Estimating the Potential Impact of Renewable Energy on the Caribbean Job Sector

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Executive Summary

In July 2009 the United States Virgin Islands (USVI) Legislature passed Act 7075 (Bill No 28-0009). This Act, which amends previous VI Code, expands the capacity of various energy efficiency and renewable energy incentive programs available within the territory and highlights the immediate need for specific policy related to VI energy strategy. The development of indigenous sources of clean energy may spur the creation of more jobs per unit of energy delivered locally than ‘business as usual’ fossil-fuel economies and many of these jobs are likely to stay domestic as they involve construction and installation. Here, we present another tool that can be useful in decision making as the territory moves forward with its Energy Efficiency (EE) and Renewable Energy (RE) campaign.

We present a Green Jobs estimator which uses local and regional data on electricity production and jobs creation to estimate one of the potential co-benefits of EE and RE. The results presented here do not quantify all employment impacts. Instead this work and supporting analysis provides a framework for future investigation. We identify future steps that can be taken to increase the resolution of the model’s predictive capabilities. The model is based on direct construction, installation and maintenance jobs and indirect (non-energy sector) job multipliers (per GWh) for different energy resources based on literature and project review. It relies on synthesized data from a number of job studies done in the U.S. and Europe as well as data from renewable energy projects within the Caribbean region. We present a model scenario where together energy efficiency and renewable energy deployment initiatives would account for a 60% reduction in fossil fuel fired electricity as compared to the BAU.

The results show a modest number of jobs can be created by renewable energy generation out to 2025. More than 540 jobs can be created by 2016 and over 800 jobs by 2025. Importantly, the cumulative number of job years is approximately 2,000 by 2025 based on the projects outlined above. These job years can be divided into a number of different job types or lengths depending on the needs of the sector. Given the lack of data available within the region, there are a number of limitations in the methodology. Nevertheless we present a framework for decision-making and for analyzing the impacts of various generation fuel mix scenarios. We will continue to examine the linkages that exist between economic sectors in the territory to approach true estimates of the potential of RE and EE to provide co-benefits to the region.

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1 Introduction

Given the economic impacts of high and uncertain energy prices, a number of islands in the Caribbean have begun to promote energy efficiency and to introduce indigenous energy resources into local energy resource mixes through government policy and commercial enterprise. In July 2009 the United States Virgin Islands (USVI) Legislature passed Act 7075 (Bill No 28-0009). This Act, which amends previous VI Code, expands the capacity of various energy efficiency and renewable energy incentive programs available within the territory and highlights the immediate need for specific policy related to VI energy strategy[i]. Further, in 2010 the governor of the USVI signed a memorandum of understanding between the USVI and federal agencies to develop a clean energy development strategy in an effort to achieve a 60% reduction in fossil fuel reliance by the year 2025[ii]. This memorandum was reached under the guidance of the U.S. Department of Energy (DOE) Energy Development in Island Nations (EDIN) initiative.

A locally produced clean energy system can provide greater energy independence, security from global market volatilities, and has notable environmental benefits due to reduced air pollution and green house gas emissions. Furthermore, it can act as a driver for significant, positive economic growth[iii]. The development of indigenous sources of clean energy can spur the creation of more jobs per unit of energy delivered locally than ‘business as usual’ fossil-fuel economies and many of these jobs are guaranteed to stay domestic as they involve construction and installation. Investments in energy efficiency measures can redirect money otherwise spent on energy costs, reduce emissions, and create an even larger number of jobs. Finally, the push for greener economies strengthens the international environmental justice movement and can encourage mitigation action against climate change.

A ‘**green job**’ is loosely defined by UNEP[iv] as

> *‘work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high efficiency strategies; de-carbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution’.*

Since the signing of the memorandum a number of initiatives have been put in place including the establishment of working groups, the submission of Requests for Proposal

(RFPs), the collection of wind anemometry data, the commissioning of a large distributed photovoltaic system, solar rebate programs and the development of educational tools such as carbon footprint calculators. Here, we present another tool that can be useful in decision making as the territory moves forward with its Energy Efficiency (EE) and Renewable Energy (RE) campaign. We present a Green Jobs estimator which uses local and regional data on electricity production and jobs creation to estimate one of the potential co-benefits of EE and RE. The results presented here do not quantify all employment impacts. Instead this work and supporting analysis provides a framework for analysis. We identify future steps that can be taken to increase the resolution of the model's predictive capabilities.

