



# Shore Power Emission Calculator (SPEC)

Presentation to NASEO

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# Shore Power Technology Assessment and Shore Power Emission Calculator *Overview*

- Characterizes shore power systems at U.S. ports
- Includes a new methodology for calculating emission reduction of shore power systems

**Shorepower Port Assessment Report** prepared under contract by:  
ERG/Energy and Environmental Research Associates (EERA):  
Jim Corbett, Edward Carr, Bryan Comer and Jordan Silberman

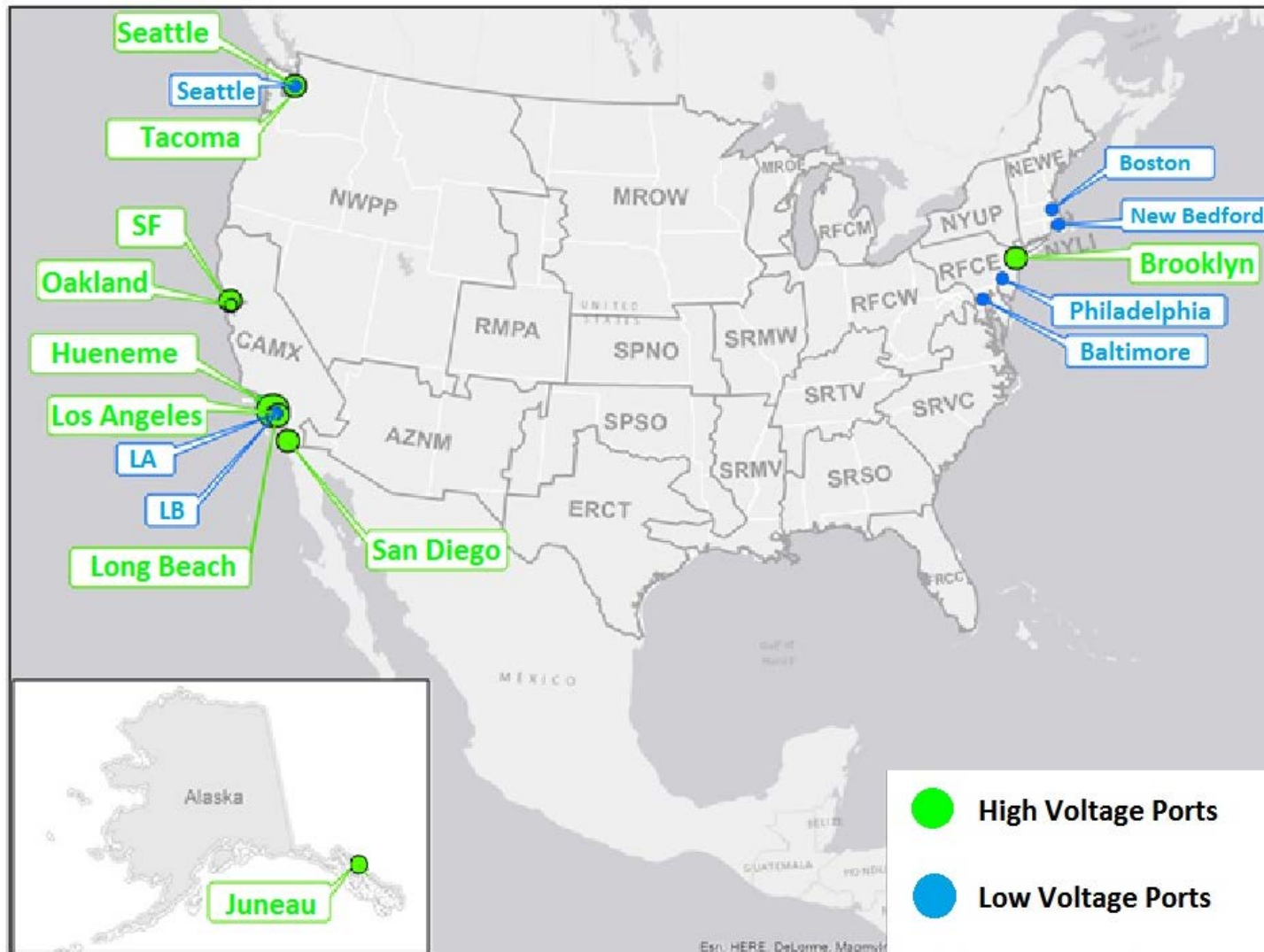


# Shore Power Assessment

## *Shore Power System ISO/IEC/IEEE Standards*

| <u>Standard</u>                                    | <u>Capacity</u>     | <u>Uses</u>               |
|--|---------------------|---------------------------|
| High Voltage Shore Connection Systems              | 6.6 kV and/or 11 kV | Cruise, Container, Reefer |
| Pre Standard- Low Voltage Shore Connection Systems | 220-480 V           | Fishing, Tug              |

# Existing Shore Power Locations





# Existing Shore Power Locations

|                      | <b>Port Name</b>         | <b>Vessel Types using OPS</b> | <b>Year of Installation</b> |
|----------------------|--------------------------|-------------------------------|-----------------------------|
| <b>High Capacity</b> | Juneau                   | Cruise                        | 2001                        |
|                      | Seattle                  | Cruise                        | 2005-2006                   |
|                      | San Francisco            | Cruise                        | 2010                        |
|                      | Brooklyn                 | Cruise                        | 2015                        |
|                      | Los Angeles              | Container                     | 2004                        |
|                      | Long Beach               | Cruise                        | 2011                        |
|                      |                          | Container                     | 2009                        |
|                      |                          | Tanker                        | 2000                        |
|                      | San Diego                | Cruise                        | 2010                        |
|                      |                          | Reefer                        |                             |
|                      | Oakland                  | Container                     | 2012-2013                   |
|                      | Hueneme                  | Reefer                        | 2014                        |
| <b>Low Capacity</b>  | Seattle                  | Fishing                       |                             |
