DRIVER SELECTION FOR LARGE OFFSHORE PRODUCTION FACILITIES

AN IMPORTANT EARLY PROJECT DECISION

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INTRODUCTION / GROUND WORK

- **Common Early Approach on Platforms:**
  - **Few Relatively Large Mechanical Drives**
  - **Larger Mechanical Drives Driven by Gas Turbines/Engines**
  - **Engine/Turbine Generators for Smaller Drives and Utilities**
- **Contemporary Large Floating Developments:**
  - **Significantly Larger Throughput**
  - **Numerous Large Mechanical Drives**
- **Decision for Types of Drives is Not Obvious:**
  - **All Electric – Relatively Few Large Gas Turbines for Power Generation with Motor Drives**
  - **Mixed Drivers - Smaller Gas turbines For Power Generation; mix or Motors & Engines as Mechanical Drives**

METHODOLOGY OF DRIVER STUDY

- **Formal Driver Study is an effective way to arrive at optimum mix of turbine, engine and motor drivers on facility**

- **Study Typically Required early in project (during FEED)**

  - **Reservoir Data is Preliminary**

  - **Comparative Analysis - Carried out on "Differential Basis"**

- **As project economic factors change, so do the results of the driver study.**

  - ***EXAMPLE: Production Sharing Agreement with Host Country where Produced Gas has no Value to Operator.***

