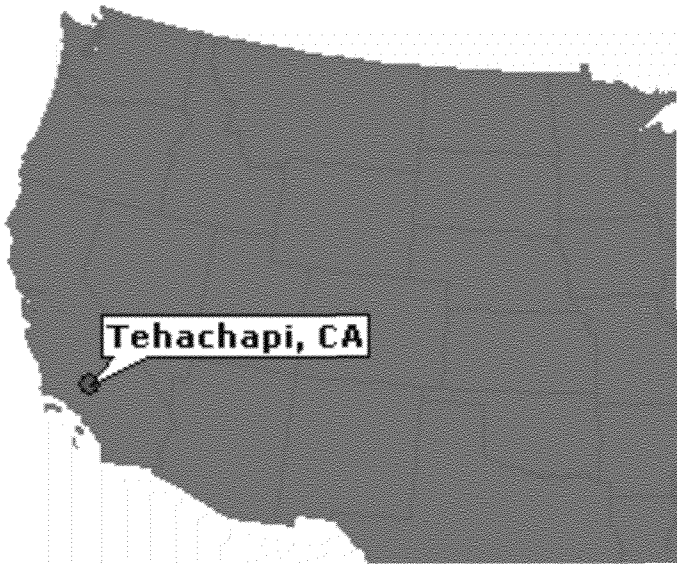
SCE Leadership in Energy Initiatives

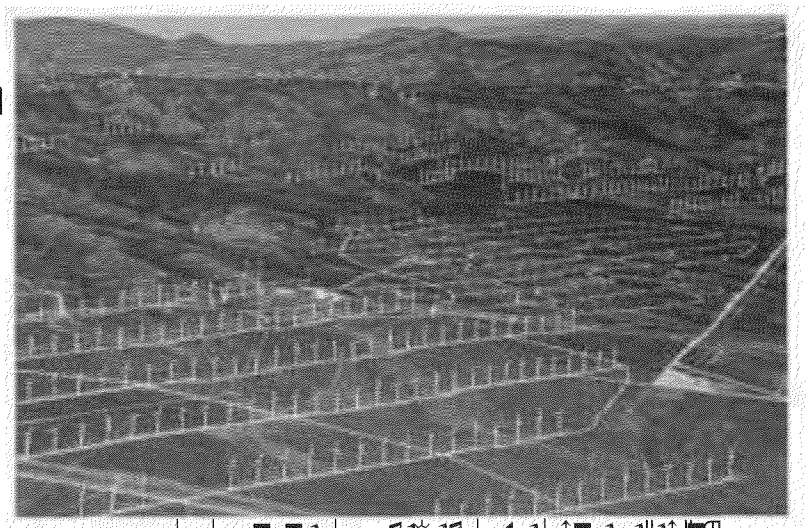
* SCE is a long-time leader in renewable energy:
  - 17% of its 2009 energy portfolio was made of renewable energy[1]
  - SCE procures:
    * ff10% of all U.S. renewable energy[2]
    * Over 65% of U.S. solar energy[2]
    * Over half of U.S. geothermal energy[2]
* SCE's EV Technical Center facility is unique among utilities:
  - Industry leading energy storage testing facility
  - BEV/PHEV/FCEV testing, evaluation and maintenance capability
  - ISO 9001:2008 registered
  - Visited by President Barack Obama in 2009
* SCE's Smart Grid vision is helping to shape the discussion on Smart Grid implementation

California Aggressive Climate and Energy Policies

Tehachapi Area

* Tehachapi is a uniquely suited location for wind development:
  - –California's largest wind resource
  - –Massive wind development potential driving grid infrastructure upgrades and expansion
* Facts:
  - –Second largest wind park in the world with ffi5,000 wind turbines
  - –660 MW of installed wind energy, with potential for thousands more[1]
  - –ffi350 square miles (Washington DC is ffi68 square miles)
  - –ffi100 miles from major So-Cal load center (LA basin)





Project Objective

- Demonstrate the performance of a Lithium-ion energy storage system for 13 specific operational uses, both individually and stacked
- Share data and results with CAISO, DOE, and other interested parties
- Test and demonstrate Smart Inverter technology
- Assess performance and life cycle of large grid-connected Lithium-ion energy storage system
- Potentially resolve key issues with wind-integration and/or remote generating sources
- Expand expertise in energy storage technologies and operations

TSP will test the largest ever grid-connected Lithium-ion Energy Storage System (8MW - 32MWh) coupled with a Smart Inverter

Potential Operational Uses

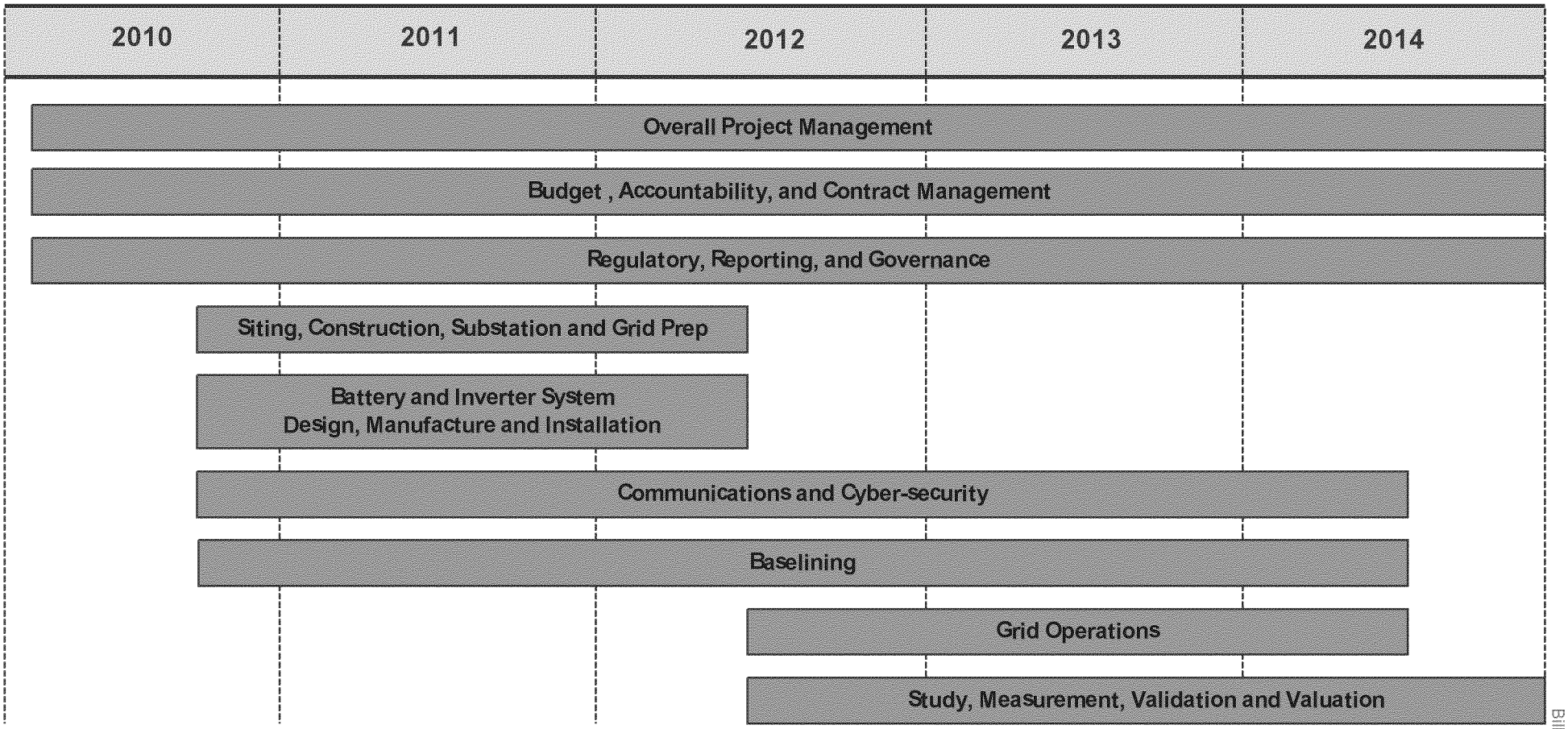
* Transmission
  - Provide Voltage Support/Grid Stabilization
  - Decrease Transmission Losses
  - Diminish Congestion
  - Increased System Reliability
  - Provide Future T&D Investment Opportunity
  - Enhance Value and Effectiveness of Renewable Energy-related Transmission
* System
  - Provide System Capacity/Resource Adequacy
  - Integrated Renewable Energy (smoothing)
  - Shift Wind Generation Output

Additional Potential Uses

* Large-scale energy storage can also offer additional benefits to the grid
  - Frequency Regulation
  - Spin/Non-Spin/Replacement Reserves
  - Ramp Management
  - Energy Price Arbitrage
  - Black Start and System Restoration (not part of this project)
  - Phasor Measurement System Participation (not part of this project)

Overall Project Timing

The DOE award negotiations are complete and the agreement was accepted by SCE on October 13, 2010



Next Steps

* Starting the design phase
* Battery system will be installed in early 2012
* Testing will take place through the end of 2014
* Project results will be made available in early 2015

3. Introduction

SCE proposes to develop a pilot program to assess the potential use of lithium ion battery cells of the type and size used in Plug-in Electric Vehicles (PEV) for energy storage in residential and small commercial applications. SCE proposes to test the concept by integrating home energy storage with Demand Response (DR) strategies[1], renewable energy generation (wind and solar) and SCE's advanced metering infrastructure.

The Scope of Work (SOW) will consist of developing system design requirements, testing and evaluation of trial installations at SCE's Electric Vehicle Technical Center (EVTC), an ISO-9001 registered facility located in Pomona, California, to include integration of batteries, controls, advanced interval metering, and solar photovoltaic generation in a specially prepared on-site facility. Field deployment will follow starting in Q4 2010, and will include the installation of up to 50 sites by the end of 2012. Demonstration sites will be selected for their availability of existing or planned renewable generation facilities, and the customer's willingness to participate.

The program assumes that peak power demand can be reduced by up to 4 kW per home for up to two hours per day. SCE will ask selected customers to participate in a residential time-of-use tariff with Edison SmartConnect™ meters[2]. A concerted attempt will be made to engage customers outfitted with early advanced meter installations however, that may not be possible in every case.
The pilot program has six objectives:

1. Assess currently available battery and control technologies by designing, testing and evaluating prototypical units at SCE's Pomona EVTC.
2. Facilitate the development of Edison SmartConnect™ compatible end-use technologies for future statewide implementation by assessing both infrastructure requirements for battery system deployment and compatibility with proposed advanced metering and control technologies.
3. Measure customer response to dynamic pricing as an indication of their willingness to engage in interactive load management approaches.
4. Evaluate and establish the requirements for safe installation and unobtrusive operation in a residential environment.
5. Partner with wind and solar contractors to assess and evaluate the benefits of using battery storage to augment renewable energy generation and compensate for fluctuating and intermittent power production.
6. Assess the longer term impacts of using automotive type lithium ion batteries in stationary applications for residential and small commercial customers as a means to expand the advanced battery market with the purpose of driving down prices to benefit both motorists and utility customers.

[1] Southern California Edison's Demand Response Programs: http://www.sce.com/b-rs/demand-response-programs/

[2] Edison SmartConnect™: http://www.sce.com/PowerandEnvironment/smartconnect/

Panel Discussion:

The Economics of Distributed Energy Storage

Johannes Rittershausen

NAATBatt Annual Conference

September 7, 2011

Agenda

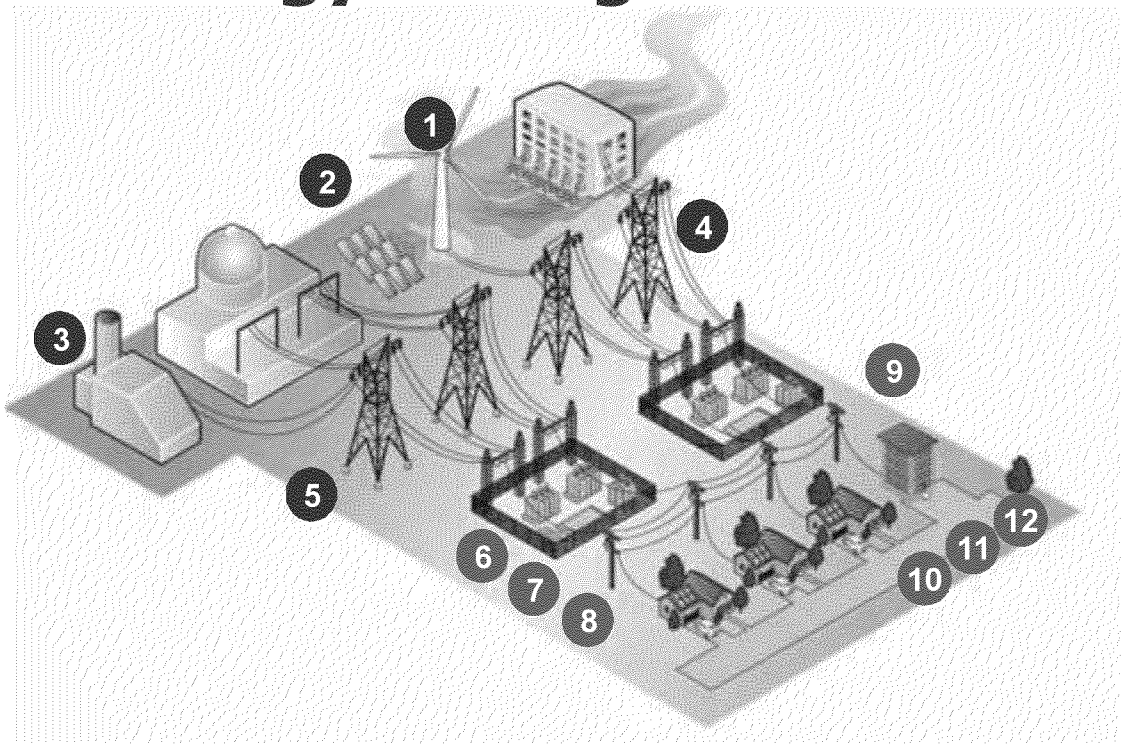
SCE's Storage Applications → A Valuation Example → Key Caveats & Conclusions

Some applications of distributed energy storage may provide attractive value propositions for both utilities and electricity consumers, although significant uncertainties remain.

SCE's Applications of Energy Storage

Application Defined:

All of the operational uses (or value streams) a storage device may provide when sited at a specific place & managed in a particular way.



Application Examples

1. Off-to-on peak intermittent energy shifting & firming
2. On-peak intermittent energy smoothing & shaping
3. Ancillary service provision
8. Peak load shifting downstream of the distribution system
10. End user retail rate optimization

● Distributed Storage Application

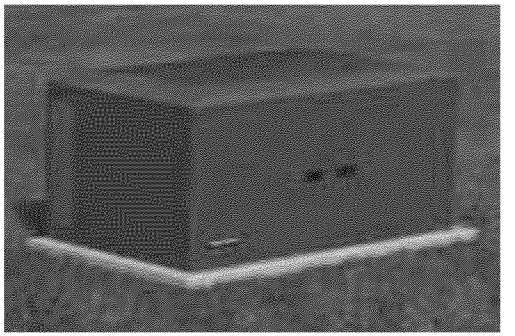
EXAMPLE: Application 8

Peak load shifting downstream of distribution system

Description

Charge device during off-peak downstream of the distribution system; discharge during 4 hours of peak period daily.

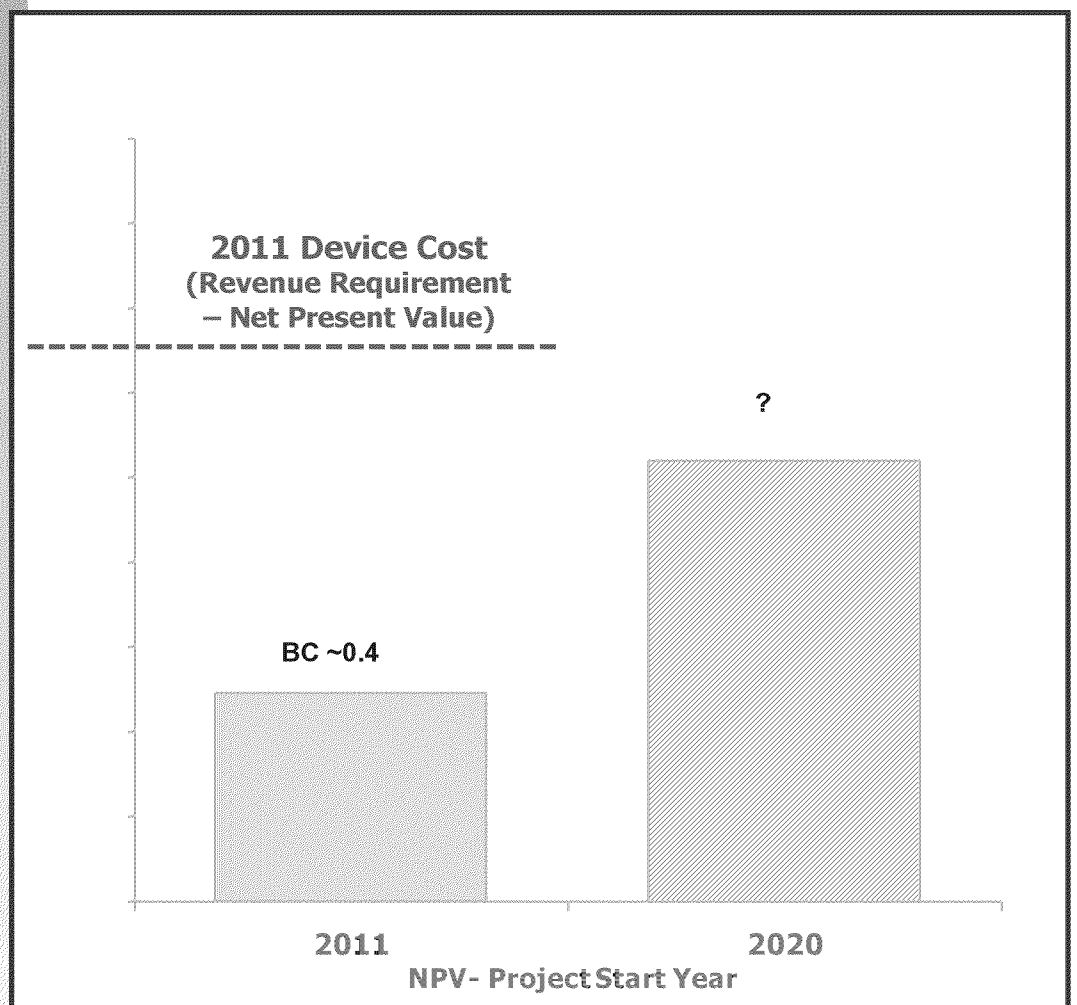
Utility owned and operated.



	Operational use	Value metric (for benefit calculation)
Primary Uses	Generation capacity	Avoided cost of procuring generation capacity
	Wholesale market energy shifting	Avoided cost of the price differential between charge and discharge less efficiency losses
Potential Other Uses	Dump energy / minimum load operating issues	Avoided cost of the price differential between charge and discharge less efficiency losses
	Locational generation	Operational flexibility and potentially the avoided cost premium of procuring local capacity
	Congestion fee avoidance	Avoided on-peak congestion fees
	Distribution power quality improvement (voltage, harmonics)	Avoided / differed cost of additional infrastructure
	Distribution upgrade deferral	Avoided / deferred cost of additional infrastructure
	Reliability improvements by avoiding faults / outages	Reliability / customer satisfaction

VALUATION EXAMPLE: App 8 Benefit/Cost Summary

25 kW, 4 hour lithium ion battery, 90% AC-to-AC efficiency



Pathways to cost-effectiveness

What you need to believe...	2020 B/C Ratio
Tech installed cost falls by 50%	1.3
T&D deferred costs increase 10%	0.7
Market rents from energy arbitrage increase by 50% (reflecting higher on-off peak spreads from more off-peak producing renewables)	0.7
All three above situations occur simultaneously	1.5

Key Caveats On Distributed Storage

Distribution upgrade deferral value is complex to realize

- **Situation-specific valuations:**
  Distribution systems are immensely diverse and complex. Engineering assessments vary widely by circuit design (e.g., overhead vs. underground), age, voltage level, weather zone, and other factors
- **Can't defer or avoid cost for existing infrastructure:**
  Value only for deferred / avoided incremental cost
- **Physical assurance:**
  Planners require assurance that devices will perform as anticipated during peak periods over the lifespan of traditional infrastructure
- **Ageing infrastructure will need to be replaced:**
  Infrastructure exceeding its useful lifespan requires upgrades to ensure reliability & safety

Utilities are risk adverse on behalf of their customers

- **Maintaining reliability is key:**
  While interested in new technologies, utilities are wary of taking new technology risk which may compromise reliability
- **"Used and useful" investments:**
  Utilities must justify their investments as "used and useful" to both regulators and customers; new technologies increase "non-performing asset" risk
- **Pilots are necessary:**
  Targeted grid pilot projects are crucial for assuring that future assets will perform both technically and economically, underpinning future investment
- **Distribution grid reliability is not a competitive market:**
  The distribution system is a natural monopoly; each utility is responsible and held accountable for ensuring distribution system reliability

Conclusions & Takeaways

Applications

- ffi Use storage applications (which bundle together all of the operational uses a device provides when sited in a particular location and managed in a specific way) as the operative concept for answering storage questions and performing economic analyses

Distributed Storage

- ffi Not one definition of "distributed": applications vary widely based on location / operating profile
- ffi Customers are utilities and / or end-users
- ffi Will require more "proof-of-concept" piloting

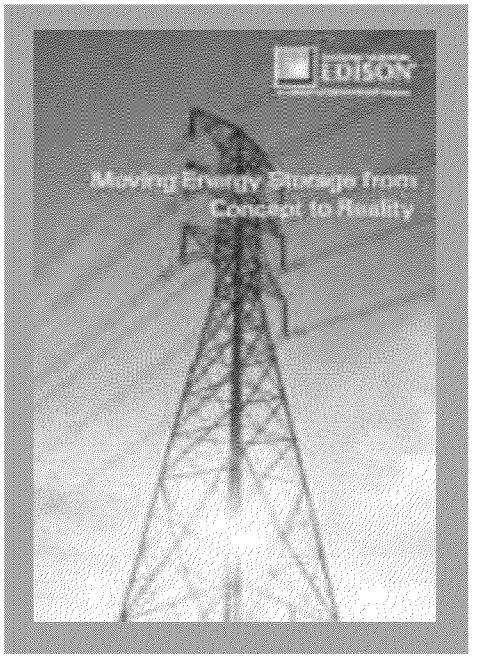
Valuation

- ffi Tech costs need to come down (exact amount will depend on the application)
- ffi Value is primarily monetized through "avoided cost"
- ffi Be careful when claiming distribution system avoided or deferred cost – this very complex

Further Information Can Be Found In:

White Paper

Communications Pamphlet



Visit http://www.edison.com/pressroom/hot_topics.asp under Smart Grid
or
e-mail energystorage@sce.com

THANK YOU!

APPENDIX

An Application-Centric Approach

Technology Development

- What are storage's specifications and requirements?
- Where & how can a technology be used?
- How much should a technology cost?

Regulatory Uncertainty

- Where are regulations unclear or absent on storage?
- At which forums should issues be considered?
- Should storage be supported with incentives?

Ownership & Business Model

- Who should own a storage device?
- What business model is most appropriate?
- How to get financing?

Benefit Realization

- What benefits can storage target / accrue?
- What is the value of these benefits?

Tehachapi Wind Energy Storage Project (TSP)

- TSP will involve the largest ever grid-applied lithium-ion energy storage system (8 MW for 4 hours) coupled with a smart, 4-quadrent inverter.

- The project intends to test & demonstrate 13 operational uses, both individually and "stacked".

SCE's $53.5 million TSP pilot will test a storage device's ability to integrate intermittent wind generation and improve grid performance.

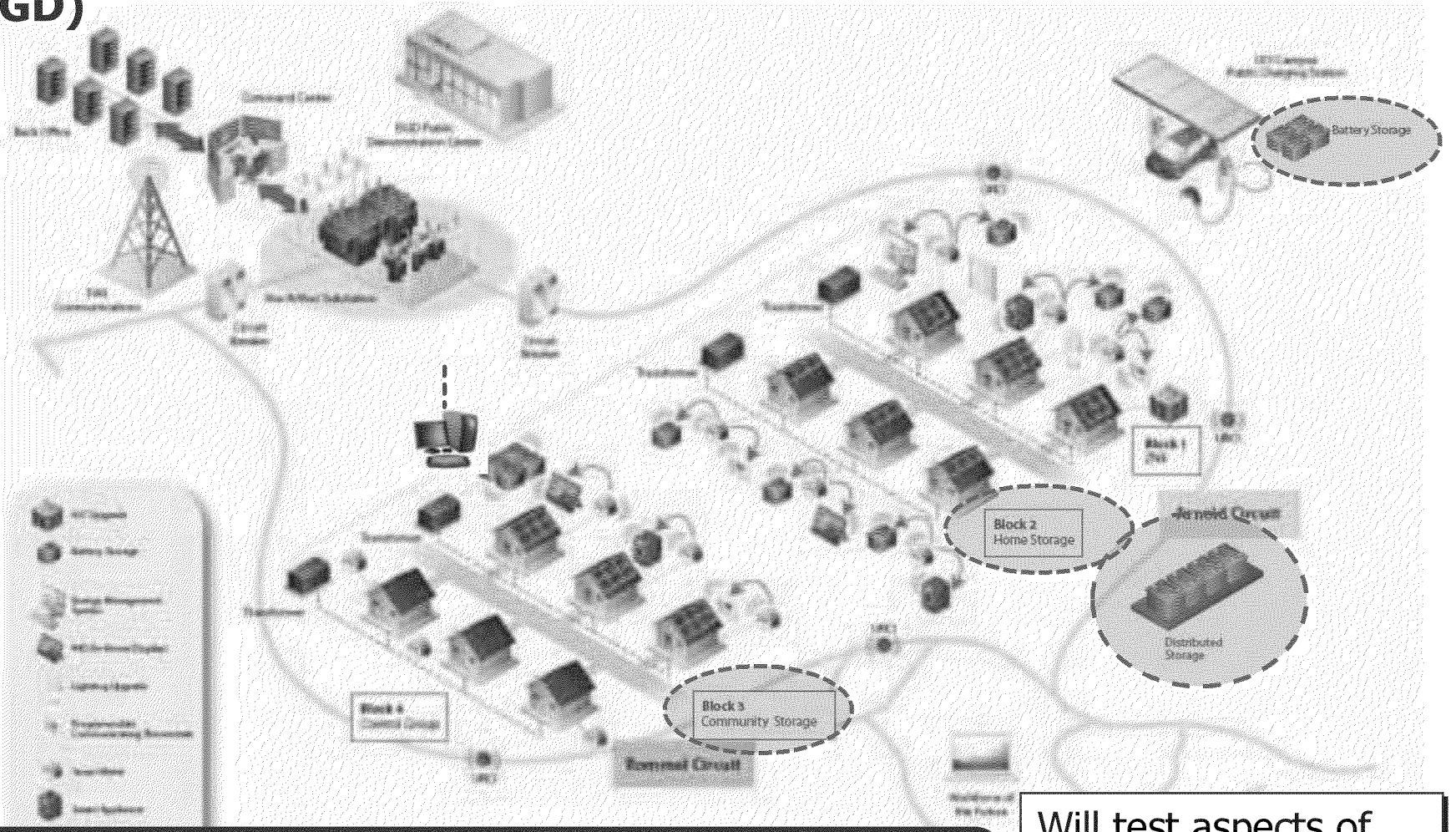
Tehachapi Wind Resource Area

Battery & Inverter System

Will test aspects of applications:

1 2 3 5

Irvine Smart Grid Demonstration (ISGD)



SCE's $79 million ISGD pilot will comprehensively test various storage operational uses and applications within a Smart Grid over a 3 year time frame.

Will test aspects of applications:

6 7 8 9 10

Key Evaluation Assumptions

While each application required specific analyses and assumptions, the following cross-cutting assumptions were made for all evaluations:

Benefits (operational use valuation)

1.ffi Generation capacity:

- ffi 2011 represented by current procurement price
- ffi 2020 uses cost of a new-build peaker

2.ffi Energy price forecast:

- ffi Prices forecasted using historical shapes and values escalated to target end years
- ffi Potential intermittent renewables price volatility is not fully captured
- ffi Forecast includes GHG pricing assumptions

3.ffi Ancillary service forecasting:

- ffi 3-year average of historical pricing
- ffi Escalated at a higher rate than inflation (using preliminary shadow prices of CAISO 33% study)

4.ffi T&D capital deferred cost:

- ffi Avoided peak D based on SmartConnect and peak DR valuation testimony (apps 7 & 8)
- ffi Avoided DG integration D and large-scale T based on SME estimates

Costs (tech installation and operating)

1.ffi Technology system cost:

- ffi For full systems (e.g., not just battery module)
- ffi Uses vendor supplied indicative pricing based on existing technology specifications

2.ffi Site preparation and land cost:

- ffi SME provided based on current storage installations, although this will vary substantially by specific site and technology parameters

3.ffi Operating cost:

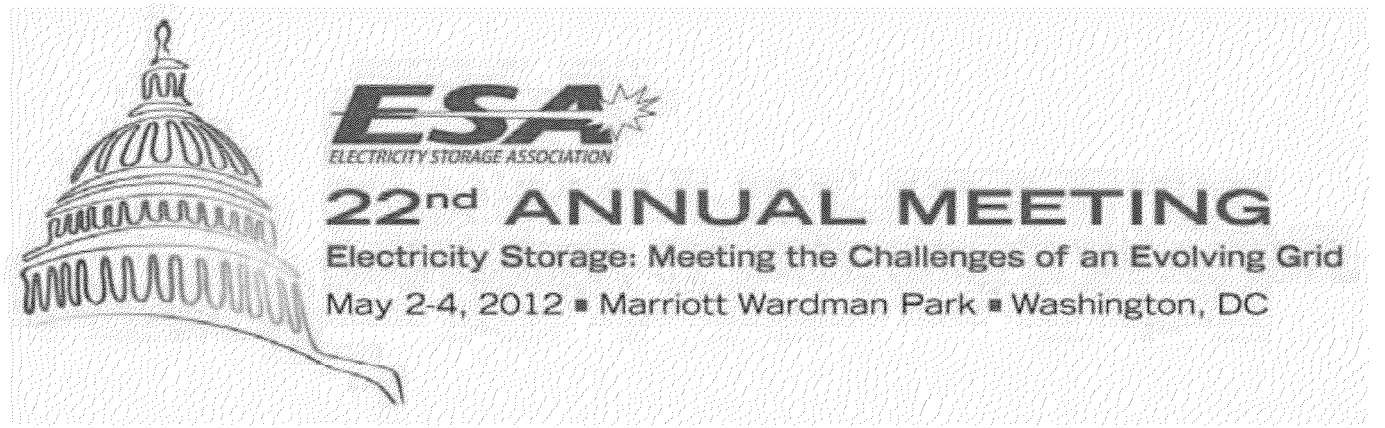
- ffi Estimated based on other existing installations, warranty costs, and SME input

4.ffi 2020 technology cost forecast:

- ffi Escalated 2011 pricing for consistency

5.ffi Assumed 30% Investment Tax Credit (ITC)

- ffi Consistent with pending federal legislation



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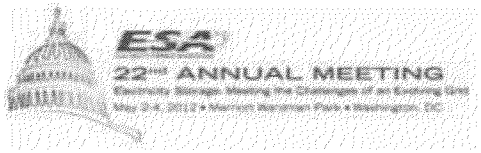

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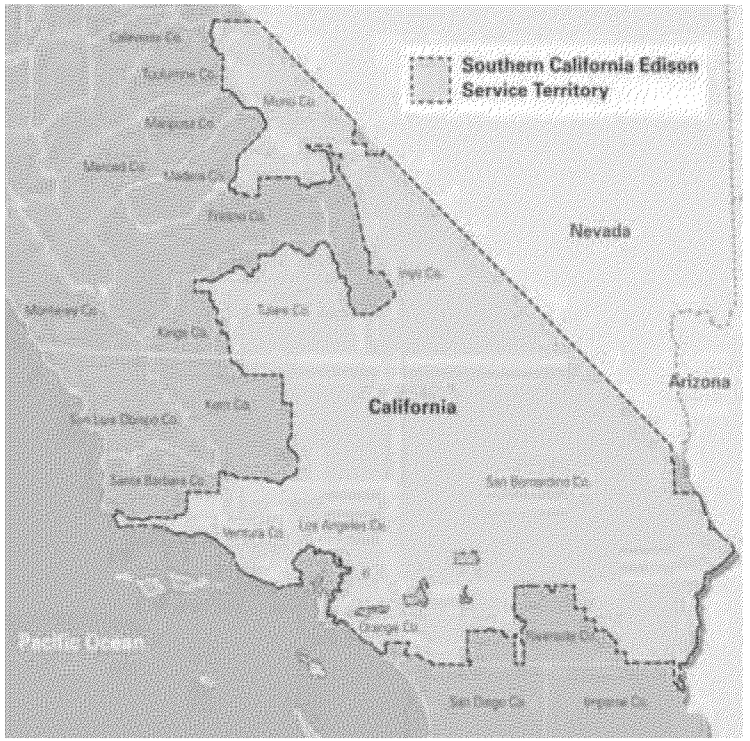

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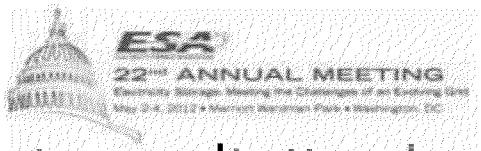

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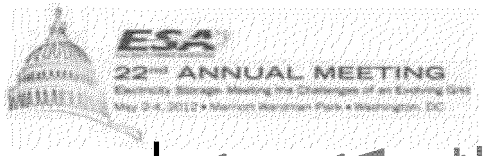

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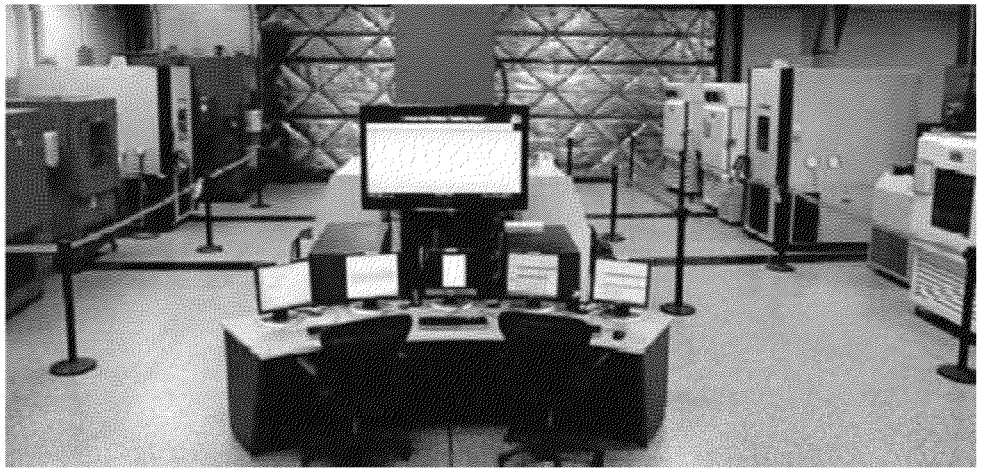

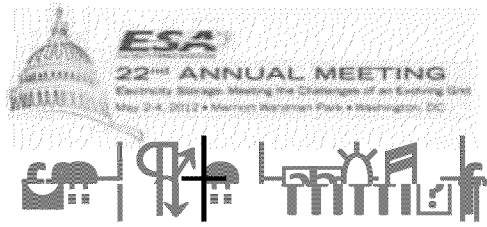

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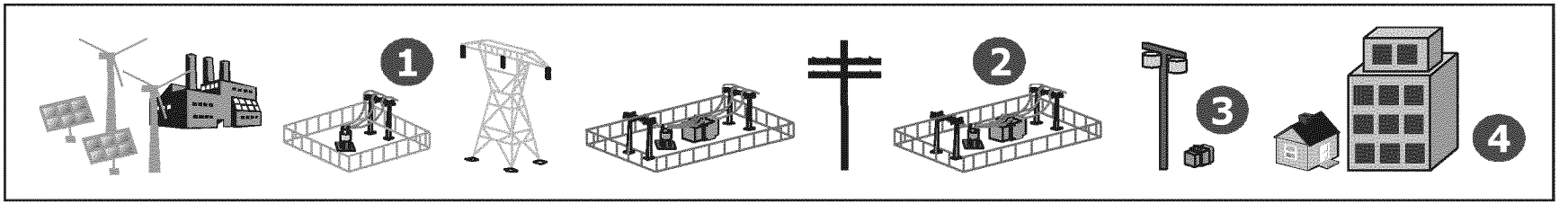

Tehachapi Storage Project

1 Large-Scale Energy Storage (8MW for 4 hours or 32MWh)

- Evaluate a utility scale lithium-ion battery's ability to increase grid performance & integrate wind generation

Irvine Smart Grid Demonstration

2 Large Transportable Energy Storage (Two 2MW/500kWh units)

- Evaluate transportable, containerized Li-ion battery systems in field and laboratory trials

3 Community Energy Storage (CES) (Distributed units: 25 to 50kW/50 to 100kWh)

- Enhance circuit efficiency, resilience, and reliability

4 Residential Home Energy Storage Unit (RESU) (4kW/10kWh)

- Evaluate home storage integration with customer HAN, smart appliances, solar PV, PEV, etc.

