HYDROPOWER
in Connecticut and the Northeast
January 11, 2008

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Editors' Note

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Margaret Miner & Amanda Branson
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Introduction

In the context of climate change and the world-wide thrust to develop renewable energy sources, federal and state governments are developing laws and policies that provide incentives for renewable power, often including new and/or expanded hydropower. Yet dams and hydropower have profound and often irreversible impacts to our rivers and streams. It is in this context that we hope to understand the relationship between financial incentives for hydropower and changes in rivers and landscapes.

This conference examined the role of hydropower in the push for renewable energy sources as well as the implications of the incentives the state and the federal governments are considering for hydro development. There was a particular emphasis on small, new hydro and the recent proposals under consideration in Connecticut and Vermont.

The questions addressed were:

• Is hydropower green?

• What is the definition of green?

• Does size matter when it comes to hydropower plants?

• What are the best means of maximizing efficiency of hydropower with ecological protections? Is there new technology that can do that better than the old?

• Is it better to improve efficiency of existing plants or turn to new ways of harnessing hydropower, such as non-biological systems or hydro-kinetics?

• What is hydropower's role in the mix of clean energy?

• How do we strike the best balance for fish, flow, recreation, and power production?

• What is the current climate of hydro regulation? Does the answer depend on your perspective: entrepreneur, environmentalist, public sector, private sector?

• What are the positives and negatives of the FERC process?

• What will new incentives from the federal and state governments mean for our rivers? Will they lead to increased hydropower Generation? Are they focusing the incentives the right aspects of hydropower?

• What are the right aspects of clean energy for federal and state governments to incentivize?

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Moderated by Eric Hammerling

The Farmington River is significantly affected by hydropower operations. The Metropolitan District Commission (Hartford region's most important utility), the Stanley Works, and the CT Department of Environmental Protection have a long-standing Riparian Agreement on hydropower releases, the most important single factor affecting flows. In addition, Summit Hydro, LLC holds a FERC license to re-start hydropower operations at two dams in Collinsville (nestled between the Upper and Lower River). This is a key location on Connecticut's most fished river and arguably most scenic river. A 14-mile stretch of the Upper Farmington, just below the MDC dam, was designated as Wild & Scenic in 1994, and a Wild & Scenic Study is underway on the Lower Farmington River. Thus, the Summit project could be a shining example of new, efficient, green hydro, or it could be flawed , or it could fail. How do we strike the best balance for fish, flows, recreation, and power production in this sensitive location?

Panel: Hydro Regulation 39

Moderated by Earl Phillips

Many resource and regulatory considerations affect the development of new hydro and the extension of existing hydro. The panel will address these issues, provide a case study description, and examine ways in which interested parties may participate in the process.

Welcome

Eric Hammerling: Okay. We're ready to go. My name is Eric Hammerling. I'm the President of the Board of Rivers Alliance of Connecticut, as well as Executive Director of the Farmington River Watershed Association. And I'm pleased to welcome you here today to this wonderful hydropower conference. If any of you are here for landfill, energy, geothermal, or wind conferences, I'm sorry that's in a different building today.

I talked to a good friend of mine recently who said if you're going to keep this conference flowing and keep it fun, you have to tell a hydropower joke. And I don't know if any of you have ever Googled "hydropower" and "joke." It's very difficult. Okay. There are no really good hydropower jokes. Hydropower just is not funny.

But I consulted the funniest person I know, who's my son, who's eight. He said, "Tell them one of those jokes where you say, 'which one of these does not belong'." So this is what we came up with. Which of the following does not belong? A basketball player, a fortune-teller, or a hydropower facility. Any thoughts? A basketball player, because the other two have turbines. Where's the applause? Okay, thank you for that pitiful applause.

Sponsors

I wanted to start out by thanking our sponsors for being able to put on this conference today. In particular, I want to thank Northeast Utilities for providing the site, as well as providing our snacks as we go on today. I wanted to thank our supporting sponsors, the Connecticut Clean Energy Fund, LFR Incorporated, and our sponsors Connecticut Science Center, The Farmington River Coordinating Committee, E-PRO/TRC, Fuss and O'Neil, Kleinschmidt Associates, and the Natural Resources Council of Connecticut.

Our Proceedings sponsors are the Connecticut Clean Energy Fund, and the Connecticut Institute for Water Resources. We will in fact have proceedings published after this conference. So many of the things that you hear today will be recorded and published.

Steering Committee

I also want to thank our steering committee members. There's a lot of work that went in to coming up with the topics and themes for this conference. And I want to ask those conference steering committee members who are here to stand as I recognize the group of them: Fred Ayer, from the Low-Impact Hydropower Institute; Russ Cohen, from the Massachusetts Riverways Program, who's not here today: he's in Costa Rica; Konstantine Drakonakis, with Connecticut Innovations and the Clean Energy Fund; Bob Gates, with FirstLight Power; Dwight Merriam, Robinson & Cole; Earl Phillips, with Robinson & Cole; Mark Smith with The Nature Conservancy. And, of course, Margaret Miner, Amanda Branson, and Rose Guimaraes of Rivers Alliance of Connecticut.

Christie Bradway is now going to say some welcoming remarks for Northeast Utilities. Christie, we always appreciate your involvement with the watershed community. I want to recognize Pat McCullough also for her environmental involvement, and Jean Ehle, who did a lot of the work logistically to help make this happen. So, Christie if you could please come forward and say a few welcoming words.

Christie Bradway: Good morning, everybody. We're really happy to host this. It's nice to see so many familiar faces. It's nice to see Bob Gates here again, and we're hoping we can keep him here a little longer today. But, you know, he was very interested in this topic.

We're at the crossroads of energy and environmental policies and concerns. It's very obvious to NU management that environmental factors are leading a lot of the strategic issues facing this company. So we're pleased to talk about, and learn about, the information that you're going to cover today. We're really impressed with the caliber of the folks on the panels and the attendants. Obviously this is an important issue for us all.

So, we hope that you have a wonderful day. I'm looking forward to learning a lot. Thank you very much for coming.

Four Perspectives on Hydropower

Eric Hammerling: At this point, the four moderators of our first four panels will introduce themselves and talk about their goals for today and what they hope to discuss in their panels. Fred Ayer will go first. Bob Gates, Earl Phillips, and then Mark Smith.

Fred Ayer: I'm Fred Ayer with the Low-Impact Hydropower Institute in Portland, Maine. The first panel this morning will be about asking the question: Is hydropower green?

We've got four panelists-two representing an industry position and two representing environmental position. I've asked them all to express to you what their definition of "hydropower" is and if, in fact, it is green. And I've asked them to take it another step further and ask; "If it is green, could it become greener as a result of forces outside of this room, or come to be considered greener?" How does that change or how does that affect what we do?

I will be a time clock, and I will be ruthless with my panelists. They are only allowed a few minutes to talk. The reason for that is we want to have all of you participate.

Bob Gates: Well good morning. I'm Bob Gates. I'm the Station Manager for Connecticut Hydro and it's a division of FirstLight Power. It useWell good morning. I'm Bob Gates. I'm the Station Manager for Connecticut Hydro and it's a division of FirstLight Power. It used to be part of Northeast Utilities. I manage ten hydroelectric clients in the State of Connecticut, and the largest hydroelectric plants in the State of Connecticut.

I was thinking about the question that was posed to me, which was: what are my goals for this session? So, I was dwelling in my own mind about what hydropower means to me. And then I had an "ah-ha," and I said, "It's really not about what it means to me, it's about what it means to all of you."

So in order to get you jump-started, I came up with a few words for you to consider.

I want to throw some words out. And I want you to listen to the word and try to think of the conference in relation to that particular word.

Synergy. To me there's an opportunity for synergy between the knowledge that everybody has in this room. We all have different perspectives, but we all bring something to the table. And I think the relationship of us-versus-them has broken down over the years to where we do work together. I see a lot of friends here, fellow businessmen, as well as people from the regulatory agencies, and non-governmental organizations. Together, we can all achieve more.

Sustainability. As a hydro owner, I look at some of the plants that are out there today. Some are a hundred years old. I have one that was built in 1904. I look at that station and I wonder about redevelopment of that station in an environmentally sensitive manner, within the regulations, and according to the public will. It's an opportunity, I think, to do it right, and to take the public's interest into account, not only locally at that site, but more globally.

Independence. Independence-oil independence-is very, very key in everybody's mind. The economy was the number-one issue of voter concern in the primary in New Hampshire. An economy that's based on oil is something that we can't live with. Hydropower is an alternative. In New England the hydro resources are great. It's just fully-developed rivers that are dammed. They're not going to dam any other others. It's just the way it is. So we have to look at ways to maximize in a smart environmental way the production of hydropower.

Stewardship. Hydropower owners need to promote stewardship in the spirit of the regulation and not just follow the regulation.

Partnership. As I said we need to work together, respect one another.

Clean. We're often called clean energy, not renewable energy. It rained today, and, as far as I'm concerned, that fuel is renewable. I mean, it is what it is. Can hydropower be done, in a better way? It might be. We should be working towards that.
And so if we combine all of these words and work together today, I think we'll get the most out of it. Again, as we have said, we need to get your opinions out on the floor. We need to discuss the issues. Thank you.

Earl Phillips: Good morning. I'm Earl Phillips. I'm the Chair of the Utility and Environmental Practice at Robinson & Cole, a law firm here in New England. My panel today is to talk about different perspectives on hydropower regulation.

We have Brian Emerick, from the DEP. Brian is the person who is really charged with oversight and input to the Federal Energy Regulatory Commission (FERC) Licensing and Exemption process.

We also have Bruce DiGennaro who is a managing partner at The Essex Partnership. Bruce has twenty years of experience in this arena and will have a private-sector perspective on licensing challenges, strategies, etc.

We also have attorney Roger Reynolds, who directs and coordi-

nates litigation on the legal side of the Connecticut Fund for the Environment. He will provide the nonprofit and assistance group perspectives. He also has nine years of service with the attorney general's office.

I'm looking forward to having some heated exchanges as we go through some of these things. When I step back and look at it, I think of the time when the Federal Power Act was designed and the Federal Energy Regulatory Commission was put in place for licensing authority. It was well thought out. It was highly detailed. I think the Water Quality Certification Process to protect the water quality of the state is well conceived, well thought out, and highly detailed.

What you'll hear from the private-sector analyst today is that a number of projects die in the evaluation stage. And they die because there's a hard look at a perspective project timeline, the energy to bring a project forward, the cost of the endeavor, and ultimately, the uncertainty.

I think the nonprofit communities are aware of that. I think the public-sector community is aware of that. That's one of our challenges. I think the challenge is being looked at, and given a lot of attention at the federal and state level, as mid-sized and smaller projects come to pass. I'm hoping we'll have some of that exchange on our panel.

Mark P. Smith: Good morning. My name is Mark Smith. I'm the Director of the Freshwater Program for the Eastern Region for the Nature Conservancy. I'm really here, I think, like a lot of us to learn today. That's what really attracted me to participate in this conference.

Today's topic is interesting to me-and I'll use climate change as an example of why that is the case. We know temperatures in the Northeast over the next one hundred years are going to rise between three and twelve degrees. We're going to have shorter, wetter winters and longer, dryer summers. Summers might be four to six weeks longer. So we have real impacts and changes that are happening that we need to address. There's a lot of attention at the national and state levels to make sure that we are proactive in that regard.

But to understand how responses to these change might affect our region I'll use some facts and figures from other parts of the country that really relate to the ethanol issue and how much that is affecting the Midwest, or has the potential to affect the Midwest. Right now we're probably producing about five or six million gallons a day of ethanol, or a year of ethanol, that's going to ten, fifteen or even nineteen billion gallons a year.

So what will that mean for that landscape out there? Well to get to fifteen billion gallons of ethanol you need about twenty-five million more acres of corn in that part of the world. Right now, about twenty percent of our corn crop goes to ethanol. It's very quickly, this year or next, going to be forty percent of our corn, and obviously much more of that in to the future. It's going to really fundamentally change that part of the country. Iowa is likely to change from an exporter of corn to an importer of corn to feed those ethanol plants.

Right now, the U.S. corn crop is the largest grain crop in the world. We export about twenty percent of our grain product to the rest of the world for food. If that twenty percent is no longer exported, it is now going to be used to fuel ethanol. We are already seeing an increase in pressure on food prices around the world because of our decisions on energy.

And just briefly, on a conservation standpoint, over the last twenty or more years, we've conserved about thirty-six million acres of highly erodeable lands through USDA farm programs by putting them in reserve; paying farmers to put them in reserves. Right now, that subsidy is about $48 an acre, but they can make over $300 an acre by growing corn and selling it to the ethanol plants. Those conserved acres might go back into corn production.

Clearly, it's really changing the landscape out there, not only locally, but regionally, nationally, and internationally with the food price. Is that what we're anticipating in the hydropower world and here in New England? The panel, at the end of the day, is going to look at the policy initiatives and ask the question: Are the policy initiatives that we're seeing on renewables going to have that same or similar type level of impact on the hydropower front?

Eric Hammerling: Okay, I want to thank all the moderators for your thoughts and for all the great work you've put into making this a successful conference before we even begin. And at this point, we're going to jump right in to the first panel.

Is Hydropower Really Green?

Fred Ayer: Good morning again. Let me introduce the panel so you know who's who. Farthest away from me is Jeff Reardon, with Trout Unlimited, the project manager for the Penobscot River Restoration Program. He's a great resource of information. Next to him is Tom Tarpey who, I guess, for around thirty years, a developer for power excellence; the guy knows his way around this business. Next to him is John Seebach, who came up by train from Washington D.C.; he's with American Rivers. He is from Kentucky and a lifelong kayaker. And next to him is Cleve Kapala, and Cleve is now with TransCanada.

I'm going to give a little bit of my sense of this and how we prepared for it, and then I'm going to turn it over to these guys. And then when we get done, we'd like to hear questions. If you are lazy and don't have questions, we can develop questions that we will ask ourselves.

When I was asked to do this panel, and the title was "Is Hydropower Really Green?," I was reminded of the words of that, sometime songwriter and fulltime Muppet, Kermit, who said, "It ain't easy being green." And it occurred to me that that was fairly accurate.

Before joining the Low-Impact Hydropower Institute five years ago, I was a hydro consultant for a number of years, and worked throughout the United States. Invariably, you spend a lot of time on the plane. I would end up sitting next to someone who would ask me that awful question: "What do you do?" I would try to explain that I worked on hydro licensing, hydropower dams, and that kind of stuff.

And I only got two kinds of reactions. These are in no particular order, but the first reaction was: "Wow, it must be wonderful to work on such green stuff. You do great things for the environment. Hydropower's green, right?" The other reaction was slightly different. "How can you sleep nights, building dams so those utility fat cats can become rich?"

When I heard this the first time, I listened to it and as I got older and wiser, I decided that these were very similar positions. They were polar opposites of each other and they were very harsh. I wondered how people came to that.

I came to conclusion that a lot of these kinds of statements about hydro, whether it's always good or always bad, come from ignorance. Some of the ignorance is real; people just don't know the answer. Some of it's contrived. If we're going to be involved in hydro, we should educate ourselves. It's an old technology and we know a lot about it. There aren't great mysteries.
I wondered how people became so detached from understanding this. I went to the oracle of all good things, Google. And I Googled green hydropower. I came up with seven or eight million entries. I took one of the first ones, which was information put together by the New York Public Interest Research Group. I thought it was sort of a neutral expert that could give me an answer.

They had done some pretty nice stuff for green hydro, or green electricity. And they had decided that they would break down all of the technologies and give you really pertinent information so you could make a good decision. And they said they wanted to look at the type of the technology, what the technology was, whether it polluted, what were the pros, and what were the cons.

So I went to hydro and here's what I got for an answer: Hydropower described the technologies of running or falling water in rivers and streams that turns turbines to create electricity. Okay, not bad. Does it pollute? Oh no, no, doesn't pollute. What are the pros? Well it provides moderate amounts of constant power and it is inexpensive. But, you want to know what's wrong with it. So this is the important one: Can impair fish migrations, but new technologies, used in most western states, can protect fish while generating power. Well, that's solved. That's great. If you read that, you might be led to believe it was an okay thing. It was good stuff.

State legislatures are creating policy that projects that produce under five megawatts can go into renewable portfolios, because they are green; because small has no impact. That's not true.

We all know it's not quite as simple as that. The LIHI has certified projects as having reduced their impacts; we hope to give them some advantage in the marketplace. We're always confronted with size. I don't want to spend a lot of time on this but, really quickly, state legislatures are creating policy that projects that produce under five megawatts can go into renewable portfolios because they are green; because small has no impact. That's not true. I could take you to a number of small dams that have been deadly for fish species and rivers. I could also show you some very large hydro projects that weren't so bad.

This next year, the LIHI is going to embark on program review of the criteria that we use when we look at projects and try to make evaluations of their greenness, if you will. When we do that, we look at water quality, we look at river flows, we look at fish passage and protection, look at cultural resources, look at recreation,

and so forth. So it's done that way and it's an objective process. That's my thirty second commercial. Give it some thought, go to our website, get involved and if you want to send in some ideas about what things you think we ought to take into consideration. We'd be glad to hear from you.
Now I'm going to turn this over. These guys are going to give you their definition of whether hydropower is green. I'm going to start with Cleve. I guess we get to go in the right order. Cleve, then John, Tom, and Jeff. They're going to get no more than 40 minutes, and I'll start pounding on the desk if they go over.

Cleve Kapala: Well if that was thirty seconds…

Fred Ayer: I keep my own time.

Cleve Kapala: Okay, thanks Fred. Let me just say a couple things because TransCanada is probably a new, or is a new name, in New England. TransCanada owns six hydroelectric projects on the Connecticut River and eight projects on the Deerfield River, not too far north of here.

All of those projects were developed between 1904, when first construction began, and when the last one went online in 1957. So they are getting to be aging projects. A New England power company developed them all. TransCanada bought them from a previous owner in 2005. So TransCanada has really been on scene as the owner for only about two-and-a-half years.

Fred asked me to talk about whether hydro is green. He's already stolen some of my thunder in that he went to Google for definitions of what is green. So I guess I'd have to say that it depends on what definition you're using for green. Believe me, the definition of green gets argued every day, in countless agencies and in statehouses around New England. If you look at some of the reviews that have been done nationally or for renewable portfolio standards of legislation, you'll see all kinds of stuff, different definitions of what is green and whether or not hydropower qualifies for it. So it just depends.

The second thing I have to say on whether it's green-and Fred also alluded to this-is it depends on the location. There are all kinds of different hydro projects scattered around the landscape from the Pacific Ocean to the Atlantic Ocean; some of them really are quite green, and some of them don't do a very good job at all in terms of the relative footprint or impact on the river, or the watershed that they exist in.

Green compared to what?

The third thing I'd say is: Green compared to what? Green compared to coal? Yeah, they probably all are pretty green compared to coal.

I'm from New Hampshire, so I just went through the New Hampshire primary and I would echo what someone said earlier about the level of discussion on the economy and on global climate change. Those were big issues in New Hampshire. I think in that context, hydro is generally pretty green.
It's very difficult to forecast what our energy costs in the future are going to be. Or fifty years down the road. But, today, from a practical standpoint, hydro is a pretty good alternative. Looking to the future, and I think Fred asked, you know, what's going to happen in the future in the next generation? It's hard to say.

It stands to reason that water management in the future-whether it's water supply, waste assimulation, hydroelectric power-it's probably going to be more intensive in the future than it is right now. We're anticipating much greater fluctuations and much

Water management in the future, whether it's water supply, waste assimulation, hydro-electric power; it's probably going to be more intensive in the future than it is right now.

greater changes in the precipitation patterns and hydrologic cycles than we've been exposed to in the past. We've already started to see this, and it's almost irrefutable that that will continue.
I think one of the challenges in the future for hydro is going to be to integrate itself well in to the changes that water management will experience over the next period of years, and to have a constructive role within the overall changes that we can anticipate in water retention.

The other big part of the debate in the future is going to be existing hydro. In terms of existing versus new, it's always going to be an advantage if an existing site is well operated, and can be improved and can be made greener. That's a better opportunity in some ways than something new with all the uncertainties associated with starting something knew.

Regulatory Solutions

There are going to be regulatory solutions in the future. And there are going to be mechanical, civil, and electrical solutions that may make hydro greener. To date, the TransCanada plants have experienced a greening as a result of relicensing our projects in Deerfield within one license. There are eight projects there. There are three on the Connecticut River. All eleven of those developments are the subject of broad, comprehensive settlement agreements. They deal with all kinds of issues that are relative to fisheries, to land protection through conservation easements, enhancement of minimum flows, reservoir elevations, and so forth. I would say that from a regulatory standpoint we've been greened to an extent by regulatory solutions.

I also want to talk about one of our oldest plants, which is the Vernon station, just north of the Massachusetts border and Mansfield, New Hampshire, and Vernon, Vermont. That plant went online in 1909, so it's almost one hundred years old. We're in the final stages of repowering that Vernon station with four new units. There were ten units when the station was originally designed. We shut down four of those units back in the mid-90s. We weren't satisfied that they were safe or that they were maintainable. We've replaced them through a license amendment, and they are in the process of coming online right now. The efficiencies that are created, the water management opportunities, and the additional generation-that's what most people are calling the incremental hydro. We think there's a lot of opportunity in incremental hydro at existing sites.

Finally, a lot of the hydro structure and infrastructure in New England is old. The questions are going to become: Can you afford to repower those sites? Can you make them better? Can you operate them better? Can you make them more efficient? Can you get more megawatt hours, more capacity out of those sites by investment?

I would just say on the Vernon station, we first started talking about this in 1992, under the New England Power Company's ownership. It's taken until today to get that off the ground. It is coming in for roughly twice what TransCanada budgeted. These things are very, very speculative in terms of the costs to get them online. Ultimately, we think we will have very good use of the water at the Vernon station. We will have more megawatt hours. We will have slightly more capacity and certainly more efficiency for the future.

John Seebach: Okay, so Fred told me to mindful of time. Hopefully, I can make this very quick by just saying "No, hydropower isn't green." But, that's not really the accurate answer either. I think it kind of unfairly picks on hydropower. The point that I'd like to leave with everyone today is that there's really no such thing as purely clean green in the world of energy.

Any way that we extract energy and electric power out of the natural resources, we're going to harm the planet in some way. To my knowledge, there is no way that you can do it without harming the planet. Whether or not something is green has a lot to do with how you extract that energy and how relatively green it is as opposed to other things., including how the project is operated, what you're looking at, and how you're defining green. If green is low emissions, then wind, solar, hydro, and nuclear, are all as green as can be. But I think that if you ask anyone that is interested in land use or in protecting rivers, like I am, or is concerned about nuclear proliferation, or the toxic nuclear waste, then each of those ways to extract the energy has problems.

It's kind of a bleak thing, I guess, to say: "There really is no green energy." But I think there's nothing that's pure green. That's it. There are certainly some things that are better than others. All those things are probably better than coal in terms of both the damage that comes from extracting energy from the environment and in terms of carbon emissions. There are varying shades of green among hydro projects. Some of them are operated very well-and actually do relatively less damage to the environment than others-but some are not.

I'm stressing there is no such thing as green energy because it's kind of an academic point. When people think about green and clean energy and something is labeled as green or clean energy, they sort of assume that it's okay. I think it sort of gives us a free pass on thinking about the damage that we're doing to the environment. I think that's damaging. I think people should be aware of the choices that they're making. When we operate hydropower, we damage the river. When we operate wind turbines, we sometimes lop off the top of a mountain and we change the way that other species can use land. I think that the key to green energy is to make sure that we're mitigating as many of the environmental impacts of the energy as we can. And that we choose the energy source that makes the most common sense based on mitigating those impacts and being able to get energy power out of the resource.

There's really no such thing as a purely clean green in the world of energy.

The other thing I would stress is that we shouldn't be in the business of destroying the environment in order to save it. When I hear people talking about new hydropower development, there's this assumption that hydro is green. I think people are looking at it from the position that it is green because it doesn't emit carbon. Therefore, we should encourage it. Encouraging it often that means we should subsidize it. Subsidizing often means helping to reduce some of the costs in development. Those costs tend to be the very things that protect the environment and make it green.

You don't get that so much with larger projects, but people are starting to take a closer look at smaller projects. They're really sort of on the margin economically. Some of the people that are proposing to develop these projects are among you. "If you just make this happen we could just bring you this energy if only we had just a little something extra to make it economically feasible." That little something extra tends to be "Let's do away with state and water quality standards. Let's ignore those and let's kind of give it a free pass on a few of these things." But I think that's wrong, and not a sound policy.

In a world where the climate is changing and people are really keyed into their energy use and emissions, hydro is going to become a more attractive source of energy. But, I also think it's going to become more attractive because other sources of energy like coal, should be forced to pay the full cost of the environmental damage that they're incurring.

Thomas Tarpey: Good morning. Since even, or maybe even especially, at my own family dinner table, I rarely get the undivided attention of the group of people I'm sitting with, I'd like to take this opportunity to ask a few questions of you folks before I begin.

By a show of hands, could those of you who believe that the phenomenon of a climate change is really taking place, please raise your hands and just for the fun of it, those who don't believe it's taking place, please raise your hands.

Those of you who believe that climate change is primarily anthropogenic in nature, would you raise your hands? Okay, that's very interesting. Those of you who believe that the problem of climate change is reaching crisis proportions, would you raise your hands? And those of you who feel that in order to meet that crisis we probably do have to reduce our human-generated carbon emissions by up to eighty percent by the year 2050, would you raise your hands?

Okay, great. Now here's the killer and my wife made me ask this question: How many of you believe that there are too many humans on earth? Good. Just because you raised your hand does not mean that you have to commit ritual suicide. Those who know Fred know that Fred is a highly trained biologist and somebody who operates generally on a pretty high academic plane. It's difficult to speak to him in sort of lay terms, I found. When Fred called me up and asked me to be on this panel, he said, the question we want you to answer is: Is hydro green? It didn't take me a second to answer in Fred's language. I said, Fred: "Is hydro green? Do earth signs evacuate in sylvan environments?" Fred hasn't answered that one yet.

Like the other people, I, too, did some checking on Google to see if there was a definition for green energy. The most compressed definition I came across was in Wikipedia. Wikipedia listed three elements of green energy. First thing is renewable. And I think that we all agree that hydropower is renewable. Second that it is non-polluting. Well that's a little dodgier in terms of how you define it, but I think a lot of people would agree that it is non-polluting. The last one is that it is environmentally-I think they used the word-friendly I think meaning non-damaging. That's where we really get down to the crux of the debate as far as hydropower is concerned.

When my family and I moved into the home that we inhabit now, which is a crumbing vintage house in Concord, Massachusetts, the only saying grace of which is that it's on the banks of the Assabet River, all other sources of entertainment paled besides watching what was happening outside our windows and in our yard. One affection that we developed, which none of us had when we arrived at that house, was a love, a respect, for turtles.

Turtles

We have watched every single year what we think is the same female turtle come up through our yard and make its way through the brush to our house, and sometimes down a section of the yard, and sometimes out into the driveway and across the road, and into a cattle hold that's across the street from us. On the banks of that cattle hold it finds a nice warm, sunny spot and digs in two or three places, until it finds just the right one, nestles in the hole and lays its eggs.

Well, because we watch that turtle so closely, we've been watching for other turtles. We stop when see a turtle in the middle of the road. We stop the car and we try to figure out in which direction the turtle was going and we put it on the side of the road so that it won't be struck by cars. We've been amazed at how many turtles we see that have been killed by cars. We think that it's highly likely that turtles are probably not going to make it for too many more centuries after having been around for three or four hundred million years. They're probably not going to make to the end of this millennium, maybe not for a couple more hundred years.

This is because the human environment has intersected with that of turtles in such a way that they just can't live with certain parts of what we do. People probably stood better chance of missing turtles on the road when they were clopping along behind a horse and buggy. They probably stood a decent chance when they were tooling along our road back in the 1920's in a Model T Ford. But when they're sitting with their heads six feet above the road, and they're driving a four thousand pound SUV, they're not very in touch with what's happening on the road. We find that they don't always swerve to miss a turtle.

Fish Passage

This is not a complete non sequiture about turtles, although I like to do a commercial for turtles whenever I can. Hydropower's greenness really, I think, hinges on its environmental friendliness. My company, Essex Hydro, has made a niche business of redeveloping industrial dams in New England. These are dams that typically have been around for anywhere from one hundred to two hundred years. We are convinced, we know in our hearts, that when these dams were built, they inconvenienced a lot of creatures that had, and still do, inhabit the rivers where those dams were located.

