Comment Set G0014, cont.
California Botanical Habitat

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Pacific Intertie 3,100 megawatts, +/-500 kV DC, 1965 LADWP

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G0014-8 cont.

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G0014-8 cont.

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Comment Set G0014, cont.
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G0014-8 cont.

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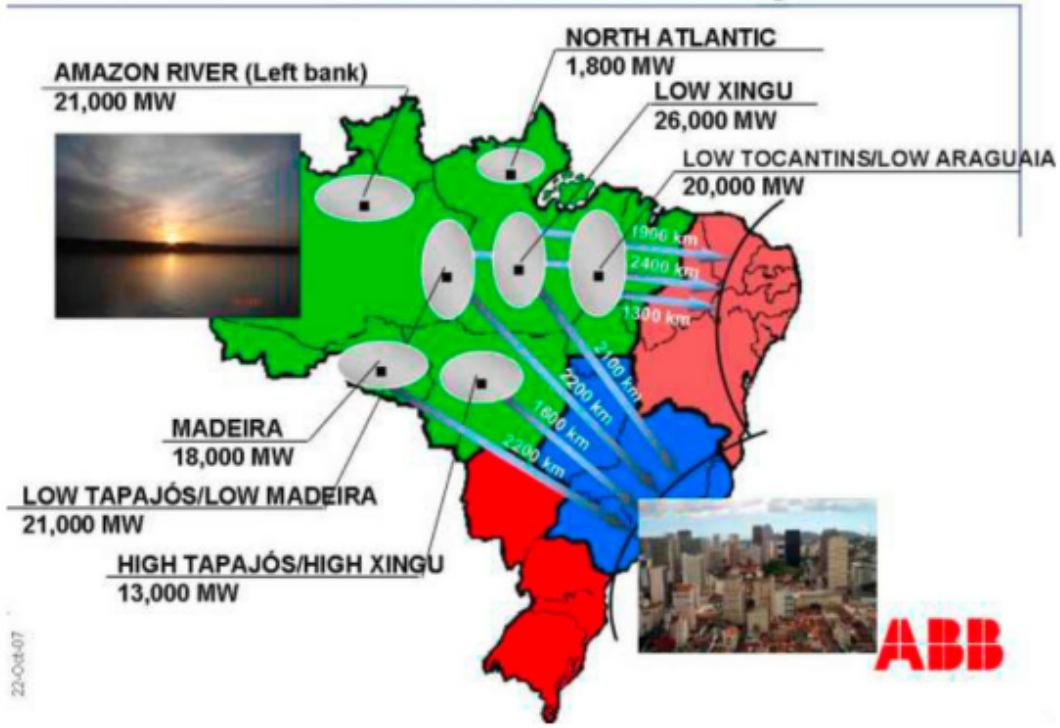
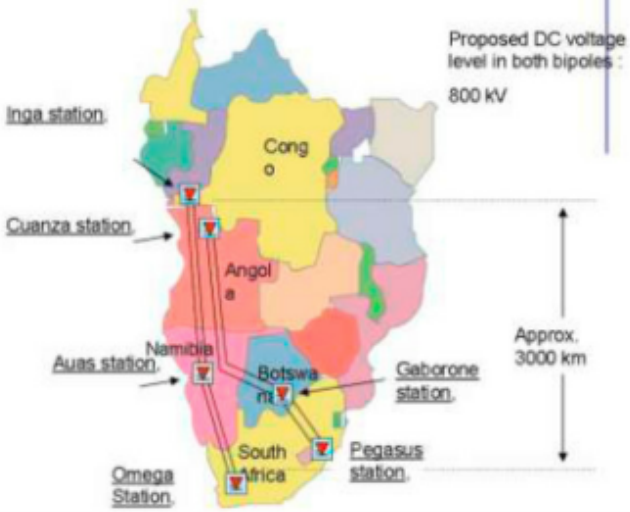
Brazil: Potential Amazonas River Projects



South Africa: West Cor Line



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+/- 800 kV 6400 MW DC converter station

