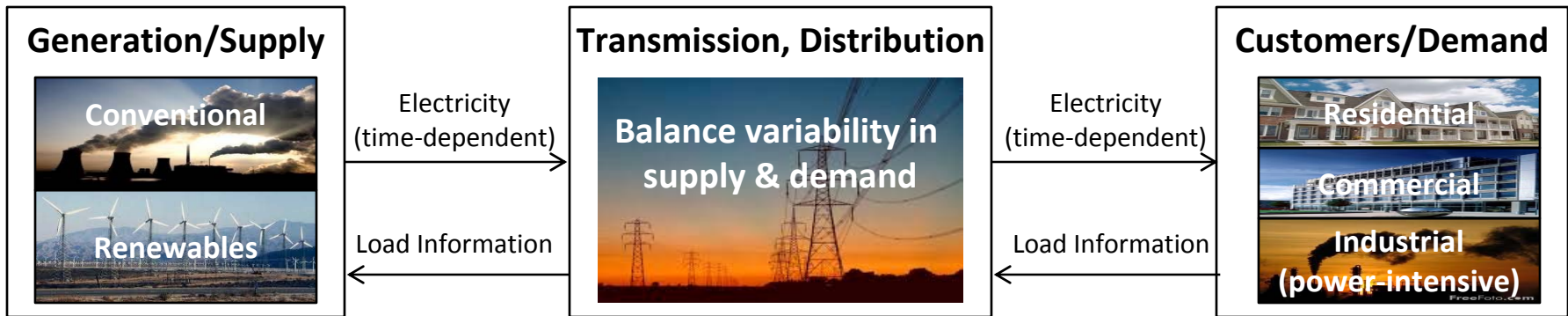


Multi-scale optimization models for power-intensive processes

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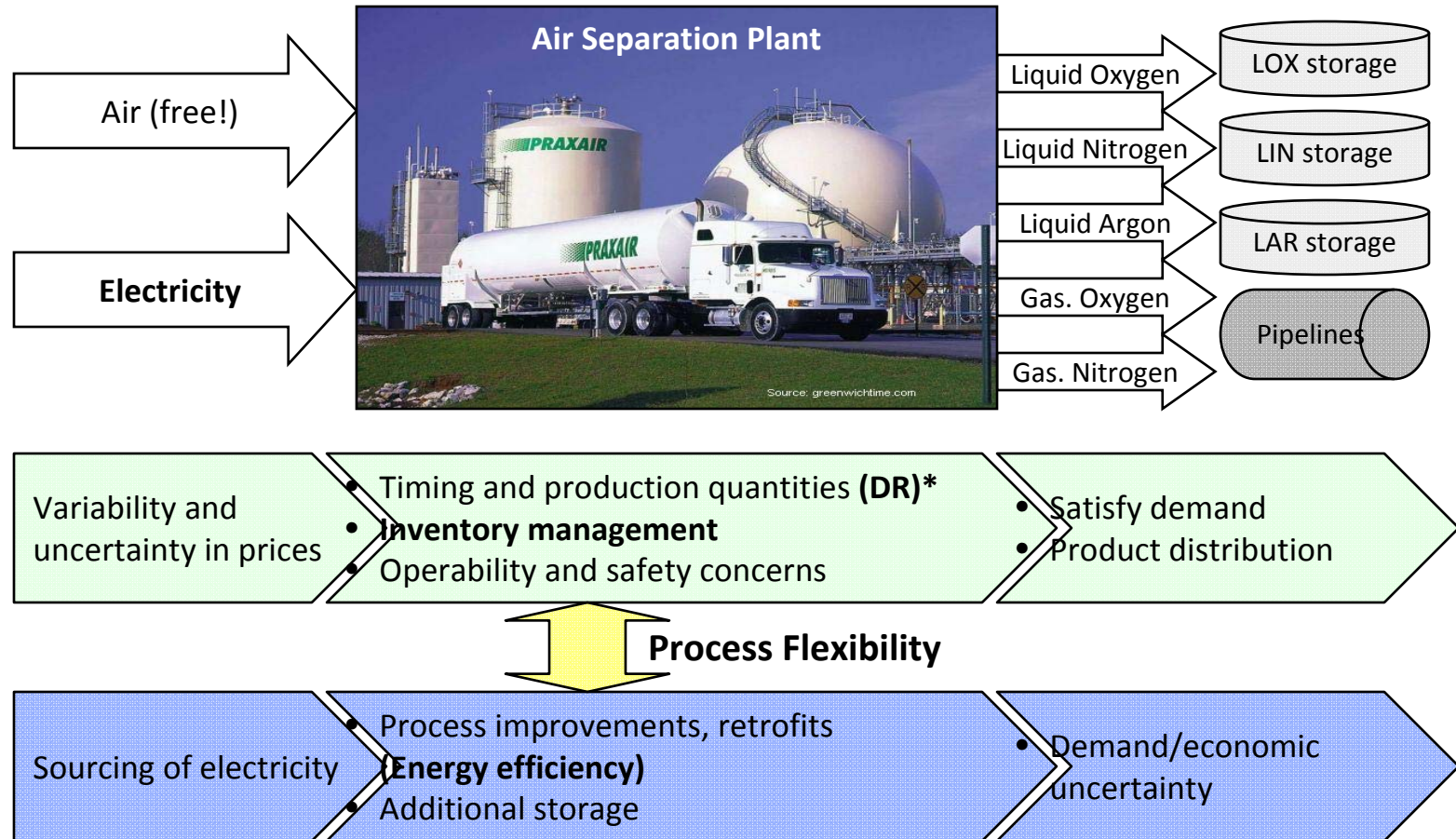
“Smart grid”

