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Technological University
of Habana
Jose Antonio Echevarría

Renewable Energy in Cuba. Role of intermittent renewable sources in the future.

Anaely Saunders, Jyrki Luukkanen, Yrjö Majanne &
Burkhard Auffermann



Turun kauppakorkeakoulu • Turku School of Economics

23rd REFORM Group Meeting, Salzburg – October 13 – 19, 2019:
Geopolitics of the Energy Transformation and Energy Democracy



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CONTENTS OF THE PRESENTATION

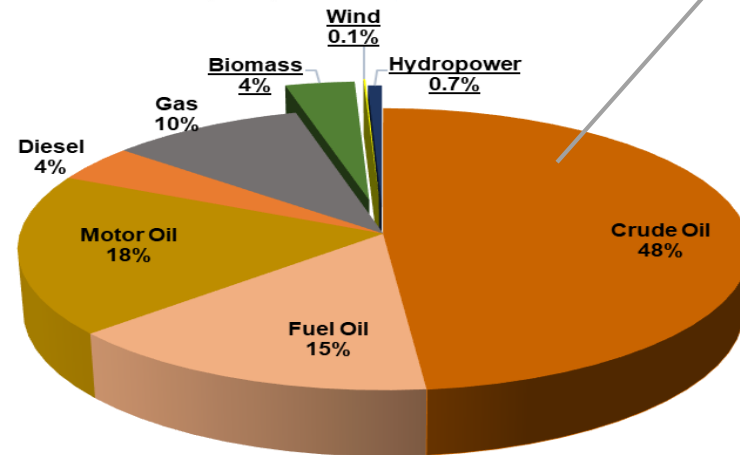
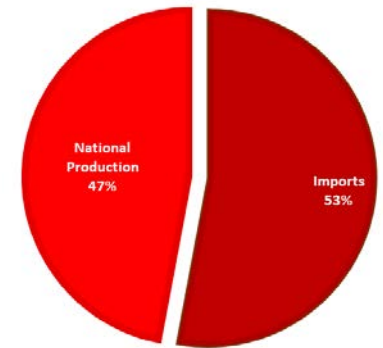
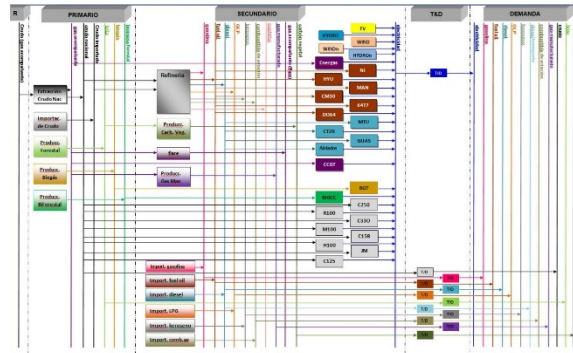
- **Characteristics of the Cuban Electrical System**
- **Reserves and Potential of Energy Resources in Cuba**
- **Potential of Renewable Energy Resources**
- **Development Plan until 2030: Renewable sources of energy and Energy efficiency.**
- **LINDA model.**
- **Conclusions**





CHARACTERISTICS OF THE CUBAN ELECTRICAL SYSTEM

- At a high percentage it is a centralized system
- High dependence on the importation of crude oil for electricity generation.
- High average cost of energy delivered
- Low use of renewable energy sources.
- More than 98.5% of the population has access to electricity





RESERVES AND POTENTIAL OF ENERGY RESOURCES IN CUBA

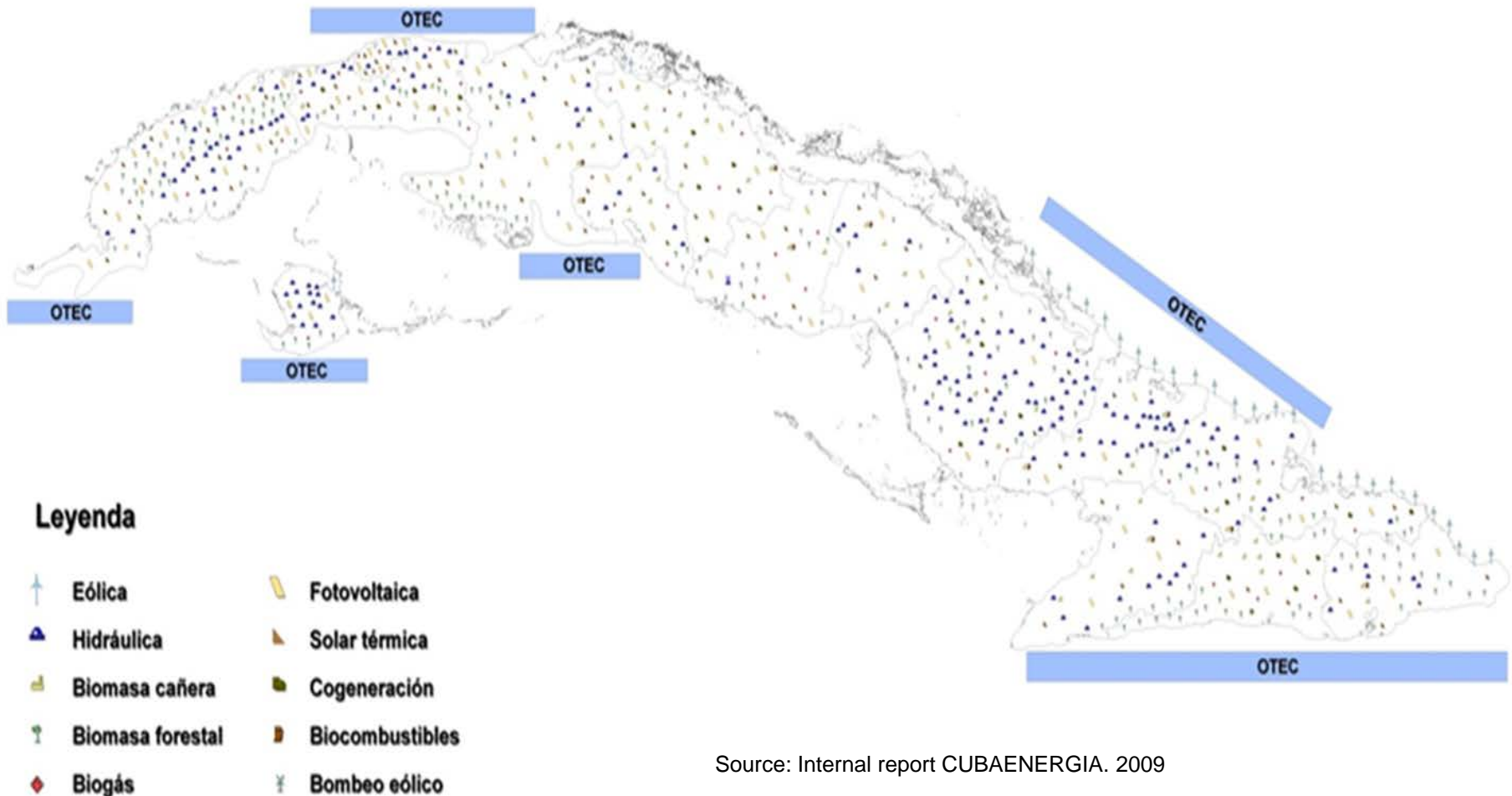
Resources	Units	Reserves or potential	Oil equivalent (million toe)
Crude oil and associated gas (onshore)	PJ	4 095	97.8
Crude oil and natural gas (EEZ) (offshore)	PJ	29 308	700
Bagasse and crop residues	Annual GW·h	17 500	1505
Peat	PJ	8 374	200
Hydropower	Annual GW·h	1 300	0.10
Biogas	Annual PJ	7.50	0.18
Wind energy	Annual GW·h	2 418	0.20
Firewood	Annual PJ	21	0.50

Source: "Cuba: A country profile on Sustainable Energy Development." IAEA. 2008





POTENTIAL OF RENEWABLE ENERGY RESOURCES



Source: Internal report CUBAENERGIA. 2009



IS FOREIGN INVESTMENT IN RENEWABLE SOURCES POSSIBLE IN CUBA?



