A Pacesetter Evaluation of the Lower Churchill Project

Presented to NL Hydro

FINAL

NLH-8001-PAC

July 2008

IPA independent project analysis

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NLH-8001-PAC

Objectives of Pacesetter Evaluation

- **Provide feedback on status of Lower Churchill Project at end of Front-End Loading (FEL) 2 phase**
  - **Determine if FEL 2 is really closed**
  - **Highlight key activities that need to be completed during FEL 3 to finalize definition and thereby minimize risk**
- **Provide early benchmarks of project's cost and schedule targets to determine and identify areas of risk**
- **Present recommendations for risk reduction and performance improvement**

Evaluation Summary (1)
Lower Churchill Project

- Activities required to complete FEL 2 are nearly done, but project still has unresolved risks
  - Detailed business objectives are not finalized
  - Project scope is not yet closed, but is planned to be closed by Gate 2B
- Team is well represented, integrated, and on track to be functional and developed, but it still requires more work
- FEL is ahead in some areas, and behind in others
  - Design work is ahead of schedule
  - Engineering schedule and execution planning is a gap

Evaluation Summary (2)
Lower Churchill Project

- **Team plans to use all required Best Practices for project controls**
- **Use of Value Improving Practices (VIPs) is planned to be in recommended range at time of sanction**
- **Many practices and lessons learned from recent IPA research need to be considered as project moves from FEL 2 to FEL 3**
  - **Lessons from Alberta**
  - **Contracting practices**
  - **Team functionality**

Key Manageable Risks

Lower Churchill Project

- **Economics behind project are not fully understood and integrated into overall business strategy, business objectives, and project objectives, but is planned to be done by Gate 2A**
- **Project needs to complete all required project execution planning activities, particularly concerning engineering-related planning by Gate 2B**
- **Project could over-commit funds prior to sanction, suffering a loss of equity if project does not go forward**
- **Team needs to be further aligned and developed in a number of key areas**

IPA's Project Analysis Methodology

- Interviewed Lower Churchill Project team members on June 3, 2008 to June 6, 2008 in St. John's, Newfoundland
- Project team was in latter half of FEL 2
- Completed IPA benchmarking workbooks
- Identified similar projects in database as basis of comparison for Lower Churchill Project
- Performed analysis of project practices and outcomes using models and bases of comparison
- Developed briefing to present results

Outline

- **Summary**
- ***Background***
- **Methodology**
- **Recent Lessons From Canada**
- **Practices**
- **Outcomes**
- **Conclusions and Recommendations**

Business Objectives
Lower Churchill Project

- **Mission Statement:**
  - **"To develop the Lower Churchill Project, respecting shareholder and stakeholder requirements and commitments, using best-in-class planning and execution practices in order to ensure the safe and environmentally sound delivery of an economically viable source of clean energy to the marketplace by 2015." ***
- **Business objectives summarized in project charter but lacked**
  - **Economic goals**
  - **Documented cost-versus-schedule trade-offs (e.g. what are we willing to spend to meet a particular date?)**
  - **Costs for alternative scopes**

*** Taken from Lower Churchill Project overview documentation**

Scope

Lower Churchill Project

- **Development of Gull Island (2250 MW) hydro-generating plant in Labrador (dam and reservoir)**
- **Construction of the following lines:**
  - **1300 km of 450 kV HVDC transmission lines to Soldier’s Pond (Newfoundland)**
  - **Submarine cable between Labrador and Island of Newfoundland**
  - **203-km, 735-kV intertie between Gull Island and existing Churchill Falls plant**
- **Construction of 2 HVDC/AC converter stations**
- **Possible HVDC transmission lines and submarine cable connection between NL and Nova Scotia, with associated HVDC/AC converter station**
- **Possible transmission lines to Romaine, Quebec**

Time Frame (1)
Lower Churchill Project

- End of FEL 2 at end of September 2008
- FEL 3 will begin in October 2008
- Engineering will start September 2008 and go through February 2012
- Bids out by mid 2009 and plans to award construction contracts by 2010
- Site bridge scheduled for construction after 2010 spring thaw
- Access to South side of river in late fall of 2010

Time Frame (2)

Lower Churchill Project

- **Financial close will be in early 2010**
- **Diversion of river and start of main dam construction in 2012**
- **Commissioning of first turbine generator unit and impounding of reservoir complete by mid December 2015**
- **Subsequent units will be installed and started by August 2016**
- **First commercial power slated for 2015 with full commercial power by 2016**

Total Estimated Costs in C$ Millions*

Lower Churchill Project

Cost Category	Estimated Cost
Process Design	19.89
Detailed Eng	214.67
Const. Supv.	Included in Const Labor
Proj. Mgmt.	163.23
Major Equipment	1,005.91
Bulk Mat'l	2,185.49
Const Labor	1,314.61
Other Const	1,429.47
Contingency	Not yet determined
Escalation	Not yet determined
TIC	6,333.26
Special	Not yet determined
Startup	Not yet determined
Total Project Cost	6,333.26

* Costs provided are as of the time of the project interview, with updated contingency

Schedule Milestones*

Lower Churchill Project

Phase	Start	Finish	Duration
Project Definition	1 Jul 2006	29 Jun 2010	47.9 months
Sanction	30 Jun 2010	30 Dec 2010	6.0 months
Detailed Engineering	1 Sep 2008	28 Feb 2012	41.9 months
Procurement	1 May 2009	12 Nov 2015	78.4 months
Construction	13 Jul 2010	17 Jan 2016	66.2 months
Startup	29 Oct 2015	17 Aug 2016	7.0 months
Execution**	1 Sep 2008	17 Jan 2016	88.5 months
Cycle Time	1 Jul 2006	17 Aug 2016	121.6 months

*** Dates provided are as of the time of the project interview**

**** Execution includes Detailed Engineering and Construction only**

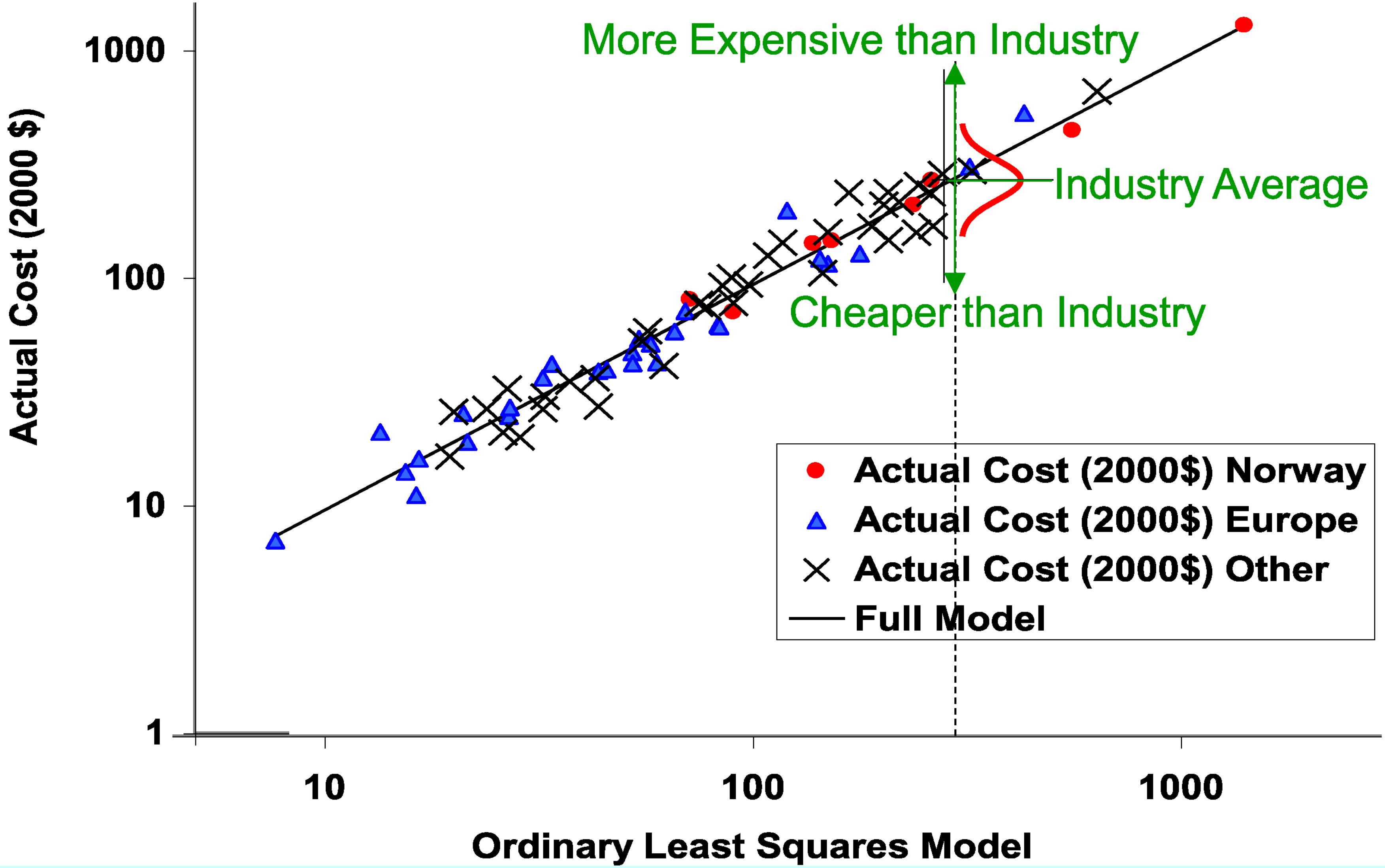
Outline

- Summary
- Background
- ***Methodology***
  - ***Framework and Approach***
  - Basis of Comparison
- Recent Lessons From Canada
- Practices
- Outcomes
- Conclusions and Recommendations

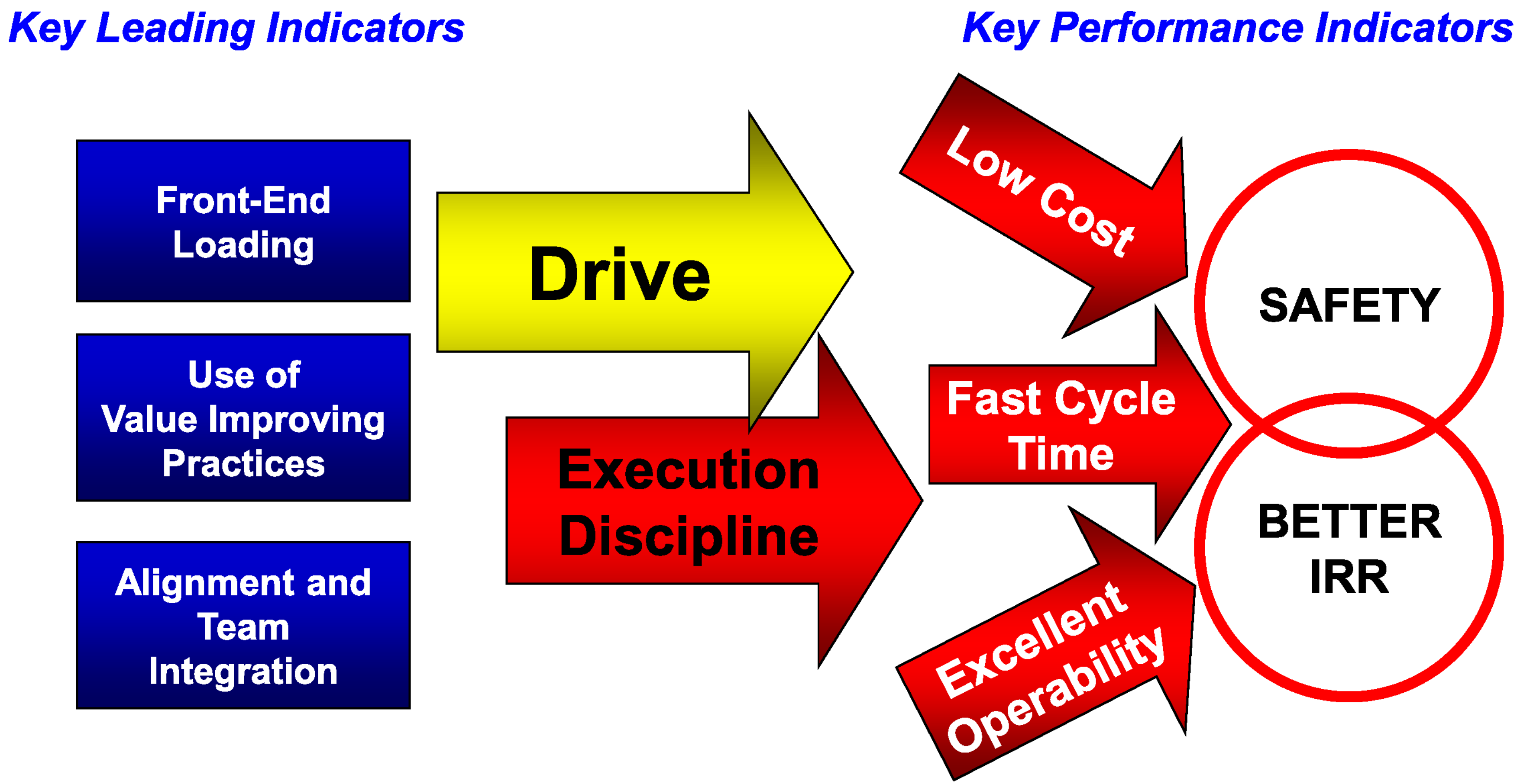
Statistical Models

- Based on historical performance of past projects
- Used to generate an industry average prediction for projects with similar characteristics
- Used to provide a statistical range around industry averages
- Used to measure project's actual/planned outcomes versus industry average

