Updates on Electro-magnetic Field Exposures and Health Effects Literature

California Department of Public Health
Division of Environmental and Occupational Disease Control
Special thanks to California Breathing
Electro-magnetic Spectrum
Electro-magnetic Wave
Agenda

- **1:30** Introduction—why are we holding this webinar?  
  10 minutes  
  Rick Kreutzer

- **1:40** Current status of EMF and health research  
  20 minutes  
  Leeka Kheifets

- **2:00** CA Public Utilities Commission EMF Policy for New Transmission Line Projects  
  15 minutes  
  Jack Sahl

- **2:15** Public health assessment of transmission line expansion—local experience  
  15 minutes  
  Andrew Deckert

- **2:30** Cell phones, smart phones, high speed networks and precautionary policies  
  15 minutes  
  Raymond Neutra

- **2:45** Panel discussion and response to questions  
  15 minutes  
  All

- **3:00** Conclusion of webinar
Dr. Leeka Kheifets is a Professor of Epidemiology in the UCLA School of Public Health. Most recently she was Head of the Radiation Studies Program at the World Health Organization. Previously she was a Technical Executive at the Electric Power Research Institute, where she directed a multi-disciplinary electric and magnetic fields (EMF) research program. She taught at the Stanford University School of Medicine in the Department of Health Research and Policy. She is widely known for her work in environmental and occupational epidemiology and has numerous publications. Dr. Kheifets serves on international and national committees that provide advice to governments on environmental policy. She is a member of the International Committee of the Swedish Radiation Protection Authority (SSI). She has served on committees for the National Academy of Sciences, Institute of Electrical and Electronics Engineers, and National Council on Radiation Protection and Measurements. Dr. Kheifets is a member of the standing committee on Epidemiology of the ICNIRP and participated in EU EMF-Net reviews. Dr. Kheifets was also a member of the National Institute of Environmental Health Sciences, the International Agency for Research on Cancer and World Health Organization Working Groups charged with evaluating potential health effects from EMF exposure. Her research interests include epidemiology of cancer, cardiovascular and neurodegenerative diseases, as well as a methodologic research in risk assessment and policy development.
Jack D. Sahl, Ph.D., M.S., M.P.H.

- is the Director of Resource and Environment Sustainability, and is building sustainability programs for Southern California Edison internal operations. Prior to this, Jack was the Director of Corporate Environment, Health & Safety; this department included Corporate Environmental Services; Environmental Projects (e.g., remediation and mitigation); Corporate Safety (including Public Safety and EMF issues management); and Corporate EH&S Compliance. SCE is a vertically-integrated electric utility company, providing service to 6 million customers over a 50,000 square-mile Service Territory.

- Dr. Sahl earned his doctorate in Epidemiology from the UCLA School of Public Health after receiving a Master of Science degree from the University of Minnesota and a B.S. in chemistry and biology from La Verne College. Jack has extensive experience with a wide range of public and worker health and safety issues, including PCBs, work injuries, and electric and magnetic fields from electric utility and telecommunication facilities. Jack performs original research, with over 35 publications in scientific journals. Jack is particularly interested in EH&S performance management, risk communication and public health policy development for emerging health and safety issues. Jack has been a key architect of the California and U.S. federal policy response for the EMF issue. Dr. Sahl has worked on the EH&S issues for the World Health Organization and governments or industry in Australia, Canada, Europe, Japan, and the United States.
Andrew Deckert, M.D., M.P.H.

- has served Shasta County as its Health Officer for the past 16 years. Prior work includes Health Officer of other California counties, family practice in county hospitals, emergency rooms, community and migrant health centers, and private family practice. He has served on the board of directors or governing councils of the Public Health Leadership Society, the California Academy of Preventive Medicine, his local medical society, and the California Conference of Local Health Officers. In 1992, he was in one of the first cohorts of the Centers for Disease Control and Prevention's year-long Public Health Leadership Institute for senior public health officials, and has received the Henrik Blum Award for public health professionals in California. He obtained his Master's of Public Health in International Health from the University of Hawaii, his medical specialty board certification in Family Practice via a UC Davis affiliated residency in Stanislaus County, and his medical specialty board certification in Preventive Medicine and Public Health via a residency with the California Department of Health Services. He is passionate about improving the public’s health in general, chronic disease and injury prevention (including through the built environment, policy change and health equity), and public health practice at the local level with a great multi-disciplinary team of colleagues at Shasta County Health and Human Services Agency--Public Health. He and his wife, a local family physician, have 3 teen sons.
Raymond Richard Neutra, M.D., C.M., M.P.H., Dr. P.H.