SECTOR ELECTROENERGÉTICO

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OPORTUNIDADES DE NEGOCIO

BIOELÉCTRICA (11 PROYECTOS)

DESCRIPCIÓN: Empresa creada para incrementar la producción de electricidad renovable de biomasa a menor costo que el de combustión fósil, mejorando el entorno.

MODALIDAD DE INVERSIÓN: Empresa mixta

PAÍS CUBANO: Zima S.A.

MONTAJO DE INVERSIÓN ESTIMADO: 120 millones de USD

LOCALIZACIÓN:

- Fábrica Urbano Neco, Ciudad Nueva y Fernando de Oros, en **Hogueras**
- Fábrica Paratari, en **Caraguayo**
- Fábrica Candelaria y Estero Colón, en **Las Tunas**
- Fábrica Júcaro, en **Camaguey de Cuba**
- Fábrica Unión Oros, en **Cruces**
- Fábrica Hólar Marías, en **Holguín**
- Fábrica Antonio Sánchez, en **Caraguayo**
- Fábrica George Washington, en **Villa Clara**

POTENCIALIDADES DEL MERCADO: Avanzar programa, acceder a tecnología y financiamiento, reducir costo, elevar seguridad energética y reducir contaminación global.

CONTACTO: Dirección de Negocios de Zima S.A., Calle 4 e internet: www.zimacuba.com (teléfono: 05) 2635444 ext. 7353 / 2635447

PARKER SOLAR FOTOVOLTAICO DE 800 MW CON 50 MW DE ACUMULACIÓN

DESCRIPCIÓN: Instalación de 100 MW en parques solares fotovoltaicos con 50 MW de acumulación utilizando baterías.

MODALIDAD DE INVERSIÓN: Empresa mixta, BOPFI o BPC con financiamiento

PAÍS CUBANO: Unión Eléctrica

LOCALIZACIÓN: Nueva provincia. Se asegura la mejor localización y el diseño legal de los terrenos antes de la aprobación, por la autoridad competente, del negocio.

POTENCIALIDADES DEL MERCADO: La electricidad generada está dirigida completamente al Sistema Eléctrico Nacional, con la finalidad de disminuir la generación eléctrica a partir de combustibles fósiles. La Unión Eléctrica asegura la totalidad de la compra de la energía eléctrica entregada por un parque solar.

CONTACTO: Dirección de Negocios de la UNE, Calle 4 e internet: www.une.cu (teléfono: 05) 7616344

SECTOR ELECTROENERGÉTICO

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OPORTUNIDADES DE NEGOCIO



DEVELOPMENT PLAN UNTIL 2030: RENEWABLE SOURCES OF ENERGY AND ENERGY EFFICIENCY

Technology by source	To install (MW)	Planned Projects	Generation (GWh/año)	Crude oil replaced (Mton/año)
Biomass	872	25	4300	960
Industrial biogas	50	531	57	15
Wind power	656	14	1968	540
Solar PV	803	191	1071	240
Hydro power	56	74	650	72





DEVELOPMENT PLAN UNTIL 2030: RENEWABLE SOURCES OF ENERGY AND ENERGY EFFICIENCY



Biomass power plants

- 57 sugar plants with 470 MW capacity
- Programme to install 25 biomass power plants which would provide 14% of electricity of the country
- Increase of boiler pressure and temperature enables three fold increase of electricity per ton of sugarcane. Today the rate is 37 kWh/tcm and the projection is 110-120 kWh/tcm



Wind power

- Existing capacity in 4 wind parks is 11,7 MW
- Programme to install 656 MW in 14 wind farms
- There are wind measurement data at 50 and 100 meters high in 32 areas of the country. The technical potential is greater than 2000 MW
- Capacity factor is estimated to be over 35%.



Solar PV

- The programme consists of installation of 191 solar PV parks in the country, 803 MW



DEVELOPMENT PLAN UNTIL 2030: RENEWABLE SOURCES OF ENERGY AND ENERGY EFFICIENCY



Hydropower

- The Plan is install 56 MW.
- Present capacity is 63 MW, 147 power plants of with 30 are connected to the main grid and 117 are insolated systems.



Bioenergy

- The plan is to build 500 industrial biogás plants and 9000 small agricultural installations.
- Use of more than 1 million hectares of marabú, for energy purposes



Energy Efficiency

- Replacing existing street lights with LED technology
- Water pumping with solar energy for agriculture
- Installation of 100 000 m² solar heater at homes





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LINDA MODEL

LONG-RANGE INTEGRATED DEVELOPMENT ANALYSIS

LINDA model for energy system analysis

- Simple to use Excel based tool for energy sector analysis and scenario building
- Can be developed to accurately model different sectors of economy
- Outputs easy to visualize
- Accounting framework type of model
- Data storage





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LINDA MODEL

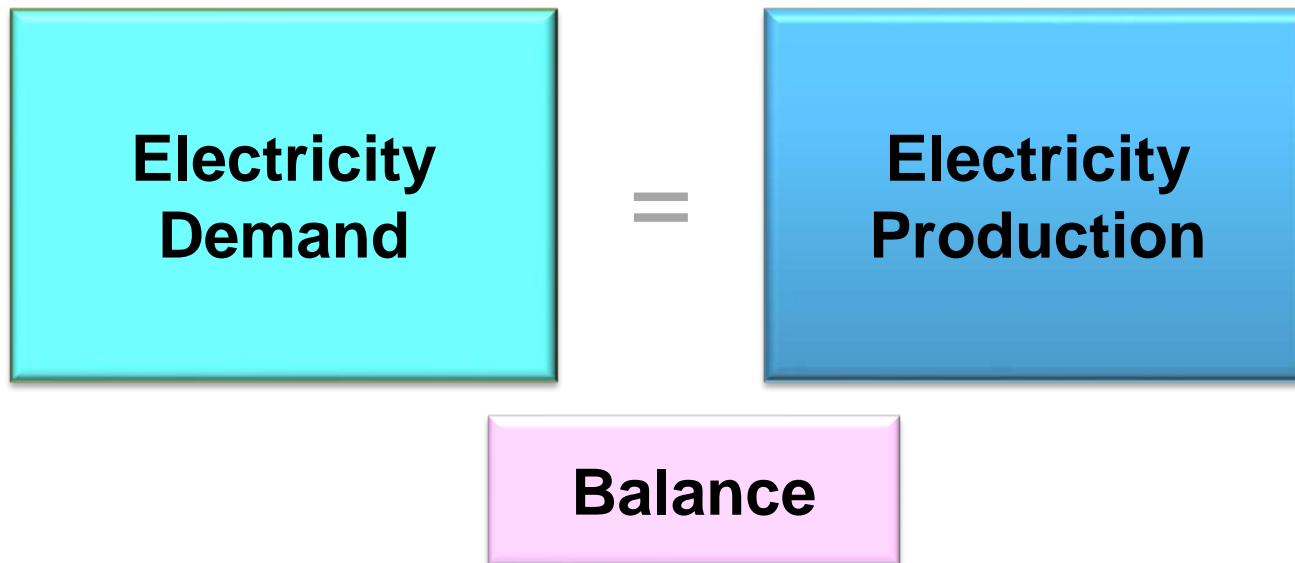
LONG-RANGE INTEGRATED DEVELOPMENT ANALYSIS

- **Integrated means:**
 - **Economic (e.g. LCOE)**
 - **Technical (energy, technology)**
 - **Environmental (CO₂ and other emissions)**
 - **Social (e.g. employment, population, urban/rural)**
 - **Other issues (e.g. water demand module)**





