COLD IRONING

Emissions Reduction Alternative for Cruise Ships while in Port

AAPA American Association of Port Authorities

Cruise Workshop
New Orleans, February 17, 2004

DOCK WATTS LCC

WHY NOW?

- Significant port growth
- Serious health impacts from air pollution
- Ports under pressure to reduce emissions
- Many options to reduce emissions
- Cold Ironing is proven technology that works today

AIR EMISSIONS CONTRAST

Cold Ironing (a.k.a. "shore power") virtually eliminates emissions from ship aux engines.

	Ship Aux Engines lb/MWh	Gas Fired Power Plant lb/MWh	Percent Reduction
NOx	32.4	0.123	99.6 %
SOx	27.1	0.007	99.9 %
Particulate	1.8	0.025	98.6 %
CO_2	1,591.7	810.000	49.1 %
HC and VOC	0.9	0.067	92.6 %

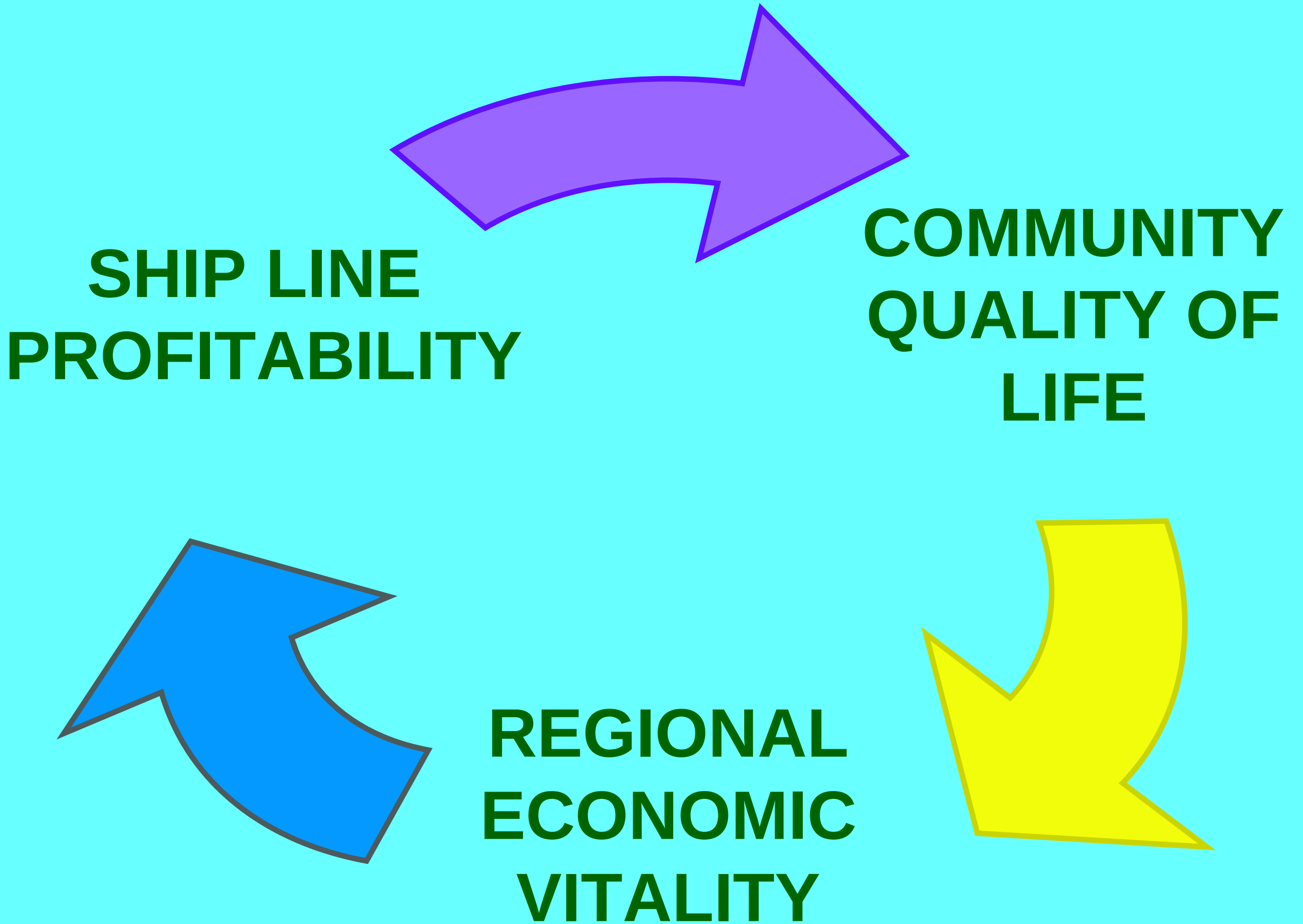
- **HFO oil ship auxiliary engine emissions based on July 2002 Entec Report prepared for European Community**
- **Power plant emissions based on Siemans-Westinghouse 2x1 F gas fired combined cycle with Dry Low NOx and SCR**

