Universal Electrification Development Strategies for Ethiopia

Alam Hossain Mondal, PhD
Research Fellow
International Food Policy Research Institute (IFPRI)
Washington DC, USA

Policy Workshop on Alternative Pathways to Improve Electricity Access in Ethiopia. Addis Ababa, Ethiopia, May 02, 2018

Outline

- **Introduction: Overview on Energy Security**
- **Objectives of this study**
- **Methodology**
- **Energy modelling (TIMES) outcomes**
- **Conclusions**

Energy Security

- **Energy is recognized as a critical input parameter for national economic development**
- **Total energy demands are still met largely by fossil fuels, such as coal, oil and natural gas (80%)--about 69% globally**
- **Demand for electricity over the next 20 years requires the addition of the same power generation capacity that was installed over the entire 20th century**

(Sources: WEO, 2010; ; EIA, 2014; Lior, 2012)

Energy Security

- **If the current rate of energy consumption continues, reserves of coal, oil and natural gas may only last 118, 46 and 59 years, respectively**
- **About 78% of total GHG emissions are related to energy activities and 41% of total CO_2 emissions come from power generation based on fossil fuels**
- **Global warming of about 0.2˚C per decade is projected by IPCC for a range of emissions scenarios**

(Sources:, BP, 2012; EIA, 2014; IPCC, 2007 and 2014)

General/background: Ethiopia

- About 30% of the population has access to electricity (2.7 million domestic customers)
- About 5% of rural households have been connected to the grid & electricity
- Ethiopian energy demands are met largely by biomass (91%)
- Electricity accounts for only 2% of total energy demand (Electricity and hydrocarbon: about 9%)

(Sources: MoWIE, 2012 and 2013; G.T. Tucho et al., 2104)

General/background: Ethiopia

- **The residential sector consumes about 93% of total energy**
- **Per capita electricity consumption is only about 75 kWh/year (average across Africa: 500 kWh/year)**
- **Power generation is dominated by hydro (90%)**
- **The renewable energy potential for electricity is significant**

Diversification of primary energy supply from a system dominated by hydro to a system involving greater use of other renewables could help improve Ethiopia's energy security and access

(Sources: G.T. Tucho et al., 2104; WB, 2015; Z. Tessema et al., 2014; MoFED, 2014)

Government strategies

- ✓ **Universal electrification**
- ✓ **Zero carbon emissions by 2025**
- ✓ **Looking for opportunities to export electricity**
- ✓ **Integration of other conversion technologies into the energy system**

To analyze the techno-economic feasibility of this diversification for a longer-term period, energy optimization models can provide valuable insights for energy policy design and investment

(Sources: MoWIE, 2013; MoFED, 2014; EEPC, 2014; FDRE, 2011)