Wall Bushing 800kV ABB

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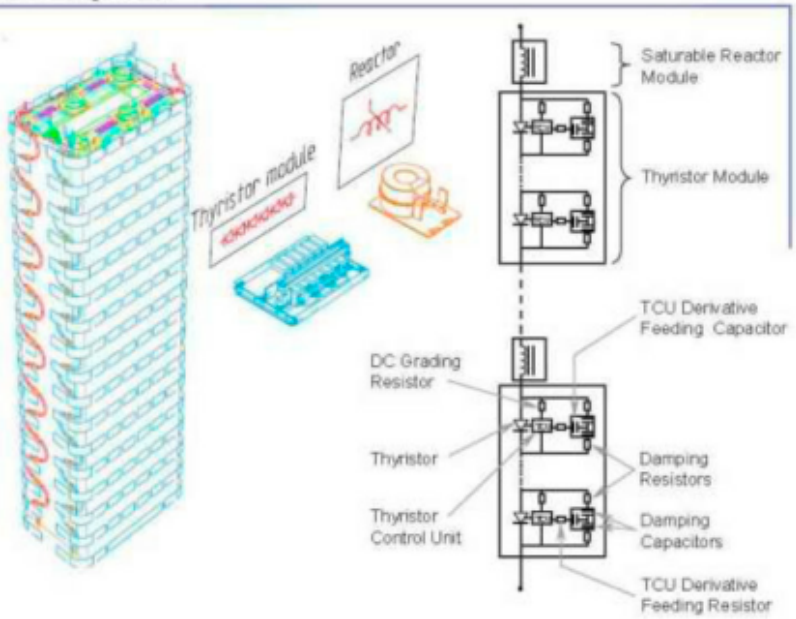
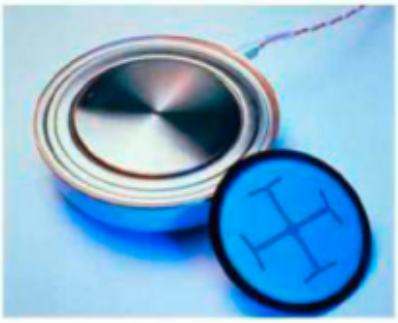
G0014-8 cont.

Thyristor Valve Layout



Thyristors

- The valve voltage is not decisive for the thyristor. Will be handled by sufficient number of thyristor positions in series. Due to the well defined voltage grading each individual thyristor position has the same electrical stress in an 800 kV valve as in a 500 kV valve!
- The critical parameter for the thyristors is the short circuit current. This is given by the ratio between rated DC current and transformer reactance



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Comment Set G0014, cont.
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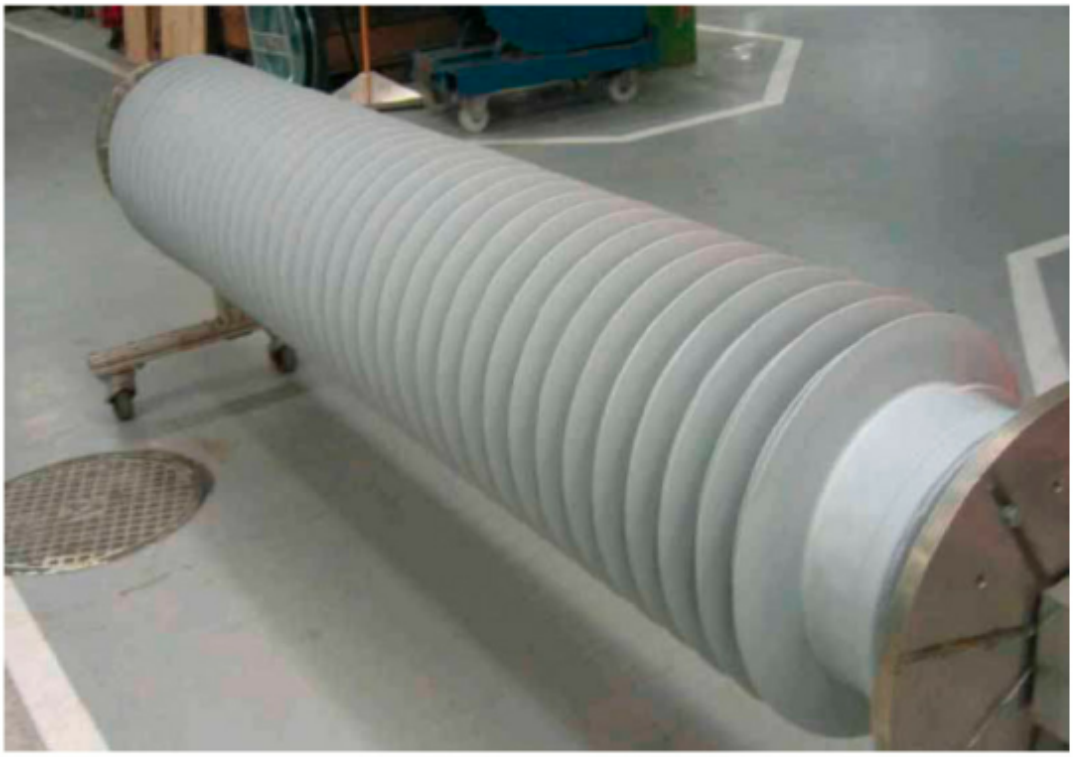
G0014-8 cont.

