

Cities & the grid

MIT 11.165/477, 11.286J

David Hsu
Associate Professor
Urban Studies & Planning
MIT

November 1, 2022

When we talk about the 'grid' ...

For the first 150 years or so, *electricity* could not be stored (easily, yet):

- electricity will be the basis of clean energy scenarios going forward
 - ▶ this assessment is based on *technology*
 - ▶ past electric 'modernity': clean, quiet, smokeless, relatively safe
 - ▶ clean resources like solar, wind, nuclear: all make electricity
 - ▶ transformations into other forms of energy like heat, liquid fuels, etc.,
- matching over space (transmission)
 - ▶ grid architecture originating in *historical development*
- matching over time (storage)
 - ▶ system demand curve created by *learned behaviors & expectations*
- matching supply and demand through costs, prices (markets)
 - ▶ markets are created by *politics and economics*
- understanding all of these aspects allows new options:
 - ▶ demand response?
 - ▶ storage?
 - ▶ behavior and social change?

Grid architecture

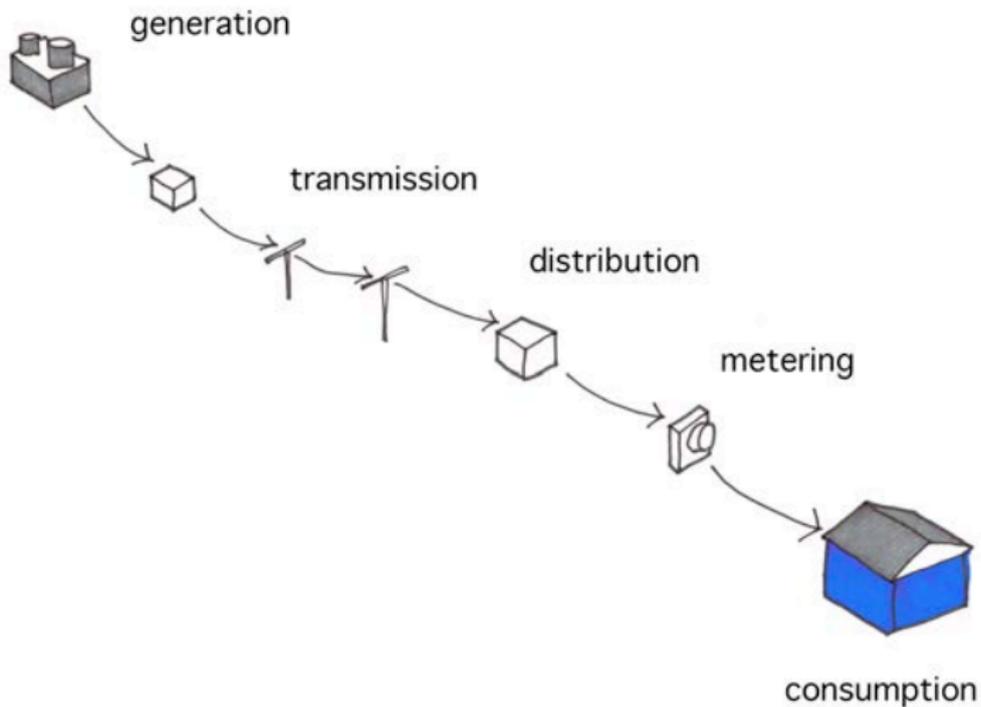
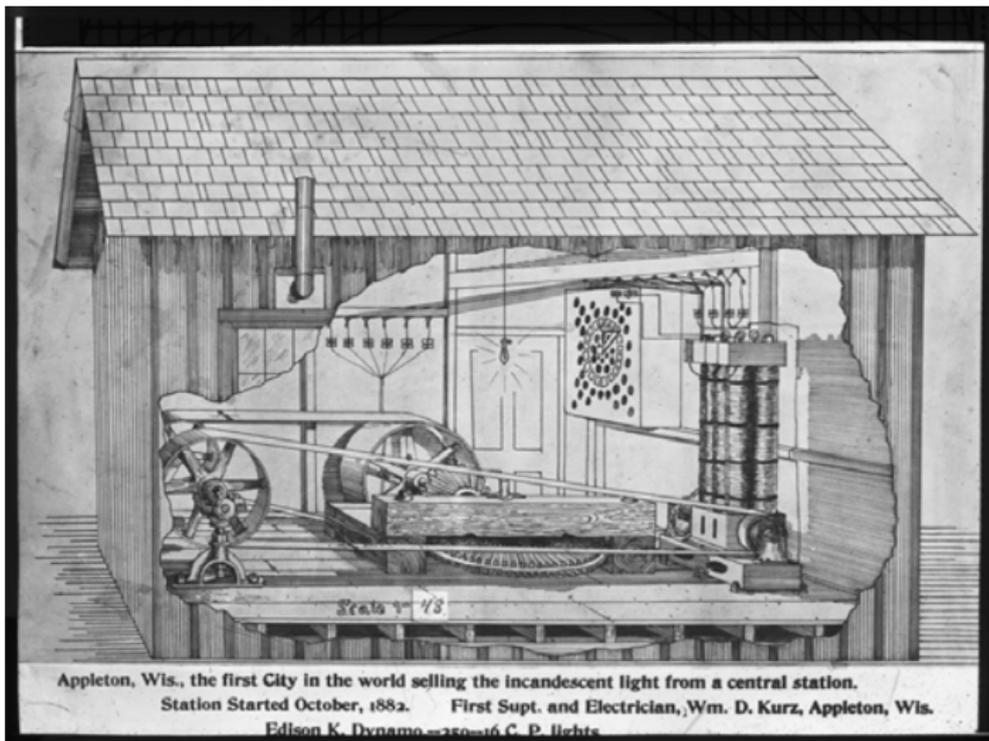