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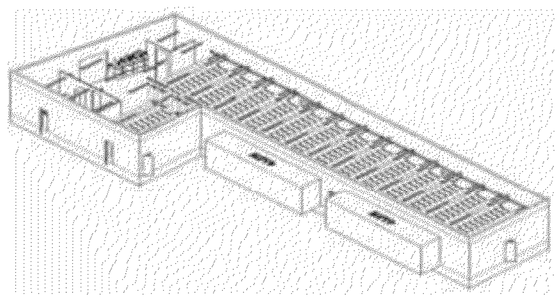

TSP will test the one of the largest grid-connected Lithium-ion Energy Storage System (8MW - 32MWh) coupled with a Smart Inverter

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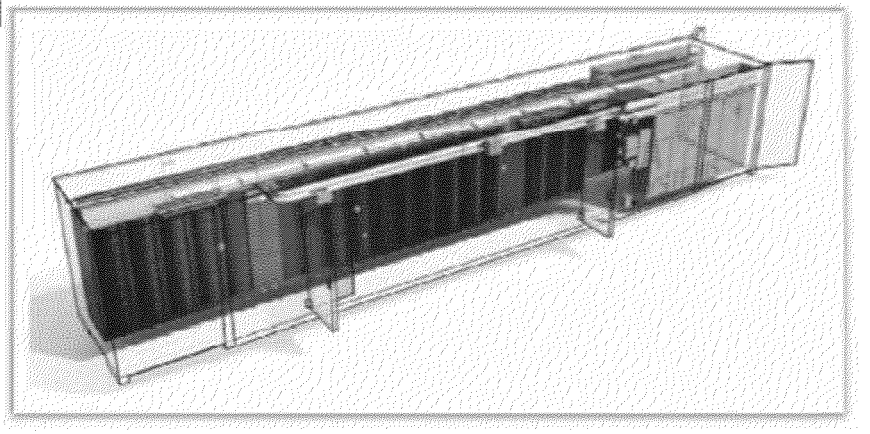

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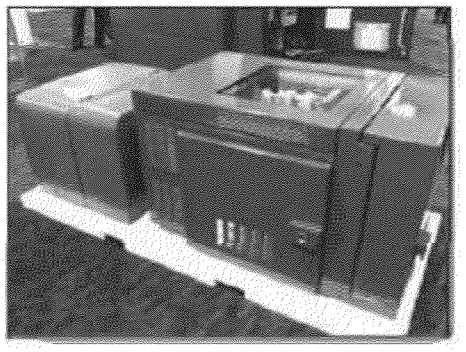

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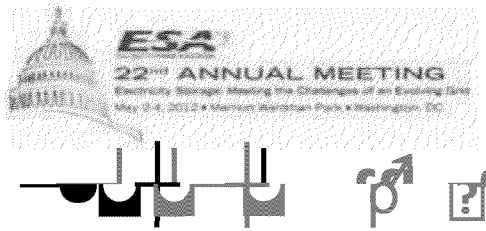

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Battery Chemistry Evaluation

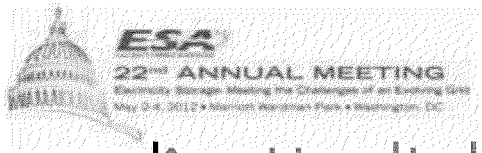
- Assess Various Chemistries for Performance and Potential Cost Reduction
- Determine Battery Operational Life
- Provide Input for Strategic Planning

System Evaluation

- Validate Full System Performance
- Validate Control System
- Prepare Documentation for Field Installation
- Train Field Personnel
- Engage Internal and External Stakeholders

Field Evaluation

- Demonstrate Functionality and Values in Actual Application
- Engage Internal and External Stakeholders



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EDISON
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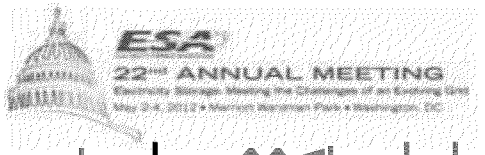

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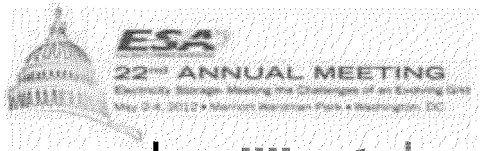

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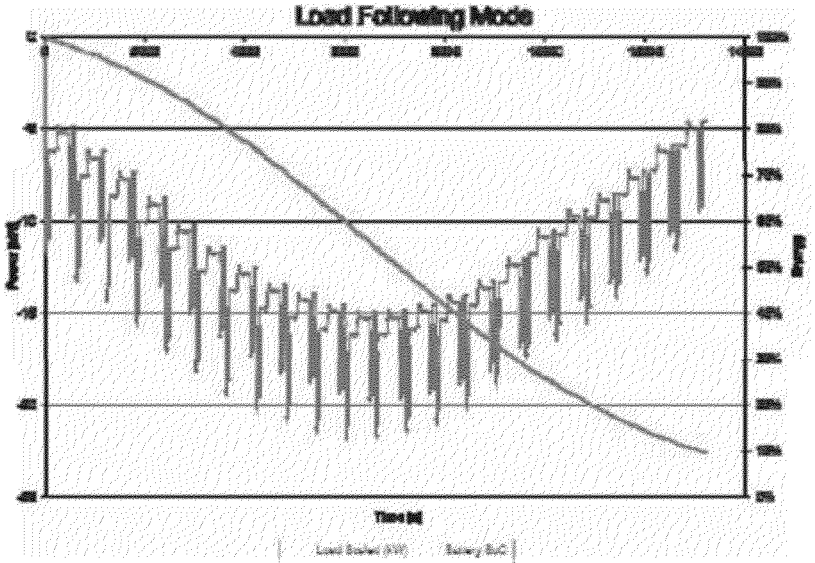
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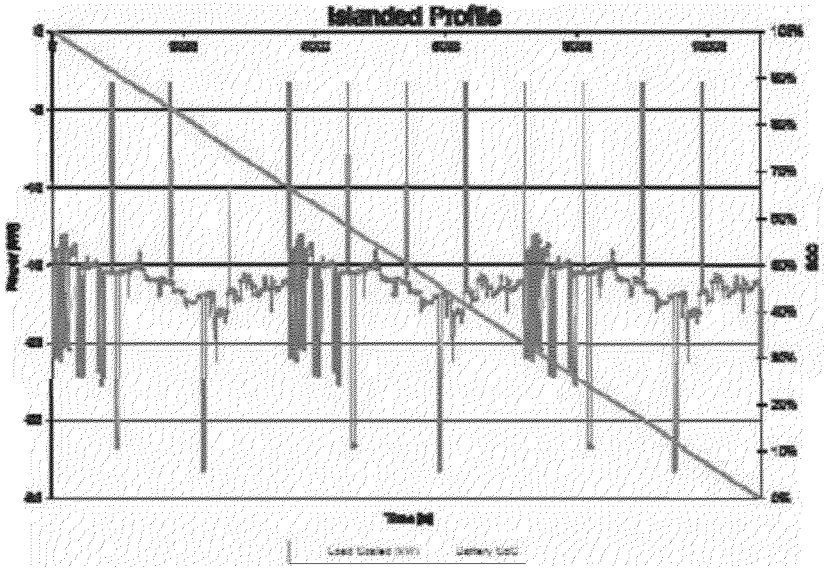
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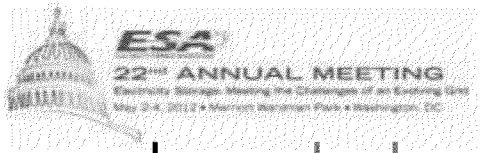

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Relative Capacity (%)
100
98
96
94
92
90
88
86
84
0
50
100
150
200
250
300
350
400
450
500
550
Cycle Number
20 °C
30 °C
40 °C
Battery A
Battery B

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20 °C
30 °C
40 °C
Battery B
Battery A
Relative Power (%)
Cycle Number
100
98
96
94
92
90
88
86
84
0
50
100
150
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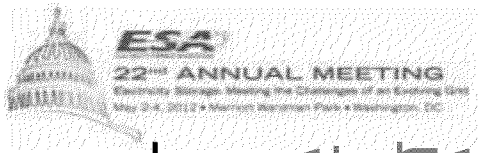

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Brightsource Signs Big Energy Storage Deal

11/29/2011
SustainableBusiness.com News

By adding energy storage capability to solar concentrating plants, Brightsource will be able to reduce their footprint and forego building an additional 200 megawatt (MW) plant.

BrightSource Energy says it's signed the "largest solar storage deal in the world" with Southern California Edison (SCE).

BrightSource will add its SolarPLUS energy storage system - which produces energy for 2-3 hours at night - to three solar tower plants it's building to supply SCE with electricity, allowing them to operate at night and reducing the land required for the project. It should also translate into lower electricity costs for SCE's customers.

"By adding storage to its solar thermal power plants, BrightSource is able to further reduce the total cost of energy by increasing its capacity factor - how much power a plant produces over a year - extending the production of electricity into later parts of the day when it is most needed by utilities," says the company.

BrightSource will also be able to eliminate an entire 200 MW plant that would have otherwise been needed to fulfill its power purchase agreement with SCE to supply 4 million megawatt-hours of electricity a year.

Building only six of the seven planned tower plants will reduce the overall footprint by 1,280 acres in the Mohave Desert.

The difference is critical because the environmental community is increasingly pushing back against developing huge swaths of desert, and plunging solar PV prices are making it ever more difficult for concentrating solar to compete.

Four out of the nine mammoth solar concentrating plants approved have change ownership, and are being developed as solar PV plants instead.

Using energy storage will also lower capital costs and permitting costs.

The new contracts, if approved by the California Public Utilities Commission, now consist of two BrightSource solar thermal plants scheduled to deliver electricity in 2015 and three plants with energy storage scheduled to deliver electricity in 2016 and 2017.

In addition, BrightSource and its partners - NRG Energy, Google and Bechtel - are currently constructing the 126 MW Ivanpah Project in southeast California.

Research by the National Renewable Energy Lab point to the high value of concentrating solar thermal power technologies with storage:

- Shifts electricity production to periods of highest demand
- Eliminates the need to build supplemental fossil fuel plants
- Provides ancillary services such as spinning reserves to help support a reliable grid
- Avoids variability and integration costs of solar PV and wind, reducing the need for additional fossil fuel units required to back up intermittent renewables

California recently passed Assembly Bill 2514, landmark legislation designed to encourage the adoption of energy storage technologies.

In April, Brightsource filed for an IPO.

S&C Electric Company Helps Southern California Edison Reduce Greenhouse Gas Emissions

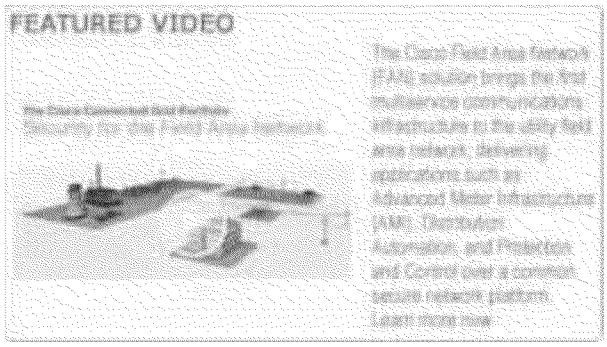
S&C Electric Company - 06.27.2011

S&C Electric Company, a global leader in smart grid solutions and renewable energy integration, announces today a turnkey energy storage project that will help Southern California Edison (SCE) reduce its greenhouse gas emissions. SCE awarded S&C a contract to furnish a turnkey 1-MW S&C Smart Grid SMS™ Storage Management System on Catalina Island, off the coast of California. The Smart Grid SMS is a fast-responding automatic controller that uses built-in intelligence to control charging and discharging of sodium-sulfur batteries.

The energy storage system will help reduce greenhouse gas emissions from the island's diesel generators. With no tie to the mainland, the diesel generators are not best equipped to handle power demand, which fluctuates throughout the day. By deploying stored energy during times of peak power demand, the Smart Grid SMS permits Catalina Island generators to run at a specific percentage of capacity for optimal performance and decreased carbon emissions.

"Working with an islanded grid poses unique challenges for reliable power delivery," says Thomas Barker, Senior Engineer, Southern California Edison. "Installing a comprehensive storage system helps us run more efficiently and reduce our emissions – all while effectively managing load changes to ensure consistent service for our 3,000 island residents plus the many visitors to the island."

S&C is the most experienced provider of energy storage systems – a new and highly complex technology – in the U.S. Since 2006, S&C has successfully furnished, installed and commissioned 12 MW of sodium-sulfur battery storage throughout the country, with another 12 MW planned for 2011. Among the completed projects are three of the world's first islanding applications.



"Energy storage enhances utilization of renewable energy resources, and it reduces the need for fossil-fuel-fired generation to serve peak demand and maintain a stable grid," says Jim Sember, S&C Vice President—Power Quality Products. "S&C continues to innovate new solutions that are helping utilities realize the full potential of energy storage in building a greener grid."

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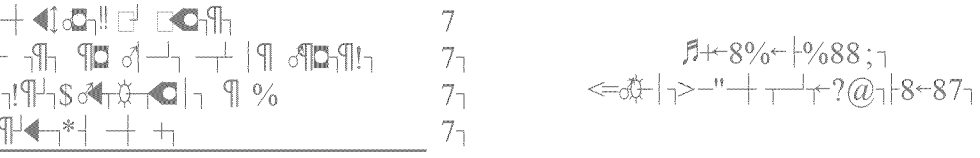

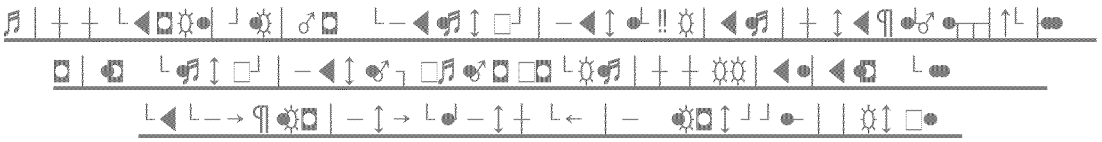

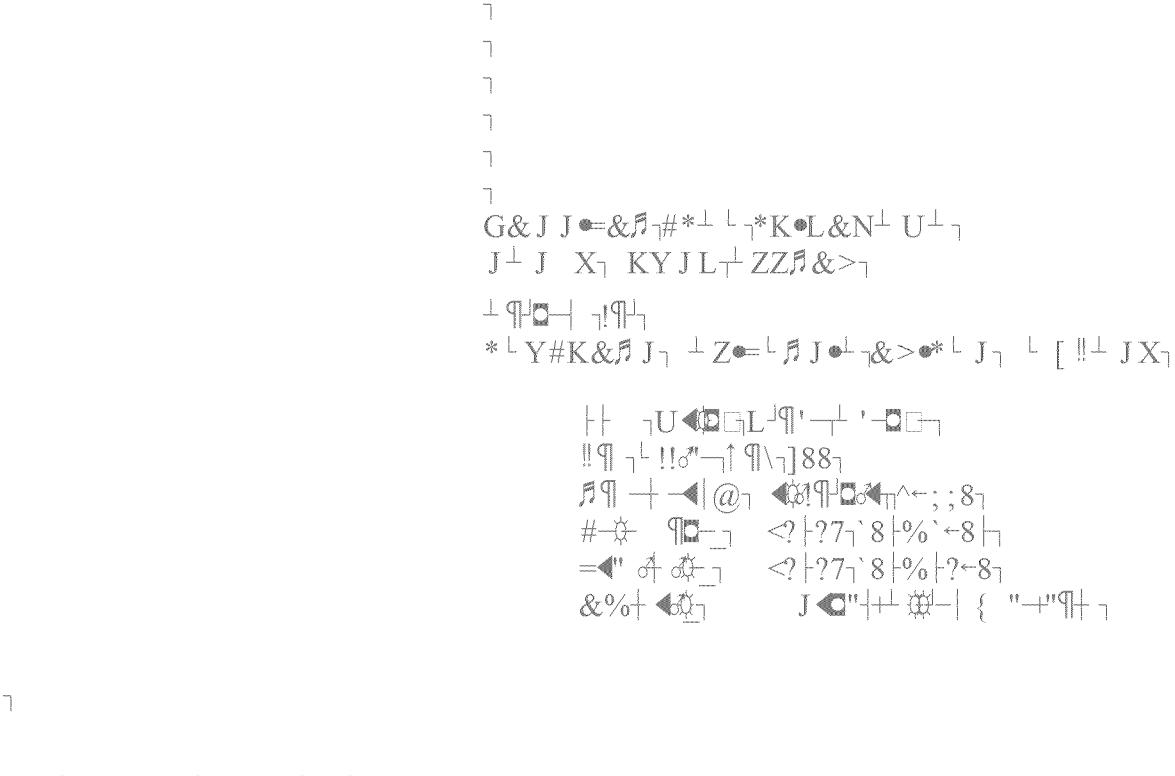

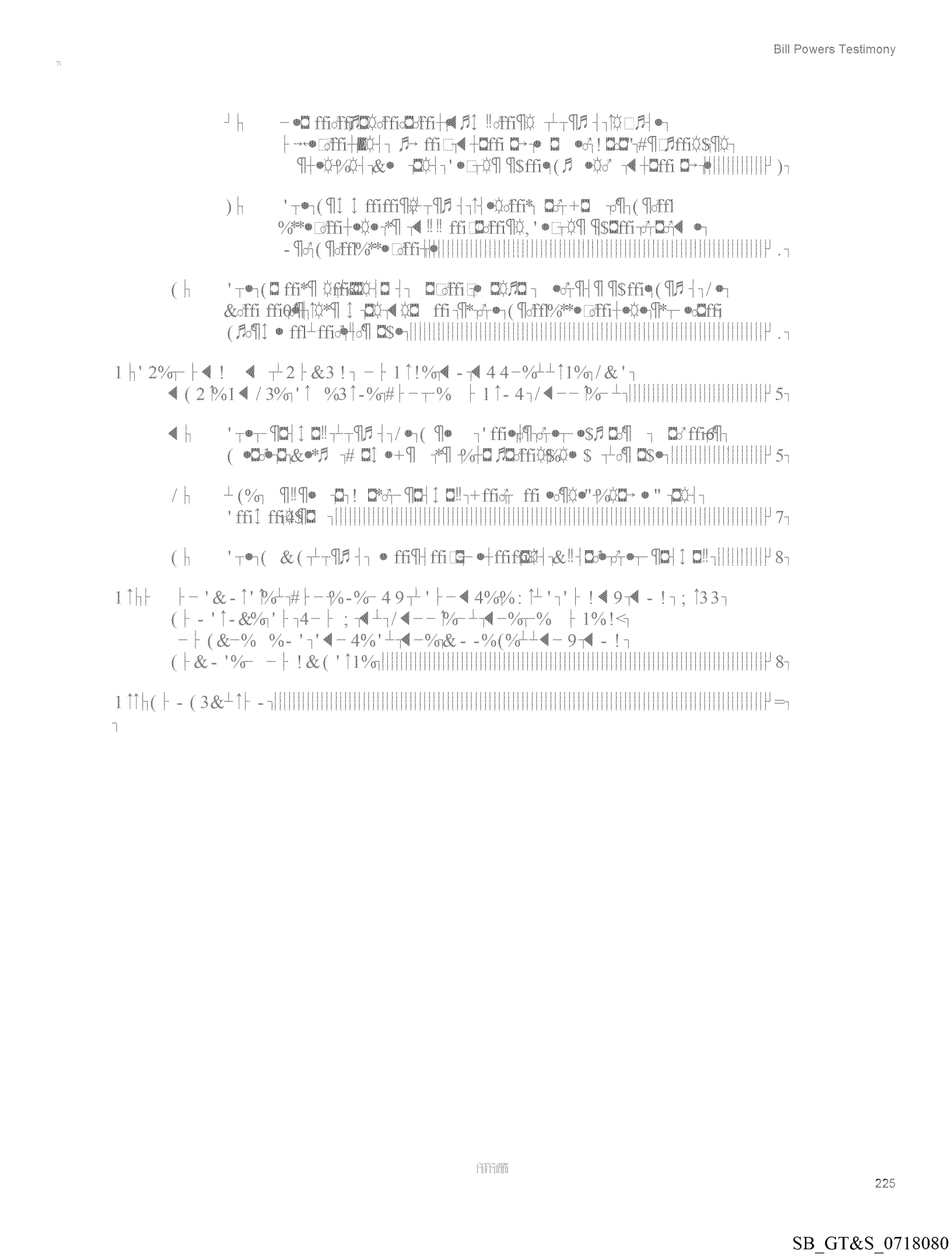

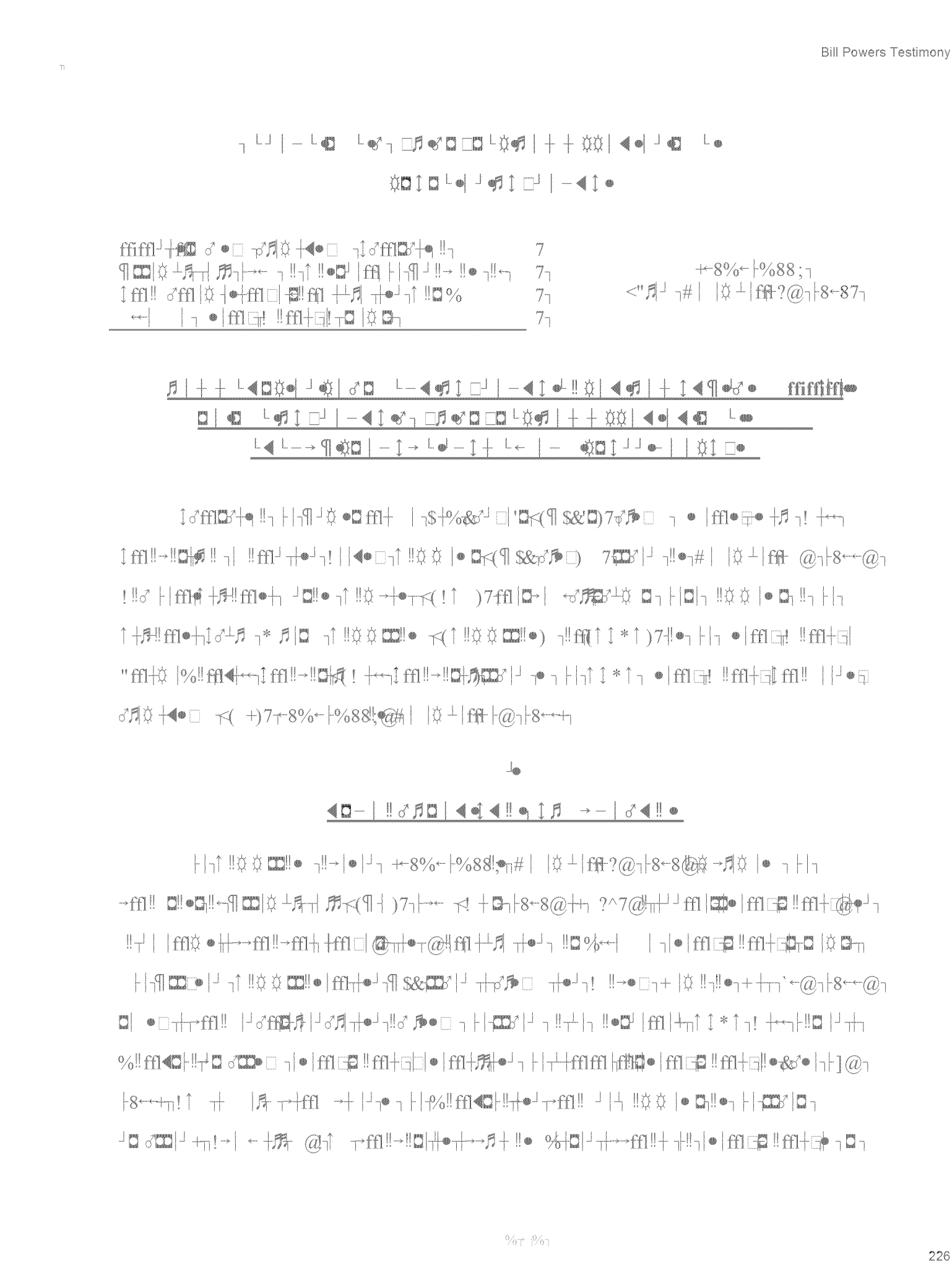

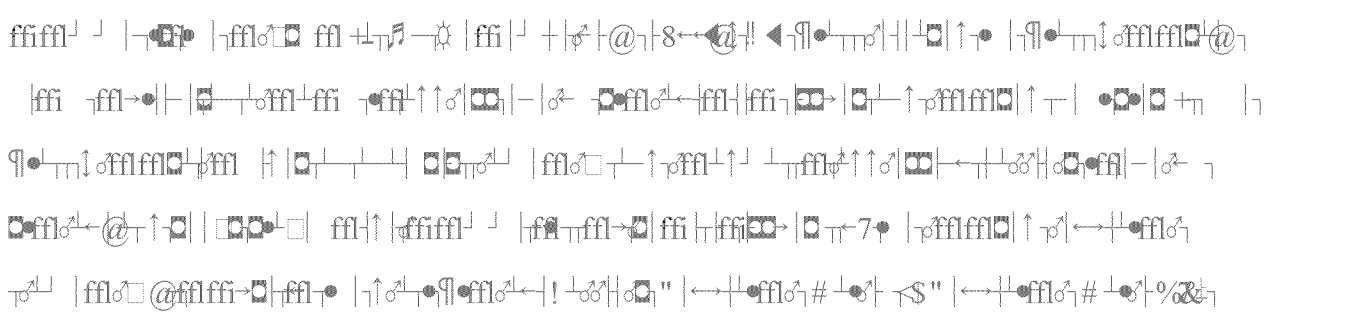

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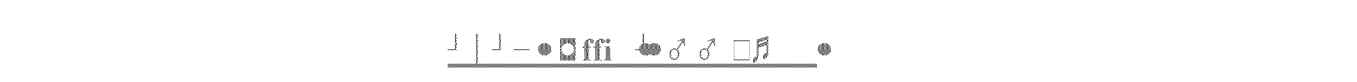

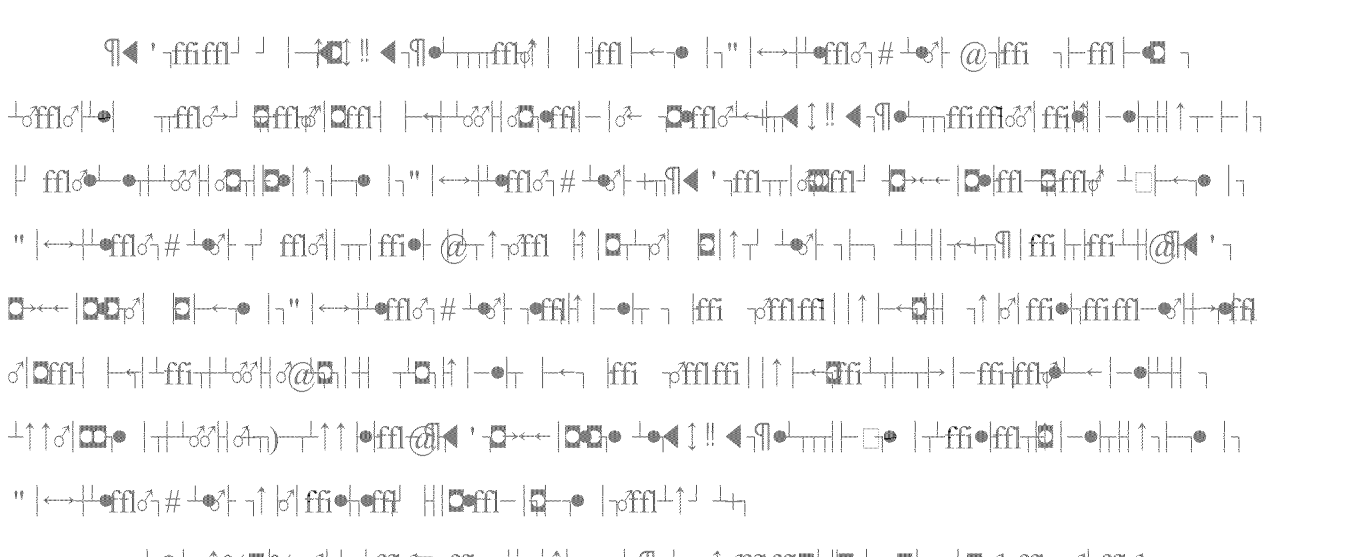

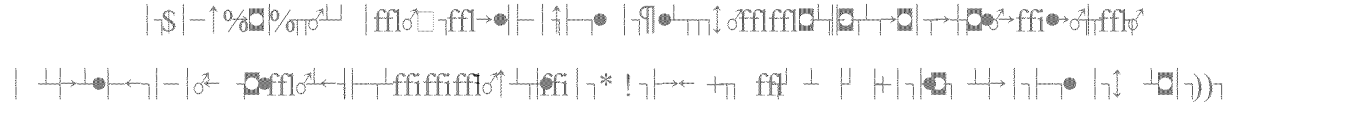

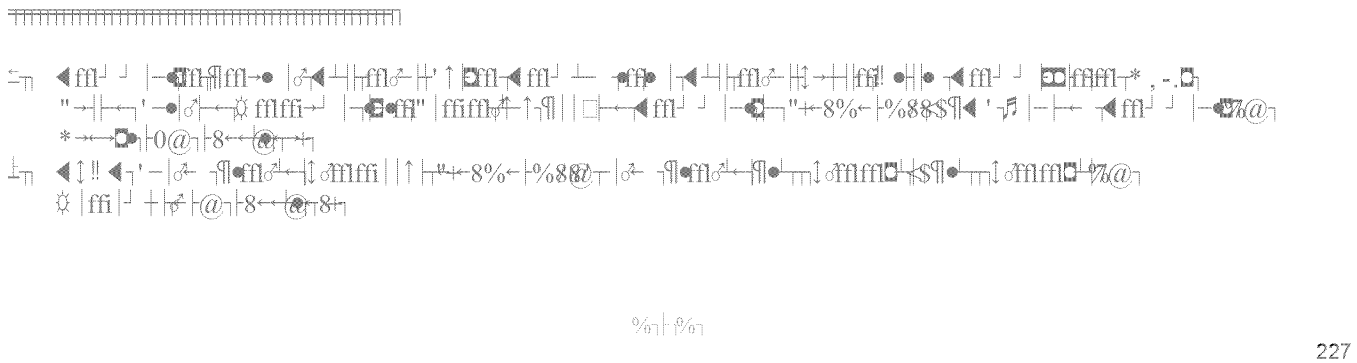

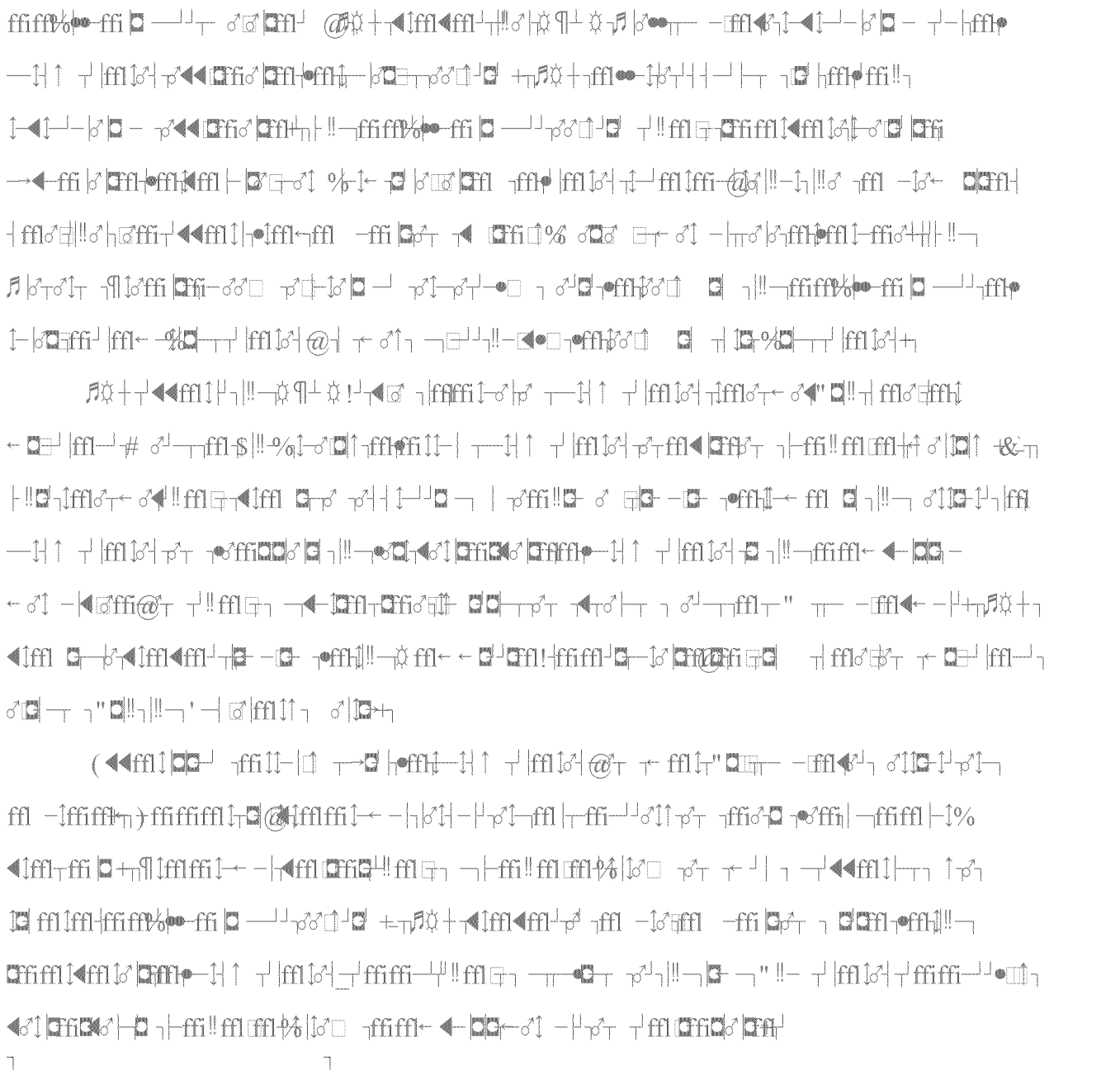

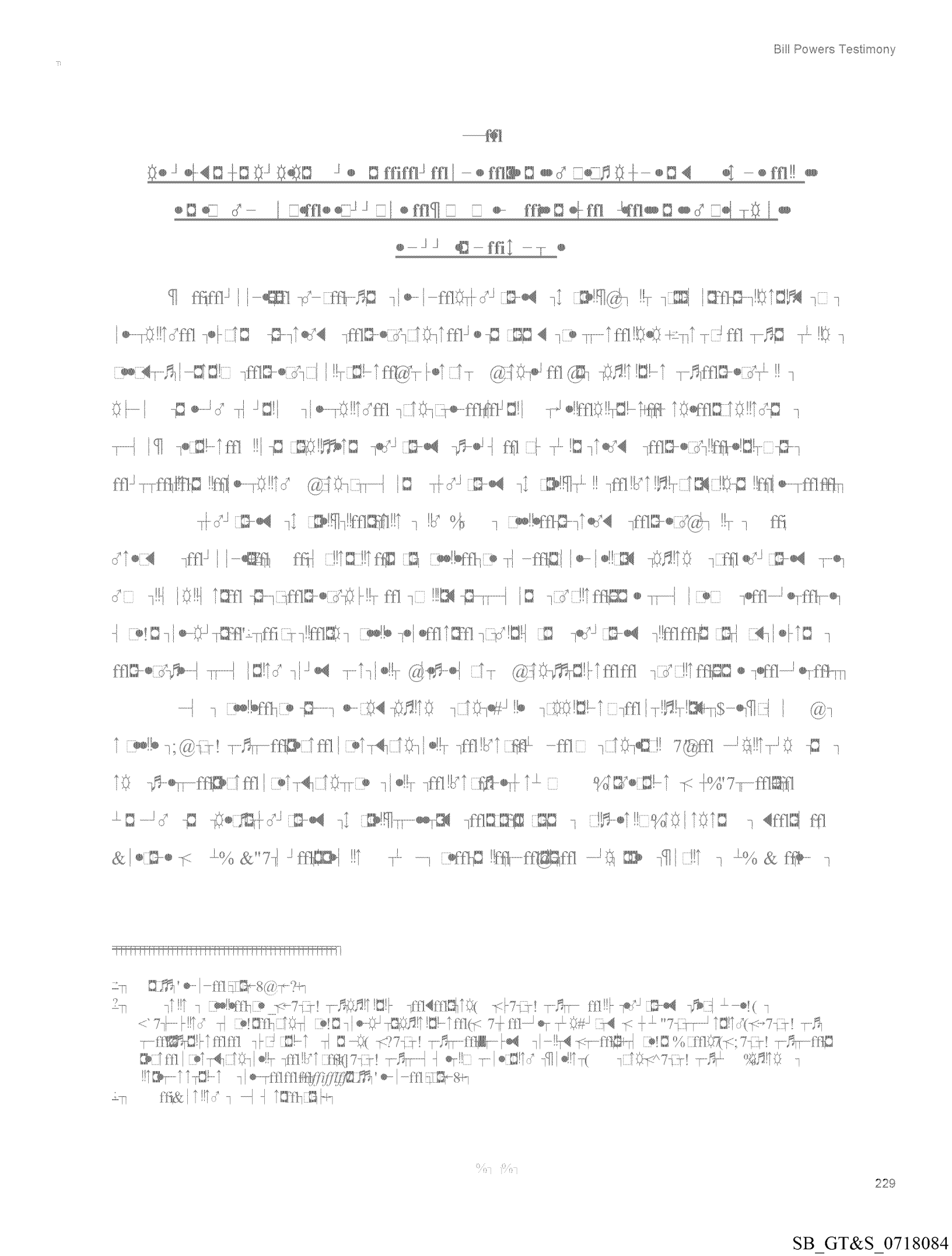

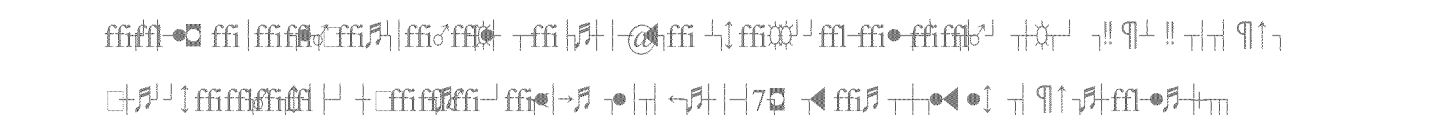

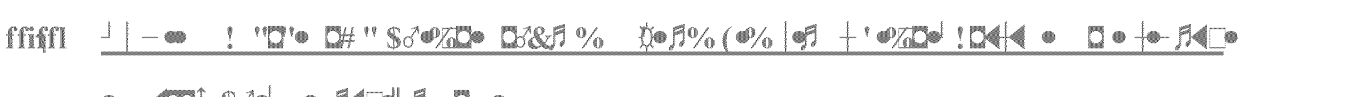

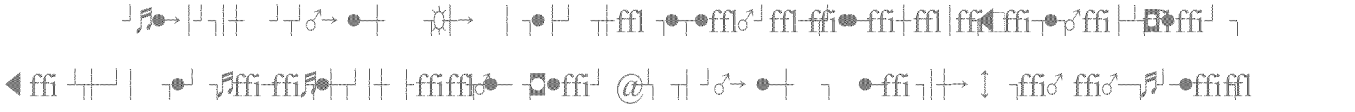

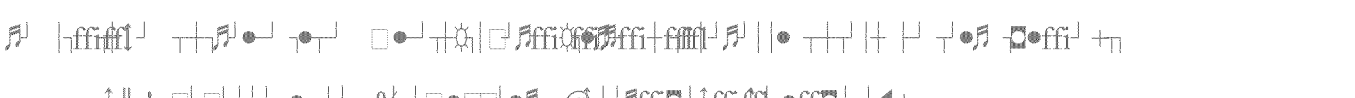

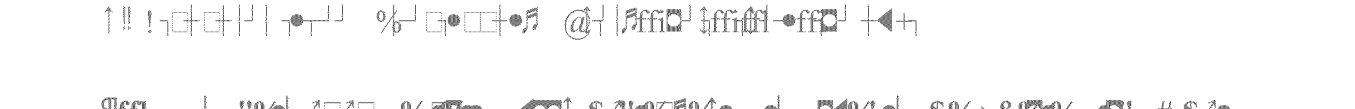

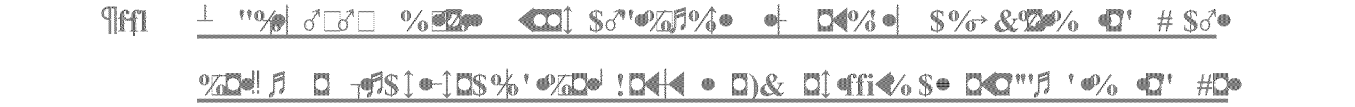

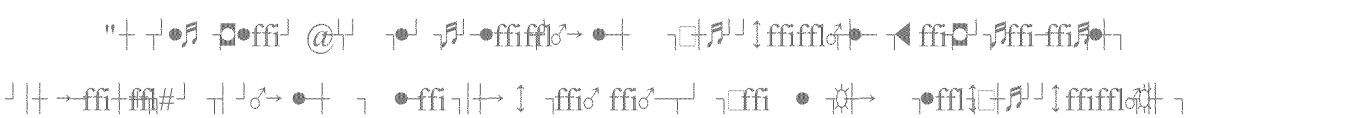

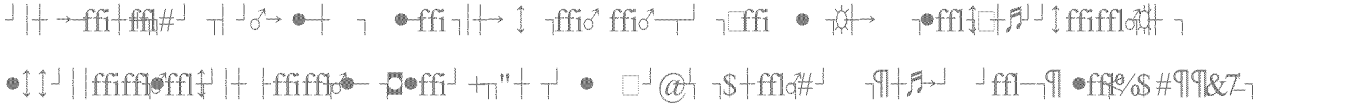

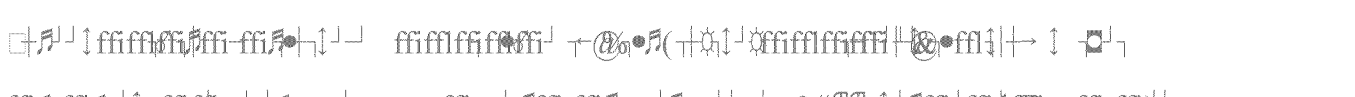

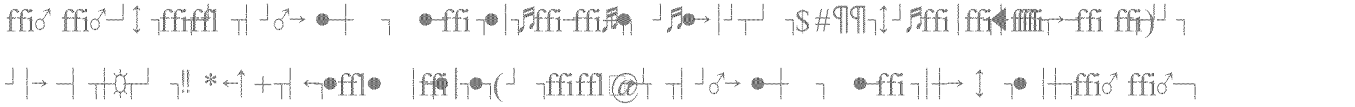

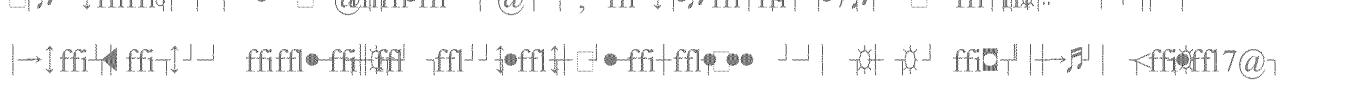

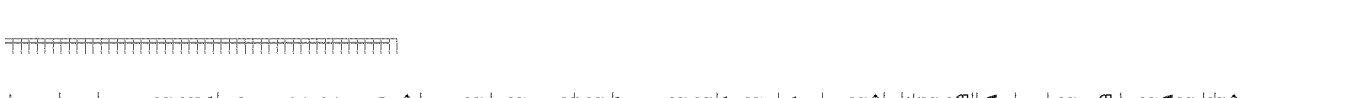

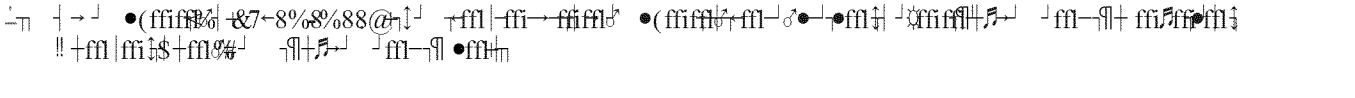

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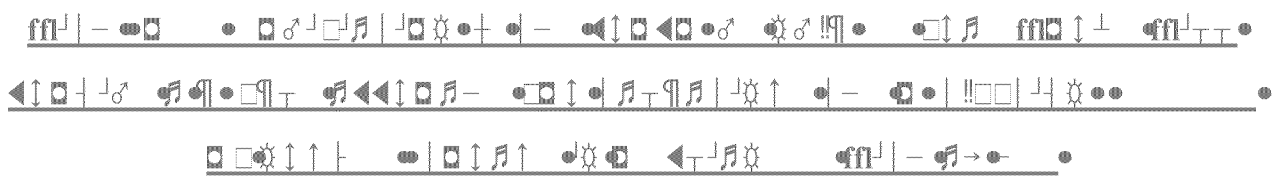