Example Analysis

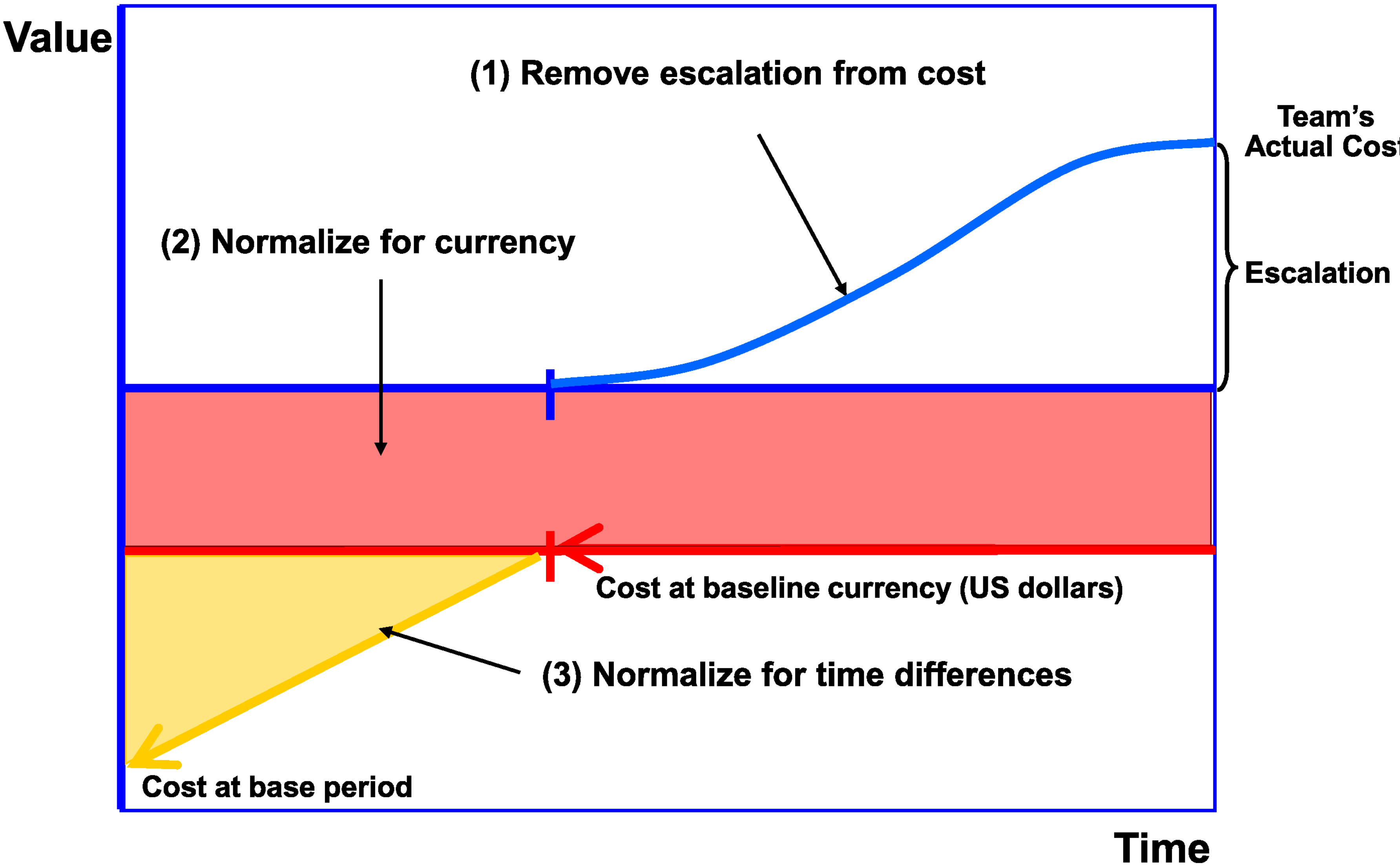


Elements of Capital Effectiveness

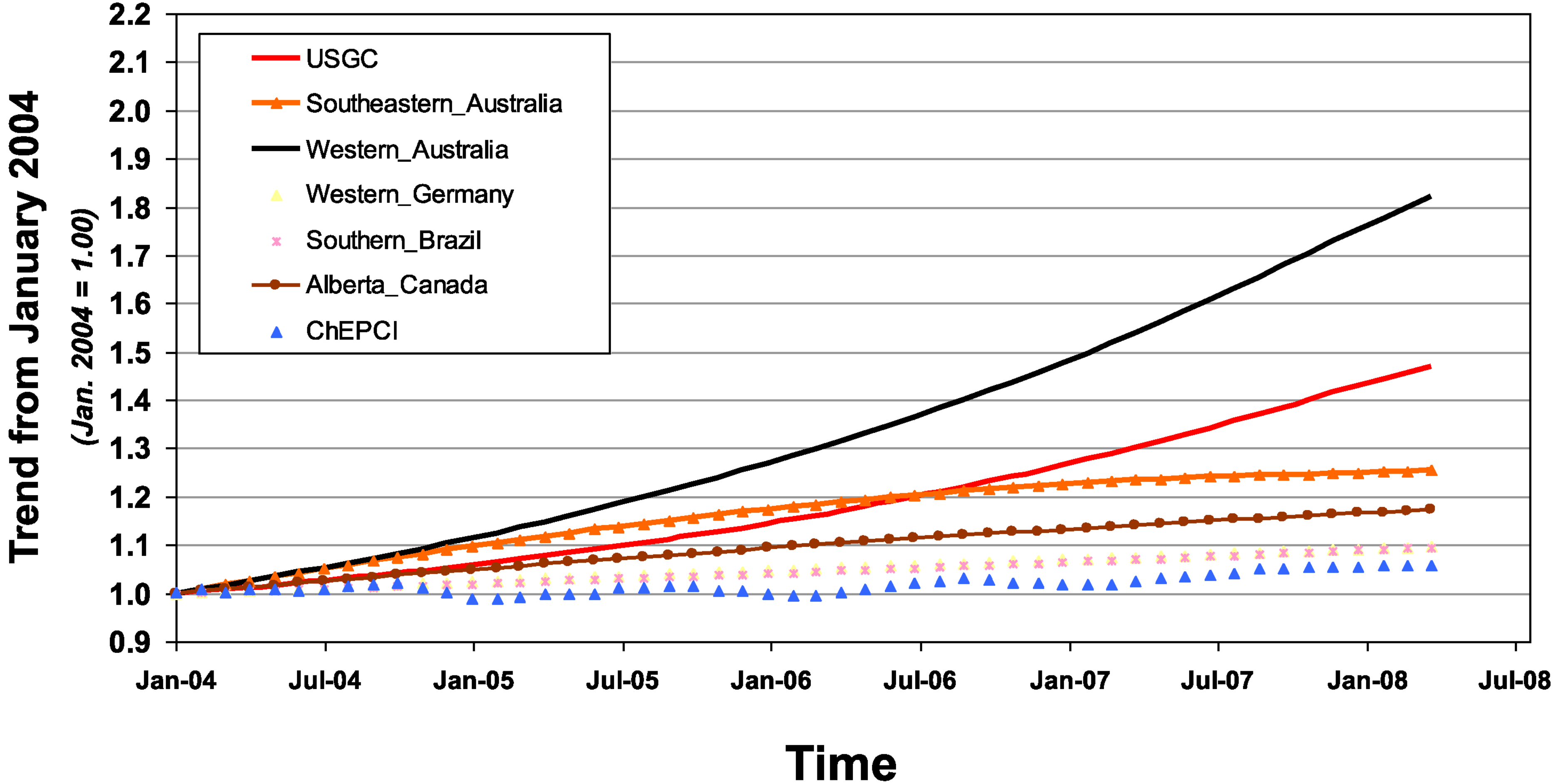


How Does IPA Normalize Costs?

Three Steps



Construction Labor Escalation



Cost escalation trends are displayed in local currency.

Lower Churchill Project Modeling

Benchmark Caveats

- **Several databases were compiled to provide bases of comparison for Lower Churchill Project**
- **Despite qualitative information and megaproject history, IPA could not produce reliable cost and schedule benchmarks**
- **A contingency benchmark is provided**
- **As cost elements get more detailed with estimate development, it might be possible to provide some information for certain pieces of scope in the future**

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- Conclusions and Recommendations

IPA Proprietary Databases

PES SMALL PROJECTS
5,000+ projects
Projects <$7MM from process industries

PROCESS PLANTS PES
10,000+ projects
Detailed histories of process plant projects

HAZRISK
400+ projects
Environmental assessments and cleanups

MEGAPROJECTS
100+ projects
$Billion class projects, all types

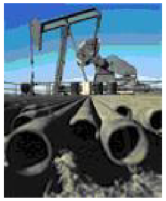
POWER PLANTS
280+ projects
Single or combined cycle plants

PLANNED TURNAROUNDS
200+ projects
Facility turnarounds

INFORMATION TECHNOLOGY
250+ projects; including Applications Development, Telecommunication, etc.

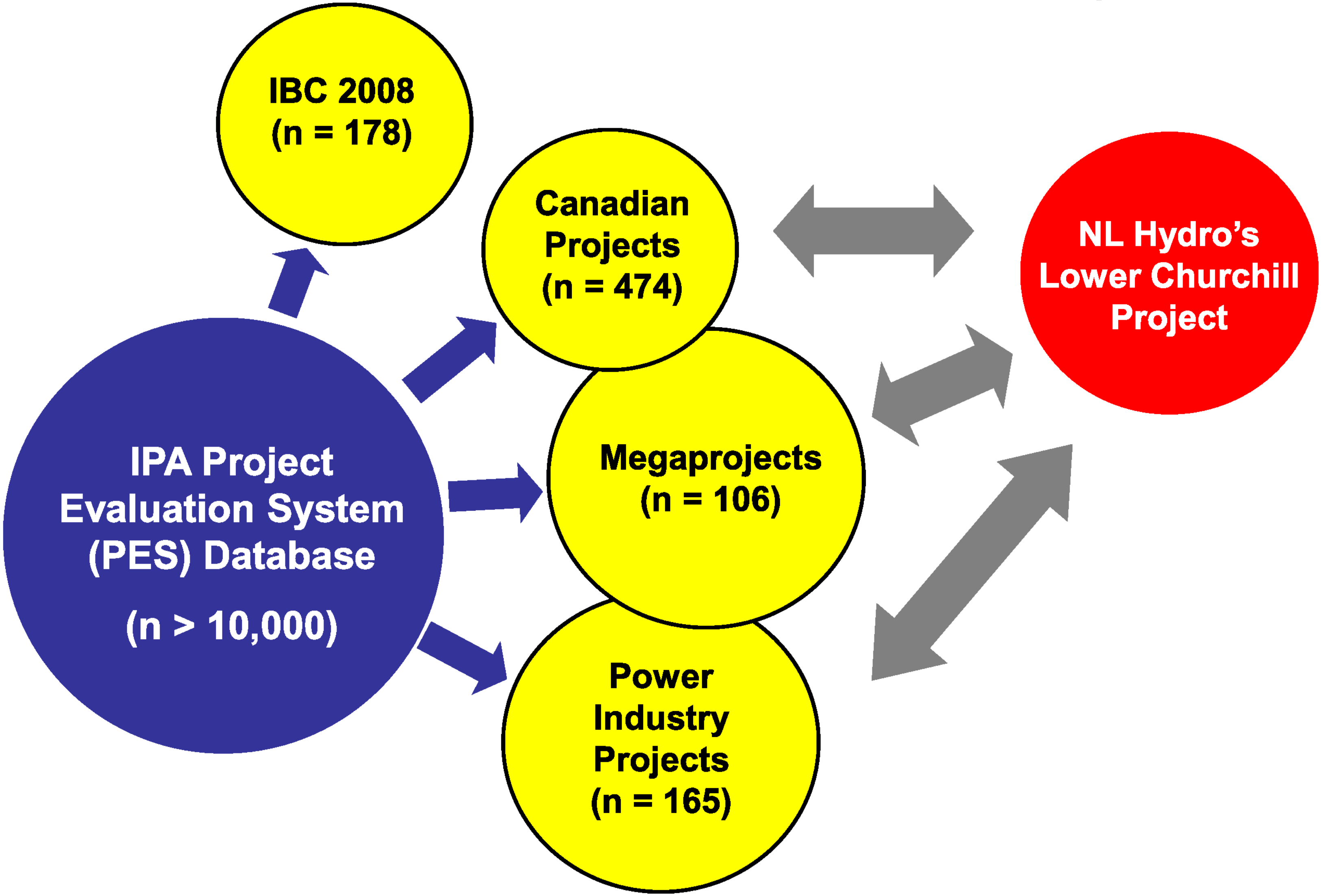
INSTRUMENTATION & CONTROL
70+ projects
Automation, DCS, SCADA, etc.

UPSTREAM PES
900+ projects
Petroleum production platform worldwide



PIPELINES
500+ projects
Pipelines, terminals, booster stations, etc.

Basis of Comparison for Analysis



IBC 2008 Database

Basis for Input Metric Industry Averages

OVERALL PROJECT DATA	• 178 completed projects
MEDIAN SANCTION DATE	• 2005 (2000 to 2007)
PROJECT COST	• Average: $72.6 million • Range: Less than $10 million to more than $1.1 billion
COMPANIES REPRESENTED	• 69 companies

Comparison Data: IBC 2008

- **Purpose: To identify industry norms in capital project practices and performance**
- **Projects included were benchmarked and presented at IBC 2008**
- **Dataset represents most recent snapshot of large capital project performance and practices**

Power Database

Basis for Power Industry Analysis

OVERALL PROJECT DATA	• 165 completed projects
MEDIAN SANCTION DATE	• 2001 (1985 to 2007)
PROJECT COST	• Average: $65.1 million • Range: Less than $10 million to more than $1.7 billion
COMPANIES REPRESENTED	• 49 companies

Comparison Data: Power Projects

- Purpose: To identify industry norms in power generation project practices and performance
- Projects are from several different companies, including several dedicated power companies
- Dataset used for two purposes:
  – To identify possible lessons from previous power projects to share with NL Hydro
  – To provide a basis for evaluating transmission line FEL

Megaprojects Database

Basis for Megaproject Analysis

OVERALL PROJECT DATA	• 106 projects
MEDIAN SANCTION DATE	• 1997 (1980 to 2007)
PROJECT COST	• Average: $1.75 billion • Range: $960 million to more than $6 billion
COMPANIES REPRESENTED	• 32 companies

What Is a Megaproject?

A project can be considered a megaproject if it meets one or more of following criteria:

- ✓ The project's cost is greater than $1 billion
- ✓ The project can potentially change its environment:
  - Regulatory environment
  - Local labor markets
  - Local political environment
  - Financial environment
  - Physical environment
- ✓ The project represents a major step-out of complexity or size for the company
  - Largest ever done by the company
  - Large project with complex interfaces

Megaprojects

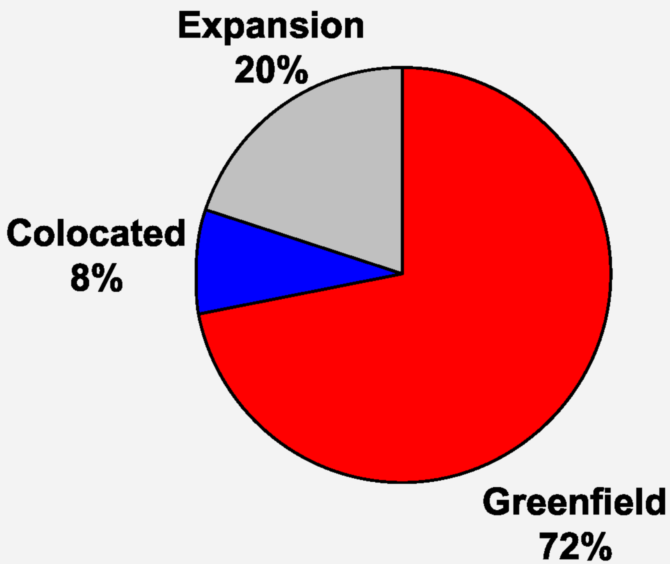
- Although counterintuitive, megaprojects are inherently **fragile** rather than robust
  - More opportunities exist for **things to go wrong**
  - These projects attract a lot of **attention**
  - Megaprojects involve a great degree of **technical and organizational complexity**
  - Little elasticity to absorb problems
- About half of megaprojects are **failures**
- **External factors** are not primary cause of failure

What is a Failure?

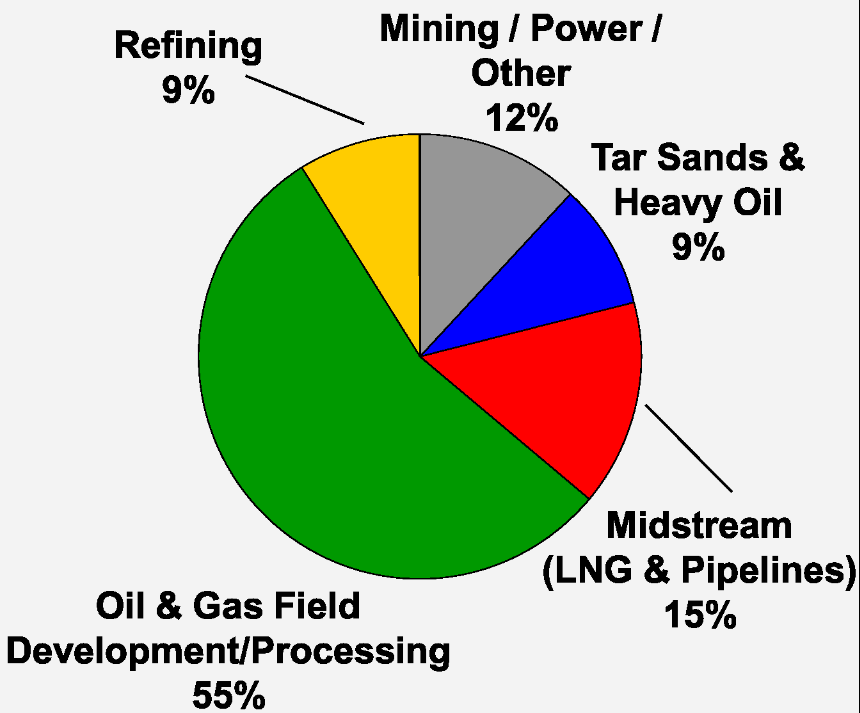
- We deem a project to be a failure if one or more of the following occurred:
  - Costs grew by 30 percent or more
  - Schedule slipped by 30 percent or more
  - Severe and continuing operational problems (first 2 years)
  - Overspent (absolute measure) by 40 percent or more
- 47 percent of on-shore megaprojects in database failed by our criteria
- A number of the failures decided to sacrifice cost, attempting to stay on schedule

Megaprojects Database

PROJECT TYPE



PROJECT SCOPE



Outline

- **Summary**
- **Background**
- **Methodology**
- ***Recent Lessons From Canada***
- **Practices**
- **Outcomes**
- **Conclusions and Recommendations**

Canadian Project Database

Recent Projects Executed In Alberta

OVERALL PROJECT DATA	• 13 projects
MEDIAN SANCTION DATE	• 2002 (1998 to 2004)
PROJECT COST	• Average: \$546 million • Range: \$160 million to \$4.5 billion
COMPANIES REPRESENTED	• 8 companies
PROJECT TYPE	• Tar Sands • Upstream • Refining/Chemical

Outcomes for Alberta Projects
Cost Growth and Schedule Slip

- **Large projects have shown pattern of significant cost growth and schedule slip**
- **Even small changes to plans can put outcomes at risk because of their complex and fragile nature**
- **Lower Churchill Project is not located in Alberta, but its ability to succeed is linked to the Alberta market**
- **This study provides insight to some underlying causes and provides recommendations to Lower Churchill Project on how to avoid similar failures**

[redacted]

Cost Growth in Alberta

Pattern Is Unusual

- In large complex projects, contingency is historically consumed in labor categories (i.e., labor and engineering)
- Well defined projects on average show little growth in quantities or costs for bulk materials or equipment
- Pattern for Alberta projects is different—most Alberta projects experienced significant quantity and cost growth in both bulk materials and equipment
  - Relative to historical norms
  - Growth was still not as high as in other project areas

[redacted]

Why the Growth in Materials?

- Some Alberta projects began execution with poorly defined engineering deliverables
  - Changes made late in FEL
  - Projects are schedule driven—sanctioned by calendar rather than by completion of FEL deliverables
  - Owner teams were reportedly too small to execute FEL well
- Contractors did not understand process units that they were building, thus underestimating the project
- Standards and specifications inconsistent or changed during detailed engineering (e.g., more steel, concrete)

Labor and Indirects Show Greatest Increases

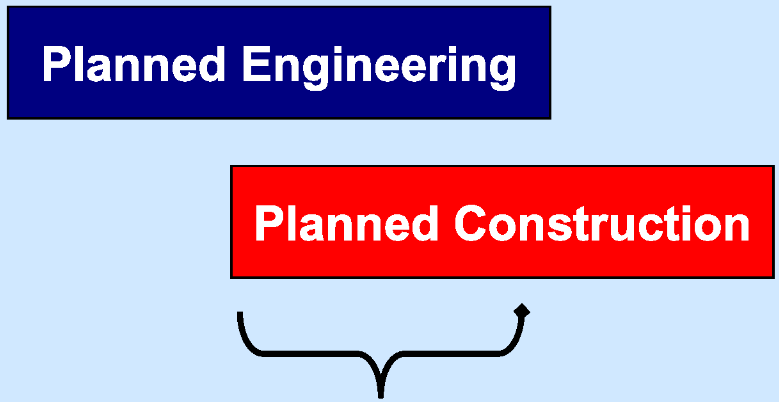
- By far, greatest cost growth was in field labor (construction labor, construction indirects, and supervision)
- Total labor hours, peak labor count, and construction durations all grew in many Alberta projects
- Some of these issues were reportedly due to poor or inexperienced labor, but there were other drivers as well

[redacted]

Why Cost Growth Is Mostly in Field

- **Root causes of spiraling field costs can be linked back to entering field with inadequate design complete**
- **Incomplete design leads to growth in quantities, increases in engineering hours, and ultimately failure in field**
- **Anecdotally, ambiguous basis for project controls (i.e., tracking progress) also exacerbated cost growth issues**
  - **Tasks were identified as complete, but still required rework or redesign due to quality issues**
  - **Tasks not reevaluated for progress tracking, so reports showed a project on track while it was actually derailed**

Projects Typically Enter Field When 50 to 60 Percent of Design Is Complete



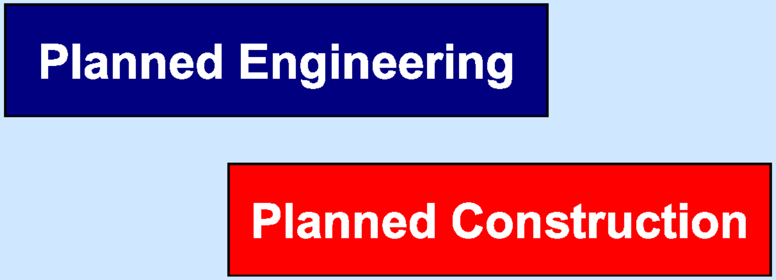
One way to look at this is how much overlap between engineering and construction is planned.

