



Future of the Electric Grid

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Distributed Energy Resources Roadmap Workshop

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Roles of the NYISO

Reliable operation of the bulk electricity grid

- *Managing the flow of power on 11,000 circuit-miles of transmission lines from hundreds of generating units*

Administration of open and competitive wholesale electricity markets

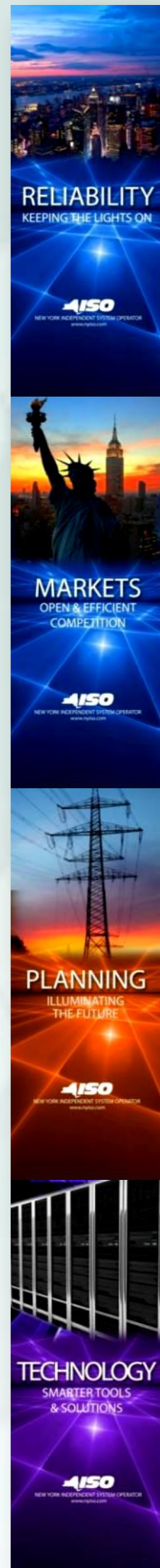
- *Bringing together buyers and sellers of energy and related products and services*

Planning for New York's energy future

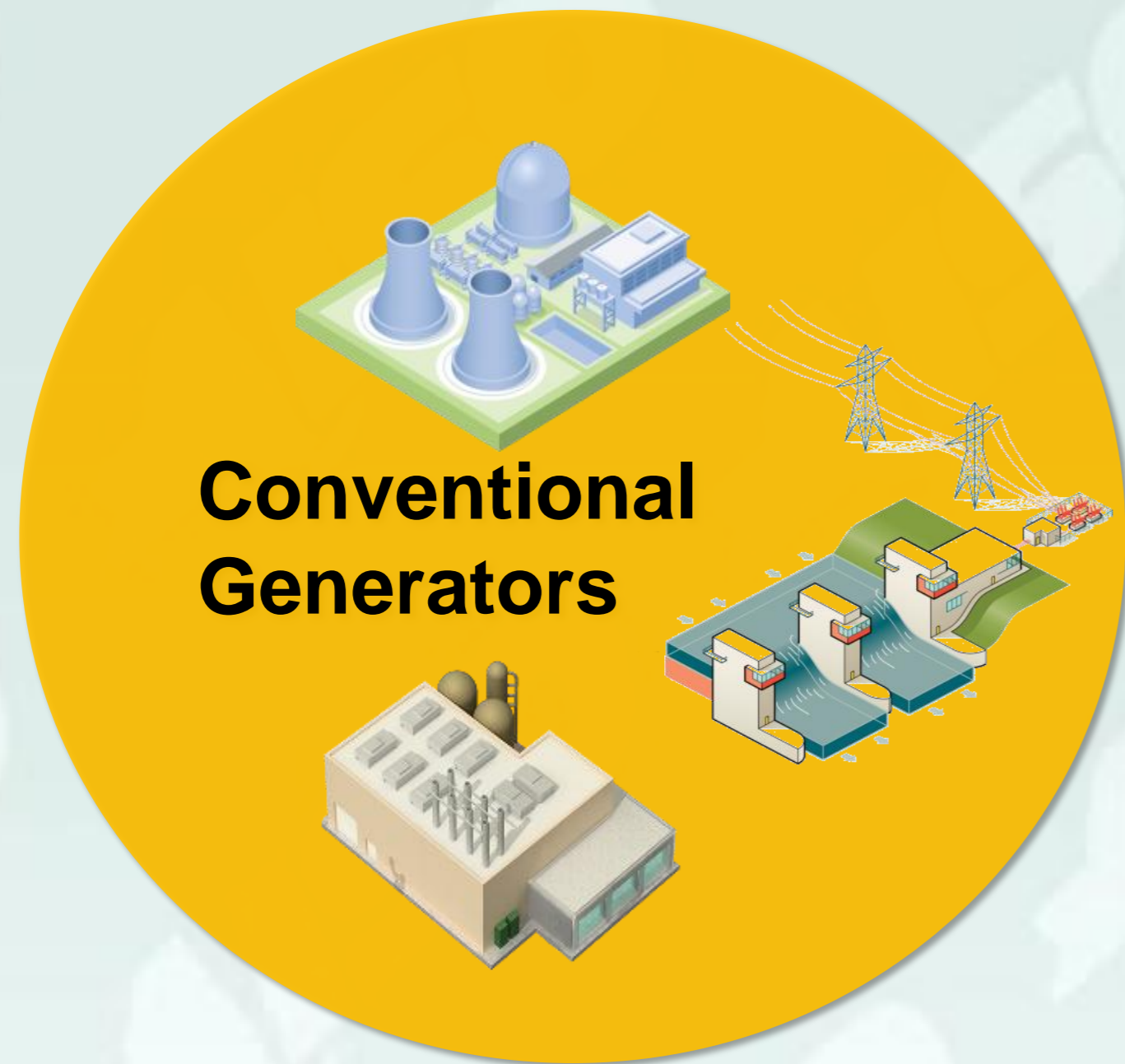
- *Assessing needs over a 10-year horizon and evaluating projects proposed to meet those needs*

Advancing the technological infrastructure of the electric system

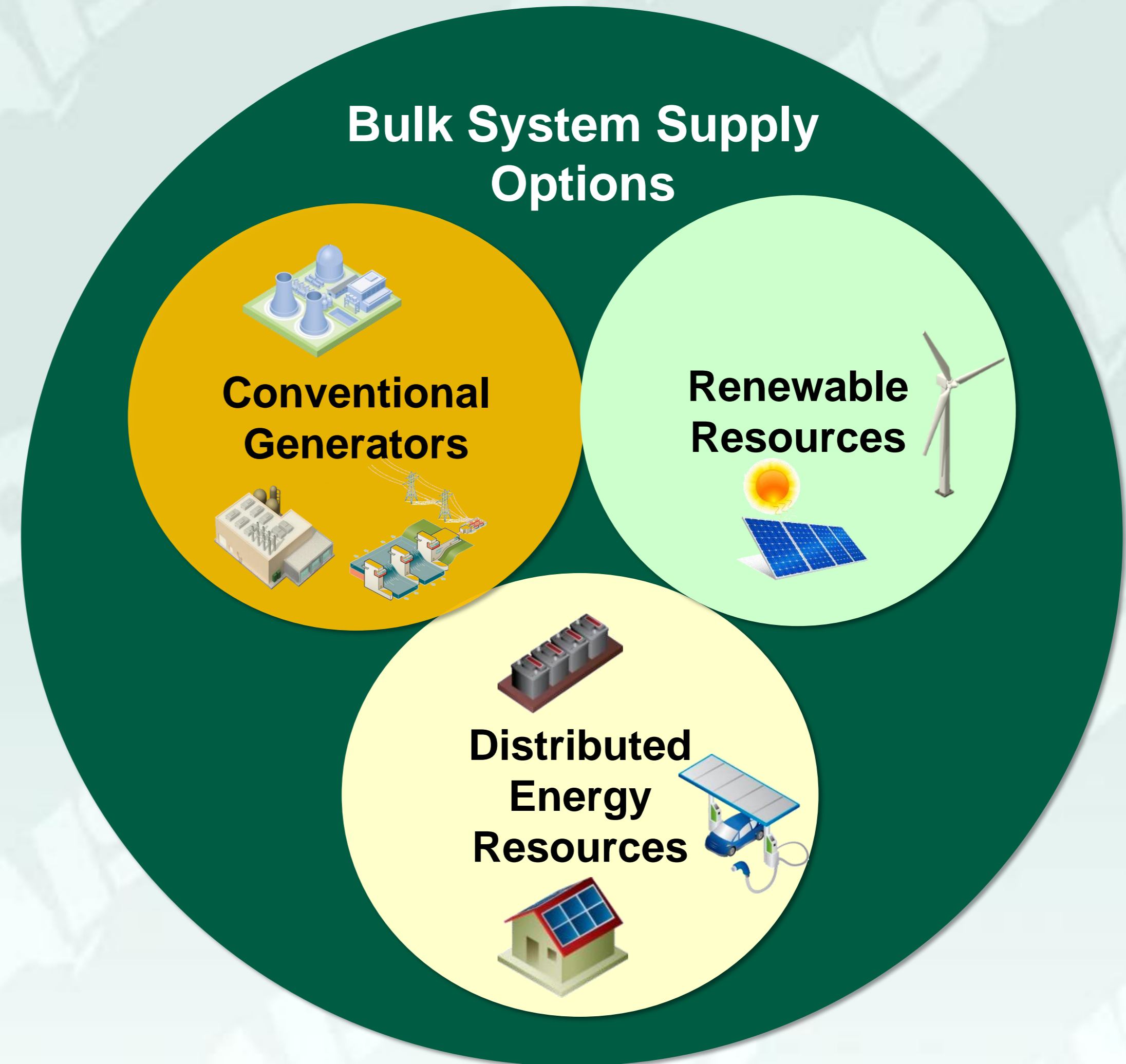
- *Developing and deploying information technology and tools to make the grid smarter*



