

# Dimensjonering av landstrøminfrastruktur - ReCharge

**KSBedrift Havn**

**Gardermoen 2. November 2017**

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02 November 2017

## Innhold



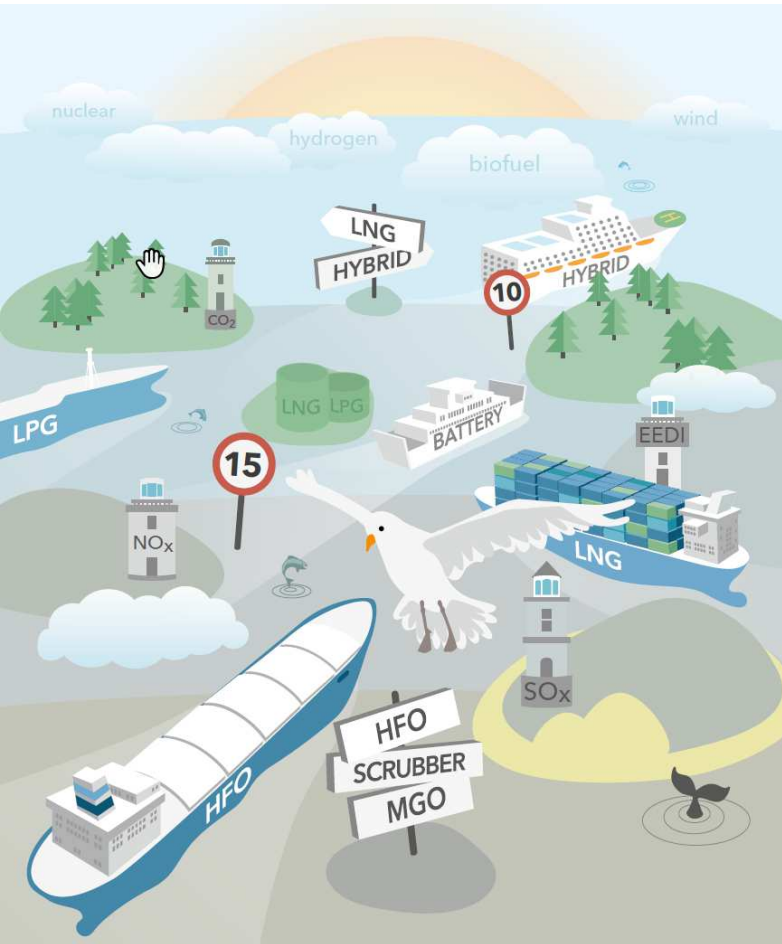
Bakgrunn

Metodikk

Case studie – Oslo havn

*Demonstrasjon: Port Intelligence Dashbord*

## Bakgrunn



- Sjøfarten er miljøvennlig sammenlignet med andre transportmidler.
- Økende press for å bli mer miljøvennlig.
- Innen 2025 skal landstrøm og ladestrøm være tilgjengelig for skip i de største havnene og i de øvrige havnene som har størst potensial for utslippskutt.
- Innen 2030 skal 40 prosent av alle skip i nærskipsfart bruke biodrivstoff eller være lavutslipps- eller nullutslippsfartøy.
- I 2050 skal transportsektoren være tilnærmet utslippsfri/klimanøytral.
- Havnene spiller en nøkkelrolle.

