Jornada sobre

Electrificación de los puertos: Proyectos en desarrollo

5 de junio de 2023

ECOPort
Autoridad Portuaria de Valencia

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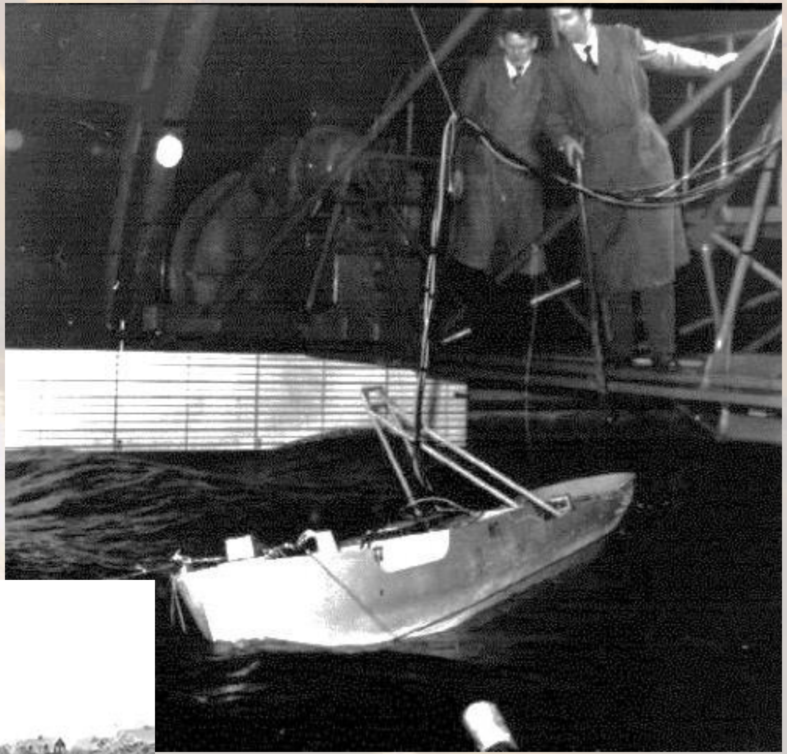
Onshore Power Supply in Sweden

Nicole Costa

June 5, 2023

SSPA – Maritime consultancy & research since 1940
Now integrated part of RISE since Jan 2023



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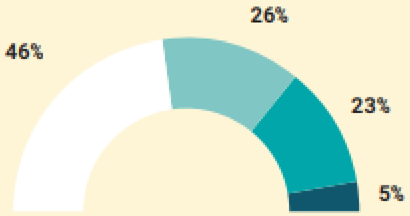
RISE Research Institutes of Sweden AB

RISE Research Institutes of Sweden is Sweden's research institute and innovation partner. Through international collaboration with industry, academia and the public sector, we ensure business competitiveness and contribute to a sustainable society.

RISE is an independent, state-owned research institute.

3,618

net sales, SEK million



Distribution of net sales

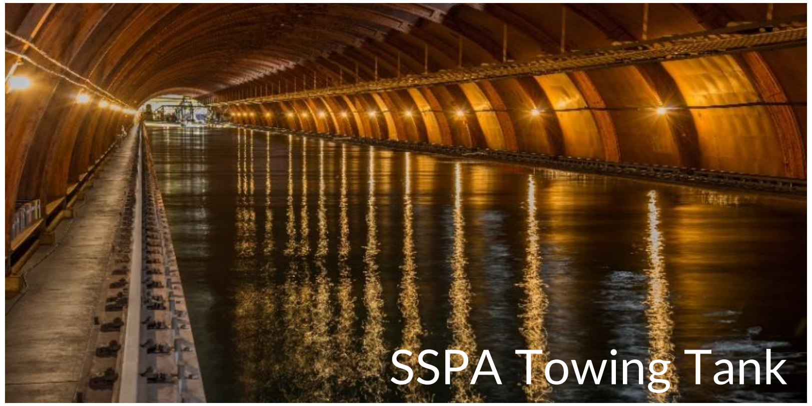
Business sector	1 651 MSEK
Public funds	954 MSEK
State funds	827 MSEK
EU funds	186 MSEK

