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Lennart Meri
(Eesti Vabariigi endine president)
(former president of Republic of Estonia)

ALTERNATIVES FOR ICEBREAKING SERVICES IN ESTONIA

Kaupo Läänerand

Deputy Secretary General for Maritime and Water Affairs, Ministry of Climate of Estonia

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Read and download full study:
https://transpordiamet.ee/uuringud#merendus

>> Published in October 2023, commissioned by the Estonian Transport Administration
>> The study was completed in collaboration with Tallinn University of Technology (TalTech), Aker Arctic Technology Inc, logscale oy and Saaresalu OÜ

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Minister

- Siseaudit
- Referent ja ministri nõunikud

Kantsler

- Personaliosakond

Elurikkuse ja keskkonnakaitse asekantsler

- Elurikkuse kaitse osakond
- Keskkonnakorralduse ja kiirguse osakond
- Metsaosakond

Rohereformi asekantsler

- Rohereformi osakond
- Kliimaosakond
- Välissuhete osakond

Energeetika ja maavarade asekantsler

- Energeetika osakond
- Maavarade osakond
- Välisõhu osakond

Elukeskkonna ja ringmajanduse asekantsler

- Ringmajanduse osakond
- Ehitus- ja elukeskkonna osakond

Liikuvuse asekantsler

- Transpordi arengu ja investeeringute osakond
- Tee- ja raudtee osakond
- Lennundusosakond

Merenduse ja veekeskkonna asekantsler

- Merekeskkonna osakond
- Meremajanduse osakond
- Veeosakond

Strateegia ja innovatsiooni asekantsler

- Kriisijuhtimise ja infoturbe osakond
- Finantsosakond
- Strateegia, analüüsi ja digiteenuste osakond
- Avalike suhete osakond
- Õigusosakond
- Üldosakond