Diagram by David Hsu, 2009

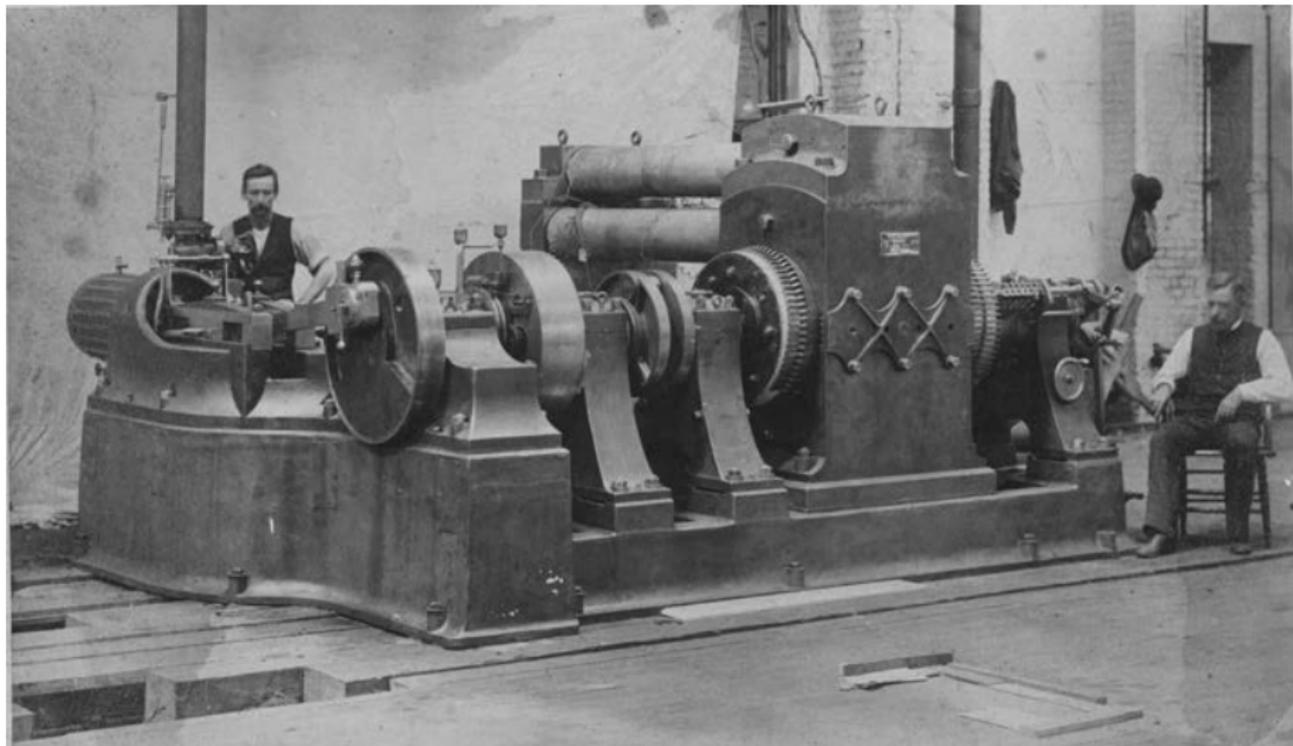
Historical development of the grid



Lawrence University, Artstor

This image is in the public domain.

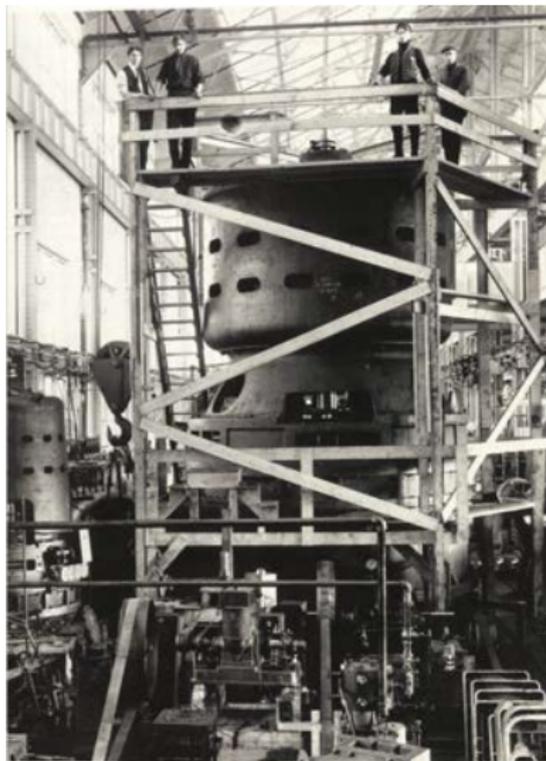
Historical development of the grid



Edison's Pearl Street Station; image from Evans & Lefer, "They Made America"

This image is in the public domain.

Historical development of the grid



Evans & Lefer, "They Made America"

© Little, Brown & Co. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

Historical development of the grid



Movie poster: 101 Studios, related entities, The Weinstein Company

Left image © 101 Studios and related entities; right image © Metacritic.com. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

Debate over utilities regulation



The Oregonian

“Let us consider for a moment the vast importance of the American utilities in our economic life . . . The utility industry in 1931 collected over four billion dollars in one year from the users of electricity, gas, telephone and telegraph. That means an average of \$133 from each and every family in the United States.”