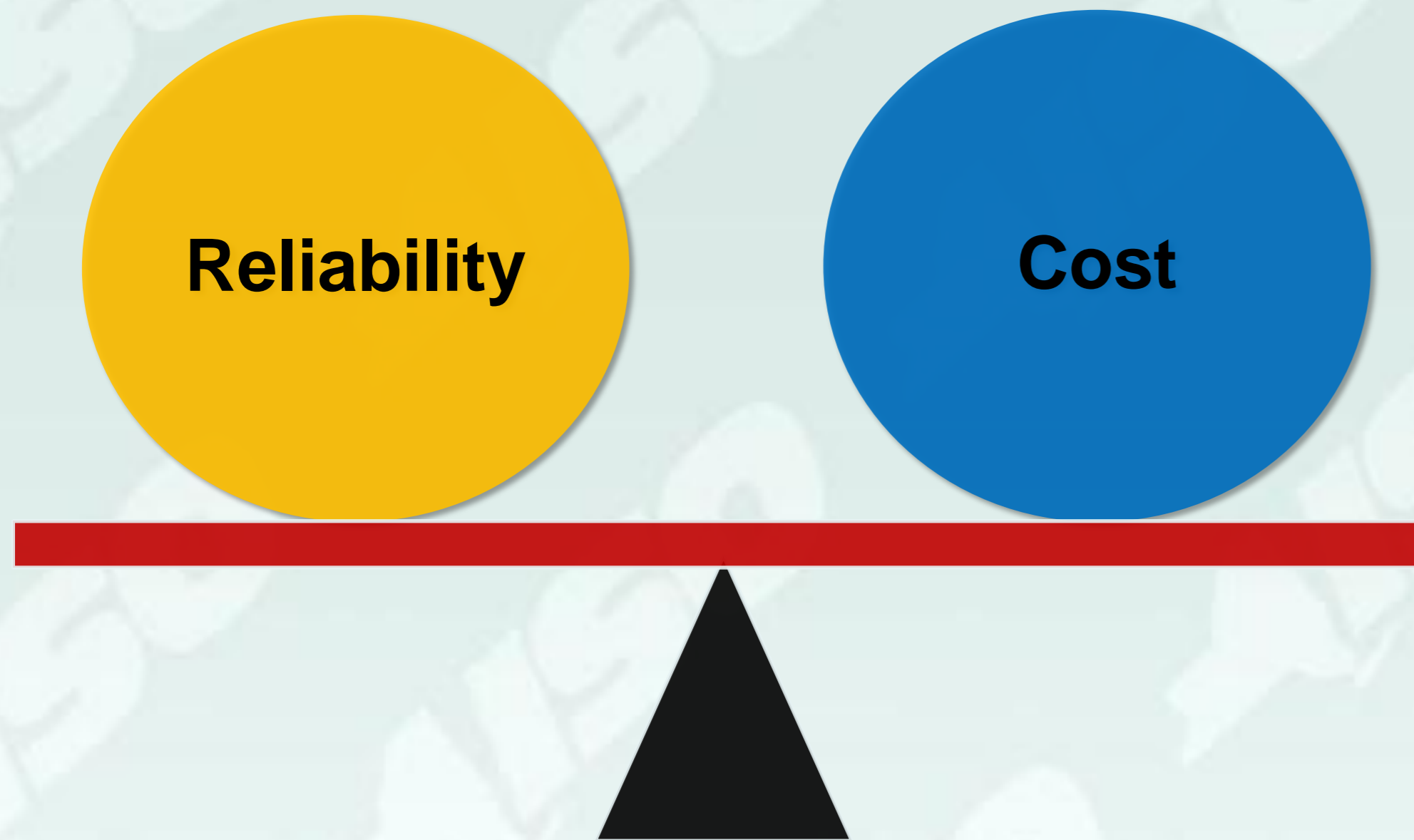
Yesterday's Energy Sources



Tomorrow's Energy Sources



Yesterday's Operating Principles



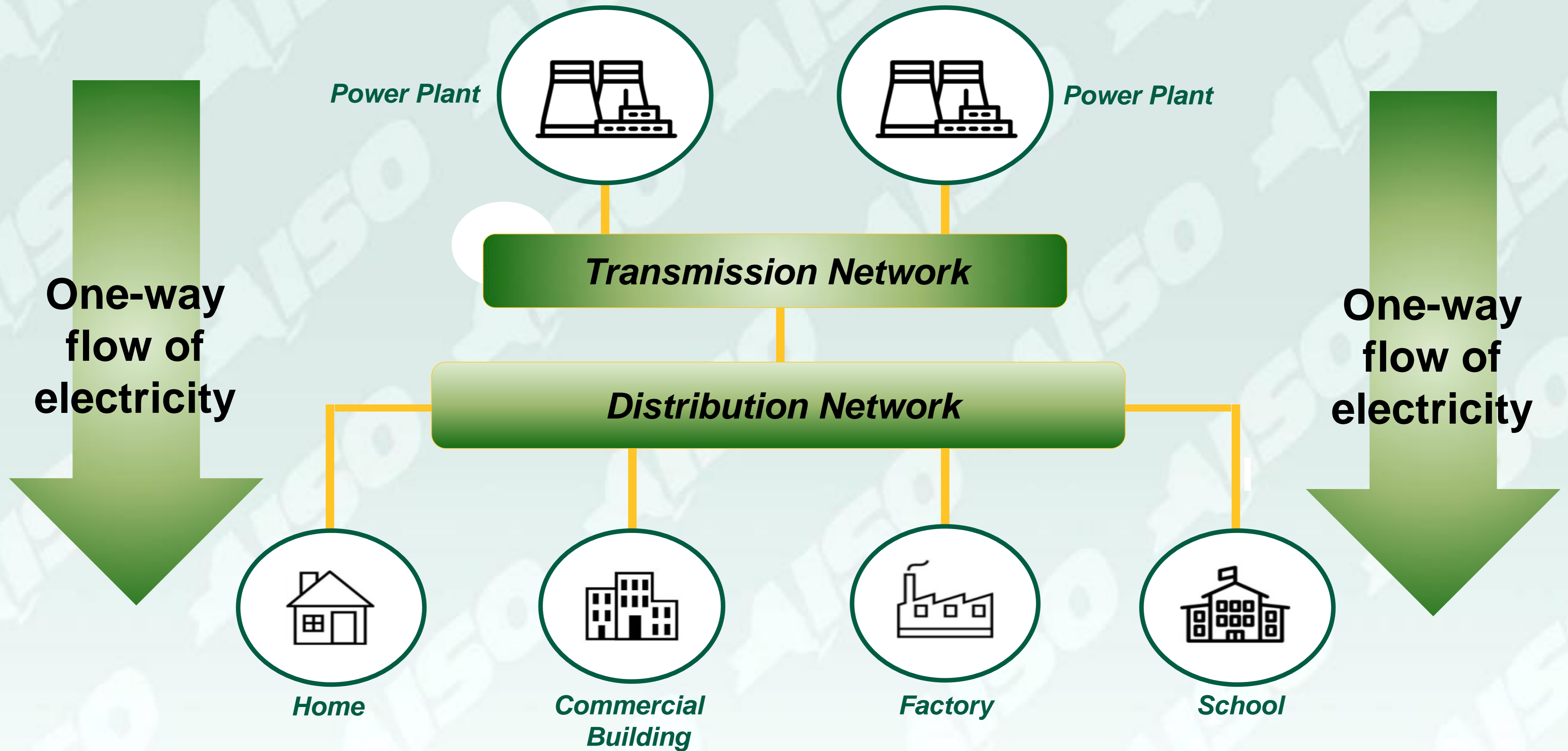
- Focus on reliability and cost
- Environmental considerations secondary

Tomorrow's Operating Principles

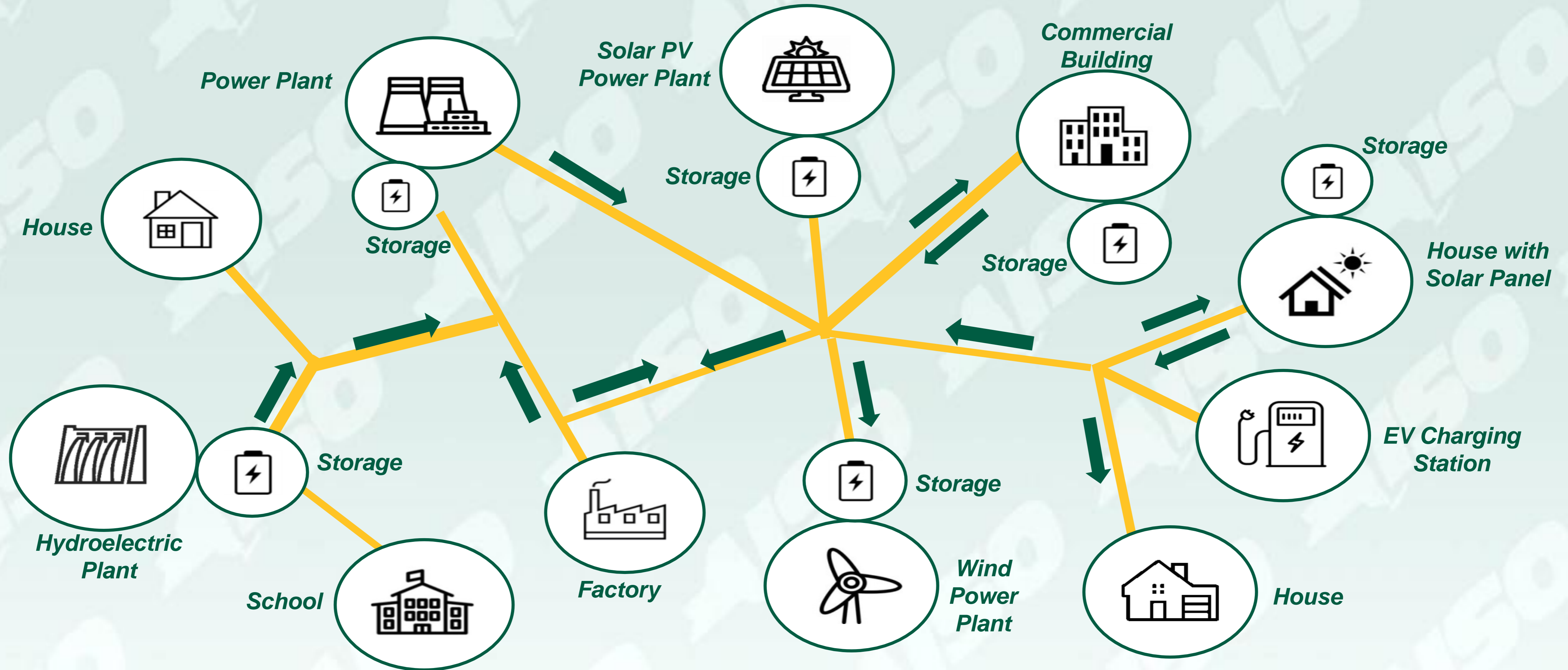


- Integrating policy into market structures
- Valuing and monetizing externalities

