

## Roadmap to a Sustainable Energy System

*Feuille de route vers un système énergétique durable*



**Xing Fu-Bertaux and Matthew Lucky**  
Worldwatch Institute / *Institut Worldwatch*

Energy Workshop, Tuesday 27<sup>th</sup> September  
Port au Prince, Haiti

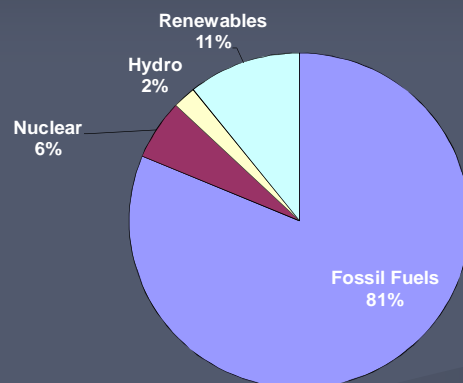
## Sustainable Energy Roadmaps

*Feuilles de route pour  
vers une énergie soutenable*

- 2 years project (2011-2013)
- Initial phase: collecting data, identifying barriers
- Worldwatch Methodology: laying out options to incentivize growth of the renewable energy sector
- Working in Haiti, Dominican Republic (first report to be published), and Jamaica

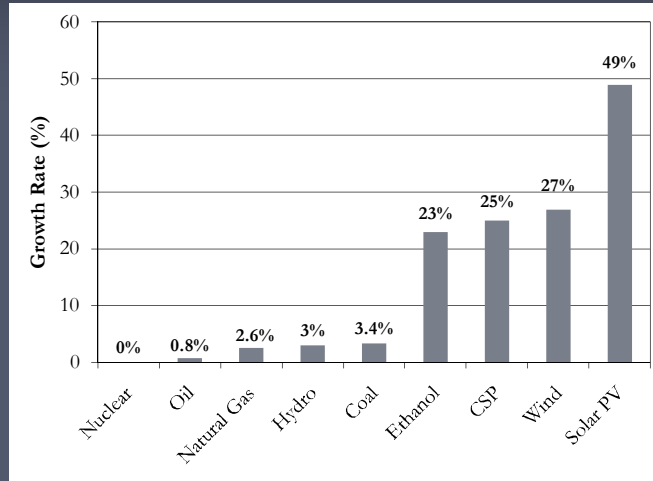
*Le système énergétique mondial est en transition*  
**ENERGY IN TRANSITION**

**Global Primary Energy Supply by  
Source - 2009**



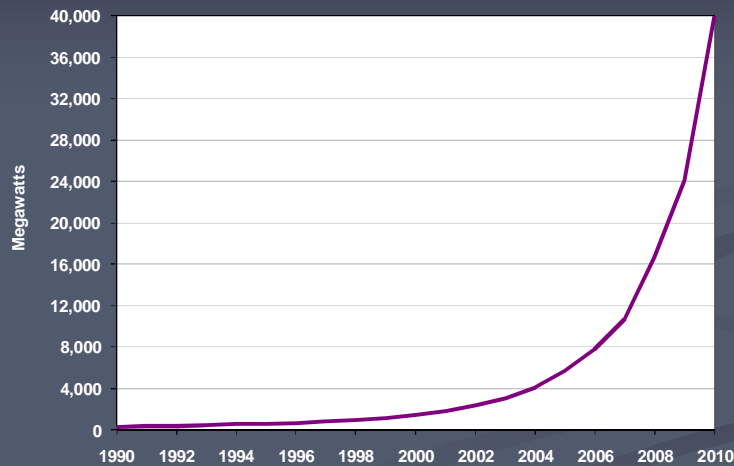
Source: IEA.

