Climate Change AI Workshop (Proposal Track)
NeurIPS 2020

A Way Toward Low-Carbon Shipping: Improving Port Operations Planning using Machine Learning

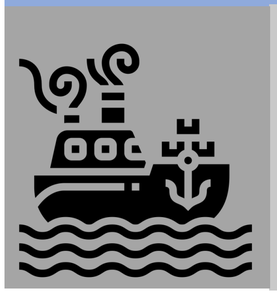
Sara El Mekkaoui[1], Loubna Benabbou[2], Abdelaziz Berrado[1]

[1]EMI, Mohammed V University in Rabat, Morocco
[2]UQAR, Canada

Shipping & Climate Change

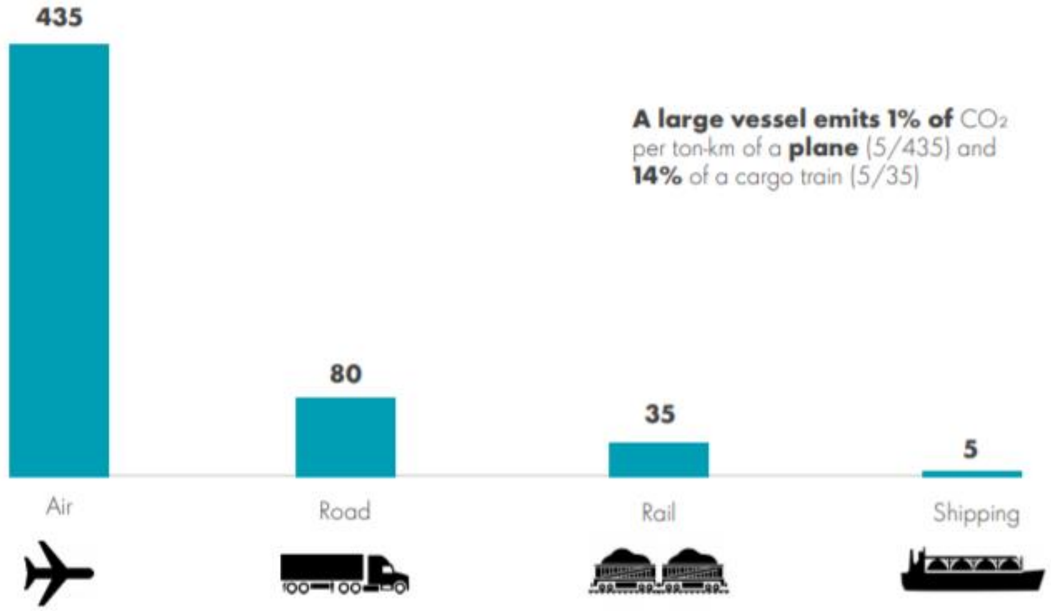
Over 80% of global trade by volume is carried by sea

80%



Shipping is the least emissions-intensive mode of transport

Emissions by Mode of Transport (g CO_2/ton-km)



Source: report "Decarbonising Shipping: All Hands on Deck"

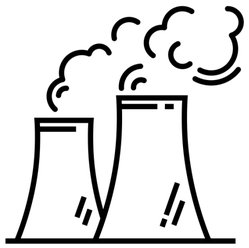
Shipping & Climate Change

Global shipping was responsible for 2.89% of global carbon dioxide (CO_2) emissions in 2018

In 2018, global shipping CO_2 emissions were 1 056 million tons which is equivalent to:

1.88 times
Canada's annual CO_2 emissions in 2018

228,142,008
Greenhouse gas emissions from 228,142,008 passenger vehicles driven for one year