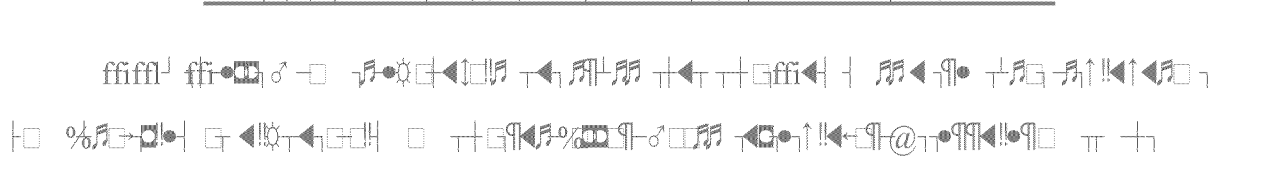

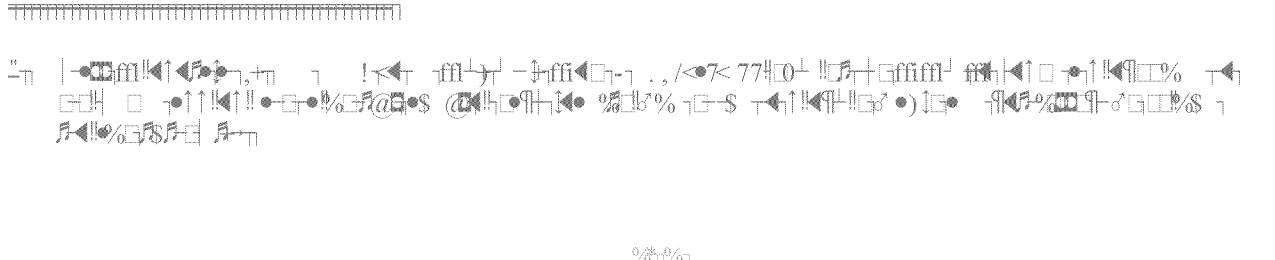

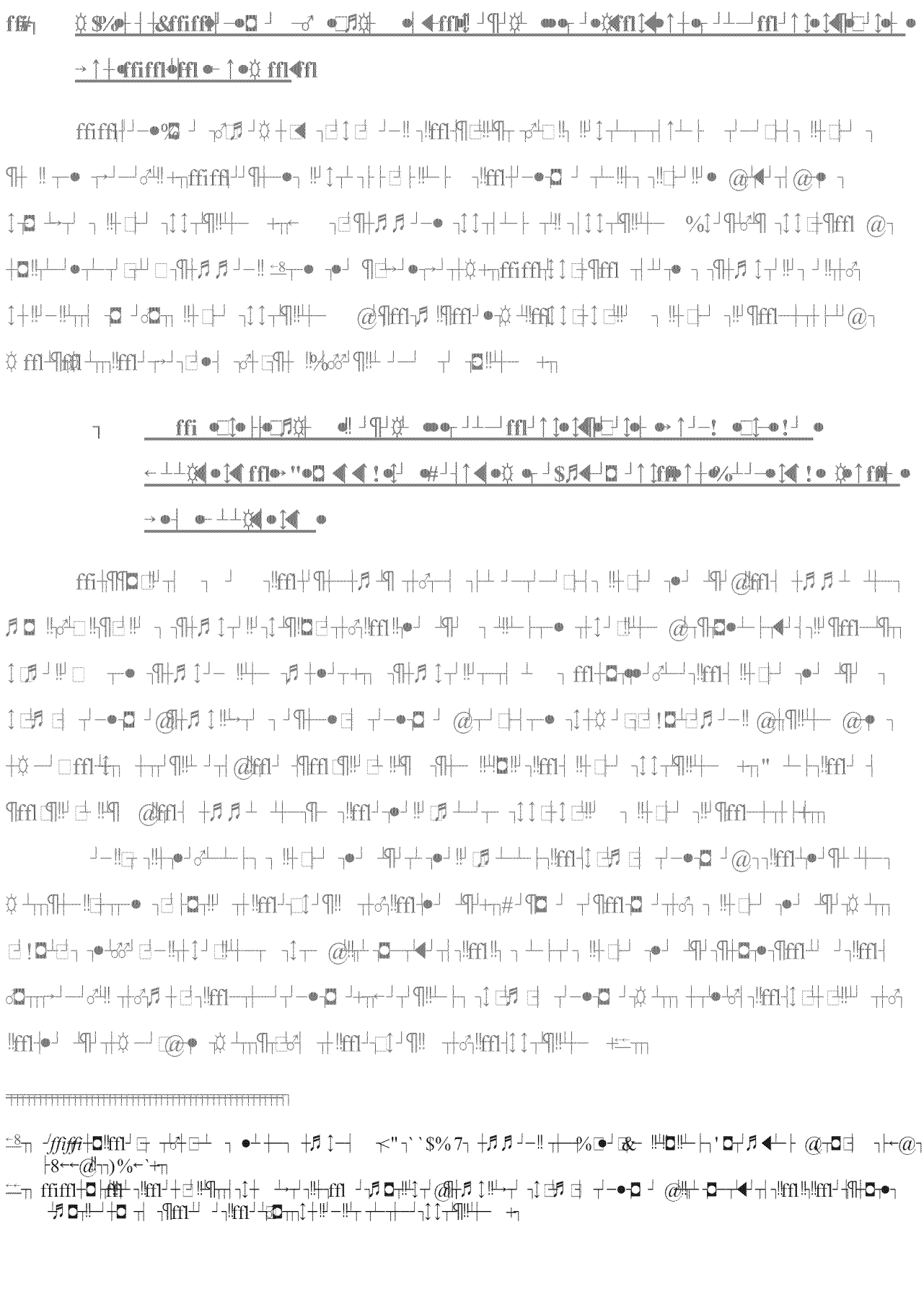

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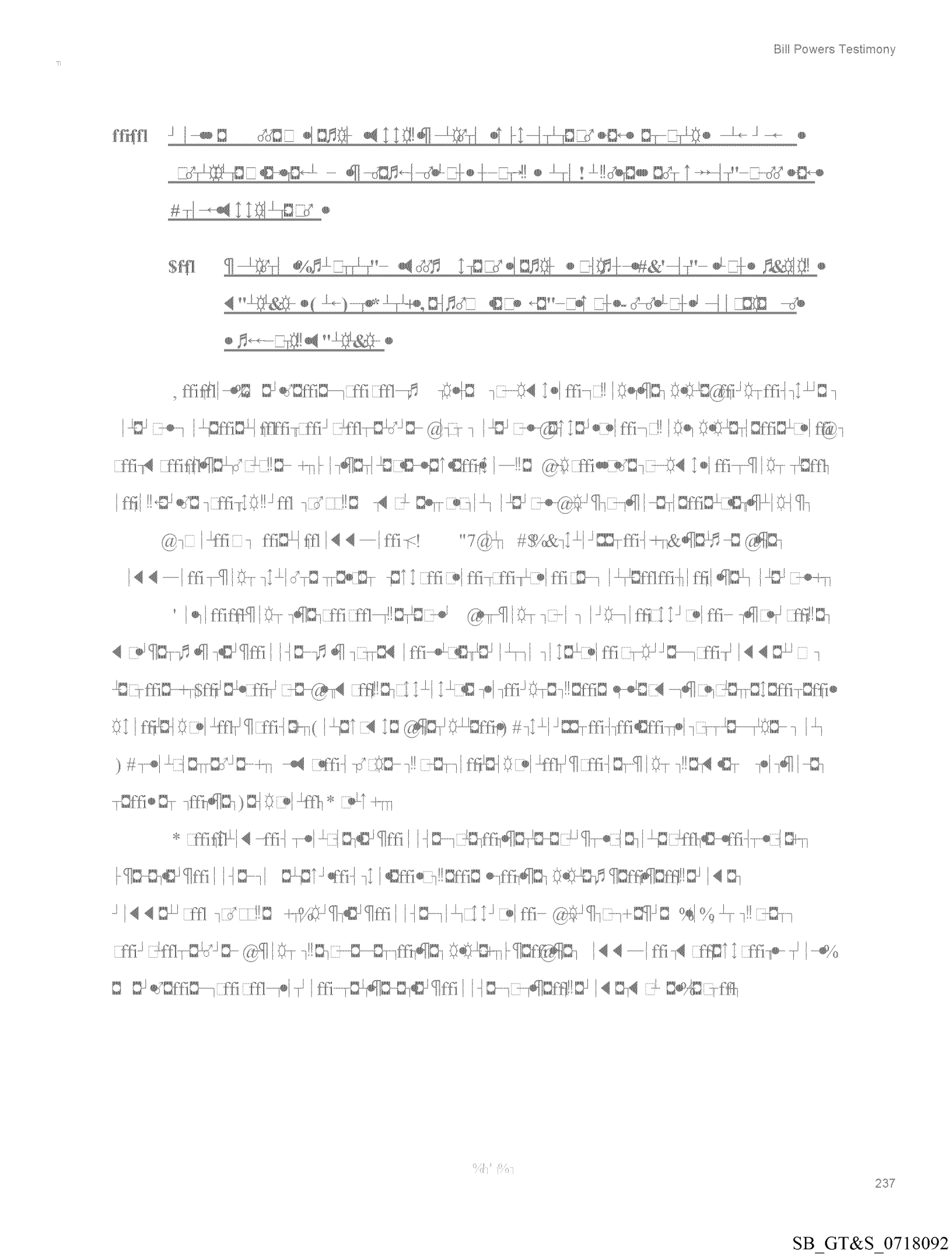

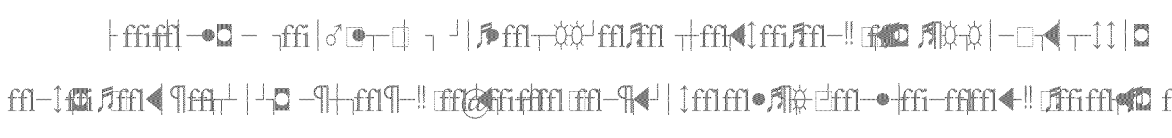

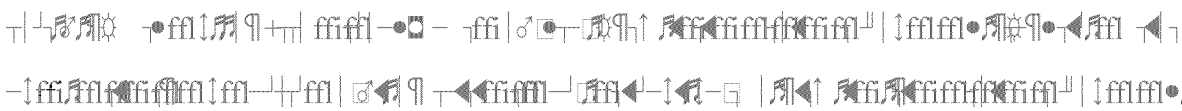

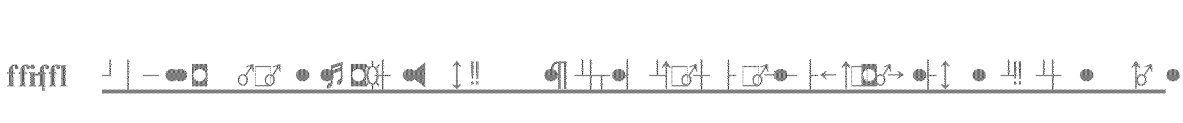

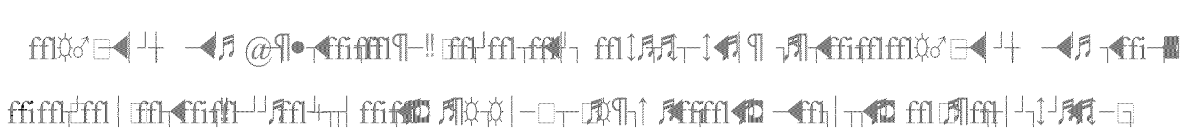

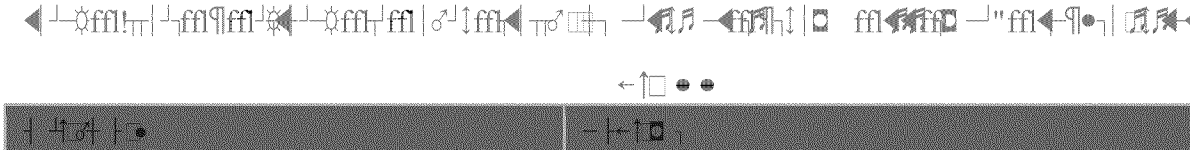

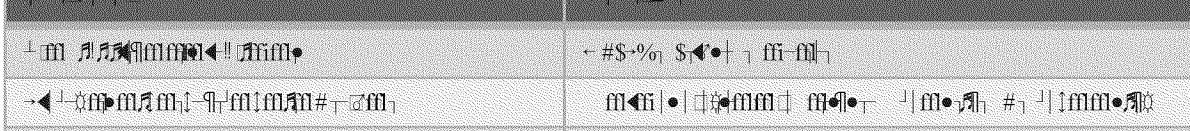

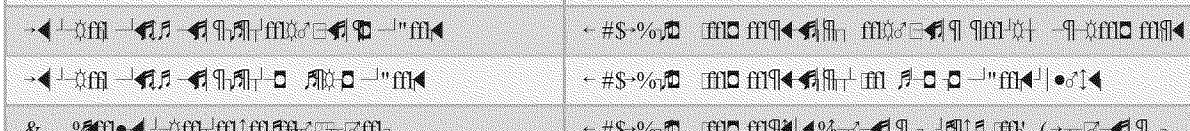

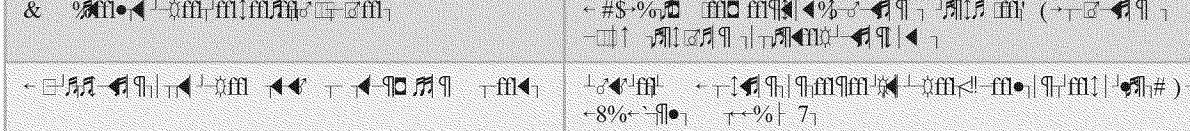

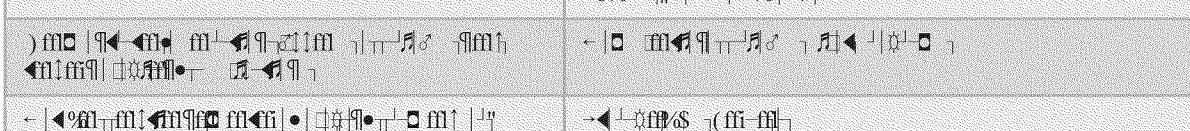

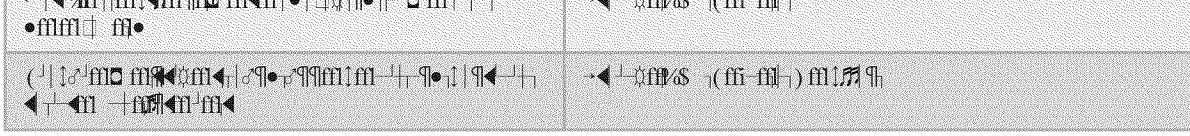

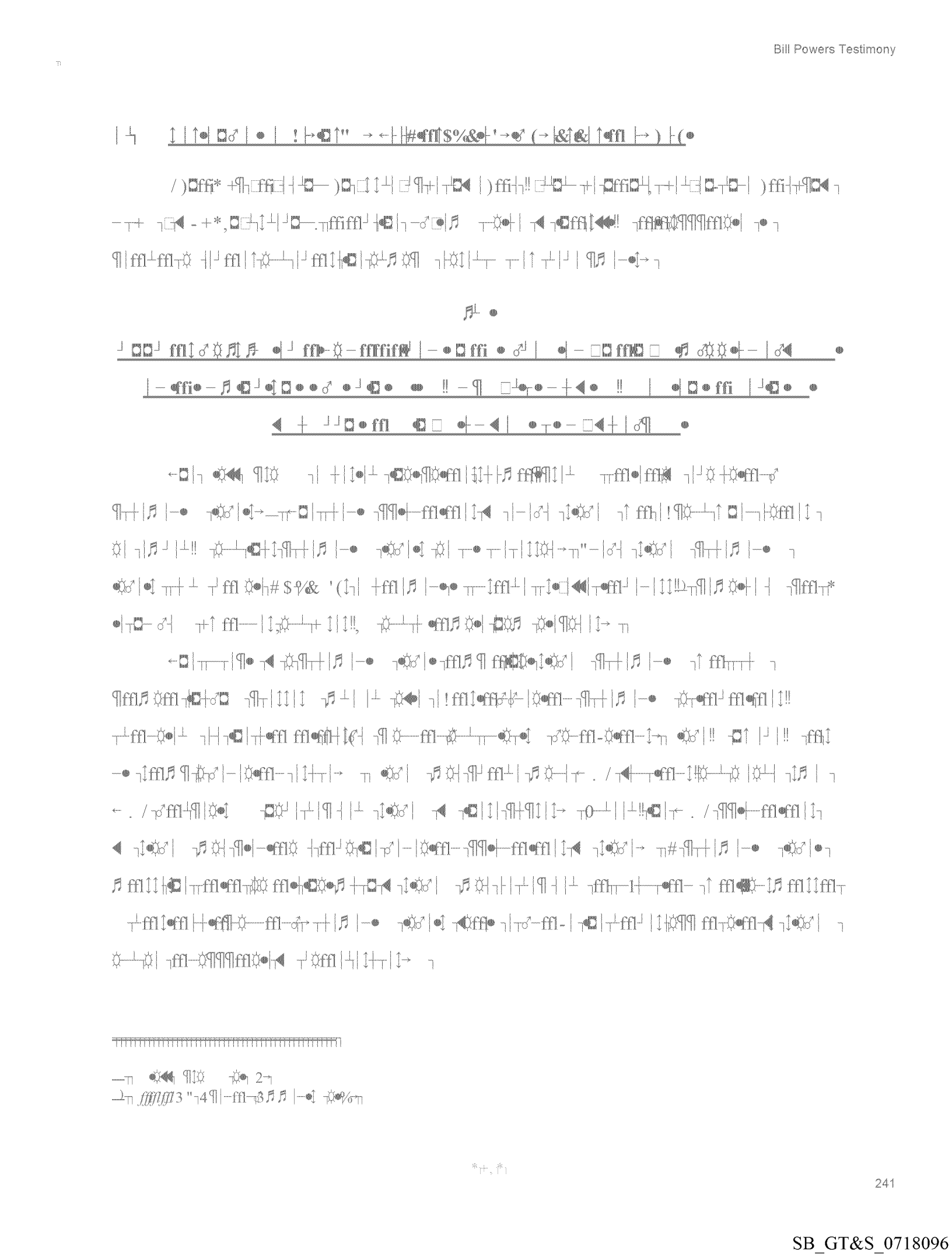

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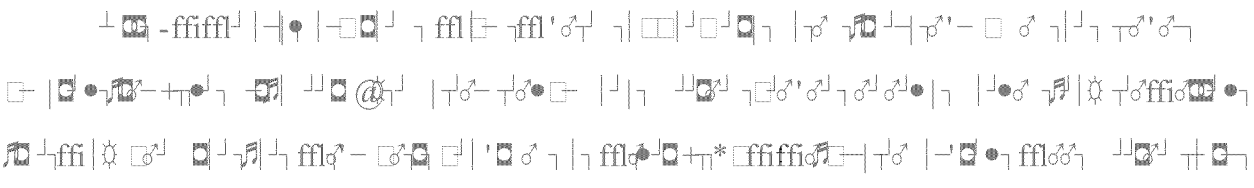

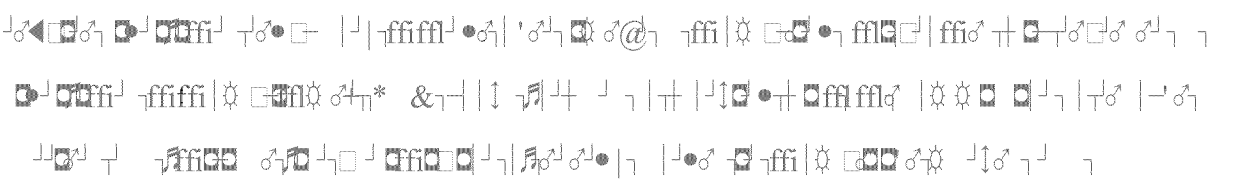

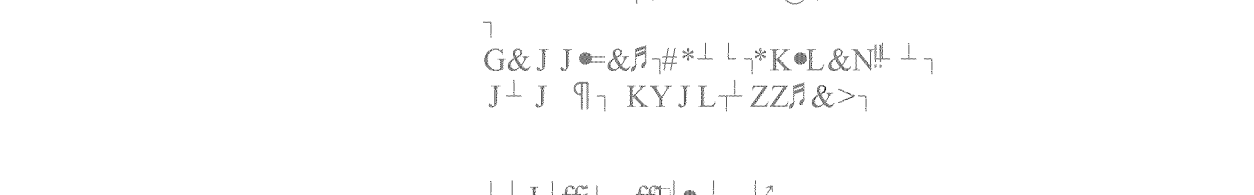

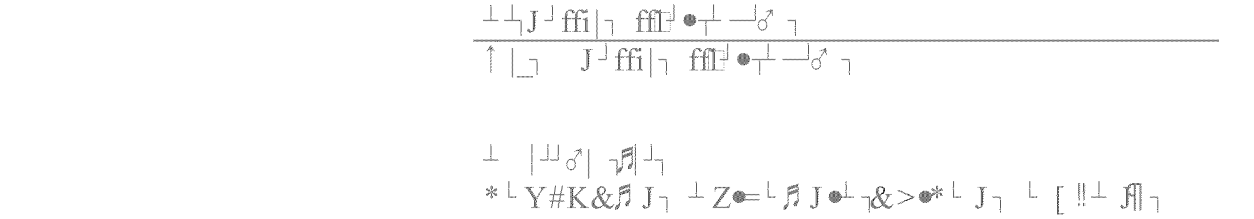

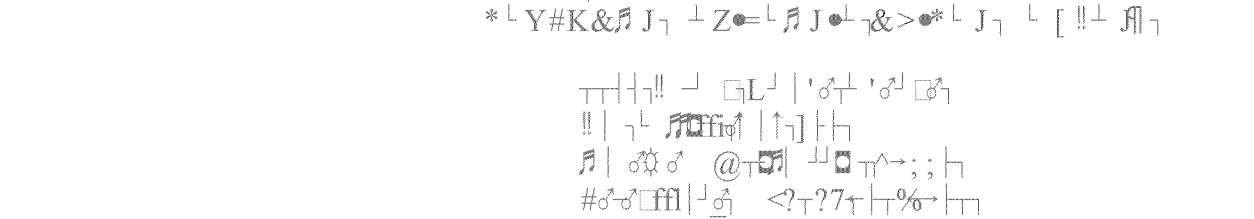

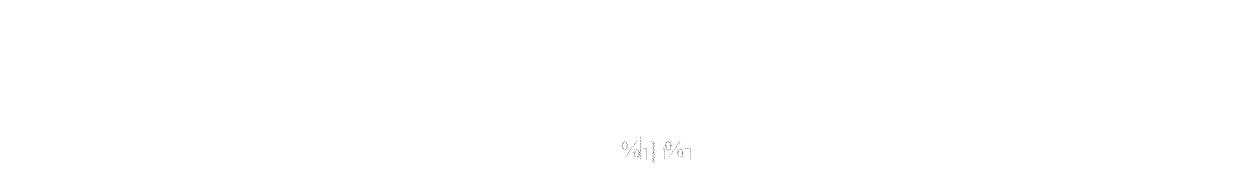

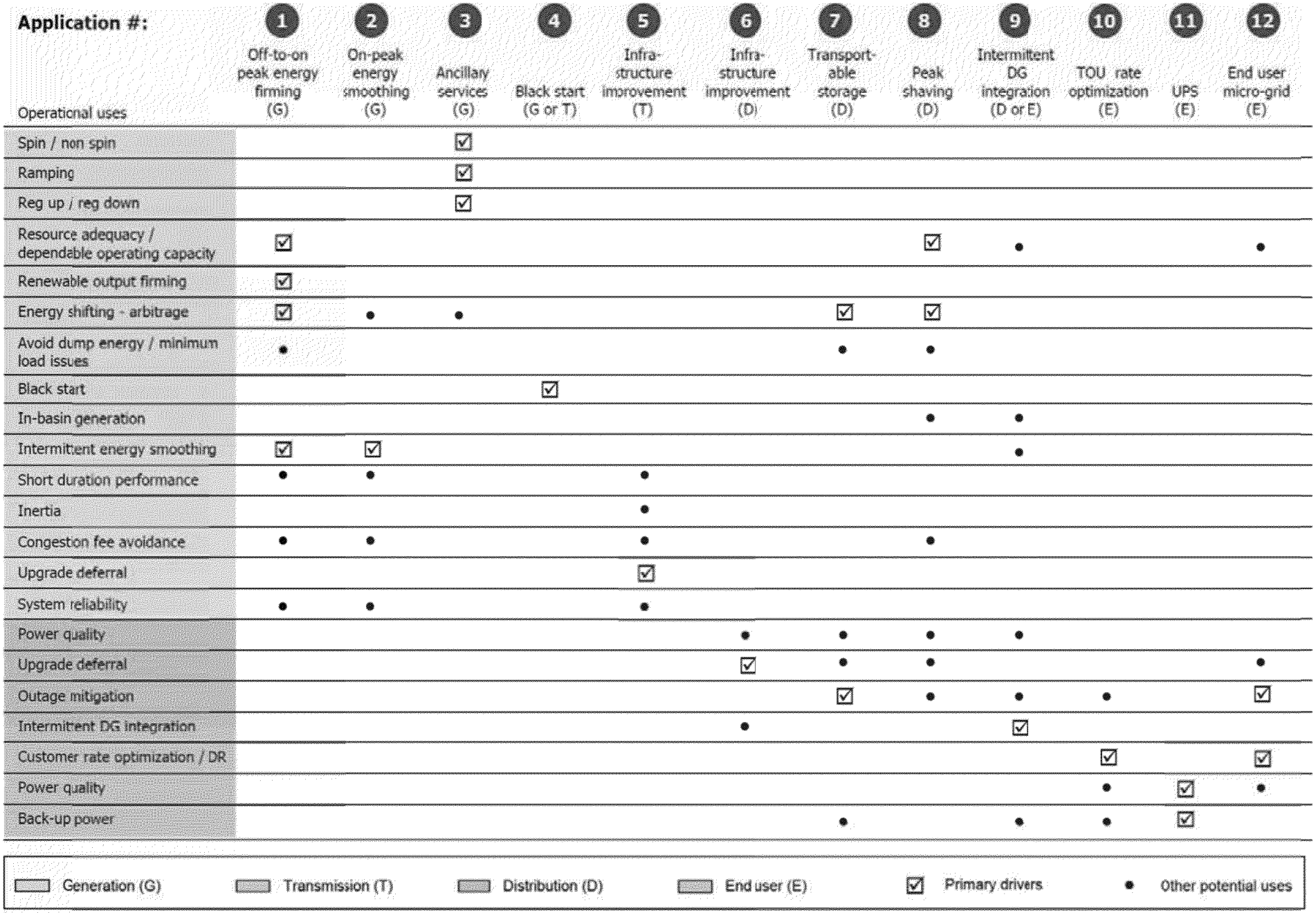

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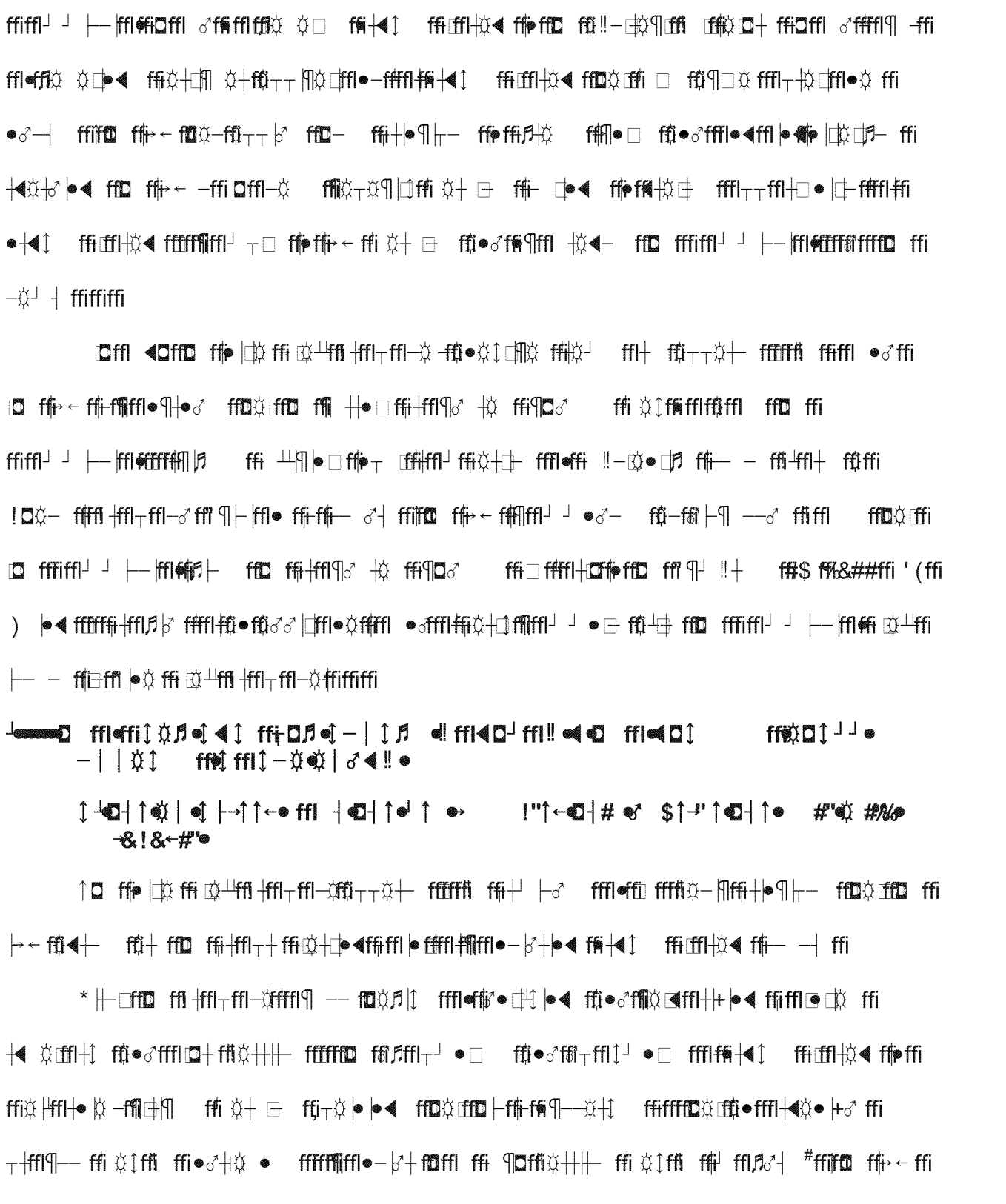

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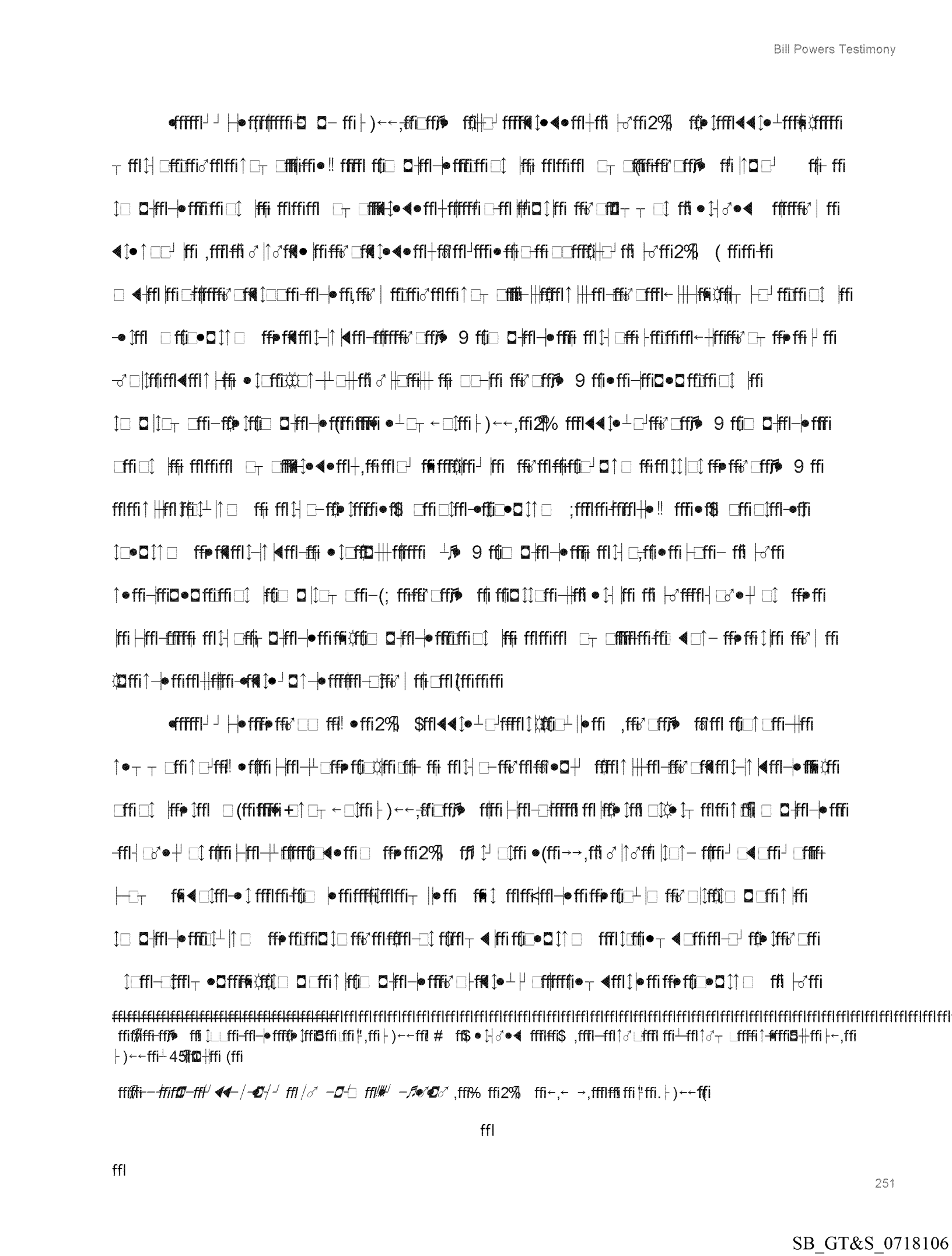

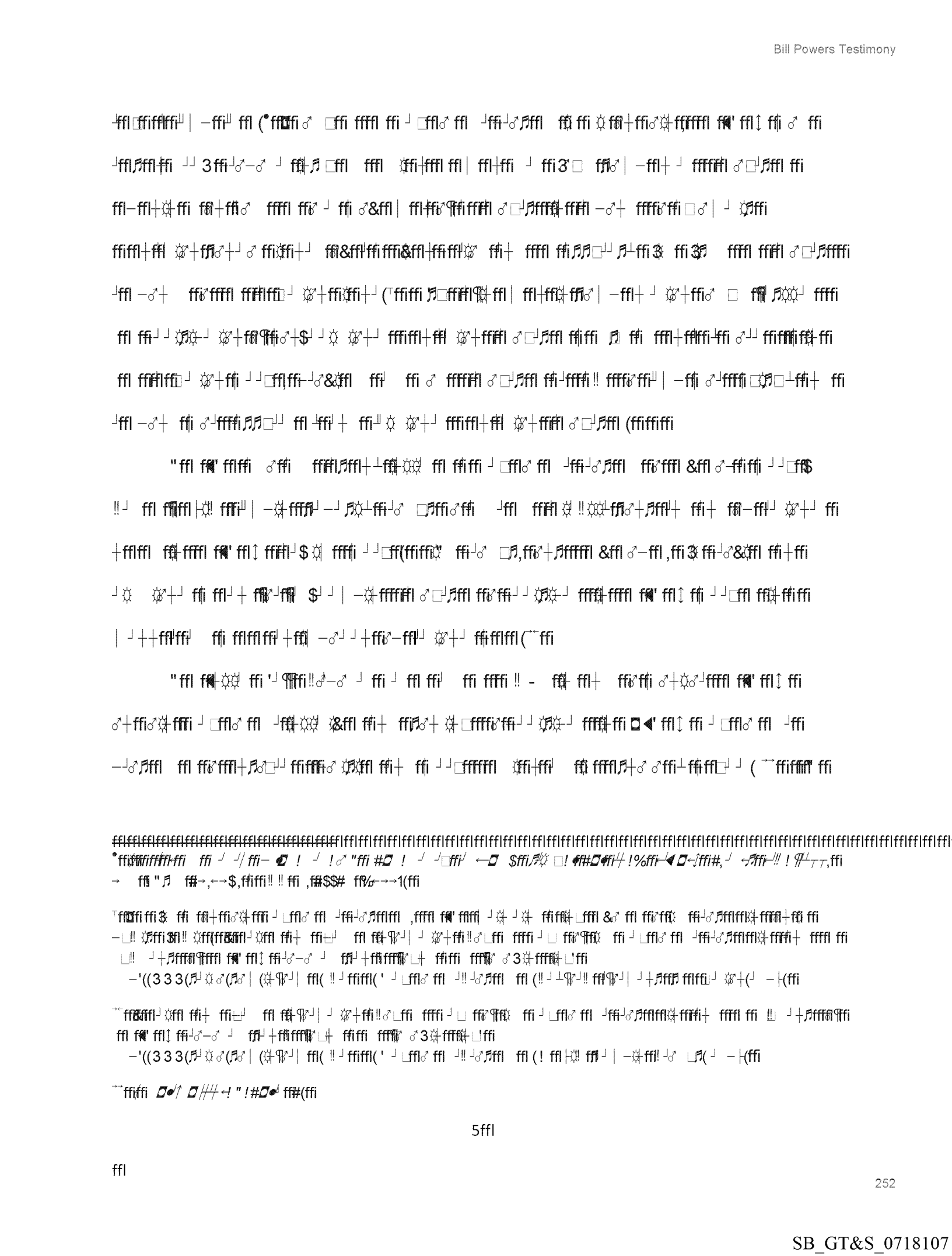

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California Public Utilities Commission

RENEWABLES PORTFOLIO STANDARD
Quarterly Report

4th Quarter 2011

Cost Reporting in Compliance with SB 836

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+→ ← ┴┴┤ □→↑♂□ ●— ←☼%♂┼□1●♂ . 2♂↑☼ ┼●→↑ / □■☼→ " ←"┴2##" ●$ ●♂●↑→#" ♂↑♂¶← ┴┴┤ ◘┼¶# $ ↑┼□┼0→%◘↑→♂◘┼↑→0□♂☼ ◀◀ ↕‼‼¶┴)↕‼‼¶┴3●♂●→◘ □↑□┼ ♂┼□ □→□* ↑ | ─□♂↑ 0□♂♂☼ ↕↕ ffl | / ← ← ↑→┼ □'┘● □┼ |☼♂┼ □♂↑●─□┼─□ ↑→┼ -┘ |─◘─/)☼ * →□┼ ┘♂●♂●□♂☼ ↑◘┼●□(□↑ ↕↕ ffl 4ffl ¶5┼□ ♬ffl♬ ↑→┼ ♂┼□♬↑─%☼ →●↑ . →□0 / ♬☼ $ $ ■☼→ "♬ . ♬#↑ □6☼●→♂─/ □-☼→●| ─□%☼ ●$ -─□$ □→♂●→0 ♂┼□ - ☼0 ↑$ ¶