## Average Global Growth Rates by Energy Source, 2005-2010



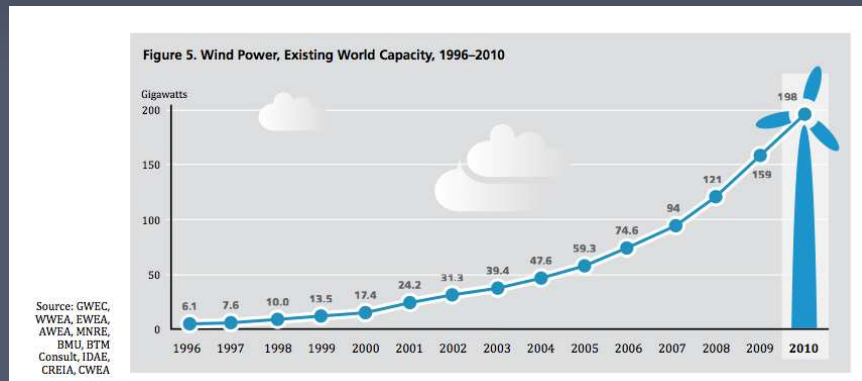
Source: REN21 2011, BP.

## World Solar PV Capacity 1990-2010



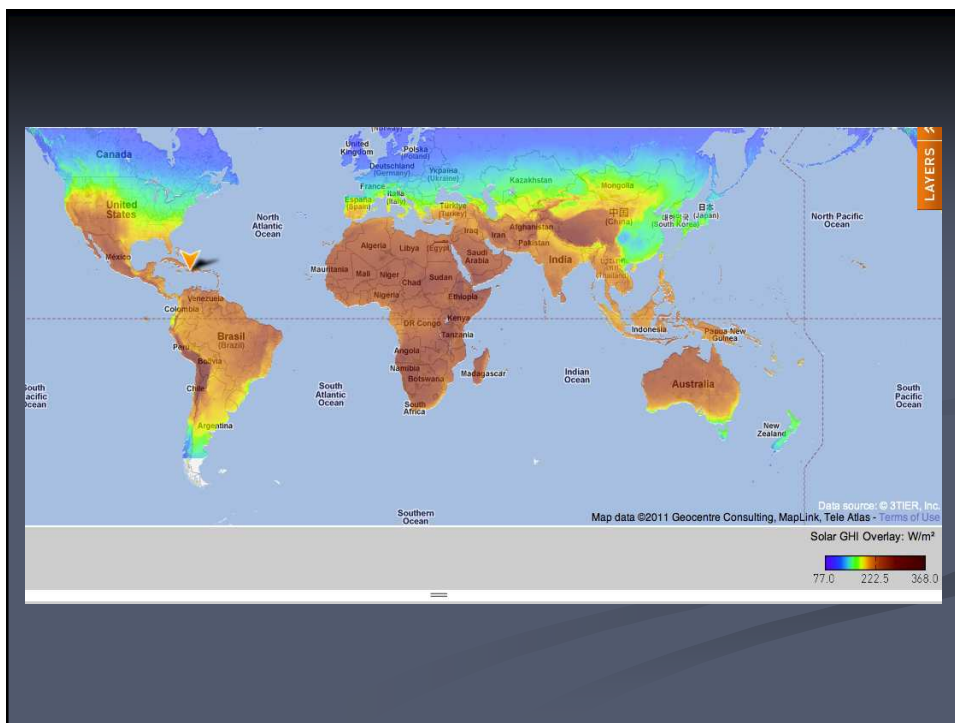
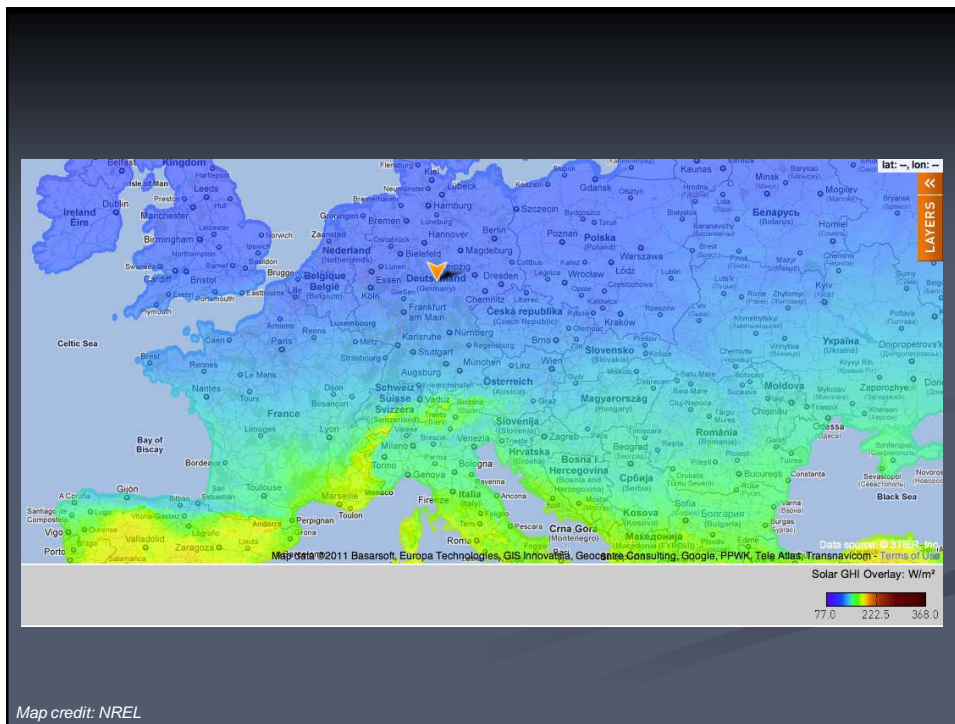
Source: REN21 2011

