

Economies of Scope and Value of Coordination in the Evolving Electric Power

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Paper outline

- **Future quality of system performance is likely to be primarily determined by the information technology (IT) supported just-in-time (JIT) and just-in-place (JIP) decision making.**
- **Performance metrics need to account for various economies of scope underlying management of an electric power interconnection whose characterization is very complex over space and time.**
- **Examples are given to illustrate the inter-dependencies between the technical characteristics and the economic outcome (social welfare and outcomes of suppliers and consumers) and the magnitude of their effects in some detail.**
- **A conjecture that in this environment it becomes possible to define private goods such as delivery service, reactive power/voltage support, reliability service, all of which are currently viewed as public goods; this would, in turn, enable compatible incentives for a variety of services and products and lead to genuine choice.**
- **IT-tools essential for doing this. R&D needs.**

Basic ideas

- A dichotomy between decentralization (technological / organizational), and coordination for system-wide reliability/efficiency. Industry at standstill.
- The basic problem is lack of systematic ways to quantify the industry performance for various types of decentralization.
- We need to answer questions concerning : (1) complete product/service design as a function of industry rules; (2) relations between products and industry organization in place; (3) mechanisms to facilitate electricity service unbundling without losing benefits of coordination.

Open R&D problems

- Future solutions are multi-fold with technical and economic outcomes never studied before.
- Paper offers examples illustrating the criticality of capturing inter-dependencies between the physical operations, industry rules in place and the IT support.
- Synergies between the physical and economic networks previously unimaginable are plausible by careful design of a supporting IT network.

Product differentiation and economies of scope

- Careful product differentiation and decomposition (aggregation) of users and suppliers are the key determinants of capturing these synergies.
- One way of quantifying the implications of service unbundling is by defining economies of scope present in today's bundled electricity service, and by analyzing potential loss of economies of scope resulting from the service unbundling.

Economies of scope in the electric power industry

- The existing literature concerning economies of scope in the electric power industry falls short of recognizing unique temporal and spatial characteristics of this industry.
- Electric power delivery, reactive power support and capacity provision are identified as three major components of the unbundled electricity service exhibiting economies of scope.
- **N.B: Extracting economies of scope of this kind has NOT been optimally done in the regulated industry of today.**

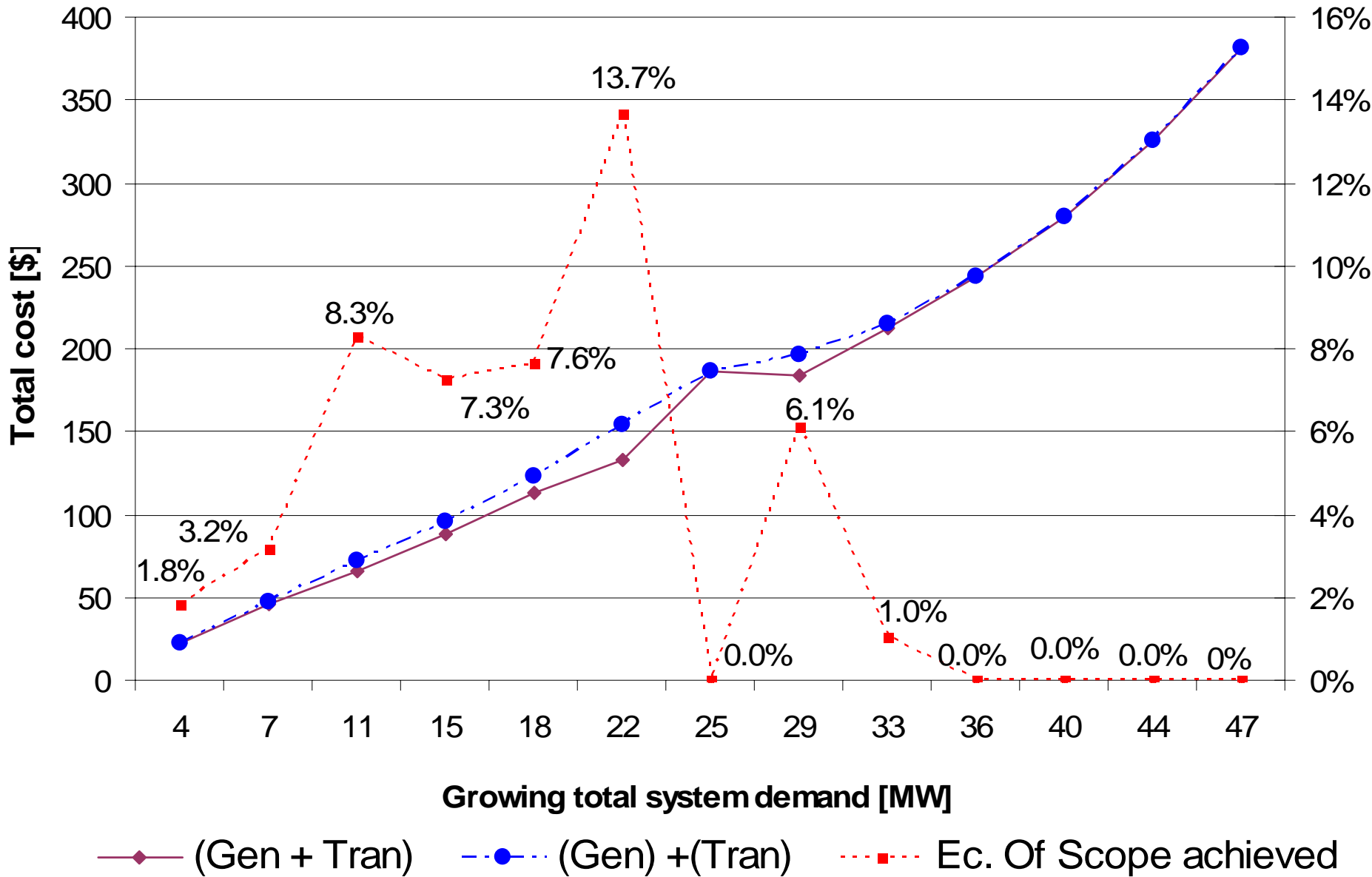
Economies of Scope in Electric Power Systems: Basic Concepts

