A Day in the Life of a Transactive Grid

GridWise® Architecture Council

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Trends for the grid of the future

- Increased penetration of DER, especially in distribution systems
- Increased variability – due to increased renewable resource integration
- Load growth low or declining
- Potential for peak load growing
- Increasingly “intelligent” devices – loads and in the electricity network

Trend impacts

- Move from central power station, load following operation to a coordinated multi-resource, supply following operation
- Changes in load patterns, e.g., the California “duck” curve with much different net load shape
- Need to effectively engage all resources and loads to maintain or improve system reliability and efficiency

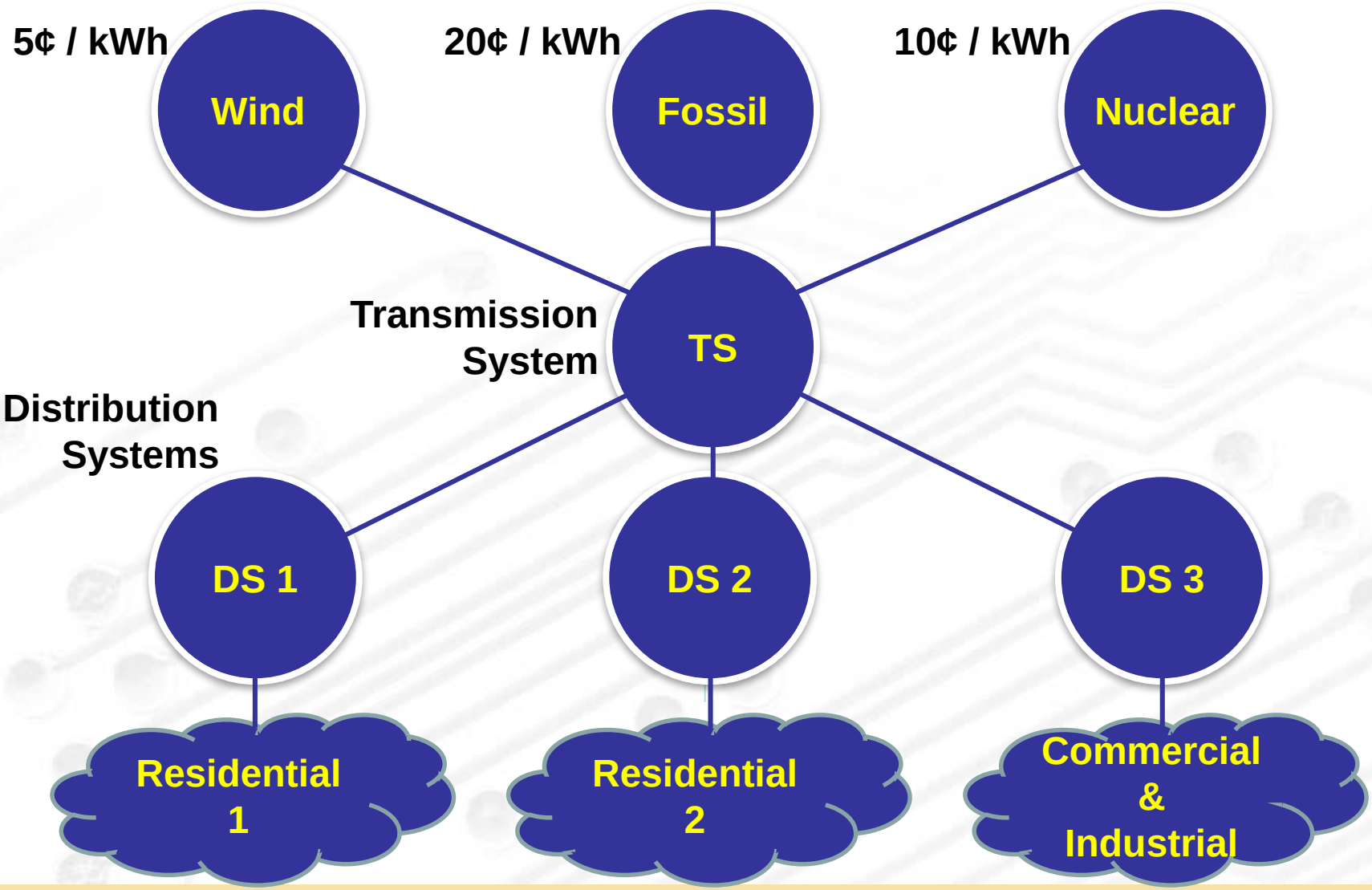
Transactive Systems

- One approach for engaging the diverse set of active parts
- How would this work from view of
  - Regional system operator?
  - Distribution system operator?
  - End-user?

