Workshop on Smart Grid Technologies and Implications for Inclusive Development in Sri Lanka

3-4 April 2018 • Galle, Sri Lanka

Energy Technology Innovation in South Asia Implications for Gender Equality and Social Inclusion

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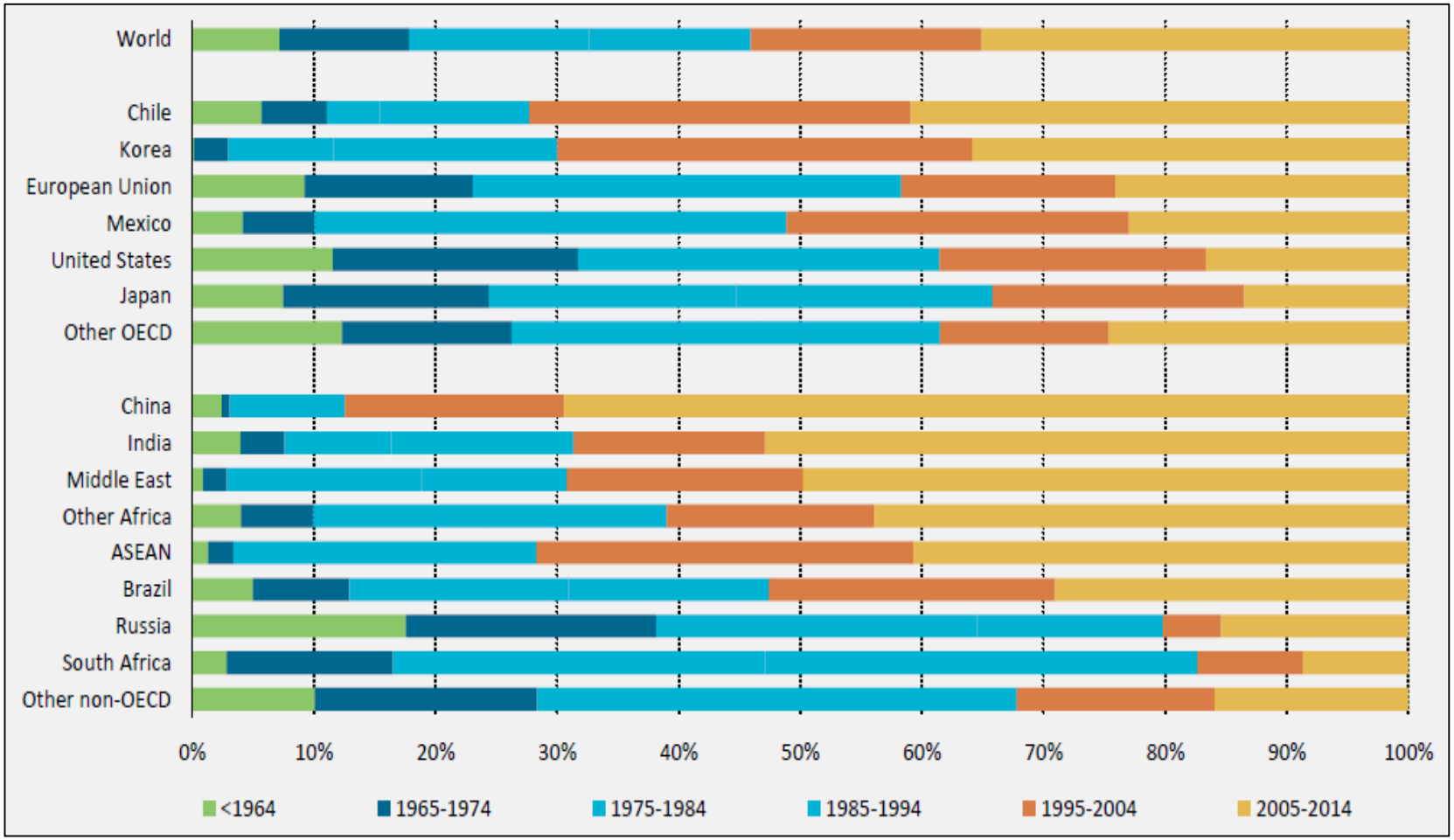
Structure

A. Energy transition; Asia
B. Energy studies frameworks for GESI

   Energy transition in Asia

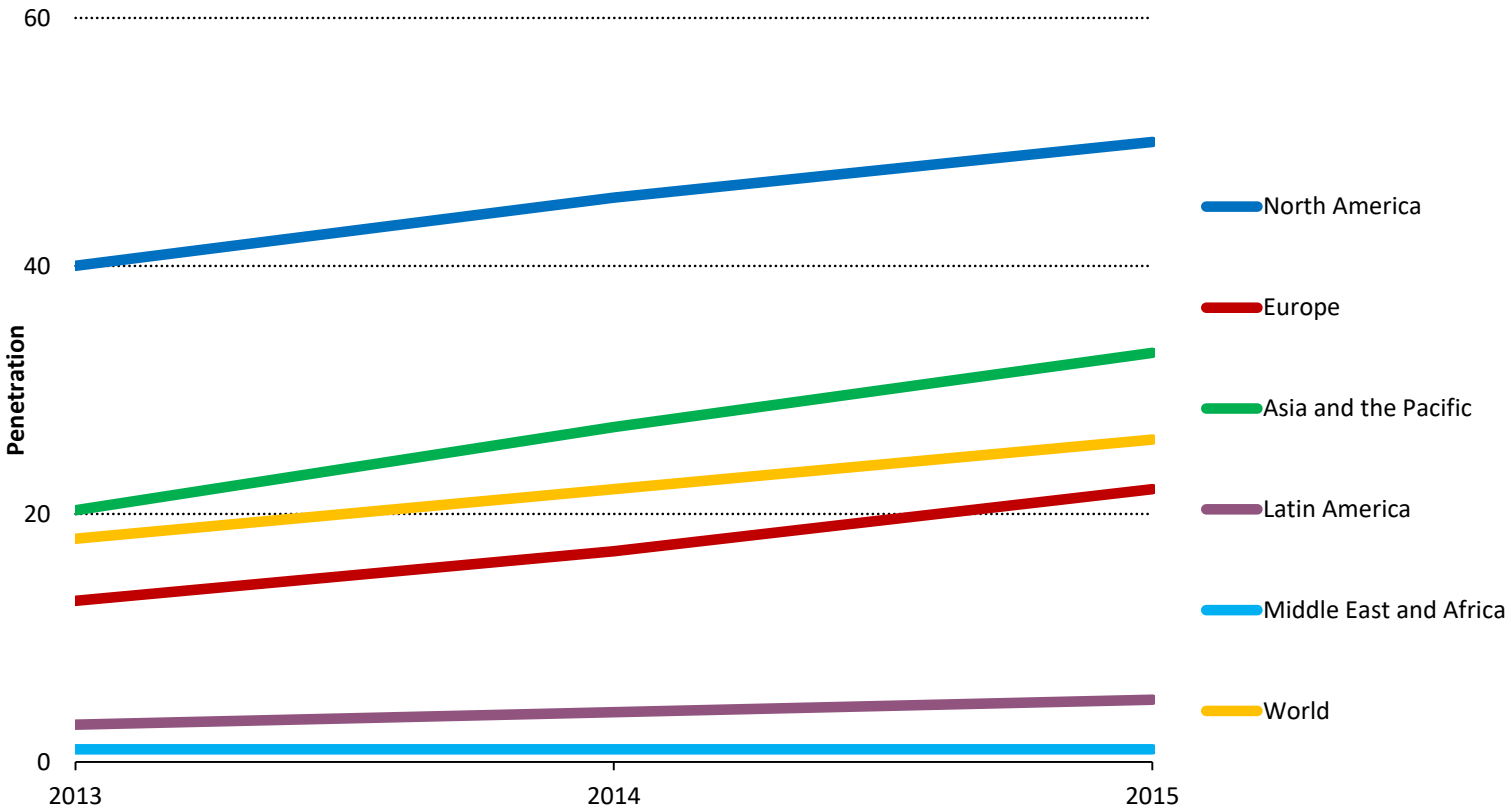
C. Technology Audit
D. GESI integrated energy systems models
E. Research Phase 2

A. Asia's low-carbon energy transition is well underway.



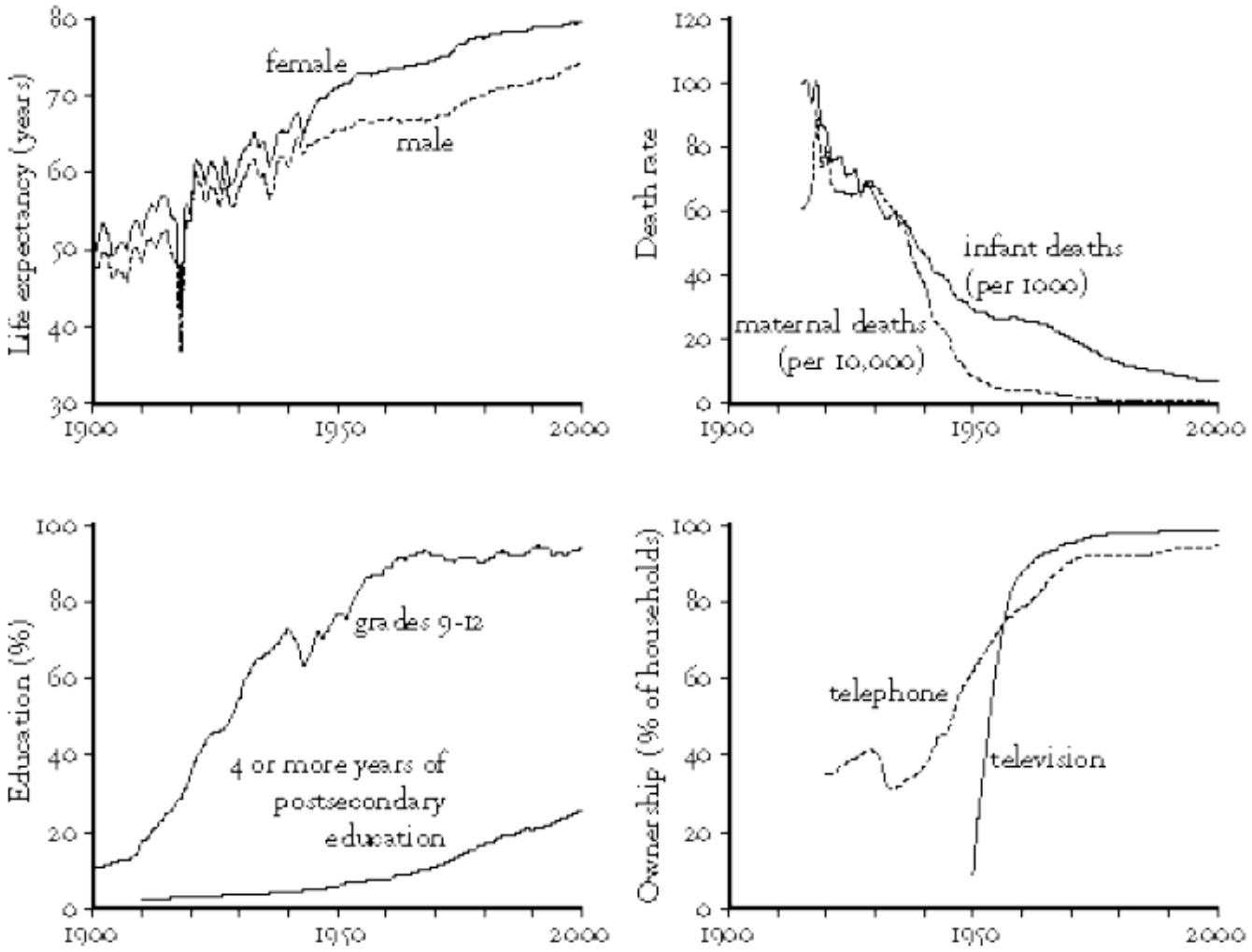
Age structure of existing power capacity, 2014 (IEA, ETP 2016)

