Federal Ministry
for Economic Affairs
and Energy

Renewable Energies in Colombia

Jose Antonio Vargas Lleras, Vice Chair
LAC, World Energy Council

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About the World Energy Council

WORLD ENERGY COUNCIL

- **The world energy leaders' network**
- **Promoting an affordable, stable, and environmentally sensitive energy system for all since 1923**
- **Truly global**
  – 90+ country member committees
- **Inclusive and impartial**
  – OECD & non-OECD
  – non-governmental
  – 3000+ members from governments ,industry, academia, & NGOs
- **Informs global, regional, national strategies**
  – Authoritative studies
  – High-level events: World Energy Congress, World Energy Leaders Summit

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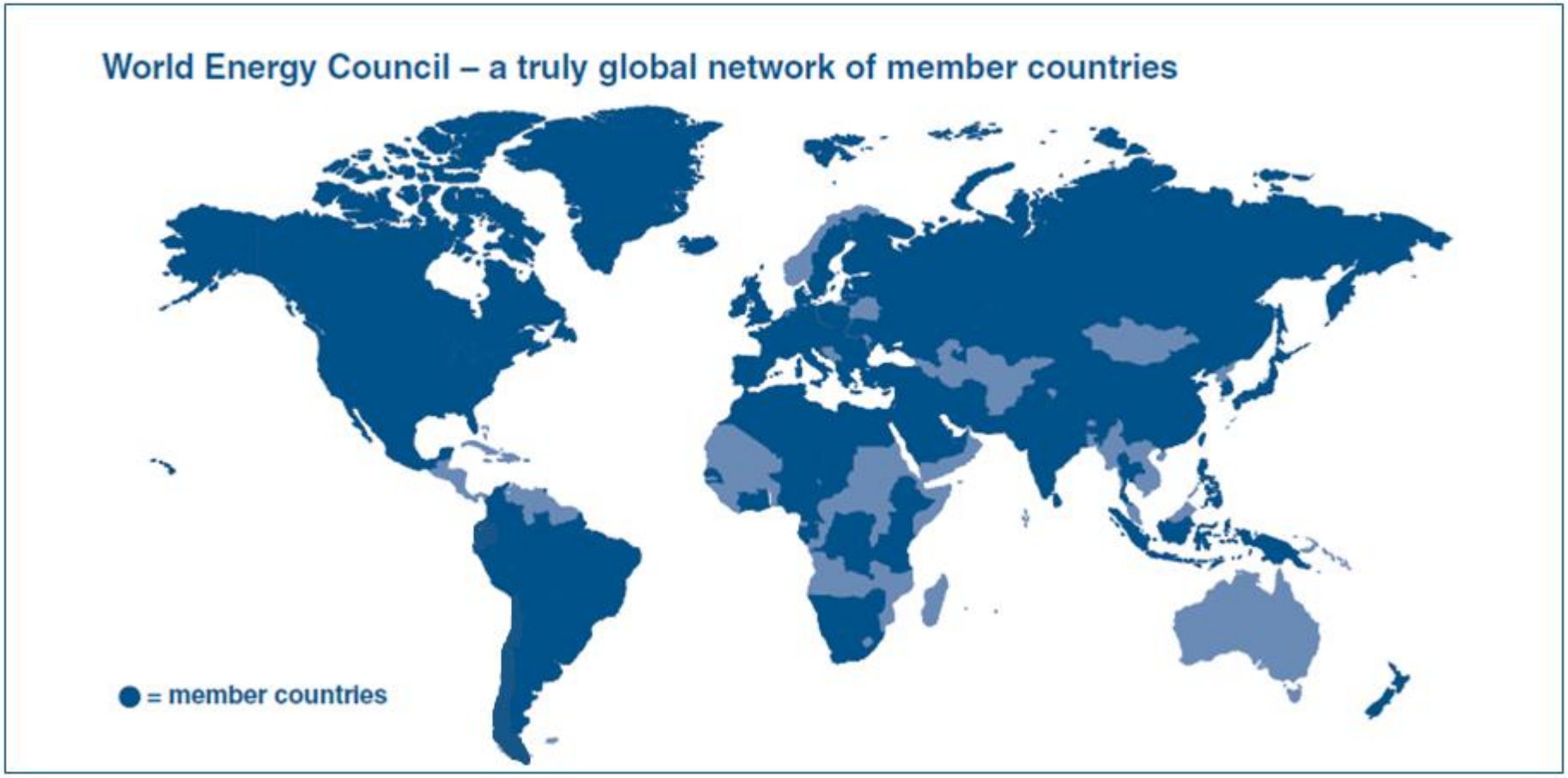
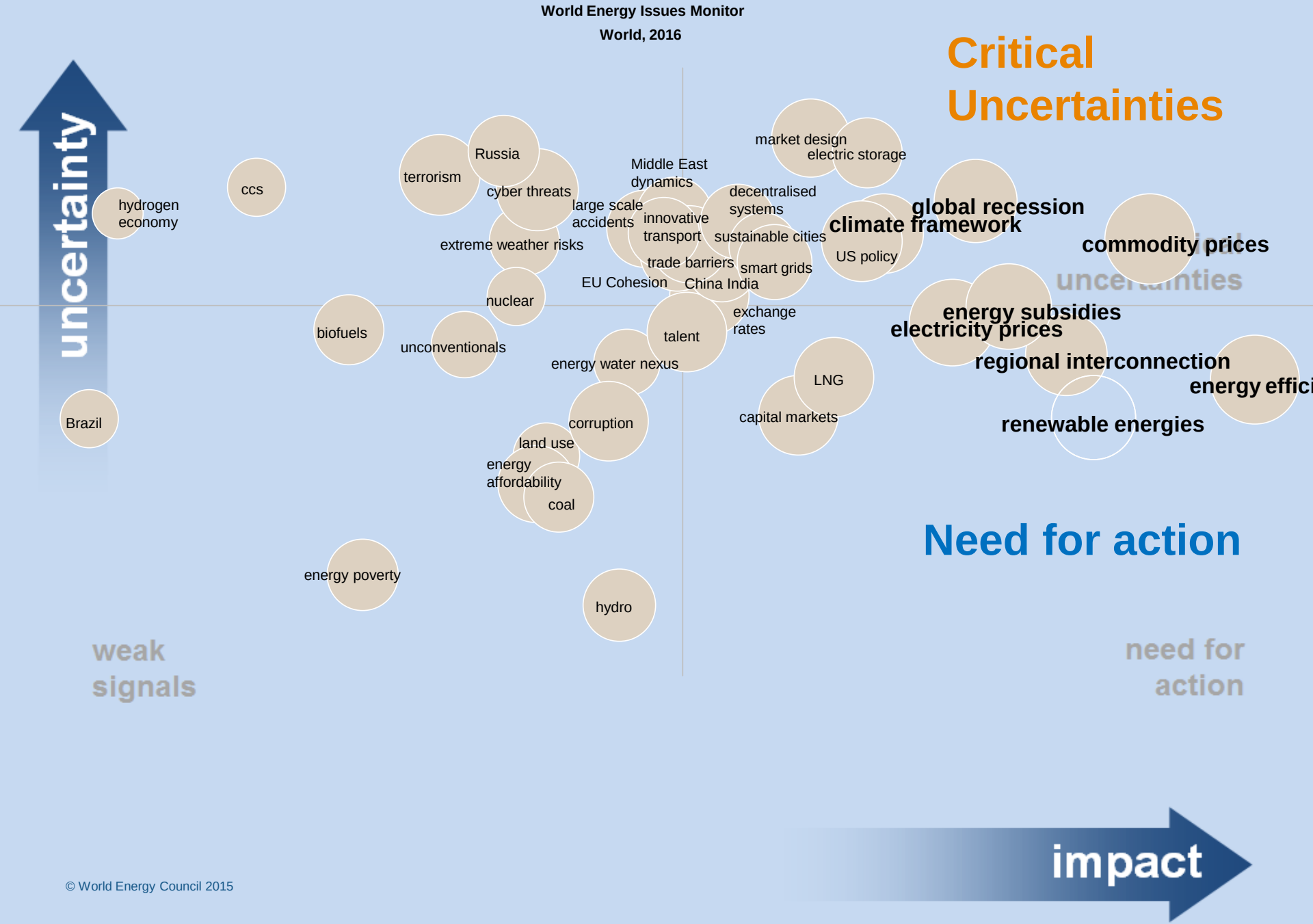
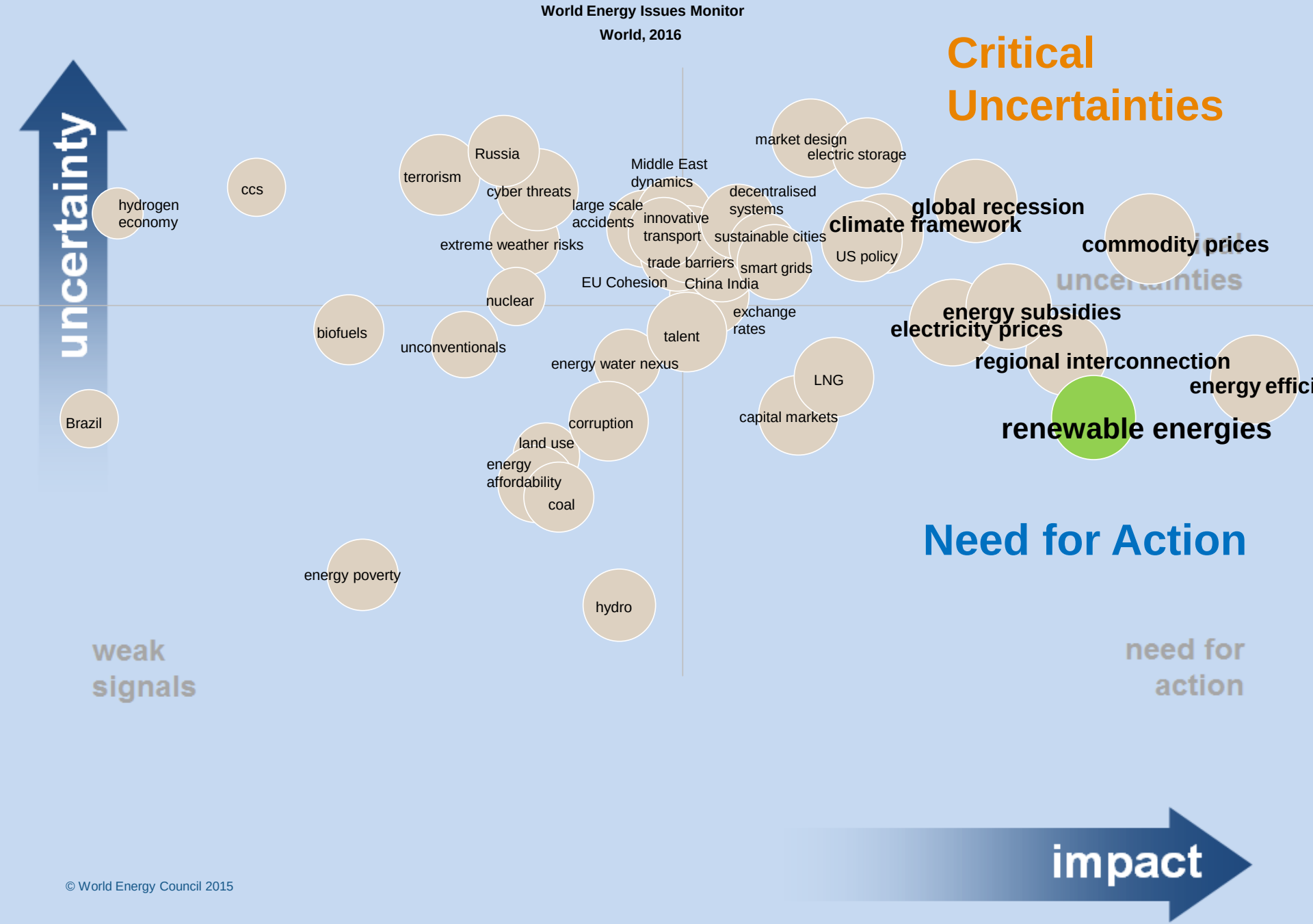
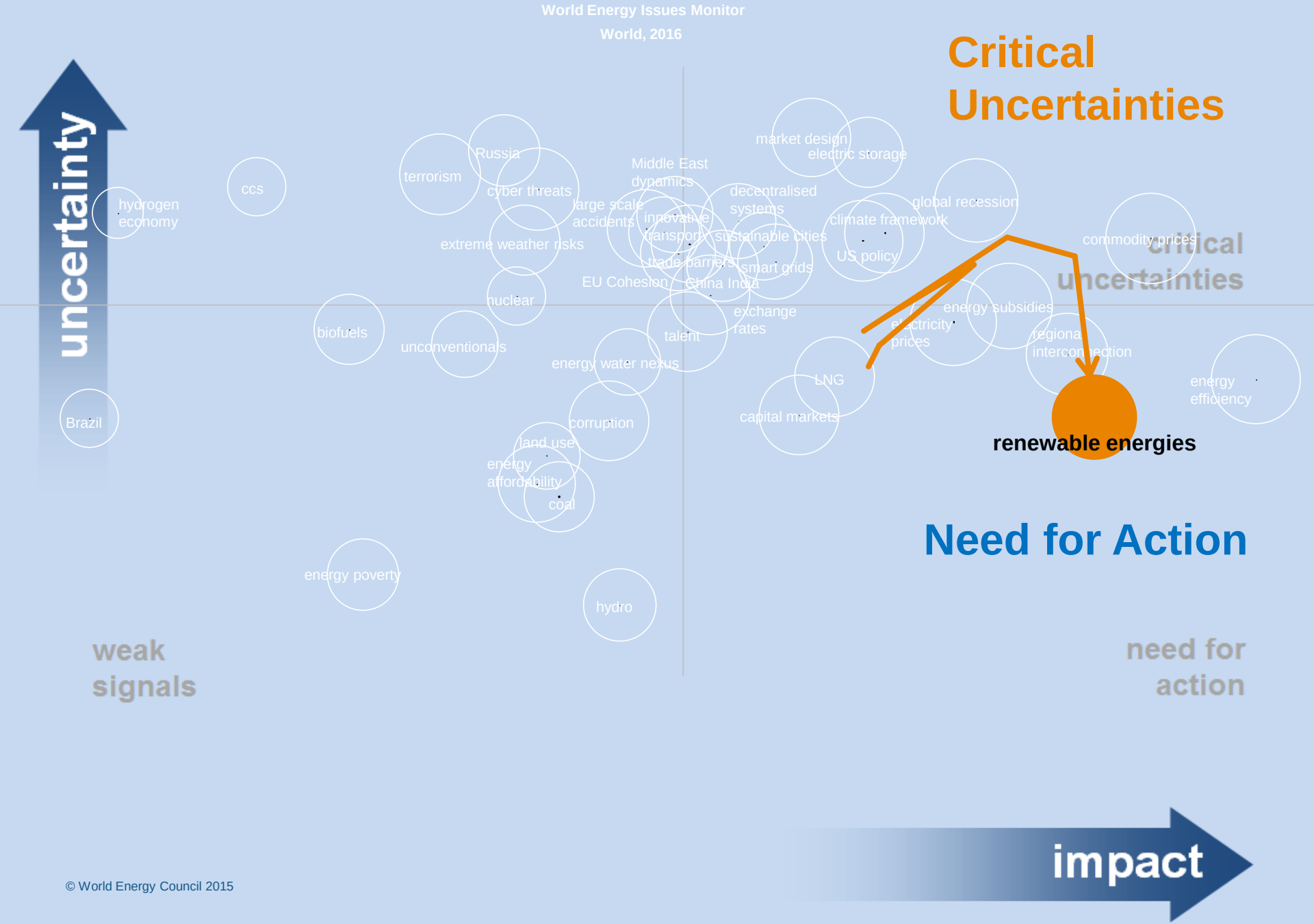






