Bundesministerium
für Wirtschaft
und Energie

# Beispiele für zwei Solarprojekte in Bolivien

Daniel Gudopp | Tobias Leschinsky
deea solutions GmbH
Berlin, 01.12.2015

Durchführer

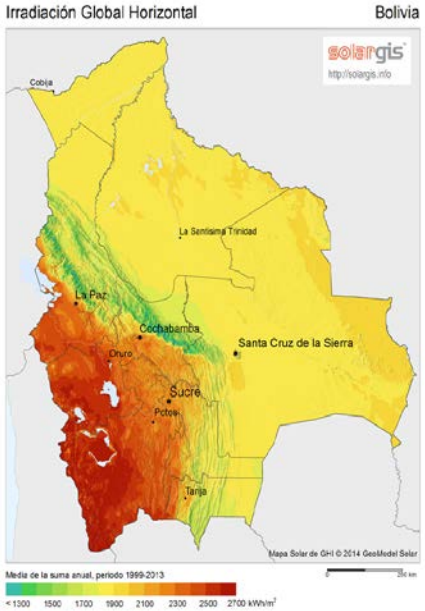
# Überblick zwei Solarprojekte

Standorte Oruro und Uyuni, netzgekoppelte Solaranlagen mit je 50 MWp Leistung

Nach Fertigstellung Bolivienes größte netzintegrierte Solaranlagen

Ort: Altiplano, beide Anlagen auf ca. 3.700 m Höhe

Status: **deea** erstellt Machbarkeitsstudie und Ausschreibungsunterlagen. Baubeginn ca. Mitte 2016 gepant

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# Überblick Projekt ORURO

Kunde: Ministerio der Hydrocarburos y Energía

Status: **deea** erstellt Machbarkeitsstudie, Auslegung der PVA, Ertragsprognose, Finanzielle & Ökonomische Analyse, O&M-Plan, Betreibermodel, Ausschreibungsunterlagen

Anlage: Fest aufgeständerte PVA mit Anschluss an das 115kV-Netz

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# Überblick Projekt UYUNI

Kunde: ENDE / Guaracachi S.A. (Energieversorger)

Status: **deea** erstellt Machbarkeitsstudie, Technologieauswahl PV vs. CSP, Design der PVA und des Netzanschlusses inkl. Hochspannungsleitung, Finanzielle & Ökonomische Analyse, Betreibermodel, Ausschreibungsunterlagen

Anlage: Fest aufgeständerte PVA mit Anschluss an das 230kV-Netz

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# Übertragungsnetz & Standorte

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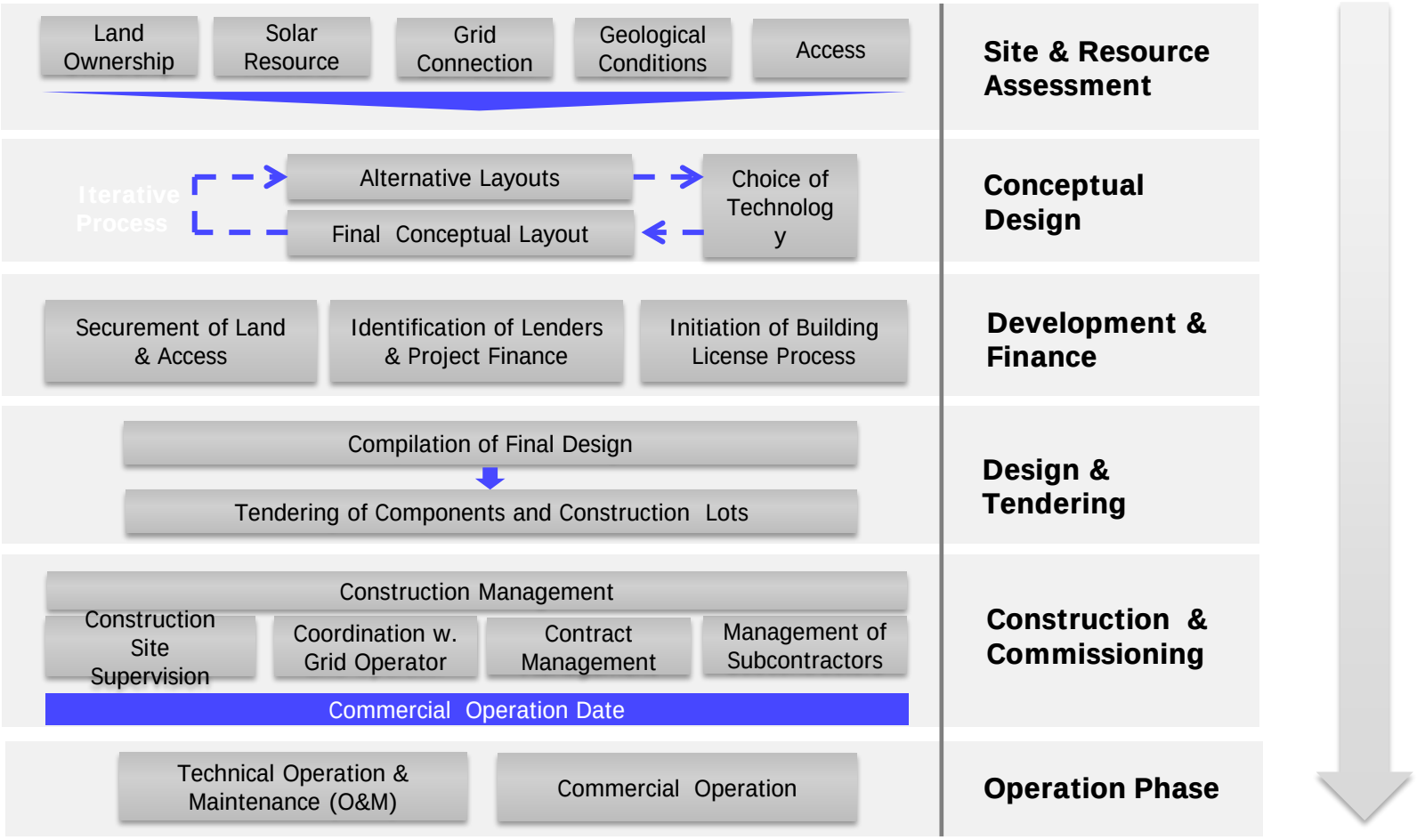
und Energie