Smart meter penetration by Regions (%)

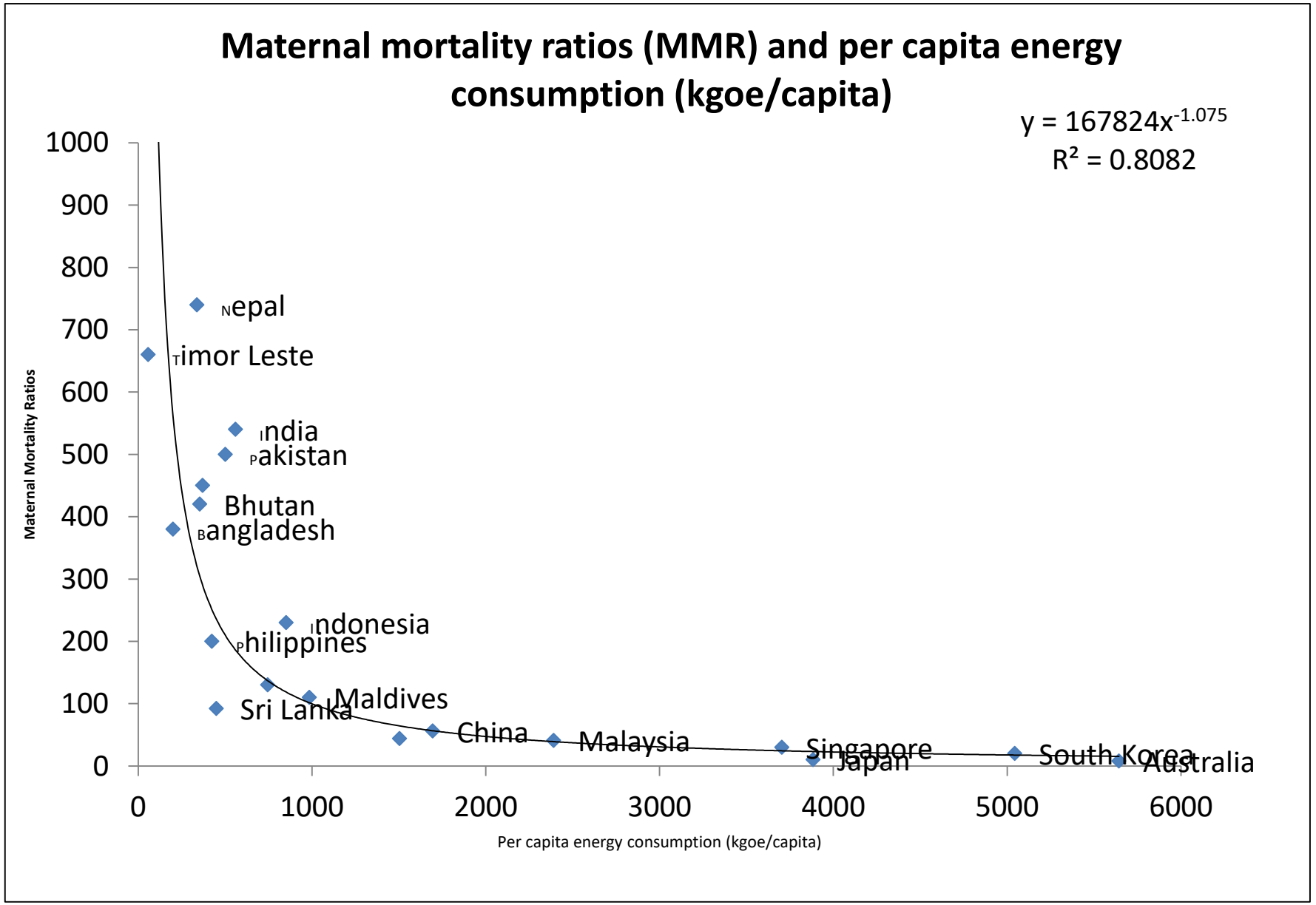


International Energy Agency, TCEP, 2016

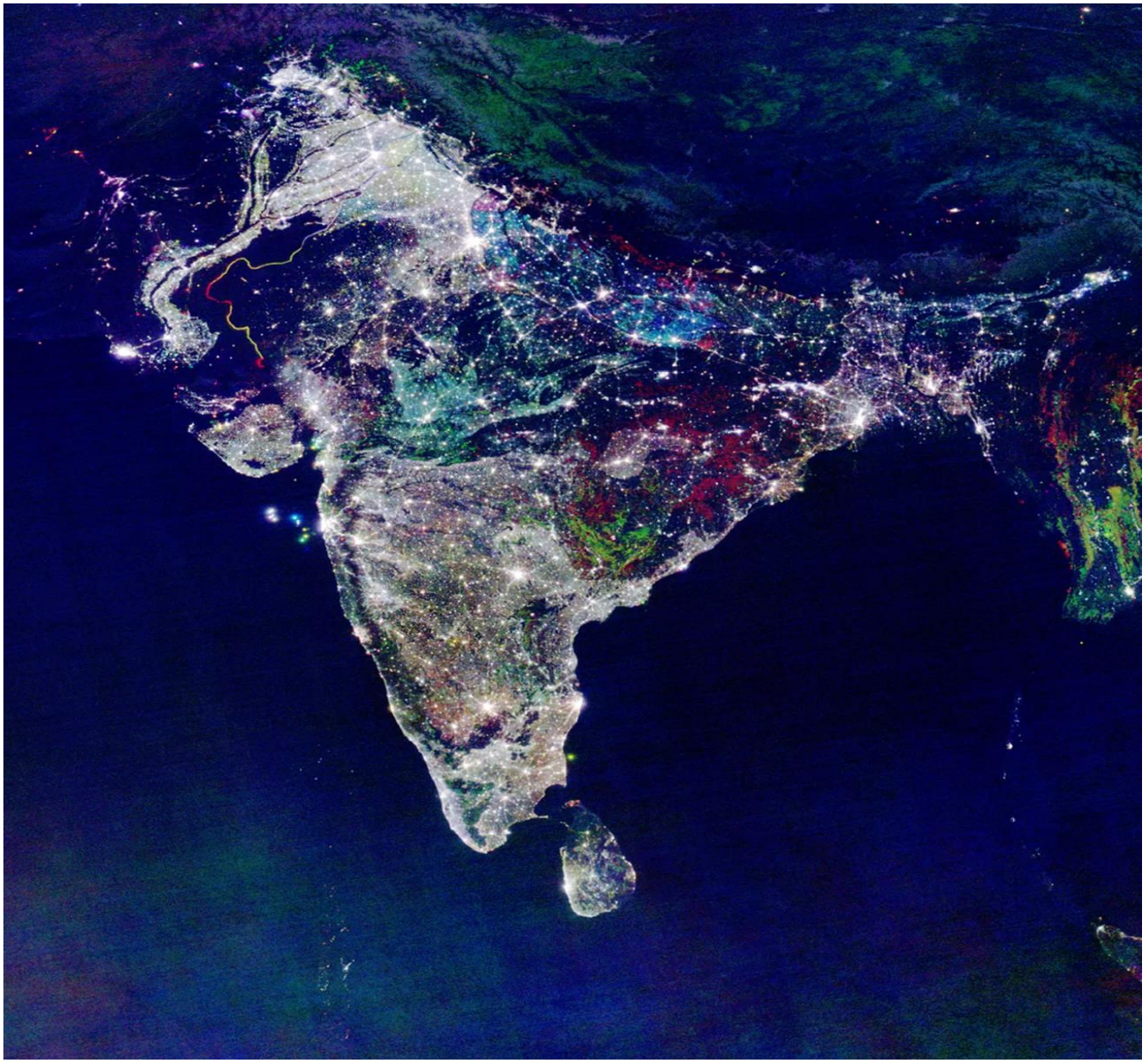
Transformed living conditions



Smil, Vaclav (2012)


Maternal mortality ratios (MMR) and per capita energy consumption (kgoe/capita)
y = 167824x-1.075
R² = 0.8082
Maternal Mortality Ratios
Per capita energy consumption (kgoe/capita)
0
100
200
300
400
500
600
700
800
900
1000
0
1000
2000
3000
4000
5000
6000
Nepal
Timor Leste
India
Pakistan
Bhutan
Bangladesh
Indonesia
Philippines
Sri Lanka
Maldives
China
Malaysia
Singapore
Japan
South Korea
Australia