130+

testbeds and demonstration environments

RISE – Safety and Transport Division / Maritime Department

SSPA MARITIME TEST CENTER



Research, Development & Innovation Areas

- Hydro- and Aerodynamics
- Wind propulsion
- Computational fluid dynamics
- Fluid-Structure-Interaction
- Ocean Energy Conversion
- Maritime Human Factors
- Zero-Carbon and Low-Carbon Fuels and Propulsion Technologies

- Sustainable Maritime Logistics
- Sports and technology (competitive sailing)
- Naval Research
- Hydrofoils
- Maritime informatics and Cybersecurity
- Smart shipping
- Sustainable ports

Research, Development & Innovation
Test & Research infrastructure

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Selection of SSPA Clients

- stx Offshore & Shipbuilding
- Stena
- MAERSK
- DSME
- VALE
- EXMAR
- TEEKAY
- 台灣國際造船股份有限公司 CSBC CORPORATION, TAIWAN
- GSI 广船国际 广船国际有限公司 GUANGZHOU SHIPYARD INTERNATIONAL COMPANY LIMITED
- WALLENIUS WILHELMSEN MARINE
- WÄRTSILÄ
- PGS
- SAMSUNG HEAVY INDUSTRIES
- Shell
- SEOUL NATIONAL UNIVERSITY
- AZIMUT YACHTS
- SIEMENS
- Kawasaki
- ConocoPhillips
- MACGREGOR
- Minesto
- HYUNDAI HEAVY INDUSTRIES CO.,LTD.
- NAKASHIMA
- Lloyd's Register
- Rolls-Royce
- KOMAC
- CSSC 江南造船(集团)有限责任公司 JIANGNAN SHIPYARD (GROUP) CO., LTD.
- KOGAS
- becker marine systems
- ExxonMobil
- Philly Shipyard
- bp
- GASNOR
- 沪东中华造船（集团）有限公司 Hudong-Zhonghua Shipbuilding (Group) Co., Ltd.
- DAMEN
- thyssenkrupp
- ABB
- EUROPEAN DEFENCE AGENCY
- Aker Arctic The Ice Technology Partner
- SIH
- Navantia
- ECHANDIA MARINE
- Fred.Olsen Cruise Lines
- FORCE TECHNOLOGY
- Maritieme Academie Harlingen
- EMSA
- MEYER WERFT
- GÖTEBORGS HAMN
- SAAB
- VIKING SUPPLY SHIPS
- FS
- KVARKENRÅDET MERENKURKUN NEUVOSTO
- SVENSKA SEGLARFÖRBUNDET 1905
- LINDHOLMEN SCIENCE PARK
- CHALMERS UNIVERSITY OF TECHNOLOGY
- European Commission
- Umeå Hamn
- SVENSKA ORIENT LINIEN
- Göteborg Energi
- DELTAMARIN
- stockholm exergi
- ULSTEIN
- wsp
- MSB Swedish Civil Contingencies Agency
- ivl
- UNIVERSITY OF GOTHENBURG
- KTH VETENSKAP OCH KONST
- Interreg
- Stena Line
- FKAB MARINE DESIGN
- NGLI
- RAMBØLL
- SWECO
- Statens vegvesen Norwegian Public Roads Administration
- REGION VÄSTRA GÖTALAND
- Swedish Energy Agency
- VINNOVA Sweden's Innovation Agency
- LMG MARIN
- KNUD E. HANSEN
- STROMMA
- FMV
- KUSTBEVAKNINGEN SWEDISH COAST GUARD
- Swedish Agency for Marine and Water Management
- SWEDISH MARITIME ADMINISTRATION
- TRAFIKVERKET SWEDISH TRANSPORT ADMINISTRATION
- FÄRJEREDERIET TRAFIKVERKET

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Onshore Power Supply in Sweden

KAJ-EL Project. Onshore Power supply (OPS) to replace aux. engines at berth
– can also be used for battery charging (AC charging)