7 asekantslerit
23 osakonda (+ üldosakond), neist 1 kantsleri alluvuses

Republic of Estonia
Ministry of Climate

Ministry of Climate

State Owned Public Limited Companies and Foundations

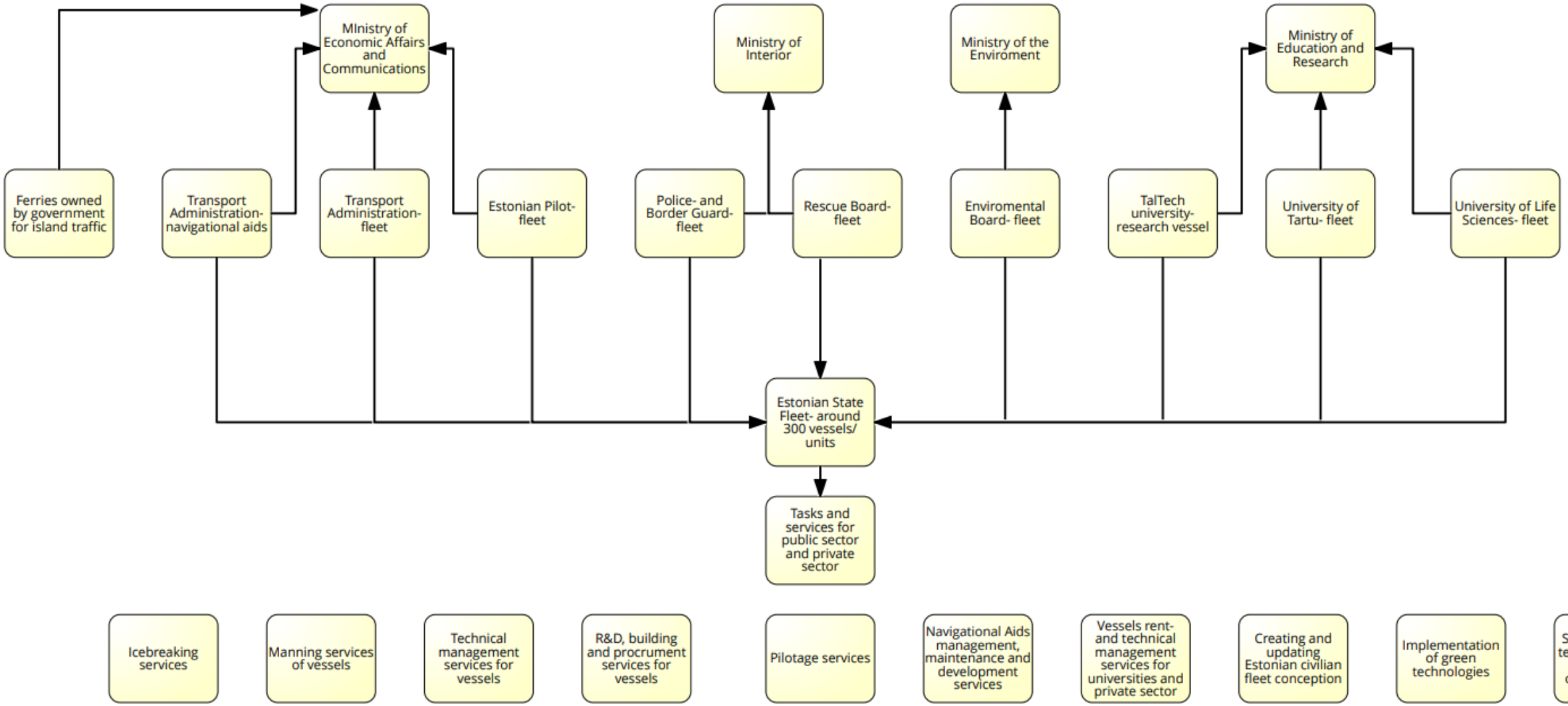
- State Forest Management Center
- Estonian Environmental Research Center
- AS Ökosil
- SA Keskkonnainvesteeringute Keskus
- AS A.L.A.R.A.
- Elering AS
- Estonian Air Navigation Services
- AS Nordic Aviation Group
- AS Operail
- AS Eesti Raudtee
- AS Saarte Liinid
- AS Tallinna Lennujaam
- AS Tallinna Sadam
- OÜ Rail Baltic Estonia
- OÜ Transpordi Varahaldus
- Estonian National Committee of the World Energy Council

State Authorities

- Estonian Environment Agency
- Estonian Museum of Natural History
- IT Centre of the Ministry of the Environment (KEMIT)
- Estonian State Fleet
- Geological survey of Estonia

Governmental Authorities

- Estonian Transport Administration
- Environmental Board


MInistry of Economic Affairs and Communications
Ministry of Interior
Ministry of the Enviroment
Ministry of Education and Research
Ferries owned by government for island traffic
Transport Administration- navigational aids
Transport Administration- fleet
Estonian Pilot- fleet
Police- and Border Guard- fleet
Rescue Board- fleet
Enviromental Board- fleet
TalTech university- research vessel
University of Tartu- fleet
University of Life Sciences- fleet
Estonian State Fleet- around 300 vessels/ units
Tasks and services for public sector and private sector
Icebreaking services
Manning services of vessels
Technical management services for vessels
R&D, building and procrument services for vessels
Pilotage services
Navigational Aids management, maintenance and development services
Vessels rent- and technical management services for universities and private sector
Creating and updating Estonian civilian fleet conception
Implementation of green technologies
Short- and long term planning of government owned vessels

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The conducted study:

>> analyses the alternatives and proposes an optimal solution for icebreaking services in Estonia for the period of 2029-2054, incl. which vessels or combinations of vessels the state should prefer to ensure an optimal solution

>> takes into account the traffic flows of Estonian ports receiving icebreaking services, assess the impacts of the different scenarios

>> analyses climate changes in combination with IMO and EU regulations

>> highlights the investments needed and the expected lifetime of existing icebreakers