Author

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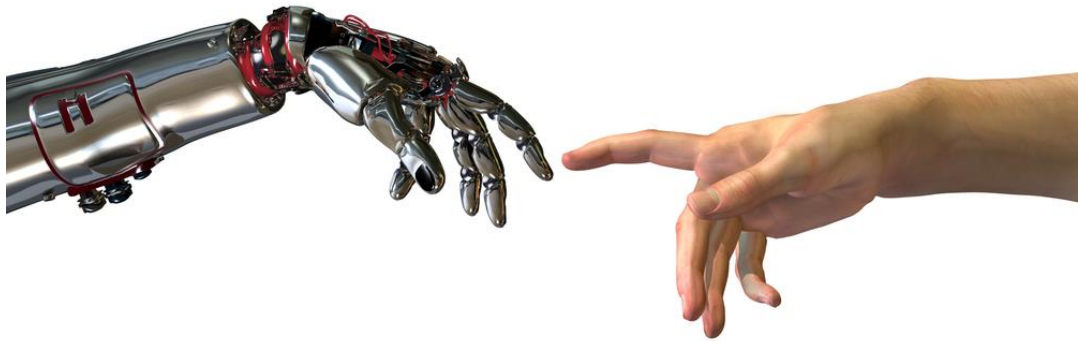
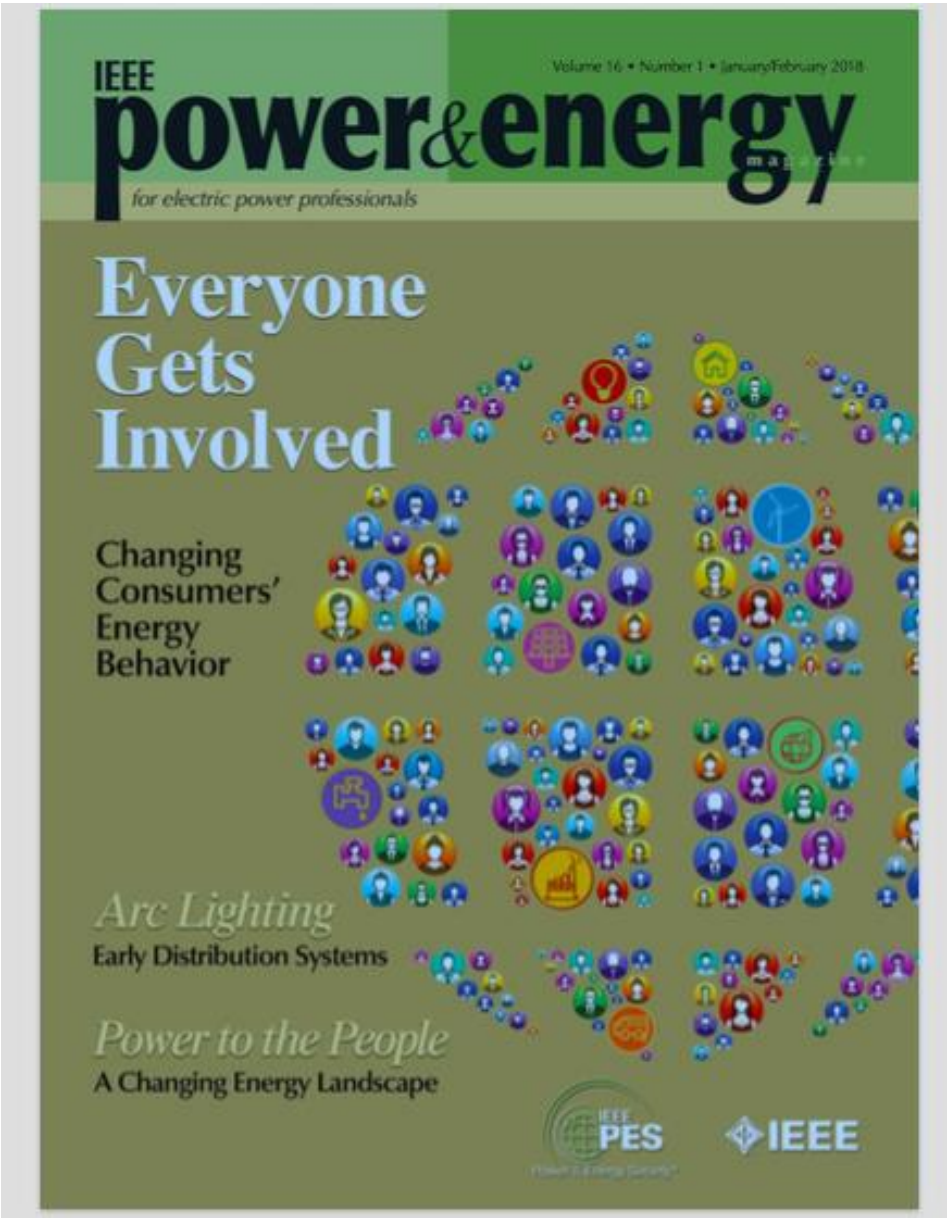
23:15 EST 14 Aug. 2003

B. Frameworks – technology and GESI pathways

- Energy/electricity access and use is valuable not in itself, but for what it enables women and men "to do or achieve" (Moss and McGann 2011, drawing from A. Sen and M. Nessbaum)
- The history of past energy transitions highlights the critical importance of end-use – consumers and demand and indicate that technology and the social settings co-evolve, depending on each other (Grubler 2012)
- ***Renewable energy technologies*** as 'disruptive technologies' can transform how energy is produced, distributed and consumed. ***Distributed systems, such as mini-grids, can potentially provide solutions for inclusive energy access.*** (Study focus)
- Energy services can improve ***women's 'economic' empowerment*** (Study focus)





"Current changes in energy and power systems … the distributed production of renewables, an increasing need for flexibility of operations, and energy storage and transmission, affect consumers in one way or another. Changes often require the active participation and support of consumers, who may become prosumers. All the new systems and technologies developed by electrical engineers may influence consumer behavior and trigger positive or negative responses. Hence, it is important for electrical engineers to understand how their work may affect consumers...

This issue encourages a conversation among electrical engineers and social scientists and facilitates the integration of their different expertise."

Who Communicates?
What is Communication About?
Where is it needed?

".. *with,* not *to*"
Person to person
Technology to person
Technology to technology

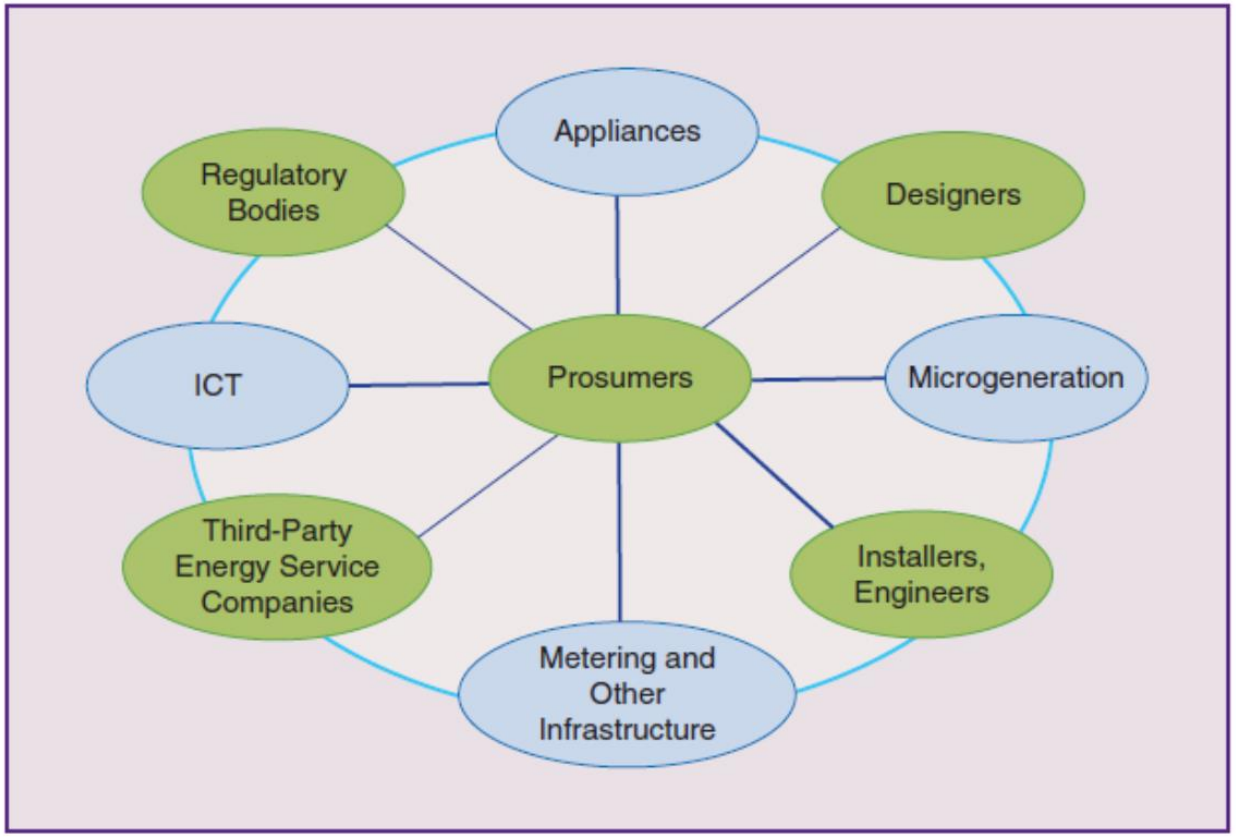
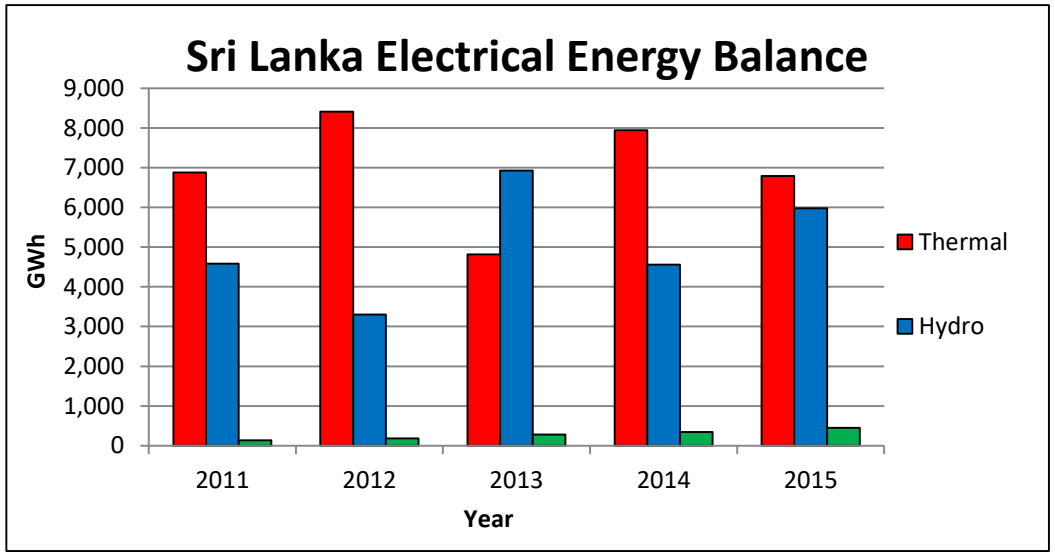


figure 2. Communications between some actors in an electricity system.