Today



Tomorrow



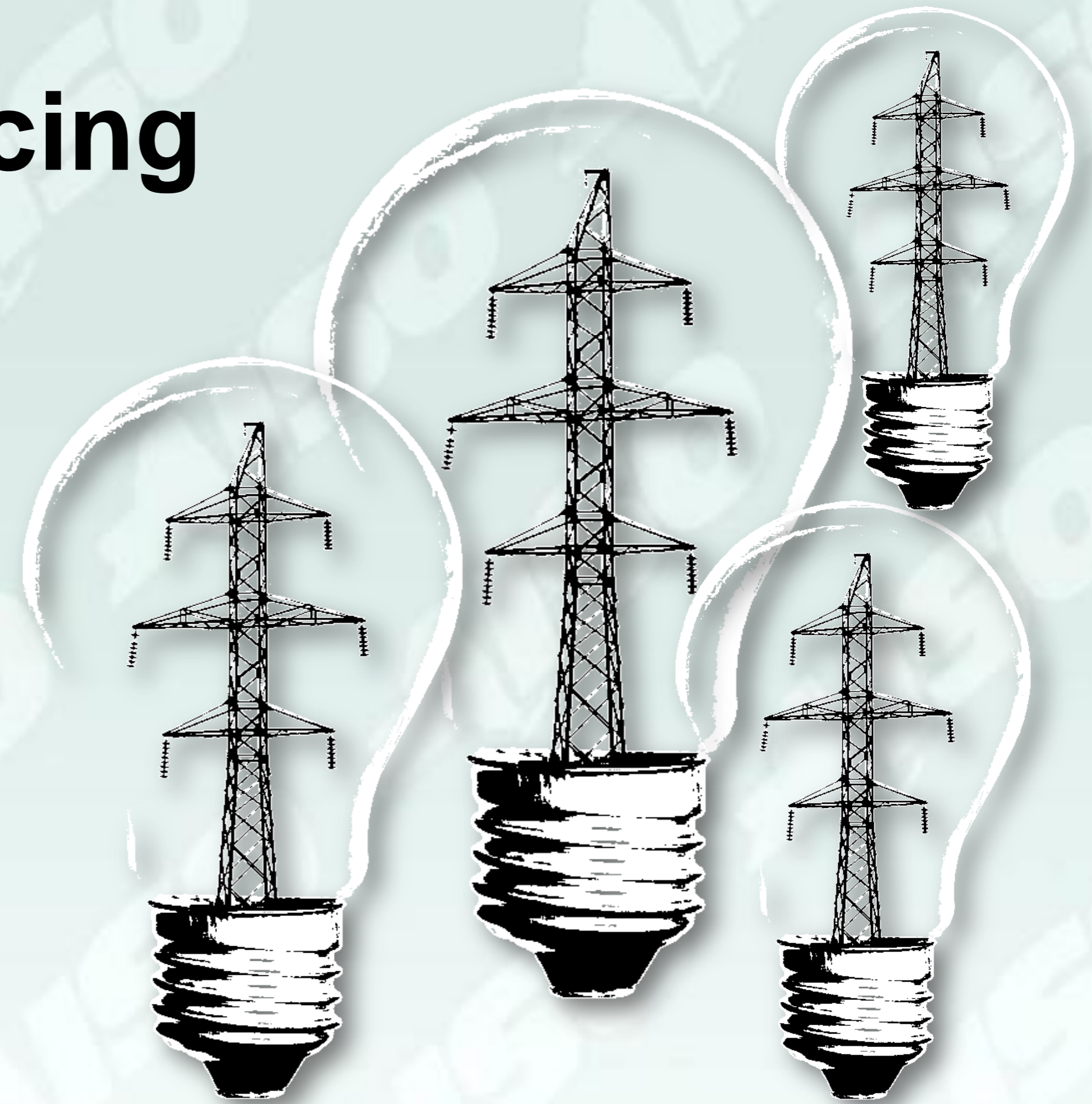
Bi-directional flow of electricity

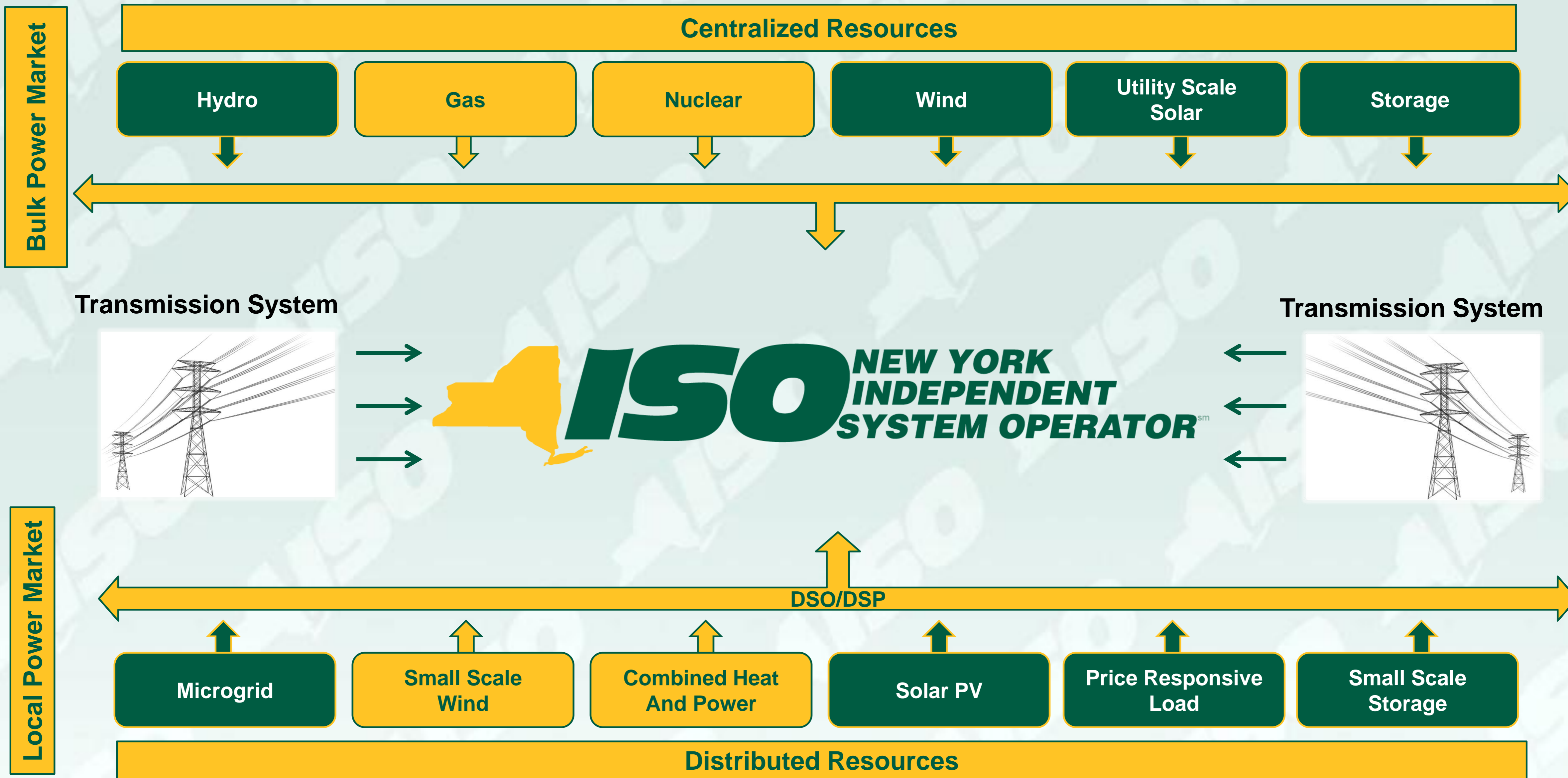
Value of Integration

Optimize:

**An integrated system balancing
centralized and distributed
energy resources**

***ISO/RTO open access and
stakeholder governance
provide structure for
collaboration and
cooperation***





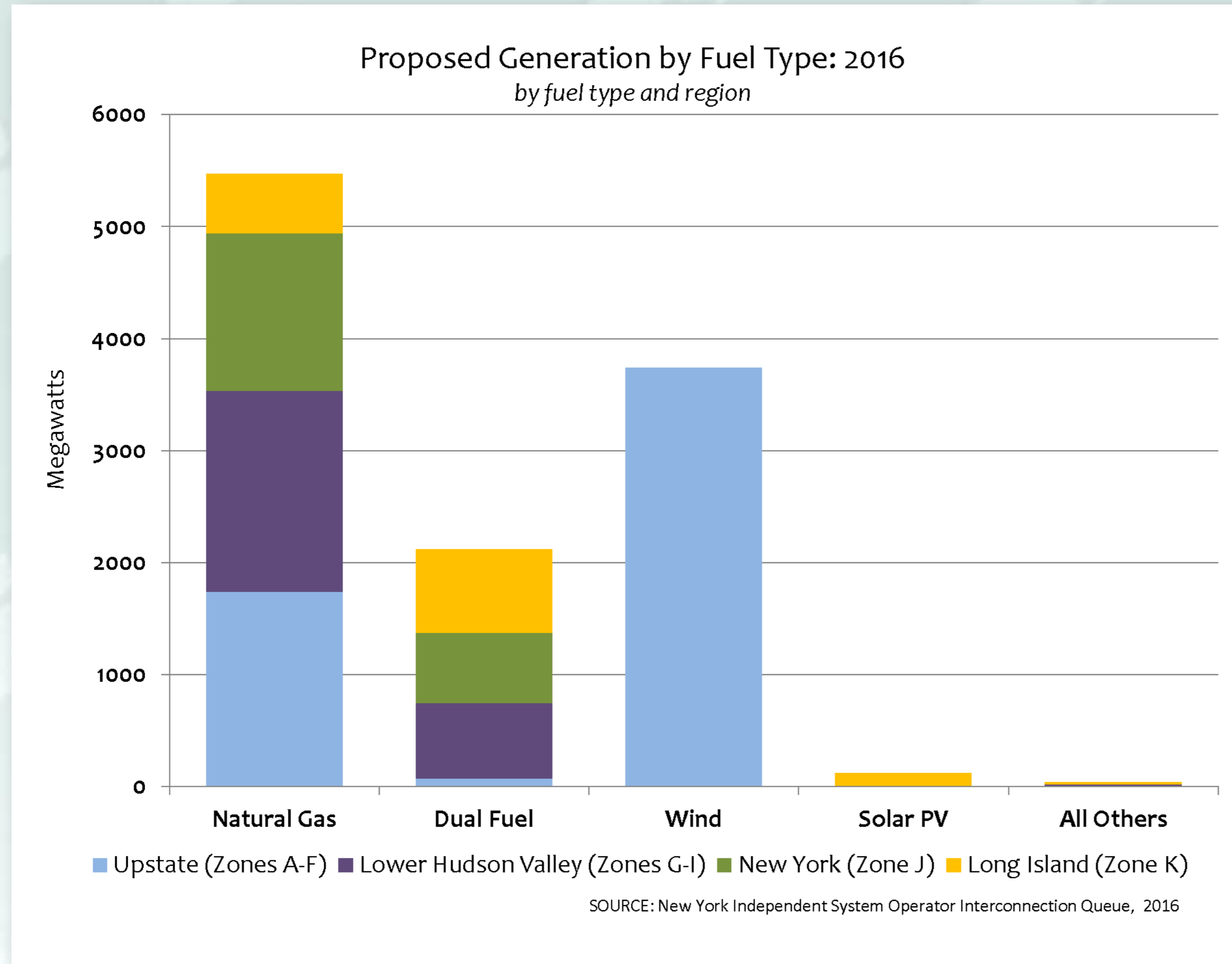
Emerging Trends

	CURRENT		FUTURE
PARADIGM	Centralized	➔	<i>Decentralized</i>
GENERATION	Dispatchable	➔	<i>Intermittent</i>
RENEWABLES	Expensive	➔	<i>Grid Parity</i>
GRID POWER FLOWS	One-way	➔	<i>Bi-directional</i>
CUSTOMERS	“Consumers”	➔	<i>“Prosumers”</i>
DEMAND	Inflexible	➔	<i>Price-responsive</i>

SOURCE: ECCO INTERNATIONAL, INC.

