The Social Judgment Approach In Determining The Elusive Carbon Pricing For Climate Change Management

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Abstract

A common yet elusive equitable carbon pricing may provide the price needed for a consensus in managing global climate change. Social judgment approach which inherently use heuristics may provide people the means to make such real world judgments amidst the complex issues of climate change. In the context of social judgment, the biased choice or availability heuristics and the sensible estimation or 'wise-choice' heuristics are investigated. Real-world data from actors were surveyed from which the hybrid heuristics were derived. These actors are the professional stakeholders associated to the electricity supply industry. A linear model of social judgment with heuristics of uncertain cues of climate change incentives was developed using a multi-level perspective (MLP) transition energy analysis framework. The results show that availability heuristics yield marginal carbon price in terms of green tax to be below the 2012 carbon pricing accord level in the expired Kyoto Protocol. This price is however within range of the Malaysian green tax. Carbon pricing in terms of electricity tariffs, the model of 'wise-choice' yield results closer to the willingness-to-pay green electricity tariffs with notions of biases. In both the heuristics models, social judgment approach narrows the gap between value-based outcomes and the raw public choice data for carbon pricing.

Key Words: *carbon pricing, social judgment, heuristics, renewable energy, public choice*

1. INTRODUCTION

Carbon pricing is a subset of a wider range of mechanisms (e.g., controlled demand management) that society may use to mitigate the effects of carbon dioxide emissions. A globally accepted common carbon pricing may provide the 'archilles heal' for global climate change agreements and modes (e.g., green taxes and fixed RE tariffs) and costs of capital for carbon free technology [1]. In real-world situations of decision-making involving public interests, common and conflicting goals of environmental management using multi-criteria technique may provide the compromise needed to resolve local conflicts of energy decision-making [2] [3]. These current concepts however do not take into account the roles of people's views and values which are vital elements in the changing socio-political landscapes for sustainable development [4]. A new approach of value-based heuristics may overcome the problems of 'non-price' benefits and costs of environmental abatement (e.g., reducing CO2 emissions) for energy decision making [5]. This study explored the new approaches of heuristics which included people's values and their worldviews.

2. LITERATURE STUDY – RATIONALE FOR HEURISTICS AND SOCIAL JUDGMENT

Heuristics

The emerging approach to handle the intricate and uncertain problem of climate change management is the study of intelligent rules called heuristics, or, about rules making procedures and protocols termed as 'meta-heuristics' [6]. Currently energy policy analysis adapts these rules or heuristics on technology deployment and expert systems [7] but they are technologically biased. This study will explore intelligent rules or rules making procedures or the art of making mental short-cuts which are termed heuristics and meta-heuristics respectively [8]. Humans use heuristics or 'smart' short-cut rules to guide through the uncertain and intricate world where human cognition cannot easily grasp its meaning such as the predictions of economic growth . Humans may share these rules within groups to provide better coordination and stability in their quest for solutions [7]. Due to the complexities and ambiguities involved [9], this energy policy analysis is built using the linear model of social judgment where a person's judgment is a weighted sum of the uncertainty cue variables [10]. Social judgment is defined as integrating information from a number of uncertainty cues about some future state of the world [10] [6]. The method of multi-level perspectives or MLP used is based on the notion of agency and structure shaping each other from external factors [11]. It provides the framework for heuristics on contextual study of technology [6]. It is also used for designing policy on dynamics of transitions [12]. Currently MLP is used in a sustainable energy policy framework for

heuristics development [11]. The two system models of heuristics that are studied for their development from the MLP transition framework are the 'cognitive miser' and the 'natural assessment' concepts. Both concepts are extensively studied in current research on judgmental heuristics [8]. The 'cognitive miser' model is the availability heuristics which suggests that people's subjective probability judgments of certain events are biased by the availability of consequences of the events in memory. The 'natural assessment' model or the intelligence for a system with limited processing resources consists in making wise choices of what to do next [13].

Heuristics are used to overcome the shortcomings of current approaches and consider user contexts [7]. The question was how would the proposition of a criteria for environmental damage mitigation could also support the distribution of private interests? In practice the problems of private fund distribution inherently found in environmental damage mitigation efforts are dependent on the income disparities across societies. This is evident at the international level where most of the "willingness-to-pay" (WTP) for high environmental damage mitigation costs were seen to originate from developed countries that can afford to pay for the high cost of environmental damage abatement. On the other hand, most of the pristine environment such as the Jurassic-age equatorial forests are at risks and in the less-developed countries [14]. These less-developed regions would have their WTP for high costs of preserving environment to be low. This may be seen as unfair unless if there is a convergence in development between the developed and less developed nations. Possibly, capital flows from the developed to less-developed countries for environmental preservation would level-off the WTP of less developed with that of the developed countries.