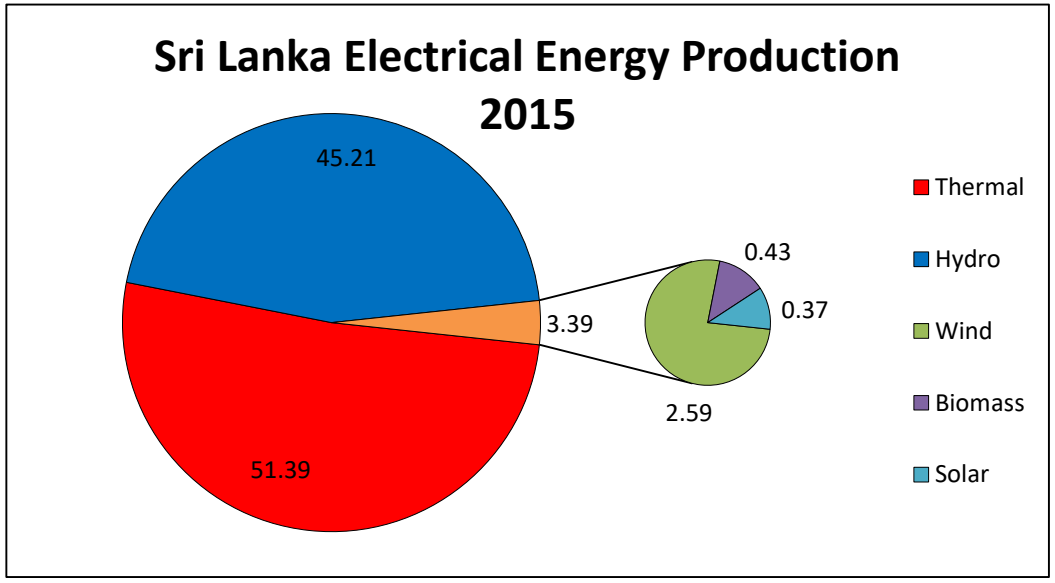
IEEE Power&Energy January/February 2018

C.

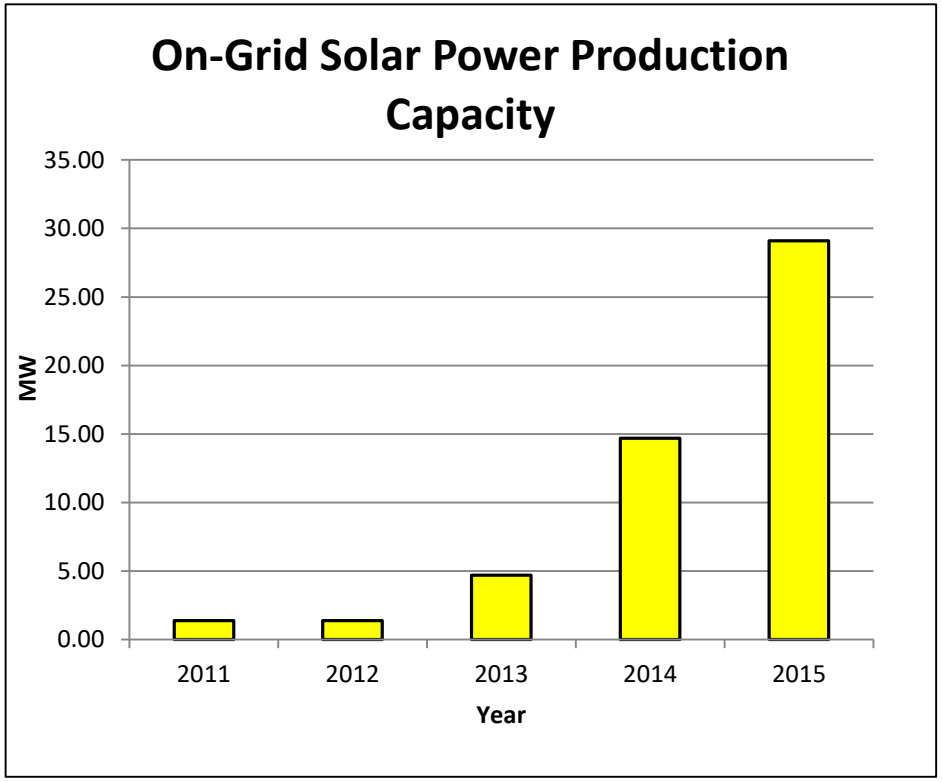
TECHNOLOGY AUDIT



GWh = gigawatt-hour
Sources: Public Utilities Commission of Sri Lanka. http://www.pucsl.gov.lk/english/; Ministry of Power & Renewable Energy, Sri Lanka. http://powermin.gov.lk/english/.



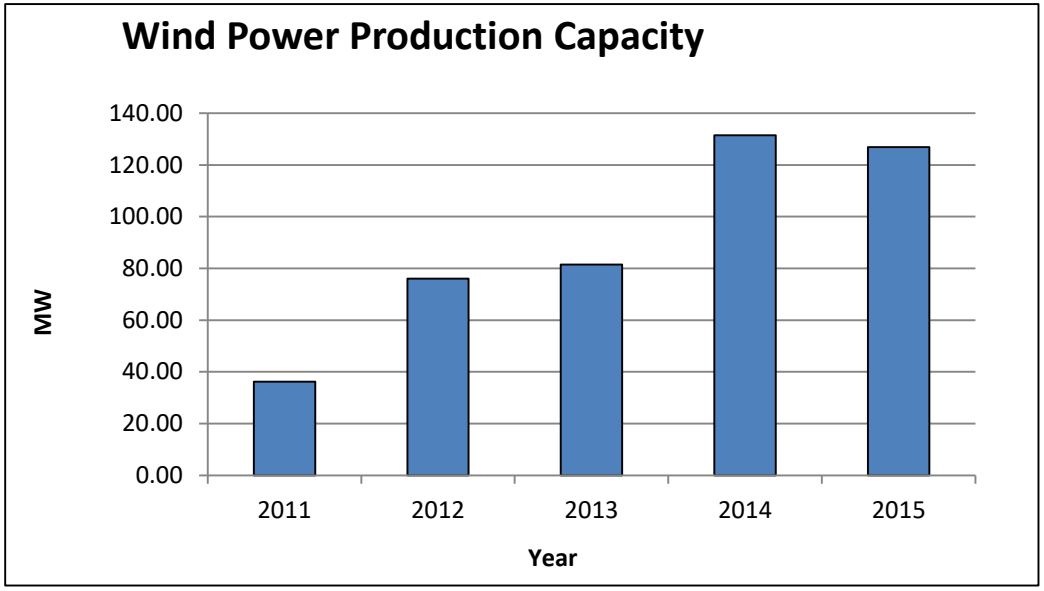
Sources: Public Utilities Commission of Sri Lanka. http://www.pucsl.gov.lk/english/; Ministry of Power & Renewable Energy, Sri Lanka. http://powermin.gov.lk/english/.



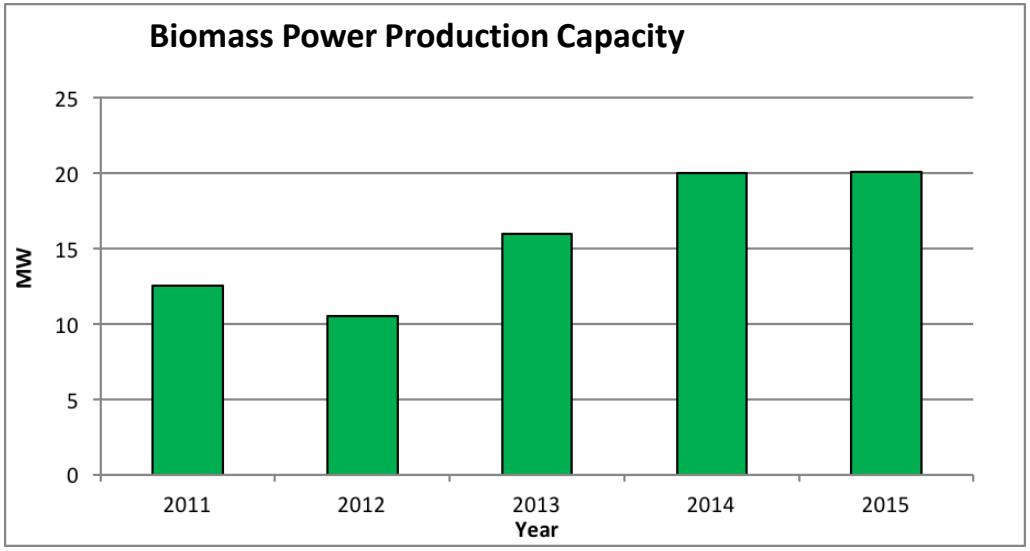
Battle For Solar Energy! (2016)

- Add 200MW of solar power to the grid by 2020, and 1000MW by 2025.
- A total of 1 million solar home systems over ten years.
- Three Schemes:
  - **Net Metering**: Carry forward excess production as credit.
  - **Net Accounting**: Be paid for excess production or pay for excess consumption.
  - **Net Plus**: Targeted at lower income households. All power produced is purchased by the utility.

Sources: Generation Performance in Sri Lanka 2016. http://www.pucsl.gov.lk/english/wp-content/uploads/2017/07/GenPerformance-2016_Draft.pdf; Ministry of Power & Renewable Energy, Sri Lanka. http://powermin.gov.lk/english/.

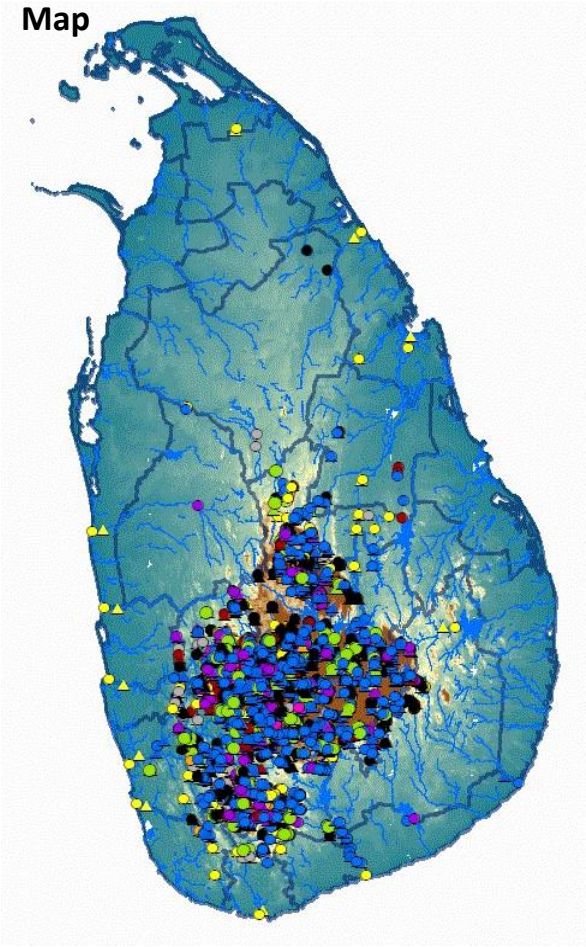


Sources: Generation Performance in Sri Lanka 2016. http://www.pucsl.gov.lk/english/wp-content/uploads/2017/07/GenPerformance-2016_Draft.pdf; Ministry of Power & Renewable Energy, Sri Lanka. http://powermin.gov.lk/english/.