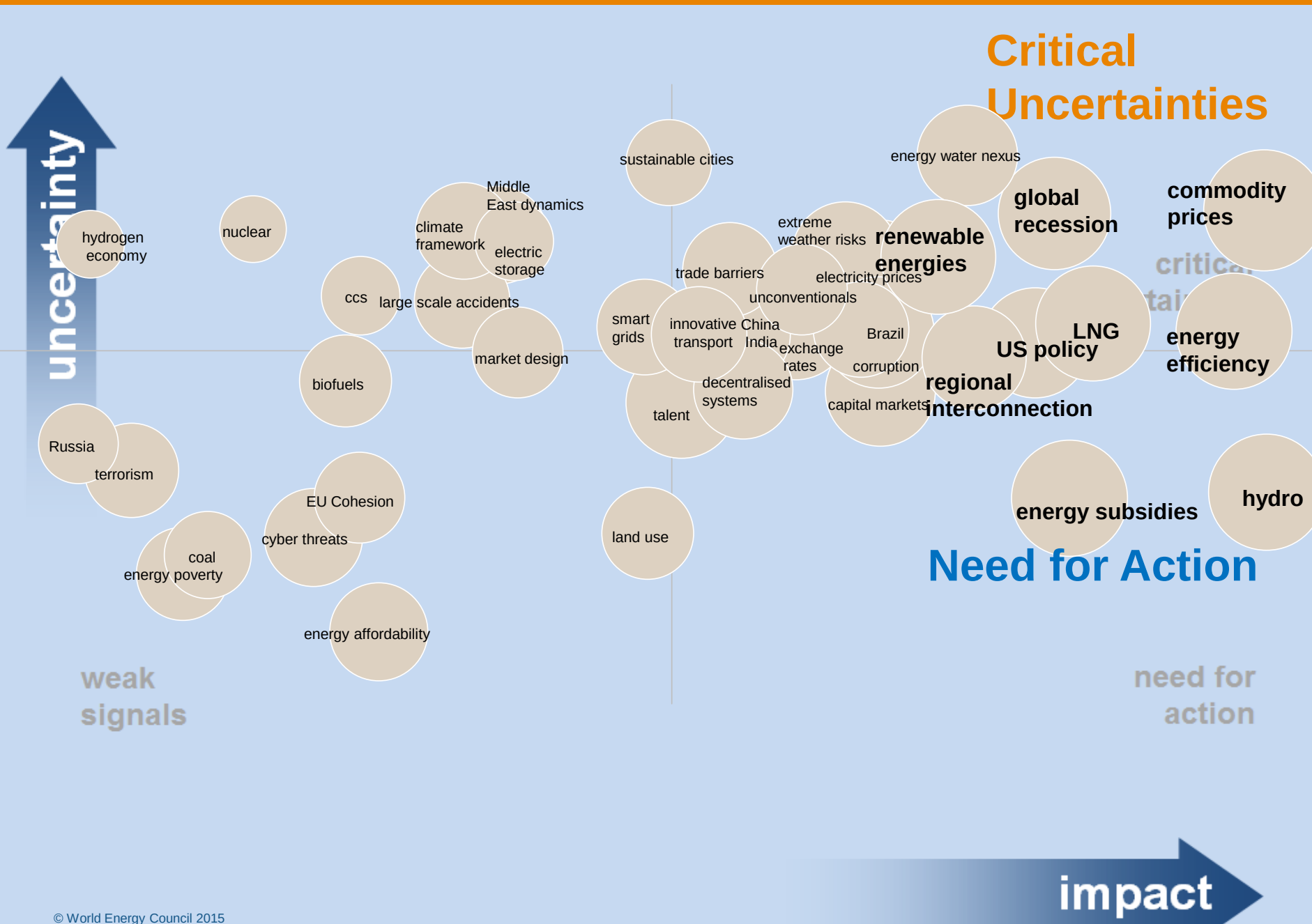
World Energy Issues Monitor

World, 2016



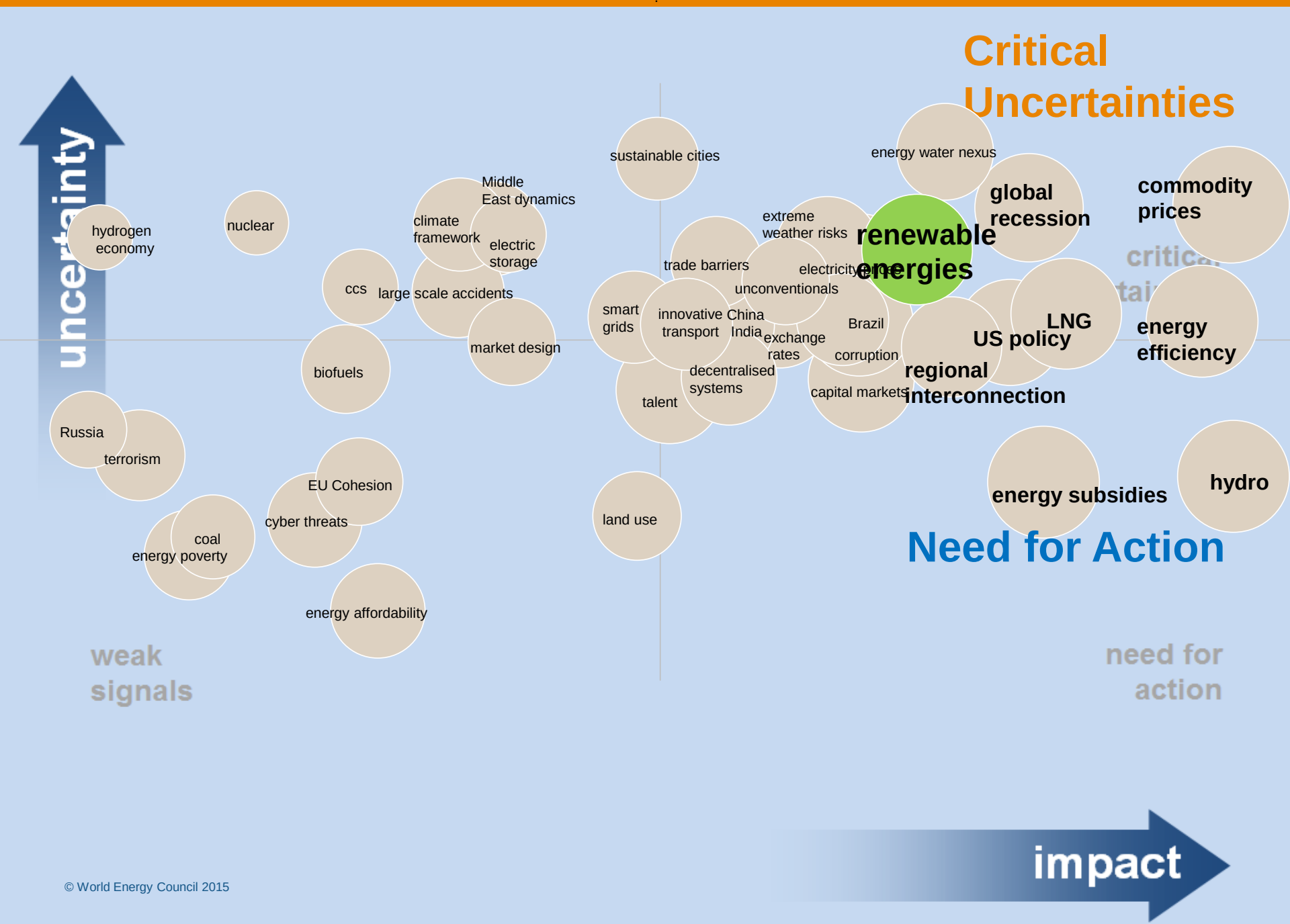
Latin America & Caribbean – Regional map

2016



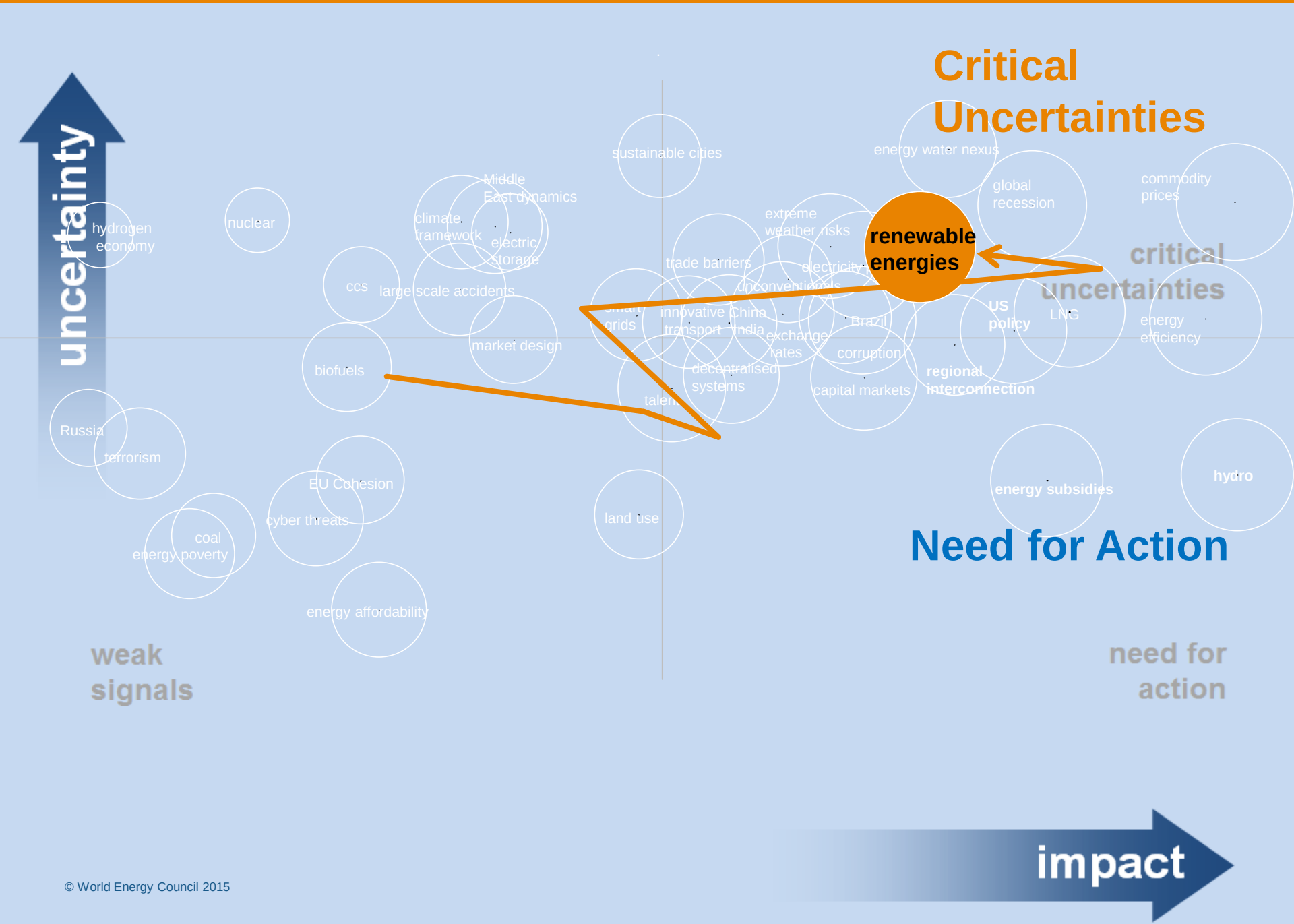
Latin America & Caribbean – Regional map