Financier: TRAFIKVERKET SWEDISH TRANSPORT ADMINISTRATION

Finalized in 2022

Partners: SSPA Your Maritime Solution Partner Since 1940, RISE, SVERIGES HAMNAR, UNIVERSITY OF GOTHENBURG SCHOOL OF BUSINESS, ECONOMICS AND LAW, SVENSK SJÖFART SWEDISH SHIPOWNERS' ASSOCIATION

Reference group: PORT OF GOTHENBURG, Göteborg Energi, Stena Teknik CARE, INNOVATION & PERFORMANCE, FÄRJEREDERIET TRAFIKVERKET, PORTS OF STOCKHOLM, AHLMARK LINES A.-B.

- 35 interviews+1 workshop ports (13), shipping companies (6), energy/grid providers (5), tech providers (4), authorities
- to understand drivers, conditions, challenges, technical & business aspects for OPS at ports & ships

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SCHOOL OF BUSINESS, ECONOMICS AND LAW

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SVENSK SJÖFART
SWEDISH SHIPOWNERS' ASSOCIATION

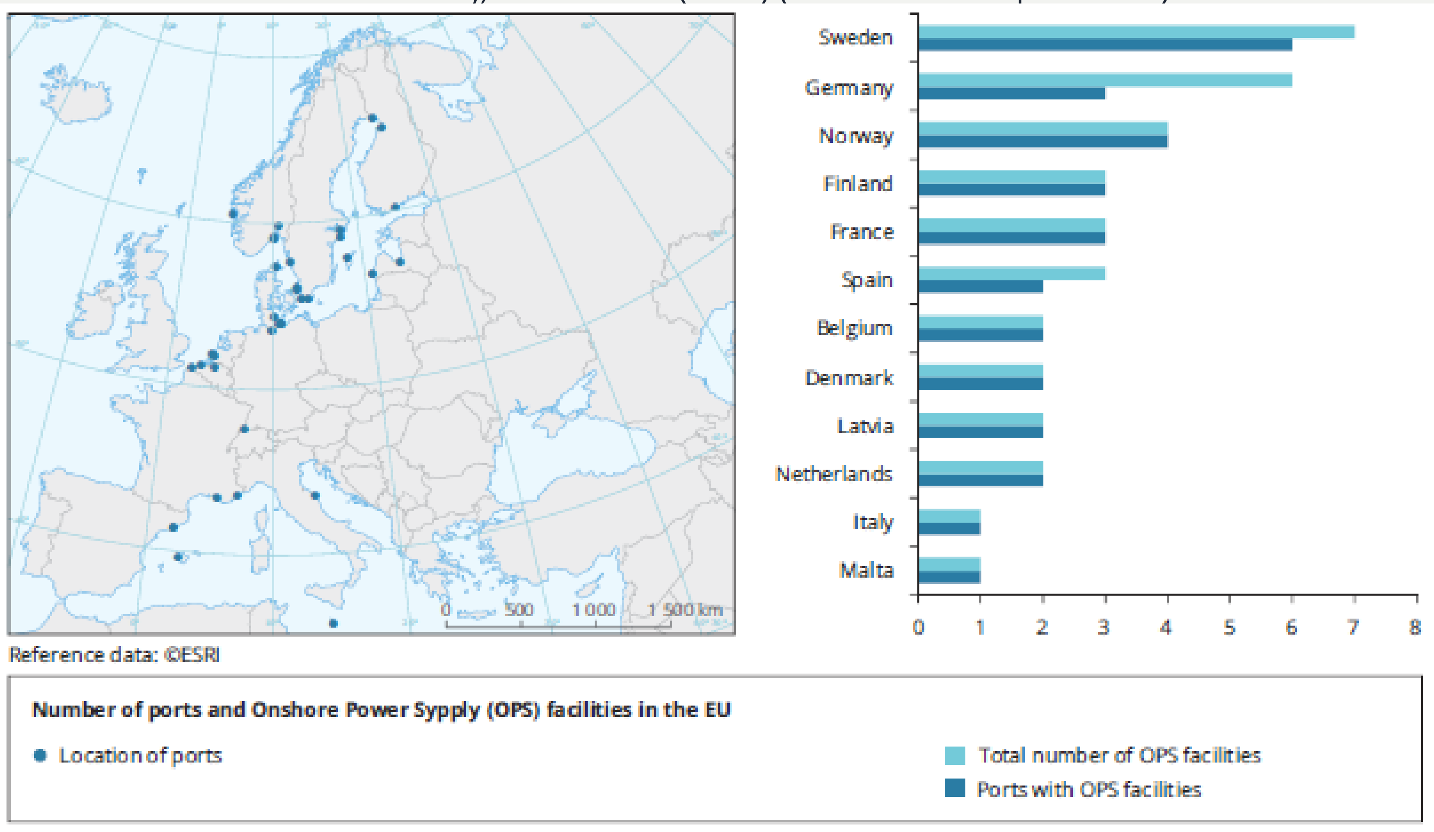
Eric Tedesjö, Sveriges hamnar

SVERIGES HAMNAR

Overview of EU ports with HV OPS

+ 12/27 EU member states
+ More than 31 EU ports
+ ~10% of vessels calling at EU ports have HV OPS

Number of ports and high-voltage OPS facilities in the European Economic Area (as of December 2020), source EAFO (2020) (from EMTER Report 2021)



Overview of ports with OPS - Sweden

Ports with OPS:

- Stockholm, Gothenburg, Visby, Helsingborg, Karlskrona, Trelleborg, Ystad, Piteå; Luleå (LV)
- preparing: Gävle, Norrköping, Skellefteå, Umeå…
- some moving/building new terminals prepared for OPS

- Majority with HV (some with LV)

- Most vessels connecting to OPS are ro-pax/ferries
  - ro-ro
  - bulk carriers
  - tankers (first in the world) + Port of Gothenburg