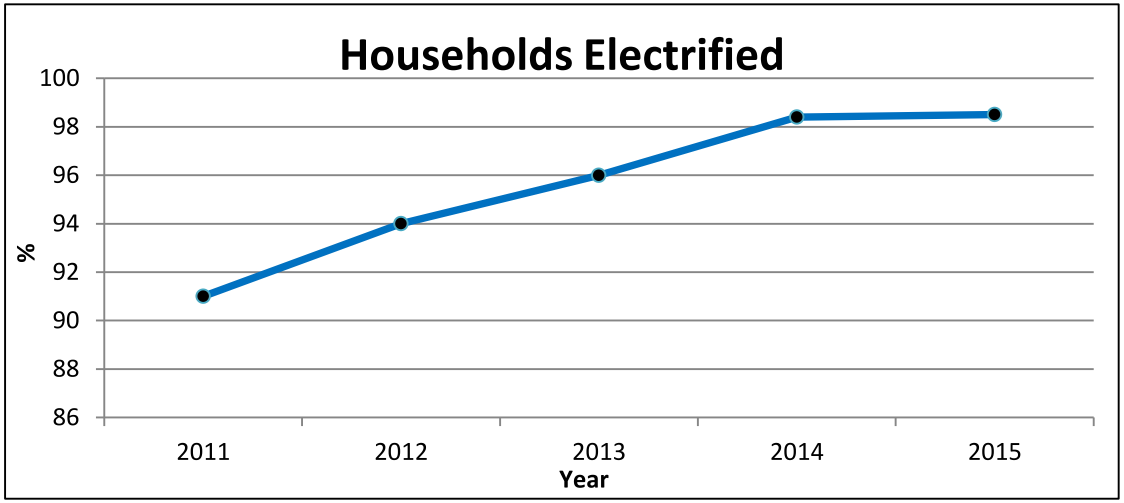


Source: Ceylon Electricity Board. http://www.ceb.lk/.

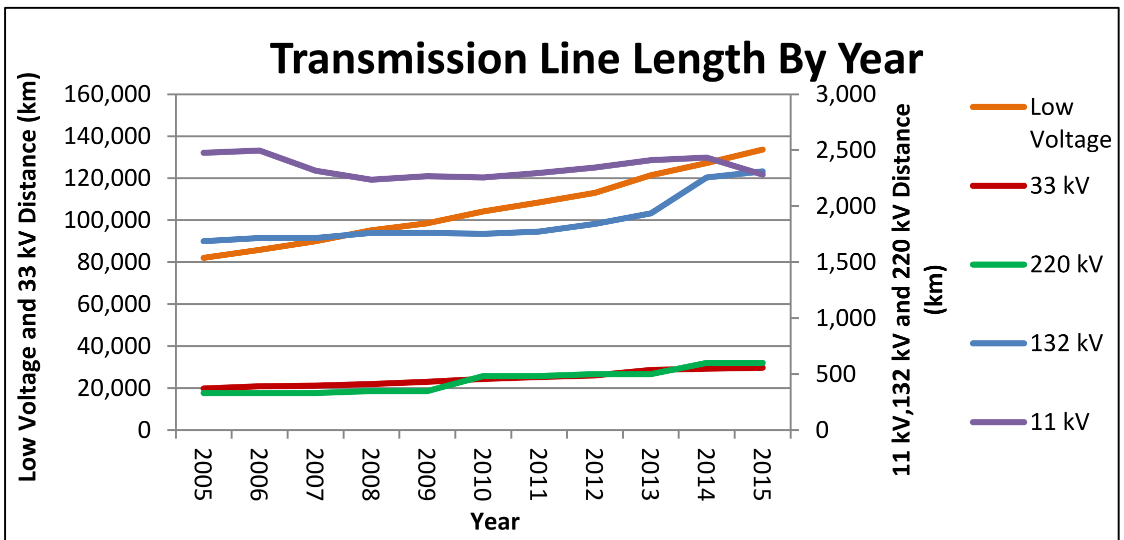
Geographic Information System Hydro Map



Source: Web Geographic Information System for Sustainable Energy Authority. http://www.gisserver.org/seagis/.

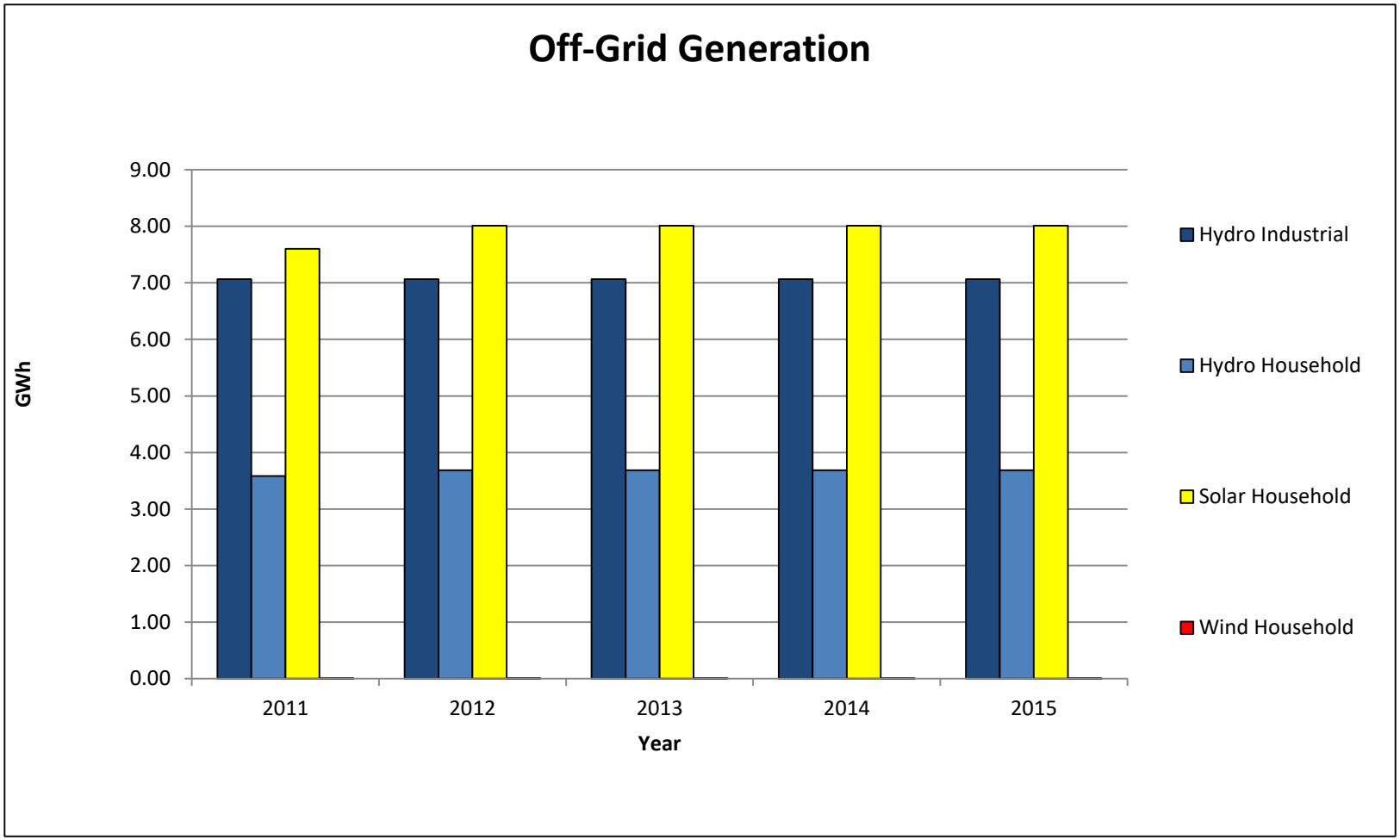


Source: Ceylon Electricity Board Statistical Digest 2011–2015.



km = kilometer, kV = kilovolt.
Source: Ceylon Electricity Board Statistical Digest 2006–2015.

Source: Ceylon Electricity Board Statistical Digest 2015.

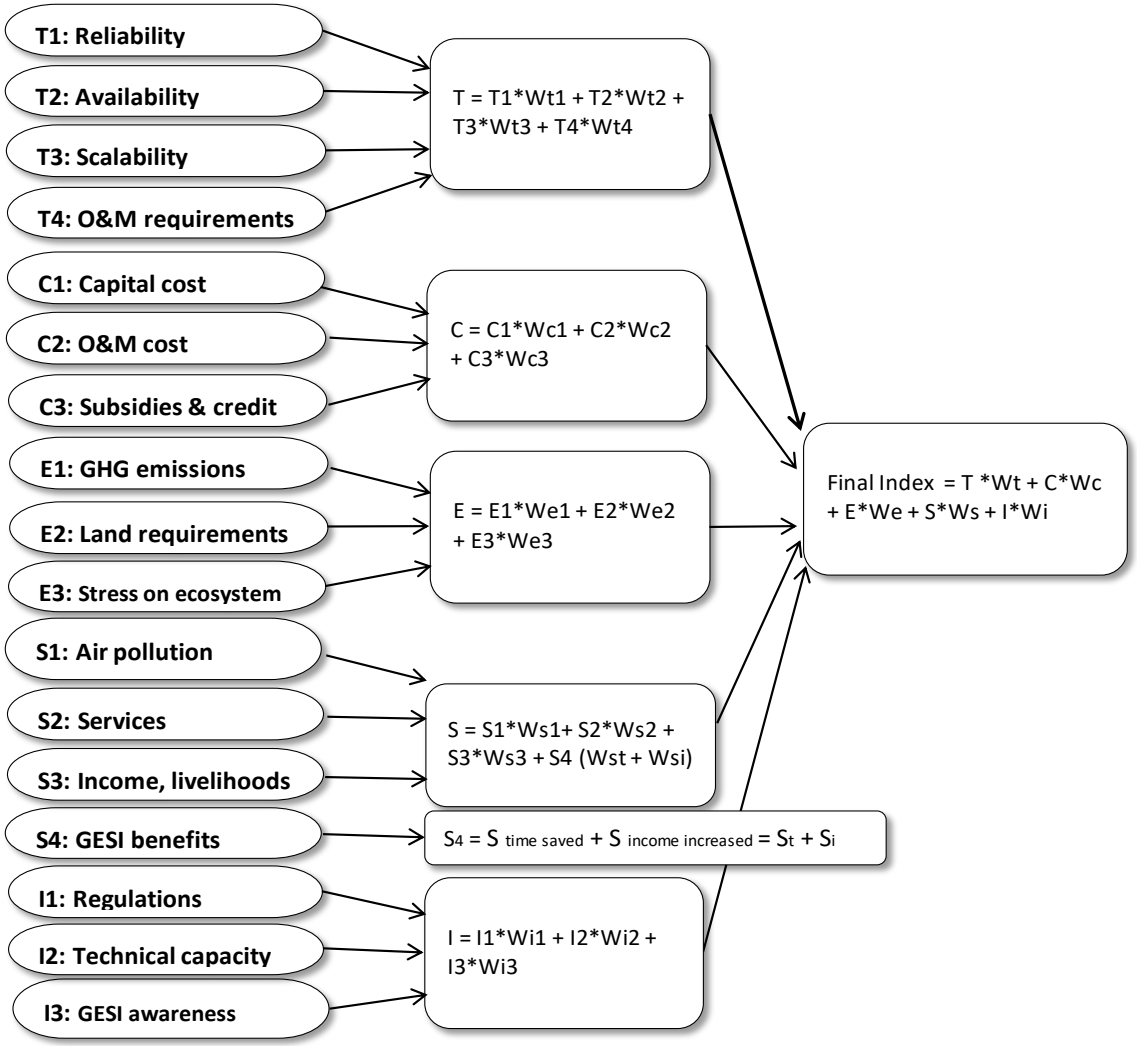


Source: Public Utilities Commission of Sri Lanka. http://www.pucsl.gov.lk/english/; Ministry of Power & Renewable Energy, Sri Lanka. http://powermin.gov.lk/english/.