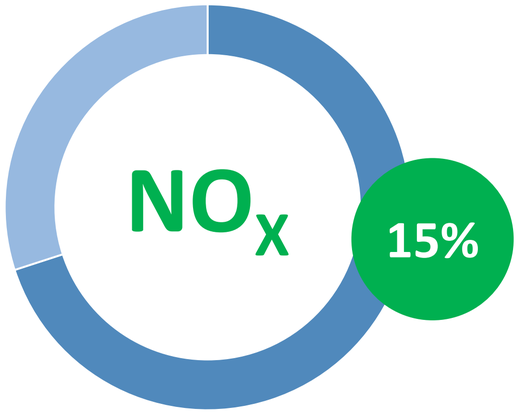


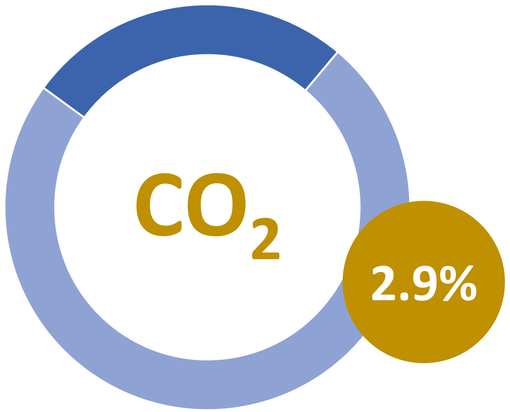
271
CO_2 emissions from 271 coal-fired power plants in one year

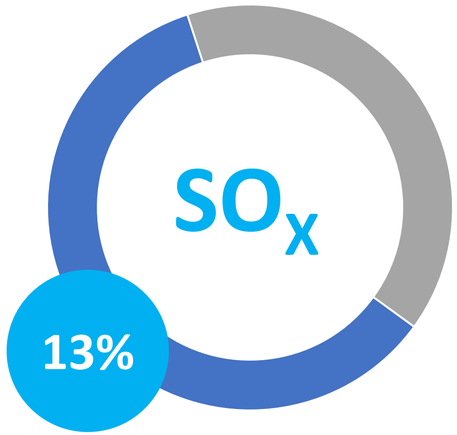
Shipping data from the *Fourth IMO Greenhouse Gas Study 2020: Reduction of GHG emissions from ships* (MEPC 75/7/15).
Equivalence data for vehicles and plants.
Equivalence data for Canada's emissions.

Shipping & Climate Change

Global share of NO_X and SO_X emissions







Shipping NOX and SOX global share from the "Third IMO Greenhouse Gas Study 2014: Safe, secure and efficient shipping on ocean."

Shipping & Climate Change

Objective

IMO INTERNATIONAL MARITIME ORGANIZATION

Reducing total annual GHG emissions from shipping by at least 50% by 2050 compared with 2008.

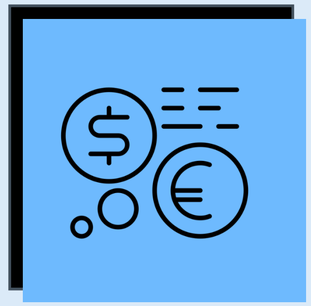
Measures

Technology

- Low-sulfur fuel oil
- Alternative fuels
- Ship design (hull and superstructure, power and propulsion)

