TODAY’S AGENDA

✓ Negawatts & Negatherms
✓ Energy Efficiency in Perspective: Less really is better
✓ The Case for GSHP: “If you’re so smart, why ain’t you rich?”
✓ Project Report: Nine Points of Light (Four Real Bright)
✓ Preliminary Findings
WHAT’S IN A NAME: THE GENESIS OF THE NEGATHERM
US Energy Consumption By Fuel

<table>
<thead>
<tr>
<th>Fuel</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
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<tbody>
<tr>
<td>Petroleum</td>
<td>40</td>
<td>40</td>
<td>40</td>
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<tr>
<td>Coal</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Natural Gas</td>
<td>23</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>Nuclear</td>
<td>24</td>
<td></td>
<td></td>
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<tr>
<td>Hydroelectric</td>
<td>8.1</td>
<td>8.2</td>
<td>8.4</td>
</tr>
<tr>
<td>Biomass</td>
<td>2.7</td>
<td>2.9</td>
<td>2.5</td>
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<tr>
<td>Geothermal</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Solar/PV</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
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<tr>
<td>Wind</td>
<td></td>
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Renewables:

Source: EIA, Annual Energy Review
Comparison of 3 Gorges to Refrigerator and AC Efficiency Improvements

三峡电量与电冰箱、空调能效对比

<table>
<thead>
<tr>
<th></th>
<th>3 Gorges</th>
<th>Refrigerators</th>
<th>3 Gorges</th>
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</thead>
<tbody>
<tr>
<td>Wholesale (3 Gorges) at 3.6 c/kWh</td>
<td>TWh/Year</td>
<td>Value of TWh</td>
<td></td>
</tr>
<tr>
<td>Retail (AC + Ref) at 7.2 c/kWh</td>
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Air Conditioners

- If Energy Star
- 2005 Stds
- 2000 Stds

Refrigerators

- If Energy Star
- 2005 Stds
- 2000 Stds

Savings calculated 10 years after standard takes effect. Calculations provided by David Fridley, LBNL
FILLING IN THE “WHITE SPACE”

Cumulative GWh Savings

- **Current Goals (gross equivalent)**
- **Current Goals (net)**
- **IOU Programs**
- **Economic**
- **Huffman Bill**
- **BBEES**
- **T24+Fed Standards**

**savings eligible to be partially claimed by IOUs**

**CPUC**

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<tr>
<td>Cumulative GWh Savings (gross equivalent)</td>
<td>0</td>
<td>5,000</td>
<td>10,000</td>
<td>15,000</td>
<td>20,000</td>
<td>25,000</td>
<td>30,000</td>
<td>35,000</td>
<td>40,000</td>
<td>45,000</td>
<td>50,000</td>
<td>55,000</td>
<td>60,000</td>
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</tbody>
</table>
THE BUILT ENVIRONMENT: 40%+ OF ENERGY, 43%+ CARBON
RETROFACT: OVER 70% OF BUILDINGS IN 2050 EXIST NOW
Green Building Materials & Technologies

Cum Gt CO₂ eliminated

€/t CO₂

0 0.50 1.0 1.5 2.0 2.5 3.0 3.5 4.0

-200 -150 -100 -50 0 50

New-build insulation
Building envelope
Retrofit floor/roof
Appliances
Lighting
Retrofit floor/roof
A/C
Windows
Heaters
Washers/dryers
Fridges/freezers
Retrofit facade

4B tons CO₂, negative cost

Sources: McKinsey & Co.
RESIDENTIAL ENERGY DEMAND

Residential Gas Usage
- Hot Water: 44%
- Heating: 44%
- Clothes Dryer: 8%
- Cooking: 4%

Residential Electric Usage
- Kitchen: 27%
- Lighting: 9%
- Electronics: 7%
- Other: 10%
- Laundry: 7%