ENERGY PLANNING: ELECTRICITY BALANCE

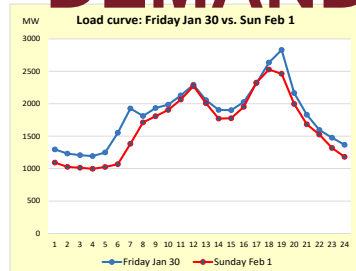
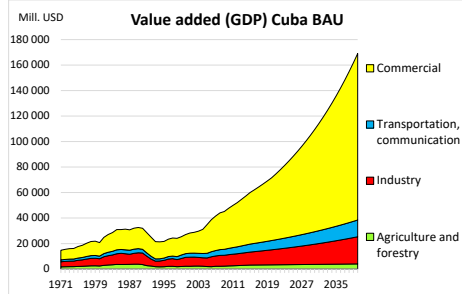


Every hour production and demand has to be equal

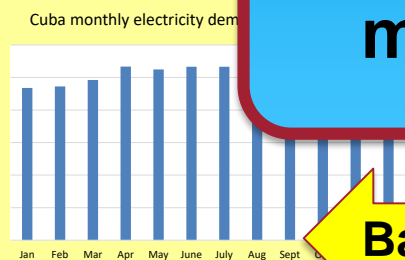
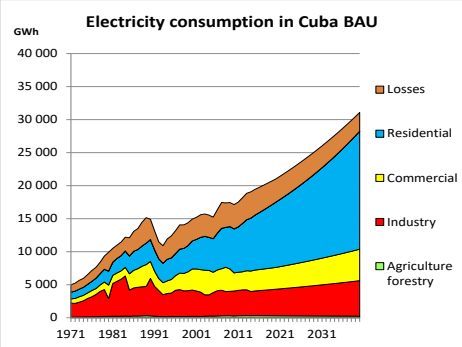
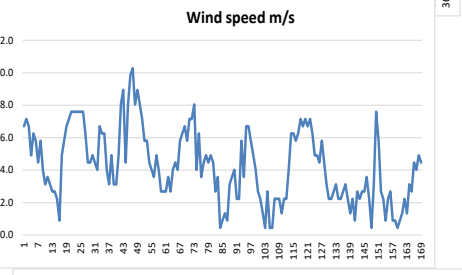
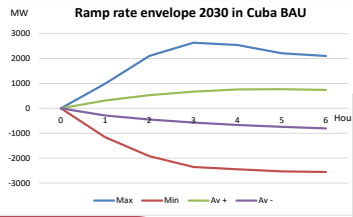
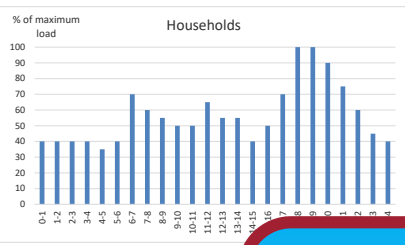
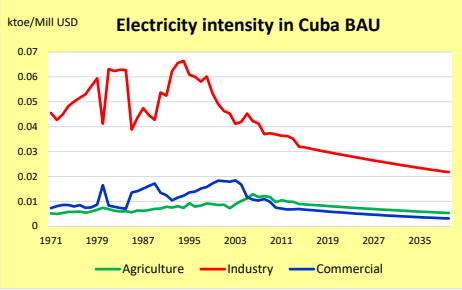
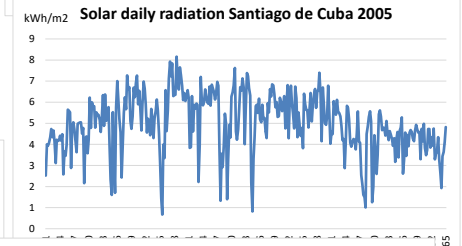
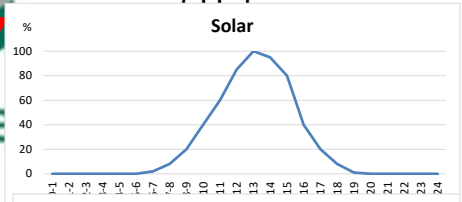




DEMAND AND SUPPLY



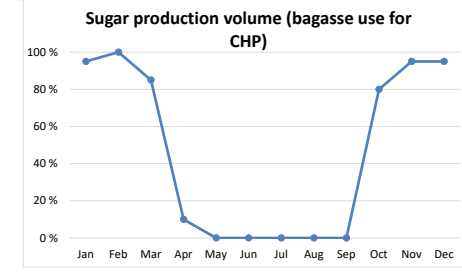
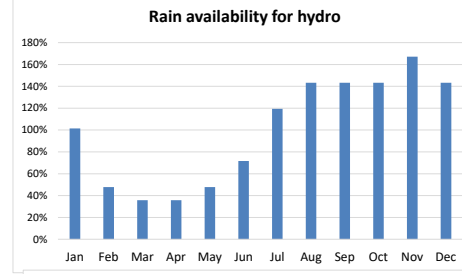
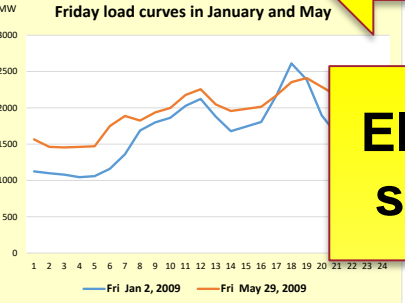
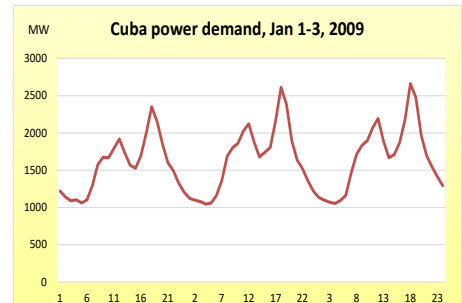
Corrollable power production (fossil)



