Circular Ports

Dr. Thanos Pallis,

Professor, Dept of Maritime Studies, University of Piraeus, Greece

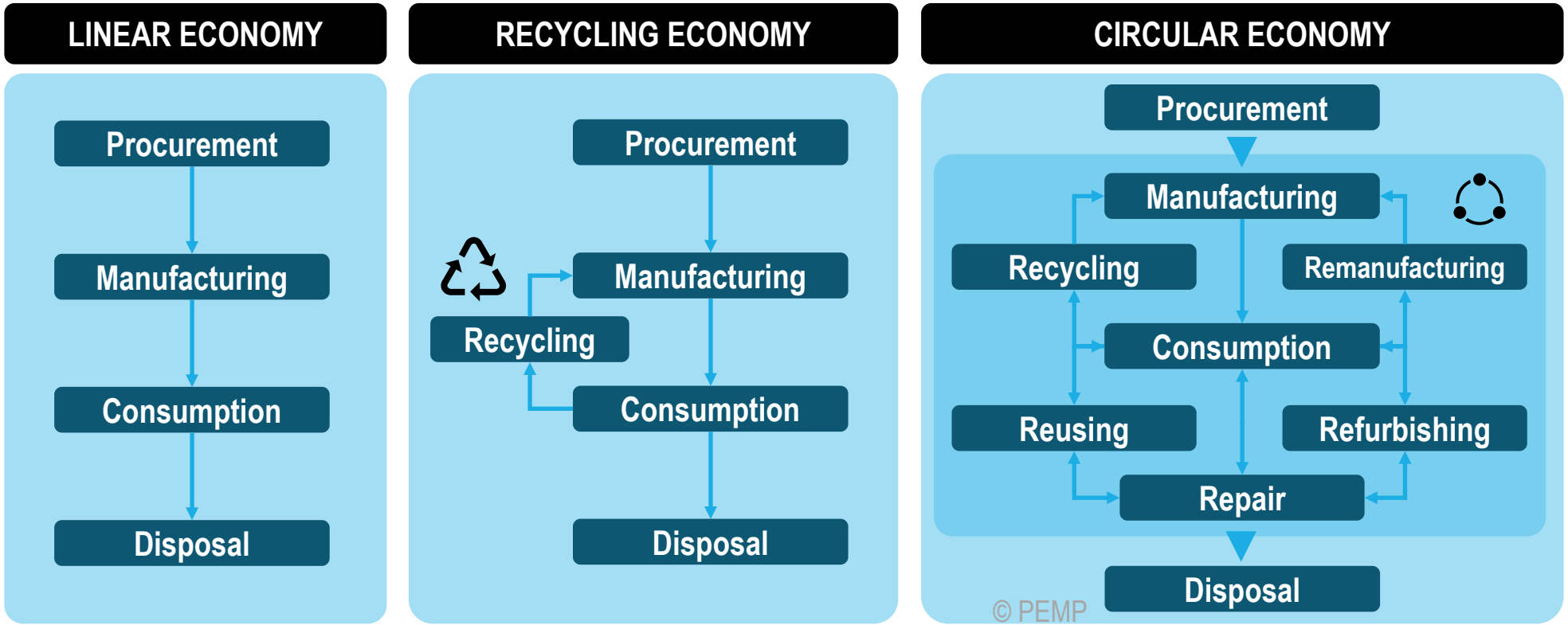
& co-director, PortEconomics.eu

https://porteconomicsmanagement.org/. | https://porteconomics.eu/

PortEconomics

From Linear to Circular Economic Principles

*The **circular economy** is a feedback system that tries to minimize the inputs of resources as well as the generation of wastes leaking into the environment.*



Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

Five interconnected themes

I. Circular Ports and Circular Maritime Supply Chains

II. Circular Economy Principles in Port Land Management

III. Implementing the Energy Transition of Ports

IV. Waste Management

V. Strategies for Circular transition

The Circular Economy in Ports and Maritime Shipping

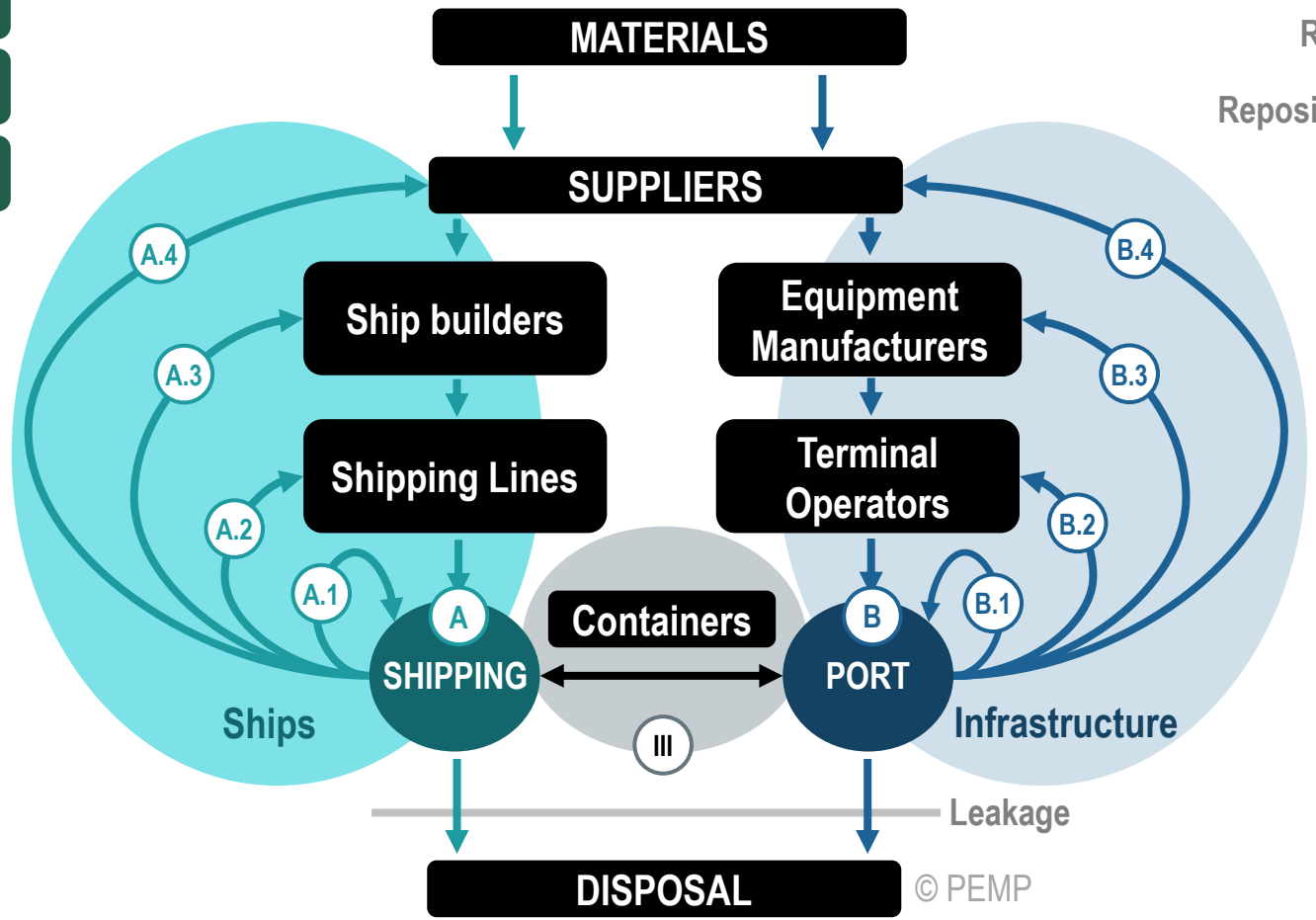
I. DRIVERS

- Industrial Ecology
- Recycling
- Renewable Energy

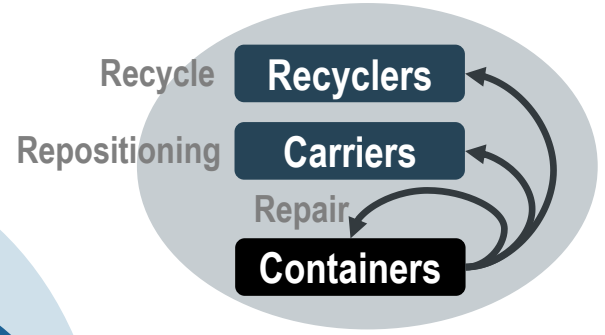
- A.4 Ship scrapping
- A.3 Ship conversion
- A.2 Ship sales or leases
- A.1 Ship maintenance

A. SHIPPING NETWORK

II. SHIPPING AND PORTS



III. CONTAINERS



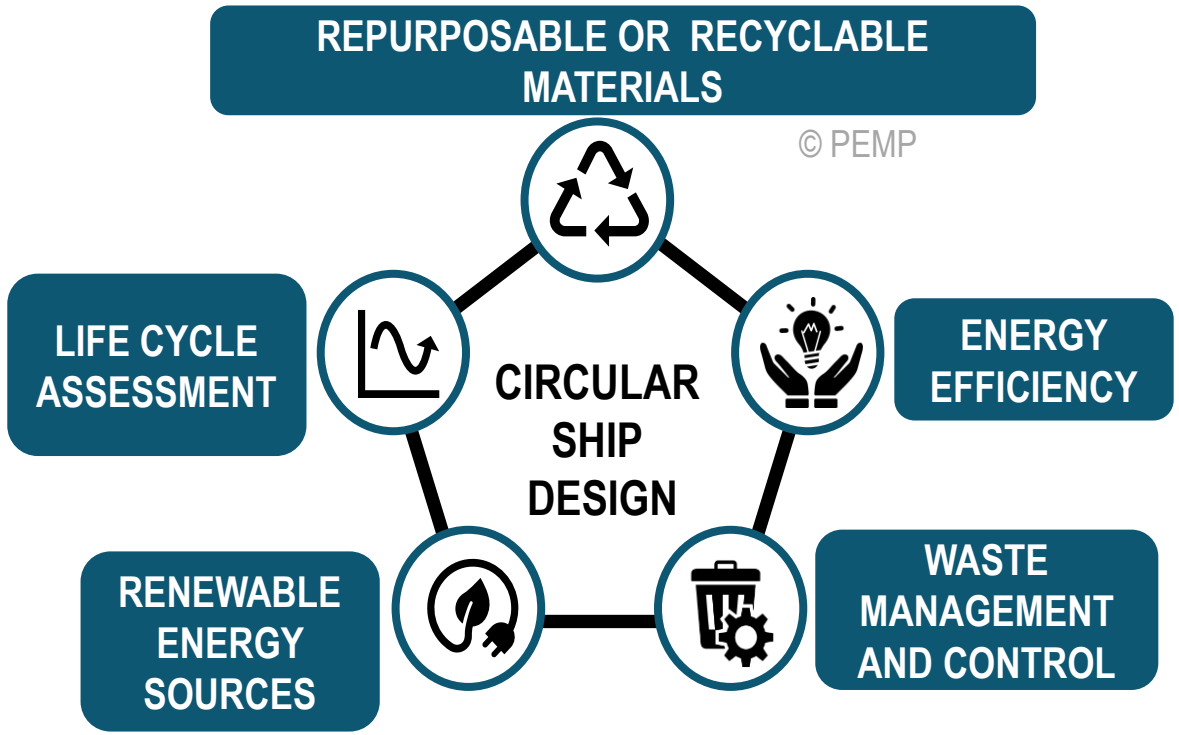
- B.4 Recycling & conversion
- B.3 Remanufacture
- B.2 Concessions
- B.1 Port maintenance