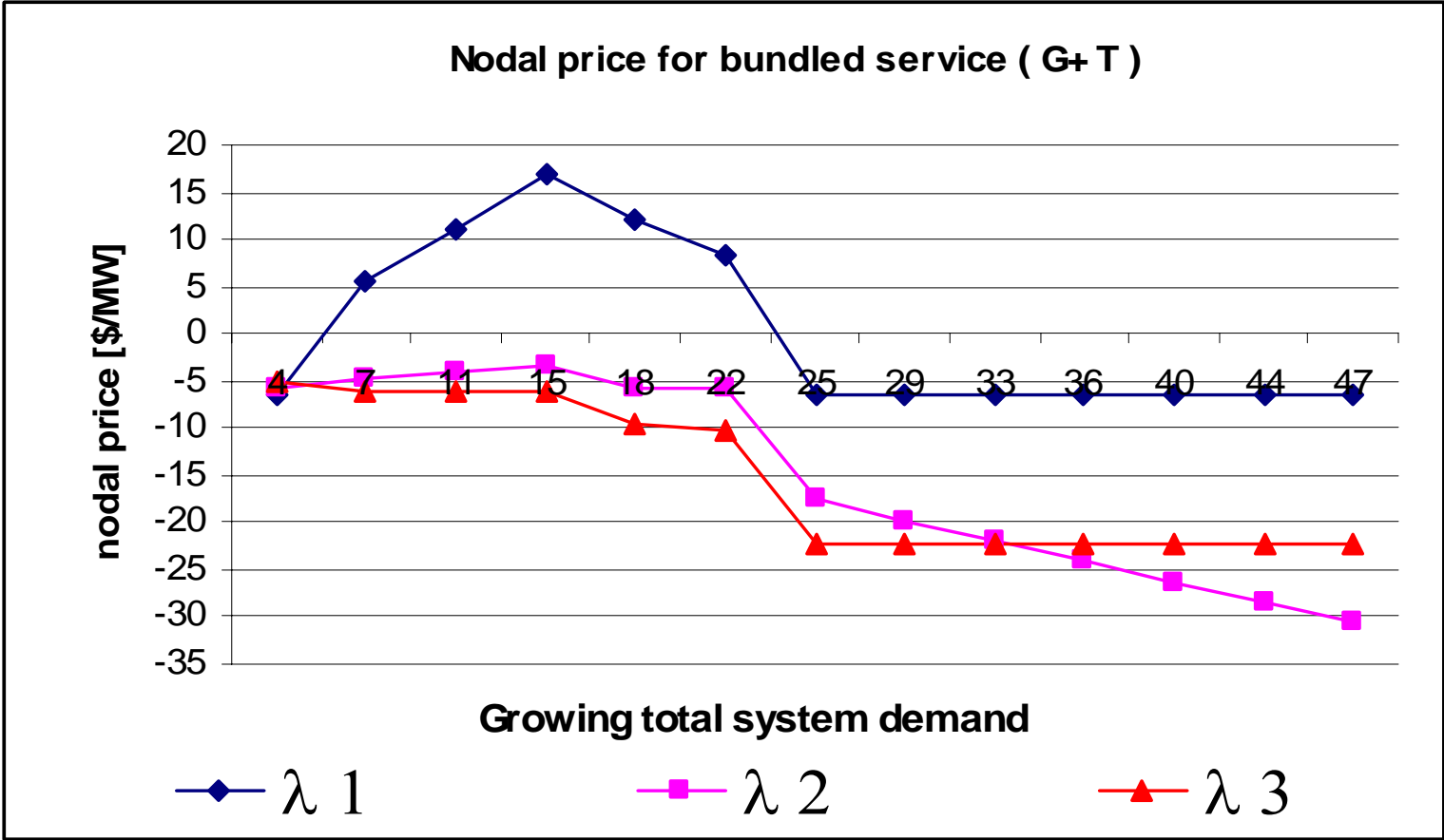
- Corporate unbundling-related (T,G and D)
- Industry structure-dependent (real power the only product; everything else an “uplift” public good; versus **near-complete set of products/services**)
- One possible set of **near-complete set of services (real power; delivery; reactive power/voltage; load following; capacity to manage failures)**

Economies of Scope in Electric Power Systems: Basic Concepts

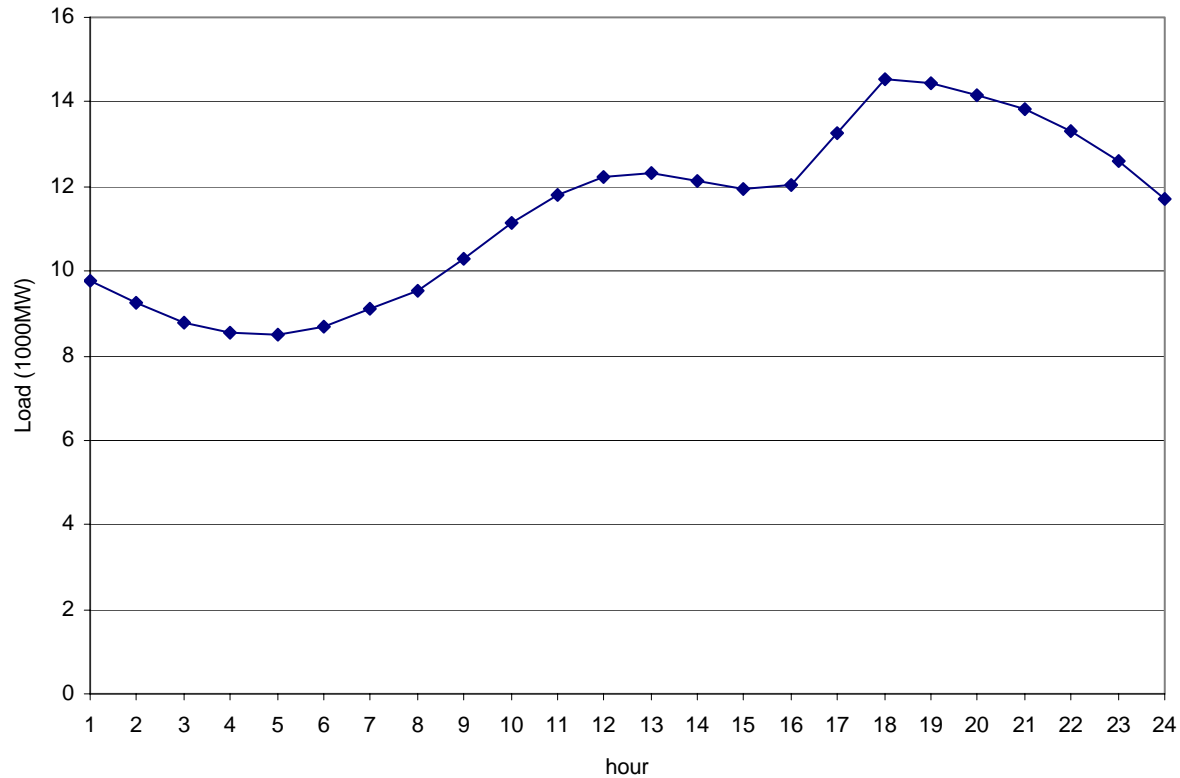
- *A. Unbundling real power and its delivery;*
- *Examples of usage-based transmission charges and nodal price based*

