**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.