|                      | Boston                   | Fishing                       |                             |
|                      | New Bedford              | Fishing                       | 2011                        |
|                      | Philadelphia             | Tug                           |                             |
|                      | Baltimore                | Tug                           |                             |
|                      | Los Angeles / Long Beach | Tug                           | 2009                        |



# Shore Power & Diesel Emissions Estimate

- **Vessel inputs**
  - Auxiliary engine load factor at berth, or “hoteling” (%)
  - Auxiliary engine emissions factors (g/kWh)
- **Activity inputs**
  - Vessel port calls per year
  - Hoteling hours per port call
- **Shore power inputs**
  - Electricity generation by facilities contributing to the shore power system (MWh)
  - Emissions by facilities contributing to shore power system
    - e.g., metric tons of SO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, CO, CO<sub>2</sub>)
  - Electrical power generation emissions factor
- **Output:**

Difference = Vessel Emissions - Shore Power Emissions





# Example Emissions Calculator – General Model

**Emissions Calculator: High Capacity Shore Power Connection (eGRID)**

| Example    | eGRID Region | Vessel Type           | Engine Size (kW) | Factor   | Annual Vessel Calls | Hours/Vessel Call |
|------------|--------------|-----------------------|------------------|----------|---------------------|-------------------|
| Northeast  | RFCE         | Passenger/Cruise Ship | 11000            | 0.64     | 26                  | 10                |
|            | RFCE         | General Cargo         | 1776             | 0.22     | 15                  | 35                |
|            | RFCE         | RORO                  | 2850             | 0.3      | 20                  | 25                |
| Alaska     | AKGD         | Container Ship        | 6800             | 0.17     | 40                  | 10                |
|            | AKGD         | Passenger/Cruise Ship | 11000            | 0.64     | 50                  | 12                |
| Florida    | FRCC         | Passenger/Cruise Ship | 11000            | 0.64     | 100                 | 10                |
|            | FRCC         | Tanker                | 1985             | 0.67     | 24                  | 20                |
| California | CAMX         | Passenger/Cruise Ship | 11000            | 0.64     | 141                 | 10                |
| Input      | Dropdown     | Dropdown              | Built in         | Built in | Input               | Input             |