- Retired in December 2007 as Chief of the Division of Environmental and Occupational Disease Control (DEODC) after 27 years at the California Department of Public Health (CDPH).
- Dr. Neutra was also the Chief of the Electric and Magnetic Fields Program (EMF), a multi-year study of policy related research.
- He has served on the scientific advisory boards of the National Institutes of Health, the Agency for Toxic Substances and Disease Registries and the World Health Organization where he chaired a workshop on the precautionary principle.
EMF and Health: Selected Topics

Leeka Kheifets
Professor
UCLA
Outline

- Exposure – ELF and RF
- Epidemiology – selected stories
- Risk Assessment
- Policy – few words
EMF Health Issue: A Review

First, electric fields here
- Short-term
- Noncarcinogenic
~1987
Then, magnetic fields everywhere
- Residence
- Workplace
- Many endpoints
~1998-present
Now, magnetic fields in residences
- Childhood leukemia
- Other assorted

Leeka Kheifets
Magnetic Field Sources

Sources of Residential Magnetic Fields

- GROUNDING
- TRANSMISSION LINES
- DISTRIBUTION LINES
- APPLIANCES

Leeka Kheifets
Some Typical Magnetic Field Levels Found at Home:

- Clothes washer:
  - 0.03 m: 0.8-40 μT
  - 0.3 m: 0.2-3 μT
  - 1 m: 0.01-0.2 μT

- Television:
  - 0.03 m: 2.5-50
  - 0.3 m: 0.04-2
  - 1 m: 0.01-0.2

- Electric range:
  - 0.03 m: 6-200
  - 0.3 m: 0.4-4
  - 1 m: 0.01-0.1

- Microwave oven:
  - 0.03 m: 75-200
  - 0.3 m: 4-8
  - 1 m: 0.3-0.8

- Fluorescent lamp:
  - 0.03 m: 40-400
  - 0.3 m: 0.5-2
  - 1 m: 0.01-0.3

- Electric razor:
  - 0.03 m: 15-15,000
  - 0.3 m: 0.1-9
  - 1 m: 0.04-0.3

- Hair dryer:
  - 0.03 m: 6-2,000
  - 0.3 m: 0.1-7
  - 1 m: 0.01-0.3

- Conventional electric blanket:
  - 0.01 m: 10 μT
  - Avg. in body: 1.5 μT
  - 1 m: < 0.1 μT

- New "low magnetic field" electric blanket:
  - 1 m: 1
  - Avg. in body: 0.15
  - 1 m: < 0.01
Note that...

- Exposure comes from many sources
- Distance to the source is the major determinant of exposure
- Exposures are prevalent and highly variable
- High prolonged exposures are rare
Many Diseases have been studied...

- **Cancer**
  - Children
    - Leukemia
    - CNS
  - Adults
    - Leukemia
    - CNS
    - Breast cancer
    - Other hormone dependent cancers

- **Sporadic Investigations of:**
  - Lung cancer
  - Non-Hodgkin’s lymphoma
  - Melanoma
  - Testicular cancer
  - Prostate cancer
  - Myocardial infarction
  - Neurodegenerative
  - Depression
  - Suicide
  - Hypersensitivity
Breast Cancer

- Major women’s health (& public health) issue
- Tied to EMF, based mainly on prior laboratory research
- Biological Hypothesis:
  - EMF → Melatonin → Cancer
Breast Cancer Early Evidence

- Epidemiologic studies largely negative
  - None designed to test specific hypothesis
- Animal studies inconsistent
  - German and US results inconsistent
- Several laboratories report effects in MCF-7 cells
  - Effect seen only in certain type of cells
  - ? relevance

Leeka Kheifets
Breast Cancer

- Well-designed residential and occupational studies with comprehensive exposure assessment found no indications of increased risk.