When we've done our redevelopments in various locations, we have installed various facilities and technologies to enhance the passage of fish, both the resident fish and anadromous fish-I

should say a diadromous, shouldn't I, because we're including eels here. We made the facilities marginally friendlier to the organisms that call that river home. But we do still inconvenience those organisms. We don't think that hydropower is going to be responsible for the extinction of many of those species. We hope that it won't be.

When we come to these forums, we're always confronted with various questions. One of which is: "How do you account for the massive decline in populations of salmon in the rivers of the Northeast?" Or: "How do you account for the mysterious and equally precipitous decline of the populations of American eels in the rivers of the Northeast?" These are excellent questions, and they're things that all of us, as citizens and stewards of the environment, need to be asking.

We think that certainly there are some locations in which dams are responsible for the decline of populations of Atlantic salmon. But we also look at various rivers in the North Atlantic on the North American continent where the decline in populations has been equally precipitous, or even more precipitous, which have no hydroelectric dams, or no dams, or no manmade impediments to movement of fish at all. So we're left with the question, "Well, if it's not dams, what is it?"

Some of you may know the Atlantic Salmon Federation. The Atlantic Salmon Federation has a number of great people working for it, one of whom is Fred Whoriskey. Fred once told me that they have twenty-six working hypotheses for the decline of Atlantic salmon in the North Atlantic, one of which is the existence of-and the continued existence of-hydroelectric facilities. But the hypotheses run the gamut from that to warming of ocean waters due to climate change, the existence of various chemicals in river waters that mimic hormones and disrupt the fish's reproductive cycles, and on and on.

Anyway, I do believe that given a relative scheme of things, hydro is green. I agree with my fellow analysts in saying that green is something of a relative value.

I want to give a plug to a couple books. You probably wondered if I was going to read to you, but I'm not going to. I would recommend that you all buy a copy of each one of these two books. The first one which you should read cover to cover was written by James Lovelock, who was a scientist, and is still alive-a scientist who generated the Gaia hypothesis, which was popular in the early 80's. His book, entitled ***The Revenge of Gaia***, is sort of an I-told-you-so. In it, Mr. Lovelock talks about the relative greenness of things and he recommends, although he would once have thought he would have died before doing so, that we start looking at nuclear power again. I'm not recommending that.

I also recommend that you purchase and not read cover to cover because you wouldn't have a family life anymore, ***Sustainable Energy,*** sub-titled ***Choosing Among Options***. It was written as an interdisciplinary effort by four professors at MIT. They are chemists, environmentalists, economists, and engineers. This book will tell you a little bit about all of the sources of energy that we have to choose among. It lays out a framework on how you can best make decisions in your community as to what sources will do the least damage to our earth. Every source does bring damage. So I think with that, I'm going to relinquish the microphone.

Jeff Reardon: Well, Fred told me-and you should understand that Fred is the president of the board of directors of the Penobscot River Restoration Trust-so when he twisted my arm to come down here I couldn't possibly say no to him. He knows I'm an argumentative kind of guy. So he said, "I want you to come down and talk about 'is hydropower green?'" I said, "Fred, that's just absolutely the wrong question, so I'm going to come up with a list of other questions." These questions may be more important for the policy discussions that much of today is devoted to. They're subsets of the big question.

I think it's the wrong question because green is in the eye of the beholder. Since Fred mentioned Kermit, remember that Kermit thought Miss Piggy was beautiful. People are going to say that anything that doesn't have carbon emissions is absolutely green, no questions asked, so let's not think about it at all. Some people are going to say if a turbine chops up a single fish, hydropower kills fish and it's absolutely not green, it's black.

I live in a world of grays. I've been doing hydropower relicensing for about ten years now. Almost all the projects that I've worked on have been settled through comprehensive settlements. I think you do that by finding the gray parts of the map and going to places where everybody can agree. Maybe it's a shade lighter, or a shade darker, but we can both agree to set the lights just about here.

Let me start with a couple really basic questions. First question: "Is hydro an important component in New England's renewal energy mix?" The answer is absolutely "Yes," with the exception of Rhode Island; if you're a small flat state, you're not going to have much hydropower. Hydropower represents the majority of the renewables, particularly if you live in northern New England.

Hydropower represents anywhere from a small fraction to as much as a quarter of the total electricity. This is generation inside of state borders based on the Department of Energy's data. I'm not sure these numbers are absolutely gospel; there are certainly questions about them. But hydro is an important part of the mix. The vast majority of Maine's renewables are hydropower, in addition to wood burning biomass.

Second question: "Does existing hydropower have real environmental costs?" Absolutely it does, there's no question about that. You know it has significant costs in terms of fish passage, but

let me just give a couple of examples that I think illustrate these costs.

The Penobscot River, which is where I've done most of my hydro licensing work, used to run 125 miles; historically 122 miles of that was river, and there was one small pond in the middle called Indian Pond. The rest of it was free flowing river. If you look at that today, there's about forty miles of free flowing river left. So, for critters that live in rivers, but not in ponds or lakes, two thirds of the habitat that was historically in Penobscot River is gone. Some of that would have been gone no matter what we did, because the weather changed and we built up the landscape. But the development of the hydro system took away huge amounts of useable habitat that used to support huge runs of fish.

Nowhere in New England that I know of is there a significant run of any diadromous fish, other than American eels. People may challenge me on this, and I hope they do. I ask this question a lot, and I have yet to have somebody make an argument that at least satisfies me. Some individual dams have good fish passage, but when you get to river systems that have two dams, three dams, four dams, five dams, there is a cumulative impact of multiple dams. In many cases they've built what we asked them to build. We either haven't been able to make fish passage work, or we are able to make it work, but the cumulative small losses at multiple sites add up to more impact than the resource can sustain. Is that all that's happened to our diadromous fish? Absolutely not. A host of other things have affected it. But there's no question the dams have a big impact.

For the most part, our hydropower system is pretty much fully developed.

Third question: "Compared to other regions how much capacity is there to increase hydro production in New England, so that we can reduce carbon emissions?" I think for the most part not, though there are places that we can make small changes that locally may make meaningful differences. For the most part, our hydropower system is pretty much fully developed. If there's a good hydro site in New England, somebody built a dam on it, either at the turn of the twentieth century, or in the 1920's, or 1950's, or the 1980's. There aren't very many sites left. The sites that I'm familiar with that are left are all sites over which we have had long public battles, and eventually decided that those dams didn't make sense to build. Dickey-Lincoln, which would have flooded a portion of the St. John River, is one of those. The Basin Mills Dam on the Penobscot is another one.

Does that mean there are no sites left? No, there are certainly small sites around. But those small sites probably don't have a tremendous amount of ability to change our overall carbon mixture. The reason I say that is because if you look at what hydropower dams produce, the big dams produce the vast majority of all the hydropower. Here's a table on the Kennebec River (figure 1). I looked at all the hydropower projects on the Kennebec River, looked at the FERC record to determine what small plants generate, what medium sized plants generate, and what larger plants generate. The over-thirty megawatt plants, of which there are only two, generate half the power we produce in the Kennebec Basin. The five to thirty megawatt plants, and there's only seven of those, produce another forty percent. Everything less than five megawatts combined produce only eight percent of the power. We're not going to significantly change our carbon footprint by adding one-half megawatt and one-megawatt plants.

Does that mean we shouldn't build any small hydro? Absolutely not, but not as a strategy for really reducing our carbon by eighty percent. Hydro may be a small piece of that, but it's not going to be the biggest piece. We're going to have to make some other, much more difficult changes if we're going to do that and be successful.

Fourth and last question: "Can we make hydropower green?" I think this is one where there's a lot of agreement from us up here on the panel. I think we can, but only if we make a realistic assessment of what the impacts are. There aren't going to be any simple answers about this.

From my perspective-and I deal mostly with the fish passage impacts of dams, and not with their impacts on broader watershed processes-give me one fifty megawatt dam, instead of forty one-megawatt dams, any day of the week. That one fifty megawatt dam has enough money to invest in building itself good fish passage and doing a good job of dealing with the economic consequences. But the fifty dams, that's fifty barriers instead of one. Would you rather have fifty stop signs between here and work or one ten-minute stoplight? That's really the kind of comparison that we are talking about.

Projects in Kennebec River Watershed, Maine

Size	# of Plants	Generation (million kWh)	% of Total
Very Small (<1 MW)	7	11.363	1.0%
Small (1-5 MW)	9	76.978	6.8%
Medium (5-30 MW)	7	484.554	42.8%
Large (>30 MW)	2	558	49.3%
Total	**25**	**1130.895**	**100%**

Figure 1.

We really need to think about that. You can only think about that in a site-specific way. Some rivers didn't have diadromous fish, historically. The fish passage implications might be much less significant on those rivers than the rivers that historically had large fish runs.

Kennebec River

I want to close with two examples where I think we've been very successful in reducing the impacts of the hydropower. They're both projects that my organization has been involved in. One of those is the classic 1993 Kennebec river re-license issue-one of the huge numbers of New England hydro projects that was re-licensed in the 1990s. Through a series of settlement agreements on those projects, FERC made a number of changes, both large and small, in operations, including damming issues, changes to minimum flows, and construction of new fish passages.

I think a lot of the hydro operators were really scared going through that process. Environmental standards were being applied at dams that were mostly built in the 1950's or earlier. The net result of those changes was monumental in some ways. We've either removed, or will remove soon, three of the thirteen dams that were re-licensed under that class since 1998. The Sandy River Dam and Edwards Dam were removed last summer. FERC has now approved the removal of the Fort Halifax Dam; it's still tied up in a court challenge, but that will be settled eventually.

The implications of that for hydropower were that we now produce about 92 - 97 percent of what we used to in the hydropower system. It's a much better system now for sea life and fish in all kinds of ways, measured by the fact that we now have a commercial harvest of close to three-quarters of a million fish in places that in 1996 didn't have any fish at all. Salmon are a little bit more difficult. And the alewives are a little more difficult now. That's a huge change for the positive.

Penobscot River

The last example I want to talk about is the Penobscot River Restoration Project. And there, people talked about tweaking the existing hydro system to get more power from it. I think that's an area where there's going to be a lot of change in New England going forward. When the new owner took over those dams, environmental groups in the state of Maine had been fighting with the previous owners over licensing of dams on the Penobscot, literally for decades.

The new owner said, "We'd like to do business in a different way." Basically the negotiation went like this: "We know a lot more about hydro than we did when these dams were built. You know a lot more about fish. We're considering fish a lot more than we did when these dams were built. Can we find a way to reconfigure this hydro system so we produce essentially the same amount of power with much less impact on fish?" That resulted in agreement where the Penobscot River Restoration Trust will purchase and remove two hydropower dams. PPL Company, which owns another seven hydropower dams in the system will reconfigure energy generation of the remaining dams, with essentially no net loss of hydropower production, and huge benefits for sea-run fish on the other side.

I think those are the kinds of places where this debate is really going to play out. In some cases, maybe can we get an extra two percent of energy out of this system without any negative impact. In some cases it may be that we can reduce the environmental impacts with minimal changes to hydropower.

Fred Ayer: I'm hoping that you have questions. We have canned questions we can use, but I'm hoping someone out here has a question. This is a great panel; a lot of knowledge sitting up here. We started a little late, so I bargained to get a little more time. Any questions on the floor either? No questions. So you got the whole thing figured out. Oh, down there, way in the back.

Audience: The gentlemen from the Essex company. About ten years ago I spoke with a senior principal of a firm that has a couple of turbines on a river in Maryland. He told me about technology that you were working on to reduce the pressure gradings in turbines and, therefore, help enhance the survivability of the fish that pass through. Am I correct? It was a turbine designed by General Electric for many years.

Thomas Tarpey: I can't judge whether your question is correct because I'm from Essex Hydro Associates. There is another company called the Essex-there's an Essex Turbine manufacturer-and there are a bunch of companies named Essex; they're different. However, there is a representative of Alden Laboratory in the audience. They are one of the foremost hydraulic laboratories in the U.S. They have recently completed a contract for the Department of Energy in which they developed something informally called "The Fish Friendly Turbine," which is a turbine through which fish can pass with little or no discomfort.

Fred Ayer: Tom, that's actually on the next panel.

Thomas Tarpey: It is?

Fred Ayer: Yeah.

Fred Ayer: Okay. Somebody up here had a question. Yes.

Life Cycle Analysis

Audience: In other energy analysis we do what we call a wells-to-wheels analysis. We look at the complete energy cycle. I'm surprised that the panel didn't refer to that for hydro-that someone has done that. You've alluded very qualitatively to some implications. Have any of you looked mathematically at all the

attributes and laid them out? Especially what the last speaker spoke about: the difference between when we look at small, medium, and large hydropower.

Fred Ayer: Is this life cycle? Is that the other phrase you might use for this? Tom?

Thomas Tarpey: That's actually one of the canned questions that I suggested to Fred. There is something called LCA Life Cycle Analysis. There is a very detailed methodology set forth by the International Standards Organization and it's listed, if you Google it under, I believe, ISO 14,080. There are large numbers of scientists and engineers who've laid out this extremely detailed methodology by which any energy source, any process actually, but any energy source can be analyzed and compared, and contrasted to other energy sources, so that you can make a decision as to what the life cycle impact is going to be of a given energy source. As a by-product of that, you can determine what's going to be the life cycle emissions of carbon, for instance, for a given source of energy. Fred Ayer: Doesn't hydro do very well compared to other energy sources? A gas turbine might last 15, 16 years, while hydro sites in New England are regularly 100, 120 years old?

Fred Ayer: Doesn't hydro do very well compared to other energy sources? A gas turbine might last fifteen, sixteen years, while hydro sites in New England are regularly one hundred, one-hundred-twenty years old?

Cleve Kapala: Yes. I use the burn station analysis. There is a one-hundred-year-old station that we're refurbishing with four new units. Although I have never done one of those analyses, certain people in the engineering section of the company have done them and hydro looks very good.

Fred Ayer: Any other questions?

Carbon Footprint and Project Site Size

Audience: I have a question for Jeff. I think it was a very interesting point that you're not going to make much difference on carbon with those small fifty one-megawatt plants. But do you have any reason to believe that those fifty small one-megawatt plants won't be built? Because anybody who owns an existing dam structure may be interested in putting in a small turbine. So, even though we know that it may not make a big difference on carbon, is there anything that's going to keep those small ones from being built? Regardless of the effect on carbon?

Jeff Reardon: In my experience, the few people I know who have looked at either starting from scratch to develop a small hydropower site or refurbishing a significantly deteriorated dam, have determined that the cost of just the construction is prohibitive even if you forget about the permits. A small dam in my town is twelve feet high in a very small river. People have asked, "Does it make sense to try to add hydro turbine on there in today's environment?" They got a very preliminary cost estimate of two-and-a-half to three million dollars on a project that would produce enough energy to generate twenty to thirty thousand dollars a year in revenue. So the really small ones sort of fall off the charts. Unless the price of energy changes a whole lot.

For the sites that are closer to the margin than a site like that one, what people are arguing about, and I think the policy debate we're going to see going forward is: "Is there a way to change what's economic and what isn't?" You can do that by having a subsidy. You can do that by having a carbon tax. You can do that by changing the regulatory site. It's not going to surprise anybody that I don't think we ought to change the regulatory site. Because the impacts are the same and I think the system's doing a good job of making hydropower projects more friends. But they're still having significant impacts.

On those changes in the regulatory system that would have a significant cost: You have to ask what we should spend money on. Do I get more carbon bang for my buck out of encouraging wind, or solar, or hydro cars, or CFL light bulbs, than I do out of encouraging small hydro? I spend a million bucks for hybrid cars. How does that compare to a million dollars worth of subsidy for, you know, ten, half-megawatt hydro plants or whatever the comparison is?

I think that's the kind of thinking we need to be doing. What's remarkable to me on the wind side, at least in Maine, in the governor's state of the state address the other night, he announced there have been two billion dollars of investment in new wind projects in the Maine. We've already put one-hundred megawatts of new wind online. On Monday, at an alert hearing, there's another proposal that's on the docket: they're considering another 186 megawatts of wind, a proposal that I think are likely to be approved.

Those are going to make relatively big changes in the energy mix. It would take an awful lot of small hydro plants to have that kind of impact. Wind is a new frontier. People are getting the best sites now and whoever's first is going to make a lot of money.

Fred Ayer: One more question maybe, I think we've got time for. Yes, please.

Pump Storage Facilities

Audience: In the Connecticut River Watershed, there are two pump-storage types of facilities. We've mostly been talking about dams. I was wondering what the panel has thought about the relative impacts of pump-storage hydro.

Fred Ayer: Just as a certifying entity, LIHI doesn't look at pump-storage because of the use of fossil fuels. Tom?

Thomas Tarpey: The existence of some sort of storage device is going to become much more important in our energy economy as intermittent renewal energy resources such as hydro, but to a much greater extent, wind, come online. Wind is available intermittently and often available out of sync with the demand. Therefore, if its value is going to remain high, there's going to have to be some way that that energy can be stored.

Forty years ago when Northfield Mountain and Bear Swamp were built, that was really the only economic technology. I think we're looking at a number of technologies today that utilize energy in a different way and don't involve the pumping of storage water. Just one is plugging in hybrid vehicles. Most of our wind capacity that's generated at midnight could go right into the batteries of plug-in hybrids and that's the way storage is going to work.

Fred Ayer: Thank you for sitting and listening. I would encourage you to question these guys as you see them through the rest of the day. Under the truth in advertising, I want to clarify something. I do not have a degree in biology. I have a degree in art, which proves that what we do is more art than science.

The Technology of Clean Hydropower

Bob Gates: What I'd like to do first is introduce the panel that's here to talk about hydro technologies.

Our first speaker will be Paul Williams. He's a senior vice president with Kleinschmidt and he will present a more global view in New England on the hydro industry and technology improvements. We have Steve Amaral from Alden Labs, who will be speaking about the fish-friendly turbine. The third speaker is Konstantine Drakonakis; he's with Connecticut Innovations and the Clean Energy Fund, which helps put forth the equity to fund projects in the State of Connecticut.

If I have a hydropower plant that's one hundred years old, and that technology was around just a shade before that, it is a very old and proven technology. When I was part of Northeast Utilities, I was always the poor sister, because I had hydropower as my portfolio. I stuck with hydropower my whole career even though I was offered chances to go off in different directions. I just liked being the clean guy. Over the years, I've taken a lot of guff over the lack of technology associated with hydro. So it really thrills me to be here to show you that there's actually been change in the hydro industry over the years. And there is more change on the horizon, and we have some fine folks here today to talk about that.

I want to hold the questions to the end. We will have presentations and there will be some interesting things to look at up on the screen. Then we'll get in to a question and answer period. Paul.

Paul Williams: Thank you, Bob. I've been asked to speak about turbine design improvements and put a slide presentation together. I'll try not to get too techie on most of the folks in the audience. Sometimes it's easier to show you things than just to explain them to you.

When we talk about turbine design improvements, I want to preface that by talking about the different types of turbines. There are a number of different hydroelectric turbines. Hydroelectric power is a very mature technology. Having said that, it's a very active market at the present time. We'll talk about conventional hydro-turbine types and later there'll be some discussion about new technologies that are not traditional or that might be more unconventional.

Types of Turbines

The conventional turbine types really fall into two categories. They're characterized as impulse turbines and reaction turbines (figure 2). The impulse turbine is best characterized by a concentrated jet of water that strikes the rotating element of the turbine in an atmospheric condition-in the air. In the reaction turbine, the water column is fully submerged. The turbine is fully enclosed and the water column is pressurized.

The impulse turbines are typically seen when you have high heads and low flows. They actually were developed on the West Coast, in California, during the gold-mining era. They're relatively uncommon on the East Coast.

The reaction turbines are the Francis Turbine and the Kaplan Turbine, which is a special type of propeller turbine. The Kaplan Turbine has adjustable blades, similar to blades on an airplane. The propeller turbine has blades in a fixed position. The Deriaz Turbine is a kind of a hybrid turbine. It's somewhere between a Francis and a Kaplan.

The two most common types on the East Coast would be the Francis and the propeller, either an adjustable propeller or a fixed

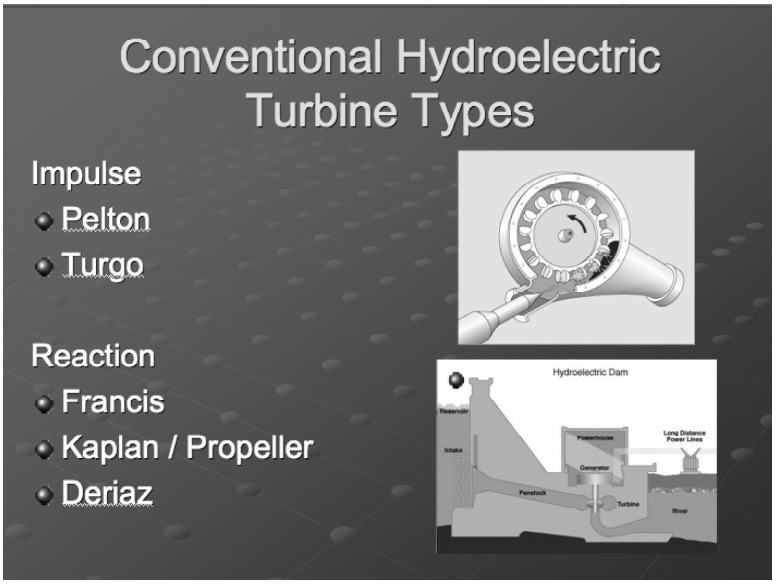

Figure 2.

propeller. So, for purposes of discussing the propeller turbine, we'll talk about the Kaplan Turbine.

Francis runners (figure 3) typically have curved buckets, usually between sixteen or twenty buckets, as opposed to a propeller turbine, which more commonly has four to six blades.

The Kaplan Turbine (figure 3) has a distributor and movable shutters, called wicket gates, which regulate the amount of water that flows through the turbine.

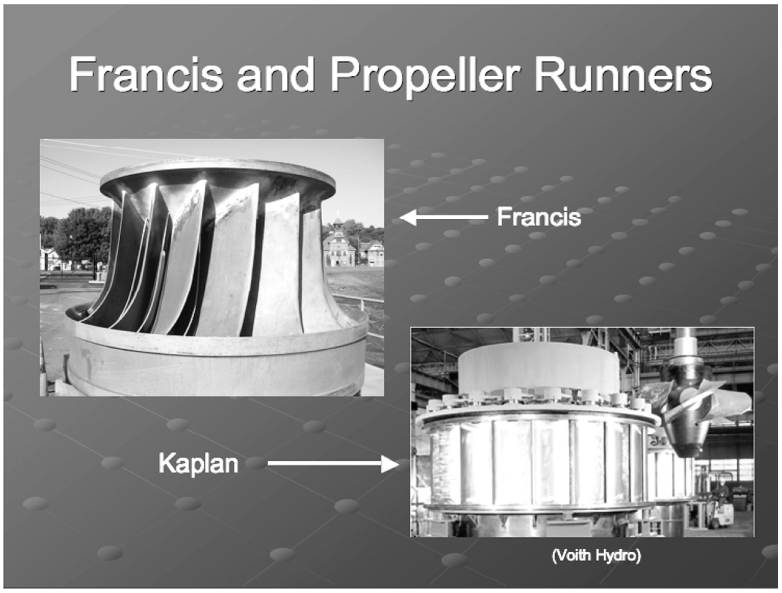

Figure 3.

The actual runner is suspended in the air (figure 3), which would be comparable to the Francis runner. The blades are attached to the hub of the unit. Those blades vary position depending on the head and the flow conditions.

Hydro-turbines in general, when you talk about rotating machinery, are slow-speed machines. Kaplan Turbines typically are slower RPM than Francis Turbines. And I would say that a range of speeds that's characteristic of both of these types of turbines might be between 72 RPM and, say, 514 RPM. That's in contrast with a gas turbine that might be turning at 3600 RPM.

Hydro technologies been around for well over one hundred years. But there are advances in design and manufacturing that result in some improvements and enhancements that benefit the industry. Part of the design enhancements result from computational fluid dynamics that we didn't have available twenty years ago. Finite element modeling allows the designer of the runner to carry his analysis to a much higher level. The ability to do the analysis to the higher level only gets you halfway there, however.

If you can't manufacture the turbine to the tolerances and to the design-to the accuracy of the design-you haven't really haven't maximized that design. But we do have advances in manufacturing. We have automated machines. Five axis milling machines. Machines can be manufactured to a much greater tolerance than they could years ago. An average efficiency gain today would be in the order of a two-to-five percent increase in turbine efficiency.

Modern materials include cavitation-resistant alloys that weren't available fifty years ago. There are higher strength materials that are available. So, back at the turn of the century, if a turbine runner was manufactured out of cast iron, the thickness of the buckets in that Francis Turbine for example, would have been much greater than today for a couple of reasons. The designer didn't have the high order analytical capability, so he'd cover up for his design uncertainties with a thicker bucket, and the strength of the cast iron versus the strength of the modern materials today would also dictate a thicker bucket.

An average efficiency gain today would be in the order of two to five percent increase on the turbine efficiency.

Today, with a modern design and higher strength materials, those buckets can be produced in a thinner profile that allows more water to fit through the same given diameter of the turbines. That leads to what we call a hydraulic capacity increase.

All the turbines would respond to the same laws of physics in that the energy that you get out of the turbine is going to be the product of the flow rate through the turbine and the head, or the vertical drop for the water, that's available. So, all else being equal, if we can take an older runner out of an existing machine and put a modern runner in, the hydraulic capacity can be increased; you're going to get more power and more energy out of that machine.

Increase Turn Down Capability

Another area of improvement today is what we call an increase in turn-down capability. I'll show you an efficiency curve in a moment to explain what I mean by the turn-down. With the turbines that are adjustable through a certain range, there comes a cut-off point as you start to back the turbine down, where the manufacturer would no longer guarantee the performance, or even go so far as to recommend that you not operate in that range because you get a rough operation and vibration.

Even if you didn't change the turbine at all, some older generators would benefit from modern materials and/or modern installation. Sometimes you find an example of an older hydro plant where the limitation isn't so much the turbine; it's actually the generator that's over heating. So, if the generator can be rewound either by itself or in conjunction with a runner replacement, there can be a double benefit to those enhancements.

The modern electronics and the digital technology that's available today allows much greater degree of control. I mentioned on the Kaplan Turbine that you have adjustable blades and those work in conjunction with the adjustable wicket gates. The relationship between the positions of both of those elements is very important.

As the head conditions or the flow conditions change, there's an optimal relationship between the blades and the gates that, in the older designs, was established by use of a mechanical cam. As head conditions or as the seasons changed, the operator would physically remove a mechanical cam and put a different mechanical cam in there that would change the relationship.

Today, that's all done with electronics that allow a much greater degree of optimization, resulting at greater energy production.

Efficiency

It is useful to look at the evolution of the water wheel (figure 4). The tub wheel goes way back to the early days of waterpower. It was very inefficient; it was probably ten percent efficient. These were used on very small sites where there was a gristmill or a sawmill-where far more water was available for power than they needed for whatever purpose it was being used for.

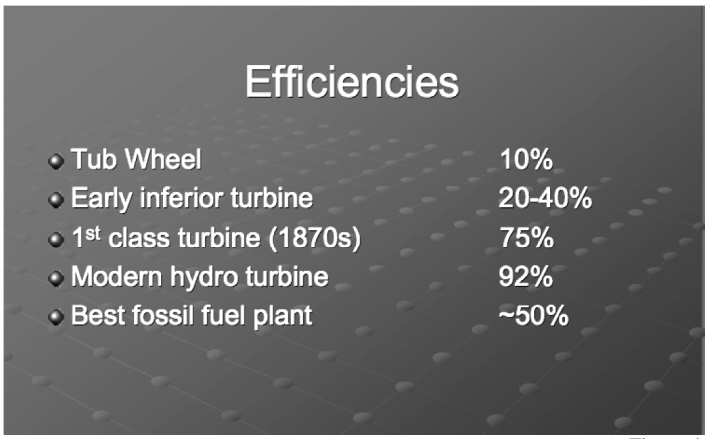

Figure 4.

A lot of work was done in New England on the development of hydroelectric turbines in the Lowell area and around Holyoke, Massachusetts. Early turbines had efficiency somewhere in the twenty-to-forty percent range. By the time we get to the 1870's, turbines had an efficiency of seventy-five percent. A modern hydroelectric turbine probably has efficiency past ninety-two percent, probably in the ninety-five percent range. That's in contrast to a modern fossil fuel plant that might have efficiency in the fifty percent range.

I wanted to illustrate the evolution of the efficiency of the Francis Turbine (figure 5). Back in the 1900's, the Francis Turbine was already eighty percent efficient. From 1900 to 1930, that efficiency went from eighty percent to ninety percent, which was a pretty good jump for that thirty year period. In the next fifty years, from 1930 to 1983, we only went from ninety percent to ninety-five percent. So, the gains today are really measured in much smaller increments than they were in the early part of the turbine development.