Experience of 14000 5" thyristors

Project	Power Transmitted, MW	Number of thyristors	Commis-sioned year	Nominal Current, A	Overload Current, A
Garabi 1 Brazil	1100	1728	2000	4020	-
Garabi 2 Brazil	1100	1728	2002	4020	-
Three Gorges-Changzhou, China	3000	4176	2003	3000	3555 @20°C
Rapid City USA	2x100	336	2003	3920	-
Three Gorges-Guandong, China	3000	4176	2004	3000	3555 @20°C
Sylmar Replacement Pproject USA	3100	2016	2004	3100	3650 @20°C

One thyristor failed during commercial operation reported (Garabi 2002)



Composite support insulator +-800 kV DC, ABB

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Comment Set G0014, cont.
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Pylon foundation, Pacific Intertie 3,100 megawatts, 1965 LADWP

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G0014-8 cont.

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Ultra high voltage DC videos:

"800 kV UHVDC" (7 min)
Large 22 MB
"800 kV UHVDC" (7 min)
Small 7 MB

http://www.abb.com/cawp/gad02181/0ca04adc1b0b9c76c12570f3002eb4c7.aspx (Index of HVDC videos, which are available in high or low resolution for faster buffering)

http://www.prysmian.com/our-products/energy/power-transmission/high-voltage-systems.html
(400 kV underground Madrid to Barajas Airport Prysimian cable and tunnel installation)

Ditta Pirelli now Prysmian Cables, founded 1872, began undersea cable production in 1886, acquired Siemens cable division 1999, has 52 manufacturing facilities in 21 countries

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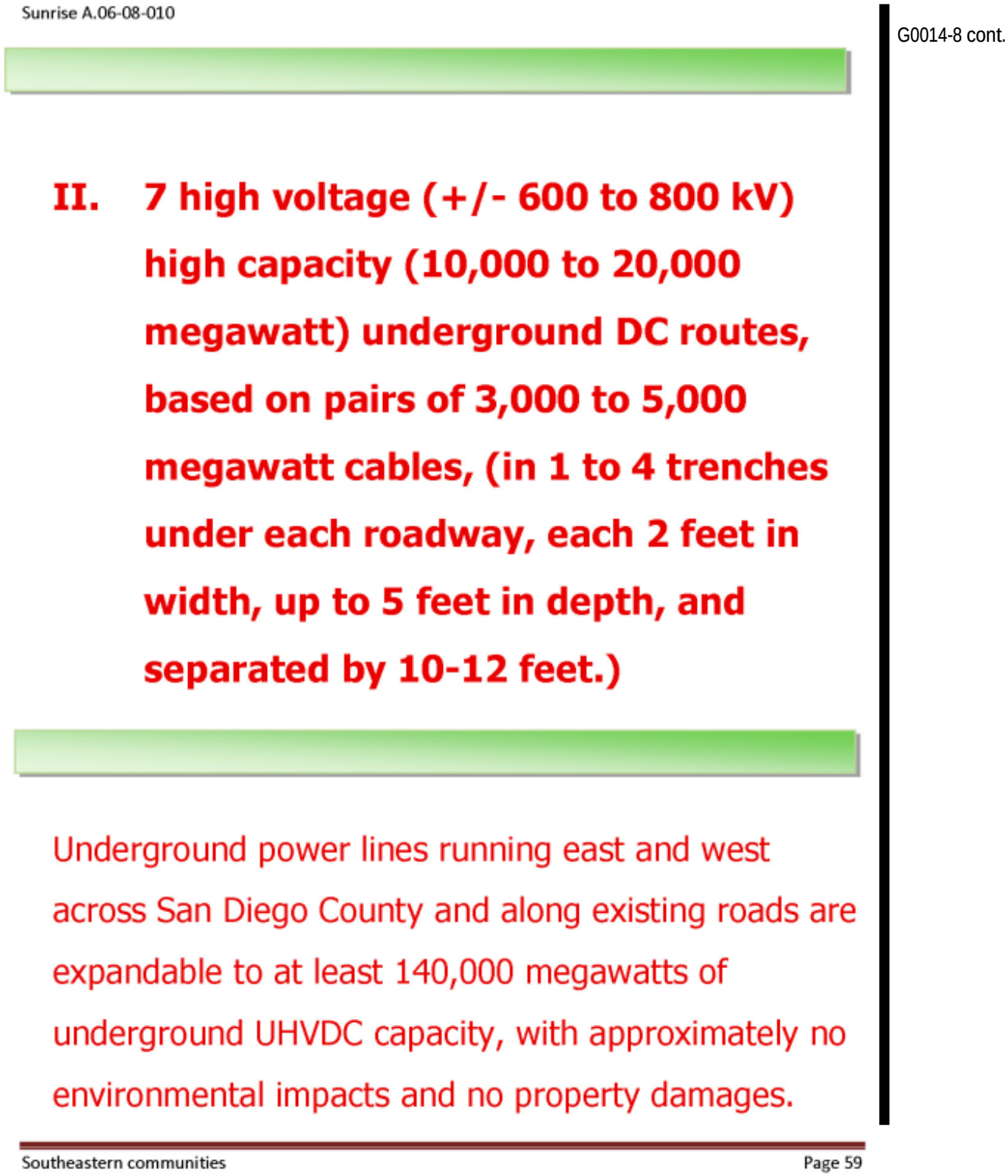
G0014-8 cont.