WHY CRUISE SHIPS?

- **High electric demand while in port (MW)**
- **High frequency of port calls for same ship (hours)**
- **High annual electric requirements (MWh)**

MWh = Air Emissions

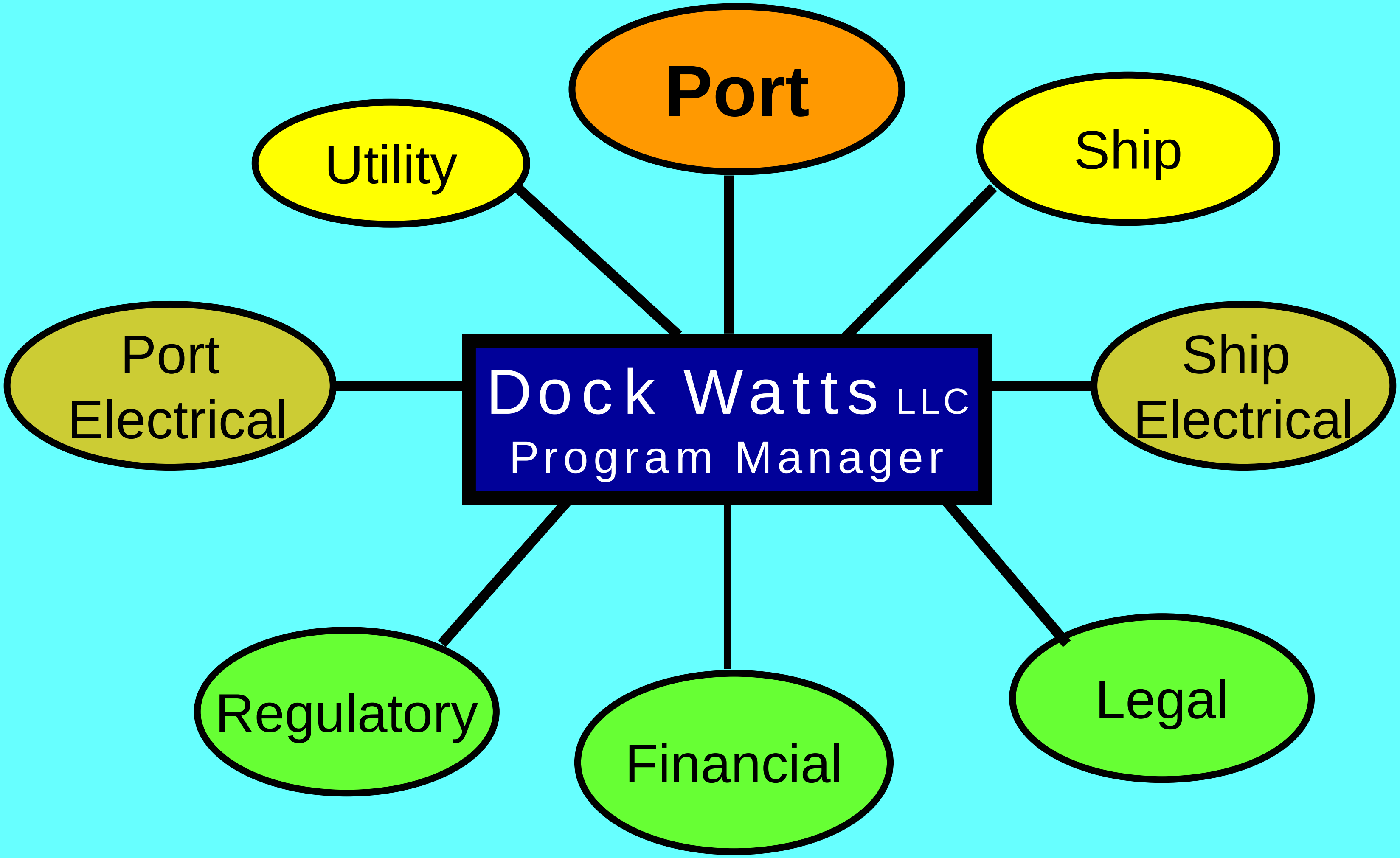
BALANCING SHORE POWER BENEFITS



FORMULA FOR SUCCESS

- **Customize solutions – not one size fits all**
- **Key components for shore power success:**
  - **Development focus and project management**
  - **Willing and capable landlord (port authority)**
  - **Support of Public Agencies (regulators)**
  - **Economical power supply (utility)**