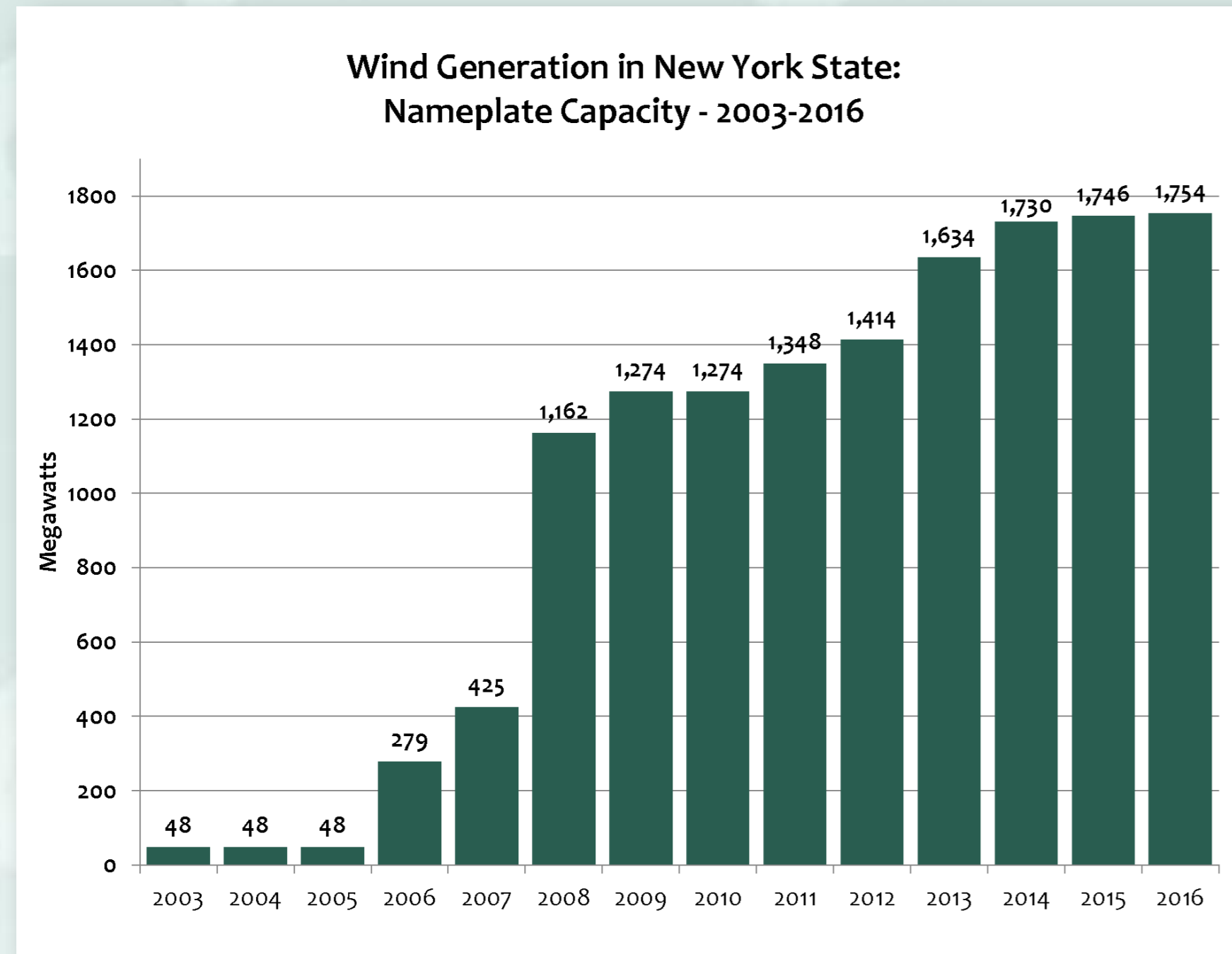
New York Electric System Trends

Proposed Generation

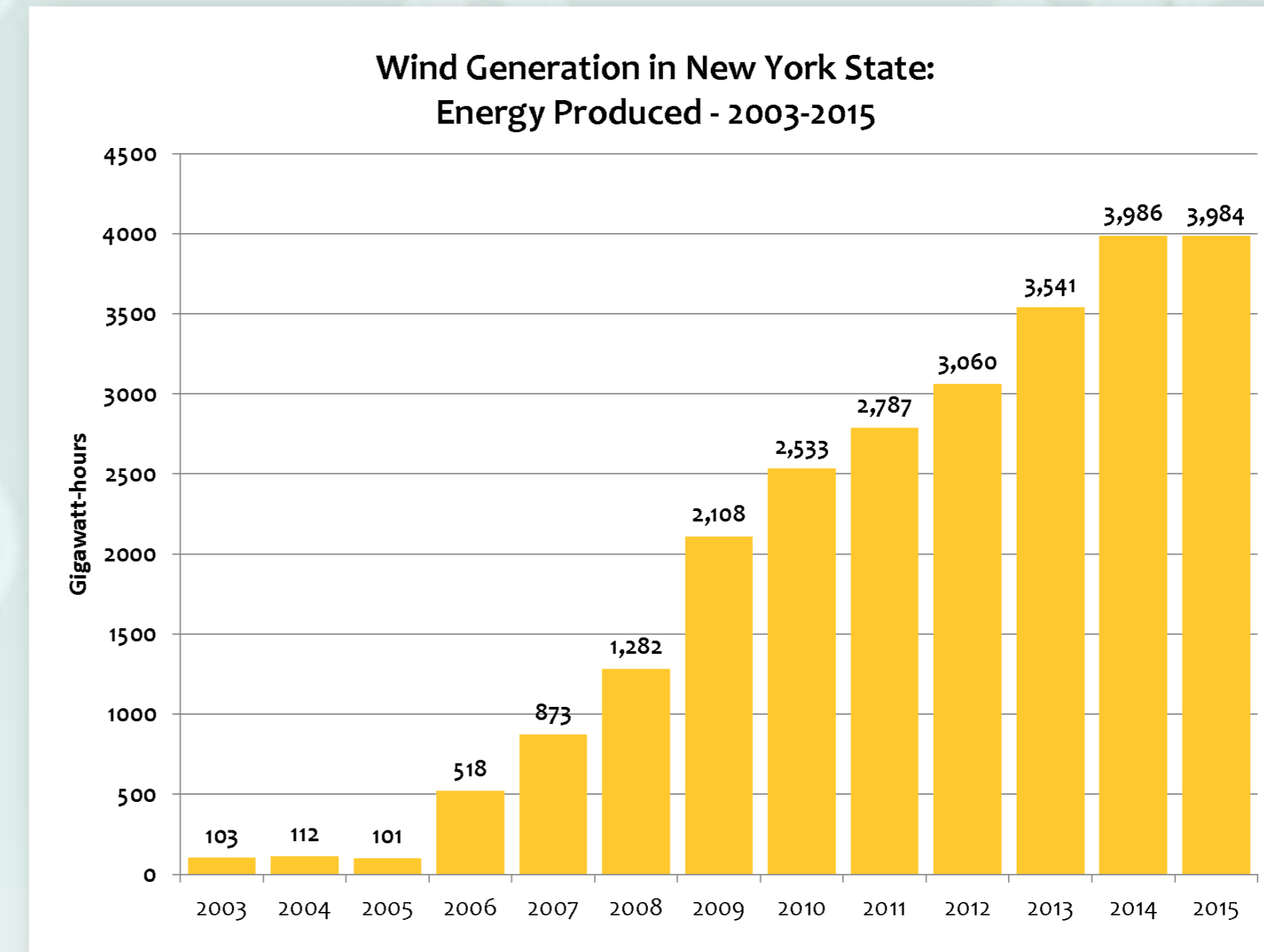


**Power plants fueled
by natural gas
(*gas-only & dual fuel*)
account for 65% of
proposed generating
capacity**

Growing Wind Power



**Wind capacity grew from
48 MW in 2003 to
1,754 MW in 2016**

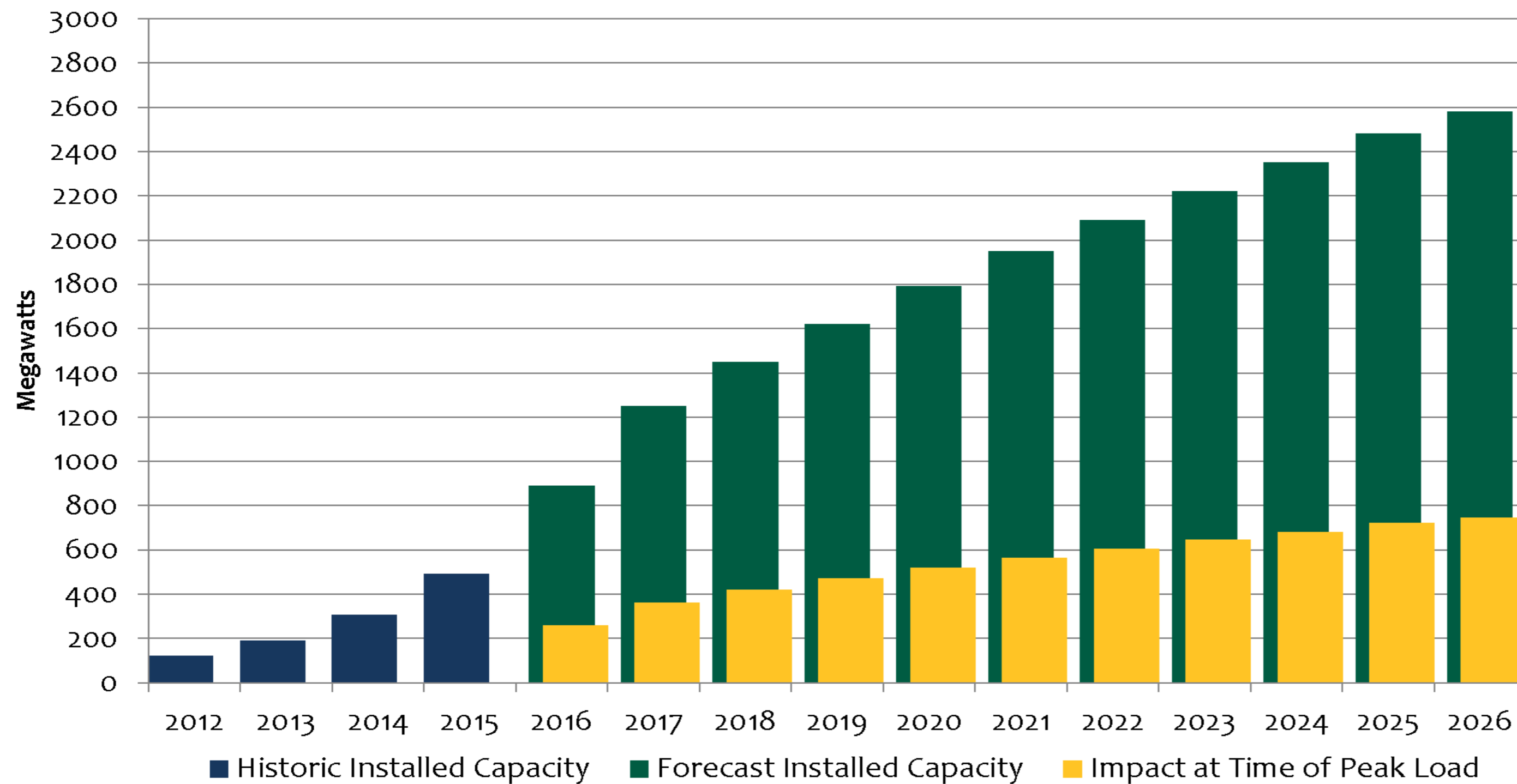


**Wind generation grew from
103 GWh in 2003 to
3,984 GWh in 2015**

SOURCE: *Power Trends 2016*, New York Independent System Operator, June 2016

Growing Solar Power

New York Solar PV Capacity
Actual & Forecast: Installed Capacity and Peak Impact



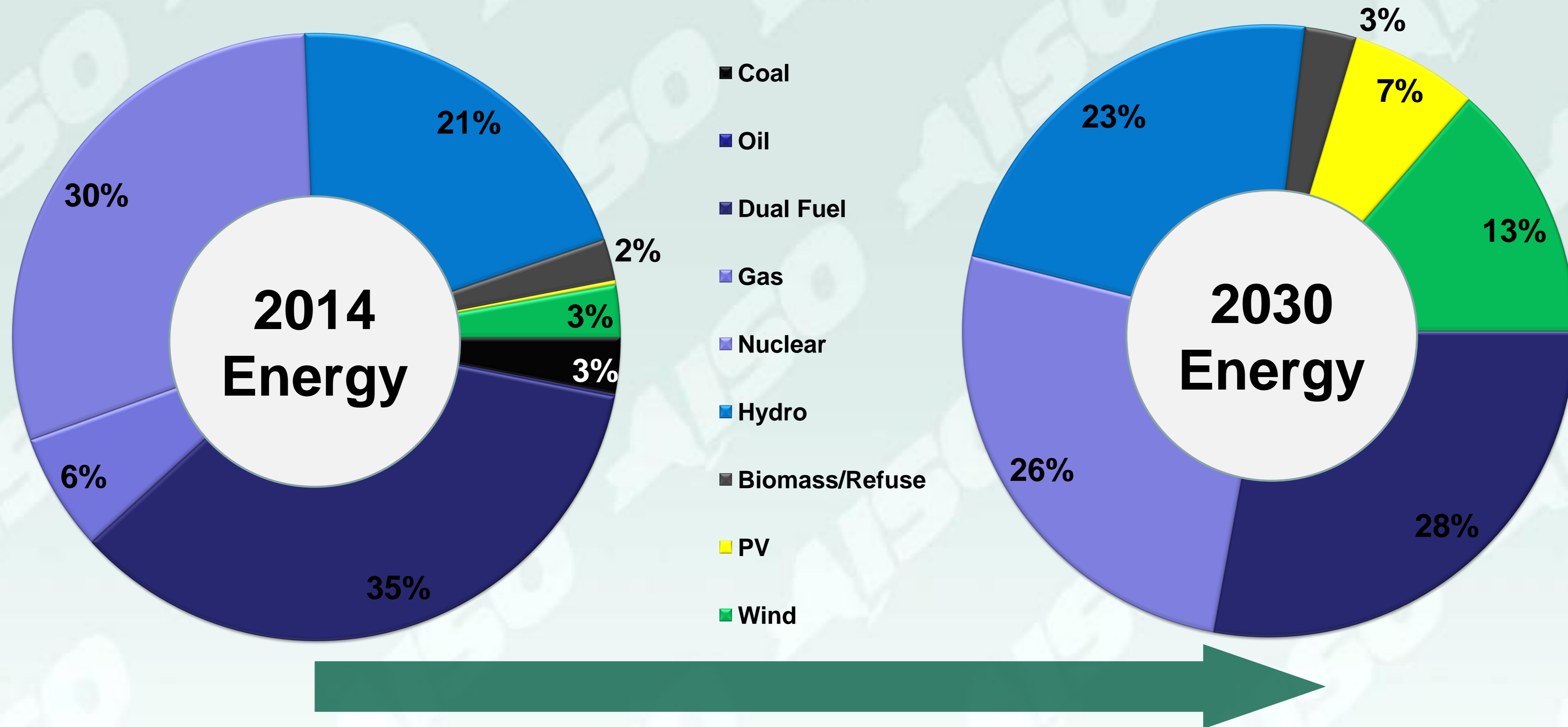
NOTE: Data represent "behind the meter" solar photovoltaic only.