The costs of carbon reductions are associated to income distribution. Carbon prices may also indicate the costs of carbon reductions. Carbon price as a wholesale electricity price (p/KWh) is also judgmental because from 2010 to 2020 it would stabilize with gradual shift from technology to industry based [15]. The judgmental cues for carbon pricing are based on the multi-level perspective (MLP) framework. In this study the policy outcome on carbon pricing is proposed to be judgmental mainly because establishing any carbon prices would be technically and politically difficulties. Although, for global efficiency it would requires a uniform carbon price across countries, it would seem to be almost an impossible task to get one. Analyzing carbon pricing through judgments may also provide clues as to which subjective pricing incentives can be important.

Social Judgment

The current literature reported that a global agreement on climate change policy to be signed by all world countries may not be reachable because of this

disparity between high WTP of developed and low WTP of less-developed regions for carbon reductions [14]. Thus CO2 emission reduction policies should focus on the objectives of cost-effective measures and their related incentives for most countries that could reach an accord to sign the global agreement. Such incentives with equitable notions may also increase consensus for climate change policies providing both profitability (with pay-offs) from the measures and stability (with incentives) in the agreements [16]. In such consensus building for public choices, the differences between gains (e.g., pay-offs) and incentives can be illustrated by a linear model of social judgment [14].

Public choices for profitability may be influenced by the incentives for carbon price stability. In a previous study [17] on climate change negotiations, the criteria for burden-sharing rules that no nation suffers a net loss of welfare (such as income levels and standards of living) would assume that welfare changes across nations are the same and that abatement costs for emission reductions may grow with GDP growth of each participating nation. This criteria increases the probability that a climate agreement may yield a surplus. Public choices for equitable or 'fair' incentives in burden-sharing rules may enhance the profitability of a climate agreement but not its stability, that is, equity improves the distribution of costs and benefits but does not seem to be effective in off-setting the incentives to free-trade. To overcome this problem, policies could be designed to further redistribute the surplus provided by the cooperators within a coalition of participants [17]. This would increase the number of strongly profitable coalitions and hence the possibility of a stable coalition structure. Such equity debate in mitigating risks of global climate change originated from the 1992 UN Framework Convention on Climate Change Article 3 which states that parties have to engage in the protection of the climate system with 'common but differentiated responsibilities' [18]. It becomes more obvious that the definition of 'equity' is not as straightforward as 'fairness' or convergence as nations have diverse interpretations of fairness and self-interests.

3. MLP FRAMEWORK OF SOCIAL JUDGMENT CUES FOR CARBON PRICING

Social judgments inherently use heuristics [19] or the "rule-of-thumb" with which the public make real world judgments amidst the complex world of uncertainty [8]. In Operations Research under uncertainty, meta-heuristics – or rules of making rules- are used such as hybridizing single neighborhood search (SNS) and the variable neighborhood search (VNS). For example, both the algorithms have been used for nurse rooster problem which have helped to reduce conflicts and tensions among nurses on shift duties [20]. Operations Research also includes combining global and local heuristics for team orienteering problem [21], self-adapting heuristic rules in optimization [28] [22] and scoring decision for forecast of future economies [23]. In

Operations Research heuristics seemed dominant for solving real-world problems under uncertainty. Similarly social judgments under uncertainty, contain elements of biases [19] and context effects [24]. The heuristics to be studied are proposed to be of two models; the biased judgment or availability heuristics [23].

In developing the linear model, the weight (w) in each perspective in the MLP transition framework is generated. The judgmental cues for carbon pricing are based on the multi-level perspective (MLP) framework. It consists of cues of values in socio-political landscapes (WVV), perceived trade gains through globalization (GR), preferences for environmental governance (EGV) and willingness to pay (WTP). Such judgmental cues from the MLP framework are shown in Figure 1 below. The policy outcome will be the carbon price which reflects the total social costs of carbon reduction .