Comment Set G0014, cont.
California Botanical Habitat



G0014-8 cont.

Comment Set G0014, cont.
California Botanical Habitat

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G0014-8 cont.

East to west highway routes from Imperial County to Western San Diego County

1. Highway S22 to 79 west to 74 into Orange County
2. Highway 78 west
3. Highway S2 to 76 west
4. Old Highway 80 west
5. Highway 94 + Southwest power line right-of-way to the east
6. Boarder road or Southwest power line right-of-way westerly
7. Unpaved roads east to west between border and Highway 2 in Mexico

High capacity underground DC cable considerations

1. Use the existing AC power network not for long distance transmission, DC can do that more efficiently with greater capacity, lower maintenance and negligible damages. AC's advantage is for internal regional distribution, which is already substantially in place.
2. Where the roads may be narrow entering a desert region with high summer heat, such a Borrego Springs CA, a small water main may incidentally accompany a pair of underground cables, may also help increase capacity under high loads when the daytime temperature may exceed 110 F, even though DC cables operate cooler than AC power lines, and are designed to provide optimum performance at 70-90 degrees centigrade (158-194 F). Also a water line can help address desert water table depletion caused by aggressive agricultural practices. Naturally, thermodynamic modeling would have to verify efficiency, compared to increasing the copper cross-section vs. night dissipation.

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G0014-8 cont.

3. While underground cable capacities have increased from 150 kV to 300 kV to 600 kV and +/-800 kV, and underground spacing does not have an electrical effect, but does have a thermal influence that could also be taken into account during cable design. Four to five meter separations are in general sufficient to maintain the thermal influence at low values, i.e. a few degrees. Two 2 cable pairs could provide 6,000 to 10,000 megawatts operating at +/-500 to 800 kV. System examples including the Pacific Intertie which has increased voltages and capacity many years after construction, when needed, long after system reliability had been proven.

4. **Cables technologies:** Underground DC power lines with a minimum or 3,000 square millimeter copper cross-section and 6.2 inch outer diameter operating at: +/- 300 kV (using XLPE, cross-linked polyethylene extruded cables), or +/- 600 kV (using PPL, Paper Polypropylene Laminate), or +/- 800 kV (using SCFF, Self Contained Fluid Filled).

5. Arguments that high voltage DC whether overhead or underground are exclusively cost effective for very long distance lines, may have been true decades earlier. However, runs as short as 20 miles have been effectively used, connecting New Jersey to Manhattan, and the cost of a 1.3 megawatt, 161 mile DC lines in the UK (BritNed) has been $530,000,000 less costly than the proposed overhead AC Sunrise Powerlink.

6. Designing an underground power line which maximizes capacity and allows for upgrades, to double, triple or quadruple the initial capacity, means that a 50 foot wide roadway could 1st use one trench 2 feet in width to separate the first cable pair by 18 inches, which could provide between 3,000 and 5,000 megawatts at +/-600 to +/-800 kV, leaving room on the opposite side of the road for the second cable pair, plus room in the center for a third pair, and if there is adequate width for 2 trenches in the

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G0014-8 cont.

middle, for a total of 4 trenches, 2 feet wide each, with a 10-12 foot separation between each trench, for a total capacity of 12,000 to 20,000 megawatts under a single county roadway, naturally depending on future requirements which can be incrementally increased.

7. While cable spool size may be determined by a delivery route which avoids any low bridges, with 6 inch cables, the expected lengths would be 500 to 600 meters, or 1640.4 to 1968.5, or .3728 miles per segment, or 268 segments and splices per 100 miles of cable, or 536.5 spools for + and - cables.

8. Using both sides of each road could provide adequate heat dissipation, or each cable could be placed in a separate trench separated by 10-12 feet, although an 8 inch separation between positive and negative DC cables is considered appropriate in a 1 foot wide trench that's 5 feet in depth, however a .4 to .5 meter (18 inch separation) could assist heat dissipation in the desert or when operating at higher capacities. Deeper burial would not benefit night time heat dissipation during the summer months and could potentially reduce capacity, since the earth would act as an effective thermal insulator at greater depth.