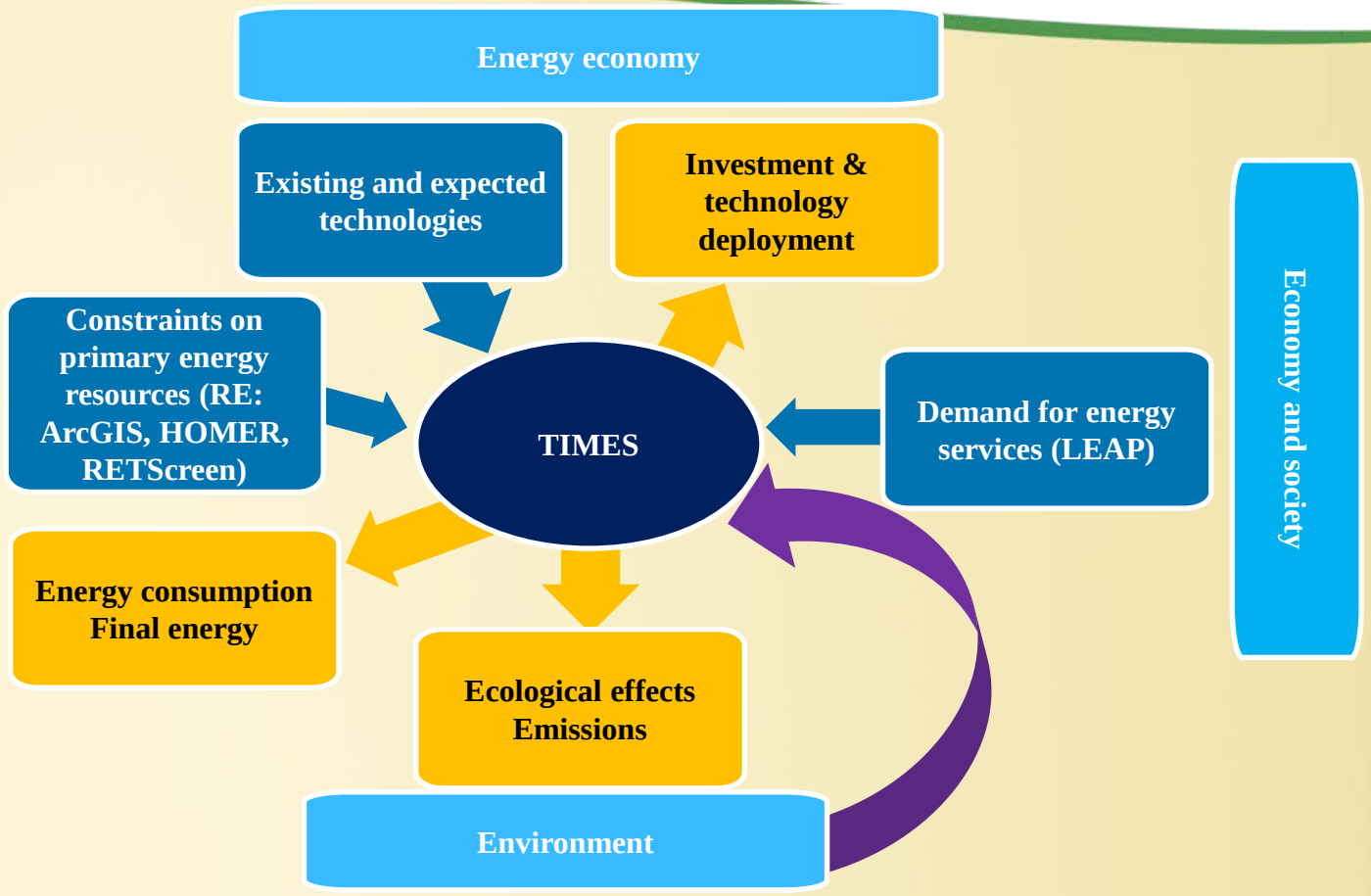
Objectives

Main

To examine the potential contribution of indigenous energy resources in the future power supply of Ethiopia