Our TE grid scenario

- TE deployed in a distribution system
- RTO offers markets for energy & services:
  - Day-ahead
  - Hourly
  - Spot markets
- All parties involved engage in planning of:
  - Load activity
  - Prices
  - Etc.
- A simple network topology

Our network topology



Our story begins at 6 PM

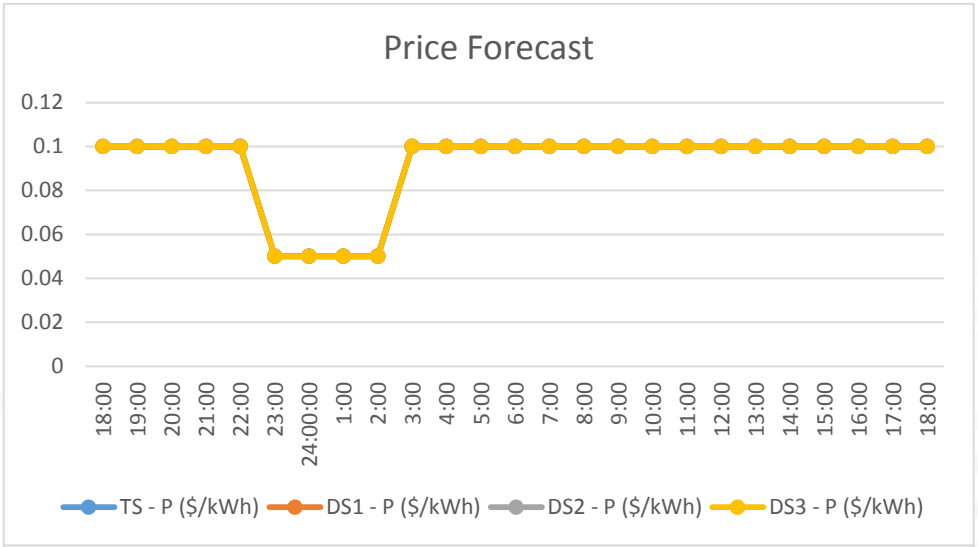
We plan the day ahead

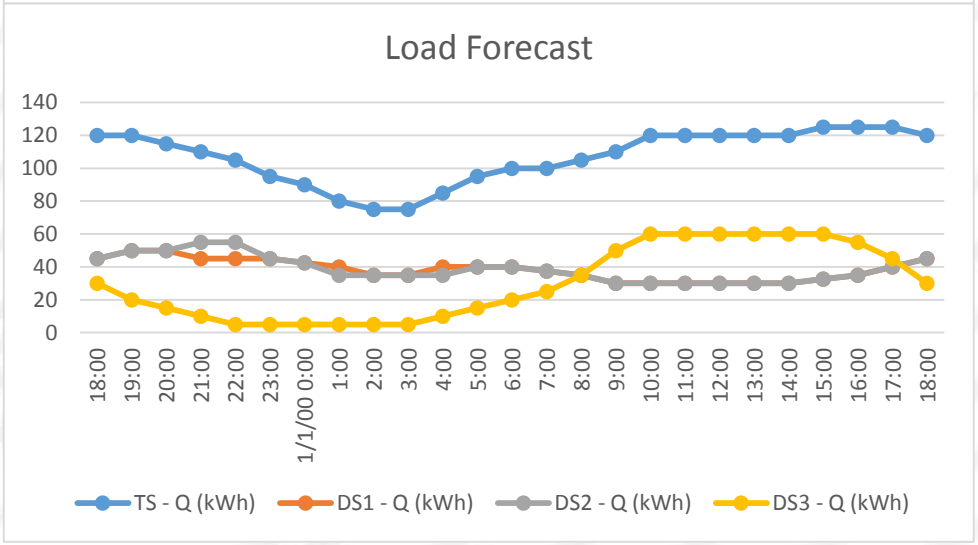
– Weather forecast
- A moderate spring day is expected
- Not unusually warm
- Moderate winds overnight