Operation

- Voyage optimization
- Energy management
- Fleet management

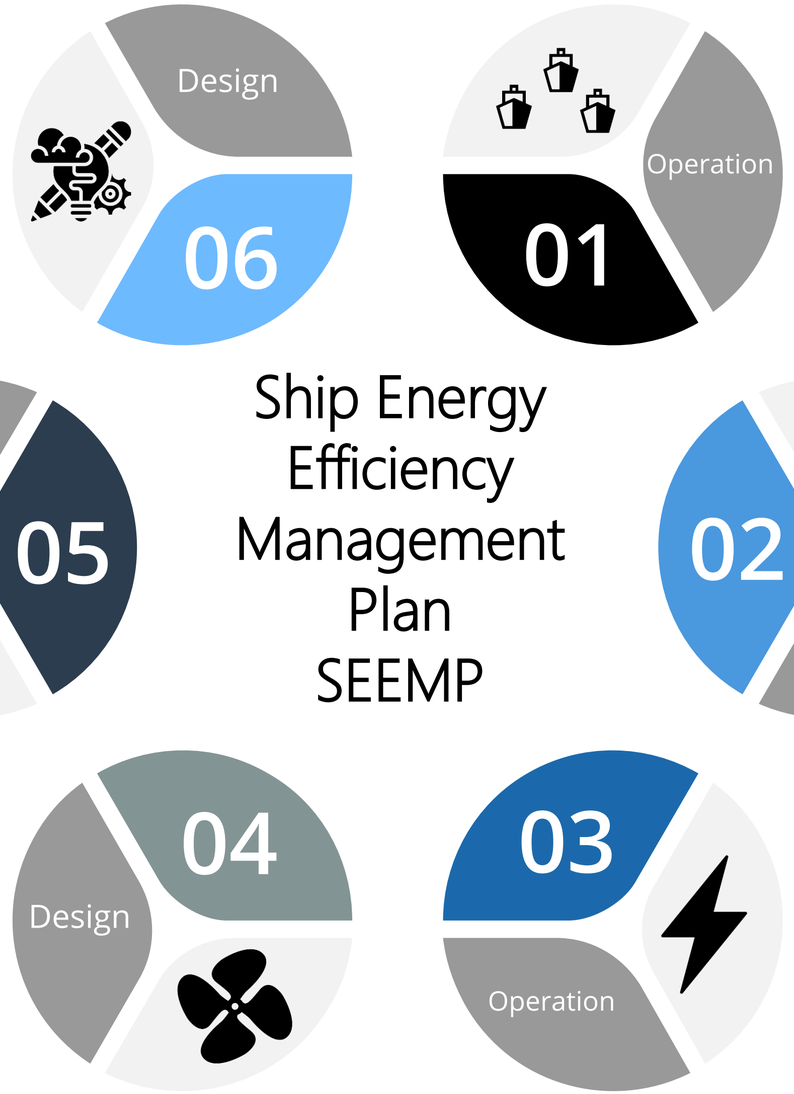


Market

- Economic incentives: emissions levies, taxes or trading systems

Shipping & Climate Change

Principal options for improving energy efficiency



Concept, design speed and capability

Fleet management, logistics and incentives

Hull and superstructure

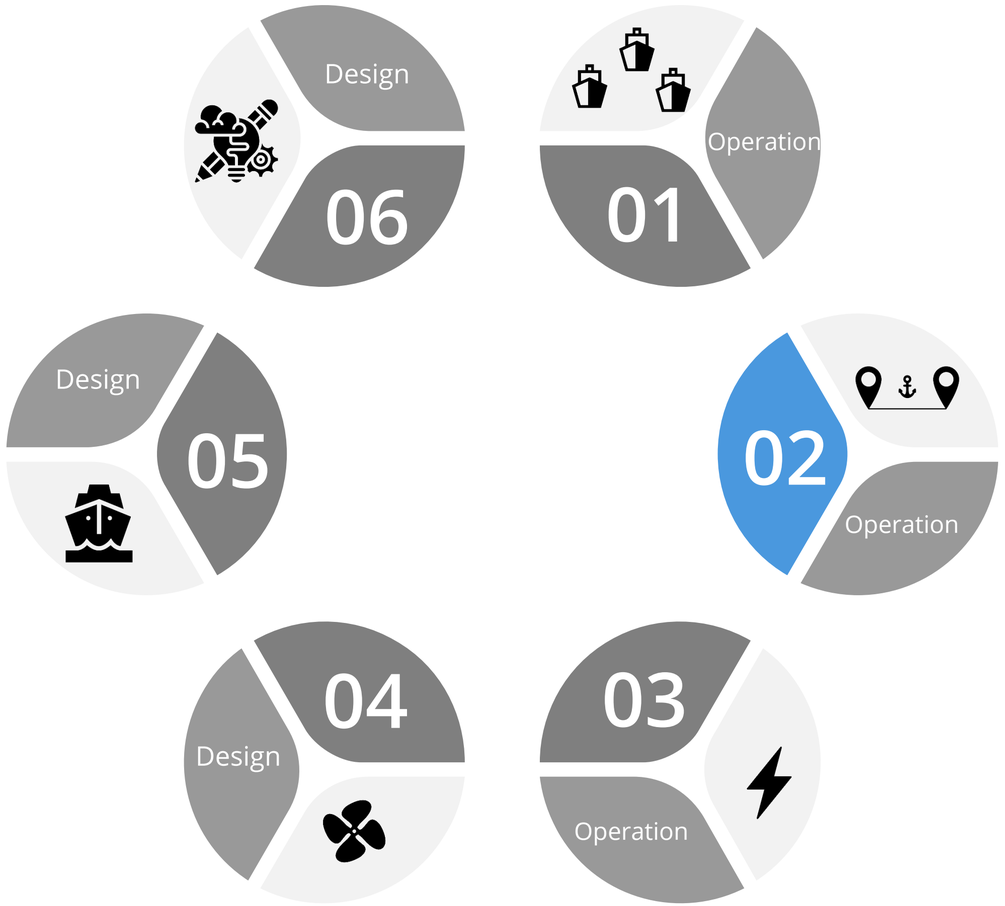
Voyage optimization

Power and propulsion systems

Energy management

Shipping & Climate Change

Voyage optimization / Just-in-time arrival



2- Voyage optimization

Up to 10% savings in CO_2 emissions

- Optimal route selection
- Just-in-time arrival
- Ballast optimization
- Trim optimization