Distribution-level Solar PV
estimated summer capability –
250+ MW
in 2016

Total expected to triple by 2026

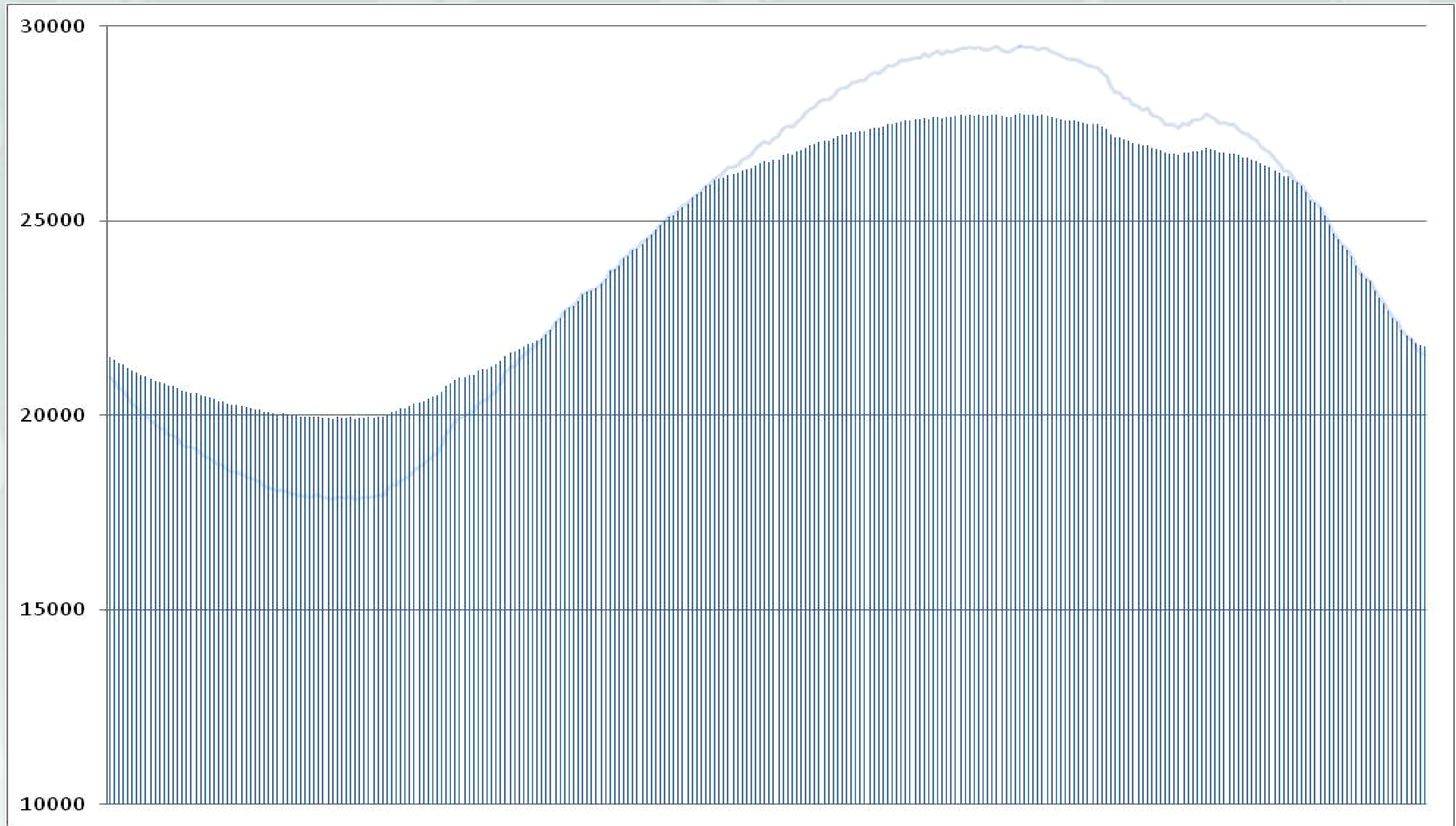
SOURCE: Power Trends 2016, New York Independent System Operator, June 2016

Policy Influence on Resource Mix



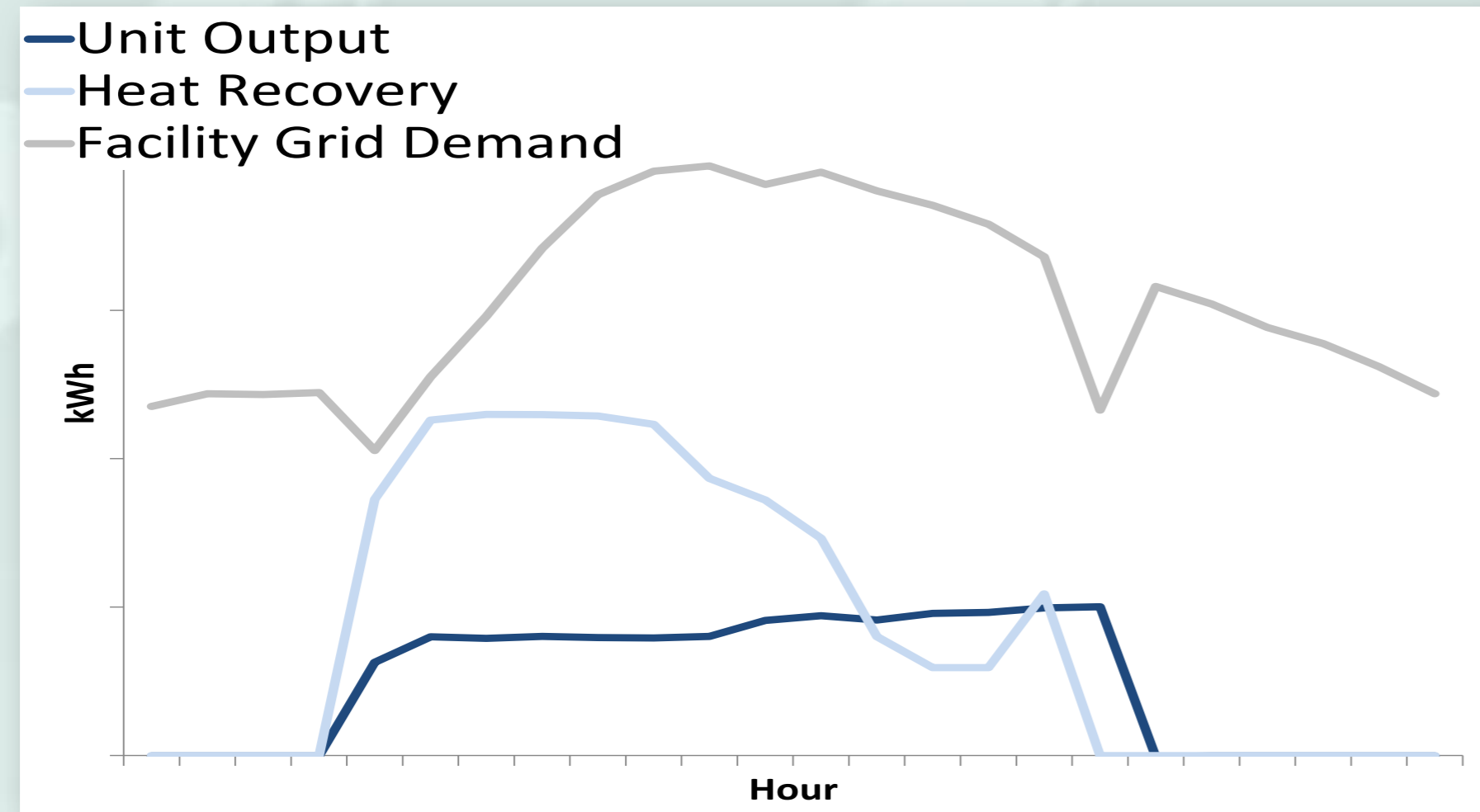
NOTE: Assumes 80% of imported GWH produced by renewable resources & 0.4% load growth before 30,000 GWH EE