  - workboats
  - recreational craft

Why electrification and OPS in Sweden?

Environment and regulations

+ IMO strategy: 50% reduction of total annual GHG emissions from shipping by 2050 (relative to 2008)
    + consistent with 2015 Paris Agreement to maintain global warming below 1.5°C

+ European Commission's "Fit for 55" package of proposals aiming at (DNV, 2021; UK P&I, 2021):
    + reduction of EU's GHG emissions by **55% by 2030** (relative to 1990)
    + **full EU decarbonization by 2050**
        + DNV: to achieve decarbonization **transport sector needs a 90% emissions reduction**

Environment and regulations

- "Fit for 55" **in shipping** (agreed March 2023 - News European Parliament, 2023)…
  - planned to cut ship emissions gradually, by **2% by 2025** (below 2020 level of 91.16 grams of CO_2 per MJ)
  - by **80% by 2050**
  - among many measures, **mandating member states to have OPS** (Directive 2014/94/EU)
    - for **passenger & container ships** at berth 2h+ for all electricity needs
      - **by 2030 at major EU TEN-T Core Network ports**
      - by 2035 at rest of EU ports if these have OPS
  - …unless using comparable technology…
  - *OPS also on seagoing & inland waterway vessels*

- **Environmental permits by the County Administrative Board** for Swedish ports – requiring OPS consideration and preparation

Drivers to have OPS for ports & ships in Sweden

Environment & political

- Environmental permits
- Reducing local air pollution and noise (*ports*)
- Preparation for future policies
- Improved environmental ratings
- Access to clean electricity in Sweden