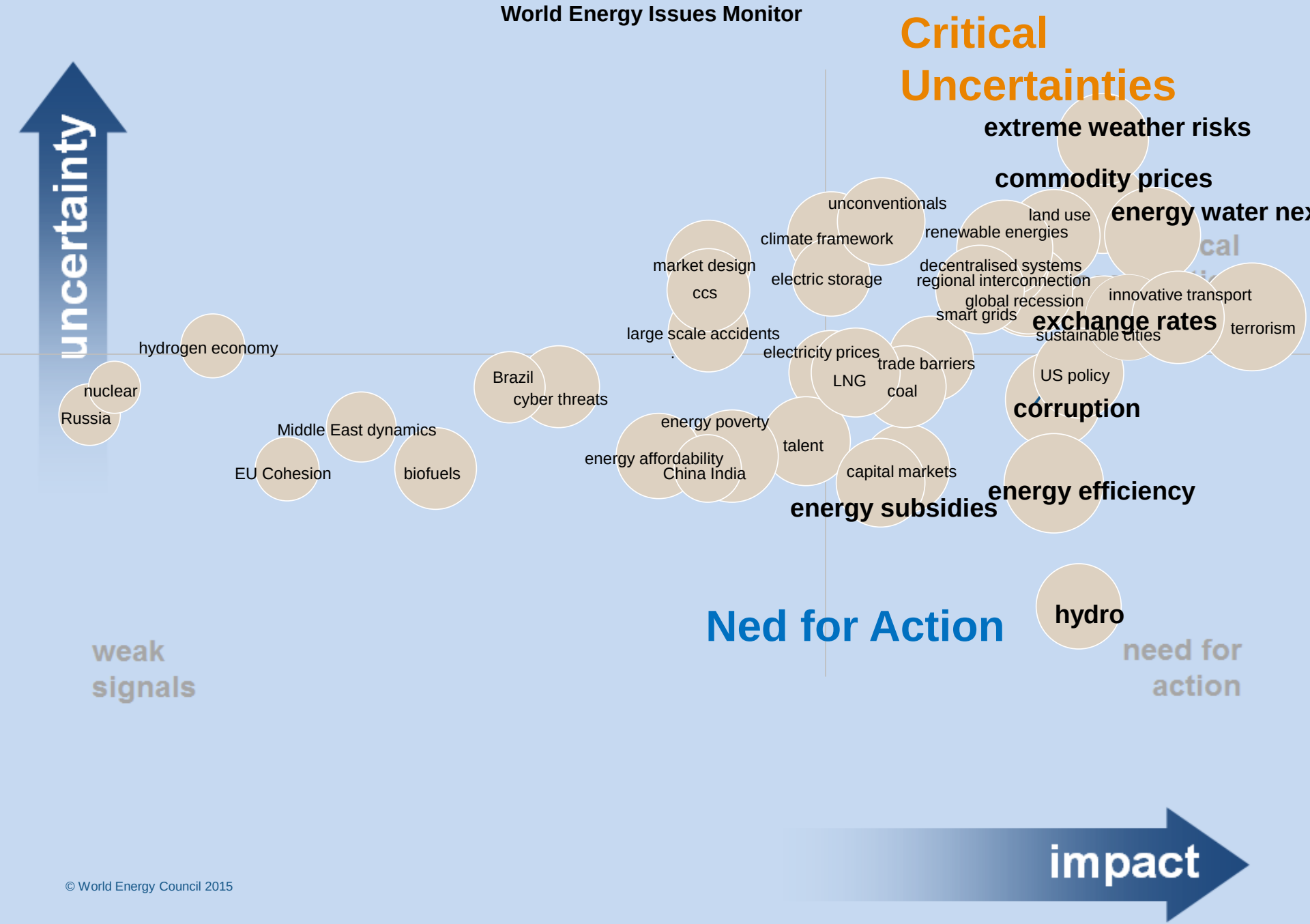
2016



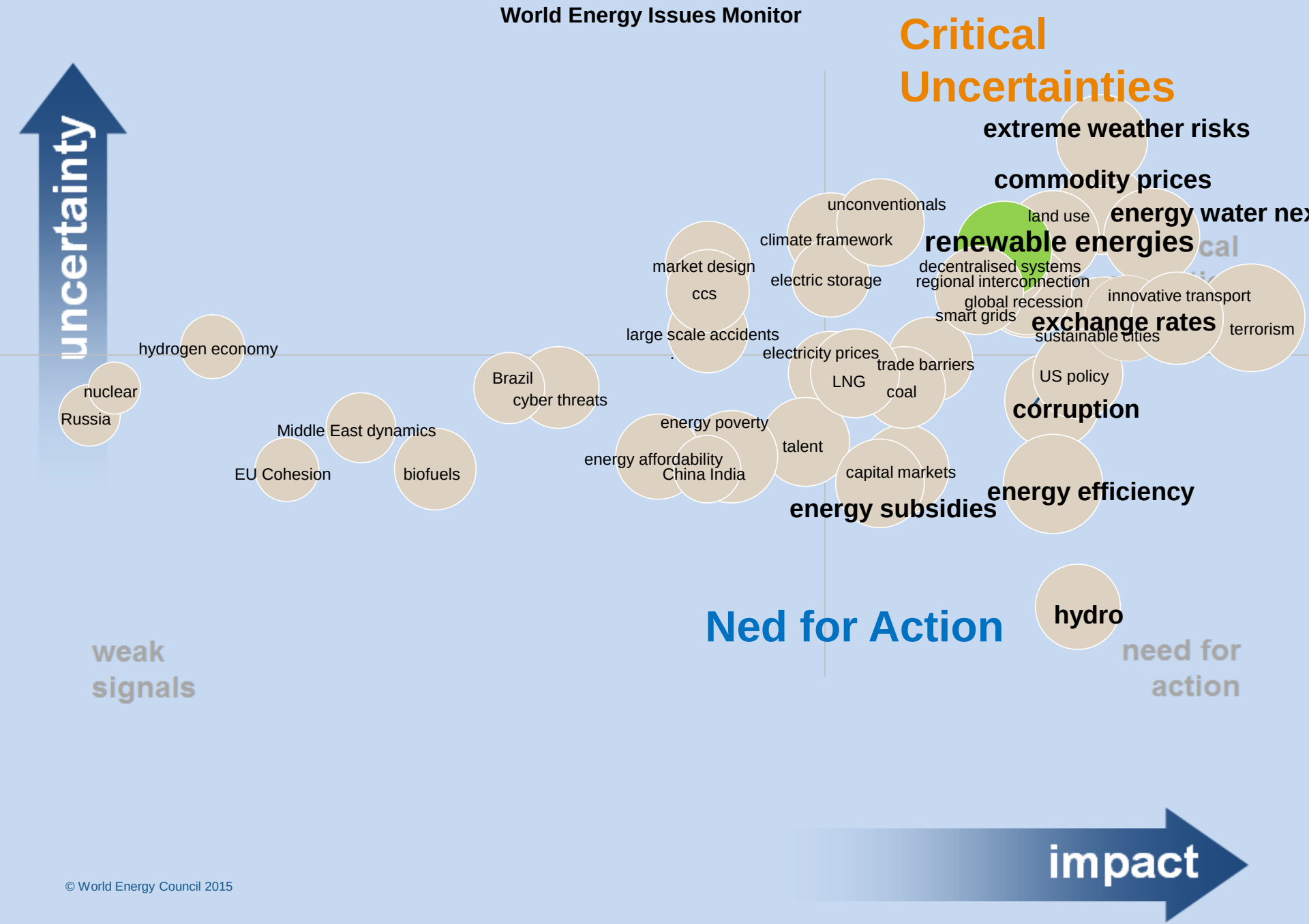
Latin America & Caribbean – Regional map