Managing Daily Loads

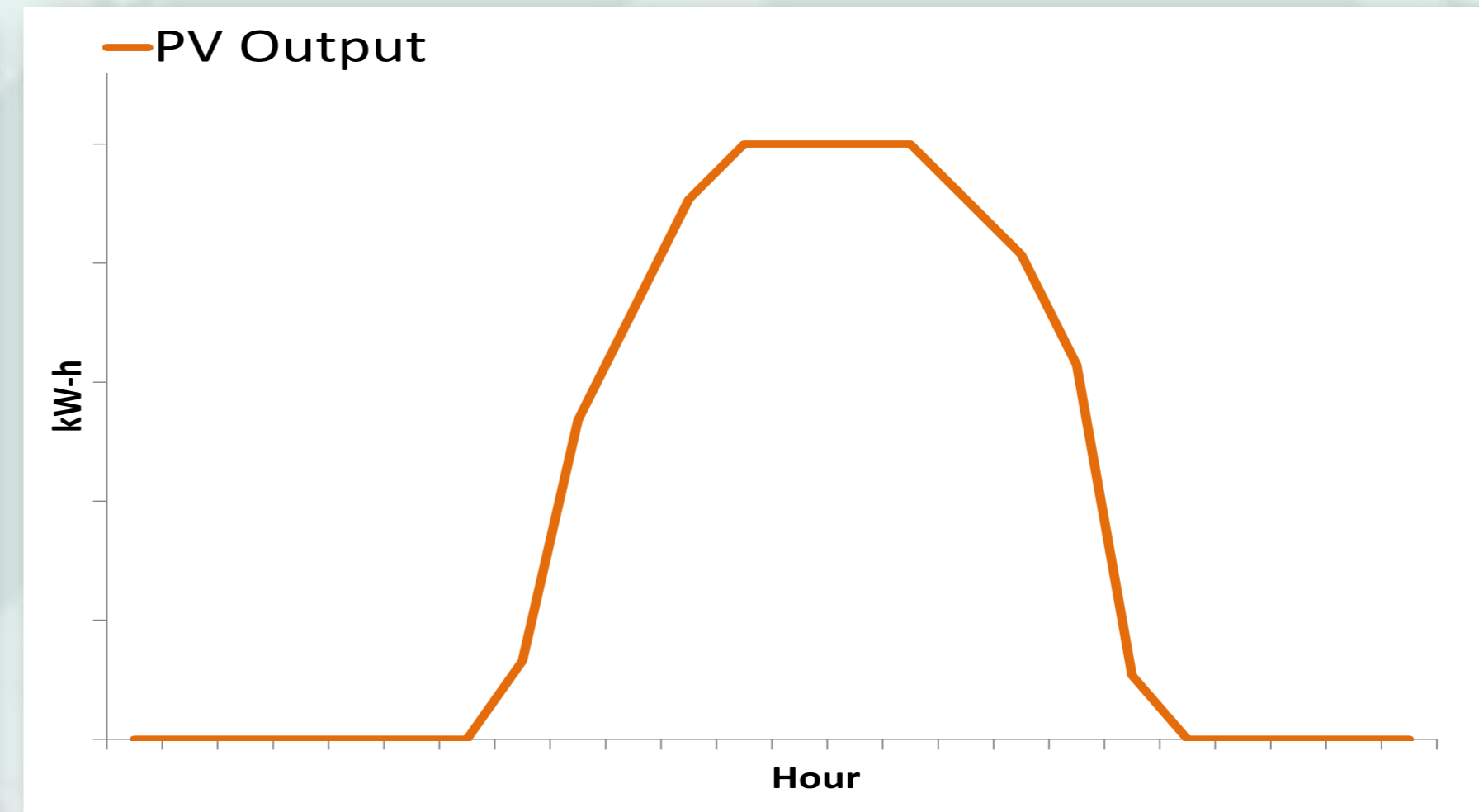


Varying Load Profiles

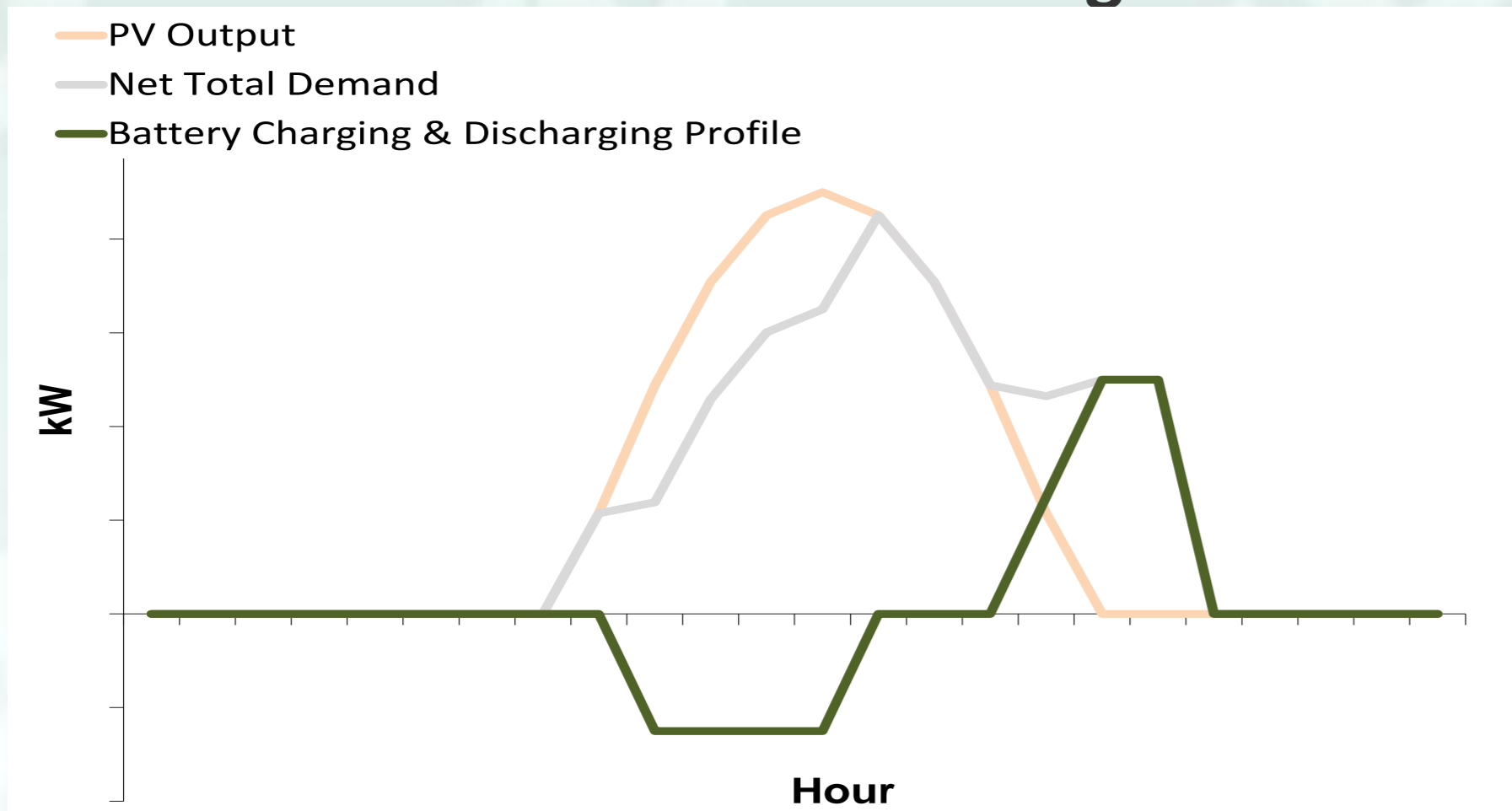
Combined Heat & Power



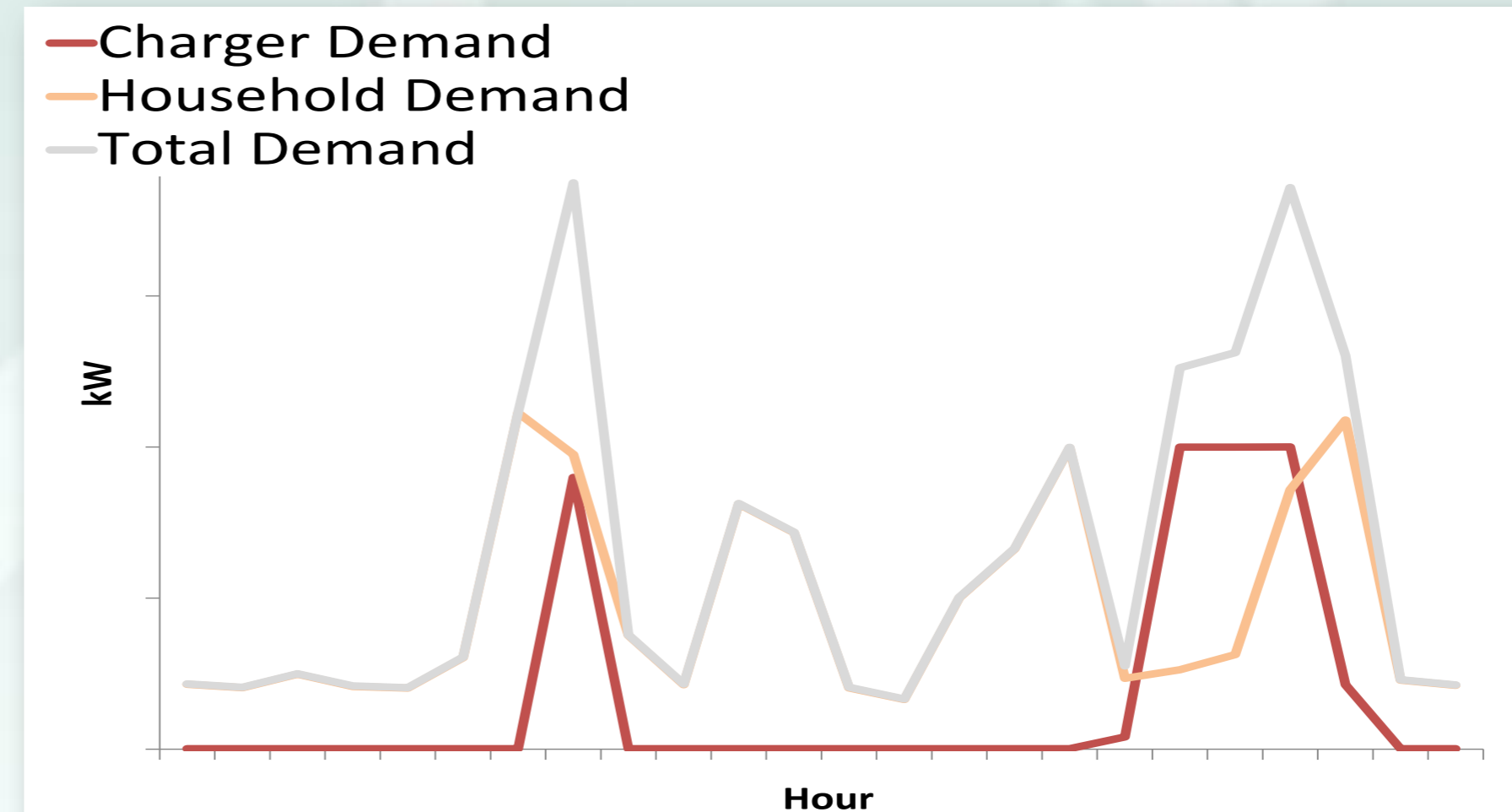
Photovoltaic Solar



Photovoltaic & Storage



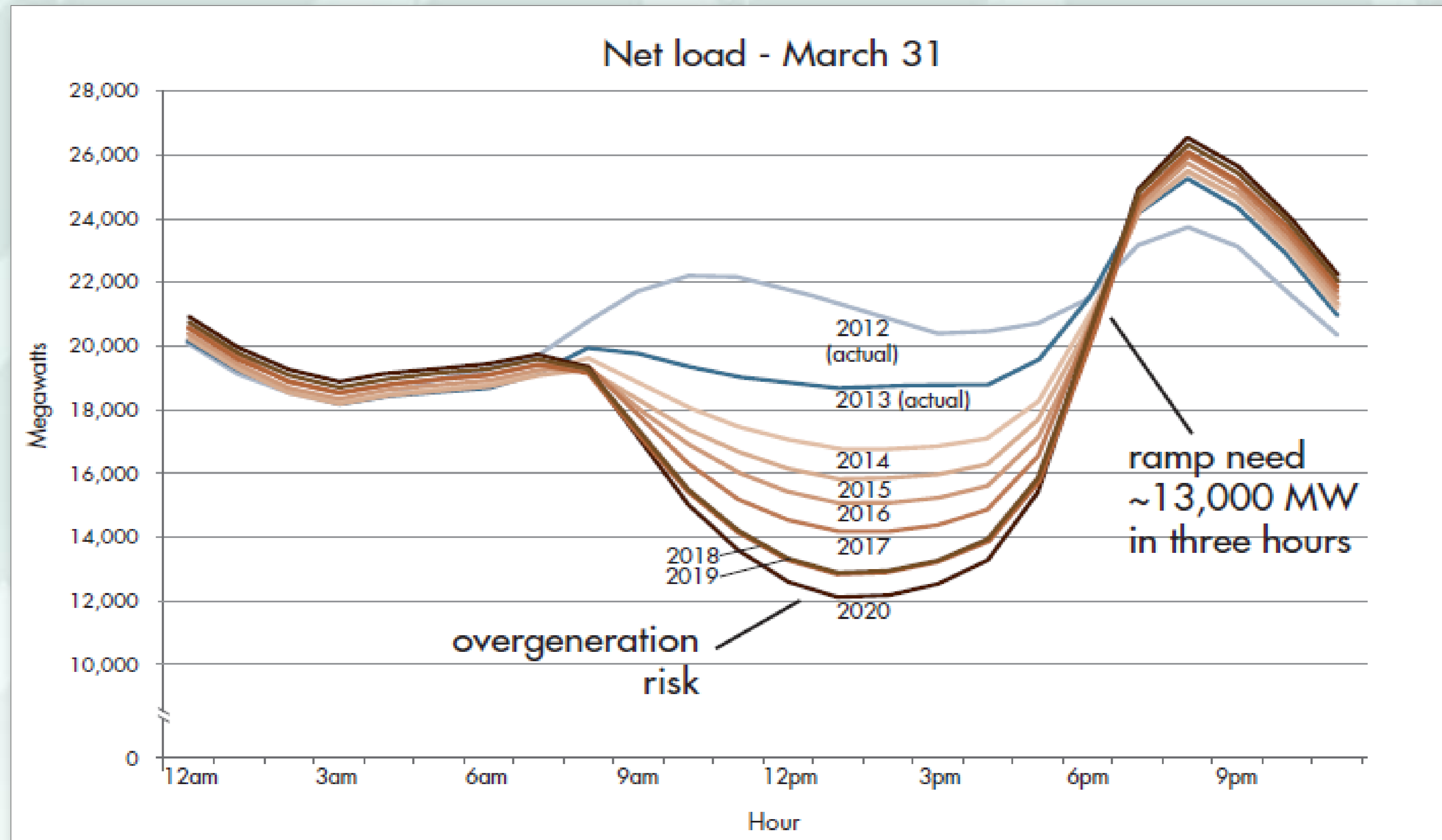
Electric Vehicles



Source: [A Review of Distributed Energy Resources](#), DNV GL for NYISO, September 2014

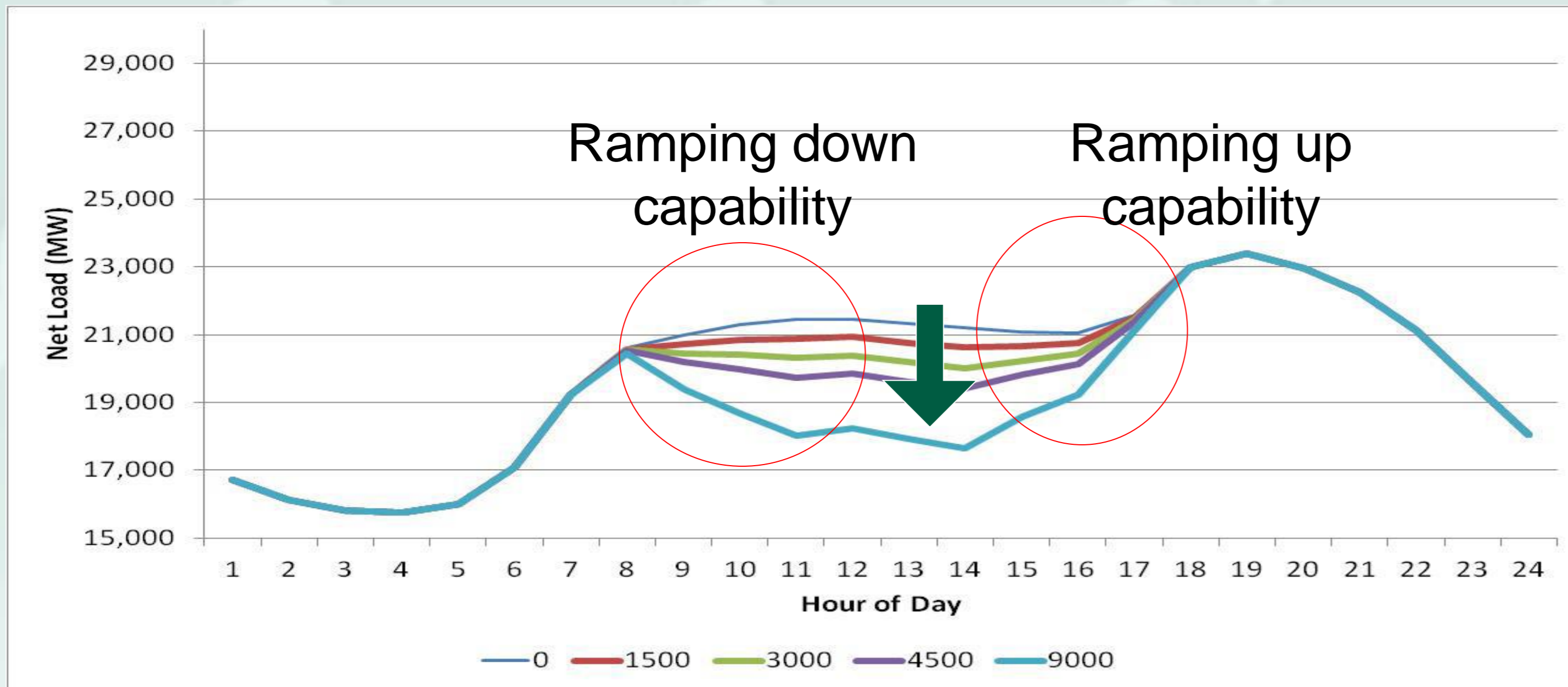
California “Duck Curve”

CAISO – March 31



Will the Duck Fly to New York?

