

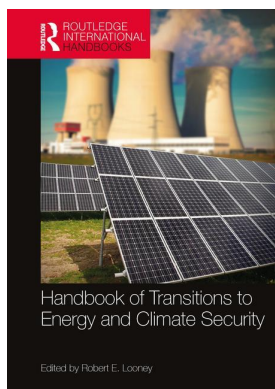
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Energy transitions in the Caribbean and Central America

Robert E. Looney

Introduction

If one had to pick one area in the Western Hemisphere where an energy transition away from imported oil and coal would be the most beneficial, it would no doubt be the Caribbean/Central American region. Currently both are beginning to experience the effects of global warming in the form of more powerful storms, shore erosion and severe droughts.

Both regions also have extremely low levels of energy security with many countries totally dependent on imported oil to meet their energy needs, and thus most exposed to external shocks stemming from rapid changes in the international price of oil. Only one country in the region, Trinidad and Tobago, has sufficient reserves of energy to be a net exporter. In part, the region's energy situation has resulted in many of the hemisphere's lowest per capita income countries being located there.

A successful energy transition at this time is even more necessary because the current system is unsustainable. The two regions have historically bridged the gap between low income and high energy costs with subsidized access to oil from regional producers. Subsidized oil was first provided by Mexico and Venezuela through the Acuerdo de San José beginning in 1980, and more recently by Venezuela alone through Petrocaribe beginning in 2001.

Petrocaribe has enabled member states to take advantage of a deferred payment system for up to 50% of market prices. The deferred payment was due in 25 years at 1–2% interest. Cuba, Nicaragua and Haiti were three of the larger beneficiaries. Steady access to cheap Venezuelan oil gave the member countries little incentive to diversify away from oil, only compounding their dependence on foreign energy imports. Intentionally or not, the loans through the Petrocaribe program have resulted in a number of the Central American and Caribbean becoming heavily indebted¹ to Venezuela in addition to becoming dependent on Venezuela for their energy security. Countries like Haiti, Nicaragua and Cuba have thus become quite vulnerable to Venezuelan political pressure.² However, with the decline in Venezuelan oil production together with the sharp drop in oil prices beginning in the fall of 2014, Venezuela has begun to cut its oil subsidies³ and it may only be a matter of time before it is forced to withdraw the program completely.

As noted, another compelling reason for initiating an energy transition is the increasing cost of inaction.⁴ The two regions, particularly the Caribbean are likely to be the most adversely

affected parts of the world by climate change. Increased hurricane intensity, hotter temperatures and increased ocean levels threaten livelihoods⁵ and lives throughout the region.⁶

Fortunately, several fortuitous developments have the potential of lowering the costs of transitioning away from imported oil. First while it is always extremely difficult to forecast future oil prices there is the distinct likelihood that prices will remain relatively low for some time.⁷ Lower oil prices should result in subdued energy prices even as the transition to alternative fuels takes place. Second, both regions are potential beneficiaries of energy initiatives such as authorizing the export⁸ of crude oil on the part of the United States, together with the energy revolution in that country and the potential for low cost liquefied natural gas (LNG) exports⁹ to the region. Finally, rapid progress in green energy technologies¹⁰ along with the low price of oil are significantly reducing the costs of transitioning away from fossil fuels

Even though both the motives to and means for initiating major efforts at energy transitions exist it is apparent that success is far from assured. While there are a number of common themes that run between the Caribbean and Central America, broad generalizations are difficult. Significant differences exist between the regions and for individual countries within each region. The next section examines some of the more relevant differences for the purpose of identifying where gains towards transitioning away from imported energy have occurred, and where progress has been more elusive.

Energy trends

While both the Central American and Caribbean countries, with the notable exception of Trinidad and Tobago, are net importers of energy, significant differences exist. Due largely to reduced opportunities for hydro-power, dependence on imports for energy use is on average about 10% higher for the Caribbean group (Table 29.1). The Central American countries have developed an integrated electricity system¹¹ linking the six countries, a development impossible to implement in the island states of the Caribbean.

The Caribbean region has a population of about 40 million (about 12% of the US population) and consumes roughly 50,000 gigawatt-hours of electricity per year (about 1% of US electricity demand). The World Bank projects the Caribbean region's electricity demand nearly to double by 2030.¹²

The region is dependent on fossil fuels, with oil and natural gas supplying roughly 90% of electricity. The transportation sector is also almost exclusively dependent on oil, leaving the region suffering from energy prices that are not only high but also extremely volatile.

Within the Caribbean sample of countries both the Dominican Republic and Jamaica have the highest rates of energy imports, both countries averaging use percentages in the 80s. However, with the exception of Cuba, all of the sample countries achieved reductions in their energy import percentages between 2000 and 2012 (the latest date of available data). Energy import percentages were the lowest for Haiti, and that country also had the greatest percentage reduction in imports (22.1%) between 2000 and 2012. In sharp contrast, during this period, Cuba increased its percentage of imported energy use by 16.4%.

Costa Rica experienced the greatest reduction between 2000 and 2012 in the percentage (16.9%) of its energy coming from imports, while Panama experienced the greatest increase (10.8%) in its imported energy. While El Salvador, Honduras and Guatemala all had slight increases in their imports as a share of total energy use, Nicaragua's fell by nearly 6%.

In the area of fossil fuel shares in total energy consumption the picture is one of gradually increasing shares in the Caribbean, and falling shares in Central America (Table 29.2). On average fossil fuels account for about 15–20% more in total energy consumption in the

Table 29.1 Energy imports, net (% of energy use)

Country	2000	2005	2010	2011	2012	2000–2012 % change
<i>Central America</i>						
Costa Rica	57.6	46.9	47.6	48.2	47.9	-16.9
El Salvador	46.6	44.8	46.2	47.6	47.5	1.9
Guatemala	25.1	30.8	26.4	25.6	25.6	1.8
Honduras	49.1	55.0	51.2	51.4	51.7	5.4
Nicaragua	46.4	48.0	46.8	48.5	43.7	-5.8
Panama	70.6	73.2	77.3	79.8	78.2	10.8
<i>Average</i>	<i>49.2</i>	<i>49.8</i>	<i>49.2</i>	<i>50.2</i>	<i>49.1</i>	<i>-0.3</i>
<i>Caribbean</i>						
Cuba	44.3	46.2	54.0	51.3	51.5	16.4
Dominican Republic	90.7	88.3	89.5	89.7	89.4	-1.4
Jamaica	84.6	88.9	82.8	82.6	82.2	-2.9
Haiti	23.3	19.5	17.8	18.0	18.2	-22.1
<i>Average</i>	<i>60.7</i>	<i>60.7</i>	<i>61.0</i>	<i>60.4</i>	<i>60.3</i>	<i>-0.6</i>
<i>Energy exporter</i>						
Trinidad and Tobago	-93.2	-116.6	-112.0	-104.9	-107.0	14.8

Source: Data from database: World Development Indicators, <http://data.worldbank.org/data-catalog/world-development-indicators>. Last updated: 10/14/2015.

