DR. KEELING: MY NAME IS RALPH KEELING FROM SCRIPPS.

I'VE HEARD SOME DISCUSSION ABOUT COMBINING BIOFUELS WITH SEQUESTRATION THAT ACTUALLY SCRUB THE ATMOSPHERE, BECAUSE THE NET EFFECT OF GROWING THE PLANT AND THEN PUMPING THE CO2 BELOW GROUND IS ACTUALLY TO REVERSE THE RELEASE. I ASSUME THAT COSTS MORE, BUT I WOULD BE INTERESTED TO KNOW WHAT THE OUTLOOK IS.

DR. FRIEDMANN: PRINCETON ACTUALLY LED THE CHARGE ON THIS, AND BOB WILLIAMS HAS SORT OF PUSHED THAT, BOTH THE SEQUESTRATION IN THE SOILS AND ALSO THE ABATEMENT FROM PLANTS QUITE A BIT.

THE DEPARTMENT OF ENERGY HAS JUST BEGUN A FORMAL TASK TO SORT OF UNDERSTAND WHAT THE REAL ABATEMENT POTENTIAL FOR THAT TECHNOLOGY IS. THAT, ACTUALLY, IS QUITE PROMISING. IT'S ONE OF THE FEW WAYS -- IF YOU DO COAL-TO-LIQUIDS TECHNOLOGY WITH CARBON CAPTURE AND SEQUESTRATION AND WITH 12-PERCENT BIOMASS COAL-FIRING, THE ARGUMENT IS YOU CAN COME CLOSE TO A CARBON-NEUTRAL FUEL. THAT REMAINS TO BE PROVEN, BUT THAT'S THE ARGUMENT.

I WOULD SAY -- AND I DIDN'T HAVE A CHANCE TO MENTION THIS BECAUSE I RAN OVERTIME; BUT IF YOU COMBINE CARBON CAPTURE AND SEQUESTRATION WITH BIOMASS COMBUSTION, YOU ACTUALLY GET A NEGATIVE EMISSIONS POWER PLANT.

DR. SOCOLOW: WHICH IS WHAT RALPH WAS JUST OBSERVING.

DR. FRIEDMANN: YES, AND THANK YOU FOR BRINGING THAT UP.

DR. SOCOLOW: JUST ADDING ONE MORE ELEMENT TO THAT, IT WAS CERTAINLY NOTHING WE LEFT OUT ON PURPOSE.

BIOMASS COLLECTION IS EXPENSIVE, AND SO THE ABILITY TO GET ENOUGH BIOMASS IN A SINGLE SPOT TO HAVE THE VOLUMES TO ACHIEVE THE EFFICIENCIES OF A SCALE WITH BIOMASS ALONE IS DIFFICULT. YOU NEED COAL-FIRE BIOMASS AND COAL-CAPTURE CO2, IT'S LIKE 20 OR 30 PERCENT OF THE PLANT. THE REST OF IT IS COAL. THE SCALE OF CO2 MANAGEMENT BECOMES A LITTLE CHEAPER, AND THAT'S ANOTHER REASON WHY THEY, IN SOME SENSE, MATCH UP. AND SO THIS IS A WRINKLE, IT IS AN ELEMENT OF THE STORY. STILL, IT'S MOSTLY ABOUT COAL.

DR. TANS: PIETER TANS FROM EARTH SYSTEMS RESEARCH LABORATORY.

I DON'T HAVE A QUESTION; I HAVE A COMMENT. SOMETIME AGO I DID AN ESTIMATE OF WHAT IT WOULD TAKE IN TERMS OF DETECTION CAPABILITY TO SEE IN THE ATMOSPHERE WHETHER ANY OF THESE THINGS ARE LEAKING. THE NICE THING ABOUT SEQUESTERING CO2 IN GEOLOGICAL RESERVOIRS, FROM OUR POINT OF VIEW AS MEASUREMENT

PEOPLE, IS THEY HAVE NO C-14 IN THEM, AND IT IS ACTUALLY RELATIVELY EASY TO DETECT THAT WITH EXISTING

METHODS. IT WOULD BE CHEAP, TOO. SO I'M NOT WORRIED ABOUT THAT.