Typical NY Winter Day: Levels of Solar Penetration



Challenges:

- **High magnitude of ramping capability**
- **Increase price of ancillary service**
- **More flexibility requirements to flatten randomness pattern of renewables**

Possible solutions:

- **CAISO "flexi-ramp" & MISO Dispatchable Intermittent Resources**
- **Flexibility Market**

Integrating Distributed Energy Resources

Distributed Energy Resources



Solar Photovoltaics



Energy Storage



Microturbines



Plug-in Electric Vehicles

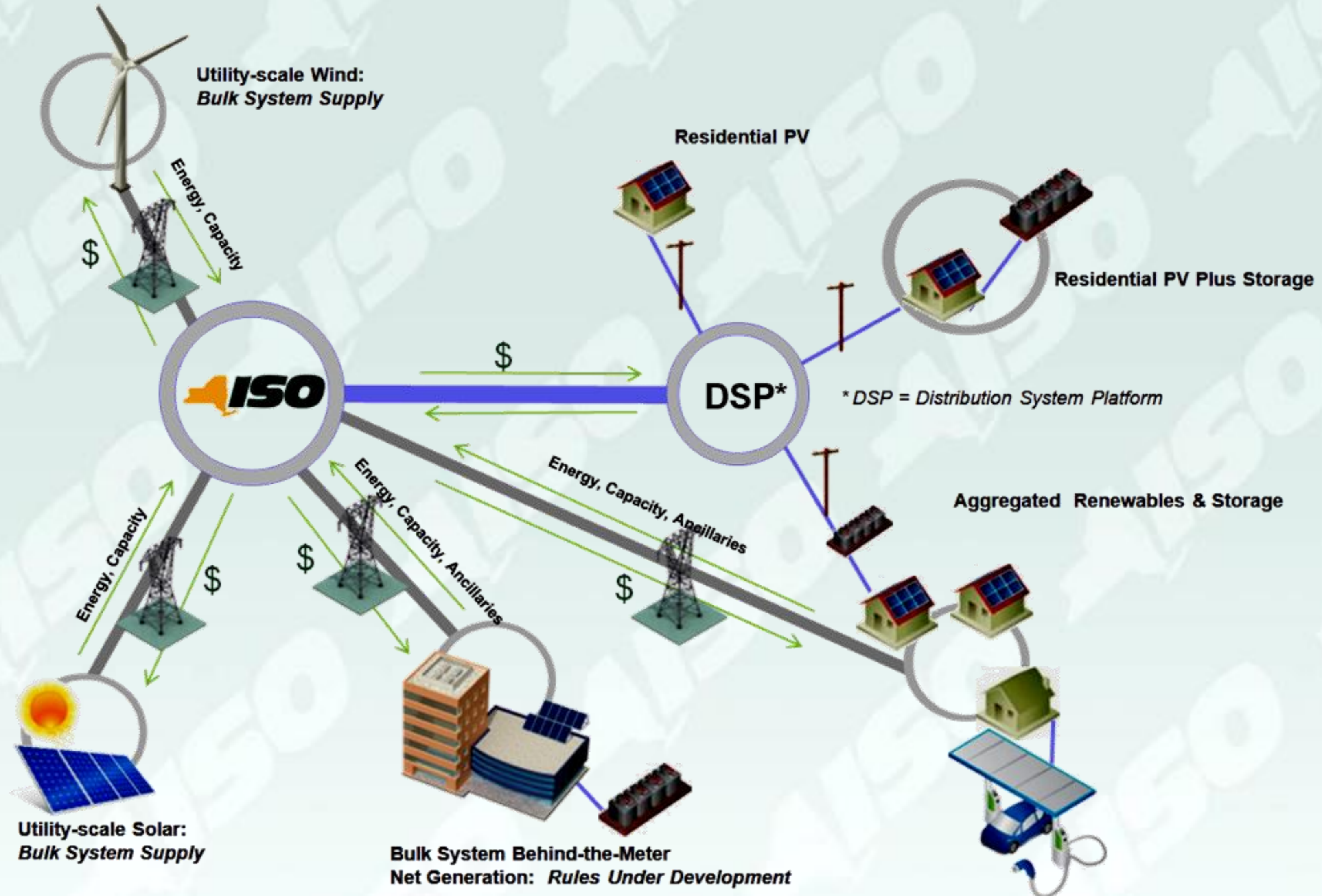


Microgrid Systems



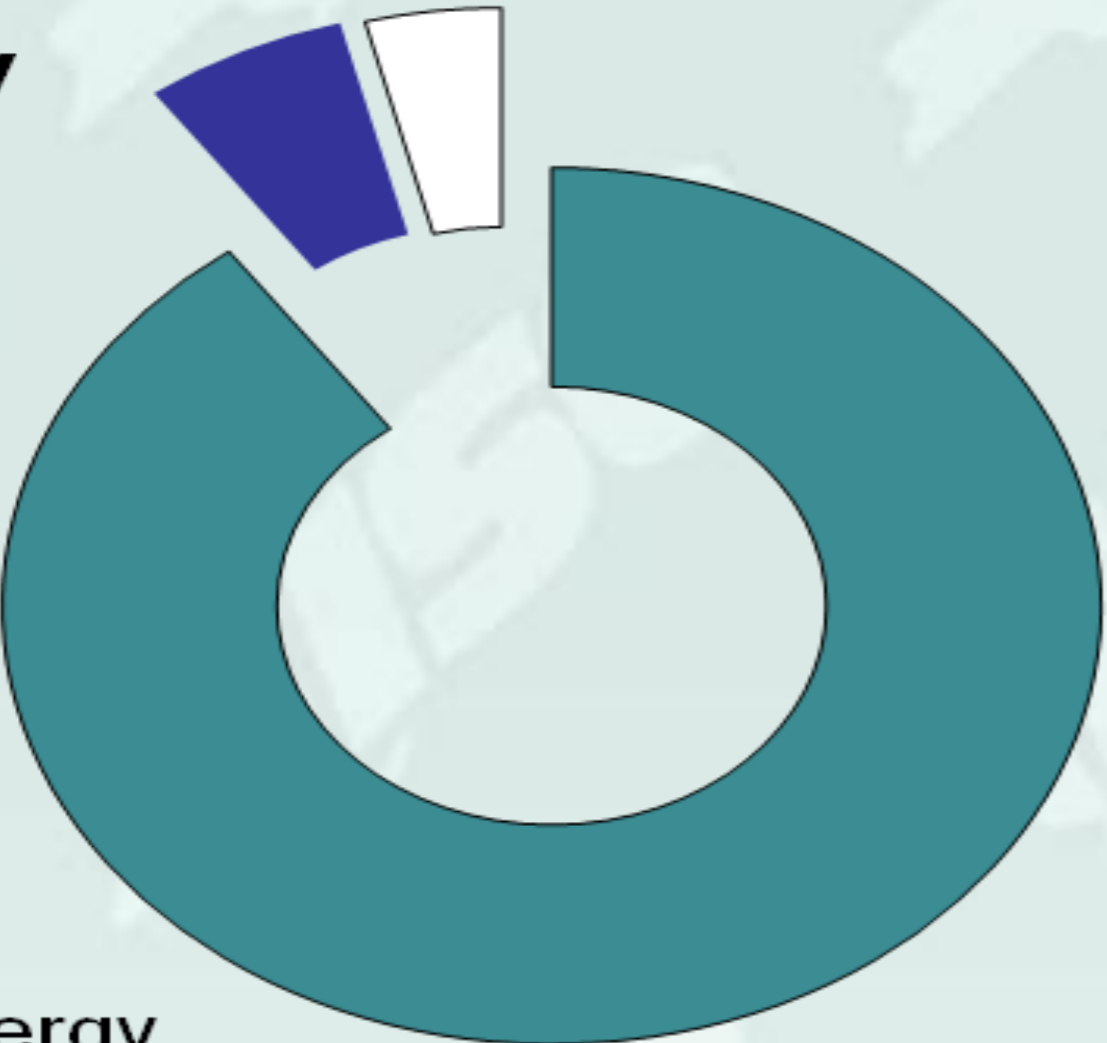
Combined Heat & Power

Integrated Approach: DER



Value of Capacity & Ancillary Services

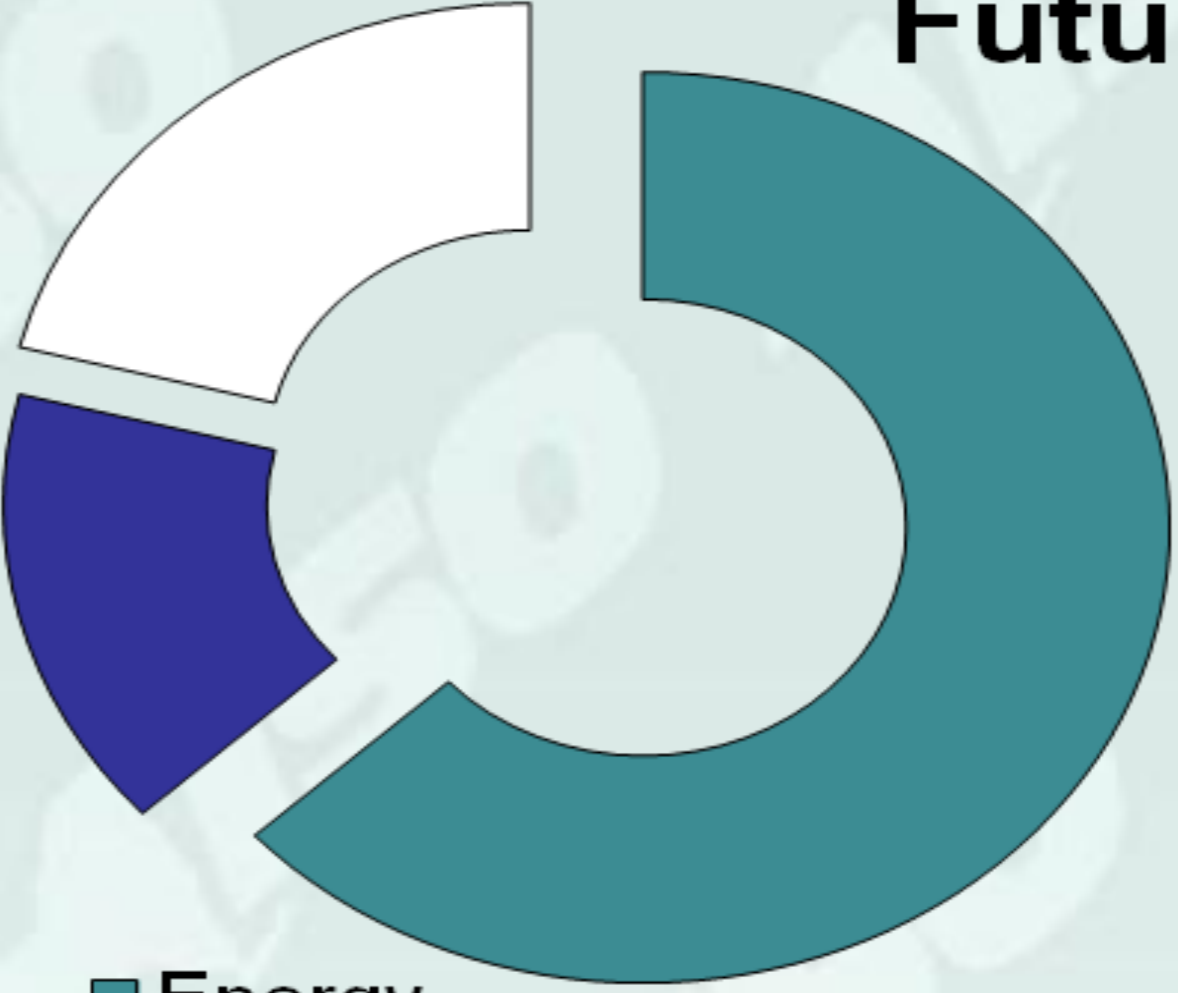
Today



- Energy
- Capacity
- Ancillary Services



Future ?