Durchführer

energie waechter

# Projektablauf am Beispiel Oruro

Projektablauf ORURO

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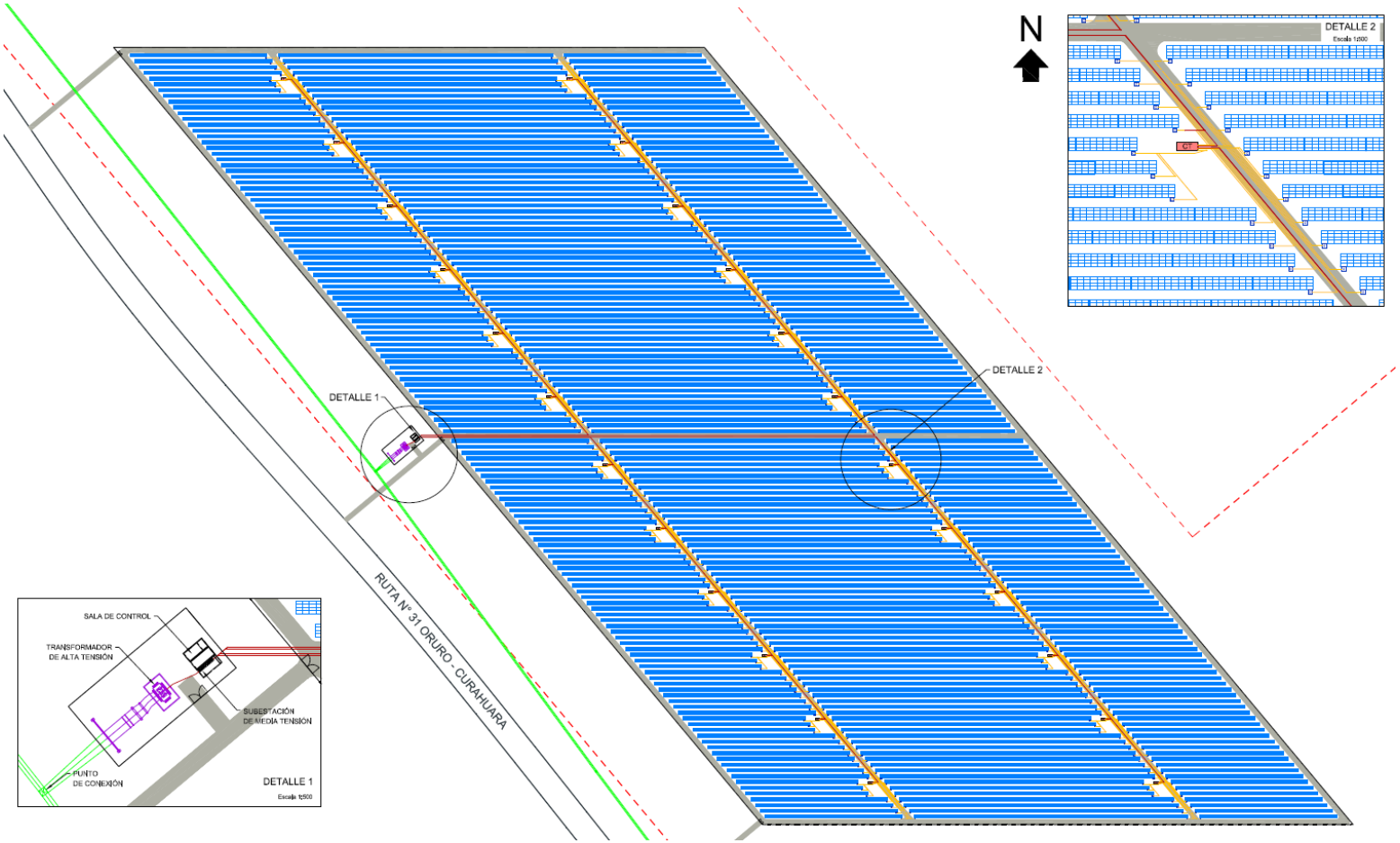
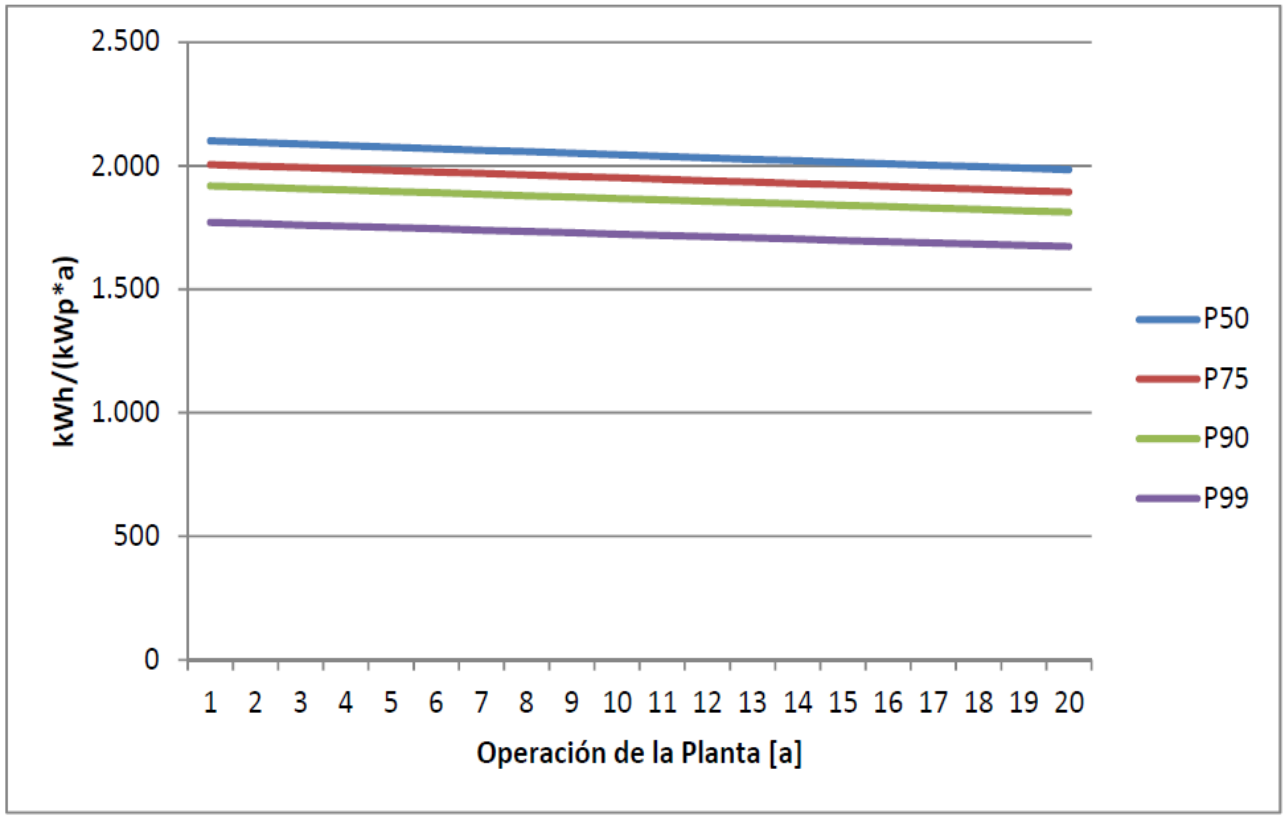
# Anlagenplanung am Beispiel Oruro