2 USVI Labor Force

The US Virgin Islands have a population of over 115,000 and as of the last quarter 2011, the unemployment rate was roughly 10%[v]. The unemployment rate has been increasing gradually since the economic depression of 2008, before which it was roughly 6% for many years.

On January 18, 2012, the USVI received news of the closure of the Hovensa refinery in St. Croix[vi]. This shutdown will devastate the local economy, as over 2000 employees of Hovensa will lose their jobs. These job losses are already starting to ripple through the economy.

Historically, the Virgin Islands' economic volatility is due largely to its historic dependency on a few key industries, especially tourism and refining. Government jobs, whether federal, territorial or local, also comprise a far greater share of the islands' employment base than is true of the United States as a whole, although this share has declined in recent years. Manufacturing remains a small portion of the Virgin Islands economy, but one of critical importance. The territory's manufacturing activity is based in St. Croix, which still has a considerable rum industry. The occupational profile of the Virgin Islands is dominated by relatively low-skilled, low-wage positions—particularly those directly associated with the tourism, construction, and maintenance industries. Wages generally lag behind the United States. The (weighted) average earnings among the 30 largest occupations are roughly $25,000 per year, compared with a U.S. average of $30,000 for the same occupations[vii].

The Water and Power Authority (WAPA) supplies all public electric utility to the territory and currently has annual sales of over 766,000 MWh with a maximum demand of 134 MW. This power is supplied through an installed diesel-fired generation capacity of 320

MW and roughly 30 miles of transmission[viii]. In sum, WAPA employs over 600 people. Additionally, the VI Waste Management Authority (VIWMA) provides sewage and waste disposal services to the territory and employs roughly 200 people. VIWMA has a number of training programs[ix] already established for workforce development, including environmental enforcement, pipe assessment certification, waste water operations licensing and GIS. These programs could potentially help provide foundational skills for a number of related jobs in RE and EE so that further exploration of the relation between these utility companies and the workforce at large is necessary.

These recent trends in the expansion of construction and maintenance job markets as well as the training programs established by utility service providers bodes well for the emphasis being placed on RE and EE in the USVI. However, the closure of Hovensa will negatively affect the associated economic sectors and employment in those sectors. Further work is needed to explore the structure of the energy sector and its employment chain. The University of the Virgin Islands and other tertiary education programs are also crucial stakeholders in the development of a workforce that can support a shifting energy paradigm. Understanding how graduates from these programs approach the job market is an important future step and we are seeking further support from the Bureau of Labor Statistics in this regard.

3 Model Description

This model was designed by the Renewable and Appropriate Laboratory (RAEL), directed by Professor Daniel Kammen, at the University of California, Berkeley. The modeling methodology is adapted from the previous work of Max Wei, Shana Patadia and Professor Kammen at RAEL[x]. The model is based on direct construction, installation and maintenance jobs and indirect (non-energy sector) job multipliers (per GWh) for different energy resources based on literature and project review. It relies on synthesized data from a number of job studies done in the U.S. and Europe as well as data from renewable energy projects within the Caribbean region. We utilize the normalization approach of taking average employment per unit energy produced over plant lifetime, as described in Section 5 below.

We model the relationship between electricity production and job growth based on BAU Assumptions from 2010 Utility data and assuming a 1% annual increase in demand over the next 15 years, as described in Section 3 below. We then modeled various scenarios based on efficiency initiatives and renewable energy proposals according to the USVI Energy Office Comprehensive Energy Strategy and the Road Map analysis[xi].

