

Resilience4Ports

Gateways to a resilient future



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Published by The Resilience Shift.
January 2021.

CITATION REFERENCE

Button, M., Davey, O., Leitch, A., (March 2021),
'Resilience4Ports: Gateways to a resilient future'.
Resilience Shift, UK

ABOUT THE RESILIENCE SHIFT

The Resilience Shift exists to inspire and empower a global community to make the world safer through resilient infrastructure. More people than ever depend on the critical infrastructure systems that provide essential energy, water, transport and communications services, and underpin food, healthcare and education. When this infrastructure fails the consequences can be catastrophic.

Supported by Lloyd's Register Foundation and Arup, the Resilience Shift provides knowledge and tools for those responsible for planning, financing, designing, delivering, operating and maintaining critical infrastructure systems. Our aim is to ensure infrastructure systems are able to withstand, adapt to, and recover quickly from anticipated or unexpected shocks and stresses - now and in the future.

DEFINING RESILIENCE

Resilience is the ability to withstand, adapt to changing conditions, and recover positively from shocks and stresses.

This applies to physical infrastructure assets, and to the wider system that these assets are part of including the natural environment, the organisations that own and operate these systems, and the humans who make decisions across the value chains for these systems.

HOW IS RESILIENCE SHIFT CONTRIBUTING TO THE ACCELERATION OF RESILIENT INFRASTRUCTURE IN PRACTICE?

The Resilience Shift is contributing to a global community equipped with a body of knowledge and tools needed to drive a global shift towards more resilient critical infrastructure.

We are focusing on tools and approaches to put this shift in resilience thinking into practice, identifying the drivers and enablers for infrastructure resilience, and advancing a common understanding of resilient systems, both within and between critical infrastructure sectors.



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ACKNOWLEDGEMENTS

The authors give thanks to project partners, Lloyd's Register Foundation and Arup, for all their valuable input during the scoping study. The authors also would like to extend their gratitude to all the stakeholders from the organisations below who contributed their advice and expertise.

- AGWA
- Asian Development Bank
- Bloomberg Associates
- Bloomberg Philanthropy
- C40 Cities
- Climate Neutral Consulting (CNC)
- Cityzenith
- Connected Places Catapult
- European Bank of Reconstruction and Development (EBRD)
- Global Covenant of Mayors for Climate and Energy (GCOM)
- Resilient Cities Network (RCN)
- Green Climate Fund
- Intel
- International Association of Ports and Harbours (IAPH)
- ITM Power
- Lloyd's Register Group
- Macquarie
- Maritime and Port Authority of Singapore
- PIANC Navigating a Changing Climate
- Port of Cork
- Port of Rotterdam
- Port of Tyne
- Resilience First
- Siemens
- Transnet South Africa
- University Maritime Advisory Services (UMAS)
- UN Global Compact
- United Nations Conference on Trade and Development (UNCTAD)
- University of York
- Wood Group

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Executive summary

In a complex and uncertain world, resilience is essential to the business continuity of ports and the critical infrastructure systems that ports connect. Society needs resilient, low carbon gateways to prosper.

In September 2020, the Resilience Shift launched Resilience4Ports, a collaborative initiative to enhance the resilience of ports. After an extensive scoping exercise, engaging the entire ports value-chain, we are launching the Resilience4Ports phase one report, identifying the trends and transformations affecting the resilience of ports.

How do we define port resilience?

The ability of ports, and the systems that they are part of, to withstand and adapt to changing conditions, and recover positively from shocks and stresses. Resilient ports will continue to provide essential services, whatever shocks and stresses they may face now, and in the future.

What is meant by the 'value chain' for ports?

The Resilience Shift uses a value chain approach to identify the many stakeholders involved in delivering a service to end-users. This includes those responsible for planning, financing, designing, delivering, operating and maintaining critical infrastructure systems. Each stakeholder can add resilience value to benefit the resilience of the whole system.

PORTS: THE GATEWAYS TO WHOLE-SYSTEM RESILIENCE

Ports can become a leading global example of the transition to a carbon neutral world by mid-century. This approach requires planning and delivering transformation in a holistic manner – one which enhances resilience of the broad elements of the port system, recognising future as well as current pressures.

This report describes our case for port resilience – including the key action areas where cross-industry collaboration is required. Our approach to developing this report hinges on the following:

- Defining the whole port system, in terms of its elements, functions and interdependencies,
- Considering multiple drivers of change and broad resilience challenges – encompassing known and unknown risks.
- Broad engagement with stakeholders from across the ports value chain.

THE DRIVERS OF CHANGE AND TRANSFORMATIONS AFFECTING PORTS RESILIENCE

Through our engagement work with the ports value chain we identified the multiple drivers of change affecting ports resilience.

The main messages we heard were:

- Port transformation – whether through decarbonisation, technological change or becoming more sustainable – has the potential to address existing resilience challenges, but also create new vulnerabilities.
- There is a fragmented nature to both port governance and the approach to the multiple transformative agendas.
- Port communities' role in resilience is critical and must be strengthened and nourished.
- There is a need to demonstrate the broad value of port resilience and promote the right type of port investments.

THE ACTIONS THAT CAN DELIVER RESILIENCE

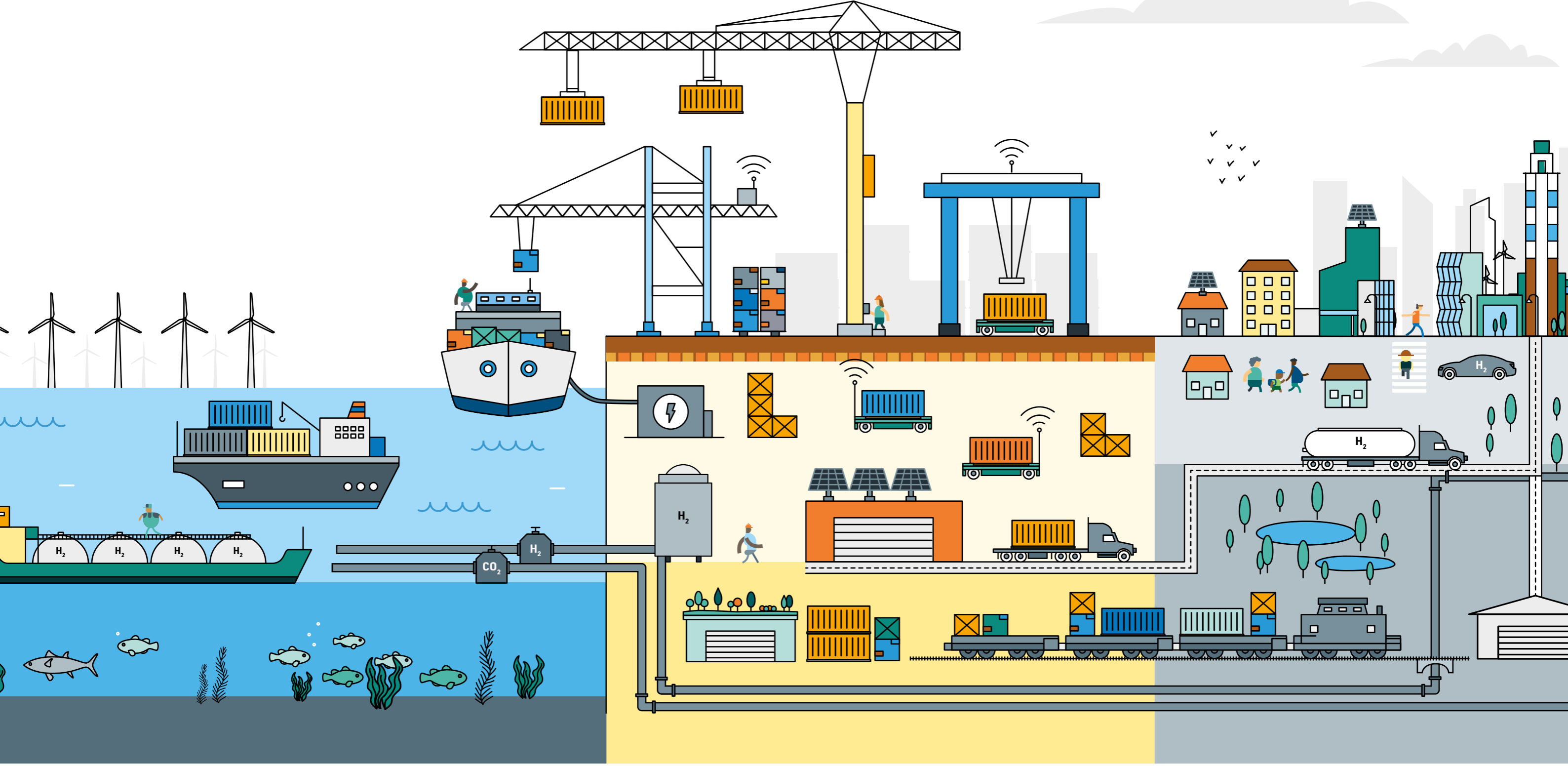
We have shaped four key action areas for cross-industry collaboration. These actions have the potential to:

- Help ensure ports can deliver critical functions to cities and communities, in an increasingly uncertain future.
- Reduce risks in the short and long term: accelerating port transformation and improving the economic resilience of port organisations.
- Unlock port investment by demonstrating the broad value of port resilience.
- Maximise the value from port decarbonisation and digitalisation.

Our work has identified that these collaborative action areas are key to enhancing port resilience:



Communities globally depend on resilient, low carbon ports to prosper. With our partners, we have been exploring opportunities for resilient, system-wide, transformation through the lenses of decarbonisation, technology, port communities and the environment.



Why Resilience4Ports?

Ports are resilience gateways. They are intermodal hubs for freight and passenger transport, representing a nexus of critical infrastructure systems.

Ports serve as critical linkages between global economies, handling nearly 90% of internationally traded goods. Ports also provide value-added services to goods that they handle and act as bases for an array of marine and terrestrial activities. This agglomeration effect means they often act a hub for research and development, for piloting new technologies and for innovation more broadly.

As such, their reliability and performance are essential to the flourishing of the economy, and society at large.

In the UK, recent port congestion resulting from Covid-19 and Brexit related stresses, has had far reaching effects beyond the port: from empty bookshops to shutdown car manufacturing. As the world becomes more connected and complex, we will see more stories like this – unless we act now.

Ports are facing multiple transformations: towards low carbon, smart logistics hubs that act in harmony with the environment, delivering increased value for communities.

What are critical infrastructure systems? Why are they so important?

Critical infrastructure protects communities from a variety of hazards; provides essential services such as energy and water; and connects communities via transport and communications networks, enabling the flow of goods and information.

More people than ever before depend on the critical services provided by infrastructure systems due to the growth of the world's population and its transition from rural to urban areas. If any of these systems fail, consequences can be catastrophic for public safety and wellbeing, the environment and the economy.

There is a risk that a lack of progress or lack of integration of these agendas will create fragility in ports rather than enhancing their critical functions. The world around us is changing faster than ever, and the speed of change is not going to slow down. As such, we cannot delay action.

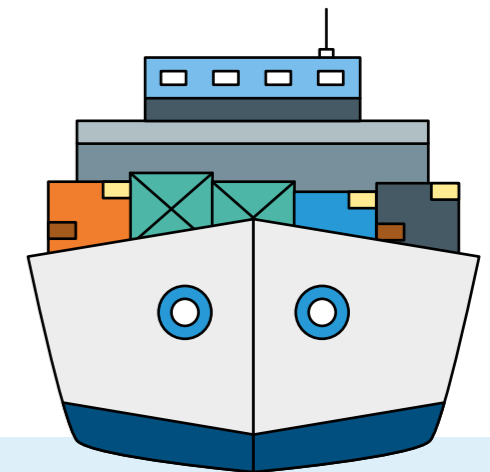
By approaching these challenges through the lens of resilience we can:

- Ensure a holistic not siloed transformation
- Focus on what ports do, not just what they are made up of
- Take a whole systems approach
- Bring together the broad port value chain.

This approach can deliver improved outcomes for society and the environment, as well as for port businesses.



Resilience is not a solo effort; it requires a village. To meet the challenges above, the port value chain will need to come together to connect, share knowledge and collaborate; to bounce back from adversity and be prepared for the future.



We are increasingly looking at ports as gateways for resilience. As ports evolve to become low carbon and smart mobility hubs around the world, they are becoming a catalyst for enhancing resilience, with far reaching benefits for supply chains, local communities and businesses at a global level.”

SETH SCHULTZ
CEO, The Resilience Shift



Ports must be prepared for the threats we can anticipate, and be able to respond to those we cannot predict or avoid, so that they continue to provide the essential services on which society depends”

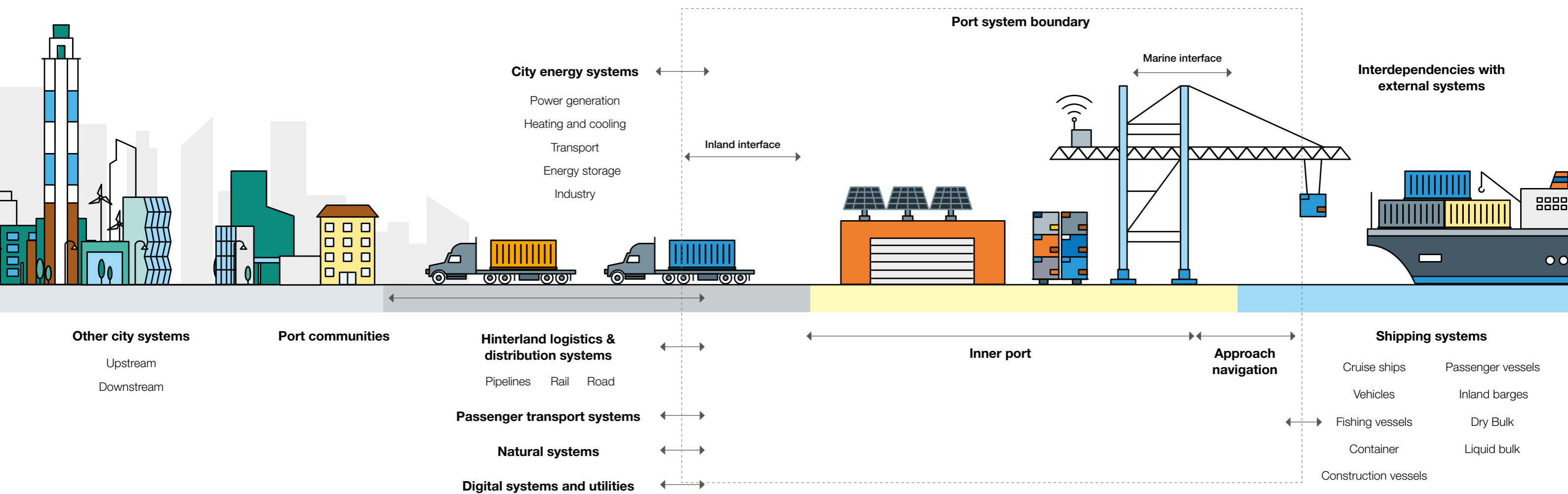
JAN REIER HUSE
Vice President at Lloyd's Register Foundation