CubaLinda model

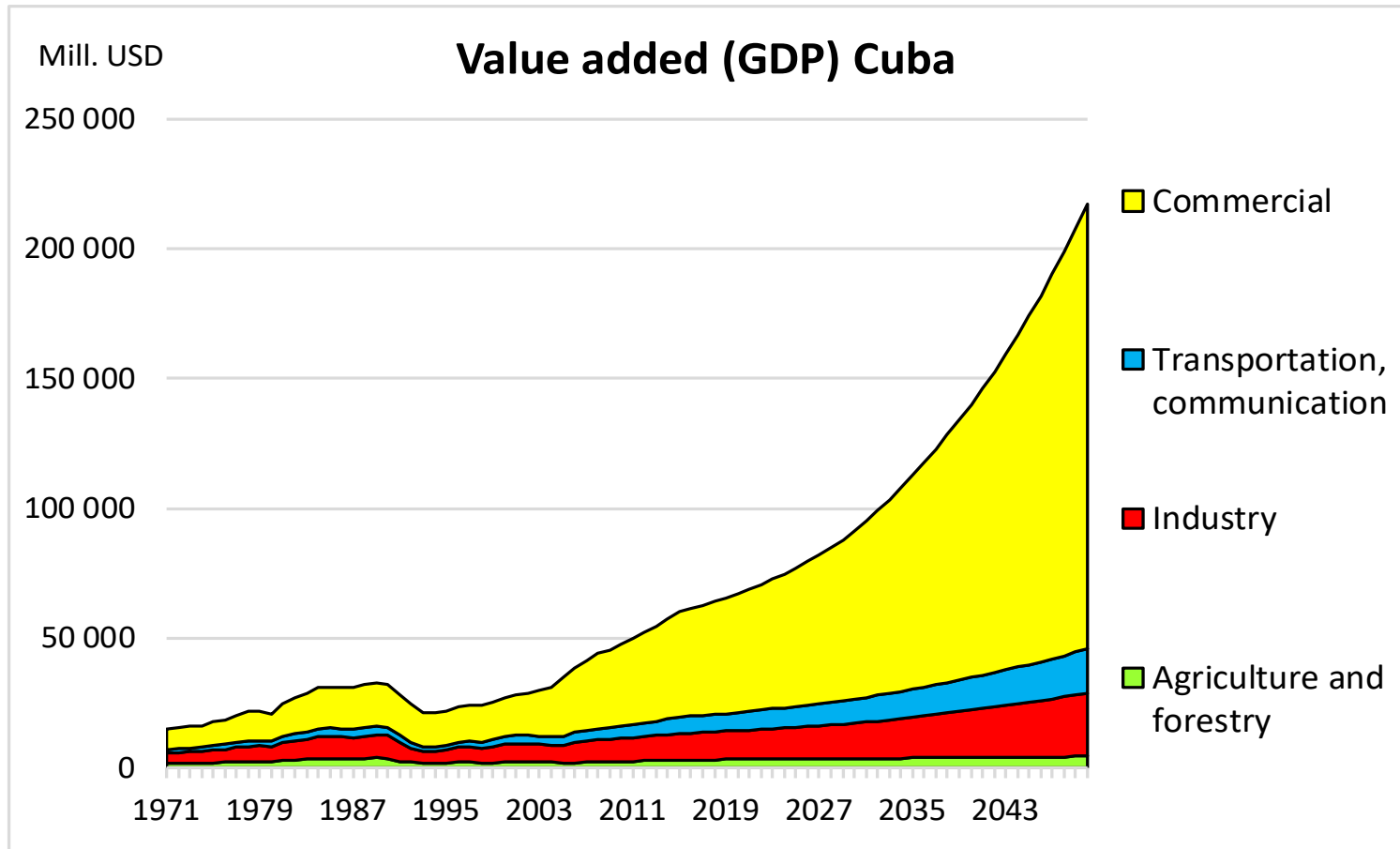
Balancing

Electricity storage?



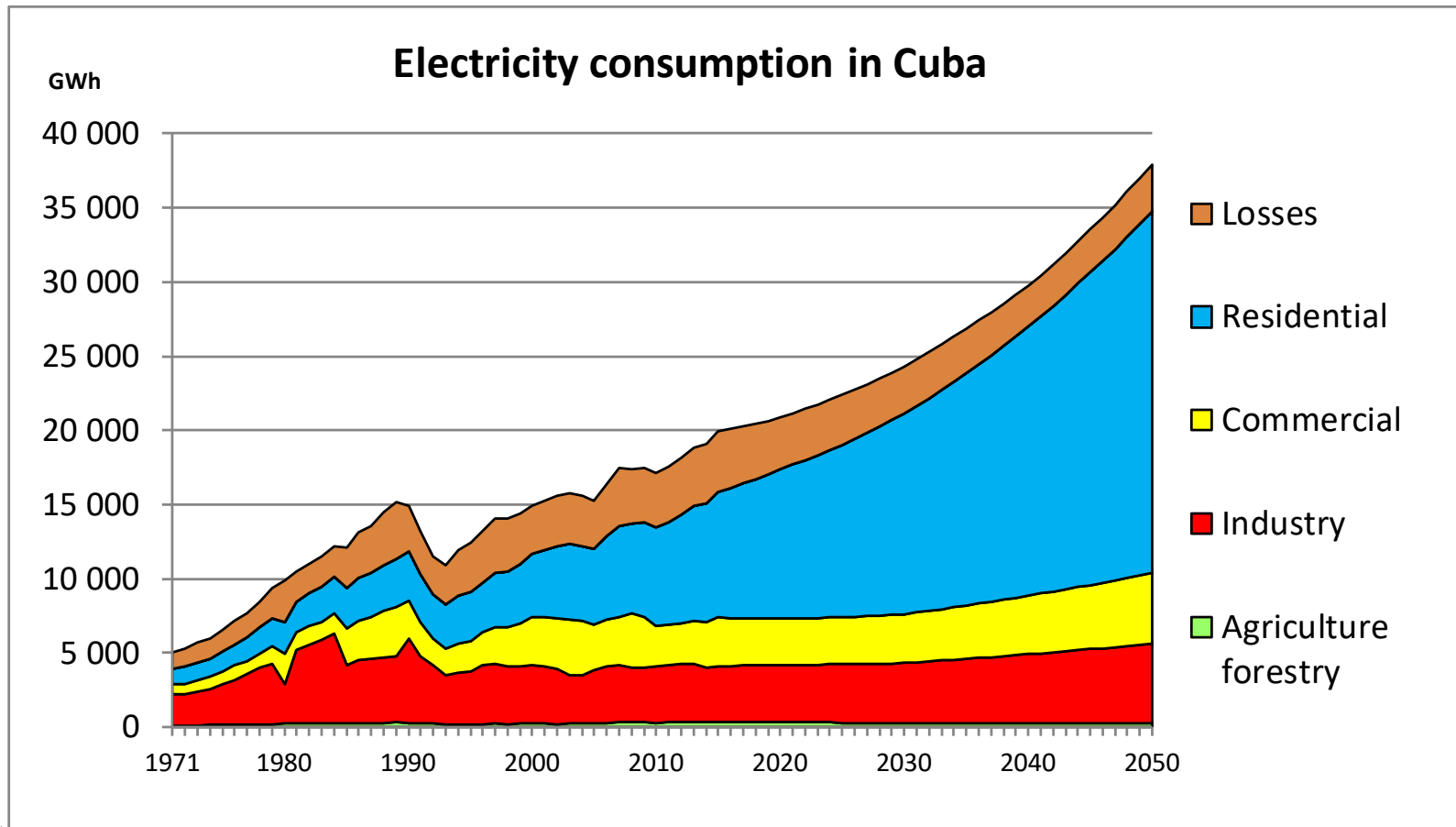


CUBALINDA-RESULTS.