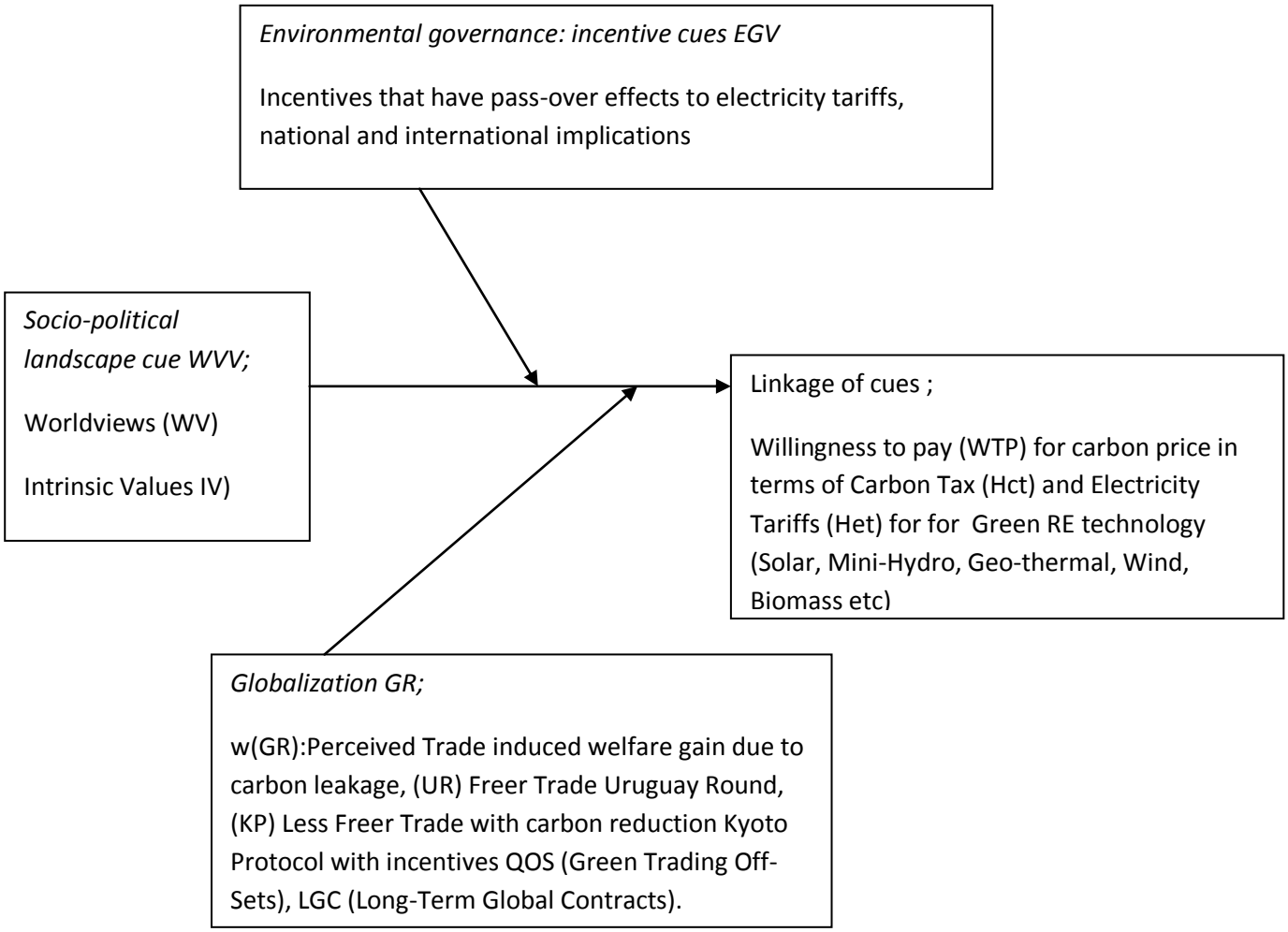

Figure 1 : Multi-level perspective (MLP) social judgment framework with cues for carbon pricing

The socio-political landscape judgment cue is about the socio-politics of real-society reflected by worldviews and intrinsic values as defined and reported from previous studies in Malaysia [26] [27]. Based on public's worldviews (WV) and intrinsic values (IV), the value weights w(WVV) in this cue WVV would be determined by the public's ratings of each of the WV and IV. The environmental governance judgment cue is based on the recent trends of the shift from 'government' to 'governance' focus as 'the state is no longer seen to be all-powerful and all-knowing actor' [29]. In this study, environmental governance is expressed by the public's independent perception of incentives for green technology. In this judgment cue is a globalization scenario of global impact of carbon leakage to welfare losses which are reductions in real income and welfare of the public in return for CO_2 emission reduction targets under the free trade agreement of Kyoto Protocol (KP). Another globalization scenario is the freer trade agreement of Uruguay Round (UR) that would increase public welfare (such as increase in real income as welfare gains). It may be implied by incentives with international implications such as Green Trading Off-Sets (QOS). The weights w(GR) is on the judgmental cue on globalization GR.