70% of Household Energy Budget
55% of Carbon Footprint
GSHP MARKET NUMBERS

• 2009 US GSHP MARKET = $3.7 BILLION (PMG)
• 2013 US GSHP MARKET = $11.1 BILLION (+300%)
• EE COMMERCIAL SECTOR = $18 BILLION ANNUAL (X10)
• COMMERCIAL RETROFITS = 360,000 JOBS (RIMS)
• 2011 HVAC EQUIPMENT MARKET = $16.8 BILLION (Freedonia)
• 30% RESIDENTIAL CREDIT, 10% COMMERCIAL “GRANT”
• FEDERAL, STATE AND MUNI INCENTIVES
• PROPERTY ASSESSED CLEAN ENERGY (PACE) BONDS
HOUSE LIKE A TREE

WILLIAM MC DONOUGH + PARTNERS
Architecture, Community Design, and Consulting

Most roof and wall surfaces are "photosynthetic"—generating energy or producing oxygen and sequestering carbon. Integrated photovoltaic and solar thermal hotwater roofing systems make this home a net energy exporter while green roofs slow stormwater runoff, filter water, and support biodiversity.

CRADLE TO CRADLE MATERIALS
Building materials are cycle throughout their life cycle and are used in ways that facilitate disassembly for reuse or return to the earth.

GROUNDSOURCE HEAT PUMPS
Heat pumps utilize the earth's temperature to heat, cool and provide hot water for the home.

SMART GRIDS
Car batteries store captured solar energy.
EE #1 IN CALIFORNIA’S “LOADING ORDER”

- Energy efficiency
- Demand response
- Distributed generation
- Renewable generation
- Cleanest available fossil resources
PROJECT NEGATHERM:
Overcoming Barriers to Borehole Drilling in California

1. Literature Review
2. Local Regulation Review
3. Consumer Survey
4. Stakeholder Interviews
5. Driller Survey
6. Field Research
7. Financial Model Research
8. Web Information Modules
LITERATURE REVIEW

Patrick Hughes, 2008

• 3.4 to 3.9 Quad BTU Annual Negatherms from aggressive deployment
• 91 to 105 GW avoided electricity generation
• $33 to 38 billion annually in reduced utility bills (2006 rates)
• Existing buildings must be improved with single, comprehensive deep-savings retrofits
• Ground loops should compare to overhead wires as a utility
REGULATION & CERTIFICATION

“A patchwork of appropriate and inappropriate responses”
58 Counties in search of a standard

Frequency of Local Permitting Fees for a typical 3 ton/3 borehole residential GSHP system

Imperial County = $4,100
REGULATION & CERTIFICATION

- Recognize the awesome potential of GSHP
- Move mindset from DWR Problem to ZNE Solution
- Consider closed-loop bores separately from water wells
- Centralize state-level permit administration
- Standardize permitting fees
- Carve out a closed-loop driller sub-classification
- Educate permitting authorities
- Sunshine well completion information
- Adjust utility rate schedules for GSHP
- Give GSHP the same property tax assessment as solar
- Include GSHP as key EE program tool
CONSUMER SURVEY

• Insight into the California Green Consumer: Susan
• 250+ Completed web surveys across SoCal and NorCal, Coastal, Inland and Mountain
• The greatest barrier to adoption to greener solutions is lack of consumer awareness about their benefits
• 69% of “green” consumers had no awareness of GSHP
• 2% surveyed had GSHP, 10.5% Propane, 24% Electric heat
• 31% preferred an on-bill utility payment for EE
INFORMATION: WHAT A CONCEPT!

Huge jumps in positive perceptions towards GSHP compared to other greener solutions with even a minimal amount of information. Especially true of cost and credibility concerns.