Table 29.2 Fossil fuel energy consumption (% of total)

Country	2000	2005	2010	2011	2012	2000–2012 % change
<i>Central America</i>						
Costa Rica	59.0	46.9	47.5	48.3	47.8	-19.0
El Salvador	44.9	44.1	46.0	47.4	47.3	5.3
Guatemala	42.3	44.2	32.7	30.9	30.9	-27.0
Honduras	48.3	54.9	51.2	51.6	51.6	6.9
Nicaragua	46.0	48.0	46.9	48.6	43.7	-5.1
Panama	70.2	73.4	77.2	79.7	78.3	11.5
<i>Average</i>	<i>51.8</i>	<i>51.9</i>	<i>50.3</i>	<i>51.0</i>	<i>49.9</i>	<i>-4.6</i>
<i>Caribbean</i>						
Cuba	69.9	80.1	88.8	86.7	86.5	23.8
Dominican Republic	90.7	88.3	89.5	89.7	89.4	-1.4
Jamaica	84.6	88.9	82.8	82.6	82.2	-2.9
Haiti	23.3	19.5	17.8	48.0	18.2	-22.1
<i>Average</i>	<i>67.1</i>	<i>69.2</i>	<i>69.7</i>	<i>69.2</i>	<i>69.1</i>	<i>2.9</i>
<i>Energy exporter</i>						
Trinidad and Tobago	99.8	99.8	99.9	99.9	99.9	-5.9

Source: Data from database: World Development Indicators, <http://data.worldbank.org/data-catalog/world-development-indicators>. Last updated: 10/14/2015.

Caribbean, with fossil fuels making up over 80% of energy consumption in Cuba, Dominican Republic and Jamaica. In contrast the highest percentage of fossil fuel consumption occurs in Panama where it averages in the 70s.

Between 2000 and 2012, the largest reductions in fossil fuel shares in energy consumption were in Guatemala (27%), Haiti (22.1%) and Costa Rica (19%). Cuba accounted for the largest increase in fossil fuel energy shares (23.8%) followed by Panama at 11.5%.

The development of alternative energies such as solar, wind and other natural sources has also varied across the two regions (Table 29.3). In general, alternative energies account for a much greater share of total energy use in Central America, with these sources averaging in the high teens. In contrast alternative sources have never accounted for 1% of total energy use in the Caribbean. Percentage-wise, both regions had a considerable expansion in these types of energy during 2000 to 2012, with Central American alternative sources increasing by 37.5% and those in the Caribbean countries at 33.1%, albeit from a very low base. In absolute shares, the biggest gains have occurred in Costa Rica, El Salvador and Nicaragua. At the same time significant reductions occurred in Honduras and Haiti.

In contrast to the sharp differences in energy patterns between the Caribbean and Central America noted previously, combustible renewables such as biogas, industrial waste, biomass, and municipal waste average around 30–35% of total energy use in both the Caribbean and Central America (Table 29.4). Also both regions had fairly significant reductions in this source of energy with its share of total energy falling by 8.8% between 2000 and 2012 in Central America and 6.7% in the Caribbean. Also between 2000 and 2012 significant reductions in this fuel source occurred in Cuba (55.4%), El Salvador (44.9%) and Panama (40.9%). The only major increase occurred in Costa Rica (55.7%).

Table 29.3 Alternative and nuclear energy (% of total energy use)

Country	2000	2005	2010	2011	2012	2000–2012 % change
<i>Central America</i>						
Costa Rica	33.8	36.6	35.2	36.0	38.7	14.6
El Salvador	19.6	23.2	35.3	34.8	33.8	72.6
Guatemala	3.3	5.1	5.5	5.2	5.4	61.4
Honduras	6.5	3.6	5.8	5.3	5.3	–18.5
Nicaragua	5.3	9.5	10.7	9.5	15.5	193.2
Panama	11.4	11.1	9.7	8.7	11.2	–2.4
<i>Average</i>	<i>13.3</i>	<i>14.8</i>	<i>17.1</i>	<i>16.6</i>	<i>18.3</i>	<i>37.5</i>
<i>Caribbean</i>						
Cuba	0.1	0.1	0.1	0.1	0.1	69.8
Dominican Republic	0.9	2.5	1.7	1.8	2.0	120.5
Jamaica	0.3	0.5	0.7	0.7	0.8	206.5
Haiti	1.2	0.7	0.4	0.3	0.3	–72.1
<i>Average</i>	<i>0.6</i>	<i>0.9</i>	<i>0.7</i>	<i>0.7</i>	<i>0.8</i>	<i>33.1</i>
<i>Energy exporter</i>						
Trinidad and Tobago	0.0	0.0	0.0	0.0	0.0	0.0

Source: Data from database: World Development Indicators, <http://data.worldbank.org/data-catalog/world-development-indicators>. Last updated: 10/14/2015.

Table 29.4 Combustible renewables and waste (% of total energy)

Country	2000	2005	2010	2011	2012	2000–2012 % change
<i>Central America</i>						
Costa Rica	8.6	16.5	17.3	15.8	13.4	55.7
El Salvador	34.0	32.1	18.5	17.6	18.7	-44.9
Guatemala	55.3	51.1	61.6	63.6	63.7	15.3
Honduras	44.4	41.4	43.0	43.3	43.0	-3.3
Nicaragua	48.3	42.5	42.5	42.0	40.8	-15.6
Panama	18.0	15.7	13.0	11.5	10.6	-40.9
<i>Average</i>	34.8	33.2	32.6	32.3	31.7	-8.8
<i>Caribbean</i>						
Cuba	30.0	19.8	11.1	13.2	13.4	-55.4
Dominican Republic	8.4	9.2	8.7	8.5	8.5	1.7
Jamaica	15.1	10.6	16.6	16.7	17.0	12.5
Haiti	75.5	79.8	81.8	81.8	81.5	8.0
<i>Average</i>	32.3	29.9	29.6	30.0	30.1	-6.7
<i>Energy exporter</i>						
Trinidad and Tobago	0.22	0.25	0.07	0.07	0.07	-67.0

Source: Data from database: World Development Indicators, <http://data.worldbank.org/data-catalog/world-development-indicators>. Last updated: 10/14/2015.

While there is some controversy as to how best to measure energy efficiency, a simple ratio of GDP per unit of energy use (Table 29.5) provides a rough picture of improvements in the use of energy. On this basis both the Caribbean and Central American countries have been improving their use of energy, with the Caribbean countries as a whole seeing a 61.7% improvement between 2000 and 2010, compared with a 15.6% improvement in Central America. Gains have been across the board with significant increases in Cuba (99.8%), Dominican Republic (55.6%) and Jamaica (47.5%). In Central America, Panama had a gain in energy efficiency of 75.1% during this time. On the other hand, two other Central American countries, Guatemala (-5.3%) and Honduras (-4.5%) saw the amount of GDP supported by a unit of energy fall during this period.

The patterns noted above illustrate the difficulty of drawing broad conclusions over the energy situation in the region as a whole, or even for the Caribbean or Central America separately. Clearly several of the patterns can be explained by differential resource endowments, especially the limited alternative energy sources in the Caribbean. Electricity generation is a prime example. In a sample of Caribbean countries 94.2% of electricity generation comes from conventional thermal plants (Table 29.6). In contrast conventional thermal accounts for only 38.1% of generation in Central America.

With the potential for hydro-power much greater, Central America generates 43.4% of its electricity from this source compared with only 4.1% in the Caribbean. Clearly however other factors are at work. While one might anticipate a greater role for renewable energy in the Caribbean, this source generates only 1.7% of our regional sample's electricity compared with 18.5% in Central America.

Table 29.5 GDP per unit of energy use (constant 2011 PPP \$ per kg of oil equivalent)

Country	2000	2005	2010	2011	2012	2000–2012 % change
<i>Central America</i>						
Costa Rica	13.1	11.9	12.4	12.9	13.4	2.3
El Salvador	9.4	9.3	10.7	10.7	10.7	13.8
Guatemala	10.0	10.5	9.6	9.4	9.5	–5.3
Honduras	7.3	6.6	7.1	7.1	6.9	–4.5
Nicaragua	6.9	7.1	7.8	8.0	7.8	12.2
Panama	9.4	11.6	14.5	15.0	16.4	75.1
<i>Average</i>	<i>9.4</i>	<i>9.5</i>	<i>10.4</i>	<i>10.5</i>	<i>10.8</i>	<i>15.6</i>
<i>Caribbean</i>						
Cuba	9.7	14.8	18.1	19.1	19.4	99.8
Dominican Republic	10.0	12.4	15.6	15.8	15.5	55.6
Jamaica	5.5	6.2	8.4	8.0	8.1	47.5
Haiti	7.3	8.1	8.6	9.0	9.4	30.1
<i>Average</i>	<i>8.1</i>	<i>10.4</i>	<i>12.7</i>	<i>13.0</i>	<i>13.1</i>	<i>61.7</i>
<i>Energy exporter</i>						
Trinidad and Tobago	2.3	2.1	2.0	2.0	2.1	–10.3

Source: Data from database: World Development Indicators, <http://data.worldbank.org/data-catalog/world-development-indicators>. Last updated: 10/14/2015.

