Development of a CO_2 Model for Competing Cargo Routes Analysis

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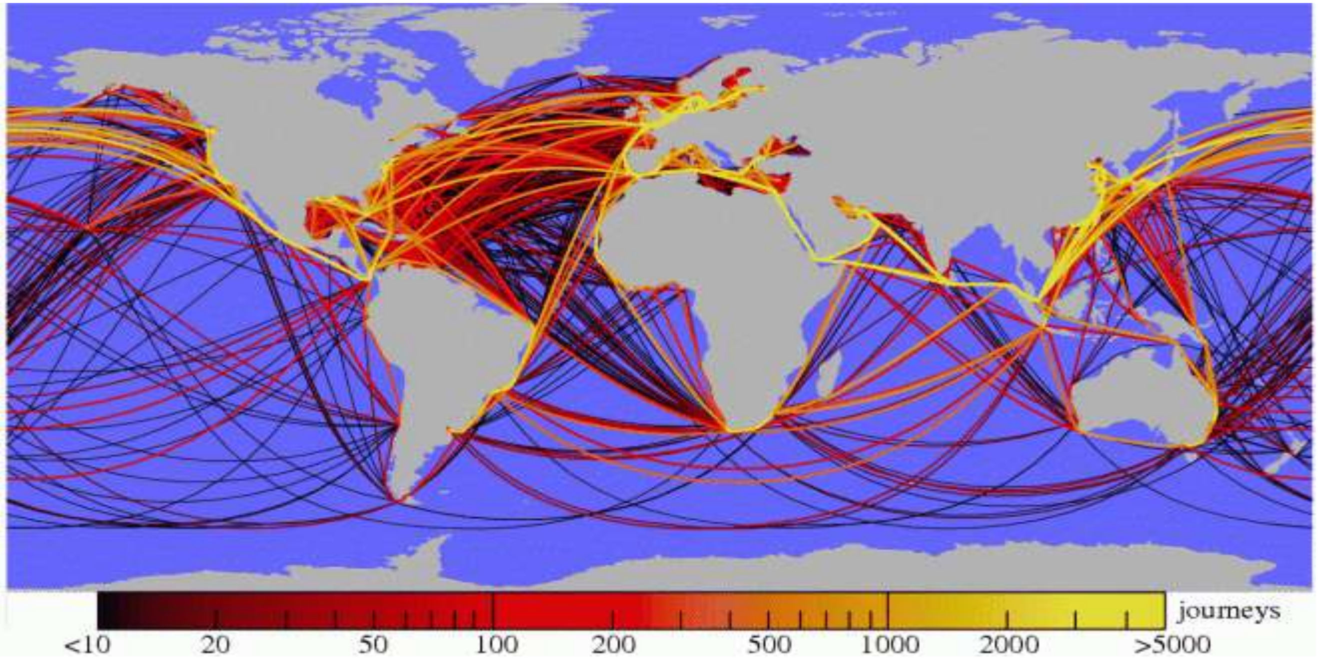
Purpose of the Model

To provide a method for the Panamá Canal Authority to compare CO_2 emissions for cargo transiting the Panamá Canal versus the same cargo using competing routes. Identifies the "greenest route".



"The complex network of global cargo ship movements" Pablo Kaluza, Andrea Kölzsch, Michael T. Gastner and Bernd Blasius, J. Royal Society: Interface

Model Drivers and Development

- GHG emissions from shipping primarily stem from fuel consumption – making CO_2 the most prominent GHG associated with movement of cargo on oceangoing vessels.
- The vast majority of CO_2 from the shipping industry is a result of international shipping.
- Growth of global commerce requires implementing a variety of reduction techniques to reduce/eliminate CO_2 emissions.
- The model was constructed to enhance and interact with a dynamic financial route analysis model (PCRCAM).
- E-ndeavor Program Management, Novix S.A., Drewry Shipping Consultants and Cardno TEC worked as a team to develop the *CO_2 Model of Emissions from Transportation Sector* (CO_2METS).
- 3rd Party review and validation by Norfolk Southern Corp.