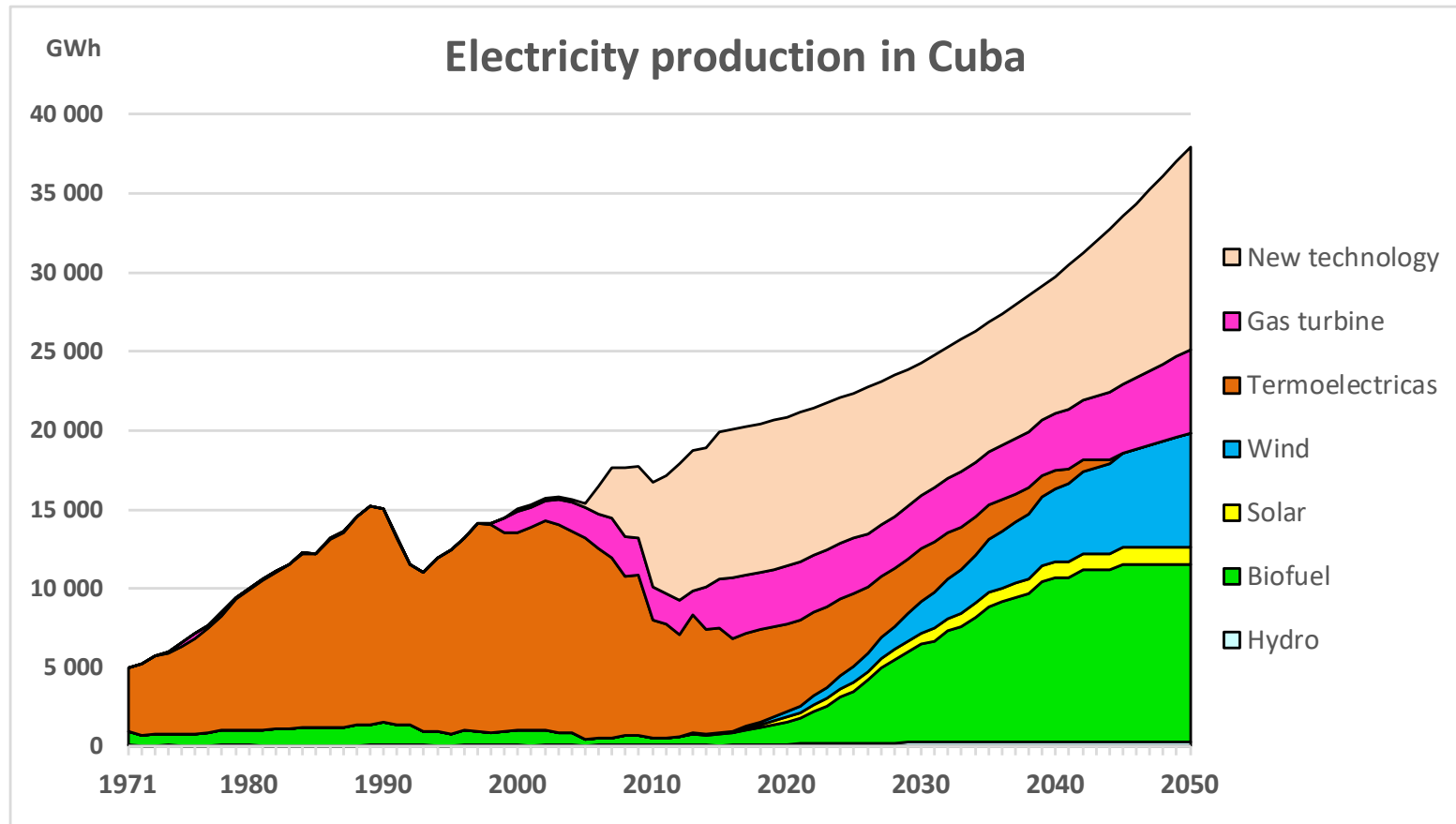


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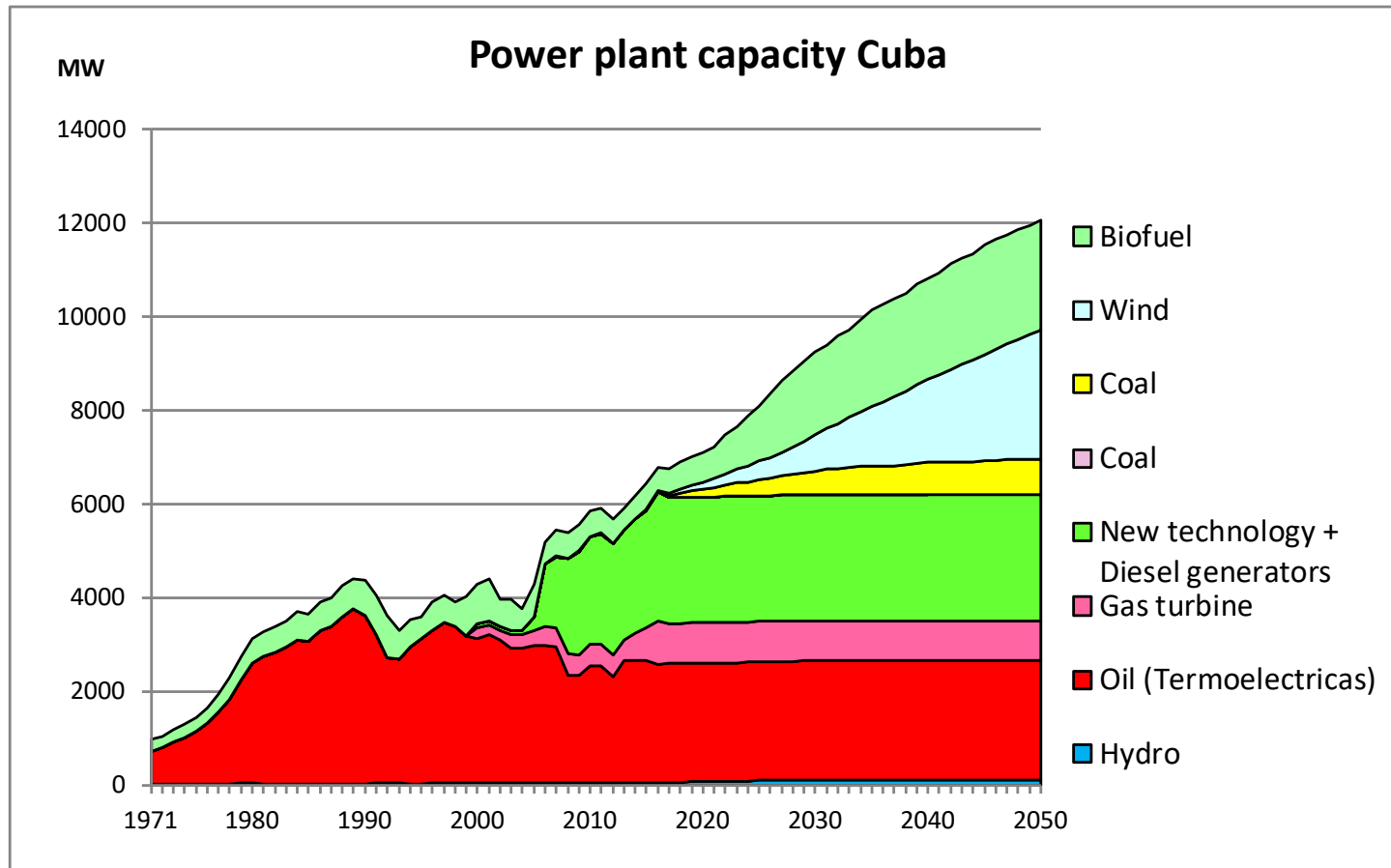