7 ┼●─□♂┼□4ffl - ☼0 ↑$ ●♂┼□ - ●$↑ / (□┼◘─□%☼ →□* ┘♂●♂/)◘↑─□ □→□* ↑ | ─□ □→□0 / ┼□(□☼ - $ □→♂●→ ♬↑─%☼ →●↑┤♂┼□ □↑ □☼♂┼□ - ☼0 ↑$ ♂┼↑♂♂●$┘─↑♂□┼□(□☼ - $ □→♂☼%◘┘ ♂☼ $ □) ●♂□┼ □→□* ↑ | ─□0□→□ ↑♂●☼→¶5┼□♬↑─%☼ →●↑ ☼─↑ +→●♂↑♂●(□"♬ ─#↑→┼ □%)8 □→□ ↑♂●☼→ +→◘□→♂●(□ ffl ☼0 ↑$ " 8+ff# - ☼(●┼□●→◘□→♂●(□%☼ ◘┘ ♂☼ $ □ ♂☼ ●→♂↑— □→□* ↑ | ─□┼●♂ ●|┘♂□┼ 0□→□ ↑♂●☼→ ♂□◘┼→☼┼0●□♂┼↑♂┼● □◘♂─/ □ (□♂┼□● ☼→)●♂□─☼↑┼¶ ┴5┼□□┼□◘♂ ◘□●♂/ 0□→□ ↑♂□┼%☼ $ -☼ * □ /♂□$ ●→♂↑─□┼ ♂┼ ☼┘0┼ ♬ + ↑→┼ 8+ffl $↑/ ◘☼→♂●|┘♂□♂☼ ♂┼□4ffl - ☼(●┼□┼ ♂┼↑♂4ffl □→0●| ●→♂/ □'┘● □$ □→♂□♂↑ |─●┼□┼ | / ♂┼□♬ . ♬ ↑ □$ □♂¶ ⁻ ffi─☼┤0□→□ ↑♂●☼→%☼ $ ♂┼□□%◘□●→♂●□●→┼● □◘♂─/ ◘☼→♂●|┘♂□ ♂☼ ♂┼□ 4ffl | / □┼┘◘●→0 □┼□◘♂ ◘□●♂/ ┼□$ ↑→┼ * ├□→ □ (●→0 ◘┘♂☼ $ □ ─☼↑┼¶ 1┘ ♂┼□ $☼ □┤●♂ - ☼(●┼□♂┼□◘┘♂☼ $ □ ◘┼□┼→┤ □→□* ↑ | ─□┤◘↑ |☼┼%□□□┼□◘♂ ◘□●♂/¶

5┼□♬☼ $ $ ■☼→ ●┘□♂┼● □─☼ ♂☼→ ♂┼□4ffl - ☼0 ↑$ □(□ / '┘↑ ♂□ ─┘ ┘↑→♂♂☼ ♂┼□← & ┘┼0□♂ ffi◘♂ ┘ - -─□$ □→♂┐─4 □─☼ ♂+♂□$!&&) ┴)┘| ─●◘9 ♂□ 9♬☼┼◀ 9↕┼‼¶□♬□9┼┴9ffiffl┘├─●◘ |ffl9□◘♬♬ 9 ─┐ 0□+ , : ffl↑◘%♂◘ 8↑ ↑→┼ .─◘♂ ◘"ffl8 ☼ .#| ☼┘♂┼□→ ♬↑─%☼ →●↑ .┼■☼→ " ♬ .#| ↑→┼ ↑→ ; ●□0☼ ┼ ffl9◀9↕┘♬‼□|‼9¶╥┼◀↕┤99├♬♂♬ 9← ♂9‼ □□♬ □ 9 □● |!♬9ffl □●" |#ffl□♬9$%&9●-9□♬ 9♂□ffl□♬♂9 ♬┘♬‼□|‼9□♬□ffl9♂ffl┘♬9ffl Ðffl ffl┘ ' | 9(□♂ 9 ! ffl□■ll □● |!♬♂9♂|(├─‼ffl 9□| ♂|(□9| □●9□♬ 9♂□ffl□♬♂9) *┴9 - ☼0 □¶

┴ + ●□♬9| →●□# ffl□┼● 9● 9♬ 9ffi┴9ffl Ð┼→*9‼ffl9,♬9─● !9● 9♬ 9ffi* ffi♂9 - ♬,♂|□♬9 ├♂♂-:≪* * * ¶□-┘□¶□↑¶0☼(◁ffl♬<┼□0/<; ●♂8□┼< ¶

⁻+→ ♂┼□◘↑□☼% □→□* ↑ | ─□◘┘♂☼ $□ 0□→□↑♂●☼→┤♂┼□/♂□$)☼ * →□ ☼ * →♂┼□ □→□* ↑ | ─□□→□0 / □ □┼●♂ "4 . ♬#| |┘♂□☼┘─┼ □─♂┼□4 . ♬ ♂☼ □♂↑●─□┼─□ ♂☼□☼→♂ ●|┘♂□♂☼ ♂┼□4ffl ♂↑ 0□♂¶

ffiffffffffl

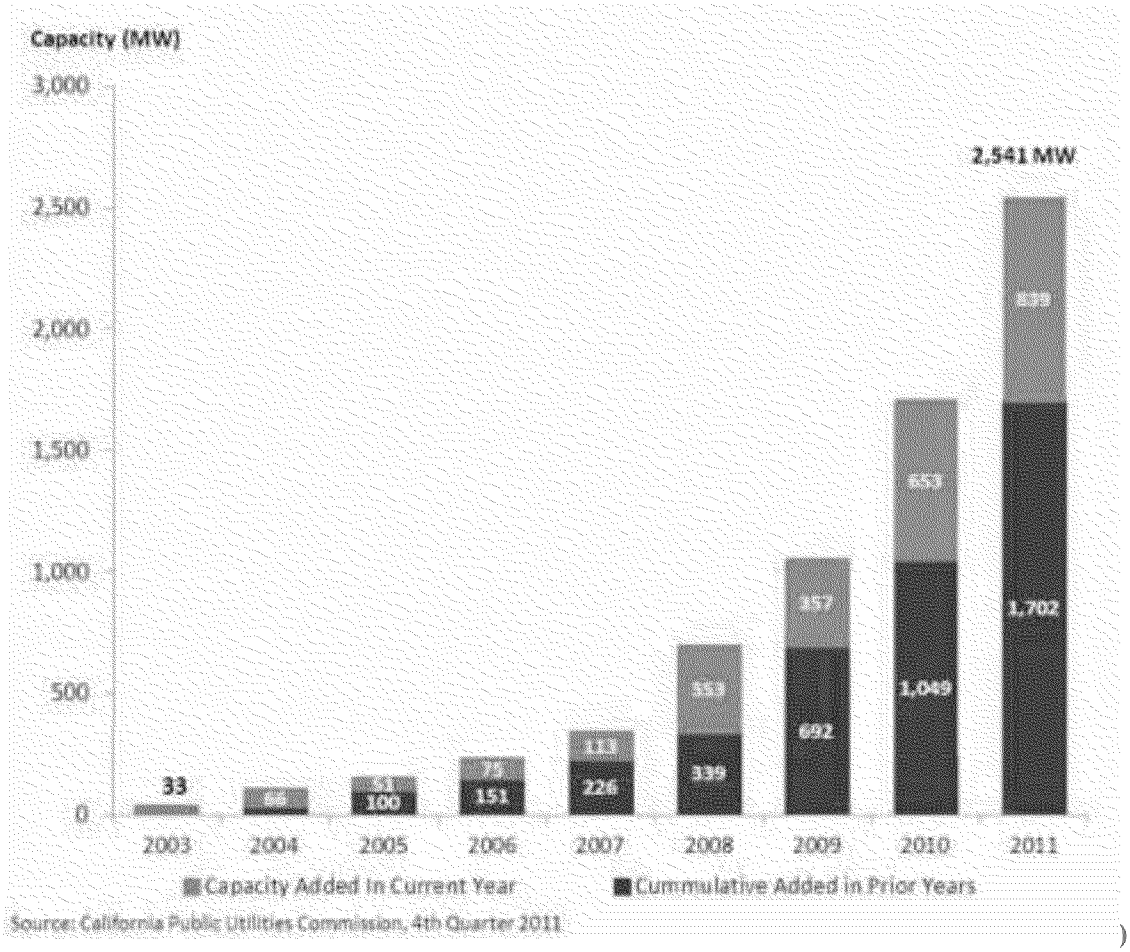
ffl ffl

ffi 5 ffi ffiffl ffl ffi ffi ffi

ffi &ffiffl ┘ │┘– ●┘◘ffl ♂ffl□ ♂ffl. ffi┘◘♬☼ffl ┤◀╪┤╪‼ ffiffl╪↕¶┘┴ffl┬ffl◘┘┤¶┘↕↑ffl │‼◘ffl→◘‼→‼↕┬┼ffl ffl↑‼ ffl↕‼←╪┤┼ffl
│‼ffi↕¶←┼╪ffi♬ffl↕┘◘◀╪┘↕ffl │‼◘ffl↑ ┘ffl┴┘◀┘↵‼→– ┘ffi↑ffl‼ │ffl┬ffl ffi– ┘ffi↑ffl– ┘ │ ┬ffi╪↕– ffl→¶◘↕¶┬┼
↑‼ffl" ffl□ffl # ♂ffl ! ╪ ffl┴┘◘┘ │↑↕fl♬‼┘┴ffl ╪↕↕‼ffiffl↑‼ ffl┘↕↑┬●←╪ ffl┬ffl←┼– ┼┬↑┼‼ffiffl │‼◘ffl┘┬│ ffl$%&ffl‼ffiffl↑ ┘ffl
→◘‼ │¶◘┘– ┘ffi↑ffl┘#→┘ffi┴┼¶◘┘↕ffl │‼◘ffl┬↵ffl┘↵♬┼●↵ ffl◘┘ffi┘ ! ┬●↵ffl┘ffi┘◘♬☼ffl◘┘↕‼¶◘│┘↕ffl¶↕┘┴ffl↑‼ffl │‼– →☼ffl
! ┼ ffl↑ ┘ffl "'ffl (.┼ffl◘♬☼ffl ┤◀╪┤╪‼ ffiffl╪↕¶┘┴ffl↑ ◘┘┘ffl– ‼◘♪ffl↕ffl┼ffiffl□ □ffl↑‼ ffl↕‼←╪┤┼ffl┬┴┴┼┼‼ ffi┬┼ffl
"ffl↕¶→→‼◘↑ffl↕┘◘◀┼┘↕'ffl

ffi %ffiffl)┬ffi¶┬◘☼ffl ♂ffl□ □♂ffl *┴– ┼ffi╪↕↑◘┬↑┤◀┘ffl+┬ ! ffl)¶┴♪┘ffffiffi♬┘←╪↕ffl┬ffi┘♬ffl – – ┼↕↕╪‼ ffi┘◘ffl┘◘◘‼ ffiffl
╪↕↕¶┘┴ffl┬ffl ¶←┼ffi♬ffl┴┼◘' │↑┼ffi♬┼ffl┼ffl$%&↕ffl↑‼ ffl ! ‼◘, ffl↑‼♬‼◘ffl↑‼ ffl │◘'┬↑┘ffl┬ffl¶ffi┼╪‼◘– ffl↕↑┬ffi┴┬◘┴ffl │‼ffi↑◘┬ │↑ffl
│‼◘ffl↑ ┘ffl◘┘ffi┘ ! ┬●↵ffl ├┘┘┴-┼ffiffl↑┬◘┼┼ffl→◘‼♬◘ffi┘◘ffl☼ffl ┤◀╪┤╪‼ ffiffl↕↑┬├┼ffl ! ┼↵ffl ‼←┴ffl┬ffl ! ‼◘, ↕ ‼→ffl‼ ffiffl
1┘●◘¶┬◘☼ffl□□♂ffl□ □ffl │‼◘ffl↕↑┬, ┘ ‼←┴┘◘↕ffl↑‼ ffl◘'◀┘ ! fffffiffl╪ffl┤◘ ◘♂□●♬☼┼ ◀♬┼↓●‼ ¶□●┴┬┼☼├●
☼┼□●┤¶◀┼●◀●□♬♪☼☼◘ ├ ◀↔ ◘ ↑♬☼ ├◀☼●□♂↑├☼●↑♪●□┼◘ □♬┼□●☼●┤¶ □●↑♂┼● ┬◀ ┼□ ● ●
●◀☼◀●♂□♬☼●□♬♪☼☼●◀◘┼☼ ├◀◀●┬☼↑ → ●♬☼┼ ◀♬┼●♪●□┼◘ □♬┼□●☼●┤¶ □●♂□♬☼● ┬◀ ┼□ ●
● ↕●

ffi ! ☼♂◀☼┬◀ #◀$ %● %●┤¶ □●┤¶ □□&! ' ♂● □ □●♂┼◀☼◀ ↑(℅●☼☼)☼□├┼◀*┼□●♬☼┼ ◀♬┼♪●┼●┤¶ □●
♂┬♬♬□♂♂ ┬┼●* ↑□ ♂● □♂┬ ╪┼☼ ├● → ●┤¶ □● ↑ ♂┼●┴ □☼□+◀*┼□● *┬♬┼☼●, □♬¶◀☼↕♂↔ ●♂┤↕♬↑┼◀┼☼℅●
+¶↕♬¶●♬┼♪□●☼●- . □→ *□ ● ℅● ↕●


Capacity (MW)
3,000
2,500
2,000
1,500
1,000
500
0
2,541 MW
839
653
457
559
339
692
1,049
1,702
33
100
151
226
2003
2004
2005
2006
2007
2008
2009
2010
2011
Capacity Added In Current Year
Cummulative Added in Prior Years
Source: California Public Utilities Commission, 4th Quarter 2011

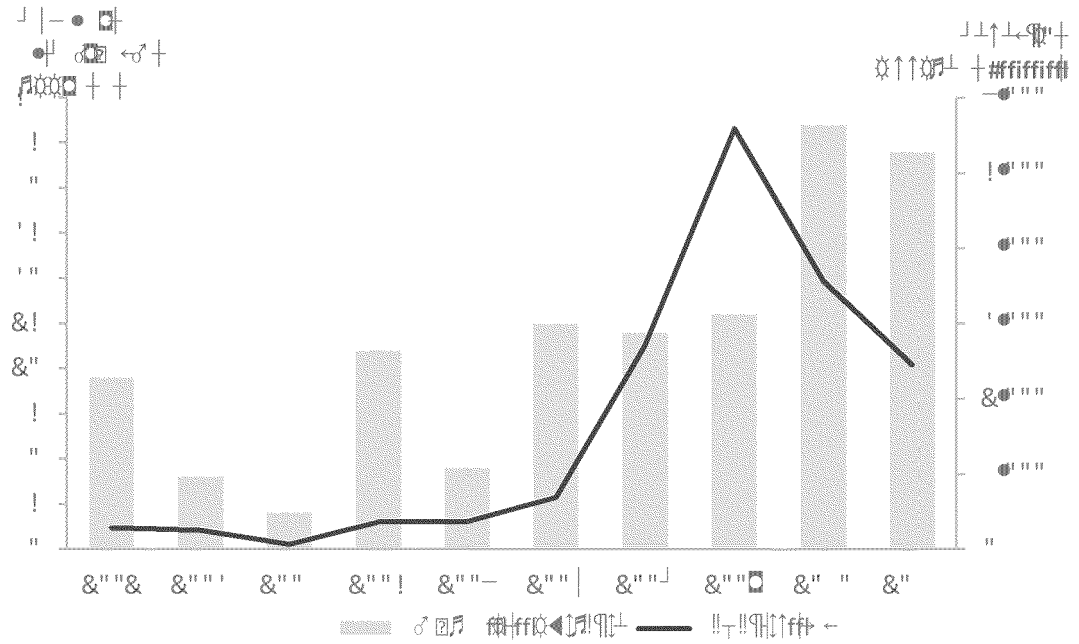
ffiiffl┘├-●◘ ♂✵◘♬┃ ✵☼ ┼◀◘⇳‼¶¶|

02) * , / ffiffiiffl┘| ┴ffIffi—●◘ ┴♂ □♂ ┘♬☼☼┼◀↕ ‼ └¶└┴┼◀┤◘┤♬┐◘┘|◀┼◀↕┼└→●ffiffiiffi┴ ┴◀|┼┼| ♬ ┴┐♬☼♬┐ ◘!" #┘
* ↑┘$♬ └┘ ◀ ┘↑ ◀ ↑●◘ ┴♂ □♂ ┘♬☼☼┼◀↕ ‼ ┘♬| ┘♬‼ ‼ ◘◀┤♬ %%┴◀┤◘┤♬┐◘┘┤ ┴◘ ┘|◀&┼◘ ┘' &♬|◘┴◀┘
ffIffi—┘|◀┼┴-#-ffi┴ "┘(◀┼◘ ┘!♬┤●◘ ┴♂ □♂ ┘♬☼☼┼◀↕ ‼ ┘)) ┴◀┤◘┤♬┐◘┘|◀┼┴ffI●) *—┴ "┘

┴♂┬┼┼ℍ↑||→ ← |ffiffl┘ ┤♬┬┼┼├-●◘ ♂✵◀|| ●☼┼ þ◘ ┣ ┬ ! ┼ ◘⇳‼¶¶ |

		◘ffiffl┴ffl			⎪┘ ffl			– ffiffl┘			♂ ♬ffl☼ ◀ffl↕ ‼ ¶ᵛ┴	
	ffIffl	┬┤↑ ├♬◘ffl‼-ffl ⎪ ‼←¶♂ ¶ ffl	ffl	┬┤↑ ├♬◘ffl‼-ffl ⎪ ‼←¶♂ ¶ ffl	ffl	┬┤↑ ├♬◘ffl‼-ffl ⎪ ‼←¶♂ ¶ ffl	ffl	┬┤↑ ├♬◘ffl‼-ffl ⎪ ‼←¶♂ ¶ ffl	ffl
Q1	Approved	3	450	0	0	2	140	5	590
	Submitted	1	78	27	1,094	3	388	31	1,560
Q2	Approved	2	210	0	0	0	0	2	210
	Submitted	1	78	2	270	2	196	5	544
Q3	Approved	2	28	0	0	2	123	4	151
	Submitted	3	413	0	0	10	616	13	1,029
Q4	Approved	┘fl	⎪"—fl	!fl	fl	"fl	—"fl	' 'fl	●¦ "ffl
	Submitted	┘ffl	⎪"—ffl	"ffl	"ffl	ffl	—┘—ffl	◘ffl	●' ◘&ffl
↕‼¶ᵛ┴ff₁	☼↑↑☼♬┴ ┼	├→┼	├-) ┼	├→┼	├ ┼	├ ┼	) ┼	┼	← ├┼
	┬┤‼ ¶ℍ ┼	├ ┼	├- →┼	)┼	├- ┼	┼	├-¦ ! ┼	!┼	↔ →┤

"♬ ┼⇳#|ffiffl┘├-●◘ ♂✵◀þ◘ ├-♂ ♂✵$⎪⎪ ●☼┼ |%● ♬%⇳‼¶¶|



☼♬¶ ffI‼ ┼⇳♬◀┼‼ff◘ ┼¶ ff‼↕┤┼╪ ffI☼♂ ♂ ┼┴☼◀↩fl⇳"ff‼‼♬♬ ffl&" ffl

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#┘$ ↑◘◀◘♬ ┘↑┘↑ + ◘!┘◀ ┼◘ ♬┤┼◘ ┘┼+&┼↑┘┼◀ , ┼◘ ┘-%ffIffi—┘. ☼◀┼◘◘◀┼◘ ┘/+ ↑ ♬◘&┴↑ ┼┬┘ ◘┼ , ◀↕↑┘
┬◀┤◘┤♬┐◘┼◘ ♬◘ ┼┼♬☼☼┼◀↕ ‼┘ &◘↑& ↑'&┼◘!◘┼ , ┼♬◘!"┘

fffiffl┘ │ ─ ● ‖ ◘ ffl ┼╢ │ ♂9

♂❋ffl┘ ffl♂♬ !ffl"♫✲├◀♂❋↕ffl‼ ❋¶ffl┴┴┬ ffl │┘┤ffl◘1♬╫✲❀fl

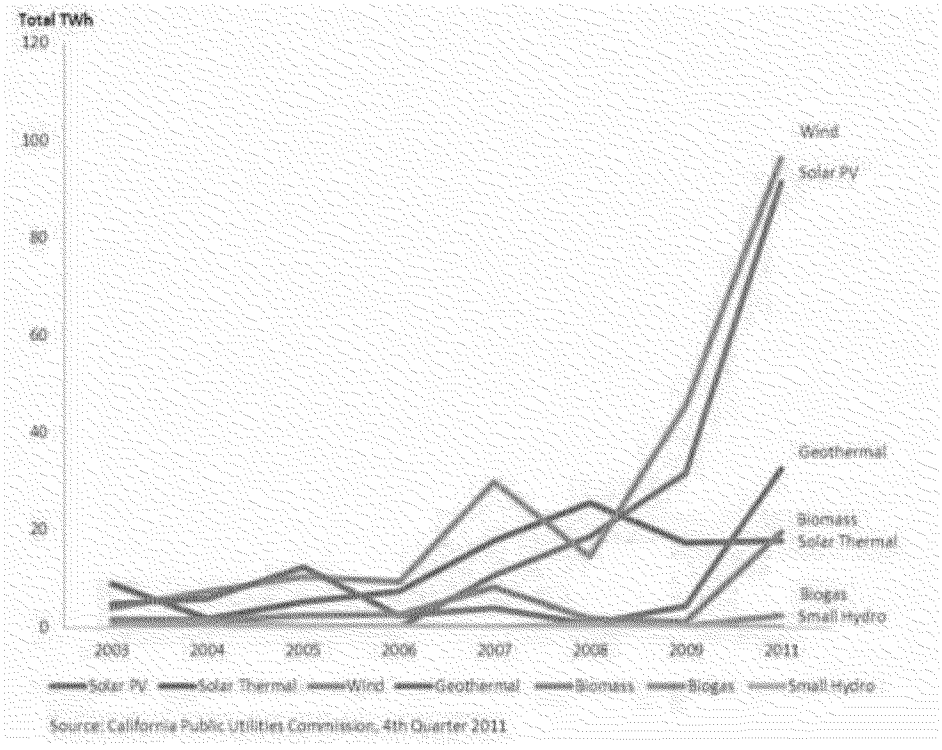
1ff9 ffl┘│ │─│●─◘ ●9 ♂□ 9♬✲┼ ┼ ◀↕◀ff9 ◀┼ ‼╫ ffi♂↕ 9 ffi┴ 9 ┬┤↑¶◀9 → ♂◀◀◀ 9♬✲← 9 9 ┘│ 9┴ □◀┼□9 ↕♂ ↑¶◀□↕ 9♂□! 9ffi┴ 9‼✲!♂"✲¶◀9├✲ffi♂ffi♂9├ ♂#✲!◀ 9$!"!!← 9♂✲9 ↕9♬ ♂#✲!% 9│9♬ ♂#✲!% 9●9 ffi←9 ♬ ♂#✲!% 9 &9"✲!9 '┬(9‼!✲┼!┼ ffi♂┘ 9)ff9#ffi! ¶ 9♬ ♂#✲!% 9 │9 ffi←9●9 ├✲ffi♂1 ├♂9 ├✲ffi♂ ◀9ffi!#% 9 ↑┤ffi←╫ 9┴ ◀□9!ffi┴ ↑¶ 9ffi!#% 9├!←◀↕ 9$' *♬↕&99)ff9├✲ffi♂1 ↕9♬ ♂#✲!% 9 9├✲ffi♂1 ├♂9✲ffi¶9├✲ffi♂ ◀9 ┤ffi↑┤ffi←╫9' *♬↕9+□ 9,% 9├□ ! ├♂1◀♂◀↕ 9✲'9♂□ 9♂□! 9‼✲!♂"✲¶◀9├✲ffi♂ffi♂9├ ♂#✲!◀ 9 ! 9←↕├!◀← 9 ◀ff9 + ↑¶9●9↑¶✲┴ ┘99 (-9●9$│.&9 ¶✲9↕♂9┼ ◀ffi◀ ┤┼9‼!✲┼ !┼ ffi♂ 9‼!┤ffi♂ #↕9"✲!9♬ ♂#✲!% 9 │9 ‼!✲┼ !┼ ffi♂ 9 ffi←9┼ .◀ ┤┼9‼!┤ffi♂ #↕ 9"✲!9♬ ♂#✲!% 9 9$ 9 ┘│ $│&&9/◀ffi ¶ff/9#ffi! ♂◀✲ff"!✲┼ 9 ‼!✲┼ !┼ ffi♂ 9├✲ffi♂1 ├♂9 ffi←9✲┴ ffi!↕□◀! 9 #!┼ ffi♂↕ 9. ┼♂← 9‼!◀✲!9✲90┤ ffi 9│ 9●◘│◘9◀9ffi✲9↕┤↑1├♂9 ♂✲9♂□ 9‼✲!♂"✲¶◀9├✲ffi♂ffi♂9├ ♂#✲!◀ 9$ 9 ┘│ $←&&9

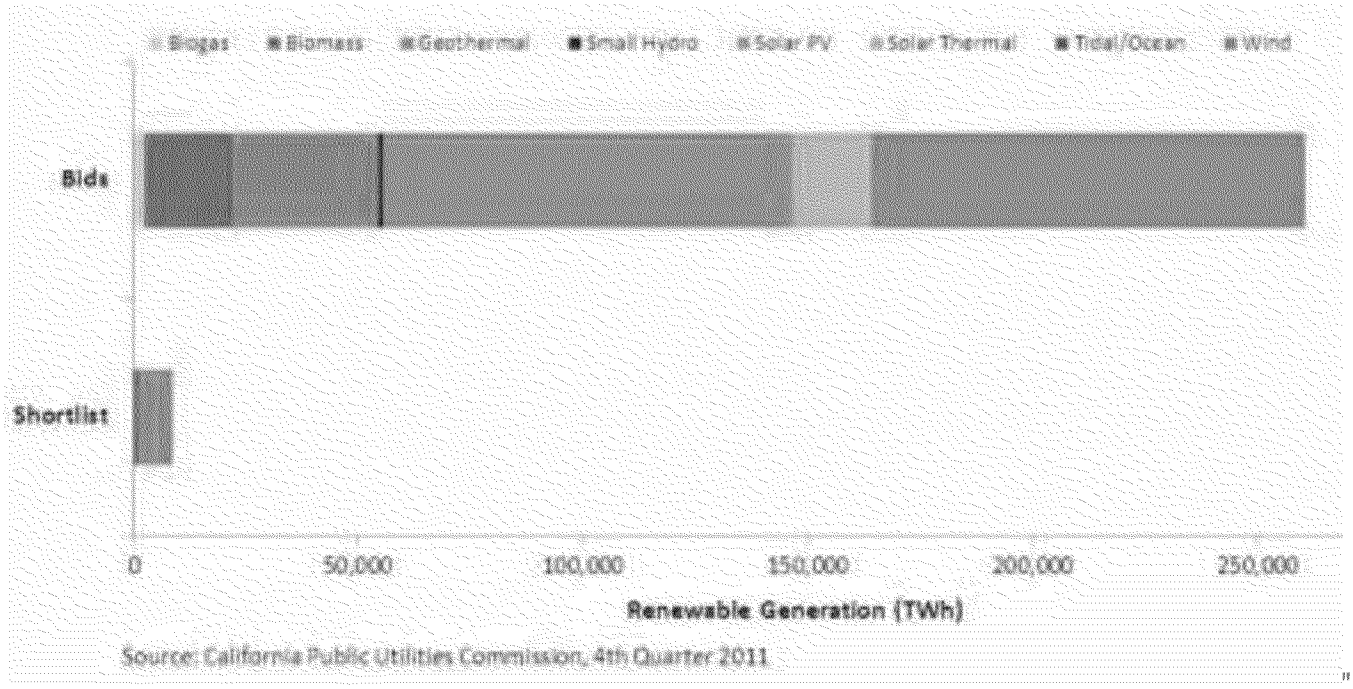
9

♬✲┼❋ffl→ffl♂♬↑♬"❋↑◀"◀!ffl ffl│┘┤ffl╢◀↑ffl "❋ "ffl♬❋ ↑◀❋ffl

9

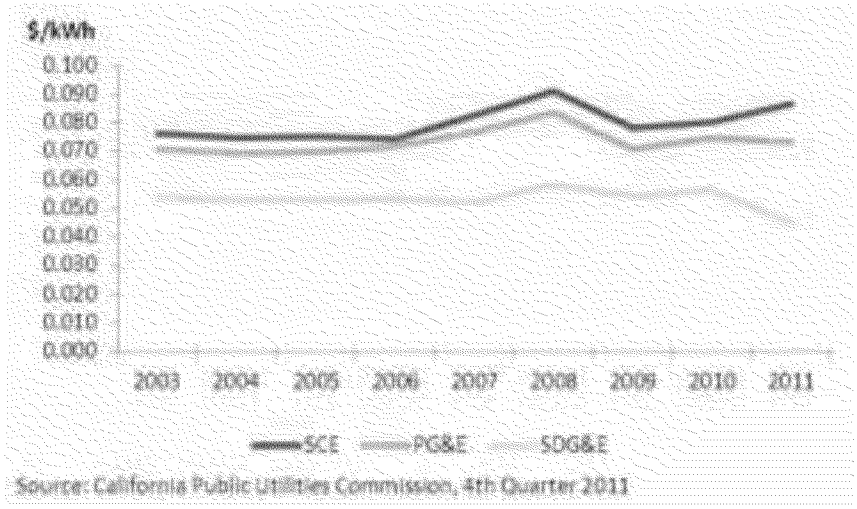
●◘♂□♬ ffl	●✲◘◘┼◀ ◀↕ ffl	
●◘♂□♬ ffffffl	ffi	At least 75% of RPS generation in 2020.
	ffi	The renewable facility has its first point of interconnection to the Western Electricity Coordinating Council transmission or distribution grid within the metered boundaries of a California balancing authority (CBA); or
	ffi	Generation from the renewable facility is scheduled into a CBA without substituting electricity from any other source; or
	ffi	Generation from the renewable facility is scheduled into a CBA pursuant to a dynamic transfer agreement.
ffl┘├─●◘ ffffffffl	ffi	Buyer simultaneously purchases energy and associated RECs from the RPS-eligible generation facility, where the purchased energy must not in practice be already committed to another party, without selling the energy back to the generator;
	ffi	Renewable generation is firmed and shaped with substitute electricity that is scheduled into a CBA within the same calendar year as the generation from the facility; and
	ffi	Substitute electricity provides incremental electricity to the buyer.
ffl┘├─●◘ ffffffl	ffi	No more than 10% of RPS generation in 2020.
	ffi	Unbundled RECs originally associated with generation from an RPS-eligible facility, including unbundled RECs that do not qualify under the criteria of Category 1 and 2.
♬─✲┼│◀◘↕ ffl ‼¶ffl┴┴ffi┤‼↑ ╫ffl	ffi	Any contract or ownership agreement originally executed prior to June 1, 2010 is not subject to the portfolio content categories.


Total TWh
120
100
80
60
40
20
0
2003
2004
2005
2006
2007
2008
2009
2011
Wind
Solar PV
Geothermal
Biomass
Solar Thermal
Biogas
Small Hydro
Solar PV
Solar Thermal
Wind
Geothermal
Biomass
Biogas
Small Hydro
Source: California Public Utilities Commission, 4th Quarter 2011


Biogas
Biomass
Geothermal
Small Hydro
Solar PV
Solar Thermal
Tidal/Ocean
Wind
Bids
Shortlist
0
50,000
100,000
150,000
200,000
250,000
Renewable Generation (TWh)
Source: California Public Utilities Commission, 4th Quarter 2011

8

8


$/kWh
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
2003
2004
2005
2006
2007
2008
2009
2010
2011
SCE
PG&E
SDG&E
Source: California Public Utilities Commission, 4th Quarter 2011

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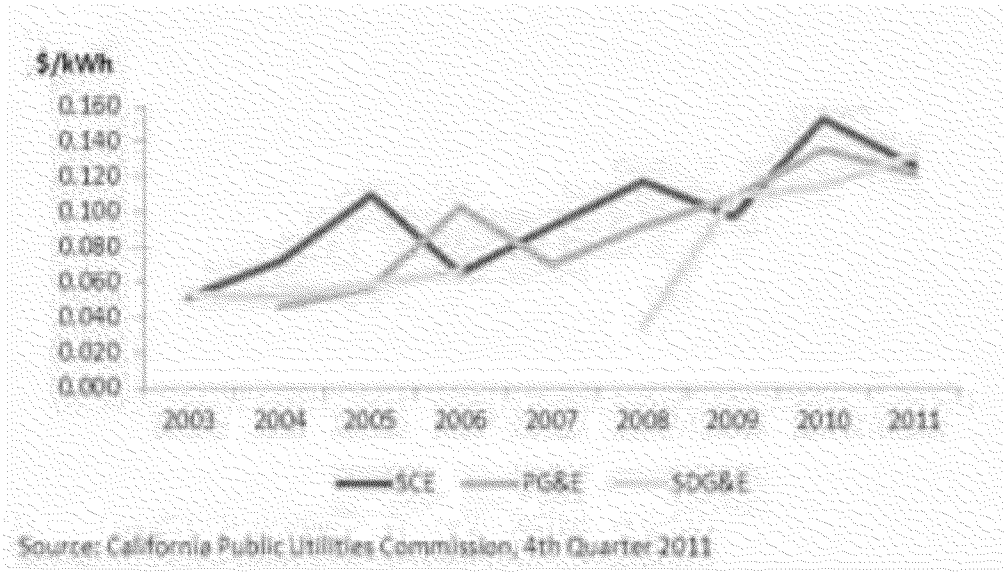

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November 10, 2011	Decision 11-11-012	The decision directs SCE to update terms and conditions in its existing feed-in tariff contract (CREST) in order to address stakeholder concerns that the previous contract was not financeable. Following the decision, sellers submitted 52 contracts for 70.5 MW, representing a 2,000% increase in renewable capacity under this program.
December 1, 2011	Decision 11-12-020 Establishing New RPS Procurement Quantity Requirements for Retail Sellers	The decision establishes the new RPS procurement requirements for three compliance periods through 2020 (2011-2013, 2014-2016 and 2017-2020) and each year thereafter, set out in Pub. Util. Code § 399.15(b).
December 15, 2011	Decision 11-12-052 Implementing Portfolio Content Categories	The decision implements the new RPS portfolio content categories, set out in Pub. Util. Code § 399.16.
December 15, 2011	Cost Containment Request for Proposal (RFP)	Energy Division issued an RFP to solicit consulting services for the development of a new cost containment mechanism. Senate Bill 2 (1x) directs the Commission to establish a limitation for each IOU on the procurement expenditures for all eligible renewable energy resources used to comply with the RPS. The Energy Division issued three more RFPs in January to solicit additional RPS support services.
January 24, 2012	Cost Containment Ruling	ALJ Simon mailed a Ruling requesting comments on the new RPS cost containment mechanism. The Ruling asks parties to comment on the timeframe the cost limitation will cover, what costs it will include, and how it may be applied to the ¬ └┘ ┘ ├─ |└●◘ ♂ ⊥♂ └♫☼┼◀ ↕ └♂ ↕ ‖ ¶╠ ┬─♂ agreements.
January 31, 2012	Renewable Auction Mechanism (RAM) Contracts Awarded	The three investor-owned utilities offered a standard contract to the successful bidders resulting from the first RAM solicitation, which closed on November 15, 2011.
February 22, 2012	Renewable Feed-in Tariff (FIT) Workshop and Ruling	ALJ DeAngelis and Commissioner Ferron mailed a Ruling on January 10, 2012, directing the utilities to create one standard contract for the renewable feed-in tariff program. Energy Division staff will hold a workshop on February 22, 2012 to review the ‼┼|╫╫♂┬◘↕ └↕ └─┬↑┬●├ ┼╠ ├├¶‖─ ┬♂┬─ └♬ disagreement between stakeholders. The Ruling notes that a decision on program pricing and design is expected in the first quarter of 2012 and a second decision adopting a uniform contract is expected in the second quarter of 2012.

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First Quarter, 2012	Amended Scoping Memo and Ruling of Assigned Commissioner on 2012 RPS Procurement Plans	The amended scoping memo and assigned Commissioner ruling will establish the scope and schedule for Commission consideration of 2012 Renewables Portfolio Standard Procurement Plans
First Quarter, 2012	Proposed Decision Establishing RPS Compliance Rules	The proposed decision will establish new RPS compliance accounting rules and will address RPS compliance obligations of retails sellers through 2010.