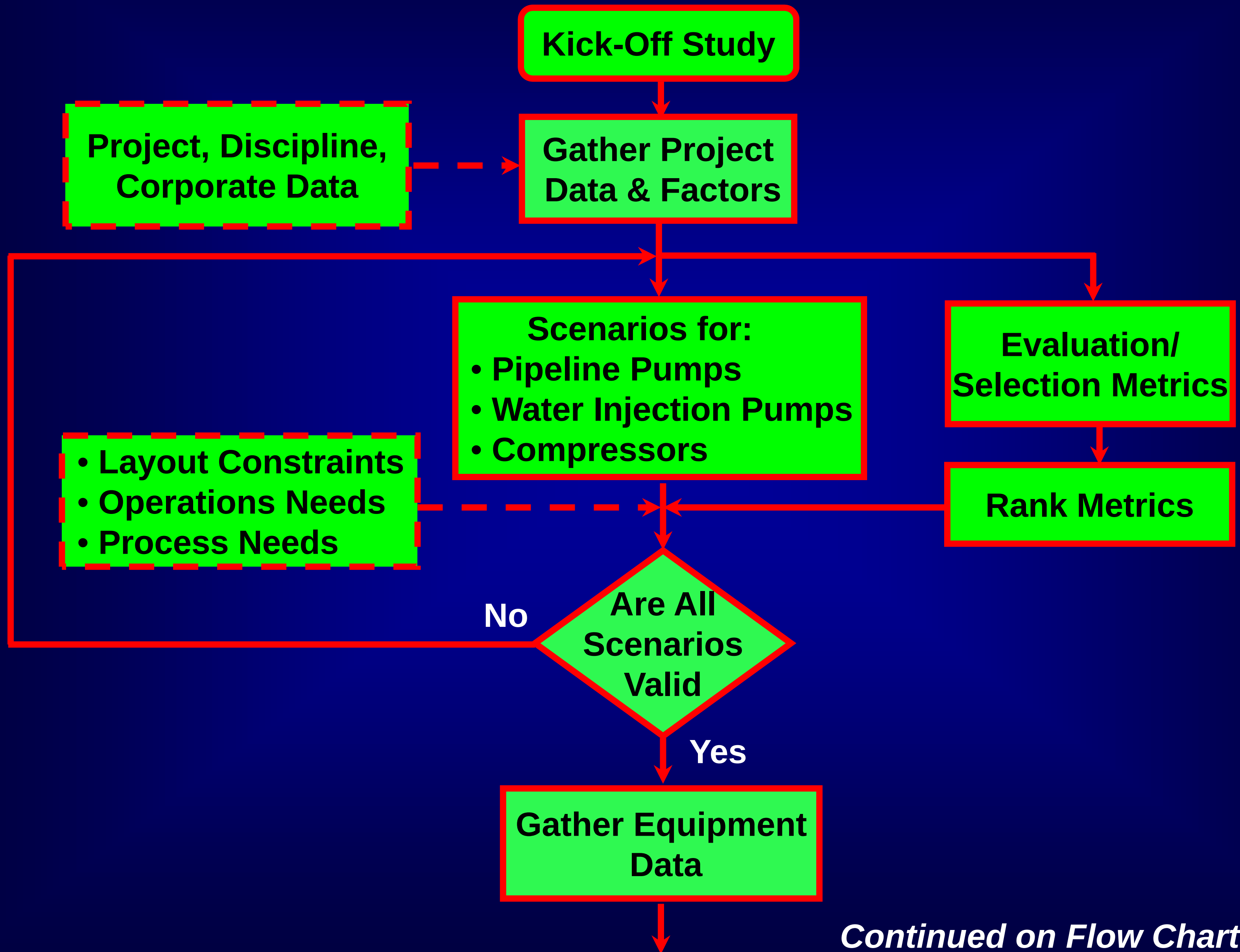
SELECTION CRITERIA

- Selection Criteria (Metrics) Defined, Ranked and Agreed Upon with ALL Stakeholders

- Metrics Linked to Project Economic Factors

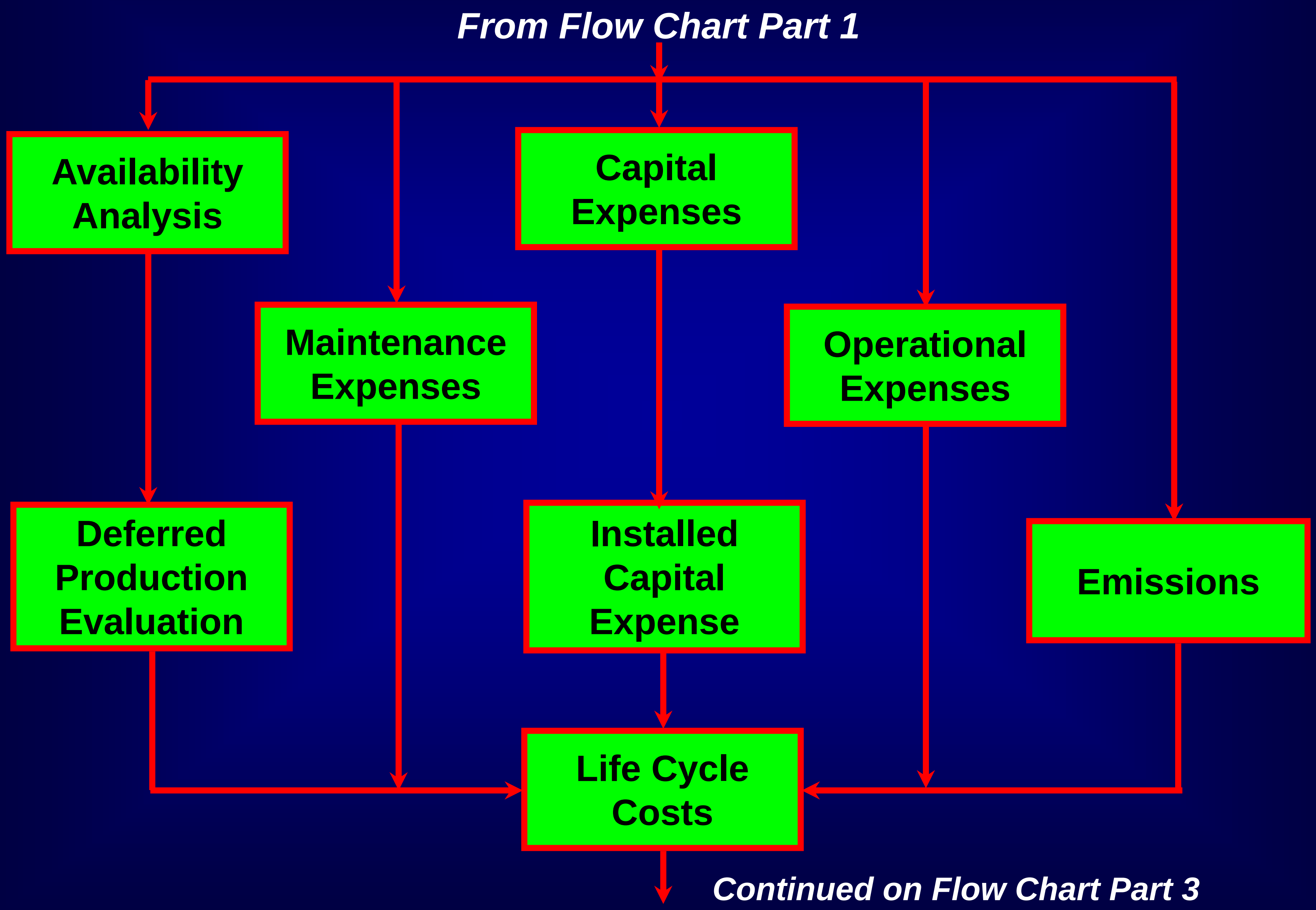
- Examples of Metrics
  - Life Cycle Costs
    - Equipment CAPEX
    - Installed CAPEX (Equipment CAPEX PLUS Installation Costs)
    - OPEX & Maintenance Costs (Includes fuel costs)
    - Environments Impacts (CO_2, NO_x, etc., penalties)
  - Inherent Safety (Layout, etc.)