The Green Job multipliers are static over time (based on aggregation). This allows for easy comparison across technologies with different life spans and capacity factors but assumes a linearity that is not realistic. In the future, we will expand on this and include cost qualifiers in the model for ease of use. For our purposes:

- One **job-year** is full time employment for one person for a duration of 1 year. Often, ‘‘jobs’’ and ‘‘job-years’’ are used interchangeably (however, referring to ‘‘jobs’’ created without a duration can be misleading)
- **Direct employment** includes those jobs created in the design, manufacturing, delivery, construction/installation, project management and operation and maintenance of the different components of the technology, or power plant, under consideration.
- **Indirect employment** refers to the ‘supplier effect’ of upstream and downstream suppliers
- **Induced employment** accounts for the expenditure induced effects in the general economy due to the economic activity and spending of direct and indirect employees
- **Common Job Metrics:** One-time and long term jobs are averaged over the expected lifetime of the technology giving Jobs/MW installed (or peak) and Jobs-years/GWh.

4 BAU Assumptions

WAPA’s energy sales from July 1, 2007, to June 30, 2008 were 829,146 MWh, up 7% from the previous twelve-month period (WAPA RFP 2007, WAPA Data 2008). WAPA has stated that it expects sales to increase to about 1,200,000 MWh by 2025. We thus assume a 1% annual increase in demand over the next 15 years and beyond to 2030. For the BAU case, we assume that oil-fired generators meet all increase in demand, with increased efficiency driven by the expanded use of heat recovery steam generators (HRSGs) in St. Thomas and St. Croix (WAPA Connect 2008). Both Hovensa and Renaissance also have 65MW systems with 80% capacity factors but for our purposes we assume that these systems do not contribute to public utility service and we do not include them in the job assessment.

5 Model Scenario

Many of the assumptions made for the expansion of EE and RE over the next two decades is taken from the U.S. Virgin Islands Energy Road Map. We assume that the goal of reducing fossil fuel use by 60% in 2025 is in part met through reducing the growth rate of electricity demand by implementing a number of the suggested energy efficiency measures. We assume energy efficiency can account for just under half of the reduction in fossil-fuel usage.

As part of its efforts to examine options for power generation replacements or additions, WAPA commissioned R.W. Beck and Associates to produce a high-level analysis of alternatives to consider that would reduce costs while maintaining system operational needs and reducing reliance on fossil fuels. The results were reported in a Fatal Flaw Analysis report released on February 25, 2008. Results from that study were used to examine options in more detail in the subsequent R.W. Beck Power Supply Evaluation completed on August 26, 2008. The Comprehensive Energy Strategy proposes a number of Energy Efficiency Initiatives including:

- Replacement of older generating units (eg Units 12,14,11,10)
- Improvements of Transmission and Distribution system to prevent losses
- Develop storage solutions to substitute for the low efficiency spinning reserve system currently in place where already fuel inefficient generators operate well below capacity
- Install leak detection systems on water distribution system to reduce water loss which currently accounts for 22% of distributed water, where water production accounts for a sixth of total energy consumed on the islands.
- Upgrade both the Richmond (St. Croix) and Harley (St. Thomas) Plants to include steam recovery generators that operate on a combined cycle
- Encouragement of cogeneration facilities at larger hotels
- Enforce building efficiency codes through VIEO and provide energy financing options to home owners and businesses to encourage compliance. Regulating building wall thickness, overhang rations, roofing materials, encouraging solar water heaters and promoting energy star appliances could reduce cooling and lighting loads significantly.

These measures, along with a smart metering program might represent an incremental saving of 310,000 MWh per year when fully implemented. Assuming a $45 million USD investment would put this on the lower end of the energy efficiency spending spectrum for the US[xii].