- The weight of the evidence available today suggests that power frequency magnetic field exposure is not a risk factor for female breast cancer development.
Figure 5: Age-specific incidence rates of cancer in children and adolescents in Europe. Values test difference between first and last decade.
Pooled Analyses of Childhood Leukemia

- Greenland et al., *Epidemiology*, 2000
  - 12 studies with fields; 4 with wire codes
  - Field studies: 2,656 cases; 7,084 controls
  - Metric of choice: time-weighted average

- Ahlbom et al., *British J. Cancer*, 2000
  - 9 studies with fields; 2 with wire codes
  - Field studies: 3,247 cases; 10,400 controls
  - Metric of choice: geometric mean
Ahlbom et al., 2000

RR
95% C.I.

μT

< 0.1 0.1 - < 0.2 0.2 - < 0.4 ≤ 0.4

≤ 0.4

Leeka Kheifets
Consistent association between childhood leukemia and exposure $> 0.3-0.4 \, \mu T$

Possible explanations:
- Chance???
- Misclassification??
- Confounding??
- Selection bias?
- Other?
- Causal relationship?
### Agents Classified by IARC (938)

<table>
<thead>
<tr>
<th>IARC Classification</th>
<th>Examples of Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carcinogenic to humans (108)</strong></td>
<td>Asbestos, Alcoholic beverages, Benzene, Mustard gas, Radon gas, Solar radiation,</td>
</tr>
<tr>
<td>(usually based on strong evidence of</td>
<td>Tobacco (smoked and smokeless), X-rays and Gamma</td>
</tr>
<tr>
<td>carcinogenicity in humans)</td>
<td><strong>Probably carcinogenic to humans (66)</strong></td>
</tr>
<tr>
<td></td>
<td>Creosotes, Diesel engine exhaust, Formaldehyde, Polychlorinated biphenyls (PCBs)</td>
</tr>
<tr>
<td><strong>Possibly carcinogenic to humans (248)</strong></td>
<td>Coffee, ELF magnetic fields, Gasoline engine exhaust, Glass wool, Pickled vegetables,</td>
</tr>
<tr>
<td>(usually based on evidence in humans which is</td>
<td>Styrene</td>
</tr>
<tr>
<td>considered credible, but for which other explanations</td>
<td></td>
</tr>
<tr>
<td>could not be ruled out)</td>
<td></td>
</tr>
</tbody>
</table>
IARC and WHO Evaluation
Extremely Low Frequencies (ELF) 2002, 2007

- ELF magnetic fields classified as Group 2B “Possibly Carcinogenic” based on
  - limited human data (epidemiologic studies) of childhood leukaemia
  - inadequate animal data

- Other exposures and outcomes considered “inadequate to classify”

Leeka Kheifets
Causality problems:

- Biophysical mechanisms: plausibility becomes shaky below 50 µT
- *In vitro* models: lack of robust and reproducible effect
- Lack of support from animal data
Interpretations for policy development

- Not proven – no need for action
- Low/no cost PP based on childhood leukemia (Kheifets et al. 2005, WHO 2007)
- Enough evidence for 0.2 µT limit according to Kundi et al. (2006)
- Extrapolation from tox leads to 10 µT Limit (Valberg 2006)
- Other outcomes (adult leukemia, brain, breast cancer, ALS, miscarriage) need to be considered thus much larger expense justifiable under PP (Henshaw et al. 2007, Bioinitiative 2008)
21ST CENTURY VISION

Flexible, Multi-Functional Network
History of RF Research

- First changes in biological parameters in laboratory ~1970
- Positive animal studies on embryo and fetal development due to heating ~1980
- Positive animal studies on effects on brain
- Increased cancer incidence with proximity to radio and TV transmitters ~1990
- Start of active research on mobile telephony ~2000 - present
Mobile phone and Cancer studies

- Focus has been on tumors in the head and neck region
- Mostly brain tumors
  - Glioma, meningioma, acoustic neuroma
- A few studies on parotid gland tumors
- Single studies on uveal melanoma, lymphoma, other tumors
Brain tumors and mobile phone use - conclusions

Taken together, evidence supports that short-term mobile phone use (<10 years) do not affect risk. For long-term mobile phone use, >10 years, more uncertainty. No data available for use more than 15–20 years. Mobile phones are still relatively new. No data available on children.
Difference in Interpretation:

![Graph showing OR values with study references and markers for ever/never and maximum](image)
Difference in Interpretation:

- Indication of increase for long term heavy users?
  - Selection bias
  - Proper comparison: non-users vs. light users

- Recall bias when reporting side of use likely explanation?