B. PORT DEVELOPMENT

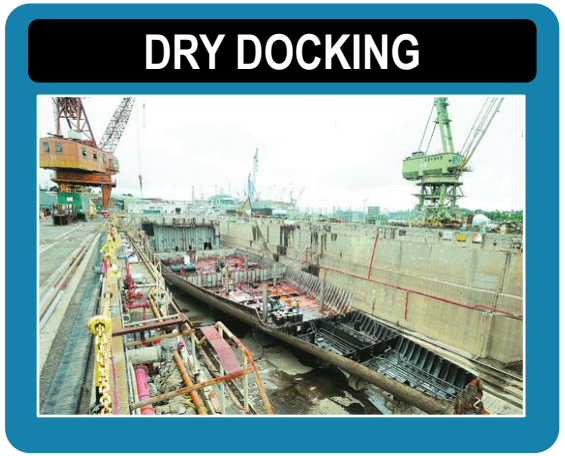
Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

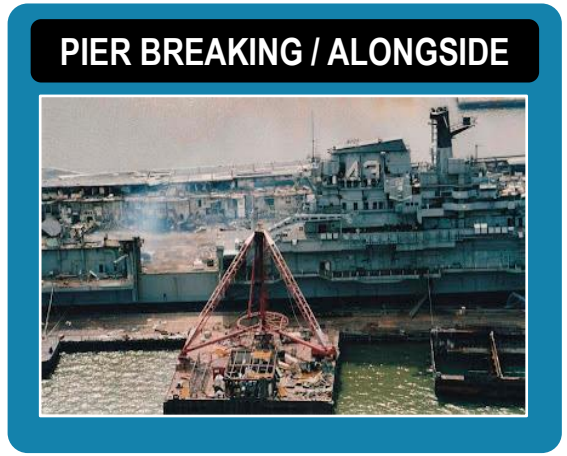
PortEconomics

Key Components of Circular Ship Design



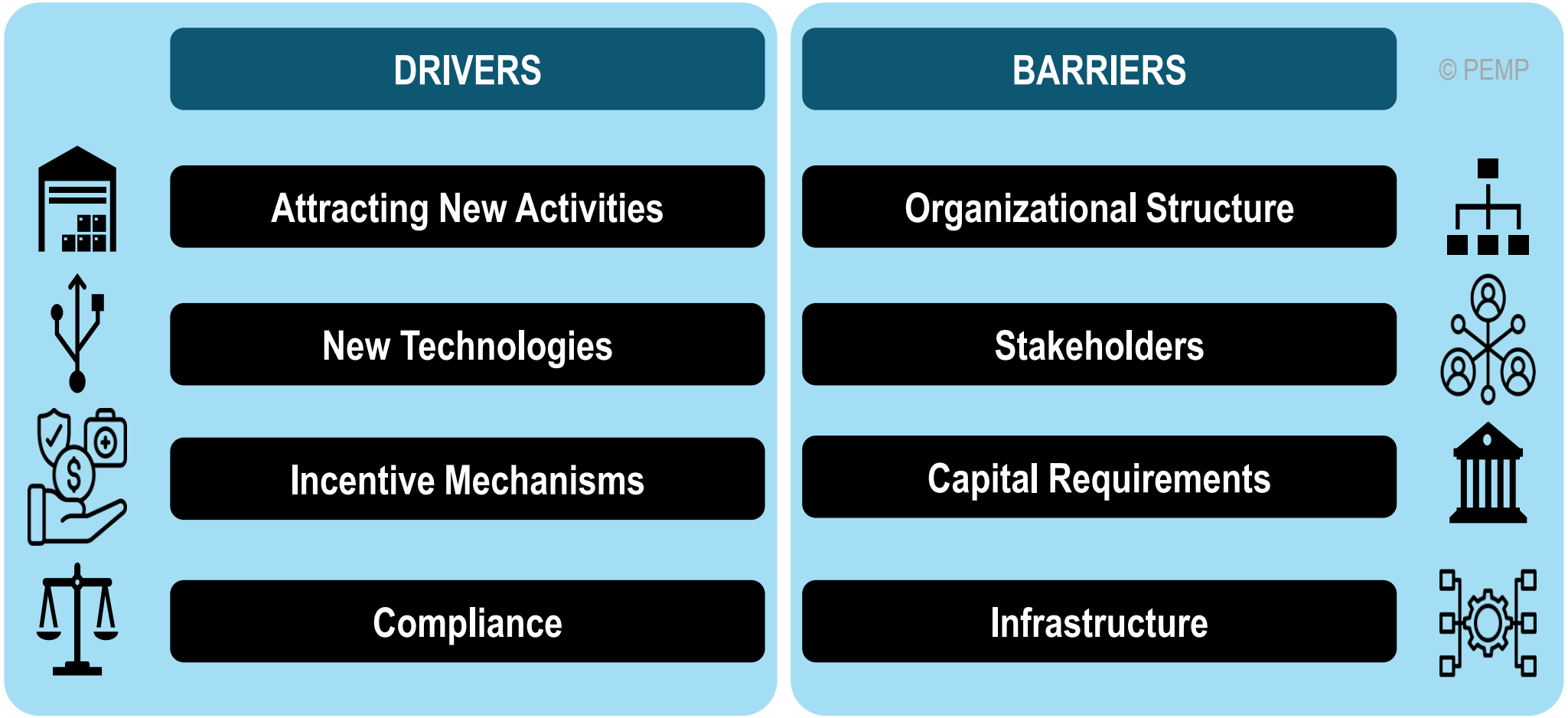
Ship Recycling Methods





Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

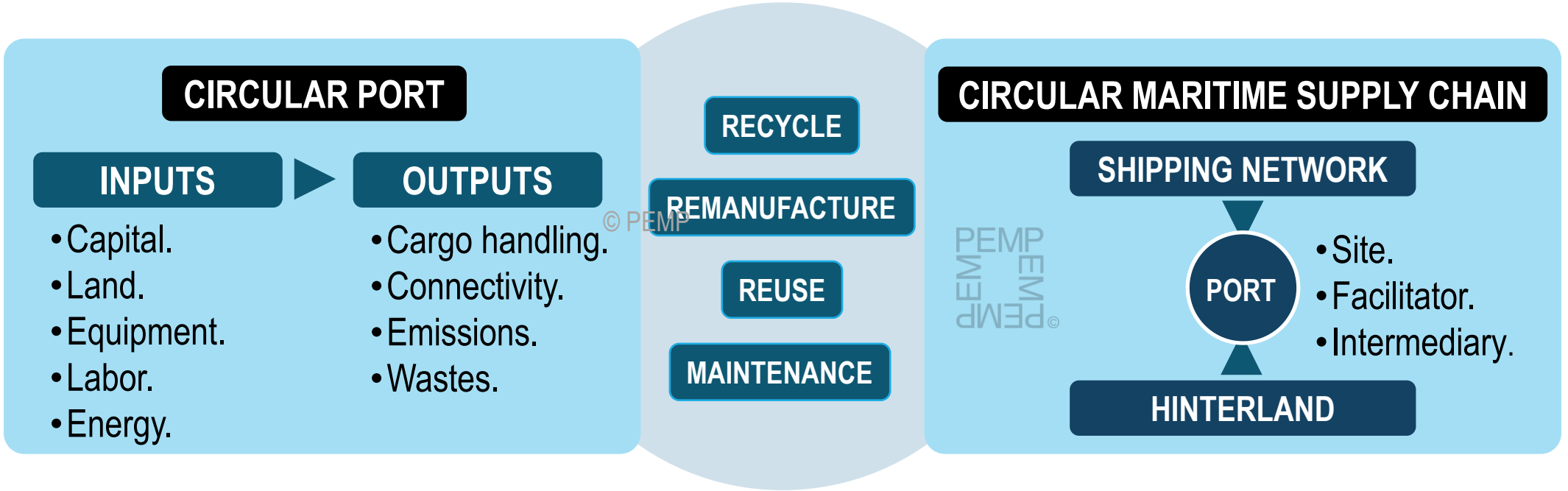
Drivers and Barriers for the Circular Economy in Ports



Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

I. Circular Ports & Maritime Supply Chains

Circular Ports and Circular Maritime Supply Chains



A. Produce at least the same outputs with fewer inputs

B. Ports to act as facilitators and intermediaries in circular maritime supply chains

C. Enhance drivers and lower barriers for the CE in ports

D. Develop conditions for advancing circularity (i.e., Material Sourcing, Hub Creation)

E. Engage of stakeholders in advancing circularity

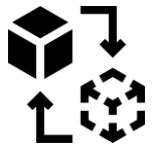
Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

Building Blocks of Material Exchange Platforms

KEY ISSUES
Governance of material exchange
Geographical scale (port, regional, etc.)

MATERIAL EXCHANGE PLATFORM

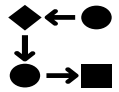
© PEMP



	MATERIAL PASSPORT	DIGITAL TWIN	MATERIAL VALUATION	MATCHMAKING
Purpose	List characteristics or identity of the material (e.g., composition, origin, toxicity or deconstructability)	Match the digital identity of the material to the physical material	Quantify the financial, environmental and societal impact of materials	Match the material or waste stream to a new high-value reuse option across industries