Table 29.6 Diversity of electricity generation (% by source)

	Conventional thermal	Hydroelectric	Other renewables
<i>Central America</i>			
Costa Rica	7.8	71.2	21.0
El Salvador	39.3	29.8	30.9
Guatemala	31.9	48.1	20.0
Honduras	54.9	37.7	7.3
Nicaragua	58.9	9.9	31.3
Panama	35.9	63.8	0.3
<i>Average</i>	<i>38.1</i>	<i>43.4</i>	<i>18.5</i>
<i>Caribbean</i>			
Barbados	100.0	0.0	0.0
Dominican Republic	86.2	12.8	0.9
Jamaica	90.7	3.7	5.6
Trinidad and Tobago	99.8	0.0	0.2
<i>Central America</i>	<i>94.2</i>	<i>4.1</i>	<i>1.7</i>

Source: World Energy Council, *Energy Trilemma Index*, 2015, <https://www.worldenergy.org/data/trilemma-index/country/>

Other differences no doubt stem from policy choices made by individual governments. If one accepts the basic premise of the energy trilemma – that a country cannot simultaneously have marked improvements in energy security, energy affordability and environmental quality, then movements in these three outcomes should in part reveal changes in national priorities in the energy area.

For the Caribbean sample (Table 29.7) Barbados appears relatively strong in energy equity, and in recent years has shifted towards energy security at the expense of environmental sustainability. The Dominican Republic on the other hand scores well in environmental sustainability and has given energy equity priority over energy security. Jamaica's highest priority has been energy equity. The country has traditionally favored environmental stability over energy

Table 29.7 The Energy Trilemma: Caribbean

	2011	2012	2013	2014	2015	2011/2015		Score
						Difference	Average	
<i>Barbados</i>								
<i>Energy performance</i>	32	36	59	63	91	-59	56.2	
Energy security	68	70	118	117	114	-46	97.4	D
Energy equity	51	45	41	34	47	4	43.6	B
Environmental sustainability	19	24	25	40	84	-65	38.4	C
<i>Dominican Republic</i>								
<i>Energy performance</i>	112	106	104	92	100	12	102.8	
Energy security	120	119	114	111	119	1	116.6	D
Energy equity	111	107	106	87	88	23	99.8	C
Environmental sustainability	56	54	55	54	56	0	55.0	B
<i>Jamaica</i>								
<i>Energy performance</i>	120	119	123	117	124	-4	120.6	
Energy security	128	127	116	121	126	2	123.6	D
Energy equity	78	76	81	79	82	-4	79.2	C
Environmental sustainability	96	98	110	90	105	-9	99.8	D
<i>Trinidad</i>								
<i>Energy performance</i>	82	86	113	64	75	7	84.0	
Energy security	66	74	79	50	61	5	66.0	B
Energy equity	50	49	95	30	33	17	51.4	B
Environmental sustainability	116	116	115	112	111	5	114.0	D

Source: World Energy Council, *Energy Trilemma Index*, 2015, <https://www.worldenergy.org/data/trilemma-index/country/>

security, although that may be changing with the country's recent drop in country ranking on environmental stability and improvement in the energy security area. As an oil producer Trinidad automatically scores well in the energy security dimension, with energy equity a close second. For the energy importers, the general pattern therefore is one of energy equity and environmental sustainability coming at the expense of energy security.

Energy priorities for the Central American countries are a bit more difficult to pin-point. Instead of the expected trilemma pattern of two energy dimensions dominating a third, the situation is generally one of a single dimension dominating the other two. As a virtue of their use of hydro-power all score the highest on the environmental sustainability dimension (Table 29.8). This doesn't necessarily signify that environmental sustainability was a goal in and of itself, but more likely that hydropower was an attractive source of electricity.

For these countries therefore, marginal changes in their rankings are likely to provide a more accurate picture of national energy priorities than that revealed through an examination of absolute levels. From this perspective, in recent years El Salvador has given preference to energy equity over energy security. The same applies to Guatemala, although that country continues to make progress in improving its environmental sustainability.

In recent years Honduras has seen a deterioration along all three energy dimensions. The decline was the greatest in the area of energy equity, suggesting a policy shift towards energy security. Nicaragua continues to make good progress in environmental sustainability while energy equity appears to take precedence over energy security. Costa Rica has one of the top scores in environmental sustainability, with the last few years signaling a shift towards energy security over energy equity. Finally, Panama continues to score extremely well in environmental sustainability with a shift towards energy equity over energy security in recent years.

Summing up, the general pattern revealed by country performance on the three dimensions of the energy trilemma is one where the Caribbean countries have given preference to energy equity and energy security over environmental sustainability. A more varied pattern exists in Central America with countries displaying continued interest in environmental sustainability, but with some attaching more preference to energy security and others showing concern for energy equity.

US initiatives towards the region

The Caribbean had an average cost of 0.33 dollars per kilowatt-hour (kWh)¹³ in 2012, nearly three times the US cost of electricity – a considerable economic burden for most of the region's economies. High electricity rates together with the extreme vulnerability to external developments faced by most of the energy poor Caribbean countries, and as noted, with the prospect that Venezuela may have to begin withdrawing its energy subsidy, Petrocaribe program, the United States has developed several energy related initiatives for the region.¹⁴ Given its concerns over global warming and the underdevelopment of renewable energy sources throughout the region, the Obama Administration has focused its efforts on expanding this source of energy. Several highlights include a \$20 million financing facility for green energy projects in the region. The US Overseas Private Investment Corporation (OPIC) will also be involved providing financing and insurance for new energy projects.

In addition to the programs initiated by the Obama Administration there are a number of public and private programs:

- The Ten Island Renewable Challenge/Operation Smart Island Economies. The Carbon War Room and Rocky Mountain Institute provide various services, including technical assistance to create roadmaps for Caribbean countries and financing.

Table 29.8 The Energy Trilemma: Central America

	2011	2012	2013	2014	2015	2011/2015		Score
						Difference	Average	
<i>El Salvador</i>								
Energy performance	33	41	37	36	56	-23	40.6	
Energy security	61	71	68	61	96	-35	71.4	C
Energy equity	63	67	64	71	66	-3	66.2	C
Environmental sustainability	15	11	11	11	18	-3	13.2	A
<i>Guatemala</i>								
Energy performance	41	47	38	26	48	-7	40.0	
Energy security	47	51	40	31	73	-26	48.4	C
Energy equity	69	72	75	73	76	-7	73.0	C
Environmental sustainability	30	35	36	29	16	14	29.2	A
<i>Honduras</i>								
Energy performance	97	94	95	105	117	-20	101.6	
Energy security	116	116	111	114	125	-9	116.4	D
Energy equity	86	83	90	102	102	-16	92.6	D
Environmental sustainability	57	53	52	55	68	-11	57.0	B
<i>Nicaragua</i>								
Energy performance	114	115	105	99	109	5	108.4	
Energy security	102	105	100	100	111	-9	103.6	D
Energy equity	101	101	91	101	101	0	99.0	D
Environmental sustainability	85	89	87	59	67	18	77.4	B
<i>Costa Rica</i>								
Energy performance	22	25	18	17	22	0	20.8	
Energy security	71	77	57	51	64	7	64.0	B
Energy equity	46	47	45	56	128	-82	64.4	B
Environmental sustainability	2	2	2	2	2	0	2.0	A
<i>Panama</i>								
Energy performance	25	27	28	43	51	-26	34.8	
Energy security	55	54	53	86	104	-49	70.4	D
Energy equity	59	60	58	50	54	5	56.2	B
Environmental sustainability	11	14	18	17	15	-4	15	A

Source: World Energy Council, *Energy Trilemma Index*, 2015, <https://www.worldenergy.org/data/trilemma-index/country/>

- Caribbean Climate Innovation Center. The World Bank's Climate Technology Program has created eight Climate Innovation Centers (CIC) throughout the world. The Caribbean CIC supports ventures through services such as proof of concept funding and access to technical facilities and information.
- Canada's Caribbean Program. Through their Foreign Affairs, Trade, and Development division, Canada's Caribbean Program serves eleven island and three continental nations, although not specifically addressing the energy sector.