Demand-Side Management (DSM)
 “Systematic utility and government activities designed to **change the amount and/or timing of the customer’s use of electricity** for the collective benefit of the society, the utility and its customers.”*

Demand Response (DR)
 → Reduce demand on operational level

Energy Efficiency (EE)
 → Permanently reduce power consumption

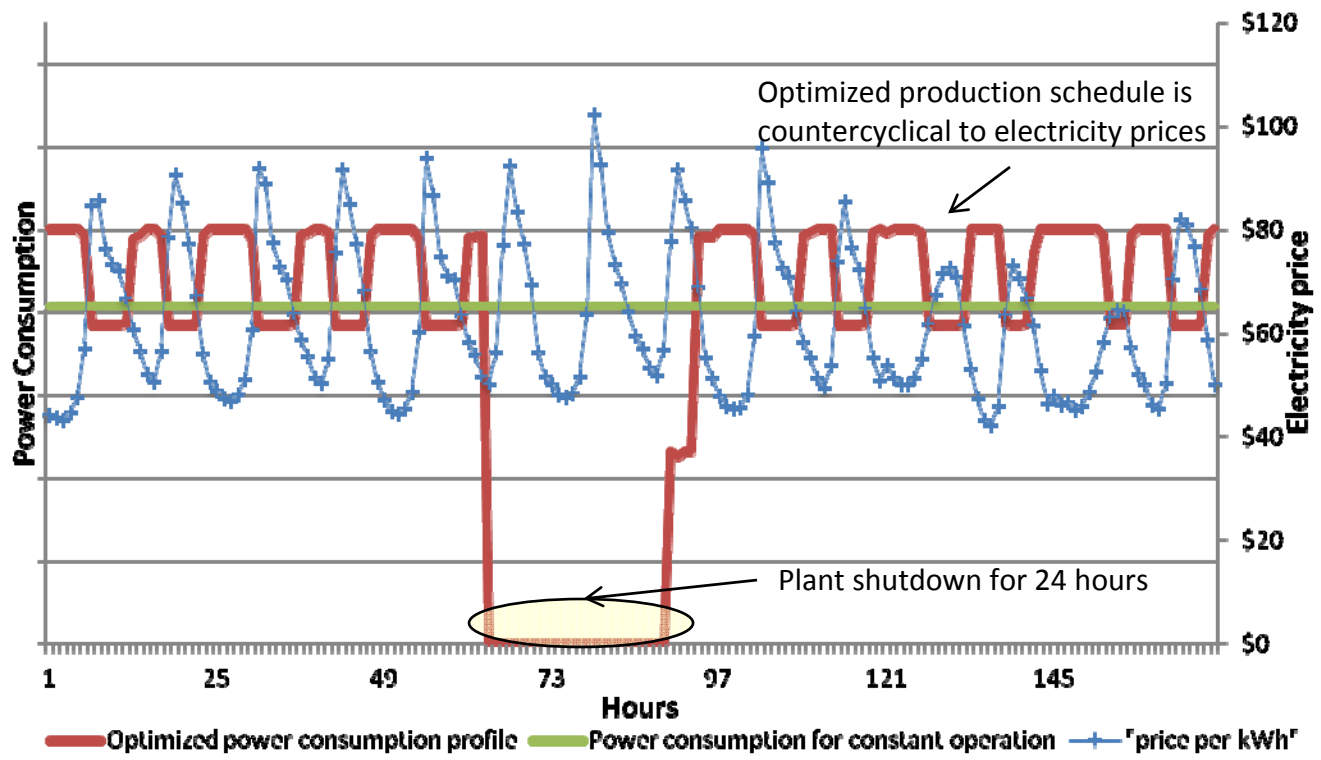
Source: [*] Charles River Associates, 2005 “Primer on Demand-Side Management, with an emphasis on price responsive programs”, CRA No. D06090, Technical report, The World Bank.