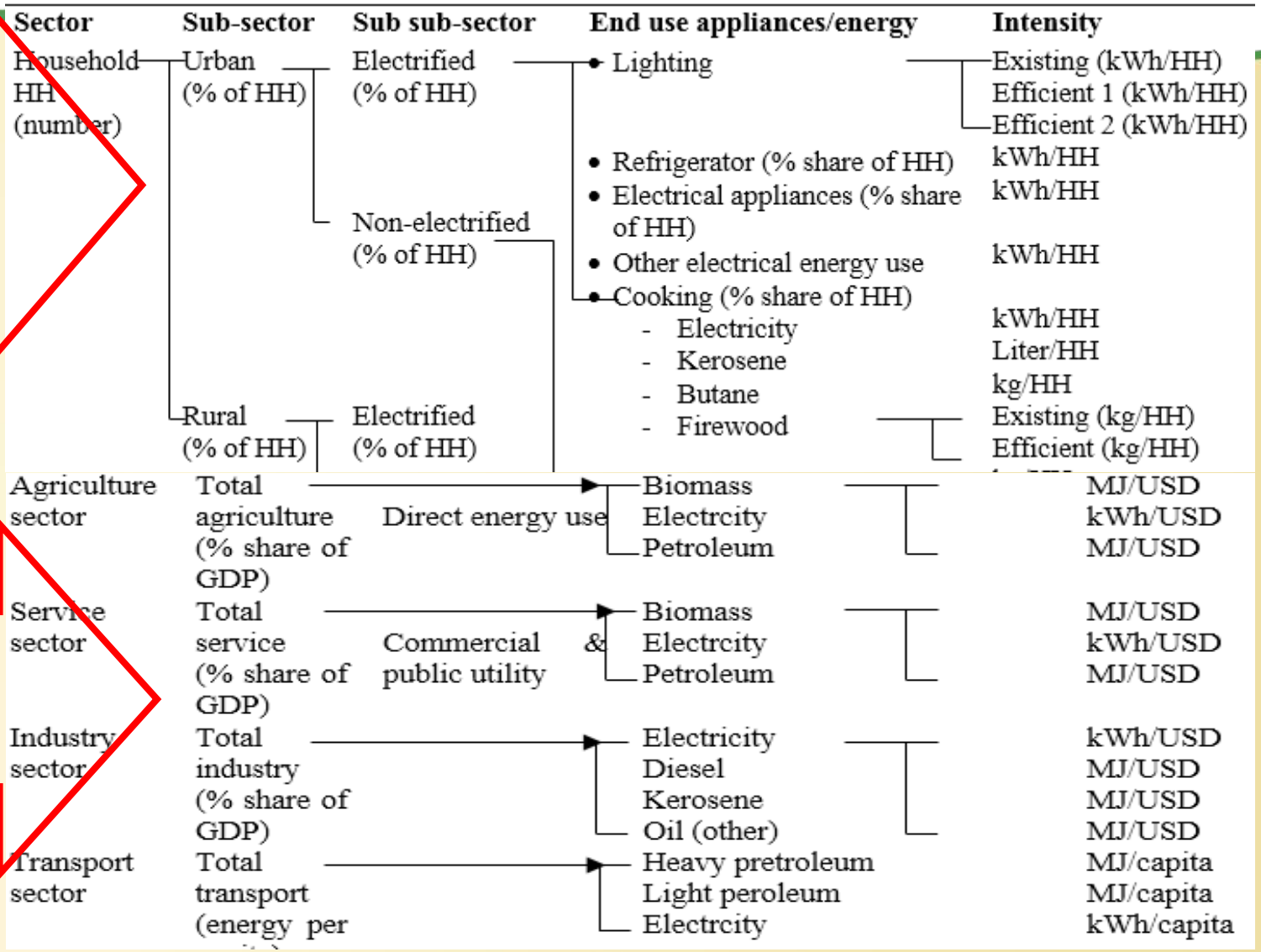
1	Develop long-term electricity demand scenarios using LEAP
2	Develop Ethiopia-TIMES model for the power sector
3	Find least-cost technology options to optimal use of energy resources
4	Search for the strategy that best improves energy security and develops a low-carbon society
5	Find the link to feed this energy assessment into a CGE nexus model to assess the implications of alternative water-energy-food strategies

Methodology (overall)



TIMES is able to answer many questions for any “what if” assessment

Methodology: Ethiopia-LEAP



Methodology: Published

Energy 149 (2018) 161–172

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

Ethiopian energy status and demand scenarios: Prospects to improve energy efficiency and mitigate GHG emissions

Md Alam Hossain Mondal*, Elizabeth Bryan, Claudia Ringler, Dawit Mekonnen, Mark Rosegrant

International Food Policy Research Institute (IFPRI), 2033 K Street, NW, Washington DC 20006, USA

