Chapter 4

Increasing the local benefits from ports

How can competitive ports be turned into engines of urban economic growth? What are the policy options for port-cities and the main policy instruments, and what is their effectiveness? This section identifies three main models for port-based urban economies: maritime clusters, port-industrial development and port-related waterfront development. In addition, a side-option is presented that does not use the port as a source of economic growth but is based on diversification of the urban economy to decrease the dependence on the port economy. A "non-regret" option involves increased co-operation between port-cities. Such policy options are archetypical, as various port-cities have strategies that combine different models.

Table 4.1. Main policy options to increase local port benefits

Policy option	Related sectors	Instruments	Examples
Maritime clusters	Logistics Maritime services Shipbuilding/repair	Developmental support Fiscal incentives/grants Co-ordination/information Human capital matching	Singapore Hong Kong
Industries	Industrial ecology Renewable energy	Spatial planning Investments	Rotterdam
Waterfronts	Tourism/recreation Food Events industry	Master planning Project implementation Incentives/investments Synergies with port	Barcelona
Diversification	Non-port sectors	Similar instruments	London Liverpool Boston

Maritime clusters

Clusters are especially important to the maritime domain, because the shipping and ports industries are highly dependent on subcontracting and various kinds of services, and because they require a very specialised local workforce (De Langen, 2002; Wijnolst, 2006).[1] For firms, participation in maritime clusters is said to generate increasing productivity through the creation of cost-reducing linkages between suppliers and customers, the formation of larger and more qualified labour pools, and through spill-overs of knowledge that work through inter-firm interaction (Brett and Roe, 2010). Particularly for shipping, ports and maritime manufacturing, clusters can facilitate better interactions with a range of ancillary services (finance, brokerage, insurance), and can enable access to information and expertise that might open new markets and provide opportunities for expansion (Weissenberg, 2006).

Successful maritime clusters enhance the port's contribution to its surrounding city and region. In cities such as London, the growth of high-value-added activities related to the maritime domain has been shown to contribute directly through employment, an increase in GDP, fiscal revenues and overseas earnings, and indirectly through the multiplier effects of wage spending and increases of demand in the supply chain (TheCityUK, 2011). For this reason, the formation of maritime clusters has been seized upon as a policy objective in many parts of the world, and governments now have at their disposal a diverse range of instruments that may help embryonic maritime clusters to emerge and consolidate, and enhance mature clusters. However, many examples of cluster-formation policies have met with mixed success (Doloreux and Shearmur, 2009; Melançon and Doloreux, 2011). The success of a given instrument for encouraging maritime clusters is context-dependent; policy cannot create clusters ex nihilo. In most instances, clusters emerge through path-dependent and market-induced processes, meaning that not all maritime clusters can be encouraged in the same manner, and that not all port regions have the potential to form maritime clusters or should pursue such a strategy (Karlsen, 2005). The role of policy is thus to respond to locally identified needs, and to encourage these tendencies only when this is logical in light of alternative uses of resources (Nauwelaers and Wintjes, 2002). The instruments presented below, and the strategy of maritime cluster formation more broadly, should therefore not be interpreted as a universally applicable panacea.

Cluster composition

A port cluster can be said to consist of "all economic activities related to the arrival of goods and ships" (De Langen, 2004b). Depending on the context, the port cluster can thus be composed of very different sub-sectoral components. Table 4.2 below, based on data compiled by Lam and Zhang (2011), summarises some of the more famous examples of maritime clusters around the world, and illustrates the diverse compositions possible based on the comparative advantages of each cluster:

Table 4.2. Maritime cluster composition in main port-cities

Maritime advantages	Hamburg	Hong Kong	London	New York/ New Jersey	Oslo	Piraeus	Rotterdam	Shanghai	Singapore	Tokyo
Port	X	X					X	X	X	
Marine insurance			X		X				X	X
Financial service	X	X	X	X	X	X		X	X	
Ship registry	X	X	X		X	X			X	
Shipowners, Operators & Managers		X	X		X	X	X		X	X
Ship classification society			X		X					
Ship agency and forwarding			X				X	X	X	
Ship brokers			X		X	X				
Legal services		X	X			X			X	
Ship building & repair	X	X					X		X	
Marine personnel				X			X	X		
Research , education & training	X	X	X		X	X	X	X	X	X
Information and communication technology (ICT) Services		X	X	X		X	X		X	
Regulators: Maritime Organisations / Associations/ex change market, etc.			X		X		X			X
Governmental support	X							X	X	
Maritime culture and heritage	X		X	X	X	X	X			

Notes: Marked boxes indicate comparative advantage in a given sub-sector.

Source: Lam, J. S. L. and W. Zhang (2011), "Analysis on Development Interplay between Port and Maritime Cluster", First International Workshop on Port Economics, National University of Singapore, December 5-6.

Port and logistics

The first and most obvious sub-sector of any maritime cluster is that of the port. The port often increases demand for a sub-cluster of firms that ensure that it performs well.

Port-side logistics firms provide stevedoring services, including loading, discharging and stowing, while other firms specialised in land-side logistics provide services such as trans-loading, warehousing and distribution. Various other firms ensure that the port's infrastructure and operations continue to perform at optimum levels through the provision of dredging, pilotage, mooring, berthing and bunkering services. Of course, port-related logistics do not always necessarily constitute the core component of the cluster, as the cases of London, Oslo and Piraeus illustrate (see Table 4.2).

A given maritime cluster could be composed entirely of firms fulfilling these logistical and port operations functions. An exclusively port-centric cluster would thus base its activities mainly around low value-added logistics activities such as cargo loading, discharging, storage and distribution, as is the case with Dublin, Ireland (Morrissey and O'Donoghue, 2013). Alternatively, the port logistics functions component might be linked to an array of value-added trans-loading and cargo transformation activities (processing, packing, consolidation, etc.), which is the case in ports such as Antwerp or Osaka (Lam and Zhang, 2011). To a large extent, the centrality of the port logistics component in the maritime cluster will be determined by local path dependencies. For example, the Drechtsteden cities in the Netherlands, located on the Rhine-Meuse-Scheldt delta, have built up a significant dredging cluster, in part due to their proximity to the Rotterdam port cluster (De Langen, 2002), but also due to their years of traditional expertise in building levees for urban flood management. The differences in the development of West German maritime clusters also reveal divergences regarding the centrality of the port logistics sub-sector. In Hamburg, the growth of high-value-added maritime service firms (insurance, banking, consulting) has pushed the traditional logistics firms away from the high-cost areas in direct proximity to the port; while in Bremen, largely due to automobile value-added activities, ports and logistics firms remain tightly interwoven within the spatial confines of the city, with back-of-port logistics progressively playing a central role in the cluster (Elsner, 2010).

Shipping and maritime services

In the same way that the ports and logistics services are often tightly interwoven into one sub-sector, the shipping and maritime services sub-sectors often go hand in hand. Ship ownership and management play a key role in the health of the maritime cluster as a whole, increasing demand for a range of services and positioning port-cities such as Singapore, Rotterdam and London as international maritime centres. To an extent, the presence of shipping companies in a given maritime cluster is the product of historical path dependencies. Thus, in Japan, for example, despite the formal dissolution of the Zaibatsu system in the post-war period, the historical privilege and power accorded to shipping companies involved in the Zaibatsu system has helped them retain positions as key players in the Japanese maritime cluster (Shinohara, 2010). With around 80% of world throughput carried by the top 20 shipping lines in 2010 (Notteboom and Rodrigue, 2010), however, the horizontal integration of the global shipping industry – mainly through alliances, mergers and acquisitions – has made shipping lines powerful global actors whose operations are largely unconstrained by any territorial considerations (Slack, 1993).

While the operational mobility of shipping can render maritime clusters vulnerable to sharp shifts in fortune, shipping companies are, however, somewhat constrained in their choice of location for their strategic command and control functions. Headquarters and regional offices for high-level decision making and deal brokering must be located in places that can provide the services without which the shipping industry could not

function. Maritime services play many roles for the shipping industry. Shipbrokers, for example, mediate between shipowners and cargo owners who need to charter a ship; they assist with the buying and selling of old ships and the building and acquisition of new ones; and they also play a key role for principals in the freight derivative market. The shipping finance industry includes investment banks, commercial banks and more specialised equity firms, which lend substantial sums to the shipping sector. This is an especially critical service, due to the capital-intensive nature of shipping, but financial actors also provide a range of other key services, such as equity and bond underwriting, merger and acquisition advice, cash management and foreign currency exchange. Due to the risks inherent in the shipping industry, insurance firms also play an important part in many maritime service clusters. Insurers provide protection against a range of liabilities, including risks to hull and machinery, cargo, energy and even piracy. This provides an incentive to locate headquarters in areas with such insurance services. London, for example, is the biggest international centre for protection and indemnity clubs, which provide mutual protection amongst shipowners and operators for risks that many insurers will not cover, including third-party risks associated with cargo, collision or environmental pollution.

Due to its complexity, the shipping industry relies heavily on legal services. Often shipping headquarters and legal firms are clustered together, as in Geneva, Hong Kong and London. On the one hand, they provide solutions and contractual expertise related to a range of fields, including salvage, pollution, shipbuilding, charter parties, insurance, cargo, energy and the environment. On the other hand, law firms assist in dispute resolution. Many disputes in the shipping sector are international in scope, and require cross-jurisdictional expertise both on the side of the legal firm and on the side of the courts. The opening of the Rolls Building, the world's largest dedicated business, property and commercial court, in London in 2011, for example, was heralded as an important move in retaining the city's position as a leading maritime centre. Finally, other services within a typical maritime services cluster include accounting, ship classification and compliance, technical consultancy and research. Different forms of intervention will benefit different aspects of a given maritime services cluster, and it is therefore important to make sure that any cluster-support policies are based on a thorough understanding of exactly which services contribute to the comparative advantage of the cluster.

Shipbuilding and repair

For many decades and even centuries, traditional maritime nations in Europe, such as Britain, Norway, Greece and Italy, built up important clusters connected to the shipbuilding yards that served their fisheries and commercial industries. Many traditional shipbuilding nations, however, could not keep pace with the rapid technological and economic changes that took place during the 1970s and 1980s, involving increasing capital requirements for exponentially larger container vessels, not to mention competition from low-cost manufacturing areas. Consequently, the core of the shipbuilding industry has shifted from Europe to Asia. In 2011, China, South Korea and Japan dominated the contemporary market for shipbuilding, controlling 41%, 33% and 20% of the global shipbuilding capacity respectively, and 94% collectively, according to information from Clarkson Research. Nevertheless, shipbuilding is an industry that naturally lends itself to cluster formation, due to the regional character of shipyards: they are immobile, and must be located near to water and intermediate inputs (Weissenberg, 2006). As a result, some European nations have retained maritime clusters based on shipbuilding activities. Regional specialisation away from large container vessel markets and towards niche markets has been one successful strategy for maintaining shipbuilding

activities and putting years of expertise and regional networking to good use (Karlsen, 2005). In Italy, for example, shipbuilding is highly concentrated and highly specialised: the Viareggio cluster remains one of the world's foremost mega-yacht centres, and is connected to an important network of subcontracting producers and service providers (Lazzeretti and Capone, 2010).

Instruments

Governments are increasingly choosing to support and stimulate cluster growth. Table 4.3 summarises the instruments that have been employed in support of maritime clusters around the world. As mentioned above, policies should be tailored to suit the needs of the cluster's specific comparative advantages and needs. Therefore, not all of these instruments will be applicable to every context. Broadly defined, they can be grouped into four different types: *developmental support* instruments that support the emergence and maturation of embryonic clusters through the formulation of broad development strategies and the provision of basic facilitating infrastructure; *fiscal and financial incentive* instruments that seek to spur or renew growth in existing clusters, by providing fiscal relief or financial transfers to strategic aspects of the cluster; *co-ordination and information-sharing* instruments that aim to improve cluster governance and overcome collective action problems; and *human capital matching* instruments that seek to better embed the cluster locally, by improving the match between the local labour pool and the cluster's human capital requirements. Each type of instrument is assessed with notable examples below.