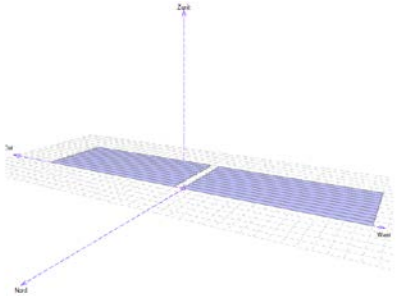


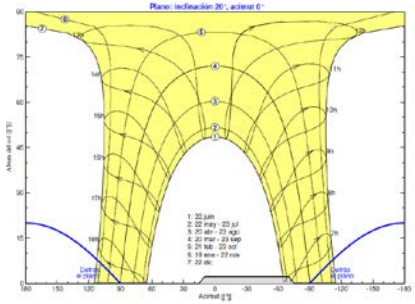
# Layout für Extreme Umweltbedingungen

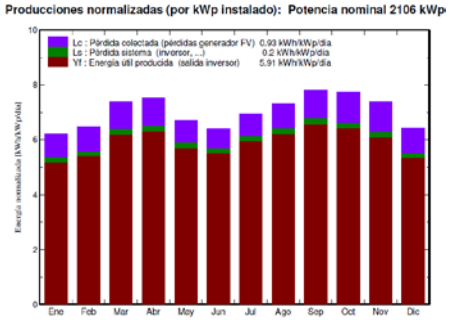
| | | General Layout | Modules | Inverters | Mounting System | Trackers: Motors + Moving Parts | Transformers | Cabling upper Ground (DC) | Cabling underground | Substations / Housing | O&M Concept |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Remote region | | Allow for maintenance works without specialized equipment | Include sufficient spare modules | Use equipment with as far as possible modular structure | Include sufficient spare parts | Include sufficient spare parts | Include sufficient spare parts | Include spare cable and spare joints | Include spare cable and spare joints | No direct impact | Spare parts concept. Concept for local works. |
| | | | | | | | | | | | |
| Height approx. 3,800 m | Description | Include in techn. specifications | Offered by most manufacturers. Operational experience available | Few manufacturers (SMA & GE) offer inverters for these conditions | Not critical. Include in techn. specification | Suitable motors and electric parts. | Rely on locally used equipment. Suitable motors and electric parts. | Suitable equipment available. Include in techn. specification. | Suitable Equipment available. Include in techn. specification. | Rely on locally used equipment. Suitable ventilation concept. | Take into account potential limitation of maintenance equipment (cranes) |
| | Status | | | | | | | | | | |
| Lowest temperature over 20 years: -21 °C | Description | Include in Techn. Specifications | Offered by most manufacturers. Operational experience available | Offered by most manufacturers. Operational experience available | Take into account for layout of expansion joints | Stop of tracking < 10 or 15 °C. Use of special greases | Rely on locally used equipment | Suitable equipment available. Include in techn. specification. | Cable layout should consider frost protection. | Rely on locally used equipment | Take into account potential limitation of maintenance equipment |
| | Status | | | | | | | | | | |
| Highest temperature over 20 years: 39 °C | Description | Include in Techn. Specifications | Offered by most manufacturers. Include in yield Prognosis | Suitable equipment available. Derating possible at temp peaks. | Take into account for layout of expansion joints | Usage of suitable motors and electric parts. | Rely on locally used equipment. Consider sufficient ventilation. | Suitable equipment available. Include in techn. specification. | Suitable equipment available. Include in techn. specification. | Rely on locally used equipment. Suitable ventilation Concept. | Take into account potential limitation of maintenance equipment |
| | Status | | | | | | | | | | |
| Wind speeds up to 120 km/h | Description | Take into account in static calculations | Use of framed modules | Not critical. Include in techn. specification | Choose static layout suitable for 150 km/h, offered by most manuf. | Use motors with uninterruptible power supply for horiz. position | Not critical. Include in techn. specification | Correct installation free of vibrations | No direct impact | Rely on locally used equipment | Take into account potential limitation of maintenance equipment (cranes) |
| | Status | | | | | | | | | | |
| High solar irradiation (GHI approx. 2400 kWh/m²) | Description | Module-Inverter-Ratio of approx.. 1.0 | Not critical. Include in techn. specification | Not critical. Include in techn. specification | Not critical. Include in techn. specification | Protect all cabling from direct sun light | Rely on locally used equipment | Protect all cabling from direct sun light | No direct impact | Rely on locally used equipment | Regular check of exposed surfaces |
| | Status | | | | | | | | | | |
| Salty environment (one of the sites is close to a salt lake) | Description | Take into account in protection and cleaning concept | Consider the use of glass-glass-modules | Use IP 64 protection | Use suitable corrosion protection (C4 or C5) | Prot. for motors, movers, joints (C4 / C5, IP64, encapsulation) | Use suitable protection (C4 / C5, IP64, encapsulation) | Use cables with suitable protection | Use cables with suitable protection | Use suitable corrosion protection (C4 or C5) | Regular check of Corrosion of all parts |
| | Status | | | | | | | | | | |
| Salty grounds | Description | All foundation with suitable corrosion concept | No direct impact | No direct impact | Foundation: Special galvanized coating, special lacquering, special concrete | No direct impact | No direct impact | No direct impact | Sand bedding. Suitable cables. If necessary, laying in tubes | Consider special concrete for foundations | Regular check of Corrosion of Foundations |
| | Status | | | | | | | | | | |
| Partially sandy grounds with low stability for foundations | Description | Take into account in static calculations | No direct impact | No direct impact | Foundations: Deeper piling, predrilling & refilling, concrete enforcem. | No direct impact | No direct impact | No direct impact | Not critical. Include in techn. specification | Rely on local standards for foundations | Include measures against sand pollution |
| | Status | | | | | | | | | | |
| Desert area / risk of sand storms | | Take into account suitable sand / dust protection measures | Take into account abrasion proof surfaces | Use IP 64 protection | Not critical. Include in techn. specification | Prot. for motors, movers, joints IP64, encapsulation) | Use suitable protection (IP64, encapsulation) | Use cables with suitable abrasion protection | No direct impact | Suitable ventilation system (filters) | Consider limitation of water access. Regular checks for abrasion. |
| | Status | | | | | | | | | | |
| Areas partly subject to flooding during raining season | Description | Suitable Drainage Concept. Elevated mounting of electric installations. | Elevated mounting | Elevated mounting | Take into account in foundation design | Elevated mounting of electric installations | Elevated mounting of electric installations | Elevated mounting of cable joints & Connectors | Elevated mounting of cable joints & Connectors | Elevated mounting of electric installations | Check for function of electric equipment in case of floods. |
| | Status | | | | | | | | | | |
| Proximity to seismic area (low risk zone) | Description | Take into account in static calculations | Use of framed modules | Include in techn. specifications | Take into account in foundation and structure design | Specialized equipment required according to seismic zone | Rely on locally used equipment | Include in techn. specifications | Include in techn. specifications | Rely on locally used equipment | Additional checkup only in case seismic activity |
| | Status | | | | | | | | | | |

