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Energy market perspectives on Neo-Carbon Energy Ecosystem

LUT School of Energy Systems

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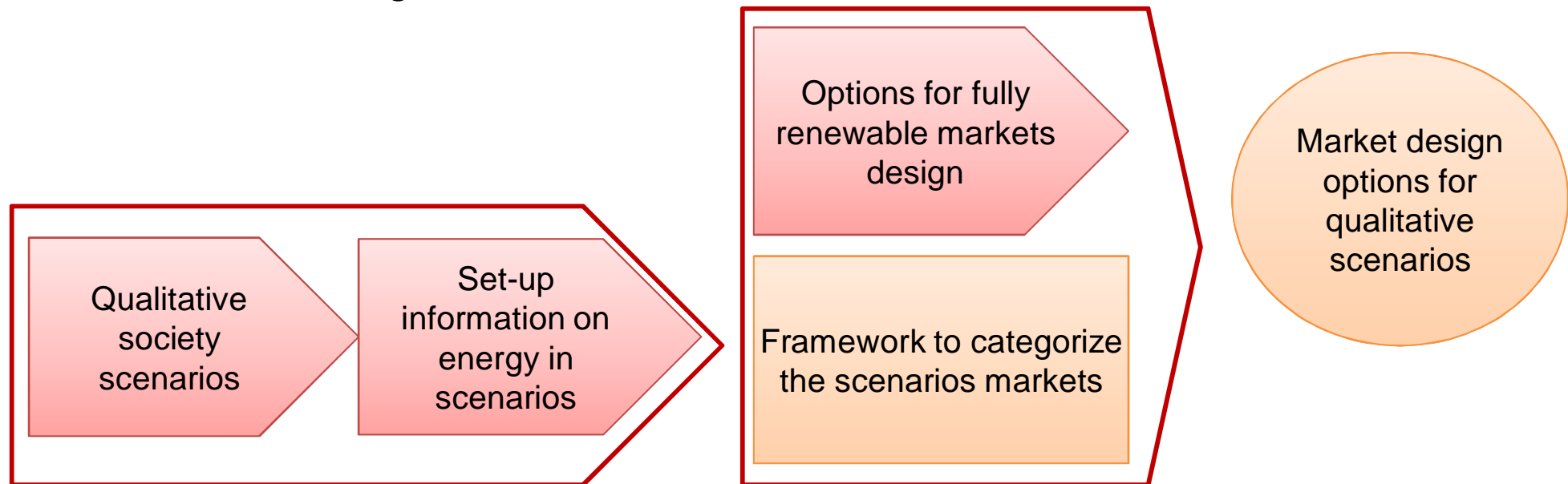


NEO
CARBON
ENERGY

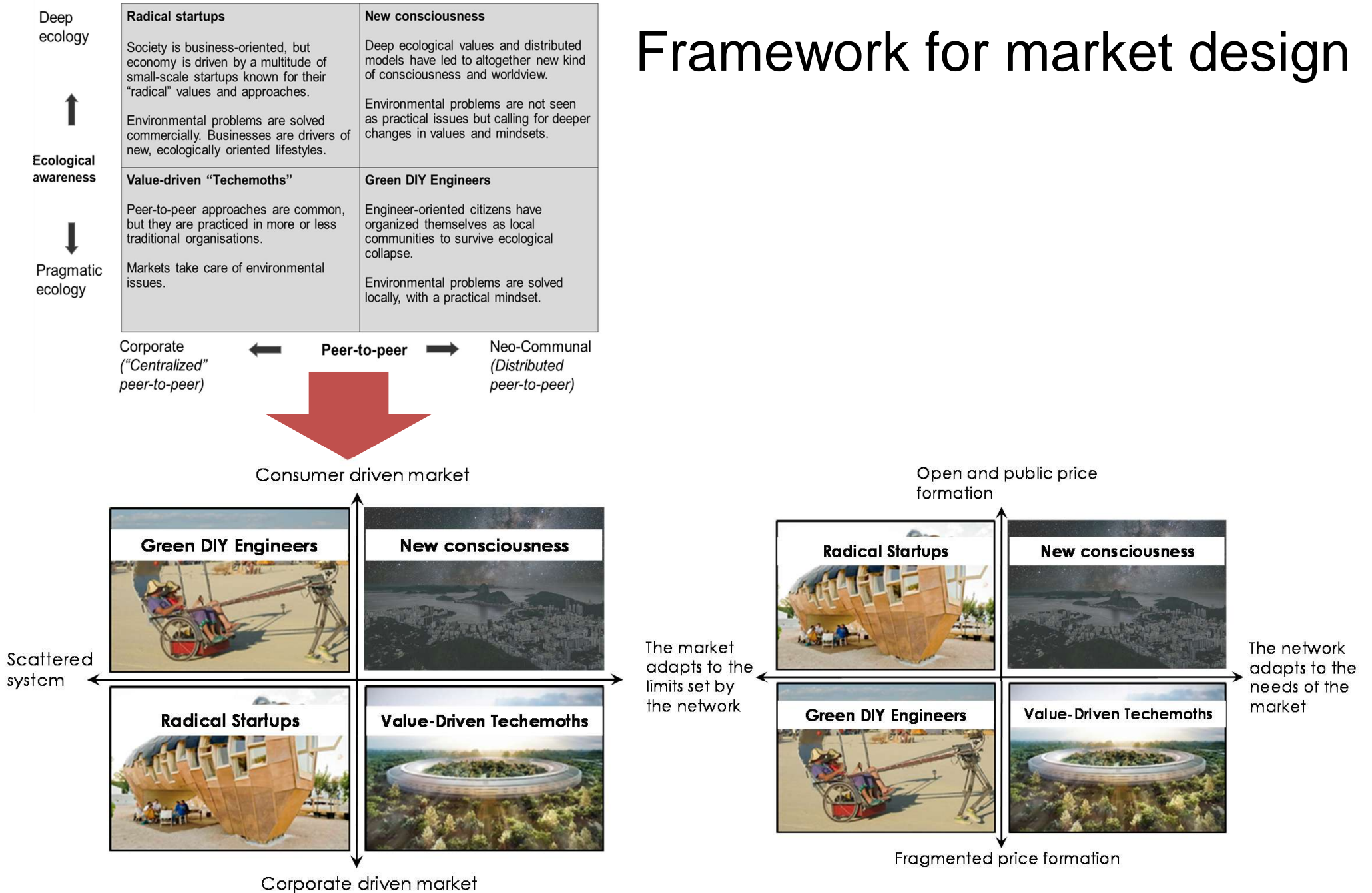
Electricity market framework in Neo-Carbon