There is a logic to focusing on renewables, and also for government financial assistance in developing projects in the area. Despite numerous physical opportunities for the development of renewables, particularly solar and wind, as noted above, there has been insignificant development throughout the region. The main constraint has been the limited opportunities for commercial profitability. In many Caribbean countries, state-owned electricity producers enjoy entrenched monopolies and have therefore not felt enough pressure to accommodate alternative sources of energy.

Currently, low oil prices and the prospects for them remaining low for some time are working to discourage investments in alternative energies. High upfront costs for renewable systems will likely continue to be the primary limiting factor to the industry. Still a number of other factors have tended to inhibit investment in renewables throughout the region.

Most importantly foreign investors have been overly cautious over financing projects owing to concerns that existing rules favor local firms or are changed capriciously for political reasons. On a broader level, there is also the perception held by many investors that many countries throughout the region have weak governance structures and retain outdated anti-business sentiments. In short, potential investors in renewable energy projects perceive a high level of resistance to private capital and regulatory reform by many countries. They are not convinced national institutional structures exist to the extent that even expanded initiatives by the United States and other countries will gain much traction in domestic markets. These are important considerations given the fact that nearly all the investments in renewables will have to be undertaken by the private sector.

There is good reason for concern. A quick glance at the World Bank's Ease of Doing Business data base shows that the Caribbean in particular ranks very poorly in terms of providing an environment conducive to large scale private sector participation. The Caribbean sample of Barbados, Dominican Republic, Haiti, Puerto Rico, Jamaica and Trinidad had an average rank of 100.5 out of 189 at the start of 2016 (Table 29.9). This was 12.3% higher than that found in Central America. While it was easier to start a business in the Caribbean, the average rank of Central American countries was 64.7% for credit and 20.3% for electricity.

With regard to concerns over governance throughout the region, at a January 2015 summit in Washington, DC as part of the "Caribbean Energy Security Initiative," the US vice-president, Joe Biden, told the region's leaders that they ought to harmonize regulatory frameworks and ensure that dispute-resolution systems were "predictable." Progress in this area while necessary is only a start at what has to be done to bring the region up to competitive standards with other potential investment destinations.

The World Bank's measure of regulatory quality (Table 29.10) illustrates the magnitude of the problem, particularly in the Caribbean region. Regulatory quality is generally low by international standards in both the Caribbean and Central America with the Caribbean sample of countries averaging in the high 30s, and Central America in the low 50s. Furthermore, the gap between the two regions has increased considerably over time from 25% in 1996 to 43% in 2014 as a result of fairly steady progress in Central America and retrogression in the Caribbean.

Table 29.9 Caribbean/Central America ease of doing business

Countries	Ease of doing business		Starting a business		Getting electricity		Getting credit		Enforcing contracts	
	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015
<i>Caribbean</i>										
Barbados	119	116	100	95	87	82	126	118	164	164
Dominican Republic	93	90	110	116	140	148	97	90	115	114
Haiti	182	179	188	187	136	133	174	171	123	120
Puerto Rico	57	56	51	45	57	57	7	6	100	100
Jamaica	64	71	9	17	80	67	7	12	107	107
Trinidad	88	85	72	68	27	24	42	36	167	167
<i>Average</i>	<i>100.5</i>	<i>99.5</i>	<i>88.3</i>	<i>88.0</i>	<i>87.8</i>	<i>85.2</i>	<i>75.5</i>	<i>72.2</i>	<i>129.3</i>	<i>128.7</i>
<i>Central America</i>										
El Salvador	86	97	125	120	107	106	107	106	109	109
Honduras	110	115	150	139	143	143	143	143	150	150
Guatemala	81	81	101	99	21	18	21	18	173	173
Nicaragua	125	123	123	119	94	90	94	90	94	94
Costa Rica	58	79	121	116	23	30	23	30	124	121
Panama	69	66	44	37	32	31	32	31	148	147
<i>Average</i>	<i>88.2</i>	<i>93.5</i>	<i>110.7</i>	<i>105.0</i>	<i>70.0</i>	<i>69.7</i>	<i>70.0</i>	<i>69.7</i>	<i>133.0</i>	<i>132.3</i>
<i>Caribbean/CA % difference</i>	<i>12.3</i>	<i>6.0</i>	<i>-25.3</i>	<i>-19.3</i>	<i>20.3</i>	<i>18.2</i>	<i>20.3</i>	<i>18.2</i>	<i>-2.8</i>	<i>-2.8</i>

Source: World Bank, *Doing Business*, <http://www.doingbusiness.org/rankings>.

Table 29.10 Regulatory quality (percentile)

Country	1996	2000	2005	2010	2013	2014	1996–2014 % change
<i>Central America</i>							
Costa Rica	72.1	70.6	66.7	68.9	68.9	70.2	-2.6
El Salvador	52.0	57.4	53.4	62.7	60.3	64.4	24.0
Guatemala	43.0	48.5	41.7	48.8	45.5	47.6	10.7
Honduras	26.5	37.3	30.4	45.5	45.9	38.9	47.1
Nicaragua	37.3	48.0	42.2	43.1	43.1	38.5	3.2
Panama	68.6	69.1	58.3	63.2	62.7	65.4	-4.7
<i>Average</i>	<i>49.9</i>	<i>55.1</i>	<i>48.8</i>	<i>55.3</i>	<i>54.4</i>	<i>54.2</i>	<i>8.6</i>
<i>Caribbean</i>							
Cuba	11.3	10.8	6.9	3.4	3.8	7.2	-36.0
Dominican Republic	41.7	44.1	42.7	47.9	48.8	51.4	23.4
Jamaica	60.3	57.8	59.3	58.9	58.4	56.7	-5.9
Haiti	17.2	15.2	11.3	17.7	19.1	14.4	-16.0
Trinidad and Tobago	69.1	72.1	67.7	68.4	59.3	59.6	-13.7
<i>Average</i>	<i>39.9</i>	<i>40.0</i>	<i>37.5</i>	<i>39.2</i>	<i>37.9</i>	<i>37.9</i>	
<i>Caribbean/CA % difference</i>	<i>25.0</i>	<i>37.9</i>	<i>29.9</i>	<i>41.1</i>	<i>43.5</i>	<i>43.0</i>	

Source: World Energy Council, *Energy Trilemma Index*, 2015, <http://data.worldbank.org/data-catalog/worldwide-governance-indicators>

In 2014 average scores in Central America were 8.6% higher than in 1996, whereas those in the Caribbean were 5.1% lower.

