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Emerging Market Attractiveness Index for hydro IPPs

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Introduction

This article addresses two primary commercial themes that affect the future development of our industry.

1. What are the most attractive future emerging markets for hydropower?
2. What parameters are utilized by international hydro IPPs to determine market attractiveness?

This paper presents a list of 100 countries ranked for hydropower project investment attractiveness based upon a research indexing model. This model presents parameters utilized by industry players for assessing global opportunities to invest hydropower projects. Key parameters have been sourced by a number of the larger Western international concerns in the industry. Whilst they all use slightly different parameters, only their commonalities have been utilized. Parameters include both macroeconomic and industry specific criterion, reflecting key features of what depicts attractive markets for future project developments. The indexing model utilizes a combination of *ex post* and *ex ante* parameters to arrive at a market attractiveness index of 138 countries for hydropower IPP investment. Quantitative empirical data utilized for the research model has been sourced from statistical databases operated by the World Bank, International Monetary Fund, and this journal.

This contribution has several key takeaways:

- Internationalization of IPPs is a trend to stay with increasing emphasis on emerging markets
- International hydro IPPs utilize overlapping parameters to steer the market selection process
- Future market attractiveness model results are important for all industry players alike as suppliers can strategically align themselves with upcoming project developments undertaken by capital investors

This endeavor has been undertaken to make an explicit contribution to the global hydropower industry, and thus the article structure and style is more managerial than academic in nature. The quantitative methodology utilized to build the research model produces results that can be disseminated to a broad audience.

1. Business trends

Renewable energy and emerging markets are the decussation of two international business trends that reflect strong prospects for sustained long term growth and demand. Growth in power generation has now shifted from developed to the developing world due to the facts that non-OECD countries account for 90% of population growth, 70% of the increase in economic output and 90% of energy demand growth over the period from 2010 to 2035 [1]. With over four billion people and the fastest growing populations existing in developing or emerging countries with substantially rising electricity demands, it is undeniable that tremendous opportunities exist in tapping into this market potential. Given that the growth in renewable energy technology market demand in these emerging markets is estimated to range from 10-18% per annum over the 2010-2020 period [2], hydropower is expected to play the largest single technology role by adding 730 TWh before 2017 in mostly non-OECD countries [3].

Consensus is that emerging and developing countries will need to secure domestic supplies of low cost renewable energy to fuel their economic growth [4]. In light of mounting pressures to curb climate change while providing critical infrastructure for clean energy services in the pursuit of green growth, global leadership is looking towards the hydropower industry to provide a clear way forward. Thus, global demand for successful implementation of economically feasible hydropower projects has never been greater.

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In light of these facts, a clear industry trend observed is that independent power producers (IPPs) are crossing borders to position themselves for capitalizing on such opportunities. Such activity can be either regionalization initiatives or full-fledged internationalization endeavors. But while markets are generally considered on an individual basis as individual project opportunities arise or are presented at conferences such as this, it would be worthwhile to understand what the likely markets of tomorrow are based upon parameters utilized by a number of the largest active international players. Such information is thus important for the supplier industry to be in step with the capital investors that undertake project developments for both greenfield and rehabilitation projects in light of new contracting opportunities that come alongside such future investments.

2. Market level parameters

To understand where global opportunities for investment in hydropower plants lie, the answer lies in the eyes of the beholder. That is to say, what may be considered good for one is not for the other, depending upon their criterion, resources, strategy, and risk tolerance.

2.1 Firm level criterion

To develop this indexing model key parameters have been sourced from a number of international hydro IPPs. To honor confidentiality and protect corporate strategies of industry actors, companies are presented anonymously (with no order of preference in either parameters or companies presented). Company specific criterion in consideration for entering new markets is listed below.

