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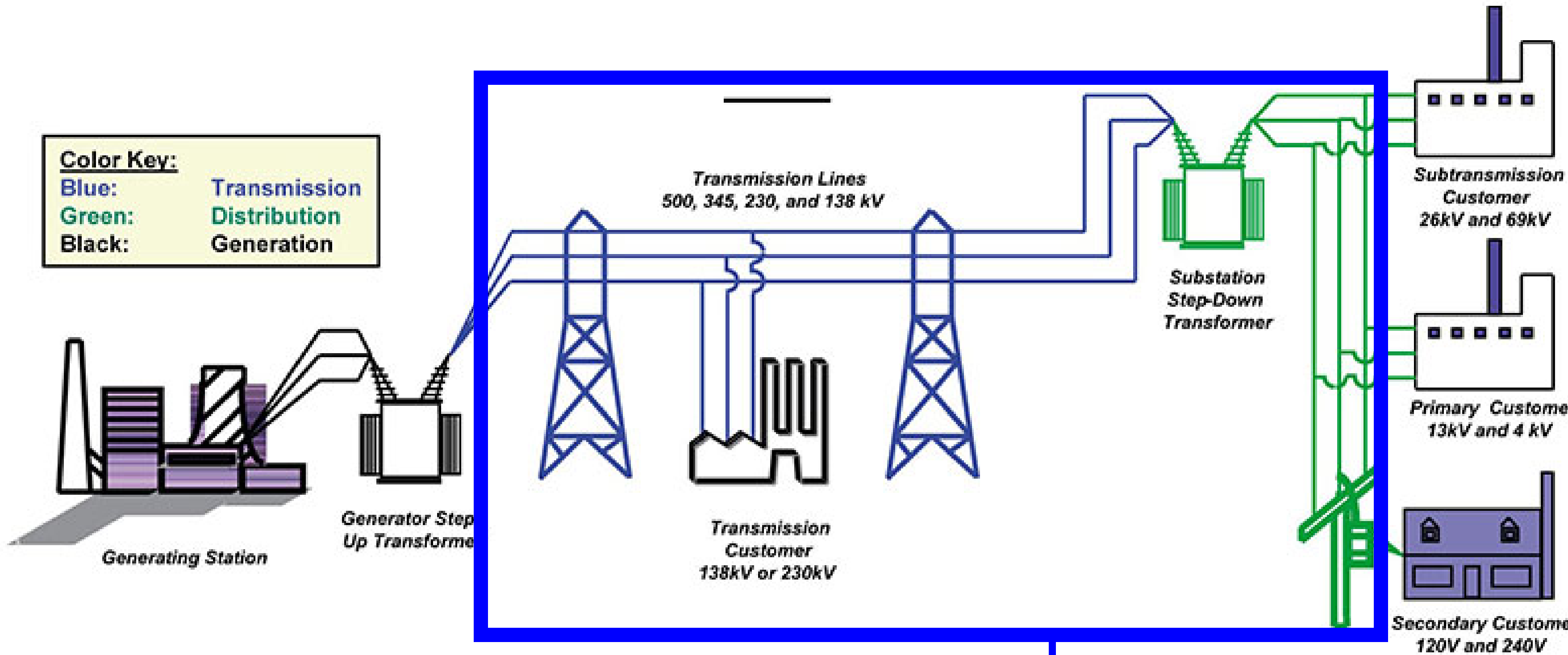
- **mitigate and adapt to climate change**

VULNERABILITY OF THE ELECTRIC POWER GRID



Generation

Transmission | **Distribution**

Usually unscathed,
except for nuclear reactors,
(require power to cool fuel
even when "shut down")

Most vulnerable to storms
and other disruptions
(also the most expensive)

Power outages hurt the economy

How can we attract and keep high-tech business if we have a vulnerable power supply?