The weights for governance are w(EGVn) for incentives with national implications, w(EGVg) for incentives with global implications and w(EGVp) for incentives with pass-over effects to electricity. The weights w(WVV) are for socio-political landscape cue and wCONV are weights for convergence cue. Since the policy outcome is on carbon pricing and incentives in the governance cue are for low-carbon energy technology which includes solar , wind, biomass energy etc. As discussed in earlier sections, policy outcomes with respect to individual's willingness-to-pay (WTP) for welfare loss (such as paying for the costs of carbon reductions) may be another indicator of conflict resolutions. The "willingness-to-pay" for a carbon price reflects the cost of carbon reduction which is policy outcome from the judgments on incentives and societal factors.

4. METHOD : DETERMINING WEIGHTS

The weights for the environmental governance cues on carbon pricing are based on judgments of carbon pricing incentives. Their weights (w) are categorized into pass-over effects to electricity tariffs and carbon taxes with national and international implications [30].

The weights w(EGVp) for carbon pricing that would have pass-over effects to

electricity tariffs are attributed to incentives CCLEVY (Climate Change Levy), ROC (Renewable Obligation Certificate) and CGF(Capital Grant Fund). Renewable energy generators receive levy exemption certificates from CCLEVY for each MWh of renewable energy electricity produced which is contributed by major electricity

suppliers. The ROC (Renewable Obligation Certificate) is issued as a requirement on electricity suppliers to source a growing percentage of electricity from eligible renewable generation capacity. It is applied to all renewable technologies equally with subsidy based on MWh of electricity generated by renewable energy resources. The Feed-in Tariff (FIT), which is an ROC approach, would maintain competitive pressures in the manufacturing industry, which is where innovation is most required, whilst reducing uncertainties and thereby decreasing financing costs for renewable projects. ROC approach transfers regulatory risk to the private sector. The Capital Grant funding (CGF) is a form of capital subsidy that buys the investment risks of innovations because of the 'public –good' nature of the technology in improving reliability. CGF grant levels (as per kW constructed) has the attraction of certainty and simplicity, although it may have the drawback of bias financing that would tend to favour those with good track records [30].

The weights w(EGVn) for carbon pricing with national implications are based on incentive instruments such as Green Tax (GTX), Green Tradable Quotas (GTQ), Long-Term Purchase Price (LTP) and Quota Off-Set Credits (QOC). Green tax (GTX) may be levied unto current tax payers who consume prime electrical energy during peak periods. Green tradable quotas (GTQ) can be in cash terms to green power plants. The long term power purchase price (LTP) contracts for renewable energy (RE) power plants can be adjustable to future electricity prices. Quota Off-set Credits (QOC) are for emission credits up to certain limit per RE plant or an efficient power plant that can off-set sales taxes. The raw data of incentives from the focus group of professionals are shown in Table 1 below:

TABLE 1. Mean scores (means) in cues to compute (α)
for classification rules (N=7)

Inst	WV Economic	IntrinsicV Beauty	Exempt CCLevy	Longterm Purchase	greenOS Freetrade	Green Tax	electariff solar	electariff biomass
1	5	7	8	7	6	4	5	4
2	10	10	10	8	10	6	10	10
3	6	8	9	9	7	7	7	6
4	5	7	2	6	4	4	4	3
5	6	6	8	5	3	7	7	3
6	5	6	5	2	2	3	3	2
7	4	4	8	8	9	2	5	2
Means	5.857143	6.857143	7.142857	6.428571	5.857143	4.714286	5.857143	4.285714

The data on social-political landscape cue in the MLP framework is shown by the Economic World View (WV Economic) and the Intrinsic Value of Beauty (IV Beauty). In the environmental governance cue, are the incentives with international implications namely the Climate Change Levy Exemption (CCLevy) and Long-Term Purchase Agreement (LongTerm Purchase). The data for globalization cue, the data is on

incentives with international implications related to free trade which is the Green Trade Off-Set (QOS). The data on Willingness-To-Pay (WTP) is shown by choices on scales of Green Tax, Solar Electricity Tariff and Biomass Electricity Tariff. The mean scores indicate the data variations.

5. RESULTS

The results include effects of the above carbon pricing incentives to carbon pricing. The cue-relations are computed using the data in Table 1 above for the correlation coefficients, as shown below in Table 2.