- Company A: resource availability, actual and potential market size, regulatory frameworks, country risk, 5 growth rates year GDP and load demand
- Company B: GDP growth, rising primary energy and load demand growth, rising per capita consumption, regulatory framework & tailored accelerated RE growth programs, long term PPA contracting opportunities
- Company C: above average GDP & load growth, liquid wholesale market, strong partner with complimentary know-how, political stability, first mover capabilities
- Company D: per capita El consumption (kWh/person), primary energy demand growth, market assessment (as % technical/economic unexploited hydropower potential), 8 year forward GDP growth rate forecasts, country level RE promotion schemes (removal regulatory hurdles or % total EL from RE), electrification ratios, forward marginal costs
- Company E: Market liberalization initiatives (with SOE divestment), marginally attractive GDP and load demand growth, political stability, grid capabilities, market structure (breadth of potential offtakers)

2.2 Criterion in common

Whilst firms have their individual criterion, it is possible to identify the commonalities they share. These commonalities can be grouped into macroeconomic and industry specific factors. Firms share common ground in stating macroeconomic criterion that embodies attractiveness for hydropower project investment, such as: GDP growth, market size, and country risk as signified through political stability. Industry specific criterion shared by firms is as follows: hydropower potential and load demand growth, RE promotion schemes, grid capabilities, and regulatory frameworks for private investment.

The positive relationship and correlation between energy and economic growth is well documented and thus becomes the cornerstone of the indexing model as presented in the following section. At the industry level, the strength of growing load demand is notably the most important industry specific criterion cited.

3. Methodology

To build this indexing model, reliance was placed upon a number of internationally renowned institutions with extensive resource endowments. The quality of the data is therefore of high international standard, as each parameter's own methodology can be scrutinized from its prospective source accordingly. The contribution this paper makes is the combination of various parameters which serves to produce results suitable for a given audience. Raw empirical data to build this model was collected as follows in the following section.

3.1 Data collection

Ex post and *ex ante* annual GDP growth rates for the time periods of 2006-2011 and 2011-2017 were sourced from the International Monetary Fund's World Economic Outlook database [5]. Annual electricity consumption figures from 2005-2010 were sourced from the World Bank's DataBank of World Development Indicators [6], with the unfortunate reality being the most recent country level data available is three years behind us. When data was lacking from this source for a number of the countries, data was further included from the US Central Intelligence Agency. The business climate scores as a measure for political stability were derived from the

World Bank's Ease of Doing Business Index [7], using the most recent scores of 2012. Market size stats (expressed as human population) were sourced from the IMF [5], whereas *ex post* reflects the year 2010 and *ex ante* covers the years 2010-2017. Lastly, data for theoretical hydropower potential was sourced from this journal's annual World Atlas [8]. Naturally, several countries were excluded for the lack of data availability, resulting in a total of 178 countries used for the model.

3.2 Analysis

Compound annual growth rates were calculated on the following parameters: *ex post & ex ante* GDP, *ex post* load demand, and *ex ante* population. Once a maximum value for each parameter was derived for all 178 countries, it was used to benchmark all other countries against it in establishing each country's positioning amongst that parameter as shown in Figure 2. In this way all parameters had their own index with a maximum score of 100. This method entails the inherent result of indexing to the highest value possible, as opposed to calculating marginal gains over OECD averages or other prescribed benchmarks.

4. Indexing model

To build the indexing model, the aforementioned criterion provided by global hydropower IPPs was utilized as a framework for analysis. Only the most critical quantifiable parameters were utilized, both for reasons of reliable data access and simplicity to allow for transferability to the wider audience. Figure 1 displays the indexing model below.

$$EMAI\{C_x\} = HPP\ i\ (F\ \cdot\ w_{10}) + [\![\left|\Delta GDP_{ep} i(w_{15})\right| + \left|\Delta GDP_{ea} i(w_{25})\right| + \left|\Delta Load_{ep} i(w_{25})\right| + \left|Pol\ i(w_{25})\right| + \left|Pop_t i(w_{3,5})\right| + \left|\Delta Pop_{ea}\ i(w_{6,5})\right|]\!]$$

Figure 1: Emerging Market Attractiveness Index for hydro IPPs

$$i = \frac{C_x}{M_z}$$

Figure 2: parameter indexing

Whereas:

$EMAI = Emerging\ Market\ Attractiveness\ Index$
$C_x = country\ x$
$HPP = hydropower\ potential$
$i = index$
$F = \ factor\ score$
$w_x = \ percentage\ weight\ assigned$
$\Delta GDP_{ep} = 5\ year\ ex\ post\ compound\ annual\ growth\ rate$
$\Delta GDP_{ea} = 7\ year\ ex\ ante\ compound\ annual\ growth\ rate$
$\Delta Load_{ep} = 5\ year\ ex\ post\ compound\ annual\ growth\ rate$
$Pol = ease\ of\ doing\ business$
$Pop_t = population\ today$
$Pop_{ea} = 7\ year\ ex\ ante\ population\ compound\ annual\ growth\ rate$
$M_z = maximum\ quantity\ amongst\ population\ within\ parameter\ z$

International hydro IPPs seek out markets that embody sizable resource bases. What is deemed 'sizable' is up for debate depending who the sponsor is, and how significant their resource base may be. To overcome this potential methodological limitation, a score of 1-10 was assigned to each country based upon the size of their resource base. Countries with vast hydropower resources received high scores whereas countries with less received low scores as displayed in Table 1 below. In this way the model produces results that carry value for both larger and smaller players alike.

Table 1: Factor scores for country level hydropower resources

Score	1	2	3	4	5	6	7	8	9	10
Hydropower potential (TWh/yr.)	1<10	10-29	30-49	50-99	100-299	300-999	1000-1999	2000-2999	3000-4999	>5000

Due to the lack of hydropower resources in a number of countries, a total of 39 countries with less than 1TWh were further removed from the model.

4.1 Limitations

This indexing model acts as a screening tool to rank the attractiveness of markets for future capital investments in hydropower project development and ownership. Thus, its results are not suited for project level decision-making, but rather as a steering tool to prioritize markets based upon firm specific considerations. Due to distinct data access and resource limitations, some criterion was excluded from the model (namely grid capabilities and country specific regulatory frameworks or promotion schemes). Because market liberalization was not utilized as a criterion, some markets presented may not allow for private investment and operation in the sector. However, it is deemed wise to include countries that are not currently open for private investment, as their situation may change leading to early mover advantage offerings.

The weighting criterion utilized in this model is most likely to change on a firm level basis based upon factors such as risk tolerance, appetite for growth, focus on industrial or consumer lead load demand growth, and the size of project portfolio a firm seeks to build within a given market. Thus the most debatable aspect of the results produced by the model is the weighting of criterion importance. The assigned importance given to each parameter was the author's best judgment, based upon information provided by industry. Some firms may find ease of doing business higher upon their priorities, whereas others may place more emphasis upon future GDP growth. If you deem the weightings to be askew based upon your own experience, I highly encourage you to make direct contact in providing your valuable input.

5. Results

The top 100 results of the indexing model for 139 countries is presented in Table 2 below.

Table 2: Emerging Market Attractiveness Index for Hydro IPPs

Rank. Country	Score	Rank. Country	Score	Rank. Country	Score	Rank. Country	Score
1. China	53,58	26. Iraq	19,74	51. France	13,47	76. Nicaragua	8,04
2. Indonesia	35,66	27. Chile	18,90	52. Germany	13,33	77. Portugal	8,03
3. India	32,93	28. Egypt	18,73	53. Zambia	13,25	78. Cote d'Ivoire	7,79
4. Peru	32,24	29. Congo DemRep	18,32	54. Uruguay	12,17	79. Kenya	7,70
5. Vietnam	29,32	30. Mexico	18,31	55. Dominican Rep.	11,72	80. Chad	7,37
6. Colombia	28,16	31. Australia	18,15	56. Uganda	11,57	81. Albania	7,36
7. Brazil	27,67	32. Madagascar	17,97	57. Uzbekistan	11,23	82. Greece	7,12
8. Ethiopia	27,51	33. Argentina	16,77	58. Congo Rep of	11,02	83. Armenia	7,05
9. Malaysia	27,33	34. New Zealand	16,71	59. Venezuela	10,85	84. Sri Lanka	7,03
10. United States	27,22	35. Korea, Rep.	16,51	60. Romania	10,51	85. Malawi	6,70
11. Papua New G.	26,09	36. Japan	15,93	61. Spain	10,14	86. Morocco	6,61
12. Myanmar	24,88	37. Pakistan	15,91	62. Bosnia / Herz	9,83	87. Poland	6,26
13. Turkey	24,34	38. Bolivia	15,88	63. Turkmenistan	9,48	88. Switzerland	6,21
14. Canada	24,16	39. Cameroon	15,85	64. Finland	9,40	89. Suriname	6,11
15. Mongolia	23,54	40. Tajikistan	15,63	65. Azerbaijan	9,37	90. Ukraine	5,88
16. Angola	23,48	41. Ecuador	15,50	66. Ghana	9,31	81. Slovak Rep.	5,86
17. Kazakhstan	23,06	42. Costa Rica	15,33	67. Italy	9,23	92. Namibia	5,79
18. Iceland	22,83	43. Sudan	14,57	68. Tanzania	9,2	93. Senegal	5,75
19. Nepal	22,81	44. Austria	14,47	69. Nigeria	9,15	94. Bhutan	5,73
20. Russia	22,70	45. Sweden	14,41	70. Philippines	8,83	95. Zimbabwe	5,72
21. Paraguay	22,20	46. Kyrgyz Republic	14,33	71. UK	8,67	96. Lao P.D.R.	5,72
22. Georgia	20,71	47. Guatemala	14,33	72. Panama	8,61	97. Honduras	5,67
23. Norway	20,59	48. Mozambique	14,10	73. Thailand	8,39	98. Bulgaria	5,47
24. Cambodia	20,23	49. South Sudan	13,67	74. Guyana	8,38	99. Montenegro	5,46
25. Iran	20,00	50. South Africa	13,62	75. Gabon	8,23	100. Netherlands	5,28