In 2016, there were 3,879 US power outages 48 minutes or longer

- # of outages up 9%; # of people affected up 26% -- in 1 year
- monetary damage, per business, per event, $9,055 - $165,482
- monetary damage from power outages, surges, spikes >$150 billion for year
- average cost of a data center outage in $740,357, up 38% from 2010
- estimated average cost of a network outage: >$9,000 per minute
- estimated average cost per Mainer, per year $461

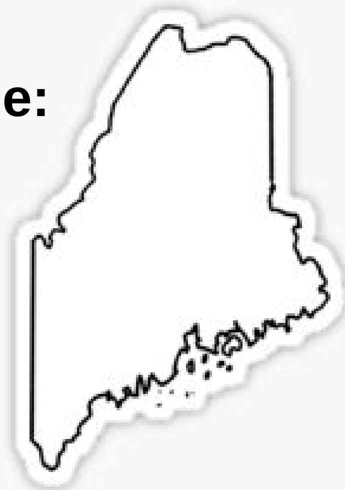
Causes	# of outages
• Natural disasters and trees falling on wires	1,279
• Faulty equipment	925
• Vehicle accidents	483
• Animals	169
• Unknown reasons	848

Data source: Eaton Corp.'s new Blackout Tracker Annual Report:

(Pg.3-4.)

Stanford University/ UC-Berkeley plan for 2050s Maine:

Maine can create over 13,000 permanent jobs,
reduce energy demand by 33% and
reduce average electricity cost by 31%



With

- an electric grid composed of smart microgrids, serving all sectors:
- power demand fully met by renewable energy:

- transition from burning fuels to electricity – in all sectors – alone will result in a 33% reduction in energy demand

- status quo: Maine's 2050 average projected energy costs: 16.7 ¢/kWh
  with transition implemented: 11.4 ¢/kWh

- annual savings per person, health & climate cost savings included: $8,912

- ***the plan would pay for itself in as little as 7 years***

https://energy.stanford.edu/news/stanford-scientist-unveils-50-state-plan-transform-us-energy-use-renewable-resources

Green Mountain Power's Stafford Hill solar farm and microgrid, Rutland, VT

- **Reduced energy costs $200,000 in the first year from energy arbitrage**
- 2.5 MW from 7,700 solar panels can power 2,000 homes
- 4 MW of battery storage levels peak and increases resiliency
- **Costs: $5.77 million, (including $4.2 million for storage) + $30,000 annual lease**
- **Revenues: generated energy value, capacity payments, renewable energy credits**
- Savings: lower Regional Network Service charges, energy arbitrage, lower transmission and ancillary services charges
- **Result: reduced cost from 18.7 ¢/kWh 17.1 ¢/kWh (25 year levelized cost)**

Powers Rutland High School as an emergency shelter when islanded from the grid

(Pg.5-6.)

Community microgrids are on line or in development

in Alaska,
California,
Maryland,
Massachusetts,
New York,
Pennsylvania,
Vermont
(not to mention Germany and Japan -- and their utilities. And several developing nations in Sub-Saharan Africa)

All

- **are self-contained power systems *confined to a small geographic area*.**
  - **with one or more power sources,**
  - **some means to store energy, such as batteries.**
- **serve one or more nearby buildings, connected by dedicated wires**
- **are operated by an intelligent energy management system**
- **minimize electric bills, by**
  - **enhancing grid stability and resiliency**
  - **demand management**
  - **shaving daily, monthly and annual demand-peaks**
  - **frequency reguilation**
  - **momentary disturbance avoidance**
- **power designated emergency loads when islanded from the power grid**

Energy storage is the key

- Reduces the cost of electricity
- Increases overall efficiency
- It is scalable; can be integrated across systems
- Permits stacked services, hybridization