DR. FRIEDMANN: WELL, THANK YOU FOR MENTIONING THAT. I DO WANT TO SAY, ACTUALLY, THAT WE ARE PURSUING THAT EXACT ISSUE AT LIVERMORE, WONDERING IF WE CAN USE THE ACCELERATOR MASS SPECTROMETRY FACILITY THERE, CAM'S, TO DO FOSSIL FUEL EMISSION VERIFICATION.

DR. FIELD: CHRIS FIELD, CARNEGIE INSTITUTION.

I WANTED TO TALK A LITTLE BIT MORE ABOUT THE LARGE NUMBER OF BLACK STARS ON JULIO'S MAP THAT HAVE NO PLANS FOR FUTURE CAPTURE AND STORAGE; AND I UNDERSTOOD FROM YOUR PRESENTATION THAT THE COST OF DOING POST-COMBUSTION CAPTURE AND STORAGE WASN'T NECESSARILY GREATER THAN ANY OF THE OTHER APPROACHES; AND I WONDER IF THERE WERE A SMALL SUBSET OF THINGS THAT COULD BE DONE IN ORDER TO OPEN THE PATH TO FUTURE INTEGRATION OF CAPTURE AND STORAGE TECHNOLOGIES IN THE EXISTING THINGS. IS THAT SOMETHING WE REALLY OUGHT TO BE PUTTING A PRIORITY ON IN THE NEXT FEW YEARS?

DR. FRIEDMANN: SURE. TWO THINGS QUICKLY:

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ONE IS IF YOU CAME AWAY WITH THE IMPRESSION THAT IT WOULDN'T COST MORE TO DO THAT, THAT WAS INACCURATE. IT DOES COST MORE. THERE IS JUST NOT A TECHNICAL BARRIER TO DOING IT.

BUT, ESSENTIALLY, WHAT YOU'LL DO IF YOU JUST PUT THE CAPTURE DEVICE ON AND RUN IT FROM THE SAME POWER PLANT, YOU'LL TURN A 1,000-MEGAWATT POWER PLANT INTO A 750-MEGAWATT POWER PLANT; THAT IS REALLY NOT VERY ATTRACTIVE FOR MANY REASONS.

PEOPLE HAVE TALKED ABOUT THE IDEA OF CARBON-READY OR SEQUESTRATION-READY POWER PLANTS; AND DAVID HAWKINS HAS A QUOTE TO SAY ABOUT THAT, WHICH IS: "USING THAT KIND OF LOGIC, MY DRIVEWAY IS FERRARI-READY."

PUTTING SORT OF A SKID NEXT TO A PLANT AND SAYING, WE'RE GOING TO BUILD SOMETHING THERE LATER, DOESN'T ACTUALLY GET YOU MUCH. THE REASON WHY IS, BECAUSE IN ORDER TO AVOID THE SCENARIO I JUST TALKED ABOUT, WHERE YOU EITHER HAVE TO BUILD A WHOLE NEW POWER PLANT OR DERATE YOUR EXISTING PLANT, YOU ACTUALLY HAVE TO INTEGRATE THE ENGINEERING WITH THE CAPTURE DEVICE INTO THE DESIGN OF THE PLANT. AND SO THE INDUSTRY THAT DEALS WITH SORT OF IGCC DEPLOYMENT AND SO FORTH VERY QUICKLY RECOGNIZED THAT A SEQUESTRATION-READY IGCC PLANT WAS KIND OF LIKE A

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UNICORN, AND THAT THEY REALLY HAD TO START THINKING ABOUT THIS INTEGRATED DESIGN QUESTION MORE CAREFULLY AND TRY TO UNDERSTAND HOW TO AMORTIZE THOSE COSTS MORE SENSIBLY.

DR. RYERSON: TOM RYERSON FROM NOAA ESRL.

I WOULD LIKE TO HEAR WHAT YOU THINK ABOUT A PRUDENT ENGINEERING OPTION THAT WOULD INCLUDE

SOMETHING LIKE A PLAN B. YOU'VE GOT A SUCCESSFUL CAPTURE PROGRAM GOING WORLDWIDE, AND YOU'VE GOT GIGATONS OF CO2 STORED UNDERGROUND. THE LONGEST TERM YOU POINTED OUT WAS MAYBE 35 YEARS OF DOING THIS ON A COMMERCIAL SCALE. BUT WE'RE WORRIED ABOUT GEOLOGIC TIMES HERE AND THE LIFETIME OF CO2 IN THE ATMOSPHERE, COUPLED WITH THE LIFETIME THAT YOU KNOW THESE THINGS HAVE WORTH DOESN'T REALLY FILL ME WITH CONFIDENCE QUITE YET.