TABLE 2. The results of calculations for correlation coefficients (α) for real-world normal distribution data (N=7)

	WVEcon	IntsicVal	Xcclevy	longtprice	gfreetrade	Greentx	solartariff	Biotariff
WVEcon			0.290463	0.230314	0.537645	0.492159	Ns	0.772969
IntsicVal			0.252872	0.416569	0.240526	0.300094	0.56742	0.429312
Xcclevy				Ns	Ns	Ns	0.857627	0.367364
Longtprice					0.67109	0.195016	Ns	0.36542
Gfreetrade						0.019074	0.904097	0.848378
Greentx							0.554803	Ns
Solartariff								0.963346
MEANS	5.9	6.9	7.1	6.4	5.9	4.7	5.9	4.3

As shown in Tables 1 and 2, attributes of worldviews and intrinsic values indicate the biases and their effects to other perspectives or cues. The normal data also have links to other judgmental cues in the MLP framework. Thus the heuristics linear model would have the socio-political landscape of worldviews and values factored in the weights of each of the judgmental cues. The results of these heuristics calculations in predicting carbon pricing with respect to Green Tax and Green Electricity Prices compared to actual public's WTP are shown below:

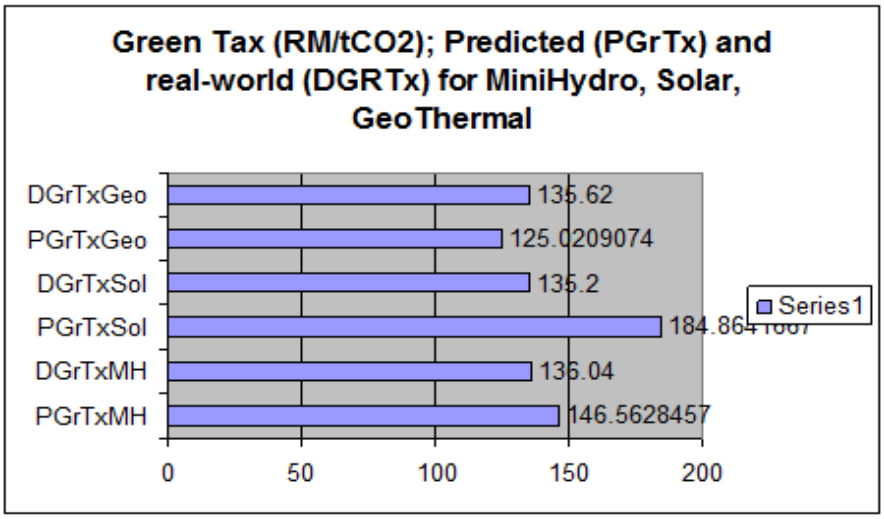

Figure 2. Carbon pricing in terms of Green Taxes for mini-hydro, solar and geothermal.

Carbon pricing in terms of green taxes with national and international implications;

WTP green taxes for wind energy and bio-fuels have small differences between predicted (PGrTxWind, PGrTxBio) and demanded (DGrTxWind, DGrTxBio) green taxes which are between RM 10/tCO2 and RM 7/tCO2.

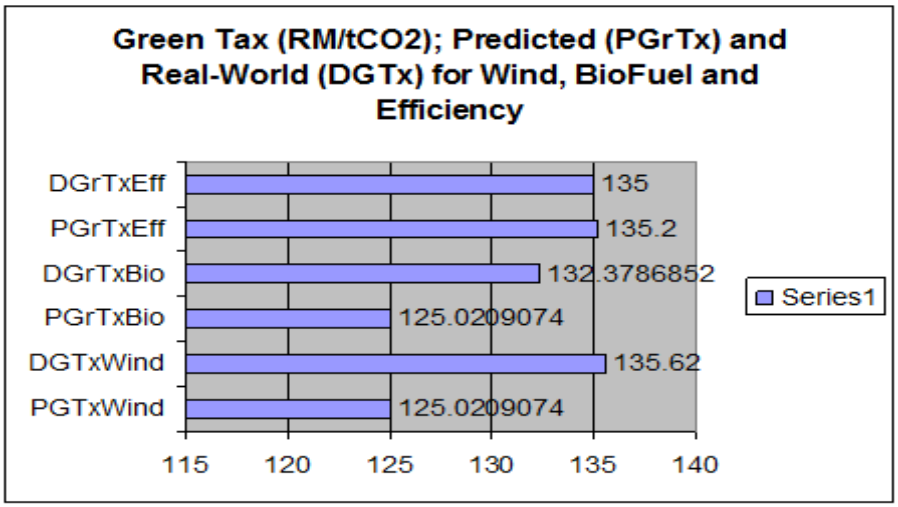

Figure 3. Carbon pricing in terms of Green Taxes for wind, bio-fuel and efficiency

Carbon pricing pass-over effect to electricity tariffs for a transition energy technology; Very small variations between predicted and the willingness to pay electricity tariffs for mini-hydro (PETrfMH, DETrfMH) and solar energy (PETTrfSolr, DETrfSolr) which is hardly 0.8 sen/KWh, but relatively bigger difference for Geo-thermals (PETrfGeo, DETrfGeo) which is 2 sen/KWh.