INPUTS  
in Blue

OUTPUTS  
in Gray

| Example          | eGRID Region | Consumption (kWh) | Vessel Power Emissions (MT) |                 |                 | Shore Power Emissions (MT) |                 |                 | Difference (MT) |                 |                 | Percent Difference |                 |                 |
|------------------|--------------|-------------------|-----------------------------|-----------------|-----------------|----------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|--------------------|-----------------|-----------------|
|                  |              |                   | NO <sub>x</sub>             | SO <sub>x</sub> | CO <sub>2</sub> | NO <sub>x</sub>            | SO <sub>x</sub> | CO <sub>2</sub> | NO <sub>x</sub> | SO <sub>x</sub> | CO <sub>2</sub> | NO <sub>x</sub>    | SO <sub>x</sub> | CO <sub>2</sub> |
| Northeast        | RFCE         | 1,947,234         | 27.07                       | 0.78            | 1,343.59        | 0.78                       | 1.80            | 776.56          | -26.29          | 1.02            | -567.03         | -97%               | 131%            | -42%            |
|                  | RFCE         | 218,221           | 3.03                        | 0.09            | 150.57          | 0.09                       | 0.20            | 87.03           | -2.95           | 0.11            | -63.55          | -97%               | 131%            | -42%            |
|                  | RFCE         | 454,787           | 6.32                        | 0.18            | 313.80          | 0.18                       | 0.42            | 181.37          | -6.14           | 0.24            | -132.43         | -97%               | 131%            | -42%            |
| Alaska           | AKGD         | 491,915           | 6.84                        | 0.20            | 339.42          | 0.49                       | 0.15            | 219.14          | -6.35           | -0.05           | -120.28         | -93%               | -25%            | -35%            |
|                  | AKGD         | 4,493,617         | 62.46                       | 1.80            | 3,100.60        | 4.45                       | 1.35            | 2,001.84        | -58.01          | -0.45           | -1098.75        | -93%               | -25%            | -35%            |
| Florida          | FRCC         | 7,489,362         | 104.10                      | 3.00            | 5,167.66        | 2.23                       | 2.96            | 3,871.69        | -101.87         | -0.03           | -1295.97        | -98%               | -1%             | -25%            |
|                  | FRCC         | 679,123           | 9.44                        | 0.27            | 468.60          | 0.20                       | 0.27            | 351.08          | -9.24           | 0.00            | -117.52         | -98%               | -1%             | -25%            |
| California       | CAMX         | 10,560,000        | 146.78                      | 4.22            | 7,286.40        | 1.22                       | 0.20            | 2,887.19        | -145.57         | -4.02           | -4399.21        | -99%               | -95%            | -60%            |
| <b>Sub-Total</b> |              |                   | <b>105.72</b>               | <b>3.04</b>     | <b>5247.98</b>  | <b>5.98</b>                | <b>3.92</b>     | <b>3265.94</b>  | <b>-99.74</b>   | <b>0.88</b>     | <b>-1982.04</b> |                    |                 |                 |
| Output           | Output       | Output            | Output                      | Output          | Output          | Output                     | Output          | Output          | Output          | Output          | Output          | Output             | Output          | Output          |