# World wind capacity 1996-2010

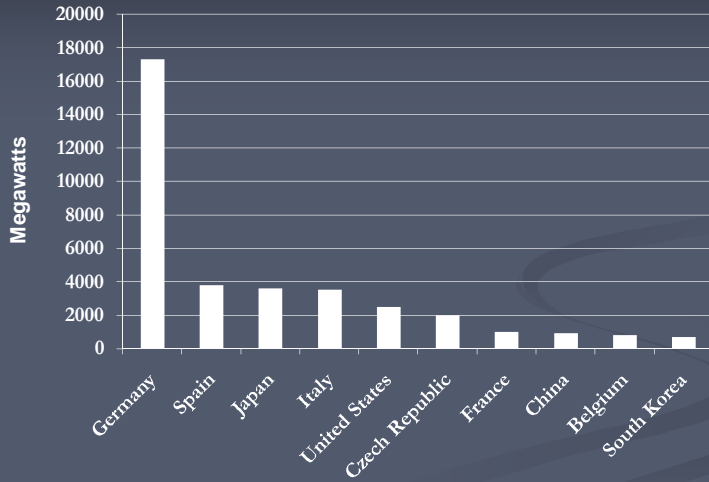


*Quelques chemins vers la réussite*

**ROADS TO SUCCESS**



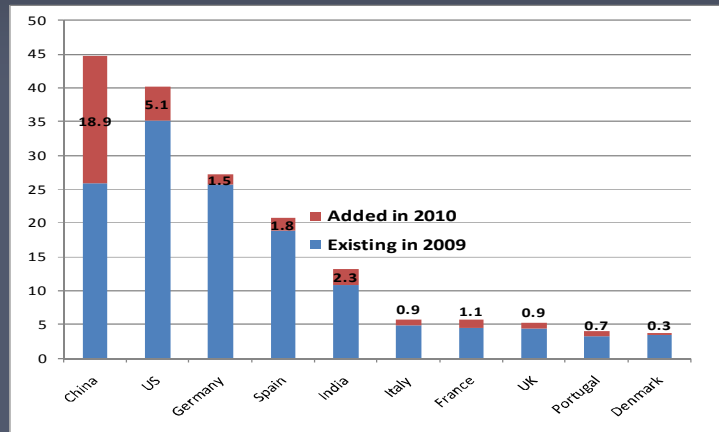
## Total Solar PV Capacity, Top Ten Countries, 2010



