Power Decarbonization Through 2050: Narratives and Equity

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Peter Fox-Penner
Director, Boston University
Institute for Sustainable Energy
Professor of the Practice,
Questrom School of Business
pfoxp@bu.edu
www.bu.edu/ise

BU
Boston University Institute for Sustainable Energy

Additional affiliations: The Brattle Group, Energy Impact Partners (EIP)
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Agenda

1. Two Narratives on Clean Power
2. More on The New Narrative
3. Funding the Distribution Grid Equitably
4. Options and Directions for Equitable and Effective Funding

1. TWO NARRATIVES ON CLEAN POWER

Decarbonzing Power:
DG-Centric Narrative

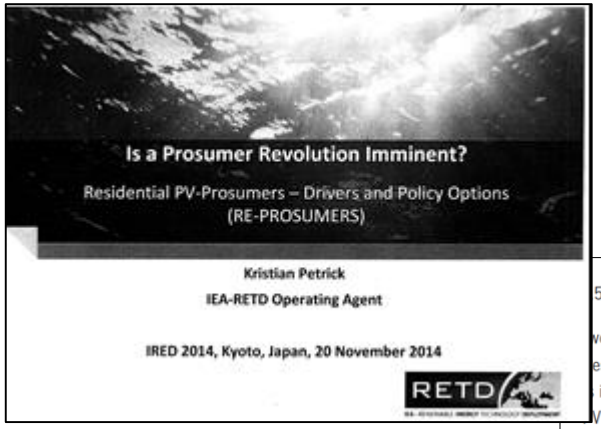
- Distributed resources are the most important element of electric decarbonization
  - Can scale rapidly – depends only on customer demand, which can be spurred via both public and private support
  - Inherently democratizes power generation
  - Personal connection to carbon solution and "energy independence"

- Working hard to equalize access to DERs
  - Grid alternatives – low income solar, house by house.
  - Solstice initiative – universal community solar. "Today, nearly 90MM American households cannot access solar power"
  - Yeloha Solar – Air BnB for residential roof space.
  - Many more initiatives and ideas

- In this narrative, grid "defection" is the ultimate good – freedom from utilities and the large grid that created the carbon problem in the first place. A clean, complete break.

- Economics of grid/utilities something between necessary impediment and an afterthought

The DG Narrative Rules!



B6 THE NEW YORK TIMES **BUSINESS** THURSDAY, MARCH 24, 2016

In Rural Midwest, Resistance to Wind Energy Power Lines

But opponents like Ms. Gatrel say that giant projects like the Grain Belt Express represent an outmoded, centralized approach to delivering energy. Just as it is healthier and more sustainable to eat foods close to where they are grown, the argument goes, so, too, should electricity be consumed closer to where it is produced.

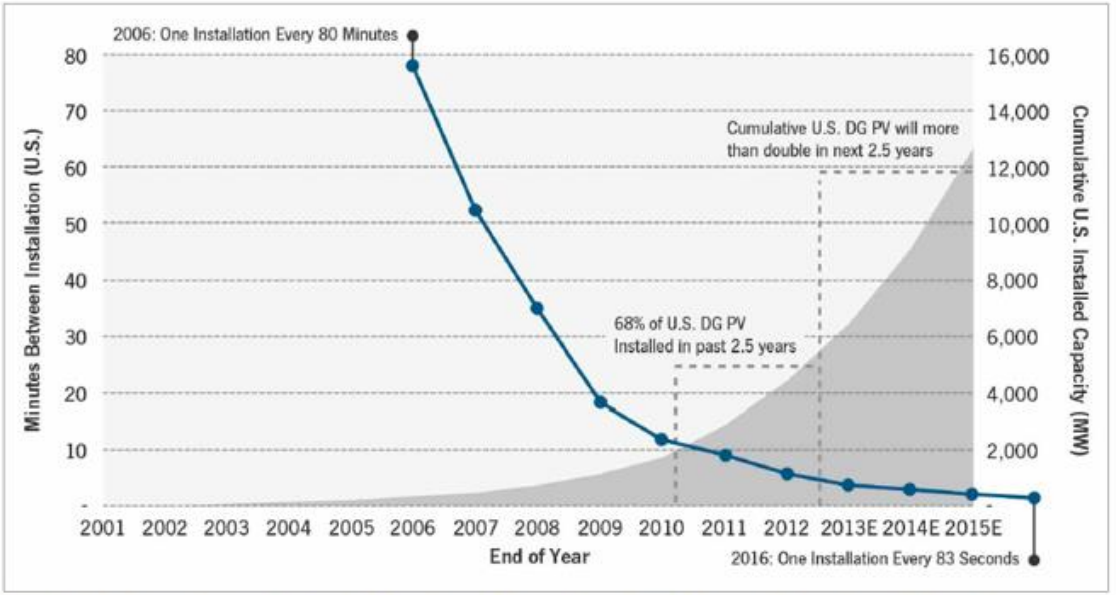
5.2 Market Driver 2: Decentralization Takes Center Stage