Table 4.3. Main maritime cluster policies

Policy instrument	Scale	Examples
Developmental support		
- National maritime cluster strategy	National	Netherlands
- National Excellency Programmes	National	Finland, Norway
- Incubators and research centres	Local	PortTech Los Angeles
- Venture capital provision	National/local	MCF Business development fund, Singapore;
Spatial planning	Local	Los Angeles, Durban
Fiscal incentives/grants		
- Ship Registry Initiatives	National	Most OECD countries
- Bilateral fiscal agreements	National	Most OECD countries.
- Tax exemption for foreign flag ships	National	Singapore's AISE scheme
- Anti-piracy measures	National	Most EU countries
- Tonnage tax	National	Most OECD countries
- Equity-raising measures	National	KG financing model, Germany
- Targeted wage subsidies	Local	Quebec, Singapore
- Niche shipbuilding	National/local	Italy, Norway
Co-ordination/information-sharing		
- Consultative fora	National/local	South Africa, Port of Brisbane
- Voluntary national associations	National	
- Local networking platform	Local	Deltalinqs Rotterdam
- Shipping exchange	National/local	Copenhagen, Shanghai, Japan; London
Human capital matching		
- Maritime training and certification	Local	Rotterdam, Singapore
- Workplace Initiatives	Local	SEVA-PORT, Southeastern Virginia, US
- Maritime scholarships and grants	National	Singapore
- Research and development	National/local	Canada; Smart Port Rotterdam

Developmental support

Any government strategy to support maritime clusters should take into account the cluster's stage of development, as the needs of the cluster evolve over time (Brett and Roe 2010; Shin and Hassink, 2011). It is possible to distinguish at least four phases in the

cluster life cycle. De Langen and Van Klink (2001) have referred to these as development, expansion, maturation and transition, while Menzel and Fornahl (2010) have identified emergence, growth, sustainment and decline as the four stages of any cluster life cycle. Each stage implies different needs, and thus a different role for government (Van Klink and De Langen, 2001). During development, the value chain and strategic relationships are still under construction, so policies should seek to provide information, foster relations and exchange know-how between firms, and create supportive infrastructure. During expansion, while firms are specialising and seeking out new markets, the government should provide risk capital, promote outsourcing and assist with internationalisation; during the maturation phase, the cluster has an established set of products and supplier-producer relationships, and thus the role of policy should be to further professionalise suppliers and seek out links and synergies with other clusters, to avoid stagnation. During the transition phase, changes in the market have brought about decline, new market entries are low and a downward spiral is possible, hence policy intervention should aim to assist with the transition of firms into new configurations or domains, and should seek to retain and reapply local expertise and talent.

Crucially, a cluster does not proceed through these stages in a linear fashion. Policy intervention might facilitate cluster adaptation, allowing it to escape decline and sustain its markets. It also might renew a declining sector by re-invigorating growth (as ship registries helped to achieve in many maritime clusters, described below), and in rare cases, the local know-how and expertise from a no longer active cluster may be transformed to create new markets and products.

During developmental stages of a cluster, the formulation of a broad set of strategies and policies can be a crucial factor in chartering an optimal growth trajectory. These policies set out a vision and a broad, multi-sectoral set of orientations for the implementation of specific sectorally-focused policies and instruments. In Finland, for example, the national government has sought to provide a broad framework for maritime cluster development through its National Maritime Cluster Programme. The programme aims to provide support for all stages of cluster development. It seeks to provide the conditions for the emergence of new clusters through funding innovative initiatives, and helps the cluster identify and pursue new business opportunities (Merk, Hilmola, Dubarle, 2012).

The Netherlands presents a good example of how national policies can support the growth and emergence of maritime clusters. Notably, the Dutch state was able to tailor policy interventions to suite the requirements of the cluster throughout the consecutive stages of its maturity. Throughout the 1980s, the "mainport" strategy constituted the central guiding principle for maritime cluster development (Merk and Notteboom, 2013). Under this strategy, the Port of Rotterdam and the airport of Schiphol were promoted above other ports as the key drivers of the Dutch economy. The strategic vision for a "Netherlands, Distribution Country" (Nederland Distributieland) was enshrined in an overarching policy framework by the same name. In line with this vision, investments in supportive infrastructure were highly concentrated onto the Mainports business environment, and various commercial initiatives sought to attract the headquarters of commercial and logistics firms to the Mainport areas. This vision succeeded in promoting the Dutch maritime cluster, which underwent considerable expansion in re-exporting activities and managed to attract a large number of European Distribution Centers (Kolk and Van der Steen, 2002). As the Dutch maritime cluster has become more complex in its composition and needs, however, the strategic orientation of the government has shifted away from an exclusive focus on Mainports, to one that aims to enhance the competitiveness of the metropolitan region Randstad Holland. This new turn in the

Netherland's maritime cluster policy has sought not only to enhance connectivity through information and transport infrastructure, but has also focused on quality of life in the region. This aspect of the new policy orientation can be seen as a response to the complexification and maturation of the maritime cluster, in that it became necessary to seek high-level headquarters and a high-quality labour pool. The Mainports are now acting as facilitators for the competitive development of Randstad Holland. This new strategic direction is also echoed in several central government documents, including the National Seaports Policy 2005-10, the economic vision on the long-term development of Mainport Rotterdam, but also the Peaks in the Delta programme (2004-10), the Randstad 2040 vision and the Randstad Urgency Programme (2008).

Provided that it is attuned to the life cycle of the maritime cluster, broad national policy support is an essential component in fostering cluster emergence and maturation. Local-level instruments also have an important role to play, however. In clusters concentrated around ports, local government and port authorities can stimulate new cluster growth through the provision of basic infrastructure, such as business premises in proximity to the port. The Port of Los Angeles has implemented successful support instruments through its PortTechLA program. Created in 2010 in direct proximity to the ports of Los Angeles and Long Beach, PortTechLA is a large complex that functions as a business incubator for hundreds of port-related companies and start-ups. It is linked to the Technology Advancement Program, which funds programmes in support of the port's Clean Air Plan and Clean Truck Action Plans. Start-ups that provide innovative forms of environmental port technology are thus supported financially by the port, further embedding the growth of the cluster within the specific local needs of the port community. The success of the programme's cluster-building objectives is evident in the businesses' track records: in 2013, 87% of the incubated start-ups begun in 2010 were still in business. This success rate is perhaps in part due to the access to venture capital facilitated by the incubator facilitates, both through events such as the PortTechEXPO Pitch Competition involving local venture capitalists, and through the various business mentoring programmes set up by PortTechLA.

In Europe, such local-level maritime cluster instruments are undergoing a process of policy transfer, in part driven by EU-level networking initiatives, such as the European Network of Maritime Clusters (ENMC). In Sibenik, Croatia, for example, the Norwegian Ministry of Foreign Affairs has sponsored the creation of a Maritime Innovation Center named CroNoMar, which is meant to function as an incubator for start-ups and development projects in the Croatian maritime sector. Norway, which has extensive experience in the field of maritime cluster development, has thus been able to transfer some of its local-level know-how to its Mediterranean partner. The model of the project seeks to foster the emergence of a local maritime cluster specialised in the shipbuilding sub-sector. Half of the incubator is reserved for established companies, with 25% for services and the remaining 25% intended for use by start-ups. After two years of operation, three shipbuilding firms had begun business there.

Spatial planning for clusters

Port authorities can also use a number of spatial planning instruments to foster their maritime clusters at the local level. Such instruments rely on the landlord function of the port authority, used to plan and develop new infrastructure as well as regulate and steer land-use patterns within the port. Port-based spatial planning instruments can encourage maritime clusters in two main ways.

Firstly, they can optimise land-use *within* the port. This involves land acquisition and the reservation of space within the port for future use in strategic sectors of activity. For example, demand for ship repair and maintenance has increased greatly in recent years, along with the expansion of the world fleet (Senturk, 2008). When coupled with other shipyard activities, such as conversion or shipbuilding, ship repair facilities can generate economies of scale within the port, and thus contribute to the growth of maritime clusters. However, such facilities present enormous land-use requirements that must be planned for. By reserving space for such facilities, ports such as Dubai and Singapore have enabled the growth of strong shipyard clusters. Furthermore, land-use planning within the port can also involve the clustering of complementary activities. Authorities in the port of Los Angeles, for example, created a new Port Master Plan in 2013 that aims to diversify and expand the commercial and academic uses of port land so as to encourage innovative collaboration between port logistics firms and research centres. The plan further aims to reduce the presence of activities on the waterfront that are not water dependent, mandating a 50% decrease in the acreage of such firms on the waterfront by 2017. Port authorities can and should provide spatial frameworks that make the most of the cluster's particular strengths, and that facilitate growth in its most important sectors.

Secondly, port authorities can also foster the maritime cluster by optimising land-use at the interface between the port and its immediate hinterland. In many ports, there is room for improvement in terms of inland depots and distribution centres for value-added logistics, which would better suit the needs of the firms that cluster in the immediate hinterland of a port (trans-loading, warehousing, road haulage, etc.). In Durban, South Africa, for example, a lack of co-ordinated planning between the port authority and the city has led to the creation of an informal logistics cluster in the residential neighbourhood of Clairwood. The cohabitation of such incompatible land uses generates many negative externalities, both for the quality of life of the residents, and for the health of the maritime cluster, which is spatially fragmented. In response to these trends, the port and city have collaborated on a Back of Port master plan, which will create new categories of land use better suited to the existence of a maritime cluster in the city, and will allow for the progressive rezoning of the back of the port area towards an inland depot model. Other ports have taken the principle of interface planning for the maritime cluster beyond logistics, and are using the proximity of the port to the city in order to benefit from the positive externalities that urban agglomerations represent in terms of human capital and infrastructure (Hall and Jacobs, 2012). In the Kop van Zuid and Research, Design and Manufacturing campus areas in Rotterdam, the Speicher area of Hamburg, and the Euro-Méditerranée area of Marseille, for example, the port-city interface has been zoned for hybrid uses that allow for a mix of maritime services, educational facilities and port-related firms.

Fiscal incentives and grants

Once the maritime cluster has been successfully supported and the precedent for further growth has been set, fiscal and financial instruments can provide strong levers for encouraging maritime cluster expansion, and in some cases, can help to renew ailing clusters. The global nature of the maritime industry now makes it possible for market actors to relocate their activity to the business environments that are most amenable. To foster their maritime clusters, governments must encourage market participation, which often means providing competitive tax regimes. A key issue thus lies in ensuring that tax reductions are offset by net gains for the national GDP and labour market.

Fiscal initiatives aimed at encouraging registration in the national fleet have become popular instruments amongst central governments seeking to provide a boost to their

maritime cluster. In many states around the world, the problem of declining registered and owned fleets grew severely from 1970-90, as states running open registries with low tax rates ("flag of convenience" states) increasingly attracted shipowners from around the world (Carlisle, 2009). One of the first maritime cluster policies implemented by central governments in many OECD countries has thus been to create low-tax, second registers open to foreign-owned ships, capable of competing with flag of convenience tax regimes. The creation of the Norwegian International Ship (NIS) registry in 1987, for example, was considered instrumental in the turnaround of the Norwegian shipping cluster during the 1990s (Benito et al., 2003).

Besides the low tax rates, which constitute a direct fiscal incentive, the comparative advantage of OECD states with open second registers usually resides in their reputation and credibility with regard to international rules, standards and regulations in the domains of maritime safety, labour laws and environmental protection. Due to the comparatively stringent oversight mechanisms of OECD states, ships that are registered with them are often seen as less risky by insurers, which in turn results in lower premiums for such ships. Thus, because compliance with international standards such as those published by the International Organization for Standardization (ISO), the International Maritime Organisation (IMO), and the ILO increases the attractiveness of the state register, adoption and enforcement of regulations can in fact constitute an important pro-cluster mechanism.[2]

In addition to compliance with international norms on safety and the environment, some states with large maritime clusters have seized upon the issue of maritime piracy to attract and retain shipowners. As the instances of piracy in high-risk areas off the coast of Somalia and West Africa have increased, so too has the demand for new security measures to ensure the transport of cargo. However, major flag states differ in the anti-piracy measures they provide to their registered ships, and some place restrictions on the ways in which ships can be protected. As concern over ship security grows in areas that are at risk, states that offer more leeway on security measures may appear as more attractive flag states to shipowners, particularly to those operating in piracy-prone areas.[3]

Various fiscal measures can be taken to discourage deflagging. One such measure that has been used with success in many states is the tonnage tax. The tonnage tax not only seeks to encourage registration in the state's fleet, but it also seeks to spur employment and productivity in the existing maritime cluster. Under the popular "Dutch model" – introduced by the Netherlands in 1996 and implemented by over 20 states around the world – the normal corporate income tax rates are still applied to shipowners' profits, but their profit itself is calculated differently. The tonnage tax under this model sets a given daily profit per ton, which is applied to the total tonnage capacity of the fleet owned by the company and calculated for a full year. The profit thus calculated is then taxed at the country's corporate tax rate, meaning that shipowners are taxed at a flat rate, irrespective of the company's actual profit or loss.[4] While the tonnage tax played an important role in slowing the decline in flag registers amongst traditional maritime states in the preceding decades, it has since become something of an international norm, and may no longer be sufficient to meaningfully contribute to the maritime cluster. Some states, such as the United Kingdom, however have tailored tonnage tax schemes to suit their own national requirements in ways that push the potential of the tax, rather than simply attempting to reduce deflagging rates.[5] In addition to the regimes described above, governments might undertake bilateral measures to increase opportunities for firms within their maritime cluster. These include reciprocal tax exemption agreements (RTEs), agreements for the avoidance of double taxation (DTAs), and comprehensive DTAs (CDTAs).[6]

Finally, clusters can be fostered through a range of targeted fiscal exemption schemes. Exemptions can target a specific sector, such as Singapore's Approved Shipping Logistics scheme for ship agencies, ship managers, international logistics operators and freight forwarders of shipping groups that provide freight and logistics services from Singapore. Or, they might deliberately target foreign vessels, such as the opening of Singapore's Approved International Shipping Enterprise scheme in 1991. A review of the specific mix of pro-maritime cluster instruments that have helped transform Singapore into one of the world's leading maritime clusters appears in Box 4.1.