We also assume that by 2025 there will be 48% renewable energy penetration on the grid. There are many potential renewable energy options that have been proposed based on preliminary feasibility studies conducted by the Energy Office in collaboration with National Renewable Energy Laboratory (NREL) and we assume the following are implemented:

- A $225 million USD investment is made in refused derived fuel plants in St. Thomas and St. Croix that feed a 17 MW waste-to-energy facility in St. Croix slated to come online by 2016. Note that this assumption may be somewhat optimistic given the recent cancellation of the Alpine Energy Group's planned waste-to-energy facility[xiii].
- 20MW of Wind Turbines installed on St. Croix and St. Thomas (nameplate capacity, 35% capacity factor). We assume that installed capacity is added incrementally until all 20MW are installed by 2016 and then capacity increases at 2% per year till 2025.
- 20MW of PV installed on St. Thomas and St. Croix by 2020 and 40MW by 2025 (nameplate capacity, 5hr/day). We assume that installed capacity is added incrementally until all 20MW are installed by 2016 and then capacity increases at 2% per year till 2025. Note that there is currently an open RFP from WAPA for approximately 10 MW of solar in the territory[xiv].

Table 1. Renewable Energy Scenario Assumptions

	2009					2025				
Source	Installed Capacity (MW)	Cap Factor	Annual Energy Use (MWh)	% of Total Energy Use	% Total Generation	Installed Capacity (MW)	Cap Factor	Annual Energy Use (MWh)	% of Total Energy Use	% Total Generation
BAU			989,313					1,200,000		
Fossil Fuels			989,313	100%	100%			488,792	41%	55%
Energy Efficiency			0	0%	0%			310,000	26%	
Solar PV	0	0	0	0%	0%	50	0.2	87,600	7%	10%
Wind	0	0	0	0%	0%	20	0.35	61,320	5%	7%
MSW	0	0	0	0%	0%	17	0.9	134,028	11%	15%
Biomass	0	0	0	0%	0%	15	0.9	118,260	10%	13%
		RE Total	0	0%	0%		RE Total	401,208	33%	45%
		RE + EE Total	0	0%			RE + EE Total	711,208	59%	

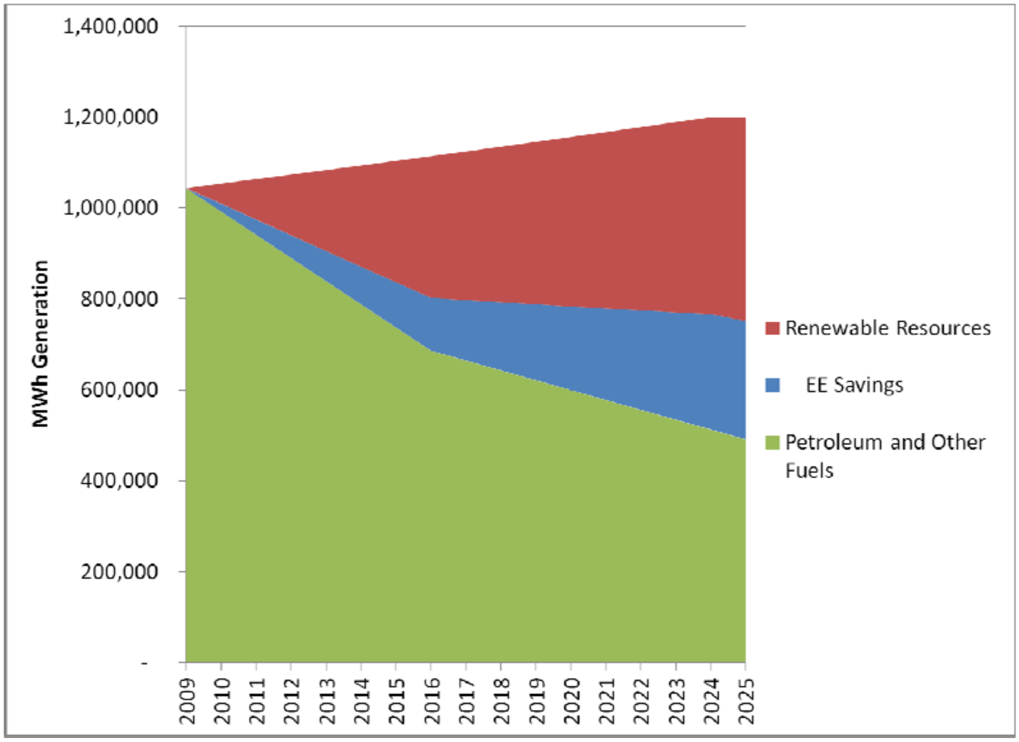

Figure 1 Generation Mix by 2025

Together this represents roughly 425,000MWh of generation a year. Assuming the business as usual 1% increase per year from 1,000,000MWh in 2010, the renewable energy solutions proposed would then account for roughly half of total electricity generation capacity. Together the energy efficiency and renewable energy deployment initiatives would account for a 60% reduction in fossil fuel fired electricity as compared to the BAU.

