Acesso a serviços energéticos e seu nexo com clima, alimento, bem estar social e água

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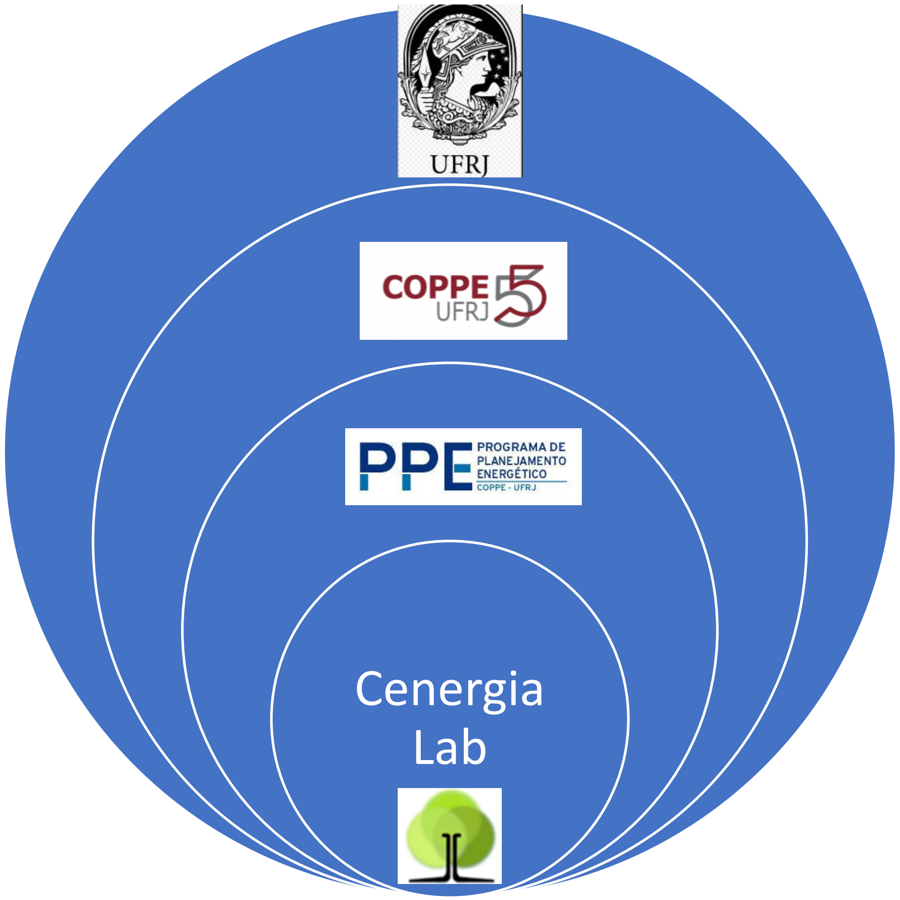
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1. “O velho está morrendo e o novo ainda não pode nascer...” (?)
2. Uma análise integrada - complexidade
3. Energia e Clima: uma análise com uso de IAMs
4. Energia e Bem-Estar: uma análise do LpT

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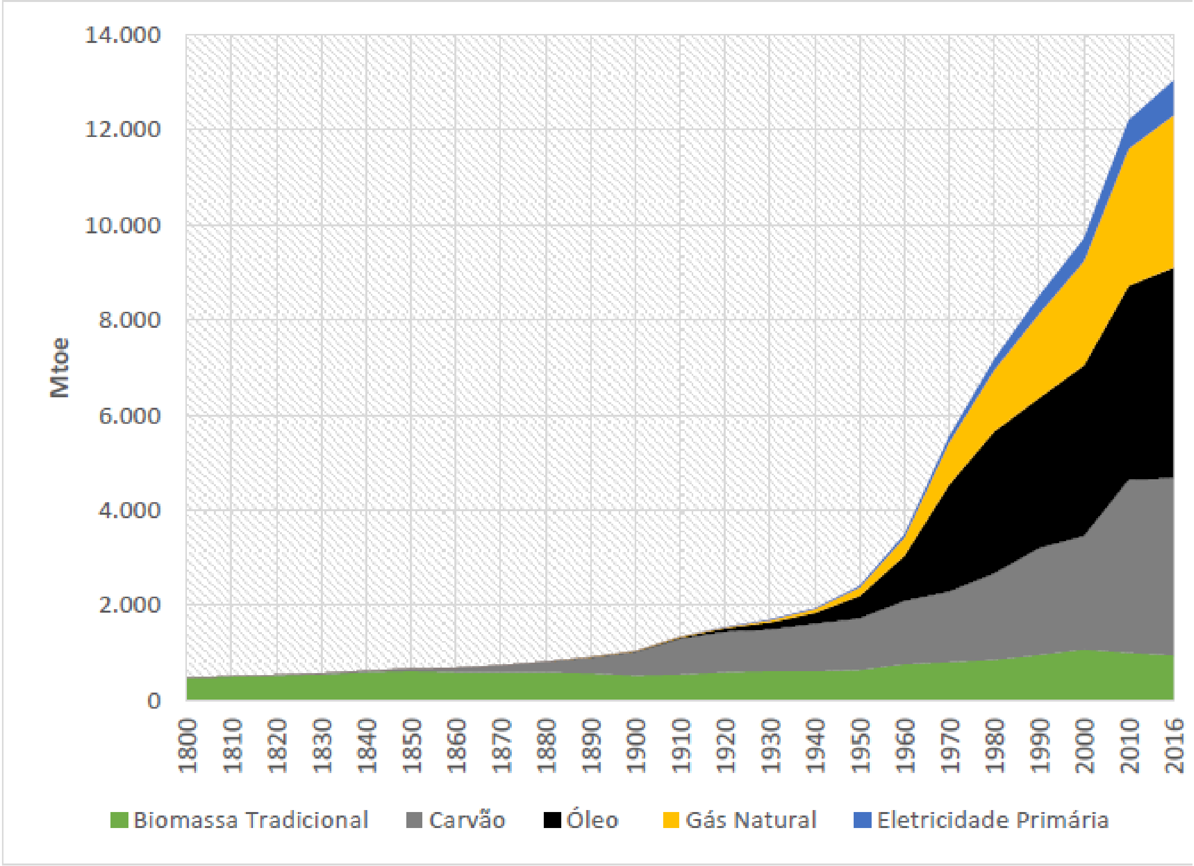
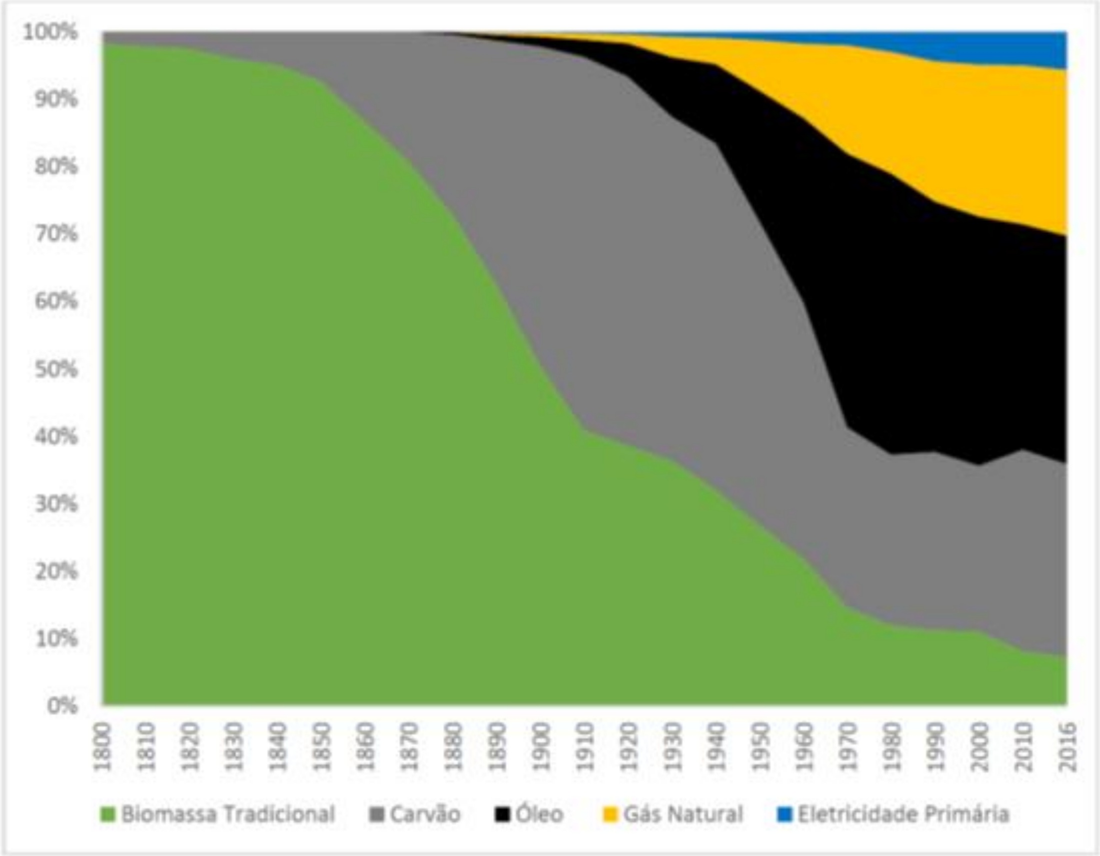
Alguns dados a partir de SMIL (2008, 2010, 2011), WARDE (2007), UN (2015) e BP (2018)