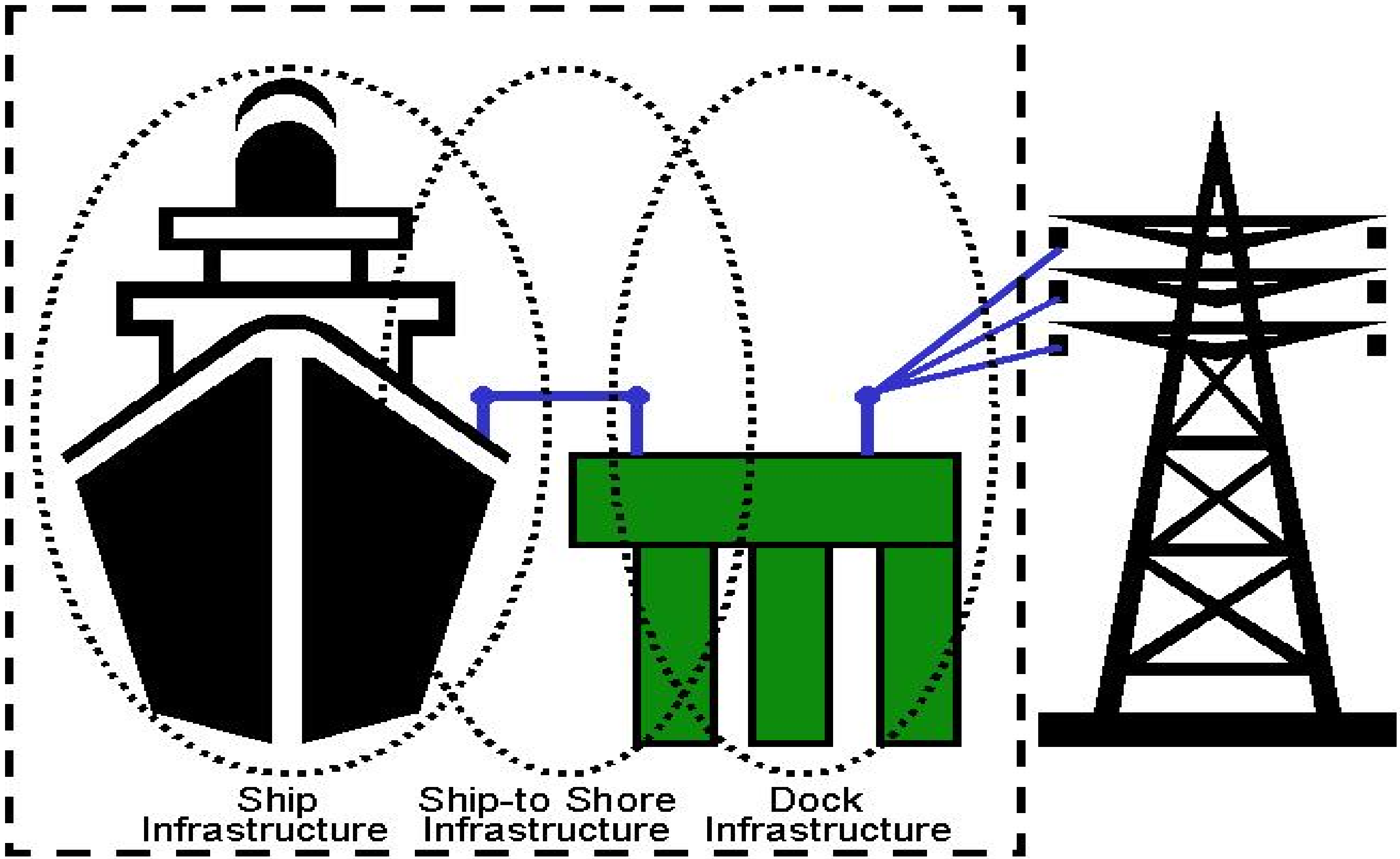
COMPONENTS OF SHORE POWER PROJECTS



DOCK WATTS' DEVELOPMENT MODEL

- Select optimal candidates (ports & ships)
- Optimize design
  - Ship on-board equipment; minimize cost, maximize portability
  - Connection between ship and port (cable management system)
  - Port/terminal electric facilities (distribution, utility interface)
- Capture economic value from emission reductions
- Finance project
- Negotiate economical power supply

SHORE POWER SYSTEM



SHORE POWER DESIGN CONSIDERATIONS

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- Port call frequency and duration
- Electric load profile while in port
- Safety
- Tidal range and draft
- Mooring operations
- Ship loading and unloading operations

SHORE POWER DESIGN CONSIDERATIONS

- Ship-to-shore interface
- Connect and disconnect operations
- Utility interface
- Communications
- Emissions verification