9. Based on immediate need 2 cables can be installed on only one side of the highway providing from 3,000 to 5,000 megawatts of capacity, of which only 1,000 or 2,000 megawatts may to be implemented at first, which can later be expanded by simply upgrading the converter stations and later expanded by installing the second cable under the other side of the road, bringing the capacity up to 6,000 or 10,000 megawatts; leaving room for 1 or 2 additional expansions, with a total capacity of 12,000 to 20,000 megawatts under each road.

10. Naturally, underground barriers are installed such as poured concrete to inhibit accidental back-hoe damages, along with signs and phone numbers.

11. Water permeable concrete and pavers can be used to retain moisture from rain, which would assist with heat conduction, heat dissipation and solar heat reflection compared

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Comment Set G0014, cont.
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to black asphalt coatings. Further, such roadways when appropriately engineered for sub-pavement drainage will absorb rain water, not create puddles and not require storm drains. The paving systems have been designed for automated, rapid, low cost installation and eliminate the need for storm drains, providing a considerably more attractive road, with better traction, which is designed to carry fully loaded high-capacity tank trucks, at a lower cost than asphalt systems, and further can be disassembled and reassembled as needed for construction purposes, all with patented and licensed, high volume, low cost manufacturing facilities in Corona California. Further, such water permeable systems are becoming a requirement in San Diego County, which is an economic, environmental, safety and engineering advantage, particularly for underground power lines.

12. When someone is willing to sacrifice a functioning wilderness and ecosystem by placing an array of hot sagging cables overhead in spite of studies showing a 70% increases in leukemia (based on only very limited EMF exposure levels), and is willing to disregard cancer deaths and oppose a vastly less damaging trench that's only 5 feet deep, then the basis of the position appears to be a matter of dogma designed to perpetuate a fraud and the taking of lives. Which is not to say that the needless destruction of nature and property for personal profit is ultimately advantageous to anyone, nor even useful from the perspective of private gain; nevertheless we see these sorts of damaging actions repeatedly, as if they were the law. Naturally, a review process needs to accumulate, measure and summarize all damages caused by a Powerlink, based on the full restoration and the full cost of equivalent property replacement, including damages done to lives, not just commercially measured values, but fully equivalent values including equivalent habitat, unobstructed views, rare species, access, personal, local and urban facilities, energy generation capabilities, access, security, operating expenses and maintenance requirements, time to locate and acquire the equivalent sites, legal and collection expenses.

13. If a small portion of an underground power line needs to go from an existing highway, where it can be regularly watched and protected. Then that portion of off-road access

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Comment Set G0014, cont.
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G0014-8 cont.

needs to be carefully photographed and mapped, with the exact location and orientation of each boulder identified, with accurate coordinates, so that the geology and plant specimens impacted can be fully restored. The value of wilderness is not what someone who wants to destroy it says it's worth. It's the full restoration and replacement cost, the same as when anyone destroys a new Mercedes or a corporate jet. Which incidentally are mass produced and far more easily replaced than wilderness, that can take over 40 years of labor, materials and accumulated knowledge to complete the restoration process at a cost of $25 to $75 per square foot. Naturally a 1 square foot hole in a jet plane does not diminish its value by $75 or even $500. The entire jet plane has a negative value until the hole is completely restored with skilled workmanship, which may mean that the loss may be in excess of $50 million, until the hole or the demand for the obstruction is completely eliminated. Of course serious and permanently enforced damages to a wilderness preserve are not just damaged just where a collection of 500,000 volt cables pass overhead, the entire paleontological, research, facilities and recreational value of our properties is overwhelmingly defeated, and require the full and complete restitution, based on everything that has been lost, including the full and equivalent replacement value, along with losses of time, expenses, legal and collection costs, plus interest (excluding inflation), adjusted for the time of the full replacement, which incidentally can and typically does take several decades of intensive effort to accommodate, and undoubtedly will not be any bargain as population pressures increases and habitat is lost, and could easily be well over 100 times more costly to either restore or replace, given the lack of equivalent wilderness regions. Based on the often poorly measured issue of inflation, homes that sold for $10,000 during the 1950's were recently resold for over $1 million, surprisingly not completely remodeled as anyone might expect, but in their original ½ century old and poorly cared for condition, while better quality homes in Bellaire have increased by over 300 times during that same period, which naturally refers to the intentional economic mismanagement of this economy.