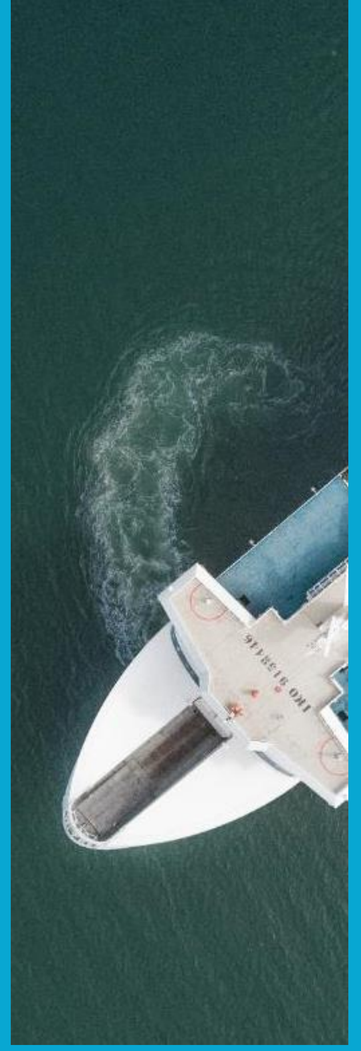
Shipping & Climate Change

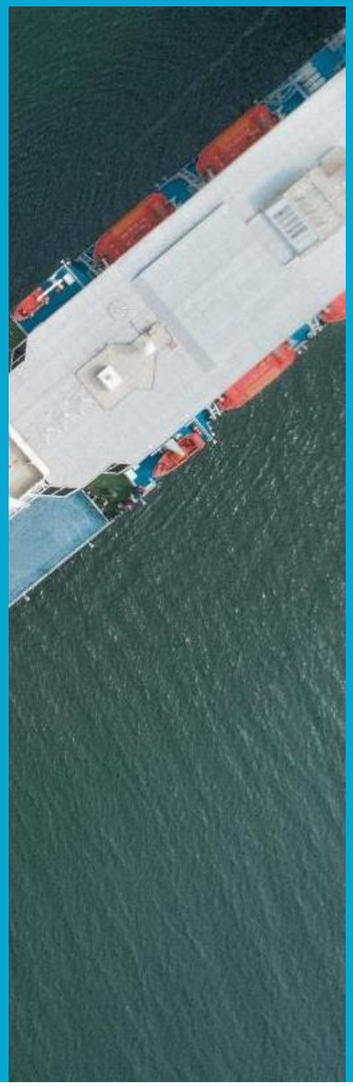
Just-in-time application in the port of **Rotterdam**

35% or 188 000 tons of CO_2 emissions can be avoided every year by shortening the waiting time of bulkers by 12 hours.

23% less fuel consumption compared to usual practice for a particular voyage.

4% or 134 000 tons of CO_2 emissions can be avoided every year from containerships activity.





Just in time trial yields positive results in cutting emissions.
Just in time sailing saves hundreds of thousands of tonnes of CO2.

Challenges

Just-in-time arrival

Concept: based on the ship maintaining an optimal operating speed, to arrive at the port when the availability of berth and port service is assured.

Advantages:
Ships adjusting their speed and lowering their gas emissions.
Reducing waiting time at ports, which allow reducing emissions at coastal areas.

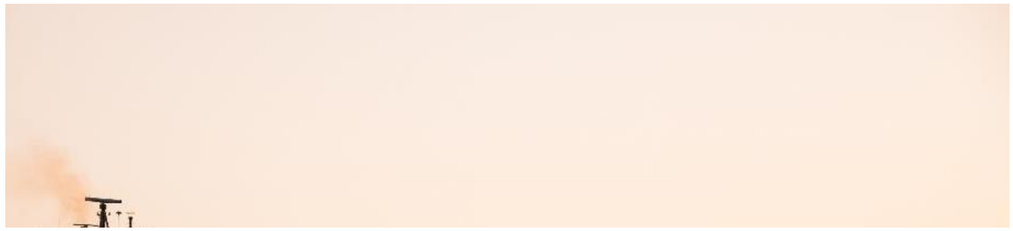
More about just-in-time arrival.