## Målet med prosjektet

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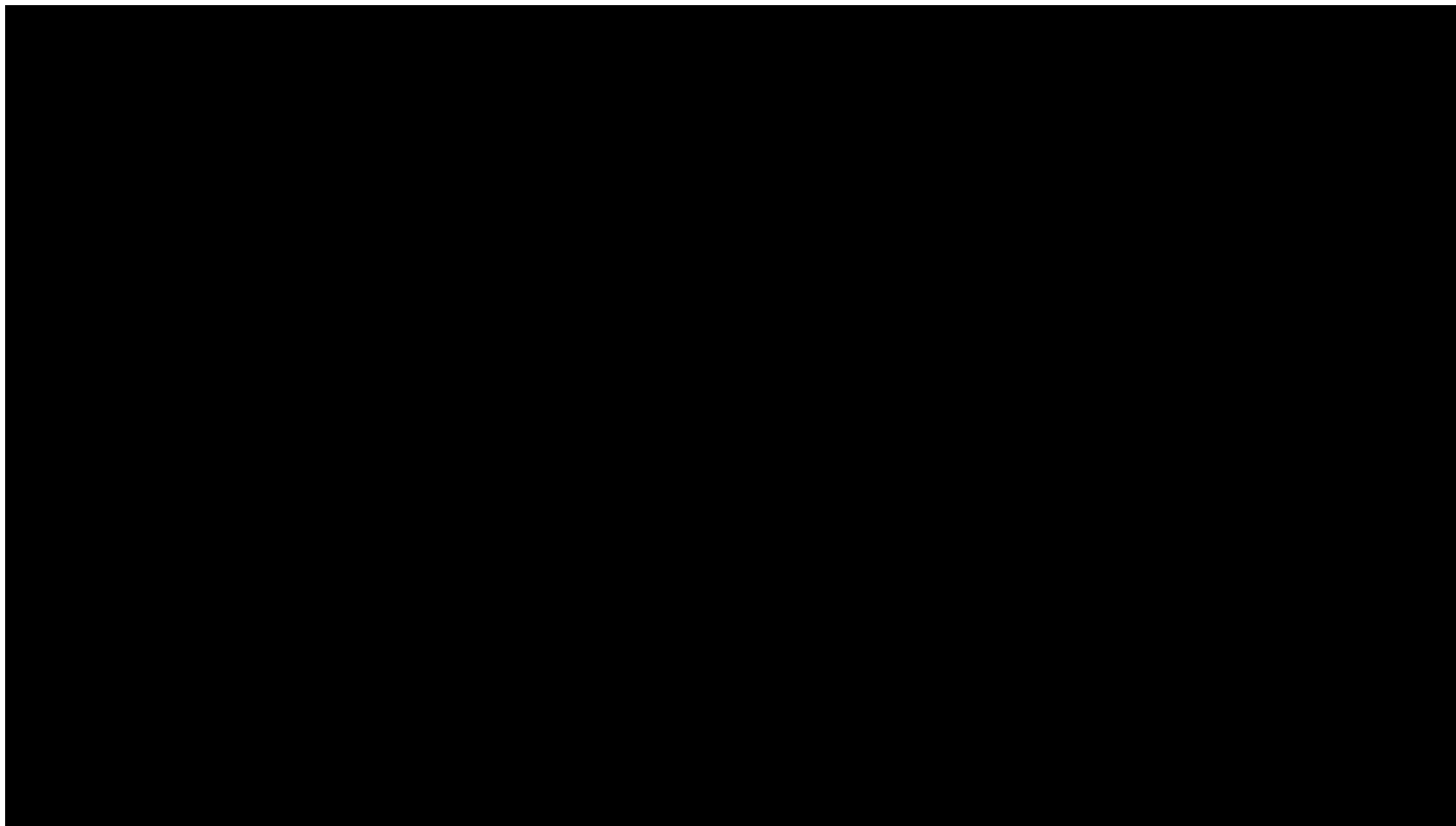
Hovedmålet med prosjektet er å analysere miljøbesparelspotensialet ved utbygging av en lade- og landstrømsinfrastruktur i gitte norske havner. Ved å synliggjøre investeringens gjeninntjeningsstid vil prosjektet kunne gi forskjellige interessegrupper innsyn i investeringsbarrierene tilknyttet en slik utbygging.

*"Prosjektet godt timet, og vil bidra til verdifull kunnskap som er relevant for en fremtidig energiomlegging i maritim sektor" - ENOVA*