$$C(G, T) < C(G, 0) + C(0, T)$$

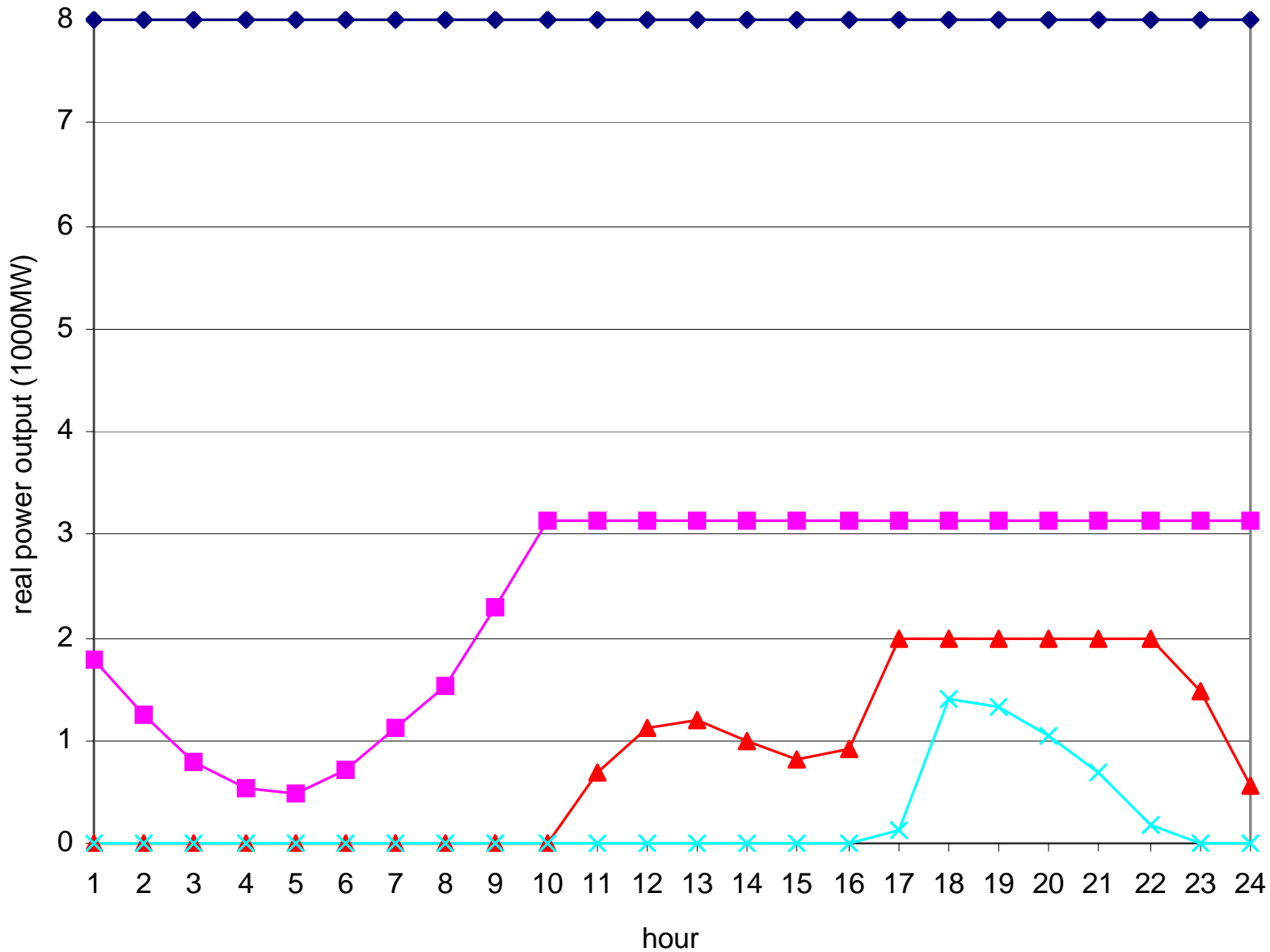




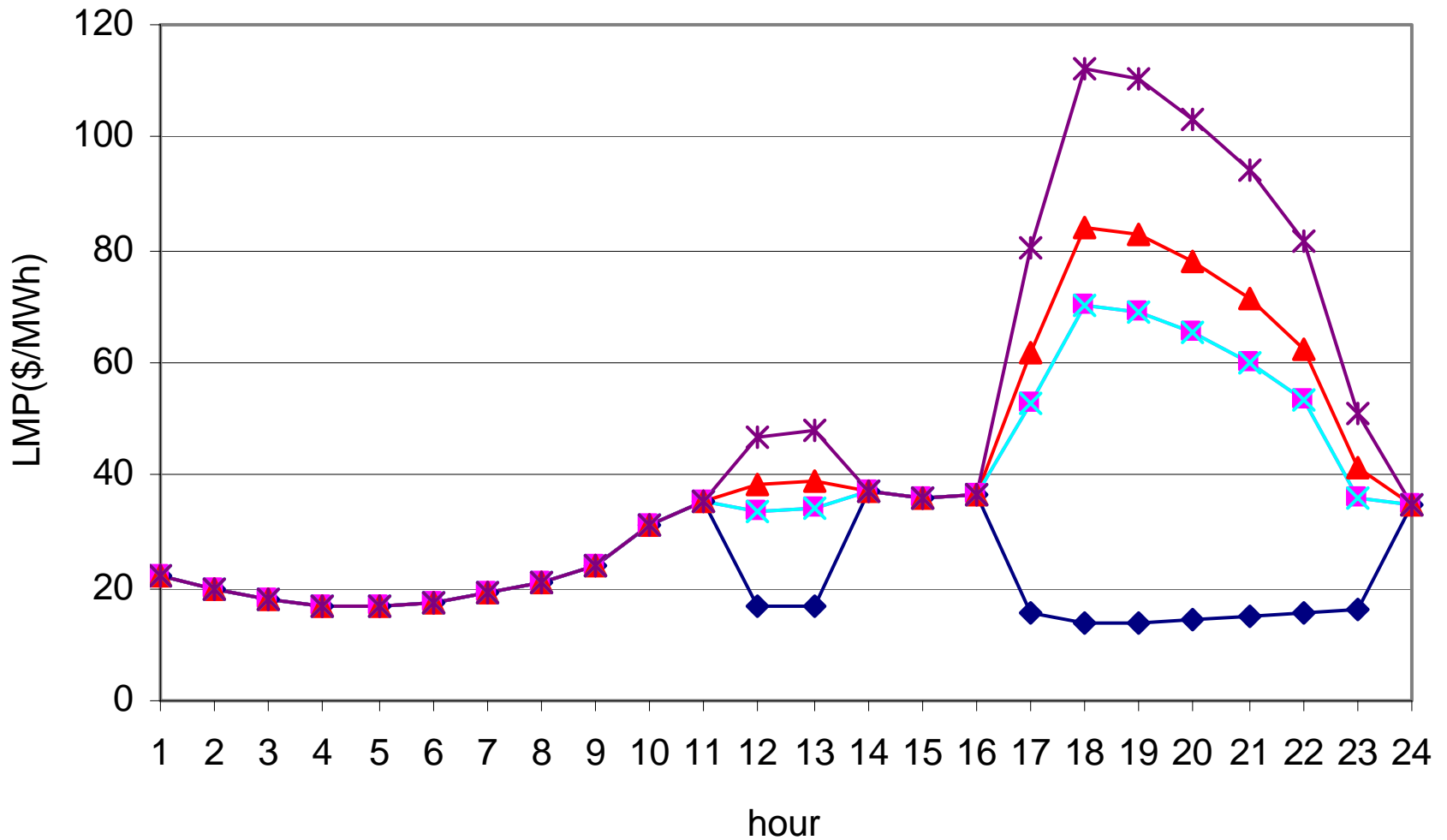
Effects of reactive power/voltage support