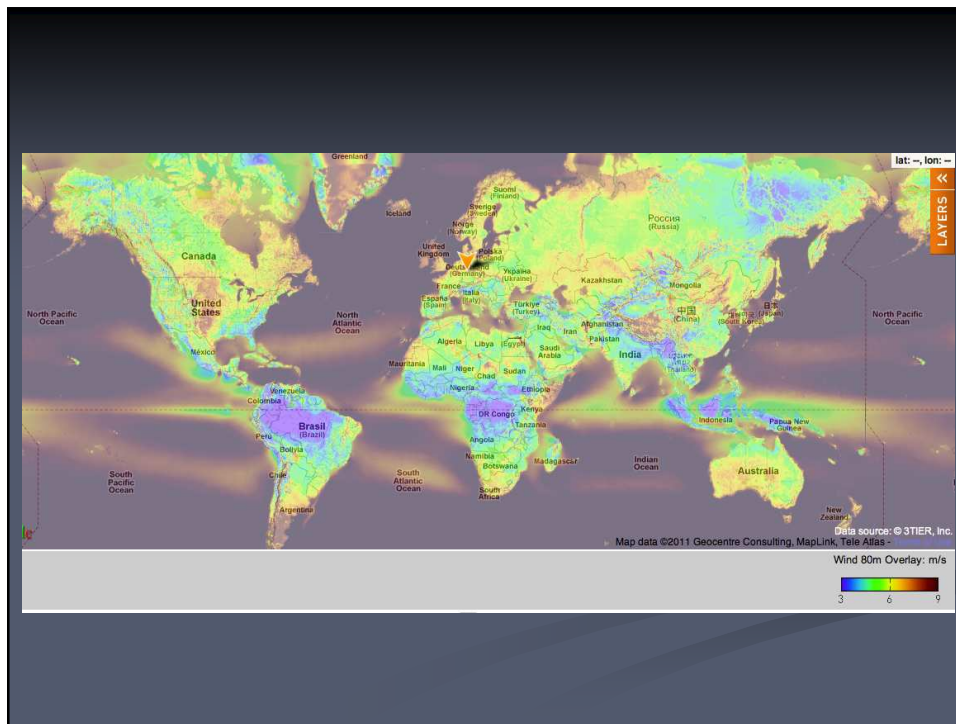
Source: REN21 2011



## Total Wind Capacity, Top 10 Countries, 2010



Source: REN21 2010

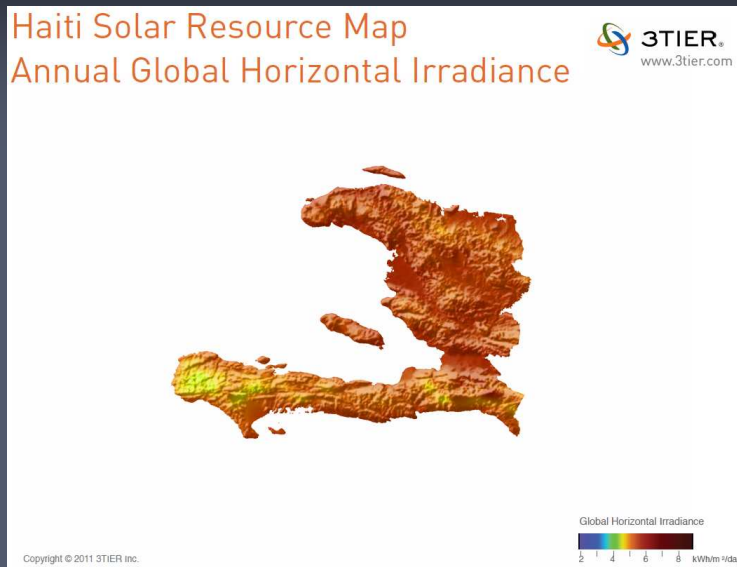


*Les ressources d'Haiti*  
**HAITI'S RESOURCES**

# Solar Methodology

- Solar estimates from satellite data and 3TIER irradiance model
- Global Horizontal Irradiance (GHI)
  - Quantity of direct beam and diffuse radiation hitting a horizontal surface
  - Appropriate for photovoltaic (PV) solar systems
- Direct Normal Irradiance (DNI)
  - Quantity of direct beam radiation hitting a flat surface that tracks the sun
  - Appropriate for concentrating solar power (CSP) systems
- Diffuse Horizontal Irradiance (DIF)
  - Quantity of diffuse radiation hitting a horizontal surface

# Haiti Solar Resource





## Solar Summary

- Haiti has a strong solar resource by global standards
  - It ranges from about 5-7 kWh/m<sup>2</sup>/day, with some areas up to 8 kWh/m<sup>2</sup>/day
  - Few locations in Germany are above 3.0 kWh/m<sup>2</sup>/day
  - Phoenix, Arizona is about 6.5 kWh/m<sup>2</sup>/day
- The solar resource is consistently strong throughout the country, including in Port-au-Prince