SO IS THERE ANY PLAN IF YOU WERE TO NOTICE LEAKS OR FRACTURING OR WELL MECHANICAL FAILURE, IS THERE ANY WAY BEFORE IT IS SEQUESTERED CHEMICALLY UNDERGROUND TO REMOVE THE LIQUID AND MOVE IT SOMEWHERE ELSE THAT'S NOT YET LEAKING?

DR. FRIEDMANN: A COUPLE OF RESPONSES TO THAT. ONE OF THEM IS THAT THERE ARE ACTUALLY A NUMBER OF VIABLE OFF-THE-SHELF MITIGATION TECHNOLOGIES IF SOMETHING SHOULD GO WRONG. AND THAT

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WAS SORT OF THE HEART OF YOUR QUESTION. IT WOULDN'T SO MUCH INVOLVE ABANDONING A SITE NECESSARILY AND MOVING THE CO2 TO SOME OTHER SITE. IT WOULD BE MORE LIKELY SAYING, OH, GOSH, THE WELLS THERE ARE LEAKING, SO LET'S PLUG THE WELLS. YOU MIGHT DEPRESSURIZE ONE PIECE OF THE FIELD AND MANAGE THE RESERVOIR AT THE SUBSURFACE.

THERE ARE ALSO -- BY THE WAY, ALL OF THE STUFF THAT I PUT UP THERE WAS ON THE ASSUMPTION THAT ALL YOU DID WAS INJECT AND WALK AWAY. WE HAVEN'T EVEN STARTED INVESTING YET IN THE OPPORTUNITIES OF ACTUALLY REALLY ENGINEERING THE RESERVOIR TO, SAY, ACCELERATE THE RATE OF DISSOLUTION. BUT WITH RESPECT TO THE BURDEN OF FUTURE GENERATIONS AROUND THE IDEA THAT SOMEHOW IN 1,000 YEARS, THERE WILL BE A PROBLEM, WE DO BELIEVE THAT THE RISKS GO DOWN OVER TIME; THEY DON'T GO UP. WE DON'T NECESSARILY KNOW WHERE THE SAFE THRESHOLD IS. BUT THE WHOLE PURPOSE OF THIS IS NOT TO STORE CO2 FOREVER. THE PURPOSE OF THIS IS TO KEEP IT OUT OF THE ATMOSPHERE AS A BRIDGING TECHNOLOGY AND BUY US SOME TIME UNTIL WE GET A DECARBONIZED ENERGY FUTURE. AND SO IN OUR COMMUNITY -- AND WE HAVE ASSIDUOUSLY AVOIDED A YUCCA MOUNTAIN SORT OF STANDARD; AND, INSTEAD, TRY TO THINK ABOUT, WELL, IS 500 YEARS GOOD ENOUGH, IS 1,000 YEARS GOOD

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ENOUGH, WHAT QUALIFIES GOOD ENOUGH. AND THAT'S AN ACTIVE DEBATE.

DR. SOCOLOW: IF I CAN JUST GLOSS THAT A SECOND. WE'VE ALL THOUGHT ABOUT HOW TO DESCRIBE RISK AND TO DISTINGUISH THE SLOW LEAK, YOU'VE LOST YOUR INVESTMENT IF YOU CAN'T DO ANYTHING ABOUT IT. IT HAS TO BE REINJECTED. ANOTHER PROJECT HAS TO COMPENSATE FOR IT. INSURANCE HAS PAID YOU OFF. YOU'VE PAID THE GOVERNMENT BACK BECAUSE YOUR SITE WASN'T ANY GOOD. NOBODY GOT HURT.

VERSUS AN ACUTE LEAK, A MAJOR SPILL, AND THEN PEOPLE DO GET HURT.

JULIO WAS TALKING JUST THEN ABOUT THE SLOW LEAK, SOMETHING DOESN'T ACTUALLY WORK, IT GOES BACK INTO THE ATMOSPHERE. WE CAN LIVE WITH THAT.