The main declines (in percentile terms) in regulatory quality between 1996 and 2014 occurred in Cuba (36%), Haiti (16%), Trinidad and Tobago (13.7%). On the other hand, the Dominican Republic experienced an improvement of 23.4%. In Central America despite slight declines in already high levels in Costa Rica and Panama, major gains were registered by Honduras (47.2%) and El Salvador (24%).

A related World Bank measure, government effectiveness, also has great relevance for implementing successful strategies in the renewable energy area. In contrast to regulatory quality government effectiveness does not show great differences between the Caribbean countries and those in Central America. However, rankings are generally quite low (35–40 percentiles), although they have been gradually improving in both regions (Table 29.11). Cuba is a bright spot in the Caribbean with a 193% improvement over its 1996 percentile, moving from the 18.1st percentile in 1996 to the 52.9th in 2014. On the other hand, Haiti's percentile ranking fell from 9.3 in 1996 to 1st by 2014 or a decline of 89.6%. During this period, government effectiveness also declined in neighboring Dominican Republic, but at the much lower rate of 12.8%.

El Salvador has led the way in Central America with its percentile increasing by 114.5% between 1996 and 2014, at the same time however both Guatemala (-28.2%) and Nicaragua (-8.3%) suffered declines.

A final index of interest for investors is that of corruption (Table 29.12). The World Bank's control of corruption measure shows another interesting contrast between the Caribbean and Central American countries. As with government effectiveness, both regions have poor records

Table 29.11 Government effectiveness (percentile)

Country	1996	2000	2005	2010	2013	2014	1996–2014 % change
<i>Central America</i>							
Costa Rica	62.0	62.9	59.0	65.1	67.9	69.2	11.8
El Salvador	24.9	35.1	44.4	56.0	49.8	53.4	114.5
Guatemala	34.1	35.6	27.8	28.7	27.3	24.5	–28.2
Honduras	19.5	33.7	30.7	31.1	25.8	20.7	5.9
Nicaragua	21.0	30.2	24.4	16.7	23.0	19.2	–8.3
Panama	57.6	62.4	37.3	59.8	62.7	63.0	9.4
<i>Average</i>	36.5	43.3	37.3	42.9	42.7	41.7	14.2
<i>Caribbean</i>							
Cuba	18.1	45.9	36.6	42.6	39.7	52.9	193.0
Dominican Republic	42.4	42.9	35.1	29.7	36.8	37.0	–12.8
Jamaica	60.5	56.6	54.6	62.7	55.0	60.1	–0.6
Haiti	9.3	3.9	5.9	2.9	3.8	1.0	–89.6
Trinidad and Tobago	56.1	70.2	60.5	63.6	63.6	64.4	14.8
<i>Average</i>	37.3	43.9	38.5	40.3	39.8	43.1	15.6

Source: World Energy Council, *Energy Trilemma Index*, 2015, <http://data.worldbank.org/data-catalog/worldwide-governance-indicators>.

Table 29.12 Control of corruption

Country	1996	2000	2005	2010	2013	2014	1996–2014 % change
<i>Central America</i>							
Costa Rica	73.7	79.0	66.8	72.4	71.8	75.0	1.8
El Salvador	21.5	36.1	42.4	51.4	47.8	43.3	101.6
Guatemala	22.9	28.3	32.7	37.6	33.0	28.4	23.7
Honduras	12.7	19.5	26.8	19.5	17.2	23.6	85.7
Nicaragua	32.2	10.7	34.1	23.3	25.4	19.2	–40.3
Panama	42.4	43.4	44.8	45.7	45.9	46.2	8.8
<i>Average</i>	34.2	36.2	41.3	41.7	40.2	39.3	14.7
<i>Caribbean</i>							
Cuba	70.7	71.2	63.9	69.5	62.2	58.7	–17.0
Dominican Republic	54.6	31.2	35.1	21.9	21.1	23.1	–57.8
Jamaica	49.3	53.7	43.9	44.3	46.5	43.8	–11.2
Haiti	10.2	4.9	2.9	7.1	11.0	7.7	–24.9
Trinidad and Tobago	83.4	62.0	55.1	45.2	47.4	33.7	–59.7
<i>Average</i>	53.7	44.6	40.2	37.6	37.6	33.4	–37.8
<i>Caribbean/CA % difference</i>	–36.2	–18.9	2.7	10.8	6.9	17.7	

Source: World Energy Council, *Energy Trilemma Index*, 2015, <http://data.worldbank.org/data-catalog/worldwide-governance-indicators>.

in this area with average scores generally in the 40s. However as in the case of regulatory quality, scores in Central America have increased over time (14.7% between 1996 and 2014), while those in the Caribbean sample have fallen (37.8% between 1996 and 2014). As a result, the Caribbean's higher average percentile differential of 36.2% in 1994 had fallen to a lower differential of 17.7% by 2014.

Between 1996 and 2014, increased corruption was a particular problem in the Dominican Republic (57.8%) and Trinidad and Tobago (59.7%). Nicaragua in Central America also saw its corruption ranking fall considerably (40.3%). In Central America, however the rest of the countries showed remarkable gains in this area. These were led by El Salvador (101.6%) and Honduras (85.7%). While these gains are impressive, the overall average scores in Central America still remain quite low by international standards.

No doubt the institutional deficiencies in both regions will severely limit interest in renewable development, especially that undertaken by foreign firms. The main concern however is with the Caribbean where not only are key governance measures low, by international standards and in relation to Central America, but many are currently in sharp decline.

Country experiences

While the prospects for a successful energy transition in the Caribbean appear bleak, there are bright spots. A closer examination of several countries' efforts and progress shows that it is possible to make progress despite a number of institutional and financial impediments.

Haiti

Even prior to the devastating January 2010 earthquake, Haiti's energy sector suffered from a number of deficiencies¹⁵ that prevented the sector from assisting the country's growth and development. The main difficulties included (1) very limited access to electricity, especially in rural areas, (2) over-dependence on fossil fuels for generating electricity, (3) significant energy losses from the national grid, (4) high cost and unreliable supplies, and (5) household reliance on wood and charcoal for home cooking. The latter practice had led to extensive deforestation.¹⁶

The earthquake was a dramatic reminder of the extent to which the country's energy sector was unsustainable. In particular, it demonstrated the urgent need for effecting a transition to a more accessible, efficient and ecologically sustainable system. However, effecting broad changes in Haiti's energy and sector is a major challenge. Not only is the country's power system one of the weakest¹⁷ in the Western Hemisphere, but the government's capacity to effect constructive change in the country's power sector is extremely limited.¹⁸

Of the four country case studies examined here, Haiti stands out in a number of important regards. Of the energy importers, Haiti derives the lowest share of its energy usage from imported fuels. Between 2000 and 2012 Haiti also had the largest percentage decrease in the share of fossil fuels in its energy mix (Table 29.2). A similar pattern exists with regard to the fuels in the country's total fuel consumption, and the decline (2000–2012) in the share of energy consumption from this source was second only to that of Guatemala. Haiti also had one of the lowest shares of energy derived from alternative sources and this share declined by far the most percent-wise (72.1%) between 2000 and 2012 (Table 29.3). In sharp contrast Haiti leads other countries by a large margin in the share of its energy derived from combustible renewables and waste (Table 29.4).

These patterns are largely reflective of the fact that most Haitian households rely on biomass, particularly in the form of charcoal, for their cooking.¹⁹ With the wide spread earthquake

-related destruction to the country's power grid, many households were forced to revert almost exclusively to biomass for their energy.

As noted the Haitian government currently has a very limited capability of undertaking a major expansion of the energy sector or even an upgrading of the current system. Of the Caribbean/Central American countries included in the World Bank's Governance Indicators,²⁰ Haiti receives by far the lowest scores in government effectiveness.²¹ Even worse, of the Caribbean/Central American countries, the country's ranking in government effectiveness has been declining at the most rapid rate (Table 29.11) since 1996, the starting date of the governance measures.