RELATIVE SHORE POWER COSTS

$500,000 historical

< $250,000 target

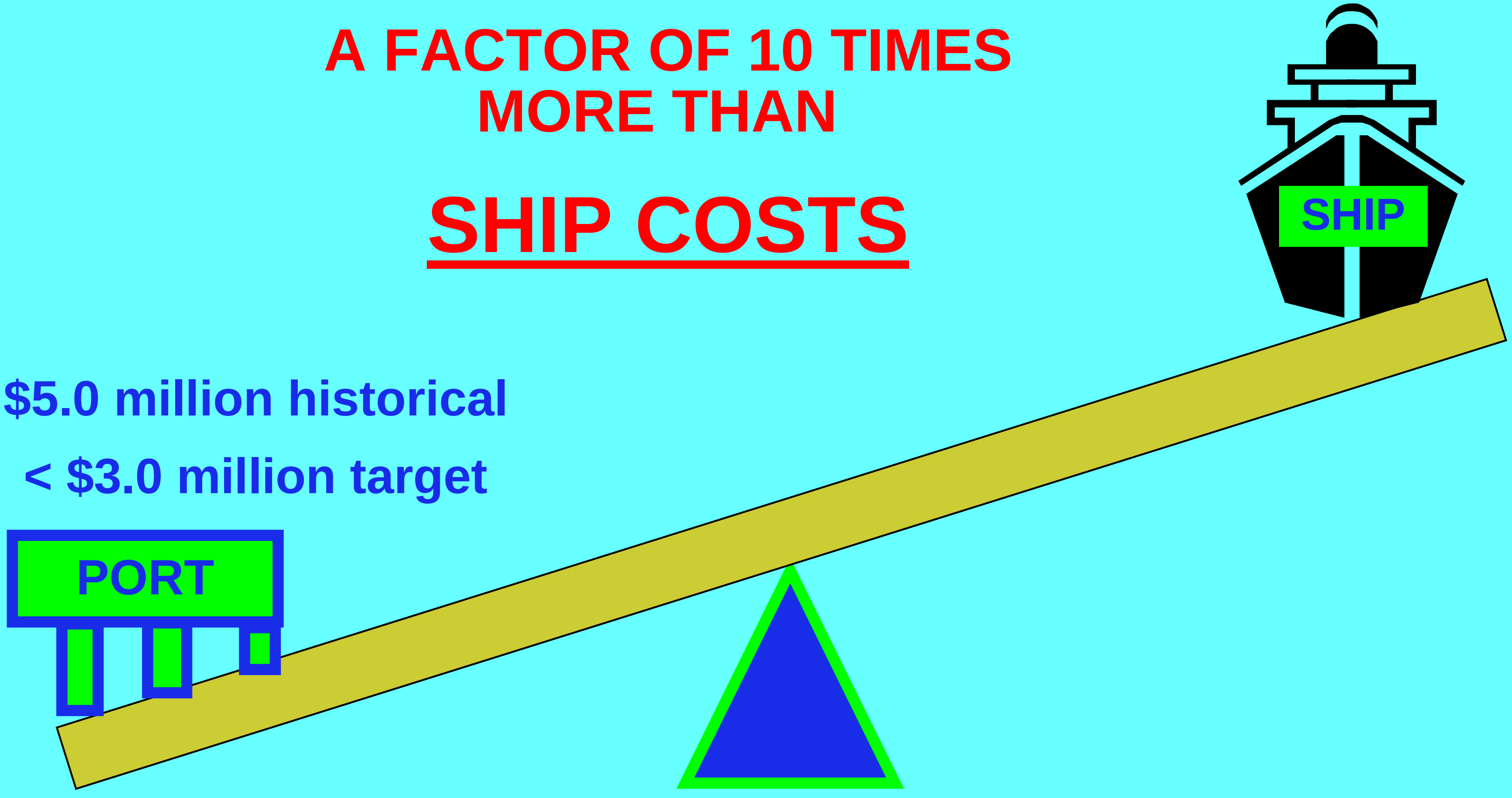
PORT COSTS

A FACTOR OF 10 TIMES MORE THAN

SHIP COSTS

$5.0 million historical

< $3.0 million target



CRUISE SHIP EMISSIONS

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Assumptions:		
	7,000	kW Cruise Ship Electric Demand
	1.5	Hours per call for shore power connect time
	32.4	NOx lb/MWh
	27.1	SOx lb/MWh
	1.8	PM lb/MWh

Vessel Name	Gross Tonnage	Installed Generation (kW)	Calls/yr	Annual Berthing Time Hours/yr	Average Hours per call	Net Berthing Time Hours/yr
Carnival Ecstasy	70,367	10,560	105	1,321	13	1,164
Carnival Pride	85,920	60,504	37	397	11	342

Vessel Name	Average Electric Load (kW)	Annual Energy (MWh/yr)	Nox Emissions Ton/Year	SOx Emissions Ton/Year	PM Emissions Ton/Year	Total Emissions Tons/Year
Carnival Ecstasy	7,000	8,145	132.0	110.4	7.2	249.6
Carnival Pride	7,000	2,391	38.7	32.4	2.1	73.3
	TOTAL	10,535	170.7	142.8	9.3	322.8

Electric Load and Hotelling hours based on the Report by Environ; Analysis of Vessel Popuation for Cost Effective Cold Ironing for the Port of Long Beach (November 19.2004)

Emissions Factor Assumptions based on EnTec Report to the Eurpean Community (July 2002)

ESTIMATED COST EFFECTIVENESS

ASSUMPTIONS: Shore Side Cost	$5,000,000	Per Berth	1	Berth
Ship Side Cost	$500,000	Per Ship	2	Ships
Emissions Reduction Period	5	Years		

Vessel Name	Calls/yr	Net Berthing Time Hours/yr		Annual Total Energy (MWh/yr)	Nox Emissions Ton/Year	SOx Emissions Ton/Year	PM Emissions Ton/Year	Total Emissions Tons/Year
Carnival Ecstasy	1,321	1,164		8,145	132.0	110.4	7.2	249.6
Carnival Pride	397	342		2,391	38.7	32.4	2.1	73.3
TOTAL					170.7	142.8	9.3	322.8