1. **Consumo anual de energia $1^{ária}$ per capita**: Império Romano (≈10 GJ) => Mundo em 1700 (≈15 GJ) => Reino Unido (RU) em 1800 (≈50 GJ).
2. **Em 2010**, ≈135 GJ no RU e ≈**300 GJ (!)** nos EUA. No mundo, em média, ≈ 79 GJ.
3. **Mas**, em 2010, ≈3 x 10^9 de pessoas (ou ≈50% da pop. mundial) com consumo anual per capita (energia $1^{ária}$) ≤ 50 GJ (heurística para mínima qualidade de vida). **Pior ainda: sem acesso a serviços energéticos modernos**!
4. **$(\text{Pior ainda})^{\infty}$** = (mais de 1/3 da pop. mundial possui consumo médio anual de energia primária ≤ 30 GJ) + (≈1 x 10^9 de pessoas a mais nestas regiões em 2050)
5. **Tudo isto a partir de conversores de baixíssima eficiência!** Isto é, a disparidade em energia útil é muito maior do que em energia primária (que já é grande)! Note-se: em termos de energia útil per capita: ano 2000 ≈ 25 vezes ano 1900. Distribuição completamente assimétrica! Há regiões em que a lenha, a biomassa catada, é a base da energia primária.

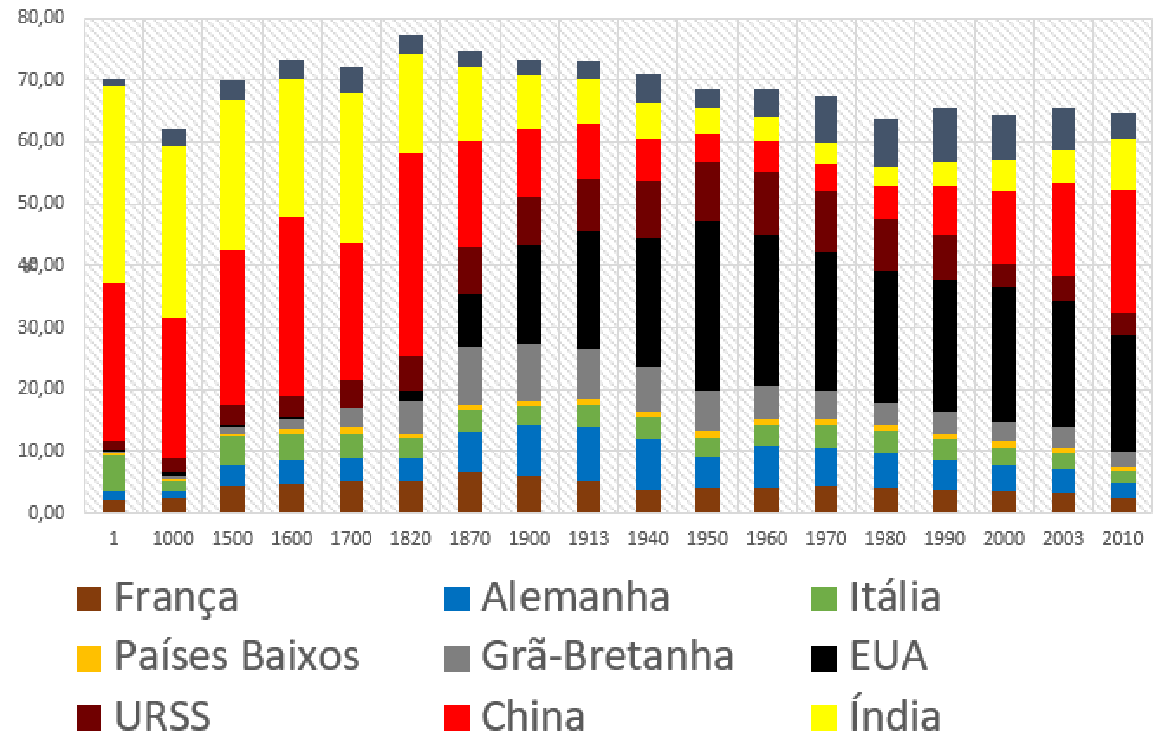


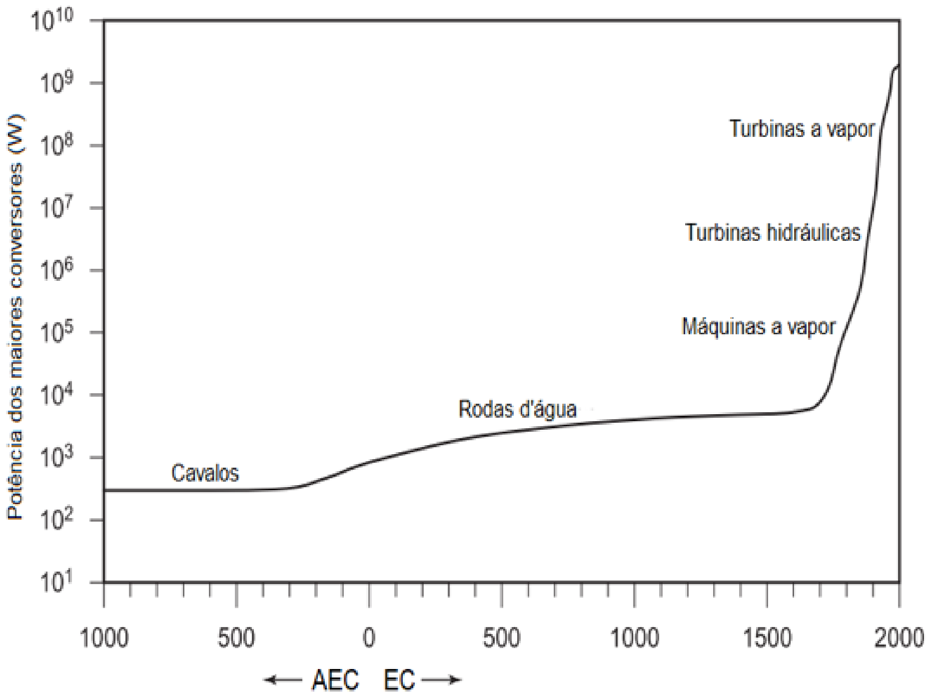


Proporção Histórica do Consumo de Energia Primária Global (1800 - 2016). Elaboração própria a partir de BP (2016), MALANIMA (2014) e SMIL (2010b).

Transições energéticas globais

Da caça-coleta à agricultura → Revolução Industrial e transição ao carvão → A transição ao petróleo





Fonte: Elaborado a partir dos dados de Angus Maddison (MADDISON-PROJECT, 2013).