Ports as a hub of systems



Port system internal interdependencies

- Port strategies, targets, budgets
- Operational procedures, standards, guidance, staff hierarchies
- Local culture and normal, staff relationships
- Flows of people, freight, energy, water
- Flows of data (stock, imports, exports, costs, fees, environmental)



The port system and its key interdependencies

PORT ELEMENTS



Social

- Port workers
- Workers unions
- Seafarers



Environmental

- The ocean
- Rivers, estuaries and deltas
- Natural harbours
- Intertidal areas
- Port land – natural and reclaimed



Economic

- Investors
- Financers
- Insurers
- Blue bond market
- Governments – tax and regulatory regime



Political or institutional

- International Maritime Organisation (IMO)
- Government bodies
- City authorities
- Logistics companies
- Port Authorities
- Port owners/landlords

- Terminal operators
- Customs and excises
- Marine security/policing
- Importers/exporters
- Shippers



Technological

- Port infrastructure
 - Harbours
 - Quays
 - Cargo handling
 - Storage
 - Transport
 - Utilities
 - Customs and security
 - Energy systems

- Dredged navigation channels
- Vessels
- Bunkering facilities
- Ship building and repair facilities
- Shipping lanes
- Global navigation / comms system

Ports as a hub of systems

CHARACTERISING PORTS AS A SYSTEM

Resilience needs the **whole system** to function, not just individual assets within the system. A port is a complex system of connected elements, itself embedded in an array of external systems. Ports are a confluence of the natural world and man-made systems.

When we think about the **elements** that make up a port, we have to consider the physical aspects, but also the wider social, environmental, political and economic features. A port's resilience is deeply connected to the community and natural ecosystem that it is part of, as much as its physical infrastructure.

How these elements relate to each other is critical. Their **interdependencies** derive from the rules, norms and procedures as well as flows of data, freight, energy and people.

As important as the elements, are the **functions** of the port: what role the port plays for society as well as the organisations governing the port. How does a port connect, provide or protect? In particular for the four critical infrastructure systems of transport, energy, water and communications.

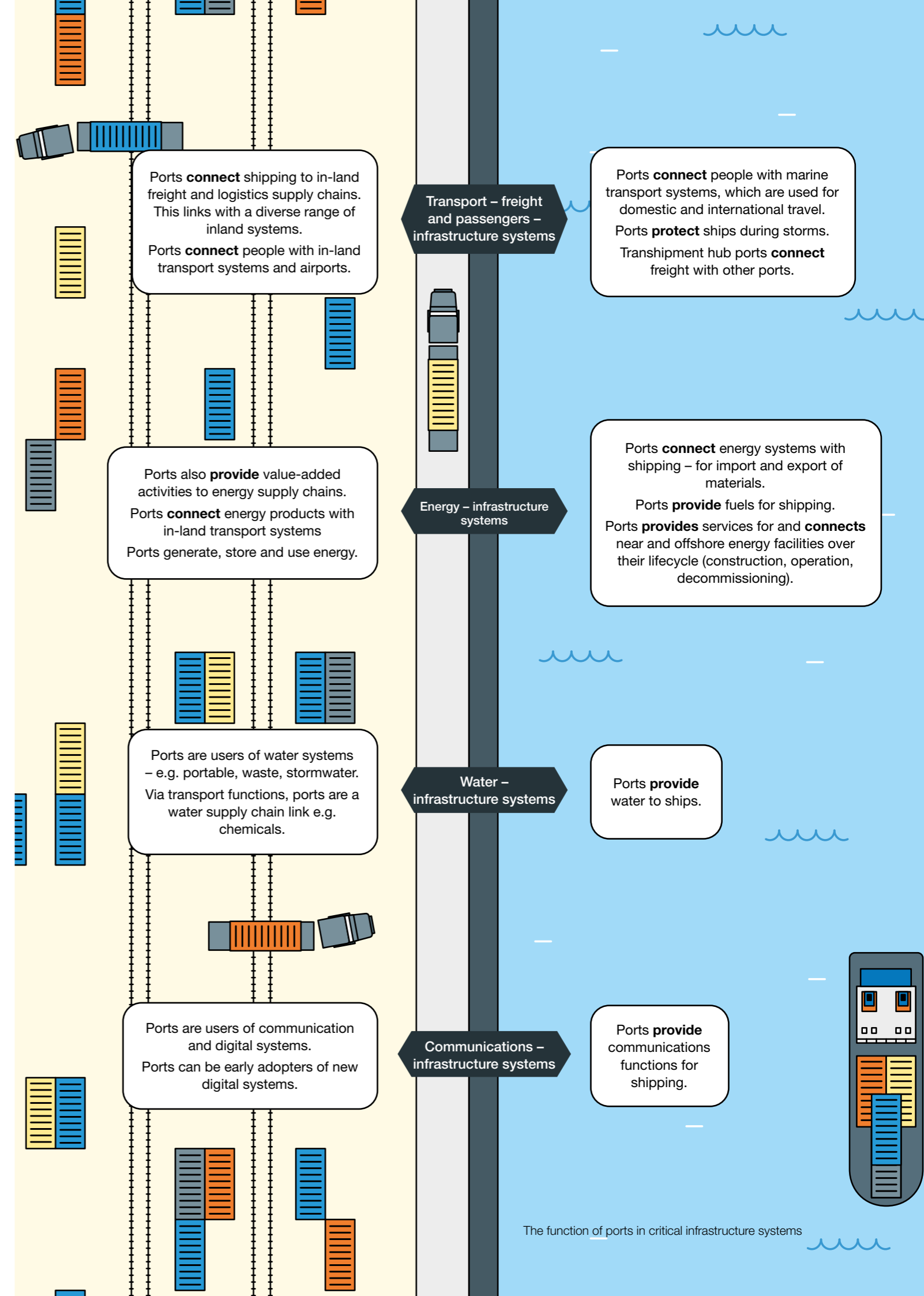
Resilience is not one size fits-all. By framing the challenge from a systems perspective, we can unlock long-lasting change. The images on the following pages set out some of the general characteristics of a port system that we have used to consider resilience challenges and opportunities.

A SYSTEM-LED APPROACH

We recognise that very few organisations have the remit to take a whole system view – boundaries are often there for a reason. But by bringing together the value chain from across the port system, and by demonstrating resilience value to everyone – not just end users - we can realise change.