Social

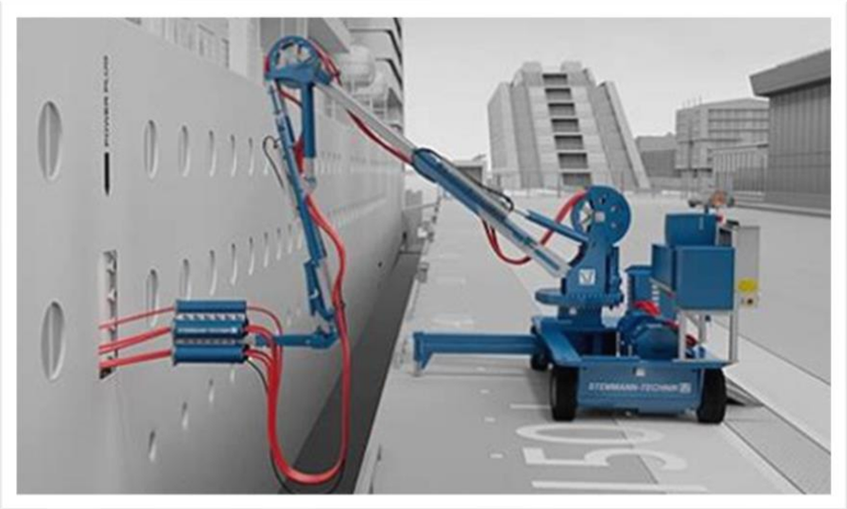
- Comfort for operators onboard and ashore (noise & vibrations)

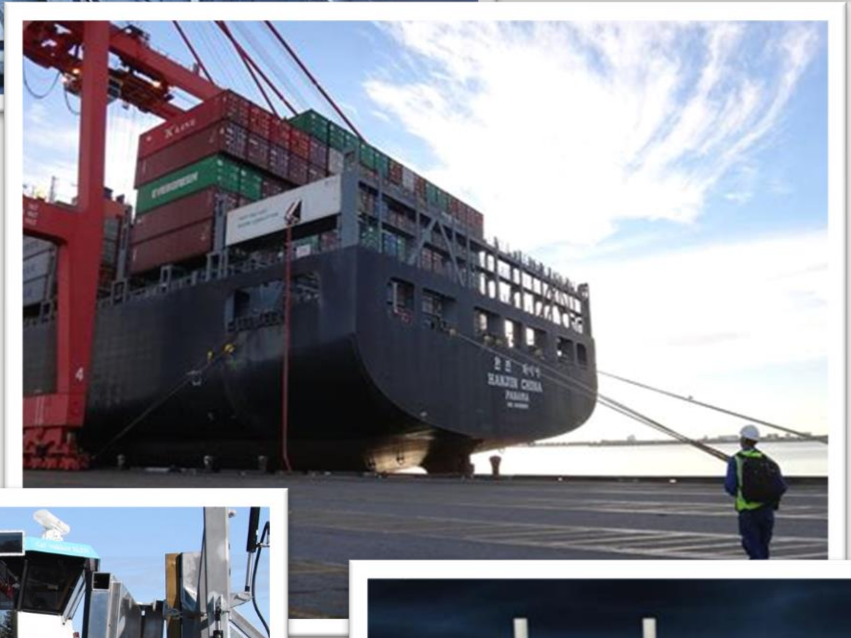
Business

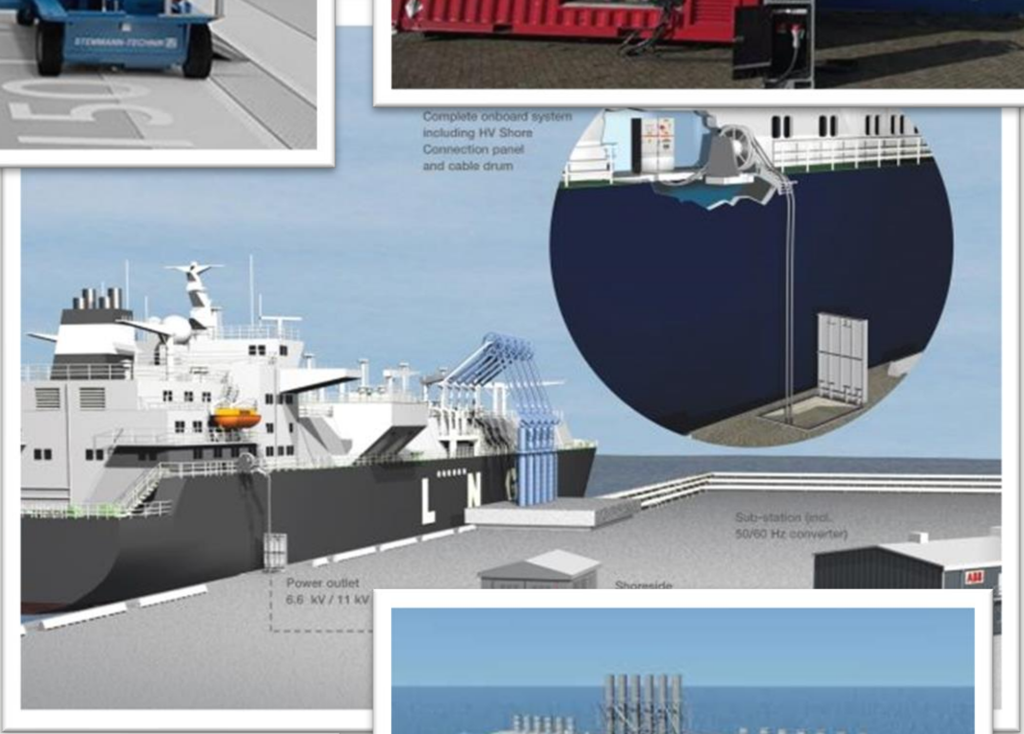
- Agreements/requests/incentives: ship owners-ports, cargo owners-ship owners/op. (incl. OPS for AC charging ships with batteries)
- Competitive advantage
- Municipal ownership of ports (lower required rate of return than private)