Renewable and Sustainable Energy Reviews 75 (2017) 11–20

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

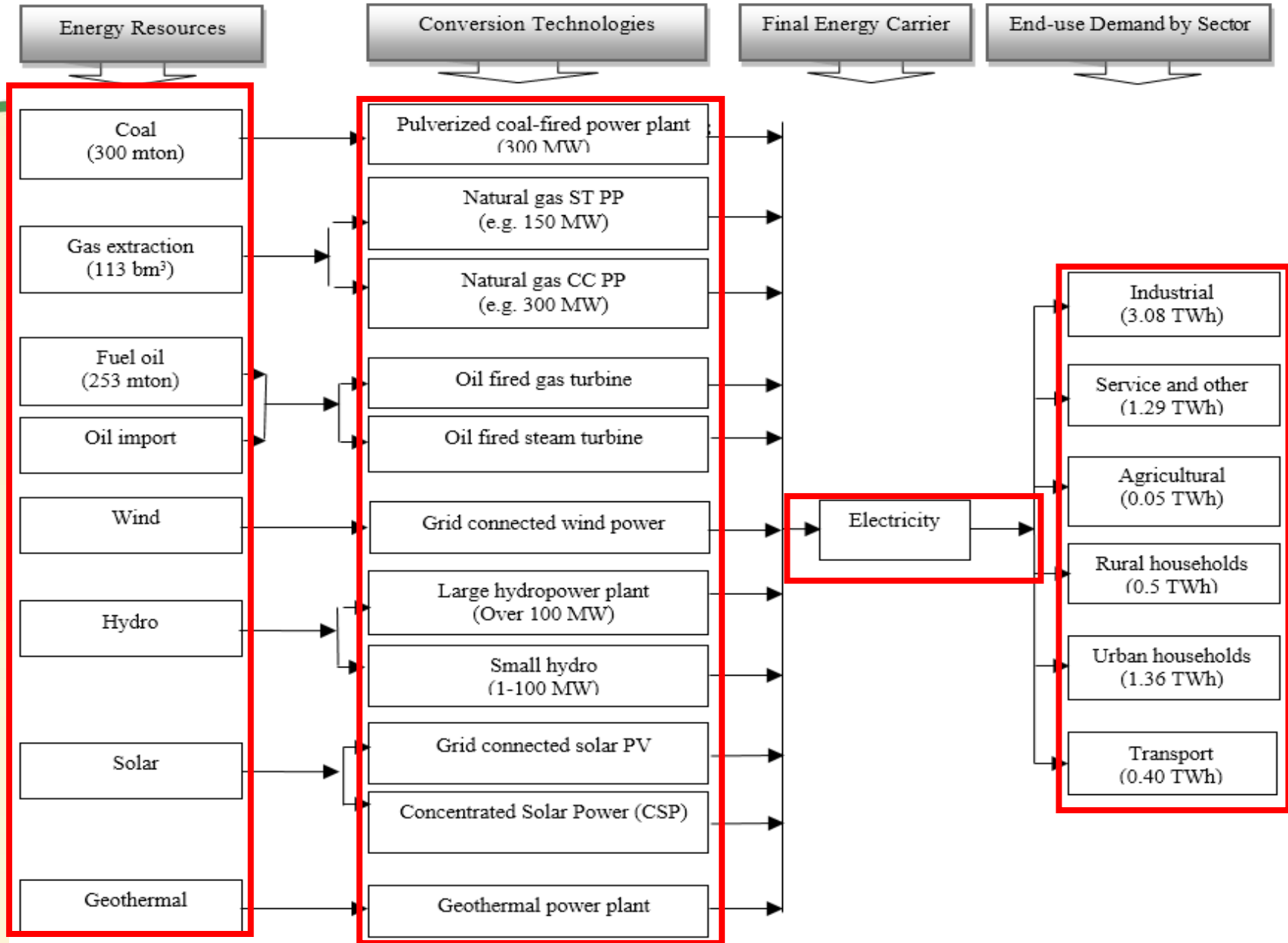
journal homepage: www.elsevier.com/locate/rser

Ethiopian power sector development: Renewable based universal electricity access and export strategies

Md. Alam Hossain Mondal*, Elizabeth Bryan, Claudia Ringler, Mark Rosegrant

International Food Policy Research Institute (IFPRI), 2033 K Street NW, Washington DC 20006, USA