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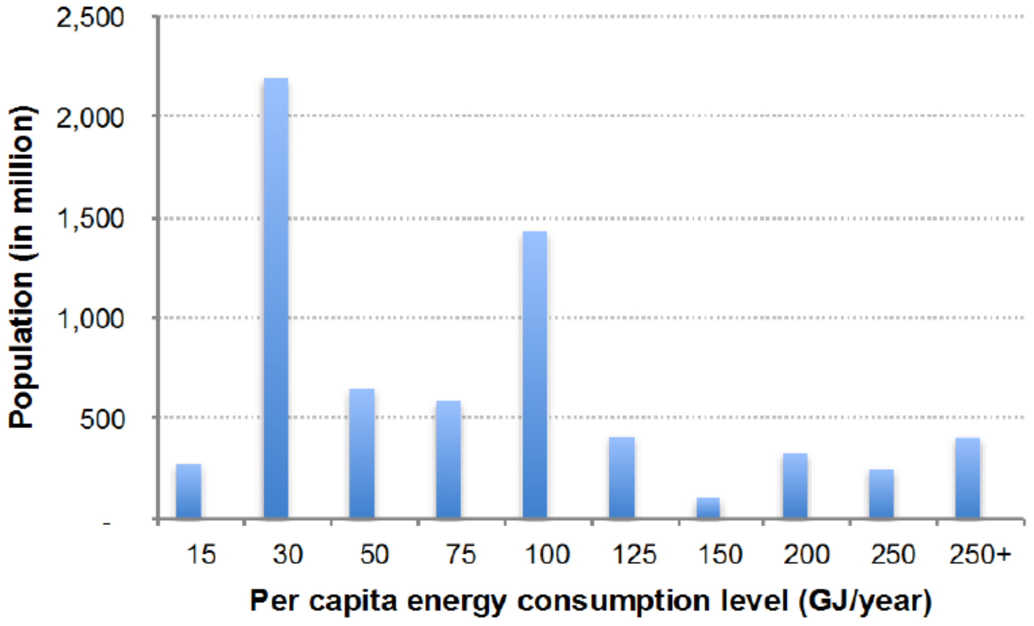
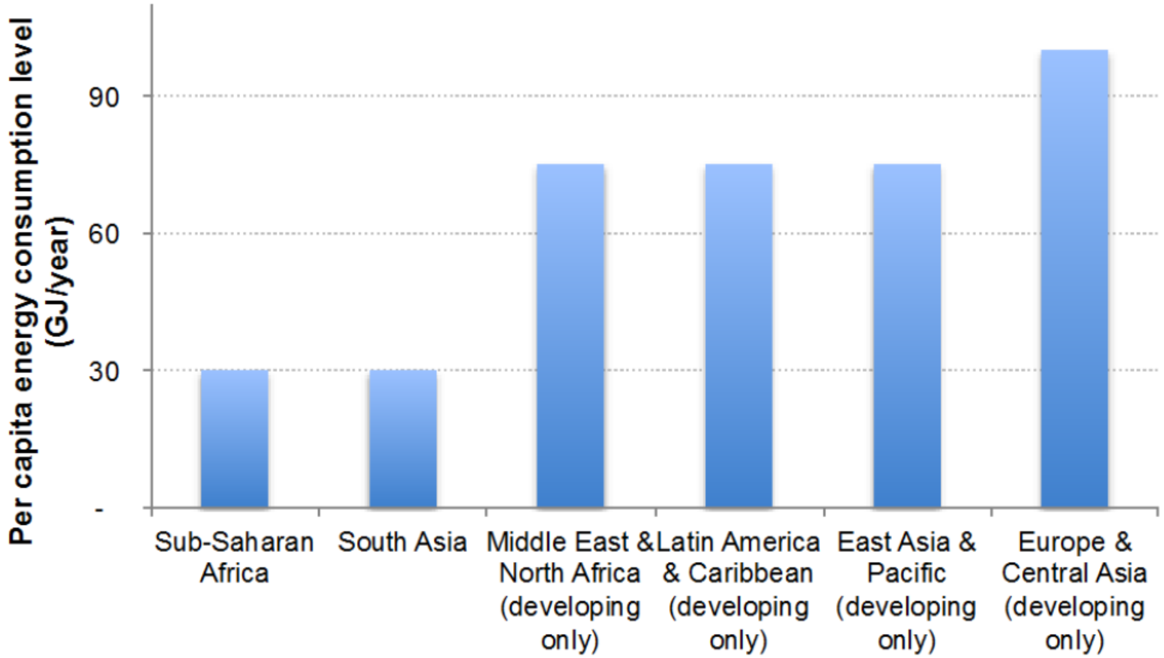
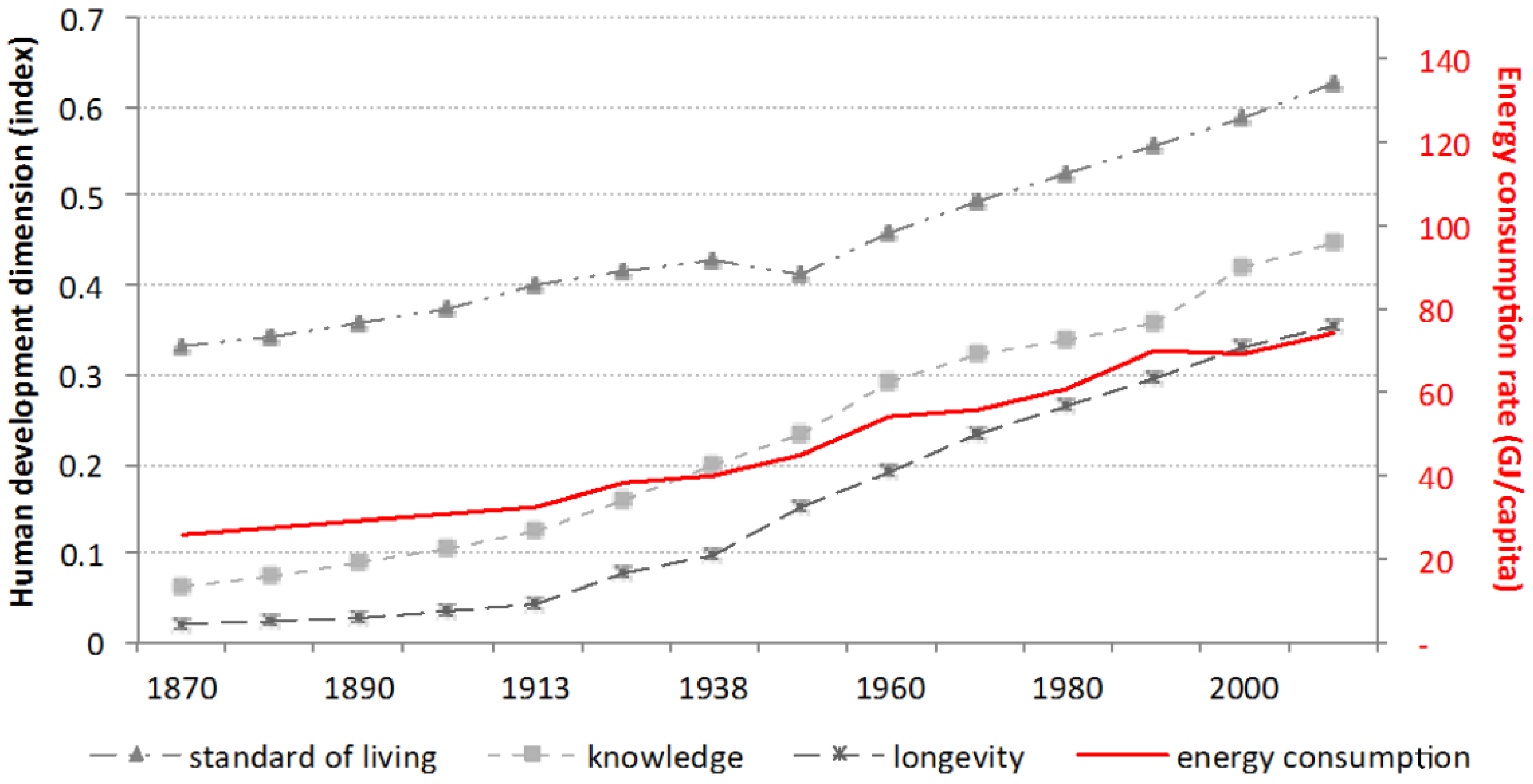