# Ertragsprognose & PoE

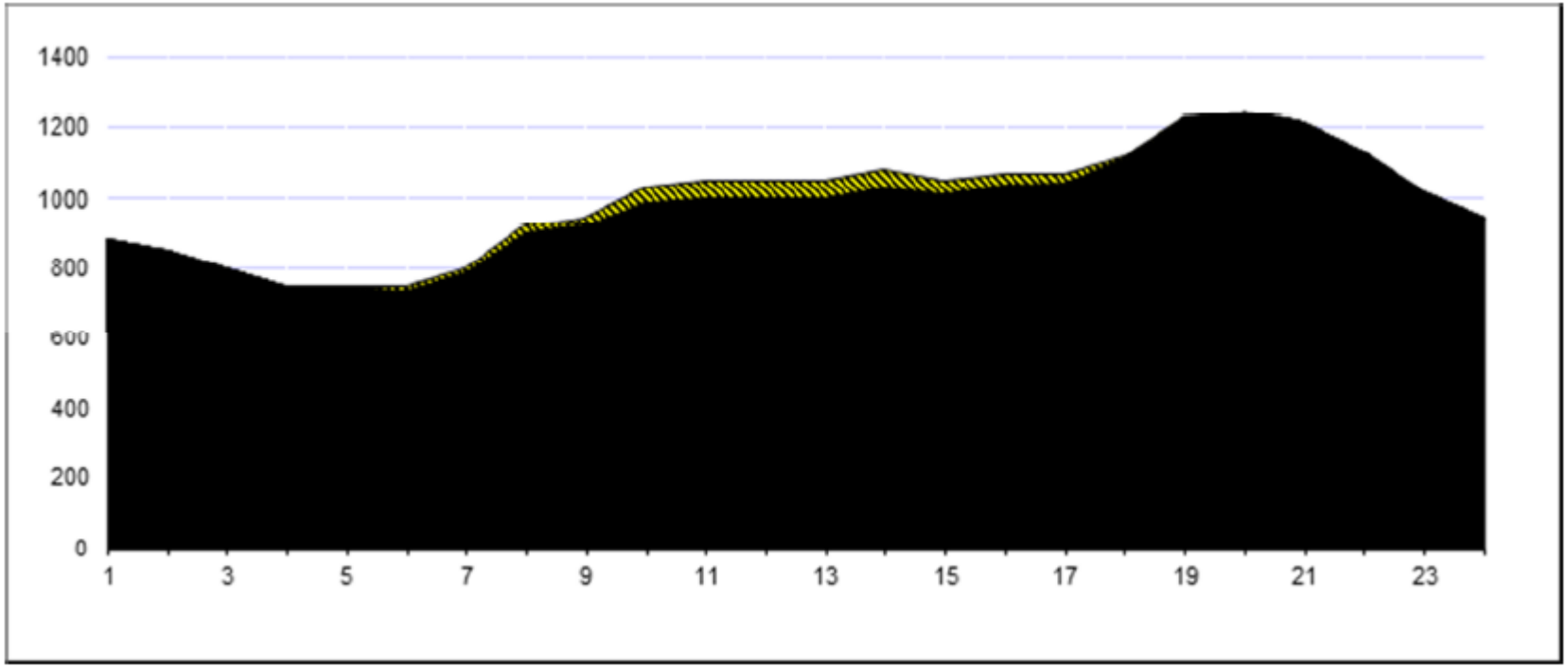




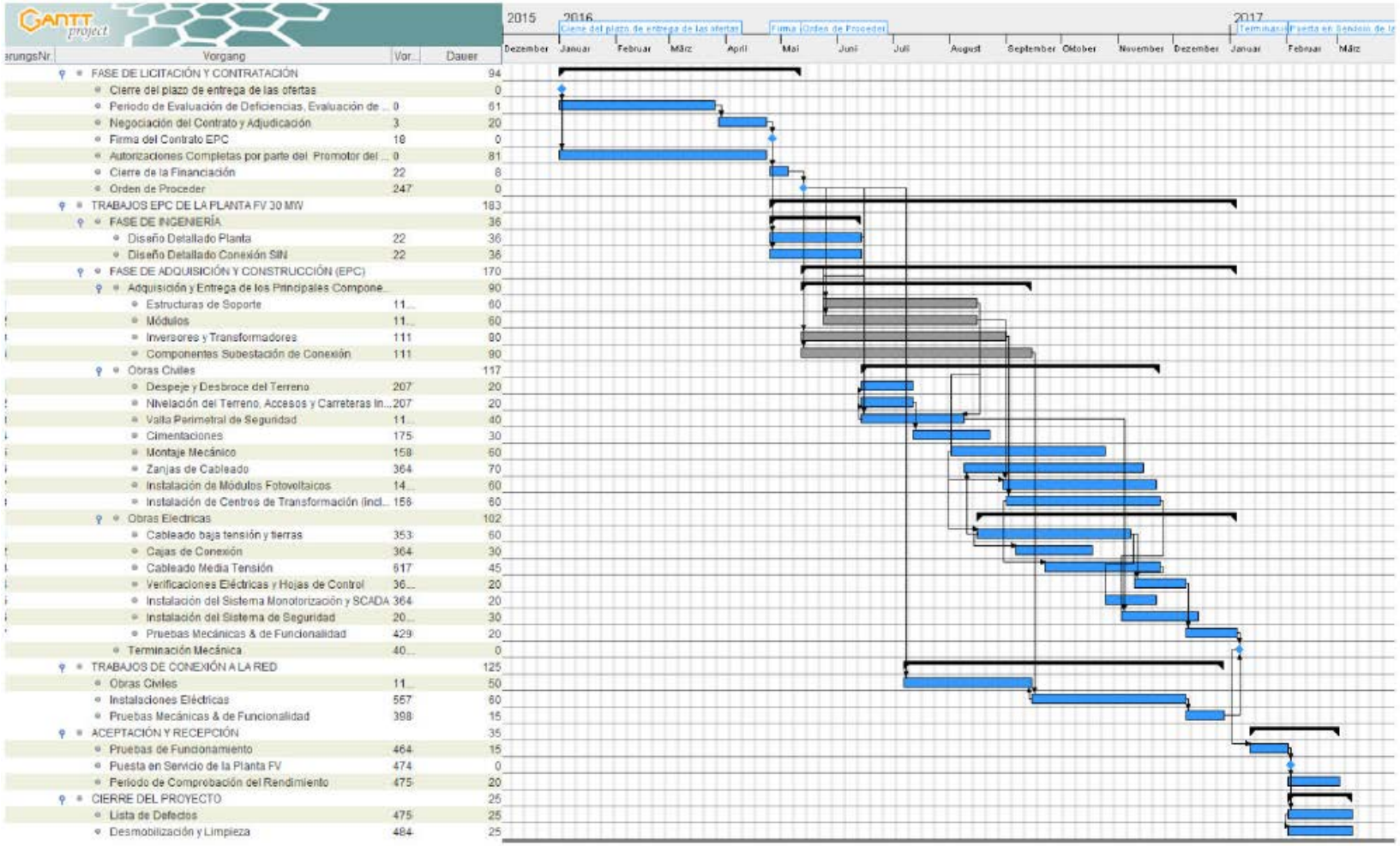


# Netzintegration der Solarleistung




X-Achse: Tageszeit, Y-Achse: MW

# Zeitablauf für die Implementierung



| rungsNr. | Vorgang | Vor... | Dauer |
|---|---|---|---|
| | FASE DE LICITACIÓN Y CONTRATACIÓN | | 94 |
| | Cierre del plazo de entrega de las ofertas | | 0 |
| | Periodo de Evaluación de Deficiencias, Evaluación de ... | 0 | 61 |
| | Negociación del Contrato y Adjudicación | 3 | 20 |
| | Firma del Contrato EPC | 18 | 0 |
| | Autorizaciones Completas por parte del Promotor del ... | 0 | 81 |
| | Cierre de la Financiación | 22 | 8 |
| | Orden de Proceder | 247 | 0 |
| | TRABAJOS EPC DE LA PLANTA FV 30 MW | | 183 |
| | FASE DE INGENIERÍA | | 36 |
| | Diseño Detallado Planta | 22 | 36 |
| | Diseño Detallado Conexión SIN | 22 | 36 |
| | FASE DE ADQUISICIÓN Y CONSTRUCCIÓN (EPC) | | 170 |
| | Adquisición y Entrega de los Principales Compone... | | 90 |
| | Estructuras de Soporte | 11... | 60 |
| | Módulos | 11... | 60 |
| | Inversores y Transformadores | 111 | 90 |