wo-thirds of all distributed PV in the U.S. have been deployed in the last 2.5 years alone, and GTM esearch forecasts another doubling in the next 2.5 years. The frequency of distributed PV deploym increasing rapidly, with one new installation expected every 83 seconds by 2016. By 2017, resid V will have doubled its share of total PV installations, increasing from 16% in 2011 to 29% in 2017. The following graphs depict these trends. On the heels of distributed PV will come other decentralized technologies, including storage, vehicle electrification and microgrids.

Back in March we had quite a discussion about NRG president and CEO David Crane's announcement that NRG will begin to offer rooftop solar systems to NRG's nearly 2.3 million retail customers. (See *Rooftop Solar, a Trend that Could Grow*). Crane opened a new line of dialogue in the industry (or a big can of worms). In his vision, centralized generation fades away to be replaced by distributed rooftop solar and maybe even gas-powered Stirling engine powered generators for back up and peak augmentation.

"Distributed vs. Centralized Generation: Battle of the CEOs," T&D World Magazine, July 2014.

FIGURE 1-7: DISTRIBUTED PV CUMULATIVE CAPACITY AND MINUTES BETWEEN INSTALLATIONS



"Utility Modernization in the Age of Distributed Generation," GTM Research, October 2013, p. 19.

Decarbonzing Power:
New Narrative

- DG is one of several essential parts of a low-carbon future. It is unquestionably essential, but it is not the only essential resource, nor is it the cornerstone.

- The solution is the combination of no-carbon resources that together:
  - Meet the under-450 ppm carbon budget and
  - Preserve reliability and
  - Preserve universal, equitable service; and
  - Do *all* of this at lowest realistic cost

- This solution portfolio is almost certainly a broad combination of demand and supply-side, large and small-scale resources integrated in a least-cost, highly flexible fashion

- Merely to realize full benefits of DG we need a highly flexible and robust grid

- Conclusion: If there is a cornerstone for this future, it is an advanced grid – not any one resource

- Implication: Business models and policies for creating an advanced grid are the key policy front.

- In these businesses and policy shifts, equity deserves more attention.

2. MORE ON THE NEW NARRATIVE

Decarbonzing Power:
How Much Supply and Grid Do we Need?

- Always do as much energy efficiency first as is feasible and cost-effective
  - Today electricity demand in developed world ~ flat
  - Decarbonized transport will raise power use 2020-80 by ~15% (U.S.)
  - Stronger EE policies and funding can bring use down further, sometimes negative
  - In developing world very large electric growth yet to occur

- Demand Response (DR) is also absolutely critical, but it provides capacity not energy