Note: Each bar refers to the maximum rate achieved. For example, 15 GJ level refers to all rates up to 15 GJ.





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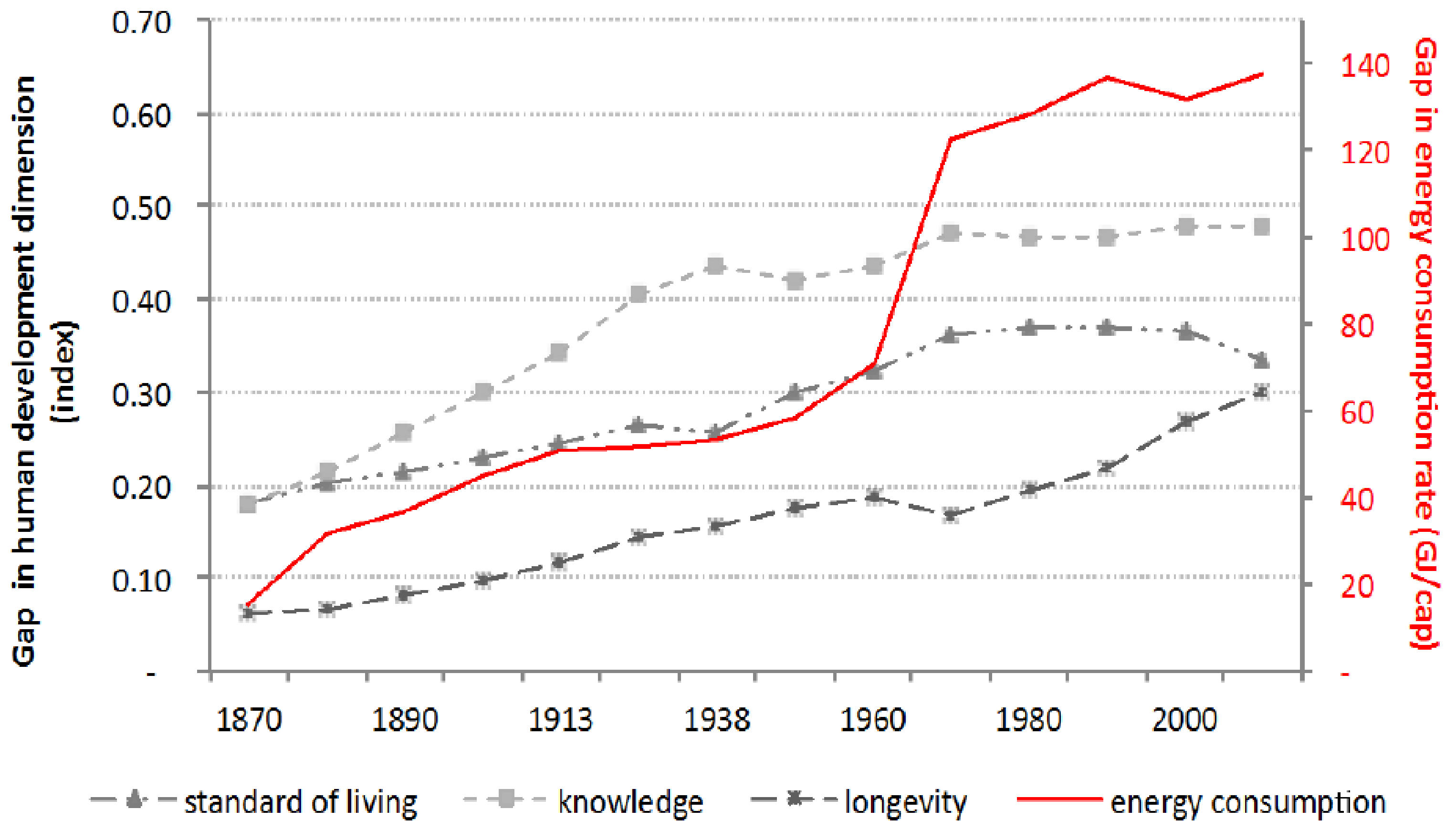