14. Why would the electric industry be expanding its dependency on imports, including massive quantities of Liquefied Natural Gas (LNG) which does not offer a stable price

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Comment Set G0014, cont.
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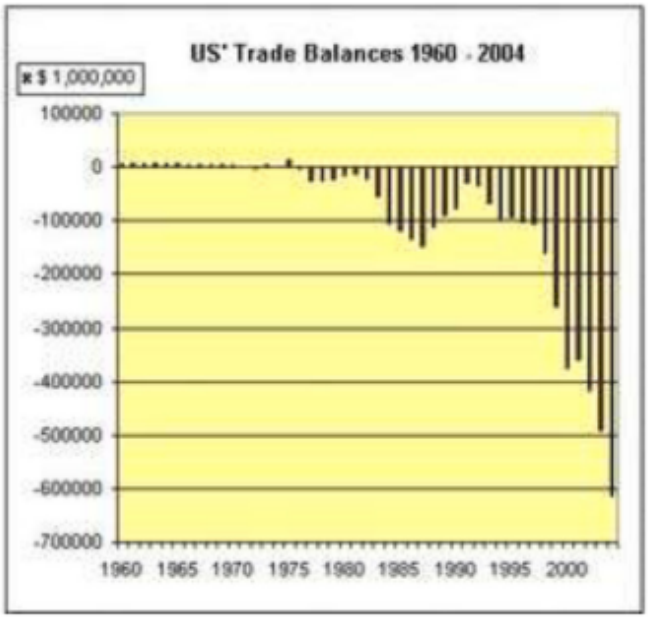
or supply, when the total national debt exceeds $90 trillion and when we have enormous quantities of renewable resources. Going deeper into debt to buy energy when we already have an abundance of energy resources doesn't save money nor develop long-term profits.

G0014-8 cont.



15. Implementing lower cost, higher capacity, nondamaging solutions is an opportunity to reverse a long history of causing needless environmental and property damages. Fortunately, it also includes economic advantages for SDGE. Apparently, Europe, Australia, China, India and Brazil have all been able to evaluate the engineering advantages and implement higher capacity UHVDC and underground systems with very significant economic advantages. But we have to circumvent or violate our environmental laws and health laws because corporate executives can't review the issues or consider change?

16. Thousands of people have pleaded with SDG&E to protect the San Diego County's extraordinary wilderness regions, their homes, ranches and farms, with no reconsideration by SDGE of any lower cost underground alternatives that could reduce all these massive and needless damages.

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G0014-8 cont.

17. The integration of a fiber optic link above the underground power line can provide for immediate security alarms directly to the local sheriff, in addition to high definition video security cameras on each cable segment to provide for security monitoring, which is also available to the public, along with free wide area high-speed internet to all residents along the power line route, with the ability to rotate and zoom one camera on each visible segment, when not being used by SDGE or law enforcement.

18. With a more efficient grid that could save SDGE over $20 billion in expansion costs over several decades, as well as saving 100's of thousands of acres from environmental devastation, and saving many billions in property losses, there's no doubt that SDGE could afford to reimburse everyone for the full replacement value of the property that was lost or was damaged along existing high power lines. Instead of the power industry spending 100's of millions of dollars trying to deny EMF and pollutant ionization, or proven associations with cancer, resources could be far better spent by providing funding for a local molecular biology institute to assist in studying cellular electron field interference, along with methods to defend against and reverse related cancers.

19. Restoration of environmental damages caused along existing power line routes can continue by researching advanced on-site propagation techniques based on rainfall for indigenous drought tolerant trees, along with nutrients, moisture retention, genetic strains and improvements to drought tolerance.

20. The public relation benefits for protecting the environment on a large scale, along with addressing the molecular biology of ion and field promoted cancers, while eliminating any significant need for eminent domain, and supporting sustainable electrical generation while resolving the huge electrical demand for plug-in hybrid vehicles, could incidentally result in a notable public relation benefits for Sempra Energy, as well as significantly increase SDGE's delivery of electricity while providing support for the governor's administration.

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21. However, with identifiable nondamaging alternatives and cost estimates provided, SDG&E cannot later say they were unaware of the damages to the environment, damages to public and private property, the massive economic losses that would be inflicted, nor the cancer risks along the 150 mile route, based on large scale medical studies, because we provided SDG&E and the CPUC with hundreds of pages of documentation which they acknowledged receiving and reading, and we further personally offered to answer any questions that might exist, or respond to the accuracy or basis of any data, or the estimates which we have provided, also which has not occurred, and which we again offer on a cooperative, working basis, in order to help find a mutually beneficial solution, or initiate research to more thoroughly respond to any issue.

G0014-8 cont.

Many people at the May 12, 2008 CPUC hearing described their own successful home solar projects that have been operational for years, which also deliver unreimbursed excess power into the SDG&E grid.

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G0014-8 cont.