Energy scenarios

























- We have looked at the 100 % renewable energy systems in year 2050 through society scenario descriptions
- We described a framework for electricity market designs in four transformative, qualitative scenarios
 - Analyses of the feasible energy markets designs in four transformative neo-carbon scenarios.
 - Identifying the required elements of the market design that enable each scenario.
 - In the process, we highlight the key issues in determining applicable market designs.



Framework for market design



The estimates of the applicability of the market designs to different scenarios

PRICING MECHANISM/SCENARIO	RADICAL STARTUPS	TECHEMOTHS	DIY ENGINEERS	NEW CONSCIOUSNESS
MARGINAL PRICING WITH ZONAL				
MARGINAL PRICING WITH NODAL				
PAY-AS-BID				
MARGINAL COST BASED DISPATCH AND PRICING ON LCOE				
COST OF SERVICE				
OVER THE COUNTER TRADING				



Extremely suitable



Moderate suitable



Very suitable



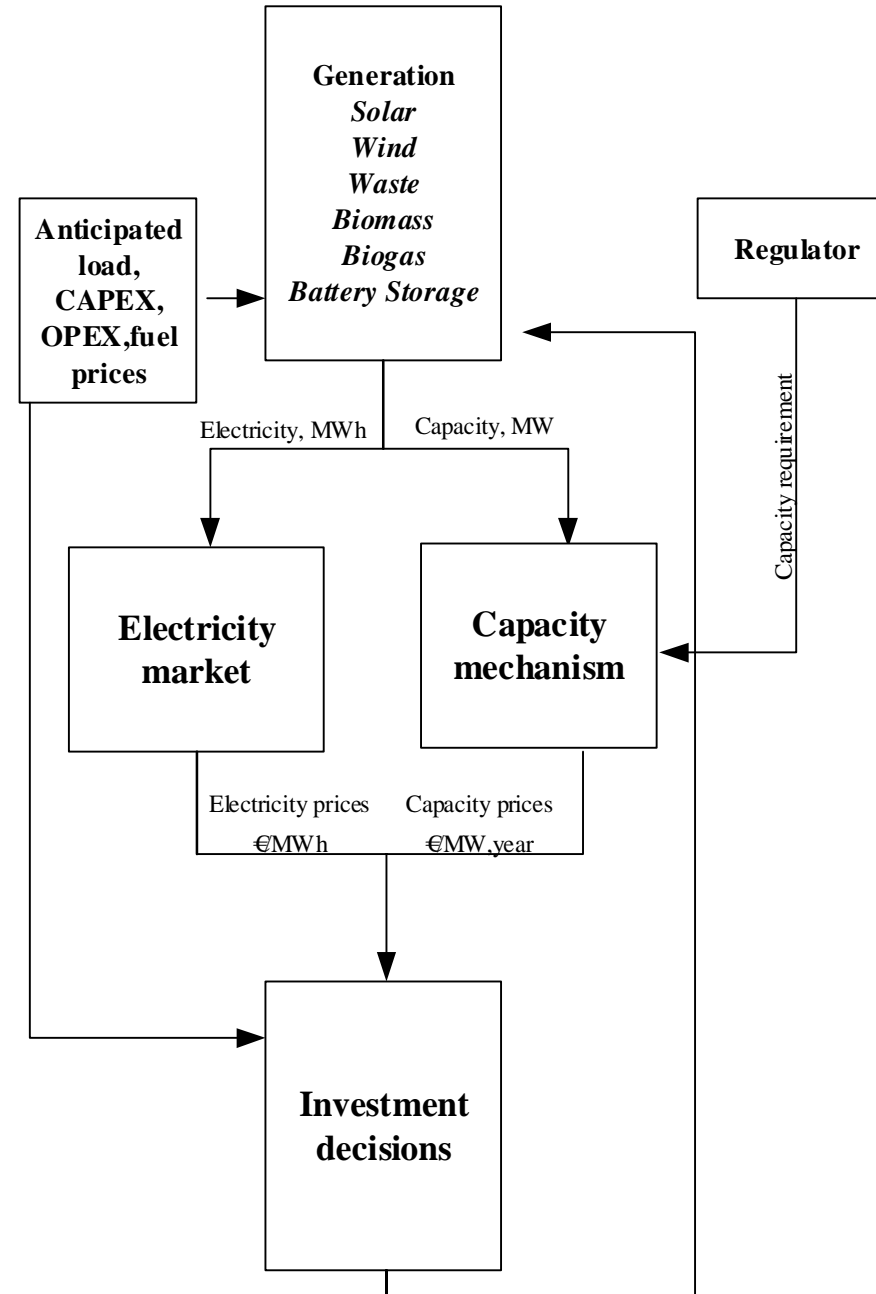
Slightly suitable



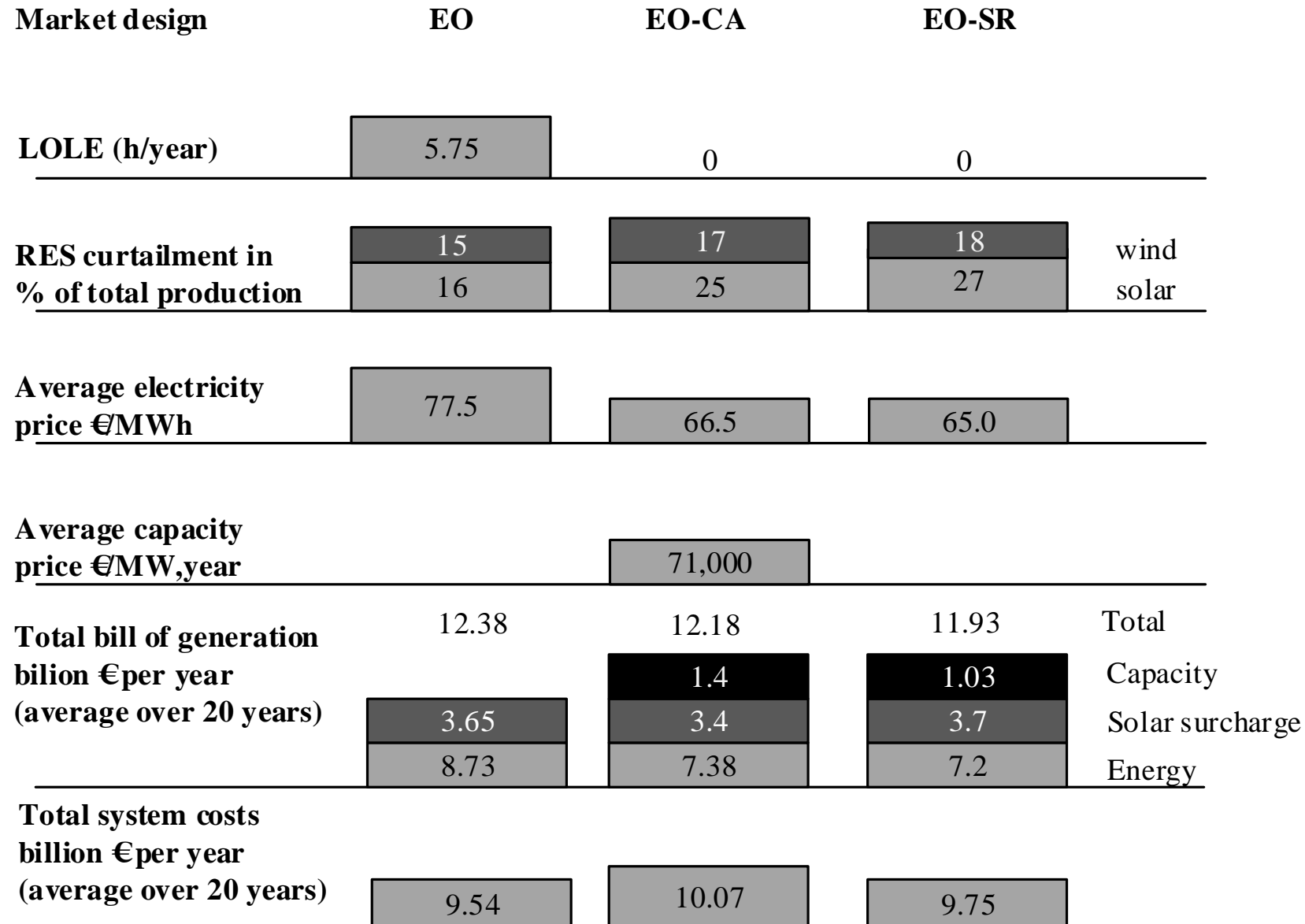
Not at all suitable

Market designs for a 100% renewable energy system

- Testing the feasibility of different market design models in the 100% RES.
- Studying the impacts of market design on short-term operation (hourly resolution) and long-term investment decisions (yearly resolution)