Practical implementation	Development of a unique material dataset	Tracking and tracing (barcodes, QR codes, RFID)	Generate data-driven decision making between several next use options	Combination of Artificial Intelligence and human expertise

Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

Action Fields for Material Sourcing Hub Creation in Ports

	FIELD	ACTION
	Material flow analysis and mapping	Detailed materials flow maps; Material exchange platforms
	Waste reduction and recycling programs	Design infrastructure; Provide incentives
	Circular material sorting and processing facilities	Provide facilities; Find funding, sourcing and support
	Collaboration, partnerships, and intermediation	Collaborative port ecosystem; Inter-firm cooperation to trade materials
	Circular material policies and incentives	Supportive policies; Incentives; Tariffs
	Education and awareness	Educational programs; Demonstrate opportunities and benefits
	Circular design and innovation	Product and supply chain design
	Monitoring and reporting	Development of metrics; Sustainability reporting

© PEMP

Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

II. Port Land Management

A. Land availability and demand for Circularity

B. The (re)development and (re)use of port sites

C. Lifecycle management of port infrastructure

D. Land concessions

Land availability and demand for CE

For CE to be implemented in a seaport context

- **Right conditions in spatial planning policy**
- **Coordination and cooperation between relevant stakeholders**
- **Irreversible decisions on land allocation**
- **Reserve the space required for circular activities**