>> assesses the cost of different forms of ownership of the icebreakers

ESTONIAN FOREIGN TRADE AND VESSEL MOVEMENT

	2014	2015	2016	2017	2018	2019	2020	2021	2022
Vessel traffic	11 573	11 634	11 837	12 139	11 673	12 108	10 958	11 056	10 729
..., in ice breaking serviced ports	10 133	10 289	10 485	11 051	11 015	11 539	10 394	10 373	9 919
... (without ro-ro and ropax)	4 387	3 848	3 981	4 229	4 338	4 653	3 980	3 948	3 804

Chart: Vessel traffic in Estonian ports (Source: EMDE)

>> Icebreaking serviced ports are Muuga, Kunda, Sillamäe, Old City, Paldiski South, Paldiski North, Miiduranna, Paljassaare (not significant cargo port), Vene-Balti, Bekkeri, Meeruse and Pärnu.

>> From the ice-breaking aspect vessel traffic should be looked at not for full year but for winter and early spring months. Therefore, following analysis of vessel traffic is for the months from December to April and for the cargo vessels.

ESTONIAN ICE BREAKING FLEET

Estonian Ice Breaking Fleet

According to the procedure for ice breaking, the ports served by the state with icebreakers are Muuga harbour, the ports of Tallinn and Kopli Bay, Paldiski North harbour, Paldiski South harbour, Kunda harbour and Sillamäe harbour, which are served up to the aquatorium, and Pärnu harbour is served from the open sea up to the point defined by the coordinates.

Icebreaking is carried out by the state with the vessels Tarmo, EVA-316 and Botnica.

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In addition, a number of companies have icebreaking/ice-class vessels:

– TS Vessels (five passenger ferries serving the main islands);
– Alfons Hakans (ice-class 1A tugs in Sillamäe, Kunda, Muuga, Paldiski and Pärnu);
– Port of Sillamäe (tug Arno);
– Port of Kunda (tug Kunda);
– Saarte Liinid (tug Panda);
– Kihnu Veeteed (passenger ferries serving small islands);
– Tallink, Viking Line, Eckerö Line (passenger ferries and ro-ro vessels sailing on the routes from Vanasadam and Muuga);
– Navy (Kindral Kurvits, Raju, Valve).

CLIMATE CHANGE AND ICE CONDITIONS

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ICE CONDITIONS IN THE GULF OF FINLAND AND GULF OF RIGA

The study utilized Copernicus Marine Environment Monitoring Service (CMEMS) reanalysis data to assess ice characteristics around the Estonian coast. The dataset encompasses 29 years, from January 1993 to December 2021, covering multiple ice seasons. Ice concentration and ice thickness data from the reanalysis model was specifically employed for the analysis.

>> The long-term data analysis spanning from 1993 to 2021 reveals significant ice occurrences throughout the study region. Notably, even the areas between Baltic Proper and Gulf of Finland have consistently exhibited ice concentration above the defined threshold for more than 10 years. Additionally, the northeastern regions of the Gulf of Finland have experienced ice cover every single year during this period.

>> Furthermore, Väinameri and Pärnu Bay have consistently been ice-covered each winter, except for the 2019/2020 winter when ice did not form in these specific areas. These findings from the long-term data analysis provide valuable insights into the historical patterns of ice presence and concentration in the study region.