Projects typically plan overlap of construction with engineering so that 50-60 percent of design is complete when construction begins.

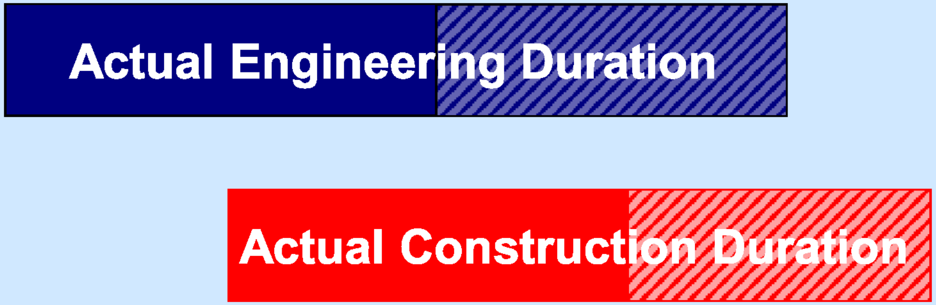
Alberta Engineering Typically Falls Behind

Start of Construction Remains Fixed

Alberta projects planned to be 40 percent design complete at start of construction



But actually enter field with far less overall design complete when field work actually begins



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Cascading Effect of Incomplete Design

- **Entering field with incomplete engineering results in escalating costs and schedule slip**
- **Increased quantities make estimate and execution plan no longer adequate for purpose of controls**
- **Original estimate and schedule were made for a project different from one now being executed**

The Path to be Avoided

When one or more of these occur

- Incomplete FEL
- Design change late in FEL
- Contractor doesn't understand scope
- Unclear specifications and standards
- Aggressive schedule targets

Increases likelihood of these happening

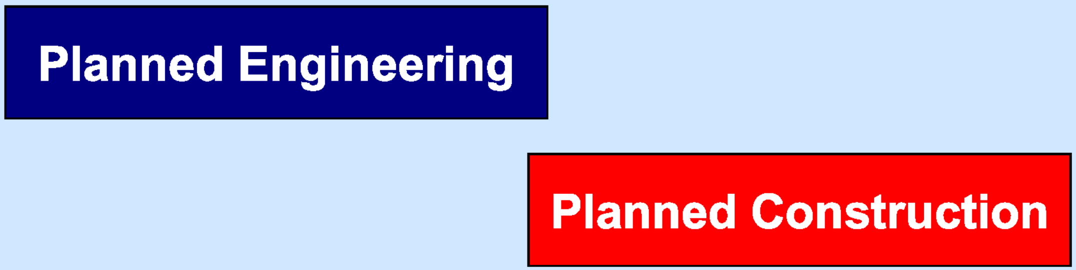
- Quantities grow
- Engineering needs rework
- (Engineering falls behind)
- (Field work begins anyway)

Ending with these results

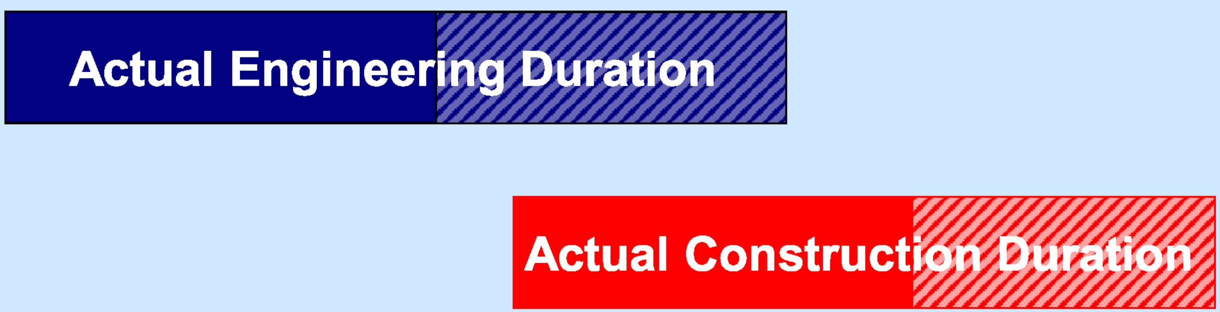
- Field quantities grow
- Labor requirements grow
- Peak labor increases
- (Productivity drops)
- (Field costs explode)

Adapting to Alberta Environment

Alberta projects need to plan for 80-90 percent design complete at start of construction with a plan for much less overlap between engineering and construction



Knowing project will actually enter field with less (but adequate) design complete



What Have We Learned?

- Lower Churchill Project is different in many ways from recently executed Alberta projects
  - Not process-oriented
  - Located in Newfoundland and Labrador
  - Sanction cannot happen without bids in hand
- However, some lessons still apply:
  - Do not count on predictable engineering productivity and performance—plan for potential slip
  - Maintain discipline when completing FEL and producing adequate bid packages
  - Have contingencies in place to account for a less productive and experienced labor force
  - Get a solid understanding of equipment and material markets and pricing before commitment

Outline

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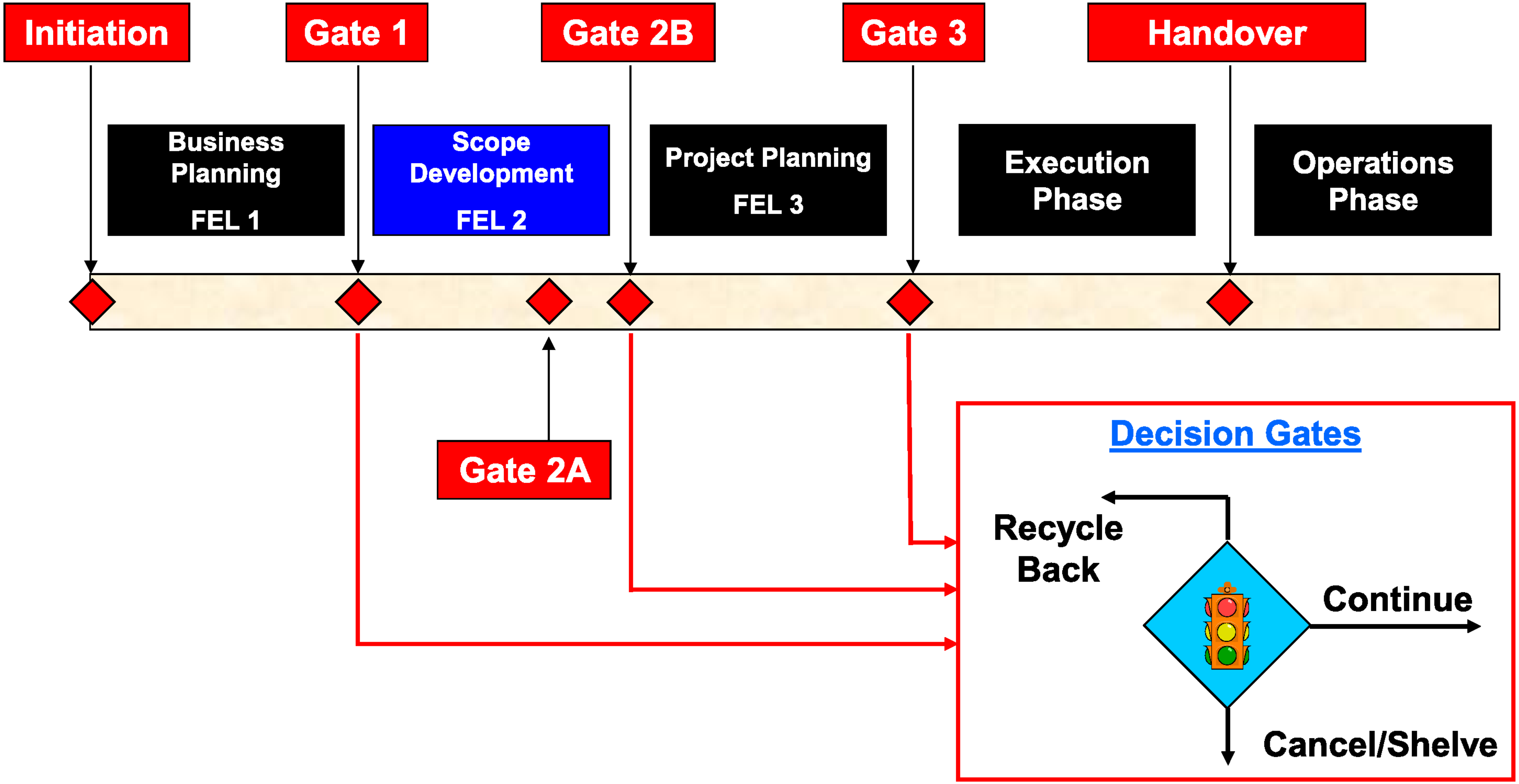
FEL 2 Is the Critical Project Definition Phase



Why Is FEL 2 the Most Important Phase?

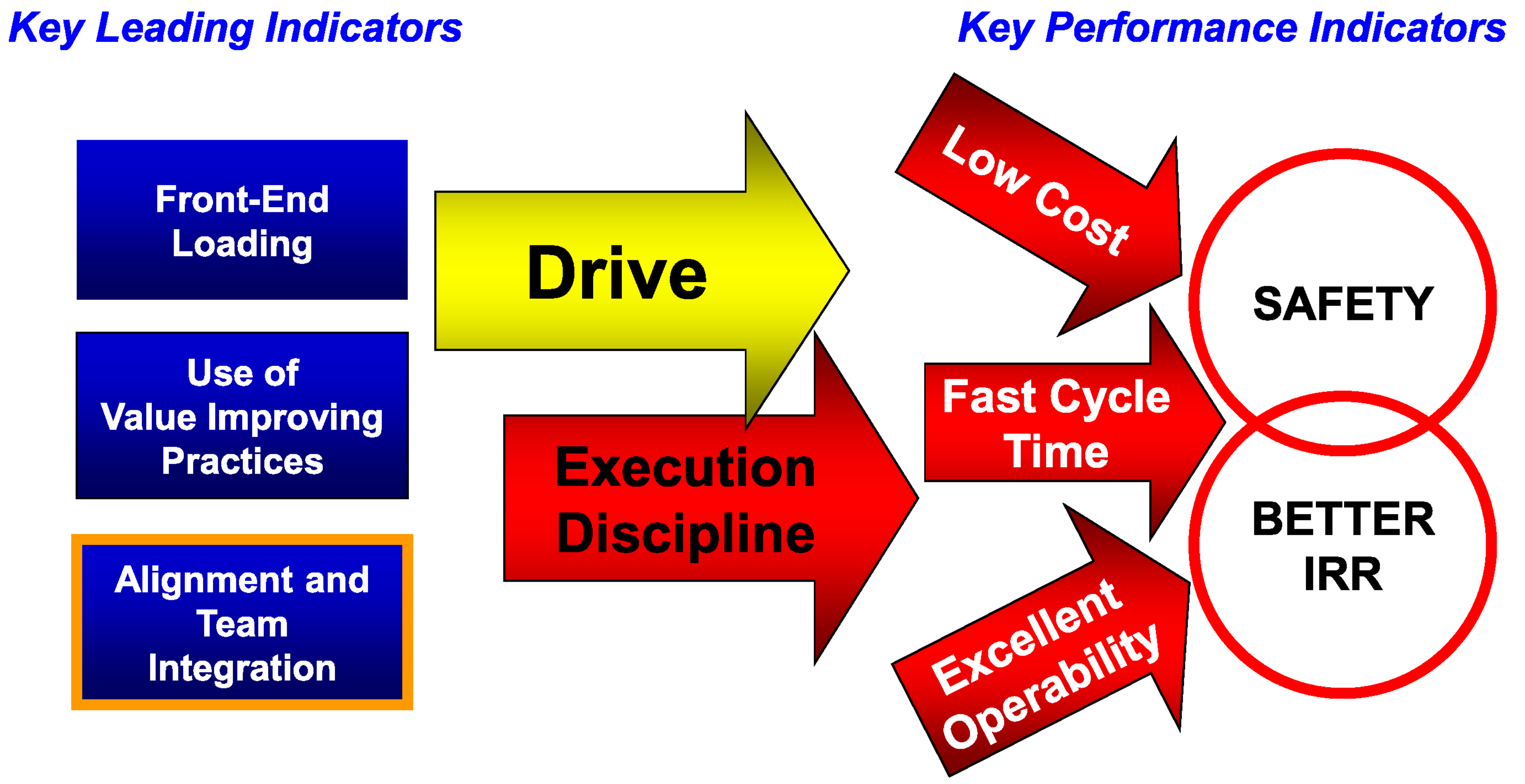
- **Starting FEL 3 without completing FEL 2 is the root cause of several problems endemic to Industry**
  - **Projects that get delayed, recycled, or cancelled during FEL 3**
  - **Projects that do not meet the business need after they are put into operation**
  - **Projects that reach *Best Practical* FEL, but do not have competitive outcomes**

Three Key Practices Facilitate Reaching FEL 2 Goals

KEY FEL 2 PRACTICES

- Clearly defined business objectives and project objectives
- Project teams with adequate representation from key stakeholders, especially business (integrated team)
- Reaching closure on project scope at end of FEL 2

Elements of Capital Effectiveness



Three Key Practices Facilitate Reaching FEL 2 Goals

KEY FEL 2 PRACTICES

- ***Clearly defined business objectives and project objectives***
- **Project teams with adequate representation from key stakeholders, especially business (integrated team)**
- **Reaching closure on project scope at end of FEL 2**

Three Key Practices Facilitate Reaching FEL 2 Goals

KEY FEL 2 PRACTICES for Lower Churchill Project

- ***Clearly defined business objectives and project objectives - Not Complete***
  - **Business objectives defined at summary level**
  - **Gaps driven by lack of explicit, formal business objectives that are translated into specific project objectives**
  - **Team was working on addressing this gap at time of project interview**

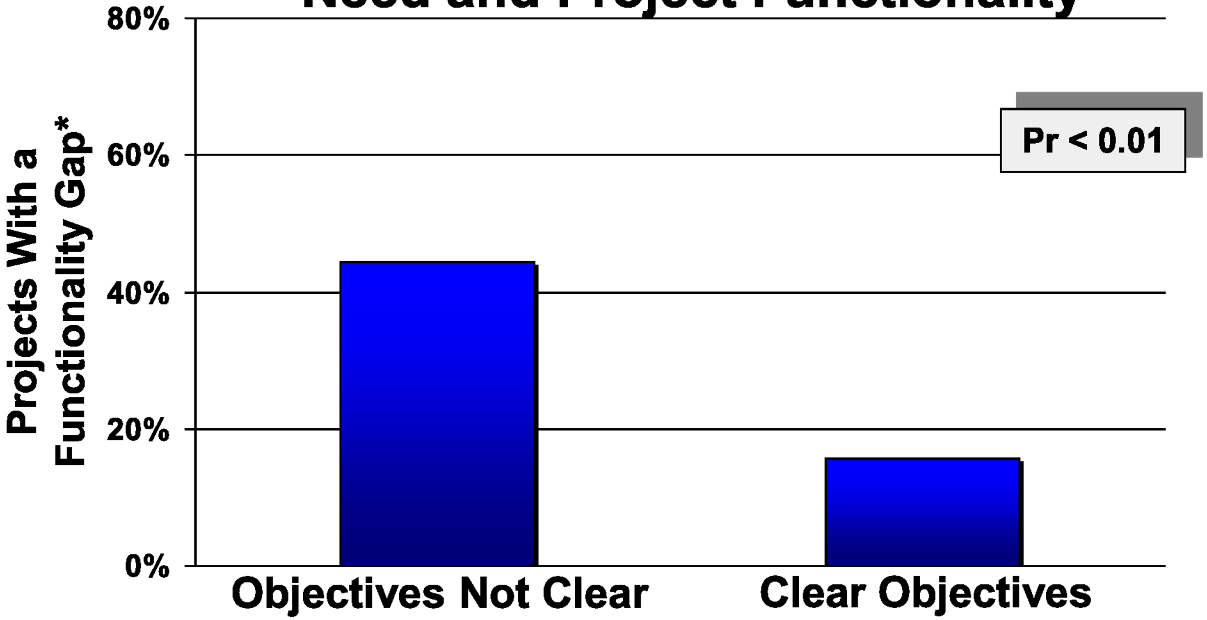
Gaps in Business Objectives

- **Several FEL 1 deliverables are not yet finalized into clear and detailed business objectives, but need to be:**
  - **Economic analysis is not complete**
  - **Market analysis is not complete**
  - **Analysis of competition is not complete**
  - **Acceptable ranges for capital investment and cost of power sold is not complete**
- **Intent is to finalize these elements prior to Gate 2B**
- **These analyses should be reduced to detailed business objectives that guide project's objectives**

Clarity of Objectives

Lower Churchill Project does not have clear alignment between business and project objectives