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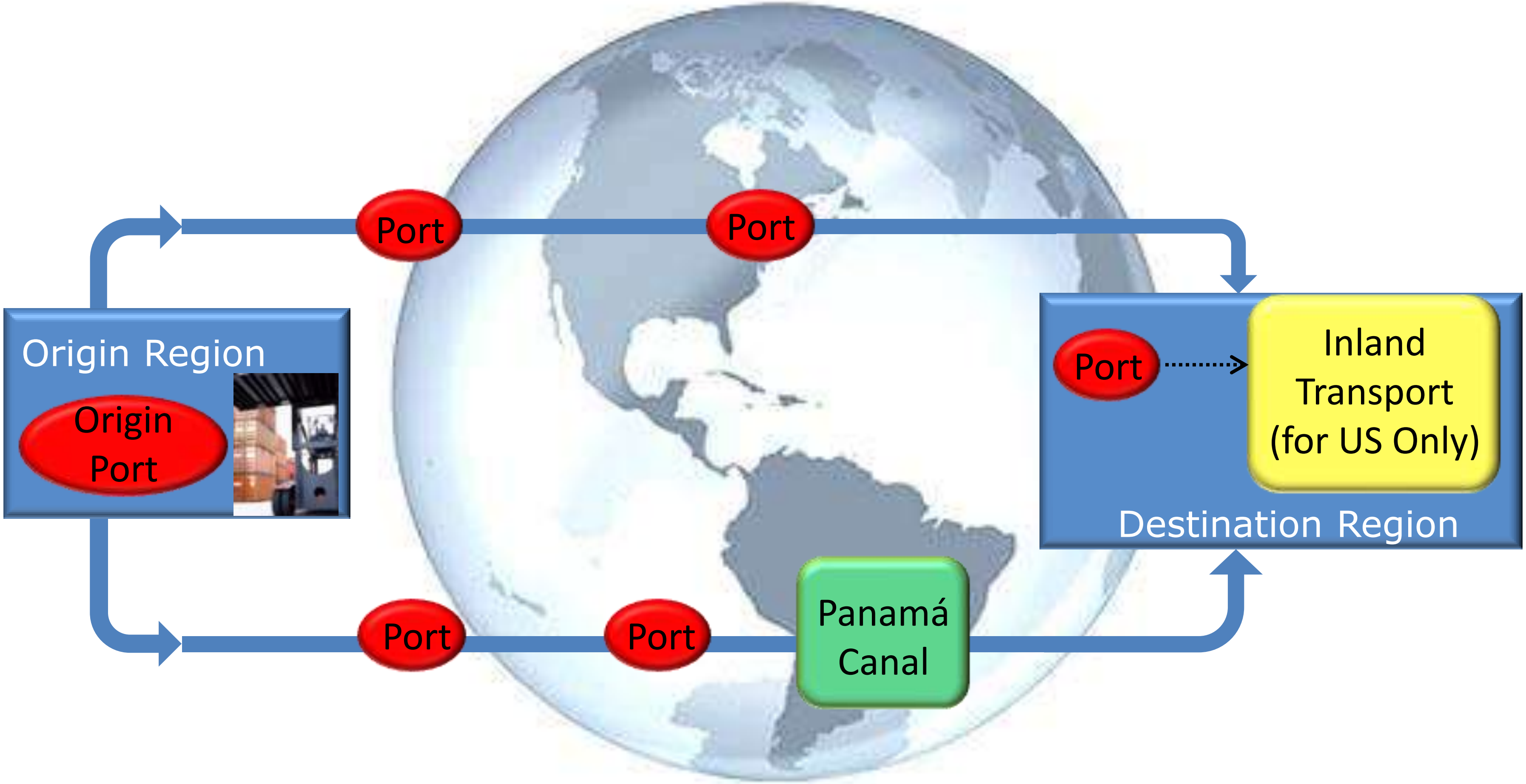