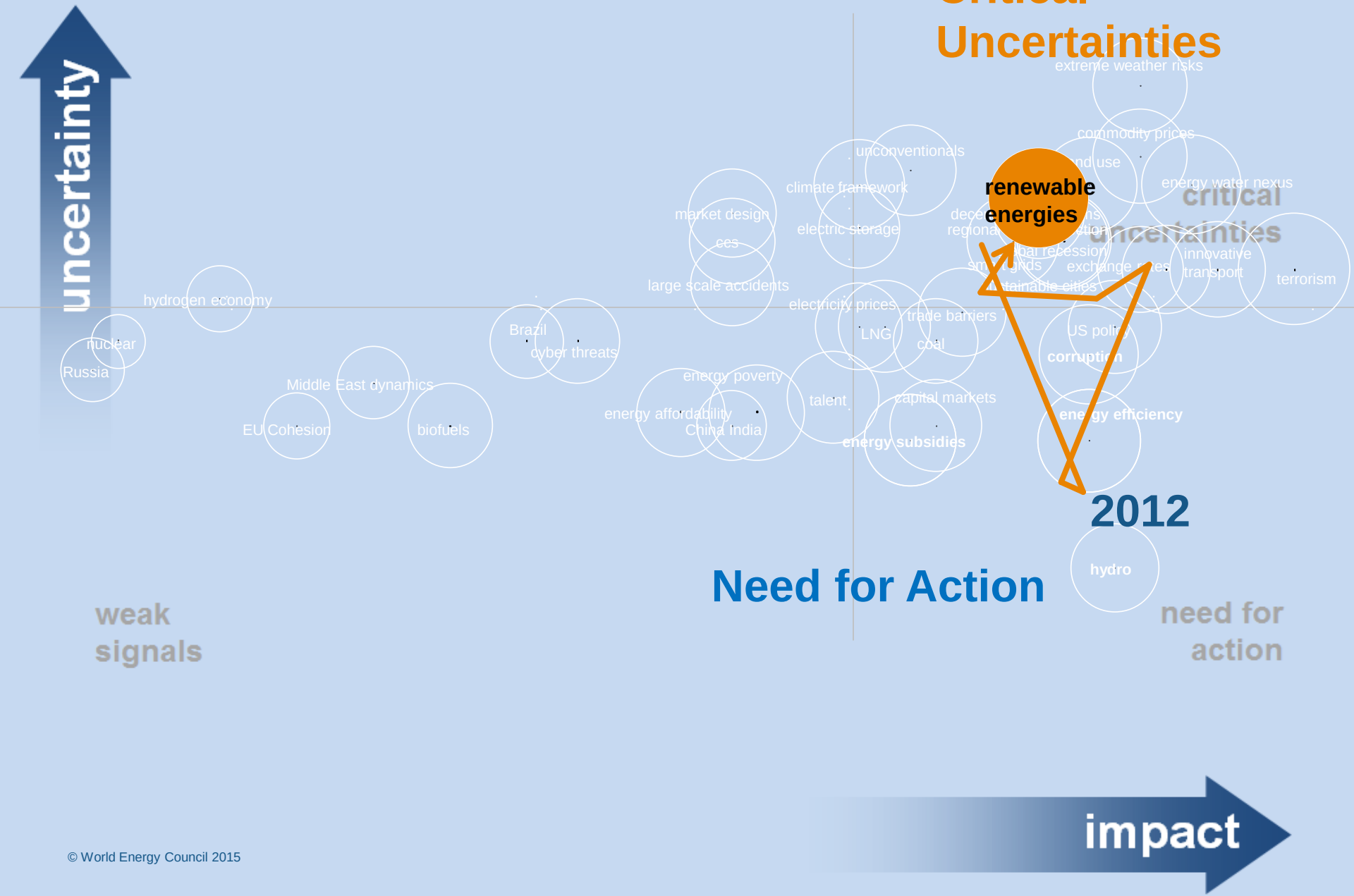
2016

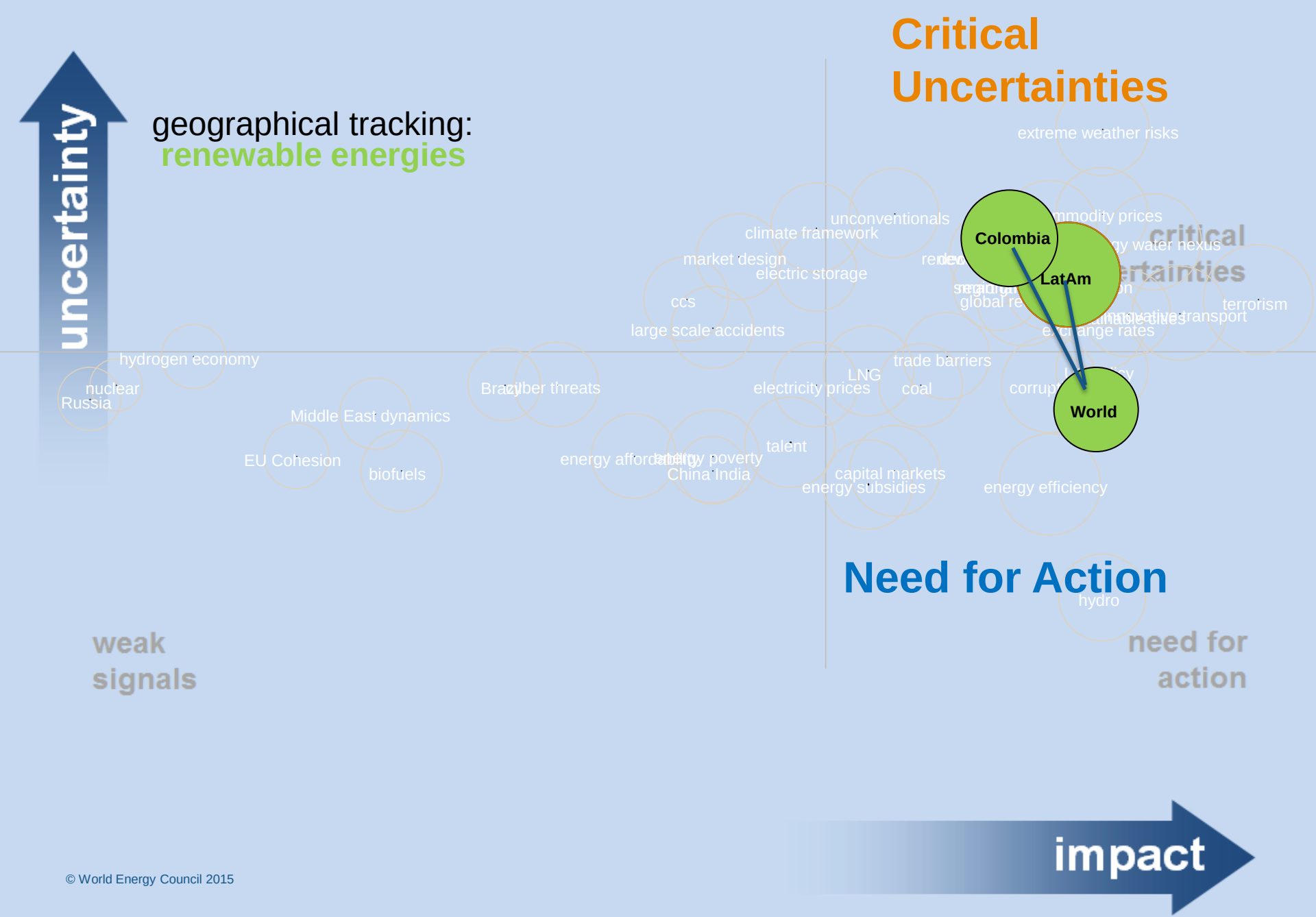




National Issues Map – Colombia – Critical uncertainties 2016







World Energy Scenarios

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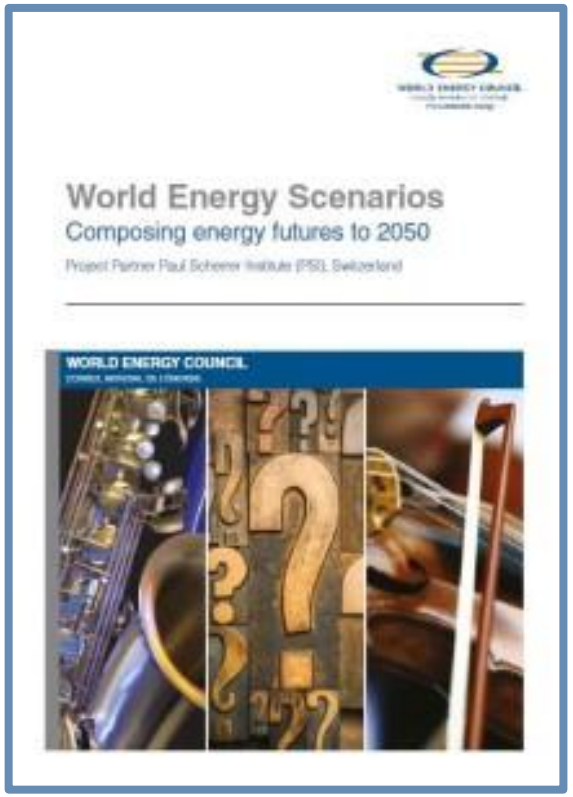
- **Jazz:**
  Trade based, consumer driven, focussed on access and affordability. achieving growth through low cost energy. Governments facilitate GHG actions.

- **Symphony:**
  Government led, voter driven, focussed on environmental goals and energy security, national and regional measures to increase share of renewables in energy mix. Binding international agreement on GHG emissions



World Energy Scenarios: Outline of Jazz and Symphony

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Jazz	Symphony
Price- conscious consumers	Environmentally-minded voters
Competitive markets pick technologies	Governments pick technology winners
Higher GDP due to efficient market practices.	Lower GDP due to non-optimal economic policies
Increased exports due to free-trade strategies	Reduced exports/imports due to nationalistic strategies
Main players are multi-national companies, banks, venture capitalists	Main players are private- and public sector companies, local governments, NGOs
Carbon market grows more slowly from bottom up, based on regional, national and local initiatives.	Carbon market is top down based on an international agreement, with commitments and allocations.

Total Primary Energy Supply: LAC

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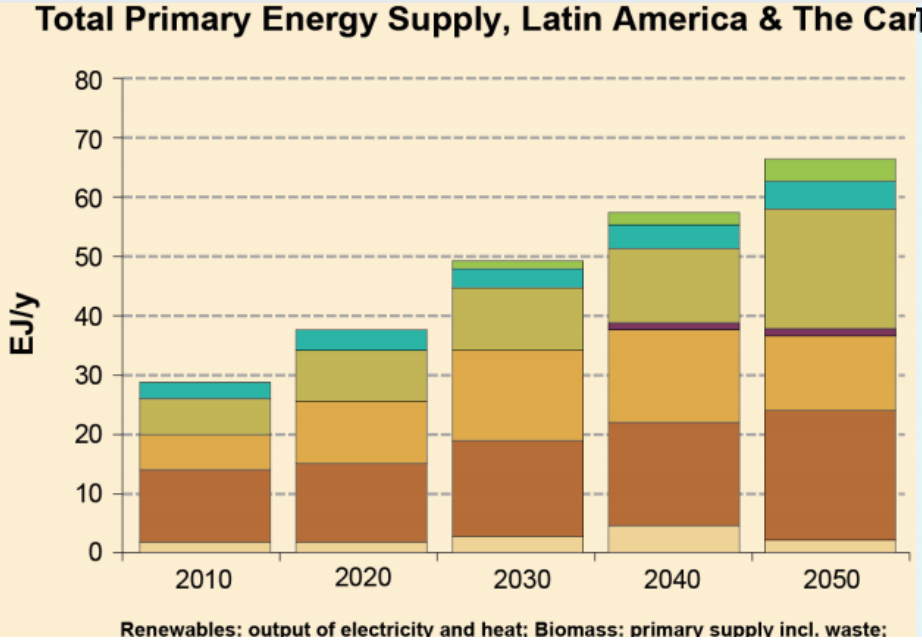
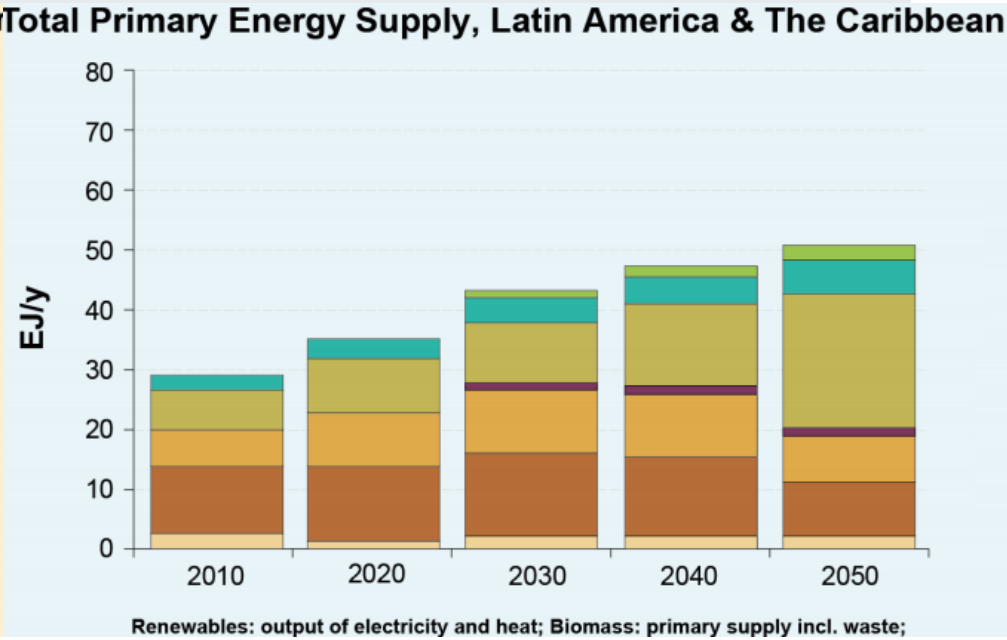
Jazz



Simphony



- Renovables
- Hidro
- Biomasa
- Nuclear
- Gas
- Petroleo
- Carbon

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Electricity Production, LAC: Jazz