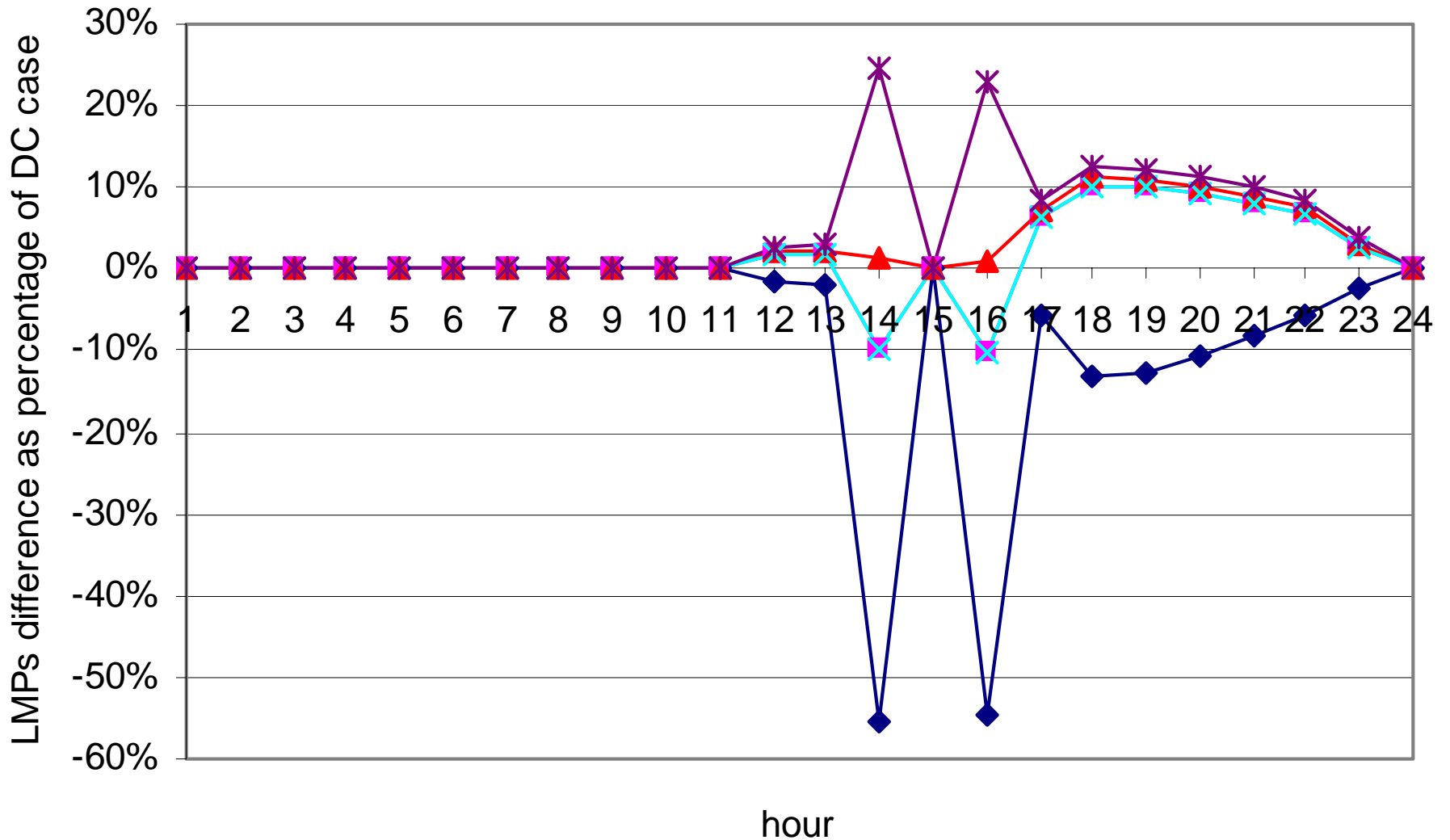
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Conference, December 16,04