	Market design	Electricity market	Capacity mechanisms
EO	“Energy only” market	Pool with marginal pricing	No
EO-CA	“Energy-plus-capacity” market	Pool with marginal pricing	Pay-as-bid capacity auction
EO-SR	“Energy-plus-strategic reserve” market	Pool with marginal pricing	Strategic reserve

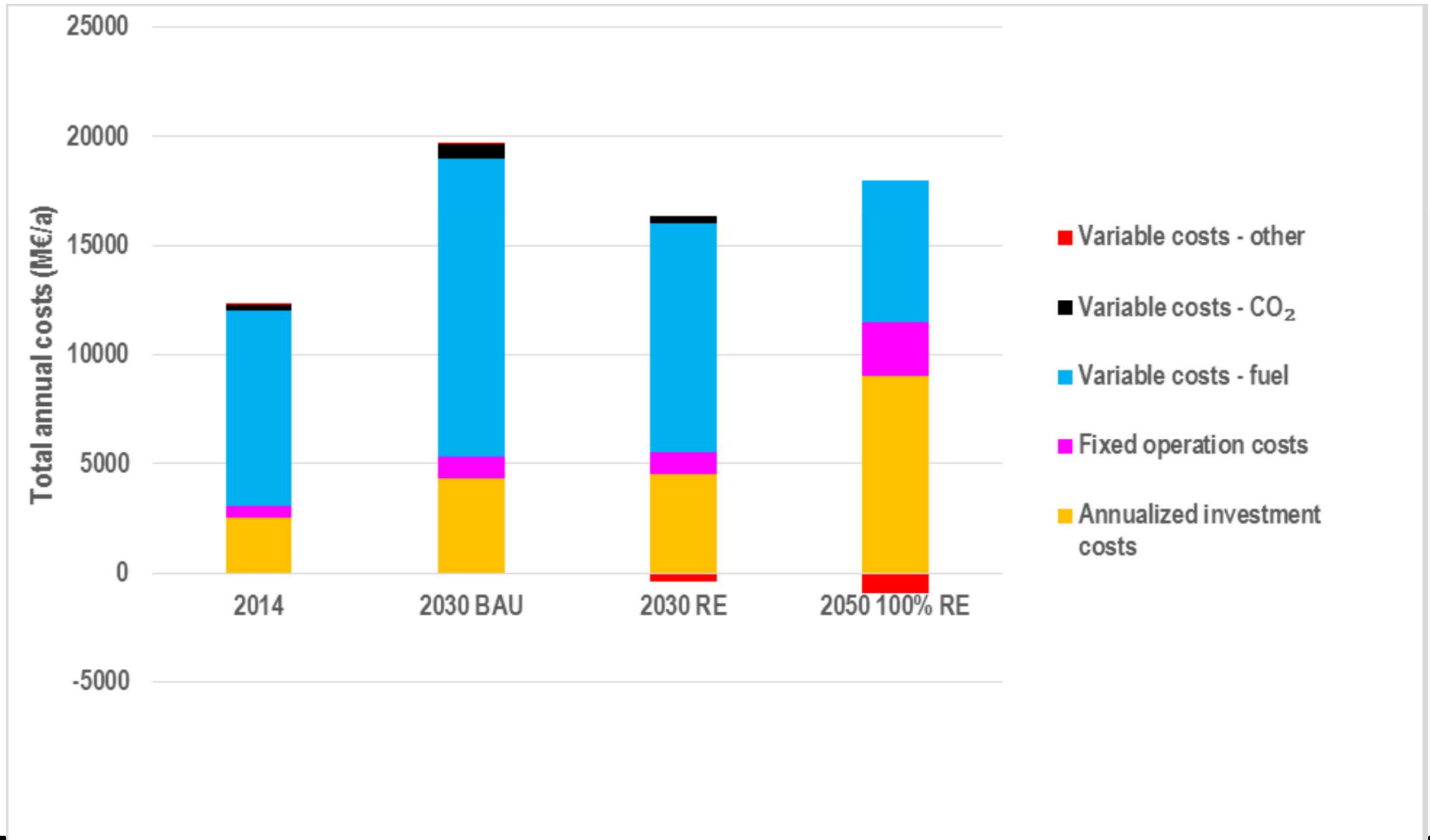


RES possibilities and barriers in Kenya and Tanzania

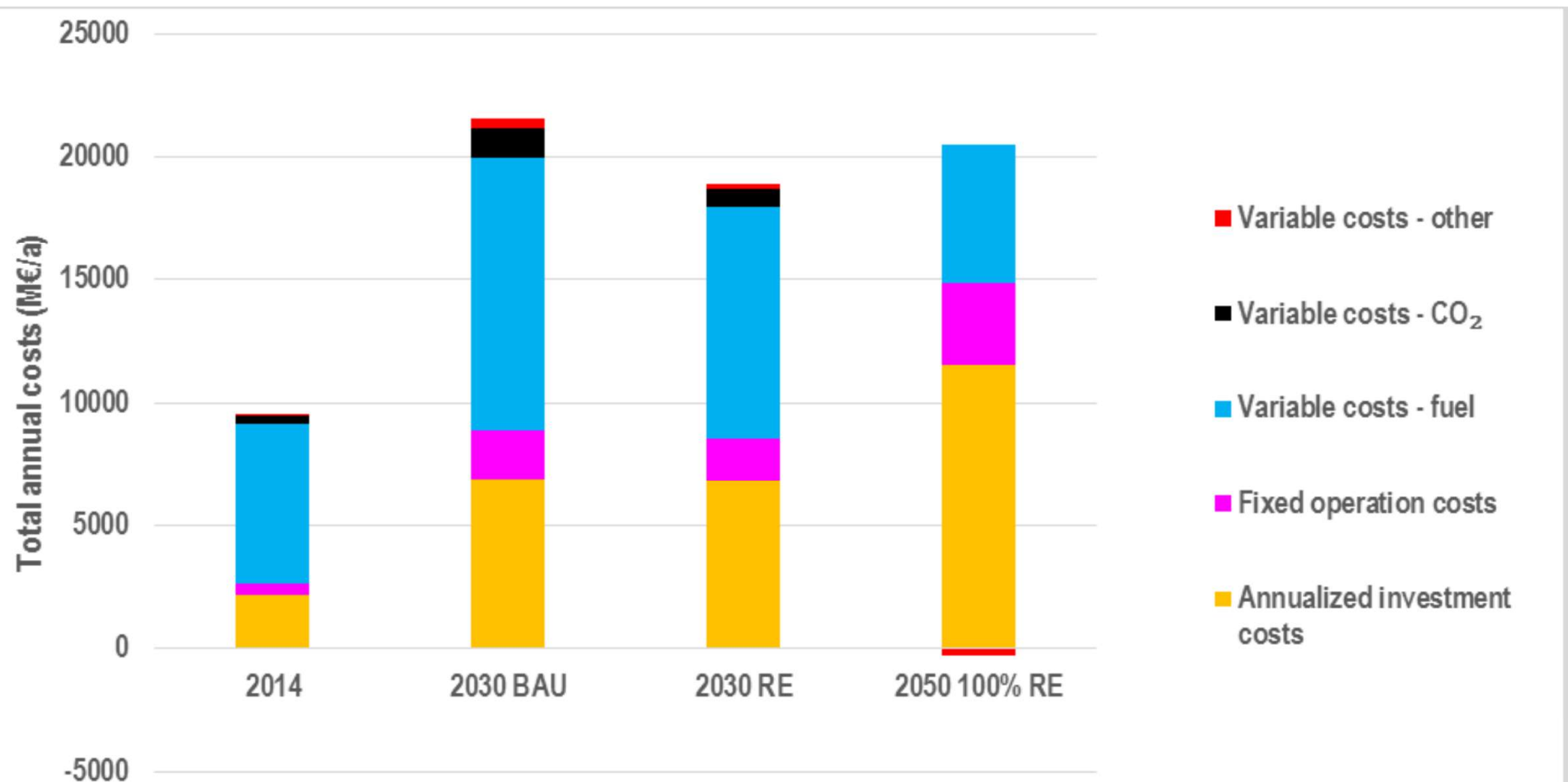
RES potential and installed capacity

	KENYA		TANZANIA	
	Estimated potential	Installed (June 2016)	Estimated potential	Installed (2013)
Large hydro	3000 – 6000 MW	820 MW	4000 – 4700 MW	562 MW
Small hydro (<10 MW)	3000 MW	0.814 MW	480 MW	4 MW
Geothermal	5000 – 10000 MW	632 MW	650 MW	-
Wind	Wind speed 8 – 14 m/s in certain areas	26 MW	Wind speed 9.9 m/s at Kititimo and 8.9 m/s at Makambako	-
Solar	Daily solar radiation 4 – 6 kWh/m ²	0.6 MW	Daily solar radiation of 4 – 7 kWh/m ²	6 MW
Bagasse cogeneration	193 MW	26 MW	500 MW	19.5 MW