Misalignment Results in Gap Between Business Need and Project Functionality

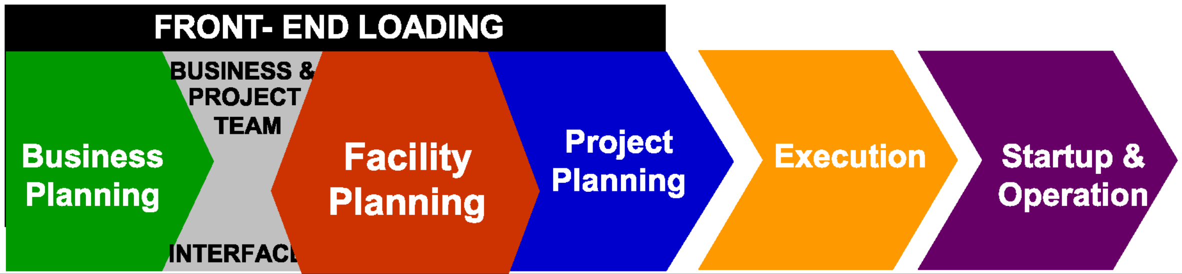


Project functionality gap = project capacity, flexibility, or reliability did not meet business need after startup

Business and Project Team Interface

[redacted]

Facility Planning



[redacted]

Effects of Clear Business Goals

Project Outcomes

[redacted]

Three Key Practices Facilitate Reaching FEL 2 Goals

KEY FEL 2 PRACTICES

- **Clearly defined business objectives and project objectives**
- ***Project teams with adequate representation from key stakeholders, especially business (integrated team)***
- **Reaching closure on project scope at end of FEL 2**

Three Key Practices Facilitate Reaching FEL 2 Goals

KEY FEL 2 PRACTICES for Lower Churchill Project

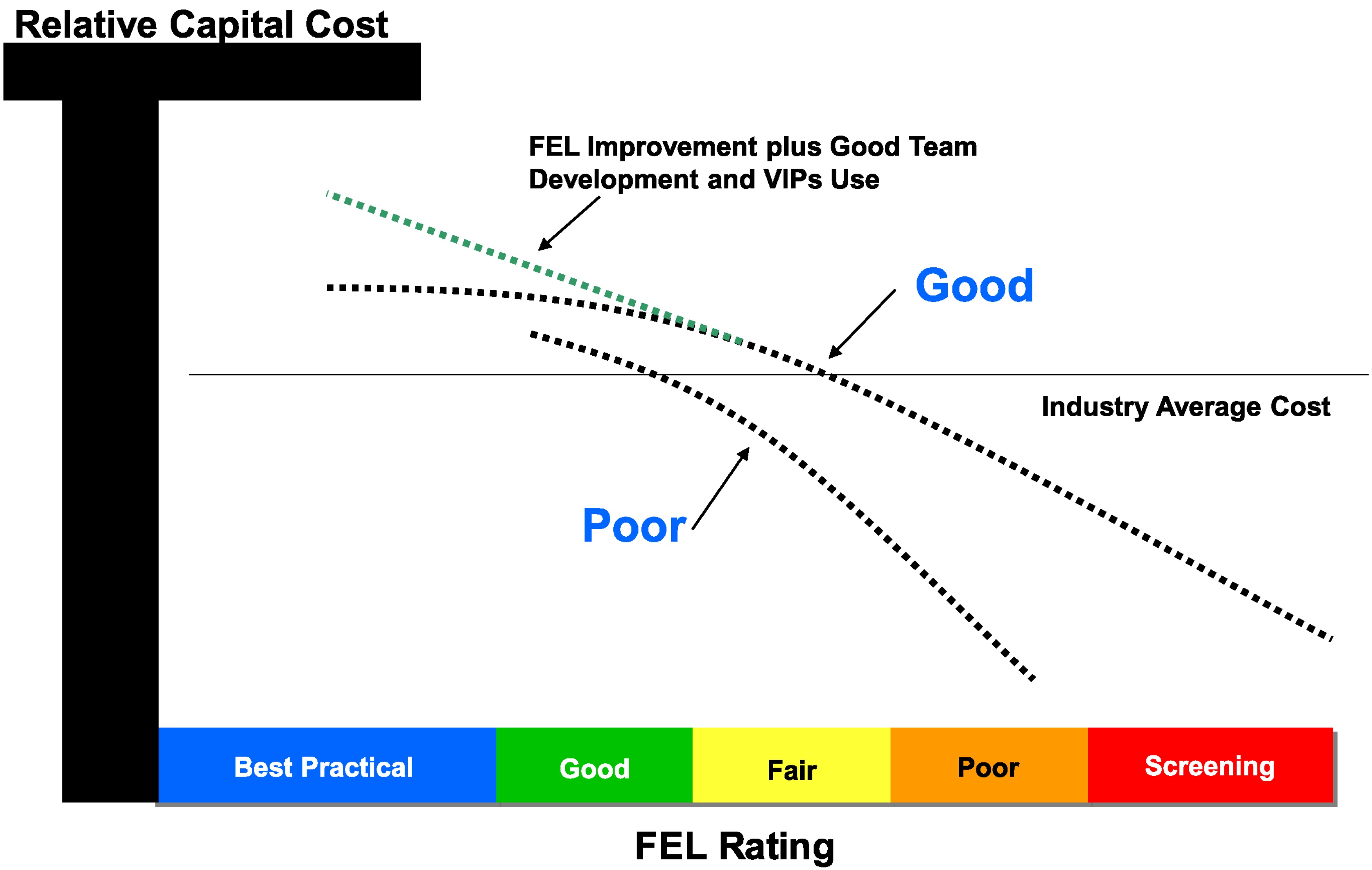
- ***Project teams with adequate representation from key stakeholders, especially business (integrated team) - Achieved***
  - All functions are represented on team
  - All major leading functions represented on organizational chart are staffed
  - Representatives are in place to engage all external stakeholders

Components of Team Development

- Project Objectives
- Team Composition
- Roles & Responsibilities
- Project Implementation Process

[redacted]

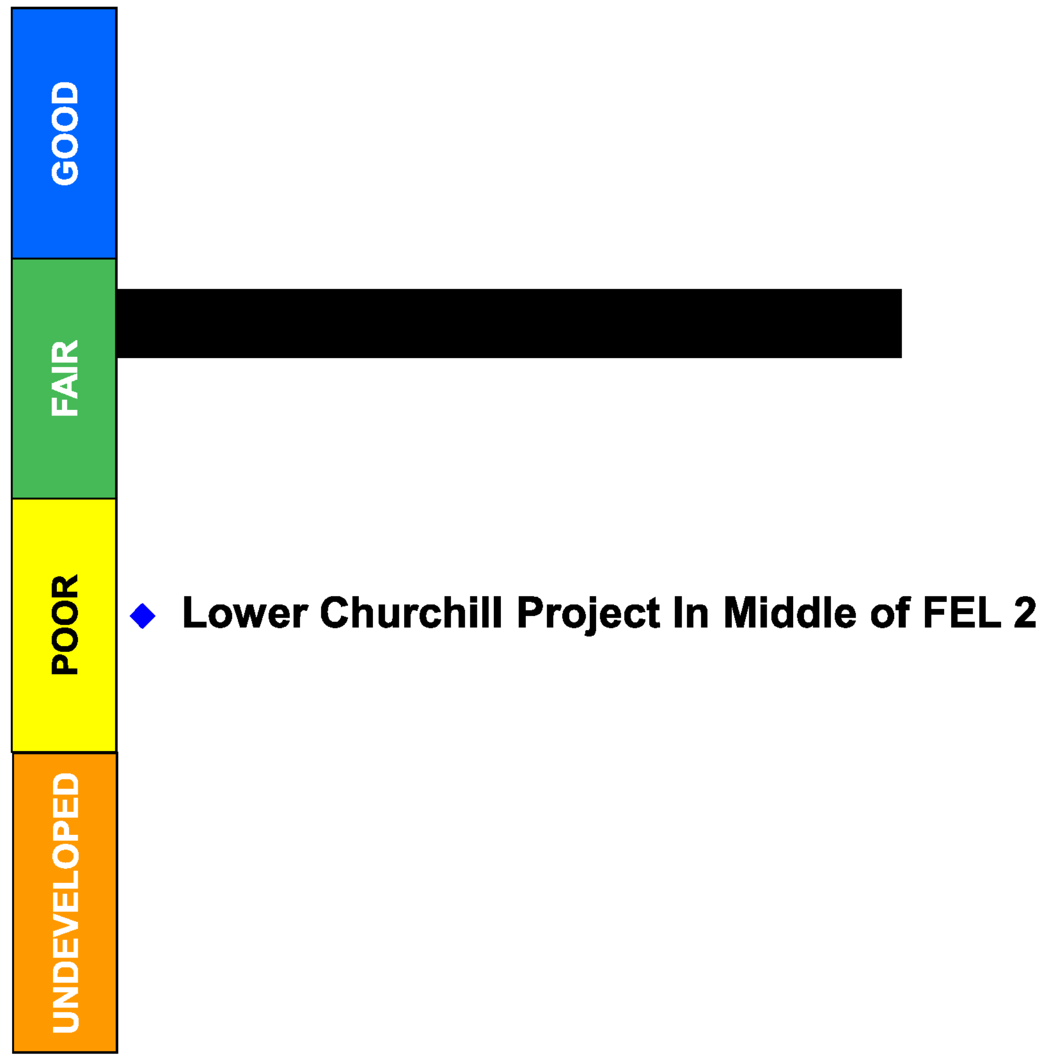
Team Development, FEL, and VIPs Use Drive Cost Performance



Lower Churchill Project TDI

Gaps Need To Be Filled Before Sanction

Team Development Index (TDI)



*** Projects sanctioned in 2007 (IBC 2008 data)**

Lower Churchill Project TDI (1)

- **Project Objectives**
  - ✘ **Business and project objectives formally documented**
- **Team Integration**
  - ✓ **Team integrated with full functional representation**
  - ✓ **Key roles staffed**
  - ✓ **Sufficient operational input was secured from experienced facility personnel**

Lower Churchill Project TDI (2)

- **Roles and Responsibilities**
  - ✓ Understood and documented; major tasks and problems identified
  - ✓ Detailed risks and mitigation plans documented in execution plans
- **Standard Work Process**
  - ✘ Team is developing NL Hydro work process alongside project development—cannot be improved due to lack of existing/established process for NL Hydro

Some Definitions

Team Development Versus Team Functionality

- **Team Development**
  - **Indicates whether certain activities have been done to establish and develop a project team**
  - **Team Development Index (TDI) is *objective* measurement by IPA on how well project team is developed**
- **Team Functionality**
  - **Reflects perception of team members of how well a project team is working together**
  - **Team Functionality Index (TFI) is *subjective* measurement by project team on how well they are working together (self-assessment of team)**
  - **Results based on responses from 35 surveys**

Questionnaire Measures Team's *Perception* of These Elements

Leadership

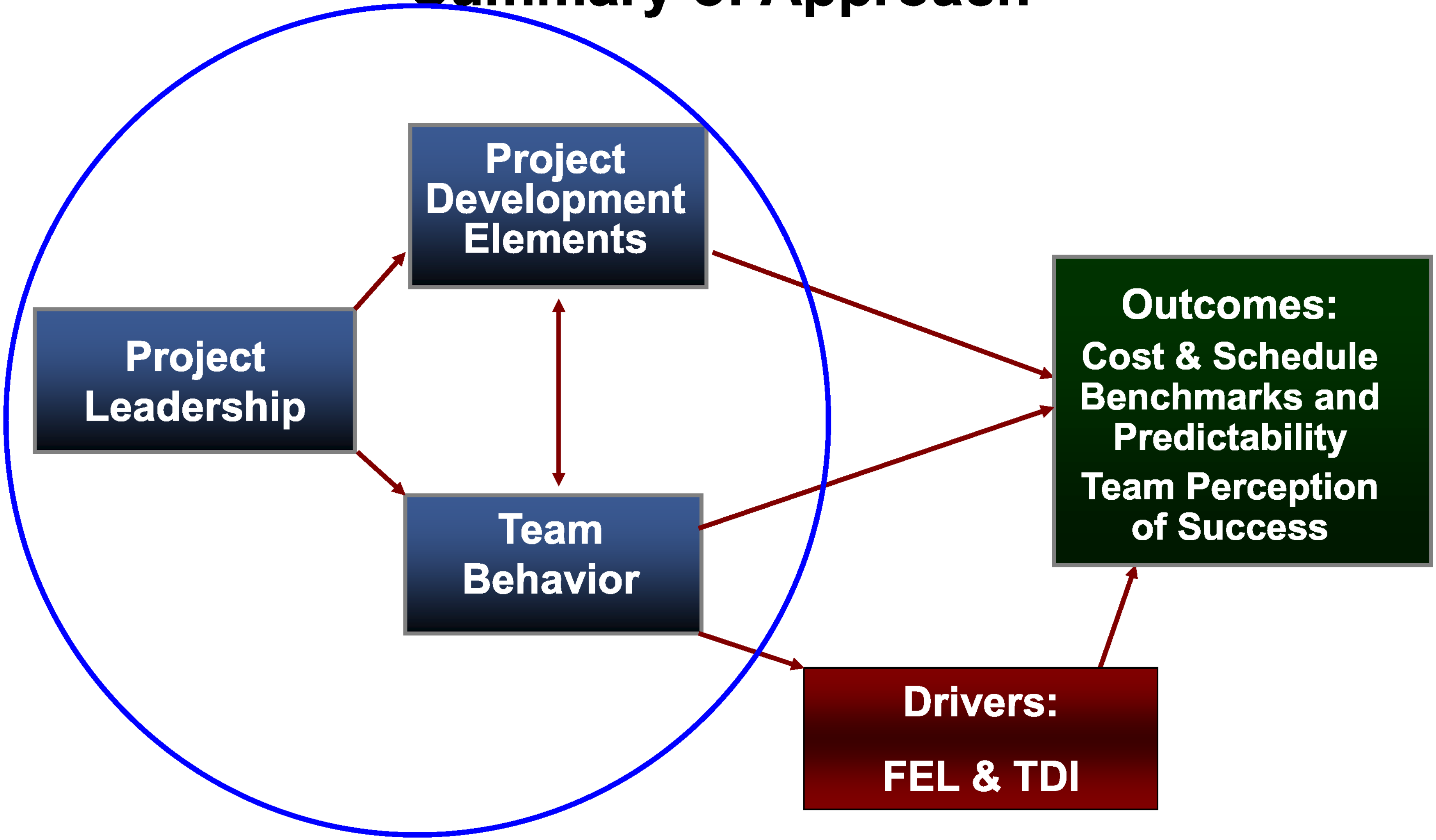
Project Development Elements

Team Behavior

Project Success

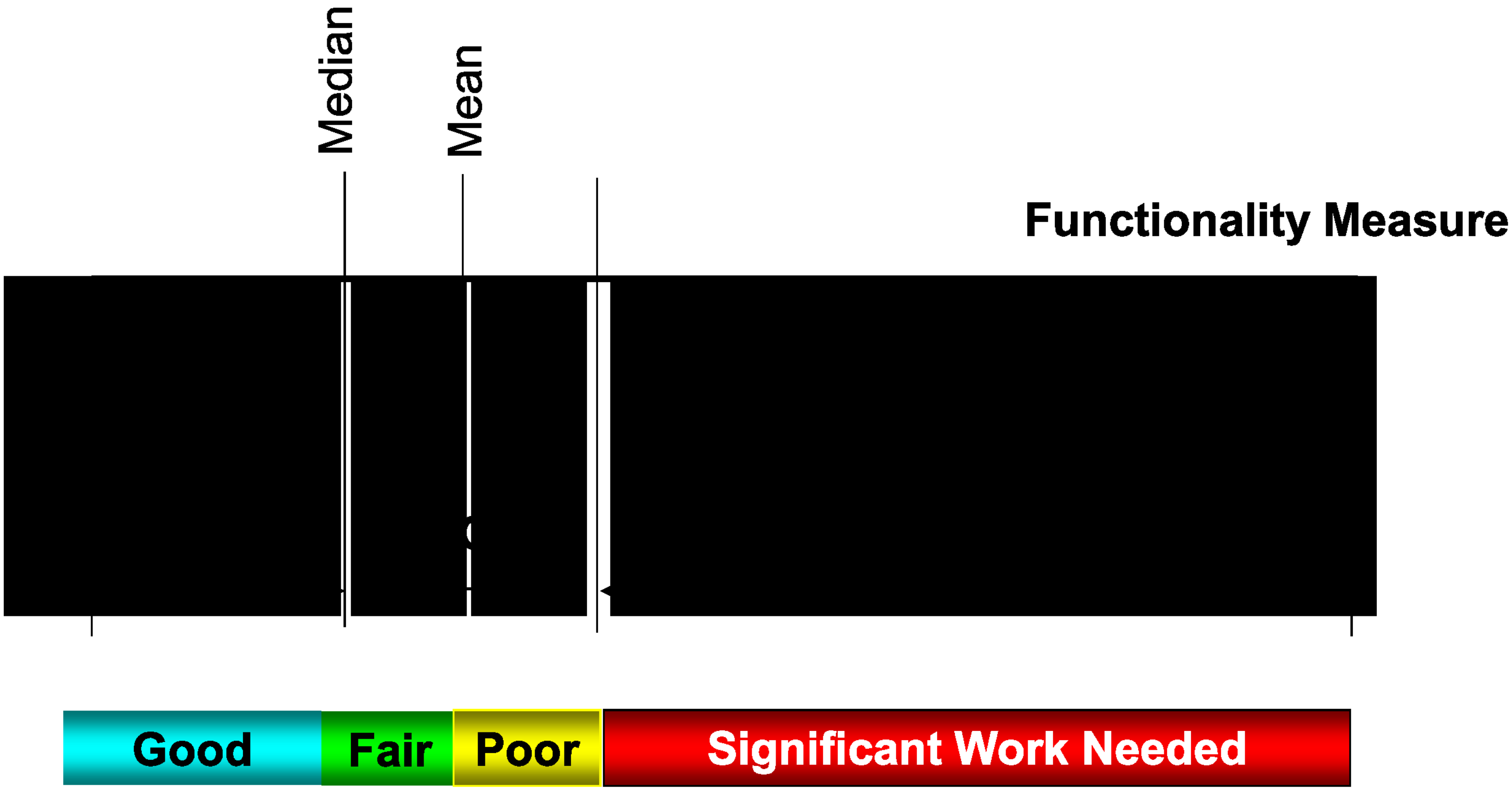
[redacted]

