Estimating the willingness to pay for environmental resources in the Chilean Patagonia

Garces-Voisenat, Juan-Pedro and Mukherjee, Zinnia

Wake Forest University

1 June 2012

Estimating the Willingness to Pay for Environmental Resources in the Chilean Patagonia

Juan-Pedro Garces-Voisenat, Wake Forest University
Zinnia Mukherjee, AIER and Connecticut College

Abstract

In this paper we assess, through contingent valuation surveys, the willingness to pay (WTP) of the population for more environment-friendly sources of energy, in the context of the proposed construction of big hydroelectric dams in the Chilean Patagonia region. We use two different data samples constructed from the survey responses: (1) A sample of Chileans currently living in Chile. These are individuals who will be receiving the economic benefits that will stem from hydroelectric dams constructed in Patagonia. Their WTP reflects the "user value" of the resource to Chileans. (2) A sample of non-Chileans or Chileans living outside Chile. Their WTP reflects the "existence value" of the natural environment in Patagonia and the expected amount people are willing to pay to protect its pristine conditions. We identify the key determinants that affect the WTP estimates. We then compare this to the real costs of generating electricity with the different currently available technologies. The WTP estimate from sample 1 would provide the Chilean governments a numerical value of the contributions Chilean residents are willing to make to protect the natural environment in Patagonia. The estimate from sample 2 will indicate the contribution that the rest of the world is willing to make in order to preserve unique natural environments and wildlife in remote places of the globe. Overall, it should be a good guide for policymaking in energy matters for developing countries.

JEL classification: O1, Q2, Q4
Key words: Energy, Environment, Sustainable Development, Chile, Patagonia
(first draft: June 2012)

Special thanks to Rodrigo Navia and to Walter Fraser for their collaboration in this paper. This research has been supported by the Center for Energy, Environment and Sustainability (CEES) and by the Department of Economics at Wake Forest University.

1. Introduction

Many emerging economies find themselves today at a crossroads of their development process. They must decide how to generate the energy that they need to advance towards higher prosperity. In doing so, they will have to choose between technical alternatives that have different impacts over the ecosystem. Some of them seem to be quite damaging to the environment (thermal plants based on fossil fuels or big hydroelectric plants), but there are some more environment-friendly methods, such as solar, wind, geothermal or small-hydro generating plants.

One of these countries is Chile. The country has been increasingly using coal and natural gas powered plants to produce energy, along with hydroelectric generation. The numerous rivers that flow down from the Andes towards the Pacific Ocean provide a good source of watering for the agricultural valleys and also the potential for the generation of electricity. Traditionally, the country has exploited this potential by building big hydroelectric dams in several rivers of the central regions and also some small hydro-generating plants. Unfortunately, the rainfall is quite irregular in the central zone of Chile, which causes frequent shortages in the electrical supply. This has increased the trend towards the construction of thermal plants based on fossil fuels. But this has also encountered some problems, as Argentina –the main provider of natural gas for the Chilean power plants- has proved to be an unreliable supplier due to their own domestic problems.

In order to increase substantially the generation of electricity, the construction of five huge hydroelectric dams is being proposed in the southern region of Patagonia, on the basins of the

rivers Baker and Pascua. Patagonia is one of the most remote regions in the world and contains unique vegetal species and wildlife that would be affected by the dams. It is also home to hundreds of thousands of Chileans (including some aboriginal peoples) most of whom oppose the project, on the grounds that it would alter and severely damage their habitat. A majority of other Chileans seems to oppose it too. The only polls that have been carried out showed in 2001 that between 60 and 75% of the general population was against the construction of the Patagonian dams, even as they were aware of the need for additional electricity for the Chilean economy.

If carried out, the project would involve flooding 29 km2 of natural reserves in two river basins and building towers and transmission power lines (with 70-meter high towers) over a stretch of about 1,000 miles of pristine wildlife lands. Many environmentalists, residents of Patagonia and NGOs emphasize that this would imply altering a fragile ecosystem and endangering vegetal and animal endemic species, some of which are at risk of extinction (like the *huemul*, a Patagonian deer).

The project would be carried out by HydroAysen, a consortium composed of a Spanish-Italian multinational and a Chilean electricity company, which would reap the financial benefits of its exploitation. They have bought the water rights over the two rivers on which the dams would be built. Both the current Chilean government and HidroAysen state that the environmental impact would be minimal and restricted to the areas of the project. Hidroaysen promises to compensate this damage with the construction of other natural reserves in the vicinity of the project. The government adds that the electric power that these dams would generate is an absolute imperative for the development of the Chilean economy, based on studies carried out by their own technical agencies.

It is important to consider that the construction of these dams could open the door to the construction of ten other large-scale hydroelectric projects that are currently under study for that area.

This papers aims to make two contributions. First, from an academic perspective, we contribute to the extensive literature of valuation of ecosystems. Second, from the policy perspective, we find some evidence of the Chilean willingness to pay to preserve Patagonia's pristine state.

The personal view of the authors is that the construction of the dams would produce a substantial environmental damage, in terms of the threat to the wildlife and flora of the place, the disruption on the lives of the local communities and in the touristic potential of the Chilean Patagonia (mostly suitable for an adventure and scenic type of tourism). We believe that this type of natural capital has an intrinsic value not only for the local communities but also for the global community as a whole, as a reserve of life and nature on the Earth (just as the Amazon rainforest, for example). However, we strive to remain as unbiased as we can in the search for answers to the real questions that interest us:

i) Are there alternatives to the dams in terms of generating the energy potential that Chile needs for its developing economy?
ii) How much is the value of this natural capital, first for the people of Chile, and then for the global community at large?
iii) If this value is substantial, would people be willing to pay enough for the transition to alternative modes of energy generation?

In this study of *contingent valuation* we attempt to measure and analyze the *willingness to pay* (WTP) of people, both in Chile and abroad, for preventing the construction of these five mega

hydroelectric dams in natural reserve areas in the region of Patagonia, Chile. The main research instruments are an online survey and a statistical and economic analysis of the results of the survey. The survey asks about their willingness to pay for such purpose and some personal information which is completely anonymous. This personal information is necessary for the study, as it is used to construct the control variables which are essential in a statistical analysis like the one we are undertaking.

2. Are there alternatives?

What HidroAysen is proposing is basically expanding the energy grid of Chile with 2750 MW of installed capacity, which would generate 18430 GWh of electricity generation on average annually. This would represent 21% of the demand in the Central Interconnected System (SIC) of Chile by the year 2020, according to their own estimates (Hidroaysen, n.d.).

The installed capacity of the Chilean energy grid was 15700 MW in the year 2010, with the following modes of generation: large-scale hydro (32%), coal and diesel (32%), natural gas (32%) and others, basically mini-hydro, wind and biomass (4%). This compares rather favorably to the world shares: 65% fossil fuels, 15% nuclear, 15% hydro and 5% others (minenergia.cl, 2012). The maximum demand in Chile is currently estimated at 8000 MW, which has the system operating at slightly over 50% of its capacity.

The forms of power generation that are considered “clean” are grouped into what are called the “non-conventional renewable energies” (NCRE), and they can be obtained through wind turbines, biomass (principally poultry and pork manure and agricultural residues), geothermal

energy, solar thermal and photovoltaic, ocean tidal waves and mini-hydro plants. Nuclear energy is considered risky because it is potentially radioactive, as has been seen in the past in Chernobyl (1986) and Japan (2011). Large-scale hydro is destructive because it has to flood vast areas of land and produces alterations of the surrounding environment. Besides, it has been found to be a source of greenhouse gases (CO2 and methane), just as much as energy generated by fossil fuels (Fearnside, 2004).

There are countries which are an example in terms of generation of clean energy and utilization of NCRE: Norway has 97% of its energy grid provided by mini-hydro plants; there is one of these plants for every 5,000 people. This is a system very respectful of the environment; the water of a river simply passes through the turbines installed on its flow, generating energy, and it is returned to the river basin. Its main advantage is that you don't flood any area or alter the flow of the river in any way. In Norway, these mini-plants are combined with touristic attractions, like camping areas, parks and fishing zones.

The United States is also quickly advancing in the implementation of clean energies. At the moment it has over 10000 MW of installed wind power and 3500 MW of solar power.