Figure 3 - Selected dimensions of human development (standard of living, knowledge, and longevity) and annual per capita energy consumption rate: Absolute gaps between OECD countries and the rest of the world, 1870-2005.

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Acesso à energia moderna = impacto em emprego e renda (impacto de 2ª ordem da educação)

um mundo com fome zero e segurança alimentar

Energia = impactos à saúde humana

Acesso à energia moderna = impacto na educação...

Acesso à energia moderna = papel da mulher

assegurar a disponibilidade e gestão sustentável da água e saneamento para todos

assegurar o acesso confiável, sustentável, moderno e a preço acessível à energia para todos

EMPREGO DIGNO

INDÚSTRIA

REDUÇÃO DAS

Energia = fonte de inovação, oportunidade x Maldição dos recursos, Doença Holandesa

CIDADES E

CONSUMO

Consumo de energia final em cidades: mobilidade, edificações

ações de mitigação e adaptação

14 VIDA DEBAIXO D'ÁGUA

15 VIDA SOBRE A TERRA

Bioenergia, alimentos, biodiversidade: AFOLU

Energia = *Just Transition* x Maldição dos recursos

17 PARCERIAS EM PROL DAS METAS

OBJETIVOS DE DESENVOLVIMENTO SUSTENTÁVEL

	Clima	Uso do solo / Alimento	Energia	Água
Clima		Mudanças climáticas e eventos climáticos extremos afeitam a produtividade das culturas e incrementam a demanda por água.	Mudanças na demanda de energia onde há mais necessidade de resfriamento ou aquecimento.	Mudanças na disponibilidade hídrica: maiores secas ou maiores enchentes.
Uso do solo / Alimento	Emissões de gases de efeito estufa (GEE) por mudança no uso do solo e produção de fertilizantes.		Energia para o bombeamento de água, produção de fertilizante, agroquímicos, uso de maquinaria e transporte.	Possível incremento de demanda e consumo de água devido à expansão de cultura e/ou mudanças na produtividade da cultura.
Energia	Emissões de GEE da queima de combustíveis fósseis do setor.	Uso de solo para produção de culturas bioenergéticas. Uso de solo para instalação de tecnologias energéticas.		Mudança no curso do rio, demanda e consumo de água das tecnologias energéticas.
Água	Mudanças no ciclo hidrológico afetam o tempo e clima local.	Mudanças na disponibilidade hídrica para agricultura.	Disponibilidade hídrica para culturas bioenergéticas, e outras tecnologias energéticas.	

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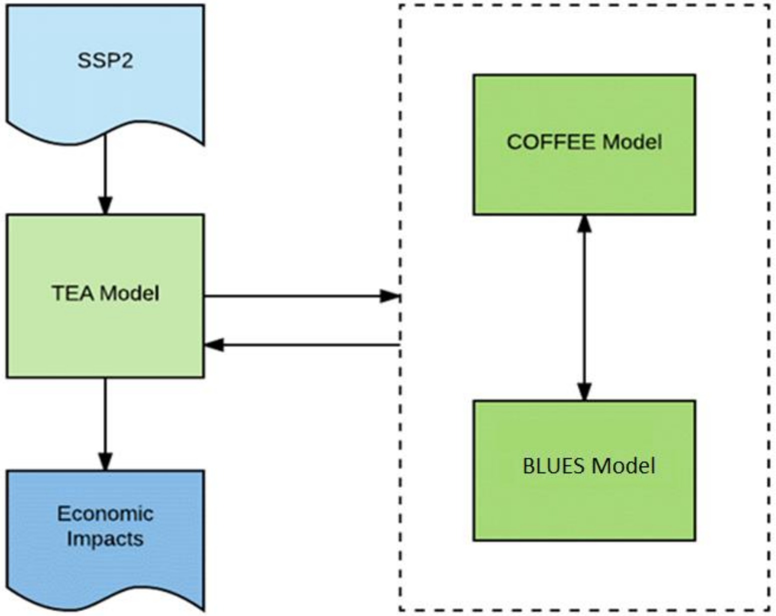
Nossos Modelos Integrados
(*Integrated Assessment Model Tools*)

Total-**E**conomy **A**ssessment (**TEA**) – CGE Model

Economy-Energy–Land Use
GTAPinGAMS
Recursive dynamic
18 regions

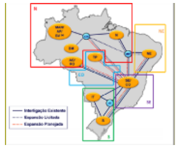


COmputable **F**ramework For **E**nergy and the **E**nvironment (**COFFEE**)