ACUTE LEAKS, WE CAN'T. AND SO THE ADDITIONAL PART OF THE STORY, WHICH JULIO CAN COMMENT ON: ARE THERE ANY CREDIBLE SCENARIOS WHERE THERE IS AN ACUTE LEAK OVER NOW OR 500 YEARS FROM NOW?

WHY DON'T YOU ANSWER THAT.

DR. FRIEDMANN: YEAH, I WOULD CERTAINLY SAY THAT WE HAVEN'T, YOU KNOW, EXHAUSTIVELY PURSUED THAT AND ANSWERED IT. WHAT I HAVE SAID IS WE, AS A COMMUNITY, TOOK THAT VERY SERIOUSLY AND TRIED TO BREAK IT APART AS WE COULD. WE SAID, LOOK, LET'S

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ASSUME WE'VE CHOSEN A BAD SITE, LET'S RUN IT INTO LIMESTONES THAT DISSOLVE. YOU KNOW, LET'S LET A NUMBER OF THINGS FAIL SPECTACULARLY AND SEE WHAT HAPPENS.

ONE OF THE THINGS WE'VE FOUND IS THAT BECAUSE THE CRUST IS WELL-CONFIGURED TO STORE CO2, ALMOST ALL THE FEEDBACKS ARE NEGATIVE. SO EVEN IF YOU CHOOSE A BAD SITE, THEY TEND TO MANAGE THEMSELVES PRETTY WELL.

IT'S NOT TO SAY THAT THERE AREN'T SCENARIOS IN WHICH THAT DOESN'T HAPPEN; BUT FOR THE MOST PART, THAT SEEMS TO BE THE CASE.

THE ONE PLACE WHERE YOU REALLY NEED TO WORRY IS IF HEAT GETS ADDED INTO THE SYSTEM, BECAUSE WHEN YOU START TO HEAT CO2, THEN IT DOES EXPAND, AND THE FEEDBACKS BECOME POSITIVE. AND THAT IS, BASICALLY, A QUESTION OF SITING MORE THAN ANYTHING ELSE.

IF A VOLCANO SHOULD ERUPT INTO A CO2 STORAGE FACILITY, I DARE SAY WE'D ACTUALLY WORRY ABOUT THE CO2 EMISSIONS FROM THE VOLCANO A BIT MORE.

DR. WEISS: A BRIEF QUESTION -- RAY WEISS FROM SCRIPPS -- TO FOLLOW UP ON PIETER TANS' COMMENT: HAS THERE BEEN ANY EFFORT TO PUT TRACERS INTO SEQUESTERED CO2 SO THAT IT MIGHT BE EASIER TO DETECT

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THEM WITHOUT USING AN ACCELERATOR MASS SPECTROMETER.

DR. FRIEDMANN: THERE HAS. TODAY'S TRACER OF CHOICE IS PERFLUOROCARBONS.

(INAUDIBLE COMMENT FROM AUDIENCE)

DR. FRIEDMANN: BUT THE WHOLE POINT IS THAT YOU ALSO CAN DETECT THEM AT THE PARTS PER BILLION LEVEL, WHICH HAS ITS PLUSES.

PEOPLE WALKED AWAY FROM SULFUR HEXAFLUORIDE AS A TRACER FOR EXACTLY THE REASON YOU MENTIONED.

PEOPLE HAVE ALSO LOOKED AT OTHER TRACERS, LIKE NOBLE GAS TRACERS, WHICH HAVE DISTINCT, EASILY-RECOGNIZED SIGNATURES. SO IT'S BEEN LOOKED AT, AND IT'S BEEN TESTED A BIT IN THE FIELD.

I DO BELIEVE THAT THERE IS MORE WORK THAT CAN BE DONE ON THAT. BUT PART OF THE ISSUE HERE IS THAT, AGAIN, WHAT YOU REALLY SHOULD BE FOCUSING ON IS A DEVICE THAT YOU CAN STRAP ONTO A WELLHEAD FOR AN

ABANDONED WELL WHICH WILL DETECT CO2 QUICKLY BECAUSE THAT'S REALLY WHERE YOUR PRIMARY RISK IS GOING TO BE.