Developmental support, easing of flag registration and fiscal relief mechanisms remain key instruments that can be deployed by central governments to support their respective maritime clusters. However, the legitimacy of sectorally focused direct subsidies has been brought into question in recent years, due to concerns over market distortion and trade disputes. Today, governments risk violating international and national trade laws through direct transfers to specific sectors of the economy, and, in certain domains, must seek alternative policy solutions. The shipbuilding sector presents a notable example of such trends. [7]

One option involves so-called industry shifts, whereby know-how and capital from traditional shipbuilding regions are retained and put to new uses. In their analysis of activities at existing and former shipyards throughout Europe, Giovacchini and Sersic (2012) have identified the development of offshore renewable energy sources as a common and successful industry shift that has been set in motion by many Northern European states as a matter of concerted policy. In effect, the development new offshore wind power facilities – not to mention experimental tidal energy generation equipment – has drawn significantly on the expertise of shipbuilders.

Yet, while industry shifts have allowed some port-cities to retain and re-use the capital and know-how of traditional shipbuilding activities, this strategy often represents a move away from – rather than a strengthening of – the rest of the maritime cluster. Alternatively, focusing on "niches" constitutes another strategy that attempts to maintain shipbuilding activities in connection with the broader maritime cluster. The promotion of niches involves focusing investment in research and development on highly innovative and customised products. By comparison with the large-scale, standardised outputs typical of Asian shipbuilding, specialisation and customisation remain competitive advantages of the European shipbuilding clusters. Niches include luxury yachts, offshore support vessels, cruise ships and naval ships. As noted above, Italy has managed to maintain many of its shipbuilding activities by specialising in cruise and luxury ships, mainly in the shipyards of Monfalcone, Marghera and Sestri Levante (Giovacchini and Sersic, 2012). Norwegian shipyards, on the other hand, have specialised in a variety of small vessels, ferries and offshore support vessels. The Norwegian government has assisted in the outsourcing of certain high-cost aspects of the production process to Eastern European countries (such as hull-building), which has supported niche specialisation by allowing the Norwegian shipyards to retain the key value-chain activities while operating at a relatively low cost. Targeted out-sourcing policies might therefore present a viable option for reductions in typically high-cost niche activities, without recourse to subsidies.

However, the reality is that such cost reductions are often achieved through reduction in the labour intensity of production, which translates into a drop in employment in the maritime cluster. Retention of niche activities through selective outsourcing is an instrument that is not without its risks, and should be weighed against alternative

development strategies focusing on high-growth, non-maritime sectors, such as offshore energy. Niche strategies are best pursued when few alternative options exist, or where retention of the activity in question is particularly important due to highly dependent supplier industries.

Box 4.1. Singapore's maritime cluster building

In the past, Singapore relied heavily on conventional port functions, providing cargo handling, ship-related services and storage. However, given the need to diversify its business operations and maintain its position as a logistics hub, the government has chosen to set Singapore up as a maritime logistics hub. It now has more than 5 000 maritime establishments, with SGD 28 billion in gross receipts, a workforce accounting for 5% of Singapore's national employment and an output that accounts for 7% of GDP. Singapore has attracted a number of shipping groups to register in its Registry of Ships.

To increase the value added of the port of Singapore, the Singapore government has undertaken a number of fiscal measures and other incentives to attract advanced logistics companies to locate around the port of Singapore and form a maritime cluster. The strategy is to build a maritime business cluster to enhance its position as a logistics hub: a clustering of port and maritime-related activities complementary to the trade in goods and services (linking port operations to international trade) and a one-stop service for customers by providing an integrated maritime logistics services and attaining economies of scale and scope. It emphasises transparency of regulations and aims to provide world-class infrastructure and an adequate supply of skilled logistics professionals. In cultivating environment attractive to foreign firms, it has employed fiscal measures and other generous incentives that have played a major role in achieving the status of a maritime logistics hub. The major tax incentives include the Approved International Shipping Enterprise (AISE) scheme, Approved Shipping Logistics Enterprise (ASLE), tax benefits for ship registration and support for business development. The AISE offers income-tax exemption for 10 years for foreign flag ships, provided that the owner or charterer controls a significant amount of ships and maintains a significant operation in Singapore. In the past, only ships under the Singapore flag were given income tax exemption, which contributed to the substantial expansion of the Singapore fleet in the 1970s and 1980s. However, in many cases there was very little further benefit for Singapore and its economy, since a large part of the fleet was operated, both commercially and technically, outside Singapore. In 1991, to increase the use of Singapore as a base for the management and control of their shipping operations, Singapore introduced a tax incentive under the AISE incentive scheme to exempt shipping lines awarded AISE status from tax on the income from vessels operated by them, whether registered under the Singapore flag or elsewhere. The ASLE provides a concessionary income tax on qualifying incremental income for established ship management, ship agencies, freight forwarders and logistics operators.

To encourage foreign vessels to register with Singapore's Registry of Ships, the profits of a shipping enterprise derived from the operation of a Singapore-registered ship are exempt from income tax. This applies to income derived from the carriage in international waters of passengers, mails, livestock or goods or from towing or salvage operations carried out in international waters by Singapore ships, and it includes the charter of Singapore ships. It also exempts shipping companies registered with Singapore from withholding tax on interest payments with respect to offshore loans to finance ships. Under this incentive scheme, there is also no tax on gains from vessel sales. The government also extends business development support to ship-owners and maritime auxiliary service providers, by providing grants and defraying expenses during initial development on a reimbursement basis.

To foster innovation within the maritime industry, the government established the Maritime Innovation and Technology Fund (MITF) in 2003. In 2002, to address a shortage of supply of skilled logistics professionals, the government established the Maritime Cluster Fund (MCF). The MITF includes the Maritime Industry Attachment Programme, the Joint Tertiary and Research Institutions and MPA research and development (R&D) Programme, the Maritime Technology Professorships and the Platform for Test-bedding, Research, Innovation and Development for New maritime Technologies (TRIDENT). The MCF was established by Singapore's Maritime and Port Authority to support the maritime industry's manpower and business development efforts.

Co-ordination and information-sharing mechanisms

Clusters that are able to co-ordinate interests among participants are better placed to overcome collective challenges and achieve common goals. De Langen (2004a) has argued that co-ordination can lower inter-firm "transaction costs" within a cluster (associated with searching for partners, time and travel expenses, performance monitoring and contract specification) and increase the scope of co-operative efforts (from investments in the labour pool to collaboration on innovative projects, collective marketing and expansion efforts, and knowledge sharing). In spite of these benefits, however, co-ordination does not come naturally to firms within a cluster, for at least three reasons (Olson, 1971; De Langen, 2004b): the risk of "free rider" behaviour by firms that benefit from the co-operative environment without committing their own resources constitutes a disincentive. In situations where benefits from co-ordination will be unequally distributed, firms that are not thriving will seek to inhibit co-operative development; and finally, the uncertainty of co-ordination can constitute a risk, dis-incentivising co-ordination among risk-averse firms.

Without any form of external intervention, co-ordination between firms within a cluster is thus generally more limited than the optimal level. For this reason, it is often necessary for government or "leader" firms[8] (De Langen, 2004a; Nijdam, 2010) to intervene to structure better governance outcomes. Instruments for better cluster governance can range in scope, from the local to national levels.

Governments have used several instruments to introduce better cluster governance, particularly with regard to relations between the port authority and the port community. These may include statutory consultative mechanisms. In South Africa, for example, where ports are nationally owned, the National Ports Act created a port consultative committee (PCC) for each port. The PCCs serve as an interface between the authorities, local government, unions and industry representatives, and help to provide better alignment between the key stakeholders of the ports cluster.

Various public actors in port-cities around the world have also created voluntary networking platforms that bring together representatives from the industries that make up the maritime cluster (shipping associations, import-export associations, cargo handlers, maritime agents, unions, etc.) and from the local institutions (chamber of commerce, municipality, port authority, regional authorities, etc.). In Brisbane, the Community Consultative Committee is run by the port authority, while in Durban, the Port Liaison Committee is run by the chamber of commerce, and in Mississippi, the River Trade and Transport Council runs the local networking platform, the Lower Mississippi Port Cluster. The Community Consultative Committee in Brisbane, like many other platforms of this kind, brings together local environmental groups, the Manly Chamber of Commerce, terminal operators (DP World), and several private actors in the port community. Through this mechanism, stakeholders are able to provide input into the port's plans, enhance co-operative efforts and share information.

Associative initiatives led by the private sector are also important cluster governance instruments, and should be encouraged by policy makers. The Dutch employers' association, Deltalinqs, is a significant example of such a structure, which brings together some 700 firms, mainly of the Rotterdam maritime cluster. Individual firms can be members, and are grouped by industry field (ship's agents, bulk and container stevedores, forwarders, pilots, transport and logistics, and so on). But Deltalinqs also features many associative members, such as the Association of Rotterdam Shipbrokers or the Association of Rotterdam Terminal operators, and thus serves as an umbrella organisation

for sub-clusters. Deltalinqs not only lobbies for the interests of the maritime cluster but also maintains a series of important partnerships with the Port of Rotterdam, the City of Rotterdam and several educational institutes. Notable joint projects that such partnerships have enabled include: Port Base, a joint initiative of the Port Authorities of Amsterdam, Rotterdam, Deltalinqs and the customs, which serves as a comprehensive information exchange for hundreds of customers and the authorities; Delta Port Donation Fund, jointly funded by the Rotterdam Port Authority and Deltalinqs, which invests in NGOs working on welfare, culture and sport in the vicinity of the port and industrial area, in order to improve the positive impact of the maritime cluster; and a series of educational and research programmes responding to the needs of the maritime cluster through workplace training and new certifications (detailed below).

It is also important to note that transnational cluster networks are gaining ground. In Europe, for example, the European Network of Maritime Clusters (ENMC) brings together 15 national clusters. The EMNC currently serves two main purposes: internally, it serves as a forum for the exchange of good practices; externally, it serves as a platform for lobbying for the interests of the EU maritime sector. Other examples include the LeaderSHIP 2015 and 2020 initiatives, which have sought to connect various shipbuilding clusters throughout Europe. The initiative brought together several industry leaders to agree on a strategy for lobbying for improved access to finance at the European level.

Finally, shipping exchanges can also constitute private-led, government-supported ventures that enhance the competitiveness and co-ordination of the maritime cluster at the national and regional levels. Shipping exchanges provide important information-sharing mechanisms, especially for those clusters that have strong maritime finance components. For many years, the Baltic Exchange has helped to spur growth in the UK and London maritime clusters, and contributed to the city's transformation into an international maritime centre. The Baltic Exchange is an international source of information on the maritime markets. In addition to its global role, it is a large contributor to the UK shipbroking industry. Some 600 companies were members of the Baltic Exchange in 2013, 400 of which were based in the UK. In light of the success that the Baltic Exchange has brought to the UK maritime cluster, it is little wonder that Denmark, Japan and China now host their own shipping exchanges. The Shanghai shipping exchange, founded in 1996, plays several co-ordinating and information-sharing roles within the Chinese maritime cluster: it helps to adjust freight rates, facilitate trade between the shipping elements of the cluster, collect and publish information on the maritime markets and standardise transactions. The exchange has helped to improve the international standing of the Chinese maritime cluster: some 300 firms were members of the Shanghai Shipping Exchange in 2013, and major shipping firms such as Hapag-Lloyd, Maersk, Pacific Shipping Company, Kawasaki and CMA-CGM have subscribed to its shipping index.

Human capital matching mechanisms

As the firms that compose a given maritime cluster are usually highly specialised, they require specific skills that are often in short supply. Increasingly, governments are seeking to better match their local labour pools with the needs of the maritime cluster, as a way of simultaneously promoting job creation and contributing to the value-added of the port.

Many maritime clusters now feature partnerships between universities, local government and maritime firms. These partnerships help to better match the local labour pool with the maritime cluster in three main ways. First and foremost, they give rise to new degrees and certifications that enable local students to develop skills needed by the

maritime cluster. Such mechanisms can serve the long-term aims of the maritime sector, especially in areas that are experiencing shortages of labour in strategic sectors. In the Rotterdam maritime cluster, for example, the Deltalinqs association has created the Maintenance College, in partnership with Albeda College, and the Process College, in partnership with ROC Zadkine and the Shipping and Transport College. The curricula of such programmes are conceived in tight collaboration with the maritime cluster, and respond directly to its labour demands.

Secondly, they provide an avenue for apprenticeships and internships with participating maritime firms. This instrument can provide a very direct mechanism for embedding the maritime cluster within the local context, as it increases the likelihood that skilled workers are retained locally. Such workplace schemes can be especially important in areas that are undergoing changes in their economy and require workforce transformation, and where risk of human capital flight is strong. In southeastern Virginia, which has undergone such challenges, the SEVA-Port Partnership between community colleges and the port authority aimed to create a local workforce skilled in the warehousing and distribution sector through such workplace internship schemes. Crucially, this programme also targeted young talent, through summer programmes with local high schools that included hands-on internships with participating logistics firms. The YoungShip programme in Møre, Norway, has adopted a similar approach, fostering informal contact between young students and key firms of the Norwegian maritime sector. The programme, which includes mentoring and aims to increase female participation in the Norwegian maritime cluster, has met with considerable success, and as of 2013, was active in a number of Norway's port-cities.