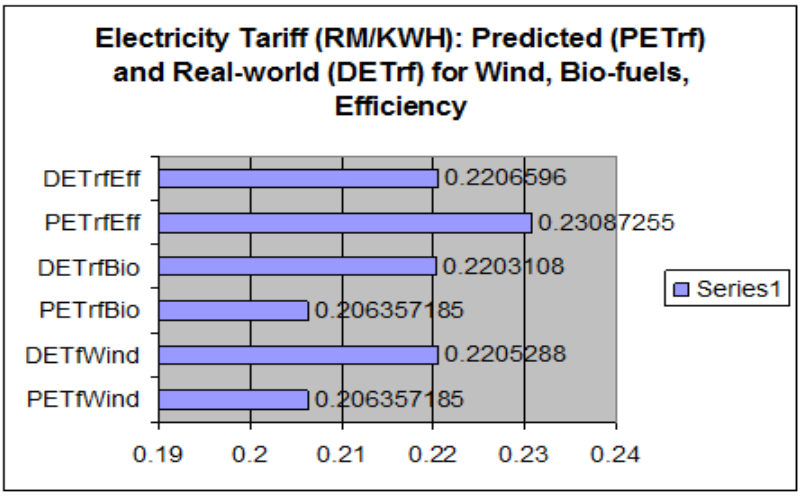

Figure 4. Carbon pricing in terms of electricity tariffs for wind, bio-fuels and efficiency

The differences between predicted (PETrf) and the willingness-to-pay (DETrf) of electricity tariffs for renewable energy from the domestic tariff of 21.8sen/KWh are 7% and 1.3% respectively.

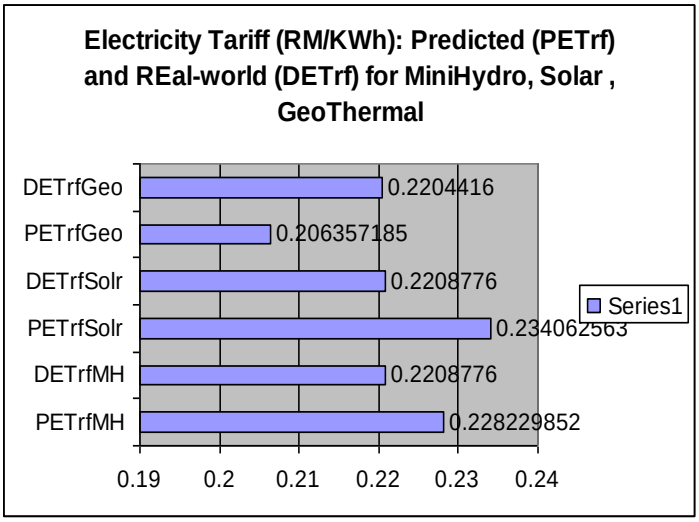

Figure 5.

Carbon pricing in terms of electricity tariffs for minihydro, solar and geothermal.

Carbon pricing pass-over effects to electricity tariffs for a transition energy technology are shown by the in Figures 4 and 5. Positive differences between predicted and willingness-to-pay are 6% for efficient energy, solar energy and mini-hydro, while negative difference for wind energy, bio-fuels and geo-thermals they are about -7% current domestic tariffs.

6. DISCUSSIONS

In the case of carbon pricing policy, the algorithm to compute the carbon pricing outcome is derived specifically from judgmental model as in Figure 1 based on the cue-relationships derived where the significant cues related to carbon pricing policy are found to be the socio-political landscape of worldviews and intrinsic values, globalization and environmental governance of incentives. Based on the cue-relationships as shown in Table 2, the value weights w(WVV) will be factored into the environmental governance (EGV) cue with the weightage w(EGV). The value weights w(WVV) have effects to environmental governance (EGV) that are based on different classes of incentives where, the incentive with pass-over effects to electricity tariffs are factored in the weight. The Climate Change Levy (CCLEVY) are preferences for incentives with pass-over effects to electricity tariffs. The incentives with national implications that are factored in the corresponding weights for environmental

governance w(EGVn), Long-Term Purchase price (LTP) incentive with national implications are also factored . The globalization cue GR with incentives of free trade Green Trading Off-Sets (QOS) have international implications are factored in the environmental governance weights w(EGVg).

Based on the linear model of social judgment of carbon pricing illustrated in Figure 1 above the carbon pricing policy outcomes are predicted from the base-line domestic electric tariff of 21.8 sen/KWh and the Kyoto Protocol with Green Taxes up to RM110 per metric tonne of CO_2 emissions (RM 110 / tCO_2) before 2012. The results are shown in Figures 2 to 5 indicating the comparisons between calculated and the WTP carbon prices by the actors.

