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Energy Management and Sustainability on the Road to 10G

OPTIMUM LOAD SHAPING

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VIRTUAL EXPERIENCE
OCTOBER 11-14

Charging Electric Vehicles and Batteries with Renewable Sources

- Overview of Load Shaping opportunities for cable
- Limits to Electrical Supply
- Limiting Demand
- Optimum Load Shaping
- Conclusions

Change = Opportunity

- Cable's has growing needs and opportunities to reduce energy costs and ensure reliability of power resources
  - Large cable fleets will transition to Electric Vehicles
  - Micro-grids can be used to power critical facilities and other assets
  - ANSI/SCTE 267 Optimum Load Shaping standard has been issued to address cable use cases
- Stressors on the grid lead us to consider ways to lessen load (demand for power)
- Load Shaping techniques time-shift electrical loads to seek lower pricing and ease congestion

The grid is changing

- Diverse Generation
- Carbon Pollution
- Inefficiencies
- Aging infrastructure
- Severe weather
- Electrification
- Cyber threats

Diverse Generation

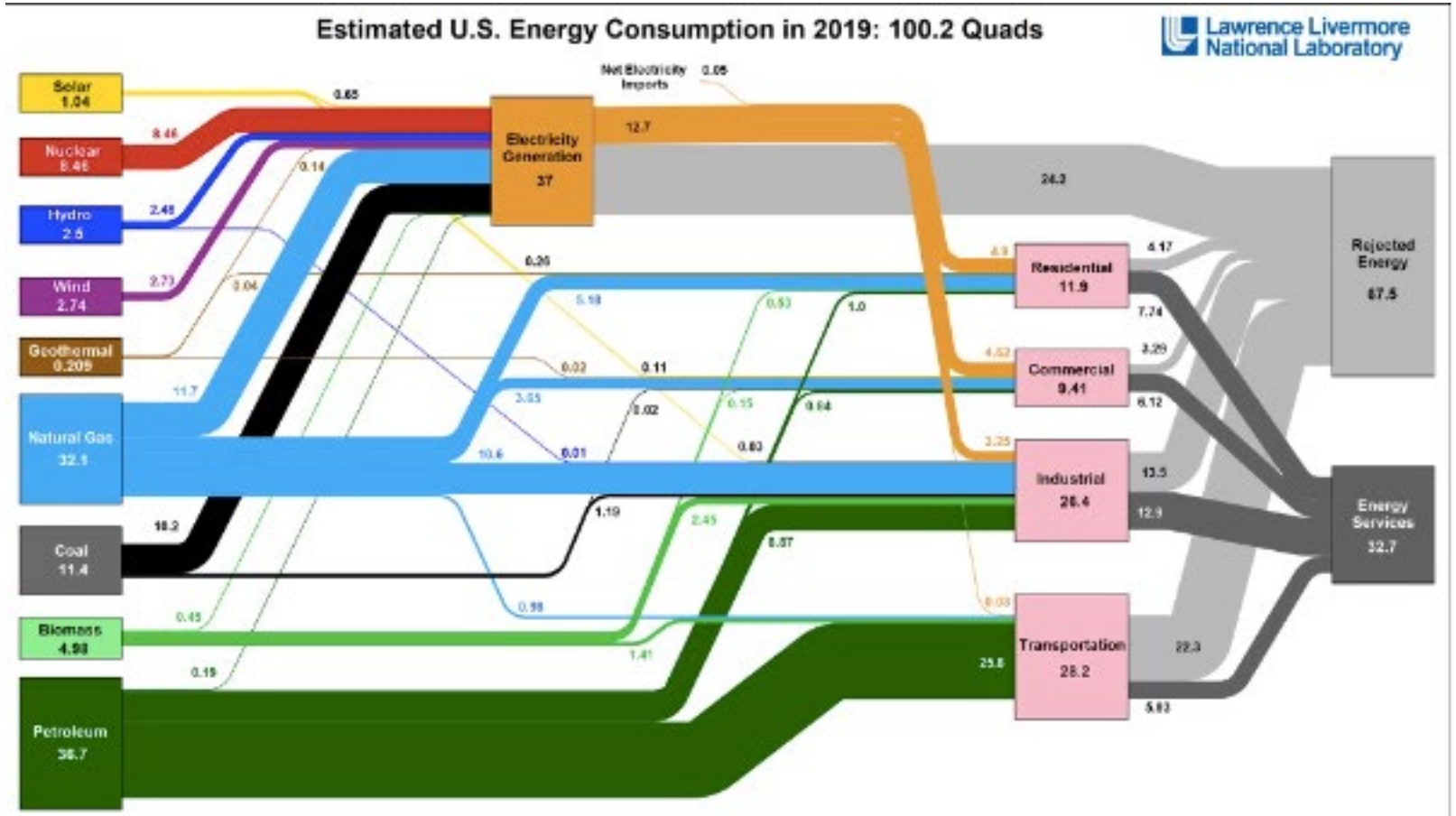
- Public Utility Regulatory Policies Act of 1978
  - allowed new entrants to generate power
- Solar, wind and other Distributed Energy Resources (DERs) are being deployed on massive scale
- Increases complexity on grid designed for one-way distribution