Thirdly and finally, educational partnerships in maritime clusters often provide scholarships and grants for maritime education programmes, which extend the breadth of the labour pool by providing greater access to education, and include the added benefit of attracting international talent. The Maritime and Port Authority (MPA) of Singapore offers a host of scholarships in the maritime field, which often lead to career paths within the maritime cluster. Under the Tripartite Maritime Scholarship Scheme, for example, talented high school graduates are granted scholarships of up to SGD 50 000 to complete the Diploma in Nautical Studies or in Marine Engineering at the Singapore Maritime Academy or Singapore Polytechnic. Scholars are co-sponsored by the MPA and a participating shipping company or union, with whom they must spend at least three years as a Marine Engineer Officer in fulfilment of their return of service obligations. The programme thus ensures that students are being trained for specific positions within the maritime cluster and that talent is retained in Singapore.

An offshoot of these forms of collaboration is that the local institutes do not simply provide better-skilled workers to the maritime cluster, but increasingly also research and development (R&D) services for ports and connected small and medium enterprises (SMEs). The Maritime Institute of Quebec, for example, has created its Innovation Maritime research centre within the framework of just such a partnership. Innovation Maritime is recognised as a College Centre for Technology Transfer by Quebec's Minister for Tertiary Education, Research and Technology Sciences, which enables it to benefit from government research grants. For example, any individuals or companies that request research and development projects from Innovation Maritime can apply for tax credits from the Quebec and Canadian ministries of science and development, and the centre is further eligible for grants from the Natural Sciences and Engineering Research Council. In 2013, Innovation Maritime had successfully carried out more than 200 research and development projects for various fields in the maritime cluster. Similarly,

the Port of Rotterdam has actively engaged in such R&D development initiatives through its partnership with the Erasmus University. The Smart Port research centre thus aims to meet a growing demand for maritime research and expertise, and collaborates with the port to produce research of direct relevance to the maritime cluster. Such collaborative R&D efforts between universities and ports are increasingly taking on a global dimension. The Singapore Maritime and Port Authority has not only signed MOUs with three of the leading universities in Singapore (the National University of Singapore, Nanyang Technical University and the Institute of High-Performance Computing), but has also begun to invest in joint R&D with the Research Council of Norway – which provides the scope for a range of collaborations between industry and universities in both countries – and jointly organises the International Maritime-Port Technology and Development Conference with the Port of Rotterdam.

Port-industrial development

In many port-cities, industrial development and port development have traditionally gone hand in hand. These forms of port-city industrialisation were more or less spontaneous, occurred during various stages of port-city development and were in many cases determined by urban specificities and land site conditions and availability. In the western Mediterranean before 1919, for example, industrial zones grew up spontaneously in the ports of Marseille, Taranto, Naples, Barcelona, Genoa, Valencia, La Spezia, Piombino, Savona and Palermo (Verlaque, 1981).

Since the late 1950s, a wave of planned industrialisation related to ports has taken place. These policies were in most cases driven by national states supporting national champions as a means of developing economically disadvantaged areas, by restructuring industries and creating new growth poles. The fundamental reasons for their development lie within the sphere of maritime transport, namely the development of very large bulk carriers, which have dramatically reduced the costs of long-distance ocean transport (Vigarié, 1981). This heavy industrial development in coastal areas, frequently referred to as Maritime Industrial Development Areas (MIDAs), was land intensive, with requirements for sites of at least 2 000 hectares. Major MIDA projects in Europe, the United States and Japan all took place in the late 1950s. The Botlek scheme in Rotterdam became operational in 1958, later extended with the development of the Europoort and the Maasvlakte, which created an area of over 10 000 hectares devoted to oil, chemical and shipbuilding industries. Antwerp developed a large site for heavy chemical industries at the same time, whereas Amsterdam and Ijmuiden introduced a major iron and steel complex. Other European examples of MIDAs include Dunkirk, Fos-sur-Mer, Le Havre, Hamburg and the Weser ports, Teeside in the UK, and Livorno in Italy. Also in Japan, ports were considered the lynchpin of regional development in their port policies; the regional development impact of port development projects was considered a sufficient return on port investment. In 1964, an Act on the creation of Special Areas for Industrial Development was approved in which ports served as hubs of development. In line with this, "developer ports" were created in depressed regions as a catalyst of industrial and urban development, as in Kashima and Tomakomai (Olukoju, 2003).

Originally concentrated in heavy industry, policies gradually shifted to lighter industrial activities, after the economic crisis of the mid-1970s. New oil refining capacity and production of primary chemicals and steel in developing countries meant a rationalisation of the industries that underpinned MIDA development, with a refocusing of port development projects. At the same time, increased population pressure in port-cities such as

Rotterdam, Hamburg and Yokohama led to pressure to limit pollution and diversify economic activity. Larger areas in ports became devoted to warehousing, commercial activities and development of light industries. An example is the port of Gioia Tauro in southern Italy, perceived in 1970 as a future MIDA, but transformed into a container trans-shipment port in the mid-1990s after decades of non-existing industrial development and non-realisation of projected steel plant and electrical power plants (Dunford and Yeung). Policies related to MIDAs are special economic zones, often located in or close to ports, which are provided with attractive conditions to attract industrial development.

Port-industrial planning projects like these have had mixed success rates. In many cases, they have led to rapid increases of population, employment and economic growth. They have in some cases increased the industrial potential of nations and facilitated the restructuration of post-war economies. The "developer ports" policies in Japan have facilitated rapid transformation of agricultural areas into industrial and commercial zones, with spectacular growth rates in Kashima (Vigarié, 1981; Olukoju, 2003). At the same time, there have been many partial failures as a result of over-ambitious projects or of a lack of continuity in planning. In southern Italy, no effective MIDAs were developed apart from Taranto (Vigarié, 1981).

One of the main challenges related to port-industrial development is the creation of linkages with the local economy. This often proves challenging, because most of the industries that have invested in MIDAs are multinational companies whose development strategies are often not aligned with those of regions and cities. As noted earlier (in Chapter 2.1), industries within port clusters are not always strongly inter-related and economic benefits often spill over to other regions in the same country – or to other countries. A related challenge is the bottom-up character of these projects, which in many cases ignored the existing regional skills and competences. In Dunkirk, for example, the arrival of heavy industry has replaced diverse competences related to the textile and port industry (such as making fishing nets, sails and other artisanal activities) with low-skilled industrial work with hard labour conditions (Boutillier, Laperche, Uzunidis, 2011).

This lack of economic linkages within the region may enforce vulnerability of regions related to one-sided economic development and path dependency. Port activity in large industrial ports can be largely focused on industrial activity to the detriment of commercial port activities. This is the case in large port-industrial complexes, but also in other ports with strong industrial orientations. In Antofagasta, Chile, all port activity is focused on the copper mining industry, exposing it to vulnerability due to specialisation and a missed opportunity to create an urban logistics sector (Merk, 2013). Various ports with an industrial focus have tried to develop other port functions, such as container terminals, but have not always succeeded, *e.g.* the container volumes in Amsterdam are marginal and present only 3% of total traffic in Dunkirk). Such one-sided development can increase a port's economic vulnerability, cutting off other possibilities for development. In Dunkirk, entrepreneurship has been stymied by the region's dependence on industrial activity, which has led to an accumulation of assets that favour heavy industrial development (Boutillier, Laperche, Uzunidis, 2011).

Some port-cities have tried to tap new and emerging sectors as a way of optimising the human capital and knowledge resources locked into the port and logistics sector. In building institutional linkages, local governments hope to transform their labour markets and reduce the local costs of business. This is the intent of the Southeastern Virginia Partnership for Regional Transformation (SEVA-PORT) (Box 4.2).

Box 4.2. The South-Eastern Virginia Partnership for Regional Transformation

Through the SEVA-PORT partnership, Virginia aims to tether its well-developed port cluster – and especially the industries involved in transport, warehousing and distribution – to the sector of computer modelling and simulation, which specialises in the creation of sophisticated models for use in the fields of gaming, engineering and medicine, and is also crucial to the operational aspects of logistics. In addition to creating this economic synergy, the policy is also intended to work as an inclusive employment mechanism, and to this end has implemented an array of training programmes for youth and dislocated workers. The first step in the project was taken in 2007, when the SEVA-PORT partnership was awarded a USD 5 million grant, created to support regional transitions from traditional industrial or agricultural sectors to innovative information-based sectors. Key to obtaining this funding was the creation of a broad regional partnership, which brings together 24 cities and counties, a number of business and industry representatives, over 10 different educational institutions and several economic development agencies from state and local government. The key mechanisms of the policy focus on upgrading the educational opportunities that will create a labour pool at the nexus of these two industries. This involves integrating certificate programmes for warehousing and distribution, truck driving, and modelling and simulation into the degrees offered by community colleges, and the expansion of internship opportunities in these same sectors through links with the private sector.

The economic vulnerability of industrial development in ports is underlined by the current global industrial restructuring. Outsourcing of heavy industries from developed economies to emerging economies has led to the closure of many industrial plants on port sites and the need for industrial reconversion. The petrochemical cluster on the port site of Marseilles-Fos is struggling, with various closures of refineries and further closures in sight (Merk and Comtois, 2012). The Port of Rotterdam foresees a large-scale restructuring of the refinery industry and aims at bundling forces with the industrial complex of the Port of Antwerp in order to be the only European location of refinery activity in 2030 (Port of Rotterdam, 2012). With the prospect of industrial rationalisation looming, many ports and port-cities are assessing new industrial opportunities that could build on existing assets and infrastructure. These include industrial ecology and renewable energy, two new options that will be explored below.

Industrial ecology

Industrial ecology, also referred to as circular economy, aims to provide systematic management of material and energy flows, using waste from one process as input for another process. Where this flow of materials or energy is achieved through collaborative relationships between normally unrelated industries, it is referred to as industrial symbiosis. Following the first widely recognised example of Kalundborg in Denmark, other examples of industrial ecology have been developed around the world. The precondition for such cases is the physical proximity of the firms between which interrelations exist or could be created.

Port sites have great potential for industrial ecology projects. Many ports are effectively large industrial estates where various industrial firms are clustered, which provides many opportunities for synergy. Moreover, ports can have substantial influence in siting industries ripe for industrial ecology projects. A recent overview analyses 31 initiatives in 23 different ports world-wide (Mat and Cerceau, 2011). Various motives inspired these projects, ranging from pollution prevention, process optimisation, and waste management to internalisation of environmental costs, local economic development and competitiveness.

While the initiatives in North America were apparently inspired by such motives as pollution prevention and environmental protection, industrial ecology in Europe and Asia is mainly understood as a driver for economic development in port-cities. Initiatives in Dutch ports, including the port of Amsterdam, Zeeland Seaports and the port of Moerdijk, aim at developing industrial ecology to attract and sustain businesses. For instance, since the 1990s, industrial ecology has been developed as a lever for competitiveness and attractiveness in the Port of Rotterdam. The OCAP-project[9] supplies horticultural businesses with residual CO_2 from Shell Pernis located on the port site, using a disused pipeline and a new distribution network of 130 kilometres of smaller pipes. Fostering local economic development was also at the core of projects undertaken in Antwerp, Ghent and Brussels. Several Japanese ports, such as Osaka, Kawasaki and Kitakyushu, have transformed themselves into recycling hubs (OECD, 2013), while eco-industrial parks have been developed in various Chinese and South Korean ports, including Tianjin, Ningbo and Ulsan.

Among the 31 case studies, the main economic sectors in which port industrial ecology projects are implemented are energy, waste, chemicals, petrochemicals, water management, construction materials, maritime industries, metallurgy and the agro-food sector (Mat and Cerceau, 2011). However, this study does not pretend to be exhaustive. In France, a national workshop in 2013 brought together stakeholders of the seven main French port-industrial complexes to highlight the progress of industrial ecology in these areas and encourage networking to share best practices and expertise.

Various drivers can promote industrial ecology in port sites. Many cases involve government pressure for more environmental responsibility. One of the drivers of the effort to promote the use of waste heat capacity in the Port of Rotterdam was pressure from the regional water board, which made it clear that it would no longer accept the emission of heat into surface water (Baas and Huisingh, 2008). Many of the Asian projects originate from the top down, based on national strategies such as the Circular Economy Law (China), the Green Growth Strategy (South Korea), Recycling Ports plan (Japan) and the Eco-town programme (Japan). Important facilitators are knowledge institutes that have helped deliver technical expertise and innovation and facilitate exchange of information and best practices. The University of Delft conducted a study in collaboration with the Port of Rotterdam to explore the possibilities of a methanol-based industrial cluster in the port area (Herder and Stikkelman, 2004). This example of port, industry and university collaboration fits into a larger picture of co-operation in this field (Box 4.3).

Co-siting and clustering can support these exchanges and utility sharing. Ports have the chance to influence this by their zoning regulations in their port master plan, in which they can cluster industries, give them water access or access to railway or inland waterway connections. In addition, they have incentives to attract certain industries, for example through their concessions for port land sites. Although port authorities can play an important role in co-siting, much depends on whether the industrial activity takes place in the port area. The port authorities of Rotterdam and Antwerp, for instance, both act as landlords not only of port terminals but of large industrial estates for the world's largest chemical clusters. This gives them more room to organise co-siting or utility sharing than the port of Tarragona, which is related to a large chemical cluster on land owned by the chemical companies themselves (EPCA, 2007).