6 Job Estimators

The number of Green Jobs created per megawatt of renewable energy deployed is estimated using a series of job multipliers that vary by location and type of technology. These multipliers estimate the direct jobs created by the development, financing, construction, operation, and maintenance of renewable energy projects. The indirect jobs created by the proposed project are not estimated in this report. For biomass and Municipal Solid Waste generation we use job multipliers from the study by Wei et al (0.2 and 0.15 job years/GWh respectively). We take the indirect and induced job multipliers from the California Clean Energy Future[xv] (1.9 and 2.5 job years/GWh respectively).

However for the resources that feature more prominently in the Road Map analysis (solar, wind and energy efficiency) we are able to develop a group of Caribbean-based job multipliers based on data from project developers in Jamaica, the Netherland Antilles, Barbados and Grenada. These estimates are based on construction and operation/maintenance employment figures provided to us by the respective project developers. We use the solar water heating experience in Barbados to average EE but this is probably an underestimation since efficiency involves a number of other job descriptions and since EE multipliers have large margins of error in general. Nevertheless the values are within the range of those cited for EE within the US.

Likewise, the job multiplier values obtained from data on Caribbean projects for wind energy projects are well within the range of those projects deployed in the US. However, we note that given the small number of installations being deployed relative to its staffing, the job multiplier for Grensol, Solar PV Company in Grenada is disproportionately high and has been excluded in one of the model runs. The data we were provided does not account for indirect job effects such as jobs from storage improvements or grid upgrades and grid management. As the WAPA system evolves to handle more fuel sources, this would be an area of potential job growth. In the future we intend to understand the linkages within the energy sector more intimately for the purpose of better estimating indirect and induced linkages.

Table 2. Caribbean Renewable Energy Projects and Multiplers

Energy Technology	Source of Numbers			Employment Components			Averages	
	Project	Project size	Equipment Lifetime (years)	CIM (jobs/MW installed)	O&M (jobs/MW actual)	Cap Factor	Caribbean Avg Total Person-yrs/GWh	AVG
Solar PV 1	Grensol Ltd	65KW	25	0	30.77	0.22	16.19	16.19*
Wind 1	Wigton Wind Farm	20.7 MW	25	3.88	0.2	0.34	0.07	0.16
Wind 2	Nu Capital, Curacao	12MW	25	1.5	1.43	0.35	0.18	
Wind 3	NuCapital, Aruba	30MW	25	1.5	1.06	0.47	0.14	
Wind 4	WEB Bonaire	10MW	25	10	1	0.34	0.25	
Energy Efficiency	Solar Dynamics Ltd	140,000 MWh saved	20	0.59		0.22	0.31	0.31

7 Results

The results show a modest number of jobs can be created by renewable energy generation out to 2025. More than 540 jobs can be created by 2016 and over 800 jobs by 2025, if we assume the accelerated installation track as described in our model scenario above (see Table 3 and Figure 2). This is likely an underestimate given the small economies present in island regions. The indirect impact of renewables on the economy is likely to be much larger and this multiplier should be addressed in the near future for better estimation.

Importantly, the cumulative number of job years is approximately 2,000 by 2025 based on the projects outlined above. These job years can be divided into a number of different job types or lengths depending on the needs of the sector. If the model is run using the Grensol solar multiplier it quickly dominates the expansion of jobs out to 2025 and increases the total number of RE and EE jobs by 2016 to 1,800.