DRIVER STUDY FLOW CHART PART 1

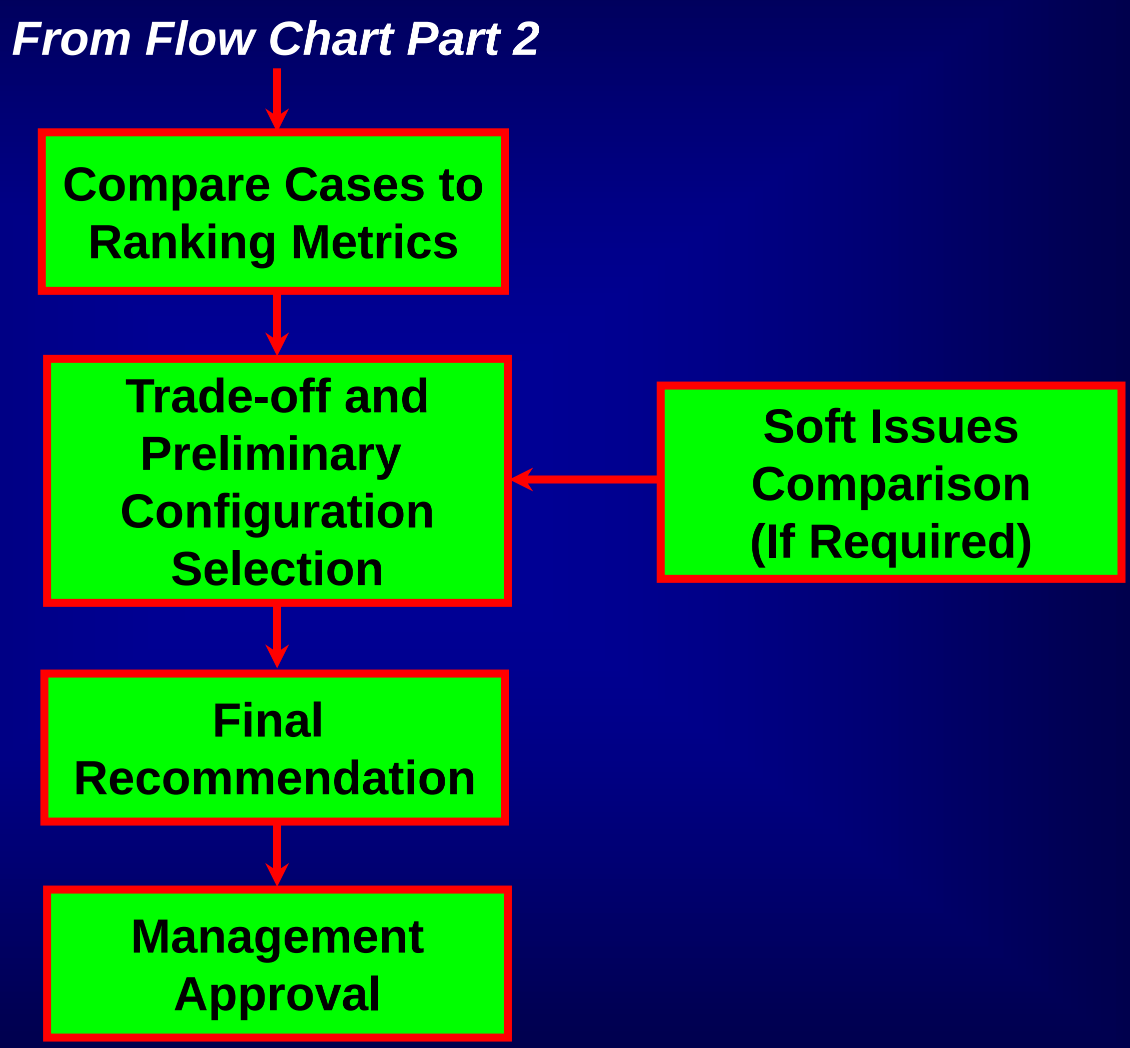


Continued on Flow Chart - Part 2

DRIVER STUDY FLOW CHART PART 2



DRIVER STUDY FLOW CHART PART 3



A SAMPLE CASE STUDY

EXAMPLE: GATHER PROJECT DATA

- **Nameplate Oil Production: 100 oil units**
- **Nameplate Gas Production: 100 gas units**
- **Nameplate Water Injection: 100 water units**
- **Life of Field: 30 years**
- **Years at Peak Oil Production: 3 years**
- **Project Economic Basis - Cost of Oil: $18.37 / barrel; Cost of Gas: $3.00 / mmscfd**