Back in the 1970's the increases in turbine efficiency were probably measured in fractions of a percent, a tenth of a percent, two-tenths of a percent. Nowadays, it's not uncommon to measure our increments of efficiency in gains in whole percentage points.

Figure 6 is a family of efficiency curves. It represents a couple of different types of turbines. The impulse turbine is the dotted line. There are also curves here that show the relative performance of an adjustable blade propeller, a fixed blade propeller, and a couple of different types of Francis Turbines.

There is one common theme: the best efficiency for all different types of turbines hovers right in the ninety-percent range (figure 6). The shape of the curve becomes important as you have varying flow available. Anything that has a very flat shape to it, over a broad range, would be desirable because as your flow dropped off, you could maintain higher efficiencies.

The fixed-blade propeller typically has a peak shape to the curve; as the flow drops off on that type of machine, its efficiency drops off quite a bit. So when we talk about increasing the turn-down capability of the machine, what we're really talking about is taking the right-hand side of that efficiency curve and improving it, so that you have higher efficiency at lower flow conditions. I'll explain a little bit later how that becomes important with today's hydro operations.

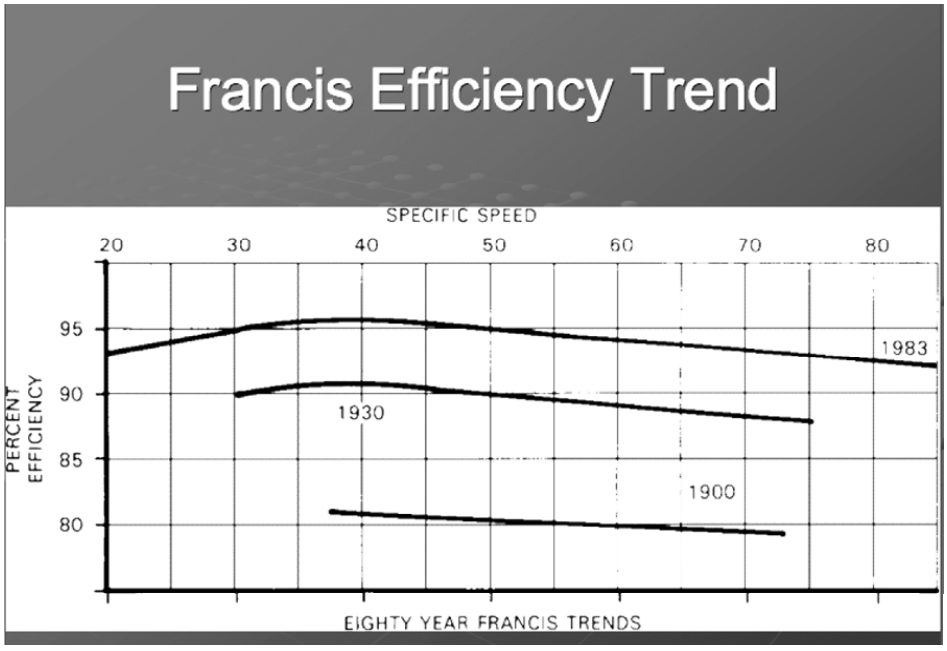

Figure 5.

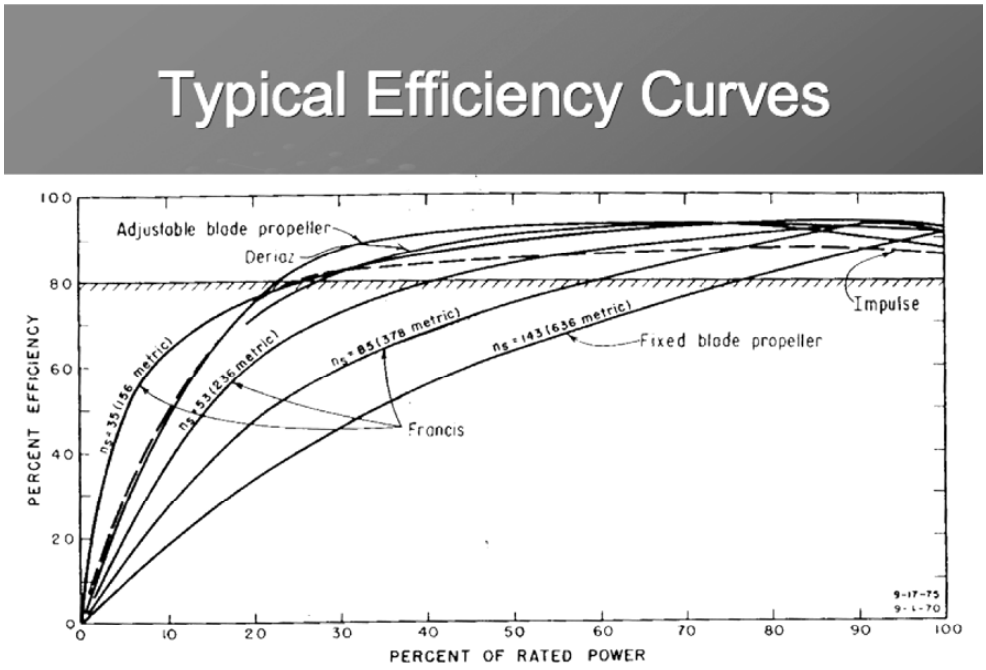

Figure 6.

No Petroleum in Turbines

The new turbine technologies have certain attributes that are beneficial from an environmental standpoint. We've talked about the fish-friendly characteristics. Steve will get into some examples of how the internal portions of the design have been modified to improve fish survivability.

Older machines would require that somebody went in with a grease gun or an automatic grease system and grease a lot of the moving parts. Today, we have what we call greaseless bushings. There are no petroleum products involved. There's nothing to leak into the environment and it greatly reduces the potential of any contamination of the water passing through the machine. In the example of the Kaplan Turbine, the internal part of it that contains the adjustable blades typically contains a lubricant. Years ago, that would be a petroleum product. Nowadays this can be accomplished either with a dry hub, or with a biodegradable lubricant.

There are also turbines that can be adapted to improve the water quality in the receiving stream. Those are called aerating turbines. There are features that are built into the turbine runner that actually increases the dissolved oxygen in the water. So, if you're pulling off of a reservoir, and the oxygen content of the water coming out of the reservoir is low, it can actually be enhanced as the water is discharged to the receiving stream.

New FERC Requirements

I mentioned a lot of activity in the industry today. We'll look at some of the reasons for this. New FERC licenses that have been issued as a result of lengthy settlement discussions contain a lot of compromises. There's a much greater emphasis on protection of the environment, specifically for the protection of the fish. The protection of fish can be addressed with changes in the design of the machinery itself. It can also be addressed by changes in the operation of the facility.

Increased environmental flow releases are another new FERC license requirement. Most plants always had some kind of a bypass flow. When we go through the re-licensing process in these detailed settlement discussions, the refinement to that flow often is greatly increased.

There have also been instances where projects used to operate in a daily cycle mode. So, for the most part, the hydro facility would cycle so that most of the time the turbine was running half-time on its full output, then it would shut off or back down significantly and allow the reservoir to recharge, and it would continue that cycle. That's frowned upon these days. Most of the time now we want to see a fairly stable reservoir level.

It also means that the amount of water that would have gone through in pulses, if you will, now is going to be regulated so that it may come through at a lower flow rate. But at the end of the day, the same amount of water passes through the site. The fact that that lower flow rate is available is one of the driving reasons for increasing the turn-down capability.

If a new runner is put in that has greater turn-down, we can satisfy both criteria. We can pass the water through the dam, satisfy the environmental requirements, and make some energy at the same time.

Water level management, for breeding of fish and waterfowl as well as for property owners' vista, makes it desirable to maintain your water levels within a much narrower band. The electronic control of the turbines comes in handy here. Now we can control the turbines to a much tighter range. And, once again, this results in higher energy production.

Some of the market drivers would be the production-tax credits that are presently available—renewable energy credits that are tradable in different market places.

Brookfield Power's School Street Facility

Some projects that present examples of these drivers are among projects that my firm is involved in. In New York, Brookfield Power's School Street Facility just received a new re-license after thirteen years of effort. At that facility, they are seriously considering installing a fish-friendly turbine to address some of fish-passage issues.

There's a series of four cascaded projects on the same river in New York. The management of the headwaters of the reservoir that feeds those projects has been changed because of the new license requirements, meaning that in the past where these four projects were pulsed in the daily cycle, now they have to pass a much greater minimum flow. These were four fixed-propeller turbines, which were incapable of generating at all with that minimum flow. The owner evaluated a couple of options available and elected to convert those turbines from fixed propellers to adjustable propellers, which allowed generation at the lower flow rates. So they were able to capture energy that otherwise would have been lost.

Some of the higher requirements for flow releases around the dams and into the receiving streams present opportunities for the installation of what we call in the industry a minimum-flow turbine. There have been a fair number of examples where these projects have gone in and qualified as incremental capacity. They qualify for the production-tax credits. The other production-tax credit incentives were applied to efficiency increases.

There's a much greater emphasis on protection of the environment, specifically for the protection of the fish.

In the past, if a turbine operated in an off-and-on condition, there wasn't too much concern about the efficiency of the lower end of the performance curve. Nowadays, the release from the reservoir is a much greater volume of water than the minimum flow of the past, and it may very well be that the small amount of water that's required to be released exceeds the turn-down capability of the turbine: the turbine cannot turn down far enough in order to pass that, so the turbine has to shut off to let that water through the dam elsewhere.

There is an efficiency enhancement called better water level management if there's no change in the water usage. That, again, produces incremental energy, which qualifies for the production-tax credits. Thank you.

Steve Amaral: Good morning everyone. As you know, I'm going to be talking about what people refer to as fish-friendly turbines. We call them advanced-technology turbines, mainly because some folks would argue that existing or conventional units are already fish-friendly. So perhaps the advanced-technology turbines are fish-friendlier.

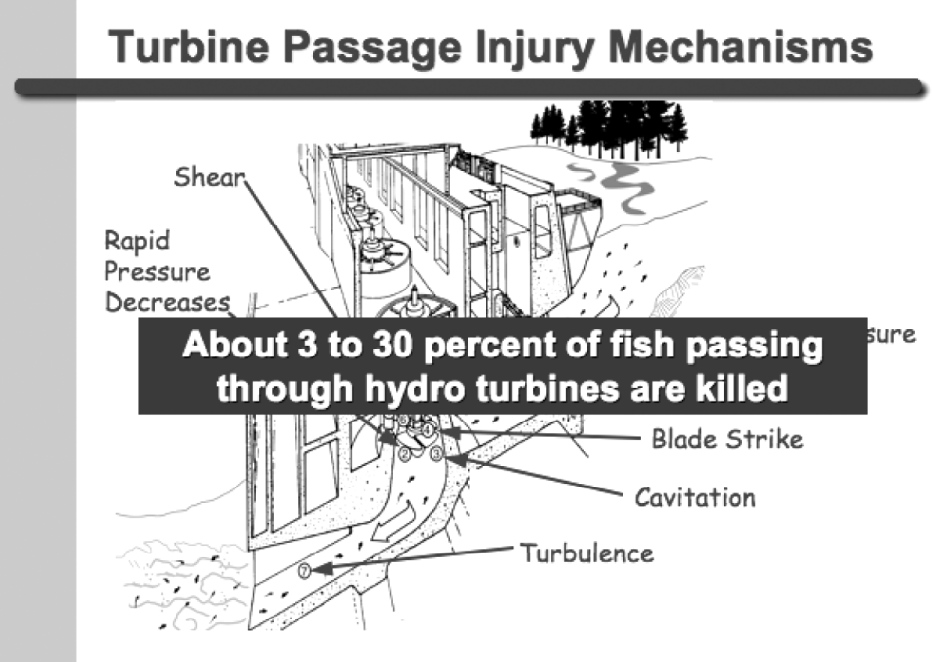

Figure 7.

I'm going to talk very briefly about several categories that easily could be expanded into a half-day session. I'll begin by going over the injury mechanisms and the bio-criteria that have been developed as a means of setting standards for a fish-friendlier advanced-technology turbine. Then I'll talk about the two—probably primary—fish-friendly turbines at this time, one being minimum-gap Kaplans, and the other being the Alden concepts on NREC, which we developed. Then I'll talk just a little bit about future applications of advanced turbine technologies, ours as well as the minimum-gap runners.

The issues that face fish as they move through turbines are numerous. They vary depending on the turbine type, the head of the site, and other characteristics. You can have increasing pressure on the upstream side as the fish enter the intake and approach the turbine. There's grinding in gaps between moving parts and stationary parts of the turbine. Obviously, fish get hit by the blades. You have rapid decreases in pressure on the down-streamside. And then there's turbulence and shear in the flow that also can damage fish.

In the early '90s, the Department of Energy established an advanced hydro-turbine technology program. They have been doing research in establishing the criteria, like minimum levels of shear and minimum levels of pressure changes, even things like the number of blades that may reduce blade strike. Both Alden Labs and Boyd, who developed the minimum-gap runners, used these bio-criteria in developing our turbine. We set the standards and then we tried to design out, or at least minimize, all those features that may damage fish.

In the end, for a conventional unit, mortality can range from about three to thirty percent (figure 7), three percent being most likely for many existing Kaplans, other than those on the Columbia River, which have big, slow-moving units, with a lot of space between the blades. Thirty percent, if you think back to those Francis Turbines, with the sixteen to twenty buckets, spinning at a couple hundred RPM, probably would be where you would put that higher mortality range.

Minimum Gap Runner

A Boyd team and a couple of the other turbine manufacturers developed the minimum-gap runner (figure 8). That team has now come up with alternative designs. See the existing Kaplan, with the adjustable blades (left side of figure 8). The top shows the maximum-blades tilt; the bottom one shows the minimum-blade tilt. You can see from the maximum-blade tilt, that you have a gap between the discharge ring and the top and the bottom of the blade. It's felt that fish can get caught as they go through these gaps. The minimum-gap runner changes the hub, as well as the blade (right side of figure 8) at the discharge range so that whenever it rotates, it's always maintaining contact. No gaps are created that fish can get stuck in.

Figure 9 is an example of the minimum-gap runner created by Voith. This is probably at one of the big hydro sites on the Columbia. They did do testing at Bonneville with a prototype. They found that they increased fish survival through it from ninety-four to ninety-seven percent. There were also tests done at Wanapum

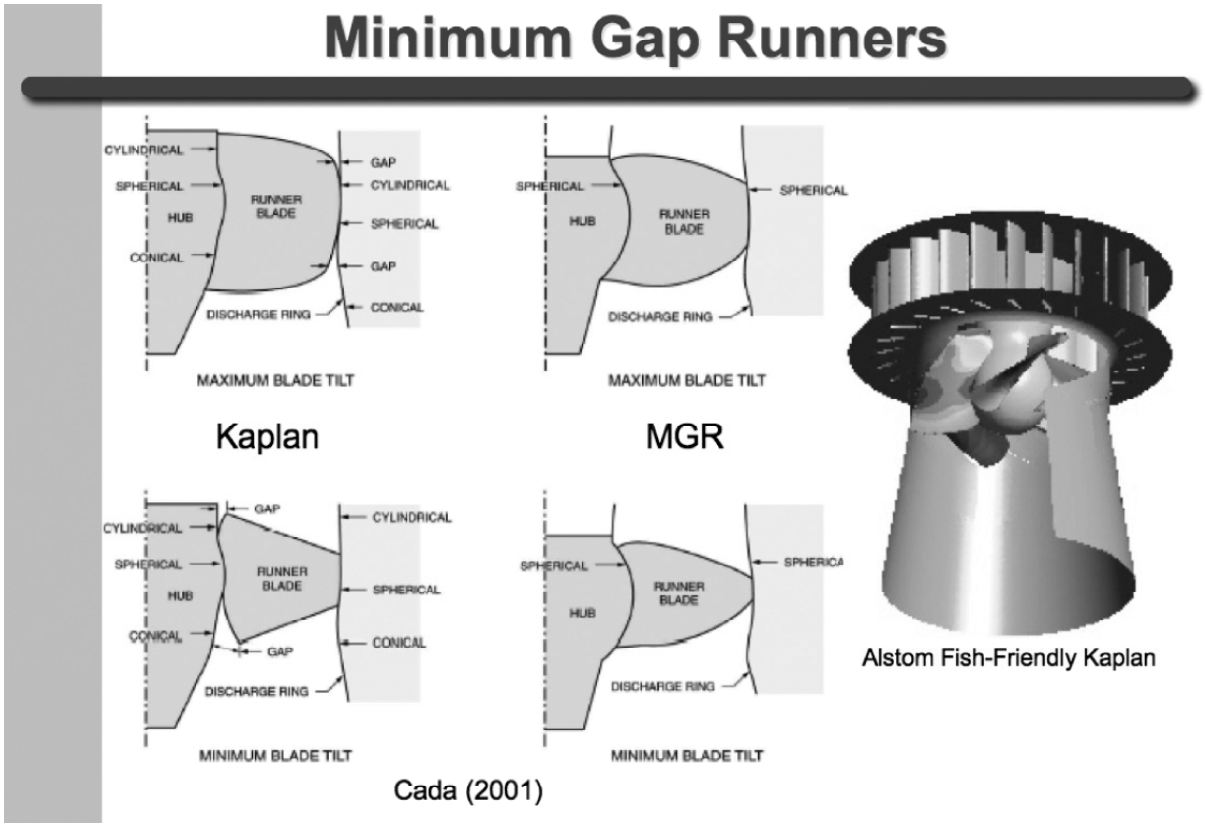

Figure 8.

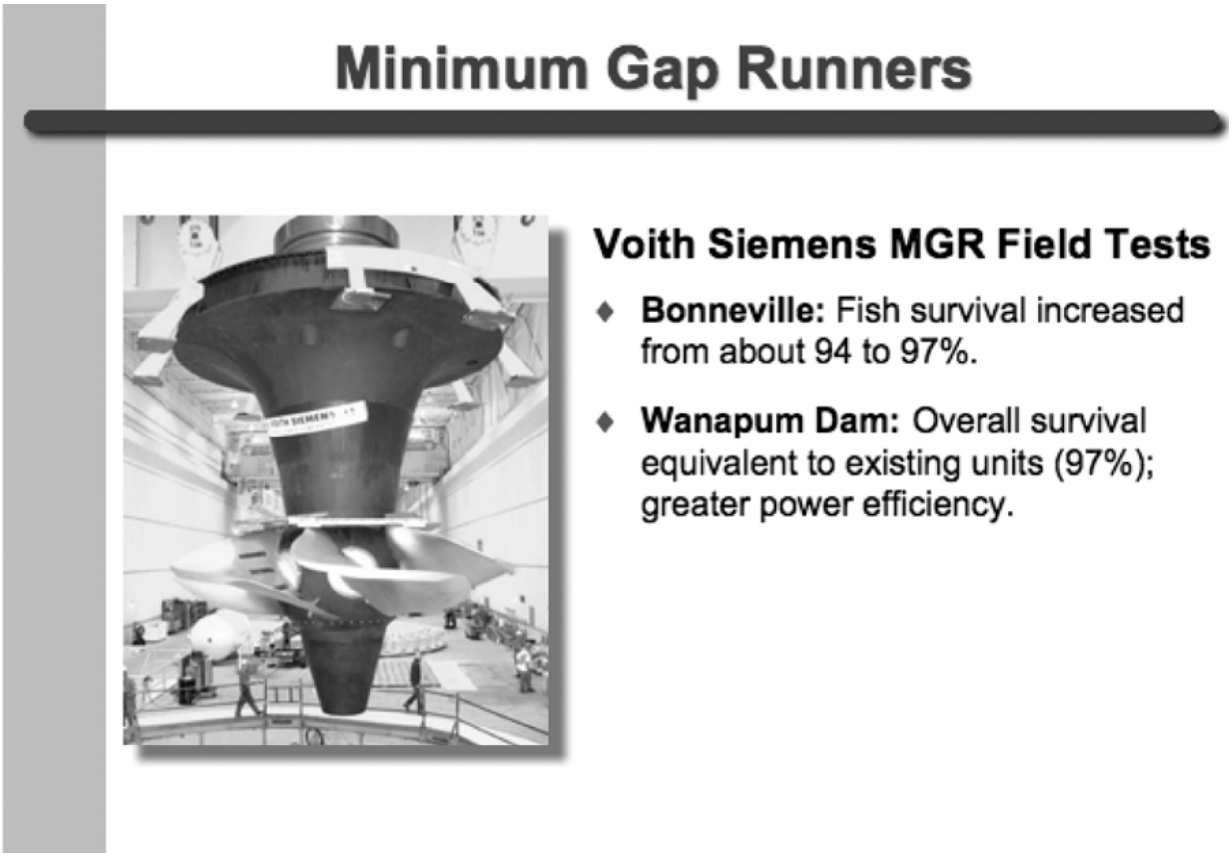

Figure 9.

Dam. The overall survival rate for both conventional units they have and the minimum-gap runners were equivalent at ninety-seven percent. However the newer units, the minimum-gap runners, are more efficient power-wise. I think they are going to replace the other units with the minimum-gap runners.

Development of Alden/Concepts Turbine

Now I'm going to talk about the development of the Alden/Concepts Turbine. It's been on-going since the mid-90s through the Department of Energy's hydro-turbine program. We developed the design, using the bio-criteria, and then conducted biological testing with a pilot-scale facility to determine if we had the expected survival rate based on the criteria we used.

We are continuing to develop, not just for our turbine, but for others. We've been doing leading-edge blade strike studies to determine the best geometry meaning the thickness of leading-edge blades and how this may reduce injury and mortality to fish. We've also been doing studies that are sort of refining our design to make it a better energy producer, while still reducing the fish mortality and injury.

Future efforts will be made to produce the turbine through a licensing agreement with one of the manufacturers. As Paul mentioned, an Alden/Concepts Turbine is targeted to be installed at Brookfield Power's School Street Facility. This is done, it will be evaluated to determine whether or not we are getting the survival rates we would expect.

Biological Evaluation

We did a biological evaluation of the pilot-scale facility in the lab (figure 10). We had a test loop with the turbine on one end and a pump on the other, drove flow through it, downstream. We injected the fish (upper right of figure 10). They went through the turbine, then were guided where they could be collected from the tank. We also injected control fish downstream (lower right of figure 10). We put over forty thousand fish through this test facility during a two-year period, including six species of fish, tested at two heads, in several size groups, and with and without wicket gates. Our big conclusion was that the wicket gates did not cause any additional damage beyond the turbine passage. This was one of the first studies of its kind and very comprehensive.

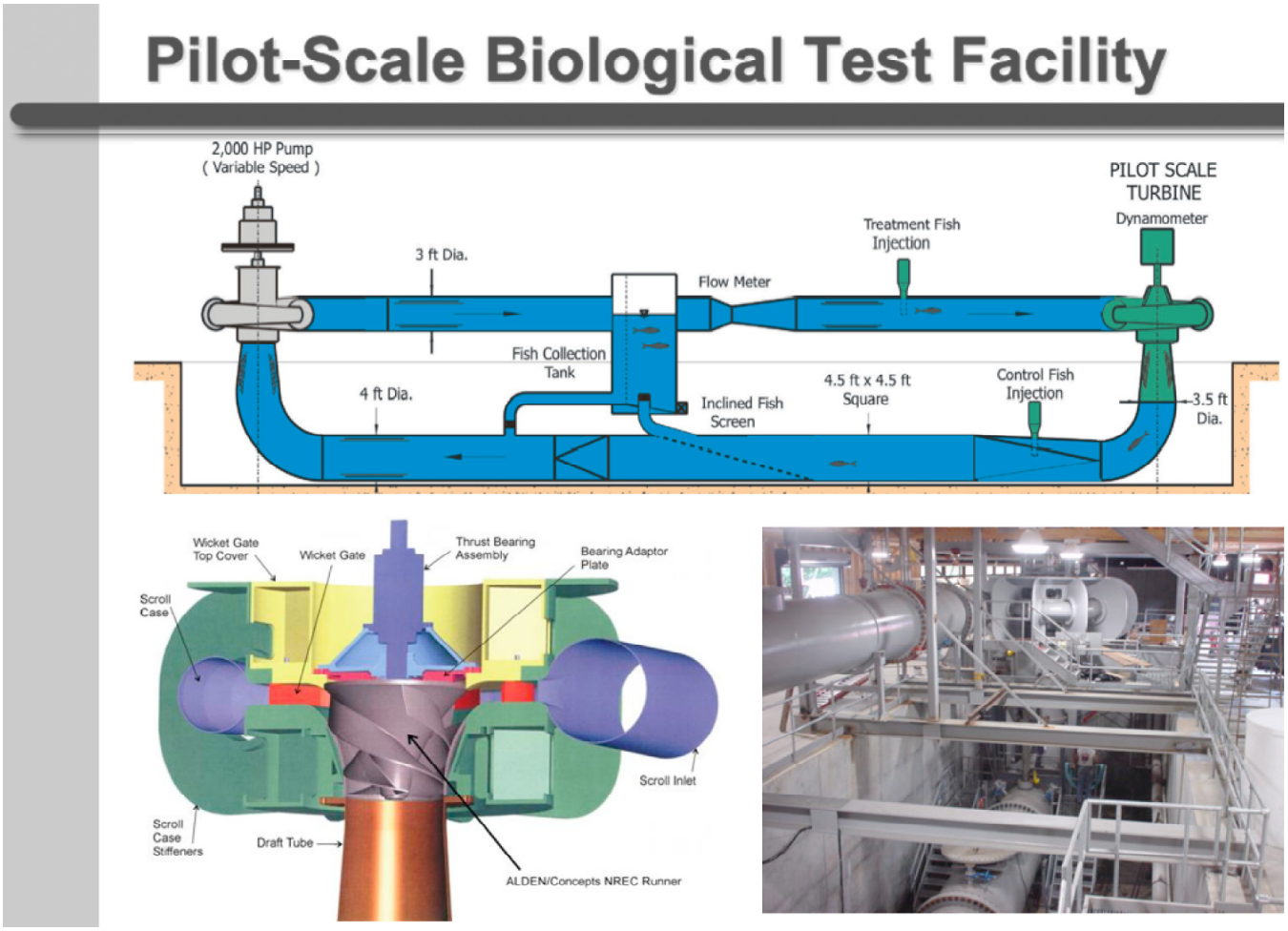

Figure 10.

Fish Length

In the graph in (figure 11), immediate survival is shown on the vertical Y-axis, and fish length is on the horizontal X-axis. There are two lines. One line represents 80 feet ahead, and the other line represents 40 feet ahead. The runner was a 4-foot diameter pilot-scale runner at 40 feet ahead, spinning at about 245 revolutions per minute; at the higher head, it spun at 340 revolutions per minute. So that's why we get the lower survival at 80 feet ahead. The relationship between fish length and survival is something that we've known for awhile. The longer a fish is, the greater the probability that it's going to be struck.

The lines are actually theoretical calculations, and they fit really well with the data produced during the biological evaluation, thus validating the original idea. The one unexpected result was white sturgeon, about five inches in length, had ninety-percent immediate survival, while the American eel, twelve-to-seventeen inches in length had one-hundred-percent immediate survival. That was certainly very surprising to us.

Then we tested the pilot-scale unit. We had to predict what would happen in a prototype, which was initially designed as a thirteen-foot diameter runner. Using the strike probability equation, we came up with two lines for eighty and forty feet ahead. For the most part, we ranged from close to one-hundred-percent survival for an eight-inch fish—ninety-four or better depending on the head (figure 12). Ninety percent or more of fish entrained at a hydro project are probably eight inches or less in length. So this is a good representation of that.

So, we should have high survival rates in the field with the prototype unit. But we think we can still do better. We've now done two years of study with several species of fish, mainly rainbow trout, looking at the ratio of fish length to blade thickness, and then determining the injury and survival rates.

Blade Shape

We started with numerical modeling studies to determine the best shape to deflect the fish. This proved to be a semi-circular blade. Then we put that shaped blade into a tank in the lab, and where we actually fired it down a path into fish that were hanging in front of it. The largest extreme that we looked at was a ratio of about 25:1, which was a ten-inch fish with a 3/8 inch blade. At twenty-four feet per second, the fish doesn't move until the blade hits it. At this speed and ratio of fish length, mortality rates are high, on the order of thirty-to-forty percent survival.