Solar energy is, no doubt, the great promise of the future which is gradually becoming a reality. This is not surprising, since the sun is a source of abundant and inextinguishable energy. The sun produces much more energy than the earth can consume and it is available practically forever. The main task for human ingenuity is how to capture it, distribute it and eventually store it. There has been substantial progress to this regard in recent years. With the help of nanotechnology, the experts have already designed devices of solar energy conversion, and are achieving the goal of cheap and efficient fuel production (solar hydrogen) and electricity

production in the form of photochemical solar cells (Kamat, 2007). Production costs are quickly declining as well and approaching competitive levels. And recently they have been developing thermal storage techniques in Arizona which will allow solar power plants to operate 24 hours a day.

The main options of clean energy open for Chile are solar, wind, geothermal, biomass and mini-hydro. All of them are starting to be used in the country. A recent study by a group of experts and political and social leaders (CCTP, 2011) estimates that by 2025 the installed capacity of NCRE in Chile could be 6600 MW (more than 10 times as much as now). It also considers that the country could obtain an additional 3400 MW from improved energy efficiency. That adds up to 10,000 MW of increased installed capacity (almost four Hidroaysen projects). Fifteen years is the time that it would take to build the dams of HidroAysen; more than enough time to generate alternatives. In the longer term, they estimate that Chile has a potential of 190,000 MW of installed capacity in NCRE (about 12 or 13 times the current size of the grid).

The room for improvement in energy efficiency in Chile comes fundamentally from four areas:

a) Increase recycling (in Chile the rate of recycling is very low)
b) Issue and enforce stricter norms of thermal isolation
c) Give incentives to the use of solar panels on the roofs of the houses and buildings in Santiago, the capital, where solar radiation is usually very high throughout most of the year
d) Give incentives for the acquisition of energy-efficient equipment in the energy-intensive industry (mining, metallurgy, cellulose, petrochemicals and cement) and in government agencies

In terms of solar energy, Chile clearly has enormous comparative advantages, especially for the photovoltaic type. It has the driest desert in the world (the Atacama Desert), with close to 365 sunny days per year. This vast extension of land doesn't have many other alternative uses. It could produce solar energy not only for Chile and its neighboring mining industry but also for the rest of South America and the world, once efficient transmission techniques have been devised. The exploitation of this type of energy has already begun, with photovoltaic plaques being installed in many sites of the desert, and the mining companies taking the lead in funding these projects. The airport in Arica plans to generate 60% of its energy from solar plaques. There is even an entire village –Huatacondo- that is obtaining all its energy from a mix of wind turbines and photovoltaic plaques.

But the desert is not the only place where solar energy can be produced in Chile. In fact, all the northern half of Chile (a stretch of some 2500 km) enjoys exceptionally high amounts of solar radiation, basically due to the influence of the Humboldt current of the Pacific Ocean. There could be enormous savings for the country if houses and industries installed solar panels for their domestic and productive needs of energy. This has started, but is still not very widespread.

It is estimated that solar concentrations in Chile are producing a KWh at a cost of 10-14 cents, compared to coal (the cheapest one), which has a cost of 8-10 (without considering environmental costs). HidroAysen promises to produce hydroelectricity at 9-10 cents per KWh (Valdivia, 2011).

Chile could also follow the example of Norway, by building more mini-hydro plants on its thousands of rivers and streams that run from the Andes mountains through the width of its

territory towards the Pacific Ocean. Experts estimate that this type of plant could generate in Chile up to 10000 MW of installed capacity.

The country also has an enormous potential for geothermal energy production. The Energy Ministry (Ministerio de Energia, Chile, n.d.) estimates that Chile could produce up to 100000 MW of this type of energy. Chile has one of the largest undeveloped geothermal areas in the world, with more than 300 hot spring sites along the Andes mountains from north to south of its geography (Lahsen, Sepulveda, Rojas & Palacios, 2005). The government has already laid the foundations of future exploration by enacting a Law of Geothermal Concessions. There is some interest –especially from the mining companies of the northern part of the country-, but very little has been done so far (Lahsen et al, 2005). The current costs of geothermal generation are estimated at around 10 cents per KWh (Energy Information Administration, 2011).

Biomass and wind energy are also possible in Chile. Pontt (2008) estimates that biogas generation costs in Chile could range between 7 and 13 cents per KWh, which is an absolutely competitive range (compared to the costs of fossil fuel energy), pointing out that this type of energy could represent up to 6% of the total installed capacity. As for wind, there are already some wind farms producing energy in the Chilean territory, but certainly the southern region of Magallanes and the area close to Cape Horn (with some of the strongest winds in the world and very sparse population) could harbor great extensions of wind farms.

All these possibilities of development of different types of clean energy are certainly a great hope for the Chilean economy, if it wants to continue growing at rates of around 5% a year, as it has been doing over the last 20 years. But the transition to new modes of energy generation is not warranted. There is an unquestionable political inertia and many barriers to change. As it

happens in many other developing economies in the world (Haines et al, 2007), there are vested interests which oppose any change. Even though the technology transfer is relatively simple for a country like Chile (very open to foreign direct investment and with a relatively well educated labor force), there are still political obstacles to overcome. Unless the government takes stronger decisive action in encouraging and directing the transition to clean renewable energies, the change cannot happen.

Over the last few years, there has been in Chile a more open debate about the definition of the energy policy for the country in the future. The most important reports produced by this debate have been those of CADE (2011), the advising commission on energy formed by the government, with a rather technical approach, and CCTP (2011), the Parliamentary-Technical-Civilian Committee, formed by technical experts, civilian organizations and some members of Congress, which produced a mix of technical and political document. Both documents coincide in the need of more citizen participation in the definition of the policies. CCTP calls for local referendums on mega-projects, so that affected citizens can have a voice and eventually a power of veto over certain projects. Aparicio (2010) holds the same view, arguing that the cost of these projects to local communities have not been taken into account when deciding about them.

The CADE report assumes that energy requirements in Chile will grow at a rate of 5% per year in Chile over the near future. CCTP holds a different view, as it advocates for more energy-saving modes of production. In fact, the growth of energy consumption in Chile has outpaced the growth of GDP over the last 25 years, doubling every ten years, which suggests that there should be ample room for saving energy in the future with a more energy-efficient policy. CADE also estimates that the operating cost of the Chilean energy grid would increase by 7.6% without the

construction of the big hydroelectric plants that are considered for the next 15 years, assuming that most of the growth of the grid would be undertaken by thermal projects based on fossil fuels.

With a different point of view, CCTP believes that the whole energy system in Chile is flawed. The planning of its growth has been left entirely to the market, which has produced a high concentration in the property of the firms generating energy. This is aggravated by the fact that these companies have complete dominion of the natural resources where their projects are built. For example, under the current regime, the hydroelectric companies own the water of the rivers in which they establish their dams, as water is liable to be privatized in Chile under the law.

It is also necessary to note that the process of environmental impact assessment lacks objectivity, as it is carried out by the same private firms that are proposing to build the project. This study of environmental impact is then presented to a committee of government appointees (ministers and regional authorities), who decide on their approval without any further consultation with the people that might be affected. This is the way that the study of environmental impact for HidroAysen was approved; all within the terms that the Chilean legal system has established for these cases.

So CCTP proposes a complete reformulation of the energy policy in Chile, with greater participation of the people involved and more incentives to small projects of electric generation designed and operated by the local communities, in order to avoid the concentration of the market in the hands of big companies and multinationals. These small local generators would be distributed throughout the country, but connected to the national grid through an incorporated distributed generation system. They also suggest greater planning in the regulation of the demand

and greater incentives to residential generation as well, as they see a need to rationalize the use of energy for environmental and economic reasons (sustainability and energy efficiency).

One very important point that this study touches upon is the need to take into consideration all the costs of the different types of energy generation when evaluating their comparative convenience. Up to now, external costs are not formally taken into account. For example, they estimate that wind-generated energy produces $1.9 of external costs per MWh, while electricity generated by coal or petroleum produces $77 of external costs per MWh. They propose imposing corrective taxes proportional to external costs for the different types of energy.

Even without taking external costs into account, CCTP estimates that the average cost of a mix of NCRE for Chile would be US$92/MWh, which is much lower than the current prices of energy in the electric market of Chile.

From a more social point of view, Aparicio (2010) makes an important contribution to the debate. He focuses mainly on the enormous negative impact that he views from the construction of mega-dams over the environment and local communities. This impact takes the form of loss of forests, natural habitats and animal species, degradation of river basins, loss of fish biodiversity, wetlands, quality of the water and visual contamination, apart from the loss of their economic base for many local communities.