Estimated Time of Arrival (ETA)

Berthing time

Proposal

Improving port operations planning and scheduling using Machine Learning



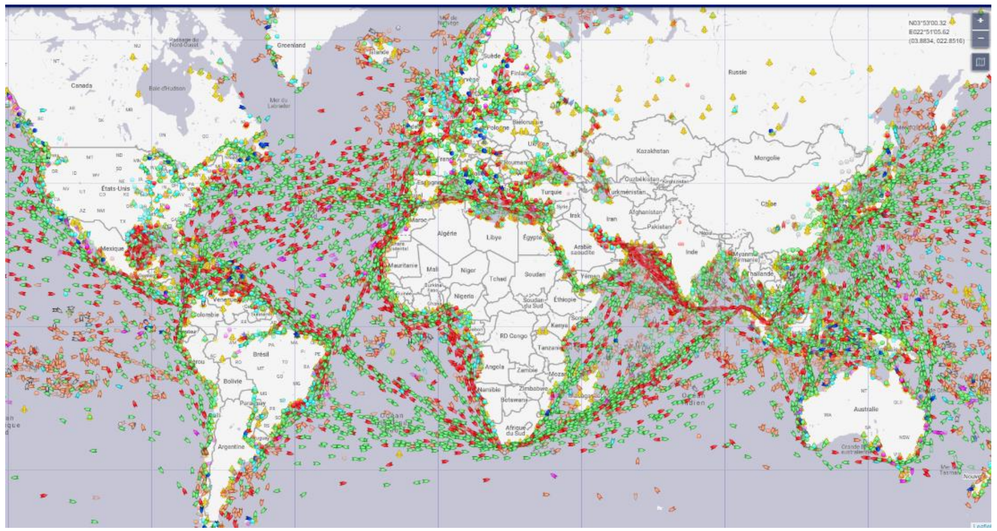
Ships arrival time prediction