Market availability of storage is driven by

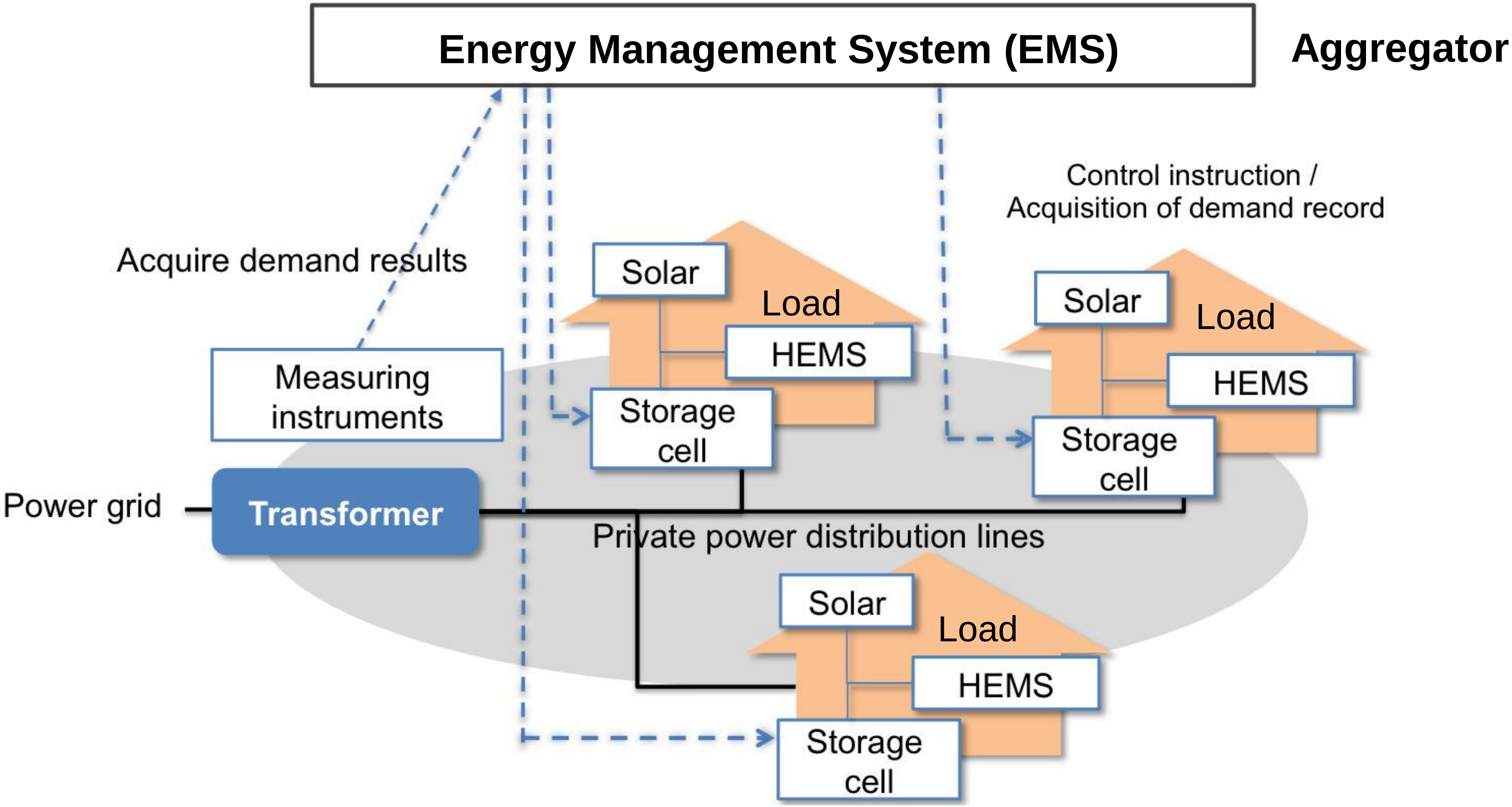
- Renewable energy growth (at expense of peaking plants)
- Distributed power generation growth
- **Declining prices:**

  2008 to 2015, cost of storage batteries dropped by 73%
  expected to drop by another 76% by 2050