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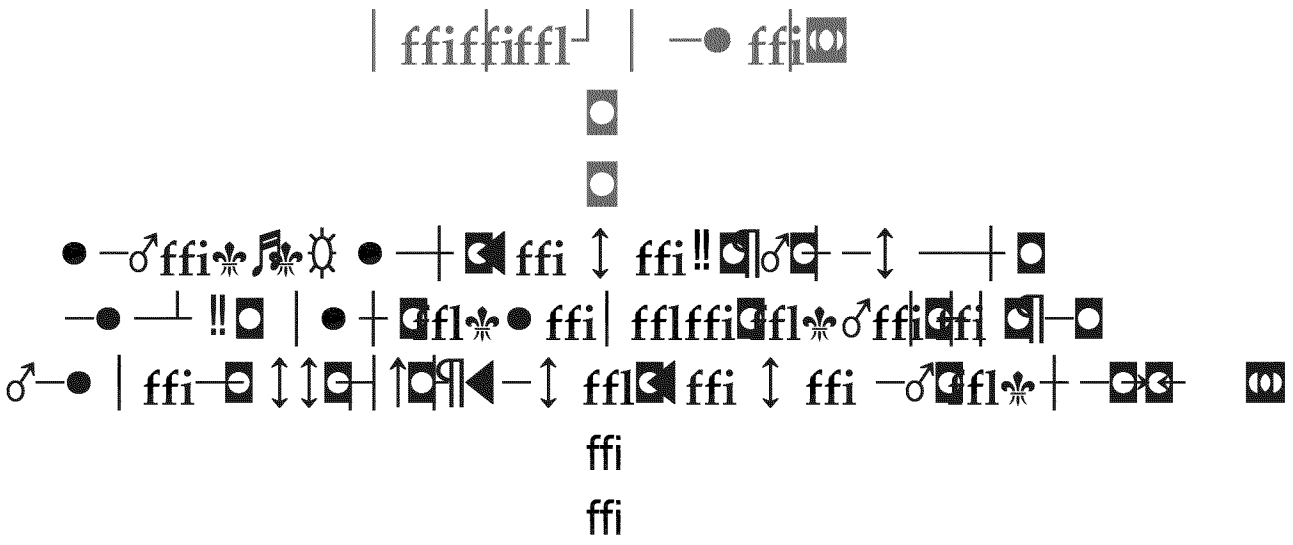

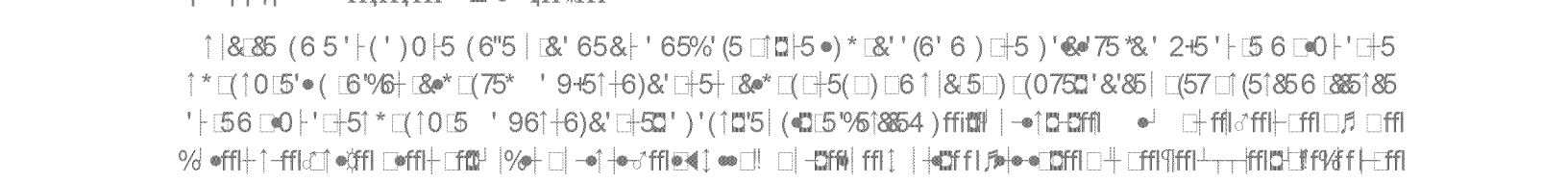

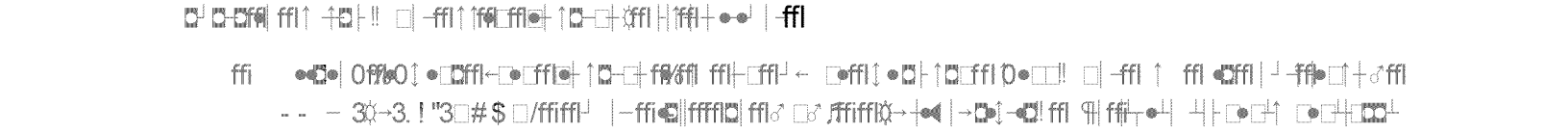

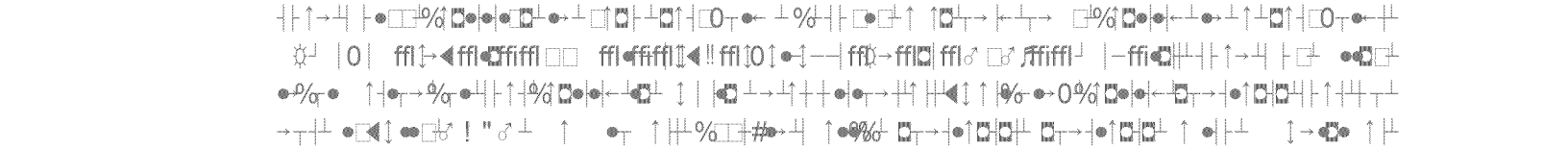

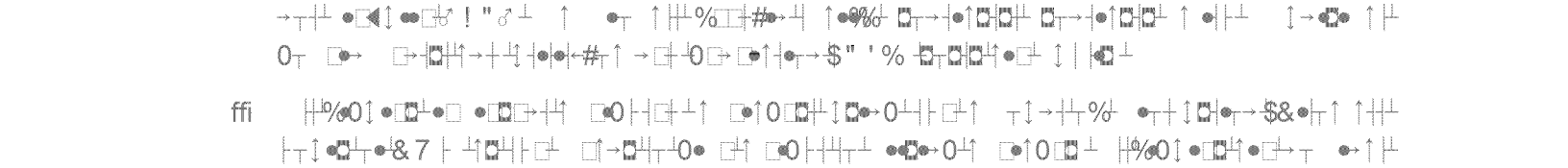

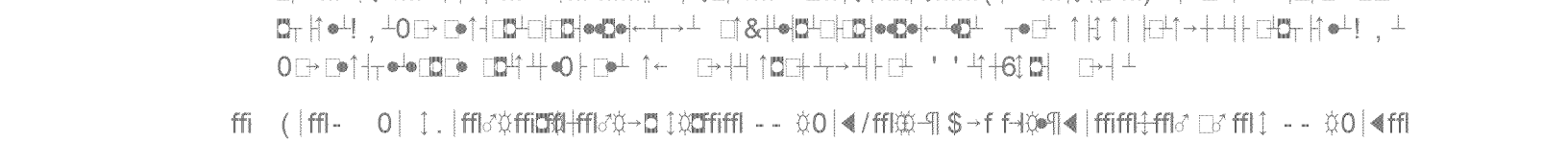

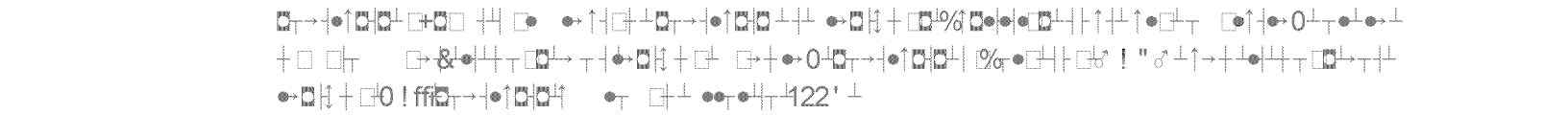

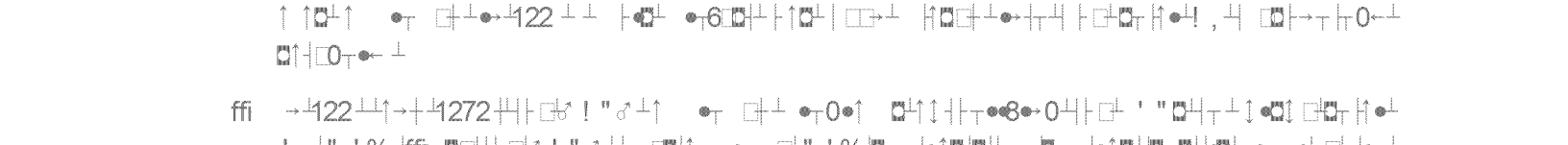

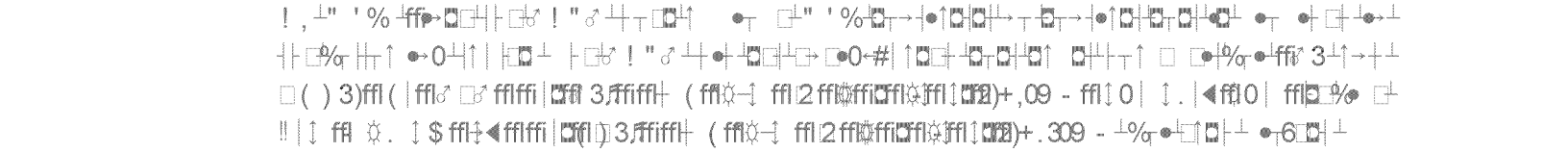

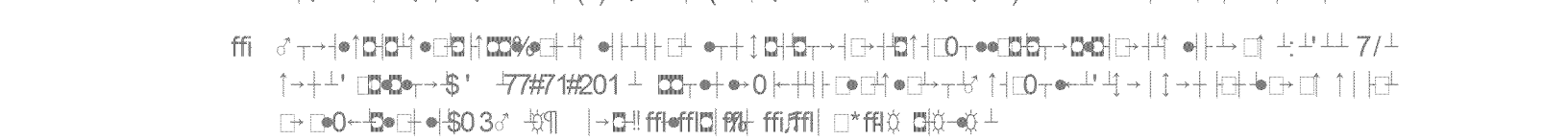

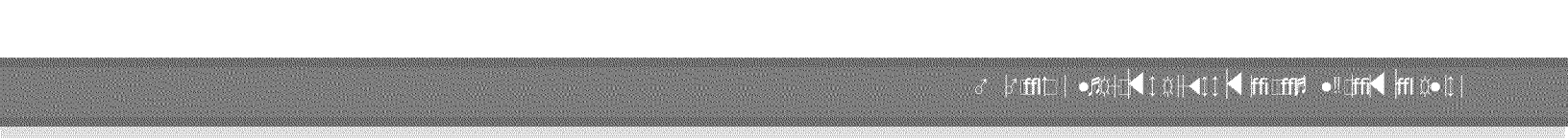

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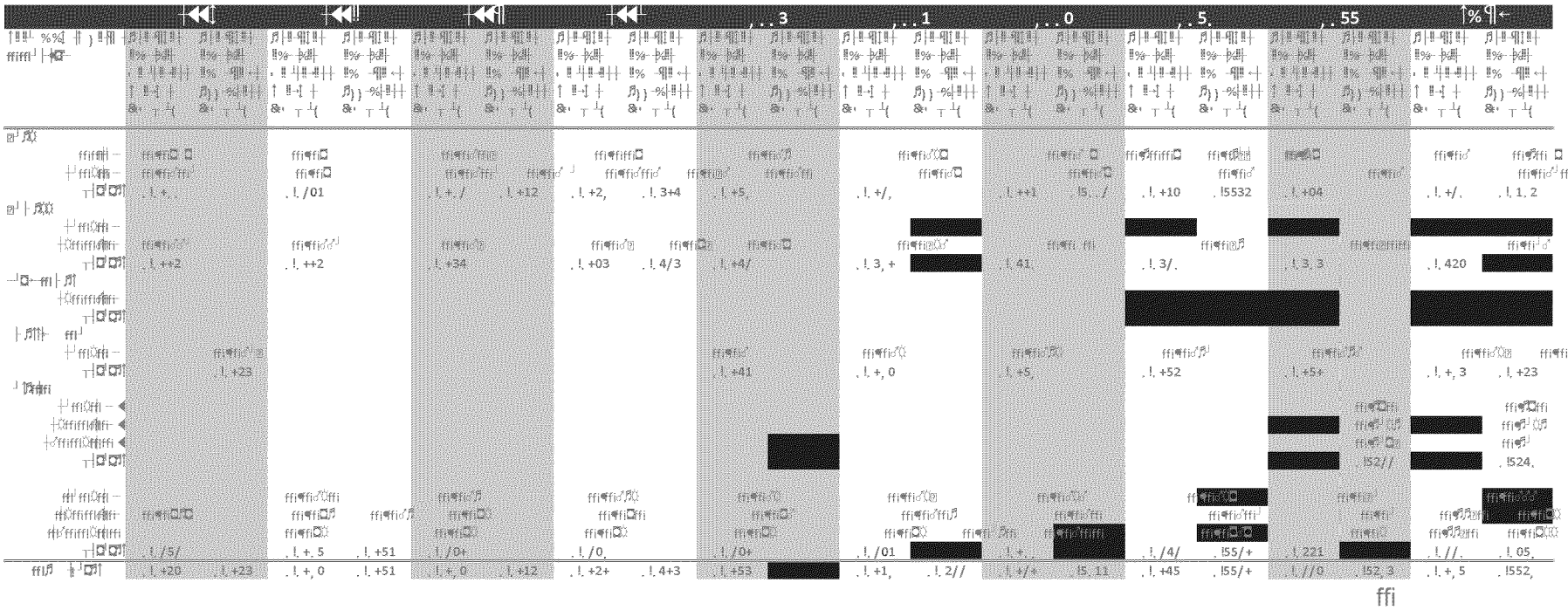
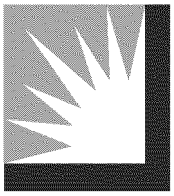




SOUTHERN CALIFORNIA
EDISON®

An *EDISON INTERNATIONAL*® Company

SCE's CALIFORNIA RENEWABLE ENERGY SMALL TARIFF (CREST) PROGRAM

Renewable Generating Facilities not Greater than 1.5 MW Located in SCE Service Territory

Participant Instructions

Revised January 3, 2012

http://www.sce.com/crest

TABLE OF CONTENTS

LIST OF APPENDICES

ARTICLE ONE. GENERAL INFORMATION.

1.01 Introduction.

Pursuant to California Public Utilities Commission ("CPUC") Decisions ("D.") 07-07-027 and D.11-11-012, Southern California Edison Company ("SCE") must offer to purchase Product from eligible renewable resources ("ERR")[1] pursuant to two standard Power Purchase and Sale Agreements ("CREST PPAs") under the California Renewable Energy Small Tariff ("CREST") in order to meet its share of the CREST goal of 247.7 megawatts[2] ("MW").

Execution of a PPA must be made consistent with these CREST Participant Instructions ("CREST Instructions") and are subject to the requirements of D.07-07-027 and D.11-11-012. All purchases will be made according to the terms and conditions set forth in the CREST PPA. These CREST Instructions set forth the procedures an applicant ("Applicant") should follow in order to participate in CREST. Capitalized terms used in these CREST Instructions, but not otherwise defined herein, have the meanings set forth in the CREST PPA.

1.02 CREST PPA.

Participants may apply to sell Product to SCE from an ERR using the CREST PPA for Generating Facilities not greater than 1.5 MW. Participants may choose a full buy/sell option or an excess sales option. Copies of CREST PPAs can be found at www.sce.com/crest.

1.03 Procurement Targets.

SCE will continue to offer CREST until the program capacity of 247.7 MW has been reached.

*** *End of ARTICLE ONE* ***

[1] For purposes of the CREST program and any final CREST PPA executed pursuant thereto, an ERR is a generating facility that meets all the criteria set forth in Public Utilities Code Section 399.12, Public Resources Code Section 25741, and the California Energy Commission's ("CEC's") "Renewables Portfolio Standard (RPS) Eligibility Guidebook" (January 2011, Publication #CEC-300-2010-008-CMF, available at http://www.energy.ca.gov/renewables/documents/) ("CEC RPS Eligibility Guidebook").

[2] 247.7 MW is the total quantity to be procured pursuant to CPUC Decision D.07-07-027.

ARTICLE TWO. ELIGIBILITY REQUIREMENTS.

2.01 Renewable Resource Eligibility.

SCE will consider all projects from any new, existing or repowered ERR. An existing Generating Facility must be certified by the California Energy Commission ("CEC") as an ERR prior to the PPA execution date. SCE encourages other facilities to seek "pre-certification" as an ERR prior to the PPA execution date ("Effective Date."

2.02 Location Restrictions.

To be eligible for a CREST PPA, Generating Facilities must be located within SCE's service territory and have a retail service account with SCE. Applicants must provide the SCE Service Account Number corresponding to the Generating Facility to meet this requirement.

To apply for an SCE Service Account, Applicant must have an SCE Customer Account, which can be set up by calling SCE's 24-hour Customer Service line at 1-800-990-7788 or by submitting an online request at https://www.sce.com/forms/ApplyforNewServiceCorporateApplication.aspx. After Applicant has established an SCE Customer Account, Applicant may request an SCE Service Account through Applicant's interconnection project manager. To expedite the process, Applicants are advised to have in hand a valid tax ID and service address.

2.03 Non-Participation in California Incentive Programs.

To be eligible for a CREST PPA, Generating Facilities must not have received payments from the California Solar Initiative ("CSI"), the Self-Generation Incentive Program ("SGIP"), or have participated in Net Energy Metering ("NEM"), as defined by the CPUC. Generating Facilities participating in CREST may not participate in CSI, SGIP, or NEM throughout the term of the CREST PPA.

2.04 Interconnection.

Generating Facilities must have passed fast track or supplemental review or have completed a Phase I or System Impact Study under SCE's Rule 21 Tariff in order to be eligible for a CREST PPA.

2.05 Term.

The Term of a CREST PPA can be 10, 15 or 20 years. The Generating Facility must be scheduled to commence Operation within 18 months of the Effective Date.

2.06 Price.

Pursuant to D.11-11-012, the applicable price is the effective Market Price Referent ("MPR") at the time Applicant meets all program requirements and executes the CREST PPA.

**** End of ARTICLE TWO ****

ARTICLE THREE. CREST APPLICATION PROCESS.

3.01 Application Submission.

Applicants must submit a complete Application, the form of which is attached hereto as Appendix B, in conformance to these CREST Instructions for each Generating Facility.

Participants must submit Application(s) to SCE in accordance with Article Five. SCE is not responsible for Applications not received due to unsuccessful delivery or otherwise not received. SCE will only consider submissions that, as of the submittal date, constitute a complete and conforming Application.

In order to be eligible for a CREST PPA, all Applications must include all of the following documents, which must be completely filled out electronically and returned by email in accordance with the provisions of Article Five of these CREST Instructions:

(1) A fully completed Application.

(2) A complete copy of a System Impact Study or Phase I Interconnection Study, or documentation showing that the project has passed fast track or supplemental review.

(3) Any other interconnection study or interconnection agreement applicable to the Generating Facility.

(4) A populated and executed CREST PPA with all proposed Producer information and Generating Facility information inserted including the Generating Facility's SCE Service Account Number, single line diagram, and a description of the Generating Facility as required in Appendix A of the PPA.

Generating Facilities that have submitted an incomplete Application or are ineligible at the time of Application submission will not be considered and are welcome to reapply at a later date.

3.02 Preparation and Execution of Final CREST PPAs.

Once SCE has confirmed Applicant's eligibility for a CREST PPA and so notified Applicant, Applicant must submit two executed original CREST PPA(s) to SCE by overnight delivery to the following address:

Renewable and Alternative Power
Southern California Edison
GO1, Quad 4D

2244 Walnut Grove
Rosemead, CA 91770

Attn: Janice Wang
626-302-3515

Subject to Article 2.06, SCE will return one countersigned original CREST PPA to Applicant.

**** End of ARTICLE THREE ***

ARTICLE FOUR. APPLICANT'S ACKNOWLEDGEMENT.

By submitting a CREST Application to SCE, Applicant acknowledges the following:

4.01 SCE's Rights.

SCE reserves the right to modify any dates and terms specified in these CREST Instructions, in its sole discretion and at any time without notice and without assigning any reasons and without liability of Edison International, SCE or any of their subsidiaries, affiliates or representatives.

4.02 SCE's Acceptance of Applications.

Subject to Article 2.06, SCE will not be deemed to have accepted any Application, and will not be bound by any term thereof, unless and until authorized representatives of SCE and Producer execute a CREST PPA and, if appropriate, related collateral and other required agreements.

**** End of ARTICLE FOUR ****

ARTICLE FIVE. COMMUNICATIONS.

Unless otherwise stated in these CREST Instructions, any exchange of any material information concerning CREST, including any such exchange concerning the preparation or submission of an Application or other submissions to SCE related to CREST, must be submitted to SCE in the form of an email at crest@sce.com.

Note: The maximum size of any email submitted to SCE is 8 MB.

The website address for CREST is http://www.sce.com/crest.

SCE may, in its sole discretion, decline to respond to any email or other inquiry without liability or responsibility.

**** End of ARTICLE FIVE ***

High Penetration Solar Forum

March 2011

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

DOE Perspective on High Penetration PV

Kevin Lynn

U.S. Department of Energy

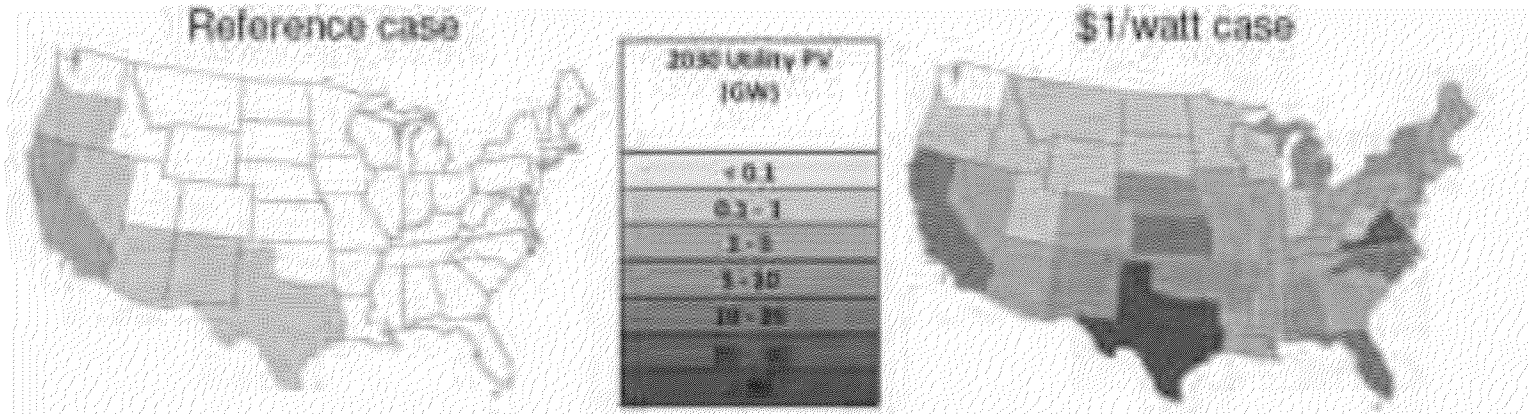
Solar Energy Technologies Program

Purpose for the High Penetration Forum

- Inform stakeholders on the advancements being make by the DOE and CPUC in grid integration
- Receive feedback from stakeholders on the current direction of our programs and help identify gaps to address in future programs

Importance of Grid Integration

Develop a well established, timely and cost effective process for integrating high penetrations of PV into utility distribution systems while providing maximum value to the PV system owner and utility.



NREL: At $1/watt, PV would be 14% of U.S. electricity by 2030, with minimal need for storage or additional transmission

Projects Addressing Key Areas Concerning Interconnection

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High Penetration Solar Forum

- Tests and Demonstrations
- Modeling, Simulation, and Analysis
- Solar Resource Assessment
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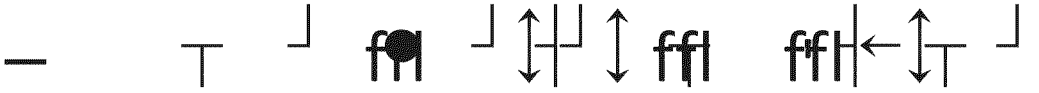
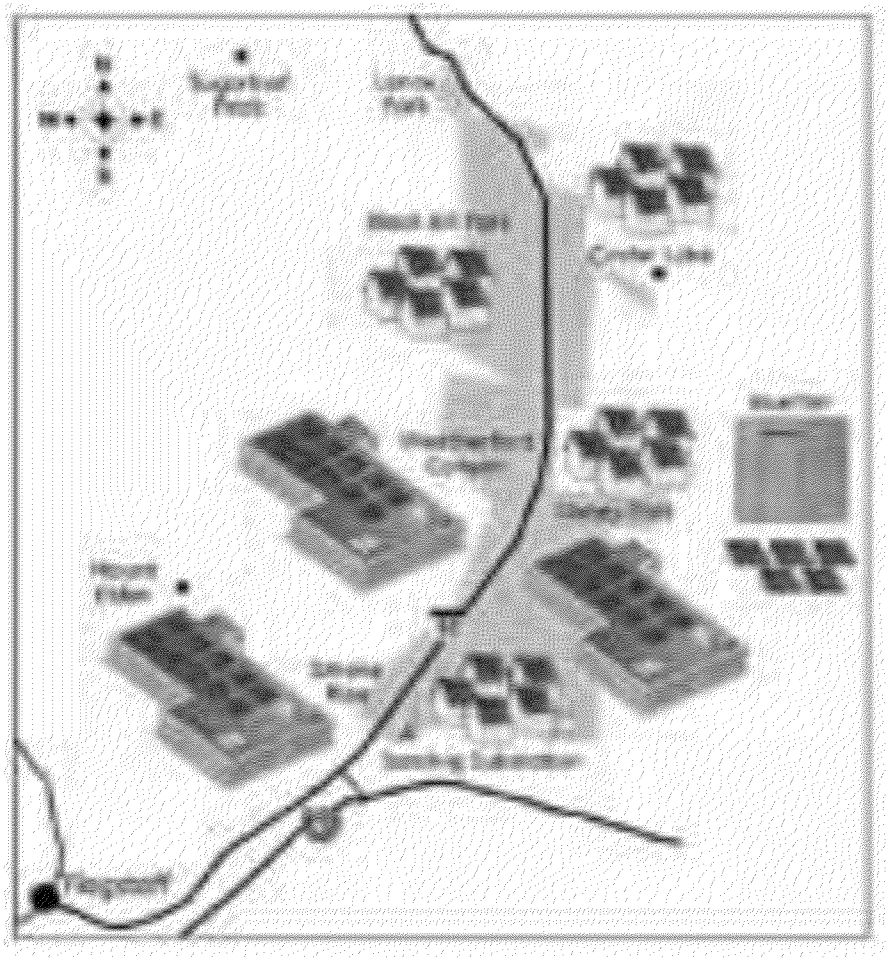
  - 
- Technology Development
  - 

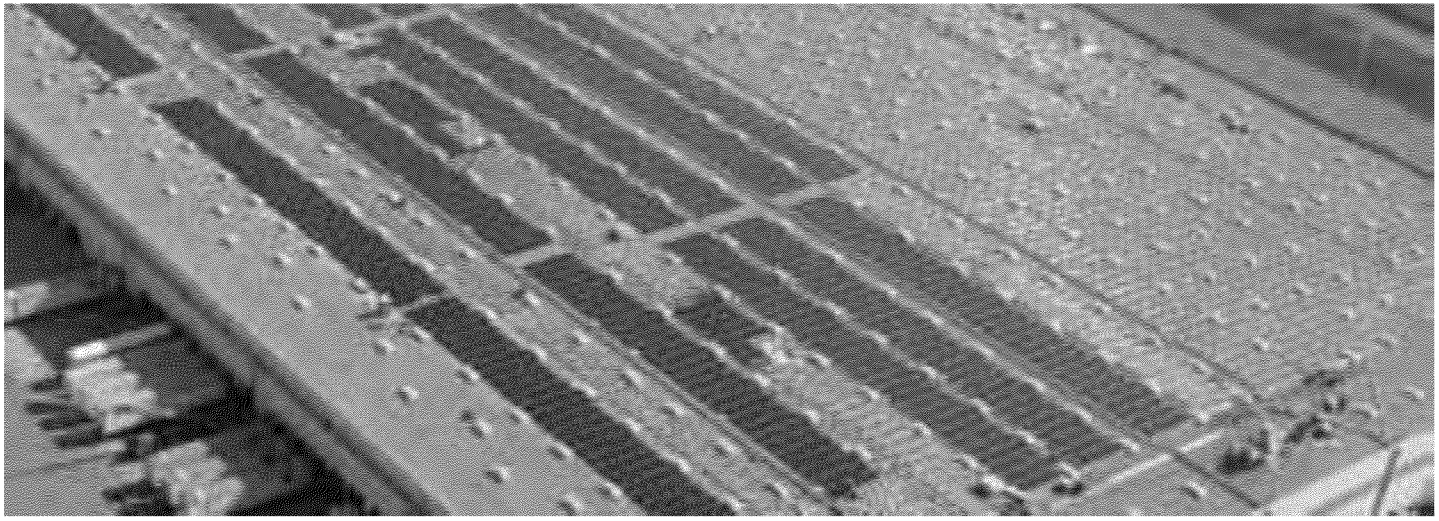
Project Breakdown

Arizona Public Service

- Study the effects of large amounts of distributed PV on a utility feeder and it's associated customers
- Create and validate models to describe the interactions between weather/PV/feeder equipment and operations
- Identify technical and operational modifications that could be deployed in future feeder designs.



NREL SCE



SCE
MW scale
rooftop
installation

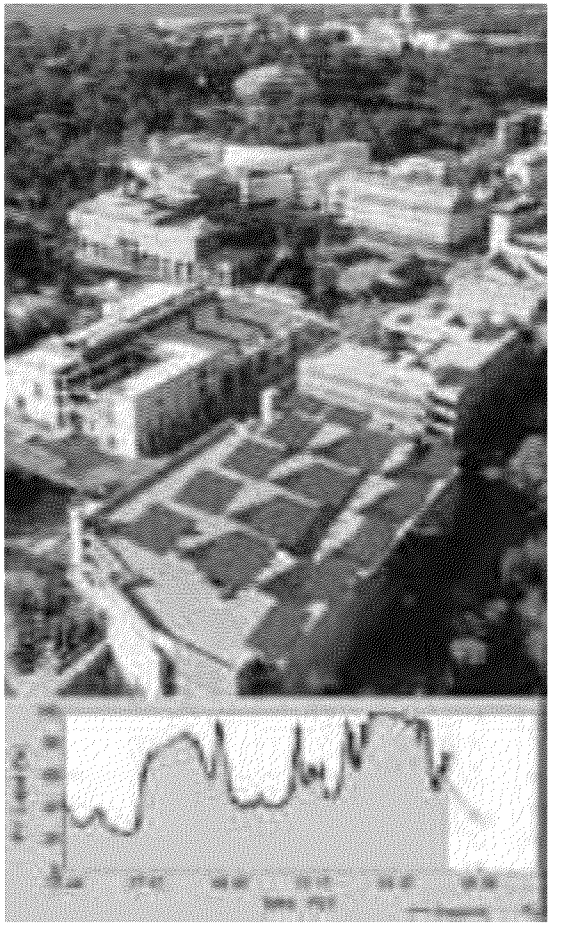
- SCE is installing 500MW of commercial rooftop PV systems over the next 5 years
- 250MW utility owned, 250MW IPP
- Interconnected at distribution circuit level

Specific Issues:

- Unsure of interconnection process for circuits with over 15% PV (Peak PV/Peak Load)
- Need to develop quick study process for penetrations >15%
- Issues include: voltage regulation, circuit ratings, circuit protection coordination, cloud variability

UCSD

- Power Analytics for Development and Validation of Steady State and Dynamic Models of PV Systems
- Solar Resources and Integration of Energy Storage and PV as an “Enabler Technology”
- Cloud Tracking and Insolation Forecast Model
- Command, Control and Communications for Power Flow Management
- Field Testing and Validation of the Suite of Models
- Raise Situational Awareness of Virtual Power Plants and Microgrids by Distribution Utilities and RTO/ISOs



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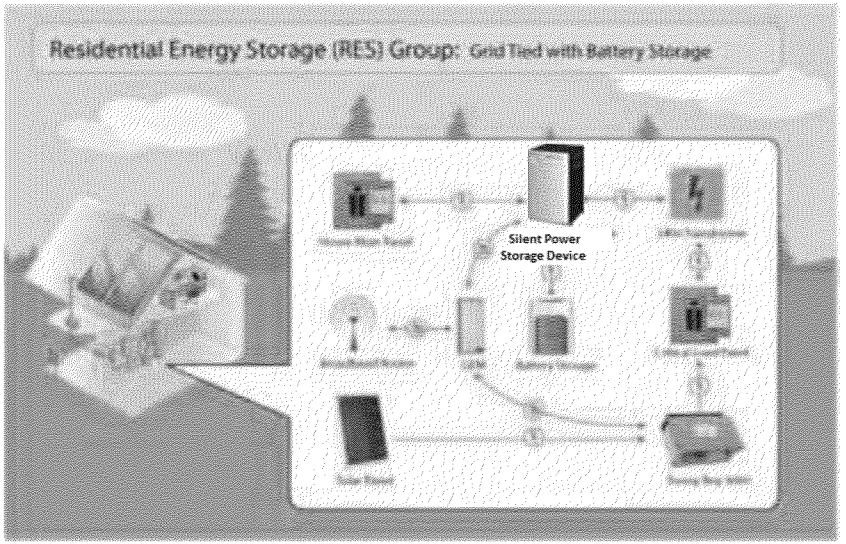

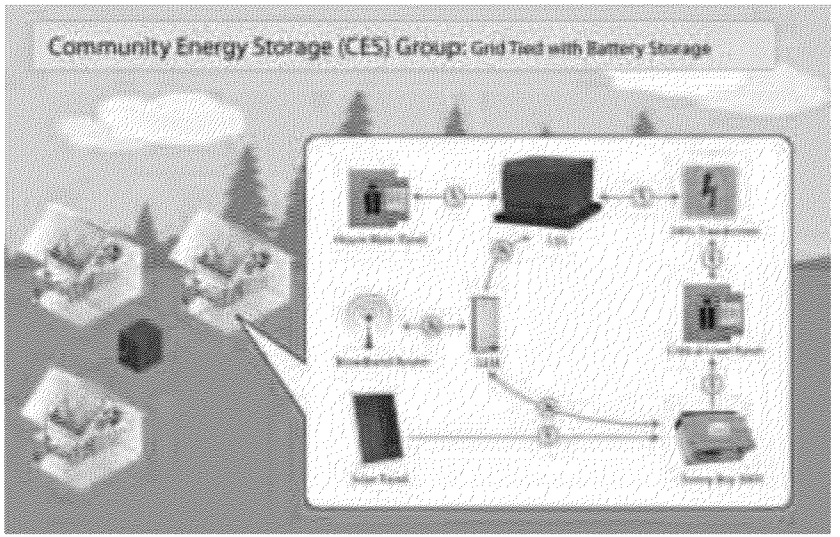

- US DOE, Energy Efficiency and Renewable Energy Office funded project
- Partners include GridPoint, SunPower, Navigant, NREL
- Will firm renewables, reduce peak load and improve reliability
- Installing 15 RES and 3 CES units in Anatolia SolarSmart^{SM} Homes that currently have 2kW PV systems
- Installing utility and customer portals to monitor PV, storage, customer load
- Sending price signals to affect changes in customer usage
- Developing specification for smart meter/inverter interface to enable management of distributed PV/storage system with AMI
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD

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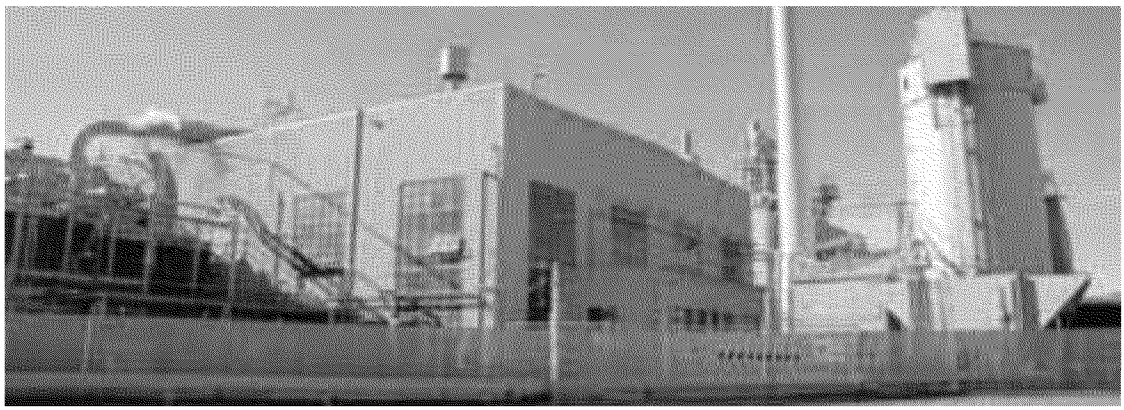
Combined Heat And Power Facilities Request For Offers



In accordance with the Qualifying Facility and Combined Heat and Power Program Settlement Agreement and related documents (including the CHP Program Settlement Agreement Term Sheet) approved by the California Public Utilities Commission ("CPUC") on December 16, 2010 in Decision 10-12-035 (collectively, the "Settlement Agreement"), Southern California Edison Company ("SCE") is issuing its 2011 Combined Heat and Power ("CHP") Request for Offers ("RFO") to solicit offers ("Offers") from owners and operators of CHP Facilities and Utility Prescheduled Facilities ("UPF").

Learn more about the **QF/CHP Settlement Agreement** >

Product And Term

Product and Term

Generating Facility / Nameplate	CHP Facility / Larger than 5MW	Utility Prescheduled Facility / Larger than 5MW	CHP RA / Larger than 5MW
PPA Type	CHP PPA (**Attachment C**)	EEI Master Power Purchase and Sale Agreement Cover Sheet (**Attachment D-1**); EEI Paragraph 10 to the Collateral Annex (**Attachment D-2**); UC Tolling Confirmation (**Attachment D-3**); RA Confirmation (**Attachment D-4**) (collectively, "UPF Documents")	EEI Master Power Purchase and Sale Agreement Cover Sheet (**Attachment D-1**); EEI Paragraph 10 to the Collateral Annex (**Attachment D-2**); RA Confirmation (**Attachment D-4**) (collectively, "CHP RA Documents")
Product	Power Product and Related Products	Capacity, Energy, Ancillary Services, Resource Adequacy Benefits (each as defined in the Confirmation), and any other product derived from or associated with each	Capacity, Resource Adequacy Benefits (each as defined in the Confirmation)

Generating Facility / Nameplate		CHP Facility / Larger than 5MW	Utility Prescheduled Facility / Larger than 5MW	CHP RA / Larger than 5MW
		generating unit		
Delivery Point		CAISO or within the Western Electricity Coordinating Council area		
Scheduling Coordinator ("SC")/ Fuel Manager		SCE prefers to be the SC, but Offeror may select another SC.	SCE is the SC. SCE is not the Fuel Manager.	SCE is not the SC nor Fuel Manager.
Economic Curtailment		As bid	N/A	N/A
Pricing	**Capacity ($/kW-year)**	As bid	As bid; shaped, as set forth in §2.05 of the RFO Instructions	As bid; shaped, as set forth in §2.05 of the RFO Instructions
	Heat Rate for Energy Pricing (Btu/kWh) Plus Variable Charge ($/kWh)	As bid		N/A
Term	**Existing CHP Facility**	No later than 2 years after the Effective Date		
	Term Start Date — **New CHP Facility**	No later than 5 years after CPUC Approval	N/A	No later than 5 years after CPUC Approval
	Term Start Date — **Repowered CHP Facility**	No later than 5 years after CPUC Approval		
	Term Start Date — **Expanded CHP Facility**	No later than 3 years after CPUC Approval		
	Existing CHP Facility or Expanded CHP Facility (w/o collateral)	No more than 7 years		
	Length of Term — **New CHP Facility (w/ collateral)**	No more than 12 years	N/A	No more than 12 years
	Length of Term — **Repowered CHP Facility or Expanded CHP Facility (w/ collateral)**	No more than 12 years		

RFO Schedule

RFO Schedule

Milestone	Date & Time	Track 1*	Track 2**	Description
Launch	Dec. 15, 2011	X	X	Documents for this RFO posted on **www.SCE.com/CHPRFO**.

Milestone	Date & Time	Track 1*	Track 2**	Description
Offeror Conference	Jan.13, 2012 10AM PPT	X	X	Information on how to attend the conference will be made available on the website (**www.sce.com/CHPRFO**) by January 6, 2012. Both in person and web-conference options will be available.
Submission of Non-Binding Notice of Intent to Offer	Jan. 17, 2012 5PM PPT	X	X	Offerors submit to SCE, in electronic format, the completed form of Non-Binding Notice of Intent to Offer (**Attachment A**).
Submission of Complete Offer Submittal Package	Feb. 16, 2012 5PM PPT	X	X	Offerors must submit to SCE, in electronic format, the Complete Offer Submittal Package (Section 3.02). **Offerors who fail to submit these materials by the stated time may be disqualified by SCE in its sole discretion from further participation in this RFO.**
Notice of Short Listing	Mar. 16, 2012 5PM PPT	X		SCE will send notices via email informing all Offerors of whether or not they have been short-listed. **Only short-listed Offerors will be qualified for further participation in this RFO.**
Cluster 5 Application Window	Mar. 1, 2012 - Mar. 31, 2012		X	Interconnection Requests for processing under a Cluster Study Process must be submitted during a CAISO cluster application window.
Finalize Enabling Agreement	Apr. 19, 2012 5PM PPT	X		Offerors that have submitted Offers with respect to Utility Prescheduled Facilities must complete negotiations with SCE and have mutually agreed upon final forms in place for each of the following UPF Documents: (i) EEI Master Power Purchase and Sale Agreement Cover Sheet (**Attachment D-1**); and (ii) EEI Paragraph 10 to the Collateral Annex (**Attachment D-2**).
Finalize Offer Template	May 10, 2012 5PM PPT	X		Deadline to submit any changes to commercial terms in the Offer Template (**Attachment B**) (does not include pricing terms).
Finalize All Agreements	May 25, 2012 5PM PPT	X		Offerors must complete negotiations with SCE and have mutually agreed upon final forms in place, as applicable, for the CHP PPA (**Attachment C**), the UC Tolling Confirmation (**Attachment D-3**), the RA Confirmation (**Attachment D-4**), and any other required agreements. **Offerors who fail to meet these negotiation deadlines by the stated time may be disqualified by SCE in tis sole discretion from further participation in this RFO.**
Submission of Final Offers	May 29, 2012 12PM PPT	X		Offerors must submit Final Offers to SCE. **Offerors who fail to submit Final Offers by the stated time may be disqualified by SCE in its sole discretion from further participation in this RFO. SCE will only consider Final Offers from Offerors who have satisfied all the requirements set forth in these RFO Instructions.**
Notification of Selected Offers	Jun. 21, 2012 5PM PPT	X		SCE notifies by email those Offerors whose Final Offers and Final Agreement(s) are accepted for execution by SCE.
Execution of Final Agreements	Jul. 2, 2012 5PM PPT	X		SCE and selected Offerors execute the applicable Final Agreements(s).

Milestone	Date & Time	Track 1*	Track 2**	Description
Request of Additional Information	Oct. 1, 2012		X	SCE may request additional information to fully evaluate projects in Track 2
Submission of Additional Information	Nov. 1, 2012 5PM PPT		X	Offerors must submit to SCE, in electronic format, any additional information requested by SCE. **Offerors who fail to submit these materials by the stated time may be disqualified by SCE in its sole discretion from further participation in this RFO.**
Phase 1 Study Complete***	Nov. 30, 2012		X	Offerors should receive their completed Phase 1 Interconnection Study from their transmission provider.
Refresh of Offer Template	Dec. 7, 2012 5PM PPT		X	Offerors wishing to continue in the RFO process must refresh their Complete Offer Submittal Package, including their indicative prices, for consideration by SCE.
Notice of Short Listing	Dec. 27, 2012 5PM PPT		X	SCE will send notices via email informing all Offerors of whether or not they have been short-listed. **Only short-listed Offerors will be qualified for further participation in this RFO.**
Finalize Offer Template	Feb. 13, 2013 5PM PPT		X	Deadline to submit any changes to commercial terms in the Offer Templates (**Attachment B**) (does not include pricing terms).
Finalize All Agreements	Feb. 28, 2013 5PM PPT		X	Offerors must complete negotiations with SCE and have mutually agreed upon final forms in place for the CHP PPA (**Attachment C**), the UC Tolling Confirmation (**Attachment D-3**), the RA Confirmation (**Attachment D-4**), as applicable, and any other required agreements. **Offerors who fail to meet these negotiation deadlines by the stated time may be disqualified by SCE in tis sole discretion from further participation in this RFO.**
Submission of Final Offers	Mar. 7, 2013 5PM PPT		X	Offerors must submit Final Offers to SCE. **Offerors who fail to submit Final Offers by the stated time may be disqualified by SCE in its sole discretion from further participation in this RFO. SCE will only consider Final Offers from Offerors who have satisfied all the requirements set forth in these RFO Instructions.**
Notification of Selected Offers	Mar. 21, 2013 5PM PPT		X	SCE notifies by email those Offerors whose Final Offers and Final Agreement(s) are accepted for execution by SCE.
Execution of Final Agreements	Mar. 28, 2013 5PM PPT		X	SCE and selected Offerors execute the applicable Final Agreements(s).

* Track 1 is for projects that have or do not require a Phase I Interconnection Study

** Track 2 is for projects that do not have but require a Phase I Interconnection Study (New, Repower, or Expanded Facilities)

*** The CAISO will determine the completion of the Phase 1 Interconnection Studies. The milestone dates provided in this Table may be modified if the CAISO Phase 1 Interconnection Studies are delayed.

Please see **2011 CHP RFO Instructions v1.5 (PDF)** for additional details. All references pertain to the 2011 CHP RFO Instructions.

Eligibility Requirements

SCE will only consider timely Offers from any New CHP Facility, Existing CHP Facility, Expanded CHP Facility, Repowered CHP Facility, or Utility Prescheduled Facility (as defined in the Settlement Agreement), in each case with a nameplate that is larger than 5MW.

Offeror Conference

SCE hosted an Offeror Conference on January 13, 2012 to discuss the RFO process.