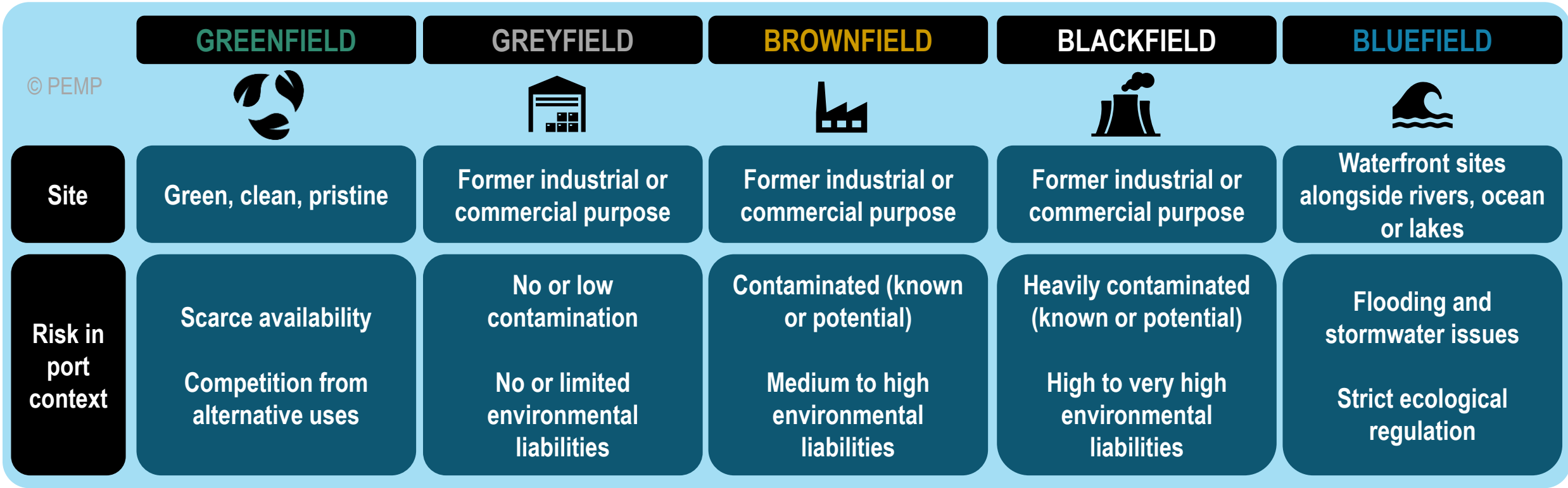
To prepare for and accommodate the transition

- Develop a systematic approach to **secure the required space** for CE developments.
- **Estimate the space** required in and around seaport systems under different CE scenarios.
- **Reserve strategic locations** in planning terms to avoid irreversible choices that hinder the CE transition.
- **Plan and develop infrastructure** for the circular economy

The circular economy as a whole could require up to 40% more space in the 2050s than the linear fossil economy of the 2020s.

PortEconomics

The (re)development and (re)use of port sites

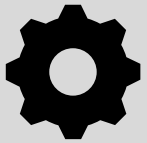
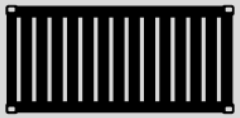
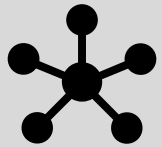


Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

III. Energy transition

A. Renewable energy integration.
B. Energy efficiency measures.
C. Waste-to-energy systems.
D. Digitalization.
E. Electrification of port equipment.
F. Energy storage solutions.
G. Lifecycle Assessment.

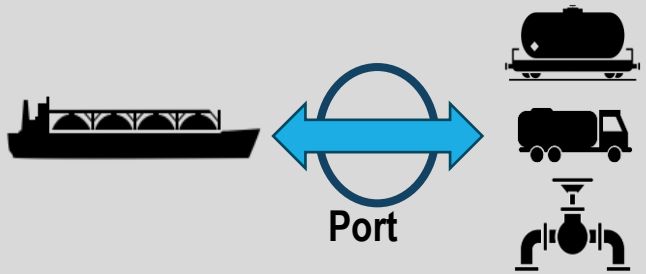
Ports and the Energy Transition: Realms of Engagement

FOOTPRINT	INFRASTRUCTURE	SUPERSTRUCTURE	CARGO FLOWS	INDUSTRY	HUBS
					
Land Use	**Enable**	**Support**	**Processes**	**Clusters**	**Connectivity**
• Land availability. • Land swaps. • Modal shift. • Spatial planning.	• Quays and terminals. • Power connection. • Energy conversion storage.	• Handling equipment. • Refueling facilities. • Energy transport.	• LNG. • Renewable energy. • Emission control.	• Energy demand changes. • Technology and process innovation.	• Hinterland access.

Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

Ports as Energy Platforms

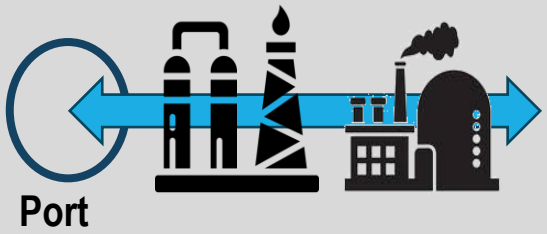
ENERGY TRANSPORT



Volume

- Gateways for the exports or imports of energy products.
- Temporary storage.

ENERGY TRANSFORMATION

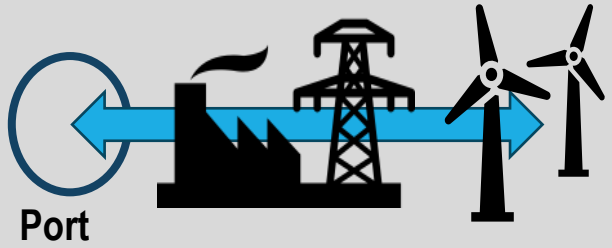


Proximity

- Sites for energy activities.