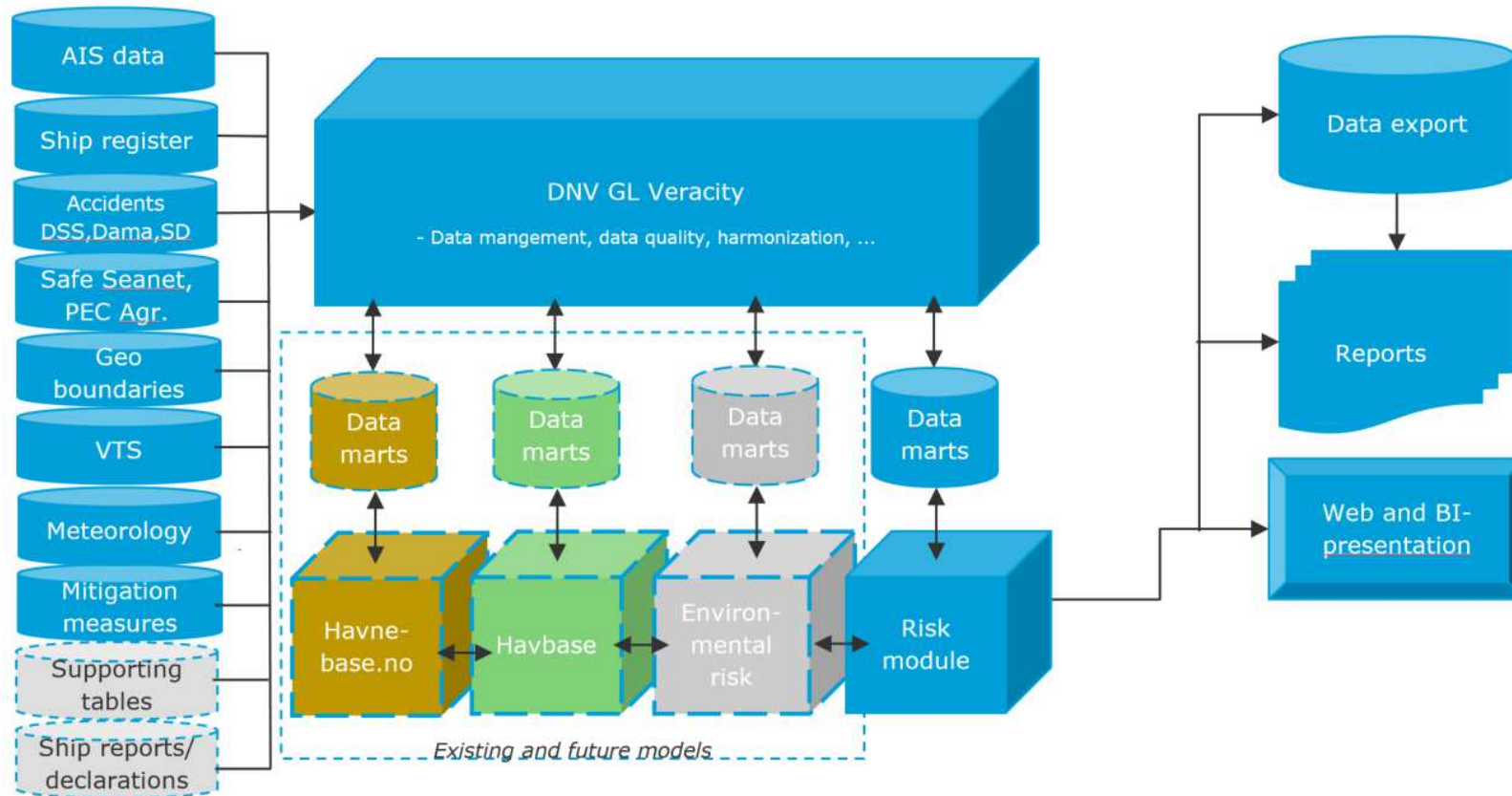


## ReCharge

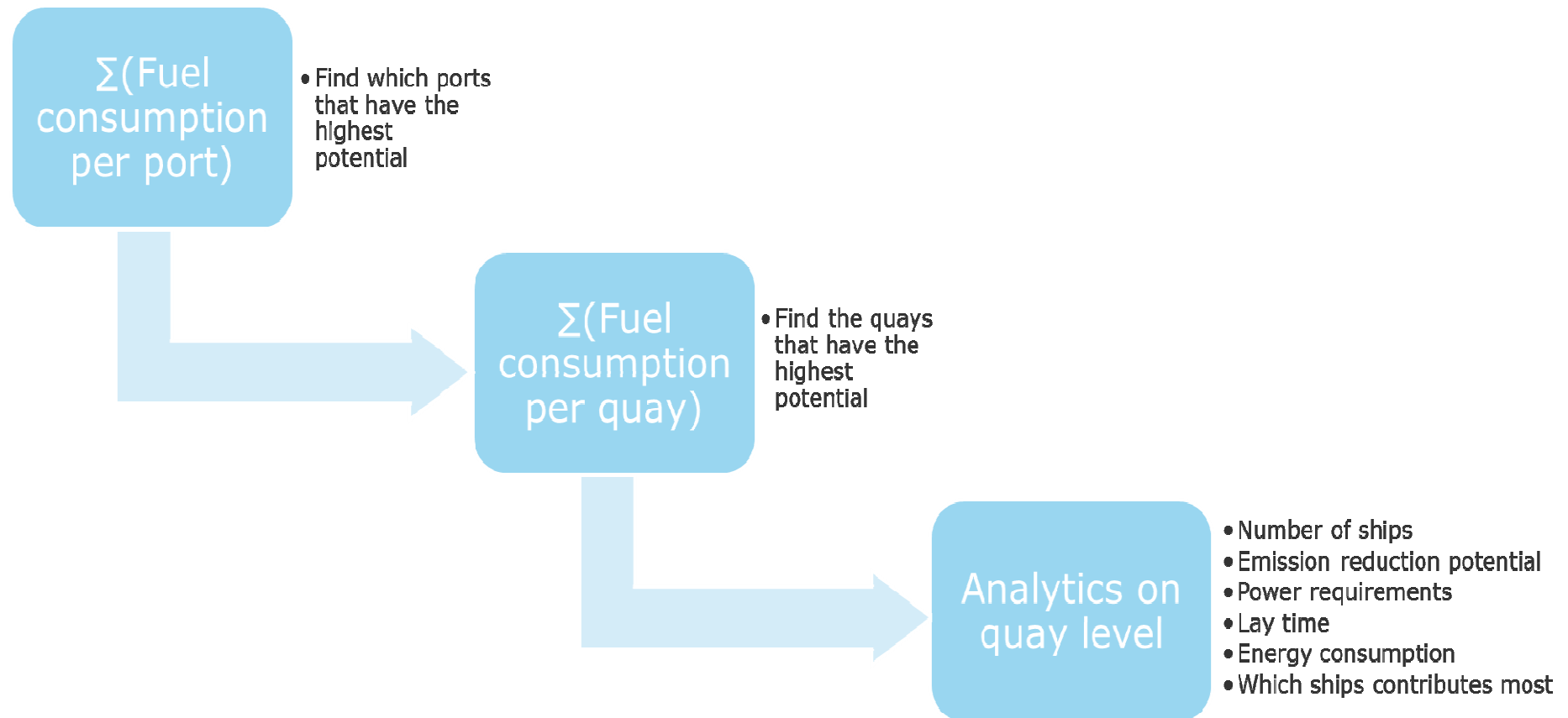
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# AIS Rammeverk



## Metodikk



# Kostnads kalkulator

Clear settings

Go to Results

## Shore Connection Cost Calculator v.1

| Ship technical input            |      | Port statistical input                 |          | Static                              |      |
|---------------------------------|------|----------------------------------------|----------|-------------------------------------|------|
| Ship type                       | RaRa | Port type                              | RaRa     | Fuel cost (USD/mt)                  | 500  |
| Power demand (kW)               | 1500 | Power demand (kW)                      | 1000     | Price electricity (USD/kWh)         | 0,04 |
| Voltage (V)                     | 690  | Share grid frequency (Hz)              | 50       | Exchange rate (NOK/USD)             | 8,5  |
| Frequency (Hz)                  | 50   | kVA                                    | 1250     | Interest rate port investment (%)   | 3,0% |
| kVA                             | 1875 | Standard                               |          | Depreciation port investment (year) | 10   |
| Standard                        |      | Cabling to connection point (m)        | 100      | Interest rate ship investment (%)   | 3,0% |
| Installation side               |      | Fixed or mobile connection?            | Fixed    | Depreciation ship investment (year) | 10   |
| Average laytime (hr)            | 4    | How many ships connected?              | 1        |                                     |      |
| Number of calls per year (-)    | 173  | Energy consumption per year (kWh/year) | 4380.000 |                                     |      |
| Years in service (-)            | 30   | Years in service (-)                   | 30       |                                     |      |
| Aux. engine SFOC (g/kWh)        | 250  |                                        |          |                                     |      |
| # of aux engine running in port | 2    |                                        |          |                                     |      |
| Maintenance cost (USD/hr)       | 2    |                                        |          |                                     |      |
| Aux engine fuel                 | MGO  |                                        |          |                                     |      |