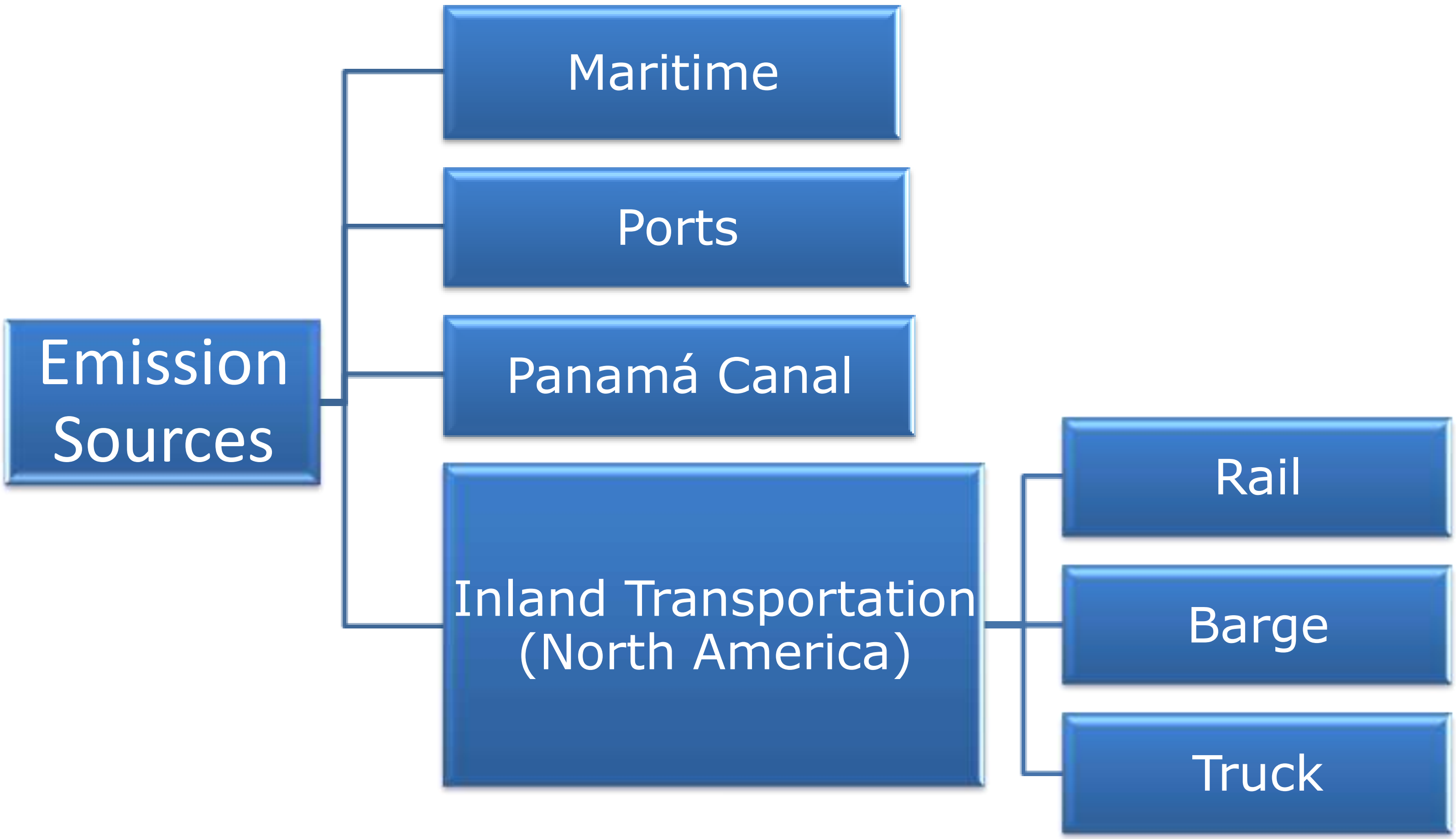
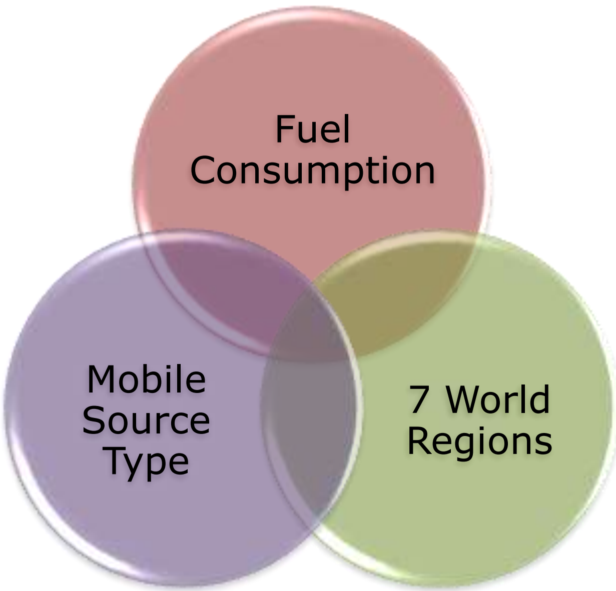
CO_2METS Overview