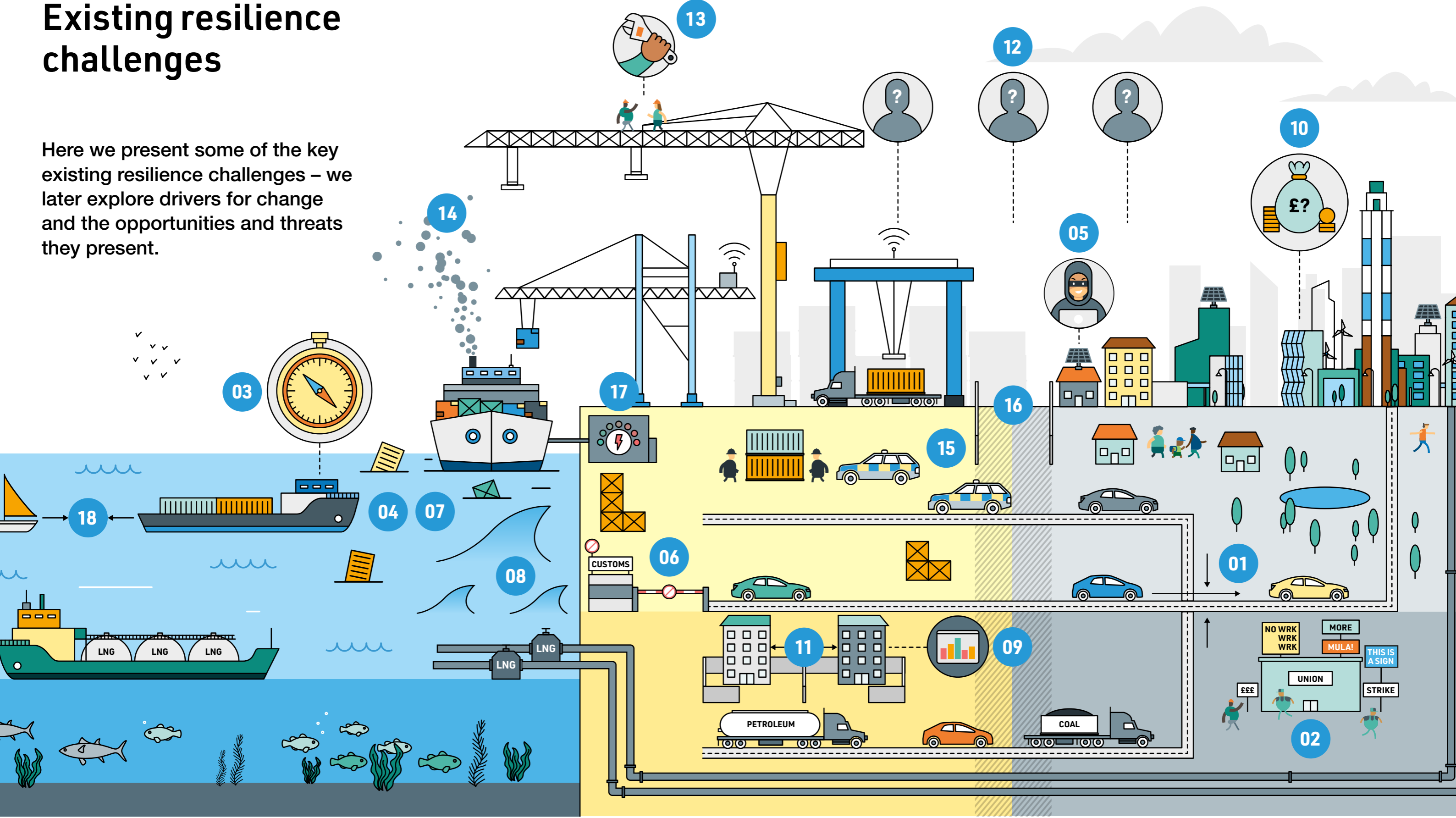
We have shaped action themes by considering resilience challenges – both those that ports currently experience, and those that they may experience in the future.

These shocks and stresses are short term events or long term pressures that could affect the functionality of the system. This chapter shows how broad those functions can be.



Existing resilience challenges

Here we present some of the key existing resilience challenges – we later explore drivers for change and the opportunities and threats they present.



- 1 – Hinterland connectivity and capacity
- 2 – Labour challenges and human factors
- 3 – Changing shipping routes and competition
- 4 – Changing vessel characteristics
- 5 – Cyber security and technology failures

- 6 – Increased barriers to trade
- 7 – Man-made hazards
- 8 – Natural coastal hazards
- 9 – Business model and market constraints
- 10 – Ability to access finance & investment

- 11 – Fragmented governance
- 12 – Lack of strategic oversight at regional national or international level
- 13 – Infrastructure asset management
- 14 – Reducing environmental impacts

- 15 – Smuggling and security
- 16 – Lack of space for expansion, or port city conflict
- 17 – Managing port energy needs
- 18 – Conflicting use of approach navigation

Drivers of change

To enhance port resilience, now and into the future, it is critical to consider the drivers for change affecting port systems and their interdependencies.

These drivers present both opportunities for enhancing resilience and the risk of creating new vulnerabilities. By taking a holistic approach to these multiple, intersecting agendas, ports can reduce risks, amplify synergies, and thus accelerate their transformations.

The following pages highlight some of the key trends and developments for these three key themes. Below we summarise the significance for ports.

DECARBONISATION

The global shift to net-zero greenhouse gas emissions will have far reaching implications for ports. This transformation affects ports on different levels:

- port operations will change;
- ports will facilitate decarbonisation of connected transport, energy and industrial systems;
- and the changes in our cities will affect the demands on ports.

The port governance structures and business models will affect the approach to this transformation, as will the port geography.

The barriers to decarbonisations are interlinked with resilience. For example, the challenge of fragmented governance, the requirement for a whole system approach to change and the need to manage uncertainty. It is therefore important to recognise the different roles the many actors in the port value chain will have in overcoming these barriers.

The regulations and incentives required for system-wide decarbonisation will affect port business models; with access to green finance, green recovery investment, and evolving shareholder concerns all playing a role.

Ports will play a significant convening role; brokering partnerships between transport, energy, industry and cities to realise broader change. Through all this change, the need for partnerships, collaboration and integration across the port value chain will increase.

TECHNOLOGICAL CHANGE

The 4th Industrial revolution is upon us. The rate of change in technological and digital applications across society and industries has never been so rapid. Throughout history technology has provided a catalyst for step changes in society. So, what does the digital age of the Fourth Industrial Revolution mean for ports?

There is a swathe of new technologies providing innovative means of generating data at a greater frequency, more cheaply. Large datasets, from sensors offshore, on vessels and attached to port assets have the ability to provide real-time understanding of the environment, equipment status and operating conditions. Generating and sharing this data has huge value across port functions. The insights generated can unlock efficiencies not only in operations and maintenance, but also in informing more efficient planning and design of the interfacing infrastructure.

Communication systems (such as 5G) are also providing the chance to quickly, remotely and efficiently transfer data, allowing rapid and increasingly automated decision making. The Internet of Things (IoT) will transform procedures, with direct machine to machine communication improving efficiency, safety and reliability – aiding decision making.

These technological developments can be enablers to broader outcomes: to greater efficiency and reliability, to safer operations, to services better integrated with land and ocean-side infrastructure, to greener ports. At the same time, these developments risk creating new vulnerabilities, and significant challenges to implementation – from human factors to integration across a fragmented port system.

PORT COMMUNITIES AND THE ENVIRONMENT

Ports rely on ecosystem services and have a duty to protect and enhance nature. These pressures will accelerate with time, affecting port development, operations and importantly ports' public perception.

A changing climate will put additional pressure on the biosphere, and present increased threats to ports; from rising sea levels, more frequent extreme storm events and extreme heatwaves. This is already creating a range of hazard ports are experiencing.¹

Ports are linked to a diverse and large ecosystem of communities, that extend beyond port workers to neighbours, those reliant on ports' functions and beyond. These communities are critical to a port's success, without them a port cannot 'survive and thrive' - the essence of port resilience.

Trust in the port's management by these communities is important. Engagement with the community through awareness campaigns, trades and skills training, community outreach programmes (including volunteering), charities, youth groups, etc, will be an indicator of that trust. Often, ports are linked with disadvantaged communities that require special attention and commitment.

As we decarbonise, a just transition for those currently employed in fossil fuel reliant jobs will be critical, overlaying with the impact of Covid-19 on the economy and jobs, and the need to create more good quality jobs and apprenticeships. This creates pressures for ports but also an opportunity; where port developments can be shown to deliver on these needs it can be a catalyst to investment and to growing ports' reputations and relations with the community.

(1) https://www.resilienceshift.org/wp-content/uploads/2019/10/RP-Ports_Final_Pages.pdf

Decarbonisation



LOW EMISSIONS PORT VESSELS

Smaller port vessels may offer an opportunity to pilot technologies before they are used at scale for seagoing vessels.