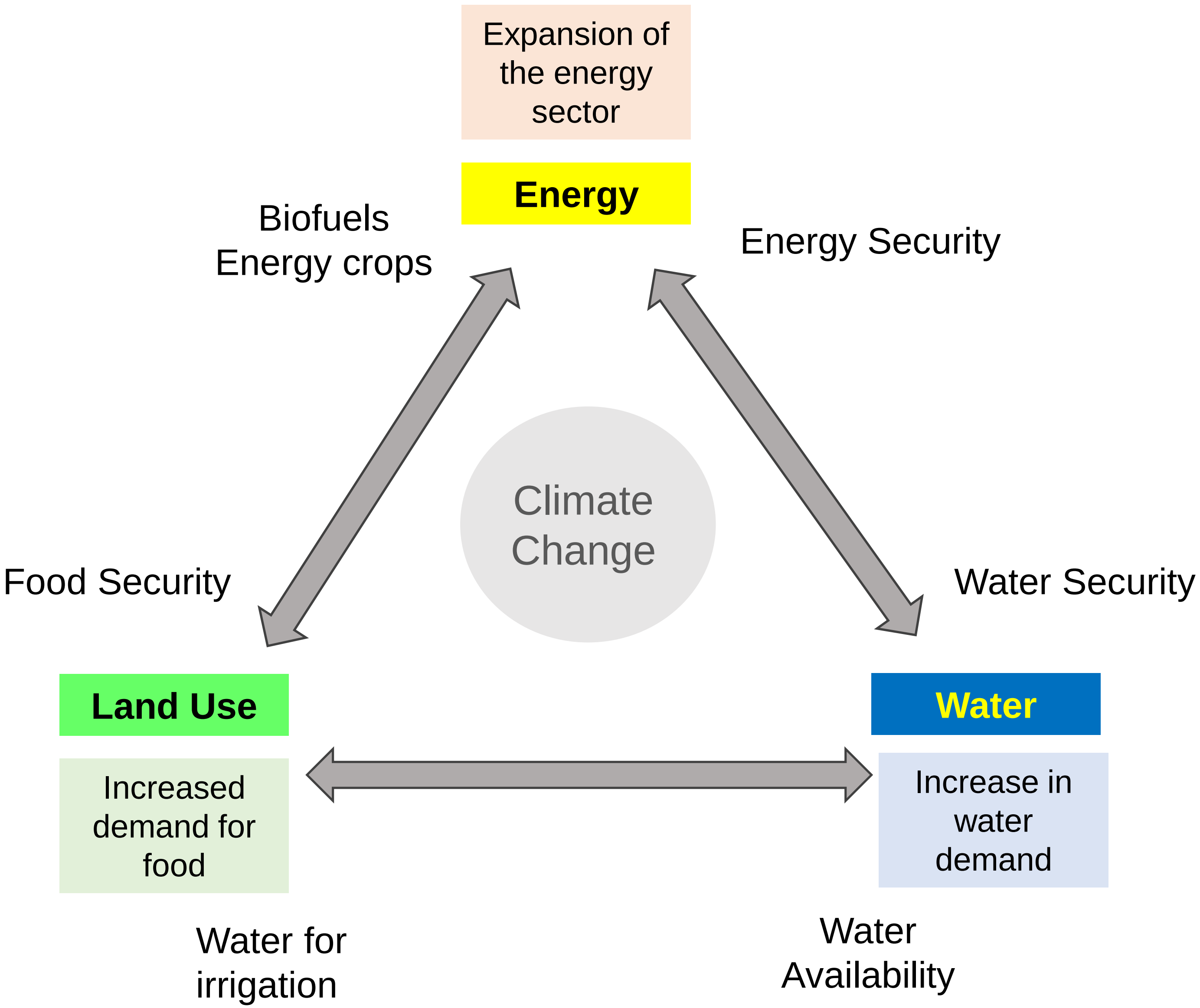
- Optimization model – Energy and Land Use
- 18 regions
- Translation into GAMS

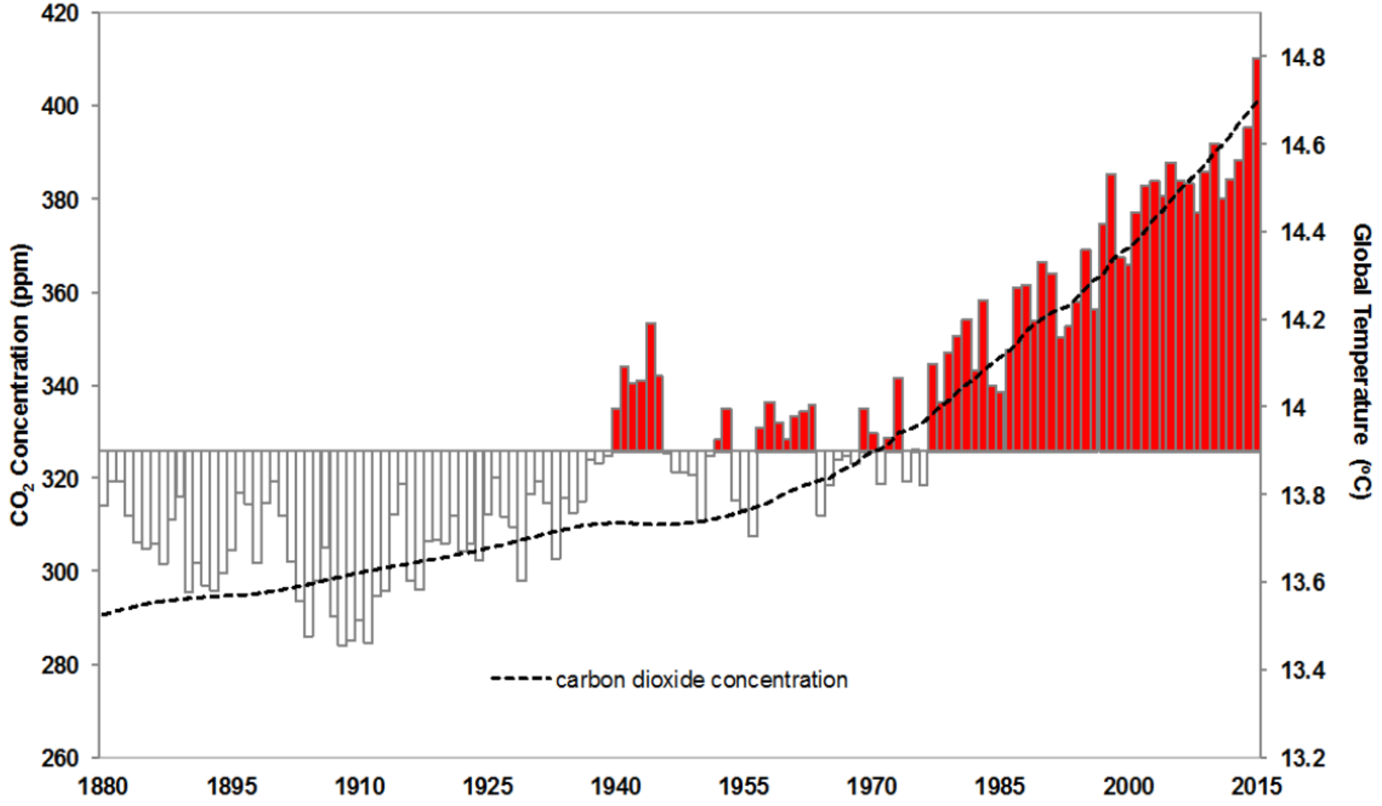
Brazil **L**and**-U**se and **E**nergy **S**ystems Model **(BLUES)**