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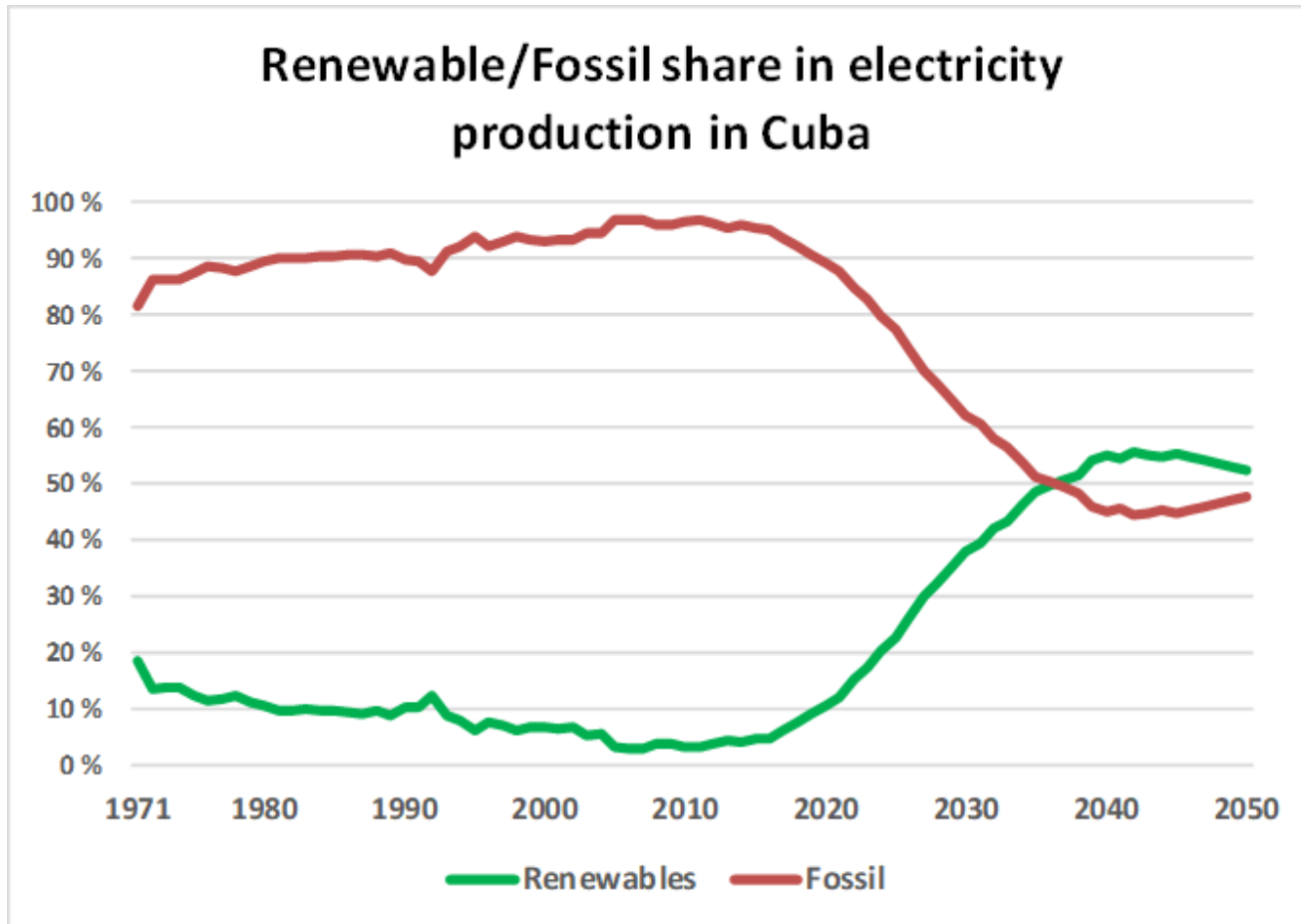


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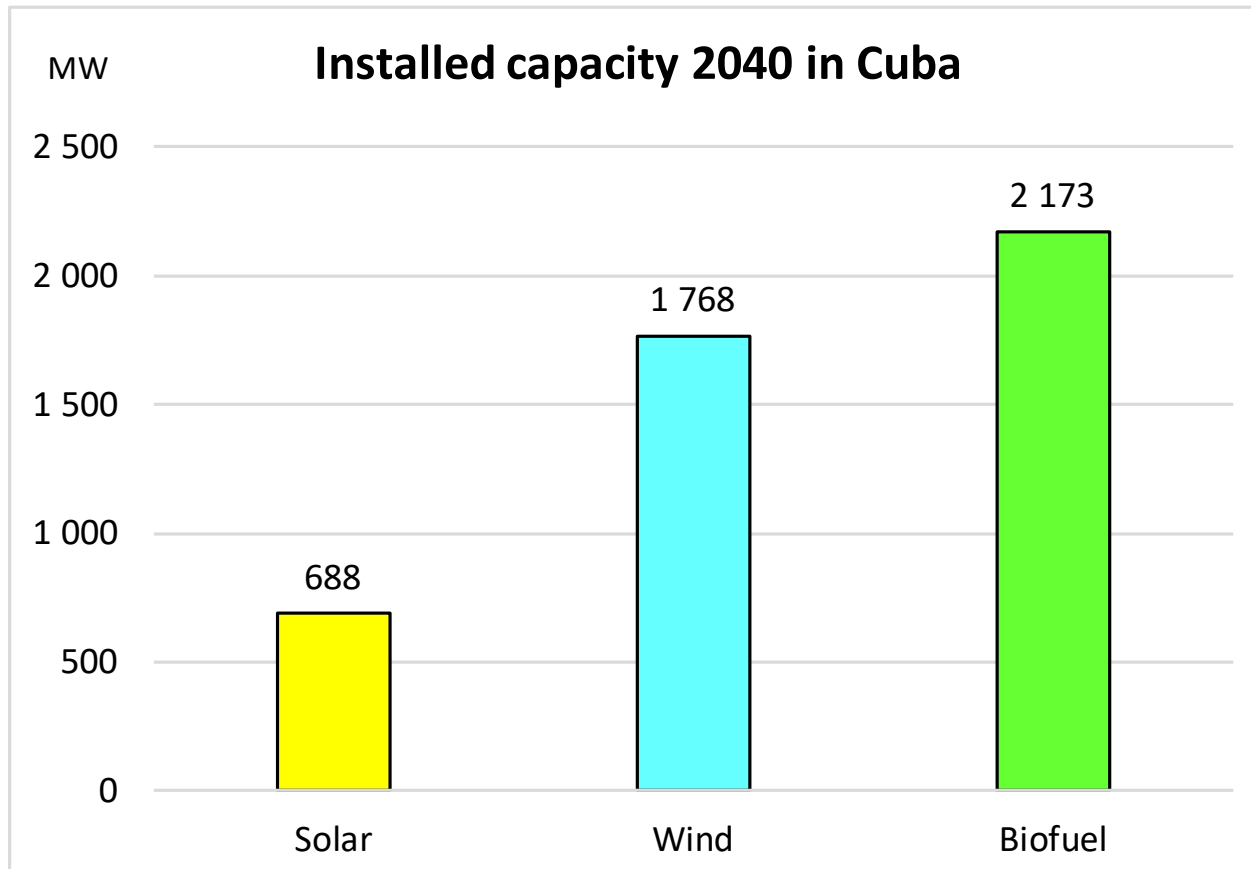