- **Project Hurdle ROR: 14%**
- **CO_2 Penalty: $40 / ton**

EXAMPLE: GATHER PROJECT DATA (CONTINUED)

FROM PROJECT ESTIMATING GROUP

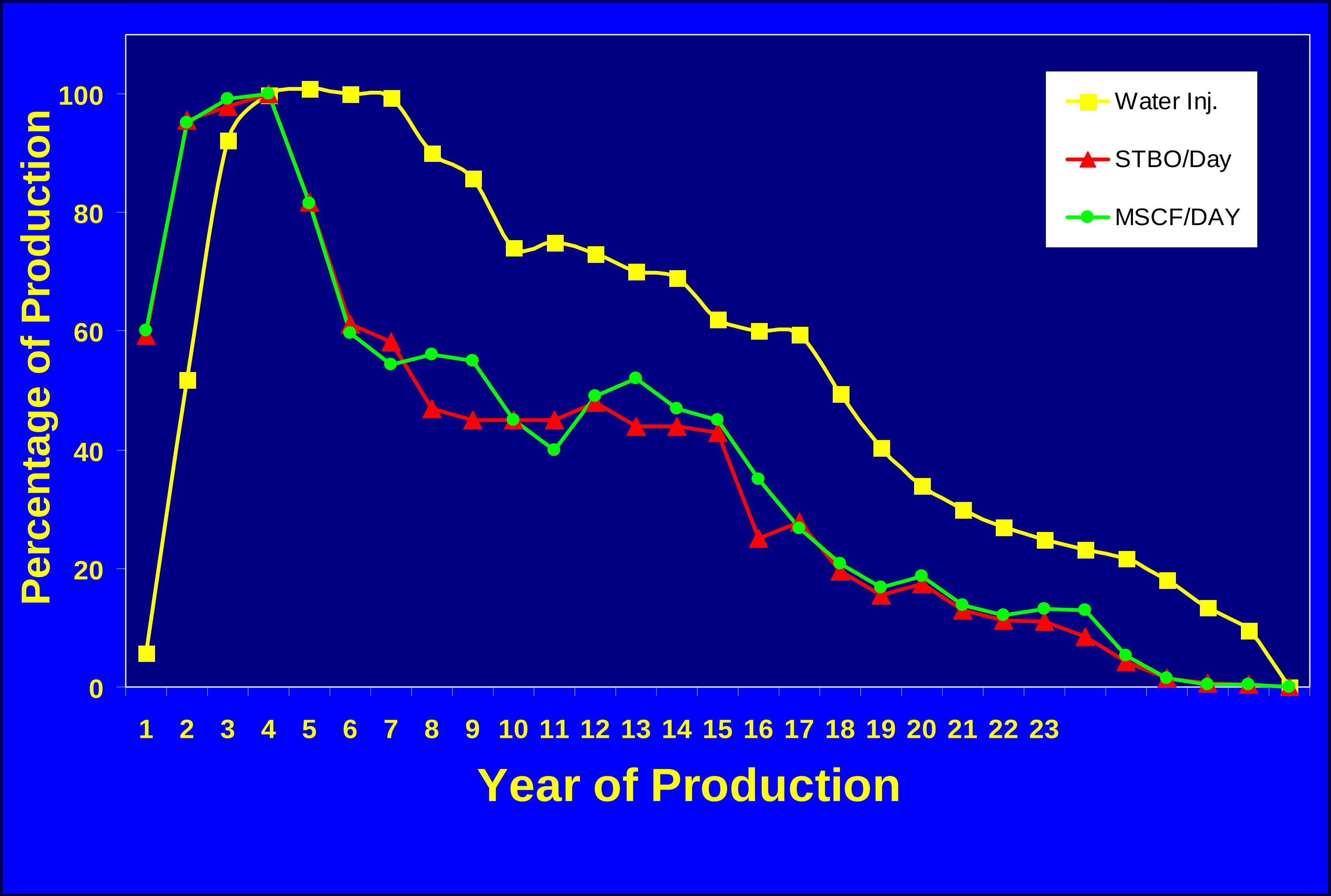
- **Project-specific Topsides Construction Factors to Help Determine Installed Capex**
- **Project-specific Hull Buoyancy Factors to Help Determine Installed Capex (Significant Issue for Floaters)**
- **Project-specific Equipment "Outfitting" Factors (wiring, instrumentation, piping, etc.)**