| Ship Cost                     |              | Port Cost                             |              | Investment cost |  |
|-------------------------------|--------------|---------------------------------------|--------------|-----------------|--|
| Total                         | Per year     | Total                                 | Per year     |                 |  |
| Investment cost (USD)         | \$ 647.059   | Investment cost (USD)                 | \$ 941.176   |                 |  |
| Energy cost fuel (USD)        | \$ 5.938.750 | Energy earning electricity (USD/year) | \$ 5.256.000 |                 |  |
| Energy cost electricity (USD) | \$ 1868.400  | Funding support (USD)                 | \$ -         |                 |  |
| Energy cost saving (USD/year) | \$ 3.970.350 | Return of investment (years)          | 4            |                 |  |
| Maintenance saving (USD/year) | \$ 124.560   | Apply level of funding (%)            | 0%           |                 |  |
| Total saving (USD)            | \$ 4.094.910 |                                       |              |                 |  |
| Funding support (USD)         | \$ -         |                                       |              |                 |  |
| Return of investment (years)  | 5,6          |                                       |              |                 |  |
| Apply level of funding (%)    | 0%           |                                       |              |                 |  |

| Ship emission reduction potential |        | Port emission reduction potential |        | Graphical representation        |       |
|-----------------------------------|--------|-----------------------------------|--------|---------------------------------|-------|
| Total                             | Yearly | Total                             | Yearly | Total yearly emission reduction | Total |
| Fuel consumption (mt)             | 116,73 | 32850                             | 1095   |                                 |       |
| CO2 reduction (mt)                | 37018  | 104134,5                          | 3471   |                                 |       |
| SOx reduction (mt)                | 22,4   | 65,7                              | 2,2    |                                 |       |
| NOx reduction (mt)                | 841    | 226,5                             | 79     |                                 |       |
| PM reduction (mt)                 | 12,8   | 36,1                              | 1,2    |                                 |       |
| NO2 reduction (mt)                | N/A    | N/A                               | N/A    |                                 |       |

| Cost of funding support - Ship |      | Cost of funding support - Port |      |
|--------------------------------|------|--------------------------------|------|
| Total                          |      | Total                          |      |
| USD/Tonne CO2 reduced          | 17,5 | USD/Tonne CO2 reduced          | 5,2  |
| USD/kg SOx reduced             | 27,7 | USD/kg SOx reduced             | 5,2  |
| USD/kg NOx reduced             | 0,3  | USD/kg NOx reduced             | 0,3  |
| USD/kg PM reduced              | 50,4 | USD/kg PM reduced              | 15,0 |

## Så hvor lønner det seg å bygge ut landstrøminfrastruktur?

| Havn         | Forbruk (mt) |
|--------------|--------------|
| Bergen       | 23366        |
| Mongstad     | 13308        |
| Husoy        | 8612         |
| Agotnes      | 7899         |
| Tromsø       | 6114         |
| Kirkenes     | 5432         |
| Oslo         | 5406         |
| Karsto       | 4228         |
| Alesund      | 4207         |
| Lyngdal      | 3808         |
| Slagentangen | 3707         |
| Stavanger    | 3467         |
| Hammerfest   | 3438         |
| Batsfjord    | 3344         |
| Floro        | 3325         |
| Tananger     | 3291         |
| Porsgrunn    | 2737         |
| Trondheim    | 2701         |



| Havn         | NOx utslipp (kg) | Innbyggere | Score       | Indeks |
|--------------|------------------|------------|-------------|--------|
| Bergen       | 1027583          | 277391     | 2,85042E+11 | 1      |
| Oslo         | 200966           | 658390     | 1,32314E+11 | 2      |
| Stavanger    | 152553           | 132644     | 20235240132 | 3      |
| Tromsø       | 272272           | 73480      | 20006546560 | 4      |
| Trondheim    | 104814           | 187353     | 19637217342 | 5      |
| Kristiansand | 109286           | 88447      | 9666018842  | 6      |
| Fredrikstad  | 64945            | 78967      | 5128511815  | 7      |
| Bodø         | 87529            | 50488      | 4419164152  | 8      |
| Porsgrunn    | 117987           | 35955      | 4242222585  | 9      |
| Haugesund    | 90276            | 36951      | 3335788476  | 10     |
| Drammen      | 44388            | 67895      | 3013723260  | 11     |
| Sandefjord   | 60254            | 45820      | 2760838280  | 12     |
| Harstad      | 86489            | 24695      | 2135845855  | 13     |
| Kristiansund | 82394            | 24526      | 2020795244  | 14     |
| Hammerfest   | 172437           | 10455      | 1802828835  | 15     |
| Lyngdal      | 177863           | 8497       | 1511301911  | 16     |
| Narvik       | 75637            | 18787      | 1420992319  | 17     |
| Horten       | 41302            | 27178      | 1122505756  | 18     |

