Autonomous ship '*Yara Birkeland*' - how far has the industry reached?

The world's first seagoing autonomous ship, called *Yara Birkeland*, was expected to be launched and to set sail in 2018, delivering fertiliser along a 37-mile route in southern Norway (figure 4). The construction cost of the ship, according to the Wall Street Journal, was estimated at about **USD 25 million, about three times as much as a conventional ship of a similar size.** As an advantage, in accordance with the developer **"it would save up to 90% in annual operating costs of the shipowner by eliminating both fuel and crew**." It was envisaged initially that the ship would be first operated by an onboard crew then remotely, before becoming fully self-guided by 2020.

Figure 1. *Yara Birkeland* illustration (source: http://hugin.info/134793/R/2210941/860932.jpg)

Table 1 *Yara Birkeland's* ship particulars.

Capacity	120, 20-foot containers
Length	80 meters
Width	15 meters
In-depth full load	6 meters
Marsh speed	6 – 7 knots
Maximum speed	15 knots
Deadweight	3,150 tonnes
Battery capacity	6.8 MWh

Notwithstanding the extremely high level of attention of the maritime industry, the initially envisaged target year of 2018 will not be met. The viability of a 'fully autonomous ship' triggered doubts and questions. However, in response to such scepticism, on 15 August 2018, **YARA**[1] announced its partnership with **VARD**[2] for continuous construction of *Yara Birkeland*, targeting the completion and launch by the first quarter of 2020. The construction costs approximately NOK 250 million (USD 29 million, as of August 2018) pertaining to the deal between YARA and VARD. The vessel will incrementally become fully automated by 2022, as it is updated in accordance with the latest information. For the first year, it will have a crew placed in a bridge container with crew facilities. By 2021, it will gradually become 'autonomous sail', monitored from a control room on land.

Who are involved?

In 2015, the Norwegian government's strategy '*Maritime Opportunities – Blue Growth for a Green Future'* adopted the development of marine autonomous vehicles as an element.
YARA holds the ownership of the project *Yara Birkeland*, which was announced officially from 2017, as a continuum of Maritime Unmanned Navigation through Intelligence in Networks (MUNIN) project from 2012 to 2015.

YARA and **Kongsberg**[3], as a high-technology system provider, built up their partnership in May 2017. In April 2018, Kongsberg and a world-renowned shipping company Wilhelmsen founded a joint firm '*Massterly*' in order to develop the optimum shipping intelligence systems. **Massterly** is chiefly responsible for building an "autonomous" vessel remote control centre in Oslo (there is no specific target completion year).

Figure 2. Norwegian PM Erna Solberg at the signing in Brevik, Norway 15 August 2018
(source: http://hugin.info/134793/R/2210941/860934.jpg)

Further, a Norwegian shipbuilding company **VARD** has just joined the partnership (as of August 2018). In addition, **ENOVA**, a Norwegian government enterprise, responsible for promotion of environmentally friendly production and consumption of energy, subsidised the project with NOK 133.6 million (USD 16 million, as of August 2018). The hull will arrive in Brevik in September 2019 and be ready for the operation in February 2020.

Figure 3. Chronology of project *Yara Birkeland* (created by the author)

In short, the project has funds and parties to supervise, provide technical systems, build the ship and construct a control centre.

What route will the vessel sail?

In southern Norwegian water, 3hrs night sailing and 21hrs in port for loading and maintenance. Between Herøya and Brevik is 7nm and 30nm to Larvik.