Next to Cuba, Haiti has by far the lowest levels of regulatory quality.²² Again, this key governance indicator has been declining over time, although not as rapidly as those in Cuba (Table 29.10). Finally, Haiti has by far the highest levels of corruption. This governance dimension has also been deteriorating over time. Finally, the country also scores the lowest in many aspects of the World Bank's ease of doing business index (Table 29.9). These patterns imply that, at least for some time, it is unlikely the Haitian government will be able to take the lead in modernizing and expanding the country's energy sector and power generating capacity.

The World Energy Council²³ did not include Haiti in its energy trilemma index. However, a similar exercise was undertaken by the World Economic Forum (WEF). The WEF's Energy Architecture Performance Index (EAPI)²⁴ is a trilemma-type construct measuring national energy performance. The index's three sub-components²⁵ bear a close resemblance to the classic trilemma. Equivalent to the trilemma's energy affordability is the WEF's Economic Growth and Development, a measure assessing the extent to which a country's energy architecture adds to or detracts from economic growth. In a manner similar to the trilemma's environmental sustainability, the WEF's Environmental Sustainability measures the environmental impact of energy supply and consumption. Finally, as with the trilemma's energy security the WEF's Energy Access and Security sub-index measures the extent to which an energy supply is accessible, secure, and diversified.

Of the four countries chosen for closer examination, Dominican Republic, Haiti, Costa Rica and Haiti, Haiti has by far the lowest overall EPI score. The country also trailed the others in energy access and security, but despite past deforestation for charcoal production, fared fairly well in environmental sustainability. Haiti and Nicaragua shared the lowest rankings in the economic growth and development component. Finally, Haiti had the lowest improvement in its EPI between 2013 and 2015. These scores further confirm the poor state of the Haitian power sector as well as that sector's ability to play a vital role in the country's economy and economic growth.²⁶

Yet despite the many obstacles, some progress has been made. In 2001 32% of the country's inhabitants had access to energy – electricity, solar, and generators. By 2012 this had increased to just 36%. For the urban regions the corresponding change was 62% to 63% while rural populations stayed at 11%. By 2012 and in terms of income group, for the country as a whole, 58.3% of the non-poor households had access to a sustainable source of energy. This declined to 28.2% for the poor and 7.9% for the extremely poor. Corresponding percentages for the urban population were 73.0% (non-poor), 51.3% (poor) and 32.4% (extremely poor). Access was much lower in the rural areas with 26.1% of the non-poor having access to a sustainable source of energy. For the poor this fell to 9.8% and further to 2.8% for those in a state of extreme poverty.²⁷

A World Bank assessment²⁸ found that much of the country's power difficulties stem from poor management and regulatory oversight of the country's electricity utility, *Electricité d'Haïti*

(EDH). Worsening commercial performance has led to a lack of infrastructure maintenance and rapidly deteriorated quality of electricity service, including frequent service interruptions and large voltage fluctuations.

EDH's weak grid infrastructure, poor commercial performance, and inadequate controls over subcontracted electricity generation by independent power producers (IPPs) have led to a financial drain on government resources. Due to its inability to meet electricity demand and in an attempt to expand electricity availability, EDH has subcontracted part of the production of electricity to IPPs. Unable to cover its operating expenses, including fuel costs and power purchases in part because of low bill collection rates, EDH has relied on fiscal transfers from the Treasury averaging US\$200 million annually in recent years (equivalent to 10% of the national budget and 1–2% of gross domestic products (GDP)).²⁹

For the near term there are numerous opportunities for donors,³⁰ the private sector, and even individuals to collaborate on some of the renewable technologies – from solar lights and charging stations for cell phones, to development of seed oil crops for biodiesel. With the spread of renewable electricity to rural areas many new jobs will be created directly and indirectly by new light industries taking advantage of local talents and resources.³¹ But these are still not at a stage that provides the entire country with a reliable low-cost energy supply. The potential to use natural gas, given the revolution underway in the US and the development of LNG export terminals along the Gulf coast, is now an increasingly realistic option. The fact that the Dominican Republic has a natural gas docking station has the potential of opening up a number of opportunities to begin the shift towards a more sustainable energy.

Realistically, for the near term there is little reason to expect Haiti to make significant progress towards transitioning to a sustainable energy mix. The country's capacity and business climate will have to be effectively dealt with before the transition towards improved energy security, sustainable environment and access to affordable power can begin in full force. In the longer term, assuming progress in institutional reforms occurs, the country has great promise for renewables, and the agreements reached in the Paris conference should help move both foreign and domestic investments and finance in this direction.

Dominican Republic

The Dominican Republic provides a contrasting case to the energy situation found in Haiti. Until 1950 the history of both countries followed a similar course of protracted power struggles, frequent periods of domestic instability and global commodity price instability. As a result, by 1950 their GDP per capita were nearly identical. Today however, Haiti has taken on many of the characteristics of a failed state, while the Dominican Republic enjoyed an income per head almost five times larger than its island neighbor.³²

Contrasts in the energy sector and related critical areas of government competency are just as pronounced. Whereas in our sample of ten Caribbean and Central American countries, Haiti had one of the lowest ratios of energy imports to total energy use, the Dominican Republic has one of the highest, averaging around 90% (Table 29.1). The difference occurs largely as a result of percentage use of fossil fuel in the national energy mix. Haiti has by far the lowest percentage, while the Dominican Republic has the highest, again around 90% (Table 29.2). The same pattern exists with combustible renewables and waste as a percentage of total energy with Haiti having the highest ratio and the Dominican Republic the lowest.

Because the Dominican Republic has little in the way of fossil energy reserves the country is extremely dependent on imports for the bulk of its energy. Currently the country's power is generated from natural gas (31%), coal (15%), diesel (6%), fuel oil (29%), isolated systems (8%),

wind (2%), and hydropower (9%). GDP per unit of energy use is considerably higher in the Dominican Republic and has increased at a much more rapid rate since 2000 (Table 29.5). As in the case of Haiti, the Dominican Republic has been receiving preferential oil-financing terms under Venezuela's Petrocaribe program.

Contrasts also abound in the area of government effectiveness where the Dominican Republic has averaged in the low 40th/high 30th percentile since 1996. On the other hand, Haiti has never reached the 10th percentile and is currently at the first percentile (Table 29.11). While not quite as striking, differences in regulatory quality (Table 29.10) are notable with the Dominican Republic averaging in the high 40th percentile and increasing by 23.4% since 1996. Haiti's, on the other hand, averaged around the 15th percentile while declining by 16% since 1996.

Corruption differences are also significant (Table 29.12) although both countries have seen a marked increase in corruption in recent years. The Dominican Republic also has developed a much more business friendly environment except for the ability of firms to obtain electricity – here both countries score, along with Honduras (Table 29.9) the lowest among the sample countries.

As noted earlier, Haiti was not included in the World Energy Council's trilemma database. The Dominican Republic on the other hand was included and posted relatively low scores on the energy security and energy equity dimensions, with environmental sustainability consistently receiving the highest score (Table 29.7). However, trilemma differences between the two countries are very apparent in the World Economic Forum's Global Energy Architecture Performance Index. Here both countries score fairly evenly in environmental stability. However, the Dominican Republic leads Haiti by a wide margin in the critical areas of economic growth and development and energy access and security.

Despite the Dominican Republic's lead over Haiti in many critical energy indices and government effectiveness the country's energy sector is still beset by a number of problems stemming from many years of low output capacity, poor sector management, rising demand and widespread theft, non-payment and technical (transmission and distribution) losses. In addition, the public energy transportation network is poorly developed, which leads to frequent energy blackouts.