Summary of Approach

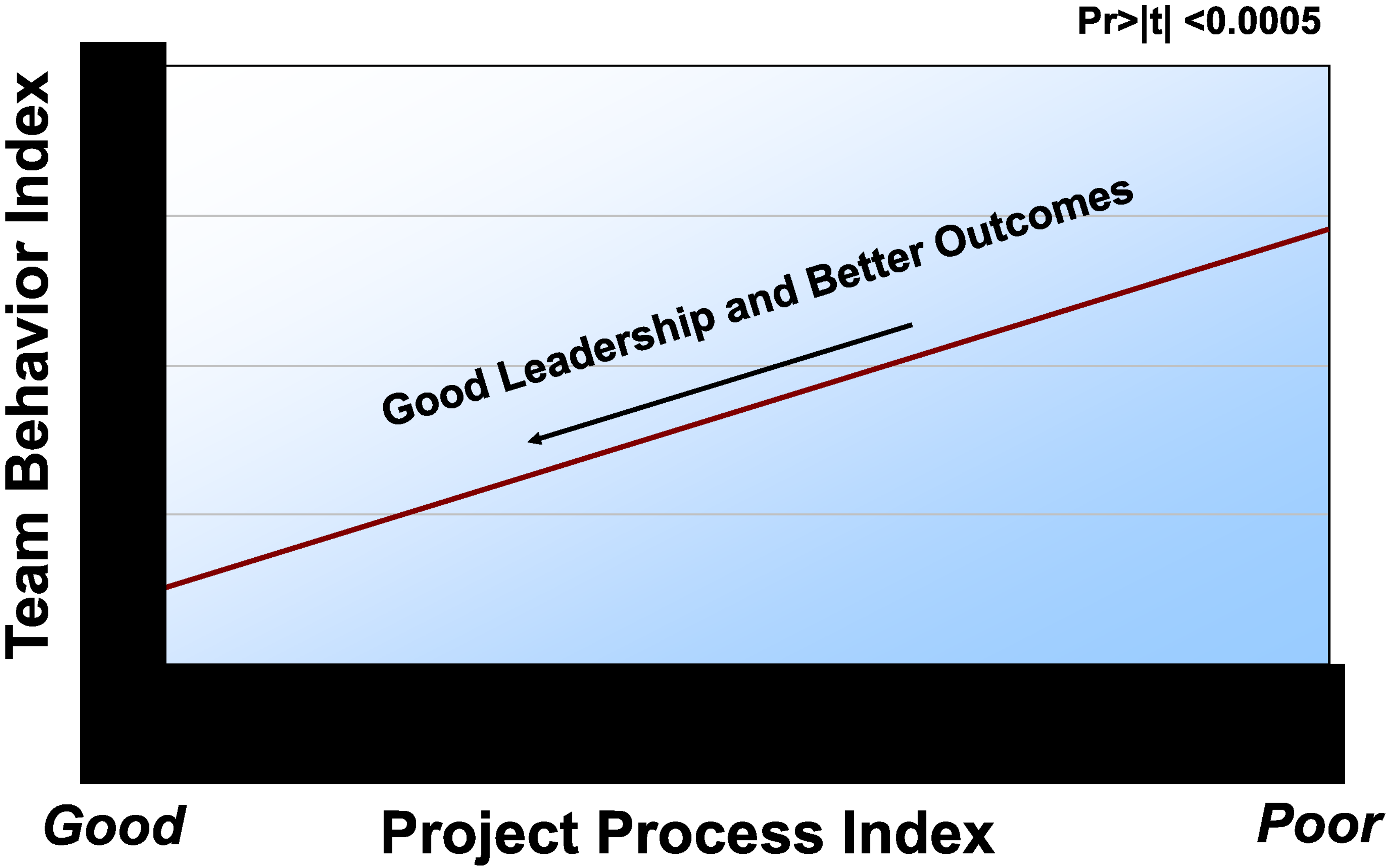


Elements of Team Functionality

The Team Functionality Scale
Four Categories

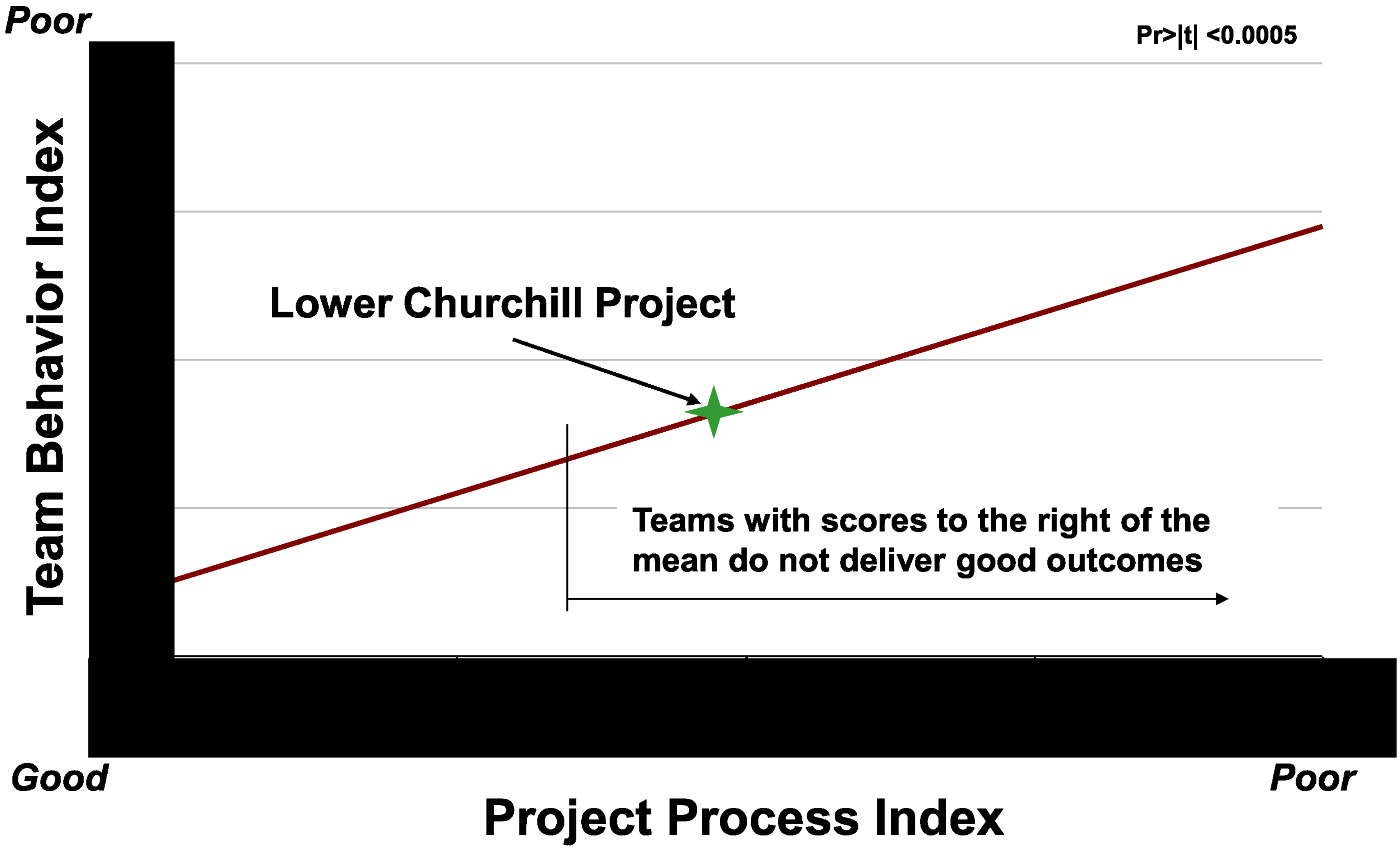


An Effective Process and Good Behavior Together Deliver Successful Projects



Lower Churchill Project Team Functionality

On Track, But Further Work Is Required



Understanding Team Functionality
Lower Churchill Project

- Currently, project team perceives that major issues need to be resolved:
  - Unclear objectives
  - Ineffective decision making
  - Poor interfaces and business leadership
  - Roles and responsibilities not understood
  - Poor alignment
- Some perceptions reflect that project is still in mid-FEL 2
- Work process is also still in development, which may be driving some perceptions

Teams: What Needs to Happen Next? (1)

Lower Churchill Project

- **Business and project objectives need to be more explicitly stated and communicated to team**
- **Roles and responsibilities for all team members should be explicitly defined and communicated**
- **Timeliness of key decisions needs to be examined and addressed in the work process requirements**
- **Communication between team members needs to be improved**
  - **Some perceptions may be driven by segregating certain commercial responsibilities to prevent information leaks**
  - **If communications cannot be improved due to secrecy, at least guide team enough to promote understanding**

Teams: What Needs to Happen Next? (2)

Lower Churchill Project

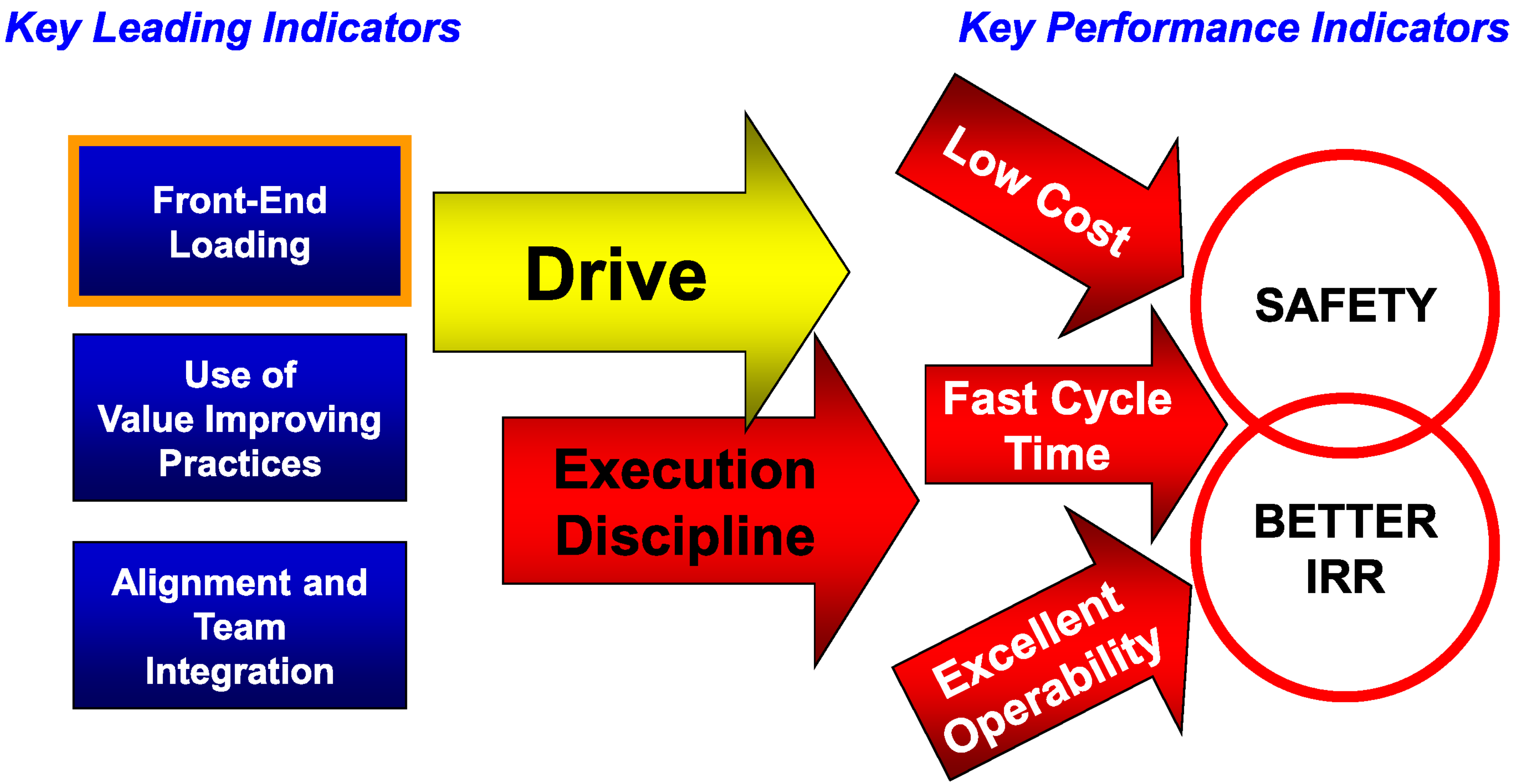
- **Continue to implement and clarify the project work process**
  - **A strong work process is tied strongly to team alignment**
  - **Process guides and informs team**
- **Some perceptions are due to challenges outside of team's control**
  - **External stakeholders**
  - **Clients and end-users**
  - **These undermine team's perception of ability to succeed**

Teams: Steering Committee

Lower Churchill Project

- **One perceived gap from survey is in vertical integration between team and business**
- **Project reportedly lacks a formal steering committee with regular meetings**
- **Some steering committee facts:**
  - **Only 6 percent of megaprojects in IPA's database did not have a steering committee**
  - **Large projects (>$100 million) with no steering committee had the following issues:**
    - **> Worse team development**
    - **> Worse FEL**
    - **> Poorer operability**

Elements of Capital Effectiveness



Three Key Practices Facilitate Reaching FEL 2 Goals

KEY FEL 2 PRACTICES

- **Clearly defined business objectives and project objectives**
- **Project teams with adequate representation from key stakeholders, especially business (integrated team)**
- ***Reaching closure on project scope at end of FEL 2***

Three Key Practices Facilitate Reaching FEL 2 Goals

KEY FEL 2 PRACTICES for Lower Churchill Project

- ***Reaching closure on project scope at end of FEL 2 - Almost achieved***
  - **The NL Hydro "market sounding" effort is a driver for scope selection, and that is not yet complete**
  - **Most work necessary to reach scope closure is complete, and some efforts are being developed concurrently**

FEL Index

Components of Pacesetter (FEL 2)

Site Factors + **Engineering Status** + **Project Execution Planning** → **Pacesetter FEL**

[redacted]

Lower Churchill Project FEL
Some Requirements to Close by FEL 2 Gate

Generation Portion of Lower Churchill Project in Mid-FEL 2
June 2008
[redacted]

Transmission Portion of the Lower Churchill Project in Mid-FEL 2
June 2008
[redacted]

Over-defined	Best	Good	Fair	Scope Develop. Complete	Scope Development in Progress	Screening Study

[redacted]

Best Practical Range at End of FEL 3
[redacted]

Industry Average at End of FEL 3
[redacted]

Best Practical Range at End of FEL 2
[redacted]

Industry Average at End of FEL 2
[redacted]

Project Definition: Generation Facility (1)

- **Site Factors *Preliminary*, *Best Practical* for FEL 2**
  - **Plot Plans complete and rated *Definitive*—further along than usually seen at this stage**
  - **Geotechnical Data are *Preliminary***
  - **Health and Safety Status is *Factored*—completing Hazard Identification (HAZID) before end of this stage is a Best Practice**
  - **Environmental Status is *Preliminary*, although risk is higher for this project than in other projects**
- **Apart from Health and Safety Status, all elements are where they should be at FEL 2**

Project Definition: Generation Facility (2)

- **Engineering Status is *Limited Study*, which is *Best Practical* for FEL 2**
  - **Front-end engineering design (FEED) package with detailed scope of work is nearly complete**
  - **Required engineering deliverables are issued for approval and have been reviewed by relevant stakeholders**
  - **Only gap in this area is cost estimate, which is not yet of control-grade quality**
- **Some engineering work is closer to where it would be at the end of FEL 3**

Project Definition: Generation Facility (3)

- **Project Execution Planning is *Factored*; *Best Practical* is *Preliminary* for FEL 2**
  - – **Business and project objectives not finalized**
  - – **Contracting strategy defined at a high level**
  - – **Execution plan already includes many requisite supporting first draft plans**
  - – **Execution plan is defined for next phase**
  - – **Schedule is critical-path method (CPM) with some resources loaded**
    - > **However, schedule does not include much detailed engineering and ties to detailed contracting tasks**
    - > **Construction schedule is very detailed**

Comparison of FEL: Generation
Lower Churchill Project as of June 2, 2008

FEL Component	Lower Churchill Project (Generation)	*Best Practical* at End of FEL 2	*Best Practical* at Authorization
Plot Plans	*Definitive* [redacted]	*Preliminary* [redacted]	*Definitive* [redacted]
Soil/Hydrology Information	*Preliminary* [redacted]	*Preliminary* [redacted]	*Definitive* [redacted]
Health and Safety Plans	*Factored* [redacted]	*Preliminary* [redacted]	*Definitive* [redacted]
Environmental Requirements	*Preliminary* [redacted]	*Factored* [redacted]	*Preliminary* [redacted]
Engineering Status	*Limited Study* [redacted]	*Limited Study* [redacted]	*Advanced Study* [redacted]
Project Execution Planning	*Factored* [redacted]	*Preliminary* [redacted]	*Definitive* ([redacted])
Composite FEL Index	[redacted]	[redacted]	[redacted]

Project Definition: Transmission Lines (1)

- Site Factors are *Preliminary*, which is *Best Practical* for FEL 2
  - Route Definition is *Preliminary*
  - Geotechnical Data are *Preliminary*
  - Health and Safety Status is *Factored*—completing a HAZID before end of this stage would be a Best Practice
  - Environmental Status is *Factored* because some lines are behind others with respect to Environmental Impact Study status
  - Rights of Way are *Preliminary*
  - Community Issues are *Preliminary*
- Apart from Health and Safety Status and Environmental Status, all elements are where they need to be at FEL 2