However, the transition from the current system to more environmentally-friendly modes of energy generation –as necessary as it seems to be- will not be easy in Chile. CCTP visualizes at least three barriers to overcome: the lack of maturity of financial markets, the lack of access of eventual new producers to networks of transmission and distribution of energy (as these are already owned by the big corporations) and the excessive administrative bureaucracy. Faced with

these barriers, the government should take a proactive stance: serve as a financial warrantor to long-term investors, guarantee the access to the grid of all potential private generators and simplify as much as possible the approval of new investment projects in NCRE. The gains at stake could be huge for the country.

We believe this section has adequately answered the first research question we had posed.

3. Related literature in contingent valuation

Researchers use stated preference methods to estimate willingness to pay for improvements in environmental quality or valuing ecosystems. Specifically, for non-market values, contingent valuation method (CVM) is commonly used. The CVM asks individuals (survey respondents) to state their willingness to pay for environment. In our survey, respondents were asked to state their willingness to pay for preserving Patagonia in its current state.

The theoretical literature on estimating willingness to pay using the contingent valuation method has focused on identifying problems with improving precision of estimates by mitigating bias that may stem from survey responses. For example, Blomquist and Whitehead (1998) and Hoehn and Randall (2002) argue that respondents who are unfamiliar with the change in environmental quality will provide willingness to pay statements that are less valid than familiar respondents.

Other uses of CVM include Cameron and Englin (1997), Cameron and James (1986), who use survey data and CVM to estimate the determinants of willingness to pay for recreational fishing days. An extensive literature exists that have used CVM to estimate willingness to pay for improvements in environmental quality such as water quality. For example, Whitehead (2003)

has estimated willingness to pay for water quality improvements in the Neuse River. Carson and Mitchell (1993) used data from a national contingent valuation survey to estimate average benefits from meeting the U.S. Clean Water Act targets. McLeod and Bergland (1999) used a double bounded method in a Bayesian framework to estimate WTP for a 25% reduction in US air and water pollution. Carlsson and Johansson-Stenman (2000) have estimated the average willingness to pay to reduce air pollution in Sweden. Vassanadumrongdee and Matsuoka (2005) employed the double bounded CVM model to measure individuals' WTP to reduce mortality risk arising from air pollution and from traffic accidents in Bangkok, Thailand.

Other studies have focused on estimating existence value. For example, Turpie (2003) provides WTP estimates for the existence of biodiversity in South Africa.

4. The survey

There are two surveys in this study. One is a survey in Spanish taken in Chile mostly among Chilean citizens, and the other one (in English) has been distributed in the United States mostly (but not exclusively) among US citizens. They are identical in the questions that they pose, but differ in the characterization of each question, according to the particular features of each country. For example, when asking about willingness to pay for preventing the construction of the Patagonian dams, the US questionnaire expresses the different optional amounts in US dollars while the Chilean one expresses them in Chilean pesos (Ch$). Both surveys are shown in the Appendix.

The survey intends to answer our second research question: How much is the value of this natural capital, first for the people of Chile, and then for the global community at large? In other

words, we are trying to find an estimate of the user value and the existence value of the resource. Eventually, this should give us an important part of the information we need for answering our third question: Is it enough? And by 'enough' we mean the monetary amount we need in order to cover the costs of the transition to more environmental-friendly types of energy. Of this cost we already have a hint from what we discussed in section 2 of this paper.

The survey has been distributed in the United States through social networks, professional and academic list-servers, class rosters, Craigslist (classified advertisements website) and personal contacts. In Chile, we have had academic collaborators distributing in their academic institutions and we have also used social networks and list-servers of professional and workers associations, as well as NGOs and citizens organizations (many of them in the Patagonia region). The distribution has been completely unrestricted and the survey made available to any person 18 years or older. In order to account for this diversity, we have included several self-identification questions in the survey (which are used as control variables in the econometric analysis).

The response rate has not been very high: roughly over 100 for each of the surveys. Moreover, many of the surveys that were responded had a low degree of completion. We are aware of the fact that this problem weakens our instrument and our final conclusions, in the hope of being able to perfect this study with a higher response rate in the future.

This research instrument (the surveys) is not entirely precise, as we cannot pretend the willingness to pay (WTP) of Chileans to be exactly the user value of the resource. Many Chileans (or Chilean respondents of this survey for that matter) will never in their lives visit Patagonia, so they will not be properly "using" its natural resources. However, we can state that a Chilean citizen is more of a user of Patagonia than a US, African or European citizen, since

Chileans own their Patagonia. On the other hand, most of them would be enjoying the benefits of hydroelectric energy eventually produced down there, so they are users by default. On the other hand, many citizens of the rest of the world might be able to visit that land, which converts them in "users". However 99% of them will never do. This doesn't prevent them from assigning a value to the 'existence' of the Patagonian ecosystem. For this reason, we assimilate their WTP to an 'existence' value of the resource, as we assimilate the WTP of Chileans to the 'user' value of the resource. They are approximate indicators, not precise values. With that caveat in mind, we can proceed.

The idea of taking this survey both in Chile and abroad responds to our belief that environmental resources are a global asset, in the sense that they provide benefits not only to the people that directly own them, but also to the global community at large in many ways, not least of them the fact that they provide a reserve of life for the whole planet. That feature of natural resources is best exemplified by the global concern about the preservation of the Amazon rainforest. Very recently, the President of Ecuador has requested some payment from the rest of the world for the country not to develop certain areas of that rainforest for commercial purposes. That request makes perfect sense, as Ecuadorians should not be the only world citizens to bear the cost of preserving natural resources which provide benefits to the whole of humanity.

In this sense, we intend here to make an estimate of the WTP of all citizens of the world to preserve Patagonia. All who benefit from the existence of a natural resource should be liable to bear the cost of its preservation. Naturally, this begs for some qualifications. Here non-Chileans are being asked about their WTP for only one natural resource (Patagonia). Probably, if they were asked what is their total WTP for all the valuable natural resources of the world, the amount

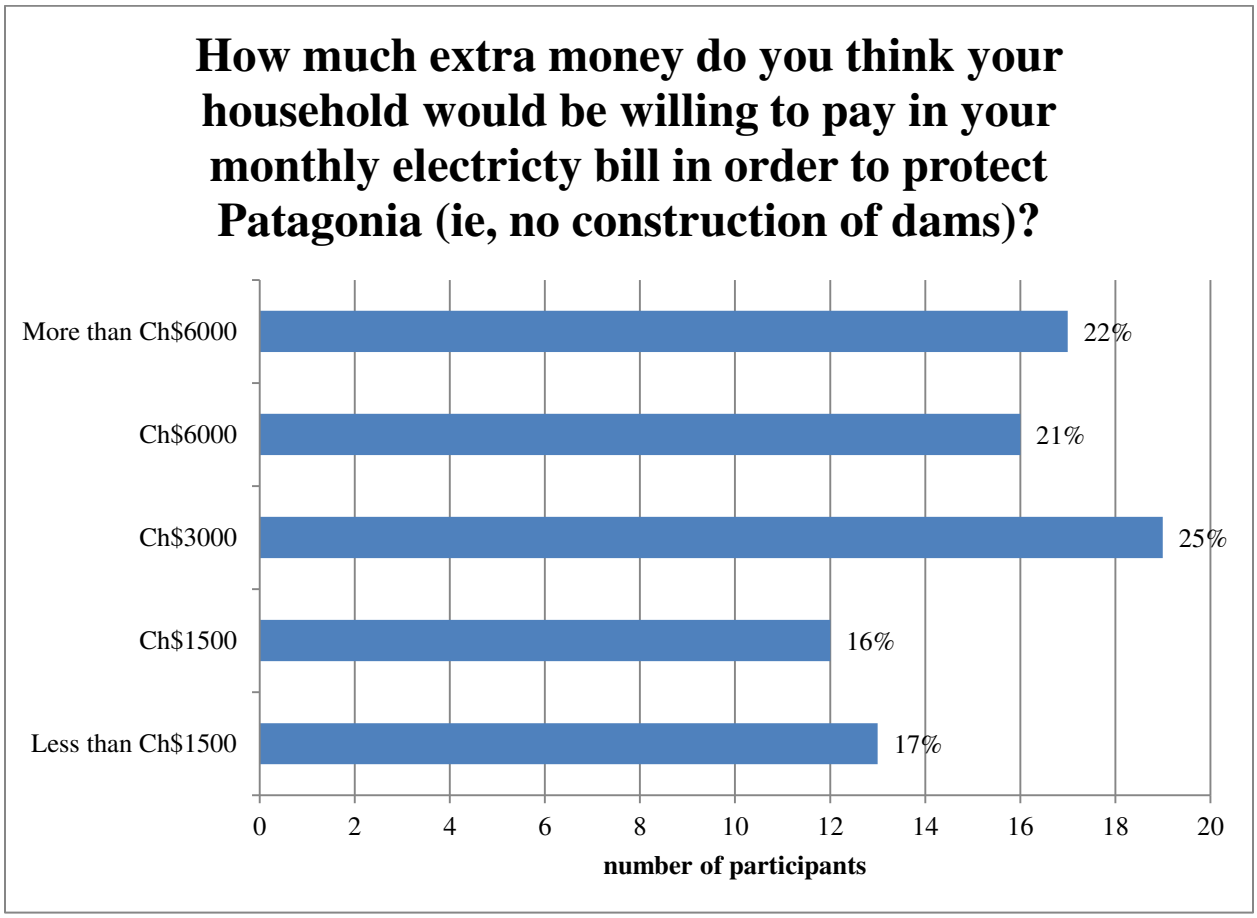
allotted to Patagonia would be somewhat smaller. This suggests that the responses to the Chilean survey are a more valuable information than the ones of the other survey.