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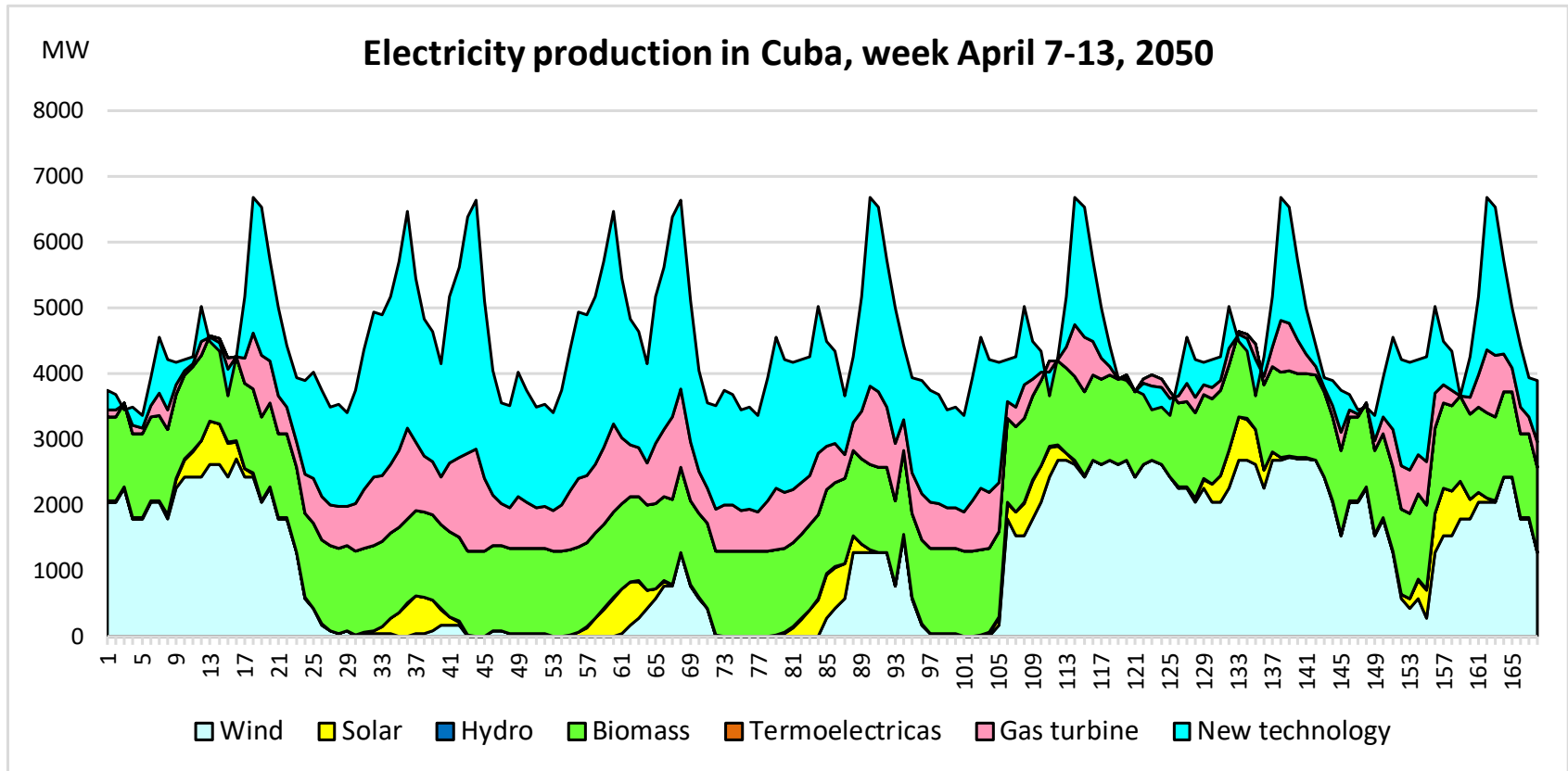


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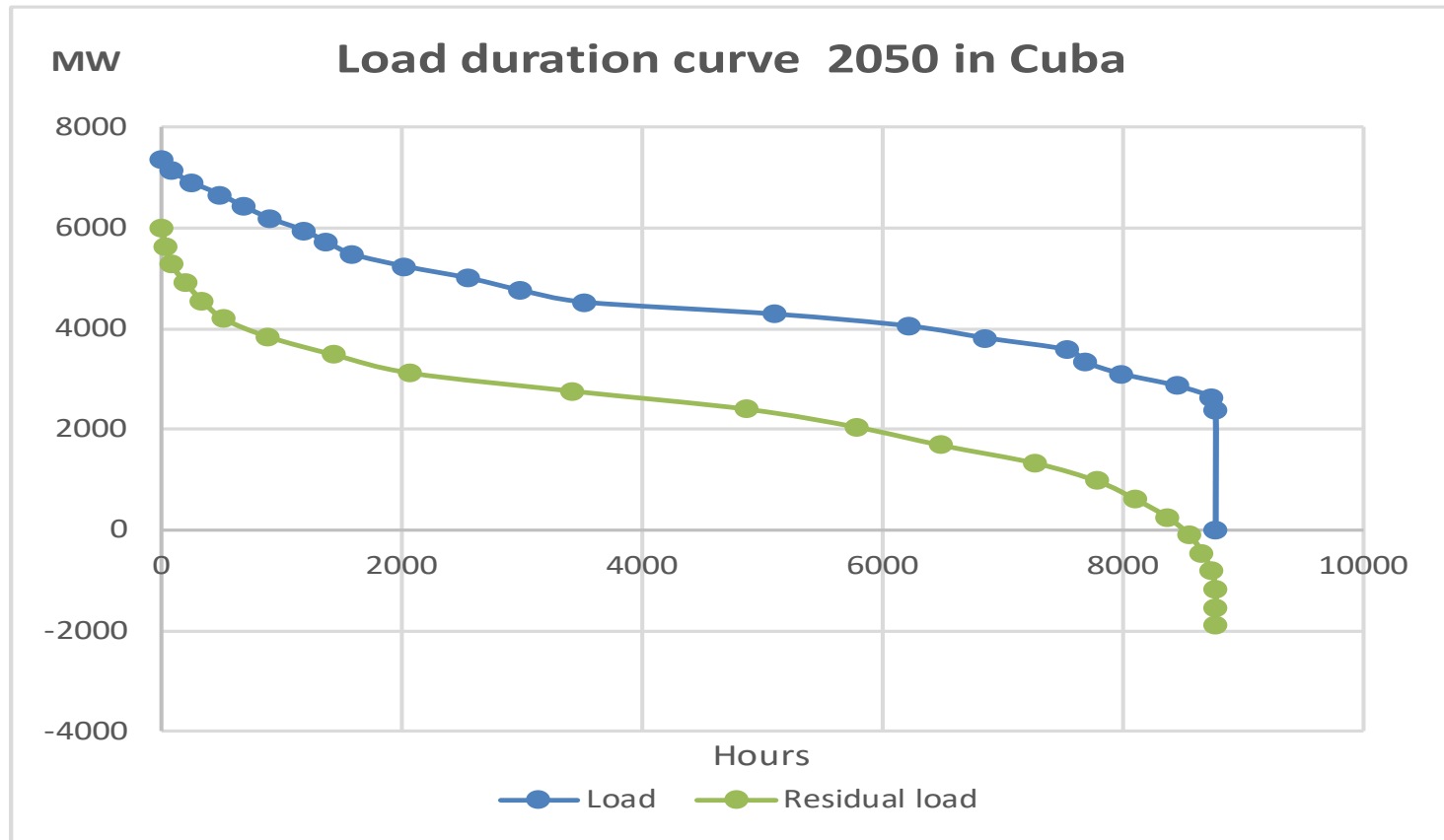