Financial

- External funding for infrastructure (Klimatklivet/EU) - partial
- Lower operational (fuel) and maintenance costs (engines) (*ships*)
- Ports moving/building new terminal = chance to add OPS from start = lower total investment






Complete onboard system including HV Shore Connection panel and cable drum
Sub-station (incl. 50/60 Hz converter)
Power outlet 6.6 kV / 11 kV
Shoreside


LNG POWER BARGE

Criteria for infrastructure decisions

- **Power demand & electricity availability**
  - Grid extensions, energy storage
- **Frequency, voltage & current** compatible
  - Frequency in Sweden 50 Hz
  - Transformers ashore or onboard – space & weight to be considered
- **Voltage & current** – based on power demand
  - LV can use AC <1 MW or DC 1-1,5 MW
  - HV only AC: 1-22 MW (reduced cable size & number than LV)
  - Boats length >25m, AC HV for quick charging
  - Boats length <25m, DC CCS-2 (LV) for quick charging
- **Plugs & cables** – different standards
  - Length of cables
  - Cables available onboard or ashore
  - *DC thinner & water-cooled cables (but shorter (5-10 meters))*
- **Location of equipment** (ashore, onboard hatch etc)
- **Connection type**
  - Manual vs. automatic (quicker connection, maintenance issues)
  - Induction (small ferries up to 200 KW)
- **Shore infrastructure**
  - Fixed vs. mobile
  - Type of quay/ramp, weather exposure
  - Mooring system
- **Time at berth/route schedule**
  - Manual connection/disconnection ~ 10-30 min
  - Minimum 2-4h at berth OPS
  - *Quick charging needs automatic connection*
  - *AC for long charging time; DC for short*
- **Certification**
  - HV requires safety training and certification
  - Equipment onboard needs to be class-approved

Standards for OPS

- **AFIR - M/581 directive** pushing for EU standardized technical solutions for OPS & charging connection points

- IEC/IEEE 80005-1:2019 Utility connections in port – Part 1: **High voltage shore connection (HVSC) systems – General requirements** – mandatory in EU according to Directive 2014/94/EU and TSFS 2016:917

- IEC/IEEE 80005-2:2016 Utility connections in port – Part 2: **High and low voltage shore connection systems – Data communication for monitoring and control**

- IEC/PAS 80005-3:2014 Utility connections in port – Part 3: **Low voltage shore connection (LVSC) systems – General requirements** (Pre-standard, to be replaced by IEC/IEEE DIS 80005-3 Utility connections in port – Part 3: Low voltage shore connection (LVSC) systems – General requirements (under development))

- There are also national standards, class society regs.