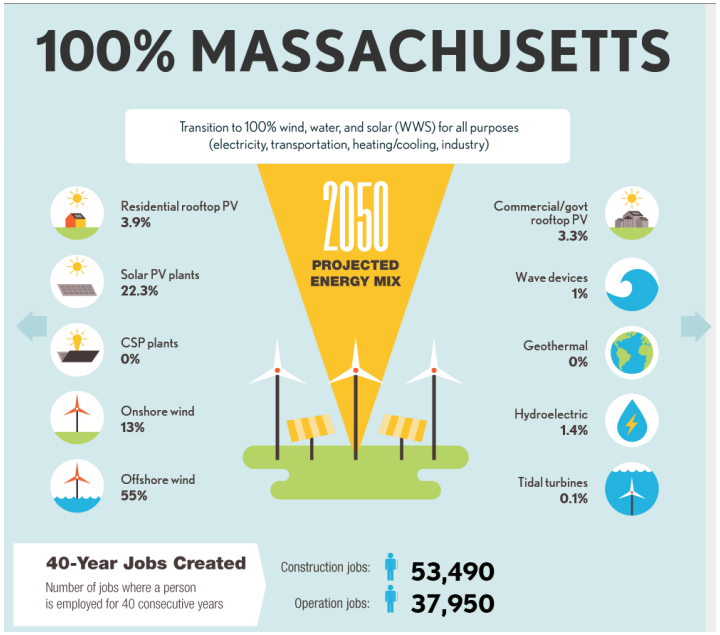
- Electrifying transport will require more – not less – capacity, storage, and grid

- Bottom line: The demand-side alone will not decarbonize us. We will need a total power supply [DG plus large-scale generation] roughly at current scale in developed world and ~5x in the developing world

Decarbonzing Power:
Much Vital DG Potential- But Much Large Power Too!

- Sunlight falling on cities has potential to supply ~25% of electricity used in the city – and then only if there is strong distribution grid

City	Maximum Local Solar Potential	Source
Seoul, Korea	30%	J. Byrne, *et al* (2015)
New York, NY	14-25%	NYISO and *NY Times* (2015)
Lisbon, Portugal	25%	T. Santos, *et al* (2014)
Boston, MA	24%	www.mapdwell.com & "Boston Community Energy Study," Boston Redevelopment Authority, 2016, p. 12.
Washington, DC	20%	www.energy.gov & www.mapdwell.com



"100% Renewable Energy," The Solutions Project, <http://thesolutionsproject.org>.

- Deep decarbonization studies uniformly assume 60% or more power from large sources, requiring both transmission and distribution. Example – Stanford Solutions Project for Massachusetts: 7% of energy from distributed solar in 2050. Reinventing fire transform scenario: ~30% rooftop PV

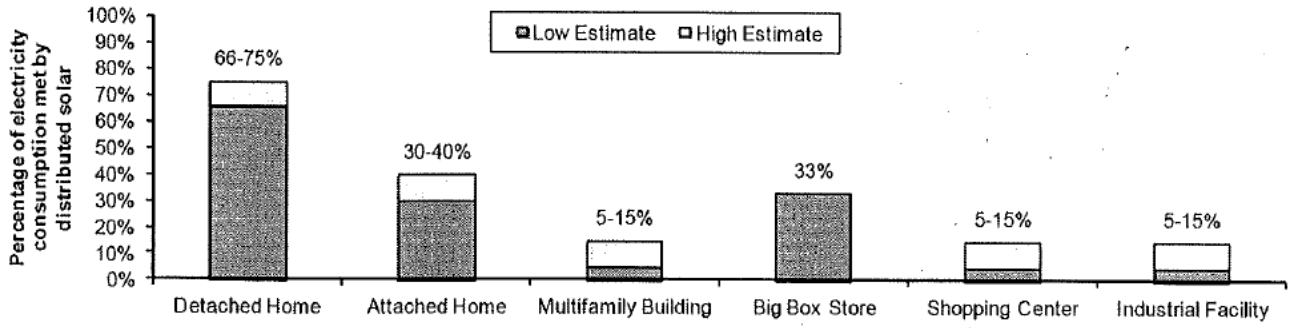
- Community solar is *fabulous*, but it requires just as much distribution grid as traditional power – sometimes more.