References:

1. http://search.abb.com/library/Download.aspx?DocumentID=9AKK101130D3429&LanguageCode=en&DocumentPartID=&Action=Launch&IncludeExternalPublicLimited=True

2. http://search.abb.com/library/Download.aspx?DocumentID=9AKK101130D3428&LanguageCode=en&DocumentPartID=&Action=Launch&IncludeExternalPublicLimited=True

3. http://www.abb.com/cawp/gad02181/f665be70ddd7edb3c1256fe2002cdf0d.aspx

4. http://www.prysmian.com/our-products/energy/power-transmission/high-voltage-systems.html

5. http://www.undergroundpower.us

6. http://www.cpuc.ca.gov/puc/

7. Next page, specifications for **+/-300 kV XLPE underground DC cable**, with a 3,000 square millimeter copper conductor, 155 mm (6.2 inch) diameter and 1,840 megawatts of capacity, with PPL and SCFF technology underground cable options to operate at +/-600 kV and +/-800 kV, with proportionally greater capacity (estimated at 3,680 megawatts, and 4900 megawatts).

   Reel diameter, or local bridge height during transport are the more significant limiting factors to cable length and power line capacity or splice reduction, with a typical reel capacity of 600 meters (1,968.5 feet).

Comment Set G0014, cont.
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G0014-8 cont.

Moderate climate, submarine cables with copper conductor

Area	Ampacity		80 kV cable bipole				150 kV cable bipole				300 kV cable bipole			
Con-ductor	Close laying	Spaced laying	Close laying	Spaced laying	Weight per cable	Diam. over cable	Close laying	Spaced laying	Weight per cable	Diam. over cable	Close laying	Spaced laying	Weight per cable	Diam. over cable
mm²	Amps	Amps	MW	MW	kg/m	mm	MW	MW	kg/m	mm	MW	MW	kg/m	mm
95	343	404	55	65	4,7	42	103	121	8,5	60	206	242	15	90
120	392	463	63	74	5,5	44	118	139	9,4	61	235	278	16	91
150	441	523	71	84	6,7	47	132	157	10	63	265	314	17	93
185	500	596	80	95	7,4	49	150	179	11	64	300	358	18	95
240	583	697	93	112	8,4	52	175	209	12	67	350	418	20	99
300	662	797	106	128	9,4	56	199	239	13	69	397	478	22	102
400	765	922	122	148	11	61	230	277	16	75	459	553	24	105
500	883	1072	141	172	13	66	265	322	18	78	530	643	26	108
630	1023	1246	164	199	15	71	307	374	21	83	614	748	30	114
800	1175	1438	188	230	17	76	353	431	24	88	705	863	33	118
1000	1335	1644	214	263	21	81	401	493	26	96	801	986	37	122
1200	1458	1791	233	287	24	85	437	537	29	100	875	1 075	40	126
1400	1594	1962	255	314	27	89	478	589	32	103	956	1 177	43	130
1600	1720	2123	275	340	30	92	516	637	35	107	1 032	1 274	47	133
1800	1830	2265	293	362	32	96	549	680	38	110	1 098	1 359	50	137
2000	1953	2407	312	385	35	99	586	722	41	113	1 172	1 444	53	140
2200	2062	2540	330	406	40	103	619	762	45	118	1 237	1 524	58	145
2400	2170	2678	347	428	42	106	651	803	48	121	1 302	1 607	61	148
2600	2275	2814	364	450	45	109	683	844	51	123	1 365	1 688	63	150
2800	2373	2937	380	470	48	111	712	881	54	126	1 424	1 762	67	152
3000	2473	3066	396	491	50	114	742	920	57	128	1 484	1 840	70	155

Sea soil: Temperature 15 deg.C, Burial 1.0 metre, Thermal resistivity 1.0 K x W /m
Cable: Copper conductor, HVDC polymer insulation, Steel wire armour

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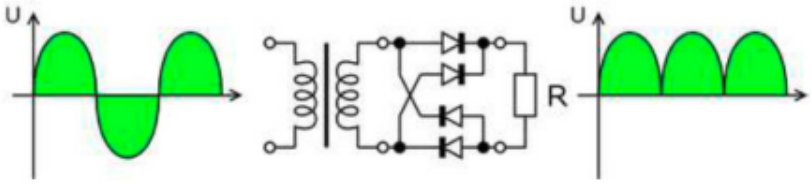
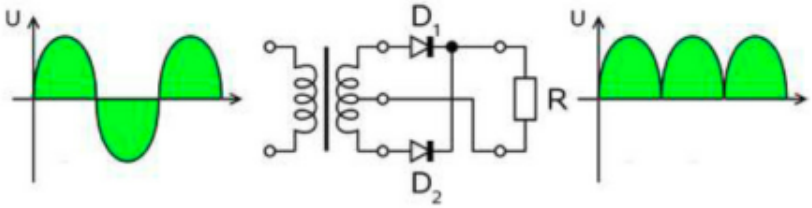
Full-wave rectification, AC to DC