PEMP ©

ENERGY GENERATION



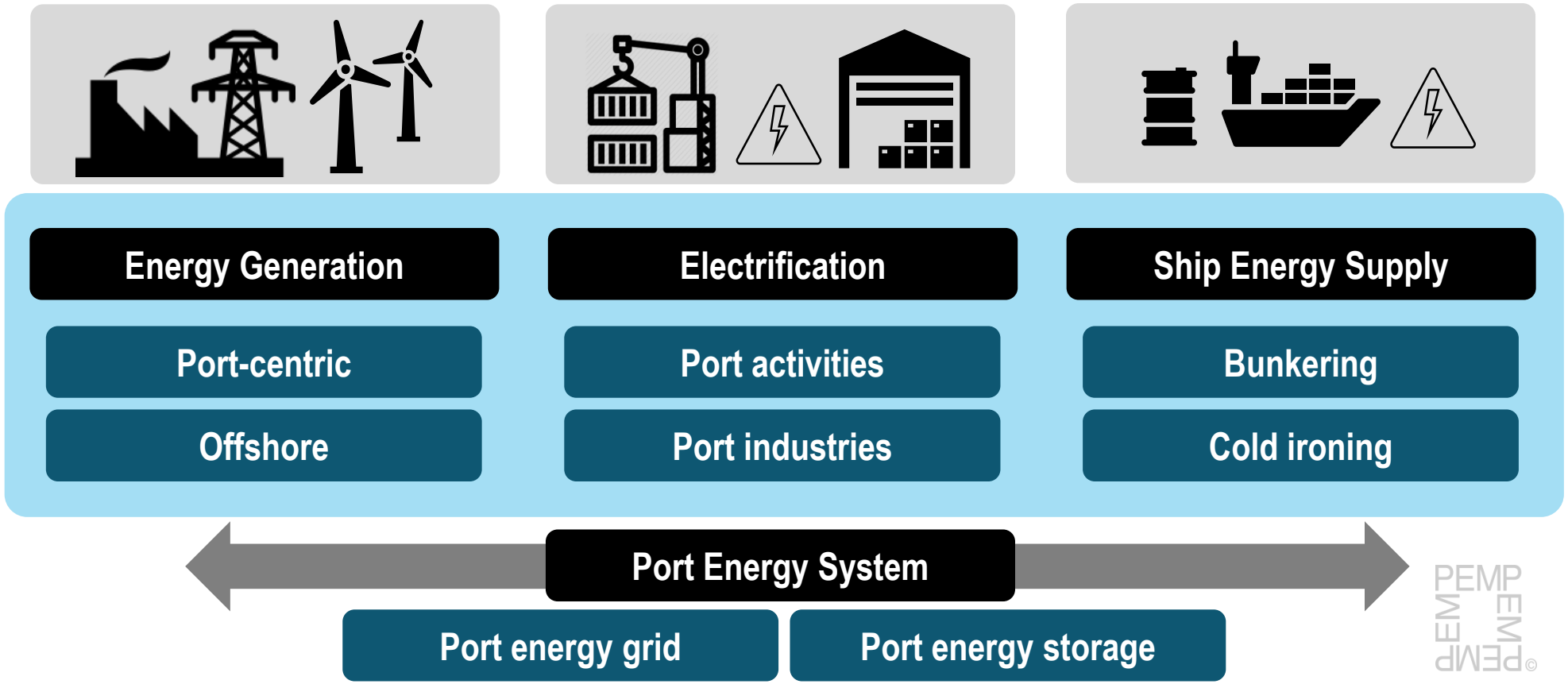
Diversity

- Provision and conventional and alternative energy products.

Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

PortEconomics

Port Energy Strategies



Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

The Decarbonization of Ports

- Energy Efficiency
- Operations Optimization (Data & Analytics)
- Future Fuels
- New-Tech./Innovative Solutions
- Shore Power
- Green Corridors
- Carbon Capture

IV. Waste Management

A. Waste management hierarchy
B. Implementing the best available techniques.
C. Extended Producer Responsibility.
D. Self-sufficiency in the community
E. Proximity