# Example Emissions Calculator – User Input Model

| Emissions Calculator: High Capacity Shore Power Connection (User Input Model) |                                  |                     |              |                            |             |                               |                              |                     |
|---|----------------------------------|---------------------|--------------|----------------------------|-------------|-------------------------------|------------------------------|---------------------|
| eGRID Region  | Generation Facility / Plant Name | Vessel Type         | Vessel Fuel  | Auxiliary Engine Size (kW) | Load Factor | Number of Annual Vessel Calls | Avg. Hotel Hours/Vessel Call | Transmission Losses |
| SRVC  | Hagood                           | USER ENTRY          | MDO (0.1% S) | 6758                       | 1           | 68                            | 10                           | 0.06                |
|   |                                  | USER ENTRY          | MDO (0.1% S) | 6758                       | 1           | 68                            | 10                           | 0.06                |
| USER ENTRY  |                                  | Passenger/Cruise Sh | MDO (0.1% S) | 6758                       | 1           | 68                            | 10                           | 0.06                |
| Dropdown  | Dropdown                         | Dropdown            |              | Input                      | Input       | Input                         | Input                        | Input               |

INPUTS  
in Blue

| Calculator:<br>Consumption (kWh) | Vessel Power Emissions (MT) |             |                 |             |             |              | Shore Power Emissions (MT) |             |                |      |       |      | Difference (MT) |             |                 |              |              |              | Percent Difference |        |        |       |         |       |
|----------------------------------|-----------------------------|-------------|-----------------|-------------|-------------|--------------|----------------------------|-------------|----------------|------|-------|------|-----------------|-------------|-----------------|--------------|--------------|--------------|--------------------|--------|--------|-------|---------|-------|
|                                  | NOx                         | SOx         | CO2             | PM10        | PM2.5       | CO           | NOx                        | SOx         | CO2            | PM10 | PM2.5 | CO   | NOx             | SOx         | CO2             | PM10         | PM2.5        | CO           | NOx                | SOx    | CO2    | PM10  | PM2.5   | CO    |
| 4,888,766                        | 67.95                       | 1.96        | 3,373.25        | 1.22        | 1.12        | 5.38         | 1.37                       | 1.59        | 2,013.45       | na   | na    | na   | -66.59          | -0.37       | -1359.80        | #####        | #####        | #####        | -98%               | -19%   | -40%   | ##### | #VALUE! | ##### |
| 4,888,766                        | 67.95                       | 1.96        | 3,373.25        | 1.22        | 1.12        | 5.38         | 2.88                       | 0.07        | 2,484.41       | na   | na    | na   | -65.08          | -1.88       | -888.83         | #####        | #####        | #####        | -36%               | -96%   | -26%   | ##### | #VALUE! | ##### |
| 4,888,766                        | 67.95                       | 1.96        | 3,373.25        | 1.22        | 1.12        | 5.38         | 1.78                       | 5.86        | 2,663.60       | 105  | 0.79  | 0.46 | -66.17          | 3.90        | -709.65         | -0.17        | -0.34        | -4.92        | -97%               | 199%   | -21%   | -14%  | -30%    | -92%  |
| <b>Sub-Total</b>                 | <b>###</b>                  | <b>5.87</b> | <b>10119.75</b> | <b>3.67</b> | <b>3.37</b> | <b>16.13</b> | <b>6.03</b>                | <b>7.52</b> | <b>7161.46</b> |      |       |      | <b>-197.83</b>  | <b>1.65</b> | <b>-2958.29</b> | <b>#####</b> | <b>#####</b> | <b>#####</b> |                    |        |        |       |         |       |
| Output                           | Output                      | Output      | Output          |             |             |              | Output                     | Output      | Output         |      |       |      | Output          | Output      | Output          |              |              |              | Output             | Output | Output |       |         |       |

OUTPUTS  
in Gray





For More Information

**SPEC website**

[www.epa.gov/ports-initiative/shore-power-technology-assessment-us-ports](http://www.epa.gov/ports-initiative/shore-power-technology-assessment-us-ports)

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Questions about the report or the calculator:

[Tech\\_Center@epa.gov](mailto:Tech_Center@epa.gov)

