough to fall within the ionizing radiation section of spectrum as depicted in Figure 1 below.

Non-ionizing Radiation

The non-ionizing section of the electromagnetic spectrum spans from ultralow energy radiation such as that associated with alternating current (AC) electricity to ultraviolet on the high energy end of the non-ionizing radiation spectrum. The radio frequency radiation associated with mobile phone technologies such as 4G and 5G is on the lower end of the non-ionizing radiation energy spectrum. As shown in the Figure 1, the radiation energies associated with visible light are much more energetic (about eight orders of magnitude) than radio frequency radiation. Additionally, infrared radiation which is used in remote control technologies is significantly more energetic than radio frequency radiation. Therefore, in addition to radio frequency radiation being non-ionizing, it is actually on the lower energy end of the spectrum.

Does Non-Ionizing Radiation Pose Any Health Risks?

As mentioned, non-ionizing radiation cannot damage the DNA

like ionizing radiation. Therefore, non-ionizing radiation such as those used in mobile phone technologies do not pose a health risk in this regard.

At the same time, a high enough power of non-ionizing radiation can cook, burn and melt materials. Common stove top burners (infrared frequency band), lasers (visible and ultraviolet frequency bands) and microwave ovens (microwave frequency band) are good examples of this. Also, radio frequency radiation at high enough power levels could cause heating effects. Therefore, the main potential health risk associated with radio frequency radiation is heating. This being said, it should be noted that the power levels of the radio frequency waves used in mobile phone devices whether 4G or 5G are far below the power levels required to cause these heating effects. To put things in perspective, the power is extremely low and would have to be orders of magnitude greater to even be felt by the body as heat let alone cause any kind of heating effects or damage to the body.

Therefore, mobile phone technologies including 4G and 5G do not pose any health risks. Moreover, this supported by the many studies assessing the potential health effects of radio frequency technologies.

Radiofrequency Radiation Studies

For the last 70 years, there have been numerous studies assessing

the health effects of radio frequency radiation. There are well over 3,000 publications in peer reviewed journals devoted to health effects of radio frequency energy at various levels and at various frequencies. To date, none of these studies have shown that mobile phones cause adverse health effects. There is an international commission specifically dedicated to evaluating health effects of non-ionizing radiation and mobile phone technologies.

International Commission on Non-Ionizing Radiation Protection (ICNIRP)

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an international commission specializing in non-ionizing radiation protection. Part of the ICNIRP's charter is to determine exposure limits for radio frequency radiation used by devices such as mobile phones and issue positions with regards to potential health effects. ICNIRP evaluates the risks associated with mobile phone technology based on scientific evidence including many studies assessing the health effect of mobile phone technologies. The official ICNIRP statement regarding mobile phone technology (including 4G and 5G) is "Acute and long-term effects of high frequency exposure below the thermal threshold have been studied extensively without showing any conclusive evidence of adverse health effects."

Positions of Other Leading Organizations

In addition, many international organizations issued statements consistent with that of the ICNIRP. Table 1 below includes statements from the leading organizations such as the World Health Organization (WHO), the US Federal Communications Commission (FCC) and the Canadian National Cancer Institute (NCI) that all agree that

there is no scientific evidence that RF-EMF from base stations, wireless networks and mobile phones cause adverse health effects when used within the prescribed limits.

Within the Kingdom, the Saudi and Information Technology Commission established minimum requirements to ensure the protection of the public and workers from any risks associated with radiofrequencies.

Conclusion

Therefore, mobile phone technologies do not pose health risks when used within the regulatory guidelines and the introduction of 5G does not pose any additional health risk in this regard. Moreover, The prescribed standards and regulations for 4G and 5G technologies are conservative and based on sound scientific evidence.

Organization	Statement
World Health Organization	To date, no adverse health effects have been established as being caused by mobile phone use.
U.S. Federal Communication Commission	To date, the weight of scientific evidence has not effectively linked exposure to radio frequency energy from mobile devices with any known health problems.
Canadian National Cancer Institute	There is currently no consistent evidence that non-ionizing radiation increases cancer risk in humans.
Public Health England	It is possible that there may be a small increase in overall exposure to radio waves when 5G is added to an existing network or in a new area. However, The overall exposure is expected to remain low relative to guidelines and, as such, there should be no consequences for public health.
Australian Radiation Protection and Nuclear Safety Agency	It is important to note that higher frequencies does not mean higher or more intense exposure. Higher frequency radio waves are already used in security screening units at airports, police radar guns to check speed, remote sensors and in medicine and these uses have been thoroughly tested and found to have no negative impacts on human health.