D. Optimal combination
Weighting multi-criteria

GESI mainstreaming Nerini's algorith

1. Technology
2. Cost
3. Environment
4. Social
5. Institution



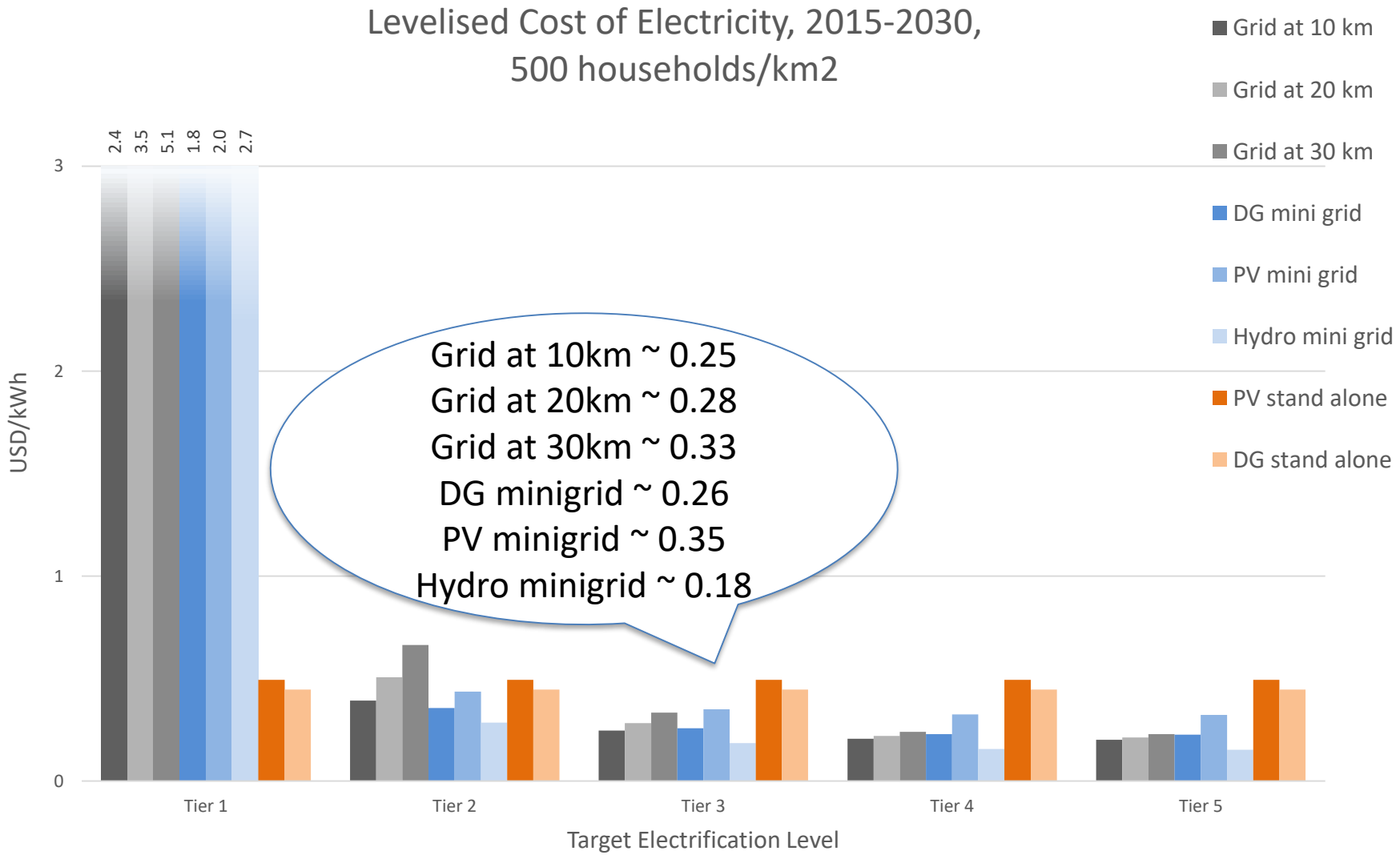
Nerini, Francesco Fuso and others. 2016. A cost comparison of technology approaches for improving access to electricity services. Energy 95. p255-265

Rural electrification -- World Bank global tracking framework (GTF)

		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Tiers	Tier Criteria	-	Task lighting *and* Phone charging	General lighting *and* Fan (if needed	Tier 2 *and* any medium power appliances	Tier 3 *and* any high power appliances	Tier 2 *and* any very high power appliances
Appliances	Indicative list of appliances		Very low power appliances	Low power appliances	Medium power appliances	High power appliances	Very high power appliances
	Lighting	-	Task Lighting	Multi-point general lighting			
	Entertainment and communication	-	Phone charging, radio	Television, computer	Printer		
	Space cooling and heating	-		Fan	Air cooler		Air conditioner, space heater
	Refrigeration	-			Refrigerator, freezer		
	Mechanical loads	-			Food processor, washing machine, water pump		
	Product heating	-				Iron, hair dryer	Water heater
	Cooking	-			Rice cooker	Toaster, microwave	Electric cooking

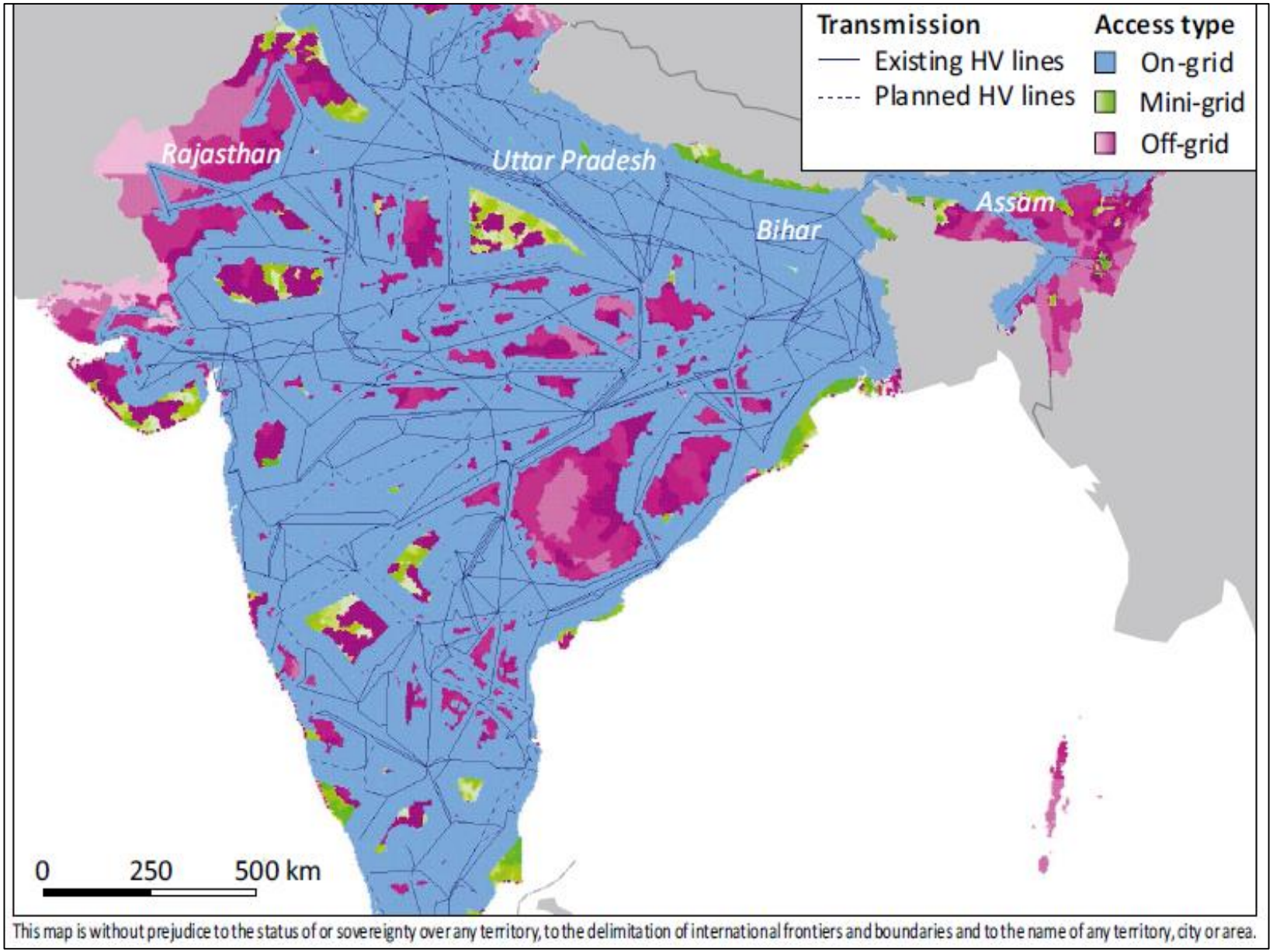
	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Annual consumption levels (Kwh)	< 4.5	≥ 4.5	≥ 73	≥ 365	≥ 1250	≥ 3000

What Pathways?