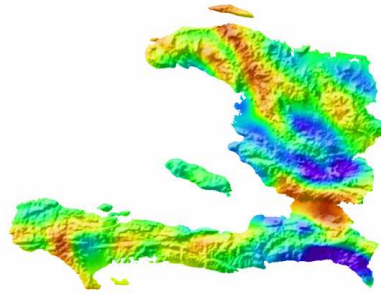
## Wind Methodology

- Wind estimates based on Numerical Weather Prediction (NWP) model
- Wind speeds measured at 80 meters
- Divided into grid points of 5.0 km per side
- Areas with strong wind potential can be re-evaluated at a 200 m per side resolution
  - 3TIERS GIS data files allow them to produce more granular maps

# Haiti Wind Resource

Haiti Wind Map  
Annual Wind Speed at 80m

 3TIER.  
www.3tier.com



5km Wind Map at 80m  
Wind speed  
3 4 5 6 7 m/s

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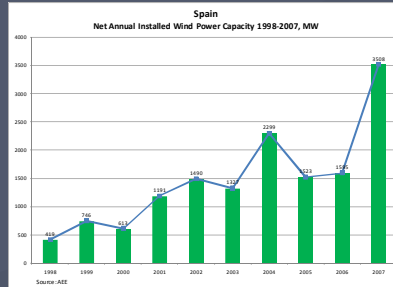
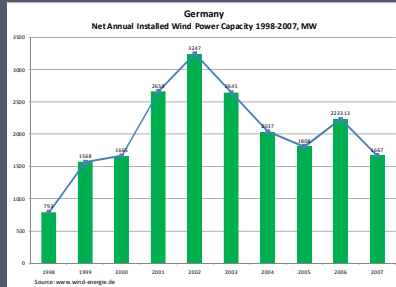
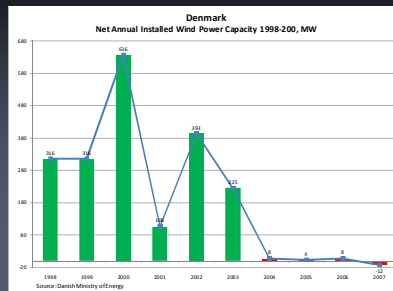
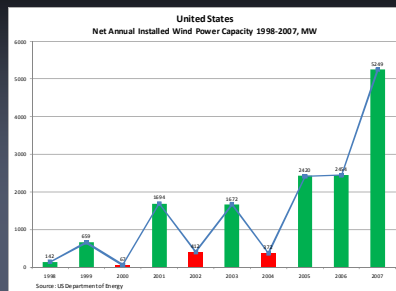
## Wind Summary

- Wind speeds of 7-9 m/s are found in several locations throughout Haiti
- The area right around Port-au-Prince has very strong wind potential
- The northwestern and southwestern regions of Haiti also have strong wind potential

*L'engagement du gouvernement est crucial*

# GOVERNMENT SUPPORT IS KEY

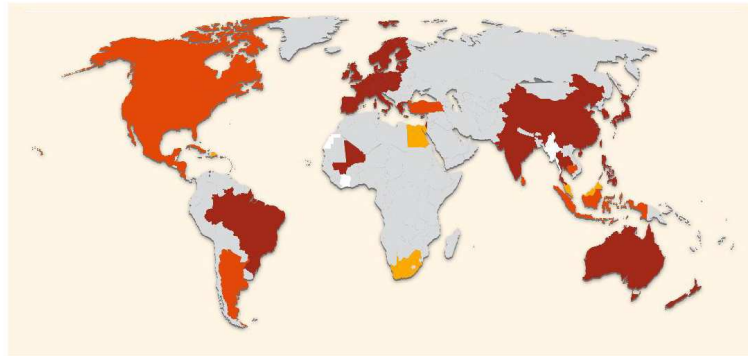
## Government support drives the wind market



■ = Years with production tax credit (US) or feed-in tariff (DK, DE, ES) for new wind turbines

■ = Years with no production tax credit (US) or feed-in tariff (DK, DE, ES) for new wind turbines