| | Componentes Subestación de Conexión | 111 | 90 |
| | Obras Civiles | | 117 |
| | Despeje y Desbroce del Terreno | 207 | 20 |
| | Nivelación del Terreno, Accesos y Carreteras In... | 207 | 20 |
| | Valla Perimetral de Seguridad | 11... | 40 |
| | Cimentaciones | 175 | 30 |
| | Montaje Mecánico | 158 | 60 |
| | Zanjas de Cableado | 364 | 70 |
| | Instalación de Módulos Fotovoltaicos | 14... | 60 |
| | Instalación de Centros de Transformación (incl... | 158 | 60 |
| | Obras Electricas | | 102 |
| | Cableado baja tensión y tierras | 353 | 60 |
| | Cajas de Conexión | 364 | 30 |
| | Cableado Media Tensión | 617 | 45 |
| | Verificaciones Eléctricas y Hojas de Control | 36... | 20 |
| | Instalación del Sistema Monotorización y SCADA | 364 | 20 |
| | Instalación del Sistema de Seguridad | 20... | 30 |
| | Pruebas Mecánicas & de Funcionalidad | 429 | 20 |
| | Terminación Mecánica | 40... | 0 |
| | TRABAJOS DE CONEXIÓN A LA RED | | 125 |
| | Obras Civiles | 11... | 50 |
| | Instalaciones Eléctricas | 557 | 60 |
| | Pruebas Mecánicas & de Funcionalidad | 398 | 15 |
| | ACEPTACIÓN Y RECEPCIÓN | | 35 |
| | Pruebas de Funcionamiento | 464 | 15 |