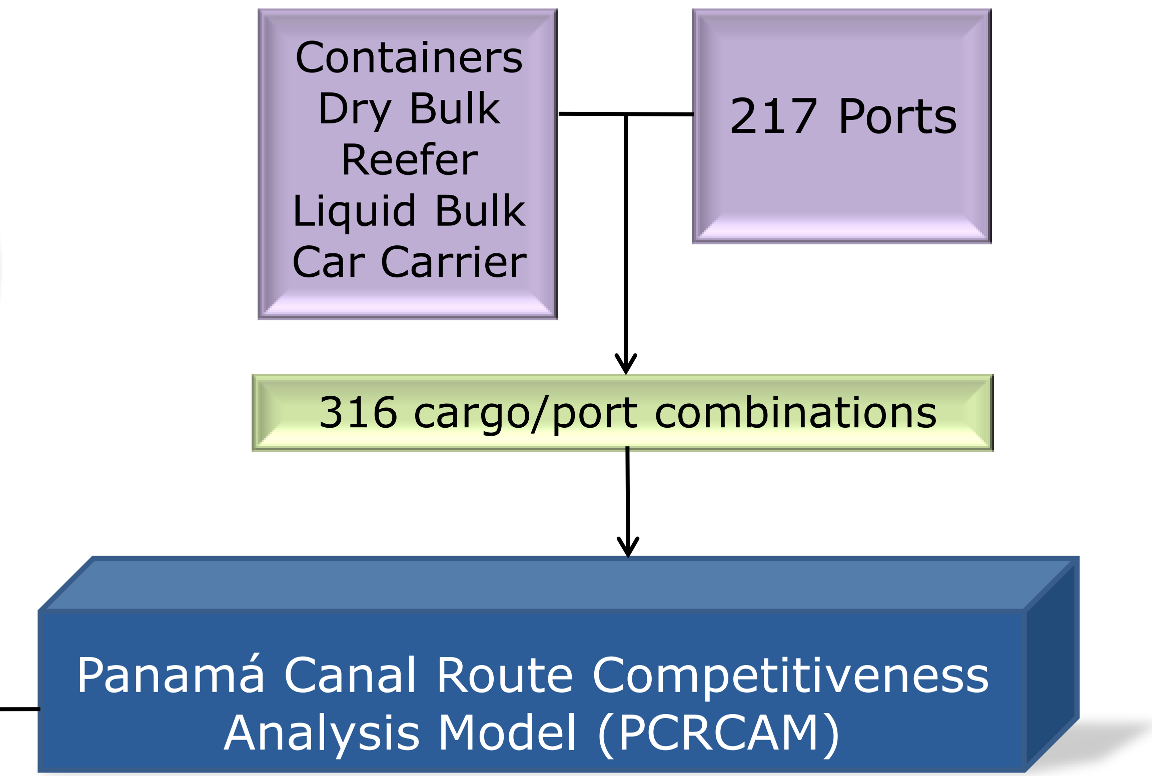
CO_2METS Data Inputs



Primary Data Inputs



Maritime Data Source for Emissions

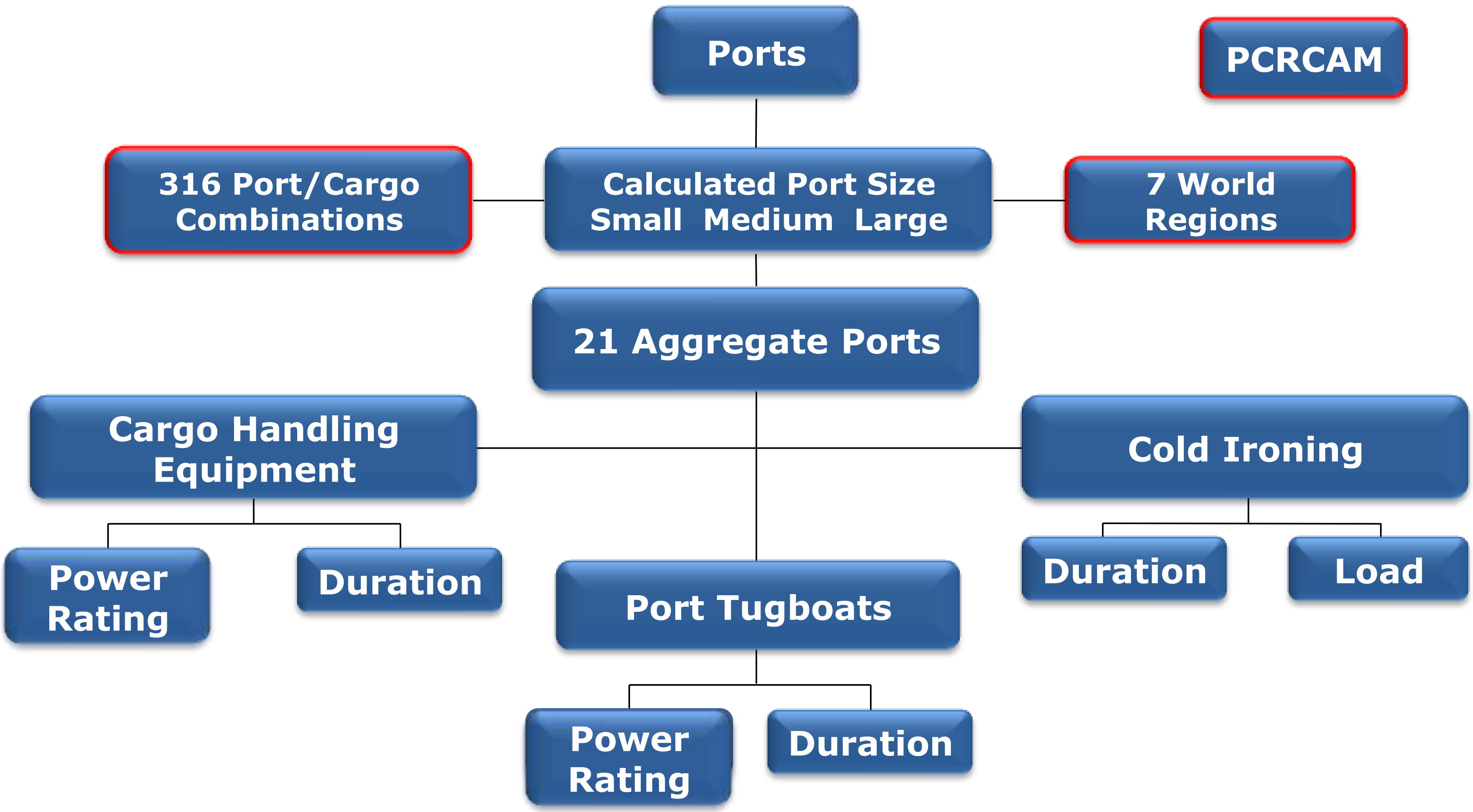


Maritime Inputs to CO_2METS

Fuel consumption evaluated using data from PCRCAM as well as user inputs

- Ship/Engine Size
- Auxiliary Engines
- Distance
- Transit Speed
- Fuel Type
- Engine Age