As Figure 2 shows, the majority of these green jobs will come from energy efficiency. We note earlier that the fastest growing job market in the territory is construction and repairs/maintenance. These are the types of job skills that can service energy efficiency projects such as retrofits or servicing energy efficient appliances. Thus there is momentum in this job market and the space for growth as efficiency measures become implemented at scale. It is important to understand and target programs and resources that provide training for these types of jobs so as to maximize the number of eligible persons entering the workforce.

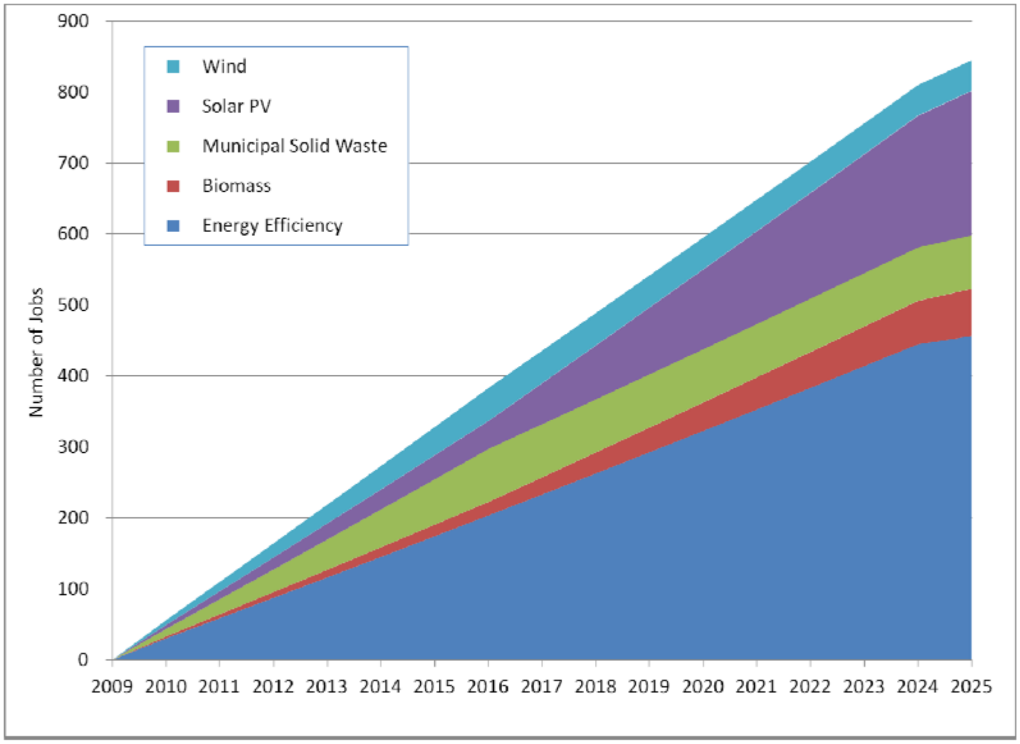

Figure 2. Green job growth estimation to 2025

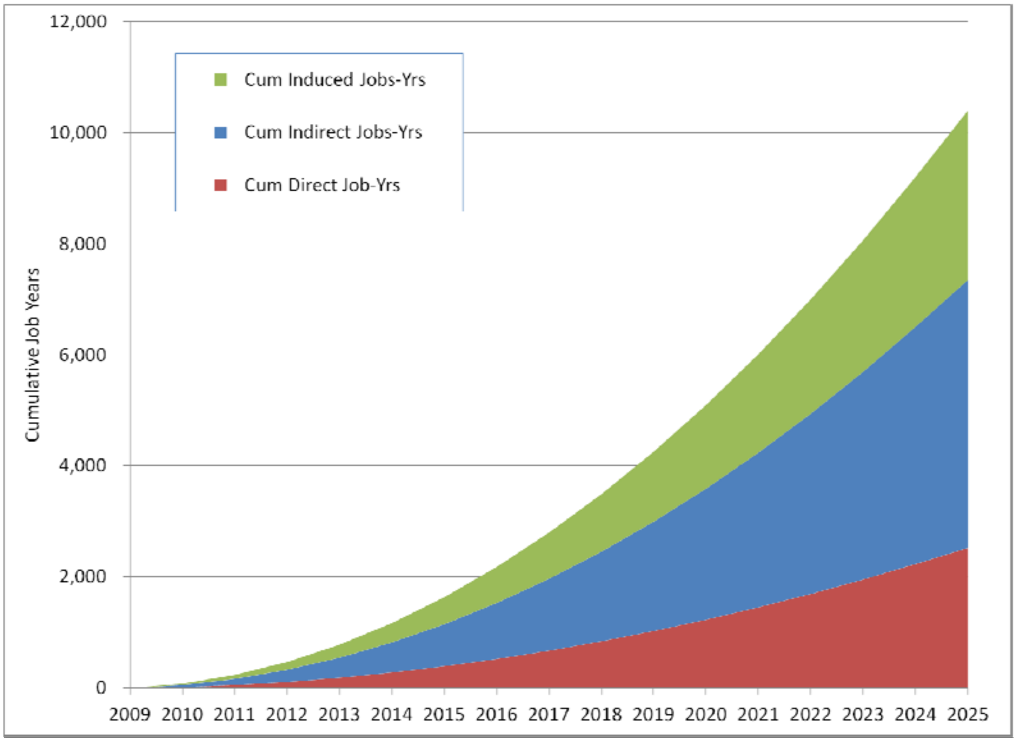

Figure 3 Projected Cumulative Growth of Direct, Indirect and Induced Job Years

Figure 3 shows the total number of cumulative job years to be quite significant. It is important to consider how the workload potential should be spread among long-term and short-term work contracts. This affects the distribution of wages and the assumptions regarding induced economic and job impacts. In the future we can further differentiate between demand and supply side energy efficiency job multipliers as we gain resolution on the areas of job training and growth.

Table 3. Job Estimator Outputs in Model Scenario[1]

OUTPUT - New Jobs vs BAU in:	2016	2025
Direct jobs	131	290
Indirect jobs	251	554
Induced jobs	162	351
Total jobs	544	1,195
Cumulative Job Years	2,178	10,397

8 Limitations

- Based on a very limited number of experiences in the Caribbean. These numbers may hold a great margin of error that has not been quantified. Comparisons are made to continental US or European projects where economies of scale are vastly different.
- The Green Job multipliers are static over time (based on aggregation). This allows for easy comparison across technologies with different life spans and capacity factors but assumes a linearity that is not realistic since jobs are not spread evenly over the life of a plant.
- The model used in this report does not consider potential jobs lost from conventional generation sources