Urbanization and Urban Density Trends: Good for Lowering Energy and Carbon, But Necessitating Grid

- Global urbanized land could triple from 2000 to 2030[1]
- The 468 largest world cities will account for ~50% energy-related GHGs by 2030[2]
- Increasing density is critical for reducing urban GHG footprint but reduces roof-space per capita

Bernstein Research:

Distributed solar can supply only a small fraction of the electricity use of most buildings



"Solar Power & the Utility Death Spiral, or How I Learned to Stop Worrying and Love the Grid," Bernstein Energy & Power, July 2014, p. 6.

1 & 2. "New Climate Economy Report," Global Commission on Economy and Climate, 2014, p. 28.

Decarbonzing Power:
Realizing Full DG Potential Requires More, Not Less, Grid

- As more DG attaches to the distribution grid, more investment needed to make grid flex
  - Many more sensors and data processing
  - Larger (not smaller) cables and more protection circuitry
  - New control architecture and market platforms

- It is true that DG will enable reduced investments in some parts of the grid
  - PV inverters can supply reactive power
  - Some DG will be able to displace distribution capacity expansion
  - There are real savings here, but they are not unlimited

- In the near term, net investment for some utilities/grids may need to go UP not DOWN to speed DG deployment
  - Costs for infrastructure and markets tend to be lumpy and upfront
  - Essential that these investments be made cost-effectively, leveraging markets, etc.
  - Not easy and not small
  - All of this intensifies need for near-term distribution grid revenue

Decarbonzing Power:
Large Scale Grid – Side Note

Need: Estimates of transmission buildout in deep decarbonization studies

- Since 40-70% of no-carbon power will come via the large-scale grid, this grid will need some investment too.
  - With (say) 30% of power generated locally, will be some savings in transmission build…
  - But more transmission in sunny and windy regions; less to coal regions
  - Net investment is still probably positive -- transmission rates unlikely to decline;
  - Transmission/distribution interface is red-hot issue
  - Not focus of this presentation – very important – less worrisome

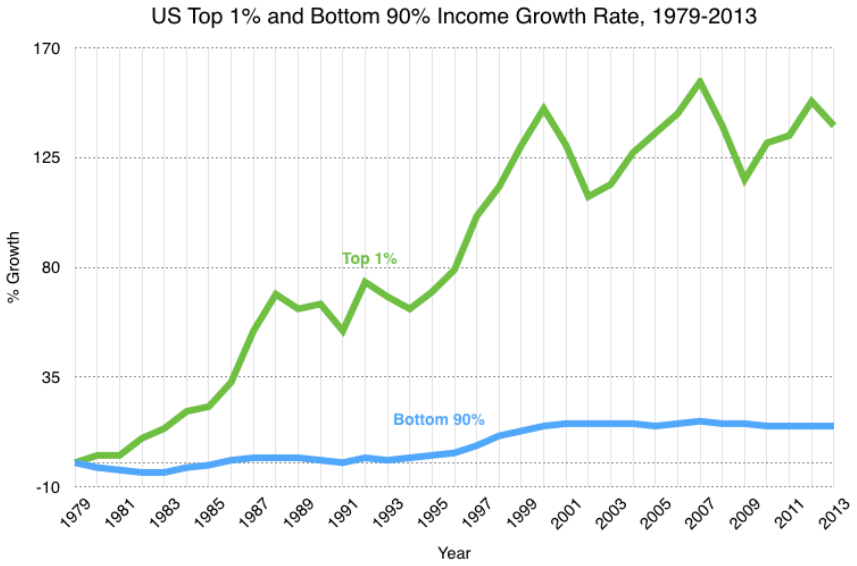
- IIASA's Global Energy Assessment projects grid investment, through 2050 at $310-$500bn/year, second only to renewables needed at $260-$1010 per year.[1] Prof. Mossoud Amin projects US grid investment at $20-$25bn/yr through 2040.[2] Reinventing Fire's Renew Scenarios has 81mm mw-miles of new transmission.[3]