Reference Energy System



Development of scenarios

Reference energy system of Ethiopia power sector

TIMES-Ethiopia database from 2014 to 2050

Scenario development

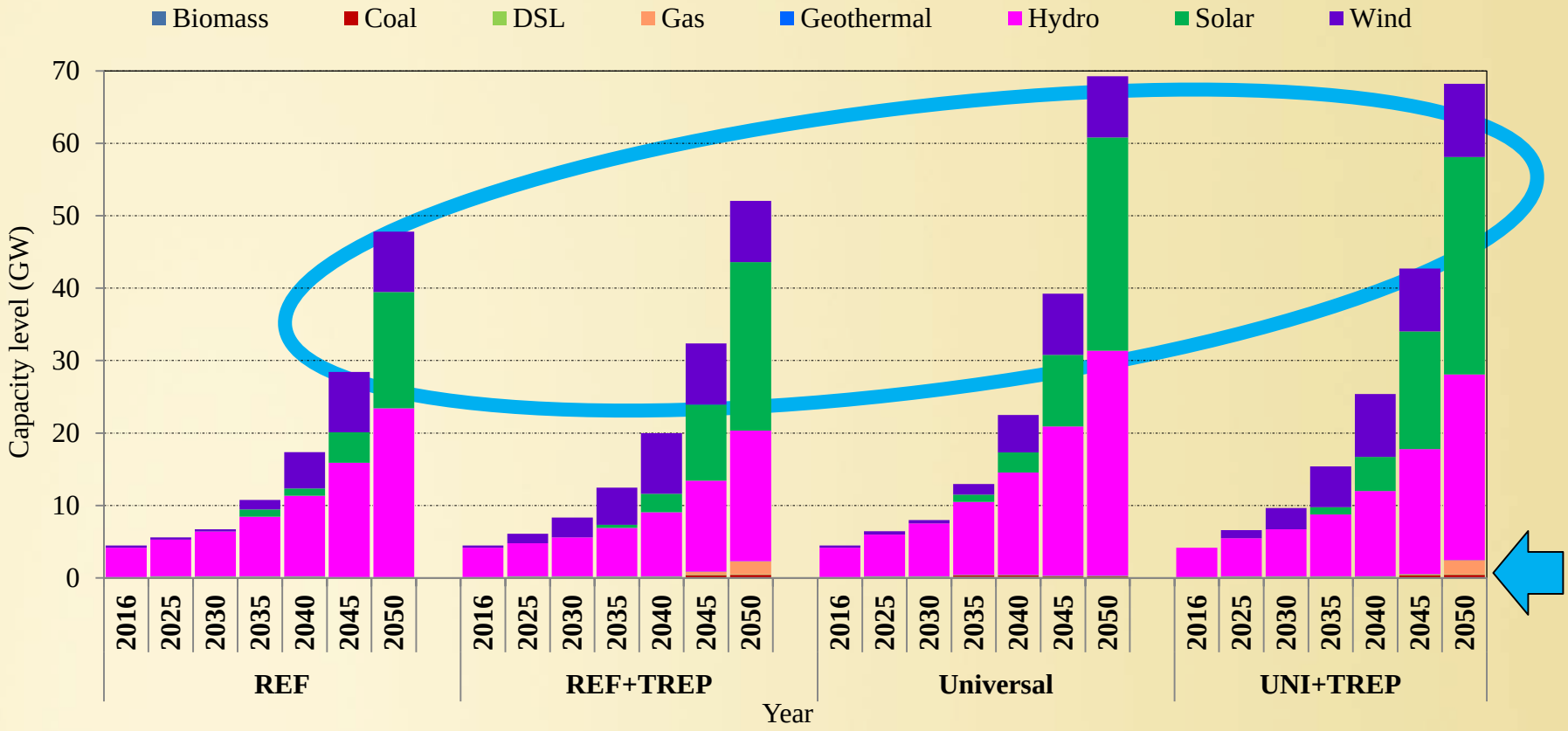
Simple cost minimization scenario

- **Reference: This scenario assumes a continuation of current energy and economic dynamics (REF)**
- **Universal electrification: Based on Govt.'s Growth and Transformation Plan (GTP) to supply electricity to all HHs by 2030 (Universal)**
- **Accelerated solar, wind and geothermal development: REF and 20% by 2025 and 40% by 2040 (Reference+TREP)**
- **Accelerated solar, wind and geothermal development: Universal and 20% by 2025 and 40% by 2040 (Universal+TREP)**