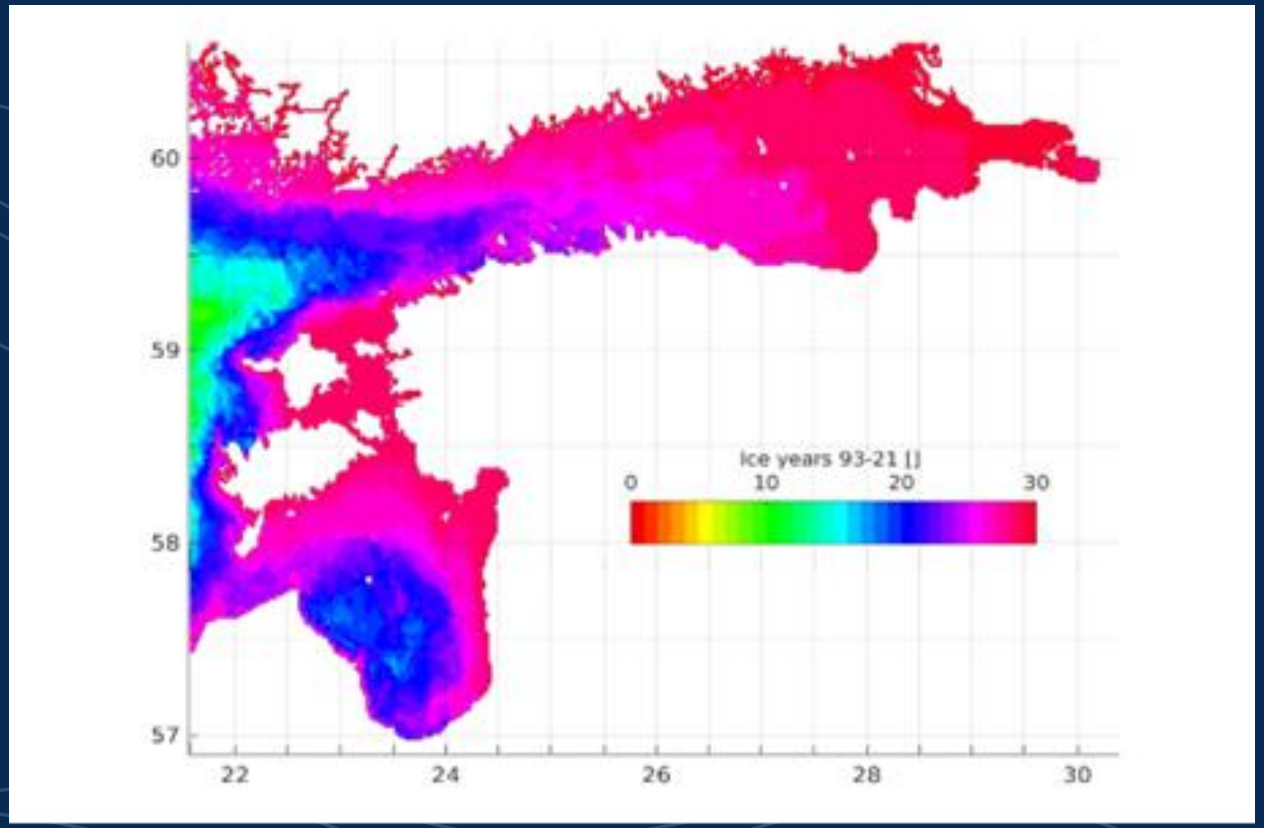


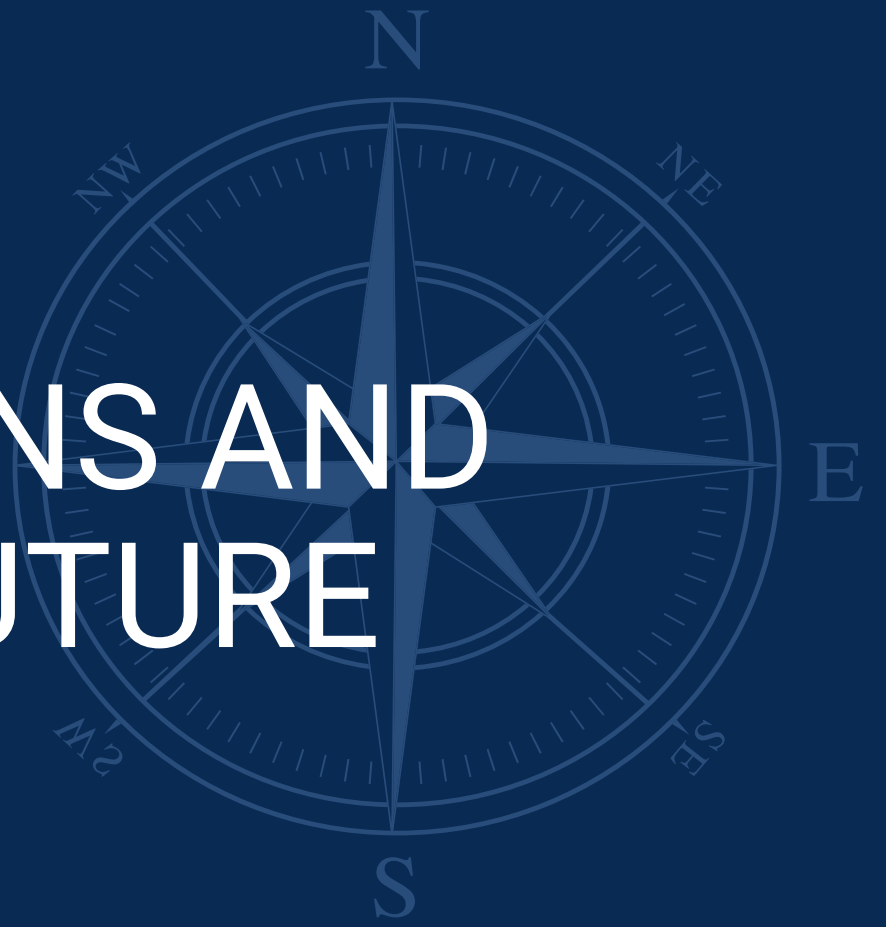
Table: Number years between 1993 and 2021 that sea ice concentration has exceeded the threshold. Data that is shown also represent the study; integrated parameters (e.g., sea ice extent;) are derived using the model grid points within this area.

What are the impacts of climate change (more frequent storms and formation of conglomerated ice) on ice conditions in the Gulf of Finland and the Gulf of Riga?

>> As temperatures are projected to increase in all climate scenarios, both in the mid-century and beyond, we can anticipate a rise in the occurrence of average and mild ice conditions. Consequently, severe winters are expected to become significantly less frequent (about 3% of winters will be severe, 71% will be average, and 26% will be mild in the next coming decades).

>> Nevertheless, it's important to note that under extreme weather conditions in warmer climate scenarios, there remains a possibility for severe winters to occur as well.

NEW REGULATIONS AND CHANGES IN FUTURE VESSELS



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BACKGROUND FOR TIGHTENING REGULATIONS

>> In 2018, the International Maritime Organization (IMO) set a goal of reducing shipping's greenhouse gas emissions by 50 percent by 2050, and in July 2023, the IMO made significant tightening of its goals. The revised IMO GHG Strategy includes an enhanced common ambition to reach net-zero GHG emissions from international shipping close to 2050, a commitment to ensure an uptake of alternative zero and near-zero GHG fuels by 2030, as well as indicative checkpoints for 2030 and 2040.

>> In July 2023, the European Parliament also finally decided on the maritime Fit for 55 package, which stipulated the carbon content of shipping fuels, fuel distribution and taxation, and included shipping as part of the emissions trading system.

>> However, these are only the latest changes in greenhouse gas emissions regulations. The first international regulations to reduce shipping's greenhouse gases came into force more than a decade ago.

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Until now, there isn't unified, single pattern in change of vessel dimensions during last five years…

HOWEVER… The future vessels will be weaker.

>> In 2011, the IMO set goals by which the structure of new ships must be designed in such a way that ships' fuel consumption and thus greenhouse gas emissions are reduced. EEDI stands for Energy Efficiency Design Index, i.e. it is used to calculate the ship's energy efficiency index (carbon dioxide emissions per tonne-mile). For the ship to operate, the index value must be lower than the reference value set by the IMO. They are gradually becoming stricter, so new ships gradually become less emitting. The regulation has already had a significant impact on the energy consumption of ships, for example by designing the hull shapes, as well as the fact that the newest ships usually have less engine power than the older ones.