- Optimization model – Energy and Land Use
- 6 Brazilian regions
- Translation into GAMS



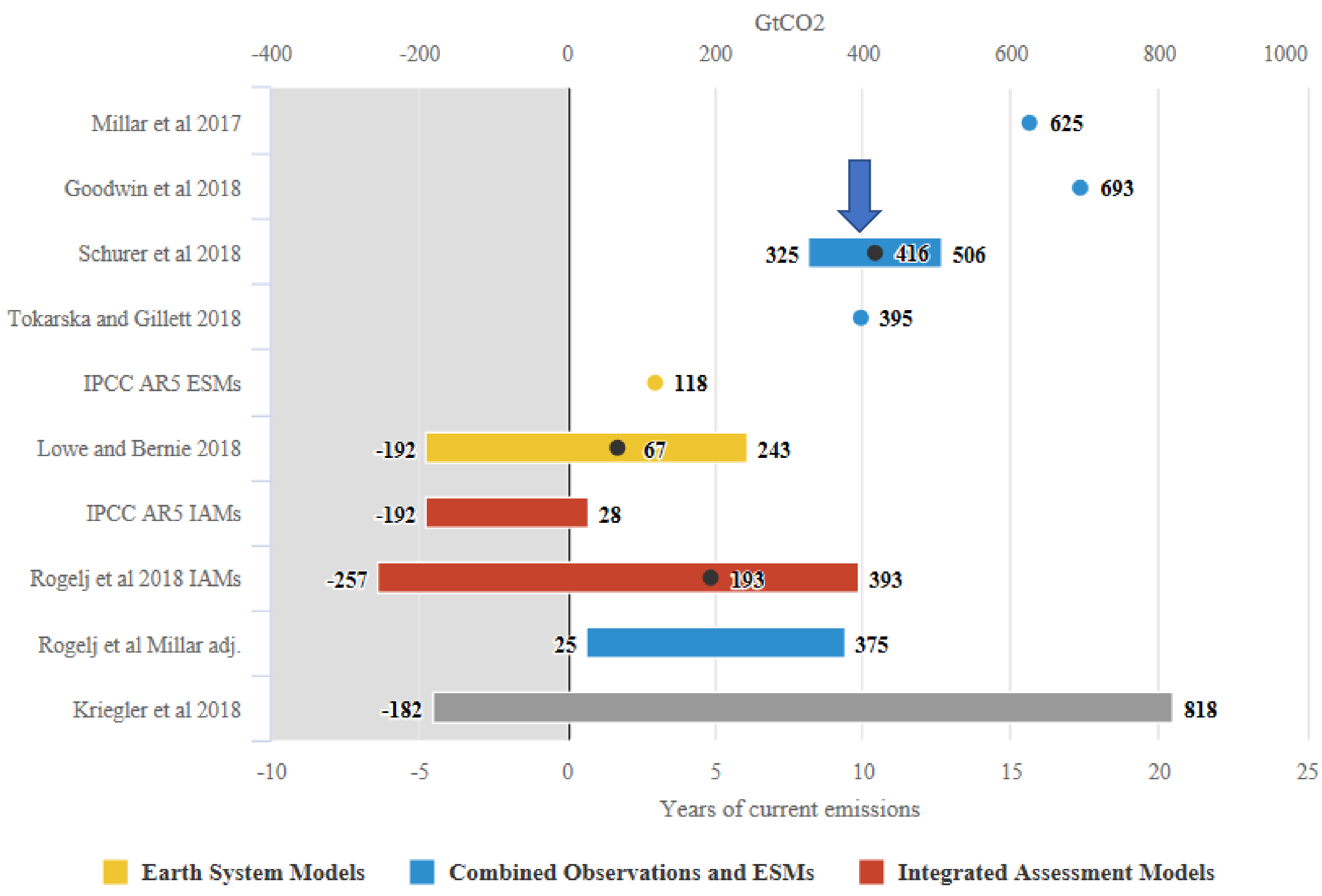
The CLEW Nexus in the COFFEE model





420
400
380
360
340
320
300
280
260
CO_2 Concentration (ppm)
14.8
14.6
14.4
14.2
14
13.8
13.6
13.4
13.2
Global Temperature (°C)
1880
1895
1910
1925
1940
1955
1970
1985
2000
2015
carbon dioxide concentration

Remaining carbon budget for a 66% chance of less than 1.5C warming



De Jan 2018 a 2100

"…meeting the urgent energy needs while enabling the achievement of higher levels of human wellbeing in all four regions where improvements are still needed, representing 78 percent of global population (based on 2010 data), would require at least **1,174 GtCO_2** and as much as **1,658 GtCO_2** of cumulative emissions between 2011 and 2050, at current decarbonisation rates and state of knowledge and technology…."

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Mudanças de estilo de vida em países OCDE, como transporte pessoal e dieta, essenciais para permitir o ΔCO_2e no resto do mundo. Este Δ pode ser, contudo, menor do que o indicado por um cenário referencial.

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Environmental Research Letters

LETTER

The power of light: socio-economic and environmental implications of a rural electrification program in Brazil

Paula Borges da Silveira Bezerra, Camila Ludovique Callegari, Aline Ribas, André F P Lucena, Joana Portugal-Pereira, Alexandre Koberle, Alexandre Szklo and Roberto Schaeffer[1]

"Electrification provides a solid basis for development of local communities. Once a community has access to electricity, it can also have access to safe potable water, better health conditions, food security, as well as lighting and information. In addition, it reduces the need for collecting and using other traditional sources of energy, such as firewood, animal dung, and crop residues for cooking and heating (Goldemberg et al 2000), which cause harmful indoor air pollution (WHO 2014).

Table 2. Electricity service related to improvements in types of uses.