<table>
<thead>
<tr>
<th></th>
<th>Coastal Before Concept</th>
<th>Coastal After Concept</th>
<th>Inland Before Concept</th>
<th>Inland After Concept</th>
<th>Mountain Before Concept</th>
<th>Mountain After Concept</th>
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<tr>
<td>Payback period</td>
<td>7.1%</td>
<td>60.0%</td>
<td>3.9%</td>
<td>70.3%</td>
<td>5.7%</td>
<td>75.5%</td>
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<tr>
<td>Cost to maintain</td>
<td>7.1%</td>
<td>41.4%</td>
<td>1.6%</td>
<td>64.8%</td>
<td>7.5%</td>
<td>64.2%</td>
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<tr>
<td>Credibility of claims/ratings</td>
<td>5.7%</td>
<td>41.4%</td>
<td>0.8%</td>
<td>50.0%</td>
<td>7.5%</td>
<td>62.3%</td>
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<td>Cost to operate</td>
<td>8.6%</td>
<td>48.6%</td>
<td>3.1%</td>
<td>63.3%</td>
<td>0.0%</td>
<td>60.4%</td>
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<tr>
<td>Lead time to install</td>
<td>1.4%</td>
<td>40.0%</td>
<td>3.1%</td>
<td>40.6%</td>
<td>9.4%</td>
<td>60.4%</td>
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<tr>
<td>Ease of financing</td>
<td>4.3%</td>
<td>45.7%</td>
<td>3.9%</td>
<td>51.6%</td>
<td>1.9%</td>
<td>60.4%</td>
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<td>Length of warranty</td>
<td>8.6%</td>
<td>40.0%</td>
<td>0.0%</td>
<td>51.6%</td>
<td>1.9%</td>
<td>58.5%</td>
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<td>Availability of incentives</td>
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<td>42.9%</td>
<td>4.7%</td>
<td>52.3%</td>
<td>3.8%</td>
<td>56.6%</td>
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<tr>
<td>Space need to site system</td>
<td>11.4%</td>
<td>32.9%</td>
<td>4.7%</td>
<td>48.4%</td>
<td>5.7%</td>
<td>56.6%</td>
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<td>Cost to purchase</td>
<td>5.7%</td>
<td>40.0%</td>
<td>5.5%</td>
<td>52.3%</td>
<td>3.8%</td>
<td>56.6%</td>
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<tr>
<td>Hassle factor to install</td>
<td>11.4%</td>
<td>32.9%</td>
<td>5.5%</td>
<td>43.8%</td>
<td>3.8%</td>
<td>56.6%</td>
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<td>Ease of permitting</td>
<td>4.3%</td>
<td>34.3%</td>
<td>4.7%</td>
<td>42.2%</td>
<td>3.8%</td>
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<td>Availability of products</td>
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<td>25.7%</td>
<td>1.6%</td>
<td>37.5%</td>
<td>5.7%</td>
<td>49.1%</td>
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<tr>
<td>Availability of installation providers</td>
<td>2.9%</td>
<td>25.7%</td>
<td>2.3%</td>
<td>31.3%</td>
<td>1.9%</td>
<td>49.1%</td>
</tr>
</tbody>
</table>
STAKEHOLDER INTERVIEWS

- 25+ Representatives from inside GSHP industry interviewed
- Marketing, branding and terminology (GSHP, Geothermal, GeoExchange)
- Consumer mindset and decision-making
- GSHP technology adoption
- Regulatory and other barriers to adoption
- Borehole drilling
DRILLER SURVEY

• California Groundwater Association Support
• Comparing Drillers inside and outside California
• Business issues, Water Wells vs. GSHP
• Sales Cycles
• Customer Interaction, Education
• Project Time Management
• Local Regulation, Fees
• Operating Certifications
• Operator Education
THE ROAD BEYOND

✓ Technical & Financial Hurdles
✓ Field Research
✓ Financial Model Research
✓ Web Information Modules
PROJECT NEGATHERM: Some Preliminary Findings

- GSHP = greatest hope for EE
- Local regulators want state guidance
- Consumers not at all aware of GSHP
- They like what they hear
- They want a utility solution