Berth productivity estimation

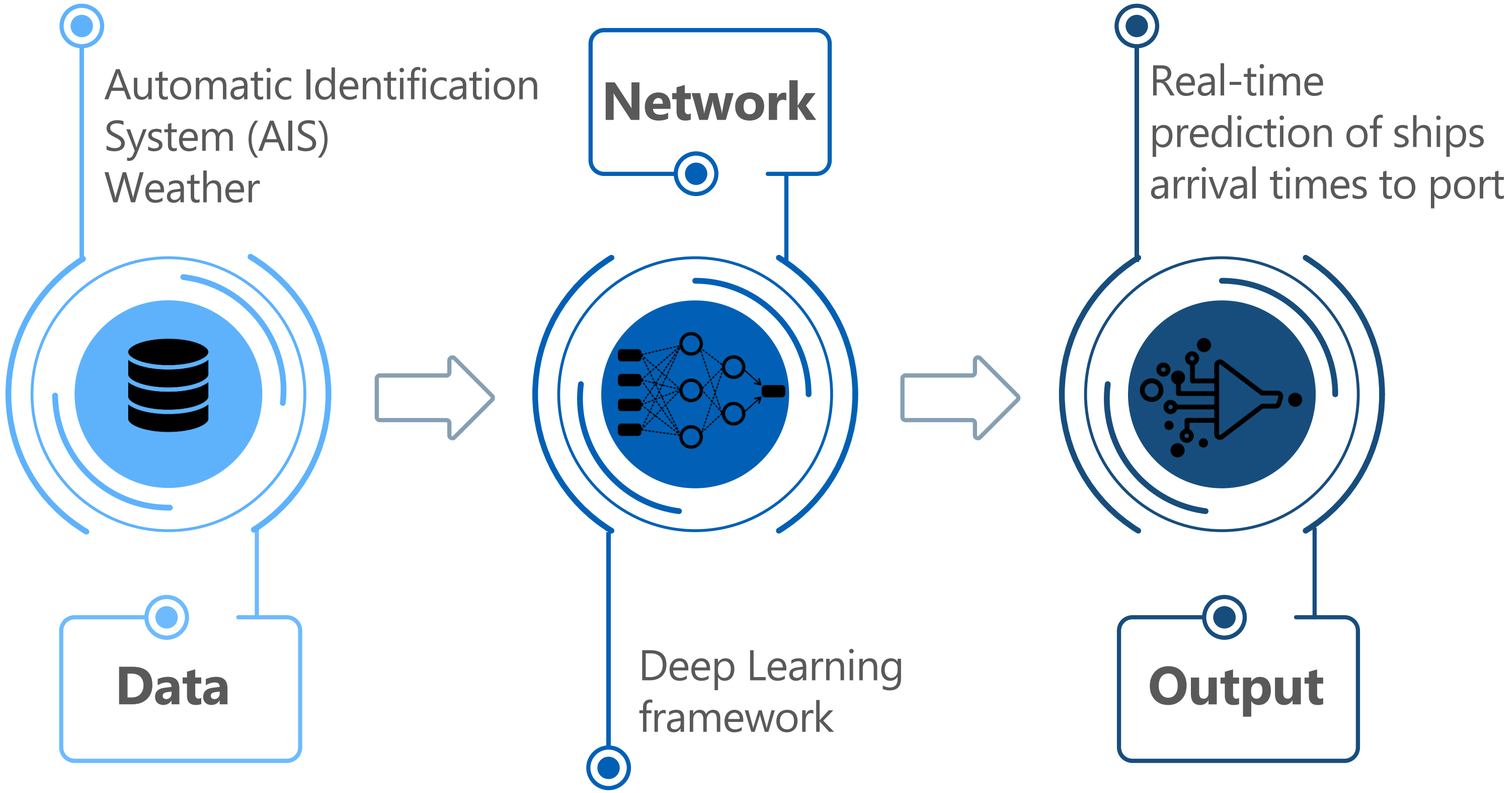
Emissions monitoring

Proposal

Ships arrival time prediction

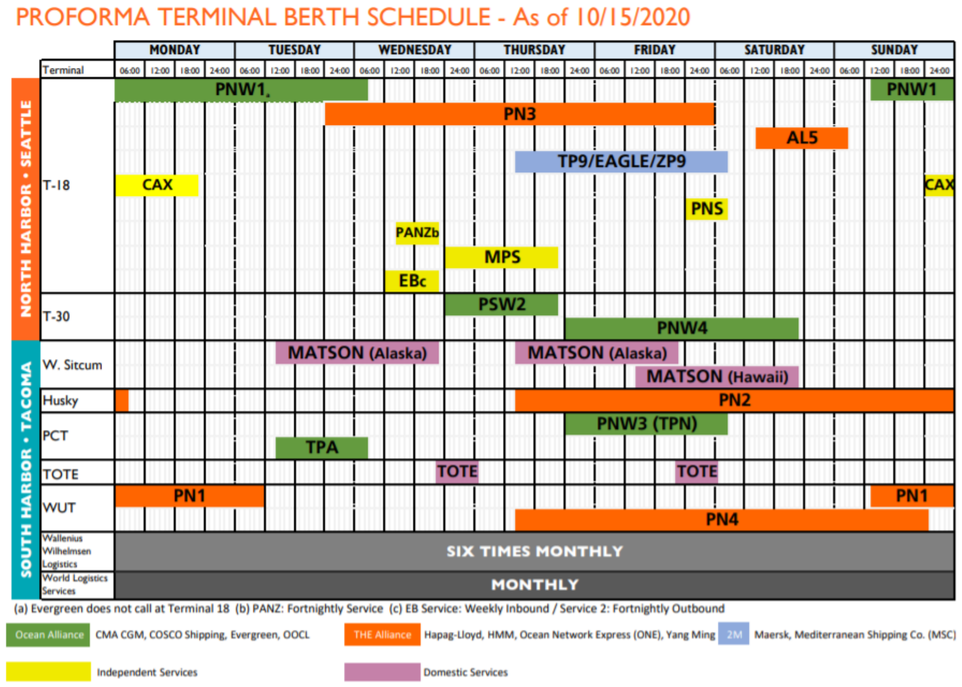


Live map of ships positions.

