Renewable Energy & Emissions – A Coordination Problem

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INTRODUCTION

Scientists and vulnerable states continue to warn of the coming dangers of climate change to the environment and societies. As leaders continue to struggle with the coordination problem that is inherent in many issues surrounding climate change, the adoption of renewable energy is a particularly difficult conversation. Inequality in access to technology, in GDP per capita, and in responsibilities for historic emissions cause some countries with the largest need for adaptation and mitigation technologies to be unable to access them. The research in this paper will try to answer three questions:

1) What is the relationship between CO_2 emissions per capita and action in furthering renewables?
2) What is the relationship between group membership and efforts to lower emissions?
3) What is the relationship in GDP per capita and efforts in lowering emissions?

METHODS

The research covers all countries in the world in order to include as many stakeholders in the global energy system as possible. In comparing how countries in different energy organizations (IEA & OPEC) and in different income brackets (Low, middle, and high income, and LDCs and SIDS) attempt to increase renewable energy use in their energy mix and how they try to lower emissions, the research used data from IEA, OPEC, and the Energy Charter Treaty sites that was originally lists. This data had to be inserted manually into ArcGIS.

Quantitative data came from the UN, World Bank and some of the global energy organizations. This data was already in excel files, but still had to be cleaned in order for joins to previous data to be successful.

To divide countries by income, I chose to illustrate by dividing low income, lower-middle income, upper-middle income, and high income into even smaller divisions, but color coding them to match with the already set divisions of the World Bank.

One of the maps is illustrative of the difference between electricity capacity of renewables in a country and the 2015 total final consumption of energy of the country. Because electricity capacity is measured in megawatts (MW) and final consumption of energy is measured in terajoules (TJ), a conversion formula had to be created:

$$1{,}000{,}000 \text{ kW} = 3.6 \text{ TJ}$$
$$1 \text{ MW} = 1{,}000 \text{ kW, so}$$
$$1{,}000 \text{ MW} = 3.6 \text{ TJ}$$
$$TJ\ Capacity = \frac{MW\ Capacity\ \times 1000}{3.6}$$

With these steps, a new column in the data was created. After finding this information, the question I wanted to answer was, "How much of current consumption could be from renewable energy if renewables were used to their maximum capacity?"

Lastly, I created point layers for each state to illustrate different data such as commitments to renewable energy, changes in emission, and GDP per capita over the choropleth maps.

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DISCUSSION

In the Declaration that came out of the first Rio Earth Summit in 1992, Common But Differentiated Responsibilities were highlighted as a way to begin to recognize the efforts that countries should be expected to make based on their historical emissions and their position in the global community, particularly their level of development and their economic prosperity.

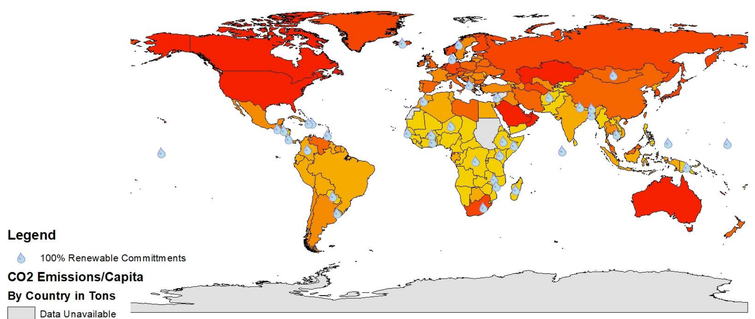
The Common But Differentiated Responsibility article in the Rio Declaration states, "The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command." Similarly, in reference to all countries, the UNFCCC calls on countries to act "in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions."

The maps and data of this research shows that the opposite is happening in terms of agreements and commitments for lowering emissions. Many countries that have committed to 100% renewables are least developed countries (ex. Afghanistan & Bangladesh), and Small Island Developing States (ex. Maldives & Vanuatu). Leading economies and emitters such as the U.S. are doing less than what the international system would expect. The U.S. has gone so far as to withdraw from the Paris Agreement, China has continued to be a major emitter even though it now competes as the largest economy on the planet, in addition to these two states, India has become vocal about the right it should have to continue to emit so that its growth continues to increase steadily.

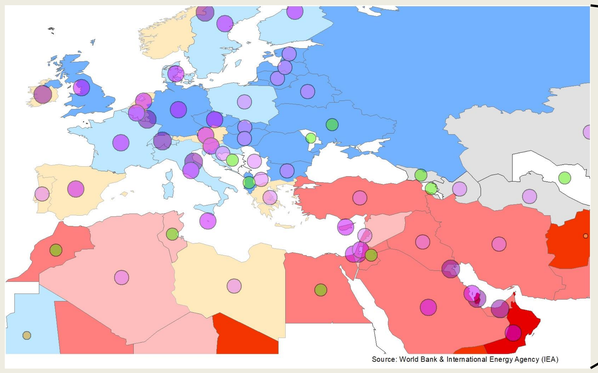
The question that remains is, "Is there a way to write an equation and determine which countries should contribute what share to lowering global emissions?" This question could be answered in the outcome of COP24 in Poland.