EXAMPLE CASE MAJOR DRIVEN EQUIPMENT TO BE CONSIDERED FOR TURBINE DRIVE

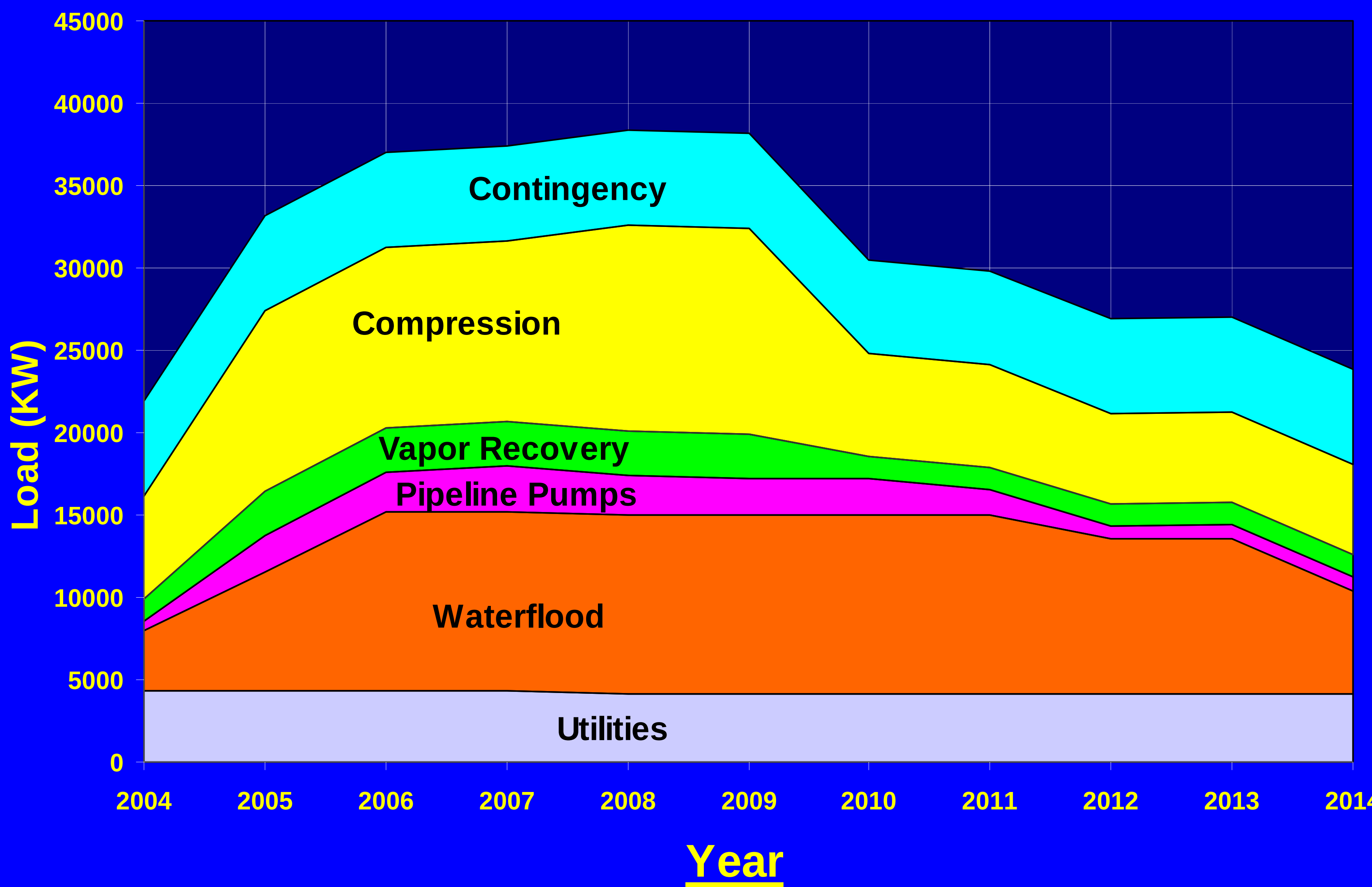
- **Power Generators**
- **Gas Compressors**
- **Oil Pipeline Pumps**
- **Water Injection Pumps**