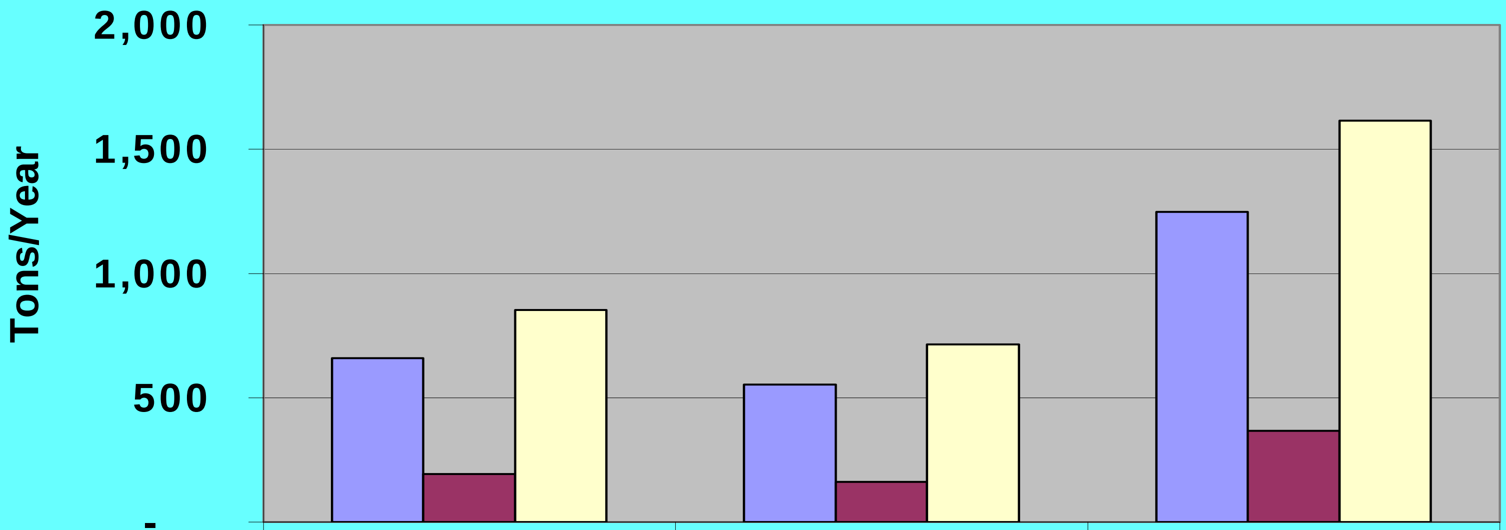
Berth Cost	$5,000,000	5 Years NOx Emissions	854	tons	NOx Cost/Ton	$7,030
Ship Cost	$1,000,000	5 Years SOx Emissions	714	tons	SOx Cost/Ton	$8,401
Total Cost	$6,000,000	5 Years PM Emissions	46	tons	PM Cost/Ton	$129,169
		5 Years Total Emissions	1,614	tons	Total Cost/Ton	$3,717

* Estimated cost effectiveness based solely on assumed capital cost of facilities and does not reflect operating cost.
* Operating cost would include net power cost, connection operations, and facilities maintenance.
* Net power cost should reflect difference between the cost of utility supplied power and ship costs to generate on-board power.

Annual emissions based on ship electric load data presented in the November 19, 2004 Environ Report to the Port of Long Beach and emissions factors presented in the July 2002 Entec report to the European Community

ESTIMATED SHORE POWER RESULTS

$6.0 million capital cost assumed for ship and shore facilities.
Analysis considers estimated emissions reductions over five years.



	NOx	SOx	Total Emissions
Carnival Ecstasy	660	552	1,248
Carnival Pride	194	162	366
Total, Two Ships	854	714	1,614
Cost Effectiveness	**$7,000/ton**	**$8,400/ton**	**$3,700/ton**

Annual emissions based on ship electric load data presented in the November 19, 2004 Environ Report to the Port of Long Beach and emissions factors presented in the July 2002 Entec report to the European Community. Operating costs are not reflected in the above analysis.