LOW EMISSIONS PORT HANDLING EQUIPMENT

Cargo handling equipment will likely transition to hydrogen and electric fuel sources.



SEQUESTRATION OF CARBON

Intertidal areas can have significant capacity for sequestration of carbon through natural means. This can play a part in ports' transition to net-zero.



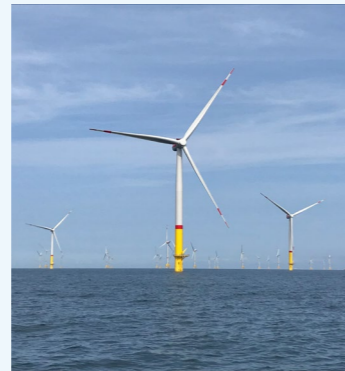
SHIFT TO LOWCARBON, DISTRIBUTED ENERGY

Ports themselves will need to adopt secure, low carbon and affordable energy systems, which are likely to include in-port generation and storage.



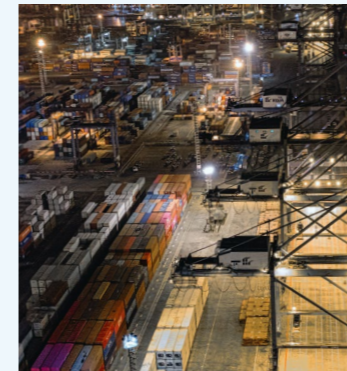
PROVISION OF LOW CARBON VESSEL FUELS

Ports will play a key role in the decarbonisation of shipping via low carbon bunkering fuels and shorepower systems.



FACILITATING OFFSHORE ENERGY GENERATION

The demand port facilities for the construction and operation of offshore wind continues to grow, this could expand to tidal or wave energy projects.



GREEN HYDROGEN PRODUCTION

For some ports, local generation and storage of hydrogen from renewable-based electricity will facilitate a resilient low-carbon energy system.



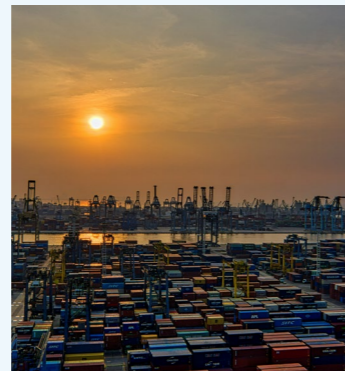
LOW-CARBON RE-FUELLING FOR HGVS/ LOCOMOTIVES

Ports can play a role in decarbonising hinterland transport systems, having a significant impact on emissions reductions.



MODAL SHIFT FROM ROAD TO SEA

The long timescales and costs associated with decarbonisation of HGVs could create a stronger case for domestic transport of goods by sea.



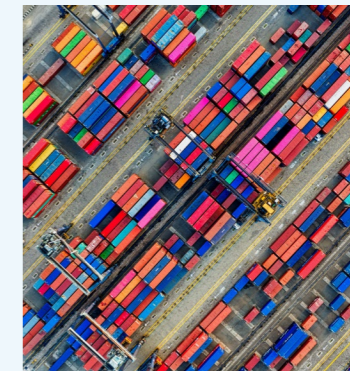
HYDROGEN IMPORT / EXPORT

As hydrogen emerges as a commodity traded globally at scale, demand for associated infrastructure will grow at certain ports.



CHANGES TO TRADED GOODS

As the world shifts away from the use of fossil fuels, the patterns of traded goods will also change.



CARBON RELATED BARRIERS TO TRADE

Differential decarbonisation between different global regions will potentially reduce the ability to trade freely, for example due to border tariff adjustments.

Technology and Digital



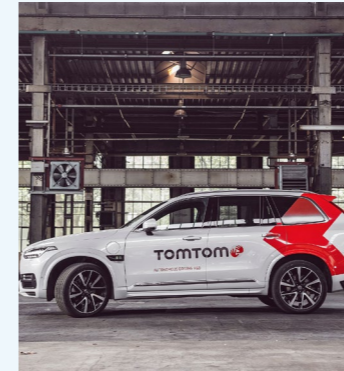
REMOTE/SEMI-AUTONOMOUS VEHICLES

For example, the use of semi-automated vehicles, remote piloted vehicles and drones for inspections and security.



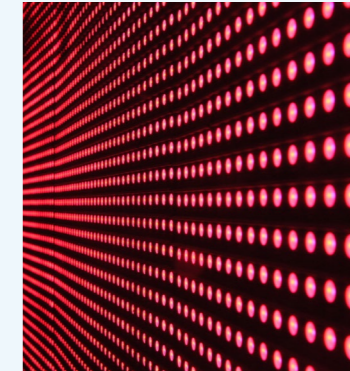
VESSEL AUTOMATION

Moving from auto-pilot to fully automated vessels. Ports adopting new navigation systems, new regulations and certifications.



AUTOMATION OF LAND-BASED OPERATIONS

Automated tacking cranes, driverless vehicles, image recognition technology. Opportunity to improve efficiency and safety and reduce downtime.



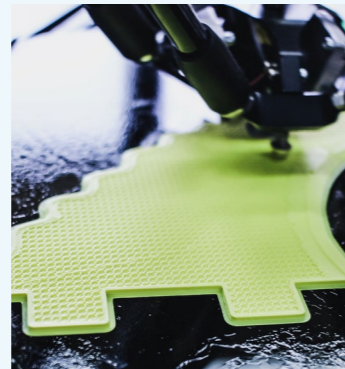
SMART SENSOR TECHNOLOGY

Improved information and data gathering. Early warning of incidents, predictive maintenance. Real-time status of operations, improved efficiency. New skills.



BLOCKCHAIN TECHNOLOGY

Implications for governance and trust created. Opportunity to improve document management systems, supply chain and financial transactions.



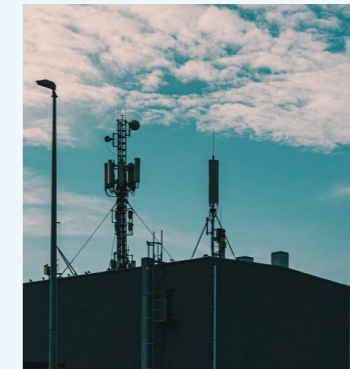
3D-PRINTING (RAPID PRODUCTION)

Potential for reduced global container trade through reshoring and increase in bulk trade to service domestic manufacturing.



AUGMENTED REALITY AND SIMULATION

Simulation currently used in navigation design and pilot training. Extended to augmented reality for navigation, operations, maintenance, asset management.



5G NETWORKS

Wide coverage and real-time sharing of critical information. Better connections between the port and port users or interdependent systems.



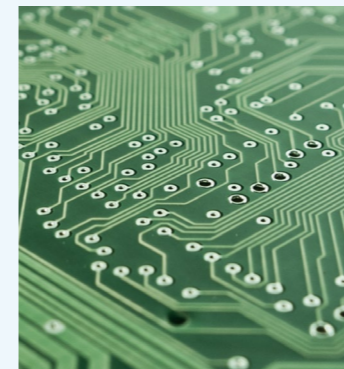
DIGITAL TWINS

Use in asset management and port planning. Use of modelling systems, photogrammetry and digital data.



ARTIFICIAL INTELLIGENCE/ MACHINE LEARNING

Building decision-making support systems based on a predictive model of behaviour. Use in maintenance or security, future equipment needs, long term utilisation, potential optimised logistics scheduling.