At the other end, when fish length equals blade thickness—that is, a six-inch fish, with a six-inch blade—the fish clearly starts to move before the blade hits. It then deflects off in one direction or

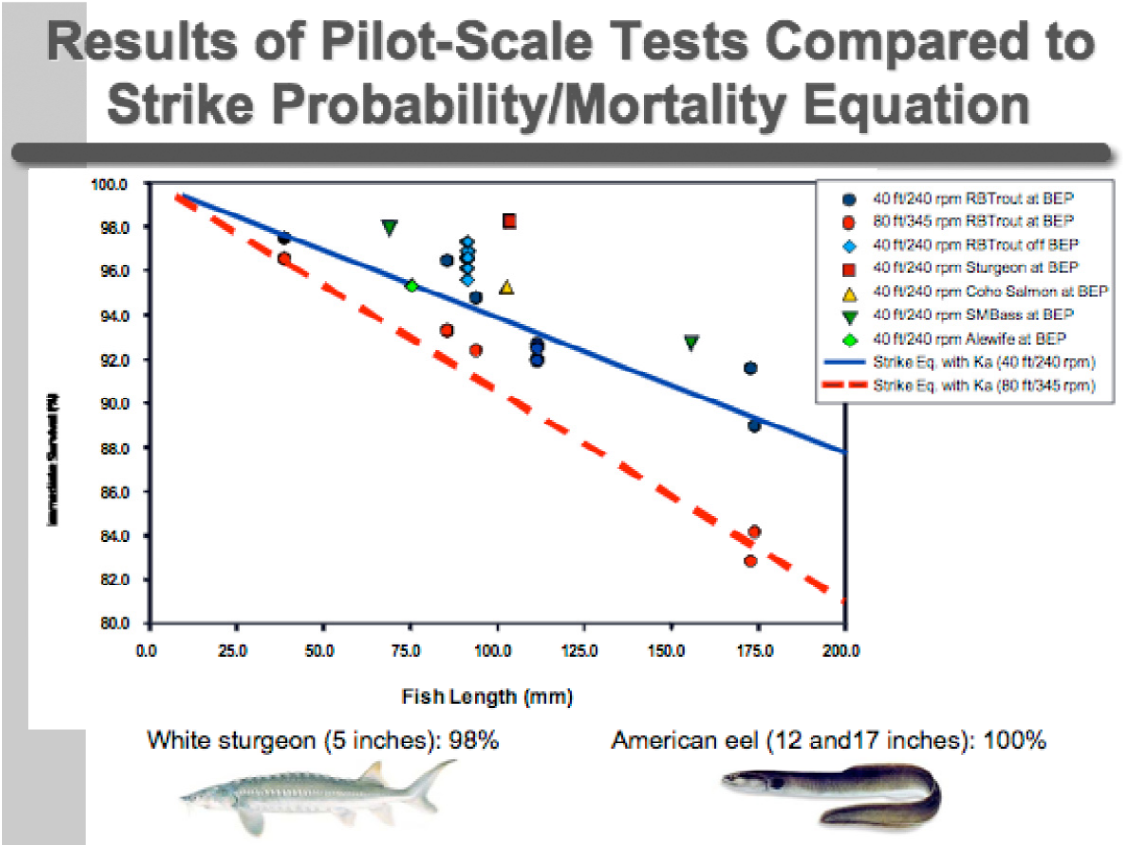

Figure 11.

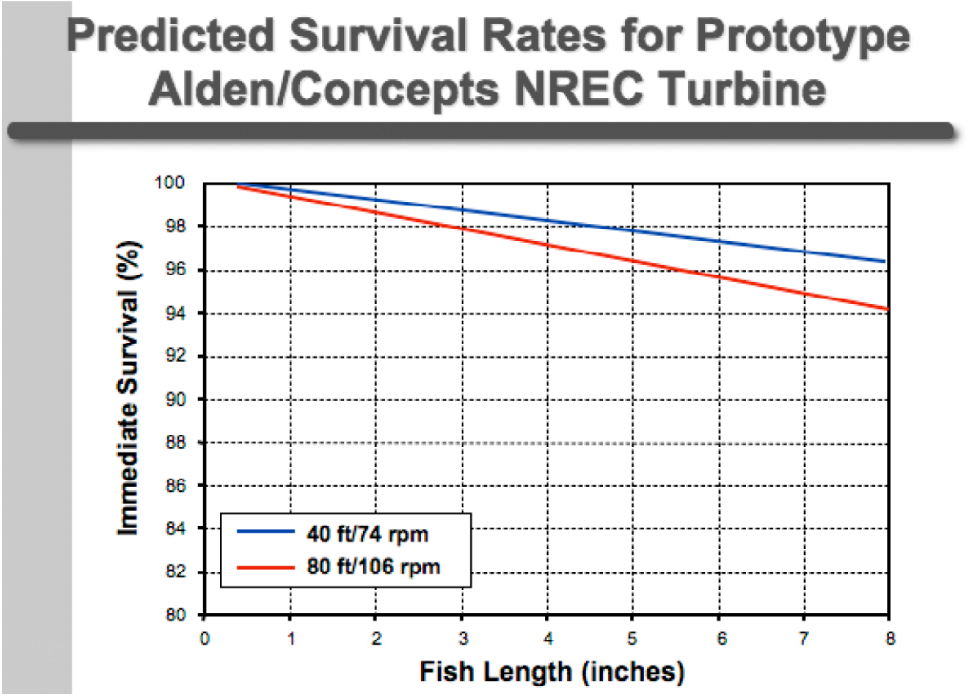

Figure 12.

the other. Fish survival in this case was one-hundred percent. We did tests at speeds up to forty-feet per second. And that was the first year of studies. We developed a really nice beta set with different speeds and different ratios. It can be used to predict what might happen at certain sites. We were using it now in our redesigned turbine to re-establish the thickness of six inches for the blade, which is what we want.

Redesign

So we're moving forward with the redesign. The first thing was to double the power output by doubling the flow. We kept the relative diameters similar, the whole scroll case for the diameter of the turbine, but with twice the flow (figure 13).

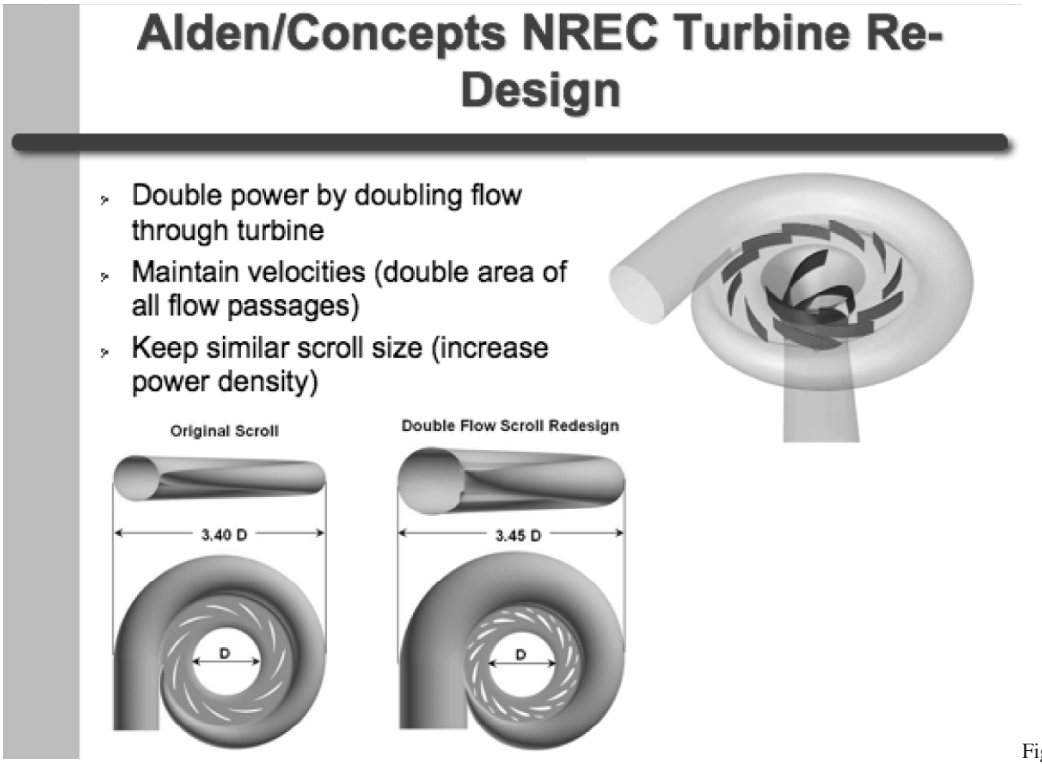

Figure 13.

We wanted to maintain the flow velocity through all areas of flow passage. We went from our traditional wicket gates to a new design. Again, the similar scroll size will help increase our power density.

Our runner is a helical design, with three blades rotating around it. There's a shroud that wraps around it, eliminating all the gaps (figure 14).

better to what it would be for a fish bypass system, the agencies will accept it as a fish passage route.

This technology certainly can be considered for capturing flows from fish bypass systems, minimum flow releases, unit replacement or upgrades, and plant expansions. Clearly we don't see everybody purchasing something like this and going out and replacing everything they have. It's still not quite on par with conventional units as far as power production is and efficiency. But hopefully, many of the redesigns will be able to improve that.

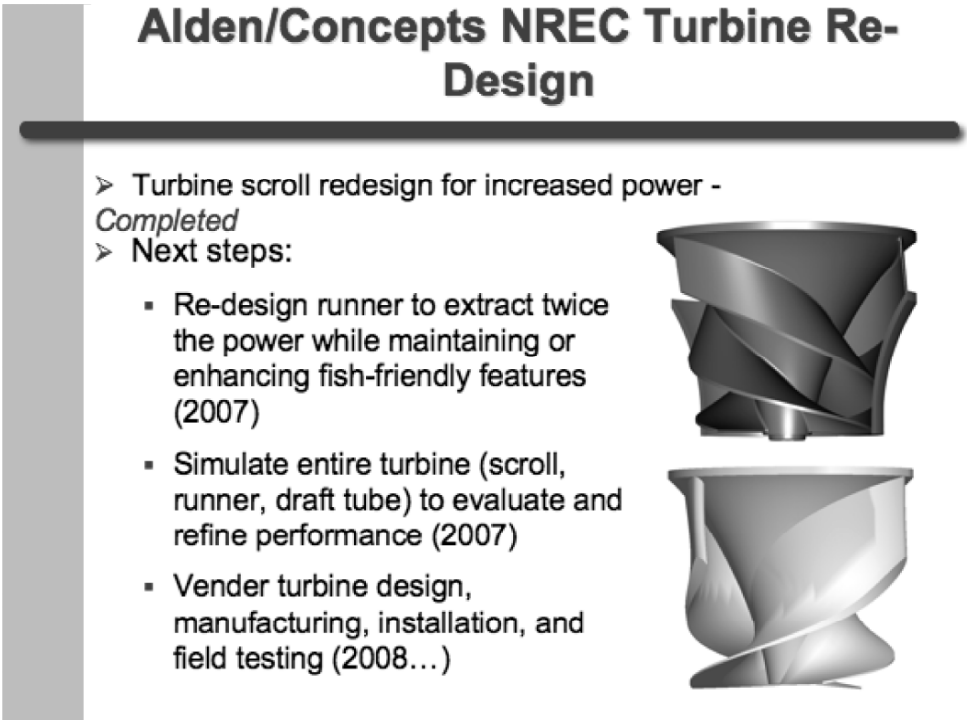

Figure 14.

Brookfield Power's School Street Facility

So we are trying to increase the power, by changing the design of the scroll case, and the runner to match the scroll case, thus making it more efficient. We've been doing this work the past two years, and will continue until we go to the vendor and have the turbine installed at a site, which hopefully will be School Street on the Mohawk River. Primary species of interest here are juvenile herring and American eel.

We selected the new design for this site, versus the minimum-gap runner for the same head and available flow, after making a theoretical calculation of fish survival for the two units. The Alden NREC unit would have lower relative water-to-blade velocity; lower RPM, shallower inflow velocity, and half the number of leading edge blades.

At School Street, they're actually building a separate powerhouse. They're going to divert fish from the existing units through the Alden turbine. As long as fish survival is equal or

Finally, we think our turbine or other new technologies will allow us to minimize power losses due to loss of diversion flows, whether it's from minimum bypasses, and flow releases, while reducing O&M costs for fish passage and downstream protection-type technologies, this protecting fish while generating low-cost power. Thank you.

Konstantine Drakonakis: Good morning everyone. My name's Konstantine Drakonakis and I'm with Connecticut Innovations and the Connecticut Clean Energy Fund. I'm going to start off today by giving a very brief overview of what we do at the Fund. I know there are a lot of questions out there on how we operate. Then I'll get into hydropower technologies that we're looking at and their environmental considerations.

Connecticut Clean Energy Fund

The mission of the Fund is to make Connecticut a leader in the sustainable balance of energy production, economic growth, and, environmental impact. The Fund develops, invests in, and promotes clean, sustainable energy sources for the benefit of Connecticut ratepayers.

Let me give you a little background. The legislature passed a bill to create the Fund in 1998 and the Fund was launched in 2000. We are presently administered by Connecticut Innovations. Our funds are collected by a surcharge on electric bills. We've collected approximately $23.5 million a year. So, we have about $150 right now.

As of this past September, we've committed approximately $78 million towards renewable energy projects. We have approximately $75 million uncommitted so far. Some of the results, under Project 100, which includes larger scale renewable projects and utilities, that may have an impact of powering 94,000 homes with renewable energy.

Under the On-Site Program—the on-site distributor generation program—we've completed 254 projects, which is equivalent to about 3.67 megawatts. We also have 122 projects in process. (That figure is a little dated; the total is actualy higher than that and it equates to about five megawatts.) We've completed ten demonstration projects, and under our communities program, we have sixty-two towns that have committed to the twenty percent by 2010 clean energy options program. We also have twenty-nine clean energy communities (figure 15).

So, why clean energy? For a healthier environment, to help us move towards energy independence, a hedge against rising energy costs, and to promote local community economic development.

The Fund looks to invest in a whole host of renewables. We cover everything: solar, fuel cells, landfill gas, and biomass. We're just starting to look at wind—more specifically small wind—as well as wave and tidal. We're also starting to look at more traditional As of this past September, we've committed approximately $78 million towards renewable energy projects. We have approximately $75 million uncommitted so far. Some of the results, under Project 100, which includes larger scale renewable projects and utilities, that may have an impact of powering 94,000 homes with renewable energy.

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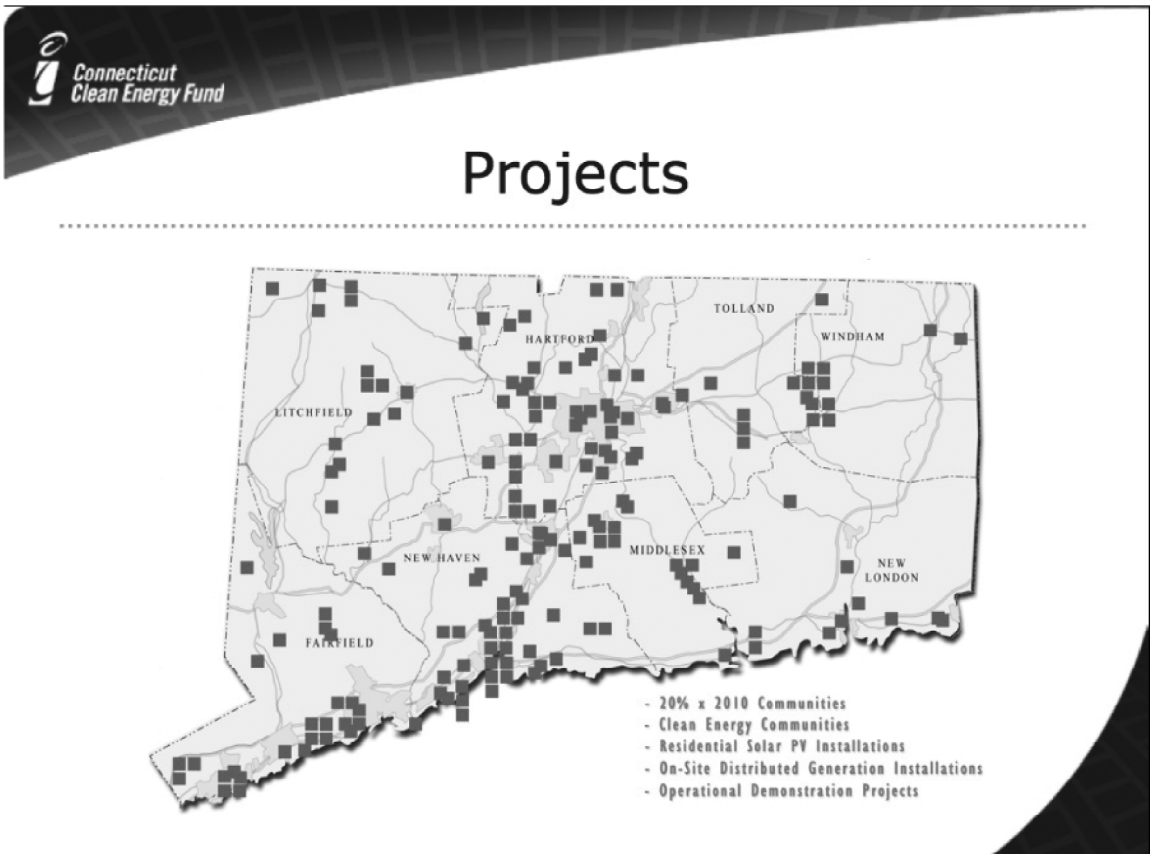

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In terms of hydro, we are interested in the promise of nonpolluting alternatives to the fossil and nuclear power plants, especially as emerging technologies in hydro and wave-energy conversion devices really emerge. We are also interested in innovations with more traditional repairs in hydro technologies.

We take an environmental perspective at the Fund. We look for technologies that are not only innovative in the renewable energy field, but also those that are sensitive to the environmental considerations.

Because these technologies are still very much new to the scene, and some of them are so diverse, they will definitely raise a lot of questions with the regulatory agencies that are concerned with natural resource management.

Quite simply, from an investor's standpoint, you just don't know what impact these technologies are going to have on the environment. But we're rather encouraged by some of the preliminary ideas.

Hydrokinetic & Hydrostatic

I'll give a brief overview of the hydro technologies that we're looking at, and a little of the science behind them. Hydrokinetic energy refers to the energy possessed by a body of water because of its motion. Hydrostatic energy taps the potential energy of the body of water because of its placement downstream; this is commonly known as head. The hydrostatic technologies, which Paul and Steve discussed, are most notably differences in Kaplan designs.

Hydrokinetic devices and the wave-energy conversion space create a system of reacting forces, where two or more bodies move relative to one another; another acts with the motion of the waves. These design concepts are known as terminators, oscillating water columns, point absorbers, attenuators, and overtopping devices.

In-stream hydrokinetic devices draw strongly from the wind industry as they are rotating devices, and are classified as horizontal-and-vertical axis turbine-driven. The good news from an environmental perspective is that these devices do not require the use of a dam or impoundment.

A company in Mansfield, Connecticut, called Windham Automated Machines approached the Fund. We were rather happy to discover this local company, which has a great track record in engineering, design and as fabricators.

Hydrostatic Turbine

Windham has designed an innovative hydrostatic turbine that targets small low-head as well as high-flow sites. It's an innovative propeller, Kaplan-style turbine, arguably the more fish-friendly of

Hydrokinetic energy refers to the energy possessed by a body of water because of its motion.
Hydrostatic energy taps the potential energy of the body of water because of its placement downstream.

So, to keep this brief, I will review the technologies that the Fund has considered, the ones that we funded, and those in the process of being deployed. We test not only for potential for commercial development from an investment perspective, but also from an environmental perspective. This is primarily because these technologies will not gain market penetration, and a good market share, if they cannot hold up to scrutiny both from an economic and an environmental perspective.

hydrostatic machines. It's designed to achieve between ninety-two and ninety-five percent efficiency. It operates over a much larger range of flow conditions. It's also modular in design, allowing for multiple "gang" installations, where it actually teams up and utilizes the resources as it flows. These units are based on one hundred kilowatts at sixteen feet of pressure and ten cfs at best. So it's truly small hydro.

Francis-style turbines achieve around eighty-two percent efficiencies at much higher percent of rate flow. WAM's turbine is more efficient; it produces power at lower flow rates, lower head, and over a much larger range of flow conditions. This next test

is really important: it's also much more cost efficient, and cost effective, due to its fabrication methodology, compared to other turbines in its class.

So we see this technology as addressing a niche in the market, in the U.S. for retrofits to existing larger scale hydro facilities as well as feasible new sites. Emerging markets also worldwide may be a big play.

From an environmental perspective, we were encouraged by the propeller design versus the vein style as well as by the incorporation of servomotors and mechanical devices to manipulate actuations in a runner blade and wicket blade angles instead of hydraulic systems. Gear reductions are also accomplished through the use of timing belts instead of oil filled gearboxes.

These features eliminate the need for hydraulic re-lubrication, with oil reservoirs located close to the water source. That, in essence, eliminates a potential environmental hazard.

At the demo site in Mansfield, just south of Mansfield Hydro Dam, we are encouraged to learn that the proposed bypass channel will make use of the natural diversion that's there. And it's understood that the predicted flow rates into the channel, to the actual bypass channel, will be low enough to allow the fish to swim by, and not be impinged on, inflow racks. So we tried to look for a balanced approached in demonstrating an innovative technology, a renewable energy technology, but one that was also sensitive to the environment considerations of the site.

Hydrokinetic Turbines

I'm going to move on to hydrokinetic turbines. By my count, there are approximately seven established companies competing in this space, with some pretty creative technologies. To name a few, the famous Verdant Axial Flow Turbine (used in the East River Test site in New York), GCK, Gorlov Helical Turbine, Natural Currents (which is developing the Red Hawk prototype for tidal turbines), and Electricity DeFrance. That's just to name a few. From an investor perspective, these technologies are really largely unproven. We've seen that, as in the case of the Verdant demonstration, where they've had to shut down to analyze some of the difficulties that they're having.

They're also unknown in terms of what changes in the licensing requirements, FERC and other resource agencies will develop. FERC has had a process, which I think is known as the FERC Verdant Exemption. Other companies also are working for more streamlined processes with FERC. Many of the environmental questions, that must be addressed in order to permit even a demonstration project cannot be answered without a deployment where the impacts can be closely monitored.

In general, however, if we look at the physical environments in which these technologies are deployed, they're relatively "natural." They do not require large impoundments and high-pressure heads. What needs to be carefully evaluated is, in my opinion, where these projects will be developed. Stressed environments or protected areas are sensitive to any type of development.

The major concerns in water environments arise from the initial site work, which can disrupt the sentiments, releasing pollution, as well as cause other alterations, especially in natural streams and tidal estuaries. Modifications to these areas may be acceptable, if developed in a manner that's really sensitive to the specific environment concerned. If you look at the rotating machines, for example, such as Verdant's turbine, we need to consider the question of fish strike. You know, some of these technologies may operate at low enough rotating speeds, and they may prove to be benign in that respect. Others may not. We also need to consider near-shore and offshore developments, and what the environmental considerations are in those cases.

Wave Technology

This brings me to wave technologies. By my count, there are eighteen competing companies, with variations on turbine and piston driven technologies, among them Ocean Motion Wave Pump, which is a single oscillating buoy piston; Ocean Wave Energy Company, which is a floating bulb buoy; Finavera's Aquabuoy, which is similar, and the Wave Dragon, one my favorites, which is a floating slack-moored energy converter of the overtopping type.

The Fund made an investment back in 2000 in to Energetech, which is now Oceanlinx. This technology uses an oscillating wave chamber that is open underneath the waterline. This captures the waves as they rise and fall. It compresses and displaces air, driving a turbine up in the narrowest point of the chamber, and then driving it out through the shoot. It can either be paired with a generator to produce energy or with a desalination unit to make fresh water. This lends itself nicely to coastal countries, which are in need of both resources.

Oceanlinx currently has six projects and contracts under way, one just next door to us in Rhode Island. They have a memorandum of understanding with the Rhode Island state authority for a 1.5 megawatt unit. Potentially be followed by a 15-to-20 megawatt unit off the coast of Block Island. This was just announced December 3rd, last year.

The environmental considerations for these technologies, will be focused most probably on the sediment and benthic environment disturbances from moorings and cable placements. There is also the possibility of destructions to drifting and actively migrating fish and invertebrates, as well as diving birds and shore birds.
In closing, the environmental impacts will have to be very closely monitored as these new and exciting technologies are deployed. The measured effects can then honestly be used to evaluate the potential effects and projected to a more full-scale project.

And just one last note: Many of you may know that as of December 20th of this past year, Congress voted and the President signed, as part of the Energy Independent Security Act of 2007, the Marine and Hydrokinetic Renewable Energy Research and Development Act, which authorizes appropriations of $50 million for each year, from 2008 to 2012. It's really my hope that the national labs and the universities that are going to be getting this money will put it to good use to further develop these technologies and to better understand the environmental impacts. So if there are any other questions, you can feel free to contact me. Thank you.

Bob Gates: I'd like to thank the panelists for their presentations. Does anybody have questions? You, sir.

Wave Technology

Audience: I have a question regarding the wave technology. What ideal sea conditions are you looking for with wave technology?

Konstantine Drakonakis: It really varies by technology. Some like small ripple effects, others like greater cascading, i.e., waves. So there are technologies that really cover the full variety of wave issues that are out there.

Audience: Are there sea restrictions as well? Like off the coast of Block Island, they're getting, depending on how far you are, twelve-footers, eighteen-footers, twenty-two-footers. Is that too big?

Konstantine Drakonakis: Again, it really depends on the technology there. If you look at Oceanlinx, they like a larger wave, but Ocean Motion works with a wave dragon, which wants enough to go over top it, to move the hydraulic piston.

Bob Gates: I believe Oceanlinx put in their first prototype was off of an Australian coast?

Konstantine Drakonakis: Yes.

Bob Gates: Okay. Way in the back.

Fish Friendly Turbine Efficiency

Audience: Just a quick question on the ultimate research turbine, the fish friendly one. Just wondering what the efficiency of that is at its current level of technology? Does it operate with wicket gates and, if so, what is the turn-down efficiency as it turns a propeller?

Steve Amaral: First thing, I'd qualify—I'm a biologist not an engineer. But the pilot scale was about eighty-nine percent, I think. We're certainly trying to improve that with the redesign. I'm not sure where it will be by the time it's ready for installation. It does operate with wicket gates, and I can't answer your question on the turn-down with the gates. Does Paul have any information about this?

Paul Williams: I can't answer as far as the actual efficiency. But in the application at School Street, part of the deal there was if the turbine ran at all, it would always run at its best efficiency point because that's a multiple-unit plan. You wouldn't want to turn that unit down; you'd run that one at pretty close to full-gate at its best efficiency, and you'd throttle it at the other five units at the plant.

Bob Gates: Okay. Sir.

Transmission

Audience: What is the method to get the energy back from the hydrokinetic technology, and how is that linked up to the grid?

Konstantine Drakonakis: Two cables, through electric transmission.

Audience: So, under the water?

Konstantine Drakonakis: Yes, under the water. They're modular, so you can link them in series.
Bob Gates: Okay. Sir.

Distribution of Funds from the Connecticut Clean Energy Fund

Audience: For the Connecticut Clean Energy Fund, what's the distribution? You said you had, I think, about seventy-five million dollars in grants out. What's the distribution of that towards R & D projects for emerging technologies versus implementation projects that are putting power online?

Konstantine Drakonakis: I think of that seventy-five million, approximately eighty-five percent is in installing capacity grant rebate programs. The remainder is pretty much split evenly between equity and project finance investments towards demonstration projects and venture stage companies. And the balance of that goes to our community program, and voluntary markets.

Audience: In addition to the issues that were raised, about sedimentation, etc., we also have a number of other questions including navigation: What happens when there's ice, what happens in a hurricane, what about the structures that might be installed into that river that will hold it in place. So there are a lot more questions than there are answers at this point.

Konstantine Drakonakis: Agreed.


The Farmington River Watershed
Facts
A watershed consists of the land area that Drains into a water body.
The Farmington River Watershed is 609 square miles, or 384,00 acres, in size.
The Farmington River is 81 miles long.
The Farmington River Watershed provides 100% of the drinking water for over 550,000 people in Greater Hartford and the Farmington Valley
The Farmington River Watershed receives over 20 million gallons per day of treated wastewater from 14 publicly owned sewage treatment plants.
In 1994 a 14-mile segment of the Farmington River received federal Wild & Scenic designation. This is the only river in Connecticut, and one of only six in New England, with such a designation.
The Farmington River Watershed is an Important atlantic salmon restoration habitat. Annually over one million juvenile salmon, called salmon fry, are stocked in the watershed.
Becket
Tyringham
Otis
Monterey
Blandford
Granville
New Marlborough
Sandisfield
Tolland
Southwick
MASS.
CONN.
Hartland
Norfolk
Colebrook
Suffield
Barkhamsted
Granby
East Granby
Windsor Locks
Winchester
Simsbury
Canton
Windsor
New Hartford
Bloomfield
Torrington
Avon
Harwinton
West Hartford
Hartford
Burlington
Farmington
Bristol
New Britain
Plymouth
Plainville
Roads
Water
Connecticut Town Boundaries
Massachusetts Town Boundaries
Farmington River Watershed
National Wild & Scenic River

Figure 16.