PRINCESS CRUISE LINES
SHORE POWER – JUNEAU, ALASKA

PRINCESS CRUISE LINES
SHORE POWER - JUNEAU, ALASKA

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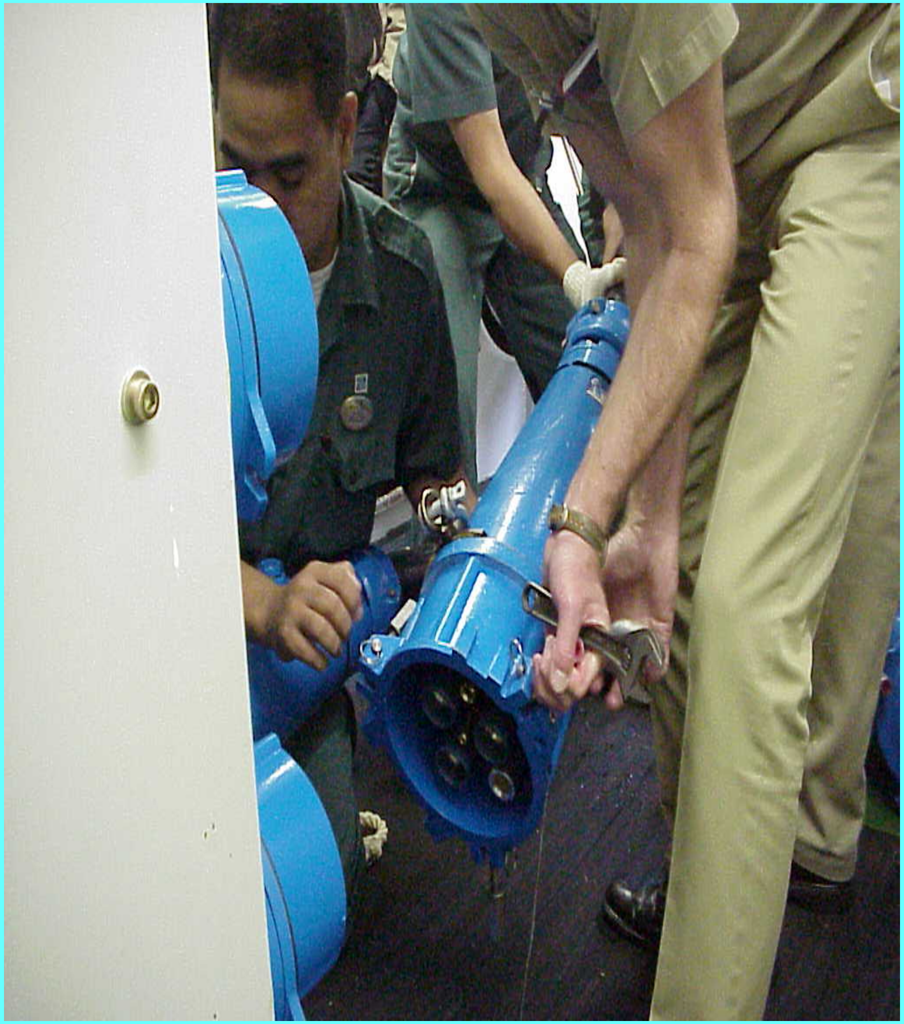
- **Emission opacity issue**
- **Involved 28 vendors from five different countries**
- **Four Princess Cruise ships retrofitted**
- **Up to 13 MW of power delivered at 11 kV**
- **$4.5 million cost, ship and shore electric facilities**
  (additional $1.1 million for shore-side steam boilers and piping)
- **Project completed in nine months**

JUNEAU PROJECT
TECHNICAL COMPONENTS

- **Shore side electric substation**
- **Cable management system**
- **Ship modifications**
- **Synchronized power transfer equipment**
- **Shore side steam boiler and piping**
  (not recommended for future cruise ship shore power project)

CABLE MANAGEMENT SYSTEM
JUNEAU, ALASKA

MAKING THE CONNECTION JUNEAU, ALASKA



PROACTIVE INDUSTRY ADVOCACY

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- Influence air quality regulations
- Capture emission reductions value
- Establish shore power standards

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