Box 4.3. Rotterdam: Co-operation between port and university

Although it has its sights firmly fixed on a global role, the Erasmus University in Rotterdam has shifted its strategy in recent years and is now clearly committed to local and urban development. Its Department of Economics recently created a "Smart Port" Centre, bringing together training, research and consultancy services linked to the port's activities. Erasmus has also joined the "Generation R" Programme and the Rotterdam Climate Initiative (RCIP), with financing for start-ups in the energy and climate sector. The university has been in charge of many impact studies for the Maasvlakte 2 programme and the westward move of the harbour. The university's Institute of Urbanism promoted the idea of the floating city, now in place in the downtown area. Similarly, the Technical University of Delft (TUD) has co-operated with the port authority in the field of computer modelling. It has a common interest with the city and the port in safety and security and transport analysis. In this sense, the metropolitan area and the port can be considered a laboratory for research activities. The Port of Rotterdam has developed on the strength of traditional activities, in particular chemicals and petrochemicals. The port industrial cluster has expanded with new international services, forwarding agencies and multinational company head offices. The fact remains that the majority of small and medium enterprises active in the port are engaged in logistics, transport and trade, and are involved primarily in the carriage of cargoes to and from their port of shipment. These firms have little interest in innovation. It is estimated that only 1% to 2% of the turnover of the port and industrial cluster is devoted to R&D. These are in fact mature industries that show clear signs of becoming ossified in routine activities.

To deal with these risks of "cognitive lock-in", local leaders have sought to reconfigure the city-port interface. Rotterdam University (which specialises in applied sciences) has established a new campus for Research, Design and Manufacturing (RDM) in one section of the old port. An incubator managed by the Technical University known as "Yes! Delft" has been established there. RDM Innovation Dock is part of the campus. Its goal is to connect practical research and entrepreneurship, by creating a degree of integration between higher education institutions, services and private industry. All these initiatives take place within an ambitious plan promoted by the city (City of Rotterdam Council) and the Port Authority, the goal of which is to redesign "Stadhavens Rotterdam" and make it a showcase for water management, by exploiting Dutch expertise in flood control and extending this know-how into the area of climate change. Beyond the RDM, the strategy relies on three other broad objectives: re-inventing delta technology in the context of the Rotterdam Climate Initiative, developing floating communities, and sustainable mobility programmes (the object being to halve lorry traffic). Rotterdam's aim is to become a knowledge port.

In the absence of these drivers, the development of industrial ecology in ports becomes more complicated. Royston (2011) explains the less active adoption of industrial ecology on port sites in the UK by more private ownership, smaller land holdings, a hands-off government policy and the absence of business associations that could have created a facilitating environment.

Renewable energy

Port development strategies are increasingly focused on renewable energy. *E.g.*, Rotterdam's Port Vision 2030, published in 2011, is based on a strategy to link the port to its emerging sustainable energy sector. Like the SEVA-PORT partnership, the Port Vision 2030 envisions this cluster synergy as an agent for industrial transformation. As Rotterdam's port switches to clean fuels and bio-based energy and integrates energy recycling and carbon capture policies into its operations, this should drive demand for transformation in the adjacent energy clusters from its present-day dominance in petrochemicals, to sustainable forms of energy production. Already, Rotterdam is one of the largest European importers of liquefied natural gas (LNG), and the port is equipped with an advanced set of liquid bulk refineries that could be used for biofuels. To oversee and encourage this transition, the port has invested in the development of a synthesis gas (syngas) cluster and has begun construction on carbon capture and storage infrastructure.

Development strategies involving maritime and the new energy sectors appear to be growing in popularity. Several other Dutch cities and ports have based their growth strategies on such links. Groningen port hopes to develop into the Bioport Eems Delta, which would be the main importer and trans-shipper of biomass. It has already developed several partnerships with industry and local authorities, including a shared roadmap with the Northern Netherlands region. The port-city region of Zeeland, between Antwerp and Rotterdam has a well-established agricultural and chemical sector and a set of policies aimed at fostering synergies between the emerging bio-mass activities of these two clusters and that of the port. As part of these policies, the Port of Terneuzen has implemented a project with two local renewable agriculture companies that combine horticulture with carbon-capture.

As one of the key growth sectors in renewable energy, offshore wind energy could bring employment and value added to the ports, by constructing future power-supply systems, clustering related industries in the port areas and thus revitalising the economy of port-cities. It has been estimated that the gross employment in the offshore wind energy sector in selected North Sea countries could be 115 000 jobs, if EU renewable energy targets are met by 2020 (Ragwitz et al., 2007). The methodology of different studies may vary, but all studies assume that the number of jobs per MW will increase as the new installed capacity goes up, because the benefits within the supply chain and export potential will grow with scale (McNeil, Straw and Rowney, 2013). For instance, 18 GW installed by 2020 could generate 22 900 to 43 400 jobs, and having 40 GW installed by 2030 could raise that number to 96 400 jobs in the UK (*ibid*.). Ports are the decisive nodes on the logistics chain for both construction and installation of the Offshore Wind Energy Plants (OWEP), as well as operation and service, which includes maintenance and repair of the Offshore Wind Farms (OWF) and OWEP (Uniconsult, 2013).

Four main functions can be distinguished for ports to engage in offshore wind energy: fabrication and installation; operations, maintenance and service; research and development; and lastly, import and export of onshore and offshore wind energy plants and components (Uniconsult, 2013). In addition to the traditional logistics tasks of storage, stowage and trans-shipment for the components, opportunities for ports to benefit from engaging in the business include related industry clustering and development of infrastructure and research facilities (Uniconsult, 2013). On the other hand, market players in the industry choosing where to locate, including offshore wind developers, component manufacturers and designers, shipowners, operators and energy providers, are evaluating ports in terms of their handling capabilities and capacities. It is critical for ports to be aware of the requirements for the offshore wind energy industry and to position themselves strategically to meet the industry's needs.

Some shared preconditions are critical, including room for expansion, a qualified labour force, and the port's connectivity to its hinterland for logistics transport (Uniconsult, 2013). The production of offshore wind energy turbines is often decentralised and the components produced in different sites in the hinterland, to be transported to storage areas near the ports. Sufficient storage space for pre-assembly or pre-storage activities is key, as is an efficient hinterland connection for transport of the heavy-lift cargo, especially for ports that serve as the consolidation ports in this supply chain, such as the Port of Belfast in Northern Ireland (*ibid*.). Service ports must offer easy accessibility, the ability to accommodate service vessels and sufficient storage space for spare parts (ORECCA, 2012).

In addition to location and infrastructure, strong political commitment from the government is of critical importance to developers as they determine whether to make their investment in a particular port. Offshore wind energy is not only capital intensive; it also requires significant technological resources. Compared to onshore wind energy, the capital cost for offshore wind projects is twice as much as that of onshore, and operation and maintenance costs can even be three times higher (World Bank, 2010). Accessibility to the wind turbines, which is not an issue for onshore wind, could become a barrier. In some northern European countries with a high population density, the limited space for large-scale onshore wind power farms encouraged a push for offshore wind energy in the national energy mix. Wind speed is often higher on the coasts than onshore in these countries. Better power production can to some extent offset the high capital costs and operational costs. On the other hand, in southern Europe, the United States and China, abundant land resources for onshore wind energy production exist, and onshore wind, with its lower costs, is a more competitive option.

In practice, a competitive institutional framework provided by the national government is necessary to support the development of the offshore wind energy industry. As with other renewable energy industries, general policy instruments and approaches like tariff feed-in, quota and tax incentives all can stimulate the sector. As a windy island set in shallow waters, the United Kingdom has a natural advantage in developing offshore wind energy technology (McNeil, Straw and Rowney, 2013). The UK government has introduced a feed-in tariff for renewable energies since 2010. While this is only permitted for energy plants under 5 MW, the offshore wind energy is mainly subsidised through a regulation called the "Renewable Obligation" (Uniconsult, 2013). This determines an obligatory minimum share of renewable energy in the total energy mix, and Renewable Obligation Orders commit UK electricity suppliers to abide by the defined quota. For suppliers that cannot fulfil the quota, a "buy-out" penalty is imposed to pay the fines for every MWH missed for the target set by the government. The fines are to be put into a fund and distributed among the suppliers who have achieved their quota. France's strategy for attracting offshore wind manufacturers involves government strategy and ministerial activism through its approach to procurement and by providing state finance to firms in the private sector (McNeil, Straw and Rowney, 2013). In Asia, China's government is also developing its offshore wind energy system, supported by a discounted corporate income tax or value-added tax, as well as feed-in tariffs or funds (KPMG, 2011). Japan and Korea have also announced plans for investing in offshore wind energy farms and approved feed-in tariffs regulation to boost offshore wind energy production. In the United States, production tax credits (PTC) and investment tax credits (ITC) are the main policy tools used to subsidise renewable energy.

Policy certainty over time is also of critical importance to encourage developers and suppliers to plan for the long term and ensure the continuity for port infrastructure upgrades. In Germany, the *Erneuerbäre Energien Gesetz* (Renewable Energy Law) provides subsidies to support the development of the wind energy industry. German ports are not only being adapted to meet the domestic industry demands, but also to facilitate export to foreign markets (McNeil, Straw and Rowney, 2013). Local municipalities, which own and manage the ports, can make long-term investment decisions that take into account of the potential economic benefits to the local economy. Bremen's state government invested EUR 200 million in offshore wind energy infrastructure and incentives on the banks of the Weser. In addition to its skilled workforce and strategic location, political and regional authorities' pro-active approach has contributed to the success of Bremerhaven's integrated development as the offshore wind energy hub in the

North Sea. Approval for wind turbine construction permits is streamlined, low investment rates are offered and short-term leases are made available to developers and operators. This support has paid off for Bremerhaven, which now has 5 000 workers employed in offshore wind energy, approximately one-third of all employees in the offshore wind energy sector in Germany (Azau, 2012). Major offshore wind-turbine and rotor-blade manufacturers have set up production, and steel foundries and offshore construction companies have also located within the port, as well as research institutes. In Bremerhaven's bid to become a prime construction port for the German offshore wind farms and the base port for the *Nordsee Ost* project, the offshore wind energy cluster is growing strongly. The port is upgrading its specialised infrastructure and developing land space for expansion of the supply base within its complex (Guillen, Wetzeler and Abstoss 2011). The government of Denmark has given continuous financial support to the offshore wind energy market since the late 1970s, along with policy certainty and a stable regulatory environment to bolster the domestic industry. Its focus on building the onshore wind-power supply chain and driving down energy costs has resulted in a mature supply chain, and no wind turbines are imported for the domestic market.

In addition, ports are exploring diversification in their portfolio of industries, such as tidal, wave and marine current energy. Tidal energy projects use the gravitational forces of the moon to generate power, while wave energy is generated by the movement of a device either floating on the surface of the ocean or moored to the ocean floor. The constant movement of marine currents can be used to drive the rotor blades with wind turbines, capturing kinetic energy to generate electric power (FEMP, 2009). Ocean energy is highly dependent on the feasibility of physical environments, and the marine engineering technology required, such as tidal turbines and wave devices, can prove challenging. Although none of these technologies is widely deployed for commercial use, the potential of ocean energy as a credible alternative low-carbon energy resource is still significant, and global potential capacity is estimated to be 748 GW by 2050 (ORECCA, 2012).

Ocean energy industries are still in an early stage of development, with a limited number of operations worldwide, but rapid technological improvement is expected to drive down the high production costs. The tidal resource produces variable, but highly predictable energy, limited to sites that have particularly strong ocean currents. The technology of tidal barrages is relatively more mature than others, but only four tidal power plants are in operation, notably the 240 MW La Rance barrage in France, which has been generating power since 1966 (IEA, 2013). The largest tidal power plant was brought into commission in Korea in 2011, with a capacity of 254 MW. Two other smaller-scale systems have been built in Canada and China. Although most of the technologies for wave energy are still in the research or early development stages, it holds substantial potential with an estimated worldwide potential at 29 500 TWh/year (terawatt hour per year) by the Ocean Energy System (OES) (IEA, 2013). Several prototypes are under review in a context of proliferating technological development (Ernst and Young, 2012). However, the diversity of systematic concepts and uncertainty over market potential make it difficult to assess the costs and schedule for large-scale commercialisation. In addition, the engineering challenges associated with intercepting energy from wave or tidal power efficiently have also limited the growth of the industries.

Ports' layout, design and facilities are critical in installing complex wave and tidal power arrays, which often require a dedicated location to deploy specialised vessels, components and equipment. Supporting infrastructures and grid connections are also critical to ensure the successful and cost-effective transport of electricity output.

Moreover, ports also need to be aware of other issues related to ocean energy development, such as the ecological impact on marine life and the marine environment, as well as on other marine industries like shipping and fishing.