\*Data fra 2016

## CASE: Oslo havn

| # of ships                | Ship size    |                   |                   |                     |                     |                     |                 |             |
|---------------------------|--------------|-------------------|-------------------|---------------------|---------------------|---------------------|-----------------|-------------|
| Ship category             | 1. < 1000 GT | 2. 1000 - 4999 GT | 3. 5000 - 9999 GT | 4. 10000 - 24999 GT | 5. 25000 - 49999 GT | 6. 50000 - 99999 GT | 7. >= 100000 GT | Grand Total |
| General cargo vessels     | 8            | 116               | 26                | 2                   |                     |                     |                 | 152         |
| Chemical-/product tankers |              | 22                | 24                | 34                  | 4                   |                     |                 | 84          |
| Passenger ships           | 7            | 5                 | 1                 | 3                   | 12                  | 20                  | 7               | 55          |
| Container ships           |              | 1                 | 19                | 21                  |                     |                     |                 | 41          |
| Other activities          | 32           | 1                 |                   | 1                   |                     |                     |                 | 34          |
| Bulk ships                | 2            | 7                 | 4                 | 1                   |                     |                     |                 | 14          |
| Oil tankers               | 2            | 1                 |                   | 3                   | 1                   |                     |                 | 7           |
| Ro Ro ships               |              | 1                 |                   | 3                   |                     |                     |                 | 4           |
| <b>Grand Total</b>        | <b>51</b>    | <b>154</b>        | <b>74</b>         | <b>68</b>           | <b>17</b>           | <b>20</b>           | <b>7</b>        | <b>391</b>  |

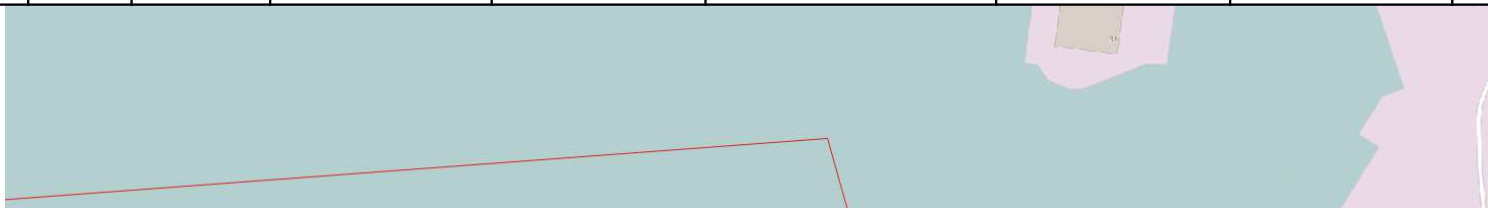
| AE fuel consumption (mt)  | Ship size    |                   |                   |                     |                     |                     |                 |             |
|---------------------------|--------------|-------------------|-------------------|---------------------|---------------------|---------------------|-----------------|-------------|
| Ship type                 | 1. < 1000 GT | 2. 1000 - 4999 GT | 3. 5000 - 9999 GT | 4. 10000 - 24999 GT | 5. 25000 - 49999 GT | 6. 50000 - 99999 GT | 7. >= 100000 GT | Grand Total |
| Passenger ships           | 125          | 452               | 1                 | 13                  | 1276                | 258                 | 204             | 2328 43%    |
| Container ships           |              | 8                 | 639               | 476                 |                     |                     |                 | 1122 21%    |
| Chemical-/product tankers |              | 56                | 360               | 405                 | 26                  |                     |                 | 847 16%     |
| General cargo vessels     | 25           | 239               | 190               | 2                   |                     |                     |                 | 456         |
| Other activities          | 234          | 1                 |                   | 0                   |                     |                     |                 | 235         |
| Ro Ro ships               |              | 2                 |                   | 196                 |                     |                     |                 | 198         |
| Bulk ships                | 0            | 32                | 143               | 1                   |                     |                     |                 | 176         |
| Oil tankers               | 0            | 18                |                   | 21                  | 3                   |                     |                 | 43          |
| <b>Grand Total</b>        | <b>385</b>   | <b>808</b>        | <b>1332</b>       | <b>1114</b>         | <b>1305</b>         | <b>258</b>          | <b>204</b>      | <b>5406</b> |