| | Puesta en Servicio de la Planta FV | 474 | 0 |
| | Periodo de Comprobación del Rendimiento | 475 | 20 |
| | CIERRE DEL PROYECTO | | 25 |
| | Lista de Defectos | 475 | 25 |
| | Desmobilización y Limpieza | 484 | 25 |

# Zeitablauf für die Implementierung

Interessengruppen

| | |
|---|---|
| **Project Sponsors / Shareholders** | • High yielding project → High tariff<br>• Low costs<br>• Low risk |
| **Supplier(s)** | • Equipment sales and high margin |
| **Utilities** | • Save and secure electricity supply<br>• Reasonable wholesale tariffs<br>• Affordable tariff to customers |
| **Customer(s)** | • Access to electricity<br>• Affordable / low tariff |
| **Lender(s)** | • Lend capital at high interest<br>• No risk → secure repayment |
| **EPC(s)** | • Delivery of EPC services<br>• Low equipment cost<br>• High project price (margin) |
| **Donor(s)** | • Efficient allocation of funds |
| **Government** | • Efficient allocation of resources (triangle of energy economics) |

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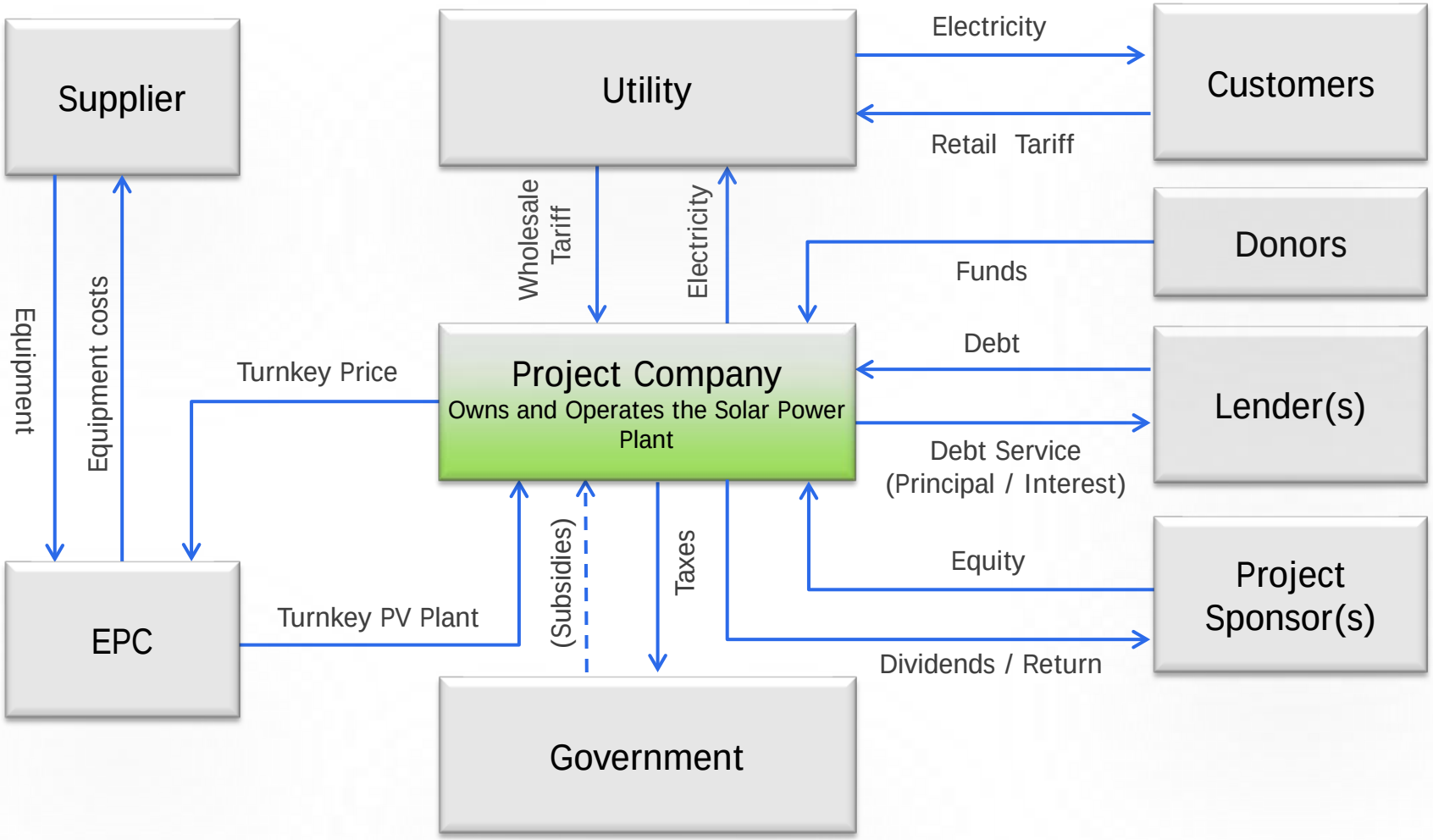
# Betreibermodell (Beispiel)