Port Inputs to the CO_2METS



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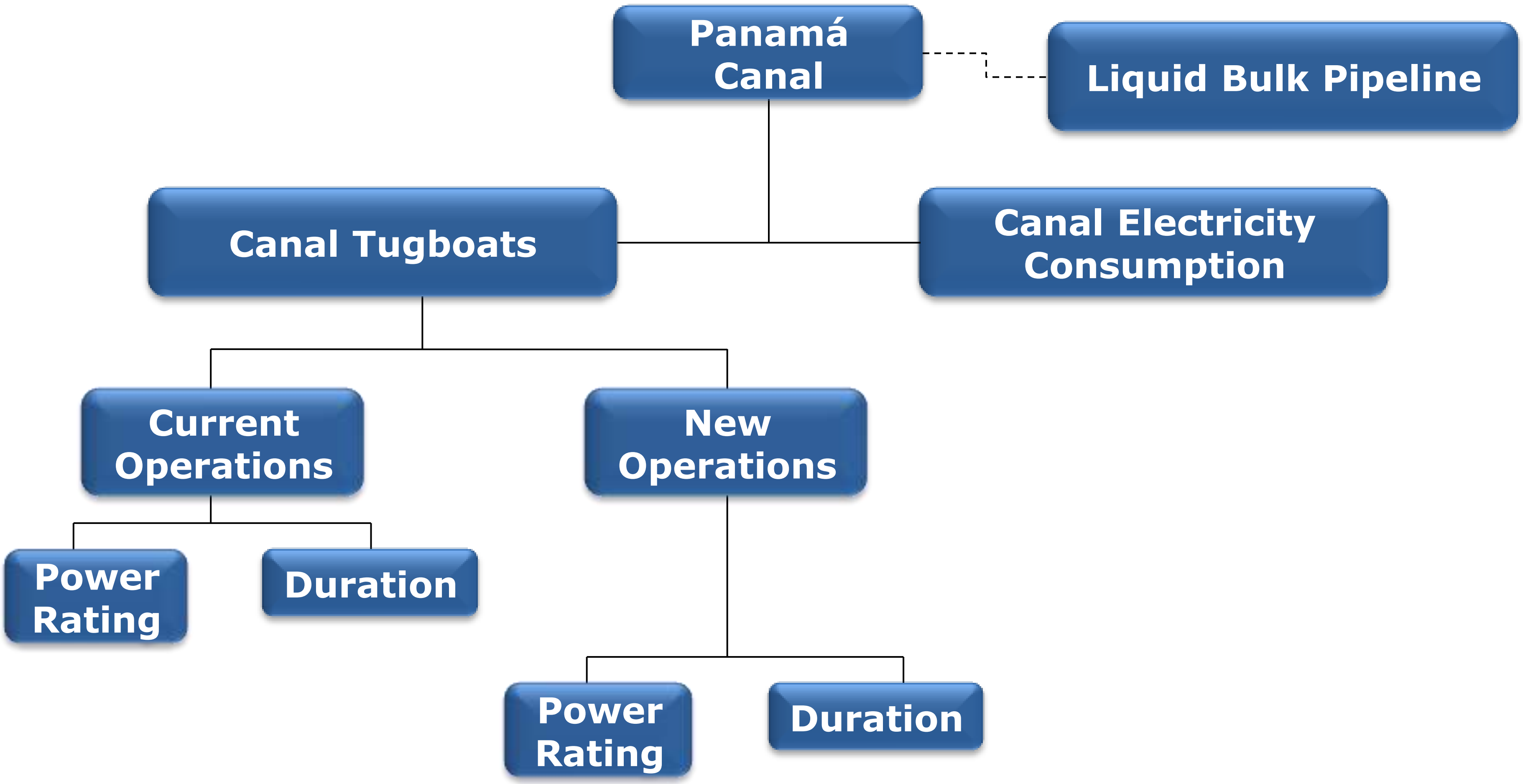
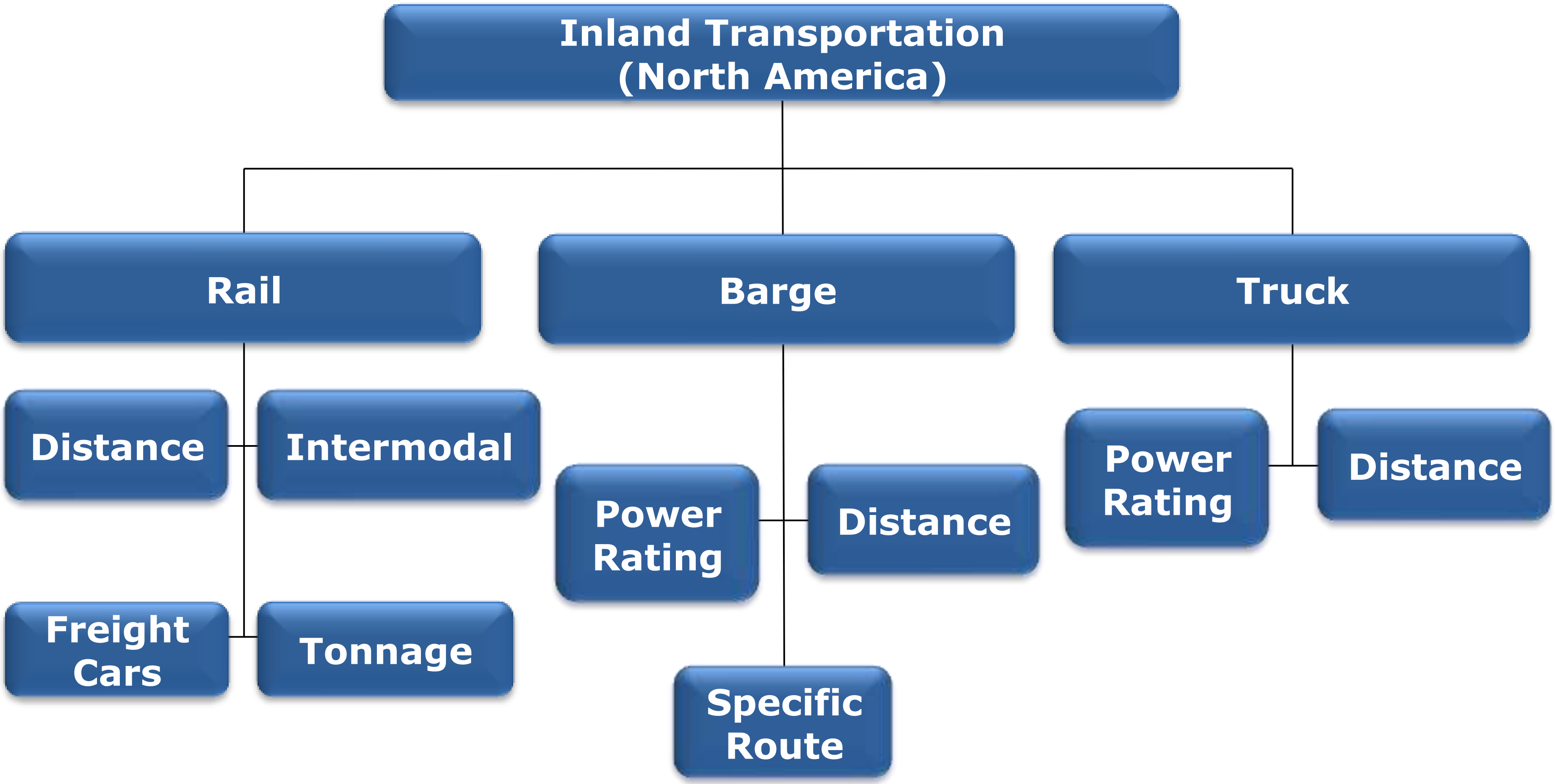
Panamá Canal Inputs to CO_2METS