Table 1: Statements from Reputable Organizations



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In Focus

EP Hosts Health, Safety & Environment Awareness Campaign

On December 29, 2019, EP hosted its second Health, Safety & Environmental Awareness Campaign in which its employees reviewed tips on slip, trip, and fall prevention, FIRST AID AWARENESS OF BURNS, AND HAZARDS OF USING CHEMICALS IN THE HOME. The second event was a follow up to the event held in July which focused on safe driving and safe living conditions for the elderly. These campaigns are part of EP's SMS Element 10 "Community Awareness and Off-the-Job Safety," which recognizes the need to support public safety. The December event began with a presentation from the EP safety coordinator who covered EP Safety Performance in 2019. The EP Manager provided remarks during the meeting and thanked all EP employees for their support in adhering to safety, he then recognized a group of employees for their positive safety performance during the 4th quarter of 2019.

Afterwards, a Loss Prevention Department representative delivered a presentation on slip, trip, and fall prevention, followed by a presentation from Johns Hopkins covering general first aid awareness focusing on medical emergencies, injury emergencies, and a presentation from the Industrial Hygiene Unit covering HAZARDS OF USING CHEMICALS in the home. After the presentations, guests were invited to view live demonstrations of proper Cardiopulmonary Resuscitation (CPR) method and Automated External Defibrillator (AED) use. The IHU displayed common detergents and cleaning chemicals used at home, explained the importance of wearing gloves and avoiding the mixing of chemicals, especially if they contain ammonia and chlorine.

EP Representative Teaches Heart Saver Course to Technical Services Employees

In collaboration with Technical Services Professional Academy, and in order to support Technical Services increase in CPR/first aid

and AED training compliance rate, a representative from the EP Awareness Group trained employees in the American Heart Association's lifesaving techniques, also known as the Heart Saver Course. Employees from across the Technical Services Business Line were certified in 2019 as part of this mandatory training which is held every two years. The course is an instructor-led course that includes videos and teaches adult CPR, child CPR, AED use, and how to relieve choking in adults, children, and infants. The course teaches skills using the practice-while-watching technique, which allows instructors to observe students, provide feedback, and guide student learning.

EP Participates in Seven Cohorts of Saudi Aramco Talent Essentials Program

In collaboration with the Academic Programs & Partnerships Department and as part of its talent development efforts, EP participated in seven Saudi Aramco Talent Essentials Program (STEP) cohorts held from January through December 2019. EP subject matter experts discussed a series of topics, an overview of EP's functions, its mission and vision, and its compliance programs; including, Environmental Health, Wastewater Management, and Water Conservation. The event was attended by 180 attendees (per cohort) and helped to enhance environmental awareness among new hires via various stewardship sessions highlighting EP's efforts in environmental protection.



Saudi Aramco Talent Essentials Program attendees discuss issues and concerns.



Managers discuss issues and concerns at the 2019 Environmental Discussion Workshop.

EP Hosts Environmental Discussion Workshop for Managers

On October 23, 2019, EP held its third Environmental Discussion Workshop for Managers in Dhahran. Some 42 participants attended. The workshop built on the successes of previous workshops conducted in 2017 and 2018. The workshop's objective was to share with management selected topics on Board Risk & HSE KPIs, key E&H

protection programs, such as EMS, GEMP, Waste Management, and the Facility Environmental Performance (FEP) System. The workshop prompted healthy discussion regarding the many challenges our operations and service organizations are experiencing today. The EP Manager's opening remarks reiterated EP's commitment to supporting proponents in meeting and/or exceeding corporate expectations. In addition, six EP subject matter experts (SMEs)

delivered presentations on topics of interest to Saudi Aramco management.