The main question in the survey is: “How much extra money do you think your household would be willing to pay in your monthly electricity bill in order to protect Patagonia (ie, no construction of dams)?” This is the question that provides us with the WTP of people both in Chile and in the rest of the world. The rest of the questions (or control variables of the analysis) are eleven and refer to the following characteristics of the respondents:

a) Energy bill and housing costs as a percentage of the monthly budget
b) Nationality and place of residence
c) Age, gender, income and educational level
d) Political and religious preferences
e) Occupation

The responses to the Chilean survey are presented below:

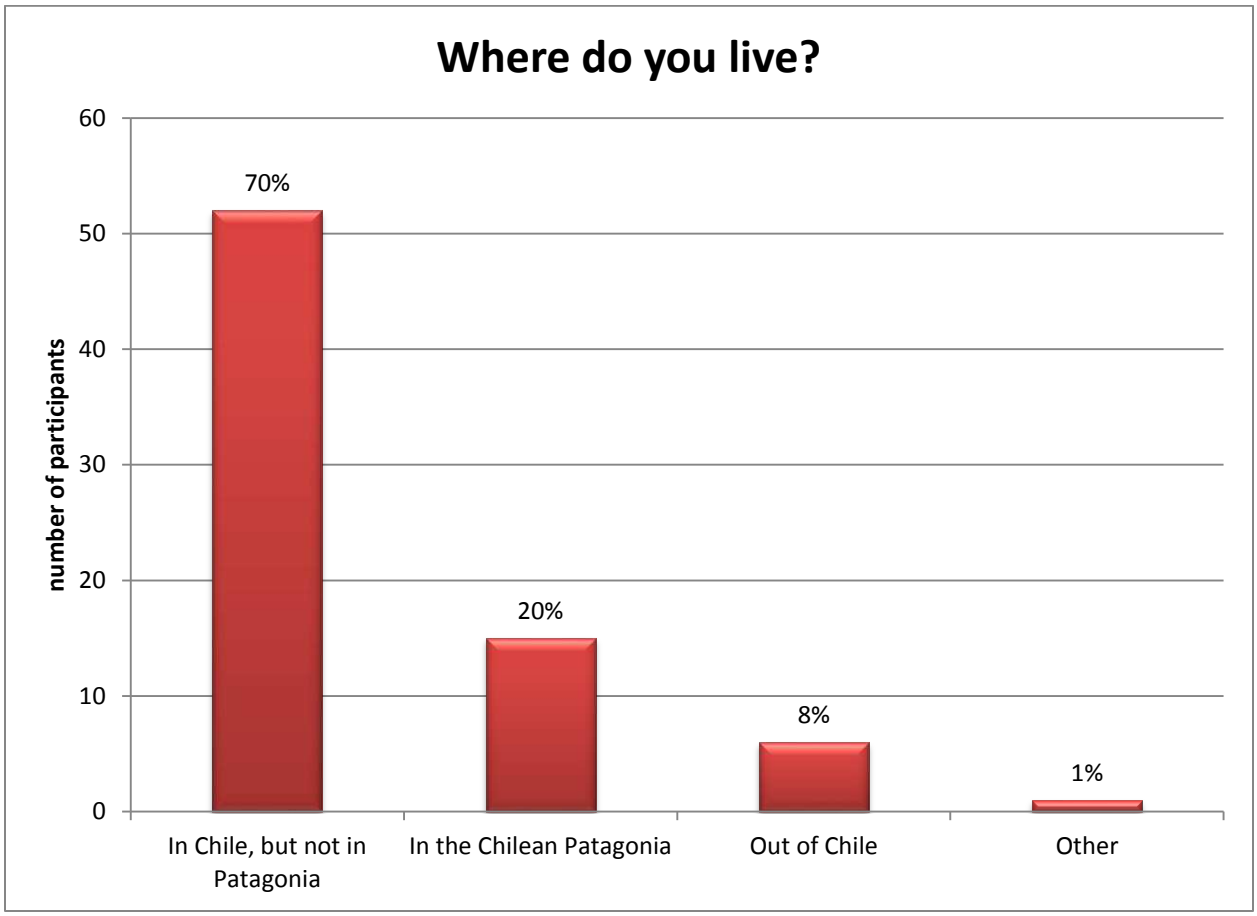
Chart 1



Exchange rate May 2012: US$1 ≈ Ch$500

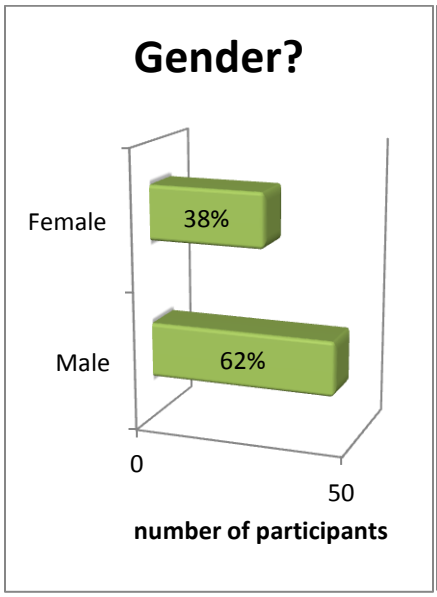
For the first question (chart 1), it appears that a majority of Chilean households would be willing to pay at least 6 dollars every month for preserving the natural resources of Patagonia, and as many as 43% would be willing to pay 12 dollars or more per month.

Chart 2



96% of the respondents are Chilean (not shown in these graphs), but only 92% live actually in Chile (Chart 2). This is still a good representation of a Chilean sample. Quite interestingly, 20% of the respondents live in Patagonia itself, which gives greater validity to our sample.

Chart 3 **Chart 4**



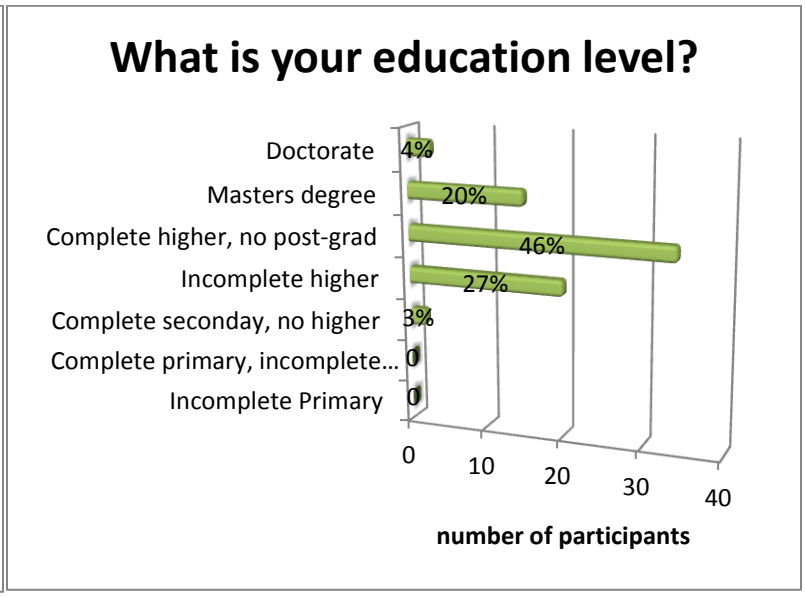


Chart 3 shows that the sample is somewhat skewed towards male participants, which could introduce some bias in the results. Another source of potential bias is the educational level of the sample (Chart 4). A majority of the participants in the sample has complete higher education or more, in a country where the average years of schooling are 10.

