**Expanded Report Outline for PGC D.4, “Life Cycle Assessment of LNG”**

**Osaka Meeting, May 2014**

**(active writing on sections shown in red; principal author initials shown)**

* + Executive Summary (not to be addressed until report is completed)
	+ **Introduction**
		- **Background (PLF)**
			* **IGU background and “four pillars” coverage of sustainability**
			* **Define LCA**
			* **Standards and practices (ISO 14040), etc.**
			* **Benefits of LCA**
			* **Uses of LCA for LNG to date**
			* **Other LCA activities**
			* **How is LNG/natural gas competing environmentally? Standard for comparison to other fuels – RE-EMERGENCE OF COAL IN EUROPE? (Coal statistics) [Qatargas paper for FLAME]**
		- **Purpose/Objective of the Study (TAW initial)**
			* **Characterize emissions of representative major LNG assets engaged in world trade for comparison to other energy forms and for all sources and uses of natural gas**
			* **Focus on transparency of LNG emissions for:**
				+ **Continuous improvement**
				+ **Higher efficiency and parallel benefits in emissions performance, i.e., “environmental footprint”**
				+ **Documenting environmental performance improvements associated with:**

**Scale increases**

**Efficiency-driven improvements**

**Improved technology over time (what would have been the results twenty years ago?)**

* + - * **Primary energy focus for meaningful comparison to other fuels (i.e., ex-E&P losses, etc.)**
			* **“Getting the LNG chain right”**
			* **Intended end users of the study**
				+ **Policy makers in existing energy import markets**
				+ **New market choices for energy sources**
			* **Benefits of natural gas – example end use emission factors**
			* **Flexibility of supply and benefits of transportability over long distances and destination flexibility**
			* **Role of natural gas in sustainable energy future**
			* **Role of LNG in world natural gas**
			* **Originality of work on LNG – first of its kind**
			* **Develop general tools for LCA of LNG covering a variety of chains**
			* **Facilitate energy choices based on environmental acceptability on an objective set of factors**
			* **Serve as a document/source of reference for the LNG industry**
			* **Provide a basis for expanded industry coverage of other activities as they develop into major industry segments (and documented with data on emissions)**
		- **Overview Discussion of LNG Chains (PLF)**
			* **Schematics of LNG industry**
			* **Traditional international trade**
			* **(Borrow chain descriptions from the World LNG Report)**
			* **Land-based facilities and technologies at this time**
			* **Current chains not covered (e.g. FSRU, FLNG); maybe covered in future studies**
	+ **Technical Approach (TAW)**
		- **Use of Chain Modules and Assumptions**
		- **System Boundaries**
			* **Feed gas at liquefaction to regas gate**
			* **Why? Results feed other analyses**
		- **Data Quality Characterizations**
		- **Examples of Chain Descriptions and Study Applications**
			* **Body of report to cover general data results**
			* **Detailed emission factor information in appendices**
	+ **Modules (not fully addressed until data development proceeds) – for outline purposes, add results of Barcelona meeting “final module” descriptions (TAW - first cut)**
		- **Liquefaction (including feed gas to plant boundary)**
		- **LNG Transport (marine carrier and overland transport)**
		- **Regasification and LNG End User Delivery (e.g. bunkering, vehicle refueling)**
	+ **What incremental emissions are added by the LNG chain? (need to compare – 12 to 15% additional emissions for adding LNG as a gas transport option) [OS]**
	+ Case Study Illustrations (to await data development, for the most part)
		- Three to 4 case studies (requires comparable confidence in data; otherwise, pinpoint deficiencies in other fuel characterization)
			* CLNG Case Comparison (requires CLNG agreement for citation
			* LNG to power – comparisons to oil, coal, depending upon comparability of LCAs (JR?)
			* LNG to vehicle fuel (IGU Study Group)
		- **General Recommendations for Report Use (Initial text based on Study Group expertise)**
		- **Potential Technology Roadmapping Applications (Initial text based on Study Group expertise) (MK)**
			* **Larger scales to achieve higher environmental performance**
	+ Study Conclusions (to await completion of the work referred to above)
		- Potential mitigation opportunities and “hot spots,”  operational changes, process efficiencies, power sources and their emissions streams, CO2 management)
	+ **Recommendations for Future LCA Studies (to await completion of the work referred to above, for the most part; initial text based on Study Group expertise)**
		- **LNG/natural gas wins downstream combustion; shouldn’t competing fuels do as a complete a job upstream?**
	+ Appendices (to await completion of the work referred to above)
		- Data sets
		- Others to be decided.