DR. SOCOLOW: A LITTLE GLOSS ON THAT IS THE PRIVATE SECTOR HAS AN ENORMOUS INTEREST IN TRACERS BECAUSE THEY DON'T WANT TO BE THE VICTIM OF UNIDENTIFIED LEAK. THEY WANT TO BE SURE THAT IF THEIR PRACTICE IS GOOD AND THERE IS SOME KIND OF A LEAK, A SLOW LEAK, LET'S SAY, IT CAN BE ATTRIBUTED TO

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SOMEBODY. AND IF THEY HAVE DONE A GOOD JOB, THEY WON'T END UP PAYING FOR SOMEBODY ELSE'S LEAK. SO THE CHANCES ARE THAT THE CO2 IS GOING TO HAVE SIGNATURE INJECTION PROJECT BY INJECTION PROJECT.

MR. CICERONE: RALPH CICERONE, NATIONAL ACADEMY OF SCIENCES.

THANKS TO ALL THREE OF YOU FOR SOME BEAUTIFULLY PREPARED AND THOUGHT-OUT PRESENTATIONS.

I THINK MY QUESTION IS FOR CHUCK. WHEN YOU HAD A SUMMARY SLIDE SHOWING THE COSTS AND POTENTIAL SAVINGS OF THE OPTIONS THAT YOU EXAMINED TODAY, IT CAME OUT TO ABOUT $80 BILLION IN THAT COST SAVINGS, WHICH IS A WONDERFULLY POSITIVE STORY, WITH INCENTIVES FOR SHOWING SOME MARKET INCENTIVES.

THERE'S ANOTHER WAY TO LOOK AT THAT; AND THAT'S $80 BILLION TAKEN OUT OF OTHER PEOPLE'S BUSINESS THAT THEY WOULD HAVE HAD WITHOUT THESE OPTIONS.

HOW MUCH OPPOSITION ARE THESE TECHNOLOGIES ENCOUNTERING FROM PEOPLE WHO PERCEIVE THAT THEY'RE GOING TO LOSE $80 BILLION OF EXPENDITURES FROM THE REST OF US?

DR. KUTSCHER: WELL, THAT'S AN EXCELLENT QUESTION.

YOU PROBABLY HAVE SEEN THE TV ADS FROM THE

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COMPETITIVE ENTERPRISE INSTITUTE TELLING US THAT CARBON DIOXIDE IS ESSENTIAL TO LIFE. CLEARLY -- AND THIS IS -- TO ME, THIS IS A REAL DIFFERENCE BETWEEN WHAT WE FACE WITH GLOBAL WARMING AND WHAT WE FACED WITH THE OZONE PROBLEM. YOU KNOW, THE INDUSTRY THAT WAS PRODUCING CHLOROFLUOROCARBONS, WHICH WAS A MUCH SMALLER INDUSTRY THAN THE INDUSTRY THAT PRODUCES COAL AND OIL AND NATURAL GAS, AND SO IT'S CLEAR THAT, YOU KNOW, THERE HAVE BEEN VARIOUS REPORTS ON HOW MUCH MONEY HAS BEEN SPENT TO ARGUE NOT TO MAKE BIG CHANGES, YOU KNOW, IN OUR ENERGY ECONOMY.

ON THE OTHER HAND, WE'RE SEEING A TREMENDOUS INTEREST FROM VENTURE CAPITALISTS RIGHT NOW IN THE WHOLE RENEWABLE ENERGY FIELD. I SHOWED THAT SLIDE AT THE SOLAR ELECTRIC POWER CONFERENCE, WHICH WAS REALLY MOSTLY A TRADE SHOW; AND IT IS TRUE THAT A FEW YEARS AGO THERE WAS 1,000 PEOPLE, AND THIS YEAR IN LONG BEACH IT WAS 12,500 PEOPLE. AND THERE'S A BOOK OUT ON CLEAN-TECH TECHNOLOGIES, AND VENTURE CAPITALISTS LIKE -- WELL, THERE'S A NUMBER OF DIFFERENT VENTURE CAPITALISTS. I WON'T GO INTO NAMES. BUT THEY HAVE POURED A LOT OF MONEY INTO WIND

POWER AND, PARTICULARLY RIGHT NOW, CONCENTRATING SOLAR POWER, AS WELL AS PHOTOVOLTAICS. THESE ARE PEOPLE THAT INVESTED IN THE SEMI-CONDUCTOR INDUSTRY,

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THAT INVESTED IN THE DOT COMS, AND THEY'RE LOOKING FOR A PLACE TO PUT THEIR MONEY NOW, AND IT'S REALLY HAPPENING. I HAVE BEEN IN THE RENEWABLE FIELD FOR 30 YEARS, AND I HAVE NEVER SEEN ANYTHING LIKE WHAT I'M SEEING RIGHT NOW.