Top 20 Emitters (as of 2013)	100% Renewables (as of April 2017)	
1. China	1. Afghanistan	29. Maldives
2. United States	2. Albania	30. Marshall Islands
3. European Union (28 states)	3. Bangladesh	31. Mongolia
4. India	4. Barbados	32. Morocco
5. Russia	5. Bhutan	33. Mozambique
6. Japan	6. Burkina Faso	34. Nepal
7. Brazil	7. Cambodia	35. Niger
8. Indonesia	8. Colombia	36. Norway
9. Canada	9. Comoros	37. Palau
10. Mexico	10. Costa Rica	38. Palestine
11. Iran	11. Denmark	39. Papua New Guinea
12. South Korea	12. DRC	40. Paraguay
13. Australia	13. Dominican Republic	41. Philippines
14. Saudi Arabia	14. Ethiopia	42. Rwanda
15. South Africa	15. Fiji	43. St. Lucia
16. Turkey	16. The Gambia	44. Samoa
17. Ukraine	17. Ghana	45. Scotland
18. Thailand	18. Grenada	46. Senegal
19. Argentina	19. Guatemala	47. South Sudan
20. Pakistan	20. Haiti	48. Sri Lanka
	21. Honduras	49. Sudan
	22. Iceland	50. Tanzania
	23. Kenya	51. Timor-Leste
	24. Kiribati	52. Tunisia
	25. Lebanon	53. Tuvalu
	26. Lesotho	54. Uruguay
	27. Madagascar	55. Vanuatu
	28. Malawi	56. Vietnam
		57. Yemen

CO2 Emissions Per Capita by Country
and Countries that Have Committed to 100% Renewable Energy

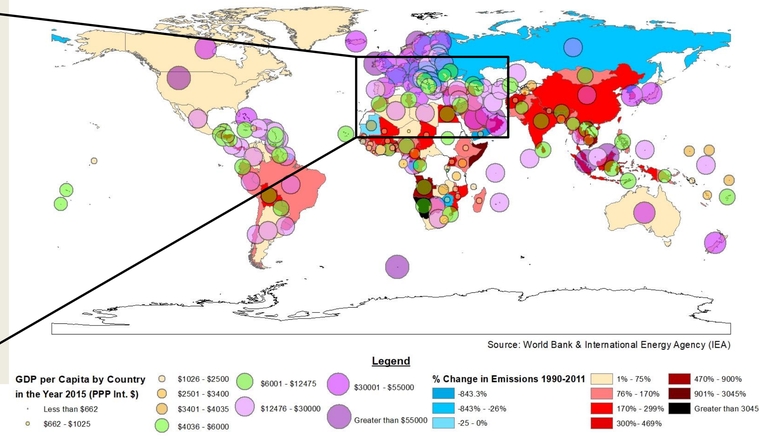


Source: unstats.un.org/unsd/environment



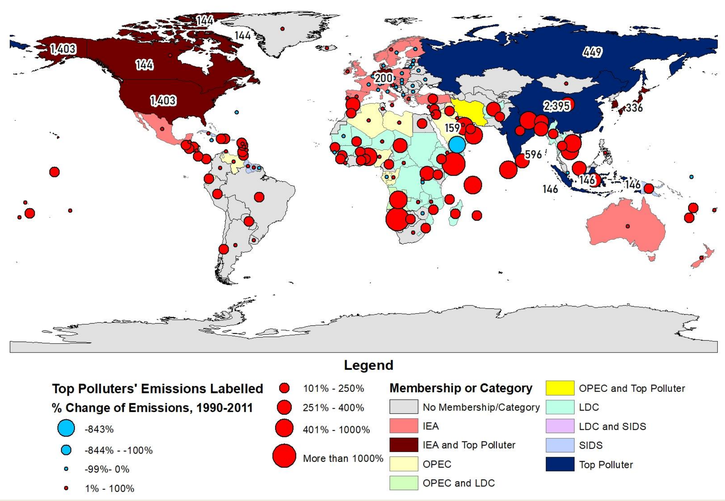
Source: World Bank & International Energy Agency (IEA)

GDP per Capita in 2015 PPP International Dollars and
% Change in Emissions from 1990 - 2011



Source: World Bank & International Energy Agency (IEA)

Change in Emissions from 1990-2011
with Categorization of Countries and Emissions of Top 10 Polluters



RESULTS

The collection of maps created out of this report illustrates that those countries most committed to renewables (SIDS, LDCs, Nordic states) are not the historical emitters and not the greatest emitters today.

Many of the countries taking large steps to base their electricity production on renewables and lower their emissions of CO_2 are diverse geographically and are not countries expected to take the lead on lowering emissions. As can be seen in the table below, none of the top 20 emitters have committed to a goal of 100% renewable energy this century. Renewable energy could be a sector where the international system sees new countries leading the way, however, those countries need financial and technological support to do so and that comes primarily from countries not currently making an effort to reduce emissions.

The map of PPP GDP per capita of countries in 2015 and the percent change in emissions from 1990-2011 illustrates that many of the largest economies have not significantly lowered their emissions. Additionally, many developing countries have *greatly* increased their emissions. The map asks the question, which countries should the international system place more pressure on to lower emissions as compared to other states?

CONCLUSIONS

The combination of all the research discussed above and illustrated through these maps leads to one final conclusion: the differentiation between countries is present in GDP per capita, emissions, and the decline of emissions. Countries also possess different potential in using and implementing new, renewable energies dependent on their financial status and their natural geographies. The need for differentiated responsibilities and actions to create changes is necessary for climate change. However, coordination between so many diverse actors with diverse perspectives and desires creates an almost insurmountable problem that may not ever be surpassed.

The amount of different groups and the clear difference in goals of those groups (particularly OPEC and IEA) make cooperation difficult. Additionally, the overwhelming desire of so many countries to continue emitting in the name of development calls for leadership from already developed countries, but these states have been inactive on average. The future of emissions now sees countries that have historically not been leaders to raise their voices and demand change.