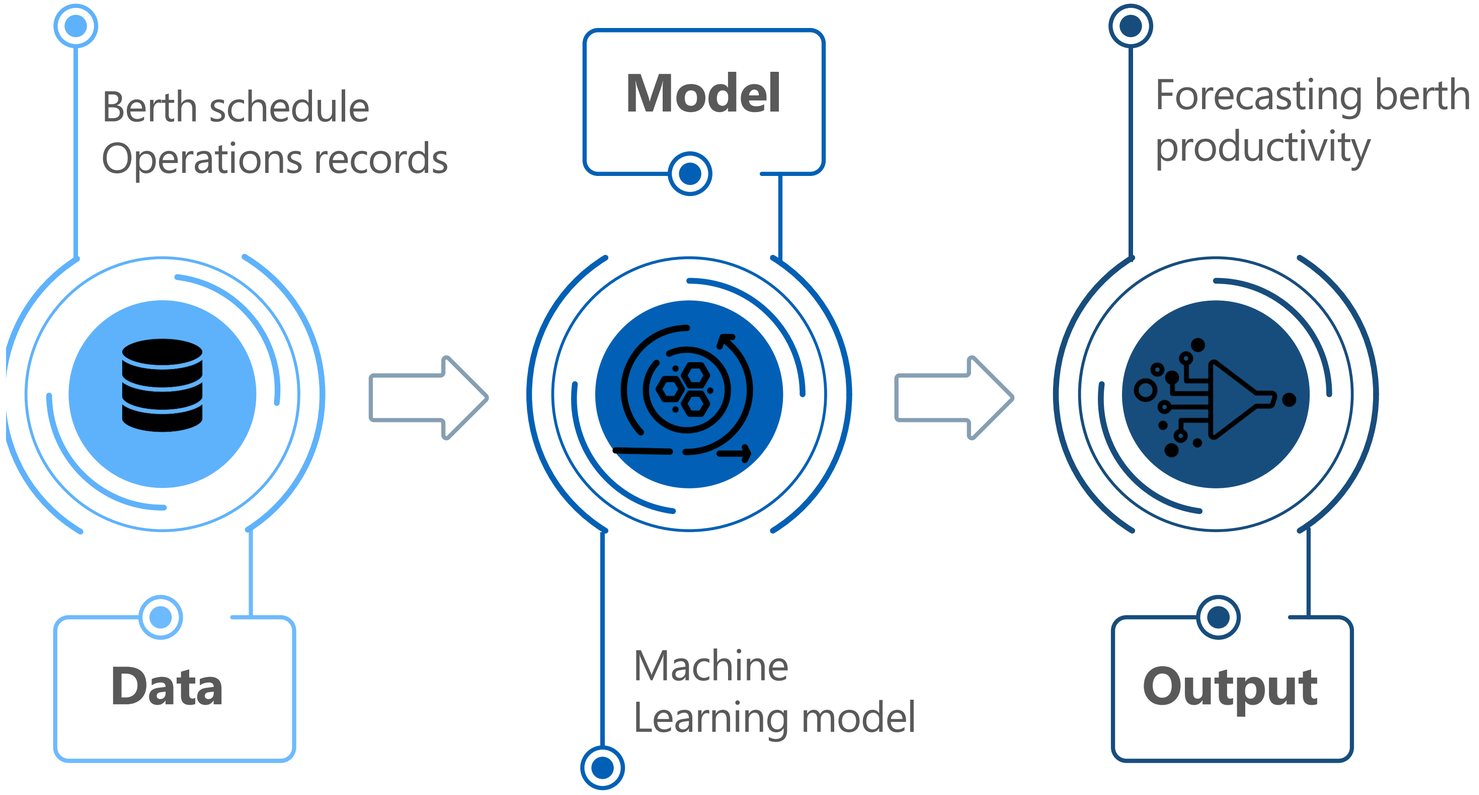


Proposal

Berth productivity estimation

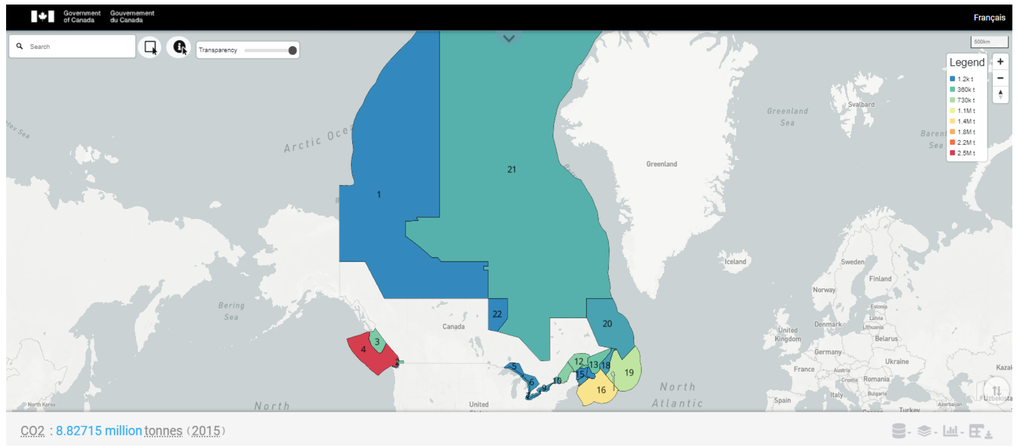


Berth schedule from the seaports of Seattle and Tacoma.