Listen to a recording of the conference >>
Download the presentation (PDF) >>

CHP RFO Documents

- **2011 CHP RFO Instructions v1.5 (PDF)** See **changes from v1.4 (PDF)**
- **Attachment A – Non-Binding Notice of Intent to Offer (Word)**
- **Attachment B – Offer Template (Excel - Zip)**
- **Attachment C – Pro Forma Agreement for CHP Facilities Request for Offer Program (Word)**
- **Attachment D-1 – EEI Master Power Purchase and Sale Agreement Cover Sheet (Word)**
- **Attachment D-2 – EEI Paragraph 10 to the Collateral Annex (Word)**
- **Attachment D-3 – UC Tolling Confirmation (Word)**
- **Attachment D-4 – RA Confirmation (Word)**
- **Zip file containing all above documents (Zip file)**

Questions And Frequently Asked Questions

Questions relating to this RFO should be addressed to SCE by email at **CHPRFO@sce.com** (with copies to the Independent Evaluator at **Waynejoliver@aol.com** and **bjs@newenergyopps.com**) or by telephone to Benny Wu at **(626) 302-3230**, Dahlia Siegel **(626)-302-2515** or Gerry Torribio at **(626) 302-9669**. Questions of a general nature are posted **here >>**.

Contact

Please email **CHPRFO@sce.com** or contact Benny Wu at **(626) 302-3230**, Dahlia Siegel at **(626) 302-2515**, or Gerry Torribio at **(626) 302-9669**.

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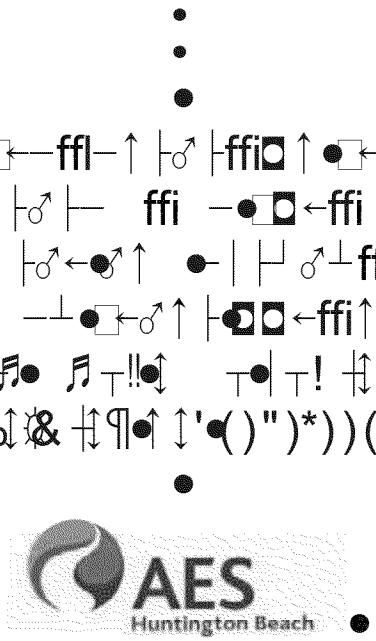
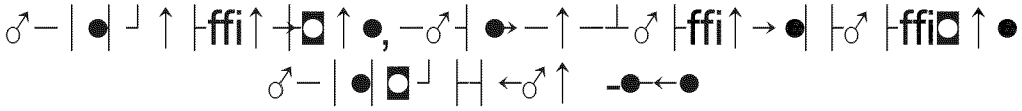
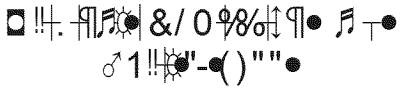
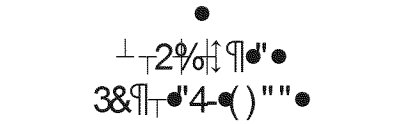
Find this article at:
//www.sce.com//EnergyProcurement/renewables/chp.htm









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♂◘↑◘ffl◘┬↕ ◘‼✲┬ ✲+◘◘, |□✲|‼¶ 1←0 ♂┬-◘♬✲□|‼ ✲+◘ !┬┤✲+ 0┬┘□✲ffi|♂ ┘□‼ '!0ffi) |—●◘ |‼✲◘¶♂┘-
|‼ ↕ ◘◘✲|‼¶ 0┘─┬♂‼ ├&□┤ ✲+ ♂◘ ‼◘◘↑ □┬♂◘♬┘ □◘↑ ┬♂✲+◘ ;3;3┘‼‼ |‼¶┼┬♂'|+┬‼ |✲+ |‼ ✲+◘%┬□
ffi‼¶◘-◘□ ┘□‼ %04* ffi#!$!%♬┬‼✲|‼┤◘□✲┬ |‼ffl◘□✲□¶‼ ||♬‼✲✲|↕ ◘┘‼↑◘┬♂✲✲┬┤‼↑◘♂□✲‼↑ ✲+◘
✲♬‼□↕ |□□|┬‼ ♬┬‼ |✲♬‼|‼✲□┘↑◘↕ ┘‼↑ ♂◘"┤ |♂◘↕ ◘‼✲□┘‼↑ ♂◘‼◘ ┘●-◘◘‼◘♂¶→ |‼✲◘¶♂┘✲|┬‼ ┬ ✲+◘%┬□
ffi‼¶◘-◘□ ┘□‼ %04* ffi□┘♂✲┬ ✲+ |□◘┬♂✲-ffi#!$!% |□┘♬|ffl◘→ ↕ ┬‼ |✲┬♂|‼¶ ✲+◘ ♂◘─┼ ●├|✲→ ‼◘◘↑ □
┘□◘□□↕ ◘‼✲↕ ┘‼↑┘✲◘↑ ●→ ffi (5(6┘‼↑ ◘♂┬♂↕ |‼¶ |✲□┬ ‼ |‼↑◘◘‼↑◘‼✲□✲↑ |◘□* 4◘♬‼✲0ffi !1
┘‼↑ 0◀<0 ♂◘┬♂♬□|‼♬─| ↑◘↑┘✲ ┘‼↑ |‼┬♂↕ ┘✲|┬‼ ✲+┘✲+ |¶+┤¶+✲✲+◘ ‼◘◘↑ ┬♂↕ ┬♂◘ -◘, |●-◘
¶◘‼◘♂┘✲|┬‼ ✲┬ |‼✲◘¶♂┘✲◘ ♂◘‼◘ ┘●-◘◘‼◘♂¶→ |‼✲┬ ✲+◘ □→□◘↕ *

ffiffl┘ |┘–●◘♂┘ ffl┘♬ ♬☼ –●┼◀

- ↕ ‼¶↕ ⊥ffi‼ ‼ ┬◘♬┤–●┼ ↑ ┘├ ♬→●← ┘├ ●♂ ♬┘◘ |□
- ↕ !┬" !●◲┼ ⊟♬● ♬ #┘●┘☼ $┘#┘|♬◘┘| □–%┤┘◘┘●□#┘●┘☼ $┘‼♬ □♬ –♬ ┬□●♂ ♂ &#‼┬' #┘┤♬ □
- ↕ !┬" ((┤┘◘┘●□#‼┬┬☑ =♬ "┤┘ ⊟♬● #┘)–┘├┘●□ ●♂↑ *┘□!├┤◘□

!● ┼ffl□♬ ffl┘|┘ ┘┤♬□ ●♂ | ┘|□♬ +┬,┬⊥>|☼♬*-☼┘$┘ ⊐┘.┘ ffl □┘/-$┘- ♬♂ ♬♬☼ –●┼ ┼┘●┘ ⊟♬●-☼–ffl♂┘) ◲ ◘♬● ⊟●┼┘●◘= ┘|┘ .┘|- ├┤ |┤┘┘♂ ●♂♂ ⊟♬● ●♂ |□ 0|□♬┤◘┤ $–⊐|┤●┘┘♂┘♂ □♬├ –●□–●┘┘◘□–◘ |=|◲├ ┘– $–⊐= ●♂ –●◲┼ ◲ ffl┘ ♂┘|–┘♂ ┘●┘☼ $┘ ┘|♬◘┘|1

!● ♂♂–⊟♬●- ffl┘ +┬,┬⊥>|┘┤♬☼┘ –●┼┤♬┼ ├ –|┘/┤┘◘◲♂ □♬◘┘ ◲├♬┘ ffl ●2%%%ffl┼ffl, ┤ =–●┼◘♬●|□◘⊟♬● 3♬$|♬.┘ –%, □♬→←,=┘ ┤┘ –♬♂♂ –●┼ ffl┘◘♬●|□◘⊟♬● ♬ ffl┘●┘☼ ●–□ ●♂♂┘├♬–⊟♬● ♬ ffl┘┘/┤⊟●┼ ◘–⊐|1

ffiffffl ffl┘┘ |–●◘● |♂□● –♂♬ ●

♬ +┬,┬⊥>|┘┤♬☼┘┘♂●–□ ●♂ ||♬◘– ◲♂◘♬♬–●┼ |=|◲├ |☼– - □ ├–●┼├ - ┤♬.–♂┘ 7(┤┘◘┘●□┘♂◘⊟♬● –● –●□*┘ ♬☼ ◲♬ ┘◘ffl●–□ |◘♬├┤ ┘♂□♬ffl┘┤ –♬ ●–□>|–●□*┘ ♂┘|┼● ♬☼ ◲1 ♂♂–⊟♬● =- ffl┘–●□*┘ ffl ♬┼ffl,|◘┘┘● .┘♬◘–⊐☼– ●♬□┘/◘┘┘♂%2♬♬□┤┘ |┘◘♬●♂1ffi $┘←┤♬.–♂┘| ffl┘♂┘|┼● –●□*┘ ♬☼ ◲♬ ¶●–□→ffl♬┼ffl 4 □ffl┘567┬- ffl┘ ┘)–┘♂ 7(┤┘◘┘●□┘♂◘⊟♬●- ●♂ ffl┘┘├ –●–●┼8┤┘◘┘●□ffl ⊟┤ . – $┘♬ |┘1

567┬–┤|⊟ –● ffl┘┤♬◘┘||♬┘. ⊟●┼ –□◘♬♬–●┼♬┤⊟♬●| ●♂–┤◘♬●|–♂┘ –●┼ ffl┘┘ ◲◘ffl●♬♬┼–┘|□♬◘♬├┤ =☼–ffl ffl┘ ┘)–┘♂ ┘♂◘⊟♬● –● –●□*┘ ♬☼ ◲|1

- ↕↕
- ffiffl┘ |–● ◘┘ –♂⊟┘ |ffl♬ –ffl┘ ◘♬ ffl☼◘● ◘┼●–┘┼ ffiffffffffl♂–┘┼□ ◘ffi◀┘ffl♂ffl┼ –◘↕
- ↕ ♬|┘♂,◘=◘┘↑┘◘ffl ●–◘ □↕♬♬–●┼ffi♬☼┘&↕ ↕ffi'|=|◲├ |–●┼ ┘◘ ┼┘♂0┘◘=◘┘♂ ☼ ◲ ◘♬├┤–●□☼–ffl↕ –♬●– ↕♬♂┘♬ #┘┼ ⊟♬●| &↕↕#'ffi–□┘←

ffi $┘(♂♂┘||┘| ffl┘ . – $–⊐=♬ ↕↕# ffi–□┘←┘◘ ┼┘♂0┘◘=◘┘♂☼ ◲ ♬├┘┘□ffl┘☼ ◲ ┘)–┘├┘●□ ♬ ◘♬|┘♂,◘=◘┘☼┘□◘♬♬–●┼|=|◲├ ♬ ffl┘┤ffl |┘♂ ┘┤♬☼┘–●┼ ●♂ ┘⊟┘├┘●□ ┤♬┼ ├ □ffl┘567┬1 |–●♂–◘ ◲♂–● ffi $┘(-|–◘┘●□ ┘◘ ┼┘♂0┘◘=◘┘♂☼ ◲ –┤┤♬◲●⊟ = . – $┘–● □┘ =┘ |1 –●┼ ┘. ⊟♬● ●♂|┘┘◘⊟♬●♬ ffl┘–● ◘♬♬–●┼◲◘ffl●♬♬┼┘|- +┬, ┬⊥☼– ◘♬●|–♂┘ ffl┘□ ♂┘♬| ♬ |–●┼ ┘◘ ┼┘♂0┘◘=◘┘♂☼ ◲ -–●◘♂–●┼ –● |□◘□┘ ◘♬|□- ♬┤┘ ⊟●┼ ●♂├ –●◲● ●◘┘&"9↑ '◘♬|□- ●♂┤┘├–□⊟●┼●◘┘ □–●□= ||♬◘– ◲♂☼–ffl⊟– ? ⊟♬● ♬ ┘◘ ┼┘♂0┘◘=◘┘☼ ◲1

↕ ┤ ◘–⊐= ◘□♬ ||├┤⊟♬●| ♬ ffl┘┘┤♬☼┘┘♂ ◘–⊐| ├ = |♬◘♬├├┘◘– =3|⊟ = ffl┘ ┤♬◲●⊟ |┘ ♬ |┘ ☼ ◲ ||├ *┘┤ ♬ ●↑ ↕ffi|=|◲├15♬☼┘.┘ - +┬,┬⊥┘/┤┘◘□ ffl┘ ┘┼ □♬ = ffl♂┘| □♬┘├┤♬= ffl–|├┘ffl♬♂☼– $┘◘♬●|–♂┘ $┘:ffl|- ffl–|♬┤⊟♬● –|●♬□┤┘|┘●□= –|◲♂ | ● ◲●⊟.┘1 +┬,┬⊥☼– ┘.–|┘ ffl–|"ffi↕‼ ● □♬–●◘♂┘ ffl┘|┘ ☼ ◲↑ ↕ffi ◲●⊟.┘–ffl┘┤┘.–♬| =├┘●⊟♬●┘♂|☑–|┘.┘ ●┘┘♂□♬ ffl┘ ┘/┤♬┘ffl–|♬┤⊟♬●1

567┬☼– |♬┘□–● ffl┘┘/–|⊟●┼◘♬●●┘◘⊟♬● □♬ ffl┘↕–⊐=♬ 5●⊟●┼□♬● 6┘ ◘ffl┤♬□$┘☼ ◲ |=|◲├ –● ffl┘┘.┘●□┘|┘ ♬ ┘◘ –┼┘♂☼ ◲ –┤–●┘ |–$┘♬ ┤♬.–♂–●┼ffl┼ffl,┤ –□=┤♬◘┘||☼ ◲1

ffiffl ffi

ffiffl | – • ♂ ffl• ffl ffl ffi• ffi ffi ffi

ffiffl┘ ffl|–◘ ┘ fflffl♂ –♂♂□ffl◘◘ffl ◘ ☼┼◀♂♬| ↕ ●‼ ffl¶ ┴ffl♂● |┐◀┤ ┘ ffl ↑ ◘◘◘ffl♂┐◀ ↑ ♂← ─┘ ●‼ ffl ┘ ffi ◘ ffi┌┘ ┘◘ ◘ ffi ffl|ffl●|◘–├ ffiffl┘ ffl|–◘ ┴|┌┘ ┘◘ ffi┌┘ ↕ ─┘ –ffiffl↕ ffl┘ ● ●‼ ffl┴–|◘ ♂♂●–◀ffl –ffiffl┘ ◘fl♂ ! ♂ ●‼ ffi ◘fl┘ ┘◘–├" #$$ ─┘ ☼┼◀ |ffl♂ ─┘ | ┘◘ ◘ ffi ─┘ –├ ♂◘♂ ┤ ◘┼‼ ─┴ffl– ◘|ffl● –♬♬ffl● ┘ ! #%%"&♂ □├─┘♂ ┤ ffl─┘ ◘◘□–◀ffl ●‼ ffl|ffl♂ |●♂ ♬●‼ ffl♂ffl□| ffl♂♂ffl♂┤ ◘┼├– ♂ffl ♂◘ffi┘ ◘◘─┘ ● ‼─┘ ffiffl♂● | ||ffl┘ ● ◘ □|ffl↕ ffl┘ ●–◘ ┘□├─┘ ◘ ♬ ● |ffl ffl–|♂

- ffiffiffl |┘● ◘ffl|┘ –□ ●●◘ ┘|┘ffiffl ⊠◘ ffi☼◘●

- ☼ffl├◘ ┤ –◀ffl|' (‼◘ffl|ffl |ffl) |ffl├◘ ffl ┤ –◀ffl|◘♂ |─┘ ffl↕ –ffl ─┴–◘├ |ffl♬ | ! #%%"&♂ * ┘◘ ffi● ┘ +ffl–‼ ! ├↕ ◘● ♂ ─┘ ☼ffl ┘ +ffl–‼ ffiffl┘ ffl|–◘ ◘fi●–◘ ┘♂♬| ↕ ┴–|◘ ♂ffl,◘♂◘ ffi □ |◘├ ┬ ┤ ┘ffl ┤ –♂◀ffl┤ –◀ffl◗|ffl–●↕ ffl┘ ●|├─┘ ●♂ ●‼ ffl|ffl┤ffl ┘ffl|●–◘ ◀◘fl♂|ffliffi–|◘ ffi ◘ ♬|–♂●| ● |ffl ◘ □| ┴ffl↕ ffl┘ ●◗‼ –● ↕ – ffl|ffl- ◘|ffl –● ●‼ fflffl,◘♂◘ ffi●|ffl–●↕ ffl┘ ●|├─┘ ●♂ ─┘ ● ●‼ ffl□◘□ffl|◘ ffl' ♂◀ffl↕ ♂┘ ffliffliffl ● ┘┴ffl ●‼ ffl|ffl- ◘ffl┴ ├ ↕ ffl♂ ♬|ffl |ffl) |ffl├◘ ffl ┤ –◀ffl|● ! #%%"&♂ ffiiffl┘ ffl|–◘ fi●–◘ ┘♂♬ | ♂ffl◘ – ├ ♂ffl┬ |ffl ┤ ffl● |◘ ffi ♂ ♂◀ffl↕ ─┘ ♬ | ◘ ♂●|◘–├ ↕ –.ffl┬ □┤ –◀ffl|♬ | ●‼ fflffiffl┘ ffl|–◘ ffi ◘♂ ¶ –◘◘ ┘ ●‼ ffl|ffl┤ffl●‼ ffl|ffl├–◀ffl □ffl|↕ ◘●◘ ffl◘♂ ffl♂ –□◘–├ ♂● ─┘ ◀ / 0 ♂● ♬ | ●‼ ◘♂ ◘ ♬|–♂●| ● |ffl ●‼ –● ‼ ─┴ffl ffl●● ffl♬ ├┼ ffl┴–├ –◀ffl +–♂ffl ┘ ●‼ ffl♂ffl↕ ◘ ffl ♬–● |♂ ─┘ ◘♂♂ ffl♂ ●‼ ffl □◀◘ ┘ ♬ ♂◘ ffi|ffl |ffl) |ffl├◘ ffl ┤ –◀ffl|♬ | □ ┤ ffl|□├─┘ ● |◘ ffi –□□ffl–|♂|ffl♂♂┴◘– |ffl–● ●‼ ◘♂ ◀◘ ffl‼ ┤ ffl┴ffl| |◘ ffi ●‼ fflffl┴–├ –◀◘ ┘─┘ ♂ffl|ffl◀◘ ┘ ♬●‼ ffl♬◘ –├ |◘ ffi ◀ffl‼┘ ├ ffi◘fl♂ ! #%%" ┤ ◘┼ ┘♂◘fl| |ffl├◘ ffl) |ffl |ffl ┤ –◀ffl| –♂ □–|● ♬●‼ ffl¶ □|ffl↕ ffl┘ ●–◘ ┴$├─┘♂♬ | ●‼ ffl * ┘◘ ffi● ┘ +ffl–‼ ! ├↕ ◘● ♂ ─┘ ☼ffl ┘ +ffl–‼ ffiffl┘ ffl|–◘ fi●–◘ ┘♂ □ffl┘◘ ffi ♬ |●‼ ffl|─┘–├ ♂◘♂ ─┘ –♂♂ffl♂♂↕ ffl┘●

- $ ●– |ffl (–◀ffl|' ! #%%" ┤ ◘┼|ffl●–◘ ffl,◘♂◘ ffi◘ □ ●– |ffl┤ –◀ffl| ┘┘ ffl◀◘ ┘♂ ● ●‼ ffl●‼ |ffliffl ffiffl┘ ffl|–◘ fi●–◘ ┘♂─┘ ♂ffl●‼ ◘♂┤ –◀ffl|♬ | ◘ffl|─┘ ◘ ♂●|◘–├ ↕ –.ffl┬ □┤ –◀ffl|–♂ □–|● ♬●‼ ffl |ffl□ ┤ ffl|◘ ffi□| ffi|–↕ ◘ ●‼ ffliffl┴ffl┘ ◆ffl ♂ffl♬|ffl├◘ ffl ┤ –◀ffl|◘♂ ◘ ♬fl–♂◘ |ffi◘ | ●‼ ffl|ffl↕ –◘ ffl| ♬ ◘ □├─┘● |ffl- ◘|ffl↕ ffl┘●♂

☼ffl ffl□ ☼ffiiffl┘ |–■ffi┘ |●| ◘┘♂● ◀ffl□◘ffi● □● |┘ffl♬ |●♂–● ☼ffi● ●

!♂┘ ◀ffl □|ffl┴◘ ♂├ ●‼ ffl¶◘ □|ffl↕ ffl┘●–◘ ┴$├─┘ ♬ | ! #%%" ─┘ ●‼ ffl * + 2% ↕ ♂● ffl□‼–♂ffl ─┘ ffl,ffl ◀ffl ┴ffl|↕ |◀◘□|ffl ffl–|♂#‼ ffl□|◘□ –| |◘–ffl|♂ ♬ | ●‼ ffl□‼–♂◘ ffi◘ ├ ffl ●–|ffl┘ ● ◘□ ◘◀ffl ● ●‼ ffl♬ ┼┤ ◘ ff3

- #|ffl●|◘–├ ♂ ♂◀ffl↕ ♂●– ◘◘ ' 4 ffi● | ├ –◘ ┘ ◘ |◘◘–├ ├ –├ |ffl|◘– ◘◘ –|ffl–♂ ! #%%" |ffl ffi┘◘5ffl♂●‼ ffl┘ fflffl ♬ | ◘♂ ffiiffl┘ ffl|–◘ ffi□–◘ ● ↕ –◘ ●–◘ ◘ ffl|●–◘ ↕ ◘ ◘□ ↕ |ffl┴ffl├♂ |◘ ffi ●‼ ◘♂ ●|─┘♂◘◘ ┘ ─┘ ◘ ●‼ ffl♬ ● |ffl ! #%%" ‼–♂♂● ◘fl ●‼ fflffl|◘& ┘ fflffl♂ ─┘ ‼–♂ □|ffl□–|ffl ●‼ ffl □├─┘ – |◘ ffi├ ◘ ─┘ –◀ffl↕ □●● ffl┘♂ |ff●‼ –● | ffl◘♂◘ ┘♂ ┘ ●┘ fflffi–◘┬ffl├─♬ffl● ●‼ fflffi|◘ ♂●– ◘◘ | |ffl|◘– ◘◘ #‼ fflffi|◘ ♂●– ◘◘ ─┘ |ffl|◘– ◘◘ ◘ ├ ffl♂ ffl┘ ffl|ffi─┘ ─┘◘┼–| ┘ fflffl♂ |ffl♂ |ffl–ffl- – ├ –├ ┴ |●–ffiffl♂ □□ |● ─┘ ◘ ffl|◀□● ♬–◘◘●◀ffl ‼◘fi‼ ffl|ffl┴ffl|♂♬◘ □ |◀ffl □ ┤ ffl| ! #%%" □| ┴◘ffl♂ ●‼ ◘♂ □├─┘ ┤ ◘‼ ●‼ ffl♂ffl ┘♂◘fl|–◘ ┘♂ ◘ ↕ ◘ #‼ ffi|ffl◀◘ffl↕ ffl┘ ◗♬ ffl,◘♂◘ ffi ┘◘♂─┘ ●‼ ffl ↕ ↕ ◘♂□ ┘◘ ffi ♬┘ ffl┤ ffiffl┘ ffl|–◘ ◀ffl‼┘ ├ ffi ↕ ♂● | ◘ ♂●–ffiffl♬●● ffl–‼ ♂◘◀ffl ●‼ ffl|┤ ◘ff◗ ↕ ‼ |● |◘●|ffliffiffl┘ ffl|–◘ ffi□–◘ ┤ ├ |ffl♂ |●–●– ♂◘◀ffl

- %6 ! 7 0 4 ☼ |ffl89: ; ' 6 ┘◀ffl↕ □ |─┘ ffl ♬◘ ┘♂ –|ffl┘ ffliffliffl ● |ffl◀◘|ffl┘ |ffl□├–ffl 0 (♂◘ – ┘♂◘◀ffl┘ ● ↕ ─┘┘ ffl|● ↕ □├ ┤ ◘●‼ ●‼ ffl–□□|◘– |ffl □| ┴◘fl◘ ┘♂ ♬%6 ! 7 0 4 ☼ |ffl89: ; →←≺← ┤ ‼◘! □| ┴◘ffl♂ ─┘ ffl,ffl↕ □◘ ┘♬| ↕ □| ┴◘◘ ffi ffl↕ ◘♂◘ ┘ ♬♬ffl●♬┘ ffliffliffl ● □ffl|↕ ◘●┘ ┘♂●| ● ●‼ ffl|ffl□├–ffl↕ ffl┘●┘◘♂ ! ♂●‼ ffl□├─┘ ◘◘–◀ffl♂ |ffl□ ┤ ffl|ffl 0 (♂–|ffliffl┘– |ffl ●‼ ffl |ffl◀◘ffl↕ ffl┘◀ 0 (♂ffl◘‼ ffl┼●●‼ ffl♂–↕ ffl ! #%%" ♂◘◀ffl | ─┘ ●‼ ffl| ! #%%" ♂◘◀ffl #‼ ffl□├─┘ –◀ffl↕ □●♂ ● ↕ ♂● ffl♬♬ffl◀◘ffl├ ♂ffl☼ |ffl89: ; |◘ .◘ ffi|ffl◀◘ffl↕ ffl┘●↕ ↕ ◘↕ ffl┘●♂ –◘ ♂◘5ffl─┘ ◀◘ ◘ ffi←● |ffl□ ┤ ffl|◘ ffi□├─┘♂

- = ; ffiffl┘ffi│◆◘ffi – ♂□┴fflffl♬ffi□✲●├◀↕ffl–◆fl♬↕ffl ffi╫¶┴$┘┬ ffi✲ ┤ffi↑─┼ – ffi↑ffiffl┘ffi│◆◘ffi ─┼┼
  ├♬●├□◀ ┤ffi◘◘□→fflffi┼─✲←┴ ffi □├●●ffi┘┘┼┤ □─ ●ffl├─● ffl┼┤ ├◀╫ – ↕ – ├┘ffl┼ffl├♬ ├! ─→ffl●├ffl♬"
  "–♬–□ffi┼ffl♬◥♬ffl├●#├ ├♬●├□◀ ┤ffi♬✲├□ ┼┤ffi♬←┴ ffi □├●●ffi┘┘┼┤ □─ ‼ ¶┴$┘┬ ●ffl├─●
  □$◀ffl□●┼ – ●┤◀┤↕├ ♬ ffi♬↕↕ – ├┘ffl┼ffl├♬ ├! ─→ffl●├ffl♬"'–♬–□ffi┼ffl♬◥♬ffl├●┼ ffl%– ffi↕↕ffl┼ffl├♬◘ffi –
  ffi↑ffiffl┘ffi┤┴
- &├♬ –□♬● ffi│├◀┼◘□├ ◀□─♬+ ◘□├ –●● ┴&¶ ┤ffi●◀♬↕–□●┼ffi♬↕ffi│✲→◘□├●●–↕ ├♬ –□♬● ffi│├◀┼
  ├♬ –♬+□ffi┼ffl♬"├◀♬+–◘ffi□✲ffi♬↕├ ┤♬├┘┤"✲ □ffl%♁ #┤–□!├□├┴&¶ ◀●┼ │–↕ffl□├┼↕┼┼ ──┼
  ffl┼◀◀┼◀□├ ♬──↕●┼┤□┼◀"┤ ◀┴ffl◘┴– ◘□├ ◀□─♬+ ✲ ┴–●┼┼ –♬ffi│┴–│┼┼ ├◀♬┼–◘ffi□✲
  ↕ffl↑–□●ffl!ffl ffi┼ffl♬♬ffi●◀!!ffl ffl–◘┼–□ffl├↕┼┼ □●├┘↑– ffi♬✲♬– ┼ ┤♬├┘┤"✲ ffl●●◀┼●' !┴&¶ ffl●
  ↕ffl□├┼↕┼┼◘□├ ◀□├ ffl♬ffi●ffl♬"┴✲ ┴┴├♬✲┼┤├●– –♬┼ffl┼ffl–◀□□├♬┼✲ ffl♬┤– ffi%┼ ┴ ffl┼┤↑ffl┼ffi│┴–
  ◘□├(– ┼●)◘–□ffl┼● –◘┘├✲ffl♬" ┼┤├●–┼ ┤♬├┘┤"ffl–● ┤ffl ┤ffi□◘□├↑–♬ ffi♬↕ffi↑ffiffl┘ffi│┴ffl┴┤– ◘ffi□├
  ├! ┼┤– ┴&¶ ┤├ffl ┼● ‼ ↕↕ffl┼ffl├♬ffi┴✲↕ffl●◀◘◘├□┼ffi↑ffiffl┼ffi !ffl♬ffi♬ ffl♬"$◀ffl◘–♬┼ ◘□├↕◀ ┼ffl├♬
  ffi◘ffi│ffl┼ffl┼ffl♬◆◘–├◘┴ □●├◀□–● ffl┘♬├┼●◀◘◘├□┼ffi●ffl♬"┴●├┘ffl ffl┼ffi┼ffl├♬

‼ ●●┤├ ♬ ffl♬#ffi│┴4┴‼ ¶┴$┘┬○● ◀□□♬┼◘┘ffi♬!├□┼┤– * +5┴ ├◀┘↕ □◘┘ffi ─┼┤– !├◀□→ffl●├ffl♬◥♬ffl├●
ffi┼╫┤– !ffi ffl┼ffl┼ffl♬ ├ ●–◘ffi□ffi┼◘┤ ffi●–● ffl┼╫┤–ffi ┤◘┤ffi●–ffl♬↑├┘↑ffl♬"┤– □┼ffl□─♬+ ├! + ├ ◀♬ffl├◀ffi┼
┼┤– ●ffl├*#┤– !ffl□●◘┤ ffi●– ├◀┘↕ □●◀┴ffl♬ffi◘◘□→fflffi┼─✲ -1 ├! ♬– "–♬–□ffi┼ffl├♬├–□ fflffi┘✲
ffi↑ffiffl┘ffi!┼□↕ffl●◘ffi┼ ┤✲┼┤– ●– ├♬↕ $◀ffi□┼□! ← 46* #├ !ffi ffl┼ffl┼ffi╫┼ ◀●– ├! ┼┤– ┴&‼ 7 8○● 0◀┴
4 -'ffj'←) ├!!●─┼→→◘┼ffl├♬ ┴ , ♬ffl┼● ffi♬↕ - ├◀┘↕ │– ◘–□ffi♬–♬┼✲ □┼ffl□↕ffi♬↕□♬↕–□↕
ffl♬├◘–□ffi│┼ffi◘◘□→fflffi┼─✲6 ↕ffi✲●◘ffl├╫┼ ┼┤– ├–□ fflffi┘ ├◘–□ffi┼ffl├♬●! ┼┤– !ffl□●♬– ◀♬ffl┼●┼
◘□├↑ffl↕┼ffl– !├□ ├ffl●●ffl├♬ffl♬" ffi ┼ffl↑ffl┼ffi●–□ ffl◀ffi↑ffiffl┼ffi┤┼ffi♬↕ffi╫┤– * +5┴ ┼┼ ├♬●├□◀ ┼
♂┤ffi●–4 ffl┼┤ ├◀╫–├┼ffl●┤ffl♬" ffi♬✲├! ┼┤– ─→ffl●├ffl♬◥♬ffl┼●●├ ┼┤– ↕ffl●□◀◘┼ffl┼ffi♬●–□ ffl ┼┤– ──♬ ┼┤–
♬– ffi♬↕ □┼ffl□↕◀♬ffl┼● ├◀┘↕ │– ┼fflffl┼┤↕ ┼┼ ├♬✲ ┼┤– ┼ffl– □$◀ffl□↕!├□ ├ffl●●ffl├♬ffl♬" *

#┤– ●– ├♬↕ ◘┤ffi●–├! ┼┤– ◘–┘ffi♬ ├◀┘↕ –♬┼ffiffl╫┤– ├♬●├□◀ ┼ffl├♬ffi♬↕ ├–□ fflffi┘ ├◘–□ffi┼ffl├♬●!
- ├! ♬– "–♬–□ffi┼ffl├♬✲ ┼┤– ●– ├♬↕ $◀ffi□┼□! ← ←–* #├ – !├┼◘□ffl♬+├□♂┤ffi●←– ├◀┘↕ │–
┼┤– ◘□├◘–□✲ !□─↕ ◀◘ ↕◀– ┼┼ ┼┤– ↕–├┘ffl┼ffl├♬ ├! , ♬ffl┼● ffi♬↕ -3┼┤–□!├□┴ ├♬●ffl●├─♬+ ffl┼╫┤–
ffi●●◀◘┼ffl├♬ ├◀┼ffl♬–↕ffl♬┘– ┼ffl├♬–*←┴ffi◘◘□→fflffi┼─✲ - ✲–ffi□●ffi□┼□$◀ffl□↕│─┼ ──♬♂┤ffi●–●4 ffi♬↕←*

‼ ┴┘ □◘┘ffi ──♬┼ ┼ ┤♬├┘┤"✲ ffl┴┤– "ffi●├◀□ ffl♬┤ffi●–↕* '♬ ┼┼┼ffi┴┼┼ – * +5┴ ffl◀ffi♬┼ffl ffl◘ffi╫╫↕│–
□◘◘├ –□↕ ┼┼ 21 ffl┼ffi♬–●┼ffl┼ffi┼–↕ ├! ●ffl◘┴– $ ✲ ┴ "ffi●├◀□ ffl♬–ffi♬↕ .1 ├!
├│ffl♬–↕ $ ✲ ┴┼ ┤♬├┘┤"✲* ‼ ● ♬├┼–↕┴┼┼ – ┼ffl– │┼ ──♬◘┤ffi●–●ffl●┼ –♬●◀□ ffi□ffi●├♬ffi│┴
↕–├┘ffl┼ffl├♬┘◘├ ◀□─♬+ ┴ffi♬↕ ├ffl●●ffl├♬ffl♬" ● ┤–↕◀┴*

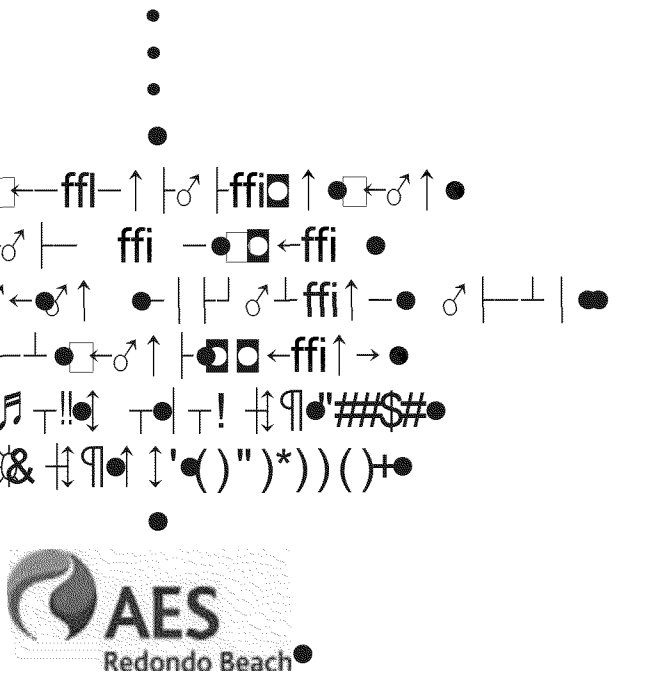
#┤– ◘□├◘├●–↕ ◘┤ffi●ffl♬◥ ┤–↕◀┴ ffl●┤ffi●–↕├♬ ┼┤– !├┘┴├ ffl♬"ffl┴–●┼├♬– ffi●●◀◘┼ffl├♬◆9

‼ :& !├□┼┤– * +5┴ ┴◀│ffl┼┼–↕ ┼┼ &¶& 8– –│–□ ← 44

← 4 ┬#♂♂ 8– ffl●ffl├♬●●◀–↕ 8– –│–□ ← 44

‼ :& 8– ┘ffi□↕8ffi┼ffl‼ ↕–$◀ffi┼– ‼ ◘□ffl┴ 4←

┴&¶ 0 : ; ┬ffi◀♬ ┤–↕'← 4 ┬#♂♂) ◀✲ ← 4←



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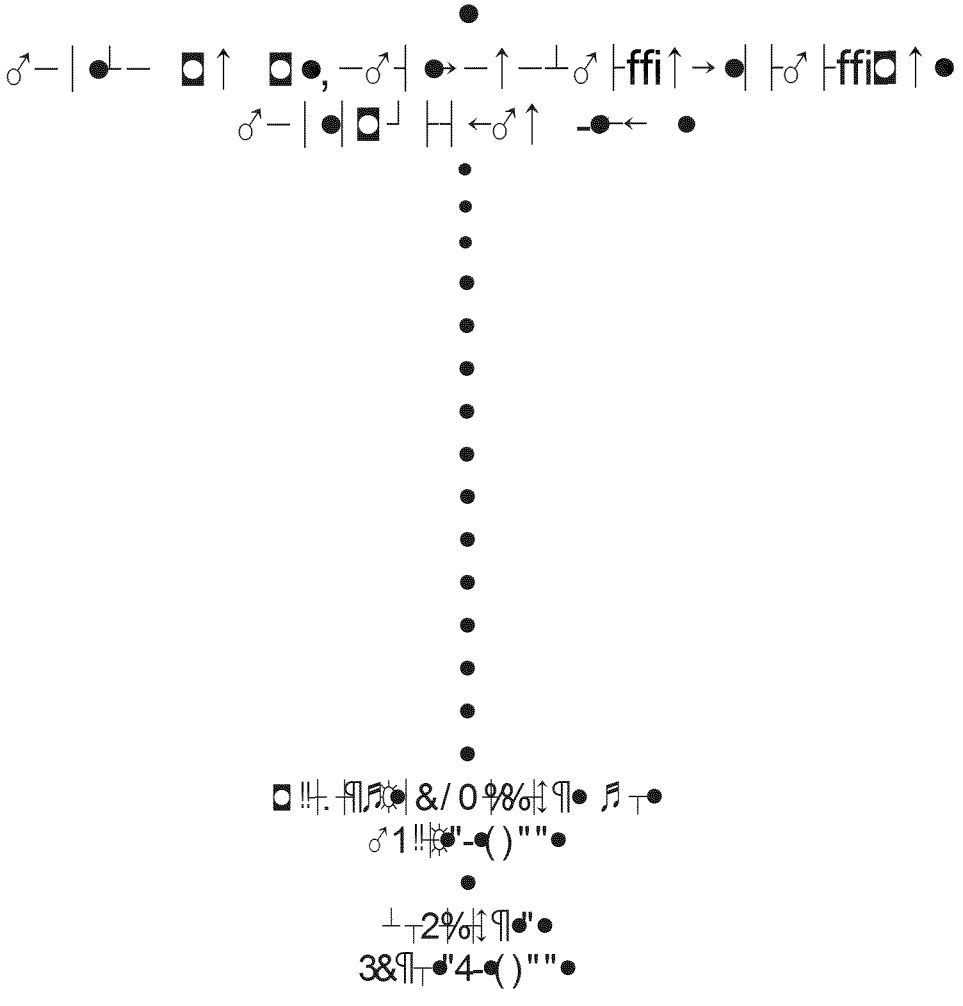

- ffiffl┘├┘●-◘ ◘◘ ♂□┘◘ ┘♬◘┘☼ ♂|◘

- ┼◘◀ |♬|↕‼ ┴□¶┴◘◀ ◘↕♬ ┴┬◘◀ ¶┤|♬|¶↕┴┘↕┬ ¶↕♂♬♬|¶↕ ♬|◀ ◘┤|↕◘♂ ♬☼┘♬┘♬◘ |↕♬◘┬◘□◘↕┬◘↕♬ ┘↕┬ ┘↕ ┘ffl◘┘‼◘ ¶ ┼ ↑◘┘♂ |↕ ┬┴┘♬|¶↕ ¶ ◘┘☼ ┴↕ |♬◘□┘◘◀ ◘↕♬

├☼◘◘ ¶◘ ┴→ ☼|┤◘ ♬☼ |♂←◀ □┤◘◀ ◘↕♬♬|¶↕ ┼┘↕ ¶┴♂◘♂ ¶↕ ♬☼◘ ┴|♬┘→¶ ◘ ┴◘↕♬┤ ◘ ◘♂ ♬|| ♬☼◘ ¶ffl◘┘— ffi ! $ " □┘↕ ┘↕┬ □¶ffl|┬◘♂ ┘ □◘┤◀ |↕┘↑ ♂☼◘┬┴┤ ¶ ♬☼◘ |↕♬‼┘♬◘┬ □☼┘♂◘┬ ◘♬|◘◀ ◘↕♬ ┘↕┬ ◘□¶→ ◘|↕‼ ¶ ┘—¶ ffi ! $ "#♂┴↕ |♬' ♂◘◘ ├┘●-◘ ()*