6. Discussion

Over the past two decades we have witnessed a number of hydropower independent power producers (IPPs) spread their geographical reach across the globe. Whilst international hydro IPPs choosing to pursue an internationalization path must prioritize markets to enter, it is equally important for the supplier industry to position themselves for upcoming contracting opportunities that arise as a result of project developments in new prospective markets.

As seen in section 2.1, firms have diverging opinions on which criterion to use in evaluating a prospective market to enter. Taking this into account, this research model has been built solely around core criterion that sought to answer the question of which country has the most suitable combination of available hydropower resources, past and future economic growth, ease of doing business, and demonstrated load demand growth.

Five of the ten top countries for market attractiveness are found in Asia. Topping the list, China holds the largest hydropower resources globally with widely known strong economic and load demand growth as a result of their continued developmental trajectory. Whilst it ranks in the mid-range for ease of doing business, its other high compensating factors leads it to the highest ranking on the index. Indonesia scores low on the business index, but the high ranking of *ex ante* GDP growth and hydropower resource base positions the country in second place. India comes in third for its high resource base, exploding population, and expansive post and future economic expansion. Finally Vietnam scores well by demonstrating high load demand growth coupled with a large resource base.

In South America Peru, Columbia, and Brazil rank in the top ten. All three countries' high rankings can be largely attributed to their large resource bases, whereas in Peru strong performance across all parameters earned it higher ranking at fourth place. The deregulated markets in South America have seen increasing numbers of foreign entrants over the past decade. With the ongoing resource boom and a number of grid integration initiatives ongoing, these markets will continue to be attractive in the coming years.

Papa New Guinea and Mongolia are two countries amongst some of the more surprising results. Upon further investigation, IPPs make up roughly half of generation capacity in Papa New Guinea whilst a vertically integrated market structure is still maintained. Despite its ample resources, Mongolia's small market (load) and the lack of full cost recovery policies have stifled foreign investment in Mongolia. Similar to Papa New Guinea, another challenge is the displacement of load centers and grid infrastructure in relation to the majority of hydropower resources. The aforementioned underscore the importance of understanding that this model is a screening tool, designed for guiding IPPs towards prospective markets to enter that meet their core criterion and thus further investigation into market specificity is demanded to fully understand its potential.

Firms in the business of providing critical infrastructure services such as power generation must choose between expanding networks across borders enabling export (regionalization initiatives), or setting up new capital investment plants further abroad. In the absence of promising new opportunities in their domestic or neighbouring markets, global internationalisation strategies are being observed from a number of IPPs active in hydropower [9]. Given the rising incomes, large populations, expanding industrial sectors and the need to secure affordable domestic supplies of clean energy, emerging markets are in great demand for the multi-fold benefits that hydropower offers. The emerging market attractiveness index presents a list of countries that are most likely to see growth in hydropower project investments in the coming years.

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