Total annual costs, Tanzania

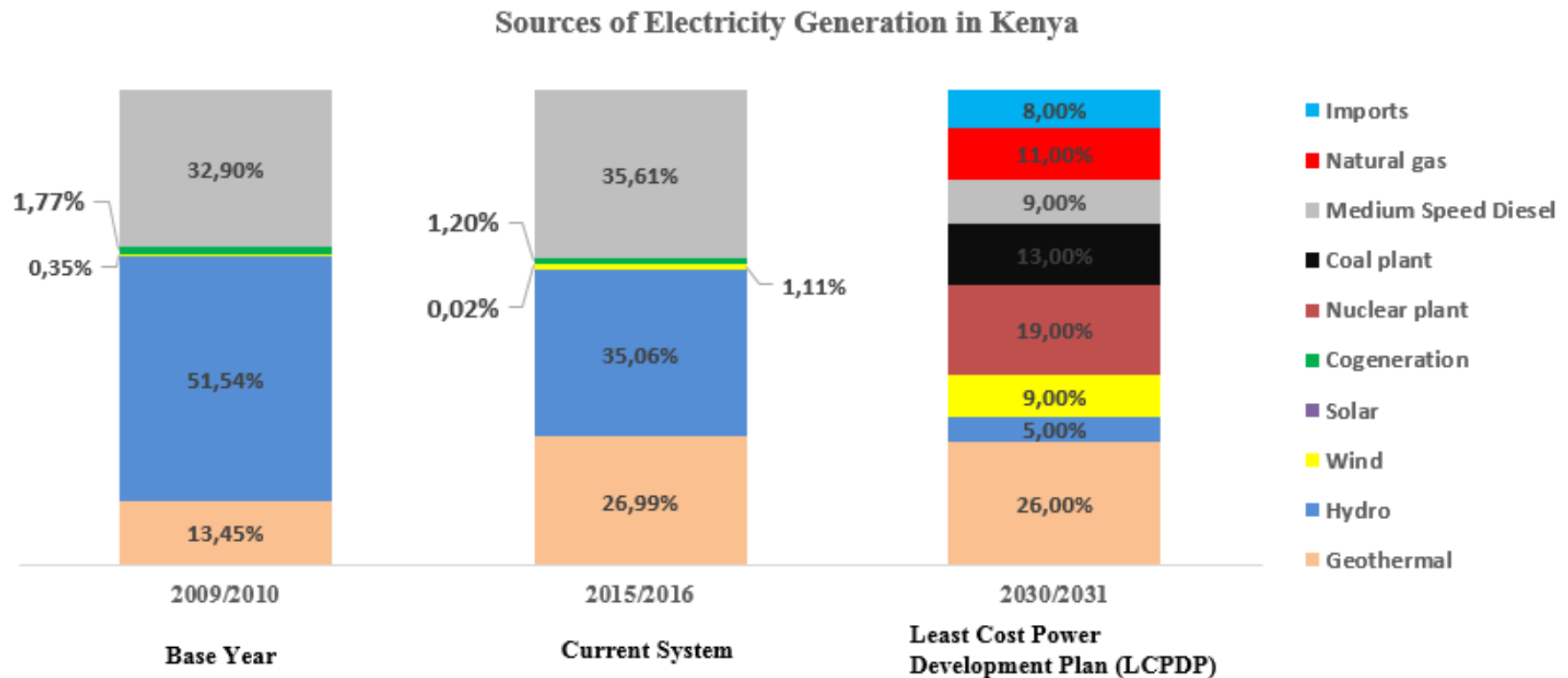


Total annual costs, Kenya

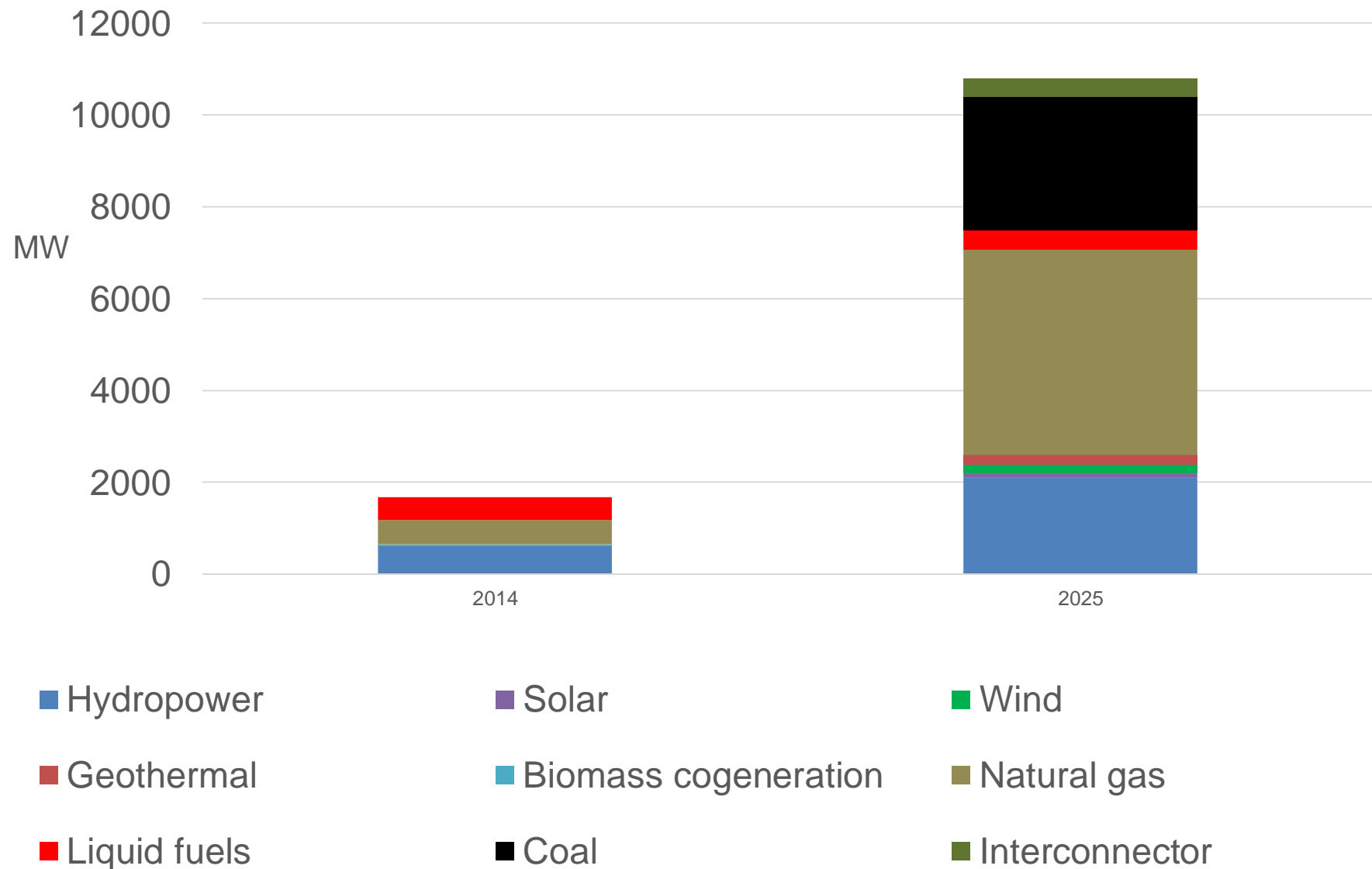


Barriers

- Political will of the decision makers
 - Kenya's LCPDP 2011 – 2031, increases the use of fossil fuels for its electricity generation (coal resources recently discovered in Kenya)



- Tanzania's Electricity Supply Reform Strategy and Roadmap 2014–2025 aims to increase the security of supply by diversifying the sources of electricity generation



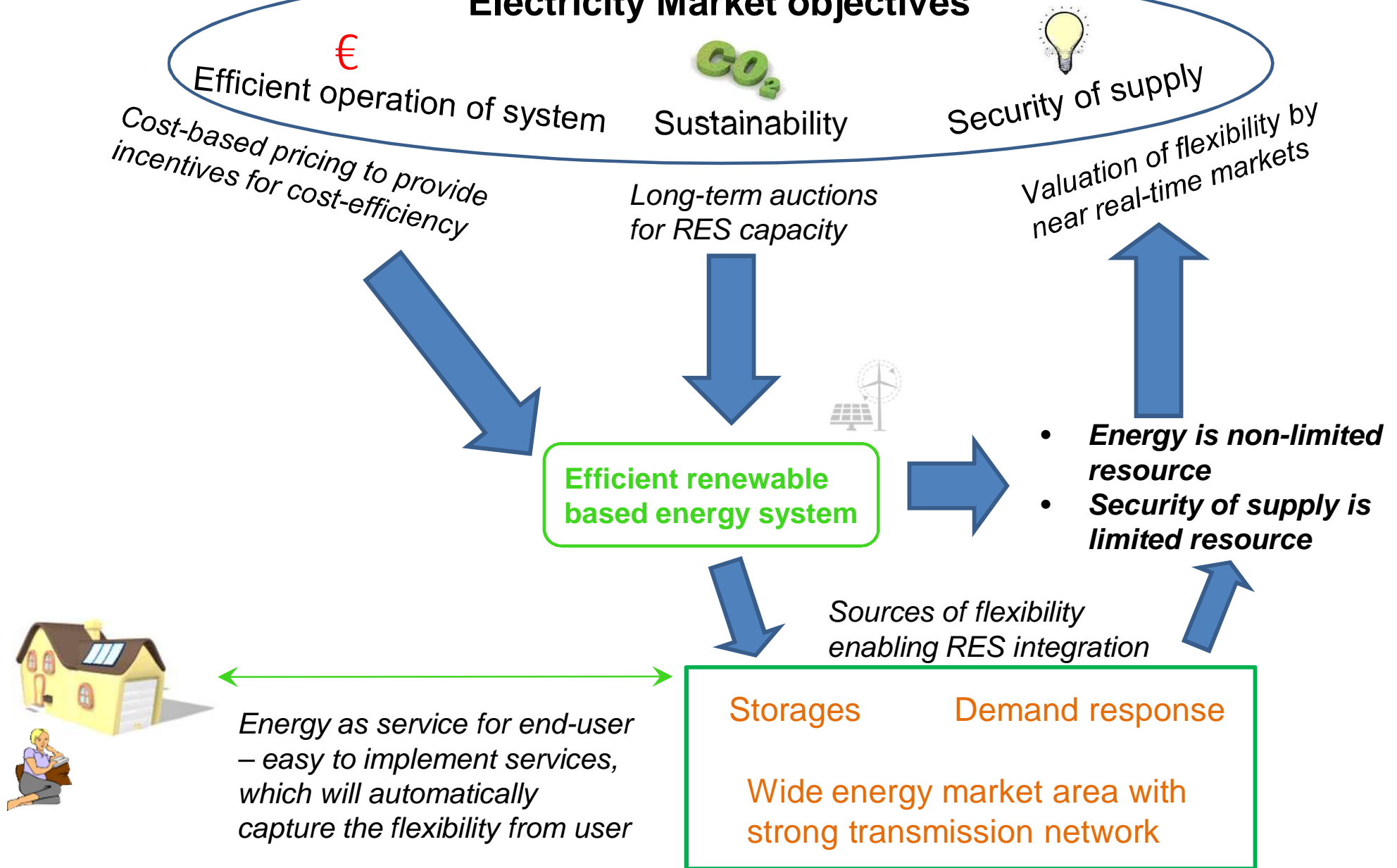
Other barriers for RES

- High capital cost, difficulties in finding financing
- Old transmission and distribution lines with inadequate capacity
 - Resources often far from demand centers
- Conflicting interests in land and water use, resistance from local communities
- Hydropower: vulnerability to variations in hydrology and climate change, no recent significant investments
- Geothermal: high exploration and development risks
- Biomass: legal framework does not support sustainable use
- Wind: insufficient wind regime data
- Solar: theft of solar panels