- Differential recall by disease status and length of exposure
Children are NOT Small Adults

- Children’s anatomy and physiology is different
- Children’s diseases are often different ...
- Children’s exposure can be different ......
- Numerous examples of increased vulnerability
Not Sufficiently Studied:

- Better exposure assessment – including personal dosimetry
- Cancer in Children
  - Brain Tumors
  - Leukemia – high exposure to bone marrow
- Cognitive
- Behavioural
- IQ
- Reproduction
  - Sperm

Leeka Kheifets
Different Perspectives on Cost of Research:

- Current estimate: 10 million per year worldwide – too much?
- If we spend 1 cent per user per year: 40 million – too little?
- If we spend 1 cent per user per billing cycle: 480 million

Leeka Kheifets
TKS 4 LIS10ING

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Leeka Kheifets
California’s EMF Policy

California Public Utilities Commission

Jack Sahl
Southern California Edison
CPUC EMF Proceedings

• Jan. ’91 – OII to develop EMF policies.
• Oct. ’91 – EMF Consensus Group formed
  – Investor-owned utilities (SCE, PG&E, SDG&E, SMUD, PacifiCorp), Fund for the Environment, Citizens Concerned about EMFs, CAUSE, American Academy of Pediatrics, American Industrial Hygiene Association, California Parents Teachers Association, Division of Ratepayer Advocates, Electric Power Research Institute, Environmental Health Coalition, International Brotherhood of Electrical Workers, AFL-CIO, Sage Associates

• Mar. ’92 – Consensus Group Report
  – Submitted to CPUC
  – 26 recommendation on research, education, and policy
• Dec. ’92 – Evidentiary hearings
• Nov. ’93 – CPUC EMF Decision issued
CPUC EMF Decision 93-11-013
November 2, 1993

• No-cost and low-cost steps to reduce EMF
• EMF Research – CDHS and NIEHS
• EMF Education Programs – CDHS and Utilities
• Measurement of EMF for Customers
• Stakeholder involvement
EMF D. 06-01-042

- EMF OIR R.04-08-020 - Explored whether changes should be made to existing CPUC policies and rules concerning EMF from electric utility facilities
- Affirmed its existing No-and low-cost field reduction policy
  - Low-Cost: about 4%
  - 15% reduction in calculated magnetic fields
- Ordered new utility design guidelines
- Confirmed computer models not intended to predict field levels
- No numeric standard
  - “We are unable to determine whether there is a significant scientifically verifiable relationship between EMF exposure and negative health consequences.”
FMP Guidelines for Magnetic Field Reduction Measures

- Approximately 4% of Total Project Cost for EMF Reduction Measures,
- 15% or more Magnetic Field Reduction,
- Design & construction of all electric power systems must comply with all applicable federal, state, and local regulations, applicable safety codes, and SCE design standards,
- MF reduction measures are not based upon any numeric values or limits,
- Possible EMF reduction measures, therefore, must meet requirements listed above…
Prioritizing Areas

• Apply “No-Cost” option(s) first that can be uniformly applied to the entire project.
• Apply “Low-Cost” options in the following order
  – School (existing or under development), Day-Care Center, Hospitals
  – Residential
  – Commercial/Industrial
  – Recreational
  – Agricultural
  – Undeveloped land
Possible MF Reduction Measures Are:

- Site Selection
  - Try to site power lines or substations away from most occupied spaces
  - Try to site MF sources (such as XFMR, switchgear, meter panels, etc.) away from occupied spaces.
- Distance
  - Increase conductor height or U.G. cable depth
  - Site power lines closer to the centerline of the corridor
  - Reduce conductor (phase) spacing
- Phase New Power Lines for MF reduction
- Re-Phase existing power lines in corridors
Design Makes a Difference
Example: Pole-head configuration makes differences...