Interpretation of results: Universal electrification scenario

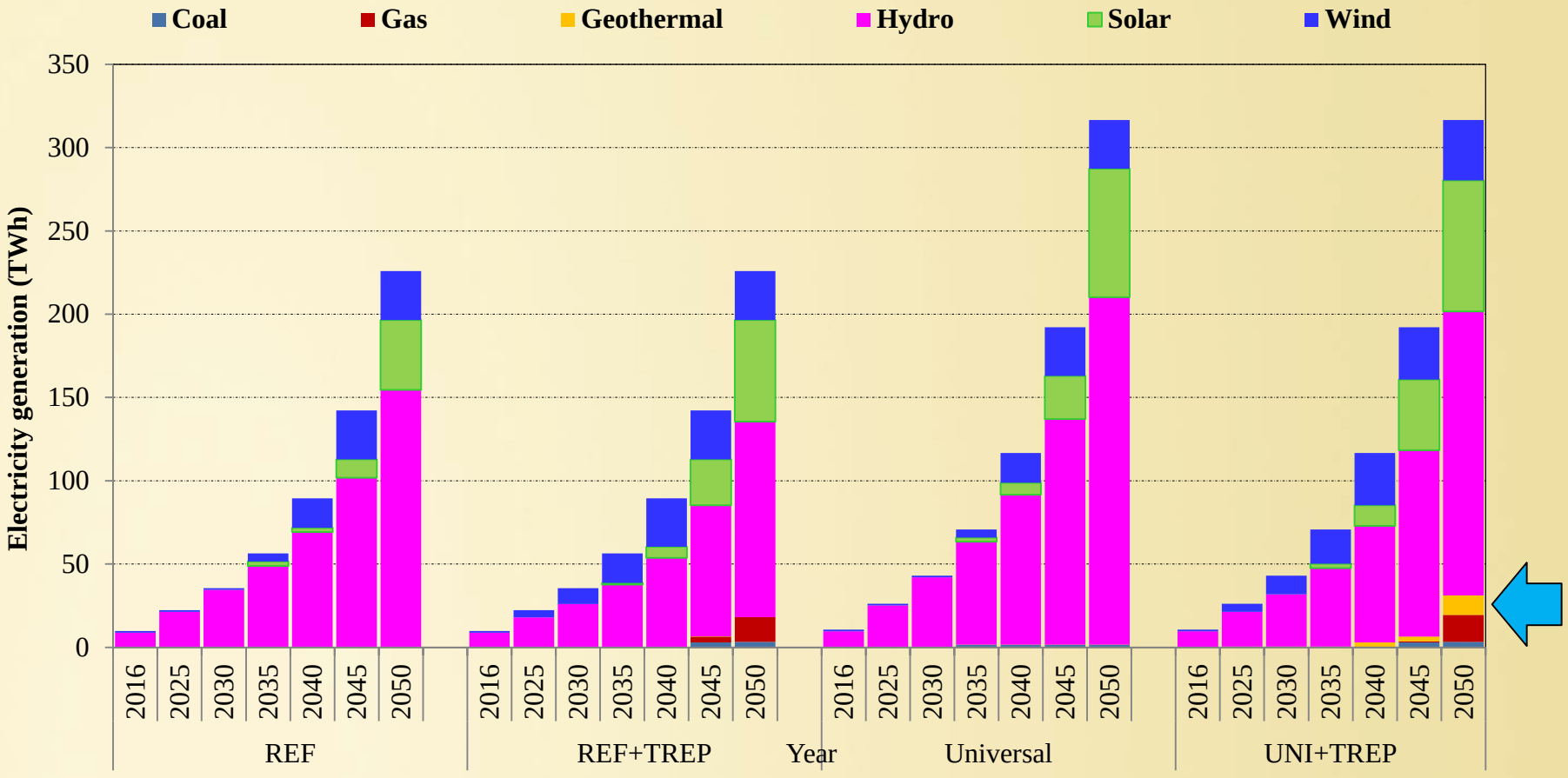
	Capacity development and fuel requirement		
	2014	2035	2050
Total capacity (GW)	4.23 (100%)	12.95	69.3 (100%)
Hydro	3.81 (90%)	10.1	31.1 (44.8%)
Solar	-	1.0	29.4 (42.5%)
Wind	0.32 (7.7%)	1.4	8.4 (12.2%)
Biomass, geothermal, DSL and coal	0.1 (2.3%)	0.43	0.3 (0.5%)
Fossil fuel requirement (PJ)	-	14.2	14.2
Imported	-	-	-
Mined (coal)	-	14.2	14.2