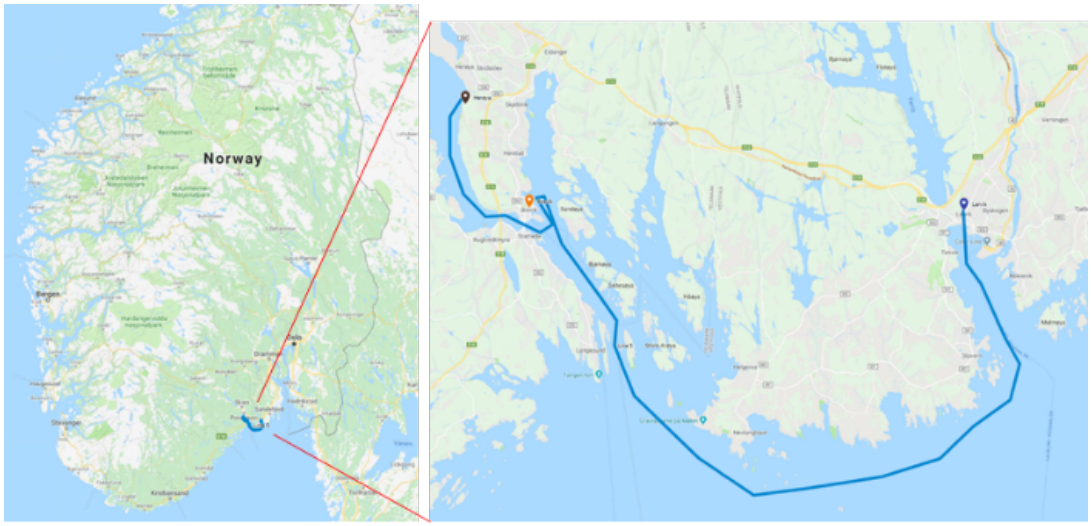
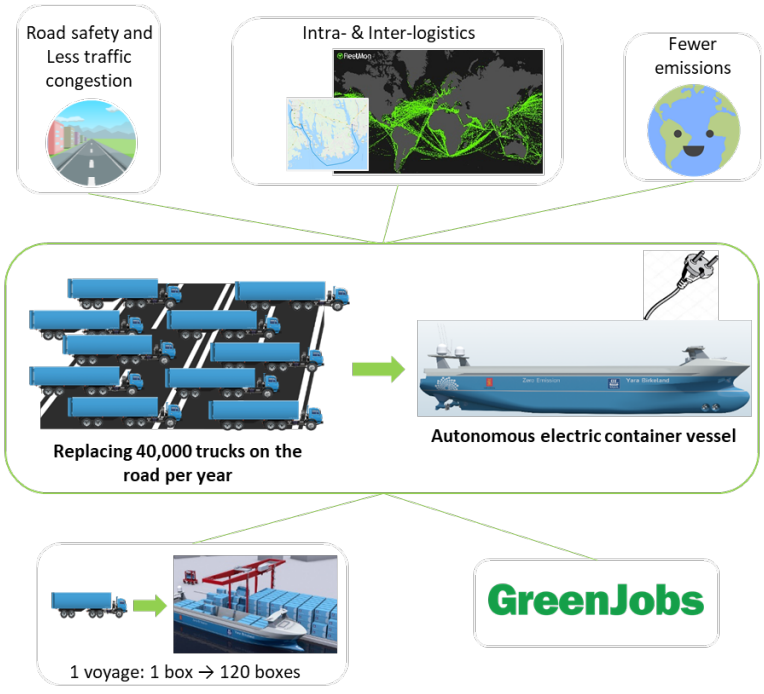


Figure 4. *37nm* Route of *Yara Birkeland* (Southern Norway, Herøya - Brevik - Larvik) (created by the author)

Owing to the precarious perception of sailing hours – the industry insists the sailing hour is relatively short -, presumably **basic living facilities**, such as accommodation and galley could be neglected in further discussion. In addition, the geographical characteristics of the routes are not known well. It is **a highly dense area with fragmented coast and islands**. As a result, proper infrastructure must be equipped.

What will be the benefit?



By replacing 40,000 trucks a year and introducing 100 per cent electricity as power resources, the project could contribute in: 1) improving road safety, 2) reducing traffic congestion, 3) improving intra- and inter- national logistics, 4) lowering Green House Gas (GHG) - NO_x, SO_x, CO_2 and PMs-, dust and noise emissions, 5) the thriving of green jobs and 6) cargo transport efficiency in terms of amount per trip (figure 5).

Figure 5. Potential benefits of this project (created by the author)

Challenges manifest

It should be noted that there are challenges to be resolved by taking into account five categories – technology reliability, technical infrastructure, policies and legislation, social and societal impact and cost effectiveness (table 2). Each challenge is marked under the categories that are to be based. It is shown the importance of policy making and cost effectiveness on operating an 'autonomous ship' in the water. The selected challenges for this paper are:

Table 2 Categorised challenges manifest by autonomous ships (created by the author).

	Challenges \ Categories	Technology reliability	Technical infrastructure	Policies & legislation	Social & societal impact	Cost effectiveness
1	**Communications: ship-ship, ship-shore, shore-shore**	X	X		X	X
2	**batteries weight, recharge and feasibility for longer voyages**	X	X			X
3	**cooling and fire extinguishing**	X	X	X		X
4	**vessel maintenance on board and ashore**	X	X	X		X
5	**inspection**			X		
6	**classification**			X		
7	**ship certification**			X	X	X
8	**situation awareness reliability of artificial intelligence**	X	X	X		X
9	**integration of humans in the loop**	X		X	X	X
10	**national and international regulations**	X	X	X	X	X
11	**necessity of basic living facilities aboard while underway**			X	X	X
12	**education and training of personnel; crew qualification and certification**	X	X	X	X	X
13	**substantial career transition scheme which minimizes social-economic impacts**			X	X	X
14	**metamorphosis from conventional management strategies**	X	X	X	X	X
15	**proper harbor infrastructure and fee calculation**		X	X		X
16	**duplicated navigation equipment, from various suppliers, in the remote control centre**	X	X	X	X	X
17	**liability ratio in case of accidents, incidents and ship wrecks and insurance implications**		X	X		X
18	**cyber security**	X	X	X	X	X