Case Study: The Farmington River

Eric Hammerling: Some of the discussion today has been thinking about hydropower at maybe the fifty-thousand-foot level, with overviews from very important issues and ideas. We thought it would be very valuable to bring some of this knowledge down to very practical level, with a very practical case study focused on some operators, some prospective operators, and some experts that all work on the Farmington River (figure 16).

For those of you who don't know much about the Farmington River, I will give you a very quick overview and a just a few factoids that you can remember when you think of the Farmington.

The Farmington is 81 miles long. The West Branch's headwaters are up in Massachusetts in Becket. If you are a drop of water flowing down through the Farmington River, you will bump against five dams before you hit the Connecticut River, then drain to the Long Island Sound.

The first two dams that you will hit along the way are managed by Tim Anthony, with the Metropolitan District Commission (MDC). Tim will talk a little about the balance that he has to consider because he manages dams that have flood-control aspects, hydropower production aspects, and flow-release aspects in terms of an agreement with another utility and with the DEP.

There are a lot of things that Tim is constantly thinking about. To add a little bit of complexity to his world, the fourteen-mile downstream stretch of the Farmington River, beginning at the base of his dam, is designated as wild and scenic. It is the first wild and scenic stretch of river in Connecticut and, until the Eightmile River is also designated, the only wild and scenic river in Connecticut. It also happens to be the most fished stretch of the most fished river for trout in the state of Connecticut.

The Farmington also happens to have incredible freshwater mussel populations from its headwaters to the Connecticut River. There are eleven species of freshwater mussels that you find in the Farmington River. That's more species of fresh water mussels that you find in any other river in Connecticut and, in fact, parallels the freshwater mussel diversity that you find in the entire Connecticut River watershed.

With that very brief overview on the Farmington River, I will turn things over to Tim, who will talk from his perspective of the MDC. Then going downstream a little bit, Duncan Broatch, with Summit Hydropower, will talk about some of his aspirations with two dams, which are former hydropower producing dams in Collinsville, Connecticut, with which he has a lot of experience. Then Laura Wildman, with American Rivers, will give her perspective on some things that we should be considering, environmentally speaking, to make our hydropower situation on the Farmington River as environmentally friendly as possible.

With that, Tim, you have the floor.

Tim Anthony: Let me start with the brief history of how the District, the MDC, got into hydro. With the incentives that were offered in the 1980s, the District ended up getting interested in developing hydro at their existing dams.

The primary regulation dam of the Farmington River, from the district's viewpoint, is Goodwin Dam. It is located just north of Riverton on the west branch of the Farmington. Goodwin Dam was legislatively authorized for the purpose of water supply back in the 1940s and construction was finished about 1960.

Hydro development was an add-on to the dam and was completed in 1986. It is 3.4 megawatt plant containing two horizontal Francis machines. That plant's flow regulation and the hydro operation followed the water-supply and release regulations that were developed for the dam through legislative acts.

That dam, since it was based on water supply, had a stringent fifty cubic feet per second minimum flow requirement that comes up to about approaching twelve billion gallons a year. The way the MDC actually gains water in its system is through the flow regulation authorizing us to store any inflows that come into our system over one hundred fifty cubic feet per second. That fifty cfs minimum release, along with the flow regulation of having to pass the average of previous week inflows in a range from zero to one hundred fifty cubic feet per second, actually runs the river. That is just the basic, natural-flow regulation.

Riparian Agreement

The MDC has a riparian obligation that dates back to when the District first started to build water-supply dams on the East Branch and the West Branch of the Farmington. Because we were bottling up water to send down the pipe to our customers in Harford, based on our state authorizations, the riparian agreement was entered into through a number of revisions over the years. At the present time, however, our agreement sits only with Rainbow Dam and Stanley Works.

That riparian agreement, on top of all the natural flows, consists of our obligation to deliver 17.4 billion gallons from the middle of May to the end of October, and then another period of release of 4.3 billion gallons from the beginning of November to the middle of March. Then there is a period where we have no obligation to release to The Stanley Works.

We are unique in that after the Goodwin Dam was built and the after the 1955 flood, the Army Corps did an evaluation and decided that it was necessary to incorporate flood-control structure within our pre-existing water-supply impoundment. At that time, the District bought into the development of Colebrook Dam and gained through purchase agreement the right to store water behind that impoundment. Now the whole situation involves the Army Corps flood storage and release regulations in conjunction with the normal regulation of flow.

Because we had an interest in Colebrook Dam, shortly after we developed the Goodwin hydro plant, we also incorporated hydro at Colebrook Dam. Those are unique turbines. They are a modular style turbine that is lowered in front of the intakes, the pre-existing infrastructure, so the private developing costs are rather low in comparison to a conventional plan.

On average, some sixty-seven billion gallons flows down the Farmington through all different forms, under all different auspices, whether it is natural flow or not.

An interesting point: on average some sixty-seven billion gallons flow down the Farmington through all different forms, under all different auspices whether natural flow or not. There is a reservoir north of Colebrook-Otis Reservoir. The releases from the Otis have to pass through my system, and those are accounted separately from natural flow.

On a weekly basis, the inflows are entered into the daily analyzed flow rate. The daily analyzed flow rate is evaluated under different categories. I have natural flow coming in to my system as well as Otis releases; then I apply the regulations of flow from Goodwin Dam to those different categories of water that have come in to my system.

The riparian owner and I then discuss, based on the average required natural flow and required natural flows for Otis releases for the week, the optimum situation, trying to benefit both of us-trying to stay within my turbine capacity, while from upstream giving him a whole different level of capacity forty-two miles downstream. We decide on equipment availability, natural flows. Again, there's forty-two miles of river below us of natural inflow watershed that we don't control. He has a different viewpoint than I have. We come to a mutually agreeable flow-rate for the week, and that flow-rate is set on a Monday-through-Monday basis.

The general arrangement, in my experience of some eighteen years of being at the head of the river and operating within these parameters, is that, the authors of the riparian agreement showed very good foresight. The flow-control scenario is very functional.

Fish

There is a lot of talk about fish in relationship to the hydro operation. Our particular projects are unique in that the upstream project, the Colebrook project, has a type of horizontal fiberglass trash rack with only about three-quarter-inch spacing. We have very limited potential for fish kill at the Colebrook project and the Goodwin project has some very deep intakes. Certain species of fish have to make a conscious decision to take certain paths through that dam as the turbines are operated. We had significant level (five years) of independent environmental monitoring that went on as part of our first license and, to the best of my knowledge, (a) very limited fish kill, if any, was documented during that period.

I'm stuck in the middle between balancing the Army Corps' requirements of public safety and limitations on storage in Colebrook Reservoir. As Eric pointed out, we have significant fishing going on-sport fishing in both pools and on the river. We have to be conscious of that scenario, including ice fishing. Our reservoir elevation control is a big factor in that situation in the wintertime.

Then we have to balance the needs of downstream users on the river. During the wild and scenic study, all the different aspects of the river and different river users were studied. Fishermen want real nice low flows; boaters and kayakers want high flows; Joe Blow working and playing on the river, just wants things right in the middle. We play a big balancing act between our operation, the riparian owner, and the Army Corps on determining what's best for everybody. We really try to take everybody's input.

Since we have some reservoirs on East Branch of the Farmington, we do have to release out of our recreation pool just to control its elevation in relationship to recreational activities at Lake McDonough behind Richard's Corner Dam.

On the East Branch, since we have to make releases, we also try to coordinate those with the riparian owner, and they become part of our credit of delivery to him. We are also trying to time those releases to coincide with weekends so that we augment the flow rate when we get the highest recreational use on the river. I am not talking large flow rates-usually just twenty-five to one hundred cfs that we release on the East Branch on weekends.

We are trying to recognize all the different wants and needs on the river and make releases that attempt to satisfy everyone and operating with the release regulations.

Eric Hammerling: Thanks, Tim.

Duncan Broatch: Well, you have all caught me in a very good mood. Why am I in a good mood? Because it is raining today and I make my living from hydropower. That's how I make all my income and that's how I put the meal on the table for my family.

It all started in college when I changed my major to soil and water science for my BS Degree. Then, to figure out how to put it all together, I had to get a degree in Civil Engineering.

I started with jobs with consulting firms in the cubicle, doing boring engineering work that I didn't like. The part that wasn't too boring was actually on feasibility studies for hydro projects. I said, "Well this is interesting." We were doing Department of Energy (DOE) funded feasibility studies for hydropower back in the late '70s. One of the fellows that we did a feasibility study for-this was when I was living down in North Carolina-came up to me and said, "Duncan, do you want to help me put this project together?" I said, "Yes, let's do that."

I left my good paying job for a less well paying job, but it was more fun. Then I decided I loved New England and that I missed it. I moved back here and my main chore was to develop hydro sites.

Collinsville Projects

Meanwhile, I always am trying to find more sites to develop. Looking around at existing dams in Connecticut, two that are feasible to develop, depending on how you access them, are the upper and lower projects in Collinsville on the Farmington River. We proceeded to file license applications on those and to study those projects. The Collinsville projects are unique in their aspects, including rather intense recreational uses. There is also a requirement for fish ladders because there is a fish ladder for salmon within the next dam downstream.

The license application process was very complicated and lengthy. After studying this site, doing all the work, we finally got the application together, sent to FERC on September 15, 1989. FERC normally comes back and asks for additional information, additional studies, and so on.

My entire file on this project exceeds the depth of one of those long filing cabinet drawers, plus a little more than that. That is all juicy stuff-all real stuff.

I can show you requests for additional information from FERC on various studies just to give you an idea of what they ask for. I feel that FERC was very complete and thorough in their process: Vegetation and wildlife on the island areas that are in the upper site; threatened and endangered species in North American Waterfowl Management Plan; impacts of re-installing flashboards at both sites; studies of structures and facilities; flow data regarding low flow; studies of the flow over the spillways; fish migration flow; wide pass redeveloping flows; common level recreation access flashboard design; statements for preservation of concerned Secretary of Interior approval; flows for the Collinsville Company; historic impact; social and economic impacts of water phosphates. This is just a small fraction of some of the material that we went through during the licensing process.

We found [hydro] sites and we filed license applications, we studied them all, and this took many years of hard work. After studying maybe twenty of them, maybe one of them happens; that's about the ratio in this business.

In doing that, the first man I went to was Brian Emerick at DEP and I said, "Brian, what's out there?" and he showed me the list of dams and so on. I started a company and called it Summit Hydropower. We found sites and we filed license applications; we studied them all, and this took many years of hard work. After studying maybe twenty of them, maybe one of them happens; that's about the ratio in this business.

Every hydro site is different. Each has its own aspects and each has its own particular things that you have to deal with. What we finally ended up putting together. It is now just me and two part-timers, who help with operation and maintenance for my company. I presently own two sites. One is Dayville, Connecticut, a one-hundred kilowatt site, that I put online in 1995. The other is a 2,780-kilowatt site in Jewett City, on the Quinebaug River. There was a third one that was in the middle of a typical New England mill, but unfortunately that mill caught on fire and burned to the ground so that one is no longer running.

Negotiations went on for quite a while for this one, in particular the emergency action plan. It has to do with the dam: what happens if that dam were to break, what areas would be inundated downstream, and what's the hazard classification of the dam, and so on.

FERC produces a scoping document. It is a rather involved process that allows people to come in and to intervene and become part of the process as well as certain dates that you allow people to comment, comment periods and things like that. FERC also

does an environmental analysis. FERC has a staff, with their own scientists and so on, for examining different aspects of projects.

After all was said and done, a few modifications were made to the project so it would be compatible with people's requests, and FERC finally issued the licenses on these projects. Licenses were issued on February 23, 2001. That is eleven years after I submitted the application to FERC.

A lot can happen in eleven years. In this case, the market went down for energy to basically three cents per kilowatt hour. The projects were basically not feasible anymore by the time I finally got the licenses.

Next, I worked with the Connecticut Clean Energy Fund to get hydro onto their list of renewable projects. Then, luckily, energy prices went up and incentives came back, so things were looking very good.

These sites are owned by Connecticut DEP and what DEP requested, very understandably, was that I get legislation passed in Hartford that simply says DEP is able to lease these dams to a developer, nobody in particular, for the purpose of hydropower. That would give a developer the ability to sit down with DEP and negotiate a lease with DEP to develop dams.

The legislative process is something I am not particularly fond of. I am much happier down in the ditches, torqueing wrenches, and working on turbines and switchgear, and so on. Nonetheless, it is part of the job. I went to Hartford to get this bill passed. It is a very difficult thing to do such a simple thing. Everybody agreed to it. There was absolutely no opposition when I went to committee. Everybody voted unanimously for it, but then when it got to the end of the legislative session, somehow my little bill didn't get passed. This happened two years in a row. In the third year, I finally got the bill passed. Now we have it in legislation; a developer can sit down with DEP and negotiate a lease for the Collinsville sites.

We were ready to sit down with DEP, negotiate a lease, and get these projects going. Well, I went to my mailbox and I got a letter form FERC saying that your licenses are hereby terminated because you didn't start construction in time. I no longer have licenses.

FERC is bound by the Federal Power Act to require that construction begin within four years of license issuance, and after four years they have to send out that nasty letter and that's the nasty letters that I got.

So be it. Now I am down in Washington, doing what I like to do, legislative work, trying to get a bill passed to reinstate licenses. If anybody wants to help me get this bill passed in Washington, please talk with me.

That's the latest with the Collinsville sites. I would be pleased to answer any questions about them. They are beautiful sites; I would love to see them developed. There are many benefits that can come from the sites, not the least of which is the energy. There are many other benefits in terms of education, history, recreation and so on.

Just one example: I took my family kayaking in the upper Farmington. We were going along, and the kayak hit the ground. We kept saying, "What's the matter; I want to go further upstream." The problem is that flashboard is all dilapidated. so the impoundment level is down, so the waterways are very shallow, so people can't go as far as they would like to.

It is very hard for us to figure out how to strike a balance when we are looking at a river's needs, our needs for power, and our needs for recreation. That is really, what we are here to talk about-how to strike this balance.

Hydro would put those flashboards back, resume the historic elevation, and allow more and better kayaking. That's just one of the hundreds of benefits of hydropower.
I think that wraps it up.

Eric Hammerling: Thank you, Duncan. We will hold the questions until the end of all three.

Laura Wildman: Thanks, and thank you all for being here. I am Laura Wildman, from American Rivers. I am an engineer with American Rivers. We protect rivers.

Balance

I like the attention given during today's discussion about striking a balance. It is very hard for us to figure out how to strike a balance when we are looking at a river's needs, our needs for power, and our needs for recreation. That is really, what we are here to talk about-how to strike this balance.

I want to make something clear at the beginning. There has been a lot of discussion about fish and the impact of dams on fish. "American Fish" is not the name of our organization. There are a lot of reasons why dams impact rivers. I think I am speaking to the choir, but I want to review them with you.

Rivers are really interesting systems; they are dynamic living systems. When I say dynamic, I mean moving systems. When healthy, they are self-sustaining systems; actually, quite amazing and very resilient to change when healthy. They transport all sorts of things not just fish; they transport a lot of other organisms, including mussels and other species that need to move up and down river systems. They transport sediment all the time, constantly; as much as they move water, they are moving sediment. I am sure there is a lot of sediment moving out there today along with the flow. They move nutrients and debris through the system, and all of this is part of the really, delicate balance that they have created to maintain themselves.

I liken putting a dam on our river to holding an American eel. Has anyone here held an American eel? [Show of hands] We have a few American eel holders.

American eel are an amazing fish. I know they look like snakes, but they are not. They are an amazing fish and they are just so strong. They are like one solid muscle. When you hold them, they just fight you. They wrap themselves around you; they just fight you constantly. A river is kind of like a super hero of all American eels because it will never stop fighting.

We need to look at balance and sustainability at once.

When you put a dam on a river, it's got to constantly fight you. That's why you maintain these structures. I can guarantee that you in the long run, mankind will probably give up before the river does, but that is, beside the point.

We all woke up this morning; we turned on our lights; we checked our email and then we ran out, got into our car, and came here. We all need to utilize power; we all need to utilize roads and the cars and everything else. All these things negatively impact the environment. I am not such an idealist that I believe we should all go back to the point where we are in some kind of hide-covered tent by the side of the river bank and moving seasonally away from the river. Though, I think, we could take some lessons from earlier tribal use.

We need to look at balance and sustainability at once. We definitely need to look at this on the Farmington. We are looking at something that supports our needs and the needs of the system because we depend on these systems. Sometimes we are going to have to make some hard choices. Sometimes we are going to have to change our needs a little, and we don't discuss that a lot. Our consumptive needs are enormous. Sometimes we need to work on changing our consumptive needs.

Non Biological & Natural Sites

We also need to think outside the box. I think our host did a nice job of telling us some of the unique things we can do to start thinking outside of the box. Maybe we need to think about hydro facilities at natural waterfalls. You are going to have less impact on a site like that because the falls is already there.
We need to talk about harnessing power from our non-biological systems. We should look to harness moving flow in our pipe systems, sewer systems, and things like that, especially when we're talking about small hydro. It's moving all the time but it's not fighting.

Let's talk about hydro that we can harness without dams; we heard some different ideas this morning, like kinetic energy. I always go back to the point that rivers are moving just like wind, so they are an obvious source of power. They're constantly moving. When we are sleeping in the middle of the night, they are moving.

We do want to harness that, we will find a way to harness that. But do we have to dam up the whole river to do it? We have to make most of the river not move anymore, just harness it in a higher way, not to say a greedier way but in a more efficient way. Can we instead back off a little, harness that constantly moving water without backing it up? I know that is hard and it surely is not going to lead to some large hydro plants, but it might be similar to some of those very small ones.

End of Life Cycle

We also talked about life cycle earlier. When I think of life cycle and sustainability, it does not just include exceptional project design, building in a long-term maintenance, and how the facility runs. It also includes end of life. When I walk rivers, I find many dams that were built quite some time ago that don't serve a purpose anymore and yet they are left in the river. End of life was never considered on these. We even see it in cases of water supply, where we will use a water-supply dam until it completely fills up with sediment and then we will walk away from it. There will be no thought to how to remove it and go on to another site.

I really think we need to be talking about full life cycle, including full end-of-life cycle, when we think about economics and sustainability. What are we going to do?

I will make the same comparison of hydro on small dams to large-dam hydro that was done earlier; it generally applies to the Farmington River. The turtle analogy was a good one. Turtles, if they in fact are extinct by the end of this millennium, they are not going to be made extinct because of the highway crossings. They are going to be extinct because of all the small road cross-

ings. There are many more small roads out there. They fragment the landscape to such a degree that they are impacting the turtle population.

Very large hydro facilities have very large impacts on rivers, but we get a lot of economic benefit out of them, too. We are not getting as much economic benefit out of the smaller dams. There are many more of them now and they are fragmenting our system to a much greater degree. The impacts of many, many small dams really are compounded to have more impact than one large dam.

I would advocate for increased efficiency at large dams and increased reduction of impacts. I am very much in support of the companies such as Northeast Utilities and others that have gone toward the Low Impact Hydro Institute's recommendations to make the dams more feasible, more sustainable, and the systems more resilient. We are getting a lot of power by increasing efficiency and reducing impacts at large dams. That is part of balancing our needs.

Dam Removal

As far as small dams are concerned, only one in twenty is converted to a hydropower facility, so you should really be able to talk about removal of the other nineteen right off the bat. We are not even talking about the other nineteen being feasible for hydropower on the small end. The water-supply dam or the historic dam-the ones that we have decided have other social benefits for the community-we need to decide that we are going to maintain them.

The Farmington is balancing a lot of these issues, and will continue to do so, especially relating to the recommendations at the Collinsville dams. If it turns out that they are not feasible for hydro, maybe we should be talking about removal of them. That might not be possible for other reasons because the upper Collinsville dam is right in the center of the town has a lot of historic issues associated with it. Why not consider removing the lower Collinsville dam, which is definitely not iconic or historic in any way?

We can look at the recreational benefits, ecosystem benefits, and maybe put in some kind of passage. I am not even going to call it fish passage, but some kind of larger passage, that passes recreational boaters, applied species, residential fish species, mussel species, and diadromous fish species.

I want to highlight the fact that we are balancing a lot of competing issues here, and sometimes this is going to take some creative thoughts and maybe sometimes changing our needs, too. Thank you.

Eric Hammerling: Thank you panel. Now we will open it up to questions.

Minimum Flows

Audience: This is for Tim. How do you determine the cfs that was the minimum that you were going to do? To follow up on that, have you ever gone below fifty cfs and if you have, why?

Tim Anthony: The fifty cfs minimum was developed back in the late '40s when the concept of building the dam was authorized. Somebody came up with that minimum a long, long time ago.

Audience: There was no study done as to why fifty cfs?

Tim Anthony: I am not sure of the answer to that question.

Audience: The second part of my question was, have you ever gone below the fifty cfs and if you did, why?

Tim Anthony: No, we haven't. It is our direct responsibility to always maintain storage in the Goodwin Dam Reservoir, West Bank Reservoir, and Colebrook Reservoir to maintain that fifty cfs no matter what, regardless of drought conditions. It has to be understood, though, that an extremely long-term drought condition might end up requiring that to be necessary. We can forecast the amount of flow that we need, the amount of volume that we need to maintain that minimum flow through a rather long-term stretch recognizing the precipitation cycles and snow-melt cycles in our area. But to the best of my knowledge, we have never gone below fifty cfs. There have been times of longer duration releases of fifty cfs in droughts.

Audience: Thank you.

Audience: Prior to that time, I believe, only the bottom reservoir in the North Branch of the Farmington River had required minimum flows and those were established by the U.S. Supreme Court. As far as I know, those were the first minimum-flow requirements. It was thirty cfs and the watershed area amounted to about one hundred square miles.

Tim Anthony: North of me, our watershed is one-hundred-twenty square miles.

Audience: Point three cfs per square mile. My guess is it came out of the Supreme Court decision.

Audience: The Quad River flows are based on navigability of the Connecticut River in Hartford.

Audience: Absolutely.

Farmington River Watershed Association Position on Collinsville Projects

Audience: I hope I am not putting you on the spot, Eric, but I am curious to know whether the Farmington River Watershed Association has taken a position on putting hydro in Collinsville.

Eric Hammerling: No, you aren't putting me on the spot. This is something we have thought about long and hard. As Duncan mentioned, this process has been going on for quite some time and it has gotten a lot of input. FRWA was one of the interveners when the process originally went on with FERC. We presented a lot of information and FERC adopted a lot of what was proposed.

The upper and lower Collinsville dams do not now have fish passage. They also don't have hydropower production, and the dams are owned by the DEP and are not likely to be taken down. At least, the upper Collinsville Dam is not likely to be taken down anytime soon.

The balance is, if we want fish passage, the only relatively short-term option for fish passage involves being paired with hydropower production. When we have looked at the balance, that is what we have come down in support of. We have gotten even more supportive in recent years as Duncan has shown an interest in working with us in terms of Low Impact Hydro Institute Certification. When he said he was willing to go through the process—Fred you are getting a lot of free advertising today—that helped us feel more comfortable about the balances being struck there.

Other questions? Thanks everybody.

Hydro Regulation

Earl Phillips: Our panel this afternoon is going to deal with hydropower regulation. I hope the panel is as exciting as some of the conversations we've had trying to prepare for this panel.

I'm Earl Phillips. I am the Chair of Environmental Practice and the Utility Practice at Robinson & Cole, as I mentioned earlier.

To my left is Brian Emerick. He's the supervising Environmental Analyst with DEP. Brian has over thirty-two years of experience. If you've plugged into the FERC Licensing Process, you've probably seen Brian as the representative of DEP. To his left is Bruce DiGennaro. Bruce is a managing partner of Essex Partnership. Bruce has over twenty years aligning himself with projects and moving projects forward as both advocate facilitator and consultant. He's going to provide the private-sector perspective on this. Last, on the far left is, Roger Reynolds. We strategically put Bruce and Roger next to one another. Roger is an attorney with Connecticut Fund for the Environment, coordinating and directing their legal efforts. He has a history of nine years with the Attorney General and as a lecturer and adjunct faculty at the University of Connecticut in their Environmental Law Clinic.

We promise some excitement. We hope that Bruce and Roger will resolve all differences by wrestling at the end of our panel.

Other Important Issues

Before we jump into the core of our program, I've thought of a couple things that show up as repeated and recent issues. I didn't see them showing up somewhere else in this conference. So I'll mention them quickly and move on because they really aren't part of my formal presentation for today.

In evaluations of hydropower projects-good, bad or otherwise-particularly in New England, as you look at old sites, the property rights ranging from rights of access, use, egress, etc, surrounding everything from the pen-stock, to the dam, to the power station, to the tail race, repeatedly show up for us. Those may be more complicated, and more difficult than any of us would like them to be, but they deserve attention.

The other issue: both Massachusetts and Connecticut have spent a fair amount of time on in recent years on dam safety. That should always be, of course, a consideration as you go forward.

In addition, there has been a fair amount of conversation, confusion, and development on the subject of sediment-freeing up sediments and/or impacts of sediments behind a dam or in a system.

Finally, and I don't pretend to be an expert on this, but others in my group are: You get in to the economic evaluation. As I mentioned in my opening, economic evaluation has been-I won't say more linear-but clearer in the past. As you get into the world of incentives, you start to see that the equation for what can make a viable project and what can destroy a project, is more complicated now than it ever has been.

Preemption & Water Quality

The last of the issues I want to mention are on the licensing front. Two issues come up repeatedly: One is the issue of preemption, and how far that preemption extends. It seems to find its way into court, and the court system, on a regular basis. In getting a FERC license, what goes out the window in terms of local review? What goes out the window in terms of state review? If you read the treatises in many of the cases from around the country, you'll read this language, which is fairly sweetening about the preemption of local and state permitting processes.

That said, you'll see many of those same considerations, which would be part of the state or local preemptive process, woven back into the 401 Water Quality Certification considerations. The challenge then becomes how many of those considerations can be brought back in. Are they tied to water quality considerations and interests? We may get into that today if we have time, but I did want to mention it.

Last, we have couple of the cases in Connecticut that are interesting in relation to those two topics. One is a case involving a zoning enforcement matter. Town zoning regulations gave the zoning enforcement officer the authority to bring actions to enforce violations of the raise. In particular, there has been an interest in building a deck that would not meet the zoning requirements. It was never granted a zoning permit. Also built on another property was a lighthouse. No zoning permit was obtained to permit construction, and the town zoning enforcement officer brought the action. The trial court then held that the federal preemption applied because the United States Congress had occupied the field of hydroelectric generation and thus the town could not regulate the building of structures in the area by requiring federal license to obtain zoning permits.

Those are the types of issues that I think are going to come up as people examine the extent of preemption. Every case, every set of facts, will be different. I just want to make you aware that there are some other things on the regulatory front that are happening that are not necessarily regulatory, but involve interpretation of those regs, or interpretation of those statutes by the courts.

I'm going to turn it over now to Brian, who's going to give us all a good sense of the playing field, the all-important FERC licensing process. Brian.

Brian Emerick: Thank you, Earl. When I took Earl's call a few months back, asked me if I would be on his panel. I was a bit hesitant. He said, well we'd like you to talk about regulation of hydropower. I became even more hesitant, largely because that regulation really doesn't rest with DEP. It rests with four words-Federal Energy Regulatory Commission-more commonly known as FERC. What I'd like to do, in ten minutes or less, which seems a bit impossible, walk you through some of the basic procedures, elements, and decisions that the commission makes with respect to hydropower.

Jurisdiction

FERC regulates the construction, operation, and maintenance of non-federal hydropower facilities. The jurisdiction is a water body located on a navigable waterway, that occupies U.S. land, uses surplus water from federal lands, affects the interest of interstate foreign commerce, and where project construction occurred after August 26, 1935, which really ties back to the Federal Power Act.

Navigability has been a matter of some discussion over the years. What does it mean? Suffice it to say, it's a very general description. It can be an old trade route. It's probably not navigation in the way you might look at it today. But nonetheless, it's very broadly defined.