Loading = 250 Amp
Phasing Transmission Circuits
Magnetic Fields Reduction by Increasing Pole Height by 5 ft Increment
Daily Power Demand Changes … and MF exposure from a power line changes over time which is why future fields can’t be predicted.
FMP Process

MF Reduction Evaluations and FMP Documentation

- **Project Need**
- **Site/Route Selection**
- **Preliminary Design & Various MF Reduction Options**

**Prioritization of Land Usage**
- **15% or more Reduction?**
  - **Yes**
  - **No or Low-Cost?**
    - **Yes**
    - **No**
      - Document Reasons for Rejections
  - **No**

Document Recommendations
Public attacks proposed 600-mile power line through Northern California

Nearly 200 Shasta and Tehama County residents packed a Red Lion Hotel ballroom in Redding on Monday evening to pepper public power transmission officials with skeptical and sometimes hostile questions about a proposed 600-mile line that would cut through north state forests and plant 150-foot towers before mountain views.

• By Scott Mobley, Redding Record Searchlight
  • Posted April 14, 2009
North Segment: Preliminary proposed TTP routes
Hundreds meet to oppose power line

COTTONWOOD – Nearly 350 people packed the North Cottonwood Elementary School multipurpose room this evening to organize against a proposed 600-mile power line stretching from northeastern California to the San Francisco Bay area that would bisect Shasta and Tehama counties.

Les Baugh, Shasta County supervisor, and Charles Willard, Tehama County supervisor, urged the standing room only crowd to telephone, send e-mail and write letters to the Western Area Power Administration (WAPA) and the Transmission Agency of Northern California (TANC), the two agencies conducting environmental review for the $1.5 billion transmission line.

“If anyone has a doubt this is real, think again,” Baugh told the crowd. “This is real. There is strength in numbers. You need to organize.”

By Scott Mobley, Redding Record Searchlight    Posted May 14, 2009 at 9:51 p.m.
LHD and DEIR

• WHO scientific review has shown links between certain EMF exposures and childhood leukemia


  ▪ WHO summary document

    Extremely Low Frequency Fields
    Environmental Health Criteria Monograph No.238


• What types of questions might LHD consider for an EMF draft Environmental Impact Review (DEIR)?
Electromagnetic Fields and Health ?’s

- What cumulative potential health affects will be created by the addition of these power lines on residents along the route, including long-term exposure to low intensity EMF?

- At what levels will residents be exposed to EMF in population centers along the route? Plans to reduce exposure?

CPUC Design Guidelines:

- In addition to cancers, what is the evidence in the scientific literature related to non-cancer human health outcomes and power-frequency EMF (eg miscarriage, Lou Gehrig’s disease)?
Are there any studies on power-frequency EMF and DNA strand breaks, including at fairly low intensities?

What impact will vegetation removal and control have on resident species, including humans? This includes the impacts of herbicides not only to resident animal species, but on drinking water supplies, pesticide drift in the air and other potential impacts to neighboring communities and individual homes.
Noise/Interference

• What electro magnetic interference will be created along the route and what will its potential human impacts be? Will the project create any interference that could interact with implanted medical devices (eg cardiac pacemakers)?

• What effects will low level but audible noise from corona discharge have on residents along the proposed route?
Other-

- Are there any telecommunications facilities associated with this project and if so, what levels of EMF exposure are expected from those telecommunication facilities?

- What might be the electrical safety issues from project-induced electrical currents and human electric shock potential?

- Is there a disparity in median income between residents along these routes and income of residents where the bulk of the power is used? Significant disparity resulting in the bulk of impacts assigned to lower income communities along the route creates a health equity issue that will need to be identified and mitigated.
• Additionally, alternative routes should be evaluated that do not place a disproportionate burden of impacts on economically depressed or rural communities.

• There is no project description of the power projects that will use these lines. Without an accurate description of these projects, environmental review and related questions about the potential human health impact, such as a Health Impact Assessment (HIA), are being deferred and should be answered before proceeding or resuming.

• Given the scientific evidence on the benefits of contact with nature to individual and community mental well-being, what will be the project impacts on mental health?
What is the impact of corona discharge on the production of ozone and expected impact of the increased ozone on initiation or exacerbation of chronic lung disease?

What are the growth inducing impacts from the population increase attributable to this significant expansion of infrastructure?

