



# Moving toward cleaner river shipping ——consideration & suggestion





## Emission legislations for inland waterway(IWW) ships

2008

**NOx:**

- IMO Tier I
- Only Three Gorges Reservoir

2011

**NOx:**

- IMO Tier I
- All IWS

**Sulphur content:**

- $\leq 4.5\%$

2015

**NOx:**

- IMO Tier I
- All IWS

**Sulphur content:**

- $\leq 3.5\%$

2017

**ECAs are expected to be set up**

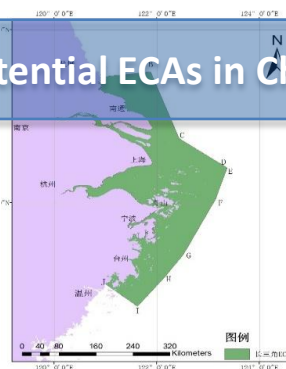
2020

**New emission regulation phase II will be effective**



Pearl River Delta ECA

Potential ECAs in China



Yangtze River Delta ECA



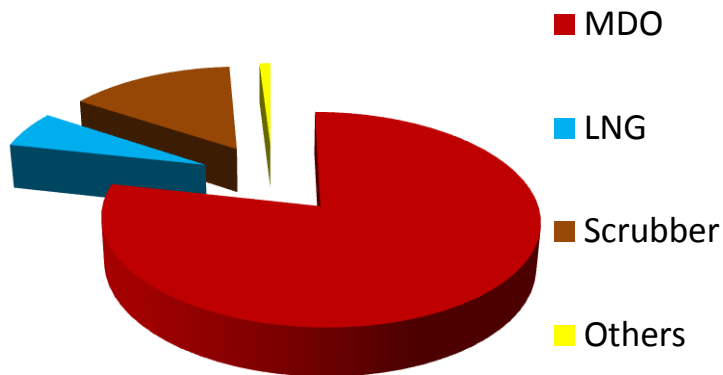
The Bohai Sea ECA



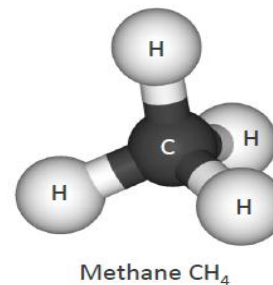
**The development of IWS will be high-tech oriented, aiming to achieve energy conservation and environmental protection.**



## Marine engine emission solutions and development of using LNG as a marine fuel in China



Solutions for SECA compliance



LNG



EGR



SCR

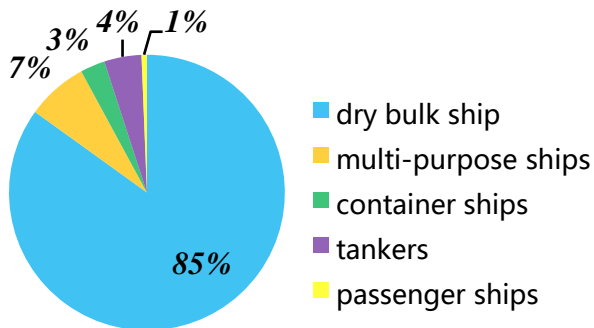
Solutions for NECA compliance

- 2010 ● Conversion of ferry Wutuo 302 opened the curtain for using LNG as marine fuel in China
- 2012 ● China MSA launched LNG fuelled ships pilot project
- 2014 ● Ministry of Finance issued the subsidy policy for new buildings
- 2015 ● China MOC issued 13th five-year-plan for further promotion of waterborne LNG application