DO YOU HAVE A FOLLOW-UP QUESTION?

MR. CICERONE: (INAUDIBLE) I'M NOT TRYING TO BE NEGATIVE. I'M JUST TRYING TO GET YOUR SENSE OF WHETHER OR NOT THAT KIND OF OPPOSITION IS GOING TO BE A SIGNIFICANT BARRIER OR NOT, WITH ALL THESE OTHER GOOD INCENTIVES ON THE TABLE THAT YOU'VE OUTLINED.

DR. KUTSCHER: THERE IS NO QUESTION THAT IT IS A BARRIER. NOW, IF YOU LOOK AT BP AND SHELL AND GENERAL ELECTRIC, THERE ARE MORE AND MORE COMPANIES RIGHT NOW THAT ARE GETTING INTO RENEWABLE TECHNOLOGIES. YOU KNOW, GE IS GETTING VERY BIG IN WIND TURBINES. BP IS BIG IN PHOTOVOLTAICS. THERE ARE STILL COMPANIES OUT THERE THAT ARE POURING A LOT OF MONEY IN OPPOSITION. ONE OF THE OIL COMPANIES RECENTLY CAME OUT AND SAID IT WAS NO LONGER GOING TO DO THAT. ONE OF THE OIL COMPANIES HAD PUT MONEY INTO, I THINK, 40 DIFFERENT THINK TANKS TO COME OUT WITH ARTICLES ARGUING AGAINST THESE TYPES OF TECHNOLOGIES, MAKING IT LOOK LIKE THERE'S, YOU KNOW, A LOT OF CONCERN AND A LOT OF OPPOSITION. THEY HAVE

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SINCE BACKED OFF. SO I THINK WE'RE SEEING A CHANGE; BUT THE REALITY IS IT IS STILL AN ISSUE. AND IT'S A BIG INDUSTRY. AND LIKE I SAY, IT'S A TOUGHER PROBLEM THAN WE FACED WITH THE OZONE BECAUSE OF THE SIZE OF THAT INDUSTRY.

DR. FRIEDMANN: IF I CAN JUST ADD SOMETHING VERY QUICKLY TO THAT.

RALPH, I'M SURE YOU KNOW, BUT MANY OF THE OTHERS MAY NOT, THAT THERE WAS A REPORT ISSUED THIS SUMMER CALLED "FACING HARD TRUTHS" THAT WAS REQUESTED BY THE SECRETARY OF ENERGY AND WAS PRODUCED ESSENTIALLY BY PEOPLE WORKING WITH OR IN THE OIL AND GAS INDUSTRY. AND ONE OF THE VERY FIRST CONCLUSIONS OF THAT WAS THAT EFFICIENCY WAS THE BIGGEST LEVER, AND THEY SHOULD GO AFTER IT. AND SO THERE DOES SEEM TO BE SOME ROUNDING OF THE CORNER ON THAT.

DR. SOCOLOW: WE'LL HAVE ONE LAST QUESTION.

DR. MACDONALD: I'M SANDY MACDONALD WITH EARTH SYSTEM RESEARCH LAB IN BOULDER, AND MY QUESTION IS FOR CHUCK.

I THOUGHT YOUR PRESENTATION WAS OUTSTANDING, AND IT SHOWED ALL OF THE DIFFERENT POSSIBILITIES ADDING UP TO HEAVEN KNOWS HOW MANY WEDGES, BUT IT'S INTERESTING THAT WHENEVER THIS SUBJECT COMES UP AND YOU HEAR A PRESENTATION LIKE

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THIS AND THEN I GO TALK TO MY FRIENDS, ONE OF WHOM IS

AN EXECUTIVE IN AN ELECTRIC POWER COMPANY, THEY ALWAYS SAY: WELL, YOU KNOW, IT'S A DISTRIBUTION PROBLEM. THE WIND BLOWS HERE, AND IT ONLY BLOWS INTERMITTENTLY, AND THE SUN ONLY SHINES AWHILE. AND I NEVER HEAR KIND OF WHAT IS SO OBVIOUS, WHICH IS A NATIONAL SYSTEM OF POWER TRANSMISSION AND DISTRIBUTION THAT WOULD SORT OF FIT WITH A RENEWABLE KIND OF SYSTEM LIKE YOU'VE DESCRIBED.