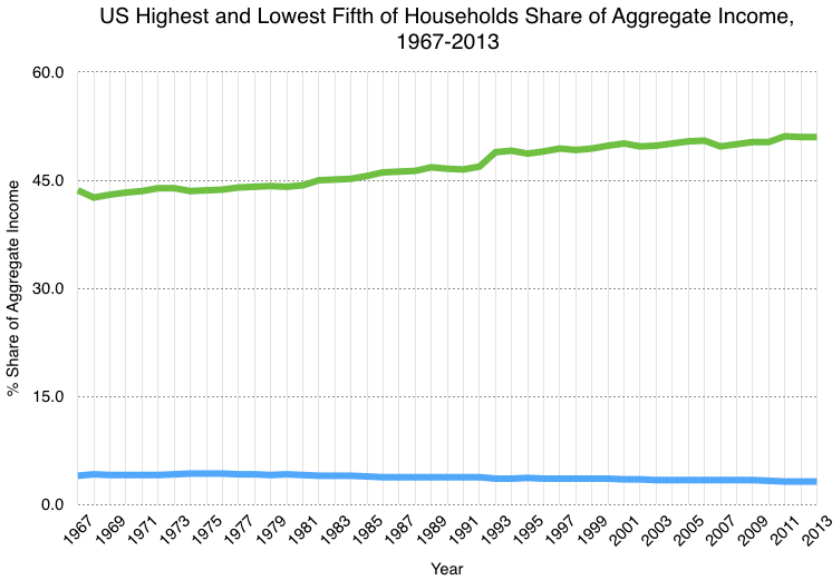
- However, large-scale grid investment is not our main focus in these slides – it is worth a separate discussion

1. IIASA Global Energy Assessment, 2012, p. 91.
2. M. Amin, Public Utilities Forthightly, March 2015, p. 32.
3. http://www.rmi.org/RFGraph-2050_installed_capacity_by_case

3. FUNDING THE DISTRIBUTION GRID EQUITABLY

Decarbonzing Power:
Income inequality in US and Europe



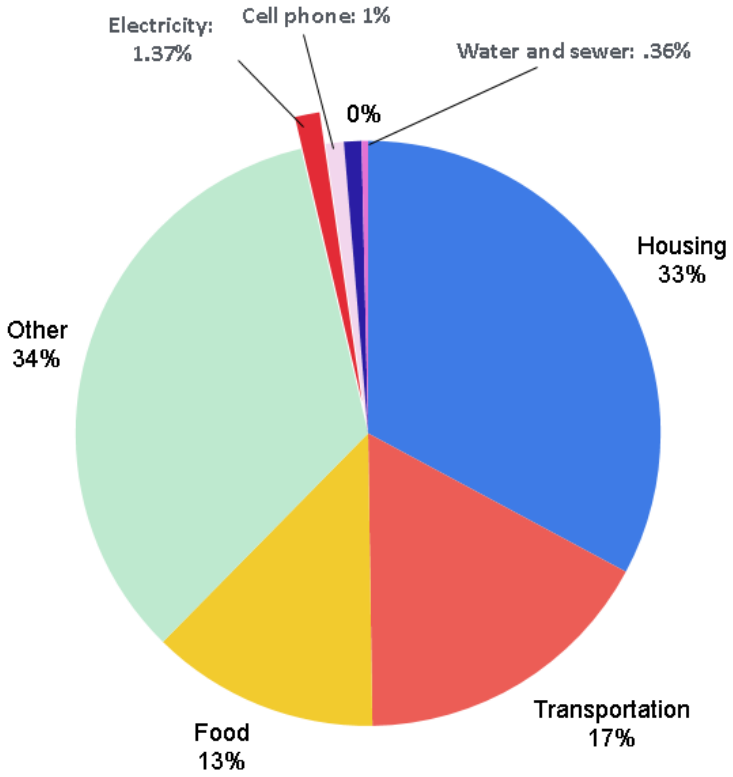


- Clean energy transformation must make this better, not worse

Decarbonzing Power:
Good and Bad News

- The good news: Electricity requires only ~1% of the average consumer's consumption budget
- The bad news: As of 2011, 45% of U.S. residents live in households that "lack sufficient income to pay for basic necessities."[1]
- In the U.S., the bottom 60% of families use ~30% of total electric sales.[2]