As shown in Figure 2 above, the predicted green taxes for mini-hydro (PGrTxMH) are close to the perceived or demanded green tax (DGrTxMH) shown as RM 148.6 /tCO_2 and RM 136/tCO_2 respectively. In the corresponding Figure 3, this narrow margin between prediction (PGrTxEff) and the demanded green tax (DGrTxEff) is also found for energy efficiency (energy conservation technology) to be from RM135.2/tCO_2 to RM 135.0/tCO_2. Wind energy and bio fuels too have small differences between predicted (PGrTxWind, PGrTxBio) and demanded (DGrTxWind, DGrTxBio) green taxes which are between RM 10/tCO_2 and RM 7/tCO_2. In contrast, as shown in Figure 2 above, the green taxes for solar energy and geo-thermals show wide variations between predicted (PGrTxSolar/ PGrTxGeo) and demanded (DGrTxSolar/ DGrTxGeo) from (RM 184.60 / RM 136.62 per tCO_2) to (RM 135.2 / RM 125.02 per tCO_2) respectively.

The pass-over effects of green technology incentives to electricity tariffs are shown in Figure 4 and Figure 5. Solar energy has the highest predicted pass-over tariff effect (PETrfSolr) of 23.4 sen/KWh compared to Geo-thermals (PETrfGeo) having the lowest predicted pass-over tariff effect of 20.6 sen/KWh.

The marginal carbon price in terms of green taxes range from RM 40/tCO_2 to RM 10/tCO_2 far below the 110/tCO_2 of the 2012 carbon pricing accord in Kyoto Protocol and now seemingly succeeded by Copenhagen negotiations COP2009. But it is within range of the Malaysian green tax that has been reduced from RM 45/tCO_2 to RM 20/tCO_2. In the carbon pricing in terms of electricity tariffs however, the model of 'wise-choice' heuristics are found from the linear model of social judgment which yield predictions closer to willingness to pay green electricity tariffs.

7. CONCLUSION

The study found consistencies for outcomes on carbon pricing based on the narrow discrepancies between public choices in their willingness to pay (WTP) and predicted carbon prices in terms of green taxes and green electricity tariffs. The aim is

to minimize the uncertainty in public choices for the 'fair' costs of societal and environmental damage abatement measures. This is as reflected in the case for the outcomes on carbon pricing of carbon reductions for climate change negotiations.

Exploring an equilibrium function between cooperators and defectors to reach to more 'stable outcomes' of public choices for carbon pricing may be proposed. Through a period of green energy development, a unique equilibrium function can be observed and perhaps the unique optimal intersections can be discovered to optimize the calculated outcomes. For example the 'stabilizing' global carbon pricing may reach a stable level and this value may solve much of the debate of a standard global carbon price.

REFERENCES

[1] Rotmans, J., Grin, J., Schot J. & Smits, R. (2004), Multi-, Inter- and Transdisciplinary Research Program into Transitions and System Innovations, Maastricht:ICIS.

[2] Hope, C., (2006). The marginal impact of CO2 from PAGE2002: an integrated assessment model incorporating the IPCC's five reasons for concerns, Integrated Assessment, 6 (1), 19-56.

[3] Nijkamp, P. & Van den Bergh, J.C.J.M. (1997), "New advances in economic modeling and evaluation of environmental issues", European Journal of Operational Research, 99, 180-196, Elsevier Netherlands..

[4] Rotmans, J., & Kemp, J., M. van Asselt (2001), 'More evolution than revolution: transition management in public policy', Foresight, 3 (1), 15-31.

[5] Witten, I. H. and Frank E. (2005), Data mining – practical machine learning Tools and techniques, 2nd Edition, Elsevier, Amsterdam.

[6] Schot, J. (1998). 'The usefulness of evolutionary models for explaining innovation: the case of the Netherlands in the nineteenth century', History and Technology, 14, 173-200.

[7] Geels, F. W. (2004), ' Understanding system innovations: a critical literature review and a conceptual synthesis ', in B. Elzen, F.W. Geels & K. Green (eds), System Innovation and the Transition to Sustainability, Edward Elgar, Cheltenham, UK., pp. 19-45.

[8] Gilovich, T., Griffin, D. & Daniel (2002). Heuristics and Biases – The Psychology of Intuitive Judgment, Press Syndicate of the University of Cambridge, UK.

[9] Van den Bergh J.C.J.M. & Bruisma, F.P (2008). Managing the Transition to Renewable Energy- Theory and Practice from Local, Regional and Macro Perspectives, , Edward Elgar, Cheltenham, UK.

[10] Brehmer, B. (1987), Social Judgment Theory of Forecasting, Judgmental Forecasting, (eds) Wright G. and Ayton P., John Wiley & Sons Ltd., Chichester, UK.

