CRITICAL SUCCESS FACTORS FOR ELECTRICITY GENERATION PROJECTS BASED ON LNG

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1. Introduction and purpose
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Introduction and purpose

Energy is one of the key factors in economic development

Oil prices have driven power generation costs extremely high in many markets

Natural gas is seen as one solution to reduce the energy bill

Not all projects manage to fulfil their objectives in time and within budget

This presentation outlines the challenges that the sponsor of an LNG power generation project faces, the ways to overcome them and be successful

Infrastructure. The facilities

LNG Discharge and reception → LNG Storage → LNG Regasification → Electricity generation → Transformation and Delivery to the network

LNG Terminal

Electric power plant

ECOELECTRICA regasification terminal and power plant. Puerto Rico
LNG regasification terminal

Typology Onshore and Offshore

**Onshore**
- **81 Terminals**
- Sendout capacity range: 1 to 30 Bcma
- LNG Storage: 30,000 to 2,700,000 m³
- 1 or 2 berthing points

**Offshore**
- **14 Terminals**

**Regasification vessel**
- **11 Terminals**

**GBS**
- **1 Terminal**
- Sendout capacity: 8 Bcma
- LNG Storage: 250,000 m³
- 1 berthing point

**Buoy sendout**
- **3 Terminals**
- Sendout capacity: 4 Bcma
- LNG Storage: 138,000 to 150,000 m³
- No berthing point

**Dock sendout**
- **8 Terminals**
- Sendout capacity range: 1 to 4 Bcma
- LNG Storage: 125,000 to 150,000 m³
- 0 or 1 additional berthing point

**Mixed configurations**
- **2 Terminal**
- Sendout capacity: 2 Bcma
- LNG Storage: 162,000 m³
- 1 berthing point

**Note:** Typical ranges

- Onshore (Canaport LNG terminal)
- Dock sendout (Bahia Blanca GasPort)
- Regasification vessel (Neptune LNG terminal)
- GBS (Adriatic LNG terminal)
- Mixed configuration (GNL Mejillones)
Power plants typology

Steam cycle
Potential fuels: solid (coal, wood, waste), liquid (oil), gas (LPG, natural gas)
Efficiency: 25% - 45%

Open cycle gas turbine
Potential fuels: liquid (diesel oil), gas (LPG, natural gas)
Efficiency: 30% - 35%

Combined cycle gas turbine
Potential fuels: liquid (diesel oil), gas (LPG, natural gas)
Efficiency: 45% - 55%

Reciprocating engine
Potential fuels: liquid (oil), gas (LPG, natural gas)

Reciprocating engine without heat recovery
Potential fuels: liquid (oil), gas (LPG, natural gas)
Efficiency: 45% - 55%

Reciprocating engine with heat recovery
Potential fuels: liquid (oil), gas (LPG, natural gas)
Efficiency: 50% - 60%
Model A

- **LNG Supplier** to **LNG Terminal Facilities**
- **LNG Flow** to **Power Plant Facilities**
- **Gas Flow** to **Electricity Consumers**
- **EPC Contractor 1** to **LNG SPA**
- **Construction** to **Equity**
- **EPC Contract** to **Equity**
- **Construction** to **EPC Contractor 2**
- **EPC Contract** to **PPA**
- **Credit Lenders**

**EPC**: Engineering, Procurement & Construction

**SPA**: Sales & Purchase Agreement

**PPA**: Power Purchase Agreement
Model B

- **LNG Supplier**
- **Credit Lenders**
- **LNG SPA**
- **BOO Company**
- **Services Contract**
- **Equity**
- **Gas Flow**
- **Guarantees**
- **Project Company**
- **SPA: Sales & Purchase Agreement**
- **PPA: Power Purchase Agreement**
- **Electricity Consumers**
- **Electricity**
- **Power Plant Facilities**
- **Electricity**
- **Gas Flow**
- **LNG Terminal Facilities**
- **LNG Flow**