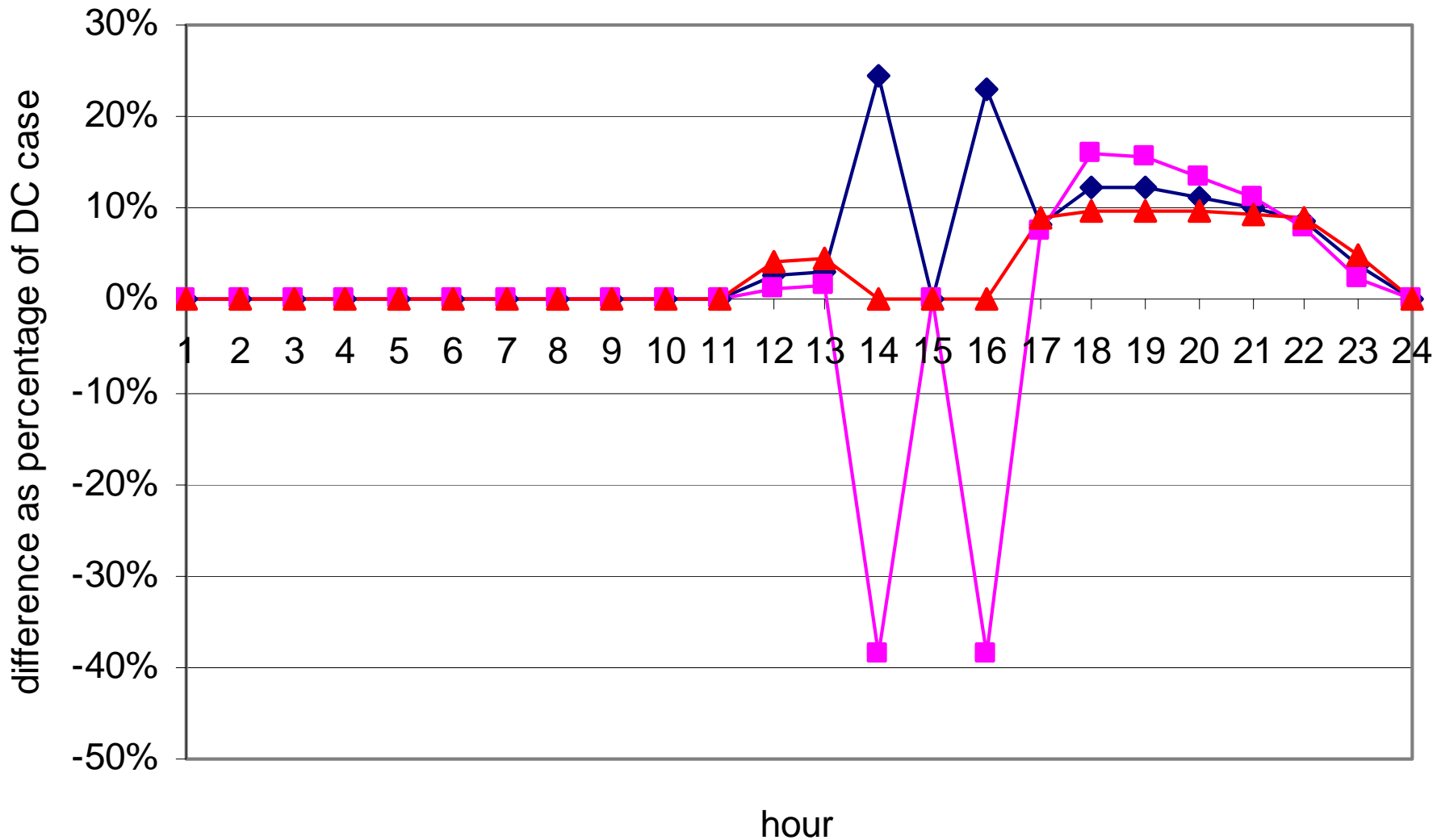
—◆— gen1 —■— gen2 —▲— gen3 —×— gen4



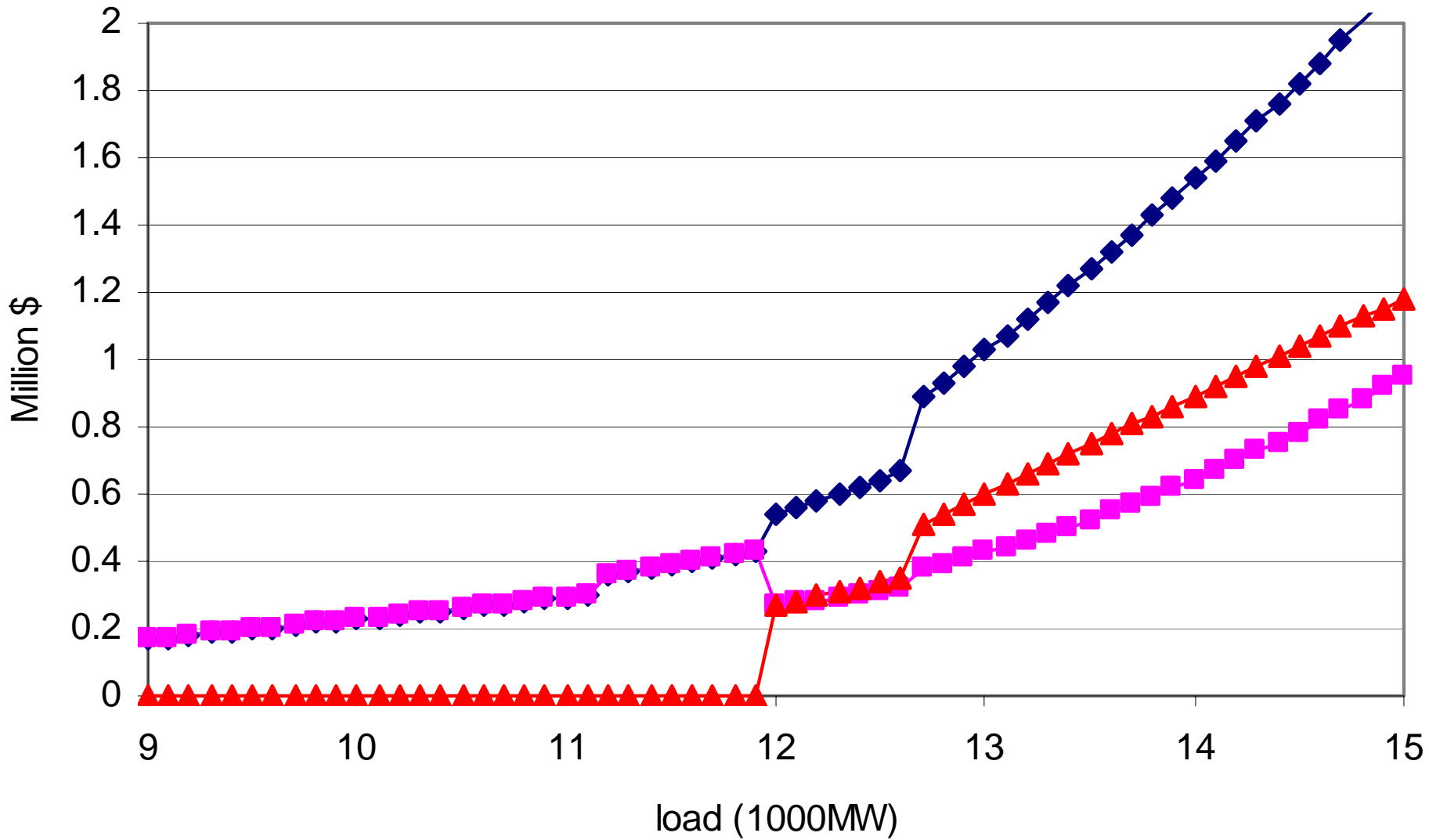
—◆— bus 1 —■— bus 2 —▲— bus 3 —×— bus 4 —*— bus 5