>> In 2021, the IMO set a requirement that existing ships must also meet the energy efficiency requirements set by the IMO. And like EEDI, this EEXI gradually tightens.

>> The EEDI regulation has already change and also coming EEXI regulation will change the new vessels operating in the Baltic Sea. The new vessels are weaker and therefore, they need more ice breaker assistance in winters (See 4.1.5 Vessels Ice-Going Capacity Based on New IMO Rules).

TO SUMMARIZE:

1. it can be concluded that the ice-going capability of merchant vessels is expected to decrease in the future and therefore the merchant vessels will need more icebreaker assistance.

2. Past studies have shown that the EEDI Phase 0 and 1 vessels need more icebreaker assistance when compared to vessels built before EEDI regulations. Now Phase 2 vessels are just entering service and Phase 3 will be introduced in the future meaning that the ice-going capability of the merchant vessels is expected to further decrease.

3. The influence of EEXI and CII is yet to be demonstrated as these regulations are so new. However, the impact is expected to be negative in respect of ice-going capability of the merchant vessels.

GOVERNANCE OPTIONS FOR WINTER NAVIGATION ASSISTANCE

GENERIC GOVERNANCE OPTIONS FOR WINTER NAVIGATION ASSISTANCE

Table 18. Generic governance options for winter navigation assistance

<table>
<tr><th rowspan="2">Option</th><th rowspan="2">Type or note</th><th colspan="2">Vessel</th><th colspan="3">c) Maintenance, safety and manning</th><th>d) Operating the vessel(s)*</th></tr>
<tr><th>a) Financing</th><th>b) Ownership</th><th>Technical maintenance</th><th>Safety management</th><th>Manning</th><th>Navigational responsibility</th></tr>
<tr><td colspan="2">1. Fully governmental operation</td><td colspan="6">Gov:t agencies finance, own, maintain and operate the vessel(s)</td></tr>
<tr><td rowspan="3">2. Public-Private-arrangements</td><td>2 a) Time chartering to an external service provider (SP)</td><td colspan="5">Gov:t agencies finance, own and maintain the vessel(s)</td><td>SP</td></tr>
<tr><td>2 b) Bareboat chartering to an external service provider</td><td colspan="2">Gov:t finances and owns the vessel(s)</td><td colspan="4">An external service provider maintains and operates the vessel(s)</td></tr>
<tr><td>2 c) Theoretically possible, but a risky option for the Government.</td><td>Gov:t finances the vessel(s)</td><td colspan="5">The vessel is owned and operated by an external service provider; a highly trusted partner and a mutual long-term committment is required</td></tr>
<tr><td rowspan="4">3. Procuring the service from the market either short or long term</td><td>3 a) A fully state-owned company</td><td colspan="6" rowspan="4">The vessel is financed, owned and operated by the provider of icebreaking and winter navigation assistance services</td></tr>
<tr><td>3 b) A company, where the state has a majority ownership</td></tr>
<tr><td>3 c) A fully privately owned commercial company</td></tr>
<tr><td>3 d) A company, where the state has a minority ownership</td></tr>
</table>

*) Bunkering of the vessel is part of operating duties, but the cost of bunker is usually separately negotiated between the Gov:t and SP

Table presents possible governance options for providing winter navigation assistance, in which the Government and external service providers can assume various roles.

The fully governmental option 1. is used, for example, in Sweden, Denmark, Canada and the U.S.