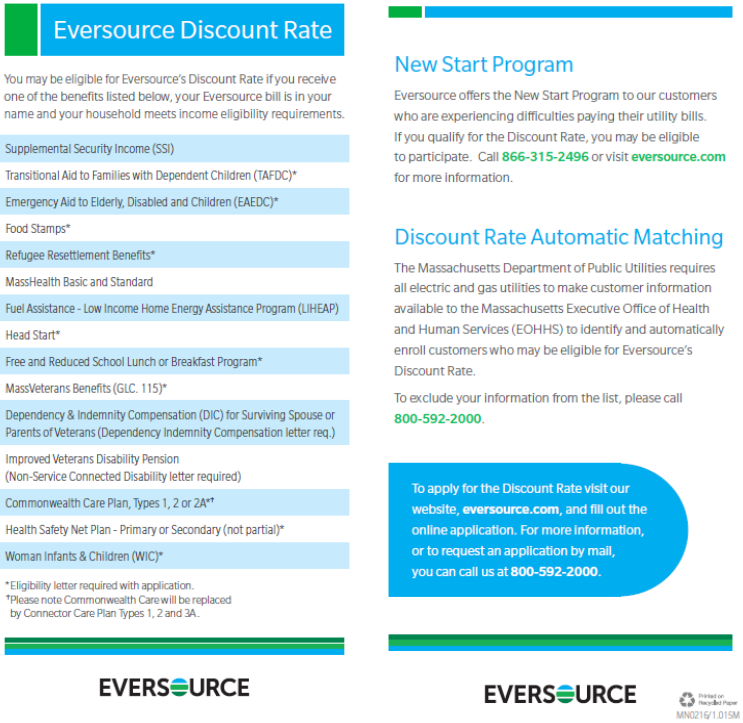
US Consumer Expenditure by Type:



1. Wood, et al, Recovery of Utility Fixed Costs, LBNL Future Electric Utility Regulation Series No. 5, DRAFT 3/9/16, p. 27.
2. Jacobson, Milman and Kammer, Energy Policy 33 (2005) p. 1827.

Decarbonzing Power:
The Electric Grid: A Rare, Successful Single-Payer U.S. System

- Only one distribution grid in any community. Everyone must take service and pay.
- Regulated and priced to ensure universal service
- As with universal health insurance, the wealthy and the healthy contribute to ensure access and lower costs for the less-wealthy/more needy



Eversource Discount Rate

You may be eligible for Eversource's Discount Rate if you receive one of the benefits listed below, your Eversource bill is in your name and your household meets income eligibility requirements.

- Supplemental Security Income (SSI)
- Transitional Aid to Families with Dependent Children (TAFDC)*
- Emergency Aid to Elderly, Disabled and Children (EAEDC)*
- Food Stamps*
- Refugee Resettlement Benefits*
- MassHealth Basic and Standard
- Fuel Assistance - Low Income Home Energy Assistance Program (LIHEAP)
- Head Start*
- Free and Reduced School Lunch or Breakfast Program*
- MassVeterans Benefits (GLC. 115)*
- Dependency & Indemnity Compensation (DIC) for Surviving Spouse or Parents of Veterans (Dependency Indemnity Compensation letter req.)
- Improved Veterans Disability Pension (Non-Service Connected Disability letter required)
- Commonwealth Care Plan, Types 1, 2 or 2A*†
- Health Safety Net Plan - Primary or Secondary (not partial)*
- Woman Infants & Children (WIC)*

*Eligibility letter required with application.
†Please note Commonwealth Care will be replaced by Connector Care Plan Types 1, 2 and 3A.

EVERSOURCE

New Start Program

Eversource offers the New Start Program to our customers who are experiencing difficulties paying their utility bills. If you qualify for the Discount Rate, you may be eligible to participate. Call **866-315-2496** or visit **eversource.com** for more information.