—◆— bus1 —■— bus2 —▲— bus3 —×— bus4 —*— bus5

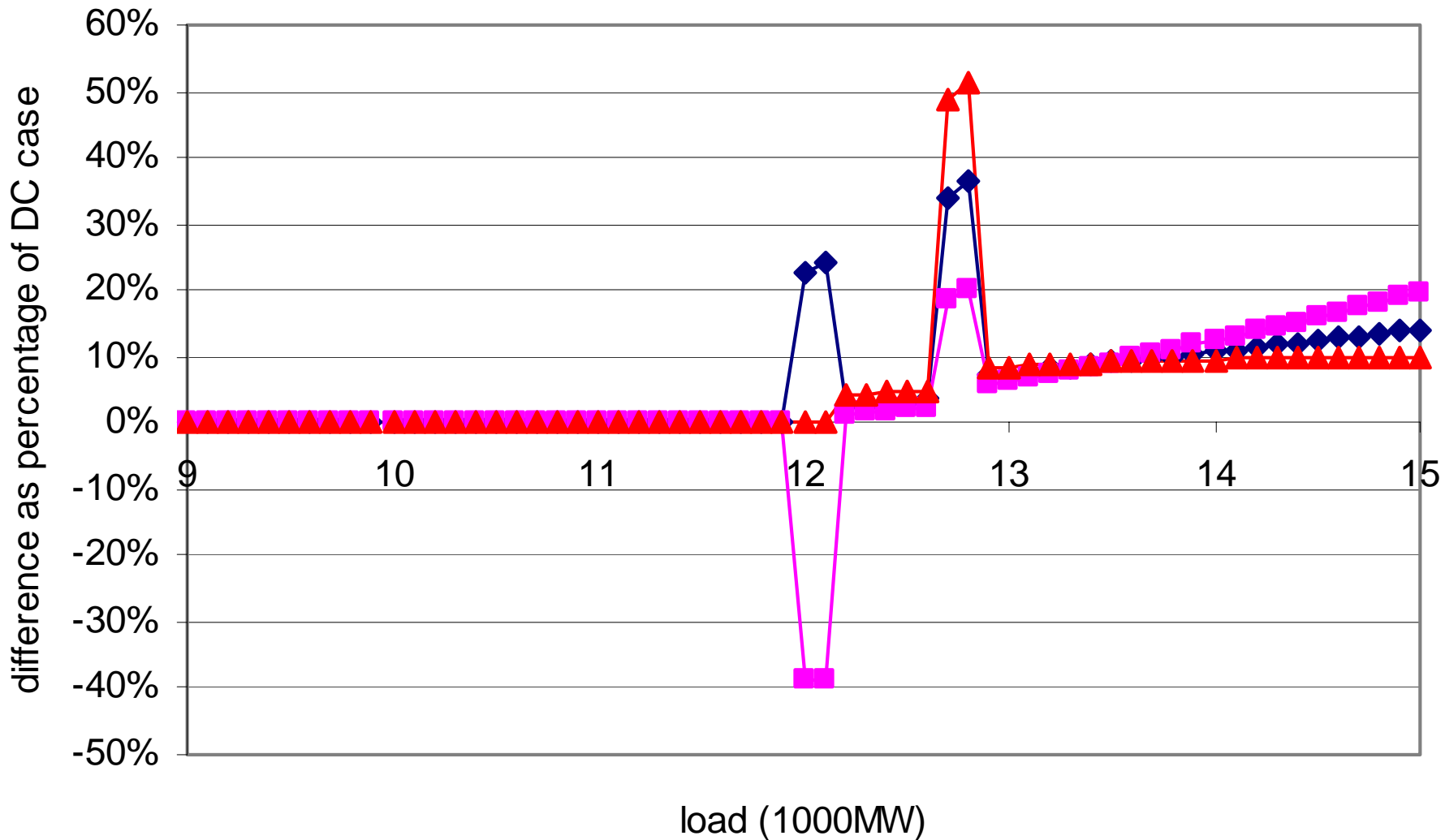


◆ load payment
 ■ generator revenue
 ▲ congestion revenue



◆ load payment
 ■ generator revenue
 ▲ congestion revenue

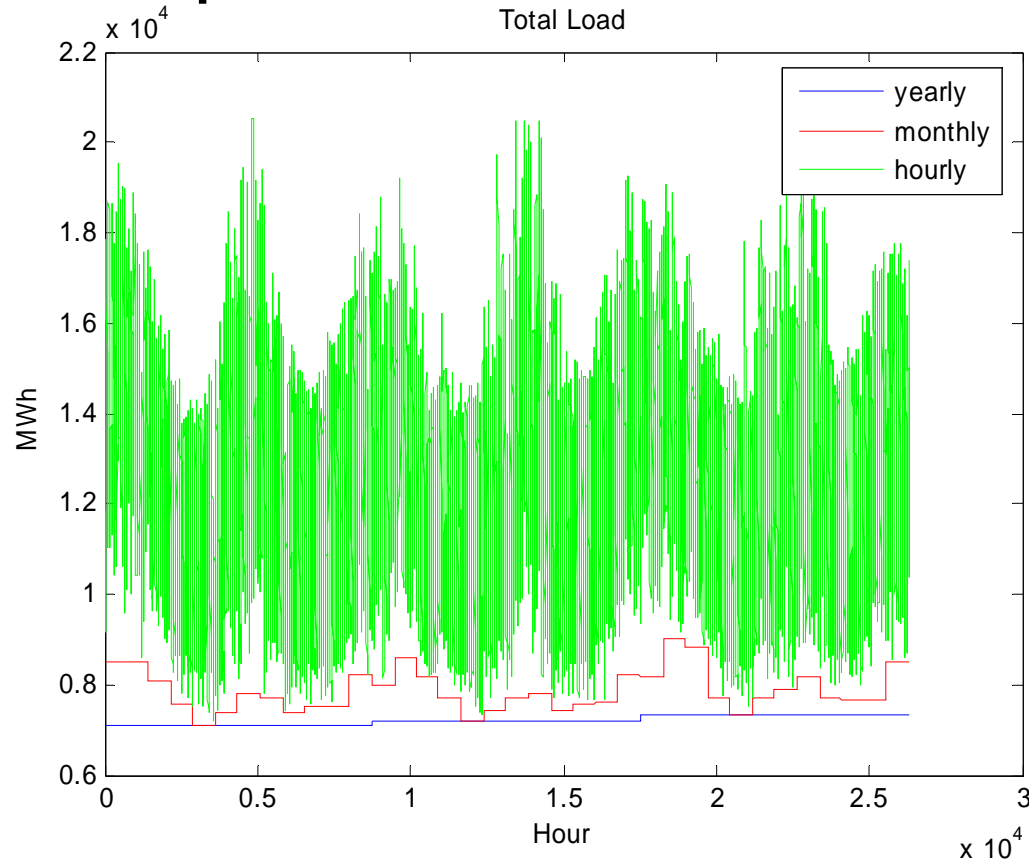
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—◆— load payment —■— generator revenue —▲— congestion revenue