– Power forecast
- Wind power available
- Low consumption expected
- Low overnight electricity price

– No transmission or distribution constraints expected

Price and Load Forecasts





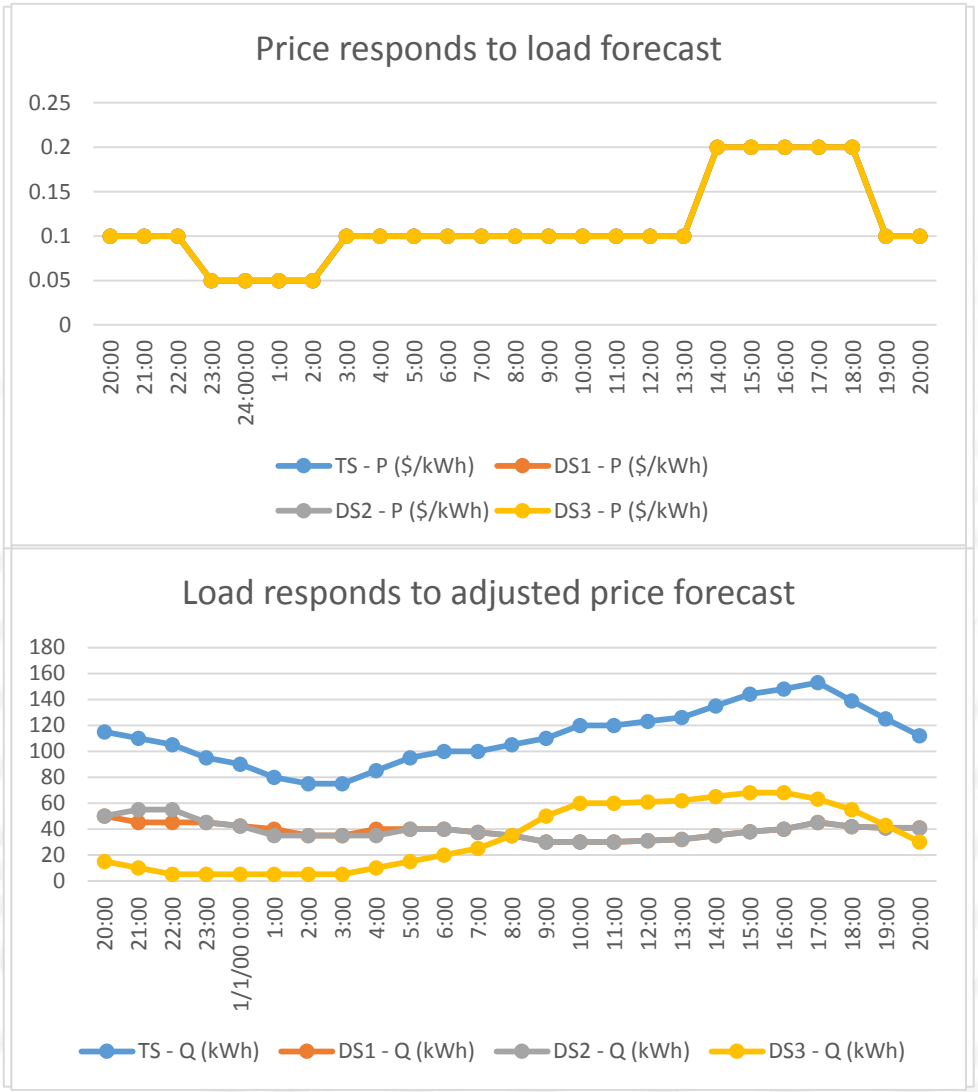
A revised weather forecast

– New weather forecast
  - Hotter than previously forecast
  - Unseasonably warm

– Loads and prices respond
  - More afternoon load than previously expected
  - Prices forecast to rise in response

– Loads and price adjust
  - Buildings moderate power consumption
    - Pre-cool from mid-morning through mid-day
    - Flatten load in late afternoon, early evening
  - Prices moderate – still higher than forecast