What are the impacts on global warming from CO2 production subsequent to the expansion of population, increased vehicle miles traveled, and the related promotion of sedentary lifestyle, decreased physical activity, increased obesity and subsequent health impacts from diabetes, heart disease, vehicle injuries etc?
Faraway power companies are the big players in TANC proposal

Four faraway power companies are depending on power lines crossing over north state residents' heads, homes and vistas to help the utilities meet renewable energy mandates and unclog congested lines.

Utility companies in Sacramento, Santa Clara, Modesto and Turlock will pay more than 98 percent of the $1.5 billion it takes to build high-capacity power lines for the Transmission Agency of Northern California. Redding's utility company has a mere 1.7 percent share.

By Ryan Sabalow, Redding Record Searchlight

Posted June 7, 2009 at midnight
Record Searchlight view of lessons learned
Transmission battles are only beginning

Our view: A state report on renewable energy is a reminder that the pressure for new power lines is intense despite the TANC project's demise.

Irate citizens can pull the plug on one power line, but California's energy developers won't stop hunting for new outlets.

That's one message out of last week's report from the Renewable Energy Transmission Initiative, a state-sponsored survey of potential nonpolluting electricity sources and the new power lines needed to connect them to our crowded cities.

Ironically, it was an earlier RETI report that helped galvanize opposition to the Transmission Authority of Northern California's project. It showed that eastern Lassen County was a relatively poor source of alternative power.

The latest RETI study hammers home the fact that, even though TANC - a coalition of municipal utilities including Redding Electric - ended its proposed power lines through the north state earlier this summer, this story is just beginning.

Redding Record Searchlight   Posted August 19, 2009
Lessons from LHD perspective

• LHD’s near to their communities
• Quick access to objective meta-analysis of health effects of EMF
• Risk communication & speed of communication
• In increasing electronic age, such EMF questions will continue to come to LHD’s and CDPH in various forms… Is PH community prepared?
• Great network of experts from industry, academia, CDPH, other. How strengthen?
• Tools:
  – WHO EMF Fact Sheets & Monograph,
  – CPUC Design Guidelines
  – need template for LHD input into EMF project
Questions? Suggestions?

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A Range of Reasons for Precaution

Raymond Richard Neutra MD
DrPH
Wrong Question for a Health Officer to Answer

- Are all scientists virtually certain that there is some health risk from transmission lines, cell phones, cordless phones and cell base stations?
(3) Right Questions

• “How certain must we be of how much ill-health from cell phones, cordless phones and base stations before we would opt for cheap or expensive protection? “

• What precautionary options are available?
(4) I don’t require certainty to lower exposure 100 fold

- Keep my cell phone off most of the time
- Use ear piece or speaker function
- Place on table 3 feet away before turning on
- Write down phone messages
- Return calls, then turn off.
- Keep it off in bus when I might expose others
(5) Why GOVERNMENTS require more certainty before recommending these steps

- Industry lawyers and lobbyists afraid that precautionary government recommendations will support tort law suits
- Industry afraid that “alarmed” citizens will push for more
- Lobbyists pressure government not to issue them
(6) Options for cell transmitters not so easy

- Unlikely to give up cell phone system entirely
- Tuscany requires modeling and lowest feasible exposure on each transmitter
- Displays web map and picture of all towers
- Change technology
(7) If precaution costs YOU money you demand certainty

- How many of you think cell phone companies should pay to lower EMFs from cell towers?
- How many would pay $1000 for safe phone?
- How many of you have cell phones? How many of you take precautions by keeping your cell phones off, use earpieces, never talk in automobile?
Your Ethical World View also influences the certainty you require before acting.

- Duty ethics (Deontological, Kantian)
- Result ethics (Utilitarian)
(9) Duty Ethics: We ought to do that which best conforms to Moral Duties

- Moses: Honor your mother and father even when it is not cost-beneficial to do so.
- Kant: Always tell the truth even if it leads to bad results!
(10) Result Ethics: Get good results & happiness for the most people

- Jeremy Bentham
- Cost Benefit Analysis
- Problem: Slight benefit for a million people swamps grievous harm to one person and violates moral duties.
(11) Different Precautionary Styles for half million power line neighbors

- Utilitarian: Decision tree: buy up electric blankets
- Duty Ethics: spare no cost to remove exposure
- Libertarian: Post signs
### Excel Cost Benefit Model

#### OVERALL ANALYSIS:

**Distribution Line Retrofit**  
Analytica Model TR-115  
(Costs are per Mile)

- **The sliders are set in the middle of the scale.**
- **These values may not be reasonable.** For reference, the analysis base case values are in column B.