Distributed renewable power generation with energy storage has already attained cost-parity with centrally generated power in a majority of markets and costs keep dropping

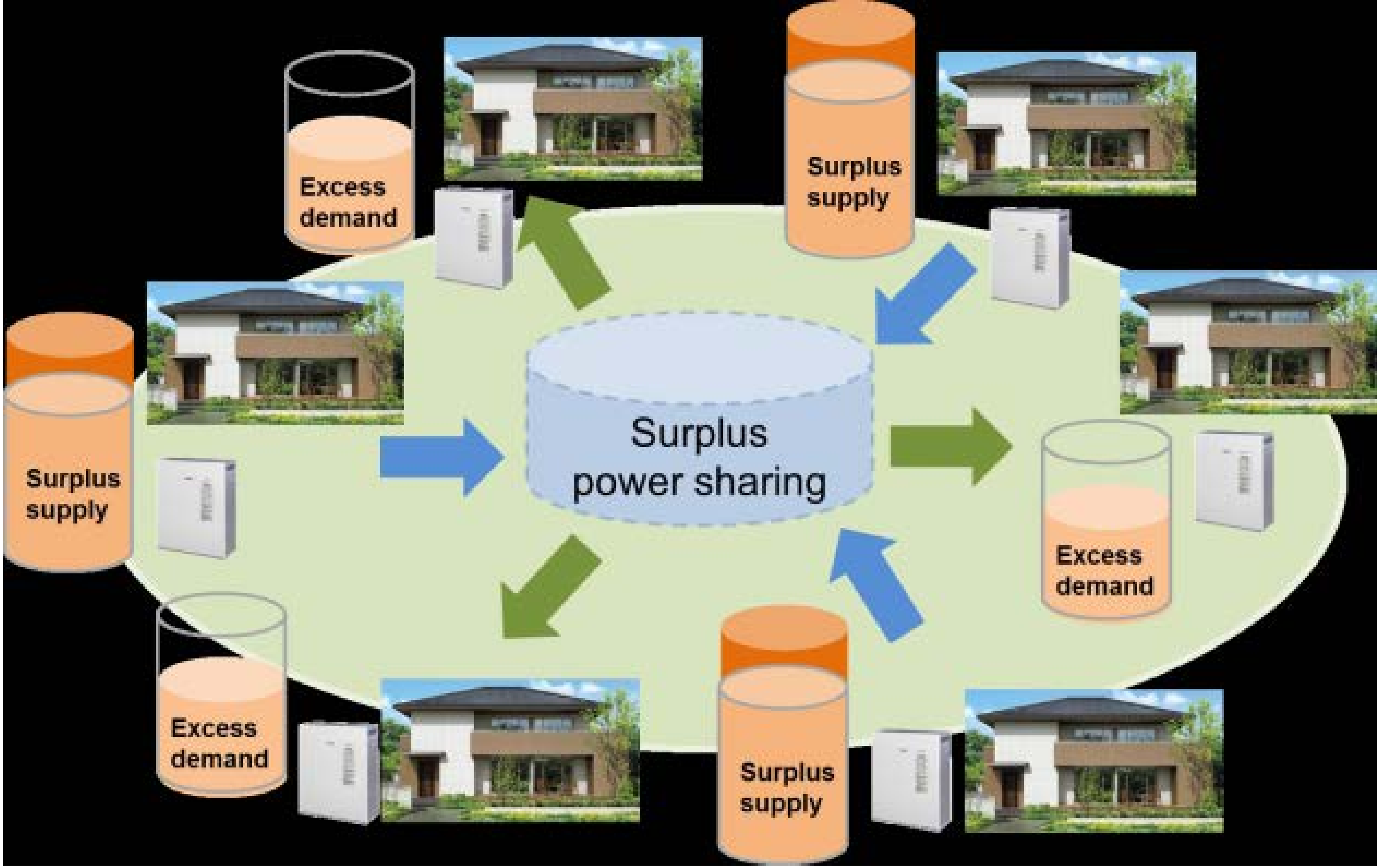
Storage mainlines solar and wind power

Community microgrid



Houses and buildings are building blocks of a community microgrid
So are energy management systems and battery storage

(Pg.14-17.)