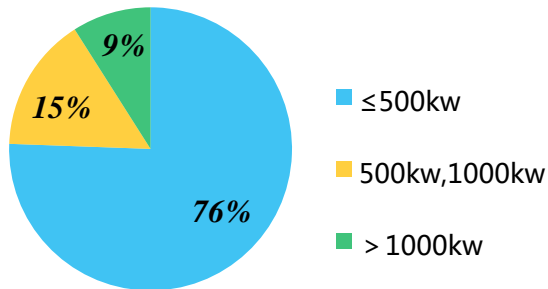


## Status of IWW ships and engines in China

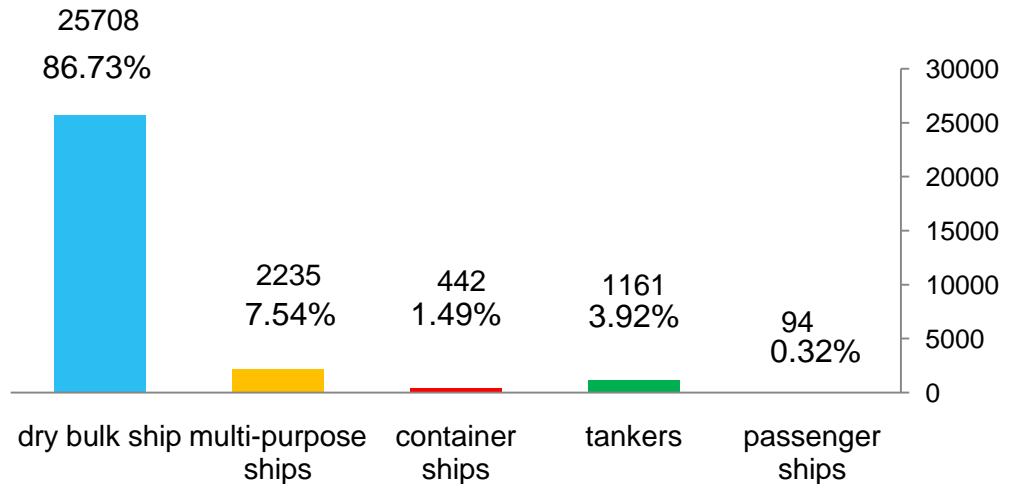
Distribution of inland ship type



Distribution of main engine power



Distribution of ship type with engine power ≤500kW



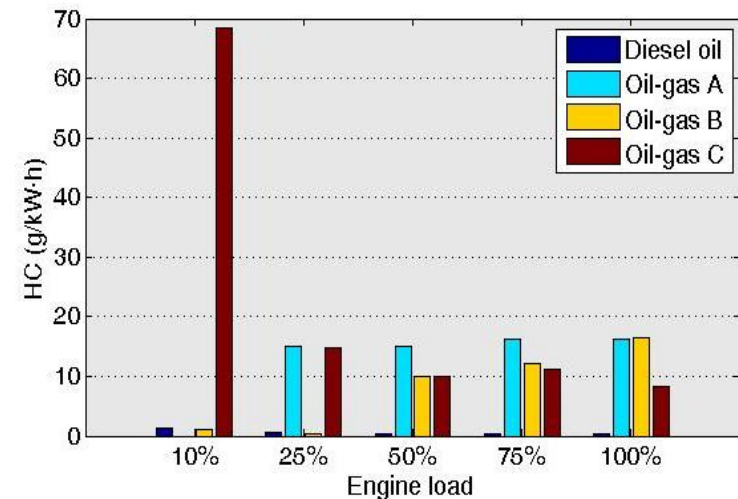
- Small size & low investment
- Low power engine dominates
- Advanced engine technology is under development
- Low skilled crew
- Cost-sensitive

**China's national conditions and industrial capabilities shall be fully considered in the development of IWW ships and engines.**



## Experiences and lessons of using LNG as a marine fuel in China

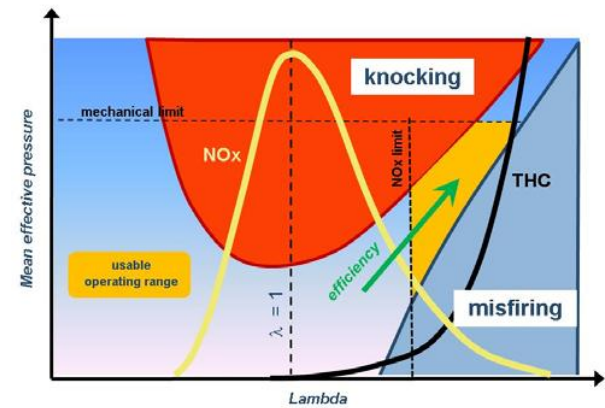
- At the beginning stage, simple retrofit technology, i.e. oil-gas co-firing engines were widely adopted on IWW ships, but it has been practically proven that the oil-gas co-firing technology can not give full play to the advantage of LNG as a clean marine fuel:
  - thermal efficiency get worse
  - NO<sub>x</sub> emissions are not obviously improved
  - Significant THC emissions (CH<sub>4</sub> slips )
- At present, Chinese industry is striving to develop dual fuel engines (with pilot fuel) and pure gas engines with high performance.



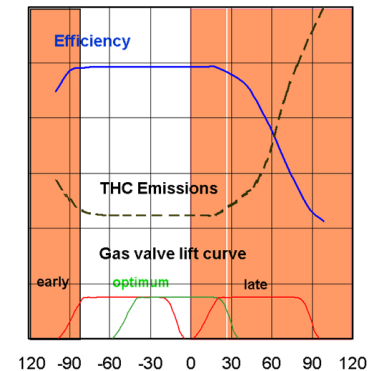


## Considerations for the future

- Further improve load response behavior to match with FPP
  - Mean effective pressure be properly lowered
  - VGT (variable turbine geometry)
- Control of THC emissions
  - valve timing optimization
  - FCT (flexible cam timing)
  - precise gas injection
  - improve oil gas mixing process
  - reduce fireland volume
- R&D of advanced gas engines
  - dual fuel engines (with pilot fuel)
  - pure gas engines
  - localization (reduce cost)



Operation window of Otto gas engines



Efficiency and THC emissions by valve timing