Updated Price & Load Forecasts



Wind forecast update

– Winds stronger than forecast until 7 AM

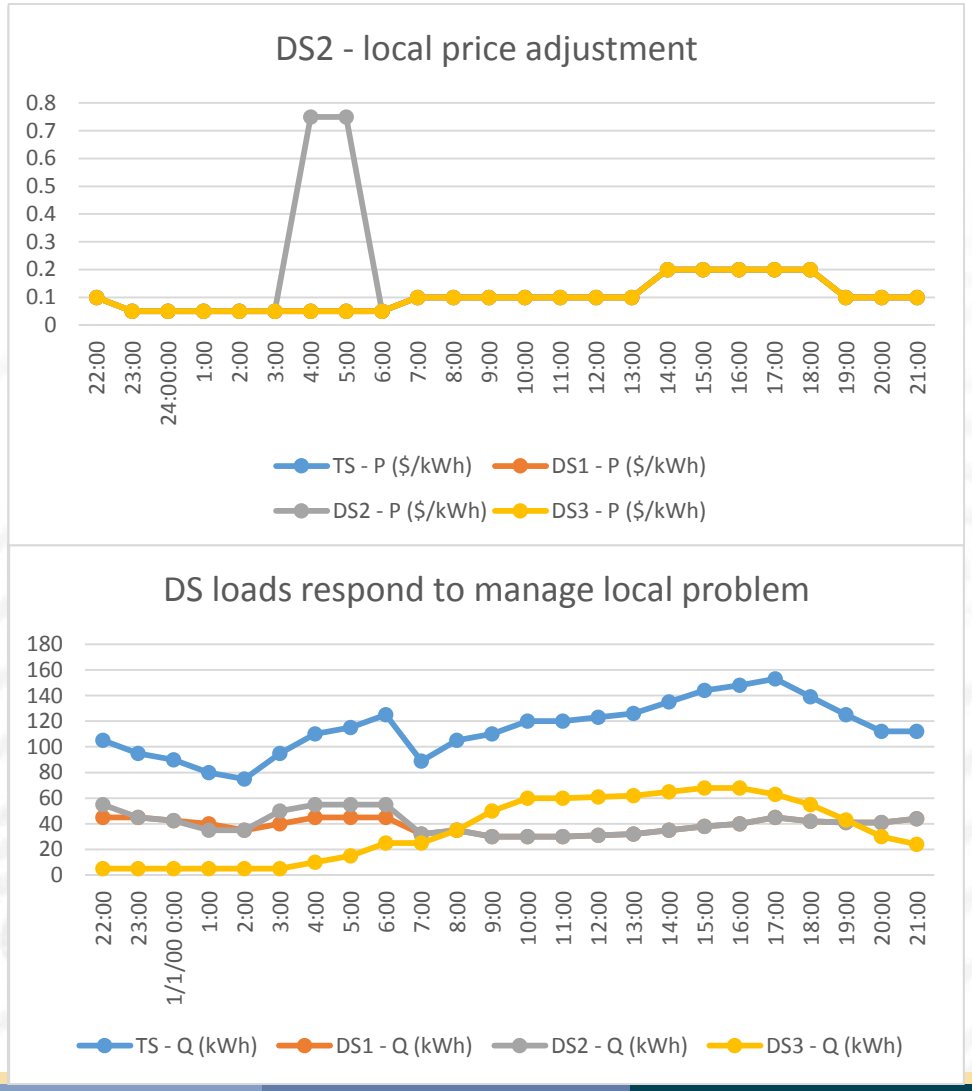
– Price drops to encourage use of excess wind power

– Loads adjust and new load forecast provided

– No need to adjust wholesale prices

– Distribution feeder constraint
  - Causing local distribution price differences
  - Iteration of load & price to resolve constraint