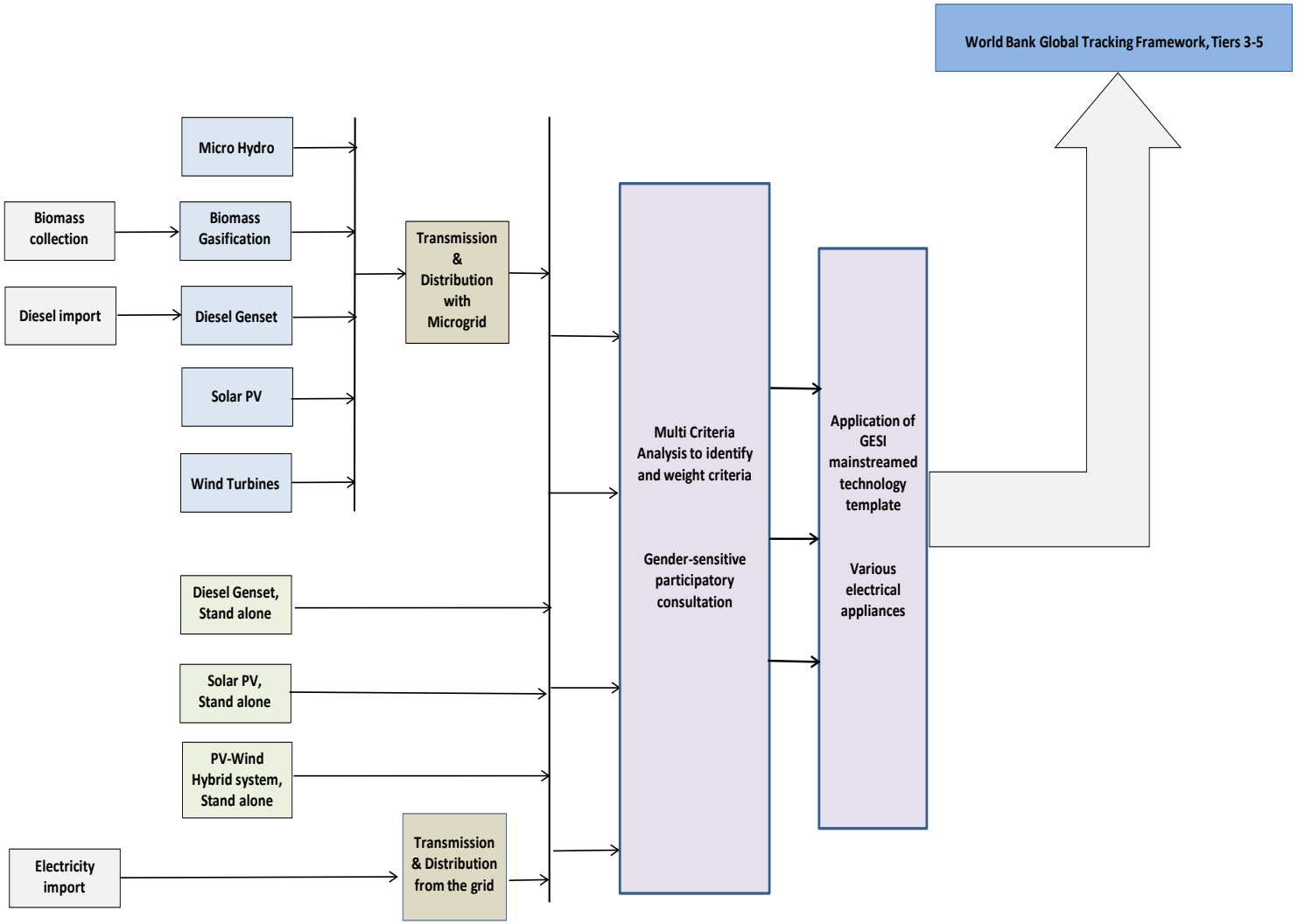
Source: A cost comparison of technology approaches for improving access to electricity services, Nerini and others, 2015

Applied to India by IEA



IEA India Energy Outlook, 2015

GESI integrated reference energy system



Note: Building on Nerini's 2014 Reference Energy System for Timor-Leste, which is developed from *Reference Energy System Methodology* (Beller, 1976). Accessed at https://www.osti.gov/scitech/servlets/purl/7191575

Example: Alternative Energy Promotion Centre, Nepal

S.N.	Programs/activities	Benifited				Caste/Ethnicity/Religion (% of the benefited population)				
		Household	Population	Male	Female	Janjati	Dalit	Madhesi	Muslim	Others (B/C/T)
1	Micro/Mini/pico hydro	22733	110937	53804	57133	15.2	4.8	10.6	4.4	65
2	IWM	27866	135986	65953	70033	15.2	4.8	10.6	4.4	65
3	SSHS	10831	43324	21229	22095	NA	NA	NA	NA	NA
4	SHS	92330	369320	180967	188353	NA	NA	NA	NA	NA
5	PVPS	1400	8565	4378	4308	66	9	0	0	25
6	Solar Dryer	26	130	64	66	46	0	0	0	54
7	Biogas- Domestic	30196	150980	14492	15704	52	1	1	0	46
8	ICS- Metal	6746	32380	16123	16257	59	9	0	0	33
9	ICS- Mud	281469	1550683	782318	766537	30	17	27	7	19
10	MSMEs	1054	5144	900*	154**	38	6	NA	NA	56
11	IGA	3217	15699	1245#	1972##	47	18	NA	NA	35

* Number of man-owned MSMEs

** Number of woman-owned MSMEs

Number of man-owned IGA

Nuber of woman-woned IGA

E. Phase 2
a. Community Energy Systems

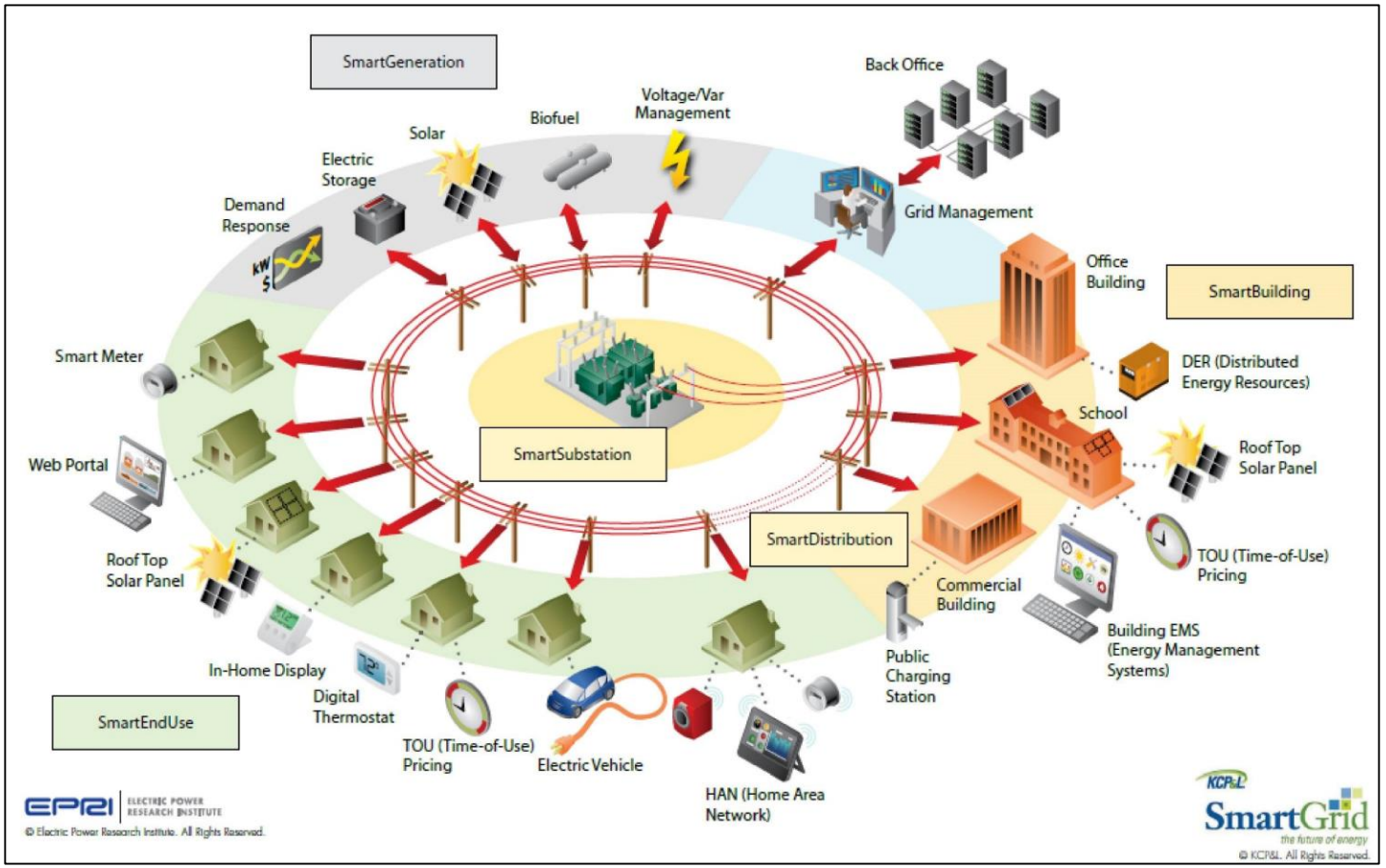
(i) citizens running projects through communities, such as cooperatives or development trusts;

(ii) a cooperative, democratic, or non corporate structure in which individuals participate actively in decision-making;

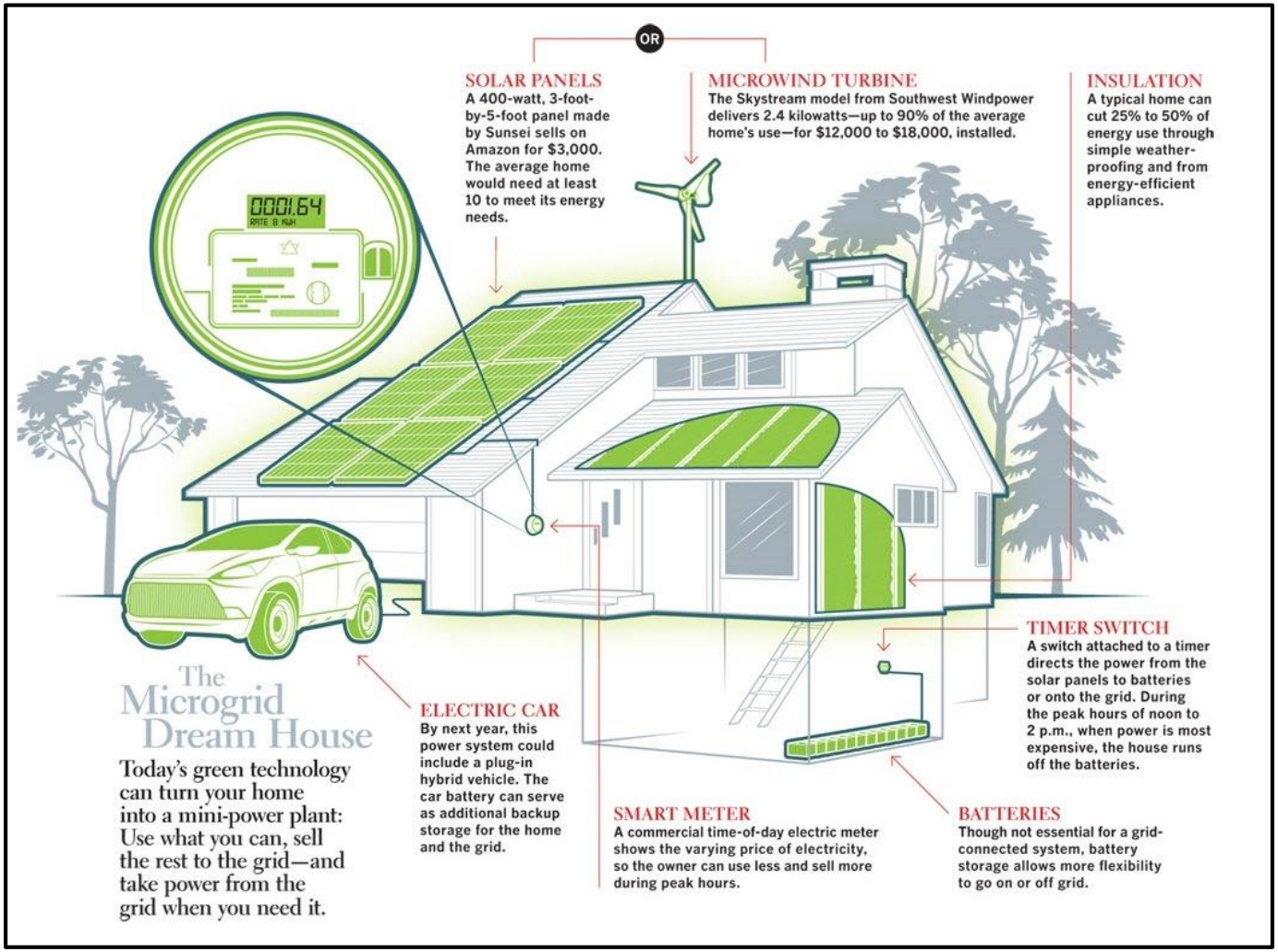
(iii) tangible local benefits to people living or working close to projects;