INTERNET OF THINGS (IOT)/ CLOUD TECHNOLOGY

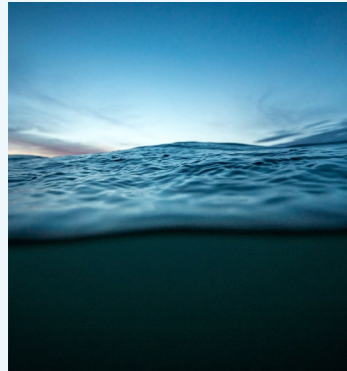
Transition to cloud-based system to improve accessible and inclusive data sharing. Integrated operating systems. Potential to reduce shipping administrative costs.



BIG DATA ANALYTICS

The ability to pool large amounts of data for drawing insights and Need for agreed uniform standardised method of data generation at global scale.

Port Communities and Environment



CLIMATE HAZARD, SEA LEVEL RISE

Potential for up to around 1.2m of sea level rise by 2100, depending on climate mitigation. Impact on coastal erosion and flood risk. Loss of intertidal areas.



CLIMATE HAZARD, EXTREME EVENTS AND TEMPERATURE

Global warming causing rising ocean temperatures, and therefore more energy for hurricanes and cyclones. Increase of average temperatures, as well as extreme heat.



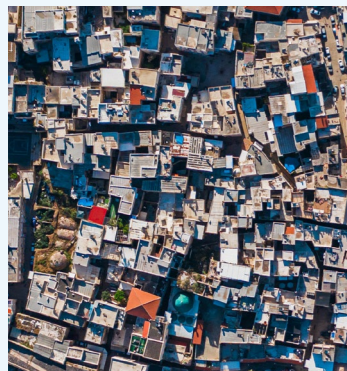
MARINE DEBRIS

There has been an increase in plastic pollution within the marine environment and there is a need for greater management of the life cycle to prevent the damaging effects to the ocean.



LOSS OF NATURAL COASTAL ECOSYSTEM

Over the last decades the world has expanded towards and developed many coastal areas removing the protection they provide.



URBANISATION AND PORT CITY GROWTH

Growth of world city dwelling population, as well as urban growth around city-centre ports will result in port city conflict as both expand.



CHANGING JOBS

Jobs crisis post-covid and the transition through decarbonisation as well as technological development will significantly change the port jobs market. The human factors linked with this change are critical.



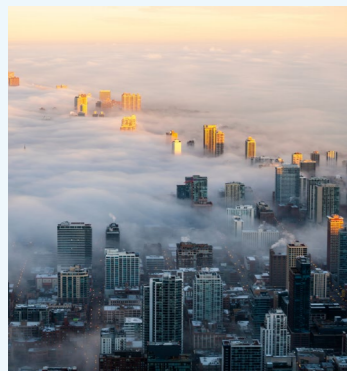
GROWING CRUISE INDUSTRY

Ten years of high growth has been severely impacted by the Covid-19 crisis. How the industry recovers will have a significant impact on communities, jobs and the environment.



SKILLS SHORTAGE

Developing the relevant and available skills as well as diversity is an important part of the Port developing organically with the port communities.



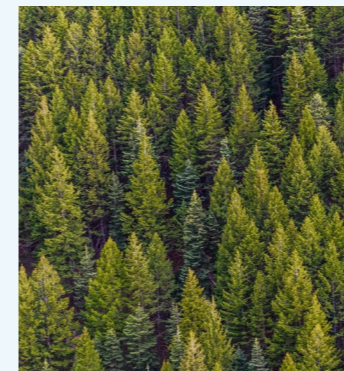
AIR QUALITY POLLUTION

Air pollution has an impact both on the health and wellbeing of the port communities as well as the public perception of the port.



RESOURCE CONSUMPTION GROWTH

There is forecast growth of resource consumption across the world, driven by both population rise and an increase in consumerism and tempered only by increased awareness and stewardship.



BIO-DIVERSITY LOSS

The biodiversity crisis will change the way the world's ocean and coastal spaces are used and managed. Ports and shipping can help enable a productive yet healthy ocean environment.



AQUACULTURE GROWTH

Port communities rely on aquaculture for both economic benefit and nutrition, maintaining the growth whilst remaining sustainable is an important balance to be managed.

Exploring resilience with the port value chain

To enable a shift in the practice of ports, we are working across the value chain to ensure different actors have the tools, knowledge and information to make the right decisions.

The Resilience4Ports initiative aims to complement work already taking place by industry organisations, by integrating themes, using whole-systems thinking and outcome-led approaches that aim to manage deep uncertainties, as well as address known risks.

In October 2020, we held two workshops attended by over thirty organisations representing different parts of the value chain. The workshops explored the three 'drivers of change' themes at a global and regional level, as well as what cross-industry action was needed to shift port practice toward resilience. This section gives a summary of what we heard at the sessions.