A full-wave rectifier converts the whole of the input waveform to one of constant polarity (positive or negative) at its output. Full-wave rectification converts both polarities of the input waveform to DC (direct current), and is more efficient. However, in a circuit with a non-center tapped transformer, four diodes are required instead of the one needed for half-wave rectification. (See semiconductors, diode). Four rectifiers arranged this way are called a diode bridge or bridge rectifier:



For single-phase AC, if the transformer is center-tapped, then two diodes back-to-back (i.e. anodes-to-anode or cathode-to-cathode) form a full-wave rectifier (in this case, the voltage is half of that for the non-tapped bridge circuit above, and the diagram voltages are not to scale).



http://en.wikipedia.org/wiki/Rectifier

Inverter (electrical), DC to AC

An **inverter** is an electrical or electro-mechanical device that converts direct current (DC) to alternating current (AC). The electrical inverter is in effect a high-power electronic oscillator. It is so named because early mechanical AC to DC converters were made to work in reverse, and thus were "inverted", to convert DC to AC. The inverter performs the opposite function of a rectifier. With HVDC power transmission, AC power is rectified and high voltage DC power is transmitted to another location. At the receiving location, an inverter in a static inverter plant converts the power back to AC.

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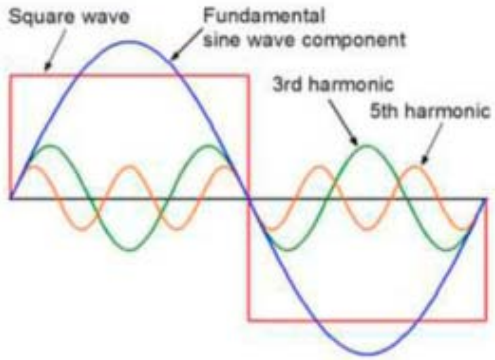
The electromechanical version of the switching device includes two stationary contacts and a spring supported moving contact. The spring holds the movable contact against one of the stationary contacts and an electromagnet pulls the movable contact to the opposite stationary contact. The current in the electromagnet is interrupted by the action of the switch so that the switch continually switches rapidly back and forth. This type of electromechanical inverter switch, called a vibrator or buzzer, was once used in vacuum tube automobile radios. A similar mechanism has been used in door bells, buzzers and tattoo guns.

As they have become available, transistors and various other types of semiconductor switches have been incorporated into inverter circuit designs.



Square waveform with fundamental sine wave component, 3rd harmonic and 5th harmonic

Output waveforms

The switch in the simple inverter described above produces a square voltage waveform as opposed to the sinusoidal waveform that is the usual waveform of an AC power supply. Using Fourier analysis, periodic waveforms are represented as the sum of an infinite series of sine waves. The sine wave that has the same frequency as the original waveform is called the fundamental component. The other sine waves, called *harmonics*, that are included in the series have frequencies that are integral multiples of the fundamental frequency.
http://en.wikipedia.org/wiki/Inverter_(electrical)

Comment Set G0014, cont.
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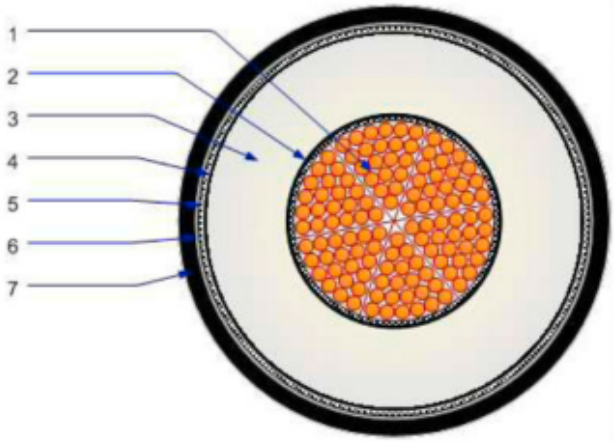
G0014-8 cont.

Laying operation, Tubigo near Milan 2005, Prysmian extruded cross-linked polyethylene XLPE cable



380 kV cable, 1 x 2000 mm2

1) CooperMilliken conductor, waterblocked; 2) semiconducting screen; 3) XLPE insulation; 4) semiconducting screen; 5) semiconducting waterswellable tapes; 6) Welded Aluminum Sheath; 7) PE outer sheath.

Cable has been design to comply with the required performances. Moreover, starting from 80% loading, it is capable to be overloaded at 180 % for 5 hours.
http://www.empersdorf.com/380kv/gutachten/CIGRE%20Turbigo%20Rho%20Nov.2006.pdf

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