Surplus Power Sharing within the micropgrid

- **80% of the community's energy needs are met from within the microgrid**
- **reducing household electric bills by 20%,**

Courtesy Smart City Shioashiya Solar Shima

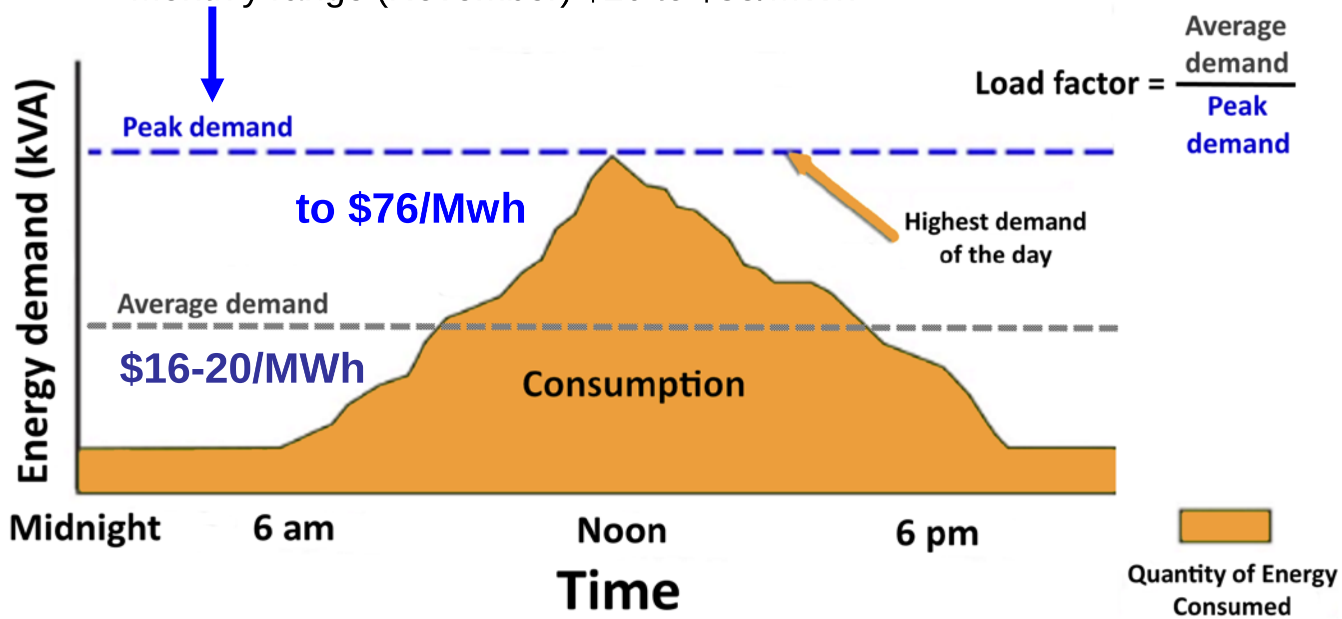
(Pg. 18-19.)

The economic potential of microgrids

- Inherent cost savings
- Job creation
- Business-ready power supply
- Conversion off imported fuels

Peak vs off-peak cost of electric power

Wholesale cost, (ISONE)
Yearly range: $16 **to $76/Mwh**
Monthly range (November) $20 to $35/MWh



(Pg. 8-10.)