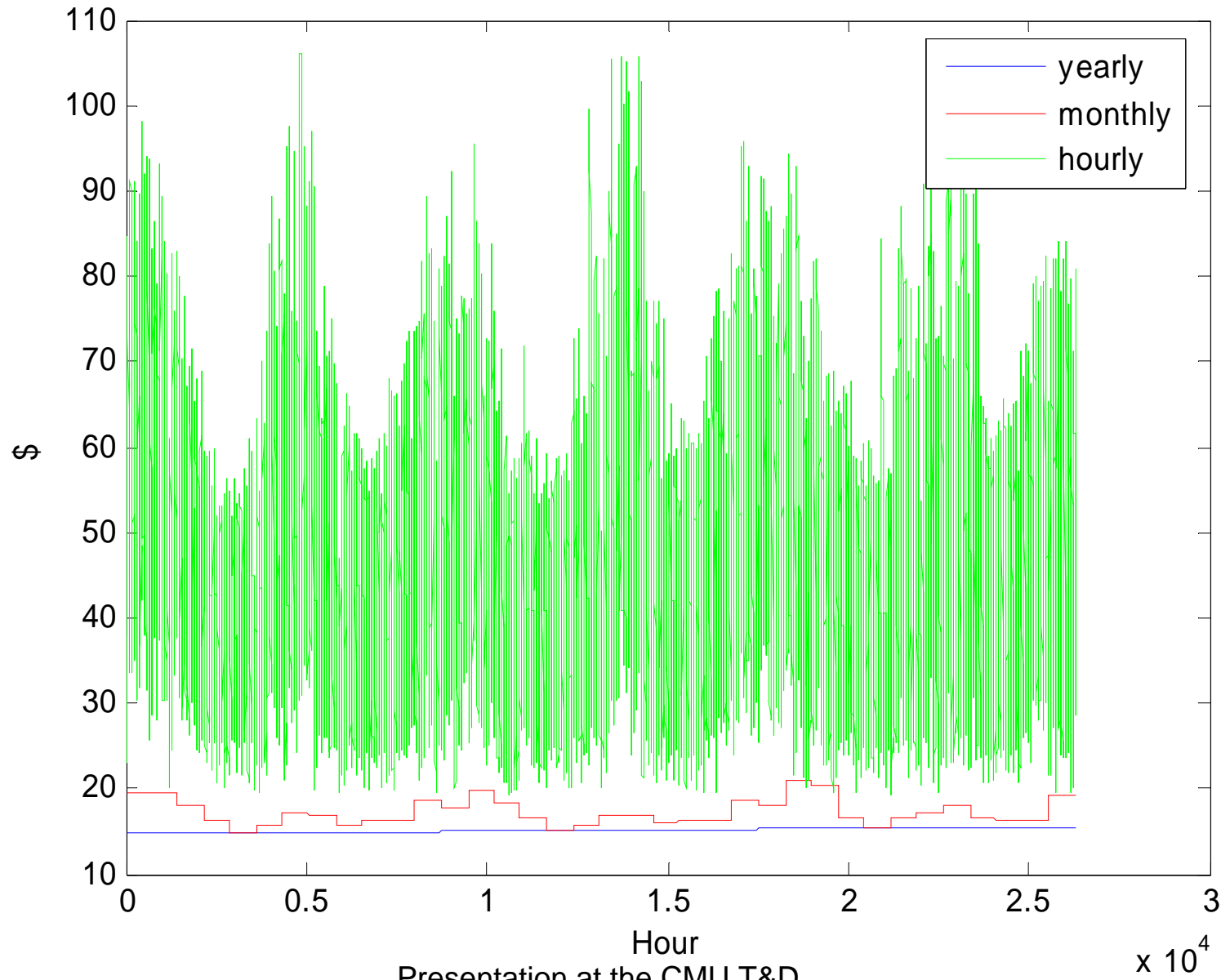
Inter-temporal effects—capacity markets

- Examples of spot market and stratum market



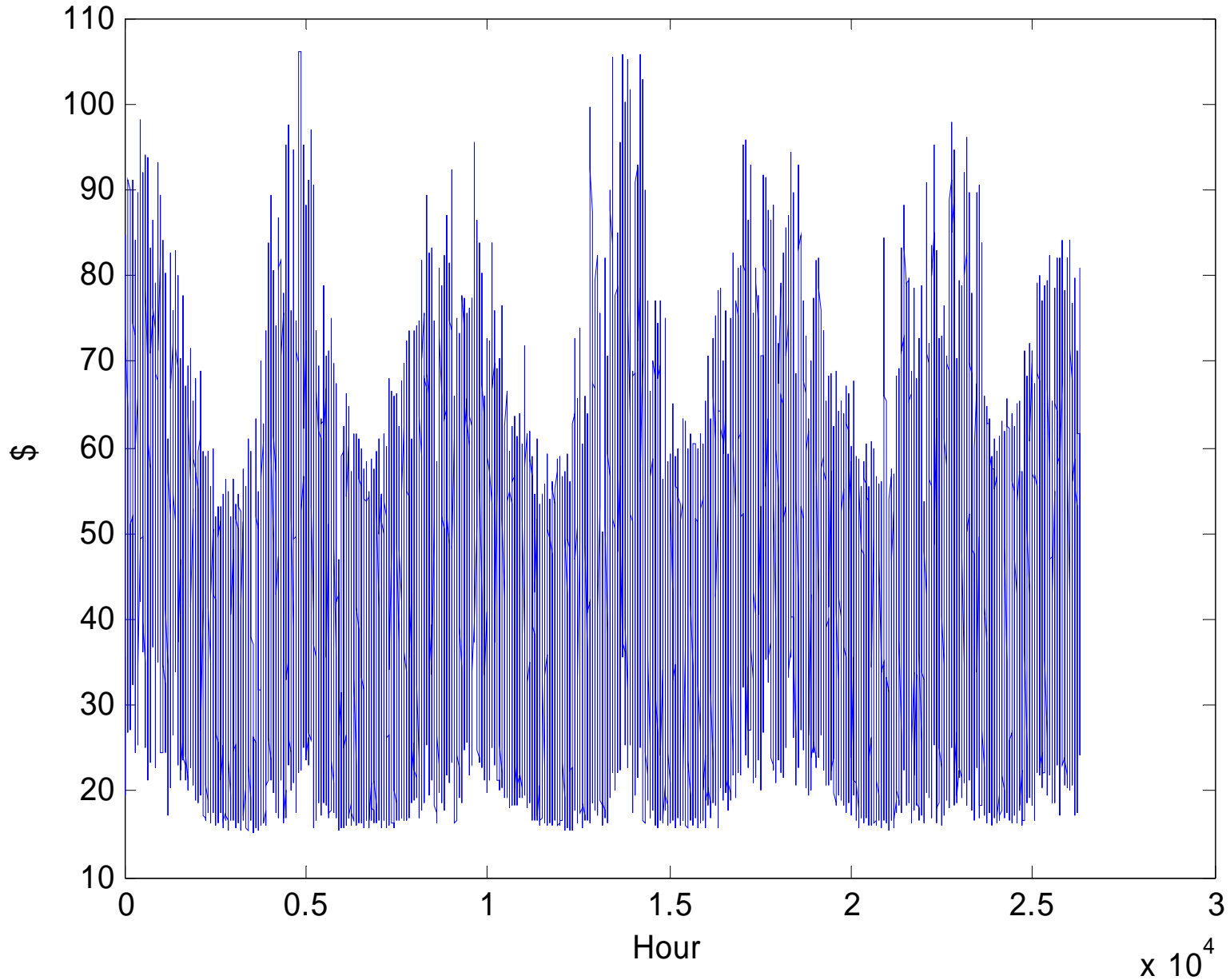
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Prices - stratum



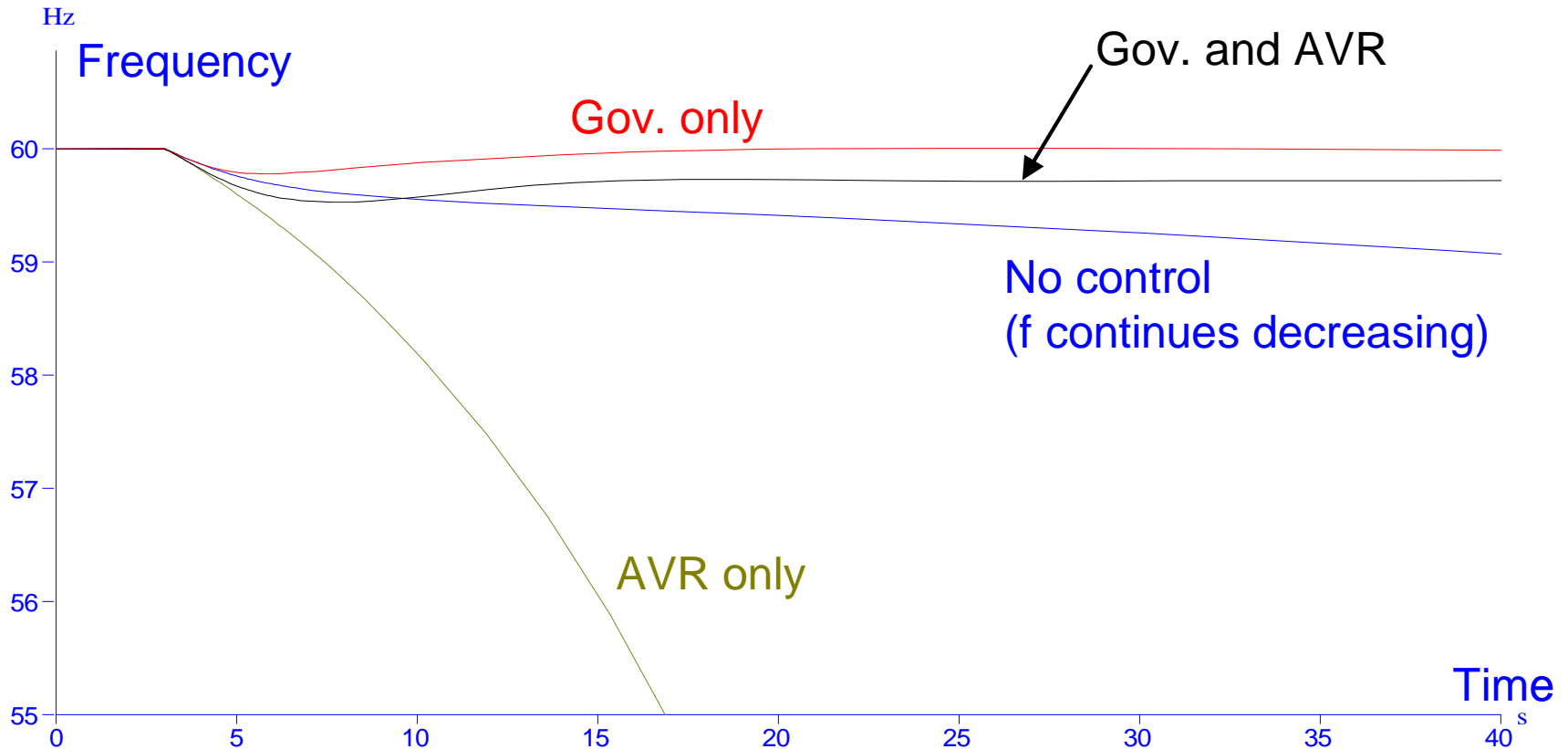
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Prices - spot