– FDR in Portland, Oregon, 1932

© The Oregonian. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

Transmission lines



Flickr, Nick Page, CC BY 2.0

Transformer yard



Wikipedia

Cities & the grid

Local distribution



My neighborhood

Local distribution



My house

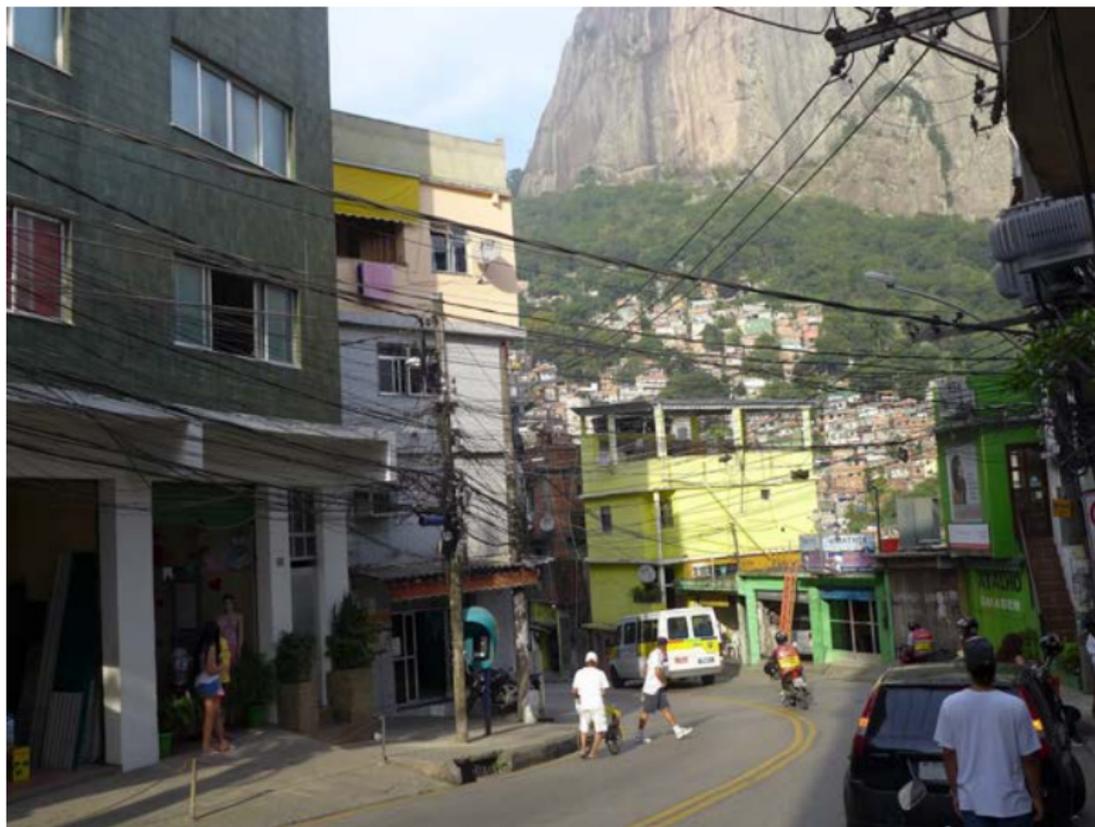
Local distribution

© Armando Lobos. License: CC BY-NC-ND. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.



Santa Marta, RdJ, Brazil by Armando Lobos, Flickr, CC BY-NC-ND 2.0

Local distribution



Rochinha, RdJ, Brazil by David Hsu

Local distribution



Santa Maria, RdJ, Brazil by David Hsu

Local distribution



Santa Maria, RdJ, Brazil by David Hsu

Local distribution



Rochinha, RdJ, Brazil by David Hsu

Local distribution



Rocinha, RdJ, Brazil by David Hsu

Local distribution



Rochinha, RdJ, Brazil by David Hsu

Local distribution



Jamshedpur, India by David Hsu

Local distribution



Jamshedpur, India by David Hsu

Local distribution

UNIT CONSUMPTION BILL
JHARKHAND BIJLI VITRAN NIGAM LTD. SEC:
 ELECTRIC SUPPLY SUB. DIVN JADUGOHA
 D1023J00000000000PBI7 METER NO. 0 CAPACITY :

PREVIOUS READING	Bill No.	MONTH	DATE	DUE DATE	DATE	LAST PAYMENT AMOUNT
	117	May-16	15/06/16	30/06/16	28/03/16	1500.00
UNITS CONSUMED	ENERGY CHARGES	FIXED/MISC. CHARGES	METER RENT	ELECTRIC DUTY	P.F.S.	F.S.
	110.00	-	-	22.00		
MINIMUM GUARANTEE	D.P.S.	CAPACITOR CHARGE	ELCB/MCB CHARGE	TOTAL ASSESSMENT	KJHHC	
	21.40	-	-	153.00	-	
CHARGED UNITS	PREVIOUS ARREAR		GRAND TOTAL	REBATE	NET AMOUNT	
0	ENERGY CHARGES	D.P.S.	2117.00	-	2117.00	
	1427.13	536.87				

BOOK & CONSUMER NO
 CONSUMER'S NAME
 ADDRESS

LOAD: 1. MF: 1

E.&O.E
 SIGN. & SEAL OF JEE (REV)

Do not insist on giving electric connects to neighbours to avoid disconnection without notice.