Chart 5

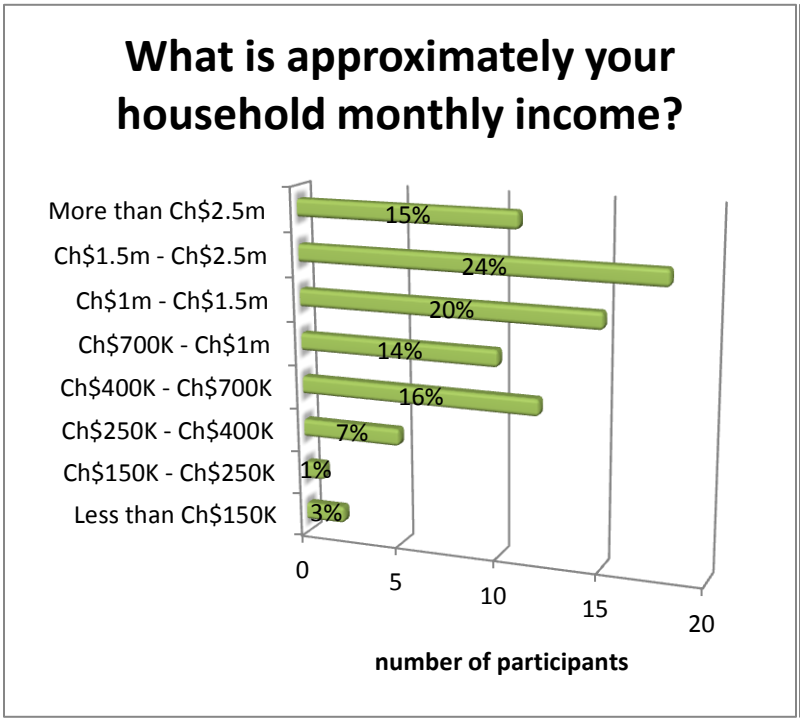
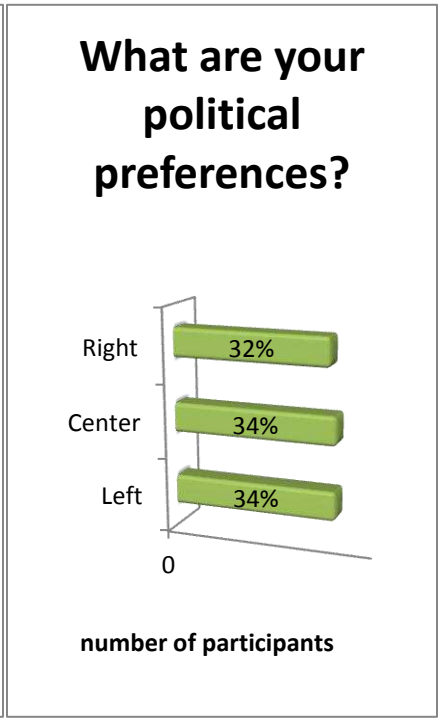


Chart 6



In terms of income, Chart 5 shows that our sample could be fairly representative for a country in which nominal GDP per capita is around US$15,000 in 2012 (considering an average household size of 4 persons and an exchange rate of Ch$500 per US dollar). Chart 6 shows political preferences perfectly divided into three thirds, which corresponds more or less to the political reality of Chile. In terms of age (Chart 7), the sample appears slightly skewed towards the group of 20-29 years of age, but the age pyramid in Chile is also thicker in the segment 20-40. Perhaps the sample under-represents the 30-39 segment, but is otherwise fairly representative of the demographic structure of the country. Finally, Chart 8 shows the responses of the question about religious beliefs. The question might be too specific for capturing the basic religious stance of the respondents of the sample, but all in all gives a fairly accurate picture of the independent-minded Chilean population, 85% of whom profess (loosely) some type of Christian faith.

Chart 7

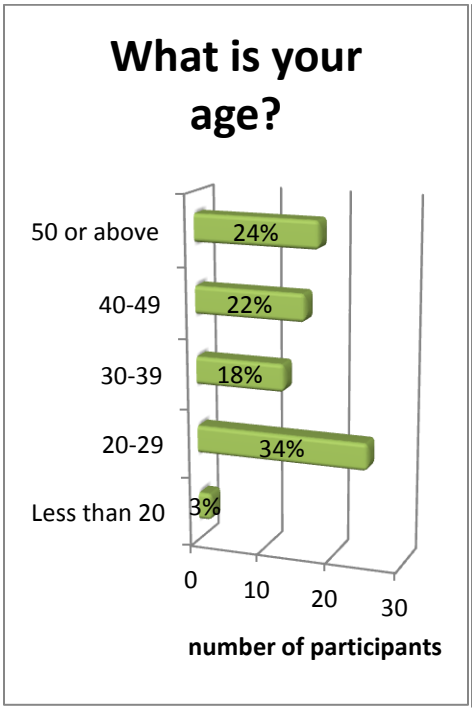


Chart 8

For 93% of the respondents, their energy bill (electricity plus transportation) represents less than 20% of their budget. Housing costs are less than 40% for the great majority (64%). As for their occupations, there is a wide variety (engineers, pensioners, manual workers, students, farmers, businessmen, educators, designers, lawyers, etc.), with no clear predominance of any single one, and students representing 22% of the sample (biggest group).

In the US survey, the responses are not much different. 68% of the respondents say their household would pay an amount between $5 and $20 per month to protect Patagonia. 18% would pay less than 5 dollars, and 10% would pay more than 20. 91% of these people live in the US and 81% of them are US citizens, with the remainder being Asian (6%), European (5%), African (1%) and other (4%). In this sample, the segment 20-29 years of age is clearly over-represented (47%), with the rest representing their normal share in the population pyramid. Liberals are also slightly over-represented (43%), while moderates are 36% and conservatives 21%. In the gender distribution there is a slight male predominance (58 to 42%), which makes this sample more

balanced than the Chilean one. In terms of education, only 1% never attended college, 32% have incomplete college and 22% finished college, but have no post-graduate degrees. 45% of the sample has some kind of post-graduate degree (probably over-represented).

The annual household income of the US sample is very evenly distributed between US$15K and US$200K. Only 15% has an annual income of less than US$15K and 12% makes more than US$200K. Finally, religious beliefs are stronger than in the Chilean sample. 36% strongly agree with the statement about the existence of God and the creation of the universe, while only 28% disagree or strongly disagree. In this sample the range of occupations has less variety than in the Chilean sample. Students predominate (51%); there is a good representation of college professors as well (19%).

In order to extract some conclusions about what determines the WTP in the Chilean sample, we have done some very simple OLS regression analysis with the Chilean sample (with the limitations imposed by the small size of the sample). Although this does not directly affect the responses to our research questions, it is interesting to have some indication as to whether the personal characteristics of the respondents affect their WTP. For that purpose, each one of the categories of the different questions takes a numeric value in ascending order, starting from 1. For example, in question 1:

1 – less than Ch$1500
2 – Ch$1500
3 – Ch$3000
4 – Ch$6000
5 – more than Ch$6000

Nationality and place of residence are excluded from the analysis because there is hardly any variation in those answers. All the other answers are ordered in ascending order, with political

preferences going from left to right (in that order), gender from male to female and religious beliefs from "strongly agree" to "strongly disagree.

The results of the OLS regression analysis are presented in the following table.