According to a recent executive survey conducted by the World Economic Forum, within Latin America only Haiti and Venezuela have a worse-functioning electricity service. The sector's problems have resulted in regular blackouts, lost productivity, and an erosion in the competitiveness of manufacturing and other sectors.³³

Although lower international fuel costs should ease pressures somewhat, the power sector will remain one of the major constraints on the country's business climate. The country was in 123rd position in terms of quality of the electricity supply in the World Economic Forum's Global Competitiveness Report for 2015–2016,³⁴ above only Haiti (138th) and Venezuela (131st) in the Latin American region. At the start of 2016 the country dropped three places in the World Bank's Ease of Doing Business³⁵ ranking, to 93rd out of 189 economies, due in part to lengthy and expensive electricity procedures – it takes an average of 82 days to get the service running, compared with 65 days on average in the region. At the start of 2016 getting electricity in the Dominican Republic was even harder than in Haiti.

While many of the country's power sector problems are well known and have been present for years, little progress has been made in addressing them. Inefficiencies and budget deficits have been covered over through public subsidies. This practice has placed considerable pressure on the country's public finances. For example, in 2014 the government's budget allocated US \$1,200m for subsidies to the electricity sector while in 2015 lower global oil prices reduced this to US \$869m, or 1.4% of GDP.

The Medina administration's energy strategy has largely centered on expanding the number of conventional coal burning thermal plants. In trilemma terms there is a clear priority towards energy affordability and to a lesser extent energy security at the expense of environmental sustainability

The administration has also advanced the idea of an "energy pact."³⁶ The idea is to approach a consensus on energy reforms through a dialogue between representatives of various sectors of society. The process was begun in 2005, but as of early 2016 had not arrived at a final reform agenda, and a set of milestones to monitor progress. It is anticipated that the pact will be finalized later in 2016, although many issues remain unresolved.³⁷

There is widespread hope that the country's energy transition will be structured to conform to international standards set at the UN's Climate Change Conference in early December 2015. However, with the planned expansion of coal-fired plants, it is difficult to see how the country will be able to conform to the new set of international standards. This is especially the case given limited government support in recent years for renewable energy.

Further hindering the country's energy transition, in 2012 a series of fiscal reforms rescinded many of the tax advantages for investing in renewables. Given the country's past record on renewables and the fact that the energy pact appears likely to focus on more conventional power sources, a notable expansion of renewable energy in the country's energy mix appears problematic in the medium term.³⁸

Nicaragua

Just as Haiti and the Dominican Republic present an interesting contrast in energy transitions in the Caribbean. Nicaragua and Costa Rica have followed somewhat different paths in moving away from fossil fuels to a more sustainable and secure energy mix. As with Haiti's relatively lower capacity (low government effectiveness, poor business climate) Nicaragua has made less progress in this transition than Costa Rica.

As with the two Caribbean countries Nicaragua and Costa Rica have pressing reasons for reaching a more sustainable energy path. In Nicaragua's case, the country is finding climate change is having a devastating effect on the country's coffee crop, forcing many farmers to shift to cocoa,³⁹ while in Costa Rica's case not only the coffee crop, but the country's booming eco-tourism industry are also adversely affected by temperature changes.⁴⁰ Both countries are heavily dependent on Venezuela's Petrocaribe program which, as noted, is in danger of being scaled back or eliminated at any time.

Some major differences in capacity in implementing an energy transition stand out. Costa Rica is slightly below the 70th percentile (2014) in the World Bank's measure of government effectiveness whereas Nicaragua is slightly below the 20th percentile. Not only that, but Costa Rica's government effectiveness percentile has increased by 11.8% since 1996, whereas Nicaragua's has declined by 8.3% during this time. Similarly, Costa Rica is in the 75th percentile (2014) in the World Bank's control of corruption index, whereas Nicaragua's percentile is 19.2. Nicaragua's ranking on this index has fallen by 40.3% since 1996, whereas Costa Rica's has increased by 1.8%. Finally Costa Rica ranks 58th (2016) in the World Bank's Ease of Doing Business, while Nicaragua comes in at 125.

Capacity differences are no doubt at least partly responsible for the big gap in energy efficiency between the two countries, and may be an element affecting energy trilemma rankings. Costa Rica gets nearly twice the GDP generated per unit of energy use (Table 29.5), while the World Energy Council gives Costa Rica grades of A for environmental stability and B for both energy security and energy equity. Nicaragua in contrast received a B for environmental

sustainability but D for both energy security and energy equity (Table 29.8). Similarly, Costa Rica ranks 11th in the World Economic Forum's Global Energy Architecture Performance Index, while Nicaragua ranks 82nd (Table 29.13).

Other differences are subtler. For both countries, the percentage of energy imports in total energy use is in the high 40s although between 2000 and 2012 Costa Rica reduced (Table 29.1) these by nearly 17%, while Nicaragua has had a reduction of nearly 6%. Similarly, Costa Rica has had a fairly dramatic reduction in fossil fuel as a share of the country's energy mix, reducing the percentage of fossil fuels from 59% in 2000 to 47.8% in 2012 or an overall reduction of 19% (Table 29.2). Nicaragua reduced its share of fossil fuels from nearly 52% in 2000 to 43.7% in 2012, for a 5.1% reduction overall.

Larger differences are seen in the area of alternative energy where these sources account for 38.7% (2012) of total energy use in Costa Rica, but only 15.5% (2012) in Nicaragua (Table 29.3). As in Haiti combustibles and renewables account for a large share of Nicaraguan energy use (40.8% in 2012), while in Costa Rica (Table 29.4), as in the case of the Dominican Republic, a relatively low share (13.4% in 2012).

Similarly, the two countries vary considerably in their energy mix for electricity generation. Hydroelectric accounts for 71.2% (Table 29.6) of Costa Rica's electricity followed by other renewable (21.0%) and conventional thermal 7.8%. Nicaragua on the other hand relies largely on conventional thermal (58.9%) followed by other renewable (31.3%) and hydroelectric (9.9%).

Both countries share a commitment to improved energy security and a sustainable environment. Costa Rica has been more successful in this regard and, as noted earlier, is one of the world leaders in moving towards a completely carbon neutral environment, now targeted for 2021. Both countries have been important developers of hydropower and geothermal energy, and have considerable scope for expansion in these areas. Both are also focused on expanding the amount of energy they will receive from solar, wind, agricultural waste and biofuels. For both countries however billions of dollars in new renewable energy investments will be necessary to take advantage of their renewable resource potentials.

The Nicaraguan case is particularly interesting in that not only is Nicaragua the poorest country in Central America, it also has until recent years had one of the highest energy costs in Central America.⁴¹ The country also relies the most on conventional thermal to generate its electricity (Table 29.6).

Over the years and despite many impediments, the country has made significant progress in addressing its energy and security needs. In the 1990s, the dilapidated state of the country's power distribution system was responsible for the loss of up to 25% of all power generated and supply could cover just one-half of consumer demand. Daily blackouts, often lasting up to 6–10 hours, were the norm as late as 2006.⁴²

In 2007 the new Government of President Daniel Ortega signed several cooperation agreements with the Venezuelan Government of Hugo Chávez. Venezuela agreed to supply discounted oil to Nicaragua under its Petrocaribe initiative, as well as to build a refinery in the country.