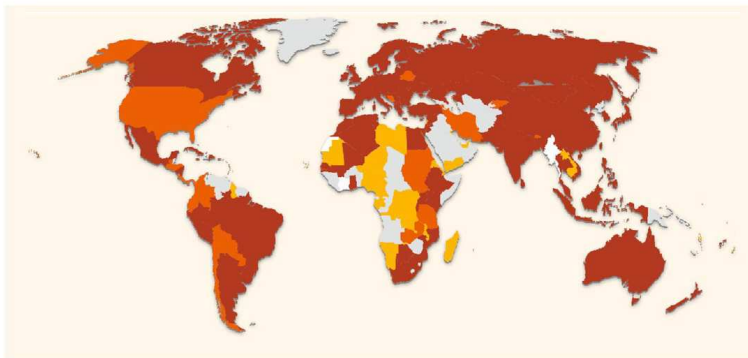
### RE and Climate Change Mitigation Policies 2004



- Countries with AT LEAST ONE National RE Policy and ONE RE Target
- Countries with AT LEAST ONE National RE Policy
- Countries with AT LEAST ONE National RE Target
- Countries without RE Policy Mechanisms and RE Targets
- No Data

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INTERGOVERNMENTAL PANEL ON climate change

### RE and Climate Change Mitigation Policies 2011



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*Quelques politiques qui fonctionnent*

## **POLICIES THAT WORK**

### **Principles**

- Loud, Long and Legal
- Measuring to manage
- Transparency, Accountability, Participation
- Flexibility

Policy	Technology	Successes	Problems
<b>Production or Investment Grant/Subsidy</b>	All renewables ready for deployment: <b>Wind, Solar, Geothermal, Small Hydro, Biomass.</b>	<b>Unites States (federal and state level)</b>	- Needs to be renewed regularly – signal for investors less predictable
<b>Government tenders for large-scale projects</b>	Utility-scale renewable projects: <b>Wind, Solar.</b>	<b>China</b> – wind and solar projects <b>United Kingdom, Denmark</b> – offshore wind projects	- Unattractive bidding conditions - Lack of predictability/one-off incentive - Lack of transparency - Focus too much on installation price and less on reliable production.
<b>Government Procurement</b>	All renewables, usually favoring cheaper ones: <b>Wind, Hydro, Biomass</b>	<b>United States (federal and state)</b> <b>Germany (federal and state)</b>	- Focus on lowest price, less effective to drive investment in innovative sources.
<b>Tax credits or subsidies for manufacturing</b>	Large set of technologies, depending on choices by policy makers.	<b>United States</b> <b>Germany</b> <b>China</b>	- Could be seen as trade-distorting and protectionist. - Doesn't necessarily lead to deployment in the subsidizing country.
<b>R&amp;D Support</b>	Technologies at earlier stages on the innovation chain: <b>Second and Third Generation Solar PV, Concentrating Solar Power, Advanced Biomass, Tidal Power, Technologies for grid integration, storage, batteries</b>	<b>Unites States</b> – DoE National Laboratories and ARPA-E <b>Germany</b> – regional solar research clusters <b>China</b> - 863 program, 973 program and National Key S&T program	- Risk of failure

Policy	Technology	Successes	Problems
<b>Price on Carbon</b>	Technology-neutral	<b>EU ETS</b> <b>RGGI</b> (parts of US, Canada)	- Price levels not sufficient to spur large-scale deployment of renewables
<b>Interconnection and net metering standards</b>	Distributed renewables: <b>Solar, Wind, Biomass, Geothermal</b>	<b>US (state-level)</b>	- Patchwork of state policies - Not a sufficient incentive, only a building block
<b>Feed-In-Tariff</b>	All renewables ready for deployment: <b>Wind, Solar, Geothermal, Small Hydro, Biomass</b>	<b>Germany, Spain, Denmark and another 60 jurisdictions world-wide.</b>	- Setting the right level of the tariff is challenging - Difficult to adapt tariff levels to market developments without creating boom-and-bust cycles.
<b>Renewable Energy Standard</b>	Cheapest among the eligible technologies: <b>Wind, Biomass, Hydro.</b>	<b>Unites States (in 27 states)</b>	- No efficient support for technologies that are not as far along the innovation chain - Definition of eligible technologies can limit effectiveness - Prices for certificates fluctuate, making for a less clear price signal.
<b>Production or Investment Tax Credit</b>	All renewables ready for deployment: <b>Wind, Solar, Geothermal, Small Hydro, Biomass, Landfill Gas.</b>	<b>United States</b>	- Needs to be renewed regularly – signal for investors is less predictable - Needs investors with large tax liabilities and elaborate financing models