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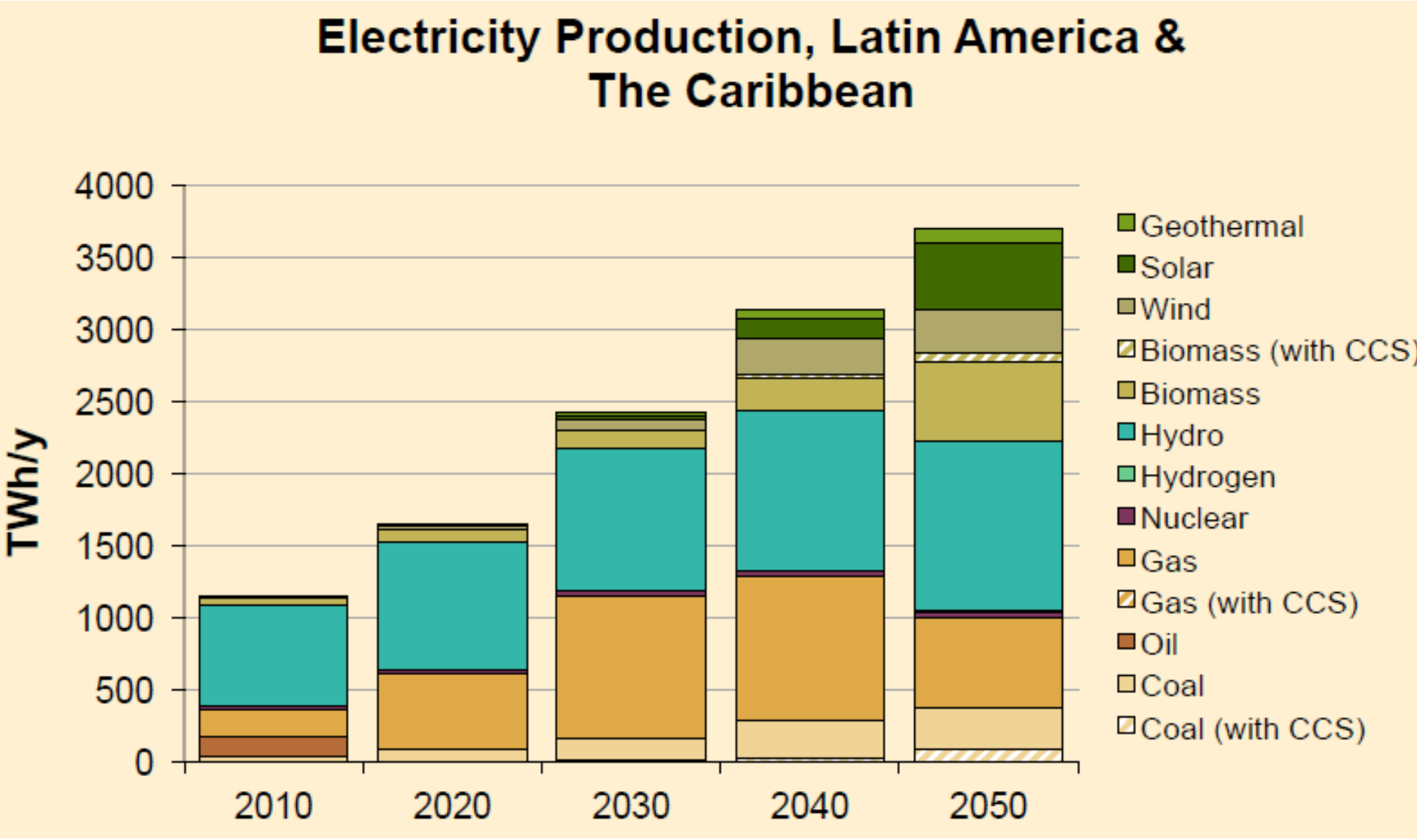

Electricity Production LAC: Symphony

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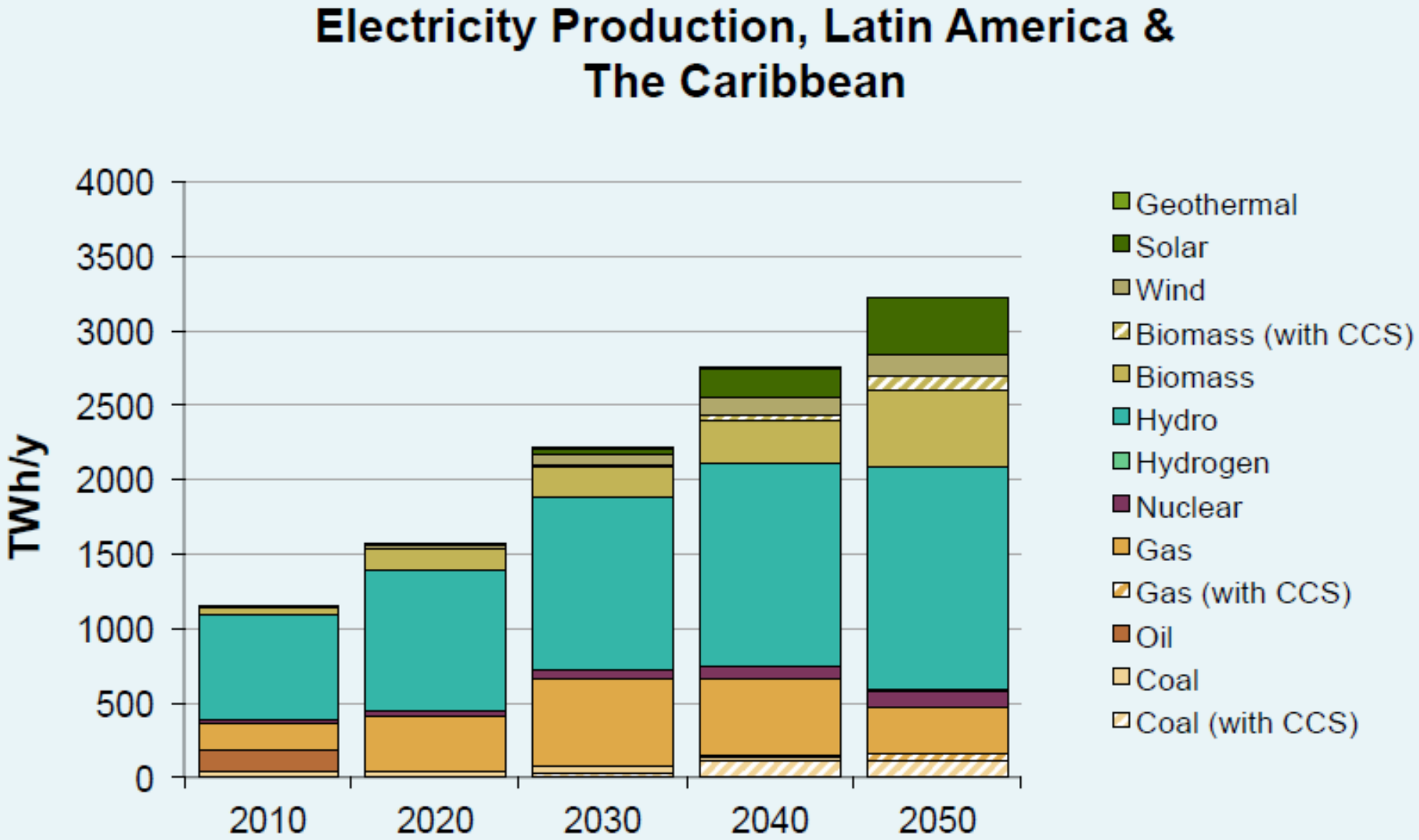

Renewable Energies Growth for Electricity Generation

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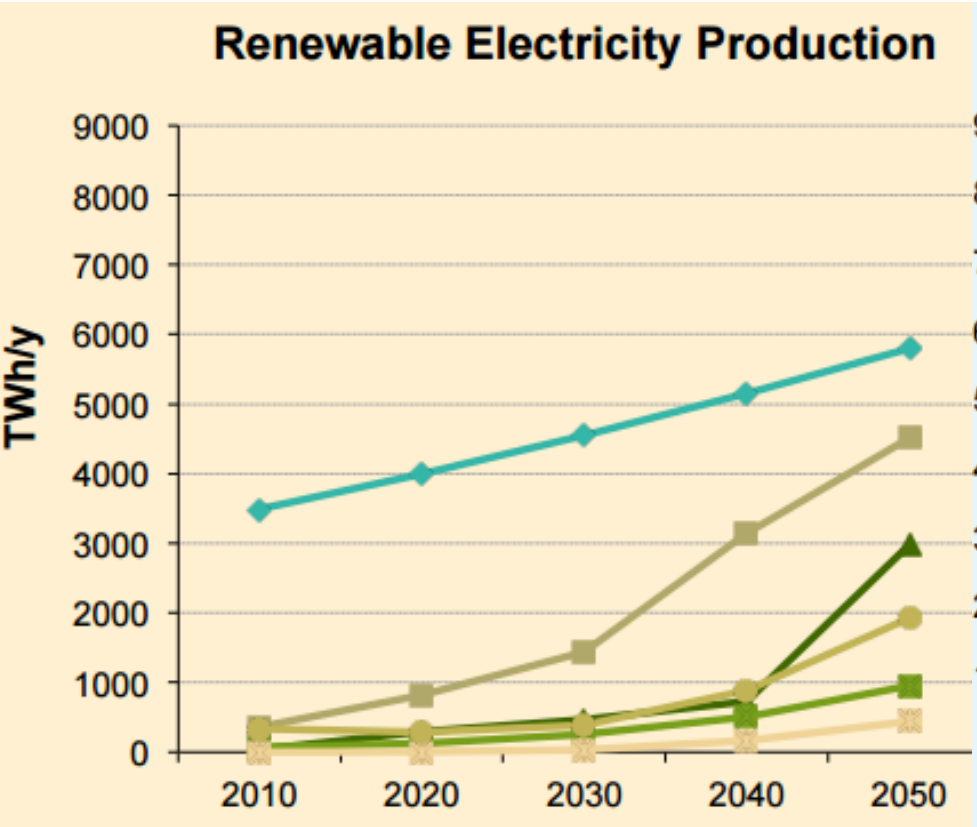
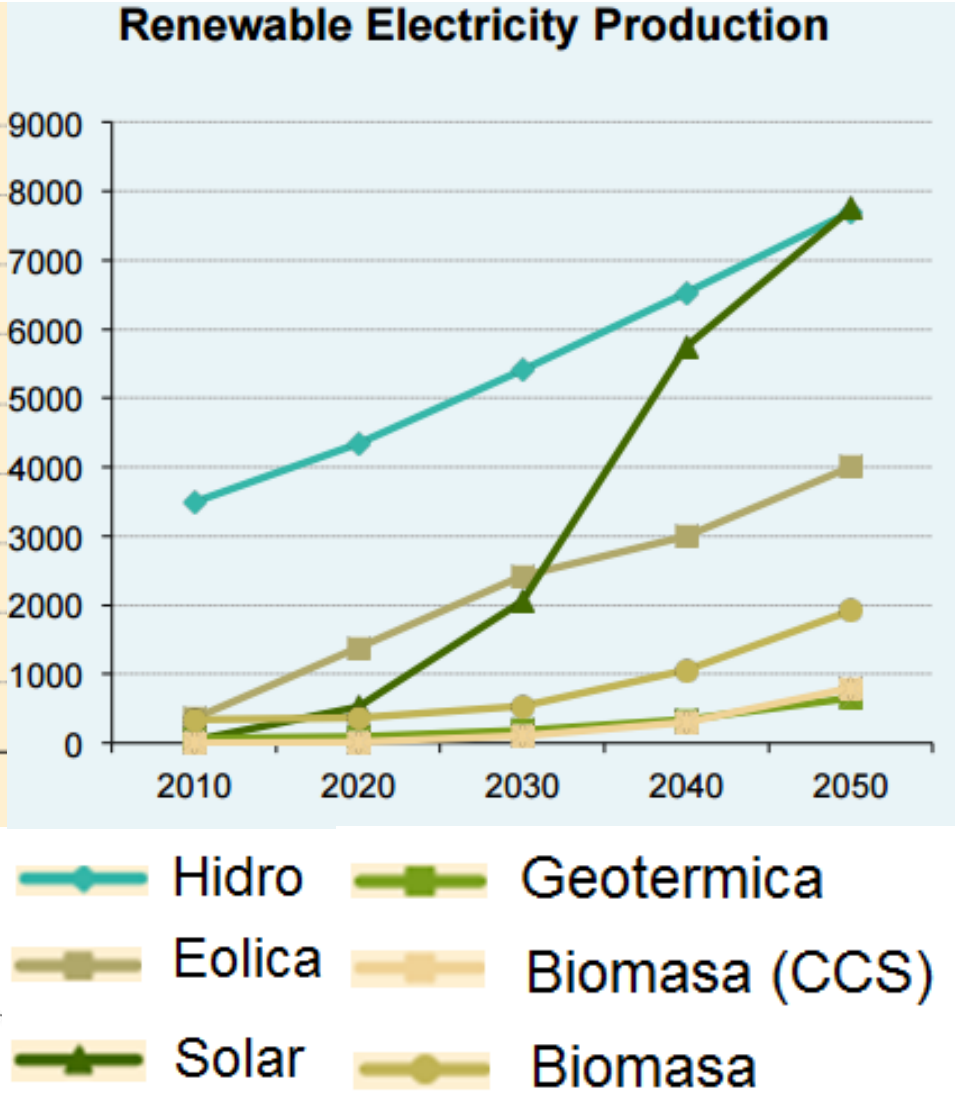
Jazz



Symphony



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Accumulated Investment in Renewables (Billones USD 2010)

