Shell .ai Hackathon

for Sustainable and Affordable Energy

Problem Statement

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Agricultural Waste Challenge: Problem Statement

Introduction

Welcome to the fourth edition of the Shell.ai Hackathon for Sustainable and Affordable Energy, a platform that brings together brilliant minds passionate about digital solutions and AI, to tackle real energy challenges and help build a lower-carbon world. In the previous three editions, we addressed some of the digital challenges around energy transition, such as windfarm layout optimisation (2020), irradiance forecasting for solar power generation (2021) and optimal placement of electric vehicle (EV) charging stations (2022). This year, we turn our attention to another challenge that, if addressed, has the potential to lower emissions in sectors that are particularly hard to decarbonise, like Aviation and Marine, and applications closer home, like cooking. Sustainable Aviation Fuel, Renewable Diesel, and Renewable Natural Gas bring the advantage of lowering the emissions of these sectors without the need to alter our existing flights, ships, homes, and the supply infrastructure.

As humanity, why aren't we using them at scale yet? Firstly, they are expensive and need ambitious government targets and substantial subsidies to be able to compete with gasoline, diesel, and conventional natural gas.[1] And even with targets and price subsidies, biofuels present another challenge. Today, 100 tons of crude oil can provide approximately 75 tons of gasoline and diesel.[2] But to get the same 75 tons of biofuel, a biorefinery needs at least 375 tons of biomass.[3] And unlike crude oil extracted from a well, these 375 tons will not be available at a single source location. Instead, they will be thinly distributed across hundreds of agricultural lands spread amongst multiple geographies.

To set up a biorefinery in a region, an understanding of the region's current and future biomass produce will be required. This biomass needs to be collected and transported to intermediate depots

1. https://www.shell.com/content/shell/corporate/global/en_gb/energy-and-innovation/the-energy-future/decarbonising-aviation/_jcr_content/root/main/section_copy/promo/links/item0.stream/1667916358181/e4f516f8d0b02333f1459e60dc4ff7fd1650f51c/decarbonising-aviation-industry-report.pdf

   https://www.mckinsey.com/~/media/mckinsey/industries/travel transport and logistics/our insights/scaling sustainable aviation fuel today for clean skies tomorrow/clean-skies-for-tomorrow.pdf

2. https://www.eia.gov/tools/faqs/faq.php?id=327&t=6#:~:text=Petroleum%20refineries%20in%20the%20United,gallon%20barrel%20of%20crude%20oil.

3. https://www.mckinsey.com/~/media/mckinsey/industries/travel transport and logistics/our insights/scaling sustainable aviation fuel today for clean skies tomorrow/clean-skies-for-tomorrow.pdf

for de-moisturisation and densification into pellets. The pellets will then need to be transported to the biorefinery for conversion to biofuel. This incurs high cost of feedstock transportation and associated GHG emissions, which will need to be minimised too.[1] The value it generates lies not only in contribution to the global energy transition, but also benefits farmers as a sustainable source of income.

In this hackathon, we challenge you to form teams, brainstorm ideas, and build digital solutions that can design and optimise this new, complex, and strategic supply chain for biorefineries of the future.

Challenge

You will be asked to create a solution that identifies optimal locations for the different assets across the waste-to-energy supply chain, from the harvesting sites to the biorefineries. Based on data provided, you will forecast the spatial distribution of biomass in a region, while meeting practical objectives and constraints. These will be provided in the detailed problem statement.

Data

We will provide the following data:

1. A historical timeseries of spatial biomass distribution
2. Factors such as net biomass demand, required number and capacity of pre-processing depots and bio-refineries
3. Cost associated for transportation of biomass and underutilisation of resources

We will ask you to forecast the spatial distribution of biomass for the next two years and design an optimal supply chain using this forecast. Your solution will be eligible for ranking on the hackathon leaderboard if it complies with all the constraints. The ranking will be based on the cost function, which will be provided in the detailed problem statement. We will keep the first year of your solution on the public leader board. You can test your solution any time to see how it ranks. We will keep the second year of your solution on the private leader board and use it to select the finalists.

1. https://www.sciencedirect.com/science/article/pii/S0306261918302022