Carbon Pollution

- Present and increasing impacts are leading communities and governments to react
- Internal and external mandates to de-carbonize are being adopted by energy suppliers

Inefficiencies

- 2/3 of energy released by burning fuels is lost as heat
  - 2/3 of atmospheric carbon released by electrical generation has provided no benefit to humanity!
- 1/3 of water consumption used by fossil generation
  - equal to portions used by agriculture and household/industrial



Aging infrastructure

- The mean time of life of grid equipment is rated at 63 years, yet the average age of equipment in the field today is 68 years, with components as old as 108 years!

C-hook failure caused 2018 Camp Bird fire in CA.
85 lives and $16.8B lost

Severe weather

- Historic cold in Texas earlier this year led to unprecedented and catastrophic grid failures.
- Unprecedented drought and heat, especially along the West coast is spiking demand for air conditioning.
- A cruel irony of higher temperatures is that it makes fossil generation less efficient - the necessary cooling of water vapor is less effective leading to a higher ratio of fuel to Kw generated

Electrification

- Many loads expected to transition to electricity
  - Cars, trucks, air-conditioners, heat-pumps, etc

Cyber threats

- Recent ransomware attacks on fuel lines and other infrastructure highlight emerging threats to grid

Strategies can be employed to limit demand

- Frugality
- Pricing
- Efficiencies
- Utility incentives
- Direct Controls
- Optimum Load Shaping

Frugality

- We might collectively change our behavior to use electricity more sparingly, but our lives of comfort and convenience likely will not significantly decrease demand

Pricing

- Carbon taxes or other market signals might increase price of electricity, driving down demand. If, when, how much are all unknown

Efficiencies

- EnergyStar appliances, building codes, advanced batteries, and many other improvements all lessen demand
- Countered by proliferation of devices and new technologies
  - e.g. Bitcoin mining estimated to consume as much power as Argentina!

Utility Incentives

- Utilities have developed strategies to avoid brownouts/blackouts
  - Peak shaving/load shedding agreements with large energy consumers
- Time of use pricing

Direct Controls

- Automated Demand Response

ANSI/SCTE 267 OLS standard

- Developed in SCTE micro-grid working group
  - shout outs:
    - Dave Geary, chair. Comcast
    - Larry Lutz, co-chair. Emerge Alliance
- Theoretical background
- Architecture
- Protocol
- Monitoring
- Use Cases
  - Cable EV fleet charging