In late 2008 the state power company, Empresa Nicaragüense de Electricidad (ENEL), announced that, thanks to assistance primarily from Venezuela and Cuba, and the installation of an additional 120 MW generating capacity, prolonged power cuts in Nicaragua would be prevented. By 2011 the Nicaraguan energy system had a surplus with a total installed capacity of approximately 1,000 MW and an average demand of 550 MW.⁴³

Renewable energy has become an integral part of the Sandinistas' economic development strategy.⁴⁴ In recent years this has involved attempts to expand the country's hydroelectric

Table 29.13 Global Energy Architecture Performance Index 2013–2015 (scores)

Country	Country rank		EPI index		Economic growth and development		Environmental sustainability		Energy access and security	
	2015	2013	2015	2013	2015	2013	2015	2013	2015	2013
<i>Caribbean</i>										
Dominican Republic	62	52	0.59	0.56	0.61	0.53	0.51	0.61	0.65	0.56
Haiti	119	94	0.44	0.43	0.44	0.44	0.67	0.64	0.22	0.20
<i>Average</i>	<i>90.5</i>	<i>73</i>	<i>0.52</i>	<i>0.50</i>	<i>0.53</i>	<i>0.49</i>	<i>0.59</i>	<i>0.63</i>	<i>0.44</i>	<i>0.38</i>
<i>% change: 2013–2015</i>										
Dominican Republic			5.36		15.09		-16.39		16.07	
Haiti			2.33		0.00		4.69		10.00	
<i>Central America</i>										
Costa Rica	11	19	0.72	0.65	0.69	0.62	0.69	0.61	0.77	0.72
Nicaragua	82	77	0.54	0.48	0.46	0.37	0.61	0.60	0.54	0.45
<i>Average</i>	<i>46.5</i>	<i>48</i>	<i>0.63</i>	<i>0.57</i>	<i>0.58</i>	<i>0.50</i>	<i>0.65</i>	<i>0.61</i>	<i>0.66</i>	<i>0.59</i>
<i>% change: 2013–2015</i>										
Costa Rica			10.8		11.3		13.1		6.9	
Nicaragua			12.5		24.3		1.7		20.0	

Source: Global Energy Architecture Performance Index, Report 2015, December 2014.

Note: Scores are on a scale of 0 to 1.

generating capacity. In 2015 hydroelectricity provided 9.9% of Nicaragua's total production of electrical energy.⁴⁵ Expansion plans include the 253-MW Tumarín hydroelectric project⁴⁶ in the South Atlantic Autonomous Region to be undertaken by Centrales Hidroeléctricas de Nicaragua at an estimated cost of some US \$1,000m and, on completion, will be one of Central America's largest hydroelectric dams. The dam, the construction of which was scheduled to be completed in 2019, was expected to generate an annual average of 1,184 GWh of energy. The Nicaraguan Government planned drastically to cut the cost of energy imports by generating 80% of the country's energy requirements from renewable sources by 2017.

Nicaragua's efforts in transitioning to a more energy and environmental sustainable mix are impressive given concerns, noted earlier, over the country's capacity to undertake such major changes. For most countries the national investment climate is critical in determining the flow of capital into renewable energy. Nicaragua has defied this general rule by ranking fourth in Latin America after Uruguay, Brazil, and Chile, but before Costa Rica in Climatescope's Enabling Framework Parameter⁴⁷ which assesses the mechanisms in place that can facilitate investment in renewables.

Despite its limitations in areas such as government effectiveness, corruption and a poor business climate, Nicaragua has developed a policy framework to support renewables and to improve legal security for investors in the sector. In addition, a highly professional microfinance industry has helped finance local businesses that specialize in assisting households and small businesses in introducing and drawing on renewable sources of energy.

Costa Rica

Costa Rica represents one of the more successful efforts in transitioning to a sustainable environment with improved energy security. The country has long been a leading advocate of hydropower and geothermal energy, and is now actively branching out into other renewables such as solar, wind, agricultural waste and biofuels.⁴⁸

These actions are all key components of the country's strategy to become carbon neutral (C-neutral) by 2021. Costa Rican President Oscar Arias observed that, "we do this with the hope that, eventually, we will be able to show the world that what ultimately needs to be done, can be done. As a small country, this is Costa Rica's important contribution to the climate change issue."⁴⁹

In part, Costa Rica's energy strategy is designed to take advantage of the country's geographical setting, and natural resource base. The presence of active volcanoes has opened up the opportunity for large developments in geothermal power generation. In addition, Costa Rica has abundant sunlight and wind, offering numerous opportunities for renewable development.

Electricity is provided by the Instituto Costarricense de Electricidad (ICE), a state controlled, vertically-integrated utility. The Costa Rican market includes private players, in the form of cooperatives and independent power producers selling electricity to ICE.

To meet the country's energy objectives, Costa Rican government offers a spectrum of incentives including import, value added and income tax breaks on select renewable energy materials and equipment. In addition, ICE periodically holds tenders to contract new clean energy capacity. A five-year net metering pilot program was in place in Costa Rica until February 2015.⁵⁰ The project was cancelled when the capacity limit of 10MW was achieved, but consumers that had already joined the program will remain connected for 15 years.

As of 2014 Costa Rica had 2.8GW of installed power capacity. Large hydro accounted for 44% of this while oil and diesel contributed 21%. The remaining 35% was clean energy of which 1.4% was from biomass and waste, 8% geothermal, 7% wind and 19% small hydro.⁵¹ As a

result of its successful energy transition, by 2015, Costa Rica was able to operate the country's grid for the first 75 days only using renewable energy.⁵²

While remarkable, Costa Rica's energy transition has not been without setbacks. By placing emphasis on energy security (less dependence on Venezuela) and environmental sustainability, the third dimension of the energy trilemma, energy affordability has suffered⁵³ with electricity tariffs increasing by 142% between 2005 and 2015.⁵⁴

The expected decline in the costs of renewable energy should help bring prices down in the future. Another factor behind the increases in tariffs stems from electricity demand simply out-running supply. This problem can be addressed through regulatory reform⁵⁵ removing restrictions on the amount of electricity smaller producers can put into the grid. Currently the private sector's generation is limited to 30% of the total power generated in the National Electric System. This highly regulated market unfortunately stifles competition. Since, ICE is not required to purchase from these generators, that means that these private generators must wait until the capacity demand increases.

With a high dependence on hydropower, the country is quite vulnerable to droughts and thus sudden surges in electricity prices. However, expanding other renewable sources over time will alleviate this problem. In short, the country has a number of options at its disposal for improving the energy affordability dimension.

In the near term, Costa Rica now has the option of importing some of its energy needs thus dampening price increases. The country is part of the Central American Regional Market (Mercado Eléctrico Regional, MER), which interconnects seven countries in the region. Due to severe droughts in the last several years Costa Rica has relied on the regional market to help meet its domestic electricity needs. In 2014, for example, Costa Rica imported 251GWh from the Central American Regional Market, 18% of all the imports that year.⁵⁶

The Costa Rica story holds out hope to many smaller countries wishing to transition to a more environmentally friendly and secure energy mix. Just knowing that this is possible will no doubt help build public support in these countries for pressing ahead. With the falling costs of renewable energies, the means are there for most countries to make significant progress on these two dimensions of the trilemma. For many however, increases in short run higher energy bills are a price they will face.

However, the Costa Rican model is not likely to take hold in larger more industrialized countries, particularly ones with heavier infrastructures and developed coal and/or oil resources. Here, a consensus on the path of the transition will be much more difficult to form.

Conclusions

The Caribbean and Central American regions illustrate the difficulty of making sweeping generalizations concerning energy transitions. Even in a regional setting where countries share a number of similarities such as small domestic markets with limited fossil energy reserves, a great variety of energy mixes are possible.

Still several patterns prevail. Progress or lack of movement toward a secure sustainable energy mix is largely related to government capacity, especially at the extremes as illustrated by Haiti with the least capacity and Costa Rica with the most. However, explaining progress in intermediate cases like Dominican Republic and Nicaragua requires additional insights. Are leftist regimes more concerned with the environment and energy security? Is there a political economy effect where democracies tend to place more emphasis on energy affordability? These may be avenues worth exploring in future research.

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