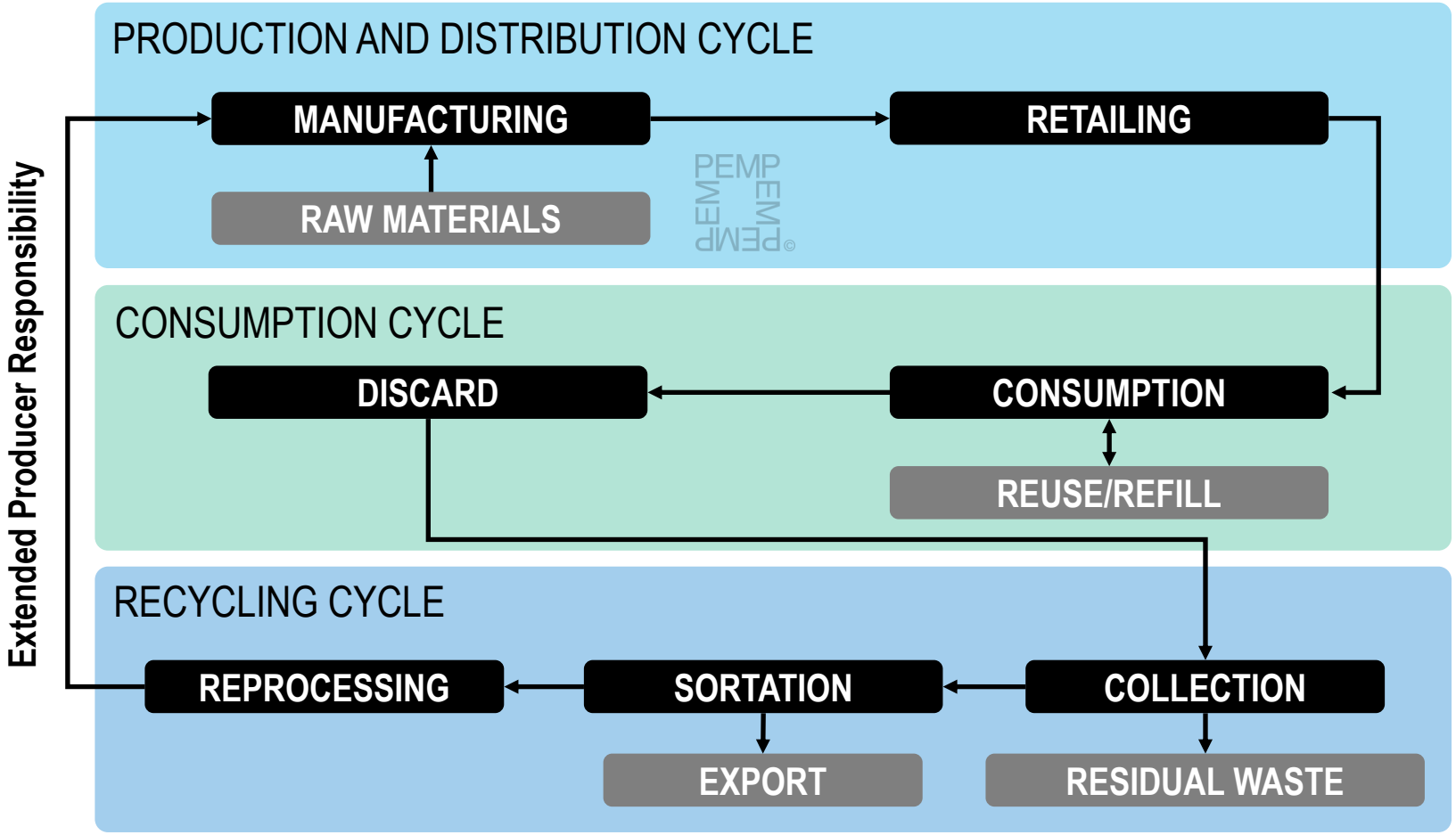
Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

The Concept of Extended Producer Responsibility

A. Waste management hierarchy

B. Arrangements for implementing the best available techniques.

C. Extended Producer Responsibilities.



Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

V. Strategies for Circular transition

A. System thinking approach

B. Path creation toward circularity

C. Self-assessment and monitoring

D. Reporting

CE Transition Phases for Ports

	CONVENTIONAL PORT	TRANSITIONAL PORT	CIRCULAR PORT
INPUTS Land Capital Energy Equipment Labor	• Focus on greenfield projects. • Diesel-powered equipment. • Carbon-related electric generation. • investments. © PEMP	• Circular clauses in concessions. • Land reuse and redevelopment plans. • Electrification and automation projects. • Energy transition projects. • Environmental accounting.	• Circular port land management. • Complete electrification and automation. • Renewable energy generation and distribution. • ESG financing (?).
OUTPUTS Cargo handling Connectivity Emissions Wastes	• Supporting linear maritime supply chains. • Shipping corridors. • Most port-related wastes discarded.	• Implementation of circular projects. • Setting green corridors. • Port-related waste recycling projects. • Emissions measurement and control.	• Supporting maritime circular supply chains. • Green corridors connectivity. • Port as material sourcing hub. • Extensive recycling and reuse of port wastes.

Break Bulk | Neo Bulk | Containerized | Liquid Bulk | Ferry & Cruise | Dry Bulk

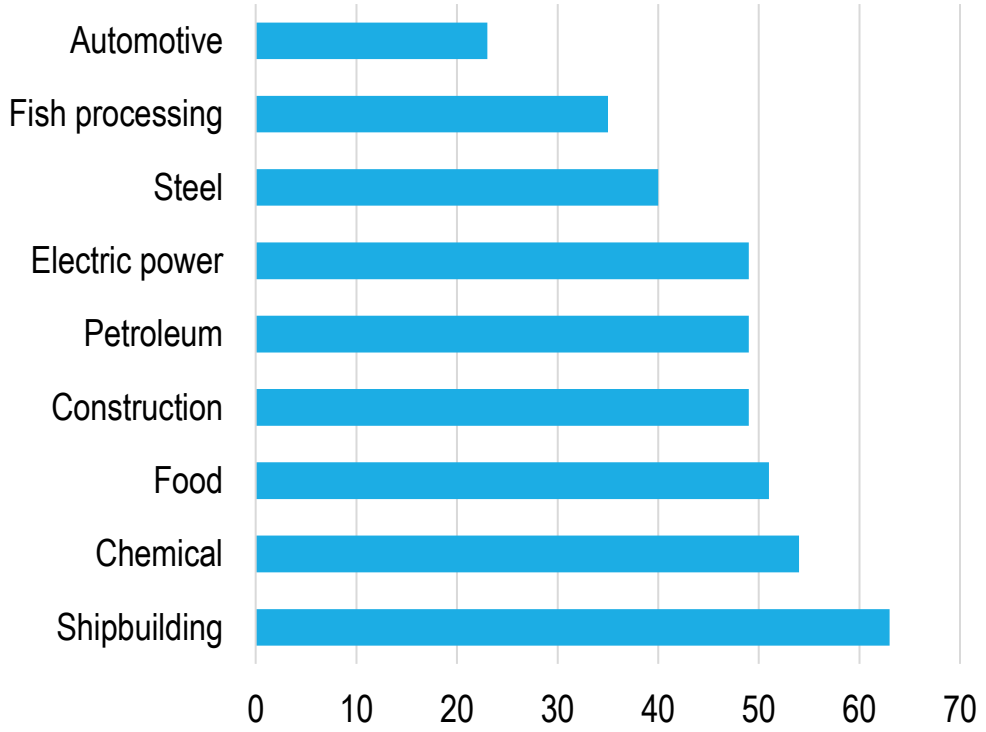
Different path dependencies by port function

Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

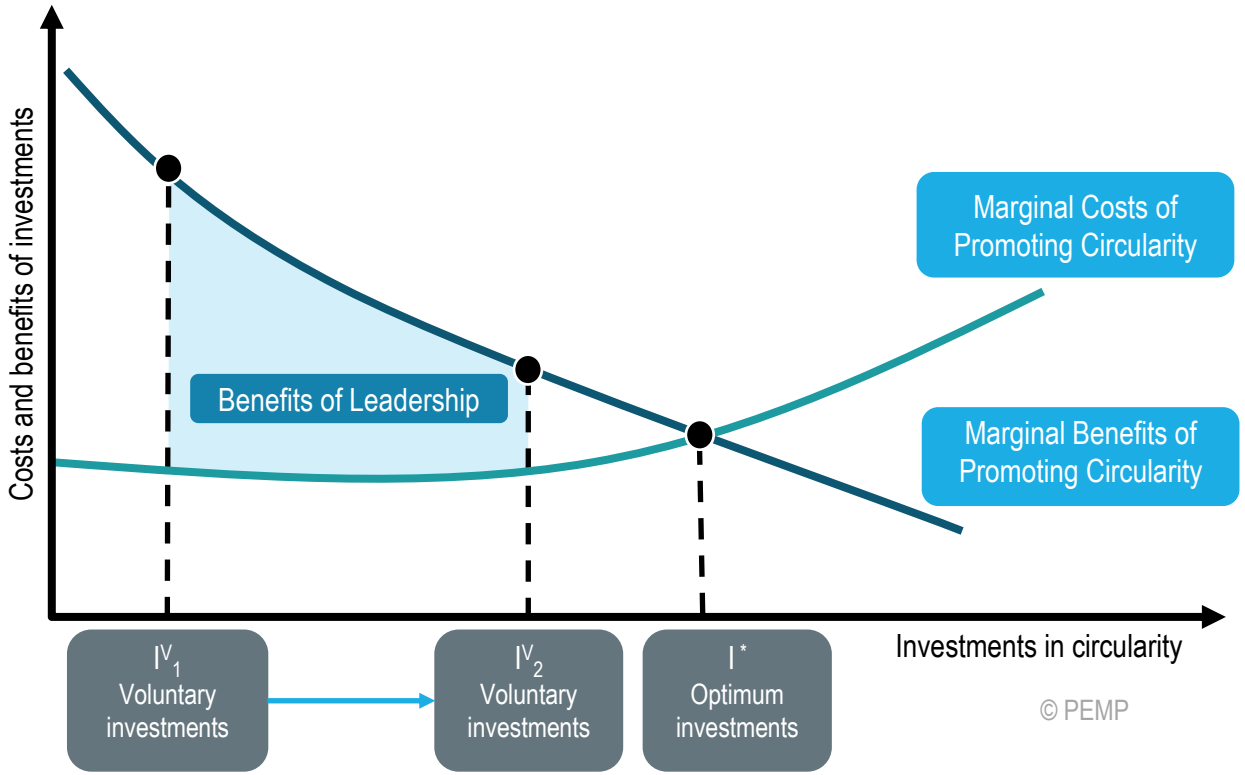
PortEconomics

Strategies for Circular transition

Industrial Sectors Located in Ports



Leadership in Promoting Circularity



Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

PortEconomics

Potential Indicators for Monitoring Port Circular Processes

INDICATOR	UNIT
Number of CE business activities located in the port area.	Absolute value
Number of CE projects in the port area	Absolute value
Share of CE start-ups in the port area which make use of incubation services	Percentage (%)
Share of tender specifications which include a circular procurement policy	Percentage (%)
Share of port companies which are members of a CE platform/s in the port cluster	Percentage (%)
Share of non-recyclable waste generated onboard ships	Percentage (%)
Share of cargo volume of end-of-life materials	Percentage (%)
Share of non-recyclable waste generated in the port area	Percentage (%)
Share of hectares of CE activities in port area	Percentage (%)
Share of direct employment from CE activities and projects in port area	Percentage (%)
Amount of end-of-life material processed in the port area	Tons, Litres, kilojoules
Share of secondary material consumption in the port area © PEMP	Percentage (%)

Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

(Transparent, Verifiable, Meaningful) Reporting

Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. For personal or classroom use ONLY. This material (including graphics) is not public domain and cannot be published, in whole or in part, in ANY form (printed or electronic) and on any media without consent. This includes conference presentations. Permission MUST be requested prior to use.

Disseminate information to generate interest
The Circular Flanders example

www.circularports.be

Port Economics, Management and Policy

Theo Notteboom, Athanasios Pallis and Jean-Paul Rodrigue

Chapter 2.7 – Ports and the Circular Economy

Authors: Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue

> Ports can play a role in setting circular supply flow principles in terms of materials, energy, land and waste management.

Follow us at:
https://porteconomicsmanagement.org/

Copyright © 2020-24, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. \

You may use the figures within for educational purposes only. No modification or redistribution permitted. For more information: https://porteconomicsmanagement.org/