Port-related waterfront development

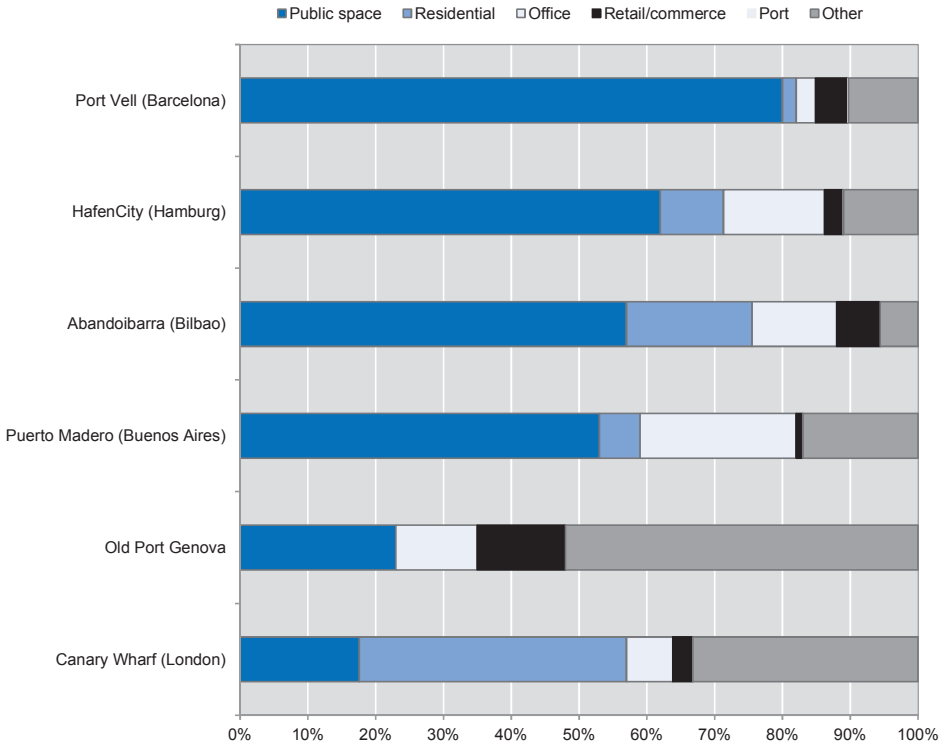
Port-related waterfront development provides a third policy option to increase local economic value from ports. These waterfront development projects, transforming former industrial port sites into contemporary places of consumption, follow similar dynamics all over the world. The emergence of the containing shipping industry accelerated the abandonment of old port areas, mainly due to the fact their piers had too little space to deal with containers. As a result, port functions, especially deep-sea shipping, started moving out of the historic port areas. Ports were faced with the enormous challenge – and opportunity – that surrounds the redevelopment of huge, abandoned land areas, including the old port and the original waterfront in the heart of the urban core (Brown, 2009; Hoyle, 1989). Port-related waterfront development might present an opportunity to create a new image, or marquee, for a city or a region – a new waterfront focal point where citizens can once again enjoy the visceral pleasure of coming to the water's edge, and to share that pleasure with visitors or tourists (Millspaugh, 2001). The many waterfront developments of recent decades have used different ways to reinvent the old port area, including commercialising the proximity to water (with marinas, fisheries and aquariums), using the port function for tourism (cruise ship passenger terminals), promoting a port's maritime heritage (with the preservation of historic buildings), and organising major events to attract people and tourism.

Typology of urban waterfronts

Urban waterfront projects are generally characterised by mixed land use. However, they can also be classified according to their economic or development orientation, whether residential, office, commercial (retail) or recreational (Daamen and Vries, 2013). They may have a principally market orientation, encouraging tourism or business, or create a public space or preservation of historical areas. Lastly, development may be motivated by financial orientation, focusing on the creation of value by intensification of land use.

Alternatively, classification of port land use could involve analysing land allocation of the public space and port terminals, in addition to non-maritime functions such as residential, office or commercial land use (Figure 4.1.). For example, Barcelona's Port Vell waterfront development has focused on creating public space. Residential, office and commercial buildings represent 20% of the land use, leaving the rest for public space (boulevards, promenades) and road infrastructure. Argentina's Puerto Madero has devoted 53% of its surface area to public space, and in Bilbao's Abandoibarra, public space also occupies the largest segment of the land use. Port Vell has focused on retail/commercial function, aiming to encourage economic vibrancy in the area. In Puerto Madero, the office area is the largest after the public space, whereas in Bilbao, the development of Abandoibarra has prioritised residential and office development, more than retail land use. Office areas make up the largest part of HafenCity in Hamburg, while Canary Wharf in London has been converted mostly to residential use.

Figure 4.1. Functional land use in selected urban waterfronts



Source: Own data collection based on data from waterfront development agencies.

The place for port functions in waterfront projects has so far been modest. While there have been increasing attempts to integrate port terminals and the waterfront areas, the most successful waterfront projects have focused land use on non-maritime functions such as residences, offices, or development of a commercial centre, etc. This does not necessarily mean that the identity of the port does not play an important role in waterfront development projects. Strengthening the link with the port can be done in different ways, such as preserving the historical port heritage, transforming the fishing port into a tourist destination, or developing marina facilities to attract pleasure boats. Liverpool's waterfront is well known for utilising its port heritage as a catalyst for tourism; its preservation of port-related heritage played a major role in making it a popular tourist destination. The Merseyside Maritime Museum, part of the World Heritage Site, attracted 1 027 475 visitors in 2010, making it the most visited free attraction in the city (Northwest Research Service, 2012). The Port of Valparaíso (Chile) is ready to start building the urban waterfront of Valparaíso called "Puerto Baron", a 12-hectare space that generates 65% of public spaces, with tourism, cultural and commercial programmes. This project will also convert an old heritage warehouse, the longest in South America and incorporate it into the new buildings. The area will also include a new passenger terminal and community boating marina. In the waterfront areas of San Francisco and Cape Town, the local fishing port attracts tourists as well as businesses; Fisherman's Wharf in San Francisco consists of a long, coast-side row of seafood restaurants and markets, whereas at the V&A Waterfront in Cape Town, equipment for the existing fishing industry is considered a way to attract pleasure boating activity.

Finding the right mix of functions

Successful waterfront projects, in general, have achieved a mix of diversified functions that make the waterfront area economically vibrant. In most cases, the mix of functions that attracts citizens, tourism, and businesses – and thus creates economic value – consists of port

functions, developing recreational and cultural activities, and expanding food-related businesses such as food markets or restaurants. Port Vell in Barcelona, which attracts more than 16 million visitors per year, is an exemplary case, where the old port area has been transformed into a successful waterfront area with an interesting mix of functions. Port Vell continues its port function through marina facilities, ship repair dockyards and a cruise terminal. In addition, it offers cultural and recreational activities including its Maritime Museum, Aquarium, water sports facilities, and a variety of events such as the International Boat Show. Its historic former warehouse, Palau de Mar, has been refurbished to accommodate restaurants with terraces on the ground floor, where visitors can enjoy the view of berthed sailing boats.

Cape Town's V&A Waterfront is another example that shows how a mixed maritime activity, surrounded with the quays that are well-equipped with recreation facilities, cafes and restaurants, can make for a unique and busy working waterfront (Charlier, 2009). In addition to the pilot boats, yachts and leisure craft offering water tours, numerous fishing boats are engaged in a real industrial activity that is more active than ever. A ferry terminal has been built in the Clocktower precinct in a mixed-use development completed in 2002, with a 6 000 square-metre tourist centre with retail stores and restaurants. These maritime activities present a working port scenery that is distinctive and attractive, which contributes significantly to the economic vibrancy of the waterfront area. San Francisco's Embarcadero also combines its existing port function with recreational activities and restaurant businesses: the passenger cruise terminal is located near Fisherman's Wharf, which houses historic fishing operations, tourist activities and seafood restaurants. The restoration of the historic Ferry Building is used as a showcase for the best regional produce and has brought vibrant commercial uses and public access to the waterfront.

Since attracting tourism is a crucial factor in stimulating an area's economy, developing a popular recreational function is important in setting up a successful waterfront site. Although many of the exemplary waterfronts possess historical landmarks or port-related heritage, a successful waterfront project does not necessarily require heritage sites if the recreational function is suitably developed. Dongjiang Bay Area in Tianjin, China, is a recent example that demonstrates that a vibrant waterfront area can be created anew without historical background. Dongjian Bay Scenic Area, which houses the largest manmade sand beach in China and Asia's largest cruise port, has become a new destination for the city's tourism and cultural industries, equipped with aquatic sports clubs and leisure facilities, Dongjiang Bay Beach also hosts a variety of festivals and events, such as the Tianjin Harbour Tourism and Culture Festival or Tianjin Sailing Competition. The Dongjiang Bay area attracts 150 000 visitors a year, and 700 000 tourists were expected in the summer season of 2013.

Achieving the right mix of functions can be a challenging task, due to the difficulties in financing a project. The land use of waterfront projects typically includes residential, commercial, tourism and recreational functions; yet the cities or redevelopment agencies are often obliged to include residential developments because low-density land uses – such as park or recreation-based anchorage – do not generate the revenue to cover the cost of buildings or preparation of the sites (Brown, 2009). Finding the right mix is closely related to how the project is going to be financed and the financial capacity of the public sector involved, which must ensure that the waterfront serves local economic as well as social interests. It is crucial to balance the functions that help finance the project (*e.g.* residences) and those that do not, yet are nevertheless essential to develop a vibrant waterfront (*e.g.* leisure or recreational sites). A waterfront development project needs a realistic business plan to achieve the concept in the master plan, based on a projection of market demand and public and private funding (Millspaugh, 2001).

Table 4.4. Main economic functions in selected urban waterfront developments

Waterfront	Port functions	Tourism and recreation	Food
Port Vell, Barcelona	Marina (Port Vell Marina) Ship repair (Barcelona 92 Marina: dockyard specialised in the maintenance of superyachts) Barcelona Ferry Terminal	Barcelona Maritime Museum; Barcelona Aquarium Events (International Boat Show, Barcelona World Race, Swim Across the Port, Catalan Wine and Cava Show) Sports facilities (Swimming Clubs: Sant Sebastià Beach with sports facilities, Barcelona Swimming Club with family activities) Markets: Palau de Mar Craft Fair, Port Antic Antique Market, Port Vell Association of Painters Market; Hotel Grand Marina; W Barcelona Hotel	Restaurants at Palau de Mar, old general trade warehouses transformed into business units on the ground floor, restaurants with terraces
HafenCity, Hamburg	Cruise terminal (Hamburg Cruise Centre HafenCity)	International Maritime Museum Hamburg Speicherstadt (historic brick buildings transformed into museum spaces) Traditional ship harbour Elb-Philharmonic Concert Hall; Hamburg-America Centre (cultural events) Sports facilities (Oberhafen); Stortebeker SV Sports Club 25 Hours Hotel; Stadthaushotel and many other hotels to be constructed Centurion business centre	Plans for public spaces with restaurants, cafes, increasing number of restaurants in Überseequartier
San Francisco Waterfront, San Francisco	James R. Herman International Cruise Terminal Ferry tours operated by different companies Marinas (Pier 39, South Beach Harbor, The Ramp) Fishing port, fish handling facilities (Fisherman's Wharf Waterfront) Ship repair (BAE Systems, San Francisco Ship Repair)	Historic preservation: Ferry Building Events: America's Cup (contest featuring the best sailors on the world's fastest boats) AT&T Park (Baseball/ Sports facility); Swimming clubs Aquatic Park (at Fishermen's Wharf Waterfront); Boating and yacht clubs	Restaurants and seafood Market at Fisherman's Wharf Waterfront
V&A Waterfront, Cape Town	Marina facilities and berths Local fishing industry occupies 60% of the harbour Ferry Terminal in the Clocktower Former commercial berths of the Victoria Basin were converted in the 1960s to cater to the expanding local fishing industry: 1) 160-metre long dry dock (Robinson Graving Dock, located near the New Basin) and 2) a Synchrolift (near the entrance runabout).	Leisure boat/ ferry cruises Cape Town Diamond Museum; Chavonnes Battery Museum Iziko Maritime Museum; Craft Market and Wellness Centre Donald Greig Bronze Art Foundry & Gallery Kids Ahoy Kids Playground Nelson Mandela Gateway & Robben Island Ocean Sailing Academy Diamond Tour; Two Ocean Aquariums	Over 80 restaurants V&A Market on the Wharf (a fresh food market)
Abandoibarra, Bilbao		Guggenheim Bilbao Museum Bilbao Maritime Museum (the Karola crane, used for many years by the shipyards, remains intact) Zubiarte Shopping Centre (commerce and leisure) Memory Lane Sculpture Collection in Ribera Park chronicles the vitality of the area's industrial past Park La Campa de los Ingleses ;Euskalduna Conference Centre/Auditorium	
Puerto Madero, Buenos Aires	Marina of Puerto Madero Yacht Club	Port heritage: 16 refurbished warehouses that house modern offices, restaurants, bars, pubs and other businesses Casino: floating casino, the Star of Fortune, a replica of a Mississippi riverboat Corbeta Uruguay Museum, a gunner boat that pioneered Arctic exploration Fragata Presidente Sarmiento, a 1897 Argentine Navy training boat converted into a museum for children Buenos Aires Yacht Club, with 200 docked sailboats. A nautical school offers classes in sailing, rowing and kayaking. Public art collection of Amalia Lacroze de Fortabat Museum Centre of Buenos Aires in the old Munich Brewery	Over 100 restaurants
Liverpool Waterfront, Liverpool	Prince' Dock area – Liverpool Cruise Terminal Arrival of Royal Navy vessels Pier Head area – Mersey Ferries terminal	Pier Head – cornerstone of the World Heritage Site, including the "Three Graces": the Royal Liver Building, Cunard Building and Port of Liverpool building, and Museum of Liverpool Albert Dock area – Tate Liverpool, Maritime Museum, International Slavery museum and the Beatles Story King's Dock area – ACC Liverpool: BT Convention Centre with 1 350-seat auditorium, 18 break-out rooms and 7 126 square metres of exhibition space, and the interlinked 11 000 capacity Echo Arena	Around 27 restaurants

Effective planning mechanisms

Master plan and implementation process

Most successful waterfront development projects begin with a master plan. This not only guides the implementation process towards the project's initial goal, but also provides common ground that the different actors (*e.g.* the private and public sector, different local authorities) can agree upon. A master plan for land use can blend the values of both old and new structures and uses, and express the desired concept in three dimensions. The plan should provide for public access to and enjoyment of water, with circulation extending from the old city, and planned uses for the water and surrounding land (Millspaugh, 2001).