AND YOU DIDN'T -- YOU DIDN'T DO IT IN THIS TALK, BUT IT SEEMS TO ME LIKE, WITH VERY NICE THINGS LIKE . . . SHORT ENOUGH THAT IF THE WIND IS BLOWING REALLY HARD . . . AND IT IS NOT BLOWING HARD IN TEXAS, SO IT SEEMS TO ME LIKE WE COULD DESIGN A COMPLETE SYSTEM, AND THAT'S THE WAY WE OUGHT TO START BY EXPLAINING THIS.

DR. KUTSCHER: OKAY. THANKS FOR THAT QUESTION.

CERTAINLY, TRANSMISSION IS AN ISSUE. YOU LOOK, FOR EXAMPLE, IN TEXAS, THEY HAVE AN AWFUL LOT OF WIND IN WEST TEXAS, BUT THEY NEED TO MOVE THAT WIND POWER FROM WEST TEXAS TO THE POPULATION CENTERS IN THE EASTERN SIDE OF THE STATE. THERE ARE A NUMBER OF WAYS THAT CAN BE ADDRESSED. CERTAINLY, SPATIAL DIVERSITY IS ONE. TYPICALLY, WHEN THE WIND ISN'T

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BLOWING IN ONE PLACE, IT'S BLOWING IN ANOTHER PLACE. AND SO IF YOU HAVE LARGE ENOUGH AREAS IN THE GRID WHERE ELECTRICITY CAN BE MOVED FROM ONE AREA TO ANOTHER, YOU CAN HANDLE THAT.

THERE ALSO HAVE BEEN NEW LAWS THAT WE'RE SEEING IN STATES; FOR EXAMPLE, IN THE STATE OF COLORADO, THEY'RE TRYING TO INCENTIVIZE UTILITIES TO BUILD TRANSMISSION LINES SO THAT THEY ACTUALLY GET PAID TO BUILD THOSE TRANSMISSION LINES AND THEY GET COST RECOVERY ON THOSE. AND SO THERE ARE THESE RENEWABLE ENERGY ZONES THAT ARE BEING CREATED WHERE TRANSMISSION IS BEING BUILT TO THOSE ZONES TO ALLOW THAT TO BE TRANSPORTED.

SO, I MEAN, I THINK THAT, YOU KNOW, THAT ISSUE IS STILL A BIG ONE. STEVEN CHU, AT LAWRENCE BERKELEY LABORATORY, HAS ARGUED THAT WE NEED SOMETHING AKIN TO WHAT WAS DONE DURING THE EISENHOWER ADMINISTRATION WITH THE NATIONAL HIGHWAY SYSTEM. I THINK WE DO NEED A BETTER NATIONAL ELECTRIC GRID. OUR GRID IS PRETTY OLD. WE SAW IN THE BLACKOUT A FEW YEARS AGO HOW SUSCEPTIBLE IT IS. SO IMPROVEMENTS NEED TO BE MADE TO THE GRID. A LOT OF PEOPLE WOULD LIKE TO SEE, AS THE GRID IS IMPROVED, NOT ONLY WILL IT ALLOW RENEWABLE POWER TO BE MOVED AROUND, BUT WILL ALSO ALLOW A SMART GRID, WHERE INFORMATION FLOWS BOTH

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WAYS IN THOSE TRANSMISSION LINES, SO UTILITIES HAVE SOME CONTROL OVER PEAK DEMAND IN HOMES AND IN BUSINESSES.

SO I THINK YOU'RE RIGHT. I THINK TRANSMISSION IS AN ISSUE, BUT THERE'S A LOT OF WORK BEING DONE ON THAT. PARTICULARLY THE WIND INDUSTRY

HAS BEEN VERY INTERESTED IN PURSUING THAT, AND I
THINK A LOT OF PROGRESS IS BEING MADE.