## Sjursøya container terminal



| IMO number | Calls | kW in port | Total laytime (hrs) | AVG laytime (hrs) | Fuel consumption (mt) | NOX emission (kg) | CO2 emission (mt) | Energy in port (kWh) |
|------------|-------|------------|---------------------|-------------------|-----------------------|-------------------|-------------------|----------------------|
| Ship #1    | 50    | 332        | 972                 | 19                | 159                   | 7009              | 505               | 322631               |
| Ship #2    | 48    | 473        | 449                 | 9                 | 129                   | 5696              | 410               | 212438               |
| Ship #3    | 26    | 473        | 448                 | 17                | 103                   | 4881              | 352               | 211828               |
| Ship #4    | 30    | 332        | 543                 | 18                | 74                    | 4511              | 325               | 180122               |
| Ship #5    | 47    | 332        | 562                 | 12                | 66                    | 3268              | 235               | 186641               |
| Ship #6    | 10    | 473        | 180                 | 18                | 58                    | 2907              | 209               | 84982                |
| Ship #7    | 20    | 332        | 328                 | 16                | 51                    | 2570              | 185               | 108851               |
| Ship #8    | 18    | 332        | 233                 | 13                | 49                    | 2224              | 160               | 77325                |
| Ship #9    | 43    | 149        | 502                 | 12                | 43                    | 2163              | 156               | 74778                |
| Ship #10   | 7     | 473        | 117                 | 17                | 40                    | 1894              | 136               | 55349                |
| Ship #11   | 7     | 332        | 118                 | 17                | 28                    | 1746              | 126               | 39156                |
| Ship #12   | 15    | 332        | 128                 | 9                 | 1233                  | 89                | 42585             |                      |

50% of the consumption



## Kostnader

### Kostnad skip

| Ship Cost                          |              |           |
|------------------------------------|--------------|-----------|
|                                    | Total        | Per year  |
| Investment cost (USD)              | \$ 716 667   | \$ 84 015 |
| Energy cost fuel (USD)             | \$ 1 188 141 | \$ 39 605 |
| Energy cost electricity (USD/year) | \$ 372 750   | \$ 12 425 |
| Energy cost saving (USD/year)      | \$ 815 391   | \$ 27 180 |
| Maintenance saving (USD/year)      | \$ 75 000    | \$ 2 500  |
| Total savings (USD)                | \$ 890 391   | \$ 29 680 |
| Funding support (USD)              | \$ -         |           |
| Return of investment (years)       | 28,3         |           |
| Apply level of funding (%)         | 0 %          |           |

ROI med 80% NOx-støtte: 5,7 år

### Kostnad land

| Port Cost                             |              |              |
|---------------------------------------|--------------|--------------|
|                                       | Total        | Per year     |
| Investment cost (USD)                 | \$ 642 857   | \$ 75 362,47 |
| Energy earning electricity (USD/year) | \$ 2 496 000 | \$ 83 200    |
| Funding support (USD)                 | \$ -         |              |
| Return of investment (years)          | 9            |              |
| Apply level of funding (%)            | 0 %          |              |

ROI med 90% ENOVA-støtte: 1 år

Totalkostnad for 5 skipsanlegg og 1 landanlegg:  
~33MNOK => 600 NOK/tonn CO2

## Lasteskip som kan fullelektrifiseres

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| Skipstype                     | Antall skip |
|-------------------------------|-------------|
| Fishing vessels               | 24          |
| Other activities              | 21          |
| Offshore supply vessels       | 7           |
| Other offshore supply vessels | 6           |
| General cargo vessels         | 6           |
| <b>Total</b>                  | <b>64</b>   |

**Årlig miljøbesparelse:**

**CO<sub>2</sub>: 12 500 mt**

**NO<sub>x</sub>: 149 000 kg**

**97 ulike ruter**

## Ny logistikkjede

- Havner som håndterer mest gods
- Norges største byer
- Ikke økt effektbehov
- Plug-in hybride kan være en god løsning
  - Case til case basis



## Port Intelligence Dashbord

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- [Link til dashbord](#)

# Takk!

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