A Feasibility Study for an HVDC Submarine Cable to Interconnect the Baja California Sur Grid to the Mexican Interconnected System

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Where?

Abstract

►Preliminary feasibility studies are presented to interconnect the electric grid in the state of Baja California Sur (BCS) to the Mexican Interconnected Electrical System (MIS) by means of a *submarine cable*

►Two technologies are considered:

- HVDC Light
- HVDC Classic

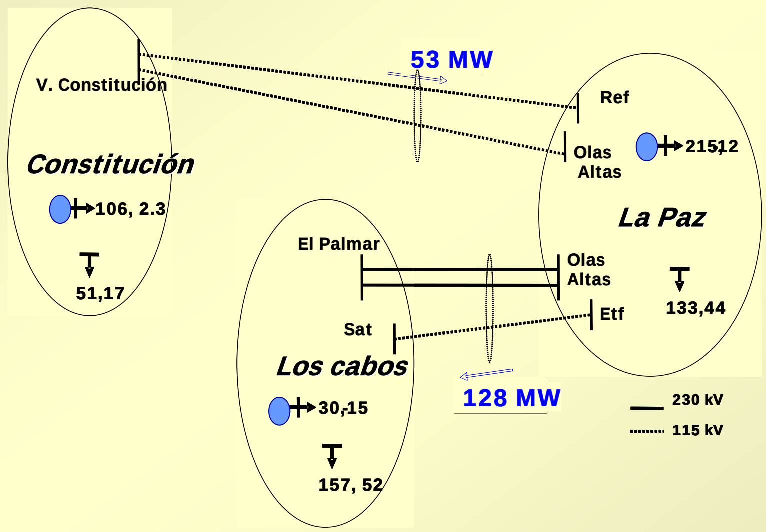
►Power flow, short circuit and contingency studies are used for assessing both alternatives

Why is this interconnection required?

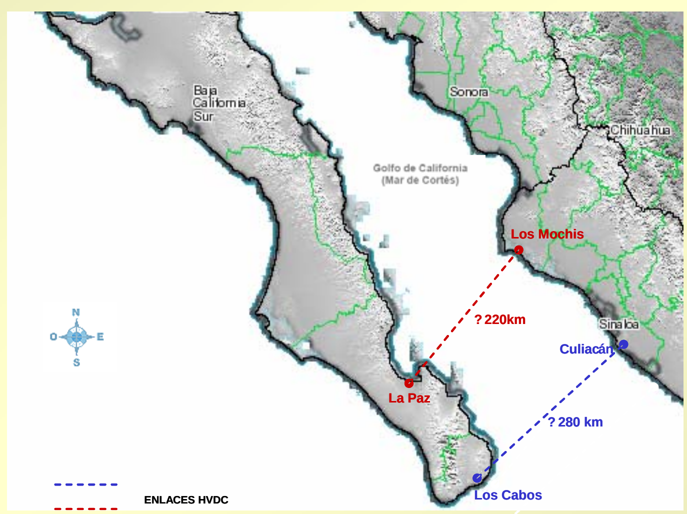
► The electrical grid in Baja California Sur has a load increase of about 10 % per year

► Currently, the energy generation cost and the enviroment detriment are very high

Schematic diagram for the BCS grid



Interconnecting points - d.c. cable



Distances involved

#	BCS	MIS	Distance * (km)
Los Cabos Zone		*Northwestern Area*	
1	El Palmar 230 y 115 kV	La Higuera 230 kV	270
La Paz Zone		*Northwestern Area*	
2	Olas Altas 230 y 115 kV	Topolobampo 230 kV	220
3	Coromuel 230 kV		203
* Total distance: Land+Sea			

Base Case Considerations

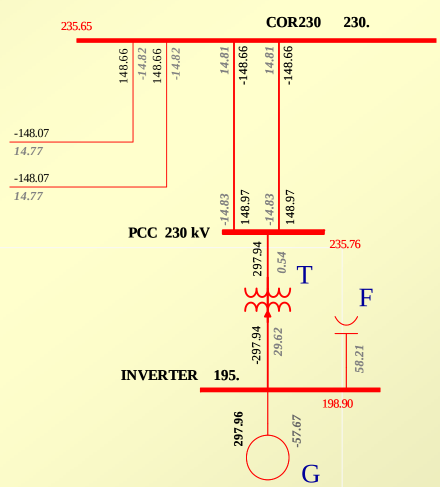
- Peak demand of 340 MW
- Generation at Los Cabos should be discarded
- Operating voltages must remain within ±5% of rated value
- Transfer limits between zones must be dealt with
- Contingencies analyzed: outages of generators, transmission lines (115 and 230 kV) and capacitors

HVDC Light

HVDC Light inverter model in BCS

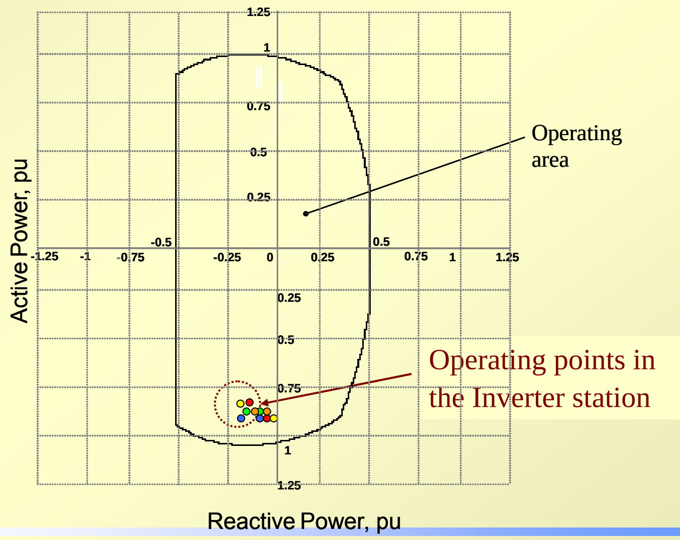
HVDC Light model

- Generator, G
- Transformer, T
- Filter, F
- Submarine cable is not modeled
- But power losses in the cable are considered