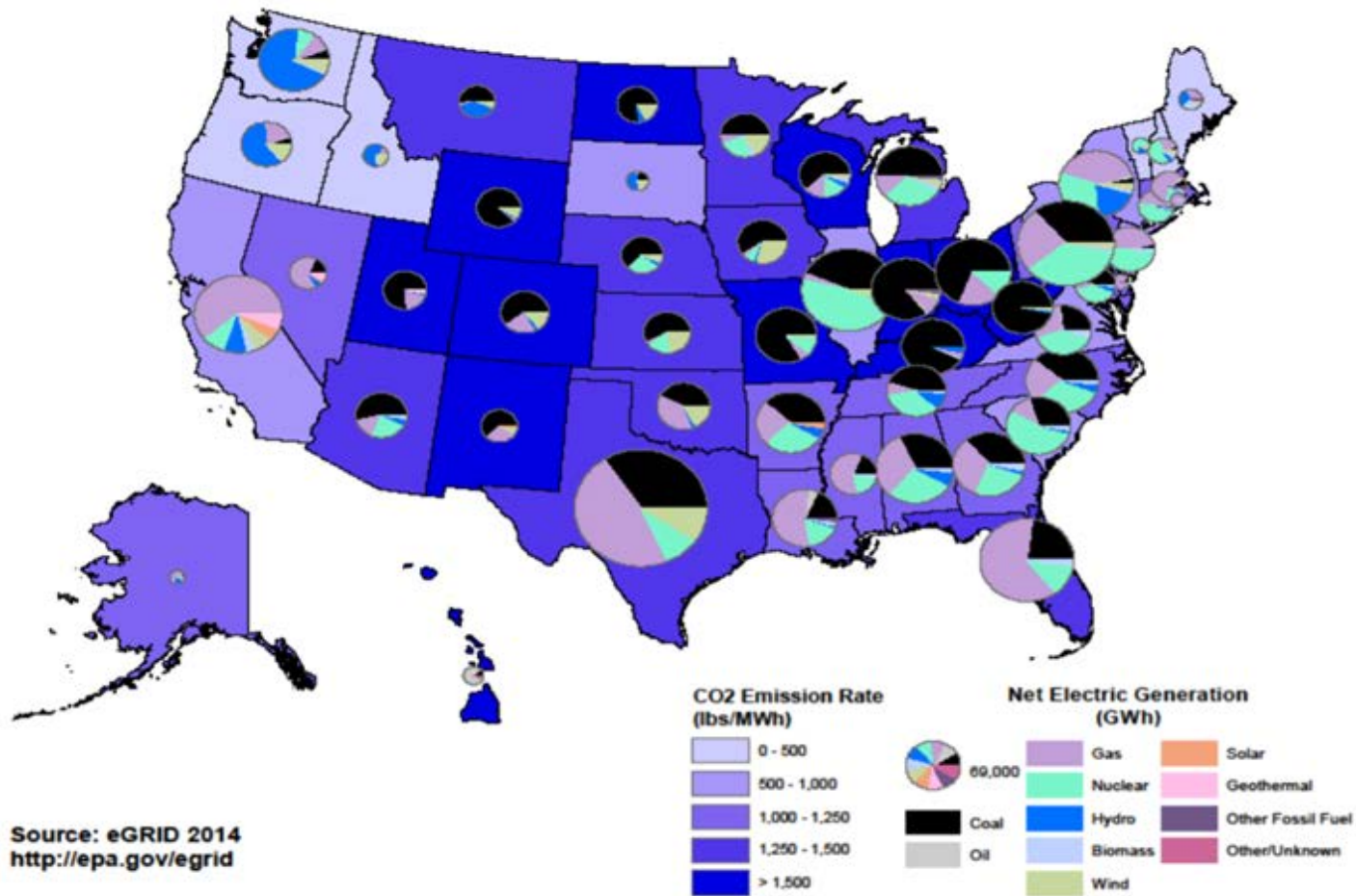
or

[tanman.arman@epa.gov](mailto:tanman.arman@epa.gov)



# Appendix

## Generation by Fuel Type and CO<sub>2</sub> Emission Rates (eGRID2014)



Source: eGRID 2014  
<http://epa.gov/egridd>