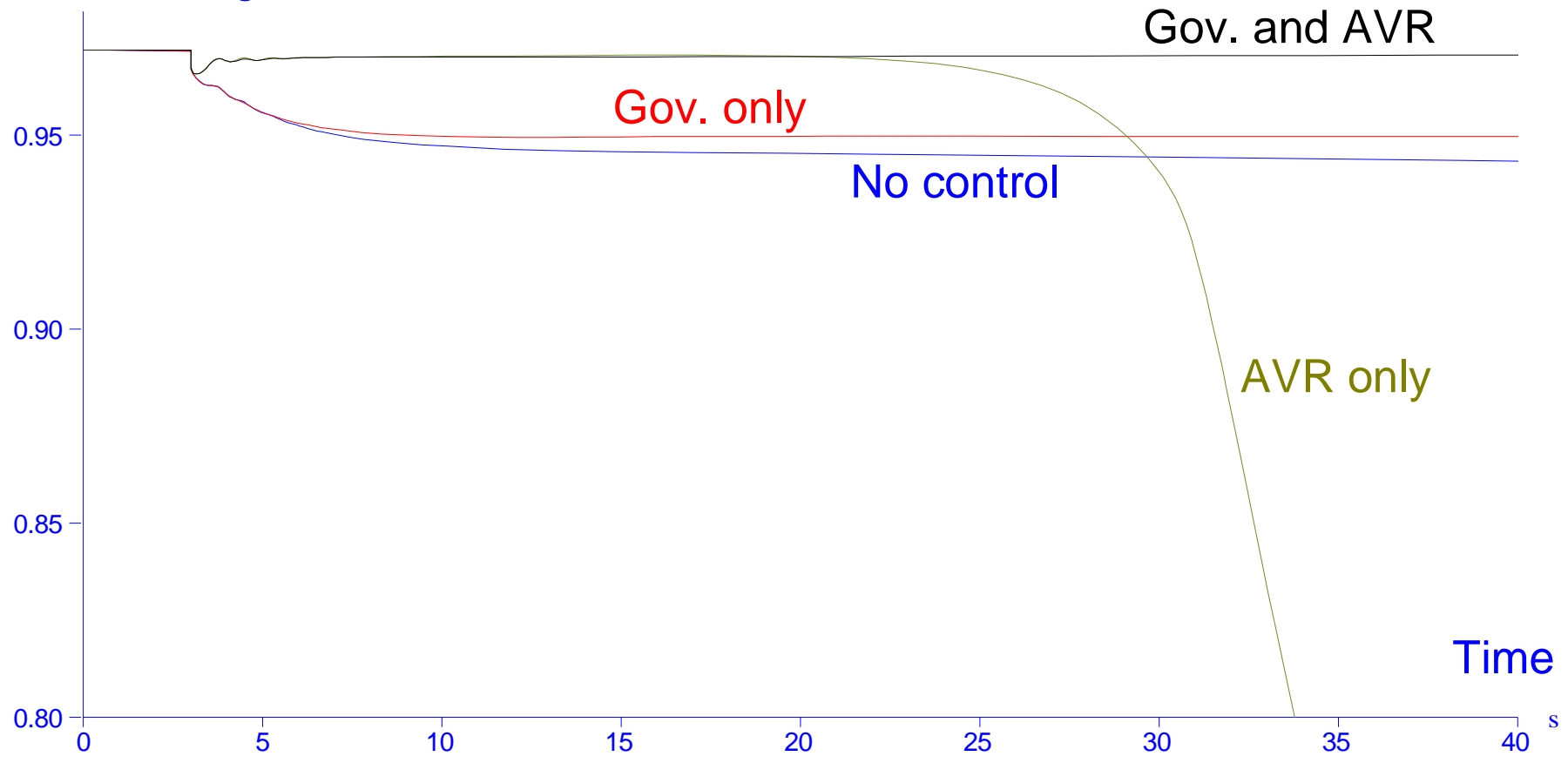


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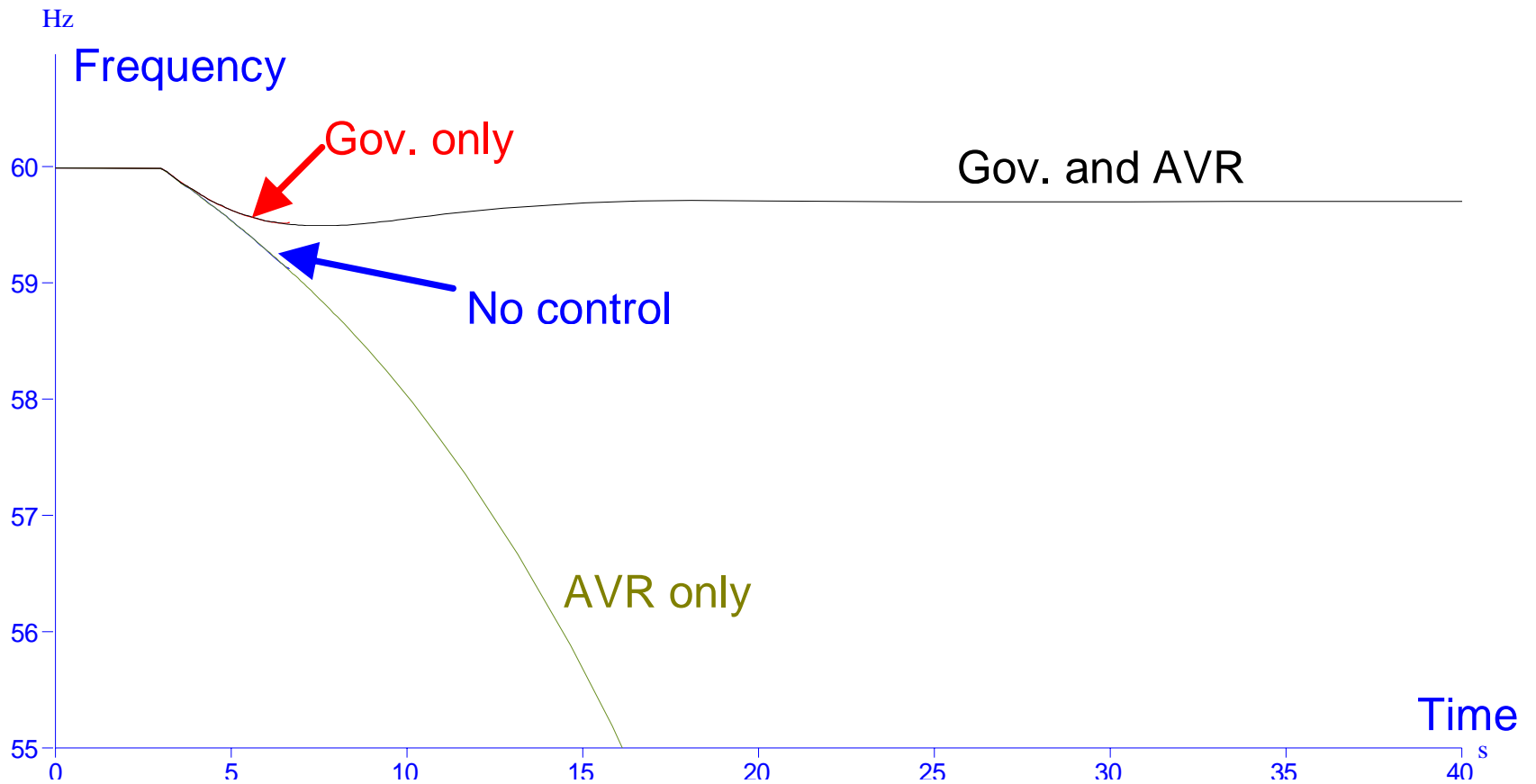
Effects of types of controllers on transmission capacity limits



PU Voltage B3



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Possibilities to design near-complete set of products/services

- These sub-services are generally inter-dependent; need IT-supported protocols which
 - Define suppliers and producers of these sub-services and ways of settling for quantity and price (charge);
 - Must be done with respect to space and time (in the regulated industry using a hierarchical approach; strong assumptions that may no longer hold under open access);
 - It is possible to do dynamic clustering for transforming data into relevant information (at present open problem).

Conclusions--Moving forward

- Need to clearly define “ancillary” services as real products/services; not negligible effects which must be managed reliably and efficiently; compatible incentives needed for giving incentives to provide these services (in particular investment in this).
- MUST develop IT tools for product differentiations, aggregation of users and providers of these services.
- Inherent part of future markets. It is potentially simple and doable.
- AN EXCITING R&D MULTIDISCIPLINARY AREA.