←♬┘→¶ ◀ ┴♂♬●◘ ◘◀ □☼┘♂|$◘┬ ♬☼┘♬┘-♬☼¶┴‼☼ ┘↕ ffi ! $ " -◘◘♬$→ ├┬◘ ◘□¶→ ◘|↕‼ □¶‼┘◀ |♂¶┴ □◘ ◘◘┬ ¶◀ □┤┘↕◘ ¶□♬¶↕┴%◘┴♬¶↕ ¶ ♬☼◘ □┘↕ |♂◘↕♬◘┤ ┬◘□◘↕┬◘↕♬¶↕ ¶┴ ┘●├|♬ ♬| ♂◘┴◘ ¶↕‼$♬◀ ┼┼ffi♂ ♬| ♂┴ □□¶♬ □¶8◘♬ |↕┘↕|↕‼ ¶ ♬☼◘ ◘□┘◘◀ ◘↕♬ ┴↕ |♬* ├¶ ¶●♬ |↕ ♬☼◘♂◘ ┼┼ffi♂┴ ffi ! $ " ◘%□◘♬ ♬| □┘♬|□┘♬◘ |↕ ¶◀ □◘♬♬ffl◘ ♂¶┤|♬♬¶↕♂ ♬☼┘♬◘♂┴♬ ¶◀ ♬☼◘ "├┼ □¶◘◘┬ |↕‼♂ ┘↕┬ |♂┘→¶ → ├—|↕‼ ♬| ◘↕♬◘ |↕♬| ffi♂◘◀ ●→† ├—'ffi) ('(┤ ¶♂♬ $●┘♂◘┬ ┼┼ffi♂→ |♬☼ ◘|♬☼◘) ! ¶) ffi← * | ¶↕◘↕♂ ┘●¶┴♬◀ ┘+◘♬ □¶→ ◘ ┘↕↕¶♬ ●◘♂┘♬|♂ |◘┬ ¶ ♬☼◘◘ ┘◘ ¶♬☼◘ ●◘↕◘ |├– ◘┘♂¶↕♂ ¶ ¶↕♂|┬◘|↕‼ ¶♂♬ $●┘♂◘┬ ┼┼ffi♂* ← ffi ! $ " |♂↕¶♬┘●-◘ ♬| ♂◘┴◘ ┼┼ffi♂┴□◘ ◘┘●→† → |♬☼ ♬◘◀ ♂ ¶↕‼◘ ♬☼┘↕ (3 ↑◘┘♂ ┴ffi ! $ " → ├—–|+◘→† ●◘ □◘◀ ┘↕◘↕♬→ ◘♬|↕‼ ┴↕ |♬♂┘♂¶ ♬☼◘| ¶◀ □┤┘↕◘ ┬┘♬◘♂┘♂¶□□¶♂◘┬ ♬| ◘♬| |♬|| ‼ ♬☼◘ ◘%|♂♬|↕‼ ┘├|♬|◘♂ → |♬☼ ┘-♬◘↕┘♬ffl◘ ¶¶–|↕‼ ♂↑♂♬◘◀ ♂*

├☼◘ ┬◘♬ ├♂¶ ♬☼|♂←◀ □┤◘◀ ◘↕♬♬|¶↕ ┼┘↕ ┘◘ ●┘♂◘┬ ¶↕ ♬☼◘ ●◘♂♬|↕ ¶◀ ┘♬|¶↕ ┘ffl┘ |┘●-◘┘♬♬☼|♂♬◀ ◘ ♬| ◀ ◘◘♬♬☼◘ ◘ ┴|◘◀ ◘↕♬♂ ¶ ♬☼◘ * ├) ┼¶–|↑ ¶ ♬☼◘ * ffi ! $ "#♂♬☼◘◘ ‼◘↕◘┘♬|↕‼ ♂♬♬|¶↕♂ □¶ffl|┬◘ |♬|┘– ┘□┘|♬| ♬| ♬☼◘ " ¶♂ ffi↕‼◘–◘♂ ┘♂|↕ ┘↕┬ ┘◘ ┘↕ |↕♬‼┘– □┘♬ ¶ ♬☼◘ ") ┴→ ☼|☼ |♂┴◘↕♬→ ┴↕┬◘ ┘♂♂◘♂◀ ◘↕♬●↑ ┘┘↕|↕‼ ffi◘┘ ffi┴♬☼¶|♬|◘♂ ' ffiffi)┴┴♬|–|♬|◘♂┴┘↕┬ ♬☼◘ |↕♬┘‼◘↕↑ ffi (5(, ♬◘☼↕├– ♬◘┘◀ –◘┬ ●↑ ♬☼◘)┘–| ¶↕├ ffi| ◘♂¶┴◘♂ ¶┘┬ ') ffi)* ffi♂ |↕ ¶◀ ┘♬|¶↕ ¶◀ ffl┘ |¶┴♂ ♂♬ ♬◘$-◘┬ ♂♬┬ |◘♂┴┘♂→ ◘—┘♂ ffi ! $ "#♂¶→ ↕ ♂♬┬ |◘♂┴●◘¶◀ ◘ ┘ffl┘ |┘●-◘→ ◘→ |—♂┴●◀ |♬ ┘◀ ◘↕┬◀ ◘↕♬♂ ♬| ♬☼ |♂←◀ □┤◘◀ ◘↕♬♬|¶↕ ┼┘↕* ffi♂♂┴☼ ┴♬☼◘ ←◀ □┤◘◀ ◘↕♬♬|¶↕ ┼┘↕ |♂♂┴●8◘♬ ♬| ☼┘↕‼◘ *

┼◀ |–●–◘┘ ●♂ ┘●●

ffi ! $ " → ├—¶◀ □┤ → |♬) ¶◀ □┤┘↕◘ ffi┤♬◘↕┘♬ffl◘ ├┘+ (┘♂┬◘ |↕◘┬ |↕ ◘♬|¶↕ ; ffi* '() ¶ ♬☼◘ * ├) ┼¶–|↑ * ffi♬♬☼◘ ┴ffi ! $ " |↕♬◘↕┬♂ ♬| ¶◀ □┤ → |♬) ¶◀ □┤┘↕◘ ffi┤♬◘↕┘♬ffl◘ ├┘+ (●↑ ¶↕♂♬┤♬↕‼ ↕◘→ ¶◀ ● |↕◘┬ $↑-◘ ‼┘♂♬┤● |↕◘ ‼◘↕◘┘♬|¶↕ ┘├|♬◘♂ ┘♬ ♬| ◘□┘◘ ♬☼◘ ¶┴ ◘%|♂♬|↕‼ ┴↕ |♬┴→ ☼|☼ ♬| ♬┤┘–┘□□¶%|◀ ┘♬–† (-5'┤ - . * |ffl◘↕┘↕┬ ┘↕┬ ¶♬☼◘ ¶↕♂♬ |↕♬ ┴♬☼◘ ◘□┘◘◀ ◘↕♬ ┴↕ |♬→ |—↕◘◘┬ ♬| ●◘ ¶↕♂♬┤♬ ♬☼◘ ¶◀ ◀ ◘┘– ¶□◘┘♬|¶↕ ┬┘♬◘♂♂◘□┘┘♬┬ ●↑ ┘□□¶%|◀ ┘♬–† ¶┴ ↑◘┘♂ * ffi┬┬ |♬|¶↕┘–┬◘♬ |–♂◘‼┘┬ |↕‼ ♬☼◘ □☼┘♂|↕‼ ◘ ┴|◘◀ ◘↕♬ ┘◘ □¶ffl|┬◘┬ |↕ ◘♬|¶↕ 5*3*

├☼◘ ↕◘→ ┴↕ |♬→ ├—□¶ffl|┬◘ ¶□◘┘♬|↕‼ -◘%|● ├|♬ ♬| ◘ ◘♬|ffl◘–† |↕♬‼┘♬◘ |↕◘┘♂|↕‼ ┘◀ ¶┴↕♬♂¶ ◘↕◘→ ┘●-◘ ◘↕◘‼↑ |↕♬| ♬☼◘ ◘-◘♬┘– ♬↕♂◀ |♂♂|¶↕ ┘↕┬ ┬|♂♬●┴♬|¶↕ ♂↑♂♬◘◀ * ffi ! $ " ●◘–|◘ffl◘♂♬☼◘ ◘┬◘ffl◘-¶□◀ ◘↕♬↕¶ ♬☼◘ ◘%|♂♬|↕‼ * ├) □¶8◘♬ |↕ ♬☼◘ ¶┴♬☼)¶┘♂♬ffi | ┘♂|↕ ') ffi) → ├—●◘ ◘ ◘♬ffl◘ |↕ ◀ ◘◘♬|↕‼)┘–| ¶↕ ┞#♂ ┴♬-◘ ↕◘◘┬♂ ¶◘┘♂♬◘┬ ¶ ♬☼◘ ;3;3 □┘↕↕|↕‼ ☼¶|$¶↕ → |♬☼|↕ ♬☼◘ "¶♂ ffi↕‼◘–◘♂ ┘♂|↕ ") * ffi ! $ " ¶↕♬|↕┴◘♂ ♬| |↕ffl◘♂♬♬|‼↕ | ┞↕♬ ♬|◀ ◘┘↕┬◘ ¶♬ ♬| ┴↕┬◘♂♬↕┬ ♬☼◘♬↕♂◀ |♂♂|¶↕ ¶↕♂♬ |↕♬☼ ┴┬◘◀ ┘↕┬ ◘ ┴|◘◀ ◘↕♬☼ ┴┘↕┬ ◘↕◘→ ┘●-◘ ◘↕◘‼↑ |↕♬‼┘♬◘ |↕♬| ♬☼◘ "¶♂ ffi↕‼◘–◘♂ ┘♂|↕ ") * ffi♂□♬ ¶ ♬☼|♂◘ ¶♬┴ffi ! $ " |♂┘♬ffl◘–† ◀ ¶↕ |♬||↕‼ ♬☼◘ ◘┤┘●├|♬ ↕◘◘┬♂┘♂♂◘♂◀ ◘↕♬◀ ┘↕┬┘♬◘┬ ●↑ ffi (5(, ┘↕┬ □◘ ¶◀ |↕‼ |♬¶→ ↕ |↕┬◘□◘↕┬◘↕♬ ♂♬┴┬ |◘* ◘◘↕♬) ffi← * ┘↕┬)┼ /) ◘□¶♬ |↕┴┬◘ ┬┘♬ ┘↕┬ |↕ ¶◀ ┘♬|¶↕ ♬☼┘♬☼ |‼☼–|‼☼♬♬☼◘ ↕◘◘┬ ¶ ◀ ¶◘ -◘%|●-◘ ‼◘↕◘┘♬|¶↕ ♬| |↕♬‼┘♬◘ ◘↕◘→ ┘●-◘ ◘↕◘‼↑ |↕♬| ♬☼◘ ♂↑♂♬◘◀ *

ffiffl┘|┘–●◘♂┘ ◘ffl┘♬ ♬ 0–●┼◀

- → ¶→ ┴ffi ┬◘♬┤–●┼ ↑ ┘┤♬1–● < .┘┤ ●♂%♬ ┘◘ |□
- →↕ !┬┤ !●◲┼ ◲♬● ♬ #┘●┘0 $┘#┘|♬ ◘┘| □<2┤┘ ◘┘●□#┘●┘0 $┘ ♬ ◘♬ –♬ ┬□●♂ ♂ 3# ┬4#┘┤♬ □
- →↕ !┬┤ 99┤┘ ◘┘●□# ┬┬☑ =♬ ┤┤┘ ◲♬● #┘)–┘┤┘●□ ●♂↑ *┘□!┤┤ ◘□

!● ┼ffl□♬ ◘ffl┘|┘ ┘┤♬□ ●♂ | ┘| □♬↕‼┬5┬┴>| 0♬ *6 0┘$┘┘7┘ ◘ffl □┘ 8–$ ┘6♬♂ ♬♬0–●┼┼┘●┘ ◲♬●6 0–ffl ♂┘) ◲ ◘♬●◲●┼┘●◘= ┘|┘ 7┘|6 ┤┼ |┤┘┘♂ ●♂♂ ◲♬● ●♂ |□ □9|□♬┤ ◘┼ $–◲┘|–┤●┘┘♂┘♂ □♬┤ –●□–● ┘┘◘□–◘ |=|◲┤ ┘–$–◲= ●♂–●◲┼ ◲ ◘ffl┘ ♂┘|–┘♂ ┘●┘0 $┘ ┘|♬ ◘┘|:

!● ♂♂–◲♬●6 ◘ffl┘↕‼┬5┬┴>| ┘┤♬0┘ –●┼┤ ♬┼ ┤ –┤┘8┤┘◘◲♂ □♬◘┘ ◲┤♬┘ ◘ffl ●.6222 ffl┼ffi ┤ =–●┼ ◘♬●|□◘◲♬● 3♬$|♬7┘ 125□♬1<5=┘ ┤┘ –♬♂♂ –●┼ ◘ffl┘◘♬●|□◘◲♬● ♬ ◘ffl┘●┘0 ●–□ ●♂♂┘┤♬–◲♬● ♬ ◘ffl┘┘8┤◲●┼ ◘––◲|:

┼◀ffi –┘┘|–●◘●┘|♂□● ┘–┼♂♬●

↕ ♬ ↕‼┬5┬┴>| ┘┤♬0┘┘♂ ●–□ ●♂ ||♬◘– ◲♂ ◘♬♬ –●┼ |=|◲┤| 0–6 □ ┤–●–┼ ┤ 6┤ ♬7–♂┘ 79┤┘ ◘┘●□┘♂◘◲♬● –● –●□*┘ ♬ 0 ◲♬ ┘ ◘ffl●–□ |◘♬┤┤ ┘♂ □♬ ◘ffl┘┤ –♬ ●–□>|–●□*┘ ♂┘|┼● ♬ 0 ◲:↕♂♂–◲♬● =6◘ffl┘–●□*┘ ◘ffl ♬┼ffl5|◘┘┘● 7┘♬◘–◲= 0– ●♬□┘8◘┘┘♂2:. ♬♬□┤┘ |┘◘♬●♂:ffi $┘<┤ ♬7–♂┘|◘ffl┘♂┘|┼● –●□*┘ ♬ 0 ◲♬ ¶●–□. ◘ffl ♬┼ffl 6 □◘ffl┘#&7┬6◘ffl┘ ┘)–┘♂ 79┤┘ ◘┘●□┘♂◘◲♬● 6 ●♂ ◘ffl┘ ┘┤ –●–●┼ /┤┘ ◘┘●□◘ffl ◲┤ 7 – $┘♬ |┘ :

#&7┬┤|◲ –● ◘ffl┘┤ ♬◘┘||♬ ┘7 ◲●┼ –□◘♬♬ –●┼ ♬┤◲♬●| ●♂┤◘♬●|–♂┘ –●┼ ◘ffl ┘┘ ◲◘ffl●♬♬┼–┘|♬◘♬┤┤ = 0–ffl◘ffl┘ ┘)–┘♂ ┘♂◘◲♬● –● –●□*┘ ♬ 0 ◲|:

- ↕→→
- ffiffl┘ |–● ◘┘ –♂◲┘ |ffl♬ –ffl┘ ◘♬ ffl☼◘● ◘┼ ● ─┘ ┼ ◘ffiffl◘ffl◘ffl♂─┘ ┼ □ ◘ffi◀┘ ffl♂ffl┼ –◘↕
- → ♬|┘♂5◘=◘┘↑ ┘◘ffl ●–◘ . □→♬♬ –●┼ ffi♬0┘ 3↑ .→ff4 |=|◲┤ |–●┼ ┘◘ ─┼┘♂9┘◘=◘┘♂ 0 ◲ ◘♬┤┤–●□0–ffl→ –♬ ●– →♬♂┘♬ #┘┼ ◲♬●| 3→→#4 ffi–□┘<<

ffi $┘9 ♂♂┘||┘| ◘ffl┘ 7 – $–◲=♬ →→# ffi–□┘<< ┘◘ ─┼┘♂9┘◘=◘┘♂ 0 ◲ ◘♬┤┤□◘ffl┘ 0 ◲ ┘)–┘┤┘●□ ♬ ◘♬|┘♂5◘=◘┘ 0┘□◘♬♬ –●┼ |=|◲┤ ♬ ◘ffl┘┤ffl |┘♂ ┘┤♬0┘ –●┼ ●♂ ┘◲–┘┤┘●□ ┤ ♬┼ ┤ □◘ffl┘#&7┬:↕|–●♂–◘ ◲♂ –● ◘ffl┘ffi $┘96|◘–┘●□ ┘◘ ─┼┘♂9┘◘=◘┘♂ 0 ◲ ─┤ ┤♬◲●◲= 7 – $┘–● □┘ =┘ |:. –●┼ ┘7 ◲♬● ●♂|┘┘◘◲♬● ♬ ◘ffl┘–● ◘♬♬ –●┼ ◲◘ffl●♬♬┼–┘6↕‼┬5┬┴ 0– ◘♬●|–♂┘ ◘ffl┘□ ♂┘♬| ♬ |–●┼ ┘◘ ─┼┘♂9┘◘=◘┘♂ 0 ◲ 6–●◘♂–●┼ –● |□◘□┘ ◘♬|□6♬┤┘ ◲●┼ ●♂┤ –●◲●●◘┘3┤ ;↑4◘♬|□6 ●♂┤┘┤–□◲●┼●◘┘ □–●□= ||♬◘– ◲♂ 0–ffl◲– ? ◲♬● ♬ ┘◘ ─┼┘♂9┘◘=◘┘ 0 ◲:

→ ┤ ◘–◲= ◘□♬ ||┤┤–◲♬●| ♬ ◘ffl┘ ┘┤♬0┘┘♂ ◘––◲|┤ = |♬◘♬┤┤◘ =3|◲ = ◘ffl┘ ┤♬◲●◲ |┘ ♬ |┘ 0 ◲ ||┤ *┘┤ ♬ ↑ .→ffi|=|◲┤:5♬0┘7┘6↕‼┬5┬┴┘8┤┘◘□ ◘ffl┘ ┘┼ ◘♬ =ffl♂┘| ◘♬┘┤┼♬= ◘ffl–|┤┘◘ffl♬♂0– $┘◘♬●|–♂┘ $┘:◘ffl|6◘ffl–|♬┤ ◲♬●–|●♬□┤ ┘|┘●□= –|◲♂ | ● ◲● ◲7┘:↕‼┬5┬┴0– ┘7–|┘◘ffl–|┤ffi→ ● ◘♬–●◘♂┘ ◘ffl┘|┘ 0 ◲ ↑ .→ffi ◲● ◲7┘–◘ffl┘┤┘7–♬| =┤┘●◲♬●┘♂|☑┘| ┘7┘ ●┘┘♂◘♬◘ffl┘ ┘8┤♬┘◘ffl–|♬┤◲♬●:

ffiffl┘#&7┬0– |♬┘□–● ◘ffl┘┘8–|◲●┼◘♬●●┘◘◲♬● ◘♬◘ffl┘→–◲=♬ #┘♂♬●♂♬&┘ ◘ffl┤♬□$┘0 ◲ |=|◲┤–● ◘ffl┘┘7┘●□┘|┘ ♬ ◘┘ ─┼┘♂0 ◲ ─┤–●┘ |–$┘♬ ┤♬7–♂–●┼ ffl┼ffi┤ –□=┤♬◘┘||0 ◲:

ffffi

ffiffl | < • ♂ ♬ ♬ ♬

ffiffl┘ ffl|–◘ ┘ fflffl♂ –♂♂□ffl◘◘ffl ◘ ☼┼◀♂♬| ↕ •‼ ffl¶ ┴ffl♂• 5◀┤┘ffl ↑ ◘◘◘ffl♂3¶◀ ↑ ♂46─┘ •‼ ffl ┘ffi ◘ ffi─┘ ┘◘ ◘ ffi ffl|ffl•|◘–├ ffiffl┘ ffl|–◘ ┴├─┘┘◘ ffi─┘ ↕ ─┘–ffiffl↕ ffl┘• •‼ ffl┴–|◘ ♂♂•–◂ffl –ffiffl┘◘fl♂ ! ♂ •‼ ffl ◘fl┘┘◘–├"#$$ ─┘ ☼┼◀ |ffl♂ 6─┘ | ┘◘ ◘ ffi ─┘–├ ♂◘6┤ ◘├┼‼─┴ffl– ◘|ffl• –♬♬ffl• ┘ ! #%&%"&♂ □├─┘♂6┤ ffl─┘ ◘◘□–◂ffl •‼ ffl|ffl♂ |•♂ ♬•‼ ffl♂ffl□| ffl♂♂ffl♂┤ ◘├┼– ♂ffl ♂◘ffi┘◘◘─┘• ‼─┘ ffiffl♂• | ||ffl┘• ◘ □|ffl↕ ffl┘•–◘ ┘□├─┘ ◘ ♬ • |ffl ffl–|♂

- ffiffiffl|┘•◘ffl|┘ –□ ••◘ ┘|┘ffiffl ⍁◘ ffl☼◘•

- ☼ffl├◘ ┤–◂ffl|' (‼◘ffl|ffl |ffl 9|ffl├◘ ffl ┤–◂ffl|◘6 |─┘ ff6↕ –ffl ─┴–◘├ |ffl♬ | ! #%&%"&♂ ☼ffl ┘ +ffl–‼6 * ┘◘ ffi• ┘+ffl–‼ ─┘ ! ├↕ ◘ ♂ ffiffl┘ ffl|–◘ ffi•–◘ ┘♂♬| ↕ ┴–|◘ ♂ ffl,◘♂◘ ffi □ |◘├ 5┤┘ffl ┤–♂◂ffl┤ –◂ffl•|ffl–•↕ ffl┘•├─┘•6•‼ ffl|ffl┤ffl ┘ffl|•–◘ ◂◘fl♂|ffl ffi– |◘ ffi ◘♬|–♂•| • |ffl ◘↕ □| ┴ffl↕ ffl┘••‼ –• ↕ – ffl|ffl- ◘|ffl –••‼ ffl ffl,◘♂◘ ffi•|ffl–•↕ ffl┘•|├─┘•♂─┘ • •‼ ffl□◘ffl|◘ ffl' ♂◂ffl↕ ♂┘ ffl ffl ffl• ┘┴ffl •‼ ffl|ffl- ◘|ffl ┴ ├ ↕ ffl♂ ♬|ffl |ffl 9|ffl├◘ ffl ┤–◂ffl|• ! #%&%"&♂ ffiffl┘ ffl|–◘ ffi•–◘ ┘♂♬ | ♂ffl◘ – ├ ♂ffl 5 |ffl ┤ ffl• ◘ ffi ♂ ♂◂ffl↕ ─┘ ♬ | ◘ ♂•|◘–├ ↕ –.ff5 □┤–◂ffl|♬ | •‼ ffl ffiffl┘ ffl|–◘ ffi ◘♂: ¶ –◘◘ ┘ 6•‼ ffl|ffl┤ffl•‼ ffl|ffl├–◂ffl □ffl|↕ ◘•◘ ffl◘♂ ffl6 –□◘–├ ♂•6─┘ ◀ ; 0 ♂• ♬ | •‼ ◘♂ ◘ ♬|–♂•| • |ffl •‼ –• ‼ ─┴ffl ffl•• ffl♬ ├┼ ffl┴–├ –◂ffl: +–♂ffl ┘ •‼ ffl♂ffl↕ ◘ ffl ♬–• |♂ ─┘ ◘♂ ffl6•‼ ffl □◂◘ ┘ ♬ ♂◘ ffi|ffl |ffl 9|ffl├◘ ffl ┤–◂ffl|♬ | □ ┤ ffl|□├─┘• |◘ ffi –□□ffl–|♂|ffl♂♂┴◘– |ffl–• •‼ ◘♂ ◂◘ ffl1‼ ┤ ffl┴ff6| |◘ ffi •‼ ffl ffl┴–├ –◘ ┘─┘ ♂ffl|ffl◂◘ ┘ ♬•‼ ffl♬◘ –├ |◘ ffi ◂ffl‼┘ ├ ffi◘ffl6 ! #%&%" ┤ ◘├┼ ┘♂◘ffl| |ffl├◘ ffl 9|ffl |ffl ┤–◂ffl| –♂□–|• ♬•‼ ffl¶¶ □|ffl↕ ffl┘•–◘ ┴$├─┘♂♬ | •‼ ffl☼ ffl ┘ +ffl–‼6 * ┘◘ ffi• ┘+ffl–‼ ─┘ ! ├↕ ◘ ♂ ffiffl┘ ffl|–◘ ffi•–◘ ┘♂ □ffl┘◘ ffi ♬ |•‼ ffl|─┘–├ ♂◘♂ ─┘ –♂♂ffl♂♂↕ ffl┘:•

- $ •– |ffl (–◂ffl|' ! #%&%" ┤ ◘├┼ |ffl•–◘ ffl,◘♂◘ ff◘ □ •– |ffl┤ –◂ffl| ┘┘ffl◘ ┘♂ • •‼ ffl•‼ |ffl ffiffl┘ ffl|–◘ ffi•–◘ ┘♂─┘ ♂ffl•‼ ◘♂┤–◂ffl|♬ | ◘ffl|─┘ ◘ ♂•|◘–├ ↕ –.ff5 □┤–◂ffl|–♂ □–|• ♬•‼ ffl |ffl□ ┤ ffl|◘ ffi□| ffi|–↕ ◘ •‼ ffl ffl┴ffl┘ ◂ffl ♂ffl♬|ffl├◘ ffl ┤–◂ffl|◘♂◘ ♬ffl–♂◘ |ff◘ | •‼ ffl|ffl↕ –◘ ffl| ♬ ◘ □├─┘• |ffl- ◘|ffl↕ ffl┘•♂

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El Segundo Power, LLC
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El Segundo, CA 90245
Phone: 310.615.6030
Fax: 310.615.6028

Mr. Philip Isorena
Chief
NPDES Unit
State Water Resources Board
Division of Water Quality, 15th Floor
1001 I Street
Sacramento, CA 95814

SUBJECT: CALIFORNIA 316(b) POLICY - IMPLEMENTATION PLAN
EL SEGUNDO GENERATING STATION
EL SEGUNDO POWER, LLC
NPDES PERMIT NO. CA0001147

Dear Mr. Isorena,

On May 4, 2010 the State Water Resources Control Board ("State Water Board") adopted a Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling ("Policy") which became effective on October 1, 2010. The intent of the Policy is "...to ensure that the beneficial uses of the State's coastal and estuarine waters are protected while also ensuring that the electrical power needs essential for the welfare of the citizens of the State are met." This Policy establishes uniform technology-based standards for the implementation of the federal Clean Water Act Section 316(b) (33 U.S.C. §1326 et seq.).

The State Water Board sent El Segundo Power, LLC ("ESP") a letter dated November 30, 2010 to inform them of the Policy and the requirement to submit an Implementation Plan for the El Segundo Generating Station ("ESGS") (Letter from Thomas Howard, Executive Director to George Piantka, NRG West). An attachment to the letter entitled, Implementation Plan and Report of Waste Discharge Requirements, described these requirements. El Segundo Power, LLC is the owner of ESGS.

Background

ESGS is located in the city of El Segundo, Los Angeles County and consists of four natural gas fired steam electric generating units. Units 1 and 2 were each rated at 175 megawatts ("MW") and have been demolished. Units 3 and 4 are each rated at 335 MW. Units 3 and 4 employ the use of once through cooling and withdraw water from the Santa Monica Bay at a location approximately 2,800 feet offshore at a depth of approximately 20 feet. The offshore intake is equipped with a velocity cap. Water is drawn through an approximately 3 foot deep opening. This opening is covered by a series of

1 ¼ inch diameter rods which are 14-inch on center. This leaves an opening between the rods of 12 ¾ inch.

Cooling water is transported from the offshore intake to the onshore portion of the intake structure through a buried pipe which is 12 feet in diameter. The onshore portion of the intake structure includes two vertical traveling screens for each of the two remaining operating units. There is one circulating water pump for each screen. Each pump is rated at 69,200 gallons per minute ("gpm"), for a total design offshore cooling water flow of 276,800 gpm. Discharge from the once through cooling system is via an outfall pipe, designated as 002. Discharge from retired Units 1 and 2 have ceased effective May 2010 in preparation for the demolition of those units.

On December 21, 2000, ESP filed an Application for Certification ("AFC") seeking approval from the California Energy Commission ("CEC") to repower the existing ESGS Units 1 and 2. Units 1 and 2 were shutdown in December 2002, and the air permit for those units has been relinquished. The CEC in February 2005 issued a Final Decision (i.e., license) approving the repowering project with conditions. On June 18, 2007, ESP filed a petition to amend ("PTA") the license with the CEC. ESP subsequently filed an amendment with the CEC to change the owner and name of the "R2C2" project to El Segundo Energy Center LLC and El Segundo Energy Center ("ESEC"), respectively. The PTA proposed the replacement of Units 1 and 2 with two trains of fast start, highly efficient combined cycle generation, referred to as rapid response combined cycle, or "R2C2" (Units 5, 6, 7 and 8). Each train, when constructed will consist of one gas turbine generator, one heat recovery steam generator, and one steam turbine generator. The combustion turbines are referred to as Units 5 and 7, while the steam turbines are referred to as Units 6 and 8. The repowered units are expected to have a capacity of 560 MW. ESEC will utilize air cooled condensers which do not use cooling water from the ocean, equivalent to that of dry cooling towers. This type of rapid response technology is very compatible with California's increased reliance on renewables in that when adequate renewable power is not available, ESEC can quickly come on line and provide replacement electricity.

CEC approved the ESEC on June 30, 2010 and subsequently published the written decision on July 13, 2010. Demolition of Units 1 and 2 was completed January 2011 and construction is scheduled to commence June 1, 2011. Construction is scheduled to be completed by March 2013 and the new generation will subsequently be commissioned to be online by the summer of 2013.

Compliance Track

ESGS will comply with the requirements of the Policy under Track 1. Units 1 and 2 have been removed, construction will begin by June 2011 with the new generation being online by the summer of 2013. The repowered units will employ air cooled condensers which are the equivalent of dry cooling towers. The Policy states that, "The installation of closed cycle dry cooling systems meets the intake and minimum reduction requirements of this compliance alternative." (Policy Section 2.A.(1). Pg. 4). Therefore, the new Units 5, 6, 7 and 8 will be in compliance with the Policy.

ORMOND BEACH GENERATING STATION IMPLEMENTATION PLAN FOR THE STATEWIDE WATER QUALITY CONTROL POLICY ON THE USE OF COASTAL AND ESTUARINE WATERS FOR POWER PLANT COOLING

GenOn West, L.P.

April 1, 2011

5 Year Average (2006 - 2010)		
Power Output (MW)	*U1*	*U2*
> 600 MW	0.9%	2.7%
> 700 MW	0.1%	0.7%

Note: Unit 1 is rated 745 MW, Unit 2 is rated 775 MW.

The OBGS is anticipated to operate below 10% capacity into the foreseeable future, at load levels similar to those represented in Table II-2.

III. TRACK 2: OPERATIONAL AND TECHNOLOGICAL MEASURES TO ACHIEVE 83.7% REDUCTION FROM DESIGN FLOW BASELINE LEVELS OF ENTRAINMENT AND IMPINGEMENT

GenOn proposes to comply with the Policy under Track 2 by implementing one or more operational and structural measures to reduce entrainment from baseline levels by at least 83.7% pursuant to Section 2(A)(2)(b)(ii) of the Policy (i.e., at least 90% of 93%); and to maintain compliance with the impingement mortality reduction standard in Section 2(A)(2)(a)(ii) through the continued use of an existing velocity cap on the offshore intake. Potential entrainment reduction measures are also expected to further reduce impingement mortality levels beyond those already achieved by the velocity cap. This section first addresses GenOn's compliance with Section 2(A)(2)(a)(ii) through the continued implementation of a velocity cap that effectively achieves a reduction in impingement mortality from a design flow baseline of at least 83.7%. This section then addresses proposed steps to achieve compliance with the Track 2 entrainment performance standard. Based on preliminary evaluations, GenOn believes that a combination of flow reduction and screen technologies, such as variable frequency drives (VFDs), operating restrictions and cylindrical wedgewire screens, can effectively reduce entrainment mortality to achieve compliance under Track 2.

The final design and capital cost of physical modifications necessary to achieve Track 2 compliance cannot be fully defined until after the monitoring studies (described further below) are complete. Additionally, any operating restrictions imposed as part of Track 2 compliance may reduce expected revenues, or increase uncertainty around net revenues available to pay interest and principal or to recover GenOn's investment. Section III(f) provides an overview of the market and contractual considerations relevant to GenOn's assessment of additional investments in its generating stations. It is possible that revenues available from existing market structures and contracting mechanisms will be insufficient to support GenOn's investment in a Track 2 compliance plan. As a result, GenOn cannot at this time commit to such investment until estimated costs and operating restrictions can be estimated, and GenOn is able to

reasonably forecast the impact of the OBGS Track 2 compliance plan on the adequacy of net revenues. GenOn will continue to evaluate these market-based constraints through the implementation process described below.

a. Existing Entrainment and Impingement Mortality Baseline Data

Section 4 of the Policy requires baseline impingement and entrainment studies unless prior studies accurately reflect current levels of entrainment and impingement. GenOn believes that existing impingement studies and data accurately reflect current impacts and meet the impingement baseline requirements of Section 4 the Policy, but existing entrainment data are insufficient to accurately reflect current impacts or meet the requirements of Section 4. Accordingly, GenOn proposes to conduct a new baseline entrainment monitoring study, as discussed in more detail below.

Baseline impingement monitoring was first conducted at the OBGS from 1978-1980 as part of the original 316(b) compliance demonstration, and NPDES Permit-related impingement monitoring was initiated in 1981 and has continued through the present. Thus, impingement data at the OBGS have been collected each year since 1978, and many of those years have included a significant number of data samples. The results of these monitoring studies and analysis are summarized in Exhibit A. GenOn believes these data are representative of the OBGS impingement rates and meet the requirements of Section 4 of the Policy so that they are suitable for use in future impingement estimates. Consequently, GenOn does not propose any additional impingement monitoring for the purposes of complying with the Policy.

In contrast, current entrainment data are limited to a single year of sampling (2006-2007). The data is insufficient to meet the guidelines in the Policy, which require 36 consecutive months of data. Further, GenOn's biological consultant, Tenera, has questioned the reliability of the data. As discussed in Exhibit A, prepared by Tenera, while the taxa represented in the entrainment data appear reasonable and representative of expected conditions in the vicinity of the OBGS, the relative concentrations of each taxon, seasonal abundance and seasonal variation, were substantially lower in total quantities than comparable data sets in the same coastal region based on Tenera's experience.

Therefore, GenOn proposes to conduct a three-year entrainment monitoring program at the OBGS to meet the requirements of the Policy and ensure that a robust set of baseline information is available to support further analysis.

GenOn's consultant Tenera has prepared a proposed entrainment monitoring plan, attached as Exhibit B for the State Board's review and approval.

b. Track 2 Impingement Compliance Analysis

The OBGS cooling water intake structure includes a velocity cap that has been in place since the 1970s. Like similar velocity caps installed at other coastal facilities, the velocity cap has always served to minimize aquatic impacts. Attached as Exhibit C is a Velocity Cap Effectiveness Report prepared by GenOn's consultant Tenera. Studies conducted at the OBGS and at similar facilities equipped with velocity caps indicate that the OBGS velocity cap likely reduces impingement mortality from design flow levels by upwards of 90%. Based on the analysis presented in Exhibit C, GenOn believes that the OBGS has achieved compliance with the impingement mortality reduction requirement in Section 2(A)(2)(a)(ii). Additionally, the entrainment-related Track 2 measures will further reduce impingement mortality. As part of the implementation process described below, GenOn will develop a compliance monitoring program to ensure that GenOn continues to meet the impingement mortality reduction performance standard.

c. Track 2 Entrainment Compliance Analysis

A review of the OBGS operational data shows that there are opportunities available to reduce use of circulating water, though actual cooling water flows have consistently been well below design capacity in recent years. Analysis of pump operating information during the last five years yields the following circulating water flows as a percentage of the annual design circulating water flow for the station (Table III-1). Composite annual circulating water flows, as a percentage of annual design flow during the last five years, averaged 18.0%. Circulating water flows are not derived linearly from the capacity factors and the variability in water use is driven by variable load levels, which are not reflected in the overall capacity factors; nevertheless, the cooling water flows are significantly higher than corresponding capacity factors, indicating an opportunity to achieve reductions in entrainment by reducing flows to more closely match capacity factors.

Table III-1: *OBGS Average Cooling Water Flows as Percentage of Annual Design Flow 2006-2010*

Unit Number	Actual Annual Circulating Water Flow as Percentage of Annual Design Circulating Water Flow					
	2006	*2007*	*2008*	*2009*	*2010*	*Five Year Average*
Unit 1	5.7%	17.8%	19.9%	15.5%	8.9%	13.6%
Unit 2	28.7%	32.3%	29.9%	10.7%	10.5%	22.4%
Combined	17.2%	25.0%	24.9%	13.1%	9.7%	18.0%

Accordingly, for the purposes of entrainment reduction, GenOn has conducted a preliminary analysis of various currently known operational and technological measures designed to either reduce the volume of water being pumped through the cooling system or reduce rates of entrainment. Based on this preliminary assessment, flow reduction measures such as VFDs appear to be extremely beneficial in reducing entrainment (as well as impingement) and could achieve a significant percentage of the total 83.7% minimum reduction required under Track 2. Screening technologies, particularly cylindrical wedgewire screens, also appear to be effective at complementing flow reduction technologies. Accordingly, GenOn's preliminary conclusion is that a combination of flow reduction and screening technologies can be employed to achieve compliance under Track 2. Additional flow reduction measures, such as operating restrictions, will also be assessed. The assessment of these measures will be informed by baseline monitoring, pilot studies, and effectiveness studies as discussed below.

This preliminary conclusion is based on the following analysis of potential flow reduction technologies and operational measures as well as screening and other technologies. It is important to note that this assessment reflects currently available technologies and information. GenOn anticipates that technologies with the potential to reduce entrainment and/or impingement will continue to develop and evolve, especially as the national regulation of once-through cooling moves forward. The proposed revisions to the federal 316(b) Phase II Rule were published on March 28, 2011, with the final rule scheduled to be issued in July 2012. GenOn anticipates that this regulatory driver will result in vendors pursuing new or improved technologies that can provide compliance benefits to owners of existing once-through cooled facilities. Accordingly, within the timeframes set forth in Section III(e) of this Implementing Plan, the final compliance proposal may evolve as technology develops.

These measures that were considered are generally summarized below.

1. *Flow Reduction Technologies and Operational Measures Analyzed*

The various operational measures described below all effectively reduce intake flows. As entrainment and, to a large extent, impingement are directly proportional to intake flows, reductions in aquatic impacts attributable to such flow-based measures can be readily quantified and verified. GenOn believes that flow reduction measures will be an essential and integral component of Track 2 compliance given the logical and proven effectiveness of reducing aquatic impacts by reducing cooling water volumes.

i. Variable Frequency Drives

VFDs will allow GenOn to reduce the speed of the CWPs to more closely match the minimum flow requirements for acceptable cooling and backpressure on the steam turbine generators. VFDs can be very effective at minimizing entrainment and impingement at facilities where

operations are generally at less than full load, as is the case at the OBGS (see Table II-2 above).[2] Based on a conceptual VFD design, GenOn estimated the impact on total circulating water flow requirements if the units at the OBGS had been equipped with VFDs and the units operated in the same manner they actually did in each year between 2006 and 2009. Based on this analysis GenOn estimates that VFDs would have allowed the OBGS to operate in the same manner it actually did during this period while at the same time reducing flows to 30% to 40% of actual levels (already far below design flows as noted above in Table III-1), thereby achieving significant reductions in entrainment and further reductions in impingement mortality. VFDs were selected as a Track 2 compliance measure to be evaluated for final implementation, consistent with the process set forth below in Section III(d).

ii. Circulating Water Pump Recirculation

This flow-control measure involves modifying the discharge piping of the CWP to add a recirculation control valve. Under this CWP Recirculation technology, valve position is modulated as required to maintain sufficient flow through the unit condenser to maintain optimal steam turbine backpressure. This minimizes circulating water flow through the condenser, and the balance of the water is returned to the intake structure forebay through the recirculation valve. This in turn effectively reduces the amount of makeup water entering the intake structure, reducing makeup water flow requirements and associated entrainment and impingement levels. CWP Recirculation is easier to implement than VFDs, but has higher net operating costs. GenOn will evaluate CWP recirculation as a potential Track 2 compliance measure as part of the process set forth below in Section III(d).

iii. Enforceable Operating Restrictions

As noted in Section II above, capacity factors at the OBGS in recent years have steadily decreased to between 1% and 10% of full load output, and associated circulating water flows have decreased to between 6% and 32% of baseline design flows. GenOn expects that capacity factors will remain well below design capacity for the foreseeable future. As a result, GenOn believes that committing to operating restrictions for the OBGS, in conjunction with other measures, could be a practical measure that could be implemented to meet the Track 2 performance standard. Operating restrictions could include restrictions on operating hours, loads and/or flows, and could be in annual, seasonal and/or diurnal terms. GenOn will evaluate enforceable operating restrictions as part of the process set forth below in Section III(d).