Project Definition: Transmission Lines (2)

- Engineering Status is *Limited Study*, which is *Best Practical* for FEL 2
  - FEED packages with detailed scopes of work are nearly complete on transmission side
  - Gaps are (1) cost estimate, which is not yet of control-grade quality, and (2) lack of finalized, detailed scope
- This element is further along in some technical areas than most projects, but some fundamental scope issues need to be resolved before moving into FEL 3

Project Definition: Transmission Lines (3)

- Project Execution Planning is *Factored*; ***Best Practical*** is *Preliminary* for FEL 2
  - – Formal business and project objectives not finalized
  - – Contracting strategy defined at a high level
  - – Execution plan already includes many requisite supporting first draft plans
  - – Execution plan is defined for next phase
  - – Schedule is CPM with some resources loaded
    - > However, schedule does not include enough detail for engineering and ties to detailed contracting tasks
    - > Construction schedule has less detail for transmission than for the dam, but this might be the norm

Comparison of FEL: Transmission

Lower Churchill Project as of June 2, 2008

FEL Component	Lower Churchill Project (Transmission)	*Best Practical* at End of FEL 2	*Best Practical* at Authorization
Route Definition	*Preliminary* [redacted]	*Preliminary* [redacted]	*Definitive* [redacted]
Soil/Hydrology Information	*Definitive* [redacted]	*Preliminary* [redacted]	*Definitive* [redacted]
Health and Safety Plans	*Factored* [redacted]	*Preliminary* [redacted]	*Definitive* [redacted]
Environmental Requirements	*Factored* [redacted]	*Factored* [redacted]	*Preliminary* [redacted]
Community Issues	*Preliminary* [redacted]	*Preliminary* [redacted]	*Definitive* [redacted]
Rights of Way	*Preliminary* [redacted]	*Factored* [redacted]	*Preliminary* [redacted]
Engineering Status	*Limited Study* [redacted]	*Limited Study* [redacted]	*Advanced Study* [redacted]
Project Execution Planning	*Factored* [redacted]	*Preliminary* [redacted]	*Definitive* [redacted]
Composite FEL Index	[redacted]	[redacted]	[redacted]

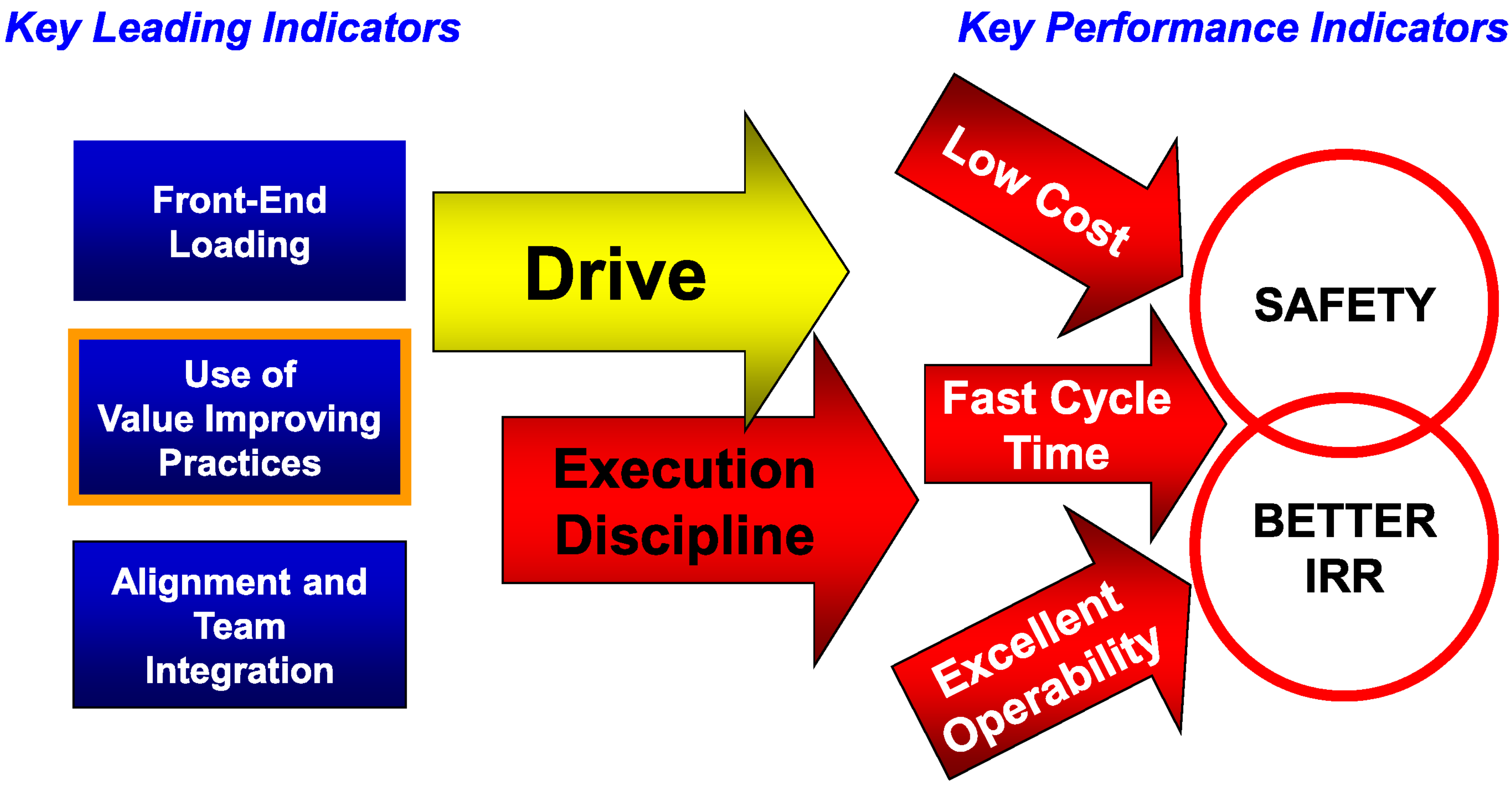
Notes on Current Schedule
Lower Churchill Project

- Good base to reach *Best Practical* by end of FEL 3, but some elements are ahead, others are behind
  - Industry average for similar sized project is [redacted] activities; project has about 2,500 activities now
  - Network design is good for this stage
    - All activities are tied to network
    - Very low number of activities without successors
    - Average activity float is within industry norms
  - Typical project of this size has about [redacted] of resources loaded by end of FEL 3; project is 21 percent loaded
- More engineering needs to be loaded into schedule, especially given Phase 3 strategy of advancing detailed engineering—it should be at Level 3

The Risk of Over Design in FEL

- **Due to the financing of the project by lenders, detailed design is planned to be complete by full funds sanction**
  - **If all current project plans are executed, the Lower Churchill Project will reach an FEL Index of [redacted] at full funds authorization**
  - **This is not typically a Best Practice, but it is a reality for the project**
- **There are two primary risks that tend to result:**
  - **Too much capital is spent on the front end, and pressure on the business to authorize the project becomes too leveraging, resulting in early de facto authorization**
  - **Because so much capital is available for engineering, it can drive out-of-sequence design work**
- **This will reportedly be addressed by the team by sequencing engineering appropriately**

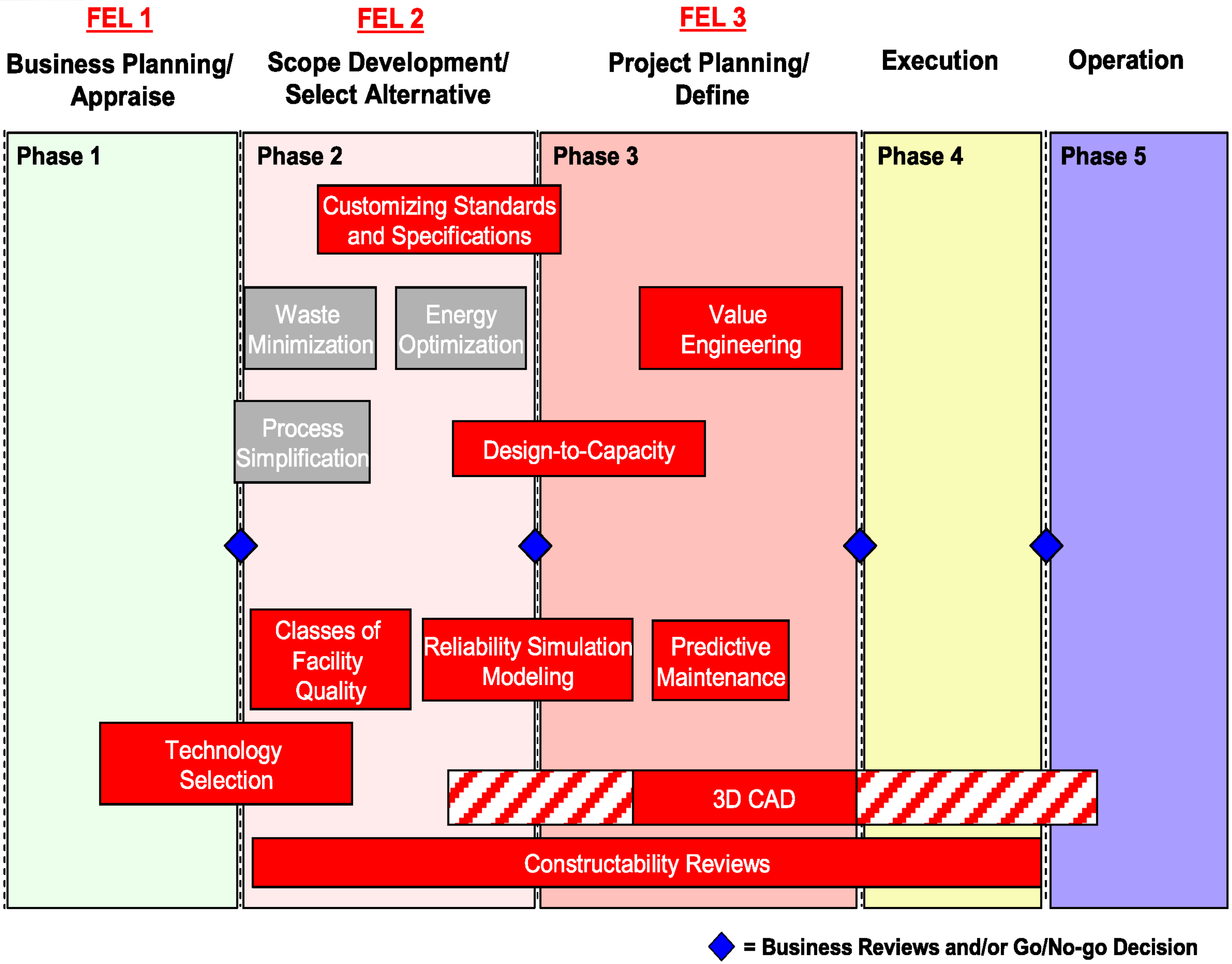
Elements of Capital Effectiveness



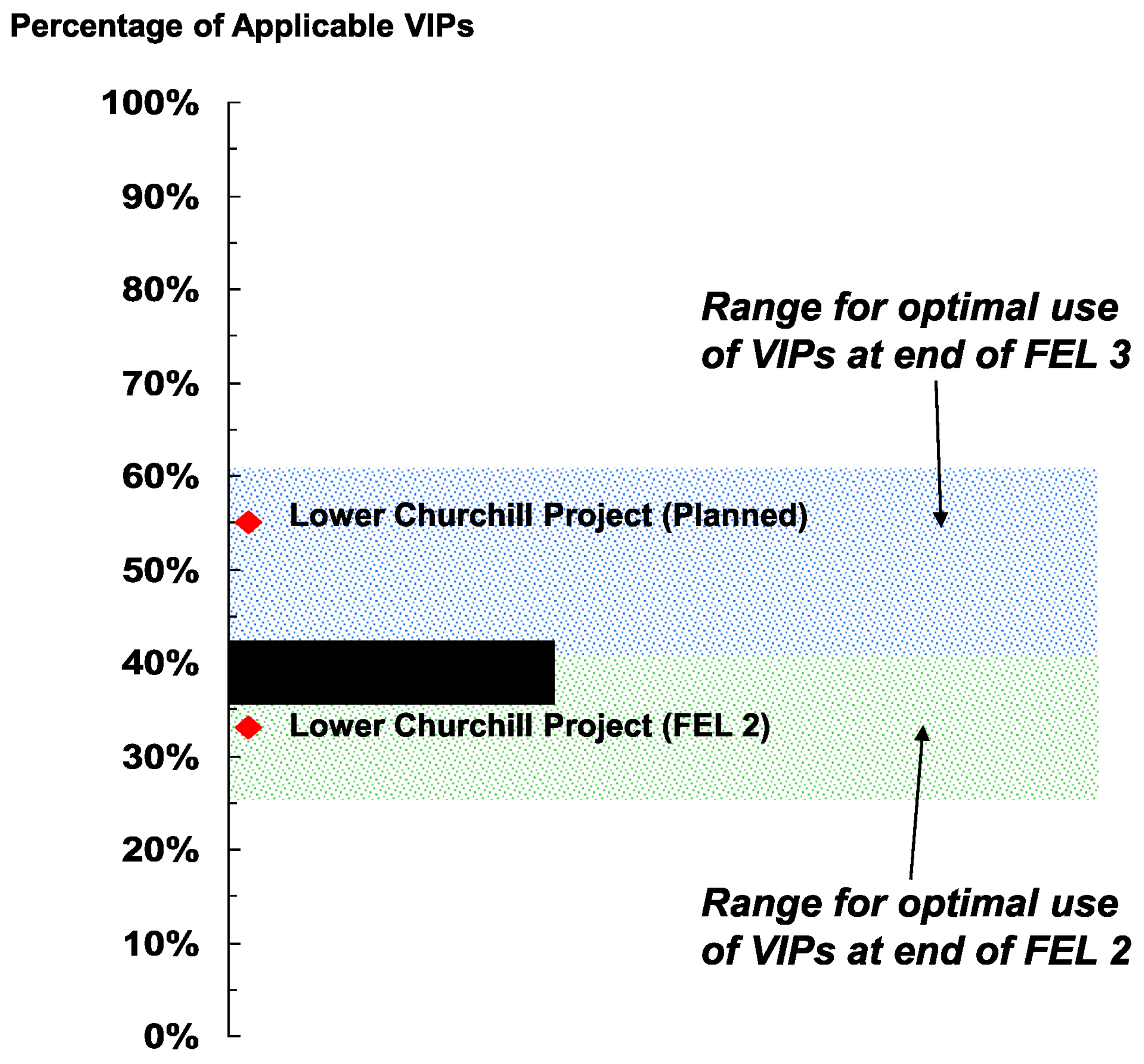
Defining Value Improving Practices

- VIPs are out of the ordinary practices used to improve cost, schedule, and/or reliability of projects:
- Used primarily during FEL
- Formal, documented practices involving repeatable work process with measurable results
- Usually facilitated by specialists from outside of project team
- 9 VIPs were applicable to Lower Churchill Project

Timing of VIPs



VIPs for Lower Churchill Project
In Recommended Range for FEL 2



Current Use of VIPs

Lower Churchill Project Used 3 VIPs

- **Predictive Maintenance**: **Predictive Maintenance philosophy on 25 percent of project scope, including real-time monitoring and "smart" transmitters**

- **Constructability Reviews**: **Performed multiple times prior to sanction, with more planned during Phase 3**

- **3D CAD**: **Entire facility is designed in CATIA, and model will be used for estimating, design, and progress tracking through FEL and execution**