Interpretation of results: Technology selection



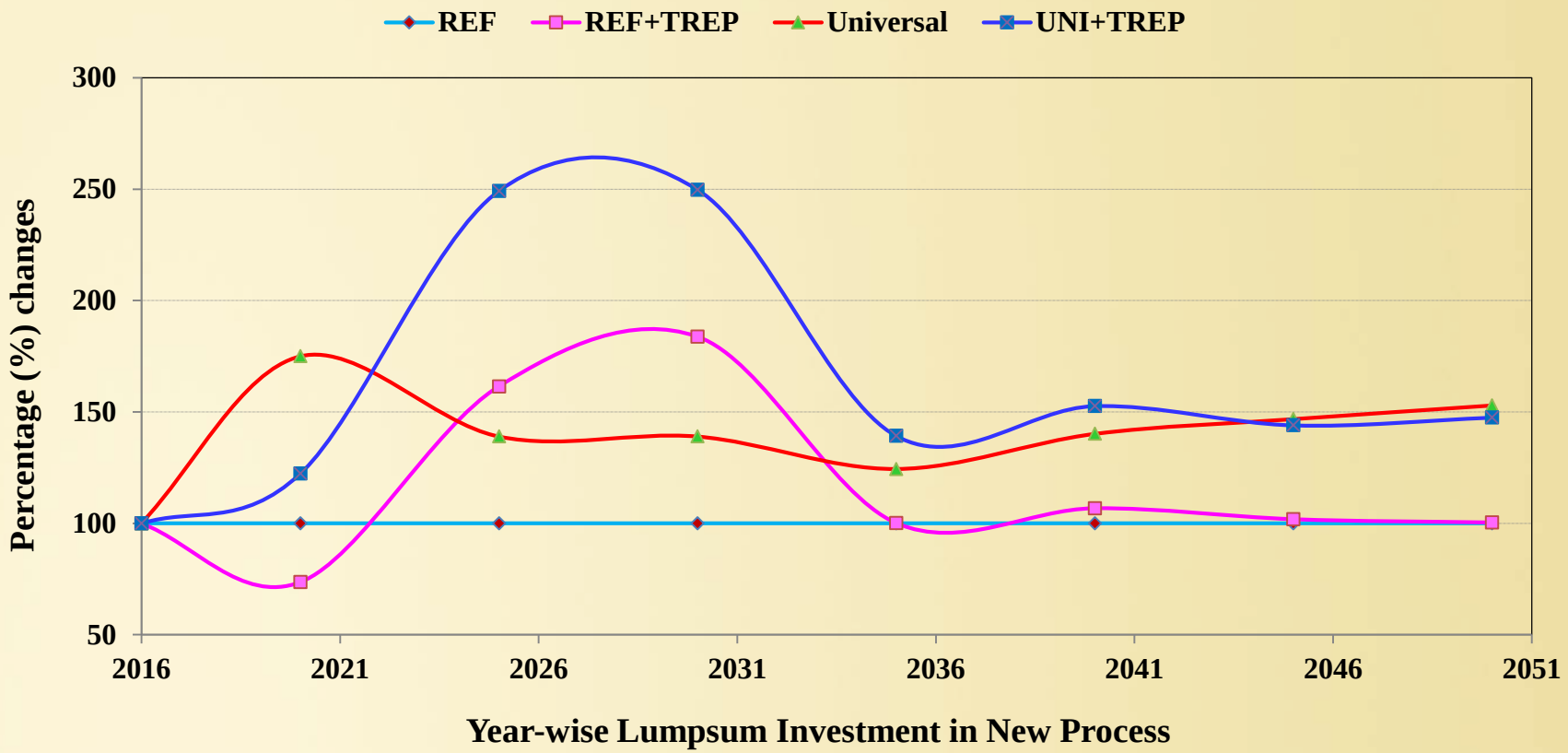
Technology capacity level in GW by year

Generation by technology



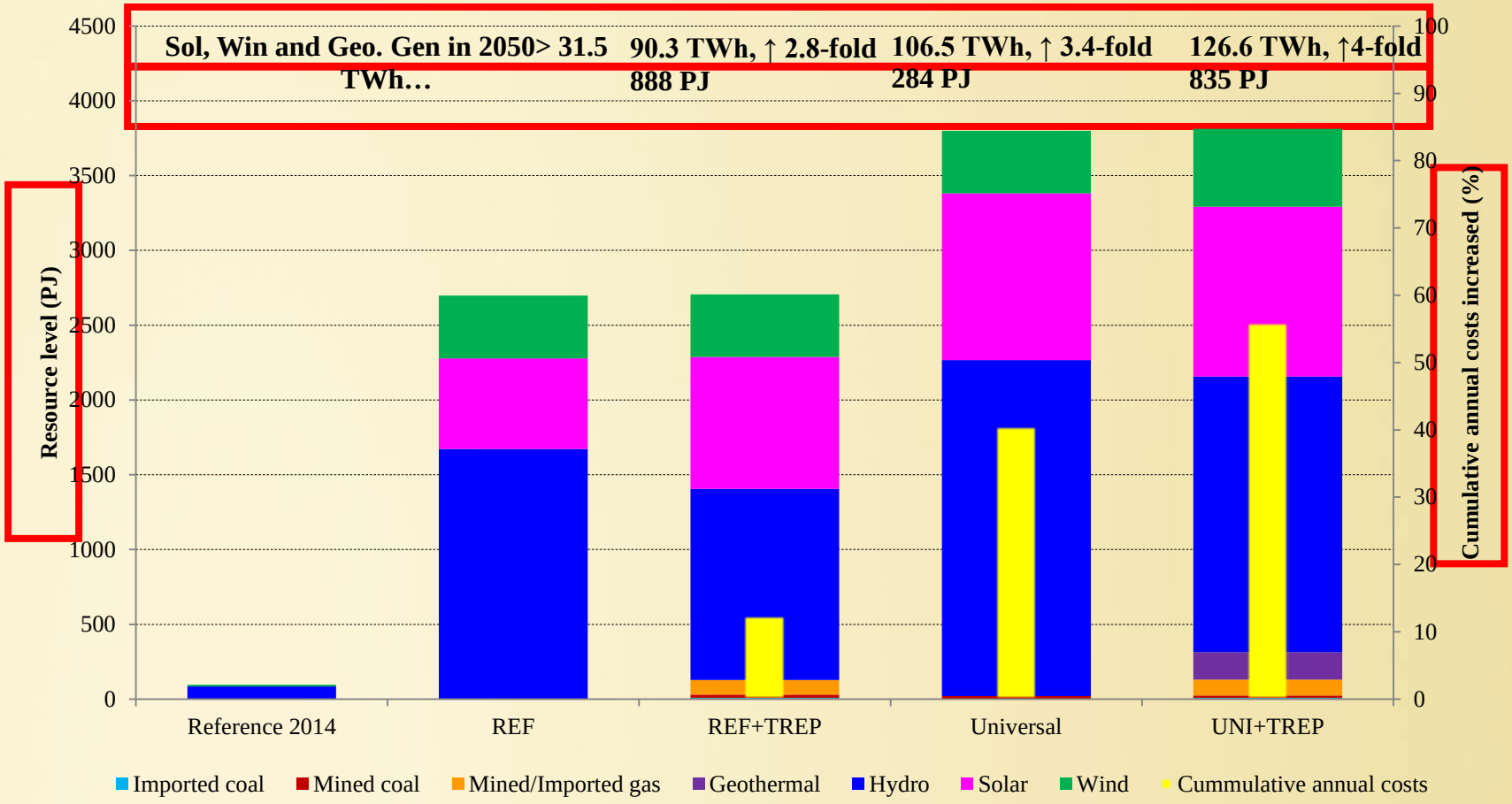
Electricity production level (TWh) by technology by year

Reference and policy scenarios



Investment comparison during the analysis period

Reference and policy scenarios



Primary energy mix in 2050

The best policy option

- **The targeted renewable energy production scenarios are the best option to meet future electricity demand**
- **Such production contributes to an increase in the total system costs by 12% compared to the reference and by 14% compared to the universal scenarios**
- **Targeted renewable energy production improves diversification of the energy supply-mix and improve energy security and would also help to improve energy access**

Conclusions

- **The primary energy supply system needs to diversify from hydro to a mix of hydro, solar, wind, natural gas and coal**
- **The diversification would enhance the country's energy security**
- **Cost implications of prioritization of renewable energy technologies are manageable**

Conclusions (cont‘d)

- **Renewable technologies (solar PV, wind and geothermal) will play an important role in generating electricity to meet future demands**
- **It is important to assess the impacts of these energy development strategies on the overall economy**
- **The Ethiopian government must weigh the tradeoffs implied in energy transitions and carefully consider long-term energy policies for the green-growth transformations and implications under climate change, energy trade, and for equity in access**

IFPRI

Ministry of Water, Irrigation and Electricity

BANQUE AFRICAINE DE DEVELOPPEMENT
AFRICAN DEVELOPMENT BANK

CGIAR
RESEARCH PROGRAM ON Water, Land and Ecosystems

Thank You

Contact:
a.mondal@cgiar.org