Intermodal Inputs to CO_2METS



Inland Waterway Transport Inputs to CO_2METS

Trip time

- # days from PCRCAM

Geographic factor

- accounts for the changes in load capacity for tug due to geographic constraints - lower Mississippi, 1 tug can tow 40 barges; upper (MN area), 1 tug can tow 9 barges. Specific route based.

Weighted average of barge capacities in the U.S. in tonnes

- 1516.6

Fuel consumption in tonnes/day as function of gross tonnage

- 5.6511 +0.01048*GRT

Truck Transport Inputs to CO_2METS

CO_2 (kg/TEU) = Distance Traveled X EF_{fuel}

CO_2 (kg/CEU) = Distance Traveled X $Ef_{fuel}/8$

EF = 1414 g/mi

- Trucks assumed to carry 2 TEU at a time
- 8 is the average number of CEU per truck
- EF is for the Heavy Duty Diesel Truck, from MOVES 2010, a USEPA modeling tool
- Empty miles are included in the calculation

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Rail Inputs to CO_2METS

Class I Annual Reports to Surface Transportation Board

- Average net tons per railcar
- Quantity of Railcars
- Average fuel economy – eastern railroads & western railroads
- Intermodal fuel consumption

Distance traveled in miles – from PC*MILER Rail©

750. CONSUMPTION OF DIESEL FUEL
(Dollars in Thousands)

LOCOMOTIVES			
		Diesel	
Line No.	Kind of locomotive service (a)	Diesel oil (gallons) (b)	Line No.
1	Freight	930,685,930	1
2	Passenger	10,815,977	2
3	Yard switching	121,699,359	3
4	TOTAL	1,063,201,266	4

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Data Sources

All data sources obtained in public domain

- Accepted international or national standards
- Widely vetted and recognized
- Ensures consistency within countries or industry communities
- Examples: IPCC Guidelines, Transportation Energy Data Book, DOE

Documentation required by legal requirements

- Documents must meet standards set by government
- Ensures consistency in reporting
- Examples: MSDS and Rail Class I Annual Reports