GOVERNANCE OPTIONS FOR WINTER NAVIGATION ASSISTANCE IN ESTONIA

Table 19. Basic governance options for winter navigation assistance in Estonia

Option	Type or note	Assigning the vessel(s)	Vessel		c) Maintenance, safety and manning			d) Operating the vessel(s)*
			a) Financing	b) Ownership	Technical maintenance	Safety management	Manning	Navigational responsibility
1. Fully governmental operation	1 a) Current arrangement	Transpordiamet	Government	Riigilaevastik (RL) vessels Tarmo and EVA 316				
	1 b) Gov:t purchases a new or used icebreaker			The new vessel would go to Riigilaevastik				
2. Public-Private-arrangements	2 a) Time chartering to an external service provider (SP)			Riigilaevastik				SP
	2 b) Bareboat chartering to an external service provider			RL	External service provider			
3. Procuring the service from the market either short or long term	3 a) A fully state-owned company or state agency			In use in Finland (Arctia Oy) and Latvia (LVR Flote)				
	3 b) A company, where the state has a majority ownership			TS Shipping as a service provider with a 10 year contract on Botnica in the Gulf of Finland				
	3 c) A fully privately owned commercial company			This option has been used for short term peak demand assignments with e.g. Alfons Håkans in Gulf of Riga				
	3 d) A company, where the state has a minority ownership			Not applicable				

*) Bunkering of the vessel is part of operating duties, but the cost of bunker is usually separately negotiated between the Gov:t and SP

= Shaded fields indicate an option currently used in Estonia

Based on the generic governance options for winter navigation assistance presented in, the current situation in Estonia with the remaining ohter potential options is shown in Table 19.

The Fully governmental operation (Option 1) is divided here into three variants, where the current arrangement is exemplified in Option 1 a). Option 1 b) envisages the sitation, where the Government decides to order a newbuilding or a second-hand icebreaker from the markets.

OPTIONS FOR ICEBREAKERS AND COST-EFFECTIVITY ANALYSIS

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OPTIONS FOR ICEBREAKERS AND COST-EFFECTIVITY ANALYSIS

Table 35. Vessel requirements in the various multipurpose uses

	Escort icebreaker	CG patrol vessel OPV	SOV (Offshore Wind)	Fairway maintenance	Navy Support Ship	Search and rescue
Level icebreaking capability	YES	YES	YES	SOME	SOME	SOME
Good manoeuvring/agility	YES	YES	YES	SOME	YES	YES
High engine power	YES	YES	NO	NO	NO	NO
Good seakeeping capability	NO	YES	YES	YES	YES	YES
High openwater speed	NO	YES	NO	NO	NO	NO
Dynamic positioning	NO	YES	YES	YES	YES	YES
Cargo capacity	NO	NO	SOME	SOME	SOME	SOME
Cargo handling	NO	NO	YES	SOME	YES	YES
Personnel requirement >20	NO	YES	YES	NO	YES	YES
Oil spill	NO	YES	NO	NO	NO	YES
Fi-Fi	NO	YES	SOME	NO	SOME	YES
Emergency towing	NO	SOME	NO	NO	SOME	YES
Work boat landing system	NO	YES	YES	YES	NO	NO
Helicopter operations	NO	YES	YES	NO	YES	YES

Table 35 identifies the main requirements for a pure icebreaker and requirements for different multipurpose uses.

Some vessel-types require more functions and some less. Further, the Table 36 shows which requirements have negative influence for icebreaking or if some features can even have positive effect.

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DETACHABLE BOW CONCEPT FOR ICEBREAKER

The benefits of the detachable icebreaking bow:

- Low price compared to a complete new icebreaker;
- Small manning compared to a "full" icebreaker;
- The pusher can be optimized more for open-water operations as the bow can be detached and left at the icebreaking site → wide operation area for the pusher;
- The bow can be designed basically only for ice operations. Little need to consider open-water issues → radical bow geometries possible;
- Easy/cheap method to produce wider channel than the pusher alone → Good maneuverability in ice for the combination;
- Fuel capacity and the independence time of the pusher can be increased if fuel is stored in the detachable bow.