[11] Berkhout, F., Angel, D. & Wieczorek, A.J. (2009). 'Sustainability transitions in developing Asia: Are alternative development pathways likely?'. International Journal of Technological Forecasting & Social Change, Vol. 76, 215-217, Elsevier.

[12] Grin, J. (2008). 'The multilevel perspective and design of system innovations' in Managing the Transition to Renewable Energy- Theory and Practice from Local, Regional and

Macro Perspectives, (eds.) Jeroen C.J.M. van den Bergh & Frank P. Bruisma), Edward Elgar, Cheltenham, UK.

[13] Luger, G. F. & Stubblefield, W. A. (1998). Artificial Intelligence – Structures and Strategies for Complex Problem Solving, Addison Wesley Longman, Inc., Harlow England.

[14] Norgaard, R.B. & Howarth, R.B. (1991), 'Sustainability and discounting the future .(ed.) Costanze, R., Ecological Economics, New York: Colombia Uni. Press.

[15] Weyant, J. (1999). Energy and Environmental policy modelling, Kluwer Academic Publishers, Massachusetts, USA.

[16] Carraro, C. & Fragnelli, V. (2004), Game Practice and the Environment, The Foundazione Eni Enrico Mattei (FEEM) series on Economics and Environment, Edward Elgar, Cheltenham, UK.

[17] Bosello, F., Buchner, B., Carraro, C. & Raggi, D. (2004),' Can equity enhance efficiency? Some lessons from climate negotiations (eds) Carraro, C. & Fragnelli, V., Game Practice and the Environment, FEEM series on Economics and Environment, Edward Elgar, Cheltenham, UK, pp. 37-64.

[18] IPCC Special Report (2000). IPCC Special Report on Emissions Scenarios, (eds.) Nakicenovic N. and Swart R. , IPCC, COP 6, 2000-2001.

[19] Freeman, C. & Perez, C. (1988). 'Structural crisis of adjustment, business cycles and investment behavior', in Giovanni Dosi, Chris Freeman, Richard Nelson, Gerald Silverberg and Luc Soete (eds), Technical Change and Economic Theory, London: Printer, pp. 38-66.

[20] Burke, E.K., Curtois, T., Post, G., Qu, R. & Valtnam, B. (2008). A hybrid heuristic ordering and variable neighborhood search for nurse rostering problem, European Journal of Operational Research, 188, 330-341.

[21] Vanteenwegen, P., Souffrieu, W., Van den Bergh, G. & Van Oud Heusten, D. (2009). A guided local search meta heuristic for the team orienteering problem, European Journal of Operational Research, 196, 118-127.

[22] Georgicva, A. & Jordanov, I. (2009). Global optimization based on novel heuristics, low-discrepancy regression and genetics algorithm, European Journal of Operational Research, 196, 413-422.

[23] Rajaratnam, K., Deling, P. & Oreastreet, G. (2010). Scoring decision in the context of economic uncertainty, Journal of Operational Research Science, 61, 421-429.

[24] Bless, H., Schwarz, N. & Wanke, M. (2003). The size of context effects in social judgment. Social judgments-Implicit and Explicit Processes, Eds. Joseph P. Forgas, Kipling D. lliams & William von Hippel, Cambridge University Press, 180-197.

[25] Nelson, R. R. & Winter, S.G. (1982). An Evolutionary Theory of Economic hange,Cambridge (MA): Bellknap Press.

[26] Faizul Shamsudin & Cees Midden (2007). Orthogonal Worldviews and Perceived Usefulness of Power Plant Technology. *International Journal of Knowledge, Culture and Change Management*, Volume 7, CG Publisher ISSN: 1447-9524, Melbourne Australia, http://www.management-journal.com.

[27] Faizul Shamsudin, Cees Midden & Florian G. Kaiser (2009). Cultural and Aesthetic Factors in Power Plant Design Preferences. *International Journal Design Principles and Practices*, Volume 3, Issue 1, CG Publisher.ISSN: 1833-1874, Melbourne, Australia. http://www.Design-Journal.com"

[28] Jiang, C., Han., X., Liu, G.,R. & Liu G., P. (2008), "A non-linear interval number Programmes for uncertain optimization problems", European Journal of operational Research, 188, 1-13, Elsevier, The Netherlands

[29] Grubb, M., Jamasb, T. & Pollitt, G.(2008). Delivering a low-carbon electricity system technologies, economics and policy, Cambridge University Press, Cambridge UK.

[30] Grubb, M. & Newbery, D. (2008), "Pricing carbon for electricity generation: national and international dimensions", (eds.). Grubb, M, Jamasb, T. & Pollitt, M. G., Delivering a low-carbon electricity system-technology, economics and policy Cambride University Press, New York, pp. 31-63.