Table 1: The explanatory power of demographic characteristics on WTP
(dependent variable: WTP) [P-values in brackets]

	reg-1	**reg-2**	**reg-3**	**reg-4**	**reg-5**	**reg-6**	**reg-7**	**reg-8**
encost	0.41							
	[0.238]							
houscost	-0.12							
	[0.700]							
age	0.12	0.14	0.13	0.10	0.11			
	[0.421]	[0.361]	[0.384]	[0.482]	[0.434]			
polit	-0.20	-0.15	-0.17	-0.21	-0.16	-0.14	-0.14	
	[0.285]	[0.423]	[0.352]	[0.263]	[0.373]	[0.451]	[0.444]	
gender	0.35	0.35	0.36					0.28
	[0.340]	[0.337]	[0.309]					[0.389]
educ	-0.19	-0.22	-0.23	-0.24	-0.22	-0.16		
	[0.465]	[0.350]	[0.312]	[0.296]	[0.327]	[0.435]		
income	0.11	0.09	0.06	0.07				
	[0.428]	[0.496]	[0.655]	[0.541]				
relig	0.05	0.12						
	[0.736]	[0.378]						
cons	2.48	2.80	3.46	4.04	4.24	4.25	3.48	2.83
	[0.123]	[0.058]	[0.005]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]
# of obs	69	69	70	71	71	71	71	73
R^2	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01
Adj-R^2	-0.05	-0.04	-0.03	-0.03	-0.02	-0.01	-0.01	-0.00

Note: All regressions have been estimated with robust standard errors.
Meaning of the variables:
Encost: energy cost as a percentage of the household budget
Houscost: housing costs as a percentage of the household budget
Age: age of the respondents
Polit: political preferences of the respondents
Gender: gender of the respondents
Educ: educational level of the respondents
Income: monthly income of the household
Relig: religious preferences of the respondents

These results are astoundingly disappointing. They are basically telling us that none of the demographic characteristics of the respondents influences their willingness to pay, not even their level of income. Only the constant is significant for most of the regressions. It is possible, but other explanations should be explored. For example, the sample size is still very small (around 70). Secondly, the explanatory variables could be organized in a different way, perhaps using average monetary values instead of categorical indexing numbers.

However, the lack of explanatory power of the demographic characteristics of the population cannot be completely discarded. Perhaps the appreciation of environmental resources is a value that is highly universal or transversal, cutting across different types of people with diverse income, nationality, political or religious beliefs, etc. It might respond more to the aesthetic preferences of people, which are a characteristic of the spirit and less affected by material conditions or even ideological beliefs.

In any case, the responses to the survey (in particular, to the first question of the survey) have provided a preliminary answer to the second research question we had posed, the one about the value that people give to the environmental resources of Patagonia. It is preliminary, because a bigger and more diversified sample (for example, in terms of the educational level) would be desirable for a more categorical conclusion in that sense. However, in the hope of obtaining that more complete sample in the future, we can still observe a certain trend in the results.

The average for the willingness to pay in the Chilean sample ("user" value) is around Ch$4000 (US$8) per month per household. The lack of diversity of the sample in certain demographic characteristics could bias the results in any direction, so we have no reason to change this estimated value. Considering that the average size of the Chilean household is 3.6 persons (Oyarzun, 2008) in a country with a population of 17 million, the 4.7 million households could

be contributing an additional 450 million dollars annually to the operation of the energy system of Chile. This estimate provides an answer to our second research question.

Just for completion, it is necessary to remember that citizens of the global community are also willing to pay something to reserve the environmental resources of Patagonia. According to our survey, that WTP is around US$9 per month per household in the United States. Probably the real figure is somewhat lower, considering the high proportion of students in our sample.

5. By way of conclusion: Is this enough?

We are now in condition of answering the third question we had posed: Is the WTP of Chileans (and eventually of the citizens of the rest of the world) enough to finance a more costly type of generation of energy among the alternatives offered by the wide range of NCRE?

If Hidroaysen would be producing (sometime after 2020) 18,430 GWh per year (1 GWh = 1 million KWh), then the 450 million dollars of the Chilean households would be able to finance up to a difference of 2.4 cents per KWh of a cleaner but eventually costlier production technology.

It seems this WTP could be marginally enough (at the current estimated costs) to substitute HidroAysen with some type of NCRE. The cost of HidroAysen electricity is 9-10 cents per KWh, while the cost of geothermal energy would be around 10 and the cost of solar energy for Chile in the range of 10-14. It seems clear that geothermal projects could certainly substitute for Hidroaysen, with the difference in cost being absorbed by slightly higher fares to be paid by "willing" consumers. As regards solar energy, as long as the costs could be kept in the lower half of the cost range, the difference in cost could also be financed entirely by the WTP of the

Chilean households. It is important to remark as well that the costs of solar energy generation are currently decreasing worldwide due to new technologies being developed. So it is not too far-fetched to think that they might eventually become totally competitive with hydroelectric generation over the next few years (perhaps the number of years that would take to build the dams of HidroAysen).

Even though in the case we have studied, the user value (the WTP of Chileans) seems to be enough to preserve an ecosystem, it is important to take into account that these ecosystems are global assets, and eventually it is important to consider the existence value of the resource before deciding about its use. In the case of the Chilean Patagonia, we have been able to measure a substantial existence value for those lands of the southernmost tip of the world. Even if Chilean households had revealed a lower WTP than the cost differential of the different types of energy, the opponents of HidroAysen could still make the case against the construction of the dams, by appealing to the global value of those environmental resources.

When environmental resources of a country have a universal value, the whole global community has a responsibility to preserve them, and developing countries who own them should be able to receive the financial support that they require in order to maintain them.

This study is only a very preliminary approach to the problem, and has aimed at proposing a valid method for evaluating the convenience of different modes of energy generation, especially as a guide for developing countries in their search for energy and environmental protection. Possible refinements include an expansion and diversification of both the Chilean and the international samples. A possible extension is also the study of the determinants of the willingness to pay for environmental resources, of which here we have only given a hint.

References

Aparicio, H. (2010). Expresiones socio-culturales y practicas económicas arraigadas en la identidad local. Universidad de Concepcion.

Blomquist, G. & Whitehead, J. (1998). Resource Quality Information and Validity of Willingness to Pay in Contingent Valuation. *Resource and Energy Economics*, 20, 179-196.

CADE (2011). Comision Asesora para el Desarrollo Electrico.

Cameron, T., & Englin, J. (1997). Respondent Experience and Contingent Valuation of Environmental Goods. *Journal of Environmental Economics and Management*, 33(3), 296-313.

Cameron, T. and James, M. (1986). The Determinants of Value for a Recreational Fishing Day: Estimates from a Contingent Valuation Survey. Discussion Paper #405, Department of Economics, University of California, Los Angeles.

Carlsson, F. & Johansson-Stenman, O. (2000). Willingness to Pay for Improved Air Quality in Sweden. *Applied Economics*, 32(6), 661-69.

Carson, R. and Mitchell, R. (1993). The Value of clean water: The public's willingness to pay for boatable, fishable, and swimmable quality water. *Water Resources Research*, 29(7), 24-25.

CCTP (2011). Chile necesita una gran reforma energética.

Energy Information Administration (2011). Annual Energy Oulook 2011.

Fearnside, P. M. (2004). Greenhouse gas emissions from hydroelectric dams: controversies provide a springboard for rethinking a supposedly "clean"energy source. An editorial comment. *Climatic Change*, 66(1), 1–8.

Haines, A., Smith, K., Anderson, D., Epstein, P., McMichael, A., Roberts, I., Wilkinson, P., Woodcock, J., & Woods, J. (2007). Policies for accelerating access to clean energy, improving health, advancing development, and mitigating climatic change. *The Lancet*, 370(9594), 1264-1281.

Hidroaysen. (n.d.). Retrieved May 26, 2012, from http://www.hidroaysen.cl/

Hoehn, J. & Randall, A. (2002) The Effect of Resource Quality Information on Resource Injury Perceptions and Contingent Values. *Resource and Energy Economics*, 24, 13-33.

Kamat, P. V. (2007). Meeting the Clean Energy Demand: Nanostructure Architectures for Solar Energy Conversion. *Journal of Physical Chemistry C*, 111(7), 2834–2860. doi:10.1021/jp066952u

Kennedy, D. (2009). Alternative Sources of Energy.

Lahsen, A., Sepúlveda, F., Rojas, J., & Palacios, C. (2005). Present Status of Geothermal Exploration in Chile. Universidad de Chile, Departamento de Geologia and Empresa Nacional del Petroleo (ENAP).

McLeod, D. & Bergland, O. (1999). Willingness to pay estimates using the double bounded dichotomous choice contingent valuation format: a test for validity and precision in a Bayesian framework. *Land Economics*, 75(1), 115-125.

Ministerio de Energia Chile (n.d.). Antecedentes sobre la matriz energética en Chile y sus desafíos para el futuro. Retrieved May 26, 2012, from http://www.minenergia.cl/

Oyarzun, E. (2008). Familia.

Pontt, J. (2008). Potencial de biomasa en Chile. Universidad Tecnica Federico Santa Maria.

Turpie, J. (2003). The existence value of biodiversity in South Africa: how interest, experience, knowledge, income and perceived level of threat influence local willingness to pay. *Ecological Economics*, 46(2), 199 – 216.

Valdivia, R. (2011). La otra cara de Hidroaysén. Retrieved May 31, 2012, from http://www.centralenergia.cl/2011/05/26/la-otra-cara-de-hidroaysen/

Valgesta Energia (2011). Impacto de las energías renovables en la operación del sistema.