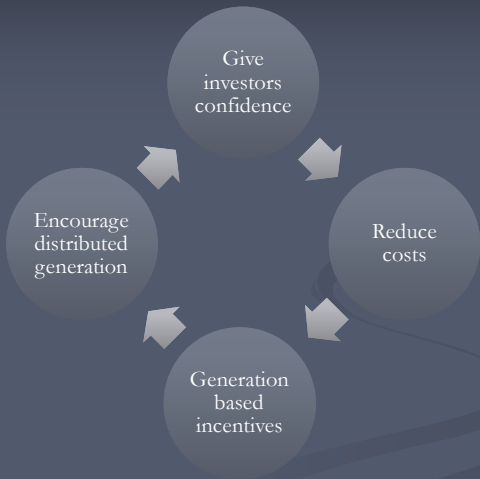
## Administrative and financial support

- Administrative support
- Specialized national funds for renewable energies
  - Mix of public and private capital
  - Facilitates “direct access” to international funds
  - Eg. IREDA, CORFO

## Making international support work for renewable energies

- Rising investments in renewable energies by MDBs
- Donors pledges and HRF
- Bilateral financing channels
- GEF/Green Climate Fund
- Haitian Delegate on the Technology Executive Committee of the UNFCCC

# Recommendations



blogs.worldwatch.org/revolt

**reVOLT**  
The Worldwatch Institute's Climate and Energy Blog

**JUN 01** **Financing the Sustainable Energy Transition: A "Smart" Role for International Public Finance**  
King Fu-Bertaux | Revolt | 2011-06-01

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The International Energy Agency (IEA) projects that between 2011 and 2050, an average of 1.5 trillion dollars will be needed annually to limit atmospheric greenhouse gas concentrations to 450 ppm. The IEA also estimates that some 80 percent of new electricity generation capacity will be installed in developing countries. Although these countries are rich in energy technologies, international support is needed to make them stabilize the global climate.

**Spending Wisely**

Developing countries (MDBs) renew, identify energy-related projects. The Report of the Secretary-General's High-level Advisory Group on Climate Change Financing states that "Spending resources wisely is critical to building the mutual confidence needed to mobilize climate finance"

**reVOLT**  
The Worldwatch Institute's Climate and Energy Blog

**JUN 16** **A Journey of a Thousand Miles Begins with a Single Roadmap**  
Sam Girard and Mark Konrad | Revolt | 2012-02-03

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Worldwatch's Energy and Climate team is busy implementing a one-year initiative, funded by the Energy and Environment Partnership with Central America (EPA), to develop a Low-Carbon Energy Roadmap for wind and solar power in the Dominican Republic. We will soon begin a similar project in Haiti and Jamaica and expand our work in the Dominican Republic to include other resources, including biomass, with the sponsorship of the Dominican Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (MARN).

Through these initiatives, we are taking a holistic approach to discerning the potential for low-carbon development, which we believe will provide insights directly useful to policymakers and business leaders. The first half of the project has yielded good results, and we hope it will be the first of many such projects for our Caribbean Program.

The small-island states of the Caribbean are perfect candidates for being "first movers" in low-carbon development. Very few of them have fossil fuel resources of their own, and the vast majority relies heavily on imported energy, specifically oil and gas. The Dominican Republic consumes, on average, 175,000 barrels of oil per day, and in 2007, 70 percent of the country's electricity was generated from oil and gas. This leaves the Dominican Republic, like all other small-island states, vulnerable to price shocks and lacking energy security.

Moreover, generating electricity from oil is very expensive, and these countries pay higher prices for their oil imports than large consumers such as the United States. Small-island countries are also especially vulnerable to spikes in a broader energy market, due to these funds. Many experts argue that public monies should be used mainly as a leverage tool to

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Pursuing the Low-Carbon Economy: The One and Only Path to Renewable Energy and Climate Change

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