Cross Cutting



Decarbonisation



Technology & Digital



Port Communities & Environment



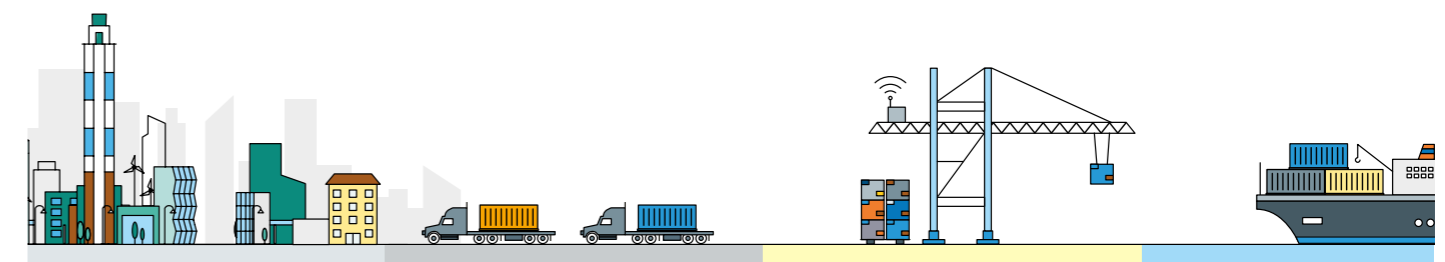
Finance



Cities



Ports



Research and consultancy



Non-profit initiatives



Energy



Figure 9 - Existing port groups linked to change and resilience

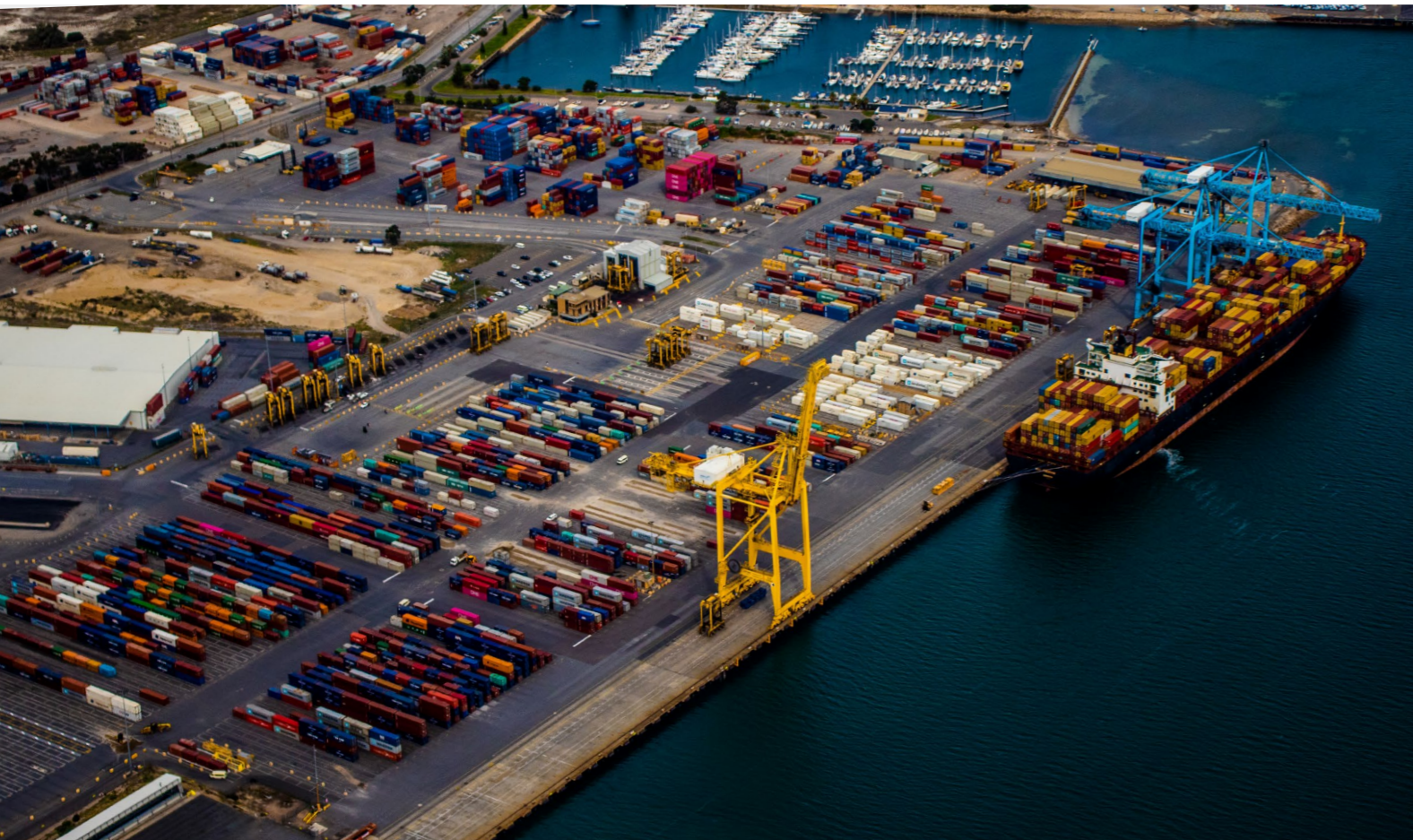
Value chain stakeholders engaged across port and interdependent sectors

Exploring resilience with the port value chain

What are the most important trends and developments?

As well as the key trends highlighted here, a range of others were selected, demonstrating the need for an integrated, broad approach to change.

Decarbonisation	Technology and digital	Port communities and the environment
<ul style="list-style-type: none"> Technology pathways Port business models and investment Provision of low carbon energy/fuels for vessels Changes to traded goods 	<ul style="list-style-type: none"> Artificial intelligence and machine learning Digital twins Big data analytics Automation 	<ul style="list-style-type: none"> Climate hazards Urbanisation and growth of port cities Air quality Collaboration with communities



What new resilience challenges could we see?

DECARBONISATION

- Uncertain techno-economic pathways and short-term planning resulting in stranded assets, delayed action and a segregated approach.
- Need for a shake-up of business models, partnerships and port policy landscape, as well as competition from other transport modes and changing patterns of traded goods.
- An increased need to integrate a fragmented port system and its interdependencies.
- Spatial constraints compounding the decarbonisation challenge.

PORT COMMUNITIES AND ENVIRONMENT

- Risk of incoherent, competing responses to a changing climate. Acute threats to low-lying coastal areas and small island states.
- A lack of focus on the non-physical aspects of resilience – a need to embrace community-focused response too.
- A lack of data to demonstrate the economic benefits of climate resilience restricting investment. Need for more long-sighted funding models.
- Increased urbanisation constricting port operation and growth, requiring better integration with communities and a focus on deprived communities.
- Technologies affecting ports operations
- A need to focus on the human-element of the transformation: skills, training and trust. Labour challenges with transition from traditional roles.
- Risk of over-reliance on sophisticated models – highlighting the need to manage deep uncertainty as well as known risks.
- Increased fragmentation from new tools and datasets. New vulnerabilities from systems lacking redundancy or reliability.

Where can change help address existing resilience challenges?

DECARBONISATION

- New revenue streams through on-site generation of low carbon energy and bunkering fuels.
- New functions and roles can help attract a new diverse workforce.
- Long term planning required can unlock new business models, collaborations and a strategic approach – with the right support.

TECHNOLOGY

- Can use technology to help map and quantify benefits beyond the port boundary, broadening case for investment.
- Opportunity to use data for predictive maintenance and better analysis of root cause. Automated technology could reduce exposure to hazards.
- Digital twins provide opportunity to stress test port systems, expand multi-stakeholder collaboration at scale and plan for transformation.

PORT COMMUNITIES AND ENVIRONMENT

- Opportunity to create new jobs through nature-based solutions to climate adaptation, and creation of smart mobility and low-carbon energy hubs.
- Opportunity for smart asset management systems to integrate climate risk management, upgrading of ageing infrastructure and green agenda.
- Increased role for social capital and communities, if nurtured and strengthened.

Exploring resilience with the port value chain

What actions do we need to enhance port resilience, now and into the future?

"We need guidance on how investments can be appraised at a systems-level"

"Financing must support low carbon, resilient ports"

"To deal with uncertainty and avoid maladaptation, there is a need to better align financing criteria with delivery of flexible and adaptive solutions that can be modified as conditions change."

"We need to identify funding opportunities for emerging technology, especially around clean energy"

"We need to collaborate with leading investors for ports that are driving ESG"

"We need to quantify whole value chain impacts – the cost of inaction"

"We need a business case for resilience, to shift from cost minimisation towards longer term success over short-term profits"

"Technology can enable evidence-based decision making to unlock resilience"

"We need to reduce fragmentation across the value chain"

"From a technology point of view, what standards and assurance processes are needed to support the resilience shift in ports?"

"Is there a space to pull best practices from other port standards/tools and help drive scalable solutions?"

"We need practical guidance on dealing with climate change uncertainties – including preparedness, flexibility and adaptive capacity"

"Resilience standards could provide quality assurance for investment and accelerate adoption of green fuels"

"We have to learn from Covid-19 and Brexit – not by focusing on causes (threats), but on consequences (impacts) and what this tells us about resilience"

"We need adaptation pathways for ports: flexibility and scalability in solutions, avoiding being locked into a particular plan as conditions change"

"Ports need guidance for the future technology pathways, and how to plan in a way that reduces risks. A roadmap can guide activities through the infrastructure life cycle"

"Ports are embracing tech in different ways – we need standardisation, to work together and speak the same language"

"Is part of the output a ports system model that can drive resilience across the range of stakeholders?"

"People are the most important element in resilience, we need to build social capital of trust and leadership"

"We need to train the new generation of port communities with the introduction of technologies"

"We need to promote the port sector as an innovative industry to attract and engage with technology"

"We must assess risks across the system, including overlapping jurisdictions – there's a need for co-ordinated planning"

"We must have a structured way of analysing specific ports, hazards, risks and consequences, to find priorities for further development"

"We could use shared vision planning, including structured technical and stakeholder dialogues to define the art of the possible – develop a filter that future projects can be checked against"

How can we enable a shift toward ports resilience?

There are approaches that we know can enhance resilience.

Our work to date has shown the importance of:

- thinking about whole systems – looking beyond the boundaries and considering interdependencies;
- overcoming fragmented governance – encouraging collaboration and moving away from siloed decision making;
- managing deep uncertainty – moving from managing known risks to unknowns;
- focussing on outcome-led approaches – thinking what system do rather than what it is;
- and stresses they may face now, and in the future.