"Affects the interest of interstate foreign commerce" also is a matter of discussion. You might say, "What's this little dam have to do with interstate commerce, or foreign commerce?" Well, some of the rulings that have come down say that because that facility is plugged into a grid, and that grid is plugged in to a larger grid, which crosses state lines and could actually cross international borders, particularly with Canada, it affects the interest of interstate foreign commerce. The provision also has been interpreted to affect interstate commerce, if you're unplugging something from the grid that's currently there for self-generation. So, again, the provision is very broadly defined in terms of the facilities regulated.

There are a few non-regulated facilities out there. That determination is made, by filing a declaration with the commission. Some of the important criteria that go into deciding whether the commission has jurisdiction or not include, again, the effect on interstate commerce, pre-1935 construction, and whether or not the facility is located on a navigable water way. The only examples that I know of in the State of Connecticut are Taftville on the Shetucket River in Norwich, which is one of Bob Gates's facilities; Tunnel on the Quinebaug River in Preston, another facility of Bob Gates; FirstLight Power, and Rainbow Dam on the Farmington River in Windsor.

Preliminary Permit

There are five types of orders issued by the commission in terms of hydropower facilities. Preliminary permits are basically an authority issued by the commission to the users to study projects, define a project area, and provide licensing and developing priorities. In fact, those studies help lead applicants to the conclusion that they want to proceed with the construction. Preliminary permits have a duration of three years.

You don't have to have the ownership rights to secure a preliminary permit. Obviously, if you proceed with development, those rights have to be secured, but the fact that you can start something that may be in someone's backyard, always strikes me as a bit unusual. Some of the phone calls that I get kind of reflect that.

Exemption

The commission issues exemptions for small conduits and small hydro-electric. Exemption doesn't mean that it's exempt from jurisdiction or regulation. It means that if and when the project is then determined to be exempt from certain provisions of the Federal Power Act.

The criteria that go into an exemption are that the facility can be up to fifteen megawatts and must have all the property rights secured at the time of the inception. A conduit exemption must serve another purpose after merely establishing a conduit for a hydropower purposes and can't occupy federal land. The exemption is in perpetuity.

Conduits are an example of a non-biological solution. I know of one facility located in municipal water supply system. It's in a vault, underground, adjacent to a road. It's under pressure reduction valve. They get forty kilowatts of energy out of it. It went in to operation in about 2005.

Small hydroelectric facilities constitute another class of exemption. They can be up to five megawatts. Pre-1977 dam, must have all the property rights, again in hand. Again, these exemptions are issued in perpetuity.

Licenses

The grandfather of facilities that are under the commission's jurisdiction are licenses. The site can be a reuse, or a new development. The terms of those licenses run from thirty to fifty years; a lot of what goes into determining that is kind of the investment that the licensee is making in the facility.

An example is the facility owned by the Quinebaug Associates. It's called the Quinebaug-Five Mile Pond Project. It's actually two facilities, one on Quinebaug River, one on the Five Mile River. The one on Quinebaug is split between Killingly and Brooklyn.

It's a 1.7 megawatt facility. And the Five Mile portion of it is 386 kilowatt. Both of those are run-of river facilities.

Another major activity of the commission is re-licensing facilities whose licenses that are expiring. We have re-licensed facilities on the Housatonic River in the last five years. We have an on-going re-licensing project, called the Scotland Project, on the Shetucket River. It's a two-megawatt FirstLight facility located in Windham.

Licensing Procedures

We hear a lot about licensing procedures. There are three basic procedures that result in obtaining the license. The first is an Alternative Licensing Process, which is a collective settlement process. That term mentioned earlier today. It's really not a procedure that's used currently. To my knowledge, it's not been used in the State of Connecticut.

The second is a Traditional Licensing Process, which is really the licensing process that's been used in Connecticut. It is one that I'm familiar with. But again, it's a procedure that's been set aside and actually is only used with the permission of the commission.

The standard licensing process, at this time, is the Integrated Licensing Process. This licensing process came about a couple years ago after a national initiative. There was a lot of discontent in terms of the timelines that were required with the traditional licensing process. An effort was made to streamline the decision-making process. From that effort, we now have the Integrated Licensing Process. The integrated process has been simplified and this is what it looks like (figure 17).

The illustration shows the steps one has to take in re-licensing; it lays out a map that will take you five-and-a-half years to get through. That's if you read all the steps along the way. It is the process that we, everyone has to use, unless you receive the commission's permission to use either the traditional or the alternative licensing process.

Our first experience with the Integrated Licensing Process, is on the Scotland project, which has just started. My first experience with this process, on a personal level, is not favorable. It's kind of cumbersome, very awkward calling for a lot of compression of comments in a process that goes on for five-and-a-half years. Maybe at the end of five-and-a-half years, I'll have a different outlook but, after three months of it, I'm not a fan.

DEP's role in this is to issue mandatory conditions, which are incorporated into the exemption. On the licensing end of it, our role is very similar to what we do in the exemption process. We're commenting, constantly looking at studies, participating in study developments, etc. But the gorilla in the room is that the DEP has the opportunity to issue a 401 Water Certificate-401 being the reference to the Fair Water Pollution Control Act. The 401 Certification is just a confirmation to the Federal Regulatory Commission, that the project that's before them is consistent with our water-quality standards and goals.

Once issued, that certification has to be incorporated into a license as issued by the department. So, typically, we are addressing fish-passage issues and a variety of different topics that tie back into our water-quality standards through the 401 Flow Management issues.

FERC has an extensive and really a terrific website [www.ferc.gov]. You get on their homepage, click on hydropower, and get more information about the licensing procedures, compliance, safety and inspections and the Federal Power Act. The key to information on a specific project is to know the project number. But once you get that project number, you can check on kind of issuance from FERC. Any kind of submission by either the applicant or anyone else is tied to that number. It's on the screen. It is a great resource. That's it. Thank you.

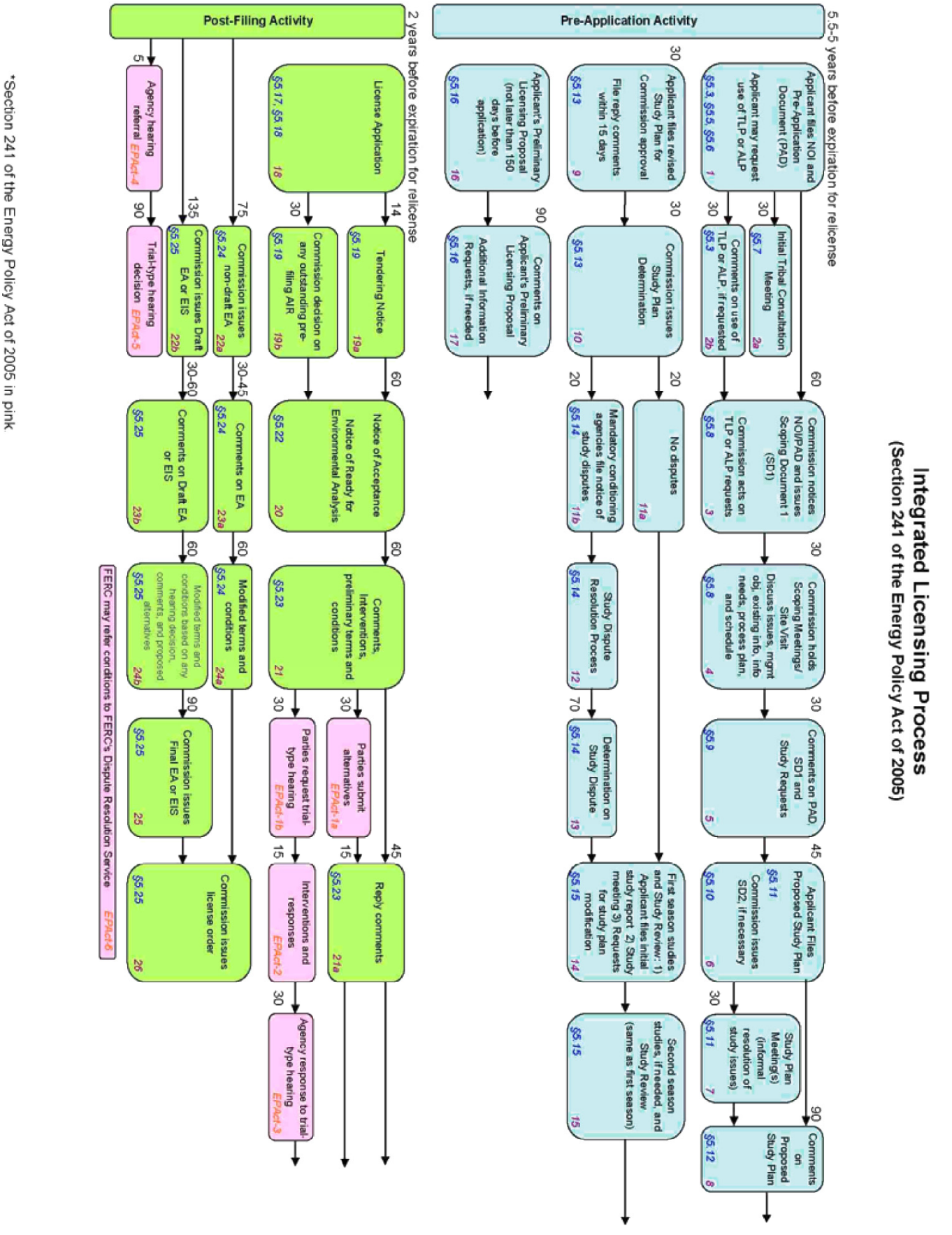
Bruce DiGennaro: As Brian said, the licensing process is governed by a four-word phrase, Federal Energy Regulatory Commission. Sometimes, we like to think of it as a four-letter word. Earl asked us to try to conduct a kind of a spirited debate here. I'm going to push the envelope a little bit. I'm just going to suggest a few ideas, and then we're going to open this discussion up and turn to Roger and allow you to ask some questions.

The FERC Process

So it's actually pretty easy to entertain questions when we talk about the FERC process because, to be honest with you, when we talk about regulating hydro, it's not just the FERC process, it's all the layers that go on top of getting a hydro project approved to build. It's God awful. I mean, you heard Duncan talk about, he submitted an application in '89, and nine years later he gets a permit. Nine years later! Can you imagine, if you wanted to build a house, and it took you over eleven years? It's just crazy. So we can talk a little bit about why that is.

Another point I wanted to make here: I couldn't design a more kind of cumbersome burden of process if I tried. Those who've been through that process know; you just saw that diagram. That's the new and improved process, all right. That's the better one. Any time a regulator says a process is cumbersome, burdensome, that should tell you something on its own.

Don't get me wrong, stuff like that keeps people like me gainfully employed. And I have the utmost respect for my friends and colleagues at FERC, the folks at DEP, and the folks in the communities with whom I work with a lot. It's not really their fault. The process is all messed up.



*Section 241 of the Energy Policy Act of 2005 in pink.

Figure 17.

I'm not anti-environmental. I'm not anti-regulatory. I'm trained as an environmental planner. When I'm not spending my time with clients, helping them survive the FERC process, I spend my time working on kind of large-scale ecosystem restoration projects and conservation projects. It's not that I don't think it's a good thing to have regulation and look at environmental impacts, but this process is just way out of whack.

time is money. That's a kind of unfortunate reality. We have a lot of clients that come to us who are interested in pursuing rehabilitation of a project or maybe even building a new project. And we get to be the bearers of bad news and say, you know, that's great, but you'll need to be prepared. This is not going to happen in a year. It's not going to happen in two years. It's not going to happen in three years. And it's going to cost a boatload of money.

It's very hard for people looking at investing money in a project, or a process, if it takes three, four, five years just to get permitted. In many cases eleven years. I know of cases taking as long as, believe it or not, twenty-five years. You can have kids, they grow old, they go to college; in twenty-five years, the project's still not built.

It's very hard for people looking at investing money in a project, or a process, if it takes three, four, five years just to get permitted. In many cases eleven years. I know of cases taking as long as, believe it or not, twenty-five years. You can have kids, they grow old, they go to college; in twenty-five years, the project's still not built.

And that's just to get a permit. Then you have to build it. That's not to mention all the things that happen that add costs along the way-another whole issue related to the process.

We have an opportunity for a carbonless energy source, a renewal energy source, that has tremendous other societal benefits. I think oftentimes that we forget all the good things that can come out of a hydro project.

I think the last thing I want to say-then I'll let Roger talk and we can entertain questions-is that we have an opportunity for a carbonless energy source, a renewal energy source, that has tremendous other societal benefits. I think oftentimes that we forget all the good things that can come out of a hydro project, including the recreational and socioeconomic impacts.

Earl didn't mention it by name, but the case he's talking about was out on Candlewood Lake. There's no way you can get a look at the creation of Candlewood Lake and not say that it's done tremendous things. People argue about all the boats that are on the lake and the problems they've caused, but there are tremendous benefits that come out of hydro and those get lost.

Unfortunately, a lot of projects don't get built, and a lot of opportunities don't get pursued, because the costs are great. A large part of that cost is the regulatory burden. It's time and it's money, and

The economic outputs may not be there at the end of the day after you add in all the costs of mitigation on top.

Earl Phillips: Bruce, I'm going to push you a little bit further.

Bruce DiGennaro: Yeah.

Earl Phillips: On the front end piece, two things: evaluation of the project as it comes through the door; the second piece, I guess, is more focused on strategy once you decided that the project is potentially viable. What are the strategic components you think are necessary to advance the project, and give it the best chance of coming out the other end of the licensing-permitting process successfully?

Bruce DiGennaro: On the front end, usually, the first thing we look at real hard is the physics of the item. I mean, what's the head at the site? Really anything under fifteen feet is a very, very steep climb; it's just not going to get built, unless the price of energy really goes through the roof because it is capital intensive. I'm beating up on the regulatory process here just to make a point, but it's also very expensive to build these things. It's a lot of concrete and a lot of facilities.

So the first thing we look at is what's the head there, and what's the configuration of the site, and make sure they actually have a viable project, just from a straight physical engineering standpoint. Another factor is the hydrology of the river. If you don't have enough water, often enough, to drive the turbines, it's not going to turn out the kilowatts. A big part of that is you can do some optimization. You try to design the equipment to match whatever that flow is, but enough head, should be the first thing.

Then we always talk to the clients about the reality of how much time and money it's going to take to get through the licensing process. I mean, in all honesty, it's very hard to get through the licensing process without spending at least a couple hundred

thousand dollars. That's if you don't have to do a lot of expensive studies. So it's not cheap, as I said; that's just a reality. Then we can do a basic proforma. Here's your cost going in; it's just like you would do for building any other kind of facility.

Collaboration is a big part as we get in to the process. The only way we get through these things is work collaboratively with regulators and the environmental community. What are the concerns? How do we best mitigate those concerns? How do we design this project so it is something that can provide all those great benefits? And the economics.

Collaboration is a big part as we get in to the process. The only way we get through these things is work collaboratively with regulators and the environmental community.

So it's a lot to consider. If you look at the projects that are held up as success stories, or have survived through to licensing, a lot of them have settlement agreements behind them. People went off and said, okay, here's a regulatory process fine and good. Let's go over here and figure out what we're really going to do. And all agree. Okay, now we'll go through all these, you know, silly procedural steps, that are there for a reason. Don't get me wrong. They survive because they had agreement going in.

Earl Phillips: It's up to you Roger.

Roger Reynolds: Let me just describe my organization for a little bit. Some of you probably have heard about who we are. I'm with Connecticut Fund for the Environment.

We've existed since 1978 or 1979. We really started off as a public interest law firm. We have slowly, and quickly at times, grown. We have a fairly major presence in the legislature. We're working on a Connecticut Climate Cap. We joined with Save the Sound, which had also existed for thirty years, about two years ago. In some ways, we are now a fairly new organization and we get our hands dirty.

I'm sort of a hold-back. I do the same thing, the sort of obligated thing we were doing back when we started out in 1979. I do a lot of the litigation. I've spent a lot of time with the DEP. I've tried to convince them to give me an office, but they've declined so far. If you see them, try to push it. Maybe Brian you can ask them for me.

Brian Emerick: We're going to intervene in that.

Roger Reynolds: Access to the show denied. So, Earl stated that he would broker no agreement between Bruce and me in any of this. I'm going to start out and break a ground rule and agree with Bruce. I think he is right about the FERC process. A lot of the federal streamline processes are like this; everyone I've seen certainly is. It's a perfect example of taking a lot of time to arrive at a lose/lose situation, where everybody's completely unhappy. I think you heard that the government agencies were unhappy with it. The developers were unhappy with it. And the environmental community is certainly unhappy with it.

It doesn't really streamline the process at all. All the roadblocks are still there. And it takes away power from the state authorities, which are the ones on the ground, who know this project, who know the environment, who should be making the decisions. It gives more decision-making power to the federal authorities. And for everyone in this room who knows the Connecticut environment fairly well, that should be a bad outcome.

Now, I'll fully disclose, that I don't actually have any experience hydropower projects. I do have a good bit of experience with other energy projects. The procedures are similar and I certainly have a lot of experience working for the environment through the agencies and working against or with projects, as appropriate.

Power of Alliances

If there's a hydropower project in your area or in your watershed that you're concerned about it, the first thing to do is to form alliances. Find out who else is concerned about it. Find out what your first selectperson thinks about it. Find out what your elected representative thinks about it. Connecticut's a small place. Find out what the attorney general thinks about it. Find out what other statewide elected officials think about it. Maybe even find out what the Commissioner of Environmental Projection thinks about it. Form alliances.

We've really found, whether you're successful or unsuccessful, is going to depend on these alliances. You can have all the high-powered legal help you want. If you haven't formed any strong alliances, you're really not going to get a whole lot of traction. I mentioned that CFE expanded significantly beyond its original mission. And the reason was because we found that courts are not in themselves always an effective vehicle. They're a really necessary part of the strategy. But we've really spent the last ten years really building up alliances and working with towns.

Some of you may be familiar with the Kelda utility lands, where we have a broad alliance in municipalities. Also, the Broadwater project; a couple of you here may have heard about it. We have, I think, twenty Connecticut towns in opposition to that, the attorney general, and the governor. Not that we made them opposed to

it, but we certainly advocated opposition and we certainly work with them. That's very powerful. I think it's the most powerful thing to do. The more people you have, the more access to money you'll have, and the more you can hire legal and scientific help and combine with your elected officials. And start that on day one.

The next thing you're going to have to do is decide whether to negotiate or litigate or, in most cases, both. You're going to have to decide what your feelings are about this project. We heard a lot about balance earlier in the day. Not everything is unacceptable. Some things are acceptable with conditions. Some things aren't. So you're going to have to decide fairly early on what you want to get out of this. Do you want to get a fish passage? Do you want to get more than a fish passage? Or is this just an inappropriate place for a hydropower project? Should it be stopped?

Negotiations

If you can accept conditions, then what you should do is enter, somehow or other, into negotiations. Now if you're dealing with a fairly sophisticated developer, and you've made your opposition known, odds are the developer will approach you. But, if the developer doesn't, there certainly are disadvantages for them.

Do whatever you have to do to preserve your rights through these proceedings. You make it known that you oppose that. It's essential to keep the leverage that you have, not to sacrifice any of your rights while negotiations going on. Just make clear that you're opposed to this. You think it's a bad idea. Either you're opposed to the waste proposed, or you're opposed to it altogether. Actually if you're opposed to it altogether, they'll probably not for be in these conversations.

At any rate, if there is something that you can live with, it's probably good to get into negotiations somehow or another. As I said, though, don't let that take you off the track; do whatever you have to do with the agencies, or whatever you have to do with your public officials. At first, if you're talking about a settlement and you're still out there making statements to the press, they'll ask "Why are you doing that?" It's pretty easy to explain. "Sure, I'd love to settle this, but sure we can't sacrifice any of our rights or any of our opposition if we don't." People may be a little irritated at first but, if they're smart, they'll understand exactly what you're doing, exactly what you have to do.

Press

Another strategy is press strategy. You have to have a press strategy. That's another invaluable alliance-if you can get a reporter interested. If you can get stories, that's very valuable. The strength of the press is really going to depend on the strength of your other alliances.

Legal

Okay, now the legal strategy. There are a number of points of access. I'll just mention a couple of them. The Environmental Impact Statement. It's like the Federal NIPA, similar to the State CEPA. If they do a statement that says "this is horrible for the environment," and they state all the reasons in an accurate way why it's horrible for the environment, at the end of the day they can proceed.

But what have to do is make an accurate statement of what all the environmental impacts are. They can do a lot for this process. The DEP has input. If you're concerned, you can provide input yourself, but it's very helpful to have government agencies making the input on your behalf. So, if you're concerned with things, you should bring your concerns to the attention of the DEP, to the attention of the National Marine Fishery Services in NOAA and so on. They have input on possible threats to an endangered species. The Army Corp. has input with weapons. And you can do a lot in the environmental impact statement. Oftentimes they will not want to deal with a full statement. So there really is a lot you can do through that.

Many decisions should be made at the state level. Water-quality standards are the primary area where the state still has a say-a very substantive say. The water-quality standards can be read very narrowly in a pollution sense or very broadly. You have to preserve boating and fishing. Broadwater, for instance, interferes with the ability to fish in certain areas. So the water-quality standards can actually be a lot broader than some people initially think they are. That's an issue that you can take up in the courts. Alternatives are an incredibly important part of the Environmental Impact Statement and Analysis. If you can present good alternatives for getting where you can get the energy in another way or for building a dam in an environmentally preferable way, that's a very powerful tool.

Science

The other thing that may be as, or more, important as legal representation, is scientific expertise. This is incredibly important. If you go in front of the DEP, or anybody else, they're going to want to know what the substance of your complaints are. It is very valuable to have solid scientific experts. In Broadwater, we have two experts: we have one for energy needs and we have one for environmental impacts. At each stage, we submit substantive scientific testimony; that's incredibly important. It is expensive. Sometimes you can get academics to help you if it's a particularly good project. But if you can get scientists on board, they're incredibly helpful and people in the agencies listen to them far more than they listen to us lawyers. Trust me.

Another important strategy is to get to know the staff at the DEP, particularly in water-quality standards. Call them frequently. Don't harass them. But get to know them. If you come with good

facts, and you come asking them what their perspective is, and have what they need from you, they'll be very receptive. That's something they don't hear very much: "What can we do for you? We have access to this scientific expertise. What can we do for you? What are you struggling with?" They usually answer the question, because it's helpful for them, too. That's very valuable for you. You can be an important part of the process. That's very different from just standing up and saying this is a horrible project. There's a time and place to stand up and say this is a horrible project. The Department of Environmental Protection, will take a hard look at the environmental quality; they decide it's okay, you're going to have a very hard time reversing this. You're in a really bad position to try to challenge them, because they have a lot of discretion and they're given a lot of deference. But if you can convince the state environmental agency, you're in a good position. So really get a relationship with the agency and with the staff people. Know what they're thinking and try to interact with them in an intelligent way.

So, I guess we've got to get to questions and answers sometime or another. And again, I just want to sort of emphasize that in the beginning, middle, and end, form your alliances and stay with your allies. Keep up the strong front.

Brian Emerick: You can look at almost any other form of energy generation, short of nuclear, and nobody carries the kind of burden that hydro does to get through the process. I can build a gas turbine in your backyard much quicker than I can build hydropower.

Earl Phillips: Yes.

Fred Ayer (from audience): I'm going to do something I don't usually do-stand up. I don't actually think that the licensing process is as bad as you're making it out to be. But I think there are a couple things that you said about the integrated licensing process-the integrated licensing process works with the licensing process. It doesn't change the state's authority. The state still has the same authority as in the traditional process.

So I don't think there's any change there. We've worked with a lot of folks who've been working on hydropower actually, and it's been a mixed bag. The deciding factor, and in fact the same factor that I think makes some hydropower projects drag on for longer than others, is the willingness of the parties to cooperate. When a project drags on, it's usually because agencies are asking for information they need to make informed decisions. The licensees are not providing that information. And they go back and forth. The people are allowing projects to drag on because they don't want to give information that might possibly burn them later.

You can look at almost any other form of energy generation, short of nuclear, and nobody carries the kind of burden that hydro does to get through the process.

Earl Phillips: We'll take questions in a moment. I would like, as you get into the answers, to point out that even given your differing perspectives, both of you are saying the same thing. Alliances are important. I think we've all seen that. Know your objectives. This is critical and important.

One thing that I think is often a concern in both camps is the sequencing. The sequencing can, frankly, screw up a project and/or screw up a position. If you get out of sequence with what your objectives are, that can be a dangerous moment.

Audience: In the regulatory process, does FERC have control over coal plants, gas plants? Is it the same process for all of them to come online as it is for hydro?

Brian: No.

Audience: No.

Earl Phillips: And why is that? The commission does have jurisdiction over natural gas pipelines. So does it also have jurisdiction over ISOs or regional transmission organizations, in terms of actual generating facilities? Hydro is the exclusive area, but they have jurisdiction over energy.

Earl Phillips: Your points are all well taken. And I think, just in fairness to Bruce, I had asked him to be a little aggressive in this conference. I see that he struck a good chord in the audience. Thank you for the clarification.

Jeff Reardon (from audience): This might be a related point, but one of the reasons that I think it's harder to permit hydro projects is that unlike other projects, once the projects are licensed, they have no fuel costs. They use a public resource for fuel. They get it for free. They get a license to use it for thirty years. If you look at, I want to build a project next year, that's going to cost me two hundred thousand dollars to permit-that sounds crazy, of course-but if you look at it, the public is giving you the right to use a public resource for thirty years. Let's say your revenue stream is half a million dollars a year; that's fifty million dollars of use of a public resource. Two hundred thousand dollars to permit that may be prohibitive on some very small projects, but that's not a huge cost for large and medium-sized projects when your operating costs are going to be for nothing.

A FERC project embodies a lot of those complicated, jurisdictional issues that make it procedurally very painful.

Bruce DiGennaro: Jeff's exactly right. I mean there's a good reason why there is an involved licensing process when you're building a project utilizing public resources. The process is designed to protect the environment. That's not a bad thing. There's a lot of reasons why it's very complicated. Earl mentioned the federal preemption you have: federal regulations, state regulations, local regulations. They all overlap; they don't match up very well. I mean, look at the mess in New Orleans. The way our government's structured is pretty messy. A FERC project embodies, a lot of those complicated, jurisdictional issues that make it procedurally very painful.

Earl Phillips: This gentleman, back here, yes.

Fred Ayer (from audience): Roger, you said you never worked on FERC project licensing I believe.

Roger Reynolds: Hydropower.

Fred Ayer (from audience): Oh, hydropower. I believe you. I've fought various licensing proceedings across the United States for thirty years. They're a pain in the butt, and far too dismal. I would say the position you're taking by saying get in there and get tough, "let's do this," is wrong. I've been through projects. I've seen typical projects work through settlement agreements. With settlement agreements, it's not that you go off to the side, and you work there together, and you make the settlement agreement the condition of the licensing. You bolster your position as a state agency. I think it's really unfair to make the process into the boogie man. Where I'm sitting here, listening, I think you need to take another look at this and see if you can't find another way to work this out, because there are some success stories. I'm not hearing any of those.

Earl Phillips: I'm not exactly sure what you're taking issue with.

Fred Ayer (from audience): The whole of the process. I wasn't aiming at just you, I was talking to both of you, who claim the processes are virtually impossible. The organization I have, I get used to hearing people say, "Oh God, you're criteria are so tough, we'll never be able to certify it." Well, we have thirty projects across the United States that are certified. They have figured it out. And, that's all I'm saying. Wouldn't you think it would be more helpful for someone entering the process if you gave them the tools to make it work, not to warn against proceeding. What I was hearing was very contentious towards this whole process. I'm just suggesting, that if you'll go to compromise, you're going to get more positive results. That's my personal observation.

Bruce DiGennaro: Yeah, yeah. Absolutely. And I'm glad you mentioned that because I want to clarify that I don't think, my criticism isn't from FERC taking too long to get through the process. That's certainly not the criticism. My criticism is the process purports to take a good bit of power away from the states. It should be with the states. And as the other gentleman said, we have tried to defend the state's role in this. For instance, the State of Connecticut has asked three times to get FERC to acknowledge that they have to do a water-quality certification for Broadwater, because the ships are going to go through Connecticut waters. They haven't done that.

We have significant concerns with them taking away state authority. We think FERC should have authority, but the states should have full authority to also approve this. And we're very nervous with that.

You're going to make the best friendships by firmly and forcefully stating your positions in the public and preserving your rights in the public forums.