PRODUCTION PROFILE

(THIS LEADS TO LOAD PROFILE)



LOAD PROFILE FOR DIFFERENT SERVICES

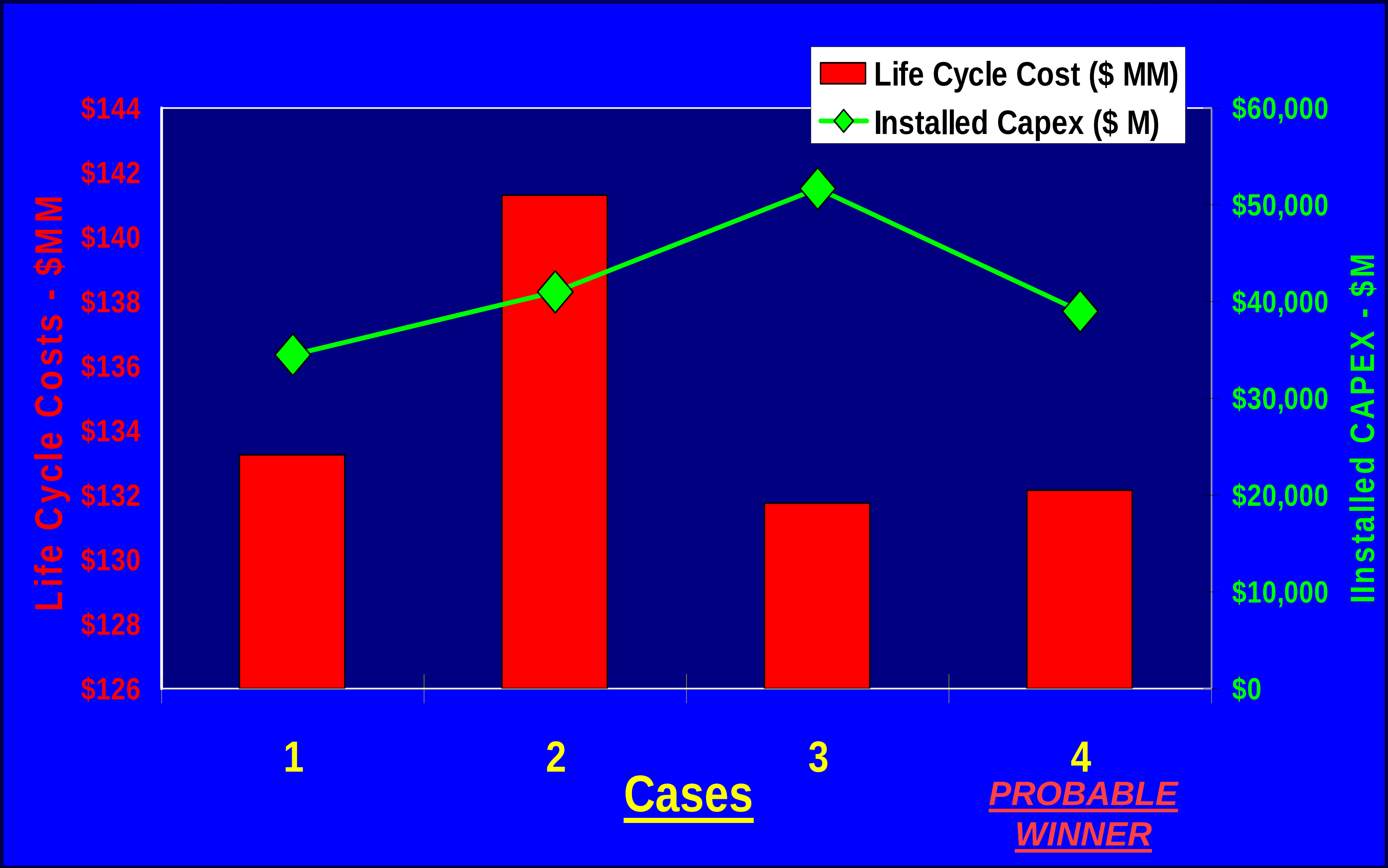


CASE STUDY - SELECTION CRITERIA

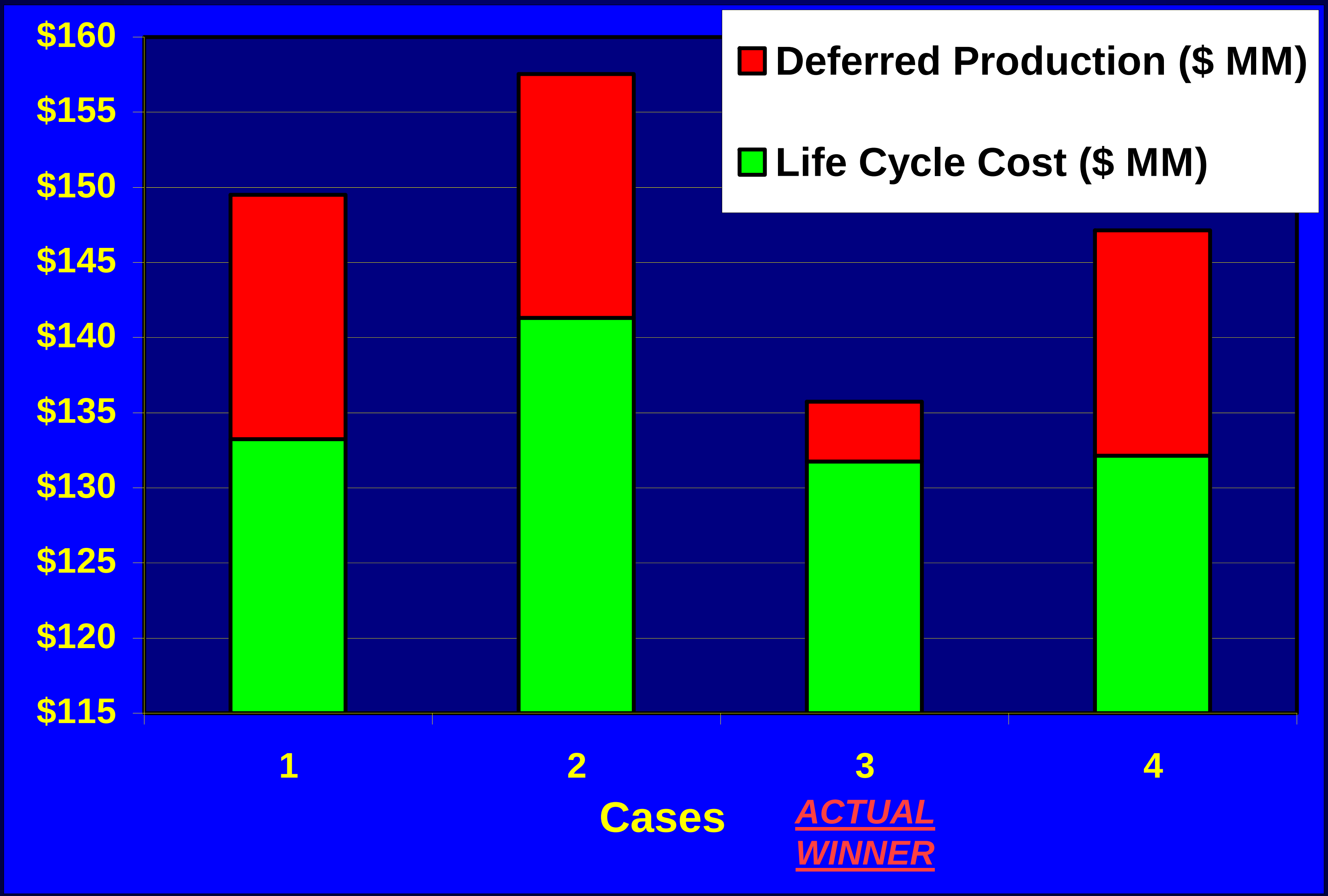
- **LIFE-CYCLE COSTS (NPV) – includes Installed CAPEX, OPEX, Availability, Deferred Production and Maintenance Costs**
- **INSTALLED CAPEX (NPV) – this is included in Life-Cycle Costs, but is broken out to Differentiate Cash Flows for each Scenario**
- **ENVIRONMENTAL IMPACT (NPV) - included CO, CO_2, NO_X and SO_X**