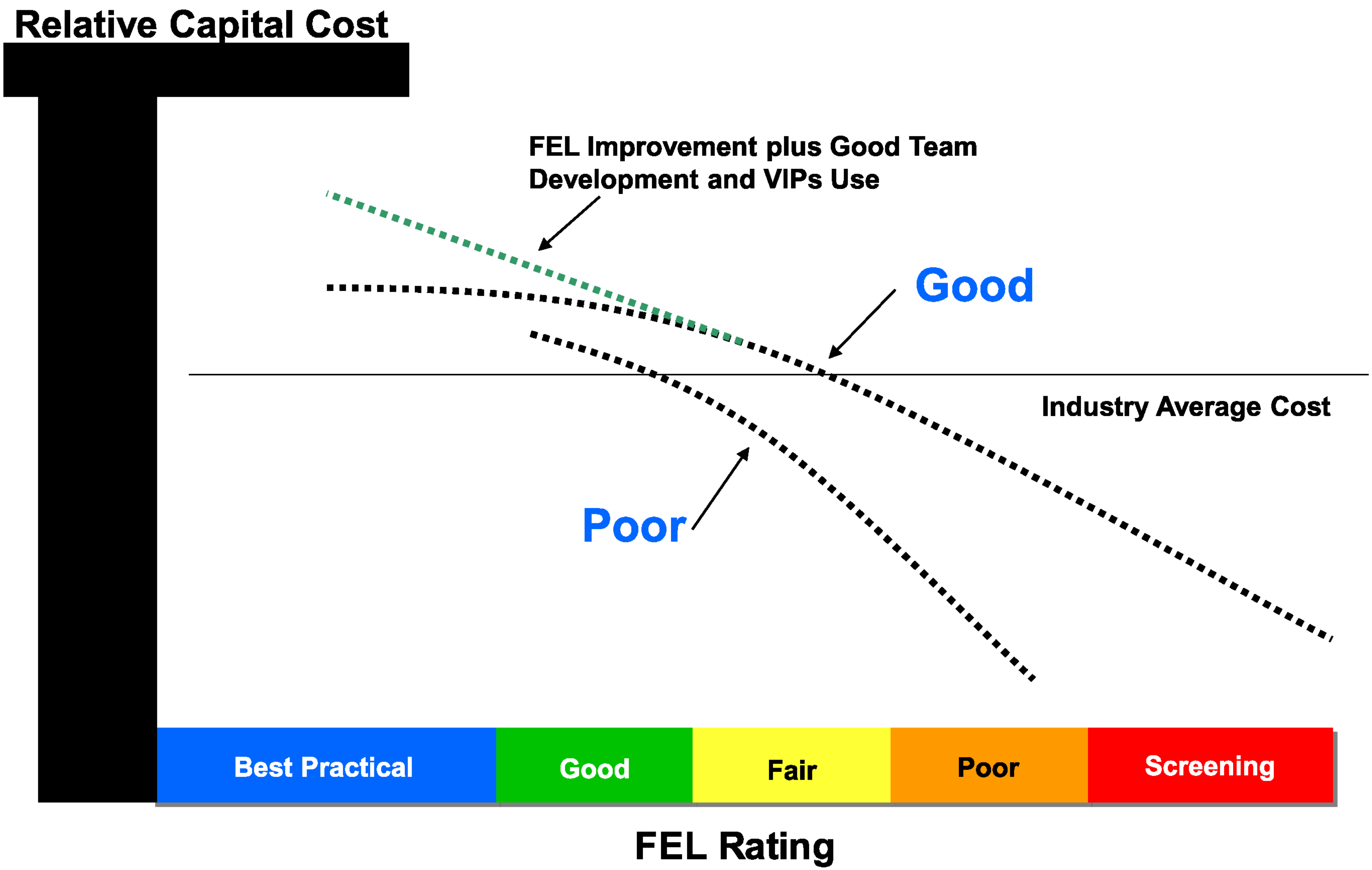
Planned Use of VIPs

Lower Churchill Project Plans 2 More VIPs

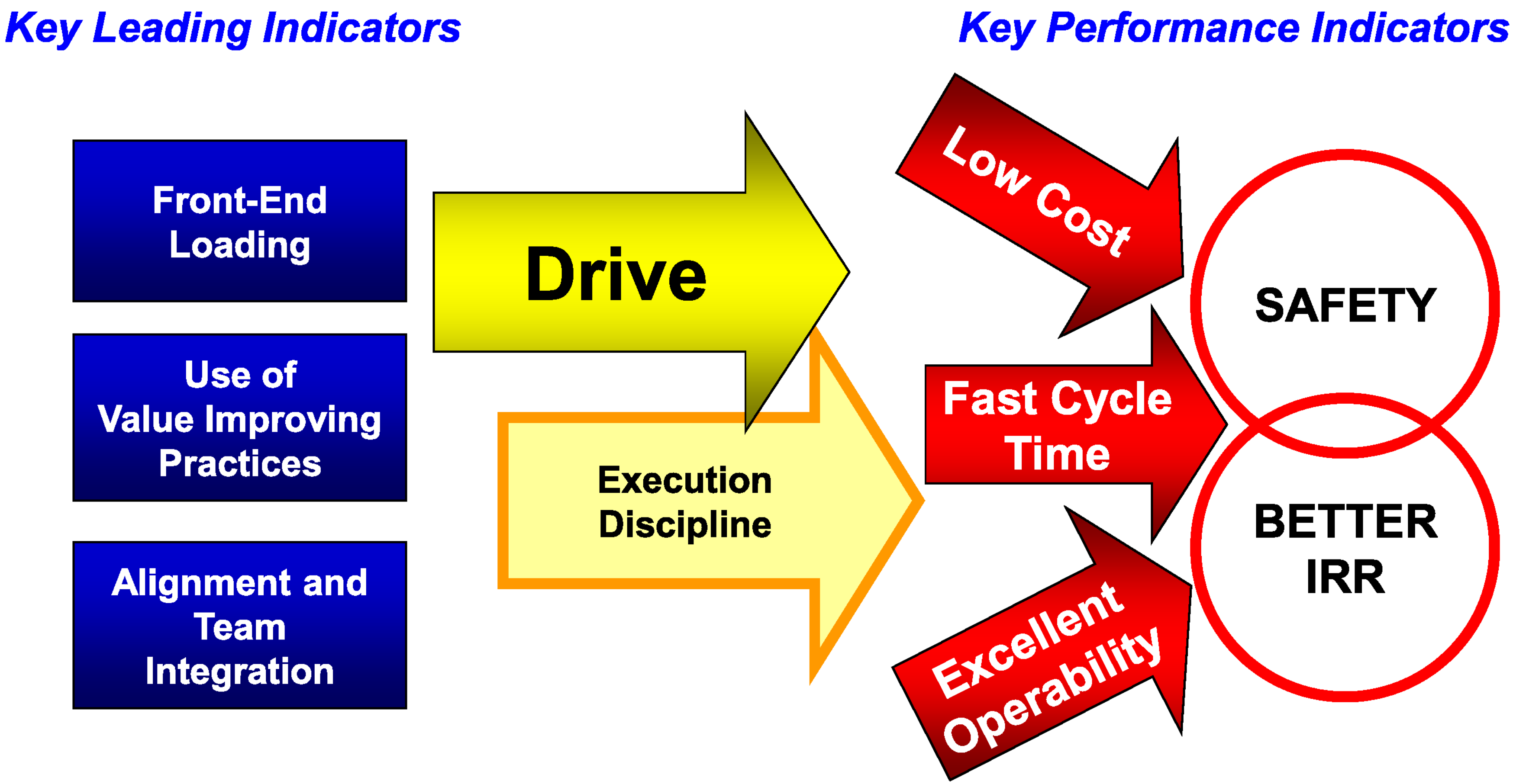
- **Process Reliability Modeling: A modeling study of plant configuration will be completed later in design**

- **Customized Standards and Specifications: Will continue in Phase 3, with focus on developing fit-for-purpose specifications that optimize cost without compromising integrity**

Team Development, FEL, and VIPs Use Drive Cost Performance



Elements of Capital Effectiveness



Project Control Index (PCI)

Estimating for Control + Control During Execution → Index

[redacted]

PCI: Key Factors

[redacted]

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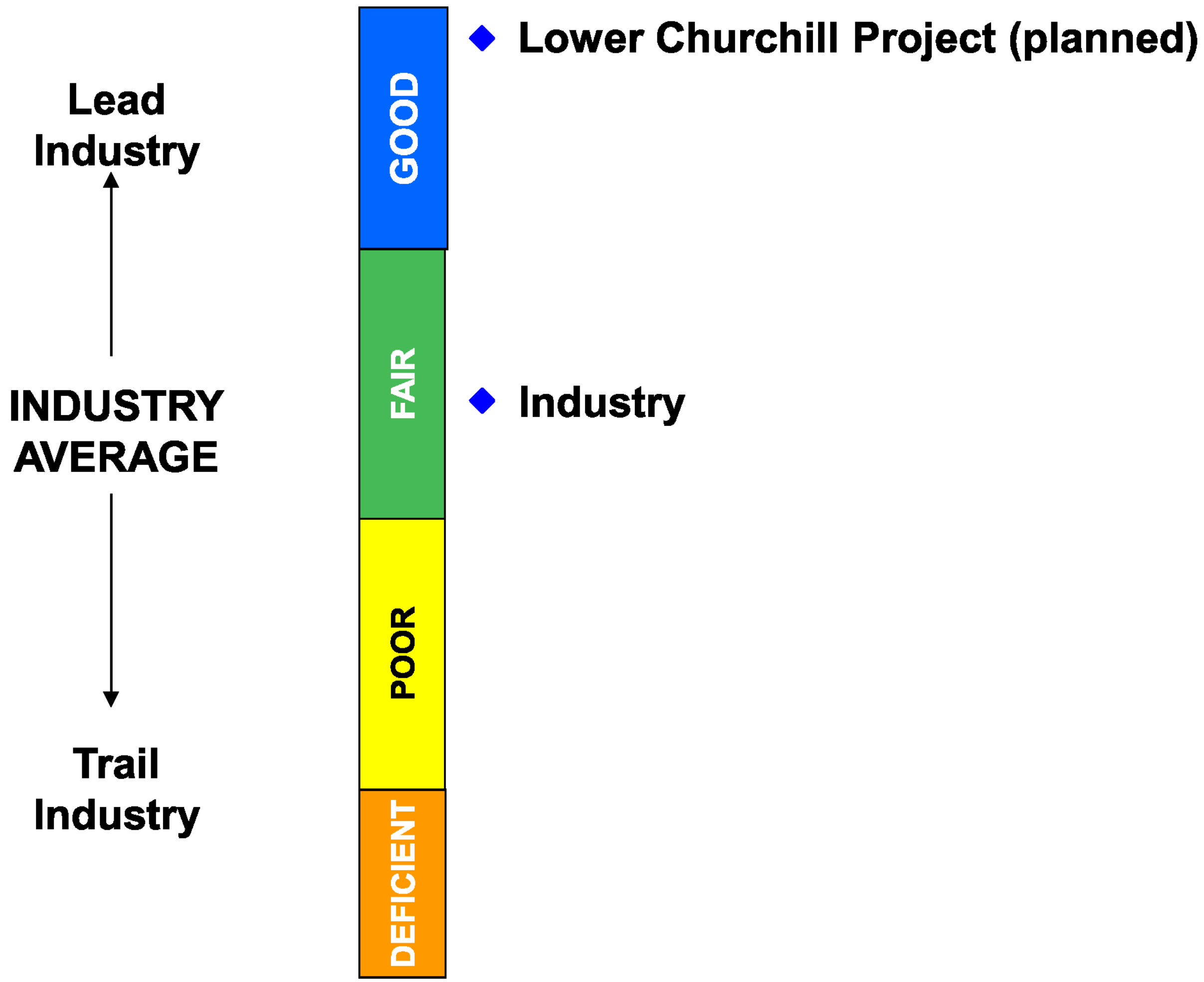
Lower Churchill Project PCI

Planned Project Controls Are Good



Lower Churchill Project's Controls

Summary of Specific Practices

- **Estimate quantitatively validated by owner: Planned**
  Estimates are being validated by NL Hydro cost group

- **Comprehensive physical progressing: Planned**
  Plan is detailed progressing for all accounts

- **Frequent and detailed progress reports: Planned**
  Detailed reports planned biweekly for all project phases

- **Owner controls specialist assigned: Done**
  NL Hydro employed controls specialists already on team

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Other Practices: Contracting

- **Lower Churchill Project team indicated consideration of incentives in contracting strategy**
- **Recent projects executed in Alberta did not benefit from incentives**
- **Historical norms for projects do not indicate that projects benefit from incentives in any way**

IPA Conclusions About Incentives

- **Use of incentive contracting has no statistically reliable effect on cost, execution time, or cycle time, but results are directionally worse**

–results

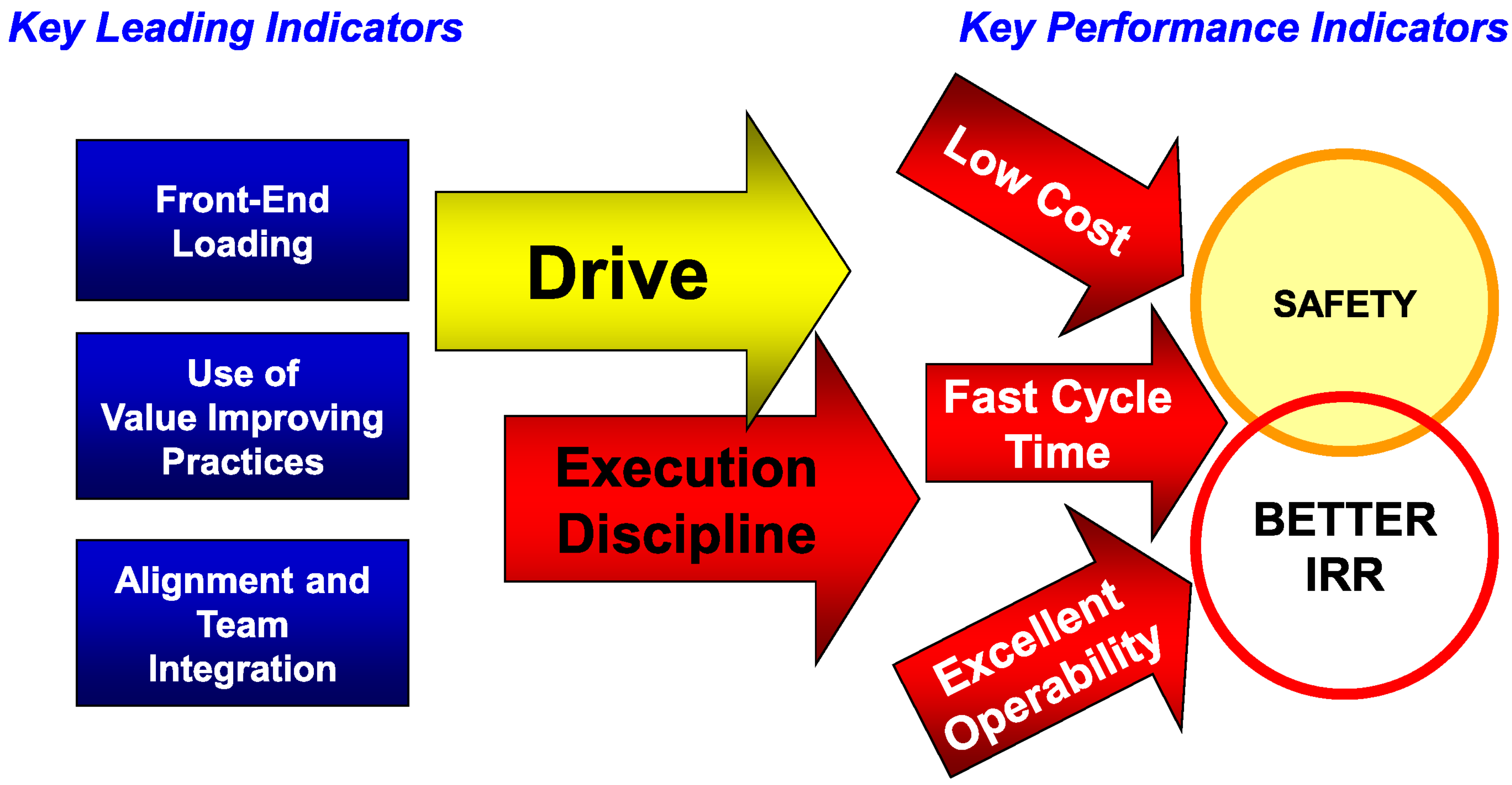
- **Use of incentives for engineering is strongly associated with poorer operability of facilities**

- ***If Lower Churchill Project team is forced to use incentives due to market realities, include strict quality measures and control as part of those incentives***

Outline

- Summary
- Background
- Methodology
- Recent Lessons From Canada
- Practices
- *Outcomes*
- Conclusions and Recommendations

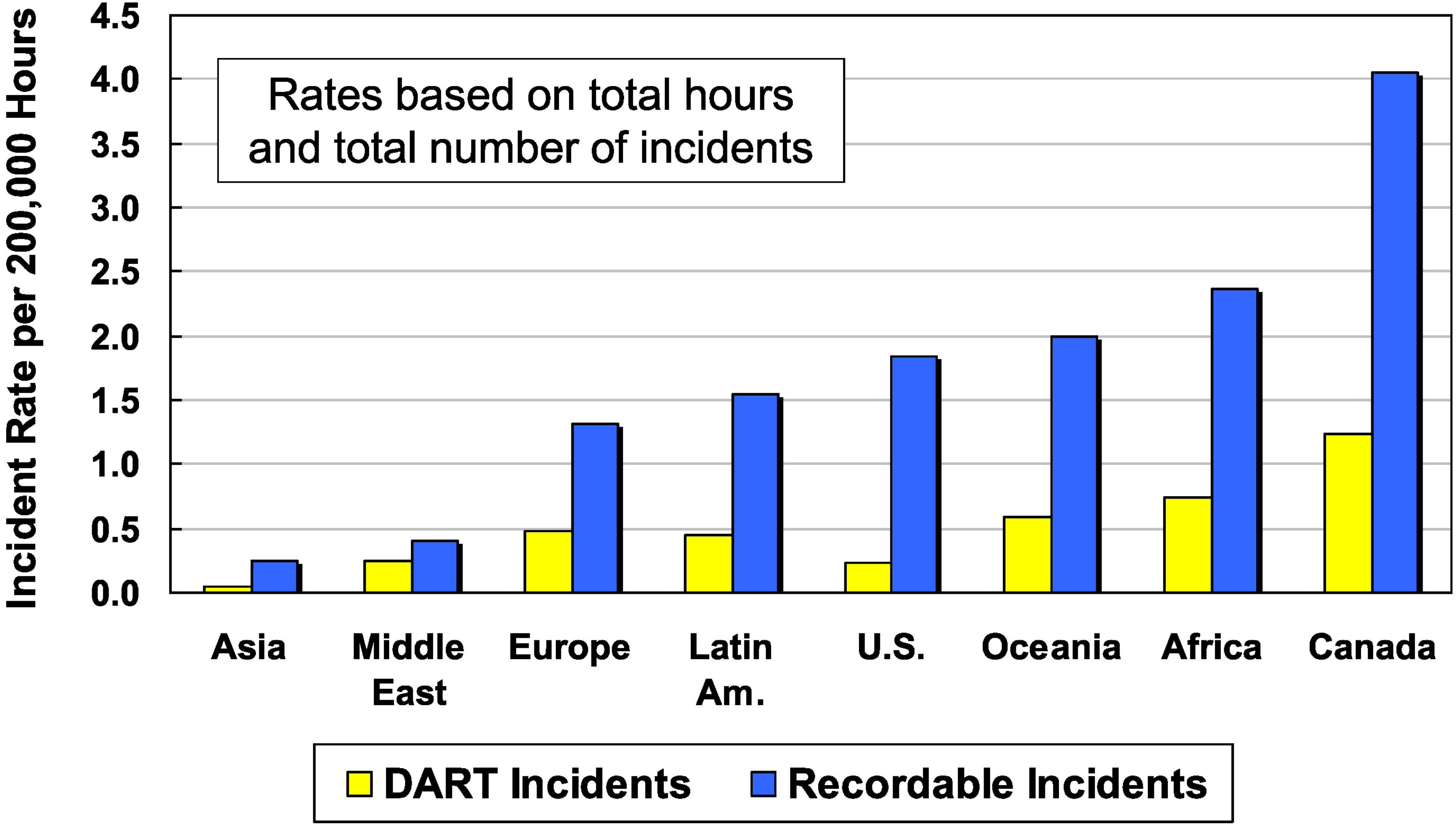
Elements of Capital Effectiveness



Lower Churchill Planned Safety

- Philosophy is to include safety from the start, not to include it later in project
- 50,000 hours in field so far without incident
- No safety Constructability Reviews on project yet
- Plans to have a Hazards Identification (HAZID) and HAZOP review prior to sanction
- Currently estimating 30 million field labor hours
- Will focus its efforts on “near miss” reporting
- No tangible safety rewards or incentives