Jamshedpur, India by David Hsu

Local distribution



Gumla, India by David Hsu

Local distribution



Gumla, India by David Hsu

Local distribution



Jamshedpur, India by David Hsu

Local distribution



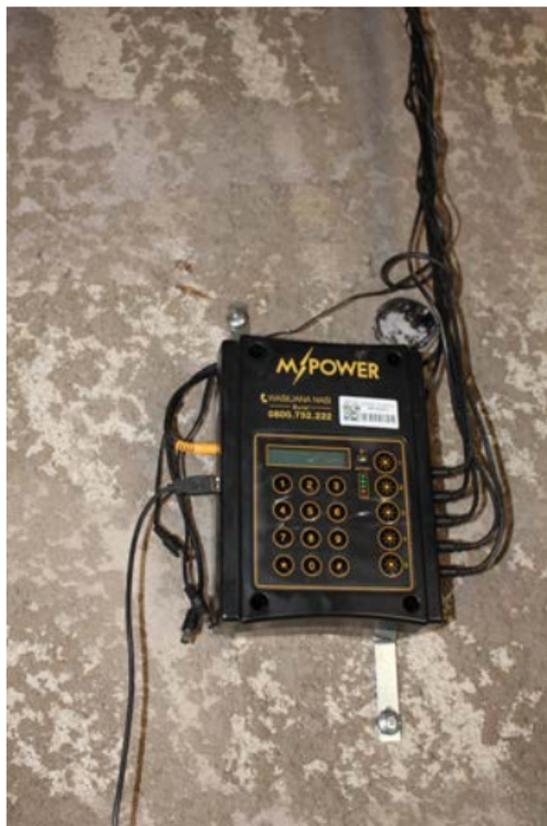
Tanzania, David Hsu

Local distribution



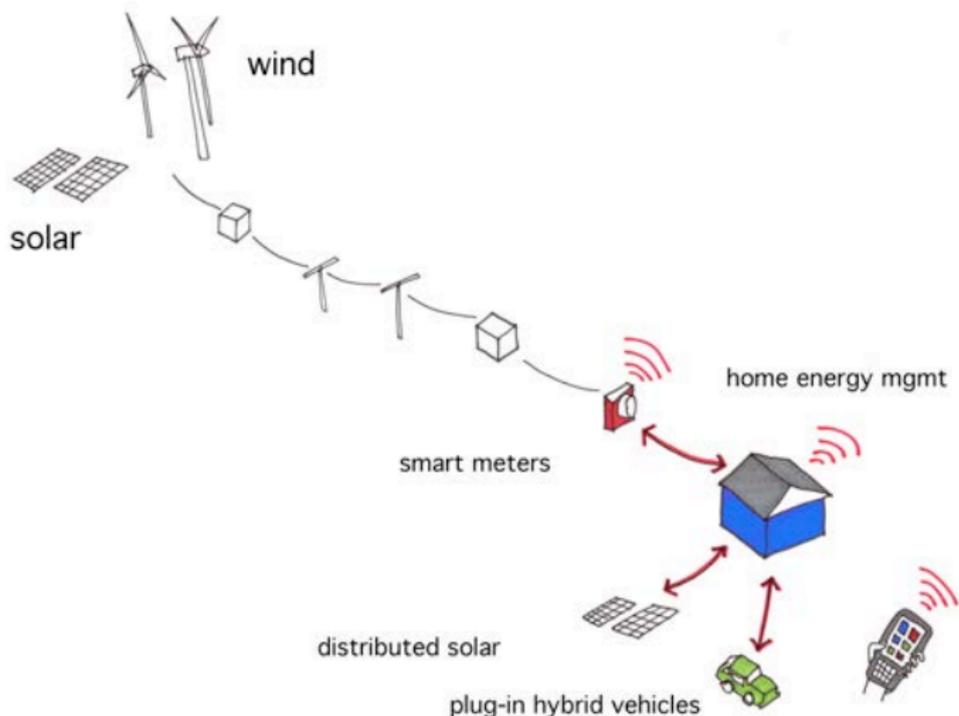
Tanzania, David Hsu

Local distribution



Tanzania, David Hsu

Grid architecture



David Hsu, 2009

Thank you!

MIT OpenCourseWare

<https://ocw.mit.edu>

11.165 Urban Energy Systems & Policy Fall 2022

For more information about citing these materials or our Terms of Use,
visit <https://ocw.mit.edu/terms>.