Standards for OPS

SSE Type		Interconnectivity	Interoperability	Data Communication	International/EU Regulatory
OPS (Onshore Power Supply)	High-Voltage Shore Connection (**HVSC**)	IEC 62613-1:2016 (General) IEC 62613-2:2016 (Connector geometry/ dimensions)	IEC/IEEE 80005-1 (HVSC) **Mandatory in EU**	IEC/IEEE 80005-2 (Data Communication)	IMO OPS Guidelines EU AFID
Also used for AC battery charging	Low-Voltage Shore Connection (**LVSC**)	IEC 60309-5	IEC/IEEE 80005-3 (under review/development)	IEC/IEEE 80005-2	IMO OPS Guidelines already refer
	LVSC – Inland Waterways (IW)	EN 15869-2:2019 (up 125A) EN 16840: 2017 (above 250A)		Possible application of IEC/IEEE 80005-2	CCNR CESNI – ES-TRIN2019
	Recreational Craft/ Marinas **For OPS or charging eg. overnight**	IEC 60309-2	Not standardized	Not standardized	Not relevant international standard applicable to

EMSA shore power guide 2022

Standards for OPS

Covered

- Voltage
- Frequency
- Plugs/sockets
- Cables
- Safety aspects
- Interconnectivity, interoperability, data communication aspects

Not covered

- Connection setup design and dimensioning (e.g., cable reel, mobile crane etc.)
- Location of
  - transformer station & of connection setup ashore
  - onboard equipment & hatch
- DC connections
- No universal solution

Under discussion

- OPS container on container vessels
- Location and safety aspects of power inlet on tankers
- DC connections

Hinders for OPS for ports & ships in Sweden

Financial

- High installation costs
- Uncertain revenue and thus return on investment (*ports*)
- Operational costs, electricity vs. fuel price (*ships*)

Technical

- Limited guidance from standards (DC, design, location)
- Incompatibility between ports/ for other vessels

Business

- Creating viable business model (*ports*)
- Utilization: how many will connect? (*ports*) / how many ports have OPS? (*ships*)

Operational

- Power demand vs. availability
- Short time at berth (*ships*)
- Conditions to connect e.g. tide, weather

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Conditions to succeed at OPS in Sweden

Financial

- **External funding**
- **Cost sharing** ports-shipping companies

  (e.g. agreeing with vessel to buy cables or converter, or to pay for maintenance and other operational costs etc.)

Business

- Agreements to connect ports-shipping companies – **long-term contracts** for utilization
- Define **business models**, how to cover investment and operational costs

Technical

- **Guidance from standards**, experts and authorities
- **Coordinate OPS technique** between ports-ship owners/operators

Operational

- Dialogue with energy provider about **securing power capacity** (ports)
- Confirm vessel time at berth, at least 2h
- Certifications & training for HV connections
- Port staff & on board crew to check conditions *(e.g. wind, draft)* and perform connections

<u>Collaboration between key actors</u>:
Port – Shipping companies – Electricity supplier – Technical expertise – Authorities – Funding agency

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Conclusions

- OPS adoption in Sweden expanding (and charging stations):
  - Upcoming developments from ”Fit for 55”
- Motivations to electrify more qualitative than quantitative (regulations+environment more than financial) – **need for business models and long contracts**
- OPS infrastructure choice depends on purpose, power demand, ship type…
  - Can be used for AC battery charging

- Compatibility & standards essential for ports and ships
- OPS further standards under development
  - **AFIR – M/581 directive** pushing for EU standardized OPS
- OPS requires:
  - business models and long contracts
  - external funding
  - securing power with energy providers in advance
  - actor collaboration (for compatibility, governance etc)
  - cost sharing
  - decision-making support from standards, equipment provider/expert consultant, & authorities

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Available resources

- KAJ-EL project report 2022
- KAJ-EL journal article https://www.mdpi.com/2071-1050/14/10/6072
- Guide on OPS and SBC from EMSA 2022
- OPS reports from Transportstyrelsen (Sweden) 2015, 2023
- SeaCharging project reports 2023

Thank you!

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RISE Research Institutes of Sweden

DÍA MUNDIAL DEL MEDIOAMBIENTE
05 / JUN

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