EP Delivers Environmental, Community Health Messaging at Key Workshop Gathering J.V. Partners

EP participated in the second day of a two-day organizational workshop focused on Company Health, Safety, and Environmental (HSE) and Operational Excellence activities on July 4, 2019. The event was hosted by the Chemicals Admin Area and was attended by representatives from various Saudi Aramco Joint Ventures and Subsidiaries; including ARLANXEO, PetroRabigh, and Sadara. EP replace with "SMEs" delivered presentations and facilitated discussions on various topics such as Greenhouse Gas Programs, Company Waste Management Systems, Food Safety Alert Systems, Water Conservation Assessments, the Importance of UN Sustainable Development Goals for Business, and an overview of EP's functions.



Ms. Krystle Pertsch presenting at the 2019 Environmental Discussion Workshop

Save the Asir Magpie Launch Campaign

The EP and Corporate Communications Department (CCD) collaborated in creating and launching a highly successful social media campaign aimed at highlighting EP's research and protection of the rare Asir Magpie. The campaign "Save the Asir Magpie" is featured on all Company social media platforms; including Twitter, Facebook, and Instagram. Well over one million people have learned about this EP initiative and is the first time the Company has launched a completely integrated media campaign of this nature. The Company's tweet about the campaign received 9,000 likes within 48 hours of its release; that's five times more than any other Company tweet to date. This demonstrates that the community is eager to learn more about the Company's biodiversity protection programs and proves that campaign materials were branded and presented in a professional manner. As a result of the campaign's launch, members of the public have uploaded their photos of the Asir Magpie in its natural habitat, which will help improve our knowledge of the bird's distribution and habitat requirements. EP plans to feed these citizen data points into a recently developed habitat model that will be submitted for publication in an international journal for biology conservation; further underscoring EP's position as credible scientific experts in this field.



EP participates at the WRDD 2019 Environmental Awareness Campaign at Abha.

EP Develops Asir Magpie Habitat Model

EP and Remote Services Sensing Group of the Engineering Support Department (ESD) have developed a habitat model using GIS for the Asir Magpie, the only species of bird that is entirely confined to Saudi Arabia, and one of the world's most endangered bird species. EP mined published and unpublished data on location and habitat needs of the Asir Magpie; including location data developed during EP's collaboration with the Smithsonian Institution in 2018. The model paints a dire picture for the long term viability of the Asir Magpie. The model indicates that only 80.4 km² of high quality habitat remains; worse yet, it is fragmented into 19 isolated patches, each of which may not be large enough to support a viable population of magpies. The research has been drafted into a scientific manuscript and will be submitted to a peer reviewed international journal to help alert the scientific community to the plight of the Asir Magpie and to

further underscore EP's position as credible scientific experts in this field.

EP Participates in WRDD 2019 Environmental Awareness Campaign at Abha

EP participated at this event sponsored by the Western Region Distribution Department (WRDD) and held at Al-Rashed Mall - ABHA, September 30 through October 5, 2019. The event's objective was to raise environmental awareness in the ABHA area as part of Saudi Aramco's citizenship and social responsibility efforts aimed at positively impacting the community. EP representatives manned the Company's environmental booth and also provided awareness messaging including; Promoting Biodiversity Concepts, Biodiversity Abqaiq Eco Park, Mangrove Eco Park, Shaybah Wildlife Sanctuary, Asir Magpie, ABHA Biodiversity, and Water Conservation. EP's booth also featured a digital platform



High attendance at the Schlumberger Contractor HSE forum.

that highlighted work protection biodiversity. More than 9,500 visitors attended the event; including families and students from local schools and universities.

EP Participation at Schlumberger Contractor HSE Forum

EP representative attended and delivered a speech at the “Schlumberger Contractor HSE Forum” held at the Al-Khobar

Kempinski Hotel on November 24, 2019. The forum opened with a welcoming speech from Ziad Jaha, Vice President and General Manager of KSA Schlumberger. His speech was followed by a speech from AbdulHameed Al-Rushaid, Vice President of Saudi Aramco Drilling and Workover. EP representative delivered an overview of environmental protection in general and focused on selected programs

and initiatives related to D&WO activities. Finally, success safe stories were presented by the Director of HSE Practices at Schlumberger. The forum also included exhibition booths for Schlumberger and its contractors which displayed HSE initiatives and related topics. The attendance at the Schlumberger HSE Forum exceeded 300 people from Saudi Aramco, 60 suppliers’ operation managers and HSE



Mr. AbdulHameed Al-Rushaid, Vice President of Saudi Aramco Drilling and Workover during the opening of the exhibition.