Vassanadumrongdee, S. & Matsuoka, S. (2005). Risk perceptions and the value of statistical life for air pollution and traffic accidents: evidence from Bangkok, Thailand. *Journal of Risk and Uncertainty*, 30 (3), 261–287.

Whitehead, J. (1995). Willingness to Pay for Quality Changes: Comparative Statics and Theoretical Interpretations of Empirical Results," *Land Economics,* 71, 207-215.

Appendix: The surveys

Chilean Survey (Spanish)

El gobierno de Chile ha dado su aprobación técnica al proyecto de generación de energía hidroeléctrica HidroAysén, que implicaría la construcción de cinco represas en la Patagonia chilena, una de las mayores reservas naturales del planeta. El proyecto sería llevado a cabo por un consorcio de corporaciones multinacionales, el cual obtendría los beneficios financieros de su operación.

Más información sobre este proyecto se puede encontrar en los siguientes enlaces (uno en castellano y dos en inglés):

http://es.wikipedia.org/wiki/HidroAys%C3%A9n

http://news.nationalgeographic.com/news/2010/05/photogalleries/100512/photos-patagonia-rivers-dams/#/patagonia-chile-dams-freshwater-rivers-rave-lake_20178_600x450.jpg

http://www.msnbc.msn.com/id/42965306/ns/world_news-world_environment/t/chiles-patagonia-get-dams-wild-rivers/#.TqgOoHKZTF8

Si se lleva a cabo, el proyecto conllevaría la inundación de 29 kilómetros cuadrados de reservas naturales en las cuencas de dos ríos (Baker y Pascua) y la construcción de torres y líneas de transmisión eléctricas a través de un trazado de alrededor de 1500 kilómetros de tierras de prístina vida silvestre. Sus opositores enfatizan el hecho de que esto implicaría alterar un ecosistema frágil y poner en peligro la existencia de especies vegetales y animales endémicas, algunas de las cuales ya están bajo riesgo de extinción (como el *huemul*, símbolo nacional). Estos opositores (ambientalistas, residentes de la Patagonia y ONGs) señalan que el proyecto causaría un daño irreparable a una de las más bellas reservas naturales de la biósfera terrestre (ver fotos adjuntas). De acuerdo a estudios realizados por organizaciones conservacionistas, sólo la construcción y los caminos de acceso impactarían seis parques nacionales, once reservas nacionales, veintiséis sitios de conservación prioritaria, dieciséis áreas de pantanos y 32 áreas de conservación protegidas privadas. Además impactaría a seis comunidades tribales del pueblo *Mapuche*.

Aquí se pueden ver videos de los opositores del proyecto:

http://www.youtube.com/watch?v=92PdJ_nowng&feature=youtu.be

http://rioslibres.com/?p=386

El gobierno y las corporaciones a cargo del proyecto señalan que el impacto ambiental sería mínimo y estaría restringido a las áreas del proyecto mismo. Además, afirman que la energía

eléctrica que estas represas generarían es un *imperativo absoluto* para el futuro desarrollo de la economía chilena, basándose en estudios llevados a cabo por las instituciones asesoras del gobierno en materias de energía:

http://www.minenergia.cl/ministerio/noticias/generales/laurence-golborne-expuso-sobre-los.html

http://www.hidroaysen.cl/atributos-y-mitos/

Por otro lado, comisiones técnicas independientes (como la Comisión Ciudadana Técnico-Parlamentaria para la Transición hacia un Desarrollo Eléctrico Limpio, Seguro, Sustentable y Justo, integrada por organizaciones ciudadanas, miembros del Congreso Nacional y especialistas chilenos en energía) han establecido que aun cuando es verdad que el país necesita más energía para su adecuado funcionamiento, también hay algunas fuentes alternativas que pueden ser exploradas, probablemente a un costo mayor (ignorando el costo del daño que el proyecto de las cinco represas impondría sobre el medio ambiente y las comunidades afectadas). Estudios recientes difieren acerca de la magnitud de este incremento de costos. Una de estas fuentes es la energía solar. El país tiene uno de los mayores potenciales en el mundo para generar energía solar, particularmente en el desierto de Atacama con sus más de 360 días anuales de sol. Y es precisamente la industria minera, concentrada mayormente en torno a ese desierto y distante miles de kilómetros de la Patagonia, la que necesitará la mayor cantidad de energía en Chile en las próximas décadas. La tecnología para la generación de energía solar está avanzando rápidamente y haciéndose más barata cada día. La Comisión Ciudadana mencionada más arriba ha sugerido recientemente ("Chile necesita un gran reforma energética", Santiago, octubre 2011) que una mezcla de energías renovables no-convencionales (incluyendo solar, biomasa, geotérmica, eólica e hidroeléctricas de pasada) no sería operacionalmente más cara que la modalidad actual (fundamentalmente basada en combustibles fósiles), y ciertamente ahorraría la necesidad de construir las mega-centrales en la Patagonia. Más aun, el mismo estudio calcula que simplemente incrementando la eficiencia en el uso de energía durante los próximos treinta años, los ahorros de energía podrían ser mayores que la electricidad generada por el proyecto de la Patagonia, y que el país podría cubrir su necesidad de energía teniendo en cuenta el crecimiento potencial de la economía.

http://www.flickr.com/photos/jorgeleoncabello/collections/72157626196641904/

El gobierno se ha mostrado reticente a dar luz verde al inicio de la construcción del proyecto, fundamentalmente porque observa que existe una oposición ciudadana significativa al mismo, principalmente por parte de los mismos residentes de la región de Aysén, donde estarían ubicadas las represas. Algunos de estos han interpuesto recursos de nulidad ante los tribunales de justicia, los cuales están siendo considerados actualmente por la Corte Suprema.

En cualquier caso, parece que la transición a cualquier modo alternativo de generación de energía podría resultar algo costosa en el corto plazo, aun cuando – de acuerdo a los estudios independientes aludidos – promete significativas ventajas de costos en el futuro y evita lo que

algunos consideran la destrucción de un valioso capital natural. A fin de comparar legítimamente los costos del proyecto HidroAysén con los de sus alternativas, el costo eventual del daño ambiental del proyecto debe ser tomado en cuenta. Esto es precisamente lo que este estudio pretende hacer. Específicamente, este cuestionario nos permitirá estimar el valor de preservar el medio ambiente natural de la Patagonia en su forma actual, evaluando la voluntad de pago por parte de los consumidores de energía. El verdadero costo del proyecto puede ser entonces calculado como el costo monetario más el costo del valor que tiene para los usuarios afectados la preservación del medio ambiente en la Patagonia. Contestando las preguntas de esta encuesta, usted nos ayudará a determinar cuánto está la gente dispuesta a pagar para evitar la construcción del proyecto, o puesto de una manera más técnica, el valor de uso o de existencia de este recurso natural (según sea usted residente, visitante o no de la Patagonia) para ciudadanos de Chile y del resto del mundo. Estamos muy agradecidos por su participación en esta encuesta.

Suponga que las represas serán construidas a menos que el 80% de los encuestados estén dispuestos a pagar una cierta cantidad de dinero que financie la transición desde energías convencionales a no-convencionales. Teniendo en cuenta esto y el escenario descrito más arriba, por favor responda las siguientes preguntas:

Cuánto dinero extra cree usted que está dispuesto a pagar su grupo familiar en la cuenta mensual de electricidad a fin de proteger la Patagonia (o sea, evitar la construcción de represas)?

a) Menos de $1500
b) $1500
c) $3000
d) $6000
e) Más de $6000

Qué parte de su ingreso mensual es su costo de energía (electricidad más transporte)?

a) Menos del 10%
b) Entre 10 y 20%
c) Más de 20%

Qué parte de su ingreso mensual es su costo habitacional (arriendo, hipoteca, etc.)?

a) Menos de 20%
b) Entre 20 y 40%
c) Más de 40%

Por favor provea la siguiente información anónima:

Dónde vive usted?

a) En Chile, pero no en la Patagonia
b) En la Patagonia chilena
c) Fuera de Chile

Cuál es su nacionalidad?

a) Chilena
b) Otra

Cuál es su edad?

a) Menos de 20
b) 20-29
c) 30-39
d) 40-49
e) 50 o mas

Cuáles son sus preferencias políticas?

a) Izquierda
b) Centro
c) Derecha

Sexo: □ Masculino □ Femenino

Cuál es su nivel educacional?

a) Primaria incompleta
b) Primaria completa, pero sin secundaria completa
c) Secundaria completa, pero sin educación superior
d) Educación superior incompleta
e) Educación superior completa, pero sin post-grado
f) Post-grado completo (master o doctorado)

Cuánto es aproximadamente el ingreso mensual de su grupo familiar?

a) Menos de $150 mil
b) $150 mil - $250 mil
c) $250 mil - $400 mil
d) $400 mil - $700 mil
e) $700 mil - $1 millón
f) $1 millón - $1,5 millón
g) $1,5 millón - $2,5 millones
h) Más de $2,5 millones

Cuán de acuerdo está usted con la siguiente afirmación: "Creo en Dios y creo que El creó el universo y el mundo"?

a) Muy de acuerdo
b) De acuerdo
c) No sé / Indiferente
d) En desacuerdo
e) Muy en desacuerdo

Cuál es su profesión u ocupación?.....