In terms of the contentious process; you have to decide what your goals are. But from the point of view of someone opposing a project, either opposing it entirely, or opposing certain parts of it, you get those through the process. So, you move through the process. You make your concerns known through the process. But if there is something short of blocking the project that you can live with, then you enter into negotiations and talk about the fact while continuing to move through the process. You certainly cannot not participate in the process or try and make believe that everybody's friends here, though in the end they might be. You're going to make the best friendships by firmly and forcefully stating your positions in the public and preserving your rights in the public forums. Have enlightened self-interests and move forward when there's a situation where you can get everything you want short of trying to block the whole deal because you're not always going to be able to do that.

Earl Phillips: I think our panel has probably run out of time. I hope you appreciate that, part of what Rivers Alliance asked us to do with this panel was to share different perspectives. I think that came out loud and clear, both in the audience and on the panel. Thank you again for your time.

Emerging Policy, Changing Landscapes

Mark Smith: This panel is titled "Emerging Policies, Changing Landscapes." We have a great group here that has agreed to come to educate us on how the world around us is changing. I think we've heard a lot from many of the speakers, from people like Duncan, who own facilities, to others, about how economics is really a key driver in determining what type projects go forward and what moves forward with hydropower and other energy. A key part of those economic decisions are the incentives provided by governments at the national and state levels. There has recently been a lot of activity at both the national and at the state level, that directly affect, the discussions that we are having here today.

We have an excellent panel. We have John Rogers, from the Boston office of the Union of Concerned Scientists, and he's going to talk to us about national policy. We are very lucky to have Anne George, from the Connecticut Department of Public Utility Control, who will talk about issues here in Connecticut. We have David Deen, who is a State Legislator from Vermont, the Connecticut River Steward, and the owner/operator of a professional fly-fishing guide service. And finally, Fred Ayer, Director of the Low-Impact Hydropower Institute. So, without further ado, I'm going to turn the discussion over to John, to give us a perspective on some of the changing policies at the national level.

John Rogers: Thank you, Mark. It's great to have the chance to talk. This is a sleepy time in the afternoon, so I'm going to keep this as exciting as possible. I could start with some fire and brimstone about climate change, but I know from the show of hands you gave Tom Tarpey that you are already believers. I will say that there is some information that has come out from my colleagues on the climate side of the house, called "Confronting Climate Change in the U.S. North East." A summary of this report appeared in July. Whichever side you're on on these debates, this is an important part of the context. It is great information that really brings the debate home; it takes climate change from a global perspective, a global problem, and brings it right down here; in fact, to the level of Connecticut, or any of the other states. It includes a number of state summaries.

So, climate is obviously one piece of the context for discussion about hydropower; energy is the other. I'm just going to talk briefly about those two topics, what's going on beyond the state; chiefly at the federal level. Energy-obviously electricity-projections from the Energy Information Administration are that our consumption is going to continue to increase, even though many of us would rather see that decrease. Renewables will phase out the non-renewables much more quickly. So, the latest federal legislation, passed last month in Washington, has some important provisions on fuel economy, energy efficiency and nuclear-loan guarantees.

Renewable Electricity Standard

The exciting part for this afternoon is what happened on the renewable electricity standard-what happened with the tax package for renewable energy. The tax package that would have included the production tax credit and the investment tax credit, both of which were important for renewable energy, did not pass even though it was in there up until the final moment. The bill passed the House and the Senate. I could give you the whole blow-by-blow account if you want, tell you how many votes came at different levels, but basically there were these different pieces of the renewable electricity standard in the tax package, and neither of them made it into the final bill.

The renewable electricity standard is particularly applicable to hydro. This would have imposed a fifteen percent requirement on utilities by the year 2020, with a qualified fifteen percent because some of that could have been met with energy efficiency. But it did achieve a majority vote in both houses, and then fell short of the sixty votes it needed in the Senate to stop a filibuster. So the renewable energy credits do have a lot of support. There is commitment from leadership to press forward with this; we as an organization are determined to press forward with the tax package because that's very important and should be doable. In terms of the renewable electricity standard, we are still trying to decide whether or not it makes more sense to wait until next session when there will be some changes in the composition of the Congress.

Here is how hydropower fits into all of this: incremental hydro was in the final version of the bill, and it covered about additional generation from increased efficiency or additions to capacity made either on or after January 1, 2001, or an effective date of an applicable state portfolio standard-and there are twenty-five states that have portfolio renewable electricity standards. There is an environmental clause that says "Incremental hydropower shall be subject to all applicable environmental laws in licensing and regulatory requirements." It doesn't give us a whole lot extra, for those of you who were looking for more protection than the stuff you've heard that already exists. But, that's what's in there.

In terms of other existing hydro, which is a piece of the energy equation, it wouldn't have been accounted for as new renewable energy under the standard, but it would have been excluded from the baseline. So it wouldn't count for you, but it wouldn't count against you. In terms of the other hydro-kinetic resources, there were a lot of negotiations between the Hydro Association and the

environmental community, and those probably will continue the next time this comes up for a vote.

Climate Policy

The other piece of the picture in terms of what we've talked about today is climate policy. There is a climate bill-Lieberman-Warner, the America's Climate Security Act, is the farthest along. It covers seventy-five percent of the economy: large industrial facilities, electric utilities, and refineries. It targets reductions, it has levels for 2020; by 2050 it's targeting seventy percent. If you do the math, achieving seventy percent reductions in seventy-five percent of the economy, doesn't get us to the eighty percent reductions that our science increasingly tells us is going to be necessary. So, clearly, there is work to be done here, but that's the vehicle that's moving along now.

Regional Greenhouse Gas Initiative

Also on the climate side, beyond the state level, is the Regional Greenhouse Gas Initiative; RGGI is a ten-state cap-and-trade agreement that covers New England and several other states. It covers power plants only, regulates the emissions of carbon dioxide, first caps them, levels them off, and then brings them down ten percent by 2019. One piece of that is how the allocation of permits happens. Most states, if not all states, are committed to one-hundred percent auction, or very close to one-hundred percent auction. That means no free giveaways. We have learned from the European experience.

Let's talk about how renewable energy fits into each of these pictures. Obviously, if the power plants-the fossil fuel emitters-are capped, that adds some cost onto them. That has implication for a non-emitting resource like hydro. So there's a little bit of an edge there. Within the RGGI target, the state RPS that existed before 2005 are figured into the baseline below which we're trying to reduce. So that gives extra oomph to those renewable portfolio standards. The other ones that have come online since, like New Hampshire's, and increases in Connecticut really have to happen for RGGI to meet its goals. Extra oomph there for hydro and other renewable energy resources.

The rights to pollute were going to be auctioned off; there's a big question about what to do with that money. We, among a number of other organizations, have signed on to a position that says most of that money should go to energy efficiency because that's how we're going to meet our goals most cheaply. But a portion of that should go to renewable energy-to supporting the development of renewable energy facilities. Our position is that it's not going to be enough just to reduce our demand, we have to be cleaning up what remains. We have to start getting rid of fossil fuel generation, taking that off-line. Obviously, hydro fits there.

One other piece is the voluntary renewable energy market. Hydro feeds into that in some cases. I think this will be dealt with that state by state, so there's a question about how voluntary renewable energy gets treated under RGGI. States are able to choose to retire some carbon-pollution permits to account for renewable-energy purchases that come from within the RGGI region. So, again, another avenue for hydro to continue to play a role in meeting both the energy goals and climate goals. I'm going to turn it over now to Anne.

Anne George: This is a brutal time period. It's the last panel on a Friday afternoon, so I think we'll try to be as brief as possible with our comments in order to have a good discussion afterward. For those of you who don't work in the State of Connecticut, or don't know the Department of Utility Control, we are the agency that regulates the utilities: the electric utilities, the natural gas utilities, water, telecommunications, and cable companies.

Renewable Portfolio Standards

Part of our charge is to implement the renewable portfolio standards that Connecticut that passed in 1998 as part of the Electric Restructuring Act. It is one piece of that Act that most people agree was positive, coming out of the restructuring of the electric industry. In Connecticut, the RPS didn't get a lot of teeth until 2003 when some changes were made to apply it to all utilities and electric suppliers in the state. We started off with a Class I and Class II. Class I is the more agreed upon, purest of the pure renewables, while Class II is the slightly less pure renewables.

We have Class III now, which includes combined team power and energy efficiency and conservation programs. We're working toward the percentages required for electrical suppliers to meet and to continuously ramp up over the years. They just made some changes to those requirements last legislative session and we will continue to ramp up on the Class I until we get to twenty percent between Class I and Class II by 2020. With regard to hydro, the state in its Class I requirement looks at run-of-river hydro less than five megawatts. When we first started implementing that language, we realized that that was not as easy to implement as we originally had thought.

As a department, we held a pretty large proceeding and had a lot of stakeholder input to determine how to best interpret the language, for the policies of the legislature and also how do it in a way that considered all the various arguments between existing hydro facilities, those that would develop new facilities, and the environmental community. In looking at our RPS, we look at implementing four goals, and four stated policy goals-economic development, the environment, reliability, and energy security. With regard to the environment, I just want to make sure that everybody understands that we are not the environmental agency. Obviously, I think a lot of you deal with the DEP. They are the experts on the environmental side. We just try to implement our policies in a way that complements the environmental goals, that does not frustrate them. Obviously, we don't always succeed at that and often what we see as a great benefit, or enhancing reli-

ability, or security might not be what the DEP sees as the most environmentally friendly solution.

So, we work with that agency a lot on issues that cross both our jurisdictions. When we looked at Class I run-of-river facilities, we tried to provide incentives for updating or re-powering older facilities. The cut-off in the statutory definition is July 1, 2003. If you began operation after July 1, 2003 and meet the other requirements, you're a Class I. If you began operation before that, you're a Class II. Class I renewable energy credits for Connecticut currently are trading in the fifty dollar range and higher. We've seen that number go up and down over the years. Class II regs, are I think, below a dollar, so there's a big difference there. For determining whether an existing older facility can become a Class I facility, we look at several things, including whether it was abandoned for a certain number of years and whether the capital improvements meet a certain threshold. We've tried to set it up in a way to avoid creating any waves for gaming the system. We've set up a procedure, and we've gotten several applications from older facilities that have made some large investments or that were abandoned and new owners come in; they've been able to fix up their plants and become Class I.

Five Megawatts

We also looked at that number, the five megawatts. There's a lot of discussion about that number, and I know several people felt strongly that it should be a stronger number in terms of looking at average output versus name-plate capacity. We chose name-plate capacity for the entire facility at a site as opposed to individual units. We felt strongly that the legislature clearly had that intent in putting the five-megawatt number in the statute. I know several people have argued that the legislature should look at that number again in the future. We don't have very many Class I facilities in Connecticut, but we have seen a fair number throughout New England. We have several Class II facilities, and there's always an incentive to possibly add some incremental power as long as you're under the five-megawatt limit.

I think that's all I wanted to say about the RPS incentives in the state. I will say, and I'm sure that others on the panel will talk about it, that other New England states have passed RPS. I don't think Vermont has a Renewable Portfolio Standard, but several states have passed it in the last couple of years, and so, therefore, you have this mandatory demand that is being put in place for greater renewable energy, and hydro is definitely a piece of it. I'm not positive on some of the other states, I know they have different rules with regard to hydro; but with more of those states coming on with RPS requirements, you see the demand growing and the supply is just not growing as fast as these percentages are ramping up.

So you have the renewable energy credits; the prices are rising, and this is something that I think we're all going to be dealing with because in the end it's the rate payers that end up paying some of these higher prices. One of the concerns of the Department is looking at what's a good equilibrium there: how much should renewable energy credits be valued at versus how much burden should be put on rate payers, and how much do renewable developers need as an extra incentive to develop a project. We're not sure how to get there. I know other states have administrative ways to deal with their alternative compliance payments. We're obviously concerned about balancing the need for renewable energy with the increasing rates and burdens that are placed on rate payers.

Other Incentives

Other incentives that we have in Connecticut for renewable power, and hydropower are part of Project 150. (It used to be Project 100.) This is a legislative-directed program to require our utility companies to enter into long term contracts with renewable projects. We have an open docket right now on a draft decision on the second phase of this. There will most likely be a third phase to get to that 150 megawatts. I have yet to see a hydropower facility get through that process. I think this is an area in which hydropower can participate, and we get to see it come through.

The Clean Energy Fund, which you heard from earlier today, obviously has other incentive programs to promote different renewable energy projects. The Clean Energy Fund is funded by a charge to rate payers, so it's something we are very interested in because rate payers often want to know what are the different components of their bills. Any success that the Clean Energy Fund has investing in a new project justifies that charge on the bills. We work with the Clean Energy Fund to try to promote those projects.

Voluntary Market

We've created a voluntary market here through the Connecticut Clean Energy Options Program, and we've got a fairly strong program for voluntary purchase of renewable power. There are currently two suppliers; one of them does have a good portion of their offering in hydro, and I believe it's Connecticut-based hydro. That is an area where hydro has made some inroads, getting some exposure in the state. We're beginning to look at the next phase of that program, and we'll probably be making some changes to the jurisdiction, the geographic areas where voluntary renewable energy credits to participate in the program can be purchased. But that's something that I think is important to the state and I think we've been very successful at promoting voluntary purchases. In implementing RGGI, the DEP draft regulations have embraced the idea of retiring allowances, based on the amount of voluntary renewable energy purchases in the state. So I think that goes a long way to further reduce the cap, but also further enhance the ability for people to say they're actually

making a change and really making a statement when they sign up for these voluntary programs.

And, just finally, I will say we work a lot with ISO New England; and they have undertaken some studies of hydro, generally large hydro. So that's going to be something that we talk about later; at what point does the renewable aspect of hydro change? Connecticut has set this five-megawatt limit, but how large can you go? I've heard some discussion about that, so I'm going to look forward to learning more. Thank you very much.

David Deen: My name is David Deen. I am a River Steward and I work with the Connecticut River Watershed Council. My counterparts from Connecticut and Massachusetts from the Council are also here. A couple of the things I'm going to say, I could have said from the audience during the last panel. I urge caution about denigrating the FERC process, and the state process, and what it takes to get through licensing, not only for the reasons that others have pointed out, but because past abuses have brought us to where we are now. It didn't just happen because government decided "we want to make a tough process." I for one, as a river advocate, want two or more forums-the state and the federal level is the courts, and any other forum I can get into-in order to protect rivers. Process efficiency does not necessarily lead to correct decisions.

Renewable Portfolio in Vermont: We did a really Vermont thing. We said, "Utilities, meet this standard. And do it by this time." I forget what the year is. "If you don't do it, we'll impose." The private sector said, "Hey, we can do that." We said, "Fine. Do it, and do it by this time." So, we don't have law in place that requires it, but we're moving toward a renewable part to our fuel mix.

That brings me around to small hydro, which is what I was supposed to be talking about in the first place. In Vermont, we have a small-hydro movement underway. It's fueled by both myth and reality. Now I'm going to just list some of the things that I hear from the advocates. I'm not advocating for any of those positions. I'll let you figure out what's myth and reality, and then I'll talk about what's underway in the state. The move is fueled by a desire to reduce our carbon footprint and that we, in Vermont, want to control over our power sources. Even though our current administration missed an opportunity to own all the dams on the Connecticut River; the official word is that we want to control power generation in the state. Dams exist. Why not convert them to hydro? Why not invest in that, bring them up to standard, make them safe, make them generate power? Dams help protect us from floods. I don't even want to go there. Hydro is, by definition, green. All right? It's a green power source. Hydro is, by definition, renewable. And here's my favorite: regulation is the sole reason all hydro sites can't be developed.

Renewable Energy in Vermont

So what have we got underway in Vermont? We've had several legislative initiatives, beginning last year. I am chair of the Fish, Wildlife, and Water Resources Committee. It is the committee that deals with issues such as hydro. So we had a couple of bills last year-and there are several bills that are being introduced this year-that require, essentially, studies. Legislation was introduced that said five megawatts is small hydro, and should have no more control on it than the net metering standards that apply to dispersed power generation. Well, the Public Service Board had a fit in front of my committee because five megawatts, if it goes down, presents some real system reliability issues. We asked the Public Service Board to tell us what would be an appropriate size for those power facilities, given their concern about system reliability.

There's a new bill this year that requires the Agency of Natural Resources to recommend to the legislature the positions that ought to be public policy in the State of Vermont on such issues as: of bypass flows; dissolved oxygen level for both wastewater treatment and hydroelectric facilities (somehow there's an equation between the two); seasonal flow and bypass run-of-river facilities; the need for new fish or flow studies at any of the micro-hydro sites that will be developed; the use of flashboards; measures to prevent fish from entering turbines and pin stocks; an analysis of the existing permitting process for small hydroelectric projects. I've been around public policy for a very long time, at least twenty years. As far as I'm concerned, "analysis of permitting process" is code for, "Let's make this permitting process disappear." So it's going to be interesting to see what the agency comes back with. In the same bill, the Public Service Board is to make a recommendation to the legislature on what the allowable maximum amount of output capacity at each of the facilities might be. That goes to the issue of system reliability.

I have begun referring to this effort it as the Children's Crusade. We have a junior-high school that has now become the point of the lance in terms of developing small-hydro in the State of Vermont. Everybody remember the Children's Crusade back in the middle ages or whatever? They recruited kids to go and whatever, and when they got there, they were captured and sold into slavery. The push behind this Children's Crusade is a private developer. Not that that's not an appropriate entity to come to the legislature to look for relief and support in their effort, but it has attempted this twice now, and it's going to be interesting to see if they continue to get answers that they don't want, when they will stop pushing.

The Alaska Approach

The other thing that's on the agenda in Vermont is the Alaska FERC approach. I know that our federal delegation is being asked to do what the senator from Alaska did, and that was to

get the federal law amended to allow Alaska to create their own FERC review process in lieu of the federal FERC review. I know that is underway with our federal delegation. I don't know how far it will go. I believe they are just getting around to reviewing it, and it's been underway for five or six years now, at the state level and the federal level. Bottom line: Even though they got that provision passed into federal law, it does say that FERC has to sign off and say that they approve the process that Alaska would adopt.

I'm right at the end. This is the second year that we've seen this kind of effort. I imagine it's going to continue. Part of the background for this is that a great number of hydro sites, were, in fact, developing power in the State of Vermont up until about the early 1900's-1920, 1930. And Vermont has an interest in history, and looks to its history to guide its future. In this case they're looking to the past use of hydropower. We'll see where it goes from here.

Fred Ayer: I have to share this with you; maybe it is good news for you. I happen to have people I'm working with in Alaska, and I asked them about how the five-megawatt process was going, and they said by the time they sent it to each of the agencies, it kept getting bigger and bigger and bigger. And by the time they got to the end of the process, there was more poundage and more paper than there was in the FERC process, so they've stuffed it into a drawer somewhere where, last word is, it's not coming out for years.

PURPA

I'm going to talk a little about history. Mark asked me to talk about a federal law with very odd name: PURPA. It sounds like something the dog did on the rug. It stands for Public Utilities Regulatory Policy Act and it takes me back to the time when I started working in hydro. There are some things about that time that remind me of today. They've got to do with subsidies and incentives for small hydro. The Public Utilities Regulatory Policy Act passed in 1978, at what I would call near the height of the energy crisis. So PURPA, besides doing some stuff with tax incentives and streamlining regulations, required utilities to purchase power from non-utility generators at avoided costs. Avoided costs meant the next most expensive source of electricity. I don't know about Connecticut or Vermont, but I know we were sixty-three to sixty-five percent oil-dependant in Maine. So the cost of the next avoided cost was key to oil, which was going up, so they said, "Okay, this will stimulate development of hydro generation." It did.

Remember Brian Emerick's slide about the different kinds of FERC processes? Let me tell you what happened right after PURPA was passed and put into effect, because it was a gold mine, and it looked like a gold rush. It was intended just to put that little thing that I talked about with the utilities into effect: Utilities might have been paying the non-utility generator a half cent or less a kilowatt hour. That would jump to ten, twelve, fifteen, and in one or two cases that I know of in Maine, seventeen cents a kilowatt hour. So the project that was not making very much money was all of a sudden on Easy Street. What did it create? Prior to the passage of PURPA, you might see fifty-to-one hundred FERC orders in a year-that is, a combination of licenses, exemptions, and so forth. Approximately fifteen hundred exemption applications were filed between '80 and '85, and FERC issued 775 exemptions during the same period. Activity also increased in other areas, with FERC issuing 5, 069 preliminary permits (that's the permit that gives you the right to study), and 430 licenses during that same period. Now, I think some of those were on pending consequences, but it made things really kind of insane.

Seeking Hydro Sites

I was working for a small engineering company in Maine with about twelve people by that later became Kleinschmidt Associates. We actually had a guy come in who looked like he was Daddy Warbucks with a great big cigar, and he represented U.S. Hydro Associates. He said, "You got any books where you've got some sites that we can go look at? We want hydro sites." Now my little organization that has a one-person staff, but people look at us on the website and they don't know-they figure we could be fifty-to-sixty people. Recently, I've been getting strange phone calls. The phone calls have gone like this: "Do you guys have a registry of hydro sites that we can find and go look at? Do you know anybody who sells hydro sites? Is there something like a real estate thing?" Now will this come to fruition? Will it be a mad dash, and will you be inundated with hydro in New England? I don't know. But it's worth at least paying attention to and watching, because as RPS go into play, you have some of the same factors.

Another aspect that I don't know if you guys are familiar with, in the voluntary market: Are institutions looking for suppliers of green hydro-not necessarily suppliers that meet state standards, but suppliers they are comfortable with. One example would be a project that we certified-negotiated an agreement-was with Bowdoin College, because the students wanted green power. So they have paid a benefit. When hydro doesn't get developed, it's mostly for economic reasons. As energy prices go up and cross a certain line, all of a sudden, hydro becomes affordable. You say, "Well, prices can't jump that much." In 1973, oil was $3.65/barrel after it had been booted twenty percent up. And a couple of years later, it was about $38, then it got up to $80 dollars/barrel before 1980 was over. Just the other day, oil hit $100/barrel. Where will it go? I don't know, but I think if you want to watch something and track something, this would be an interesting thing to keep an eye on. That's all.

A Fundamental Change in Prices

Mark Smith: Okay, Fred, thank you. I want to take the moderator's prerogative, and ask a couple of questions myself before I open it up to the audience. One, legislation is an answer, but we just heard from John and Anne, and David, that there are a lot of changes here, a lot of moving parts. Things are moving very quickly on the energy front: on renewable, we have RGGI; we have Renewable Portfolio Standards; we have efforts to streamline the environmental process; we have tax credits that didn't make it but will be back again. So my question to the panel is: "Does this really represent a sea change in energy policies? A sea change of the conditions under which hydro will be evaluated in New England, maybe sort of a son of PURPA, you know, a really significant, fundamental change? Or will change be much more incremental? So, to anybody who cares to venture-either Anne, or John, or David. Anne?

Anne George: I don't know if it's a huge, fundamental shift. I think a lot of these different policies are starting to converge, and you have greater momentum. I think that if there's any federal climate policy, it will definitely have some greater momentum going into increased renewables. Everything that I hear is wind, a lot of solar, a lot about biomass, and I hear a little bit about hydro. I'm not sure how much of the push is going to be for hydro and how much these incentives will help bring hydro along. But there's definitely a convergence of these policies that are going to promote increased renewables. As prices of oil and natural gas continue to escalate, you're going to start seeing people turning to alternatives. We're definitely in a very natural gas-dependent region, and I think everybody understands that we need to diversify our fuel mix here. We are moving in that direction, but what place hydro takes, I'm not sure.

Mark Smith: We're not at that tipping point yet, but it could be out there.

Jeff Reardon (from audience): My concern is that as the price pressure for energy continues to escalate, instead of holding hydro accountable for its impacts on the environment, public policy majors will say, "Well, you know, we need the energy so badly, we're going to re-institute that environmental subsidy to that source of power, rivers be damned." I don't know where the break point is-$200/barrel for oil?-when we're going to be so desperate for fuel that anything can go in our rivers. I'm very concerned about that.

Fred Ayer: So you have that in play. When you look at the numbers I read from PURPA, they had a couple of consequences. They also occupied a lot of state employee and federal employee's time. You don't process seven to eight hundred applications in a two-year period without clogging the system. So there are other kinds of things that may occur if you get a rush. But I do think there is a crisis going on. I don't think the break point is $200/barrel; I bet it's probably under $110/barrel when things start to look really good and you'll start to take those old feasibility studies off the shelf and look at them.

John Rogers: Can I just add one thing hot off the press? In terms of New England as a market, not so much for electricity, but for renewable energy certificates and renewable energy credits for complying with the Renewable Portfolio Standards of Massachusetts, Tom Tarpey and I, and others were on Deacon Hill on Wednesday, the Senate passed an energy bill, the House has already passed one, that adds hydro to Massachusetts. Massachusetts is half the load in New England, and it now; assuming some version of this survives Congress, hydro will now be a Massachusetts RPS. So that's an important factor when it comes to the economics of hydro in this region. Size still is to be determined. The Senate version creates a second tier for existing hydro; much like some of the other states in the region have, then incremental hydro, I think up to five megawatts, and then new hydro up to twenty-five megawatts. There are some environmental protections in there including a requirement for low impact and other stuff. But the House version does not have the same language. We'll have to see what comes out.

My concern is that as the price pressure for energy continues to escalate, instead of holding hydro accountable for its impacts on the environment, that public policy majors will say, "Well, you know, we need the energy so badly, we're going to re-institute that environmental subsidy to that source of power, rivers be damned."

Small Hydro Vs. Large Hydro

Mark Smith: My second question actually addresses the size issue because all day we've been hearing about small hydro. Early on, we heard that small hydro isn't economically viable: There aren't really many good sites, it costs too much, its too hard to get permitted. But then, on the other hand, I listen to the discussion here: If it's under five you get this; it's easier; we're trying to encourage small hydro; you only get credit if you're small hydro,

or in small increments. So, I guess from a policy standpoint, should we be incentivizing small hydro or not? Because we've heard that the impacts are just as bad. I think Jeff said, "I'd rather have one big project than fifty small projects because they fragment the rivers more." Should we be incentivizing small hydro?

The size argument is one of the worst things the policy makers are doing.

Is there some real difference from a policy standpoint that policy makers should be paying attention to, like, "That's a really bad idea; let's focus on incremental, large facilities?" or "No, small hydro is the way to go, that's where all our attention should be." What's the view on small versus large?

David Deen: Investment in incremental and existing facilities would account for the most power-production dollars invested. Because of PURPA and other initiatives, there just aren't a whole lot of new sites that can be responsibly developed in Vermont. Earlier, Cleve mentioned the Vernon Project on the main stem of the Connecticut; I believe that it qualifies for that federal increased power production incentive by changing turbines at the facility. So we've gotten some additional power; that was a case where an incentive brought them along. I know that they wanted a very quick turn-around on their 401 and on the FERC license in order to beat the federal deadlines. Based on a recent study in Vermont, an incremental increase in existing hydro facilities probably will produce the biggest return on the dollar.

Fred Ayer: I would say that my organization has one case they love to make, and that is that the size argument is one of the worst things the policy makers are doing: to arbitrarily pick a project and say, "If it's under five megawatts, it's good, and if it's over five megawatts, it's bad." Even if it doesn't say that, it implies that. I think that anybody who has worked in the hydro field for a number of years as I have, can tell you that they can take you to two-megawatt, three-megawatt projects that are disasters. They also can take you to-I can take you-out West to some five-hundred-megawatt projects that are pretty easy on the environment, considering their size. So, size makes an easy shortcut for policy makers to say, "Oh, what's the number?" It's either five megawatts or thirty megawatts. It really doesn't get at the crux of the issue, which is the environmental side. The only way you're going to get to that is to look at a resource-based way of assessing facilities, and whether the five megawatts or another five hundred and ninety megawatts is still passing that same goal.

John Rogers: This goes back to the question in the earlier panel, "Is hydropower green?" I think the World Resources Institute has a list that sort of qualifies renewable energy, or energy options, by their impact, and incremental hydro is very high in terms of being attractive. Again, if you can do it with the existing infrastructure-no new impoundments, no new diversions of water, presumably just by upgrading-then that's an excellent option potentially at any time.

Fred Ayer: Not a big issue here, maybe, in New England, but if you go out West there are huge federal dams that have no generation attached to them, but they have flood control and water supply attached to them. So, to add generation is a fairly straightforward issue. They aren't going anywhere. Those dams are not going to be removed because they are the heart and soul of certain agricultural communities. We have to accept that. But I think if you add generation to that, you get a bigger bang for your buck. So, yeah, I'd be supportive of incremental.

Mark Smith: Anne, do you want to speak to this?