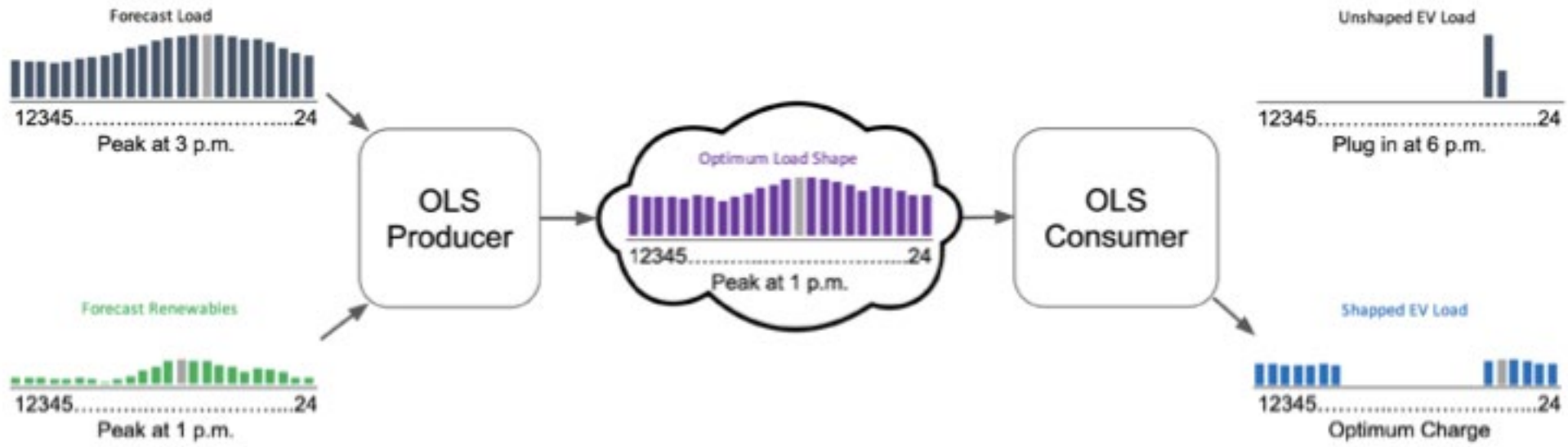
Theoretical background

- Research into load shaping has demonstrated economic value
- Cruickshank has studied effects of shaping load to availability of renewables
  - maximizes efficiency of fossil generation
- Simulations of:
  - no renewables - variable fossil generation
  - flat fossil generation
  - flat fossil generation with renewables
- Cost optimization using Unit Commitment model

$$\min\left\{\sum_{t=1}^{n}\left\{\sum_{i=1}^{N} v_i c_i(p_i)\right\}\right\}, v_i \in \{0,1\}$$

Architecture

- OLS adopts client-server model (Producer-Consumer pattern)
- Energy supplier such as utility uses any logic they choose to produce a daily OLS signal
  - table of values representing % of daily demand to use in an hourly increment
- Consumers, e.g. EV chargers, attempt to match load signal to optimize overall system



Protocol

- OLS defines a Data Model in YANG
  - simple table of timestamps and values
- Transport and encoding formats not normatively defined
  - an HTTP REST OpenAPI specification is provided as a reference
  - other formats, e.g Protobuf, could be implemented
- Human and machine readable assets available on Github: https://github.com/cablelabs/scte-ols

Monitoring

- No back-channel of monitoring mechanism has been defined
  - performance based incentive programs expected to develop and employ audit solution
- Could be standardized as market knowledge is developed

Cable Use Cases

- EV fleet charging
  - partner with local/regional energy suppliers that can provide OLS signals
  - shape load to support grid reliability and to lower energy costs for cable operator
- Micro-grid management systems
  - Consume OLS and re-target it internally to orchestrate internal loads

OLS could be applied to many other load shaping use cases inside and out of the cable industry

Benefits of Load Shaping and OLS

- Reduce fossil fuel utilization
  - improves efficiency by reducing peaks, starts/stops, up/down ramping
  - reduces fuel costs, water consumption, pollution
- Accelerate transition to low-carbon economy
- Reduce investments in electrical infrastructure
  - provides non-wired solutions to local congestion
- Lowers costs to electrical consumers where time of use or other incentives are offered
- Improves Service Continuity for cable operators as grid failures are reduced

Thank You!

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