Updated Price & Load Forecasts



Real time constraint

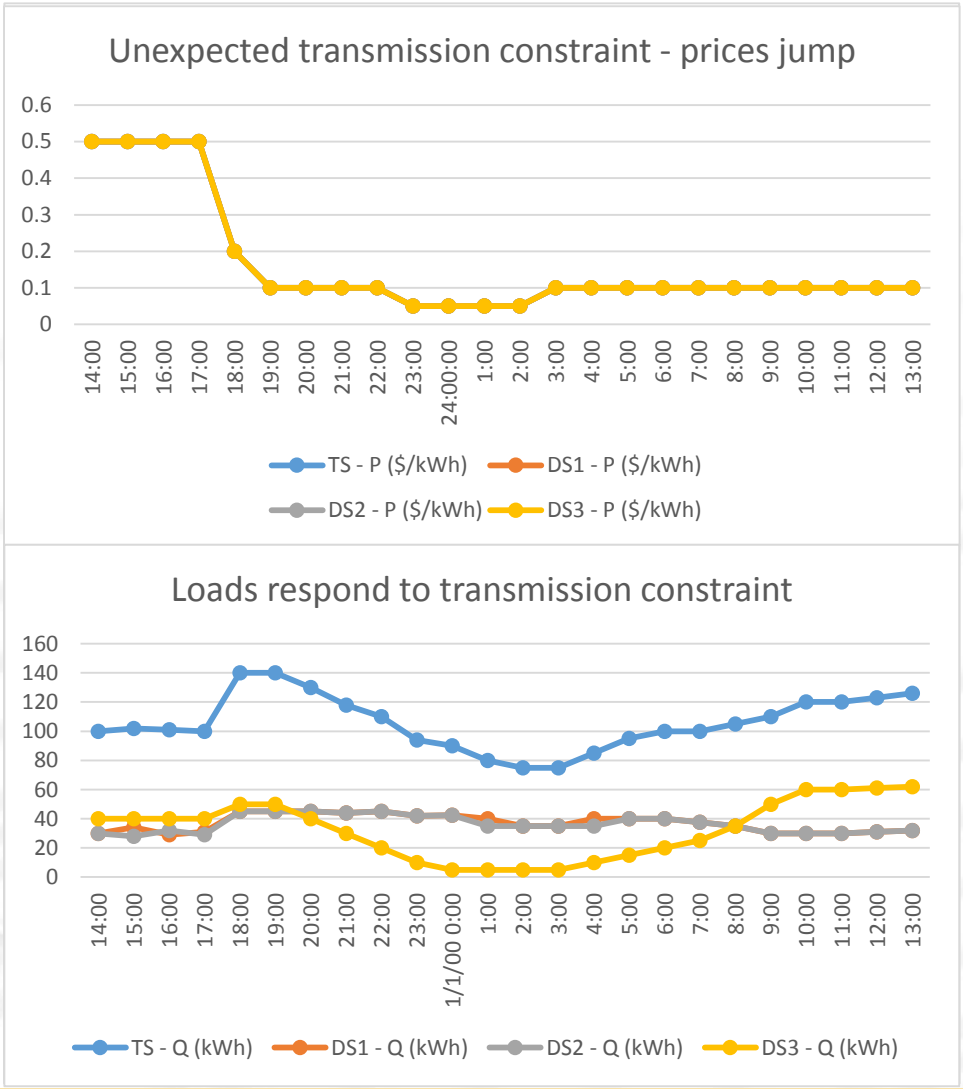
– Temperature increases
  - Loads increase
  - Unexpected transmission constraint

– Prices changes
  - Price at constrained node (LMP) increases
  - Prices downstream rise now and later

– Loads changes on affected feeders
  - Load curtailment
  - Load shifting

LMP = Local Marginal Price

Updated Price & Load Forecasts



Key points from the "simulation"

- Exchange of information between systems
  - Systems: bulk power, distribution, and end-uses
  - Critical to engaging all elements of the system
- Price changes based on:
  - Time
  - Location
  - Grid conditions
- Price changes must be transparent to all
- Various mechanisms for price-response actions
- Forecasts of price and load are useful at all levels

Key points: End-user view

- End-user response is useful if:
  - Based on "actionable information" such as price forecast
  - Magnitude of price change → Magnitude of response
- End-users should:
  - Provide more information than available now
  - Provide information about planned consumption
- Responses will vary across categories of end-user

Key points: Distribution view

- Distribution system coordinates:
  - Response of end-users
  - “Needs” of the bulk power system
- Roles of distribution system
  - Moderate responses
  - Maintain distribution reliability
- Distribution compared to transmission
  - Distribution system is more dynamic
  - Flexible approaches are required

Key points: Regional operator view

- Regional operations manage:
  - Financial risk
  - Reliability risk
- Reduce risks with better information about:
  - Present loads
  - Future load behavior
- Reducing risk reduces costs to all stakeholders

For more information:

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