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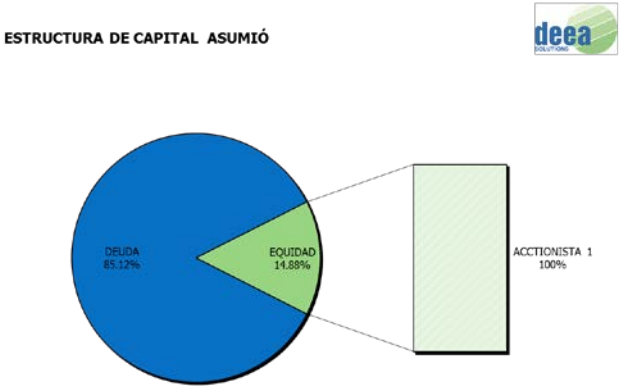
# Finanzierung

- Keine privatwirtschaftliche Beteiligung an Projekten
- Ein Anteilseigner
- Hoher Fremdkapitalanteil
- Finanzierung zu großen teilen über Entwicklungsbanken in $US
- Kredit der Nationalbank in BOB ist im Gespräch
- Moderates Zinsniveau
- Lange Kreditlaufzeiten
- Bis zu 5 tilgungsfreie Jahre



# Ökonomischerer Wert

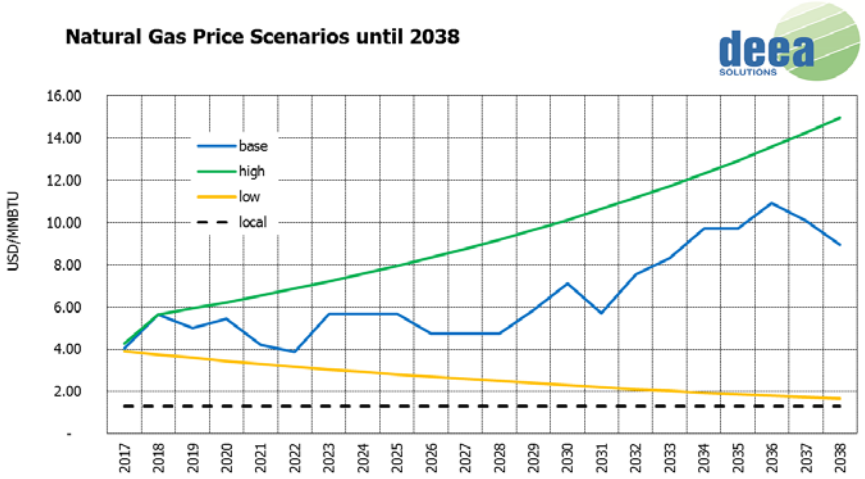
Ökonomischer Wert hängt stark von der Bewertung des nicht verbrauchten Erdgase ab

- Wert der eingesparten Subventionen
- Potentieller Verkaufswert des Erdgase

→ Analyse von Preisszenarien

**Weitere positive Externe Effekte**

- Wissenstransfer
- Technologietransfer
- Ansehen und Reputation
- Regionale Entwicklung
- Energiepolitische Signalwirkung



# Lessons Learned

# VIELEN DANK!

Bundesministerium
für Wirtschaft
und Energie

Durchführer

**Daniel Gudopp**
Managing Partner

deea solutions GmbH
Kennedyallee 93
60596 Frankfurt am Main

MOB +49 (0) 172/ 57 77 199
TEL +49 (0) 69 / 45 000 255
FAX +49 (0) 69 / 45 092 825
MAIL d.gudopp@deea-solutions.com
WEB www.deea-solutions.com