* Demand Side Management (DSM) consists of Demand Response (DR) and Energy Efficiency (EE)

Operational savings are due to process flexibility and inventory, which facilitate load shifting.

Optimized production schedule vs. constant operation

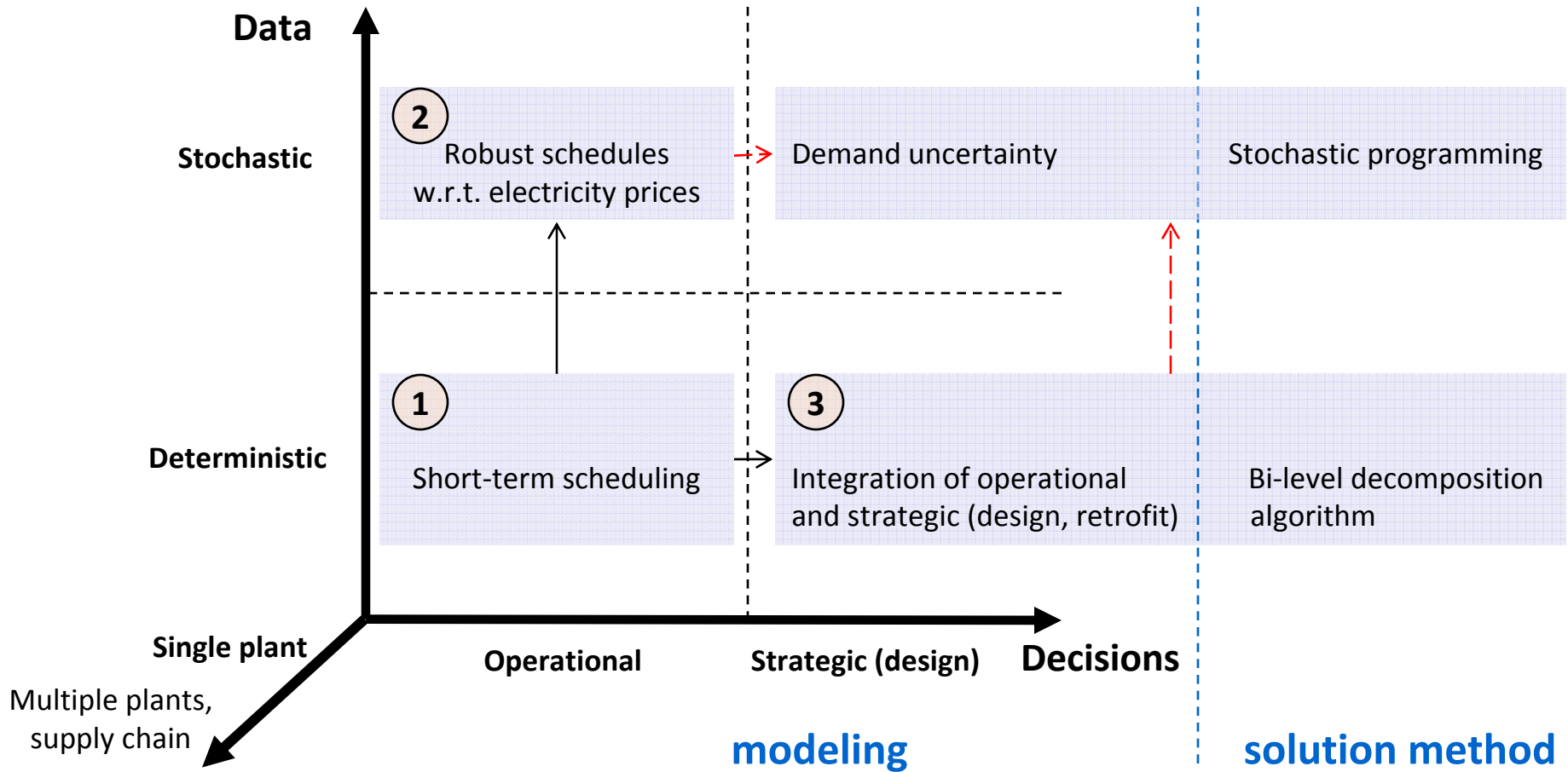


Remarks on case study

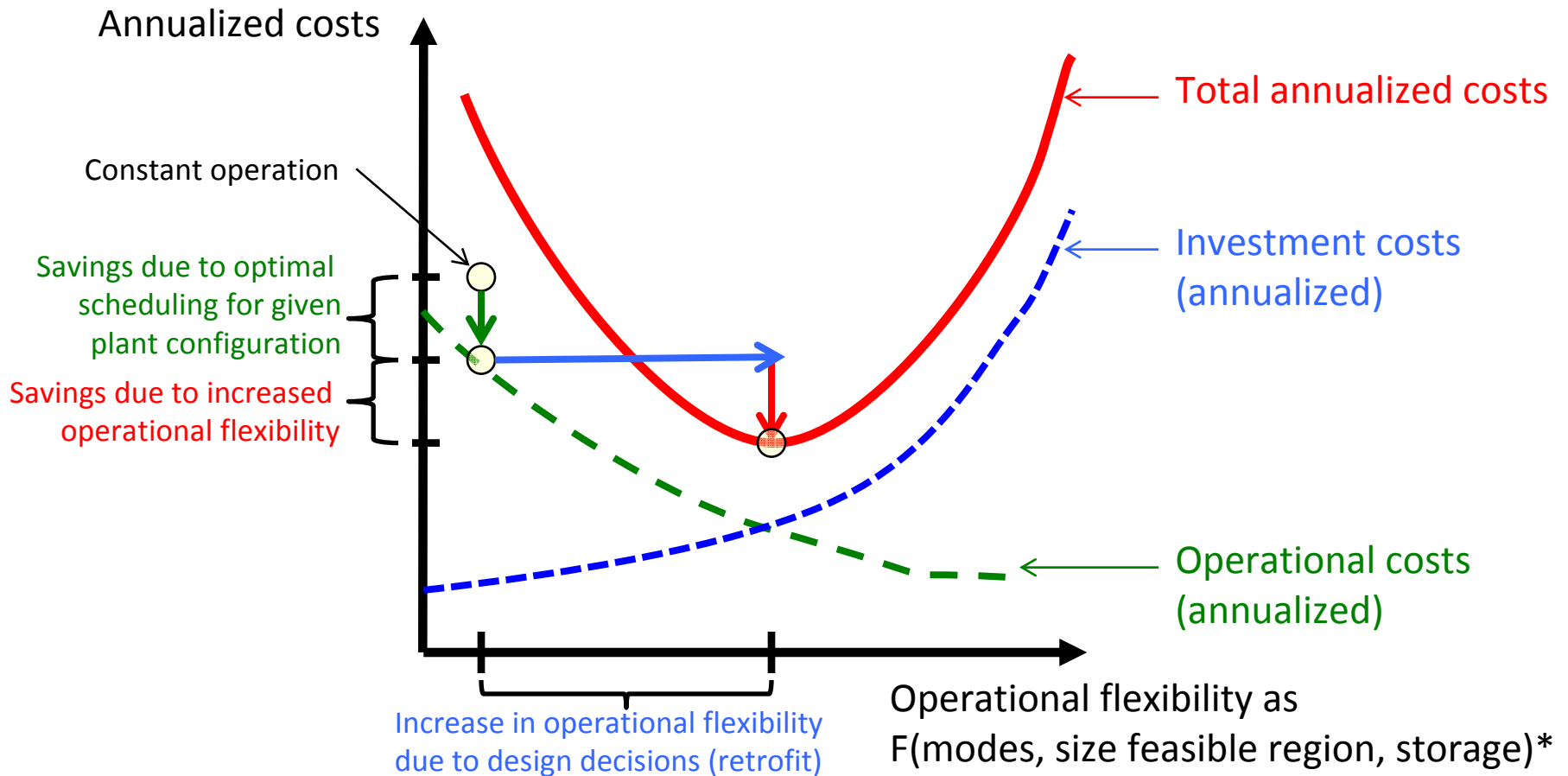
- Potential savings of **>\$200,000 yearly** at one plant (vs. constant operation)
- Single plant, 80% utilization, day-ahead (time-sensitive) pricing, weekly schedule

Source: CAPD analysis; Mitra, S., I.E. Grossmann, J.M. Pinto and Nikhil Arora, "Optimal Production Planning under Time-sensitive Electricity Prices for Continuous Power-intensive Processes", submitted for publication (2011)

Main question: How to design flexible processes such that operational savings are realized?



Operational flexibility is key to achieve economic savings with Demand-Side Management.



[*] Operational flexibility for chemical processes in the spirit of

- Swaney, R.E., and Grossmann, I.E. An Index for Operational Flexibility in Chemical Process Design, Part I: Formulation and Theory. *AIChE Journal*, 31:621, 1985.
- Grossmann, I.E., and C.A. Floudas. Active Constraint Strategy for Flexibility Analysis in Chemical Processes. *Comp. Chem. Eng.*, 11:675, 1987.