Discount Rate Automatic Matching

The Massachusetts Department of Public Utilities requires all electric and gas utilities to make customer information available to the Massachusetts Executive Office of Health and Human Services (EOHHS) to identify and automatically enroll customers who may be eligible for Eversource's Discount Rate.

To exclude your information from the list, please call **800-592-2000**.

To apply for the Discount Rate visit our website, **eversource.com**, and fill out the online application. For more information, or to request an application by mail, you can call us at **800-592-2000**.

EVERSOURCE

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"Eversource Discount Rate," Eversource, <https://www.eversource.com/Content/docs/default-source/bill-inserts/MA/2016-02-ema-discount-rate.pdf?sfvrsn=0>.

How Utilities and their Regulators React to Underfunding

1. Lower profits, which then almost always leads to:

2. Reduced investment, especially in new capabilities

3. Reduced Energy Efficiency spending

4. Raising Rates, often for the Least Vocal and Least Powerful Customer Groups

Higher rates create a “death spiral”, but grid owners/operators cannot die. Instead, you just repeat steps 1-4 above.

From Standpoint of Grid Equity, Grid Defection is Not A Positive

- Very few customers will completely unhook from the grid, but many will use it less (some will appear or claim to sue it less but won't – different issue).

- Complete grid defection is the equivalent of stopping your property tax payments while you send your child to private schools

- Both leaving and reducing use of the local grid raise this question: What is the most equitable and effective way to fund the grid?

4. OPTIONS AND DIRECTIONS FOR EQUITABLE AND EFFECTIVE GRID FUNDING

Reform Grid Pricing Significantly

- Disaggregate the grid into the services it provides
- Set a regulated price for each service
- Involve markets, but they cannot replace regulated prices and fairness judgements
- The battle over Net Energy Metering is only the beginning -- enormous complexity in grid ratemaking is coming forward

> "If utilities are to use their infrastructure as insurance, they will need to change the way they charge customers. A health insurance company's business model, for example, is based on healthy people financing treatments for ill people. . . . Utilities could offer memberships, or stream services like the internet network Netflix, where customers pay a fixed amount. Or energy providers could offer contracts of service for electricity 'on demand', which would be more expensive, as 'as available', based on solar or other intermittent renewable generation . . . "*

* "Transformation of the Electricity Sector," Oxford Energy Forum, Issue 104, February 2016, p. 6.

Finance the Grid with Other Revenue Sources

- Allow whomever owns the grid to pay for it by selling things other than grid services
- NY REV proceeding is considering this

> "… Staff recommends a combination of financial incentives that consist of new MBEs opportunities, practical adjustments to conventional ratemaking methods, and concrete targets with new positive-only, symmetrical, and bidirectional earnings impacts… New MBEs can come in several forms. In addition to their conventional functions, utilities in the role of platform providers will be able to earn revenues from various value-added services provided to market participants, for example, micro-grid engineering."*
>
> * "Staff White Paper on Ratemaking and Utility Business Models," State of New York Department of Public Service, July 2015, p. 28.

- May include public funding from sources such as cap-and-trade auctions, public-private partnerships, and others
- If the death spiral gets severe, we could see public takeovers of distribution companies – but this will not *in itself* solve revenue problems and could make them worse

What Am I **Not** Saying

- **NO** – DG isn't essential, and shouldn't grow
  - It is essential
  - It will grow very fast
  - It does provide unique customer value

- **NO** – Utilities deserve a blank check or a bailout

- **NO** – Utilities can't integrate DERs on their system for reliability or technical reasons

- **NO** – Utilities can't integrate DERs due to revenue loss

- **NO** – We will always have the same utility owner-operators of the grid

What I Am Saying

- We are tending to view the rate of growth of DG solar as the bellwether of clean power transformation
- This is too narrow a view
- The objective is a clean end-to-end grid that preserves equitable access
- Efforts to bring rooftop solar to low-income customers are great, but do not address need for systemic change
- We need greater focus on new grid business/revenue models with improved economic equity.