Anne George: I'll leave the environmental questions to others, but I would point out that if hydro is going to play a part in fuel diversity and in having some sort of downward affect on prices, it's going to have to be larger. You have these small hydros, and that's wonderful, but you're really trying to change the energy profile in New England, the facilities need to be larger than what we've got. Natural gas sets the price for fuel in New England most of the time. But if you're going to have a big renewable block to affect that, and hydro is going to be part of that, I don't see how all these little projects are going to add up to help with prices. I know the argument has been made at the Connecticut Legislature about that size number. I know Margaret Miner has been there plenty of times to make that argument. I think that from the legislators' point of view, picking a number was an easier, more comfortable way of dealing with the issues. But I agree with you, I've heard the argument that there are plenty of small hydro projects that aren't that great and larger ones that are much better.

Mark Smith: So I guess one conclusion is small may not always be beautiful. With that, let me open up to the floor, and get some questions for this panel. Starting here in the front, and then we'll go to the back…

Audience: I'd just like to get some of the addresses of the sites that are available.

Fred Ayer: I get ten percent.

Mark Smith: Actually, FERC actually has lists and beautiful maps of all of New England, state-by-state, with their power, current development, and potential. FERC has done all of that, or DOE has done all of that for you.

Consequences of PURPA

Audience: I was busy going to high school and college during PURPA days, so a question for Fred, or anyone else: We know PURPA generated a lot of activity. A lot of permits went

into the pipelines, some of those permits got approved, and we know that there were costs with that because we were paying seventeen cents a kilowatt hour for power when the market price was many times lower than that. The question is, did it work as public policy? Did PURPA do what it was intended to do? How much new non-oil generation came on board as a result of the kinds of incentives we're talking about now that were intended to stimulate new stuff? Maybe there are technologies that are available today that weren't available then, that will work where they didn't in the 80's. What was the experience then?

Fred Ayer: What happened during what I always referred to as the PURPA era, was that it generated a lot of paper, a lot more paper than concrete and steel. It got everyone's attention. There were a lot of unintended consequences. To my mind, PURPA is what caused the environmental community to pay attention to hydro; before that, there was not much activity. So it did lots of things. Carter's goal was to get more renewable energy out there; remember. we were in an energy crisis. I can't give you the numbers. But, for instance, in the Salmon River in Washington state, there were 510 preliminary permits bottling up one river system. I guarantee you that no more than about two of them got built.

David Deen: During the '90s, when New England was going through a fit of "electric restructuring," I did a lot of legislative work around that issue. In Vermont the alternative renewable part of the energy mix accounted for only about ten or twelve percent of the power used, but it accounted for one-third of the over-market cost, called stranded costs at that point. This was because under the PURPA, if the facility was built, the utilities had to buy the power at that marginal cost rate. So, of all the stranded costs that we were dealing with as part of restructuring in Vermont, one-third of those costs were attributable to PURPA projects. So PURPA did lead to some development, but it was really expensive power.

Mark Smith: Guest here in the front, then we'll go to the back.

Impact of the Current Bush Administration

Audience: If we can move to the political realm for a question. I don't have any clear sense of the impact of the Bush Administration on the issues we've been discussing today, and I'm wondering if any of you have any observations on that?

Mark Smith: So the question is: Over the last seven years, has there been significant change to the hydropower environment in New England or in the country? Is that your question?

Audience: Well, the environmentalists have a pretty clear picture of what, or where, the Bush Administration has been on virtually all of our issues. I don't have any sense at all of what impact the Bush Administration policy has been on the hydropower issues we've been discussing.

Mark Smith: Okay.

Fred Ayer: Very little influence. Let me say it this way: Hydro, in the national scheme, is small potatoes. It just doesn't register on the radar screen. The administration is dealing with the big energy heavy hitters: oil and coal. You can think all the hydro thoughts you want to, but one thing I can tell you, having been in this community for thirty-five years, it's a small group of people that work around and with hydro. Politically, we just don't register.

Mark Smith: The only thing I know was that there was an effort for FERC generally, I think, to give the power generators rights of appeal on conditions to the permits that they didn't like to the secretary-rights that other interveners may not have had. So there were some procedural changes to the integrated process that occurred. There were some concerns about whether they would favor one side more than the other. John, did you want to jump in?

John Rogers: That was congress, not FERC.

Mark Smith: So that was not the administration?

John Rogers: With regard to the overarching policy issues that I mentioned, the renewable electricity standard, and the climate legislation, it's not clear whether. . . I mean part of the reason the federal RES did not pass, was that it was part of the energy bill of last month. It wasn't clear if the White House would have signed it into law.

Mark Smith: I would prefer to bring this conversation back to pure public policy rather than this particular political issue. There are some policy issues that are involved with it, but just to shift the focus back. I think we want to keep it a little bit broader.

David Deen: Well, as a matter of public policy, I want to go back to caution with which I started my remarks. With an administration that is starving the natural-resource agencies, and don't have what's needed in terms of professional staff, it's nice, to have a state forum, where you can get some attention to those issues that the state is committed to, and be able to intervene around those issues that the Feds can't get into. If both of those forums fail then, in fact, there is a matter of "Go ahead and start at the agency, but we're going to Federal Court and we're going to make you uphold the law."

Mark Smith: So, checks and balances are still a good idea-that is what I'm hearing. Are there any other questions before I turn it over to Margaret? I would like to thank you all, and please help me thank our panel.

Closing Remarks

Eric Hammerling: I'm not Margaret Miner. But, Margaret asked me to lead off with some observations on themes that came up today. Then Margaret will supplement that and say some additional things. There are about ten observations that I made through the course of the day. Number one: Everyone uses Google. Many references to Google. Number two, again borrowing from Kermit the Frog: "It's not easy being green."-which I think is the appropriate And we heard about all of the hurdles to many of those who are trying to produce power in a green fashion, and those who are interested in protecting rivers in a not-green fashion, perhaps.

There are many considerations in the hydropower mix that we heard about today, from siting, to operations and management, to whether facilities are existing or new. We heard about the physics of flow and ebb, we heard about efficiency. The economic situation for producing power is always a complicated one, but a real driver. We heard about infrastructure, costs, speed, shape and thickness of blades, and that size matters. We also heard that opportunities for new hydro that would make a real difference in our carbon footprint may be limited and that perhaps the incremental improvements to existing larger facilities may represent the best bang for the buck for the state. We need to think about life cycles: of start up, sustainability, and take-down of facilities when they no longer have a use. There are many new technologies, new turbines, hydro-kinetic, and non-biological solutions that are showing promise, but it appears that they are still a ways from contributing meaningfully to the grid. There need to be more incentives for existing facilities to upgrade. We heard a bit about turtles today. Also, RPS, renewable energy incentives, and LIHI certification got a lot of play on the different sides of built-in demand for renewable energy as well as for finding ways to strike an appropriate balance. FERC got a lot of discussion today. This might be one of those, "mend it but don't end it" type of situations. FERC is certainly providing a lot of important protections for public resources, and perhaps it's serving a role in stemming that gold rush that may be coming as energy prices rise.

A final observation: No one suggested that we should build new dams. I thought that was interesting. No one said that, and I think there is some pretty broad agreement on that topic.

Margaret Miner: Thanks, Eric, and thank you all for being here. One thing that I sensed here is that we have a lot of things in flux. We have public policy in flux; we have untested technology in flux. We have moving targets; we're not sure where it's going to end. But early on, I think it was Cleve Kapala said, "We have to integrate hydro-electric policy with a general water-management policy in the state, the region, and the nation."

In Connecticut, we are extraordinarily fractioned. The people that are here in this room, each of whom has something important to say that could help us to find good solutions, probably won't see each other again. You'll go back to your separate silos. We have the DEP and the DPH. We have the Clean Energy Fund, the Connecticut Energy Advisory Board, and Connecticut Innovations. And then we have quite a few legislators, who have a few ideas about what we should do. It's a very uncoordinated system. The only venue we have right now to come together is the Water Planning Council, which consists of the commissions-the DEP, Office of Policy and Management, Department of Public Health, the DPUC-but they have kind of written general water management off their agenda. They say, "Well, we really only do water supply."

We have to integrate hydro-electric policy with a general water management policy in the state, the region, and the nation.

Those of us in the room will not be able to exchange ideas again unless we, spend another Friday in a conference, unless there's some place in this state where the policy makers and the scientists can get together and work on some good solutions. We don't have that now. Think of some public policy or legislative ways that we can bring the talents we have here to work together to solve some of these problems in terms of stream flow, hydro-electric, drinking water reservoirs-all a part of a single moving system, as Laura says, and we need a much more coordinated way of looking at this resource. So, I'm looking forward to getting a lot of special wisdom from you, and thanks for being here. School is out.

Participant Biographies

Steering Committee

Fred Ayer, Executive Director, Low Impact Hydropower Institute, has been involved with hydroelectric projects and FERC relicensing for over thirty years and worked on over seventy-five hydro regulatory projects prior to joining the Low Impact Hydropower Institute as its Executive Director in June 2003.

Highlights of his work as a consultant include: assisting the Avista Corporation (Spokane, WA) in the successful collaborative relicensing of its 790 MW Noxon Rapids and Cabinet Gorge Projects on the Clark Fork River in Montana and Idaho; advising the Catawba-Wateree Relicensing Coalition in North and South Carolina in connection with their participation in an upcoming FERC relicensing, and leading training sessions for US Forest Service and National Park Service officials on FERC relicensing. Other training-related activity includes speaking at FERC Outreach Sessions for Alternative Licensing Processes in nine states; presenting workshops on collaborative processes at the National Conservation Training Center's Hydropower Workshops in three states; lecturing regularly at a dam-removal course offered by University of Wisconsin, and chairing an international panel at a 2001 hydropower conference in Prague, Czech Republic. In March of 2007, Fred was sent by the World Wildlife Fund to present the Institute's program and criteria at a one-day seminar in Beijing.

From 1983 through 1990, he served as Director of Environmental Affairs at the Bangor Hydro-Electric Company, where he was instrumental in developing the relicensing strategy for the 13 MW West Enfield Project that included the removal of a dam in one river as mitigation for impacts on another.

Fred is a graduate of Olivet College, where he majored in art. He and his wife Elaine, and their two dogs, Lucy and Emmy, live in Portland, Maine.

Russ Cohen is a professional environmentalist and wild-foods enthusiast. He received his bachelor's degree in land-use planning from Vassar College in 1978, and a master's degree in natural resources and a law degree from Ohio State University in 1982. He has been employed by the Riverways Program of the Massachusetts Department of Fish and Game since 1988, and has served as its Rivers Advocate since 1992. Massachusetts Riverways promotes the restoration and protection of the ecological integrity of the Commonwealth's watersheds: rivers, streams, and adjacent lands. Other past employers include the Nature Conservancy; the Land Trust Alliance; the Hillside Trust, a land trust in Cincinnati, Ohio, and the Massachusetts Audubon Society. Russ has received several awards for his rivers work including an Environmental Merit Award from the U.S. Environmental Protection Agency. Russ is in his thirty-third year of teaching courses about wild edibles. He also writes articles on foraging and gives slide presentations featuring many of his favorite edible wild plants and mushrooms found in New England. Russ's foraging book, *Wild Plants I Have Known . . . and Eaten*, came out in 2004.

Konstantine Drakonakis is a Manager of New Technology Investments and Infrastructure Development at Connecticut Innovations, which administers the Connecticut Clean Energy Fund. He oversees venture-stage equity investments in clean energy, project financing for beta and alpha stage technology projects, and clean-energy infrastructure development programs for the CCEF. His project and investment experience covers the full range of renewable technologies, including fuel cell and hydrogen generation, solar and wind, hydro and tidal, and smart-grid and energy-storage technologies. Konstantine draws on his experience in environmental and civil engineering project-management and consulting to evaluate technologies for their investment potential as well as to oversee and manage operational demonstration projects. His past work specialized in hydrology and hydraulics, as well as natural resources management, planning, and restoration ecology. His expertise has been utilized on design and review of energy generation, utility and stormwater treatment, dam removals, reservoir management, water supply and utility construction, wetland restoration, residential and commercial development, and industrial park projects.

Konstantine received his master's degree in environmental management at Yale University, with a focus in industrial environmental management. He earned his civil and environmental engineering degree from the University of Vermont, and is a member of the National Civil Engineering Honors Society. Konstantine is also a co-founder of the "Cleantech in Connecticut Network".

Robert A. Gates joined FirstLight Power Resources Services, LLC as its Station Manager for the Connecticut Hydro System in November 2006. Prior to that, he worked for Northeast Utilities for twenty-five years in their hydroelectric divisions – four years at the Northfield Mt. Pumped Storage Project, seven at the Turners Falls Project, and thirteen as the Station Manager for Connecticut Hydro.

Robert is responsible for the Connecticut Hydro operations, maintenance, project engineering, environmental, safety, and regulatory aspects for ten hydroelectric stations that total 130 MW. He served for ten years as the relicensing manager for the Housatonic River Project, a development that lists the five largest hydroelectric stations in Connecticut, and is currently responsible for the relicensing of the Scotland Project. His position as Station Manager requires close relations with a myriad of non-governmental organizations and governmental agencies.

He has a bachelor's degree in civil engineering from Norwich University and an Executive M.B.A from the University of New Haven.

Eric Hammerling, Executive Director of the Farmington River Watershed Association, has an M.S. in environmental science/range management from the University of California at Berkeley, a B.A. degree in history from the University of Michigan, Ann Arbor, and sixteen years of experience with national and regional conservation organizations.

Eric is President of the Board of Rivers Alliance of Connecticut and has been the Board lead on hydropower issues with Executive Director Margaret Miner. Eric serves as FRWA's alternate representative and Treasurer for the Farmington River Coordinating Committee, an oversight committee established when the Upper Farmington River was designated as Wild and Scenic in 1994. Eric is also serving as FRWA's alternate representative to the Lower Farmington River and Salmon Brook Wild and Scenic Study Committee.

Eric was Northeast Regional Director for the National Fish and Wildlife Foundation (overseeing grants in all New England states, New York, and New Jersey), and has served as a Special Environmental Consultant to the Massachusetts Environmental Trust and the David and Lucile Packard Foundation.

Dwight Merriam, a Partner with the law firm Robinson & Cole, represents developers, local governments, landowners, and advocacy groups in land development and conservation issues. He has published over two hundred professional articles on land-use law, co-edited *Inclusionary Zoning Moves Downtown*, *Eminent Domain Use and Abuse: Kelo in Context*, co-authored *The Takings Issue*, and authored *The Complete Guide to Zoning*.

He is a Fellow and Past President of the American Institute of Certified Planners, a former Director of the American Planning Association (APA), and a previous Chair of APA's Planning & Law Division. He is also a member of the American College of Real Estate Lawyers and The Counselors of Real Estate, a Fellow of the Royal Institution of Chartered Surveyors, and teaches land-use law at Vermont Law School.

Dwight received his B.A. in sociology, *cum laude*, from the University of Massachusetts at Amherst, where he was also elected to Phi Kappa Phi. He received his Master of Regional Planning from the University of North Carolina at Chapel Hill and his J.D. at Yale Law School.

Margaret Miner has been the Executive Director of Rivers Alliance of Connecticut since 1999. The mission of Rivers Alliance is to protect all the state's waters by helping those around the state who share this goal, and by working to enact good environmental laws and regulations.

She is on the Board of the Connecticut League of Conservation Voters, and is Co-chairman of the Water Planning Council Advisory Committee, and a member of the DEP Commissioner's Policy Group on stream flow. Her awards include an EPA Environmental Merit Award for work on the Shepaug River, A Friend of the River Award from the Housatonic Valley Association, and honors from the Connecticut Fund for the Environment.

She was formerly Executive Director of the Roxbury Land Trust. Her weekend job is as an editor and writer. Her most recent publication, with her husband, Hugh Rawson, is *The Oxford Dictionary of American Quotations*.

Earl Phillips is a Partner with the law firm Robinson & Cole, and Chair of the firm's twenty-five member Environmental and Utilities Practice Group, which includes lawyers and environmental analysts. His group's practice regularly involves project and utility (e.g., energy and water facilities) siting and/or permitting, energy project structuring, negotiation of incentives and financing, crisis management, compliance counseling and risk management, and brownfields development.

Earl is widely published, and has served as Chairman of the Environmental Section of the National Institute of Municipal Law Officers as well as a member of the Executive Steering Committee of the Environmental Policies Council of the Connecticut Business & Industry Association, and the Executive Committee of the Environmental Law Section of the Connecticut Bar Association.

He graduated from Wesleyan University with a B.A., *cum laude*, having majored in Earth and Environmental Science, and earned his J.D. from the Catholic University of America. He has taught courses in environmental, water, and land use law at Wesleyan University, the University of Connecticut, and the Rensselaer Polytechnic Institute.

Mark P. Smith is the Director of the Eastern U.S. Freshwater Program for The Nature Conservancy (TNC). The Freshwater Program works with the Conservancy's fourteen state programs from Virginia to Maine to develop and implement conservation strategies to protect the natural biodiversity of freshwater systems.

Prior to joining The Nature Conservancy, Mark spent six years as the Director of Water Policy at the Massachusetts Executive Office of Environmental Affairs (EOEA). Prior to that, he spent six years with the U.S. Environmental Protection Agency in Boston as the project manager for the Casco Bay Estuary Project, part of EPA's National Estuary Program.

Panelists

Is Hydropower Really Green? Moderated by Fred Ayer

Cleve Kapala has worked for almost thirty years in the areas of energy and environmental policy, regulatory compliance, and permitting. He is the Director of External Affairs and Relicensing for TransCanada. His responsibilities have included supervision of the Fifteen Mile Falls Hydroelectric Project and Deerfield River Project relicensing efforts, which impact 369 MWs and 85 MWs, respectively, of the company's 579 MWs of conventional hydro capacity. He is also responsible for supervision of external and community affairs on the Connecticut and Deerfield rivers; statewide external affairs and legislative involvements of concern to the company in New England; management and communication of negotiation and litigation matters relating to the property taxes and plant and land assets, and leadership on certain policy initiatives of interest to the company.

Jeff Reardon was hired as New England Conservation Director for Trout Unlimited in 1999. His work for TU has included representing TU in FERC licensing proceedings for more than twenty dams in northern New England and organizing several small dam removal projects. Many of these cases have resulted in collaborative settlements with the dam owner. Since 2006, Jeff's work for TU has been devoted to coordinating design and permitting for the Penobscot River Restoration Project, an innovative project on Maine's largest river in which the Penobscot River Restoration Trust will purchase three dams, remove two of them, and decommission a third with a fish bypass channel. Other provisions allow the dam owner the opportunity to maintain nearly all of its current hydropower production on the Penobscot. Jeff is a graduate of Williams College.

John Seebach came back to American Rivers in June 2007 from the Hydropower Reform Coalition, where he had served as National Coordinator since January 2005. He now chairs the Coalition, working with large and small NGOs from across the country to make hydropower dams less harmful to fish, wildlife, and local communities. Previously, John worked as a grant writer for American Rivers, an English teacher, an interpreter, a policy analyst, and a raft guide. He has a Master's degree in International Relations, with a concentration in environmental dispute resolution, from the University of Kentucky, and an undergraduate degree in English from Davidson College.

A Kentucky native, John has been an avid hiker, canoeist, and kayaker for as long as he can remember.

Thomas A. Tarpey is President of Essex Power Services, Inc. (EPSI), as well as Executive Vice President of Essex Hydro Associates, L.L.C. (EHA), with responsibility for the overall project management of EHA's hydroelectric projects, including site evaluation; oversight of environmental and regulatory affairs; supervision of design, construction contract negotiations, construction supervision, and supervision of the operations of Essex's hydroelectric plants.

He is also a Vice President of A & D Hydro, Inc., which owns and operates two hydroelectric facilities in Massachusetts. He is a member of the Granite State Hydropower Association, and served as President of that organization from 1986 through 1990. He is a founding member and the current President of the Bay State Hydropower Association.

Before joining Essex in 1980, Tom served as a member of the staff of the New Hampshire Governor's Council on Energy. He was in the United States Coast Guard from 1969 to 1973, and graduated from Amherst College.

Mr. Tarpey enjoys sailing, skiing (low intermediate), hiking in the Sierras, and squeamishly baiting hooks for his eight-year-old son.

The Technology of Clean Hydropower Moderated by Robert Gates

Steve Amaral is a Senior Fisheries Biologist with Alden Research Laboratory, Inc., located in Holden, Massachusetts. Steve has B.S. and M.S. degrees in Fisheries Biology, both from the University of Massachusetts. Steve began his career in fish passage at the Holyoke Fish Lift on the Connecticut River, where he counted and monitored migrating anadromous fish. Prior to joining Alden, he was the Project Leader for anadromous fish technical assistance activities conducted by the Mass Cooperative Fish & Wildlife Research Unit and a biologist with Stone & Webster Environmental Services. At Stone &Webster, Steve investigated the use of fish protection and passage technologies for application at all types of water intakes. In 1994, Steve was part of a team of biologists and engineers that joined Alden to provide their clients with environmental services. At Alden, Steve has participated in numerous fish protection and passage studies conducted in the lab and field, including evaluations of behavioral deterrents, angled bar racks and louvers, barrier nets, cylindrical wedgewire screens, and the Alden/Concepts NREC fish-friendly turbine. Steve has also conducted numerous aquatic assessments for FERC Environmental Evaluations s and Environmental Impact Statements, and has served as a fish-passage expert for hydro and water intake regulatory hearings in Canada and the U.S.

Konstantine Drakonakis *See Steering Committee*.

Paul Williams is a Senior Project Manager and Vice President at Kleinschmidt Associates. He currently serves as Vice Chair of the National Hydropower Association's Research & Development Committee and is Past President of the Maine Association of Engineers. Paul received a B.S. in Civil Engineering from the University of New Hampshire, and has participated in numerous technical seminars and conferences related to hydraulic design, field performance testing, and hydraulic machinery.

Paul has over thirty years of engineering experience with a variety of energy related projects, including the planning, development, design, operations, and maintenance of hydro plants and related mechanical systems. He has conducted efficiency testing of more than seventy-five hydro turbines, performed many feasibility studies for hydro re-development, and conducted numerous analyses of alternative energy production technologies. He is currently involved in a number of new hydro capacity additions and rehabilitation projects for a variety of hydro owners.

Case Study: The Farmington River Moderated by Eric Hammerling

Duncan Broatch is President, Summit Hydropower, Inc. (SHI), and Representative, CT Small Power Producers Association. Duncan has a B.S. from the University of New Hampshire in Soil and Water Science, an M.S. from NC State University in Civil Engineering. SHI is a Connecticut corporation in business since 1983. Comprised of President Duncan Broatch, plus three employees, SHI develops, builds, refurbishes, maintains, operates, leases, and owns hydroelectric facilities. SHI's goals are to provide long-term benefits to future generations and to our environment by developing and improving hydropower projects in an environmentally responsible fashion while maintaining uncompromising standards of safety and high-quality workmanship

SHI currently owns and operates two hydro facilities located in Eastern Connecticut: Wyre Wynd Hydro and Dayville Pond Hydro. Electricity from both of SHI's sites is currently sold to the New England grid at wholesale market rates. Other electric companies buy the electricity from the grid and deliver it to their customers.

Timothy J. Anthony has held the position of Hydroelectric Supervisor for The Metropolitan District (MDC) for over eighteen years. He is responsible for overseeing the operation and maintenance of the District's two hydroelectric facilities, the 3 MW Colebrook Hydroelectric facility at the US Army Corps of Engineers' Colebrook River Lake Dam, and the 3.4 MW Goodwin Hydroelectric facility at Goodwin Dam. Both facilities are on the West Branch of the Farmington River.

Inherent with the operation of the District's hydroelectric facilities, he has the responsibility of managing and executing the river flow regulation for Goodwin Dam and MDC's responsibilities associated with the operation of the Farmington River.

Tim's prior experience includes over fifteen years in the manufacture and installation of industrial heat-treating equipment, the aviation support industry, and hydroelectric turbines. His last prior employment was with Obermeyer Hydraulic Turbines, the manufacturer of the District's Colebrook Hydroelectric equipment.

The MDC is a nonprofit municipal corporation, chartered by the Connecticut General Assembly in 1929 to provide potable water and sewerage services. Today, the MDC provides quality water supply, water pollution control, mapping, and household hazardous waste collection to eight municipalities and to portions of other towns in the Greater Hartford region.

Laura Wildman, Director of River Science, is an environmental/water resource engineer with American Rivers, who specializes in aquatic restoration and fisheries habitat. She received her B.S. degree in civil engineering from the University of Vermont in 1989, and her Masters in Environmental Management from Yale in 2004.

Prior to joining American Rivers, she served as a consulting engineer for eleven years, during which she managed many dam removal projects throughout the Northeast and in the Midwest, as well as numerous river restorations, fish habitat improvement, and low-flow analysis projects. She is a well-known expert on the topic of dam removal, speaking regularly around the nation on this subject.

Hydro Regulation Moderated by Earl Phillips

Brian J. Emerick is a Supervising Environmental Analyst at the Connecticut Department of Environmental Protection in the Office of Environmental Review. He has been employed by the DEP for approximately thirty-two years. His responsibilities related to hydropower development include the coordination of the Department's participation in the FERC's licensing process.

Bruce DiGennaro is an environmental planner and facilitator with twenty years of experience negotiating complex regulatory issues involving land, water, and energy resources. He has directed and managed large-scale water and energy projects throughout the country including: hydroelectric licensings and compliance plans; water-supply planning and policy studies; multi-party negotiations and collaborative stakeholder processes; recreation and shoreline management planning; and ecosystem restoration planning. Bruce has worked for a variety of clients, including private businesses, utilities, government agencies, and environmental organizations. He is now Managing Partner at The Essex Partnership. He received his B.S. degree in Environmental Planning and Management from the University of California at Davis.

Roger Reynolds has been directing and coordinating legal casework at the Connecticut Fund for the Environment (CFE) since 2003. He is also an adjunct lecturer at University of Connecticut School of Law, where he runs the Environmental Law Clinic and teaches Negotiation. Before coming to CFE, Roger was an Assistant Attorney General for nine years, and litigated numerous environmental, consumer-protection, and antitrust cases on behalf of the state of Connecticut. He was also a law clerk to the Honorable Richard N. Palmer and Robert J. Callahan on Connecticut's Supreme Court. Roger received his law degree from New York University School of Law, where he was an editor of the Environmental Law Journal. In 2006, Rivers Alliance of Connecticut named him Environmental Attorney of the Year.

Emerging Policy, Changing Landscapes Moderated by Mark P. Smith

John Rogers is Northeast Clean Energy Project Manager for the Union of Concerned Scientists (UCS), helping to implement a range of cutting-edge clean energy and climate policies that the organization has helped win in the region. UCS is the leading science-based nonprofit working for a healthy environment and a safer world; its Clean Energy Program focuses on encouraging the development of clean and renewable energy resources and on improving energy efficiency. John joined UCS in 2006 with fifteen years of clean-energy experience in the private and public sectors, including as co-founder of Soluz, Inc., a leading developer of clean-energy solutions for rural markets. He holds a Master's degree in Mechanical Engineering from the University of Michigan and an A.B. degree from Princeton University.

Anne C. George, a Republican, was first appointed Commissioner of the Connecticut Public Utility Control Authority on July 1, 2003. She was reappointed by Governor M. Jodi Rell to a second four-year term commencing on July 1, 2007. As Commissioner, Anne focuses on renewable energy and natural gas issues. She presided over the Department's docket creating the state's first clean-energy choice program for electricity consumers, called "CT Clean Energy Options." She currently serves as Chair of the National Association of Regulatory Commissioners' Committee on Electricity and is a member of the National Council on Electricity Policy. She is immediate Past President of the New England Conference of Public Utility Commissioners and is a member of the Leadership Group for DOE/EPA's National Action Plan on Energy Efficiency.

Prior to her service on the Authority, she served as the Governor's Special Counsel on Energy, Chief Legal Counsel, and Deputy Legal Counsel. She has a Bachelor of Arts degree from the University of Maryland at College Park and a Juris Doctor degree from Georgetown University Law Center in Washington, D.C.

David Deen has served as the River Steward for the Connecticut River Watershed Council since 1998 in the Upper Connecticut River. The River Steward is responsible for public education and advocacy about issues affecting the river and its tributaries. Since 1991, David has been an elected member of the Vermont House of Representatives, where he is currently Chair of Fish, Wildlife and Water Resources and is a member of the Local Government Committee and the House Rules Committee. He has served as Vice-chair of the Ways and Means Committee and as Chair of the Natural Resources and Energy Committee. He is also the owner and operator of *Strictly Trout* Flyfishing Guide service, the oldest professional flyfishing guide service in Vermont. He has an M.S. in Environmental Science from Antioch New England Graduate School.

Fred Ayer See *Steering Committee*

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