Depending on the size of waterfront area or local planning conventions, a master plan can contain several plans for different districts in the waterfront area. In the waterfront developments of San Francisco or Liverpool's docklands, plans are established for different districts in the waterfront area. The Port of San Francisco, under its Waterfront Land Use Plan, divides its waterfront area into five different districts: Fisherman's Wharf, Northeast Waterfront, the Ferry Building Area, South Beach/China Basin (adjacent to Mission Bay) and the Southern Waterfront, each with an individual theme and goals. Liverpool Waterfront also has divided docklands, each with its own theme and function: Princes Dock, Pier Head, Albert Dock, and King's Dock. Albert Dock brands itself with its cultural and heritage-based attractions; Princes Dock has a maritime character, with its Cruise Terminal, where navy vessels can be observed. Alternatively, a master plan can initially decide the percentage of the land use function (*e.g.* residential, office, commercial, leisure) of the entire waterfront site, as in Buenos Aires' Puerto Madero and Bilbao's Abandoibarra.

An incremental approach to designing and financing the project is important in the implementation process. A successful waterfront development agency relies on an incremental approach to design, a high degree of political autonomy and the ability to move quickly and flexibly to time individual development projects with market cycles (Brown, 2009). In Cape Town's V&A Waterfront, the development process has been incremental, although the initial master plan covered the entire 123-hectare site. The project first focused on refurbishing historical buildings and architecture in the Pierhead Precinct, which have been converted to new uses, such as restaurants, shops, a theatre and a craft market, etc. (Van Zyl, 2005). Next, the Victoria Wharf Shopping Centre was completed, originally covering 26 500 square metres, but extended several times given its popularity and demand. Initiatives such as V&A Marina luxury housing project and a mixed-use development in the Clocktower Precinct followed, after the success of the waterfront's earlier projects.

Project leading entities and implementation agency

Waterfront projects in port-cities generally involve the old port area adjacent to the city centre, and involve the local port authority and city government. In some cases, the state or national government can also take part in the process. One of the crucial conditions for completing a successful waterfront project is an absence of intra-local conflict (*e.g.* between the local port authority, city government and other interested parties). This can be achieved either through strong support and leadership from the national government or effective co-ordination among the different local authorities or actors. In the cases of the V&A Waterfront and Puerto Madero, the national government

strongly backed the project, which facilitated its implementation; the transformation of the old port in the V&A Waterfront was made easier by the fact that the initiative came from the South African government itself. The port therefore had to make room for a redevelopment considered to be of national interest, with no local conflict between the port and the city (Charlier, 2009). In Puerto Madero, the national government established the implementation agency, Corporación Antiguo Puerto Madero S.A. (CAPMSA) with the Buenos Aires city government, and facilitated the process by transferring the territory of Puerto Madero to it.

In the case of Barcelona's Port Vell and San Francisco's Waterfront, the port authority played a leading role in the waterfront development, both in land use planning as well as the negotiation process. In 1988, for the Port Vell waterfront project, the Port of Barcelona set up the Urban Management Port 2000, which is responsible for the operation and management of the port's public spaces. Port 2000 drafted the Special Plan for Port Vell in 1988, and its final version was agreed and approved after a long process of negotiations between the various authorities with responsibility for urban planning. In San Francisco, the port initiated the land use planning process in 1991 and led the negotiations with a citizens' advisory committee, whose 27 members represented maritime businesses, port tenants, labour unions and neighbourhood organisations, etc. In cases where ports play a secondary role in assisting the project, their co-operation is nevertheless valuable. In Cape Town's V&A Waterfront, the local port authority contributed to the process by arranging for an efficient system for controlling the traffic at the common entrance for the V&AW and the commercial port, and by helping to ensure a vibrant working waterfront. Tugs and pilot boats were allowed to remain in this zone and use it as their operational base (Charlier, 2009). In Bilbao's Abandoibarra, the port authority took part in the development by transferring the key land parcels (including the site of the Guggenheim Museum) to Ria 2000 Organisation, an implantation agency that led the waterfront redevelopment.

In the implementation process, a separate agency dedicated to the waterfront project is often established in the form of a corporation. Setting up an independent body facilitates the financing of the project and also plays a role as third-party mediator if conflicts arise among the different stakeholders. HafenCity of Hamburg is co-ordinated by HafenCity Hamburg GmbH, a corporation owned by the city of Hamburg. This separate agency manages relations between the public and the private sector, and also acquires and contracts real estate developers and larger users. While 97% of HafenCity sites are the property of Hamburg, the corporation manages the Special Fund for City and Port, which includes the proceeds of sales of building sites, financing infrastructure, roads, bridges, promenades, parks, site clearance, planning, acquisition of investors, etc. The Abandoibarra Project in Bilbao is managed by a non-profit limited liability company, Bilbao Ria 2000, established in 1992. A private firm of public shareholders, it includes the Spanish government, through the Ministry for Economic Promotion, the Bilbao Port Authority, the national railway companies and the local and regional public authorities. The stakeholders of Bilbao Ria 2000 assign the land parcels they own to Bilbao Ria 2000, which finances the project through sales of land in Abandoibarra. Bilbao Ria 2000 invests in the development of the land by reclaiming the land parcels via private bank loans and reselling them to private developers. In the old port regeneration project in Genoa, establishing a separate agency, the Porto Antico di Genova, helped the dialogue between the municipality and the port, whose relationship is complicated by long-standing feuds over territorial occupation (Marshall, 2001).

Table 4.5. Implementation of waterfront development

Project, City	Implementation Agency	Main shareholders
Abandoibarra, Bilbao	Bilbao Rio 2000	SEPES (land management company, a public body under the Ministry of Development): 25% City of Bilbao: 15% Bilbao Port Authority: 10% National railway companies: 15% Basque and provincial government: 30%
Puerto Madero, Buenos Aires	Corporación Antiguo Puerto Madero S.A. (CAPMSA)	Owned equally by the municipality of Buenos Aires and the national state
Port Vell, Barcelona	The Urban Management Port 2000	Established by the Port of Barcelona
HafenCity, Hamburg	HafenCity Hamburg GmbH	Owned by the City of Hamburg
Old Port Redevelopment, Genoa	The Porto Antico di Genova	City of Genoa: 51% Chamber of Commerce: 39% Genoa Port Authority: 10%
V&A Waterfront, Cape Town	The V&A Waterfront Company Ltd.	Established by Transnet Ltd. (successor of the South African Transport Services), now sold to an international private consortium (Lexshell 44 General Trading Ltd.).

Incentives and public investments

Cleaning and preparation of the sites, building basic infrastructure and creating non-profit oriented sites (public spaces, parks, promenades and sports facilities) are provided by public investments; funding may come directly from a public institution or from the proceeds of land sales. In Port Vell, EUR 51.54 million was invested by the Port of Barcelona; for San Francisco's Bay Trail, the trail system that links parks and points of interest around the waterfront area, the initiative and initial funding were supported by the state of California, which designated a regional planning agency for the planning and management of the trail. In HafenCity, Puerto Madero and Abandoibarra, funding of these basic infrastructure and non-profit sites was prepared with lease and sales of the land parcels. In Puerto Madero, the implementation agency, CAPMSA did not receive any initial budget from the state or the municipality. Lease bidding and sales of the docks were the source of funding for the development of public space.

The private sector can also play a major role in construction of the infrastructure in return for the rights to proceed with profit-oriented private developments, which leads to public-private partnerships or concessions. For San Francisco's Waterfront, the port issued a request for proposals to developers interested in redevelopment of the Ferry Building and Pier 1 as a new commercial office building; the commercial components were required to finance the historic preservation and adaptive reuse of the buildings in exchange for ground rent (Brown, 2009). At Port Vell in Bilbao, the port held concession projects with private investments, such as the World Trade Centre, Aquarium, Imax cinema, Maremagnum (leisure and shopping centre), and the Marina. For these concession projects, EUR 396.52 million was invested by private actors and EUR 158.10 million by the Port of Barcelona.

Hosting mega-events can help pay for construction of infrastructure by attracting attention and investment from public institutions. In Genoa, part of Old Port was redesigned and opened to the public for the International Expo in 1992, which paved the way for the rehabilitation of the extended waterfront area. The Expo was located in the Old Port, and investments by the state made it possible to restore old buildings, build an aquarium and rearrange the open spaces. Hosting events like the G8 summit meeting in 2001 and being designated European City of Culture in 2004 also provided resources for transforming other parts of the Old Port. Barcelona's Port Vell was launched for the Barcelona Olympics in 1992; Marseille is pursuing its waterfront project, Cité de la

Méditerranée, backed by its current designation as the European City of Culture 2013. In San Francisco, the port's waterfront development managed to gain legislative support from the state of California for the 2013 America's Cup international yacht race. A law was passed establishing the America's Cup District as the equivalent of an Infrastructure Financing District, which gives San Francisco the flexibility to finance important waterfront improvements, such as financing for the America's Cup Village and construction of a cruise ship terminal at Pier 27.

As for port-cities, it is advantageous to create synergies with their port functions in developing and promoting the waterfront areas. One of the port functions that show a close link with waterfront development is operating cruise terminals. In many waterfront development projects, cruise activity is considered an important element of port-cities' capacity to develop and reinforce the urban tourism industry, since cruise tourism has now become a new market (CTUR, 2007). According to the European Cruise Council, over 6 million European residents booked cruises in 2011, a 9% increase over 2010; and the direct cruise tourism expenditures directly generated an estimated 153 012 jobs. In North America, the Cruise Lines International Association reported USD 19.6 billion in direct spending by the cruise lines and passengers, creating 356 311 jobs generated by cruise industry expenditure. To capitalise on this opportunity, co-operation between city and port is needed. The formula used to establish co-operation and define actions is often a "Cruise Club" grouping the port authority, the chamber of trade and industry, the municipality, maritime companies, public tourism agencies and tourism companies (CTUR, 2007). In Marseille, the Club de la Croisière Marseille-Provence has been organised by the chamber of trade and industry, the municipality and the port authority, aiming to bring together public institutions and tourism interests to promote the cruise industry. Developing a new cruise terminal in conjunction with other functions of the waterfront is another way of promoting the cruise industry in port-cities. HafenCity of Hamburg is developing a new cruise terminal to combine cruise and hotel facilities in the waterfront area of Überseequartier, where shopping centres and entertainment facilities are under development. In Liverpool, the Princes Dock area was developed with the Liverpool Cruise Liner Terminal, which is surrounded with hotels, restaurants, bars, coffee shops, apartments and office buildings. The cruise terminal contributes to the area's economic vibrancy, since the arrival of cruise ships at the new terminal attracts many thousands of additional visitors.

The development of a marina for pleasure boating can also help establish a vibrant waterfront area. Sailing, yachting and power boating generate income for a city; support services such as sailing schools, tour operators, insurance brokers, maritime financiers, yacht charters, yacht brokers and marinas bring regular income to the city and hinterland (Anderson and Edwards, 2001). Moored yachts add atmosphere to the waterfront area, attracting visitors. Developing marina facilities and promoting water sports has been one of the components that contribute to the success of several waterfront projects. Barcelona's Marina Port Vell, opened in 1992 for the Olympic Games, is now a yachting destination that provides mooring rents and supplementary services, such as refuelling and waste collection. Several yacht clubs are located on the site, offering water sports programmes and activities. San Francisco's Pier 39 waterfront complex, with its restaurants, more than 90 shops and marina, is a major attraction.

Side-option: Urban diversification

Staking the growth of local industry on the performance of the port can be a risky strategy, particularly in smaller port-cities. Over-reliance on the port can render the urban economy vulnerable to the notoriously volatile shipping industry, as the comparison of

London and Liverpool demonstrates (Box 4.4). The advent of containerisation dealt a major blow to both cities' maritime sectors, since technology upgrades were not only economically unfeasible but also fiercely contested by organised labour (Levinson, 2006). In analysing the economic history of Boston since the seventeenth century, Glaeser identifies three periods of structural decline in which Boston had to reinvent itself, one to recover from its decline as a maritime power.

To avoid the fate of Liverpool in the 1980s, some port-cities have tried to reduce their dependence on the port through explicit economic diversification. Other well-established continental European port-cities have managed to encourage activities that increase their appeal. Antwerp has invested in its fashion business, and Hamburg in its local media industries. Rotterdam has benefited from strong public investment in real estate development to become a leading architectural centre (OECD, 2011).