"Confirmo que mi participación en esta encuesta ha sido completamente voluntaria. Además, comprendo que es totalmente anónima y que no puedo derivar ningún beneficio sustancial directo de ella ni sufrir ningún daño o menoscabo a causa de mi participación."

a) De acuerdo
b) En desacuerdo

US Survey (English)

The government of Chile has given its technical approval to a project of hydro-electric energy generation that would entail the construction of five dams in the southern region of Patagonia, one of the major natural reserve areas of the planet. The project would be carried out by a consortium of multinational corporations, which would reap the financial benefits of its exploitation.

More information on this project can be found below:

http://news.nationalgeographic.com/news/2010/05/photogalleries/100512/photos-patagonia-rivers-dams/#/patagonia-chile-dams-freshwater-rivers-rave-lake_20178_600x450.jpg

http://www.msnbc.msn.com/id/42965306/ns/world_news-world_environment/t/chiles-patagonia-get-dams-wild-rivers/#.TqgOoHKZTF8

http://en.wikipedia.org/wiki/HidroAys%C3%A9n

If carried out, the project would involve flooding 29 km2 of natural reserves in two river basins and building towers and transmission power lines over a stretch of about 1,000 miles of pristine wildlife lands. Its opponents emphasize that this would imply altering a fragile ecosystem and endangering vegetal and animal endemic species, some of which are at risk of extinction (like the *huemul*, a Patagonian deer). These opponents (environmentalists, residents of Patagonia and NGOs) say it would cause irreparable damage to *one of the most beautiful natural reserves of the*

earth's biosphere (see pictures attached). According to studies of some preservation movements, just the construction and access roads will impact six national parks, eleven national reserves, twenty-six conservation priority sites, sixteen wetland areas and thirty-two privately owned protected conservation areas. This is in addition to six tribal communities of the aboriginal *Mapuche* people.

See videos by opponents of the project:

http://www.thecleanestline.com/rios-libres/

The government and the corporations involved hold the view that the environmental impact would be minimal and restricted to the areas of the project. In addition, they state that the electric power that these dams would generate is an absolute "imperative" for the future development of the Chilean economy, based on studies carried out by the energy agencies of the government.

http://translate.google.com/translate?hl=en&sl=es&u=http://antiguo.minenergia.cl/minwww/opencms/02_Noticias/index/noticia_detalle.jsp%3Fnoticia%3D/02_Noticias/10.0.1.6.noticias_anteriores/f_noticia_16_06_2011.html%26nom%3D&ei=ID9AT9uANo_MtgfOpsG6BQ&sa=X&oi=translate&ct=result&resnum=1&ved=0CCQQ7gEwAA&prev=/search%3Fq%3Dhttp://www.minenergia.cl/ministerio/noticias/generales/laurence-golborne-expuso-sobre-los.html%26hl%3Den%26prmd%3Dimvns

On the other hand, independent technical committees (like the Citizens Technical-Parliamentarian Committee for the Transition to a Clean, Safe Sustainable and Fair Electrical Development, integrated by NGOs, Congress members and energy specialists in Chile) have established that while it is true that the country is in need of more energy for its adequate functioning, there are also some alternative sources that could be explored, probably at a higher cost (ignoring the cost of the damage the five-dams project would impose on the environment and aboriginal communities), although recent studies differ regarding the magnitude of the increase in costs. One of those sources is solar energy. The country has one of the greatest potentials in the world of generating solar energy in the northern part of the country, and particularly in the Atacama Desert, with its average of 360+ sunny days per year. And it is precisely the mining industry, close to this desert and thousands of miles away from Patagonia, the one which will need the greatest amount of energy in Chile over the next few decades. The technology for solar energy generation is quickly advancing and getting cheaper every day. The Citizens Committee mentioned above has recently suggested ("Chile needs a great energy reform", Santiago, October 2011) that a mix of non-conventional renewable energies (including solar, biomass, geothermal, wind and small-hydro) would not be operationally more expensive than the present more fossil-fuel oriented mode of generation, and would certainly spare the need of building the mega-dams in Patagonia. Moreover, they have calculated that just by increasing the efficiency in the use of energy over the next thirty years, the energy savings would be larger

than the power generated by the Patagonian project and the country would be meeting its energy needs given the potential growth rate of the economy.

http://www.flickr.com/photos/jorgeleoncabello/collections/72157626196641904/

The final political decision by the government to go ahead with the project is still pending and has been delayed by significant national and international opposition to it, most notably by the residents of the Patagonian region, some of whom have taken court action to nullify the project. Their petitions are currently under consideration by the Supreme Court.

In any case, it seems that the transition to any alternative mode of energy generation could be somewhat costly in the near term, even though –according to the alluded independent studies- it promises significant cost advantages in the future and avoids what some consider to be the destruction of some valuable natural capital. In order to legitimately compare the costs of the five-dams project with alternatives, the eventual cost of the damage to the environment of the project must be taken into account. This is precisely what this survey is directed to do. Specifically, this survey will enable us to estimate the value of preserving Patagonia's natural environment, by assessing the willingness to pay of energy consumers. The true cost of the five-dams project can then be ascertained as the monetary cost of the project plus the cost of the value of preserving Patagonia's natural environment. By answering the questions below, you will enable us to determine how much people are willing to pay to avoid the destruction of Patagonia, or put differently, the value of the existence of this natural environment to people across the globe. Whatever this cost is, the result of this survey will be extremely useful for researchers and policymakers. We are grateful for your willingness to participate in the survey.

Suppose that the dams will be built unless 80% of the respondents to this survey are willing to pay a certain minimum amount of money to amortize the transition from conventional to non-conventional sources of energy. Taking into account this and the above scenario, please answer the following:

How much extra money do you think your household would be willing to pay in your monthly electricity bill in order to protect Patagonia (ie, no construction of dams)?

a) Less than $5
b) $5
c) $10
d) $20
e) More than $20

What part of your monthly income is your energy bill (electricity plus transportation costs)?

a) Less than 10%

b) Between 10 and 20%
c) More than 20%

What part of your monthly income are your monthly housing costs (rent or mortgage)?

a) Less than 20%
b) Between 20 and 50%
c) More than 50%

Please provide the following anonymous information:

Where do you live?

a) United States
b) Chile
c) South America, but not Chile
d) Europe
e) Asia
f) Africa
g) Australia/New Zealand
h) Other

What is your nationality?

a) US citizen
b) Chilean
c) South American, but not Chilean
d) European
e) Asian
f) African
g) Australian/New Zealander
h) other

What is your age?

a) Less than 20
b) 20-29
c) 30-39
d) 40-49
e) 50 or above

What are your political preferences?

a) Liberal

b) Moderate
c) Conservative

Sex: □ Male □ Female

What is you education level?

a) Incomplete primary school
b) Complete primary, but no secondary level schooling
c) Complete secondary, but no college
d) Some college, but did not complete and receive college degree
e) Complete college with degree, but no post-graduate degree
f) Post-graduate degree – master's or professional degree
g) Doctoral degree

What is approximately your household annual income?

a) Under $15,000
b) $15,000 - $25,000
c) $25,000 - $35,000
d) $35,000 - $50,000
e) $50,000 - $75,000
f) $75,000 - $100,000
g) $100,000 - $200,000
h) More than $200,000

How strongly do you agree with the following statement: "I believe in God and believe He created the universe and the world"?

a) Strongly agree
b) Agree
c) Not sure / indifferent
d) Disagree
e) Strongly disagree

What is your profession or occupation? ……

"I hereby state that my participation in this survey has been completely voluntary. Furthermore, I understand that it is totally anonymous and that I cannot derive any major direct benefit from or be harmed in any way by it."

a) Agree
b) Disagree