(iv) profits returning to the community or being reinvested in other community energy schemes.

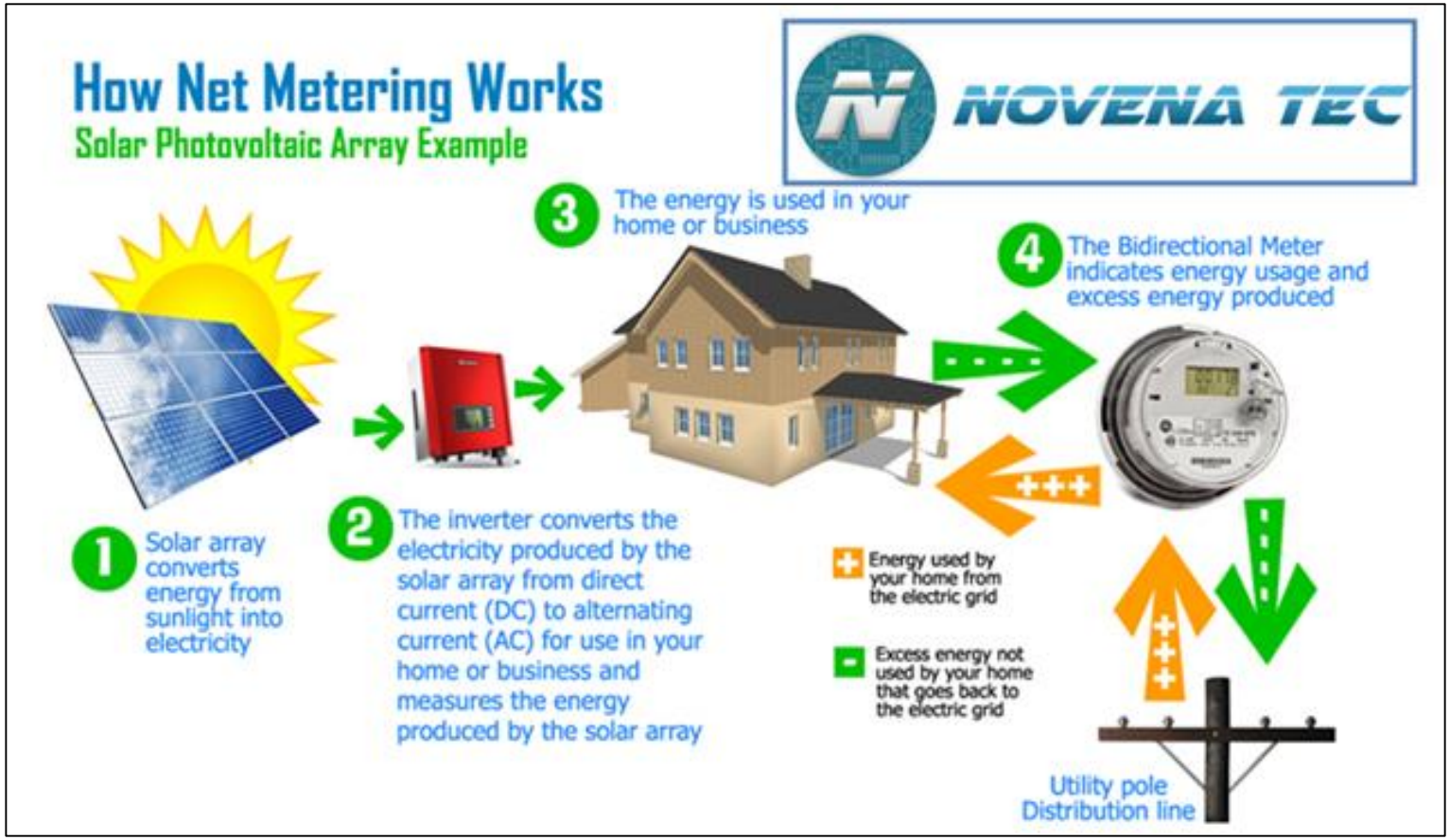
IRENA, 2016



Source: Electric Power Research Institute. 2010. *Kansas City Power & Light Smart Grid Demonstration Project*. https://www.smartgrid.gov/files/Kansas_City_Power_Light_Smart_Grid_Demonstration_Project_201006.pdf.



Source: http://austinspc.com/2011/04/10/what-is-a-microgrid/



Source: http://redcube.lk/?r=products/productsStore/view&id=1803

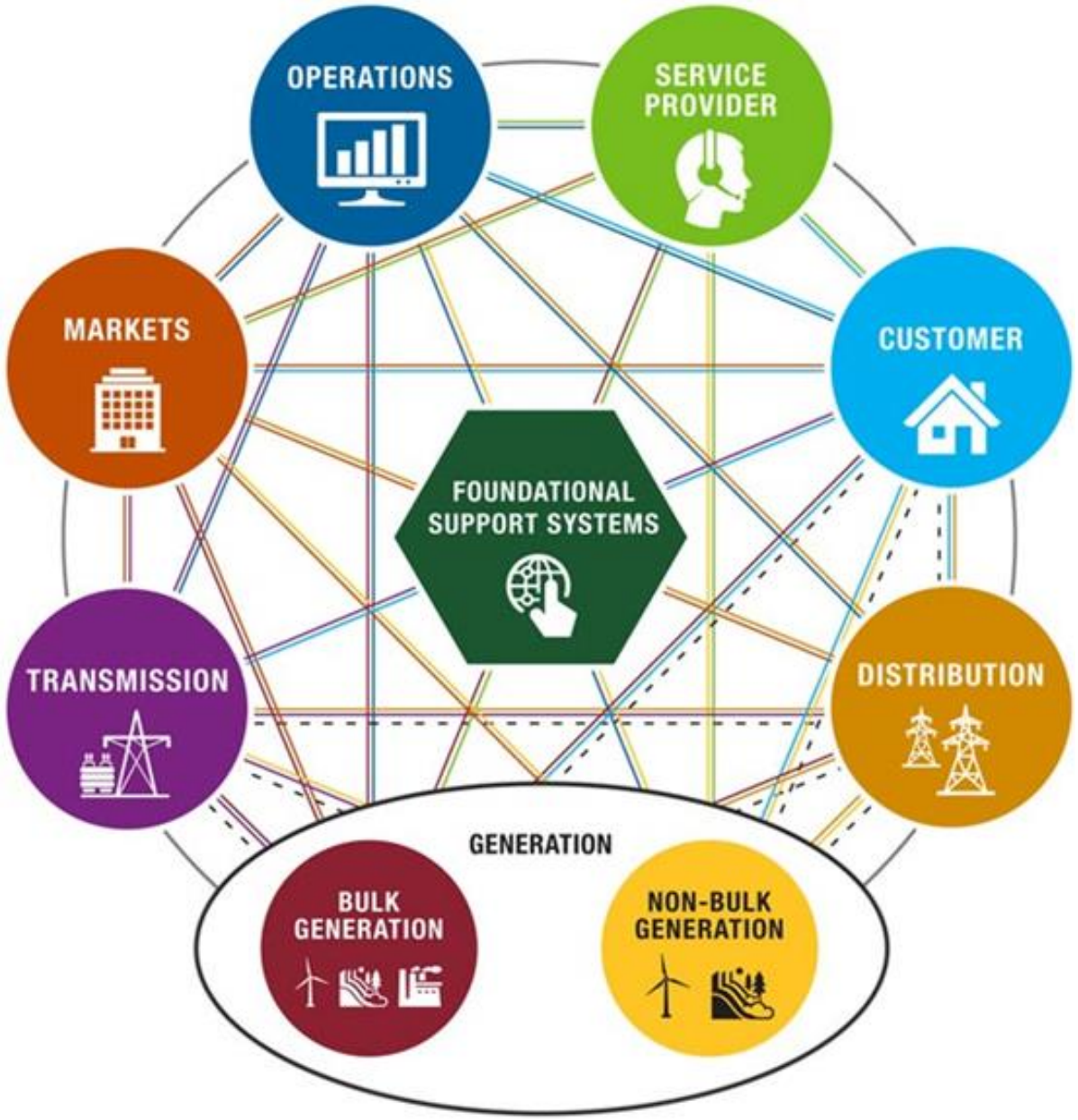
- Scoping research on smart grid pilot programs, with a focus on mini grids and PV systems,

- Further development of the GESI integrated modified reference energy system with the view to adapting and applying the system to a test site,

- Include energy savings based on an optimal combination of renewable energy resources, and storage of all energy vectors including battery storage and electric vehicles, and the intensive use of the latest technologies on power electronics, control and digitization,

- Test case or pilot.

(b) Policy and planning frameworks designed to integrate GESI in smart grid drawing from the IEEE ‘domains’ framework.



Power to the people?

Just what does empowering consumers mean?

Consumers as "energy citizens"

"aside from turning formerly passive energy consumers into more active and informed ones, empowering consumers can also help to make them act as energy citizens.

Why is this distinction important?

Because whether you look at people as consumers or as citizens matters:

conceptually, when trying to understand energy-related choices and behavior,

practically, when designing policies to address people's concerns,

and of course politically, when peo-ple get involved and become active participants in energy-related policy making themselves."

Gerd Schonwalder, European Commission