#### USER SELECTIONS

**Economic Assumptions**  
- **Base**: 80%  
- **User**: 80.0%  
- **Min**: 0%  
- **Range**: 100%  
- **Max**: 100%

**Facts**
- Probability of Hazard: ?  
- Risk Ratio: ?  
- Mitigation Effectiveness
  - Optimal Phasing: 81.8%  
  - Undergrounding: 98.1%

**Total Project Cost Multiplier**
- Opt.Phasing (1=$1.75K): 1  
- Undergrounding (1=$1,650K): 1  
- Property Values (1=$1,685K): 1

**Values**
- One Life-Year Lost: $100K  
- One Non-Fatal Cancer: $300K  
- One Alzheimers’ Case: $200K  
- One Person-Outage Hour: $10  
- One Contingency: $10K

#### Total Equivalent Cost per Mile for 35 Years - 115 kV Line

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>No Change</th>
<th>Re-Phasing</th>
<th>Underground</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EMF Health</strong></td>
<td>$680,501</td>
<td>$124,205</td>
<td>$12,953</td>
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<tr>
<td><strong>Cost</strong></td>
<td>$574,016</td>
<td>$577,436</td>
<td>$3,773,049</td>
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<tr>
<td><strong>Property Values</strong></td>
<td>$0</td>
<td>$0</td>
<td>-$1,685,333</td>
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<tr>
<td><strong>Outages</strong></td>
<td>$119,657</td>
<td>$119,657</td>
<td>$111,541</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$1,374,174</td>
<td>$821,298</td>
<td>$2,212,210</td>
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</tbody>
</table>

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### Graph

- Outages
- Property Values
- Cost
- EMF Health

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(13) Even Economists Don’t Require Absolute Certainty for Precaution

- Horizontal axis: How certain there is some risk
- Vertical axis: how big the risk is next to a transmission line
- Blue: do nothing
- Grey: rephase line
(14) Ways to see costs and needed benefits

<table>
<thead>
<tr>
<th>Source</th>
<th>Pop</th>
<th>Miles</th>
<th>Unit Cost</th>
<th>Tot $</th>
<th>Elec. Bill Incr.</th>
<th>Lives To Save</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans. Lines</td>
<td>.5M</td>
<td>1700 miles</td>
<td>80 Thou Per Mile</td>
<td>136 million</td>
<td>0.06 %</td>
<td>27</td>
</tr>
</tbody>
</table>
Ethical Analysis

• If transmission lines, base stations or side stream cell phone exposure are closest to the poor and people of color do we have special duties toward them?

• How much protection does the majority owe the minority living near these sources?

• Should we increase utility bills a fraction of a percent to protect the few even if “not cost beneficial”?
(16) “Usual Rules of Thumb” applied to re-phasing

- Don’t spend too much money ($136M)
- Don’t do it if the most exposed people not hurt (98.8% of exposed not affected).
- Don’t do it if overall rate of leukemia not much affected (only 1.05 fold increase)
- Do it if risk is above “de minimis” (100x bigger!)
- Do it if it is cost beneficial (rephasing passes that test)
- Do it if hardly effects utility bills (0.06%)
- Do it if it corrects unfairness (targets a few)
(17) Tranquilizing Framing used to Characterize Cell Phone Evidence

- Emphasize null results in short term users who were not expected to have an effect to begin with
- Focus on any impact on societal annual rate of target disease not on lifetime added risk in exposed (the reg. metric)
Questions for local health officials (LHOs)

- Should the role of LHOs be restricted to opining as to whether or not there is virtual certainty that an environmental factor poses a hazard?
- Should a LHO help stakeholders understand the precautionary options open to them?
- Should a LHO help stakeholders understand the financial interests and ethical world views that are at work in evaluating those options?
(19) Further Reading on Precautionary Options and how to evaluate them

• www.ehib.org/emf