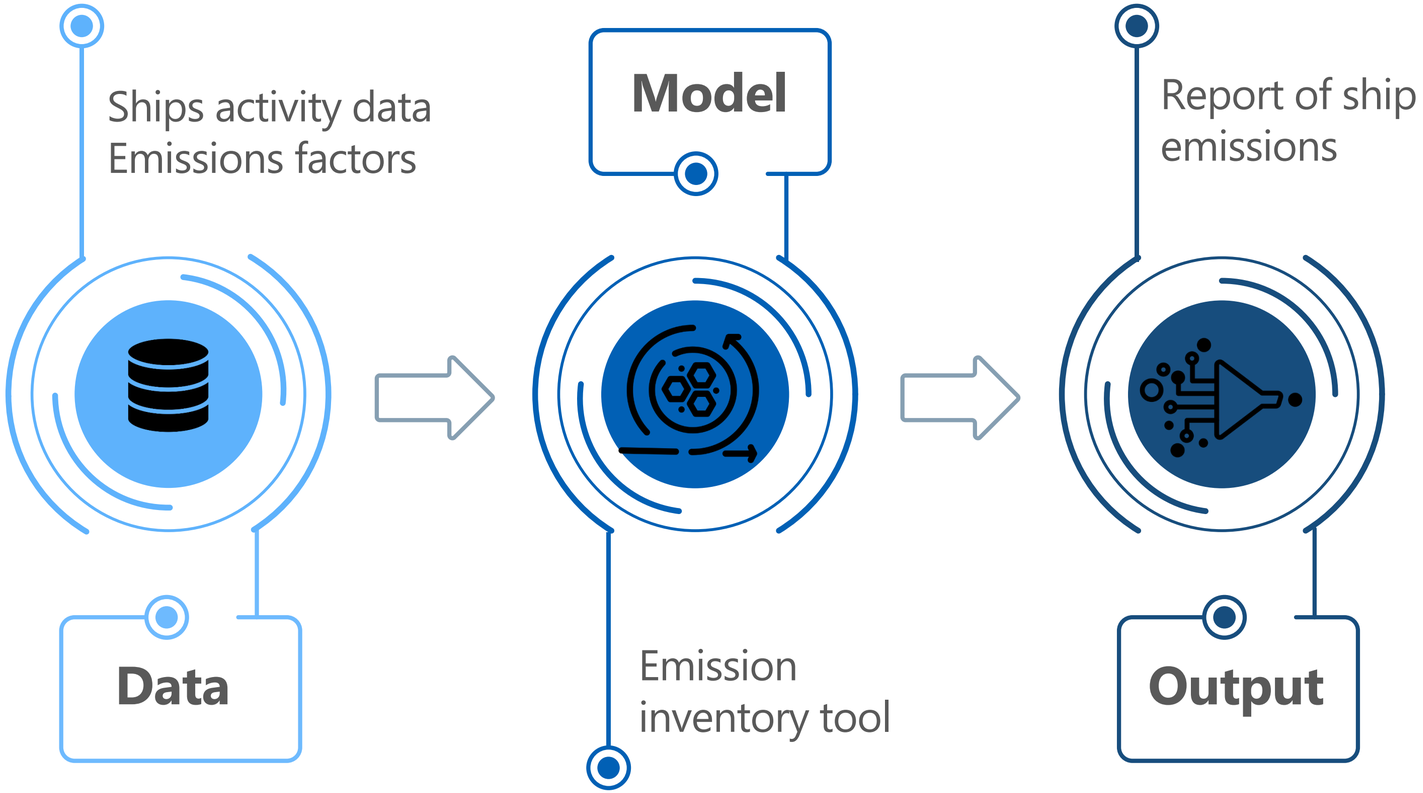


Proposal

Emissions monitoring



[CO2 emissions map from Canada's National Marine Emissions Inventory Tool.]



Thank you

Contact Details

@ saraelmekkaoui@research.emi.ac.ma

@ loubna_benabbou@uqar.ca

@ berrado@emi.ac.ma

جامعة محمد الخامس بالرباط
Université Mohammed V de Rabat

ECOLE MOHAMMADIA D'INGÉNIEURS

UQAR