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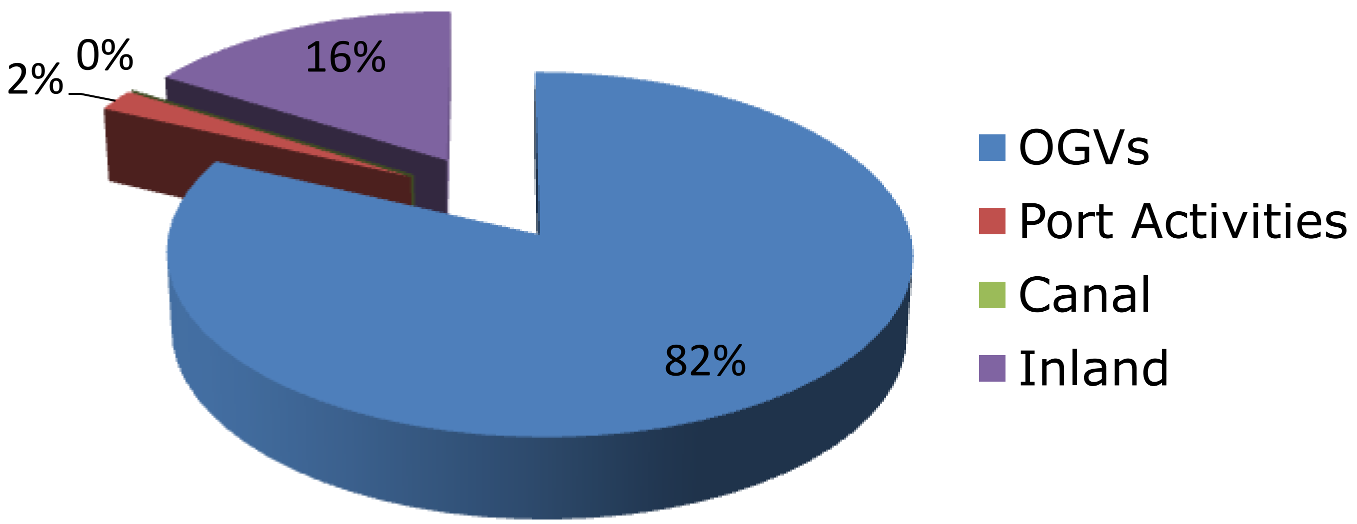
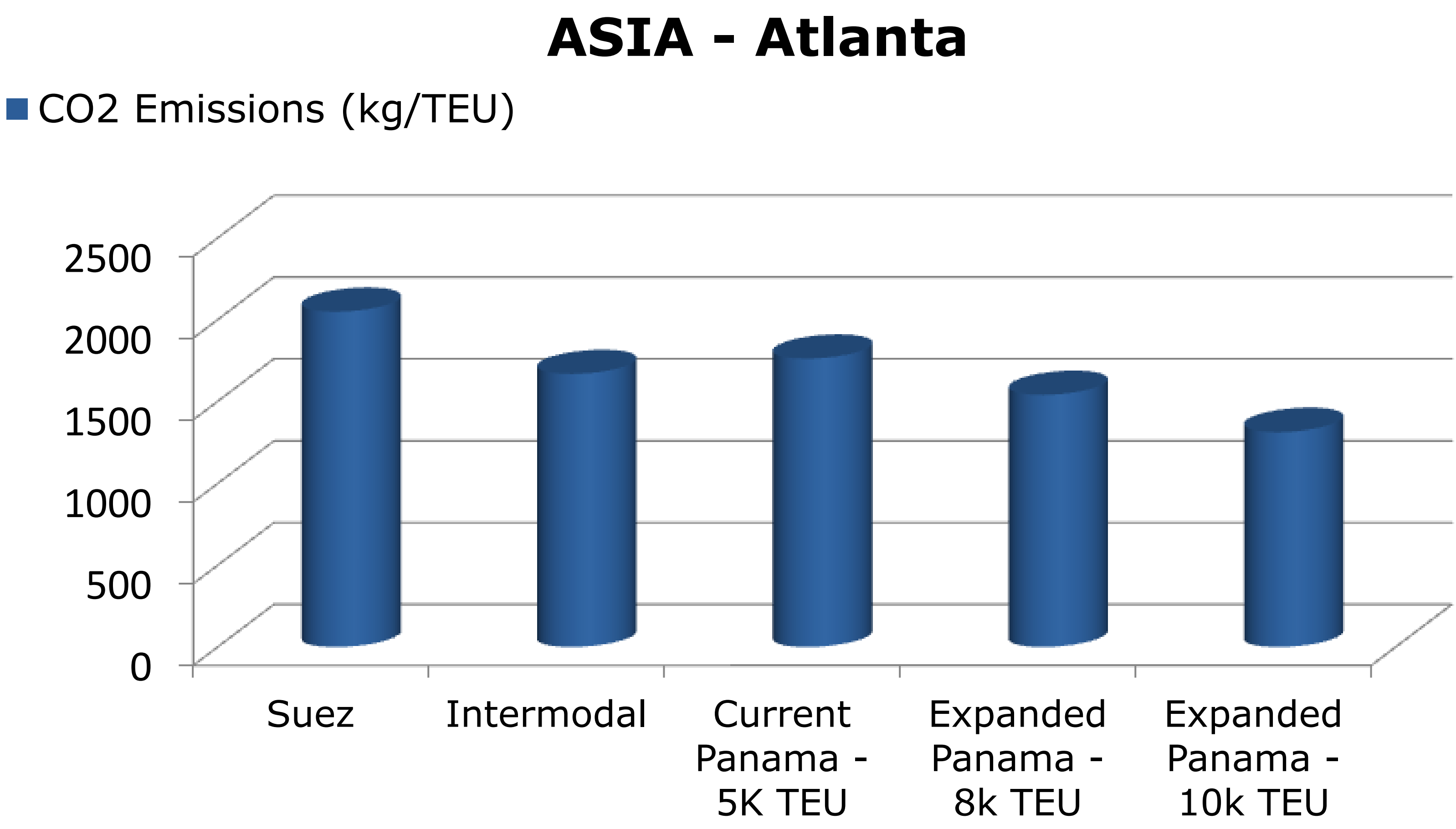
Example Outputs from CO_2METS

NE Asia/Columbus via Panamá Canal (kg CO_2/TEU)

% Contribution to Total Emissions



Example Outputs from CO_2METS



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Further Application of CO_2METS

- Can be used by ports, shippers, rail
- Identify green routes for any sector
- Readily refined to capture specific requirements (example: regional focus vs global)
- Green route selection can be used with green product promotion
- Combined with the financial competitive analysis model, provides user a comprehensive and dynamic tool for market analysis and forecasting.

Questions/Contact Information

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