(Environment *Costs were not assessed in 2000-2002 studies, but will be assigned values in future)*

CASE STUDY - ECONOMIC RESULTS WITHOUT PRODUCTION DEFERMENT



CASE STUDY - ECONOMIC RESULTS WITH PRODUCTION DEFERMENT



IMPACTS OF ALL ELECTRIC SOLUTION

COMPLEXITY, SIZE AND FLEXIBILITY

- **Electric Power System Increases in Size / Complexity**
- **15 to 100+ Megawatts of Installed Generation**
- **If Integrated Drill Rig, The Load Increase Probably in Range 5 to 15 MW.**
- **Generator Range From 8 to 40 MW**
- **Larger Generators and Motors Probably Water Cooled**
- **Increased Flexibility for Futures and Load Changes**

ELECTRICAL ROOMS AND BUILDINGS

- **Drastic Increase in Number and Size over Traditional GOM Platforms**
  - **More Switchgear and Motor Control Centers**
  - **Variable Frequency Drives**
  - **Auxiliary Equipment and Control Panels Associated with the Gas Turbine Generators**
- **Consider Sub-stations to Reduce Cabling and Offshore Hook-up**
- **Buildings Range One to Three Story and 1,500 to 12,000+ Square Feet**

<u>REFLECTIONS ON EARLIER DRIVER STUDIES</u>

- **The Methodology Discussed Above has been Used on Numerous Large Projects Currently in Operation. The Studies were Necessarily Done Early in the Project (Concept Select Stage) and were Based on the Best Load and Reservoir Data Available at the time as well as the Best Understanding of Field Development and Operation**
  - **The Methodology has been found to be "Robust" and is Continuing to be Applied on Projects. The Primary Enhancements to the Methodology have been in: 1) the Evaluation of Production Flaring, and 2) in Assigning Actual Economic Value to CO_2 Emissions.**
  - **It is <u>Absolutely Essential</u> that the Metrics be Thoroughly Considered and that <u>ALL</u> Stakeholders Agree with them and with their Ranking. It is Equally Important that These Metrics be Honored in the Evaluation of the Scenarios.**
  - **Formal Records Should be Kept of the Study.**

CONCLUSIONS

- **Analytical Method has Withstood the Test of Time and Has been found to be Extremely Useful for the Selection of the Mix of Drivers for Large Mechanical Loads and Main Power Generators on Numerous Large Offshore Facilities.**
- **ALL Stakeholders must agree on Metrics.**
- **Must Formally Document Assumptions, Metrics, results and Recommendations.**
  - **Results of Previous Studies have been used to Formally Justify Power Plant Designs**
- **Follow Methodology all the way Through – do NOT Jump to Premature Conclusions!**

Questions and Comments