Regional Incident Rate Comparison
Canada Stands Out



* DART: Safety incidents involving days away (aka "lost time"), restricted duty, or job transfer

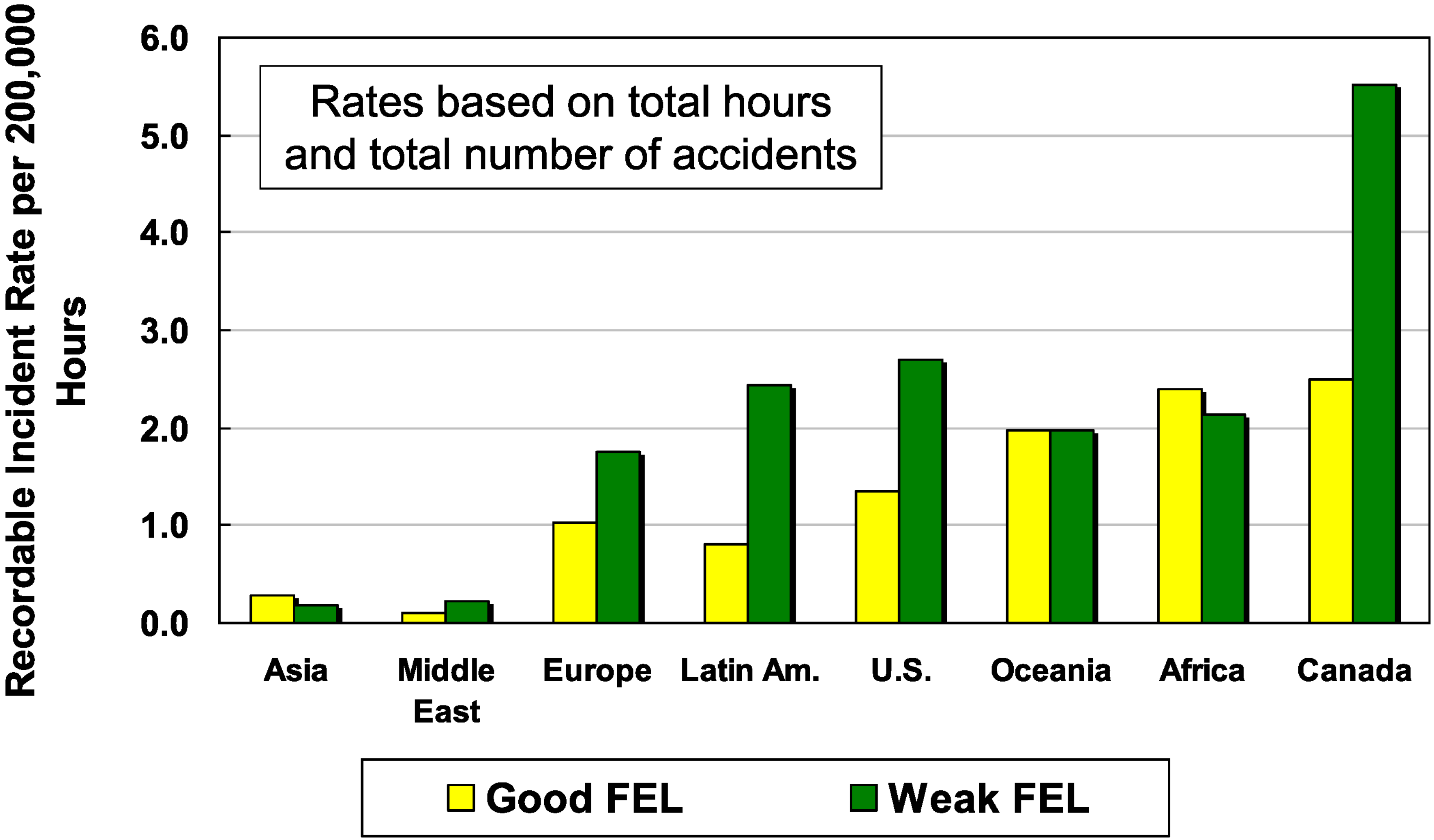
Contributors to Successful Construction Safety Program

- IPA identified practices that contribute to better safety:
  - Reward workers for identifying hazards
  - Pre-task planning done before every task
  - Use of substance abuse testing as part of safety program
  - Recognition awards
  - Safety performance in contract incentives
  - Immediate feedback on safety suggestions
  - Change in position as form of discipline
- Lower Churchill Project plans to use all practices except safety incentives in contracts and change in position as discipline

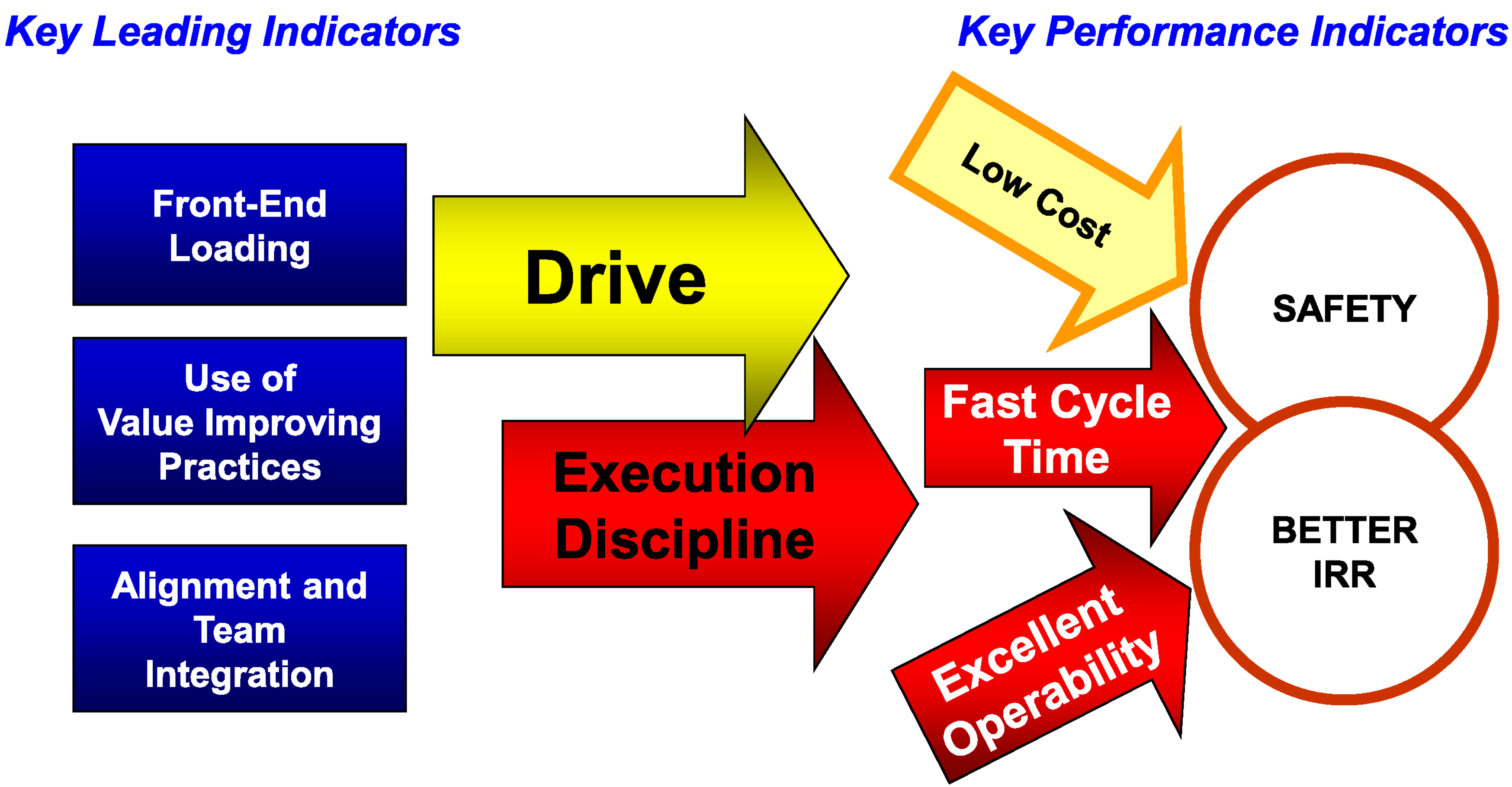
FEL and Safety

- **Research has shown that safety performance also correlates with FEL Index**
- **Two primary contributors to better FEL also correlate with safety:**
  - **Project execution planning**
  - **Health and safety requirements**
- **Lower Churchill Project should ensure that these elements are *Definitive* by sanction**

Good vs. Weak FEL Comparison
Good FEL Mitigates High Rate in Canada



Elements of Capital Effectiveness

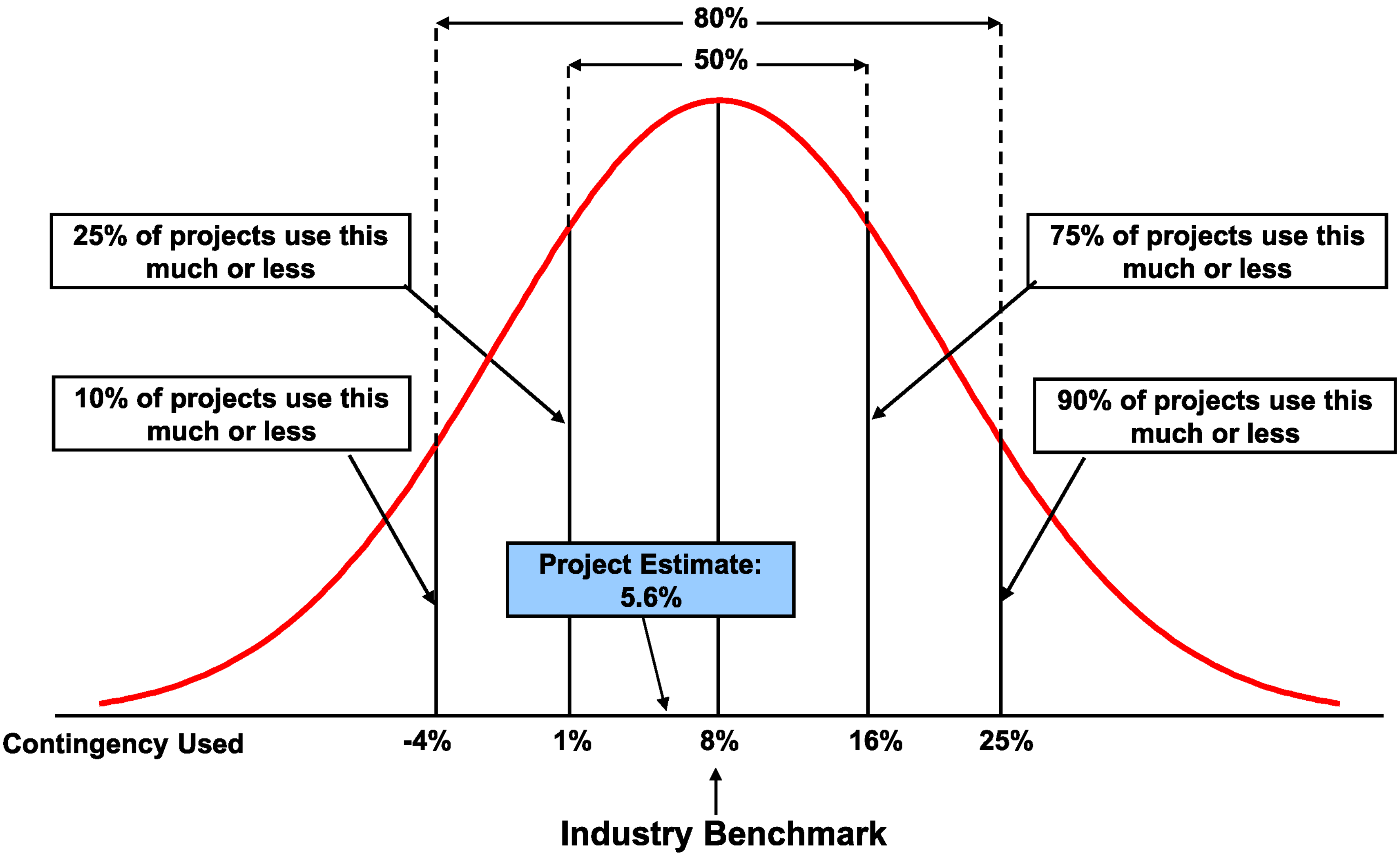


Contingency Analysis

- IPA definition: Contingency is the amount of money that experience has demonstrated must be added to an estimate to provide for uncertainties in:
  - the level of project definition, and
  - the uncertainty associated with commercially unproven technology
- How much contingency would Industry typically use, given project characteristics and current level of preparedness?
- Historical data is based on estimates for full-funds sanction (at end of FEL 3 stage)
- General megaproject norms for FEL 2 contingency are about 15 percent

Contingency Allowance Analysis

Historical Norms As Measured at Sanction



A Word on Construction Wages

Lower Churchill Project

- **Projects in Alberta are experiencing all-in wage rates of C$75 - C$110**
- **Lower Churchill currently has C$59 in estimate**
- **Current strategy is to leverage interest of Newfoundland laborers working in Alberta to return to NL**
  - **Close to home**
  - **Provincial pride**
- **The level of risk might not be represented adequately in the risk mitigation plan**

Outline

- Summary
- Background
- Methodology
- Recent Lessons From Canada
- Practices
- Outcomes
- ***Conclusions and Recommendations***

Conclusions (1)
Lower Churchill Project

- Practices required to complete FEL 2 are nearly achieved, but project still has unresolved risks
  - Detailed business objectives are not finalized
  - Project scope is not yet closed
- Team is well represented, integrated, and on track to be functional and developed, but it still requires more work
- FEL is ahead in some areas, and behind in others
  - Design work is ahead of schedule
  - Engineering schedule and execution planning is a gap

Conclusions (2)

Lower Churchill Project

- **Team plans to use all required Best Practices for project controls**
- **Use of VIPs is planned to be in recommended range at time of sanction**
- **Many practices and lessons learned from recent IPA research need to be considered as project moves from FEL 2 to FEL 3**

Key Manageable Risks
Lower Churchill Project

- Economics behind project are not fully understood and integrated into overall business strategy, business objectives, and project objectives
- Project needs to complete all required project execution planning activities, particularly in engineering
- Project could over-commit funds prior to sanction, suffering a loss of equity if project does not go forward
- Team needs to be further aligned and developed in a number of key areas

Recommendations (1)
Lower Churchill Project

- **Complete required economic deliverables and recast business and project objectives**
  - **To understand project's drivers, economics and power market constraints need to be understood**
  - **Otherwise scope cannot be closed, and if project continues without closed scope, resources will be inefficiently used**
  - **Without detailed business and project objectives, team will not develop into an aligned and functional group**

Recommendations (2)
Lower Churchill Project

- Complete FEL activities before Gate 2B
  - Much engineering work is ahead of schedule, but fundamental issue of finalizing scope is still unresolved
  - Execution planning is well developed, but it is far ahead on construction planning and behind on engineering planning
  - Issues around management of external stakeholders are on track for this stage
  - Other site factors are also at appropriate level of development for this state
    - > Exception is Health and Safety Status
    - > HAZID should be complete prior to Gate 2B

Recommendations (3)
Lower Churchill Project

- **Implement a formal steering committee for project**
  - Should be comprised of stakeholder representatives and professionals with project experience
  - Should meet periodically with team to review deliverables and ensure alignment with overall business objectives
  - Should also be a means to more vertically integrate team with business
  - Role of committee is to provide guidance, but let team handle technical aspects of project

Recommendations (4)
Lower Churchill Project

- **Address team issues**
  - **Although practices correlated with good team development are employed, team perceives that major issues remain**
    - > Unclear objectives
    - > Ineffective decision making
    - > Poor interfaces and business leadership
    - > Roles and responsibilities not understood
    - > Poor alignment
  - **Continue to communicate the work process requirements as they are developed**
  - **When business and project objectives are finalized, share them with entire team to ensure alignment**

Recommendations (5)
Lower Churchill Project

- **Be mindful of lessons learned from Alberta**
  - **Although project execution plan avoids many issues in recent Alberta projects, some issues are the same:**
    - > **Unavailable engineering and construction labor**
    - > **Less experienced labor**
    - > **Slips in engineering tied to construction**
  - **If Lower Churchill Project falls behind in engineering:**
    - > **Project might issue bid packages with incomplete or preliminary drawings**
    - > **Packages could be delayed and force a less desirable negotiation period**

Recommendations (6)
Lower Churchill Project

- **Develop contingency plans for labor-related risks**
  - **Labor wage in cost estimate does not come close to typical wages offered in Alberta’s current market**
  - **Engineering costs increased rapidly in past few years**
  - **Furthermore, a lack of experience in engineering and construction (in Alberta) has reportedly impacted productivity in both areas**
  - **Consider impacts of these factors on productivity, estimating, potential schedule slips, and safety plans**

Thank You

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