Finally, diversification strategies have also been evident in smaller port-cities at risk of losing market share to their neighbours. The port-city of Ningbo, for example, grew from a simple transit point in the 1980s to a fully-fledged industrial port-city specialised in port-based industries in the 1990s. Since the 2000s, it has come to view this dependency on the port as a potential source of vulnerability, especially in view of fierce regional competition. Ningbo has now made a concerted attempt to diversify its economy as a way of decreasing dependency on the port (Huang and Bao, 2011), by investing in its agricultural resources and in the petrochemical and paper industries.

Box 4.4. Liverpool and London: Two cities dependent on their port economies

During the nineteenth century, port operations at Liverpool handled around 40% of the world's trade. The city's economy, which had expanded rapidly during the Industrial Revolution, was based mainly around the import and export of commodities, with cotton chief among them. By the mid-nineteenth century, Liverpool's cotton market was the largest in the world, supplying textile mills in Manchester and Lancashire to form a major port-dependent economic cluster. However, as demand for Northern England's textiles and other traditional exports fell, so did activity and employment in the port. Containerisation rendered Liverpool's docks all but obsolete, and most of the south end docks were closed by 1975. Since all Liverpool's sectors were dependent on port activity in some way, it was unable to recover from the shock of changing shipping systems, and the city hit its lowest point during the 1980s, with high rates of unemployment, out-migration and political extremism. In many ways, London negotiated a similar transition, with very different outcomes. London too had a strong cluster of economic activity in the city centre, based on the docks of the River Thames. Containerisation requiring ships with deeper draughts relocated London's port activity downstream to the east, resulting in the loss of dock-related employment in the city centre. London, however, was able to rely on a local economy supported by a diverse range of services, most notably in banking, insurance and finance, and negotiated the decline of its port traffic much more successfully. The maritime sector itself was kept afloat through its connections with financial service sectors clusters in the City of London, and is now the world's leading centre for shipbroking, freight derivatives, bank finance, shipping insurance and securities and shipping legal services.

No regret option: Co-operation with neighbouring port-cities

Regional networking between neighbouring port-cities is becoming increasingly common to help them face common challenges. Port-cities require capital to finance state-of-the-art infrastructure, and must increasingly compete for different sources of funding not only nationally, but also at the regional or international level. As political and administrative entities, port-cities are also responsible to their electorates, and must optimise the economic benefits associated with increased maritime activity, while mitigating negative social and environmental consequences. Co-operative networking amongst port-cities is increasingly employed to reach these goals.

Box 4.5. Challenges and opportunities of regional port-city networks in the EU

In response to the challenges of economic development in the post-industrial era, and the funding opportunities proposed by the EU for cross-border co-operative projects, neighbouring European port-cities have begun to represent their interests and steer projects collectively in co-operative fora. Ducruet (2006b) compares two early examples of such port-city networking initiatives: the Normandie Métropole and the South Coast Metropole partnerships, both of which were created in 1993. Normandie Métropole was an associative partnership between the mayors of Caen, Rouen and Le Havre, and sought to unite a broad policy network of actors from infrastructure, education, technology and research. Its aim was to increase the profile of the three port-cities within Europe, to position them competitively vis-à-vis other cities in France and Europe, and to provide a co-ordinated planning framework for projects round the Seine estuary. On the other side of the Channel, the South Coast Metropole was made up of Poole, Bournemouth, Southampton, Portsmouth and the Isle of Wight on the southern coast of England, which have experienced similar patterns of decline in their manufacturing and maritime sectors. The partnership aimed to represent interests collectively and to respond to the funding opportunities for jointly led projects offered by the EU through its regional development funds.

In their two decades of existence, these networks have met with mixed success. In some ways, the Normandie Métropole network can be seen to have failed. Having encountered problems with divergent interests, mismatches between the economic and administrative structures of the respective cities, and a lack of logistical integration between them, it was eventually dissolved (Merk et al., 2011). The South Coast Metropole has been more successful, securing EU funds, which have gone towards regional projects in the fields of tourism and innovation. Furthermore, though they may have lost their initial élan, these two networks arguably set precedents for networking efforts on both sides of the Channel, which have helped to foster further innovative forms of port-city networking. Having met with little success after a first attempt in 1996, the Channel Arc (Arc Manche) network was revived in 2003, bringing together five French and five English maritime regions along the channel. With co-funding from the North-West European Interreg III B programme between 2004 and 2008, the Channel Arc succeeded in producing its Strategic Vision for the Channel Area (the Espace Manche Development Initiative or EMDI), which in turn drove the creation of a EUR 173.5 million Interreg fund specifically for transnational projects in the coastal region surrounding the Channel, one of the busiest stretches of water in the world. With the support of this fund, these port-city regions have gone on to produce the (Channel Arc Manche Integrated Strategy (CAMIS), which has an integrated plan for joint initiatives in the fields of maritime safety, economic development, tourism, environmental protection and innovation. In their own ways, both the Normandie Métropole and the South Coast Metropole set the stage for these subsequent institutional successes in co-operation between neighbouring port-cities.

Co-operation and networking in port-city regions is similar to the port co-ordination mechanisms described above, in seeking to enhance capacities and align the interests of a multiplicity of actors. However, because municipal and regional governments have much wider mandates than port authorities, co-operative measures between port-cities often go well beyond seeking to improve the competitiveness of a given port, and try to respond to collective problems that cannot be resolved on an individual level.

Co-operation between neighbouring port-cities can provide a clear advantage, providing access to regional funding and the opportunity to co-ordinate regional solutions to regional issues. Organising around shared interests can make possible a range of responses sensitive to several policy fields, and help individual port-cities overcome larger challenges, such as environmental management, long-term integrated planning and economic development. Often the impetus for such co-operation emerges in response to specific threats (such as the degradation of collective environmental resources in the Baltic), or to specific opportunities (the creation of funds for pluri-jurisdictional and transboundary projects in the Channel). Maintaining the momentum of such partnerships is not always successful: divergent interests, administrative mismatches and legitimacy deficits of transnational action by sub-national actors can exhaust such efforts. However, the increasing institutionalisation and diffusion of such instruments is to be encouraged, and port-cities should try to institute permanent, resilient frameworks for co-operation.

Notes

1. In recent years, economic development policies in many OECD member states have ceased to focus exclusively on single sectors, and have instead begun to concentrate on the linkages amongst firms within multi-sectoral "clusters". Such clusters are comprised of economic actors from diverse parts of the value chain, and can include producers, customers, suppliers, labour markets, training institutions, intermediary services, industrial associations and government actors (Porter, 1998; Dayasindhu, 2002; Porter, 2003). Clusters are usually defined spatially, as regions or areas that feature higher than average concentrations of value-added activity within a given domain (IT, maritime, agriculture, textiles, etc.). They can be distinguished from industrial districts or simple geographic concentrations of firms in that they are linked through formal networking platforms, and usually benefit from some degree of co-operation and collective governance (Doloreux and Shearmur, 2009).

2. In its attempt to increase its reputation and thus its registrations, Singapore, for example, has adopted all major IMO conventions on ship safety and marine pollution, maintains a "white list" status on most port state control regimes, and is host to no less than nine separate classification societies. Hong Kong has likewise endeavoured to comply with international safety, labour and environmental norms as a way of decreasing credit costs for its registered shippers (CUHK, 2013). Furthermore, both countries have undertaken a range of measures to make registration more attractive. In Hong Kong, these include the removal of registration fees, the introduction of flexible rules for crew nationality, the creation of a 24-hour registration service, free vessel inspections and the creation of a public relations group for the register. Hong Kong and Singapore's registries respectively occupied the fourth and sixth places on the list of the top merchant fleets by tonnage in 2010, according to the IHS Fairplay data.

3. To enhance anti-piracy capabilities in their shipping sector, governments use two main instruments. Firstly, the flag state can provide protection at its own cost through Vessel Protection Detachments (VPDs). VPDs are small teams composed of guards from the government military or navy, and are currently provided by France, Israel, Spain, Belgium and Italy, amongst others. Secondly, states can allow shipping companies to employ private security companies (PSCs). This second measure has proven controversial, resulting in protracted debate in the German parliament in 2013, for example, about the oversight of such PSCs, and whether their operation poses a threat to the exclusively sovereign power to make decisions over the use of force. While PSCs may present issues of training and oversight (Van Ginkel, Van der Putten, Molenaar, 2013), allowing them can also carry several advantages, such as cost-effectiveness and flexibility for shipowners. In nations that allow PSCs, issues of oversight and training should be addressed through the introduction of stringent operational criteria. In Norway, for example, PSCs can only apply for temporary firearms licenses, and cannot engage in the use of force without the approval of the shipmaster. Norway also requires reporting on vetting procedures for any shipping

company wishing to use a PSC, including background checks of the staff. Few public accreditation standards for PSCs exist, however, and it appears important to move toward the formulation of such standards in order to harmonise best management practices across the global private security sector. As of 2013, major European maritime states that allow or were debating approval for PSCs included Italy, Belgium, the UK, Denmark, Norway, Greece, Spain, Cyprus[(i)(ii)], Germany and France.

(i) Note by Turkey:

The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

(ii) Note by all the European Union Member States of the OECD and the European Union:

The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

4. When business is going well, this tax regime often translates into an effective tax rate of <1% for participating companies (PWC, 2009). However, when business is going poorly, the tonnage tax can also constitute a drain on participating companies, which must pay taxes even in situations of negative net income (many tonnage tax regimes require a minimum 10-year participation in the scheme with no opt-out option).

5. In the UK, eligibility for the tonnage tax involves two main requirements. On the one hand, ships must be "strategically and commercially managed in the UK". Several factors are assessed as part of this definition: headquarters and decision-making operations of the company should be located in the UK; activities such as route planning, cargo booking, personnel management, technical vessel management and direction of foreign offices should be carried out in the UK; the overall share of work and number of employees in the UK should outweigh that done elsewhere, vessels should be flagged, classed, insured or financed in the UK, and so on. This ensures that the loss of potential taxation through the implementation of the tonnage tax regime is amply compensated for through increased activity in the UK maritime service cluster. On the other hand, the UK tonnage tax regime includes a "training commitment", which requires participating companies either to train officers and cadets (who must be British or EU nationals), or to transfer funds to the Maritime Training Trust. This requirement effectively builds a human capital matching mechanism into the tonnage tax regime, ensuring tha t the maritime cluster remains embedded in the UK labour market. Since its introduction in 2000, the UK tonnage tax has been credited with reversing the decline in shipowners and operators in the UK, and contributing to threefold and sixfold growth in the UK-owned and UK-registered fleets respectively during the 2000-09 period (MaritimeUK, 2012). The policy has furthermore been credited with contributing an extra 189 700 jobs to the UK economy (direct, indirect and induced), and with more than doubling the shipping industry's GDP contribution, as compared with what it would otherwise have been (Oxford Economics, 2013).

6. The logic behind such bilateral agreements, in which the parties agree to reciprocally exempt ship operators from certain taxes in both countries (RTEs) or in one only (DTAs and CDTAs), is that they foster trade relationships, improve the competitiveness of the maritime cluster and enhance its attractiveness for ship

operators. Maritime and trade-dependent countries often form such agreements. New Zealand, for example, had 37 DTAs in force in 2013, with five signed and not yet in force, and seven more under negotiation. Additionally, Section CV 16 of New Zealand's Income Tax Act 2007 allows for income exemptions for any state in which reciprocal exemptions are made for New Zealand ship operators, meaning that most of its DTAs can also effectively function as RTEs.

7. While output from the shipbuilding sector grew enormously during the late 1960s, the oil crisis of 1973 severely diminished its global output, with supply outpacing demand. Throughout the 1980s and 1990s, this over-capacity led to a drop in profitability that developed countries in Europe and Asia dealt with in part through rationalisation policies (caps on capacity increases) and in part through subsidies (FMI, 2003). The rationale behind subsidisation was to retain capacity and a competitive stance whilst awaiting a new upswing in activity. In 2004, for example, EU-wide subsidies to the shipbuilding sector were in the vicinity of EUR 100 million. However, while the shipbuilding sector did pick up again, profitability did not increase in tandem. Furthermore, concerns over the cyclical tendencies of the shipbuilding sector, coupled with several trade disputes – such as that between Korea and the EU, over which the World Trade Organization ruled in favour of Korea in 2005 – have spurred a global effort to reduce subsidies in the global shipping industry, which has succeeded in the removal of many (if not all) forms of subsidy. In 2013, for example, the European Commission ruled that that tax advantages received by Spanish shipbuilders were unlawful and should be repaid to the Spanish state. While various alternative options for direct and indirect subsidies remain open to the shipbuilding sector in different nations around the world – including the EU, with the non-selective tax scheme approved by the commission in 2012 – other intelligent policy solutions remain open to developed nations seeking to preserve the know-how and sunken capital tied up in their shipbuilding sectors.

8. "Leader firms are firms that have – due to their size, market position, knowledge and entrepreneurial skills – the ability and incentive to make investments with positive externalities for other firms in the cluster" (De Langen, 2004a).

9. Organic CO_2 for Assimilation of Plants.

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