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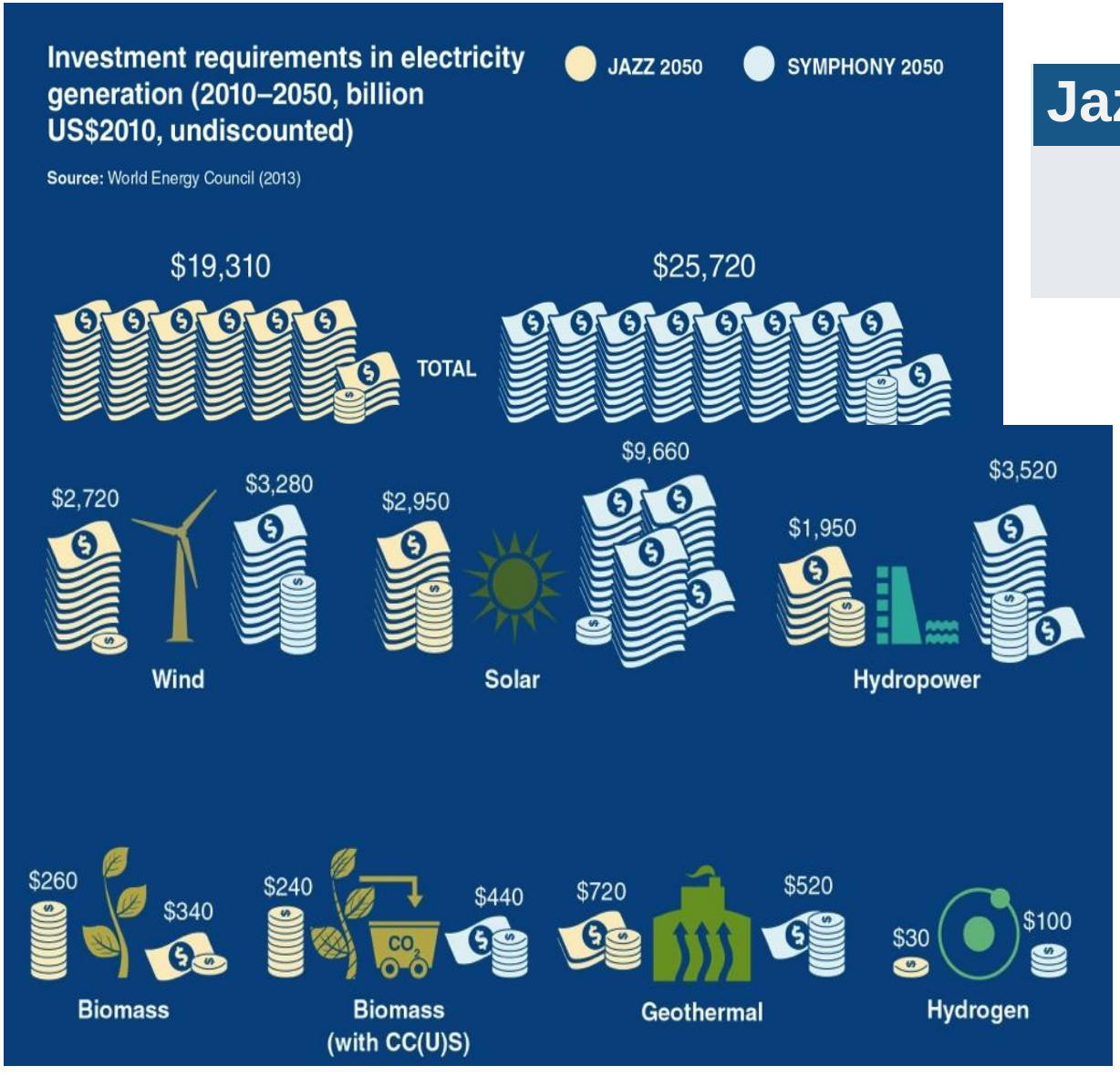

Jazz	Symphony
46%	70%

Share of renewable energy investment for electricity generation

Solar PV and Wind Energy prices are competitive

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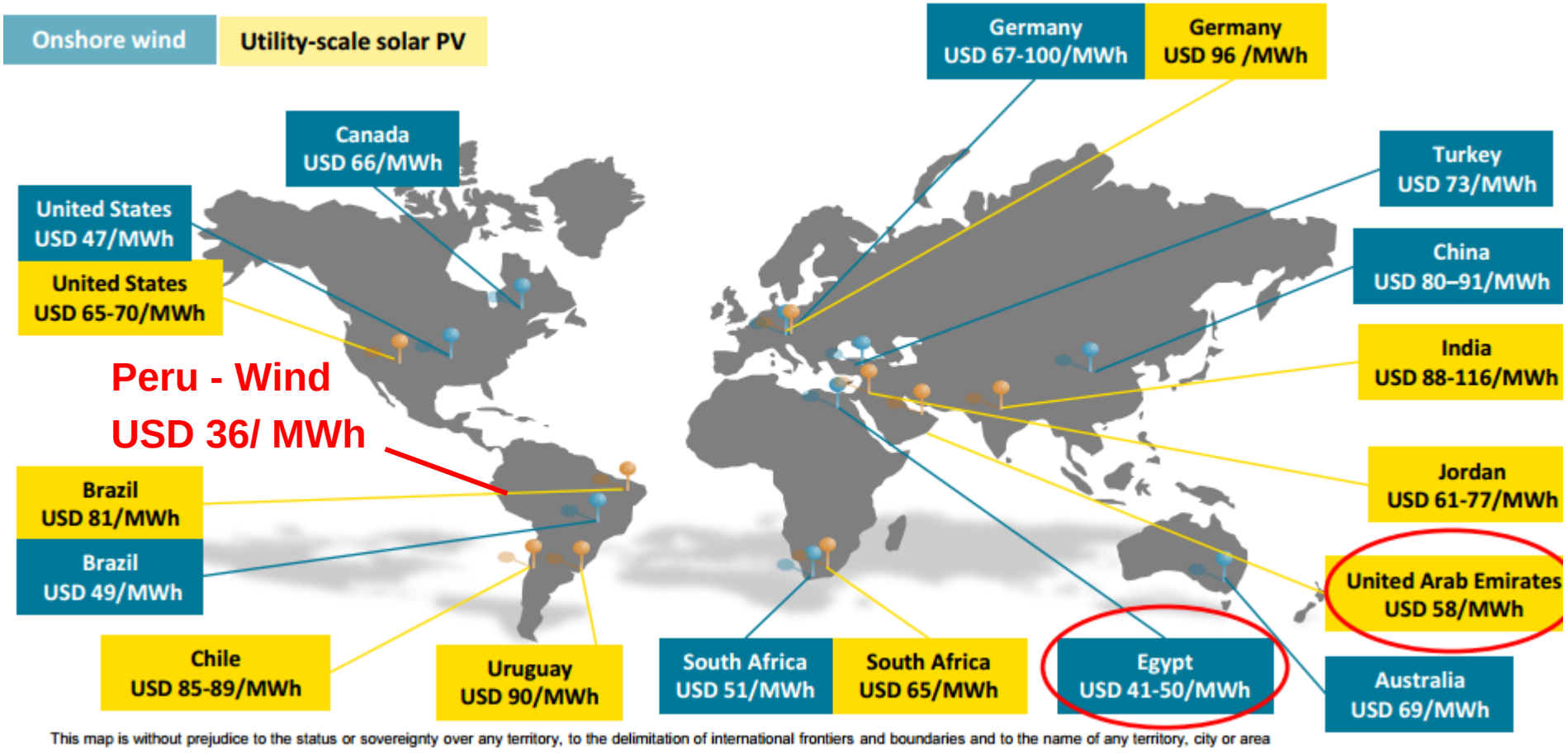
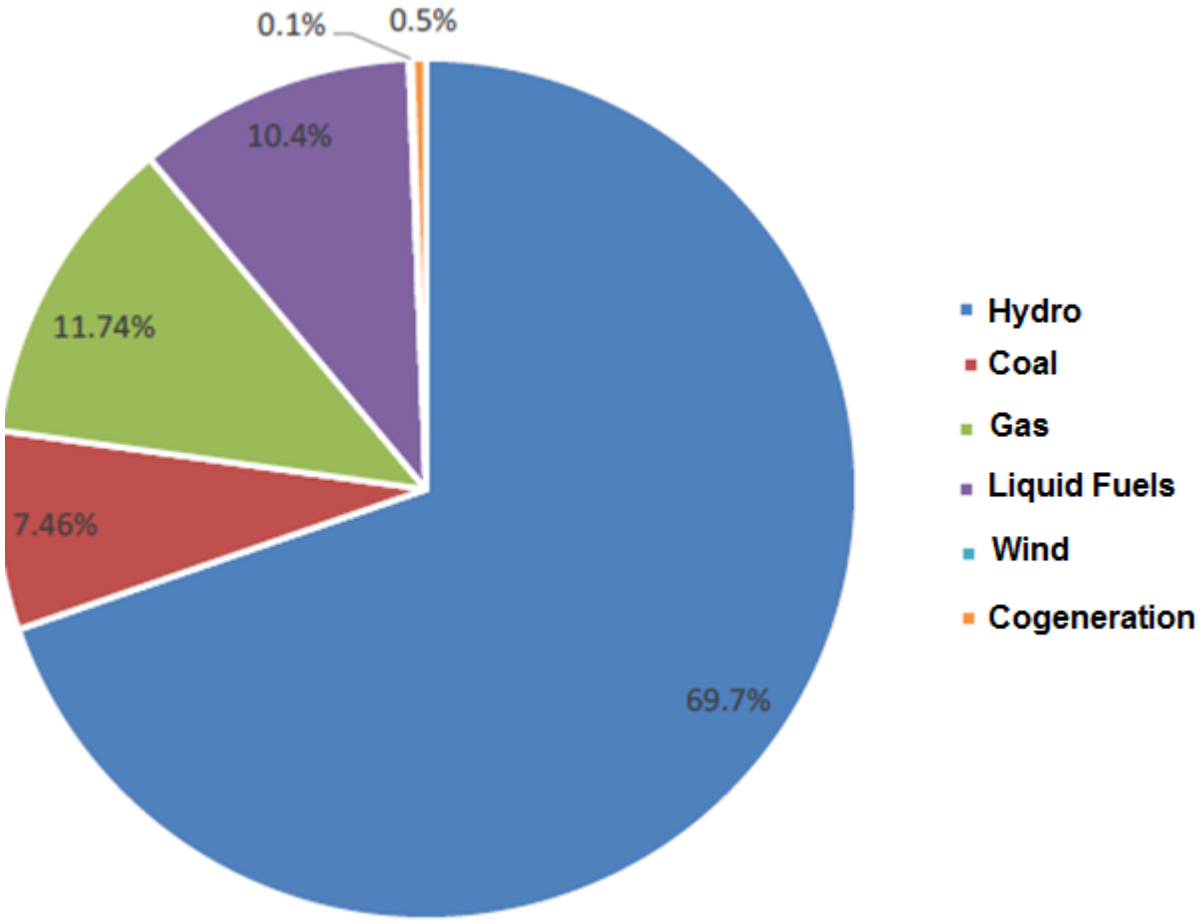
Countries which have announced implementing long term contracts for renewables between 2015-2019.



Source: https://www.iea.org/newsroomandevents/speeches/151002_MTRMR2015_Launch_slides.pdf

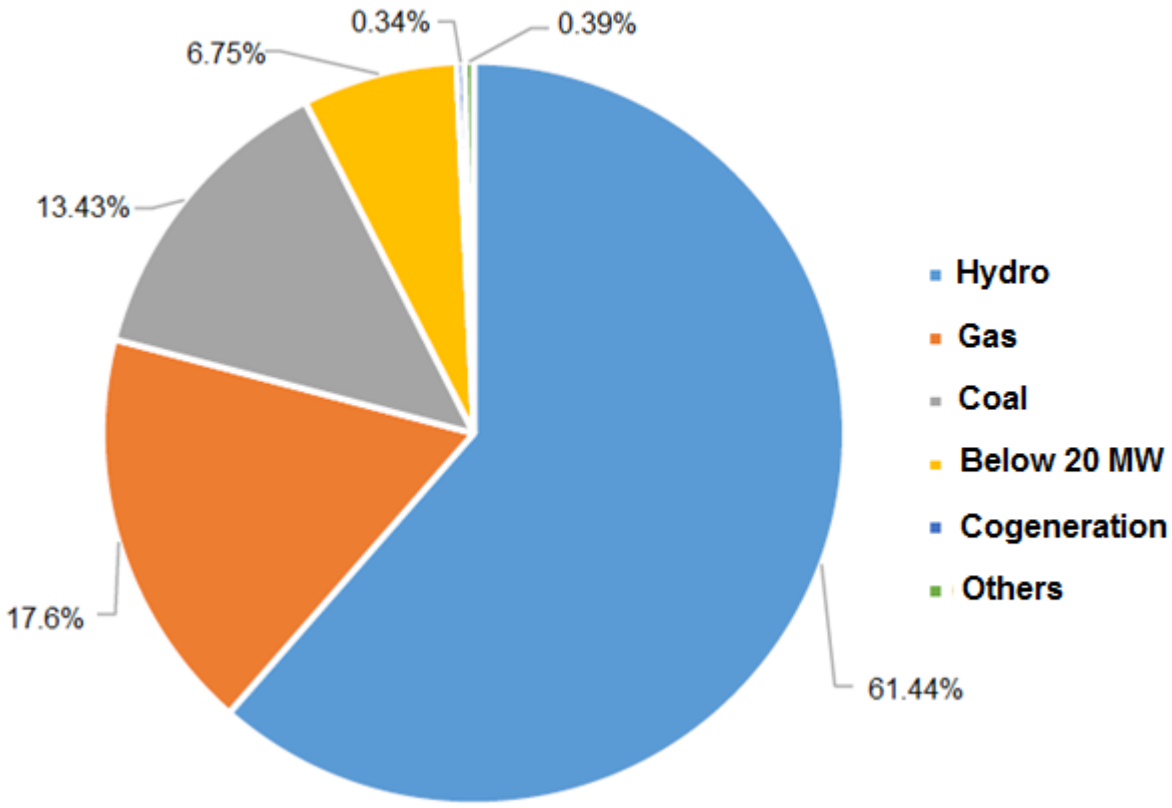
Electricity Mix in Colombia-2015



At the moment the country has 19 .5 MW of wind installed in La Guajira and connected to the National Grid