- Energy
- Capacity
- Ancillary Services



Central Station



Variable Generation



Demand Response

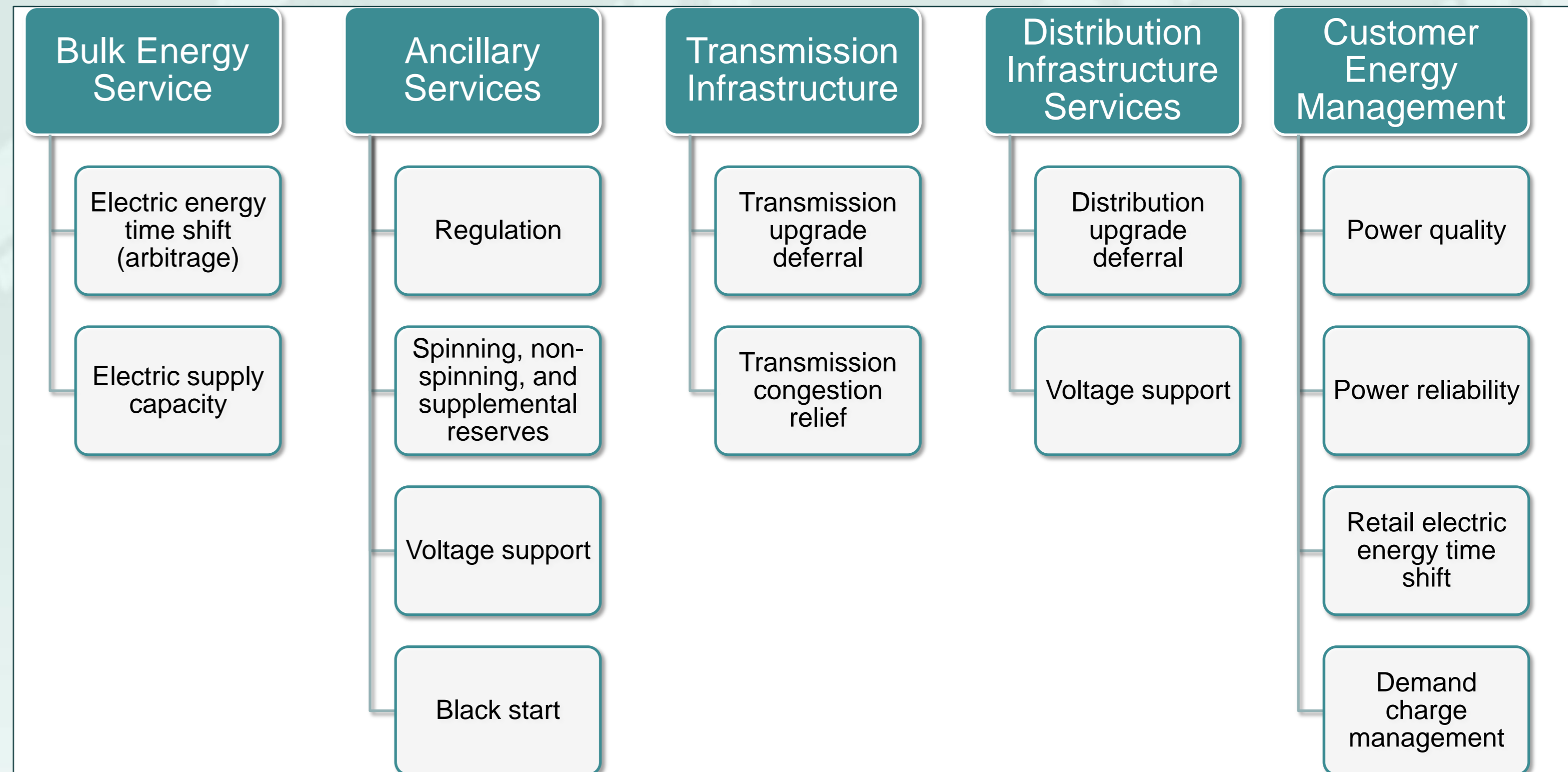
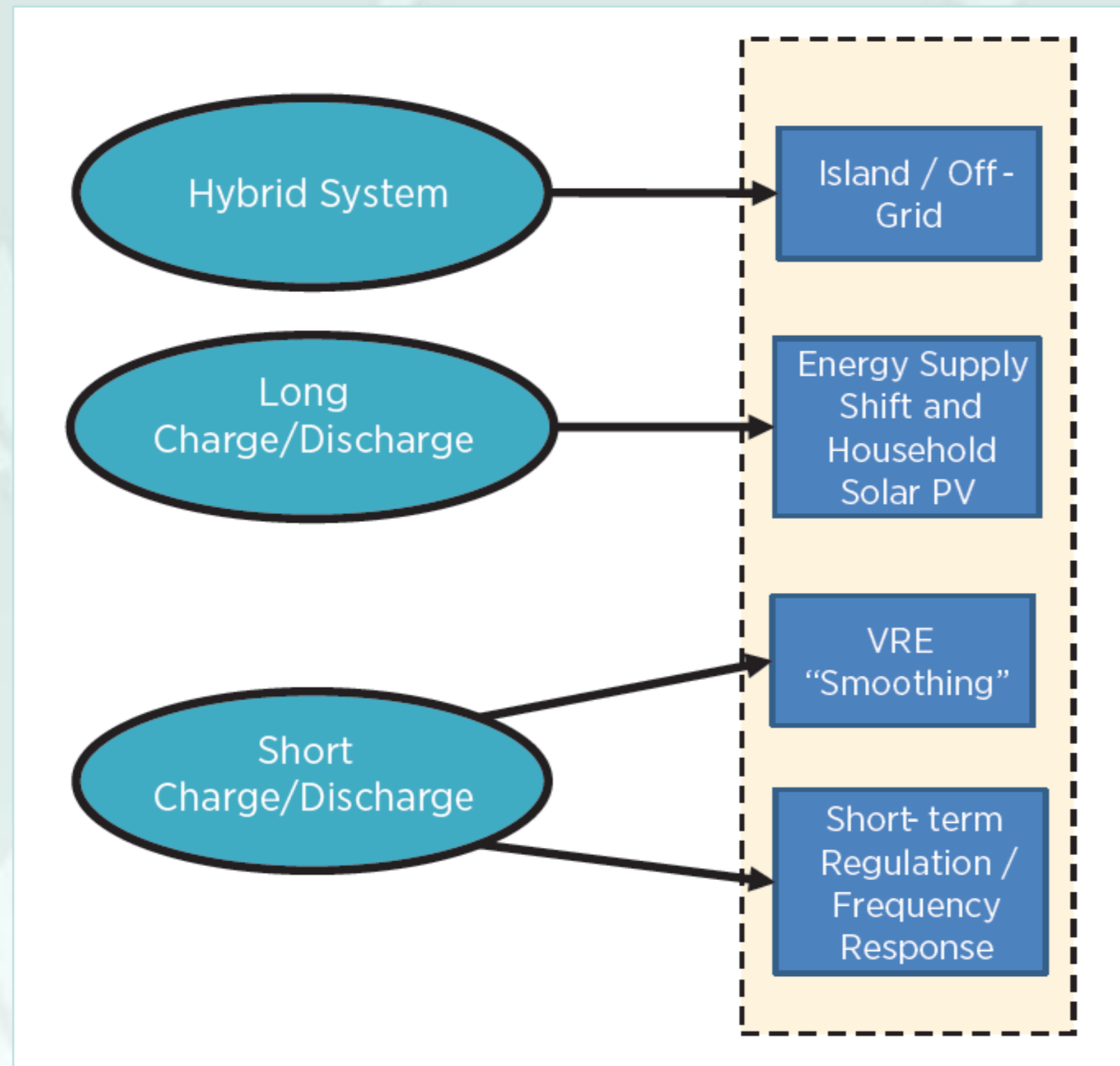


Energy Storage

Source: EPRI

Storage to Facilitate CES/REV Integration?

Matching Battery Capabilities with Applications



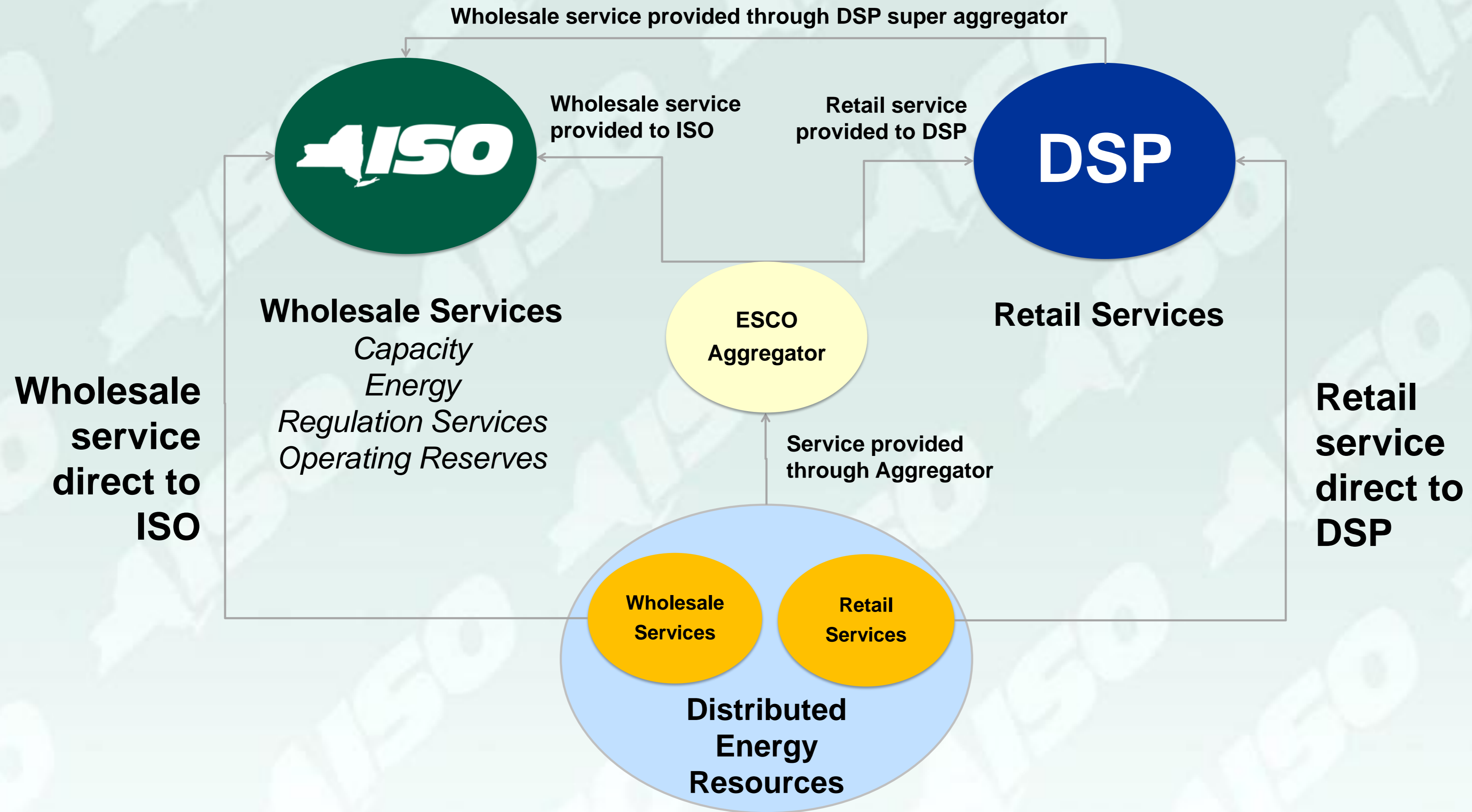
Source: International Renewable Energy Agency

Important considerations for battery selection application

Storage offers flexible array of potential services

DER Integration

Roadmap for Wholesale Markets



Considerations for the Future Grid

- **Transmission**
 - *Western NY Public Policy Project*
 - *AC Transmission Projects*
- **Grid-Scale Storage**
 - *Including Canadian Hydro*
- **Animating Demand**
 - *Reforming Energy Vision (REV)*
 - *Dynamic Pricing (Incentivize load to follow generation)*
- **Regional Markets**
 - *Balance renewables over a larger regional footprint*



The Mission of the New York Independent System Operator, in collaboration with its stakeholders, is to serve the public interest and provide benefit to consumers by:

- *Maintaining and enhancing regional reliability*
- *Operating open, fair and competitive wholesale electricity markets*
- *Planning the power system for the future*
- *Providing factual information to policy makers, stakeholders and investors in the power system*

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