P-Q Diagram

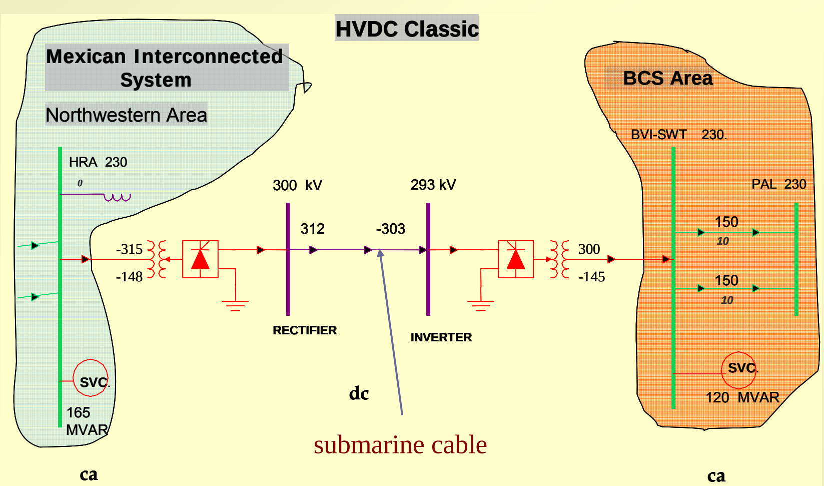
HVDC Light in HRA230 kV



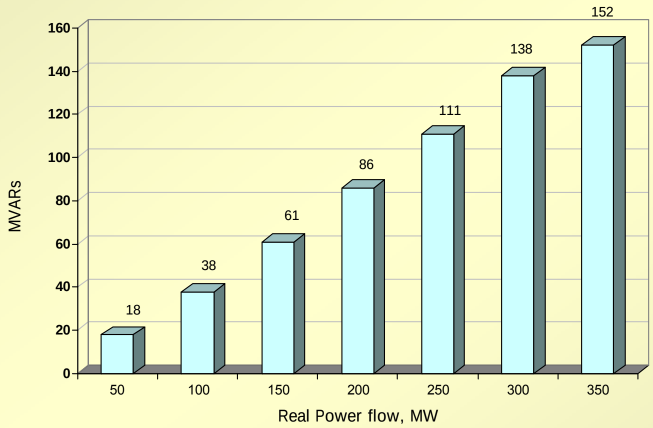
Main parameters (HVDC Light)

- Transfer over the d.c. link: 300 MW
- Rated voltage ±150 kV
- To comply with voltage criteria, at least TWO generating units should remain in operation at the BCS grid

HVDC Classic



Reactive power requirements



Reactive power absorbed at each converter station as a function of active power transfer in the d.c. link

Effective Short Circuit Ratio (ESCR)

- Unlike HVDC Light, ESCR is an important factor in the design
- Ratio defined as the short circuit capacity in the a.c. side over the active power capacity of the d.c. link
- ESCR ≥ 3 is recommended

ESCR in the MIS with HVDC Classic

Machines in the MIS			
	all machines	without MZD-U1	without TPO-U1
Electrical substation	**Short circuit capacity (MVAcc)**		
HRA-230	3723	3660	3643
TOP-230	2764	2760	2146
HVDC Classic power flow (MW)	0	300	300
Qc (MVAR)	0	150	150
	Effective short circuit ratio (ESCR)		
HRA-230	none	11.700	11.643
TOP-230		8.700	6.653

ESCR > 3% in both substations

ESCR in BCS Area with HVDC Classic

Machines in BCS Area							
	2	3	4	5	5	5	6
HVDC Classic power flow (MW)	300	260	220	180	188	184	150
Qc (MVAR)	150	130	110	90	94	92	75
Electrical substation	**Effective short circuit ratio (ESCR)**						
PAL-115	-0.10	0.52	1.18	2.00	2.25	2.20	2.86
PAL-230	-0.09	0.59	1.34	2.28	2.59	2.52	3.28
OLA-115	-0.03	0.82	1.83	3.51	4.47	4.22	5.51
OLA-230	-0.05	0.85	2.03	3.61	4.35	4.17	5.40
COR-230	-0.06	0.86	2.12	3.67	4.33	4.18	5.39

ESCR > 3% in these operating conditions

Main parameters (HVDC Classic)

- Transfer over the d.c. link: 180 MW
- Rated voltage ±150 kV
- Reactive power compensation needed: 90 MVAR at each station
- To comply with ESCR, at least FIVE generating units should remain in operation at the BCS grid

Conclusions

- Both HVDC technologies analyzed are able to supply the total peak demand of the BCS grid
- Restrictions limit this transfer to 300 MW for HVDC Light and 180 MW for Classic
- Power losses: 22.0 MW Light, 13.2 MW Classic
- Aspects to assess in detail: reactive power requirements (Classic), smaller filter size (Light), less environmental impact with polymeric cables (Light)

Conclusions

- An economic analysis is being performed, considering factors such as: savings in generation and maintenance costs, power loss cost over time, additional reactive power compensation in the case of HVDC Classic

- Subsequent investigation will discuss transient and oscillation analysis results

Thanks for your attention…