Household social and community uses	Productive uses	Education uses	Health uses	Public administration uses
Improved quality of life (light, TV, radio). Light: children and women gain additional time at night (reading, homework); improved light quality (200 times brighter) and cost per lumen; reduced cooking times and easier cleaning due to illuminated room; increases productivity for self-consumption. Safety: street lighting allows children and women to socialize at night; facilitates community activities (light, TV, radio, discotheques); potential effect on birth rates.	Raises productivity: increased profit and employment e.g. light extends work time; electricity allows applications such as water pumping (irrigation), soldering, motive applications (drilling, sawing, mills), cold chain (e.g. for small shops and restaurants, milk processing, beef storage), fish ponds, electric fences, video, cinemas, etc, permits use of ICT.	Studying at night; adult education; allows retention of qualified teachers. Schools can serve as anchor clients for service providers. Subsidizing public services is an efficient way of targeting subsidies with reduced free rider effects.	Light for emergencies, childbirths; vaccine fridges; HIV. Domestic light seems to be correlated with more whitewashed walls and fewer insects.	Allows for more efficient public administration. Increase working time and improves quality of service.

Source: Motta and Reiche (2001).

Table 1. Summary of the different stages of the LpT program.

Phase	Period	Goals and achievements
Phase I	2004–2008	Provide universal power access to rural communities not connected to the grid.
Phase II	2008–2010	Provide power access to 1 million families that had not been connected in the first stage, reaching almost 3 million households.
Phase II-extension	2010–2011	Provide electricity access to isolated communities, areas with no connection to distribution lines, low population density, difficult access and poor infrastructure, reaching further 1.7 million new electrical connections.
Phase III	2011–2014	As the majority of the population already had access to electricity, the focus of this extension was to reach communities living in areas with significant logistic and infrastructure difficulties, particularly in the North and Northeast regions. The target for the period was the connection of 795 000 new households (MME 2011).
Phase IV	2014–2018	Expected to provide power access in isolated areas and the Amazon region.

Source: Borges *et al* (2016).

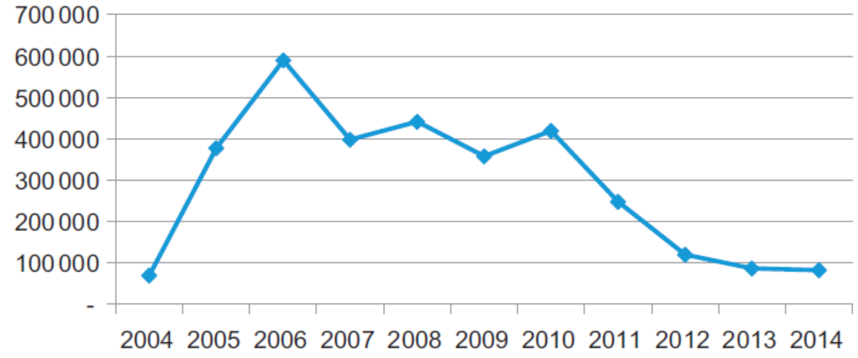

Figure 2. New electrical connections made by year (EPE 2015 and Brazil 2016a).

The LpT program exceeded the initial target of providing electricity access to 10 million citizens. During its 10 years of execution, the program reached over 3.3 million households, equivalent to more than 15 million people

4. Empirical assessment of the results of the LpT program

Variáveis Dependentes: Índice de Desenvolvimento Humano e suas três dimensões básicas: educação, saúde (longevidade) e renda.

a. MHDI: Municipal Human Development Index. Geometric mean of the indices for the Income, Education and Longevity dimensions, described below.

b. Municipal Human Development Index—Education Dimension (MHDI_E): is obtained by the geometric mean of the frequency of children and young people at school, with weight of 2/3, and the education of the adult population, weighing 1/3.

c. Municipal Human Development Index—Longevity Dimension (MHDI_L): is obtained from the indicator of life expectancy at birth, using the formula:

$$\frac{\mathcal{O} - Min}{Max - Min} \qquad (1)$$

Where: $\mathcal{O}$ is the observed value of the indicator; Min is the minimum value; Max is the maximum value and the minimum and maximum values are 25 and 85 years, respectively.

d. Municipal Human Development Index—Income Dimension (MHDI_Y): is obtained from the per capita income indicator, using the formula:

$$\frac{\ln(\mathcal{O}) - \ln(Min)}{\ln(Max) - \ln(Min)} \qquad (2)$$

Where: $\mathcal{O}$ is the observed value of the indicator; Min is the minimum value; Max is the maximum value and the minimum and maximum values are R$ 8.00 and R$ 4033.00 (at August 2010 prices).

4. Empirical assessment of the results of the LpT program

Variáveis Exógenas

The explanatory variables used in the study were as follows:

a. Share of the population living in households with electric power (I_LIGHT): the ratio of the population living in permanent private households with electricity access to the total population living in permanent private households, multiplied by 100.

b. *Bolsa Família* control variable (V_BF): financial amount passed on to municipalities for the management of the *Bolsa Família* family grant program (in Brazilian reais).

$$Y_{i,t} = \alpha + \beta_1 * I_{\mathrm{LIGHT}\,i,t} + \beta_2 * V_{BF\,i,t} + \varepsilon_{i,t} \qquad (3)$$

There are no official data about the actual municipalities that took part in the LpT program. Therefore, it was necessary to identify and filter the municipalities that were served by the program based on the variation of the rate of electrification: all municipalities that had an increase above 40% in the period were considered in the analysis. By applying this selection criteria, 805 municipalities were selected, comprising 12 million people in 2010, the approximate number of people served by the program according to MME (2017).

4. Empirical assessment of the results of the LpT program

Table 4. Panel regression model results.

	Coefficients[a] Random effect	Fixed effects
Dependent Variable: MHDI		
T_LIGHT	0.2286	0.2054***
V_BF	0.0245	0.0258***
R^2	0.90	0.95***
Hausman test	0.008956	
Dependent Variable: MHDI_E		
T_LIGHT	0.2286	0.5210***
V_BF	0.0245	0.0543***
R^2	0.90	0.94***
Hausman test	2.2e-16	
Dependent Variable: MHDI_L		
T_LIGHT	0.2286	0.0425***
V_BF	0.02456	0.0112***
R^2	0.90	0.94***
Hausman test	2.2e-16	
Dependent Variable: MHDI_Y		
T_LIGHT	0.0819	0.0528***
V_BF	0.0105	0.0121***
R^2	0.64	0.78***
Hausman test	5.06e-05	

[a] ***: Significant at 1%.

"…the **education component** is the most affected by electrification…
The assessment conducted by Kanagawa and Nakata (2008) confirm this influence. According to the study, which aimed to reveal quantitative relations between access to electricity and advancements in socioeconomic condition in rural Assam state, **India**, it is estimated that the literacy rate could rise to 74% from 63% with the electrification in the area.
.. In the case of **income**, there should be a delay between electrification and income growth, being education perhaps the transmission channel for that. This means that labour productivity rises, due to education, to then cause income growth in the Brazilian poorest municipalities…"

OBRIGADO

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