Challenges with detachable bow:

- Works best in level ice and channel conditions. Functionality at open sea conditions not optimal:
- Performance in ridges;
- Seakeeping characteristics;
- Icebreaking always needs power and thrust no matter how efficient the bow design is → finding a suitable pusher for difficult ice conditions with thick ice can be challenging;
- The bow is weight-critical which adds some challenge to the design and building of the bow.
- The bow is purposely built for certain tug-type and the possibilities to mount the bow into other vessels without modifications are limited. Basically, this means that the tug probably shall be chartered with a long-term contract.

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FINANCIAL ANALYSIS OF THE ALTERNATIVES

SCENARIO 1:
1 multipurpose icebreaker with offshore functionality in Gulf of Finland (Primary) + 1 multipurpose icebreaker for Gulf of Riga (standard)

SCENARIO 2: 1 multipurpose icebreaker with offshore functionality in Gulf of Finland (Primary) + 1 multipurpose icebreaker in Gulf of Finland (Secondary) + 1 tug with a detachable bow icebreaker for Gulf of Riga

SCENARIO 3: 1 multipurpose icebreaker with offshore functionality in Gulf of Finland (Primary) + 1 multipurpose icebreaker in Gulf of Finland (Secondary) + 1 multipurpose icebreaker in Gulf of Finland (Third) + 1 tug with a detachable bow icebreaker for Gulf of Riga

TO SUMMARIZE:

1. Icebreaking in Estonian waters and ports is characterized by a short winter season. This means that there is good reasons for finding multipurpose uses for the icebreaker.

2. Depending on the technical specifications and required capabilities, a multipurpose icebreaker is typically 20% more expensive than a similar size conventional icebreaker.

3. Recommended multipurpose uses for Estonian governmental functions include mainly the following:

- Coast Guard patrol vessel (with SAR functions)
- Fairway maintenance vessel
- Navy Service Vessel

Table 54. Summary of estimated costs for winter navigation assistance options in Estonia. Costs for icebreakers are based on the Chapter 5

	Option	Sub-option	Investment cost, M€	Estimated range of annual operational cost in EUR million with fuel and capital cost (no interest rate)		Possibility for charter in offshore markets	Security of service supply	Duration of the arrangement
				Mild winters	Severe winters			
Gulf of Finland	A. One suitable new icebreaker	A.1. State-owned conventional IB	80	7,1	9,0	No	Very high	~50 years
		A.2. State-owned multipurpose IB	100	8,4	10,5	Maybe*		
		A.3. Chartered		5,5	7,5	Yes, during off-hire	High	5 to 10 years
	B. Sea tug with connectable icebreaker bow; supplement to an icebreaker	B.1. State-owned	30 (with motorised bow > 40)	0,8 (1,1)	1,1 (1,5)	No	Very high	Tug ~50 years, bow 25+ years
		B.2. Chartered		0,3**	0,6**		High	5 to 10 years
	C. Two sea tugs without an icebreaker bow	C.1. State-owned	50	1,0	1,4		Very high	~50 years
		C.2. Chartered		0,4**	0,7**		High	5 to 10 years
	D. Co-operation with Finland during peaks		Upon agreement, tentatively 1+ M€/active month				Very high / very long	
Gulf of Riga	E. One suitable icebreaker	E.1. State-owned conventional IB	40	3,9	4,3	No	Very high	~50 years
		E.3. Chartered		4,0	5,0		High	5 to 10 years
	F. Sea tug with connectable icebreaker bow; supplement to an icebreaker	B.1. State-owned	18+8=26	0,7	1,0		Very high	Tug ~50 years, bow 25+ years
		F.2. Chartered		0,3**	0,6**		High	5 to 10 years
	C. One sea tug without an icebreaker bow	G.1. State-owned	25	0,5	0,7		Very high	~50 years
		G.2. Chartered		0,2**	0,4**		High	5 to 10 years

*) unless limited by funding source, such as EU's CEF or Military Mobility

**) For icebreaking period only (4 months)

***) Fixed annual depriaction over 20 years, no interest cost included

= Vessels owned by Riigilaevastik

= Offshore activities would require a commercial operator

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