Conclusions on studies of RES in Kenya and Tanzania

- Significant renewable energy potential in both countries but also indigenous fossil fuel resources
- Policy focus on least cost options for improving access to energy and improving security of supply
- Simulations show that renewables based system would help meeting the increasing demand while reducing CO₂ emissions and would be cost effective in the long run

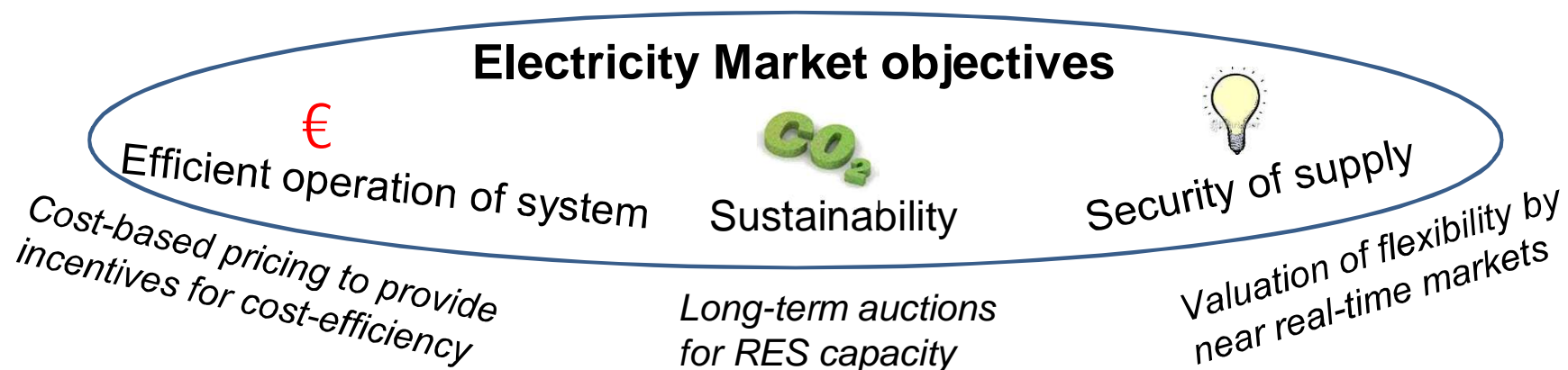
Electricity Market objectives



Reforms in electricity market designs, financing solutions, and innovative partnerships are essential for renewing the energy system

Reforms in electricity market designs, financing solutions, and innovative partnerships are essential for renewing the energy system

1. Energy market has to be capable to value flexibility
2. All the stakeholders have to face cost-based prices
3. There will be different markets for different resources: real-time markets for flexibility and long-term auctions for generation capacity
4. For end customer, energy can be bundled in other services. The service provider can gain profit from flexibility, provided by customer's IoT devices
5. Development of market design should be foreseeable, even if the development of the energy system was revolutionary



NCE WP 1 – LUT: Electricity market design & case country analyses

Key publications

Journal papers

- Weiss et al. “Market designs for a 100% renewable energy system: Case Isolated power system of Israel”. *Energy*, Vol. 119, Jan. 2017, pp. 266-277. (<http://dx.doi.org/10.1016/j.energy.2016.12.055>)

Conference papers

- Abdulganiyu, I. et al. “Prospects, Barriers and Possible Mitigation Measures of Integrating Renewable Energy into Kenyan Power System and Market” in EEM (European Energy Markets) 2017 conference, Dresden 6.-9.6.2017 (<https://doi.org/10.1109/EEM.2017.7981880>)
- Salovaara et al. “100 % Renewable Energy System - Challenges and Opportunities for Electricity Market Design”. EEM 2016 conference. (<https://doi.org/10.1109/EEM.2016.7521307>)

M.Sc. thesis

- Abdulganiyu, Ibrahim Olalekan ”Possibilities and barriers for increasing renewable power generation in Kenya and Tanzania”. M.Sc. Thesis. LUT 2017 (<http://urn.fi/URN:NBN:fi-fe201705226693>)

Research reports

- Salovaara, K., Makkonen, M., Gore, O., Honkapuro, S. *Electricity Markets Framework in Neo-Carbon Energy 2050 Scenarios*. Neo-Carbon Energy WP 1 working paper 3/2016. ISBN 978-952-249-419-1. Lappeenranta University of Technology 2016.
- Gore, O., Bogdanov, D., Salovaara, K., Honkapuro, S. *Market designs for a 100% renewable energy system*. LUT Scientific and Expertise Publications 56. ISBN 978-952-265-973-6. Lappeenranta University of Technology 2016.

www.greencampus.fi

Thank you!

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