- Environment Protection Policy
- Environment Excellence Framework
- Environmental and Health Systems & Programs

Mr. Humoud Al-Utaibi, General Supervisor of Environmental Engineering Division/ EP during his speech

representatives, and KSA Schlumberger management. It is worth mentioning that Schlumberger hosts such “HSE Forums” for all of its contractors, approximately fifty (50), working in Saudi Arabia.

Corporate Website Biodiversity Portal Fills a Key Gap

EP has partnered with the Public Affairs’ Corporate Communication Department (CCD) to launch a biodiversity protection portal on the corporate website. EP’s benchmarking studies of peer international oil companies (IOCs) revealed that Saudi Aramco did not have a dedicated webpage detailing biodiversity protection success stories. This gap has been filled by the biodiversity portal, which is now on a par with or exceeds those of other IOCs (as measured by the number of case studies reported). The biodiversity portal includes case studies on major biodiversity protection success stories, such as Shaybah Wildlife Sanctuary, Asir

Magpie Restoration, combatting desertification by planting native trees, establishing a dhub hub on Company land, creating a wetland for wildlife at Khurais, establishing artificial reefs, and mangrove plantations. EP and CCD have developed a roadmap in order to significantly add more biodiversity protection success stories to the biodiversity portal in 2020; including the protection of over 900 km² of high quality terrestrial habitat on Company land, which has the potential to place us well ahead all other IOCs in this regard. This biodiversity portal fosters stewardship by promoting public awareness of the Kingdom’s biodiversity assets and highlights the Company’s invaluable initiatives to conserve natural resources.

Mangrove Rehabilitation Project at Jazan Economic City (JEC)

To raise awareness within the local community, Saudi Aramco PMT, in collaboration with Leaf Global Environmental Services, launched

a Mangrove Educational event at Jazan Economic City on December 4, 2019. The motivation behind the event was to enhance the knowledge of local students regarding the planting process, which relies on water temperature and waster salinity, both of which change throughout the year.

The event included 145 students from several different local schools who were invited to attend this educational awareness event to relay the important role mangroves play in the local environment, including but not limited to: providing a protective ecosystem where a variety of animals (shrimp, fish, small mammals, crustaceans) are protected until such time they can enter the Red Sea as adults which then supports a thriving fishing industry and biodiversity for pleasure diving. In addition they learned that mangroves also reduce coastal erosion, saving local areas from land loss during heavy rains, a topic that has recently raised interest. Mangroves are “carbon



Participants planting mangrove seedlings.

sinks,” as such coastal forests such as mangroves help fight against global warming by removing carbon dioxide from the atmosphere, most of which is stored within the plant. When mangrove tree roots, branches, and leaves die they are usually covered by soil, which is then submerged under tidal water, slowing the breakdown of materials and boosting carbon storage.

A post-presentation competition was organized and the students were encouraged to participate in the competition actively and attentively. Distinguished students were honored with prizes, certificates, and shields. The participants were escorted to the planting locations to help plant the mangrove seedlings. Each participant was provided with an identification tag containing the plantation details. Plantation activities commenced at the site from 10:20 to 10:45 a.m.

A prize and shield distribution ceremony was conducted shortly after the plantation activities at

the base camp. Coast guards were awarded with shields and participants were awarded with participation certificates. Mr. Yahya Al Saati delivered the closing speech at the end of the event.

EP Participated in Sustainability Reporting Standard Development for Oil and Gas

EP participated in the development of Sustainability Reporting Standards for Oil and Gas led by Global Reporting Initiative (GRI), a multi-stakeholder standard setting organization based in Amsterdam. Joseph Martin, Environmental Specialist from EP, was selected as a member of 15 member Project Working Group to develop the standards. GRI's standards development process is a comprehensive stakeholder consulted process involving multiple stakeholders in the process. The project-working group is the focal point of the standards development process consisting of members from various geographies,

organizations, and expertise, selected through a globally advertised process. During June 2019, members of the working group participated in a survey to identify the most important subjects to be addressed in the standard. During a workshop in October 2019, the 15 member team deliberated on these impacts in detail and developed an initial framework for the standard. GRI, with the help of a group of subject matter experts, developed the details of the standards document which was discussed and reviewed by the project-working group through online discussions and a web based collaborative platform. The final draft of the standard will be presented to Global Sustainability Standards Board (GSSB) during the second quarter of 2020 and the approved standards document will be published for public comment during the third quarter of 2020. Once the public comments are incorporated, the standard will be finally approved by GSSB toward the end of the third quarter of 2020.