FOUR AREAS WHERE ACTION IS NEEDED

Using the outputs of the workshop, as well as our own research and analysis, we have identified four thematic areas where action is needed to enhance port resilience.



1 LEARNING LESSONS FROM COVID-19 AND BREXIT

Ports around the world have been subject to a diverse range of shocks and stresses from the Covid-19 crisis; from sudden changes in volumes of goods transported to worker shortages and the seafarer crisis. We must learn from this period of intense difficulties.

Additionally, as the UK leaves the transition period for departure from the EU, the response of ports – in the UK and EU - to these significant changes can tell us a lot about resilience.

Reflecting on this period could show us what good looks like for resilience, in a way that is transferable to future crises, whatever their form; from responding to a changing climate to technology-related shocks.

2 DEVELOPING GUIDANCE FOR INTEGRATED PORT TRANSFORMATION

Ports are undergoing simultaneous transformations – to become both low carbon energy and smart mobility hubs. Both of these agendas are associated with uncertain technology pathways, new business models and human factor challenges around new skills, new ways of working and adopting new technology.

At the same time, ports need to adapt to a changing climate, respond to the global biodiversity emergency and enhance social value.

There is significant risk that these intersecting agendas, if not treated holistically, result in more fragility and vulnerability in port systems – affecting port businesses and the communities that depend upon their critical functions.

There is a need for practical guidance on how to take an integrated approach to these challenges, acknowledging uncertainty and enhancing resilience.

3 PROMOTING PORT INVESTMENT THAT ENHANCES WHOLE SYSTEM RESILIENCE

To realise the huge opportunity resilient, low-carbon ports can deliver to society, a step-change in finance, investment and insurance is needed. This involves increasing the flow of finance to where it is most needed, but also enabling financial appraisal of projects in a manner which maximises system-level benefits.

4 CONVENING A PORT'S VALUE CHAIN TO UNDERSTAND AND SHAPE RESILIENCE

As well the port knowledge and guidance described above, which could be developed for multi-port application, there is a need for a common approach to port specific resilience appraisal and enhancements. Such an approach needs to focus on convening the value chain for the whole port system, as well as the actors associated with key external interdependencies.

There's a need for this approach to capture – and eventually quantify – resilience value outside of as well as within the port system. A common tool and framework for port resilience appraisal could be structured to assist port transformational planning and implementation.

The insights captured in this report are a snapshot of the collective outcomes from the first phase of the Resilience4Ports initiative. We look forward to continuing this journey together with our partners and the wider ports community.

Previous work

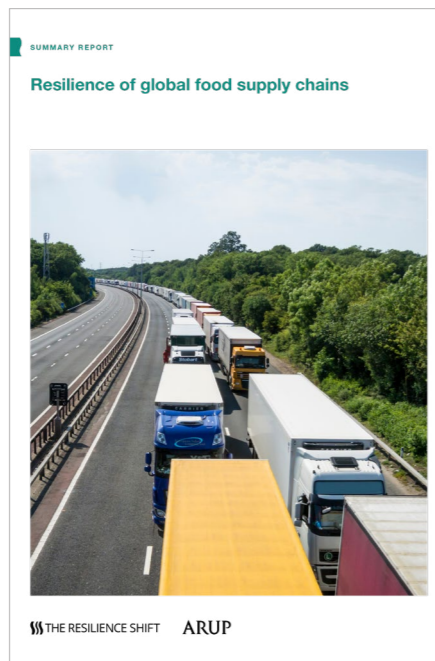
For further reading on the port as a system from our portfolio of work, please refer to the 'Ports primer' that captures best practice for resilience, and the 'Ports and logistics' round-table report that explores the resilience challenges facing ports. Related research was also conducted into global food supply chain logistics, and captured in the project report and workshop findings, shown here.



<https://www.resilienceshift.org/publication/primer-ports>



<https://www.resilienceshift.org/publication/resilience-shift-round-table-ports-and-logistics/>



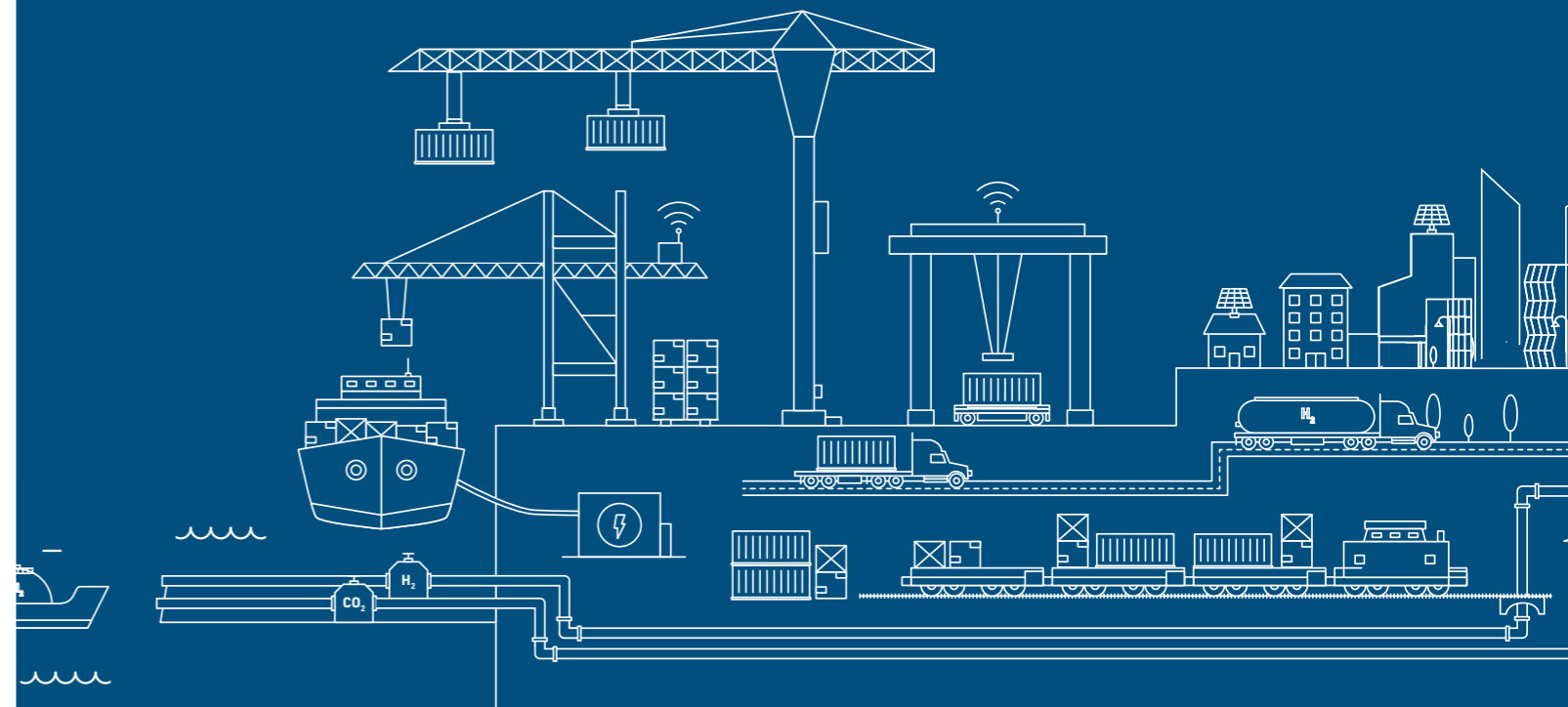
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