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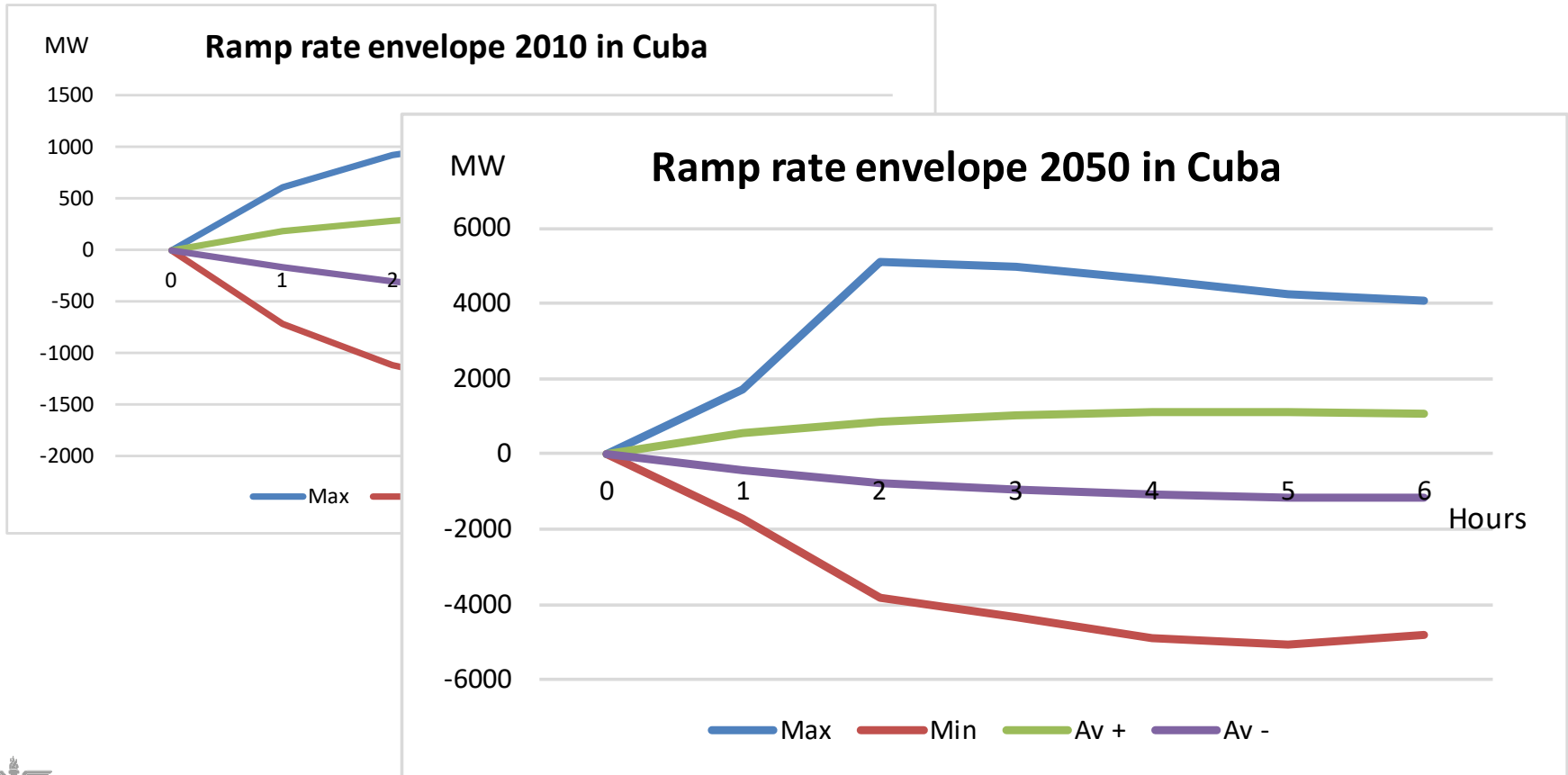


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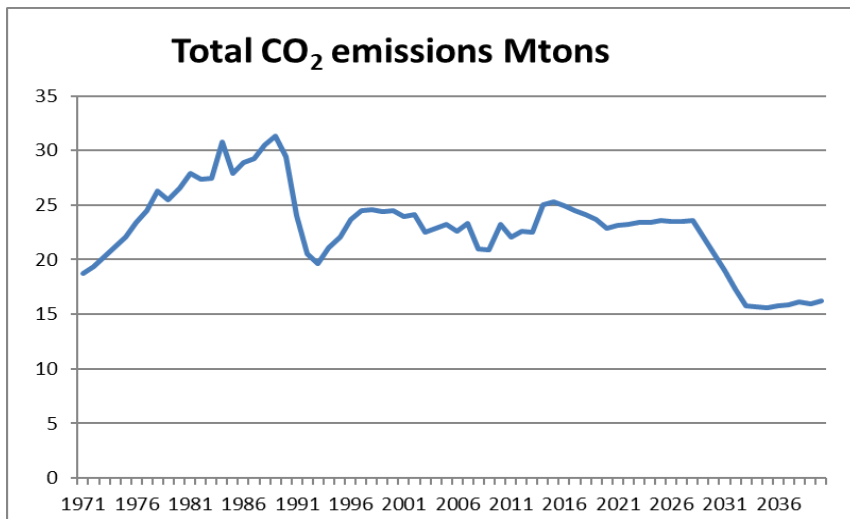
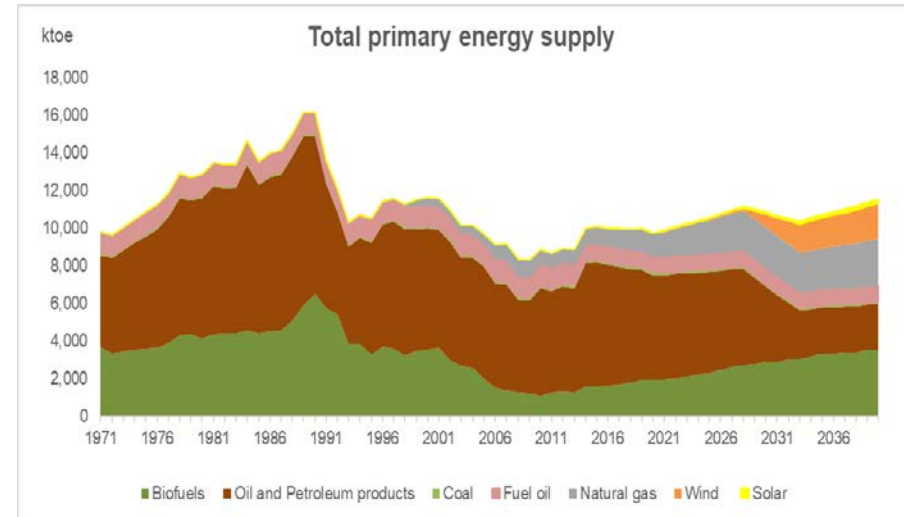
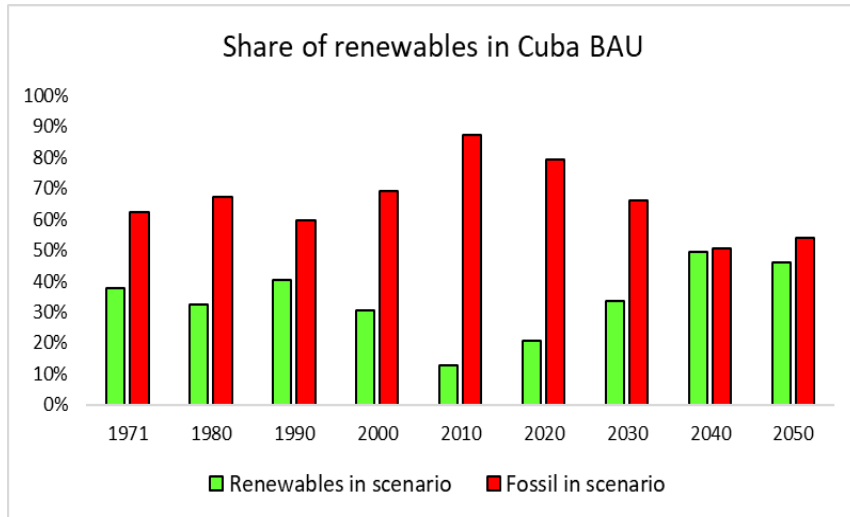


CUBALINDA-RESULTS.





CONCLUSIONS



- Change of the Electricity Generation Matrix
- Increase in the use of renewable energy sources
- Reduction of the costs of the energy supplied
- Reduction of environmental pollution



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Thank you



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