Source: UPME

Electricity Mix 2029: UPME Scenario 5

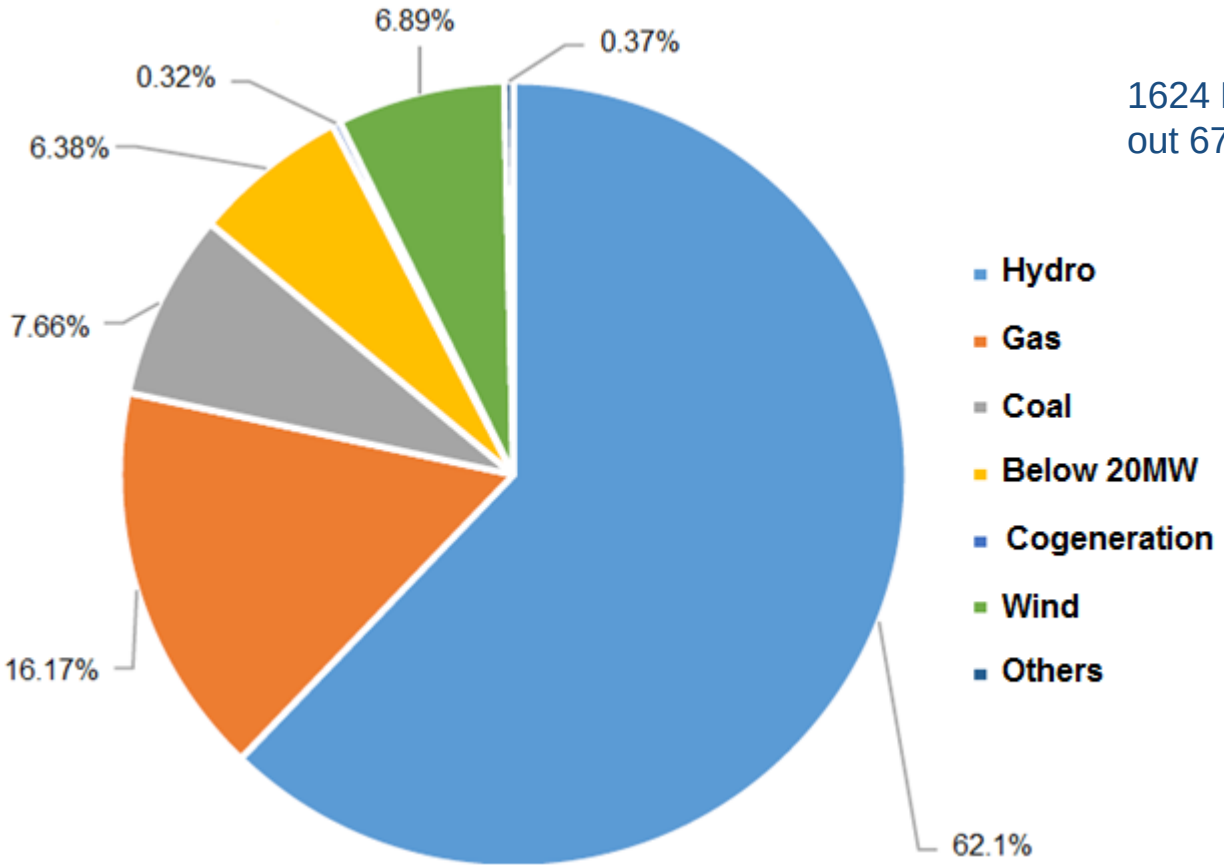


This Scenario projects:

1700MW of Coal and additional 115MW of Gas

Source: UPME, Plan de Expansion y Transmision2015-2029

Electricity Mix 2029: UPME Scenario 8



1624 MW in wind in La Guajira crowd out 670 MW of coal

Source: UPME, Plan de Expansion y Transmision2015-2029

Electricity Mix 2029: UPME Scenario 11

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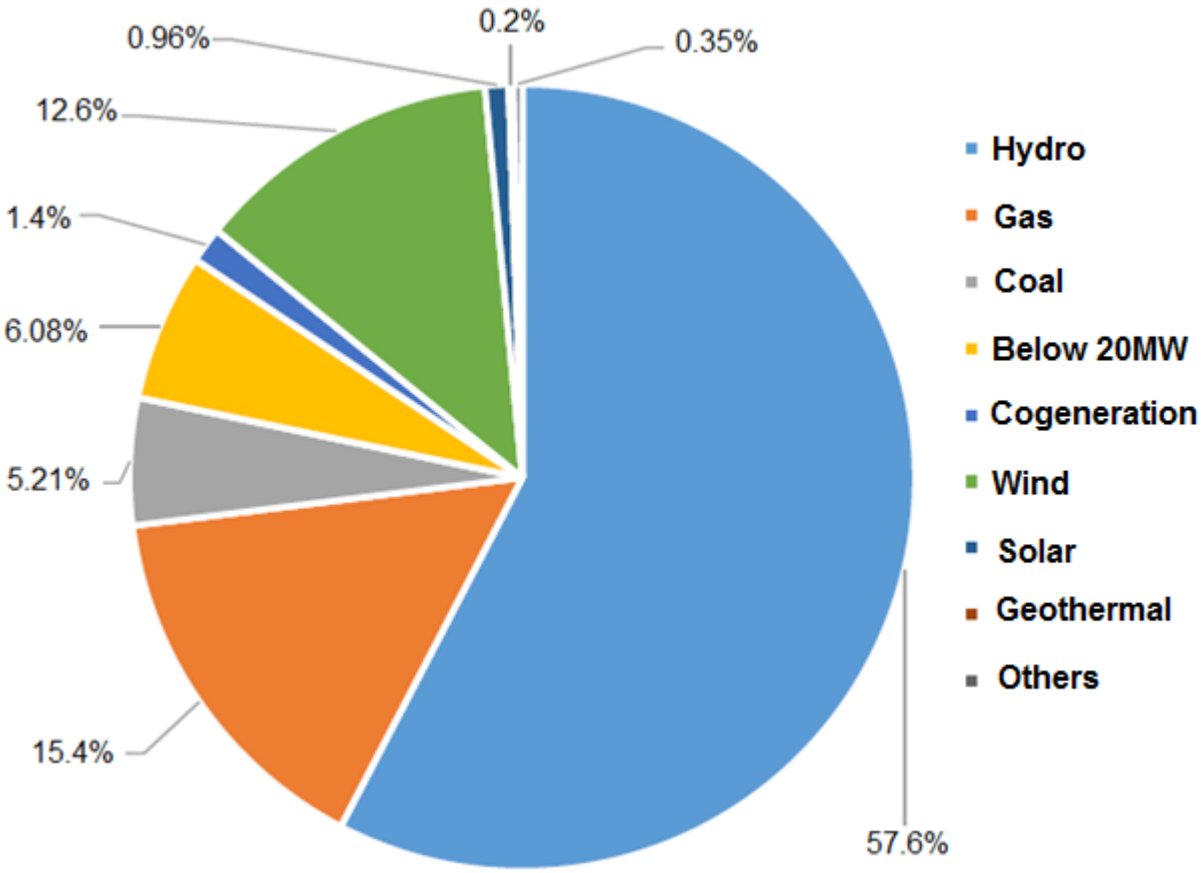

This Scenario projects:

572MW of Non conventional Renewables

Source: UPME, Plan de Expansion y Transmision2015-2029

Wind Energy Potential in Colombia

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Region	Potential (MW)	Average Speed (m/s) at 80 m [1]
Atlantic Coast	20,000	9 La Guajira 5-7 in the rest of the region
Santander	5,000	5-6
Boyacá	1,000	4-5
Huila	2,000	5-6
Valle del Cauca	500	3-4
Total	28,500	

Wind can contribute to the **security and reliability** of the energy system in Colombia due to the **complementarity** between wind and hydrological cycles, which has been widely studied.

Jepirachi Wind Park in La Guajira (19.5MW)

Source: UPME Integración ERNC en Colombia 2015
1-IDEAM:http://atlas.ideam.gov.co/visorAtlasVientos.html

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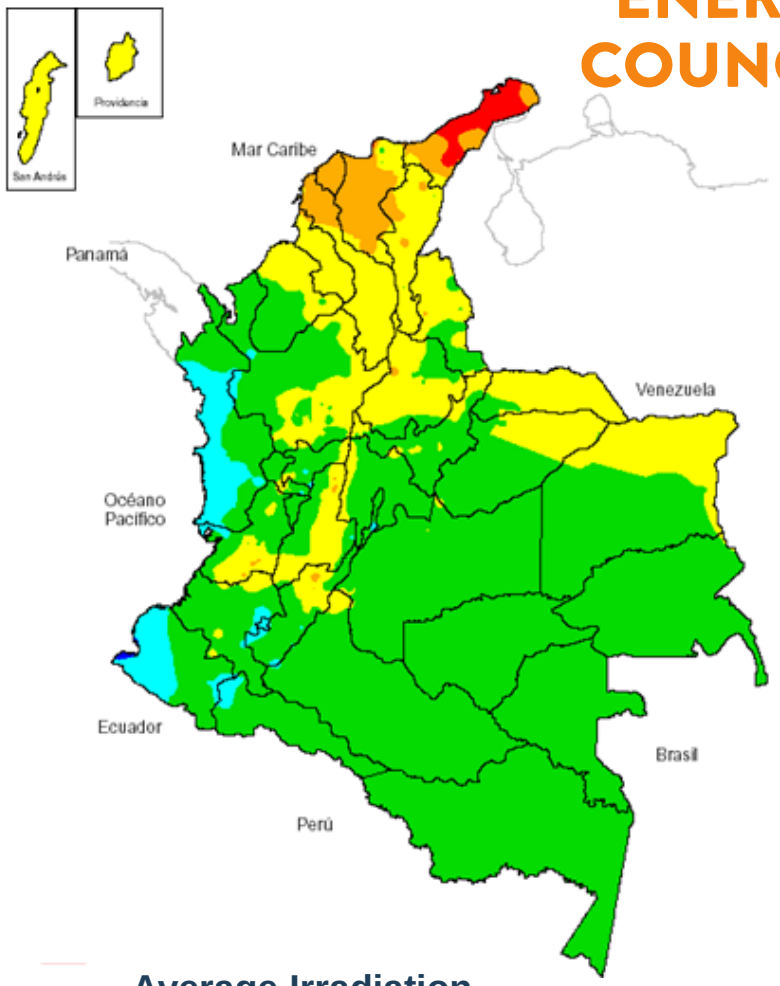
Solar Energy Potential in Colombia

Region	Average Irradiation (Kwh/m2/d)
La Guajira	6.0
Atlantic Coast	5.0
Orinoquia	4.5
Amazon	4.2
Andean Region	4.5
Pacific Coast	3.5



Average Irradiation

Colombia 4.5Kwh/m2/d

Germany: 3.0Kwh/m2/d

Source: UPME Integración ERNC en Colombia 2015

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Geothermal Energy Potential in Colombia

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Estimated Potential: 1-2 GW

Regions with potential:

- Nevado del Ruiz volcanic area
- Chiles volcanic area
- Cerro Negro volcanic area
- Azufral volcanic area

} Near border with Ecuador

Source: UPME Integración ERNC en Colombia 2015

Biomass Potential in Colombia

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Type of residue	Potential (GWh)
Agriculture (palm, sugar cane, coffee, panela cane, corn, rice, banana)	91.8
Pecuary (Bovine, poultry, pig)	32.7
Methane sources (ethanol distilleries, bovine sacrifice plants, etc)	55
Others (trimming residues, market plazas, etc)	113.9
Total	**293**

Source: UPME Integración ERNC en Colombia 2015

Interesting opportunities in:

- palm residue utilization for cogeneration

-Crop residue use

-Residue use for cement industry

Off grid areas: a big opportunity for Renewables

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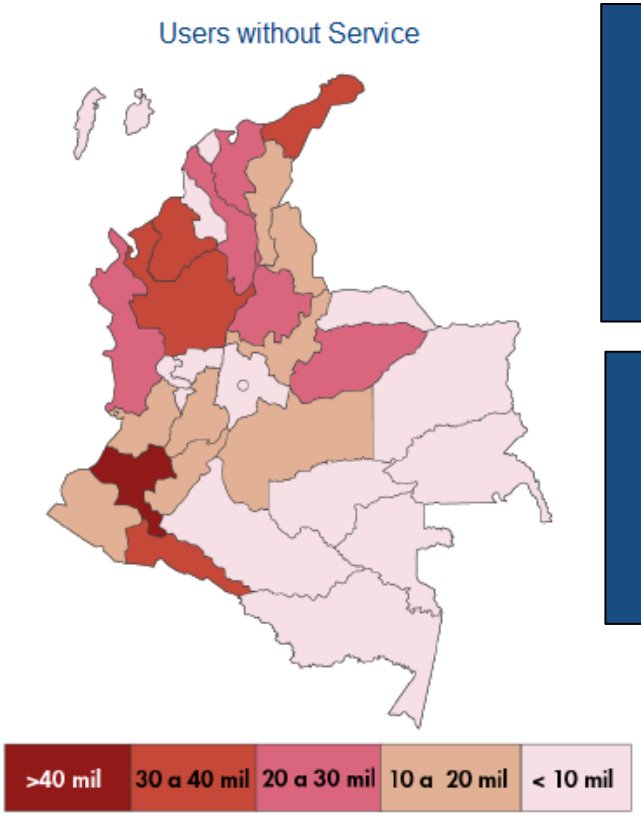

Regulatory incentives for providing electricity in Off Grid Areas

Subsidies for renewable energy technologies

Source: Presentacion Carlos Fernando Eraso, Viceministro de Energia, Colombia

Off grid areas: a big opportunity for Renewables

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Some government plans include:

Plan PaZifico:

- Bring energy to 4 departments in the pacific coast.
- Projected investment of USD 92 million
- Grid expansion
- Individual solutions using renewables

Source: Presentacion Carlos Fernando Eraso, Viceministro de Energia, Colombia

Law 1715 (2014)

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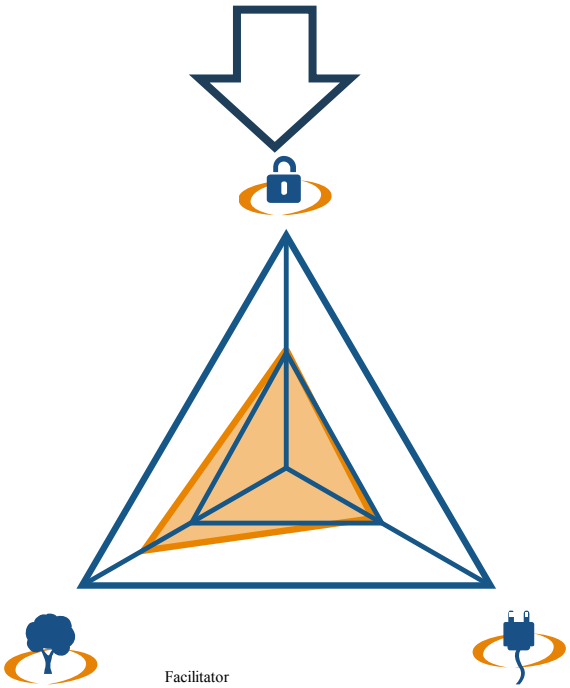
Objective:

To promote the development and use of non conventional sources of energy, especially **renewables** , in the national energy system, through its integration to the energy market, their role in off grid areas as necessary means for a **sustainable economic development**, **reduction of CO2 emissions** and **security of supply**.



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Law 1715 (2014) – Fiscal Incentives

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Art. 11	Income tax deduction (reduce from income base the equivalent to **50% of total investment value during 5 years**.)	Reduce the base payment of Income Tax for unconventional energy projects (FNCE)
Art. 14	Accelerated depreciation (Annual **depreciation rate up to 20%**)	
Art. 12	**VAT(IVA) Exclusion** for all equipment, materials and machinery used for renewable energy projects	
Art. 13	"Derechos Arancelarios" **Tariff exemption**	Tariff exemption for machinery, equipment, materials and inputs used for unconventional energy projects.

Source: Presentacion Carlos Fernando Eraso, Viceministro de Energia, Colombia

Regulatory landscape: What has been done?

Res. 153 (2013)	Establishes rules for reliability charge (cargo por confiabilidad) of supply contracts of **agricultural origin fuels**
Res. 132 (2014)	Defines methodology to determine firm energy of **geothermal plants**.
Res. 061 (2015)	Modifies methodology to determine firm energy of **wind energy plants**.
Res. 227 (2015)	Defines methodology to determine firm energy of **Solar PV** plants.
Res. 024 (2015)	Regulates activity of large scale **auto generators** in the national grid.

Regulatory landscape: What has been done?

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Res. 153 (2013)

Establishes rules for reliability charge (cargo por confiabilidad) of supply contracts of **agricultural origin fuels**

- Supply contracts must include the information which shows that:

1. The supplier will have **availability** of agricultural fuels required by the generator to accomplish its firm energy obligations.

2. Identification of **the number of years** in which the agricultural fuel supply can be ensured to fulfil its back up obligations for firm energy.

- Reliability charge for **cogeneration plants**: all plants which fulfil the above requirements and which are centrally dispatched, may actively participate in the Reliability charge mechanism.

Regulatory landscape: What has been done?

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Res. 132 (2014) Defines methodology to determine firm energy of **geothermal plants**.

ENG[kWh]=PONED xFRECx(1-IHF)

Where:

ENG: Energy generated by a geothermal plant

PONED: Design Specific Net Power [kWh/kg/s]

FREC: Flow of geothermal resource [kg/s]

IHF: Forced Historical Unavailability

Base Firm Energy: generation which the plant is capable of delivering with 100% probability of being surpassed

95% Firm Energy: generation which the plant is capable of delivering with a 95% probability of being surpassed in the probability distribution curve.

To declare its firm energy, the plant may choose any value within Base firm energy and 95% Firm Energy, however it must issue a warranty for the differential between the declared energy and Base Firm Energy Value.

Regulatory landscape: What has been done?

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Res. 061 (2015)

Modifies methodology to determine firm energy of **wind energy plants.**

For plants without wind information:

Base Firm Energy [kWh/day]= 24*1000*0.060*CEN

95% PSS Firm Energy [kWh/day]=24*1000*0.073* CEN

Where:

CEN: Net Effective Capacity (MW)

For plants with wind information and historical series longer than 10 years, this historical data will be used to determine firm energy.

Base Firm Energy: generation which the plant is capable of delivering with 100% probability of being surpassed

95% Firm Energy: generation which the plant is capable of delivering with a 95% probability of being surpassed in the probability distribution curve.

To declare its firm energy, the plant may choose any value with in Base firm energy and 95% Firm Energy. However it must either issue a warranty for the differential between the declared energy and Base Firm Energy Value or show contracts for firm energy with another generator which must cover obligations.

Regulatory landscape: What has been done?

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Res. 227 (2015) Defines methodology to determine firm energy of **Solar PV** plants.

$$EN[kWh/month]=\frac{1}{I_{STC}} K_C * K_{INC} * V_m(TA) * GHI_m * (1 - IHF) * POT_{dc}$$

Where:

EN: Energy per hour generated during one month [kWh/month]

I_{STC}**:** Irradiation in constant conditions ISTC=1kW/m^2

Kc: Constant for Solar PV losses= 0.8957

K_{INC} **:** Constant which varies depending on the support technology

V_m**(TA):** Value for losses due to environment temperature according to the PV module used during a given month. [C]

GHI_m**:** Aggregated horizontal irradiation for a given month [kWh-month/m^2]

IHF: Forced historic unavailability

POTdc: Joint power of PV modules [kEpeak]

Base Firm Energy: generation which the plant is capable of delivering with 100% probability of being surpassed

95% Firm Energy: generation which the plant is capable of delivering with a 95% probability of being surpassed in the probability distribution curve.

To **declare its firm energy**, the plant may choose any value with in Base firm energy and 95% Firm Energy. However it must either issue a warranty for the differential between the declared energy and Base Firm Energy Value or show contracts for firm energy with another generator which must cover obligations.

Regulatory landscape: What has been done?

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Res. 024 (2015) Regulates activity of large scale **auto generators** in the national grid.

- Establishes conditions of connection to the national grid.
- Auto generators must install a **meter** which is able to tele measure energy demanded and supplied in an hourly basis.
- Subscribe a **backup contract** with the grid operator, this way the operator can supply the required energy to the auto generation when needed.
- **Prices** for back up services are freely determined by the auto generator and grid operator. They are never treated as regulated costumers.
- To **deliver excess energy** to the grid the auto generator must be represented by a generator in the wholesale market.

Colombia and COP21

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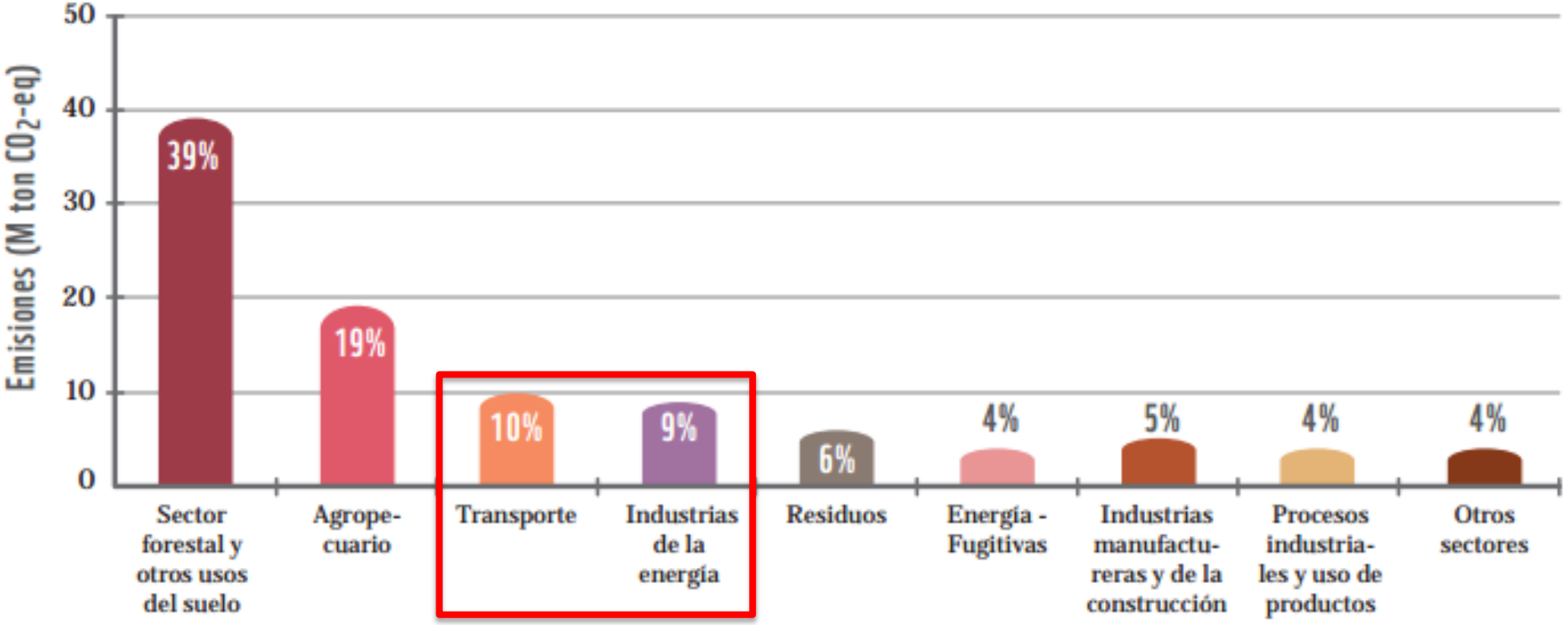
Colombia GHG emissions → 0.46% of global emissions.

How are emissions distributed across sectors at the moment?



Fuente: Proyecto Informe Bienal de Actualización, IDEAM 2015

Source: El acuerdo de Paris: Asi actuara Colombia frente al cambio climatico. 2016

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Colombia and COP21: Mitigation measures

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Renewable energies are part of this agenda

Source: El acuerdo de Paris: Asi actuara Colombia frente al cambio climatico. 2016

Renewable Energies: In the agenda of the Colombian Government

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"…There is also a great challenge, a nice challenge, and is to diversify energy sources, especially to ***non-conventional renewable sources****. For example, wind energy, solar energy. The price of these technologies has been falling rapidly. They are now profitable.*

Colombia fortunately also has very important ***comparative advantages to produce such energy****. We have plenty of sunshine and wind. That makes us particularly suited to develop this energy. We must have a* ***share of renewable energy*** *within a few years to be much greater than we have at this time…"*

President Juan Manuel Santos, 2 May 2016

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Thank You

Jose Antonio Vargas Lleras, Vice Chair
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