**Key Terms:**
- BOO: Build, Own & Operate
- SPA: Sales & Purchase Agreement
- PPA: Power Purchase Agreement
Model C

**LNG Flow**
- LNG Supplier
- LNG SPA
- LNG Terminal Facilities

**Gas Flow**
- BOO Company
- Credit Lenders
- Project Company

**Equity**
- BOO Company
- EPC Contractor 2

**Credit**
- Credit Lenders
- Project Company

**Services Contract**
- Project Company

**Construction**
- Project Company

**Electricity**
- Project Company
- PPA
- Electricity Consumers

**SPA**
- LNG SPA

**PPA**
- EPC Contract

**BOO**
- Build, Own & Operate

**EPC**
- Engineering, Procurement & Construction

**SPA**
- Sales & Purchase Agreement

**PPA**
- Power Purchase Agreement

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**Business models**

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© STREAM
Business models

Model D

LNG Supplier → LNG Terminal Facilities → Power Plant Facilities → Electricity Consumers

LNG Flow → Gas Flow → Electricity

LNG SPA

BOO Company 1 → Credit Lenders

Credit Lenders → BOO Company 1

Credit

Equity

Project Company

TSA

PGSA

PPA

BOO: Build, Own & Operate
TSA: Terminal Services Agreement
PGSA: Power Generation Services Agreement
SPA: Sales & Purchase Agreement
PPA: Power Purchase Agreement
Tolling Model

- **LNG Supplier** to **LNG Terminal Facilities** via **LNG Flow**
- **Credit Lenders** provide **Credit** to **Project Company**
- **Equity** in **Project Company**
- **Guarantees** from **LNG SPA**
- **Project Company** to **Power Plant Facilities** via **Gas Flow**
- **Services Contract** from **Electricity Consumers**
- **Power Plant Facilities** to **Electricity Consumers** via **Electricity**

**SPA:** Sales & Purchase Agreement
Business challenges

- Power demand
- Uses of electricity
- Seasonality
- Medium to short term
- Reliability
- Conditions precedent
- Price issues

- Global market
- Steady production
- Take-or-pay
- Medium to long term
- Guaranties
- Conditions precedent
- Price issues

- PPA
- Spot power market with no firm commitment

- LNG SPA
- Reduced LNG spot market
### Power generation economic model

<table>
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<tr>
<th>Fixed costs</th>
<th>Variable costs</th>
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<td>Fuel</td>
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<tr>
<td>Financial costs</td>
<td>Emissions (CO₂)</td>
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<td>Fixed taxes and fees</td>
<td>Income Tax</td>
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<tr>
<td>Fixed Operation and Maintenance</td>
<td>Variable Operation and Maintenance</td>
</tr>
</tbody>
</table>

- **Fuels historic prices estimation**
  - Price\(_{\text{Fuel1}}\) = SLP\(_1\) * RI + K\(_1\)
  - Price\(_{\text{Fuel2}}\) = SLP\(_2\) * RI + K\(_2\)
  - \vdots
  - Price\(_{\text{FuelN}}\) = SLP\(_N\) * RI + K\(_N\)

- **Current averaged generation costs**

- **Ceiling price for gas**
  - Ceiling price\(_{\text{Gas}}\) = SLP\(_G\) * RI + K\(_G\)

- **Ceiling price for LNG**
  - Ceiling price\(_{\text{LNG}}\) = SLP\(_{\text{LNG}}\) * RI + K\(_{\text{LNG}}\)
Real life markets are very complex structures.
## Business challenges

| Financing               | Project 1 | Project 2 | Project 3 | Project 4 | Project 5 | Project 6 | Project 7 | Project 8 | Project 9 | Project 10 | Project 11 | Project 12 | Project 13 | Project 14 | Project 15 | Project 16 | Project 17 |
|-------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Access to LNG supply    |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |
| Commercial aspects      |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |
| Gas regulation          |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |
| Environment             |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |
| Electricity regulation  |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |
| LNG technology          |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |
| Power generation technology |         |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |

Least Important → Most Important
LNG is available only to those able to compete with worldwide LNG demand

LNG price is a significant issue. Economic models ought to estimate if LNG will be competitive if introduced in an existing power market

Project sponsors must overcome many uncertainties. Risk mitigation is mandatory, both for the power generation business as well as for the LNG supply business

If you want different results, do not do the same things.

- Albert Einstein -
Thank you for your kind attention

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