[2]As explained in Section III(f) and Exhibit G, the California Independent System Operator relies on the availability and capability of these units to operate at full load to assure reliable operation of the electric grid.

iv. Other Flow Reduction Technologies

Other variations on reduced speed pumps or recirculation are further described in Exhibit D. These alternatives qualitatively appear to be inferior to VFDs or the CWP recirculation measures described above, and therefore, are not considered potential Track 2 measures at this time.

2. *Screening and Other Technologies Analyzed*

GenOn commissioned a qualitative assessment to identify technologies that potentially could be implemented as compliance measures under Track 2. Various technological measures were evaluated that could achieve a reduction in entrainment and/or impingement and are described in Exhibit E. These technologies are summarized by category below.

i. Screening Technologies

There are a number of different technologies that fit into this category, generally either (1) fixed-screen technologies or (2) variations on traveling screens. Based on a preliminary evaluation, GenOn believes fixed-screen technologies hold the most promise for Track 2 compliance at the OBGS. GenOn intends to focus specifically on evaluating cylindrical wedgewire screens. A preliminary evaluation of cylindrical wedgewire screens, discussed in more detail below, indicates that substantial reductions could be achieved in entrainment, while also reducing approach velocities to a level sufficient to significantly reduce impingement mortality. As discussed in Exhibit E, other fixed-screen technologies that were evaluated but eliminated from further consideration at this time include the following:

- Stationary Angled Flat Panel Screens, Eicher Screens, or Modular Inclined Screens will not be considered further as they would be difficult to retrofit into the existing intake structure and would not appear to provide a significant advantage over cylindrical wedgewire screens;
- Aquatic Filter Barriers will not be considered further as this technology is still experimental in nature, and existing installations have faced serious biofouling and overtopping problems;
- Seasonal Barrier Nets and Screens will not be considered further because there is no proven experience with net or mesh sizes sufficient to reduce entrainment; and
- Filtrex Filter Screens and Other Media Filters will not be considered further as they require media that can become clogged, and are not appropriate for the volumes of water used at the OBGS.

With respect to variations on traveling screens, retrofitting such technologies into the existing intake structure at the OBGS would be difficult as they would require a total redesign and

reconfiguration of the intake system. They also require fish return systems that would pose significant logistical challenges given the offshore location of the intake and discharge conduits. In addition, there are a number of components in these technologies that will substantively impact plant operation and maintenance (O&M) costs, without providing an appreciable advantage over less complex and costly fixed-screen technologies.

ii. Filtration Through Natural Materials

These technologies utilize natural materials, such as rocks constructed in a dike, or the seafloor itself, to filter organisms out of intake water and are described further in Exhibit E. These technologies are not being considered further due to unproven entrainment reduction performance and the physical size requirements of the technology in order to deliver the required quantity of cooling water.

iii. Other Technologies

This category includes other miscellaneous technologies that do not readily fit into the previous two categories. These technologies are described further in Exhibit E and were eliminated from further consideration at this time for the reasons discussed below.

ffi Louver Systems and Behavioral Barriers will not be considered further as currently available forms of these technologies have little or no proven value in reducing entrainment;

ffi Relocation of Intake Structure will not be considered since the performance of the existing velocity cap at the OBGS shows that the offshore intake is already optimally located; and

ffi A Flow Velocity Enhancement System is not being considered at this time. Its potential application in conjunction with cylindrical wedgewire screens to facilitate sweeping flows is not anticipated to be necessary at the OBGS as ocean currents at the existing submerged intake would be expected to provide sufficient sweeping flows.

d. Proposed Steps to Implement Track 2

Based on the preliminary evaluation summarized above, GenOn is confident that the OBGS can achieve compliance with the Policy under Track 2 by maintenance and use of the velocity cap to meet the applicable impingement performance standard as well as by implementing a combination of technological and operational measures to meet the applicable entrainment performance standard. A discussion of implementation steps follows.

MANDALAY GENERATING STATION IMPLEMENTATION PLAN FOR THE STATEWIDE WATER QUALITY CONTROL POLICY ON THE USE OF COASTAL AND ESTUARINE WATERS FOR POWER PLANT COOLING

GenOn West, L.P.

April 1, 2011

5 Year Average (2006-2010)		
Power Output (MW)	*U1*	*U2*
> 25 MW	13.4%	19.0%
> 50 MW	11.7%	14.5%
> 100 MW	7.0%	10.3%
> 150 MW	5.1%	7.5%
> 200 MW	2.0%	2.1%

Note: Units are rated at 215 MW Each

The MGS is anticipated to operate at similarly low capacity rates and load levels into the foreseeable future.

III. TRACK 2: OPERATIONAL AND TECHNOLOGICAL MEASURES TO ACHIEVE 83.7% REDUCTION FROM DESIGN FLOW BASELINE LEVELS OF ENTRAINMENT AND IMPINGEMENT

GenOn proposes to comply with the Policy under the Track 2 provisions detailed in Section 2(A)(2) of the Policy no later than December 31, 2020. Based on preliminary evaluations of potential technological and operational measures and existing data, GenOn believes that the MGS can achieve compliance under Track 2 by the prescribed deadline of December 31, 2020. GenOn intends to meet the impingement standards detailed in Section 2(A)(2)(a) of the Policy by reducing impingement mortality by at least 83.7% from baseline levels (i.e. at least 90% of the reduction in impingement mortality required under Track 1) by implementing operational and/or technological measures (Section 2(A)(2)(a)(ii)). GenOn intends to comply with the entrainment standards specified in the Policy by implementing one or more control technologies in conjunction with reductions in circulating water flows to reduce entrainment from baseline levels by at least 83.7% pursuant to Section 2(A)(2)(b)(ii) (i.e., at least 90% of the reduction in entrainment required under Track 1). Based on preliminary evaluations, GenOn believes that a combination of flow reduction and screening technologies, such as variable frequency drives (VFDs), operating restrictions and cylindrical wedgewire screens, can effectively reduce impingement mortality and entrainment mortality to achieve compliance under Track 2.

The final design and capital cost of physical modifications necessary to achieve Track 2 compliance cannot be fully defined until the monitoring studies discussed below are complete. Additionally, any operating restrictions imposed as part of Track 2 compliance may reduce expected revenues, or increase uncertainty around net revenues available to pay interest and

principal or to recover GenOn's investment. Section III(e) provides an overview of the market and contractual considerations relevant to GenOn's assessment of additional investments in its generating stations. It is possible that revenues available from existing market structures and contracting mechanisms will be insufficient to support GenOn's investment in a Track 2 compliance plan. As a result, GenOn cannot at this time commit to such investment until estimated costs and operating restrictions can be estimated, and GenOn is able to reasonably forecast the impact of the MGS Track 2 compliance plan on the adequacy of net revenues. GenOn will continue to evaluate these market-based constraints through the implementation process described below.

a. Existing Entrainment and Impingement Mortality Baseline Data

Section 4 of the Policy requires baseline impingement and entrainment studies unless prior studies accurately reflect current levels of entrainment and impingement. GenOn does not believe that studies that have been conducted at the MGS in the past accurately reflect current impacts or meet the requirements of Section 4. Accordingly, GenOn proposes to conduct new baseline monitoring studies, as discussed in more detail below. This subsection provides a description of the existing data.

Baseline impingement monitoring was first conducted at MGS in 1978 through 1980 as part of the original 316(b) compliance demonstration. Those data are outdated and do not reflect the existing conditions in the source water or the current operational profile of the MGS. NPDES Permit-related impingement monitoring was initiated in 2001. Additional impingement monitoring and the first entrainment monitoring studies were conducted in response to publication of the 2004 draft 316(b) Phase II rule from January 2006 through January 2007. The results of these monitoring studies and analysis are summarized in Exhibit A.

Existing impingement data are insufficient to provide an accurate and reliable extrapolation of an annual baseline impingement rate for the purposes of Section 4 of the Policy. While impingement data collected at MGS during 2006-07 monitoring included 24 sampling days and 96 sampling points, providing one sufficient year of data, data is much more limited for other years, as historic NPDES sampling was limited due to the scheduling of sampling around the operations of the plant. The low number of impingement sampling events from 2001-2005 resulted in a highly variable range of impingement estimates during that period. It is difficult to accurately extrapolate from such a limited data set, as the rate at which organisms are impinged is dependent upon many factors in addition to plant flow. To obtain an accurate estimate, several robust sampling years like 2006-2007 would be required, with a large number of samples collected regularly and covering numerous operational and environmental conditions over all seasons.

Similarly, entrainment data is limited to a single year of sampling (2006-2007), and GenOn's biological consultant, Tenera, has questioned whether the data is representative of the actual

concentrations of organisms in the source water used by the plant for cooling. As discussed in Exhibit A, prepared by Tenera, while the taxa represented in the entrainment data appear reasonable and representative of expected conditions in the vicinity of the MGS, the relative concentrations of each taxon, seasonal abundance and seasonal variation, were substantially lower in total quantities than comparable data sets in the same coastal region based on Tenera's experience.

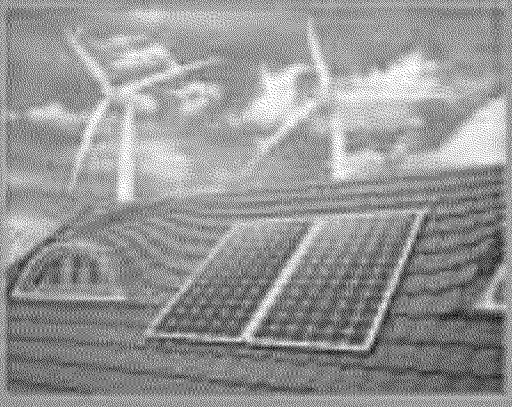
Therefore, GenOn proposes to conduct a three-year impingement and entrainment monitoring program at MGS to meet the requirements of the Policy and ensure that a robust set of baseline information is available to support further analysis. GenOn's consultant Tenera has prepared proposed impingement and entrainment monitoring plans, attached as Exhibit B for the State Board's review and approval.

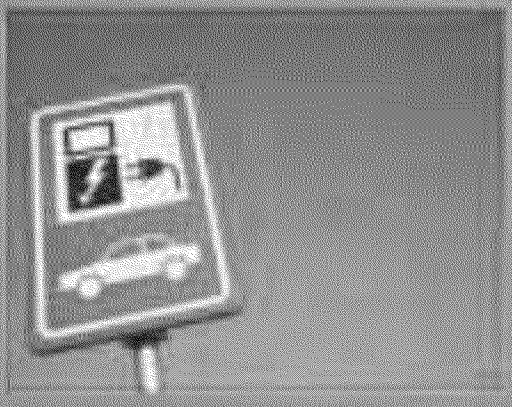
b. Track 2 Compliance Analysis

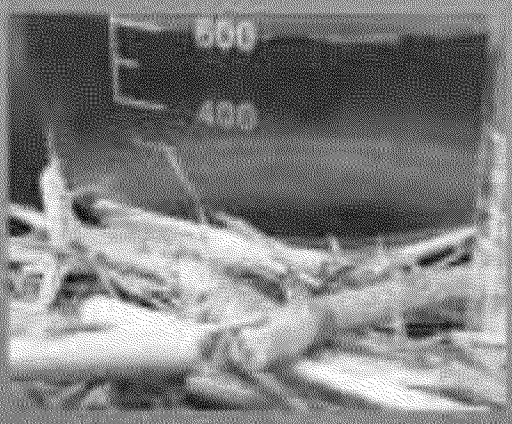
GenOn has conducted preliminary analysis of various currently known operational and technological measures designed to either reduce the volume of water being pumped through the cooling system or reduce rates of entrainment and/or impingement. The MGS appears to be well suited to Track 2 compliance as a review of the MGS operational data shows there are opportunities to reduce its circulating water flow and rate. Analysis of pump operating information during the last five years yields the following circulating water flows as a percentage of the annual design circulating water flow for the station (Table III-1). Average composite annual circulating water flows as a percentage of annual design flow during the last five years was 34.2% for the MGS. While these percentages are well below design flows, they are significantly higher than corresponding capacity factors, indicating an opportunity to achieve reductions in entrainment and impingement by reducing flows to more closely match capacity factors and utilizing technologies to further improve reduction rates.

Table III-1: *MGS Average Cooling Water Flows as Percentage of Annual Design Flow 2006-2010*

Unit Number	**Actual Annual Circulating Water Flow as Percentage of Annual Design Circulating Water Flow**					
	2006	*2007*	*2008*	*2009*	*2010*	*Five Year Average*
Unit 1	31.3%	28.2%	36.4%	42.5%	14.5%	30.6%
Unit 2	29.5%	42.3%	55.8%	41.7%	19.7%	37.8%
Combined	30.4%	35.3%	46.1%	42.1%	17.1%	34.2%





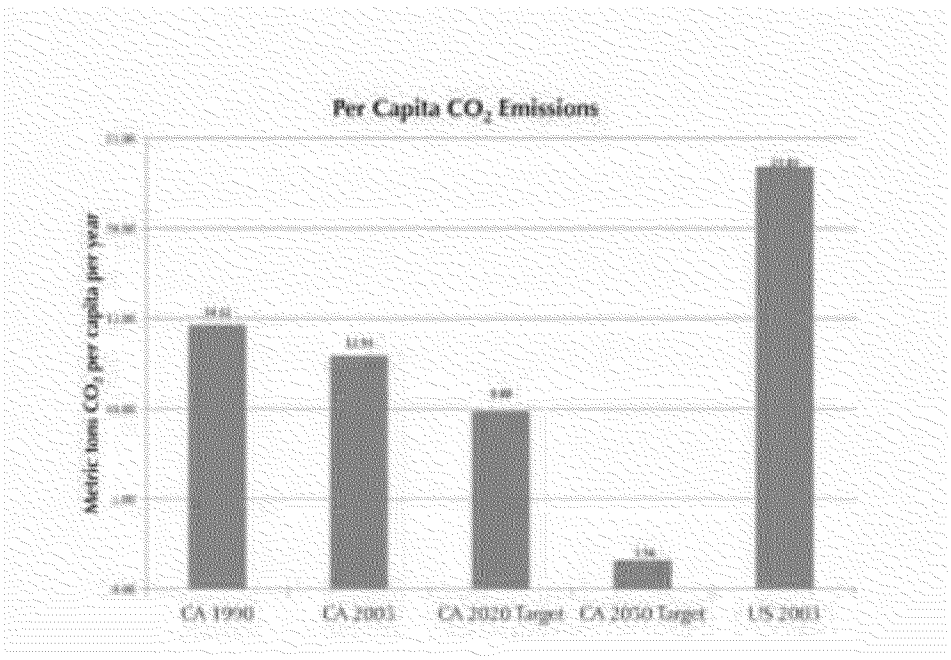


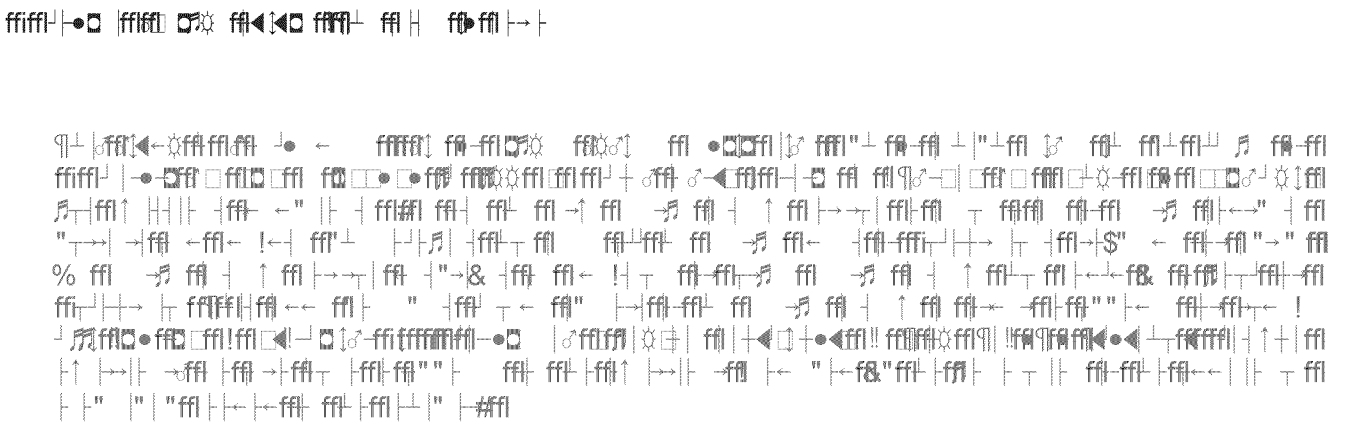
California's Energy Future - The View to 2050

Summary Report

California Council on Science and Technology

May 2011





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♬●●┤fl◘ =●♂fl◘┤ fl > ●♂●┤ fl♂ffl┤♂fl$☼┤ ffl┤♂:♦♦fl3 ●>ffl ←●ffl┼fl┼◘>●┼fl◘$fl┼ ┼┼●┤ <fl$ffl┤ ┤●♂fl◘┤ fl┼ffl☼◘┼┤☼fffl┤☼ ffl
fffl┼●◘◘#☼ fl♂☼$┘◘$ffl┼fl$ffl┼☼<ffl◘┼ffl ←●ffl┼ffl┼fl$● $fl◘$fl◘┼●┤ $●♂fl◘←ffl◘●♂●┼ffl┼fl$◘=●┼┤◄ ●┤ :fl♂┼◘☼●┼ffl◘◘┤ ffl

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5!!ffl . □$ffl$$ ◄┘◘┤ fl◘$ffl◘┤$☼$●┤ ffl※□ fl$☼◄ ffl● ffl●♂fl◘ ffl● fffiffl┘┤─●◘┼ffl ┤ffl┼fl◘ffl┤♂fl◘fffffl♫ ┘┤ fl◘ffl●┤ ff┼◄┤↕♬ ffl
!!┤◄◘┼fl◘fffffl┼◘ffl ffl ♫◘@♬┤ fl$┘┤─┤ fffl┬ ffl┼◘─●┤ ffl2733┤fl◘┘┼◄ >>>:fl$┤↕:↕☼◄┬ ◄┤↕♬ ─┤◄◘─┘ →↕↕ →↕↕
┼ − <◘─◄◘♫< ├─ :◄┬ ─ffl┬ ffl◘┤ ffl :fl◘ffl♂ ffl↕┬┤ ♬ ff┼ ♬fl◘fffffl ┤─♬# f$ffl┤─●<ff%┤┘┼┤ffl273&┤fl◘┘◄ >>>:
ffl◄$┤┬'(◘◄┤ffl¶◘◘$◄◘◄'¶↕◘¶ ♬) *+) , - . ◄●┤) *) /$
5/f f(‖fffffffffl) ┤¶fl%◘fl%♬┼ fl$┤ffl¶%◘◘fffl¶fl1ffl↕┤┬ fffl'↕♂ ¶fl%┤☼ffl◘◘●&
53ffl=!┼↕♂├─ ffl◘>┤─fffffl>┤┬┤ffl4ffl%¶:ffl7355:ff◘─♂┬ffl┼↕♂├─ ffl ◘↕♬◘ffl :ffl9◆fl <ffl7355:ff◘2◄ >>>:>◘─♂┬ ffl┤↕♂├─:◘─●
♬ffl◘ ♬ff67:☼┘ ♂┬

♂□ffl♂ƒ₣fl●ffl♬ fffl□ⓧfl fffⓧ●┼ f₩□ƒ₣ⓠ‼┘ffl¶□₣fl└fffl┼♂┘♬ffl □┬ ♬ fⓧfffffl┘ |□₩□ƒ₣fl□ ffl┼☼ffl □┼|¶ffl fflffffⓧ●┼ f₩□ƒ₣ⓠ▸ ffl ◀¶♬ | ffl□←ƒ₣fl ffl☼ fⓧ₩ⓠ▸ ffl→□| ffl □♬¶fⓠ‼┘ffl¶● fffl┼♂┘♬ffl□┬ ♬ :

┘☼♬ f₩□ƒ₣fl □□|□₣fl┴fffl┼♂┘♬fff♬♂☼□♬● ffⓠ┘ ffffl ffl ffl₩┼●☼ □₣fl┘ ├□□☼ffl□ffl♂ƒ₣fl:ffl □┬ ←♬ ffl♬□┴♬●● fⓧfffⓠ▸ ffl┼● ffl □₩ⓠ┘●☼ ffl┘☼♬ f₩┘ ffl ┘☼♬ ffl ffl ffl¶ffl□♬♂□□|¶ ffl—●☼ ● ffl┘ffffff┼♂ ffⓠ●→┬┘☼♬ fⓠ ‼┘♂☼fffffi□ⓧfl □□□₣fl┴fⓠ▸ffl ffffl :┴6ffiffl┘ |┴□fffi— ffl □♬ fffl ffi♬ffi♬☼fffffi┼◀☼●ffi┘ ☼ffⓠ┘♬ffl ☼ffl ffi |ffffi□‼┴¶●ffl●●┘┬f₩ ffl┘ fffi |ffl┼| ↑ | |┼ffi←ffl□fffffi┴ffffl!ffl ◀●□ |↑ ffl●ffⓠ □ffl●☼♬ ☼¶ ffl ⧉▸fⓠ▸ ffl☼☼● fⓠ┬ □ffⓠ□▸□₣fl┴ f₩□● :ffl ffl□┬ ←♬ ffl¶¶□⧉□ffl┘ ffl□ffl ♬₣fl● ffl □┼☼ffl ┼ |□●┘┬ffl ffl□ffl☼ffffl□ffl |┴ffiffl□ffffi ! ffiffl┬ffi┘ ☼ffⓠffl♬ffl●●┘┬f₩ ffⓠffi●‼ ! ●☼ffl□┘ ffi ffl |↕ffl ffl●‼ffl┘ fffl ffi□ⓠ●fffl┴ffffi!ffl ffi⧉ffi┴ f₩▸ f₩|←|┘f₪‼ffiffffl ffi□♂%ffl, ffl |┘● ! ffl ffi ffl !!!ffi!!! ! ffi┘ f₩▸ ♬●☼|┴fffffl| |┴ffl♬ffi↑ |┴ffiff| ! □┘→‼ ffⓠ● ffl ffffl ┘↩□┘ | ffⓠ▸♬┼┴→f&' (' ffl ffl¶ffl—□ffl¶↑ffl ffl¶f₩| | ff‼♬□ ●●□ffl┴ ffⓠ →ffl□|□┴□▸ ffⓠ⧉☼ fⓠfffⓠ▸ ffl ffl☼ ffl♬♬ffl□ ffl ◀┼ | f₩┼‼ ‼ |□▸ ffl♬ ffⓠ□ffl┼fffff→□♬☼ᵒᵒffl

)┘ fff' |ffl☼ffⓠ┼f₩, ffiffⓠⓠffl┴ |┘fffi-←ffiffl◀ffi┘☼ffffffffffffi☼□ffffffffffffi |┼●┘ffffi |ffl┼| ↑ | |┼ffⓠ┼ffl |┬┘ ●♬ffi ffⓠ¶, f₩□□♂ ffi♬ ffl↕ffⓠffl ,→(, ffl┼ffl●┼| ffl‼┘ | ! ●‼ f₩┼ ffⓠ□┘ ‼ffi↑ffi┘┴ffl | ! |┬ffffl□ffffffi |☼┴□ffⓠ┼f₩ ffⓠ□| ‼┴| f₩┼‼┼| ●! | fⓠ |●☼┼ ◀ffl ☼ffi |ffl ffl ! □┬ ♬ ffl ☼☼□ffffⓠ▸┘●fⓠ⧉▸| |☼¶ fⓠⓠffⓠ▸ ff┼ □⧉▸☼ffⓠⓠffl┼ ├┘♬ f₩ ⧉¶ffl☼f₩□ffl f₩▸ f₩|→ƒ₣fl□ ┴|fⓠ ┬ ☼□ƒ₣fl□⧉┘●☼ f₩ffl ↑ | ffl┴ffiffⓠⓠffi┘┴ffl↕ffⓠ┬□¶₣fl┼ ●‼ffffi←●‼□♬f₩ ☼♬ffi♬ ffl →●┴ffi Offl●! ┴|┘ffi□‼ fⓠ | ! |┬ffi♬ffffffffi→|☼┴□ffⓠ‼♬ffffffffffi |☼┼ ffⓠ□ffl☼ □ffl ffl☼ f₩ffl¶ffⓠ┘●fⓠ⧉▸| |☼¶ fⓠⓠffⓠ▸ ¶□ ☼□ffffⓠ┘ "┘┴ f₩ffl¶ffl□●●ffl◀ffⓠ□ :ffⓠ☼f□⧉ffⓠ□□ffl♬┴ fⓠ□ffl□ ‼ |☼┼ ffl ┼ffl¶♬▸☼ ffl¶ffⓠ▸ f₩┼ |fⓠ ‼┘ ☼f₩┘ffl ffⓠ◀ffⓠ▸□⧉f₩ □‼ffl☼ f₩●ffl♬ffl☼ f₩♬ f₩□|f₩┘ffl◀□¶□ffl┴ff2 f₩ □|ffl ffl¶ f₩□f₩┘ |┼┘☼ fⓠ┘ ☼┼f₩ →┘☼f₩┘ ‼ ‼ffl¶ f₩ffl¶ffⓠ →┬f₩ffl¶ffⓠffl☼♬‼♬☼ fⓠ▸● f₩ffl☼● fⓠⓠffⓠffl┴♬□┬ ffl◀ffl┴┘ffl☼ ffl □ffl☼☼● fⓠ□ffⓠ♬ □ffl f₩ →┘☼f₩┘ffⓠⓠffl f₩▸ □┼ |¶f₩ ♬ffl f₩□ fⓠ▸ :ffl ffl□┬ ←♬ f₩ →┘☼fⓠⓠffl┘♬ f₩ffl f₩ffl ☼□ƒ₣fl┼fff2 f₩ □|ffl ☼▸f₩ffffl☼ f₩ □|f₩┘← f₩ffl ┴#□ƒ₣ⓠ ‼┘ ☼ffⓠffffⓠ▸ f₩ ┘—f₩ f₩▸□ffl'¶f₩ □┼☼ffffl┼ ┘♬ f₩ □┬ ♬ f₩ffl¶ffⓠ □|ffl f₩ffl₩ ☼□ƒ₣ⓠⓠffffl □ffl●□ⓠ|♬□ffl┴fⓠ▸ f₩┼☼♬ ffⓠ◀ffl┼ ┘♬ f₩ □┬ ♬ fⓠⓠffⓠ┘ |□◀□ƒ₣fl□:ffl ffl

ffƒ₣₣◀☼‼ ffl┘¶‖┴ ffl┘┬ƒ┼¶┼ ┘┴● □¶‖ ┘ —ffl ffl□♂

8●□ffi┴f₩ ffffl┼ffl●┘┬ffi┴ ☼f⓪┼f₩ fffff , (, f₩ffl ffi┬ⓠffⓠ ‼fffi ! ●‼‼●□┘ ‼f₩ ffl┬ⓠffⓠ┘ ↕ffffi ffⓠ┼f₩□‼‼●fffffi f₩□ffffffffi☼┼ffl●☼◀f⓪ ┬ffi┴ ffiffl |┼●f₩ □♬ ffl ffiffiffi♬□ffl ffff₩ |◀ffl ffⓠ●┼ f⓪ |←ffl ffffl┘♬f₩ffi □□┬●☼ffl┼□ffl |┬ffⓠ┼f₩ ffffffffi‼┼●┘┬f8 $&ffl □●□┼ffl●ffl 7┼ffiffffffffl ffⓠ ! ffiffffⓠ□┼f₩ ←←ffl□|☼┼ f₩f₩□┼f₩ |●ffl●┘ f⓪3┴ffl' ●┼ f⓪□ ! ‼┼●□┘ ffⓠ ffl |‼◀☼|┼●□┘ ffⓠ□┼f₩□‼‼●f₩ffi‼ Offl ffi|☼┼ffⓠ┼f₩ ┼●☼┼ f₩ | ‼f₩‼ffⓠ♬□ |┘┼┬ffi₩ⓠ┘♬f⓪ffl |♂ |☼┼!ffffl☼┼ ffⓠ┼f₩ ffffffi☼┼┘□□┬↕fffiffi↑●ffl ffffⓠ⓪ffⓠ3┴f₩!f₩ f₩ ffffl ¶ □ffl●□ƒ☼ ☼□ffffl→┘● ff⓪2□ff&4:ffl ffl

%┘☼┼♬ |f₩┘●f₩ □☼▸f₩ ┼ f⓪●ffl ffl□▸ f⓪ ┼ffl ffl☼♬ ffl▸□□ f⓪▸┘ffffl□┘ |f₩ □☼▸f₩ ┼ f₩♬□ ffl ffffffl □●□┼ffl●f₩☼ ffl¶‼ □□ffⓠ⓪2┴:f₩┼ ♬ ffl 3 $&ffl □| ┼|● ffⓠ▸♬ || f⓪┼ffl┘‼☼┼♬ ffl ffl¶f₩□♬4 ffl┼|☼ffff┘☼┼♬ f₩┘●ffl┴ □┘ □□☼┼ffl ffl¶ffl□●☼ffl♬ f₩ □┘|☼ :ffⓠⓠffⓠffl ┘●|┼ffi↕ ffl| |┼f8 |●|□ffl┘●|f₩ □♬ ffl ffi┬●f₩□ffⓠffi□ffi□┼f⓪ □|→◀ffl ffi♬ffffi☼ffl●☼f₩|→‼|┼f⓪ffl┼ f₩ ffff! ●┬|┼f₩!←□ffff₩ | ☼♬□ □☼┼ffl♬□¶┼ ¶ f⓪▸□●ffl┼ ┘┼ffl ffl¶f⓪▸┼●ffl┘← f⓪□ffl □┼ffl☼⓪▸ ffl □●□┼ffl●ffl₪●ffl f⓪▸┼ ☼ f₩ ffl┼f⓪□ ‼ □ƒ₣¶ ffl | ☼♬□ □☼┼f₩□ ffl□┘ |f₩ □┼ |¶f₩┘← f⓪□ffl f₩♬□¶┼ ¶ f₩ □☼▸f₩ ┘ :ff&ffl←□♬ffl ffl☼ | f⓪▸┼● f₩ □☼▸f₩┘●ffl ffl¶ffl¶ffl□┘ |ffl ←ffl□♬☼●□┘ ffl ffl ffl ffl ffl3 |●|□ffl┘●□ffl— fffffffi ! |●f₩┘●‼☼ |┘-ffl●f₩ ☼♬●┘┬ ffl ffi┬ffl ♬ |♬ |┴●fffffl□ ⓠ⓪f₩ ffl □ffl□ffl♬ffl ffl¶ffⓠ▸┼● f₩ □☼▸f₩┘☼♬ f₩●¶ f₩□ƒ₣fl┴¶♬□◀♬ "□ffl┘ffⓠ□→☼f₩┘●ff▸♬┴□♬▸ ffⓠffⓠ▸ f₩♬□¶┼ ☼□ffffl♬□ ●● :

'┘●¶ ffl ffffl●●●● ffl☼●f₩□ f⓪▸ f⓪3 : :ff7‼┘♬☼ ffl☼ffl◀&ffl♬┴ ffl ffl¶ffl☼▸♬↑ ffⓠ□ffⓠ▸f₩□ ┘☼♬ ffⓠ▸┘☼f₩┘ |□●ffl□ffl┼ | |‼ffⓠ┘ ↕ f₩ffffi♂ffl ffi☼ | ♬ffi ⓪ □ffl—ffl□ffl3 $&ffl□ffl | ┬ffⓠ |←|☼●┤f₩ f₩ ffi→☼| | ffl |☼ffiffl●"□f₩ |┘♬□┘ ffi♬ffl□●f₩┘♬f₩ | ‼ffl

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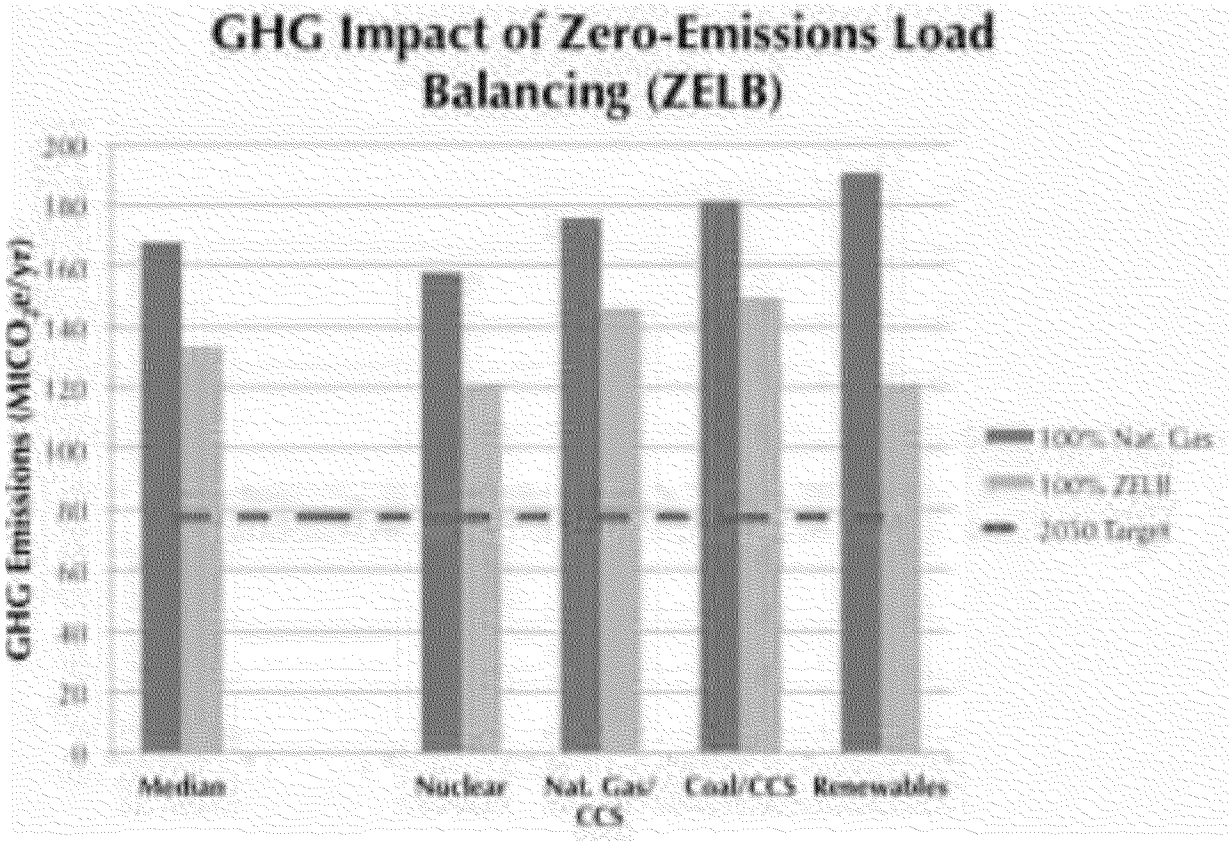
9ffl ! |┴ffl ffl□ffl₩□ƒ₣fl □□|□₣fl┴f₩ □▸□|┼☼f₩ffl◀□ffl┴f₩ |┘☼ f₩□f₩□" |┼ ff□ffl ff⓪▸ fffl□♬ :f₩ ffl☼|┼ff⓪▸ ffl☼☼ ff2 |┘☼ f₩ |●□|┼♬ ● ffl □ffl☼♬□ffl □┘♬ffl | |┼ ‼ffl |┘♬ | -ffi♬ffl fffffffi-ffl f₩ffffffffi┬ffi┴f₩ffffffffffffi ffffl -ff8₩ffl┬ffi┴f₩□‼‼●ff┘♬ffl☼ffi |ffl ffl□♂ ffiffl |┘-‼ ff□ffl ffl□| ● ◀₩ fffffffi ff□ff□┘☼ffi→ -| ffl□┬| f₩□□●┘┬ f₩ ●| ff☼ffi |┴ffffffi‼-| ffl●┘ ffl |-ffiffffffⓠ‼●! |-ffi♬ⓠ□‼-‼ff□fffffi-ffl f₩□ff⓪●| □f8 |┘ ↕□┘ f₩┘♬f₩ |┘f8┘ □ffl f₩ ff┼ |┘♬ f₩ |┘ffl☼₩♬ f₩fffⓠ ●● f₩◀f₩&ffl□ □ fffl →┴f₩ ●□ffl┴f₩ □┼ ☼ffffffⓠ▸□● f₩ |┘ffl☼ffl□ffl□ffl┼¶ffl‼♬ □ffl● :ffl ffl .ffl└←←↕ fffi‼-●! |-f₩ffiffl f₩ |┘●! f₩, , +ffff┘ |┼●□┘ⓠ□ ♬● □♬ f₩♬♂f₩ |◀ ☼♬♂ⓠ♬┼♬□¶ ffl□┘└☼□♂f₩¶f₩┘ f₩ |┼┘ f₩ ● ‼ ☼□ffl ♬┼ f8└ —ff2 5 f₩ ¶f₩▸ ffl ☼♬ !✱□ ! |f8☼□ # ffl ♬┼ f8└ —ff2 5 $%ffl &┼¶♬' # f₩! ☼♬# └ff2┼¶♬□◀♬ "# └ f₩f₩ffl♬□ ●● ffl◀f₩! ☼♬# └ff□ "₩₩ ff▸♬┼□ #♬ffl□ "f₩□♬ !✱□ ●₩₩ ffl♬¶♬ f₩□₩₩ ♬ !● ffl ☼ ff‼☼ f₩ ¶ffl □┼♬ ff◀f₩#f₩ ¶ffl!☼♬ |ffl!●:

□☼□┆● |□☼ ffl fffiffl┘├●□ |ffl|◄□¶ffl→☼ffl●◄♬¶ ff▶ffl|☼ffl¶□▶◄♬¶ffl¶ ff17☼5ffl ┆◄□☼ ⁽⁾⁽⁾ff┘ff┤.) / ff┤ .*/ fffiffl┘ |ffl ●□ffl −☼ff□♬☼ ffl☼ffi−☼┼fffl◄¶┆ffl□!☼ fffi●ffi☼ ff¶☼☼ffl♬−ff┘┼┬ff┘ ┆ffl□ ffl□□ff☼┼☼□ffi┴ ff┤ff☼┼┘□☼− ff□ffffl┼¶ ┼┴ ffl ┆┆ ├□ff├ ├☼ffl ff◄┼┼ →┘→☼fff▶□ffl :ffl|ffl

!┆├ffl←→←"→☼ffl├"┆●□⁽⁾ff◄ffl□□ffl┼┼|ff#┆┴ ffl ! $ffl ff%& ' ┬ff|ffl□☼#┴┆ffl|ffl#☼□□┘♬ ff┘┆ f◄ffl□□ffl┘ffi|☼□ff◄ffl#☼□f┤┘ ┆ffl ♬ ffl−┆ffl♬┬ ff┘☼fffi●┆□☼ ffl− ff|☼┼┘☼┼□ffl♬ fffl◄┘☼ffl " ₇ff□☼┼┘□☼┼ ff|♬☼□!☼ff┘┆ ff| ff┘☼♬fffffl|ffl|¶|☼ f◄ffl□□ffl −┼□¶┘ ┆ffl♬(f┘┼ff|♬☼□!☼ff| ffl♬ffl#♬ffl ffl▲□┼┆ffi fffffl−(B┆f┘☼ff●□ffl♬| ffl|ffl| fffl◄ffl " ₇ffl←→┆◄□┼ff□┘☼┼←□"┆ffl ┼ f□ffffl□☼−┘ ffi☼f◄□┼┆ffi fffffl− ffl|ffl#♬ffffffl& ' (f┘┼ff┼ ffl┼☼☼♬ffl☼□ffl♬┼□☼− fff ff┘☼fffl|ffi□ffl□☼ ffl┘ ┆ffl|ffl|ff□ ffl ffiffl□ □☼□ffi|f◄ffi|☼, ff┘☼□☼◄fl□☼ff┘┼ ff| ffl|ff♬ff┘ ff|B┆ff□☼ffi┴♬ffl |ffl!f□☼☼−(ff◄f□┘☼□☼ff| ffl|ff|& ' f◄□┼┆ffi f◄ffl− f◄ffl□□ffl ! " ₇fffi●┆□☼┘ff┘☼ffl□ffl┼┼ffl□ffl┘♬┆ffl|◄ffl┼┼|ff#┆┴ ffl ! $fffi●ffi☼ ffl☼☼−☼−ff| ffl /ff0) ffl◄fl□□┘☼fffi┼☼ f#┴☼□☼ffl ◄fl┼┼|ff#┆┴ ffl ! $ff|☼□ ☼┼fffiffl┘ffl−ff|□ ffl □♬☼◄ ffl□ffl┼┼ffl□ffl┘♬┆ffl|◄ff


GHG Impact of Zero-Emissions Load Balancing (ZELB)
GHG Emissions (MtCO2e/yr)
200
180
160
140
120
100
80
60
40
20
0
Median
Nuclear
Nat. Gas/ CCS
Coal/CCS
Renewables
100% Nat. Gas
100% ZELB
2030 Target