1) communications: ship to ship, ship to shore, and shore to shore, 2) batteries weight, recharge and feasibility for longer voyages, 3) cooling and fire extinguishing, 4) vessel maintenance on board and ashore, 5) inspection, 6) classification, 7) ship certification, 8) situation awareness reliability of artificial intelligence – the virtue of human response should be acknowledged , 9) integration of humans in the loop, 10) national and international regulations, 11) necessity of basic living facilities aboard whilst underway, 12) education and training of personnel; crew qualification and certification, 13) substantial career transition scheme which minimizes social-economic impacts, 14) metamorphosis from conventional management strategies (who is in charge - liability ratio), 15) proper harbor infrastructure and fee calculation: customs and clearance of access to ports (without crew), 16) duplicated navigation equipment, from various suppliers, in the remote control centre, 17) liability ratio in case of accidents, incidents and ship wrecks and insurance implications and 18) cyber security.

When all these factors are put together it is questionable if there is a business case for autonomous ships in international trade.

Resources

https://www.yara.com/corporate-releases/yara-selects-norwegian-shipbuilder-vard-for-zero-emission-vessel-yara-birkeland/

https://www.wilhelmsen.com/media-news-and-events/press-releases/2018/wilhelmsen-and-kongsberg-establish-worlds-first-autonomous-shipping-company/

https://www.km.kongsberg.com/ks/web/nokbg0240.nsf/AllWeb/4B8113B707A50A4FC125811D00407045?OpenDocument

http://www.unmanned-ship.org/munin/about/

https://cleantechnica.com/2018/04/05/massterly-wilhelmsen-kongsberg-launching-new-autonomous-shipping-firm/

Government of Norway. Norwegian Ministry of Trade, Industry and Fisheries. (2015). *Maritime Opportunities – Blue Growth for a Green Future: The Government's Maritime Strategy.* Norway: Norwegian Government Security and Service Organisation.

Annotations

[1]About YARA
In collaboration with customers and partners, YARA grows knowledge to responsibly feed the world and protect the planet, to fulfill its vision of a collaborative society, a world without hunger and a planet respected. Our crop nutrition solutions and precision farming offerings allow farmers to increase yields and improve product quality while reducing environmental impact. Our environmental and industrial solutions improve air quality and reduce emissions, and are key ingredients in the production of a wide range of products. We foster an open culture of diversity and inclusion that promotes the safety and integrity of our employees, contractors, business partners, and society at large.
Founded in 1905 to solve emerging famine in Europe, YARA has a worldwide presence with more than 17,000 employees and operations in over 60 countries. In 2017, YARA reported revenues of USD 11.4 billion.
www.yara.com

[2]About VARD

Vard Holdings Limited ("VARD"), together with its subsidiaries (the "Group"), is one of the major global designers and shipbuilders of specialized vessels. Headquartered in Norway and with 9,000 employees, VARD operates nine strategically located shipbuilding facilities, including five in Norway, two in Romania, one in Brazil and one in Vietnam. Through its specialized subsidiaries, VARD develops power and automation systems, deck handling equipment, and vessel accommodation solutions, and provides design and engineering services to the global maritime industry.

VARD's long shipbuilding traditions, cutting-edge innovation and technology coupled with its global operations and track record in constructing complex and highly customized vessels have earned it recognition from industry players and enabled it to build strong relationships with its customers.

VARD was listed on the Main Board of the Singapore Exchange on 12 November 2010. The majority shareholder of VARD is Fincantieri Oil & Gas S.p.A., a wholly owned subsidiary of FINCANTIERI S.p.A. Headquartered in Trieste, Italy, FINCANTIERI is one of the world's largest shipbuilding groups and has, over its 200 years of maritime history, built more than 7,000 vessels.

www.vard.com

[3]About KONGSBERG

KONGSBERG (OSE-ticker: KOG) is an international, knowledge-based group delivering high-technology systems and solutions to clients within the oil and gas industry, merchant marine, defense and aerospace. KONGSBERG has 7,000 employees located in more than 25 countries and total revenues of NOK 14.5 billion in 2017. Follow us on Twitter: @kongsbergasa. kongsberg.com

This article was created for the promulgation purpose of state-of-the-art information on the progress of an 'autonomous ship', *Yara Birkeland*. Sources of technical information were obtained by the courtesy of the Internet press of YARA, Kongsberg, VARD and Norwegian government. Detailed source links are enclosed. Chronological and categorical analysis were conducted by the author and the interpretations of individuals are not subject to the author's responsibility.