Job creation potential in the US energy sector

2006 and 2016 -- generation by coal down 53%
generation by natural gas up 33%
generation by Solar up 5,000%

In 2016 alone,

- **solar** employment increased 25%, adding 73,000 new jobs to the economy,
- **wind** energy employment increased 32%
- jobs in **energy efficiency** increased by 133,000
  - ***added 300,000 net new jobs, 14% of the entire US job growth***

Of 6.4 million total energy industry employment

Solar employees	***374,000***	***→ 43% of all new energy jobs***
Up in 2016 by 25%	***74,000***	
Expected in 2017: 7%	*20,700*	
Wind power employees	***102,000***	
Up in 2016 by 32%		
Energy efficiency, new jobs	***133,000***	
Fossil fuel employees	**187,117**	**→ 22% of all energy jobs**
Oil	12,840	
Coal	86,035	
Natural gas	82,125	

U.S. Energy and Employment Report
US DOE, January 2017

(Pg. 20.)

The most significant barriers in the way of microgrids in Maine

regulatory (designed to uphold the central generation utility model)

- statutory and regulatory definitions could classify some microgrids as "public utilities;"
- laws prohibit microgrid developers, even municipalities, from running private lines over or under public ways
- regulated utilities are not required to make available their local distribution lines to microgrids at a reasonable cost
- outdated regulatory environment recognizes as actors in the electric power market only
  Central power generators
  Power distributors (the transmission network) and
  Consumers of electric power
  not Community Microgrids
- local ordinance may prohibit energy generation everywhere but in an industrial zone (except for solar rooftops)

* **Under Maine's utility regulations, electric utilities are locked-in to operate under a 19th century business model, in spite of a fast-changing 21st century power market**

- ultimately undermining grid security and resiliency and,
- hurting the utilities long term interest *)

EXPERTS:

Morningstar Investments, NRDC and EEI *see state regulators as key* to keeping utilities viable, as distributed energy advances in the marketplace

Regulators should rethink the way utilities recover costs:

- Utilities should ***not*** be in the commodity business, dependent on growth in electricity use.
- S**hould focus, instead, on service businesses that earn their profits by maintaining and improving the electricity grid**
- Utilities should be paid a "reasonable cost-based" payment by distributed generators for the use of their wires
- Conversely, utilities should fairly compensate distributed generators for their power
- Utilities that figure out how to extract value from distributed energy will prosper. E.g.: NRG Energy, Edison International, Green Mountain Power

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**)See, in 2014, IEE's"Death Spiral" report; EE/NRCM joint report & Morningstar Investment advisors's industry analysis – Overview: https://microgridknowledge.com/think-utility-death-spiral-hogwash-think/*

For LD-257, (128th Maine Legislature), consider:

NRDC/EEI strategy brief's recommendations, that regulators

- develop rate designs that reward customers for using electricity more efficiently, via real-time pricing and variable demand charges that take advantage of digital meters

- expand utility earnings opportunities through performance-based incentives tied to energy efficiency, clean energy generation, and grid improvements

- ensure that energy efficiency services reach underserved populations

- ensure that electricity users take advantage of all cost-effective energy efficiency measures

- support reasonable utility investment in smart meters, energy storage and smart microgrids

Possible model: New York's *Reforming the Energy Vision* (REV) policy
http://www3.dps.ny.gov/W/PSCWeb.nsf/All/CC4F2EFA3A23551585257DEA007DCFE2?OpenDocument

(Pg. 24.)

LD-257, (128th Maine Legislature) should ENABLE community microgrids:

require regulators to

- encourage distribution utilities, in partnership with communities, to generate solar power as part of islandable microgrids
- enable distribution utilities to significantly benefit from energy storage and microgrid investments
- allow the installation of private wiring across public rights of way for the exclusive purpose of connecting components of islandable community microgrids
- allow islandable community microgrids to be established and operated as a new class of power consumers, i.e., without in any way classifying or treating them as electric utilities

encourage and incentivize local governments

- to enact zoning regulations that encourage distributed renewable and very low carbon power generation
- to establish residential and commercial microgrids powered by renewable or very low carbon energy sources – solar, wind, small hydro, biomass, hydrogen fuel cells, and combined heat and power (CHP) systems powered by any of the above; in combination with appropriate energy storage.

(Pg. 24-25.)

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