- The model uses a generic multiplication factor for indirect and induced jobs. It does not investigate these job effects as it relates to the specific context of the USVI, the Caribbean region or developing countries in general.

[1] 60% Fossil Fuel Reduction by 2025 with Accelerated PV, Wind and MSW Deployment by 2016

9 Future Ideas

- Continue study of island renewable energy and energy efficiency deployment projects to understand what regional employment figures are achievable and to see how these figures compare to common literature, particularly with regard to energy efficiency and solar PV installations.
- Continue literature review to understand what other job estimators use as formulae particularly for power generation energy efficiency and building efficiency
- Develop a general understanding of employment landscape in the USVI to determine what skilled/appropriate capacity there is locally for construction, installation and operation.
- Develop another component of the estimator that considers investment costs for incorporation in the cost/benefit analysis of different technologies and strategies.

10 Conclusion

This report presents a green jobs estimator for the USVI based on local generation data and estimates of green job multipliers from regional and international contexts. The model shows that by 2016 as many as 540 direct jobs can be created throughout the territory by shifting away from fossil fuel electricity generation. By 2025, the number of direct jobs grows to over 800 jobs. Given the lack of data available within the region, there are a number of limitations in the methodology, largely centered on the model's conservative nature in estimating the indirect impacts of increased deployment of renewable energy and energy efficiency projects. We present a framework for decision-making and for analyzing the impacts of various generation fuel mix scenarios. We will continue to examine the linkages that exist between economic sectors in the territory to better approach true estimates of the potential co-benefits of renewable energy and energy efficiency in the region.

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