COP25 Summit and Sidelines Presentations

The 25th Conference of the Parties (COP25) to the United Nations Framework Convention on Climate Change (UNFCCC) was held in Madrid, Spain December 2-15, 2019. EP representatives under the leadership of HRH Prince Abdulaziz bin Salman Al Saud, Minister of Energy and the guidance of his Chief Negotiator, along with SMA and LAW, provided technical support during the COP25. Amongst the many agenda items under the COP, COP 25 was meant to conclude remaining items from the "Paris Rulebook" aiming to operationalize the Paris Agreement (PA) in 2020. These items include PA Article 6 on carbon markets and common time frames (frequency of reporting/ updating Nationally Determined Contributions (NDCs)). However, due to countries divergent views, these items remain unresolved and delayed until 2021 COP26 in Glasgow. Moreover, on December 9, 2019, the Kingdom presented the first Biennial Update Report (BUR1) to all parties during a special event under COP25, which was publically streamed online. The BUR1 contained KSA's National GHG inventories, national circumstances, institutional arrangements, and KSA efforts to combat climate change. Chile, COP25 Presidency, launched the "Climate Ambition Alliance," which was joined by 73 parties that intended to submit enhanced NDCs by 2020 and committed to achieve net-zero emissions (carbon neutrality) by 2050. Throughout 2020, Chile and the U.K. will join

efforts to get additional state and non-state entities to join the alliance on the road towards COP26. With the U.K. climate leadership, recent adoption of the Green Deal by the EU, and the UN's Secretary General mission of raising the bar in 2020, emphasis on the phasing-out of fossil fuels will be more evident.

Biodiversity Protection Area at Abha Celebrated in the Arabian Sun

EP's Biodiversity Protection Area program has been highlighted in a three page feature article in the Arabian Sun, including a full front page spread. The article celebrates EP's initiative to (i) conduct comprehensive biodiversity surveys at the site, and (ii) designate 49 km² as a Saudi Aramco Biodiversity Protection Area. The site now protects an extraordinary array of native biodiversity, including over 61 birds, 37 plants, 18 mammals, and 6 reptile species; including 24% of all of Saudi Arabia's terrestrial mammal species, 23 species listed as nationally High Conservation Priority, 16 endemic or near endemic species, 12 migratory species, and two internationally threatened species. This is one of the most important sites for biodiversity in the Kingdom. EP developed a site-specific Biodiversity Action Plan, which was endorsed by both WRDD and EP managers to further protect the site's high value biodiversity. This program positions the Company as one of the most significant custodians of terrestrial biodiversity in the Kingdom and underscores the Company's

commitment to land protection.

EP Conducted Two Training Workshops for 45 SAGB School Inspectors

In collaboration with the Utilities & Facilities Services Department (UFSD), EP conducted training workshops on October 13-14 for 45 Saudi Aramco Government Built School (SAGBS) inspectors in order to enhance their knowledge enabling them to conduct more comprehensive inspections. The workshops objective was to familiarize inspectors with Company requirements; including water safety, food safety, and pest control.

Revisions to Saudi Aramco Environmental Health Code

EP published its eighth edition of the Saudi Aramco Environmental Health Code for all Company operations, providing guidance on measures needed to protect the health of the Company's employees, dependents and contractor workforce. The latest revision process, which focuses on four existing codes and the creation of one new code for Aviation, involved consultation with key internal stakeholders within the Company and endorsement from the Health Protection Standards Committee. The revised codes align with government requirements, best practices and industry norms, and also introduce a number of new requirements for ensuring the safe supply of drinking water and a Person in Charge of Food Safety scheme for Company operated food outlets.



